



Utah Department of Transportation

Traffic Signal Management Plan



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Valuable assistance and support were provided by staff from the FHWA Resource Center and their consultants, who are developing guidelines to assist agencies to prepare traffic signal management plans.

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EXECUTIVE SUMMARY

The purpose of this Traffic Signal Management Plan (TSMP) is to provide a framework for delivery of high quality service to the public through an efficient and well-maintained traffic signal system. The plan describes the objectives of traffic signal management within the context of the Utah Department of Transportation (UDOT) vision, mission, strategic goals and accountability. The plan sets out strategies to guide the maintenance, design and operation of the traffic signal system. It also defines appropriate measures of performance to determine the extent to which the objectives are being met, and verification reports to confirm that the defined strategies continue to be appropriately implemented on an ongoing basis.

There are four primary audiences for this TSMP.

- 1) UDOT internal signal timing and maintenance staff,
- 2) UDOT management,
- 3) Other municipalities in Utah,
- 4) Public.

This document shows how all the system management activities support UDOT's vision, mission, strategic goals and accountability for traffic signal management. For UDOT staff and other municipalities in Utah who own and maintain traffic signals, this document describes in detail the strategies to employ while maintaining, designing and operating the system.

1 INTRODUCTION AND BACKGROUND

1.1 Purpose of this document

The traffic signal system is a dynamic infrastructure component that is integral to meeting the travel needs of all users of the transportation network. To ensure that the design, operation and maintenance of the system is sensitive to and reliably meets the needs of all users, UDOT must effectively plan and utilize its resources to meet this directive.

Smooth and equitable flow of traffic combined with the UDOT strategic goals (defined in section 1.4) is our objective for most situations. This document will help to summarize how UDOT will accomplish this.

The purpose of this document is to:

- Provide a framework to sustain and advance the maintenance, design and operation of the traffic signal system
- Describe how the traffic signal system within UDOT supports the transportation and mobility goals of the State and our partner agencies
- Provide a basis for funding future operations
- Provide a basis for succession planning

1.2 Approach to preparation of this document

This document builds from the July 2011, World Class Traffic Signal Maintenance and Operations Quality Improvement Team report and has been prepared collaboratively by staff and management with responsibilities for planning, designing, operating and maintaining UDOT's traffic signal system. The team proceeded through the following steps:

- Collect and collate relevant planning and management documents that guide the programs and activities related to the traffic signal system.
- Critically examine all the activities currently undertaken by staff in planning, operating and maintaining the traffic signal system, and in managing the staff and programs.
- Confirm the linkages between program goals, objectives and strategies, and the activities of staff managing the traffic signal system, to ensure that:
 - All activities undertaken are essential to support the goals and objectives, and
 - There are no relevant goals or objectives that are not supported by appropriate activities.

The hierarchy of vision, goals, objectives and strategies adopted for the traffic signal management plan (TSMP) is illustrated in Figure 1.

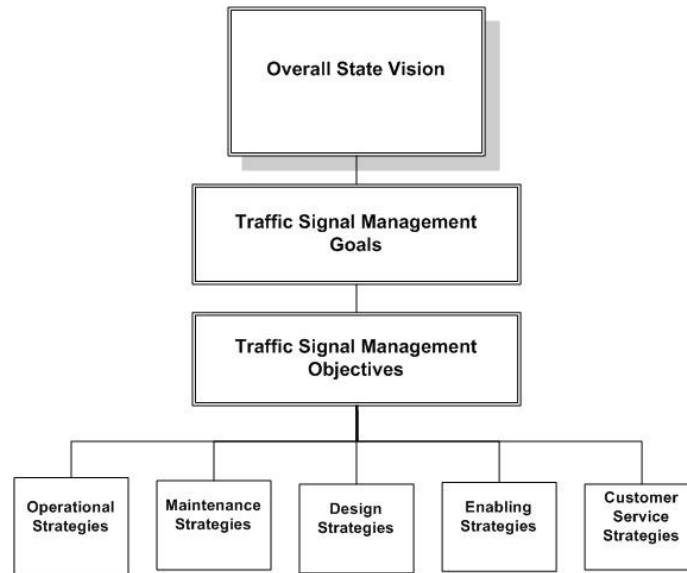


Figure 1 Hierarchy of vision, goals, objectives and strategies

1.3 Future of this document

This is expected to be a living document that will constantly guide future activities but also be modified as the State’s goals and objectives change to meet the changing demands of our stakeholders and to strive towards world-class traffic signals. It has been structured so that the activities of staff are either described in appendices or in other documents that are referenced here. The activities are mainly described in policies and procedures that already exist and are either referenced or compiled in this document for completeness, or are noted as necessary and not yet documented. As these procedures change to match changing technologies and administrative structures, the relevant appendices or referenced documents can be changed accordingly, without the need for major revisions to the document. More significant changes, such as when state and regional goals and objectives change, or when UDOT’s guiding plan is updated, will periodically require updates to the body of this plan.

This plan contains an action plan that describes the steps needed to be undertaken to adopt, disseminate, expand and modify the plan. This will ensure continued relevance and suitability of the plan, and improve the practices that support management of the traffic signal system as time goes on.

1.4 Agency’s Vision and Guiding Principles

The UDOT 2015 Strategic Direction document provides a clear written explanation on how to achieve the goal of making Utah an extraordinary place to live, work, and play with a world-class transportation system. The Vision, Mission and Goals of the Utah Department of Transportation are as follows:

Vision:

Keeping Utah Moving

Mission:

Innovating transportation solutions that strengthen Utah's economy and enhance quality of life.

Goals:

- **Zero Crashes, Injuries and Fatalities.** *UDOT is committed to safety, and we won't rest until we achieve zero crashes, zero injuries and zero fatalities.*
- **Optimize Mobility.** *UDOT optimizes traffic mobility by adding roadway capacity and incorporating innovative design and traffic management strategies.*
- **Preserve Infrastructure.** *We believe good roads cost less, and through proactive preservation we maximize the value of our infrastructure investment for today and the future.*

The document also identifies the Emphasis Areas and Core Values that guide development of the goals, policies and actions:

UDOT's CORE VALUES

- *Innovation*
- *Dedication*
- *Integrity*
- *Public Responsiveness*
- *Passion*
- *Fiscal Responsibility*

EMPHASIS AREAS

- *Integrated Transportation*
- *Collaboration*
- *Education*
- *Transparency*
- *Quality*

The UDOT 2011 Quality Improvement Team Final Report for World Class Traffic Signal Maintenance and Operations (see Appendix) documents 20 recommendations to move UDOT towards world-class maintenance and operations. Based on the report, the following objectives are key in moving towards world-class traffic signal operations:

1. Safe signal operations
2. Efficient and optimized signal timing and coordination
3. Consistency in the quality of operations
4. Comprehensiveness in coverage

1.5 Traffic Signal System

1.5.1 Traffic Signal Equipment

Table 1 shows the number of signal devices in the State of Utah. Table 1 also shows the non-UDOT signal devices within the State of Utah. Figure 2 shows a map of the UDOT signals statewide. As of February 5, 2016 over 91% of UDOT's traffic signals and over 81% of non-UDOT traffic signals statewide are connected to the ATMS network.

The ATMS communications network in Utah is mostly fiber optics (90+%). The remainder (less than 10%) is via radio. By 2018, the goal is to have 100% of UDOT’s traffic signals connected and 90+% of the non-UDOT traffic signals connected to the ATMS network. Figure 3 shows the growth of the ATMS fiber-optic network since 2001. Figure 3 also shows that in 2013 over half of the fiber optics infrastructure on the ATMS network is privately owned from trade agreements with telecommunications companies.

Table 1: Signal Devices in Utah

UDOT Signal Devices (Rev: 2-5-16)				
	Traffic Signals	HAWKS	Flashers	Connected to ATMS
Region 1	318	2	4	276
Region 2	506	5	15	516
Region 3	246	3	5	219
Region 4	96	0	6	54
Total	1166	10	30	1065
Non-UDOT Signal Devices (Rev: 2-5-16)				
	Traffic Signals	HAWKS	Flashers	Connected to ATMS
Region 1	106	1	1	65
Region 2	506	24	46	413
Region 3	104	3	0	98
Region 4	57	0	0	48
Total	773	28	47	624

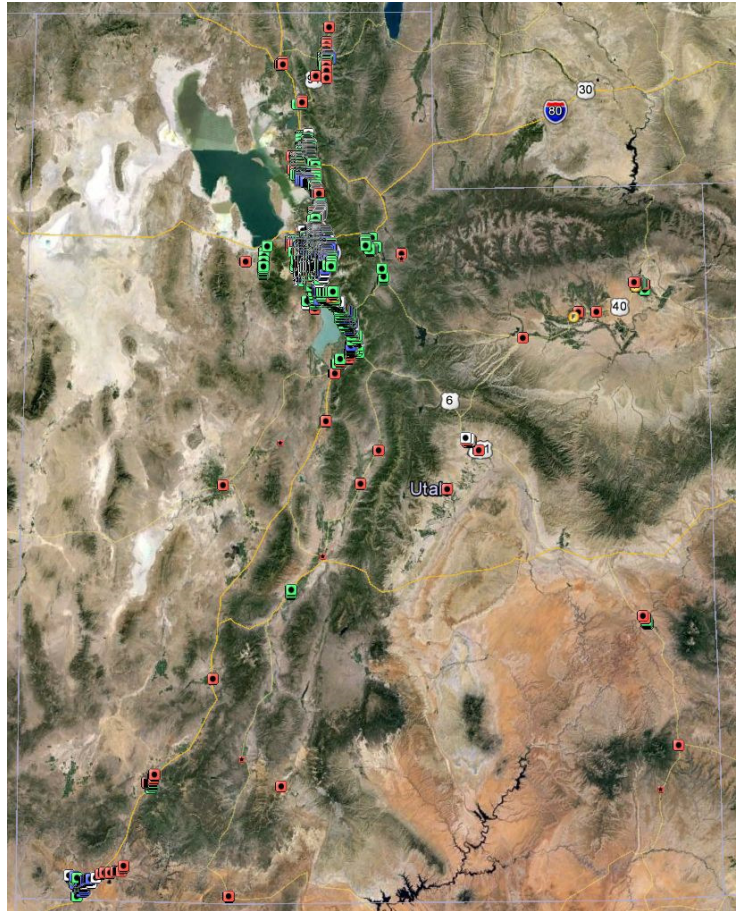


Figure 2: Map of UDOT Signals

Chapter 7.2 titled, “Interagency Agreements” discusses in more detail who operates and maintains the traffic signals in the State of Utah.

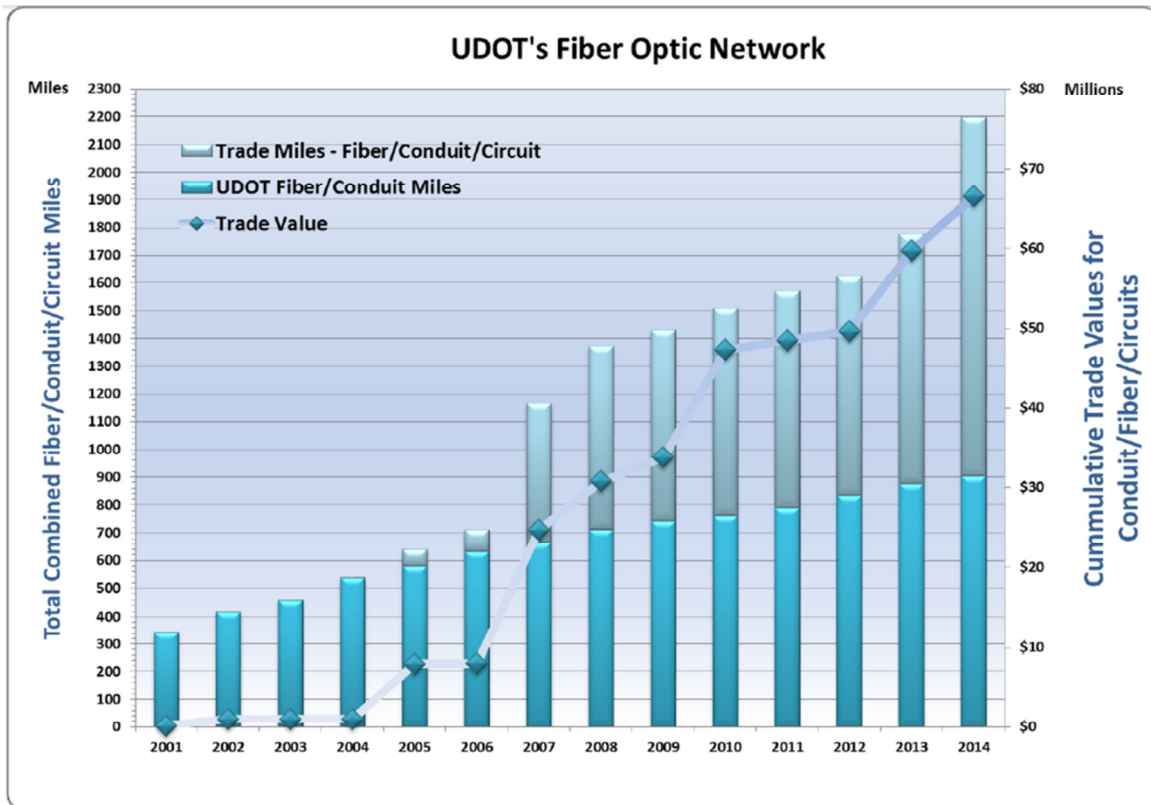


Figure 3: Utah's ATMS Fiber Optics Growth

1.5.2 Traffic Signal Operations

Smooth and equitable flow of traffic combined with the UDOT strategic goals is our objective for traffic signal operations for most situations. This includes all traffic management strategies in optimizing mobility and in UDOT's vision of "Keeping Utah Moving". All traffic management strategies in optimizing mobility and increasing safety are encouraged to be used for all intersections. At Continuous Flow Interchanges (CFI's), additional objectives are first to prevent any vehicles which have made a main thru movement from being stopped at a subsequent crossover thru as formalized in the referenced document, "Continuous Flow Intersection Operational Objectives" dated June 18, 2012.

In obtaining our traffic signal operations goals by regularly updating signal timing, it is also necessary to do the following:

- Signal Timing Desk in Control Room – Staff a console in the signal control room of the TOC from 7:00 AM to 7:00 PM Monday through Friday with a qualified traffic signal operations employee who can make manual overrides to signal timings on an as-needed basis without delay.
- Special Event Support – Develop, optimize and run special signal timing plans that will optimize traffic flows for ingress and egress for major special events. This also involves working closely with local law enforcement, event coordinators, and other jurisdictions.
- Incident Management Signal Adjustments – Develop, optimize and run signal coordination detour plans around incidents along major freeways.

Traffic signals are coordinated when the intersections are in close proximity to one another and when traffic volumes between the adjacent intersections are large. The need for coordination can be identified through observation of traffic flow arriving from upstream intersections and can be measured and evaluated through the use of the Automated Traffic Signal Performance Measures (<http://udottraffic.utah.gov/signalperformancemetrics/>).

1.5.3 Traffic Signal Personnel

- Org Chart of the Traffic Engineering, Operations and Maintenance staff
- Description of existing operations, structure and procedures
- Description of relationship with adjacent agencies and regional partners – including who owns/operates/maintains which signals.
- Operations and Maintenance Budget

In 2011 UDOT executive leaders re-organized UDOT internally to move towards world-class traffic signal maintenance and operations, knowing the large return-on-investment that well maintained and operated signals provide. In doing this, a Matrix organization was created. In the new structure, there are signal engineers located at the Region offices who report to both the Traffic Signal Operations Engineer, a statewide position located at the Traffic Management Division office, and the Region Operations Engineer who resides at the Region office. The Region Signal Engineers directly supervise the maintenance activities in their region, review signal plans, manage traffic signals, review warrants, respond to public records requests, and work directly with the Statewide Signal Engineers and region traffic engineers in moving towards world-class traffic signals.

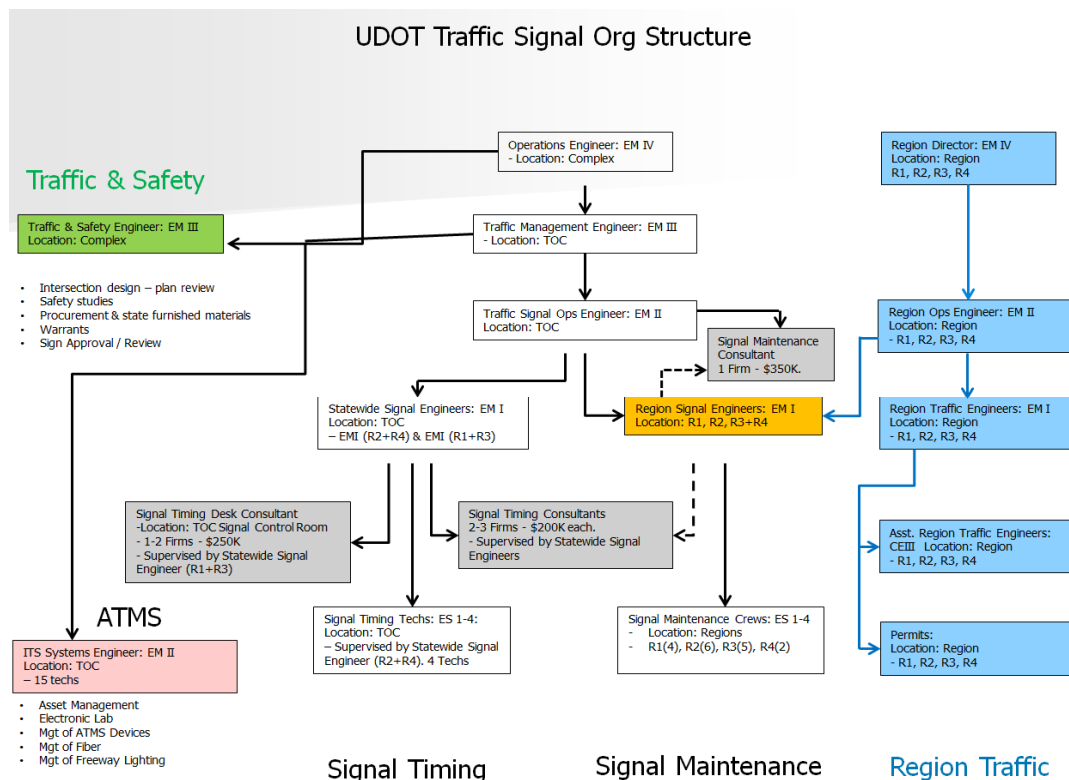


Figure 4: Organization Structure for UDOT Traffic Signals

The organization structure for traffic signals at UDOT comprises of four main groups:

1. Traffic & Safety – Central Office – Statewide Responsibility
2. Signal Timing – Traffic Operations Center – Statewide Responsibility
3. Signal Maintenance – Region Offices – Region Responsibility
4. Region Traffic – Region Offices – Region Responsibility

Traffic & Safety

The Traffic & Safety Division is under the direction of the UDOT Operations Engineer (who is an Engineering Manager Level IV). The Traffic & Safety division is managed by UDOT's Traffic & Safety Engineer, (Engineering Manager Level III), who oversees seven general areas:

- Zero Fatalities Program
- School & Pedestrian Safety Program
- Oversight of operations, including signs, freeway striping, Utah MUTCD.
- Safety studies, crash reports
- Signal and lighting design, including signal standards, equipment contracts, signal warrants
- Railroad safety and inspection
- Ropeways (ski-related equipment, tramways, gondolas, chairlifts)

The Traffic & Safety Division is centrally located at the UDOT headquarters, has statewide responsibility, and works closely with the Traffic Management Division and Regions in traffic & safety related issues.

Signal Timing

Signal timing on UDOT's 1150+ traffic signals is done under the direction of the Traffic Management Division at the Traffic Operations Center and is supervised by the Traffic Signal Operations Engineer (Engineering Manager Level II). Under the direction of the Traffic Signal Operations Engineer are two full-time Statewide Signal Engineers (Engineering Manger Level I) whose main responsibilities include signal timing statewide. One statewide signal engineer oversees the signal timing in Regions 1&3 and the other oversees the signal timing in Regions 2&4. Both statewide signal engineers also supervise engineering consultants to assist them in the signal timing responsibilities, and work closely with the Region Signal Engineers who are also sometimes involved in signal operations. In addition to their signal timing responsibilities, the Statewide Signal Engineer over Regions 2&4 also supervise a group of four signal operations technicians who are devoted full-time to statewide signal operations and have a strong background in electricity, electronics, and have received on-the-job training in signal operations. The Statewide Signal Engineer over Regions 1 & 3 supervises the Signal Timing Desk, which is staffed from 7:00 AM to 7:00 PM Monday through Friday by consultants and UDOT Signal Timing personnel. The Signal Timing Desk deals with a variety of activities that includes but is not limited to modifying signal timing for incidents and special events, taking public phone calls, assisting the Statewide Signal Engineers with signal coordination and maintaining the central signal management system.

Having a dedicated full-time team of engineers, technicians and consultants solely devoted to traffic signal operations is valuable for UDOT in keeping expertise and skills sharp in signal operations and in helping to train others statewide.

Signal Maintenance

Each of UDOT’s four regions has signal maintenance crews who reside in the regions. These signal maintenance crews are directly supervised by the Region Signal Engineers (Engineering Manager Level I’s) who report to both the Statewide Traffic Signal Operations Engineer and the Region Operations Engineers in their respective Region. This helps to keep the expertise high and operations consistent from the statewide level and also to be in tune with the local level issues and concerns

Table 2: UDOT Traffic Signal Maintenance

UDOT Traffic Signal Maintenance (Rev: 2-5-16)

Region	# Signals	# Technicians	Supervisor	Notes
1	320	4	R1 Signal Engineer	
2	511	6	R2 Signal Engineer	
3	249	5	R3&R4 Signal Engineer	1 tech resides in Uinta Basin.
4	96	2	R3&R4 Signal Engineer	1 tech resides in Richfield, 1 tech in St. George.
Total	1176	17		

Table 2 shows the number of signal maintenance technicians we have for each region and the corresponding supervisor engineer for each group. Regions 1 & 2 have relatively small geographic areas, where Region 3 has approximately 2 dozen signals 120 miles away from the UDOT Region 3 headquarters in Orem in the Uinta Basin. As a result, a signal technician resides in the Basin who also has other assignments with utility locating, freeway lighting maintenance and other duties as assigned.

Due to the rural nature of Region 4 (95 signals and a geographical area covering over ½ of the State of Utah), the maintenance signal responsibilities are divided up between two signal technicians (1 resides at the Region 4 headquarters in Richfield and the other resides at a satellite office in St George). Both Regions 3&4 share the Region Signal Engineer who resides in the Region 3 office. The Region 3 maintenance signal crew will assist the Region 4 signal crew during times when they are short staffed.

A Signal Maintenance Consultant who reports directly to the statewide traffic signal operations engineer is used to help maintain and manage signal maintenance work statewide. The Region Signal Engineers also work jointly with the signal maintenance consultant in identifying maintenance needs. The Signal Maintenance Consultant does the following tasks:

- Contract Management & Administration – materials procurement, funding management, contractor oversight, training, and tracking of numerous elements for UDOT reporting including complaints, labor, budgets, devices, completed work, site visits, etc.
- Technical Field Engineering – timely complaint response, diagnostic ability for both hardware and operational issues, correct application of new technology, proactive site evaluations, communication integration of signal elements, technical support for automated signal performance measures, etc.
- Contractor Project Preparation – all elements of a typical UDOT PS&E process – design, estimation, contractor oversight, inspection, and final integration of the completed work.

Region Traffic

The State of Utah is divided into 4 UDOT Regions. Each region has a Region Operations Engineer (Engineering Manager Level II). The Region Operations Engineers have a small team of Region traffic engineers who assist the Region Operations Engineer in their daily duties, including: access management, permits, signal warrants, signing, striping, and overall operations in general. The Region Operations Engineer jointly supervises the Region Signal Engineer with the Statewide Traffic Signal

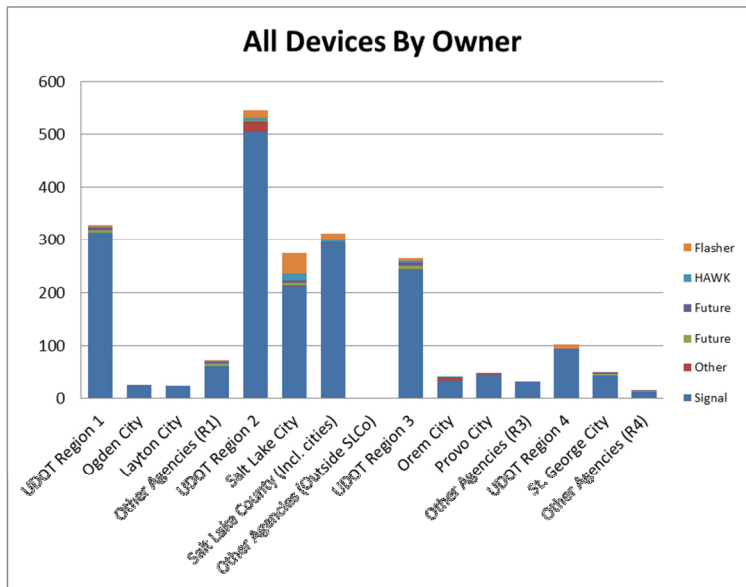


Figure 5: Devices by Owner (Rev: 6-3-15)

Operations Engineer.

Relationship with Adjacent Agencies and Regional Partners

The owning agency has overall responsibility for their signal timing and maintenance activities. The larger jurisdictions, including Salt Lake City, cities within Salt Lake County, Orem City, Provo City, St George City, Layton City, Logan City, and Bountiful City operate and maintain their own traffic signals. Ogden City and most of the other smaller cities statewide who own traffic signals outsource their signal timing and proactive maintenance activities to a local engineering consultant firm. Emergency maintenance is performed by UDOT (without any formal agreements). Ogden City has a formal agreement where UDOT charges them for time and materials. There are approximately 70 additional signals owned by other jurisdictions that UDOT responds to for emergency maintenance. UDOT operates and maintains all signalized intersections that are on State Routes. UDOT and Orem City work together every year in optimizing signal timings for all signals in Orem City Further details are found in chapter 7 titled, "Interagency Communication/Collaboration".

Operations and Maintenance Budget

The operations and maintenance budget changes slightly each year but generally is around \$5,000,000 annually (for just equipment and consultant support only). They are statewide funds (no federal funding) that are from the transportation fund.

- \$2,000,000 is appropriated by the Legislature and is a use or loose each fiscal year (July 1 to June 30th) as it is current expense funding.
- \$3,000,000 is appropriated by the Transportation Commission and comes from the Statewide Transportation Improvement Fund (STIP) Construction Management. These funds do not expire at the end of the fiscal year and can be rolled over year after year.

Table 3: Budget for Signal Operations and Maintenance

UDOT Traffic Management - Traffic Signals Operations & Maintenance - Budget Fiscal Year 2016							
Total Amount Programmed	CODE	Funding Source					
		Current Expenses		Program Funds			
Description		\$376,645	\$368,399	\$1,240,756	\$2,470,000	\$530,000	
		Current Expense Consultant Support		Current Expense Maintenance	Statewide Traffic Signal Equip.	Operations	
Signal Maintenance Equipment & Contractor Labor	MTN			\$1,220,756	\$200,000		\$1,420,756
Signal Cabinets / Power Pedestal Upgrades	CAB				\$250,000		\$250,000
Battery Backup / UPS	UPS				\$300,000		\$300,000
Right Turn Overlaps / FYA's	FYA				\$100,000		\$100,000
Traffic Signal & Pedestrians Heads / Backplates - Replacement	SIG				\$250,000		\$250,000
LED Group Replacement (**Buy LED's Only)	LED				\$400,000		\$400,000
Controllers / MMU's	MMU				\$400,000		\$400,000
BIU's / Power Supplies / Electronics / DIGIS / Switches / Click 650's	ELEC				\$170,000		\$170,000
Public Relations Outreach	PI					\$100,000	\$100,000
SCATS Support	SCATS					\$30,000	\$30,000
Automated Signal Performance Measures Software Support	SPM			\$20,000			\$20,000
Timing Consultant Support	TIME					\$400,000	\$400,000
Flex Lanes	FLEX				\$250,000		\$250,000
Signal Timing Desk Consultant Support	DESK	\$376,645					\$376,645
Maintenance Consultant Support	PTE		\$368,399				\$368,399
Signal Maintenance Emergencies	EMERG				\$150,000		\$150,000
Total:		\$376,645	\$368,399	\$1,240,756	\$2,470,000	\$530,000	\$4,985,800

The \$5 million that the Traffic Management Division at UDOT receives annually is used only for signal maintenance and signal operations for UDOT intersections statewide. The UDOT Traffic & Safety Division receives an additional \$5 million for the construction of new traffic signals, adding additional phases, and some signal re-builds. The utility bills are paid for separately from state maintenance funds that each region administers.

Table 3 shows the budget breakdown for fiscal year 2016 for signal operations and maintenance. Each year, the budget categories are revised to meet the current needs and goals of that year. For example, in Fiscal Year 2015 and Fiscal Year 2016, a one-time project was needed to replace some of the problematic signs along a reversible lane corridor in Salt Lake City. In addition, we plan on installing several dozen UPS battery backup systems at critical intersections that we may not do in other years.

2 TRANSPORTATION GOALS AND OBJECTIVES

The UDOT 2015 Strategic Direction and Performance Measures document provides a clear written explanation on how to achieve the goal of making Utah an extraordinary place to live, work, and play with an agency focused in moving towards a world-class transportation system. The following Strategic Goals were developed to help UDOT meet the challenges of an ever growing and changing state:

- *Preserve Infrastructure*
- *Optimize Mobility*
- *Zero Crashes, Injuries and Fatalities*

The UDOT 2011 Quality Improvement Team Final Report for World Class Traffic Signal Maintenance and Operations documents 20 recommendations to elevate UDOT to world class maintenance and operations. Based on the report, the following objectives are key to achieve world class traffic signal operations.

1. Safe signal operations
2. Efficient and optimized signal timing and coordination
3. Consistency in the quality of operations
4. Comprehensiveness in coverage

2.1 Performance Measures

The following measures of performance will answer the question, “Are the strategies we have implemented having the desired effect?” The goal of performance measurement is to validate the effectiveness of activities, strategies and progress towards objectives and goals. Ideally performance measures are actionable and automated to the greatest extent possible to minimize the level of effort involved in collection and analysis. Some guiding principles to follow are:

- What is the trend – are signal operations improving, staying the same or getting worse and by how much?
- What are our areas of most need?
- Our success will not be measured by how much data we collect, but instead how we use the data to improve the operation of our network.

Table 4 indicates what performance measures may be applicable to each objective, and appropriate methods of obtaining each performance metric:

Table 4: Matching Performance Measures to Objectives

Objective	Automated Signal Performance Measures													Measurement Method				
	Traffic Volumes	Split Monitor	Purdue Phase Termination	Purdue Coordination Diagrams	Purdue Travel Time Diagram	Purdue Link Pivot	Purdue Split Failure (Future)	Percent Arrivals on Green	Detector Error Alarms	Executive Reports	Red Light Monitoring	Approach Delay	Arrivals on Red		Speed	Pedestrian Delay (Future)	Preemption Durations (Future)	Flash Duration (Future)
Improve Traffic Flows				X	X	X		X		X		X	X					Automated
Improve Capacity Allocation	X	X	X				X											Automated
Improve Pedestrian Service	X	X	X												X			Automated
Improve Bicycle Service	X	X	X															Automated
Maintain Working Detection	X		X						X									Automated
Maintaining Working Preemption																X		Automated
Minimize Pollution and Noise					X	X	X	X						X				Automated
Automate Traffic Counts	X									X								Automated
Develop Origin-Destination Data					X													Automated
Improve Safety				X			X				X			X		X		Automated
Time to Return Intersection to Full Operation after Fault or Incident																	X	Automated
Total Contractor Cost of Maintenance Activities	Weekly Report Maintained by Maintenance Consultant																Weekly	
Total Quantities of Contractor Items Repaired	Weekly Report Maintained by Maintenance Consultant																Weekly	
Total Number of Maintenance Work Orders Created	Traffic Operations Center Monthly Report																Monthly	
Average Response Time of Maintenance Work Orders	Traffic Operations Center Monthly Report																Monthly	
Percent of Signals Communicating to Central System	Traffic Operations Center Monthly Report																Monthly	
Best Practice for World Class vs Current UDOT Practice	Subjective rating each fiscal year on progress with July 2011 QIT report																Annual	
Percent of Signals that Can Detect Bicycles	Tracked in Statewide Detector Database																Annual	
Percent of Signals with UPS Battery Backup Systems	Tracked in Statewide Detector Database																Annual	
Percent of Signals with Cabinet Power Transfer Switch	Toggle switch in police box and plug accessible to connect generator																Annual	

UDOT uses an automated traffic signal performance metrics system that is accessible at: <http://udottraffic.utah.gov/signalperformancemetrics/>. It is the goal to have every intersection that is connected with communications to bring back various automated metrics through the website.

3 MAINTENANCE

Maintenance is the most important aspect impacting operational efficiency of a traffic signal system. The key is to focus on preventative maintenance to minimize the level of effort involved in routine maintenance and emergency repairs. The primary goal of preventative maintenance is to prevent the failure of equipment before it actually occurs. It is designed to preserve and enhance equipment reliability by replacing worn components before they actually fail. When preventative maintenance activities are properly implemented, UDOT will realize several benefits, including:

- Extending the life of the installation by preserving infrastructure
- Identifying potential problems that can be addressed before the signal fails or malfunctions
- Reducing the frequency and severity of malfunctions and failures
- Optimizing mobility and improving safety
- Making better use of manpower and resources
- Reducing our exposure to liability

The success of an effective preventative maintenance program can be measured by the number of trouble calls received and work orders that were initiated by external resources (e.g. public, other agencies). A good preventative maintenance program will practically eliminate the need for emergency maintenance (beyond those associated with a crash, loss of power, acts of God, etc.). ITE and IMSA publications estimate that after hour's calls can be reduced by as much as 75% due to an increased emphasis on preventative maintenance activities.

Signal preventative maintenance and signal timing routine maintenance procedures are defined in external documents.

- Aerial Preventative Maintenance
- Ground-Level Preventative Maintenance
- Signal Timing Routine Maintenance

The activities listed in this section help to ensure that the system continues to operate as expected and if deviation is detected, that it is corrected.

3.1 Maintenance Strategies

3.1.1 Preventive maintenance

These strategies:

- a) Ensure that components of the traffic signal system that are consumed in normal operation, and age or deteriorate, are regularly refreshed to prevent equipment failures.
- b) Minimize the potential for damage by others and if it occurs, accommodates repair in a timely manner.

3.1.1.1 Aerial Preventative Maintenance

This activity includes maintenance items that require the utilization of a bucket truck and possible closing of a lane in order to properly perform the work. Examples include but are not limited to the following:

-
- Group replacement of all signal LEDs (including pedestrian heads),
 - Straightening and tightening signal heads,
 - Ensuring signal hoods, back plates, end caps and upper hand-hole covers are in place,
 - Cleaning the cameras (both video and CCTV).

This activity will be performed every four years as part of the current LED replacement schedule until Year 2016, where this activity will be modified to be performed once every other year.

3.1.1.2 Ground-Level Preventative Maintenance

This activity includes maintenance items that do not require the use of a bucket truck or taking of a traffic lane to accomplish. Examples include but are not limited to the following:

- Cleaning / evaluating the physical condition of the cabinets;
- Analyzing vehicle and pedestrian detection;
- Checking/replacing cabinet power, wiring, switches, UPS, breakers, relays, flashers, load switches, BIUs; MMU/conflict monitor testing;
- Testing preemption;
- Pull-boxes; cabinet filter replacement; detector maintenance, etc.

This activity is performed annually and older electronic equipment (i.e. older than approximately 10 years should be considered for replacement before it catastrophically fails).

3.1.2 Emergency maintenance

A plan is in place (Emergency Response Plan for UDOT's Traffic Signals) to formalize the priority, process and plan of emergency response to traffic signals. This includes when immediate response is required, guidelines where battery backup systems should be deployed, and a plan when action should be taken for generator power. These strategies ensure efficient and effective response when equipment fails and an emergency response is required to restore operation.

- Equip all signal cabinets with a power transfer switch in the police panel of the cabinet and an external generator power plug accessible from the outside so generators can simply be plugged into the cabinet and power transferred to the generator by non-technical UDOT employees for long durations of blackouts.
- Restore stop-go operation at intersections at which power has been cut and will not be restored within 3 hours.
- Maintain a sufficient number of generators and connector cables for each maintenance station with traffic signals in their area so they can assist connecting generators for signal power. This will allow for a quicker response in restoring power than depending entirely on the signal maintenance crews.
- Maintain a sufficient number of generators with and connector cables for each signal maintenance crew.
- Restore operations at intersections where major damage has occurred.

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- Maintain a sufficient stock of large items at the UDOT warehouse, such as signal poles, mast arms, and controller cabinets, and sufficient spares of the other items so full operation can be restored for at least 3 intersections within 24 hours.
 - Maintain sufficient spares of safety-critical equipment on each maintenance vehicle to allow restoration of safe operation at an intersection that experiences safety-critical equipment failure within two hours.
 - Provide sufficient technicians on duty, on call or on contract to ensure safety-critical issues can be attended within 30 minutes (or sooner) plus travel time 24/7 365 days of the year. An immediate response is required for the following situations:
 - Signal knockdowns
 - Signals operating in flashing mode
 - Fallen or loose traffic signal and/or pedestrian signal heads
 - Twisted heads over 30 degrees or where a conflicting indication could be perceived.
 - Dark signals (after contacting the power company).
 - Stuck signals (after failed attempts are made to place a recall through the central system).
 - Exposed wiring.
 - Lack of signal indication (i.e. burned out green, yellow, or red) - If just one signal head for the phase.
 - Signals showing conflicting movements.
 - Have maintenance contracts in place to accommodate without delay, repairs that cannot be undertaken by maintenance technicians.

3.1.3 Maintenance management

- Train all staff to be proficient in all the activities to which they are assigned.
- Analyze maintenance logs and report effectiveness and efficiency (monthly, annually, etc.)
- Proceed cautiously to ensure new equipment can be maintained cost effectively and staff can develop adequate maintenance skills.
- Provide staff with the flexibility to work non-standard hours when required to accommodate emergency or unusual maintenance circumstances.
- Use an asset management system to track equipment failures. The system should have GIS capability to display data geographically. Maintain an inventory of all pertinent traffic signal equipment. Add devices to inventory.

3.2 Maintenance Performance Measures

The following measures (see Table 5) will verify, through periodic assessment, the extent to which the maintenance strategies have been successfully implemented.

Table 5: Maintenance Performance Measures

Performance Measure	Supports Strategy	Target	Timing
Percent of functional detection.	Preserve Infrastructure and Optimize Mobility.	Maintain operation of 95% of all detection in the signal system at any given time, including during construction.	Report monthly
% of preventative maintenance vs. reactive maintenance.	Zero Crashes, Injuries and Fatalities. Preserve Infrastructure	Allocate 70% of maintenance resources (funding and staff) to proactive maintenance.	Report monthly
Time to respond to emergency calls	Improving safety and optimize mobility	Travel time to site is 30 minutes (or sooner) plus travel time. Varies by type of reported fault.	Report monthly
Ground PMs including MMU testing.	Zero Crashes, Injuries and Fatalities. Preserve Infrastructure	Completed annually for each signal.	Report monthly
Aerial PMs	Zero Crashes, Injuries and Fatalities. Preserve Infrastructure	Complete every two years	Report monthly
On-going funding for proactive signal equipment replacement and maintenance.	Preserve Infrastructure	Budget \$4,300 annually per signal for maintenance.	Report annually
Signal Maintenance Budget on-line	Transparency	Show all expenditures for maintenance activities	Update weekly

3.3 Action Plan

The following ACTION PLAN (see Table 6) summarizes the tasks that UDOT must undertake in order to move from one Capability and Maturity Level to the next or to improve upon the good basic service provided to the citizens. These tasks fill in the gaps that were identified when documenting the strategies and tactics currently done by UDOT.

Table 6: Maintenance Action Plan

Existing Condition	Future Condition	Action Plan	Timing
Most maintenance of signal system is emergency maintenance.	Documented preventive maintenance plan.	Develop Preventive Maintenance Program For ground and aerial work.	June 2016
Approximately \$3,700 per traffic signal is budgeted annually for signal maintenance.	Maintain similar budget level. If budget drops below \$3,500 per signal annually, request additional funding. Goal is \$4,300.	Maintain budget and track spending.	Maintain Efforts.
As of 2012, estimate that approximately 75% of detection is functional.	Maintain operation of 95% of all detection in the signal system at any given time, including during construction.	Create contract for maintenance consultant and a contract for contractor on-call to fix/replace detection.	Complete (2013). Maintain contracts.
Emergency response time varies region by region, policy does not exist on how to deal with blackout intersections.	Respond within 30 minutes (or sooner) plus travel time. Develop automated paging system to notify tech automatically. Utilize TOC operators in placing recalls on stuck intersections.	Develop a new program that defines emergency, response time and utilizes other resources support for power outages. Implement a new central system that has paging features. Train operators in placing recalls remotely.	June 2016 have plan in place, regions on board, and generators purchased. Have generator plugs installed at key intersections initially and grow from there. Have new central system in place and operating. Have operators trained.

4 DESIGN

This chapter describes design strategies (including ATMS) that are employed, as appropriate, to satisfy one or more of the objectives, from the point of view of how the signals will control and facilitate movement of traffic and other road users. Design strategies must work in conjunction with the operations and maintenance strategies to provide efficient system operations. A commitment in moving towards world-class signal operations is a simultaneous commitment to world-class traffic signal maintenance, signal timing, signal coordination, and design. These strategies ensure that

- a) The installed signal system is uniform.
- b) The signal system has the capabilities to meet current and future operational needs
- c) The traffic signal system is cost effectively maintained.

4.1 Design Strategies

4.1.1 Traffic Signal Design Strategies

- Follow the latest version of the UDOT *“Signalized Intersection Design Guidelines”* that is updated and maintained by the Division of Traffic & Safety. UDOT Traffic & Safety has prepared this guideline as a tool for uniform understanding of the signal design process. The purpose is to consolidate the current design standards and practices into a single reference point to help foster accurate, efficient, and consistent signal designs. All design and construction work will follow the latest version of the *UDOT Standard Specifications & Drawings*.

4.1.2 ATMS Design Strategies

- UDOT has one of the most advanced traffic signal systems in the country. Interconnection allows UDOT and its partners to optimize signal timing and operations, collect valuable performance data, monitor operations, troubleshoot problems, and respond quickly to maintenance issues.
- All traffic signals shall be connected to the existing ATMS network unless otherwise approved by the ATMS Project Manager.
- The preferred interconnection method is to integrate the traffic signal or ATMS device into the ATMS fiber optic infrastructure. If fiber is not within a reasonable distance, the signal can usually be connected by Ethernet radio.
- If connecting the signal is not possible as approved by the ATMS Project Manager, then the design should include ATMS equipment and conduits for future interconnect, including future fiber runs.
- Integration of the signal equipment into the ATMS network is typically accomplished by an integration consultant; the project budget and schedule should anticipate this work.
- At the beginning of the design process, coordinate with the Region Project Manager, Traffic Signal Engineer, and an ATMS Project Manager regarding signal operations during construction, interconnection, ATMS requirements and to determine project specific interconnect features.
- Steps should be taken to install temporary wireless communications anytime the fiber optics communications is down for construction.

4.2 Design Performance Measures

The following performance measures (see Table 7) define how well design strategies are being implemented.

Table 7 Design performance measures

Performance Measure	Supports Strategy	Target	Timing
Automated system health monitoring	Preserve Infrastructure	All IP devices on ATMS network	http://511.commuterlink.utah.gov:9090/map & weekly report from Salt Lake City
Communications to detection	Preserve Infrastructure, Optimize Mobility	Establish communications to all detectors	Report monthly
Percent of signals communicating to central system	Optimize mobility, zero crashes, injuries and fatalities	All UDOT intersections	95% statewide by Dec. 2016. 98% by Dec. 2017. 100% by Dec. 2018.

4.3 Action Plan

The following ACTION PLAN (see Table) summarizes the tasks that UDOT must undertake in order to move from one Capability and Maturity Level to the next or to improve upon the good basic service provided to the citizens. These tasks fill in the gaps that were identified when documenting the strategies and tactics currently done by UDOT.

Table 8 Design Action Plan

Existing Condition	Future Condition	Action Plan	Timing
Percent of signals communicating to central system	Establish communications to all UDOT intersections.	Work with UDOT ITS project managers in establishing a connection plan for each signal.	Have plan for each signal complete by January 2016.
Automated system health monitoring is a website showing communications status of each IP device.	The program should automatically flag itself if the IP device is in a failed communications state for a defined period of time.	Work with UDOT DTS in enhancing the program to interface directly with the UDOT work order system.	Plan in place by January 2016.
Communications to detection	All IP detectors (radar, pucks, video) to communicate to ATMS network.	Have consultants and staff integrate IP detectors to the ATMS network.	Report monthly. Have all devices connected by December 2016.

5 OPERATIONS

This chapter describes operational strategies that will be employed, as appropriate, to satisfy one or more of the objectives as discussed in Chapter 2 titled, “Transportation Goals and Objectives”, from the point of view of how the signals will control and facilitate movement of traffic and other road users.

Operational strategies must work in conjunction with the design and maintenance strategies to provide efficient system operations. A commitment in moving towards world-class signal operations is a simultaneous commitment to world-class traffic signal maintenance, signal timing, signal coordination, and design.

5.1 Operational Strategies

The following operational strategies should be used when they are appropriate. The UDOT strategic goals should be the baseline in deciding when to employ each strategy.

The activities that follow ensure that:

- a) The traffic signals operate safely and efficiently.
- b) Traffic signal operations are uniform.
- c) Traffic signal operation is consistent with the needs of all users.

5.1.1 Operational Strategies – General Operations on Standard Intersections

5.1.1.1 System Efficiency

- Install hardware and software to continually monitor performance under all conditions to which the operational strategies are being applied, and report the quality of that performance by using SPMs.
- Monitor traffic conditions and review signal timing whenever conditions change beyond a pre-determined amount using SPMs.
- Operate signals in a mode that suits current traffic conditions (e.g., time-of-day mode, adaptive signal control, traffic responsive pattern selection, peer-to-peer, signal controller internal logic processor, time-of-day phase omits, variable lane use, innovative phasing).
- At locations where real or perceived yellow trap is not possible, allow for lead-lag left-turn phasing to optimize the flow along the arterial.
- Perform signal re-timing evaluations every 30 to 36 months at a minimum – until the system is capable of automated, real-time monitoring using SPMs.

5.1.1.2 Signal Timing Routine Maintenance

This activity includes signal timing items. Examples include but are not limited to the following:

- Drawing a sketch of the intersection;

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- Measuring the crosswalks to verify pedestrian clearance time;
 - Checking/modifying critical timing parameters, such as the yellow, red clearance, minimum green;
 - Updating controller firmware;
 - Checking time-clocks;
 - Optimizing timing, coordination and detection parameters, etc.

This activity is performed every three years.

5.1.1.3 Signal Coordination

- Coordinate signals along arterial roads to minimize stops along the arterial, while keeping side street delay to an acceptable level.
- Away from major arterials, distribute phase splits to balance delays on all approaches.
- Where protected/permissive left turns are provided, allow the protected phase to be excluded from the signal pattern, if the traffic characteristics warrant.
- When providing coordination, include consideration for integrated transportation (cyclists, pedestrians, public transportation, etc.).

5.1.1.4 Multimodal Safety and Efficiency

- Use phase clearance times and pedestrian walk and clearance times calculated to comply with UT MUTCD and other applicable standards and internal policies.
- Depending on the area, optimum synchronization of vehicular traffic may be compromised to accommodate pedestrian, bicycle and transit needs.
- Provide adequate signal timings for bicycles.
- Provide priority for Light-Rail-Transit (LRT) and Bus-Rapid-Transit (BRT) routes.

5.1.1.5 Automated Signal Performance Measures (SPMs)

- Implement SPM software to manage signal operations at each signal that UDOT owns.
- Utilize SPMs of signal operations tied to clear goals and objectives. Potential SPMs include:
 - Percent of vehicles arriving on green and red.
 - Percent of split failure and unused green time.
 - Purdue Link Pivot – automatically optimizes offset with % of vehicles arriving on green.
 - Corridor travel times.
 - Total traffic volume served.
 - Purdue Phase Termination and Split Monitor.

5.1.1.6 Regional Coordination and Compatibility

- Coordinate signals across jurisdictional boundaries (Tactics: operate all signals on one system).
- Participate in regular operations coordination meetings (technical subcommittees) with other agencies, including most cities along the Wasatch Front.
- Coordinate arterial signals with ramp meters.
- Develop special timing plans to accommodate traffic diverted by freeway incidents. Implement when necessary.
- Develop special signal timing plans to accommodate special events. Implement when necessary.
- Develop special signal timing plans to accommodate adverse weather. Implement when necessary.
- Assist other partners with signal timing and training so the transportation network is seamless.

5.1.2 Operational Strategies – Continuous Flow Intersections

- The operational strategies for Continuous Flow Intersections (CFIs) are somewhat different than the operational strategies UDOT uses for normal and standard intersections. For example, the 1st priority is to prevent any vehicles which have made a Main Thru movement from being stopped at a subsequent crossover (i.e. prevent a “double-stop” for through traffic) than for priority to be given in providing good progression for through movements on a coordinated route. For a listing of all priority of objectives and a means to achieve those objectives for CFIs, please see the most recent document titled, *“Continuous Flow Intersection Operational Objectives”*.

5.2 Performance Measures

The following performance measures (see Table 9) will answer the question, “Has the selected strategy been implemented as intended?”

Table 9 Traffic Operations Performance Measures

Performance Measure	Supports Strategy	Target	Timing
Minor phase max-out	Minimize phase failures	Active evolution of SPM's Purdue Link Pivot and Purdue Split Failure metrics	Development of Purdue Split Failure by December 2015. Continuous monitoring and fine-tuning.
Percent of detection installed that detect bicycles.	Optimize Mobility; Zero Crashes, Injuries and Fatalities; Active Transportation	All Matrix Wavetronix radar approach intersections to detect bike lanes.	Annual report
Percent of signals arriving on green	Optimize Mobility; Zero crashes, Injuries and Fatalities	Fewer arrivals on red.	Monthly report; available on SPM site.
Automated volumes	Optimize mobility	All intersections	Available on SPM site.
Improve pedestrian service	Optimize mobility; active transportation	All intersections	Create a new metric in the SPM website that will measure the time from the ped call to start of green at all intersections.

5.3 Action Plan

The following ACTION PLAN (see 10) summarizes the tasks that UDOT must undertake in order to move from one Capability and Maturity Level to the next or to improve upon the good basic service provided to the citizens. These tasks fill in the gaps that were identified when documenting the strategies and tactics currently done by UDOT.

Table 10 Traffic Operations Action Plan

Existing Condition	Future Condition	Action Plan	Timing
Improve pedestrian service	Pedestrian delay is automated through SPMs.	Software programming is needed to add new performance measure.	June 2016.
Minor Phase Maxout	Purdue split failure metric to measure green occupancy ratio and red occupancy ratio	Software programming is needed to add new performance measure.	December 2015.

6 MANAGEMENT AND ADMINISTRATION

All elements of traffic signal management (maintenance, design, and operations) are intended to provide a service to the public. There are management and customer service activities that are required to establish an appropriate and supportive environment for those elements. Those enabling and supporting strategies are described below.

6.1 Enabling strategies

The following strategies create and maintain an environment within UDOT that allows the maintenance, design and operations strategies to be effectively and sustainably implemented.

6.1.1 Personnel Strategies

The following activities and targets that a well-trained group of staff with sufficient resources is available to handle staff changes and temporary fluctuations without compromising the performance of the traffic signal system.

- Provide sufficient staff to maintain and operate the traffic signal system (See Table 11):
 - Provide one traffic engineer for every 75 to 100 signals.
- Provide one signal technician for every 40 to 50 signals.
- Coordinate the activities of all relevant staff involved in planning, designing, operating and maintaining the traffic signal system.
- Develop and implement a succession plan for each staff position.
- Document procedures to the extent necessary for a new or temporarily assigned staff member to be able to efficiently complete the duties of the position.
- Maintain minimum staff qualifications for signal technicians and engineers.
- Signal Technicians – Qualifications are defined in the document, *“Procedures and Guidelines for Electronic Technical Specialist Certification Program”*. A summary of the minimum qualifications are in the Table 12.
- Traffic Signal Engineers – Traffic signal engineers at UDOT who are a part of the Traffic Management Division must have a valid Utah Professional Engineer license. In addition, it is desired that they obtain the “Professional Traffic Operations Engineer” from ITE.

6.1.2 Values and Expectations

Encourage all employees to follow the following values:

- Integrity – We will be honest, impartial, and fair in all our actions and services.
- Trust – We can count on each other and increase synergy within our team.
- Excellence – We do our best at all times and look for ways to do even better.
- Mutual Respect – We treat each other the way we want to be treated.

Encourage all employees to follow the following expectations:

- Responsibility – “People know you for what you’ve done, not for what you plan to do.”
- Punctuality – “Know the true value of time; snatch, seize, and enjoy every moment of it. No idleness, no delay, no procrastination; never put off till tomorrow what you can do today.” - Lord Chesterfield.
- Quality Service – “There is no labor a person does that is undignified, if they do it right.” – Bill Cosby.

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- Listening – “Seek first to understand, then to be understood.” – Stephen R. Covey.
 - Take Initiative – “Knowing is not enough, we must apply. Willing is not enough, we must do!” – Johann von Goethe.
 - Learning – “It’s not Kindergarten thru 12th grade; it’s Kindergarten till 80+. It’s not a matter of getting an education; it’s a matter of staying educated.” – Tom Decoster.

6.1.3 Training Strategies

The following activities define qualifications appropriate for all staff and a policy to ensure staff remains appropriately qualified.

- Provide an on-going technical training program for maintenance and signal operations personnel (both technicians and engineers) by doing the following:
- Quarterly Signal Training - Provide training with all signal personnel (maintenance and operations) quarterly for a minimum of 4 hours. This involves bringing everyone together quarterly and having the Traffic Signal Operations Engineer assign topics for discussion and training.
- UDOT University – Department wide training in various areas can be found at: <http://www.udot.utah.gov/udotu/index.php>
- Electronic Technical Specialist Certification Program (UDOT 06C-64) – A formal policy for signal technicians that recognizes and rewards technical skills, academic competence, longevity at UDOT, and leadership skills.
- UDOT Annual Conference – A multi-day annual conference conducted by UDOT for engineers that cover a broad range of topics.
- Bi-monthly Cross-Training – Every two months, the signal maintenance technicians will cross-train for a day with signal maintenance technicians from a different region.
- Consultant and Vendor Training with UDOT Staff – Most of the contracts with consultants (both operations and maintenance) provide the opportunity for the consultant to train UDOT staff one-on-one in the field or classroom training (if desired). Some vendor contracts are also set up this way.
- Traffic Signal Webinars – As opportunity arises, participate in relevant webinars.

Table 11: Staffing for UDOT Signal Operations and Maintenance

Staffing for Signal Operations and Maintenance (Rev: 4-24-15)			
UDOT Staffing (including consultants and contractors)	# of Equivalent FTE Positions	Responsibility	Operations or Maintenance
Traffic Signal Operations Engineer	1	Statewide	Both
Statewide Signal Engineers	2	Statewide	Operations
Region Signal Engineers	3	Regions	Both - mostly maintenance
Hybrid Electronic Specialists / Engineers	4	Statewide	Operations
Consultant Operations Support (estimated)	4	Statewide	Operations
Region 1 Signal Technicians	4	Region 1	Maintenance
Region 2 Signal Technicians	6	Region 2	Maintenance
Region 3 Signal Technicians	5	Region 3	Maintenance
Region 4 Signal Technicians	2	Region 4	Maintenance
Consultant / Contractor Maintenance Support (estimated)	4	Statewide	Maintenance
Total:	35	# Signals / FTE	
Total Signals & Hawks (4-24-15)	1161	33	
Total Estimated FTE's for Operations	11	106	
Total Estimated FTE's for Maintenance	24	48	

Table 12: Minimum Qualifications for Signal Technicians

Summary of Minimum Qualifications Required for Hiring and Advancement of Signal Technicians (UDOT Policy 06C-64)

	Electronic Technical Specialist I	Electronic Technical Specialist II	Electronic Technical Specialist III (Lead)	Electronic Supervisor	Electronic Manager
Technical Skills Prerequisite	None	Competency at ETS I	Competency at ETS II		
Minimum Combined Education and Work Experience	6 Months	2 Years	2 Years	3 Years OR IMSA Level III Certification	3 Years OR IMSA Level III Certification
IMSA Certification or Licenses	Must obtain Level I within one year of hiring	Level II Traffic Signal (if hired from outside UDOT, Level I and II must be obtained in one year)	Level III (Bench or Field) OR Traffic Signal Inspection and Highway Lighting OR Journey Electrician License	(If hired from outside UDOT, Level I and II must be obtained in one year)	(If hired from outside UDOT, Level I and II must be obtained in one year)

6.1.4 Safety Strategies

All UDOT employees working on or near traffic signals shall follow the following UDOT policies:

- UDOT Policy 06E-02 “Personal Protective Equipment and Safety Clothing”.
- Aerial Truck Procedures and Safety Practices.

6.1.5 Inter-Department Coordination Strategies

- Coordinate the activities of all relevant staff involved in planning, designing, operating and maintaining the traffic signal system.
- The roles and responsibilities between the various traffic signal groups (Traffic Management Division (TMD), Traffic & Safety, Regions) are briefly described in the guideline, “*World-Class Signals: Management Procedures*”.
- Regularly review new technology developments beyond traffic signals that will require modifications to existing equipment and practices (e.g., connected vehicles).

6.2 Customer Service Strategies

The following activities will support the strategy of providing exceptional customer service:

- Empower all employees to be ambassadors by providing them with a good understanding of the traffic signal system, and training them to recognize when it is appropriate to discuss with customers and when to refer to a more qualified staff member.
- Report our performance in responding to complaints.
- Report regularly to senior leaders; show where the traffic signal management plan is heading and how it is responding to UDOT’s goals and objectives.

6.3 Performance Measures

The following measures (see Table 13) will verify, through periodic assessment, the extent to which the management activities have been successfully implemented.

Table 13 Management performance measures

Performance Measure	Supports Strategy	Target	Timing
Best Practice vs UDOT Practice on Subjective Evaluation	Preserve Infrastructure; Optimize Mobility; Zero Crashes, Injuries and Fatalities	Obtain greens in all areas.	Ongoing
Time to respond to customer	Optimize Mobility; Zero Crashes, Injuries and Fatalities	Initial response within 1 working day	AIMS online work order system. Monthly Report
Time to close out request	Optimize Mobility; Zero Crashes, Injuries and Fatalities	Goal of 5 working days or less for most issues.	Monthly Report
Types of Inquires	Preserve Infrastructure; Optimize Mobility; Zero Crashes, Injuries and Fatalities		AIMS online work order system. Monthly Report
New Work Orders	Transparency; Collaboration		Monthly Report
Work orders closed during the month	Transparency; Collaboration		Monthly Report

6.4 Action Plan

The following ACTION PLAN (see Table 14) summarizes the tasks that UDOT must undertake in order to move from one Capability and Maturity Level to the next or to improve upon the good basic service provided to the citizens. These tasks fill in the gaps that were identified when documenting the strategies and tactics currently done by UDOT.

Table 14 Enabling Action Plan

Existing Condition	Future Condition	Action Plan	Timing
List of Re-build priorities	A list is assembled allowing Traffic & Safety to prioritize their funding for re-builds.	Maintain an on-going list of the top ten intersections for re-builds	December 2015

7 CHAPTER 7 – INTERAGENCY COMMUNICATION/COLLABORATION

Collaborating with all stakeholders in ensuring a seamless transportation network regardless of who owns and operates the signal devices has been and is a priority of UDOT. Professional contacts have been developed and are maintained at a staff level for all jurisdictions in Utah that own traffic signals. Working together in creating one single statewide transportation network where all jurisdictions in the State of Utah share the same ATMS system is necessary for us to meet a growing society's transportation needs.

7.1 History of Interagency Collaboration

The earliest attempts to coordinate traffic signals in Salt Lake City date back to the 1930's. Electro-mechanical controllers started to appear on the market featuring multiple rotary dial systems. This innovation made it possible to have a dial for the time of day and individual dials for different cycle lengths. Small groups of signals could be coordinated by installing a relatively simple electrical wire from controller to controller and designating one of the controllers in the system as the "master". It could send out a pulse that, in simple terms, required that other controllers check to make sure they are in step with the master. There were serious physical limitations on the number of signals that could belong to a coordinated group and they couldn't be more than a few thousand feet apart.

Small clusters of intersections began operating in a coordinated mode. UDOT had this type of system installed on several of their roadways (notably State Street, 400 South and 700 East to name a few) and Salt Lake City had systems in a sort of patchwork pattern surrounding the State Roads. It was theoretically possible to have approximate coordination between groups but it was difficult maintain any sort of reliability.

In the mid 1970's UDOT and Salt Lake City embarked on a project to determine the feasibility of implementing a mostly aerial communications network of twisted pairs of copper wire with direct connections to each signalized intersection AND to install a computer powerful enough to "talk" to each traffic signal controller. The internationally recognized engineering firm of JHK and Associates was ultimately selected to oversee the collection and analysis of data to determine costs and try and "take the pulse" of the state of coordination in the Salt Lake area. Hundreds of hours of travel time studies were gathered using special graphing equipment installed in SLC owned vehicles.

The travel studies showed there was much room for improvement when comparing average travel times and speeds, as well as number and duration of stops, with an idealized notion of what might be better for drivers and better for reducing emissions associated with stopping and idling vehicles.

Once it was determined that it would not only be feasible to implement a computerized traffic signal control system and that the benefits would outweigh the costs many times over, JHK worked with both agencies to design the communications network and the interfaces with all the different types of controllers currently in use, which included electro-mechanical and solid state electronics equipment. The system was largely funded by the Federal Highway Administration. UDOT and Salt Lake City

cooperated to provide about 7% of the cost, mostly with “in-kind” services associated with implementing and testing the system. The contract to deliver a computerized traffic signal control system was awarded to Computran Systems, Inc.

UDOT and Salt Lake City staff members began work with Computran to mimic the existing timing plans and eventually transition to timing plans that would be able to reduce the number and duration of stops and thus reduce travel times with the additional benefit of a corresponding reduction in fuel consumption and vehicle emissions.

The system was installed and ready for testing by about 1982 and attained final acceptance in 1984. Once the more cohesive timing plans could be implemented more travel studies were conducted and compared with the “before” studies. The consensus was that nearly every route could be improved by about 25% and some by as much as 50%.

The initial number of traffic signals included in this system was about 350 with each agency owning about half. Using this system it no longer mattered whether an intersection belonged to UDOT or Salt Lake City. The traffic signals could be placed modes of coordination depending upon the time of day and the day of the week. It was even possible to have some special event timing plans.

This system functioned with a high level of reliability and remained in place for about 15 years. In the meantime, traffic signal controllers evolved into individual microcomputers that could store large data bases of timing parameters. Copper wire was beginning to be abandoned in favor of fiber optic cable with enormous data carrying capability. Computers evolved away from a single “main frame” concept into a network of minicomputers. Individual signal controllers no longer had to be told what to do on a second-by-second basis.

Once Salt Lake City had been selected to be the host city for the 2002 Olympics, there was a great deal of interest in trying to expand the scope beyond merely computerized traffic signal control. UDOT with a lot of help from Senator Robert Bennett embarked on a pilot project to determine the feasibility of integrating some other functions into a type of advanced traffic management system. The other desirable functions were to be the control of electronic variable message signs designated for freeways and surface streets as well as a comprehensive video surveillance network to provide virtual monitoring coverage of I-15 and I-215.

There were only a few such systems in existence at the time and after the pilot project demonstrated its worth, Utah, with essential FHWA support, became one of the very first to design, build and implement an inter-agency advanced traffic control system. A huge benefit to Salt Lake City was that UDOT deeded the pilot project property and building that they might develop it into a satellite control center and major communications hub. Fiber-optic cable was installed in underground conduit and it covered the entire freeway system as well as provided interface capability to nearly every signalized intersection in the Salt Lake Valley. Reliability was ramped up by ensuring multiple instances of redundancy for communication pathways.

UDOT began construction of a state-of-the-art facility to house all the requisite computers and servers and provide an operations center with a control room equipped with a wall of multiple high definition video monitors. Salt Lake City and Salt Lake County were brought onboard to host satellite control centers with full functional capacity for all the integrated components. The UDOT Traffic Operations Center opened in 1999 and the satellite centers followed soon thereafter. The old computer system was dismantled and the National Guard agreed to remove the aerial copper wire.

The new system, which came to be known as CommuterLink, included more than 600 traffic signals, 150+ video surveillance cameras and 20+ variable message signs. Cooperative agreements were made between the inter-agency partners regarding how aspects of the system would be developed and implemented. This high level of cooperation is actively in place to this day. CommuterLink (name changed now to UDOT Traffic) expanded to cover nearly all of the UDOT traffic signals in the State of Utah and dozens in other cities and counties from Logan to St. George.

In an effort to improve inter-agency coordination and in helping to ensure a seamless transportation network between stakeholders, in 1992 the Utah Legislature created Utah Code 72-6-115 and Utah Code 63A-3-107 that had the following effects:

- Mandated a Traffic Management Committee (TMC) comprising of 5 jurisdictions and later expanded to 8.
- TMC shall make recommendations to law enforcement agencies related to traffic flow and incident management.
- TMC shall make recommendations to the Department, counties, and other municipalities on increasing the safety and efficiency of highways using current traffic management systems, including traffic signal coordination, traffic monitoring, freeway ramp metering, variable message signs, and incident management.
- The Department shall implement and administer traffic management systems to facilitate the efficient flow of motor vehicle traffic on state highways to improve regional mobility, and to reduce motor vehicle emissions where those improvements are cost effective, as determined by the committee.

The TMC evolved into a defacto planning committee for interagency signal coordination and mandated that if desired by the cities and counties, that all signals under city or county control to be integrated into the existing traffic management system. In 1996 procurement documents for a new central system went out and in 2000, ICONS (later changed to Siemens i2) was procured. Funding was a combination of state and CMAQ funds.

While the owning agency has responsibility for the maintenance and operations of their traffic signals, a shared communications network is in place that is managed by UDOT.

Today, we now manage inter-agency coordination through Technical Subcommittees (managed by the Metropolitan Planning Organizations (MPOs)) which are an outgrowth of the TMC, as well as personal dialogue with all partner agencies. In 2015 UDOT replaced the i2TMS Siemens central signal system with Intelight's MaxView central system with all the signal partners (approximately 20 cities and counties) statewide sharing the same central system and communications network.

7.2 Interagency Agreements

In most situations, the owning agency performs their own operations and maintenance with a high level of collaboration among partners. Details are as follows:

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- City of Ogden – They own approximately 20 signals and will call UDOT for emergency maintenance needs when needed. UDOT has a formal agreement in place to charge them for time and materials.
 - Cities in Region 1 (except Bountiful, Layton, Logan & Ogden) – The cities contract with a local engineering consultant firm for signal timing and proactive signal maintenance activities. UDOT responds to emergencies.
 - Provo City – An agreement dated December 23, 2009 defines that the owning agency has final say over the signals but defines that for signal operations a high level of collaboration and mutual support and various levels of action in making signal timing changes (i.e. act first, notify later; collaborative action; owner only). By defacto, UDOT maintains the signal timing on all of the UDOT signals and coordination on most of the Provo City owned signals.
 - Orem City - An agreement dated December 23, 2009 defines that the owning agency has final say over the signals but defines that for signal operations a high level of collaboration and mutual support and various levels of action in making signal timing changes (i.e. act first, notify later; collaborative action; owner only). By defacto, Orem City and UDOT work together each year in maintaining the coordination on all signals within Orem City limits.
 - Cities within Utah County (except Provo & Orem Cities) – The cities contract with a local engineering consultant firm for signal timing and proactive signal maintenance activities. UDOT responds to emergencies.
 - St George City – An agreement dated April 22, 2004 defines that each agency will operate and maintain their own signals but that we will share ATMS and ensure that monitoring status of signal operations is available to all parties.
 - Cities in Region 4 (except St George City) – Price City owns 1 signal that UDOT maintains and operates without a formal agreement. Santa Clara City owns 2 signals that UDOT maintains and operates without a formal agreement. Cedar City owns 1 signal that UDOT maintains and operates without a formal agreement. Washington City owns 8 signals where we have a formal contract until October 2015 to operate and maintain the signals. We’re currently working with them to have them contract with a local engineering consultant firm for signal timing and proactive signal maintenance activities and UDOT would respond to emergencies.
 - Utah Transit Authority (UTA) – An agreement is in place that defines that UTA will be responsible for the TRAX transit operations and maintenance of the TRAX elements of the system.
 - Salt Lake County – An informal handshake agreement that UDOT will maintain the operations of the signal at 10600 South and Automall Drive, since it is the only signal located between two state owned signals and is in close proximity.
 - All Partners (besides the exceptions provided) – An informal handshake agreement that we share the ATMS devices but operate and maintain our own signals. We share the ATMS network, central signal management system, CCTV cameras, SPMs, and other devices.

In meeting UDOT’s vision of “Keeping Utah Moving”, UDOT assists the other agencies as requested in operations and maintenance support with no formal agreements in place. In turn, the favor is often returned to UDOT, especially in areas where travel time is long or personnel are absent or on vacations.

All agencies in Utah with connected traffic signals purchase and maintain compatible signal equipment to work within the Utah ITS architecture framework. Most vendors honor the same pricing and equipment to all cities that they provide to UDOT on their contracts. In addition, most jurisdictions purchase equipment from the UDOT contracts and use the UDOT central warehouse state furnished items as needed in obtaining signal equipment that includes cabinets, steel, detection, LEDs, and related signal equipment.

8 CHAPTER 8 – REVIEW/UPDATE OF TSMP

This TSMP should be reviewed annually. It should be updated as appropriate each year. A major review of goals, objectives, strategies and performance measures should be undertaken at least once every three years.

The annual review should be initiated by the UDOT Traffic Signal Operations Engineer each year approximately one year after the previous review and at the same time the internal evaluation “*Best Practice vs UDOT Practice on Subjective Evaluation*” is completed.

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