1. OBS/CCS Business Requirements

1.A. Executive Summary

1.A.1. Introduction

1.A.1.1. Relationship of Part C, OBS/CCS Statement of Work, to RFP

Part C of the OBS/CCS Request for Proposal (RFP) contains business, technical and functional information, and requirements for the Project. Each part (A, B and C) of the RFP has its own Table of Contents located at the beginning of each piece. Part C also includes Appendices A through M.

Provisions for handling questions or issues related to this RFP are addressed in Part A, Subsection **1.E, Questions and Interpretation of Proposal**.

1.A.1.2. Make-Up of Part C, OBS/CCS Statement of Work

Part C is divided into three sections that are described below.

Section 1 is organized as follows:

- **Subsection 1.A, Executive Summary** provides an overview of King County Metro, the OBS/CCS Project, and this procurement.
- **Subsection 1.B, Description of Existing Systems, 2004** contains a description of KCM, its business organization, vehicle fleets, and existing technical systems.
- **Subsection 1.C, Planned Systems Development and Implementation Environment** describes planned upgrades to these existing systems that will occur before OBS/CCS implementation. The delivered OBS/CCS must support and integrate with these changes.

Section 2. Level 1 OBS provides subsections on general technical specifications for the Project (**2.A.**), functional requirements (**2.B.)**, and Proposer questions (**2.C.**).

Section 3. Level 2 CCS/OBS provides subsections with specifications for either upgrading or replacing the current Computer Aided Dispatch/Automatic Vehicle Location (CAD/AVL) system (**3.A.**); functional requirements (**3.B.**); and Proposer questions (**3.C.**).

Appendices include, among others, a TCIP Data Dictionary, a Glossary of Terms and Acronyms, an Interface Control Document specification, descriptions of legacy systems and equipment with which the OBS/CCS is required to integrate or interface, OBS and CCS Administrative Toolkit specifications, and other related Project information.

1.A.1.3. RFP Invitation

The County is soliciting proposals from qualified companies to provide a comprehensive system with the following functionality:

- Level 1: fully integrated, comprehensive systems to provide an integrated, multi-functional on-board system for Revenue Vehicles which automatically exchanges data with a Base Operations (BO) data management system via an upgraded wireless data transmission system.
- Level 2: Communications Center systems which either upgrade or replace the existing Computer Aided Dispatch/Automatic Vehicle Location (CAD/AVL) systems utilized for fleet communications; data exchange; and vehicle tracking, control, and monitoring.

These integrated systems, the OBS/CCS, are to be cooperatively designed, developed, and thoroughly tested by the Contractor. Functionality will be implemented in stages with the Revenue Vehicle and Base Operations systems implemented initially (Level 1), and the fleet management and CAD/AVL systems implemented later in conjunction with KCM's new 700 MHz radio system (Level 2). Both Project levels require the Contractor to follow a defined sequence of Project phases that culminate in fleet-wide implementations and operational testing.

OBS/CCS Project design, systems and interface development, integration, and testing shall all be done in a manner compliant with applicable components of the National Intelligent Transportation Systems (ITS) Architecture. System architecture and development must be coordinated and integrated with existing and planned subsystems as well as with the Regional Fare Coordination System (RFCS) project and the Transit Radio System (TRS) project.

KCM intends to fund a portion of this Project with Federal Transit Administration grant funds.

It is the intent of the County that all parts of this RFP collectively present clear, sufficient, useful, and unambiguous information which provide adequate means to achieve successful procurement of the intended system.

1.A.2. King County Metro Overview

King County Metro is the Transit Division of the Department of Transportation, King County, Washington, serving an annual ridership of 98.5 million within a 2,134-square-mile area. It provides transit services to the City of Seattle and the surrounding King County area, operating over 1,300 revenue vehicles which include standard and articulated coaches, electric trolleys, dual-powered buses, and streetcars. This fleet is operated out of seven transit bases located in north, south, central, and east King County. KCM's administrative offices are located in downtown Seattle as is the current Communications Center where the fleet management and CAD/AVL functions are performed. Among other services, the Agency also manages large vanpool and Paratransit fleets.

The *King County Transit Division Technology Systems Strategic Plan* states:

> "The Transit Division seeks to use technology to achieve operational efficiencies and enhance service effectiveness. These technologies will be used to help achieve the division's goals of safe, reliable, convenient, and responsive public transportation services that provide mobility options to people in King County. Investments in technology will help transit be more efficient and help integrate regional transit services."

Key to this effort is KCM's commitment to work within the Puget Sound Regional ITS Architecture (http://www.psrc.org/datapubs/pubs/reg_arch.htm), developed to meet the guidelines of the National ITS Architecture Policy on Transit Projects. KCM has also committed to using industry standards such as the Transit Communications Interface Profiles (TCIP).

The OBS/CCS Project is one of three major ITS projects either planned or in progress to upgrade on-board and operations management systems. The OBS/CCS along with the RFCS and TRS projects are part of KCM's comprehensive plan to move from existing systems, which are close to the end of their useful lives, to new technology. This plan is being implemented in stages to maximize the value of each new or upgraded system and subsystem. These upgrades are closely linked to KCM's business functions and to the needs of the transit customer.

KCM is currently controlling its transit service using a 450 MHz radio, signpost-based AVL system that was installed in 1990–92. Since that installation KCM staff has been fully responsible for system maintenance and management. Staff members also have implemented numerous upgrades and modifications that have resulted in a very stable, reliable, and useful Radio/AVL system. A new CAD/AVL system user interface was developed in house with the direct involvement of the Communications Coordinators, the primary users. KCM staff is very knowledgeable about the Radio/AVL data, systems, and equipment. *It is a priority for KCM to continue to have a high degree of control over the management and maintenance of the next-generation systems*.

1.A.3. Project Overview

KCM and the Contractor will mutually agree on the Project plan for implementation of Levels 1 and 2 functionality. Level 1 will be implemented first. Then, when the TRS project's new 700 MHz radio system is ready and the County has completed construction of a new Communications Center facility, the Level 2 functionality will be implemented. The need to accomplish this work in stages is also dictated by business requirements to ensure that essential functionality is not degraded as equipment and systems reach the end of their expected life and are replaced.

1.A.3.1. Project Levels

In both Levels 1 and 2, the OBS/CCS Contractor is responsible for working with KCM staff to design and develop

- interfaces to and from KCM's legacy systems.
- internal data flows required for the new systems to function reliably.

KCM staff expects to modify existing processes and data sources that currently provide planned service (route and schedule) information to meet the new systems' requirements. Interface and data flow requirements will be identified during design.

Level 1 will procure and install hardware and software systems and subsystems on KCM's Revenue Vehicles to replace, upgrade, and interface to existing on-board systems. Additionally, "back office" business functions and data management systems will be installed at the transit bases to support the management and exchange of data between the Revenue Vehicles and the KC Wide Area Network (KCWAN). Finally, the Contractor will be responsible for developing processes and tools for presenting and sharing OBS/CCS-generated data with selected KCM business groups including, but not limited to, vehicle maintenance, operations management, and service planning.

In Level 1, the Contractor will be required to work with the RFCS and Digital Video Recording System contractors and KCM staff to design and implement an upgraded Wireless Local Area Network (WLAN) on board the vehicles and at each base to support the data exchange requirements of all three projects: Digital Video Recording System (DVRS) video data, RFCS fare data, and the Level 1 OBS. Functionality will also be added to the vehicle's existing Driver Display Unit (DDU).

The Level 1 implementation will not interface with the legacy 450 MHz radio/AVL systems, which will continue to function as they currently do via an on-board interface to the DDU.

Level 2 involves either the upgrade or replacement of the legacy CAD/AVL system with the new Communications Center System (CCS). Additional management and reporting functionalities that are not common to most CAD/AVL systems are also required. Since the CCS can only be implemented in conjunction with the new radio system, Level 2 will require a high degree of collaboration by the Contractor with KCM staff and the TRS contractor to successfully transition the fleet from the legacy 450MHz radio system. The TRS contractor will procure new radios and will be required to work collaboratively with the OBS/CCS Contractor to develop the interfaces, message sets, and protocols required to support Level 2 functionality.

1.A.3.1.1. Project Levels and Phases

The OBS/CCS project levels and major phases are summarized in the Table below:

Table 1.A.3.1.1. OBS/CCS Project Levels and Phases

Levels	Phases
Project	Pre-Design: Develop baseline schedule and clarify requirements
	Preliminary Design Review (PDR) for Levels 1 and 2
Level 1	Design
	Pilot Project
	Installation and Implementation
	Conditional Acceptance
Level 2	Design and Development
	Installation and Test
	Implementation
Project	Full System Acceptance

1.A.3.2. Project Objectives

The following provides an overview of the products and services that are to be provided by the Contractor for each Project level.

1.A.3.2.1. Level 1 Objectives

a. Add a Vehicle Logic Unit (VLU) to monitor system and subsystem health status and to manage event priorities, messaging with and between subsystems, data exchange at the transit base, and data logging and reporting for the integrated subsystems and software components.

b. Work with ERG, Inc., the RFCS contractor, to:

    i. Add OBS controls to the existing DDU, providing approved displays and functions using ERG's DDU development toolkit. Prior to Level 1 installation, the RFCS contractor will provide certification for all DDU modifications to verify that pre-existing radio and fare transaction processing continues to operate correctly.

    ii. Interface to the existing fare transaction processor (FTP).

c. Add an annunciator system to provide programmable automated interior announcements, external route and destination announcements, and interior "next stop" signs.

d. Add Automatic Vehicle Monitoring (AVM), a process of collecting, filtering, and reporting on data collected from the Engine Control Module (ECM) and an array of selected I/O (input/output) sensors.

e. Add a new Automatic Passenger Counting (APC) subsystem that uses remote sensing technology to at least one-third (1/3) of the fleet.

f. Automatically change destination signs to the correct display at the specified location along the route. Integrate the signs so they can receive signage data updates via the WLAN.

g. Implement a WLAN as an upgrade of the existing WDOLS to provide connectivity between the Revenue Vehicle and the base for all data exchanges, AVM signaling, and, optionally, vehicle-to-roadside communications.

h. Interface to the legacy Transit Signal Priority (TSP) subsystem.

i. Provide an OBS Administrator Toolkit containing utilities for data management functions, setting configurable system parameters, monitoring/managing vehicle configuration, and other troubleshooting, debugging, and diagnostics tools for system administration and maintenance. This Toolkit shall reside on the KCWAN and is described as part of the required Base Operations management utilities.

j. Provide necessary design elements to implement Level 2 functionality and the TRS Project.

k. Provide training support for Operators and maintenance and administrative staff (including LAN, database, and OBS Administrator).

l. Comply with the national and regional ITS architectures; published transit industry standards including J1708/J1939 families, J2496 cabling and TCIP; and published IT and communications standards such as TCP/IP.

1.A.3.2.2. Level 2 Objectives

a. Either replace or upgrade the existing CAD/AVL system and functions.

b. Install and implement the new CCS in a newly constructed Communications Center facility, expected to be completed by the County in early 2006.

c. Develop interfaces to the new TRS in collaboration with the TRS Contractor.

d. Replace and upgrade on-board systems for managing voice communications.

e. Modify the OBS configuration to add the new mobile radio interface and enable the VLU to decode and encode radio messages, respond to poll and contention messages and commands from the CCS, control the mobile radio *receive* and *transmit* channels, and control the radio push-to-talk line when the VLU is in data mode.

f. Modify the DDU to enable Level 2 functionality such as text messaging and joint rail/bus tunnel operations. (See Subsection **3.B.4, *RV17-Interface to 700 MHz Radio***.)

g. Provide a CCS Administrator Toolkit containing utilities for data management functions, setting configurable CCS parameters, and other troubleshooting, debugging, and diagnostics tools for system administration and maintenance.

h. Provide training support for Communications Coordinators and maintenance and administrative staff (including LAN, database, and CCS Administrator).

i. Comply with the national and regional ITS architecture; published transit industry standards including J1708/J1939 and TCIP; and published IT communications standards such as TCP/IP.

1.A.4. KCM Scope and Approach

1.A.4.1. Approach

KCM's approach to achieving Project objectives is to select a Contractor who will do the following:

a. Collaborate with KCM staff, the RFCS contractor, and the successful TRS contractor.

b. Use the latest proven technology.

c. Implement a modular, largely "off-the-shelf" system with interoperable, loosely coupled ("plug and play") subsystems.

d. Secure all needed tools and documentation to manage and maintain the systems.

e. Assist KCM in ensuring continuity and stability in the revenue operations, management, and communications systems throughout the Project.

KCM desires to maintain a degree of control and flexibility over the system throughout its useful life. This will include having the abilities to modify system parameters, change vehicle configurations, and replace a subsystem or device without requiring outside assistance.

1.A.4.1.1. Form, Fit, and Function

This RFP has been written primarily as a "form, fit, and function" requirements document. The Technical Requirements sections in Part C (**C.2.A.** and **C.3.A.**) address the systems' "form and fit" by describing how and in what form the equipment and software will be provided. The Functional Requirements sections (**C.2.B.** and **C.3.B.**) include KCM's Universal Modeling Language (UML) approach to describe what "functions" the system shall perform. These use case specifications provide descriptions of what the OBS/CCS should do and how its modular components should interact. It is not KCM's intention to request a completely new design in response to these requirements, but rather to be clear in describing the desired functionality.

Proposers are expected to describe all proposed functionality and how requirements will be met. These descriptions must specify where off-the-shelf components and applications can be used, and what modifications or enhancements they would need to meet requirements. They must also identify all involved risks, issues, and concerns.

KCM considerations for proposal "form, fit and function" will include the following:

a. Degree to which functional and technical requirements can be met by off-the-shelf designs.

b. Extent to which the Proposer is willing and able to deliver an open, modular system with tools for Agency administration, configuration and maintenance.

c. Proposer's approach to addressing requirements that it has determined may add costs and/or risks to the Project that are disproportionate to the expected benefits.

1.A.4.1.2. Modularity

KCM is committed to fielding a modular system with well-defined subsystems and interfaces. For this project, a "subsystem" is defined as a peripheral system or a software module in either the OBS or CCS system that has a completely defined, published interface control document (ICD), preferably using standard formats and languages such as TCIP, TCP/IP, J1708/1587, J1939, or a KCM-approved alternative. A subsystem will usually consist of both hardware and software, and must be configured so that its replacement does not require major modifications to the rest of the system.

A "device" is defined as a piece of hardware that may compose all or part of a subsystem. Those devices that are part of a subsystem (e.g., APC sensor) must also have a standard, defined interface such as RS232/RS485 and must utilize standard connections.

To the greatest extent possible, proposed subsystems shall be modular, commercially available, off-the-shelf units with an open architecture and adaptable to future upgrades and new functionality. This project embodies the federal objectives for intelligent transportation systems and standards. In 1999, a $2.9M STP grant was awarded for the purpose of funding development of an integrated on-board system. See Subsection **2.A.1.3, Baseline Expectations**.

1.A.4.2. In Scope

This Project intends to provide the major work products or services identified below. It will not address those items identified in Subsection **1.A.4.3, Not in Scope**.

1.A.4.2.1. Level 1: On-Board Systems for the Revenue Vehicle and Base Operations Domains

Level 1 shall have three primary, sequential phases: a design effort; a pilot implementation of all required functionality at each transit base and on a subset of the fleet; and full system implementation on all KCM Revenue Vehicles. The Level 1 system shall integrate with components being provided by other KCM contractors, including those for the RFCS and DVRS projects. Conditional Acceptance will follow a period of successful Level 1 operation. See Subsection **2.B, Level 1 Functional Requirements**.

1.A.4.2.1.1. Level 1 Revenue Vehicle

The following shall be provided on the Revenue Vehicles:

a. Automatic Passenger Counting (APC) subsystem for at least one third of the fleet. Distribution will be proportional to each vehicle type.
b. Automatic Vehicle Monitoring (AVM) subsystem for selected fleet types.
c. Interface to existing Driver Display Unit (DDU).
d. Interface to and added functions and screens for the existing Fare Transaction Processor (FTP).
e. Interface to existing Destination Sign systems.
f. Interface to existing DVRS system.
g. Interface to existing Transit Signal Priority (TSP) system.
h. New Interior Sign(s).
i. New Vehicle Area Network(s) (VAN).
j. New Vehicle Logic Unit (VLU).
k. On-Board Automatic Vehicle Location (OB AVL).
l. Annunciator upgrade and interface to the Public Address (PA) System.
m. Upgrade Revenue Vehicle's existing WDOLS system to a WLAN.

1.A.4.2.1.2. Level 1 Base Operations

The Level 1 Base Operations functionality shall be installed on the KCWAN and shall include the "back office" services needed for data development, staging, transmission to the vehicle, and activation. Additionally, required functionality shall include the abilities to receive data from the Revenue Vehicle, store and report this data, and display a vehicle status indicator on the base's AVM Signal.

It also shall include OBS Administrator tools to do the following:

a. Manage, stage, and transmit data to the Revenue Vehicle.
b. Manage, receive, and report historical data from Revenue Vehicle.

c. Manage systems.
d. Set and modify vehicle, subsystem, and device configurations.
e. Set and manage user and system access.
f. Troubleshoot and debug problems.

The following shall be provided to meet Level 1 BO requirements:

a. AVM Signal at each transit base.
b. Base Server(s) located on KCWAN.
c. Secure data storage at each transit base (may be Base Server).
d. Interface to Revenue Vehicle.
e. OBS Administrator Toolkit located on Base Server(s).
f. Reporting (preformatted reports and scripted, web-based queries).
g. Upgrade for each base's existing WDOLS system to a WLAN.

1.A.4.2.2. Level 2: Communications Center Systems/On Board Systems

Level 2 shall include design and development of all required CAD/AVL to provide Transit Service Communications staff with the tools to manage daily KCM service operations, including:

a. Radio call prioritization and management.
b. KCM transit schedule information.
c. Incident management forms.
d. Current Revenue Vehicle location and status information.
e. Emergency Alarm processing.
f. Revenue Vehicle fleet polling.
g. System databases.
h. Reporting functions.

Level 2 shall include design and development of an on-board interface to manage the new TRS radios. The selected CCS alternative (upgrade or replacement) will be designed in parallel with the OBS effort.

Level 2 functionality is interdependent with that of the TRS implementation. The design, testing, and implementation phases for these two projects shall occur concurrently. Level 2 schedules for testing and implementation will be dependent on the TRS project schedule.

A detailed description of the Level 2 scope may be found in Subsection **3.A.1, Level 2 Overview**.

1.A.4.2.3. Optional and Future Functionality

1.A.4.2.3.1. Optional Functionality

Optional functionality is detailed in Subsection **2.A.4.1.** It is secondary in importance to the Project's required functionality, and a Proposer's ability to deliver optional items will be considered accordingly. Optional functionality must be proposed and priced with all risks clearly identified and described. Identified risks must include those implementations that might adversely affect other required functionality, alter the function of existing on-board systems, or substantially increase the risk of Project success. KCM will determine whether to include some, all, or none of this functionality based on costs and identified risks.

1.A.4.2.3.2. Future Functionality

While not within the scope of the Project, Subsection **2.A.4.2, Future Functionality** enumerates desired future enhancements to the provided system. The OBS/CCS design shall not preclude their later addition.

1.A.4.3. Not in Scope

1.A.4.3.1. Existing Radio/AVL System Interface

Level 1 functionality does not include interfacing to the existing 450 MHz radio/AVL system.

1.A.4.3.2. New Transit Radio System

An independent project, the TRS project’s scope includes replacing both the radio system infrastructure and the existing mobile radios on both KCM’s Revenue and Non-revenue Vehicles.

1.A.5. Assumptions

a. KCM staff will manage all KCM database modifications and work processes.

b. KCM and the OBS/CCS Contractor shall collaborate on development of the interfaces and data management schemes between the OBS/CCS systems and the Transit Enterprise Database tables, so that all information needed for OBS/CCS will be generated in a reliable, production process. No permissions will be required to share or reuse the interfaces (See Part B Section **41.7, Contract Deliverables**).

c. All OBS hardware will be modular, rugged devices with standard connectors that are compliant with Subsection **2.A.1, General and Level 1 Technical Specifications**.

d. The replacement of any subsystem with a comparable, off-the-shelf device(s) produced by another manufacturer shall require minimal software modifications to the OBS/CCS.

e. Software shall be coded using ANSI standard software languages with configurable interfaces that comply with TCIP when applicable. To the extent specified in the RFP, the source code, included libraries and utilities, compilation tools, development environment, documentation and test tools shall be provided.

f. All OBS equipment, on-board and at the bases, will be installed and tested at KCM bases by internal staff. The Contractor will work with Vehicle Maintenance and Radio Maintenance staff to prototype the installation procedure for each vehicle type in the fleet. See Subsection **1.B.3, Base Operations and Maintenance** for a fleet description.

1.A.6. Guidelines for Interpretation of the RFP

This RFP is meant to provide functional specifications in a manner such that OBS/CCS Project goals are achieved and their achievement is based on the selection of a viable solution from among those proposed by competing Proposers in accordance with applicable policy and law. Pursuant to this, functional specifications herein are accompanied by some information that is not direct specification but rather description of background, experiences, concept, need, strategic goals, sample design, anticipated use, etc. This ancillary information is presented to assist the Proposer to more fully meet KCM needs and expectations.

Even though generally functional, some specifications are quite detailed and include thresholds, accuracy requirements, and other restrictive constraints deemed essential to the successful implementation of this project at KCM. Where context does not otherwise clarify, direct specifications are those which include phraseology such as “require/requires/required,” “shall/will/must,” etc.

The following rules are established to aid resolution in the event that the Proposer encounters contradictory, unclear and/or omitted information, and/or Proposer wishes to recommend alternative specifications to achieve a comparable end.

1.A.6.1. Prior to Contract Award

If any statement(s) made in Part C are perceived to conflict with any other statement(s) in Part C, Proposers shall identify all such statements and request clarification from KCM, using the process described in Part A, Subsection **1.E, Questions and Interpretation of Proposal**. In response, KCM will issue associated Addenda to each Proposer who is actively registered for the Project at that time.

If any statement(s) made in Part C are perceived to conflict with any statements(s) made in any other Part(s) of this RFP, the conflict shall be resolved as follows:

- The statement(s) made in the other Part(s) of this RFP shall prevail in the following areas:
    - Involving standard procurement rules and procedures relating to KCM, all applicable governmental agencies and laws with jurisdiction over KCM, and/or all applicable funding agencies, partnerships, etc. which are associated with KCM.
    - Concerning timetables, contract adjudication, contract administration, project management, deliverable quantities, warranty, intellectual property, or any other topic covered in Part B, **Terms and Conditions**.
- The statement(s) made in Part C shall prevail in those areas which in general concern project technical details. These include, among others, those pertaining to technical specifications, locations, required standards, functional requirements, acceptance testing, etc.

If any statement(s) in any Part of the RFP is perceived as unclear, Proposers shall identify all concerned statements and request clarification from KCM. This will be especially important with regard to questions on whether and how associated subsystem(s) will be interfaced and/or undergo acceptance testing. KCM will issue clarifications as indicated above.

If any additional information not already presented in the RFP is needed prior to Contract Award, Proposers shall specify all information wanted. KCM will issue responses as indicated above.

If a Proposer believes that certain alternative specifications can be substituted to achieve a comparable system, Proposer shall identify all relevant RFP specifications. Such specifications shall include but not be limited to any related to changes in thresholds, accuracy and complexity. Proposers may use the process described in Part A, Subsection **1.E.** to describe alternative specifications, clearly identifying each and every RFP subsection and area involved. KCM may issue responses as indicated above.

KCM reserves the right to accept or refuse any alternative specifications presented.

Proposers are invited and encouraged to provide solutions that extend functionality and/or otherwise "fill holes" in the specifications, provided that such solutions do not adversely affect the required functionality or increase the cost or risk of the Project. Proposers are free to share such solutions with other Proposers through the Part A, Subsection **1.E.** process or to privately propose such solutions in the formal issuance of their proposal. Proposers are advised that associated price increases may counterbalance the advantage of such enhanced proposals. Proposers are free to attach enhancement option pricing distinct from the main pricing scheme.

1.A.6.2. Subsequent to Contract Award

Should any previously undetected/unresolved statement(s) conflict with any other statement(s) anywhere in the RFP and should they not be readily resolved by rules herein, KCM shall be the sole judge as to which interpretation shall prevail.

Should any previously undetected/unresolved issue(s) arise regarding acceptance testing, this RFP (all Parts, and as amended in the procurement and evaluation processes) shall serve as the basis of last resort for determination of appropriate method and extent of acceptance testing in the area at issue. KCM shall be the sole judge regarding method and extent of acceptance testing.

1.A.7. Guidelines for Proposer Responses to Scope of Work

In Parts A and B, the RFP provides information on proposal requirements, evaluation procedures, and Contract terms and conditions of a general nature. Several additional guidelines apply and are presented below.

1.A.7.1. Nature and Intent of Required Specifications

While the required specifications herein range from broadly functional to highly detailed, KCM's intent is to implement a well-integrated, modular, high-performance, high-reliability, robust system that includes a complex of applications as emphasized throughout this RFP. While the KCM specification may be unusual in that a UML model with detailed descriptions is provided for what may be pre-existing, proprietary software modules, it is understood that a variety of solutions have been designed and implemented in the industry that meet the requirements but are different from our model. The intent is to provide a clear, unambiguous description of what functionality is desired and how it would work well within the context of KCM's current systems and practices. The response to this specification shall describe how and to what extent each requirement will be satisfied.

The response to each requirement shall clearly identify and describe what is currently provided by existing off-the-shelf products, what can be provided with modifications to existing designs, and what cannot/will not be provided due to technical or cost constraints. A proposal that parrots the requirement and states compliance, without an explanation as to how it will perform each task, will be considered non-responsive. Proposers are encouraged to take exception to requirements or functionality that they deem technically flawed or too difficult to provide at a reasonable cost. Alternative approaches that can provide the requested functionality are strongly encouraged.

Implicit in this RFP is the assumption that there exist competent Proposers with more collective expertise in applicable technical areas than the staff writing these specifications—with the important exception that internal staff has more expertise in understanding KCM needs and wants for end-products, infrastructure, and extended integration potential. The Proposer's task at hand is to propose and, if awarded the Contract, to implement a solution to KCM's stated needs so that the RFP's specifications are collectively met and/or improved upon to the fullest extent possible. This shall be done within given Project constraints in such areas as scope, timeline, affordability, and available technology.

1.A.7.2. Provision for Handling of SOW Problem Areas

Some Proposers may assert that parts of these specifications are not feasible, are technically unattainable, and/or are otherwise problematic vis-à-vis the core objectives of the OBS/CCS Project due to the unknowns created by the large amount of integration required, the rapidly-evolving nature of related technology, and KCM's interest in procuring latest-available, proven technology. Such problematic areas, if any, will be a special challenge for clarification and resolution between KCM staff and Proposer's staff. The process described in Part A, Subsection **1.E.** exists to resolve as many of these issues as possible.

However, KCM anticipates that some Proposers may regard a given specification as problematic while others may not, based on disparity among Proposers in areas such as technical and business capability. KCM will assess identified problem areas and may or may not revise a given specification when the problem is not broadly shared among Proposers.

This RFP is intended to present a solid picture of what KCM wants. Proposals risk being disqualified as non-responsive if they do not address all required specifications in effect at the conclusion of the procurement process. See Part A, Subsection **1.T.5, Proposer's System Self-Assessment**.

In addressing aforementioned problematic specifications (should any remain following the clarification and addenda processes described in Part A), proposals may indicate requirement non-compliance and/or substitution, along with explanation and justification for same. KCM will, upon review of all applicable responses, determine the appropriate handling based on considerations including the following:

- Degree of diversity of response (some compliant/others not, all non-compliant, etc.) on indicated item.
- Degree of relative impact (trivial versus major, etc.) on the intended system that the item itself and/or requirement response imposes.

KCM wishes to make it clear that no Proposer shall be penalized for providing a compliant solution in a nontrivial area where most or all other Proposers fail to comply. In such cases either the latter shall be disqualified as non-responsive or the item shall be re-classified from "required" status and the affected Proposers shall be given due chance to adjust the overall proposal based on such re-classification.

Some potential specification problem areas—and appropriate Proposer response—are discussed below.

1.A.7.2.1. Potential Specification Problem Area: Feasibility

If the Proposer believes that an item of a specification is cost-prohibitive or otherwise not feasible for the OBS/CCS, Proposer shall so state in the response and provide therein the explanation for this determination. As applicable, Proposer shall indicate alternative specifications which Proposer would meet if awarded and which Proposer believes would fulfill the main objectives and constraints.

Conceivable examples include (among others) requirements for which

- the number and extent of unknown/unfamiliar factors which must be resolved subsequent to proposal submission represent risk which is too great to keep price estimate in affordable range.
- solutions exist which are much more affordable and achieve the main objectives, but which involve requirements modification.
- a much larger market (as in joint or subsequent procurements of similar items by other transit entities) would be required to cost-justify the degree of new development required to provide an item as specified.

1.A.7.2.2. Potential Specification Problem Area: Technical Attainability

If the Proposer believes that an item of a specification is not attainable due to technical reasons, Proposer shall so state in the response and provide therein the explanation for this determination. As applicable, Proposer shall indicate alternative specifications which Proposer would meet if awarded and which Proposer believes would fulfill the main objectives and constraints.

Conceivable examples include (among others) requirements for which

- “off-the-shelf,” “open architecture,” and/or other ITS-promoted stipulations do not yet exist for a given item specified.
- named standards (including network interface protocols) do not currently cover the item as specified at the indicated level of detail.
- proprietary or other legal restrictions currently block implementation.

1.A.7.2.3. Potential Specification Problem Area: Technical Virtue

If the Proposer believes that an item as specified is technically flawed, impractical, and/or inferior to one the Proposer can provide, Proposer shall so state in the response and provide therein the explanation for this determination. As applicable, Proposer shall indicate alternative specifications which Proposer would meet if awarded and which Proposer believes would improve the outcome while fulfilling the main objectives and constraints.

Conceivable examples include (among others) requirements for which

- improved system and/or product design now exists to meet main functional requirements, and differs with current specifications.
- the item’s associated implementation cost is believed to be markedly out of proportion to the associated benefit.
- implementation of one component or goal as specified would be incompatible with implementation of another component or goal as specified.

1.B. Description of Existing Systems, 2004

1.B.1. General

1.B.1.1. Introduction

Information included in this section is provided as background and context for Proposers to better understand the County's requirements.

1.B.1.2. Make-up of Subsection 1.B, Part C, OBS/CCS Scope of Work

Subject areas addressed in this subsection are organized as follows:

Transit Operations Business Rules: A summary of the KCM business policies and practices. Proposed solutions should be designed with these practices in mind in order to facilitate a smooth transition to the new OBS/CCS system.

Base Operations and Maintenance: A brief description of how operations are organized at the seven transit bases. It also includes the types of vehicles assigned to each base and how Vehicle Maintenance is organized to maintain the fleet.

Existing Systems: An overview of the systems that KCM currently operates and that OBS shall either replace or interface to, including:

- Existing On-Board Systems
- Legacy Radio/AVL Systems
- Transit Enterprise Data Systems:
    - Transit Enterprise Database (TED)
    - HASTUS Scheduling System
    - Geographic Information System (GIS)

1.B.2. Transit Operations Business Rules

This section provides a summary of Operations business rules and procedures that are the basis for many OBS requirements. These business practices must be supported in the design and configuration of the proposed OBS. Additional operating information is contained in KCM's *The Book: Transit Operating Instructions* which will be provided to attendees at the Pre-proposal Conference (see Part A, Subsection **1.H, Mandatory Pre-proposal Conference**).

1.B.2.1. Operator Login and Radio Use

Operators are required to log in to the on-board radio to activate the Public Address system using their vehicle's Mobile Data Terminal (MDT) keypad to enter their route, run, default voice channel and Operator identification number. Once the login process is complete, the MDT transmits the login information to the Communications Center system. Transmittal of the login data for scheduled routes places the vehicle in the Communications Center system's polling table and allows Coordinators to monitor the vehicle's location and call the vehicle using the using the CAD/AVL system.

On board, a successfully completed login allows Operators to adjust handset and hailing speaker volume, activate the public address system, initiate emergency alarms, and engage in radio communications with the Communications Center via the MDT.

1.B.2.2. Initiating Calls

After a successful login, the current system allows Operators to initiate Requests to Talk (RTT), Priority Requests to Talk (PRTT), and Emergency Alarms (EA). Established policy guides Operators in choosing the type of message to initiate:

Table 1.B.2.2. Operator Radio Use Guidelines

Message Type	Established Use Guidelines
RTT (Request to Talk)	Customer information, lost and found assistance, sick customer (non-emergency), minor traffic accidents, radio traffic reports, off-peak transfers (first call), routing information, early or late operation, minor mechanical problems and coach changes, reports of vandalism, fare information, and requests to see a supervisor.
PRTT (Priority Request to Talk)	Coach breakdown, yard changes, off-peak transfers (second call), major or severe accidents, coach fire, downed overhead wire, power outage, reports of crime in progress, non-injury assaults, robbery with no visible or reported weapons, problems endangering you or your customers on the freeway, inability to accommodate wheelchair customer, mistaken use of the Emergency Alarm, and to let the Coordinator know the Operator can talk after using the Emergency Alarm.
EA (Emergency Alarm)	For medical emergencies Operators are instructed to initiate the EA and then immediately follow with a PRTT call to request emergency medical assistance on or off the vehicle. For other emergency situations in which voice communications would put the Operator or customers in physical danger, press the Emergency Alarm button. The emergency alarm means, “Send police immediately. I am in danger and cannot talk.” Operators are instructed to press the PRTT button when they can safely talk. When an emergency situation exists (e.g., danger of bodily harm or medical emergency), the Operator presses a silent emergency alarm (EA) floor button. KCM purposely avoids accompanying the silent alarm with any obvious visual cues of acknowledgment to the Operator that the EA has been received by the Communications Center. Currently an Operator is able to see that the EA has been received and acknowledged by observing an unreferenced symbol that is displayed on the MDT. If safe to do so, the Operator follows the EA with a PRTT. If a PRTT is not initiated, the Coordinator assumes the Operator needs immediate police assistance.

1.B.2.3. Responding to Calls

Operators answer calls from the Communications Center by picking up the handset when prompted by incoming call tones, using the handset's "push-to-talk" button and identifying themselves by route and run number, then releasing the "push-to-talk" button and awaiting the Coordinator's message. Operators are asked to refrain from using unnecessary phrases and to keep conversation to a minimum. If the message is understood, Operators are to indicate that by replying "ten-four." Coordinators, at the end of the call say "ten-seven" to signal that the transmission is completed and the radio channel is soon to be clear.

Implementation of OBS/CCS will result in changes to the Operator login and Emergency Alarm processes including:

- Coordinator's ability to remotely log an Operator into or out of a vehicle.
- A more noticeable yet still subtle EA acknowledgment of receipt from the Communications Center to the Operator.
- Automatic transmission of security microphone audio to the CCS with EA activation.
- Automatic flashing of vehicle exterior marker lights to guide police/fire and other field staff to the correct vehicle.
- Ability to cease EA-related functions (EA, transmission of security microphone audio to the CCS, and flashing of vehicle exterior marker lights) with an Operator-initiated PRTT or single CCS command.

1.B.2.4. Radio Communications

1.B.2.4.1. Data Mode

The normal state of a logged-in revenue vehicle is "data mode" where the MDU sets the radio receiver to a data channel. The MDU decodes a steady stream of contention and poll messages from the Radio/AVL system, which "polls" each logged-in vehicle every one to two minutes. Each MDU replies to its poll with a poll response message containing its current odometer reading, its most recent signpost encounter, the last timepoint received from the Radio/AVL system, and all timepoints crossed since the last poll response. Logins, RTTs, PRTTs, and EA messages are sent to the Radio/AVL system as contention messages.

1.B.2.4.2. Voice Mode

When a vehicle's radio stops receiving contention messages on its data, the MDU switches its radio to "voice mode" on its default voice channel. In voice mode, the radio operates like a conventional two-way radio, RTT and PRTT do not work, and the Operator must listen for a clear channel before transmitting. While the system is in voice mode, the MDU switches the radio to its data channel every 15 seconds. If the MDU decodes contention messages, it keeps the radio on the data channel. If it doesn't decode contention messages, the MDU switches the radio back to the voice channel.

1.B.2.5. Arrival, Departure and Schedule Adherence

After Operator login, the MDT continuously displays the current time. Operators are also required to have an approved timepiece in their possession while operating a vehicle. All Operators must drive the vehicle to try to arrive at the scheduled timepoints at the times shown on their run card.

Timepoints listed on the run cards are arrival times unless otherwise indicated. (Timepoints at terminals reflect departure times.) Late operation beyond the control of the Operator is excusable. Late operations beyond a specified threshold must be called in to the Coordinator. Early operation is considered to be within the Operator's control. Operators who arrive at a timepoint too early or leave a timepoint before their scheduled time may receive a performance report in the category of "early operation." "Estimated timepoints" do not have these performance requirements and are described below.

1.B.2.5.1. Estimated Timepoints

An estimated timepoint is a location along a route where trips are assigned an estimated arrival time. Estimated timepoints are specified for segments of express routes scheduled to operate service without concern for early operation. Estimated timepoints are used for reference and, if early, the Operator may continue to the destination without waiting for the scheduled time. Routes using estimated timepoints, in the estimated timepoint portion of their trip, tend to show as "early operation" in the legacy CAD/AVL system when the route makes good time on the portion of the trip that is estimated. There is an indicate in the CAD/AVL System that shows the Coordinators which timepoints are estimated.

With OBS, schedule status will not be displayed to Operators for estimated timepoints. Estimated timepoint location information, however, will remain. The schedule data will include an indicator for estimated timepoints for filtering and reporting on schedule adherence.

1.B.2.5.2. Layovers

KCM provides Operators with a minimum five-minute scheduled layover after each revenue trip, except in cases where any of the following is true:

- The trip is less than 15 minutes long.
- The trip is the last revenue trip before the coach returns to the base.
- The trip is a live through route.
- The layover has been reduced by mutual agreement of KCM and the Union.

1.B.2.5.3. Start of Trip

If required by a run card indicator or The Book, update events such as change destination sign, set fare and update trip number must be implemented at the start of a new trip. Operators are required to be aware of and implement these changes. On through routes, changing destination signs and setting fares occurs before the trip boundary is passed. The locations for changes on through-routed trips are not currently related to the schedule events in any meaningful way.

1.B.2.6. Customer Service

As part of its mission to provide a high level of service to its customers, KCM is responsive to the Federal Americans with Disabilities Act (ADA) guidelines. Established procedures for "Next Stop" and other on-board announcements address this goal.

1.B.2.6.1. On-Board Announcements

Operators are required to announce:

- A stop that has been requested by a passenger.

- All stops in the Ride Free Area (RFA), including timely notice of the last Ride Free Area stop for that route.
- All transfer points, major intersections, major public buildings, and landmarks.
- Express (limited stop) service, including an initial announcement of the first and last stops just prior to the express portion of the trip as well as each express stop, upon approach, while operating the express portion of the trip.

Announcements must be loud enough to be heard in the priority seating (wheelchair securement) area behind the driver's cockpit. If the Public Address system is broken, Operators are required to make the on-board announcements loudly enough to be heard in the priority seating area.

1.B.2.6.2. Transfer Points

When two routes are scheduled to meet at a transfer point at the same time, run cards will contain one of two instructions that Operators are required to follow. These are:

1. If the vehicle is on time, wait up to two minutes for passengers from connecting route(s). If the connecting route(s) has not arrived after two minutes, the Operator must call the Coordinator for instructions before leaving the timepoint.
2. Watch for passengers who may want to transfer from connecting route(s). This instruction does not require the Operator to call the Coordinator.

KCM encourages Operators to accommodate unscheduled transfer requests made by passengers as long as it is safe to do so.

1.B.2.6.3. Lift/Ramp Deployment

KCM tracks the use of lifts and ramps on its revenue vehicles for use in preventive vehicle maintenance and Federal reporting requirements. Operators are currently required to record each lift/ramp boarding through a key press on the farebox. The OBS/CCS implementation must accurately track lift/ramp use and distinguish between boarding and alighting via the lift/ramp.

1.B.2.6.4. Unplanned Events

Transit operations require the ability to successfully manage unplanned events. Circumstances may require Operators to run rerouted trips, late trips, extra trips, and special service; and to participate in road jumps and coach changes. Circumstances may also require supervisors to cancel individual trips.

OBS/CCS requirements include the ability for the OBS/CCS to distinguish a vehicle's circumstance (e.g. rerouted versus off-route) in order to provide accurate tracking, on-board and remote customer service data, data collection, and reporting of unplanned events.

1.B.2.6.5. Operator Request Form

When assigned a coach that reveals a mechanical problem or defect while in service, Operators are required to complete an Operator Request (OR) form upon returning to the base, where the form is provided to Vehicle Maintenance staff for follow-up and repair. Form fields include:

- Date
- Vehicle identification number (VID)
- Operator identification number (OID)

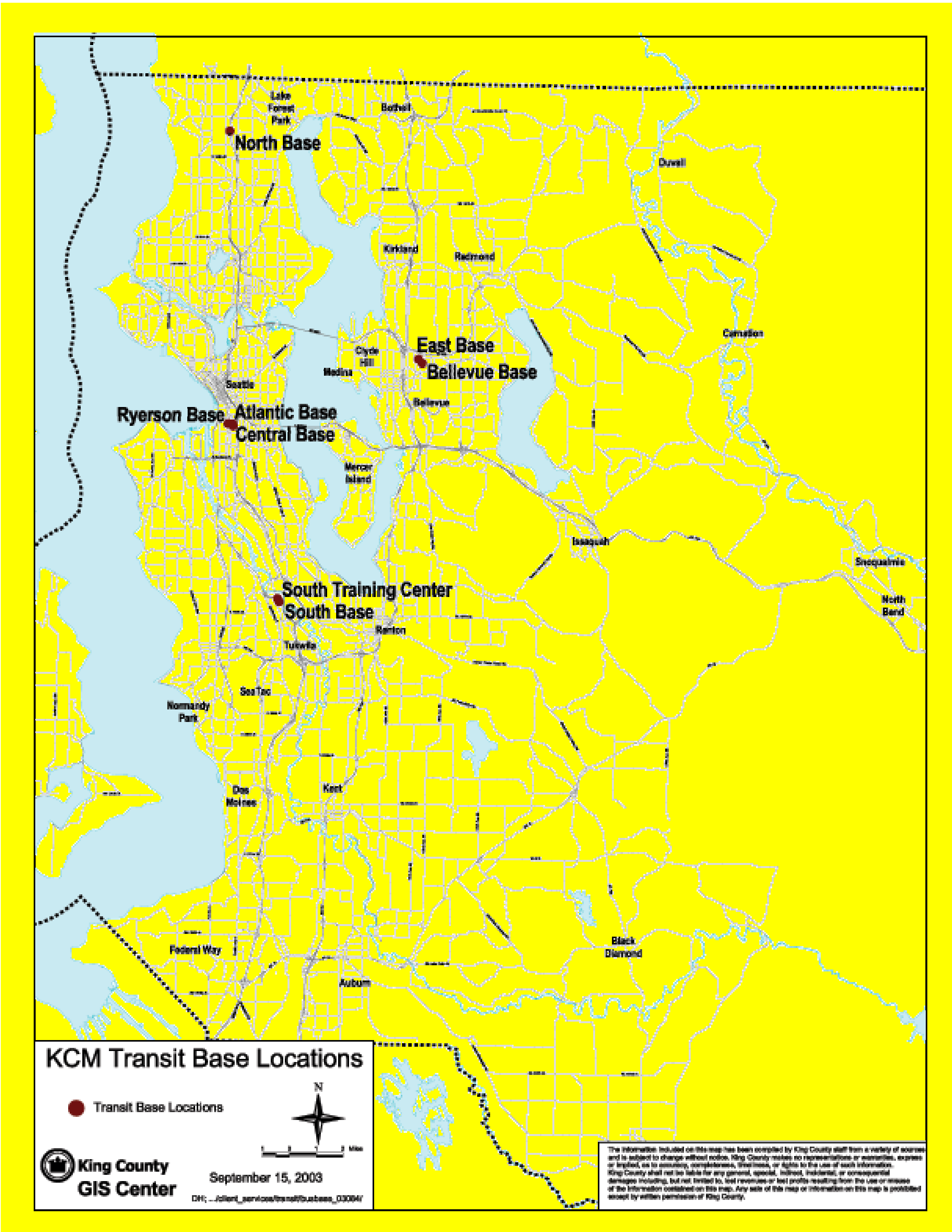
- Route and run numbers
- Problem code

1.B.3. Base Operations and Maintenance

KCM operates out of seven transit bases, which are geographically distributed. Each base operates service in specific areas and/or operates specific types of vehicles. Maintenance staff, shops, and skills vary depending on the base. Where there are multiple bases located in close proximity to each other they are referred to as part of a campus. The two campuses, seven bases, and an overview of the type of service and vehicles that are operated out of each are described below. Note: The numbers and types of vehicles in Table ***1.B.3.1, Peak Signout by Base***, vary over time and are provided for descriptive purposes only.

Central Campus	Atlantic Base Central Base Ryerson Base
Bellevue Campus	East Base Bellevue Base
North Base	
South Base	

Figure 1.B.3. KCM Transit Base Locations in King County



1.B.3.1. KCM Fleet Assignments by Base, Sept 03

These tables provide a snapshot of vehicle assignments and peak signout for each base at the time that this RFP was written. The data is provided as general information. Some fleet types will be retired and the distribution of the fleet changes over time. Table ***1.C.5, 2006 Fleet and OBS Equipment Plan*** shows KCM's anticipated fleet composition at the time of OBS/CCS implementation.

Table 1.B.3.1. Peak Signout by Base

	P E A K S I G N O U T								
FLEET	AB	BB	CB	EB	NB	RB	SB	TR	**Total**
09-900 TROLLEY									
11-30'GILLIG		36			10		35		**81**
12-CHAMPION DIESEL VAN				22					**22**
23-NEW FLYERS			72	32	51	50	38	0	**243**
25-NEW FLYER HYBRID									
30-40'AMERICANAS						54			**54**
31-35'GILLIG			7		5				**12**
32-40'GILLIG		79	47	54	60	62	47		**349**
33-CENTER PK GILLIG			1						**1**
36-NEW FLYERS									
40-ARTIC TRLY	40								**40**
41-40' GILLIG TROLLEY	82								**82**
42-BREDA CONVERSION									
50-BREDA DUAL MODE	38			28	40		67		**173**
56-VAN: DIESEL									
90-SOUND TRANSIT GILLIG			6	28			7		**41**
92-SOUND TRANSIT 40' HYBRID									
93-SOUND TRANSIT BREDA				17					**17**
95-SOUND TRANSIT NEW FLYER				11					**11**
TOTAL PEAK SIGN OUT	**160**	**115**	**133**	**192**	**166**	**166**	**194**	**0**	**1126**

1.B.3.2. Vehicle Maintenance at the Operating Bases

KCM's fleet is maintained by County staff assigned to the KCM Vehicle Maintenance (VM) section. Note: VM is a closed, union shop (ATU Local 587). In addition to each base having a maintenance shop, there are also specialty shops at some bases as follows:

AB—Atlantic Base: consists of vehicle maintenance/repair shop; electronics shop; paint shop for AB/CB/RB.

BB—Bellevue Base: consists of vehicle maintenance/repair shop.

CB—Central Base: consists of vehicle maintenance/repair shop; body shop for AB/CB/RB; upholstery shop for AB/CB.

EB—East Base: consists of vehicle maintenance/repair shop; body shop for BB/EB; upholstery shop for BB/EB.

NB—North Base: consists of vehicle maintenance/repair shop; body shop; paint shop for BB/EB/NB; upholstery shop.

RB—Ryerson Base: consists of vehicle maintenance/repair shop; upholstery shop; Waterfront Street Car.

SB—South Base: consists of vehicle maintenance/repair shop.

Other shop locations include:

CSC—Component Supply Center: consists of various component rebuild shops; body shop for SB and major body work/major accident repair for all locations; paint/sign shop (paint shop for SB and major paint jobs/whole-coach paint jobs, sign shop makes all bus stop signs, special service signs, various project signs, etc.); warranty office (handles all vehicle warranty tracking/claims); Inventory and Materials Management for all operating bases and CSC shops.

NRV—Non-Revenue Vehicle Shop: handles maintenance/repair and replacement for all KCM non-revenue vehicles.

Fleet Engineering: handles all maintenance training needs for the various coach systems, projects and retrofits, preventive maintenance schedules/tasks, etc.

1.B.4. Existing On-Board Systems

1.B.4.1. Automatic Passenger Counting (APC)

1.B.4.1.1. APC Hardware

KCM has APC on approximately 15% of the fleet, about 175 vehicles. There are two types (generations) of APC systems in use today.

1.B.4.1.1.1. APC Sensors, First-Generation

Pachena, Ltd. built KCM's first-generation APC system, which has been in use since about 1984. These APCs use floor mats for sensors. About 160 of these are in service, installed proportionately in all vehicle types in the fleet. The main processing unit (ATVIS) is connected to the vehicle's mobile radio system via a LonWorks/RS-232 interface. (LonWorks goes from the radio and RS232 to ATVIS). This interface supplies the signpost reception, odometer, route/run, and clock from the radio to the APC. Door status signals are also supplied to ATVIS from door sensors.

The primary types of data recorded by the APC include the following:

- At each bus stop (in conjunction with the opening and closing of the doors): the time, the number of boardings and de-boardings, and the odometer reading.
- At each signpost: the time and odometer of entry and exit of the signpost field.
- Other records: an hourly time record, a distance record every mile or so if no other event has occurred, and some mat switch diagnostic records.

Data is stored on the vehicle in ATVIS and downloaded approximately weekly via a manual process using a laptop, which must be connected via cable to ATVIS.

1.B.4.1.1.2. APC Sensors, Second-Generation

The second-generation, infrared (IR) APCs, some of which are currently being installed, are supplied by Integrated Vehicle Technologies (IVT). At present 25 are installed. By the end of 2004, another 80 IVT APC systems will be installed.

The architecture of the IVT system differs from the older system in that there is a Passenger Counter Unit (PCU) at each door which sends information to a Main Processing Unit (MPU), currently installed at the front of the vehicle near the driver cockpit. The PCU is similar whether it is using mat sensors or IR sensors. It sends counts and door status information to the MPU via J1708/1587. The MPU connects directly to the radio via LonWorks (no RS-232 interface needed) for signpost reception, odometer, route/run, and clock.

The stop/count data is recorded in essentially the same manner for both systems. In addition, the IVT APC can record GPS location (if available), the peak signpost signal level, and the odometer and time of the reading (received from LonWorks).

1.B.4.1.1.3. MPU Data Storage

Data is stored in the MPU. A laptop can be connected to the MPU for data downloading and diagnostic/maintenance purposes. Data downloading can also be performed with a PDA (using a cable).

1.B.4.1.2. APC Processing Software

Processing is similar for both the old and newer APCs. The "raw" APC data is assigned to blocks (route/run combinations) based on the dispatch data. Data for a block is then validated through a comparison to an existing template for that block. The template includes times and mileages for timepoints, bus stops, and signposts along the block. Certain diagnostic tests are performed against the data:

1. Comparing the total on passenger counts against the total off passenger counts.
2. Comparing the distance the vehicle traveled between every signpost pair against the template distance.

Data that is successfully matched in this way is output to several tables, including ones at the stop point and Timepoint Interchange (TPI) levels. These tables are used to prepare various reports and/or summary tables for subsequent use by KCM planners, schedulers, management, etc. KCM staff has used MS Access to create a user-friendly system of APC reporting to provide pre-defined reports to users, based on summary APC data created with Focus. The KCM GIS Toolbox also provides access to some APC data.

In addition to the validated data, several diagnostic reports run against the raw data to provide a picture of hardware performance. Measures include total mileage traveled, average signpost puddle size, and the difference between the on and off counts. Tracking these measures over time can provide a sense of how the hardware is performing.

1.B.4.2. Mobile Data Terminal (MDT)

The Mobile Data Terminal (MDT) is the Operator interface to the radio and Public Address (PA) systems. Operators use the MDT to log in to the radio system, initiate requests to talk (RTT/PRTT), and control the PA system. Maintenance staff uses the MDT to set default radio and PA volume levels. The MDT contains audio amplifiers and audio switches for the radio and PA systems. It is used as a connection point for the radio handset, the Emergency Alarm (EA) switch, and the PA microphone and speakers. The MDT controls the vehicle radio transmit and receive channels via channel-control lines between the MDT and the radio transceiver.

The RFCS project will replace the MDT with a universal Driver Display Unit (DDU) that will provide the Operator and maintenance staff with an interface to the radio system, to the PA system, and to all future on-board systems. Features that are currently part of the MDT (audio amplifiers and audio switches; and the connection points for the handset, EA and PA and radio channel-control) will be moved to a new Radio Control Unit (RCU).

1.B.4.3. Mobile Data Unit (MDU) and Radio/Automatic Vehicle Location (AVL)

The Mobile Data Unit (MDU) is a microprocessor-based device that controls the on-board radio system, Automatic Vehicle Location (AVL) processing, and data communication processing. The MDU consists of a processor board with a 186 processor, system memory, and clock; a modem board that contains a modem and the firmware that performs Reed-Solomon error detection and correction; and a power-supply board. The MDU stores the Vehicle identification (VID) number in non-volatile memory. The VID is used to determine which data channel the MDU instructs the MDT to send to the radio transceiver. Every data packet sent to the vehicle by the Data Communications Controller (DCC) over the radio is error-checked and corrected by the modem board, and then sent to the MDU processor where the message is decoded. The processor checks each message sent on its data channel to see whether it contains its VID in the address field or in the acknowledgment field. The MDU processor monitors the vehicle odometer signal, which it receives from the vehicle transmission or wheel sensors. It also monitors signpost IDs and signal strengths received via its signpost receiver input.

1.B.4.3.1. MDU and Radio/AVL Replacement

The following items describe lessons learned by KCM from experience with the existing CAD/AVL systems. Desired system characteristics are reflected in OBS/CCS technical and functional requirements for the MDU and Radio/AVL replacement.

a. A database of stored messages and SQL queries written by KCM maintenance staff is far more useful than pre-defined reports when troubleshooting AVL and radio problems.

b. In order to test a vehicle's radio with the current system, a technician must place a Request to Talk (RTT), wait for an answer, and then ask a Coordinator for a report on how the vehicle radio sounds in the Communications Center. The new OBS/CCS should automate this testing to reduce radio traffic from the vehicle and to allow better use of both the technician and Coordinator's time.

c. The current AVL system has a "shared memory viewer" which is used to observe individual vehicle performance in real time and as a problem-tracking, troubleshooting aid. The new AVL system should come equipped with an equivalent shared memory viewer.

d. Experience has shown that successful operation of an AVL system is directly proportional to having honest performance standards and continuous performance monitoring. KCM therefore expects the same from the OBS/CCS Contractor. The Contractor and KCM will agree on appropriate performance measures to accurately measure system status.

e. In the current AVL system (vehicle), the Data Acquisition and Control System (DACS), located in the Communications Center, and the MDU use sent-received queue positions to keep track of messages sent to and from a vehicle. The new system should ensure that each message sent between the CCS and OBS has a unique identification as well as a way of verifying the integrity of the message.

f. The MDU uses a two-bit message number to help the DCC distinguish between duplicate and subsequent contention messages. The new system should ensure tracking of duplicate and contention messages.

g. The current system uses an "EA Ack" message to acknowledge an Emergency Alarm. Other "Ack" messages are generic: a VID in an Ack field can acknowledge an RTT, a PRTT, a login, or an unexpected signpost. The new system should use directed acknowledgments, e.g. RTT-Ack, PRTT-Ack, etc., or use sent/received Ack-queue positions to help DACS and the vehicle keep track of acknowledgments.

1.B.4.3.1.1. CAD/AVL

The following items describe lessons learned by KCM from experience with the existing CAD/AVL systems. Desired system characteristics are reflected in OBS/CCS technical and functional requirements for the CAD/AVL system.

a. The current AVL system does a very good job tracking vehicles through layover points. The current AVL system is capable of calculating an end-of-trip timepoint even when the vehicle is not at the end-of-trip location. The new system should perform this same task at least as well as the current system.

b. After a vehicle has been off route, our current system puts it back on route as soon as it encounters an on-route event. The new system should have a similarly rapid facility to put the vehicle on route based on direction of travel and identification of a known point, preferably a section of street.

c. After the completion of a voice call, the MDU sends the MDT/radio back to a data channel after ten seconds of silence on the voice channel. If there is on-channel interference or on-channel noise, the MDU interprets the noise as an ongoing call, and it never sends the radio to data mode. To prevent this condition in the future, DACS or its equivalent should send the MDU a call-complete flag when a Coordinator presses the End Call button. The Communications Center should be able to send a “remote reset” to a vehicle.

d. The current radio/AVL system doesn’t allow an Operator to cancel an RTT or PRTT. In order to reduce unnecessary radio traffic, the new system should permit RTTs and (erroneously sent) PRTTs to be cancelled.

1.B.4.3.1.2. PA System

The following items describe lessons learned by KCM from experience with the existing CAD/AVL systems. Desired system characteristics are reflected in OBS/CCS technical and functional requirements for the PA System.

a. When a vehicle receives a radio message over the current system, PA operation is suspended until the radio call is completed. The Operator can cancel the radio call and re-enable the PA by picking up the radio handset and putting it back in its cradle.

b. The current on-board PA system is often difficult for passengers to hear because the volume level of the announcements is either too loud or not loud enough. The new OBS system should monitor the ambient noise and adjust the PA amplifier gain as necessary.

1.B.4.4. On-Board Networks: LonWorks and J1708

1.B.4.4.1. LonWorks

LonWorks, a network made by Echelon, is the current on-board vehicle area network (VAN). The MDU puts route, run, Operator ID, time, date, odometer pulses, and signpost IDs on the LonWorks network. The APC’S MPU and the Transit Signal Priority Automatic Vehicle Identification (AVI) tag receive this data via LonWorks.

The version of LonWorks implemented by KCM is no longer supported by Echelon and is now considered to be non-standard by the LonWorks user community.

Level 1 requires the Contractor to provide a new on-board VAN to replace LonWorks.

1.B.4.4.2. J1708 J1939

Currently, all Revenue Vehicles have J1708 cabling installed at the factory.

1.B.4.4.3. ECM Networks

Fleet No. 2300, 60-foot New Flyers, have the Allen Bradley multiplexing system. Fleet No. 4100, 40-foot Gillig trolleys, have the Dynex I/O Controls system. The capability of either system for passing data to a new VLU is unknown, and is not included on the manufacturers' primary features lists.

1.B.4.5. Destination Signs

The following table summarizes the makes and models of destination signs that are currently installed on the fleet. It also shows current plans for fleet retirements and new fleet implementation. The VLU will need to interface to the destination signs on the fleet at the time of implementation. *Table **1.C.5, 2006 Fleet and OBS Equipment Plan*** contains current projections for KCM's fleet composition at the time of OBS/CCS implementation.

Table 1.B.4.5. Destination Sign Types

Fleet No.	Vehicle	Sign Brand	Model	Type	Count	Program
1100	30' Gillig	Luminator	MAX 3000 Ultra	LED illuminated Flip-Dot	95	PC Card
2300	60' New Flyer	Luminator	MAX 3000 Optima	LED illuminated Flip-Dot	274	PC Card
2599	60' New Flyer Low Floor Hybrid Prototype	Twin Vision	J1708	LED, in service 2004	1	Handheld
2600	60' New Flyer Low Floor Hybrid	Luminator	Horizon LED	LED, in service 2005	213	PC Card
2900	60' New Flyer Low Floor Diesel	Luminator	Horizon LED	LED, in service 2005	30	PC Card
3100	35' Gillig	Luminator	MAX 2000	LED illuminated Flip-Dot	13	PC Card
3200	40' Gillig	Luminator	GTI	Fluorescent illuminated Flip-Dot	345	PC Card
3300	40' Gillig Center Park	Luminator	GTI	Fluorescent illuminated Flip-Dot	2	PC Card
3500	40' Gillig	Luminator	MAX 2000	LED illuminated Flip-Dot	50	PC Card
3600	40' New Flyer Low Floor	Luminator	Horizon LED	LED	50	PC Card
4000*	40' MAN Trolley			Retiring by Q4 2005	46	
4100	40' Gillig Trolley	Luminator	Horizon LED	LED	91	PC Card
4200	60' Breda Trolley (Conversion)	Luminator	Prototypes are Horizon LED, in service Q3 2004		2	PC Card
4200	60' Breda Trolley (Conversion)	Competition	Luminator or Twin Vision, in service by Q4 2005		57	Unknown
5000	60' Breda			Retiring by Q4 2005	216	
9000	40' ST Gillig**	Luminator	MAX 3000 Optima	LED illuminated Flip-Dot	19	PC Card
9000	40' ST Gillig**	Twin Vision	J1708	LED	20	Handheld
9300	60' ST Breda**			Retiring by Q4 2005	20	
9500	60' ST New Flyer Low Floor**	Twin Vision	J1708	LED	13	Handheld
	60' ST New Flyer Low Floor Hybrid**	Twin Vision	J1708	LED, in service 2005	22	Handheld
TBD	*Replacement vehicle type for retired 28' Champion Van*					

* The 4000 fleet should be gone by late 2005 or early 2006. These vehicles will be replaced by a modified Breda bus and the total count will be 59. The rest of the Bredas will leave but will be replaced by the 2600 fleet of Hybrids.

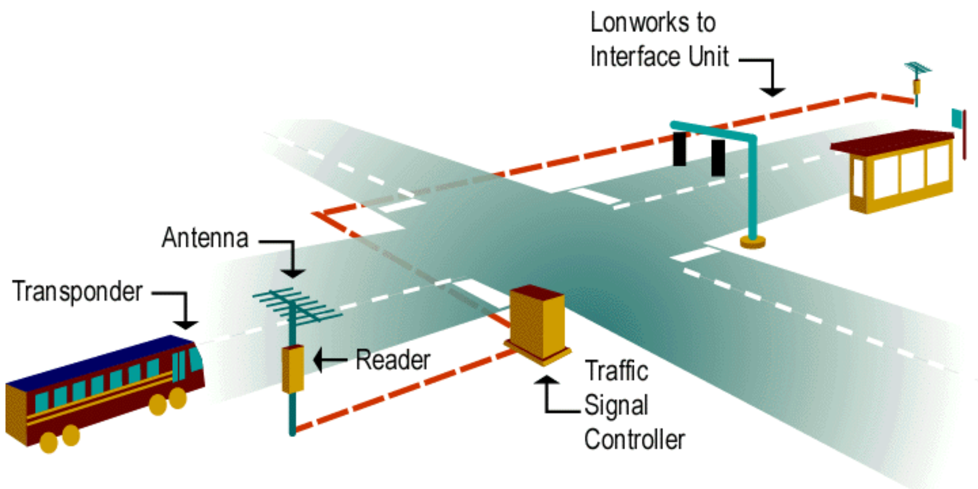
** These vehicles are operated and maintained under contract by KCM for Sound Transit (ST), the regional transit provider.

1.B.4.6. Transit Signal Priority (TSP)

1.B.4.6.1. Concept Overview

TSP is one of several possible solutions to the problem of providing improved efficiency to Transit operations by reducing delay at signalized intersections. TSP refers to the concept of detecting a vehicle in the flow of traffic and providing more "green time" for the Transit vehicle as it travels within the general traffic stream.

Figure 1.B.4.6.1. TSP Concept



1.B.4.6.2. KCM TSP System

KCM, working with partner signal-operation agencies, has selected a more sophisticated TSP system that provides the needed flexibility of control. Four major components comprise the TSP system: on-board equipment, on-street equipment, base computer, and controller firmware modifications/TSP strategies.

1.B.4.6.2.1. On-Board Equipment

The main component of the on-vehicle equipment is the Amtech RF (radio frequency) tag. The vehicle has this dynamic tag mounted on its upper right front exterior corner. The tag or transponder contains a data packet that includes static data fields of System, Agency, and Vehicle ID, and dynamic data fields of Driver Number, Route, Run, Trip, and Class. Future fields are reserved for Lateness and Ridership with the migration to a "smart bus." The dynamic data is sent to the tag upon driver login via the on-board Tag Interface Unit (TIU). The tag remains passive until activated by the roadside antenna and Amtech tag reader unit.

Figure 1.B.4.6.2.1. TSP On-Board Equipment

Tag Interface Unit

Amtech RF Tag

1.B.4.6.2.2. On-Street Equipment

On-street equipment consists of a pole- or mast-arm-mounted antenna, a pole-mounted Amtech tag reader enclosure, communication network, and a Transit Priority Request Generator co-located in the signal controller cabinet. The reader assembly (including antenna and reader enclosure) is generally located 500 to 1,000 feet in advance of the intersection. The pole-mounted tag reader controls the antenna, verifies tag-read integrity, and sends the tag information to the Transit Priority Request Generator in the signal-controller cabinet.

The Transit Priority Request Generator (TPRG) provides the needed processing capability to determine conditional priority requests. This unit furnishes an interface between the reader and the traffic controller via 24 programmable Inputs/Outputs (I/Os).

The TPRG provides conditional screening of the priority request once the tag read is validated and sent by the reader. The signal technician or engineer combines user-defined parameters and functions to dictate when and if a transit signal priority service call shall be requested.

1.B.4.6.2.3. Base Computer (Transit Priority Request Server)

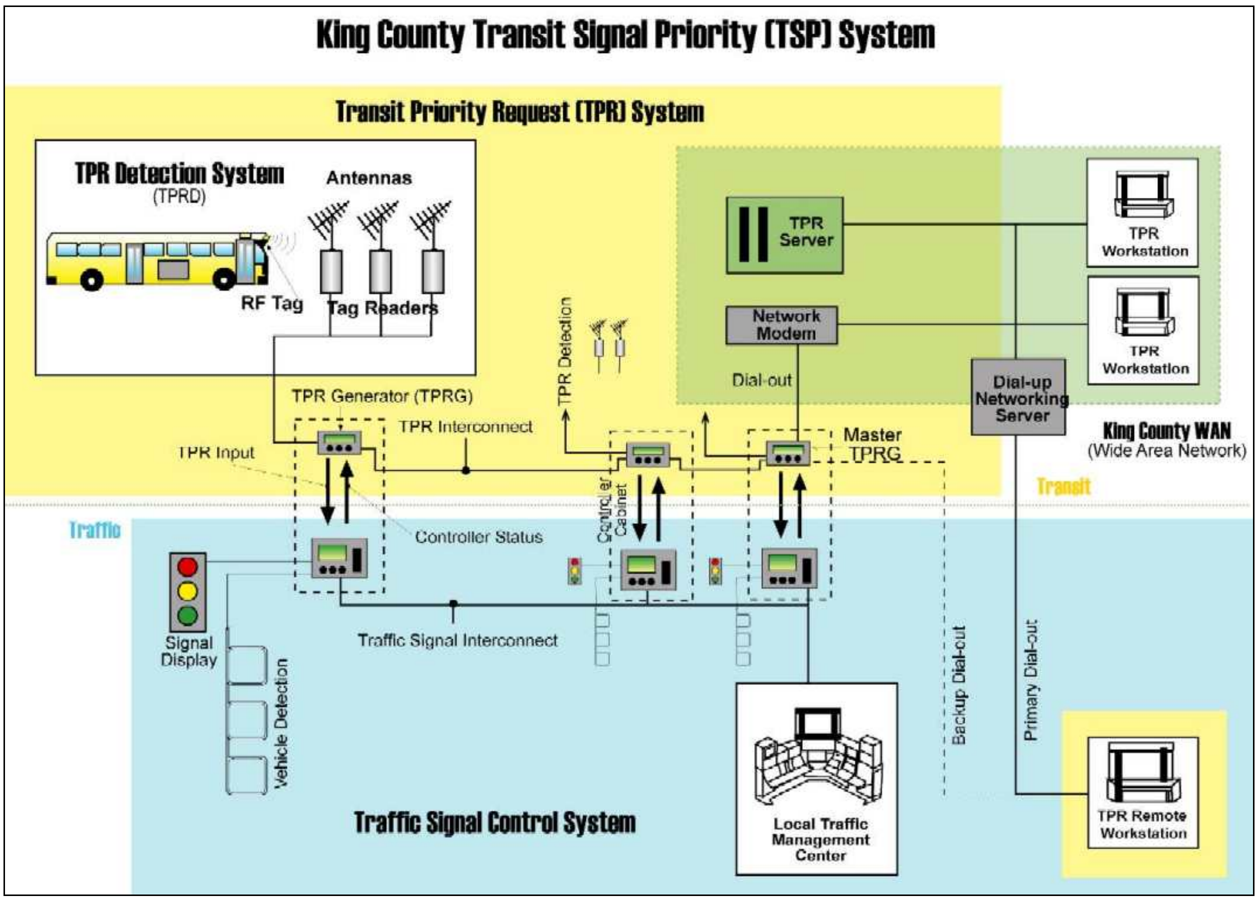
The base computer provides a remote means to communicate to the various Transit Priority Request Generator systems in the field. This system is designed as a dial-up network, communicating to each Transit Priority Request Generator subsystem. The primary function of this system is to enable the uploading operations and transponder logs, and the downloading of programmable settings to each reader/Transit Priority Request Generator subsystem. Operations logs provide daily records of all activities, including diagnostics, records of TSP requests, and information about what phase the controller was in before and after the TSP request. Transponder logs record all tagged vehicles that pass through the intersection. These two sources of log data provide the needed feedback loop for system optimization.

1.B.4.6.2.4. Controller Firmware Modifications/TSP Strategies

All of the controller types being used in this project have required the traffic controller manufacturers to provide specific firmware modifications for TSP control strategies. The degree of modification has varied depending on the flexibility of existing firmware and the specific traffic jurisdiction’s signal operating policies and goals. The City of Seattle, for example, developed firmware implementation requirements that can be summarized as follows:

- Traffic signals shall extend their green interval for approaching priority vehicles.
- Traffic signals shall shorten red displays for approaching priority vehicles.
- Traffic signals shall not shorten any minimum or clearance intervals.
- Traffic signals shall not skip any phases.
- Traffic signals shall not break coordination.

Figure 1.B.4.6.2.4. KCM TSP System



1.B.4.6.3. Current Development

The existing TSP system is being upgraded to reflect KCM's experience with and anticipated improvements in on-board systems. Notably, the data set from the vehicle to roadside equipment can be configured from a larger set of data fields. KCM is also pursuing a move to two-way communication between the vehicle and the TPRG. More information on this is given in Subsection **2.A.4.1.1, Wireless TSP**.

1.B.4.7. Digital Video Recording System (DVRS)

1.B.4.7.1. Project Description

The DVRS project's installation of on-board "security cameras" is part of the County's Transit Security Enhancement Program which uses technology to improve safety and security on Revenue Vehicles. This project's goal is to deter criminal activity and obtain video images for use in support of police investigations, criminal prosecutions, and claims mitigation.

1.B.4.7.2. Description of Work

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 of 290 digital video recording systems will be installed by the end of 2004.

A summary of key functions follows.

a. System records continuously while vehicle is powered up and for 30 minutes after shutdown.

b. Vehicles are equipped with four or five interior color cameras.

c. Recordings are saved for approximately 100-plus hours, which is typically six to 10 days of vehicle operation, after which a new recording cycle begins.

d. Operators save an "incident" using the Emergency Alarm or Save Event button.

e. Saved events are automatically off-loaded via a wireless LAN to the Transit Police server when a vehicle returns to the base.

f. The WLAN uses Cisco equipment and 802.11b protocol with access points at each of the seven bases.

g. Transit Police have wireless field access for real-time viewing within line of sight of camera coaches.

1.B.4.8. Wireless Data On/Offload System (WDOLS)

This section outlines the current configuration of the WDOLS supporting the Security Camera system.

1.B.4.8.1. Physical Network Configuration

1.B.4.8.1.1. Revenue Vehicles

Each Security Camera–equipped vehicle is configured using an 802.11b Cisco Aironet 350 series Wireless LAN PC Card Adapter. The vehicle CPUs are configured with Microsoft Windows ME or Windows XP and the Cisco Aironet wireless client software.

1.B.4.8.1.2. Bases

Each transit base is configured with a varying number of Cisco Wireless Access Points (WAPs). Two different models of Cisco Aironet WAPs are in current use. The two models are 350 and 1200. It is anticipated that the Regional Fare Coordination Project may upgrade all the WAPs to the 1100 or 1200 model.

Table 1.B.4.8.1.2. Current Installation of Wireless Access Points

Base	Number of Access Points—Cisco Model #
Atlantic	1—350
Bellevue	2—350
Central	1—350
Central, at camera shop	1—1200
East	2—350
North	6—350
Ryerson	2—350
South	1—350
South Training	0

1.B.4.8.1.3. Physical Network Topology

Each WAP is wired via CAT5 Ethernet cable into a single Cisco switch port configured for 100/full speed and duplex. Each switch is configured with a management module that functions as a router. Also attached to the switch is a Cisco VPN server configured with DHCP services. The switch is connected to the I-NET fiber backbone, which allows access to other King County Wide Area Network resources.

1.B.4.8.2. Logical Network Configuration

1.B.4.8.2.1. Private Network

Both Revenue Vehicles and WAPs are configured on a private network to insulate any external threats to the KCWAN. Each base has its own independent wireless private network. Vehicles on private network “North Base” cannot communicate with vehicles on private network “South Base.” However, technicians and servers can communicate with vehicles at any base from anywhere on the KCWAN.

1.B.4.8.2.2. Private Network IP Addressing

Each Revenue Vehicle has its own assigned static IP address for the private network. Because the IP addressing configuration is identical at each base, a vehicle can move from one base to another and still communicate with the first base's private network. Because vehicles move from base to base, static IP addressing requires that each Revenue Vehicle have a unique IP address.

1.B.4.8.3. VPN Configuration

In order to grant the Revenue Vehicle access to nodes on the KCWAN, a Cisco VPN solution was installed. Each of the Security Camera CPUs is configured with a simple Microsoft Windows ME scheduled task that executes a batch file which attempts to make a VPN connection with the VPN server located at each base every six minutes. If the vehicle is within range of a WAP and successfully communicating with that WAP, then a VPN connection is established. If not, the scheduled task errors out and is scheduled to try again in another six minutes. Each VPN server is configured with DHCP services and as apart of the authorization process allocates successfully authenticated vehicles a valid public IP address on the KCWAN.

Once the Revenue Vehicle is authorized and allocated a valid KCWAN IP address, an additional command in the VPN batch file updates WINS with the NetBIOS name of each vehicle and the KCWAN IP address. This is necessary in order to address each vehicle from the KCWAN. There are a number of requirements stipulating that nodes on the KCWAN communicate with the vehicle by either network name or IP address. Since VPN is configured to use DHCP, the only remaining option is to reference each vehicle by network name. The current implementation uses WINS, but is not restricted to using WINS. This authentication approach is expected to be revised for RFCS implementation.

1.B.5. Legacy Radio/AVL (R/AVL) System

1.B.5.1. 450 MHz Radio/AVL System

Implemented in the early 1990s, the existing KCM radio system provides communications between the Communications Center Coordinators and Transit Operators and other field staff. Transit mobile radios are installed in approximately 1,300 fixed-route Revenue Vehicles and 250 Non-Revenue Vehicles.

KCM's radio system is a simulcast network with three primary sites that are located on the Bank of America Tower building in downtown Seattle, Tiger Mountain near Issaquah, and Gold Mountain near Bremerton. These sites are linked by microwave to the Communications Center in the Exchange Building in downtown Seattle. Minor sites are located at Westlake Station and Pioneer Square Station in the Downtown Seattle Transit Tunnel; North Base, Roosevelt, Federal Way, and High Point. The minor sites provide additional radio coverage where topography is problematic. These sites are linked to the Communications Center by either fiber-optic or T1 lines.

The Transit radio system uses eight 450 MHz radio channels: four vehicle voice channels, two vehicle data channels, two service supervisor channels, and two 800 MHz channels utilized by Power and Facilities staff. The following is an update of the channel configuration table found in the *King County Radio Comprehensive Plan*, April 1998.

Table 1.B.5.1. 450 MHz Radio Channels

Function/ Channel #	Users	Configuration	Transmitter Frequency (MHz)	Receiver Frequency (MHz)
Revenue Vehicle/Voice Channel 1	Shared voice channel for RVs. Used by Transit Operators and Communications Coordinators.	Multi-site simulcast (surface only)	452.650	457.650
RV/Voice Channel 2	Shared voice channel for RVs. Used by Transit Operators and Communications Coordinators.	Multi-site simulcast (surface only)	452.725	457.725
RV/Voice Channel 3	Shared voice channel for RVs. Used by Transit Operators and Communications Coordinators.	Multi-site simulcast (surface and Tunnel)	453.375	458.375
RV/Voice Channel 4	Shared voice channel for RVs. Used by Transit Operators and Communications Coordinators.	Multi-site simulcast (surface and Tunnel)	453.525	458.525
RV/Data #1 or Channel 5	Vehicle location and other data from odd number RVs	Multi-site simulcast (surface only)	452.375	457.375
RV/Data #2 or Channel 6	Vehicle location and other data from even number RVs	Multi-site simulcast (surface only)	452.800	457.800
Supervisor/ Voice #1 or Channel 7	Tunnel staff including Service supervisors, Transit Police, Facilities Maintenance staff. Communications Coordinators and Waterfront Streetcar.	Multi-site simulcast (surface and Tunnel)	452.275	457.275
Supervisor/ Voice #2 or Channel 8	Service supervisors at street surface, Communications Coordinators, Vehicle Maintenance staff, Transit Police, Base Cars	Multi-site simulcast (surface and Tunnel)	452.350	457.350
Maintenance/ Voice #1 or M1	Facilities maintenance staff	Multi-site simulcast (surface and Tunnel)	851.0125	806.0125
Maintenance/ Voice #2 or M2	Power Distribution staff	Multi-site simulcast (surface and Tunnel)	851.7625	806.7625
Signpost AVL transmitters	Part of RV's Automatic Vehicle Location system	302 low power beacon units mounted along bus routes	49.830	N/A
10 GHz Microwave Path #1	Voice, data and control links for radio system sites	Exchange Building to Columbia Center	10533.75	10618.75
10 GHz Microwave Path #2	Voice, data and control links for radio system sites	Columbia Center to Tiger Mountain	10536.25	10616.25
10 GHz Microwave Path #3	Voice, data and control links for radio system sites	Columbia Center to Gold Mountain	10551.25	10621.25

The system uses conventional, simulcast communications on voice and data channels. There are continuous analog data communications occurring at 2400 baud on the data channels. Voice communications between Communications Center staff and field staff are conducted as analog voice transmissions. The system is “quasi-trunked,” as vehicle radio transmissions are assigned to available channels by the Data Acquistion Control System (DACS), based on the service route operated by the Revenue Vehicle.

Transit radios used by other field staff (Service Supervisors, Transit Police, Power and Facilities, and Vehicle Maintenance personnel) are not equipped with the Revenue Vehicle data radio functions and are limited to radio voice communications.

The legacy radio system will be replaced as part of the Transit Radio System (TRS) project, scheduled to begin its procurement process concurrent with that of the OBS/CCS.

1.B.5.2. Legacy Automatic Vehicle Location (AVL) System

Transit's AVL system is signpost based, with 350 signposts located throughout the service area. The Data Communications Controller (DCC), which is located in the Communications Center, polls in-service vehicles every one to two minutes. When a Revenue Vehicle passes a signpost transmitter, the signpost identification number and vehicle's odometer reading are stored on the its MDU. When the vehicle is polled by the DCC, the signpost data are transmitted, along with the vehicle's current odometer reading and timepoint times. DACS calculates the vehicle's current location from the transmitted data and then broadcasts it for display on the Communications Coordinators' AVL monitors in the Communications Center. DACS calculates schedule adherence by comparing the scheduled arrival time with the time the vehicle has recorded as its arrival time at a timepoint.

The Coordinators utilize AVL data in real time to respond to emergencies and other incidents by dispatching assistance to a coach's current location, and by assessing the impacts of various disruptions on service. Other Transit staff use historical AVL data for KCM system performance reporting and analysis.

1.B.5.3. Legacy Radio/AVL Components:

1.B.5.3.1. Data Acquisition and Control System (DACS)

In addition to determining Revenue Vehicle location and schedule adherence, DACS plays a key role in the radio communications process. KCM's Service Communications Coordinators, operating in the Communications Center, prefer to manage vehicle radio traffic in logical groupings, such as having all trolley bus operators talk to a designated Communications Coordinator. DACS manages Revenue Vehicle voice channel assignments by switching vehicles to voice channels according to the service route operated by the vehicle. DACS routes radio calls based on logic that associates vehicles to routes, routes to groups, and groups to Coordinator assignments.

1.B.5.3.2. Data Communications Controller (DCC)

Communication on the two data channels is managed by the Data Communications Controller (DCC), which performs the continuous fleet polling process needed to support AVL functionality. The DCC also manages the traffic of contention messages, such as Operator logins, Request to Talk messages and Emergency Alarms, from the revenue fleet.

1.B.5.3.3. CAD/AVL

In addition to providing voice communications with the revenue fleet and a variety of field staff, the system uses two channels for the data communications required to support the Computer-Aided Dispatch and Automatic Vehicle Location (CAD/AVL) functions used by Service Communications staff. These functions include automated call prioritization, Emergency Alarm processing and incident logging, schedule management, resource tracking, and vehicle location displays. Sample screen shots of the CAD and AVL modules are provided below in figures ***1.B.5.3.3.b*** and ***1.B.5.3.3.c***.

KCM's CAD/AVL system has received a significant number of upgrades and revisions in recent years including a complete rewrite of the CAD/AVL user interface, major hardware upgrades, and substantial revisions to the vehicle tracking logic.

The functions of the CAD/AVL system provide the Communications Coordinators with the tools to respond to and manage Transit service disruptions, incidents, and emergencies in the interest of maintaining service reliability and safety.

The Radio and CAD/AVL systems are closely integrated to provide the Coordinators with the ability to accomplish the following:

- Conduct voice radio communications with all KCM field staff (radio).
- Track the location and schedule adherence of in-service Revenue Vehicles (AVL).
- Manage radio call processing, query supporting KCM data, and document incidents (CAD).

These functions are integrated within each Coordinator workstation to facilitate radio call processing, accessing of essential information, and dispatching of resources in a time-efficient manner that is essential to the KCM operating environment.

The system provides access to key CAD/AVL functions, including:

- Onscreen intake and response to data radio messages from Transit Operators, such as PRTTs, RTTs and Emergency Alarms; and other data radio management functions.
- Automated forms for collecting data related to radio calls such as the Coordinators' Service Record (CSR), and safety report forms.
- Automated access to schedule data and other frequently used information such as lists of public safety service phone numbers and jurisdictions.
- Real-time AVL data, viewed by route/run, route, or geographic area, and other mapping functions.

Each of the CAD/AVL workstations in the Communications Center has two large PC monitors, one displaying the CAD/Windows computing environment for computer-aided dispatch, and the other displaying mapped AVL data.

Figure 1.B.5.3.3.a. Coordinator's CAD/AVL Workstation

Communications Coordinators use the AVL system to manage transit service by:

- Answering calls from transit operators, internal staff and external agencies.
- Helping operators determine what kind of help they need.
- Logging incidents and accidents.
- Dispatching and coordinating the efforts of on-scene help, including police, fire, supervisors, mechanics, safety officers, or others.
- Helping to set up reroutes for adverse weather or road closures.
- Filling late or missing service with extra or standby coaches.
- Sharing information with partner agencies.

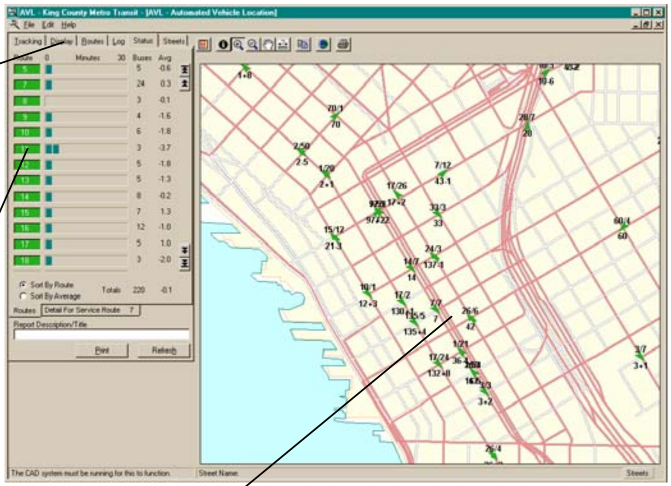
The **Automatic Vehicle Location (AVL) Display** provides dynamic updates on vehicles and their current status and location.

Figure 1.B.5.3.3.b. Coordinator Screen: AVL Display

Tabs provide quick access to various display options, such as route selection, address queries, and other optional features that can be displayed on the map.

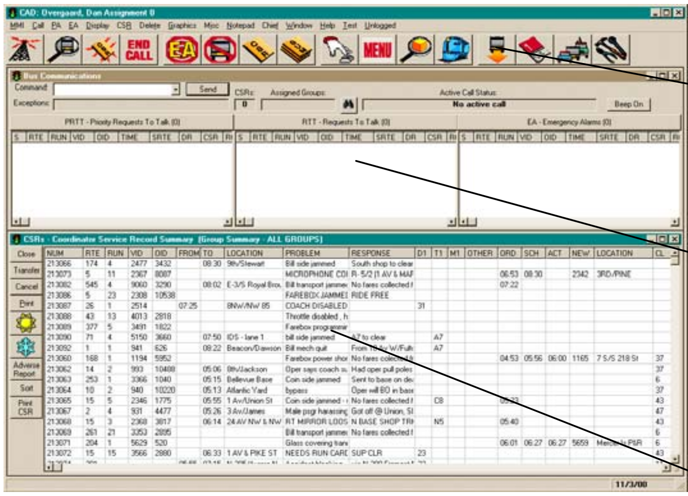
A dynamic bar graph provides an overview of the on-time status of each route. Coordinators can "drill down" by clicking on a specific route number, which will then show the current on-time status of every coach on that route.

Bus locations are updated automatically every 30 to 90 seconds depending on the number of coaches being polled. Bus icon colors change to indicate on-time, early, late, or emergency status. Coordinators can track any bus, view any set of routes, and pan or zoom to any part of the transit service area.



The **Computer-Aided Dispatch (CAD) Display** supports call management, schedule lookups, incident logging, and related functions.

Figure 1.B.5.3.3.c. Coordinator Screen: CAD Display



One-click hot keys provide quick access to critical features such as schedule displays.

Operator calls are sorted as:

- Request to Talk
- Priority Request to Talk
- Emergency Alarms

Calls are taken in order and priority.

The Coordinator Service Record is the official record of how accidents, incidents, schedule delays, and other service disruption are resolved.

1.B.5.3.4. AVL Systems Integration

Systems integration is critical to the performance and success of the legacy AVL system. The Scheduling and Transit Geographic Information Systems (GIS) are the primary sources that AVL uses to track Revenue Vehicles and calculate schedule adherence. These data flow through the Transit Enterprise Database (TED) to AVL on a biweekly basis. DACS time is synchronized to WWVB or to an Internet time standard and it sends time syncs every 30 minutes to the fleet on the data channels. On board the vehicle, the AVL system shares Operator login, time, current odometer and other data with the APC and TSP systems.

Vehicle location data is automatically routed over the Internet to the University of Washington, where it is processed for display in BusView and MyBus, two applications developed by UW engineers under demonstration grant funding from the Washington State Department of Transportation, the Federal Highway Administration, and the Federal Transit Administration.

1.B.5.3.4.1. MyBus

MyBus provides a tabular route and destination display with predicted vehicle arrival and departure status information, similar to the displays typically found at airports. The information is available for all active schedule timepoints in King County Metro's system, as well as for the Sound Transit routes operated by King County.

The MyBus website is: http://www.mybus.org/.

1.B.5.3.4.2. BusView

BusView provides a dynamic map display of current vehicle locations. Users can select routes to be displayed, and watch vehicles travel along the route as updates are provided by the AVL system. An alarm feature can notify users when the next vehicle has arrived at a specified point along the route.

The BusView website is: http://busview.org

1.B.5.3.4.3. Other Users of AVL Data

Several workgroups within KCM use data provided by AVL. Schedule adherence data and Coordinator Service Records provide a comprehensive picture of operations history. Users have direct desktop access to the historical AVL database, and can run ad hoc reports at any time.

Desktop users of AVL data include KCM workgroups such as Transit Scheduling, Transit Safety, Management Information & Transit Technology, Customer Assistance, Base Operations, Service Quality, and Service Communications.

AVL data are utilized for a variety of purposes:

- Evaluating on-time performance by trip, route or corridor.
- Adjusting schedule reliability at timed transfer points such as Transit centers.
- Investigating accidents, incidents and other service disruptions.
- Collecting trend data and performing impact analyses of service interruptions.
- Investigating customer complaints, claims, and queries.
- Providing data for performance indicator reports.

In addition to using the standard desktop-reporting tool, Transit Scheduling staff use a specialized module of the HASTUS Scheduling system, which provides automated tools for analyzing and managing scheduled running times.

1.B.6. Transit Enterprise Data Systems

1.B.6.1. Transit Enterprise Database

KCM consolidated its enterprise data in the early 1990s, facilitating data sharing among its various systems. This consolidated distribution database replaced multiple point-to-point interfaces between systems with a single interface between each system and the enterprise database.

KCM has recently reengineered the storage and accessibility of the Agency's enterprise data into a new Transit Enterprise Database (TED). TED uses an enterprise data model to facilitate the integration of Agency schedule, GIS, bus stop, employee, and vehicle data. It currently includes a number of reporting tables drawn from these data sources for use by downstream systems. It will be a key source of information to the chosen OBS. Logical data models (in the form of Entity Relationship Diagrams), server models, and data dictionaries are available to document this database.

TED is an Oracle database and can accept direct input from any other SQL-based database via database link. It can also input files that are produced with specified formats:

- Oracle export file.
- Comma-delimited.
- User-Defined Delimited Files (excluding use of Oracle or SQL Server execution commands).
- Fixed-field-width files.

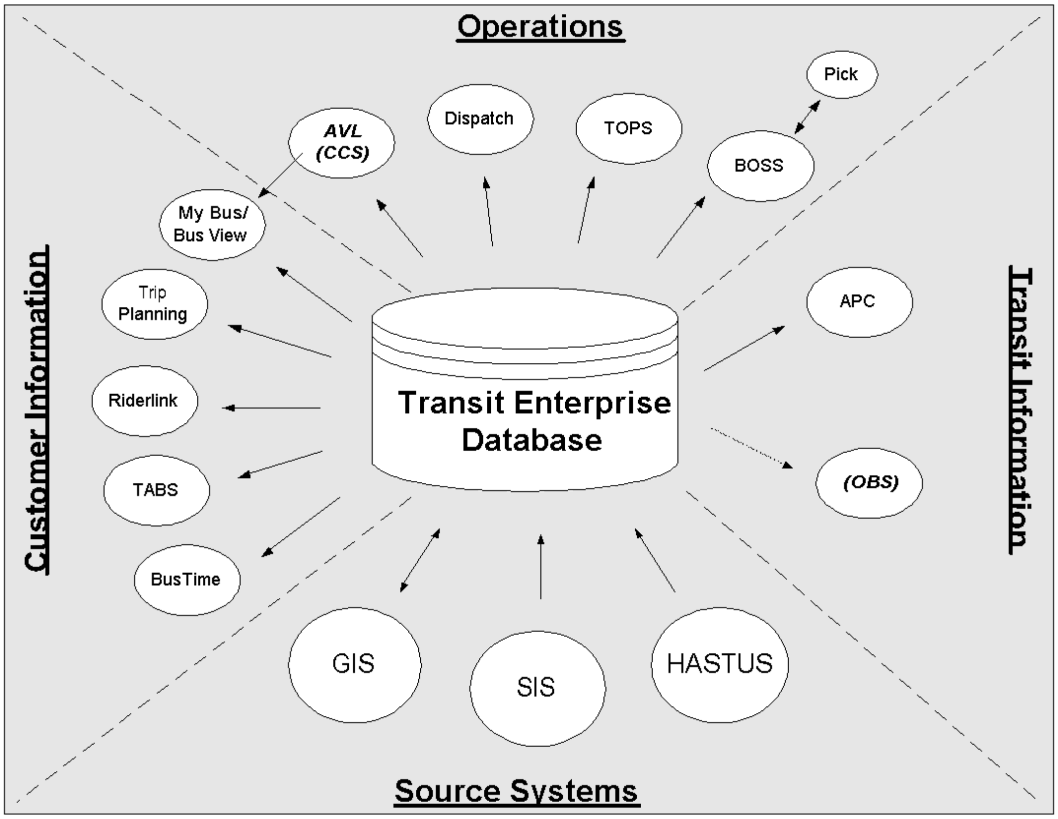
- XML Validated Schemas.

TED is at the current version of Oracle 9i release 2 and continues to migrate to the newer releases as they become available. Oracle is the preferred platform for KCM data systems.

1.B.6.1.1. KCM's Enterprise Data Systems: Pictorial Representation

The exchange of data between automated Transit systems and the Enterprise Database is graphically depicted in the following figure.

Figure 1.B.6.1.1. Transit Business & Enterprise Data Systems



1.B.6.1.2. KCM-Supported Operating Systems and Databases

1.B.6.1.2.1. Operating Systems:Windows 2000

KCM supports the following operating systems:

- Windows 2000 Advance Server
- Windows XP
- Linux
- UNIX (HP/Compaq Tru64)

1.B.6.1.2.2. Database Software

KCM supports the following database software:

- SQL Server 2000
- Informix
- Oracle 9i

1.B.6.1.2.3. Software Tools:

KCM supports the following software tools:

- Crystal Reports
- ASP.NET
- VB.NET
- Oracle 9ias,
- Oracle 9i Developer
- Oracle 9i Designer
- Perl
- Java
- J2EE
- Microsoft IIS
- Apache
- Cold Fusion
- C/C++

1.B.6.2. HASTUS Scheduling System

The current scheduling software used by KCM is HASTUS V5.10.1 created by Giro, Inc., located in Montreal, Canada. **Appendix F** provides additional information on data and reporting requirements for interfacing to HASTUS.

1.B.6.2.1. Description of HASTUS Scheduling Modules

The KCM implementation of HASTUS V5.10.1 utilizes five modules.

- Vehicle: This module is used to create trips and simple blocks.
- Minbus: After trips are created, Minbus can optimize block creation.
- Crew: After optimized blocks are created, this module is used to create Operator assignments.
- SuperMicro: This module is used to optimize the creation of Operator assignments.
- ATP: Actual historical running time measurements between TPIs are imported into ATP for analysis for possible modification of future scheduled running time.

1.B.6.2.2. Basic Scheduling Definitions

The basic purpose of HASTUS is to efficiently produce vehicle assignments (i.e., Blocks) and Operator assignments (i.e., Runs) based on vehicle trips, which are also created in HASTUS. The following scheduling-related definitions are useful in understanding how KCM schedules service:

- Block: The operating schedule of a Revenue Vehicle from the time it leaves the base until it returns to the base. A Block may also be referred to as a Route/Run pairing (e.g., Route 5, Run 2). Blocks are described in terms of a sequence of trips, which consist of a list of Timepoints (see definition below) served by the vehicle and the scheduled times of service for each of those Timepoints. Blocks may contain one or more service trips and at least two deadhead trips (the trips to and from the base, or from the end of one service trip to the beginning of another). A Block may contain one or more Operator work assignments.
- Operator Assignment: A unit of driver work of any size from part of a trip to a full day's run of roundtrips. May include work on different vehicles. The lengths of Operator assignments are prescribed by contractual agreements.
- Timepoint: A location (associated in GIS with a node) along a route where trips are assigned a specific arrival and/or departure time.
- Timepoint ID Number: A unique integer given to a named location, identifying it as a specific timepoint. As of January 2004, the system contained 2,308 Timepoint ID Numbers.
- Timepoint Interchange (TPI): A geographic path between two timepoints. The TPI is referenced by the concatenation of its two Timepoint ID Numbers. Currently, KCM’s data model assumes a single path between two timepoints at any given point in time.

Below is an example of a block with its associated timepoints. This block includes a deadhead trip from East Base to the first timepoint on the first service trip, a service trip, a deadhead trip between the last timepoint on the first service trip and the first timepoint on the second service trip, a second service trip and a final deadhead trip from the last timepoint on the second service trip to East Base. In this case, the block would include a single Operator assignment. In other words, a single driver would operate this vehicle assignment.

Table 1.B.6.2.2. Block 21203

(One could also call this Route 212, Run 3)

Time Point ID	Time Point Name	Scheduled Time	
4	EAST BASE	06:41A	**Deadhead Trip**
7331	EGT BAY1	06:58A	First Service Trip
7373	EGPR ITRM	07:00A	
7232	RICH E GT	07:02A	
4827	EXP ECHA	07:05A	
4824	I 90 STA	07:11A	
449	ID N/B	07:15A	
336	UNIV N/B	07:19A	
1749	CPS A/B	07:23A	
			Deadhead Trip
7331	EGT BAY1	08:10A	Second Service Trip
7373	EGPR ITRM	08:12A	
7232	RICH E GT	08:14A	
4827	EXP ECHA	08:17A	
4824	I 90 STA	08:23A	
449	ID N/B	08:27A	
336	UNIV N/B	08:31A	
1749	CPS A/B	08:35A	
4	EAST BASE	09:03A	**Deadhead Trip**

1.B.6.3. Geographic Information Systems (GIS)

1.B.6.3.1. KCM GIS History

KCM has always needed geographic information to carry out its mandate to provide excellent public transportation services. In 1980, the Agency began development of its own Geographic Information System (GIS) to support several critical information systems. Over the next two decades, GIS has become increasingly important to the Agency and now has dedicated staff to support interfacing to multiple ongoing transit business systems and functions. KCM currently relies on a variety of GIS data and a mixture of GIS industry-standard off-the-shelf products, customized macros, and internally developed applications.

1.B.6.3.2. One-Agency GIS

KCM has centralized the coordination and maintenance of the transportation and street network layers of GIS within a single organizational unit. This ensures interoperability of spatial data on a single base map for the entire agency. Staff in this unit is responsible for creating, maintaining, analyzing, and delivering KCM geographic information to support agency staff and automated systems. GIS staff also provides transit map/data products, user support, vendor software installation and maintenance, and KCM applications support.

The reliance on a single base map has necessitated that the GIS unit develop processes and procedures that deliver fast response times to data maintenance requests. Typically, changes to spatial layers can be made and delivered to production databases for use in agency information systems within 24 hours. This is accomplished through several mature data-entry applications and a suite of nightly automated batch routines. GIS staff works closely with agency information systems to use the existing base map and to incorporate any new requirements for applications and data.

1.B.6.3.3. Information Systems Dependence

Along with Scheduling and Facilities information, GIS is a primary source of core information to a variety of KCM systems that rely on spatial information for operations, customer information and planning (see Figure ***1.B.6.1.1, Transit Business and Enterprise Data Systems***). These systems include Service Implementation, Automatic Passenger Counters, Title VI reporting, mileage tracking, Automatic Vehicle Location, Bus Time automated customer information, Ridematching, service planning, facilities planning, fare analysis, policy analysis, Automated Trip Planning system, safety/security information management, Commute Trip Reduction Law program management, and the Americans with Disabilities Act program. These systems receive coordinate information, spatial shape files, maps, or other services. Data are retrieved directly from production databases or preprocessed through interfaces developed and maintained by KCM GIS staff.

1.B.6.3.4. GIS Data Publication, Access, and Maintenance

KCM GIS simultaneously publishes data to two data storehouses: a geographic production library containing geographic shape data and attributes, and TED, the Oracle database that receives geographic coordinates and attributes. KCM users access both of these libraries for ad hoc queries, reports, and spatial interfaces. The predominant geographic user application interfaces within KCM are ESRI's ArcView and the KCM GIS Toolbox. The Toolbox was developed in house as a Visual Basic and MapObjects application that facilitates viewing KCM revenue service and street information. KCM GIS staff supports both of these interfaces.

KCM GIS staff also supports data maintenance application interfaces for core KCM information. These include interfaces for the transportation network, safety accidents, security incidents, radio signpost, route, timepoint, and bus stop location maintenance. All of these are accessed by specific workgroups within the Agency. Some of these interfaces provide tools to maintain data directly in TED, whereas others maintain data in GIS that is then loaded into the Oracle database nightly. GIS also maintains these nightly batch-loading routines.

1.B.6.3.5. GIS Data Interrelationships

GIS maintains its core spatial information (route service paths, timepoints, bus stops) as linear referenced objects to the transportation network. Point features, such as bus stops, are identified by an edge ID, distance from the from-intersection, and a side of the street. Linear features, such as route service paths, are identified as an ordered set of transportation network edges. More complex features are created from these core objects: Trips are an ordered set of route service paths and blocks are an ordered set of trips. Each of these ultimately relies on a connection to the transportation network. The transportation network is maintained by KCM GIS, and the connection of the network to higher-order transit objects is maintained through the tools developed by KCM GIS.

1.B.6.3.6. GIS Specifications

The format for KCM GIS data in the production spatial data storehouse is ESRI shape files stored in the State Plane Washington North Zone projection, in feet units. The reference datum is NAD 83 HPGN (High Precision GPS Network). Coordinates in TED are stored in this projection. Streets share a high degree of relative accuracy throughout the network. The absolute accuracy of the transportation network is +/- 25 feet in most incorporated areas, but the network could be significantly less accurate in unincorporated King County. Similarly, completeness is relatively high in incorporated areas specifically where KCM provides fixed-route service. Newer sub-divisions outside the KCM service area are often incomplete or missing altogether. Since transit objects are geographically referenced to the transportation network, they mirror these specifications.

1.B.6.3.7. GIS Data for CAD/AVL

GIS also developed and supports an application used to package spatial and tabular data necessary for the CAD/AVL system. This application creates the sequence and location of events that a coach is expected to encounter as it completes a daily piece of work.

1.B.6.3.8. TNET Changes

KCM GIS will complete the TNET (Transportation Network) project in 2004, delivering a high-accuracy multi-modal transportation network in a Geodatabase format utilizing ESRI’s SDE and Oracle. Transportation routes for pedestrians, rail, water traffic, and other modes will be included in the network with a real-world accuracy of +/-10 feet in most areas west of the Cascades. This network will replace the current street network and all transit objects will be registered to it, forcing a location change for all transit features and changes to location attributes stored in the feature attribute table. A new data maintenance application is being developed that will be used by a consortium of data maintainers throughout the county including King County Metro Transit, Road Services, E911, and many local cities. These “owners” are the best equipped to maintain transportation-related features within their jurisdictions. TNET will, therefore, deliver a superior transportation network suitable for use with GPS applications that will be complete in most areas using the latest digital orthophotography. It will also put in place a superior data maintenance strategy that will ensure the long-term completeness and utility of the network.

KCM GIS is coordinating the consortium of data maintainers, and will work very closely with other County departments and local agencies to ensure timely maintenance of the transportation network to satisfy business requirements. Also, in most cases, the business needs of King County E911 exceed those of KCM for accuracy and completeness of the network. The Geodatabase structure for the new transportation network will continue to support ESRI shape files as an exchange format.

1.B.6.4. Stop Information System (SIS)

Stop Sequence data currently exists in TED and is maintained by a non-MITT application. KCM is developing the Stop Information System, a replacement application that will provide stop sequence data which is unique by route path. This data will also facilitate any type of sequenced event data along the route service path such as timepoints and landmarks for annunciation data.

1.B.6.5. KCM Data Management

KCM has key systems that store data in Oracle, Informix, and SQL Server databases. In each case, the data has primary and foreign keys defined at the table level to ensure data integrity. Most of the databases have metadata documentation of their logical and physical design including table and attribute definitions.

All KCM design work and code must go through a design review of peers, a development system, and test/QA system prior to release for production. All documentation must be available in written Adobe PDF or MS Word format before it can be placed into the test/QA environment. A signoff form for placing new project work into production is completed prior to going live.

1.B.6.6. King County Wide Area Network (KCWAN)

Network services provided by the KCWAN include operation and maintenance of King County’s Wide Area Network, which encompasses more than 215 sites. These services include maintenance of network connections as well as connectivity to the Internet and the State Intergovernmental Network. Data, voice, and video communications are provided by these networks.

Information and Telecommunications Services (ITS), a Division of King County’s Department of Information and Administrative Services, provides support services and oversight for the KCWAN.

1.C. Systems Development and Implementation Environment

This section provides a description of the anticipated County environment for design, testing, and implementation of the OBS/CCS. KCM has committed to multiple projects that will be underway during the same timeframe as OBS/CCS. Collaboration and coordination between all projects is essential for successful implementation of each because there is a high degree of interdependence.

1.C.1. Project Dependencies

1.C.1.1. Interdependent Projects

The OBS/CCS Project is one of four separate, concurrent, interdependent projects to replace and upgrade many of the KCM's transit systems to current technology. The four projects are:

1. Regional Fare Coordination System (RFCS), also known as "Smart Card"
2. OBS/CCS Project
3. Transit Radio System (TRS) Project
4. Communications Center Relocation Project

The parties responsible for each of these projects, including Contractors and KCM staff, shall

- determine clear functional and technical boundaries between the systems.
- collaborate on design issues.
- deliver open, published interfaces between systems.
- upgrade the existing environment and provide a stable, well-documented platform for subsequent implementations.

1.C.1.2. Coordination and Collaboration Requirements

During Contract negotiations, KCM will finalize detailed requirements for collaboration between the OBS/CCS Contractor and the other three projects. KCM has limited staff and facility resources for supporting large implementations; therefore coordination during implementation will be critical. Final requirements will depend on the timing and circumstances at the inception of and during the OBS/CCS project. The following areas of possible conflict and confusion must be addressed by the activities of the Technical Interface Committee (see Section **1.C.1.3.** below):

- Project dependencies: Each of the projects is providing equipment and functionality upon which the subsequent project is dependent. Therefore, it is essential that interface designs support this evolution. The contracts and the County will expect and facilitate collaboration on understanding the full system requirements for each device/subsystem and communications layer.
- Installation: Each project will be installing equipment onto the same Revenue Vehicles with KCM staff performing the installations and contractors providing instruction and oversight. Each install must be prototyped, tested, verified, completed, and documented in such a way as to facilitate the next install. The installation planning must be thoroughly coordinated in order to minimize the frequency and duration of time that Revenue Vehicles are pulled out

of service. This is because there are constraints on the number of vehicles that can be out of service at any given time.

- Training: The operating environment will change incrementally and quickly with the cumulative effect of these projects. It will be a challenge to coordinate training for staff that must maintain 24/7 operations as a top priority. Careful attention must be given to when, how, what, and to whom training should be provided to facilitate a smooth transition and, most importantly, to continue to provide reliable, high-quality service to the riding public.
- Legacy KCM systems interfaces: The new systems shall interface with existing KCM systems (radio/AVL, scheduling, fare collection, security, etc.). These mission-critical systems shall not be degraded during the design, test, and implementation of these new projects.

1.C.1.3. Technical Interface Committee

Proposers for OBS/CCS are hereby advised that KCM has issued a separate RFP for a technically linked but otherwise independent procurement for a new Transit Radio System (TRS). Responses to that RFP will receive a complete and competitive evaluation fully independent of the complete and competitive evaluation of the OBS/CCS proposals. The presence or absence of a radio equipment vendor in an OBS/CCS proposal will not influence or determine the outcome of the TRS procurement.

The Contractor is required to integrate and interface the OBS/CCS with the new TRS. The technical relationship between the two projects requires both the contractors and all subcontractors to be willing and able to work openly and collaboratively with one another without prejudice or bias regardless of historical relationships. To this end, the OBS/CCS Contractor shall work cooperatively with the TRS contractor on an as-needed basis as directed by the KCM Project Manager. Both projects' contractors, as part of their respective contracts with the County, will be required to sign a certification to that effect (see Part A, Attachment **P, Contractor's Certification Regarding Systems Integration**).

In addition, KCM will chair a Technical Interface Committee (TIC) comprised of the TRS and OBS/CCS projects' contractors and KCM staff. The purpose of the TIC will be to address and successfully resolve integration and interface issues between the Radio, On-Board, and Communications Center Systems. In this forum the contractors shall exchange information and resolve issues and define and develop their required interfaces, interface documentation, and interface test plans.

The OBS/CCS Contractor shall ensure that their project management and, as appropriate, their technical staff attend all TIC meetings to establish needed processes and develop required operational interfaces in a timely manner and within the final project schedule. KCM will designate a County employee as the committee chair. It is envisioned that the TIC would meet monthly or on an as-needed basis as determined by the Committee chair.

KCM may choose to involve contractors and KCM staff from other related projects when technical issues dictate. Projects in addition to those mentioned above that may require integration include the Regional Fare Coordination System (RFCS) and the Security Camera Project. Others may emerge over time.

The TIC will not necessarily address and does not relieve Contractors of their responsibilities to provide other integration and interface deliverables such as attending design review meetings; providing interface control documents, equipment prototypes and production units; coordinating installation; and meeting testing requirements.

The OBS/CCS Contractor will be required to define, develop, implement, document, test, and support all interfaces and interconnections required for the successful operation of its systems, including integration with related systems. As detailed in Section **2.A.3.1, Project Phases and Deliverables**, successful test completion for each phase of the Project will be required to ensure that all such interface issues have been addressed.

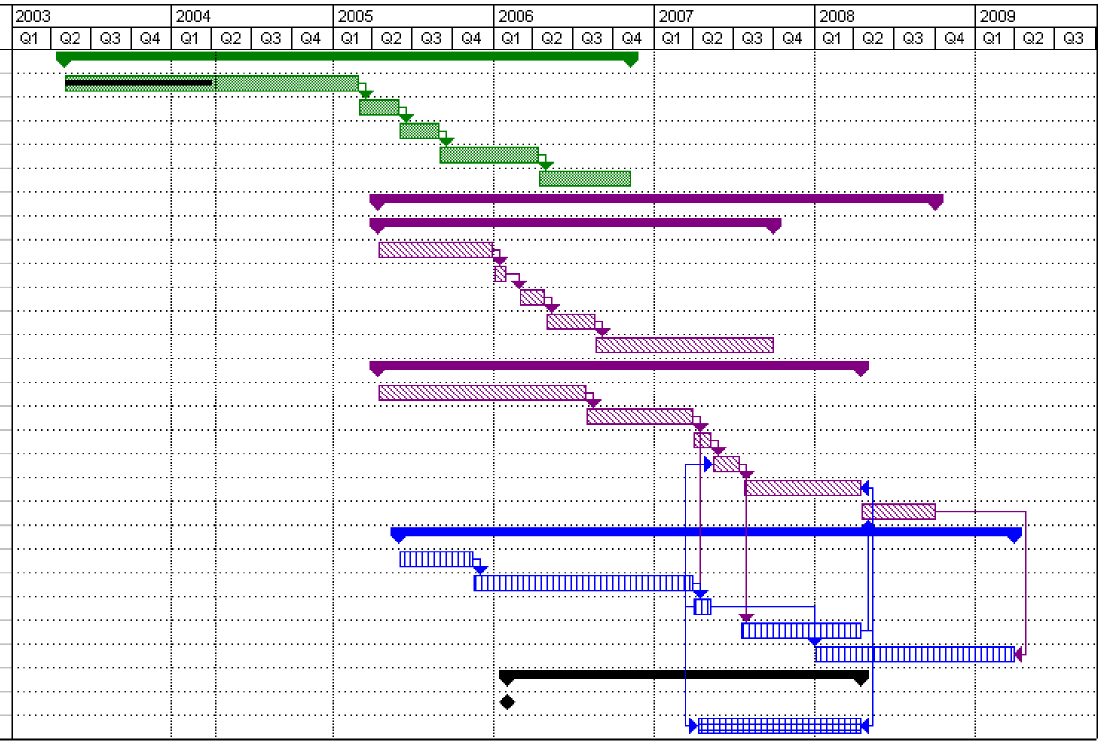
Working in concert, KCM has developed system interface requirements and allocated these functions to the scopes presented in each use case, based on a general understanding of good system engineering principles and current market offerings. Proposers should focus on responding directly to the requirements as presented. Alternate methods or architectures for delivering required functionality may be proposed. However, Proposers must be aware that proposed changes in scope to this Contract may affect another contract and are subject to County negotiation and approval. Proposers should also be aware that King County reserves the right to make changes to the project design and that all final scope, schedule, and budget decisions will be made at KCM's approval.

Proposers are strongly encouraged to demonstrate their ability and commitment to supporting this system integration methodology and to discuss what measures they have taken in the past in projects requiring collaboration to develop radio and on-board system interfaces. Additionally they should discuss what measures they intend to apply in this Project to ensure a successful outcome.

Figure 1.C.1.3. Combined Transit Projects Schedule

This schedule is provided for context and to identify points of integration and coordination. The actual schedule for each project is subject to negotiations and the schedule performance of the interdependent project(s).

ID	Task Name
1	**REGIONAL FARE COORDINATION SYSTEM "smart card"**
2	Design/Development
3	Beta Installation at Bellevue Base
4	Beta Test
5	Full Installation - All Other Bases (est. 10 per day)
6	RFC Acceptance Test
7	**OBS/CCS PROJECT**
8	**LEVEL 1: OBS**
9	OBS Design and Development
10	Prototype OBS Install on All Fleets
11	Install OBS Equipment on Pilot vehicles
12	Conduct and Accept Pilot Test
13	OBS Install & Implement (est. 5 per day)
14	**LEVEL 2: CCS**
15	CCS Design (Coordinated with TRS Contractor)
16	CCS Install & Test in New Comm Center
17	CCS Pilot Installation
18	Conduct Radio/CCS Pilot Test
19	Migrate fleet to CCS w/radio installs
20	**OBS/CCS Full System Acceptance (Concurrent with TRS acceptance)**
21	**TRANSIT RADIO SYSTEM PROJECT**
22	Design/Development for Radio System
23	Install and test new radio system
24	Install Radios for Radio/CCS Pilot Test
25	Install New Coach Radios at all Other Bases (est. 10 per day)
26	Acceptance Test - Radio
27	**COMMUNICATIONS CENTER RELOCATION PROJECT**
28	New Comm Center Available for Radio/CCS installation and testing
29	Parallel Comm Center Operations



1.C.2. RFCS ("Smart Card") Project

The Regional Fare Coordination System contract was awarded to ERG Transit Systems (USA), Inc. in April 2003 and the design phase is currently underway. The purpose of this project is to implement a single, common fare-collection system for bus, rail, ferry, monorail, and vanpool travel in the Central Puget Sound region. KCM is acting as the lead agency, providing project administration during the implementation phase of the project. Other participating agencies are Community Transit, Everett Transit, Kitsap Transit, Pierce Transit, Sound Transit and the Washington State Ferries. The RFCS will provide "seamless" transfers among transit modes and systems; expand each agency's fare policy and ridership incentive capabilities; support accurate revenue reconciliation and daily financial settlement among the seven partner agencies; and introduce new levels of customer convenience to obtain and use pre-paid fare media.

The RFCS project scope includes the devices necessary to implement the RFCS in the existing on-board environment. RFCS and OBS/CCS project schedules may overlap. The contract language for ERG was carefully designed to facilitate a collaborative relationship and to try to avoid legal or technical problems that could risk the success of either project. *Figure 1.C.5.2, RFCS LIM Architecture* describes the anticipated on-board architecture after RFCS is implemented.

1.C.2.1. RFCS Equipment

The equipment and systems necessary to operate and maintain an integrated RFCS will include smart cards, customer service terminals, retail revalue network, fare transaction processors, data acquisition systems, a clearinghouse system, and other back office systems. Of particular relevance to the OBS/CCS Project are the following on-board subsystems provided by the RFCS project with which the VLU will be required to interface:

Driver Display Unit (DDU): An operator interface device to replace the current mobile data terminal (MDT); capable of becoming the sole operator control terminal for all on-board systems. This device consists of a software programmable display with programmable soft keys on its perimeter. The DDU will initially include fare collection and radio system controls.

Radio Controller Unit (RCU): A device that will serve as an adapter to enable the DDU to replace the existing mobile data terminal (MDT) and to interface with the existing mobile data unit (MDU). The RCU and MDU will be removed along with the 450 MHz radio when the new TRS mobile radio is installed.

Fare Transaction Processor (FTP): An on-board device that will allow fare cards to be read and encoded during the fare payment process through a contactless interface. The FTP will be used for implementing a secure, automatic Operator login process.

Data Acquisition Computer (DAC): A computer, located at the transit base, that manages data exchanges between on-board RFCS equipment and fixed-end RFCS systems via the WDOLS. To avoid confusion with the legacy CAD/AVL Data Acquisition and Control System (known as DACS), the Base Data Acquisition Computer will be referred to within this document as the "RFCS Server."

Wireless Data On/Off Load System (WDOLS): The primary method for transferring data between the FTP and the designated base DACS. Cisco 802.11b equipment will be located both on the vehicles and at the bases.

1.C.2.2. RFCS Integration Modes

The RFCS project scope includes implementation of the “smart card” fare collection system in two configurations as described below.

1.C.2.2.1. Limited Integration Mode (LIM)

Installation of the LIM architecture will take placed before the Level 1 functionality is available. The LIM implementation will include the following tasks:

- Install the FTP “smart card” fare collection system.
- Replace legacy MDT with programmable, soft-key driver display unit to provide operator interface to radio and fare-collection functions.
- Design and install a RCU adapter to interface DDU to legacy PA system and 450 MHz radio/AVL functions. The 450 MHz radio/AVL system will continue to provide current functionality.
- Install a secure, high-speed 802.11x WDOLS system for transferring data between the vehicle and the RFCS Server using Cisco equipment. The RFCS server will be a County device that interfaces to the ERG Clearinghouse.

1.C.2.2.2. Full Integration Mode (FIM)

The RFCS FIM architecture includes full integration with Level 1 functionality and will be implemented when Level 1 equipment is installed. The FIM implementation will include the following tasks:

- Move control of the DDU from the FTP to the VLU.
- Certify OBS modifications to the DDU described in Section **2.B.2.4.1, *RV12-Interface to DDU*** use case.
- Develop an interface between the FTP and the VLU to enable the real-time exchange of fare collection messages and to support new OBS functionality described in Section **2.B.2.4.1, *RV14-Interface to FTP*** use case.
- Move control of the WDOLS to enable implementation of an integrated wireless local area network (WLAN) managed by application software residing on the VLU. See Section **2.A.1.6.3, Wireless Local Area Network**.

1.C.3. Transit Radio System (TRS) Project

Radio communications are mission critical for KCM’s Operations, Vehicle Maintenance, Power and Facilities, Transit Safety and Transit Security Sections.

The TRS project will provide a life-cycle replacement of the existing 450/800 MHz radio system with a new 700 MHz system; support implementation of the new CCS; and ensure the continuity of operational communications during the replacement period. The 450 MHz radio system was installed in 1990–1992 and is due for replacement, both because of its age and because of new FCC regulations affecting spectrum use. If the radio system is not replaced in a timely manner, then users will start to experience interference and other operational problems due to new licensees on new narrow-band frequencies adjacent to the transit radio channels. Figure ***1.C.7.4, Level 2 & TRS Architecture***, describes the planned on-board architecture after implementation of CCS and the new radio system. Note that the RCU and MDU are eliminated and that their functions shall be relocated to the VLU.

Under a separate contract, King County Metro will be replacing its current radio system with a modern, wireless network offering voice and data communications. This network will include digital mobile radios and base stations capable of receiving and transmitting data streams over dedicated digital RF channels. In addition, voice communications will be supported on dedicated digital trunked RF channels.

1.C.4. Communications Center Relocation Project

A new KCM Communications Center facility is scheduled for construction and will house the new CCS and user consoles. Successful completion of the Communications Center Relocation Project is required before Level 2 Installation. The current Communications Center is described in Section **1.B.5, Legacy Radio/AVL Systems**. It is expected that both the current and the new Communications Centers will be in concurrent operation throughout the CCS implementation until all of the fleet has migrated to the new radio system.

1.C.5. OBS/CCS Level 1

The requirements for implementation of Level 1 functionality are described in Section 2 of this Statement of Work. The Project scope requires coordination and collaboration with the following projects, which are planned for implementation concurrently with Level 1. Figure ***1.C.7.3, Level 1 Architecture***, depicts the anticipated on-board architecture after Level 1 is completed.

The following table, 2006 Fleet Plan, summarizes the composition of the fleets planned for OBS implementation.

Table 1.C.5. 2006 Fleet and OBS Equipment Plan

					Fleet Size	Subsystems by Fleet Type		
	FLEET ID#	**MFG**	**YR in SVC**	**TYPE**	**2006**	**APC (33%)**	**AVM (66%)**	**Interior Signs**
KCM								
Actuals	3200	Gillig	1996-99	40' diesel	395	130	0	395
	3100	Gillig	1997	35' diesel	15	5	0	15
	1100	Gillig	1999-2000	30' diesel	95	31	95	95
	2300	New Flyer	1999-2000	60' diesel	273	90	273	546
	1200	Champion	2002	25' diesel	35	12	0	0
	4100	Gillig	2002	40' trolley	100	33	100	100
	3600	New Flyer	2003-2004	40' diesel	100	33	100	100
Planned	2600		2005	60' hybrid	213	70	213	426
	?		2005	60' diesel	30	10	30	60
	4200	Breda	2006 (rebuilt)	60' trolley	50	17	50	100
			KCM Subtotals		**1,306**	**431**	**861**	**1,837**
Sound Transit*								
Actuals	9000	Gillig	1999-2000	40' diesel	51	17	51	15
	9500	New Flyer	1999-2000	60' diesel	13	4	13	26
Planned	9600		2004-2005	60' hybrid	22	7	22	44
	?		2005	60' diesel	16	5	16	32
			ST Subtotals		**102**	**34**	**102**	**117**
			Total Vehicles and OBS Equipment		**1,408**	**459**	**947**	**1,922**

***** These vehicles are owned by Sound Transit (ST) and operated and maintained by KCM. All of the ST vehicles that are operated by KCM shall be provided with the same functionality and subsystems that will be installed onto the KCM fleet.

1.C.5.1. Interdependent Projects

The following two projects will be actively in design, testing, or implementation mode during some part of the OBS/CCS Project. These projects include the following specific integration/interface requirements with the OBS/CCS.

1.C.5.1.1. RFCS

The OBS/CCS Contractor will provide the OBS functionality and interfaces necessary to support the RFCS FIM implementation outlined above in Subsection **1.C.2.2.2**, including those steps needed to accomplish the following:

- Move control of the DDU from the FTP to the VLU.
- Develop and certify OBS modifications to the DDU as described in the Section **2.B.2.4.1, *RV12-Interface to DDU*** use case. DDU modifications should address the full OBS/CCS system requirements and should be implemented so that Level 1 functions are activated for Level 1, and Level 2 modifications can be activated later when a new radio is installed.
- Develop an interface between the FTP and the VLU to enable the real-time exchange of fare-collection messages and to support new OBS functionality described in Section **2.B.2.4.1, *RV14-Interface to FTP*** use case.
- Move control of the WDOLS to enable implementation of an integrated WLAN managed by application software residing on the VLU. See Section **2.A.1.6.3**.

1.C.5.1.2. Digital Video Recording Systems (DVRS) Project

The OBS/CCS Contractor shall coordinate changes to the WLAN to support DVRS wireless data requirements, if necessary.

1.C.5.2. Dependent Projects

Just as the RFCS project is expected to provide building blocks for the OBS project, Level 1 is responsible for providing an on-board infrastructure capable of supporting Level 2 functionality and the Transit Radio System (TRS) project.

1.C.6. OBS/CCS Level 2

Detailed requirements for implementation of Level 2 functionality are described in Section 3 of this Statement of Work. These include coordination and collaboration with both the TRS and Communications Center Relocation projects.

1.C.6.1. Level 2 Project Dependencies

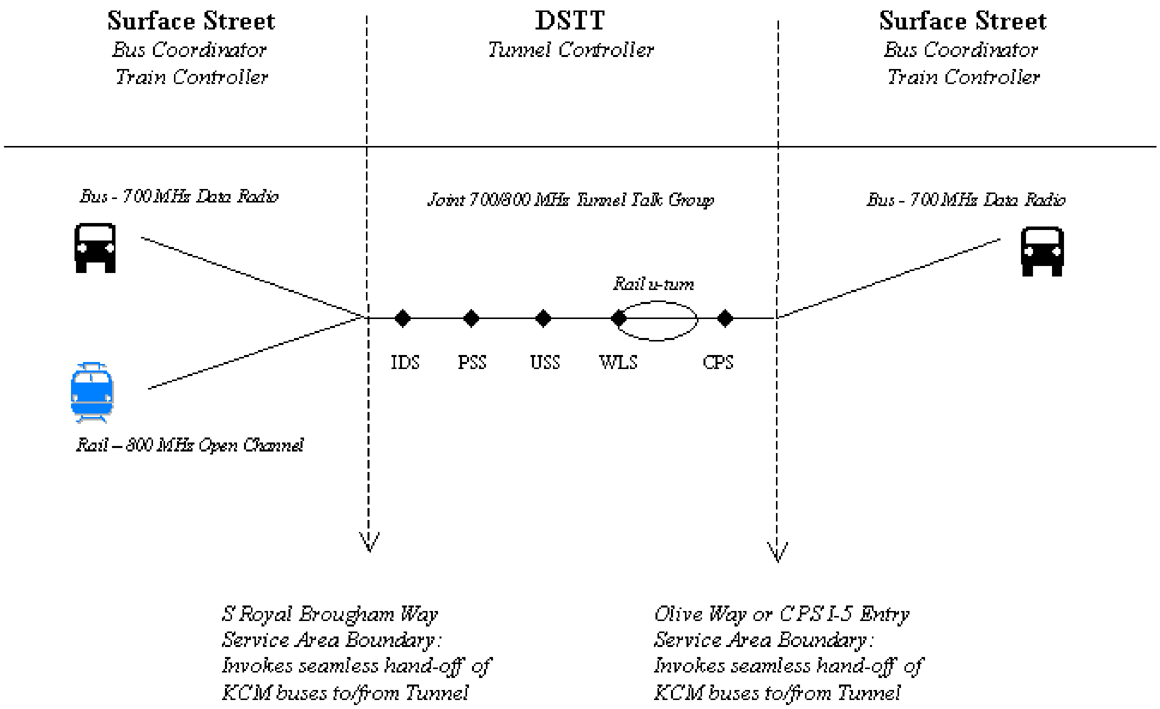
CCS design and implementation shall be done in parallel with the design and implementation of the new radio system to be provided by the TRS project. With the implementation of the CCS and new TRS, KCM’s AVL system will migrate from the current signpost-based AVL system to a decentralized GPS-based “smart bus” system, which was provided by the Level 1 implementation. The on-board hardware and software components critical to implementing CCS and the TRS include the following:

- **Vehicle Logic Unit (VLU):** Central on-board computer/server/network manager for data management and storage. The VLU must be capable of managing the TRS interface and supporting the real-time responses for AVL polling. Additionally, the VLU shall provide asynchronous processing to manage all of the peripheral components with queuing capability when multiple events occur simultaneously.
- **On-Board Automatic Vehicle Location (OB AVL):** Provides the capability to determine location and to monitor route and schedule adherence on board the revenue vehicle. This information will ultimately be relayed to the Communications Center via poll responses and messages to the new radio system.
- **Vehicle Area Network (VAN):** On-board network(s) to manage the transmission of data and messages among the integrated subsystems in such a way as to support the technical and functional requirements of this RFP.
- **DDU Upgrade** to add the required displays and messages for Level 2.

1.C.6.2. Joint Tunnel Operations

The Downtown Seattle Transit Tunnel (DSTT) will be shared by KCM-operated buses and Link light rail. There will be three separate service coordinators with distinct service area boundaries that will manage the transit modes operating through the DSTT: a train controller, tunnel controller, and bus coordinator. Figure ***1.C.6.2, Joint Tunnel Operations***, below, illustrates the service area boundaries within which each coordinator will operate and where the hand-off and return of responsibilities will occur. Each manager will have the ability to at least listen to channel operations outside of their boundaries and, when notification of a service issue is necessary, speak with another service area's manager.

Figure 1.C.6.2. Joint Tunnel Operations



The DSTT will operate on Sound Transit's 800 MHz radio system and Link light rail will operate using the open channel communications typical of rail operations. KCM-operated buses will operate on KCM's 700 MHz radio system and will use data radio communications (see use case ***RV17-Interface to 700 MHz Radio*** for details.) Upon entering the DSTT service area, KCM coaches will automatically switch from data radio communications to sharing open channel communications with Link light rail using the Joint 700/800 Tunnel Talk Group under the coordination of the Tunnel Controller. The OBS/CCS vendor will be responsible for designing an automatic switching method for KCM buses. The design will include a real-time display on the DDU notifying Operators that the switch has occurred. KCM operated buses and Link light rail will share the open channel communications while in the DSTT, each accessing the shared channel from their respective frequencies, 700 MHz and 800 MHz.

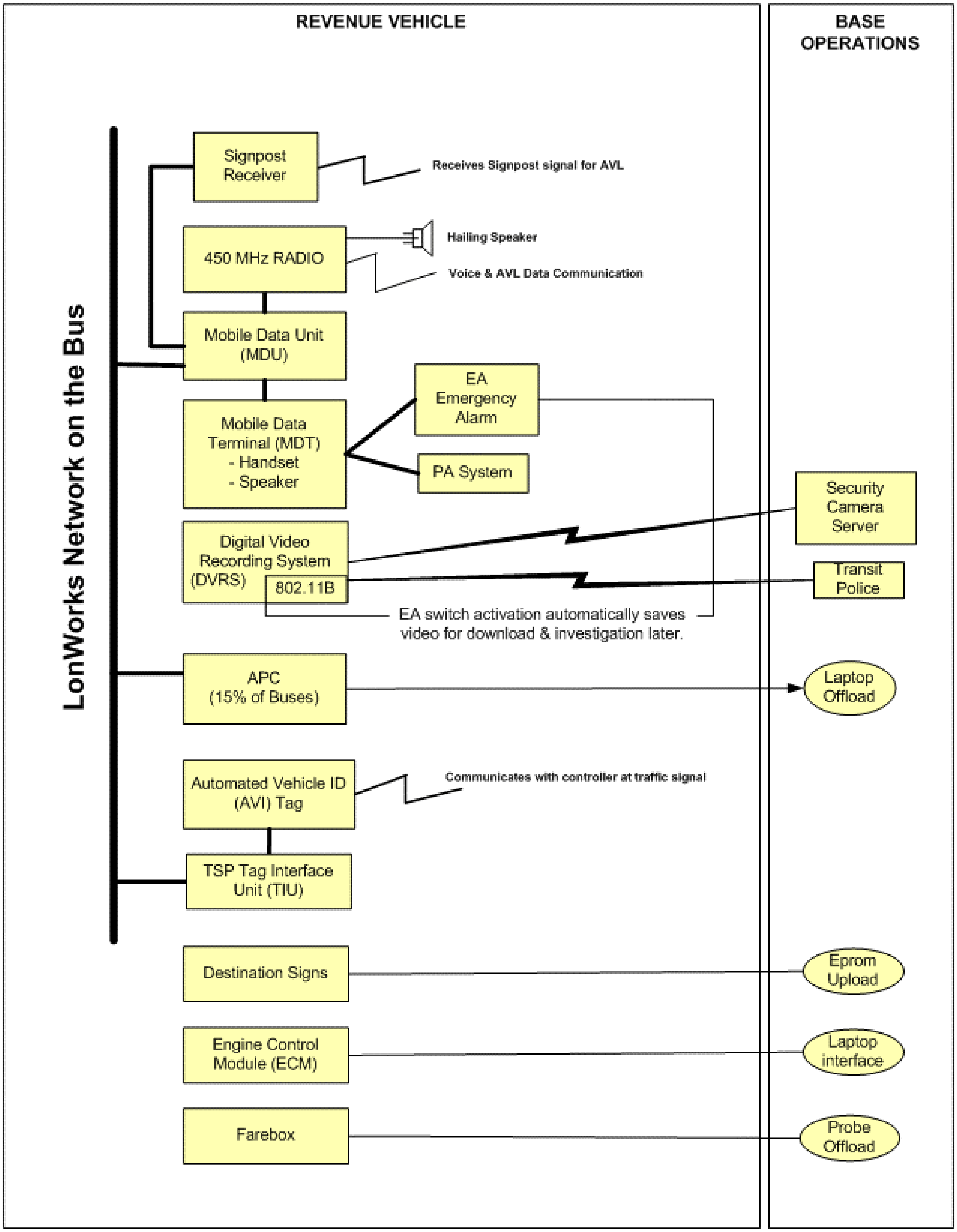
1.C.7. Evolving On-Board Architecture

These four figures are provided to depict the changes resulting from the implementation of each of the major projects that will affect the on-board architecture.

1.C.7.1. 2004 On-Board Architecture

Figure ***1.C.7.1.*** depicts the current architecture of the revenue vehicles in the KCM fleet. Every KCS vehicle has the same architecture except for APC and Security Camera systems, which are installed on a fraction of the fleet.

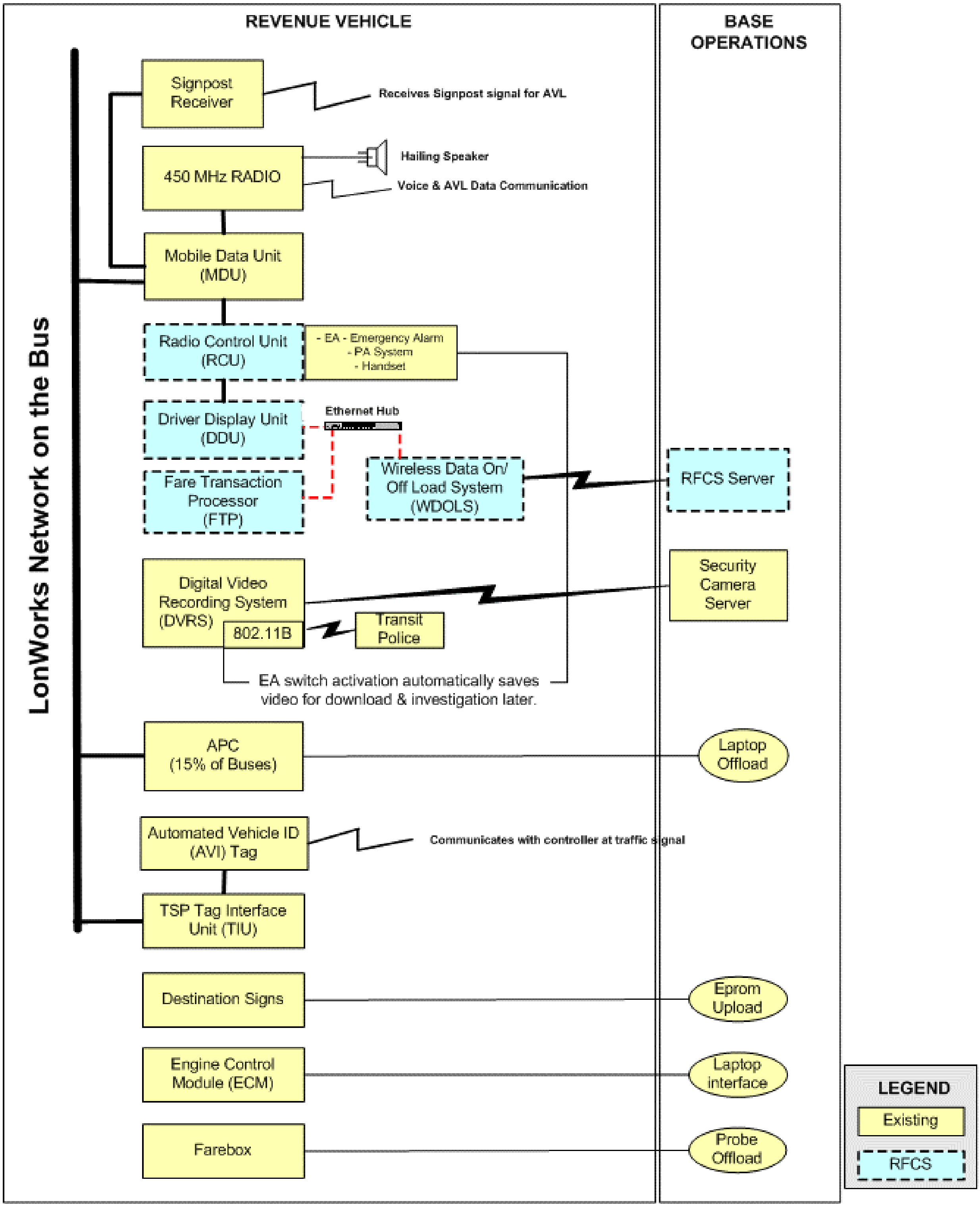
Figure 1.C.7.1. 2004 On-Board Architecture



1.C.7.2. RFCS LIM Architecture

Figure ***1.C.7.2.*** depicts the RFCS architecture for Limited Integration Mode (LIM) implementation which is to occur prior to Level 1.

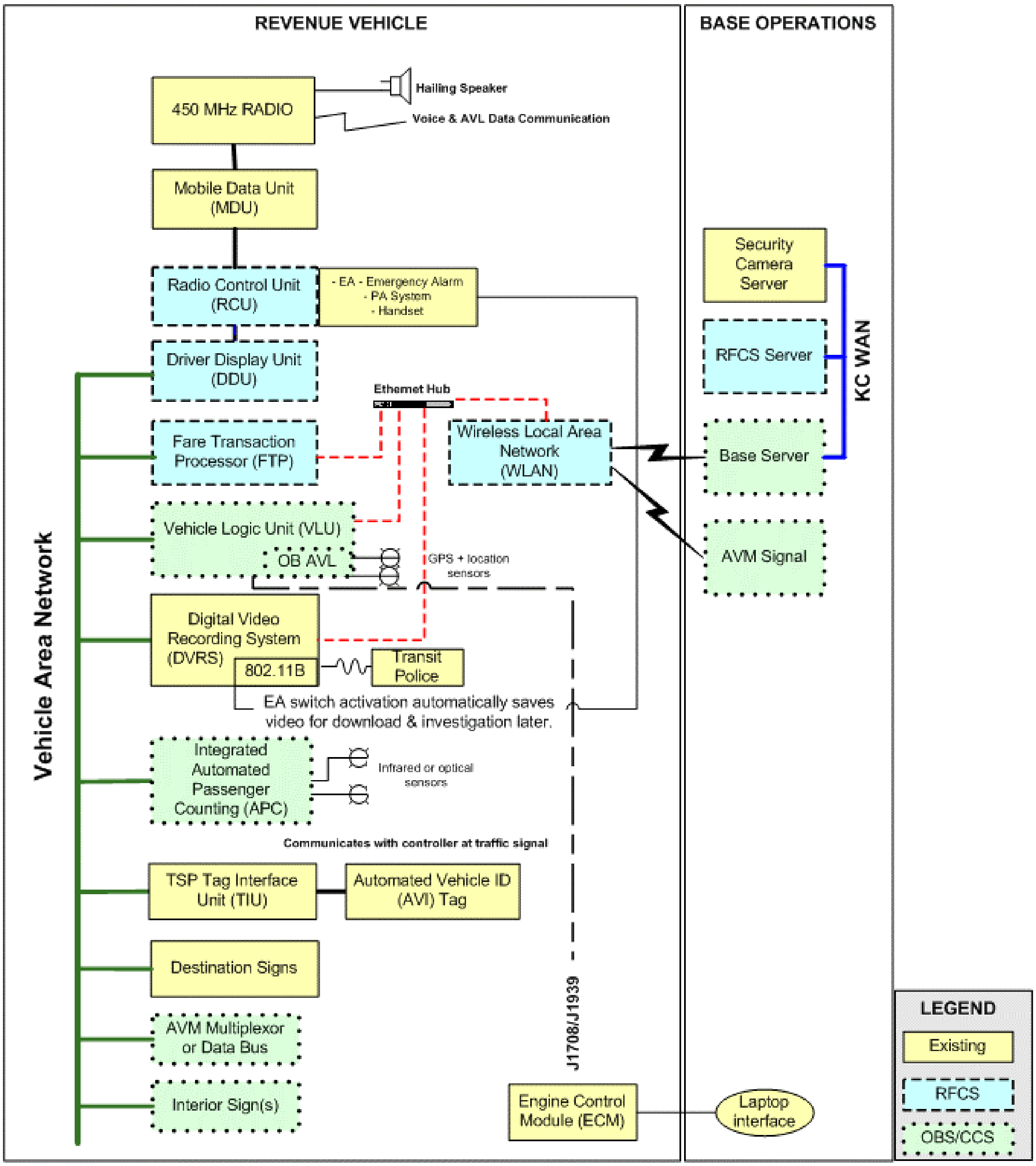
Figure 1.C.7.2. RFCS LIM Architecture



1.C.7.3. Level 1 Architecture

Figure ***1.C.7.3***. depicts the architecture for Level 1 which includes installing OBS equipment and reconfiguring the RFCS-provided equipment for implementation of the RFCS Full Integration Mode (FIM).

Figure 1.C.7.3. Level 1 Architecture



1.C.7.4. Level 2 and TRS Architecture

Figure ***1.C.7.4.*** depicts the architecture for the Level 2 and TRS project implementation which will include removing the old radio, MDU and RCU; installing a new radio, and connecting the new radio to the VLU.

Figure 1.C.7.4. Level 2 & TRS Architecture