2. Level 1 Requirements

2.A. Level 1 Technical Requirements

2.A.1. General and Level 1 Technical Specifications

The Contractor shall provide a completely installed, fully functioning OBS/CCS. Any errors or omissions in these specifications do not in any way relieve the Contractor from this responsibility.

2.A.1.1. Introduction and Overview

Subsection **2.A.1.** contains general OBS/CCS requirements and specific Level 1 technical specifications that include KCM's operational and technical requirements. These specifications attempt to provide all equipment and operational constraints. The provided system must include all needed equipment, including brackets, nuts, bolts, and connectors, as well as all testing and installation services needed to provide a completely operational system in accordance with the intent of these specifications.

Proposers will include in their proposals all costs required to design, provide, and maintain a complete Transit OBS/CCS in accordance with these specifications and to provide KCM with a fully operable system in accordance with the intent of these specifications.

2.A.1.2. General Technical Requirements and Underlying Principles

2.A.1.2.1. Industry Standards: ITS and TCIP Compliance

The OBS and CCS shall demonstrate conformance with the Intelligent Transportation Systems (ITS) National Architecture and will utilize the emerging TCIP standards.

2.A.1.2.1.1. ITS Architecture Conformance

The Contractor shall prepare and submit for review and approval an ITS National Architecture Conformance Plan (Subsection **2.A.3.1.2.3, Level 1 Design Phase Deliverables**), including at a minimum the following:

a. Elements of the OBS/CCS affected.

b. Applicable standards.

c. Description of approach to achieving ITS conformance.

d. Description of conformity to the Central Puget Sound ITS Regional Architecture. Reference documents are available at the Puget Sound Regional Council (PRSC) website located at http://www.psrc.org/datapubs/pubs/reg_arch.htm

   The planned OBS/CCS functionality was included in the Regional Architecture. The design of OBS/CCS will be mapped to the current "ITS market packages" and to the existing regional architecture and provided to the PSRC.

e. Approach to achieving the requirements of "Federal Transit Administration National ITS Architecture Policy on Transit Projects, Section VI, Project Implementation." This document is available online at http://www.its.dot.gov/aconform/Policy_2.htm

2.A.1.2.1.2. TCIP Compliance and Conformance

The OBS/CCS shall include open, defined, and compliant interfaces that utilize the emerging TCIP standards which are being further developed under the oversight of the American Public Transit Association. Specific TCIP data elements and messages that have been identified for

OBS/CCS use are included in the UML model section of the document. See Sections **2.B.2.4** and **3.B.4**.

2.A.1.2.1.2.1. Scope of TCIP Use by System

Objective: The Transit Enterprise Database (TED) and the server on which data is staged for transmission to the RV will exchange KCM's Transit service, configuration, and performance information. See Subsection **2.A.1.5.1.2, Base Operations (BO) Domain** for a discussion of system architecture requirements, including the separate functionalities attributed to the OBS "Landing Pad" server and the OBS Base Server.

NOTE: Whether two separate servers or a single server provides both the Landing Pad and Base Server functionalities will be determined by the Contractor's proposed system architecture.

The following discussion envisages a Landing Pad server at each Transit base that is continuously available to receive or transmit staged data to the RV. This server then moves the appropriate data sets received from the vehicle to their specified servers

The Base Server will serve as a transitional location to convert and store data exchanged between TED and the Landing Pad. The independent format used to exchange data should conform to the TCIP-XML industry standard. Figure ***2.A.1.2.1.2. TCIP Data Flows***, depicts a potential logical framework for this exchange.

Implementation of TCIP-XML described interfaces applies to the OBS Administration tools as well as the following Use Cases:

- ***BO3-Manage Historical Data***
- ***BO1-Verify Vehicle Configuration***
- ***BO2-Update Vehicle Data***

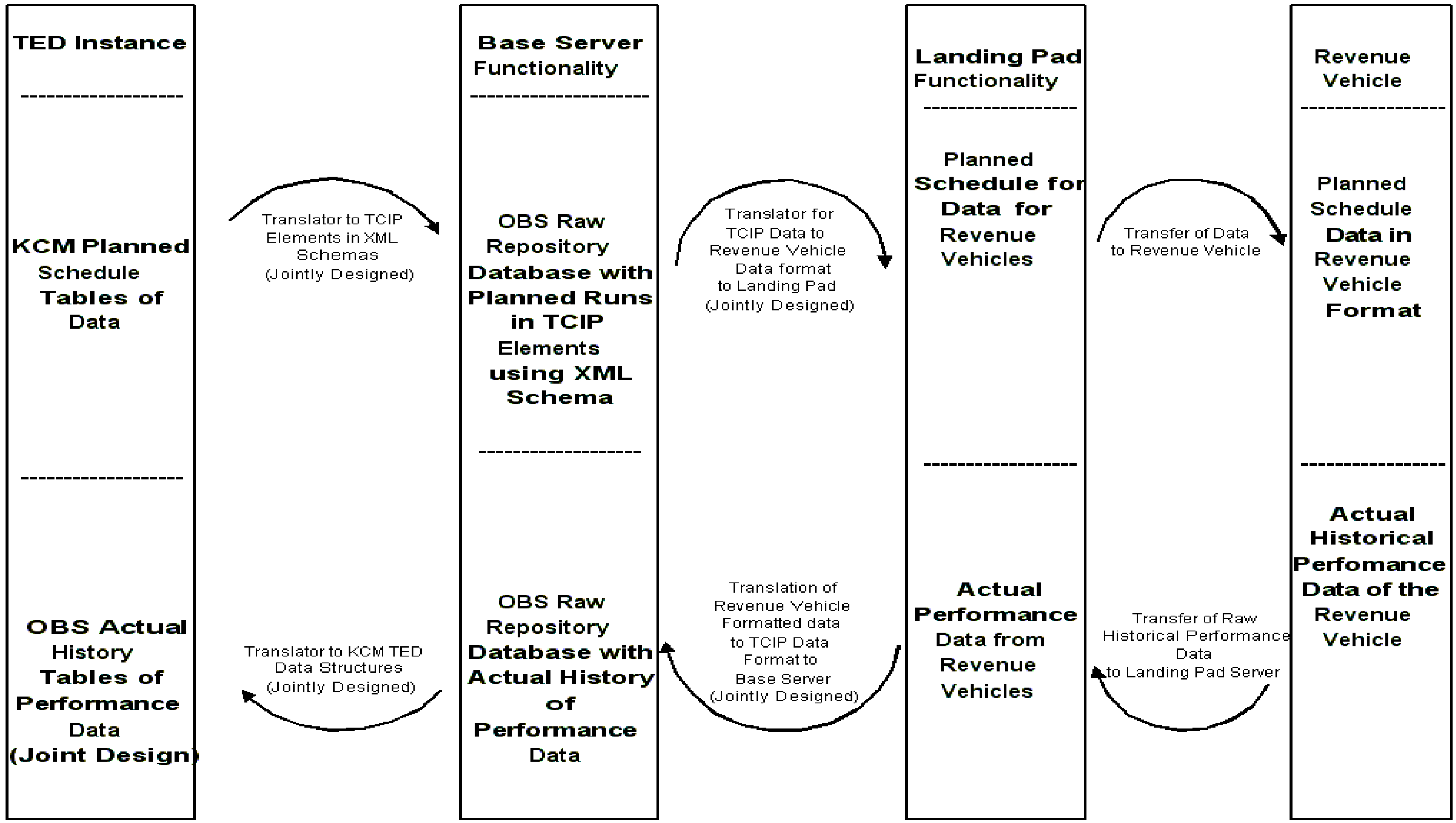
As illustrated in Figure ***2.A.1.2.1.2***, the TCIP interfaces will be restricted to the data flows between TED and the Base Server, and the Base Server and the Landing Pad. For a discussion of KCM's technical requirements for the data flows at each Transit base, see Subsection **2.A.1.5, Physical System Configuration Overview**. The Contractor shall identify a proposed physical architecture with a written discussion of its advantages and disadvantages.

During the Preliminary Design Phase, KCM and the Contractor shall agree upon a validated version of the TCIP-XML schema to be used. Using the chosen schema, the Contractor shall provide a detailed TCIP Data Dictionary that contains data elements, messages, and data flows. Appendix **A** provides an example of the acceptable structure and composition required for this Dictionary.

The following diagram is used to show a logical flow of data and processes only. It shows data flowing from the Transit Enterprise Database to the Revenue Vehicle in the upper half of the figure. The lower half of the figure traces the flow of the Revenue Vehicles daily performance (historical) data to TED. Data flowing in each direction undergoes a translation into TCIP data elements.

Figure 2.A.1.2.1.2. TCIP Data Flows

NOTE: The Landing Pad & Base Server functionality may be located on a single server or separate servers. System architecture will be based on the



Contractor's recommended configuration.

2.A.1.2.1.2.2. Requirements for TCIP Compliance

The OBS/CCS System shall provide a design that satisfies the following requirements for TCIP compliance:

a. As represented by the vocabulary in the Base Server: TED Data Elements and Landing Pad subsystems shall agree upon vocabularies described by the TCIP-XML schema (not APIs) as a neutral exchange language. [According to NTCIP 1400 v 1.05, this is a Level 2 conformance requirement.]

b. The Base Server and XML files (exchanged between the Base Server and the other servers) will be validated against a known vocabulary (TCIP-XML schema), but should allow for any needed extensions. The KCM Project Manager must approve any proposed extensions. TCIP-XML schema with extensions should be validated by at least two different vendors' XML Schema validation tools.

c. Message content (between TED and the Base Server, and Landing Pad and Base Server) can be transformed from native vocabulary to TCIP-XML and from TCIP-XML to the native vocabulary. The data stored in the Base Server must internally support TCIP-XML data structures (and tags); the Base Server relational database schemas and data need not be structured using TCIP objects.

d. Access (import and export) functions to Base Server should use an IT industry standard such as SOAP, SQL/XML, XSLT, or other data exchange standards (e.g., Geo-Spatial One-Stop (GOS)). Applications, such as OBS Administration Tools, that use the Base Server for information should also use access functions using the TCIP-XML representation.

e. System design must describe the behavior of the messages/files exchanged between the Base Server and Landing Pad. Workflow processes and communications protocols (e.g., implementation dialogs) will be defined for all exchanges. The exchange must be documented through UML diagrams.

f. TCIP-XML must conform to the balloted TCIP standard or an agreed-upon vocabulary.

2.A.1.2.1.2.3. TCIP Business Area Conformance

As illustrated in Figure ***2.A.1.2.1.2***, data configuration and service data flow from TED to the Base Server. The Landing Pad may access the datasets and reformat the stored data from the Base Server. Historical performance data is collected on board the Revenue Vehicle, off-loaded to the Landing Pad, and then made available in the TCIP-XML to TED via the Base Server. The Base Server will maintain each data set in its original, translated, and/or reformatted forms.

The general categories of datasets stored on the Base Server shall consist of the following:

a. Configuration and service datasets used to load onto the vehicles.

b. Reporting/Historical data off-loaded from the vehicles.

c. Data to manage configuration and historical data including monitoring upload and download sets.

d. Data imported and exported from the OBS Administration Tools.

These data may come from any of the eight current TCIP Business Areas and also from forthcoming business areas and TCIP Dialogs. All the business area objects should be contained in the TCIP-XML schema according to the version agreed upon during the Preliminary Design Phase. Although all the data elements, frames, and messages are included in the TCIP-XML schema, only those that are needed will be used.

2.A.1.2.1.2.4. TCIP Object Requirements

In an interface control document (ICD), the Contractor shall document the following:

a. TCIP-to-Landing Pad Interface requirements.
    i. Table with translation of each data-element description from TCIP to Landing Pad including constraints or extensions, and special properties.
    ii. Table with data elements missing from TCIP that are needed by the Landing Pad.
    iii. Table must identify all required and optional data elements of the interface.
b. Landing Pad-to-TCIP Interface requirements.
    i. Table with translation of each data-element description from Landing Pad to TCIP including constraints or extensions, and special properties.
    ii. Table with data elements missing from TCIP that are provided by the Landing Pad.
    iii. Table must identify all required and optional data elements of the interface.
c. Recommendations for missing TCIP-XML vocabulary and/or “local use codes” for code type data elements.
d. Requirements for relationships among TCIP vocabulary necessary for Landing Pad XML file upload or download including referential and business rule integrity checking.

KCM will document a set of Business Rule integrity checks for the Transit Enterprise Database (TED). The Contractor shall verify that TED and Agency database requirements for data loading and data formatting are met.

Table ***2.A.1.2.1.2.4.a*** lists data sets expected to be stored in the Base Server. The TCIP Business Areas that support these datasets are listed in a separate column. This table is for information purposes only. Additional requirements are emerging from the TCIP standards-development effort, and those should be reviewed for applicability to this project prior to PDR.

In Table ***2.A.1.2.1.2.4.a***, the eight TCIP Business Areas are referenced by their acronyms:

- Common Public Transportation (CPT)
- Incident Management (IM)
- Passenger Information (PI)
- Scheduling/Runcutting (SCH)
- Spatial Representation (SP)

- On-Board (OB)
- Communications Center (CC)
- Fare Collection (FC)

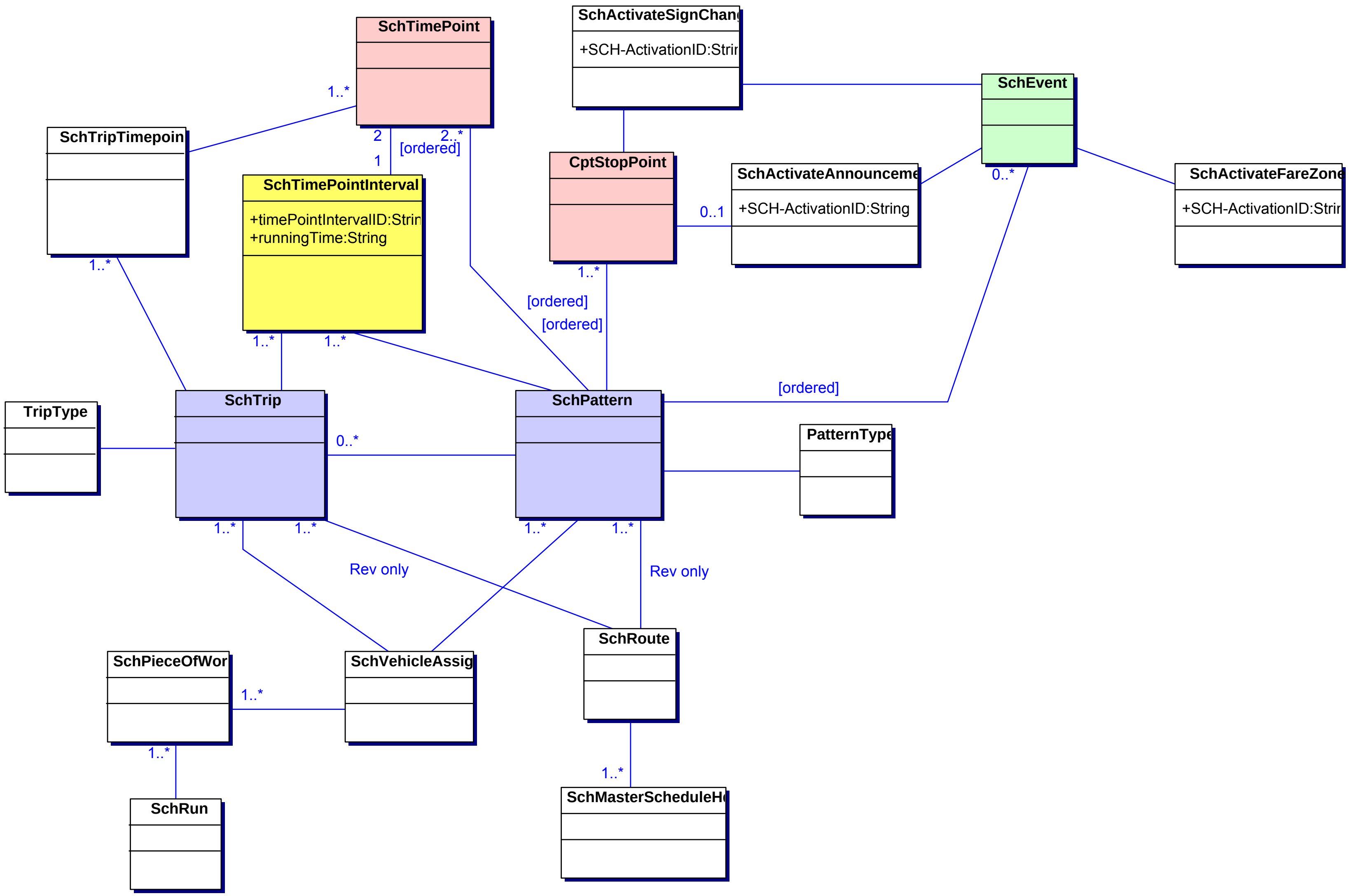
Table 2.A.1.2.1.2.4.a Data Flow Requirements for OBS Base Server

Use Case	Data for Base Server	TCIP Business Areas
From TED to Landing Pad via Base Server		
RV-11-Manage AVM	Thresholds for alarms	OB/CC: CcParameterRateConfiguration, CcChangeReportingRate, CcParameterThreshold, CcThresholdMonitorRequest
RV-7-Determine Vehicle Location; RV-5-Monitor System Health	Threshold for location confidence; reporting frequency for location/time information	OB/CC: (polling frequency may be found in CPT); CcChangeRadioMode
RV-12-Interface to DDU	Configurable limits on screen brightness and volume level controls used by Operator	NA
RV-13-Interface to Destination Signs; RV-10-Manage PA and Annunciator	Sign-change location (and time); wait time at layover before sign change; Event trigger definitions for Annunciator/Signage/Driver Messages/Fare Zone	OB/CC and SCH: CcActivateAnnouncementFreeForm, CcActivateAnnouncementFromLibrary; CcAnnunciatorMessageEntry; SchEvent, SchActivateSignChange, SchActivateAnnouncment; SchPattern
RV-13-Interface to Destination Signs; RV-10-Manage PA and Annunciator	Annunciator and sign library	CC: CcAnnunciatorLibrary
RV-9-Stop Point Activities	Bus stops; event triggers	CPT: CptStopPoint, CptStopPointInventory; SchPattern (also SchEvent)
RV-8-Route & Schedule Adherence	Thresholds for monitoring route and schedule adherence	CcActivateRouteAdherence (CcRouteAdherenceEntry): CcActivateScheduleAdherence
RV-4-Update Vehicle Data	Service Data including Activation date	SCH and CC: SchRoute; SchVehicleAssign, SchRun (or CcOperatorAssign)
From Landing Pad to TED via Base Server		
RV-5-Monitor System Health	Security and priority definitions (Alarm categories)	CPT: CptSeverityTable, CptPriorityTable
RV-9-Stop Point Activities	Ridership, boardings/alightings, load, dwell time data, unscheduled stops	OB: ObStopPointRecord, ObDoorRecord, OB-PassengerLoad

Use Case	Data for Base Server	TCIP Business Areas
RV-8-Route and Schedule Adherence	Service performance data including schedule adherence, running times, route adherence (includes unscheduled trips)	Derived data from CcPTVMessageTemplate and ObStopPointRecord); SchRunningTime: OB-RouteAdherenceStatus, OB-ScheduleAdherenceOffset
RV-14-Interface to FTP	Fare usage data	FC: FcFareUsageData
RV-11-ManageAVM	AVM data	OB: ObParameterDumpResponse

Figure ***2.A.1.2.1.2.4.b*** illustrates one interpretation of the relationship among key TCIP data concepts that are included in Table ***2.A.1.2.1.2.4.a***. This model is described as a class diagram where classes prefaced with a TCIP Business Areas acronym refer to a TCIP Message. For example, in the model, the Timepoint Interchange (TPI) is a basic building block used to build service patterns. Trips are considered instances of a pattern. Each pattern is attributed with an ordered set of bus stops, time points, and event triggers. The time point describes the beginning and end points of the pattern. Trip and pattern type classes may be transformed to SCH-TripType or SCH-ServiceType codes.

Figure 2.A.1.2.1.2.4.b View of TCIP Object Relationships



2.A.1.2.1.3. DSRC Standard

The Contractor shall identify the applicability of, and compatibility with, the emerging Dedicated Short Range Communications (DSRC) for WLAN implementation. (See Subsection **2.A.1.6.3, Wireless Local Area Network**.)

2.A.1.2.2. General "Latest-Technology" Requirement

Contractor shall configure the most robust and cost-effective, latest-technology system to meet KCM's fleet-wide needs and in consideration of KCM's developing ITS-related systems requirements. The software and hardware to be delivered shall be the current production version as determined during the Project's Design Phase; e.g. if the wireless spread spectrum technology is significantly improved between the time the RFP is published and the end of system design, the newer technology shall be utilized. Proposer shall fully explain the configuration proposed, together with whole life-cycle costs associated.

2.A.1.2.3. Reference Documents

Any identified standard in the submitted proposal must include both the publishing agency's full set of standards language and detailed documentation about which sections would apply.

In addition to the requirements designated elsewhere in this specification, the design, materials, and testing of the On-Board Systems/Communications Center System shall be in accordance with the latest issues and addenda of the applicable Military and Federal Standards and the American Society of Automotive Engineers (ASAE) in effect on the date the solicitation is issued.

2.A.1.2.3.1. Society of Automotive Engineers

- J1708–90 Serial Data Communications Between Microcomputer Systems in Heavy-Duty Vehicle Applications, Recommended Practice
- J1587–94 Joint SAE/TMC Electronic Data Interchange Between Microcomputer Systems in Heavy-Duty Vehicle Applications, Recommended Practice
- J1455–88 Joint SAE/TMC Recommended Environmental Practices for Electronic Equipment Design (Heavy-Duty Trucks), Recommended Practice
- J1939 Recommended Practice for a Serial Control and Communications Vehicle Network
- J2496 Transport Area Network Cabling

2.A.1.2.3.2. Military MIL-STD 810E

Environmental Test Methods and Engineering Guideline 1989-90

2.A.1.2.3.3. Electronic Industries Association

- 152-C-88 Minimum Standards for Land Mobile Communication FM or PM Transmitters, 25-866 MHz
- 204-D-89 Minimum Standards for Land Mobile Communication FM or PM Receivers, 25-866 MHz
- 232-E-91 Interface Between Data Terminal Equipment and Data Circuit-Terminating Equipment Employing Serial Binary Data Interchange

- 374-A-81 Land Mobile Signaling Standard Electrical Characteristics of Generators and Receivers for Use in Balanced Digital Multipoint Systems

2.A.1.2.3.4. NEMA 4 and 4x Enclosures (in NEMA 250)

"Enclosures for Electrical Equipment (1000 V Maximum)"

2.A.1.2.4. KCM-Specific Terms

In order to further the understanding of KCM's requirements, the attached Glossary defines KCM-specific terms that are used uniformly throughout this specification and are herein related to general terminology throughout the transit industry: See Appendix **M, Glossary of Terms and Acronyms**.

KCM advises the Proposer that this section is not a simple “Glossary” to be bypassed by those already familiar with Transit or other industry-specific terminology. Rather, this section details usage that is specific to KCM and the OBS/CCS and that is associated with specific requirements, conditions, and other implementation-relevant information also stated herein.

2.A.1.2.5. General Resolution of Differences in Interpretation of Specification

This section is provided in an effort to proactively minimize the chance of incorrect implementation due to misunderstood terms and situations. It also relates these terms to conditions, policies, and systems in place or under development that the Contractor will have to know about in order to properly implement the OBS/CCS.

KCM cautions that terms such as “component” are so broad as to invite a wide range of interpretations with radically different results in the end product. While KCM endeavors to detail herein the intended application of such terms in the OBS/CCS, it is possible that some other terms of common usage are not similarly detailed.

For terms whose meaning specific to the OBS/CCS project is not described or referenced anywhere in this document, nor clarified formally in succeeding correspondence or announcement to Proposers prior to contract award, and which have a generally accepted and unambiguous meaning in the industry appropriate to the context applied herein, that meaning shall be construed as the applicable one in case of subsequent disagreement over meaning. Exception to this applies when the context in which the term is used clearly implies an alternate meaning or intent.

Proposers are advised further that terms and standards that are described in KCM’s *The Book: Transit Operating Instructions* are to be applied in the implementation of the OBS/CCS. If any conflict in interpretation is perceived between this procurement specification and these operating instructions, and is not resolved at time of contract award, then the context as presented in this procurement specification shall prevail.

KCM further notes that references to certain established formal standards are intended exactly as those standards exist, *at a minimum*, unless otherwise explicitly stated. This means that additional specifications may be included herein, requiring features in excess of compliance with the indicated standard.

Otherwise, omission of terms from discussion in this or any other section shall not constitute permission for the Proposers to apply their own definitions. It is the responsibility of the Proposer to identify any ambiguity of meaning or expected implementation during the process described in Part A, and formally submit it to KCM’s attention for proper resolution by KCM.

2.A.1.2.6. Life Expectancy of System

KCM requires all major component systems of the OBS/CCS to be operational as such for a period of at least 15 years, unless otherwise explicitly stated. Normal maintenance, parts replacement, and other reasonable instances of momentary or temporary down time do not violate this requirement.

Major component systems of the OBS/CCS to which this life expectancy applies include:

2.A.1.2.6.1. Communications Layers

All equipment and systems needed to provide the required Communications Layers including the Transit Radio System, WLAN and VAN.

2.A.1.2.6.2. On-Board Subsystems

All equipment and software needed to provide the required vehicle subsystems. For detailed descriptions and technical requirements for the following equipment, see Subsection **2.A.1.5.3, Revenue Vehicle Subsystems: Definition and Requirements**.

a. The On-Board Automatic Vehicle Location (OB AVL) module of the Vehicle Logic Unit (VLU), including all attached vehicle location subsystems (hardware and sensors).

b. Interior Sign.

c. Automatic Passenger Counter (APC) processor and associated sensors.

d. Wireless Local Area Network (WLAN) equipment.

e. Automatic Vehicle Monitoring (AVM) equipment and sensors.

f. Other systems as applicable, e.g. interfacing components, enhancements to previously installed systems, and/or other items provided but not specifically itemized here.

g. All associated cabling, wiring, mounting, antennas, etc.

h. OBS Administrator Toolkit: utilities and processes.

2.A.1.2.6.3. Base Equipment

All equipment required to support the "back office" functionality of the OBS/CCS, including but not limited to the following items. See Subsection **2.A.1.5.1.2, Base Operations Domain** for descriptions and technical requirements for the following equipment:

a. Base Server

b. Landing Pad server

c. AVM Signal

2.A.1.2.6.4. Communications Center System

All equipment, systems, and utilities required to provide the specified CCS.

2.A.1.2.7. Integration Extent

OBS/CCS is intended to be a fully integrated system, with respect to both prior Agency investment of resources, and future implementations. KCM recognizes and accepts that not every existing system at KCM can or should be continued into the new configuration of the OBS/CCS.

However, KCM requires that the end product provided by the OBS/CCS fulfill the threefold objectives of:

a. Assurance of full continuation of essential functions of legacy systems including RFCS and DVRS devices, Destination signs, AVI tag, and the ECM.

b. Implementation of new systems providing properly functioning replacement, extension, and/or enhancements to previously existing systems as specified.

c. Assurance of an open system architecture, allowing inter-operability and expandability and providing an upward migration pathway with respect to ITS-related systems to be implemented later, and to other systems as a whole.

2.A.1.3. Baseline Expectations

KCM has considerable experience with its existing Radio/Automatic Vehicle Location system and is very familiar with the capabilities and limitations of such a system (see Subsection **1.B.4.3.1, MDU and Radio/AVL Replacement**). Moreover, KCM is familiar with the sorts of radio/CAD/AVL-related complications and problems that modernized equipment and technology may fail to address.

The new OBS/CCS shall be equal or superior, in all significant ways, to KCM's present systems and shall provide, relative to its present products, significant improvement in the following areas:

2.A.1.3.1. Modularity and Upgradeability

The software components and hardware subsystems that make up the OBS/CCS systems shall be as modular, inter-connectible, open-platform, and interoperable as practically possible. Modularity is required to provide maximum potential for design efficiency, functional independence, operating efficiency, reliability, performance, upgradeability, interchangeability, and maintainability. These characteristics will apply not only to the procured system elements, but also to legacy KCM subsystems currently in use on the vehicles and to those planned to be in operation at the time of the Level 1 system implementation.

KCM also requires modular software development in order to limit the degree of system modifications that would be needed to support the acquisition or development of future KCM systems. For example, not every GIS-related attribute that KCM will eventually want in the system is necessarily specified here, nor is every bit of processing specified that will relate to given attributes which themselves are specified here.

KCM seeks a robust system that will perform the basic OBS/CCS functions faithfully while either allowing a large degree of customization locally by KCM IT staff, or providing affordable, responsive vendor support over the lifetime of the system to achieve the same results.

2.A.1.3.1.1. Equipment

Standard, commercially available hardware devices shall be used wherever possible. All functionally identical modules, assemblies, and devices shall be fully interchangeable among all equipment acquired under this contract. All subsystems, devices, and assemblies shall be connected using standardized durable, positive-locking, indexed quick-disconnect fasteners.

2.A.1.3.1.2. OBS Software

2.A.1.3.1.2.1. Operating System

The OBS operating systems provided for servers and on-board equipment shall be commercially adopted and provide standardized functionality.

2.A.1.3.1.2.2. VLU Master System

The master software system residing on each Revenue Vehicle is generally referred to throughout this document as the VLU, also the term for the piece of hardware on which it resides. This *Master System* is a separate software application whose functional modularity is described by the Revenue Vehicle domain use cases and which will provide, among other functions, all of the functionality necessary to interact with the vehicle's named subsystems (see Subsection **2.A.1.5.4, Revenue Vehicle Subsystems**). There are numerous "software modules" that are described in the UML model in an effort to clearly communicate the KCM requirements. KCM understands that these software modules may be pre-existing and tightly integrated with each other in order to deliver the needed functionality, and, with the exception of the On-Board AVL module described below, KCM does not require that they are modularized as described. However, the functional modularization of the Levels 1 and 2 systems as designed, developed, and built must be described using UML tools and provided as Project deliverables.

The VLU will be the heart of the OBS and will have the ability to appropriately interact with all of the Revenue Vehicle subsystems (see Subsection **2.A.1.5.4, Revenue Vehicle Subsystems**) and to support communications via the WLAN with the Base Server using approved, published, public ICDs.

2.A.1.3.1.2.3. On-Board AVL

One of the functional software components that compose the VLU's Master System is the On-Board Automatic Vehicle Location (OB AVL) module, which is described in the ***RV7-Determine Vehicle Location*** use case. The OB AVL module shall provide a derived location for the rest of the OBS (longitude and latitude) using an on-board GPS receiver and other KCM-approved location determination devices (gyroscope, odometer, etc.). The requirement is for location to be determined by a navigation algorithm that collects inputs from multiple sources, correlates the input of these devices, and calculates a solution based on the reported reliability and weighting of each input device.

The OB AVL module will also be able to determine vehicle location if the required GPS data is not available. It is understood that long-term location accuracy may be degraded by the loss of GPS. KCM will offer for consideration, but not require, the existing signpost system for use as one of the additional sources of location data.

The OB AVL modular software component is different from the other functional software modules that comprise the Master System in that KCM wants it to adhere to the same modularity requirements proposed for the vehicle's subsystems. For example, its operational and data exchanges with the reporting AVL subsystem(s) and all other modules of the Master System will use an open, public interface described by a unique published ICD for each type of interaction (see Section **2.A.1.5.3, Revenue Vehicle Subsystems: Definitions and Requirements**).

The OB AVL shall also include the tools and capability to load and utilize alternative location determination software.

Table 2.A.1.3.1.2 Level 1 OBS Software Modularity Requirements

Software	Responsible Party	Manufacturer	Brief Description	Device(s) (Hardware)	Function (Use Case Reference)	Software
VLU's Master System	OBS	TBD	The Master System includes all of the software required to provide all RV use case functionality, including the management of all subsystem interfaces. The OB AVL mentioned below is a modular component of the Master System.	VLU (Vehicle Logic Unit) Wheelchair lift or ramp sensor Vehicle Area Network (VAN) used for connectivity to all subsystems.	▪ ***RV1-Initiate Vehicle for Operation*** ▪ ***RV5-Monitor System Health*** ▪ ***RV6-Manage Events*** ▪ ***RV8-Monitor Route & Schedule Adherence*** ▪ ***RV9-Monitor Stop Point Activities*** ▪ ***RV3-Take Vehicle Out of Operation***	Proprietary, Modular, Portable, Upgradeable, and Configurable
OB AVL (On-Board Automatic Vehicle Location) Module	OBS	TBD	Modular component of the VLU's Master System which receives information from input devices that provide location data. It then uses this information to determine and report a current location solution.	<u>Required Sensors</u>: - GPS - Odometer <u>Optional Sensors</u>: - Gyroscope - Compass - Signpost - Other	▪ ***RV7-Determine Vehicle Location***	▪ Modular software component of the Master System. ▪ Proprietary Modular, Portable and Upgradeable. ▪ Published ICDs for interfaces with rest of Master System and each input device.

2.A.1.3.2. Vandalism Protection

The Contractor shall protect all equipment and components from common vandalism and physical abuse by individuals wielding portions of their body, or wooden or metallic implements.

2.A.1.3.3. Revenue Vehicle/Communications Center Interaction

Because the most operationally critical interface is between the OBS Master System and the Communications Center System, the Contractor shall take all precautions to ensure that Communications Coordinator/Vehicle Operator communications are *not adversely affected* by implementation of either Level 1 or Level 2 Project functionality and equipment. Operators, Coordinators, and automated processes will use this interface intensively for voice and data communications and to manage service.

2.A.1.3.3.1. Insuring Continuous Communications

Proposers shall submit system performance targets and a graduated plan of testing and implementation to ensure, at each, that the system can support reliable, continuous communications between the OBS and the CCS. All design, testing, and implementation plans shall be constructed to ensure these continuous communications. Contingency planning and system redundancy may be required for the initial stages of implementation.

2.A.1.3.3.2. Level 1

In Level 1 of the Project, the OBS shall be inserted into the center of the legacy and new on-board systems, and shall be required to migrate the on-board environment from LIM (limited integration mode) to FIM (full integration mode). See Subsection **1.C.2.2, RFCS Integration Modes**.

2.A.1.3.3.3. Level 2

In Level 2, the Contractor shall be required to work with the TRS contractor to develop interfaces and protocols for interactions between the new mobile radios and radio system, CCS and OBS. When the new mobile radio is installed on board the vehicle, the RCU and MDU will be eliminated. From this point forward, the VLU will assume all responsibility for interacting with the radio system and CCS.

2.A.1.3.4. Server/Workstation Hardware Requirements

The Contractor shall specify servers and workstations that meet the following physical, electrical, installation, and additional security requirements.

2.A.1.3.4.1. Physical Requirements

All non-vehicle servers shall be operational in a regular office environment under normal temperatures for a non-air-conditioned building (operating base environment). A UPS will be provided to supply partial power conditioning for each affected server, if any are located at the bases.

Each server shall have a minimum specification that meets optimal operational requirements for the software during peak data periods. Such servers shall have full system redundancy including a robust raid array and shall utilize data replication as well as have local backup systems if specified. (See Subsection **2.A.1.3.4, Server/Workstation Hardware Requirements.)**

2.A.1.3.4.2. Electrical Requirements

Any special electrical requirements for equipment that is outside a normal 110-120V outlet with a 15 Amp circuit will be documented in full. Such documentation will detail all physical requirements, including those for power adapters as well as voltage, amperage, and ground isolation requirements.

2.A.1.3.4.3. Installation Requirements

KCM technical staff will perform installation of all equipment and software under the Contractor's supervision as necessary. The Contractor's installation requirements include, at a minimum, documentation for and training on the system requirements, installation procedures and maintenance procedures including but not limited to hands-on instruction with written step-by-step setup instructions. The Contractor shall provide personnel contacts for installation support for all software and hardware. All server and software specifications will be detailed in the provided documentation.

2.A.1.3.4.4. Additional Security Requirements

All servers located outside of KCM's main Computer Center are at a higher risk of exploitation and security violation. Therefore the Contractor will provide security and encryption systems that meet the highest industry standards to ensure data integrity and accuracy, and system security from unauthorized access to software or data. Data security is considered to be mission-critical, especially for certain sets of pass-through information like the DVRS streaming video files and the RFCS financial data. All unauthorized and/or failed attempts to access such data will be logged by the system and reported to the OBS Administrator.

2.A.1.3.5. Server/Workstation Hardware Procurement

In the interest of ensuring that KCM is self-sufficient in performing routine system maintenance and configuration for both Levels 1 and 2 functionality and operation, the following describes the requisite server/workstation hardware purchasing and installation approach for the OBS/CCS procurement.

2.A.1.3.5.1. Specifications

The Contractor will provide KCM with complete hardware specifications for each of the following:

1. OBS Base Server and CCS servers: optimum specifications for five-year replacement cycle based on KCM growth estimates.
2. OBS Landing Pad servers (if part of the agreed-upon system configuration): optimum specifications for five-year replacement cycle based on KCM growth estimates.
3. CCS CAD/AVL Coordinator terminal: optimum specifications for five-year replacement cycle.

2.A.1.3.5.2. System Documentation

The Contractor will provide systems documentation including but not limited to the following:

1. OBS and CCS hardware/firmware configuration documentation for each specified server or terminal.
2. OBS and CCS software installation and configuration documentation including Operator, programmer, and user's manuals.

3. OBS and CCS database documentation, schema, and data for all jointly or Contractor-designed databases. See Subsection **2.A.1.7, Data Collection, Management, and Reporting**.
4. Test plans for all phases of installation and configuration. See Section **2.A.2, Testing** and Part B (Terms and Conditions), Section 28.0 Testing.

2.A.1.3.5.3. KCM Approach

Upon approval of the Contractor's specifications and documentation, KCM will use provided information to do the following:

1. Purchase the OBS Base Server, OBS Landing Pad servers, and CCS server(s).
2. Purchase the CCS CAD/AVL Coordinator terminals based on the Contractor's specifications.
3. Install and configure the various OBS and CCS servers including the installation and configuration of all operating-system software, OBS and CCS system and subsystem software, and database scripts. All such installations and configurations will be completed in accordance with the mutually agreed-upon installation and configuration procedures, documentation, and database schema provided by and under the on-site supervision of the Contractor.
4. Set up and install the CCS Coordinator terminals, based on the mutually agreed-upon installation and configuration documentation, and under the on-site supervision of the selected OBS/CCS Contractor.

2.A.1.4. OBS/CCS Technical Requirements

This subsection provides the high-level Project requirements for all provided hardware and software.

2.A.1.4.1. Physical and Materials Requirements

The system's equipment shall meet the following physical and materials requirements.

2.A.1.4.1.1. Equipment Requirements

All provided equipment shall comply with the following requirements.

2.A.1.4.1.1.1. Transit-oriented Design

All equipment shall be designed for use in the transit industry, with specific attention to ergonomics, reliability, efficiency, and safety for passengers, Operators, maintenance personnel, and other system users.

2.A.1.4.1.1.2. Current Model Standards

Equipment furnished under these specifications shall be the latest model in current production, as offered to commercial trade, and shall conform to quality workmanship standards and use materials consistent with transit industry requirements. Any modifications or upgrades performed upon the equipment or software during installation will be performed upon the entire fleet. Changes in any manuals or schematics will reflect all changes.

2.A.1.4.1.1.3. Hardware Standards

Information technology hardware provided under this contract shall comply with the following requirements:

a. Servers and communications equipment shall be rack mountable in a 19” wide standard rack mount. If this format is not available, any alternative must be approved by the KCM Project Manager.

b. Systems, equipment, or enclosures cannot be more than 68.5” in height to meet fire-code ceiling-clearance restrictions and earthquake mounts.

c. Servers shall be compatible with a multi-vendor-type KVM switch, keyboard, and monitor system.

d. All servers and equipment shall be clearly labeled with the name of the device.

e. Operational maintenance and support documentation shall be provided as part of the Design Review tasks. See Subsection **2.A.3.1.2.3, OBS Design Phases Deliverables**.

2.A.1.4.1.1.4. Screw, Nut, and Washer Requirements

All external screws, nuts, and locking washers shall be stainless steel or an approved alternate non-corrosive material; no self-tapping screws shall be used unless specifically approved.

2.A.1.4.1.1.5. Corrosion Resistance

All parts shall be made of corrosion-resistant material, such as plastic, stainless steel, anodized aluminum, or brass.

2.A.1.4.1.1.6. Authorized and Unauthorized Access

Equipment shall be designed to prevent unauthorized access, and to facilitate authorized access.

2.A.1.4.1.2. ADA Requirements

All equipment and devices shall comply with the requirements of 49 CFR Parts 27, 37, and 38 as amended, implementing the provisions of the Americans with Disabilities Act (ADA) of 1990, as amended.

2.A.1.4.2. Electrical Requirements

2.A.1.4.2.1. Equipment Power Supply

All equipment installed in County or third-party facilities with the exception of any on-board equipment shall operate without equipment damage from a nominal line voltage of 120 VAC, within voltage tolerances of plus or minus 10% and a frequency range of 57 Hz to 63 Hz.

2.A.1.4.2.2. Electrical Protection and Grounding

2.A.1.4.2.2.1. Specifications and Regulations

The Contractor shall provide equipment that meets applicable specifications and criteria of the Underwriters Laboratories Incorporated (UL), National Electrical Code (NEC), and the regulations of the State of Washington and local jurisdictions.

2.A.1.4.2.2.2. Certifications

The Contractor shall be responsible for securing Underwriters Laboratories and other electrical certifications, and shall be responsible for any costs associated with the certification process and/or inspections.

2.A.1.4.2.2.3. Circuit Breakers

All device enclosures shall contain an easily accessible master circuit breaker that will remove power from the equipment when tripped. Circuit breakers shall clearly indicate when they have been tripped.

2.A.1.4.2.2.4. Grounding

All enclosures, chassis, assemblies, panels, switch boxes, terminal boxes, and similar enclosures or structures shall be grounded.

Contractor shall provide protective grounding to ensure that all exposed metal equipment and metal fixtures are connected to a common ground point in the electrical cabinet.

2.A.1.4.2.3. Wiring

2.A.1.4.2.3.1. Conductor Bundling

Conductors that have the potential of operating at 50 volts or more shall not be bundled with any other lower-voltage conductors.

2.A.1.4.2.3.2. Wire Dress

Wire dress shall allow sufficient slack for three additional “re-terminations” without excess tension.

2.A.1.4.2.3.3. Wire Splices

Wire splices are not permitted.

2.A.1.4.2.3.4. Wire and Cable Ties

Wire and cable ties shall not be so tight as to cause indentation and damage to the insulation.

2.A.1.4.2.3.5. Wire Tie and Cable Support

Adhesive-mounted bases shall not be used to support wire ties or cable supports.

2.A.1.4.2.3.6. Conductors Free from Metal Edges

All conductors within each enclosure shall be installed free from metal edges, bolt heads, and other sharp or interfering points.

2.A.1.4.2.3.7. Strain relief

All conductors providing connections between components shall be provided with strain relief, and be clear of moving objects that could damage either the conductor or the object.

2.A.1.4.2.3.8. Indexing and Labeling

All terminations and cables must be clearly indexed, labeled, and schematically identifiable. All wire labels shall be non-metallic and shall resist standard lubricants and cleaning solvents.

2.A.1.4.2.3.9. Wiring Harness

When components must be connected to each other through individual wires, the wiring shall be incorporated into a wiring “harness,” where each branch of each circuit can be separated from others for troubleshooting.

2.A.1.4.2.3.10. Wiring Harness Quick Disconnect

All components interconnected through individual wires contained within a “harness” shall be disconnected from the harness by disconnecting a durable, positive-locking, indexed quick-disconnect fastener. Wiring harnesses shall be grouped, numbered and color-coded.

Such harnesses shall not contain wires of different voltage classes unless all wires within the harness are insulated for the highest voltage present in the harness.

2.A.1.4.2.4. Printed Circuit (PC) Boards

2.A.1.4.2.4.1. Printed Circuit Backbone

Where possible, all components shall be connected to the main logic circuitry by plugging into slots on a printed circuit “backbone.”

2.A.1.4.2.4.2. Interchangeability

All PC boards shall be interchangeable with the same printed circuit board on other devices purchased under this contract.

2.A.1.4.2.4.3. Through-hole Plating

All PC boards that have through-holes shall be through-hole plated.

2.A.1.4.2.4.4. Construction Specifications

All PC boards shall be at least NEMA Grade FR-4, epoxy glass, green with weave appearance, and shall have a heat/mechanical load limit of five. The “five” indicates the “peel strength” of the laminate (pounds per inch of width needed to peel off a strip of copper cladding at an elevated temperature, NEMA publication LI 1-1971). The copper laminate shall be firmly affixed to the PC board and shall not blister or peel when heated with a soldering iron.

2.A.1.4.2.4.5. Component Side

The component side of the board shall be silk-screen printed with component references and other identifying information that corresponds to PC board schematics to aid in repair and troubleshooting.

2.A.1.4.2.4.6. Clearance Between Components

Sufficient clearance between components shall be provided to allow for component testing, removal, and replacement.

2.A.1.4.2.4.7. Test Points

Identifiable test points for circuit troubleshooting shall be provided on modules and PC boards.

2.A.1.4.2.4.8. Language for Markings

All markings on PC boards shall be in English.

2.A.1.4.2.4.9. Serial Number

All PC boards shall have a unique, permanent serial number that cannot be altered during normal repair.

2.A.1.4.2.4.10. Fuses

Fuses or built-in protection shall be provided on all driver circuits to prevent damage to those transistors or other devices that drive relays, solenoids, print heads, and motors. The fuses shall be easily replaceable without damaging the PC board.

2.A.1.4.2.4.11. Indexing

All PC boards shall be “indexed” to prevent insertion in the wrong slot or the wrong direction.

2.A.1.4.2.4.12. Identifiers

All PC boards shall contain the manufacturer catalog or reference number, version level, and serial number for tracking purposes. All such identifiers shall be permanently affixed to the board.

2.A.1.4.2.4.13. Pin/Socket Connectors

PC boards in on-board equipment shall employ pin/socket connectors, and shall not use printed card edge fingers.

2.A.1.4.2.5. Relays

2.A.1.4.2.5.1. Contact Tips

The contact tips of any relays shall not be placed in parallel for the purpose of carrying a current load at or above the manufacturer's contact tip rating.

2.A.1.4.2.5.2. Bifurcated Contacts

Bifurcated contacts shall be used in low-voltage applications whenever necessary due to dry contact switching requirements.

2.A.1.4.2.5.3. Accessibility

All relays shall be installed so that they are fully accessible for testing, removal, and replacement.

2.A.1.4.2.5.4. Captive Spring Retainers

All relays shall be socketed with captive spring retainers to hold relays in place.

2.A.1.4.2.6. Switches

2.A.1.4.2.6.1. Switch Poles

Poles of switches shall not be placed in parallel to carry current at or in excess of manufacturer's contact pole rating.

2.A.1.4.2.6.2. Keying

Switches shall be provided with a “keying” feature such that, after installation, the body of the switch will be constrained from mechanical rotation.

2.A.1.4.2.7. Equipment Enclosures

Equipment will be installed in indoor and outdoor environments, with various levels of sheltering ranging from significant protection to none. All outdoor equipment shall be designed for exposure to salt-laden marine air, fog, rain, hail, and other environmental conditions prevalent in the Puget Sound area.

2.A.1.4.2.7.1. Environmental Requirements

OBS and CCS equipment shall be able to operate under additional environmental requirements presented in the respective subsystem technical specifications as applicable.

2.A.1.4.2.7.2. Temperature and Humidity

Enclosures shall include any provisions necessary to maintain the internal equipment at an acceptable temperature and humidity.

2.A.1.4.2.7.3. Moisture and Dust Resistance

Enclosures shall be designed to prevent entry of moisture during a driving rainstorm and to minimize entry of dust.

Any moisture or dust entering the enclosure shall not cause short circuits or equipment failure.

2.A.1.4.3. Environmental Requirements

2.A.1.4.3.1. Electromagnetic Compatibility

The Contractor's approach to electromagnetic compatibility shall ensure that the electrical and electronic components and subsystems operate in their intended environments without being affected by or causing harmful interference in the presence of other devices such as powered wheelchairs or other mobility aids. Protection shall be provided against radio frequency and electromagnetic interference (RFI/EMI) emission sources, as well as internal conductive or inductive emissions.

2.A.1.4.3.1.1. Transmission Lines

Operation of OBS & CCS equipment shall not be affected by the electromagnetic fields generated by utility transmission lines, by an overhead catenary at distances as close as 25 feet, or by local power distribution lines at distances as close as 50 feet.

2.A.1.4.3.1.2. Electric Transit Vehicles

Operation of OBS equipment shall not be affected by electromagnetic effects present during transit operations such as the running of electric trolley buses and light-rail vehicles.

2.A.1.4.3.1.3. DSTT and LRT Equipment

Operation of OBS and CCS equipment shall not affect or be affected by equipment in the Downtown Seattle Transit Tunnel (DSTT) or at a Light Rail Transit (LRT) right-of-way.

2.A.1.4.3.1.4. Other On-Board Equipment

Operation of OBS and CCS equipment shall not affect or be affected by other on-board equipment including vehicle power supplies, radios, automatic vehicle identification systems, and on-board data collection and processing equipment.

2.A.1.4.3.1.5. EMI/RFI Protection

Contractor shall describe what provisions shall be included for EMI/RFI protection. See Section **2.A.3.1.2.3, Level 1 Design Phases' Deliverables**.

2.A.1.4.3.1.6. Certification

The Contractor shall certify through the Contractor's expense the electromagnetic compatibility of equipment to be furnished. See Section **2.A.3.1.2.4, Level 1 Pilot Phase Deliverables**.

2.A.1.4.3.1.7. Code Adherence

Equipment shall meet applicable codes, standards, and specifications at the time of manufacture.

2.A.1.4.3.1.8. Specified Standards

On-board equipment shall meet the following standards.

Table 2.A.1.4.3.1.3.8. On-board equipment standards

Specification	Standards
Electrostatic Discharge	IEC(EN) 61000-4-2
Radiated Electric Field	IEC(EN) 61000-4-3
Conducted Electric Field	IEC(EN) 61000-4-6
Conducted Transient Burst	IEC(EN) 61000-4-4
Conducted Surge	IEC(EN) 61000-4-5
Magnetic Fields	IEC(EN) 61000-4-8
Emissions	CISPR 22 (EN 5022)

Subject to written approval from the KCM Project Manager, the Contractor may apply for a waiver of certain tests for office-based computer equipment. On-board equipment shall be subject to all identified tests.

2.A.1.4.4. General Software Requirements

All software delivered in performance of this contract shall meet the following requirements. Any exceptions shall be requested in writing with an accompanying explanation as to the specific technical reasons for why an exception is needed.

a. All software (proprietary or bespoke) will include identification, external and internal documentation, and appropriate, acceptable licenses for all included files, utilities, and libraries needed for successful system operation.

b. All software will include vendor name(s), address, and contact information.

c. All software shall be self-diagnostic, reporting processing errors and system failures to the OBS Administrator. (See Appendix **K, OBS and CCS Administrator Toolkits**.)

d. No software shall contain hard-coded user login information for access to data or database processes. When access is requested, the software must prompt for, accept, and validate login information provided by the user before allowing any type of access.

e. All source code shall include application and individual module descriptions and documentation, both internally and as part of the required system documentation.

f. All source code shall be provided with the appropriate compiler(s), complete description of the development environment, cross-compiling techniques (if needed to achieve Project goals), and any other “make" or “build files” utilities, libraries, tools, etc., needed to successfully re-compile and execute modified code.

g. Required version and identification numbers for software support and all features shall be provided to identify the software version on each device, and verify that it is the correct or most recent version for that device. Each developed code set will identify the module to which the code belongs.

h. Contractor will provide both printed and electronic versions of the Software Documentation as defined in Part B**,** Exhibit 1.

i. All software shall be written in a common and well-known modern high-level, highly structured language. All software shall be the current version in production at the time of installation. Software versions to be approved by the KCM Project Manager.

j. KCM-specific and other customizable parameters shall be user-modifiable, not hard-coded into the source code. A complete list of these user-settable parameters shall be determined during Design. The OBS and CCS System Administrator Toolkits shall include utilities to set and modify all such parameters.

k. Application software (both user and system) shall be portable; i.e. the compiled source code shall be transferable to other, similar computers using the same operating system and similar hardware platforms, without any modifications.

l. All user and system interfaces shall have online help features.

m. The system shall contain all supporting software required to implement, operate, modify, and maintain all graphics displays and interactive screens.

The developed software will be provided with a process flow chart and instructions on how to restart or continue processing when error occurs. Such errors will be logged and OBS Administrator utilities will provide error information to the user upon demand. All error codes must be descriptive and must explicitly identify the failure point in the code, the record(s) impacted, and instructions on how to restart the application or flush and rerun the entire software module.

2.A.1.4.5. System Security

The Contractor shall provide an audit mechanism that tracks alterations to data and software. The Contractor shall individualize logins to all software tools, including those provided for facilitating the tracking of any and all alterations. Each login shall have a unique name and password to identify its user. Each login shall have assigned privileges that can be limited to the ability to alter only specific types of data or files (for example, the ability to alter only the GIS data or only the schedule data, but not necessarily both).

Data relayed from other subsystems on the bus will be protected by the OBS from any alteration. In this case, the VLU will act as a pass-through device for use of the WLAN. Subsystems with unalterable data include the DVRS streaming-video offloads and all RFCS daily reporting information. All data relays from subsystems will contain a checksum to ensure data integrity that may be tracked back to the original subsystem.

The Contractor will provide information regarding all diagnostic activities to include, at a minimum, the ID of the person performing the diagnostic, date, time, activity performed, any discrepancies at completion of the diagnostic; and equipment/software statuses.

2.A.1.4.5.1. System Security Plan

The Contractor shall develop a comprehensive System Security Plan which identifies the system elements that require protection, and identifies mechanisms, procedures, and processes to counter security threats to those elements.

The System Security Plan shall identify system users, and describe rules that govern how those users will have access to system data, resources, and processes. The System Security Plan shall identify methods of detecting security breaches regardless of whether there is a detectable change in the performance of the system. All security-breach detection shall be confidential, and accessible only to users with appropriate access permission.

The System Security Plan shall be submitted with the design documentation, and approved by KCM Project Manager. The plan shall include, at a minimum, the details of how the following are protected.

a. Software source and compiled code, all data communications methods, and interface control documents.

b. Interruption of service, including as a minimum component, device, subsystem or system operation, and system communications.

Features shall be provided to ensure that all transaction and system-created files are uniquely identified, and that no files are lost or missed during data transfer. Verification features shall be provided to confirm that there have been no losses of data at any point in the system.

The System Security Plan shall include a description of how the software encrypts and de-encrypts all passwords, access, file transfers, etc., and an explanation of how to change generated keys and the encryption algorithms.

2.A.1.4.6. System Reliability and Availability Requirements

2.A.1.4.6.1. Equipment Reliability Requirements

Reliability is defined as Mean Time Between Failures (MTBF) for any specified type of OBS and CCS equipment in service. The proposal shall include a MTBF estimate and supporting calculations for all relevant OBS and CCS equipment including but not limited to:

- Automatic Passenger Counting (APC) processor and sensors.
- Automatic Vehicle Monitoring (AVM) sensors and multiplexor (if applicable).
- GPS receiver and antenna.
- Interior Sign.
- Vehicle Logic Unit (VLU).
- Base Server.

2.A.1.4.6.2. Availability

All systems, servers, databases, and software processes shall be available for access and use at least 99.9% of the time, based on a 24-hour operating day and a 365-day operating year. The other one-tenth of a percent, approximately 45 minutes per month, allows for maintenance procedures and unscheduled downtime. Determination of compliance with this requirement will be based on a monthly average.

The Contractor shall prepare a System Availability Measurement Plan (see Subsection **2.A.3.1.2, OBS Design Phases' Deliverables**). Availability is defined as the probability that a component, a device, a data server, or computer system is operating. The base equation shown below in Figure ***2.A.1.4.6.2*** shall be used to calculate availability. The four primary components of availability are:

a. Required operating hours: time the equipment is required for operational activities.

b. Scheduled maintenance hours (as applicable): time required for pre-defined scheduled equipment and system maintenance and servicing activities.

c. System out-of-service hours: time that the relevant system is not available for operations.

d. Effective operating hours: required operating hours minus scheduled maintenance hours.

Figure 2.A.1.4.6.2. Availability Base Equation

$$\text{Availability} = \frac{\text{Effective operating hours} - \text{System out-of-service hours}}{\text{Effective operating hours}}$$

2.A.1.4.6.3. Failure Review Team

A Failure Review Team (FRT) shall be established to evaluate which failures are chargeable against the Contractor's reliability requirements. The FRT shall be comprised of at least one member from KCM or designated KCM representative, and at least one member from the Contractor. Responsible parties within this team will initially attempt to settle any disputes. The KCM Project Manager will make a final and binding decision on any disputes that remain unsettled after a period of two weeks after the FRT first meets to evaluate a specific failure.

2.A.1.4.6.4. Corrective Action

2.A.1.4.6.4.1. Contractor Responsibility for Remedial Action

In the event that the devices do not meet the reliability requirements, the Contractor shall identify and implement remedial action, including, as necessary, modification of the equipment, on-site engineering services, on-site technical services, or other related action at no cost to the County.

2.A.1.4.6.4.2. Replacement of Affected Device

In the event the installed equipment does not meet these requirements, and remedial action requires the Contractor to take an individual device (other than depot maintenance devices) out of service for more than 12 hours to implement equipment modifications or replacement, the Contractor shall arrange for a supplemental device at that location as necessary, so that there will be no reduction in service while remediation is taking place.

The Contractor shall provide a replacement device within 24 hours of notification.

2.A.1.5. Physical System Configuration Overview

The functional requirements described in KCM's UML model are divided among three domains or areas of operation:

- Revenue Vehicle
- Base Operations
- Communications Center

An overview of the three domains is provided below.

The OBS functional requirements also describe the new and legacy equipment residing on the Revenue Vehicle that will be interactive, modular parts of the Level 1 system. These are listed below in Table ***A.1.5.3, Revenue Vehicle Subsystems***.

2.A.1.5.1. Domain Descriptions

2.A.1.5.1.1. Revenue Vehicle (RV) Domain

This domain includes all of the systems, subsystems, and functionality that will reside on the Revenue Vehicle. All Revenue Vehicles will have the majority of described functionality installed. The mobile implementation will involve equipping all vehicles with vehicle logic units (VLUs), an on-board vehicle area network (VAN), and automatic vehicle location

(AVL). Peripheral systems for customers and Operators for all Revenue Vehicles will include interior announcements and displays, exterior announcements, automated destination signs, and transit signal priority.

Most vehicles will have automatic vehicle monitoring (AVM) installed but vehicles older than ten years will not be AVM-equipped. Fifty percent of Revenue Vehicles will be Contractor-equipped with APC equipment, replacing all existing passenger-counting equipment. Approximately 25% of the fleet will have legacy DVRS systems already installed and their integration into the OBS will be required. KCM plans to continue DVRS installations until 100% of the fleet is equipped.

2.A.1.5.1.2. Base Operations (BO) Domain

This domain includes the functional requirements for Base "back office" Operations and will be composed of a data-acquisition computer system with built-in virus protection and full system redundancy to ensure continuous data transmission exchanges to and from the RV. This system will serve as the gateway to the KCWAN for all data transferred between the Revenue Vehicle and Base Operations domains via the WLAN. Detailed functional requirements for the Base Operations domain generally reside in the following use cases:

- ***BO1-Verify Vehicle Configuration***
- ***BO2-Update Vehicle Data***
- ***BO3-Manage Historical Data***

The following definitions describe the primary requirements for equipment located in this domain. Please note that the *functionality described for the Base Server and the Landing Pad may reside on the same server or on separate servers*.

The actual system design will depend upon the Contractor's proposed configuration. Depending on the Contractor's approved system architecture, the desired Landing Pad functionality may reside on the Base Server system.

1) **Base Server**: a KCWAN networked server system with full system redundancy located at a centralized KC server facility and containing data for the entire fleet (Revenue Vehicles at all Transit bases). This system shall provide desktop access to all OBS Administrator functions (see the **OBS Administrator Toolkit** in Appendix **K**) including those tools needed to accomplish the following:
   - Select, process, prioritize, stage, and transmit data to the Revenue Vehicles.
   - Receive, process, and distribute historical performance data from the Revenue Vehicles at the end of their service day, ensuring data safety.
   - Develop, stage, and transmit system parameters and configuration changes and software updates to the Revenue Vehicles.
2) **Landing Pad:** a KCWAN networked computer that will ensure uninterrupted operations for data exchanges with the Revenue Vehicles whether or not the KCWAN connection is viable. This computer shall be used to ensure a secure on- and off-load location for data streams to and from the Revenue Vehicle, providing the ability to manage vehicle data in the temporary absence of KCWAN connectivity. The data residing on this computer will be fully backed up.

The need for a separate Landing Pad may be obviated by the ability to retain a large enough quantity of data on the Revenue Vehicle so that temporary WAN disruptions do not affect the secure retention, transfer, and distribution of data between the Revenue Vehicle and the Base Server.

3) **AVM Signal**: The AVM Signal, located at each Base, will receive a vehicle health status message from the Revenue Vehicle immediately upon the vehicle's return to base, displaying one of three possible indicator lights: green, yellow, or red. This signal is used to provide easy identification of vehicles that will need maintenance work, allowing them to be parked in an accessible location in the yard away from the rest of the vehicles. An AVM Signal will be installed at each base in a central location(s) (e.g., fueling bay) to be agreed upon during system design. See use case ***RV3-Take Vehicle Out of Operation*** for a functional description of AVM signal generation and issues.

2.A.1.5.1.3. Communications Center (CC) Domain

Level 1: The existing Communications Center includes all of the existing CAD/AVL systems and functionality, including the interface with the Revenue Vehicle. KCM's existing Communications Center is located on the 12th floor of the Exchange Building at 821 2nd Ave, Seattle, WA 98104. The Coordinator workstations, radio/AVL hardware, software, and staff work out of that location. In Level 1, the OBS will *not* interface to this legacy CAD/AVL system.

Level 2: The new Communications Center facility is under construction by KCM and is planned for completion in 2005. It will house the new Coordinator workstations, and other hardware and software required for the new or upgraded Level 2 CCS. The new CCS and a modified OBS will interface with each other via the new radio system. Installation of Level 2 systems both in the CC and RV domains will be done in conjunction with the new radio system implementation.

2.A.1.5.2. Vehicle Logic Unit (VLU): Physical Requirements

The on-board VLU will be the central processing and data storage unit for all OBS operations. It will provide centralized connectivity with all legacy and new subsystems (see Section **2.A.1.5.3.** following). All software supporting this functionality and interfacing with these subsystems will run as part of the VLU's Master System described in Section **2.A.1.3.1.2, OBS Software**.

The VLU's random access memory and physical storage capacities shall be sized to provide 150% of processing and storage needs for all of the following simultaneously:

- All software required by OBS operation, including but not limited to operating systems, firmware, OBS software with complete sets of needed libraries and utilities, and configuration files including settable parameter values.
- A maximum of 14 consecutive working days' worth of collected historical data, AVM data, and OBS system diagnostics and performance data.
- A maximum of four service data sets and other types of data required for vehicle operation.

If items stored on the VLU exceed 85% of capacity, the system shall provide notification of same to the OBS Administrator.

Operational requirements for the VLU are detailed in use case ***RV1-Initiate Vehicle for Operation***.

2.A.1.5.3. Revenue Vehicle Subsystems: Definition and Requirements

All Contractor-provided subsystems shall comply with the following “subsystem” definition and modularity requirements. Subsection **2.A.1.5.4**, **Revenue Vehicle Subsystems,** provides a detailed description and technical requirements for each of the vehicle’s subsystems.

2.A.1.5.3.1. Subsystem Definition

Legacy subsystems shall be integrated and interfaced to the OBS in a manner compliant with this definition. For the purposes of this specification, a subsystem is defined as a peripheral hardware device or interconnected set of devices which are external to the VLU but reside on one or more Revenue Vehicles. A subsystem must do all of the following:

- Communicate via a standardized protocol and data format such as TCIP, TCP/IP, J1708/J1939, J1587 or a KCM-approved alternative, and use standard connectors and data transport media such as RS232, RS485, Ethernet, etc.
- Provide an interface and data exchange with the VLU (*Master System*), to support the functionality described in the associated use cases listed in the “Function (Use Case Reference)” column of the Table ***2.A.1.5.3, Revenue Vehicle Subsystems*** below.
- Provide an open, public interface described by a published ICD. See Appendix C for ICD requirements.

2.A.1.5.3.2. Revenue Vehicle Subsystem Modularity

Subsystems and their connectivity to the VLU’s Master System will be designed to facilitate subsystem replacement or upgrade without requiring major modifications to the rest of the OBS (see Subsection ***2.A.1.3.1.2.2,* VLU Master System**). Application software within the subsystem may be proprietary, provided that any of its required configurable parameters and management tools are included as part of the associated use-case interface. The vehicle’s subsystems are listed in Table ***2.A.1.5.3*** below and detailed descriptions of each subsystem follow.

Subsystems that will be provided by the Contractor are considered new. These have the “Responsible Party” identified as "OBS Contractor" and will be required system deliverables. Those subsystems that have the “Responsible Party” identified as "KCM" describe legacy (existing) subsystems with which the Contractor is required to interface and, in some cases, upgrade. All other subsystems are to be provided by ERG, the contractor for the RFCS project; the to-be-selected contractor for the TRS project; or other KCM contractor or supplier.

Table 2.A.1.5.3. Revenue Vehicle Subsystems

Subsystem	Responsible Party	Manufacturer	Brief Description	Device(s) (Hardware)	Cross-reference (For Use Cases, Part C, Sections 2 and 3)
APC (Automatic Passenger Counting)	**OBS Contractor**	TBD	Detect, count, and report passenger boardings and alightings	- APC Processor - APC Sensors	***RV9-Monitor Stop Point Activities***
AVM (Automatic Vehicle Monitoring)	**OBS Contractor**	**RV OEM:** - Gilllig - New Flyer - Champion - etc. Note: see	Capture, log, filter, & report AVM data from: - OEM drive train via an Engine Control Module (ECM) - I/O sensors inputs Signal RV Status: - Signal and report AVM alarms. - Signal vehicle health status on AVM Alarm Signal	- I/O sensors - Multiplexor: I/O monitoring device, as required - AVM Alarm Signal	***RV11-Manage AVM***
DDU (Driver Display Unit)	**RFCS**	ERG	Primary interface and control point for RV Operator.	DDU	***RV12-Interface to DDU***
Destination Signs	**KCM**	Luminator Twin Visions	- Store all sign codes and associated display text. - Control exterior signage via VLU.	Destination-sign processor and all exterior signs	***RV13-Interface to Destination Signs; Subsection 1.B.4.5, Destination Signs***
DVRS (Digital Video Recording Systems)	**KCM—under installation**	Transit Security Systems	- Record on-board video and save (protect) event footage. - Provide a live link to Transit Police. - Provide automated video download via WLAN.	- DVRS - Security microphone	***RV15-Interface to DVRS***
EA (Emergency Alarm)	**KCM**	TBD	Provide silent alarm from Revenue Vehicle to the Communications Center via the existing radio system. Level 2: OBS VLU must properly activate & deactivate all required functions.	Floor switch and connections to: - Level 1: legacy radio and MDU/RCU; - Level 2: new radio and VLU	***RV6-Manage Events***; ***RV17-Interface to 700 MHz Radio***; ***CC6- Respond to Revenue Vehicle Communications***

Subsystem	Responsible Party	Manufacturer	Brief Description	Device(s) (Hardware)	Cross-reference (For Use Cases, Part C, Sections 2 and 3)
FTP (Fare Transaction Processor)	**RFCS**	ERG	Smart card reader, fare collection processor, and customer interface for smart-card transactions.	FTP and card reader	***RV14-Interface to FTP***
Interior Sign	**OBS Contractor**	TBD	Passenger information display (PID) device to provide automated interior signage.	Interior Sign	***RV10-Manage PA and Annunciator***
OB AVL (On-Board Automatic Vehicle Location)	**OBS Contractor**	TBD	Modular software component of the VLU that collects location information from various peripheral sensor devices to determine vehicle's geographical location over time.	<u>Required Sensors:</u> - GPS receiver - Odometer <u>Optional Sensors:</u> - Gyroscope - Signposts - Other	***RV7-Determine Vehicle Location***
PA System (Public Address)	**KCM & OBS Contractor**		Provides PA system for inside and outside the Revenue Vehicle for Operator and automated announcements.	<u>KCM-Provided:</u> - Speakers - PA Microphone <u>Contractor-Provided:</u> - PA Amplifier - Ambient Noise Detection	***RV10-Manage PA and Annunciator***
Radio (Level 2)	**TRS**	TBD – RFP scheduled for release in 2004	Provides voice communications, text messaging, decoding of data messages received from the CCS, response to poll messages and commands from CCS, and critical alarm reporting.	700 MHz mobile radio	***RV17-Interface to 700 MHz Radio***
TSP (Transit Signal Priority)	**KCM**	Tag-McCain Traffic Optional Wireless-KCM & OBS	Provide information to traffic signal controller to obtain signal priority when needed.	- AVI Tag Unit	***RV16-Interface to TSP Tag***
WLAN (Wireless Local Area Network)	**RFCS & OBS Contractor**	Cisco	Wireless data exchange medium between RV and the Base	- On-board Wireless card - On-board router - Wireless access points at bases	Subsection **2.A.1.6.3, Wireless Local Area Network**

2.A.1.5.4. Revenue Vehicle Subsystems

The following subsystems shall be included as part of Level 1 functionality. The VLU (*Master System*) shall have a means for monitoring and reporting the health status of each subsystem and device. A description of VLU software requirements is included in Part C, Subsection **2.A.1.3.1.2.2, VLU Master System**.

2.A.1.5.4.1. Automatic Passenger Counting (APC)

The APC functional requirements are described in the ***RV9-Monitor Stop Point Activities*** use case. The APC hardware shall include the following:

- Sensors, probably infrared or optical, at each Revenue Vehicle door to detect passenger boardings and alightings.
- APC processor(s) that provides passenger count data to the VLU including:
    - Boardings for each door.
    - Alightings for each door.
    - Boardings via the wheelchair lift or ramp.
    - Alightings via the wheelchair lift or ramp.
    - Aggregate passenger load, if APC subsystem is able to calculate. If not, the VLU will calculate.
    - Changes in door(s) status: open or closed.

2.A.1.5.4.2. Automatic Vehicle Monitoring (AVM)

The AVM requirements are described in the ***RV11-Manage AVM*** use case. AVM deals with collecting data on a Revenue Vehicle's engine, brake, and transmission systems performance in order to identify problems, improve maintenance, and reduce vehicle breakdowns. The AVM data will be collected from the Engine Control Module (ECM) provided by the vehicle's manufacturer and from multiple I/O sensors that will be added by OBS. These I/O sensors will monitor additional mechanical and electrical systems that are not addressed by the ECM computer.

The AVM hardware shall include the following:

- Connections to the ECM computer(s).
- I/O Sensors—a maximum of 24 sensors needed to monitor KCM's selected vehicle systems' changes of state.
- Multiplexor—the OBS shall connect the VLU to the various I/O sensors, collecting and logging individual "change of state" data streams from each sensor. Some newer vehicles already have an installed "data bus" which may be utilized for connecting to the I/O sensors. However, the majority of the fleet will not have the capability to monitor I/O sensors and shall require the installation of a multiplexing unit (multiplexor) or other similar device.
- AVM Signal—a display device or LED sign installed at each Transit base that automatically indicates the vehicle's health status for use by maintenance workers. This information will be received via the WLAN from the Revenue Vehicle when it returns to the base.

2.A.1.5.4.3. Driver Display Unit (DDU)

The DDU functional requirements are described in the ***RV12-Interface to DDU*** use case. It is the primary interface for the Operator to interact with the OBS and its integrated subsystems. The RFCS contractor, ERG, will provide the DDU hardware as part of its smart-card implementation. The OBS/CCS Contractor will collaborate with ERG to develop the interface to the VLU and modify the DDU displays to add new screens, menus, and interface "buttons" for requisite OBS functionality.

2.A.1.5.4.4. Destination Signs

KCM has several makes and models of exterior destination signs which are described in Subsection **1.B.4.5, Destination Signs**. Functional requirements are described in ***RV13-Interface to Destination Signs***. Those destination signs that are to interface with the VLU will have a processor for storing sign codes and the display parameters associated with each code. The only hardware required for interfacing to these signs should be connectors and cabling. Each destination-sign system includes:

- Destination-sign processor.
- Exterior signs (front, side, rear, etc.)—the specific number and placement of exterior signs varies by vehicle fleet type.

2.A.1.5.4.5. Digital Video Recording System (DVRS)

The DVRS includes cameras and a processor for the continuous recording of digital video during Revenue Vehicle operation. Recording which takes place during Emergency Alarms (see following subsection) is protected (designated read-only) for subsequent transmission via the WLAN to the Transit base. The Contractor shall provide the connector(s) and cabling required to support the requirements described in the ***R15-Interface to DVRS*** use case. The OBS design shall also address the WLAN requirements of the DVRS for both the data exchange at the transit base and a secure, live video link for Transit Police who are within broadcast range during Revenue Vehicle operation.

2.A.1.5.4.6. Emergency Alarm (EA)

The EA is a silent alarm that is activated when an operator presses a foot switch located to the left of the brake pedal. EAs have the highest priority of all processes on the RV and in the Radio/AVL system. Currently, when a Coordinator (in the Communications Center) accepts an EA, the following events occur, in sequence:

1. The vehicle's location is displayed on that Coordinator's AVL screen.
2. A Coordinator Service Record is opened.
3. An EA Acknowledgment message is sent to the vehicle.

The EA switch is currently connected to two devices:

- The Radio/AVL equipment, to provide reliable, redundant silent alarm capability.
- The DVRS processor, to trigger the protection (read-only status) of recorded video footage surrounding and including the EA event.

The EA switch connection uses a self-monitoring circuit. Switch activation or any disturbance to the switch or switch cable causes an EA to be sent over the radio. The current system sends an EA “blind” on a voice channel and then as a contention message on a data channel. This process continues until an EA Acknowledgment is received.

In Level 1, the VLU will *not* directly interface to the EA switch. In Level 2, with the addition of the new mobile radio, the VLU will be connected directly to the EA switch to provide the functionality described in the ***RV6-Manage Events*** use case. This direct connection is essential to ensuring the reliability of the alarm. The OBS design will define how the EA switch is to be connected to the VLU.

2.A.1.5.4.7. Fare Transaction Processor (FTP)

The FTP will provide smart-card fare-collection functions including storing fare tables, performing transactions, storing fare-transaction data and providing the passenger interface for smart-card fare transactions. ERG, the RFCS contractor, will provide the FTP hardware. ERG also will enable operator login functionality using its smart-card technology. FTP requirements are described in the ***RV14-Interface to FTP*** use case.

2.A.1.5.4.8. Interior Sign

The Contractor shall provide a passenger information display (PID) device that meets the requirements set forth in the ***RV10-Manage PA and Annunciator*** use case. Most vehicles will have at least one interior sign with the sole exception of articulated vehicles, which will have two signs.

Signs will display "Next Stop" information as well as date/time information and other preformatted messages.

2.A.1.5.4.9. On-Board Automatic Vehicle Location (OB AVL)

OB AVL functional requirements are detailed in the ***RV7-Determine Vehicle Location*** use case. The OB AVL will be comprised of both a modular software component of the VLU, which contains the vehicle location algorithm, and peripheral sensor devices, which provide a variety of location-information inputs. The OB AVL software module and its associated input sensors shall comply with the “subsystem” definition provided in Part C, Subsection **2.A.1.5.3** above. OB AVL sensors will include:

- GPS unit.
- Odometer.
- One or more additional devices (see Part C, Section **2, Table 2.A.1.5.3** above).

2.A.1.5.4.10. Public Announcement (PA) System

The PA system to be provided will utilize the vehicle’s existing speakers and Operator microphone. The existing PA switch is also available for use if compatible with the Contractor’s proposed design. PA system requirements for on-board and on-street announcements from the RV are set forth in the ***RV10-Manage PA and Annunciator*** use case.

The Contractor will provide the following hardware for the Level 1 implementation:

- A variable-gain PA amplifier.
- Ambient Noise Detection.
- PA Switch—to be provided if KCM’s existing PA Switch is not compatible with the Contractor’s proposed PA system.

2.A.1.5.4.11. Radio System (Level 2 Only)

In Level 1, the VLU will *not* be required to interface with the existing 450 MHz Radio/AVL system. Instead, needed equipment and systems will be provided by the RFCS project to support the legacy radio system requirements (see Subsection **1.C.2.1, RFCS Equipment**) and this installation will function independently from the Level 1 implementation.

In Level 2, the TRS contractor will implement a new radio system and the legacy radio system will be eliminated. At that time, the Level 1 OBS functionality must be extended to manage radio communications as described in the ***RV17-Interface to 700 MHz Radio*** use case located in Subsection **3.B.4**. The Contractor shall be responsible for the following:

- Providing an appropriate connector and cabling between the new radio and the VLU. In the interest of efficiency, these will be installed if possible, but not activated, with the Level 1 equipment.
- Collaborating with the TRS contractor to develop an ICD between the VLU and the new mobile radio that will allow KCM, in the future, to replace the radio make/model without changing the communications scheme between the RV and the Communications Center.

Additionally, the CCS shall have a defined interface for changing OBS operating parameters for the management of events such as changing or disabling the vehicle's schedule or route-adherence thresholds. The ICD for the radio shall give KCM the ability to replace the radio on the vehicle without changing the communications scheme between the vehicle and the Communications Center.

2.A.1.5.4.12. Transit Signal Priority (TSP)

Every Revenue Vehicle currently has a TSP Tag (also called an Amtech RF tag) mounted on the outside of the vehicle above the windshield and connected to the LonWorks network via an RS232 connection. The tag remains passive until activated by a roadside antenna and Amtech tag reader unit. The OBS shall connect to the TSP Tag and support the requirements in the ***RV16-Interface to TSP Tag*** use case.

2.A.1.5.4.13. Wireless Local Area Network

The Contractor shall provide a WLAN communications link for data exchanges between the Revenue Vehicle and the Base Operations domain. This system will also be used by the Transit Police for real-time monitoring of the DVRS video broadcast when equipped police vehicles are within broadcast range. The OBS design shall describe how the existing WDOLS devices and access points will be upgraded to meet the needs of the Level 1 and Level 2 implementations. Also, at KCM's option, the WLAN may be required to support communications between the Revenue Vehicle and roadside equipment such as a traffic signal controller as described in Subsection **2.A.4.1.1, Wireless TSP**.

2.A.1.6. Communications Layers

The OBS will utilize three primary methods of communication among and within the Project's three domains (see Section **2.A.1.5.1.** above), each with its own type of connective layer, as follows:

a. **Level 1**:

  i. <u>WLAN</u>: Revenue Vehicle to Base via the Wireless Local Area Network.

  ii. <u>VAN</u>: VLU to Subsystems, excepting only the EA, via the Vehicle Area Network.

b. **Level 2**:

   i. TRS: Revenue Vehicle to Communications Center (OBS to CCS) via the new Transit Radio System

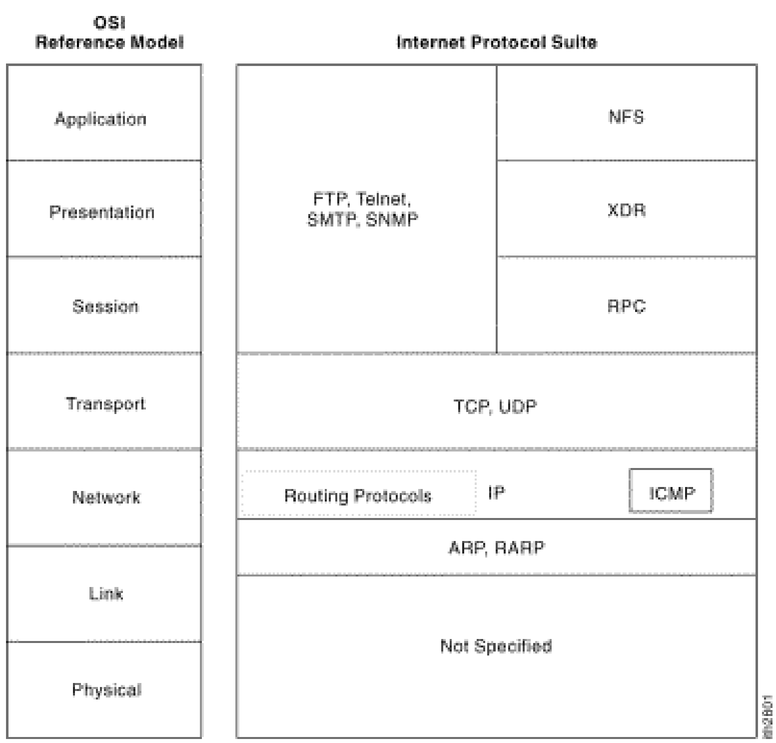
All three of these communications modes shall be implemented as either an upgrade or a replacement to a preexisting, functioning system. Each implementation shall require a separate migration plan (See Section **2.A.3.1.2.3, Level 1 Design Phases' Deliverables**) for moving to the new systems without adversely affecting ongoing operations. Additional information on the Communications Layers is provided in Subsections **1.B, Description of Existing Systems, 2004,** and **1.C, Systems Development and Implementation Environment**.

The Contractor shall replace the vehicle's current legacy LonWorks network with a Vehicle Area Network. This VAN will support all OBS requirements for data exchanges between the VLU and all attached subsystems and devices.

2.A.1.6.1. Protocols and Standards

2.A.1.6.1.1. Standard Interfaces and Protocols

In keeping with this project's commitment to modularity, all parts of the on-board data network architecture must use open standards as defined by OSI model. The OSI model is defined by layers one through seven and is used to define the Transmission Control Protocol and Internet Protocol (TCP/IP).



OSI REFERENCE MODEL

The OSI Reference Model is based on a proposal developed by the International Organization for Standardization (ISO). The OSI model has seven layers.

7) **Application** : Provides different services to the applications.

6) **Presentation** : Converts the information.

5) **Session** : Handles problems which are not communication issues.

4) **Transport** : Provides end-to-end communication control.

3) **Network** : Routes the information in the network.

2) **Data Link** : Provides error control between adjacent nodes.

1) **Physical** : Connects the entity to the transmission media.

2.A.1.6.1.2. Internet Protocol

The Internet Protocol (IP) is a network-layer (Layer 3) protocol that contains addressing information and some control information that enables packets to be routed. IP is documented in RFC 791.

2.A.1.6.1.3. Physical Network Standards

The physical network data wiring shall use the Ethernet standards as defined in the IEEE standards known as 802.3.

2.A.1.6.1.4. Network Protocol Standards

TCP/IP version 4 shall be used for all data communication between network-connected devices. All networking devices shall have the ability to upgrade to TCP/IP version 6 by the year 2005.

2.A.1.6.1.5. Wireless Transmission Protocol Standards

The wireless connectivity between the Revenue Vehicle and the transit base may use one or a combination of standards defined by the IEEE as 802.11a, 802.11b, and 802.11g. The 802.11x standards use the 2.4 GHz and 5 GHz radio spectrum known as the unlicensed band. The WDOLS system, provided by the DVRS project, is using the 802.11b standard in the 2.4 GHz spectrum. A licensed spectrum alternative is discussed in **Section 2.A.4.1.3, Licensed Spectrum for WLAN**.

2.A.1.6.2. Transit Radio System

2.A.1.6.2.1. Level 1 450 MHz Radio/AVL System

In Level 1 the OBS will *not* have an interface to the existing 450 MHz Radio/AVL System. The RFCS project will provide the devices and controls necessary to operate the legacy 450 MHz Radio/AVL system, and this arrangement will be in place during Level 1 implementation. The RFCS contractor will support the current radio-system functionality by connecting the new Driver Display Unit (DDU) to the legacy Mobile Data Unit via an adapter called the Radio Control Unit (RCU). The DDU and RCU will enable KCM’s legacy radio/AVL system to function in the same manner that it does today.

Production RFCS devices will be made available to the Contractor early in the Level 1 design process including:

- DDU (see use case ***RV12-Interface to DDU***).
- RCU: for Level 1 test bench, no interface required.
- FTP (see use case ***RV14-Interface to FTP***).
- WDOLS: including equipment installed both on board the Revenue Vehicles and at the transit bases. See Section **2.A.1.6.3, Wireless Local Area Network** below.

2.A.1.6.2.2. Level 2 TRS

Level 2 modifications to the OBS primarily relate to the use of the new 700 MHz radio system and communication with the Level 2 CCS implementation in the Communications Center. Detailed radio communications-layers requirements for Level 2 are provided in Subsection **3.A, Level 2 Statement of Work**.

2.A.1.6.3. Wireless Local Area Network

The Contractor will upgrade the legacy Wireless Data On/Off Load System to provide an integrated WLAN system that fully meets each vehicle's increased data-exchange requirements. The WDOLS system is currently under construction for the DVRS project and will be upgraded during the RFCS implementation. KCM will provide detailed descriptions of the RFCS system specification and architecture, and as-built documentation of the same as soon as these are available.

2.A.1.6.3.1. General WLAN Requirements

The Contractor shall be responsible for providing a WLAN to meet all performance requirements specifically outlined in this section and as required to meet all other functional and technical requirements provided in this RFP. Aerial photographs of each transit base and peak load information is provided in Appendix **B, Transit Bases Information**.

Proposers shall, in responding to this section, take into account the following baseline requirements:

a. The WLAN shall provide the connectivity between Revenue Vehicles and the Base Server(s) supporting the full data-exchange requirements of OBS/CCS.

b. The WLAN shall serve all seven of Metro Transit's operating bases: Atlantic, Bellevue, Central, East, North, Ryerson, and South. In addition, the WLAN will serve the South Training facility adjacent to South Base.

c. All vehicles, including those temporarily assigned to Operations Training, shall be synchronized with the rest of the fleet in terms of on-board data, system configurations, and the daily off-load of automatic vehicle maintenance (AVM) data.

d. Each location shall be configured with sufficient access points to provide the necessary coverage and throughput to support the required upload and download data volumes for OBS, RFCS, and DVRS within the required operational time frames described in Subsection **2.A.1.6.3.6** below. Maps of base layouts are provided in Appendix **B, Transit Bases Information**.

e. The WLAN shall not be a stand-alone system intended for OBS use only. It will serve multiple devices and systems on board KCM transit vehicles, and multiple servers and processes located on the KCWAN that support those systems.

f. Currently the DVRS project has security-camera systems installed on 160 vehicles, is funded for up to 400, and is expected to continue to expand as new bus fleets are procured. The WLAN shall be sized to support the data throughput with a fleet-wide deployment of the DVRS system.

g. The on-board WLAN shall be configured to support an additional feature of the DVRS. Transit police cars are equipped with "briefcase" WLAN and laptops to facilitate real-time viewing of on-board video during security incidents, if the police car is within receiving range of the wireless system.

h. It is King County's intention to use the most recent and most advanced solutions for network security, user authentication, and data encryption in the implementation of the WLAN. King County's Information and Telecommunications Services Division manages the KCWAN (see Section **1.B.6.6, KCWAN**), and shall have final approval for all network security and configuration options proposed for implementation during this Project. The connection to the KCWAN is via a Cisco network implemented for the DVRS project. The existing WDOLs configuration for this purpose is described in more detail in Section **1.B.4.8, WDOLS**.

   The WDOLS configuration currently under deployment is to be enhanced by ERG, the RFCS vendor, during their final system design in 2004. This configuration will meet the requirements of the RFCS project. Additional technical information, if any, regarding the WDOLS configuration beyond what is provided in Subsection **1.B.4.8** will be provided by Addendum when it becomes available.

i. The WLAN, or KCM Project Manager-approved alternative, shall support the communications requirements of the AVM Signal and, optionally, wireless TSP. (See Subsection **2.A.4.1.2, Wireless TSP**.)

Table **2.A.1.6.3.1** summarizes the involved systems and their uses of the WLAN.

Table 2.A.1.6.3.1. Systems To Be Supported by the WLAN

System	Transmissions from Vehicle	Quantity & Frequency	Transmissions to Vehicle	Quantity & Frequency
Digital Video Recording System (See items *f* and *g* above)	Transmit video "event" files and diagnostic data to base	About 20 MB per incident; may or may not involve multiple incidents per day	Set parameters and check system status while coach is in the yard	Quantity and frequency vary
Regional Fare Coordination System	Transmit fare transactions, event files, and other system data to base.	About 200K (?) daily or twice a day if coach goes out on two assignments	Transmit fare tables, "hot list" of blocked cards, configuration data, and other updates	About 200K (?) daily or twice a day if coach goes out on two assignments
OBS—Vehicle to Base's Data Acquisition Computer	Transmit vehicle data to base as required by OBS/CCS scope	Quantity and frequency estimates to be provided by OBS proposers, based on RFP requirements	Transmit vehicle data as required by OBS/CCS scope	Quantity and frequency estimates to be provided by OBS proposers, based on RFP requirements
OBS—Vehicle to AVM Signal	Transmit vehicle status information to AVM Signal at base as required by OBS/CCS scope	Vehicle status indicator should be based on a very small amount of data downloaded each time the vehicle returns to a base.	N/A	N/A

2.A.1.6.3.2. WLAN Encryption

The network data being transmitted between the bus and the transit base shall be protected from unauthorized access and/or tampering. The data shall be protected during transmission over the wireless network. The WLAN encryption solution shall satisfy the following requirements:

a. The encryption shall meet the National Institute of Standards and Technology (NIST) standards as defined in FIPS-197 or FIPS 46-3.

b. No proprietary encryption or key management software will be used to protect the transmission of data or encryption keys.

c. The management of encryption keys shall not be accomplished using pre-shared keys.

d. All encryption shall use so-called public key-based key management using Certificates of Authority.

e. The OBS/CCS Contractor's proposed encryption method shall be subject to the review and approval of the County's ITS Division and the OBS/CCS Project Manager.

2.A.1.6.3.3. WLAN Architecture

The wireless architecture solution to be provided by the Contractor shall include the following criteria and technological strategies to insure safe, reliable, and secure communications between the KCWAN and mobile CPUs located on each bus.

a. The OBS/CCS Contractor's proposed authentication and encryption solutions shall be compatible with the County's Cisco-based network and shall use the most current commercially available technology. The proposed solution shall be subject to the review and approval of the County's ITS Division and the KCM Project Manager.

b. The final solution should account for bandwidth and fault tolerance considerations. Wireless Access Points (WAPs) should be strategically and abundantly placed to provide sufficient coverage of each base so that mitigation of bandwidth issues insure that data can be quickly and efficiently transmitted to and from the vehicle during peak traffic times.

c. The system shall support peak load requirements for file transfers with 99.9% accuracy within 30 minutes after vehicle shutdown.

d. The systems on board shall track the status of all file transfers and shall resume transfers of data from point of interruption.

e. To the greatest extent possible and practical, the Revenue Vehicles should be isolated from other subnets and unauthorized users on the KCWAN in order to minimize their vulnerability to viruses and worms.

2.A.1.6.3.4. WLAN Communications to Base

The system architecture proposed by the Contractor shall provide an efficient and robust system for assuring reliable and adequate data-storage capacity to meet specified requirements. See Sections **2.A.1.5.1.2, Base Operations Domain** and **2.A.1.7, Data Collection, Management and Reporting** for server equipment and data management requirements.

The Base Operations domain shall have a data acquisition computer that provides continuous, uninterrupted operations to receive, secure, process, and transmit datasets to designated locations. The following use cases contain functional requirements for such operations:

- ***BO1-Verify Vehicle Configuration***
- ***BO2-Update Vehicle Data***
- ***BO3-Manage Historical Data***
- ***RV1-Initiate Vehicle for Operation***

2.A.1.6.3.5. WLAN Spectrum Alternatives

Proposals shall include a solution for each of the alternatives for WLAN spectrum outlined below.

2.A.1.6.3.5.1. Alternative 1: Unlicensed Spectrum

Continue to use unlicensed spectrum, and upgrade WAP infrastructure and on-board devices as required. Under this option, the Contractor will upgrade the infrastructure of WAPs as required to support the communication requirements of OBS, RFCS, and the DVRS system.

In evaluating this alternative, Proposers may assume the reuse of the on-board WDOLS equipment installed by the Regional Fare Coordination system.

The WLAN currently installed uses 802.11b technology. King County is open to continuing to use this technology, if Proposers can show that it meets or exceeds the contract performance requirements, or to upgrading to newer wireless protocols such as 802.11g or the anticipated 802.11j. In responding to the RFP questions for this section of the RFP, Proposers shall provide a detailed discussion of their analysis and recommendations for which technology to use in this deployment. A list of required questions to be addressed in this discussion is provided in Subsection **2.C, Level 1: SOW Vendor Questions**.

2.A.1.6.3.5.2. Alternative 2: Licensed Spectrum

See Subsection **2.A.4.1.1, WLAN with Licensed Spectrum**.

Use licensed spectrum, and replace WAP infrastructure and mobile devices as required. Under this alternative, the Contractor will replace or upgrade all fixed and mobile components of the WLAN that use unlicensed spectrum with devices that use licensed spectrum. Within Alternative 2, options such as 4.9 GHz and 5.9 GHz may be proposed; the key requirement that must be addressed is the adoption of licensed spectrum rather than unlicensed spectrum.

In responding to the RFP questions for this section of the RFP, Proposers shall provide a detailed discussion of their analysis and recommendations for which technology to use in this deployment. A list of required questions to be addressed in this discussion is provided in Subsection **2.C, Level 1: SOW Vendor Questions**.

2.A.1.6.3.6. Operational Environment for the WLAN

This subsection summarizes the operational context in which the WLAN will function. Transit vehicles have two limited windows of time during which they will be within range of the WLAN and available for communications to and from the KCWAN: either before their scheduled “pull-out” or after their scheduled “pull-in.” These two periods are discussed below.

2.A.1.6.3.6.1. Pull-out Time

a. Pull-outs occur when vehicles are scheduled to leave the base. Operators have 10 minutes from their scheduled “sign-in time” inside the operations building, before they are scheduled to drive out of the yard. Typically, Operators will turn on the coach and spend no more than 1-3 minutes in the yard, completing their coach inspection and setup, before leaving. Some Operators take a little longer to complete this process, while others may complete it early and leave before their scheduled pull-out time.

b. Peak-hour pull-outs for each base may exceed 100 vehicles per hour. A base-by-base summary of pull-in and pull-out activity is provided in Appendix **B, Transit Bases Information**.

c. A working assumption for WLAN operation is that due to the operational time constraints and typical equipment boot-up times, only the most critical uploads should be scheduled to occur during the pull-out window. Vehicles that are Initiating for Operation shall have priority over vehicles that are transferring files at the end of the service day. The OBS Administrator shall have the automated tools and flexibility to manage this process.

2.A.1.6.3.6.2. Pull-in Time

a. Pull-ins occur when vehicles return to the base. Depending on weather and traffic, pull-ins are more often late than early, relative to their scheduled arrival time.

b. A working assumption for WLAN operation is that the best time to perform most uploads and downloads will be after pull-in, when the coach has been parked but systems are still available for communications.

c. Peak-hour pull-ins for each base may exceed 100 vehicles per hour. When a coach returns to the base and is parked and shut down, the on-board systems typically will remain powered up for approximately one hour after the shut-down. This shall be a settable parameter in the VLU. Vehicles also may be powered up again at any time to be moved for washing and fueling, maintenance and other activities; and unscheduled bus movement around the base may occur at any time. Each time the coach is restarted, the shut-down process is reset for another hour. A base-by-base summary of pull-in and pull-out activity is provided in Appendix **B, Transit Bases Information**. It should be noted that random coach movements for maintenance are not reflected in these charts.

d. During maintenance activities a coach may be started and turned off multiple times, without regard for the state of on-board systems or communications with the WLAN.

2.A.1.6.3.7. WLAN Performance

The minimum performance requirements for the WLAN are as follows:

- The system shall support 150% of peak load requirements estimated in Table ***2.A.1.6.3.1, Systems To Be Supported by the WLAN***, including the peak load requirements submitted by the OBS/CCS Contractor.
- All data transfers must be completed with 99.9% accuracy within 30 minutes after vehicle shutdown.
- The system shall track the status of all *data* transfers and shall resume interrupted transfers from point of interruption, if possible. When transferring files, it is understood that transfers will likely have to resume not from the point of interruption, but from a point after the last successfully transferred file (i.e., from the beginning of the file that was interrupted).

The WLAN shall be designed with the ability to expand bandwidth/throughput by adding or upgrading base equipment.

The WLAN shall be designed with the ability to add new WAP sites either at an existing transit base or at other sites yet to be determined.

2.A.1.6.4. Vehicle Area Network (VAN)

A VAN shall be provided with the Level 1 system that will enable the VLU to satisfy all functional requirements for data communications with all integrated subsystems and devices. The legacy vehicle area networks will either be replaced or incorporated into the new on-board network architecture.

Subsection **1.C.7.2, RFCS LIM Architecture** provides a high-level block diagram of networks that should be in place before Level 1 implementation, and Section **1.C.7.3, Level 1 Architecture** provides a diagram of how the architecture might look after Level 1 implementation. These diagrams show that when Level 1 is implemented a new VAN shall be installed to accomplish the following:

- Replace LonWorks interface to the TSP Tag.
- Interface with all of the Subsystems and Devices listed in the table below.
- Provide a high-speed Ethernet connection to the WLAN.

2.A.1.6.4.1. Vehicle Area Network Requirements

The overall VAN requirements are meant to provide the capacity and performance necessary to meet the functional and technical requirements described in Section **2.B, Level 1: Functional Requirements (Use Case Specifications)**.

The OBS VAN shall utilize cabling and protocols supported by published standards, and shall provide for asynchronous messaging.

2.A.1.6.4.1.1. Bandwidth

The VAN shall provide the bandwidth required to support the transfer of data files and messages to connected subsystems identified in Table ***2.A.1.6.4.1, Subsystems/Devices on the VAN*** below.

2.A.1.6.4.1.2. Performance

The performance requirements for the network connection vary by subsystem/device. Overall performance of the network must allow all message traffic to be handled error-free within a maximum of 500 milliseconds. Radio message traffic must be handled in real time.

Table 2.A.1.6.4.1. Subsystems/Devices on the VAN

Subsystem/Device	Data	Messages*	Use Case
APC Processor	Configuration data?	Passenger counts →	*RV9-Monitor Stop Point Activities*
ECM Multiplexor or Data Bus		ECM data/alarms → I/O Sensor data →	*RV11-Manage AVM*
Destination Signs	Sign Code data	Update sign code ↔	*RV13-Interface to Destination Signs*
Door Sensors Lift/Ramp Sensors	N/A N/A	Open/closed → Deployed/stowed →	*RV9-Monitor Stop Point Activities*
DDU	Configuration data	All Operator display messages ↔ Error codes →	*RV12-Interface to DDU*
FTP	Hot lists Configuration data Valid OID lists	Transactions ↔ Fare set ↔ Trip change ↔ Zone toggle ↔ Error codes →	*RV14-Interface to FTP*
Interior Sign(s)	Configuration data?	Update display ← Error codes →	*RV10-Manage PA and Annunciator*
Level 2: CCS 700 MHz Radio	Configuration data?	<u>Audio</u>: Handset, Hailing Speaker, Security Microphone, etc. ↔	*RV17-Interface to 700 MHz Radio*

Subsystem/Device	Data	Messages*	Use Case
		Real-time Data: AVL, RTT/PRTT, etc. ↔	
DVRS Security Camera(s)	Configuration data?	Save Event → Error codes →	*RV15-Interface to DVRS*
TSP	N/A	TSP Tag Updates ↔	*RV16-Interface to TSP Tag*
* Data flow direction is indicated by the associated arrow as follows: → one-way communications from subsystem to the VLU. ↔ two-way communications between the subsystem and VLU. ← One-way communication from VLU to subsystem.			

2.A.1.6.4.2. Existing Vehicle Area Networks

KCM's entire fleet of revenue vehicles currently has the following VAN resources.

2.A.1.6.4.2.1. LonWorks

This network is to be abandoned and replaced by the new OBS VAN.

2.A.1.6.4.2.2. J1708/J1939 and J1587

Every vehicle has a backbone cable installed. The majority have a J2496 backbone cable which was installed by the bus manufacturer and which is not currently being used. The J2496 cable can carry J1708/J1939 and power. The older Gillig fleets (VID's 3200-3594 and 3185-3199) were purchased before the J2496 standard was published and have six twisted pair cablings installed, none of which are being used.

2.A.1.6.4.2.3. Ethernet

The RFCS project plans to install an Ethernet hub to support the requirement to transfer data at high speed to the WDOLS for transfer to/from the base.

2.A.1.7. Data Collection, Management, and Reporting

The OBS will support all current business needs for data loading, collection, and reporting, both for in-house use and to meet federal and state reporting requirements. Reporting requirements for off-loaded, historical data are detailed in the ***BO3-Manage Historical Data*** use case.

On-board data collection will include the date, time (expressed with an accuracy of not less than hours, minutes, and seconds), and location of each logged event's occurrence. Each event will be uniquely identified by vehicle ID, block of work (if in revenue service), GPS location, Operator ID, and unique, pseudo-coded ID provided by the VLU. See the ***RV6-Manage Events*** use case for detailed requirements.

All off-loaded data will be available in both its original format (as received from the vehicle) and in a translated format that meets TCIP standards. NOTE: Specific TCIP standards to be used for implementation will be determined by joint agreement between KCM and contractor during Preliminary Design Review. See Subsection **2.A.1.2.1.2, TCIP Compliance and Conformance** for additional requirements.

2.A.1.7.1. Seamless Data Updates for the Revenue Vehicle

The following data update/replacement requirements are detailed in the ***RV4-Update Vehicle Data*** and ***BO2-Update Vehicle Data*** use cases, which also include a preliminary list of all data types residing on the vehicle. The Contractor and KCM will jointly assemble a complete list of data requirements for transfer during system design. The Contractor will provide a method of updating and replacing one or more sets of data residing on the Revenue Vehicle on an as-needed basis. Although route and schedule updates generally are performed on a bi-weekly basis, many vehicle updates will occur on a nightly basis.

2.A.1.7.1.1. Data Update Trigger

A "trigger" transmitted with each new data set will activate the service data set residing on the vehicle. This type of trigger will also be replaceable by subsequent transmittal to the vehicle and such replacement will not require retransmission of the linked data set.

2.A.1.7.1.2. Primary and Foreign Keys

Each set of data sent to the vehicle will be identified by either a primary-key value or a foreign-key value. This value will be used to trace back to the original data source for debugging purposes. The Base Server and the Revenue Vehicle will independently track information regarding version(s) and content of all data residing on the vehicle.

2.A.1.7.1.3. Version Control

Version control will be maintained on a per-vehicle basis through periodic comparisons that typically will occur daily, but may occur more frequently. Any identified discrepancy will generate an alarm to the OBS Administrator. The OBS Administrator's Toolkit will also provide the ability to initiate a request for the Revenue Vehicle to transmit one or more of its service data sets. These will then be used to check for discrepancies between the vehicle's data sets and those stored on the base server. Any configuration or version conflict shall be reported to the OBS Administrator.

2.A.1.7.1.4. Data Structure

The structure of all data on the Landing Pad and the vehicle, and required update and replacement processes, will be determined by the Contractor and approved by KCM during system design.

2.A.1.7.2. Data Backup and Recovery

The Contractor shall prepare a comprehensive plan for data backup, archiving, and recovery. (See Subsection **2.A.3.1.2.3, OBS Design Phases' Deliverables**). Data will be available on a 24 x 7 basis. For additional server equipment requirements for data backup and recovery, see Subsection **2.A.1.3.4, Server/Workstation Hardware Requirements**.

2.A.1.7.2.1. Data Backup

Each active server (determined during the system's final design review) shall provide backup capabilities via both local and remote (networked) storage devices and software. Licenses will be provided for each server, covering all proprietary software used for data backup. Data backups will occur on an hourly basis. All file systems used will be a minimum of raid 0 + 1.

2.A.1.7.2.2. Data Recovery

In the event of a primary data storage failure by one or more servers, it shall be possible to recover or access and transfer data from a secondary server or backup device. The Contractor shall provide a detailed description of the proposed process for KCM evaluation.

2.A.1.7.2.2.1. Data-storage failure indicator

In the event of a primary data-storage failure and/or backup data-storage battery failure, the system shall have a visible indicator on the affected server or backup device's display to alert the OBS Administrator.

2.A.1.7.2.2.2. Disaster Recovery Plan

The Contractor shall provide a disaster recovery plan detailing how to restart a failed server to allow full restoration of all processing within four hours of failure discovery by KCM staff. Additionally, this plan must ensure that full data recovery, with data integrity already verified, is completed and all server processing is restored within 24 hours of restoration of processing.

2.A.1.7.2.2.3. Database Integrity

Database integrity shall be preserved throughout all data loads, data conversions and data-reporting processes. Each database will have an archived log of all database activities, allowing data recovery to a configurable point in time. Databases will be operational on a 24 x 7 basis with tools provided to tune and clean up the database on as-needed basis. Any desired deferred constraints and index checks will require approval of the KCM Project Manager and KCM technical staff.

2.A.1.7.3. Comprehensive and Accurate Data Collection and Management

For detailed descriptions of the following functionality, see the ***RV6-Manage Events***, ***RV3-Take Vehicle Out of Operation*** and ***BO3-Manage Historical Data*** use cases.

2.A.1.7.3.1. Data Collection

All collected data will be the property of KCM. Modifications to the data may only be performed by KCM employees or with prior, written authorization from the KCM Project Manager. Data from the databases shall be archived and a parameterized process will be required as part of the OBS Administrator Toolkit listed in Appendix **K**.

2.A.1.7.3.1.1. Configurable Parameters

The OBS will provide the ability to differentially set configurable parameters used for data collection based on location (e.g., city streets vs. rural areas). Some areas may require a larger offset for collecting and mapping data points. Others, like those located in Seattle's Central Business District, will require a smaller offset.

2.A.1.7.3.1.2. Unique Identification Tag

The OBS will assign each on-board event a unique ID tag that translates directly to a TED (Transit Enterprise Database) ID tag, as provided by KCM. Each set of data offloaded from the vehicle will be identified by either a primary-key value or a foreign-key value. This value will be used to trace back to the original (on-vehicle) data source. All collected data will be comprehensive for each event.

2.A.1.7.3.2. Data Management

All offloaded data will be maintained in both its original format and in the translated TCIP format, with any gaps in the data that may occur during conversion identified and tracked. When a data value is not present for a particular field, data will not be interpolated to fill such nulls. When a gap in data is continuously reported, the system will automatically notify the OBS Administrator.

2.A.1.7.3.2.1. Normalized database

Data will be stored in a normalized database, utilizing standard data-integrity rules for first and second normal form. Any de-normalizing of the data structures in the database tables and views will require KCM approval. KCM will allow use of XML schemas in the database when such schemas have been validated with a minimum of four different validation programs provided by different KCM-approved vendors.

2.A.1.7.3.2.2. Data Manipulation

For debugging and tracking purposes, all data manipulation shall occur in the OBS Raw Repository utilizing a separate schema from that used for the original data. OBS Administrator tools will provide utilities to access and control all data and data processes involved with the Landing Pad and the OBS Raw Repository.

2.A.1.7.3.3. Data Accuracy and Completeness

The highest industry standards for data accuracy and completeness will be required. Any gaps in the data will need to be identified and logged by the software during processing. All gaps in data shall be tracked, and this information shall be made available upon demand for debugging and troubleshooting purposes.

2.A.1.7.4. Data Exchange Requirements (Software)

All data transferred to and from the Revenue Vehicle will be verified for accuracy and completeness using an industry-standard verification technique such as checksum or other KCM-approved methodology. Contractor-provided OBS Administrator utilities (written scripts and procedures) will perform all data exchanges.

2.A.1.7.4.1. Data Exchange Standards and Logs

Each data exchange will comply with agreed-upon TCIP standards and will also maintain a log of the activities and record counts of partial and completed transactions. At a minimum, this log will track the following:

- Number of transmission retries.
- Number of errors in the batch or transactional interface.
- Detail of each erroneous transaction (including unique ID).
- Number of successful transfers.

2.A.1.7.4.2. Data Recovery from Processing Errors

OBS Administrator utilities will provide recovery from errors that occur during processing. Such recovery utilities will support both the reprocessing of the entire data set and the reprocessing of erroneous data only. A parameter-driven system will be provided to allow KCM to set thresholds for acceptable errors and parameters for data rollback if unacceptable errors occur during processing.

2.A.1.7.4.3. GIS/Map Characteristics

KCM intends to provide support for Contractor-developed map interface applications as well as data, using KCM's GIS-standard ESRI supported products. For functional requirements see **CC7-Manage Transit Service & Geographic Data** use case. All map interface applications developed by the Contractor shall adhere to the following requirements:

a. Any map interfaces shall be open source or an ESRI-supported map control.

b. All geographic data inputs and outputs from the map interface shall be ESRI-supported data formats.

c. Location linear references for point and line features shall be drawn from KCM's transportation network.

d. Location coordinate information shall be exchanged in the State Plane Washington State North Zone projection, feet units, NAD 83 HPGN (High Precision GPS Network) datum. The OBS shall provide an algorithm that converts received and transmitted GPS data to this format.

e. Coordinates and linear reference information will be provided as a part of the integrated dataset of schedule and stop data for transmission to the vehicle. Shapefiles and geodatabases are available for map interfaces.

2.A.1.7.5. Reporting Requirements

The Contractor will deliver a reporting system that includes a minimum of 20 predefined reports and scripted queries for processing and display via the KC intranet. For detailed functional requirements on reporting the vehicle's historical performance data, see the ***BO3-Manage Historical Data*** use case.

2.A.1.7.5.1. Reporting Performance Requirements

All reporting on the vehicle's performance (schedule and route adherence) will be managed via the web and available from TED within two hours of the vehicle's return to base. Data will support special ad hoc queries for up-to-date information. Other, more standard daily reports will provide previous-service-day information, configured for queries ordered by input date and time.

Each summary report of the previous day's activity will run in less than 10 minutes during peak data transmission periods and may contain up to three years of historical data.

2.A.1.7.5.2. Report & Query Availability

KCM intends to develop other reports and queries using this historical data over time as user requirements develop. The OBS reporting system will make both the Contractor-provided and the subsequent KCM-developed reports available for initiation by either a set date/time trigger or a user request. Specific requirements for Contractor-provided reports will be determined during design and based on requirements set by KCM business groups.

2.A.1.7.5.3. User-Defined Parameters and Configurable Defaults

Some reports and all queries will utilize user-defined parameters or KCM-settable defaults. A report or query that includes data based on input parameters will be considered a single report or query for purposes of meeting the agreed-upon delivery requirements.

2.A.1.7.5.4. Report types

Reports may include, but are not limited to, those including the following types of data:

- Automatic Passenger Counting (APC)—currently reported.
- Automatic Vehicle Location (AVL)—currently reported.
- Vehicle Alarms.
- Lift and Ramp Usage.
- On-time Performance (schedule and route adherence)—currently derived.

2.A.1.7.5.5. Replacement of Existing Reporting Systems

As detailed in Subsection **1.B.4, On-Board Systems**, KCM's existing systems currently provide AVL and APC data reporting. Business groups have developed many analytic processes to use and report on this data. In some cases these will need to be replicated in their existing format. In others, users hope to take advantage of the increased data-collection capabilities provided by the OBS to develop new reports and queries.

2.A.1.7.5.6. Reporting Needs of Transit's Service Development Groups

Some primary business groups that use collected data include Service Development's Scheduling, Service Planning, and Transit Route Facilities groups. It should be noted that Service Development does not expect OBS to replace the functionality of the data systems it currently uses to access schedule and ridership data. Instead, they prefer to have access to data that could either be used within current applications or be used within future data systems. This will give them the flexibility to take advantage of the new technology provided by OBS to develop new tools or design additional reports as needed.

- **Service Planning** primarily uses APC ridership data, and seldom uses either APC or AVL to measure on-time performance.
- **Transit Route Facilities** is usually interested in a single facet of APC data: summary counts of passenger boardings and deboardings at bus stops for a given period of time.
- **Scheduling**, which is primarily interested in comparing on-time performance to schedules, uses APC data in conjunction with AVL data to calculate average running times by TPI over time for use in making schedule revisions. Scheduling does use APC ridership data to assign the appropriate coach type (e.g., a standard versus an articulated) to a given trip.

  Additionally, Scheduling's primary automated tool is the HASTUS Scheduling System. One Contractor-provided report will meet the interface requirements for data import into the HASTUS ATP Module which allows schedulers to use observed travel-time data as a basis for scheduling travel time along transit routes. Scheduling now regularly imports AVL data into HASTUS. The AVL data is imported in the form of a flat, delineated file, whose specifications are given in Appendix **F, Current Reporting Requirements for Scheduling**. After the data is imported into HASTUS, schedulers can graphically display the travel-time data. HASTUS can also use the data to recommend scheduled running times that more closely match observed running times.

2.A.1.7.6. Historical Data Transmission and Processing Performance Requirements

The vehicle will transmit data to the Base's Landing Pad via the WLAN. The Landing Pad will then initiate processes to convert this raw historical data into the approved TCIP format and load both the raw data and the converted "TCIP" data into the OBS Raw Repository. These processes will also accomplish the following:

- Provide vehicle-maintenance alarm-event information to designated KCM personnel within 15 minutes of the receipt of data from the vehicle.
- Complete the transmission of raw data from the vehicle to the Landing Pad within 30 minutes of the vehicle's arrival at the transit base.

2.A.2. Testing

This section describes the different types of testing required for the implementation of all Level 1 functionality; the Contractor's responsibility for developing appropriate test plans; and general testing requirements. Requirements shall also be applicable to all Level 2 Testing as described in Subsection **3.A.6.5.**

2.A.2.1. General Testing Requirements

All of the components, subsystems, and system's processes constituting both the Level 1 and Level 2 functionality shall be tested individually and together to ensure that they meet the Contract requirements and provide a properly functioning system. This shall be true for all levels of testing as appropriate. The work under this section shall include all labor, materials, documentation, and support services required to completely inspect and test all hardware and software.

Contractor shall be responsible for the performance of all of the tests described below to satisfy the objectives of each testing phase. KCM shall oversee the performance of the tests.

2.A.2.1.1. Contractor-Provided Test Plans

The Contractor shall be responsible for providing an appropriate test plan for each type of required testing. Each plan must be approved by KCM prior to the commencement of any testing. KCM will only approve test procedures if they are inclusive and thoroughly test each Level 1 Subsystem and interface, both independently and collectively. Such plans shall cover each piece of required functionality available at the time of each test.

Testing shall be iterative: top-level functionality shall be tested and approved first, followed by testing and approval of secondary functionality, tertiary functionality, etc., until all required functionality is approved. Submitted test plans shall reflect this iterative approach to testing unless otherwise approved by the KCM Project Manager.

2.A.2.1.2. Contractor-Provided Certification of Readiness for Testing

The Contractor shall provide written Certification of Readiness for Testing after receipt of written KCM approval for each test plan, and at least 30 days prior to the beginning of each round of required testing. At a minimum, this certification shall include the following:

a. Assurance that all required Contractor-provided test equipment, documentation, equipment, and training, if appropriate, have been delivered and/or accepted by KCM.

b. If second or later round of tests, a narrative description of the successful resolution of each previously identified problem.

Additional Certification of Readiness requirements for each type of testing, if any, are described below in the appropriate test description section.

2.A.2.1.3. KCM Acceptance of Readiness for Testing Certification

Within 15 days of receipt of each and every Contractor's Certification of Readiness for Testing, KCM shall either accept or reject the Certification in writing. If accepted, the KCM Project Manager shall issue a written Notice of Readiness for Testing and testing shall commence as planned. If rejected, KCM must provide detailed written comments indicating the reasons for rejection and providing specific requirements for the Contractor to meet prior to accepting the Certification. No testing shall commence prior to the issuance of a written KCM Notice of Readiness for Testing.

2.A.2.1.4. KCM Participation

All test results must be certified and approved by KCM staff. No individual test or testing task will be deemed complete or successful unless approved in writing by the KCM Project Manager.

KCM reserves the right, at its discretion, to witness any or all inspections and/or tests, using KCM personnel and/or Consultants and agents. The KCM Project Manager may identify specific tests that must be witnessed by representatives from other King County contractors in support of interface development for on-board subsystems provided by others. In addition, KCM reserves the right to develop additional test procedures to be performed by the Contractor or other designated organizations.

The Contractor shall pay all Contractor-incurred travel, accommodation, and living costs for the witnessing of inspections and tests.

2.A.2.2. Test Equipment

The Contractor shall be responsible for furnishing sufficient quantities of all Contractor-provided subsystems for each level of testing. KCM will provide legacy subsystem equipment early in the design phase for system design and development and for Factory Acceptance Testing (FAT).

Additionally, the Contractor shall develop two complete sets of all equipment and materials needed for testing during the FAT and subsequent on-site testing. Each set shall comprise a “test bench” and shall be used and approved as complete by KCM during FAT. One test bench shall be provided to KCM for subsequent use in equipment and systems testing and verification purposes.

2.A.2.3. Test Stages

The Project plan and schedule shall include each of the following stages of testing. The following outlines the testing sequence, associating each test with its appropriate Milestone. See Subsection **2.A.3.1.2.** for associated contracts deliverable requirements lists (CDRL). Detailed requirements for each of these tests are provided below beginning in Subsection **2.A.2.5, Factory Acceptance Testing**.

2.A.2.3.1. Factory Acceptance Tests (FAT)

Factory Acceptance Testing shall be performed to ensure that the Contractor-provided systems and subsystems, and legacy subsystems, meet all functional and environmental requirements and specifications. Factory Acceptance Testing is performed prior to on-site installation and is a task required for completion of the Pilot Readiness Acceptance Milestone.

2.A.2.3.2. Prototype Installation Testing

The complete Level 1 system and a full set of vehicle subsystems shall be installed on each identified vehicle type and evaluated for its compliance with all functional, environmental, and ergonomic requirements and specifications. The full set of FAT tests shall be performed on each vehicle. This task, along with the Prototype Field Testing described below, is required for completion of the Prototype Acceptance Task.

2.A.2.3.3. Prototype Field Testing

Operational testing shall be performed on Base Operations functionality and each vehicle type to ensure that the Level 1 system and all integrated subsystems function properly in each of the vehicles during operation. This task is required for completion of the Prototype Acceptance Milestone.

2.A.2.3.4. Pilot Test

The Pilot Test phase shall begin once the first set of at least 100 vehicles with the complete Level 1 system and full set of integrated subsystems are placed into revenue service. The objective of the Pilot Test is to confirm the functional acceptability of the Level 1 system in revenue service before continuing with full fleet installation. This task is required for completion of the Pilot Test Acceptance Milestone. Any Type II Failures must be successfully resolved before a Notice of Apparent Completion will be issued by the KCM Project Manager.

2.A.2.3.5. Acceptance Testing

Following successful completion of the Pilot Test Acceptance Milestone, full Level 1 rollout will begin. Acceptance testing will be performed on all equipment and software placed into operation to demonstrate the performance of the system as a whole. The completion of Acceptance Testing will be contingent upon the system meeting specified performance levels. Any Type II Failures must be successfully resolved before a Notice of Apparent Completion will be issued by the KCM Project Manager.

Two types of Level 1 Acceptance Testing will be required.

2.A.2.3.5.1. Base Acceptance Testing

First, the successful completion of Acceptance Testing for all vehicles at each base is a task required to meet that base’s Equipment Acceptance Testing Milestone.

2.A.2.3.5.2. Level 1 Conditional Acceptance Testing

The successful completion of Base Acceptance Testing for all eight KCM transit bases is a prerequisite to the start of the full Level 1 Conditional Acceptance Test period.

The Level 1 Conditional Acceptance Test period will begin immediately after Notice of Apparent Completion has been approved for all eight bases’ Equipment Acceptance Testing. All Level 1 functionality will continue to be tested in revenue service until all test requirements have been met. Upon successful completion, KCM will issue a Notice of Apparent Completion of Level 1 Conditional Acceptance and Level 1 of the Project will be deemed complete.

2.A.2.3.5.3. Full System Acceptance Testing

The Full System Acceptance Test period will begin immediately after Notice of Apparent Completion has been approved for Level 2 Conditional Acceptance Testing. All Level 1and Level 2 functionality will continue to be tested in revenue service until all test requirements have been met and the system has functioned properly through a service change period.

2.A.2.4. Testing Procedures and Definitions

2.A.2.4.1. General

2.A.2.4.1.1. Testing Procedures

For each inspection and test, the Contractor shall do the following:

a. At least 30 days prior to testing or inspection, submit a detailed Test Procedure to the KCM Project Manager for review and approval. Notwithstanding this requirement, high-level test plans that include proposed procedures for each function and type of testing are a required Design Phase deliverable.

b. Provide check-off sheets for the items to be inspected, measurements to be taken, features required to be present, and the performance criteria.

c. Be responsible for all Contractor, Supplier, and Subcontractor inspections and tests to be performed, including those performed under the Contractor's Quality Assurance plan.

d. Repair, replace, and/or correct any and all hardware and software not passing inspections and/or tests, and not meeting the approval of the KCM Project Manager. Contractor shall also reschedule the pertinent hardware or software for inspection and testing.

e. Receive KCM approval prior to proceeding with any tests or inspections.

f. Submit the final report to the KCM Project Manager for review within 30 days of the completion of the inspection or test.

g. Retain all inspection and test results for a period of not less than three years, during which the results shall be available for review.

2.A.2.4.1.2. Peak Load Testing

Testing shall simulate ultimate system size, processor utilization, and performance. Each level of testing shall simulate 150% of actual usage during peak loads, including:

a. Peak loads of the technology.

b. Peak loads of the fleet, base, and administrator functions.

2.A.2.4.2. Test Plan

The Contractor shall prepare a test plan and applicable procedures that shall govern the conduct of activity, surveillance, direction, and methods of observing and recording the pertinent data. The Contractor shall provide an Overall Inspection and Test Plan and specific Test Plans for each specific test. The KCM Project Manager shall approve each specific test plan prior to proceeding with testing. At a minimum, the following elements shall be included in the test plan:

a. Dates, times, and locations of testing.

b. Identification of special hardware, software, tools, and test equipment to be used during testing, including support and calibration tools and instrumentation.

c. Applicable County, State, Federal, and industry standards to be met.

d. Technical publications to be referenced.

e. Spares and consumables to be available.

f. Maintenance facilities needed.

g. Staffing requirements to be met.

h. Scheduling of personnel.

i. The format and specific data to be collected during the test period together with the method used to report the test results.

j. Preventive maintenance tasks to be performed during the test.

k. Record-keeping procedures and forms.

l. Procedures for monitoring, correcting, and retesting variances.

m. Procedures for controlling and documenting all changes made to the Level 1 system after the start of testing.

n. Block diagram(s) of the hardware test configuration during each phase of testing, including Contractor- and KCM-supplied equipment and any test or simulation hardware.

o. Comprehensive narrative of how the testing will be conducted and any functions or features that will not be tested during each phase of testing.

p. A list of individual tests to be performed during each phase of testing and the purpose of each test segment.

q. Techniques and scenarios to be used to simulate ultimate system sizing, processor utilization, and performance, especially during peak load testing.

r. Copies of any certified test data (e.g. environmental data) to be used in lieu of testing.

2.A.2.4.3. Test Procedure Outline

The test procedure shall include, at a minimum, the following:

a. Objective of test; function or feature to be tested.

b. Purpose of each test segment.

c. Test setup and environmental conditions.

d. Descriptions of all simulation tools and techniques to be used during the test.

e. Detailed description of test specimens including drawings, part numbers, inspection and test records, maintenance records, and calibration records.

f. Detailed test procedures to be followed.

g. All inputs and expected results for each test segment.

h. Test equipment to be used, including any measuring equipment and/or any equipment aiding in the performance of the tests.

i. The level and schedule of preventive maintenance during the test.

j. Acceptance criteria for each test (pass/fail criteria).

k. Retest procedure.

l. Test data sheet format.

m. Test notification to engineer.

n. Test reports.

2.A.2.4.4. Test Tools and Logging

The Contractor shall provide automated tools for measuring and capturing data packets and data flows at each major interface, from end to end, between the VLU and all subsystems. The test tools may include standard off-the-shelf communications software or customized in-house trace and logging software. In the design review, the Contractor shall propose a suite of tools and describe the methodologies for use.

Automated test tools shall be thoroughly documented in their use, including all potential results and error codes or messages.

The test plan and procedures shall include the ability to automatically identify points of data corruption or transmission failure.

The reporting of test data must be in English, and provide the ability to sort by time, event type, and other key attributes, so that an end-to-end verification of data flows can be readily obtained.

Event-log messages shall be logically grouped and labeled, fully parsed, and loaded into a database in a production manner, so that they are readily available for troubleshooting and analysis.

2.A.2.4.5. Test Reporting

The Contractor shall provide KCM with a complete report documenting the operation and reliability of each component and the system as a whole during all types of testing. The report shall be in a form acceptable to the KCM Project Manager.

The Contractor shall maintain complete records of all factory and field test results with records keyed to the steps enumerated in the test procedures. The following items shall be included in the test records:

a. Purpose of the test and a reference to the appropriate section of the test procedures.
b. Test results for each test segment, including a passed/failed indication and any modifications made to the procedures during the test.
c. Identification of the Contractor’s test engineer and of the KCM representative(s) witnessing the test.
d. Date and duration of test.
e. Provision for comments by the KCM representative.
f. Copies of any variance reports generated.
g. System logs or printouts saved as part of the test.

2.A.2.4.6. Test Failure Resolution

The test procedures shall describe the process to be followed for the resolution of test problems, failure recurrence control, and general test conduct ground rules.

2.A.2.4.6.1. Failure Review Team

During design, the Contractor and KCM shall jointly develop a detailed description of the responsibilities and composition of a Failure Review Team. This Team shall include at least one member of both the Contractor’s and KCM staff, and it shall have the authority to make recommendations to the KCM Project Manager regarding the determination of a failure type and the need for retesting of any equipment or software. It shall also have the authority to recommend to the KCM Project Manager resolution of any other testing issues. In all cases, the KCM Project Manager shall have final authority.

2.A.2.4.6.2. Type I and Type II Failures

2.A.2.4.6.2.1. Type I Failures

A Type I failure is a malfunction resulting from conditions beyond the control of the Contractor, or failures that are minor in nature and quickly corrected. Type I failures may include:

- Power or communications outage.
- Mechanical equipment malfunctions.

- Accidents or mishandling.
- Localized equipment failures.
- Test facility or instrument failure.

Unless otherwise approved by the KCM Project Manager, in the event of a Type I failure the test period shall be suspended for the time necessary to make the corrections, and testing shall resume starting at the point where testing was suspended. For a valid test, the testing shall restart from stage one when there was any loss of data from the failure.

Time suspension shall begin when the failure is first noticed, and it shall extend only as long as required to correct the failure.

If a second Type I failure occurs in the same device, the Contractor shall provide evidence that the failures were distinct and unrelated in order to retain a Type I failure classification. Final determination of the failure Type shall be made by the Failure Review Team described above.

2.A.2.4.6.2.2. Type II Failures

A Type II failure is a malfunction that involves conditions within the control of the Contractor, failures related to the system design, or failures that may be of a minor or major nature that cannot be easily and quickly corrected. Type II failures include, but are not limited to:

- Two of the same Type I failures that occur after the first Type I failure has been corrected.
- Two of same Type I failures that are not distinct and that are related.
- Design deficiencies.
- Software or firmware problems or recompilations.
- Failure to meet performance requirements.

Unless otherwise approved by the KCM Project Manager, in the event of a Type II failure, the test period shall be restarted at time zero after corrections are made. The cost for repairing, replacing, or correcting the malfunctioning equipment shall be the responsibility of the Contractor.

2.A.2.4.6.3. Retesting

Upon receipt of test results indicating a Type II failure, the Contractor shall stop any remaining testing. The Contractor shall perform corrective work and notify the KCM Project Manager of the system’s readiness to repeat the test. The complete test shall be rescheduled and repeated, subject to the KCM Project Manager’s approval. Any such retesting shall be conducted at the expense of the Contractor and any time lost shall constitute a Contractor-caused project delay.

2.A.2.5. Factory Acceptance Testing (FAT)

2.A.2.5.1. General Requirements

The Contractor shall provide a comprehensive Factory Acceptance Test (FAT) program that shall consist of the following individual test programs:

a. Functional Test

b. Environmental Test

c. Electromagnetic Test

d. Radiated Electromagnetic Test

e. Maintainability Test

f. Human Factors Test

Each equipment type shall be subject to the FAT unless waived by the KCM Project Manager.

One item of each equipment type shall be tested as described below.

If the Contractor can prove by certification of using authority, property, or independent testing organization that equipment manifestly similar to that specified here has been subjected to testing to the extent specified, the associated test may be waived, subject to approval. The Contractor shall submit independently verified tests to KCM for approval at least 60 days prior to the scheduled start date for the FAT.

Factory Acceptance Testing shall be performed in controlled laboratory conditions at an approved factory or independent facilities.

2.A.2.5.2. Functional Test

The purpose of this test shall be to demonstrate that for each Level 1 equipment type and system, the functions specified throughout this document, including all limiting conditions, shall be met.

Each item of equipment shall be required to execute all hardware and software functions as detailed in these specifications and to meet the performance-criteria requirements.

The procedures for handling maintenance (troubleshooting and correcting faults) and service functions shall also be written and demonstrated.

The Contractor shall be responsible for developing a functional test procedure that satisfactorily demonstrates all equipment and system functions and shall submit this test procedure for approval 30 days in advance of the test.

To successfully pass the Functional Test, each function specified shall be tested ten times in a row without failure. Each piece of equipment shall have passed the functional test before the environmental tests are started.

2.A.2.5.3. Environmental Tests

Environmental tests shall be performed one time for each item of on-board and outdoor equipment and shall be tested per SAE Recommended Practice J1455 JAN88, as follows:

2.A.2.5.3.1. Thermal Shock Test

The Thermal Shock Test shall be per Subsection **2.A.1.2.3.1, Society of Automotive Engineers** of the aforementioned SAE Recommended Practice, and shall use the thermal profile portrayed in Figure 2C of said section, except that:

a. The storage temperature limits shall be 25 to +150 degrees Fahrenheit.

b. The presoak shall be two hours at 25 degrees Fahrenheit.

c. Hour 24 to hour 25 shall be at 70 degrees Fahrenheit.

Functional tests shall occur immediately prior to and after the 25-hour test period.

2.A.2.5.3.2. Thermal Cycle Test

The Thermal Cycle Test shall be per Subsection **2.A.1.2.3.1, Society of Automotive Engineers Standards** of the aforementioned SAE Recommended Practice, and shall use the thermal profile portrayed in Figure 2B of said section, except that:

a. The temperature limits shall be 10 to +135 degrees Fahrenheit.

b. The chamber temperature shall be held for two hours minimum at 10 degrees Fahrenheit, followed by two hours minimum at +135 degrees Fahrenheit, followed by two hours minimum at +70 degrees Fahrenheit.

c. Tests shall occur immediately prior to and every 30 minutes during the test period, which will terminate at eight hours minimum, provided that all conditions above are satisfied.

2.A.2.5.3.3. Humidity Test

The Humidity Test shall be per Section **2.A.1.2.3.1, Society of Automotive Engineers** of the aforementioned SAE Recommended Practice, and shall use the humidity profile portrayed in Figure 3A, Recommended Humidity 8 Hour Cycle, of said section, except that:

a. Temperature limits shall be 10 to +135 degrees Fahrenheit.

b. Humidity shall be 95% relative humidity (non-condensing).

2.A.2.5.3.4. Shock and Vibration Tests

The Contractor shall ensure that the County vehicle fleet shock and vibration conditions are considered to ensure that proper isolation/protection is built into the design of the components. In addition, the following test requirements shall be met.

2.A.2.5.3.4.1. Vibration Test

System components shall be tested per the Procedure I of MIL-STD-810E, Method 514.4, Procedure I, Category I, Curve of Figure 514.4-1, with the following changes:

a. The vibration sweep shall be 1.5g, 5.5 to 200 Hz. The cycling time shall be two hours on each axis for a total of six hours. The equipment shall operate normally during and after this acceleration test, and the equipment shall not experience broken or loosened parts from this vibration.

b. At the conclusion of each axis frequency sweep cycle, the equipment shall be subjected to a vibration of 3 g-forces at a frequency sweep between 7 and 14 Hz for a period of one minute, and 4 g-forces at a frequency sweep between 70 and 140 Hz for a period of one minute. The equipment shall operate normally after these acceleration tests and shall not experience broken or loosened parts from this vibration.

2.A.2.5.3.4.2. Shock Test

System components shall be tested per Procedure I of MIL-STD-810E, Method 516.4 with the following changes:

a. Half-sine shock pulse with a peak value (A) of 5 g and duration (D) of 20 milliseconds.

b. System components shall operate normally after the shock tests and shall not have experienced broken or loosened components as a consequence of these tests.

2.A.2.5.4. Electromagnetic Test

Equipment shall be tested for electromagnetic compatibility per Subsection **2.A.1.2.3.3, Electronic Industries Association**.

Equipment shall not sustain any permanent damage as a result of the exposure to electromagnetic fields nor shall it lose any data.

This testing shall take into account the conditions existing at King County facilities including bus tunnel and trolley conditions.

2.A.2.5.4.1. Radiated Electromagnetic Energy Test

The Contractor shall identify requirements and demonstrate compliance with applicable Federal Communication Commission (FCC) regulations concerning conducted and radiated radio-frequency energy.

2.A.2.5.4.2. Maintainability Test

The Contractor shall conduct a maintainability test that consists of introducing faults into the equipment and systems, and then measuring the time required for a technician to correct the fault.

Thirty days prior to the start of the FAT tests, the Contractor shall submit to the KCM Project Manager a Maintainability Test Plan for approval. The Maintainability Test Plan shall show:

a. The basis of sample-size selection.

b. A list of faults to be introduced into the equipment. This list shall represent every known failure mode for each unit of equipment and system.

c. A reasonable time limit for repair performed by an average technician based on field experience.

The maintainability test shall be conducted in the following steps:

1. The Contractor shall provide several units of the equipment to the KCM Project Manager to simulate failed components, mis-adjustments, and incorrect settings.
2. The simulated failures shall be introduced in proportion to their expected failure rate.
3. The Contractor's maintenance personnel shall be unaware of the simulated failures and shall be assigned to troubleshoot the equipment.
4. The repair times shall be recorded and the mean-time-to-repair (MTTR) shall be compared with the advance list provided by the Contractor.
5. Maintainability Test results shall be reviewed and approved by the KCM Project Manager.

2.A.2.5.5. Human Factors Test

The human factors test shall verify that features and operating characteristics affecting the use of the Level 1 users and King County personnel are easy to understand, easy to use, and quick in response to customer and personnel actions. The test shall be designed to evaluate items such as the following:

- Ergonomic factors engineering.
- Time to perform a transaction.

- Number of steps required to complete a task.
- Time to reset the device.
- Time to initialize the device from a complete power-down.
- Time to switch between various operating modes.
- ADA compliance with regard to customer information, automated announcements, and displays.
- Facilitation of transit operator/customer interaction as a human factor.

2.A.2.6. Prototype Installation Testing

All FAT requirements shall be repeated on site after the Level 1 systems and a complete set of connected subsystems are installed on one vehicle of each fleet type. The purpose of this testing is to ensure that all installation and operational requirements are met on board the Revenue Vehicle. This set of vehicles will constitute the prototype installation set and undergo the Prototype Field Testing described below.

2.A.2.7. Prototype Field Testing

The Prototype Field Testing shall be operational testing in the field to simulate revenue operations and to assess the performance of the functions and features that cannot be tested in a static, factory environment including:

a. Route adherence.
b. Schedule adherence.
c. Passenger counting.
d. Trigger events.
e. Automated stop announcements and displays.
f. Destination-sign changes.
g. Usability testing by Transit Operators.
h. Installation testing—to determine the fully integrated system functions and features (perform on a variety of vehicle types).
i. Data and configuration management via the WLAN.

2.A.2.8. Pilot Testing

The Level 1 Pilot Test shall demonstrate the same level of system functionality and the services to be provided for full Level 1 rollout, involving King County personnel just as the full system would require, but on a smaller scale. A minimum of 100 Revenue Vehicles will be included in the Pilot Test. The Pilot Test shall involve the exercise of the small-scale system under revenue service conditions. All requirements for the system shall be tested.

The transit base, or combination bases, and the mix of vehicle types to be included in the Pilot shall be determined during design. The Pilot Test Plan shall address the widest possible selection of vehicle types and transit base equipment that can be effectively included and managed.

2.A.2.8.1. Pilot Test Objectives

The primary objectives of the Pilot Test shall be to:

a. Validate that the system meets the functional, operational, and technical specifications as defined in Section 2, Level 1 Requirements.

b. Ensure that the technology, system design, and implementation meet the internal needs, including any specific requirements or constraints with respect to physical implementation or operational processes.

c. Provide an assessment of, and field experience with, equipment reliability and maintenance requirements.

d. Provide an assessment of, and field experience with, the process of loading and unloading data and other information to and from the Revenue Vehicles using the full set of OBS Administration tools and other procedures and processes located on the Base Server.

e. Provide an assessment of, and field experience with, the use of the WLAN for transmitting data and other required information between the Revenue Vehicle and the Base Server.

f. Provide an overall assessment of the program's cost-effectiveness and fiscal impact.

g. Determine the appropriate scope of full rollout based upon the outcomes of Pilot Test evaluation.

2.A.2.8.2. Pilot Test Settling-in Period

The initial period following commencement of revenue service in the Pilot Test stage will be known as the Pilot Test Settling-in period. This period will provide a short time for the Contractor and KCM to correct minor implementation errors in advance of Pilot Testing. The Pilot Test Settling-in period will last a minimum of 10 days. The KCM Project Manager will notify the Contractor when Pilot Testing can begin.

2.A.2.8.3. Changes to County Business Processes

The Contractor shall provide information to KCM regarding each aspect of Pilot Test implementation, operation, and evaluation that impacts existing operations. This information will be used to update business practices. At a minimum, impacts and required changes shall be identified in the following areas:

a. Customer service.

b. Ridership data management.

c. Training.

d. Equipment installation.

e. Equipment operation.

f. Equipment testing and maintenance.

g. Computer and network operations.

h. Public transportation operations.

i. Marketing.

Changes required to existing business practices shall be identified a minimum 60 days prior to the scheduled start of the Pilot Test.

2.A.2.8.4. Test Equipment and Documentation

All test equipment and documentation materials required for the Pilot Test shall be provided by the Contractor a minimum of 60 days prior to the scheduled start of the Pilot Test.

2.A.2.8.5. Pilot Test Plan

The Contractor shall prepare and submit a Pilot Test Plan to the KCM Project Manager for review and approval 60 days prior to the scheduled start of the Pilot Test.

At a minimum, the Pilot Test Plan shall include:

a. Schedule of all development, installation testing, and implementation activities.

b. Description of proposed tests, procedures, recording methods, and test equipment.

c. Contractor recommendations of infrastructure elements required to meet the objectives of the Pilot Test.

d. Data analysis procedures to demonstrate successful operation of all functionality over time, with such functionality identified by functional module (use case).

e. Training and documentation.

King County reserves the right to make changes to the Pilot Test Plan as required and deemed necessary to meet and evaluate Pilot Test objectives. The final Pilot Test infrastructure is subject to approval and confirmation by King County.

2.A.2.8.5.1. Certification of Pilot Test Readiness

Prior to beginning the Pilot Test, the Contractor shall submit a Certification of Pilot Test Readiness to the KCM Project Manager. At a minimum, this Certification shall certify that:

a. The Contractor has completed and the KCM Project Manager has accepted the Pilot Test Plan and all related procedures.

b. The Contractor has submitted and the KCM Project Manager has accepted all deliverables required to be submitted prior to conducting the Pilot Test.

c. The Contractor has submitted and KCM Project Manager has accepted all required intellectual property documentation.

d. The Contractor has provided all training required to be conducted prior to beginning the Pilot Test.

e. The Contractor has satisfied all applicable pre-test conditions imposed by this Contract or the accepted Pilot Test Plan.

f. The Contractor has completed all applicable software coding and system integration including interfaces with all subsystems.

g. The Contractor has completed installation of all equipment to be used in the Pilot Test.

h. All required systems are integrated, on line, and ready for use.

i. The Contractor is aware of no matters that will adversely affect the ability to conduct the Pilot Test in complete conformity with the Pilot Test Plan.

j. The Contractor is ready to begin the Pilot Test immediately.

The Contractor shall not begin the Pilot Test until the KCM Project Manager has accepted the Certification. The Contractor shall promptly provide any documentation or information requested by the KCM Project Manager to assist in review of the Certification or the Contractor's state of readiness.

2.A.2.9. Acceptance Testing

a. Acceptance Testing shall be performed at a system level after the start of revenue service, with all components and subsystems completely functional, operational, on line and in service.

b. Acceptance Testing shall be conducted by the Contractor in cooperation with King County personnel and shall be subject to King County review and approval.

c. The Level 1 system will be installed in phases: Acceptance Testing of the equipment may also be conducted in phases.

d. Reliability calculations for a particular equipment type in a group will remain consistent throughout the Acceptance Testing period.

e. Grouping of devices for Acceptance Testing shall be described in detail in the Contractor's Acceptance Testing Plan and shall be subject to the KCM Project Manager's approval.

f. King County reserves the right to make changes to the Acceptance Testing Plan as required and deemed necessary to meet and evaluate OBS/CCS performance objectives.

2.A.2.9.1. Acceptance Testing Settling-in Period

The initial period of time following the completion of installation shall be designated as the Acceptance Testing Settling-in period.

a. The Acceptance Testing Settling-in period will last for at least 30 days of revenue service prior to beginning Acceptance Testing.

b. During the Acceptance Testing Settling-in period, the Failure Review Team shall establish a failure review test process.

c. At the end of the Acceptance Testing Settling-in period, the Mean Transactions Between Failures (MTBF) for high-transaction-volume equipment of the same type shall be not less than 40% of the MTBFs presented in Subsection **2.A.1.4.6.1, Equipment Reliability Requirements** for each type of Level 1 equipment.

d. For equipment of the same type in a low-transaction-volume environment, the mean operating hours between failures (MOHBF) in a group shall be not less than 40% of the mean hours between failures presented in Subsection **2.A.1.4.6.2, Availability**, for each type of Level 1 equipment.

e. If at the end of the Acceptance Testing Settling-in period the above MTBF and mean operating hours between failures (MOHBF) criteria are not met, then the reliability of the equipment shall be monitored until these criteria are met for 30 consecutive days.

f. Acceptance testing shall not commence until the MTBF and MOHBF requirements described in this section are met.

2.A.2.9.2. Acceptance Test Plan

Contractor shall develop an Acceptance Testing Plan. The plan shall be a comprehensive and detailed document, describing the management, monitoring, recording, and reporting procedures that will govern the Acceptance Testing period.

The Acceptance Testing Plan shall be submitted to the KCM Project Manager for review and approval 60 days prior to the scheduled start of the Acceptance Test period.

King County reserves the right to make changes to the Acceptance Testing Plan as required and deemed necessary to meet and evaluate KCM performance objectives.

2.A.2.9.3. Acceptance Test Requirements

At the end of the settling-in period, Acceptance Testing shall begin and shall be conducted over a minimum of 90 days under revenue service conditions. This time period shall be required for both types of Acceptance Testing, Base Equipment Acceptance Testing, and full Level 1 Conditional Acceptance Testing. Specific requirements are as follows:

a. The Acceptance Testing shall be conducted in three performance periods related to the reliability of the system. The MTBF and MOHBF requirements during the Acceptance Testing shall be incrementally increased from the settling-in-period values in 60 consecutive-day periods as follows:

    i. 0-30 days: 60% of the MTBF and mean hours of operation between failures specified in Subsection **2.A.1.4.6.1.** for each type of OBS/CCS equipment.

    ii. 31-60 days: 80% of the MTBF and mean hours of operation between failures specified in Subsection **2.A.1.4.6.1.** for each type of Level 1 equipment.

    iii. 61-90 days: 100% of the MTBF and mean hours of operation between failures specified in Subsection **2.A.1.4.6.1.** for each type of Level 1 equipment.

b. Each subsequent Acceptance Testing period shall not commence until all requirements specified for the previous period of testing have been met.

c. During the Acceptance Testing period, chargeable failures shall be identified and recorded per Subsection **2.A.2.4.6, Test Failure Resolution**.

d. Within 15 days following the completion of each period of Acceptance Testing, the Contractor shall provide all testing data, documentation, reports, and all other related information to the KCM Project Manager.

e. For any single group, if after 60 consecutive days, the MTBF and MOHBF for that period has not been met, the Acceptance Testing shall continue beyond the 60 consecutive days until the equipment has achieved the applicable reliability requirement.

f. Under no circumstances shall the Acceptance Testing for any group be allowed to proceed to the next 30-consecutive-day test period until the previous criteria has been met by that group.

g. For each group, the MTBF for high-transaction-volume devices for a given 30-consecutive-day period shall be derived by summing all the transactions for the 30-consecutive-day period for that group and device type and dividing by the number of chargeable failures recorded during that period for that group and device type.

h. If for any reason a test period is not comprised of 30 consecutive days, then the average MTBF shall be calculated by summing the transactions and chargeable failures for each individual test period, totaling not less than 30 days of test data.

i. Should the equipment fail to meet the performance requirements as specified herein, the Contractor shall make such improvements to the equipment and/or systems as are needed to meet the requirements.

j. The Contractor shall continue to improve Level 1 equipment and systems until the Contract requirements are met.

k. KCM reserves the right to limit the migration of the installed equipment if the Acceptance Test requirements are not being met.

2.A.3. Other Project Requirements

This section describes the remaining high-level requirements for the successful execution of the Project.

2.A.3.1. Project Phases and Deliverables

This section provides a brief overview of the defined Project Phases and a listing of Project Deliverables, organized by Project Phase and Milestone.

2.A.3.1.1. Project Phases and Milestones

The Project Phases and associated payment Milestones for Project Levels 1 and 2 are summarized in the Tables ***2.A.3.1.1.a*** and ***2.A.3.1.1.b*** shown below. The final Project Phase, Full System Acceptance is summarized in Table ***2.A.3.1.1.c***. For more detailed requirements, see Part **B**, **Section 9.0, Progression of System Development Work**.

The final Project Phase/Milestone, Full System Acceptance, will occur after completion of both the Level 1 and Level 2 Conditional Acceptance Milestones. A detailed description is provided in Subsection **3.A.3.5, Full System Acceptance**, and testing required for the completion of the milestone is described in Subsection **3.A.7.5.2.10, Full System Acceptance Testing**.

Table 2.A.3.1.1.a Level 1: OBS Phases & Milestones

Level 1 Project Phase	Estimated Duration	Associated Milestones	Payment Milestone
Design	10 months	Preliminary Design Review Acceptance	L1.P1.M1
		Critical Design Review Acceptance	L1.P1.M2
		Final Design Review Acceptance	L1.P1.M3
Pilot Project	9 months	Pilot Readiness Acceptance	L1.P2.M1
		Prototype Acceptance	L1.P2.M2
		Pilot Installation Acceptance	L1.P2.M3
		Pilot Test Acceptance	L1.P2.M4
Installation & Implementation	17 months	Installation & Implementation Readiness Acceptance	L1.P3.M1
		Base 2 Equipment Acceptance	L1.P3.M2
		Base 3 Equipment Acceptance	L1.P3.M3
		Base 4 Equipment Acceptance	L1.P3.M4
		Base 5 Equipment Acceptance	L1.P3.M5
		Base 6 Equipment Acceptance	L1.P3.M6
		Base 7 Equipment Acceptance	L1.P3.M7
		Level 1 Conditional Acceptance	L1.P3.M8

Table 2.A.3.1.1.b. Level 2, CCS & OBS Phases & Milestones

Level 2 Project Phase	Estimated Duration	Associated Milestones	Payment Milestone
Design & Development	19 months	Preliminary Design Review Acceptance	L2.P1.M1
		Critical Design Review Acceptance	L2.P1.M2
		Final Design Review Acceptance	L2.P1.M3
		Factory Acceptance Test (FAT) Acceptance	L2.P1.M4
		CCS User Bench Test Acceptance	L2.P1.M5
Installation & Test	5 months	Readiness Acceptance	L2.P2.M1
		Installation Acceptance	L2.P2.M2
		Field Test Acceptance	L2.P2.M3
Implementation	12 months	Pilot Test Acceptance	L2.P3.M1
		Mid-Implementation Test Acceptance	L2.P3.M2
		Level 2 Conditional Acceptance	L2.P3.M3

Table 2.A.3.1.1.c. Full System Acceptance Phase & Milestone

Project Phase	Estimated Duration	Associated Milestones	Payment Milestone
Full System Acceptance	5 months	Full System Acceptance	FSA.1

2.A.3.1.1.1. Design Phase and Design Reviews

The Design effort shall be organized to clearly identify the work and decisions needed to adapt the Contractor's off-the-shelf products to KCM's requirements. It is essential that KCM and Contractor staffs develop an agreed-upon approach and work plans to accomplish what is needed and keep the Project on schedule.

The System Design Phase for each Project Level shall be divided into three distinct review milestones. General objectives for both Level 1 and 2 Design Review milestones are listed below. Unique requirements for the Level 2 Design Reviews are described in Subsection **3.A.7.6.1, Level 2 System Design and Design Reviews**.

a. Design reviews shall be conducted at each milestone to evaluate the progress and technical, functional, and programmatic adequacy of the system designs for Project Levels 1 and 2 in accordance with the functional, performance, and reliability requirements of the Contract during each design phase.

b. The three design review milestones for Project Levels 1 and 2 consist of Preliminary Design Review (PDR), Critical Design Review (CDR), and Final Design Review (FDR).

c. The PDR for Levels 1 and 2 shall occur concurrently. The CDR and FDR for Level 1 and Level 2 shall be conducted independently.

d. All Design Reviews shall be conducted at locations approved by the KCM Project Manager.

e. Prior to each review, a design-review package shall be submitted that includes all required Design Review items.

f. Unless noted otherwise, Design Review items shall be submitted as follows:
   i. In 50% completion form at Preliminary Design Review.
   ii. In 75% completion form at Critical Design Review.
   iii. In final form at Final Design Review.

g. Each Design Review deliverable, including test plans, shall include identification of each required functionality addressed by the deliverable. Such identification shall include the appropriate RFP/Contract section cross-reference.

h. Design-review packages shall be provided at least 30 days before a design-review meeting.

i. The Contractor shall conduct the three formal design reviews.

2.A.3.1.1.1.1. Project Preliminary Design Review (PDR)

The PDR shall begin upon the Contractor's receipt of the County's Notice to Proceed. Certain deliverables, identified as Pre-Design deliverables in Subsection **2.A.3.1.2.2** (Level 1) and in Table **3.A.7.6.2.5.a** (Level 2), are required for the PDR milestone completion for each Project Level. These Pre-Design deliverables will be due immediately after the Contractor receives the Notice to Proceed. The approach and work plans defined by these deliverables will be implemented during each Project Level's subsequent Design phase.

KCM has three primary objectives for the Project PDR. The first is to familiarize KCM with the Contractor's intended design and procurement activities for both Project Levels 1 and 2. Level 2 design-review activities during this combined PDR shall ensure that the Level 1 implementation will seamlessly support the addition of Level 2 functionality, and outline the CCS development and interface to the Transit Radio System project.

The second PDR objective is to resolve external interfaces and provide the basis for proceeding to Critical Design Review (CDR). The PDR is to ensure, among other things, that the Contractor has provided sufficient attention to contract requirements for modularity of all subsystems and major software components for all Level 1 functionality. While these areas will also be reviewed for the Level 2 design at this time, lack of some radio-system-implementation details may make this review less complete. Any further detailed analysis required for Level 2 will be completed during the Level 2 CDR, described in Subsection **3.A.7.6.1.2**.

The last PDR objective is to ensure that the Contractor understands the nature of and has correctly identified all KCM requirements for system performance, testing, in-house system control and configuration, and ongoing system maintenance. Review will be focused on the identification of all functionality supporting the following abilities:

a. To change system settings and configurable parameters on an as-needed basis.

b. To use OBS Administrator tools to achieve defined functional uses.

c. To support system maintenance, diagnostic, and troubleshooting purposes.

d. To define test plans and performance.

The PDR shall represent approximately 50% completion of the total system engineering and organizational design phase and shall review the following:

a. Current and Proposed Project schedule and Project plan.

b. Issues relating to Project dependencies created by integration with other KCM contractors and KCM personnel.

c. All Pre-design deliverables.

d. All PDR deliverables, at 50% completion level.

e. System modularity and interfaces planned for OBS modular software components (RV and BO domains) and all subsystems/devices including both new and legacy equipment.

f. Confirmation that the Contractor is familiar with the intended operations and maintenance environment. In addition to a review of all proposed standards, this shall include, but not be limited to, the review of each legacy system, fleet type, operating base, maintenance facility layout, and the KCWAN as well as all communication layers both on and off the Revenue Vehicle.

2.A.3.1.1.1.2. Level 1 Critical Design Review (CDR)

The objectives of the CDR are to review the Project's progress and evaluate compliance of the completed work and/or work in progress with KCM goals and requirements. The CDR shall represent approximately 75% completion of the total system engineering and organizational design phase. The results of the design effort will be reviewed along with required deliverables including, but not limited to, revised drawings, narratives, and interface control documents. KCM staff will be briefed on the design details for the OBS Pilot Project implementation. The CDR shall also include installation and test plans for the OBS Pilot Project.

The CDR shall cover review of the following:

a. All CDR deliverables, at 75% completion level.

b. Revisions to deliverables submitted for the PDR.

2.A.3.1.1.1.3. Level 1 Final Design Review (FDR)

The objective of the FDR is to determine whether the detailed design satisfies the design requirements established in the Contract documents. For the purposes of change control, the design baseline for all program elements shall be established at the FDR. After the conclusion of the FDR Milestone, the Contractor shall submit any proposed changes that affect design characteristics to the Project Manager for approval.

The FDR shall be conducted when detailed design is complete with all Design Review deliverables prepared in final form. The Project Manager shall have on-site access to Contractor drawings and other design and manufacturing information related to manufacturing release of devices, including microprocessor source code and other proprietary technical data. On-site access shall be provided at the Contractor's facility. The Contractor may establish suitable confidentiality agreements.

The FDR shall cover review of the following areas:

a. All FDR deliverables in final form (100% complete).

b. Latest revisions to the deliverables submitted for the CDR.

2.A.3.1.1.2. Level 1 Pilot Project Phase

The Level 1 Pilot Project Phase includes the Pilot Readiness Acceptance, Prototype Acceptance, Pilot Installation Acceptance, and Pilot Test Acceptance Milestones. Identified deliverables for this phase are listed in Table ***2.A.3.1.2.4, Level 1 Pilot Project Phase Deliverables***.

Requirements for the testing for all milestones in this phase are detailed in Subsection **2.A.2, Testing**. While KCM staff will be responsible for all hardware and software installation on the vehicles, Contractor staff must be on site for all such installations and system testing, providing support and oversight on an as-needed basis. The successful completion of testing for each milestone is required before a Notice of Apparent Completion (NAC) will be issued for that milestone. The KCM Project Manager must issue a NAC before the Contractor is allowed to move on to the next milestone.

2.A.3.1.1.2.1. Pilot Readiness Acceptance Milestone Requirements

The Pilot Readiness Acceptance Milestone requirements include all activities and deliverables needed prior to beginning use of the OBS on the vehicles and at a Transit Base. Required activities are as follows:

a. All factory and bench testing must have been successfully completed.

b. Contractor must have delivered any necessary revisions to the detailed installation and testing plans and manuals.

c. All OBS equipment for prototyping and piloting milestones is on site at the KCM installation facility; includes equipment specifications; installation and maintenance documentation, and tools.

d. All needed software is on site along with successfully tested instructions to load, configure, and perform.

e. WLAN is installed and has successfully undergone some level of operational testing.

f. Landing Pad/Base Server and required connections to the KCWAN are in place and have successfully undergone some level of operational testing.

g. TED modifications and the required data sets are in place to support the on-board database (OBDB) requirements.

h. Required training for operations and maintenance staff is successfully completed.

i. Pilot routes have been selected and data collection on those routes has been completed.

j. Contractor has delivered a plan for installing, configuring, implementing, and testing the OBS Administrator tools and Base Server operations.

k. Contractor has delivered a Project marketing plan and materials for informing King County employees and the riding public.

l. The Pilot Project Plan is complete and has been submitted for approval by the KCM Project Manager. The Plan must include:

   i. Pilot schedule including: prototype installs, Operator and maintenance training, pilot installation, pilot test plan, data collection, reporting, and marketing.

ii. Installation plan: identifying where the installation will be done and the division of labor between Contractor and KCM personnel; specific fleet types and number of vehicles to be included; dependencies and points of coordination with other KCM projects and legacy systems.

iii. The base(s) involved in the pilot.

iv. Detailed training plan and instruction materials.

v. Processes for ensuring Contractor oversight of KCM installation work to ensure that the warranty requirements of this contract are enforceable.

vi. Process for communicating with Pilot Operators and passengers, including collection of Operator feedback, problem and error identification and correction, and responses to Operators regarding issues they have identified.

m. Any other activity determined to be necessary before the start of the Prototype Acceptance Milestone. Additionally, the requisite set of OBS equipment shall be assembled by the Contractor into one installation kit for each fleet type.

2.A.3.1.1.2.2. Prototype Acceptance Milestone

The Prototype Acceptance Milestone requires the Contractor to work with KCM staff as part of an OBS Prototyping Team to prototype the installation for one vehicle of each identified vehicle type in the fleet. There may be up to 10 vehicles total for prototyping, and each vehicle selected for prototyping will already be equipped with the legacy RFCS and DVRS.

2.A.3.1.1.2.2.1. Prototype-Test Vehicle Specifications

The OBS Prototyping Team shall determine the following for each vehicle type selected for prototyping:

a. For every item of hardware to be installed, including on-board and base equipment:

i. Identify where it will be located.

ii. Determine how it will be mounted. If mounting brackets are required, the drawings and specifications for the mounting hardware shall be included in the vehicle installation plan and instructions.

iii. Describe all connectors and connection points, wiring and wiring bundles.

iv. Identify power source and connection.

v. Identify test points and test equipment.

vi. Provide all required documentation, guides, and manuals for all hardware deliverables. Parts manuals identifying all components, brackets, fasteners, wiring, etc. shall be provided. Service manuals identifying system operation, test procedures, maintenance and troubleshooting procedures along with detailed wiring schematics are also required.

b. For all software installations:

i. Provide step-by-step written instructions for installing and verifying each software module.

ii. Describe where and how software shall be obtained for loading.

iii. Provide all required documentation, guides, and manuals for all software deliverables.

2.A.3.1.1.2.2.2. Prototype Testing

Prototype testing shall include:

a. Each prototype installation shall undergo Installation Testing as described in Subsection **2.A.2.3.2**.

b. Each prototype installation shall then undergo Field Testing as described in Subsection **2.A.2.3.3** before installation plans and instructions are completed.

c. Testers shall verify that WLAN and OBS Administrator tools and Base Server processes are performing properly.

2.A.3.1.1.2.2.3. Installation Plans and Documentation

Installation plans and documentation shall include:

a. A complete set of documentation including work breakdown structure by job class, step-by-step instructions, wiring and installation diagrams and schematics, software install instructions and test equipment, and testing to be performed to verify that an installation was performed correctly.

b. Detailed configuration details for operation of the Pilot Test.

2.A.3.1.1.2.3. Pilot Installation Acceptance Milestone

The Pilot Installation Acceptance Milestone will be complete when 1) all of the selected vehicles are fully equipped with the Level 1 Product; 2) Base Operations equipment is installed and operational; 3) maintenance, operations and technical staff are trained; 4) the system has successfully performed the Use Case functions related to data updates and configuration management; and 5) OBS service is ready to be put into operation. Additionally, acceptance of the Pilot Installation Acceptance Milestone requires the following:

a. Documentation on the installation activities.

b. Documentation that designated Operations, Maintenance, and Technical staff has been successfully trained.

c. A fully operational WLAN, as demonstrated by having successfully transferred data and configuration changes between the vehicle and the Base Server.

d. Successful extraction of the agreed-upon data (from TED and other sources) and automatic transmission of that data onto the vehicles.

e. Successful demonstration of the functions described in the ***BO3-Manage Historical Data*** use case, and testing of those functions for accuracy and correctness.

f. Reports and web-based query tools in place and operating successfully.

g. AVM signal and AVM Event reporting tools operating successfully.

h. All other Base Server processes and procedures operating successfully. These include diagnostic, troubleshooting, debugging, configuration, and a full set of OBS Administrator tools.

2.A.3.1.1.2.4. Pilot Test Acceptance Milestone

The Pilot Test Acceptance Milestone requires the following activities:

a. Provision of updated Installation plans and documentation that reflect the lessons learned in the pilot.

b. Provision of a full report on pilot test data, documentation, and performance results.

c. Demonstration that bug fixes and errors in the software have been corrected.

d. Delivery of revised Installation and Implementation Plans for KCM review and approval.

2.A.3.1.1.3. Level 1 Installation and Implementation Phase

The Level 1 Installation and Implementation Phase includes the Installation and Implementation Readiness Acceptance Milestone and then a separate, sequential Base Equipment Acceptance Milestone for each of the remaining six Bases (Bases 2 through 7). The KCM Project Manager must issue a NAC for each Base before the Contractor is allowed to move on to the next Base Milestone.

2.A.3.1.1.3.1. Installation and Implementation Readiness Acceptance Milestone

The Installation and Implementation Readiness Acceptance Milestone requirements include delivery of all equipment kits for each fleet type needed for installation during the Base 2 Milestone. Additionally, training requirements for Operations staff as described in Subsection **2.A.3.8** will also be required for completion of this milestone.

2.A.3.1.1.3.2. Bases 2-7 Equipment Acceptance Milestones

Each Base Equipment Milestone for bases 2 through 7 has the same requirements and these include Operator training and system installation and implementation. These requirements must be completed at each Base before the next Base Milestone may begin. The delivery of equipment kits for installation at the next Base also must occur before the previous Base Equipment Milestone will be considered complete. Finally, the successful completion of testing at each base is required before starting the next Base Equipment Milestone. See Subsection **2.A.2.3.5, Acceptance Testing** for specific requirements.

2.A.3.1.1.4. Level 1 Conditional Acceptance

The successful completion of Level 1 OBS operational testing on the full set of KCM Revenue Vehicles for a period of one full service change cycle (approximately five months) will be required to achieve Level 1 Conditional Acceptance. See Subsection **2.A.2.3.5, Acceptance Testing** for specific requirements.

2.A.3.1.1.5. Level 2 Phases

For detailed information on Level 2 phases and milestones, see Subsection **3.A.3.4**.

2.A.3.1.1.6. Full System Acceptance Phase/Milestone

See Subsections **3.A.3.5** and **3.A.7.5.2.10**.

2.A.3.1.2. Project Deliverables

2.A.3.1.2.1. General Requirements for Deliverables

a. Monthly Project reports and Schedule updates, to be provided by Contractor. These will provide update and progress information for the preceding month's Project activities and will be delivered within 10 days of that month's conclusion. This reporting is less extensive and independent of that required for the Design Review phase milestones described below. For late or missing reports or updates, see Part **B** (Terms and Conditions), Section **10.6, Late Schedules and Reports**.

b. Proposed technical and other required documentation for all Project phases:

   i. Seven paper copies and one electronically formatted version shall be provided for each submittal.

   ii. Each drawing submittal shall include one reproducible on Mylar, sepia, or equivalent.

c. Proposed equipment mock-ups: The Contractor shall provide mock-ups of equipment for evaluation during CDR, if not previously required, as follows:

   i. Mock-ups shall be either real equipment, or if real equipment is not available, a substitute media of the same physical dimensions subject to the review and approval of the KCM Project Manager.

   ii. Mock-ups shall be presented spatially as if an installed system where appropriate to allow evaluation of ergonomic factors for Operator use and vehicle operation.

   iii. Presentation of all customer and KCM personnel interface panels, operation, display and audio messages shall be subject to mock-up for use in focus groups.

d. Proposed prototype equipment: The Contractor shall provide prototypes of each custom-designed and/or subcontractor- or OEM-provided piece of equipment and operational software that allows evaluation under simulated operation in an in-service environment. The prototype shall include at least the following:

   i. Fully operational unit or subsystem.

   ii. All interfaces operational.

   iii. All software and firmware operational.

   iv. Operator interface functions, if applicable.

   v. Customer information display functions, if applicable.

   vi. Any specified OEM equipment that is directly attached to or interactive with the operational unit or subsystem.

   vii. Any prototype equipment that requires few or no changes may be used as the Factory Acceptance Testing (FAT) unit, subject to the review and approval of the KCM Project Manager.

2.A.3.1.2.2. Pre-Design Phase Deliverables

Prior to the Design Phase (pre-design), the Contractor will be responsible for providing certain deliverables as outlined in Table ***2.A.3.1.2.2, Levels 1 & 2 Pre-Design Phase Deliverables*** shown below. There are no milestones tied to the pre-design time period and provision of these deliverables shall be required for the successful completion of the Preliminary Design Phase Milestone. Additional deliverables required for the successful completion of the PDR Milestone are listed below in Tables ***2.A.3.1.2.3*** (Level 1) and ***3.A.7.6.2.5.b*** (Level 2).

The Contractor's proposed additions for each list of deliverables needed to meet Project goals must be approved by the KCM Project Manager prior to inclusion in the Project requirements. These lists will be organized first by Project Level, then Phase and Milestone. Additionally, proposed lists of additions to both Level 1 and 2 Design Review Phase deliverables must be organized as follows:

a. A separate list of deliverables for progressive review at each of the three Design Review milestones for each Project Level (see Subsection **2.A.3.1.2.3** following for further information).

b. A separate list of deliverables for each individual Design Review milestone for each Project Level, containing proposed additions pertinent only to the achievement of that milestone's goals.

Table 2.A.3.1.2.2. Levels 1 & 2 Pre-Design Phase Deliverables

Note 1: *Project* Deliverables for the Pre-Design Phase must include both the OBS and CCS.

Note 2: The "Reference" column shown in this and all other tables of Phase Deliverables contains some but *not necessarily all* pertinent references contained within the RFP. The Contractor will be responsible for ensuring that each provided deliverable meets all RFP requirements.

Milestone No.	Deliverable No.	Category	Deliverable Description	Reference (See Note 2)
L1.P1.M1 L2.P1.M1	P1	Project	Project Schedule with Milestones	Part B, Section 10.2
L1.P1.M1 L2.P1.M1	P.2	Project	Project Plan by Phase and Milestone, including work assignments for all Key Personnel.	
L1.P1.M1 L2.P1.M1	P.3	Project	Plan for Agency/Contractor Requirements Review	
L1.P1.M1 L2.P1.M1	P.4	Project	Lists of Recommended Additions to each set of Deliverables, organized by Project Level, Phase and Milestone.	Subsection 2.A.3.1.2.2. Pre-Design Phase Deliverables
L1.P1.M1 L2.P1.M1	P.5	Project	List of Project Issues and Mitigation Strategies (Schedule, Technical, Other Contractors, etc.)	
L1.P1.M1 L2.P1.M1	P.6	Project	Outlines of content for each required document/deliverable.	Subsection 2.A.3.1.2. and Tables 3.A.7.6.2.5.b through 3.A.7.6.2.5.g
L1.P1.M1 L2.P1.M1	P.7	Project	Documentation for proposed design and implementation Standards (industry, state, national, international, etc.) including proposed TCIP version.	Subsections 2.A.1.2.1.2, 2.A.1.2.3, 2.A.1.4.3, 2.A.1.6, 2.A.1.7.
L1.P1.M1 L2.P1.M1	P.8	Project	Quality Assurance Plan	Subsection 2.A.3.7.
L1.P1.M1 L2.P1.M1	P.9	Project	Software Version and Configuration Control Management Plan	
L1.P1.M1 L2.P1.M1	P.10	Project	Requirements Management Plan including all required software and documentation.	Subsection 2.A.3.5.
L1.P1.M1 L2.P1.M1	P.11	Project	Contact Information for Contractor's Principal Trainer	Subsection 2.A.3.8.1.
L1.P1.M1 and all other Level 1 & Level 2 Milestones	P.12	Project	Project Documentation Website – updated with current versions of all documentation throughout the Project's life, including all appropriate IP materials in accordance with Part B, Section 41..	Subsection 2.A.3.2.1.1. Part B, Section 41.0 Intellectual Property

2.A.3.1.2.3. Level 1 Design Phase Deliverables

The three Milestones included in this phase are the Preliminary Design Review (PDR), Critical Design Review (CDR) and Final Design Review (FDR). These are shown in columnar form in Table ***2.A.3.1.2.3***. Deliverables are due for each milestone with an "X" in its column.

Table 2.A.3.1.2.3. Level 1 Design Phase Deliverables

Note 1: 'Notes' Column Key:
(1) Deliverable should only include updates and modifications on an as-needed basis for CDR and FDR Milestones.
(2) Deliverable listed is to be provided in progressive stages of completion for each design review milestone as follows: 50% complete for PDR; 75% complete for CDR; 100 % complete for FDR. At each stage, finer detail shall be provided.

Note 2: The "Reference" column shown in this and all other tables of Phase Deliverables contains some but not necessarily all pertinent references contained within the RFP. The Contractor will be responsible for ensuring that each provided deliverable meets all RFP requirements.

Milestone No.	Category	Deliverable Description	Required for Milestone Completion			Notes (See Note 1)	Reference (See Note 2)
			PDR	CDR	FDR		
L1.P1.M1 L1.P1.M2 L1.P1.M3	Project	Schedule Compliance report including discussion of variances or delays.	X	X	X	(1)	
L1.P1.M1 L1.P1.M2 L1.P1.M3	Project	Revised Project Plan by Phase and Milestone including work assignments for all key personnel.	X	X	X	(1)	
L1.P1.M1 L1.P1.M2 L1.P1.M3	Project	Contractor's proposed work assignments for management team and key personnel; includes scope for and devices to be supplied by each subcontractor, if any.	X	X	X	(1)	
L1.P1.M1 L1.P1.M2 L1.P1.M3	Project	Implementation strategy for integration and installation in cooperation with KCM personnel and other KCM contractors including, but not limited to, the RFCS and TRS projects.	X	X	X	(2)	
L1.P1.M1 L1.P1.M2 L1.P1.M3	Project	Project Issues report including recommended mitigation strategies (schedule, technical, critical path, etc.) including, but not limited to, those related to dependencies created by integration with other KCM contractors.	X	X	X	(1)	
L1.P1.M1 L1.P1.M2	Project	Outstanding information needs and decisions required from KCM, if any,	X	X	X	(1)	

Milestone No.	Category	Deliverable Description	Required for Milestone Completion			Notes (See Note 1)	Reference (See Note 2)
			PDR	CDR	FDR		
L1.P1.M3		including those related to other KCM contractors.					
L1.P1.M1 L1.P1.M2 L1.P1.M3	System: Standards	Conformance plan including proposed system(s) architecture with physical and logical diagrams, and a detailed narrative that maps Level 1 to the National ITS Architectures Standards.	X	X	X	(1)	Subsection 2.A.1.2.1.
L1.P1.M1 L1.P1.M2 L1.P1.M3	System: Standards	Detailed descriptions of methodologies used to meet chosen TCIP and other national, County, and industry standards including complete documentation on all standards utilized, if not already provided. This information must include the translations and enforcement of referential integrity triggers.	X	X	X	(2)	Subsection 2.A.1.2.1.
L1.P1.M2 L1.P1.M3	System	Description of operational and physical compatibility with all legacy subsystems and equipment including integration and installation methodology.		X	X	(2)	
L1.P1.M3	System	Detailed human-factors engineering results			X		
L1.P1.M1 L1.P1.M2 L1.P1.M3	System	Narrative description of proposed system for problem and fault tracking, resolution, and reporting process for system design, development, implementation, warranty, and maintenance. **Note**: FDR must include sample Problem Tracking & Resolution Report Logs.	X	X	X	(1)	2.A.3.7.3.1. Various other Level 1 SOW sections.
L1.P1.M1 L1.P1.M2 L1.P1.M3	Design: HW	Complete list of all proposed Contractor-provided equipment including device name, model number, provider (contractor, OEM, or subcontractor), power requirements, physical dimensions, and available documentation (technical, reference, support, installation, user manuals, etc.).	X	X	X	(1)	
L1.P1.M2	Design: HW	Detailed technical descriptions of all Level		X	X	(2)	

Milestone No.	Category	Deliverable Description	Required for Milestone Completion			Notes (See Note 1)	Reference (See Note 2)
			PDR	CDR	FDR		
L1.P1.M3		1 equipment, including all technical, reference, support, installation, and use manuals and documentation provided by original equipment manufacturers.					
L1.P1.M2	Design: HW	Mockups of all proposed Contractor-provided equipment.		X			Subsection 2.A..3.1.2.1.c. Proposed equipment mock-ups
L1.P1.M3	Design: HW	Prototypes of all proposed Contractor-provided equipment, including all required documentation.			X		Subsection 2.A..3.1.2.1.d. Proposed prototype equipment
L1.P1.M2 L1.P1.M3	Design: HW	Detailed hardware and subsystem interface descriptions including wiring schematics, mounting arrangements, mockups/prototypes, and installation methods for all OBS base and vehicle equipment.		X	X	(1)	
L1.P1.M1 L1.P1.M2 L1.P1.M3	Design: System	System Availability Measurement Plan	X	X	X	(1)	Subsection 2.A.1.4.6. System Reliability & Availability Requirements
L1.P1.M3	Design: System	Shutdown and startup sequences for the Base Server, VLU, and each modular subsystem.			X		
L1.P1.M1 L1.P1.M2 L1.P1.M3	Design: SW, modularity (RV and BO domains)	Functional block diagrams for each system, subsystem, and device, showing all subsystems and software components as system modules. Must include legacy and Contractor-supplied equipment.	X	X	X	(2)	• Subsection 2.A.1.5.3. Subsystems. • Subsections 2.B.2. and 3.B.3. contain Levels 1 & 2 use cases which describe modular SW components.
L1.P1.M1 L1.P1.M2 L1.P1.M3	Design: SW, modularity	Top-level data model illustrating the major logical and functional entities' relationships, including each Level 1 software component and database, and illustrating required system modularity.	X	X	X	(2)	
L1.P1.M1 L1.P1.M2 L1.P1.M3	Design: SW modularity	Detailed narrative descriptions of each proposed software module, system, and subsystem, including all interactions and shutdown procedures.	X	X	X	(2)	RV3-Take Vehicle Out of Operation Use Case

Milestone No.	Category	Deliverable Description	Required for Milestone Completion			Notes (See Note 1)	Reference (See Note 2)
			PDR	CDR	FDR		
L1.P1.M1 L1.P1.M2 L1.P1.M3	Design: SW interfaces	Detailed software interface descriptions including an Interface Control Document (ICD) for each file and data exchange within and between the Base Operations and Revenue Vehicle Domains. This includes, but is not limited to, the VLU and OBS modular software components, all OBS subsystems and connected devices (including legacy systems), and Base Operations equipment (WLAN, Landing Pad, Base Server, AVM Alarm). The ICD will include flow and content required for interfacing.	X	X	X	(2)	• RV7-Determine Vehicle Location use case; • Appendix C. Interface Control Document.
L1.P1.M1, L1.P1.M2	Design: SW interfaces	A schedule and list of responsibilities for the completion and approval of detailed definitions of all system interfaces.	X	X		(1)	
L1.P1.M2 L1.P1.M3	Design: Comm.	Detailed description of all proposed communications layers, interfaces, and protocols.		X	X	(2)	
L1.P1.M2 L1.P1.M3	Design: VAN	Detailed description of proposed on-board vehicle area network (VAN) design including schematics and methodology for subsystem addressing.		X	X	(2)	
L1.P1.M2 L1.P1.M3	Design: WLAN	Detailed description of proposed WLAN implementation: include alternatives analysis; equipment list; plan for location of AVM signals and WLAN access points at each Base; Base maps showing proposed locations and coverages.		X	X	(1)	• Subsection 2.A.1.6.3. • Appendix B. Transit Bases Information
L1.P1.M1 L1.P1.M2 L1.P1.M3	Design: Power	Single-line power diagrams and functional block diagrams for each device, including a functional overview and a description of how each device and subsystem periodically reports its health status to the VLU and goes into and out of service.	X	X	X	(2)	

Milestone No.	Category	Deliverable Description	Required for Milestone Completion			Notes (See Note 1)	Reference (See Note 2)
			PDR	CDR	FDR		
L1.P1.M1 L1.P1.M2 L1.P1.M3	Design: Power	Detailed description of the proposed Vehicle Power Management System including configuration tools, shutdown sequences and prioritized use for equipment, and battery management.	X	X	X	(1)	
L1.P1.M1 L1.P1.M2 L1.P1.M3	HW / Elec.	Identification of power and other facility requirements for each equipment type and for the vehicle as a whole including wiring diagrams and schematics.	X	X	X	(1)	
L1.P1.M1 L1.P1.M2 L1.P1.M3	HW / Elec.	Detailed description of provisions to be included for EMI/RFI protection.	X	X	X	(1)	Subsection 2.A.1.4.3.1. Electromagnetic Compatibility
L1.P1.M2 L1.P1.M3	Design: SW	Software design descriptions (top level of software documentation) for microprocessor-based and programmable equipment.		X	X	(2)	
L1.P1.M2 L1.P1.M3	Design: SW	Identification and detailed descriptions of special software requirements.		X	X	(1)	
L1.P1.M2 L1.P1.M3	Design: SW	Software system-level flow charts.		X	X	(1)	
L1.P1.M1	Design: SW/DB	Entity-Relationship Diagram of data, attributes, flow diagrams, pseudo code, and definition of all primary keys for each proposed database.	X				
L1.P1.M2 L1.P1.M3	Design: SW/DB	Entity-Relationship Diagram, primary keys, foreign keys, modules for interfacing, and software flow charts for each proposed database.		X	X	(2)	
L1.P1.M2 L1.P1.M3	Design: SW/DB	All proposed data formats and database design schema.		X	X	(2)	

Milestone No.	Category	Deliverable Description	Required for Milestone Completion			Notes (See Note 1)	Reference (See Note 2)
			PDR	CDR	FDR		
L1.P1.M1 L1.P1.M2 L1.P1.M3	Design: Functional Requirements	Detailed narrative descriptions of all proposed modifications to Subsection 2.C. Level 1: OBS Use Cases for Revenue Vehicle and Base Operations requirements, including proposed solutions to technical specifications, and issues and questions for each use case. Descriptions and diagrams should be organized by use case and provided as updates to KCM's existing documentation, using standard UML tools and methodology.	X	X	X	(2)	Subsection 2.B. Level 1 Functional Requirements (Use Case Specifications)
L1.P1.M2 L1.P1.M3	Design: Data	Proposed system controls and methodology to create, manage, report, troubleshoot, and debug all types of data logging.		X	X	(2)	
L1.P1.M2 L1.P1.M3	Design: Data	Proposed composition of all data sets, files, and databases for transmission between Base and Revenue Vehicle.		X	X	(2)	
L1.P1.M1 L1.P1.M2 L1.P1.M3	Design: Data	Proposed functions, methods, and protocols for handling data during transmission between the Vehicle and the Base, including encryption/decryption methodology, other security methodology, and data backup, archiving, and recovery procedures.	X	X	X	(2)	Subsection 2.A.1.7.3, Comprehensive and Accurate Data Collection and Management Subsection 2.A.1.7.4, Data Exchange Requirements
L1.P1.M2 L1.P1.M3	Design: Data	Proposed "trigger" methodology for DDU prompts; activating data sets on the vehicle, including storage and replacement strategies.		X	X		• RV4-Update Vehicle Data • RV12- Interface to DDU • BO2 Update Vehicle Data
L1.P1.M2 L1.P1.M3	Design: Security	System Security Plan including proposed methodology for providing system security for all servers and data.		X	X	(2)	Subsection 2.A.1.4.5. System Security Various other Level 1 SOW subsections
L1.P1.M2 L1.P1.M3	Design: Security	Design for access control for the equipment and software menus.		X	X	(2)	
L1.P1.M1 L1.P1.M2	Design: System	Proposed OBS Events Matrix divided into planned and unplanned events with logged	X	X	X	(2)	RV6-Manage Events Appendix G, Event Log Matrix

Milestone No.	Category	Deliverable Description	Required for Milestone Completion			Notes (See Note 1)	Reference (See Note 2)
			PDR	CDR	FDR		
L1.P1.M3		data fields, priority and type for each event; proposed methodology for handling event errors and retries.					
L1.P1.M1, L1.P1.M2 L1.P1.M3	Design: System Configuration	Detailed narrative descriptions of all required KCM system controls and configuration functionality including configurable parameters with identified defaults; diagnostic, debugging, and troubleshooting utilities; and OBS Administrator Tools. **Note**: The completed OBS Administrator Toolkit must be provided as part of FDR.	X	X	X	(2)	Appendix K. OBS & CCS Administrator Tools
L1.P1.M1 L1.P1.M2 L1.P1.M3	Design: Procedure	Proposed business and automated procedures to manage Operator Road Reliefs, Unscheduled Coach Changes, and Road Jumps.	X	X	X	(1)	RV-1-Initiate Vehicle for Operation use case
L1.P1.M2 L1.P1.M3	Design: Reports	Draft system reports and formats including, at a minimum: report description, reporting data set, all user parameters indicating whether required or optional, each field definition including data source, and any calculations, special formatting requirements, and access or security restrictions.		X	X	(2)	Subsection 2.A.1.7.5. Reporting Requirements.

Milestone No.	**Category**	**Deliverable Description**	**Required for Milestone Completion**			**Notes** (See Note 1)	**Reference** (See Note 2)
			PDR	**CDR**	**FDR**		
L1.P1.M1 L1.P1.M2 L1.P1.M3	Design: GUI	Proposed content and format of each operator, system administrator, and any other user interface message, including those shown on the DDU and on each server (Landing Pad, Base Server, and VLU), including error and diagnostic messages. User interface information shall include, at a minimum: user interface description, field-level definitions, function key (or other control) definitions and processing logic; implemented business rules and/or special processing logic, CRUD (create, read, update, delete) functions, and access and/or security restrictions.	X	X	X	(2)	• RV1-Initiate Vehicle for Operation • RV3-Take Vehicle Out of Operation • RV10-Manage PA & Annunciator • RV12- Interface to DDU Various other Level 1 SOW Sections
L1.P1.M1 L1.P1.M2 L1.P1.M3	Design: GUI	Complete set of proposed customer information messaging for all internal and external audio/video displays and announcements including flow charts, display graphics, messages and menus, as well as messaging and accommodation for all operating boundary and error conditions. Customer message information shall include, at a minimum: customer message description, field-level definitions, function-key (or other control) definitions and processing logic, implemented business rules and/or special processing logic, CRUD (create, read, update, delete) functions, and access and/or security restrictions.	X	X	X	(2)	Use Cases: • RV1-Initiate Vehicle for Operation • RV3-Take Vehicle Out of Operation • RV10-Manage PA & Annunciator • RV12- Interface to DDU Various other Level 1 SOW Sections
L1.P1.M1 L1.P1.M2 L1.P1.M3	GIS	GIS Data Collection Tool. **Note**: completed tool as well as documentation is due at FDR.	X	X	X	(2)	• Subsection 2.A.1.7.4.3. • CC7-Manage Transit Service & Data Collection
L1.P1.M3	DDU	ERG Test Bench certification of all Contractor-provided functionality for DDU.			X		

Milestone No.	Category	Deliverable Description	Required for Milestone Completion			Notes (See Note 1)	Reference (See Note 2)
			PDR	CDR	FDR		
L1.P1.M2	Installation	Draft descriptions of installation plans and manuals for all relevant project phases and milestones. Must include list of all required equipment and tools as well as migration plans for all legacy system(s).		X			
L1.P1.M3	Installation	Final installation plans and manuals for all relevant project phases and milestones. Must include list of all required equipment and tools as well as migration plans for all legacy system(s).			X		
L1.P1.M3	Installation	Assembly drawings down to the lowest replacement unit level.			X		
L1.P1.M3	Installation	Electrical schematic drawings, down to the individual signal or wire level, for each electrical circuit including connections.			X		
L1.P1.M2 L1.P1.M3	Testing: Standards	Proposed performance standards for all areas and types of testing.		X	X	(1)	
L1.P1.M1 L1.P1.M2 L1.P1.M3	Testing	Narrative descriptions, designs, methodologies and data requirements for the complete set of proposed Test Plans for each required function and each level of required testing (factory, bench, installation, operational, warranty) organized by Project level, phase, and milestone. **FDR**: Each test plan will identify the required function(s) and/or functionality tested, identifying functions by lowest SOW or Use Case subsection. Use of historical "real" data will be required for all operational and warranty testing.	X	X	X	(2)	Subsection 2.A.2. Testing
L1.P1.M1 L1.P1.M2 L1.P1.M3	Training	Proposed Training Program including plans, procedures, and materials for each type of required training.	X	X	X	(2)	Subsection 2.A.3.8. Training
L1.P1.M2 L1.P1.M3	Testing	Detailed description of special tools for system testing, installation, and maintenance including test bench		X	X	(2)	Subsection 2.A.2.4.4. Test Tools and Logging

Milestone No.	Category	Deliverable Description	Required for Milestone Completion			Notes (See Note 1)	Reference (See Note 2)
			PDR	CDR	FDR		
		equipment.					
L1.P1.M2 L1.P1.M3	Testing	Proposed MTBF calculations for implemented systems, including basis for calculations, sample size, measurement assumptions, etc.		X	X		Subsection 2.A.2.9. Acceptance Testing
L1.P1.M3	Testing	Demonstration of compatibility with Agency WAN, WLAN, legacy, and Contractor-provided subsystems and other connected devices.			X		
L1.P1.M3	HW Specification	Specifications for KCM-provided servers, workstations, and operating systems and other requisite software. Must include systems documentation and migration procedures/capabilities for each server.			X		Subsection 2.A.1.3.5.
L1.P1.M3	Documentation	Flow charts or structure charts that give an overview of the processor software modules.			X		• Part B, Exhibit 1, “Software Documentation” • Subsection 2.A.3.2.
L1.P1.M3	Documentation	Software documentation at the second level, consisting of the data model (entities and attributes) to the lowest level of decomposition with software module descriptions (or elemental process descriptions) in structured narrative format. The second level of software documentation is one level above source code and should include descriptions for each equipment type.			X		• Part B, Exhibit 1, “Software Documentation” • Subsection 2.A.3.2.
L1.P1.M3	Documentation	Input data definitions at Base Server, OBS, software module, and subsystem levels.			X		• Part B, Exhibit 1, “Software Documentation” • Subsection 2.A.3.2.
L1.P1.M3	Documentation	Output data definitions at Base Server, OBS, software module, and subsystem levels.			X		• Part B, Exhibit 1, “Software Documentation” • Subsection 2.A.3.2.
L1.P1.M3	Documentation	Interrupt structure definition.			X		• Part B, Exhibit 1, “Software Documentation” • Subsection 2.A.3.2.

Milestone No.	Category	Deliverable Description	Required for Milestone Completion			Notes (See Note 1)	Reference (See Note 2)
			PDR	CDR	FDR		
L1.P1.M3	Documentation	Configurable program parameters at Base Server, OBS, software module, and subsystem levels.			X		• Part B, Exhibit 1, "Software Documentation" • Subsection 2.A.3.2.
L1.P1.M3	Documentation	Diagnostic routines for each processor and subsystem self-test.			X		• Part B, Exhibit 1, "Software Documentation" • Subsection 2.A.3.2.
L1.P1.M3	Documentation	Identification and description of all error-handling routines.			X		• Part B, Exhibit 1, "Software Documentation" • Subsection 2.A.3.2.
L1.P1.M3	Documentation	Data dictionary with TCIP translation, where appropriate, and metadata.			X		• Subsection 2.A.1.2.1.2.1. • Part B, Exhibit 1, "Software Documentation" • Appendix A. TCIP Data Dictionary
L1.P1.M3	Documentation	System Operations and Maintenance manuals.			X		• Part B, Exhibit 1, "Software Documentation" • Subsection 2.A.3.2.
L1.P1.M3	Documentation	All other required software documentation.			X		Part B, Exhibit 1, "Software Documentation"

2.A.3.1.2.4. Level 1 Pilot Phase Deliverables

Table 2.A.3.1.2.4. Level 1 Pilot Phase Deliverables

Note: The "Reference" column shown in this and all other tables of Phase Deliverables contains some but not necessarily all pertinent references contained within the RFP. The Contractor will be responsible for ensuring that each provided deliverable meets all RFP requirements.

Milestone No.	Milestone Name	Deliverable Description	Reference (See Note)
L1.P2.M1	Ready	Test Bench including all equipment and other materials.	Subsection 2.A.2. Testing
L1.P2.M1	Ready	Special Tools, Diagnostic Equipment, and other required tools for system implementation and testing, with documentation and manuals	Subsections 2.A.3.8.5.5, 2.A.3.8.5.6 & 2.A.3.8.5.7
L1.P2.M1	Ready	Contractor certification of the electromagnetic compatibility of equipment to be furnished with legacy equipment of the on-board environment.	Subsection 2.A.1.4.3.1 Electromagnetic Compatibility
L1.P2.M1	Ready	Equipment delivery for Prototype Acceptance and Pilot Installation Acceptance Milestones including an additional 10% spare units for use during installation in the event a failure occurs during installation. All equipment must be palletized for delivery.	Subsection A.3.1.1.2.1.c.
L1.P2.M1	Ready	Plan for installation, configuration, implementation, and testing of OBS Administrator tools.	Subsection A.3.1.1.2.1.j.
L1.P2.M1	Ready	Project marketing plan and materials for KC employees and transit customers.	Subsection A.3.1.1.2.1.k.
L1.P2.M1	Ready	All lesson plans, detailed instructor guides for each training program, student workbooks, manuals, publications, videos, transparencies, and any other training aids used by an instructor when teaching a course.	Subsection 2.A.3.8. Training
L1.P2.M1	Ready	PC-based interactive training application.	Subsection 2.A.3.8. Training
L1.P2.M1	Ready	Eight "Bus in a Box" Simulators.	Subsection 2.A.3.8. Training
L1.P2.M1	Ready	Detailed electrical-system instructor guides and training aids.	Subsection 2.A.3.8. Training
L1.P2.M1	Ready	All required training aids.	Subsection 2.A.3.8. Training
L1.P2.M1	Ready	On-Call Contractor Contact: detailed notification and response contact information (telephone and pager numbers).	Subsection 2.A.3.8. Training
L1.P2.M1	Ready	Current Parts list and Parts manuals.	Subsection 2.A.3. Other Project Requirements
L1.P2.M2	Prototype	Complete set of (new & revised) documentation including work breakdown structure by job type, step-by-step instructions, wiring and installation diagrams and schematics, software installation instructions, and test procedures, including those to determine successful installation.	Project Phases: Pilot

Milestone No.	Milestone Name	Deliverable Description	Reference (See Note)
L1.P2.M2 L1.P2.M3 L1.P2.M4	Prototype, Pilot Install, Pilot Accept	Problem & Fault Tracking & Maintenance Performance Reports including Problem Tracking & Resolution Report Logs.	Subsection 2.A.3.7.3.1. & various Level 1 SOW sections.
L1.P2.M3	Pilot Install	Complete documentation on installation activities.	Project Phases: Pilot
L1.P2.M3	Pilot Install	Documentation that designated staff has been successfully trained.	Project Phases: Pilot
L1.P2.M3	Pilot Install	Reports and Web-based query tools.	Project Phases: Pilot
L1.P2.M3	Pilot Install	Updated Installation plans and documentation that reflect the lessons learned in the Pilot.	Project Phases: Pilot
L1.P2.M4	Pilot Accept	Full report on Pilot test data, documentation, testing, and performance.	Project Phases: Pilot
L1.P2.M4	Pilot Accept	Revised Installation and Implementation Plan for review and approval with all revised documentation and manuals.	Project Phases: Pilot

2.A.3.1.2.5. Level 1 Installation and Implementation Phase Deliverables

Table 2.A.3.1.2.5. Level 1 Installation and Implementation Phase Deliverables

Note: The "Reference" column shown in this and all other tables of Phase Deliverables contains some but not necessarily all pertinent references contained within the RFP. The Contractor will be responsible for ensuring that each provided deliverable meets all RFP requirements.

Milestone No.	Milestone	Deliverable Description	Reference (See Note)
L1.P3.M1	Ready	Equipment Delivery, on a base-by-base basis, including an additional 10% spare units for use during installation in the event a failure occurs during installation. All equipment must be palletized for delivery.	
L1.P3.M1	Ready	Detailed Installation Plans.	Subsection 2.A.2. Testing
L1.P3.M1	Ready	Detailed Testing Plans.	Subsection 2.A.2. Testing
L1.P3.M1	Ready	Documentation for Equipment Ready and Installation Acceptance.	
L1.P3.M1	Ready	All required tools for equipment installation and maintenance.	Subsections 2.A.3.8.5.5.- 2.A.3.8.5.7.
L1.P3.M2 thru L1.P3.M7	Base 2-7	Equipment, tools, and revised documentation for succeeding Base Equipment Acceptance Milestone.	
L1.P3.M2 thru L1.P3.M8	Base 2-7, Conditional Acceptance	Problem & Fault Tracking & Maintenance Performance Reports including Problem Tracking & Resolution Report Logs.	Subsection 2.A.3.7.3.1. & various Level 1 SOW sections.
L1.P3.M8	Conditional Acceptance	"As-built" drawings and system documentation for all Level 1 hardware and software, including but not limited to schematics, diagrams, drawings, illustrations, manuals, and descriptions.	

2.A.3.2. Documentation

All documentation shall be managed for configuration and version-control purposes, traceable to the requirements. This management shall include the tracking of all documentation changes as the Project progresses.

2.A.3.2.1. Documentation Control and Management

The following requirements apply to documentation control and management. They add to but do not replace other documentation requirements stated elsewhere in the RFP.

a. All software and versions used to produce documentation shall be provided to and approved by the KCM Project Manager.

b. All system documentation, including manuals and training materials, shall be available for download from a Project website.

c. Unless otherwise specified, one electronic copy and at least seven paper copies of all documentation shall be provided to the KCM Project Manager.

d. All draft electronic documentation shall be provided in Adobe Acrobat PDF format suitable for printing. All final electronic documentation shall be provided in both Adobe Acrobat PDF format and native file format.

e. KCM shall have the right to reproduce and reuse all documentation, subject to Intellectual Property rights and requirements as defined in **Part B (Terms and Conditions): Section 41.0 Intellectual Property**. In all cases, KCM shall have the right to reproduce, reuse, and distribute all documentation for the purpose of operating and maintaining OBS/CCS.

2.A.3.2.1.1. Documentation Website

The Contractor shall establish and manage all system documentation via a Project website throughout the Contract term, including the Extended Warranty period, if any. The Contractor shall also be responsible for management of this website and its web server.

This website shall provide the latest versions of all such documentation. It is KCM's intention to take over management of this website if and when the Contractor ceases to do so. The following requirements shall apply:

a. All documentation shall be downloadable in a usable format through the Project website.

b. Access to the website and access to documents within the website shall be user- and password-controlled and available to users only as necessary, as identified by the KCM Project Manager.

c. The Contractor shall update the website with the latest versions of documents throughout the Contract.

d. Documentation shall be in the English language.

e. Website structure must be approved by the KCM Project Manager and shall be indexed using the UML model package structure, system documentation type and/or logical grouping. Potential UML diagrams required may include sequence and class.

2.A.3.2.2. Manuals

2.A.3.2.2.1. General Requirements

The Contractor shall supply the full complement of manuals and documentation required to train KCM personnel to operate and maintain all system components installed in or on a KCM facility, or operated by KCM. General requirements for manuals follow:

a. Manuals shall be provided according to an agreed-upon schedule.

b. Manuals in final (as-built) version shall be provided to the KCM Project Manager in three forms: on the Project website, on CD-ROM, and printed.

c. Manuals shall be written in the English language.

d. Manuals shall be divided and tabbed into logical and/or functional sections.

e. Manuals shall be indexed.

f. Manuals shall include documentation on the hardware and the software associated with each component.

g. Manuals shall be updated as required over the life of the Contract to reflect all configurations operational in the field.

h. Manuals shall be furnished as "Controlled" documents, and each manual shall contain a unique number.

Revisions to a manual shall comply with the following:

a. All revisions shall be issued by manual number.

b. Revisions to draft and approved manuals shall be recorded on a control list to be maintained in the front of each manual.

c. The list shall be issued with each revision and shall contain the date of the revision and the page references for that revision.

d. The training documentation shall be separate from the operation and maintenance manuals, but may reference those manuals. Training documentation requirements are defined in Subsection **2.A.3.8, Training**.

2.A.3.2.2.2. Paper Format

Physical requirements for printed manuals are as follows:

a. Manuals shall be designed to withstand continuous, long-term use in a commercial environment.

b. Manuals shall lie flat when opened and permit easy addition and replacement of pages.

c. Covers for all manuals shall be made from materials that are oil-, water-, and wear-resistant.

d. Pages shall be 8½ x 11 inches except where otherwise specified, and shall be double-sided.

e. Sides of pages intentionally left blank shall be so noted.

f. Figures, illustrations, diagrams, and drawings shall be labeled as *figures*. Figures may be a maximum of 11x17 inches, folded to 8½ x 11 inches with the identification clearly marked.

2.A.3.2.2.3. Computerized Format

The Contractor shall supply manuals, catalogs, diagrams, views, illustrated parts catalog, troubleshooting flow charts, schematic drawings and all other required documentation in electronic format on CD-ROM as follows:

a. Text shall be provided in the latest version (current production version at deployment, as agreed to by the KCM Project Manager) of Adobe Acrobat and in the latest version of Microsoft Word or approved commercially available word processing program for native format files.

b. Drawings shall be provided in .eps or .dxf file formats.

c. Graphics files shall be provided in TIFF, GIF and/or JPEG formats.

d. The Contractor shall be responsible for updating manuals to reflect current OBS and CCS parameters in the event that changes are made to the system or operational procedures. Manuals shall be updated and maintained by the Contractor throughout the life of the Contract, and provided to KCM in a timely manner in the formats specified above.

2.A.3.2.2.4. System Operations Manual

The Contractor shall provide seven copies of the System Operations Manual (see Subsection **2.A.3.1.2.3, Level 1 Design Phase Deliverables**). One copy shall be provided in an electronic format on a CD-ROM. The document shall include the following:

a. Complete diagrams.

b. Illustrations.

c. Instructions for operation of the system, including normal operating and communications procedures.

d. Diagnostic procedures.

e. Restart/recovery procedures.

f. Other necessary procedures for operating the system.

g. Complete descriptions of functions necessary for generating reports.

2.A.3.2.2.5. System Maintenance Manual

The Contractor shall provide seven copies of the System Maintenance Manual (see Subsection **2.A.3.1.2.3, Level 1 Design Phase Deliverables**). One copy shall be provided in an electronic format on a CD-ROM. This document shall be comprehensive and shall provide complete detailed technical descriptions of maintenance operations, including, but not limited to, the following:

a. General descriptions.

b. Theory of operations.

c. Preventive maintenance schedule and activities.

d. Troubleshooting techniques.

e. Corrective measures, both temporary and permanent.

f. Locations and availability of support services for all major components.

g. Point-to-point component wiring schematics.

h. Assembly and disassembly drawings.

i. Installation guidelines.

j. List of required maintenance tools. Complex tools and test equipment each require a separate operator's manual.

k. Component parts lists.

l. Schematic diagrams.

2.A.3.2.2.6. Software Documentation

KCM has developed the OBS/CCS requirements using Unified Modeling Language (UML) and the TogetherSoft ControlCenter Version 6.1 application. Software documentation provided by the Contractor shall use UML methods and language and shall be compatible for import into the KCM OBS/CCS UML model. Additional information on UML and the TogetherSoft applications can be found at http://borland.com/together/controlcenter/index.html.

Software Documentation for the specific application software/firmware used for this project shall include all of the items set forth in Part **B**, Exhibit **1, Definitions: "Software Documentation"**. These requirements shall also include the following:

a. Description of the software/firmware for each system and subsystem, include UML data flow and other diagrams as necessary to demonstrate software structure.

b. Description of the software development life cycle.

c. Identification of standards used in software development.

d. Commented source code listing of all application software/firmware.

e. Data dictionary for all elements used; to include definition, type, and length for each element. TCIP elements should be identified along with their TED and vehicle translated formats.

f. Ownership or license rights to the software/firmware used for the Project as specified in Part B (Terms and Conditions).

2.A.3.2.2.7. Current Parts List (CPL)

The Contractor shall provide a comprehensive and detailed Current Parts List (CPL) for each and every subsystem included in the system.

a. Parts shall be numerically coded for inventory purposes.

b. The CPL (see Subsection **2.A.3.1.2.4, Level 1 Pilot Phase Deliverables**) shall be categorized and related to each particular system or subsystem component.

c. The CPL shall contain the source vendor's name, identification numbers and codes, or other means to identify the manufacturer of each component.

d. The CPL prices and quantity discounts shall be included in the response to Part **A**, Attachment **B, Price Proposal Worksheets**.

e. The CPL shall identify new equipment and products that will be developed for this application.

f. The CPL shall note which products are replacing existing equipment.

2.A.3.2.3. Maintenance Documentation and Manuals

Maintenance manuals shall contain complete data required for preventive and corrective maintenance of all parts of the vehicles associated with the OBS systems, including but not limited to the following:

a. General information and specifications.

b. A complete, well-developed troubleshooting guide covering all the mechanical, electrical, and electronic components.

c. All preventive maintenance and adjustment requirements.

d. Complete wiring and schematic diagrams and schedules for wire and cable sizes and ratings including actual cable layout, plus locations in the Revenue Vehicle of all electrical and electronic components.

e. Illustrative drawings, such as isometrics, exploded views, or photographs identifying components in relationship to each other as mounted in the buses.

f. Components shown in exploded views with all parts clearly identified including Contractor and manufacturer’s part numbers.

g. Rebuilding procedures for all rebuildable components.

h. Detailed, well-illustrated procedures for component change-out plus servicing, adjusting, testing, and run-in information as required.

i. Repair and calibration instructions and values.

j. List of special test equipment/tools required for maintaining and repairing systems down to the component level.

In addition to the maintenance manuals, the Contractor will provide the following OEM vendor manuals and publications:

a. Bus electrical wiring diagrams identifying component layout.

b. Electrical system diagnostic and troubleshooting guides.

c. Electronic data-control troubleshooting manuals.

2.A.3.2.3.1. Special Tools and Diagnostic Equipment Manuals

The Contractor shall supply 50 sets of complete operator manuals for all special tools and diagnostic equipment identified in Subsection **2.A.3.2.3.1, Special Tools and Diagnostic Equipment Manuals**. These manuals shall be provided 90 days before the delivery of the first production OBS hardware.

2.A.3.2.3.2. Parts Manuals

Illustrated parts books shall contain exploded views that show all parts used on the OBS and subsystems built under this contract, and no other parts. The exploded views will show all fasteners and miscellaneous hardware.

The books shall contain data arranged so that part numbers can be readily found and identified in the illustration for each system and subsystem component, assembly, subassembly, or piece part from an orderly breakdown of the complete system. It shall contain a ready reference part-number index and part-name index and be sufficiently well illustrated to identify items requiring repair, replacement, and storage for use in the maintenance of the buses. All sub-assemblies (such as wiper motor, starter motor, etc.) shall have the original manufacturer's part number displayed at the beginning of the appropriate parts listing section.

Lists shall include at least the following information for all parts:

a. Generic description and specifications.
b. Contractor part number.
c. Brand name, where applicable.
d. Original manufacturer's part number.
e. Indication if the part is custom-manufactured only on request.
f. Standard hardware described by size, type, material, and grade.

The parts manual shall include all original manufacturer names and addresses. It shall also include all special tools, test and diagnostic equipment, and their original manufacturer names and addresses.

2.A.3.2.3.3. Parts Pricing List

The parts pricing list shall list all parts by alphabetical order starting with "A" and ending with "Z," and then in numerically ascending order starting with "0" and ending with "9." The parts list shall supply the purchase price (including freight) and a description of the part. Updated price lists will explicitly indicate all part-number changes since the last general issue of the price list. Unit of sale will also be noted; e.g. *each*, *minimum 5*, *per foot*, etc. This information shall be submitted as part of the information provided in response to Part **A**, Attachment **B, Price Proposal Worksheets**.

2.A.3.2.4. Test Documentation

See **Subsection 2.A.2, Testing**.

2.A.3.3. Project Management and Staffing

2.A.3.3.1. Dedicated Staff Throughout Project Life Cycle

Timely and successful Project completion will require a long-term commitment to the Project by the Contractor’s Project Manager and other designated Key Personnel. Therefore, Key Personnel as defined in **Part B (Terms and Conditions), Section 7.0** shall be assigned to work no less than half-time on the Project for the phases and milestones to which they are committed by the staffing plan provided in response to **Part A, Attachment B, Price Proposal Worksheets**. Key Personnel shall include only those individuals who have the expertise and authority to address technical problems that affect the OBS/CCS functioning and transit operations.

The following work shift definitions shall apply.

- Day Shift = 7:00 AM to 4:00 PM Pacific Time*.
- Swing Shift = 3:30 PM to 12:00 AM Pacific Time.
- Mid Shift "Graveyard" = 11:30 AM to 7: 30 AM Pacific Time.

* Pacific Standard Time or Pacific Daylight Savings Time, whichever is in effect.

2.A.3.3.2. Design Phase Staffing

During the Design Phase, Key Personnel shall be available via the telephone within no more than four hours during normal business hours, Pacific Time.

2.A.3.3.3. Pilot Phase to Full System Acceptance Staffing

From the start of the Pilot Project Phase through Full System Acceptance, the Project shall be supported at all times by a Contractor presence within King County. The Pilot Project Phase begins when the Notice of Apparent Completion is given for the Design Phase.

2.A.3.3.4. Contractor "On Call"

Key Personnel shall reside in the King County area with designated personnel available for response 24 hours per day, seven days a week (24 x 7). Any time that a problem arises with the Project causing installation work to be interrupted or adversely impacting revenue operations, an authorized County representative shall call a designated On-Call Contractor number. An OBS/CCS problem call by an authorized County representative shall be answered by or returned by Key Personnel within two hours.

2.A.3.3.5. Contractor "On Site"

The Contractor shall ensure that Key Personnel are always available and responsive to the needs of the Project. KCM expectations for on-site availability are outlined below.

As the Project progresses into implementation, the risk of negatively affecting transit operations increases; therefore the response times become proportionally shorter. The following are the response-time expectations for Key Personnel to physically arrive on site and assist in resolving the problem. The following response times apply *upon receipt of a Problem notification* issued by the designated KCM Supervisor or Project staff to the On-Call Contractor number. The detailed notification and response contact information shall be provided as part of the Level 1 Pilot Readiness Acceptance Milestone.

The Contractor shall provide KCM with no less than three phone number(s) that will always be answered or will automatically allow the caller to send a page for a return call. Failure to respond shall be a basis for Contractor-caused delays and charges.

NOTE: the *normal work hours* referred to in the following may vary by Project Level and Phase; *e.g.*, KCM's normal business hours (8:00 a.m. to 5:00 p.m.) will constitute normal work hours during the Design Review Phase while equipment installations on the Revenue Vehicles during the Level 1 Installation & Implementation Phase may occur during the normal Swing Shift described in Subsection **2.A.3.3.1** above.

Maximum response times for the Contractor to be on site are listed below.

a. Installation: The Contractor shall provide full-time staffing in support of the Prototype Installation (see Subsection **2.A.3.1.1.2.2, Prototype Acceptance Milestone** for information on installation prototyping) and Pilot Installation milestones. The Contractor shall provide on-site oversight and assistance throughout all installation activities to certify that the installations are correct and that all warranty requirements are met.

b. During normal work hours (to be determined by the KCM Project Manager for each Project Level and Phase): within two hours of a call for assistance regarding an issue that is adversely affecting revenue operations, or within four hours to address an issue that is adversely affecting progress on a project task.

c. After normal work hours: within four hours of a call for assistance regarding an issue that is adversely affecting revenue operations, or within eight hours to address an issue that is adversely affecting progress on a project task.

2.A.3.4. Project Communications and Decision-making Process

All project communications and decision-making processes shall be documented, coordinated, and signed off by the KCM Project Manager and the Contractor Project Manager. Any actions undertaken in response to communications or decisions that have not been signed off by the KCM and Contractor Project Managers are undertaken at their own risk.

2.A.3.5. Requirements Management

KCM has developed a Requirements Management Plan for this project, and is using the product RequisitePro to identify and track requirements and to provide traceability between detailed requirements and high-level functional requirements (for more information see http://www-3.ibm.com/software/awdtools/reqpro/).

The Contractor shall utilize a requirements management tool and processes throughout the project. Every requirement shall be traceable down to a specific test(s) and up to a high-level functional requirement.

2.A.3.6. Configuration Management

The Contractor shall provide a configuration management plan and software tool that is in compliance with **ISO 10007:2003—Quality Management Systems—Guidelines for Quality Management in Projects**. ISO standards documents may be obtained from the International Organization for Standardization (ISO) at http://www.iso.ch/iso/en/ISOOnline.frontpage.

2.A.3.7. Progress and Performance Monitoring

The Contractor shall provide a Quality Assurance Project Plan specifically for the OBS/CCS Project, and such a plan shall be in place and adhered to throughout the Project. Additionally, the Contractor shall provide an overall Project Management, Progress and Performance Monitoring Plan, which describes how the Project is managed, administered, and controlled with respect to contract-management processes.

2.A.3.7.1. Quality Assurance

The Contractor shall provide a quality management plan, system, and tool that are in compliance with **ISO 10006:2003, Quality Management Systems—Guidelines for Quality Management in Projects**.

2.A.3.7.2. Progress and Performance Reviews

For the duration of the Contract, the Contractor shall participate in monthly progress and performance reviews in Seattle.

2.A.3.7.2.1. Design, Pilot, and Implementation

The Contractor shall participate in regular Project status reviews with KCM and its consultants, and shall provide detailed reports on the progress of the OBS/CCS, beginning with Contract award through the completion of the full OBS/CCS implementation.

These reviews may be held as often as is deemed necessary by the KCM Project Manager, depending upon the stage and progress of the project.

The reviews may be combined with design review meetings.

2.A.3.7.2.2. Post Implementation

Once the OBS/CCS implementation is completed, the Contractor shall participate in system performance reviews with KCM and its contractors and consultants, and shall provide detailed reports on the agreed-upon performance standards for the OBS/CCS, including at a minimum the following:

a. Equipment and system performance:
    i. All OBS Subsystems.
    ii. VLU Performance,
    iii. Communication Layers—Radio, WLAN, and VAN.
b. Failure analysis.

2.A.3.7.3. Status Reporting

Immediately after award of the Contract, KCM and the Contractor shall agree on the final format of a status report which aggregates the inputs from all parties. The Contractor shall provide Monthly Progress Reports. At a minimum, the following information shall be provided:

a. Current Overall Status
    i. Tasks Completed/Deliverables Provided
    ii. Outstanding Deliverables
    iii. Progress Versus Implementation Plan
b. Issues and Resolution
    i. Technical
    ii. Third Parties
    iii. Other

2.A.3.7.3.1. Problem Reporting

In addition to status reports issued on an ongoing basis, the Contractor shall implement a separate system for reporting, tracking, and resolving problems.

a. Problem tracking and resolution report logs shall be provided to the KCM Project Manager as part of the Fault Tracking and Maintenance Performance Report.

b. The degree of automation to be employed for this activity shall be agreed between the KCM Project Manager and the Contractor, but regardless of the degree of automation, it shall perform the following functions at minimum:

   i. The system shall assign numbers to problems as they are reported to enable accurate tracking.

   ii. Each problem shall be logged on the date reported.

   iii. The log shall be updated as the status of the problem changes and shall provide the following minimum information:

      1. Anticipated solution.
      2. Date solution is to be provided.
      3. Date solution was provided.
      4. Date solution was tested.
      5. Results of the test.

c. Problems shall not be closed until the solution has been successfully tested and has been "signed off" by the Contractor and the KCM Project Manager.

2.A.3.8. Training

The Contractor shall provide a program of instruction, instructional materials, and training aids targeted to specific groups of personnel. The timing of the training, delivery of the selected training aids and equipment, and constitution of the groups to be trained will be specified by the KCM Project Manager in coordination with the following groups:

- Operations (OPNS)
- Vehicle Maintenance (VM)
- Information Technology (IT) staff

2.A.3.8.1. Principal Training Contact

The Contractor shall designate a specific individual as the "Principal Training Contact" for the scheduling and accomplishment of the Contractor and subcontractor/vendor training. The Contractor will provide a name, complete mailing address, telephone number, and fax number for this person to the KCM Project Manager not later than 90 days after Notice to Proceed.

2.A.3.8.2. General Training Requirements

The following general requirements shall apply to all Contractor-provided training:

a. Materials, schedule, instructors, and course outlines must be approved by the KCM Project Manager.

b. The Contractor shall provide to the KCM Project Manager copies of all lesson plans, detailed instructor guides for each training program, student workbooks, manuals, publications, videos, transparencies, and any other training aids used by an instructor when teaching a course as part of Level 1: Pilot Readiness Acceptance Deliverables.

c. The Contractor shall identify the instructors and provide their qualifications to KCM. Training may be conducted by the Contractor, approved subcontractors, third-party software suppliers, and/or original equipment manufacturers (OEMs).

d. The Contractor shall inform KCM of any training support equipment (such as audio visual equipment, specifications for PC-based training software, etc.) and/or supplies required of KCM for the Contractor portion of the training.

e. On-site Requirements: The Contractor shall ensure that the same approved instructors who conduct the "Train the Trainer" courses will assist KCM Instructors with the delivery of their first 1-3 training sessions.

f. The Contractor shall suggest any additional appropriate training courses.

2.A.3.8.3. Training Program Plan

The Contractor shall develop and submit to KCM for approval a Training Program Plan. The plan shall be based on criteria identified in this specification, and shall, at a minimum, provide the following for each course:

a. Brief course description.

b. Expected performance objectives, and explanation of how the expected objectives will be measured.

c. Outline for the course content.

d. Class schedule with lesson plans.

e. Type or method(s) of presentation that will be used.

f. Resources required (equipment, classroom/shop space, supplies).

g. Intended audience and the maximum class size.

h. A proposed training schedule, based on the training program requirements and project schedule.

i. Identification of parties who will supply the required training staff for all OBS/CCS courses, including what will be provided by subcontractor, third party, and/or OEM staff.

2.A.3.8.4. Operations "Train the Trainer" Training

The Contractor shall conduct the two "Train the Trainer" courses described below.

The Contractor shall provide suitable training aids, books, manuals, and publications to be distributed to students during training. These materials will be kept by the students and serve as reference materials while on the job. This section addresses the specific requirements to provide the Operations work group with training and instructional materials.

2.A.3.8.4.1. OBS Operations Instructor Course

The OBS Operations Instructor course shall be provided in four separately scheduled sessions. The training plan for this course shall provide lesson plans for 24 classroom hours (three days), with approximately 10 personnel per session.

The target population for this training is 22 Transit instructors, two Service Coordinator instructors, and two Service Supervisor instructors, a total of 26 KCM instructors.

The OBS Operations Instructor course shall provide a comprehensive training program that prepares KCM Instructors to do the following:

a. Describe and demonstrate proficiency with all OBS systems with which Operations staff will or could interact, including:

i. Use of all controls, system settings, and handling of alarms.
ii. Level 1 Operator functions.
iii. Level 2 Operator functions.
iv. User troubleshooting actions.
v. Other operational items as requested.
vi. Troubleshooting tips for instructors and service supervisors.

b. Be prepared to conduct the four-hour Operator Training course (described below) utilizing the materials and lesson plans provided by the Contractor.

c. Be prepared to conduct the two-hour Service Supervisor Training course (described below) utilizing the materials and lessons plans provided by the Contractor.

2.A.3.8.4.2. OBS Management Overview Instructor Course

The OBS Management Overview Instructor course shall be provided once. The training plan for this course shall provide lesson plans for eight classroom hours (one day) with approximately 10 KCM personnel in attendance.

a. The target population for this training is Operations supervisory personnel who have successfully completed the four-hour Operator Training course delivered by a trained OBS Operations Instructor.

b. The OBS Management Overview Instructor course shall provide a comprehensive training program that prepares KCM Instructors to conduct the two-hour OBS Management Overview course (described below) utilizing the materials and lesson plans provided by the Contractor.

2.A.3.8.4.3. Instructional Materials

The Contractor shall supply the following instructional materials as part of Level 1, Pilot Readiness Acceptance Deliverables.

The Contractor shall provide everything needed for KCM Instructors to deliver the following three OBS training classes, including the lesson plans, training aids, schedules, class size, and facility requirements.

2.A.3.8.4.3.1. Operator Training Course

The target audience for this course is the approximately 3,000 Transit Operators who operate KCM Revenue Vehicles and ultimately are the primary users of the OBS.

a. The total Operator training course shall be tailored to a four- hour training session including both classroom time and field time.

b. The KCM Instructor shall be given the tools to teach Transit Operators how to interact with OBS, including:

i. Use of all controls, system settings, and handling of alarms.
ii. Level 1 Operator functions.
iii. Level 2 Operator functions.
iv. User troubleshooting actions.

v. Other operational items as requested.

c. Contractor training staff will provide on-site assistance with three OBS Operator Training sessions during the Pilot Project Phase, and up to three additional sessions when requested by the Operations Training Supervisor in writing and at least two weeks in advance.

2.A.3.8.4.3.2. Service Supervisor Training

The total Service Supervisor Training course shall be tailored to a two-hour training session including both classroom time and field time.

The KCM Instructors shall be given the tools to teach Service Supervisors how to do the following:

a. Troubleshoot problems with the OBS, including disabling selected functions that may appear to be malfunctioning (such as incorrect stop announcements for the operating trip, or incorrect schedule or route-adherence status reported by the OBS, etc.).

b. Manage a coach change, trip change, extra trip, re-route, and road relief.

2.A.3.8.4.3.3. OBS Management Overview

The total OBS Management Overview course shall be tailored to a two-hour training session of classroom instruction.

The KCM Instructors shall be given the tools to provide KCM management an overview of the following:

a. OBS Subsystems and functionality.

b. Features and functions for the Operator.

c. Features and functions for transit management.

d. Highlights and advantages of the new technology.

e. Aspects of the OBS system that remain the same as the legacy systems.

2.A.3.8.4.4. Classroom and Field Materials

The Contractor shall provide 50 original, bound sets of classroom and field materials; one electronic copy, and one photo-ready copy. The following requirements shall apply to these materials:

a. Pages shall be 6 x 9 inches except where otherwise specified, and shall be double-sided.

b. Sides of pages intentionally left blank shall be so noted.

c. Figures, illustrations, diagrams, and drawings shall be labeled as *figures*. Figures may be a maximum of 8½ x 11 inches.

2.A.3.8.4.5. “Bus in a Box” Simulator

The Contractor will provide eight desktop “Bus in a Box” simulators (one per base, plus one for the South Training Center) which demonstrate the full OBS systems functioning (keys, menus, lights, announcements, etc.) from the Transit Operator perspective.

a. Simulator will include fully functioning OBS components: VLU; DDU; Interior Sign; EA Switch; PA amplifier, speaker and microphone; Operator Handset, etc.

b. Simulator will include a perpetual license for software capable of simulating Revenue Vehicle operations including all of the functions described in use cases ***RV12-Interface to DDU*** and ***RV6-Manage Events,*** and Appendix **H, DDU Functionality Matrices**.

c. The simulation shall emulate vehicle movement along a route, to include stop/start, door open/door closed, movement indicated by an odometer, on-route/off-route, and Level 2 radio functionality. (See Appendix **H, DDU Functionality Matrices**.)

d. Simulator will be fully configurable via an Intranet connection by the OBS Administrator or authorized Training supervisor(s).

e. Simulator shall have the capability of storing/loading up to three different operational configurations, possibly different configurations for different simulators.

f. Simulator shall provide the full range of configuration and parameter settings of OBS-equipped vehicles, e.g. the ability to enable/disable Level 2 CCS and the new TRS radio screens on the DDU or adjust the range of volume adjustments by an Operator.

g. Simulator must comply with the requirements in **Subsection 2.A.1.4.1, Physical and Material Requirements** (if applicable, PC specifications will be provided to KCM for purchase and install) and **2.A.1.4.4, General Software Requirements**.

h. Simulator must be no larger than five feet wide by three feet high by three feet deep, and must be mounted on a moveable stand.

i. The unit will be powered by a self-contained power supply with an input voltage of 110v at 60 Hz.

2.A.3.8.4.6. Interactive OBS Tutorial

The Contractor shall provide an interactive training application, upgradeable by KCM, which covers the systems information included in the OBS Operator Training course (described above).

a. The OBS Tutorial design shall allow it to be loaded onto the KC Intranet or loaded directly onto a PC.

b. Tutorial must comply with the requirements in **Subsection 2.A.1.4.4, General Software Requirements**.

c. The OBS Tutorial shall be designed to:

   i. Provide the user with an introduction to OBS functions accessible by a Transit Operator.

   ii. Reflect the functions, menus, and key-press responses that a Transit Operator will see in the field.

   iii. Be completed by the average user within 30 minutes.

2.A.3.8.4.7. OBS General Orientation Training Video

The Contractor shall provide 10 copies on DVD of a training video that reviews the information included in the General Orientation. This OBS Training video shall meet the following requirements:

a. Show video footage of KCM equipment, vehicles, and Operators.

b. Be no longer than 10 minutes in length.

c. Be approved by the KCM Project Manager during the Pilot Project Phase.

2.A.3.8.5. Vehicle Maintenance Training

2.A.3.8.5.1. Vehicle Maintenance Instructional Materials

The Contractor will supply the following instructional materials 90 days before delivery of the first production OBS hardware provided under this contract.

a. Two detailed electrical-system instructor guides and training aids to cover:
    i. Explanation of the electrical and electronic systems.
    ii. Electrical and electronic component function and location.
    iii. Wiring-diagram analysis and interpretation.
    iv. Troubleshooting the electrical and electronic systems.
    v. Use of diagnostic test equipment and analysis of results.
    vi. Preventive maintenance of the electrical system and components.

b. Two complete sets of master engineering electrical and electronic wiring diagrams.

2.A.3.8.5.2. Vehicle Maintenance Training Aids

Ninety days before the delivery of the first production OBS hardware, the Contractor will supply one Programmable Logic Controller (PLC) test and operation training aid consisting of a complete set of PLC I/O blocks, and typical output items such as lights. The unit will be constructed on a plywood frame, will be no larger than four feet by eight feet, and will be mounted on a moveable stand. If a larger board is needed, two boards (4x6s or 4x8s) can be connected for a total size of four feet by twelve feet. The unit will be powered by a self-contained power supply with an input voltage of 110v at 60 Hz.

If KCM selects a conventional electrical system, the Contractor will provide one electrical-system training aid representative of the electrical systems utilized on the vehicle.

Wiring of either unit must include a junction panel enclosure and terminal strips for the purpose of inducing problems for student troubleshooting and training. The electrical training aid will be constructed using actual Revenue Vehicle parts identical to those used on the vehicles provided to KCM under this contract.

2.A.3.8.5.3. OEM “Train the Trainer” Maintenance Training

The Contractor will secure from the OEM vendors four each “Train the Trainer” course slots covering the system components. Training will cover preventive maintenance, overhaul, diagnostics and troubleshooting, and repair of the OBS systems and subsystem components provided by the Contractor.

This training will include the use of the instructional materials provided during each course. All courses will include tuition, transportation, and lodging. All four trainers will not necessarily be trained simultaneously. KCM will work with the Contractor to schedule this training.

The “Train the Trainer” program will include the following:

2.A.3.8.5.3.1. Programmable Logic Controller (PLC) System (if supplied)

The PLC courses will include but not be limited to:

- *Introduction to PLCs*
- *Diagnostics and Troubleshooting of PLCs*
- *Programming the PLC*

2.A.3.8.5.4. Maintenance Training Program Content

The Contractor will provide maintenance training utilizing three modules of instruction: general orientation, technical orientation, and stand-alone courses.

All training will be delivered on a schedule determined by the KCM Project Manager and coordinated with the Contractor.

2.A.3.8.5.4.1. The General Orientation

The Contractor will provide an initial orientation for maintenance personnel. The general orientation will be provided in five KCM Revenue Vehicle maintenance facilities—taking place on and around the bus—and may, at the discretion of KCM, be provided on more than one shift.

The orientation session will not exceed four hours in duration and will include, but not be limited to, the following:

- Overview of vehicle's systems.
- Component location and general function.
- OBS hardware operation and controls.
- Servicing and inspection.

The target population for this training is 270 maintenance and service personnel. Audience size will be approximately 15 personnel per session, and the orientation will be repeated until all available mechanics have attended it (approximately three presentations per facility).

2.A.3.8.5.4.2. The Technical Orientation

The Contractor will provide a structured program of technical training not to exceed 120 class hours to a maximum class size of 15 mechanics, electronic technicians, or radio technicians. The program will be delivered a minimum of seven times at KCM locations to be specified by the KCM Project Manager. Training will consist of specific and identifiable separate areas of instruction concerning the following:

- Electrical, electronic, and Programmable Logic Controller Systems (if selected by KCM).
- Individual components installed on the bus.
- Use of all OEM & Contractor special-purpose tools and diagnostic equipment.

The target population is 105 mechanic, electronic technician, or radio technician personnel.

Electrical-system instruction will cover the major failure events experienced in the system, and how to recognize the failure signs through troubleshooting with test equipment.

Students will be given failure/trouble parameters and shown step-by-step troubleshooting procedures to isolate problems. Hands-on exercises with the actual electrical and electronic systems on a Revenue Vehicle will reinforce troubleshooting procedures.

The Contractor will provide suitable training aids, books, manuals, and publications covering the electrical and electronic systems. These materials will be distributed to students during training, and students will keep them and use them as reference materials while on the job.

2.A.3.8.5.4.3. Stand-Alone System-Specific Courses

The Contractor will provide the following stand-alone system-specific courses:

a. Vehicle Logic Unit, including board-level maintenance and testing.

b. Automated Passenger Counting subsystem, including APC processor, sensors, and tests.

c. Stop Annunciating System and Interior Signs, including speakers, PA, microphone and Operator handset, and multi-functional tests.

d. Vehicle Area Network, including all subsystem nodes/connections and the EA Switch.

e. AVM, including I/O Sensors connections to multiplexer or data bus (vehicle dependent); parameters and tests.

f. Wireless Local Area Network (WLAN) On-Board equipment and tests.

g. WLAN Access Points and connection to the Base Server

Each course shall consist of no fewer than four hours wherein the system will be explained at a component level for electronic technicians. These courses will be conducted at the KCM Training Facility. Each course shall be delivered twice, to a class size of 10 as coordinated with the KCM Project Manager.

The Contractor will provide suitable training aids, books, manuals, and publications covering the system-specific courses. These materials will be distributed to students during training, and students will keep them and use them as reference materials while on the job.

2.A.3.8.5.5. Special Tools and Diagnostic Equipment

Upon delivery of the equipment for the Pilot Readiness Acceptance Milestone, the Contractor shall provide all required special tools and diagnostic equipment. All tools and electronic test equipment must be of heavy-duty, industrial-grade quality approved by the KCM Project Manager.

2.A.3.8.5.6. Special-Purpose Electrical & Electronic Diagnostic Tools

Contractor will provide seven complete sets of industrial-quality electrical and electronic system test equipment and diagnostic tools to include digital multi-meters (Fluke 88 or approved equal), scope meters (Fluke 98 or approved equal), carbon pile testers, inductive pick-up ammeters, laptop computers and software, etc.

2.A.3.8.5.7. Repair Tool Set

Contractor shall provide any other special tools required to maintain and repair all provided equipment.

2.A.3.8.5.8. Portable Radio Simulator

Contractor shall provide twelve portable simulators, which will emulate VLU inputs from or outputs to the new 700 MHz radio system, for use by Radio Maintenance technicians on a vehicle or in the shop. The simulator should generate and read the following:

a. Poll messages.
b. Poll-response messages.
c. GPS input.
d. Contention messages.
e. Contention-allowed messages.
f. Odometer input.
g. Gyro input.
h. Accelerometer input.
i. All messages transmitted between the OBS and CCS.

2.A.3.8.6. Information Technology (IT) Training

The Contractor shall propose an OBS/CCS IT Training plan for KCM staff responsible for managing and maintaining the network connections, software interfaces, applications, data, and software tools provided with OBS/CCS. The training plan shall address the technical and functional requirements described in the following sections of this RFP document:

a. Subsection 2.A.1.6.3, Wireless Local Area Network

b. Subsection 2.A.1.7, Data Collection, Management and Reporting

c. Applicable Section 2.B. use cases including, but not limited to:

i. BO1-Verify Vehicle Configuration

ii. BO2-Update Vehicle Data

iii. BO3-Manage Historical Data

iv. RV2-Verify Vehicle Configuration

v. RV4-Update Vehicle Data

2.A.3.8.6.1. OBS/CCS Technical Training

Each OBS/CCS Technical Training course shall consist of no fewer than four hours. Each course shall be delivered twice, to a class size of up to 10 as coordinated with the KCM Project Manager, unless otherwise indicated. The target audience will be IT professionals and technical staff including database administrators, programmers, systems analysts, network administrators, schedulers, etc. Each course shall consist of both lecture and practical hands-on methods of instruction.

Successful course completion shall require a passing grade on a comprehensive written and practical exam to be provided by the Contractor and approved by the KCM Project Manager. The classroom instruction and the associated exam may be conducted separately. If a third or more of students fail to pass, the Contractor shall provide an additional course session.

The Contractor will provide suitable training aids, books, manuals, and publications covering the OBS/CCS IT Training courses. These materials will be distributed to students during training, and students will keep them and use them as reference materials while on the job.

The Training Plan will address the following IT-specific courses and any additional course topics that are required to manage and maintain the integrity of the OBS/CCS data and network connections. All translation algorithms will be explained, detailing how and where they relate to any translation that is necessary during the data processing including any correlation to current systems such as the current GIS data.

2.A.3.8.6.1.1. Data Dictionaries and Data Mapping

Provide a logical and architectural description of the data flows from TED to the OBS and from OBS to TED including TCIP translations at both ends. Explain the processes for error checking and backup and the tools for managing configuration and version control. This will include an entity-relationship diagram (ERD) of data elements.

2.A.3.8.6.1.2. Data Collection

The Data Collection course shall be delivered twice, to a class size of up to five as coordinated with the KCM Project Manager. The target audience will be KCM staff with both operational and technical experience. This training course shall consist of no fewer than 16 hours of classroom and field training wherein the GIS data collection tool will be explained and demonstrated.

The GIS data-collection tool to be provided by the Contractor shall include the requisite hardware, software, and process(es) to collect map data for use in the on-board database (OBDB) to meet the requirements described in Subsection **C.2.C*, RV8-Monitoring Route and Schedule Adherence***, paragraph 5.3, Technical Specifications—Route Adherence.

2.A.3.8.6.2. OBS System Administration

This course shall consist of detailed instruction and hands-on experience with managing and use of the OBS Administrator's Toolkit, which is described in Appendix **K**.

2.A.3.8.6.3. WLAN—WAN Network Connections

This course shall consist of an explanation of the Level 1 WLAN connection(s) to the KCWAN, monitoring tools, access management, troubleshooting techniques, etc., required to maintain reliable, secure connections between the vehicles in the fleet, the bases, the Communications Center, and the KCWAN.

2.A.3.8.6.4. Reporting

This course shall consist of an explanation of the content, organization, and relationships of the historical data that will be generated by OBS and CCS. For Contractor-provided report templates and scripted queries, the course will address formatting, management, and maintenance of the data and processes that support the automatic generation of reports. All configurable parameters will be identified and defined.

KCM will use the current version of Crystal Reports and Crystal Enterprise for managing both Contractor-provided and in-house-developed report templates and scripted queries.

2.A.3.9. Installation

The Contractor and KCM staff shall co-develop the process by which the new OBS equipment and software will be installed onto the fleet. Contractor will document the process and submit it to the KCM Project Manager for approval.

2.A.3.9.1. Vehicle Installation Prototype

The Contractor shall work with KCM staff to prototype the installation for each identified vehicle type in the fleet. There may be up to ten different types of vehicles in the fleet. Detailed installation planning shall be performed after the design phase.

2.A.3.9.1.1. Prototyping Team

The Contractor and KCM shall assign a team of individuals to form an OBS Prototyping Team with all of the skills required to carry out the OBS installation, including but not limited to vehicle engineer, vehicle mechanic, electronic technician, radio technician, sheet metal worker, software engineer, etc.

A vehicle that is already equipped with RFCS and DVRS equipment shall be selected from each fleet type for prototyping. The OBS Prototyping Team will work together on installing a full set of OBS hardware and software onto each type of vehicle, including both APC and an interface to the DVRS system.

2.A.3.9.1.2. Prototype Installation

The OBS Prototyping Team shall determine the following for each type of vehicle to be OBS-equipped:

a. For every item of hardware to be installed:
    i. Identify where it will be located.
    ii. Determine how it will be mounted. If mounting brackets are required, the drawings and specifications for the mounting hardware shall be included in the vehicle installation plan and instructions.
    iii. Describe all connectors and connection points, wiring and wiring bundles.
    iv. Determine power source and connection.
    v. Identify test points and test equipment.
b. For all software installations:
    i. Provide step-by-step instructions for installing and verifying each software module.
    ii. Describe where and how software shall be obtained for loading.
    iii. Describe how software upgrades will be applied.

2.A.3.9.1.3. Prototype Testing

Each prototype installation shall undergo Operational Field Testing (see Subsection **2.A.2.3.3.**) before installation plans and instructions are completed.

2.A.3.9.2. Installation Plans

The following requirements apply to implementation of the OBS/CCS (including Pilot Test equipment, unless otherwise indicated):

a. The Pilot Test shall consist of equipment installed at only one base, to be specified by the KCM Project Manager.
b. Installation of equipment shall occur during days and times to be specified by KCM, and may occur on weekdays and/or weekends (Saturdays and Sundays).

c. KCM staff shall perform installation with supervision and approval by the Contractor.

d. Installation of equipment will be performed at a KCM-designated location.

2.A.3.9.2.1. Installation Tasks

KCM installation tasks will include but are not limited to the following:

a. Install the VLU, GPS antenna, APC processor and sensors, discreet I/O sensors, and ambient-noise-detection sensors on all PA system speakers and replace the existing “stop requested” sign(s) with the new Interior Sign(s).

b. Establish VAN connections with: EA Switch, DDU, WLAN, FTP, RCU, PA, Interior Sign, ECM, TSP AVI Tag, I/O sensors, and, as applicable, DVRS and APC systems.

The DDU, VLU, and RCU must be operational once the on-board equipment is installed.

No system startup shall occur on the day of a seasonal service schedule change. These usually occur on the first Saturday in February, last Saturday in May, and the third Saturday in September.

2.A.3.9.3. Manuals and Documentation

The following items are to be submitted for approval by the KCM Project Manager:

a. Installation drawings, schematics, and wiring diagrams for all hardware.

b. A work breakdown structure showing each task and its relationship to the installation process.

c. Step-by-step instructions for hardware and software installation and testing on each vehicle type.

d. Definition of wiring lengths and bundles so that installation kits can be prepared and staged in advance.

e. Test equipment and processes for verifying correct installation.

2.A.3.9.4. Installation Responsibility

KCM will be responsible for vehicle and site preparation per requirements provided by the Contractor in design reviews, and will be responsible for the installation of equipment in vehicles. The Contractor shall provide supervisory and technical support for equipment installed by KCM.

a. The Contractor shall coordinate with KCM representatives and installation shall comply with KCM requirements.

b. The Contractor shall specify the facility requirements for installation of equipment and systems including, at a minimum, space requirements, environmental requirements, communications requirements and connections, and electrical requirements.

c. KCM will be responsible for the installation of conduit for power lines and data communication lines in Agency facilities and for the installation of such lines on Agency premises.

d. The Contractor shall be responsible for technical supervision, technical support, system testing, commissioning, and performance.

2.A.3.9.5. Installation Equipment

The Contractor shall provide all required vehicle and facility mounting and installation hardware, cabling, and connectors.

The Contractor shall provide any power conditioning and uninterruptible power supply equipment required for the installation facility.

2.A.3.9.6. Delivery

The Contractor shall be responsible for the delivery of OBS/CCS equipment and materials to designated locations. Shipping shall be FOB with freight, taxes, and duties prepaid. The Contractor shall also be responsible for providing local storage and transportation prior to delivery.

2.A.3.9.7. Miscellaneous Supplies

The Contractor shall be responsible for providing all miscellaneous supplies required for installation and test of OBS equipment, including but not limited to wiring, cables, spare connectors, seals, adhesives, etc.

2.A.3.9.8. Tuning

The installation process and cost shall include a process for “tuning” the installation and system to ensure proper functioning.

2.A.4. Optional and Future Functionality

The following sections describe capabilities that KCM will either consider for inclusion in this contract based on cost and feasibility (priced options), or want the OBS/CCS design to allow for as future functionality.

2.A.4.1. Priced Options

The three priced options desired by KCM are the following:

- WLAN with Licensed Spectrum
- Wireless TSP
- Bluetooth Short-Range Wireless Technology

KCM may exercise one or more of these options based on the evaluation of the proposal responses, costs, and risks. If KCM decides not to include one or more of these priced options in this Contract, then the system design shall address each non-included option as future functionality, described in Subsection **2.A.4.2.** The response to this Priced Options section should detail the proposed approach to system inclusion for each option as well as the estimated technical, cost, and risk implications the option would have on the proposed system.

Each of the following options shall be addressed by the proposal both as requested here and in Part A, **Attachment 3, Price Schedule**. The response to this section shall *not* include price information.

2.A.4.1.1. WLAN with Licensed Spectrum

The WLAN shall provide secure, broadband short-range wireless transmission of data between the Revenue Vehicle and the Base Server and other applications. The use of licensed spectrum should reduce interference with and improve the security of WLAN communications. Baseline requirements for the WLAN system are provided in Subsection **2.A.1.6.3, Wireless Local Area Network (WLAN)** and in Subsection **2.A.1.6.3.5,WLAN Spectrum Alternatives**.

2.A.4.1.1.1. WLAN Licensed Spectrum Alternatives

The proposed solution and price for this option shall provide for the WLAN to operate in *one* of the following spectrums which provide for public safety licenses:

- 4.9 GHz band, see Appendix **L, 4.9GHz Federal Register Notice**.
- 5.9GHz band: DSRC (Dedicated Short Range Communications), find FCC Notice of Proposed Rule Making for 5.9MHz DSRC band at http://www.itsa.org/subject.nsf/Files/FCC%20NPRM/$file/FCC-02-302A1.pdf

2.A.4.1.1.2. WLAN Alternatives Analysis

The response to this section should provide a brief comparison of the above alternatives and discuss the reasons for the one selected for this proposal.

2.A.4.1.2. Wireless TSP

KCM is pursuing a move to a two-way communications architecture between the vehicle and the roadside Transit Priority Request Generator (TPRG), while maintaining the Amtech RF Tag for legacy TSP operations and other operations using the tag (such as tunnel SCADA control). KCM is committed to a TSP scheme where the TPRG is roadside, located in the signal control cabinet. The decision to request or not request priority will be made roadside and not on board the vehicle. The data exchange between the vehicle and the roadside may be handled either by a software module on the vehicle that communicates using the existing system's communications protocol, or by enabling the roadside equipment with TCIP-compliant communications to exchange data with a similarly compliant on-board system.

The system shall support either a KCM-provided and -supported TSP Manager application module within the VLU, or a TCIP-compliant application module to respond to data queries by roadside equipment. The TSP Manager application would enable KCM to configure and manage data communications between the WLAN and TSP-equipped traffic signal controller and, perhaps, for other vehicle-to-roadside communications. The following table summarizes estimated system impacts on the WLAN by the TSP system.

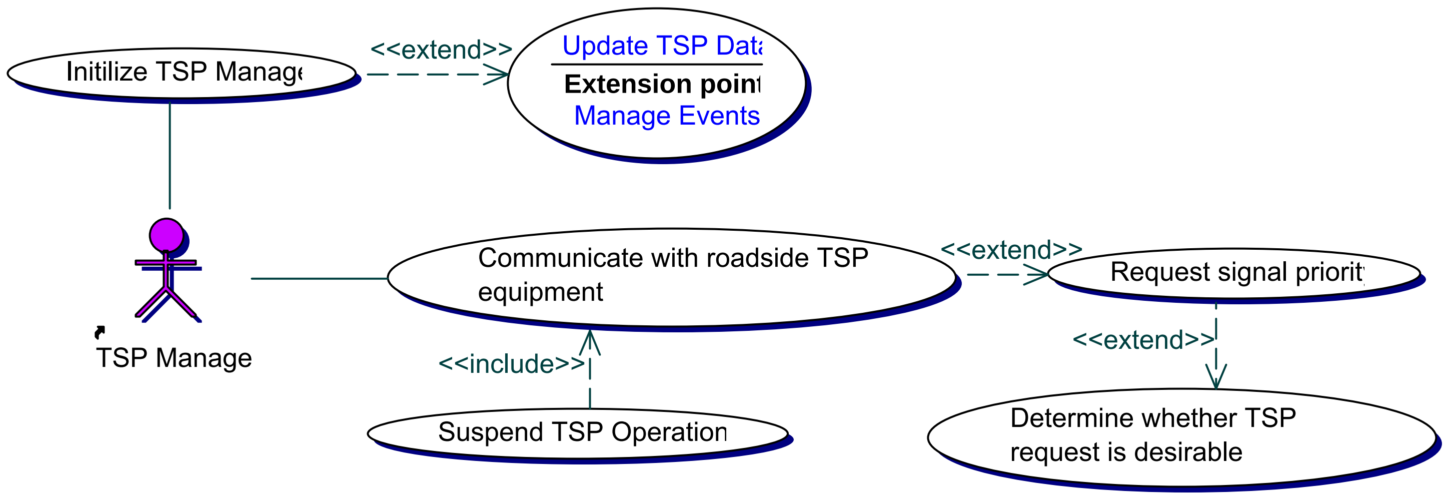
Table 2.A.4.1.2. TSP System's Estimated WLAN Activity.

System	Vehicle to Network	Quantity & Frequency	Network to Vehicle	Quantity & Frequency
Wireless TSP	Vehicle to TPRG* TSP Data	10 kb per intersection	TPRG to Vehicle TSP Data	10 kb per Revenue Vehicle

The proposed solution shall address the following use case requirements.

NOTE: See Subsection **2.B.2.4.1, RV-6-Manage Events**, for a description of the Event Manager functionality.

1.1.1 UseCase Diagram Manage TSP Data: Wireless Option



1. Manage TSP Data: Wireless Option

1. Brief Description

The King County Transit Signal Priority (TSP) System currently communicates data via an Amtech RF tag (see use case ***RV-16-Interface to TSP Tag***). The next step envisioned in KCM development of the TSP system is to use the WLAN communication capabilities to directly interact with the TSP interface unit (Transit Priority Request Generator) located in the traffic signal cabinet.

As with the tag system, which would need to be maintained even with the development of this capability, the data set consists of 35 variables recognized by the TSP system. Additionally, the Revenue Vehicle and TSP equipment would need to use the WLAN network connectivity in order to provide location and status information and negotiate a signal priority request. Accordingly, this system will require a real-time software module running on the VLU or other on-board processor to handle TSP operations on the bus. Optimally, the TSP Manager for the wireless option will have the capability to assess the need for priority based on schedule adherence and other variables, such as passenger load if available, and then determine whether signal priority is needed. When priority is not needed the TSP Manager will not send a request to the TSP interface unit.

2. Pre-conditions

The *Start up system* step of the ***RV-1-Initiate Vehicle for Operation*** use case has been successfully completed.

3. Flow of Events

3.1 Basic Flow

During normal operations, the TSP variables should be initialized and updated by the TSP Manager automatically with no additional input required by the Operator.

Initialize TSP Manager

The TSP Manager shall automatically prepare to manage TSP variables and communications.

1) System will load and start TSP Manager software module.
2) System will establish TSP connection with the WLAN.
3) System will load “static” TSP data.
4) System will obtain data for “dynamic” TSP variables. The set of TSP variables is shown on the tables in the Technical Specifications, *TSP Data Fields* section of the ***RV-16-Interface to TSP Tag*** use case.
5) System will begin watching for TSP roadside access points.

Update TSP data

The Event Manager shall provide the defined data set based upon the current configuration of the vehicle.

1) The Event Manager will determine the current vehicle configuration through the processes of the ***RV-2-Verify Vehicle Configuration*** use case.
   a) The vehicle configuration will affect the TSP message and protocols, e.g.:
      i) When the configuration includes an APC system, then the TSP data set will include current passenger load.
      ii) When an APC system is not available, then passenger load will not be available.
2) The Event Manager will update data automatically to ensure that the signal priority request is accurate.
3) The data will be formatted as a TSP message between the Revenue Vehicle WLAN and a roadside

TSP access point.

4) The wireless TSP Manager must remain in continuous operation.

Communicate with roadside TSP equipment
The WLAN shall transmit TSP messages to roadside TSP access points.

1) WLAN will continuously seek roadside TSP access points whenever it is not being used for a higher-priority function.
2) Detect a TSP access point and establish communications.
3) The TSP Manager will transmit the defined TSP message automatically.
    a) The TSP message will be re-transmitted until an acknowledgment is received.
    b) The TSP message will utilize PK Packet protocol. See Appendix **E, TSP Tag Interface**.
    c) The system will respond to PK protocol requests for data.
4) For some locations the roadside equipment may have a dialog with the TSP Manager in order to determine when the vehicle has exited the intersection.

Log event
The Event Manager shall log all TSP events and TSP packets transmitted.

3.2 Alternative Flows

3.2.1 Determine whether TSP request is desirable

Determine whether TSP request is desirable
The TSP Data Manager shall self-deny priority under certain configurable situations.

1) Because signal priority is a scarce resource, it is desirable for the on-board TSP Manager to be able to self-deny priority under certain configurable situations such as:
    a) On-time or early operation. (See use case ***RV-8-Monitor Route and Schedule Adherence***.)
    b) Out-of-service operation.
    c) Low-priority service
2) The parameters for self-denial will be configurable by the OBS Administrator.
3) When the criteria for self-denial is met, then the TSP Manager will not tie up the TSP roadside access point.

3.2.2 Suspend TSP operations

Suspend TSP operations
The TSP Manager's use of the WLAN system shall be suspended when other higher-priority activities require access to the communications device.

1) The Event Manager will determine WLAN priorities. (See use case ***RV-6-Manage Events***).
    a) Higher-priority activities may include but are not limited to:
        i) Emergency conditions, such as Transit Police access to DVRS video. (See ***RV-15-Interface to DVRS*** use case Alternative Flow *Provide live video link Interface*.)
        ii) Base operations, such as schedule downloads and data updates. (See use case ***RV-4-Update Vehicle Data***.)
2) TSP Manager's use of the WLAN will be suspended.

4. Post-conditions

TSP data communications shall have requested signal priority when needed and negotiated with the TSP roadside access point to determine the optimal signal timing.

5. Special Requirements

5.1 Technical Specifications

5.2 Performance

TSP data update latency
Data shall be updated automatically to ensure that the signal priority request is accurate

1) A maximum of 10 seconds should be sufficient for everything but location.
2) Location data latency requires that it be updated so that the vehicle is reporting near-real-time location and not at the point of measurement. *Describe the latency of the location data to be updated and reported.* (See use case ***RV-7-Determine Vehicle Location*** for vehicle location requirements.) *Discuss how latency could be managed to provide near-real-time location.*

5.3 Testing

Wireless TSP test plan
A test plan addressing all of the requirements of this use case shall be provided and approved by the KCM Project Manager in design.

6. Extension Points

RV-16-Interface to TSP Tag

RV-1-Initiate Vehicle for Operation

RV-2-Verify Vehicle Configuration

RV-6-Manage Events

RV-8-Monitor Route and Schedule Adherence

RV-15-Interface to Security Cameras

7. Assumptions

The WLAN system will be able to work in the field at operational speeds sufficient to request priority and receive it when traveling at normal road speeds.

KCM is responsible for the roadside equipment.

The TSP tag will remain in place and continue to require data updates for tunnel SCAEDA and Vehicle Maintenance applications even if the TSP wireless option is implemented.

8. Issues

The requirements in this use case describe a Wireless TSP option to develop an improved TSP system. The specific message dialogs between the vehicle and the roadside TSP access point have not been developed.

The implementation of this use case will require simultaneous development effort on the part of the OBS contractor and KCM to coordinate the roadside and on-board TSP designs.

The use of location derived from GPS for the purpose of managing signal priority may be a patent issue?

There are some IP protections on the design of the existing KCM system.

2.A.4.1.3. Bluetooth Short-Range Wireless Technology

KCM wishes to add Bluetooth-enabled communications for on-street customers already equipped with Bluetooth transmitter/receiver technology in a commercially available PDA or cell phone. As a first step toward utilizing this technology to benefit transit customers, the Level 1 System shall support the Bluetooth-based exchanges between Bluetooth-enabled customers and the VLU that are described below. The Contractor shall provide a Bluetooth transmitter/receiver for the vehicle only, and all transmission shall be required to cover a thirty-foot radius. **NOTE**: on-board passengers wishing to use a Bluetooth device will be required to sit in the front part of those Revenue Vehicles which are longer than thirty feet in length.

The Contractor-provided Bluetooth "device" shall be integrated into the OBS as another subsystem and shall be considered another customer information device and managed accordingly. In addition to the functionality described below, this device shall have a standard set of functionality including, but not limited to, the following:

- Defined interface control document (ICD).
- Inclusion in "health status" reporting.
- Inclusion in "vehicle configuration" tracking, checking, and updating.
- Reporting all activities to the Event Manager for appropriate logging and reporting.

OBS Bluetooth communications with Transit customers shall consist of the following:

2.A.4.1.3.1. Interior Announcement

Whenever the vehicle's "next stop" announcement is made over the Internal Sign system, the vehicle shall also transmit "next stop" information for a Bluetooth-enabled receiver held by an on-board customer. In this case, the transmission shall be directed within the vehicle and cover a thirty-foot radius extending from the front of the vehicle.

2.A.4.1.3.2. Exterior Announcement

Whenever the vehicle makes an external route/destination announcement (triggered when the vehicle's front door is opened), the vehicle shall also transmit the route and destination information to Bluetooth-enabled on-street customers. This transmission shall extend outside the vehicle, beyond its front door in a thirty-foot radius.

2.A.4.1.3.3. Receipt of an On-Board Customer Transmission

Communication from an on-board customer to the vehicle shall consist of a request to disembark the vehicle at the next stop triggered by a pre-selected Bluetooth "next stop" announcement. The Contractor-provided Bluetooth unit shall inform the passenger that her request has been received and shall report the request to the Event Manager for logging and activation of the interior "Stop Requested" audio announcement and visual display. The Event Manager may also be required to indicate to the Operator, via the DDU, that this type of Bluetooth request has been made.

2.A.4.1.3.4. External Receipt of On-Street Customer Transmission

Communication from an on-street customer to the vehicle shall consist of a request to board a specific vehicle, triggered by the Bluetooth transmission of a pre-selected route and destination message. The Contractor-provided Bluetooth unit shall pass the received information to the Event Manager who shall inform the passenger that the request has been received. The Event Manager will log the activity, including whether or not a response was transmitted, and indicate to the Operator, via the DDU, that this type of Bluetooth request has been made. This functionality is for use by those on-street customers who currently would hold up a Special Assistance card identifying desired route number to notify an Operator that they wish to board her vehicle.

Should this priced option be exercised by KCM, the method of integrating the above-described functionality into the modular OBS shall be proposed by the Contractor during design and must be approved by the KCM Project Manager.

2.A.4.1.3.5. BlueTooth Test Plan

A test plan addressing all of BlueTooth subsystem requirements shall be provided and approved by the KCM Project Manager during the system Design Phase. These shall include all the testing of all technical, functional, and operational specifications, including interaction with a commercially available PDA or cell phone.

2.A.4.2. Future Functionality

The following capabilities have been identified by KCM as desirable but *have not been included* in the RFP requirements. These future functions shall be considered by the Contractor during all phases of system design and development so that the delivered system shall not preclude, but rather provide the basis for their future implementation. The Proposer's response to this section shall include a discussion of the feasibility of such enhancements as well as other potential technical issues (see Subsection **2.C. Level 1 SOW Vendor Questions**).

2.A.4.2.1. PC-Based Route-Mapping Tool

As an alternative to conducting data collection for bus stop inventories out in the field, KCM is interested in considering a PC-based route-mapping tool. The tool would be loaded onto the KCM Planners' PCs and would enable them to trace a route on the KCM Transit Service Area map. It would replace or be an alternative to the GIS Data Collection tool described in the use case ***RV8-Monitor Route and Schedule Adherence*, **Technical Specifications. The Transit Service Area map has a high degree of accuracy and would include all needed attributes. See Subsection **1.B.6.3, Geographic Information Systems (GIS)** for more information on the KCM Transit Service Area Map.

2.A.4.2.2. Hands-Free Microphone

KCM is interested in fielding an alternative to the Public Address System "gooseneck" microphone currently installed on all its vehicles. One possible alternative would be a "hand free" PA microphone with the following characteristics:

- Integrated with the VLU to ensure the PA system is effectively shared by the Operator, Annunciator system, and Coordinator announcements.
- Activated either by a button/switch mounted on or near the steering wheel, or by pressing a button on the DDU.
- Providing clear audio pickup without generating feedback over the PA speakers.
- Real time: the audio should be broadcast as the Operator speaks.

2.A.4.2.3. Transfer Connection Protection

KCM would like to add the capability for the CCS to automatically send a message via radio to an Operator who is making a planned connection with another transit vehicle, and indicate whether or not to wait. This function would have configurable parameters for establishing the wait-time limits based on near-real-time schedule adherence.

2.A.4.2.4. Automated Electronic Run-Number Sign

In the future, KCM may replace the existing manual device called the "run-number box," which is located in the upper right area of the vehicle dashboard, with an electronic version that could be automatically updated by OBS. The run-number box is for display of the Run Number portion of a Block ID identifier and is used by Service Quality Supervisors on the street to identify the specific block of work that a vehicle is operating. Each work assignment has a Block ID that is composed of a unique Route/Run-number designation.

2.A.4.2.5. Farebox Integration

After implementation of the RFCS "smart card" project, the farebox will be utilized for cash fares only. If KCM chooses to upgrade or replace the current GFI farebox system then the OBS system shall have the capability to interface to a Farebox Subsystem. The interface will provide the ability to collect and log cash-fare collection events with amount, date/time, and location stamp.

2.A.4.2.6. Real-time Customer Information Signs at Bus Stops

This system uses the latest technology to provide reliable vehicle arrival-time predictions to customer displays at selected bus stops for the benefit of passengers waiting at those stops. Such predictions would need to have a higher degree of accuracy when the vehicle is nearing the stop, especially within one to two minutes of actual arrival.

2.A.4.2.7. Text-to-Voice Audio Driving Instructions for Operators

To minimize visual distraction and as a supplement to displaying text messages on the DDU screen, KCM is interested in functionality that would enable the translation of text messages to voice. The VLU would include an application to convert text messages to voice. The idea is that the driving instructions for a re-route could be provided either over the WLAN (planned) or the radio (unplanned), and then stored and replayed by an Operator.

2.A.4.2.8. Wireless Access for On-Board Passengers

In the future, the County would like to explore the option of providing Transit passengers with the capability to utilize the WLAN on each vehicle to wirelessly connect to the Internet. It is required that KCM's use of the WLAN for the Project's required functionality, as described in Subsection **2.A.1.6.3.** and Subsection **2.B**, would *not* be degraded in any way if public wireless access were to be provided.

2.B. Level 1 Functional Requirements

Proposer must describe in detail how the proposed system will satisfy the requirements for each Use Case Specification (UCS) in this section. The Level 1 UCSs include all functional requirements for Level 1 of the project and also include the modifications to Level 1 UCSs required in Level 2. (Level 2 requirements are clearly labeled).

The Contractor shall meet the following objectives:

- Design, deliver, and install hardware and software onto the entire fleet of KCM Revenue Vehicles and at the transit bases.
- Replace and upgrade legacy on-board systems.
- Create a fully integrated environment that will interface to existing OBS Subsystems.
- Implement an enhanced Wireless Local Area Network (WLAN) system both on board and at each base to support full OBS functionality.

NOTE: The Level 1 implementation does not include an interface to the current 450MHz radio/AVL system.

The response to this section of the RFP shall comply with the requirements included in Subsection **2.A, General and Level 1 Technical Requirements**.

The requirements in this Subsection **2.B.** are intended to fulfill the Project objectives defined in Subsection **1.A.4, KCM Scope and Approach**.

2.B.1. Overview

This subsection provides an introduction to how KCM used Unified Modeling Language (UML) as a tool to communicate requirements. UML is a graphical language for visualizing, specifying, constructing, and documenting a system. UML provides a standard way to plan and document system concepts and business processes and functions, as well as a system's concrete aspects. KCM used UML to describe and model the functional requirements for the system and to define the relationships among subsystems and components. Additional information regarding UML is widely available on line and in reference books.

KCM staff selected UML to improve how information is presented and systems are managed throughout the procurement, design, test, implementation, and maintenance phases. While the Contractor will not be expected to develop the actual software code using UML, the Contractor shall develop, maintain, and provide a UML model of the OBS/CCS system as part of final system documentation (as-built). The OBS/CCS Model shall include use case specifications (UCS) and the following UML diagrams:

- Use Case
- Class
- Activity
- Sequence
- Deployment

A number of UML applications exist on the current market. For this Project, KCM has chosen TogetherSoft Control Center. (Detailed information on TogetherSoft can be found at www.borland.com). NOTE: The OBS/CCS RFP CD includes a copy of the model in the file named OBSCCS.tpr. The .tpr extension indicates that it is a TogetherSoft file.

2.B.1.1. Introduction to KCM Use of UML

KCM staff started the RFP development process by assembling use-case diagrams. The use-case diagrams are helpful in three areas.

- Determining features (requirements). New use cases often generate new requirements as the system is analyzed and the design takes shape.
- Communicating with clients. Their notational simplicity makes use case diagrams a good way for developers to communicate with clients. The OBS/CCS project team worked closely with stakeholders to define the separate use cases.
- Generating test cases. The collection of scenarios for a use case suggests a suite of test cases for those scenarios.

Once use cases were identified and modeled in the use case model, a Use Case Specification document was developed in collaboration with stakeholders to detail the specific functional requirements contained within the boundaries of the use cases.

2.B.1.2. UML Definitions

The OBS/CCS UML Model consists of Use Case Diagrams, Activity Diagrams, and Use Case Specifications. What follows are some definitions that will help toward understanding the model.

Actor: An actor is an entity—a user, a support technician, another system—that interacts with the system for the purpose of completing an event. A single Actor role may apply to multiple job titles among the users; similarly, a single user may play more than one Actor role. Actors appear as stick figures in a UCS.

Activity Diagram: Activity diagrams address the dynamic view of a system by showing the flow from activity to activity. An activity diagram focuses on the flow of activities involved in a single process, and shows how those activities depend on one another. Activity diagrams can be divided into object swimlanes that identify which object is responsible for each activity. A single transition comes out of each activity, connecting it to the next activity.

A transition may branch into two or more mutually exclusive transitions. Guard expressions (inside [ ]) label the transitions coming out of a branch. A branch and its subsequent merge marking the end of the branch appear in the diagram as hollow diamonds. A transition may fork into two or more parallel activities. The fork and the subsequent join of the threads coming out of the fork appear in the diagram as solid bars.

Extends: An “extend” relationship indicates that instances of a use case may be augmented with some additional behavior defined in an extended use case.

Includes: An “include” relationship allows one use case to include in its flow of events behaviors specified in another use case. An include relationship is a directed relationship between use cases, implying that the behavior in the additional use case is inserted into the behavior of the base use case. The use case may only depend on the results of performing the behavior defined in the additional use case, but not on the structure.

Generalization: A generalization is a relationship between parent and child use cases that implies that the child use case contains all the attributes, sequences, and extension points defined in the parent use case and participates in all relationships of the parent use case. A generalization relationship is one in which the child is a more specialized form of the parent use case.

Use-Case Diagram: A description of a set of sequences of actions, including variations, that a system performs that yield an observable result of value to an actor. Use-case diagrams describe what a system does from the standpoint of an external observer. The emphasis is on *what* a system does rather than how. Use-case diagrams are closely connected to scenarios. A scenario is an example of what happens when someone interacts with the system. A use case is a summary of scenarios for a single task or goal. An actor is who or what initiates the events involved in that task. Actors are simply roles that people or objects play. Use cases are represented as ovals. Communications are lines that link actors to use cases. A use-case diagram is a collection of actors, use cases, and their communications.

Use-Case Model: The use-case model is a model of the system's intended functions and its environment, and serves as a contract between the customer and the developers. The use case-model is used as an essential input to activities in analysis, design, and test.

2.B.1.3. Level 1 Use-Case Specifications (UCS)

There are a total of 19 Level 1 UCS: 16 address functions on board the Revenue Vehicle and three describe Base Operations functionality. For a more complete description of the physical architecture see Subsection **2.A.1.5.1, Domain Descriptions**.

The response to this section shall adhere to Part A, Section **1.T.4, Guidelines for Interpretation and Response to Functional Requirements**.

Each use-case name has an alphanumeric prefix indicating the domain where the functionality is to reside and a unique number assigned to it, e.g., ***RV1*** is the first use case in the Revenue Vehicle domain. The different domains each have a number of use cases whose functionality interacts with and mirrors each other. These “companion use cases” have been given the same names with different domain prefixes, e.g. ***BO2-Update Vehicle Data*** and ***RV4-Update Vehicle Data***. Level 2 of the project involves the Communications Center (CC) domain and modifications to the RV domain which are addressed in Subsection **3.B, Level 2 Functional Requirements**.

2.B.1.3.1. Revenue Vehicle (RV)

The RV domain shall be the platform onto which the On-Board Systems shall be installed. The OBS will be comprised of a VLU “master system” and all OBS subsystems, sensors, and modular components. The Vehicle Area Network (VAN), described in Subsection **2.A.1.6.4.**, will provide the communications medium between and among the VLU and OBS subsystems. The Level 1 RV use cases include:

RV1-Initiate Vehicle for Operation

RV2-Verify Vehicle Configuration

RV3-Take Vehicle Out of Operation

RV4-Update Vehicle Data

RV5-Monitor System Health

RV6-Manage Events

RV7-Determine Vehicle Location

RV8-Monitor Route and Schedule Adherence

RV9-Monitor Stop Point Activities

RV10-Manage PA and Annunciator

RV11-Manage AVM (Automatic Vehicle Monitoring)

RV12-Interface to DDU (Driver Display Unit)

RV13-Interface to Destination Signs

RV14-Interface to FTP (Fare Transaction Processor)

RV15-Interface to DVRS (Digital Video Recording System)

RV16-Interface to TSP (Transit Signal Priority) Tag

2.B.1.3.2. Base Operations (BO)

This domain includes the functionality that must reside at each Transit Base in order to manage the exchange of information between the Revenue Vehicle and the KCM management systems that will reside on the King County Wide Area Network (KCWAN). The Wireless Local Area Network (WLAN), described in Subsection **2.A.1.6.3.**, will provide the communications medium between the RV and BO.

BO1-Verify Vehicle Configuration

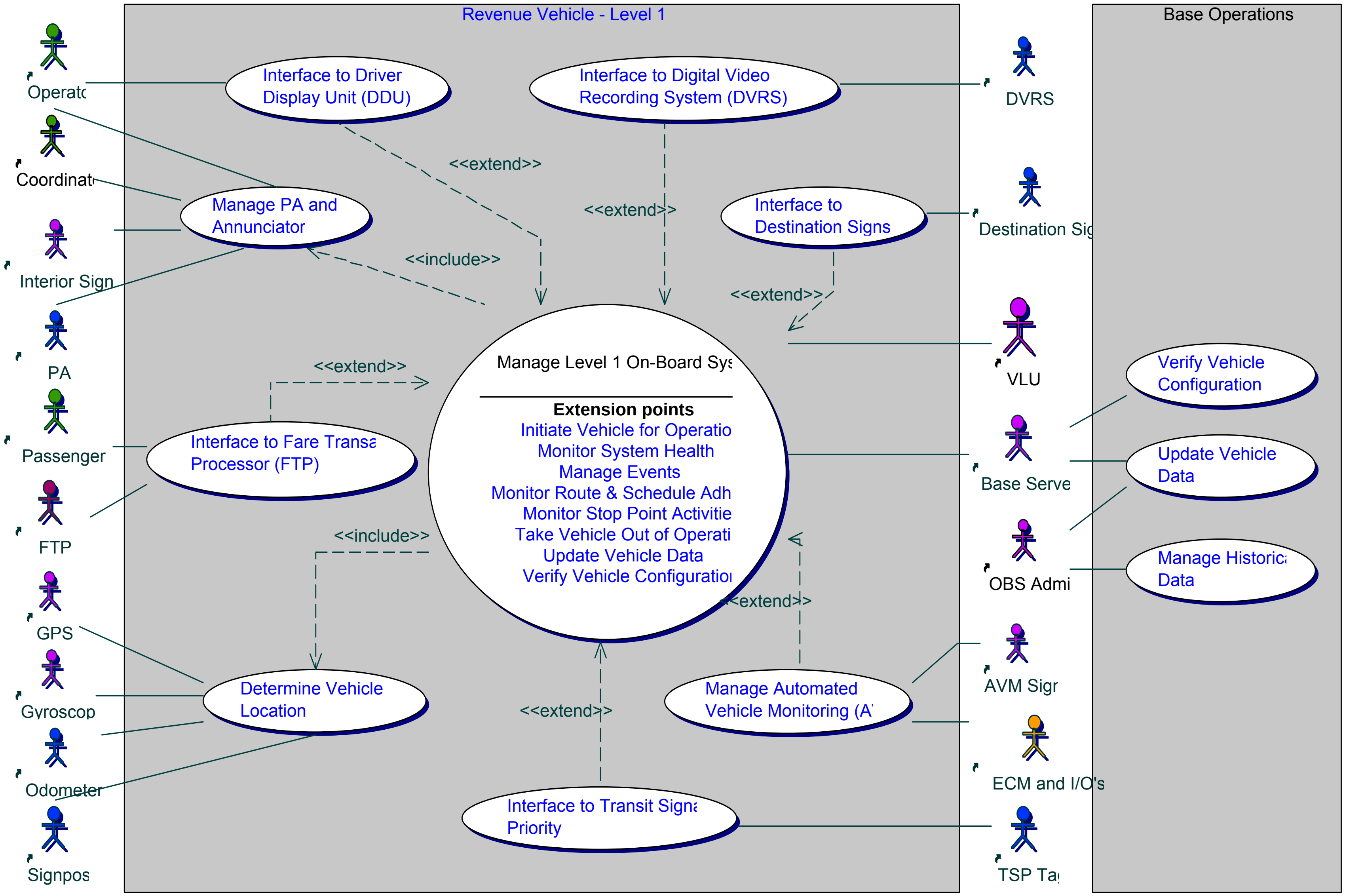
BO2-Update Vehicle Data

BO3-Manage Historical Data

2.B.2. Level 1 Business Model

The following Figure **2.B.2.** provides an overview of the Level 1 use cases and their relationships to the system and to each other.

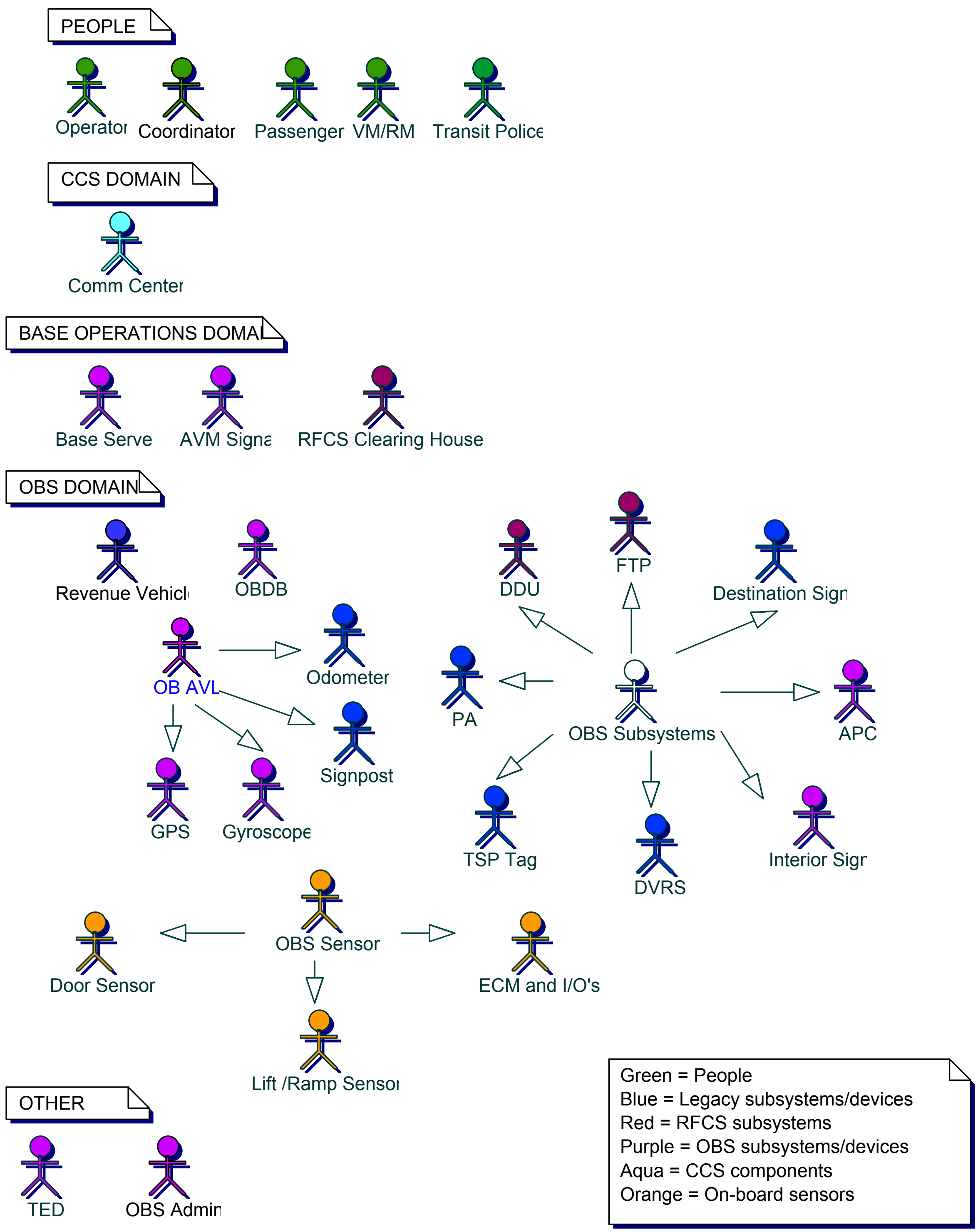
Figure 2.B.2. Level 1 Global Business Use Case



2.B.3. Level 1 Actors Glossary

The following Figure **2.B.2.3.** depicts the Actors that were identified in the Level 1 use cases. The glossary includes all Level 1 actors and their descriptions.

Figure 2.B.3. Level 1 Actors



- **Actor** *APC*

  The Automatic Passenger Counter (APC) subsystem includes remote sensors for each vehicle door connected to a processor that can provide the following data for each door: boardings, alightings, door status summary, and, possibly, passenger load . The system shall also have the ability to identify and report on boardings and alightings via the wheelchair lift or ramp.

- **Actor** *AVM Signal*

  The AVM Signal subsystem shall be a device located at the base to indicate the vehicle health status. When an out-of-tolerance condition exists it will characterized as either a "red" or "yellow" condition to indicate the urgency of the problem. The AVM Signal will be used to ensure that vehicles are parked in the appropriate place for maintenance attention and to enable maintenance tasks to be managed more efficiently.

- **Actor** *Base Server*

  The Base Server is a server located at each transit base that will be used as part of the WLAN system to store and manage the transfer of data, both between the vehicle and the base, and between the central data repository managed by the OBS Administrator.

- **Actor** *Comm. Center*

  The Communications Center (CC) houses the CAD/AVL system for the Service Communications Coordinators to manage service delivery, communications, and incident response.

- **Actor** *Coordinator*

  "Coordinator" refers to a job classification of Service Communications Coordinator. Coordinators work in the Communications Center and are the primary users of the CAD/AVL system. The Coordinators manage service operations, incident response, and voice communications.

- **Actor** *DDU*

  The Driver Display Unit (DDU) will be the primary interface for the transit Operator to interact with the OBS. This device will be connected to and controlled by the VLU. It will contain all of the necessary screens and interface "buttons" required for OBS functionality. (Note: The DDU and its software tools are currently included in the RFCS "smart card" contract scope.)

- **Actor** *Destination Sign*

  The Destination signs are mounted on the exterior of the Revenue Vehicles to display route and destination information. See Section **1.B.4.5, Destination Signs** for a detailed list of the makes and models of signs currently installed on the different fleet types. KCM has several makes and models of signs. The current signs all have a processor for storing sign codes and the specific display parameters associated with each code. The ICD for the destination sign should include the instructions and data structure for the VLU to be able to automatically change the signs; and parameters and protocols for enabling the VLU to update the sign code(s) and display files stored on the sign on an as-needed basis.

- **Actor** *Door Sensor*

  The Door Monitor Sensor is the I/O sensor that detects and reports the state of the door to the stop point manager and the APC.

- **Actor** *DVRS*

  The Digital Video Recording System (DVRS) consists of signs, color cameras, a microphone, a digital video recorder, storage device, wiring and cabling, Save Event button, and LED status indicator light. The system interfaces with the Radio system by way of the Emergency Alarm Switch.

- **Actor** *ECM and I/O's*

  Engine Control Modules (ECMs) and Input/Output sensors (I/Os) refer to two separate data sources for monitoring a Revenue Vehicle's engine, transmission, and brake systems. The ECM refers to the vehicle manufacturer's on-board computer which will provide a data stream on engine, brake, and transmission systems functioning. The I/Os shall collect and publish changes in state from a separate set of sensors such as the door and lift/ramp monitor sensors. Additional I/Os shall be approved by vehicle maintenance staff. The data collected from the ECM and I/O’s will be interpreted, logged and managed by the AVM software on the VLU.

- **Actor** *FTP*

  The Fare Transaction Processor (FTP) will be the passenger interface for “smart card” fare transactions. The FTP may also automate, or partially automate, Operator login by reading preloaded information from the Operator “smart card” ID, and communicate valid login data to the VLU. Because the transit Operator must monitor and manage smart-card transactions, there will numerous data exchanges between the DDU and the FTP which must be facilitated by the VLU.

- **Actor** *GPS*

  The GPS (global positioning satellite) receiver and antenna which shall provide location and time information along with quality measures to the vehicle location manager. GPS will be one of the sensors utilized in determining vehicle location (and time).

- **Actor** *Gyroscope*

  Gyroscope refers to either a gyroscope or a compass sensor which may determine the vehicle's current heading and provide it to the vehicle location manager.

- **Actor** *Interior Sign*

  The Interior Sign will display stop requested, time & route, and next stop information including common destinations, transfers, and landmarks. The sign shall be a LED device with a display in a color, font, and resolution that meets project requirements for ease of viewing by sight-impaired customers. The "stop requested" display shall be handled separately from the route information in such a way as to ensure that it is separate from the dynamic customer information, e.g. a light on the end of the sign when the cord is pulled. The Interior Sign will provide display functionality but could also provide audio tones. The content of this display shall be driven by commands received from the annunciator manager (part of the VLU functionality). The sign should have the ability to provide its own health status reports and alarms to the VLU.

- **Actor** *Lift/Ramp Sensor*

  Every vehicle in the fleet has either a wheelchair lift or ramp. The Lift/Ramp Sensor will detect and report the state of the lift or ramp, i.e. deployed, stowed, raised, lowered, etc. The Lift/Ramp Sensor data will be used to determine when the lift or ramp is used for boarding and when it is used for alighting.

- **Actor** *OB AVL*

  The On-Board Automatic Vehicle Location is a modular software component that will reside on the VLU and will provide time and a derived location prediction to the rest of the OBS (longitude and latitude).

The requirement is for location to be determined by a navigation algorithm that collects inputs from multiple devices and sensors, e.g. GPS receiver, gyroscope, and odometer, and calculates a solution based on the continuity and weightings of the various inputs. It is also required that the OB AVL be able to determine location and time when GPS is not available. It is understood that long-term accuracy may be degraded by the loss of GPS. KCM will offer but not require the existing signpost system for use as yet another source of location data. OB AVL is the only software component that shall be modular.

- **Actor** *OBDB*

The term "On-Board Data Base" is used to describe the full set of data and files that reside on the VLU and contain all of the stop, route, schedule, and customer information data required to provide the OBS functionality; and the historical data such as AVL, APC, error events, etc. The OBDB shall be managed by the OBS Administrator.

- **Actor** *OBS Admin*

The OBS Administrator refers to the individual(s) and the fixed-end software application that enables authorized staff to configure on-board system parameters; define the data libraries and update software executables for transfer; define event priorities, and establish priorities for historical data downloads from the RV to the Base Server.

- **Actor** *OBS Sensor*

This actor represents all of the sensor devices that are interfaced to the OBS. Included are the engine control module (ECM), I/O's, door monitor sensors and lift/ramp monitor sensor.

- **Actor** *OBS Subsystems*

OBS Subsystem is defined in Subsection **2.A.1.5.3.** OBS subsystems include:

  - APC
  - AVM Multiplexer (if needed)
  - AVM Signal
  - DDU
  - Destination Sign system
  - FTP
  - Interior Sign
  - 700 MHz Mobile Radio
  - Security Camera system
  - TSP Tag
  - WLAN

- **Actor** *Odometer*

The odometer shall be one of the primary vehicle-location sensors. The odometer will provide distance-traveled information to the vehicle location manager. The OB AVL module shall monitor odometer calibration and make adjustments to the calibration factor as necessary as tires wear or are replaced. The current AVL system uses the bus odometer to determine location. The odometer signal, either a wheel sensor or transmission pulse, can be made available for OBS.

- **Actor** *Operator*

  Operator is used to refer to any KCM employee who is licensed and authorized to operate a Metro coach or fixed-rail vehicle, including operations, maintenance, training, and service quality staff. Transit Operator is the job-classification title for employees whose job is to operate a vehicle in revenue service.

- **Actor** *PA*

  The Public Announcement (PA) system includes the existing speakers, speaker amplifier, and an Operator microphone. Ambient noise detection will be added by the OBS project. Transit Operators will share the use of the PA with the Coordinators in the Communications Center and with the annunciator system. The annunciator will automatically make internal and external announcements for passenger information. The existing hardware shall be upgraded, on an as-needed basis, for use by the OBS.

- **Actor** *Passenger*

  A Passenger is anyone riding on and not operating the vehicle, primarily the riding public.

- **Actor** *Revenue Vehicle*

  A Revenue Vehicle is the mobile platform for the OBS. A Revenue Vehicle is the entity that is managed and tracked by Coordinators in the Communications Center. Revenue Vehicle may refer to a coach, streetcar, train, or van, but is most typically a coach.

- **Actor** *RFCS Clearing House*

  The RFC (regional fare coordination) Clearing House is the fixed-end system that manages all "smart card" fare-transaction data that is collected and downloaded from the fare-transaction-processor (FTP)-equipped Revenue Vehicles.

- **Actor** *Signpost*

  The current AVL system is a signpost-based system. This system of precisely located signposts may be used by the vehicle location manager to provide reliable location information when a vehicle is in an urban canyon or if the GPS system is not available.

- **Actor** *TED*

  The Transit Enterprise Database (TED) contains the route, schedule, and customer information data for the OBS.

- **Actor** *Transit Police*

  King County Sheriff's Department police officers, contracted by KCM, patrol the KCM fleet service area and respond to incidents.

- **Actor** *TSP Tag*

  The Transit Signal Priority (TSP) system is installed on the fleet to communicate vehicle and route information to TSP-equipped traffic signals. The TSP uses an Automated Vehicle Identification (AVI) Tag (see Appendix **E, TSP Tag Interface** for the TSP/AVI interface control document). The OBS will add lateness and load data to the vehicle and route information to enable selective signal priority in the future. The OBS design shall address the option of using the WLAN for communications with roadside equipment in the future.

- **Actor** *VM/RM*

  Vehicle Maintenance (VM) and Radio Maintenance (RM) staff are those personnel who are responsible for maintaining equipment and systems located on board Revenue Vehicles.

2.B.4. UML Model: Level 1

2.B.4.1. Revenue Vehicle Use-Case Specifications

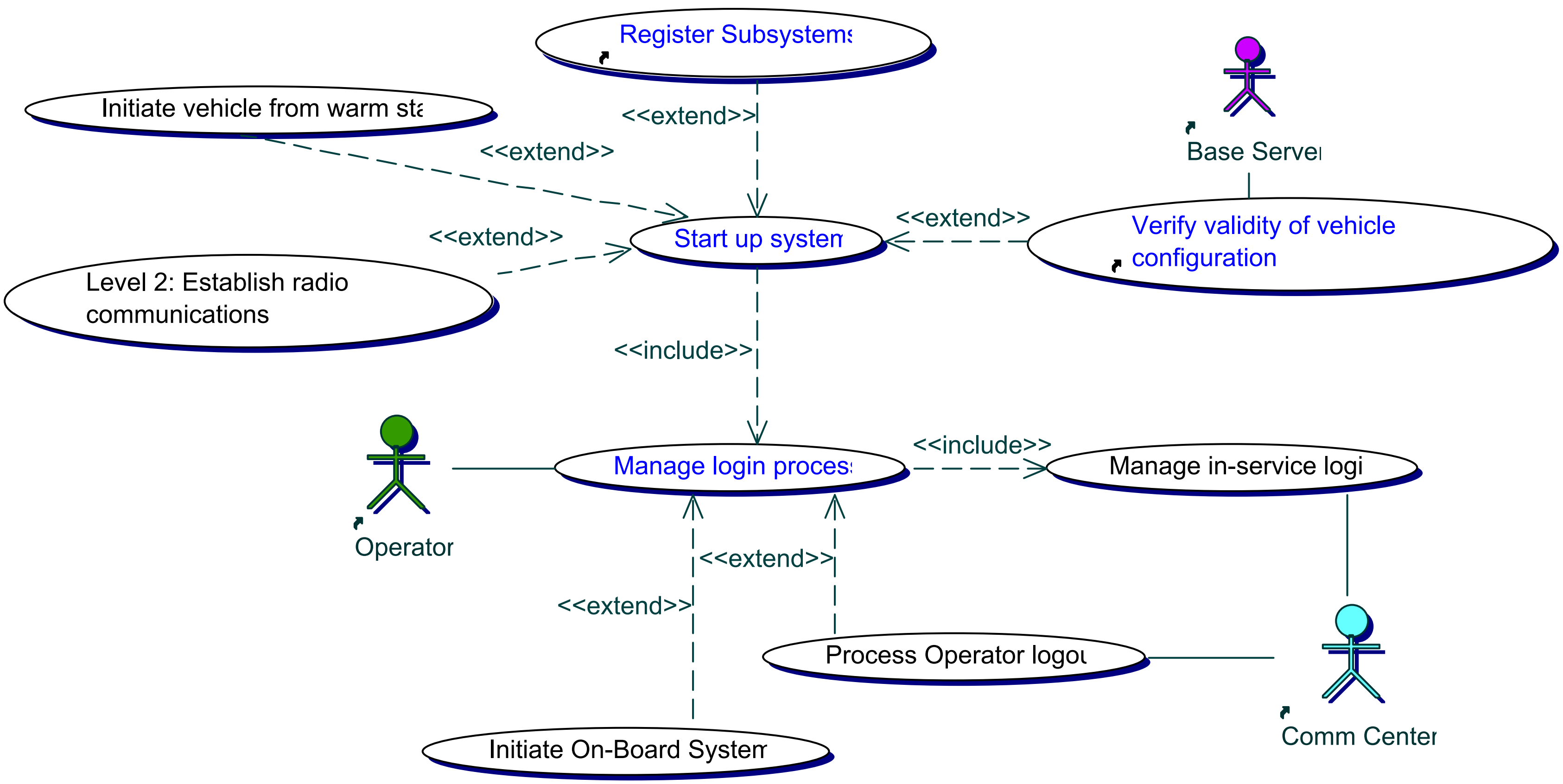
2.B.4.1.1. RV1-Initiate Vehicle for Operation

This use-case package includes the following UML diagrams:

Use-Case Diagrams

Activity Diagrams

Figure 2.B.4.1.1.RV1.a. UseCase Diagram RV1-Initiate Vehicle for Operation



2. RV1-Initiate Vehicle for Operation

1. Brief Description

This use case addresses the activities that are required in order to operate a Revenue Vehicle.

There are different requirements and a different flow of events for Level 1 and Level 2. The Basic Flow describes the requirements in Level 1, where the OBS (On-Board System) will not interface to the legacy 450 MHz Radio/AVL system. Alternative Flow *Level 2: Manage login process and establish radio communications* describes anticipated requirements for when the Vehicle Logic Unit (VLU) performs all radio-management functions including encoding/decoding the 700 MHz radio message traffic.

2. Pre-conditions

The vehicle is turned off.

In the case of a Cold Start: The *Shut down OBS* step in use case ***RV3-Take Vehicle out of Operation*** has been completed.

In the case of a Warm Start: The *Shut down OBS* step in use case ***RV3-Take Vehicle out of Operation*** has *not yet been completed*. See Alternative Flow *Initiate vehicle from warm start*.

3. Flow of Events

The basic flow is triggered when an Operator turns vehicle power on (by using what is normally referred to as the “master switch”).

3.1 Basic Flow

Start up system
When a vehicle is turned on, the OBS and all components shall perform normal startup procedures.

1) OBS will execute the Register subsystems step within the **RV5-Monitor System Health** use case.
    a) This process confirms the presence and health status of each subsystem.
    b) This process also provides the subsystem addresses to the OBS for data exchanges and dialogues between subsystems and between the OBS and the Base Server.
2) OBS will execute use case ***RV2-Verify Vehicle Configuration***.
3) OBS will set initial TSP Tag values to null. (See use case ***RV16-Interface to TSP Tag***.)

Manage login process
The system shall interface to the FTP and provide both automated and manual override login methods and processes.

1) The FTP will provide a login data message based on the Operator’s “smart card.”
    a) System will successfully complete the *Validate Operator ID for login* step in the ***RV14-Interface to FTP*** use case.
    b) If no login or an invalid login is provided, some Operator controls of the vehicle systems may be disabled.
        i) If the Operator ID (OID) is invalid, the FTP will send an “Invalid login” message to the VLU and Event Manager will prompt a message for display on the Driver Display Unit (DDU) (see ***RV12-Interface to DDU***).
        ii) For security purposes, a valid login may be required before the Operator will be able to do anything other than use the radio to call the Communications Center. For example, the interface to the FTP, destination signs, and PA system may be disabled or the vehicle will not be able to be put into gear.
    c) If a valid login is provided, the “Valid login” message will include, but not be limited to:

i) OperatorID: a unique number to identify the specific individual.

ii) BlockID: an identifier associated with a specific route/run in the current OBDB. (See use case ***RV4-Update Vehicle Data***.)

(1) An automated login provided via a smart card may include the Block ID. If not provided automatically, the Operator must manually enter the information.

(2) The OBS will prompt display of the route/run on the DDU.

(3) All BlockID's that are provided, either automatically and manually, shall be logged.

iii) (Optional) Vehicle ID (VID): a fully automated login may include the VID in order to match the vehicle and Operator assignments.

(a) The System will confirm that the VID on the smart card matches the number of the vehicle on which the Operator is logging in.

(i) The system will log the results of the comparison.

(ii) When the VID on the smart card does not match the vehicle to which the Operator is logging in, then the DDU will display a message informing the Operator of this fact.

{a} The DDU will prompt the Operator to call the Coordinator.

{b} The Operator should be allowed to accept the change in vehicle and continue with initiating the vehicle.

d) The System will display the login data on the DDU and prompt the Operator to indicate acceptance of the login data by pressing a key on the DDU.

2) Manual Operator Login: The Operator will have the option of logging the OperatorID, BlockID, and the fallback voice channel, if required, by entering the data on the DDU rather than using a smart card.

3) The maximum number of login data-entry attempts will be a configurable parameter controlled by the OBS Administrator.

a) When the number of invalid login attempts exceeds the number allowed, the Event Manager will prompt the DDU to display a message informing the Operator of this fact and directing the Operator to call the Coordinator for assistance.

4) The Operator can override of any of the automatically entered login data derived from the smart card, e.g. BlockID or VehicleID.

5) A login override switch will be installed in a secured area of the vehicle, e.g. the radio box, where it can be activated by authorized personnel such as maintenance or service quality staff.

a) The login override switch will enable full vehicle functionality.

b) When the login is overridden and Block ID is not provided, the vehicle will be monitored as an unlogged coach in the Communications Center.

Initiate On-Board Systems

The VLU shall automatically determine the correct OBS subsystem settings based on the Revenue Vehicle's current time and location relative to the block of work provided.

1) The OBS will determine from the login information how to handle the block in subsystems.

a) In the case of a valid login, the OBS will activate subsystems based on the time and service data set associated in the On-Board Database (OBDB) with the BlockID.

b) When the login does not match a work assignment in the service data set, then the OBS will handle the block as unscheduled work on the DDU, destination signs, and annunciator system. (See Subsection **5.2.1, Block ID Data Requirements** below).

2) The system will initiate the ***RV8-Monitor Route and Schedule Adherence*** use case.
3) When the vehicle is "on route," then the OBS will initiate subsystem settings consistent with where the vehicle is in the route and schedule, and trigger the appropriate settings for all OBS functions.
    a) At a base prior to beginning a block of work, all components will be initialized to the proper settings for traveling along the deadhead route to the terminal for the first trip.
    b) Regardless of where the vehicle starts, system will perform the following:
        i) Display the next scheduled timepoint and scheduled arrival time on the DDU.
        ii) Activate the Annunciator and Interior Signs.
        iii) Optional: Set fare. (See the *Set fare* step in use case ***RV14-Interface to FTP***).
4) If at startup the vehicle is "off route," then the OBS subsystems will be set based on time and the login.
    a) System will change the destination signs to display the route scheduled for the current time.
    b) Route Adherence Manager will signal "off route" status.
    c) Schedule Adherence Manager will display the next scheduled timepoint and arrival time.
    d) As soon as the vehicle is determined to be on route, the system will update the subsystems to the correct settings.

Log Events
The system will maintain a historical record of ALL login and initiation events in this use case.

1) The OBS logs will include the following information (this executes the *Log events* step in use case ***RV6-Manage Events***):
    a) Startup events
    b) Each login data entry including:
        i) OperatorID entered
        ii) BlockID entered
        iii) VID, if provided with the login
        iv) Login override switch activated
    c) System initiation events

3.2 Alternative Flows

3.2.1 Level 2: Manage Login Process and Establish Radio Communications

Establish radio communications
The OBS shall automatically establish a communications link between the Revenue Vehicle and the CCS using the new 700 MHz radio system.

This executes the *Establish radio communications* step in use case ***RV17- Interface to 700 MHz Radio*** and the companion use case ***CC2-Log in Revenue Vehicle.*** The specific Level 2 requirements will be finalized in collaboration with the 700 MHz radio system design and the CCS design processes. This alternative flow identifies only the *additions* and *changes* to the process.

1) The OBS will automatically establish communications with the CCS as soon as the *Start up system* step is completed. It is operationally desirable for the system to establish a link between the vehicle and the CCS prior to Operator login.
    a) As per the ***RV6-Manage Events*** use case, the system should send a message to the DDU that radio communications and AVL tracking are operational. Radio functionality that will be enabled includes RTT/PRTT and EA.

b) The vehicle should automatically generate unlogged coach messages. See Alternative Flow *Unlogged vehicles* in use case ***CC2-Log in Revenue Vehicle***.

Manage login process

The login process shall include all of the requirements in the Basic Flow and shall provide for additional functionality regarding login validation.

1) The Communications Center System will further verify the information. (See use case ***CC2-Log in Revenue Vehicle***.)
   a) If the CCS validation process detects a discrepancy, then the OBS will receive a message identifying the discrepancy.
      i) The DDU will display the login information, highlighting the field with invalid data.
      ii) The OBS will prompt the Operator to re-enter the login data in that field.
      iii) The OBS will have a configurable number of times to allow an Operator to re-enter the login.
      iv) If the login will not work, there will be a business process (not a technical one) to resolve the problem.
   b) When the CCS verifies a valid login, it will send notification to the OBS.
      i) The vehicle will receive a login acknowledgment from the CCS verifying the OperatorID and BlockID.
      ii) The system will display a message on the DDU to inform the Operator that the login has been accepted and the system is working.
2) Resume the Basic Flow at *Initiate On-Board Systems* (above).
3) The OBS will provide the capability for a Coordinator to remotely log in an Operator. (See use case ***CC2-Log in Revenue Vehicle***.)
   a) When a Coordinator remotely logs in an Operator, a message will be displayed on the DDU to notify the Operator.
   b) The OBS will log and report the new login data provided via the CCS.

Process Operator logout

The Operator shall use one of a variety of methods to log out from a vehicle and/or work assignment.

NOTE: The current system has no provisions for Operators to log out.

1) Manual Operator logout options will be provided on the DDU. (See use case ***RV12-Interface to DDU***.)
2) With Level 2 implementation, CCS capabilities will enable a Coordinator to remotely log out an Operator. (See use case ***RV8-Monitor Route and Schedule Adherence***.)
3) The system will provide the Operator with the following In-Service logout capabilities:
   a) Change Operator: a process for allowing an Operator to log out while retaining the BlockID (as in a "road relief").
      i) When the vehicle is still turned on and the Operator logs out, then the system will automatically initiate the *Manage login process* step above.
      ii) All event records will continue to include the last Operator ID until a new one is provided.
      iii) When the first Operator fails to log out, the relief Operator login data will create a new record with the same VID, same BlockID, and new OID.
   b) Change Work:

i) Level 1: When an Operator enters a login for a different work assignment (BlockID), the CCS should automatically log out the first assignment and then process the new login. (This will occur when an Operator is instructed by a Coordinator to operate a different work assignment.)

ii) Level 2: When the above occurs and an Operator is still logged in to her first vehicle:

(1) The CCS will automatically send an acknowledgment and message requesting that the Operator confirm that she has changed vehicles. (See ***CC2-Log in Revenue Vehicle***.)

(2) The Operator may either confirm or deny that she has logged in to a different vehicle.

(a) When confirmed, the OID will be automatically logged out on her previous coach.

(b) When denied, the *Manage login process* step will restart.

c) Change Vehicle: a process enabling an Operator to change both the OID and BID (as in a “coach change” or “road jump,” in which an Operator moves from one vehicle to another). A coach change shouldn't necessarily require an Operator to log out from her first vehicle. When the CCS receives the login from the replacement vehicle, it should request confirmation of the coach change from the OBS.

3.2.2 Manage In-Service Login

Manage in-service login
The OBS will include a method for enabling a relief Operator to log in to a vehicle that is already logged in and actively in service.

1) Whenever one Operator takes over for another, the OperatorID will be updated through the login process so that the correct OperatorID is used in all subsequent data records for the bus.

2) The OBS/CCS design will address the need for an Operator to be able to change from one coach to another.

3) One Operator might relieve another on an in-service vehicle for a variety of reasons:

a) Scheduled Road Relief: The schedule for a block can include multiple Operator assignments. For example, Operator B meets the vehicle at a scheduled time and location to begin a work assignment and relieve Operator A at the end of hers. When a road relief occurs, the vehicle will already be operating a block of work and the OBS should continue to operate seamlessly while managing, logging, and reporting the OperatorID change.

i) The On-Board Database (OBDB) should include a trigger point to automatically display a message on the DDU informing the Operator that a road relief is scheduled at the next stop and directing her to log out prior to leaving the vehicle.

ii) A second trigger point, when the vehicle departs the scheduled road relief point, should instruct Operator B to log in if he is a new Operator on this coach.

(1) Road relief Operators will be required to enter their OperatorIDs.

(2) Road relief Operators will not be required to re-enter the BlockID.

b) Unscheduled Change: Unscheduled Operator changes typically occur in the case of vehicle breakdown, and may involve a Coach Change or a Road Jump.

i) Coach Change: When a vehicle breaks down someone drives a replacement vehicle to meet and replace the one that has broken down.

(1) In Level 2, the Communications Center should be able to remotely log off either the Operator and/or the Block.

(2) Managing a coach change will be handled by a combination of business and automated processes to be developed by the Contractor in collaboration with KCM staff.

ii) Road Jump: In a Road Jump, the Operator of a disabled vehicle gets off that vehicle and relieves the Operator of the next vehicle that arrives. The displaced Operator then remains with the broken-down vehicle until a) a replacement vehicle in which that Operator can continue her route arrives, or b) the next scheduled vehicle arrives, causing the Road Jump process to be repeated. In each case, the Operator should log out of the vehicle that she was on, and log in to the next, or replacement, vehicle.

(1) Level 2: The OBS design will allow an Operator to log out both the Operator ID and the Block ID. This should result in the broken-down vehicle reporting as an unlogged vehicle in poll responses to the CCS.

(2) Level 2: Once an Operator has logged out of one vehicle, she will then be able to log in on a different vehicle.

4) Level 2 only: A coach change will allow but not require an Operator to log out from her first bus. When the CCS receives the login from the replacement bus, it should request confirmation of the coach change from the OBS. When a coach change occurs and an Operator is still logged in to her first vehicle, the system will handle it as follows:

a) The CCS will automatically send an acknowledgment and message requesting that the Operator confirm that she has changed vehicles. (See ***CC2-Log in Revenue Vehicle***).

b) The Operator may either confirm or deny that she has logged in to a different vehicle.

i) When confirmed:

(1) The OID will be automatically logged out on her first vehicle and block.

(2) The CCS will send an acknowledgment and text message to be displayed on the replacement vehicle informing the Operator that she has been automatically logged out of her previous coach.

ii) When denied, the *Manage login process* step will restart.

5) Resume the Basic Flow at *Establish radio communications*.

3.2.3 Initiate Vehicle from Warm Start

Initiate vehicle from warm start
When a logged-in vehicle is shut down and restarted before the OBS times out and shuts down, the OBS will handle subsystems and logging accordingly.

1) When the *Shut Down OBS* step in use case ***RV3-Take Vehicle out of Operation*** has not occurred, then the subsystems that had been initiated prior to the vehicle shutdown will resume operation seamlessly.

a) The radio communications link will have continued to operate and provide poll responses; therefore the *Establish radio communications* step is not needed.

b) The login process should be the same as the *Manage in-service login* described above.

2) Return to the *Initiate On-Board Systems* step in the Basic Flow and pick up where it left off prior to vehicle shutdown.

3) Log Events.

4. Post-conditions

The Revenue Vehicle shall provide communications, AVL route and schedule messaging, and on-board functionality appropriate for the login data entered by a valid, authorized Operator.

5. Special Requirements

The OBS shall be designed to enable it to work reliably with the components provided by the RFCS project (DDU and FTP), the new 700 MHz radio system and the Contractor provided CCS.

5.1 Performance

5.1.1 Reliability

Reliability
The process for initiating a Revenue Vehicle shall be highly reliable and robust, as quantified by KCM and the vendor during design.

It is operationally critical that Operators be able to get logged in and begin operating service without system problems. *Describe the proposed approach and, if possible, quantify the expected reliability in mean time between failures associated with the proposed process. Include a description of the redundancies, tools, and processes that would be included to deliver the needed reliability.*

5.1.2 Efficiency

Efficiency
The efficiency of the system shall meet KCM's needs for speed, reliability, and simplicity in the login/system startup process.

1) The time to complete the *Start up system* step, defined as the delay between when the vehicle master switch is turned on and the login screen appears on the DDU, shall not exceed 60 seconds.
2) The time to complete each subsequent step will be subject to KCM approval. *Describe the proposed process and the expected time that each step should take. Include an estimated total time for an average person to complete the processes described in the Basic Flow of this use case. Discuss ways that the proposed design has been streamlined to achieve a quick, simple process.*

5.2 Technical Specifications

5.2.1 Block ID Data Requirements

Block ID Data Requirements
The OBS design shall support the requirement for BlockID to be provided to address all of the operational scenarios described below.

1) Normal Revenue Service Operations: Hastus System-derived BlockID that is entered reflects the Operator's specific work assignment, trips, patterns, stops, and triggers.
   a) Trip Change: It should be possible for an Operator to enter a BlockID and operate a trip outside of the schedule. (For example, a vehicle that normally provides service to a school at 3:00PM may need to operate a school trip at 12:00PM due to school early dismissal; the system must support this business process.)
   b) Extra Trip: The OBS design must enable an Operator to select a specific pattern to operate a trip that is not part of a scheduled block (for example, in the case where an extra trip is added to meet unusual demand on a route).

   Discuss how the system could accommodate operating a trip outside of its planned schedule.

   Discuss the implications for reporting: How would schedule adherence be reported? How would reporting and AVL tracking in the CC handle the instance where the school trip is operated out of the normal sequence and then subsequent trips resume on-schedule operation?
2) Special Service: The design must accommodate service which is provided for special events, such as major sporting events. For example, KCM operates special trips from Park & Ride lots to an event. Vehicles are then staged at the venue to transport passengers back to the Park & Ride lot. Special service may not have an associated schedule in Hastus but should have a unique BlockID.
3) Non-Revenue Operations will not have an associated schedule in Hastus but should have a unique BlockID. The system design should address the requirements for certain types of non-revenue operations, including but not limited to:

a) Operations Training: There should be a set number of Block IDs, available to Operations Training staff, that would enable the OBS systems to mirror revenue operations on the inside of the coach but appear to be out of service from the outside. (The exterior announcements on a training coach should be turned off and the destination signs display "No Passengers.")

   i) Some of the training blocks should be unique to the training function, e.g. a loop trip that would begin and end at the training base that is not a normal service route.

   ii) Other training blocks should duplicate regular service blocks to mirror normal route and schedule adherence functionality.

b) Maintenance: Vehicle and radio maintenance login should enable additional privileges and access that an Operator would not need.

   i) Maintenance staff should be allowed to log in on multiple vehicles.

   ii) System should enable radio communications.

   iii) System design should provide for test routes to check vehicle and OBS performance.

   iv) System should provide access to screens and functions on the DDU—not accessible with normal operating logins—for maintenance of the VLU.

   v) System should enable all OBS functions in order to troubleshoot hardware problems.

   vi) Radio Maintenance staff should have access to tools and controls to enable monitoring and troubleshooting of the OBS interface to the Radio/AVL system.

c) Safety and Security: Safety and Security staff sometimes operates a vehicle for an investigation into the circumstances of an accident or security incident. No automated customer information is needed.

d) Other Service: Unplanned service that not part of the OBDB service data set, e.g. emergency evacuation. No automated customer information will be provided.

5.2.2 Login Security

Login Security

The system shall assure that only authorized personnel can put a vehicle into service.

1) Measures for initiating the vehicle from a *cold start* should include:

   a) Security:

      i) The design should provide obstacles and barriers to unauthorized operation of a Revenue Vehicle. *Discuss how a vehicle could be disabled from operation if a valid login is not received (e.g. the transmission will not go into gear).*

      ii) The solution will need to provide tamper-proof methods for identified authorized users. (For example, a universal password is discouraged because it could easily be shared via the Internet.)

   b) Flexibility:

      i) The solution should accommodate operational requirements to make pull-out; therefore back-up methods that are consistent with normal business practices must be included.

      ii) The login process design must also address the non-revenue operation requirements for maintenance and training. Maintenance personnel should have the ability to operate a vehicle within the confines of a base unencumbered by buzzers and alarms.

2) Security measures will be needed for initiating the vehicle from a *warm start*.

   a) Because the vehicle is still logged in and sending poll responses, the steps required for validating authorized operation may need to be different. (The simplest solution is to require a valid login.) *Describe recommended tools and methods for providing security measures in both cold start and warm start scenarios.*

b) If feasible, KCM may prefer the use of a smart card for Operator login in warm-start situations. *Discuss the possibilities of using a smart card for Operator login, or a physical security mechanism to inhibit unauthorized personnel from opening the vehicle doors with the outside switch.*

5.3 Testing

Testing Plan
The testing plan shall include test cases for each requirement statement in this use case.

5.4 Usability

DDU Prompts
The OBS shall have prompts and help messages on the DDU in order to minimize the possibility of an Operator getting "stuck" and not knowing what to do next in any login or other DDU operation.

6. Extension Points

CC2-Log in Revenue Vehicle

CC10-Log out Revenue Vehicle

RV2-Verify Vehicle Configuration

RV3-Take Vehicle out of Operation

RV4-Update Vehicle Data

RV5-Monitor System Health

RV6-Manage Events

RV8-Monitor Route and Schedule Adherence

RV12-Interface to DDU

RV14-Interface to FTP

RV17-Interface to 700MHz Radio

7. Assumptions

7.1 Smart Card scope

Integration of system with Smart Card elements
The successful proposer shall work in coordination with ERG to provide an integrated on-board solution.

1) The ERG contract includes the following components and functions that the OBS design must support.
   a) Driver Display Unit (DDU): see use case ***RV12-Interface to DDU***.
   b) Fare Transaction Processor (FTP): the device that will be used to read a smart card and collect fares. (See use case ***RV14-Interface to FTP***.)
2) ERG will be responsible for delivering the equipment and processes required to load the login data onto the RFCS smart card and read by the FTP. The OBS will be required to accept the login data provided by the FTP.

7.2 Level 2: 700 MHz radio interface

RV17-Interface to 700MHz Radio
The Level 2 requirements for the VLU to manage on-board radio communications with the new 700MHz radio and CCS system will be accomplished in collaboration with the TRS contractor and the CCS design.

8. Issues

If feasible, KCM may want the system to include the capability to initiate operation of the radio system and activate the RTT/PRTT buttons on the DDU before the full VLU boot-up is completed. *Describe approach and feasibility.*

Figure 2.B.2.4.1.1.RV1.b.* *Activity Diagram* *<u>Start up System</u>

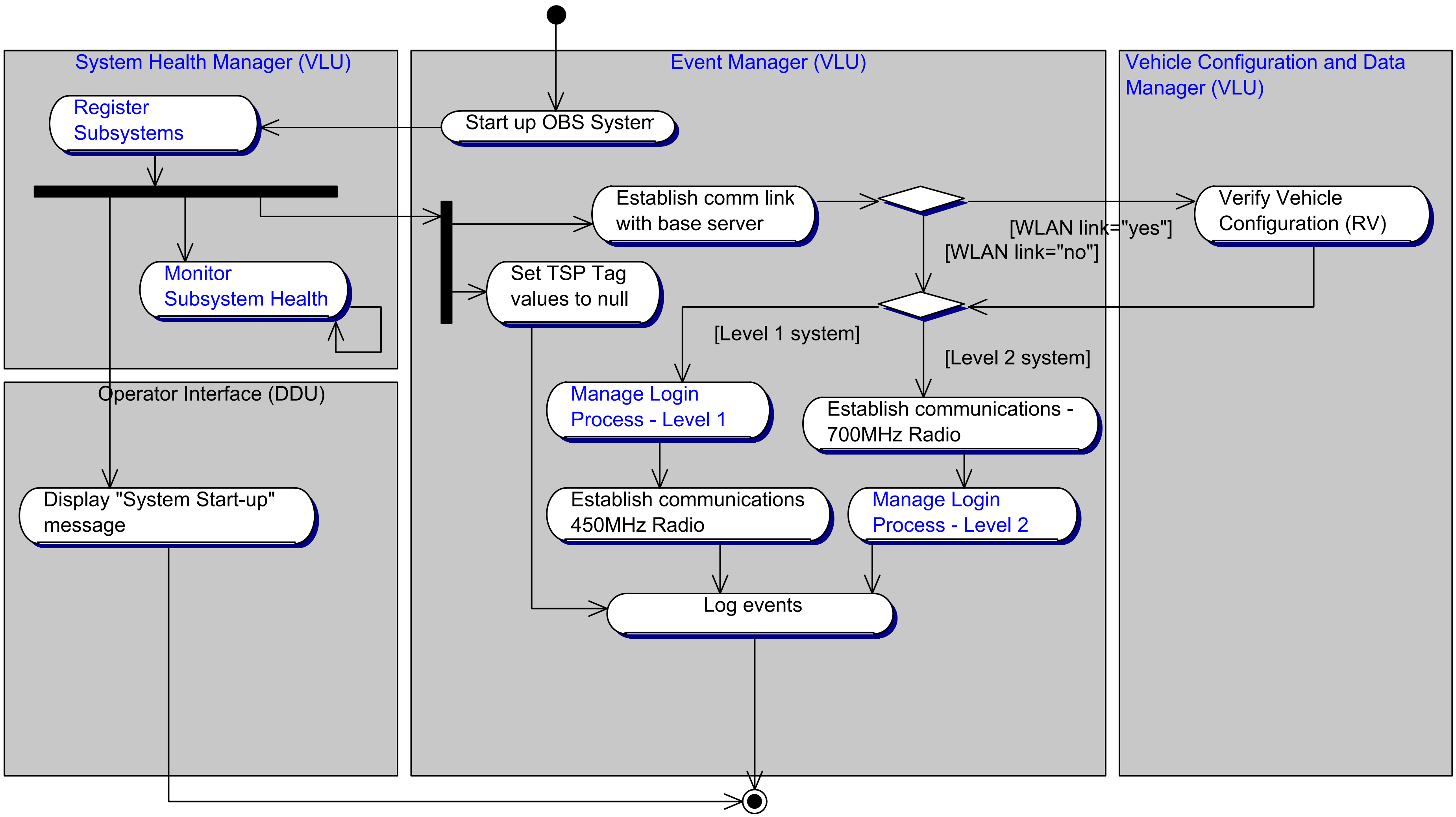


Figure 2.B.2.4.1.1.RV1.c. Activity Diagram <u>Level 1 Login Process</u>

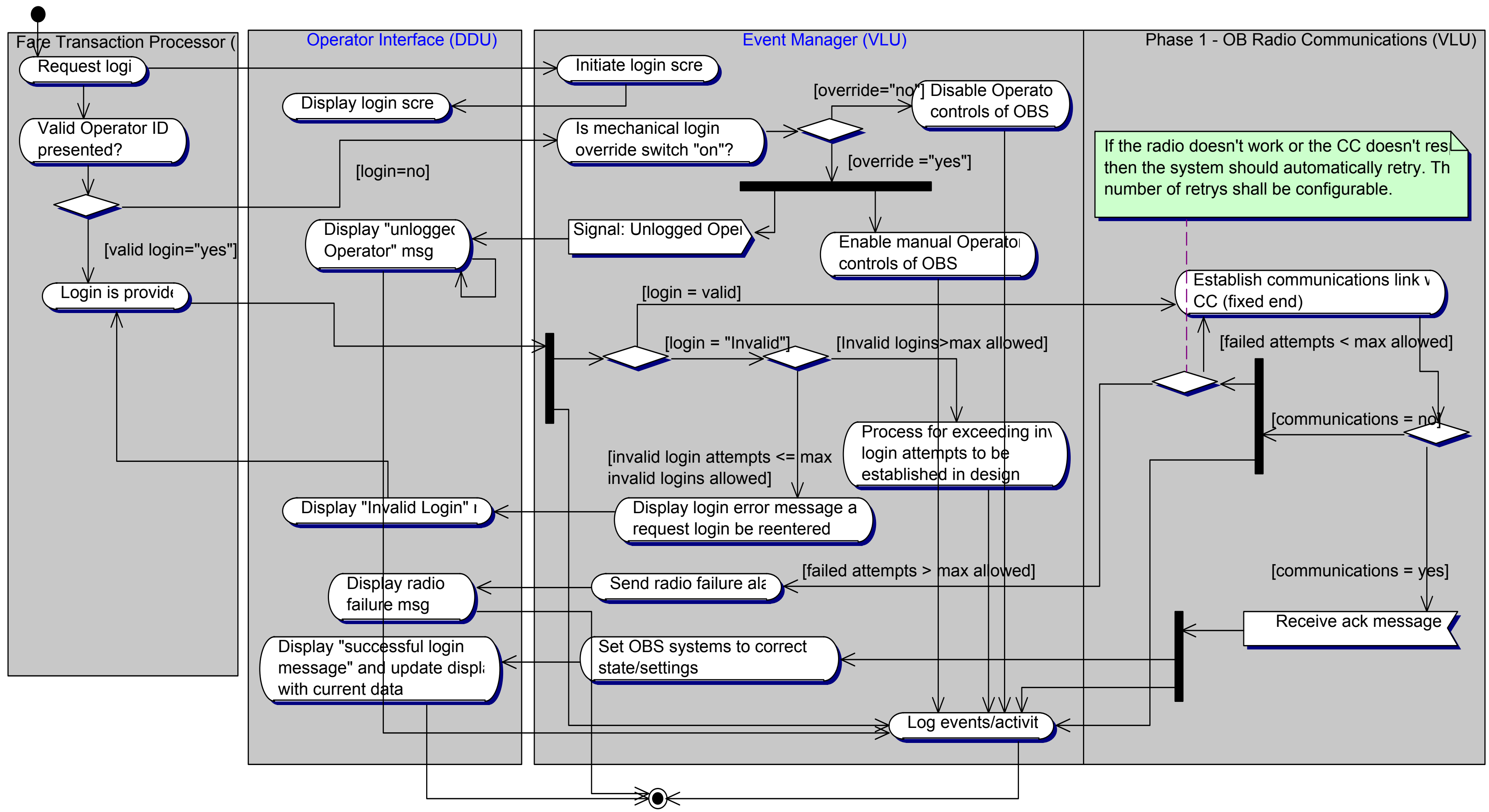


Figure 2.B.2.4.1.1.RV1.d. *Activity Diagram* ***Level 2 Login Process***

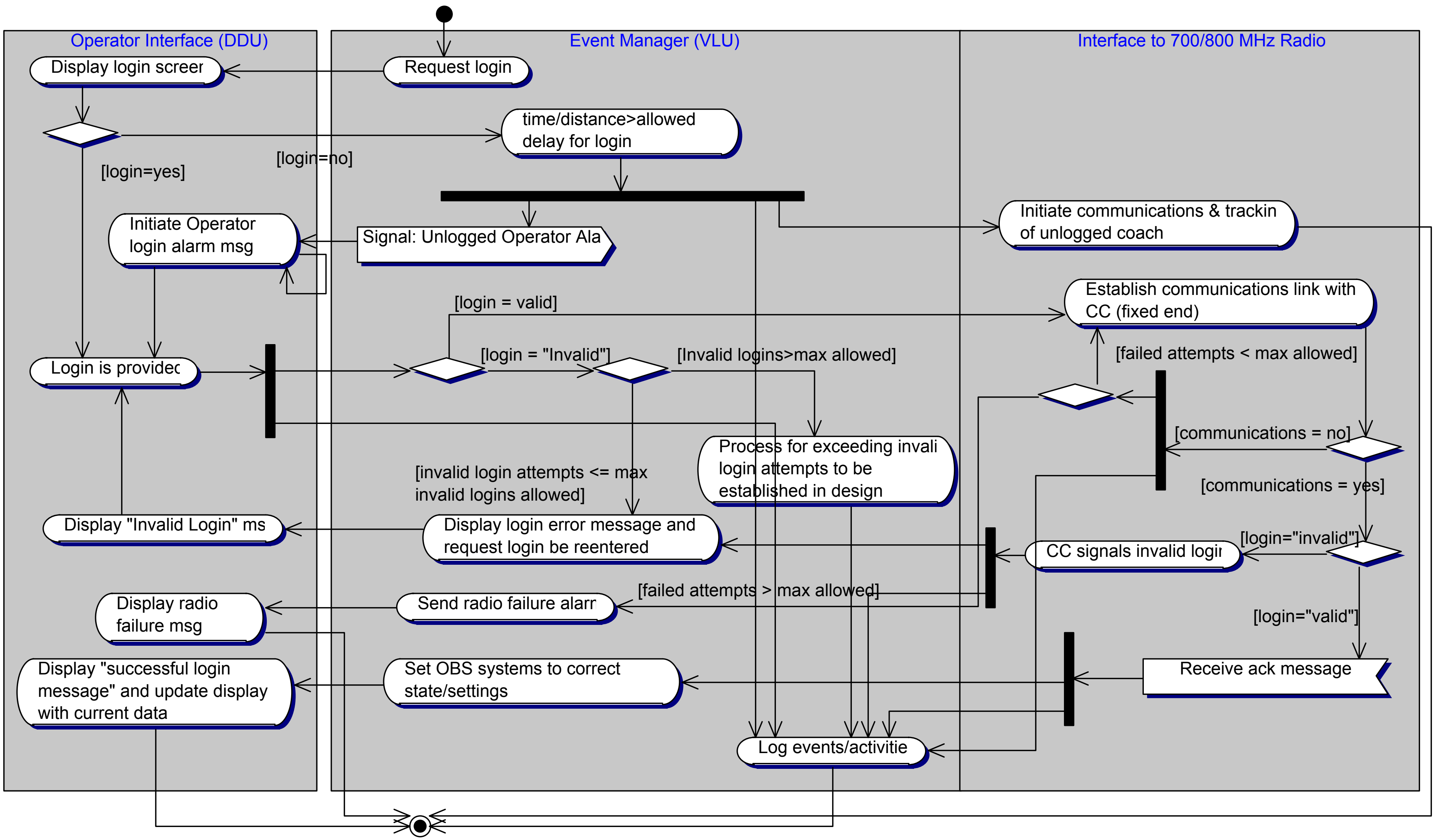
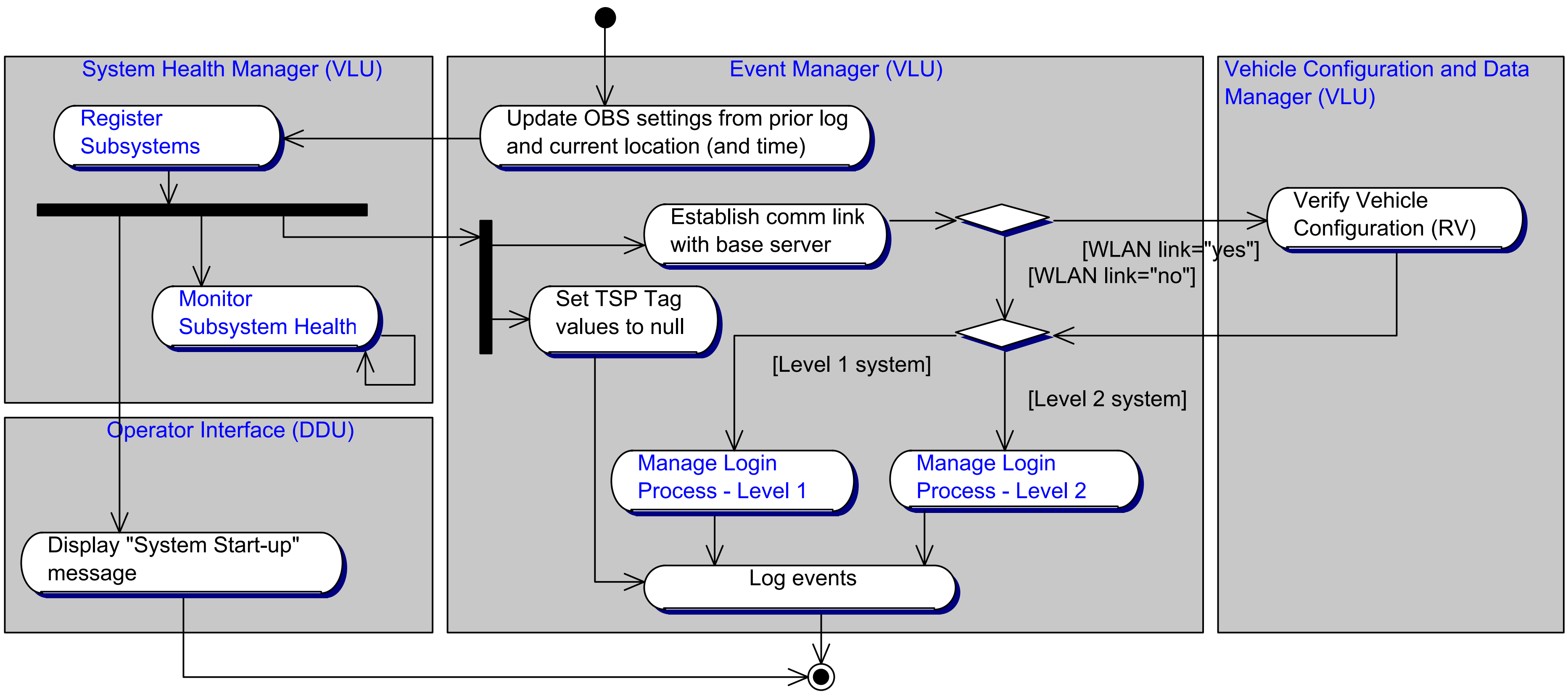


Figure 2.B.2.4.1.1.RV1.e. Activity Diagram <u>Initiate vehicle from warm start</u>



2.B.4.1.2. RV2-Verify Vehicle Configuration

This use case package includes the following UML diagrams:

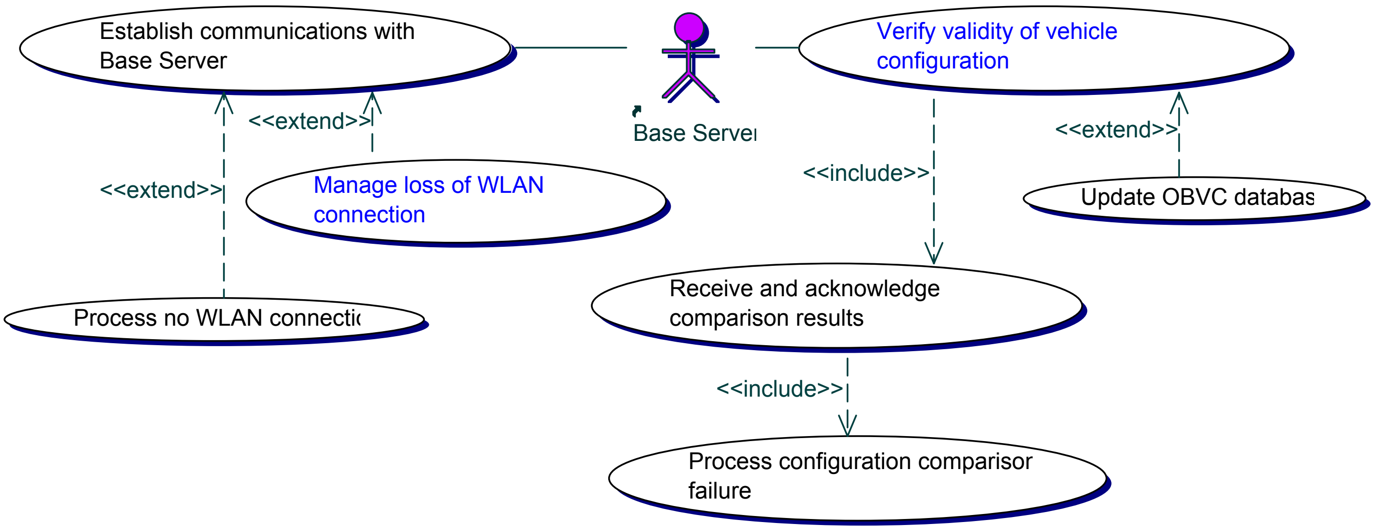
UseCase Diagrams

Figure ***2.B.4.1.2.RV2.a. RV2-Verify Vehicle Configuration***

Activity Diagrams

Figure ***2.B.4.1.2.RV2.b. Verify Vehicle Configuration (RV)***

Figure 2.B.4.1.2.RV2.a. UseCase Diagram RV2-Verify Vehicle Configuration



3. RV2-Verify Vehicle Configuration

1. Brief Description

This use case occurs during the processing of the ***RV1-Initiate Vehicle for Operation*** use case. It compares, on a vehicle-by-vehicle basis, each vehicle's current OBS and subsystem hardware configuration information with the same configuration information stored on the Base Server. The companion use case ***BO1-Verify Vehicle Configuration*** details the Base Server's role in this comparison process.

Both the Base Server and the vehicle maintain hardware configuration information for each specific vehicle in their respective On-Board Vehicle Configuration (OBVC) databases. The compared configuration information includes the list of OBS and subsystem hardware devices previously identified as resident on the vehicle during the execution of the *Register Components* step within the ***RV5-Monitor System Health*** use case. The OBS should report its current configuration to the Base Server, the Base Server should confirm that the vehicle meets the minimum requirement for revenue service, and then it should advise the OBS Administrator of equipment changes, additions, or deletions.

NOTE: OBS and subsystem software, firmware, configuration, and initialization files are subject to version comparison during the processing of the ***RV4-Update Vehicle Data*** use case.

2. Pre-conditions

The *Register components* step in use case ***RV5-Monitor System Health*** has been successfully completed.

The *Start up system* step in use case ***RV1-Initiate Vehicle for Operation*** has been successfully completed.

The vehicle has a complete profile of its unique hardware configuration in its OBVC database as well as current health status information for all OBS and subsystem devices.

3. Flow of Events

3.1 Basic Flow

Establish communications with Base Server
The system shall automatically establish communications with the Base Server via the WLAN.

All subsequent communications during the processing of this use case shall occur via the WLAN.

Verify validity of vehicle's configuration
The system shall compare the vehicle's hardware configuration with the Base Server's hardware configuration for this vehicle.

1) The Revenue Vehicle will transmit its current configuration information to the Base Server.
2) The Base Server will log the receipt of this information and transmit an acknowledgment of receipt to the vehicle.
3) The Base Server will execute a comparison process checking for consistency between the vehicle's transmitted configuration information, and the configuration information stored on the Base Server.
4) The Base Server will determine and log configuration comparison results for each completed comparison, designating the comparison as *successful* or *unsuccessful*.
    a) A *successful* comparison is one where consistent information resides on both the Base Server and the vehicle.
    b) An *unsuccessful* comparison occurs when either the Base Server or the vehicle's OBVC database contains a hardware device that does not exist in the other's OBVC database. (See Alternative Flow *Process Configuration Comparison Result Failure*.)

Receive and acknowledge comparison results
The vehicle shall receive and acknowledge all comparison results transmitted by the Base Server.

1) The Base Server will send comparison results to the vehicle.

2) The vehicle will send an acknowledgment of successful receipt to the Base Server.

Update OBVC database
The vehicle shall update its OBVC database to reflect the results of the configuration comparison process.

(NOTE: The Base Server also will update its own OBVC database with these results; see use case ***BO1-Verify Vehicle Configuration***.)

3.2 Alternative Flows

3.2.1 Process No WLAN Connection

Process No WLAN Connection
The system shall log any failure by the vehicle to initiate contact with the Base Server after a cold start.

1) The vehicle fails to establish contact through the WLAN.
2) The system will send a report of WLAN unavailability to the Event Manager. (See use case ***RV6-Manage Events***.)
3) The Event Manager will log the report.

It is anticipated that the inability to establish a connection with the WLAN may be due to either a system failure or the vehicle being out of WLAN range when such connection is attempted. When a cold start occurs, vehicles are not always parked at a KCM base and they will not be able to communicate to a Base Server.

3.2.2 Manage Loss of WLAN Connection

Manage Loss of WLAN Connection
The system shall log any loss of WLAN contact with the Base Server during the verification process.

1) The vehicle loses contact with the Base Server after communications have been established.
2) The system will send a "Loss of WLAN Connection" report to the Event Manager.
3) The Event Manager will log the report.
4) The VLU and the Base Server will keep track of what files have been completely downloaded successfully.
5) When communications are reestablished, the system will complete any transfer that was interrupted.
   a) The system will not handle the exchange as an error.
   b) The method for handling interrupted communications will also apply when a vehicle that is in revenue operation drives within range of a WLAN and initiates communications in passing.

(NOTE: The Base Server also will log this event and send an appropriate alarm message to the OBS Administrator; see use case ***BO1-Verify Vehicle Configuration***).

3.2.3 Process Configuration Comparison Failure

Process Configuration Comparison Failure
The system shall log and report any configuration comparison failure to the OBS Administrator.

1) The Base Server will transmit a comparison result of "unsuccessful" or to the vehicle.
2) The system will send a "Configuration Comparison Failure" event to the Event Manager.
3) The Event Manager will log the event.
4) The Event Manager will generate an alarm, if appropriate.
5) If the configuration failure is related to a critical subsystem, a message should be displayed on the DDU informing the Operator of the failure. For example, if the coach has DVRS (security camera) equipment but it's malfunctioning, the Operator should be aware of the fact that the DVRS is not working.

(NOTE: The Base Server also will log this event and send an appropriate alarm message to the OBS Administrator; see use case ***BO1-Verify Vehicle Configuration***).

4. Post-conditions

Any critical alarm sent to the Event Manager that indicates configuration comparison failure ("unsuccessful" or "unknown" types) must be immediately displayed on the DDU to the vehicle's Operator. It is anticipated that certain types of critical alarms will indicate that the vehicle will be unable to perform revenue service operation, but any such determination will be made by the Operator.

The vehicle and Base Server have updated their respective On-Board Vehicle Configuration databases and these now contain consistent information based on the results of this just-completed comparison process.

5. Special Requirements

6. Extension Points

BO1-Verify Vehicle Configuration

RV1-Initiate Vehicle for Operation

RV4-Update Vehicle Data

RV5-Monitor System Health

7. Assumptions

Implementation of OBS must include the proper hardware configuration and completion of each vehicle's OBVC database and Base Server's respective OBVC database for that specific vehicle. This information includes the initial configuration information for all subsystem and OBS hardware devices.

The criticality of all configuration comparison alarm types that indicate incompatible configuration information will be designated by the OBS Administrator or authorized Maintenance staff. The Contractor will supply all necessary utilities for making such designations. Such utilities will be part of the OBS Administrator's Toolkit and will reside on the Base Server.

8. Issues

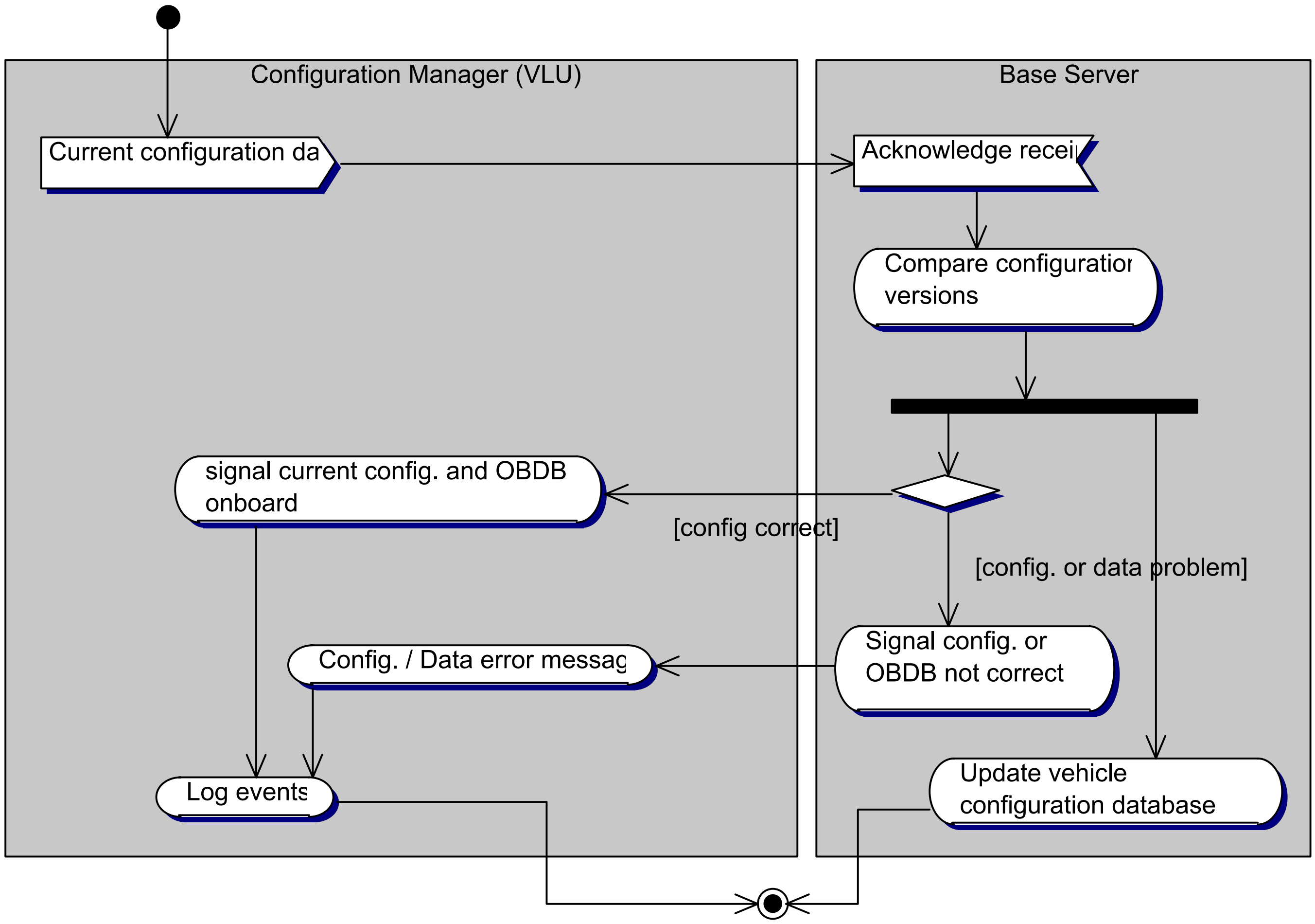
The manner in which configuration status information is stored on the vehicle will be a decision for the Contractor. However, since daily configuration comparisons must be made for all hardware that comprises the vehicle's OBS and subsystems before the vehicle can begin revenue service, such information must be stored in a manner that will expedite the speed and accuracy of such comparisons.

The existing configuration file on each vehicle should be updated at every startup within range of a WLAN, and after each equipment failure event.

Discuss the proposed method for tracking and reporting configuration failure events.

Level 2: the CCS should be notified with a message when something happens on an in-service vehicle that causes the on-board configuration to drop below the minimum required for revenue service.

Figure 2.B.2.4.1.2.RV2.b. Activity Diagram RV2-Verify Vehicle Configuration



2.B.4.1.3. RV3-Take Vehicle Out of Operation

This use case package includes the following UML diagrams:

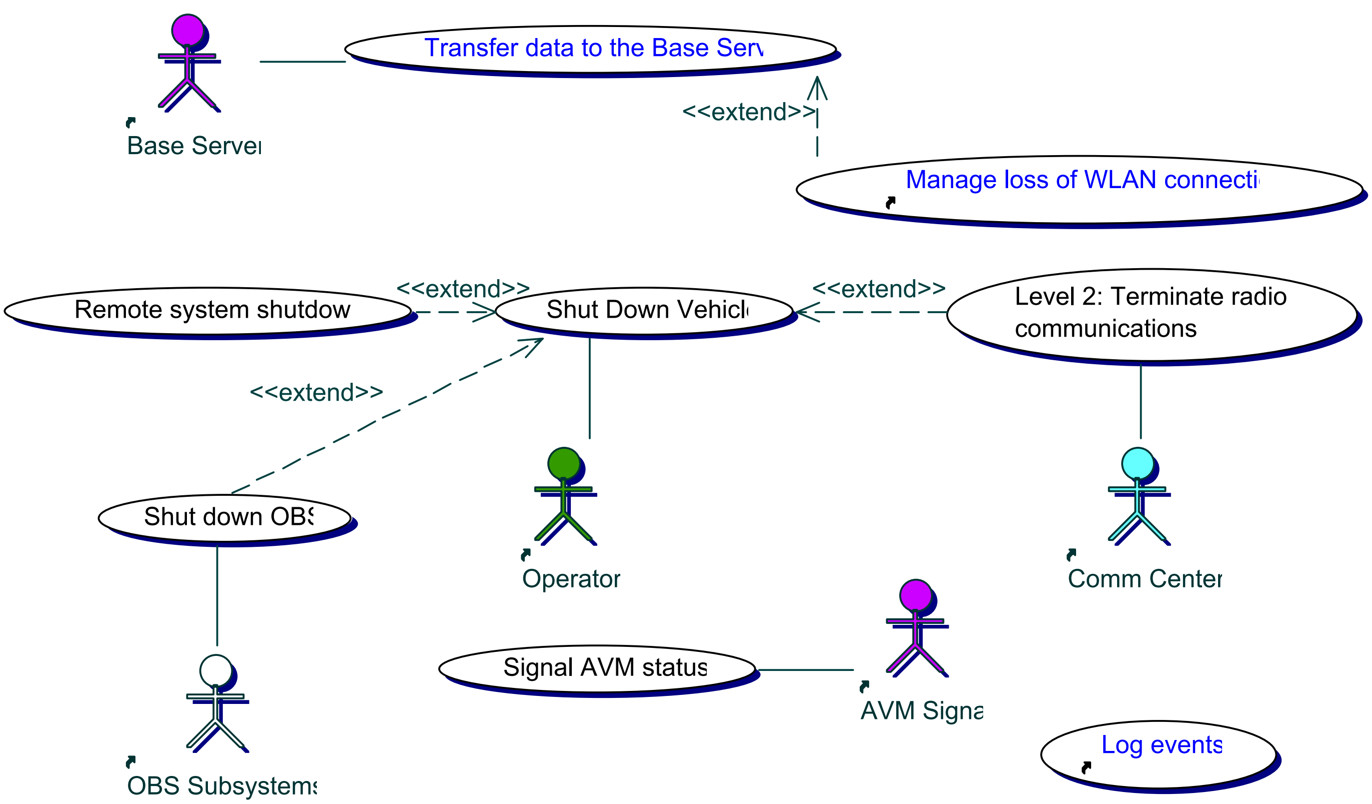
UseCase Diagrams

Figure ***2.B.4.1.3.RV3.a. RV3-Take Vehicle Out of Operation***

Activity Diagrams

Figure ***2.B.4.1.3.RV3.d. Take Vehicle Out of Operation***

Figure 2.B.4.1.3.RV3.a. UseCase Diagram RV3-Take Vehicle Out of Operation



4. RV3-Take Vehicle Out of Operation

1. Brief Description

This use case describes the activities that occur when a Revenue Vehicle is shut down after returning to any of the KCM transit operating bases (see Subsection **1.B.3, Base Operations and Maintenance**). Included OBS activities are:

- Transfer data/files to a Base Server.
- Signal AVM status.
- Initiate and monitor the ***RV4-Update Vehicle Data*** use case.
- Terminate radio communications.
- Shut down OBS systems.

The alternative flow *Remote system shutdown* describes requirements for when a Revenue Vehicle is shut down at a remote location.

2. Pre-conditions

The Revenue Vehicle has successfully completed the ***RV1-Initiate Vehicle for Operation*** processes.

The VLU and WLAN are in good health and operating normally, as defined in use case ***RV5-Monitor System Health***.

The vehicle has returned to one of the seven KCM transit bases or the South Training Facility.

3. Flow of Events

This use case is triggered when a vehicle establishes a link with a Base Server via the WLAN. See Subsection **2.A.1.6.3, Wireless Local Area Network (WLAN)**.

3.1 Basic Flow

Transfer data from vehicle to the Base Server
The system shall automatically establish a secure communications link with any base via the WLAN and initiate a process to download data in priority order.

1) The system will successfully complete a vehicle authentication process prior to any data exchange.
2) The system will transmit all data collected since the last successful download in priority order. (See use case ***BO3-Manage Historical Data***.)
    a) The OBS Administrator will have the tools to dynamically configure the transmission priorities for data and files, uploads and downloads.
    b) Data will include, but is not limited to, the following:
        i) Event Log. (See use case ***RV6-Manage Events***.)
        ii) AVM data. (See use case ***RV11-Manage AVM***.)
            (1) AVM events: data associated with a fault condition(s) detected since the last AVM data download.
            (2) ECM (Engine Computer Module) data: full data set from the vehicle's original equipment manufacturer (OEM) computer.
            (3) I/O sensors: full data set collected from the I/O sensors.
        iii) Fare data. (See use case ***RV14-Interface to FTP***.)
        iv) Video data. (See use case ***RV15-Interface to DVRS***.)
        v) Maintenance log(s)

- OB AVL Log: see use case ***RV7-Determine Vehicle Location***.
- VLU and OBS Subsystem event logs
- Level 2 only: Radio log(s): see use case ***RV17-Interface to 700MHz Radio***.

(1) WLAN log: events and activities included in this use case plus wireless activities in support of the following use cases:

- ***RV1-Initiate Vehicle for Operation***
- ***RV14-Interface to FTP***
- ***RV15-Interface to DVRS***

(2) OBS Administrator: data related to configuration, versions, processing errors, etc.

c) The data sets and format will be approved by the KCM Project Manager during design.

3) The OBS and Base Server systems will mutually verify that all historical data/files have been successfully transmitted from the vehicle and received on the Base Server Landing Pad. The ***BO3-Manage Historical Data*** use case addresses the requirements for data management after it has been successfully received by the Base Server.

4) After all of the data has been successfully transferred from the vehicle to the Base Server, the system will automatically initiate the ***RV4-Update Vehicle Data*** use case to upload new data and files onto the vehicle. This process may continue after the vehicle is shut down and until the *Shut down OBS* step below occurs.

5) Confirmed successful transmission and receipt by the Base Server will serve as a trigger for old/outdated data to be deleted or overwritten after a configurable number of hours.

Signal AVM status
The system shall provide a communications link between the vehicle and the AVM Signal to display vehicle status information.

See Technical Specifications, *AVM Signal* below

1) When the vehicle is in range, the OBS will send a message to the AVM Signal indicating the vehicle health status.

2) The AVM Signal will display a status indicator based on the vehicle ECM and I/O sensor faults that occurred since the last AVM data transfer. (See use case ***RV11-Manage AVM***.)

   a) A *Red* indicator signals that the AVM monitor detects a current fault condition, e.g. low coolant.

   b) A *Yellow* indicator signals that a fault condition occurred during operation but is no longer present, e.g. the engine temperature exceeded the defined threshold but is currently operating in the normal range.

   c) A *Green* indicator signals that no AVM faults have occurred.

3) When the AVM Signal displays a *Red* or *Yellow* fault condition, the associated AVM event data associated with a Red or Yellow status will be sent automatically to maintenance staff as an e-mail or other kind of message for follow-up.

Shut down vehicle
When an Operator shuts down a vehicle (turns off the master switch) within range of a Base Server, the system shall automatically initiate a configurable process to complete unfinished data transfers and shut down on-board systems and equipment.

1) Some of the on-board equipment will be shut down whenever the vehicle master switch is turned off.

a) The system will be designed so that equipment that is not needed will be powered off when the vehicle is shut down. The specific subsystems that should be shut down when the vehicle is shut down will be selected in design, e.g. TSP, Interior Sign, etc.

b) The design will include a method and tools for KCM to reconfigure which subsystems will be shut down in this step and which subsystems will continue to operate until the *Shut down OBS* step described below.

2) Subsystems that are required for communications and security will continue to operate for a configurable time delay after the vehicle is turned off, e.g. radio, DVRS, DDU, etc.

3) System will initiate and monitor the ***RV4-Update Vehicle Data*** use case processes.

Shut down OBS
The VLU shall provide the methods and tools for properly closing applications and powering down OBS subsystems that continued to operate after the vehicle power was turned off.

1) The VLU will have a configurable time for continued VLU operation after the *Shut down vehicle* step has occurred.

2) The VLU will signal the power management system to shut down and power off remaining operating subsystems when *both* the following conditions are met:

   a) The predetermined time has elapsed.

   b) The ***RV4-Update Vehicle Data*** file transfers have been successfully completed when the vehicle has returned to the base.

3) The VLU will also have an absolute cut-off time for shutting down the OBS.

   a) The shut-down process must guard against draining the vehicle's batteries.

   b) The shut-down process should also have a means to detect when a download process is "stuck."

Log events
Every step in the flow and any errors or exceptions will be logged.

3.2 Alternative Flows

Remote system shutdown
The OBS design shall accommodate scenarios when the vehicle is unable to communicate via the WLAN to a Base Server.

1) Off site: The OBS design will address the operational requirements for the following scenarios in which a vehicle is shut down at a location where it is not in the range of a base WLAN access point:

   a) Long Layover: When an Operator turns the vehicle off at a layover location and does not restart it within the defined time between vehicle shutdown and OBS shutdown.

   b) Off-site Parking: When certain work assignments require that the Revenue Vehicle be parked overnight somewhere other than a transit base, e.g. on Vashon Island.

2) WLAN Failure: When the WLAN system at a base fails, the VLU will log all attempts to establish communications and process the shutdown as if it were off site.

Manage loss of WLAN connection
The system shall respond to the scenario where the vehicle loses its connection to the WLAN during the data transfer process.

Execute the *Manage loss of WLAN connection* step in use case ***RV2-Verify Vehicle Configuration***.

Level 2: *Terminate radio communications*
The On-Board System shall automatically terminate radio communications as a part of the *Shut down OBS* step.

1) Immediately prior to OBS system shutdown, the vehicle will transmit a message to the CCS to initiate the ***CC10-Log out Revenue Vehicle*** use case.
   a) The message will have the effect of automatically logging out the Vehicle ID.
   b) The OBS system will wait to receive a log out acknowledgment from the CCS.
      i) When the acknowledgment is received, proceed to the next step.
      ii) If an acknowledgment is not received, the system will retry for a configurable, specified number of attempts; then log the event and proceed to the next step.

4. Post-conditions

All steps in this use case have been successfully performed.

The ***RV4-Update Vehicle Data*** file transfers have been successfully completed.

A trigger has been set for the ***RV1-Initiate Vehicle for Operation*** use case indicating that all required data transfers were either successfully or unsuccessfully completed and therefore, the vehicle OBS is fully ready for revenue service.

All OBS components were shut down properly.

5. Special Requirements

5.1 Performance

AVM Data
AVM data shall be made available to maintenance staff in a timely manner for maintenance scheduling and repair.

1) Data related to a “red” or “yellow” AVM event will be automatically sent to maintenance and available for query within 30 minutes after the Revenue Vehicle returns to the base and establishes a WLAN connection.
   a) The content, format, and routing of AVM event messages will be jointly developed by KCM and the Contractor, and approved by the KCM Project Manager in the design phase.
   b) The design will address the handling of AVM event data messages. (See use case ***RV6-Manage Events***.)
      i) There will be one message per AVM event message type within a given time frame, e.g. when a system is detecting intermittent high coolant temperature there will be one AVM Event message generated for display and transmission.
         (1) The AVM Event Message to be transmitted to Vehicle Maintenance will include summary information on the timing, duration, and temperatures detected that were out of tolerance. *Describe the proposed approach for assuring that the system does not generate redundant messages for the same AVM event.*
         (2) When the AVM Signal is not working and the AVM Event Message is successfully sent then the AVM event should be cleared from the AVM log after a configurable time delay.
      ii) The system will have the capacity to record and store up to 1,000 AVM event messages between downloads. *Describe the process for managing event messages when the number of events exceeds storage capacity, e.g. when the same error is detected every other second for several hours*.
      iii) When the AVM Signal is not working and the AVM message is successfully sent, then the AVM event should be cleared from the log after a configurable time delay.
   c) AVM data must be accessible from any base.

d) VM staff will be able to identify at which base the vehicle is currently located. *Discuss how the system can be designed to ensure that AVM event data can be routed and managed that is downloaded when a vehicle passes by a WLAN while in revenue operation and transmits the event.*

Meet legal and security requirements
All of the system authentications and wireless security requirements shall be satisfied before any data is transmitted.

1) See Subsection 2.A.1.6, Communications Layers.

2) System design must meet legal requirements for video data.

   a) The functions, methods, and protocols for recording events and managing and transmitting video data will satisfy the evidentiary needs for prosecution.

   b) The King County Sheriff's Office and the King County Prosecuting Attorney's Office will approve of the final design of the OBS system as it applies to this use case.

3) Fare collection data will be protected.

   a) The fare data transmitted from the FTP will satisfy RFCS security protocols.

   b) Due to the regional nature of the RFCS, there will be a two-step approval process for the functions, methods, and protocols for handling fare data. First, the KCM RFCS Site Manager will review and approve. Then, the Site Manager will present to the RFCS Regional Team for Contract Administrator approval.

5.2 Technical Specifications

Log WLAN activities
The On-Board System shall log all WLAN activities and events.

1) WLAN activities will be logged in a separate table or file (see use case ***RV6-Manage Events***), and include, but not be limited to, the following:

   a) Vehicle authentication attempts.

   b) Connect location (and time).

   c) IP address or other subsystem identifier to indicate the source of the data.

   d) Duration of connect time.

2) The log will include the status (successful, interrupted, or completed interrupted), file type, and size of transfers.

3) The log will include WLAN use when the vehicle is in operation, such as:

   a) When the Transit Police monitor the security camera system in real time. (See use case ***RV15-Interface to DVRS***.)

   b) If the system is interrogated by a traffic signal for transit signal priorities. (See Subsection **1.A.4.1.1, Wireless TSP**.)

Data transfer priority
The OBS Administrator will use the Toolkit to configure and change the priorities and the order for data transfers.

1) The initial priorities will be determined in the design process and approved by the KCM Project Manager.

2) The OBS Administrator will have the ability to dynamically set and change priorities according to business needs. *Describe the proposed process and tool to be used for setting and changing the priorities.*

   a) Prioritization of data and bandwidth usage: the order for transferring files shall be configurable.

   b) Priority shall be configurable based on Vehicle ID, vehicle type, and application.

3) The make-up of the data sets and files will be determined in design. (See use case ***BO3-Manage Historical Data*** for a more complete description of data and reporting requirements.)

AVM Signal

The design will include an AVM Signal for providing Vehicle Maintenance staff with information regarding the health status of the vehicle.

1) The AVM Signal will be a device that appears as one of the following. Discuss the type of AVM Signal proposed and the reasoning behind why this will be the best choice.
   a) LED/LCD display to identify the vehicle, status color and describe the fault; e.g. "display in *Red*" **VID2400:—hot engine**; or "display in *Yellow*" VID9024:—low oil pressure.
   b) Device resembling a traffic light. (This is a less desirable option but cost and operational performance will be the deciding factors.)
2) One AVM signal will be placed at each base at a location to be approved by KCM during design. The base layouts differ; therefore the best location for the signal will vary. Site selection criteria include:
   a) Every vehicle should pass by the AVM signal after returning to a base and before it is put back into revenue service.
      i) Possible locations for the AVM signal include the wash station, refueling station, or the hostlers shack.
      ii) The key to selecting the best location will be to ensure that vehicles that require maintenance are parked in a designated location away from the vehicles that are ready for revenue service.
   b) The system must accommodate cases where the vehicle does not pass the AVM signal as soon as it returns. (Normally the Operator parks the vehicle in a lane and shuts it down. Then it is re-initiated by an Equipment Service Worker to be driven into the fuel bay or other location where the AVM signal may be situated.)
   c) The system should signal all AVM events that have occurred since the last time that the AVM Signal link was established, even if the vehicle has been initiated and shut down multiple times in the interim.
   d) Data related to a "red" or "yellow" fault condition will be a priority over most other data to be to be transmitted to the Base Server.

Level 2: Remote logout

The Coordinator will have the ability to remotely log out an Operator and/or a Block. (See the *Remote logout* step in the ***CC10-Log out Revenue Vehicle*** use case.)

1) The vehicle should report its status as an unlogged vehicle to the CCS and initiate the Request Login screen on the DDU.
2) It is assumed that the Coordinator will communicate with the Operator as appropriate prior to remotely logging off the Operator or block of work.

Manage power

The system design shall manage the electrical load on the vehicle batteries during the shutdown processes after the vehicle is turned off.

1) KCM Vehicle Maintenance has overall responsibility for power management on the vehicles and the OBS power management solution will be approved by KCM.
2) The design will include, but not be limited to, a shutdown process for all subsystems.

   Describe the proposed plan for managing all subsystem shutdown processes including messages, data exchanges, and power source or PLC logic.

3) The design will provide methods and tools for the configuration and control of on-board equipment shutdown.
   a) KCM will determine the equipment to be turned off whenever the vehicle power is off.
   b) KCM will determine the equipment that will continue to operate after the vehicle is shut down, and the length of time and conditions for continued operation.
4) Power management should be configurable. Describe how and to what extent this is feasible. Discuss trade-offs and recommend which equipment power decisions should be handled mechanically, and therefore dealt with during installation.
5) The system should allow for different delay times for OBS components. The radio, WLAN, and DVRS “security camera” system may have longer delays than the rest of the components but not so long as to drain the batteries. *Describe how the system could manage different delay intervals.*

   Discuss how the system could be configured so that the DVRS “security camera” system connection will stay live as long as possible if the Transit Police are connected when the vehicle was shut down. (The scenario to be addressed is one where the Operator triggers an EA and then is forced to turn off the vehicle.)

5.3 Testing

Take Vehicle Out of Operation test cases
The test plan shall include, but not be limited to, test cases for each requirement statement and all supporting details in this use case.

6. Extension Points

BO3-Manage Historical Data

CC10-Log out Revenue Vehicle

RV1-Initiate Vehicle for Operation

RV2-Verify Vehicle Configuration

RV4-Update Vehicle Data

RV5-Monitor System Health

RV6-Manage Events

RV11-Manage AVM

RV12-Interface to DDU

RV14-Interface to FTP

RV15-Interface to DVRS

RV17-Interface to 700MHz Radio

7. Assumptions

All file transfers can be completed between the time that the WLAN link is established and the time the *Shut down OBS* step is performed. It is assumed the time it takes for the Operator to park the vehicle and turn it off will be added to the configurable setting for continued operation after the *Shut down vehicle* step***.***

Any vehicle can park at any base and connect to the WLAN to download and upload files. (It is common practice at KCM for a vehicle to be assigned to one base but to lay over at another base during midday. It is also common practice for vehicles to be loaned from one base to another.)

Current System Shutdown Methods

Some fleet types have a PLC (programmable logic control) unit set to allow 30 minutes of continued on-board system operation after the vehicle is turned off, with one exception. The current radio installation (Level 1) has the radio connected directly to battery power while the remainder of the on-board equipment is wired to the PLC. This is to enable the radio to continue to operate for 60 minutes after the vehicle is shut down. A direct connection to the radio also enables the CAD/AVL system to continue to receive poll responses from the vehicle.

The two different wiring systems used on KCM vehicles are described below.

Figure 2.B.4.1.3.RV3.b. Current System Shutdown Methods: Hard-Wired System

Hard-Wired System

Older vehicles were "hard-wired." This means a wire is run from the battery to a circuit breaker, to a switch, to a device, then back to the battery. The dotted lines run the length of the bus, 40 to 60 feet. Sometimes the wire crosses back and forth across the width of the vehicle several times.

This same circuit is required for every device used on the vehicle. Every light, gauge, horn, etc. adds more wire and weight to the vehicle. The amount of wire used on a vehicle is measured in miles and hundreds of pounds.

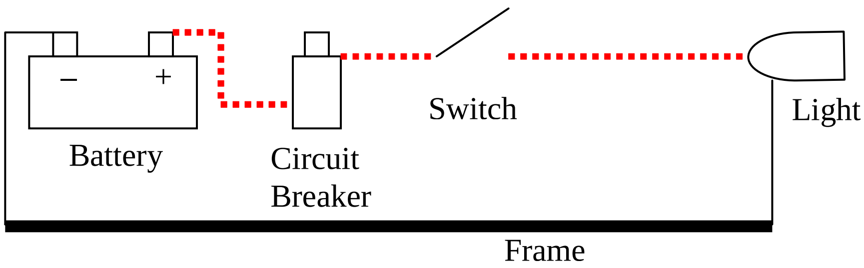


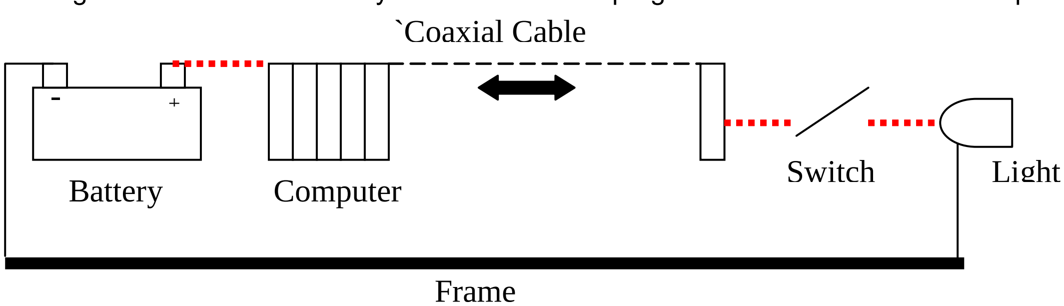
Figure 2.B.4.1.3.RV3.c. Current System Shutdown Method: PLC System

PLC System

A vehicle wired with a Programmable Logic Control (PLC) system uses computers to replace the circuit breaker and many of the switches. A single coaxial-type cable runs the length of the vehicle and controls all the devices. Multiple signals run up and down the coaxial cable. The computer decides which signal goes to which device and when.

The dotted wire now only runs between the battery and the computer or the computer and the device. All these wires are short because the coaxial cable is the only one that runs the length of the bus. Signals are carried both ways on the coaxial cable. This reduces the amount and weight of wire used.

The other advantage of a PLC system is the ease of making changes to the bus. A hard-wired system needs wires strung the length of the bus. The PLC system needs a new program downloaded into the computer.

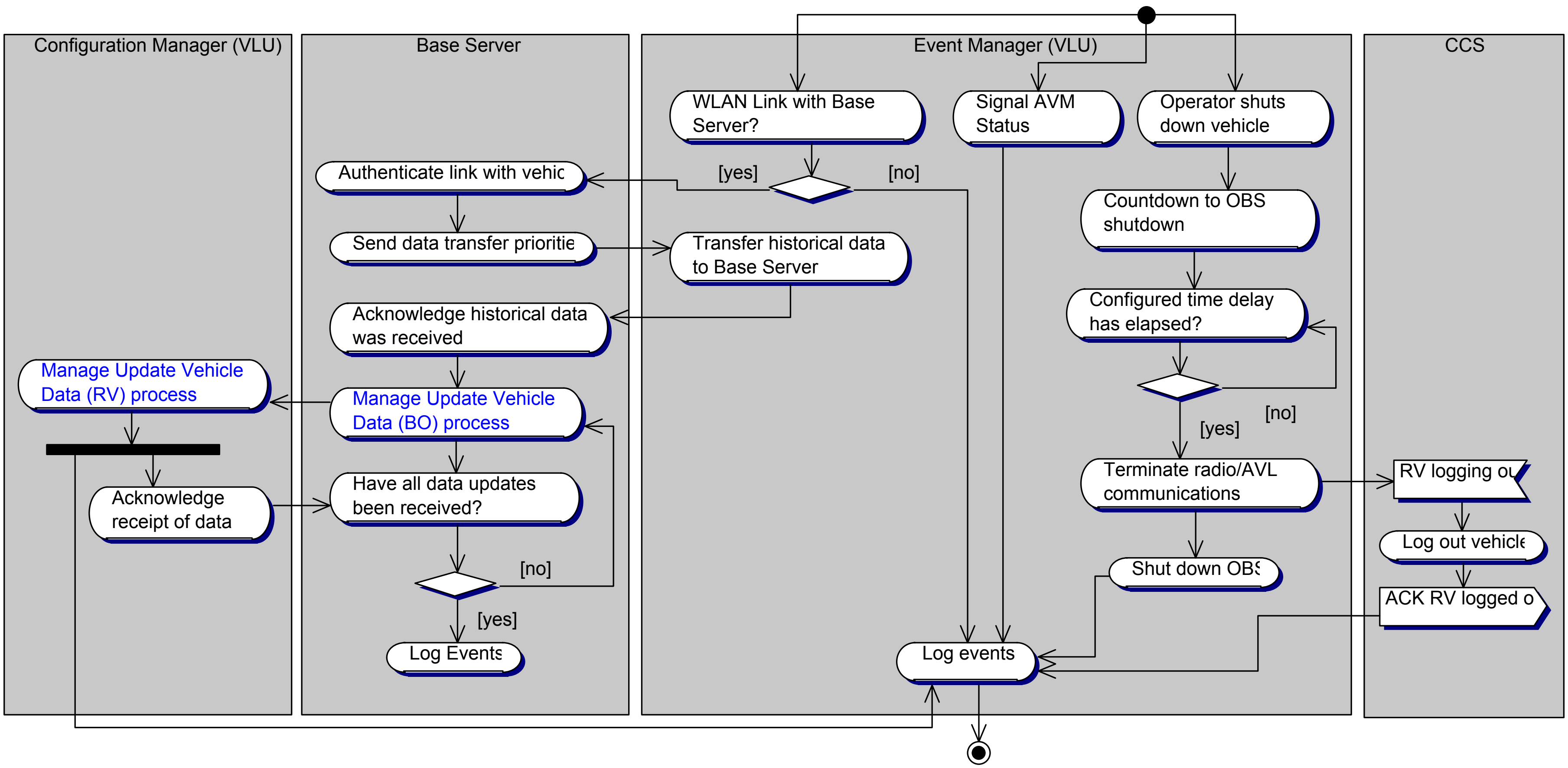


8. Issues

WLAN security both at the base and when in normal revenue operation.

There must be careful consideration given to how to manage the AVM event data associated with a red or yellow AVM Signal status to assure that it is provided to the proper maintenance staff responsible for repair.

Figure 2.B.4.1.3.RV3.d. Activity Diagram Take Vehicle Out of Operation



2.B.4.1.4. RV4-Update Vehicle Data

This use case package includes the following UML diagrams:

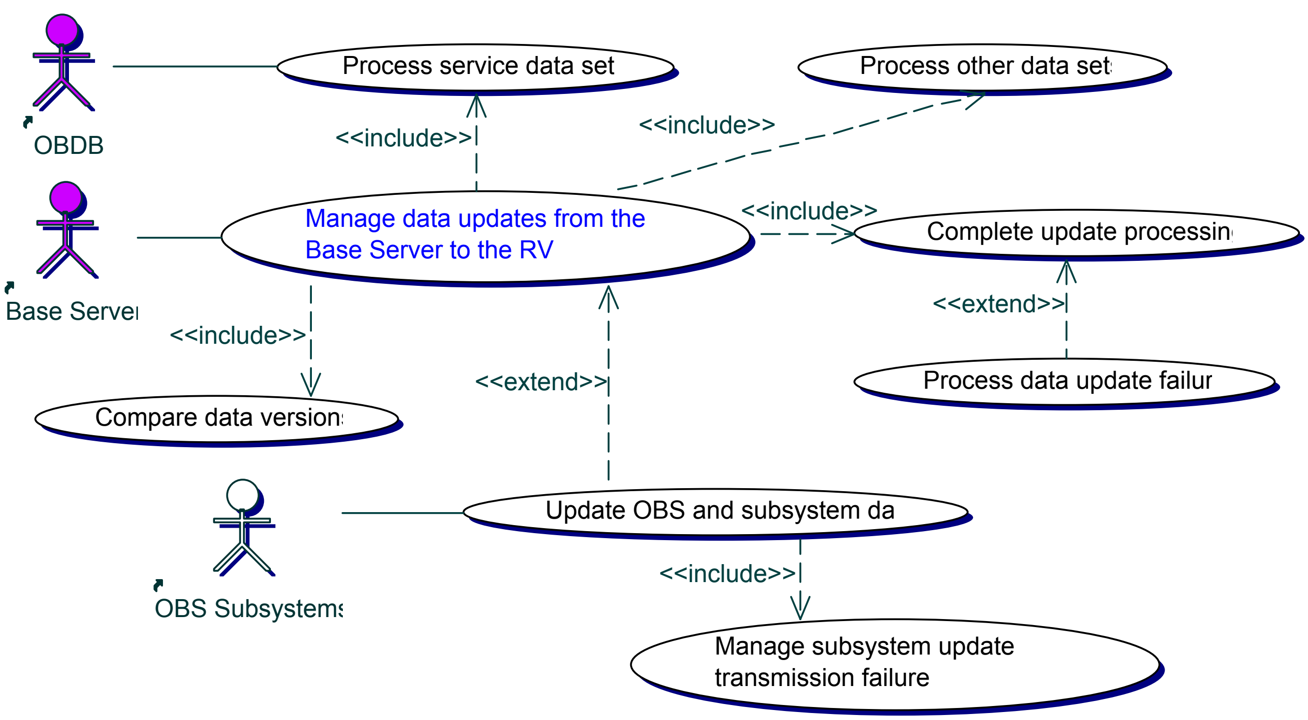
UseCase Diagrams

Figure ***2.B.4.1.4.RV4.a. RV4-Update Vehicle Data***

Activity Diagrams

Figure ***2.B.4.1.4.RV4.b. Update Vehicle Data (RV)***

Figure 2.B.4.1.4.RV4.a. UseCase Diagram RV4-Update Vehicle Data



5. RV4-Update Vehicle Data

1. Brief Description

All data updates to the vehicle by the Base Server will occur during the processing of the ***RV1-Take Vehicle out of Operation*** use case. The companion ***BO2-Update Vehicle Data*** use case details the Base Server's role in the data update process.

Both service data and other system- and hardware-specific data will reside on the vehicle. See the Special Requirements section below for a preliminary list of data residing on the vehicle. The service-related data sets will provide the vehicle with all data needed to enable full OBS functionality for scheduled operation. Each vehicle will be able to store and manage up to four different service data sets: "operating," "current," "next," and "previous."

- *Operating*: the service data set that is currently being used by the OBDB.
- *Current*: a replacement set of service data that is intended to immediately replace the operating service data set.
- *Next*: a replacement set of service data that will be triggered to replace the operating data at some future time.
- *Previous*: the most recently replaced operating service data set.

The "current" and "next" service data sets will be staged on the Base Server a few days before the service change to assure that the whole fleet gets the new set. Each new set will contain staged update or replacement data which will be activated by a date "trigger" provided by the OBS Administrator. The Event Manager will manage the activation trigger events. (See RV6-Manage Events.)

In addition to the staged service data updates, both the Base Server and the Revenue Vehicle maintain vehicle-specific information about the vehicle's current files and data set(s) in their respective On-Board Databases (OBDB). The Base Server also maintains a complete set of the files and/or data sets currently designated as resident on each and every vehicle. A comparison process is used to confirm that the Base Server's version information is consistent with the vehicle's. During the comparison process, the version of each file or data set on the vehicle will be compared with the version resident on the Base Server. Appropriate updates will be transmitted to the vehicle and recorded in both the vehicle's and Base Server's vehicle configuration databases.

2. Pre-conditions

The *Transfer data from vehicle to Base Server* step of use case ***RV3-Take Vehicle Out of Operation*** has been successfully performed.

The OBS Administrator, using utilities provided on the Base Server as part of the OBS Administrator's Toolkit, must prepare and stage on the Base Server all of the various data updates for transmission to the vehicle. Data preparation includes activities such as identifying update priority and criticality; validating data sets and types; checking for required activation date "triggers," if appropriate; and identifying each data set and transfer date. If no files are identified for transmission, a system indicator will be able to provide this message to the vehicle when WLAN contact is initiated.

3. Flow of Events

After the completion of the transfer of historical data from the Revenue Vehicle to the base, this use case will be initiated by the *Transfer data from vehicle to Base Server* step of use case ***RV3-Take Vehicle Out of Operation***.

3.1 Basic Flow

Manage data updates from the Base Server to the vehicle
The Base Server shall transmit staged data updates to the Revenue Vehicle on an as-needed basis.

1) The vehicle will initiate contact via the WLAN with the Base Server in order to receive needed data updates.
2) If no update data has been identified and staged for transfer to the vehicle by the OBS Administrator, the vehicle will log this information and proceed to the *Compare data versions* step below.

3) The Base Server will compare data version information between the vehicle and the Base Server for each identified and staged data set.
   a) If the vehicle's version is newer than the Base Server's version for any staged file or data set:
      i) The newer version will not be overwritten.
      ii) An alarm will be generated for the OBS Administrator.
   b) If the Base Server's version is newer, the Base Server will transmit its version to the vehicle.
   c) Consistent version information will cause notation that no update was required.
4) The vehicle will acknowledge receipt of each data update.
5) The Base Server and the vehicle will log and store in their respective OBVC databases each received update along with information such as (successful/unsuccessful) transfer status and acknowledgment, update type, priority, trigger (if any), and write date/timestamp or other identifier for version-control purposes.

Process service data sets
The OBS shall activate the transmitted service data sets.

1) An effective date, contained in a separately transmitted "trigger" event, will be used by the OBS to activate each identified set.
   a) Separate data sets may include stops, employee data, pattern event sequences, and schedule data.
   b) The trigger may be sent at the same time the replacement set is transmitted or sent at a later date.
   c) The ability to configure, send, and update this type of trigger will be a part of the OBS Administrator's Toolkit.
2) After all replacement service data sets and their triggers have been identified, stored, and logged, all triggers will be reviewed and activation of each appropriate service data set will occur.
   a) If a "current" or "next" set is identified for activation, the "operating" data set will become an archival set labeled "previous" and maintained until overwritten by subsequent activations.
   b) In the event that any activated "operating" data set is discovered to be in error, the "previous" data set will once again become the "operating" set. An OBS Administrator tool will provide a way to cause this action. A warning message will be transmitted to the Event Manager for transmission to the OBS Administrator when such a rollback occurs.

Compare data versions
The OBS shall compare version information for all other files and data sets resident on the vehicle with the same information on the Base Server.

1) If the vehicle's version is newer than the Base Server's version for any file or data set:
   a) The newer version will not be overwritten.
   b) An alarm will be generated for the OBS Systems Administrator.
2) If the Base Server's version is newer, the Base Server will transmit its version to the vehicle.
3) Consistent version information will cause notation that no update was required.
4) All updates, along with version information, will be recorded in both the vehicle's and the Base Server's respective OBVC databases.

Update OBS and subsystem data
The OBS shall update subsystems with transmitted data.

1) OBS will update the VLU with required data (e.g., firmware, configuration, parameter, system and/or application software) and log each update.
2) Each subsystem's update data will be identified as either an update or replacement set, and transmitted to that subsystem's control unit for processing, if appropriate. The subsystem will send acknowledgment of each successful update received, if possible.

Update other data sets
The system shall be updated with all other successfully transmitted data sets.

Complete update processing
The vehicle shall update databases and log update activities.

1) The vehicle will update its OBVC database with all successfully transmitted data-set information for version comparison use during the ***RV2-Verify Vehicle Configuration*** use-case processing.
2) Information about the processing of all successful data update activities will be sent to the Event Manager for logging.
3) If all updates have been successfully transferred and acknowledged, the Base Server and the vehicle will both log the completion of the file transmission process.
4) An alarm for each "critical" and "non-critical" subsystem-update data-transmission failure will be sent to the Base Server via the WLAN either immediately or, in the event of loss of WLAN connection, the next time successful contact is achieved.

3.2 Alternative Flows

3.2.1 Data Update Failure

Process data-update failure
The OBS shall manage an incomplete data-set update.

1) When the OBS identifies a data-set-update failure, or is notified of one by the Base Server, the Event Manager will process the event.
   a) The Event Manager will initiate the *<u>Process event</u>* step in use case ***RV6-Manage Events***, which will identify the data update and its configurable designation as service-"critical" or "non-critical."
   b) When a service-critical alarm(s) is generated, the OBS shall have the configurable ability to generate a message on the DDU indicating the nature of the failure to the Operator at vehicle startup.

   NOTE: In general, the Operator will not be notified regarding software problems that she cannot resolve. A message should only be displayed when a specific vehicle has a problem that will affect revenue service operations. At no time should every vehicle at a base send an alarm to all the Operators at startup.

3.2.2 Subsystem Update Transmission Failure

Manage subsystem update transmission failure
The OBS shall handle the situation where the vehicle is unsuccessful in transmitting update data to a subsystem.

1) The vehicle will send information to the Event Manager for the generation, logging, and transmission of an appropriate maintenance log event.
2) A service-critical event may be displayed on the DDU at vehicle startup during the ***RV1-Initiate Vehicle for Operation*** use case. (See NOTE above.)
3) When transmission failure is due to loss of connection to the WLAN, system will execute the *Loss of WLAN Connection* step in use case ***RV2-Verify Vehicle Configuration***.

4. Post-conditions

This use case, upon the successful completion of its processing, has updated both the Base Server and the Revenue Vehicle with consistent and complete configuration information needed for the next processing of the ***RV2-Verify Vehicle Configuration*** use case.

Unsuccessful data update information will be passed to the Event Manager for logging and the generation of appropriate alarms. Any failed update required for revenue operation will cause an "unsuccessful" flag to be set by the system and reviewed at the start of the ***RV1-Initiate Vehicle for Operation*** use-case processing.

Any service-critical alarm that indicates file transmission failure will be displayed to the next Operator who starts the vehicle during the ***RV1-Initiate Vehicle for Operation*** use case. The Operator will determine whether or not the alarm requires that the vehicle be taken out of revenue service.

5. Special Requirements

5.1 Technical Specifications

5.1.1 Vehicle Data

General vehicle data sets
Certain files and/or data sets shall reside on each vehicle, and be subject to the updates described in this Use Case.

Such files may have system-wide distribution while others will be either fleet- or vehicle-specific.

The following list of files is not necessarily complete: the determination of a complete set of file and data requirements for transmission from the Base Server to the vehicle will occur during system design by agreement between the Contractor and KCM.

1) OBS and devices' initialization files and/or configuration data. This will include settings for any or all on-board and subsystem software systems' variable parameters (vehicle- or fleet-specific; updated on an as-needed basis); both those provided as part of the OBS and those already resident on the vehicles which are included as part of the legacy subsystems.
2) OBS, subsystems' and devices' firmware and application updates and patches (vehicle/device-specific; updated as needed).
3) Standardized interior announcements and displays: additional non-stop-related messages for audio and video displays, e.g. public service announcements (global, updated as needed).
4) Fare Transaction Processor's (FTP) data (global)
   a) "Hot List" of lost and stolen ("blocked") cards (updated daily)
   b) Fare Tables (updated as needed)
   c) Revalue Events, e.g. for those revalues that have occurred in a card-not-present environment
5) Employee ID data for Operator login validation. Operations and Maintenance personnel identification numbers may be used for manual login validation if an automated or partially automated login is not required. A different validation strategy may be required (global; updated as needed) if validated login is used for vehicle startup or operation. See *Manage Login Process* step in use case ***RV1-Initiate Vehicle for Operation***.

Service-related vehicle data sets
Certain files and/or datasets of service-related information shall reside on each vehicle and be subject to the updates described in this use case.

1) A maximum of four full sets of service data will reside on the vehicle at any one time:
   a) The data set being used for operation, designated "operating."
   b) A replacement data set, designated "current."

c) A replacement data set, designated "next."

d) An archival data set, designated "previous."

2) Updates to data sets may be issued on a bi-weekly basis and will generally contain minor service modifications.

3) Full replacement of the entire service data set will occur at least three times per year and will include data for all KCM routes.

4) The OBS Administrator will have a utility to define a "trigger" that contains the effective date of the new service data.

a) This trigger will be sent to the vehicle along with each service data set and will be used to activate the data for operational use by the vehicle.

b) The OBS Administrator will be able to send a replacement trigger for any "current" or "next" service data set residing on the vehicle up until that set has been activated.

5) Service data sets will include the following information:

a) Service (route, block trip, schedule, and stop) data.

b) Geographic service data.

c) Planned event data in order of travel and/or time.

d) Destination sign codes and data (per fleet type) including, if necessary, a standardized translation matrix for all possible sign types.

e) Exterior stop announcements which mirror destination sign displays.

f) Interior stop announcements: data for audio and video displays that contain designated landmark and major stop information for announcement. Such announcements will occur on a per-stop basis for a particular route sequence for user-selected locations.

5.2 Performance

5.3 Testing

6. Extension Points

BO2-Update Vehicle Data

RV1-Initiate Vehicle for Operation

RV2-Verify Vehicle Configuration

RV3-Take Vehicle out of Operation

RV6-Manage Events

7. Assumptions

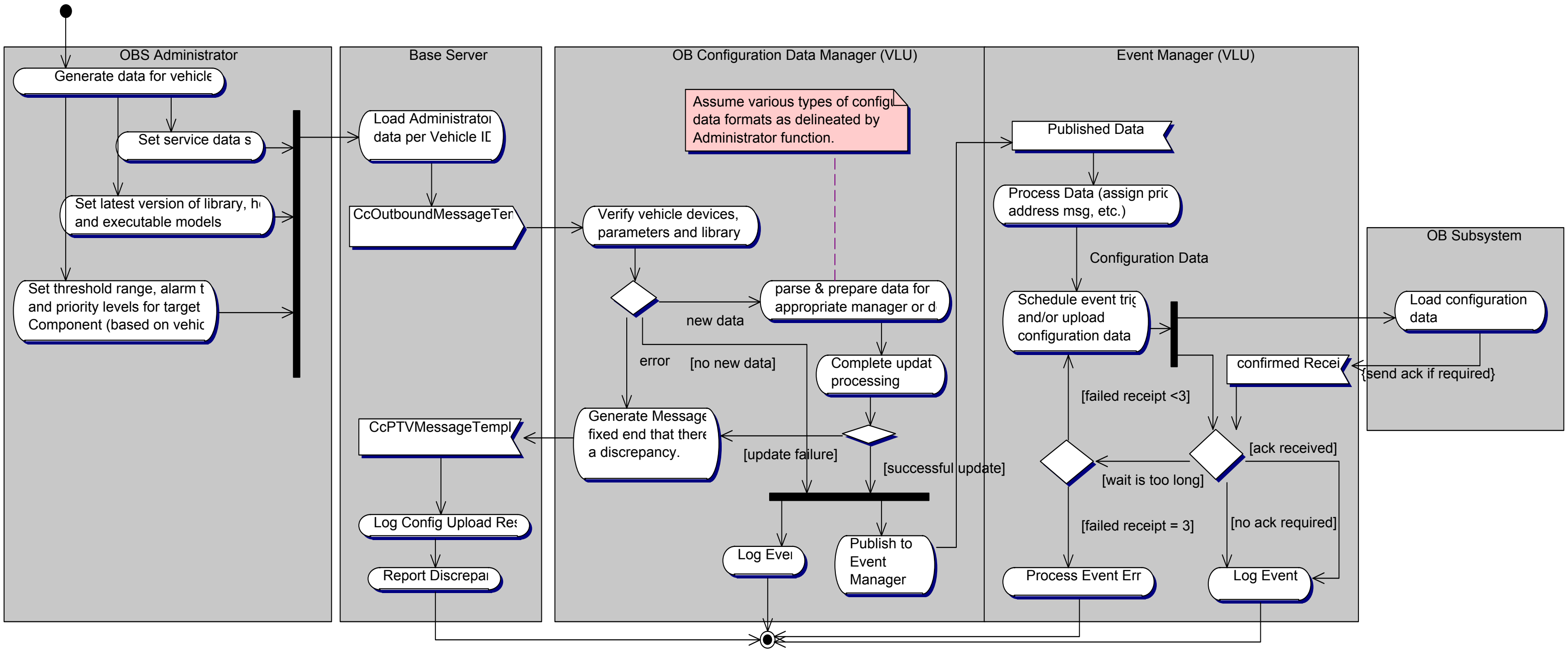
OBS implementation must include the installation and appropriate population of the On-Board Vehicle Configuration databases that reside on both the Revenue Vehicle and the Base Server. This information includes, but is not limited to, "operating," "current," "next," and "previous" lists and versions for all data sets listed above.

The next scheduled WLAN connection with the Base Server occurs during the processing of the ***RV1-Initiate Vehicle for Operation*** use case.

8. Issues

KCM's current configuration provides electrical power to the vehicle for approximately 30 minutes after the engine has been shut down. During the processing of the ***RV3-Take Vehicle out of Operation*** use case, the transfer of data from the vehicle to the Base Server may require the use of some of this time. Any remaining time will be available for the OBS to process this use case. It is currently unclear if this will be an adequate amount of time to complete this processing.

Figure 2.B.4.1.4.RV4.b. **Activity Diagram *Update Vehicle Data (RV)***



2.B.4.1.5. RV5-Monitor System Health

This use case package includes the following UML diagrams:

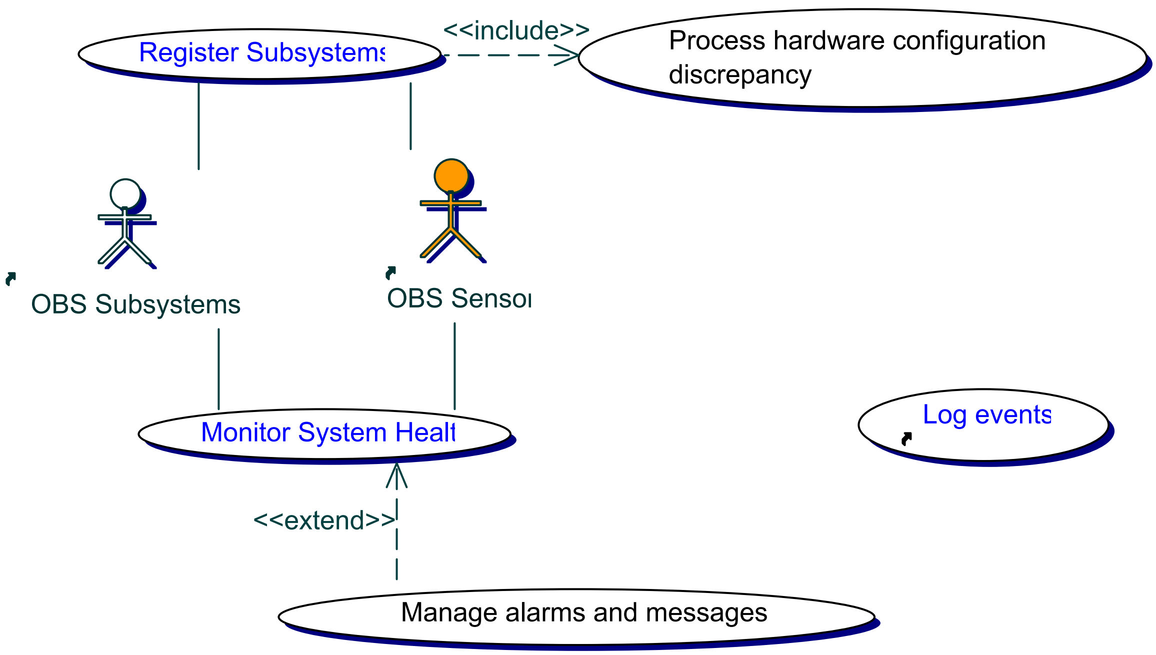
UseCase Diagrams

Figure ***2.B.2.4.1.5.RV5.a. RV5-Monitor System Health***

Activity Diagrams

Figure ***2.B.2.4.1.5.RV5.b. Monitor System Health***

Figure 2.B.4.RV5.a. UseCase Diagram RV5-Monitor System Health



6. RV5-Monitor System Health

1. Brief Description

This use case addresses the role of monitoring the health status at startup and during normal operations of all OBS Subsystems, the On-Board Automatic Vehicle Location (OB AVL) component, and all OBS sensors. This function must collect, log, and publish all health status events to the Event Manager (***RV6-Manage Events***) for processing. The thresholds and conditions for the parameters and reporting mechanisms must be configurable.

2. Pre-conditions

The vehicle and On-Board Systems have been shut down, successfully executing the *Shut down system* step in use case ***RV3- Take Vehicle out of Operation***.

3. Flow of Events

This is initiated at the same time as the *Start up system* step in use case ***RV1-Initiate Vehicle for Operation***.

3.1 Basic Flow

Register subsystems
The system shall automatically register all subsystems upon vehicle startup.

1) After the VLU boots up, each subsystem, the OB AVL component, and, where possible, associated sensors should be contacted and registered.
2) The OBS design shall provide the tools to change on-board subsystems over time and to reconfigure the reporting parameters.
3) The system shall have for a method to register "dumb" subsystems which are not equipped to provide health status in a request/response dialog.
    a) Each subsystem must also provide information regarding its ability to properly operate, i.e. its "health status." If a subsystem included in the vehicle configuration file is not detected, its health status shall be assumed to be "bad." In this case go to Alternative Flow *Hardware Configuration Discrepancy*.
    b) Registration shall include identifying the on-board network address and protocol, if applicable, for each subsystem.
4) System will log successful subsystem registration events and transmit the subsystem registration data and health status information to initiate the ***RV2-Verify Vehicle Configuration*** use case and to complete the ***RV1-Initiate Vehicle for Operation*** use case.
5) At a minimum, the system must accommodate the following subsystems and sensors, and the OB AVL component,
    a) Automatic Passenger Counter (APC): The APC shall consist of sensors located at each door and a processor that interprets the sensor data into counts. The APC system shall report a malfunction of any one of the parts of the system, including which part is malfunctioning, and, when possible, an error code to indicate the nature of the malfunction. (See use case ***RV9-Monitor Stop Point Activities***.)
        i) Lift sensor—this sensor will monitor the lift states: deployed, raised or, stowed.
        ii) Ramp sensor—this sensor will monitor the ramp states: deployed or stowed.
    b) Automatic Vehicle Monitoring (AVM): The system will manage and report on AVM and health status events by monitoring Engine Control Module (ECM) and I/O sensor outputs. (See use case ***RV11-Manage AVM***.)
    c) Driver Display Unit (DDU):
        i) This device will be provided by the RFCS (Regional Fare Coordination System) contractor and will be the primary interface between the Operator and the OBS. (See use case ***RV12-Interface to DDU***.)

ii) If the DDU fails, then there shall be some means for the Operator to be notified. An inoperable DDU shall not cause any other device to become inoperable with the possible exception of the FTP (this shall be determined by the Smart Card project manager).

d) Destination Sign: A variety of makes and models of destination signs are installed on the fleet. All of them have a separate processor for storing sign codes and managing the user interface with the signs. The OBS shall automate the process of changing the signs and updating the sign code file. All of the signs should be configured to send an error message to the VLU when there is a problem with the system. The manufacturer's error codes shall be included in the message for maintenance troubleshooting. (See use case ***RV13-Interface to Destination Signs***.)

e) Emergency Alarm (EA) Switch: This system has the highest priority: the switch's operation and the system's ability to process Emergency Alarms must be assured when the vehicle is in operation. (See use case ***RV15-Manage Events***.) Proposer should describe how the EA switch and interconnecting cables will be monitored for continuity, opens, and shorts, and what will happen when the EA circuit is disturbed.

f) Fare Transaction Processor (FTP): The FTP is the smart card reader and display device for passengers. If the FTP malfunctions, the Operator shall be immediately alerted. The policy for handling of fare transactions when the FTP is not functioning properly is an operations decision. (See use case ***RV14-Interface to FTP***.)

g) Interior Sign: The Interior Sign system shall be delivered with OBS subsystems. There will be a method for determining the health status of the equipment. Some vehicles will have one sign, while others, such as articulated coaches, will have two. In the case of multiple signs the health status monitor should be capable of reporting which sign is malfunctioning. (See use case ***RV10-Manage PA and Annunciator***.)

h) On-Board AVL: This will be a modular software component that resides on the VLU and interfaces to multiple sensors in order to determine vehicle location (and time). (See use case ***RV7-Determine Vehicle Location***.) The following sensors will be monitored:

i) GPS (Global Positioning System) Receiver: The GPS receiver will be a peripheral subsystem of the OB AVL (On-Board Automatic Vehicle Location) component. Health status problems can occur as a result of problems with the on-board receiver, the satellites, or path obstructions. The OB AVL component shall identify and report GPS reception problems. A malfunctioning receiver should trigger an error message and the system should also report conditions such as when fewer than four satellites are available, or when reception problems make it impossible to calculate an accurate location. Both health status and confidence factors shall be logged each time an event log entry is created. Note: All event log entries shall contain the location and time of the event.

ii) Gyroscope or compass: The gyroscope/compass may be a sensor for the OB AVL component. The OB AVL component shall identify and report gyroscope data problems. A malfunction should initiate an error message. A health status event shall be logged when a gyro malfunction is detected and, while the malfunction is present, the gyroscope signal shall not be used to calculate location.

iii) Odometer: The odometer shall be used as sensor for the OB AVL component. The OB AVL component shall identify and report odometer data problems. A malfunctioning odometer should cause an error message to be generated. An error message should also be generated when the distance measured by the odometer differs more than +/-2% from the distance between two GPS fixes when a Revenue Vehicle is traveling in a straight line. A health status event shall be logged and the navigation filter shall assess the odometer signal to determine if recalibration would resolve the issue. Odometer issues and recalibration by the OB AVL component shall be logged, and maintenance alarm event shall be generated when the calibration changes by more than 2%.

iv) Signpost Receiver (option): If the OB AVL design includes inputs from the KCM signpost system, then the signpost receiver health must be monitored.

i) Public Announcement (PA) system: The PA system includes the speakers, ambient noise detection, amplifier, and microphone. The health status monitor shall include a means for reporting on the health status of each PA subsystem, even each speaker if possible. (See use case ***RV10-Manage PA and Annunciator***.)

j) Level 2 only: The health status monitor will report problems with the mobile radio system.

   i) The mobile radio will be a new 700 MHz radio. The make and model will be determined by the Transit Radio System project. (See Subsection **3.B**, use case ***RV17-Interface to 700MHz radio***.)

   ii) If the new radio system vendor uses an operator handset hook-switch to indicate when the handset is hung up or not hung up, the health of the hook switch must also be checked. A hook switch stuck in the open position could cause problems with radio communications. The OBS requirements will be coordinated with the TRS contractor.

k) Security Camera: The security camera system is a self-contained, legacy subsystem with the ability to report health status issues. The system health monitor shall provide a means for logging health status reports generated by the security camera system. (See use case ***RV15-Interface to DVRS***.)

l) Transit Signal Priority (TSP): The health status monitoring of the legacy TSP Tag shall consist of logging error codes that the system is designed to generate. (See use case ***RV16-Interface to TSP Tag***.)

m) Vehicle Logic Unit (VLU): Health status software shall include error codes that apply to each specific subsystem, the OB AVL component, or other application that resides in the VLU Vehicle Operation software.

n) Vehicle Area Network (VAN): The VAN shall be tested to ensure that all connections are working and can provide the required communications between subsystems. See Subsection **2.A.1.6.4, Vehicle Area Network (VAN)**.

o) Wireless Local Area Network (WLAN): See Subsection **2.A.1.6.3, Wireless Local Area Network (WLAN)**.

Monitor system health

The system shall continuously monitor overall system and subsystem health status when in operation.

1) Monitor system health.

   a) The VLU shall include a “watch dog timer” to detect and correct VLU hang-ups.

   b) Manage power.

      i) System will monitor input power to the OBS and record events that fall above or below threshold values.

      ii) System will monitor and record DC input voltage to the radio. The recording frequency and data format will be addressed in design and approved by the KCM Project Manager.

      iii) At a minimum, voltage that exceeds configurable minimum or maximum thresholds should be recorded along with the date and time of the event. The duration and voltage measured for all instances of system functioning outside of the thresholds should be logged in a maintenance event log.

2) Monitor subsystem and sensor health.

   a) Each time an action is performed by a subsystem, an acknowledgment should be sent to the Event Manager, if possible, when the action is successfully completed (for example, “The destination sign was changed and is displaying the correct sign code”).

   b) “Smart” subsystems/sensors shall report health status at startup and at regular, preferably configurable, intervals.

c) If the subsystem or sensor is a "dumb" one, such as the PA system, then there should be some method to determine subsystem/sensor health.

3) The system shall manage and report subsystem/sensor failure with a minimum of disruption to the remaining OBS functionality.

Manage alarms and messages
The system shall automatically generate health status event alarms and notifications when subsystem or sensor failures occur.

1) The type of alarms and messages shall be configurable.

2) Depending on the severity of the failure, the system must respond with the selected notification or alarm.

   a) Response mechanism should be configurable by device and type of health event.

Health status alarms and messages are addressed more fully in the ***RV15-Manage Events*** use case.

Log events
The system shall maintain a complete record of system health events in a maintenance log.

1) The system health event log should include the following:

   a) Registration.

   b) Health Status at startup.

   c) All subsystem malfunctions and error codes.

2) The content and frequency of event logging shall be configurable by the OBS Administrator. (For example, an APC sensor failure could potentially generate an error code every time the door opens. The OBS Administrator should be able to impose some constraints on how, and how often, such errors should be logged.)

3.2 Alternative Flows

3.2.1 Hardware Configuration Discrepancy

Process Hardware Configuration Discrepancy
The system shall signal any discrepancy identified while performing the Register Subsystem process.

(Also see the ***RV2-Verify Vehicle Configuration*** use case: a discrepancy could be identified during the processing of that use case.)

1) When a subsystem included in the configuration file (e.g. the destination sign) is not detected, it should be reported to the Event Manager. (See use case ***RV15-Manage Events***.)

4. Post-conditions

The Operator is fully informed on the health status of all mission-critical subsystems and sensors.

A maintenance log of all health status events is downloaded each time a vehicle returns to a base and the log contains the information necessary to identify and troubleshoot the problem.

The OBS Administrator is able to adjust thresholds and parameters to minimize false-positive error messages.

5. Special Requirements

5.1 Performance

5.2 Technical Specifications

Register subsystem
The system must identify and report a subsystem included in the vehicle configuration and *not* detected in the Register Subsystem process.

Describe how the system will do this.

Health Status Data
All health status event codes shall be included in a database which can be queried by Maintenance staff to organize health status events by subsystem, error message, and/or event priority along with providing a text description of the event.

Monitor subsystem health
The OBS shall monitor the health of all OBS subsystems and sensors.

1) *Discuss how the health of the following legacy subsystems and equipment will be monitored.*
   a) Destination sign system.
   b) EA (Emergency Alarm) switch.
   c) ECM (Engine Control Module), depending on AVM design.
   d) Odometer, if applicable.
   e) PA system.
   f) Digital Video Recording System (DVRS).
   g) TSP (Transit Signal Priority) Tag.
2) *Discuss how the health of the following planned subsystems to be provided by others will be monitored.*
   a) DDU (Driver Display Unit).
   b) FTP (Fare Transaction Processor).
   c) Wireless Local Area Network (WLAN).
   d) 700 MHz radio.
3) The following OBS-provided subsystems must be monitored. *Describe how the health of each will be monitored.*
   a) Automatic Passenger Counter (APC) and sensors.
   b) I/O sensors.
   c) GPS receiver and antenna.
   d) Gyroscope.
   e) Compass.
   f) Interior sign.
   g) Odometer, if applicable.
   h) Vehicle Logic Unit (VLU).
      - *Describe and discuss the configuration, advantages, and disadvantages of the proposed operating system(s).*
      - *Describe scenarios that might cause the VLU to hang up and the processes for getting the system back into normal operation.*
      - *What problems have been experienced with previous implementations and how were they addressed?*
        - *Is a core dump process included? If so, how is it managed? Is it configurable?*
        - *If so, describe how and when this would be accomplished.*

- o *If a file is created, how would it be accessed and analyzed?*

i) WLAN (Wireless Local Area Network) devices.

4) Certain subsystems will be “smart;” i.e. capable of signaling health status to the System Health Monitor.
   - *Based on the proposed design, list which subsystems would be “smart.”*
   - *Describe how the health of each “smart” subsystem would be monitored.*
5) If the subsystem is “dumb,” such as the PA system, discuss whether/how health status can be monitored.
   - *Based on the proposed design, list which subsystems would be “dumb” or incapable of signaling health status.*
   - *Describe how/if the health of each “dumb” subsystem would be monitored.*
6) The system health monitor must be modifiable in order to accommodate the replacement of a subsystem with a new, possible "smart" version, or the addition of a new subsystem.

Alarm and message handling

The OBS Administrator shall have the ability to configure parameters or thresholds to better manage alarms.

- *Describe the type of parameters/thresholds that the system would provide.*
- *Describe how the system would handle a failure in the Event Manager.*

5.3 Testing

Error condition testing

The test plan for monitoring system health shall address the detection, handling, and reporting of all known error conditions for each identified subsystem individually and in combinations.

The health status test plan will be approved by the KCM Project Manager in design. Contractor will provide standard test tools for failure/completion of health status check.

6. Extension Points

RV1-Initiate Vehicle for Operation

RV2-Verify Vehicle Configuration

RV3-Take Vehicle out of Operation

RV6-Manage Events

RV7-Determine Vehicle Location

RV9-Monitor Stop Point Activities

RV10-Manage PA and Annunciator

RV11-Manage AVM

RV12-Interface to DDU

RV13-Interface to Destination Signs

RV14-Interface to FTP

RV15-Interface to DVRS

RV16-Interface to TSP Tag

RV17-Interface to 700MHz Radio

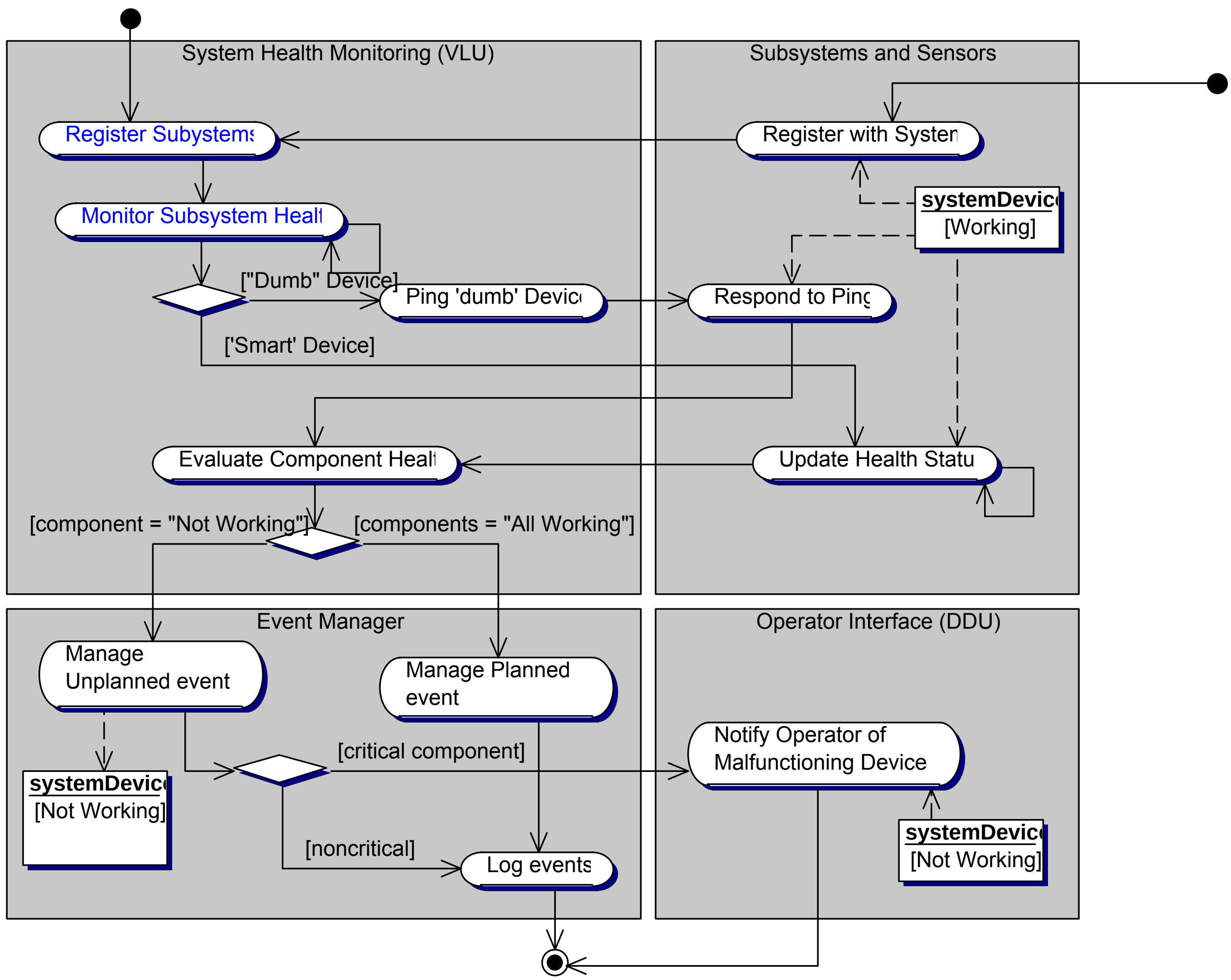
7. Assumptions

The health status of all subsystems and sensors can be monitored and reported on.

8. Issues

Discuss how OBS will provide the capability to manage health status events in such a way as to facilitate maintenance without generating too much data for it to be useful. The system design must consider how the health status event log can be filtered and sorted in real time to optimize its use.

Figure 2.B.4.1.5.RV5.b. **Activity Diagram *Monitor System Health***



2.B.4.1.6. RV6-Manage Events

This use case package includes the following UML diagrams:

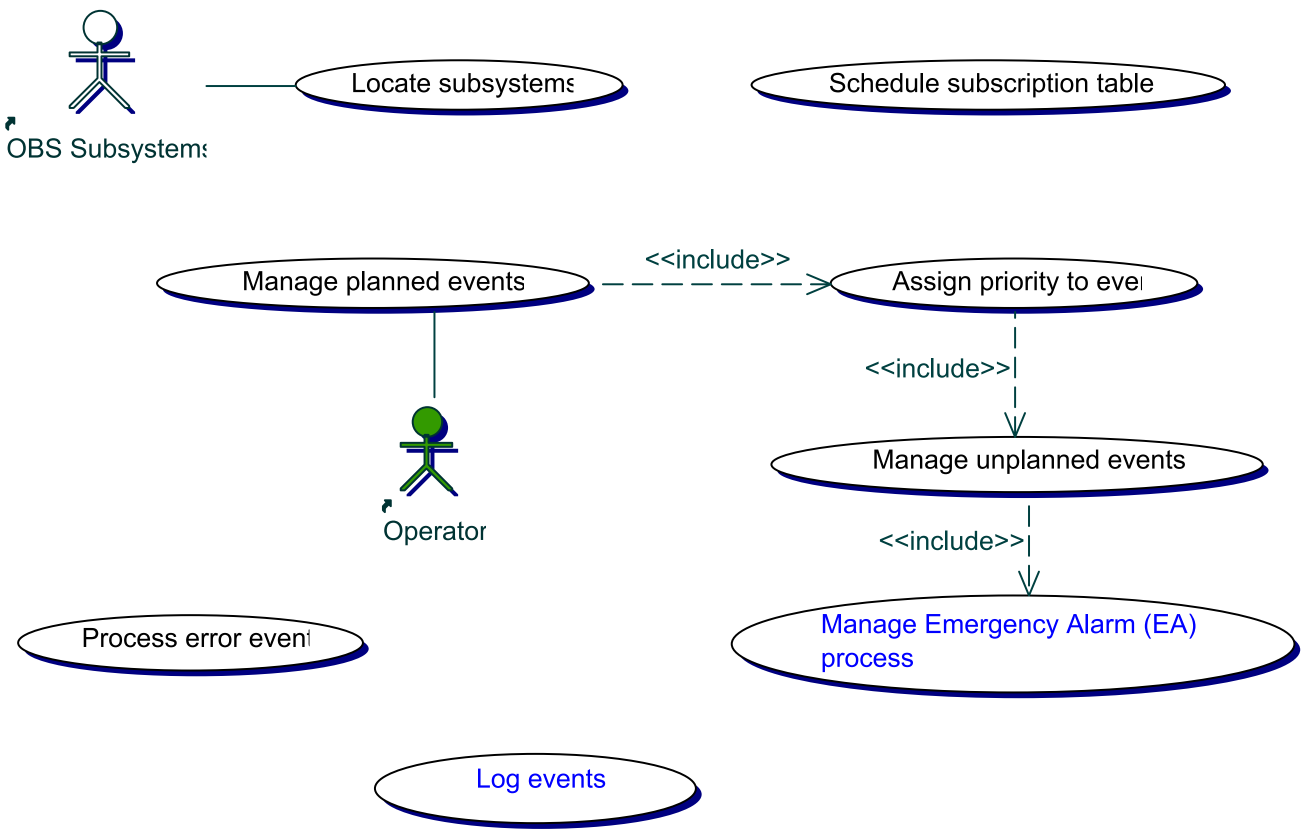
UseCase Diagrams

Figure ***2.B.4.1.6.RV6.a. RV6-Manage Events***

Activity Diagrams

Figure ***2.B.4.1.6.RV6.b. Manage Events***

Figure 2.B.4.1.6.RV6.a. UseCase Diagram RV6-Manage Events



7. RV6-Manage Events

1. Brief Description

The Event Manager is at the core of the VLU functional requirements. This use case is intended to describe the essential logic capacity for the system to be able to deal with multiple applications and dependent systems in a dynamic environment where both planned and unplanned events occur.

An *event* is the term adopted for this RFP to describe any of the transactions that must be managed and logged. Events include all planned and unplanned instances where the OBS processes information, e.g. raw data is exchanged among subsystems on board the vehicle, or between the vehicle and Base Server or Communications Center.

A *planned event* is an instance that is expected and that should be acted upon in a prescribed way. This includes such activities as Operator login, initiating a radio call, stopping at a scheduled stop, arriving at a scheduled timepoint, initiating a destination sign change, etc. The Event Manager has been modeled to address the functional requirements for scheduling, queuing, and signaling subsystem activities.

Unplanned events are, by definition, not expected to occur: off-route operation, mechanical or subsystem alarms, an Emergency Alarm, stopping at an unscheduled stop, etc.

For a more complete list of planned and unplanned events, see the Appendix **G, Event Log Matrix**.

Definitions of terms used in this use case:

- *Publish* event: Provides access to information that is available to other subsystems/classes. The dialog is defined by a Publish-Subscribe Pattern, e.g. location (and time) will be published to the network for retrieval by others.
- *Push* Event: This is a spontaneous message (or a response to a request) that is sent to one or more recipients, for example, an alarm. “Push” signals or is directed to specific recipient(s) and may require an acknowledgment or response message/signal.
- *Store* (information): This event stores information for retrieval by other subsystems and software modules. For example, “Operator login information.”
- *Subscribe*: Provides the ability for a subsystem or component to identify data elements that should be published for their use. Subscription table is used to describe the dynamic data requirements for a specific on-board configuration. In other words, who needs to know what and when do they need to know it?
- *Manage*: Any process or method that is needed by a subsystem. They may involve the processes listed below:
    - Manage Trigger Events: Schedules and initiates events that are based on internal or external state changes.
    - Manage Reporting: Creates, prioritizes, and publishes/pushes of messages to the Revenue Vehicle subsystems and OB AVL component interfaces.
    - Manage Configuration Update: Uploads, validates and integrates information from external subsystems (in particular messages received from the Base Server).

2. Pre-conditions

The Vehicle Logic Unit (VLU) and Vehicle Area Network (VAN) are functioning properly.

3. Flow of Events

This use case is triggered when the *Start up system* step in the ***RV1-Initiate Vehicle for Operation*** use case has been successfully executed.

3.1 Basic Flow

Locate subsystems
The Event Manager shall maintain current address and data requirements for each installed subsystem.

1) The Event Manager should apply the information provided by execution of use case ***RV2-Verify Vehicle Configuration*** by adjusting for a variety of configurations. (For example, the addition of an APC unit should alter the data provided to the TSP system—see ***RV16-Interface to TSP Tag***.)
2) The Event Manager should therefore manage the flow of messages on the vehicle area network. (See Subsection **2.A.1.6.4. Vehicle Area Network**.)

Schedule subscription tables
The system shall have the ability to automatically reconfigure the flow of data on the network based on the configuration of subsystems installed.

1) Every VLU should be capable of adapting the flow of data and event management with the addition or removal of optional subsystems such as an APC or Security Camera.
2) Publish Event Data: Many subsystems will rely on data from other subsystems. For example, if a vehicle has an APC installed, then passenger load will be provided to the TSP each time it is updated. The Event Manager must "know":
   a) What data is available with the current configuration.
   b) What information is needed where.
   c) The format in which it is needed.
   d) The response time requirements.
3) Subscribe: The system shall also allow a subsystem to subscribe to event data.
4) Push Event Data: When the system sends information to a specific subsystem(s), the subsystem(s) will return an acknowledgment that the information (e.g. radio activities, EA) was received.

Assign priority to event
The Event Manager shall organize events based on priority and the requirements for the functional subsystems and their dependencies.

1) The Event Manager must be able to prioritize the handling of multiple events. (For example, if an Emergency Alarm switch is activated, this should trigger a number of different things depending on what's available: in Level 2, an EA message should be sent to the CCS via the 700 MHz Radio, and the VLU must continue to send the message until an EA Acknowledgment is received from the CCS; then, if there is a security microphone, it should be turned on, etc.)
2) The VLU must have sufficient capacity and processing power to be able to suspend and queue an *important and not-time-critical* activity in order to handle an *important and time-critical* event instantaneously.
3) Priority will be the most fundamental basis for how events are managed.
4) The priority assigned to an event should be reconfigurable.
5) Preliminary event priorities are provided below.
   a) A1, *Important and Time-Critical*: A1 events must be handled instantaneously and may be preemptive. Examples may include:
      i) Emergency Alarm and related functions (Security Camera, Security Microphone, and Flashing Marker Lights).
      ii) Poll message processing.
      iii) Poll response processing: Real-time radio events such as poll message and poll response (encoding and decoding, error checking and correction) must have the highest priority, even above EA.
      iv) Time.

v) Location.

vi) Radio voice communication to/from fixed end.

b) A2, *Important and Not-Time-Critical*: A2 events must be handled promptly, but they are lower in priority than A1 or B1 events. If an A1 or B1 event occurs, then the system should be able to suspend processing and queue A2 event activities until after A1 and B1 events are processed. Examples may include:

i) On-route verification.

ii) Passenger load update.

iii) Stop point record.

iv) Annunciator/Interior sign trigger for next stop.

v) Alarm messages (System Health, AVM, etc.).

c) B1, *Not Important but Time-Critical*: B1 events should be handled within the required time unless an A1 event interrupts or precludes the system from processing the event within the required timeframe. B1 events may include:

i) Door sensor values.

ii) Enter stop point.

iii) Leave stop point.

iv) TSP trigger.

d) B2, *Not Important and Not-Time-Critical* events are lower in priority than A1, B1, or A2 events. They may be interrupted or terminated by a requirement to process a higher-priority event. B2 events may include:

i) Public Service Announcement (PSA).

Manage planned events
The VLU shall receive, prioritize, and process planned events.

1) VLU will receive a planned event trigger. The event trigger may be based on time or location (for a scheduled event), a state change (such as “door not closed”), or the request in a request-response pair.

2) VLU will determine the event priority.

3) VLU will processe the event. Types of planned events to be managed include:

a) Scheduled: The ***RV8-Monitor Route and Schedule Adherence*** use case determines where a Revenue Vehicle is along its selected route and identifies planned event triggers. (A common sequence of triggers might be: 1) change destination sign, 2) update display on interior sign, 3) initiate announcement by the annunciator, 4) enter stop point zone, 5) exit stop point zone, etc.)

b) Triggered by another event: For example, the APC system is initiated when the door status changes from “all doors closed” to “door(s) open.” When the door status is returned to “all doors closed,” then the Event Manager should update the TSP data with the current passenger load.

c) Request-Response: Many planned events (for example, polling) are of the request-response type, which requires that the Event Manager be able to identify the type of request and process it correctly. Three general request-response types are described below.

i) Match response to request (and requestor) and push the Event to the recipient.

ii) Send response to the requested subsystem and push the Event to the recipient, e.g. acknowledgment required.

iii) Look up subscribers and push the event to subscribers.

4) The system shall provide a means for handling planned events that are aborted by an unplanned event. Possible examples of this situation include:
    a) Emergency Alarm is initiated while an incoming radio call is underway.
    b) The vehicle is driven out of range before use case ***RV1-Initiate Vehicle for Operation*** is completed.

Manage unplanned events

The Event Manager shall manage unplanned event activities without impairing system availability and functionality.

1) VLU will receive an unplanned event. An unplanned event is one that is, by definition, not scheduled and not a part of the planned activities.
2) VLU will determine the event priority.
3) The design will manage any unplanned event including:
    a) Known: changes in state, errors, or messages that were anticipated by the system design.
    b) Unknown: conditions that were not anticipated by the design.
4) VLU processes the unplanned event according to its type:
    a) AVM alarm event type. (See use case ***RV11-Manage AVM***.)
        i) VLU immediately processes the alarm according to event priority.
        ii) VLU assigns download priority so that the event log data will be properly routed for follow-up or repair. (For example, if the unplanned event was triggered by low oil pressure, then Vehicle Maintenance should receive a report of the problem shortly after the vehicle returns to the base and downloads the log file.)
    b) Health Status Alarm Event: Subsystem/ Equipment Failure. (See use case ***RV8-Monitor System Health***).
        i) The subsystem/equipment and error code information, if available, will be logged and pushed to Maintenance for follow-up when the vehicle returns from service.
        ii) The Event Manager will process the event in accordance with the event designation as mission-critical or non-critical. The final list of subsystems/equipment events and the categorization as mission-critical or non-critical must be configurable.
            (1) The Operator will be notified in the event of a critical subsystem/equipment failure.
            (2) Method of notification must be approved by the KCM Project Manager.
                (a) A preliminary list of critical subsystems/equipment follows:
                    - AVM (to be determined by Vehicle Maintenance)
                      - Fire Suppression System
                      - Low Fuel indicator
                    - DDU
                    - Destination Sign
                    - Emergency Alarm (EA) switch
                    - Fare Transaction Processor (FTP)
                    - Interior Sign
                    - OB AVL – e.g. sensor failure or degraded
                    - Outside Announcements

- Public Address (PA) System
- Radio
- Security Camera
- WLAN

(3) In the case of a non-critical subsystem/equipment failure, the Operator need not be notified. A list of non-critical subsystems/equipment would include but not be limited to:

- APC
- AVM I/O Sensors

Manage simultaneous events
The OBS shall prioritize and manage simultaneous events.

1) When there is a subsystem failure, the system will have a process for managing the downstream impacts, e.g. if the OB AVL component becomes unreliable, the OBS must update affected system settings such as poll messages, APC, FTP, and the annunciator.
2) The OBS will have the ability to queue events for subsequent processing.
3) Queued events shall be handled as time-sensitive, e.g. the annunciator should not trigger a queued announcement if another announcement trigger has since passed.

Process error events
There shall be configurable parameters for how errors will be processed.

1) When an error occurs in the processing of an event type, there shall be a logical method for handling and reporting the error.
2) The system shall provide a process to retry specified event types for a configurable number of times from 0 to a maximum number approved by the KCM Project Manager.
3) A retry process failure should initiate activities to ensure that the problem does not go unnoticed.
4) The error will be logged and the problem reported upon return to the base.

Log events
The system shall provide a chronological record of all events and activities that have occurred since the last time the data was downloaded successfully (that is, since the last time the *Transfer data from vehicle to the Base Server* step of use case ***RV3-Take Vehicle out of Operation*** was completed).

1) The system will continue to log events—including shut down of all integrated subsystems and powering-off of the VLU—until the system is automatically shut down.
2) A configurable list of desired Event Log Data Fields and possible Events is provided in Appendix **G, Event Log Matrix**. These lists are preliminary and should be finalized in design.
3) In addition to the records identified above as standard fields, there should be one or more records for each logged event with data to describe the specific information related to the event, including error codes for equipment malfunctions, passenger ons/offs for each door in a stop point zone, etc.
4) The system shall provide multiple event logs and a procedure for continuing to write to an event log even as one is being downloaded.

3.2 Alternative Flows

Manage Emergency Alarm (EA) process
The event manager shall handle EA processing as the highest priority in order to provide the highest level of security for passengers and Operators.

1) The OBS will manage EA processing as it relates to OBS Subsystems.
2) An EA is activated when an Operator activates the EA switch located on the floor of the driver compartment.
3) Level 1 and Level 2: Activation of an EA initiates the following:
   a) The radio management system (MDU in Level 1 and VLU in Level 2) will immediately send an EA message first on a voice channel and then on a data channel, and then look for an EA ACK (acknowledgment) response. Note: In Level 1 the OBS will not monitor MDU—Radio/AVL messages and in Level 2 the VLU will be responsible for managing the messages to the CCS.
      i) If an EA ACK is not received, the procedure repeats until an EA ACK is received, or until the voice/data cycle has repeated 20 times.
      ii) After 20 unsuccessful attempts to transmit the EA message, the Event Manager shall process a "critical" event.
      iii) The specific protocols and message sequences will be determined during the design phase.
   b) Vehicle running lights will commence flashing when the EA is activated and will continue flashing until the EA is cleared.
      i) There will be no in-coach indicator that the running lights are in EA mode separate from the EA indicator on the DDU. See Appendix **H, DDU Functionality Matrix**.
      ii) The only way to initiate the flashing running lights is via the EA.
4) The Operator can clear the EA by sending a follow-up Priority Request to Talk or Request to Talk.
   a) A PRTT that follows an EA from a vehicle is identified as an EA follow-up and signals that the Operator is available to safely discuss the EA situation with a Coordinator.
   b) As a back-up, the Coordinator has the option to remotely clear the EA if he perceives that it was a false alarm.
   c) When the EA is cleared, the vehicle running lights will cease flashing and the radio will stop transmitting security microphone audio.
5) Level 2 only: When the vehicle receives the EA ACK it will transmit audio from the security microphone to the CCS.
   a) The system will continue to:
      i) send continuous (or nearly continuous) security microphone audio to the CCS.
      ii) monitor the CCS for command or contention-allowed messages.
      iii) transmit periodic location updates to the CCS.
   b) The only way to initiate the security microphone will be via the EA.
   c) When the EA is cleared, security microphone audio transmission will cease.

4. Post-conditions

The event was processed properly by the VLU.

The exchanges of data/messages between subsystems enable the system to perform all required activities.

Events were accurately logged.

5. Special Requirements

5.1 Performance

5.1.1 Reliability

Reliability
The system design must provide a reliable, stable platform, with quantification to be agreed upon between KCM and successful Proposer during system design.

Describe how the design will accommodate:

- *Simultaneous events of different priorities*
- *Unknown event errors*
- *Repetitive errors*

Provide MTBF (mean time between failures) calculations for implemented systems. Include the basis for the calculations such as the sample size and measurement assumptions.

- *Describe a problem that your firm has experienced with reliability. Discuss how the problem was identified and what modifications were made to resolve it.*

5.1.2 Response Time

Response Time
Response times must be consistent with the criticality of various events.

Provide estimated response times for different event types.

Describe if, when, and how the system would perform a “core dump” or other process, and the estimated time to recover.

5.2 Technical Specifications

5.2.1 Event Log Data

Event Log Data
Describe the proposed system’s capabilities for logging events.

Discuss the extent to which the proposed system can provide data identified in the event log matrix.

Describe how the system design handles and manages repetitive errors and logging.

Describe when and where the logs will be cleared from the VLU.

5.2.2 Event Processing

Event Processing
Describe system controls over the impact of event errors and retries so that the system doesn’t get consumed with the same event happening over and over again.

Describe the system tools, configurable and embedded, to maintain/limit error logs.

5.2.3 Unknown/Unplanned Events

Unknown/Unplanned Events
The Event Manager must be capable of handling unplanned events besides those that were identified and accounted for in system design.

Describe how the system is expected to manage unknown, unplanned events.

Discuss how unknown, unplanned events or event combinations will be logged for post-processing and maintenance follow-up.

Unknown/unplanned events, once experienced, may be re-classified as “known/unplanned” events, and added to the event processing logic. *Describe the recommended process for making these modifications after the system has been accepted.*

5.2.4 Level 2: EA Event Processing

EA Activation
When the EA switch is activated, the radio system will send an EA message to the Communications Center and vehicle running lights will commence flashing.

1) The EA message shall be transmitted via redundant paths to ensure that the EA is sent and received. (Note: in Level 1, The MDU sends an EA first on a voice channel, then on a data channel and, if it doesn’t receive an EA ACK on the data channel, the radio is switched back to its voice channel and the procedure is repeated until an EA ACK is received or until the process has been repeated five times.
   a) The new system will probably use a similar approach to the current one. The EA ACK is one of the most important messages in KCM Operations, and the EA process must provide for an extremely reliable (99.999%) and redundant (dual channel/path) design. (NOTE: The EA is essentially at 100% reliability now because if it fails for any reason, the system sends another EA.)
   b) The new system will include activation and deactivation of security microphone audio while an EA is in progress.

EA Acknowledgment
An Emergency Alarm Acknowledgment (EA ACK) message provides verification to the vehicle radio that the EA message was received in the CCS and that a CSR (Coordinator Service Record) was opened and assigned to a Coordinator.

EA “Fast Poll” Messages
The OBS design must be coordinated with the new 700MHz radio system design to ensure that EA “fast poll” messages are reliable, simple and fast.

1) The design will be coordinated with the Transit Radio System contractor to ensure that the vehicle radio will:
   a) Interrupt audio transmission long enough to “sniff” for messages from the CCS.
   b) Provide location-update interrupts while transmitting audio from the security microphone.

Discuss possible solutions to providing interrupts or other methods for exchanging data and transmitting audio on a half-duplex system.

Clearing EA Status
When a follow-up PRTT or RTT is sent by the Operator, then the vehicle systems shall return to normal operations.

1) Running lights will cease flashing.
   a) *Discuss the proposed solution for controlling the running lights in Level 1 when the DDU is managing the legacy 450MHz radio system.*
   b) *Describe the proposed interface to the lights and discuss the differences, if any, in Level 1 and Level 2.*
2) Security microphone transmissions will cease.
3) The radio will be sent back to its data channel.

5.3 Testing

Test plan

The test plan shall include, but not be limited to, test cases for each requirement statement and all supporting details in this use case.

6. Extension Points

RV1-Initiate Vehicle for Operation

RV2-Verify Vehicle Configuration

RV11-Manage AVM

RV16-Interface to TSP Tag

RV3-Take Vehicle out of Operation

RV8-Monitor System Health

RV7-Determine Vehicle Location

RV8-Monitor Route and Schedule Adherence

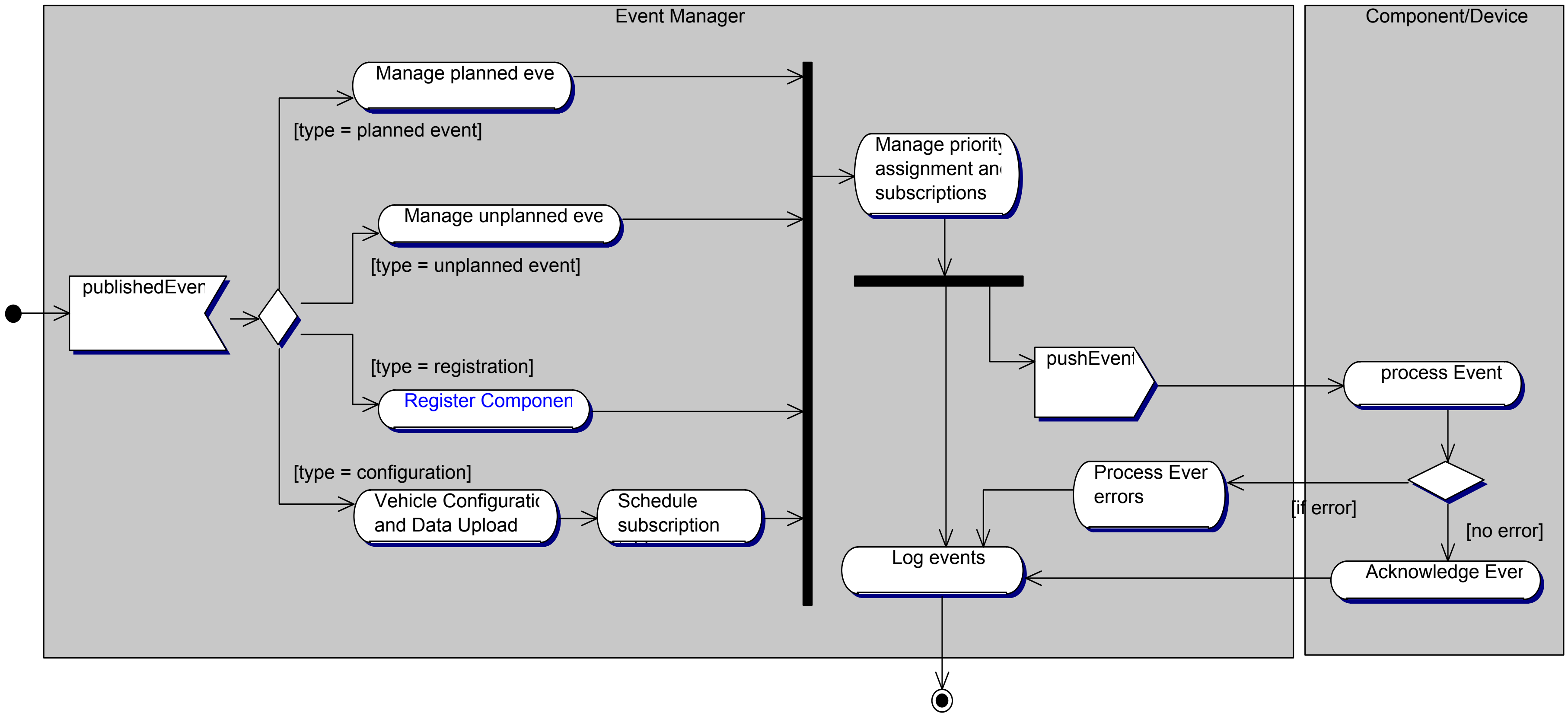
7. Assumptions

It is expected that the amount of event data reported and tracked by this use case will play a large part in the vendor's determination of memory storage requirements for information on the bus.

8. Issues

We have defined a preliminary set of events and event types, both planned and unplanned. Other events and event types may be identified in design and a determination will be made in dialog with the successful proposer about how to appropriately handle or filter additional event types that may be tracked.

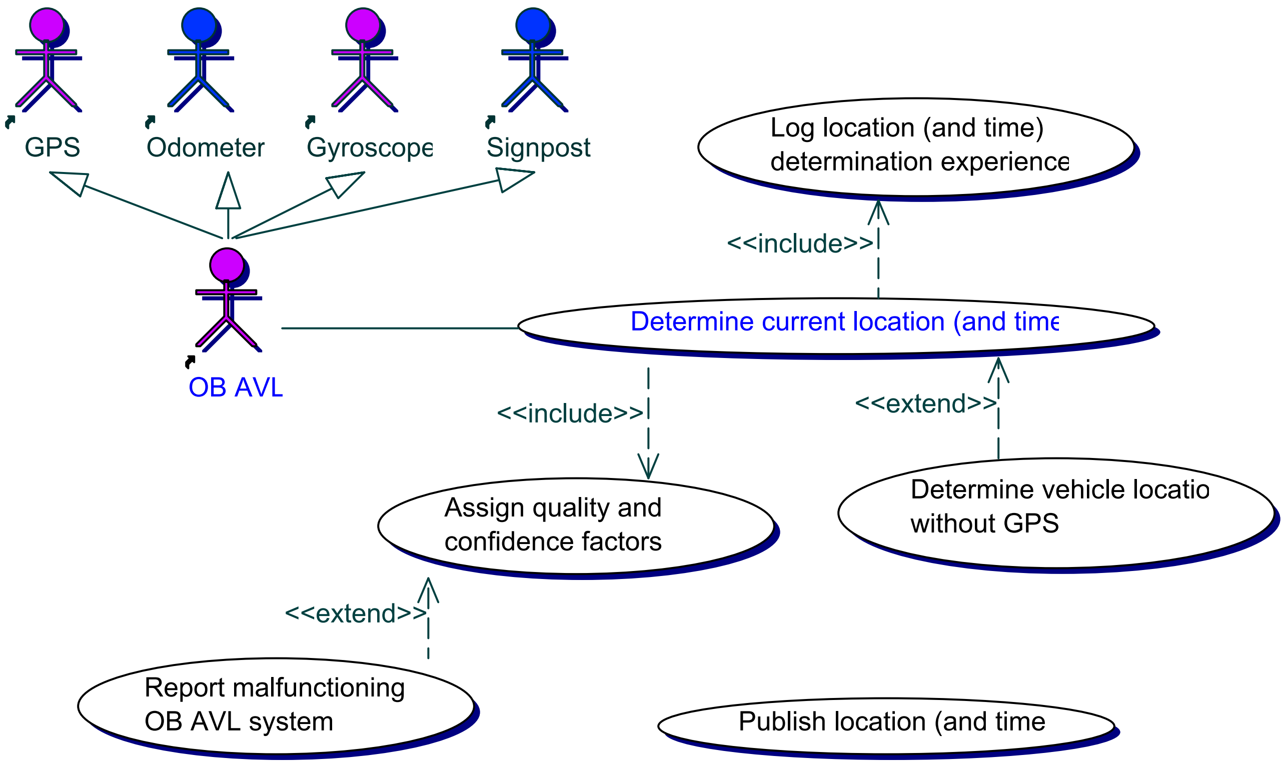
Figure 2.B.4.1.6.RV6.b. Activity Diagram Manage Events



2.B.4.1.7. RV7-Determine Vehicle Location

This use case package includes the following UML diagram:

Figure 2.B.4.1.7.RV7.  ***UseCase Diagram RV7-Determine Vehicle Location***



8. RV7-Determine Vehicle Location

1. Brief Description

This use case describes the requirements for the On-Board Automatic Vehicle Location (OB AVL) component. The OB AVL component shall collect location information from *multiple* sensors and calculate a location solution accurate to within 20 feet. The OB AVL component is further described in Subsection **2.A.1.5.2, Vehicle Logic Unit: Physical Requirements**. The Vehicle Location Manager shall employ a logical tool to derive the location solution, diagnose sensor issues, and provide quality measures.

2. Pre-conditions

The *Start up system* step of use case ***RV1-Initiate Vehicle for Operation*** has been successfully completed.

OB AVL sensors are functioning properly.

3. Flow of Events

This use case is triggered when an Operator starts a Revenue Vehicle.

3.1 Basic Flow

Determine current location (and time)
The system shall derive location using a combination of sensor inputs, including GPS.

The system will determine the following current location information:

1) Position
2) Time
3) Compass Heading
4) Odometer distance since the last good location fix
5) Velocity
6) Acceleration, if available

Assign quality and confidence factors
The system shall assign "quality" factors to the sensor input data and a "confidence" factor to the location solution.

1) Quality Factors: The design should include a method for determining the "quality" of the input for each of the sensors that provide data to determine the location solution (e.g., the number of working satellites that the GPS receiver is receiving transmissions from).
2) Confidence Factor: The design should include a method for assigning a numerical value to indicate the aggregate degree of confidence in the solution. (For example, a value of 10 means that all sensors are working perfectly and the location solution is +/- 10 feet; a value of 100 means that the GPS receiver was seeing three satellites, and is now seeing four or more satellites; therefore the previous data must have been off by 100 feet.) The values and their method of determination shall be developed in design and approved by the KCM Project Manager.
3) The threshold for location confidence must be a configurable parameter to enable the managing of Communications Center and customer reporting.
4) Level 2 only: When the confidence factor falls below the defined threshold, the location should not be reported to the CCS. (See use cases ***RV6-Manage Events*** and ***CC3-Manage Revenue Vehicle Polling***.)

Publish location (and time)
The system shall publish location (and time) at a designated, configurable frequency to all on-board components and subsystems that require location information in the required format(s) using the VAN.

Log location (and time) determination experience
The system shall store data with a confidence factor (if available).

1) OB AVL confidence and sensor quality factors will be recorded in a separate maintenance log.
2) Changes in the confidence factor that are outside the configurable parameters will be pushed to the Event Manager. (See use case ***RV6-Manage Events***.)
3) The system shall record change of health status information from sensors.

3.2 Alternative Flows

3.2.1 Determine Vehicle Location without GPS

Determine Vehicle Location without GPS
The OB AVL component shall be capable of providing current location and keeping accurate time when an accurate unambiguous GPS fix is not available.

3.2.2 Report Malfunctioning OB AVL System

Report malfunctioning OB AVL system
If the location determination system is malfunctioning, the system shall flag location data in the Event Log and shall not report bad locations in a poll response.

1) The design might include the ability to transmit the last know good location.
2) The design might include, if available, the odometer distance from that location.

4. Post-conditions

Accurate Location and Time data has been published to the vehicle area network and correctly logged.

5. Special Requirements

5.1 Performance

Position Data
Position (location) data shall include x, y, and z variables.

1) Position will be provided and reported in TCIP-compliant format. (See use case ***RV3-Manage Historical Data***.)
2) Altitude data collected as the z-variable shall be logged for post-processing to add to available GIS data. *Discuss the potential for use of z-variable in poll responses.*
3) The OBS will use and report position in the WA State Plane NAD 83 projection. Describe how and when source data provided in NAD 83 will be converted for on-board processing.
4) Both raw and projected coordinates will be logged.
5) GPS longitude and latitude input will be converted to the desired projection for event reporting and poll responses. *Describe how and where this conversion will occur.*

Accuracy
The system shall determine vehicle location to within 10 feet of a designated point (x,y) on the vehicle, e.g. the location where the GPS antenna is mounted.

1) There shall be both a manual and an automatic way of verifying the location data provided. *Describe such systems that have been implemented elsewhere and are currently in service.*
   - *Describe how location data is validated, especially regarding schedule adherence data.*

- *Describe issues—e.g., identifying the end of one trip and beginning of another when the vehicle jostles for position at a layover or turns back early—that have been noted and discuss what has been done to resolve the issues.*
- *Describe how accuracy should be measured to test and evaluate the proposed OB AVL component.*

2) System design will accommodate scenarios that can lead to a degradation in accuracy. Describe the estimated degradation in accuracy when GPS or another sensor fails. The description should address the overall effect on the ability to determine location by using the remaining sensors.

   Describe the measured effect on accuracy in the following GPS-adverse circumstances:

   - *Vehicle speed: discuss the effect on accuracy for a vehicle traveling at 10, 30 or 60 mph.*
   - *Urban canyon.*
   - *Tunnel: up to 2.0 miles long and not in a straight line.*
   - *Adverse weather: heavy rain.*
   - *Corridors through heavily forested and mountainous areas.*

Reliability
The OB AVL shall reliably provide accurate location information.

- *Provide the expected mean time between failure (MTBF) for the proposed system and a explanation as to how it was calculated. (See Subsection* **2.A.1.4.6, System Reliability and Availability Requirements**.)
- *Provide MTBF data for each proposed sensor.*

5.2 Technical Specifications

Determine Location
System design shall include the method for determining location.

- *Describe the proposed solution for determining location. Include a description of the strengths and weaknesses of the selected method.*
  - *Provide a description and specification for the primary location reference sensor. For example, if it is GPS, then what is the minimum number of satellites required to achieve the accuracy requirement?*
    - *Provide descriptions and specifications of supplementary sensors.*
    - *Describe the logical relationship between the sensors.*
    - *Describe how the system handles bad sensor data or sensor failure.*

The system shall determine the following location and time data:

1) Position. *Describe how Position shall be reported on the vehicle area network (VAN) in order to support all of the downstream functionality.*
   a) The system must maintain in real time the required accuracy at normal operational speeds.
   b) *Describe the proposed frequency of location determination calculations.* (How often will the VLU perform a calculation while all other systems are functioning? In Level 1? In Level 2?)
   c) *Describe how often the proposed system will log location and time, include changes in state that will be logged: distance, time, door state, speed, etc.*
2) Time. *Describe a system of time synchronization.*
   - *Describe the primary source, e.g. GPS or WWV.*
   - *Describe the backup time source when the primary source is not available, e.g. a highly accurate clock.*

- *How does the system synchronize the backup time source at system startup (e.g. from the Base Server or from the GPS receiver)?*
- *How does the system synchronize time with connected subsystems?*

3) The current KCM system syncs its master clock against an NBS source on the internet. Time syncs are automatically sent to the buses twice an hour via the 450 MHz radio system. On the buses, each MDU contains a highly accurate clock which is powered by backup battery when the system is powered off.
4) System will report time errors based on known good time fixes if the error is over a defined threshold.
   a) All subsystems will use the same time source, so that events will be synchronized in time for post-process analysis. *Discuss the recommended approach to assure that all systems use the same time source. Describe how time drift between vehicles or systems is handled. How does it affect performance? How is it detected and corrected?*
      i) Compass Heading. *Describe the source and accuracy of compass heading. If applicable, describe the specific performance parameters of the gyroscope or compass proposed.*
      ii) Odometer. *Describe how odometer readings will be determined. Explain the methods and frequency of odometer recalibration.*
      iii) Signpost system. *Describe whether and how the proposed location determination component may utilize the existing KCM signpost system.* Signposts currently transmit their identification number once or twice a second depending on how they have been configured.
      iv) Velocity. *Describe how this value will be derived and whether it should be derived within the OB AVL or other component. Velocity is useful for safety and accident event reporting. It may also be reported to the Transit Signal Priority (TSP) system.*
      v) Acceleration (Acceleration can be an important data point when conducting accident investigations). *Describe how this value can be determined and whether it should be derived within the vehicle location or other component. Discuss the cost and technical issues related to reporting acceleration.*
5) Reporting frequency shall be determined during design by agreement between KCM and the Contractor. *Describe the recommended reporting frequency for location (time)*.
6) Data to be recorded in a maintenance log shall be finalized during system design. *Describe the specific data that would be recorded in a maintenance log and how it should be used to analyze system performance and troubleshoot problems.*

Quality and confidence factors
The system shall assign quality factors to the sensor input data and a confidence factor to the location solution.

1) Each of the various sensor types will have appropriate quality factors assigned for its data. Describe the nature and characteristics of quality factors that can be reported for each sensor type.
2) The system will, to the extent possible, mitigate or avoid typical sensor problems. Describe the kind of sensor problems that most commonly occur with each sensor type, and what can be done to mitigate or avoid those problems.
3) The system will monitor the health and quality of each applicable sensor. What tools or techniques will be used to monitor each of the following sensor types?
   - *GPS Receiver*
   - *Odometer*
   - *Gyroscope*
   - *Compass*
   - *Clock*

- *Optional: Signposts*

4) The system will assign a confidence factor to location data. Describe the proposed approach to determining and assigning confidence factors based on system and sensor performance.

5.3 Testing

Location Accuracy

System testing shall measure the accuracy of the OB AVL component.

1) Location will be measured from an agreed-upon point—e.g., the GPS antenna—on the vehicle. *Discuss recommendation for measurement point.*
2) Performance and accuracy will be measured in the following circumstances:
   a) Vehicle speed: a vehicle traveling at 10, 30 and 60 mph.
   b) Urban canyon: a five-block radius around the Columbia Tower located at 5th Ave. and Columbia St. in downtown Seattle.
   c) Tunnel: up to 2.0 miles long and not in a straight line.
   d) Adverse weather: heavy rain.
   e) Heavily forested and mountainous areas.
   f) No GPS.
   g) GPS with selective availability.

6. Extension Points

RV1-Initiate Vehicle for Operation

RV5-Monitor System Health

CC3-Manage Revenue Vehicle Polling

RV6-Manage Events

7. Assumptions

In Level 1, the OB AVL location data shall be used exclusively by on-board systems while the current Radio/AVL system will continue to rely on the legacy signpost-based AVL system.

In Level 2, the OB AVL location data will be sent to the CCS in poll responses and the CCS will use this data for all service management functions.

8. Issues

KCM prefers an AVL solution that can function with and without GPS as recommended by the FTA. *Discuss the cost and complexity issues with developing such a solution.*

The legacy signpost system is a possible backup to GPS. *Describe the technical feasibility of developing a location algorithm that includes signpost data.*

2.B.4.1.8. RV8-Monitor Route and Schedule Adherence

This use case package includes the following UML diagrams:

UseCase Diagrams

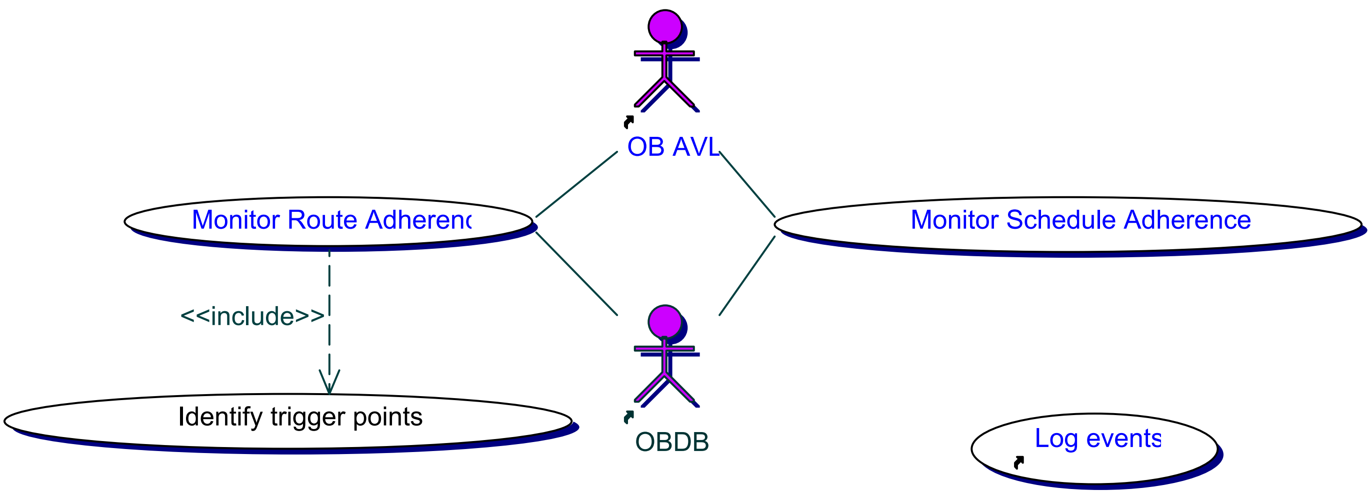
Figure ***2.B.4.1.8.RV8.a. RV8-Monitor Route and Schedule Adherence***

Activity Diagrams

Figure ***2.B.4.1.8.RV8.b. Monitor Route Adherence***

Figure ***2.B.4.1.8.RV8.c. Monitor Schedule Adherence***

Figure 2.B.4.1.8.RV8.a. UseCase Diagram RV8- Monitor Route and Schedule Adherence



9. RV8-Monitor Route and Schedule Adherence

1. Brief Description

This use case describes the requirements for the OBS system to monitor location and a) determine whether the vehicle is on route or off route at any given time, b) identify trigger points along the route where actions are required, and c) determine schedule adherence at timepoints. The ability to accurately and reliably provide route and schedule adherence information is essential.

Route adherence will be determined by comparing the actual vehicle location information with operating Service Data Set stored on the on-board database (OBDB), including the geophysical route description, timepoint, stop, trigger points, etc. The Route Adherence function will signal the Event Manager whenever there is a change in route adherence status. Route adherence also includes the requirement to monitor for and signal the Event Manager when a trigger point on the route is reached. (Certain planned events occur when the vehicle has reached a pre-specified location along the route; this location is referred to as the *trigger point*.)

2. Pre-conditions

The ***RV1-Initiate Vehicle for Operation*** use case has been successfully completed.

The OB AVL subsystem is operational and current location information is being provided. (See use case ***RV7-Determine Vehicle Location***.)

The ***RV4-Update Vehicle Data*** use case was successfully executed and the OBDB contains a complete valid "operating" Service Data set and all other needed data files used for performance comparison purposes (including all trigger point data).

3. Flow of Events

This use case is triggered when an Operator puts the vehicle into motion after having successfully logged in to a scheduled block of work.

3.1 Basic Flow

Monitor route adherence
The system shall compare the current vehicle location (and time) with the planned service path and schedule to determine and report route adherence status.

1) Route adherence will be monitored and updated whenever there is a change in the status, from on-route to off-route or from off-route to on-route.

2) There will be three possible route-adherence status conditions:

   a) *Off-route*: When the vehicle goes off route, the Event Manager will be notified to disable route-related annunciator displays and announcements and to monitor for the vehicle to get back on route. (See use case ***RV6-Manage Events***.)

      i) Stops, timepoints, or other trigger points that have been skipped will be logged as missed.

      ii) The system will identify when an Operator turns back early, ending one trip before reaching the terminal in order to begin the next trip.

   b) *On-route*: When the OBS detects that the vehicle is operating on the planned route path or gets back on route after having been off, the following will occur:

      i) The OBS will report that the vehicle is on route.

      ii) The system will monitor for trigger points from the point where the vehicle is on route.

      iii) *Verified On-route*: Additional methods for validating the return to on-route status after being off-route will be addressed in design.

         (1) Verified on-route status will be required before re-enabling the route-related annunciator displays and announcements.

(2) On-route status parameters will be configurable.

(3) Level 2 only: Poll responses may or may not include both on-route and verified on-route.

3) The OBS Administrator will configure parameters for route adherence as necessary, using tools included in the OBS Administrator toolkit.

4) The system will publish route adherence status.

   a) System will update display on the DDU. (See use case ***RV12-Interface to DDU***.)

   b) Level 2 only: The route adherence status will be included in the poll response. (See Subsection **3.B, Level 2 Functional Requirements**, use case ***RV17-Interface to 700 MHz Radio***)

      i) The poll response message will include either “off-route” or “verified on-route.”

      ii) The poll response may also include the unverified on-route status.

Identify trigger points
The route adherence monitor shall identify and send event messages for trigger points which have been identified in the operating Service Data Set.

1) The vehicle must be on route in order to identify trigger points.

2) The system will determine when each trip has logically ended and the next begun.

   a) The first trip will always be a deadhead route.

   b) System will identify layover location(s) and calculate dwell time.

      i) Sometimes a vehicle will park outside of the designated layover location.

      ii) Sometimes a vehicle will be moved within a layover zone during the layover time.

3) System will identify StopPointZone. (See use case ***RV9-Manage Stop Point Activities***.)

   a) System will signal and log when the vehicle enters the zone of a scheduled stop.

   b) System will signal and log when the vehicle exits the zone of a scheduled stop.

4) System will have the configurable ability to send a message for display to signal the Operator when the vehicle approaches the point where a road relief is planned. (See the <u>*Log in Operator*</u> step of the ***RV1-Initiate Vehicle for Operation*** use case.) The Operator will have the ability to do either of the following:

   a) Log out for the road relief.

   b) Override the road relief and continue operation.

5) System will signal the Annunciator when it's time to make an announcement. (See use case ***RV10-Manage PA and Annunciator***.)

6) System will signal when it's time to change the Interior Sign display. (See use case ***RV10-Manage PA and Annunciator***.)

7) System will change destination sign. (See use case ***RV13-Interface to Destination Signs***.)

8) System will change fare set, when enabled by FTP. (See use case ***RV14-Interface to FTP***.)

9) System will identify Timepoint arrival and departure times (where arrival and departure time is the same, only arrival time will be identified) for schedule adherence (described below).

Monitor schedule adherence
Schedule adherence shall be determined at each scheduled timepoint.

1) The On-Board System will identify and log the arrival and departure time (where arrival and departure time is the same, only arrival time will be identified) at each scheduled timepoint.

2) The OBS Administrator will have the tools to select either the arrival or departure time at timepoints for measuring adherence. (See Subsection ***1.B.2, Transit Operations Business Rules*** for additional information.)
   a) The OBS Administrator can select either arrival or departure time as the global setting for schedule adherence.
   b) The OBS Administrator will have the capability to override the global setting for selected timepoints (e.g., when the global default is arrival time, some timepoints should be measured from departure time).
      i) *Arrival Time (the default for most timepoints)*: The difference between the scheduled arrival time and the actual arrival time at a timepoint. (For example, where scheduled arrive time is 9:04AM and the actual arrival time is 9:07:35AM, then the schedule adherence would be recorded as +2:35.)
      ii) *Departure Time (applicable to a terminal, layover or transit center)*: The difference between the scheduled departure time and the time the vehicle actually leaves the timepoint. (For example, where the scheduled departure time is 8:04PM and the actual departure time is 7:59:35PM, then the schedule adherence at that timepoint would be recorded as -4:25.)
      iii) *Estimated Time*: Used with estimated timepoints that are indicated on passenger schedules and operator run cards. With an estimated timepoint, Revenue Vehicles will proceed on arrival to the next timepoint, even when ahead of schedule (early).
         (1) For an estimated timepoint the DDU will display next timepoint, but will not display either "early" or "late."
         (2) The poll message will include schedule adherence at estimated timepoints.
3) Schedule adherence will be measured and logged in minutes and seconds.
4) System will provide schedule adherence updates to OBS subsystems in the required formats and timeframes.
   a) System will update display on the DDU. (See use case ***RV12-Interface to DDU***.)
   b) System will update the Transit Signal Priority (TSP) data. (See use case ***RV16-Interface to TSP Tag*** and Subsection **2.A.4.1.1, Priced Options, Wireless TSP**.)
   c) Level 2 only:
      i) Schedule adherence will be included in the poll response, rounded to the nearest second. (See use case ***RV17-Interface to 700MHz Radio***.)
      ii) The system will have the configurable ability to publish schedule adherence status rounded to the nearest minute when the vehicle is excessively late. (For example, the system may normally report schedule adherence in minutes and seconds except when 30 or more minutes late, in which case adherence would be rounded to the nearest minute.)
      iii) System will automatically send a message to the CCS when the vehicle is too far behind schedule to recover at the next layover, e.g. the vehicle is 20 minutes late and a 15-minute layover is scheduled before the Operator should begin the next trip. This would apply to all but the last revenue trip of the block. (See use case ***CC6-Respond to Revenue Vehicle Communications***.)
      iv) System will send a message to CCS when the vehicle returns to the base before its scheduled pull-in time. The parameters for triggering an “early return to base” message will be configurable. (See use case ***CC6-Respond to Revenue Vehicle Communications***.)

Log events
The system shall log each change in state or update of the route or schedule adherence.

3.2 Alternative Flows

4. Post-conditions

Route and schedule adherence status reports were timely and accurate.

Changes in route adherence status caused the Event Manager to disable/enable annunciator functions. (See use case ***RV6-Manage Events***.)

Trigger-point activities were signaled at the time and place specified in the Current Service Data Set (See use case ***RV4-Update Vehicle Data***.)

5. Special Requirements

5.1 Performance

Route Adherence
The system shall be designed to ensure that the annunciator is enabled only when the vehicle is on route.

1) Route adherence comparisons will be performed frequently enough to assure accurate information. How frequently does the proposed design compare current location to planned? Discuss the feasibility of including the option for time periods between comparisons to be governed by a variable parameter that can be set by Metro staff on an as-needed basis.
2) Route adherence parameters will be configurable. What configurable route adherence parameters are proposed? Describe the tools and methods to be provided for re-configuring the route adherence parameters.
3) The system will provide performance parameters for determining that a vehicle has gone off route, such as:
   a) Degree of change in direction of travel. *How would this be detected?*
   b) Change in travel distance between known points. *How would this be detected?*
   c) The system must be able to handle challenging re-route scenarios such as the following:
      i) The vehicle is rerouted to a road that is parallel to and 300 feet west of the planned route. *Discuss design implications.*
      ii) The vehicle takes a slightly different turn and re-routes to a road that is *beneath* and parallel to the bridge that was the planned route. *Discuss design implications.*
   d) Other. *Describe.*
4) To support business needs, the system must be able to quickly identify off-route status. *Quantify the performance of the proposed system in this regard:*
   - *How will the system measure distance traveled from the point the vehicle departs from the planned path?*
   - *How will the system detect and utilize data regarding variance in the vehicle heading from the plan?*
   - *How will the system measure time elapsed from the point at which the vehicle departs from the planned path?*

5.2 Technical Specifications

Route adherence
The OBS design shall include the configurable ability to detect and report when a vehicle changes from on-route to off-route operation

1) The Contractor will provide the tools and training for collecting and managing the OBDB data needed to determine route adherence status. *Describe the proposed methods and tools required to create this data. Discuss the technical feasibility of generating the required data set by using PC-based GIS tools.*

2) OBS Administrator will have tools for managing, editing, and/or modifying the on-board route adherence parameters.

3) System will use a logical, configurable process for managing route adherence. *Describe the proposed approach. Does the route adherence manager set a "change of state" variable that is checked by the Event Manager thereafter?*

   a) System will accurately report off-route operation. *Under what circumstances/conditions will the system report that it is off route? Provide specific performance parameters.*

   b) System design will address direction-of-travel issues.

      i) System will identify when a vehicle's current direction of travel is different from the planned path. *Describe the proposed method and tools for this. Include specific settings and data included in the designed solution: heading in degrees, time delay, etc.*

      ii) System will be able to distinguish a turn for a lane change from a turn to change direction of travel. *Discuss the logic or mechanism for this.*

   c) System design will establish configurable lateral offsets from the planned linear path in order to set boundaries on how wide the corridor is and therefore be able to identify if a vehicle is traveling on a road parallel to the planned road (off route) or if it is in fact traveling on the freeway a couple of lanes away from the usual lane (on route). *Describe the proposed method and tools for this*.

      i) *Discuss the design implications.*

4) System will accurately determine that a vehicle has gotten back on route after being off route. *Describe the proposed methods and tools for this:*

   - *What are the parameters and conditions by which the system will determine that the vehicle is on route?*
   - *Is there a method proposed to verify (double-check) that the vehicle is in fact on route before enabling the annunciator?*

Schedule adherence
The OBS design shall include the configurable ability to detect and report schedule adherence at designated timepoints.

1) Level 2 only: Estimated Timepoints—KCM Scheduling must designate which timepoints are estimated and pass this into the enterprise data set where it can be managed automatically.

   a) The HASTUS scheduling system will be upgraded by KCM to include a data element to identify estimated timepoints. The OBDB will include the ability to identify when a timepoint is estimated.

   b) The OBS system will report estimated timepoints in such a way that the poll data and historical data can be filtered to include or exclude estimated timepoints for reporting and tracking.

2) Off-schedule operation is a part of planned operation to a point. There are times when the entire system will experience extreme service interruptions. *Describe how the system is designed to handle off-schedule operation outside of the normal limits.*

   a) System will be able to accommodate scenarios such as the following: "The Seattle area is hit by an unexpected snowstorm: traffic in downtown is at a standstill; most vehicles are operating modified snow routes; therefore most vehicles report as off-route and some trips are running hours late."

      Discuss the proposed approach for managing this scenario.

- *Discuss the functional and reporting logic for managing the schedule adherence status messages.*
- *Is there a limit to the system's ability to track what is really happening when it no longer has any relation to the schedule data (e.g. when the Operator ends a trip while off-route and begins another from a different point than planned)?*

Log route and schedule adherence events

The content and format of route and schedule event data shall be approved by the KCM Project Manager.

1) The system shall have a method for identifying schedule adherence at estimated timepoints in the Event Log.
   a) Reports of on-time performance shall include the ability to filter out schedule adherence at estimated timepoints.

   Describe the proposed approach to logging route adherence and schedule data. How will the following missed-trip scenarios be reported and logged?

   - *The vehicle deviates from the planned path and does not service some stops.*
   - *The vehicle is so far behind schedule that one or more trips is not performed.*

6. Extension Points

CC6-Respond to Revenue Vehicle Communications

RV1-Initiate Vehicle for Operation

RV4-Update Vehicle Data

RV6-Manage Events

RV7-Determine Vehicle Location

RV9-Manage Stop Point Activities

RV10-Manage PA and Annunciator

RV13-Interface to Destination Signs

RV14-Interface to FTP

RV16-Interface to TSP Tag

RV17-Interface to 700 MHz Radio

7. Assumptions

8. Issues

Figure 2.B.4.1.8.RV8.b.  ***Activity Diagram <u>Monitor Route Adherence</u>***

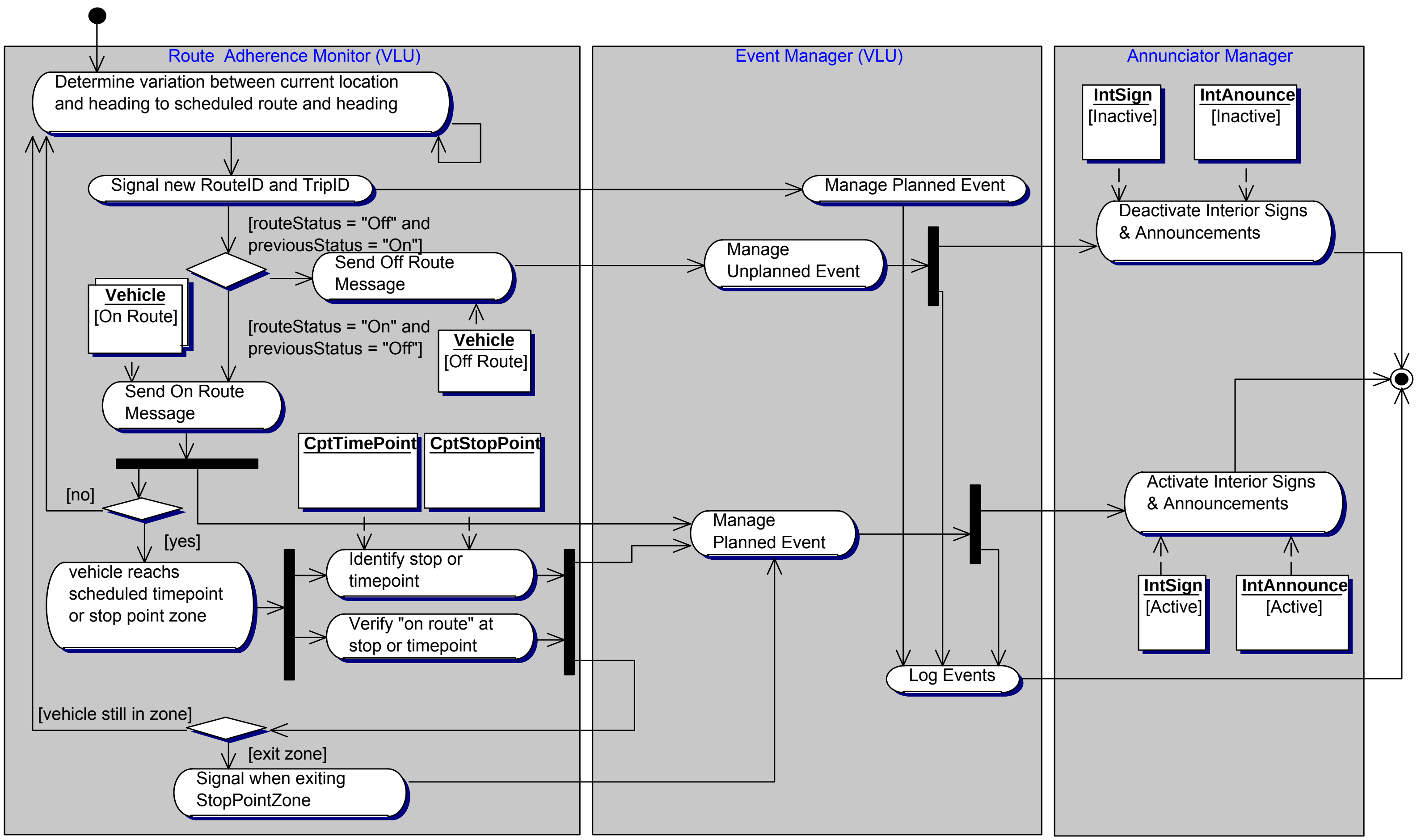
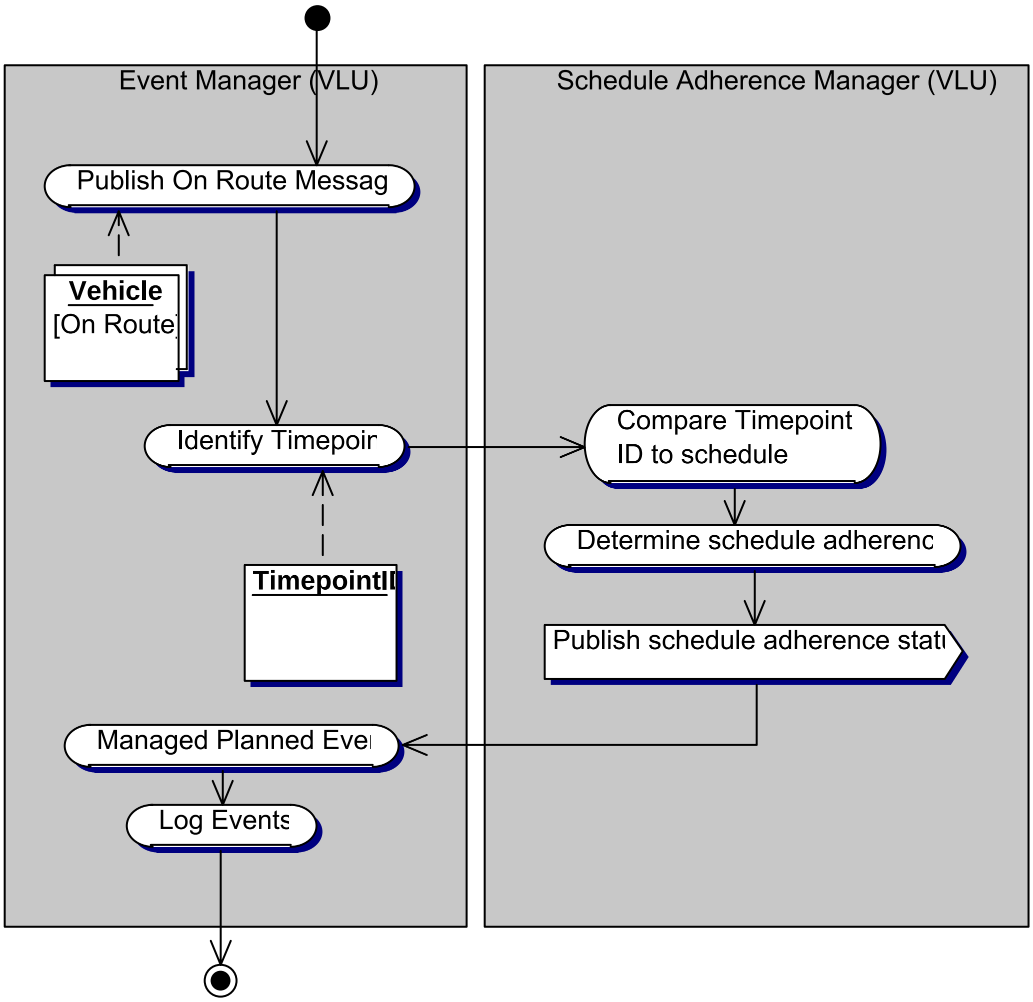


Figure 2.B.4.1.8.RV8.c. ***Activity Diagram*** ***Monitor Schedule Adherence***



2.B.4.1.9. RV9-Monitor Stop Point Activities

This use case package includes the following UML diagrams:

UseCase Diagrams

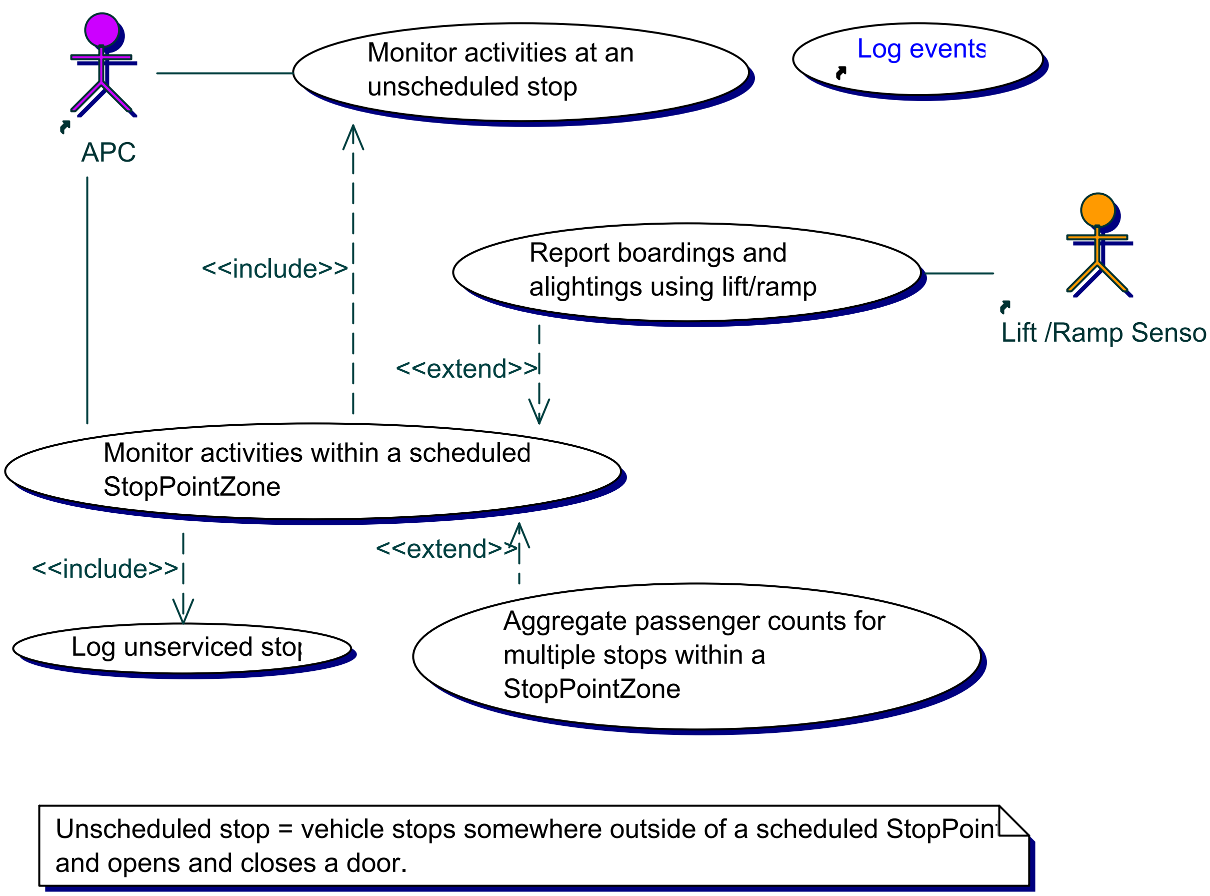
Figure ***2.B.4.1.9.RV9.a. RV9-Monitor Stop Point Activities***

Activity Diagrams

Figure ***2.B.4.1.9.RV9.b. Count Passengers***

Figure ***2.B.4.1.9.RV9.c. Monitor Stop Point Activities***

Figure 2.B.4.1.9.RV9.a. UseCase Diagram RV9- Monitor Stop Point Activities



10. RV9-Monitor Stop Point Activities

1. Brief Description

This use case describes the data collection and logging activities for the Automatic Passenger Counting (APC) subsystem. The APC tracks and logs activities at each scheduled and unscheduled stop. (Unscheduled stops may occur during off-route operation, or while the vehicle is on route between scheduled stops.)

The Stops data set stored on the OBDB will include both the Stop ID and a Stop_Distance attribute for each active stop. A stop point zone is the area surrounding a Stop Point location (x,y). A vehicle may stop within the specified zone for passenger boardings and alightings. The Stop_Distance attribute is defined as an offset in feet +/- from the Stop Point and can be displayed as a spatial shape on a GIS map.

When a vehicle is not equipped with an APC subsystem, the OBS will monitor and log all changes in state for the Door and Lift/Ramp Sensors.

The primary activities at each stop within a stop point zone are as follows:

- Associate all activities with a Stop Point Zone to the StopID.
- Count, log, and aggregate all boardings and alightings received from the Passenger Counting Unit (PCU) for each door.
- Log and aggregate passenger counts for multiple stops with the zone.
- Count, log, and aggregate the number of lift cycles received from the lift sensors.
- Count, log, and aggregate the number of ramp cycles received from the ramp sensor(s).
- Count, log, and aggregate lift and ramp passenger boardings and alightings.
- Log the arrival and departure times, locations, and number of times where the vehicle stops within a zone (for Operations purposes).
- Log the number of times each vehicle door opens, including zero passenger counts for those door openings where no boardings and alightings occur.
- Publish current vehicle load (aggregate passenger count) to the Event Manager.

2. Pre-conditions

The ***RV1-Initiate Vehicle for Operation*** use case was successfully completed and an APC system is installed and functioning properly.

The Door and Lift/Ramp Sensors are in good health.

The vehicle capacity was defined at OBS installation and was provided to the TSP component.

All subsystem defaults are set to a null value.

3. Flow of Events

3.1 Basic Flow

Report boardings and alightings using lift/ramp
The lift/ramp sensors shall send a message to the Stop Point Manager indicating that a lift/ramp cycle has occurred.

All KCM RevenueVehicles are equipped with either a lift or a ramp for disabled passengers. The OBS shall monitor lift/ramp sensors to track the following per stop and stop point zone:

1) Monitor and log lift usage:
    b) Log the total number of lift cycles.
    c) Log lift activity by type of activity: lower, raise, or stow

d) Aggregate each sequence as either a passenger boarding or alighting. (Based on the sequence of lift activities, determine whether a passenger boarded or alighted from the vehicle.)

2) Monitor and log ramp usage:

a) Log the total number of ramp deployment cycles.

b) Log passenger boardings and alightings when ramp is deployed.

Monitor activities within a scheduled stop point zone
The Stop Point Manager shall receive, aggregate, and log passenger boardings and alightings each time one or more doors opens within a stop point zone using the Passenger Counting Unit.

1) Receive and log door openings from the Door Sensor, reporting these to the Event Manager for real-time reporting to subsystems (e.g. Public Address system for external stop announcement).

2) Receive and log passenger boardings and alightings from the Passenger Counting Unit (PCU).

3) Aggregate and log the total boardings and alightings received from the PCU and the lift/ramp cycle counts.

4) Calculate and log the vehicle's total passenger load for Transit Signal Priority (TSP) data.

Log events
All Stop Point activities will be logged.

See use case ***RV6-Manage Events***.

3.2 Alternative Flows

3.2.1 Multiple Stops Within a Stop Point Zone

Aggregate passenger counts for multiple stops within a Stop Point Zone
If the vehicle stops more than once within the scheduled stop's zone, passenger boardings and alightings received for each stop within the zone shall be included in the total passenger counts logged for the scheduled stop.

The Stop Point Manager shall determine and log the total number of boardings and alightings for all stops that the vehicle makes within this area as follows:

1) Log the total boardings and total alightings per door.

2) Log the total boardings and total alightings via the lift or ramp.

3) Publish passenger load to the TSP for signal priority request (See use case ***RV16-Interface to TSP Tag***).

4) Log the total number of times the vehicle stopped within the stop point zone (defined in the OBDB as offset parameters from the StopPoint).

3.2.2 Unscheduled Stop

Monitor activities at an unscheduled stop
If the vehicle makes an unscheduled stop, the Stop Point Manager shall record door openings, passenger boardings, and passenger alightings as detailed above in the Basic Flow section of this use case.

1) If an unscheduled stop occurs within a KCM-determined distance (configurable parameter) outside a regularly scheduled stop's zone, passenger counts shall be aggregated as described in Alternate Flow <u>*Aggregate passenger counts for multiple stops within a Stop Point Zone*</u>. There will be a Stop attribute for the configurable parameter for the length of a zone (defined in current system as "Stop_Distance").

2) If an unscheduled stop occurs outside this distance, all passenger counts shall be recorded as described in the Basic Flow.

3) Unscheduled stops include, but are not limited to, both "night" stops and "flag" stops.

3.2.3 Unserviced Stop

Log unserviced stop

If a vehicle passes a regularly scheduled stop zone without stopping, the Stop Point Manager shall record the time when the vehicle passed the stop along with the stop identification/location.

4. Post-conditions

All stop point activities have been accurately logged and reported including every time a door is opened/closed, passenger boardings/alightings, and all ramp/lift usage.

5. Special Requirements

5.1 Performance

The OBS and APC subsystem's hardware and methodology for counting, logging, aggregating, and reporting must comply with the National Transit Database (NTD) method of sampling and aggregating the data.

Passenger Counter Accuracy

The Passenger Counting subsystem shall demonstrate accuracy that meets KCM requirements for a series of stop cycles, performed during revenue vehicle service.

A stop cycle is the series of events in which a vehicle comes to a stop, opens the doors, people get on and/or off, the doors close, and the vehicle pulls away.

Detailed KCM accuracy requirements follow.

1) Accumulated Count: An accumulated count for both boarding and alighting passengers, to within five percent for each 100 consecutive boarding and alighting passengers. That is, for every 100 consecutive boarding and alighting passengers, the system "on" count must be within the range of 95 to 105, inclusive, and the system "off" count must be within the range of 95 to 105, inclusive.
2) Stop-by-Stop: For 85 percent of all in-service stops, the passenger boarding and alighting count shall be exact. This shall include stops for which there was boarding-only activity, alighting-only activity, or both boarding and alighting activity. If a scheduled stop had no boarding activity and the APC recorded no boarding activity (logged as a null), this would be considered a correct count.
   a) For 90 percent of all stops, the boarding and alighting count shall be within +/- 1 of actual.
   b) For 97 percent of all stops, the boarding and alighting count shall be within +/- 2 of actual.
3) All accuracy tests shall be conducted during revenue service by KCM. County personnel shall determine actual passenger counts while riding the vehicle. Contractor's staff may participate in and audit these counts. County will perform these tests during all operational testing periods (See Subsection **2.A.2, Testing**) and KCM will give the Contractor at least seven days' notice prior to accuracy testing being performed, unless waived by Contractor. Passenger-counter counts shall be based on either the counts displayed on the unit's display or the recorded data, or both. OBS counts shall be based on the OBS' recorded data. Contractor may conduct its own revenue service accuracy tests, or hire a third party to do such tests, at Contractor's expense.
4) A valid test of the above conditions shall contain a minimum of 500 stops, with an average number of boardings per stop (total stops/total boardings) of at least 1.75. During prototype and pilot testing, the tests shall be conducted for each vehicle type prior to acceptance. During Base Equipment and Conditional Acceptance testing periods, accuracy checks for acceptance may be conducted on a selected number of systems.
5) The accuracy of the passenger counter shall not be adversely affected by normal passenger behavior, such as standing in stairwells while the vehicle is in motion, or hesitation while inserting fares into the farebox when entering/leaving the vehicle.

6) Because of wide doorways in some vehicles, the counter must be capable of counting simultaneous “ons” and “offs” in a two-stream operation. That is, the APC subsystem shall be able to count two persons entering or exiting in parallel, or one person entering and one exiting simultaneously, or one person standing in the stairwell while others get on or off.

5.2 Technical

Automatic Passenger Counting (APC) Subsystem

The hardware units that comprise this system shall use remote sensor-based technology on each of the vehicle’s doors to determine passenger boardings and alightings connected to a separate processor called the Passenger Counting Unit (PCU).

Provide an APC Monitor tool (see Subsection **2.A.2.4.4, Test Tools and Logging**). The APC Monitor tool shall provide the ability to reset the passenger on/off counts at each doorway to zero, and to reset the trip odometer to zero.

Logic

All PCU’s must be microprocessor-controlled to allow for ease of logic changes for any of the functions performed by the APC.

1) The microprocessor must be readily available and supported in the U.S. marketplace such that KCM could easily acquire test/programming equipment for the microprocessor for the purpose of future modifications.
2) All firmware should use Flash Memory EEPROMS to allow the system firmware to be changeable via the PCU communication port. Options for updating Flash Memory via a wireless communication port should be described.
3) The OBS must provide the abilities to configure all required parameters and transmit these to the APC to change system firmware or logic for any of the functions performed by the APC.

Reasonable calculation results

The OBS shall log all results, even when outside of normal limits.

The Event Manager will not publish passenger load outside of normal limits to the TSP, e.g. a negative number of passengers, load numbers greater than 200% of vehicle load capability, and other nonsensical results.

System Diagnostics

The Contractor shall provide all needed troubleshooting diagnostics and tools for subsystem hardware and software.

6. Extension Points

RV1-Initiate Vehicle for Operation

RV16-Interface to TSP Tag

7. Assumptions

The vehicle capacity is set during installation and will be used by the Event Manager to signal how full the coach is.

8. Issues

Describe the proposed door sensor management system which will receive the door sensor signal including door open/not closed or door closed/not open methodology, and how it will provide real-time dissemination of this information to pertinent subsystems (Stop Point and Public Address systems).

For ramps and lifts, describe the proposed technology and systems for managing each component’s passenger counting. This methodology should not rely on the sequence of either lift or ramp sensors, but rather provide accurate counts of passenger boardings and alightings during the period of time the lift or ramp is deployed.

Figure 2.B.4.1.9.RV9.b. Activity Diagram <u>Count Passengers</u>

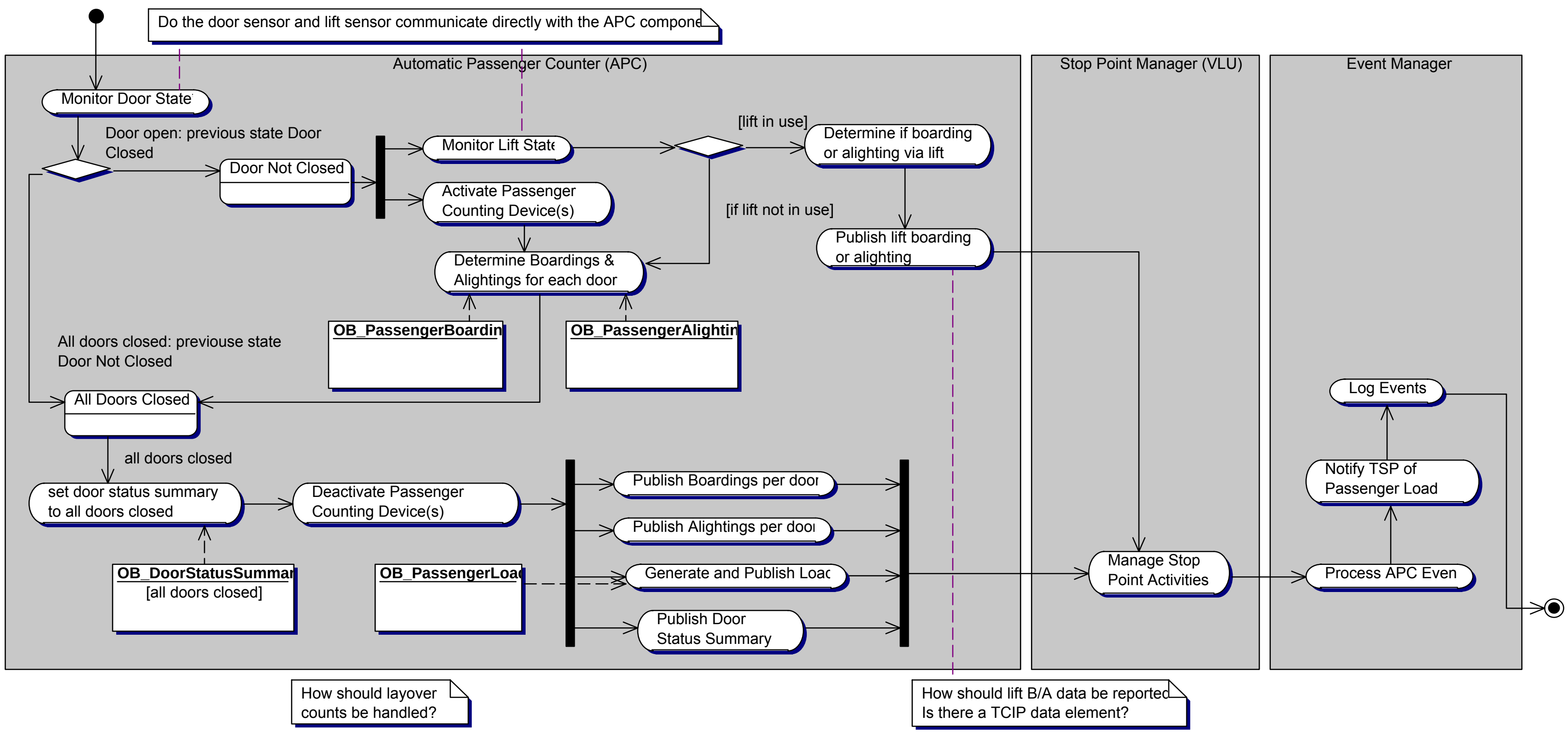
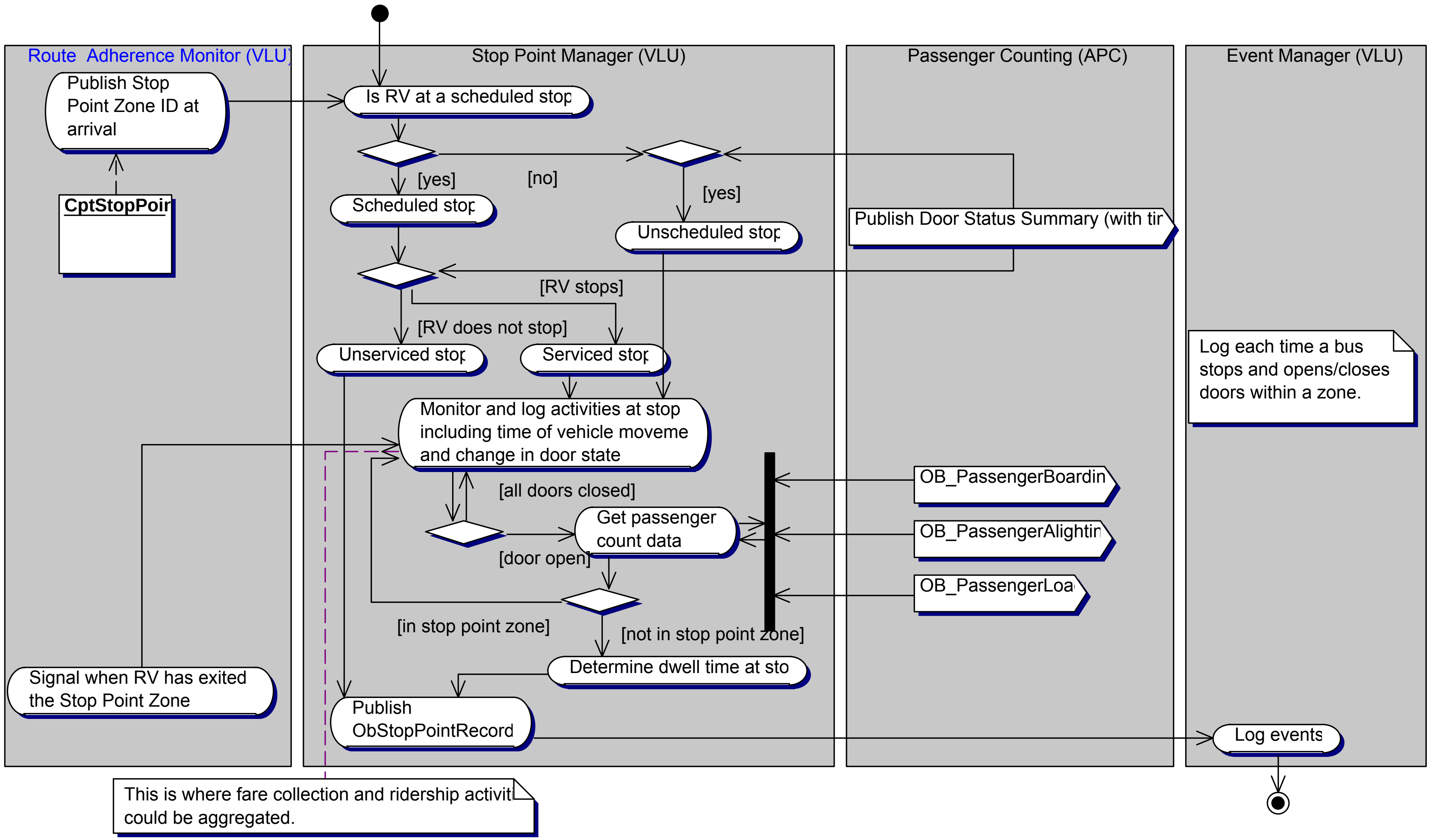


Figure 2.B.4.1.9.RV9.c. ***Activity Diagram Monitor Stop Point Activities***



2.B.4.1.10. RV10- Manage PA and Annunciator

This use case package includes the following UML diagrams:

UseCase Diagrams

Figure ***2.B.4.1.10.RV10.a. RV10-Manage PA and Annunciator***

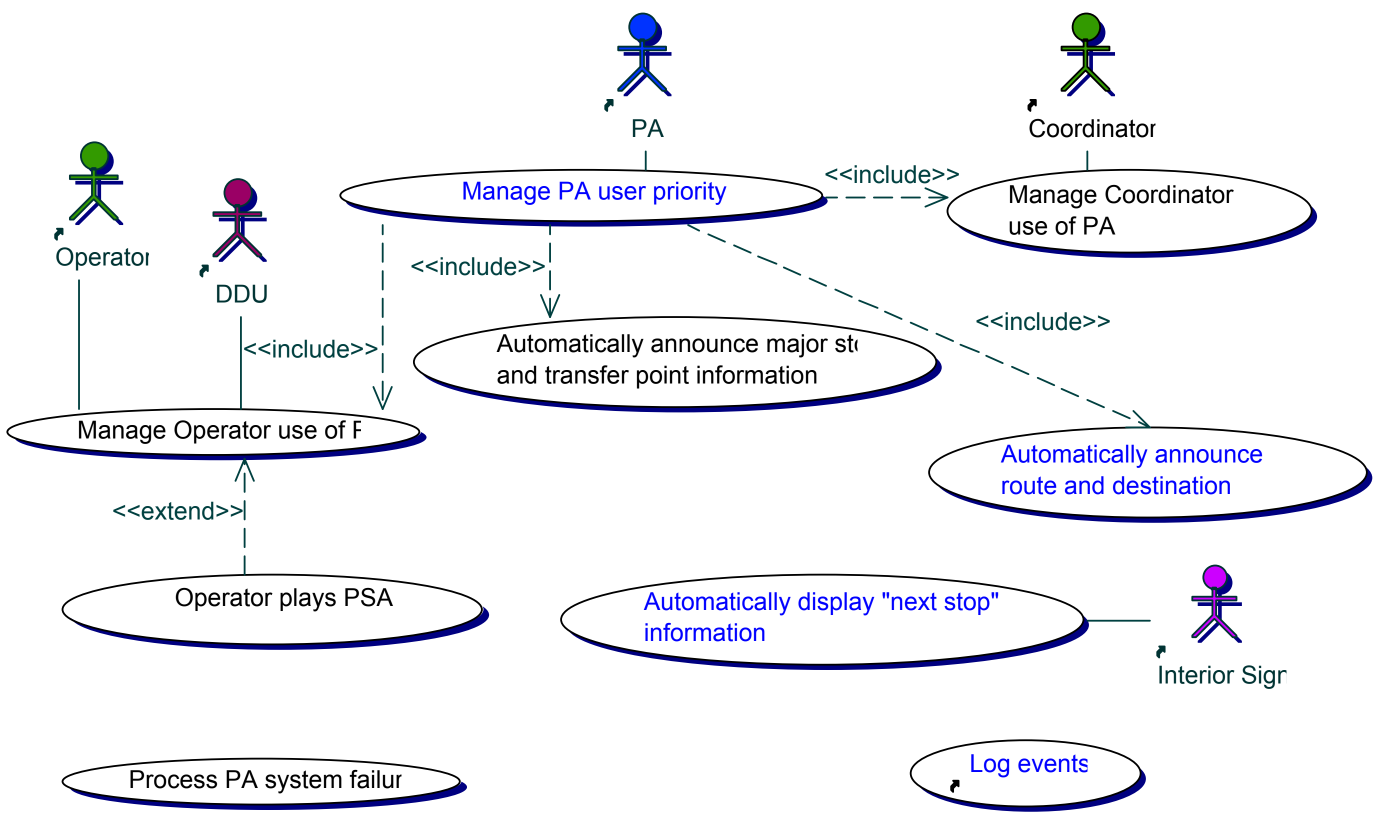
Activity Diagrams

Figure ***2.B.4.1.10.RV10.b. Manage Interior Sign***

Figure ***2.B.4.1.10.RV10.c. Provide Exterior Announcement***

Figure ***2.B.4.1.10.RV10.d. Provide Interior Announcements***

Figure 2.B.4.1.10.RV10.a. UseCase Diagram RV10- Manage PA and Annunciator



11. RV10-Manage PA and Annunciator

1. Brief Description

This use case describes the requirements for the on-board system to manage shared use of the public announcement (PA) system and provide annunciator system functionality. The Operator, Communications Coordinator, and automated Annunciator system will share use of the PA system. The OBS must ensure that the user with the highest priority is given control in a way that supports business processes. Additionally, the OBS design must address the PA amplifier and volume control settings (manual and automatic).

The Interior Sign will be a separate on-board subsystem which must have a well-defined interface which will allow for replacement without VLU modifications beyond normal software drivers and controls. The Interior Sign will display information for passengers on board a Revenue Vehicle, including stop requested, time & route, and "next stop" information such as stop name, landmarks, and transfers.

The PA system devices include the PA amplifier, interior PA speakers, the hailing speaker (above the driver's seat) and the exterior speaker (next to front door on outside of vehicle).

The matrix below summarizes which users will use each device and the relative priority of each user:

PA system devices	Coordinator	Operator	Annunciator
PA Amplifier	yes-1	yes-2	yes-3
Interior PA Speakers	yes-1	yes-2	yes-3
Hailing Speaker	yes-1	no	no
Exterior Speaker	no	yes-1	yes-2

2. Pre-conditions

The *Log in Operator* step in use case ***RV1-Initiate Vehicle for Operation*** use case has been successfully completed.

The block of work provided at login has scheduled stops with associated automated announcements and displays in the on-board database (OBDB).

The vehicle is "on route." (See use case ***RV8-Monitor Route and Schedule Adherence***.)

3. Flow of Events

Announcements and displays will be triggered by the Event Manager and determined by the Operator login, location (and time), and route adherence status. (See the *Manage planned events* step of the ***RV6-Manage Events*** use case.)

3.1 Basic Flow:

Manage PA user priority

The OBS system shall provide methods and tools to assure that the user with the highest priority has control of the PA system.

1) The following priorities should apply (See *Assign priority to event* step in the ***RV6-Manage Events*** use case):
   a) First priority: A Communications Coordinator announcement has top priority and can override the Operator and the annunciator system. (See alternative flow *Coordinator announcement*.)
   b) Second priority: Operator announcements shall have priority over the automated announcement system.
      i) See alternative flow *Operator initiates announcement*.
      ii) See alternative flow *Play pre-recorded Public Service Announcement*.
   c) Third priority: The automated announcement system shall utilize the PA when it is not in use by either of the other users.

i) When an automated announcement is missed, the Event Manager will send a message for display on the DDU to indicate what announcement was missed.

ii) The Operator will interact with the DDU to manually initiate the announcement.

iii) The missed announcement message will be cleared from the DDU when the vehicle arrives at the next announcement trigger.

2) The final logic and methods for managing priority shall be approved by the KCM Project Manager in design.

Automatically announce route and destination
The annunciator system shall initiate a prerecorded announcement of the route and destination over the exterior speaker when the selected passenger door(s) is opened.

1) Automatic external route and destination announcements will be the default.

   a) The OBS Administrator will have the ability to enable/disable Operator control of exterior announcements.

   b) When enabled, the Operator has the option of disabling exterior announcements via key presses on the DDU. (See use case ***RV12-Interface to DDU***.)

2) When a door(s) is opened, the system will automatically announce the route and destination.

   a) The OBS Administrator will have the ability to configure the exterior announcement to be initiated by opening a specified door or doors, e.g. front door only or any door.

3) The exterior announcement will be linked to the destination sign code and will change at the same time that the destination sign code is changed. (See Performance: *Synchronize destination signs, exterior announcement, and interior display* requirement in use case ***RV13-Interface to Destination Signs***.)

   a) Some destination sign codes may have no announcement associated, e.g. “Training Coach, No Passengers.”

   b) The audio must be phrased as a person would speak and not as a literal reading of the destination sign. For example, when the destination sign displays “5 Express, via Greenwood, to Northgate,” the corresponding announcement should be something like “This is the 5 Express to Northgate via Greenwood Ave.”

4) The system must allow the OBS Administrator to mute/disable the exterior announcement for selected stops. An exterior announcement should *not* play in the following situations:

   a) The vehicle stops at a terminal that is not a through route.

   b) The vehicle stops at a stop that is also a layover zone for that work assignment.

Automatically display “next stop” information
The system shall automatically update the interior sign display with current information.

1) Automatic "next stop" displays will be the default.

   a) The OBS Administrator will have the ability to enable/disable Operator control of “next stop” displays.

   b) When “next stop” displays are enabled, the Operator has the option of disabling them via key presses on the DDU. (See use case ***RV12-Interface to DDU***.)

      i) When the Operator elects to disable the “next stop” displays, only the dynamic, location-dependent event data will be excluded from the display. The following functions shall continue to operate:

         (1) Time and route will continue to be displayed on the sign.

         (2) “Stop Requested” functionality will always be enabled.

2) The display content will include but not be limited to the following:
   a) Stop Requested.
      i) Whenever a passenger pulls the Stop Request cord or presses a Stop Request button, the interior sign will display "Stop Requested."
      ii) The Stop Requested display will be distinctive and unique from the other information provided on the interior sign so as to make it readily apparent to the passengers.
      iii) An audible tone will sound when a passenger requests a stop. The Stop Request tone shall be unique from any other automated tones or alarms so that it is readily identifiable by both passengers and the Operator.
         (1) The tone should sound each time a passenger pulls a cord or pushes a button.
         (2) Vehicles in the fleet that were purchased after 1996 will sound the stop requested tone twice for each time the signal strip under seats in the securement area is triggered.
      iv) "Stop Requested" will be removed from the interior display when the vehicle stops and a door is opened.
   b) Current time.
      i) Time will be published by the On-Board AVL component. (See use case ***RV7-Determine Vehicle Location***.)
      ii) When GPS time is not available, there must be a backup time source.
   c) Current route number and service type, e.g. 28E for route 28 Express or 28 for local service.
      i) The route number will be the same as what is displayed on the destination sign. (See use case ***RV13-Interface to Destination Signs***.)
         (1) Route number will not be displayed when the following is true:
            (a) The destination sign is set to "To Terminal" or "________ Base" (base route).
            (b) The vehicle is not operating scheduled service, e.g. it is operating a vehicle maintenance test route.
      ii) Optional: The route destination is also displayed at intervals that do not interfere with "next stop" displays.
   d) "Next stop" information.
      i) The system will automatically display updated "next stop" information for *all* stops when the vehicle is on route.
      ii) When a vehicle goes off route, the system will immediately cease "next stop" displays for location-dependent triggers until the vehicle has been verified as back on route by the Route Adherence Manager.
      iii) The display for the next stop will be triggered when the vehicle departs a stop.
      iv) At major stops and transfer points, the content of the "next stop" display will be the visual equivalent of the automated interior announcements, including the following:
            (a) Stop name.
            (b) Landmarks and common destinations.
            (c) Transfer points to other routes and modes.
            (d) Route-specific information, such as "last stop in Ride-Free area."
            (e) Other information may be included, such as current fare.

Automatically announce major stop and transfer point information

The system shall automatically announce stop information for designated major stops and transfer points.

1) Automatic stop audio announcements will be the default.
   a) The OBS Administrator will have the ability to enable/disable Operator control of audio “next stop” announcements.
   b) When announcements are enabled, the Operator will have the option of disabling them via key presses on the DDU. (See use case ***RV12-Interface to DDU***.)
2) Automatic announcements will be made only when the vehicle is on route.
   a) The annunciator will be programmed to automatically announce the selected stops currently defined by the KCM stop announcement guide, which will be provided after contract award.
   b) The OBS Administrator will have the ability to designate the stops for which an announcement is required.
   c) The content of the announcement will sometimes vary at the same stop for different routes.
3) Automated stop announcements must be temporarily disabled when the vehicle is off route.
   a) When the vehicle is off route a message will be displayed on the DDU instructing the Operator to make all required announcements.
   b) The message should be replaced when the vehicle returns to on-route status to notify the Operator that the announcements will be made automatically.
4) The Location Determination Manager will report a low quality factor or sensor health problems where appropriate. (See the *Assign quality and confidence factors* step in use case ***RV7-Determine Vehicle Location***.)
   a) If the PA status is *available*, then the system will play the specified announcement.
      i) The announcement will be sent to the speakers.
      ii) Simultaneously, the system will display text summary on the DDU. (See use case ***RV12-Interface to DDU***.)
   b) If the PA is *not available*, then the announcement will be sent to the DDU where it should be highlighted, or flash, to alert the Operator that an announcement was missed.
5) The Operator should have the option of manually triggering the current announcement.
   a) The “current” announcement is the last announcement that was triggered.
   b) The current announcement will be displayed on the DDU whether it played automatically or not.
   c) The announcement display should indicate the content of the current announcement.

Log Events

The OBS Administrator shall have the ability to configure PA and Annunciator events to be logged.

The type of events to be logged will include but not be limited to:

   a) An Operator disables an automatic function.
   b) An Operator enables an automatic function after previously disabling it.
   c) An automated announcement is missed because the PA is in use by a higher-priority user.

3.2 Alternative Flows

3.2.1 Coordinator Announcement

Coordinator makes PA announcement
The Coordinator shall be able to make an announcement over the selected PA system resources.

1) The *Establish radio communications* step in the ***RV1-Initiate Vehicle for Operation*** use case must be successfully completed before a Coordinator can access the PA system.
2) This alternative flow is triggered when a Coordinator sets up the call. (See use case ***CC5-Initiate Communications to Revenue Vehicle***.)
3) The VLU will receive a message via the radio system to set up a Coordinator announcement.
   a) System will determine which PA systems resources are needed (e.g., the hailing speaker just for the Operator or the interior PA speakers for the passengers). In the current system, the call-mode speaker is activated with a tone sent from the Legacy CAD/AVL system. (This method is simple and has worked well and should be considered for the proposed system.)
   b) System will execute the *Manage PA user priority* step in the Basic Flow.
   c) Note: The Operator can end a call by picking up the handset and hanging it back up. (See the Subsection **1.B, Description of Existing Systems** and use case ***RV17-Interface to 700 MHz Radio***.)
4) Coordinator will make an announcement.
5) When the Coordinator ends the call, the PA status should revert to its state before the Coordinator announcement, and/or automatically reset to “PA available.”
   a) The parameters and configuration must be approved by KC Project Manager in design.

3.2.2 Operator Announcement

Operator makes PA announcement
The Operator shall be able to make an announcement over the interior PA speakers.

1) The *Log in Operator* step in the ***RV1-Initiate Vehicle for Operation*** use case must be successfully completed before an Operator can access controls or use the PA.
2) This alternative flow is triggered when an Operator presses the PA key on the DDU. (See use case ***RV12-Interface to DDU***.)
3) System will execute the *Manage PA user priority* step in the Basic Flow.
4) When PA is available, system will activate the Operator’s PA microphone and change the display on the DDU to indicate that the PA is ready for the Operator to make an announcement.
5) Operator will make an announcement and press the PA key a second time to turn off the microphone and change status to “PA available.”
   a) If the Operator stops talking but does not manually turn off the microphone as described above, the system shall be able to do all of the following:
      i) Detect that the Operator has stopped talking.
      ii) After some time has elapsed signal the Operator and automatically reset the PA status to “PA available.”
      iii) Re-enable automatic announcements.
   b) The DDU display will indicate when the system has re-enabled the annunciator.

3.2.3 Prerecorded Public Service Announcement (PSA)

Operator plays PSA
The Operator shall play a prerecorded PSA by pressing the appropriate keys on the DDU.

The system design will allow up to 20 different PSA's, the list and content of which will be approved by KCM project management.

1) The Operator will select an announcement from a list of PSA's on the DDU. (For example, "Please move to the back to allow more passengers to board," "Smoking, eating and drinking are not allowed," or "Profanity is not allowed.")
2) System will execute the *Manage PA user priority* step in the basic flow.
3) The PSA will be played over the PA.
4) The DDU will automatically return to the main screen.

3.2.4 PA System Failure

Process PA system failure
The system will log PA malfunctions and display a message on the DDU that the PA is not working and that the Operator must make all required announcements.

4. Post-conditions

PA system usage implemented the priority scheme described in the Basic Flow.

Automatic "next stop" announcements were initiated at the correct place along the route when the vehicle was on route and disabled when the vehicle was off route.

The volume for announcements was set according to the ambient noise, and was audible to passengers in all areas of the vehicle without being overly loud.

Specified PA and Annunciator events were logged.

5. Special Requirements

5.1 Performance

ADA Compliance
The annunciator system design shall provide customer information in a way that satisfies the intent of the ADA.

1) The interior sign display characteristics, including size, color(s), fonts, and flash rates, will all be selected for ease of viewing by those with visual impairments.
   a) The following links describe current guidelines and information regarding displays for persons with disabilities.
      i) http://www.access-board.gov/publications/bulletins/alarms.htm
      ii) http://www.access-board.gov/research&training/VMS/finalreport.htm

   Discuss and compare the proposed interior sign characteristics with the recommended guidelines. Provide applicable certifications, test results, or other basis for the proposed interior display characteristics.
2) Annunciator features and functions will be designed to meet the needs of disabled customers. Describe proposed annunciator features and functions, and discuss how they meet this requirement.

Ambient noise detection and automatic PA volume level
Ambient noise sensors shall provide input for automatically controlling the volume level at each PA speaker, or in multiple zones on a zones based upon the level of ambient noise.

1) The existing PA speakers will be upgraded and ambient noise sensors added at each speaker, or at critical points on each bus.
2) The PA system will have the capability to set different volumes for different areas within a vehicle.
   a) The system should include technology to automatically set the PA volume at each speaker, or in each zone, based on the ambient noise detected at the speaker or in the zone.
   b) The system should be able to establish different volume settings for different situations inside and outside the vehicle.
      i) Zones in a vehicle: The back of a coach is much noisier than the front; therefore the optimum volume for the back of the coach would be louder than that for the front. Discuss the possibility of creating two zones on a standard 40-foot vehicle and possibly three zones on an articulated 60-foot vehicle. Describe the proposed solution to adjusting volume within different zones of a vehicle.
      ii) Exterior announcement: The route and destination announcement volume should be determined by the ambient noise detected outside of the vehicle (e.g. an announcement on a quiet street will play at a lower volume than at a noisy downtown stop).
   c) The OBS Administrator will have the capability to turn off this feature and to configure the following using an upload of configuration data.
      i) The DDU will have a configurable minimum and maximum volume.
      ii) There will be a configurable default volume setting in the midrange in case of malfunction of the system's ambient noise detection.
      iii) The Operator shall have the ability to turn off automatic volume levels and to set volume manually.

Interior sign characteristics
The interior sign shall be an off-the-shelf device with a standard interface that will be mounted on the vehicle ceiling.

1) The interior sign will provide a LED display.
   a) The display will be capable of displaying in a color and font that meet project requirements for ease of viewing by sight-impaired customers under all lighting conditions.
   b) The content of this display shall be driven by commands received from software installed on the VLU.
2) One sign will be installed on vehicles that are up to 40 feet. Articulated 60-foot buses will have two signs: one near the front of the vehicle and one near the middle.
   a) The sign must be small enough to mount on the vehicle ceiling without creating a low-hanging safety hazard.
   b) The sign must provide a display that can be easily read by a passenger with normal sight from anywhere in the vehicle.
3) The Stop Requested display will be handled separately from the route information in such a way as to ensure that it is distinctive from the dynamic customer information. *Discuss how the appearance of "Stop Requested" on the sign can be made distinctive. (Would the words appear in a different font or color, or perhaps in a dedicated area on the sign?) Describe how the system will provide an audible tone each time the "stop requested" sign is illuminated.*

5.2 Technical Specifications

Provide OBS Administrator and Operator controls
The system design shall include the addition of controls on the DDU for the PA and the annunciator.

1) The OBS Administrator will have the capability to enable or disable the Operator's control over annunciator functions and volume.

2) Configurable options for the exterior speaker and the interior PA speakers will include the following:
   a) Mute Control (off/on) for annunciator and/or exterior announcement.
   b) Volume control.
      i) Operator will have control over volume of Operator's announcements over the PA.
      ii) The range of settings will be limited to preset high and low thresholds (an Operator will never be able to set the volume so low that it is entirely inaudible).
      iii) The OBS Administrator will have the capability to globally enable or disable functions remotely by updating the DDU configuration settings over the WLAN.

Announcement trigger

The system will provide the OBS Administrator with a variety of options for specifying when an announcement will be triggered.

1) The on-board database (OBDB) will include a complete set of annunciator event triggers and associated audio content for every unique pattern.
2) The OBS Administrator will have the tools to configure offset distance or time.
   a) Announcements are associated with a Stop/Pattern and presented as an event in the sequence of events for the pattern.
      i) The trigger can be in the approach to the stop, e.g. 500 feet prior to entering the StopPointZone (as defined in TCIP).
      ii) Announcement timing can be based on predicted travel time to the stop (based on average speed). When the trigger point is crossed, the speed should be used to determine if it is time to begin the annunciation or if a speed-related delay has to be introduced before the beginning of the announcement so that the announcement is completed 30 seconds prior to reaching the stop. (For example, the trigger point is passed—if speed is fast, announce immediately; if speed is slow, delay, then announce.) This method would provide more consistent announcement timing when the vehicle's average speed along a route varies by time of day and day of week. (For example, rush hour average speed may be 10 mph while evening service along the same corridor may average 30 mph.)
      iii) The trigger can be in the departure from a stop.
         (1) An announcement is made as the vehicle is departing a stop when there is a large distance between stops.
         (2) An announcement is made on departure from the stop when the express service pattern is going to deviate from the local service pattern of the same route number. (For example, both local and express service make all downtown stops but follow a different path after leaving downtown.)
   b) Certain announcements are associated with a geographical trigger point placed at a point along a route. There may be some situations where an announcement should be triggered but offset distance is not reliable. *Describe how the proposed design will address the following situations:*
      - *When stops are miles apart, and an announcement must be made both when departing the previous stop and again as the vehicle approaches the next stop.*
      - *When the vehicle is approaching a stop from a freeway and the approach speed could cause the announcement to play too late to inform passengers in time to request the stop.*
3) The OBS Administrator shall be able to define the stops where an announcement is required, and the associated trigger point parameters.
   a) OBS Administrator will designate which stops should be announced.

i) OBS Administrator will select stops that will always be announced.

ii) OBS Administrator will select route-specific announcement trigger.

b) The system will enable stop-announcement trigger-point parameters to be set in the following ways:

i) As a global setting for all selected stops.

ii) For a specific stop.

iii) For all stops associated with a TPI (Timepoint Interchange, the path between two timepoints).

iv) For all stops on a route pattern.

4) It may be desirable for some announcements to be included or excluded based on time of day or day of week. (For example, the Ride Free zone would require a “This is the last stop in the Ride Free area” message between the hours of 6:00AM and 7:00PM, but not after 7:00PM, when the Ride Free policy is not in effect.) *Discuss feasibility and approach.*

Audio data management

The system shall provide current tools and methods for creating, managing, and maintaining audio data that will deliver clear sound that is not garbled or truncated by compression.

1) Announcement database:

a) The proposed audio file format must include the following:

i) Next stop—on street and cross street.

ii) Landmark—closest stop on the current trip to a landmark included in the KCM designated landmarks list or map layer (to be provided by KCM after contract award).

iii) Transfer information—stops.

b) System must have a compression scheme for managing audio file volume. *Describe the proposed scheme.*

- *Describe performance characteristics of the resultant sound quality in playback.*

2) The audio system shall provide a clear, articulate voice with a Northwest regional accent. *Describe the recommended approach for creating consistent, high-quality audio.*

- *Describe the recording equipment to be provided.*
- *Provide a CD with sample audio announcements.*
- *Describe the tools proposed for managing and maintaining audio data files.*
- *Discuss the tradeoffs with using different voice talents, agency employees, Internet sites, etc.*
- *Discuss the number and types of voices for creating the audio. What are the advantages and disadvantages of using one, two or several voices?*
- *Describe relevant experience, if any, where different voices were used for different types of service or service areas, e.g. male for express service and female for local; regional accents such as Asian in the international district, Hispanic in the south, etc.*
- *If recommending the use of professional voice talent or an Internet site, describe the proposed method for assuring that local place names such as Snoqualmie, Issaquah, or Benaroya are pronounced correctly.*

3) *Describe the requested data and format required in order for audio to associate to a stop, pattern, block, etc. in a database*. Announcements should consist both of information that is usually the same and information that varies by route and time of day.

a) Information that is always the same would include transfer points.

b) Information that varies by route would include the following:

   i) Landmarks: should be announced at the closest stop for each route. Announcement timing will depend on the path taken before or after the stop

   ii) Route-specific: information such as "This is the last stop downtown" applies to only some of the routes serving a stop (e.g. express vs. local).

c) Information that varies by time of day would include fare information.

Control PA system

The system shall be capable of managing and prioritizing shared use of the PA by multiple users.

1) The functional relationship between the PA system resources, interior speakers, hailing speaker, and exterior speaker must support shared use. *Describe the functional relationship of these components.*

   - *To what extent will the system design support simultaneous audio messages? For example, would it be possible for the following activities to occur simultaneously:*
     - *A Coordinator makes an announcement over the hailing speaker.*
     - *An automated stop announcement plays on the interior speakers.*
     - *An exterior announcement is triggered by the front door opening.*
   - *Describe the proposed method and controls for setting the volume for each part of the PA system.*
   - *Describe the feasibility of including the capability to play a prerecorded message over the hailing speaker to communicate to the Operator in addition to displays and tones on the DDU. This capability would have the advantage of communicating with the Operator without her having to take her eyes off of the road. This capability would be helpful for both planned and unplanned audio messages.*
     - *An example of a planned audio message: "There is a road relief scheduled for the next stop. Please log off."*
     - *An example of an unplanned audio message: "The driver display unit is not responding."*
   - *If this is possible, describe how it would work and all associated additional cost.*

2) A desirable system option is the priority override function described in the Basic Flow. *Discuss the technical approach and feasibility of this option.*

   - *Will the system interrupt a lower-priority user in the middle of making an announcement in some or all situations, or will the system wait until the PA is not in use?*
   - *Discuss how your proposed design supports, or does not support, the following statements:*
     - If PA status is "busy" when a Coordinator initiates a call, then the Coordinator message should override the current user whether the current user is the Operator or an automated announcement.
     - If the PA status is "busy" when the Operator presses the PA switch on the DDU, then the system should allow the Operator to override the automatic announcement.
     - If the PA status is "available" when an automated announcement is triggered, then the system shall initiate the automated announcement.
     - If the PA status is "busy" when an automated announcement is triggered, then the announcement will not be played and the DDU display of current announcement will begin to flash.

3) The system must coordinate priority and volume levels for various communications. *Describe how the proposed design would manage assigning control over PA resources and setting volume for the following list of example communications:*

- Coordinator announcement over PA for passengers, e.g. "New fares go into effect on Monday, January 1st".
- Coordinator announcement to the Operator on the hailing speaker, e.g. "All route 5 Operators please pick up your handset for an announcement".
- Operator announcement over the PA to communicate to the passengers, e.g. "There is a traffic problem ahead and we will be re-routing around it."
- Automatic "next stop" announcement by the Annunciator over the PA, e.g. "The next stop will be 8th Ave NW and NW 85th St, transfer to the route 48."
- Exterior announcement, e.g. "This is the 5 express to Northgate via Greenwood Ave."

4) The OBS shall include a PA amplifier with multiple inputs and multiple automatic gain controlled outputs. The amount of amplification for each zone shall be determined by the ambient noise level in each zone. The attack time, i.e., fast, slow, and off, will be selectable through firmware and via the DDU keypad.
   - *Describe the power source and means of connection.*
   - *Describe where and how will it be installed and maintained.*
   - *Provide the make, model, and specifications.*
5) The fleet currently has the hailing speaker and the Operator handset connected directly to the radio so that the Operator can communicate via the handset even if a major component such as the MDT is not working. *Describe the proposed configuration and the capability for Operator communication that is not dependent on the VLU or the DDU.*
6) If technically feasible, KCM may wish to have an additional set of pre-recorded system messages to alert the Operator to certain events.
   a) If provided, the system message pre-condition would be completion of the <u>*Start up system*</u> step in the ***RV1-Initiate Vehicle for Operation*** use case. The Operator will not be required to log in before this function is enabled.
   b) When the Hailing Speaker is not is use by the Coordinator, optional System messages will play over the hailing speaker when specific events occur.
      i) System messages would be a limited set of announcements to assist in communicating with the Operator when an action is required, such as "Please log in," or notification of a system health alarm relevant to the Operator, such as "The DDU is not responding" or "The engine is overheating."
      ii) The system message set will be configurable by the OBS Administrator. Configuration will include but not be limited to the following:
         (1) Configurable thresholds for health alarm announcement.
         (2) Delay: time between vehicle startup and when the system prompts for a login so as to allow the Operator time to log in without needing to be asked.

5.3 Testing

PA and Annunciator test cases

The test plan shall include test cases for each requirement statement and supporting details in this use case.

1) Manage PA user priority. Test scenarios should evaluate the system's ability to manage every combination of PA users in sequence and in combination.
2) Automatically announce route and destination.
   a) Test for synchronization of the exterior announcement and interior display with both automatic and manual changes in the destination sign code.

b) Evaluate automatic volume settings in a variety of locations both quiet and loud.

c) Test the system's ability to mute the announcement at designated stops.

d) Test the system's ability to enable and disable the Operator's capability to mute announcements.

3) Automatically display "next stop" information.

a) Incorporate ADA focus group input regarding sign performance and parameters.

b) Test the system's ability to remove dynamic information when the vehicle goes off route.

c) Test the system's ability to enable display of dynamic information when the vehicle gets back on route after having gone off route.

d) Test the system's ability to enable and disable the Operator's capability to turn off the route-specific dynamic displays.

4) Automatically announce major stop and transfer-point information.

a) Test the system's ability to suspend stop announcements when the vehicle goes off route.

b) Test the system's ability to re-enable stop announcements when the vehicle gets back on route after having gone off route.

c) Evaluate the quality and clarity of the sound in all areas of the vehicle.

d) Evaluate the ability to manage audio within vehicle zones based on ambient noise in the zone.

e) Test the system's ability to enable and disable the Operator's capability to turn off the automatic stop announcements.

5) Log Events.

6) Coordinator Announcement.

a) Test the ability for a Coordinator to make an announcement to passengers over the interior speaker system.

b) Test the capability for a Coordinator to make an announcement over the hailing speaker only.

c) Verify that Coordinator has priority over optional system announcements for use of the hailing speaker.

7) Operator Announcement.

a) Test the system's ability to enable an Operator announcement over the PA.

b) Test the system's ability to re-enable automatic announcements after the Operator has finished with his announcement.

8) Prerecorded Public Service Announcement (PSA).

9) Provide OBS Administrator and Operator Controls.

10) Announcement Trigger.

a) Test each type of trigger with a variety of scenarios such as:

i) The vehicle goes off route between stops.

ii) The vehicle goes back on route after being off route. *Determine the specific requirements for the system to verify that it is back on-route and therefore re-enable automatic announcements.*

iii) The vehicle approaches a stop requiring an announcement multiple times, at a variety of speeds.

iv) The vehicle approaches a stop from a wide thoroughfare and from the freeway, where it may approach the stop from more than one lane.

b) Measure the delay from the time that the vehicle reaches a trigger point to the time the announcement begins.

6. Extension Points

CC5-Initiate Communications to Revenue Vehicle

RV1-Initiate Vehicle for Operation

RV6-Manage Events

RV7-Determine Vehicle Location

RV8-Monitor Route and Schedule Adherence

RV12-Interface to DDU

RV13-Interface to Destination Signs

RV17-Interface to 700MHz Radio

7. Assumptions

7.1 Hardware

The existing speakers and PA microphone will be used by the OBS system.

The hailing speaker is located above the driver's seat in the cockpit area.

The OBS will provide a PA amplifier and ambient noise detection.

7.2 Logic

The offset distance to trigger an announcement will be based on the travel distance rather than a direct line.

Route number, destination, and Express service type, if applicable, are available and loaded for all circumstances to which the vehicle may be assigned. These elements are available as audio files and closely matching display text.

7.3 Annunciator data

KCM will provide all content for the annunciator displays and audio announcements formatted and organized in accordance with the Contractor's requirements. Stop names and sequences are automatically generated from existing data files. If not assured in the source data, stop names will be examined for understandability by the general public, and information loaded to vehicles will contain no transit jargon or ambiguous material.

Transfer points represent an agreed-upon set that coincides with transfer locations identified by and in use with other KCM information systems, such as the ATIS trip-planning system. Transfer points are kept current. If routes available for transfer at a transfer point are to be announced, lists of such routes are generated in an automated way, and vary in content depending on time of day and day of the week.

Landmarks associated with stop announcements represent an agreed-upon set that coincides with landmarks and common destinations available in other KCM information systems.

8. Issues

The exterior speaker is located on the outside of the vehicle near the front door on most vehicles. However, on some fleet types the speaker is located midway between the front and rear doors. Prior to implementation the project team will need to work with representatives of the disabled community to determine whether a new speaker should be installed nearer the front door of these vehicles.

Figure 2.B.4.1.10.RV10.b. Activity Diagram <u>Manage Interior Sign</u>

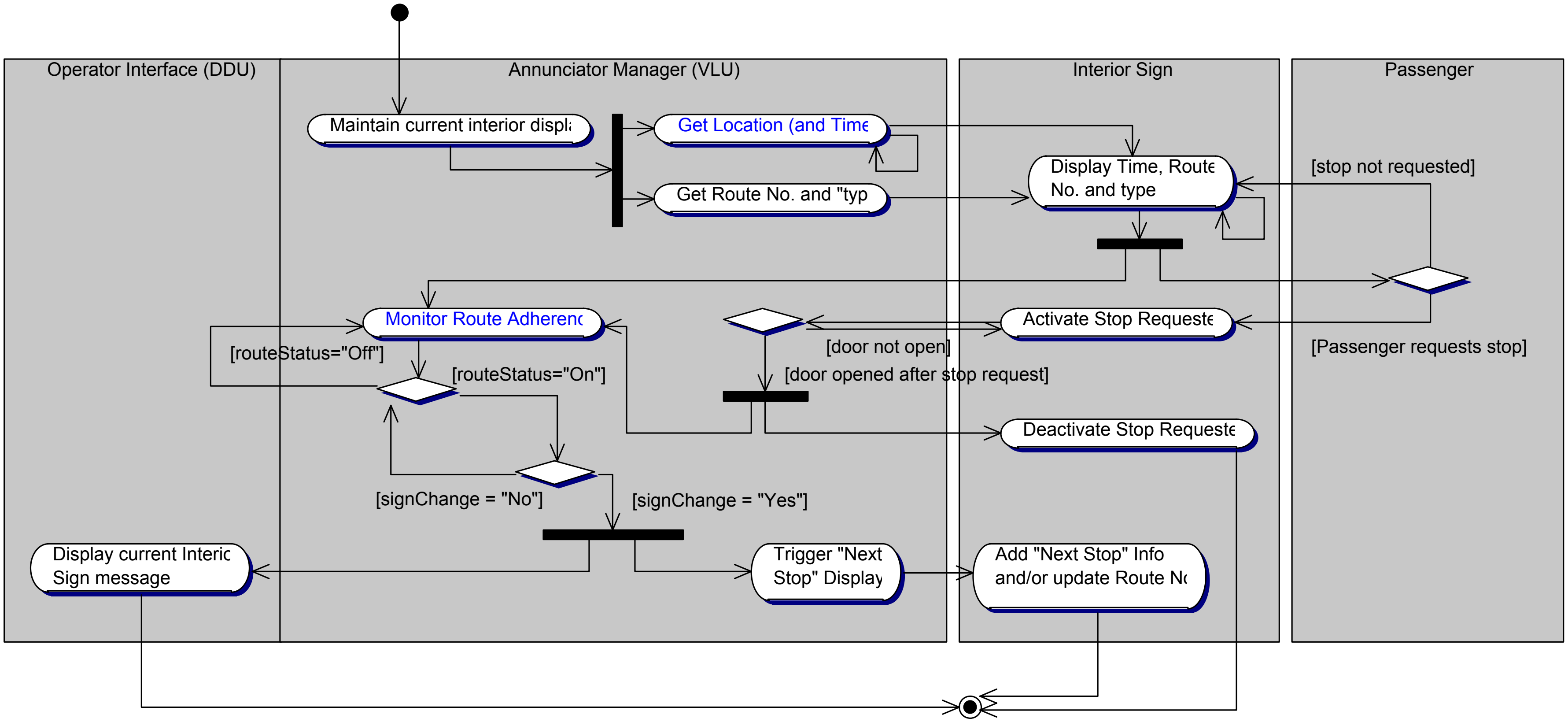


Figure 2.B.4.1.10.RV10.c. ***Activity Diagram <u>Provide Exterior Announcement</u>***

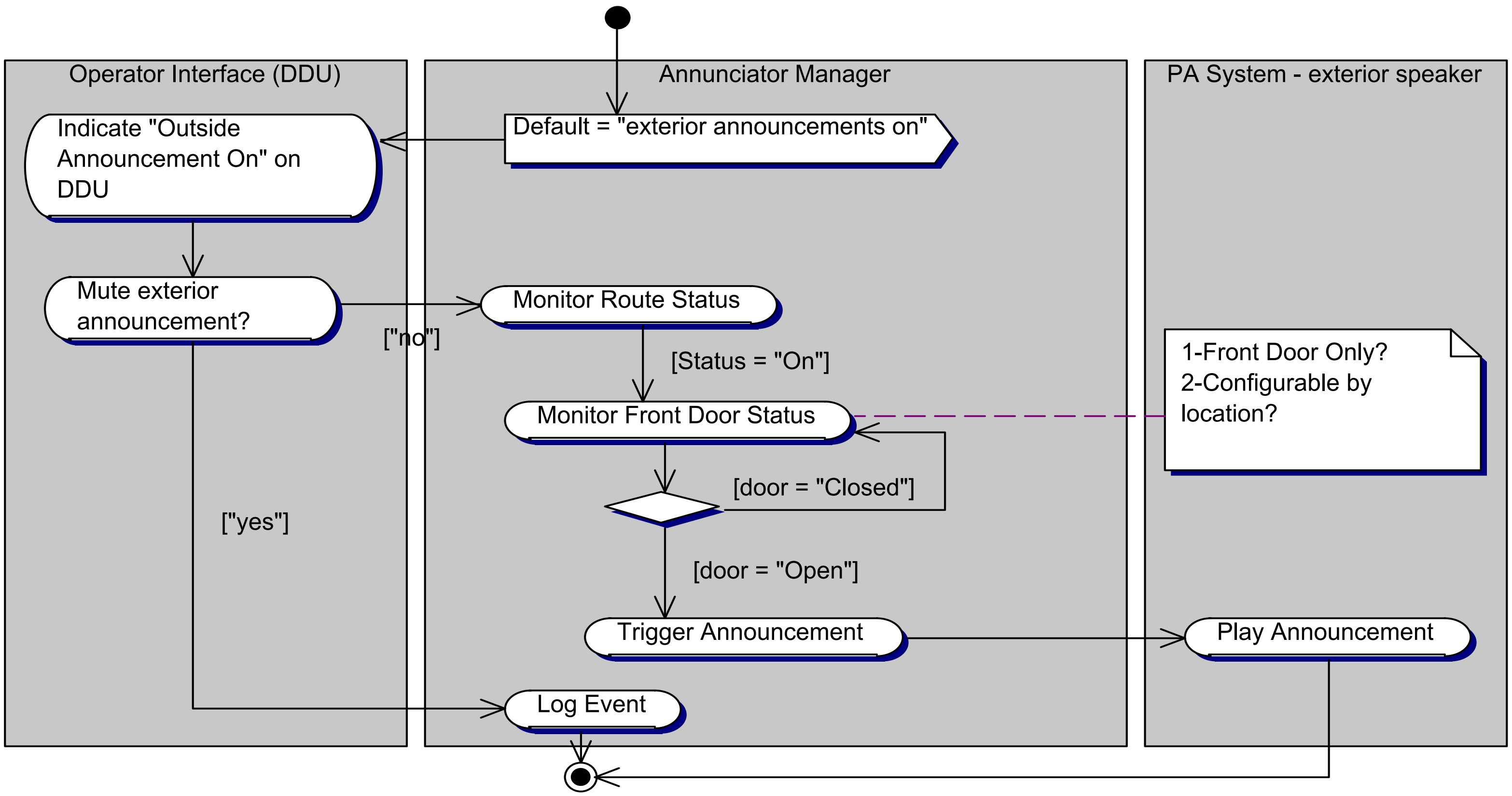
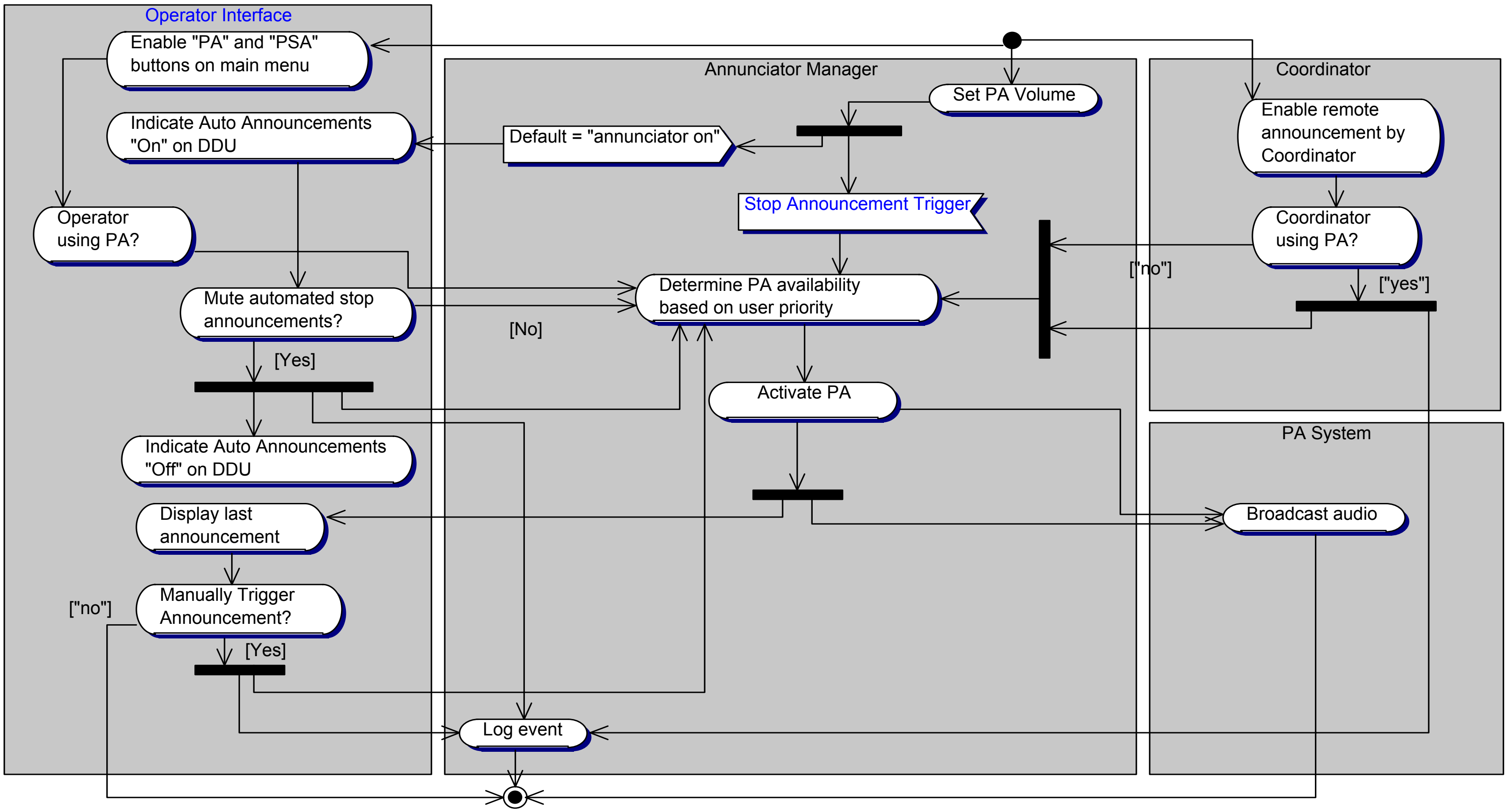


Figure 2.B.4.1.10.RV10.d. Activity Diagram Provide Interior Announcements



2.B.4.1.11. RV11-Manage AVM

This use case package includes the following UML diagrams:

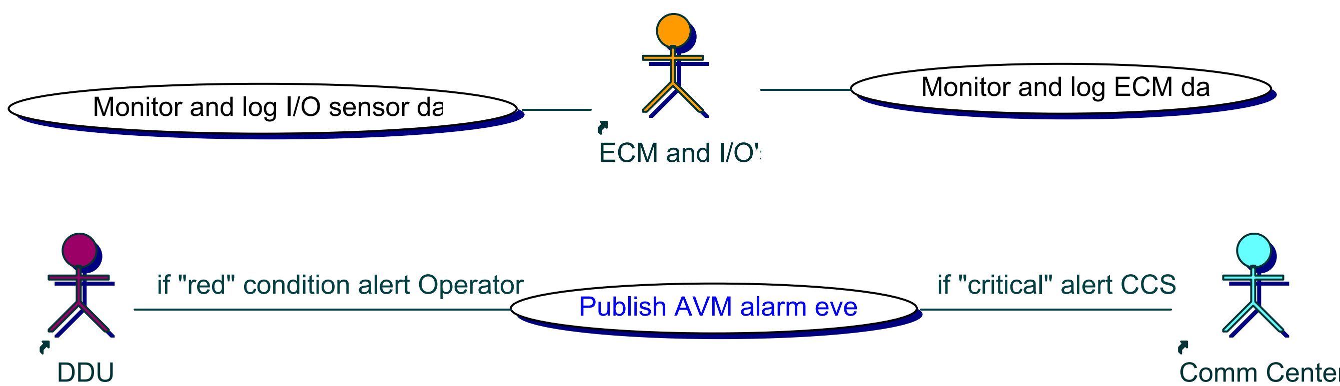
UseCase Diagrams

Figure ***2.B.4.1.11.RV11.a. RV11-Manage AVM***

Activity Diagrams

Figure ***2.B.4.1.11.RV11.b. Manage AVM Activity***

Figure 2.B.4.1.11.RV11.a. UseCase Diagram RV11- Manage AVM



12. RV11-Manage AVM

1. Brief Description

The Automatic Vehicle Monitoring (AVM) Manager will collect and report on the vehicle's drivetrain (engine, transmission, brakes, and electrical system) status and health. The two primary purposes for AVM are to 1) provide the basis for reliable alarm identification with near-real-time reporting capability and 2) to provide maintenance personnel with an efficient manner in which to process a significant amount of historical AVM data into useful information. Collected information will support effective fleet management decisions and allow the development of preventive maintenance practices based on historical device/system performance and health issues.

AVM information will be collected via the J1708/1939 network from the vehicle's engine control module (ECM) and a specified number of supplementary input/output sensors (I/Os). The ECM is provided by the vehicle (original equipment manufacturer) OEM to monitor the vehicle drivetrain performance. The OEM will have already programmed in thresholds and operating parameters for the systems and data that it collects. The ECM will send an alarm when drivetrain system performance is outside of normal operating range. The County accepts the OEM operating parameters for fault conditions. I/O sensors will supplement the ECM by monitoring points in the vehicle that are not handled by the ECM. I/O sensors will be connected to the VLU through either an electrical multiplexing unit (multiplexer) or, in newer vehicles, a built-in electrical bus. While the ECM also is connected to and collects data from sensors, these are connected directly to the ECM and their data reporting requirements are included as part of the ECM system. The term "I/O sensor" is used in this use case to refer only to those sensors hooked up to the VLU through a non-ECM connection, i.e. a multiplexer or a built-in electrical bus.

The AVM Manager will continuously evaluate the ECM and I/O sensor data streams, logging and reporting all input. Lapses in transmission from any reporting device (ECM, I/O sensor or multiplexer/data bus) will be reported as a health problem. (See use case ***RV5-Monitor System Health***.)

2. Pre-conditions

The *Start up system* step in the ***RV1-Initiate Vehicle for Operation*** use case has been successfully executed.

3. Flow of Events

This use case will be triggered as early as possible in the *Start up system* process to allow the AVM Manager to begin collecting ECM and sensor readings immediately after the vehicle is turned on.

3.1 Basic Flow

Monitor and log ECM data
The AVM Manager shall continuously monitor and log all data reported by the ECM from startup until engine shutdown.

1) ECM-captured critical and alarm (fault) conditions will be identified and reported to the Event Manager, and used during the ***RV3-Take Vehicle out of Operation*** use case.
2) The AVM Manager will also log an AVM health status event to the Event Manager if one of the following is true:
    a) The data for a connected device is no longer being reported by the ECM.
    b) The ECM fails to respond to requests for information.

Monitor and log I/O sensor data
The AVM Manager shall continuously monitor and log all I/O sensor data from startup until engine shutdown.

1) The AVM Manager will interpret and log all "change of state" data received from any sensor via the I/O interface, providing a record of readings over time on a per-sensor basis.
    a) The system will provide KCM with configurable parameters to set the normal operating-range thresholds for each sensor. See the "OBS Sensors and Threshold Requirements" Table in the *Issues* section below.

b) The sequence of changes of state for some connected sensors will indicate required information, e.g. lift-sensor sequences indicate passenger loading or unloading activities and may be used as the basis for counting passengers (see use case ***RV9-Manage Stop Point Activities***). This information also must be identified and logged.

2) Identification of any non-reporting sensors or loss of communication with the I/O interface will cause the system to log a "yellow" or "red" alarm condition. (See the *Signal AVM status* step in use case ***RV3-Take Vehicle out of Operation***.)

3) The system shall continue monitoring, logging, and reporting all received sensor data until the *Shut down vehicle* step of the ***RV3-Take Vehicle out of Operation*** use case.

Publish AVM Alarm Event

The AVM Manager shall report AVM alarms to the Event Manager.

1) Two types of (ECM) alarms reported to the AVM Manager shall be considered critical and will indicate either an "overheated engine" (low coolant level) or an "abnormal oil temperature" condition. These alarms are based on readings for these two systems indicating out-of-tolerance operating conditions. These will be processed by the Event Manager (see use case ***RV6-Manage Events***) as follows:

   a) For display on the DDU, identifying the critical alarm with a message indicating that the vehicle is to be taken out of operation as soon as is safely possible.

   b) Level 2 only: To the CCS, including critical condition, all out-of-tolerance data readings, and readings collected just before and after the alarm condition existed. This information will be passed on to the appropriate maintenance personnel for action.

2) All other ECM and multiplexer/bus I/O sensor alarms will be reported to the Event Manager as AVM events for transmission to the vehicle's base during the ***RV3-Take Vehicle out of Operation*** use case. Upon the vehicle's return to the base, the Event Manager will use this information to do the following:

   a) Activate the appropriate alarm light on the external AVM Signal display device using the WLAN or TSP tag for transmission.

      i) A red light indicates a currently existing fault state.

      ii) A yellow light indicates that an "out of tolerance" condition did exist at some point during the vehicle's last period of operation but is no longer in existence.

   b) Send an AVM event to the Base Server via the WLAN for transmission to Vehicle Maintenance. Additional information provided in the AVM event will include the reason for the alarm, all out-of-range data, and data collected just before and after the alarm condition existed. The time period for normal data to be transmitted shall be set by a configurable parameter.

   c) Compile all AVM data and event information for end-of-day transfer from the vehicle to the Base Server via the WLAN for use by Vehicle Maintenance.

      i) Specific problem data for transfer should include the system monitored and time/date data was recorded.

4. Post-conditions

All AVM data was accurately monitored, logged, reported, and transmitted to the Base Server.

5. Special Requirements

5.1 Technical Specifications

5.1.1 AVM Data Interface

AVM Data Interface Specification
An interface specification (ICD) will be required for all AVM data whether reported by the ECM or the multiplexer/bus.

ECM "fault" conditions and related data sets will be specified by type, vehicle type and specific vehicle ID.

5.1.2 ECM

ECM Compatibility
The system shall be compatible with multiple ECM types.

The type and sophistication of ECM differs by the type of vehicle on which the device is installed. The newest vehicles have a fully multiplexed data system and a fully interactive computer from which critical operating data can be retrieved and into which operating parameters can be input. An OEM-provided monitoring system to collect and store readings taken over time from the vehicle's engine, transmission, brakes, electronic traction control, and cooling system is standard on KCM vehicles.

5.1.3 I/O Sensors

I/O Sensors
System multiplexer shall provide connectivity to specified electronic sensors.

The multiplexer/bus provides connectivity to a specified set of electronic sensors installed on the vehicle as part of a J1708/J1939 network. For a draft list of sensors to be attached to the multiplexer/bus, see the *Special Conditions* section below. The final list of required sensor hookups will be provided by KCM during system design but shall number no more than 24 I/O devices. Each sensor reports "change of state" (binary) codes and/or analog readings to the multiplexer/bus, which in turn reports this data to this use case. The challenge here will be in correctly interpreting these readings and reporting derived information. The OBS Contractor will be responsible for providing the multiplexer (see Assumptions below).

5.1.4 Reporting

Reporting
AVM data shall be reported as detailed in appropriate use cases.

Reporting requirements for the full set of ECM and I/O data are detailed in the ***BO3-Manage Historical Data*** use case. Reported information will include both AVM events as well as the entire set of data for WLAN transmission to the base "landing pad." Data readings which indicate alarm conditions will be derived and reported separately as AVM Events. These event will contain "out of tolerance" data streams as well as a specified time period for the set of normal readings occurring before and after each alarm condition. See the ***RV3-Take Vehicle out of Operation*** use case for data transmission and alarm generation at the Base.

6. Extension Points

BO3-Manage Historical Data

RV1-Initiate Vehicle for Operation

RV3-Take Vehicle out of Operation

RV5-Monitor System Health

RV6-Manage Events

RV9-Manage Stop Point Activities

7. Assumptions

While both the ECM and the multiplexer/bus will have connected sensors providing data readings, sensors connected to the ECM are considered to be part of ECM functionality. The sensor data referred to in the *Monitor and Log I/O Sensor Data* step above refers to only those readings received from sensors connected to the multiplexer/bus.

The Door-Open switch information will be collected by the VLU from another source.

All vehicles have unused, OEM-installed cables available. (See Subsection **2.A.1.6.4.2, Existing Vehicle Area Networks**.)

Newer vehicles have electrical buses built in by the OEM that can be used to provide the electrical connectivity for the specified set of non-ECM I/O sensors. The Contractor shall provide multiplexer units for the specified Revenue Vehicle fleet types which are to be equipped with AVM functionality (see Table ***1.C.5, 2006 Fleet and OBS Equipment Plan)***, and do not have an OEM-provided electrical bus with which the VLU can interface. The Contractor shall also provide kits for each vehicle containing all wiring and connectors needed to hook up I/O sensors through the electrical management unit to the VLU. KCM maintenance personnel will complete all wiring and connectivity required for hookup, based on KCM-approved prototypes developed by the vendor during system design.

Vehicle and Event Managers will have system processing and reporting priority for all alarm conditions on an as-needed basis.

All AVM data received by this system will be reported in read-only format.

8. Issues

We are interested in tracking and monitoring road speed, acceleration, and braking data streams for use by our Safety group during incident/accident investigations. If an Operator activates the "protect video stream" function for the security camera, which triggers the cameras to film at a higher frames/minute rate, can this same trigger be used to add (near) real-time speed and braking data to the reported information?

There are currently vehicles which perform revenue service but do not begin and/or end work at a transit base. Options for updating these vehicles should be discussed in the proposal.

OBS Sensors and Threshold Requirements

This list of (non-ECM) sensors would be needed to help Vehicle Maintenance (VM) identify early vehicle problems and make the necessary repairs before major components fail. The “No. of Wires” column below indicates the number of wires needed at that sensor’s location to meet KCM monitoring requirements.

The AVM wiring harness for these sensors would need 20 wires with a minimum 20% spares. All harnesses over 5 feet long must have wire identification numbers at least every 5 inches.

Table 2.B.4.1.RV11. OBS Sensors and Threshold Requirements

I/O SENSOR	NO. OF WIRES	SENSOR AND REPORTABLE THRESHOLD(S) DESCRIPTIONS
Engine oil pressure, reported in real time via the radio	1	This should be a real-time event reported via the radio to the Coordinator and then by the Coordinator immediately to the VM shop where the maintenance lead can access and assess the information. This process is to minimize damage to the engine. Reportable threshold: oil pressure below 25 P.S.I. when engine speed is greater than 1200 R.P.M.
Very low engine coolant level, reported in real time via the radio		In the event the coolant is lost, the engine will be severely damaged. A sender located in the block that is capable of detecting the presence of coolant will be required. Reporting is handled in the same manner as with low engine oil pressure.

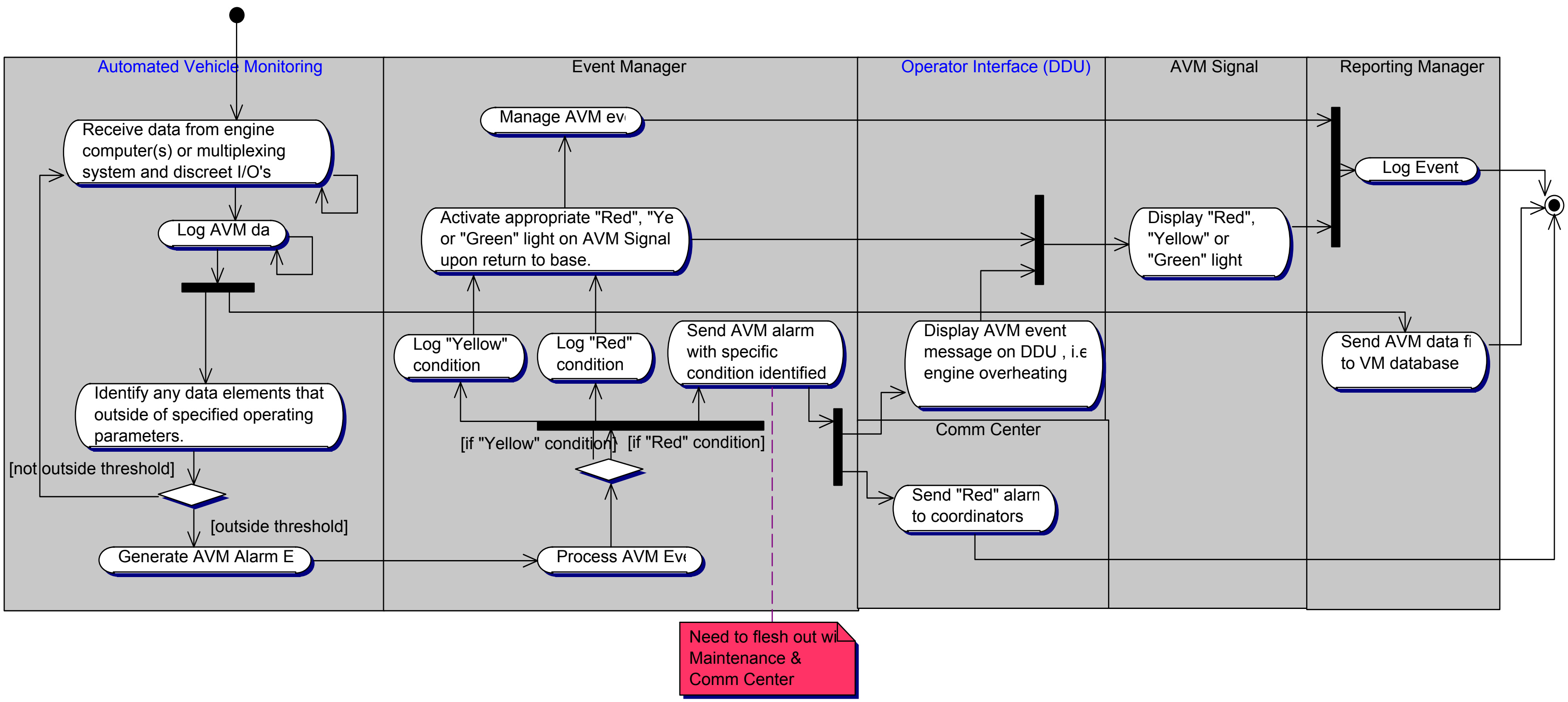
I/O SENSOR	NO. OF WIRES	SENSOR AND REPORTABLE THRESHOLD(S) DESCRIPTIONS
Transmission retarder temperature	1	This sensor will see peak transmission oil temperatures. Knowledge of peak temperature/duration is useful in setting preventive maintenance (P.M.) intervals and troubleshooting transmission and retarder problems. Preferred range would be analog between 200 and 400 degrees F. with a flagged event report at 365 F. If analog is not available, a report of temperatures in excess of 350 degrees and the duration of the period should be tracked.
Engine air intake restriction	1	This sensor is intended to measure intake vacuum. Useful for P.M. intervals and troubleshooting low engine power complaints as this is an area not monitored by the engine's ECM (ECU). A simple switch set to close at (a vacuum of) 25 in./hg. will suffice.
Exhaust backpressure	1	A sensor here will measure exhaust restriction. Useful for P.M. intervals and troubleshooting low engine power complaints as this is an area not monitored by the engine E.C.U. This will also give advance warning of a plugged muffler and would help workflow scheduling. A switch set at 4 in/hg (pressure) will work. This switch must be isolated from the exhaust gas heat.
Differential oil temperature	1	Monitoring differential oil temperature will be useful in early failure diagnosis, troubleshooting, and P.M. intervals. An analog sensor with a range of 100 degrees F. to 400 degrees F. would be preferred. A switch with a settable (dial-in) threshold would be less desirable but useful.
Brake drum temperature	1	Heat is in direct proportion to braking action. Benefits of knowing brake efficiency would be safety, troubleshooting, and facilitation of product testing. This area needs sensors aimed at each brake drum capable of detecting temperatures without direct contact, (e.g., infrared sensors), with a range from 100 degrees F. to 1200 degrees F, and able to withstand a harsh environment of dirt and water.
Brake chamber pressure	1	
Air compressor discharge temperature	1	A rise in discharge temperature may indicate an obstruction or restriction. Knowing this will allow more efficient troubleshooting. The parameters for this sensor would be the same as the differential oil temperature sensor. Analog 100–400 degrees F. or a settable switch.
Wheelchair pressure	1	
Battery equalizer voltages	1	Normally unseen but a component of charge rate. The equalizer has no direct readout (voltmeter). An analog reading of tenths of a volt from 11.5 to 14.2 would make charging-system troubleshooting easier and quicker.
Charge rate	1	An analog reading of alternator output in tenths of a volt from 24 to 28.5 volts. Helpful in troubleshooting and PM.

I/O SENSOR	NO. OF WIRES	SENSOR AND REPORTABLE THRESHOLD(S) DESCRIPTIONS
Hinge fail switch for both modes	2	The articulation joint on the 2300 fleet reports problems in distinct ways. Unfortunately the report to the shop is usually just a “hinge failure.” Monitoring which path the fault signal came down would help accurately troubleshoot intermittent hinge problems. This would only require detecting the presence of a 12v signal.
HVAC low charge pressure	1	

The following areas would require additional spare wires available for future use.

Engine/Transmission compartment	5	
Wheelchair Lift	1	

Figure 2.B.4.1.11.RV11.b. Activity Diagram <u>Manage AVM</u>



2.B.4.1.12. RV12-Interface to the Driver Display Unit

This use case package includes the following UML diagrams:

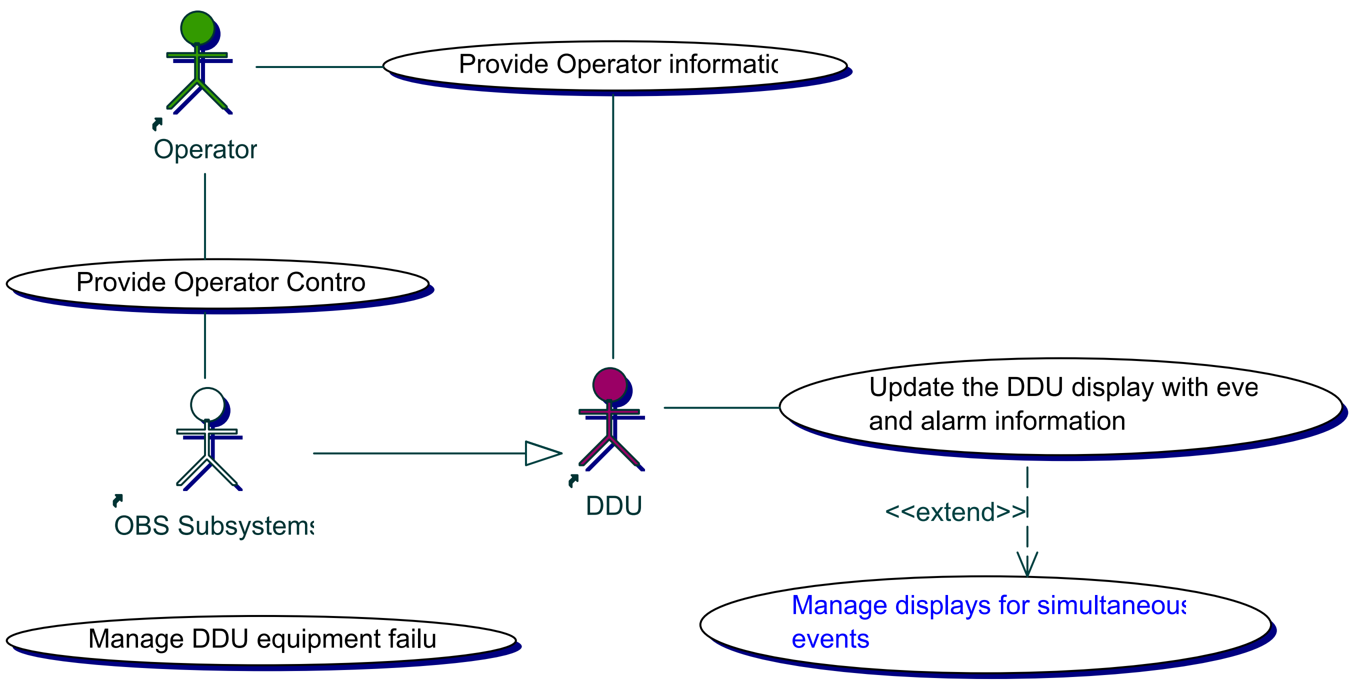
UseCase Diagrams

Figure ***2.B.4.1.12.RV12.a. RV12- Interface to the DDU***

Activity Diagrams

Figure ***2.B.4.1.12.RV12.b. Interface to the DDU Activity***

Figure 2.B.4.1.12.RV12.a. UseCase Diagram RV12- Interface to the DDU



13. RV12-Interface to Driver Display Unit

1. Brief Description

The Driver Display Unit (DDU) will be the sole interface for Operator interaction with the OBS. The DDU will be provided by ERG as a part of the RFCS smart card project. The device will consist of a software programmable display with programmable soft keys on the perimeter. ERG will design and deliver a DDU that supports the legacy 450MHz radio functionality, the RCU interface, and required smart card functions including login and logout, radio communications, the public address system, and fare collection. See Subsection **1.C.2, RFCS ("Smart Card") Project**.

The OBS development task, with regard to the DDU, will be to add modules to the user interface software necessary to support the new OBS requirements. OBS modifications will provide Operator controls for on-board system settings and overrides and modifications to the functionality provided by the ERG design to enable capabilities provided by OBS (e.g., Level 2 enhancements to the process for establishing radio communications—see the ***RV17-Interface to 700 MHz Radio*** use case). OBS will also add the display of service and status information such as run card timepoints, schedule and route adherence, text messages, event and alarm information, etc. See Appendix **H, DDU Functionality Matrices** for a description of the functions and relationships that are desired for the OBS. In order to facilitate this, the RFCS contract has a number of provisions to provide the OBS design team with the access and tools to do the necessary design work. See Subsection **1.C, Systems Development and Implementation Environment**, for additional DDU information.

It is essential that the DDU management interface be designed with a clear set of priorities for processing competing DDU events. It is also essential that the menus, displays, and screens are easy to read and navigate with a minimum of keystrokes. Final screen designs will be validated with Operator focus-group usability studies and approved by the KCM Project Manager.

2. Pre-conditions

Level 1: The *Manage login process* step and all preceding steps of the ***RV1-Initiate Vehicle for Operation*** use case have been successfully completed.

The Operator has logged in to a work assignment with associated schedule and trip data in the OBDB.

3. Flow of Events

This use case is triggered by an Operator turning on a vehicle.

3.1 Basic Flow

The basic flow describes the Level 1 functional requirements for the operator interface software that will function on the DDU.

Provide Operator controls
The Operator shall use the DDU interface to control OBS subsystem functions as detailed in Appendix **H, DDU Functionality Matrices**.

1) The DDU should be in its normal operational state and the main menu will be displayed.
2) A successful Operator login must be provided before the system will enable full access to Operator controls and information.
    a) Level 1: The OBS shall support the RFCS-developed login requirements. (See the ***RV1-Initiate Vehicle for Operation*** use case Basic Flow.)
    b) Level 2 only: Upon successful completion of system startup the VLU will enable only limited functions. (See the ***RV1-Initiate Vehicle for Operation*** use case Alternate Flow *Phase 2: Manage login process and establish radio communications*.)

Provide Operator information
The DDU shall display current service and status information.

The screen design and layout will include current information related to the work assignment and status.

Update the DDU display with event and alarm information
When an event or alarm occurs the DDU shall update the display.

1) Management of the display will be in accordance with the priority assigned by the Event Manager. (See use case ***RV6-Manage Events***.)
2) The DDU display will alert the Operator to changes in status (e.g., by a predetermined tone or flashing element on the display).
3) Thresholds for alarms will be configurable by the OBS Administrator.

Manage displays for simultaneous events
The VLU and DDU shall, in combination, effectively deal with the occurrence of simultaneous events and actions.

1) When events, key presses, or transactions occur simultaneously, the DDU will place them in a queue and display them in accordance with the priority assigned by the Event Manager.
2) If a fare transaction is interrupted with a higher-priority event, the DDU and FTP will complete the transaction in progress and immediately switch to processing the higher-priority event.
   a) Customer interactions should not be interrupted by events.
   b) The time delay will be the minimum required for handling the immediate fare transaction in order to ensuring fare data integrity.
3) Optimization of the handling of simultaneous events without locking up, losing data, or only partially handling a process shall be developed by the OBS vendor and approved by both OBS and RFCS project management.
4) Level 2 only: Text Messages:
   a) Incoming text messages will be displayed upon receipt and placed in a queue for subsequent review by the Operator.
   b) Outgoing text messages will also be placed in a queue along with receipt acknowledgment for an Operator to review.
   c) All queued messages will be retained in chronological order until the Operator deletes the message or the system is logged out.

3.2 Alternative Flows

Manage DDU Equipment Failure
The OBS design shall include a method for handling and reporting a malfunctioning DDU.

1) The Operator will be notified by a KCM Project Manager–approved method that does not rely on the DDU.
2) The Contractor will work with the TRS contractor to develop an OBS design enabling the Operator to communicate with a Coordinator via the mobile radio even when the DDU is not working properly.

4. Post-conditions

Successful completion of the DDU shutdown as part of the *Shut down vehicle* step in use case ***RV3-Take Vehicle out of Operation***.

5. Special Requirements

5.1 Performance

Update the DDU display with event and alarm information
When an event or alarm occurs, the DDU shall update the display.

1) Management of the display will be in accordance with the priority assigned by the Event Manager. (See use case ***RV6-Manage Events***.)
2) The specific methods and protocols for when, how, and what to display on the DDU will be developed in collaboration with the RFCS project, Transit Operations, Maintenance, and Safety, and will be approved by the KCM Project Manager.
3) Planned Events to be displayed may include but are not limited to:
    a) Beginning and end of trip.
    b) Automatic destination sign change.
    c) Next run card information (on street, cross street, and scheduled arrival time).
    d) Schedule adherence at last timepoint.
    e) Current stop announcement. (See use case ***RV10-Manage PA and Annunciator***.)
    f) Automatic fare set (optional).
    g) Public Service Announcements (initiated by Operator).
4) Unplanned Events to be displayed may include but are not limited to:
    a) Off-route operation.
    b) AVM alarm (red condition). (See use case ***RV11-Manage AVM***.)
    c) Incoming radio message.
    d) Incoming text message.
    e) Health status alert for OBS components.
5) The OBS Administrator should have the ability to configure what events will be logged.

5.2 Technical Requirements

Operator information
The design of the DDU display shall provide all information designated by KCM as necessary to the performance of the Operator's job.

DDU display may include but is not limited to:

1) Clock: should ALWAYS be clearly displayed in the same location on ALL screens.
2) Run Card Information (trips, indicates, timepoints and scheduled times) e.g. if the vehicle is on route, the next timepoint and scheduled arrival time should be indicated.
3) Alarms and Events Messages.
4) Flashing, tone or color options to the extent practical for the transit operating environment and possible on the DDU provided.
5) The capability to enable/disable certain functions and screens so that they will only work when the vehicle is stationary with the brake set.
6) Current Customer Information.
    a) Destination sign.
    b) Current Announcement.
7) Route and Schedule Status.
8) Route/Run.

9) Level 2 only: The following screens and displays will be added. (See use case ***RV17-Interface to 700 MHz Radio.)***
   a) Text Messages from CCS.
   b) Incoming radio call type: single vehicle call, all call, hailing speaker/call mode, PA call.
   c) Remote log in/out activities by the CCS.

Operator controls
The DDU shall provide the Operator with the ability to control OBS functions as detailed in the Appendix **H, DDU Functionality Matrices**.

1) The controls and screens may include but are not limited to:
   a) OBS Login/Logout: See the ***RV1-Initiate Vehicle for Operation*** and ***RV3-Take Vehicle out of Operation*** use cases.
   b) Fare Transaction Processor: See the ***RV14-Interface to FTP*** use case for possible modifications such as "automatically change the fare set."
   c) Destination Signs: See use case ***RV13-Interface to Destination Signs***.
   d) PA Switch and Annunciator: See use case ***RV10-Manage PA and Annunciator***.
   e) Level 2 only: See use case ***RV17-Interface to 700 MHz Radio***. (Note: In Level 1, the interface functionality will be in support of the radio system that is implemented by the RFCS contractor and should not require modification.)
      i) Text Messaging.
         (1) Operators will be able to send preprogrammed text messages to the CCS.
         (2) The methods and protocols for sending/receiving text messages (e.g., text messaging will not be enabled unless the vehicle is parked) will be approved by KCM Operations Training and Safety staff.
      ii) The OBS Administrator will have the ability to enable/disable Operator controls, add/delete text messages, and modify DDU displays by transmitting a DDU configuration file update.

Operator displays
The DDU design shall provide Operators with the ability to adjust display and volume preferences.

1) There will be default settings established for volume(s) and display parameters. These default settings will be different for different vehicle fleet types.
2) In the case of a cold start, the system will automatically implement all default settings.
3) There will be configurable limits on the level of adjustment an Operator can make (e.g., they cannot reduce the display lighting to the point that the screen blanks out).
4) The design will provide for system overrides (these will be approved by the KCM Project Manager in design).
5) The DDU will include maintenance screens with controlled access for maintenance staff use in troubleshooting and maintenance functions. The list of functions shall be configurable.
6) Optional: The DDU will include an Electronic Operator Request Form.
   a) An Electronic Operator Request Form will include a drop-down list of common problems from which an Operator can select one or more.
   b) The selected problem(s) would be logged by the Event Manager and forwarded to VM for follow-up.
   c) At vehicle shutdown the system will prompt the Operator to complete an Operator Request (OR) form.

5.3 Testing

Usability Testing
Both Level 1 and Level 2, Design phases shall include formal usability testing by KCM Operators.

DDU Software Certification
The OBS-designed DDU software shall undergo a certification process prior to implementation for operational testing.

1) The Contractor will provide the OBS DDU displays and layout to the RFCS contractor for DDU certification.
2) The DDU certification process has been established so that the RFCS contractor can verify that the preexisting radio and fare transaction screens and functionality continue to operate properly after the OBS screens and functions are added to the DDU applications.

5.4 Usability

DDU display modifications
The content and layout of the DDU shall be designed for ease of use and understanding as demonstrated by adherence to the latest human-factors guidelines and KCM Operator usability testing.

1) OBS modifications to the DDU displays will supplement the preexisting RFCS and 450 MHz radio displays and key assignments. Unassigned keys and sufficient application memory are provided for OBS display modifications.
2) DDU design will keep the RTT/PRTT buttons active from any Operator screen.
3) A maximum of three clicks or key presses will be required to move to any screen or menu from the main DDU display.
4) DDU design will adhere to most current human-factors guidelines, and will be subject to usability testing by KCM Operators. *Describe the proposed in-house or subcontracted staff expertise in usability. Describe the methods and processes for designing in usability features.*

6. Related Use Cases

RV1-Initiate Vehicle for Operation

RV3-Take Vehicle out of Operation

RV6-Manage Events

RV10-Manage PA and Annunciator

RV11-Manage AVM

RV13-Interface to Destination Signs

RV14-Interface to FTP

RV17-Interface to 700 MHz Radio

7. Assumptions

The VLU shall manage the DDU and provide the connectivity to integrated components for which the Operator has control, including radio, PA system, fare transaction processor, destination signs, etc. It shall also manage the networking of data between the OBS Subsystems, e.g. send schedule adherence status updates to the TSP Tag.

450 MHz Radio and smart card displays and menus will already be programmed into the DDU by the RFCS project including the login screens (see Subsection **1.C, System Development and Implementation Environment**). The

preexisting screen layout and functions provided by the RFCS project shall not be altered when adding the new OBS screens, menus and functions.

The Contractor will work with Operations management and an Operator focus group to develop the design and layout of the new DDU screens. The KCM Project Manager shall approve the DDU modifications in design.

8. Issues

The RFCS contractor will work with KCM and the OBS Contractor to assure that the radio and fare-collection key assignments and screens will remain fixed on the DDU in Level 1 and Level 2. Optimally, the layout for all OBS functionality should be accommodated by the screen designs from the start. When new functionality is added then the VLU will forward the necessary files to modify the new displays.

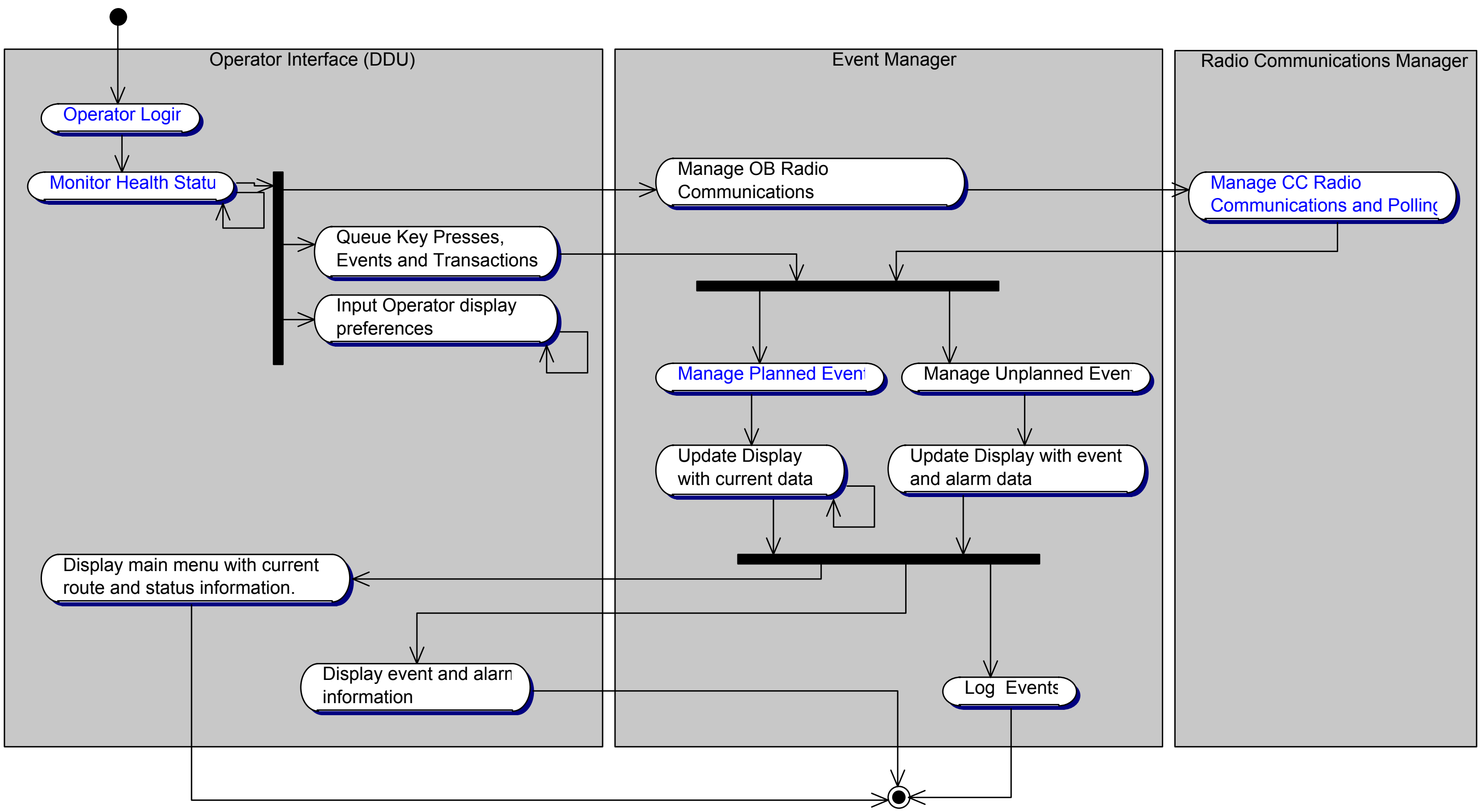
OBS system functionality will be added in two phases. Phase 1, with the current radio system will include:

- Run card information
- Customer information
- Route and schedule adherence information
- Optional: electronic work order form

Phase 2, with implementation of the new radio system will add:

- Text messages

Figure 2.B.4.1.12.RV12.b. Activity Diagram Interface to DDU



2.B.4.1.13. RV13-Interface to Destination Signs

This use case package includes the following UML diagrams:

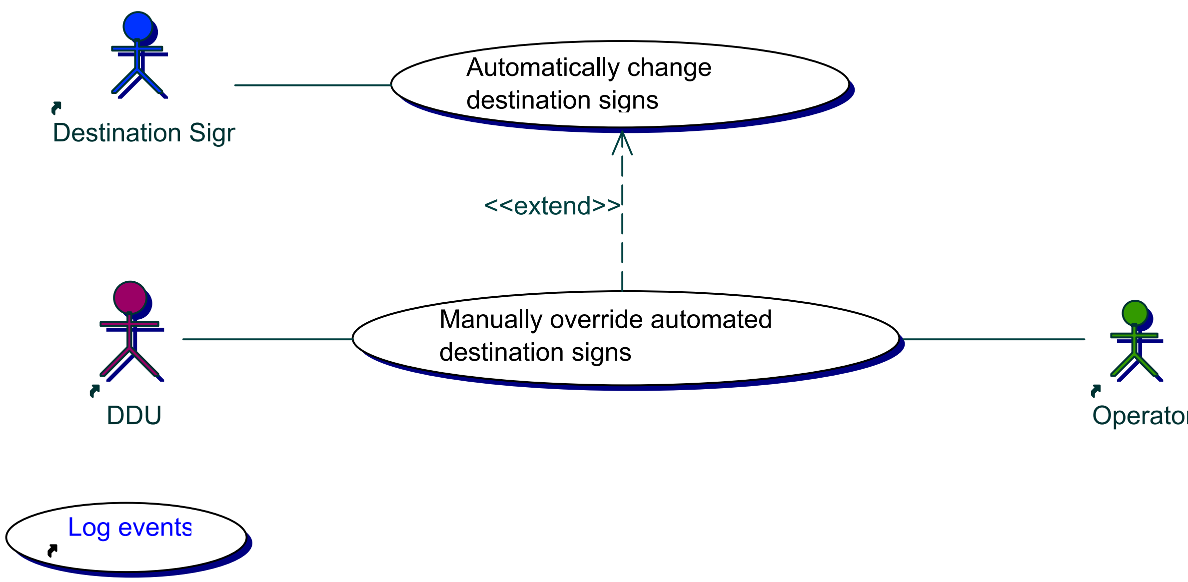
UseCase Diagrams

Figure ***2.B.4.1.13.RV13.a. RV13- Interface to Destination Signs***

Activity Diagrams

Figure ***2.B.4.1.13.RV13.b. Interface to Destination Signs***

Figure 2.B.4.1.13.RV13.a.  ***UseCase Diagram RV13- Interface to Destination Signs***



14. RV13-Interface to Destination Signs

1. Brief Description

The Destination Sign System is installed by the Revenue Vehicle manufacturer. Destination signs are mounted on the exterior front, side, and rear of the vehicle. There are a variety of makes and models installed depending on when the vehicle type was procured (see Subsection **1.B.4.5, Destination Signs**). This use case describes how the Vehicle Logic Unit (VLU) must automatically set a new destination sign code based on login, location, and time.

The ***RV4-Update Vehicle Data*** use case addresses the requirement to wirelessly load new destination-sign files. Sign codes and associated content are programmed by Vehicle Maintenance staff and then loaded onto each vehicle's sign processor. The destination sign files provide a complete set of all authorized KCM sign codes. The sign code prompts the associated display of the service route number and destination and, when applicable, service type and/or "via" path of travel, e.g. "5 Express via Greenwood to Northgate." The content of the signs on the front, side, and back of the vehicle will vary.

2. Pre-conditions

The ***RV1-Initiate Vehicle for Operation*** use case has been successfully completed.

3. Flow of Events

This use case begins with the *Initiate On-Board Systems* step in the ***RV1-Initiate Vehicle for Operation*** use case.

3.1 Basic Flow

Destination signs will be changed automatically to display the appropriate customer information related to the current location (and time) and BlockID entered at Operator login.

Automatically change destination signs
The OBS shall automatically send a destination sign code at the appropriate location for the login provided.

1) System will associate the current location (and time) with the current work assignment (Route/Run) login to identify the trigger point at which to change the destination signs. (See use case ***RV8- Monitor Route and Schedule Adherence***.)
    a) The OBS Administrator can configure sign-change location (and time).
2) System will determine the correct destination sign code.
3) System will push the correct destination sign code to the Destination Sign System.
4) Destination Sign System will return an acknowledgment.
5) System will update display on DDU with current destination sign text.

Log events
The Event Manager shall log each destination sign change.

1) Event Manager will log location (and time) of change. (See use case ***RV6-Manage Events***.)
2) Event Manager will indicate whether the sign change was automatic or manual.
3) Event Manager will include the sign code in effect by the change.

3.2 Alternative Flows

3.2.1 Manually override automated destination signs

Manually override automated destination signs
The Operator shall have the option to manually set the destination sign code.

1) The Operator will enter a new destination sign code on the DDU.
    a) When a destination sign code is manually entered, it will override the automatic setting.

b) The sign change will remain in effect until the Operator returns the destination sign to automatic operation.

c) When the vehicle arrives at the next destination-sign trigger point, the system will signal the Operator.

i) When manual override is "on," a message will be displayed on the DDU informing the Operator that a sign-change point has been reached.

ii) The Operator will have the option of accepting the new sign code.

(1) If the Operator accepts the automatic prompt, the system will return to automatically changing the signs.

(2) If the Operator does not accept the suggested change, the system will maintain the sign code that was last entered manually.

2) The DDU display must clearly indicate when the destination signs are set to manual override.

3) The Operator can re-enable the automatic destination sign function by pressing a button on the DDU.

4. Post-conditions

The destination signs have automatically displayed the correct information for the work assignment entered at login, and have also displayed any manually-entered changes.

5. Special Requirements

5.1 Performance

Synchronize destination signs, exterior announcement, and interior display
Every destination-sign code change shall simultaneously change the exterior announcement to the appropriate corresponding audio and update the "route" identifier displayed on the interior sign.

1) In order to meet the requirements of the ADA, it is a high priority that the exterior audio and interior sign reflect the current destination sign text. *Describe how the proposed design will assure that the displays and audio are in sync.*

- *What defaults and protections are proposed to guard against an incorrect exterior announcement?*
- *Provide a sequence diagram describing the flow of data and estimated response times between the VLU, Destination Sign System, Annunciator and PA.*

5.2 Technical Requirements

Manage destination-sign trigger point
The system shall include the ability to define the trigger point at which the destination sign will automatically change.

1) The system will trigger changes in destination information at designated points along the route. (See use case ***RV8-Monitor Route and Schedule Adherence***.)

2) When a layover is scheduled at a terminal, the system will support sign changes at the layover.

a) One sign code will be in effect during the layover.

b) The system should wait for a configurable time prior to departing the first stop and changing to the sign for the next trip.

3) The system will trigger changes in "via" signage during a trip.

a) On numerous routes the destination sign may be changed multiple times in a single trip in order to update the "via" information. (For example, at the beginning of a trip the signs would read "Route 26 via Fremont to Greenlake;" then when the coach reaches Fremont, the signs would change to "Route 26 to Greenlake.")

b) The design will accommodate a maximum of three "via" changes in any one trip, defined as a unique pattern.

Interface Management for Destination-Sign Systems
The OBS design shall provide the capability to interface to multiple sign types.

1) The system shall be able to interface to each destination-sign type included in *Table* ***1.B.4.5, Current Destination Sign Types***. Describe how the proposed system will include interface and configuration management tools for these sign types. Discuss previous experience with implementing interfaces to different makes and models of sign systems.

2) The system shall be able to interface to other sign types as they are added to KCM's operations. *Describe the proposed methods and tools for adding a new sign type.*

Update Destination Sign Files
The OBS shall automate the process to load new destination-sign files.

1) The existing systems use a PCMIA card to store destination-sign code data. Each time the sign file is to be updated, maintenance staff manually loads the new file onto each vehicle. The OBS will receive new destination-sign files wirelessly. (See use case ***RV4-Update Vehicle Data***.)

2) If possible, the OBS may load sign files via the VAN in lieu of the PCMIA card. *Discuss the proposed approach and technical feasibility of this option.*

5.3 Testing

Destination-sign test cases
The test plan shall include test cases for each requirement statement in this use case.

1) Automatically change destination signs.

   a) The test plan must include the following operating scenarios:

      i) Normal on-route service operation.

         (1) "Via" sign changes.

         (2) Through-route sign changes.

      ii) On-route operation that goes off route, and then returns to on-route, for one of the following reasons:

         (1) A sign-change trigger is missed while off route.

         (2) The vehicle turns back early, so that the end of trip is not reached, and begins operating another trip.

      iii) Layover arrival and departure changes.

2) Log events.

3) Manually override automated destination signs.

4) Synchronize destination signs and exterior announcement.

5) Manage destination-sign trigger point.

6) Interface management for Destination Sign Systems.

6. Extension Points

RV1-Initiate Vehicle for Operation

RV4-Update Vehicle Data

RV6-Manage Events

RV8- Monitor Route and Schedule Adherence

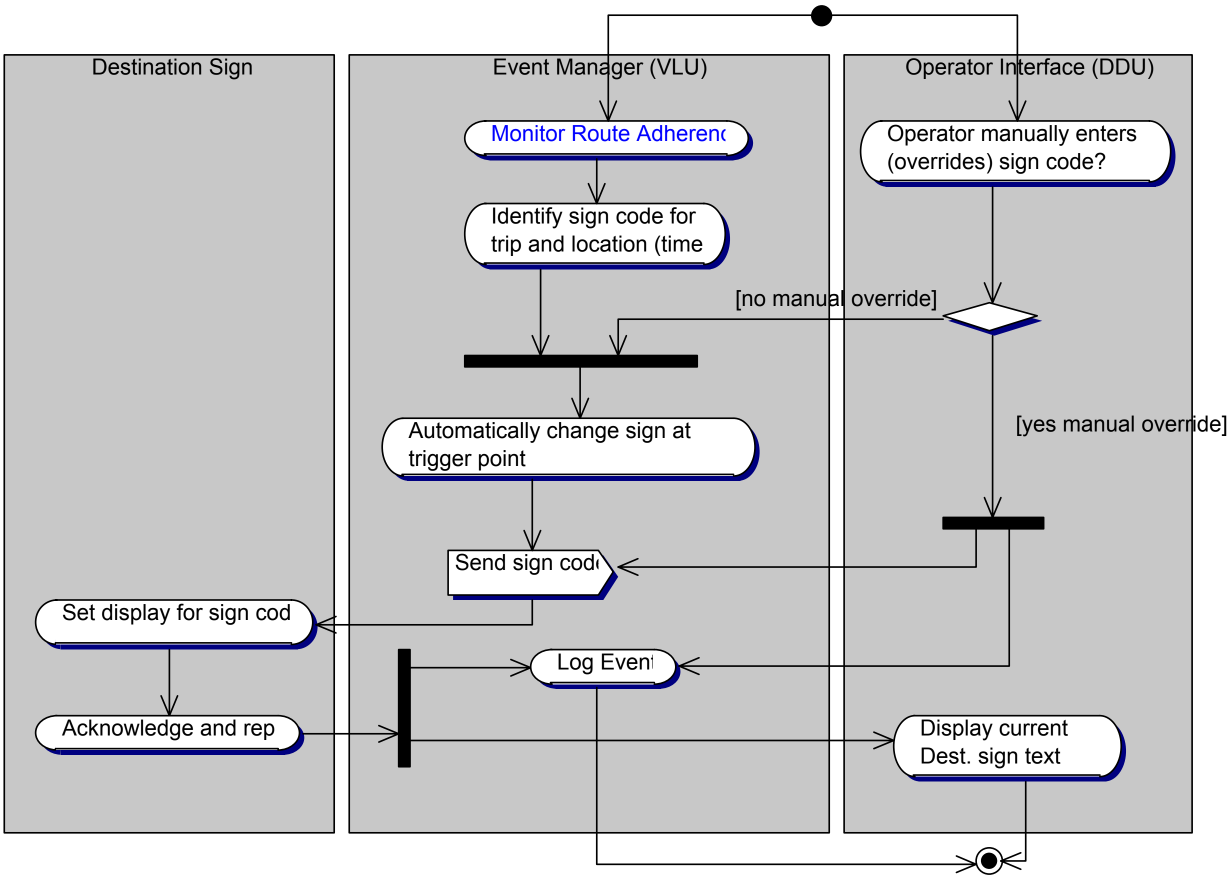
7. Assumptions

"Current" and "next" destination-sign code files will be stored on the VLU for loading onto the sign system processor. See the ***RV4-Update Vehicle Data*** use case.

8. Issues

KCM has been informed that we have the second-largest known sign program on the continent, behind only Los Angeles. Memory on the Destination Sign Operator Display/Keypad (ODK) can only handle 320KB or less. Apparently, the memory on the older sign versions on the Gillig 3200s is less. Those vehicles are programmed through the side sign instead of the ODK. That sign has a Flash System Processor Board (SPB) with less memory. Given this constraint, it is likely that sign files may have to be segmented by fleet. The trolley fleet would be an obvious choice but not a desirable solution. In general, only trolleys operate trolley routes but on occasion a diesel coach may be assigned to a trolley route. KCM prefers treating all the coaches the same, for consistency and reliability.

Figure 2.B.4.1.13.RV13.b. Activity Diagram <u>Interface to Destination Signs</u>



2.B.4.1.14. RV14-Interface to Fare Transaction Processor

This use case package includes the following UML diagrams:

UseCase Diagrams

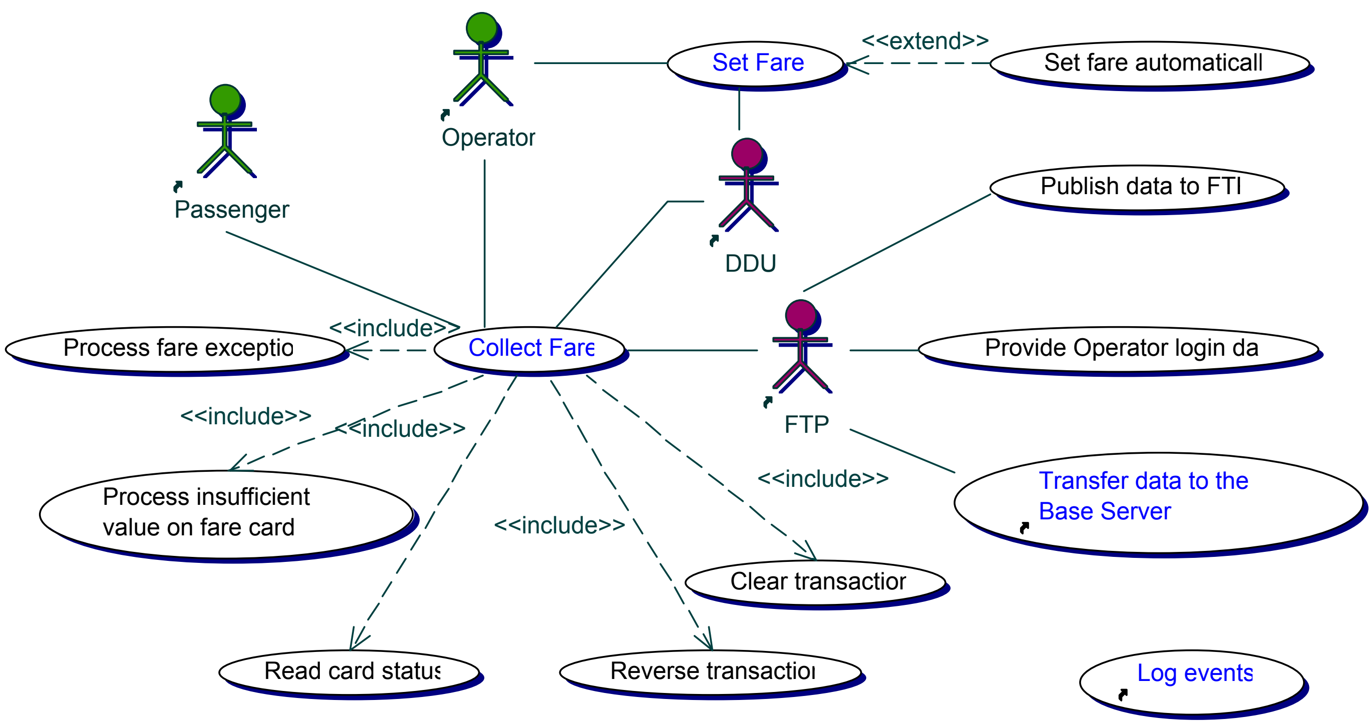
Figure ***2.B.4.1.14.RV14.a. RV14-Interface to FTP***

Activity Diagrams

Figure ***2.B.4.1.14.RV14.b. Collect Fare***

Figure ***2.B.4.1.14.RV14.c. Set Fare***

Figure 2.B.4.1.14.RV14.a. UseCase Diagram RV14- Interface to FTP



15. RV14-Interface to FTP

1. Brief Description

The ***RV14-Interface to FTP*** use case includes those OBS activities that interact with the Fare Transaction Processor (FTP) subsystem which will be provided by the Regional Fare Coordination System (RFCS) Project. The following use case describes the VLU Event Manager's activities and their relation to the companion FTP processes.

Cash fare collection using fareboxes is not described within this use case document. There is no integration of either the FTP or the OBS with the cash farebox.

2. Pre-conditions

The *Shut down vehicle* step in the ***RV3-Take Vehicle Out of Operation*** use case has been successfully completed.

The ***RV4-Update Vehicle Data*** use case has been successfully executed and the FTP has been provided with the list of current, valid OperatorID's.

3. Flow of Events

This use case is triggered when an Operator turns vehicle power on (by using the master switch), which also triggers the *Start up system* step in the ***RV1-Initiate Vehicle for Operation*** use case.

3.1 Basic Flow

Provide Operator login data
The FTP shall send the OBS a login data message based on data obtained from a "smart card" form of Employee ID (identification card) onto which a valid OperatorID has been preloaded.

1) A valid login is required before a Revenue Vehicle can be put into operation for any purpose including normal revenue operations and non-revenue operations such as maintenance, training, testing, special service, etc.
   a) If a valid login is not provided, then the vehicle cannot be put into operation unless the login override switch is activated.
   b) The login override switch will be placed in a secure location (e.g., the radio lockbox) that can only be accessed by authorized personnel.
2) The Operator will provide login information by presenting a smart card to the FTP.
   a) The FTP will validate the smart card by verifying that the OID matches the list of authorized ID's provided by the ***RV4-Update Vehicle Data*** use case.
      i) If the Employee ID smart card does not contain a valid Operator ID, then the FTP will send an "Invalid login" message to the Event Manager on the VLU.
      ii) When a valid Operator ID is identified, the FTP will provide a "Valid login" data message to the Event Manager on the VLU.
   b) The "Valid login" data message will include:
      i) Operator ID: a unique number to identify the specific individual.
      ii) (Optional) BlockID: a number to indicate a specific route/run or general type of trip, e.g. maintenance test drive, training, or special service.
      iii) (Optional) VID: the card may be loaded with the Vehicle ID (VID) in order to match the vehicle and Operator assignments.

Set fare
The Operator shall manually set fares for the FTP.

The functionality to enable the Operator to manually select the fare set, using the DDU, will be resident on the DDU at the completion of the FTP installation. The OBS shall support this previously existing interaction between the DDU and the FTP as follows:

1) The DDU presents the Operator with a list of fare set options.
2) The Operator determines the fare set using business rules that are based upon trip and location, and chooses the selected fare set in the DDU.
3) The Planned Event Manager sends a "Fare set change" signal to the DDU and the FTP, indicating the selected fare set. (See use case ***RV6-Manage Events***.)
4) Both the DDU and the FTP display current fare set information.
5) The OBS system logs and stores the current fare set.

Collect fare
The OBS shall support FTP exchanges between the DDU and the FTP for payment of fare.

1) The FTP and DDU both display status of transaction, including, if applicable, amount deducted from and balance remaining in electronic purse.
2) The Operator may clear the transaction from the DDU and FTP screens. Alternatively, the transaction will automatically clear on its own.
3) The default fare will appear on both DDU and FTP screens.

Log events
System shall log FTP messages exchanged with the DDU and/or VLU.

1) FTP messages will be maintained in a separate log for post-processing by authorized KCM personnel.
2) The FTP message log will not include any identifying information related to the customer or fare card value.

Publish data to FTP
The OBS Event Manager shall provide the FTP with current data including but not limited to location and time.

While the FTP is currently specified to be able to store all fare-setting and fare-collection activities, the system may be expanded to store the location and time information of each transaction if provided this information by the OBS.

Transfer data to the Base Server
The OBS shall "tunnel" fare collection information from the FTP via the WLAN to the Base Server.

This data transfer process is further described in the ***RV3-Take Vehicle Out of Operation*** use case.

3.2 Alternative Flows

3.2.1 Set Fare Automatically

Set fare automatically
The OBS shall automatically determine the appropriate fare set and provide this information to the Operator, via the DDU, for review.

1) The Event Manager determines the appropriate fare set based upon the vehicle's trip and location. It then sends a signal containing information about the chosen fare set to the Driver Display Unit (DDU).
2) The Operator reviews the selected fare set and decides whether or not to override it. If the Operator chooses to override the fare set, resume the Basic Flow at the *Set fare* step.
3) If the Operator chooses not to override the selected fare set, a "Fare set change" signal is sent by the Event Manager to the DDU and the FTP.
4) Both the DDU and the FTP display current fare set information.

5) The OBS logs and stores the current fare set.

3.2.2 Process Fare Exception

Process fare exception
The OBS shall support fare exception dialogues between the DDU and the FTP.

1) The Operator, after being informed by the passenger of the type of fare exception required, enters the exception type into the DDU.
2) The Event Manager passes the fare exception to the FTP and the FTP displays the new fare.
3) Return to the Basic Flow, resuming at the *Collect fare* step.

3.2.3 Process Insufficient Value on Fare Card

Process insufficient value on fare card
The OBS shall support Insufficient Value on Fare Card dialogues between the DDU and the FTP.

1) The DDU displays status of transaction including Balance Due. If there was a deduction from the electronic purse, the amount deducted and the balance remaining (should be zero) will display.
2) The Operator may clear the transaction from the DDU and FTP screens. Alternatively, the transaction will automatically clear on its own.
3) The OBS Event Manager signals the FTP that the transaction is cleared.
4) The default fare will appear on both DDU and FTP screens.

3.2.4 Reverse Transaction

Reverse transaction
The OBS shall support the ability to reverse a fare payment transaction.

In situations where there has been a passenger fare-payment error, or in certain fare-dispute situations, it will be necessary for an Operator to reverse the payment transaction.

1) Upon learning of an error in fare payment, the Operator reverses the transaction.
   a) The Operator selects “Reverse Transaction” from DDU screen.
   b) The OBS Event Manager signals the FTP to log a new transaction event that reverses the previous transaction.
2) The DDU displays the status of the transaction.
3) The Operator may clear the transaction from the DDU and FTP screens. Alternatively, the transaction will automatically clear on its own.
4) The default fare will appear on both DDU and FTP screens.
5) Return to the first step of the Basic Flow.

3.2.5 Clear Transaction

Clear transaction
The OBS shall support the ability to clear a fare-payment transaction.

In certain situations, for example when a passenger disputes a fare, it will be necessary for the Operator to clear the payment transaction.

1) The Operator may clear the transaction from the DDU and FTP screens. Alternatively, the transaction will automatically clear on its own.
2) The default fare will appear on both DDU and FTP screens.

3.2.6 Read Card Status

Read card status
The OBS shall support the ability for a passenger to view the current status of his smart card on the FTP.

1) After the FTP has verified the validity of the card, and checked its stored value, the DDU displays card status including, if applicable, pass type and balance remaining in electronic purse (depending upon agency business rules).
2) The Operator may clear the transaction from the DDU and FTP screens. Alternatively, the transaction will automatically clear on its own.
3) The default fare will appear on both DDU and FTP screens.

4. Post-conditions

All fare collection transactions have been handled and logged.

5. Special Requirements

5.1 Performance

5.2 Technical

5.2.1 FTP Requirements

While all FTP functionality will be handled by the Regional Fare Coordination project, certain FTP requirements and details are documented here in order to provide a fuller picture of the environment in which the OBS will operate.

Initial FTP data
The VLU shall transfer necessary data to the FTP before this use case begins.

Necessary FTP data includes:

1) “Hot List” of lost and stolen (“blocked”) cards, to be updated daily.
2) Fare tables, each with an effective date.
   a) FTP will store, at a minimum, two fare tables:
      i) Current fare table.
      ii) Fare table applicable to next Service Change.
   b) Fare tables will be specific to the agency for which the coach is providing service; e.g. King County coaches will have a different set of fare tables than will the Sound Transit coaches operated by King County.
   c) FTP will automatically implement fare-table transitions for scheduled fare changes, holiday fare tables, etc. based upon each fare table’s effective date.
3) Revalue Events (e.g., for those revalues that have occurred in a card-not-present environment), to be updated as needed.

Role of FTP in fare collection
The FTP shall deduct appropriate amounts from a passenger’s smart card and pass that information to the OBS.

NOTE: The FTP is <u>not</u> used when cash fares are collected. The stand-alone GFI farebox will be used to collect cash.

1) The passenger views current fare on the FTP.
2) The passenger presents RFCS smart card to the FTP (either tags the FTP or holds the smart card within close proximity).
3) The FTP processes smart card information:

   a) Verifies card is valid, checking against hot list of lost and stolen ("blocked") cards. If the card is invalid, the FTP will notify the passenger and Operator, and the use case will end.

   b) Calculates fare due, applying regional business rules about transfers and upgrades.

   c) Collects fare payment, first verifying stored value. If insufficient value is stored on the passenger's smart card, go to Alternate Flow *Insufficient Value on Fare Card.*

   d) Deducts amount due from electronic purse.

4) The FTP stores transaction information on passenger's smart card and stores the fare transaction event, passing the information to OBS.

Role of FTP in insufficient fare transactions
The FTP shall detect and handle instances of insufficient value on a passenger's smart card, and complete the transaction with the OBS system.

1) After passenger has tagged the FTP with his smart card, FTP notifies passenger and Operator of an insufficient amount on the smart card.

2) FTP deducts amount available, if any, from electronic purse.

3) FTP stores transaction information on passenger's smart card.

4) FTP displays the amount deducted (if any) from the passenger's electronic purse, and the Balance Due.

   a) Depending upon business rules decided by agencies, FTP might also display the balance remaining in electronic purse.

5) The passenger pays the difference in cash.

6) FTP stores fare transaction event.

Role of FTP in reversing transactions
The FTP shall provide Operators with the ability to reverse a fare transaction, for example in the case of a passenger fare payment error.

1) The passenger notifies the Operator that there has been an error in fare payment.

2) Operator reverses transaction, as described in Alternative Flow *Reverse Transaction*.

3) The Event Manager signals the FTP to log a new transaction event that reverses the previous transaction.

4) The passenger presents his smart card to the FTP (either tags the FTP or holds the smart card within close proximity).

5) The FTP stores the reversing transaction information on the passenger's smart card.

6) The FTP restores the stored value, if any, deducted in the previous transaction.

7) The FTP logs the reversing transaction.

8) The FTP displays a message indicating that the prior transaction was reversed.

Role of FTP in reading card status
The FTP shall enable the passenger to view the current status of his smart card, without debiting any fare from the card.

1) Passenger presents his smart card to the FTP (either tags the FTP or holds the card within close proximity).

2) FTP processes the smart card information.

   a) Verifies card is valid, checking against hot list of lost and stolen ("blocked") cards. If the card is invalid, the FTP will notify the passenger and Operator, and the use case will end.

   b) Confirms available fare payment resources on smart card by checking for pass and for stored value (electronic purse).

3) FTP stores transaction information on passenger's smart card.

4) FTP stores the fare transaction event.

6. Extension Points

RV1-Initiate Vehicle for Operation

RV3-Take Vehicle Out of Operation

RV4-Update Vehicle Data

RV6-Manage Events

RV12-Interface to DDU

7. Assumptions

The systems shall display fare transaction information concurrently on the DDU and the FTP. The content of each display will be subject to agency business rules and fare collection policies. For example, an open issue is whether or not the agencies wish the FTP to display the balance remaining in the passenger's electronic purse.

The RFC project will be responsible for the following:

- Providing the OBS Contractor with the ICD (interface control document) for the FTP.
- Assisting with migration from "Limited Integration Mode" (LIM) to "Full Integration Mode" (FIM). See Subsection **1.C.7, Evolving On-Board Architecture**.
  - In LIM, the FTP is connected directly to the DDU and the DDU is connected directly to the WDOLS device.
  - In FIM, those connections will be severed and each device (FTP, DDU, and WDOLS) will connect directly to the VLU.

8. Issues

As the RFC system has not yet been fully developed, the use cases described within this document are conceptual.

While it is expected that the FTP equipment will be functional on the vehicles prior to the installation of the OBS, some vehicles may have their OBS installed simultaneously with or prior to the installation of the FTP. It is expected that the details of installation and testing for successful interaction between these systems will be worked out during the Level 1 design of the OBS Project.

At OBS implementation, a modification may be required to the equipment on the vehicle to enable the move from the RFCS "Limited Integration Mode" (LIM) to "Full Integration Mode" (FIM).

Figure 2.B.4.1.14.RV14.b. ***Activity Diagram <u>Set Fare</u>***

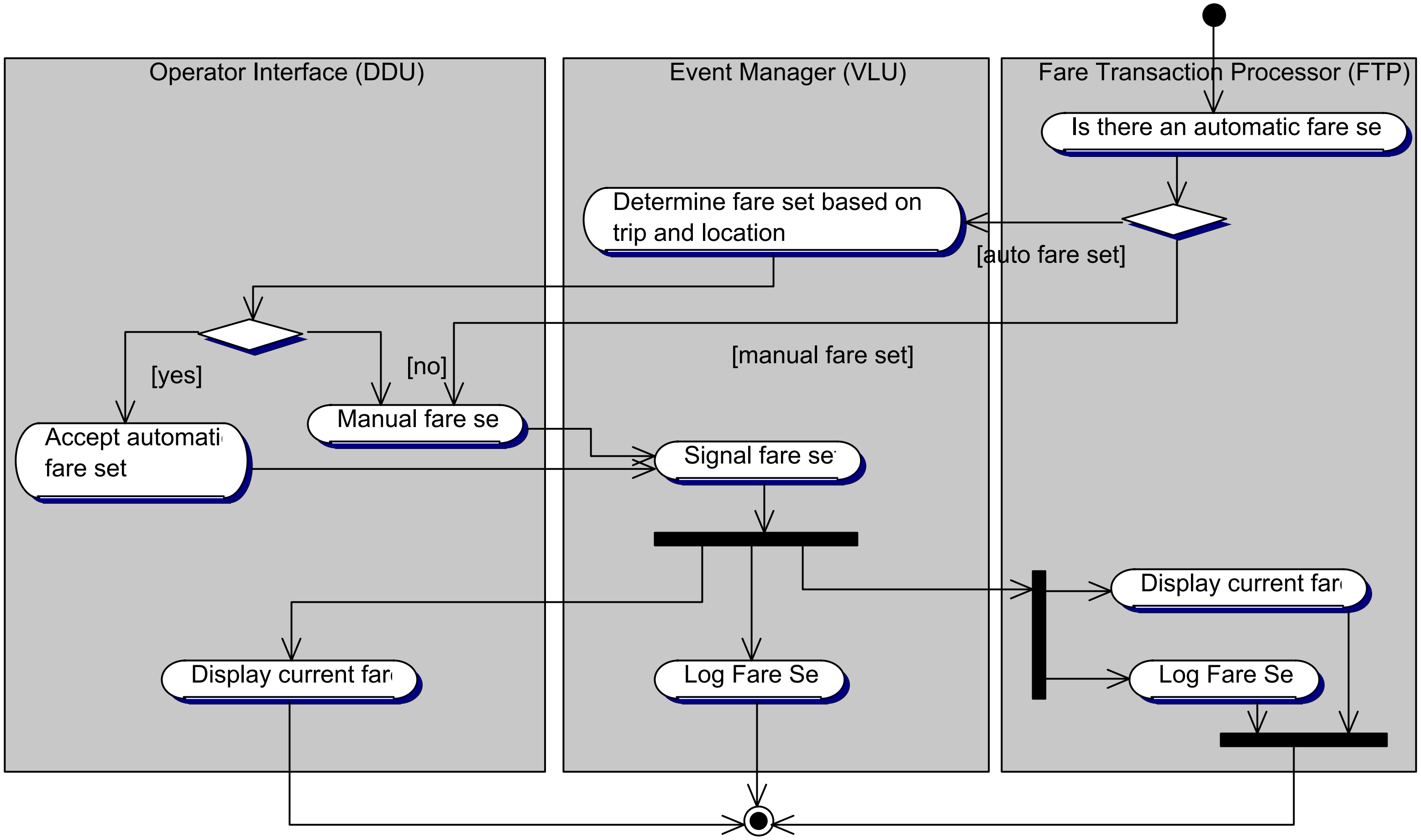
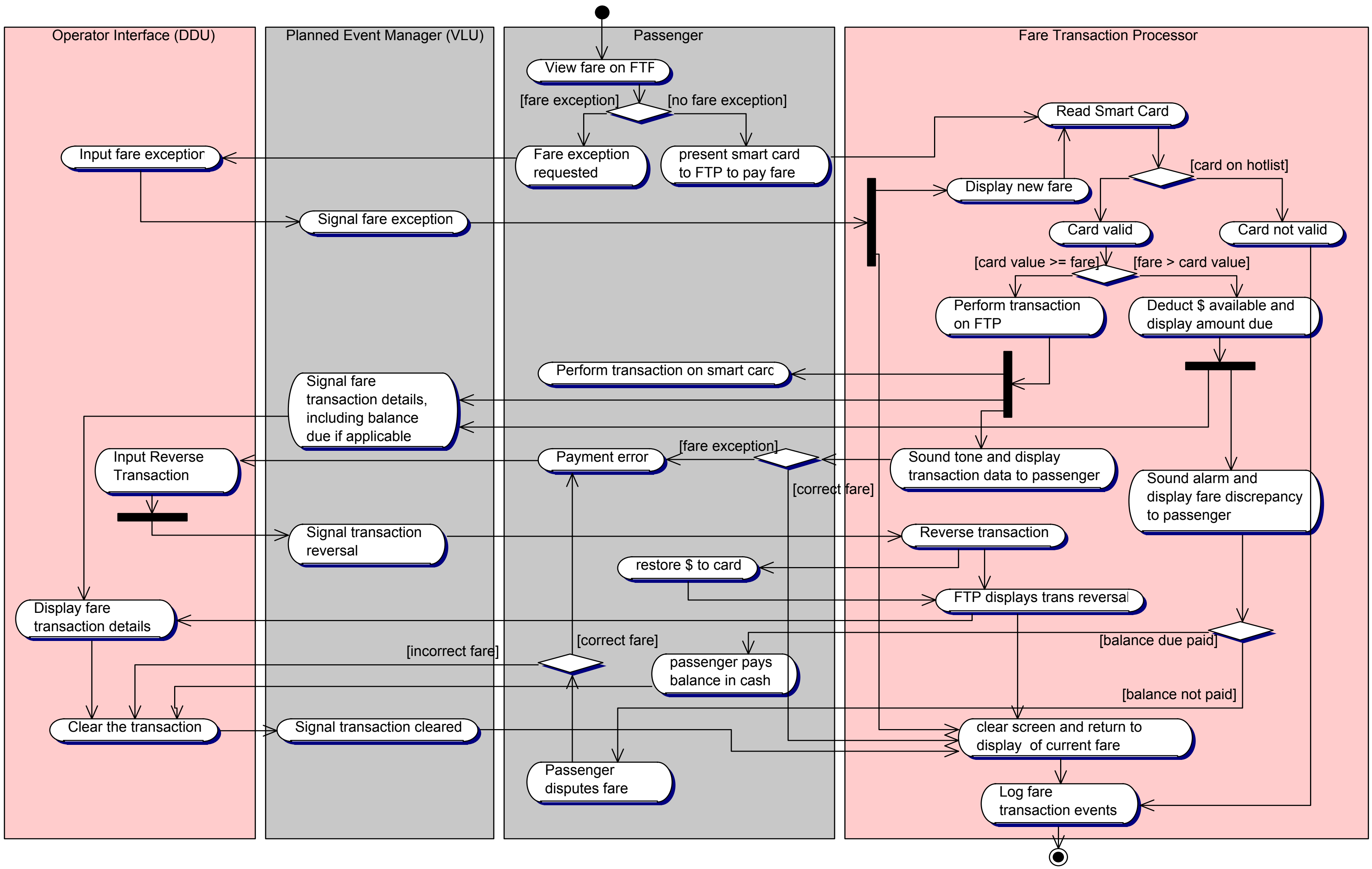


Figure 2.B.4.1.14.RV14.c. Activity Diagram <u>Collect Fare</u>



2.B.4.1.15. RV15-Interface to Digital Video Recording System (DVRS)

This use case package includes the following UML diagrams:

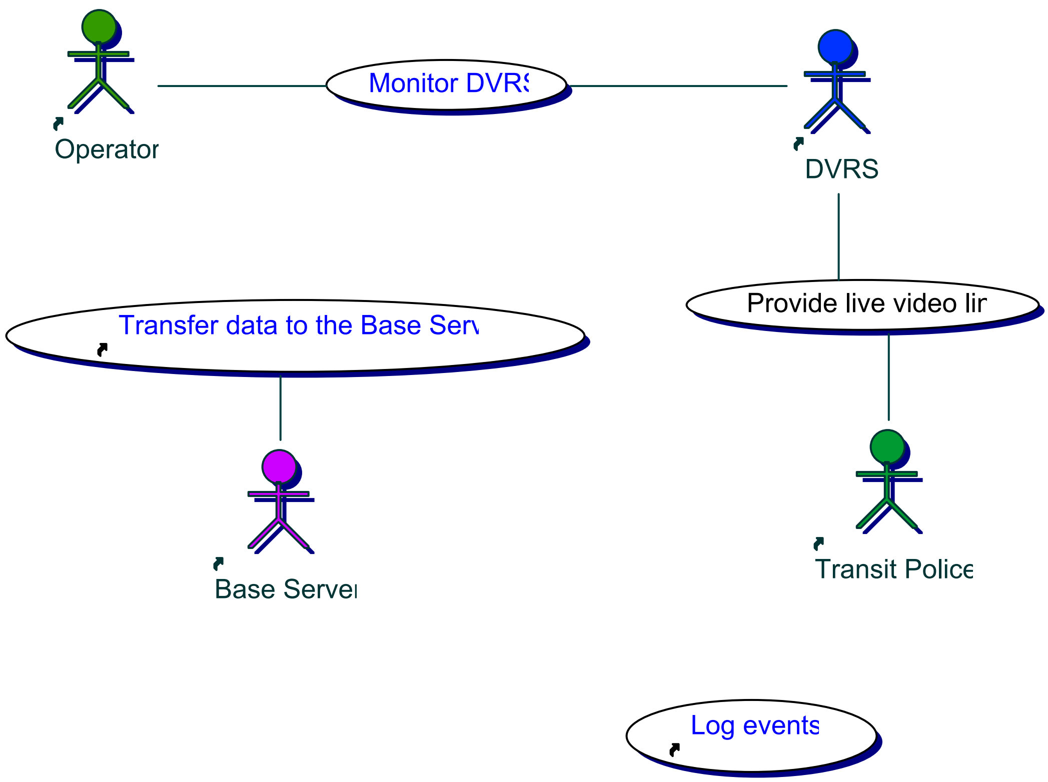
UseCase Diagrams

Figure ***2.B.4.1.15.RV15.a. RV15-Interface to DVRS***

Activity Diagrams

Figure ***2.B.4.1.15.RV15.b. Interface to DVRS***

Figure 2.B.4.1.15.RV15.a. UseCase Diagram RV15- Interface to DVRS



16. RV15-Interface to DVRS (Digital Video Recording System)

1. Brief Description

See Section **1.B, Description of Existing Systems**, and **1.C, Systems Development and Implementation Environment**, for additional information on the Digital Video Recording System project. The Digital Video Recording System (DVRS) is provided by Transit Surveillance Systems, Inc. The DVRS consists of signs, color cameras, a microphone, a digital video recorder, storage device, wiring and cabling, Save Event button, and LED status indicator light. The system interfaces with the Radio system by way of the Emergency Alarm Switch. A total 290 DVRS will be installed by the end of 2004.

<u>Summary of key DVRS functions</u>:

- System records continuously while coach is powered up and for 30 minutes after shutdown.
- Coaches are equipped with four or five interior color cameras.
- A single omni-directional microphone is located in the front of the coach. This is the device that will provide audio when an emergency alarm (EA) is active. (See use case ***RV6-Manage Events***.)
- Recordings are saved for approximately 100+ hours, which is typically 6-10 days of coach operation, after which a new recording cycle begins.
- Operators save an “incident” using the Emergency Alarm (EA) or Save Event button.
- Saved events are automatically off-loaded via a wireless LAN to the Transit Police server when a coach returns to the base.
- The DRVS WLAN uses Cisco equipment and 802.11b protocol with access points at each of the seven bases.
- Transit Police have wireless field access for real-time viewing within line-of-sight of camera coaches.

<u>The OBS will not control the DRVS but will support its functionality in several ways</u>:

- OBS will monitor the DVRS system health.
- OBS will provide connectivity between the DVRS and the WLAN.
- OBS will publish time to the DVRS.
- Level 2 only: OBS will receive audio input from the Security Microphone to the radio.

2. Pre-conditions

The *<u>Start up system</u>* step in the ***RV1-Initiate Vehicle for Operation*** use case has been successfully completed.

3. Flow of Events

The Digital Video Recording System is triggered when an Operator starts a DVRS-equipped vehicle.

3.1 Basic Flow

Monitor Digital Video Recording System
The OBS shall maintain an interface to the DVRS to monitor the system health and activities related to handling “saved” events.

1) The OBS will receive health status and error messages from the DVRS. (See use case ***RV5-Monitor System Health***.)
2) The DVRS will continuously record video whenever the vehicle power is on.
    a) Normal operating mode records at 1 frame per second.
3) The system is currently designed to “save” video whenever an EA is initiated or the Operator presses the “Save Event” switch.

a) EA: The DVRS is connected to the EA switch. When the EA switch is pressed, it triggers the DVRS to save video of the event.

b) "Save Event" switch: There is a switch mounted on the left wall of the driver cockpit that the Operator can use to save recorded video when an incident occurs that may require subsequent investigation.

4) When the Operator takes action to save an event by activating either the EA or Save Event switch, the DVRS will respond as follows:

a) DVRS will save a digital video file to a protected area in the hard drive. Current save settings are as follows:

i) Save five minutes at the normal recording speed (1 frame/sec).

ii) Save five minutes of video after at high speed (configurable for 5-15 frames/sec) after activating the event-save process.

iii) The current average file size for a saved event is approximate 60 megabytes.

iv) Settings for the time before and after are user-definable.

b) The OBS Administrator will have the capability to change the settings for duration of "saved" video to be recorded as part of the ***RV2-Verify Vehicle Configuration*** use case.

Log events
The OBS shall log "saved" events.

1) The following events will be logged in the Event Log. (See use case ***RV6-Manage Events***.)

a) EA switch is activated. There should be one event record for an EA, not a separate one for the security cameras for evidentiary purposes.

b) "Save Event" switch is activated.

Transfer data to the Base Server
The OBS shall "tunnel" video files from the DVRS via the WLAN to the Base Server.

This data transfer process is further described in the ***RV3-Take Vehicle Out of Operation*** use case.

3.2 Alternative Flows

3.2.1 Provide Live Video Link

Provide live video link
The OBS shall enable the Digital Video Recording System to take control of the WLAN system and transmit live video when a link is established with a transit police computer.

1) Transit Police will be equipped with a laptop that has an 802.11b card and authentication key for establishing a live video link.

2) The OBS will discontinue video transmission via the WLAN when the Transit Police disconnect or move out of range.

3.2.2 Log Events

Log events
The OBS shall log live video links.

The OBS will log the following instances of video link as Security Camera events:

1) A live video link is established with an authorized user.

2) The link is disconnected by an authorized user.

3) The link is dropped due to loss of signal.

4) Unauthorized or failed linking attempts.

4. Post-conditions

The OBS has enabled a live video link when and only when a properly equipped transit police unit initiates the communication.

Security Camera events have been accurately logged.

5. Special Requirements

5.1 Performance

Provide security of video files
The methods and processes for transmission and storage of video files shall meet evidentiary rules.

1) The system design must address the specific requirements for the handling and storage of evidence that can be used in court.

2) The methods and protocols for the handling of video files shall be approved by the King County Transit Police and Prosecuting Attorney's Office.

5.2 Technical Specifications

Synchronize time
The DVRS shall have the same system time as the VLU in order to index on time and location recorded in the Event Log as evidence.

1) The DVRS system clock is currently updated by the system server via an IP address.

2) The DVRS-2 system has an Ethernet port which could be used to update the system clock from another source. However, this Ethernet port is now used by transit security police to download data via a laptop from the DVRS-2 unit. Transit security will have an ongoing requirement to download video from the DVRS hard drive. *Describe how the OBS system time and DVRS system time can be synchronized without sacrificing the capability to download video to a laptop.*

Provide connections for security camera events
The OBS design shall include connections to the EA switch and the Save Event switch.

1) The Digital Video Recording System is already connected to the EA switch.

2) If possible, the OBS will use existing cables and connections. (Note: this is uncertain. The EA switch is not a simple "on/off" device. Extensive modifications were performed in the I/O panel of the DVRS unit to accept the signal from the EA switch.)

3) Future connections with the DVRS must be coordinated with King County Radio Maintenance and Transit Surveillance Systems and approved by the KCM Project Manager.

Level 2: Remote CCS control
Optimally, a Coordinator will be able to control the duration of the event video remotely after it has been activated by an EA.

Discuss feasibility and cost.

1) The ability to continue to record video of an event for longer than five minutes could be useful if the situation prompting the EA continues to unfold for longer than five minutes.

2) At present, approximately one third of EA activations are accidental. In the interest of minimizing the video file size for download, it would be useful for the Coordinator to have the ability to halt recording after it is determined that the EA was a mistake.

5.3 Testing

Security Camera interface test cases

The test plan shall include, but not be limited to, test cases for each requirement statement and supporting details in this use case.

1) Monitor Digital Video Recording System.
2) Log events.
3) Provide live video link.
4) Provide security of video files.
5) Synchronize time.
6) Provide connections for security camera events.
7) Level 2: Remote CCS control.

6. Extension Points

RV1-Initiate Vehicle for Operation

RV2-Verify Vehicle Configuration

RV5-Monitor System Health

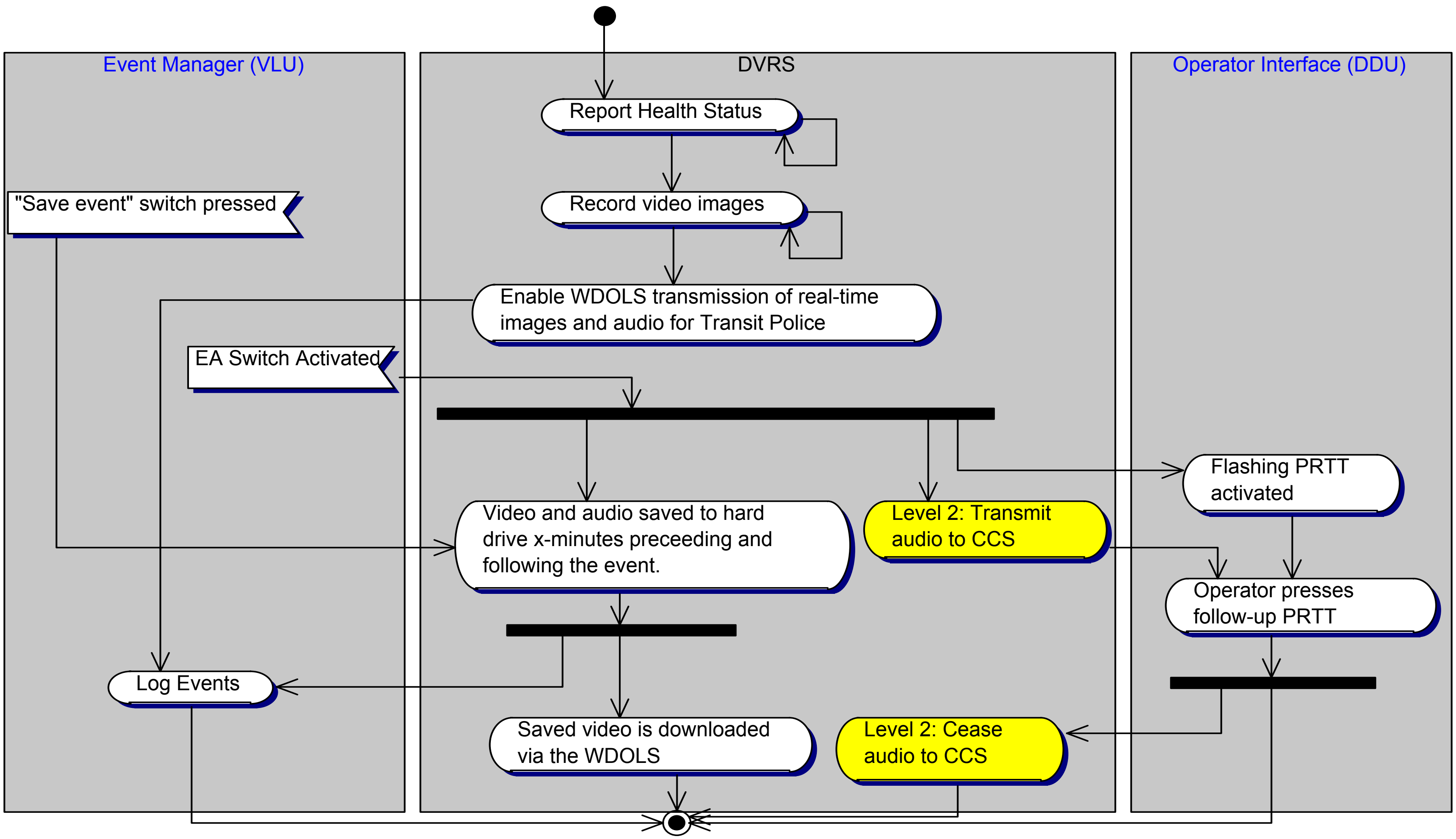
RV6-Manage Events

7. Assumptions

Vehicles with a Digital Video Recording System have a 802.11b WLAN system installed for video file and diagnostic data transmission.

8. Issues

Figure 2.B.4.1.15.RV15.b. ***Activity Diagram Interface to DVRS***



2.B.4.1.16. RV16-Interface to Transit Signal Priority (TSP) Tag

This use case package includes the following UML diagrams:

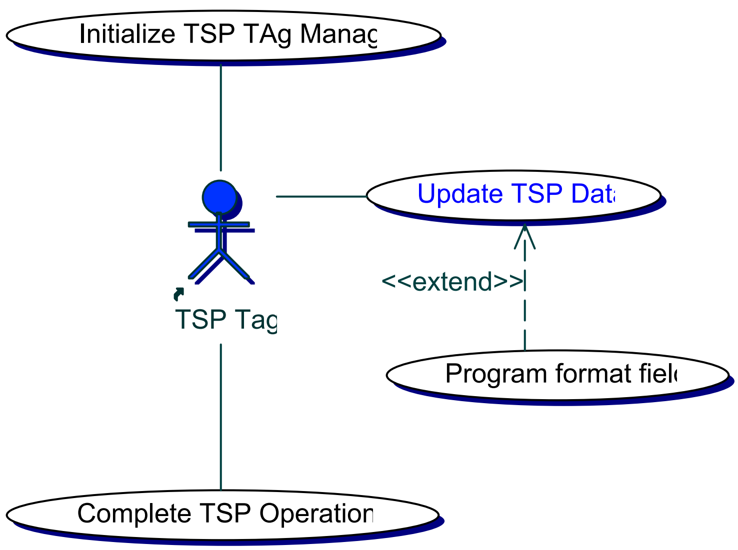
UseCase Diagrams

Figure ***2.B.4.1.16.RV16.a. RV16-Interface to TSP Tag***

Activity Diagrams

Figure ***2.B.4.1.16.RV16.b. Interface to TSP Tag***

Figure 2.B.4.1.16.RV16.a. UseCase Diagram RV15- Interface to TSP Tag



17. RV16-Interface to TSP Tag

1. Brief Description

The King County Transit Signal Priority system communicates data via an Amtech RF tag. The passive RF tag is a proprietary device that was developed for toll and freight applications, but that we are using for communications between the vehicle and roadside equipment. The objective of the communication is for the vehicle to obtain signal priority based on availability and need.

The RF tag is programmed via a serial interface with data from the On-Board Systems. The tag data consists of static and dynamic data: static data is programmed into the tag when installed, and the dynamic data is drawn from a set of 34 variables recognized by the TSP system (see list in *Technical Specification*s below).

The on-board TSP provides information to the transit priority request generator at the roadside. The traffic controller receives the request, processes the information, and determines whether it can provide priority.

The format field denotes the variables used by the system. The tag programmer must be re-configurable in order to program user-specified tag formats.

2. Pre-conditions

The ***RV1-Initiate Vehicle for Operation*** use case has been successfully completed.

3. Flow of Events

The TSP tag manager is triggered by successful completion of the *Log in Operator* step in the ***RV1-Initiate Vehicle for Operation*** use case.

3.1 Basic Flow

During normal operations, the tag manager shall automatically initialize and update the tag with no additional input required by the Operator.

Initialize TSP Tag Manager

As part of system startup the OBS shall initialize the TSP Tag.

1) The following steps are required for initialization. (See the *Start up system* step in use case ***RV1-Initiate Vehicle for Operation***.)
    a) Power RF tag.
    b) Establish connection with RF tag.
    c) Initialize values for all dynamic fields to null.
    d) Subscribe to data sources for each variable.
    e) TSP Tag Manager ready to program data.

Update TSP Data

The OBS shall continuously update configured dynamic fields on the RF tag while in operation.

1) Static fields will not be modified.
2) Write accuracy is confirmed. The tag will be queried to verify that the dynamic data is accurate.
3) Tag must remain in continuous operation.

Complete TSP Operations

The system shall power down the RF tag during VLU shutdown.

(See use case ***RV3-Take Vehicle Out of Operation***.)

1) Static field data will not be modified.
2) Dynamic data fields will be set to null value.

3.2 Alternative Flows

3.2.1 Configure New Tag Format

From time to time, it will be necessary to configure new tag formats for presenting alternate operational variables. The format must match the profile stored in the TSP tag reader and identified with the proper "format" code.

Program format field
The VLU configuration shall support the ability to configure the variables to be published to the TSP tag.

1) The OBS Administrator will have the ability to configure the message to update the variable TSP fields.
2) The TSP tag fields will be configured by selecting the combination of the 34 variable types recognized by the TSP system.
   a) The total dynamic data area is 74 bits.
   b) The recognized variables are shown in the TSP Data Fields list in the *Technical Specifications* section below.
   c) The TSP tag can display 128 bits per page. Two pages are available but only one page is currently in use. The OBS design should be configurable to allow for use of the second page of data on the tag.

4. Post-conditions

Dynamic data fields set to null value.

5. Special Requirements

5.1 Performance

Dynamic data update speed
Dynamic data must be updated within 10 seconds of change, except for location data.

Near-real-time location data
Location data must be updated before the coach moves outside the location accuracy requirements established by the location system with the goal of having near-real-time location data.

5.2 Technical Specifications

TSP Data Fields
TSP fields shall include all static and dynamic data specified by KCM.

Programmed fields include a user-selected subset of the following fields. (*The asterisked fields are the default fields currently in use, **double-asterisked fields are default fields, but not currently in use.)

Data Field	**Bits**	**Description**
Static Data -- Programmed during tag installation (34 bits total).		
System*	5	KC Metro System is "1"
Agency*	5	1=KC, 2=CT, 3=ST
Bus ID*	17	Unique vehicle ID
Format	7	Matches street-side equipment configuration

Each vehicle tag shall have a defined format. Vehicles will have different formats depending on the operational use. The format is defined when the static information is programmed.

Dynamic Data -- Programmed during operation (74 bits total)

1. OperatorID*	var.	OperatorID from Operator login
2. Class**	var.	undefined
3. Route*	var.	Hastus route

4. Run*	var.	Hastus run
5. Trip**	var.	Hastus trip
6. Lateness**	var.	on-time status
7. Ridership**	var.	real-time passenger load
8. SignRoute	var.	timetable route number
9. SignExpres	var.	timetable express flag
10. Schedule	var.	agency schedule ID
11. Override	var.	self-exclusion from priority
12. SecurityAler	var.	panic button tripped
13. Latitude	var.	encoded latitude coordinate angle*
14. Longitude	var.	encoded longitude coordinate angle*
15. Speed	var.	
16. StopRequested	var.	flag
17. Movement	var.	to indicate left/through, or to identify a specific phase
18. RequestService	var.	request service strategy ID number
19. RequestLevel	var.	self-assessment of level of need
20. – 34. Aux0 - Aux9	var.	Auxiliary supporting data which may be used by KCM.

5.3 Testing

6. Extension Points

RV1-Initiate Vehicle for Operation

RV3-Take Vehicle Out of Operation

Subsection 2.A.4.1.1. Wireless TSP

7. Assumptions

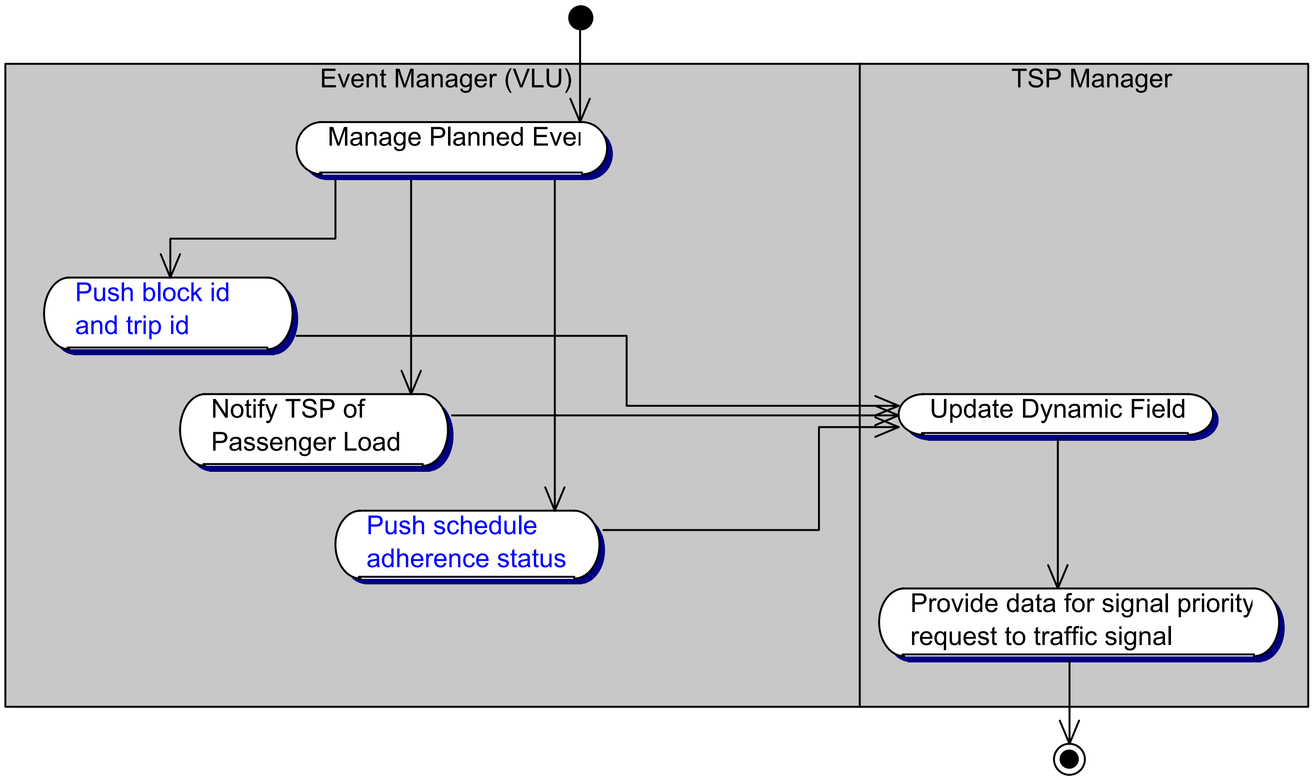
Maintaining the RF tag data is required even if the Priced Option described in Subsection **2.A.4.1.1, Wireless TSP** is implemented.

Tags are already installed on the existing fleet or will be provided by KC Metro. Tags must be mounted in their current location on the front of the Revenue Vehicle to be read by the roadside equipment, and require metallic backing to maximize read potential.

When KCM decides to change the format or content of the TSP fields the TSP Tag reformatting will be performed manually by KCM maintenance personnel.

8. Issues

Figure 2.B.4.1.16.RV16.b. ***Activity Diagram <u>Interface to TSP Tag</u>***

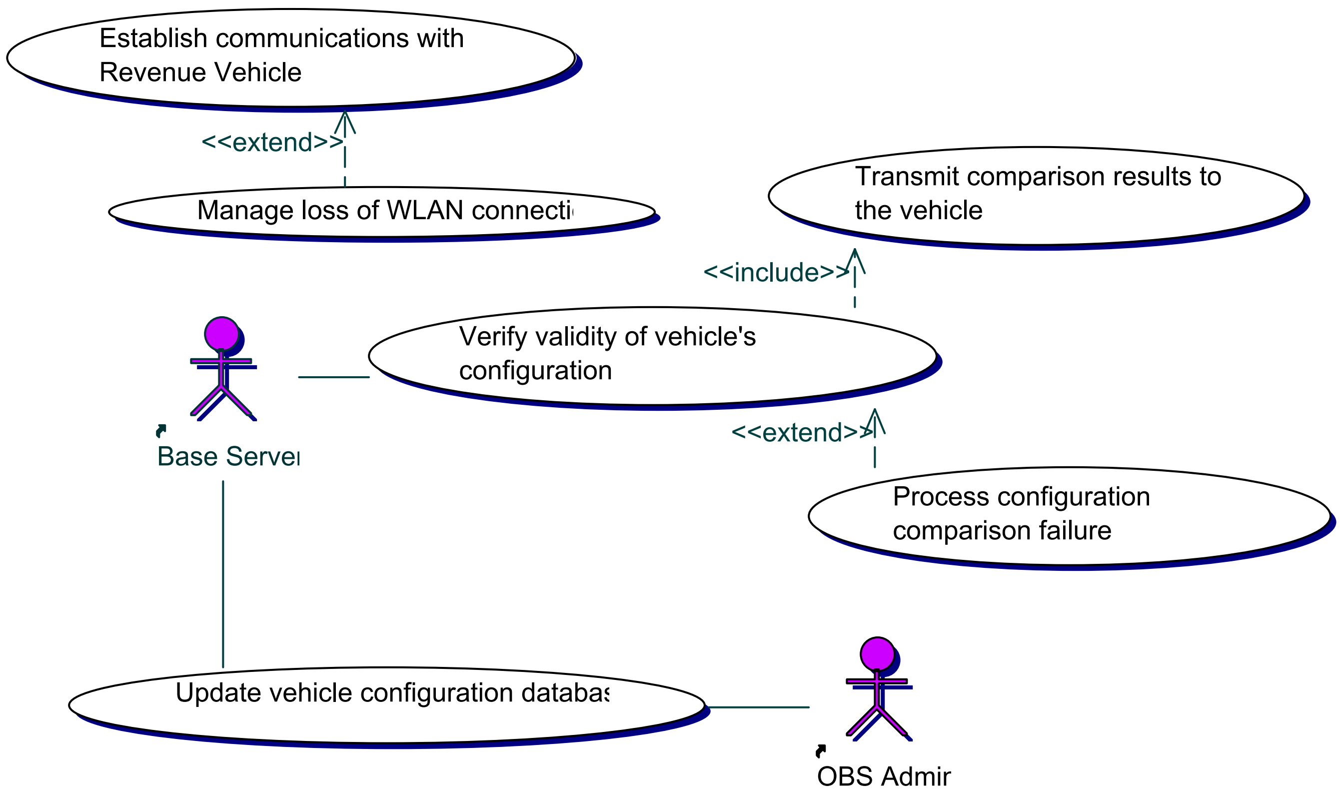


2.B.4.2. Base Operations Use Case Specifications

2.B.4.2.1. BO1-Verify Vehicle Configuration

This use case package includes the following UML diagram:

Figure 2.B.4.2.1.BO1. UseCase Diagram BO1-Verify Vehicle Configuration



18. BO1-Verify Vehicle Configuration

1. Brief Description

This use case describes the process that runs on the Base Server during its interaction with each vehicle to compare the server's stored vehicle and vehicle area network (VAN) device information with the same configuration information stored on the vehicle. The companion use case ***RV2-Verify Vehicle Configuration*** details the vehicle's role in this process.

Both the Base Server and the Revenue Vehicle maintain configuration information for the specific vehicle in their respective Vehicle Configuration databases. The compared configuration information on the vehicle includes the list of OBS and component hardware devices previously identified as resident on the vehicle during the execution of the *Register components* step within the ***RV5-Monitor System Health*** use case.

The Base Server's role in this comparison is to determine and report discrepancies, if any, to the vehicle as well as the OBS Administrator. The OBS Administrator may choose to forward some or all of the discrepancy information to other business groups.

2. Pre-conditions

The *Register components* step in ***RV5-Monitor System Health*** use case has been successfully completed.

The *Start up system* step in the ***RV1-Initiate Vehicle for Operation*** use case has been successfully completed.

The Base Server has a complete profile of the vehicle's unique configuration in its Vehicle Configuration database as well as current health status information for all OBS and component devices.

3. Flow of Events

3.1 Basic Flow

Establish communications with Revenue Vehicle
The Revenue Vehicle shall contact the Base Server via the WLAN.

All subsequent communications during the processing of this use case shall occur via the WLAN.

Verify validity of vehicle's configuration
The system shall verify that the vehicle's hardware configuration is consistent with the Base Server's hardware configuration for this vehicle.

1) The Revenue Vehicle will transmit its current configuration information to the Base Server.
2) The Base Server will log the receipt of this information and transmit an acknowledgment of receipt to the vehicle.
3) The Base Server will execute a comparison process checking for consistency between the vehicle's transmitted configuration information, and the configuration information stored on the Base Server.
4) The Base Server will determine and log configuration comparison results for each completed comparison, designating the comparison as either *successful* or *unsuccessful*.
    a) A *successful* comparison is one where consistent information resides on both the Base Server and the vehicle.
    b) An *unsuccessful* comparison occurs when either the Base Server or the vehicle's Vehicle Configuration database contains a hardware device that does not exist in the other's Vehicle Configuration database.

Transmit comparison results to the vehicle
The Base Server shall transmit all logged comparison results to the vehicle.

1) The Base Server will send comparison results to the vehicle.

2) The vehicle will send an acknowledgment of successful receipt to the Base Server.
3) The Base Server will log the acknowledgment.

Update Vehicle Configuration database
The vehicle shall update its Vehicle Configuration database to correctly reflect the equipment discovered during the start-up configuration check.

3.2 Alternative Flows

3.2.1 Manage Loss of WLAN Connection

Manage Loss of WLAN Connection
The system shall log, and notify the OBS Administrator of, any loss of WLAN contact with the vehicle during the verification process.

1) The Base Server loses contact with the Revenue Vehicle after communications have been established.
2) The Base Server is unable to reestablish contact within the guidelines established in Subsection **2.A.1.6.3, Wireless Local Area Network (WLAN)**.
3) The system will identify and log the incomplete process.

3.2.2 Process Configuration Comparison Failure

Process Configuration Comparison Failure
For each *unsuccessful* configuration comparison, the Base Server shall send a "Configuration Comparison Failure" alarm to the OBS Administrator and log the sending of the alarm.

(NOTE: The vehicle also will log this event and may generate an alarm message, if appropriate, for display on the DDU; see use case ***RV2-Verify Vehicle Configuration***.)

4. Post-conditions

Any alarms sent to the OBS Administrator that indicate an *unsuccessful* configuration comparison will generally be forwarded to and evaluated by Vehicle Maintenance.

The vehicle and Base Server have updated their respective Vehicle Configuration databases and these now contain consistent information based on the results of this just-completed comparison process.

5. Special Requirements

6. Extension Points

RV1-Initiate Vehicle for Operation

RV2-Verify Vehicle Configuration

RV5-Monitor System Health

7. Assumptions

Implementation of OBS must include the proper configuration and completion of the vehicle's and Base Server's respective Vehicle Configuration databases. This information includes the initial configuration information for all component and OBS hardware devices.

The criticality of all configuration comparison alarm types that indicate incompatible configuration information will be designated by the user. The Contractor will supply all necessary utilities for making such designations. Such utilities will be part of the OBS Administrator Toolkit and will exist on the Base Server.

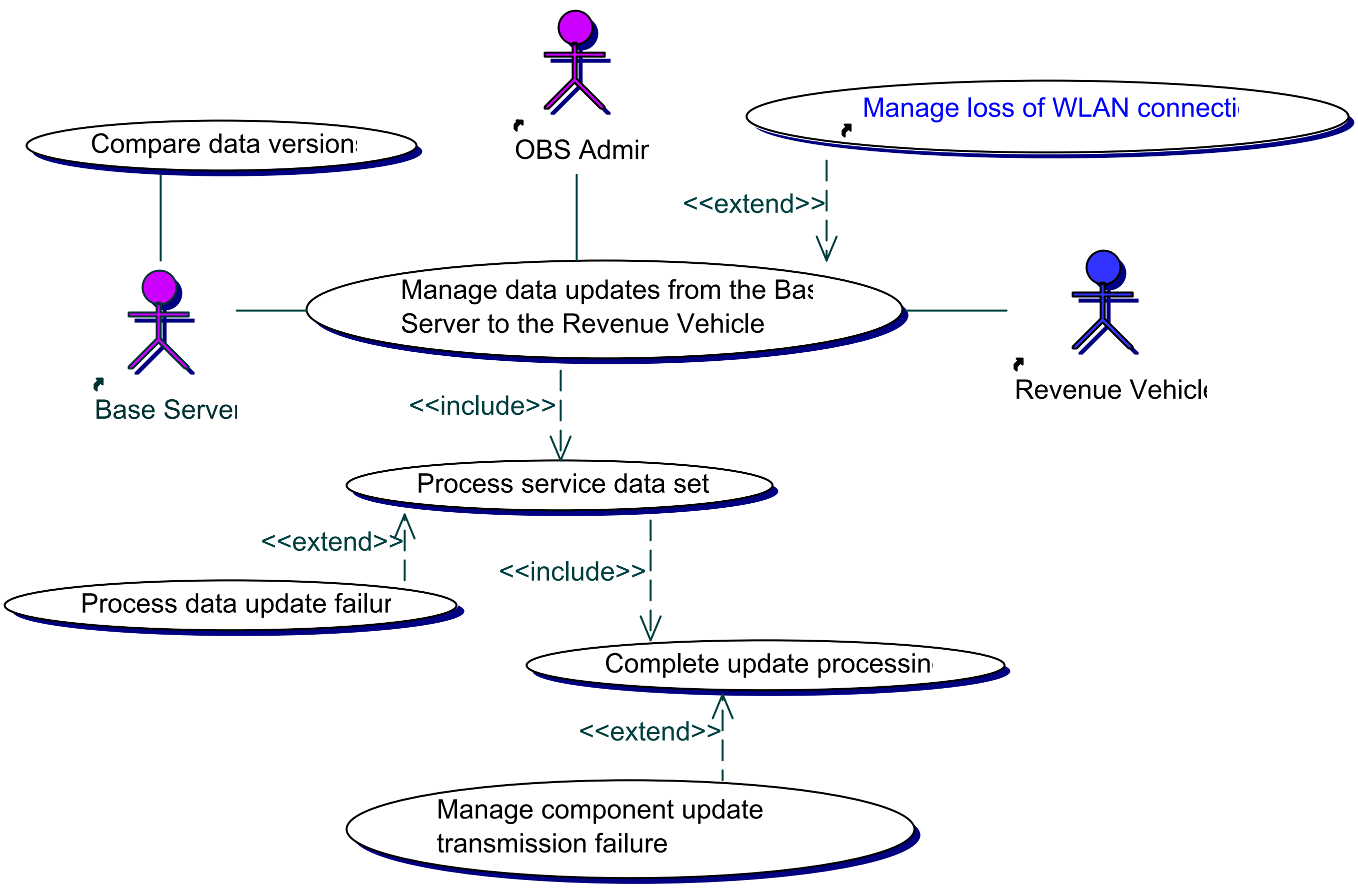
7.1 Issues

The manner in which configuration status information is stored on the vehicle will be a decision for the Contractor. However, since daily configuration comparisons must be made for all hardware that comprises the vehicle's OBS Subsystems before the vehicle can begin revenue service, such information must be stored in a manner that will expedite the speed and accuracy of such comparisons.

2.B.4.2.2. BO2-Update Vehicle Data

This use case package includes the following UML diagram:

Figure 2.B.4.2.2.BO2. UseCase Diagram BO2-Update Vehicle Data



19. BO2-Update Vehicle Data

1. Brief Description

This use case describes the Base Server's processes for identifying, staging, and transmitting update files and/or data sets to the Revenue Vehicle and is a companion to the ***RV4-Update Vehicle Data*** use case which describes the vehicle's side of the update process.

In addition to those updates scheduled for transmission to a vehicle(s) by the OBS Administrator, the Base Server also will maintain a complete set of files and/or data sets currently designated as resident on each vehicle, on a vehicle-by-vehicle basis. See the *Special Requirements* section in the ***RV4-Update Vehicle Data*** use case for a preliminary list of these files and data sets.

NOTE: Comparison of the VLU and subsystem hardware configuration occurs during the processing of the ***RV2-Verify Vehicle Configuration*** use case.

2. Pre-conditions

The *Transfer data from vehicle to Base Server* step of the ***RV3-Take Vehicle out of Operation*** use case has been successfully reached.

The OBS Administrator, using utilities provided on the Base Server as part of the OBS Administrator's Toolkit, must complete the preparation and staging of the various data updates for transmission to the vehicle. Data preparation includes activities such as identifying update type, priority, and criticality; validating data sets and types; preparing and staging required activation date "triggers," if appropriate; and identifying each data set and transfer date. If no files are identified for transmission, a system indicator will be able to provide this message to the vehicle when WLAN contact is initiated.

3. Flow of Events

After the completion of the transfer of historical data from the bus to the base, this use case will be initiated by the OBS in the *Transfer data from vehicle to Base Server* step of the ***RV3-Take Vehicle Out of Operation*** use case.

3.1 Basic Flow

Manage data updates from the Base Server to the vehicle

The Base Server shall transmit data updates to the Revenue Vehicle.

1) The vehicle will contact the Base Server via the WDOLS and request that it provide the needed data updates.
2) If no update data is identified, the Base Server will log this information and proceed to the *Compare data versions* step below.
3) The Base Server will transmit each identified data update.
4) The vehicle will acknowledge receipt of each data update.
5) The Base Server will log and store the update receipt along with other information as needed for version control purposes.

Process service data sets

The Base Server shall arrange triggers for the activation of each service data replacement set.

1) The Base Server will identify each transmitted service data replacement set as either a "current" or "next" set based on the designated effective date of the data set.
   a) This effective date will be transmitted as a "trigger" event and will cause the on-board activation of each identified set.
   b) The Base Server will be able to send the trigger at the same time as the service data set.
   c) The Base Server will also be able to send a new or replacement trigger at a later date.

d) The ability to configure, send, and update this type of trigger will be a part of the OBS Administrator's Toolkit.

2) The Base Server will use the trigger effective date to determine which service data is current and which is next for data version comparison purposes.

Compare data versions
The version information for each file and data set resident on the vehicle shall be compared with the same information on the Base Server.

1) If the vehicle's version is newer than the Base Server's version for any file or data set:
   a) The vehicle's version will not be overwritten.
   b) An alarm will be generated for the OBS Administrator.
2) If the Base Server's version is newer, the Base Server will transmit its version to the vehicle.
3) Consistent version information will cause notation on both the Base Server and the vehicle that no update was required.
4) All updates, along with version information, will be recorded in both the vehicle's and the Base Server's respective vehicle configuration databases.

Complete update processing
The Base Server shall update databases and log update activities.

1) The Base Server will update its vehicle configuration database with all successfully transmitted data set information for version comparison use during the ***RV4-Update Vehicle Data*** use case processing.
2) If all updates have been successfully transferred and acknowledged, the Base Server and the vehicle will disconnect, both logging the completion of the file transmission process.
3) The Base Server will receive an alarm from the vehicle for each "critical" and "non-critical" component update data transmission failure either immediately or, in the event of loss of WDOLS connection, the next time successful contact is achieved.

3.2 Alternative Flows

3.2.1 Data Update Failure

(improper receipt of acknowledgment for any individual file transfer)

Process data update failure
The Base Server shall handle the situation where a data update is not successfully transferred.

The Base Server may determine transmission failure, or the vehicle may determine failure and pass this information to the Base Server.

1) The Base Server will generate an alarm for the *OBS Administrator*, sending information indicating a transmission failure for each named data update and its designation as service-"critical" or "non-critical."
2) The Base Server will generate an alarm for the *vehicle*, sending information indicating a transmission failure for each named data update and its designation as service-"critical" or "non-critical."

3.2.2 Loss of WDOLS Connection

Manage loss of WDOLS connection
The Base Server shall respond to any loss of contact with the vehicle during file transmission.

1) The Base Server will log the loss of contact with the vehicle and any incomplete data updates.
2) The Base Server will then send an appropriate alarm to the OBS Administrator, indicating date and time of WDOLS failure along with each failed or uncompleted data update and its designation as service-"critical" or "non-critical."

3.2.3 Component Update Transmission Failure

Component update transmission failure
The Base Server shall respond to the situation where the vehicle is unsuccessful in transmitting update data to a component system.

1) The Base Server will receive an appropriate alarm from the vehicle indicating component transmission failure for each component and its failed data update(s) along with the data update's designation as service-"critical" or "non-critical."
2) The Base Server will log this alarm and transmit it to the OBS Administrator.

4. Post-conditions

This use case, upon the successful completion of its processing, has updated both the Base Server and the Revenue Vehicle with consistent and complete configuration information needed for the next processing of the ***RV2-Verify Vehicle Configuration*** use case.

Unsuccessful data update information will be passed to the OBS Administrator for logging and the generation of appropriate alarms. Any failed update required for revenue operation will cause an "unsuccessful update" flag to be set by the system and reviewed at the start of the ***RV1-Initiate Vehicle for Operation*** use case processing.

Any service-critical alarm that indicates file transmission failure shall be displayed to the OBS Administrator. While the Operator will determine whether or not the alarm requires that the vehicle be taken out of revenue service, the OBS Administrator will be responsible for providing this information to the appropriate maintenance staff.

5. Special Requirements

6. Extension Points

RV1-Initiate Vehicle for Operation

RV2-Verify Vehicle Configuration

RV3-Take Vehicle Out of Operation

RV4-Update Vehicle Data

7. Assumptions

OBS implementation must include the installation and appropriate population of the Vehicle Configuration databases that reside on both the Revenue Vehicle and the Base Server. This information includes, but is not limited to, "current" and "next" lists and versions for all data sets listed above.

Critical alarms sent to the OBS Administrator by the Base Server will be made available to maintenance and/or other staff according to KCM business rules.

The next scheduled WDOLS connection with the Base Server occurs during the processing of the ***RV1-Initiate Vehicle for Operation*** use case.

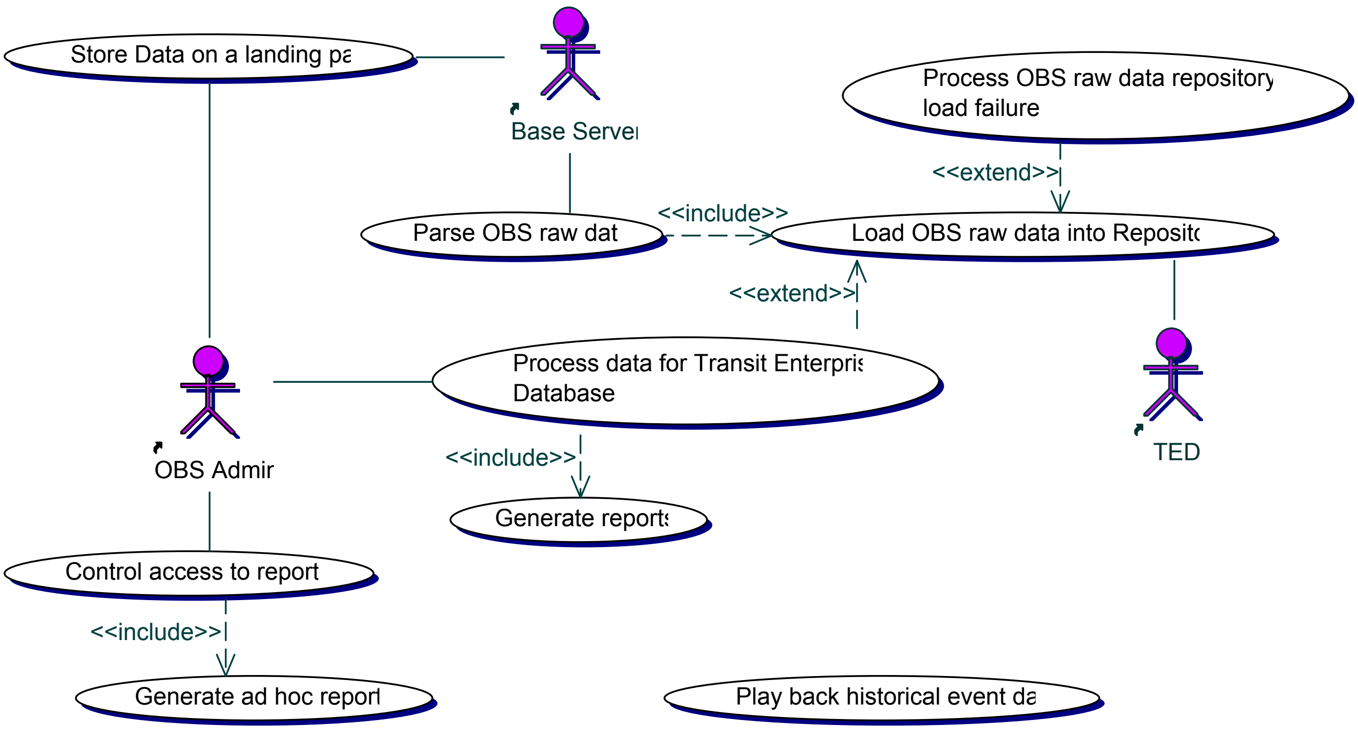
8. Issues

KCM's current configuration provides electrical power to the vehicle for approximately 30 minutes after the engine has been shut down. During the processing of the ***RV3-Take Vehicle out of Operation*** use case, the transfer of data from the vehicle to the Base Server may require the use of some of this time. Any remaining time will be available for the OBS to process this use case. It is currently unclear if this will be an adequate amount of time to complete this processing.

2.B.4.2.3. BO3-Manage Historical Data

This use case package includes the following UML diagram:

Figure 2.B.4.2.3.BO3.a. UseCase Diagram BO3-Update Vehicle Data



20. BO3-Manage Historical Data

1. Brief Description

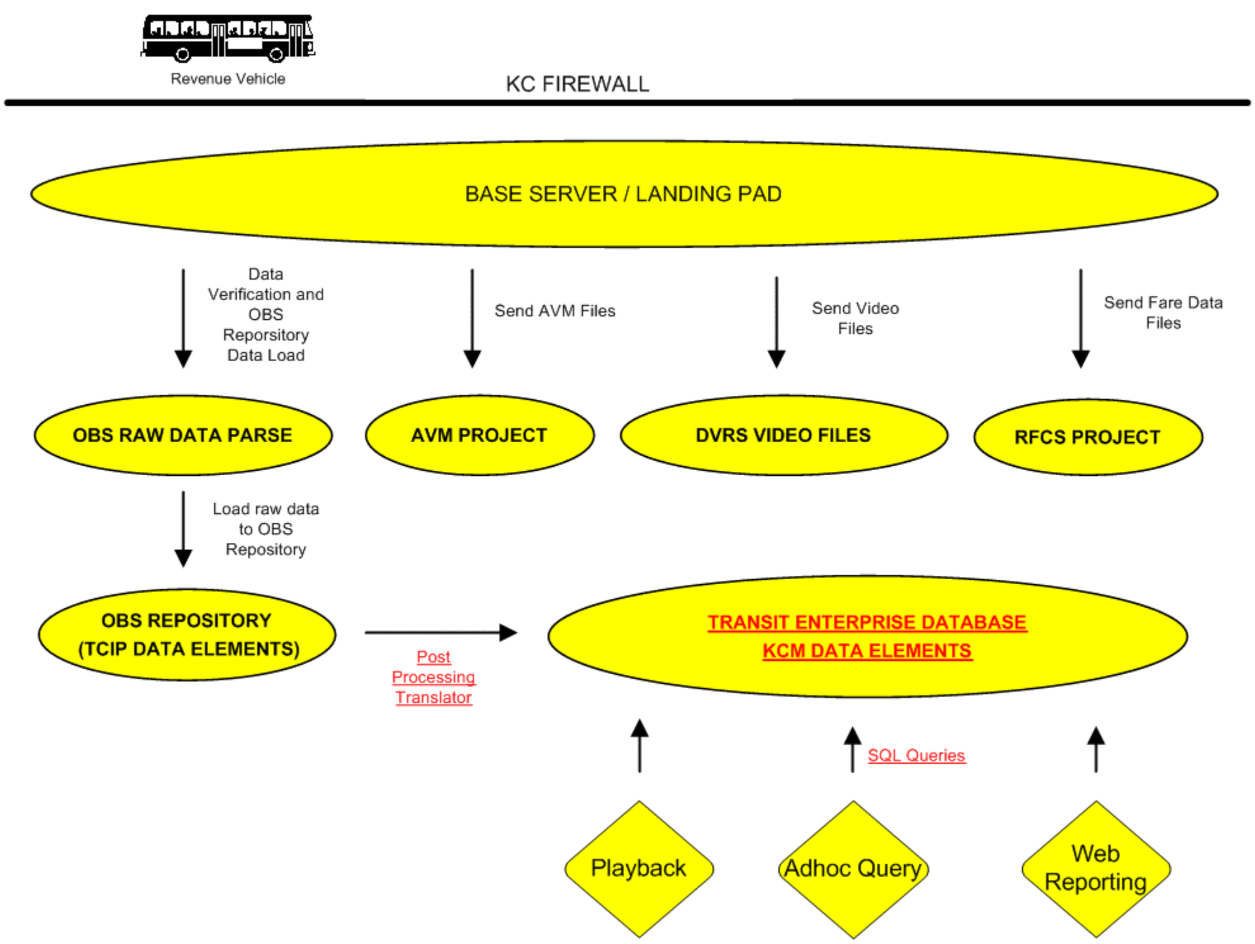
This use case describes the process for how data will be organized and distributed and should comply with the requirements in Section **2.A.1.7, Data Collection, Management and Reporting**. The use case addresses several aspects of data management:

- The loading of raw data after the download from the Revenue Vehicle to Base Server.
- The processing for verification of data loaded.
- The processing of data to load into the enterprise database.
- Reporting against raw unprocessed data and processed data loaded into databases.

Users of the OBS data will be able to query-report on the raw data and/or preprocessed populated databases. The OBS Administrator will have the capability to configure, start, stop, and change access rights to any part of this process in order to assure data integrity and accuracy.

Each of the agency's departments has special requirements to access and report on the raw data in order to provide reports for KCM management, county, state, and federal uses. Ad hoc reporting is one of the mainstays of each of the departments in KCM.

Figure 2.B.4.2.3.BO3.b. KCM data organization and distribution



2. Pre-conditions

The *Manage transfer of data from the vehicle* step in the ***RV3-Take Vehicle Out of Operation*** use case has been successfully completed.

3. Flow of Events

This use case is triggered when data is successfully loaded onto the Base Server Landing Pad on the KCWAN.

3.1 Basic Flow

Store data on a Landing Pad (Base Server)
The Landing Pad shall store data transferred from the Revenue Vehicle (RV).

1) The Landing Pad will store Revenue Vehicle data inside the KC firewalls and on the KCWAN.
2) The Landing Pad will be automatically backed up via a local device.
   a) The OBS Administrator will be able to perform manual backup either locally or remotely.
   b) The OBS Administrator will be able to manually or automatically restore the Landing Pad via a local or remote device.

Parse OBS raw data
The system shall parse raw data into configurable, separate data loads.

1) Raw data will be parsed, creating load records for each data load that is defined.
2) Raw data will be distributed to their respective servers in the form received from the vehicle.
   a) Fare collection data will be passed directly to the fare collection database for the RFCS database processing.
   b) Security camera video data will be passed directly to the security database.
   c) Automatic Vehicle Monitoring (AVM) data will be passed directly to the Vehicle Maintenance server.
3) OBS raw data will be parsed and verified.
4) After verification the data will be automatically processed for loading into the OBS Repository.
   a) The OBS raw data sets will include, but not be limited to, the types identified in the *Manage transfer of data from the vehicle* step in use case ***RV3-Take Vehicle Out of Operation***.
   b) Duplicate data will be flagged for later use.
   c) The data will be verified for gaps and tagged to ensure integrity.
   d) The system will provide primary keys for loading and data translation subject to KCM approval.

Load OBS raw data into Repository
The system shall load OBS raw data into the Repository and also translate the raw data into TCIP-formatted data.

1) The OBS Administrator will have the ability to configure either real-time or batch load of OBS Data.
2) The system will load and store the raw data into the OBS Repository database.
3) The raw data will be translated into TCIP-formatted data elements and stored in the Repository.
4) The system will load duplicated data into a duplicate data table with both sets of records, OBS raw and TCIP-formatted.
5) KCM can access both versions of the OBS data in the Repository to develop reports and queries, and to read all data.
6) The system will provide views into the data for querying and reporting that are approved by the KCM Project Manager.

7) The system will notify the OBS Administrator when data is ready for loading into the Transit Enterprise Database (TED).

Process data for Transit Enterprise Database

KCM will retrieve the data from the OBS Repository for loading into KCM databases.

1) KCM will translate the TCIP-formatted data for loading into the TED.
2) KCM will activate the Generate Reports trigger when the data is ready.

Generate reports

The Contractor shall provide triggers to automatically launch and manually process all reporting for the various KCM business groups.

1) The Contractor will provide standardized reports.
   a) The system will automatically generate a minimum of 20 reports from the enterprise database to be released by the OBS Administrator to the intranet.
   b) The system will allow for random running of standardized reports based on user request via the intranet.
2) The system shall provide standardized queries that allow parameterized input by KCM users.

Control access to reports

The OBS Administrator shall have the ability to grant access and to control standardized reports and queries.

1) Authorized personnel will have the ability to regenerate reports.
2) The OBS Administrator will have the ability to assign different levels of Administrative privileges on the Landing Pad and OBS Raw Database Repository.
   a) The OBS Administrator will have supervisory rights on the Landing Pad.
   b) The OBS Administrator will have tools to manually manage the data loads that allow for update, delete, and insert to the OBS Raw Database Repository.
3) The OBS Administrator will have tools to manage the web reporting.
   a) The OBS Administrator will have the capability to revert and/or replace with previous or updated data and rerun reports.
   b) The OBS Administrator will have the ability to configure the threshold on required data for publication of reports based on the file type and report type.
   c) At any point in time the OBS Administrator may set up and/or halt an automatic release of reports.
   d) The OBS Administrator will be able to grant to any individual or group the rights to read and run any report.
   e) The OBS Administrator will have the ability to filter out bases, fleet type, and report type from publication based on business needs at that time.

Generate ad hoc reports

KCM users shall use Crystal Reports and other SQL tools to write their own reports against the OBS data.

1) The Contractor will provide documentation to enable KCM staff to query the OBS Raw data on the Repository using date timestamps, bus route numbers, blocks of work, and/or vehicle ID for the data querying.
2) KCM will provide the ad hoc query capability into the Transit Enterprise Database.

Play back historical event data

The system shall provide the ability to play back historic event data while displaying the vehicle location on the KCM transit base map.

1) Authorized users will have tools for playing back, via the King County LAN, the event log data that is gathered from the Revenue Vehicle.
    a) The OBS Administrator Toolkit will include the means to control user access to this functionality.
2) The system will provide the ability to play back on-board events logged during vehicle operations. (See use case ***RV6-Manage Events***).
3) Level 2 only: The system will provide the ability to play back events logged by the CCS. (See use case ***CC12-Manage Data Reporting***).
4) The system will simultaneously display vehicle location on the current KCM GIS base map and the corresponding event log in a separate window on the same display device. These two displays will remain synchronized as information is provided over time.
    a) The vehicle location display will enable a user to view the path that a vehicle traveled, with the vehicle's icon indicating whether or not the vehicle was logged in. It will include established iconography and GIS map.
    b) The corresponding event log contents (e.g. APC data, door open and close data) will be available in a tabular format. This data will scroll as the vehicle travels its path over time.
    c) The user will be able to alter the viewing speed of the playback.
5) The playback feature will provide a variety of options for the user to call up patterns or routes of interest for a specified time period. A user can select a piece of work for playback by choosing any of the following:
    a) A specific trip or a block of work.
    b) A route number or TPI with a direction of travel, date, and start time: this will allow a user to view every vehicle that operated the route or TPI of interest during a specified period.
    c) A start and end time for playback (e.g., when the planner is only interested in the last 15 minutes of a trip).
    d) The established map features/layers for playback display at the time of or during playback.

3.2 Alternative Flows

Process OBS Raw Database Repository load failure

The OBS Administrator shall be able to restart or reverse from any point in the process when a failure occurs in the load or processing of the Landing Pad data to the OBS Raw Database Repository.

4. Post-conditions

All steps have been completed successfully and reporting is available with all triggers issued successfully.

Data was successfully stored, backed up, parsed, and delivered to the appropriate designated location.

OBS data was verified for loading onto TED.

Historical data is accessible to users for querying, reporting, and playback.

Standard reports were auto-generated.

5. Special Requirements

5.1 Performance

Archiving

The OBS Administrator shall have methods and tools for archiving data.

1) A configurable archiving method is required to move data out of the Repository when data is aged beyond current online use.
2) Archived data can be reloaded, if necessary in the future.
3) An Entity-Relationship Diagram (ERD) for historical OBS data will be provided during design and approved by the KCM Project Manager.
   a) The ERD will enable KCM to program standard queries to the database.
   b) The ERD shall detail the primary and foreign key relationships between tables.
   c) A quality review of the ERD will be performed by the KCM data architects and programmers.

AVM data
AVM data collected from the ECM and I/O sensors will be post-processed and available to Vehicle Maintenance staff for query and analysis within 30 minutes after the data has been downloaded.

1) OBS raw data from the AVM logs on the vehicle will be set into a parameter-delimited format.
2) Specific data formats may correlate to the type of I/O data that is collected by sensor type.
3) Specified formats will be jointly designed, owned, and approved during design.

5.2 Technical Specifications

Data storage
Bus data storage will be configured for redundancy and load sharing.

1) The Landing Pad (Base Server) will have communications with other Landing Pads to verify availability.
2) The Landing Pad will be able to handle the load of multiple Bases if any one Landing Pad is unavailable.
3) The Landing Pad will be configurable to best utilize the resources on the server.
4) The OBS Administrator will be able to adjust CPU resources and data loads on the Landing Pad based on business requirements.
5) The Landing Pad should be able to load-balance with other servers on the KCWAN configured to support the OBS Project.

Data filtering
The reporting system design will provide the ability for a user to filter data for statistical analysis.

Crystal Enterprise compatibility
Users will be able to employ Crystal Enterprise to query data in a raw format from the OBS Repository.

OBS Repository ER Diagram
The TCIP Repository database must have an Entity-Relationship Diagram outlining the formats and columns that exist in each table as well as the relationships between tables and columns including key fields.

Unique records
The Contractor shall only load unique records into the primary tables used for processing into the TED.

5.3 Testing

Backup testing
Testing shall verify that the system can be backed up, restored onto another server, and fully operational within eight hours.

Test processes will provide duplicate records and verify that duplicates are removed during the backup process and loaded into the database duplicate tables.

6. Extension Points

CC12-Manage Data Reporting

RV3-Take Vehicle out of Operation

RV6-Manage Events

7. Assumptions

1. System will utilize an ANSI SQL-compliant product.
2. Data load is completed to TED.
3. Web tools with SQL access for reporting will be utilized.
4. Data-access capabilities will be configurable by OBS Administrator based on user requirements.
5. Designs of data schema, data elements, reports, and data load will be jointly designed, owned, and upgraded by Contractor and KCM.
6. Oracle Database will be the preferred database of choice utilized for the OBS Repository.
7. Record and store heuristics of data, reports, and accuracy based on expected number of data.
8. Enterprise Crystal Reports for the web will be the preferred reporting tool for the OBS project.
9. UNIX will be the preferred platform for the OBS Repository operating system.

8. Issues

1. Ad hoc query of TCIP Data (OBS Raw Database) will require a full understanding of the TCIP Data.
2. AVM Data will be in stored in what format?
3. The Contractor will be provided read-only access to KCM databases to design reports.
4. Does the load to the OBS Raw Database occur in real time or batch after a download is complete from the bus?
5. How will gaps in the data be identified and kept to ensure the integrity of the data?
6. How to identify cancelled or skipped trips?
7. The OBS data must map to TCIP data elements and regional data flows.
8. Discuss how, and where in the process, a TCIP translator will be employed.
9. Discuss how you will be able to utilize the current KCM GIS data to integrate the playback function.
10. Discuss specifically how location (and time) data will be stored and reported.
11. Describe how the CCS poll response data will be mapped to the Event Log data. See the following use cases:
    - ***CC3-Manage Revenue Vehicle Polling***
    - ***CC12-Manage Data Reporting***
    - ***RV6-Manage Events***
    - ***RV17-Interface to 700MHz Radio***
12. Describe what TCIP elements provided in Appendix **A, TCIP Data Dictionary**, you will be utilizing.
13. Describe TCIP data elements that are not listed that are required for your product.
14. Describe how you will utilize the Figure **2.A.1.2.1.2.4.b, View of TCIP Object Relationships**, which describes the envisioned interfaces and data flows between all components connected to the OBS system.
15. Describe how you can meet the requirements in the Puget Sound Regional ITS Architecture and where you

deviate. (See Subsection **2.A.1.2.1, Industry Standards: ITS and TCIP Compliance**)

2.C. Level 1 SOW Vendor Questions

2.C.1. Questions for Level 1 Technical Requirements

This subsection contains questions to be addressed by Proposers in responding to the requirements included in Part C, Subsection **2.A, Level 1 Technical Requirements**. Additional questions regarding Level 2 requirements are included in Part C, Subsection **3.C, Questions for Level 2 Technical Requirements**. Proposals shall address the questions in the order presented, identifying each answer by the question number shown below. Subsection **2.C, Questions** reflects the organization and content of Subsection **2.A**; for example, questions related to Subsection **2.A.2, Testing**, may be found below in Subsection **2.C.2, Testing**. Answers need to be specific, detailed, and straightforward using clear, concise, easily understood language.

When formulating answers, Proposers shall consider information provided and requirements included in the entire RFP. Special consideration should be given to the instructions provided in Part A, the Terms and Conditions detailed in Part B, and applicable standards, regulations, and functional requirements described in Part C. Failure to do so will be at the Proposer's own risk.

Along with other proposal contents specified in Part A, Section **2.E**, the Proposer’s responses to questions contained in Subsection **2.C.** are intended to provide KCM reviewers with the information needed to judge the worthiness of each proposal. KCM’s proposal evaluation team will assign points to each proposal based on the guidelines set forth in Part A, Section **2, Proposal Evaluation and Contract Award**. That section sets forth the weighted-maximum-scoring-points system that will be used for evaluating each proposal, including the responses to the questions contained in this subsection.

The answers to these questions shall constitute the Proposer's full response to Part C, Subsection **2.A, Level 1 Technical Requirements** comprised of:

- Subsection **2.A.1, General Technical and Level 1 Technical Specifications**.
- Subsection **2.A.2, Testing**.
- Subsection **2.A.3, Other Project Requirements**.
- Subsection **2.A.4, Optional and Future Functionality**.

Proposers shall prepare their answers in accordance with the instructions provided in Part A, Subsection **1.T.3, Response Content Requirements**. Answers to these Part C, Subsection **2.C**. questions in combination with the Proposer’s System Self-Assessment described in Part A, Section **1.T.5**, and responses to the Level 1 Functional Requirements in Part C, Subsection **2.B**,will constitute the Proposer's detailed Level 1 system proposal to KCM.

> **NOTE**: The questions shown below for a given section or subsection shall be assumed to cover all subordinate subsections, if any. Additional questions may or may not be given for any such subsections.

2.C.1.1. General and Level 1 Technical Specifications

The Proposal response to Subsection **2.A.1** shall address the full set of specifications for a fully installed functioning system.

2.C.1.1.1. Introduction and Overview

It is important that each Proposer pay careful attention to Subsection **2.A.1, General and Level 1 Technical Specifications** as well as any Addenda updates that may be issued. This subsection outlines the basic system to be provided by the Contractor in Level 1, and general technical requirements for hardware and software systems to be provided for both Project levels. Proposals shall respond to all aspects of Subsection **2.A.** Any exceptions to specifications shall be explained on a separate sheet attached to your Proposal, referencing the RFP section, subsection, and paragraph.

2.C.1.2. General Technical Requirements and Underlying Principles

2.C.1.2.1. Industry Standards: ITS and TCIP Compliance

Describe the Proposer's approach to meeting the requirements outlined in this subsection.

2.C.1.2.1.1. ITS Architecture Conformance

Discuss the recommended method and approach to ITS compliance.

Discuss your approach to achieving the goals of the "Federal Transit Administration National ITS Architecture Policy on Transit Projects, Section VI, Project Implementation."

2.C.1.2.1.2. TCIP Compliance and Conformance

Describe your proposed approach to using the emerging Transit Communication Interface Profiles (TCIP) standards to develop open, defined, and compliant interfaces.

Discuss your approach to the use of TCIP in data management and data flows, using industry standard TCIP-XML.

Describe where you propose that the TCIP data conversions should occur between the Transit Enterprise Database and the Base Operations Domain.

2.C.1.2.1.3. DSRC Standard

Identify the applicability of and compatibility with the emerging Dedicated Short Range Communications (DSRC) for WLAN implementation.

2.C.1.2.2. General "Latest Technology" Requirement

Describe your proposed approach to satisfying the requirement to ensure that the latest technology solution is implemented.

Provide a full explanation of your proposed OBS/CCS hardware and software configuration, together with associated whole life-cycle costs. Discuss any performance and cost trade-offs made in developing your proposed solution.

2.C.1.2.3. Reference Documents

Identify the full set of standards to be used and the sections that will apply to your proposed solution.

2.C.1.2.4. KCM-Specific Terms

No questions.

2.C.1.2.5. General Resolution of Differences in Interpretation of Specification

No questions.

2.C.1.2.6. Life Expectancy of System

Identify specific areas of concern, if any, with meeting the life-expectancy requirement for subsystems and components. Discuss alternative recommendations for satisfying the intent of this requirement.

2.C.1.2.7. Integration Extent

Describe your approach to integrating OBS/CCS with legacy systems.

Describe your approach to assuring full continuation of essential functions of legacy systems including RFCS and DVRS devices, Destination signs, AVI tag, and ECMs.

Describe your approach to providing an open system architecture, allowing inter-operability and expandability and providing an upward migration pathway with respect to ITS-related systems to be implemented later, and to other systems as a whole.

2.C.1.3. Baseline Expectations

2.C.1.3.1. Modularity and Upgradeability

Describe how your proposed system will meet the requirements for modularity and upgradeability for equipment and software.

2.C.1.3.1.1. Equipment

Confirm how your proposed equipment will meet the requirement for standard, commercially available hardware devices.

2.C.1.3.1.2. OBS Software

2.C.1.3.1.2.1. Operating System

Describe your preferred operating system(s).

2.C.1.3.1.2.2. VLU Master System

Describe possible constraints that might keep the system from meeting requirements for near-real-time processing of multiple and simultaneous requests for interaction from contending subsystems and internal processes.

Discuss any concerns or issues you might have with complying with KCM requirements for published, public (open) ICDs. Include your definition of the term “public” as used in this context.

2.C.1.3.1.2.3. On-Board AVL

Describe your proposed approach for modularizing the On-Board AVL software module to allow the replacement or upgrade of the module and/or its reporting sensors.

Discuss any concerns or issues you might have with complying with KCM requirements for published, public (open) ICDs. Include your definition of the term “public” as used in this context.

2.C.1.3.2. Vandalism Protection

Discuss the physical composition of your proposed equipment and other proposed techniques for protection against common vandalism and physical abuse.

2.C.1.3.3. Revenue Vehicle/Communications Center Interaction

Discuss your approach to providing systems that will support reliable, continuous communications between the OBS and the CCS throughout design, testing, and implementation throughout both Level 1 and Level 2.

2.C.1.3.4. Server/Workstation Hardware Requirements

Discuss your concerns, if any, about meeting the server/workstation hardware requirements.

2.C.1.3.5. Server/Workstation Hardware Procurement

Discuss your concerns, if any, about the proposed server/workstation hardware procurement approach.

2.C.1.4. OBS/CCS Technical Requirements

2.C.1.4.1. Physical and Materials Requirements.

Discuss your concerns, if any, about meeting the equipment requirements. Describe any recommended additional requirements or proposed alternatives.

2.C.1.4.2. Electrical Requirements

Discuss your concerns, if any, about meeting the electrical requirements. Describe any recommended additional requirements or proposed alternatives.

2.C.1.4.3. Environmental Requirements

Discuss your concerns, if any, about meeting the environmental requirements. Describe any recommended additional requirements or proposed alternatives.

2.C.1.4.4. General Software Requirements

Discuss your concerns, if any, about meeting the general software requirements. Describe any recommended additional requirements or proposed alternatives.

2.C.1.4.5. System Security

Describe your approach to tracking software and data alternations (audit mechanism).

Describe other proposed system security measures, including those for ensuring data integrity.

Describe your approach to meeting requirements for tracking all diagnostic activities. Describe any recommended additional requirements or proposed alternatives.

2.C.1.4.6. System Reliability and Availability Requirements

2.C.1.4.6.1. Equipment Reliability Requirements

Provide a list of OBS/CCS equipment and describe your proposed MTBF estimate and supporting calculations for each device.

2.C.1.4.6.2. Availability

Describe how your proposed system will meet availability requirements.

2.C.1.4.6.3. Failure Review Team

No questions.

2.C.1.4.6.4. Corrective Action

Describe your proposed approach to meeting requirements for taking corrective action. Describe any recommended additional requirements or proposed alternatives

2.C.1.5. Physical System Configuration Overview

2.C.1.5.1. Domain Descriptions

2.C.1.5.1.1. Revenue Vehicle Domain

Describe your proposed approach to developing physical and system architectures that will meet the functionality described for the Revenue Vehicle Domain. This should detail how logical functions are allocated to the physical entities (multiple processors) including the relation to the VAN.

2.C.1.5.1.2. Base Operations Domain

Describe your proposed approach to developing physical and systems architectures that will meet the functionality described for the Base Operations Domain. This should include how logical functions are allocated to the physical entities (multiple processors).

2.C.1.5.1.3. Communications Center Domain

See Subsection **3.C, Level 2 Questions**.

2.C.1.5.2. Vehicle Logic Unit: Physical Requirements

Provide a complete description of your proposed VLU. Include processing and data-storage capacity.

Describe how you determined that your proposed VLU will meet 150% of system's processing and storage requirements.

Describe your proposed configuration including communications ports and types of connections between the VLU and all connected equipment.

2.C.1.5.3. Revenue Vehicle Subsystems: Definition and Requirements

2.C.1.5.3.1. Subsystem Definition

Describe the standard connector and data transport medium for each subsystem.

Describe the communications protocol and data format for data exchanges between the VLU and each subsystem.

2.C.1.5.3.2. Revenue Vehicle Subsystem Modularity

Describe you approach to ensuring that the VLU's Master System and connected subsystems will be designed to facilitate subsystem replacement or upgrade without requiring major modifications to the rest of the OBS.

Describe your approach to developing open, public, published interface control documents for equipment provided by others (see Table ***2.A.1.5.3, Revenue Vehicle Subsystems***).

2.C.1.5.4. Revenue Vehicle Subsystems

2.C.1.5.4.1. Automatic Passenger Counting

Describe your proposed APC subsystem and its configuration. Include a complete product description with technical and performance specifications.

2.C.1.5.4.2. Automatic Vehicle Monitoring

Describe your experience, if any, with AVM systems.

List and describe your experience with vehicle types and their engine control modules.

Describe your experience in installing sensors for additional mechanical and electrical systems monitoring.

Provide a product description of your proposed I/O sensors.

Provide a product description of your proposed multiplexor and identify those vehicle types that will need one.

Provide a full description of your proposed AVM Signal.

2.C.1.5.4.3. Driver Display Unit

Discuss your proposed configuration for connecting the VLU and the DDU for real-time messaging and data exchange. Include the perceived advantages and disadvantages of your proposed configuration.

2.C.1.5.4.4. Destination Signs

Discuss your proposed connection and cabling from the VLU to each destination sign system described in Subsection **1.B.4.5, Destination Signs**.

2.C.1.5.4.5. Digital Video Recording System

Discuss your proposed configuration for connections between the VLU and the DVRS for real-time messaging and data exchange at the transit base. Include the perceived advantages and disadvantages of the proposed configurations.

2.C.1.5.4.6. Emergency Alarm

Discuss your proposed configuration for connecting the VLU to the EA switch without degrading or interfering with existing connections.

2.C.1.5.4.7. Fare Transaction Processor

Discuss your proposed configuration for connecting the VLU and the FTP for real-time messaging and data exchange. Include the perceived advantages and disadvantages of the proposed configurations.

2.C.1.5.4.8. Interior Sign

Describe your proposed interior sign and its features and characteristics. Include a complete product description with technical and performance specifications.

2.C.1.5.4.9. On-Board AVL

Describe your proposed OB AVL subsystem (software module) and its configuration including chosen sensors. Provide a complete product description for each of the proposed sensors that includes technical and performance specifications.

Describe your experience with providing on-board AVL solutions using multiple location sensors: number of vehicles involved, type of deployments, performance and accuracy levels achieved.

2.C.1.5.4.10. Public Announcement System

Describe your proposed PA system configuration and Contractor-provided hardware including PA Amplifier, Ambient Noise Detection device, and PA Switch, if required. Discuss connections with the legacy speakers and PA microphone.

Provide a complete product description for each of the proposed devices that includes technical and performance specifications.

2.C.1.5.4.11. Radio System (Level 2 Only)

See Subsection **3.C, Level 2 Questions**.

2.C.1.5.4.12. Transit Signal Priority

Discuss your proposed connection between the VLU and the TSP Tag.

2.C.1.5.4.13. Wireless Local Area Network

Discuss your proposed WLAN communications link for data exchanges between the Revenue Vehicle and the Base Operations domain.

Provide a description of how this system will be used by the Transit Police for real-time monitoring of the DVRS video broadcast.

Describe your approach to determining the upgrade needs of the existing WDOLS devices and access points.

Discuss the feasibility of using the proposed WLAN to support Revenue Vehicle-to-roadside communications.

2.C.1.6. Communications Layers

Discuss your approach to determining how to upgrade or replace each of the three existing communications modes (WLAN, VAN, Radio) while ensuring that there are no adverse affects on ongoing operations.

2.C.1.6.1. Protocols and Standards

2.C.1.6.1.1. Standard Interfaces and Protocols

Describe your proposed on-board data network architecture and how it will comply with the OSI model and use TCP/IP. Discuss any areas of concern.

2.C.1.6.1.2. Internet Protocol

Describe your proposed approach to compliance and discuss any areas of concern.

2.C.1.6.1.3. Physical Network Standards

Describe your proposed approach to compliance and discuss any areas of concern.

2.C.1.6.1.4. Network Protocol Standards

Describe your proposed approach to compliance and discuss any areas of concern.

2.C.1.6.1.5. Wireless Transmission Protocol Standards

Describe your proposed approach to compliance and discuss any areas of concern.

2.C.1.6.2. Transit Radio System

2.C.1.6.2.1. Level 1 450 MHz Radio/AVL System

Discuss any areas of concern regarding the implementation of Level 1 functionality without adversely impacting the legacy radio system operation. If there are areas of concern, discuss your recommended alternative approach.

2.C.1.6.2.2. Level 2 TRS

Proposer information regarding TRS requirements should be provided in response to Section **3, Level 2 Requirements**.

2.C.1.6.3. Wireless Local Area Network

2.C.1.6.3.1. General WLAN Requirements

Described your proposed solution or approach to satisfying the following baseline WLAN requirements:

a. Provide an initial estimate of the WLAN bandwidth and throughput requirements. Describe the proposed WLAN architecture and system throughput.

b. Describe any concerns or issues with providing coverage at all KCM transit bases.

c. Describe your proposed WLAN protocols, data flows and processes to synchronize and maintain current on-board data and system configuration.

d. Provide the proposed number of wireless access points (WAP) for each base. Describe the method used to arrive at the proposed number of WAPs. Discuss areas of concern at specific sites.

e. Describe how the proposed WLAN will support the needs of the identified on-board subsystems. Describe how the WAPs will connect to the KCWAN and to multiple servers.

f. Specifically address the WLAN design requirements to provide sufficient throughput for DVRS video data without degrading the data-exchange requirements of the other subsystems.

g. Describe how the proposed WLAN design will provide Transit Police with the capability for real-time viewing of on-board video.

h. Describe the proposed approach to delivering a WLAN with the latest technologies for security, authentication, and data encryption at the time of implementation.

i. Describe how the WLAN will meet the requirements for the AVM Signal and, optionally, wireless TSP.

Provide an updated version of Table ***2.A.1.6.3.1, Systems to be Supported by the WLAN***, providing updated figures that are consistent with your proposed solution, and adding an “Issues/Questions” column in which your questions and concerns about each supported system are documented.

2.C.1.6.3.2. WLAN Encryption

Describe your proposed method of encryption and how it will specifically satisfy the stated requirements.

2.C.1.6.3.3. WLAN Architecture

Describe your proposed WLAN Architecture and how it will specifically satisfy the stated requirements.

2.C.1.6.3.4. WLAN Communications to Base

Describe the WLAN architecture in the Base Operations Domain and how it will satisfy the reliability and data-storage-capacity requirements in support of the requirements in Subsection **2.B, Level 1 Functional Requirements**.

2.C.1.6.3.5. WLAN Spectrum Alternatives

Describe your recommended WLAN spectrum alternative. Compare and contrast the technical and performance considerations for each alternative and discuss the tradeoffs considered in determining your recommendation.

Provide a detailed solution that satisfied the given WLAN requirements for each of the following alternatives.

2.C.1.6.3.5.1. Alternative 1: Unlicensed Spectrum

Describe your proposed approach to upgrading the legacy Wireless Data On/off Load System (WDOLS) and meeting the requirements for utilization of existing equipment an systems.

Describe the advantages and disadvantages of this alternative.

2.C.1.6.3.5.2. Alternative 2: Licensed Spectrum

See questions for Subsection **2.A.4.1.1, WLAN with Licensed Spectrum**.

2.C.1.6.3.6. Operational Environment for the WLAN

Describe how your proposed WLAN design will accommodate the operational constraints described in this subsection.

2.C.1.6.3.7. WLAN Performance

Provide a detailed description of your proposed WLAN performance. Specifically address each performance requirement listed.

Describe how WLAN bandwidth/throughput can be increased or new sites added.

2.C.1.6.4. Vehicle Area Network (VAN)

Provide a detailed description of your proposed VAN.

2.C.1.6.4.1. Vehicle Area Network Requirements

Provide a description of your proposed VAN cabling.

List the published standards with which the VAN will be in compliance.

Describe any concerns regarding asynchronous messaging on the VAN.

2.C.1.6.4.1.1. Bandwidth

Describe the bandwidth of your proposed VAN, including a breakdown of overhead and throughput.

Describe how the proposed bandwidth will support all of the identified transfer requirements for data/files and messages.

2.C.1.6.4.1.2. Performance

Provide your proposed VAN performance specifications.

Discuss how the requirements for speed and accuracy will be met.

Describe specifically how real-time radio messages will be handled in addition to other on-board messaging.

Discuss any concerns regarding VAN connections to each of the identified subsystems.

2.C.1.6.4.2. Existing Vehicle Area Networks

Describe how and to what extent your proposed VAN utilizes the Revenue Vehicle's existing VANs.

Describe your proposed approach to utilization of the Ethernet hub to manage the high-speed transfer of data between OBS Subsystems and the WLAN.

Describe how and to what extent Ethernet will be used for other purposes in addition to the high-speed connection to the WLAN. Provide your specific experience with using Ethernet on public transit vehicles.

2.C.1.7. Data Collection, Management and Reporting

Provide a technical overview of how the OBS data will be stored, collected, managed, and reported on. The functional and special technical requirements shall be addressed in the response to the applicable use cases in Subsection **2.B.** and **3.B.**

Discuss any concerns with the stated requirements.

2.C.1.7.1. Seamless Data Updates for the Revenue Vehicle

Describe your proposed approach for satisfying the business requirements of update management. Describe your philosophy on the use of primary and foreign keys in a database; and the conceptual data structure for each of the proposed system's domains.

2.C.1.7.2. Data Backup and Recovery

Describe your proposed approach to satisfying the stated requirements for data backup and recovery.

Describe your proposed methods for ensuring database integrity in each step of the process as data is provided to the vehicle, stored in the VLU, and transferred to the Base Server/Landing Pad for storage and processing.

Discuss any areas of concern with meeting these requirements.

2.C.1.7.3. Comprehensive and Accurate Data Collection and Management

2.C.1.7.3.1. Data Collection

2.C.1.7.3.1.1. Configurable Parameters

Describe your proposed approach to and degree of configurable control over the parameters for the frequency and content of the data collected.

2.C.1.7.3.1.2. Unique Identification Tag

Describe the recommended approach to assigning a unique identification tag for each event on which data is collected.

2.C.1.7.3.2. Data Management

Describe your proposed data management scheme.

Describe your proposed approach to developing a normalized database.

Identify recommended XML validation programs.

Describe your relevant experience and proposed data-manipulation tools and utilities. Provide specific examples of tools and utilities included in your standard product.

2.C.1.7.3.3. Data Accuracy and Completeness

Describe your proposed methods and utilities for ensuring data accuracy and completeness.

2.C.1.7.4. Data Exchange Requirements (Software)

Describe related experience with data-exchange processes.

2.C.1.7.4.1. Data Exchange Standards and Logs

Provide your proposed industry-standard verification technique.

Describe your proposed methods for logging and tracking data exchanges:

- Between the Landing Pad/Base Server and the VLU.
- Between the VLU and OBS Subsystems.

Describe how your proposed system continues to write log files while it is also transmitting data from the vehicle to the Landing Pad/Base Server.

2.C.1.7.4.2. Data Recovery from Processing Errors

Describe your proposed methods for data recovery.

2.C.1.7.4.3. GIS/Map Characteristics

Describe how your proposed system will comply with the GIS and map characteristics requirements.

Describe any concerns with the GIS and map data requirements.

Discuss where conversions will be managed, tracked, and logged in order to correlate the following:

- GPS and OB AVL location data to service data provided by the process described in Subsection **2.B, RV4-Update Vehicle Data**.
- GPS and OB AVL location data to Event Log data described in Subsection **2.B, RV6-Manage Events**.
- OBS Historical data (see **2.B, BO3-Manage Historical Data**) and CCS Historical data (see **3.B, CC12-Manage Data Reporting**).

2.C.1.7.5. Reporting Requirements

Provide a suggested list of standard reports and scripted queries.

Describe any concerns or issues with the reporting performance requirements.

Discuss experience with and recommended approach to meeting the reporting requirements for Service Development Groups:

- Service Planning
- Transit Route Facilities
- Scheduling and the HASTUS ATP Module

2.C.1.7.6. Historical Data Transmission and Processing Performance Requirements

Describe how these performance requirements will be met.

Discuss any concerns with meeting the stated requirements.

2.C.2. Testing

2.C.2.1. General Testing Requirements

Discuss any concerns with meeting the stated requirements.

Provide a preliminary list and brief description of recommended tests.

2.C.2.2. Test Equipment

Discuss any concerns with meeting the stated requirements.

Describe your proposed "test bench."

2.C.2.3. Test Stages

Discuss any concerns with meeting the stated requirements.

2.C.2.3.1. Factory Acceptance Testing (FAT)

Describe your proposed factory acceptance tests.

2.C.2.3.2. Prototype Installation Testing

Describe your proposed approach to Prototype Installation Testing.

2.C.2.3.3. Prototype Field Testing

Describe your proposed approach to Prototype Field Testing.

2.C.2.3.4. Pilot Testing

Describe related experience with the pilot test of a system fielded by your organization that is most similar to OBS/CCS.

2.C.2.3.5. Acceptance Testing

2.C.2.3.5.1. Base Acceptance Testing

Describe your proposed approach to base acceptance testing including scope and documentation.

Discuss any concerns with meeting the stated requirements.

2.C.2.3.5.2. Level 1 Conditional Acceptance Testing

Describe your proposed approach to Level 1 Conditional Acceptance Testing including scope and documentation.

Discuss any concerns with meeting the stated requirements.

2.C.2.3.5.3. Full System Acceptance Testing

Describe your proposed approach to Full System Acceptance Testing including scope and documentation.

Discuss any concerns with meeting the stated requirements.

2.C.2.4. Testing Procedures and Definitions

2.C.2.4.1. General

Discuss any concerns with meeting the stated requirements.

2.C.2.4.2. Test Plan

Discuss any concerns with meeting the stated requirements.

2.C.2.4.3. Test Procedure Outline

Provide an example of a test procedure outline that was used for a similar transit system implementation.

2.C.2.4.4. Test Tools and Logging

Describe your standard set of test tools and logging software.

2.C.2.4.5. Test Reporting

Provide an example of a test report that was used for a similar transit-system implementation.

2.C.2.4.6. Test Failure Resolution

2.C.2.4.6.1. Failure Review Team

No questions.

2.C.2.4.6.2. Type I and Type II Failures

Discuss any concerns with the categorization and handling of Type I and Type II failures.

2.C.2.4.6.3. Retesting

No questions.

2.C.2.5. Factory Acceptance Testing (FAT)

2.C.2.5.1. General Requirements

Provide a list of equipment of the same make and model proposed for OBS/CCS which has successfully certified testing that satisfies KCM requirements. Include:

- The specific test and standard of performance.
- The testing authority.
- The date and location tested.
- The final test results.

2.C.2.5.2. Functional Test

Discuss your proposed approach to and any concerns with meeting the stated requirements.

2.C.2.5.3. Environmental Tests

No questions.

2.C.2.5.4. Electromagnetic Test

No questions.

2.C.2.5.5. Human-Factors Test

Describe your recommended approach to and experience with human-factors testing as described in the requirements.

2.C.2.6. Prototype Installation Testing

Discuss any concerns with meeting the stated requirements.

2.C.2.7. Prototype Field Testing

Discuss any concerns with meeting the stated requirements.

2.C.2.8. Pilot Testing

Describe in detail the recommended Pilot Test approach and how best to include the widest mix of vehicle types and Base Operations functions.

Discuss the advantages and disadvantages of performing pilot testing out of one transit base or multiple bases.

2.C.2.8.1. Pilot Test Objectives

Identify concerns, if any, with the identified pilot-test objectives.

Provide a list of additional pilot-test objectives that should be considered.

2.C.2.8.2. Pilot Test Settling-in Period

No questions.

2.C.2.8.3. Changes to County Business Processes

Describe your organization's specific experience with and proposed approach to coordinating changes to County business processes.

2.C.2.8.4. Test Equipment, Documentation, and Training

No questions.

2.C.2.8.5. Pilot Test Plan

Describe any additional items that are recommended for the Pilot Test Plan.

Describe your concerns, if any, with the Pilot Test Plan requirements.

2.C.2.9. Acceptance Testing

Describe any additional items that are recommended for Acceptance Testing.

Describe your concerns, if any, with the Acceptance Testing requirements.

2.C.3. Other Project Requirements

2.C.3.1. Project Phases and Deliverables

2.C.3.1.1. Project Phases and Milestones

Discuss any concerns or issues you have concerning the stated Project Phases and Payment Milestones specifications. Provide any proposed modifications or suggested alternatives. Discuss each phase and milestone separately.

2.C.3.1.2. Project Deliverables

Discuss any concerns or issues you have with the stated requirements for Milestone Deliverables. Provide any proposed modifications or suggested alternatives. Discuss the set of deliverables for each phase and milestone separately.

Provide any suggested additions or modifications for the Pre-Design-Phase Deliverables shown in Table ***2.A.3.1.2.2***.

2.C.3.2. Documentation

2.C.3.2.1. Documentation Control and Management

Discuss any concerns or issues you have with the stated requirements for documentation control and management. Provide any proposed modifications or suggested alternatives.

2.C.3.2.1.1. Documentation Website

Describe your proposed website solution to meeting the requirements of this subsection.

Discuss any concerns or issues you have concerning the stated requirements. Provide any proposed modifications or suggested alternatives.

2.C.3.2.2. Manuals

Discuss any concerns or issues you have with the stated requirements for manuals given in this subsection. Provide any proposed modifications or suggested alternatives.

2.C.3.2.3. Maintenance Documentation and Manuals

Discuss any concerns or issues you have with the stated requirements for maintenance documentation and manuals given in this subsection. Provide any proposed modifications or suggested alternatives.

2.C.3.3. Project Management and Staffing

Discuss any concerns or issues you have with the stated requirements for dedicated Project staff given in this subsection. Provide any proposed modifications or suggested alternatives.

Discuss any concerns or issues you have with the stated requirements for the Contractor presence in the King County area, providing a breakdown by Project Phase and Milestone. Provide any proposed modifications or suggested alternatives.

2.C.3.4. Project Communications and Decision-making Process

No questions.

2.C.3.5. Requirements Management

Describe your proposed requirements-management tools and processes for the life of the Contract.

Discuss its compatibility with KCM's Requirements Management Plan developed in RequisitePro, including the ability to provide importable updates.

2.C.3.6. Configuration Management

Describe your proposed configuration management plan and software tool, including how its meets specified standards.

2.C.3.7. Progress and Performance Monitoring

Describe your approach to developing a Quality Assurance Project Plan for the OBS/CCS Project that will meet the given requirements in this subsection, including how its meets specified standards.

Describe your approach to developing a Project Management, Progress, and Performance Monitoring Plan for the OBS/CCS Project that will meet the given requirements in this subsection, including how its meets specified standards.

Discuss any concerns or issues you have with the stated requirements given in this subsection. Provide any proposed modifications or suggested alternatives.

2.C.3.8. Training

Describe your experience in providing the type of comprehensive training specified in this subsection.

2.C.3.8.1. Principal Training Contact

Discuss any concerns or issues you have with the stated requirements given in this subsection. Provide any proposed modifications or suggested alternatives.

2.C.3.8.2. General Training Requirements

Discuss your available staff resources for providing the types of training specified in this subsection.

Describe your existing training materials that relate to the given requirements.

2.C.3.8.3. Training Program Plan

No questions.

2.C.3.8.4. Operations "Train the Trainer" Training

Discuss any concerns or issues you have with the stated requirements given in this subsection. Provide any proposed additions, modifications, or suggested alternatives.

Describe your existing "Bus in a Box" simulator, if any, and identify potential modifications that would be necessary to allow it to meet the requirements of Subsection **2.A.3.8.4.5**.

Describe your other existing training materials, if any, that relate to the given requirements, especially those for an interactive OBS Tutorial (Subsection **2.A.3.8.4.6**) and an OBS General Orientation training video (Subsection **2.A.3.8.4.7**).

2.C.3.8.5. Vehicle Maintenance Training

Discuss any concerns or issues you have with the stated requirements given in this subsection. Provide any proposed additions, modifications, or suggested alternatives.

Describe your existing training materials, if any, that relate to the given requirements; especially those for operation, preventive maintenance, overhaul, diagnostics, troubleshooting, and repair of the OBS and subsystem components to be provided by the Contractor.

Describe your existing tools and diagnostic equipment, if any, that relate to the given requirements; especially those described in Subsections **2.A.3.8.5.5**, **2.A.3.8.5.6, 2.A.3.8.5.7,** and **2.A.3.8.5.8**.

2.C.3.8.6. Information Technology (IT) Training

Describe your approach to providing an OBS/CCS IT Training plan that meets the given requirements of this subsection.

Describe your existing training materials, if any, that relate to the given requirements.

Discuss any concerns or issues you have with the stated requirements given in this subsection. Provide any proposed additions, modifications, or suggested alternatives.

2.C.3.9. Installation

Discuss any concerns or issues you have with the stated requirements given in this subsection. Provide any proposed additions, modifications, or suggested alternatives.

2.C.3.9.1. Vehicle Installation Prototype

Describe your experience, if any, in working cooperatively with customer staff to prototype installations for different types of Revenue Vehicles.

Provide a "best practices" list for developing the described OBS Prototyping Team and achieving the requirements listed in this subsection.

2.C.3.9.2. Installation Plans

Describe your experience, if any, in providing oversight for the installation of Contractor-provided systems and equipment on the Revenue Vehicles by customer staff.

2.C.3.9.3. Manuals and Documentation

No additional questions.

2.C.3.9.4. Installation Responsibility

No additional questions.

2.C.3.9.5. Installation Equipment

No additional questions.

2.C.3.9.6. Delivery

No additional questions.

2.C.3.9.7. Miscellaneous Supplies

No additional questions.

2.C.3.9.8. Tuning

Describe your approach to developing a "tuning" process to meet given requirements.

2.C.4. Optional and Future Functionality

2.C.4.1. Priced Options

Describe your experience, if any, with the technologies required by each of the priced options.

Provide a detailed discussion of the feasibility of each priced option.

Discuss your proposed approach to system inclusion for each priced option along with the estimated technical, cost, and risk implications that the option would have on your proposed OBS/CCS. Include proposed solutions or mitigation strategies, if any, for each identified technical or risk implication.

2.C.4.1.1. WLAN with Licensed Spectrum

Provide a description of a WLAN system which will utilize licensed spectrum and satisfy all of the WLAN requirements (also see Subsection **2.A.1.7.3.5, WLAN Spectrum Alternatives**).

2.C.4.1.2. Wireless TSP

Provide an updated version of Table ***2.A.1.6.3.1, Systems to be Supported by the WLAN***. The table must:

- Add the information given in Table 2.A.4.1.2, TSP System's Estimated WLAN Activity.
- Provide updated figures that are consistent with your proposed solution.
- Add an "Issues/Questions" column in which your questions and concerns about this option system are documented.

Note: See question for Subsection **2.A.1.6.3.1, General WLAN Requirements**.

2.C.4.1.3. Bluetooth Short-Range Wireless Technology

Provide any information you might have about similar operational implementations of this type of technology.

2.C.4.2. Future Functionality

Describe your experience, if any, with the technologies required by each of the identified future functions.

Provide a detailed discussion of the feasibility of each identified future function along with any identified technical and risk implications that it might have on your proposed OBS/CCS. Include proposed solutions or mitigation strategies, if any, for each identified technical or risk implication.

Discuss your proposed approach to providing the basis for each identified future function within the proposed OBS/CCS.

Discuss your business strategy for providing KCM with a minimum-cost upgrade path for each identified future function.