| Con Ops Reference Number | Concept of Operations  USH 14 / STH 26 ADAPTIVE SIGNAL CONTROL SYSTEM  Janesville, WI |
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| 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 on USH 14 from USH 51 to Wright Road and on STH 26 from USH 14 to Kettering Street in Janesville, WI. The ASCT system should support future expansion up to 25 signals, including potential expansion outside these limits. A location map is in Figure 1. |
| 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. |
| 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 accommodate variable traffic flows due to diversion from IH 39, maximize throughput when an incident on IH 39 causes major diversions to the system, provide flexibility during construction when intersection reconfiguration, relocation, or closures change the operational needs of the corridor, and improve existing and future traffic flow at all other times. |
| 1.2-3 | This project will add adaptive capabilities to the existing signal system. |
| 1.2-5 | All the capabilities of the existing coordinated system will be maintained. |
| 1.2-7 | Adaptive capability will be provided for all coordinated signals identified in Figure 1 as being part of the ASCT system. |
| 1.2-8 | The adaptive capability will be provided for signals currently operated by the City of Janesville and WisDOT. WisDOT will operate and maintain all signals that are part of the ASCT system. The City of Janesville will maintain ownership and pay electric costs for current city-owned signals that are part of the proposed ASCT system. WisDOT will maintain ownership and pay electric costs for current WisDOT-owned signals and new temporary and permanent signals (installed as part of the IH 39 improvement project) that are part of the proposed ASCT system. |
| 1.2.10 | Operational responsibilities and communications access descriptions are in Figure 2. |
| 1.2-10 | The adaptive system will be integrated with the Statewide Traffic Operations Center |
| 1.3 | 1.3 Procurement |
| 1.3.0-1 | The ASCT system will be procured using a competitive, best value procurement process based on responses to a request for proposals. Award will be issued to multiple vendors which will then be individually selected on an on-call basis for ASCT projects throughout the state. For the USH 14 / STH 26 corridor, the selected system will be the one that provides the best value, subject to financial and schedule constraints and requirements documented herein. |
| 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 | References Specific to the Adaptive Locations   * Model Systems Engineering Documents for Adaptive Signal Control Technology (ASCT) Systems * WisDOT Traffic Signal Design Manual (TSDM) * IH 39 Alternate Routes Analysis * USH 14 Traffic Signal Interconnect Study (KL Engineering) * Various traffic signal plans and traffic signal timing plans provided by the City of Janesville and WisDOT |
| 2.0-1.0-3 | Adaptive Signals  \* NCHRP Synthesis 403: "Adaptive Traffic Control Systems: Domestic and Foreign State of Practice" (<http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_syn_403.pdf>) |
| 2.0-1.0-4 | ITS, Operations, Architecture, Other   * Wisconsin Statewide ITS Architecture Website (http://www.topslab.wisc.edu/its/architecture/scope.htm) |
| **2.0-1.0-5** | **NTCIP**   * **List applicable NTCIP standards**   **ADD MORE COMPLETE LIST HERE SO USERS CAN PICK AND CHOOSE.** |
| 2.0-1.0-6 | NEMA   * Traffic signal cabinets in this corridor are NEMA TS-1 and proposed NEMA TS2 cabinet(s) |
| 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 arterial has 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. |
| 3.1.1.4 | 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. |
| 3.1.1.5 | 3.1.1.5 Jurisdictions |
| 3.1.1.5.0-1 | The signals are owned and/or operated and/or maintained by several separate agencies. WisDOT owns/operates/maintains the traffic signals at USH 14 & USH 51, the two ramp terminals at the IH 39 & USH 14 interchange, and the proposed signal at Newville Road. The City of Janesville currently owns/operates/maintains all other signals in the proposed ASCT system. WisDOT will take over operations and maintenance of all Janesville signals in the ASCT system during construction of IH 39. The City of Janesville will retain ownership of the signals and pay utility power costs.  All funding for signal improvements, ASCT implementation, signal and ASCT operations, signal and ASCT maintenance, and other work related to the ASCT system will be funded through the IH 39 project.  Before the end of the IH 39 construction that requires the use of the ASCT system, WisDOT, in coordination with the City of Janesville, will complete an evaluation to determine the future of the ASCT system. Based on the current project construction schedule, this evaluation would occur in 2019. |
| 3.1.2 | 3.1.2 Traffic Characteristics |
| 3.1.2.1 | 3.1.2.1 Overview |
| 3.1.2.1.0-1 | The traffic characteristics are quite directional during the AM peak and fairly balanced during the mid-day and PM peak.  The Surrounding areas have commercial and retail land use, including several big box stores. This results in mid-day and weekend traffic peaks and variable trip origins and destinations.  New coordinated signal timing plans have been prepared for USH 14 but haven’t been implemented as of February, 2013.  A railroad crossing at the Kennedy Road intersection passes through the intersection diagonally, shutting down all directions of traffic for 12 to 15 minutes. |
| 3.1.2.2 | 3.1.2.2 Peak Periods |
| 3.1.2.2.0-1 | There is a heavily directional AM commuter peak. During the AM peak, traffic is heavily directional in the westbound direction on USH 14 and heavily directional in the southbound direction on STH 26. The peak hour volume on USH 14 in the westbound direction is 650, while the peak hour volume in the eastbound direction is 500. The peak hour volume on STH 26 in the northbound direction is 650, while the peak hour volume in the southbound direction is 950. |
| 3.1.2.2.0-2 | Traffic is balanced during the PM commuter peak. During the PM peak, the volumes in the two directions are similar, with 900 vehicles per hour in both the eastbound and westbound direction on USH 14, and 1,250 vehicles per hour in the southbound direction and 1,200 vehicles per hour in the northbound direction on STH 26. |
| 3.1.2.3 | 3.1.2.3 Business Hours |
| 3.1.2.3.0-2 | Business hours volumes in the two directions are balanced between the peaks. |
| 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 light. During holiday shopping periods, evening flows are elevated. |
| 3.1.2.5 | 3.1.2.5 Weekends |
| 3.1.2.5.0-1 | During the weekends, the flows are oriented toward retail establishments. Flows are variable, and sometimes heavy, depending on season, retail events, etc. |
| 3.1.2.6 | 3.1.2.6 Events and Incidents |
| 3.1.2.6.0-2 | Heavily directional incident-related traffic is experienced in this area when an incident occurs on IH 39. |
| 3.1.2.7 | 3.1.2.7 General |
| 3.1.2.7.0-2 | At most intersections there is a high proportion of turning traffic. |
| 3.1.2.7.0-6 | There are significant turning movements onto and off the coordinated route. |
| 3.1.2.7.0-7 | Traffic conditions change quickly when an incident occurs on IH 39. |
| 3.1.2.8 | 3.1.2.8 Future Traffic Conditions |
| 3.1.2.8.0-1 | IH 39 is being reconstructed near the USH 14/STH 26 corridor. During construction, it’s expected that there will be an increase in traffic through the corridor due to diversion from IH 39. There may occasionally be a large traffic diversion from IH 39 to the corridor when an incident occurs on IH 39. There will be intersections within the corridor that may be relocated, reconfigured, or closed at some point during construction. New signalized intersections will be added to the system during construction. Existing signalized intersections may have changes in volumes, phasing, and location. Temporary signals will be present at some existing or newly signalized intersections. Some signalized intersections may be temporarily unsignalized when ramps or intersection approaches are closed. |
| 3.1.3 | 3.1.3 Signal Grouping |
| 3.1.3.0-1 | The locations of signals to be operated under adaptive control are shown in figure 1. |
| 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. |
| 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.... |
| 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, several big box stores, fast food restaurants). |
| 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 two freeway interchanges. |
| 3.1.4.3 | 3.1.4.3 Pedestrians and Public Transit |
| 3.1.4.3.0-1.0-5 | Pedestrian phases are infrequently 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 2 bus lines operating along the route (or within the network). The buses operate at a frequency of twice per hour all day. |
| 3.1.4.3.0-2.0-2 | The system map for these routes is in figure 3. |
| 3.1.4.4 | 3.1.4.4 Agencies |
| 3.1.4.4.0-1 | The existing signal system on STH 26 is operated by the City of Janesville. There is a proposed signal system on USH 14 that hasn’t yet been activated. More information on the proposed USH 14 signal system is in KL Engineering’s USH 14 Traffic Signal Interconnect Study. The existing signals at USH 14 & USH 51, and USH 14 & IH 39 ramps belong to WisDOT. The WisDOT-operated signals are not part of a 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 1. |
| 3.1.4.5.0-1.0-1 | Signals in the existing STH 26 system has dial-up communications via MARC or TACTICS software. |
| 3.1.4.5.0-1.0-2 | The master controller for the STH 26 system is at the STH 26 & Kennedy Rd. intersection. The USH 14 & Deerfield Drive and Deerfield Drive & Lucey Street intersections are in a two-signal system with the master controller at the USH 14 & Deerfield Drive intersection. |
| 3.1.4.5.0-1.0-3 | Communications infrastructure is twisted wire pair cable for the existing STH 26 system and the proposed non-adaptive USH 14 system. |
| 3.1.4.5.0-1.0-4 | All proposed ASCT intersections on USH 14 and STH 26 have the same general detector configuration. They all have advanced detection, but no stop bar detection on the main road. All detection is via inductive loop detectors. |
| 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. |
| 3.2.0-4 | The coordinated signal operation is often disrupted by rail preemption or emergency vehicle preemption at individual signals. An adaptive system may be expected to recover from these disruptions more quickly than the existing system. |
| 3.2.0-5 | The existing system cannot detect unexpected changes in traffic demand as a result of incidents on the adjacent 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. |
| 3.2.0-7 | A traditional coordinated system would require frequent re-timings during IH 39 construction, given the addition, deletion, and moving of signal locations during different construction stages. |
| 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: |
| 3.3.0-2 | * Recognize changes in traffic conditions and react quickly and automatically to accommodate those changes. |
| 3.3.0-3 | * 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 | * More quickly recover from preemption. |
| 3.3.0-9 | * Efficiently accommodate the addition, deletion, and moving of signalized intersections during IH 39 construction. |
| 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 adaptive traffic control system that responds to changing traffic conditions, and reduces delays and corridor travel times, while balancing multimodal transportation needs. |
| 3.4.2 | 3.4.2 Goals |
| 3.4.2-1 | The goals of the ASCT system are: |
| 3.4.2-1.0-1 | * Support vehicle, pedestrian and transit traffic mobility. |
| 3.4.2-1.0-3 | * Support interoperability between agencies |
| 3.4.2-1.0-4 | Facilitate traffic flow on alternate routes during periods of diversion from IH 39. |
| 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: |
| 3.4.3.0-1.0-1 | To support vehicle, pedestrian and transit traffic mobility:   * Allow effective use of all controller features currently in use or proposed to be used * Minimize adverse effects caused by preemption and unexpected events |
| 3.4.3.0-1.0-3 | To support agency interoperability:   * Provide facilities for data exchange and control between systems * Allow remote monitoring and control * Adhere to applicable traffic signal and ITS design standards |
| 3.4.3.0-1.0-4 | To support regional systems:   * 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 |
| 3.4.4 | 3.4.4 Operational Objectives |
| 3.4.4.0-1 | The operational objectives of the ASCT system will be to: |
| 3.4.4.0-1.0-1 | Smooth the flow of traffic along coordinated routes during normal operations |
| 3.4.4.0-1.0-2 | Maximize the throughput of traffic along coordinated routes during diversion events from IH 39. |
| 3.4.4.0-1.0-3 | Equitably serve adjacent land uses during off peak and weekend hours |
| 3.4.4.0-1.0-6 | Control operation by changing the objectives under various circumstances |
| 3.4.4.0-1.0-7 | For the USH 14 & USH 51 intersection, maximize intersection efficiency. |
| 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: |
| 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; |
| 3.5.0-1.0-4 | Manage queues so they do not exceed the available storage capacity and are located so they do not affect the capacity of other movements at closely spaced intersections. Manage queues to avoid spillback onto IH 39. |
| 3.5.0-1.0-5 | Manage the distribution of green times for vehicles and pedestrians in an equitable manner during off peak and weekend periods |
| 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 |
| 3.6.1.0-2 | Could TRPS operation be used? TRPS will not be effective in handling all traffic scenarios presented in the Future Traffic Conditions Section. Installation of a TRPS system would require signal cabinet upgrades, software upgrades, additional traffic detection, and frequent signal re-timings. |
| 3.6.1.0-3 | How successful would TRPS be if it were used. TRPS would improve operations during typical peak periods when the fluctuations are fairly small and predictable. However, TRPS would not react quickly enough to a surge of traffic that results from freeway diversion. TRPS would also have to be recalibrated every time a traffic signal was modified, removed, or added during construction. |
| 3.6.2 | 3.6.2 Complex Coordination Features |
| 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.   * Multiple (repeat) phases or phase reservice: This would improve operations during typical peak periods when the fluctuations are fairly small and predictable. However, it would not have a major benefit for surges of through traffic that results from freeway diversion. * Variable phase sequence: This would improve operations during typical peak periods when the fluctuations are fairly small and predictable. However, it would not have a major benefit for surges of through traffic that results from freeway diversion. * Omit phase under some circumstances: This would improve operations during diversion events, especially if phases can be omitted to maximize throughput. However, like TRPS, this advanced feature may be too slow to respond. * Detector switching: This would improve operations during typical peak periods when the fluctuations are fairly small and predictable. However, it would not have a major benefit for surges of through traffic that results from freeway diversion. * Coordinate different phases at different times: This would improve operations during typical peak periods when the fluctuations are fairly small and predictable. However, it would not have a major benefit for surges of through traffic that results from freeway diversion. * Coordinate turning movement phases: Turning movements are not the major movements at any of the intersections. * Coordinate beginning or end of green: This would improve operations during typical peak periods when the fluctuations are fairly small and predictable. However, it would not have a major benefit for surges of through traffic that results from freeway diversion. * Early release of hold: This would improve operations during typical peak periods when the fluctuations are fairly small and predictable. However, it would not have a major benefit for surges of through traffic that results from freeway diversion. * Hold the position of uncoordinated phases: This would improve operations during typical peak periods when the fluctuations are fairly small and predictable. However, it would not have a major benefit for surges of through traffic that results from freeway diversion. * Late phase introduction: The intersections within the proposed ASCT system do not have high pedestrian volumes. * Stop-in-walk: This would improve operations during typical peak periods when the fluctuations are fairly small and predictable. However, it would not have a major benefit for surges of through traffic that results from freeway diversion. * Dynamic max: This would improve operations during typical peak periods when the fluctuations are fairly small and predictable. However, it would not have a major benefit for surges of through traffic that results from freeway diversion. * Double cycle or half cycle: This would improve operations during typical peak periods when the fluctuations are fairly small and predictable. However, it would not have a major benefit for surges of through traffic that results from freeway diversion. |

| Con Ops Reference Number | Concept of Operations Sample Statements | System Requirements  (Tailor as required - See Guidance) | Guidance Section |
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| 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: |  | 3.4  3.5 |
| 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  When the coordinated phase associated with the IH 39 diversion route experiences cycle failure at the following locations on two consecutive cycles, the ASCT shall alter the state of the signal controllers, maximizing the throughput of the coordinated route:   1. STH 26 interchange ramp terminals 2. USH 14 interchange ramp terminals 3. USH 14 & USH 51 intersection   USH 14 & Wright Road intersection  2.1.1.0-7.0-2(1)  When queue spillback is detected from one signalized intersection to an adjacent signalized intersection on the mainline (STH 26 or USH 14), the ASCT shall alter the state of signal controllers, preventing queues from exceeding the storage capacity between signalized intersections.  2.1.1.0-7.0-2(2)  When a railroad preemption occurs, the ASCT shall alter the state of signal controllers, preventing queues from exceeding the storage capacity between the railroad crossing and the adjacent signalized intersection.  2.1.1.0-7.0-4  Under normal traffic conditions, the ASCT shall alter the state of signal controllers providing two-way progression on a coordinated route.  2.1.1.0-7  The ASCT shall alter the adaptive operation to achieve required objectives in user-specified conditions. | 3.4  3.5 |
| 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 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. | 2.1.3.0-2  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 on every lane of every approach at every signalized intersection. The ASCT shall detect queues that spillback from signalized intersections to adjacent signalized intersections and queues that exceed storage capacity of left turn lanes.  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.)  2.1.1.0-9.0-1  The ASCT shall alter operations, to minimize repeated phase failures.  2.1.3.0-3  When queues are detected that spill back from a signalized intersection to an adjacent signalized intersection, the ASCT shall execute the “maximize throughput” adaptive operation strategy.  2.1.3.0-4  When queues are detected that spill back from a signalized intersection to an adjacent signalized intersection, queues in the opposing left turn lane do not exceed the left turn storage capacity, and the left turn phasing is protected/permitted, the ASCT shall omit the associated protected left turn phase. | 3.4  3.5 |
| 4.1.0-5 | The system operator needs to minimize the chance that a queue forms at a specified location. | 2.3.0-5  (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  (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.  2.2.0-5.0-5  (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. | 3.4  3.5 |
| 4.1.0-7 | 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. | 2.1.2.0-12  The ASCT shall not alter the order of phases at the STH 26 interchange ramp signals or the USH 14 interchange ramp signals. | 3.4  3.5 |
| 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.  2.1.1.0-11.0-2  The ASCT shall determine the coordinated route based on traffic conditions. | 3.4  3.5 |
| 4.2 | 4.2 Network characteristics |  | 4.1 |
| 4.2.0-1 | The system operator needs to eventually adaptively control up to 25 signals, with the ability to communicate via Ethernet communications | 1.0-1  The ASCT shall control a minimum of 25 signals concurrently | 4.1 |
| 4.2.0-2 | The system operator needs to be able to adaptively control a minimum of 4 independent groups of signals | 1.0-2  The ASCT shall support groups of signals.  1.0-2.0-2  The ASCT shall control a minimum of 4 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. | 4.1 |
| 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 1 to 25 signals.  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 the following traffic conditions:   1. Under normal operations, signals on USH 14 between Newville Road and Wright Road will operate in a coordinated fashion and signals on STH 26 between USH 14 and Kettering Street will operate in a coordinated fashion. 2. When the IH 39 alternate route follow USH 14 from south of the system to USH 51, signals on USH 14 between USH 51 and Wright Road will operate in a coordinated fashion. Signals on STH 26 will operate the same as scenario 1. 3. When the IH 39 alternate route follows USH 14 from IH 39 to USH 51, signals on USH 14 from IH 39 to USH 51 will operate in a coordinated fashion. Signals on STH 26 will operate the same as scenario 1.   When the USH 14 or STH 26 interchanges have ramp closures, pushing additional traffic onto USH 14 or STH 26, signals on USH 14 between IH 39 and STH 26 and signals on STH 26 between USH 14 and IH 39 will operate as one coordinated system.  The ASCT shall be capable of accepting changes to these scenarios and capable of handling the addition of scenarios. | 4.1 |
| 4.3 | 4.3 Coordination across boundaries |  | 4.2  4.3 |
| 4.3.0-1 | The system operator needs to adaptively control signals owned and operated by multiple agencies. | 3.0-1  The ASCT system shall be capable of integrating Siemens and\or Econolite traffic signal systems. | 4.2  4.3 |
| 4.3.0-3 | The system operator needs to adaptively coordinate signals on two crossing routes simultaneously. | 4.0-1.0-4  The ASCT shall support adaptive coordination on crossing routes. | 4.2  4.3 |
| 4.4 | 4.4 Security |  | 4.3.4 |
| 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. | 5.0-1  The ASCT shall be implemented with a security policy that addresses the following selected 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 prescribed by WisDOT IT Enterprise Support. | 4.3.4 |
| 4.5 | 4.5 Queuing interactions |  | 4.4 |
| 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 on every lane of every approach at every signalized intersection. The ASCT shall detect queues that spillback from signalized intersections to adjacent signalized intersections and queues that exceed storage capacity of left turn lanes..  2.1.3.0-3  When queues are detected that spill back from a signalized intersection to an adjacent signalized intersection, the ASCT shall execute the “maximize throughput” adaptive operation strategy. | 4.4 |
| 4.6 | 4.6 Pedestrians |  | 4.5 |
|  |  |  | 4.5 |
| 4.6.0-2 | The system operator needs to accommodate infrequent pedestrian operation while maintaining adaptive operation. | 8.0-2  When a pedestrian phase is called, the ASCT shall accommodate pedestrian crossing times during adaptive operations. | 4.5 |
| 4.7 | 4.7 Non-adaptive situations |  | 4.6 |
| 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. | 4.6 |
| 4.8 | 4.8 System responsiveness |  | 4.7 |
| 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 20% of the cycle length.  2.6.0-3  The ASCT shall limit the changes in the direction of primary coordination to no more than four times per hour. |  |
| 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 no more than four times per hour. |  |
| 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 allow changes in the length of consecutive cycle length of up to 50% of the cycle length. | 4.7 |
| 4.9 | 4.9 Complex coordination and controller features |  | 4.8 |
| 4.9.0-1 | The system operator needs to implement the following advanced controller features while maintaining adaptive operation: |  | 4.8 |
| 4.9.0-1.0-1 | 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. | 4.8 |
| 4.9.0-1.0-4 | * Permit different phase sequences under different traffic conditions | 7.0-6.0-4  The ASCT shall dynamically choose the best phase to serve based on measured traffic conditions in real time. | 4.8 |
| 4.9.0-1.0-5 | * Allow one or more phases to be omitted under certain traffic conditions or signal states. | 2.1.2.0-7  The ASCT shall omit protected left turn phases at signals with protected/permitted left turn phasing if cycle failure is detected for the opposing through movement in two consecutive phases and queues in the left turn lane do not exceed the left turn storage capacity.  2.1.2.0-8  The ASCT shall omit a user-specified phase during railroad preemption and recovery from railroad preemption. | 4.8 |
| 4.9.0-1.0-10 | * Allow the operator to specify which phase receives unused time from a preceding phase | 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:   * next phase; * next coordinated phase; * user-specified phase.   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:   * previous phase; * next phase; * next coordinated phase; * user-specified phase. | 4.8 |
| 4.9.0-1.0-12 | * Allow the coordinated phase to terminate early under prescribed traffic conditions | 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. | 4.8 |
| 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 ASCT shall begin a non-coordinated phase later than its normal starting point within the cycle when all of the following conditions exist:   * 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 | 4.8 |
| 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.  2.1.2.0-2  The ASCT shall not prevent the protected left turn phase to lead or lag the opposing through phase at any time. | 4.8 |
| 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. | 4.8 |
| 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. | 4.8 |
| 4.10 | 4.10 Monitoring and control |  | 4.9 |
| 4.10.0-1 | The system operator needs to monitor and control all required features of adaptive operation from the following locations: | 5.0-2  The ASCT shall provide monitoring and control access at the following locations: | 4.9 |
| 4.10.0-1.0-1 | Monitor and Control:   * WisDOT SW Region Office   Monitor Only:   * Statewide Traffic Operations Center * IH 39 Field Office * City of Janesville | 5.0-2.0-1  Monitor and Control:   * WisDOT SW Region Office   Monitor Only:   * Statewide Traffic Operations Center * IH 39 Field Office * City of Janesville | 4.9 |
| 4.10.0-1.0-5 | * Local controller cabinets | 5.0-2.0-5   * Local controller cabinets | 4.9 |
| 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. | 4.9 |
| 4.11 | 4.11 Performance reporting |  | 4.10 |
| 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 90 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 90 days:   * volume * occupancy * queue information * phase utilization * arrivals in green * green band efficiency   6.0-12  The ASCT shall store the following data in 15 minute increments:   * volume * occupancy * queue information   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  The ASCT shall maintain a log of all signal state alterations directed by the ASCT. | 4.10 |
| 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 90 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 90 days:   * volume * occupancy * queue information * phase utilization * arrivals in green * green band efficiency   6.0-12  The ASCT shall store the following data in 15 minute increments:   * volume * occupancy * queue information | 4.10 |
| 4.11.0-4 | The system operator must be capable of storing all operational data and signal timing parameters calculated by the adaptive system, and export selected data to the system server. | 6.0-2  The ASCT shall export its systems log in the following formats:   * CSV   6.0-3  The ASCT shall store the event log for a minimum of 90days  6.0-6  The ASCT system shall archive all data automatically after a user-specified period not less than 90 days.  6.0-7  The ASCT shall provide data storage for a system size of 25 signal controllers. The data to be stored shall include the following:   * Controller state data * Reports * Log data * Security data * ASCT parameters * Detector status data   6.0-10  The ASCT shall store data logs in a standard database . | 4.10 |
| 4.11.0-5 | The system operator needs to report performance data in real time to the Southwest Region via the ITSNet. | 3.0-1  The ASCT system shall be capable of integrating Siemens and\or Econolite traffic signal systems.  3.0-1.0-1  The ASCT shall send operational data to the Southwest Region via the ITSNet  3.0-1.0-5  The ASCT shall send performance data to the Southwest Region via the ITSNet | 4.10 |
| 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  The ASCT shall log 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  6.0-1.0-5  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 | 4.10 |
| 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 90 days:   * volume * occupancy * queue information * phase utilization * arrivals in green * green band efficiency   6.0-8  The ASCT shall calculate and report relative data quality including:   * The extent data is affected by detector faults * Other applicable items   6.0-9  The ASCT shall report comparisons of logged data when requested by the user:   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  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 90 days.  18.0-3.0-5  The ASCT shall archive the ASCT log in the following manner:   1. The ASCT log shall be archived before data is deleted from the system. 2. The ASCT log shall be archived every 90 days. 3. The ASCT log shall be in CSV format. 4. All ASCT log entries shall be time stamped with the date and time, accurate to the nearest second.   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. | 4.10 |
| 4.12 | 4.12 Failure notification |  | 4.11 |
| 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.  13.2-2  In the event of communications failure, the ASCT shall issue an alarm to user-specified recipients.  13.3-2  In the event of adaptive processor failure, the ASCT shall issue an alarm to the STOC. | 4.11 |
| 4.12.0-2 | The system operator needs to immediately and automatically pass alarms and alerts to the Statewide Traffic Operations Center (STOC). | 13.1.0-3  In the event of a detector failure, the ASCT shall issue an alarm to the STOC.  13.2-2  In the event of communications failure, the ASCT shall issue an alarm to the STOC.  13.3-2  In the event of adaptive processor failure, the ASCT shall issue an alarm to the STOC. | 4.11 |
| 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. | 4.11 |
| 4.13 | 4.13 Preemption and priority |  | 4.12 |
| 4.13.0-1 | The system operator needs to accommodate railroad preemption at the USH 14 & Kennedy Drive and USH 14 & Newville Road intersections. | 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 the following actions at non-preempted signal controllers during railroad preemption:   1. Omit phases 2. Dwell on certain phases 3. Activate blank-out signs   Activate fixed-message warning signs  11.0-6  The ASCT shall operate normally at non-preempted signal controllers when special functions are engaged by a preemption event.  11.0-8  The ASCT shall not prevent the local signal controller from operating in normally detected limited-service actuated mode during preemption. | 4.12 |
| 4.13.0-2 | The system operator needs to accommodate emergency vehicle 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.  11.0-6  The ASCT shall operate normally at non-preempted signal controllers when special functions are engaged by a preemption event  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. | 4.12 |
| 4.14 | 4.14 Failure and fallback |  | 4.13 |
| 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. | 13.2-1  The ASCT shall execute user-specified actions when communications to one or more signal controllers fails within a group. (SELECT THE APPROPRIATE ACTION)  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.  13.3-1  The ASCT shall execute user-specified actions when adaptive control fails:  2.1.1.0-2  The ASCT shall operate non-adaptively when adaptive control equipment fails.  2.1.1.0-2.0-1  The ASCT shall operate non-adaptively when a user-specified detector fails.  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.  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.  2.1.1.0-2.0-4  The ASCT shall operate non-adaptively when a user-defined communications link fails.  13.2-1.0-2  The ASCT shall switch to the alternate operation in real time without operator intervention.  13.3-1.0-2  The ASCT shall release control to local operations to operate under its own time-of-day schedule. | 4.13 |
| 4.15 | 4.15 Constraints |  | 4.14 |
| 4.15.0-1 | The system operator is constrained to use the following equipment: |  | 4.14 |
| 4.15.0-1.0-1 | * Controller type | 14.0-3  The ASCT shall fully satisfy all requirements when connected with Siemens EPAC and/or Econolite controllers. | 4.14 |
| 4.15.0-1.0-3 | * Communication system | Fiber optic, wireless, and radio communication systems with Ethernet connection. | 4.14 |
| 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:   * Windows-PC, | 4.14 |
| 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  The vendor shall provide the following training.  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 a WisDOT facility |  |
| 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 STOC shall provide maintenance via a separate maintenance contract managed by the STOC. 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 2 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 2 years. Preservation of requirements fulfillment especially includes all IT management requirements as previously identified. |  |
| 4.18 | 4.18 Maintenance |  |  |
| 4.18.0-1 | Each maintaining agency needs all applicable equipment to be readily accessible. |  |  |

| Con Ops Reference Number | Concept of Operations Sample Statements |
| --- | --- |
| 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 15 intersections, with potential future expansion up to 25 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. |
| 5.2 | 5.2 Operational objectives |
| 5.2.0-5 | The system, or the operator, will select the appropriate coordination objective, depending on the current traffic conditions:   1. The objective of the coordination will be to provide for smooth flow along the arterial road during normal operations, 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 different phase lengths are required to accommodate the demand. 2. The objective of the coordination will be to maximize the throughput along the coordinated route during periods of heavy diversion traffic from IH 39. 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. 3. The objective of the coordination will be to manage the lengths of queues stored at IH 39 ramp terminal intersections and closely spaced intersections 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. 4. At the isolated USH 51 & USH 14 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. |
| 5.2.0-6 | 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. |
| 5.2.0-7 | 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. |
| 5.2.0-10 | 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 |
| 5.3.0-2 | 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 coordination using historical parameters in the event of a loss of real-time data. |
| 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. |
| 5.5 | 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. |
| 5.5.0-3 | 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: |
| 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; |
| 5.6.0-1.0-3 | 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; |
| 5.6.0-1.0-5.0-1 | 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. |
| 5.6.0-3 | 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. |
| 6 | 6 Chapter 6: Adaptive Operational Environment |
| 6.0-1 | The system will be operated from the WisDOT SW Region Office and monitored from the STOC and IH 39 Field Office. |
| 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 WisDOT SW Region in an 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 WisDOT Bureau of Information Technology Systems (BITS)) 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. |
| 6.0-7 | 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. |
| 6.0-9 | Complaints or requests for changes in operation will be handled by WisDOT SW Region on an as-needed basis. |
| 6.0-11 | Maintenance of all field equipment will be performed by STOC maintenance contract staff. |
| 6.0-13 | Funding for maintenance of the adaptive system will come from the IH 39 Improvement Project. Additional funds will be required to accommodate the additional equipment installed for the adaptive system. |
| 6.0-14 | Additional communications equipment and potential annual fees will be incurred with the adaptive system. These costs will be covered by the IH 39 Improvement Project. |
| 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. |
| 6.0-19 | The agency will seek technical support from the vendor for assistance in using the adaptive software for 2 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. |
| 7 | 7 Chapter 7: Adaptive Support Environment |
| 7.1 | 7.1 Institutions and Stakeholders |
| 7.1.0-1 | Existing stakeholders of the traffic signal system include:   * WisDOT * City of Janesville * City of Janesville Fire Department * City of Janesville Police * Rock County Sheriff * Rock County Highway Department * Wisconsin State Patrol * Janesville Transit System * Wisconsin & Southern Railroad * Union Pacific Railroad |
| 7.1.0-2 | The stakeholders who will be affected by or have a direct interest in the adaptive system are: WisDOT and the City of Janesville. |
| 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 | ASCT Communications will be provided via the ITSNet to the WisDOT Statewide Traffic Operations Center in Milwaukee, the WisDOT SW Region Traffic Section, and the IH 39 Field Office (provided an ITSNet connection is made to the field office). The City of Janesville will be provided with “view only” access if requested. |
| 7.4 | 7.4 Utilities |
| 7.4.0-1 | Fiber optic, radio, or wireless communications will be installed to accommodate the installation of the ASCT. |
| 7.5 | 7.5 Equipment |
| 7.5.0-1 | No test equipment, outside of the equipment needed for ASCT operation, will be needed. |
| 7.6 | 7.6 Computing hardware |
| 7.6.0-1 | No computing equipment, outside of the equipment needed for ASCT operation, will be needed. WisDOT anticipates that it will have in its possession or will be easily be able to procure the following equipment which will be needed to interface with the system from a remote location and print reports:   * Computer CPU * Computer monitor * Mouse or track ball * Keyboard * Printer * Power, printer, and other associated cables. * System Server, if needed |
| 7.7 | 7.7 Software |
| 7.7.0-1 | WisDOT SW Region will be responsible for coordinating with the vendor to implement software updates. |
| 7.7.0-2 | WisDOT SW Region will be responsible for coordinating with the vendor for keeping software licenses current. |
| 7.7.0-3 | WisDOT SW Region will be responsible for controlling ASCT software. |
| 7.7.0-4 | The vendor shall update any equipment added to WisDOT’s network and shall do so only with adequate advanced notification and approval from WisDOT |
| 7.7.0-5 | The vendor shall be required to update all equipment and software with each product update and shall do so each and every time the vendor issues the update to any other outside agency or client. |
| 7.8 | 7.8 Personnel |
| 7.8.0-1 | WisDOT SW Region traffic operations personnel will be responsible for operation of the ASCT system. |
| 7.8.0-2 | WisDOT SW Region operators will be available during normal business hours. STOC staff will be available 24 hours a day, 7 days a week, to receive alarms and initiate alert response protocols. |
| 7.8.0-4 | Maintenance will be performed through STOC maintenance contracts. |
| 7.8.0-5 | WisDOT staff will require sufficiently thorough training to allow them to install, configure, monitor, operate and maintain all components of the ASCT system |
| 7.9 | 7.9 Operating procedures |
| 7.9.0-1 | WisDOT SW Region will be responsible for backing up databases. Database backups will be required once every 90 days. Backup data will be stored on an independent device. |
| 7.10 | 7.10 Maintenance |
| 7.10.0-1 | Traffic signal maintenance will be performed by the same WisDOT STOC ITS maintenance contractor that is maintaining the ITS facilities on IH 39 in the Janesville area. |
| 8 | 8 Chapter 8: Operational Scenarios |
| 8.1 | 8.1 Overview |
| 8.1.0-1 | 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:   * Moderate balanced flows * Light balanced flows * Demand affecting event * Fault conditions (communications, detection, adaptive processor) * Signal priority and preemption * Pedestrians * Installation   For each scenario, describe the following elements:   * Network * Traffic conditions * Operational objectives * Coordination and timing strategies * Summary of operations. |
| 8.4 | 8.4 Moderate balanced flows |
| 8.4.1 | 8.4.1 Arterial road with irregular spacing |
| 8.4.1.1 | 8.4.1.1 Road network |
| 8.4.1.1.0-1 | The section of USH 14 to be coordinated using ASCT has 11 signalized intersections. It is a four lane arterial road with a raised median and exclusive left turn lanes at each intersection. Most of the intersections provide access to commercial or residential areas. However, the STH 26 intersection and IH 39 interchange ramp terminals provide access to arterial roads that accommodate regional traffic rather than providing local access. There are nearby signals on STH 26 that require coordination with this critical intersection. The signals to the north on STH 26 will be in the adaptive system, while the signals to the south on STH 26 will be part of a separate TOD system. The USH 14 & STH 26 is an eight-phase intersection with protected-only left turns on all approaches. The IH 39 interchange ramp terminal intersections have protected-only left turn phasing. The other intersections have protected/permissive or permissive only left turns on the side streets. There is no regular spacing between the intersections and therefore no "resonant" cycle length.  Traffic signals at Pontiac Drive & Pontiac Place and Deerfield Drive & Lucey Street are closely spaced to intersections on USH 14. These intersections will not be coordinated with the USH 14 intersections.  The section of STH 26 to be coordinated using ASCT has 4 signalized intersections. STH 26 is a four lane arterial with a raised median and exclusive left turn lanes at each intersection. The two currently signalized intersections at Morse Road and Kettering Street provide access to commercial areas and have protected-only left turn phasing. Two intersections are interchange ramp terminal intersections for IH 39 that are not currently signalized, but will be signalized during IH 39 construction and when construction is complete.  USH 14, STH 26, and IH 39 are all functionally classified as arterial roads. |
| 8.4.1.2 | 8.4.1.2 Traffic conditions |
| 8.4.1.2.0-1 | During business hours, traffic is generally uncongested and the flows along USH 14 and STH 26 are similar in both directions. At lunch time 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. 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 sufficient capacity and prevent phase failures. |
| 8.4.1.3 | 8.4.1.3 Operational objectives |
| 8.4.1.3.0-1 | The operational objectives for this condition are to:   * Provide smooth flow along USH 14 and STH 26; and * Provide signal timing that prevents phase failures at all intersections. |
| 8.4.1.4 | 8.4.1.4 Coordination and signal timing strategies |
| 8.4.1.4.0-1 | The coordination approach for these conditions is to provide progression and maximize bandwidth while providing two-way coordination. The strategies applied while maintaining this cycle length are:   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, select phase sequence that provides smooth flow along the arterial   At each intersection, select phase times that will accommodate occasional use of pedestrian phases. |
| 8.4.1.5 | 8.4.1.5 Summary of Operation |
| 8.4.1.5.0-1 | The USH 14 & STH 26 intersection is the critical intersection that will control the cycle length for the entire group. 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 (if called) 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 USH 14 or STH 26. |
| 8.6 | 8.6 Demand affecting event |
| 8.6.1 | 8.6.1 High travel day (e.g., Mothers' Day, Super Bowl, Diversion from adjacent route) |
| 8.6.1.0-1 | During periods of major activity within or close to the ASCT's area of operation, the traffic flow will be higher than typical peak periods and may become oversaturated. The system will determine the predominant direction of heavy traffic and coordinate accordingly, with an appropriate cycle length and offset.  During construction, alternate routes for freeway diversion traffic are USH 14 from USH 51 to IH 39, USH 14 from IH 39 to the east or a combination of both. It’s also expected that STH 26 from USH 14 to IH 39 will be used frequently as a diversion route.  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. |
| 8.8 | 8.8 Fault Conditions |
| 8.8.1 | 8.8.1 Communications Fault Condition |
| 8.8.1-1 | If a communication is lost to an adaptively controlled intersection, the intersection will operate using observed, historical parameters. If a communication failure occurs, and there is insufficient historical parameters the impacted signal will run in either time-of-day or free mode. The fallback mode will be specified by the user based on location and time of day. All communication failures will be automatically transmitted to designated staff for appropriate action. All other non-affected signals will continue to run in adaptive mode. |
| 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. If more than fifty percent of detectors fail at a single intersection or group of intersections, the system will cease operation at that intersection(s) and go to a fallback operation specified by the user. All detection failures will be automatically transmitted to designated staff for appropriate action. |
| 8.9 | 8.9 Priority and Preemption |
| 8.9.1 | 8.9.1 Railroad Preemption |
| 8.9.1.1 | 8.9.1.1 USH 14 & Kennedy Road Railroad Preemption |
| 8.9.1.1.0-1 | A railroad crosses through the middle of the USH 14 & Kennedy Road intersection. Upon preemption, the signals on USH 14 and Kennedy Road introduce a clearance phase to serve all phases before the train arrives. Upon completion of the clearance intervals, the signal dwells on red indications for all through and left turn movements. The only movements allowed to proceed when a train is present are the stop controlled northbound and southbound right turn movements. Once the preemption is released, the preempted signal will return to adaptive control.  Other signalized intersections in the adaptive system will maintain adaptive operations during railroad preemptions. |
| 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. Pedestrian recall is used for pedestrian phases that are adjacent to the coordinated movements.  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. |
| 8.12 | 8.12 Installation |
| 8.12.0-1 | 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.  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, and 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. |