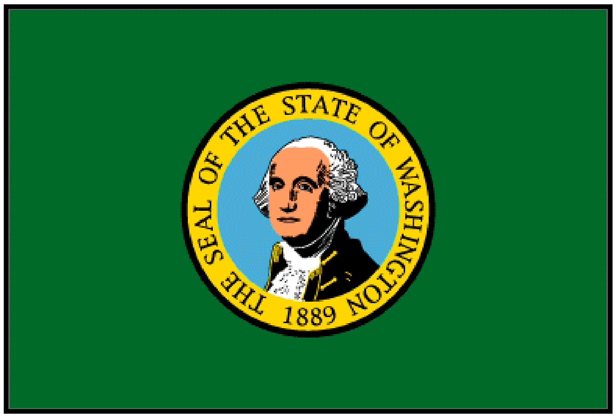

Computer-Aided Dispatch - Traffic Management Center Field Operational Test Final Evaluation Plan:

WSDOT Deployment

Contract #: DTFH61-02-C-00061
ITS Program Assessment Support Contract
Task SA61004

Submitted to:

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1.0 Introduction

Reducing traffic related fatalities and improving emergency response capabilities are two primary goals of the U.S. Department of Transportation's (USDOT's) Intelligent Transportation Systems (ITS) Public Safety Program. To help achieve these goals, the ITS Public Safety Program is committed to:

- Improving incident detection and notification.
- Reducing emergency response times.
- Improving information flows between emergency response agencies (real-time wireless communications links, integration of systems).[1]

The current Federal Highway Administration (FHWA) funded Computer-Aided Dispatch Traffic Management Center (CAD-TMC) integration and data exchange Field Operational Test (FOT), is one of many initiatives intended to meet the program goals. Most major metropolitan areas in the United States rely on some type of advanced traffic management system(s) (ATMS) to help manage mobility, congestion, and incident response. Many states have installed an extensive infrastructure of remote cameras, loop detectors, and other ITS applications that provide traffic management services. These systems are operated from centralized TMCs, where traffic-related information is received and processed and appropriate remedial actions are deployed and coordinated. However, to date, many of these systems are not integrated with the CAD systems used by public safety and law enforcement agencies.[2]

To demonstrate how the integration of CAD and TMC systems can improve incident response capabilities and how institutional barriers can be overcome, the USDOT is sponsoring two FOTs that will integrate CAD-TMC systems in Washington State, and Utah, respectively. As stated in the Request for Proposals (RFP) for the CAD-TMC Integration FOT evaluation:

> Transportation, law enforcement, fire, and emergency medical personnel are discovering significant improvements in public safety operations can be made when information is shared across organizations and jurisdictions. Equipment and personnel can be more efficiently deployed, incidents can be cleared faster, and incident scenes can be made safer for the responders and the traveling public.
>
> To date there has been little effort to integrate highway traffic management with public safety systems. Nor have systems supporting public safety operations been developed in the context of a regional ITS architecture or ITS standards. Most existing CAD systems are proprietary and not equipped to easily share information with systems with dissimilar interfaces. Further complicating integration are various data, message formats and standards used by public safety

[1] Adapted from http://www.itspublicsafety.net/index.htm.
[2] FHWA ITS Public Safety Program brochure, "DOT Projects in Utah, Washington State Will Demonstrate Public Safety, Transportation Integration System."

> agencies and transportation agencies. Nevertheless, CAD and ATMS systems can be integrated and data can be shared, provided that a number of related institutional and technical challenges are addressed. New procedures and methods of response that capitalize on the availability of the shared information must also be developed.[3]

This document presents the Evaluation Team's plan for conducting the evaluation of the FOT in Washington State. A companion document exists for the evaluation of the Utah deployment. Each Evaluation Plan includes the experimental design for testing hypotheses at one of the FOT sites. Each plan also includes a detailed discussion of goals and objectives; a work break down structure (WBS); description of the evaluation management structure and schedule; and high-level outlines of deliverables' content. The Evaluation Plans also contains a discussion of the target audiences for the report and includes a proposed report distribution list. The remaining sections of the WSDOT Evaluation Plan address the particular issues identified in the RFP:

- **Section 2: Project Overview**. This section includes a description of: all relevant WSDOT and WSDOT systems included in the FOT: operational roles and responsibilities of each participant in the FOT, and; proposed project plans and activities.
- **Section 3: Goals and Objectives of the FOT and the Evaluation.** This section discusses the goals and objectives for the FOT, as identified by the State, and the evaluation goals and objectives identified by the Evaluation Team, including:
  - System Performance Study – Did the system perform as expected?
  - System Impact Study – How did the FOT help improve incident response capabilities at the state level and between state agencies and local, county, and municipal agencies?
  - Traveler Information – Was the additional information provided to the traveling public and the news media through Washington State's DOT's (WSDOT) Web page, 511 system beneficial?
  - Institutional and Technical Issues – what were these and how were they resolved?
  - Lessons Learned – what were these and how are they useful?
  - Benefits Summary – quantitative and qualitative benefits.

- **Section 4: Evaluation Approach.** This section includes the high-level outlines of the contents of each test plan deliverables, and an overall summary of evaluation approach, including:
  - The identification of the individual test plans to be developed.

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[3] FHWA solicitation: "National Evaluation of the Computer-Aided Dispatch (CAD) – Traffic Management Center (TMC) Integration Field Operational Test Request for Proposals," March 7, 2003, page 1.

- The level of effort allocated for carrying out each of the individual test plans.
- The Work Breakdown Structure (WBS).

- **Section 5: Detailed Test Plans – Outline and Level of Effort.** This section includes descriptions of the specific test plan outlines, level of effort, institutional challenges and technical issues to be addressed in each FOT.
- **Section 6: Evaluation Management Structure.** This section includes a description of the evaluation management structure.
- **Section 7: Schedule and Milestones.** This section includes a summary of the evaluation schedule, including milestones for data collection, evaluations, and deliverables, and the data management approach. This section also includes a high-level outline of the final report and the evaluation findings briefing. The discussion of the target audiences for the report and includes a proposed report distribution list is also included in this section of the report.

2.0 Project Overview

2.1 Background

The primary emergency response agency for State roadways in Washington is the Washington State Patrol (WSP). Emergency cellular 911 calls are received at the WSP dispatch center and in-field troopers regularly report progress as they respond to crashes and events in the field. As a result, the WSP dispatch center is quite regularly the primary source of information about events that impact the Washington State roadway system. For this reason, the Washington State Department of Transportation (WSDOT) maintains close communication with WSP dispatchers to understand what accidents and events are happening on the roadway system.

However, this relay of information from WSP to WSDOT is either performed verbally using either radio or telephone reports, or by the transfer of data to a read-only WSP CAD located in the WSDOT Traffic Systems Management Center that is separate from any CAD system used by WSDOT. It is easily understood that during emergency events, this communication link can be a significant demand on time and resources.

Consequently, in a recent internal performance study conducted by WSDOT, the results showed that while the number of times information is relayed from WSP to WSDOT is high, there are still a large number of crashes and events that are reported to WSP that are not relayed to WSDOT.[4] This study further revealed that a number of these events could have allowed WSDOT to assist in the response to the event and disseminate information via the existing traveler information system.

To address this situation, WSDOT and WSP have embarked on a program of integrating the two agencies in a more systematic fashion. In particular, automated links will be created between the WSP's new CAD system and the WSDOT's Condition Acquisition and Reporting System (CARS).

The WSP has installed a state-of-the-art computer-aided dispatch (CAD) system for its dispatchers statewide, bringing all dispatchers to a common platform. The selected CAD platform is capable of outputting information and data using a Universal Data Transfer.

Similarly, WSDOT operates a statewide Condition Acquisition and Reporting System (CARS) to record accident, construction, traffic, and road condition events. WSDOT dispatchers view CARS to assist in roadway response. CARS also supplies a portion of the traveler information content to WSDOT's 511 system and Internet pages. CARS is based wholly on ITS standards

[4] Adapted from: Legg, Bill, WSDOT, "APPLICATION FOR RFA Number DTFH61-02-X-00062, Computer-Aided Dispatch (CAD) – Traffic Management Center Integration Field Operational Test (FOT)."

and exchanges data using Extensible Mark-Up Language (XML). WSDOT operations include five Traffic Management Centers (TMCs), which cover all state roads across the state.

Transportation officials within Washington State have already made significant progress in establishing a well coordinated and cooperative working relationship between WSDOT and the Washington State Police (WSP). The two agencies established a Joint Operations Policy Statement (JOPS) that states the two agencies would share data. The two agencies hold an annual senior management retreat and have monthly regional coordination meetings[5]. WSP and WSDOT share space and provide access to each other's systems on a read only basis.[6] To this end, this data integration project represents the logical next step in expanding the working relationship between the two agencies, as well as with local, municipal, and county government agencies.

2.2 Project Agencies

The agencies, vendors, and consultants involved with the project are shown in Table 2-1.

Table 2-1. Project Participants

Agency/Vendor/Consultants	Project Role
WSDOT	Lead contracting agency. Overall project management. TMC – Traveler Information operations.
WSP	Lead emergency response agency. CAD system operators. Emergency response to events.
Skagit County Emergency Medical Services (EMS)	Emergency medical transport for all vehicular accidents in Skagit County. Test improved information to dispatchers
Castle Rock Consultants	Documentation of functional system requirements. Development of code for transmission of data. Systems integration for CAD to TMC data exchange. User training, outreach, and education. Review of potential transfer to other states.
Printrak, A Motorola Company	Public safety CAD vendor. Cooperation on understanding output parameters.

[5] For example, most TMCs outside the Seattle area are housed in WSP offices.
[6] WSP placed a CAD remote data terminalin selected TMCs around the State. Although these CADs are used by WSDOT staff to obtain information on events, the staff cannot modify the data. In addition, WSDOT has placed a fully functional work station at the WSP Bellevue office.

Created by the Washington State legislature in 1977, WSDOT is responsible for managing most of the State's transportation infrastructure, including approximately 73,000 centerline miles of state and local roadways and 3,000 bridges and tunnels.[7] WSDOT operates throughout the entire State of Washington, and covers six operating regions: Northwest Region; North Central Region; Eastern Region; Southwest Region; South Central Region; and the Olympic Region.

WSDOT currently operates six TMCs in the following locations: Tacoma (Olympic Region); Seattle (Northwest Region, including Everett, and has some coverage of most of the state for back-up or emergency purposes); Vancouver, Washington (Southwest Region); Spokane, Washington (Eastern Region); and Yakima (supports North Central and South Central Regions). One additional TMC is being added in Bellingham, Washington (to support traffic management in that portion of the Northwest Region and international border crossing operations).

Each WSDOT TMC offers traffic management services 24 hours per day, 7 days per week (24/7). Typically, there are seven radio operators on duty across the state during business hours. Incident response is handled by the WSDOT Incident Response Group that typically handles approximately 4,500 incidents per year. Four of the six regions have formal incident response plans in place.

The WSP is an accredited law enforcement agency that operates throughout the entire State of Washington, covered by eight operating districts: District 1 – Tacoma; District 2 – Bellevue; District 3 – Union Gap; District 4 – Spokane; District 5 – Vancouver; District 6 – Wenatchee; District 7 – Marysville; and District 8 – Bremerton. Each district has several detachments to serve localities within the appropriate district, with approximately 38 detachments operating throughout the State.[8]

The WSP is organized into seven bureaus, which administer the activities of nearly 1,000 commissioned officers and more than 1,000 non-commissioned personnel: Field Operations, Fire Protection, Forensic Laboratory Services, Investigative Services, Management Services, Technical Services, and Office of the Chief.[9]

The Communications Division of the WSP Technical Services Bureau operates a 24/7 statewide emergency communications system that includes eight centers statewide. The division provides emergency dispatch services for mobile units of the Washington State Patrol; Department of Fish and Wildlife; Liquor Control Board; Department of Transportation; State Parks, and other state and federal agencies.[10]

The Communications Division performs the following duties:

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[7] Adapted from: Legg, Bill, WSDOT, "APPLICATION FOR RFA Number DTFH61-02-X-00062, Computer-Aided Dispatch (CAD) – Traffic Management Center Integration Field Operational Test (FOT)."
[8] Adapted from: Legg, Bill, WSDOT, "APPLICATION FOR RFA Number DTFH61-02-X-00062, Computer-Aided Dispatch (CAD) – Traffic Management Center Integration Field Operational Test (FOT)."
[8] Adapted from: Legg, Bill, WSDOT, "APPLICATION FOR RFA Number DTFH61-02-X-00062, Computer-Aided Dispatch (CAD) – Traffic Management Center Integration Field Operational Test (FOT)."
[10] Adapted from: Legg, Bill, WSDOT, "APPLICATION FOR RFA Number DTFH61-02-X-00062, Computer-Aided Dispatch (CAD) – Traffic Management Center Integration Field Operational Test (FOT)."

- Receives, relays, and dispatches emergency calls for service.
- Dispatches services provided to line troopers and other State agencies.
- Provides assistance to the public via telephone or in person.
- Answers Emergency 911 calls.
- Utilizes CAD.
- Works with other law enforcement agencies and communications centers.

In 2000, WSP provided motorist assistance to 447,206 motorists, and investigated 41,804 vehicle collisions statewide.[11]

2.3 Existing CAD Systems

The WSP is actively purchasing and installing a new CAD system to replace its existing system. The new CAD system, which is nearly operational (July 2003), will allow minor changes to be made to accommodate this exchange of information. The Evaluation Team views the benefits of this timing as follows:

- FHWA can leverage the financial commitment of the WSP and, therefore, no project funds will be spent on the CAD system implementation.
- Because this project intends to work with the universal data transfer from the newly implemented CAD system and interface via recognized ITS standards with no expected modifications or special setups within the CAD system, the benefits and results of this test should be transferable to most any other state operating a CAD system with ITS standards-compliant TMC equipment.
- Because the purchase and installation of the new CAD system is a high priority project for WSP, this project implementation will occur under a rapid rollout timeframe. Effectively, upon project initiation, all key components requiring integration will be in place, and the Evaluation Team can leverage the training and fine tuning being performed on the WSP CAD system.

WSDOT staff operates the CARS to enter and view accidents, construction, and major events. CARS currently provides real-time reporting on five Interstates, six U.S. Highways, and 29 State Highways throughout the State. WSDOT plans to use CARS to disseminate information on all incidents affecting travel statewide via the 511 Traveler Information System.

WSDOT also operates the following systems that will be included in the FOT:

- **ATMS.** The WSDOT Advanced Traffic Management Systems collect information from a wide variety of networked field equipment, including over 200 CCTV cameras, ramp meters,

[11] Adapted from: Legg, Bill, WSDOT, "APPLICATION FOR RFA Number DTFH61-02-X-00062, Computer-Aided Dispatch (CAD) – Traffic Management Center Integration Field Operational Test (FOT)."

traffic detectors, Variable Message Signs, and Road Weather Information Systems (RWIS)/ESS station.

- **511.** WSDOT also operates the state's 511 Traveler Information System to supply statewide travelers with accurate real-time information while en route.
- **Geographic Information Systems (GIS).** GIS is used by several agencies to display real-time information more efficiently and effectively. By using GIS, information can be plotted and understood by personnel in the field more easily and quickly through geographic display.

2.4 FOT Summary

The system integration and data exchanges within this project are summarized as three main components, defined as follows:

Component #1 – PRIMARY ALERT

PRIMARY ALERT will serve as the main connection between the WSP CAD system and the WSDOT TMC. This component will filter the CAD data and transfer those portions suited for receipt and use by the TMC. The key aspects of *PRIMARY ALERT* are as follows:

- Only specified fields will be transferred form the WSP CAD system into the TMC system. Although there is a tremendous amount of data generated by the CAD system, only a small portion of that data is of interest to WSDOT, and similarly, only a portion could be shared with other public agencies.
- The exchange of information between agencies will be seamless and automatic, e.g., not requiring the operators to re-enter data in a different format or perform any intermediate tasks to exchange data. Any data translations will be accomplished using automated software code that performs required translations without user intervention.

Component #2 – RESPONSE SUPPORT

The intent of the *RESPONSE SUPPORT* component is to transfer any available information from WSDOT to the WSP that would support response efforts of the State Patrol. Unlike *PRIMARY ALERT,* this information transfer will consist of information about other external events near the incident.

For example: In the event that a crash is reported to WSP on I-5 just north of Tacoma, the *PRIMARY ALERT* component will transfer information from WSP to WSDOT. *RESPONSE SUPPORT* will query the TMC database and return information to WSP about nearby events, such as slow traffic, construction, accidents, or other extreme events (i.e., pass closures, flooding, National Weather Service warnings, etc.) that might impede the patrol officer's response.

Component #3 – SECONDARY ALERT

The third component is *SECONDARY ALERT* , which is intended to reach those event responders beyond the WSP and WSDOT jurisdictions, including local EMS providers, tow truck dispatchers, and local utility companies. The general philosophy of *SECONDARY ALERT* is as follows:

> To provide as comprehensive and complete information in the most useful fashion to secondary responders across the entire State of Washington, recognizing that the dispatch systems of these secondary responders vary widely in complexity.[12]

At least one EMS provider (Skagit County EMS) will serve as a demonstration for the transfer of information to the CAD system of a non-WSP responder. In this regard, *SECONDARY ALERT* will function very similar to *PRIMARY ALERT*, in that event descriptions will be filtered to allow limited descriptions as needed to describe an event from one CAD system to another.

Each component identified will be based on the following principles:

- Information exchange will be facilitated by using the latest ITS and Internet industry standards using open hardware and software platforms, allowing both primary and secondary responding agencies to exchange information as agreed upon.
- The system will rely on institutional agreements (Memorandums of Understanding [MOUs]) on information to be exchanged based on each agency's own operating requirements and needs.
- The integration of CAD systems will use off-the-shelf technology and standard data exchange mechanisms.
- The vocabulary used for the exchange of incident management and traffic management information will be based on industry-approved standards for data elements and messaging, specifically, Message Sets for External Traffic Management Center to Center (MSETMC2C) and IEEE 1512.
- The system will provide information security and privacy using standard Internet encryption mechanisms (at a 56-bit level or higher).
- Location-specific information will use location-referencing standards and coordinate normalization to allow different mapping systems to utilize and display incident information.
- Turbo Architecture may be used to define specific data flows between participating agencies (on a project basis) and to ensure compatibility with the National ITS Architecture.
- The system will be designed to allow easy testing and evaluation by an independent third party.
- The system will be designed to allow open expansion to include additional participating agencies as required in the future, if practical. The FOT will test the feasibility of including additional participating agencies.

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[12] Adapted from: Legg, Bill, WSDOT, "APPLICATION FOR RFA Number DTFH61-02-X-00062, Computer-Aided Dispatch (CAD) – Traffic Management Center Integration Field Operational Test (FOT)."

- The system will be designed to minimize communication latencies in order to provide information exchanges in a timely manner. Participating agencies will be consulted in order to establish communications performance requirements.
- The system will allow communications from CAD-to-TMC and TMC-to-CAD and will be tested to include information exchange with secondary agencies.

The proposed system architecture for the CAD-TMC FOT integration is shown in Figure 2-1.[13]

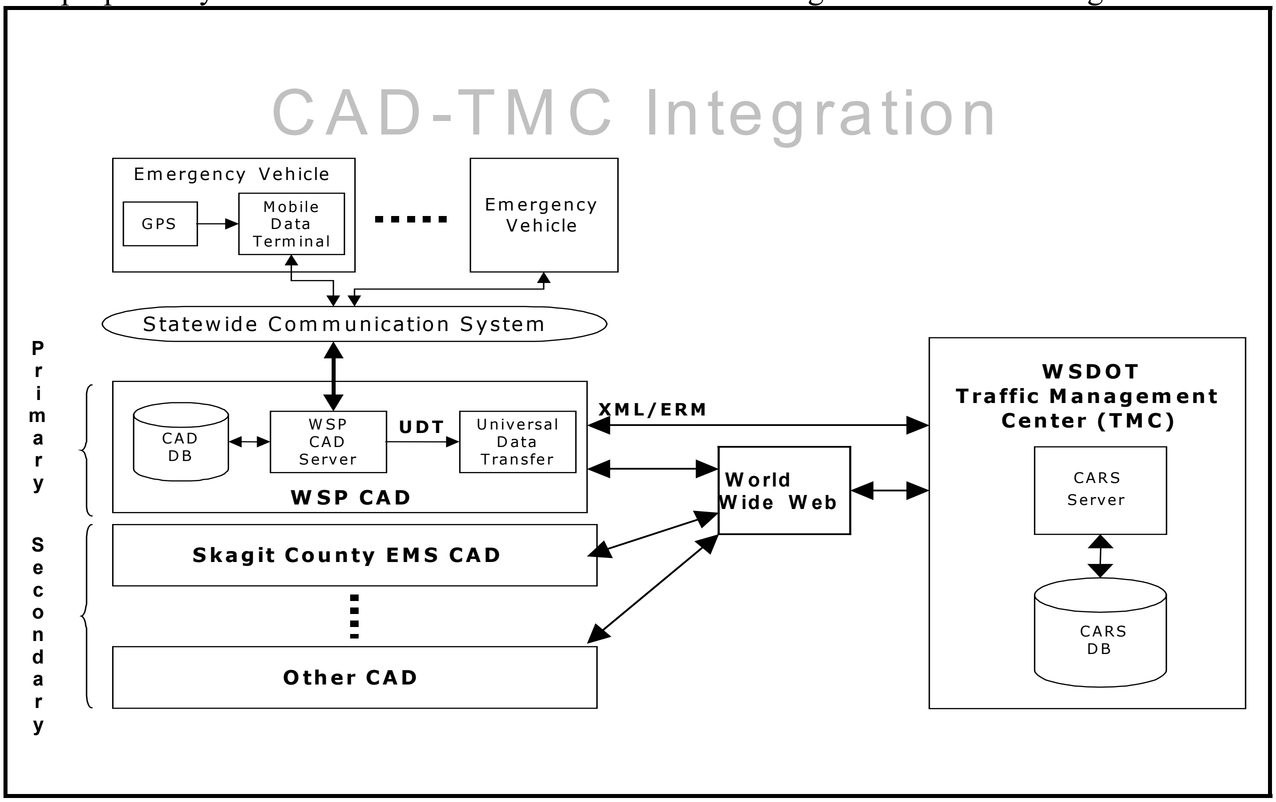

Figure 2-1. Proposed System Architecture

[13] Adapted from: Legg, Bill, WSDOT, "APPLICATION FOR RFA Number DTFH61-02-X-00062, Computer-Aided Dispatch (CAD) – Traffic Management Center Integration Field Operational Test (FOT).", p. 16

3.0 FOT and Evaluation Goals and Objectives

3.1 Overview

The RFP for the CAD-TMC FOT evaluation states that:

> As part of the Evaluation Planning activities, it is critical that the contractor collaborate with WSDOT and UDOT to ensure evaluation needs are accommodated by the FOT. Collaboration will help to identify FOT benefits and challenges that are not quantifiable and assist in sharing lessons and approaches between the two sites. Collaboration provides the contractor the opportunity to coordinate with the FOT teams on challenges that may arise including:
>
> - Ability to collect, archive, and provide operational data needed
> - FOT teams desired evaluation topics not initially identified by the contractor,
> - FOT teams approach to implementing applicable standards such as IEEE and NTCIP,
> - Access to operational personnel and facilities; and schedule information; and
> - Address concerns identified during these reviews.[14]

The Evaluation Team recognizes that meeting these requirements is essential to ensuring a successful evaluation and has worked to develop evaluation goals and objectives that:

- Meet the stated evaluation needs of FHWA and the States of Utah and Washington.
- Enable the Evaluation Team to assess both quantitative and qualitative impacts.
- Rely on sources of data currently available for establishing the "before project" baseline and measuring the "after project" impact.
- Enable a "realistic" assessment of impacts, that is, assess impacts and benefits that are directly tied to the results of the FOT and do not overstate or understate the results.
- Are "flexible" in nature so that issues such as changes in the project schedule or availability of additional data do not require redefining significantly revising the evaluation.

The goals and objectives for this evaluation were developed using an iterative approach involving extensive review by FHWA and the states. First, the Evaluation Team reviewed all available project documentation, including the application submitted to FHWA by each state in response to FHWA's Request for Applications distributed on May 16, 2002. Based on this review, the Evaluation Team presented high-level goals and objectives in its proposal submitted in response to FHWA's March 7, 2003 RFP. These proposed goals and objectives were reviewed with the FHWA COTR and the Mitretek analyst on May 6, 2003, and then again during a June 2,

[14] FHWA solicitation: "National Evaluation of the Computer-Aided Dispatch (CAD) – Traffic Management Center (TMC) Integration Field Operational Test Request for Proposals" March 7, 2003, page 4.

2003 kick-off meeting with Washington State. The proposed goals and objectives were revised based on these meetings, and presented to the FHWA COTR and the Mitretek analyst on June 16, 2003, and to Washington State during an evaluation strategy briefing conducted on June 26, 2003. The final evaluation and objectives presented in this plan reflect the input obtained from FHWA and the two states throughout this process.

The remainder of this section of the Evaluation Plan is structured as follows:

- 3.2 – A summary of the Evaluation Team's understanding of FHWA's goals and objectives for the FOT.
- 3.3 – A summary of the Evaluation Team's understanding of Washington State's goals and objectives.
- 3.4 – The goals and objectives developed for the evaluation based on the Evaluation Team's review of project documents and feedback obtained from FHWA and Washington State.
- 3.5 – A comparison of the goals and objectives established by the Evaluation Team with those established by FHWA and Washington for the FOT, with the intent of demonstrating how the evaluation goals and objectives track to the FOT goals and objectives.

3.2 FHWA Goals and Objectives

The Evaluation Team used the following high-level FHWA-established FOT goals and objectives as the starting point for developing goals and objectives for the evaluation:

- The FOT will demonstrate the feasibility of automating the seamless transfer of information between traffic management workstations and police, fire and EMS CAD systems from different vendors.
- The FOT will incorporate ITS standards such as IEEE 1512 and NTCIP into the integration of public safety and transportation information systems. Other standards areas that will have to be addressed are those pertaining to geographic information systems (GIS).
- The FOT will extend the level of integration to include secondary responders such as utilities; towing and recovery; public works; and highway maintenance personnel.

FHWA has also identified a number of specific quantitative goals and objectives to be assessed during the evaluation, in particular, to:

- Determine how the FOT enhances communications among responders.
- Assess the extent to which the FOT enhances efficiency in documenting incidents.
- Determine how the FOT enhances on-scene operations.
- Measure the extent to which the FOT reduces incident clearance times.

FHWA has also specified that the final evaluation report include an assessment of institutional and technical challenges, and a summary of lessons learned and benefits, both qualitative and quantitative. This final evaluation report will draw upon the lessons from both Washington State and the parallel deployment in Utah.

3.3 Washington State Goals and Objectives

The high-level goals established for the FOT by the State of Washington include:

- To demonstrate that open communication between the law enforcement and transportation agencies can improve emergency response and traveler information distribution. This open communication involves state agencies and county, municipal, and local government agencies.
- To demonstrate how this information exchange can be done without placing additional burdens on the already busy emergency response and radio dispatch staffs.[15]

The State also adopted the high-level goals and objectives for the FOT established by FHWA described previously – automating the seamless exchange of data, using the appropriate ITS standards, and integrating local, municipal and county level emergency responders.

During the course of the June 26, 2003 evaluation strategy briefing, the Evaluation Team proposed a series of questions to Washington State designed to obtain additional insight into the State's view of more specific goals, objectives, and impacts that will be realized through the FOT. These questions, and the State's responses, are presented in summary form in Table 3-1.

Table 3-1. Washington State-Expected FOT Benefits

Evaluation Team Questions	State Response
Why is the FOT being implemented?	The primary reason the FOT is being implemented is to enable the electronic exchange of data between agencies on a near-real time basis.
What is the defining "need"?	Automated electronic data exchange between WSDOT and WSP.
What are the expected project impacts? • Safety • Mobility • Traveler Information • Institutional Challenges • What Else?	Expected project impacts include: Further break down of institutional barriers between the two agencies. Reduce the time needed to deploy assets to respond to an incident. Reduce exposure of response personnel. Reduce secondary collisions resulting from the

[15] FHWA ITS Public Safety Program brochure "DOT Projects in Utah, Washington State Will Demonstrate Public Safety, Transportation Integration System."

Evaluation Team Questions	State Response
	initial incident. Reduce the time needed to post incident related information on the State's traveler information systems (web, 511) as well as provide information to the media. Improve the quality of information provided to the media and traveling public. Integrate local, county, and municipal government emergency management and response agencies (fire and rescue, law enforcement).
What is Washington's Measure of Success?	The long-term measure of success for the FOT would be to reach the point where the two agencies actually share data on a near real time basis.

3.4 Evaluation Goals and Objectives

The evaluation goals and objectives established for the Washington State CAD-TMC FOT are presented in Table 3-2.

Table 3-2. Evaluation Goals and Objectives

Evaluation Goal	Evaluation Objectives
Assess System Component Performance	Determine the feasibility of automating the seamless transfer of information, between traffic management workstations and police, fire, and EMS CAD systems from different vendors. Investigate the benefits of incorporating ITS standards such as IEEE 1512 and NTCIP into the integration of public safety and transportation information systems. Also, address standards related to Geographic Information Systems (GIS) and sharing data between map databases from different vendors. Determine the benefits of extending the level of integration to include secondary responders such as utilities, towing and recovery, public works, and highway maintenance personnel.
Assess System Impact	Determine whether CAD-TMC integration improves: • Productivity and efficiency. • mobility. • safety. • integration with 511/Internet interface.

Evaluation Goal	Evaluation Objectives
Assess Institutional Challenges and Technical Issues	Identify institutional challenges and technical challenges and document how they were resolved.
Identify Lessons Learned	Prepare Lessons Learned Summary. Identify institutional challenges and technical issues and document how they were resolved.
Summarize Benefits	Develop Benefits Summary.

3.5 Combined Evaluation Goals and Objectives

Table 3-3 presents a comparison of the goals and objectives established by FHWA, Washington State, and the Evaluation Team. The intent of this comparison is to demonstrate how evaluation activities will track directly to state project activities while also conducting the assessment requirements of FHWA's National Evaluation Program. As can be seen, the goals and objectives developed for the Evaluation Plan are derived from both the FHWA and State goals and objectives, which in turn helps ensure that the evaluation correctly reflects stakeholder interests.

Table 3-3. Combined Evaluation Goals

FHWA	Washington State	Evaluation Plan
The FOT will automate the seamless transfer of information between traffic management workstations and police, fire and EMS CAD systems from different vendors.	To enable the electronic exchange of data between agencies on a near-real time basis. This electronic data exchange will address the one outstanding need that still exists between WSDOT and WSP.	Document System Component Performance
The FOT will incorporate ITS standards such as IEEE 1512 and NTCIP into the integration of public safety and transportation information systems. Other standards areas that will have to be addressed are those pertaining to Geographic Information Systems (GIS).	The State has committed to using ITS standards and develop a system that conforms to the National ITS Architecture.	Document System Component Performance
The FOT will extend the level of integration to include secondary responders such as utilities, towing and recovery, public works and highway maintenance personnel.	Integrate local, county, and municipal government emergency management and response agencies (fire and rescue, law enforcement).	Document System Component Performance

FHWA	Washington State	Evaluation Plan
System Impact: • Computer requirements. • FOT enhances commun-ications among responders. • FOT enhances efficiency in documenting incidents. • FOT enhances on-scene operations. • FOT reduces incident clearance times. • FOT improves information available to traveling public and media.	Expected project impacts include: • Reduce the time needed to deploy assets to respond to an incident. • Reduce exposure of response personnel. • Reduce secondary collisions resulting from the initial incident. • Reduce the time needed to post incident related information on the State's traveler information systems (web, 511) as well as provide information to the media. • Improve the quality of information provided to the media and traveling public.	System Impact Study:
Assess Institutional Challenges and Technical Issues	Further break down institutional barriers between the two agencies.	Identify institutional and technical challenges and document how they were resolved.
Document Lessons Learned	Not specifically established, but fully supported.	Lessons Learned Summary.
Summarize Benefits	Not specifically established, but fully supported.	Benefits Summary.

4.0 Evaluation Approach

4.1 System Component Performance Study

The System Component Performance Study will address two objectives of the CAD-TMC evaluation: (1) examine system component performance, and (2) discuss how well the project meets the FOT objectives. These overall objectives can be met by completing the following activities:

- Describe the environment in which the FOT will operate that could affect the applicability of the CAD-TMC concept to other sites and the interpretation of the system impacts data – this will help other potential deployers better understand the applicability of the CAD-TMC concept to their site.
- Identify key performance measures that should be met by similar deployments to achieve the system impacts observed by the FOT deployment. This will help other deployments identify and focus on the performance goals needed to achieve similar results. Also, document the design basis for these performance measures to help other deployments adjust these measures to better suit their local conditions.
- Calculate and document the key performance measures for the system as it was deployed. This will help identify limitations in the deployed system that might affect the observed system impacts. Also, identify and document other performance measures that are gathered by the deployment team (e.g., during component and integration testing). While this data is not as critical to the evaluation as the key measures, the data should be available from the deployment team to reduce the cost associated with reporting the data.
- Identify other factors that affect the performance of the deployed system. After the system is deployed, users may identify other factors that could make the system more useful and knowledge that could benefit others in developing similar systems.

In addition to these activities related to evaluating the performance of the deployed system, the Evaluation Team will also:

- Evaluate the degree to which ITS standards such as IEEE 1512 and NTCIP were incorporated into deployed system.
- Address the approach used to share data between map databases from different vendors and GIS standards that were applied.

The plan for each of these activities is described in the following Sections 4.1.1 through 4.1.6.

4.1.1 Describing the FOT and Its Operating Environment

There are several reasons why it is important to document the FOT deployment and its operating environment. First, the national Evaluation Team cannot design the evaluation without a good understanding of the deployment, and second, those interested in the evaluation results cannot interpret them without understanding the deployment. Also, the deployment will change over time, and these changes not only have the potential to impact the evaluation (e.g., by altering the deployment schedule), but also are important evaluation results in and of themselves. Deployment changes often occur to accommodate important new information that was learned in the deployment process, so documenting changes to the planned deployment can be a key to identifying lessons learned.

This description is particularly important for the CAD-TMC evaluation because considerable cooperation already exists between WSDOT, WSP, and other agencies involved in responding to incidents. This high level of existing cooperation will limit the impact of the FOT on incident response rates in much of the State.. Understanding that the State began with a high level of cooperation is important so that readers of the evaluation results do not misinterpret the expected low impact on response rates as general indicators that increasing cooperation and integration does not improve these rates.

For these reasons, the national Evaluation Team will maintain a version-controlled description of the WSDOT CAD-TMC Integration FOT. As changes to the deployment and deployment plans occur, this description will be updated. When changes occur to the FOT description, the impact of these changes on the evaluation activities will be considered, and if necessary, the Evaluation Plans will be revised accordingly. Also, the FOT changes will be reviewed to ascertain whether the changes should be listed as a lesson learned during the FOT, and if so, the change will be further investigated.

4.1.2 Identifying Key Performance Measures and the Design Basis

The system performance measures are another important tool for interpreting the evaluation results. If an installed system has weak performance measures, then a lack of system impacts might be attributed to an inadequate deployment. However, the performance measures evaluated for the FOT can serve several other useful purposes:

- The key performance measures, how the deployment team identified appropriate values for these measures, and how they were computed during testing can help other deployments select and calculate appropriate performance measures for similar deployments.
- Identifying performance measures can help other sites build acceptance criteria into their contracting language for similar deployments that are based on these performance measures.

For these reasons, the national Evaluation Team will work with the WSDOT CAD-TMC deployment team to identify the key performance measures of the WSDOT CAD-TMC system. In general, these performance measures will involve the type, timeliness, accuracy, and quality of the data exchanged between the systems operated by the various stakeholder groups: WSDOT; WSP; and Skagit County EMS. Other performance measures will help identify the ease of operating the resulting system and the degree to which the system was used. The following list describes some of the key performance measures identified by the Evaluation Team:

- Changes in the number of types of incidents broadcast and changes in the type and detail of information provided on incidents
- Frequency with which information on events is shared.
- Lag time between incident verification and information availability to the TMC, to other CAD users, and to the public.
- Quality and accuracy of information exchanged.
- Delay times in responding to dispatch requests.
- Type of TMC information available on the CAD-TMC FOT
- Ease of access to this TMC information
- Degree of interoperability between the participating FOT stakeholders outside of the CAD-TMC FOT.
- Extent to which the deployed system was used by CAD and TMC operators and by secondary responders.
- Degree to which the system decreased reliance on manual methods for exchanging data.
- Lag time between incidents and arrival of WSDOT's incident management teams.

The Evaluation Team will work with the FOT implementers to identify other measures and the expected values of these measures after the design of the WSDOT CAD-TMC is complete. At the same time, the Evaluation Team will document the design basis for the expected values of the performance measures and will work with the deployment team to determine those measures that will be computed as part of the deployment validation effort and those that will be computed by the Evaluation Team. For both types of measures, the data collection and analysis plans will be documented in the evaluation test plan.

4.1.3 Documenting Performance Measures

The primary purpose in identifying the performance measures is to compute them after the deployment is complete to ensure that the deployed system performs as expected. The computed measures help determine whether the deployed system lives up to its design expectations. If a system is not performing as designed, it will not be clear whether the lack of system impacts is because of weaknesses in the deployment or weaknesses in the overall approach. It is important for the Evaluation Team to compute and analyze these performance measures to properly interpret the system impact study results.

The final set of performance measures and the methods for evaluating them will not be finalized until the Detailed Test Plans are produced. The Evaluation Team has identified the objective, hypothesis, measures of effectiveness (MOE), data source, and analysis that might apply for each of the measures listed in the previous sections. These elements are summarized in the following Table 4-1.

Table 4-1. System Performance Measures

Objective	Hypothesis	MOE	Data Source	Analysis
Document the system component performance.	The system meets functional specifications.	Types of incidents broadcast and data available for those incidents	Interviews with deployment staff.	Review and description of interview results.
			Design documents.	Review and description of these documents.
			CAD message logs.	Sampling and summarization of messages broadcast.
			CARS message logs	
		The lag time between incident verification by WSDOT/WSP and information availability to the general public and partner agencies.	CAD message logs.	Analysis of message log time stamps.
			CARS message logs	
			Operator interviews.	Review and description of interview results.
		The quality and accuracy of information exchanged.	Operator interviews.	Review and description of interview results.
				.
		The type of TMC information available.	Interviews with deployment staff.	Review and description of interview results.
			Design documents.	Review and description of these documents.
			CAD message logs.	Sampling and summarization of messages broadcast.
			CARS message logs	
		Ease of access to CAD and TMC information.	Interviews with CAD and TOC operators.	interview results.
	The CAD and TMC systems will be able to link data on an	Use of common standards enabling the linking of	Interviews with deployment staff.	Review and description of interview results.

Objective	Hypothesis	MOE	Data Source	Analysis
	incident	information between the different systems	Design documents.	Review and description of these documents.
		Ability to obtain the same data on an incident from each system	CAD message logs.	Sampling and summarization of messages broadcast.
			CARS message logs	
	Using the system -improved incident response procedures.	Percentage of events where information is ahared between agencies	Interviews with CAD and TOC operators.	interview results.
			CAD message logs.	
		Degree of interoperability achieved.	CARS message logs	Review and description of interview results.
		The extent to which the system was used.	Interviews with CAD and TOC operators.	interview results.
			Software and Web site usage statistics.	Analysis of usage statistics.
Automate the seamless transfer of information between traffic management workstations and police, fire, and EMS CAD systems from different vendors.	The FOTs will decrease the reliance on manual methods for exchanging information.	Percentage of time that initial exchange of information is generated automatically.	Interviews with CAD and TOC operators and secondary responders.	Review and description of interview results.
			Observations of CAD and TOC operator activities.	Review and description of observation results.
	The FOTs will increase the extent and reliability of information exchanges.	Information will be used to improve responses.	Case analyses of events.	Review and summarization of events.
			Interviews with operators/facility managers.	Review and description of interview results.

Objective	Hypothesis	MOE	Data Source	Analysis
Extend the level of integration to include secondary responders such as utilities, towing and recovery, public works, and highway maintenance personnel.	Improved integration of secondary responders will reduce incident recovery time by getting required recovery personnel to the incident site as quickly as possible to begin recovery operations.	Identify secondary responders who are utilizing the system.	Interviews with deployment staff.	Review and description of interview results.
		Document information made available to responders and the extent to which it is used.	Interviews with secondary responders.	Review and description of interview results.

4.1.4 Identifying Other Factors Affecting System Performance

In many cases, some factors that affect system performance – and in particular, user acceptance of the system – are difficult to identify up front. For example, a certain class of users may want the data presented to be organized differently from other users, and may have difficulty expressing how best to organize the data until a system is in place. Identifying these factors can be important both for the FOT deployment, which can use this feedback to improve the deployed system, and for those deploying similar systems in the future, because they can build those systems to consider these additional factors.

The Evaluation Team will conduct periodic post-deployment interviews with the users of the resulting system that include questions regarding suggested improvements. These suggested improvements will be relayed to the deployment team and included in the evaluation report.

4.1.5 Evaluating the Degree to which ITS Standards Were Incorporated

One goal of FHWA is to encourage the use of ITS standards. This is important not only because the use of standards can facilitate deployment – those who developed the standards are experts in the field and using the standards leverages their expertise – but also because standards-based deployments are more easily ported to other locales. The Evaluation Team will take the following steps to evaluate the degree to which ITS standards were incorporated in this FOT deployment:

- Conduct a scan of existing standards (e.g., IEEE 1512, NTCIP) to determine which standards are ready for deployment.
- Scan all standards activities to ensure that the most current standards information is available, including standards validation and vendor compliance.
- Identify which standards the FOT teams selected and why they selected them.

4.1.6 Identifying the Approach Used to Share Geographic Data

One difficulty that is often encountered in sharing data between road-based systems is overcoming the incompatibilities in the underlying map data in the systems. These incompatibilities can be as simple to correct as different naming conventions for roads (e.g., "Rd" instead of "Road", "1st" instead of "First"), or can be as complex to correct as actual differences in the road topology (e.g., missing roads), differences in the road names, or differences in the road coordinates. Taken together, these incompatibilities can degrade the effective communication between systems.[16] Documenting how the WSDOT FOT overcame these difficulties – and the extent to which these difficulties impeded the effectiveness of the system – can help sites that might employ similar techniques.

To achieve this goal, the Evaluation Team will interview the deployment team to document the approach used to share data between these systems. The Evaluation Team will also conduct performance tests on the effectiveness of these approaches by conducting round-trip exchanges of location information and performing statistical tests on the differences introduced by these exchanges. The Evaluation Team will supplement these analytical results on the effectiveness of the data-sharing approach with interviews with system operators to identify the frequency with which the location data was incorrect and the extent to which poor location data impeded incident response.

4.2 System Impact Assessment

This section outlines the approach to be taken in estimating the system impacts of CAD-TMC integration. System impacts will be evaluated using elements of the framework provided by FHWA's National ITS Program Goal Areas: Mobility; Capacity/Throughput; Productivity; Safety; and Customer Satisfaction[17]. The evaluation will seek to quantify and document the benefits across these measurable areas for two very broadly defined beneficiary groups: incident responders and travelers. The benefits that each group realizes are different. The evaluation will seek to determine the Productivity and Safety Benefits for the response community. It will seek to determine the Mobility and Safety benefit made possible by improved traffic flow conditions, which will result in improved traffic flow conditions and increased Capacity/Throughput.

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[16] In this FOT, the importance of these incompatibilities is not as critical as in some other systems because there is a human-in-the-loop. This FOT deployment is designed to present data to human operators to improve their decision making. These human operators can normally adapt for many of the differences in map databases.

[17] Additional information regarding the ITS Evaluation Guidelines – ITS Evaluation Resource Guide can be accessed from the FHWA Website at http://www.its.dot.gov/EVAL/eguide_resguide.htm.

The evaluation premise for the first group, the incident response community, is that anticipated benefits of the integration are the result of improved interaction between members of the incident management and response communities at three levels: center-to-center; center-to-responder; and responder-to-responder. Within the response community, the stakeholders will be considered to be primary responders and responders from other agencies. Primary responders are the DOT response crews that are dispatched to verify the incident and establish the follow-on response requirements.

Responders from other agencies are dispatched to the scene based on the nature of the incident. This group can include police, fire and rescue, hazardous materials crews, and towing and recovery crews. The benefits of integrating the dispatch systems for these two communities will likely be the product of a quicker and more accurate understanding of the incident management requirements for the specific incident in progress, which will lead to more efficient execution of the incident management activities.

The evaluation premise for the second group, the travelers, is that improvements in incident management will be realized in terms of increased mobility (reduced delay). In addition, increased safety (reduced secondary crash rates) will be realized by improved link performance (reduced incident duration, improved incident specific traffic management plans, and improved diversion route availability and performance).

4.2.1 Baseline System Performance

While this evaluation will seek to identify the benefits of CAD-TMC Integration projects, it will also serve an important role in documenting the baseline performance of mature, high-performance incident management systems currently in use. Capturing the system description and performance qualities of the system in its current form will establish a benchmark performance level that will be useful as other states and localities upgrade and modernize their incident management capabilities. In order to conduct this baselining activity, the incident management system must be documented and the performance of each of the components must be measured to determine expected performance levels as well as the variation in those measurements. Working with the agencies involved, the Evaluation Team will draft descriptions of each applicable activity in its baseline form and document current performance.

Figure 4-1. Expected System Impacts

The quantitative aspect of the baselining activity will require access to a broad range of databases to document not only the incident management process, but to establish relationships between incident management processes, traffic flow characteristics (on the freeway and on the diversion routes), and secondary crash occurrence. The databases and information required are those that will support answering the following questions:

- What happened? What was the impact of the event on the highway? Where was it? What time did it occur? What were the weather conditions?

- What DMS messages (and other traveler information techniques) were in place prior to the event and what was the message history after the event (i.e., warnings to drivers, variable speed limit responses, diversion instructions, etc.)?
- How long did the event clearance process last?
- How did the highway section perform over the timeframe (including a period before and after)?
- Were there any secondary effects (i.e., crashes, severe impacts on diversion route flow, etc.)?

To support this effort, an initial screening process will be used to identify “hot spots”. Hot spots are those freeway locations that indicate an incident history that will prove useful for evaluation and which can support the data requirements outlined in the list of investigative questions. Data requirements to identify the hot spots are incident histories that identify location, direction of travel, incident type**,** time-of-day, day-of week, date, and weather conditions. A data search will be used to identify the high-incident locations and high secondary-incident locations (defined as secondary incidents occurring within 2 miles up or down stream of either direction). Once hot spots are identified, the following data can be pulled to develop a complete picture of the incident management activity at a “system level”:

- The incident history.
- Variable Message Sign (VMS) history, if applicable.
- Highway performance indicators (volume, spot speeds, etc.).
- Traffic queues or congestion moving back from an incident.
- Secondary incident-occurrence history, if any.

The evaluation objective will be to establish a performance baseline for defined incident classifications (type, number of lane closures, hazmat involvement, etc.) that includes an understanding of the relationships between these “system level” measures. Figure 4-2 provides an example of such an integrated picture, which can lead to a set of statistical process performance and control measures. The evaluation team recognizes that data availability may be problematic, and will target corridors where arterial data is more readily available such as where the parallel arterials are operated by WSDOT

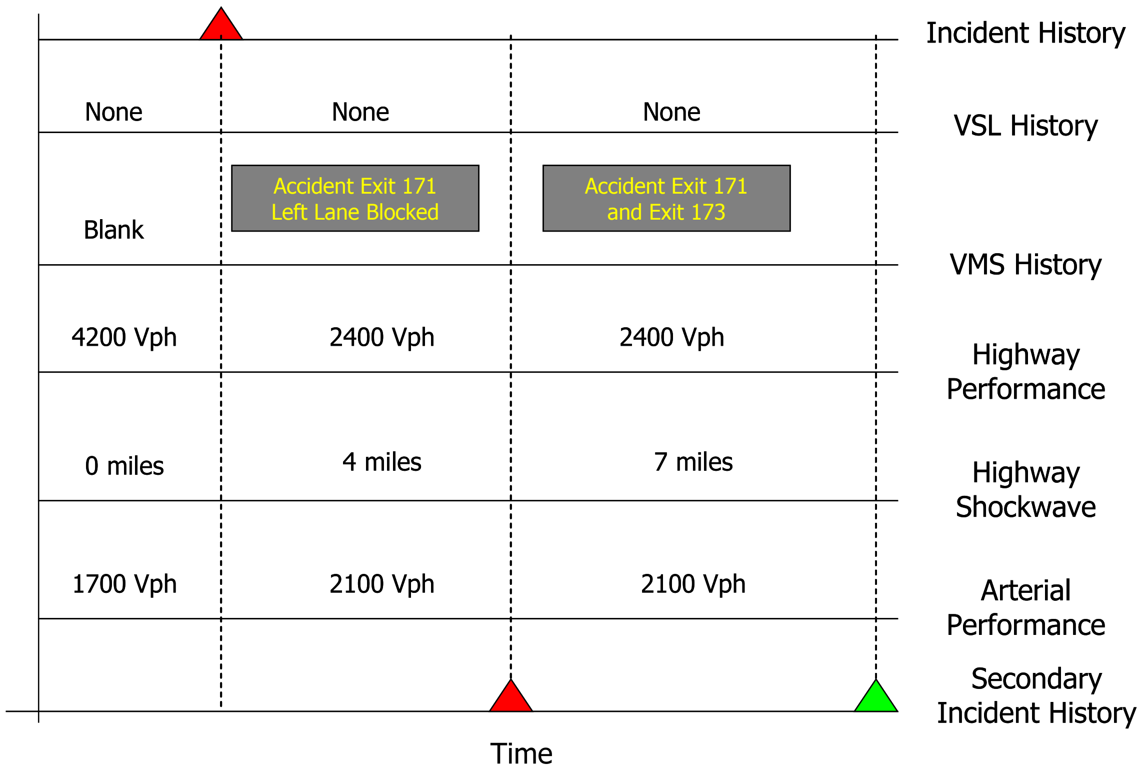


Figure 4-1. System Performance Measures

4.2.2 Documenting the Learning Curve

Documenting the "learning curve" associated with the CAD-TMC Integration is an important part of the evaluation. The Evaluation Team will work closely with the stakeholders to identify the "milestone" events that will take place over the life of the deployment and evaluation.

Once the baseline system performance is documented qualitatively and quantitatively, the Evaluation Team, with the stakeholders, will identify key technology insertions and monitor the emergence of adjustments in operational concepts. The adjusted operational concepts will indicate opportunities for conducting follow-up interviews for revising the qualitative aspects of the baseline and produce a milestone-based documentation of the impact on process and procedures that may produce new efficiencies in communications, response, and overall incident management.

To capture the quantitatively measured aspects of the learning curve, the Evaluation Team will establish a data collection concept that will make periodic data pulls fixed around known technology insertions and stakeholder-identified changes in concepts of operation. This effort will capitalize on the improvements in automatic reporting that are anticipated as part of the integration effort. The Evaluation Team realizes that the range and depth of data available at the beginning of the effort may be less than that available at the end of the effort. This enrichment of data availability, particularly in relational format, will be a key aspect of the evaluation leading to improved ability to monitor and measure the incident management system. Data collection to support evaluation will take into account the need to identify "burn-in" times associated with new technologies and operational concepts.

4.2.3 Systems Impact Evaluation Approach

To evaluate the benefits of the CAD-TMC integration, the Evaluation Team developed a set of objectives and hypotheses to guide the identification of MOEs, data requirements, and analysis methods. Tables 4-2 through 4-5 presents the experimental design for evaluation of the system impact for each of the four National ITS Goal Areas.

Table 4-2. System Impact Experimental Design for Productivity

Objective	Hypothesis	Measure	Data Sources	Analysis Method
To determine if the CAD-TMC integration improves the efficiency and productivity of incident response.	CAD-TMC integration enhances communications among responders.	Develop a process flow map of communications network used for specific incident classifications identifying all modes/all communications by type (voice or data and mode [wire or wireless].	Communication logs and a survey.	Quantitative/ qualitative survey analysis. Before/after comparison of communications systems.
	CAD-TMC integration improves efficiency of on-scene operations.	Determine total on-scene time required by incident classification from first arrival to last departure. Assess impact of CAD-TMC on reducing duration, shorter time, quicker response, etc. Compare *baseline* and *after* data.	Incident management logs to determine the on-scene time for each incident classification.	Descriptive statistical analysis.
	CAD-TMC integration reduces incident clearance times.	Determine total time from incident detection until incident clearance for each incident classification. Compare *baseline* data with *after* data.	Incident management logs, radio and communication logs.	Descriptive statistical analysis.
	CAD-TMC integration enhances efficiency in documenting incident management.	Determine number of incidents for which TMC traffic management logs, incident response dispatch logs, and highway performance monitoring system data are correctly merged in near-real time Determine ability of information management system to correctly archive incident management data in	Incident management records and surveys (designed to provide qualitative and quantitative data) of IM personnel from on-scene personnel to	Quantitative/ qualitative survey analysis. Before/after comparison of incident management logs.

Objective	Hypothesis	Measure	Data Sources	Analysis Method
		relational databases to support incident debriefs, statistical process control methods, and management level review.	senior management within the major stakeholder groups, i.e., WSDOT and WSP	

Table 4-3. System Impact Experimental Design for Mobility

Objective	Hypothesis	Measure	Data Sources	Analysis Method
To determine if the CAD-TMC integration improves mobility and reduces delays during incidents.	CAD-TMC integration enhances mobility during incident management (IM) activities.	Determine speed and/or lane occupancy profiles to determine duration/length of traffic characteristics (i.e., congestion and speed) in response to various incident classifications. Compare *baseline* and *after* data.	For high crash frequency freeway sections: average speeds for the location.	Descriptive statistical analysis and comparison of the no-incident case, the *baseline* w/incident case, and the *after* w/incident case.

Table 4-4. System Impact Experimental Design for Capacity/Throughput

Objective	Hypothesis	Measure	Data Sources	Analysis Method
To determine if CAD-TMC integration enhances incident-specific traffic management plans.	CAD-TMC integration enhances incident-specific traffic manage-ment plans.	Determine the diversion effect on traffic volumes over the affected link for specific incident classification. Compare *baseline* and *after* data.	For high crash frequency freeway sections: measure volume during incidents of each particular classification to approximate the level of traffic diversion.	Descriptive statistical analysis of key measures and comparison of *baseline* and *after* cases.

Table 4-5. System Impact Experimental Design for Safety

Objective	Hypothesis	Measure	Data Sources	Analysis Method
CAD-TMC integration will reduce exposure of response personnel and secondary crashes during incident response activities.	CAD-TMC increases safety for response personnel.	Determine reduction in exposure time for response personnel from first arrival to last to leave. Determine traffic volume and speed at incident location and key diversion points to determine effects of TMC-provided traveler information on driver diversion decisions.	For exposure time: incident management logs to determine change in duration of on-scene operations for specifically defined incident classifications. Sources for incident location and key diversion point volumes include TMC data.	Descriptive statistical analysis of key measures and comparison of *baseline* and *after* cases.
	CAD-TMC increases safety the traveling public.	Determine local relationship between incident duration and occurrence of secondary crashes using the method developed in the Maryland CHART secondary crash study.[18]	Jurisdiction-identified high crash frequency freeway segments, and records for all crashes (same and opposite direction within 2 miles and 2 hours) to identify secondary crash patterns.	Descriptive statistical analysis of key measures and comparison of *baseline* and *after* cases.

4.2.4 Deployment Specific Evaluation Components

The WSDOT FOT includes several unique aspects that require special attention during the evaluations. WSDOT intends to include an automated interface to its 511 and Internet-based traveler information services to improve the quantity, quality, and timeliness of incident information provided to the traveling public.

[18] Chang, Gang-Len; Shrestha, Deepak; and Point-Du-Jour, Jean Yves, "Performance Evaluation of CHART: An Incident Management Program in 1997." Paper prepared by the University of Maryland and the Maryland State Highway Administration, 2000.

The Evaluation Team developed the following hypotheses related to the integration of the 511 and Internet-based traveler information services, as presented in Table 4-6.

Table 4-6. Traveler Information Assessment

Objective	Hypothesis	MOE	Data Source	Analysis
To determine if CAD-TMC integration will improve incident management information available to travelers.	CAD-TMC integration enhances customer satisfaction and mobility during incident management activities by improving traveler information.	Determine change in the percent of eligible incidents reported on traveler information Website or through 511. Determine change in time between when the incident occurred and when information became available to the public. Determine if number of Website hits and 511 calls increased. Determine if media were able to use information.	Sources include: Washington State Patrol and WDOT incident logs and Website logs; 511 call logs; interviews with media.	Descriptive statistical analysis of key measures and comparison of *baseline* and *after* cases.
		Assess satisfaction of the traveling public with improved traveler information.	Web-based survey of traveling public.	Quantitative/ qualitative survey analysis.

4.3 Institutional Challenges Evaluation Approach

The institutional challenges will be identified and documented through the following efforts:

- **Stakeholder Interviews.** Interviews will project stakeholders will provide the primary information source for identifying challenges and the processes by which they were resolved. These interviews will be conducted on a "before" and "after" basis.
- **Document Review.** Interviews will be supplemented by the review of documents (meeting minutes, correspondence, project reports) generated through project activities. Document review, in particular meetings minutes, will be used to document the processes by which the institutional challenges were resolved.

Challenges to be assessed through the Institutional Challenges Assessment include:

- Documenting inter-agency cooperation at the State level, in particular, the processes used for identifying and solving problems.
- Assessing how county and municipal agencies are integrated into the program (Skagit County EMS).
- Identifying what information is shared, and how the agencies determined that this was the right information to share.
- Documenting how WSP and WSDOT determined what the information availability would be for exchanges between the CAD-TMC systems.
- Documenting how frequently the information provided through the project is used by:
  - Responders
  - Travelers
  - Media
- Documenting how these end-users used the information provided, and identifying how the information was used.
- Determining if end-users found the information useful and why or why not.
- Assessing how the various CAD vendors were able to establish working relationships and share data.

4.4 Technical Issues Evaluation Approach

This assessment will document how the FOT teams addressed technical challenges such as overcoming the barriers associated with incompatible and/or proprietary systems. In conducting the study, the Evaluation Team will review copies of technical documentation (e.g., concept of operations, requirements, and design documents) produced by the FOTs to identify challenges that they have referenced. Follow-up interviews with technical staff at each participating group will be used to review the specific challenges addressed in these documents; identify additional challenges that may have occurred; and evaluate how those challenges were resolved. The Evaluation Team will also become integrated with the FOT activities (e.g., by participating in FOT team meetings, joining email exchanges) in order to identify technical challenges as they occur.

Issues to be addressed include:

- Problems encountered with developing message sets.
- Documenting how WSP and WSDOT determined what the information availability would be for exchanges between the CAD-TMC systems, and how the information filter was designed and developed.
- Problems encountered with building Legacy System Interfaces.
- Establishing interoperability between incompatible and/or proprietary systems.

4.5 Lessons Learned Assessment

This assessment will meet FHWA's objective to summarize lessons learned during the other portions of this evaluation. Lessons learned will be gleaned from all aspects of the evaluation. The Evaluation Team will also explicitly request information on lessons learned during all interviews associated with this evaluation. This process will be ongoing throughout the project and information will be shared on a regular basis with the project partners and with FHWA, such that the evaluation may serve to actually improve the deployments.

4.6 Benefits Summary

The Benefits Summary will address FHWA's objective to document benefits pertaining to enhanced field operations associated with locating and responding to incidents; enhanced communications among responders; enhanced on-scene activities; and enhanced efficiency in documenting the incidents. The benefits from the FOT deployments will be derived from the Systems Impact Study, which measures quantitative impacts of the FOTs on system characteristics, (i.e., the time operators spend on notification activities, quicker response times, and congestion delays caused by an incident). The Benefits Summary will ensure that data collected to evaluate these system impacts is supplemented with other data necessary to estimate primary and secondary benefits of these system impacts. The Evaluation Team will plan the data collection to support a variety of benefits estimates, including decreased operator time, decreased dispatching errors, quicker injury treatment, decreased traffic delays, and reduction in secondary incidents and injuries.

5.0 Detailed Test Plans – Outline and Level of Effort

All test plans to be developed for the CAD-TMC evaluation shall be prepared as specified in the solicitation:

> The contractor shall develop detailed Test Plans for both the UDOT and WSDOT test sites. The plans shall describe impacts of the FOT with a focus on comparison of impacts before and after the system implementation. Each test plan shall address, at a minimum, the following:
>
> - Test objectives and approaches,
> - Data collection methods,
> - Methods for evaluating implementation of applicable standards,
> - Test schedule,
> - Pre-test activities,
> - Test Activities,
> - Post-test activities,
> - Data requirements,
> - Data analysis,
> - Report format and expected contents; and
> - Estimated resources required to complete all activities described in the individual test plans.[19]

This section of the Evaluation Plan presents a high-level overview of the elements that will be included in the test plans for each evaluation goal and study area.

5.1 High-Level Outlines

5.1.1 System Performance Assessment

The objectives of the System Performance Assessment are to determine if:

- The performance of the system components met functional specifications and requirements.
- Automation enabled the seamless transfer of information between traffic management workstations and police, fire, and EMS CAD systems from different vendors.
- Secondary responders, including the private sector and municipal/county government, were successfully integrated.

[19] Op. cit., page 4

An additional component of the System Performance Assessment will be to:

- Assess the degree to which ITS standards such as IEEE 1512 and NTCIP were incorporated into the system.
- Asses if the system enables the sharing of data between map databases from various vendors and GIS standards that were applied.

The hypotheses are that each of the these objectives is true:

- The system did meet functional performance specifications and did enable the seamless transfer of information.
- Secondary responders were successfully integrated into the system.
- ITS standards and the sharing of map databases using GIS were successfully incorporated into the system.

The measures of effectiveness that will be used to test the hypotheses include:

- Documenting actual system performance and comparing this to functional specifications to see if these were realized, and if not, identifying why.
- Assessing the degree of interoperability obtained – was information successfully exchanged between different vendor CAD systems and agency legacy systems?
- Documenting the extent to which existing manual information exchange systems were replaced by automated information exchange.
- Documenting the timeliness, quality, and accuracy of information exchanged.
- Determining the extent to which secondary responders are successfully integrated into the system, and the extent to which they use the system.

The Evaluation Team will also review which standards are used and why, and how these standards were incorporated into the system.

Data collection will be accomplished through reviewing system performance logs; CAD message logs; developing “before” and “after” communication process flows to identify the impact of automation; the review of usage statistics; direct observation of dispatchers and operators using the CAD and TMC systems; and interviews with end-users and secondary responders.

5.1.2 System Impact Study

The objective of the System Impact Study will be to determine if the integration of CAD and TMC systems:

- Improves mobility and reduces incident-caused delays.
- Improves the efficiency and management of incident response activities.

- Reduces the exposure time of response personnel at roadside, thus reducing the risk of injury due to a secondary incident.
- Reduces secondary crashes related to incidents.

The hypotheses are that each of these facets is true. The measures of effectiveness that will be used to test these hypotheses include:

- Comparing the “before” and “after” data for total on-scene time required by incident classification.
- Comparing the “before” and “after” data from detection through clearance by incident classification.
- Comparing the “before” and “after” data for speed profiles and the diversion of traffic volumes during incident responses by incident classification.
- Comparing reductions in incident response personnel exposure time and compare existing research to estimate improved safety.
- Determine the “before” and “after” local relationship between incident duration and occurrence of secondary crashes using existing research to determine the extent of incremental impact.

The Evaluation Team recognizes that in conducting this test:

- Additional factors that may impact before and after conditions need to be considered so that the actual impact of the project is correctly measured.
- Significant improvements in mobility, efficiency, and other measures of effectiveness may already have been obtained through the coordination and integration of incident response activities previously implemented by the State. The Evaluation Team, to the extent data is available, will measure the impact of the integration of secondary responders on incident response measures of effectiveness.

The data that will be collected to conduct these tests includes: a review of incident management logs; incident management records and surveys; traffic data showing volumes and travel speeds; and interviews with stakeholder groups.

The objective of the 511/Internet interface portion of the System Impact Study is to determine if integrating CAD and TMC systems:

- Enables near real-time data exchange with 511 and Internet-based traveler information.
- Improves customer satisfaction and mobility during incident management activities by improving traveler information.
- Reduces the time needed for the news media to obtain and disseminate improved traveler information.

The hypothesis is that each of these facets is true. The measures of effectiveness that the Evaluation Team will use to test the hypothesis are:

- Determine the change in the percent of eligible incidents reported on the traveler information Website and the 511 systems.
- Determine the change in time between when the incident occurred and when information became available to the public via the Website and 511 systems.
- Assess the satisfaction of the traveling public with improved traveler information.

The proposed data collection plan will include obtaining WSP CAD reports, WSDOT incident logs, and Website logs to determine when incidents were posted versus when they occurred. A Web-based questionnaire of the traveling public will be fielded to determine traveler satisfaction.

5.1.3 Institutional Challenges Assessment

The goal of the Institutional Challenges Assessment is to document how the FOT teams addressed institutional challenges and how these institutional challenges were finally resolved.

The Evaluation Team will identify the institutional challenges in the following ways:

- Be integrated with FOT activities to identify challenges as they occur.
- Review technical and management documentation (such as inter-agency Memorandums of Understanding [MOUs)] or Memorandums of Agreement [MOAs]) to identify challenges encountered by the FOT teams.
- Use baseline stakeholder surveys to identify challenges.
- Follow up interviews with technical staff to document how challenges were addressed and resolved.

The output of this assessment will be documentation, in the form of a section in the final report, of the challenges encountered and how the challenges were resolved.

5.1.4 Technical Issues Assessment

The goal of the Technical Issues Assessment is to document how the FOT teams addressed technical challenges and how technical challenges were finally resolved.

The Evaluation Team will identify the technical challenges in the following ways:

- Be integrated with FOT activities to identify challenges as they occur.
- Review technical and management documentation to identify challenges encountered by the FOT teams.
- Follow-up interviews with technical staff to document how technical challenges were addressed and resolved.

The output of this assessment will be documentation, in the form of a section in the final report, of the technical challenges encountered and how the technical challenges were resolved.

5.1.5 Lessons Learned Summary

The objective of the Lessons Learned Summary is to document the lessons the FOT team learned in the process of integrating their TMC and CAD systems. This documentation will include documentation on the existing WSDOT/WSP integration, how it was accomplished, and the lessons learned from these earlier efforts.

The Evaluation Team will collect the lessons learned information by:

- Conducting interviews with team members.
- Gathering information from current and previous project documentation.

This will be an ongoing process throughout the life of the evaluation project. The output of the Lessons Learned Summary will be documentation, in the form of a section in the final report, of the lessons learned by WSDOT and WSP in integrating their systems.

5.1.6 Benefits Summary

The objective of the Benefits Summary is to consolidate and report the benefits that accrued by integrating CAD and TMS systems in one section of the final report. Specifically, the Evaluation Team will look at all the benefits identified in all of the studies undertaken as part of the evaluation, including:

- Enhanced field operations associated with locating and responding to incidents.
- Enhanced communications among responders; enhanced on-scene activities.
- Enhanced efficiency in documenting the incidents.
- Improved interagency working relationships.
- Enhanced communication with the traveling public and media.

The benefits will be derived from the Systems Impact Study (for example, response times and time spent by personnel on notifying partner agencies about incidents), and by interviewing FOT team members.

The measures of effectiveness will include:

- Response and clearance times.
- Operator time per incident/activity.
- Satisfaction of team members.

5.2 Test Plan Work Breakdown Structure

The work breakdown structure for conducting each test is shown in Figure 5-1.

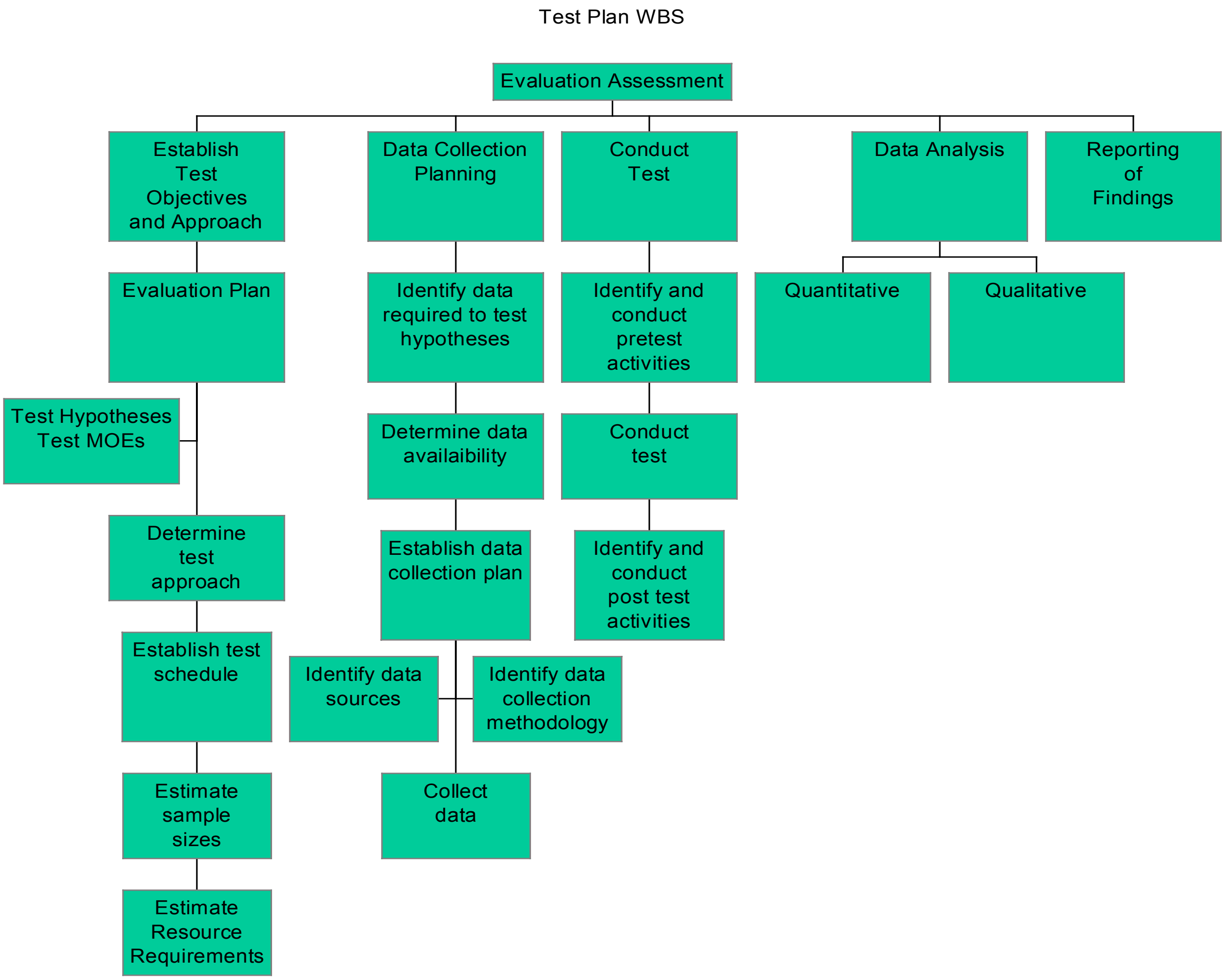


Figure 5-1. Test Plan Work Breakdown Structure

5.3 Estimated Resource Requirements

The estimated resource requirements needed to conduct the proposed tests are shown in Table 5-1. To complete the tests, the Evaluation Team proposes consolidating a number of test activities to ensure the most effective use of resources. As an example of measures that will be taken to make most efficient uses of resources, the Evaluation Team proposes consolidating data collection activities across all test plan activities. To demonstrate how this will work, if the results of a particular stakeholder interview will be used to support more than one test, all necessary questions will be consolidated into a single questionnaire so that all information can gathered in one interview.

Preparation of test plans will be accomplished as follows. Each test plan will be the responsibility of a particular team member, with input from other team members, as follows:

- System Performance Test Plan – Robert Haas, SAIC
- Assessment of Standards – Leslie Jacobsen, PB
- Integration of Secondary Responders – John O'Laughlin, PB
- System Impact Test Plan – William Louisell, SAIC
- Data Requirements and Collection – Leslie Jacobsen, PB
- 511/Internet Interface – Leslie Jacobsen, PB
- Institutional Challenges – Nick Owens, SAIC
- Technical Issues – Robert Haas, SAIC
- Lessons Learned – Joel Ticatch, PB
- Benefits Summary – Joel Ticatch, PB

Table 5-1. Estimated Resource Requirements

Evaluation Team Member	Preparation of Test Plans	Data Collection (Before)	Data Collection (After)	Data Analysis
Mark Carter, SAIC	4			
Nick Owens, SAIC	16	8	8	8
William Louisell, SAIC	12	20	20	12
Robert Haas, SAIC	12	20	20	12
Leslie Jacobsen, PB	12	20	20	12
John O'Laughlin, PB	12	20	20	8
Jason Stirbiak, PB	16	32	54	8
Joel Ticath, PB	4			

6.0 Evaluation Management Plan

The staffing plan for the evaluation is summarized in Table 6-1.

Table 6-1. Evaluation Staffing Plan

Team Member	Position	Responsibilities
Mark Carter, SAIC	Program Manager	Ensuring task adequately addresses FHWA FOT goals and objectives.
Nicholas Owens, SAIC	Principal Investigator	Ensuring task remains on schedule and within budget. Ensuring all deliverables are completed and delivered on time. Assist with Lessons Learned and Benefits Summary.
William "Chuck" Louisell, SAIC	Transportation Engineer	Lead for System Impact Study.
Robert Haas, SAIC	Systems Engineer	Lead for System Performance Assessment.
Joel Ticatch, PB	PB Task Leader	Ensuring all PB tasks are completed and time and within budget. Assist with Lessons Learned and Benefits Summary.
Leslie Jacobsen, PB	Transportation Engineer	Lead for all data collection, before and after. Assist with System Impact Study and System Performance Assessments.
John O'Laughlin, PB	Public Safety Specialist	Lead for all safety assessments.
Jason Stribiak, PB	Transportation Engineer	Data collection activities.

Mr. Mark Carter, who has extensive experience in evaluating ITS deployments and in managing multidisciplinary, multicompany teams, will ensure that the SAIC Evaluation Team maintains ongoing and consistent contact with the FHWA Project Manager and the Mitretek analyst.

Mr. Nicholas Owens will manage project activities on a day-to-day basis. He will use SAIC management tools developed to ensure that project tasks are completed on schedule and within budget. He will also assist with the Institutional Challenges Assessment and the Lessons Learned and Benefits Summaries.

Mr. Joel Ticatch of PB will be responsible for ensuring that all PB activities are completed on time and within budget. He will also assist with the Lessons Learned and Benefits Summaries.

Mr. Leslie Jacobson of PB will be primarily responsible for managing the "before" and "after" data collection and data analysis activities. Mr. Jacobsen will also provide support in developing the Evaluation Plan and Detailed Test Plans, with respect to identifying data sources and types, and in developing data collection methods. He will be also primarily responsible for assessing how well the deployments meet FOT objectives (particularly the standards assessment), and for managing evaluation field activities. He will also assist with the Institutional Challenges Assessment.

Mr. William C. "Chuck" Louisell of SAIC will be primarily responsible for developing the experimental design for the evaluation, and for assessing system impact. He will also support the collection and analysis of "before" and "after" data, as well as the development of the Evaluation Plan and the Detailed Test Plans.

Mr. Robert Haas of SAIC will support Mr. Louisell in the experimental design component for the FOT evaluations. Mr. Haas will assist Mr. Jacobsen with assessing deployment success in meeting FOT objectives by incorporating GIS and other standards into the CAD-TMC systems. Mr. Haas will be primarily responsible for assessing system technical performance, supporting the collection and analysis of "before" and "after" data, and assisting in developing the Evaluation Plan and the Detailed Test Plans.

Mr. John O'Laughlin of PB Farradyne will be primarily responsible for developing the incident response components of the Evaluation Plan and Detailed Test Plans, and in assessing the effectiveness of the CAD-TMC integration to improve incident response processes and operations. He will also assist with identifying appropriate data sources and types to obtain quantitative results for the incident response component of the evaluation. He will also assist with the Institutional Challenges Assessment.

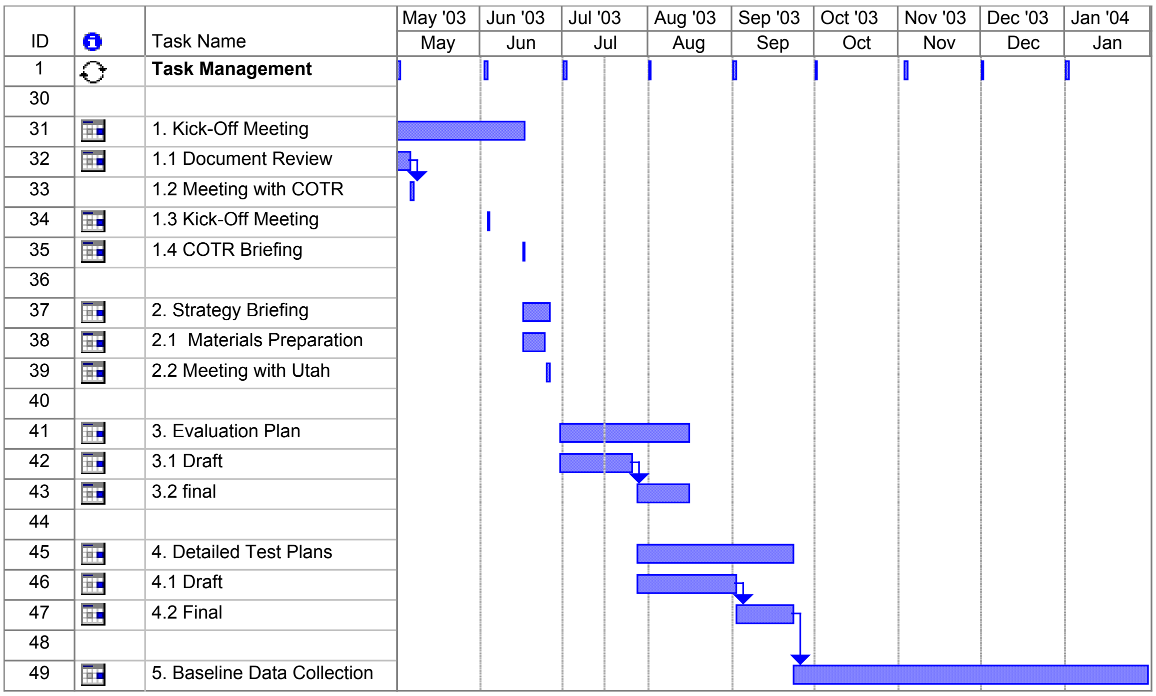
Mr. Jason Stribiak of PB Farradyne will provide the Evaluation Team with an on-site presence for the collection of data.

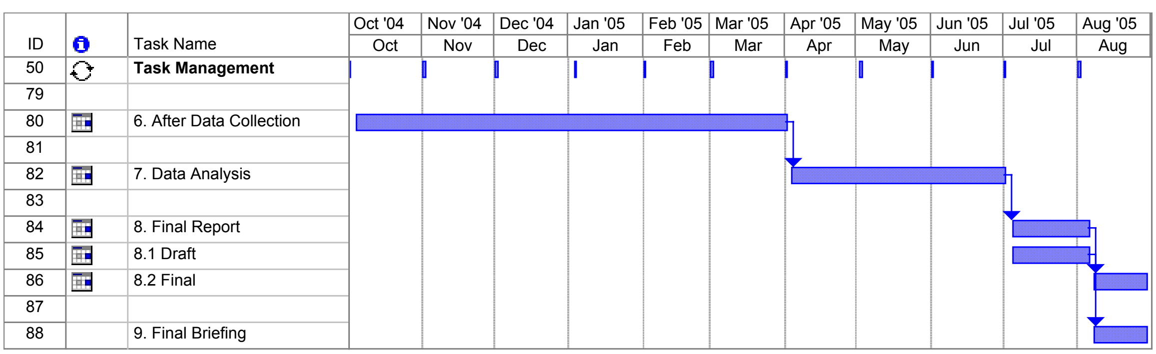
7.0 SCHEDULES AND MILESTONES

7.1 Evaluation Schedule

Table 7-1 shows the evaluation schedule from the start date of May 2003 through the expected project completion data of August 2005, based on the current project schedule.

Table 7-1. Evaluation Schedule





7.2 Evaluation Milestones and Deliverables

The evaluation milestones and deliverables are summarized in Table 7-2. All milestone dates are based on actual dates or on dates based on the current FOT implementation schedule.

Table 7-2. Evaluation Milestones and Deliverables

Evaluation Milestone	Date	Activity Summary	Deliverable
Kick-off Meeting	June 2, 2003	Initial meeting with WSDOT Project Manager.	Briefing to FHWA COTR and Mitretek on meeting results.
Strategy Briefing	June 25, 2003	Presentation of evaluation strategy to WSDOT Project Team. Included discussion of FOT and evaluation goals and objectives and data sources and requirements.	Detailed PowerPoint summary of evaluation strategy provided to WSDOT and FHWA. Included summary of goals and objectives; data collection plans; and summary of project
Draft Evaluation Plan	July 25, 2003	Draft Evaluation Plan submitted to FHWA.	Draft Evaluation Plan
Final Evaluation Plan	August 18, 2003	Final Evaluation Plan submitted to FHWA.	Final Evaluation Plan
Detailed Test Plans	September 1, 2003	Detailed test plans submitted to FHWA.	Detailed Test Plans
Baseline data collection	September 2003 – January 2004	Collection of baseline data.	No contractually required deliverable.
After data collection	Winter 2004 – Spring 2005	Collection of after data.	No contractually required deliverable.
Draft Final Report	Summer 2005	Draft final report submitted to FHWA.	Draft Final Report
Final Report	Summer 2005	Final report submitted to FHWA.	Final Report
Final Evaluation Briefings	Summer 2005	Final briefing on evaluation findings to Washington State.	Detailed PowerPoint presentation summarizing evaluation findings.

7.3 Data Management Plan

7.3.1 Overview

Two types of assessment data will be captured and accommodated under this data management plan: Quantitative data and qualitative data.

Examples of quantitative data include (1) total counts of roadway incidents over a prescribed time period, and (2) distributions of incidents by typology (e.g., percent of events characterized as "blocking" incidents, incidents involving hazardous materials spills, etc.). Qualitative data can include synopses of interviews and other anecdotal summaries describing new efficiencies achieved during the performance of specific functions, the reliability associated with particular incident management responses, etc.

Quantitative data will generally be stored as files in Microsoft® *Access*. Qualitative data will be stored as text files, typically in Microsoft® *Word,* and will be organized in directories and files by subject matter.

7.3.2 Data Storage

A single, centralized platform will be used for storage of the authoritative "master" database over the life of the evaluation study. Data will be routinely downloaded from the FOT sites to the centralized platform, processed, and analyzed. Individual databases – or database subsets – will be copied to evaluators' local computers, as appropriate, in support of more sophisticated analyses, special studies, etc. Updates to the databases will always be made on the central platform and then copied, as needed, to the local platform.

The following elements will be stored on the central platform:

- Raw data precisely as downloaded from the FOT sites.
- Sanitized data after it is certified "compliant".
- Archived analysis tools and data queries.
- Outputs of the assessment process.

Naming convention safeguards and control procedures will be implemented to ensure that individual "snapshots" of the raw data, as downloaded from the FOT sites, are maintained and not overwritten by subsequent updates to the database. As new tools and queries are defined, they will be added to the archive. Access to the central platform will be carefully limited and controlled.

7.3.3 Downloading and Processing Data

Depending on the data involved, downloads from the FOT systems to the central platform will be accomplished by one of the following methods:

- Automatically (a software program developed by the Evaluation Team will copy and extract the needed data from the appropriate FOT systems and transmit them to the central platform.
- Electronically (a member of the State FOT Team will copy and extract the needed data and e-mail them to the SAIC Evaluation Team for loading on the central platform.
- Manually (a member of the State FOT Team will copy and extract the needed data, burn them to CD or other medium, and physically send them to the SAIC Evaluation Team for loading on the central platform).

Detailed data extraction and transmission instructions will be furnished, as appropriate, to the FOT Team.

Data will extracted from the FOT systems at least monthly, or more frequently when appropriate. At the outset of the evaluation period, the data extraction schedule will be furnished both to the FOT Team and FHWA; the schedule will be updated in the event that requirements or data volumes change.

The data, once loaded on the central platform, will be combed for completeness, consistency, uniformity in coding, and adherence to prescribed formats. Records that meet these conformance and validity checks will be deemed "compliant" and written to the "sanitized" databases.

7.3.4 Analysis Tools and Data Queries

Analysis of the study's quantitative data will normally be performed using SQL (structured query language) queries, Visual Basic (VB) analysis modules, and other analytic scripts, as needed. These queries will be conducted on the central platform, and the outputs of these exercises will be saved as Reports. The SQL queries, VB analysis modules, and other scripts will be archived for delivery to FHWA at the conclusion of the study.

From time to time, when more sophisticated quantitative analyses are required, the work will be performed on evaluators' local computers using copies of the databases from the central platform.

Qualitative assessments will generally be presented as text files or tabular data showing trade-off analyses, etc.

7.3.5 Security Management, Safeguards, and Controls

Access to the central platform will be password-protected so that only authorized members of the Evaluation Team can successfully log on to system. Even among the Evaluation Team, only those persons designated as Database Administrators will have rights to update the original databases. Other users will be able to copy the databases only, customize them to address specialized needs, and generate and execute queries. They will not, however, be authorized to change or update the databases.

All data saved to the central platform will be simultaneously imaged to dual hard drives, to ensure ongoing data backup activities. As an additional precaution, the hard drives will be backed up daily, whenever there is activity on the platform.

The databases, analysis tools, and system outputs will all be archived with date-and-time stamps. At the conclusion of the study, the final databases and archived analysis tools will be delivered to FHWA.

7.4 Quality Control Review for all Deliverables

All levels of report development, from the first outline to the final report will go through the Quality Control Review Process outlined in Figure 7-1. This includes both a technical review and editorial review by the team's writer/editor to ensure readability and consistency. The Evaluation Team firmly believes in the benefit of working with the COTR from the outline stage to ensure that the document meets the COTR's needs in as early a draft stage as possible.

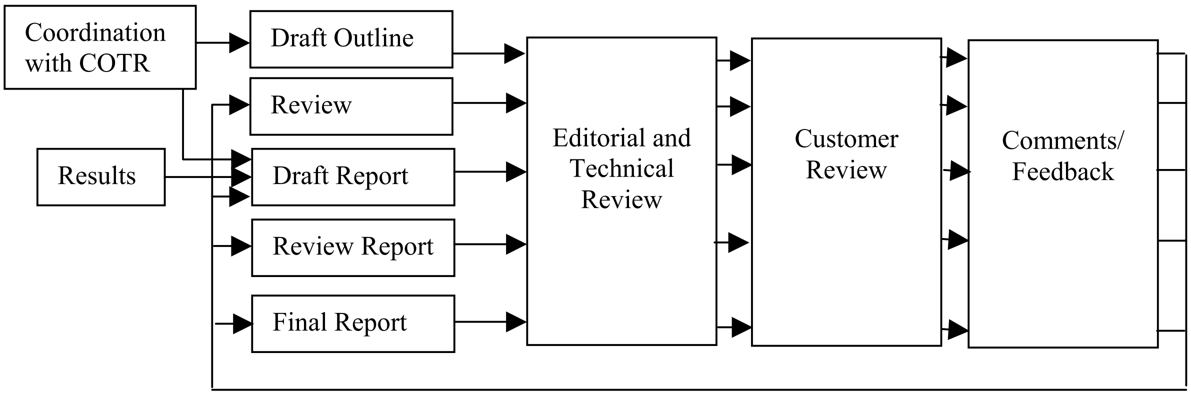


Figure 7-1. Draft and Final Deliverables Quality Control Review Process