Adaptive Control Software – Lite (ACS-Lite) Implementation Template

Developed by: FHWA Resource Center – Operations Technical Support Team

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Purpose

Adaptive Control Software Lite (ACS-Lite) is a tool designed specifically to improve signal timing on closed-loop traffic signal systems. Given the prevalence and wide distribution of closed-loop traffic signal systems throughout the United States and the relatively low deployment cost and infrastructure requirements of ACS-Lite; great potential exists for improving the quality of signal timing. Considering the (D-) grade assigned nationally to traffic signal operations by the NTOC in 2005, and the estimated 300 million Vehicle hours of delay attributable to poor signal timing on major roadways, this technology is long overdue.

The public-private partnerships formed to develop and distribute ACS-Lite are anticipated to enhance and facilitate deployment of the system and have already generated a significant level of interest. It is imperative that the FHWA Resource Center, Research and Development, Office of Transportation Management, and Division Offices deliver consistent and accurate information about the capabilities, functionality and limitations of ACS-Lite as any of the partners may serve as a point of contact by agencies seeking to acquire information about the system. The purpose of this template is to provide a framework to effectively promote and support the deployment of Adaptive Control Software Lite (ACS-Lite). This template includes discussion of the following aspects of ACS-Lite:

- Background
- Key Features
- Limitations
- Benefits
- Cost
- How to Obtain ACS-Lite
- Marketing Material

The template also includes an appendix with detailed technical information, Frequently Asked Questions (FAQs), field test information and contact information for the project partners. Development of a workshop is being considered to provide information about how to improve signal timing operations and maintenance with a focus on ACS-Lite.

Background

The FHWA undertook a ten year effort beginning in 1992 to develop Adaptive Control Software (ACS) that modified signal timing to accommodate changing traffic patterns. The results of this effort were five control strategies that operated effectively on several configurations of arterial systems including grid networks. The most widely deployed of these algorithms was RHODES, credited with using a predictive optimization technique that was easily configured. Adaptive Control Software (ACS) has been found to produce significant reductions in travel time, delay and fuel consumption. The drawback of the
ACS systems was/is the high cost of deployment. Fully adaptive traffic signal control systems typical cost $10,000 to $40,000 per intersection and require significant maintenance and professional staff to perform optimally. The cost of deployment has proven prohibitive for most public agencies despite the numerous benefits that have been documented.

In 2001 the FHWA recognized both the benefits and cost barriers to adaptive control systems and undertook an effort to make ACS technology accessible to jurisdictions that cannot afford to invest in centrally managed ACS systems. Closed Loop Systems (CLS) are the most prevalent signal control systems in the United States. ACS-Lite is designed specifically for closed loop systems with the express goal of being low-cost to make it widely accessible to most small to medium size jurisdictions. The cost to deploy ACS-Lite is equivalent to the cost of a typical traffic signal retiming project; which ranges $1500 - $3500 per intersection. ACS-Lite was developed initially to be deployed on arterial routes and is not currently appropriate for grid networks. The types of arterial facilities utilized during the ACS-Lite field tests are indicative of the types of facilities where ACS-Lite will prove to be most effective.

**Key Features**

- FHWA initiated the ACS-Lite program to assess, and then pursue, the best, most cost-effective solution for applying ACS technology to current, state-of-the-practice closed-loop traffic signal control systems.

- Several National Electrical Manufacturers Association (NEMA) closed-loop traffic control system vendors (Econolite, Eagle, Peek, and McCain) have provided guidance and support to the ACS-Lite team.

- ACS-Lite is designed specifically for closed loop systems; 90% of the traffic signal systems in the U.S. are estimated to be closed loop systems (this does not mean all closed loop systems are suited for ACS-Lite Deployment, nor does it indicate that 90% of all traffic signals are controlled by closed-loop systems).

- ACS-Lite is intended to make Adaptive Control System (ACS) technology widely accessible without the upgrade and maintenance costs required to implement the full ACS systems.

- ACS-Lite uses NTCIP for data and control.

- ACS-Lite provides adaptive control within the readily-understandable and standard context of cycle, splits, and offset.

- ACS-Lite downloads new parameters to each controller every 5-15 minutes and the local controller performs the second-by-second control of the intersection.
• ACS-Lite does not have the high vehicle detector requirements typically associated with adaptive systems.

• Simulation studies and field test show significant delay and travel time improvement is possible on the arterial route.

• ACS-Lite was developed to run on Windows-XP embedded on a field-hardened PC platform in a controller cabinet either replacing the master controller or working in concert with the master, depending on the controller manufacturer.

Limitations

• ACS-Lite is currently limited to NEMA closed-loop traffic control systems manufactured by Eagle (SEPAAC NTCIP v4.01b), Econolite (ASC/2 NTCIP) or PEEK (3000E with NTCIP translator hardware). Other controller models may be compatible with the system in the future. This may limit deployment options.

• The McCain test in El Cajon, CA will use BiTran 233 software on 170 local controllers and a 2070 NTCIP McCain Master controller currently being developed. More information will be available on this field test after November 2006.

• ACS-Lite was not designed to operate on grid networks or to provide optimization on several major crossing arterials. Currently progression has only been tested along a single route, crossing routes are a possibility but not for simultaneous progression.

• ACS-Lite requires a minimum of 9600 baud communications and is limited to 12 intersections at this baud rate. Higher baud rates or IP communications eliminates this limitation.

• The TOD Tuner algorithm (long-term signal system parameter maintenance) has not yet been developed and may require several years to be fully incorporated into the software.

• The Operations and Maintenance requirements are still being explored, a good estimate of the requirements in this area may not be available until after early adopters deploy the system.

• ACS-Lite may prolong the onset of saturated conditions but does not currently have logic to shift its operational strategy to manage saturated conditions.
• Controller manufacturers not participating in the initial development of ACS-Lite will have to purchase a software license from Siemens. The license and royalty fees have not yet been determined.

• ACS-Lite will not solve poor planning and design features that create bottlenecks and congestion on arterials. These issues should be considered first, signal timing has limited ability to remove traffic congestion.

Benefits

• Reduce delay and improve travel time by keeping the signal timing plans current.
• Improve platoon progression.
• Reduce emissions (hydrocarbons, carbon monoxide, NOx).
• Reduce fuel consumption.
• Increase agency efficiency and productivity.
• Reduce capital, operating and maintenance costs by reducing the need for signal retiming.
• Easily configured and calibrated.
• Compatible with existing closed loop systems.
• Locks in the performance gains of signal retiming.
• Developed through a public private partnership.

Cost

The cost of ACS-Lite should be broken down into categories; infrastructure and integration. ACS-Lite requires a compatible system of traffic signal controllers on a closed loop system that meet minimal communications and detection requirements. ACS-Lite is considered an upgrade or retrofit to an existing system. Free of infrastructure cost, which is readily quantifiable, a fair estimate of ACS-Lite integration cost might range between $10,000 and $30,000 depending on the size and complexity of the system. Compare this cost with the cost of a routine traffic signal retiming project which generally ranges $2000 - $3500 per intersection. The funding mechanisms for traffic signal retiming can also be applied to ACS-Lite deployment.

How to Obtain

ACS-Lite will only be available through the vendors that accepted the invitation to participate in the ACS-Lite program. The vendors include Econolite, Siemens (Eagle),
McCain and Peek. To obtain ACS-Lite an agency should contact the appropriate vendor according to the type of system they are currently operating. If a system replacement is planned utilizing one of the participating vendor’s traffic signal control products, ACS-Lite should be specified for inclusion with the new system.
Marketing Material

The ACS-Lite Marketing Materials will include:

- Tri-fold leaflets
- Executive Multimedia presentation, highlighting testimonials from the test site engineers, vendors and development team.
- ACS-Lite Workshop
- ACS-Lite displays at professional conferences
- ACS-Lite Article in ITE Journal
- ACS Full Page Advertisement in ITE Journal
- Signal Timing on A Shoestring Workshop
- ACS-Lite presentations by FHWA Resource Center
- Marketing efforts of vendors
Technical Information†

Functionality

ACS-Lite provides adaptive control within the industry standard context of cycle, splits, and offset utilizing three control algorithms. The control algorithms include a Run Time Refiner, Transition Manager and Time of Day Tuner. Figure 1 below describes how the algorithms work in tandem to update traffic signal timing on a cyclical basis.

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**Figure 1. Illustrates the control strategy that ACS-Lite employs to update traffic signal timing.**

*Run Time Refiner*

The Run Time Refiner is tasked with adapting to traffic in real-time by changing cycle, splits, and offsets in small, incremental steps and downloading these changes to the controller every 5-15 minutes. These small steps serve two purposes:

1. Minimize the effects of transition from one plan set to another and
2. Reduce the risk of the controller being sent by ACS-Lite into a poor set of plan parameters due to failed detectors, loss of communications, or other anomalies.
The Run-Time Refiner utilizes the optimization principles of balancing the degree of phase utilization on each phase, by tuning splits, and capturing the most traffic as possible on the coordinated phases during the green, by tuning offsets. These two algorithms use the concept of being “driven directly by the data” using very simple models of how predicted changes to parameters impact the operation. In essence, ACS-Lite operates on the principle that the recent past predicts the near future (i.e. the conditions you see now will continue in the next few cycles). While the performance response times (i.e. how long it takes ACS-Lite to find the “right” set of traffic parameters for a given situation) suffer slightly due to the lack of a traffic model, the savings in configuration and maintenance/calibration are substantial. Both algorithms use a “surrogate” measure for delay & stops rather than attempting to calculate delay from a vehicle-movement-based traffic model.

Split tuning

The split adjustment algorithm executes on each controller independently. The cycle time is assumed to be fixed and constant on all controllers in the system, although this is not a necessary assumption. First, the surrogate performance measure phase utilization is calculated for each split by determining how much of the available green time is being used. Essentially this is a measure of the degree of saturation on the approach. Splits that are using all of their allotted time being occupied by traffic are candidates for increased split values. Similarly, splits that are not using all of their available green over the last few cycles are candidates to give up their time to other phase splits. The basic algorithm reduces the maximum predicted phase utilization of any phase on the controller by exchanging time amongst the various phases. This has the net effect of balancing the degree of utilization across all phases. To preserve opportunities for progression on coordinated movements, a bias is added to each coordinated phase utilization estimate to ensure extra green time is allocated to the coordinate phase. This is visualized cycle-by-cycle on the ACS-Lite software interface as shown in Figure 2.

Figure 2. Example of phase utilization estimates for an intersection.

Figure 2 shows the phase utilization percentage and a color-coded representation (green for low utilization, yellow for medium, and red for high utilization). The numbers above the average utilization estimate indicate the maximum flexibility that ACS-Lite has to
modify the split, if necessary and possible. For example, phase 2 shows a current split of 80. Its theoretical minimum is 26 (perhaps constrained by the walk + ped clearance time) and theoretical maximum is 107. Expressed as a difference from 80 seconds, the second row shows that the split could go down by 54 seconds or up by 27 seconds from its current setting of 80. Since the algorithm must maintain the current cycle length, for example, it would be possible if the traffic was very light to reduce all of the splits to their minimum value.

In this manner, ACS-Lite adjusts the splits of the controller assuming the general structure of North American controllers with rings, barriers, and phases. Split-phasing, overlaps, extension times, gap-out logic, “adaptive” protected/permitted lefts, and all standard or vendor-specific features and operational behaviors of existing controllers are left intact. Any number of phases, rings, and barriers are compatible with the Run-Time Refiner algorithms with the assumption that each barrier crosses all rings. More sophisticated search algorithms are necessary to mitigate barriers that do not cross all rings.

**Offset Tuning**

Two offset adjustment methods were developed based upon the same principle of “capturing” the maximum amount of (statistically) progressed traffic flow in the green band provided by the coordinated phase. For each iteration of the algorithm, a small positive change, no change, or a small negative change to the offset value are evaluated. The Distributed Offset Adjustment (DOA) algorithm adjusts the offsets at each intersection independently, while also considering the effects of the offset changes on the arriving platoons at upstream and downstream intersections. The Network Offset Adjustment (NOA) algorithm adjusts the offsets of all the intersections in the system to capture the most (statistically) progressed traffic flow among all possible combinations of offset adjustments. The ACS-Lite user-interface software allows the size of adjustments for each optimization to be determined as well as the type of offset adjustment algorithm to use (NOA or DOA). In addition to these methods, an offset selection algorithm was also developed to provide more of a “traffic responsive” mode of operation for locations without advanced loops at every intersection.

The calculation of a “statistical flow profile” and the surrogate for progressed traffic (delay & stops) is demonstrated in Figure 3. As shown below, the statistical flow profile is derived from the last few cycles of occupancy collected at the upstream detector(s). For each second of the cycle, the average occupancy and volume is computed. Similarly for each second of the cycle, the probability that the light is green during that second is calculated. Using these two estimates, the “capture efficiency” of the phase for the current offset value and alternative offset values are calculated, and the best results is selected and downloaded to the controllers.
Transition Manager

When transitioning between one plan and another, ACS-Lite manages the transition to minimize the time spent out of coordination. Transition between two distinct timing plans is a process that depends on the closed-loop system or controller manufacturer, and the configured transition mode. There are several standard transition strategies.

- **Short way** (reduced splits, shorter cycle)
- **Long way** (increased splits, longer cycle)
- **Dwell** (hold in the synch phase until it is in coordination)
- **Best way** (calculate whether short way or long way will be faster)

Whether it is best for a particular controller to transition short way or long way depends on (amongst other factors) the difference between the pattern offsets. The Transition manager accepts a transition request from the Run-Time Refiner and either chooses the best transition method or prepares an incremental set of steps that performs better than allowing the controller to manage the process itself.

The traditional goal of transition is simply to get into sync with the new pattern as quickly as possible. However, ACS-Lite may be able to apply a more sophisticated basis for selecting a transition mode. Specifically, the quickest path to synchronization may not be the most beneficial path in terms of traffic performance. For instance, when signals are saturated, short way transition (which may be the quickest path to synchronization) may cause queues to buildup, which cannot be dissipated quickly under the new plan. It may be preferable to use long way transition in this case, to ensure that
the signal is not inadvertently forced into a congestion scenario that negates the progression opportunities of the new signal plan.

**Time Of Day (TOD) Tuner**

The TOD Tuner has not yet been fully developed and incorporated into the functionality of ACS-Lite. Once complete this component will periodically update the time-of-day signal timing plans based on statistically significant changes in the underlying traffic flow. By doing this, ACS-Lite will, in essence, remember the changes to splits and offsets that have become significant as they reoccur frequently during specific times of day. ACS-Lite utilizes the base signal timing plans as the baseline for its operation and currently does not modify cycle lengths in real-time.

**Development & Project Partners**

ACS-Lite research was funded by the FHWA and developed through a partnership with Siemens ITS, Purdue University and the University of Arizona. Some key development outcomes include:

- ACS-Lite is designed to operate on closed-loop systems.
- Designed to leverage as much of the existing infrastructure as possible
- ACS-Lite can utilize low-bandwidth communication 9600 Baud minimum to support up to twelve controllers, IP communication can support up to 32 controllers.
- Limited detection is required to function
- National Transportation Communications for ITS Protocol (NTCIP) standards are utilized to transfer information between the ACS-Lite field processor and traffic controllers.
- A web-based user interface supports configuration and adjustment of ACS-Lite, and allows the user to view status of real-time operations, retrieve log files of archived data and control decisions, and configure the adaptive algorithm and communications parameters.
- ACS-Lite was developed to run on Windows-XP embedded on a field-hardened PC platform in a controller cabinet. As much as possible, the C++ code has been designed for portability to embedded platforms such as the 2070 or ATC.

Siemens maintains the licensing rights for the ACS-Lite software. An invitation was sent out for traffic signal controller manufactures to participate in the integration of ACS-Lite; 4 manufactures responded: Eagle, Econolite, Peek, and McCain. Other manufacturers may integrate the ACS-Lite software by purchasing a license from Siemens. Siemens has not yet determined what the licensing fee for ACS-Lite with other manufacturer’s controllers will be.
**System Configuration and hardware requirements**

The diagrams below describe the physical connection of ACS-Lite to a typical closed loop traffic signal system. ACS Lite resides on a field hardened CPU that performs the operations of the field master. A communications link between ACS Lite and the field controllers (serial or IP over twisted-pair, fiber, wireless, etc.) allows the software to monitor and evaluate traffic conditions and provide refinements to signal timing on a cycle by cycle basis.

![Figure 4. Typical ACS-Lite System Configuration](image)

**ACS Lite Hardware**

The original hardware architecture (as shown above) was designed so that the ACS Lite would reside in a field hardened CPU and connect to a serial port on the OSM. However, this schema did not fit all manufacturers due to the complexity in the modifications to the OSM software. For McCain systems, ACS-Lite operates as shown in Figure 1. For Peek and Eagle systems, ACS-Lite performs the function of the master controller. For
Econolite systems, ACS-Lite communicates with each local over a second serial channel to the master, or can perform the function of the master controller.

The ACS Lite field hardened CPU hardware has the following minimum requirements:

- **Operating System:** Windows XP Professional or Windows XP Embedded
- **Processor:** Intel-compatible, 366MHz
- **RAM:** 512MB
- **Hard Drive:** 5GB minimum, Temperature-hardened
- **I/O:** VGA, mouse, keyboard, Ethernet, Serial, USB
- **Power Supply:** 120VAC
- **Communication:** Internal/external GPRS/GSM/CDMA/EDGE modem; IP
- **Operating Temperature:** NEMA Specification, -34C to +74C

**Detection Needs ‡**

In general, a “fully actuated” detector configuration is preferred but not required for ACS-Lite operation, with a separate detector channel for each lane. ACS-Lite can operate with a minimum of one detector (or detection zone) per “main street” approach, or coordinated phase, for offset tuning. One detector at the stop bar, per phase, is necessary for split tuning. This detection layout is shown in Figure 5. Not all intersections need to be enabled for both offset and split tuning. Deployment costs can be decreased by enabling intersections with low-volume side streets for offset tuning only.

![Figure 5. ACS-Lite preferred detection layout](image)

The detector for offset tuning is necessary at some point upstream of the intersection, at least as far upstream as the typical location of dilemma-zone detectors on approaches that are coordinated (220-300’ or more, depending on design speed). A further upstream location, where traffic does not typically queue over the detector during the red, improves the performance of the offset tuning algorithm. Mid-block and exit detectors are also supported by the software. For split tuning, one detector per phase is necessary at the
stop bar. One detector in each lane per approach is recommended, for all phases. Typical agency loop lengths or zone sizes (20-40’, or 3-4 6’ zones in series) have shown reasonable field performance.

Field Test Description and Results

Four test Sites for ACS-Lite were commissioned to verify the functionality of the software with each of the manufacturer’s controller hardware and to evaluate the performance of the adaptive algorithms.

Gahanna, Ohio – Econolite, NEMA
Houston, Texas – Eagle, NEMA
Bradenton, Florida – Peek, NEMA
El Cajon, California – McCain, 170

Gahanna, Ohio – Econolite, NEMA

The first deployment of the ACS Lite software was in Gahanna, Ohio; a suburb of the city of Columbus. The city has a CLS along Hamilton Road with I-270 to the south and Clark State Road to the north, as shown in Figure 6. Hamilton Road serves as a connection between the city of Columbus to the north and I-270 to the south. Hamilton Road does not serve as a major route and is classified as a principal arterial.
The system consists of an Econolite manufactured CLS. The system was installed in the early 1990s. The city maintains the system through a contract with a local electrical company and has no traffic signal maintenance personnel on staff. Similarly, the city uses a traffic engineering consultant to periodically examine the system for any remedial work as well as updates of the signal timing plans. The system was last retimed in May 2001.

The control equipment consisted of nine ASC-2S Econolite actuated controllers interconnected with a 1200 baud twisted pair copper media. There were a few system detectors installed previously, principally around the intersection of Hamilton Road and Granville Road. In order to get the system ready for the ACS-Lite deployment, three system video detectors were installed as follows; northbound Hamilton Road north of I-270 interchange, southbound Hamilton north of Clark State Road and westbound Clark State Road east of Hamilton Road. These systems detectors are used by the ACS-Lite software for signal offset selection. Split tuning was applied at Granville, Clark State, Morrison, and the Eastbound off-ramp from I-270.

Additionally, one loop detector each for north and southbound Hamilton Road’s center lane at Granville Road was also installed. This is the major and most congested intersection in the system and these loop detectors were used by the ACS Lite software to optimize the splits for Hamilton Road and Granville Road. Additionally, a spare set of twisted-pair communication lines were used to communicate between the locals and ACS-Lite using the second serial port on each local controller. 9600-baud modems were added to each cabinet for this communication link. A few detectors at several intersections were split out into individual channels to improve data fidelity.

An Application Program Interface (API) was written for ACS-Lite to interface with Econolite field equipment using principally NTCIP communications. The API also translated some Econolite vendor-specific data into NTCIP equivalent information. The ACS-Lite software was initially designed to interface with the OSM. However, in this case, the software modification of the OSM to recognize Lite and process the data requests was found to be too costly. Therefore, the ACS-Lite software was modified to bypass the OSM and go directly to each intersection.

Field data was collected for 5 weekdays during AM and PM peaks for both the “before” and “after” conditions. The results of the deployment consisted of a comparison of “before” and “after” are shown in Table 1.

Unit Costs:

- Total Delay - $12.10 per hour
- Stops - $0.014 per stop
- Fuel Consumed - $0.59 per liter ($2.25 per gallon)
Table 1. Gahanna, Ohio Before and After Study Results

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<th>Before (per veh)</th>
<th>After (per veh)</th>
<th>Savings (per veh)</th>
<th>Peak Hours (all vehs)</th>
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Houston, Texas – Eagle, NEMA

The second ACS Lite deployment was on State Route 6 in North-western Houston, Texas. State Route 6 connects to I-10 to the south and extends beyond George Bush International Airport to the north. SR6 is several miles West of Beltway 8. The State Route 6 test site consisted of eight signalized intersections beginning with Clay Road on the South and ending at West Little York Road to the north. The system was last retimed in the Fall of 2004.

The system hardware consisted of 9 Eagle Model SEPAC 608 M52 controllers with an On Street Master. The communication media was twisted pair copper wire operating at 1200 baud. There were no previously-existing system detectors along State Route 6 although all intersections had advance loops on coordinated approaches already installed.

The following system modifications were implemented to prepare the system for the ACS Lite deployment. Modems were upgraded from 1200 to 19,200 baud. Six video detectors were installed as follows; northbound and southbound on State Route 6 at Clay Road, Keith Harrow Boulevard and West Little York Road. Offset tuning was performed at all
intersections in the system. Split tuning was enabled at Clay Road, Keith Harrow Boulevard and West Little York.

As in the case of Econolite field test, an API for the Eagle test was also developed to translate a handful of vendor-specific data objects to NTCIP format. The remainder of the communications between ACS-Lite and the local controllers was directly using NTCIP and the ACS-Lite special MIB objects. ACS-Lite managed the TOD schedule and synced the local controllers’ clocks in the role of the master. The field data collection procedures were similar to those in Gahanna, Ohio. Table 2 shows the results of the before and after travel time and delay study.

Unit Costs:

- Total Delay - $12.10 per hour
- Stops - $0.014 per stop
- Fuel Consumed - $0.59 per liter ($2.25 per gallon)
Table 2. Houston, Texas Before and After Study Results

<table>
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<tr>
<th></th>
<th>Before (per veh)</th>
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<th>Peak Hours (all vehs)</th>
<th>Peak Hours Savings</th>
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Frequently Asked Questions

1) Were the traffic signal timings optimized prior to the deployment and testing of ACS-Lite?
Signal timing on each of the four corridors where ACS-Lite was tested was not updated prior to the implementation of ACS-Lite.

2) Who supplies the ACS-Lite field processor and how much does it cost and has it been tested to NEMA TS2 environmental specifications?
The controller manufacturer will supply a hardened field processor that meets the NEMA TS2 environmental specifications. The cost of the processor will be similar to the cost of a high-end PC.

3) Will ACS-Lite effectively manage saturated flow situations?
There are no specific features of the ACS-Lite algorithms that manage the system differently when all approaches to an intersection are oversaturated. The split tuning algorithms are designed to move available time from phases that are under-saturated to phases that are over-saturated. A goal of ACS-Lite (as well as all adaptive control systems) is to prolong the time before saturated conditions occur and recover faster from
saturated conditions once they have happened. In the near future, the ACS-Lite system will be enhanced to adapt (increase) the cycle time to better handle saturated conditions.

4) **Does the size of the loops used for vehicle detection affect the operation of ACS-Lite?**

The length of the loop is not critical to the performance of the algorithms. Standard loop designs (e.g. 6’ advance loops/zones, 20-40’ stop bar loops/zones) have performed adequately for all field tests. Better performance will be achieved with detection zones that are separated out by lane-by-lane, but it is not necessary that the zones are separated by lane.

5) **Are the phase tuning detectors also used for local actuated operations?**

Yes. The same detectors that are used to operate the intersection are used for collection of the data for phase tuning.

6) **Are the algorithms and software developed with FHWA funding readily available? If so where?**

The software will be available to agencies through each of the controller manufacturer companies (Siemens, Econolite, Peek, and McCain).

7) **Is there a logic identifying detector errors and a plan B under such conditions?**

The identification of detector errors/diagnostics is a function of the controller. Upon receipt of a detector error message (e.g. max presence, erratic, or no activity) from the controller, ACS-Lite will remove/neglect that detector from its calculations. When the detector is repaired and starts reporting correct data again, the information is automatically re-introduced into the calculations.

8) **Does the ACS-Lite System archive signal timing for later use.**

ACS-Lite stores all second-by-second phase timing data, detector data, and its control decisions for later analysis for up to one month.

9) **Is it possible in the future to have more than 12 intersections without the IP communications?**

ACS-Lite is capable of supporting more than 12 controllers on a serial communications channel that is faster than 9600bps.

10) **How does ACS-Lite handle incidents?**

ACS-Lite handles incidents by modifying the splits and offsets of the traffic pattern (and in the future - cycle time) to adapt to the increases and decreases in traffic flows on the facility it is managing. Detector diagnostics/failure conditions are the responsibility of the controller software (e.g. a stalled vehicle in a left-turn bay). ACS-Lite currently has
no component for tactical modification of phase durations using hold and force-off commands (e.g. truncating phases due to downstream flow restrictions)

11) Does ACS Lite have algorithms for arterials in both directions (like CBD's in both east-west and north south directions) or it is currently implemented only for one direction of travel?

Currently, ACS-Lite can handle only one offset value per pattern but any number of phases can be designated as progression phases. Enhancements to the algorithms to deal with grid systems are planned for future work.
References

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