

Con Ops Reference Number	Concept of Operations Sample Statements
1	1 Chapter 1: Scope
1.1	1.1 Document Purpose and Scope
1.1-1	<p>The scope of this document covers the consideration of adaptive signal control technology (ASCT) for use within Seminole County Florida.</p> <p>Seminole County’s Advanced Traffic Management System (SCATMS) project will integrate the use of adaptive signal control technology within the existing signal system to optimize efficiency throughout the network. The project will provide real-time adaptive control to 31 intersections on 6 different corridors (4 new adaptive corridors and the expansion of 2 existing SynchroGreen systems). These adaptive systems will be primarily focused around the freeway interchanges of Interstate 4 to improve mobility on the roadway network, maximize bandwidth, reduce delay on the cross streets and to achieve the maximum roadway capacity possible.</p>
1.1-2	This document describes and provides a rationale for the expected operations of the proposed adaptive system.
1.1-3	It documents the outcome of stakeholder discussions and consensus building that has been undertaken to ensure that the system that is implemented is operationally feasible and has the support of stakeholders.
1.1-4	<ul style="list-style-type: none"> • The intended audience of this document includes: system operators, administrators, decision-makers, elected officials, other nontechnical readers and other stakeholders who will share the operation of the system or be directly affected by it including: FHWA • FDOT District 5 • The seven (7) cities within Seminole County – Altamonte Springs, Casselberry, Lake Mary, Longwood, Oviedo, Sanford and Winter Springs.
1.2	1.2 Project Purpose and Scope
1.2-1	An adaptive traffic signal system is one in which some or all the signal timing parameters are modified in response to changes in the traffic conditions, in real time.

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1.2-2	<ul style="list-style-type: none"> • The purpose of providing adaptive control on SR 46, HE Thomas Pkwy (CR 46A), Lake Mary Blvd, SR 434, SR 436, and SR 414 is to Enable real-time coordinated response to incidents, special events, varying school schedules, and other non-scheduled events. • Implement real-time timing-plan changes in and around the interstate, help with traffic congestion around the school system (public schools, private schools, Seminole State College) and eliminate the need for special coordinated plans around the various shopping centers. • Reduce oversaturation at critical intersections during peak periods, which causes large delays at minor intersections across the system for larger periods than needed. • Prevent the need for larger cycles due to the unpredictability of traffic and pedestrian movements.
1.2-3	This project will add adaptive capabilities to the existing coordinated signal system.
1.2-4	This project will replace the existing coordinated traffic signal system to provide adaptive control.
1.2-5	All the capabilities of the existing coordinated system will be maintained.
1.2-6	The adaptive capability will be available at all signalized intersections within the agency's jurisdiction.
1.2-7	Adaptive capability will be provided for all coordinated signals within (describe the area to be covered)
1.2-8	The adaptive capability will be provided for signals operated and monitored by SCTE centralATMS.now system.
1.2-9	Interfaces will be provided to the signal system operated by SCTE. SCTE staff will utilize web based applications that are accessible from the LAN or from remote locations with full system monitoring and override capabilities. name any agency whose signal system will be integrated or interfaced with the new adaptive system)
1.2-10	The adaptive system will be integrated with Naztec ATMS
1.3	1.3 Procurement
1.3.0-1	In 2000, the City of Orlando issued an RFP for an Alpha Test of traffic signal controllers. The RFP (#RFP00-391) is referenced in Chapter 2. Naztec was deemed the “winner” of the Alpha Test and was selected to be the preferred

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	<p>vendor for the City (see Orlando Board minutes). Following the City of Orlando’s lead, Seminole County decided to abandon its previous controller manufacturer (Peek) and convert over to Naztec. Utilizing the City of Orlando Naztec contract and \$3M in funds from FHWA/FDOT, Seminole County began the conversion to Naztec in 2001. Following the expiration of Orlando’s contract, Seminole County entered into its own contract directly with Naztec and has had a County specific contract ever since. After the \$3M in FHWA/FDOT funds were exhausted in 2003, the County has spent an estimated \$7M-\$8M in County funds since then to continually expand our Naztec system, as well as purchase Naztec’s ATMS. Now central software and our first adaptive system (SynchroGreen).</p> <p>As mentioned, our current ASCT system was initially procured using an existing County contract directly with Naztec (contract #IFB-600592-09/GMG) and utilizing only County funds. If the continued use of existing County contracts is found not feasible with this new \$4M in FHWA/FDOT funds, future licenses will be procured using</p>
1.3.0-1.0-1	a combination of best value procurement for software and system integration services, and low-bid procurement for equipment and construction services.
1.3.0-1.0-2	a best value procurement process based on responses to a request for proposals.
1.3.0-1.0-3	a low-bid process based on detailed plans and technical specifications.
1.3.0-2	A request for qualifications (RFQ) will be issued to all potential vendors. Responses will be used to develop a short list of suitable systems and a request for proposals (RFP) will be issued to those vendors. The selected system will be the one that provides the best value, subject to financial and schedule constraints.
1.3.0-3	Field equipment (parts and labor) will be procured using a low-bid process based on detailed plans and technical specifications.
1.3.0-4	A detailed procurement plan will be prepared after the system requirements have been determined.

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2	<p>2 Chapter 2: Referenced Documents</p>
2.0-1	<p>The following documents have been used in the preparation of this Concept of Operations and stakeholder discussions. Some of these documents provide policy guidance for traffic signal operation in this area, some are standards with which the system must comply, while others report the conclusions of discussions, workshops and other research used to define the needs of the project and subsequently identify project requirements.</p>
2.0-1.0-1	<p>References Specific to the Adaptive Locations</p> <ul style="list-style-type: none"> • Business Planning / Strategic Planning Documents for relevant agencies • Concept of Operations for related agency/facility-specific systems • Requirements of related systems • Studies identifying operational needs • Regional ITS Architecture documents • Planning studies and Master Plans • Transportation Improvement Programs (TIP) • Long Range Transportation Plans
2.0-1.0-2	<p>Systems Engineering</p> <ul style="list-style-type: none"> • “Systems Engineering Guidebook for ITS”, California Department of Transportation, Division of Research & Innovation, Version 3.0, <http://www.fhwa.dot.gov/cadiv/segb/> • "Systems Engineering for Intelligent Transportation Systems, An Introduction for Transportation Professionals", <http://ops.fhwa.dot.gov/publications/seitsguide/index.htm> • “Developing Functional Requirements for ITS Projects”, Mitretek Systems, April 2002 • "Developing and Using a Concept of Operations in Transportation Management System, FHWA TMC Pooled-Fund Study (http://tmcpfs.ops.fhwa.dot.gov/cfprojects/new_detail.cfm?id=38&new=0) • NCHRP Synthesis 307: Systems Engineering Processes for Developing Traffic Signal Systems
2.0-1.0-3	<p>Adaptive Signals</p>

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	<p>* NCHRP Synthesis 403: "Adaptive Traffic Control Systems: Domestic and Foreign State of Practice" http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_syn_403.pdf</p>
2.0-1.0-4	<p>ITS, Operations, Architecture, Other</p> <ul style="list-style-type: none"> • FHWA Rule 940, Federal Register / Vol. 66, No. 5 / Monday, January 8, 2001 / Rules and Regulations, DEPARTMENT OF TRANSPORTATION, Federal Highway Administration 23 CFR Parts 655 and 940, (FHWA Docket No. FHWA-99-5899] RIN 2125-AE65 Intelligent Transportation System Architecture and Standards • Regional ITS Architecture Guidance Document; "Developing, Using, and Maintaining an ITS Architecture for your Region; National ITS Architecture Team; October, 2001
2.0-1.0-5	<p><u>NTCIP</u></p> <ul style="list-style-type: none"> • List applicable NTCIP standards • ADD MORE COMPLETE LIST HERE SO USERS CAN PICK AND CHOOSE.
2.0-1.0-6	<p><u>NEMA</u></p> <ul style="list-style-type: none"> • List applicable NEMA standards • INSERT MORE COMPLETE LIST SO USER CAN PICK AND CHOOSE
2.0-1.0-7	<p><u>PROCUREMENT</u></p> <ul style="list-style-type: none"> • NCHRP 560: <http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_560.pdf> • Special Experimental Project 14 (SEP 14): <http://www.fhwa.dot.gov/programadmin/contracts/sep_a.cfm> • The Road to Successful ITS Software Acquisition:<http://www.fhwa.dot.gov/publications/research/operations/its/98036/rdsuccessvol2.pdf>

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3	3 Chapter 3: User-Oriented Operational Description
3.1	3.1 The Existing Situation
3.1.1	3.1.1 Network Characteristics
3.1.1.1	3.1.1.1 Arterial
3.1.1.1.0-1	The arterial has regularly spaced signalized intersections. The spacing between major intersections is approximately XX, with less important intersections spaced at XX. The locations at which ASCT is being considered are illustrated in FIGURE XX.
3.1.1.1.0-2	The free-flow travel time between major intersections is approximately XX seconds. (Expand this description as appropriate to cover additional arterials or networks.)
3.1.1.1.0-3	The travel time between key intersections allows two-way progression when cycle lengths of XX seconds (CL=travel time) or YY (CL= 2x travel time) seconds can be used. (Add descriptions of additional cycle lengths if appropriate.)
3.1.1.1.0-4	Most of the corridors within the project area have has irregularly spaced signalized intersections and there are no “natural” cycle lengths that allow two-way progression.
3.1.1.1.0-5	During the peak periods, the cycle length is generally determined by the needs of one or more critical intersections.
3.1.1.1.0-6	The cycle length required to service traffic at the critical intersection(s) is generally close to a “natural” cycle length.
3.1.1.1.0-7	The capacity of the arterial changes during the day, with parking restrictions providing higher capacity during peak periods.
3.1.1.2	3.1.1.2 Grid
3.1.1.2.0-1	The network is a uniform grid. (Expand this description and include figures as appropriate.)
3.1.1.2.0-2	The signal phasing is similar at all intersections, and is typically... (Describe the phasing)
3.1.1.2.0-3	Several intersections have multi-phase intersections that require a higher cycle length than most intersections.

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3.1.1.2.0-4	Several roads in the grid are higher capacity arterials.
3.1.1.2.0-5	The signals along one or more higher capacity streets generally require a higher cycle length than most of the grid intersections.
3.1.1.2.0-6	The capacity of some roads in the network changes during the day, with parking restrictions providing higher capacity during peak periods.
3.1.1.3	3.1.1.3 Isolated intersection or Small Group
3.1.1.3.0-1	There is one critical intersection in the project area, and the timing of adjacent intersections mainly needs to accommodate progression for the platoons serviced by the critical intersection.
3.1.1.3.0-2	<p>The system will be used to improve operation at a single, isolated intersection that does not operate efficiently with typical vehicle-actuated operation. It requires (choose as appropriate):</p> <ul style="list-style-type: none"> • Different phase sequences at different times of the day • Phase reservice to prevent queue overflow in turn bays • Different cycle lengths for different periods • Different splits (phase maximums) for different periods
3.1.1.4	3.1.1.4 Freeway Interchange
3.1.1.4.0-1	The project location has several closely spaced intersections with major turning movements at a freeway interchange. It requires careful management of queue lengths on some approaches.
3.1.1.4.0-2	Queuing from on-ramps affects the distribution of traffic across the lanes on the arterial.
3.1.1.4.0-3	Queuing from on-ramps affects the saturation flow of some movements during green.
3.1.1.5	3.1.1.5 Jurisdictions
3.1.1.5.0-1	<p>The signals are owned by multiple local jurisdictions and operated by Seminole County per organizational agreements and/or maintained by several separate agencies. (Describe which signals are owned, operated and maintained by which agency. Maintenance is performed through existing agreements with FDOT and six (6) Cities within Seminole County (Altamonte Springs, Casselberry, Longwood, Oviedo, Sanford and Winter Springs).</p>

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3.1.2	3.1.2 Traffic Characteristics
3.1.2.1	3.1.2.1 Overview
3.1.2.1.0-1	<p>The traffic characteristics are illustrated below These corridors are some of the most tightly spaced, heavily traveled and congested roadways in Seminole County. Not only do they serve the daily transportation needs of the local and regional population commuting back and forth to work, they also carry a significant amount of traffic through Seminole County to neighboring agencies. The following shows the peak Average Daily Traffic (ADT) volumes on the corridors included in the Project:</p> <p>Over the years, the roadway network in Seminole County has experienced increasing congestion and travel delays due to such high traffic demands and increasing pedestrian traffic crossing at the intersections.</p>
3.1.2.2	3.1.2.2 Peak Periods
3.1.2.2.0-1	There are heavily directional commuter peaks. E.g., during the AM peak, traffic is heavily directional in the XX direction. The peak hour volume in the XX direction is xxxx, while the peak hour volume in the YY direction is yyyy.
3.1.2.2.0-2	Traffic is balanced during commuter peaks. E.g., during the AM peak, the volumes in the two directions are similar, with xxxx vehicles per hour in the XX direction and yyyy vehicles per hour in the YY direction.
3.1.2.2.0-3	Traffic conditions vary during the commuter peaks. E.g., During early part of the AM peak period, traffic flows predominantly in the XX direction, then later in the period it becomes balanced (or flows predominantly in the opposite direction) Choose description as appropriate.
3.1.2.2.0-4	A major traffic generator close to the intersections to be coordinated has non-cyclical peaks. (E.g., a shipping port at which the peak traffic is influenced by the tides, or a military base at which activity does not operate on a weekly cycle.) The direction and magnitude of the peak hour flows is unpredictable and non-uniform.
3.1.2.3	3.1.2.3 Business Hours
3.1.2.3.0-1	Business hours volumes are light between the peaks
3.1.2.3.0-2	Business hours volumes in the two directions are balanced between the peaks.
3.1.2.3.0-3	Business hours flows are predominantly in the XX direction.

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3.1.2.3.0-4	Business hours flows are directional, but vary during the day. E.g., during the morning business hours, the predominant flow is in the XX direction, while during the afternoon hours it is in the YY direction.
3.1.2.3.0-5	During the lunchtime period, there are minor peaks, as illustrated in FIGURE XX. (Include graphics as appropriate.)
3.1.2.4	3.1.2.4 Evenings
3.1.2.4.0-1	During the evenings after the PM peak, the flows are....(Select an appropriate description and illustrate with graphics as appropriate)
3.1.2.4.0-1.0-1	Directional
3.1.2.4.0-1.0-2	Balanced
3.1.2.4.0-1.0-3	Heavy
3.1.2.4.0-1.0-4	Light
3.1.2.5	3.1.2.5 Weekends
3.1.2.5.0-1	During the weekends, the flows are....(Select an appropriate description and illustrate with graphics as appropriate)
3.1.2.5.0-1.0-1	Balanced weekend flows
3.1.2.5.0-1.0-2	Changing weekend patterns
3.1.2.5.0-1.0-3	Saturday or Sunday peaks (Related to retail, recreation, worship and other factors.)
3.1.2.5.0-1.0-4	Weekend retail traffic
3.1.2.5.0-1.0-5	Weekend recreational traffic
3.1.2.6	3.1.2.6 Events and Incidents
3.1.2.6.0-1	Heavily directional event traffic is experienced in this area. (give details such as time of events, duration, day of week, volumes)
3.1.2.6.0-2	Heavily directional incident-related traffic is experienced in this area. (E.g., during peak periods, during off-peak period, during weekends)All 6 corridors within the project area either tie into the interstate or the OOCEA toll road. During incidents on Interstate-4, vehicles will divert to the secondary roadway, seeking an alternate path and thereby creating

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	congestion and bottle necks.
3.1.2.7	3.1.2.7 General
3.1.2.7.0-1	High proportion of turning traffic along the arterial or within the network.
3.1.2.7.0-2	At (some or most or all) intersections there is a high proportion of turning traffic.
3.1.2.7.0-3	Queues often overflow from turn bays at (locations) during (periods of time).
3.1.2.7.0-4	Traffic along the arterial is predominantly through traffic.
3.1.2.7.0-5	The origin or destination of most traffic lies within the corridor or grid.
3.1.2.7.0-6	There are significant turning movements onto and off the coordinated route. (Expand the description as appropriate.)
3.1.2.8	3.1.2.8 Future Traffic Conditions
3.1.2.8.0-1	Describe any changes in traffic conditions that are expected to occur within the likely expected life of the proposed ASCT.
3.1.3	3.1.3 Signal Grouping
3.1.3.0-1	The initial locations of signals to be operated under adaptive control are illustrated below. Ultimately adaptive control may be expanded to a significant percentage of the signals within the jurisdiction.
3.1.3.0-2	All the signals are relatively close and are expected to be coordinated as one group.
3.1.3.0-3	While the signals are relatively close, the traffic conditions are such that they will normally be coordinated as two (or more) separate and independent groups.
3.1.3.0-4	While the signals are relatively close, the traffic conditions vary and sometimes they would be expected to be coordinated as one group, while at other times they may be coordinated as two (or more) separate and independent groups.
3.1.3.0-5	Although the signals are all on the one route, the distance between them is sufficiently great that they will normally be coordinated as two (or more) separate and independent groups.

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3.1.3.0-6	The signals to be coordinated are on two (or more) arterials separated by XX miles, and will always be operated as two separate groups.
3.1.3.0-7	While the signals will normally be operated as two (or more) separate and independent groups, there are occasions (such as when there is a major incident on the parallel freeway) when they should operate as one coordinated unit along the same arterial.
3.1.4	3.1.4 Land Use Characteristics
3.1.4.1	<i>3.1.4.1 Existing Land Uses</i>
3.1.4.1.0-1	(Edit or or select from the following statements if your situation includes an arterial.) The arterial....
3.1.4.1.0-1.0-1	Passes through residential neighborhoods.
3.1.4.1.0-1.0-2	Frontage land uses are mainly retail (E.g. strip mall with numerous driveways, shopping mall with several signalized driveways, big box outlet).
3.1.4.1.0-1.0-3	Frontage land uses are mainly offices.
3.1.4.1.0-1.0-4	Frontage land uses are mainly commercial.
3.1.4.1.0-1.0-5	Frontage land uses are mainly service trades.
3.1.4.1.0-1.0-6	Frontage land uses are mainly manufacturing.
3.1.4.1.0-1.0-7	Serves a mixture of land uses, including residential, office, commercial, retail, service trades, manufacturing, education (high schools, middle schools, elementary schools and a college
3.1.4.1.0-1.0-8	Serves major shopping centers on both the SR 46 and SR 436 corridors.
3.1.4.1.0-1.0-9	Provides a parallel route to a freeway.
3.1.4.1.0-1.0-10	Provides access to a freeway interchange.
3.1.4.1.0-2	(Edit or or select from the following statements if your situation includes a grid or similar network.) The road network...

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3.1.4.1.0-2.0-1	Encompasses a downtown area with mixed uses and a variety of activities. (Edit the description as appropriate.)
3.1.4.2	3.1.4.2 Future Land Use Changes
3.1.4.2.0-1	Describe any changes in land use that are expected to occur within the likely expected life of the proposed ASCT.
3.1.4.3	3.1.4.3 Pedestrians and Public Transit
3.1.4.3.0-1	This section describes the influence of pedestrians on the signal operation.
3.1.4.3.0-1.0-1	Pedestrian delays are a factor in choosing phasing and timing parameters.
3.1.4.3.0-1.0-2	Pedestrians impede turning movements at , especially right turns.
3.1.4.3.0-1.0-3	Pedestrians are present every cycle.
3.1.4.3.0-1.0-4	Pedestrians are present most cycles.
3.1.4.3.0-1.0-5	Pedestrian phases are rarely called.
3.1.4.3.0-2	This section describes the influence of transit on the signal operation.
3.1.4.3.0-2.0-1	There are XX bus lines operating along the route (or within the network). The buses operate at a frequency of XX per hour during peak periods, and (describe operation during other periods).
3.1.4.3.0-2.0-2	Buses enter (and/or leave, and/or cross) the coordinated route at (describe the locations where buses turn or cross coordinated routes).
3.1.4.3.0-2.0-3	A light rail line operates along the coordinated route. (Describe the operation, such as shared lanes, exclusive lanes, in the median, side running, with or without signal priority)
3.1.4.3.0-2.0-4	A light rail line operates parallel to the coordinated route in a separate right of way. It crosses each of the cross streets approximately XX feet from the intersection, and its operation preempts the signals on the coordinated route. (Describe how it actually operates in your situation.)
3.1.4.4	3.1.4.4 Agencies
3.1.4.4.0-1	The existing signal system is operated by (name the agency). Some intersections are controlled by signals belonging to (name other agencies). These are controlled by XX agency (or coordinated with the system operated by YY agency).

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3.1.4.4.0-2	The effectiveness of (name to agency, such as transit and fire department) is affected by the operation of the signal system.
3.1.4.5	3.1.4.5 Existing Architecture
3.1.4.5.0-1	The existing system architecture is illustrated in FIGURE XX. (Provide an appropriate system network block diagram, and describe the following elements, as applicable.)
3.1.4.5.0-1.0-1	TMC and workstations
3.1.4.5.0-1.0-2	Local hubs, on-street masters, etc.
3.1.4.5.0-1.0-3	SCTE communications infrastructure is fiber optic cable
3.1.4.5.0-1.0-4	Detection locations and technology (e.g., video, loops or other technology; stop line, advance or mid-block detection zones)
3.2	3.2 Limitations of the Existing system
3.2.0-1	The following statements summarize the limitations of the existing system that prevent it from satisfactorily accommodating the traffic situations described above. (Select from the following samples and create new descriptions that fit your situation.)
3.2.0-2	The existing system cannot recognize the onset of peak periods, so the peak period coordination plan introduction times are set conservatively to ensure they cover the normal variation in duration and intensity of the peak. This means that the timing is often less efficient during the early and late parts of the peak periods.
3.2.0-3	The peak direction fluctuates during the peak, so the peak period plan is a compromise. An adaptive system would be expected to recognize the direction of heaviest flow in real time and react accordingly, rather than use a plan that is less efficient but can accommodate a range of flows.
3.2.0-4	The coordinated signal operation is often disrupted by light rail priority (or rail preemption, or bus signal priority). An adaptive system may be expected to recover from these disruptions more quickly than the existing system. (Describe how the existing system recovers and how long it takes. Quantify how much improvement may be expected from an adaptive system.)
3.2.0-5	The existing system cannot detect unexpected changes in traffic demand as a result of incidents on the adjacent

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	freeway. As a result, the congestion on the arterials is greater than would be the case if the signal timing could automatically adjust to the unexpected conditions. This would also reduce the need for manual intervention by operators when the incident is brought to their attention.
3.2.0-6	The existing system cannot detect the changes in traffic conditions before and after games at the XXXX stadium. As a result, the coordination plan introduction times are set very conservatively, and they generally begin operating before they are needed and continue until well after the traffic disperses. An adaptive system could be expected to reduce this inefficiency and match the signal timing more closely to the actual traffic patterns.
3.3	3.3 Proposed Improvements to the System
3.3.0-1	This section describes in broad terms the improvements that are desirable in order to address the limitations described above. The main improvements that are desired are: (Select from the samples below and create new descriptions that suit your situation.)
3.3.0-2	<ul style="list-style-type: none"> • Recognize changes in traffic conditions and react quickly and automatically to accommodate those changes.
3.3.0-3	<ul style="list-style-type: none"> • Overcome the institutional boundaries that currently prevent the signals under the control of the different jurisdictions from operating in a coordinated fashion.
3.3.0-4	<ul style="list-style-type: none"> • More efficiently accommodate rail, emergency vehicles and transit vehicles and more quickly recover from preemption and priority.
3.3.0-5	<ul style="list-style-type: none"> • Improve the management of queues within the network.
3.3.0-6	<ul style="list-style-type: none"> • Recognize the existence of differing traffic conditions in various parts of the network and react in each section appropriately.
3.3.0-7	<ul style="list-style-type: none"> • Improve the productivity of staff by automating many of the routine processes.
3.3.0-8	<ul style="list-style-type: none"> • Keep signal timing current rather than letting its efficiency deteriorate between periodic signal re-timing efforts.
3.4	3.4 Vision, Goals and Objectives for the Proposed System
3.4.1	3.4.1 Vision
3.4.1-1	The vision of the ASCT system is to provide an advanced traffic control system that responds to changing traffic conditions, and reduces delays and corridor travel times, while balancing multimodal transportation needs. (Customize

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	this statement to suit your situation.)
3.4.2	3.4.2 Goals
3.4.2-1	The goals of the ASCT system are: (Select from the following items and customize to suit your situation.)
3.4.2-1.0-1	<ul style="list-style-type: none"> • Support vehicle, pedestrian and transit traffic mobility.
3.4.2-1.0-2	<ul style="list-style-type: none"> • Provide measurable improvements in personal mobility
3.4.2-1.0-3	<ul style="list-style-type: none"> • Support interoperability between agencies
3.4.2-1.0-4	<ul style="list-style-type: none"> • Support regional systems
3.4.2-1.0-5	<ul style="list-style-type: none"> • Support congestion environmental policy objectives
3.4.2-1.0-6	<ul style="list-style-type: none"> • Meet a timely project implementation schedule
3.4.3	3.4.3 User Objectives
3.4.3.0-1	The objectives of the adaptive system that support the stated goals are: (Select from the following items and customize to suite your situation.)
3.4.3.0-1.0-1	<p>To support vehicle, pedestrian and transit traffic mobility:</p> <ul style="list-style-type: none"> • Be capable of supporting priority operations for light rail and buses • Allow effective use of all controller features currently in use or proposed to be used • Minimize adverse effects caused by preemption and unexpected events
3.4.3.0-1.0-2	<p>To support measurable improvements in personal mobility:</p> <ul style="list-style-type: none"> • Adjust operations to changing conditions • Reduce delays • Reduce travel times • Provide the same level of safety provided by the existing system to vehicles, pedestrians and transit.
3.4.3.0-1.0-3	<p>To support agency interoperability:</p> <ul style="list-style-type: none"> • Provide facilities for data exchange and control between systems • Allow remote monitoring and control

Model Systems Engineering Documents for ASCT

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	<ul style="list-style-type: none"> ● Adhere to applicable traffic signal and ITS design standards
3.4.3.0-1.0-4	<p>To support regional systems:</p> <ul style="list-style-type: none"> ● Be compliant with the regional ITS architecture ● Allow center-to-center and system-to-system communication ● Connect to regional traffic control systems ● Report traffic conditions to regional traffic conditions information systems
3.4.3.0-1.0-5	<p>To support environmental objectives:</p> <ul style="list-style-type: none"> ● Reduce vehicle emissions through improvements in appropriate determinants such as vehicle stops and delays
3.4.3.0-1.0-6	<p>To support a timely schedule:</p> <ul style="list-style-type: none"> ● Be sufficiently mature and robust that risk is low and little or no development time will be required. ● Be ready for full operation by (specify an appropriate date if you have an imposed deadline)
3.4.4	<p>3.4.4 Operational Objectives</p>
3.4.4.0-1	<p>The operational objectives of the ASCT system will be to: (Select the samples appropriate to your situation)</p>
3.4.4.0-1.0-1	<p>Smooth the flow of traffic along coordinated routes</p>
3.4.4.0-1.0-2	<p>Maximize the throughput of traffic along coordinated routes</p>
3.4.4.0-1.0-3	<p>Equitably serve adjacent land uses</p>
3.4.4.0-1.0-4	<p>Manage queues, to prevent excessive queuing from reducing efficiency</p>
3.4.4.0-1.0-5	<p>Control operation using a combination of these objectives</p>
3.4.4.0-1.0-6	<p>Control operation by change the objectives under various circumstances</p>
3.4.4.0-1.0-7	<p>For a critical isolated intersection, maximize intersection efficiency.</p>
3.5	<p>3.5 Strategies to be Applied by the Improved System</p>
3.5.0-1	<p>The adaptive coordination and control strategies that may be employed to achieve the operational objectives are: (Select the samples that are applicable to your situation)</p>
3.5.0-1.0-1	<ul style="list-style-type: none"> ● Provide a pipeline along a coordinated route to maximize the throughput during periods of high demand;
3.5.0-1.0-2	<ul style="list-style-type: none"> ● Provide a pipeline along a coordinated route to smooth the flow of traffic in one or both directions;
3.5.0-1.0-3	<ul style="list-style-type: none"> ● Distribute phase times in a way that equitably shares the green time between various movements and minimizes the risk of phase failures;

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3.5.0-1.0-4	<ul style="list-style-type: none"> ● Manage queues so they do not exceed the available storage capacity and are located so they do not affect the capacity of other movements;
3.5.0-1.0-5	<ul style="list-style-type: none"> ● Manage the distribution of green times for vehicles and pedestrians in an equitable manner;
3.5.0-1.0-6	<ul style="list-style-type: none"> ● Employ a combination of these strategies when they are compatible.
3.5.0-1.0-7	Not Used
3.6	3.6 Alternative Non-Adaptive Strategies Considered
3.6.1	3.6.1 Traffic Responsive Pattern Selection
3.6.1.0-1	
3.6.1.0-2	Could TRPS operation be used? (If not, why not)
3.6.1.0-3	How successful would TRPS be if it were used.
3.6.2	3.6.2 Complex Coordination Features
3.6.2.0-1	<p>The following features are currently used in coordination patterns. These features will need to remain available in fallback operation should the ASCT fail. (Select from the list as appropriate.)</p> <ul style="list-style-type: none"> ● Multiple (repeat) phases or phase reservice ● Variable phase sequence ● Omit phase under some circumstances ● Detector switching ● Coordinate different phases at different times ● Coordinate turning movement phases ● Coordinate beginning or end of green ● Early release of hold ● Hold the position of uncoordinated phases ● Late phase introduction ● Stop-in-walk ● Dynamic max ● Double cycle or half cycle

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3.6.2.0-2	<p>The following features have not been used in the current coordination patterns. While they have been considered, they are not suitable in this situation for the following reasons. (Select from the list as appropriate, and explain why each is not suitable.)</p> <ul style="list-style-type: none"> ● Multiple (repeat) phases or phase reservice ● Variable phase sequence ● Omit phase under some circumstances ● Detector switching ● Coordinate different phases at different times ● Coordinate turning movement phases ● Coordinate beginning or end of green ● Early release of hold ● Hold the position of uncoordinated phases ● Late phase introduction ● Stop-in-walk ● Dynamic max ● Double cycle or half cycle

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4	4 Chapter 4: Operational Needs	
4.0-1	<p>This chapter describes the operational needs of the users that should be satisfied by the proposed ASCT system. Each of these statements describes something that the system operators need to be able to achieve. Each of these needs will be satisfied by compliance with one or more system requirements. In the attached list of requirements, each one is linked to one or more of these needs statements.</p>	
4.1	4.1 Adaptive Strategies	
4.1.0-1	<p>The system operator needs the ability to implement different strategies individually or in combination to suit different prevailing traffic conditions. These strategies include:</p>	
4.1.0-1.0-1	<ul style="list-style-type: none"> • Maximize the throughput on coordinated routes <p>Note to user when selecting these requirements: Select from requirements in the 2.2 group when sequence-based systems are allowed (sequence-based systems explicitly calculate cycle, offset, and split). Select from requirements in the 2.3 group when non-sequence-based systems are allowed (non-sequence-based systems do not explicitly calculate cycle, offset, and split). (Select requirements from both groups when the vendor is given the choice of supplying one type of adaptive operation or the other.)</p>	<p>2.1.1.0-7 <i>The ASCT shall alter the adaptive operation to achieve required objectives in user-specified conditions. (The required objectives are specified in Needs Statement 4.1.0-1. Responding to this requirement demonstrates how the proposed system allows the user to define the conditions at which the objectives shift and their associated requirements are fulfilled.) (The alteration may be made by adjusting parameters or by directly controlling the state of signal controllers.)</i></p> <p>2.1.1.0-7.0-1 When current measured traffic conditions meet user-specified criteria, the ASCT shall alter the state of the signal controllers, maximizing the throughput of the coordinated route.</p> <p>2.1.1.0-10 The ASCT shall determine the order of phases at a user-specified intersection. (The</p>

Con Ops Reference Number	Concept of Operations Sample Statements	Satisfied by System Requirement (Select to suit your needs)
		<p>calculation will be based on the optimization function.)</p> <p>2.2.0-4 (Sequence-based only) <i>The ASCT shall calculate offsets to suit the current coordination strategy for the user-specified reference point for each signal controller along a coordinated route within a group.</i></p> <p>2.2.0-4.0-1 (Sequence-based only) The ASCT shall apply offsets for the user-specified reference point of each signal controller along a coordinated route.</p> <p>2.2.0-5 (Sequence-based only) <i>The ASCT shall calculate a cycle length for each cycle based on its optimization objectives (as required elsewhere, e.g., progression, queue management, equitable distribution of green).</i></p> <p>2.2.0-5.0-3 (Sequence-based only) The ASCT shall calculate optimum cycle length according to the user-specified coordination strategy.</p> <p>2.3.0-2 (Non-sequence-based only) The ASCT shall calculate the appropriate state of the signal to suit the current coordination strategy at the critical signal controller. (A critical signal controller is defined by the user.)</p> <p>2.3.0-3 (Non-sequence-based only) At non-critical intersections within a group, the ASCT shall calculate the time at which a user-specified phase shall be green, relative to a reference point at the critical intersection, to suit the current coordination strategy .</p> <p>2.3.0-4 (Non-sequence-based only) When demand is present, the ASCT shall implement a user-specified maximum time between successive displays of each phase at each intersection.</p> <p>2.2.0-2 (Sequence-based only) The ASCT shall select cycle length based on a time of day schedule.</p> <p>2.2.0-5.0-1 (Sequence-based only) The ASCT shall limit cycle lengths to user-specified values.</p> <p>2.2.0-5.0-2 (Sequence-based only) The ASCT shall limit cycle lengths to a user-specified range.</p>

Con Ops Reference Number	Concept of Operations Sample Statements	Satisfied by System Requirement (Select to suit your needs)
		<p>2.2.0-5.0-4 <i>(Sequence-based only)</i> The ASCT shall limit changes in cycle length to not exceed a user-specified value.</p> <p>2.2.0-5.0-4.0-1 <i>(Sequence-based only)</i> The ASCT shall increase the limit for the following XX cycles based on a change in conditions.</p> <p>2.2.0-5.0-4.0-1.0-2 <i>(Sequence-based only)</i> The increased limit shall be user-defined.</p> <p>2.2.0-5.0-4.0-1.0-1 <i>(Sequence-based only)</i> The change in conditions shall be defined by XX successive adaptive increases in cycle length at the maximum rate.</p>
4.1.0-1.0-2	<ul style="list-style-type: none"> ● Provide smooth flow along coordinated routes <p>Note to user when selecting these requirements: <i>Select from requirements in the 2.2 group when sequence-based systems are allowed (sequence-based systems explicitly calculate cycle, offset, and split).</i> <i>Select from requirements in the 2.3 group when non-sequence-based systems are allowed (non-sequence-based systems do not explicitly calculate cycle, offset, and split).</i> <i>(Select requirements from both groups when the vendor is given the choice of supplying one type of adaptive operation or the other.)</i></p>	<p>2.1.1.0-7.0-4 When current measured traffic conditions meet user-defined criteria, the ASCT shall alter the state of signal controllers providing two-way progression on a coordinated route.</p> <p>2.1.1.0-10 2.2.0-2 <i>(Sequence-based only)</i> The ASCT shall select cycle length based on a time of day schedule.</p> <p>2.2.0-4 <i>(Sequence-based only)</i> The ASCT shall calculate offsets to suit the current coordination strategy for the user-specified reference point for each signal controller along a coordinated route within a group.</p> <p>2.2.0-4.0-1 <i>(Sequence-based only)</i> The ASCT shall apply offsets for the user-specified reference point of each signal controller along a coordinated route.</p> <p>2.2.0-5 <i>(Sequence-based only)</i> The ASCT shall calculate a cycle length for each cycle based on its optimization objectives (as required elsewhere, e.g., progression, queue management, equitable distribution of green).</p> <p>2.2.0-5.0-1 <i>(Sequence-based only)</i> The ASCT shall limit cycle lengths to user-specified values.</p> <p>2.2.0-5.0-2 <i>(Sequence-based only)</i> The ASCT shall limit cycle lengths to a user-specified range.</p> <p>2.2.0-5.0-3</p>

Con Ops Reference Number	Concept of Operations Sample Statements	Satisfied by System Requirement (Select to suit your needs)
		<p>(Sequence-based only) The ASCT shall calculate optimum cycle length according to the user-specified coordination strategy. 2.2.0-5.0-4</p> <p>(Sequence-based only) The ASCT shall limit changes in cycle length to not exceed a user-specified value. 2.2.0-5.0-4.0-1</p> <p>(Sequence-based only) The ASCT shall increase the limit for the following XX cycles based on a change in conditions. 2.2.0-5.0-4.0-1.0-2</p> <p>(Sequence-based only) The increased limit shall be user-defined. 2.2.0-5.0-4.0-1.0-1</p> <p>(Sequence-based only) The change in conditions shall be defined by XX successive adaptive increases in cycle length at the maximum rate. 2.3.0-3</p> <p>(Non-sequence-based only) At non-critical intersections within a group, the ASCT shall calculate the time at which a user-specified phase shall be green, relative to a reference point at the critical intersection, to suit the current coordination strategy . 2.3.0-2</p> <p>(Non-sequence-based only) The ASCT shall calculate the appropriate state of the signal to suit the current coordination strategy at the critical signal controller. (A critical signal controller is defined by the user.) 2.3.0-4</p> <p>(Non-sequence-based only) When demand is present, the ASCT shall implement a user-specified maximum time between successive displays of each phase at each intersection.</p>
4.1.0-1.0-3	<ul style="list-style-type: none"> Distribute phase times in an equitable fashion <p>Note to user when selecting these requirements: Select from requirements in the 2.2 group when sequence-based systems are allowed (sequence-based systems explicitly calculate cycle, offset, and split).</p>	<p>2.1.1.0-7 The ASCT shall alter the adaptive operation to achieve required objectives in user-specified conditions. (The required objectives are specified in Needs Statement 4.1.0-1. Responding to this requirement demonstrates how the proposed system allows the user to define the conditions at which the objectives shift and their associated requirements are fulfilled.) (The alteration may be made by adjusting parameters or by directly controlling the state of signal controllers.)</p> <p>2.1.1.0-7.0-3 When current measured traffic conditions meet user-specified criteria, the ASCT shall alter the state of signal controllers providing equitable distribution of green</p>

Con Ops Reference Number	Concept of Operations Sample Statements	Satisfied by System Requirement (Select to suit your needs)
	<p><i>Select from requirements in the 2.3 group when non-sequence-based systems are allowed (non-sequence-based systems do not explicitly calculate cycle, offset, and split).</i></p> <p><i>(Select requirements from both groups when the vendor is given the choice of supplying one type of adaptive operation or the other.)</i></p>	<p>times.</p> <p>2.1.1.0-8.0-1 <i>The ASCT shall provide a user-specified maximum value for each phase at each signal controller.</i></p> <p>2.1.1.0-8.0-1.0-1 The ASCT shall not provide a phase length longer than the maximum value.</p> <p>2.1.1.0-8.0-2 <i>The ASCT shall provide a user-specified minimum value for each phase at each signal controller.</i></p> <p>2.1.1.0-8.0-2.0-1 The ASCT shall not provide a phase length shorter than the minimum value.</p> <p>2.2.0-2 (Sequence-based only) The ASCT shall select cycle length based on a time of day schedule.</p> <p>2.2.0-5.0-1</p> <p>2.2.0-3 (Sequence-based only) The ASCT shall calculate phase lengths for all phases at each signal controller to suit the current coordination strategy.</p> <p>2.2.0-5 (Sequence-based only) <i>The ASCT shall calculate a cycle length for each cycle based on its optimization objectives (as required elsewhere, e.g., progression, queue management, equitable distribution of green).</i></p> <p>(Sequence-based only) The ASCT shall limit cycle lengths to user-specified values.</p> <p>2.2.0-5.0-2 (Sequence-based only) The ASCT shall limit cycle lengths to a user-specified range.</p> <p>2.2.0-5.0-3 (Sequence-based only) The ASCT shall calculate optimum cycle length according to the user-specified coordination strategy.</p> <p>2.2.0-5.0-4 (Sequence-based only) <i>The ASCT shall limit changes in cycle length to not exceed a user-specified value.</i></p> <p>2.2.0-5.0-4.0-1 (Sequence-based only) <i>The ASCT shall increase the limit for the following XX cycles</i></p>

Con Ops Reference Number	Concept of Operations Sample Statements	Satisfied by System Requirement (Select to suit your needs)
		<p><i>based on a change in conditions.</i></p> <p>2.2.0-5.0-4.0-1.0-2 (Sequence-based only) The increased limit shall be user-defined.</p> <p>2.2.0-5.0-4.0-1.0-1 (Sequence-based only) The change in conditions shall be defined by XX successive adaptive increases in cycle length at the maximum rate.</p> <p>2.3.0-2 (Non-sequence-based only) The ASCT shall calculate the appropriate state of the signal to suit the current coordination strategy at the critical signal controller. (A critical signal controller is defined by the user.)</p> <p>2.3.0-3 (Non-sequence-based only) At non-critical intersections within a group, the ASCT shall calculate the time at which a user-specified phase shall be green, relative to a reference point at the critical intersection, to suit the current coordination strategy .</p> <p>2.3.0-4 (Non-sequence-based only) When demand is present, the ASCT shall implement a user-specified maximum time between successive displays of each phase at each intersection.</p> <p>2.4.0-3 The ASCT shall calculate optimum phase lengths, based on current measured traffic conditions. (The calculation is based on the optimization objectives.)</p> <p>2.1.1.0-8 <i>The ASCT shall provide maximum and minimum phase times.</i></p>
	<p>ORDER OF REQUIREMENTS ONLY RESORTED TO THIS POINT. REMAINDER STILL TO BE DONE</p>	<p>ORDER OF REQUIREMENTS ONLY RESORTED TO THIS POINT. REMAINDER STILL TO BE DONE</p>
<p>4.1.0-1.0-4</p>	<ul style="list-style-type: none"> • Manage the lengths of queues <p>Note to user when selecting these requirements: Select from requirements in the 2.2 group when sequence-based systems are allowed (sequence-based</p>	<p>2.2.0-4 (Sequence-based only) The ASCT shall calculate offsets to suit the current coordination strategy for the user-specified reference point for each signal controller along a coordinated route within a group.</p> <p>2.2.0-4.0-1 (Sequence-based only) The ASCT shall apply offsets for the user-specified reference point of each signal controller along a coordinated route.</p> <p>2.1.1.0-7.0-2 When current measured traffic conditions meet user-specified criteria, the ASCT</p>

Con Ops Reference Number	Concept of Operations Sample Statements	Satisfied by System Requirement (Select to suit your needs)
	<p><i>systems explicitly calculate cycle, offset, and split).</i></p> <p><i>Select from requirements in the 2.3 group when non-sequence-based systems are allowed (non-sequence-based systems do not explicitly calculate cycle, offset, and split).</i></p> <p><i>(Select requirements from both groups when the vendor is given the choice of supplying one type of adaptive operation or the other.)</i></p>	<p>shall alter the state of signal controllers, preventing queues from exceeding the storage capacity at user-specified locations.</p> <p>2.2.0-5.0-3</p> <p>(Sequence-based only) The ASCT shall calculate optimum cycle length according to the user-specified coordination strategy.</p> <p>2.2.0-5</p> <p>(Sequence-based only) The ASCT shall calculate a cycle length for each cycle based on its optimization objectives (as required elsewhere, e.g., progression, queue management, equitable distribution of green).</p> <p>2.3.0-3</p> <p>(Non-sequence-based only) At non-critical intersections within a group, the ASCT shall calculate the time at which a user-specified phase shall be green, relative to a reference point at the critical intersection, to suit the current coordination strategy</p> <p>.</p> <p>2.3.0-2</p> <p>(Non-sequence-based only) The ASCT shall calculate the appropriate state of the signal to suit the current coordination strategy at the critical signal controller. (A critical signal controller is defined by the user.)</p> <p>2.3.0-4</p> <p>(Non-sequence-based only) When demand is present, the ASCT shall implement a user-specified maximum time between successive displays of each phase at each intersection.</p> <p>2.2.0-2</p> <p>(Sequence-based only) The ASCT shall select cycle length based on a time of day schedule.</p> <p>2.2.0-5.0-1</p> <p>(Sequence-based only) The ASCT shall limit cycle lengths to user-specified values.</p> <p>2.2.0-5.0-2</p> <p>(Sequence-based only) The ASCT shall limit cycle lengths to a user-specified range.</p> <p>2.2.0-5.0-4</p> <p>(Sequence-based only) The ASCT shall limit changes in cycle length to not exceed a user-specified value.</p> <p>2.2.0-5.0-4.0-1</p> <p>(Sequence-based only) The ASCT shall increase the limit for the following XX cycles based on a change in conditions.</p> <p>2.2.0-5.0-4.0-1.0-2</p>

Con Ops Reference Number	Concept of Operations Sample Statements	Satisfied by System Requirement (Select to suit your needs)
		<p>(Sequence-based only) The increased limit shall be user-defined. 2.2.0-5.0-4.0-1.0-1</p> <p>(Sequence-based only) The change in conditions shall be defined by XX successive adaptive increases in cycle length at the maximum rate. 2.1.1.0-10</p>
4.1.0-1.0-5	<ul style="list-style-type: none"> • Manage the locations of queues within the network <p>Note to user when selecting these requirements: Select from requirements in the 2.2 group when sequence-based systems are allowed (sequence-based systems explicitly calculate cycle, offset, and split). Select from requirements in the 2.3 group when non-sequence-based systems are allowed (non-sequence-based systems do not explicitly calculate cycle, offset, and split). (Select requirements from both groups when the vendor is given the choice of supplying one type of adaptive operation or the other.)</p>	<p>2.1.3.0-2 When queues are detected at user-specified locations, the ASCT shall execute user-specified timing plan/operational mode.</p> <p>2.2.0-3 (Sequence-based only) The ASCT shall calculate phase lengths for all phases at each signal controller to suit the current coordination .</p> <p>2.1.3.0-1 The ASCT shall detect the presence of queues at pre-configured locations.</p> <p>2.1.3.0-3 When queues are detected at user-specified locations, the ASCT shall execute user-specified adaptive operation strategy.</p> <p>2.1.3.0-4 When queues are detected at user-specified locations, the ASCT shall omit a user-specified phase at a user-specified signal controller.</p>
4.1.0-1.0-6	<ul style="list-style-type: none"> • At an isolated intersection, optimize operation with a minimum of phase failures (based on the optimization objectives). 	<p>2.4.0-2 The ASCT shall calculate a cycle length of a single intersection, based on current measured traffic conditions. (The calculation is based on the optimization objectives.)</p> <p>2.4.0-3 The ASCT shall calculate optimum phase lengths, based on current measured traffic conditions. (The calculation is based on the optimization objectives.)</p> <p>2.4.0-4</p>

Con Ops Reference Number	Concept of Operations Sample Statements	Satisfied by System Requirement (Select to suit your needs)
		2.1.1.0-8.0-1 <i>The ASCT shall provide a user-specified maximum value for each phase at each signal controller.</i> 2.1.1.0-8.0-1.0-1 The ASCT shall not provide a phase length longer than the maximum value. 2.1.1.0-8.0-2 <i>The ASCT shall provide a user-specified minimum value for each phase at each signal controller.</i> 2.1.1.0-8.0-2.0-1 The ASCT shall not provide a phase length shorter than the minimum value. 2.1.1.0-8 <i>The ASCT shall provide maximum and minimum phase times.</i>
4.1.0-2	The system operator needs to manage the coordination in small groups of signals to link phase service at some intersections with phase service at adjacent intersections. <i>Note that phase-based systems do not explicitly calculate cycle, offset and split at all intersections.</i>	2.5.0-3 (Phase-based only) The ASCT shall calculate the time at which a user-specified phase shall be green at an intersection. 2.5.0-2 (Phase-based only) The ASCT shall alter the state of the signal controller for all phases at the user-specified intersection. 2.5.0-4 (Phase-based only) When demand is present, the ASCT shall implement a user-specified maximum time between successive displays of each phase at each intersection. 2.5.0-5 (Phase-based only) The ASCT shall alter the operation of the non-critical intersections to minimize stopping of traffic released from user-specified phases at the user-specified critical intersection. 2.5.0-6 (Phase-based only) The ASCT shall alter the operation of the non-critical intersections to minimize stopping of traffic arriving at user-specified phases at the user-specified critical intersection. 2.5.0-7 (Phase-based only) The ASCT shall adjust the state of the signal controller so that vehicles approaching a signal that have been served during a user-specified phase at an upstream signal do not stop.
4.1.0-3	The system operator needs to change the operational	2.1.1.0-7.0-1

Con Ops Reference Number	Concept of Operations Sample Statements	Satisfied by System Requirement (Select to suit your needs)
	<p>strategy (for example, from smooth flow to maximizing throughput or managing queues) based on changing traffic conditions.</p>	<p>When current measured traffic conditions meet user-specified criteria, the ASCT shall alter the state of the signal controllers, maximizing the throughput of the coordinated route. 2.1.1.0-7.0-2</p> <p>When current measured traffic conditions meet user-specified criteria, the ASCT shall alter the state of signal controllers, preventing queues from exceeding the storage capacity at user-specified locations. 2.1.1.0-7.0-3</p> <p>When current measured traffic conditions meet user-specified criteria, the ASCT shall alter the state of signal controllers providing equitable distribution of green times. 2.1.1.0-7.0-4</p> <p>When current measured traffic conditions meet user-defined criteria, the ASCT shall alter the state of signal controllers providing two-way progression on a coordinated route. 2.1.1.0-7</p> <p><i>The ASCT shall alter the adaptive operation to achieve required objectives in user-specified conditions. (The required objectives are specified in Needs Statement 4.1.0-1. Responding to this requirement demonstrates how the proposed system allows the user to define the conditions at which the objectives shift and their associated requirements are fulfilled.) (The alteration may be made by adjusting parameters or by directly controlling the state of signal controllers.)</i></p>
4.1.0-4	<p>The system operator needs to detect repeated phase failures and control signal timing to prevent phase failures building up queues. The operator in this case is trying to prevent a routine queue from forming where it will block another movement in the cycle unnecessarily. For example, the operator may need to prevent a queue resulting from the trailing end of the through green from blocking the storage needed by an entering side-street left turn in the subsequent phase. An overall queue management strategy, particularly when congestion is present, is covered under 4.1.0-1.0-5.</p>	<p>2.1.1.0-9</p> <p>The ASCT shall detect repeated phases that do not serve all waiting vehicles. (These phase failures may be inferred, such as by detecting repeated max-out.) 2.1.1.0-9.0-1</p> <p>The ASCT shall alter operations, to minimize repeated phase failures.</p>
4.1.0-5	<p>The system operator needs to minimize the chance that a queue forms at a specified location.</p> <p>Note to user when selecting these requirements: Select from requirements in the 2.2 group when sequence-based systems are allowed (sequence-based systems explicitly calculate cycle, offset, and split).</p>	<p>2.3.0-5</p> <p>(Non-sequence-based only) The ASCT shall adjust signal timing so that vehicles approaching a signal that have been served during a user-specified phase at an upstream signal do not stop. 2.5.0-7</p> <p>(Phase-based only) The ASCT shall adjust the state of the signal controller so that vehicles approaching a signal that have been served during a user-specified phase at an upstream signal do not stop.</p>

Con Ops Reference Number	Concept of Operations Sample Statements	Satisfied by System Requirement (Select to suit your needs)
	<p>Select from requirements in the 2.3 group when non-sequence-based systems are allowed (non-sequence-based systems do not explicitly calculate cycle, offset, and split).</p> <p>Select from requirements in the 2.5 group when phase-based systems are allowed (phase-based systems do not explicitly calculate cycle, offset and split at all intersections).</p> <p>(Select requirements from two or all three groups when the vendor is given the choice of supplying the type of adaptive operation.)</p>	<p>2.2.0-5.0-5</p> <p>(Sequence-based only) The ASCT shall adjust offsets to minimize the chance of stopping vehicles approaching a signal that have been served by a user-specified phase at an upstream signal.</p>
4.1.0-6	<p>The system operator needs to modify the sequence of phases to support the various operational strategies.</p>	<p>7.0-6</p> <p><i>The ASCT shall provide a minimum of XX different user-defined phase sequences for each signal.</i></p> <p>7.0-6.0-1</p> <p>Each permissible phase sequence shall be user-assignable to any signal timing plan.</p> <p>7.0-6.0-2</p> <p>Each permissible phase sequence shall be executable by a time of day schedule.</p> <p>7.0-6.0-3</p> <p>Each permissible phase sequence shall be executable based on measured traffic conditions</p> <p>7.0-7</p> <p>The ASCT shall not prevent a phase/overlap output by time-of-day.</p> <p>7.0-8</p> <p>The ASCT shall not prevent a phase/overlap output based on an external input.</p> <p>7.0-9</p> <p>The ASCT shall not prevent the following phases to be designated as coordinated phases. (User to list all required phases.)</p>
4.1.0-7	<p>The system operator needs to fix the sequence of phases at any specified location. For example, the operator may need to fix the phase order at a diamond interchange.</p>	<p>2.1.2.0-12</p> <p>The ASCT shall not alter the order of phases at a user-specified intersection.</p>

Con Ops Reference Number	Concept of Operations Sample Statements	Satisfied by System Requirement (Select to suit your needs)
4.1.0-8	The system operator needs to designate the coordinated route based on traffic conditions and the selected operational strategy.	2.1.1.0-11 <i>The ASCT shall provide coordination along a route.</i> 2.1.1.0-11.0-1 The ASCT shall coordinate along a user-defined route. 2.1.1.0-11.0-2 The ASCT shall determine the coordinated route based on traffic conditions. 2.1.1.0-11.0-3 The ASCT shall determine the coordinated route based on a user-defined schedule. 2.1.1.0-11.0-4 <i>The ASCT shall store XX user-defined coordination routes.</i> 2.1.1.0-11.0-4.0-1 The ASCT shall implement a stored coordinated route by operator command. 2.1.1.0-11.0-4.0-2 The ASCT shall implement a stored coordinated route based on traffic conditions. 2.1.1.0-11.0-4.0-3 The ASCT shall implement a stored coordinated route based on a user-defined schedule.
4.1.0-9	The system operator needs to set signal timing parameters (such as minimum green, maximum green and extension time) to comply with agency policies.	2.1.1.0-12 The ASCT shall not prevent the use of phase timings in the local controller set by agency policy.
4.2	4.2 Network characteristics	
4.2.0-1	The system operator needs to eventually adaptively control up to XXX signals, up to XXX 30miles from the TMC (or specified location).	1.0-1 The ASCT shall control a minimum of XX signals concurrently
4.2.0-2	The system operator needs to be able to adaptively control up to XX independent groups of signals	1.0-2 <i>The ASCT shall support groups of signals.</i> 1.0-2.0-2 The ASCT shall control a minimum of XX groups of signals. 1.0-2.0-4 Each group shall operate independently 1.0-2.0-1 The boundaries surrounding signal controllers that operate in a coordinated fashion shall be defined by the user.

Con Ops Reference Number	Concept of Operations Sample Statements	Satisfied by System Requirement (Select to suit your needs)
4.2.0-3	The system operator needs to vary the number of signals in an adaptively controlled group to accommodate the prevailing traffic conditions.	1.0-2 <i>The ASCT shall support groups of signals.</i> 1.0-2.0-3 The size of a group shall range from 1 to XX signals. 1.0-2.0-5.0-1 The boundaries surrounding signal controllers that operate in a coordinated fashion shall be altered by the system according to a time of day schedule. (For example: this may be achieved by assigning signals to different groups or by combining groups.) 1.0-2.0-5.0-2 The boundaries surrounding signal controllers that operate in a coordinated fashion shall be altered by the system according to traffic conditions. (For example: this may be achieved by assigning signals to different groups or by combining groups.) 1.0-2.0-5 <i>The boundaries surrounding signal controllers that operate in a coordinated fashion shall be altered by the ASCT system according to configured parameters.</i> 1.0-2.0-5.0-3 The boundaries surrounding signal controllers that operate in a coordinated fashion shall be altered by the system when commanded by the user.
4.3	4.3 Coordination across boundaries	
4.3.0-1	The system operator needs to adaptively control signals operated by (specify jurisdictions).	3.0-1 <i>The ASCT shall support external interfaces according to the following detailed requirements. (Insert appropriate requirements that suit your needs. Interface data flows should be documented in your ITS architecture. Interface requirements include:</i> <ul style="list-style-type: none"> ● <i>Information layer protocol</i> ● <i>Application layer protocol</i> ● <i>Lower layer protocol</i> ● <i>Data aggregation</i> ● <i>Frequency of storage</i> ● <i>Frequency of reporting</i> ● <i>Duration of storage)</i>

Con Ops Reference Number	Concept of Operations Sample Statements	Satisfied by System Requirement (Select to suit your needs)
4.3.0-2	The system operator needs to send data to another system that would allow the other system to coordinate with the ASCT system.	3.0-1 <i>The ASCT shall support external interfaces according to the following detailed requirements. (Insert appropriate requirements that suit your needs. Interface data flows should be documented in your ITS architecture. Interface requirements include:</i> <ul style="list-style-type: none"> ● <i>Information layer protocol</i> ● <i>Application layer protocol</i> ● <i>Lower layer protocol</i> ● <i>Data aggregation</i> ● <i>Frequency of storage</i> ● <i>Frequency of reporting</i> ● <i>Duration of storage)</i> 3.0-1.0-1 The ASCT shall send operational data to XX external system. (Insert appropriate requirements that suit your needs.) 3.0-1.0-2 The ASCT shall send control data to the XX external system. (Insert appropriate requirements that suit your needs.) 3.0-1.0-4 The ASCT shall send coordination data to the XX external system. (Insert appropriate requirements that suit your needs.)
4.3.0-3	The system operator needs to adaptively coordinate signals on two crossing routes simultaneously. (Include signals on crossing arterials within the boundaries of the adaptive systems mapped in Chapter 3.)	4.0-1.0-4 The ASCT shall support adaptive coordination on crossing routes.
4.3.0-4	The system operator needs to receive data from another system that will allow the ASCT system to coordinate its operation with the adjacent system.	3.0-1 <i>The ASCT shall support external interfaces according to the following detailed requirements. (Insert appropriate requirements that suit your needs. Interface data flows should be documented in your ITS architecture. Interface requirements include:</i> <ul style="list-style-type: none"> ● <i>Information layer protocol</i> ● <i>Application layer protocol</i> ● <i>Lower layer protocol</i>

Con Ops Reference Number	Concept of Operations Sample Statements	Satisfied by System Requirement (Select to suit your needs)
		<ul style="list-style-type: none"> ● <i>Data aggregation</i> ● <i>Frequency of storage</i> ● <i>Frequency of reporting</i> ● <i>Duration of storage)</i> <p>4.0-1.0-1 The ASCT shall alter its operation to minimize interruption of traffic entering the system. (This may be achieved via detection, with no direct connection to the other system.)</p> <p>4.0-1 <i>The ASCT shall conform its operation to an external system's operation.</i></p> <p>4.0-1.0-3 The ASCT shall alter its operation based on data received from another system.</p>
4.3.0-5	The system operator needs to constrain the adaptive system to operate a cycle length compatible with the crossing arterial.	<p>4.0-1.0-2 The ASCT shall operate a fixed cycle length to match the cycle length of an adjacent system.</p>
4.3.0-6	The system operator needs to detect traffic approaching from a neighboring system and coordinate the ASCT operation with the adjacent system.	<p>4.0-1.0-1 The ASCT shall alter its operation to minimize interruption of traffic entering the system. (This may be achieved via detection, with no direct connection to the other system.)</p> <p>4.0-1 <i>The ASCT shall conform its operation to an external system's operation.</i></p>
4.4	4.4 Security	
4.4.0-1	The system operator needs to have a security management and administrative system that allows access and operational privileges to be assigned, monitored and controlled by an administrator, and conform to the agency's access and network infrastructure security policies.	<p>5.0-1 The ASCT shall be implemented with a security policy that addresses the following selected elements:</p> <p>5.0-1.0-1</p> <ul style="list-style-type: none"> ● Local access to the ASCT. <p>5.0-1.0-2</p> <ul style="list-style-type: none"> ● Remote access to the ASCT. <p>5.0-1.0-3</p> <ul style="list-style-type: none"> ● System monitoring.

Con Ops Reference Number	Concept of Operations Sample Statements	Satisfied by System Requirement (Select to suit your needs)
		5.0-1.0-4 ● System manual override. 5.0-1.0-5 ● Development 5.0-1.0-6 ● Operations 5.0-1.0-7 ● User login 5.0-1.0-8 ● User password 5.0-1.0-9 ● Administration of the system 5.0-1.0-10 ● Signal controller group access 5.0-1.0-11 ● Access to classes of equipment 5.0-1.0-12 ● Access to equipment by jurisdiction 5.0-1.0-13 ● Output activation 5.0-1.0-14 ● System parameters 5.0-1.0-15 ● Report generation 5.0-1.0-16 ● Configuration 5.0-1.0-17 ● Security alerts 5.0-1.0-18

Con Ops Reference Number	Concept of Operations Sample Statements	Satisfied by System Requirement (Select to suit your needs)
		<ul style="list-style-type: none"> ● Security logging 5.0-1.0-19 ● Security reporting 5.0-1.0-20 ● Database 5.0-1.0-21 ● Signal controller 5.0-3 <p>The ASCT shall comply with the agency's security policy as described in (specify appropriate policy document).</p>
4.5	4.5 Queuing interactions	
4.5.0-1	The system operator needs to detect queues from outside the system and modify the ASCT operation to accommodate the queuing.	<p>2.1.3.0-2 When queues are detected at user-specified locations, the ASCT shall execute user-specified timing plan/operational mode.</p> <p>2.1.3.0-1 The ASCT shall detect the presence of queues at pre-configured locations.</p> <p>2.1.3.0-3 When queues are detected at user-specified locations, the ASCT shall execute user-specified adaptive operation strategy.</p>
4.5.0-2	The system operator needs to detect queues within the system's boundaries and modify the ASCT operation to accommodate the queuing.	<p>2.1.3.0-2 When queues are detected at user-specified locations, the ASCT shall execute user-specified timing plan/operational mode.</p> <p>2.1.3.0-1 The ASCT shall detect the presence of queues at pre-configured locations.</p> <p>2.1.3.0-3 When queues are detected at user-specified locations, the ASCT shall execute user-specified adaptive operation strategy.</p>
4.5.0-3	The system operator needs to detect queues propagating outside its boundaries from within the ASCT boundaries, and modify its operation to accommodate the queuing.	<p>2.1.3.0-2 When queues are detected at user-specified locations, the ASCT shall execute user-specified timing plan/operational mode.</p> <p>2.1.3.0-1 The ASCT shall detect the presence of queues at pre-configured locations.</p>

Con Ops Reference Number	Concept of Operations Sample Statements	Satisfied by System Requirement (Select to suit your needs)
		2.1.3.0-3 When queues are detected at user-specified locations, the ASCT shall execute user-specified adaptive operation strategy.
4.5.0-4	The system operator needs to store queues in locations where they can be accommodated without adversely affecting adaptive operation.	2.1.3.0-2 When queues are detected at user-specified locations, the ASCT shall execute user-specified timing plan/operational mode. 2.1.3.0-1 The ASCT shall detect the presence of queues at pre-configured locations. 2.1.3.0-3 When queues are detected at user-specified locations, the ASCT shall execute user-specified adaptive operation strategy. 2.1.3.0-4 When queues are detected at user-specified locations, the ASCT shall omit a user-specified phase at a user-specified signal controller. 2.1.3.0-5 The ASCT shall meter traffic into user-specified bottlenecks by storing queue at user-specified locations. 2.1.3.0-6 The ASCT shall store queues at user-specified locations. 2.1.3.0-7 The ASCT shall maintain capacity flow through user-specified bottlenecks.
4.5.0-5	The system operator needs to prevent queues forming at user-specified locations.	2.1.3.0-2 When queues are detected at user-specified locations, the ASCT shall execute user-specified timing plan/operational mode. 2.1.3.0-1 The ASCT shall detect the presence of queues at pre-configured locations. 2.1.3.0-3 When queues are detected at user-specified locations, the ASCT shall execute user-specified adaptive operation strategy. 2.1.3.0-4 When queues are detected at user-specified locations, the ASCT shall omit a user-specified phase at a user-specified signal controller. 2.1.3.0-5 The ASCT shall meter traffic into user-specified bottlenecks by storing queue at user-specified locations.

Con Ops Reference Number	Concept of Operations Sample Statements	Satisfied by System Requirement (Select to suit your needs)
		2.1.3.0-6 The ASCT shall store queues at user-specified locations. 2.1.3.0-7 The ASCT shall maintain capacity flow through user-specified bottlenecks.
4.6	4.6 Pedestrians	
4.6.0-1	The system operator needs to accommodate infrequent pedestrian operation and then adaptively recover. (This is appropriate for rare pedestrian calls.)	8.0-3 When a pedestrian phase is called, the ASCT shall accommodate pedestrian crossing times then resume adaptive operation.
4.6.0-2	The system operator needs to accommodate infrequent pedestrian operation while maintaining adaptive operation. (This is appropriate for pedestrian calls that are common but not so frequent that they drive the operational needs.)	8.0-2 When a pedestrian phase is called, the ASCT shall accommodate pedestrian crossing times during adaptive operations.
4.6.0-3	The system operator needs to incorporate frequent pedestrian operation into routine adaptive operation. (This is appropriate when pedestrians are frequent enough that they must be assumed to be present every cycle or nearly every cycle.)	8.0-2 When a pedestrian phase is called, the ASCT shall accommodate pedestrian crossing times during adaptive operations. 8.0-5 The ASCT shall execute pedestrian recall on user-defined phases in accordance with a time of day schedule. 8.0-7 When specified by the user, the ASCT shall execute pedestrian recall on pedestrian phase adjacent to coordinated phases. 8.0-8 When the pedestrian phases are on recall, the ASCT shall accommodate pedestrian timing during adaptive operation.
4.6.0-4	The system operator needs to accommodate the following custom pedestrian features. (Describe custom features in this need and then create appropriate requirements.)	
4.6.0-5	The system operator needs to accommodate early start of walk and exclusive pedestrian phases.	8.0-1 When a pedestrian phase is called, the ASCT shall execute pedestrian phases up to XX seconds before the vehicle green of the related vehicle phase. 8.0-4 The ASCT shall execute user-specified exclusive pedestrian phases during adaptive operation.
4.7	4.7 Non-adaptive situations	

Con Ops Reference Number	Concept of Operations Sample Statements	Satisfied by System Requirement (Select to suit your needs)
4.7.0-1	The system operator needs to detect traffic conditions during which adaptive control is not the preferred operation, and implement some pre-defined operation while that condition is present.	2.1.1.0-1 The ASCT shall operate non-adaptively during the presence of a defined condition.
4.7.0-2	The system operator needs to schedule pre-determined operation by time of day.	2.1.1.0-5 The ASCT shall operate non-adaptively in accordance with a user-defined time-of-day schedule.
4.7.0-3	The system operator needs to over-ride adaptive operation.	2.1.1.0-3 The ASCT shall operate non-adaptively when a user manually commands the ASCT to cease adaptively controlling a group of signals. 2.1.1.0-4 The ASCT shall operate non-adaptively when a user manually commands the ASCT to cease adaptive operation. 2.1.1.0-5 The ASCT shall operate non-adaptively in accordance with a user-defined time-of-day schedule.
4.8	4.8 System responsiveness	
4.8.0-1	The system operator needs to modify the ASCT operation to closely follow changes in traffic conditions.	2.6.0-1 The ASCT shall limit the change in consecutive cycle lengths to be less than a user-specified value. 2.6.0-2 The ASCT shall limit the change in phase times between consecutive cycles to be less than a user-specified value. (This does not apply to early gap-out or actuated phase skipping.) 2.6.0-3 The ASCT shall limit the changes in the direction of primary coordination to a user-specified frequency.
4.8.0-2	The system operator needs to constrain the selection of cycle lengths to those that provide acceptable operations, such as when resonant progression solutions are desired.	2.6.0-3 The ASCT shall limit the changes in the direction of primary coordination to a user-specified frequency. 2.6.0-5 The ASCT shall select cycle length from a list of user-defined cycle lengths.
4.8.0-3	The system operator needs to respond quickly to sudden large shifts in traffic conditions.	2.6.0-4 When a large change in traffic demand is detected, the ASCT shall respond more quickly than normal operation, subject to user-specified limits.

Con Ops Reference Number	Concept of Operations Sample Statements	Satisfied by System Requirement (Select to suit your needs)
4.9	4.9 Complex coordination and controller features	
4.9.0-1	The system operator needs to implement the following advanced controller features while maintaining adaptive operation:	
4.9.0-1.0-1	<ul style="list-style-type: none"> Service a phase more than once per cycle 	7.0-1 When specified by the user, the ASCT shall serve a vehicle phase more than once for each time the coordinated phase is served.
4.9.0-1.0-2	<ul style="list-style-type: none"> Operate at least 8 overlap phases 	7.0-2 The ASCT shall provide a minimum of XX 8 phase overlaps.
4.9.0-1.0-3	<ul style="list-style-type: none"> Operate four rings, 16 phases and up to three phases per ring (Edit to suit your needs). 	7.0-3 The ASCT shall accommodate a minimum of XX phases at each signal 7.0-4 The ASCT shall accommodate a minimum of XX rings at each signal. 7.0-5 The ASCT shall accommodate a minimum of XX phases per ring
4.9.0-1.0-4	<ul style="list-style-type: none"> Permit different phase sequences under different traffic conditions 	7.0-6 <i>The ASCT shall provide a minimum of XX different user-defined phase sequences for each signal.</i> 7.0-6.0-1 Each permissible phase sequence shall be user-assignable to any signal timing plan. 7.0-6.0-2 Each permissible phase sequence shall be executable by a time of day schedule. 7.0-6.0-3 Each permissible phase sequence shall be executable based on measured traffic conditions
4.9.0-1.0-5	<ul style="list-style-type: none"> Allow one or more phases to be omitted (disabled) under certain traffic conditions or signal states. 	2.1.2.0-6 The ASCT shall omit a user-specified phase when the cycle length is below a user-specified value. 2.1.2.0-9 The ASCT shall omit a user-specified phase according to a time of day schedule 2.1.2.0-7 The ASCT shall omit a user-specified phase based on measured traffic conditions.

Con Ops Reference Number	Concept of Operations Sample Statements	Satisfied by System Requirement (Select to suit your needs)
		<p>2.1.2.0-8 The ASCT shall omit a user-specified phase based on the state of a user-specified external input.</p>
4.9.0-1.0-6	<ul style="list-style-type: none"> Prevent one or more phases being skipped under certain traffic conditions or signal states. 	<p>2.1.2.0-5 The ASCT shall prevent skipping a user-specified phase according to a time of day schedule.</p> <p>2.1.2.0-3 The ASCT shall prevent skipping a user-specified phase when the user-specified phase sequence is operating.</p> <p>2.1.2.0-4 The ASCT shall prevent skipping a user-specified phase based on the state of a user-specified external input.</p>
4.9.0-1.0-7	<ul style="list-style-type: none"> Allow detector logic at an intersection to be varied depending on local signal states 	<p>7.0-15 The ASCT shall operate adaptively with the following detector logic. (DESCRIBE THE CUSTOM LOGIC)</p>
4.9.0-1.0-8	<ul style="list-style-type: none"> Accommodate the following custom features used by this agency (describe the features) 	<p>7.0-14 (Describe requirements to suit other custom controller features that must be accommodated.)</p>
4.9.0-1.0-9	<ul style="list-style-type: none"> Allow any phase to be designated as the coordinated phase 	<p>7.0-9 The ASCT shall not prevent the following phases to be designated as coordinated phases. (User to list all required phases.)</p>
4.9.0-1.0-10	<ul style="list-style-type: none"> Allow the operator to specify which phase receives unused time from a preceding phase 	<p>2.1.2.0-10 The ASCT shall assign unused time from a preceding phase that terminates early to a user-specified phase as follows:</p> <ul style="list-style-type: none"> next phase; next coordinated phase; user-specified phase. <p>2.1.2.0-11 The ASCT shall assign unused time from a preceding phase that is skipped to a user-specified phase as follows:</p> <ul style="list-style-type: none"> previous phase;

Con Ops Reference Number	Concept of Operations Sample Statements	Satisfied by System Requirement (Select to suit your needs)
		<ul style="list-style-type: none"> ● next phase; ● next coordinated phase; ● user-specified phase.
4.9.0-1.0-11	<ul style="list-style-type: none"> ● Allow the controller to respond independently to individual lanes of an approach. This may be implemented in the signal controller using XX extension/passage timers, which may be assignable to each vehicle detector input channel. This may allow the adaptive operation to be based on data from a specific detector, or by excluding specific detectors. 	<p>7.0-12 <i>The ASCT shall not prevent the local signal controller from performing actuated phase control using XX extension/passage timers as assigned to user-specified vehicle detector input channels in the local controller.</i></p> <p>9.0-1 The ASCT shall set a specific state for each special function output based on the occupancy on a user-specified detector.</p> <p>7.0-12.0-1 The ASCT shall operate adaptively using user-specified detector channels.</p>
4.9.0-1.0-12	<ul style="list-style-type: none"> ● Allow the coordinated phase to terminate early under prescribed traffic conditions 	<p>7.0-10 The ASCT shall have the option for a coordinated phase to be released early based on a user-definable point in the phase or cycle. (User select phase or cycle.)</p>
4.9.0-1.0-13	<ul style="list-style-type: none"> ● Allow flexible timing of non-coordinated phases (such as late start of a phase) while maintaining coordination 	<p>8.0-6 The ASCT shall begin a non-coordinated phase later than its normal starting point within the cycle when all of the following conditions exist:</p> <ul style="list-style-type: none"> ● The user enables this feature ● Sufficient time in the cycle remains to serve the minimum green times for the phase and the subsequent non-coordinated phases before the beginning of the coordinated phase ● The phase is called after its normal start time ● The associated pedestrian phase is not called
4.9.0-1.0-14	<ul style="list-style-type: none"> ● Protected/permissive phasing and alternate left turn phase sequences. 	<p>2.1.2.0-1 The ASCT shall not prevent protected/permissive left turn phase operation.</p> <p>2.1.2.0-2 The ASCT shall not prevent the protected left turn phase to lead or lag the opposing through phase based upon user-specified conditions.</p>
4.9.0-1.0-15	<ul style="list-style-type: none"> ● Use flashing yellow arrow to control permissive left turns and right turns. 	<p>7.0-11 The ASCT shall not prevent the controller from displaying flashing yellow arrow left turn or right turn. (SELECT AS APPLICABLE)</p>

Model Systems Engineering Documents for ASCT

Con Ops Reference Number	Concept of Operations Sample Statements	Satisfied by System Requirement (Select to suit your needs)
4.9.0-1.0-16	<ul style="list-style-type: none"> Service side streets and pedestrian phases at minor locations more often than at adjacent signals when this can be done without compromising the quality of the coordination. (E.g., double-cycle mid-block pedestrian crossing signals.) 	7.0-13 When adaptive operation is used in conjunction with normal coordination, the ASCT shall not prevent a controller serving a cycle length different from the cycles used at adjacent intersections.
4.9.0-1.0-17	<ul style="list-style-type: none"> Use negative pedestrian phasing to prevent an overlap conflicting with a pedestrian walk/don't walk 	8.0-9 The ASCT shall not inhibit negative vehicle and pedestrian phase timing.
4.10	4.10 Monitoring and control	
4.10.0-1	The system operator needs to monitor and control all required features of adaptive operation from the following locations: (Edit and select as appropriate to suit your situation.)	5.0-2 <i>The ASCT shall provide monitoring and control access at the following locations:</i>
4.10.0-1.0-1	<ul style="list-style-type: none"> Agency TMC 	5.0-2.0-1 <ul style="list-style-type: none"> Agency TMC
4.10.0-1.0-2	<ul style="list-style-type: none"> Maintenance facility 	5.0-2.0-2 <ul style="list-style-type: none"> Maintenance facility
4.10.0-1.0-3	<ul style="list-style-type: none"> Workstations on agency LAN or WAN located at (specify) 	5.0-2.0-3 <ul style="list-style-type: none"> Agency LAN or WAN
4.10.0-1.0-4	<ul style="list-style-type: none"> Other agency's TMC (specify) 	5.0-2.0-4 <ul style="list-style-type: none"> Other agency TMC
4.10.0-1.0-5	<ul style="list-style-type: none"> Local controller cabinets 	5.0-2.0-5 <ul style="list-style-type: none"> Local controller cabinets
4.10.0-1.0-6	<ul style="list-style-type: none"> Maintenance vehicles 	5.0-2.0-6 <ul style="list-style-type: none"> Maintenance vehicles
4.10.0-1.0-7	<ul style="list-style-type: none"> Remote locations (specify) 	5.0-2.0-7 <ul style="list-style-type: none"> Remote locations via internet
4.10.0-2	The operator needs to access to the database management, monitoring and reporting features and functions of the signal controllers and any related signal management system from the access points defined for those system components.	5.0-4 The ASCT shall not prevent access to the local signal controller database, monitoring or reporting functions by any installed signal management system.
4.11	4.11 Performance reporting	

Model Systems Engineering Documents for ASCT

Con Ops Reference Number	Concept of Operations Sample Statements	Satisfied by System Requirement (Select to suit your needs)
4.11.0-1	The agency needs the (specify external decision support system) to be able to monitor the ASCT system automatically.	3.0-1.0-3 The ASCT shall send monitoring data to the XX external system. (Insert appropriate requirements that suit your needs.)
4.11.0-2	The system operator needs to store and report data used to calculate signal timing and have the data available for subsequent analysis.	6.0-4 The ASCT shall store results of all signal timing parameter calculations for a minimum of 2 years . 6.0-5 The ASCT shall store the following measured data in the form used as input to the adaptive algorithm for a minimum of 2 years : <ul style="list-style-type: none"> ● volume ● occupancy ● queue length 18.0-1 The ASCT shall report measures of current traffic conditions on which it bases signal state alterations. 18.0-2 The ASCT shall report all intermediate calculated values that are affected by calibration parameters. 18.0-3 <i>The ASCT shall maintain a log of all signal state alterations directed by the ASCT.</i>
4.11.0-3	The system operator needs to store and report data that can be used to measure traffic performance under adaptive control.	6.0-4 The ASCT shall store results of all signal timing parameter calculations for a minimum of 2 years . 6.0-5 The ASCT shall store the following measured data in the form used as input to the adaptive algorithm for a minimum of 2 years : (edit as appropriate) <ul style="list-style-type: none"> ● volume ● occupancy ● queue length
4.11.0-4	The system operator needs to store all operational data and signal timing parameters calculated by the adaptive system, and export selected data to (specify appropriate external system).	6.0-2 The ASCT shall export its systems log in the following formats: (edit as appropriate)

Con Ops Reference Number	Concept of Operations Sample Statements	Satisfied by System Requirement (Select to suit your needs)
		<ul style="list-style-type: none"> ● MS Excel ● Text ● CSV ● Open source SQL database <p>6.0-3 The ASCT shall store the event log for a minimum of XX days</p> <p>6.0-6 The ASCTsystem shall archive all data automatically after a user-specified period not less than XX days.</p> <p>6.0-7 The ASCT shall provide data storage for a system size of XX signal controllers. The data to be stored shall include the following: (edit as appropriate)</p> <ul style="list-style-type: none"> ● Controller state data ● Reports ● Log data ● Security data ● ASCT parameters ● Detector status data <p>6.0-10 The ASCT shall store data logs in a standard database (specify as appropriate).</p>
4.11.0-5	The system operator needs to report performance data in real time to (specify external system).	<p>3.0-1 <i>The ASCT shall support external interfaces according to the following detailed requirements. (Insert appropriate requirements that suit your needs. Interface data flows should be documented in your ITS architecture. Interface requirements include:</i></p> <ul style="list-style-type: none"> ● <i>Information layer protocol</i> ● <i>Application layer protocol</i> ● <i>Lower layer protocol</i> ● <i>Data aggregation</i> ● <i>Frequency of storage</i>

Con Ops Reference Number	Concept of Operations Sample Statements	Satisfied by System Requirement (Select to suit your needs)
		<ul style="list-style-type: none"> ● <i>Frequency of reporting</i> ● <i>Duration of storage)</i> 3.0-1.0-1 The ASCT shall send operational data to XX external system. (Insert appropriate requirements that suit your needs.) 3.0-1.0-5 The ASCT shall send performance data to the XX external system. (Insert appropriate requirements that suit your needs.)
4.11.0-6	The system operator needs to be able to report the exact state of signal timing and input data for a specified period, to allow historical analysis of the system operation.	6.0-1 <i>The ASCT shall log the following events: (edit as appropriate)</i> 6.0-1.0-1 Time-stamped vehicle phase calls 6.0-1.0-2 Time-stamped pedestrian phase calls 6.0-1.0-3 Time-stamped emergency vehicle preemption calls 6.0-1.0-4 Time-stamped transit priority calls 6.0-1.0-5 Time-stamped railroad preemption calls 6.0-1.0-6 Time-stamped start and end of each phase 6.0-1.0-7 Time-stamped controller interval changes 6.0-1.0-8 Time-stamped start and end of each transition to a new timing plan
4.11.0-7	Have the ability to generate historic and real-time reports that effectively support operation, maintenance and reporting of system performance and traffic conditions.	6.0-5 The ASCT shall store the following measured data in the form used as input to the adaptive algorithm for a minimum of 720 days: (edit as appropriate) <ul style="list-style-type: none"> ● volume ● occupancy ● queue length

Con Ops Reference Number	Concept of Operations Sample Statements	Satisfied by System Requirement (Select to suit your needs)
		<p>6.0-8 The ASCT shall calculate and report relative data quality including:</p> <ul style="list-style-type: none"> ● The extent data is affected by detector faults ● Other applicable items <p>6.0-9 The ASCT shall report comparisons of logged data when requested by the user:</p> <ul style="list-style-type: none"> • Day to day, • Hour to hour • Hour of day to hour of day • Hour of week to hour of week • day of week to day week * Day of year to day of year <p>6.0-11 The ASCT shall report stored data in a form suitable to provide explanations of system behavior to public and politicians and to troubleshoot the system.</p> <p>18.0-3 <i>The ASCT shall maintain a log of all signal state alterations directed by the ASCT.</i></p> <p>18.0-3.0-4 The ASCT shall maintain the records in this ASCT log for 2 year period.</p> <p>18.0-3.0-5 The ASCT shall archive the ASCT log in the following manner: (Specify format, frequency, etc., to suit your needs.)</p> <p>18.0-3.0-1 The ASCT log shall include all events directed by the external inputs.</p> <p>18.0-3.0-2 The ASCT log shall include all external output state changes.</p> <p>18.0-3.0-3 The ASCT log shall include all actual parameter values that are subject to user-specified values.</p>
4.12	4.12 Failure notification	
4.12.0-1	The system operator needs to immediately notify maintenance and operations staff of alarms and alerts.	<p>13.1.0-3 In the event of a detector failure, the ASCT shall issue an alarm to user-specified recipients. (This requirement may be fulfilled by sending the alarm to a designated</p>

Con Ops Reference Number	Concept of Operations Sample Statements	Satisfied by System Requirement (Select to suit your needs)
		<p>list of recipients by a designated means, or by using an external maintenance management system.</p> <p>13.2-2 In the event of communications failure, the ASCT shall issue an alarm to user-specified recipients. (This requirement may be fulfilled by sending the alarm to a designated list of recipients by a designated means, or by using an external maintenance management system.</p> <p>13.3-2 In the event of adaptive processor failure, the ASCT shall issue an alarm to user-specified recipients. (This requirement may be fulfilled by sending the alarm to a designated list of recipients by a designated means, or by using an external maintenance management system.</p> <p>13.2-3 The ASCT shall issue an alarm within 2 minutes of a detection failure.</p>
4.12.0-2	The system operator needs to immediately and automatically pass alarms and alerts to the (specify external system).	<p>13.1.0-3 In the event of a detector failure, the ASCT shall issue an alarm to user-specified recipients. (This requirement may be fulfilled by sending the alarm to a designated list of recipients by a designated means, or by using an external maintenance management system.</p> <p>13.2-2 In the event of communications failure, the ASCT shall issue an alarm to user-specified recipients. (This requirement may be fulfilled by sending the alarm to a designated list of recipients by a designated means, or by using an external maintenance management system.</p> <p>13.3-2 In the event of adaptive processor failure, the ASCT shall issue an alarm to user-specified recipients. (This requirement may be fulfilled by sending the alarm to a designated list of recipients by a designated means, or by using an external maintenance management system.</p> <p>13.2-3 The ASCT shall issue an alarm within XX minutes of detection of a failure.</p>
4.12.0-3	The system operator needs to maintain a complete log of alarms and failure events.	<p>13.1.0-4 In the event of a failure, the ASCT shall log details of the failure in a permanent log.</p> <p>13.1.0-5 The permanent failure log shall be searchable, archivable and exportable.</p>

Con Ops Reference Number	Concept of Operations Sample Statements	Satisfied by System Requirement (Select to suit your needs)
		13.2-4 In the event of a communications failure, the ASCT shall log details of the failure in a permanent log. 13.2-5 The permanent failure log shall be searchable, archivable and exportable.
4.13	4.13 Preemption and priority	
4.13.0-1	The system operator needs to accommodate railroad and light rail preemption (explain further)	11.0-1 The ASCT shall maintain adaptive operation at non-preempted intersections during railroad preemption. 11.0-4 The ASCT shall resume adaptive control of signal controllers when preemptions are released. 11.0-5 The ASCT shall execute user-specified actions at non-preempted signal controllers during a preemption. (E.g., inhibit a phase, activate a sign, display a message on a DMS) 11.0-6 The ASCT shall operate normally at non-preempted signal controllers when special functions are engaged by a preemption event. (Examples of such special functions are a phase omit, a phase maximum recall or a fire route.) 11.0-7 The ASCT shall release user-specified signal controllers to local control when one signal in a group is preempted. 11.0-8 The ASCT shall not prevent the local signal controller from operating in normally detected limited-service actuated mode during preemption. 11.0-3 The ASCT shall maintain adaptive operation at non-preempted intersections during Light Rail Transit preemption.
4.13.0-2	The system operator needs to accommodate emergency vehicle preemption (explain further)	11.0-4 The ASCT shall resume adaptive control of signal controllers when preemptions are released. 11.0-5 The ASCT shall execute user-specified actions at non-preempted signal controllers during a preemption. (E.g., inhibit a phase, activate a sign, display a message on a

Con Ops Reference Number	Concept of Operations Sample Statements	Satisfied by System Requirement (Select to suit your needs)
		DMS) 11.0-6 The ASCT shall operate normally at non-preempted signal controllers when special functions are engaged by a preemption event. (Examples of such special functions are a phase omit, a phase maximum recall or a fire route.) 11.0-7 The ASCT shall release user-specified signal controllers to local control when one signal in a group is preempted. 11.0-8 The ASCT shall not prevent the local signal controller from operating in normally detected limited-service actuated mode during preemption. 11.0-2 The ASCT shall maintain adaptive operation at non-preempted intersections during emergency vehicle preemption.
4.13.0-3	The system operator needs to accommodate bus and light rail transit signal priority (explain further)	12.0-1 The ASCT shall continue adaptive operations of a group when one of its signal controllers has a transit priority call. 12.0-2 <i>The ASCT shall advance the start of a user-specified green phase in response to a transit priority call.</i> 12.0-3 <i>The ASCT shall delay the end of a green phase, in response to a priority call.</i> 12.0-4 <i>The ASCT shall permit at least XX exclusive transit phases.</i> 12.0-5 <i>The ASCT shall control vehicle phases independently of the following:</i> 12.0-6 The ASCT shall interface with external bus transit priority system in the following fashion..... (explain the external system and refer to other interfaces as appropriate) 12.0-2.0-1 The advance of start of green phase shall be user-defined. 12.0-2.0-2 Adaptive operations shall continue during the advance of the start of green phase. 12.0-3.0-1

Con Ops Reference Number	Concept of Operations Sample Statements	Satisfied by System Requirement (Select to suit your needs)
		<p>The delay of end of green phase shall be user-defined. 12.0-3.0-2 Adaptive operations shall continue during the delay of the end of green phase. 12.0-4.0-1 Adaptive operations shall continue when there is an exclusive transit phase call. 12.0-5.0-1</p> <ul style="list-style-type: none"> ● LRT only phases <p>12.0-5.0-2</p> <ul style="list-style-type: none"> ● Bus only phases <p>12.0-8 The ASCT shall accept a transit priority call from:</p> <ul style="list-style-type: none"> ● a signal controller/transit vehicle detector; ● an external system. <p>12.0-7 The ASCT shall interface with external light rail transit priority system in the following fashion..... (explain the external system and refer to other interfaces as appropriate)</p>
4.13.0-4	The system operator needs to accommodate light rail priority (explain further)	
4.14	4.14 Failure and fallback	
4.14.0-1	The system operator needs to fall back to TOD or isolated free operation, as specified by the operator, without causing disruption to traffic flow, in the event of equipment, communications and software failure.	<p>13.1.0-2 <i>The ASCT shall use the following alternate data sources for operations in the absence of the real-time data from a detector:</i></p> <p>13.1.0-2.0-3 The ASCT shall switch to the alternate source in real time without operator intervention.</p> <p>13.1.0-1 <i>The ASCT shall take user-specified action in the absence of valid detector data from XX vehicle detectors within a group. (SELECT THE APPROPRIATE ACTION.)</i></p> <p>13.1.0-1.0-1</p>

Con Ops Reference Number	Concept of Operations Sample Statements	Satisfied by System Requirement (Select to suit your needs)
		<p>The ASCT shall release control to central system control.</p> <p>13.2-1 <i>The ASCT shall execute user-specified actions when communications to one or more signal controllers fails within a group. (SELECT THE APPROPRIATE ACTION)</i></p> <p>13.2-1.0-1 In the event of loss of communication to a user-specified signal controller, the ASCT shall release control of all signal controllers within a user-specified group to local control.</p> <p>13.3-1 <i>The ASCT shall execute user-specified actions when adaptive control fails:</i></p> <p>13.3-1.0-1 The ASCT shall release control to central system control.</p> <p>2.1.1.0-2 <i>The ASCT shall operate non-adaptively when adaptive control equipment fails.</i></p> <p>2.1.1.0-2.0-1 The ASCT shall operate non-adaptively when a user-specified detector fails.</p> <p>2.1.1.0-2.0-2 The ASCT shall operate non-adaptively when the number of failed detectors connected to a signal controller exceeds a user-defined value.</p> <p>2.1.1.0-2.0-3 The ASCT shall operate non-adaptively when the number of failed detectors in a group exceeds a user-defined value.</p> <p>2.1.1.0-2.0-4 The ASCT shall operate non-adaptively when a user-defined communications link fails.</p> <p>13.1.0-2.0-1</p> <ul style="list-style-type: none"> ● Data from a user-specified alternate detector. <p>13.1.0-2.0-2</p> <ul style="list-style-type: none"> ● Stored historical data from the failed detector. <p>13.1.0-1.0-2 The ASCT shall release control to local operations to operate under its own time-of-day schedule.</p> <p>13.2-1.0-2 The ASCT shall switch to the alternate operation in real time without operator intervention.</p>

Con Ops Reference Number	Concept of Operations Sample Statements	Satisfied by System Requirement (Select to suit your needs)
		13.3-1.0-2 The ASCT shall release control to local operations to operate under its own time-of-day schedule. 13.3-4 During adaptive processor failure, the ASCT shall provide all local detector inputs to the local controller.
4.15	4.15 Constraints	
4.15.0-1	<i>The system operator is constrained to use the following equipment:</i>	
4.15.0-1.0-1	<ul style="list-style-type: none"> ● Controller type (list acceptable equipment) 	14.0-3 The ASCT shall fully satisfy all requirements when connected with XX controllers (specify controller types).
4.15.0-1.0-2	<ul style="list-style-type: none"> ● Detector type (list acceptable equipment) 	14.0-2 The ASCT shall fully satisfy all requirements when connected with detectors from manufacturer XX (specify required detector types).
4.15.0-1.0-3	<ul style="list-style-type: none"> ● Communication system (list acceptable equipment) 	
4.15.0-1.0-4	<ul style="list-style-type: none"> ● Cabinet type and size (list acceptable equipment) 	
4.15.0-1.0-5	<ul style="list-style-type: none"> ● Signal management system (list acceptable systems) 	
4.15.0-2	Not used	
4.15.0-3	The system operator needs to use equipment and software acceptable under current agency IT policies and procedures.	14.0-1 The vendor's adaptive software shall be fully operational within the following platform: (edit as appropriate) <ul style="list-style-type: none"> ● Windows-PC, ● Linux, ● Mac-OS, ● Unix.
4.15.0-4	Not used	
4.16	4.16 Training and support	

Con Ops Reference Number	Concept of Operations Sample Statements	Satisfied by System Requirement (Select to suit your needs)
4.16.0-1	The agency needs all staff involved in operation and maintenance to receive appropriate training.	15.0-1.0-1 The vendor shall provide training on the operations of the adaptive system. 15.0-1.0-9 The vendor shall provide a minimum of XX hours training to a minimum of XX staff. (specify how much training will be required) 15.0-1 <i>The vendor shall provide the following training. (Edit as appropriate.)</i> 15.0-1.0-2 The vendor shall provide training on trouble-shooting the system. 15.0-1.0-3 The vendor shall provide training on preventive maintenance and repair of equipment. 15.0-1.0-4 The vendor shall provide training on system configuration. 15.0-1.0-5 The vendor shall provide training on administration of the system. 15.0-1.0-6 The vendor shall provide training on system calibration. 15.0-1.0-7 The vendor's training delivery shall include: printed course materials and references, electronic copies of presentations and references. 15.0-1.0-8 The vendor's training shall be delivered at (specify locations for training). 15.0-1.0-10 The vendor shall provide a minimum of XX training sessions (specify how many sessions over what period).
4.16.0-2	The agency needs the system to fulfill all requirements for the life of the system. The agency therefore needs the system to be maintained to repair faults that are not defects in materials and workmanship.	16.0-1 The Maintenance Vendor shall provide maintenance according to a separate maintenance contract. That contract should identify repairs necessary to preserve requirements fulfillment, responsiveness in effecting those repairs, and all requirements on the maintenance provider while performing the repairs.
4.16.0-3	The agency needs the system to fulfill all requirements for the life of the system. The agency therefore needs the system to remain free of defects in materials and workmanship that result in requirements no longer being fulfilled.	16.0-3 The Vendor shall warrant the system to be free of defects in materials and workmanship for a period of XX years. Warranty is defined as correcting defects in materials and workmanship (subject to other language included in the purchase

Con Ops Reference Number	Concept of Operations Sample Statements	Satisfied by System Requirement (Select to suit your needs)
		documents). Defect is defined as any circumstance in which the material does not perform according to its specification.
4.16.0-4	The agency needs the system to fulfill all requirements for the life of the system. The agency therefore needs support to keep software and software environment updated as necessary to prevent requirements no longer being fulfilled.	16.0-2 The Vendor shall provide routine updates to the software and software environment necessary to preserve the fulfillment of requirements for a period of XX years. Preservation of requirements fulfillment especially includes all IT management requirements as previously identified.
4.17	4.17 External interfaces	
4.17.0-1	The system operator needs to be able to turn on signs that control traffic or provide driver information when specific traffic conditions occur, when needed to support the adaptive operation, when congestion is detected at critical locations or according to a time-of-day schedule	17.0-1 The ASCT shall set the state of external input/output states according to a time-of-day schedule. 17.0-2 The ASCT output states shall be settable according to a time-of-day schedule 9.0-1 The ASCT shall set a specific state for each special function output based on the occupancy on a user-specified detector. 9.0-2 The ASCT shall set a specific state for each special function output based on the current cycle length. 9.0-3 The ASCT shall set a specific state for each special function output based on a time-of-day schedule.
4.17.0-2	The system operator needs to react to commands issued by (specify an external control or decision support system, such as an ICM system or another signal system).	3.0-1 <i>The ASCT shall support external interfaces according to the following detailed requirements. (Insert appropriate requirements that suit your needs. Interface data flows should be documented in your ITS architecture. Interface requirements include:</i> <ul style="list-style-type: none">● <i>Information layer protocol</i>● <i>Application layer protocol</i>● <i>Lower layer protocol</i>● <i>Data aggregation</i>● <i>Frequency of storage</i>

Con Ops Reference Number	Concept of Operations Sample Statements	Satisfied by System Requirement (Select to suit your needs)
		<ul style="list-style-type: none"> ● <i>Frequency of reporting</i> ● <i>Duration of storage)</i> <p>7.0-8 The ASCT shall not prevent a phase/overlap output based on an external input.</p> <p>2.1.1.0-6 The ASCT shall operate non-adaptively when commanded by an external system process.</p> <p>4.0-1 <i>The ASCT shall conform its operation to an external system's operation.</i></p> <p>2.1.2.0-4 The ASCT shall prevent skipping a user-specified phase based on the state of a user-specified external input.</p> <p>2.1.2.0-8 The ASCT shall omit a user-specified phase based on the state of a user-specified external input.</p> <p>3.0-1.0-6 The ASCT shall receive commands from the XX external system.</p> <p>3.0-1.0-7 The ASCT shall implement the following commands from the XX external system when commanded: (Edit as appropriate for your situation)</p> <ul style="list-style-type: none"> ● Specified cycle length ● Specified direction of progression ● Specified adaptive strategy
4.18	4.18 Maintenance	
4.18.0-1	Each maintaining agency needs all applicable equipment to be readily accessible.	

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5	5 Chapter 5: Envisioned Adaptive System Overview
5.1	5.1 Size and grouping
5.1.0-1	The agency has plans to adaptively control a total of XX intersections.
5.1.0-2	The system will control intersections in groups that are defined by the operator.
5.1.0-3	A group of intersections may be comprised of simply one intersection, or up to the total number of intersections that are sufficiently close to warrant coordination under the prevailing traffic conditions.
5.1.0-4	During some traffic conditions, there may be separate groups of intersections operating with different characteristics (e.g., different cycle lengths, some coordinated some not, offsets in different directions).
5.1.0-5	During periods when traffic conditions are similar or operating characteristics (such as cycle length) are similar, or traffic volumes on the coordinated route are heavier, different groups may be formed or specified by the operator.
5.1.0-6	The group of intersections at XX is XX miles away from the group of intersections at XX. These two groups of intersections will always operate entirely independently.
5.2	5.2 Operational objectives
5.2.0-1	The objective of the coordination will be to provide for smooth flow along the arterial road, minimizing the number of stops experienced by vehicles traveling along the road. Where "natural" cycle lengths exist that permit two-way progression, the system will generally operate at one of those cycle lengths unless longer phase lengths are required to accommodate the demand.
5.2.0-2	The objective of the coordination will be to maximize the throughput along the coordinated route. This may involve a tradeoff that increases delay to cross streets and turning movements in order to maximize the green time provided to coordinated traffic flows.
5.2.0-3	The objective of the coordination will be to control traffic in a manner that equitably serves the adjacent land uses. The delays experienced by the traffic entering and leaving the coordinated route will be balanced with the delays and stops experienced by other traffic traveling along the route.
5.2.0-4	The objective of the coordination will be to manage the lengths of queues stored at critical locations within the coordinated group so that long queues do not block upstream intersections or otherwise reduce the capacity available during the green phases. This will involve controlling phase lengths so that the size of platoons entering a downstream block do not exceed the storage length if the platoon will be stopped. It will also involve control of offsets and phase lengths so that queues may be stored in locations where they will not adversely affect capacity of the system.
5.2.0-5	The system, or the operator, will select the appropriate coordination objective, depending on the current traffic conditions. For example, during commuter peaks the primary objective may be to maximize the throughput along the road in the peak direction. Then during the business hours the objective may be to balance delays between traffic associated with the adjacent activity and traffic simply traveling through the system.
5.2.0-6	The operator will be able to define for each group of intersections the appropriate operational objective. For example, near a freeway interchange or in a location with heavy turning movements, the queue management strategy may be specified, while on an arterial with long signal spacing the smooth flow objective may be specified.

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Con Ops Reference Number	Concept of Operations Sample Statements
5.2.0-7	During moderate to light traffic conditions, one or more phases may be omitted (e.g., a protected phase if protected/permissive left turns are operated), in order to more efficiently serve other movements, provided it is safe to do so. This may be accomplished through a time of day schedule or based on the measured traffic conditions.
5.2.0-8	Within these operational objectives, the ASCT system will change its operation to accommodate the rise and fall of volumes through the peaks and the changing patterns of flow throughout the day and week. However, there is also a stochastic element to traffic in the short term, with the number of arrivals for a phase varying from cycle to cycle, and pedestrians not being present on all phases in all cycles. It is therefore desirable for the system to have some local tactical control. While vehicle-actuated coordination typically allows phases to run longer or shorter from cycle to cycle to match the actual number of vehicles using the phase, the system will also allow the operator to decide where the unused time will be used. If a phase is to be skipped, the operator can specify that the spare time will be added to the existing phase, the following phase or the next coordinated phase.
5.2.0-9	At an isolated intersection with widely varying traffic patterns and a high degree of saturation during peak times, the system will calculate the optimum cycle length, phase sequence and phase times in real time to match the changing traffic conditions.
5.2.0-10	At a small group of intersections, with the user defining one as being critical, while the adjacent intersections require a lower cycle length or progression must be provided for specific phases to minimize the formation of queues on the approaches to the critical intersection, the phase lengths of the critical intersection will be determined by the system based on the current traffic conditions. The operation of the adjacent intersections will then be set so that platoons departing the critical intersection are progressed through the non-critical intersections, or platoons arriving at the critical intersection do so at a time when they will have little or no delay waiting for the appropriate phase.
5.3	5.3 Fallback operation
5.3.0-1	The system will have a fallback state that allows coordination using a common cycle length for all signals within a coordinated group.
5.3.0-2	The system will have a fallback state that allows individual intersections to operate in a vehicle-actuated, isolated mode in the event of failures of the adaptive processor software or hardware, detectors or communication.
5.3.0-3	The system will have a fallback state that allows one or more intersections to be slaved from a critical intersection in the event of failures of the adaptive processor software or hardware, detectors or communication.
5.4	5.4 Crossing routes and adjacent systems
5.4.0-1	A coordinated group will be able to include more than one coordinated route, such as two crossing arterials. The system will be able to maintain coordination along both roads.
5.4.0-2	The agency needs the adaptive system to maintain coordination with another adjacent system either by sensing arriving traffic or by using constraints on cycle length.
5.4.0-3	The system will accept data from a neighboring system that allows it to stay in coordination with the adjacent system while still operating in adaptive mode.
5.5	5.5 Operator access
5.5.0-1	Operators, traffic engineering and maintenance staff will be assigned different levels of authority, and access to equipment for which they are authorized, based on their roles and responsibilities. This will allow them to control, view, monitor and analyze the operation of the system as appropriate.
5.5.0-2	The system will be a stand-alone system not connected to a LAN or WAN

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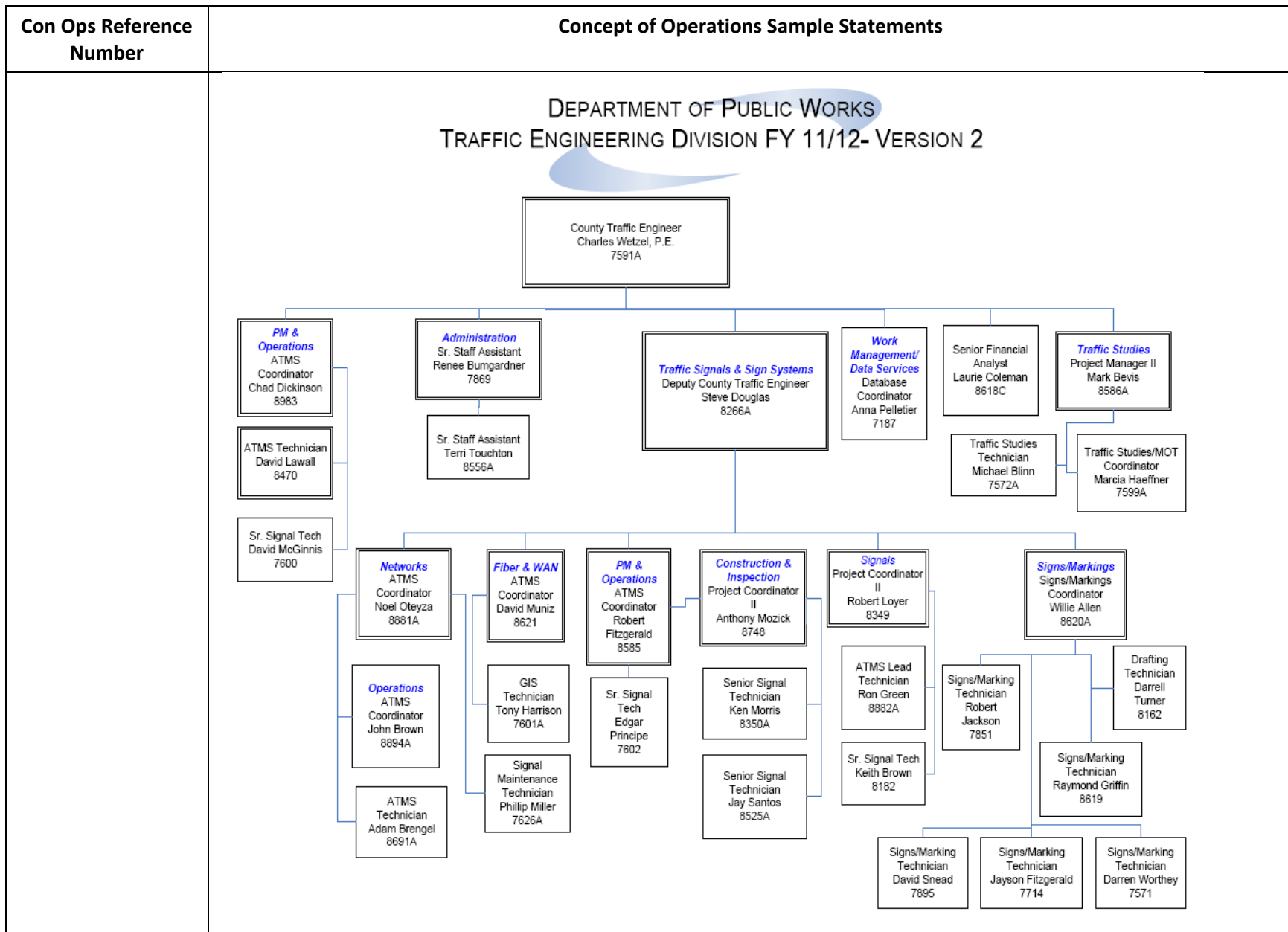
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5.5.0-3	The system will be connected to the agency's LAN, allowing access to all authorized users.
5.5.0-4	The system will allow access by authorized users outside the agency
5.6	5.6 Complex coordination and controller operation
5.6.0-1	The agency will use the following complex coordination and controller features: (Select from following needs as appropriate)
5.6.0-1.0-1	the ability to repeat a phase, such as running a left turn phase before and after its opposing through movement;
5.6.0-1.0-2	provision for the required number of rings, phases, phases per ring, and overlap phases;
5.6.0-1.0-3	the ability to operate different phase sequences based on different traffic conditions or by time-of-day;
5.6.0-1.0-4	the ability to omit a phase under some traffic conditions or based on external input to allow a shorter cycle length to operate, or to provide additional time to other phases;
5.6.0-1.0-5	special features unique to this agency, such as (give specific examples)
5.6.0-1.0-5.0-1	the ability to use flashing yellow protected/permissive and permissive only phasing
5.6.0-1.0-5.0-2	The ability to maintain coordination with external movements by preventing phases from being skipped, or by omitting phases, based on time-of-day, external input or when certain phase sequences are in operation.
5.6.0-1.0-6	The agency will permit phases or overlaps by time-of-day schedule or external input.
5.6.0-2	the ability to designate the following phases as coordinated phases; (Specify which phases may be designated as the coordinated phase)
5.6.0-3	the ability to separately monitor each lane on an approach and take different action depending on the conditions measured in each lane;
5.6.0-4	the ability to allow the coordinated phase to terminate early if the coordinated platoon is short;
5.6.0-5	the ability to introduce a non-coordinated phase later than its normal starting point within a cycle, if it can be served with minimum green within the remaining time available;
5.6.0-6	protected/permissive and permissive only phasing
5.6.0-7	support for flashing yellow protected/permissive and permissive only phasing
5.6.0-8	The agency may operate external devices using discrete signal outputs from the ASCT including occupancy on a detector, cycle length, and time-of-day. (User select desired features.)
5.7	5.7 Organizations Involved

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6	<p style="text-align: center;">6 Chapter 6: Adaptive Operational Environment</p>
6.0-1	The system will be operated and monitored from TMC.
6.0-2	shop.
6.0-3	The system will be operated and monitored from workstations located (specify who will have workstations and where they will be located).
6.0-4	An operator will be able to have full access to the system from each local controller or on-street master.
6.0-5	The central server equipment will be housed at (specify location) in an (airconditioned or non-airconditioned?) air conditioned environment.
6.0-6	Equipment compatibility constraints
6.0-6.0-1	The central server will be a standard platform maintained by the agency IT Department) and able to be replaced independently from the software.
6.0-6.0-2	The agency selection of controller will not be constrained by the adaptive software.
6.0-6.0-3	The agency prefers specific detector technology. (Specify your selected detector types) .
6.0-6.0-4	The agency prefers to use the following controller types. (Specify acceptable controller types.)
6.0-7	The operators will already be experienced in setting up and fine tuning traditional coordinated signal systems. They will require training specific to the adaptive system, sufficient to allow them to set up, adjust and fine tune all aspects of the system.
6.0-8	<p>The set up and fine tuning of the system will be done by the manufacture and SCTE contracted out. A review of the system's operation will be performed quarterly (specify frequency) utilizing arterial travel time technology (i.e. Bluetooth travel times by BlueToad)</p>
6.0-9	Complaints or requests for changes in operation will be handled by the in-house operators on an as-needed basis.
6.0-10	Complaints or requests for changes in operation will be handled by on-call contract staff on an as-needed basis.
6.0-11	Maintenance of all field equipment will be performed by in-house (OR contract) staff
6.0-12	<p>Maintenance of the following field equipment will be performed by SCTE (OR contract) staff, (i.e. ATC controller and software, ASCT detection, central software and server, and all network and communication equipment.</p>
6.0-13	Funding for maintenance of the adaptive system will come from (specify funding program or source). An increase of \$xxx per year will be required to accommodate the additional equipment installed for the adaptive system.
6.0-14	Additional communications equipment and annual fees will be incurred with the adaptive system. This will amount to approximately \$xxx per year, and will be

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	covered by (specify program or budget allocation details).
6.0-15	Replacement or repair of defective or failed equipment will be covered for xx years by the manufacturers' warranties. The labor cost of replacement during this period will be included in the purchase price.
6.0-16	The agency expects maintenance of parts and equipment for a period of XX years will be included in the purchase price.
6.0-17	The agency expects maintenance of all adaptive system software for a period of xx years will be included in the purchase price.
6.0-18	The agency expects to operate this system using the latest software for a period of CC years.
6.0-19	The agency will seek technical support from the vendor for assistance in using the adaptive software for XX years.
6.0-20	Operations and maintenance staff will have the ability to log in to the system from remote locations via the internet, and have full functionality consistent with their access level.
6.0-21	The ASCT's operation will be able to be customized to suit the different situations that will be experienced in the different areas where it will operate.
6.0-21.0-1	The agency's experienced operators will be able to write customized routines using the ASCT's API.
6.0-21.0-2	The vendor will be able to provide customized routines that take advantage of the ASCT's API.
6.0-22	Include any additional needs for support or information from the vendor that will be needed by your agency, and that will become requirements in the contract or purchase documents.

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7	7 Chapter 7: Adaptive Support Environment
7.1	7.1 Instutions and Stakeholders
7.1.0-1	Existing stakeholders of the traffic signal system include: (list all stakeholders, such as:) <ul style="list-style-type: none"> ● Sponsoring agency ● Neighboring agencies that operate signals ● Regional agency ● Fire departments ● Police departments ● Transit agencies ● Railroad operators
7.1.0-2	The stakeholders who will be affected by or have a direct interest in the adaptive system are: (List existing and include new stakeholders)
7.1.0-3	The activities that will be undertaken by the adaptive system stakeholders include: preparation of timing parameters, implementation and fine tuning, system monitoring and adjustment, system performance monitoring and evaluation.
7.1.0-4	<ul style="list-style-type: none"> ○ The organizational structure of the units responsible for installation, operation, maintenance are illustrated in the attached organization chart. The roles, responsibilities and required qualifications and experience are described below. (Describe as appropriate)



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7.2	7.2 Facilities
7.2.0-1	Describe the current and/or proposed TMC.
7.2.0-2	Will there be a satellite TMC (e.g., at Corp Yard, at a major event center, at a local EOC?)
7.2.0-3	Describe the locations elsewhere within the agency, such as on a LAN or WAN, from which access to the system will be required?
7.2.0-4	Is airconditioning required?
7.2.0-5	Describe the location where a separate server will be located. (E.g., IT server room, TMC back room, signal maintenance area, remote hub, remote on-street cabinet)
7.2.0-6	Describe who is responsible for providing and maintaining staff facilities (e.g., personnel, public works, building services, etc.?)
7.2.0-7	Describe who is responsible for fire control facilities (e.g., part of operating group's responsibility, or the responsibility of another group, such as building services?)
7.2.0-8	Describe who is responsible for secure access to the TMC, workshop, or office with adaptive system workstations? (E.g., Is it the responsibility of the operating group or another group, such as building services?)
7.3	7.3 System Architecture Constraints
7.3.0-1	The adaptive processor/server will be protected within the agency's firewalls. The IT Department will provide resources, equipment and system management so that operators will have appropriate access to the system locally, from within the agency's LAN and from remote locations.
7.3.0-2	The communications media available for use by the system is illustrated in the communication diagram below. (LIST AVAILABLE MEDIA, PROVIDE A MAP OR BLOCK DIAGRAM AS APPROPRIATE. SHOW LOCATIONS OF ANY GAPS, BANDWIDTH AND LATENCY CONSTRAINTS, PROTOCOLS AND AVAILABLE ALTERNATIVES.)
7.3.0-3	The Regional ITS Architecture is illustrated in Figure XX. The adaptive system will operate within the local ITS Architecture of (NAME THE AGENCY). It will interact with the Regional ITS Architecture in the following manner. (DESCRIBE LOGICAL ARCHITECTURE AND PHYSICAL ARCHITECTURE. INCLUDE DATA FLOWS.)

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7.4	7.4 Utilities
7.4.0-1	Are utilities the responsibility of the operating group, or are they the responsibility of another group, such as building services?
7.5	7.5 Equipment
7.5.0-1	Describe what test equipment is required to support the adaptive system (e.g., communications testers, fiber testers, controller testers). Is this currently available or is additional equipment required?
7.5.0-2	Will vehicles be the responsibility of the operating group or another group within the agency? What types of vehicles will be required, and how many?
7.6	7.6 Computing hardware
7.6.0-1	Describe the additional computing equipment required to support the operation, such as printer, copier, additional monitors, scanner.
7.6.0-2	Describe who is responsible for maintenance and repair of the and equipment.
7.6.0-3	Describe who is responsible for replacement of the computing equipment when it reaches the end of its useful life?
7.7	7.7 Software
7.7.0-1	Who is responsible for keeping software up to date?
7.7.0-2	Who is responsible for keeping software licenses current?
7.7.0-3	What controls are proposed governing Seminole County will control software use and availability on workstations and other support computers.
7.8	7.8 Personnel
7.8.0-1	A minimum of two operators will be available for routine operations.
7.8.0-2	Describe what hours will operators be available.
7.8.0-3	Describe what training will operators need.

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7.8.0-4	Describe what maintenance staff will be required. Will this be provided by existing staff or will additional staff be required?
7.8.0-5	What qualifications and training will the maintenance staff require?
7.9	7.9 Operating procedures
7.9.0-1	SCTE will be responsible for backing up databases once a week to a backup PC on-site.
7.10	7.10 Maintenance
7.10.0-1	Describe the arrangements for maintenance. (E.g., is it done in-house or contracted out? Is it 24/7? Is equipment repair done in-house or externally?)
7.11	7.11 Disposal
7.11.0-1	Describe what material and/or equipment will need to be disposed of during the life of the project, and how it will be disposed.
7.11.0-2	Describe how system components will be disposed of at the end of their useful life.

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8	8 Chapter 8: Operational Scenarios
8.1	8.1 Overview
8.1.0-1	<p>The following operational scenarios describe how the system is expected to operate under various conditions. The proposed ASCT system is expected to be able to manage the following operational scenarios and issues envisioned for both the current and future project locations. Scenarios are described for the following operational conditions: (Edit to suit your situation.)</p> <ul style="list-style-type: none"> • Typical heavy congested conditions • Typical heavy uncongested conditions • Moderate balanced flows • Light balanced flows • Demand affecting event • Capacity affecting event • Fault conditions (communications, detection, adaptive processor) • Signal priority and preemption • Pedestrians • Installation <p>(For each scenario, describe the following elements:</p> <ul style="list-style-type: none"> • Network • Traffic conditions • Operational objectives • Coordination and timing strategies • Summary of operations.)

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8.2	8.2 Typical Heavy (congested) Traffic
8.2.1	8.2.1 Example: Arterial Road with Diamond interchange
8.2.1.1	8.2.1.1 Road network
8.2.1.1.0-1	Broadway is an arterial road that passes through a diamond interchange. While the arterial primarily provides access to the freeway from residential areas to the east and west, it also serves a major shopping area, restaurants and office land uses adjacent to the freeway. Ramp meters are used on the freeway on-ramps during periods of heavy traffic on the freeway.
8.2.1.2	8.2.1.2 Traffic conditions
8.2.1.2.0-1	During the morning peak, traffic is heavy approaching the freeway from the residential areas. Congestion occurs at the freeway interchange and two other locations (A Street and B Street). During the afternoon commuter peak, traffic is heavy departing the freeway interchange, and congestion occurs at three locations, including east-bound left turns on Broadway east of the freeway at B Street and C Street.
8.2.1.3	8.2.1.3 Operational objectives
8.2.1.3.0-1	<p>The agency has a policy of seeking smooth flow on arterial streets for routes that carry predominantly through traffic, and equitable distribution of green time at intersections that predominantly serve adjacent land uses. When congested, the agency seeks to avoid building queues on freeway off-ramps, and seeks to minimize queue spillout into through lanes. In the morning peak, the operation is designed to provide through progression approaching the freeway, and to maximize throughput at other intersections along Broadway approaching the interchange. During the afternoon peak, the operation is designed to control queue buildup on the northbound freeway off-ramp and frontage road in order to prevent queue backup onto the freeway.</p> <p>The operational objectives under these conditions are to:</p> <ul style="list-style-type: none"> • Accommodate the traffic at all intersections with a minimum of phase failures • Control inflows to the diamond interchange to prevent queue spillback into upstream intersections; and • Provide smooth flow along the arterial road.
8.2.1.4	8.2.1.4 Coordination and signal timing strategies

Con Ops Reference Number	Concept of Operations Sample Statements
8.2.1.4.0-1	<p>The diamond interchange runs a TTI-four-phase operation from a single signal controller.</p> <p>The coordination approach for the morning peak is progression, maximizing bandwidth in the direction approaching the freeway interchange. This requires a 90-second cycle which provides good resonant progression in both directions, with 40% bandwidth efficiency in the peak direction, when side-street volumes are low. This cycle length also minimizes delay with no effect on throughput at the diamond, given that the lost time is offset by the internal double clearance, which means that increasing the cycle length does not increase throughput.</p> <p>The coordination approach in the afternoon peak is to maximize progression bandwidth leaving the interchange, except at X which is routinely congested and the agency seeks to allow queues to build on the side-street approach to maximize throughput on the arterial. Queue formation on the eastbound arterial approach to the freeway is allowed to maximize the green time and throughput for the northbound ramp approach.</p> <p>The signal timing strategies used by the system to accommodate this situation are:</p> <ul style="list-style-type: none"> • At the diamond interchange, select phase times that ensure queues do not exceed storage lengths. • At the critical intersection(s), select phase sequence that eliminates queue overflow in left turn bays • At each intersection, select phase times that eliminate phase failures • At the other arterial road intersections, provide sufficient time to serve all turning and side street traffic without phase failures • At the other arterial road intersections, provide green on the coordinated route phases in a manner that minimizes the stops for through traffic along the arterial.
8.2.1.5	8.2.1.5 Summary of Operation
8.2.1.5.0-1	<p>The actuated system will measure the traffic flow and determine when each of these operational objectives should be in force, and therefore which of the coordination and timing strategies to give priority to in making its adaptive decisions. The adaptive system will use the 90-second cycle in the morning peak to preserve resonant progression. The adaptive system will not alter the operation of the diamond interchange phase sequence. The adaptive system will seek to balance green time utilization when side-street demand is important, such as during the noon peak. The adaptive system will seek to minimize residual queuing at congested locations, preferring to build queue at x and y if demand cannot be accommodated. The adaptive system will prevent residual queue buildup on the freeway ramps.</p> <p>The adaptive system reports bandwidth, arrivals on red as a measure of bandwidth utilization, and phase utilization measurements that were used to adaptively adjust green times.</p>
8.2.2	8.2.2 Example: Arterial with one critical intersection
8.2.2.1	8.2.2.1 Road network
8.2.2.1.0-1	<p>The section of Broadway Road to be coordinated using ASCT has six signalized intersections. It is a six lane arterial road with a two way left turn lane, and exclusive left turn lanes at each intersection. Most of the intersections provide access to local businesses and residential areas. However, one intersection (name of cross street) is an arterial road that accommodates regional traffic rather than providing local access. There are no nearby signals on this cross street that require coordination with this critical intersection. This is an eight-phase intersection with protected left turns on all approaches. The other intersections have permissive left turns on the side streets.</p>

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	Broadway is classified by the MPO as an arterial road of regional significance.
8.2.2.2	<i>8.2.2.2 Traffic conditions</i>
8.2.2.2.0-1	There is one critical intersection (Cross Street) that has heavier traffic than the other intersections at all times of the day. At its heaviest (typically during the AM and PM peaks) most movements are congested with occasional phase failures. Traffic is heaviest in one direction when these conditions are experienced, typically northbound during the AM peak and southbound during the PM peak. The traffic on Broadway is 50% heavier than the traffic on (Cross Street) during this condition.
8.2.2.3	<i>8.2.2.3 Operational objectives</i>
8.2.2.3.0-1	<p>The operational objectives for this arterial under these conditions are to:</p> <ul style="list-style-type: none"> • Maximize the throughput along Broadway; • Accommodate the traffic at the critical intersection with a minimum of phase failures; and • Provide smooth flow along the arterial through other intersections.
8.2.2.4	<i>8.2.2.4 Coordination and signal timing strategies</i>
8.2.2.4.0-1	<p>The signal timing strategies used by the system to accommodate this situation are:</p> <ul style="list-style-type: none"> • At the critical intersection, select phase times that eliminate phase failures • At the critical intersection, select phase sequence that eliminates queue overflow in left turn bays • At the critical intersection, select phase times that eliminate queue overflow in left turn bays • At the critical intersection, distribute green time to maximize the throughput on Broadway • At the non-critical intersections, provide sufficient time to serve all turning and side street traffic without phase failures
8.2.2.5	<i>8.2.2.5 Summary of operation</i>
8.2.2.5.0-1	Under these conditions, the ASCT system will select a phase arrangement and calculate phase times that accommodate traffic at the critical intersection. It will then set the timing at the other intersections to provide a green band in the

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	<p>direction of heaviest traffic along the arterial, to minimize the number of stops in that direction.</p> <p>The green time for the non-arterial phases at those intersections will be set to accommodate the traffic using those phases, while allocating the remaining time to the arterial road. The system will determine the sequence of phases on the arterial (lead-lead, lead-lag or lag-lag) that minimizes the stops in the non-coordinated direction under these conditions.</p>
8.2.3	8.2.3 Example: Arterial with several critical intersections
8.2.3.1	8.2.3.1 Road network
8.2.3.1.0-1	<p>The section of Broadway Road to be coordinated using ASCT has ten signalized intersections. It is a six lane arterial road two way left turn lane, and exclusive left turn lanes at each intersection. Two intersections (name of cross streets) are arterial roads that accommodate regional traffic rather than providing local access. There are no nearby signals on the cross streets that require coordination with this critical intersection. One intersection provides access to a major shopping district. These are all eight-phase intersections with protected left turns on all approaches. The remaining intersections provide access to local businesses and residential areas. Those intersections have protected left turns on Broadway and permissive left turns on the side streets.</p> <p>Broadway is classified by the MPO as an arterial road of regional significance.</p>
8.2.3.2	8.2.3.2 Traffic conditions
8.2.3.2.0-1	At times when traffic conditions are very heavy, one of the three key intersections is the critical intersection. This varies depending on the level of demand on the two crossing arterials or activity in the shopping district. When traffic is very heavy, it is typically heaviest on Broadway in one direction (such as northbound during the AM peak and southbound during the PM peak). In these conditions, Broadway carries higher volumes than the crossing arterials.
8.2.3.3	8.2.3.3 Operational objectives
8.2.3.3.0-1	<p>The operational objectives for this arterial under these conditions are to:</p> <ul style="list-style-type: none"> • Maximize the throughput along Broadway • Accommodate the traffic at the critical intersection with a minimum of phase; and

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	<ul style="list-style-type: none"> • Provide smooth flow along the arterial through other intersections.
8.2.3.4	8.2.3.4 Coordination and signal timing strategies
8.2.3.4.0-1	<p>The signal timing strategies used by the system to accommodate this situation are:</p> <ul style="list-style-type: none"> • Determine the critical intersection • At the critical intersection, select phase times that eliminate phase failures • At the critical intersection, select phase sequence that eliminates queue overflow in left turn bays • At the critical intersection, distribute green time to maximize the throughput on Broadway. • At the non-critical intersections, provide sufficient time to serve all turning and side street traffic without phase failures • At the non-critical intersections, provide green on the arterial road phases in a manner that minimizes the stops for through traffic along the arterial.
8.2.3.5	8.2.3.5 Summary of operation
8.2.3.5.0-1	<p>Under these conditions, the ASCT system will determine the critical intersection and select a phase arrangement and calculate phase times that accommodate traffic at that intersection. It will then set the timing at the other intersections to provide a green band in the direction of heaviest traffic along the arterial, to minimize the number of stops in that direction. The green time for the non-arterial phases at those intersections will be set to accommodate the traffic using those phases, while allocating the remaining time to the arterial road. The system will determine the sequence of phases on the arterial (lead-lead, lead-lag or lag-lag) that minimizes the stops in the non-coordinated direction under these conditions.</p>
8.2.4	8.2.4 Example: Crossing arterials
8.2.4.1	8.2.4.1 Road network
8.2.4.1.0-1	<p>Broadway is an arterial road with seven signalized intersections. Cross Street is also an arterial road with five signalized intersections, and it crosses Broadway, as illustrated in the figure.</p>
8.2.4.2	8.2.4.2 Traffic conditions

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8.2.4.2.0-1	<p>During heavy traffic conditions (such as AM and PM peak) the Broadway/Cross Street intersections is the critical intersection, and queues develop on all approaches. Typically the northbound direction on Broadway is significantly heavier than the southbound. Likewise, the eastbound traffic on Cross Street is significantly heavier than the westbound.</p>
8.2.4.3	<p>8.2.4.3 Operational objectives</p>
8.2.4.3.0-1	<p>The operational objectives for these arterials under these conditions are to:</p> <ul style="list-style-type: none"> • Maximize the throughput along Broadway • Maximize the throughput along Cross Street • Accommodate the traffic at the critical intersection with a minimum of phase failures; and • Provide smooth flow along the arterial through other intersections.
8.2.4.4	<p>8.2.4.4 Coordination and signal timing strategies</p>
8.2.4.4.0-1	<p>The signal timing strategies used by the system to accommodate this situation are:</p> <ul style="list-style-type: none"> • At the critical intersection, select phase times that eliminate phase failures • At the critical intersection, select phase sequence that eliminates queue overflow in left turn bays • At the non-critical intersections on both arterials, provide sufficient time to serve all turning and side street traffic without phase failures • At the non-critical intersections, provide green on the arterial road phases in a manner that minimizes the stops for through traffic along the arterial.
8.2.5	<p>8.2.5 Example: Grid network</p>
8.2.5.1	<p>8.2.5.1 Road network</p>
8.2.5.1.0-1	<p>The intersections to be coordinated are on a grid network with relatively fixed intersection spacing. The roads typically have four lanes plus separate left turn bays at intersections. Based on the intersection spacing and typical mid-block vehicle speeds, there is a resonant cycle length of approximately 60 seconds that would provide coordination on most streets. This cycle length would also accommodate pedestrian movements at all intersections.</p>

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8.2.5.2	<i>8.2.5.2 Traffic conditions</i>
8.2.5.2.0-1	During heavy traffic conditions (such as peak shopping periods and PM peak hours), the demand at many of the intersections cannot be accommodated at the resonant cycle length. In addition, at key locations the block length is such that not all of the demand on some approaches can be stored in the approach block.
8.2.5.3	<i>8.2.5.3 Operational objectives</i>
8.2.5.3.0-1	<p>The operational objectives for the streets in this network under these conditions are to:</p> <ul style="list-style-type: none"> • Accommodate the traffic at all intersections with a minimum of phase failures; • Control inflows to blocks to prevent queue spillback into upstream intersections; and • Provide smooth flow along as many routes as possible through the network.
8.2.5.4	<i>8.2.5.4 Coordination and signal timing strategies</i>
8.2.5.4.0-1	<p>The signal timing strategies used by the system to accommodate this situation are:</p> <ul style="list-style-type: none"> • Determine which routes need to be coordinated and which blocks can best accommodate no coordination, • At each intersection, select phase times that minimize phase failures; • Determine the critical intersection(s) within the network • At the critical intersection(s), select phase sequence that minimizes queue overflow in left turn bays • At the critical intersection(s), distribute green time to maximize the throughput on the coordinated routes. • At the non-critical intersections, provide sufficient time to serve all turning and side street traffic without phase failures • At the non-critical intersections, provide green on the coordinated route phases in a manner that minimizes the stops for through traffic along the coordinated route. • At intersections with limited approach block length, set the timing of upstream intersections so that queues do not exceed the block length.
8.2.5.5	<i>8.2.5.5 Summary of Operation</i>
8.2.5.5.0-1	The network will operate at a 60 second cycle length, because that has been determined to be a resonant cycle length

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	<p><u>at which two-way progression can be provided on the coordinated routes. the ASCT will select the most appropriate phase sequence at intersections where phase sequence is permitted to vary, and select phase times that accommodate all pedestrian activity and distribute green times to minimize phase failures, and implement offsets that provide progression along the coordinated routes. Because XX block is short, the offsets will be set so that when a coordinated platoon passes through A Street, it will always clear B Street, so the block is cleared and available to store turning traffic from A Street.</u></p>
8.3	<p><u>8.3 Typical Heavy (Uncongested) Traffic</u></p>
8.3.1	<p><u>8.3.1 Example: Isolated Intersection</u></p>
8.3.1.1	<p><u>8.3.1.1 Road network</u></p>
8.3.1.1.0-1	<p><u>A Road and B Road are two important limited access arterials that intersect and there are no other intersections sufficiently close that traffic flow would benefit from providing coordination. At the intersection, each road has three through lanes on each approach, dual left turn lanes and exclusive right turn lanes. Although pedestrian crosswalks are provided, there are rarely pedestrians at this isolated location.</u></p>
8.3.1.2	<p><u>8.3.1.2 Traffic conditions</u></p>
8.3.1.2.0-1	<p><u>Traffic is heavily directional during the commuter peaks. A Road is predominantly northbound during the AM and southbound during the PM, whicl B Road is predominantly eastbound during the AM and westbound during the PM. There is significant turning traffic in the peak directions. The left turn bays in the peak direction often overflow (east to north during the AM peak and west to south during the PM peak). There are occasional phase failures resulting in carryover queues at the end of phases. However, because of the high volumes and relatively long queues that form under vehicle-actuated (free) operation, there is a significant portion of each phase green during which the throughput is well below saturation flow, but not sufficiently low that phase gap-out occurs. The intersection delay (and therefore the LOS) would be improved by using a lower cycle length than can be achieved using normal vehicle-acuated operation.</u></p>
8.3.1.3	<p><u>8.3.1.3 Operational objectives</u></p>
8.3.1.3.0-1	<p><u>The operational objective for this case is to reduce delay by improving the efficiency of each phase.</u></p>

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8.3.1.4	<i>8.3.1.4 Coordination and signal timing strategies</i>
8.3.1.4.0-1	<p>The signal timing strategies used by the system to accommodate this situation are:</p> <ul style="list-style-type: none"> • Select a cycle length that minimizes overall delay at the intersection • Select a phase sequence that maximizes the efficiency of the movements in the peak direction • Distribute phase times to minimize phase failures on all approaches • Modify cycle length and phase times if necessary to accommodate occasional pedestrians
8.3.1.5	<i>8.3.1.5 Summary of Operation</i>
8.3.1.5.0-1	The adaptive system will measure the traffic flow and determine the appropriate cycle length and phase times to accommodate the current demand. When traffic volumes are sufficiently high, lead-lag operation will be selected for one or both approaches and unused time generally added to the phases serving the peak directions.
8.4	<i>8.4 Moderate balanced flows</i>
8.4.1	<i>8.4.1 Arterial road with irregular spacing</i>
8.4.1.1	<i>8.4.1.1 Road network</i>
8.4.1.1.0-1	<p>The section of Broadway Road to be coordinated using ASCT has six signalized intersections. It is a six lane arterial road with a two way left turn lane, and exclusive left turn lanes at each intersection. Most of the intersections provide access to local businesses and residential areas. However, one intersection (Cross Street) is an arterial road that accommodates regional traffic rather than providing local access. There are no nearby signals on this cross street that require coordination with this critical intersection. This is an eight-phase intersection with protected left turns on all approaches. The other intersections have permissive left turns on the side streets. There is no regular spacing between the intersections and therefore no "resonant" cycle length.</p> <p>Broadway is classified by the MPO as an arterial road of regional significance.</p>
8.4.1.2	<i>8.4.1.2 Traffic conditions</i>
8.4.1.2.0-1	During business hours traffic uncongested and the flows along Broadway are similar in both directions. At lunch time

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	<p><u>there is an increase in traffic turning into and out of the several side streets that service local shops and restaurants. There is little pedestrian activity except at Cross Street where there are bus stops and local shops. There is enough side street and turning movement traffic that most signal phases are called every cycle. The left turn volumes are sufficiently high that they need protected turn phases to provide sufficiently capacity and prevent phase failures.</u></p>
<p><u>8.4.1.3</u></p>	<p><u>8.4.1.3 <i>Operational objectives</i></u></p>
<p><u>8.4.1.3.0-1</u></p>	<p><u>The operational objectives for this condition are to:</u></p> <ul style="list-style-type: none"> • <u>Provide smooth flow along Broadway; and</u> • <u>Provide signal timing that prevents phase failures at all intersections.</u>
<p><u>8.4.1.4</u></p>	<p><u>8.4.1.4 <i>Coordination and signal timing strategies</i></u></p>
<p><u>8.4.1.4.0-1</u></p>	<p><u>The coordination approach for these conditions is provide progression, maximizing bandwidth while providing two-way coordination. This can be done at a resonant cycle length of 80 seconds. The strategies applied while maintaining this cycle length are:</u></p> <ul style="list-style-type: none"> • <u>At each intersection, provide sufficient time to serve all turning and side street traffic without phase failures;</u> • <u>At each intersection, select phase times (or offsets) that provide smooth flow along the arterial in both directions.</u> • <u>At each intersection, select phase sequence that provides smooth flow along the arterial</u> • <u>At the specified intersection, select phase times that will accommodate frequent use of all pedestrian phases.</u> • <u>At other intersections, select phase times that will accommodate occasional use of pedestrian phases.</u>
<p><u>8.4.1.5</u></p>	<p><u>8.4.1.5 Summary of Operation</u></p>
<p><u>8.4.1.5.0-1</u></p>	<p><u>The critical intersection will determine the minimum cycle length that can be used for the entire group. This cycle length will accommodate all phases and all pedestrian movements. Provided it is not higher than the 90 second resonant cycle length, the system will set the cycle length to be 90 seconds. It will detect the balanced flows and select offsets that provide a reasonable compromise between the two directions of travel. At the non-critical intersections, the non-coordinated phases will be set to accommodate pedestrians and vehicles, and all spare time will allocated to the coordinated phases to maximize the bandwidth for progression bands along the road. During periods (such as lunch time) when there is more turning traffic associated with local retail activity) extra time will be provided to those phases within the overall cycle length, at the expense of the coordinated phases on Broadway.</u></p>

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8.5	8.5 <u>Light Balanced Flows</u>
8.5.1	8.5.1 <u>Arterial Road</u>
8.5.1.1	8.5.1.1 <u>Road network</u>
8.5.1.1.0-1	<p><u>The section of Broadway Road to be coordinated using ASCT has six signalized intersections. It is a six lane arterial road with a two way left turn lane, and exclusive left turn lanes at each intersection. Most of the intersections provide access to local businesses and residential areas. However, one intersection (Cross Street) is an arterial road that accommodates regional traffic rather than providing local access. There are no nearby signals on this cross street that require coordination with this critical intersection. This is an eight-phase intersection with protected left turns on all approaches. The other intersections have permissive left turns on the side streets.</u></p> <p><u>Broadway is classified by the MPO as an arterial road of regional significance.</u></p>
8.5.1.2	8.5.1.2 <u>Traffic conditions</u>
8.5.1.2.0-1	<p><u>During some periods of the weekdays and weekends traffic is light but predominantly passing along the arterial. There is little pedestrian activity and little side street and turning movement traffic. The left turn volumes are sufficiently light that they do not need protected turn phases to provide sufficiently capacity, and can normally be accommodated by permissive phases. There is a resonant cycle length of 45 seconds that will provide two-way coordination when the protected left turn phases are omitted.</u></p>
8.5.1.3	8.5.1.3 <u>Operational objectives</u>
8.5.1.3.0-1	<u>The operational objectives for this condition are to:</u>
8.5.1.3.0-2	<ul style="list-style-type: none"> <u>• Provide smooth flow along Broadway; and</u>
8.5.1.3.0-3	<ul style="list-style-type: none"> <u>• Provide signal timing that prevents phase failures at all intersections.</u>
8.5.1.4	8.5.1.4 <u>Coordination and signal timing strategies</u>
8.5.1.4.0-1	<p><u>The coordination approach for this condition is to provide progression along the arterial, maximizing bandwidth while providing two-way coordination. The timing strategies applied to do this are:</u></p>

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	<ul style="list-style-type: none"> • At each intersection, provide sufficient time to serve all turning and side street traffic without phase failures; • At each intersection, select phase times (or offsets) that provide smooth flow along the arterial in both directions; • At each intersection, omit protected turning phases to minimize the impact of occasional turning vehicles on other traffic; • At each intersection, select phase times that will accommodate occasional use of pedestrian phases.
8.5.1.5	8.5.1.5 Summary of Operation
8.5.1.5.0-1	<p>During light traffic conditions, protected left turn phases will be omitted and a cycle length of 45 seconds implemented. If traffic volumes decrease (such as during late nights), the 45 second cycle length and two-way coordination will be maintained unless the volumes fall below a minimum threshold, in which case the signals will be set to operate in free, vehicle-actuated mode. If traffic increases to the extent that it can no longer be accommodated within the 45 second cycle length, or left turning volumes can no longer be accommodated without the protected left turns, then a longer cycle length will be implemented and a new coordination strategy selected to match the current traffic conditions.</p>
8.6	8.6 Demand affecting event
8.6.1	8.6.1 High travel day (e.g., Mothers' Day, Superbowl)
8.6.1.0-1	<p>During periods of major activity within or close to the ASCT's area of operation, the traffic characteristics are often similar to the peak periods, either oversaturated or unsaturated. The system will behave in a similar fashion to those periods, and the detection system will determine whether unsaturated or oversaturated conditions prevail. If there is heavily directional traffic before or after the activity, the system will determine the predominant direction and coordinate accordingly, with an appropriate cycle length and offset. If the event traffic is not as heavy as peak hours, but the traffic on the corridor is still highly directional, then the system will recognize this and provide coordination predominantly in the heaviest direction, even though the cycle length may be similar to business hours (with balanced flows) cycle lengths.</p> <p>The entire corridor may be set by the operator to operate as one or more coordinated groups under this condition, or the system may have the freedom to operate it as one or more groups subject to user-specified criteria, such as similar required cycle lengths in different parts of the corridor, or the volume of traffic at key locations exceeds a threshold.</p>

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8.7	8.7 Capacity affecting event
8.7.1	8.7.1 Weather event
8.7.2	8.7.2 Incident within the system (const., mtce, fire)
8.7.2.0-1	<p>When an incident occurs on the coordinated route and temporarily reduces the capacity of the route (such as emergency vehicles stopped, unscheduled construction/maintenance, or traffic crash), there will typically be congestion upstream of the blockage, and lighter than normal traffic downstream. In such a situation, it is appropriate for the downstream signals to operate with different characteristics from the upstream signals.</p> <p>If the downstream signals experience lighter traffic as a result of the blockage, those signals should be coordinated as a group, with cycle length, splits and/or offsets that react to the measured traffic. If the blockage is in the peak direction, then it may be appropriate to coordinate in the opposite direction if that traffic is similar to or greater than the normal peak direction. If the blockage is in the non-peak direction, there may be no need to depart from the normal operation.</p> <p>While intersections upstream from the blockage may register increased congestion, the appropriate response would not be to increase the capacity in the congested direction. On the contrary, the approach should be to match the capacity for phases in the direction towards the bottleneck to the actual capacity of the bottleneck, and prevent this movement from adversely affecting cross street traffic and the flow in the non-affected direction.</p> <p>The system will recognize the presence of an abnormal obstruction and modify the signal operation to react to the changed traffic conditions in an efficient manner.</p>
8.8	8.8 Fault Conditions
8.8.1	8.8.1 Communications Fault Condition
8.8.1-1	If a communication failure prevents the adaptive system from continuing to control one or more intersections within a defined group, all signals within the group will revert to an appropriate, user-specified fallback mode of operation, either time-of-day operation or free operation. The fallback mode will be specified by the user based on location and time of day. All communication failure alarms will be automatically transmitted to maintenance and operations staff for appropriate attention.
8.8.2	8.8.2 Detection Fault Condition

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8.8.2.0-1	<p>The system will recognize a detector failure and take appropriate action to accommodate the missing data. For a local detector failure, the local controller will place a soft recall or maximum recall (to be user-specified) on the appropriate phase, and issue an alarm. For a detector that influences the adaptive operation (e.g., a system detector), the system will use data from an alternate (user-specified) detector, such as in an adjacent lane or at an appropriate upstream or downstream location. If the number of detector failures within a specified group exceeds a user-specified threshold, the system will cease adaptive operation and go to a fallback operation specified by the user (such as time-of-day operation or free operation). The fallback operation will be specified by the user based on location and time of day. All detector failure alarms will be automatically transmitted to maintenance and operations staff for appropriate attention.</p>
8.9	8.9 Priority and Preemption
8.9.1	8.9.1 Railroad Preemption
8.9.1.1	8.9.1.1 <i>EXAMPLE PREEMPTION SCENARIO - Example 1.</i>
8.9.1.1.0-1	<p>XX arterial runs north-south and there are gated railroad grade crossings on several of the east-west routes that cross XX Arterial, namely XX Blvd and XX St. The rail line is approximately XXft. to the east of XX Arterial. The railroad gated crossing preempts the signals at XX intersection and also XX (TWO INTERSECTIONS ON THE ARTERIAL). Upon preemption, the signals on XX arterial introduce a clearance phase, to ensure any vehicles queued on or close to the railroad tracks can clear before the gates descend. Upon completion of the clearance interval, the signal continues limited operation. The phases that would normally send traffic in the direction of the grade crossing are inhibited until the gates are raised. Once the clearance sequence is completed, the signal returns to normal operation. There is also a queue detector on the eastbound departure side of XX Arterial, which detects the presence of a queue approaching the grade crossing when the gates are lowered. If such a queue is detected, the phases that normally send traffic in the direction of the grade crossing are inhibited as long as the gates remain lowered. When an intersection responds to a railroad preemption, all signals within the coordinated group are released to local control, and operate according to a time-of-day schedule. Once the preemption is released, all the signals in the coordinated group return to adaptive control.</p>

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8.9.2	8.9.2 Light Rail Priority
8.9.2.1	8.9.2.1 EXAMPLE LIGHT RAIL PRIORITY SCENARIO.
8.9.2.1.0-1	<p>LRT priority will be provided at each intersection on an LRT route. The input requesting priority will come EITHER from the centralized priority system The system will have the capability to extend the existing green if that will serve the LRV, introduce an early green by shortening or skipping other phases, or run a phase called exclusively by the LRV.</p> <p>The decision to provide priority will be determined within the local controller, based on user-definable and settable rules. These rules will include such items as: length of time or number of cycles since last priority was provided, and priority level if there are competing requests.</p> <p>The LRT system has its own logic to determine whether a priority request for an approaching LRV will be transmitted to the signal controller, based on such parameters as schedule adherence, route number, in-service or out-of-service and passenger loading. This logic will not reside within the adaptive system.</p>
8.9.3	8.9.3 Bus Signal Priority
8.9.3.1	8.9.3.1 EXAMPLE BUS PRIORITY SCENARIO.
8.9.3.1.0-1	<p>Bus priority will be provided at each intersection on a bus route. The input requesting priority will come from the centralized priority system.</p> <p>The system will have the capability to extend the existing green if that will serve the bus, introduce an early green by shortening or skipping other phases, or run a phase called exclusively by the bus.</p> <p>The decision to provide priority will be determined within the local controller, based on user-definable and settable rules. These rules will include such items as: length of time or number of cycles since last priority was provided, and priority level if there are competing requests.</p> <p>The bus system has its own logic to determine whether a priority request for an approaching bus will be transmitted to</p>

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	the signal controller, based on such parameters as schedule adherence, route number, in-service or out-of-service and passenger loading. This logic will not reside within the adaptive system.
8.9.4	8.9.4 Emergency Vehicle Preemption
8.9.4.0-1	When an intersection responds to an EV preemption, other signals within the coordinated group continue to operate adaptively. The preempted signal returns to adaptive control once the preemption is released.
8.10	8.10 Scheduled Events
8.10.0-1	<p>The system will recognize the increasing traffic as patrons arrive for the event and adopt an appropriate mode of operation. During the event, when there is little associated traffic, the system will recognize the traffic conditions and operate normally, then recognize the changing traffic pattern as patrons begin to leave the event and adopt the appropriate mode of operation until the traffic clears.</p> <p>The system will then return to normal operation.</p>
8.11	8.11 Pedestrians
8.11.0-1	<p>Pedestrian crossing times must be accommodated. At locations with wide pedestrian crosswalks and a history of conflicts between turning vehicles and pedestrians, the pedestrian walk is displayed some seconds before the compatible vehicle green. At crosswalks with high pedestrian volumes, a pedestrian recall is used during the periods when the pedestrian volumes are high. Pedestrian recall is used for pedestrian phases that are adjacent to the coordinated movements.</p> <p>During periods when pedestrian volumes are high and queuing of the conflicting right turn movement becomes unacceptable, the vehicles are directed elsewhere by prohibiting the movement (such as by operating a No Right Turn sign).</p> <p>When side street traffic is light and no pedestrian is present, a vehicle may arrive on the side street shortly after the point at which its phase would normally be initiated. Typically it would then wait an entire cycle before being served. However, it is often possible to serve one or two side street vehicles within the remaining green time. So the system will be able to start a phase later than normal when there is no pedestrian call for that phase, provided it can be</p>

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	<p><u>completed before the time the phase would normally end.</u></p>
<p><u>8.12</u></p>	<p><u>8.12 Installation</u></p>
<p><u>8.12.0-1</u></p>	<p><u>During installation and fine tuning, the operator will calibrate all the user-defined values in the system. In order to understand the response of the system to changes in traffic conditions, it is necessary to examine the results of intermediate calculations, in addition to the overall outputs and changes of state commanded by the system.</u></p> <p><u>For example, if a cycle length is calculated based on a calculated parameter, such as level of saturation of detectors in critical lanes on critical movements, then the state of that calculated parameter must be available for inspection for each detector. This will allow the operator to properly calibrate each detector, then separately calibrate the parameters in the cycle length calculation or look-up table. This would also allow an operator to identify a faulty detector that is causing an incorrect measure to be calculated, even though the detector has failed; or identify a detector on which traffic behavior is different from other detectors on that phase, such as a left turn lane that has a heavy U-turn volume.</u></p>