Orange County, FL

Model Systems Engineering (MSE) Guidance

Adaptive Signal Control Technology (ASCT)

Financial Project No. 434917-1

MSE Matrix

February 1, 2014

Concept Ops Reference Number	**Concept of Operations Statements**
1	1 Chapter 1: Scope
1.1	1.1 Document Purpose and Scope
1.1-1	The scope of this document covers the consideration of adaptive signal control technology (ASCT) for use within the vicinity of Florida Mall and Disney World in Orange County, FL. The ASCT will be deployed at 38 traffic signals along US 441, SR 482, SR 535, and SR 536.
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	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 and FDOT District 5.
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.
1.2-2	The purpose of providing adaptive control in this area is to maximize traffic throughput by adapting to fluctuating conditions and accommodating the occasional pedestrian presence, while minimizing disruption to vehicle progression.
1.2-3	This project will add adaptive capabilities to the existing coordinated signal system.
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 vicinity of this project.
1.2-7	Adaptive capability will be provided for all coordinated signals along US 441 and SR 482 near Florida Mall.
1.2-8	The adaptive capability will be provided for signals operated by Orange County Traffic Engineering.
1.2-9	Interfaces will be provided to the signal system operated by Orange County Traffic Engineering.
1.2-10	The adaptive system will be integrated with Siemens M52 signal controllers.
1.3	1.3 Procurement
1.3.0-1	The ASCT system will be procured using a purchase order on existing contracts process.
1.3.0-1.0-2	A best value procurement process based on responses to a request for proposals.
1.3.0-4	A detailed procurement plan will be prepared after the system requirements have been determined.
2	2 Chapter 2: Referenced Documents
2.0-1	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.
2.0-1.0-1	• Transportation Improvement Programs (TIP)

2.0-1.0-1	• Long Range Transportation Plans
2.0-1.0-4	**ITS, Operations, Architecture, Other** • 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 • Florida Statewide and Regional ITS Architectures <http://www.consystec.com/florida/default.htm> • Final FDOT District 5 Regional ITS Architecture http://www.consystec.com/florida/d5/web/_regionhome.htm • Orange County's Advanced Traffic Management System (OCATMS) Feasibility and Implementation Study, April 2002
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
3.1.1.1.0-4	The arterials have irregularly spaced signalized intersections, and there is no "natural" cycle length that allows 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.
3.1.1.5	3.1.1.5 Jurisdictions
3.1.1.5.0-1	FDOT District 5 owns the signals for the proposed project but Orange County, FL operates and maintains the signals.
3.1.2	3.1.2 Traffic Characteristics
3.1.2.1.0-1	The traffic characteristics are illustrated below. These corridors are some of the most tightly spaced, heavily traveled and congested roadways in Orange 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 Orange County to neighboring jurisdictions. The following shows the peak Average Daily Traffic (ADT) volumes on the corridors included in the Project: US 441 – Orange Blossom Tl – daily traffic volume range from 43,900 to 68,400 (2010 Count) SR 482 – Sand Lake Rd – daily traffic volume range from 28,800 to 45,300 (2010 Count) SR 535 and SR 536 volumes fluctuate wider due to the proximity to Disney World and other tourist attractions. Over the years, the roadway network in Orange County has experienced increasing congestion and travel delays due to such high traffic demands and increasing pedestrian traffic crossing at the intersections.
3.1.2.2	3.1.2.2 Peak Periods
3.1.2.2.0-3	Traffic conditions vary during the weekday peaks. E.g., during the AM and midday Peak periods, traffic flows predominantly in the North Bound direction, then later in the PM peak period it becomes balanced, then in the evening it flows predominantly in the opposite South Bound direction.
3.1.2.3	3.1.2.3 Business Hours
3.1.2.3.0-3	Business hours flows are predominantly in the North/South direction.

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 North Bound direction, while during the afternoon hours it becomes balanced.
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:
3.1.2.4.0-1.0-2	Directional
3.1.2.4.0-1.0-3	Heavy
3.1.2.5	3.1.2.5 Weekends
3.1.2.5.0-1	For this corridor weekend traffic on Saturdays is Changing to accommodate retail and other factors traffic.
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
3.1.2.6	3.1.2.6 Events and Incidents
3.1.2.6.0-1	Heavily directional event traffic in the North/South Bound during multiple peaks.
3.1.2.6.0-2	Heavily directional incident-related traffic in the West Bound during AM Peak lasting 60 minutes or more with a vehicle volume up to 2600 (vph) is typically experienced on weekdays in this area when there is an incident on SR 528 or I-4.
3.1.2.7	3.1.2.7 General
3.1.2.7.0-1	There is a high proportion of turning traffic along the arterial or within the network.
3.1.2.7.0-2	Where turns occur there is a high proportion of turning traffic.
3.1.2.7.0-3	Queues often overflow from turn bays at most intersections during PM Peaks.
3.1.2.7.0-4	Traffic along the arterials is predominantly through traffic.
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. Installation of transit signal priority and opening of the nearby Sunrail station within the life of the system will likely increase the number of buses.
3.1.3	3.1.3 Signal Grouping
3.1.3.0-1	See attached list.
3.1.3.0-2	All the signals are relatively close and are expected to be coordinated as two group; one for the US 441/SR 482 area and one for the SR 535/SR 536 area.
3.1.4	3.1.4 Land Use Characteristics
3.1.4.1	3.1.4.1 Existing Land Uses
3.1.4.1.0-1	The arterial is used for a mixture of land uses, and a major event center.
3.1.4.1.0-1.0-7	Serves a mixture of land uses, including retail.
3.1.4.1.0-1.0-8	Serves a major event center, including a regional mall and Disney World
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 can impede turning movements at some intersections with pedestrian calls occasionally called.
3.1.4.3.0-1.0-5	Pedestrian phases are occasionally 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 six bus lines operating along the route (or within the network). The buses operate at a frequency of 6 per hour during peak periods.
3.1.4.4	3.1.4.4 Agencies
3.1.4.4.0-1	The existing signal system is operated by Orange County.
3.1.4.4.0-2	The effectiveness of the following agencies/departments is affected by the operation of the signal system: transit, and fire/emergency response.
3.1.4.5	3.1.4.5 Existing Architecture
3.1.4.5.0-1	The existing system architecture is illustrated below. (Provide an appropriate system network block diagram, and describe the following elements, as applicable.) See attached list.
3.1.4.5.0-1.0-1	TMC and workstations
3.1.4.5.0-1.0-2	The adaptive system will employ a distributed network, without the need of a central server with a separate processor at each intersection to implement adaptive changes in service.
3.1.4.5.0-1.0-3	The communications infrastructure will use Ethernet based fiber optic cable at all intersections with remote and TMC network access which will be shared with other agencies.
3.1.4.5.0-1.0-4	The project will employ video and loop based detection using IP capable cameras & magnetometer detectors on all movements at all intersections.
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.
3.3	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	• Recognize changes in traffic conditions and react quickly and automatically to accommodate those changes.
3.3.0-4	• More efficiently accommodate emergency vehicles and transit vehicles and more quickly recover from preemption and priority.
3.3.0-5	• Improve the management of queues within the network.

3.3.0-6	• Recognize the existence of differing traffic conditions in various parts of the network and react in each section appropriately.
3.3.0-7	• Improve the productivity of staff by automating many of the routine processes.
3.3.0-8	• 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 times, while balancing multimodal transportation needs.
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	• Support vehicle, pedestrian and transit traffic mobility.
3.4.2-1.0-2	• Provide measurable improvements in personal mobility
3.4.2-1.0-4	• Support regional systems
3.4.2-1.0-5	• Support congestion and environment policy objectives
3.4.2-1.0-6	• 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	To support vehicle, pedestrian and transit traffic mobility:
3.4.3.0-1.0-1	• Be capable of supporting priority operations for light rail and buses
3.4.3.0-1.0-1	• Allow effective use of all controller features currently in use or proposed to be used
3.4.3.0-1.0-1	• Minimize adverse effects caused by preemption and unexpected events
3.4.3.0-1.0-2	To support measurable improvements in personal mobility:
3.4.3.0-1.0-2	• Adjust operations to changing conditions
3.4.3.0-1.0-2	• Reduce delays
3.4.3.0-1.0-2	• Reduce travel times
3.4.3.0-1.0-2	• Provide the same level of safety provided by the existing system to vehicles, pedestrians and transit.
3.4.3.0-1.0-4	To support regional systems:
3.4.3.0-1.0-4	• Be compliant with the regional ITS architecture
3.4.3.0-1.0-4	• Allow center-to-center and system-to-system communication
3.4.3.0-1.0-4	• Connect to regional traffic control systems
3.4.3.0-1.0-4	• Report traffic conditions to regional traffic conditions information systems
3.4.3.0-1.0-5	To support environmental objectives:
3.4.3.0-1.0-5	• Reduce vehicle emissions through improvements in appropriate determinants such as vehicle stops and delays
3.4.3.0-1.0-6	To support a timely schedule:
3.4.3.0-1.0-6	• Be sufficiently mature and robust that risk is low and little or no development time will be required.
3.4.3.0-1.0-6	• Be ready for full operation within six months of notice to proceed.

3.4.4	3.4.4 Operational Objectives
3.4.4.0-1	The operational objectives of the ASCT system will be to: (Select the samples appropriate to your situation)
3.4.4.0-1.0-1	Smooth the flow of traffic along coordinated routes
3.4.4.0-1.0-2	Maximize the throughput of traffic along coordinated routes
3.4.4.0-1.0-3	Equitably serve adjacent land uses
3.4.4.0-1.0-4	Manage queues, to prevent excessive queuing from reducing efficiency
3.4.4.0-1.0-5	Control operation using a combination of these objectives
3.4.4.0-1.0-6	Control operation by changing the objectives under various circumstances
3.5	3.5 Strategies to be Applied by the Improved System
3.5.0-1	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)
3.5.0-1.0-1	• Provide a pipeline along a coordinated route to maximize the throughput during periods of high demand;
3.5.0-1.0-2	• Provide a pipeline along a coordinated route to smooth the flow of traffic in one or both directions;
3.5.0-1.0-3	• Distribute phase times in a way that equitably shares the green time between various movements and minimizes the risk of phase failures;
3.5.0-1.0-4	• 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	• Manage the distribution of green times for vehicles and pedestrians in an equitable manner;
3.5.0-1.0-6	• Employ a combination of these strategies when they are compatible.
3.6	3.6 Alternative Non-Adaptive Strategies Considered
3.6.1	3.6.1 Traffic Responsive Pattern Selection
3.6.1.0-1	Traffic responsive pattern selection (TRPS) timing has never been used due to limitations in geometry, and spacing, as well as ineffectiveness.
3.6.2	3.6.2 Complex Coordination Features
3.6.2.0-1	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.)
3.6.2.0-1.2	• Variable phase sequence
3.6.2.0-1.4	• Detector switching
3.6.2.0-1.5	• Coordinate different phases at different times
3.6.2.0-1.6	• Coordinate turning movement phases
3.6.2.0-1.7	• Coordinate beginning or end of green
3.6.2.0-1.9	• Hold the position of uncoordinated phases
3.6.2.0-1.11	• Stop-in-walk
3.6.2.0-1.12	• Dynamic max
3.6.2.0-1.13	• Double cycle or half cycle

3.6.2.0-2	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.)
3.6.2.0-2.1	• Multiple (repeat) phases or phase reservice because of ineffectiveness limitations
3.6.2.0-2.3	• Omit phase under some circumstances because of ineffectiveness limitations
3.6.2.0-2.8	• Early release of hold because of ineffectiveness limitations
3.6.2.0-2.10	• Late phase introduction because of ineffectiveness limitations

Concept Ops Reference Number	Concept of Operations Statements	System Requirements Statements
4	4 Chapter 4: Operational Needs	
4.0-1	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.	
4.1	4.1 Adaptive Strategies	
4.1.0-1	The system operator needs the ability to implement different strategies individually or in combination to suit different prevailing traffic conditions. These strategies include:	
4.1.0-1.0-1	• Maximize the throughput on coordinated routes	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.
		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.
		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.)
		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.
		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

		2.2.0-2 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.)
4.1.0-1.0-2	• Provide smooth flow along coordinated routes	2.2.0-4 The ASCT shall determine the order of phases at a user-specified intersection. (The calculation will be based on the optimization function.)
		2.2.0-5.0-3 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
		2.3.0-2 (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.
		2.3.0-4 (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.)
		2.2.0-2 (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.
4.1.0-1.0-3	• Distribute phase times in an equitable fashion	2.1.1.0-7.0-3 The ASCT shall determine the order of phases at a user-specified intersection. (The calculation will be based on the optimization function.)
		2.2.0-3 When current measured traffic conditions meet user-specified criteria, the ASCT shall alter the state of signal controllers providing equitable distribution of green times.

		2.3.0-3 The ASCT shall calculate optimum phase lengths, based on current measured traffic conditions. (The calculation is based on the optimization objectives.)
		2.3.0-2 (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.
		2.3.0-4 (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.)
		2.1.1.0-7 (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.
		4.1.0-1. The ASCT shall alter the adaptive operation to achieve required objectives in user-specified conditions. (The required objectives are specified in Needs Statement
		2.2.0-2 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.)
		2.1.1.0-8.0-2.0-1 The ASCT shall provide a user-specified minimum value for each phase at each signal controller.
		2.2.0-5.0-1 The ASCT shall not provide a phase length shorter than the minimum value.
		2.4.0-3.0-1 The ASCT shall provide maximum and minimum phase times.

4.1.0-1.0-4	• Manage the length of queues	2.2.0-4 When queues are detected at user-specified locations, the ASCT shall execute user-specified timing plan/operational mode.
		2.2.0-5.0-3 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.
		2.1.3.0-1 (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 The ASCT shall detect the presence of queues at preconfigured locations.
		2.3.0-4 (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.)
		2.2.0-2 (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.
		2.1.3.0-4 When queues are detected at user-specified locations, the ASCT shall execute user-specified adaptive operation strategy.
		2.2.0-5.0-1 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 determine the order of phases at a user-specified intersection. (The calculation will be based on the optimization function.)

4.1.0-1.0-5	• Manage the locations of queues within the network	2.2.0-3 When queues are detected at user-specified locations, the ASCT shall execute user-specified timing plan/operational mode.
		2.1.3.0-3 The ASCT shall detect the presence of queues at preconfigured locations.
4.1.0-3	The system operator needs to change the operational strategy (for example, from smooth flow to maximizing throughput or managing queues) based on changing traffic conditions.	2.1.1.0-7.0-1 (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.
		2.1.1.0-7.0-2 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.
		2.1.1.0-7.0-3 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.
		2.1.1.0-7.0-4 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 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.
4.1.0-4	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	2.1.3.0-1 The ASCT shall detect the presence of queues at preconfigured locations.
		2.1.1.0-9 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.)

	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.	2.1.1.0-9.0-1 The ASCT shall alter operations, to minimize repeated phase failures.
		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.
4.1.0-5	The system operator needs to minimize the chance that a queue forms at a specified location.	7.0-6 The ASCT shall provide a minimum of 8 different user-defined phase sequences for each signal.
4.1.0-6	The system operator needs to modify the sequence of phases to support the various operational strategies.	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
		7.0-7 The ASCT shall not prevent a phase/overlap output by time-of-day.
		7.0-8 The ASCT shall not prevent a phase/overlap output based on an external input.
		7.0-9 The ASCT shall not prevent the following phases to be designated as coordinated phases. (Including: Main street through movements)
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 The ASCT shall provide coordination along a route.
		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 The ASCT shall store four user-defined coordination routes.
		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 500 signals, up to 30 miles from the TMC (or specified location).	1.0-1 The ASCT shall control a minimum of 500 signals concurrently.
4.2.0-2	The system operator needs to be able to adaptively control up to 50 independent group of signals.	1.0-2 The ASCT shall support groups of signals.
		1.0-2.0-2 The ASCT shall control a minimum of 50 groups of signals.
		1.0-2.0-1 The boundaries surrounding signal controllers that operate in a coordinated fashion shall be defined by the user.
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 The ASCT shall support groups of signals.
		1.0-2.0-3 The size of a group shall range from one to 50 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 The boundaries surrounding signal controllers that operate in a coordinated fashion shall be altered by the ASCT system according to configured parameters.
4.3	4.3 Coordination across boundaries	
4.3.0-1	The system operator needs to adaptively control signals operated by Orange County	3.0-1 The ASCT shall support external interfaces according to the referenced interface control documents and the following detailed requirements. (Insert appropriate requirements that suit your needs. Interface data flows should be documented in your ITS architecture. Interface requirements include:
		3.0-1 • Data aggregation
		3.0-1 • Frequency of storage
		3.0-1 • Frequency of reporting
		3.0-1 • Duration of storage
~~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.~~	~~3.0-1.0-1~~ ~~The ASCT shall send operational data to Orange County TMC external system. Describe your external system (Insert appropriate requirements that suit your needs.)~~
		~~3.0-1.0-2~~ ~~The ASCT shall send control data to Orange County TMC external system. Describe your external system (Insert appropriate requirements that suit your needs.)~~
		~~3.0-1.0-4~~ ~~The ASCT shall send coordination data to Orange County TMC external system. Describe your 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~~ ~~• Data aggregation~~
		~~3.0-1~~ ~~• Frequency of storage~~
		~~3.0-1~~ ~~• Frequency of reporting~~
		~~3.0-1~~ ~~• Duration of storage~~
		~~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.)~~
		~~4.0-1~~ ~~The ASCT shall conform its operation to an external system's operation.~~
~~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.~~	~~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.)~~
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 that address these elements.	5.0-1.0-1 • Local access to the ASCT
		5.0-1.0-2 • Remote access to the ASCT
		5.0-1.0-3 • System monitoring
		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 • 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~~ ~~The ASCT shall comply with the agency's security policy as described in Orange County Standard Operating Procedure (SOP)~~
4.5	4.5 Queuing interactions	2.1.3.0-1 The ASCT shall detect the presence of queues at preconfigured locations.

4.5.0-1	The system operator needs to detect queues from outside the system and modify the ASCT operation to accommodate the queuing.	2.1.3.0-3 When queues are detected at user-specified locations, the ASCT shall execute user-specified adaptive operation strategy.
		2.1.3.0-2 When queues are detected at user-specified locations, the ASCT shall execute user-specified timing plan/operational mode.
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.	2.1.3.0-1 The ASCT shall detect the presence of queues at preconfigured locations.
		2.1.3.0-2 When queues are detected at user-specified locations, the ASCT shall execute user-specified timing plan/operational mode.
4.5.0-4	The system operator needs to store queues in locations where they can be accommodated without adversely affecting adaptive operation	2.1.3.0-5 The ASCT shall meter traffic into user-specified bottlenecks by storing queues at user-specified locations.
		2.1.3.0-1 The ASCT shall detect the presence of queues at preconfigured locations.
~~4.5.0-5~~	~~The system operator needs to prevent queues forming at user-specified locations.~~	~~2.1.3.0-5~~ ~~The ASCT shall meter traffic into user-specified bottlenecks by storing queues at user-specified locations.~~
4.6	4.6 Pedestrians	8.0-2 When a pedestrian phase is called, the ASCT shall accommodate pedestrian crossing times during adaptive operations.
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.)~~	~~8.0-1~~ ~~When a pedestrian phase is called, the ASCT shall execute pedestrian phases up to 0 seconds before the vehicle green of the related vehicle phase.~~
4.6.0-5	The system operator needs to accommodate early start of walk and exclusive pedestrian phases.	8.0-4 The ASCT shall execute user-specified exclusive pedestrian phases during adaptive operation.

		2.1.1.0-1 The ASCT shall operate non-adaptively in accordance with a user-defined time-of-day schedule.
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.	2.1.1.0-5 The ASCT shall operate non-adaptively in accordance with a user-defined time-of-day schedule.
4.7.0-2	The system operator needs to schedule pre-determined operation by time of day.	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.
4.7.0-3	The system operator needs to over-ride adaptive operation.	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	2.6.0-4 When a large change in traffic demand is detected, the ASCT shall respond in real time compared to normal operation, and subject to user-specified limits.
~~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.~~	
4.9	4.9 Complex coordination and controller features	7.0-2 The ASCT shall provide a minimum of four phase overlaps.
4.9.0-1.0-2	• Operate at least four overlap phases	7.0-3 The ASCT shall accommodate a minimum of eight phases at each signal.
~~4.9.0-1.0-3~~	~~• Operate two rings, eight phases and up to four phases per ring (Edit to suit your needs)~~	~~7.0-4~~ ~~The ASCT shall accommodate a minimum of two rings at each signal.~~
		~~7.0-5~~ ~~The ASCT shall accommodate a minimum of four phases per ring.~~
		~~7.0-6~~ ~~The ASCT shall provide a minimum of eight different user defined phase sequences for each signal.~~

4.9.0-1.0-4	• Permit different phase sequences under different traffic conditions	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
		7.0-12 The ASCT shall not prevent the local signal controller from performing actuated phase control using eight extension/passage timers as assigned to user-specified vehicle detector input channels in the local controller.
4.9.0-1.0-11	• Allow the controller to respond independently to individual lanes of an approach. This may be implemented in the signal controller using eight 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.	9.0-1 The ASCT shall set a specific state for each special function output based on the occupancy on a user-specified detector.
		7.0-12.0-1 The ASCT shall operate adaptively using user-specified detector channels.
		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 cycle.
4.9.0-1.0-12	• Allow the coordinated phase to terminate early under prescribed traffic conditions	8.0-6 • 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
4.9.0-1.0-13	• Allow flexible timing of non-coordinated phases (such as late start of a phase) while maintaining coordination	8.0-6 • The phase is called after its normal start time
		8.0-6 • The associated pedestrian phase is not called
4.9.0-1.0-14	• Protected/permissive phasing and alternate left turn phase sequences.	2.1.2.0-1 The ASCT shall not prevent protected/permissive left turn phase operation.
4.9.0-1.0-15	• Use flashing yellow arrow to control permissive left turns and right turns.	7.0-11 The ASCT shall not prevent the controller from displaying flashing yellow arrow left turn or right turn. (SELECT AS APPLICABLE)

4.9.0-1.0-16	• 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.
4.10	4.10 Monitoring and control	5.0-2 *The ASCT shall provide monitoring and control access at the following locations:*
4.10.0-1.0-1	• Agency TMC	5.0-2.0-1 • Agency TMC
4.10.0-1.0-2	• Maintenance facility	5.0-2.0-2 • Maintenance facility
4.10.0-1.0-3	• Workstations on agency LAN or WAN located at (specify)	5.0-2.0-3 • Agency LAN or WAN
4.10.0-1.0-5	• Local controller cabinets	5.0-2.0-5 • Local controller cabinets
4.10.0-1.0-6	• Maintenance vehicles	5.0-2.0-6 • Maintenance vehicles
4.10.0-1.0-7	• Remote locations (specify)	5.0-2.0-7 • 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	
~~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 Orange County TMC 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: (edit as appropriate)

		6.0-5 • Volume
		6.0-5 • Occupancy
		6.0-5 • Queue length
		6.0-5 • Phase utilization
		6.0-5 • Arrivals in green
		6.0-5 • Green band efficiency
		6.0-12 The ASCT shall store the following data in 5 minute increments: (edit as appropriate)
		6.0-12 • Volume
		6.0-12 • Occupancy
		6.0-12 • Queue length
		18.0-1 The ASCT shall report measures of current traffic conditions on which it bases signal state alterations.
		18.0-3 The ASCT shall maintain a log of all signal state alterations directed by the ASCT.
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 30 days.
		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)
		6.0-12 The ASCT shall store the following data in 15 minute increments: (edit as appropriate)

		6.0-12 • Volume
		6.0-12 • Occupancy
		6.0-12 • 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 • MS Excel
		6.0-2 • Text
		6.0-2 • CVS
		6.0-3 The ASCT shall store the event log for a minimum of 730 days.
		6.0-6 The ASCT system shall archive all data automatically after a user-specified period not less than 2 years.
		6.0-7 The ASCT shall provide data storage for a system size of 500 signal controllers. The data to be stored shall include the following: (edit as appropriate)
		6.0-7 • Controller state data
		6.0-7 • Reports
		6.0-7 • Log data
		6.0-7 • Security data
		6.0-7 • ASCT parameters
		6.0-7 • Detector status data
~~4.11.0-5~~	~~The system operator needs to report performance data in real time to Orange County TMC.~~	~~3.0-1~~ ~~• Data aggregation~~
		~~3.0-1~~ ~~• Frequency of storage~~

		~~3.0-1~~ ~~• Frequency of reporting~~
		~~3.0-1~~ ~~• Duration of storage~~
		~~3.0-1.0-1~~ ~~The ASCT shall send operational data to Orange County TMC external system. (Insert appropriate requirements that suit your needs.)~~
		~~3.0-1.0-5~~ ~~The ASCT shall send performance data to the Orange County TMC 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, including the following events:	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 730 days: (edit as appropriate)
		6.0-5 • Volume
		6.0-5 • Occupancy

		6.0-5 • Queue Length
		6.0-5 • Phase Utilization
		6.0-5 • Arrivals in Green
		6.0-5 • Green Band Efficiency
		6.0-8 The ASCT shall calculate and report relative data quality including:
		6.0-8 • The extent data is affected by detector faults
		6.0-9 The ASCT shall report comparisons of logged data when requested by the user:
		6.0-9 • Day to day,
		6.0-9 • Hour to hour
		6.0-9 • Hour of day to hour of day
		6.0-9 • Hour of week to hour of week
		6.0-9 • Day of week to day week
		6.0-9 • Day of year to day of year
		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.
		18.0-3 The ASCT shall maintain a log of all signal state alterations directed by the ASCT.
		18.0-3.0-4 The ASCT shall maintain the records in this ASCT log for 2 year period.

		18.0-3.0-5 The ASCT shall archive the ASCT log in the following manner: MS Excel, and/or CSV (twice daily).
		18.0-3.0-1 The ASCT log shall include all events directed by the external inputs.
		18.0-3.0-2 The ASCT log shall include all external output state changes.
		18.0-3.0-3 The ASCT log shall include all actual parameter values that are subject to user-specified values.
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.	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.
		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.
		13.2-3 The ASCT shall issue an alarm within five minutes of detection of a failure.
~~4.12.0-2~~	~~The system operator needs to immediately and automatically pass alarms and alerts to the Orange County TMC.~~	~~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.~~
		~~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.~~

		~~13.2-3~~ ~~The ASCT shall issue an alarm within five minutes of detection of a failure.~~
4.12.0-3	The system operator needs to maintain a complete log of alarms and failure events.	13.1.0-4 In the event of a failure, the ASCT shall log details of the failure in a permanent log.
		13.1.0-5 The permanent failure log shall be searchable, archivable and exportable.
		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 preemption. (E.g., apply an emergency 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.
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 preemption. (E.g., apply an emergency route).~~
		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 applying an emergency 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)	12.0-3.0-2 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.
		12.0-8 The ASCT shall accept a transit priority call from: • A signal controller/transit vehicle detector;
		12.0-8 • An external system.
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.	13.1.0-2 The ASCT shall use the following alternate data sources for operations in the absence of the real-time data from a detector: a historical analysis of service.

		13.1.0-2.0-3 The ASCT shall switch to the alternate source in real time without operator intervention.
		13.1.0-1 The ASCT shall take user-specified action in the absence of valid detector data from one vehicle detectors within a group. (E.g., use ASCT historical data, and/or use controller operations).
		13.1.0-1.0-1 The ASCT shall release control to central system control or use controller operations.
		13.2-1 The ASCT shall execute user-specified actions when communications to one or more signal controllers fails within a group. (E.g., use ASCT historical data, and/or use controller operations).
		13.3-1 The ASCT shall execute user-specified actions when adaptive control fails: E.g., use ASCT historical data, and/or use controller operations).
		13.3-1.0-1 The ASCT shall release control to central system control or use controller operations.
		2.1.1.0-2 The ASCT shall operate non-adaptively when adaptive control equipment fails.
		13.1.0-2.0-2 • Stored historical data from the failed detector.
		13.1.0-1.0-2 The ASCT shall release control to local operations to operate under its own time-of-day schedule.
		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	

4.15.0-1.0-1	• Controller types TS2 type-2 controller: Siemens M52 Using the Detector Call Input Method as the detector call input component.	14.0-3 The ASCT shall fully satisfy all requirements when connected with Siemens M52 controllers.
4.15.0-1.0-2	• Detector types	14.0-2 The ASCT shall fully satisfy all requirements when connected with existing inductive loop detection.
4.15.0-1.0-3	• Communication systems	Ethernet
4.15.0-1.0-4	• Cabinet type and sizes	14.0-5 The ASCT shall fully satisfy all requirements when connected with Existing cabinets including: NEMA TS1 and TS2 type-2 cabinets: Type 5: [H -58'', W - 40'', D - 28''] Type 4: [H -48'', W - 30'', D - 18'']
4.15.0-1.0-5	• Signal management systems	14.0-6 The ASCT shall fully satisfy all requirements when utilizing signal management system software from Siemens including: TACTICS.
~~4.15.0-2~~	~~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)~~
		~~14.0-1~~ ~~• Windows-PC,~~
4.16	4.16 Training and support	
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 16 hours training to a minimum of 10 staff.
		15.0-1 The vendor shall provide the following training including: (Calibration)
		15.0-1.0-2 The vendor shall provide training on troubleshooting 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 the project's primary TMC.
		15.0-1.0-10 The vendor shall provide a minimum of two, eight-hour 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 two years. Warranty is defined as correcting defects in materials and workmanship (subject to other language included in the purchase documents). Defect is defined as any circumstance in which the material does not perform according to its specification.

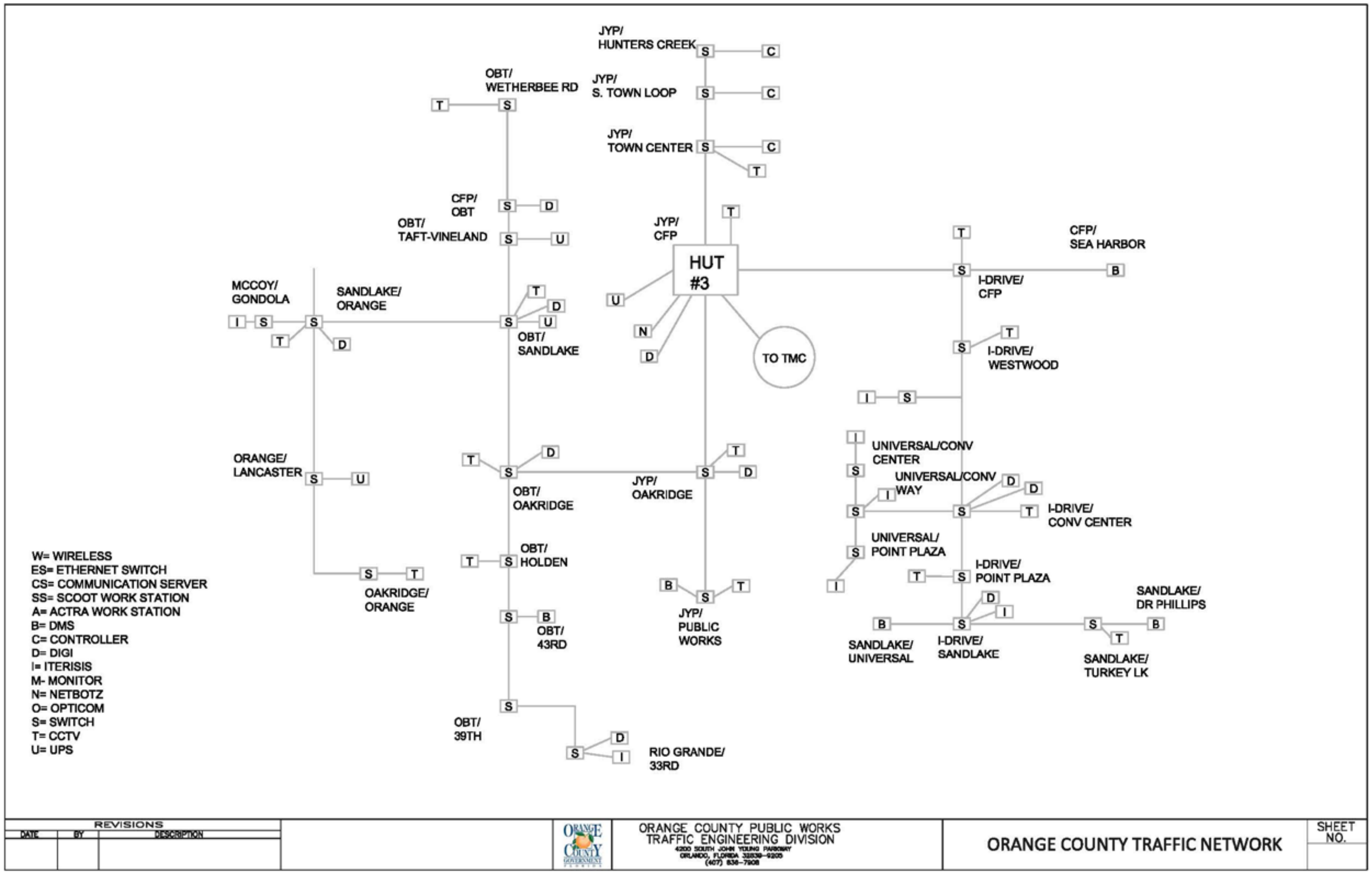
4.16.0-4	The agency needs the system to fulfill all requirements for the life of the system. The agency therefore needs support to keep software and software environment updated as necessary to prevent requirements no longer being fulfilled.	16.0-2 The Vendor shall provide routine updates to the software and software environment necessary to preserve the fulfillment of requirements for a period of two years. Preservation of requirements fulfillment especially includes all IT management requirements as previously identified.

Concept Ops Reference Number	Concept of Operations Statements
4.18.0-1	Each maintaining agency needs all applicable equipment to be readily accessible.
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 27 intersections, with plans for more in the future.
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, offset 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 Southwest of first project is 10 miles away from the group of intersections at Sand Lake and Orange Blossom Trail, Orange County, FL. 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 does 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.
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.
5.3	5.3 Fallback operation
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.
5.4	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.
5.5	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 stand-alone system not connected to a LAN or WAN
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
5.6.0-1.0-1	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;
5.6.0-1.0-5.0-1	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 any phases as coordinated phases.

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
6	6 Chapter 6: Adaptive Operational Environment
6.0-1	The system will be operated and monitored from the Orange County, FL TMC location.
6.0-2	The system will be operated and monitored from the Orange County, FL signal shop location.
6.0-3	The system will be operated and monitored from workstations from the following locations: Orange County, FL offices in Public Works Traffic Operation building.
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 Orange County TMC in an air-conditioned environment.
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: Iteris video detection products Inductive loops
6.0-6.0-4	The agency prefers to use the following controller types: TS2 type-2 controllers: Siemens M 52
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	The set up and fine tuning of the system will be performed by vendor.
6.0-9	Complaints or requests for changes in operation will be handled by the in-house operators on an as-needed basis.
6.0-11	Maintenance of all field equipment will be performed by in-house operators
6.0-12	Maintenance of the following field equipment will be performed by in-house staff. All equipment will be maintained by Orange County Traffic Engineering.
6.0-13	Funding for maintenance of the adaptive system will come from Orange County Traffic Engineering. An increase of $2700 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 $2700 per year, and will be covered by the Orange County Traffic Engineering.
6.0-15	Replacement or repair of defective or failed equipment will be covered for 2 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 2 years will be included in the purchase price.
6.0-17	The agency expects maintenance of all adaptive system software for a period of 2 years will be included in the purchase price.
6.0-18	The agency expects to operate this system using the latest software for the life of the system.

6.0-19	The agency will seek technical support from the vendor for assistance in using the adaptive software for the life of the system.
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.
7	7 Chapter 7: Adaptive Support Environment
7.1	7.1 Institutions and Stakeholders
7.1.0-1	• Sponsoring agency: Orange County
7.1.0-2	The stakeholders who will be affected by or have a direct interest in the adaptive system are: Orange County and FDOT District 5.
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.
7.2	7.2 Facilities
7.2.0-1	The current Orange County TMC includes servers for TACTICS Signal Management System by Siemens, SCOOT Adaptive Signal Control, Cameleon Video Management System, and RTC School Zone Management, in addition to supporting communication servers. It also includes three workstations for two operators and a supervisor. Feeds from CCTV camera located throughout FDOT District 5 can be monitored on a 5'x20' video display wall. The TMC has access to over 450 traffic signals and 100 CCTV cameras maintained by Orange County, in addition to CCTV cameras owned by other agencies in FDOT District 5.
7.2.0-6	Describe who is responsible for providing and maintaining staff facilities: Orange County Facilities.
7.2.0-7	Describe who is responsible for fire control facilities: Orange County Facilities.
7.2.0-8	Describe who is responsible for secure access to the TMC, workshop, or office with adaptive system workstations? Orange County Facilities.
7.3	7.3 System Architecture Constraints
7.3.0-2	The communications media available for use by the system will be: (LIST AVAILABLE MEDIA, PROVIDE A MAP OR BLOCK DIAGRAM AS APPROPRIATE. SHOW LOCATIONS OF ANY GAPS, BANDWIDTH AND LATENCY CONSTRAINTS, PROTOCOLS AND AVAILABLE ALTERNATIVES.) Orange County Traffic Engineering network consists of an EX-8200 router located at the TMC. That router is connected to a series of Juniper EX 4200 switches over 10 gigabit fiber links. The switches have gigabit fiber links that connect the traffic signal controllers to the system. Orange County does not see any issues or bandwidth constraints.



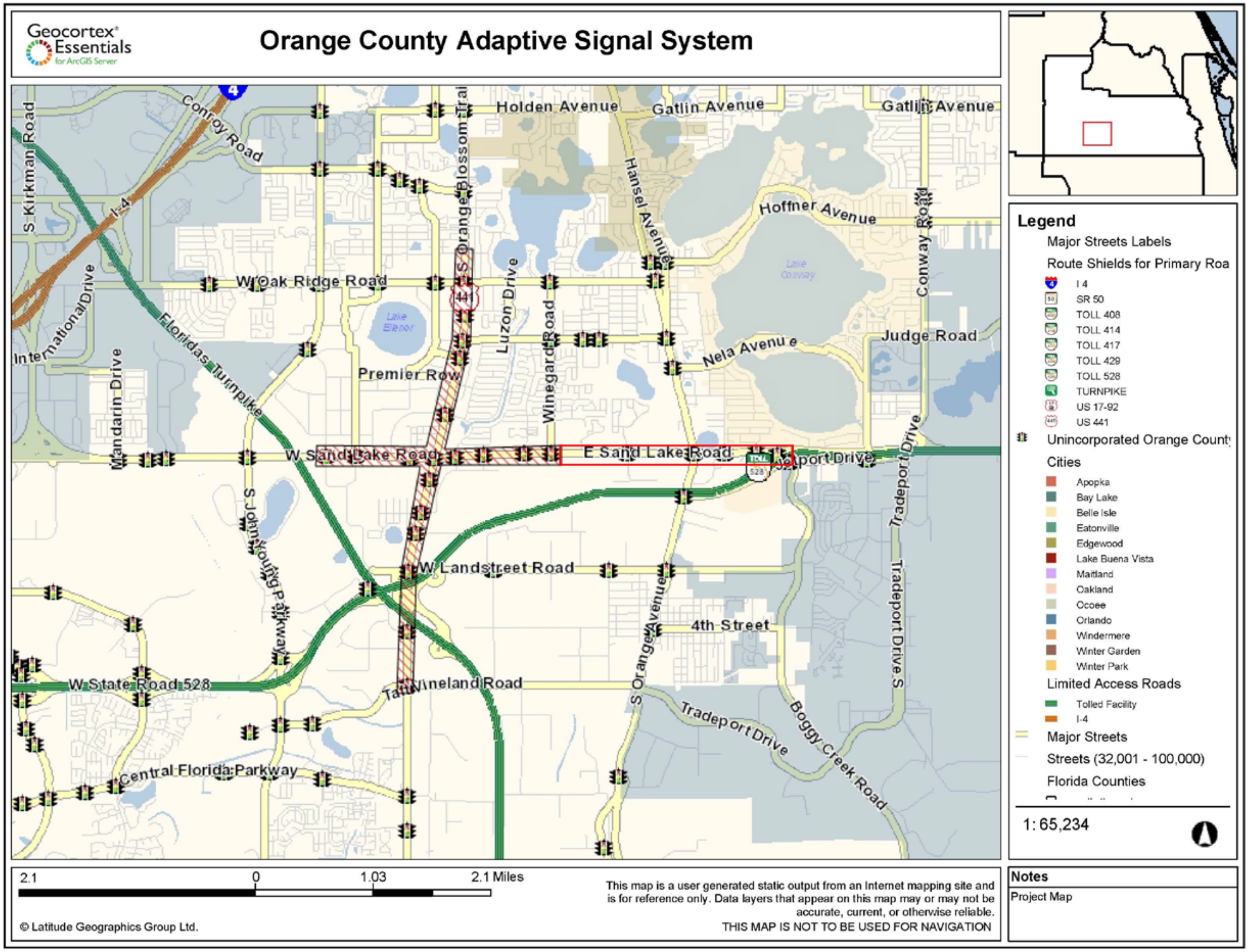
7.3.0-3	The adaptive system will operate within the Florida Statewide and Regional ITS Architectures, as well as the Final FDOT District 5 Regional ITS Architecture, as referenced in Chapter 2.
~~7.4~~	~~7.4 Utilities~~
~~7.4.0-1~~	~~The operations group is responsible for the utilities of the ASCT.~~
7.5	7.5 Equipment
7.5.0-2	Vehicles will be the responsibility of the operating group.

7.6	7.6 Computing hardware
7.6.0-2	Orange County is responsible for maintenance and repair of the computing equipment.
7.6.0-3	Orange County 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	Orange County is responsible for keeping software licenses current.
7.8	7.8 Personnel
7.8.0-1	Two existing operators will be available for routine operations.
7.8.0-2	Operators will be available during Mondays through Fridays 6:30 AM - 6:30 PM.
7.9	7.9 Operating procedures
7.9.0-1	TMC staff will be responsible for onsite backing up and storage of databases.
7.11	7.11 Disposal
7.11.0-1	If material and/or equipment will need to be disposed of during the life of the project, disposal will occur through Orange County standard operating procedures.
7.11.0-2	If system components will be disposed of at the end of their useful life, disposal will occur through Orange County standard operating procedures.
8	8 Chapter 8: Operational Scenarios
8.1	8.1 Overview 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.)
8.1	• Typical heavy congested conditions
8.1	• Demand affecting event
8.1	• Fault conditions (communications, detection, adaptive processor)
8.1	• Signal priority and preemption
8.1	• Pedestrians
8.1	• Installation (For each scenario, describe the following elements:
8.1	• Network
8.1	• Coordination and timing strategies
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	US 441 and SR 482 are arterial roads that pass through a major retail and industrial area. The arterials also provide access to tourist attractions to the west, SR 528 and the airport to the east, Florida Turnpike to the south, and I-4 to the north and west.

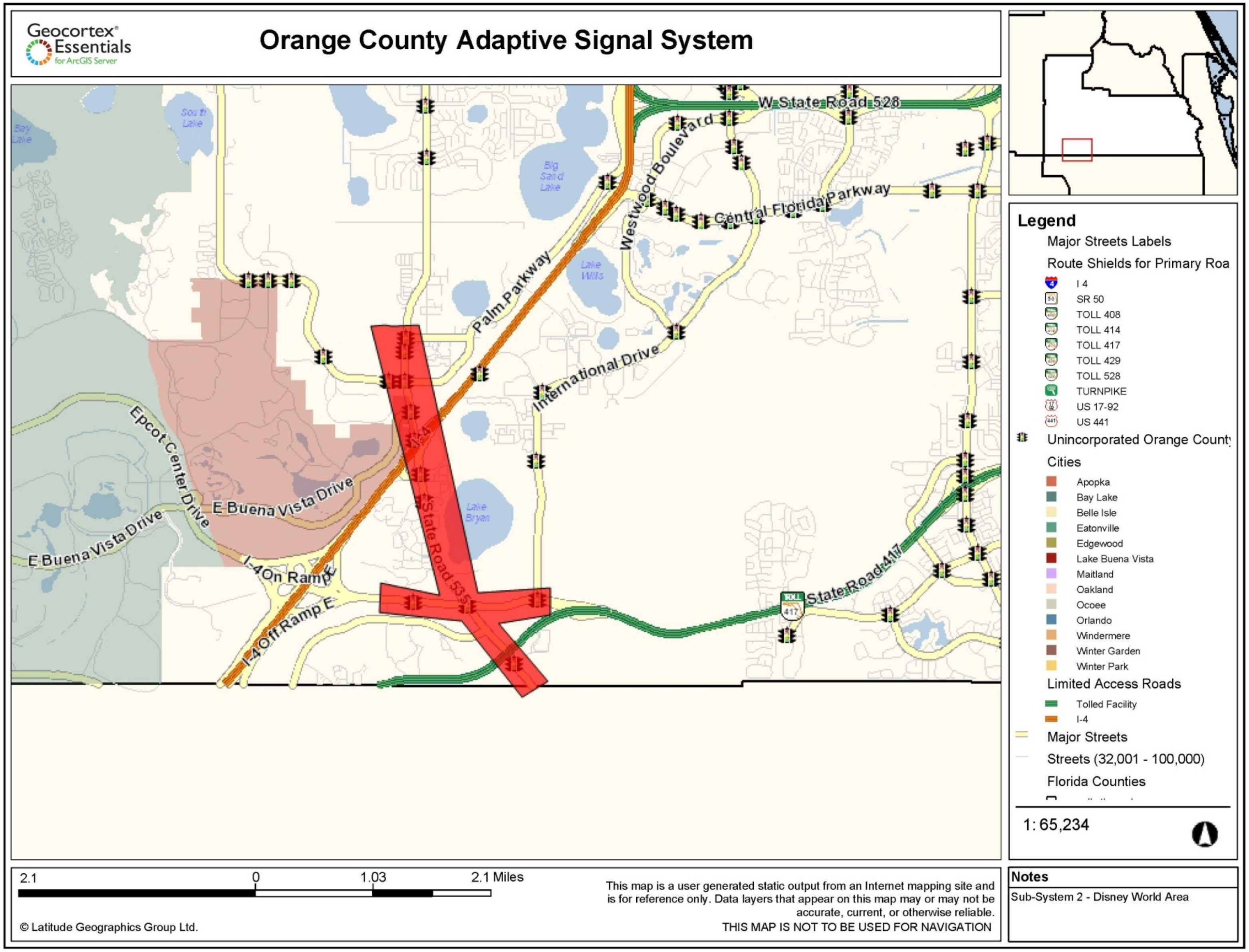
8.2.1.2	8.2.1.2 Traffic conditions
8.2.1.2.0-1	Traffic conditions vary during the weekday peaks. E.g., during the AM and midday Peak periods, traffic flows predominantly in the North Bound direction, then later in the PM peak period it becomes balanced, then in the evening it flows predominantly in the opposite South Bound direction.
8.2.1.3	8.2.1.3 Operational objectives
8.2.1.3.0-1	Orange County 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, Orange County seeks to avoid building queues on side streets, and seeks to minimize queue spill out into through lanes. In the morning peak, the operation is designed to provide through progression, and to maximize throughput at other intersections along US 441 and SR 482. During the afternoon peak, the operation is designed to control queue buildup on the northbound and southbound US 441 and eastbound and westbound SR 482. The operational objectives under these conditions are to:
8.2.1.3.0-1	• Accommodate the traffic at all intersections with a minimum of phase failures
8.2.1.3.0-1	• Provide smooth flow along the arterial road.
8.2.1.4	8.2.1.4 Coordination and signal timing strategies
8.2.1.4.0-1	• At the critical intersection(s), select phase sequence that eliminates queue overflow in left turn bays
8.2.1.4.0-1	• At each intersection, select phase times that eliminate phase failures
8.2.1.4.0-1	• At the other arterial road intersections, provide sufficient time to serve all turning and side street traffic without phase failures
8.2.1.4.0-1	• 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	The adaptive 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 seek to balance green time utilization when side-street demand is important, such as during the noon and weekend peaks. The adaptive system will seek to minimize residual queuing at congested locations. The adaptive system will prevent residual queue buildup on the side streets. 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.
~~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~~	~~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. Broadway is classified by the MPO as an arterial road of regional significance.~~
~~8.2.2.3~~	~~8.2.2.3 Operational objectives~~

~~8.2.2.3.0-1~~	~~• Maximize the throughput along Sand Lake Rd and Orange Blossom Trail;~~
~~8.2.2.3.0-1~~	~~• Accommodate the traffic at the critical intersection with a minimum of phase failures; and~~
~~8.2.2.3.0-1~~	~~• Provide smooth flow along the arterial through other intersections.~~
~~8.2.2.4~~	~~8.2.2.4 Coordination and signal timing strategies~~
~~8.2.2.4.0-1~~	~~• At the critical intersection, select phase times that eliminate phase failures~~
~~8.2.2.4.0-1~~	~~• At the critical intersection, select phase sequence that eliminates queue overflow in left turn bays~~
~~8.2.2.4.0-1~~	~~• At the critical intersection, select phase times that eliminate queue overflow in left turn bays~~
~~8.2.2.4.0-1~~	~~• At the critical intersection, distribute green time to maximize the throughput on Sand Lake Rd and Orange Blossom Trail~~
~~8.2.2.4.0-1~~	~~• At the non-critical intersections, provide sufficient time to serve all turning and side street traffic without phase failures~~
8.2.3	8.2.3 Example: Arterial with several critical intersections
8.2.3.2	8.2.3.2 Traffic conditions
8.2.3.2.0-1	At times when traffic conditions are very heavy, several key intersections become critical. 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 US 441 in both directions. In these conditions, US 441 carries higher volumes than the crossing arterials.
8.2.3.3	8.2.3.3 Operational objectives
8.2.3.3.0-1	The operational objectives for this arterial under these conditions are to:
8.2.3.3.0-1	• Maximize the throughput along Sand Lake Rd and Orange Blossom Trail;
8.2.3.3.0-1	• Accommodate the traffic at the critical intersection with a minimum of phase; and
8.2.3.3.0-1	• 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	• Determine the critical intersection
8.2.3.4.0-1	• At the critical intersection, select phase times that eliminate phase failures
8.2.3.4.0-1	• At the critical intersection, select phase sequence that eliminates queue overflow in left turn bays
8.2.3.4.0-1	• At the critical intersection, distribute green time to maximize the throughput on arterials.
8.2.3.4.0-1	• At the non-critical intersections, provide sufficient time to serve all turning and side street traffic without phase failures
8.2.3.4.0-1	• 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	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.

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	US 441 (Orange Blossom Tl) is an arterial road with 14 signalized intersections. Cross Street SR 482 (Sand Lake Rd) is also an arterial road with 13 signalized intersections and it crosses US 441, as illustrated below. SR 535 (Apopka Vineland Rd) is an arterial road with 9 signalized intersections. Cross Street SR SR 536 (World Center Dr) is also an arterial road with two signalized intersections and it crosses SR 535, as illustrated below. Ar



Sub-system 1 – Florida Mall



8.2.4.2	8.2.4.2 Traffic conditions

8.2.4.2.0-1	During heavy traffic conditions (such as midday and PM peak) US 441/SR 482 intersection is the critical intersection, and queues develop on all approaches. Typically the northbound direction on US 441 is significantly heavier than the southbound during the AM and midday peak periods. The eastbound and westbound traffic on SR 482 are balanced throughout the day. Traffic on SR 535 and SR 536 fluctuates significantly by time of day, day of week, or month of year.
8.2.4.3	8.2.4.3 Operational objectives
8.2.4.3.0-1	• Maximize the throughput along US 441 and SR 482
8.2.4.3.0-1	• Maximize the throughput along SR 535 and SR 536
8.2.4.3.0-1	• Accommodate the traffic at the critical intersection with a minimum of phase failures; and
8.2.4.3.0-1	• Provide smooth flow along the arterials through other intersections.
8.2.4.4	8.2.4.4 Coordination and signal timing strategies
8.2.4.4.0-1	The signal timing strategies used by the system to accommodate this situation are:
8.2.4.4.0-1	• At the critical intersection, select phase times that eliminate phase failures
8.2.4.4.0-1	• At the critical intersection, select phase sequence that eliminates queue overflow in left turn bays
8.2.4.4.0-1	• At the non-critical intersections on both arterials, provide sufficient time to serve all turning and side street traffic without phase failures
8.2.4.4.0-1	• 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.
8.8	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
8.8.2.0-1	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.
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.
8.11	8.11 Pedestrians
8.11.0-1	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.~~ ~~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).~~ 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 completed before the time the phase would normally end.