
**National Evaluation Program
FY 2003 Earmark Evaluation:
Utah CommuterLink Expansion
Case Study Evaluation Final Report**

Submitted to:

**United States Department of Transportation
Research and Innovative Technology Administration
ITS Joint Program Office
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16. Abstract This report presents a case study of the ongoing expansion of the Utah Department of Transportation's CommuterLink Program. The program is expanding to include local and municipal government agencies outside of the Salt Lake Valley by integrating across the jurisdictional boundaries of the Cities of Orem and Provo, Davis County, and the UDOT Regional Headquarters. With the exception of Davis County, each of these entities now operates its own Traffic Control Centers for its jurisdiction. However, each entity wanted to collectively operate as one system that shares information, utilizes shared resources, and coordinates traffic management across boundaries while maintaining responsibility for their individual jurisdictions. The case study identifies institutional and technical lessons learned and benefits.			
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TABLE OF CONTENTS

EXECUTIVE SUMMARY	1
1.0 INTRODUCTION.....	7
1.1 OVERVIEW	7
1.2 EVALUATION AREAS OF FEDERAL INTEREST	11
1.3 REPORT ORGANIZATION	11
2.0 CASE STUDY EVALUATION METHODOLOGY	12
2.1 EVALUATION APPROACH	12
2.2 DATA COLLECTION ACTIVITIES	13
2.3 METRICS USED TO MEASURE PROJECT SUCCESS	13
3.0 CASE STUDY RESULTS	14
3.1 FINDINGS	14
3.2 BENEFITS	16
3.3 RESOURCE REQUIREMENTS:	17
3.4 METRICS USED TO MEASURE PROJECT SUCCESS	17
3.5 LESSONS LEARNED	19
4.0 CONCLUSIONS	22
APPENDIX: STAKEHOLDER INTERVIEWS.....	23

LIST OF ABBREVIATIONS

ATMS	Advanced Transportation Management System
C2C	Client-to-Client
CAD-TMC	Computer-Aided Dispatch – Traffic Management Center
CCTV	Closed-Circuit Television
CMAQ	Congestion Mitigation and Air Quality
DMS	Dynamic Message Signs
DPS	Department of Public Safety
EMS	Emergency Medical Services
FHWA	Federal Highway Administration
FOT	Field Operational Test
FTE	Full-Time Employee
FTP	File Transfer Protocol
FY	Fiscal Year
IEEE	Institute of Electrical and Electronics Engineers
IMT	Incident Management Team
IP	Internet Protocol
ITS	Intelligent Transportation Systems
JPO	Joint Program Office
MAG	Mountainland Association of Governments
MPO	Metropolitan Planning Organization
NTCIP	National Transportation Communications for ITS Protocol
O&M	Operations and Maintenance
PSAP	Public Service Answering Point
RITA	Research and Innovative Technology Administration
TCC	Traffic Control Center

TMC	Transportation Management Center
TMDD	Traffic Management Data Dictionary
TOC	Traffic Operations Center
UDOT	Utah Department of Transportation
UHP	Utah Highway Patrol
USDOT	United States Department of Transportation
UTA	Utah Transit Authority
VMS	Variable Message Signs
VPN	Virtual Private Network

Executive Summary

Project Overview

To date, the Utah Department of Transportation's (UDOT) Intelligent Transportation System (ITS), known as CommuterLink, has primarily been deployed in the Salt Lake City metropolitan area (Salt Lake County with some coverage on Interstate-15 [I-15] in Davis and Utah Counties).¹ Thus far, the ITS deployments have been made possible through a combination of funding sources totaling \$70 million via Federal (\$17 million), State (\$52 million), and local resources (\$1 million), of which the ITS Earmarks play a critical role.²

The CommuterLink system uses technology to save time and money.³ According to UDOT statistics posted on the CommuterLink Website, the CommuterLink system has already helped increase peak-hour freeway speeds by 20 percent, and reduce freeway delays, traffic signal stops, and intersection delays by 36, 15, and 27 percent, respectively, which results are projected to save travelers in Utah more than \$100 million each year.⁴ The computer-controlled system is designed to monitor and manage traffic flow on freeways and surface streets using closed-circuit television (CCTV) cameras; dynamic message signs (DMS); the 511 Travel Information Line; and coordinated traffic signals, ramp meters, and sensors for traffic speed and volume, pavement, and weather. Travel information can be disseminated to the public via electronic roadway signs, radio, television, telephone, and the Internet. The CommuterLink system includes the following applications:

- **Camera System:** CommuterLink uses more than 200 CCTV cameras. The cameras are spaced approximately every half mile on I-15, I-215, I-80, and the 2100 South Freeway. In addition, cameras are installed at various locations on US-89, US-6, I-84, and the Norman H. Bangerter Highway, as well as at key intersections on surface streets. Camera coverage also is expanding in the Ogden and Provo areas.
- **Video System:** The UDOT system is shared with any agency interested in receiving or sharing video and that is connected to the UDOT fiber optic system. Provo and Orem also incorporate video into the UDOT system. The other agencies typically do not have operations staff available to operate the video system.

¹Note: Most of the overview information describing the existing capabilities of the Utah CommuterLink system was obtained from the Utah CommuterLink Website, last accessed July 21, 2008:

<<http://commuterlink.utah.gov/ie.htm>>.

²Utah CommuterLink Website, Frequently Asked Questions (FAQ) page, last accessed June 25, 2008:

<<http://www.commuterlink.utah.gov/ie.htm>>.

³Dr. Joseph Perrin, R. Disegni, and B. Rama. "Advanced Transportation Management System Elemental Cost Benefit Assessment", University of Utah, March 2004

⁴Utah CommuterLink Website FAQ page. The Website does not provide the methodology that was used to develop these estimates and does not include before and after data.

- **Dynamic Message Signs:** Local agencies in the expanded coverage area have the ability to view the messages that are on DMS throughout the region. The agencies do not have the ability to either control the signs or post new messages. If the agencies want a particular message on a sign, they request it through UDOT.
- **Traffic Signals:** To help manage traffic on surface streets, CommuterLink operators monitor more than 600 traffic signals in the Salt Lake Valley. All agencies in the expanded coverage area use the same signal control software except Provo and Orem, which have different signal control systems from UDOT.
- **Traffic Monitoring Stations:** UDOT has expanded its coverage of traffic monitoring stations into Utah, Davis, and Weber Counties. (UDOT wasn't sure if any local agency used this feature. Agencies have access to real-time data through CommuterLink stations).
- **Traveler Information:** UDOT has expanded its traveler information coverage into Utah, Davis, and Weber Counties to incorporate the new traffic monitoring stations.
- **Event Reporting System:** UDOT inputs information about incidents, construction, and other events in its event reporting system. Local agencies have access to the information in this system.

Evaluation Approach

This evaluation was conducted as a case study and as a qualitative assessment of the Utah CommuterLink expansion project. The following elements were included in the evaluation:

- **Institutional Issues:**
 - Cooperative working relationships between the State and local/municipal government agencies that were established.
 - Methods that the State and local/municipal government agencies used to develop an integrated incident management program.
 - Operational changes that were required to enable county and/or municipal systems to expand hours of operation, and in particular, if these systems were able to expand to provide 24/7 operations.
- **Technical Issues:**
 - Selection and use of standards—Conformance with National ITS Architecture, particular standards selected, and issues encountered in selecting and implementing standards.
 - Establishment of Data Exchange Protocols—Were agencies able to collect and exchange data; what format was developed for data exchange; and what information was exchanged?
 - Integration of State/local Systems—How was this accomplished, and what interfaces were developed?

- Establishment of Data Exchange Filters—Identifying what data elements needed to be exchanged, and when these should be exchanged.
- **Lessons Learned and Benefits:**
 - Project management and organization—How did the State and the county/municipal agencies share responsibilities?
 - What was the issue resolution process used and how well did the process work?
 - Funding—How did the State leverage Earmark funds to obtain additional funding from other sources?
 - How has integration impacted incident management? Qualitative assessment of improved detection, improved response times, change in procedures, reduced delay times, and enhanced data exchange capabilities.
- **Resource Requirements:**
 - Capital and operating costs.
 - State funding requirements.
 - Full-time employee (FTE) requirements for development, operations, and maintenance.

Evaluation Findings

At the time the data collection for the case study was completed in spring 2008, the CommuterLink expansion had been successfully deployed, based on a number of the following contributing factors:

- **Institutional:**
 - *Cooperative Working Relationships:* UDOT was proactive in working with the participating agencies in planning the CommuterLink expansion project. Monthly meetings were held with project agency staff to discuss and resolve issues, and all State and local agencies involved in the planning the expansion were included.
 - *Joint Requirements Development:* The key factor that contributed to the success of the CommuterLink expansion was that UDOT worked collaboratively with local and municipal agencies to document system requirements. This ensured that the needs of all project partners were identified and addressed as feasible.
 - *Operations and Maintenance (O&M) Requirements and Needs:* All O&M, both equipment and resources, were identified in advance and incorporated as part of the overall system expansion. Operations and maintenance are generally the responsibility of the system/equipment owner, and this approach enabled all participating agencies to plan for and request budget funds and technical resources to support CommuterLink in advance of the deployment.
 - *Expanded Operations:* Each stakeholder agency operates its system during normal business hours, and no agency has expanded their hours of operation. Instead of UDOT expanding its operations, it was resolved that the local and municipal agencies turn system control over to UDOT when the local personnel are not on duty. Salt

Lake City is an example of a jurisdiction that has adopted this approach. This approach enables UDOT to monitor local roadways in addition to the Interstate system, depending on the level of ITS infrastructure deployed in each jurisdiction. UDOT indicated that this has been accomplished through informal agreements with the participating local agencies.

- **Technical:**

- *Format Standards:* Utah currently uses the Institute of Electrical and Electronic Engineers (IEEE) 1512 standards for the CommuterLink system, which is used by both State and local/municipal agencies. Each local/municipal agency participating in the project has a workstation for the CommuterLink system so all agencies are using the centralized system.
- *Signal Management System:* In addition, nearly all State and local agencies use the same signal management system. The only exceptions are Provo and Orem, which each operate their own respective systems. UDOT and the two cities have reached an agreement where Provo and Orem will provide UDOT with their signal management software, which UDOT will then install as part of the CommuterLink system.
- *Browser-Based Application:* UDOT also is moving to a browser-based application that will eliminate the need to update the software installed on each workstation as system enhancements and upgrades are pushed through.
- *Building Excess Capacity:* A key to the success of the CommuterLink expansion has been that the system was designed to accommodate future expansion and added functionality. Building excess capacity into the system and modernizing hardware, as feasible, have helped ensure the successful expansion of the CommuterLink system. This design also has enabled the system to be upgraded as new technologies or system modifications become available.

- **Benefits:**

- *Integrated Traffic Signal Control:* The primary benefit identified by UDOT is that of integrated traffic signal control. UDOT noted that this functionality has been used to support planned events—an example cited was a presidential visit to Salt Lake City where UDOT took over signal control on the presidential route and surrounding roadways to manage traffic operations.
- *Improved Incident Response and Management Activities:* UDOT also indicated that the expansion of the CommuterLink system has improved incident response and management activities. While this information was anecdotal in nature, UDOT indicated that the system expansion had improved the ability of State and local/municipal agencies to detect and verify incidents and had contributed to reductions in both response time and incident-related delays. The system provides a larger area of coverage, which has improved incident detection and response capabilities.

- **Funding**
 - *External Funding Sources:* Utah has relied on multiple funding sources for the CommuterLink expansion. In addition to the Earmark funds, the State also has obtained CMAQ funding to support State and local/municipal agencies.
 - *State Funding Sources:* The State has been able to obtain State funding to support the expansion. UDOT noted that the rate of expansion depends on the level of funding obtained, and that the stakeholder groups meet and prioritize needs; as funding is obtained, particular components are deployed.

Lessons Learned

The Evaluation Team believes that the most significant lesson learned from the deployment is ***the importance of the working relationships that UDOT and other State and local/municipal agencies have developed.*** Without question, conducting joint requirements analysis and development has been a major factor in obtaining local buy-in and support. UDOT meets with all project partners on a regular basis and issues are resolved as they are identified. While this is done informally in many instances, the key point is that the time is taken to address and resolve each concern. Again, this approach has helped ensure local buy-in and support: partners are heard; concerns are addressed; and a working relationship is established, then cultivated for long-term mutual association. UDOT has been very flexible in addressing issues and meeting local needs.

Other lessons learned related to project management include:

- **Manage the Public's Expectations:** The system's primary purpose is to improve operations. The secondary purpose is to provide better information to the public. It is important not to give the public the impression that the system will be able to "work magic," rather, information provided on improving operations should be focused and very clear so as not to raise expectations that cannot be met.
- **Advance Planning is Critical for Long-Term Success:** Planning for hardware upgrades—type of equipment, resource requirements, funding; and planning for operations and maintenance—identify who is responsible for O&M and who determines resource requirements, training, and funding needs.

Conclusions

The ongoing expansion of the CommuterLink system in Utah continues to be a successful deployment. UDOT has adopted lessons learned from previous expansions into its overall planning and deployment strategies. Local agencies have been proactively involved and system and user requirements have been developed based on their needs as well as on those of UDOT. The system has been developed using open standards to ensure interoperability and has been developed so that additional and/or expanded functionality can be incorporated.

The Evaluation Team identified the following two key conclusions:

- **Conclusion #1:** The expansion of the CommuterLink system has been a success. The system is being deployed and used by the State and local/municipal agencies. As can be

noted in reviewing the interview notes, while issues remain, such as the control of traffic signal systems in the Cities of Orem and Provo,⁵ overall, the deployment has gone smoothly and issues are being successfully addressed.

- **Conclusion #2:** The success of the expansion is due in large part to the project management approach used by UDOT. The Evaluation Team recommends that other jurisdictions considering either a new deployment or expansion of an existing traffic management/traveler information system consider the lessons learned from the UDOT CommuterLink expansion, including the following elements:
 - ***Develop a Working Relationship with all Project Partners:*** This approach ensures that all partners are involved in the project and that the necessary lines of communication and information exchange are established. This approach also helps to ensure “buy-in” by project partners to support the project; the more involved partners are, the more ownership they will take of the process and final product.
 - ***Develop Joint Requirements:*** This approach helps to ensure that technical issues are proactively identified and addressed; that the needs of all project partners are incorporated into the system requirements; and further strengthens the building of working relationships with project partners.
 - ***Build Excess Capacity into the System:*** UDOT has placed a major emphasis on developing CommuterLink to accommodate future expansion. UDOT also has designed the system to incorporate additional or new functionality. This action ensures that new technologies or applications can be integrated and that CommuterLink will remain a robust system.

⁵ Discussed in the 7/26/07 UDOT TOC interview notes.

1.0 Introduction

1.1 Overview

The Utah Department of Transportation's (UDOT) Intelligent Transportation System (ITS), known as CommuterLink, to date has primarily been deployed in the Salt Lake City metropolitan area (Salt Lake County with some coverage on Interstate-15 [I-15] in Davis and Utah Counties).⁶ Thus far, the ITS deployments have been made possible through a combination of funding sources totaling \$70 million via Federal (\$17 million), State (\$52 million), and local resources (\$1 million), of which the ITS Earmarks play a critical role.⁷

The CommuterLink system uses technology to save time and money.⁸ According to UDOT statistics posted on the CommuterLink Website, the system has already helped increase peak-hour freeway speeds by 20 percent, and reduce freeway delays, traffic signal stops, and intersection delays by 36, 15, and 27 percent, respectively.⁹ These results are projected to save travelers in Utah more than \$100 million each year.¹⁰ The computer-controlled system is designed to monitor and manage traffic flow on freeways and surface streets using closed-circuit television (CCTV) cameras; dynamic message signs (DMS); the 511 Travel Information Line; and coordinated traffic signals, ramp meters, and sensors for traffic speed, volume, pavement, and weather. Travel information can be disseminated to the public via electronic roadway signs, radio, television, telephone, and the Internet.

Operators in the UDOT's Traffic Operations Center (TOC) monitor and manage traffic flow on surface streets and freeways. The UDOT TOC is connected to smaller Traffic Control Centers (TCCs) in Salt Lake City and Salt Lake County, as well as the Utah Transit Authority's (UTA) three Radio Control Centers. These agencies work together to improve travel along the Wasatch Front. The traffic, weather, and accident information collected at the TOC is communicated to Utah travelers via the 511 Travel Information Line, electronic roadway signs, radio, television, and the Internet. This information helps travelers "Know Before They Go" and enables them to make informed transportation decisions.

All real-time information gathered by CommuterLink is brought together at the UDOT's TOC. This 34,000-square-foot facility in the western area of Salt Lake City houses all the computer and communications systems, including a two-story wall of viewing screens and computer-generated traffic status maps, to allow TOC operators to make timely traffic-related decisions.

⁶Note: Most of the overview information describing the existing capabilities of the Utah CommuterLink system was obtained from the Utah CommuterLink Website, last accessed July 21, 2008:

<http://commuterlink.utah.gov/ie.htm>.

⁷Utah CommuterLink Website, Frequently Asked Questions (FAQ) page, last accessed June 25, 2008:

<http://www.commuterlink.utah.gov/ie.htm>.

⁸Dr. Joseph Perrin, R. Disegni, and B. Rama. "Advanced Transportation Management System Elemental Cost Benefit Assessment," University of Utah, March 2004.

⁹Utah CommuterLink Website FAQ page. The Website does not provide the methodology that was used to develop these estimates and does not include before and after data.

¹⁰Ibid.

Using advanced technologies such as CCTV cameras and traffic and weather sensors, TOC operators can monitor traffic, detect problems, and take actions necessary to return traffic flow to normal.

As traffic congestion throughout the State increases, so does the need to expand CommuterLink. UDOT and its partners are currently developing plans to expand the CommuterLink system into the heavily traveled areas both north and south of the current coverage, by expanding in Utah County (Provo area) and into Davis and Weber Counties (Ogden area). While it is evident that much has been accomplished in the Salt Lake area, there are ample opportunities for successful integration activities both to the north and south of the current coverage. By utilizing funds from this Earmark, as well as other funding sources, Davis, Weber, and Utah Counties are positioned to reap the benefits of ITS deployments. These counties are growing at a rapid pace and need to provide a more efficient and safer traveling experience throughout their regions. The expansion of CommuterLink in these areas is a beginning toward that end.

The Fiscal Year (FY) 2003 ITS Earmark was used to expand the CommuterLink system outside and beyond the Salt Lake Valley area by integrating across the jurisdictional boundaries of the Cities of Orem and Provo, Davis County, and the UDOT Regional Headquarters (St. George). With the exception of Davis County, each of these entities now operates its own TOC for the individual jurisdictions. However, each entity wants to operate as a linked system that shares information, utilizes shared resources, and coordinates traffic management across boundaries, while maintaining responsibility for the individual jurisdictions. Figure 1 presents a screen map of the Utah CommuterLink system with the areas targeted for expansion marked by arrows.¹¹

¹¹Source: Utah CommuterLink Website accessed June 25, 2008 at: <<http://www.commuterlink.utah.gov/ie.htm>>.

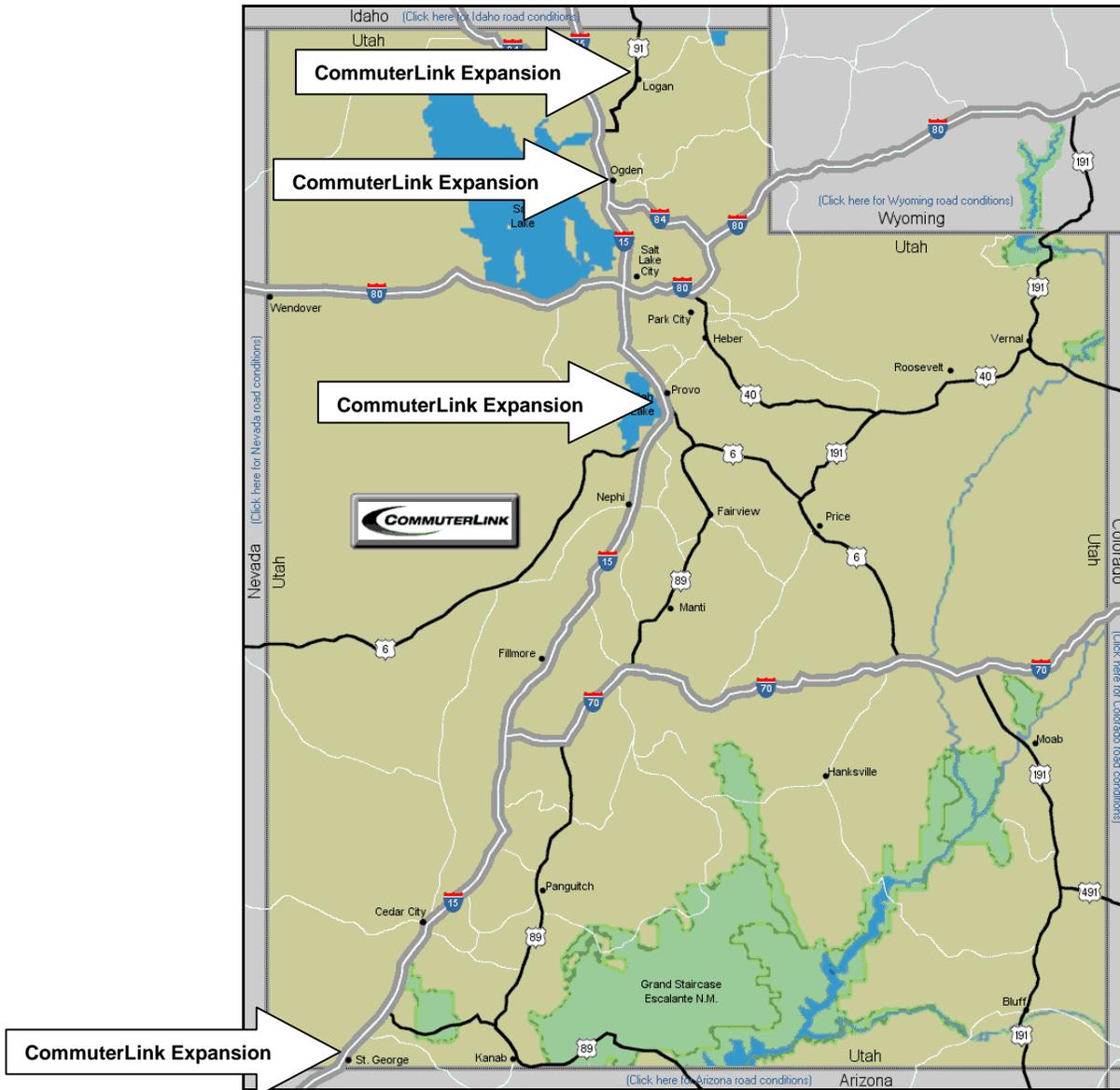


Figure 1. Utah CommuterLink system Expansion Viewed on June 25, 2008.

Source: CommuterLink software

This section describes the current capabilities of CommuterLink in these areas of recent expansion. The capabilities are discussed in terms of the subsystems currently included in CommuterLink:

- **Camera System:** CommuterLink uses more than 200 CCTV cameras. The cameras are spaced approximately every half mile on I-15, I-215, I-80, and the 2100 South Freeway. In addition, cameras are installed at various locations on US-89, US-6, I-84, and the Norman H. Bangerter Highway, as well as at key intersections on surface streets. Camera coverage also is expanding in the Ogden and Provo areas.

- **Video System:** The UDOT video system is shared with any agency interested in receiving or sharing video, and which already is connected to the UDOT fiber optic system. Most agencies in the expanded area of coverage (Utah, Davis, and Weber Counties) receive a view-only video feed. However, a few have control capabilities, specifically in the Bountiful, Ogden, Provo, and Orem areas. Provo and Orem also have video that is incorporated into the UDOT system. The other agencies typically do not have operations staff available to operate the video system.
- **Dynamic Message Signs:** Local agencies in the expanded coverage area have the ability to view the messages broadcast on the DMS throughout the region. The agencies do not have the ability to either control the signs or post new messages. If the agencies want a particular message on a sign, they must request it through UDOT. Additionally, UDOT is conducting a test using DMS to post travel times—if an ongoing 6-month trial produces positive results, then posted travel times will be added to the DMS throughout Salt Lake, Davis, Summit, and Utah counties.
- **Traffic Signals:** To help manage traffic on surface streets, CommuterLink operators monitor more than 600 traffic signals in the Salt Lake Valley. Using data from traffic sensors, the signal timing patterns can be adjusted to accommodate traffic demand and to help reduce stops and delays at intersections. In the event of a freeway accident, the signal timing can be changed to facilitate the additional traffic by maximizing the use of alternate routes on surface streets. Special timing patterns also can be used to help alleviate traffic delays caused by special events. With the exception of Provo and Orem, all other agencies in the expanded coverage area use the same signal control software via workstations that allow them to operate their signals through a central system. Since Orem and Provo have different signal control systems, they operate their own signals, and have incorporated some of the State signals into their systems. Provo and Orem are in the process of upgrading their central signal control software, and will provide a client to UDOT that will operate on UDOT operator workstations.
- **Traffic Monitoring Stations:** UDOT has expanded its coverage of traffic monitoring stations into Utah, Davis, and Weber Counties. The data from these stations is used to provide traveler information, such as the information displayed on the CommuterLink congestion map. The data also is archived so connected agencies can retrieve archived data through a file transfer protocol (FTP) site. (UDOT wasn't sure if any local agency used this feature. The primary FTP site users are research organizations such as the University of Utah.) UDOT makes the archived data available via the FTP site every month, and agencies have access to real-time data through CommuterLink stations. UDOT also has a standards-based Web service that distributes data in real-time to media outlets.
- **Traveler Information:** UDOT has expanded its traveler information coverage into Utah, Davis, and Weber Counties to incorporate the new traffic monitoring stations. The information is primarily distributed through the Web, the 511-phone system, and the few DMS outside Salt Lake County.
- **Event Reporting System:** UDOT inputs information about incidents, construction, and other events in its event reporting system, and provides information access to local agencies.

UDOT staff centrally input the data, which can be viewed by all. Since most agencies don't have the staff and resources to actively manage the system, UDOT has determined that this is the best approach to ensure information is input and updated in a timely fashion.

1.2 Evaluation Areas of Federal Interest

The State of Utah continues to have a strong record of success with addressing the institutional, technical, and operational issues involved with the deployment of ITS projects, as evidenced by the State's successful deployment of the Federal Highway Administration (FHWA)-sponsored Computer-Aided Dispatch – Traffic Management Center (CAD-TMC) Integration Field Operational Test (FOT). The expansion of the CommuterLink system to county and municipal jurisdictions within the Salt Lake and Utah Valley areas provided the opportunity to conduct a qualitative case study assessment of a number of issues of interest to FHWA and the Research and Innovative Technology Administration (RITA) ITS Joint Program Office (JPO).

The most significant benefits derived from conducting the evaluation of this Earmark include the documentation of the institutional and technical issues and lessons learned. Utah has a well-established working relationship among State agencies (UDOT, Utah Highway Patrol [UHP], and UTA), as well as local agencies in and around Salt Lake City (Valley Emergency Communications Center, and Salt Lake City Fire and Police Departments). The process, by which these issues were resolved, in particular, between State and local government agencies, will be of value to other States considering similar deployments. This process will be a valuable addition to the existing body of "lessons learned" currently available for States, governments, and other stakeholder groups.

1.3 Report Organization

The report presents the CommuterLink Expansion Case Study Evaluation Final Report. The remainder of the document is organized as follows:

- **Section 2.0 Case Study Evaluation Methodology.** This section provides an overview of the evaluation approach.
- **Section 3.0 Case Study Results.** This section presents the case study findings, benefits, and lessons learned.
- **Section 4.0 Conclusions.** This section presents the key conclusions derived from the case study.

2.0 Case Study Evaluation Methodology

2.1 Evaluation Approach

This evaluation was conducted as a case study and as a qualitative assessment of the Utah CommuterLink expansion project. The following elements were included in the evaluation:

- **Institutional Issues:**
 - Cooperative working relationships between the State and local/municipal government agencies that were established.
 - Methods that the State and local/municipal government agencies used to develop an integrated incident management program.
 - Operational changes that were required to enable county and/or municipal systems to expand hours of operation, and in particular, if these systems were able to expand to provide 24/7 operations.
- **Technical Issues:**
 - Selection and use of standards—Conformance with National ITS Architecture, particular standards selected, and issues encountered in selecting and implementing standards.
 - Establishment of Data Exchange Protocols—Were agencies able to collect and exchange data; what format was developed for data exchange; and what information was exchanged?
 - Integration of State/local Systems—How was this accomplished, and what interfaces were developed?
 - Establishment of Data Exchange Filters—Identifying what data elements needed to be exchanged, and when these should be exchanged.
- **Lessons Learned and Benefits:**
 - Project management and organization—How did the State and the county/municipal agencies share responsibilities?
 - What was the issue resolution process used and how well did the process work?
 - Funding—How did the State leverage Earmark funds to obtain additional funding from other sources?
 - How has integration impacted incident management? Qualitative assessment of improved detection, improved response times, change in procedures, reduced delay times, and enhanced data exchange capabilities.
- **Resource Requirements:**
 - Capital and operating costs.
 - State funding requirements.

- Full-time employee (FTE) requirements for development, operations, and maintenance.

2.2 *Data Collection Activities*

The Evaluation Team used the following data collection techniques to obtain the information needed for the case study:

- **User Interviews:** The Evaluation Team worked with UDOT and other stakeholder agency staff and project participants to identify and schedule the appropriate personnel to be interviewed. Activities included developing interview guides, and conducting interviews in person. The interviews were conducted in two phases during the project: first, to discuss and document deployment and development issues, and second, to document operating experience. The interviews were conducted after project partners had time to gain operating experience.
- **Document Review:** The Evaluation Team worked with UDOT and project participants to identify relevant documents, such as inter-agency agreements or memoranda of understanding, for review during the course of the evaluation.
- **Participation in Stakeholder Meetings:** The Evaluation Team originally proposed attending a statewide Traffic Management Committee meeting, which included subject-specific subcommittees such as the Incident Management Coordination Committee. However, these meetings met as needed and none were scheduled during the evaluation period.

2.3 *Metrics Used to Measure Project Success*

Following are the metrics used to measure project success:

- Number of agencies involved with the project. This included identifying agencies that at some point decided not to participate in the project, as well as those that chose to continue their participation.
- Joint operation of:
 - Camera control.
 - Sign control.
 - Traffic signal systems.
- Adoption of standards (such as the Institute of Electrical and Electronics Engineers [IEEE] 1512 standards) by all project stakeholder agencies governing data exchange and communications.

3.0 Case Study Results

This section presents the case study results obtained through interviews with the following agencies and individuals:

- UDOT Traffic Operations Center – Mark Taylor, Signal Operations; Chris Siavrakas, TOC Control Room Manager; and Brad Cameron, UDOT Project Manager.
- Provo City – Casey Seer and Dave Graves.
- Orem City – Keith Larsen and Adam Lough.
- UDOT TOC – Dave Kinnecom, Traffic Management Division Leader.
- UDOT TOC – Brad Cameron, UDOT Project Manager, and John Grant, TransCore.
- UDOT TOC – Bryan Chamberlain, Project Manager.

The interview questions and interview results are included in the appendix to this report.

The presentation of case study results tracks back to the evaluation methodology presented in section 2 of this report.

3.1 Findings

Following is a summary of the institutional and technical findings.

Institutional

- **Cooperative Relationships:** UDOT was proactive in working with the participating agencies in planning the CommuterLink expansion. All State and local agencies involved planning the expansion participated in monthly meetings to discuss and resolve issues. To the State's credit, agencies from jurisdictions that were not in the initial phase of the CommuterLink expansion were included as full partners, which helped obtain local buy-in and support.

The key factor that contributed to the success of the CommuterLink expansion was that UDOT worked collaboratively with local and municipal agencies to document system user requirements. By utilizing this approach, UDOT ensured that:

- *Stakeholder Needs:* The CommuterLink expansion focused on meeting the needs of all stakeholder groups, not just a select group of agencies, and that the expansion was a collaborative effort rather than a top-down deployment.

- *Local/Municipal Agency Component Ownership:* Local and municipal agencies were able to take ownership of their CommuterLink components due to being included in the initial requirements identification and documentation phase of the deployment.
- *Operations and Maintenance (O&M) Needs:* In addition, the O&M requirements and needs, for both equipment and resources, were identified in advance and incorporated as part of the overall system expansion. Operations and maintenance are generally the responsibility of the system/equipment owner, and this approach enabled all participating agencies to plan for and request budget funds and technical resources to support CommuterLink in advance of the deployment. This approach gave all agencies the advance time needed to work through their respective budget processes in a timely manner.
- **Integrated Incident Management Program:** Utah has established a state-wide Traffic Management Committee that includes UDOT; UHP; UTA; Metropolitan Planning Organizations (MPOs); and municipalities from around the State, including Emergency Medical Services (EMS), and fire and rescue agencies. The Committee has established technical subcommittees to coordinate operations for specific issues including incident management and traffic signal planning issues. While the responsibility for system management depends on the system component—the Interstate system is managed by the State, while municipal and city agencies manage their road systems—the State is able to coordinate activities through the state-wide Committee. These forums provided opportunities for the stakeholder groups to meet and be able to develop coordinated incident response procedures.

UDOT and UHP currently have a well established incident management program. The agencies participated in an FHWA-sponsored CAD-TMC integration pilot project and have the technical capability to exchange incident data on a real-time basis. As part of this program, the agencies have developed procedures for time-stamping incident duration. The timestamp is based on the activities of all response agencies, not just a particular agency, and can be used to measure the entire incident duration. This FOT included the Valley Emergency Communications Center, an agency, which handles incident response calls for local and municipal agencies, the UTA, and the Salt Lake City Police and Fire Departments.

- **Expanded Operations:** Each stakeholder agency operates its system during normal business hours, and no agency has expanded its hours of operation. To expand operations, local and municipal agencies turn system control over to UDOT when the local personnel are not on duty. Salt Lake City is an example of a jurisdiction that has adopted this approach, which enables UDOT to monitor local roadways in addition to the Interstate system, depending on the level of ITS infrastructure deployed in each jurisdiction. UDOT indicated that this expanded operations approach has been accomplished through informal agreements with the participating local agencies.

Technical

- **Format Standards:** Utah currently uses the IEEE 1512 standards for the CommuterLink system, which is used by State and local/municipal agencies. Each local/municipal agency participating in the project has a workstation for the CommuterLink system so all agencies are using the centralized system.
- **Signal Management System:** Nearly all State and local agencies use the same signal management system. The only exceptions are Provo and Orem, which each operate their own respective systems. UDOT and the two cities have reached an agreement where Provo and Orem will provide UDOT with their signal management software, which UDOT will then install as part of the CommuterLink system. Each agency is responsible for operating and maintaining the signal management system in their respective jurisdiction. This ensures that the systems are operated to meet local needs, while still having the functionality to support expanded operations as necessary.
- **National Transportation Communications for ITS Protocol (NTCIP) Standards:** The State also is using the NTCIP standards for traffic signal control, although UDOT indicated that problems have been encountered. Specifically, the Orem and Provo systems were not interoperable with the State system even though all systems used the NTCIP standards. The State also indicated that in some jurisdictions where systems and/or equipment were not modernized, communications using NTCIP were problematic.
- **Internet Protocol (IP) Addressing:** UDOT initially planned on point-to-point communications with each participating agency. This created problems for some of the smaller jurisdictions, and as a result, the communications system is starting to use IP addressing. This has significantly improved overall communication and made use of the existing fiber optic network more efficient.
- **Browser-Based Application:** UDOT also is moving to a browser-based application that will eliminate the need to update the software installed on each workstation as system enhancements and upgrades are pushed through.
- **Fiber Optic Cabling:** UDOT emphasized the importance of laying as much fiber optic cable as possible, and underscored the importance of establishing in-house expertise with cable installation and use. The State further emphasized that it was important that any contractors hired to install fiber optics have the appropriate expertise as well.

3.2 Benefits

Following is a summary of the CommuterLink system benefits:

- **Integrated Traffic Control:** The primary benefit identified by UDOT is that of integrated traffic signal control. UDOT noted that this functionality has been used to support planned events. One example cited was a presidential visit to Salt Lake City where UDOT took over signal control on the presidential route and surrounding roadways to manage traffic operations.

- **Improved Incident Response Time and Management Activities:** UDOT also indicated that the CommuterLink system expansion has improved incident response and management activities. While this information was anecdotal in nature, UDOT affirmed that the system expansion had improved the ability of State and local/municipal agencies to detect and verify incidents, and had contributed to reductions in both response time and incident-related delays. The system provides a larger area of coverage, which has improved incident detection and response capabilities.
- **Improved Incident-Related Data Exchange Capabilities:** Since agencies are able to use the CommuterLink workstation to both send and receive incident data, improvements in incident-related data exchange capabilities have been realized.

3.3 Resource Requirements:

Utah has relied on multiple sources of funding for the CommuterLink expansion. In addition to the Earmark funds, the State also has obtained and used Congestion Mitigation and Air Quality (CMAQ) funding to support State and local/municipal agencies. The State also obtained State funding to support the expansion. UDOT noted that the rate of expansion depends on the level of funding obtained, and that the stakeholder groups meet and prioritize needs; as funding is obtained, particular components are deployed.

UDOT indicated that two new personnel had been hired to support system operation. Given the expansion of system coverage, more operators are needed to manage system-generated data. The personnel hired are contracted personnel provided by a state-contracted staffing agency.

Including the Earmark funds, following information summarizes the sources and amounts of funding for the CommuterLink expansion:

- State funding:
 - \$3 million for capital expenditures.
 - \$4.15 million for system maintenance.
 - \$2 million for traffic signal upgrades.
- CMAQ funding: \$3 million.

Additional State funding also was provided through an EMS maintenance program and infrastructure included in highway projects.

3.4 Metrics Used to Measure Project Success

No municipal or local government agency dropped out during the course of the project. There have been some delays with the system expansion implementation in the Cities of Ogden and Provo, where technical issues have been problematic. The only exception is Sandy City, which has not determined if it will join independently or be represented by the county government.

As of April 2008, 15 of 16 municipal and local government agencies that were invited to participate in the expansion project have accepted the CommuterLink expansion, as listed below.

- Ogden
- Bountiful
- Salt Lake City
- Layton
- Davis County
- Weber County
- Cache Valley MPO
- Wasatch Front MPO
- Logan
- Provo
- Orem
- Salt Lake County (represents smaller cities)
- St. George
- UTA
- University of Utah
- American Fork
- Spanish Fork
- FHWA
- Department of Public Safety (DPS)

Initially, it was expected that more than 80 percent of local governments would participate. Since this level was exceeded, the project was deemed to have been a success.

All participating agencies have received or will receive CommuterLink workstations, which will provide access to the CommuterLink system. All CommuterLink interactions will be accomplished using the IEEE 1512 standards. At present, camera images are exchanged using encoders and decoders to enable the exchange between agencies and systems. Weather information also is exchanged using the Clarus exchange format. Traffic data is provided to Traffic.com and other traffic information service providers using the Traffic Management Data Dictionary data elements.

As noted, all localities and the State use the same signal control system, with the exception of Orem and Provo. Signal management can be shared as necessary, and once the Orem and Provo signal system software is installed by UDOT, signal management will be shared with these agencies as well. Once this is completed, the expansion project will enable the joint operation of camera, signal and traffic signal control systems.

3.5 Lessons Learned

Project Management

The Evaluation Team believes that the most significant lesson learned from the deployment is *the importance of the working relationships that UDOT and other State and local/municipal agencies have developed*. Without question, conducting joint requirements analysis and development has been a major factor in obtaining local buy-in and support.

As noted, UDOT meets with all project partners on a regular basis, and issues are resolved as they are identified. While these meetings are conducted informally in many instances, the key point is that the time is taken to address and resolve each concern. Again, this approach has helped ensure local buy-in and support—partners are heard, concerns are addressed, and a working relationship is established, then cultivated for long-term mutual association. UDOT has been very flexible in addressing issues and meeting local needs. Other lessons learned related to project management include:

- **Manage the Public’s Expectations:** The system’s primary purpose is to improve operations. The secondary purpose is to provide better information to the public. It is important not to give the public the impression that the system will be able to “work magic,” rather, information provided on improving operations should be focused and very clear so as not to raise expectations that cannot be met.
- **Advance Planning:** It was determined that advanced planning is critical for long-term success, and can be accomplished by:
 - Planning for hardware upgrades, including types of equipment, resource requirements, and funding.
 - Determining O&M needs by identifying who is responsible for overall O&M, and in determining resource requirements and funding needs.
 - Developing a Training Plan and identifying who needs training, what training is needed, how it will be provided, and by whom.

System Design and Technical Requirements

A key to the success of the CommuterLink expansion project has been that the system was designed to accommodate future expansion with added functionality. By building excess capacity into the system and modernizing hardware, as feasible, this design has helped ensure the successful expansion of the CommuterLink system. This design also has enabled the system to be upgraded as new technologies or system modifications become available. Specific actions taken by UDOT included:

- **Building Additional Work Stations at the Salt Lake City TOC:** Initially, only three work stations were required, but room was provided for six work stations to accommodate future expansion.

- **Routing Cable Connections:** The connecting cables were routed into the TOC through two sides of the building to ensure redundancy by having two separate paths for information flow. Extra conduit banks were added to provide increased capacity.
- **Planning Additional Server Space in Existing Locations:** Extra space was included in the server locations to allow for installation of additional servers in the future as required by expansion.
- **Accommodating Cabinet Size for Future Installations:** Size 6 cabinets were used when installing CommuterLink infrastructure at intersections to ensure that the cabinets had room to accommodate future CCTV and/or video equipment installations.
- **Installing Detectors in all Ramps:** Detectors were installed in all ramps rather than only those ramps initially included in the system. This action ensured that all ramps were equipped with the necessary infrastructure so that no further installation was required as ramp metering system coverage was expanded or as additional ramps are brought online.
- **Standardizing Formats to Manage Data and Increase Data Flow:** UDOT discovered that the CommuterLink system expansion significantly increased the amount of data being received. The State determined that the best way to manage the increased data flow was for all information to be brought into a central location, and then sent out in multiple formats tailored to the application. Standardized data formats and protocols were needed to ensure data consistency and quality, as well as to ensure that operators were able to properly manage the data being received.
- **Providing Staffing for Data Management Activities:** The State also discovered that many organizations were interested in gaining access to the data, including MPOs and other groups within UDOT. In addition to developing the data formats and protocols, UDOT also had to provide staffing to manage data and plan for data feeds. The State emphasized the importance of including planning for management of data as a key element of project planning: identifying who wants access to data; what data is needed; how data will be used; and how to provide the data to these agencies.

Interoperability

- **Interoperability and Data Exchange:** The National ITS Architecture and the IEEE 1512 standards were used to help ensure interoperability and open exchange of data.
- **Open Standards Used to Overcome Signal Control Issues:** Some problems have been encountered where local jurisdictions are using proprietary signal control systems, but the overall system is designed to promote interoperability through the use of open standards.

Funding

- **Creative External Funding Sources:** UDOT's continued use of creative funding is critical to the ongoing success of the CommuterLink expansion. In particular, working with MPOs to obtain programmatic support and access to CMAQ funding has been of significant benefit to the project. UDOT always has partnered with local agencies when applying for CMAQ funding. This partnership demonstrates that the benefits will be realized by both State and local agencies, and has helped gain support from MPOs providing CMAQ funding approval.
- **Cost/Benefit Analysis:** In 2004, UDOT commissioned the University of Utah to conduct a cost/benefit analysis of the CommuterLink system. The report¹² quantified benefits by system component and type of benefit (reduced delay, improved safety, environmental) per component, and estimated a total benefit of \$179 million and a benefit/cost ratio of 16.7. Of this benefit, some \$35.6 million were estimated to be environmental benefits (reduced emissions, reduced fuel consumption, fewer stops). This study also has been of significant benefit to the State when seeking additional funding from all sources, which demonstrates quantifiable benefits from the CommuterLink deployment has been a key in maintaining management and legislative support.

¹²Dr. Joseph Perrin, "Advanced Transportation Management System Elemental Cost Benefit Assessment," UDOT (March 2004).

4.0 Conclusions

The ongoing expansion of the CommuterLink system in Utah continues to be a successful deployment. UDOT has adopted lessons learned from previous expansions into its overall planning and deployment strategies. Local agencies have been proactively involved and system requirements have been developed based on the agencies' needs as well as for UDOT. The system has been developed using open standards to ensure interoperability, and with forethought and planning, so that additional and/or expanded functionality can be incorporated for future needs.

The Evaluation Team identified the following are the two key conclusions:

- **Conclusion #1:** The expansion of the CommuterLink system has been a success. The system is being deployed and used by the State and local/municipal agencies. As can be noted in reviewing the interview notes, while issues remain, such as the control of traffic signal systems in the Cities of Orem and Provo,¹³ overall, the deployment has gone smoothly and issues are being successfully addressed.
- **Conclusion #2:** The success of the expansion is due in large part to the project management approach used by UDOT. The Evaluation Team recommends that other jurisdictions considering either a new deployment or expansion of an existing traffic management/traveler information system consider the lessons learned from the UDOT CommuterLink expansion:
 - ***Develop a Working Relationship with all Project Partners:*** This approach ensures that all partners are involved in the project and that the necessary lines of communication and information exchange are established. This approach also helps to ensure “buy-in” by project partners to support the project; the more involved partners are, the more ownership they will take of the process and final product.
 - ***Develop Joint Requirements:*** This approach helps to ensure that technical issues are proactively identified and addressed; that the needs of all project partners are incorporated into the system requirements; and further strengthens the building of working relationships with project partners.
 - ***Build Excess Capacity into the System:*** UDOT has placed a major emphasis on developing CommuterLink to accommodate future expansion. UDOT also has designed the system to incorporate additional or new functionality. This action ensures that new technologies or applications can be integrated and that the CommuterLink system will remain a robust system.

¹³ Discussed in the July 26, 2007 UDOT TOC interview notes.

APPENDIX: Stakeholder Interviews

UDOT CommuterLink Expansion Interview Questions

- **Institutional Issues:**

- How were cooperative working relationships between the State and local/municipal government agencies established?
- How did the State and local/municipal government agencies develop an integrated incident management program?
- Did county and/or municipal agencies expand hours of operation? Did they expand to provide 24/7 operations? Were there other operational changes required as part of the CommuterLink expansion?
- How many agencies are involved with the project? (List involved agencies.)
- Are there any agencies that at some point decided not to participate in the project? (List agencies.) Why did they drop out?

- **Technical Issues:**

- How many interfaces with other agencies have been completed? (List agencies.)
- What systems have been integrated with each agency?
 - Camera control.
 - Sign control.
 - Traffic signal systems.
- What standards were used to enable the CommuterLink expansion? Were they selected to be in conformance with the National Architecture? What standards were selected? Were there issues encountered in selecting and implementing standards? If so, what?
- Did all agencies involved adopt these standards for use?
- Were agencies able to collect and exchange data? What format was developed for data exchange? What information was exchanged?
- How was the integration of State and local systems accomplished? What interfaces were developed?
- What data elements needed to be exchanged? When (under what conditions) are these elements exchanged? Were any filters used?

- **Lessons Learned and Benefits:**

- Project management and organization: How did the State and the county/municipal agencies share responsibilities?
- Was an issue resolution process used? If so, what was used? How well did the process work?

- Funding—How did the State leverage Earmark funds to obtain additional funding from other sources?
- How has integration affected incident management? (Qualitative assessment of improved detection, improved response times, change in procedures, reduced delay times, and enhanced data exchange capabilities.)
- **Resource Requirements:**
 - What capital and operating costs are required? Include source of funds, including Earmark money.
 - What were the FTE requirements for development, operations and maintenance?

When: **Thursday, July 26, 10 a.m. – Noon**

Where: UDOT Traffic Operations Center

Who: Mark Taylor, Signal Operations; Chris Siavrakas, TOC Control Room Manager; Brad Cameron, UDOT Project Manager.

- **Institutional Issues:**

- How were cooperative working relationships between the State and local/municipal government agencies established?

These relationships have been in place for over 6 years in Salt Lake County. Dave Kinnecom got things established. Have an inter-agency agreement, but never really have to look at it. Any given agency has access to all the agencies' data, including ability to change signal timing. Rarely use this feature, but do in emergencies. Agency staff meetings are held every other month. Address small issues before they get big. Agree on strategy. In other counties, these meetings have not been in place as long.

Good personal relationships. UDOT has a culture of being open and cooperative. The Winter Olympics helped.

Davis and Weber Counties started later, but was going well, meeting every 3 months. Internal turnover has slowed the progress.

Utah County is not as smooth. Years ago, UDOT traffic engineer gave the operation of the State signals over to the agencies in the County. (Provo and Orem felt they were abandoned years ago and asked to get operational authority; now they feel they are doing a good job). They have a legacy system and sole source new signals. That system can't interoperate with the UDOT standards-based system. Orem and Provo are sharing camera images, but they use different encoders and decoders (purchased decoders and encoders that aren't compatible with UDOT encoders and decoders). They have agreed to provide a copy of their central signal system when they upgrade. They have a strong feeling of independence.

UDOT has been successful with connecting to the smaller cities in the County.

- How did the State and local/municipal government agencies develop an integrated incident management program?

The first hurdle was getting internal support and resources in UDOT. Incident Management Team (IMT) first was established in 1994 or 1995 in Salt Lake County, and expanded to the other two regions (1 and 3) before the Olympics. UDOT has a very close working relationship with the UHP.

The incident management program works very well in Salt Lake County and pretty well in Utah County (UHP dispatch out of TMC for those two counties). Davis and Weber Counties are a little more difficult because UHP is dispatched out of the local agencies. The relationships are not as close there.

-
- Did county and/or municipal agencies expand hours of operation? Did they expand to provide 24/7 operations? Were there other operational changes required as part of the CommuterLink expansion?

Not that UDOT is aware. Salt Lake City asks UDOT to change signal timings after hours. After-hour traveler information would be through UDOT, but rarely necessary for incidents on local streets or roads.

- How many agencies are involved with the project? (List involved agencies.)

- Ogden
- Bountiful
- Salt Lake City
- Layton
- Davis County
- Weber County
- Cache Valley MPO
- Wasatch Front MPO
- Logan
- Provo
- Orem
- Salt Lake County (represents smaller cities)
- St. George
- UTA
- University of Utah
- American Fork
- Spanish Fork
- FHWA
- DPS

- Are there any agencies that at some point decided not to participate in the project?(List agencies.) Why did they drop out?

Sandy City is trying to decide if it is going to be represented by the county or join independently.

- **Lessons Learned and Benefits:**

- Project management and organization: How did the State and the county/municipal agencies share responsibilities?

UDOT is lead and the local agencies work off UDOT project managers. Local agencies take an active role in coordination and setting priorities. Local agencies don't have the resources to keep up to date with current technologies. Local agencies monitor signals for on-line and off-line.

- Was an issue resolution process used? If so, what was used? How well did the process work?

Not sure – check with Brad and Dave. Haven't had to use it.

- How has integration affected incident management? (Qualitative assessment of improved detection, improved response times, change in procedures, reduced delay times, and enhanced data exchange capabilities.)

Better camera coverage, more data stations. Not sure there has been significant delay reduction, but better information is collected to determine the correct response. The integration helps in formulating correct response more quickly.

- **General Lessons Learned:**

- Original communication was via a daisy-chained modem. Now, when UDOT is upgrading to NTCIP, there are problems with communicating to the agencies on the channel without upgrading their equipment—keep communication channels independent agency to agency. IP over Ethernet works well.
- Manage expectations of the public. The system's primary purpose is to improve operations. The secondary purpose is to provide better information to the public.
- Need to have operations and maintenance resources to support the capital system.
- Need to consider how to train new local agency personnel and turnover.
- Need specialized skill and knowledge about fiber. Not as easy as copper wire. The design of the communication system is critical. Need a balance of in-house expertise and contracted-out skills.
- How to pay for new software or other upgrades? How to actually implement software upgrade for all the users of the system?
- UDOT is moving to browser-based applications so each workstation doesn't have to be upgraded when new features are implemented.

- Think about how to upgrade hardware (workstation) in advance. Try to see as far in the future as possible.
- Suggest installing as much conduit/fiber as possible.
- Planning for expansion is important.
- All information needs to be brought into a central location and then sent out in multiple formats tailored to the application. Standardized formats and protocols are needed – this is important.
- There is a lot of interest from MPOs and other groups within UDOT in getting access to data. There is so much data coming in, it is difficult to get the real-time data in the format they need. Need to provide staffing to manage data and plan for data feeds. Management of data should be planned for from day 1. Find out who wants data, what they want, and how to provide it.
- Evaluation and performance measures are important. How to separate ITS improvements from other improvements? How much benefit overall due to ITS improvements.

When: **Thursday, July 26, 1 p.m.**

Where: Provo City Offices

Who: Provo City – Casey Seer and Dave Graves

Address: 1377 South 350 East, Provo, UT

- **Institutional Issues:**

- How were cooperative working relationships between the State and local/municipal government agencies established?

Overall relationship is good. Initially, UDOT was a little more directive. Over time, both have met in the middle. UDOT has learned some policy and procedure that Provo hasn't learned yet. So, procedures are developing and people are learning about one another. Provo City staff didn't feel that they were fully apprized of the policy.

A lot of the policy was developed in Salt Lake County and support was focused there more. Provo and Orem developed more independently. Geographic separation means that the local agencies need to be a little more independent. Can still make the systems seamless.

- How did the State and local/municipal government agencies develop an integrated incident management program?

Haven't been really involved.

- Did you expand hours of operation? Did you expand to provide 24/7 operations? Were there other operational changes required as part of the CommuterLink expansion?

No.

Equipment has allowed UDOT to see into Utah County, but Provo has not been able to make use of 24/7 operation at UDOT.

- **Technical Issues:**

- What systems have been integrated between you and UDOT?
 - Camera control.
 - Sign control.
 - Traffic signal systems.

CCTV cameras are shared (seamless); 48 cameras, 5 from UDOT. All are on City's network.

No variable message signs (VMS) in Utah County.

Provo manages traffic signal system throughout the City. They are working to provide UDOT access to signal system for special events and other events. They will provide a client to UDOT to access the Provo server. (The current UDOT system and the Provo system don't communicate with one another.)

Data collection not integrated yet.

Video detection not integrated yet, either.

- Were you involved in any discussion of standards? Did you adopt any standards for use?

City follows the State lead in following national standards. Provo has started to look at outputting NTCIP status. Both Provo and UDOT wanted to do more than just share status. The NTCIP protocols available from both systems for client-to-client (C2C) isn't rich enough to do what both agencies want. Improvements are being made in the upgrades of the central system that will make C2C broader and richer. (Provo is on the UDOT network.)

Provo is moving toward a centralized database and managing data rather than managing devices.

- What information do you exchange with UDOT? Were any filters used to limit the information exchanged (e.g., by function, by geographic area)?
 - Camera images.
 - Camera control.
 - Working on signal control client at UDOT.
 - Traffic data stations also will eventually exchange data. UDOT is trying to figure out what they want (how to filter).

- **Lessons Learned and Benefits:**

- Project management and organization: How did you share responsibilities with UDOT?

Responsibilities are shared based on who owns the devices or systems. Shared fiber.

- Was an issue resolution process used? If so, what was used? Did you ever have to use it? How well did the process work?

Provo entered into an agreement with UDOT. No dispute resolution process deemed necessary.

- How has integration affected incident management? (Qualitative assessment of improved detection, improved response times, change in procedures, reduced delay times, and enhanced data exchange capabilities.)

Not involved, but City dispatch would like to be more involved. Provo Public Safety Answering Point (PSAP) center is not on the UDOT network.

- **Resource Requirements:**

- Did you contribute any funding for Capital or Operating expenses?

There may be some funding from MPO to CommuterLink. Otherwise, Provo funds capital and operation for their equipment, UDOT for UDOT's.

- Did you have any additional FTE requirements for development, operations, and maintenance of the system? If so, how much?

Not because of CommuterLink, but did increase staff because of expansion of Provo devices. CommuterLink may have been a catalyst in the expansion.

- **General Lessons Learned:**

- It is important to consider the partnership from every side. Local presence in operating and managing is important.
- Make sure you do your homework on interoperability to make it as easy as possible to share.
- Make sure you don't lock yourself out of expandability in design—design for the future.
- Design in extra capacity. Have spares in stock.

When: **Thursday, July 26, 3 p.m.**

Where: Orem City Offices

Who: Orem City – Keith Larsen and Adam Lough

Address: 1450 West 550 North, Orem, UT

- **Institutional Issues:**

- How were cooperative working relationships between the State and local/municipal government agencies established?

Orem always has had a good relationship with UDOT, mostly through Region 3. Orem has been managing traffic for years. They had an established working relationship with Region 3. (Orem operates the signals, Region 3 maintains. As the Traffic Management Center (TMC) started to be developed, Orem worked with Headquarters (Dave Kinnecom). Orem matched the Provo system.

TMC didn't consider Utah County when they first developed the Advanced Transportation Management Systems (ATMS). Then asked that Orem conform to what they wanted. CommuterLink wasn't ready for Orem at first and Orem had to make some decisions on what to use. Would like more say in some of the decisions. UDOT didn't seem to think Orem had the know how to put the systems in place. It is getting better now.

Think about how system might need to expand and needs in the area of potential expansion.

- How did the State and local/municipal government agencies develop an integrated incident management program?

Not involved yet. UDOT will come into the City's Traffic Operations Center (TOC) during events to help manage. Orem would like to enter events in the CRS directly. They are supposed to get access. (Orem can handle planned events pretty well, but not emergencies yet; upgrading signal system).

Suggest unique log-in (right now, one log-in for all Utah County.)

- Did you expand hours of operation? Did you expand to provide 24/7 operations? Were there other operational changes required as part of the CommuterLink expansion?

Orem has chosen to extend their hours and staff for events. But not required by UDOT and integration didn't necessitate expansion. Turn operation over to UDOT TMC at 6:00 and they can monitor the network and can call out City staff. UDOT will be getting signal system client so they will be able to do more.

Needed to work to show Orem's system could work with UDOT system.

- **Technical Issues:**

- What systems have been integrated between you and UDOT?

- Camera control.
- Sign control.
- Traffic signal systems.
- CCTV.

Would like to get some signs and could integrate those. Orem can see the signs in Salt Lake County now. Orem wants to share control of those signs. Won't be able to program the UDOT signs when they are expanded to Utah County (Orem is OK with that).

Orem will integrate traffic data.

Can see incidents and have access to traffic data.

Orem will provide a client for the signal system.

Want to be integrated as well as possible. Want to get information to public.

- Were you involved in any discussion of standards? Did you adopt any standards for use?

Developed an architecture. Probably need to look at updating it.

New signal system will be NTCIP compliant.

- What information do you exchange with UDOT? Were any filters used to limit the information exchanged (e.g., by function, by geographic area)?

Share camera images. Get incident information. Want to exchange traffic data. Orem hasn't thought about filtering yet. Orem would like to have the arterials in Orem included on the UDOT congestion map.

Have some concern over security—right now, very limited number of people have access to the Orem system.

- **Lessons Learned and Benefits:**

- Project management and organization: How did you share responsibilities with UDOT?

Orem can move the UDOT cameras and operate. UDOT maintains their equipment and Orem maintains theirs.

For field devices, generally whoever gets there first will correct the problem. Locates go with whoever owns the road.

- Was an issue resolution process used? If so, what was used? Did you ever have to use it? How well did the process work?

Have an agreement with UDOT for ATMS. No need for dispute resolution to this point.

- How has integration affected incident management? (Qualitative assessment of improved detection, improved response times, change in procedures, reduced delay times, and enhanced data exchange capabilities.)

The integration provided visibility into the incident response system. No formal role in incident management. Orem is considering more incident management capabilities.

- **Resource Requirements:**

- Did you contribute any funding for Capital or Operating expenses?

Orem funded fiber and the devices they own and operate. City funds operation and maintenance of their devices. Signals use multi-mode fiber so City purchases the modem when UDOT installs new signals in the City.

- Did you have any additional FTE requirements for development, operations, and maintenance of the system? If so, how much?

No, did not have to add staff. The City has changed the tasks that they do, however. Save time in some areas, spend more time in others.

The City would like to have an operator in the TOC continuously from morning through evening peak.

- **General Lessons Learned:**

- The City would like the system to have access to the Internet.
- Need to make sure there is enough bandwidth to grow and expand the system.
- Would like to have live video out to the Web, rather than snapshots.
- Working well together. Sharing what we can and working to share more.
- Need to communicate from the beginning. Need to make sure local agencies are heard. Consider needs of all the agencies, including the ones that won't be involved in the first implementation but will in future expansion. Realize it is a two-way street.

When: **Friday July 27, 8:30 a.m.**

Where: UDOT TOC

Who: Dave Kinnecom, Traffic Management Division Leader

- **Institutional Issues:**

- How were cooperative working relationships between the State and local/municipal government agencies established?

Successful where local government is passionate about traffic management. If they aren't, difficult to get them involved. If they do, they can find common ground.

Have partnered to get Federal and grant money so it is a win-win.

The partner agencies decided to share the responsibilities and systems when first starting 10 or 12 years ago.

The fiber backbone is connected to about 16 different locations.

- How did the State and local/municipal government agencies develop an integrated incident management program?

The original emphasis in traffic management was Salt Lake County and especially the signal system, preparing for the Olympics. They have changed to a state-wide focus. The incident management function seemed to be a natural fit.

The relationships work best in the metropolitan areas and deteriorate as you move further out.

UDOT has always worked well with DPS, and this relationship really solidified when UDOT offered DPS space in the TOC for dispatch, which did not control its own space previously. (Communications Bureau is separate unit within DPS from UHP). IMT also helped solidify relationships with UHP.

Olympics helped solidify relationships throughout the region.

- **Lessons Learned and Benefits:**

- Was an issue resolution process used? If so, what was used? How well did the process work?

Operational agreements really focused on general principles. In reality, the resolution process escalates within each organization.

- Funding—How did the State leverage Earmark funds to obtain additional funding from other sources?

UDOT used CMAQ funds through the three MPOs. They have scheduled a certain level of funding for ITS programmatically. UDOT teamed with other agencies to present a united front with MPO. Also have \$3 million state funding per year.

UDOT sometimes has spread the deployment dollars too thin so they may not have always had the critical mass needed.

- **Resource Requirements:**

- What capital and operating costs are required? Include source of funds, including Earmark money.

State funding of \$3 million capital.

Operating cost for the division is \$8.3 million—half is maintenance.

\$2 million for traffic signal upgrades.

CMAQ runs \$3 to \$4 million.

Emergency response maintenance money.

Include some infrastructure in other highway construction projects.

When: **Friday, July 27, 9 a.m.**

Where: UDOT TOC

Who: Lynne Yocum (former American Fork City) Fiber Manager

- **Institutional Issues:**

- How were cooperative working relationships between the State and local/municipal government agencies established?

Initially, UDOT wanted all point-to-point communication. This caused problems for American Fork. Changing to IP addressing worked better so they didn't need as much fiber or as many paths. The designer that City used was not fiber communications savvy. The City has changed designers at this point.

American Fork has always had a positive relationship with UDOT. As soon as they found a solution, all things moved ahead well.

- **Technical Issues:**

- What systems have been integrated between you and UDOT?
 - Camera control.
 - View sign messaging.
 - Traffic signal systems.

The signal system was the only field element integrated. The integration activity also provided a workstation at American Fork.

- **Lessons Learned and Benefits:**

- Project management and organization: How did you share responsibilities with UDOT?

American Fork and UDOT coordinated well. We had meetings and took minutes. American Fork was responsible for coordinating "betterment," access to building, railroad, and utilities. American Fork responsible for the design. UDOT administered construction.

- **Resource Requirements:**

- Did you contribute any funding for Capital or Operating expenses?

Earmark and City funding.

- **Other:**

- Are all the local governments involved connected to the UDOT fiber? If so, were there any issues in allowing them on, such as security concerns either on the UDOT side or the local agency side? If not, how are they connected?

Every City that makes sense will be included on the fiber. It is a closed network. A few outlying areas aren't on the fiber. Generally use a dedicated circuit for these.

- What network security measures are in place?

Use Virtual Private Network (VPN) and firewall for each agency.

When: **Friday, July 27, 10 a.m. - Noon**

Where: UDOT TOC

Who: Brad Cameron, UDOT Project Manager, and John Grant, TransCore

- **Institutional Issues:**

- How were cooperative working relationships between the State and local/municipal government agencies established?

Brad started in 2001 and UDOT was already getting CMAQ funding for Utah County. They had more money than time to spend it with the Olympics coming up. Cameras were installed anywhere there was a route to a venue. (The initial funding was \$500K in Utah County and \$1 million in Wasatch Front area.) Utah County had very little ITS in place. UDOT wanted to share the wealth rather than focus on State projects. Spreading the money helped solidify the relationship.

Region 3 ceded the operation of the signals in Provo and Orem to the locals. In 1997, UDOT developed a statewide signal management group and offered to control signals from local jurisdictions as well as state signals. Outside Provo and Orem, the local agencies wanted to have the State operate the signals. Provo and Orem already had control and personnel, so they wanted to keep control (other local agencies didn't have the expertise anyway).

- How did the State and local/municipal government agencies develop an integrated incident management program?

Local involvement in incident management is minimal – primarily UDOT and UHP/DPS.

- Did county and/or municipal agencies expand hours of operation? Did they expand to provide 24/7 operations? Were there other operational changes required as part of the CommuterLink expansion?

No change in hours of operation.

Spanish Fork is letting UDOT manage their signals. They don't really have the staff to monitor or tie in to CommuterLink.

Springville aren't staffed to actively manage signals, but they are interested in being connected to CommuterLink.

Pleasant Grove doesn't have fiber to them. They have 20+ signals, but spread broadly. Trying some wireless communication. Pleasant Grove has interest in being connected to CommuterLink, but no funding.

American Fork is fully connected to CommuterLink. All the signals are tied in. The operational change is that they now will have visibility in how UDOT manages the

signals (all are on State Routes and owned and operated by UDOT) and may get more involved in operations.

- How many agencies are involved with (has a workstation) the project? (List involved agencies.)
 - Ogden
 - Bountiful
 - Salt Lake City
 - Layton
 - Davis County
 - Weber County
 - Wasatch Front MPO
 - Logan
 - Provo
 - Orem
 - Salt Lake County (represent smaller cities)
 - St. George
 - UTA
 - University of Utah
 - American Fork
 - FHWA
 - DPS
 - Valley Emergency Communications Center

On the horizon:

- Pleasant Grove
 - West Valley
 - Mountainland Association of Governments (MAG) MPO
- Are there any agencies that at some point decided not to participate in the project?(List Why did they drop out?

West Valley may choose not to participate.

- **Technical Issues:**

- How many interfaces with other agencies have been completed? (List agencies.)

Same as list above.

- What systems have been integrated with each agency?
 - Camera control.
 - Sign control.
 - Traffic signal systems.
 - Camera system.
 - Signals systems.

Workstation that has view only functions for all system and can control its own devices. Can enter incidents, but no agencies really do.

- What standards were used to enable the CommuterLink expansion? Were they selected to be in conformance with the National Architecture? What standards were selected? Were there issues encountered in selecting and implementing standards? If so, what?
 - TMDD 1.6.
 - NTCIP.
 - IEEE 1512.

Essentially, if there was a standard, it was employed.

The standards were identified in the National Architecture.

Some issues because the standards aren't mature. Some aren't robust enough or specific enough. DMS is very mature and not many issues. IEEE 1512 is still evolving.

- Did all agencies involved adopt these standards for use?

In essence, yes. The sticking point is NTCIP standards for signals. Orem and Provo maintain that their system is NTCIP compliant, and UDOT maintains that their signal system is. However, the systems don't interoperate.

- Were agencies able to collect and exchange data? What format was developed for data exchange? What information was exchanged?

Data exchange is not really needed except for the TMC-CAD integration. Generally, there are workstations from a central system or clients on someone's desktop.

Data is exchanged with Traffic.com. using Traffic Management Data Dictionary (TMDD). Traffic data is exchanged.

Also sharing data with other traffic information providers using TMDD.

Weather data also is exchanged – into Clarus. Use the Clarus exchange format.

- How was the integration of State and local systems accomplished? What interfaces were developed?
 - Workstations were installed in other agencies.
 - Camera images are shared through encoders and decoders.
 - There will be a client for Provo and Orem signal systems in the TOC.

UDOT will be changing architecture.

- What data elements needed to be exchanged? When (under what conditions) are these elements exchanged? Were any filters used?
 - Traffic Management Data Dictionary (TMDD) data elements to traffic providers.
 - Weather data elements.
 - IEEE 1512 data elements.
 - Regular exchange.
 - No filters.
- What network security measures are in place?

Firewalls and VPN connection.

Workstation authentication and privileges.

- **Lessons Learned and Benefits:**

- Project management and organization: How did the State and the county/municipal agencies share responsibilities?

For State money, State makes decisions. If MPO funding, UDOT gathers the agencies to make decisions.

Project management will go with the funding. If State funds, State manages. If local funding through MPO, local agencies manage with state oversight.

Operation and maintenance of device go with the owner of the device.

- How has integration affected incident management? (Qualitative assessment of improved detection, improved response times, change in procedures, reduced delay times, and enhanced data exchange capabilities.)

CommuterLink is the main tool used for incident management. As CommuterLink expands, incident management can expand into those areas. UDOT now has teams in 3 regions, and 12 or 13 incident managers. CommuterLink improves visibility of incident, determining correct response, etc.

- **Resource Requirements:**

- What were the FTE requirements for development, operations and maintenance?

Additional FTEs are needed as the system expands. No real guidance on how many needed. UDOT has outsourced integration work. ITS maintenance staff has been as large as seven, including manager.