Adaptive Signal Control Manual

VERSIONS

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1.0	JLitvak	07/12/2021	Preliminary document release

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1. Operational Description

Transparity® Adaptive Signal Control is a traffic management strategy in which traffic signal timing changes, or adapts, based on actual traffic demand. This is accomplished using an Adaptive traffic control system consisting of both hardware and software. Adaptive provides a set of tools that can be used to achieve Adaptive operations that adjust cycle length, splits, and offsets to real time trends in traffic. These tools use Adaptive profiles, which are a strategy that can be scheduled to run on a selected group of controllers.

There are two types of Adaptive profiles.

1.1 Basic Adaptive

A basic Adaptive system adjusts cycle lengths, offsets, and splits based on demand as measured from standard detectors at individual intersections. The basic Adaptive profile does not require system detection. This type of profile starts by implementing a user configured base pattern and then incrementally adjusting the splits, offsets, and cycle length.

1.1.1 Critical Intersection Control (CIC) Split Adjustment

Each controller determines its split allocation and cycle request using local detectors that the user designates as “Adaptive Detectors.” For each phase, the Adaptive detectors on that phase use the phase parameters of that phase to measure whether the phase goes to max or gaps out. The Adaptive detectors and gap timers are used to measure demand even in the case where a phase may go to max due to a pedestrian or because it is the sync phase.

- If a phase maxes out (goes to force-off), that phase requests more time to be added to its split. The phase must max consecutively by a user defined “consecutive max count.”
- If a phase gaps out within the user configurable “optimal gap range” that phase requests less time for its split. For example, if a phase gaps within 90% of its split time, then we may infer that current phase split is appropriate for that phase and we should not reduce the split. The phase must gap consecutively by a user defined “consecutive gap count.” For each phase the user may determine a minimum split for that phase beyond which the split cannot be reduced.
- The amount a phase split can change is limited by a user defined “Adaptive phase step.”

1.1.2 Adaptive Cycle Adjustment

Once each phase has determined its split request the information is sent to the *Transparity* central server. For each controller, the sum of the split requests in the greatest ring determines the cycle request for that intersection. The server selects the greatest cycle request out of the group as the next cycle length for that group. The amount that the cycle can change is limited to a user configurable “Max Cycle Delta.” The highest possible cycle length is limited by a user defined “Max Cycle Time.” The lowest possible cycle length is effectively determined by the controller in the group that has the highest sum of minimum splits.

1.1.3 Adaptive Offset Adjustment

The offsets are adjusted incrementally from the base plan offsets. Each cycle, the next cycle length data is fed into a Tru-Traffic diagram that references the distance between intersections and design speed. In basic Adaptive the user defines a progression weighting factor based on the desired inbound vs outbound progression. The Tru-Traffic algorithm calculates the optimum offset for each controller and that becomes the offset for the next cycle.

1.2 ADVANCED ADAPTIVE

An advanced Adaptive system uses the same split and cycle length calculation routines as the basic Adaptive system. The advanced system differs from the basic Adaptive system in that it uses system detectors to monitor for sudden changes in traffic volumes and directionality.

1.2.1 Adaptive Pattern Selection Based on Volume

The user can define volume thresholds that command a new plan to the Adaptive group when there are sudden changes in volume, like responsive operation. For example, when the system detector volume reaches 75% of a heavy volume threshold, it can select a new Adaptive plan with a higher Adaptive cycle length, as well as other differences such as alternate sequences.

1.2.2 Adaptive Offset Optimization Based on System Detector Data

The user can define thresholds of inbound vs outbound volume as measured in real time from inbound/outbound system detectors. Per each directional volume threshold (preferential, semi-preferential, or balanced), the user defines a weighting factor to be used in the offset optimization (100% for one-way directionality, 50% for most balanced). When the percentage of inbound vs outbound reaches the threshold, the system selects the appropriate weighting factor and performs a new Tru-Traffic optimization using the current Adaptive cycle length and new weighting factor.

2. SPECIFIC OPERATIONAL FUNCTIONS

2.1 SIZE AND GROUPING

ADAPTIVE is not limited to the number of intersections or number of control groups defined by the system operator. Adding and/or removing intersections within a sub-system is easily accomplished via the *Transparity* user interface. Intersections are permitted to participate in more than one sub-system if desired or operationally advantageous.
Sub-systems can be commanded into operational plans manually, via time-of-day, or via volume/occupancy thresholds. The sub-systems are configured to operate as independent systems without grid system constraints.

Sub-systems can be figured with directional links and within each link, system detectors and/or advanced loops can be assigned to collect volume, occupancy and speed.
The system will control intersections in groups, or sub-systems that are defined by the operator.

ADAPTIVE provides customized timing for each designated sub-system which can operate with independent cycle lengths and coordinated traffic flow options, based on real-time directional flows and spot speeds. Each sub-system consists of a significant arterial street with short links of other intersecting arterial streets. The sub-systems are purposely designed to allow maximum flexibility for arterial street signal timing without encumbering them with grid system constraints.

ADAPTIVE allows for the sub-systems to be easily re-configured, increased or decreased.

2.2 MODES OF OPERATION

The *Transparity* central management system offers a variety of control and synchronization modes for the sub-systems and traffic controllers managed by the central system. Traffic signals can be commanded into FREE, Peer-to-Peer Synchronization, TOD Coordination, Adaptive, Traffic Responsive, and/or a hybrid between responsive and Adaptive (dynamic base pattern Adaptive) which allows for the selection of Adaptive base patterns via volume thresholds and cycle-by-cycle modifications thereafter.

When measured volume drops below the user-defined threshold for FREE operations, the traffic controllers within the sub-group can drop into one of two FREE modes.

- Traditional FREE operations
- FREE with Peer-to-Peer Synchronization

Traditional FREE operations provide fully actuated phase service with the option to place each approach in minimum or maximum recall. Unlike traditional FREE operations, FREE with Peer-to-Peer Synchronization provides a means of synchronizing the start of arterial through movements by passing signal state messages to each controller over the Ethernet network (Peer-to-Peer). This operation is ideal for use when volumes are not high enough to justify the use of common cycle lengths between intersections (coordinated), but while it is desirable to reduce stops between intersections.

When system detector volumes exceed user-defined thresholds, the central system initializes Adaptive operations with the base-pattern ideal for the measured volume. While between volume thresholds, cycle-by-cycle analysis of demand is measured and the base signal timing parameters (cycle length, phase splits, and offset) are adjusted to meet real-time demand. Upon exceeding a different volume threshold, the based pattern configured for the threshold is issued and cycle-by-cycle modifications resume thereafter. Operators may elect to utilize a single volume threshold for the initialization of Adaptive operations or issue the base pattern via time of day.

System administrators can configure several Adaptive profiles which can be configured with unique flow options to either maximize directional flow or balance flow via the ratio of directional volume. When using the balanced flow approach, directional volumes are used as weighting factors in the offset optimization algorithm. As volumes change, the offsets favor the heaviest flow or optimize in both directions when volumes are equal in both directions of the arterial.

2.3 Coordination

Each sub-system operates in FREE Mode (without coordination of offsets and cycle lengths) when the system detection identifies that traffic volumes have dropped below a specified threshold.

When the system detection for a given sub-system reaches and exceeds the designated threshold volume, that sub-system operates under coordination with specific cycle lengths and offsets determined by the Adaptive system. The Adaptive system provides a range of flow options, or strategies, based on the selected cycle length, spot speeds and directional volumes measured from the system detection. The timing parameters are automatically selected based on either an algorithm that maximizes directional flow (minimizes stops and/or delay) or by balancing flow based on percentage directional volume splits.

There are two different coordination modes: fully Adaptive and responsive. A fully Adaptive system that would allow coordination changes every cycle might provide virtual real-time dynamic operation but might also be over-reactive to random flow fluctuations. On the other hand, a responsive system that would allow changes only periodically would provide stability but might also be too slow to respond to rapidly changing traffic patterns.

There is a default coordination timing plan for each sub-system when ADAPTIVE is temporarily inoperative.

2.4 Cycle Lengths

Both traditional and FREE with Peer-to-Peer Synchronization allows for intersections to service all phases without a prescribed cycle length. During Adaptive operations, the cycle length is adjusted to meet the arterial demand up to a user-defined maximum and minimum cycle length. System administrators can specify minimum split times for each phase per intersection to ensure that pedestrian intervals, minimum green intervals, and ideal proportions for green time is accounted for in minimum cycle lengths.

During FREE Mode operation there are no prescribed cycle lengths. During the Adaptive coordination mode, cycle lengths used on each sub-system are determined from traffic volume and occupancy data obtained from system detectors at one designated location for each corridor. Cycle lengths for each Adaptive period consider the duration of pedestrian intervals, minimum green intervals, clearance intervals, and the ideal proportions for the green intervals serving each movement.

2.5 SPLIT TIME

While in coordinated operations, local or collector street approaches are fully actuated and use of green time is determined by the occurrences of vehicle and pedestrian detection. Unused split time can be configured for use by the next phase in sequence or reserved for use by the arterial through movements. Whether in TOD coordination or Adaptive coordination, the proportionality of split time for arterial approaches is preserved and established via the proportion of volumes in each approach.

At local or collector street approaches to a signalized intersection with limit line detection only, the green intervals for those approaches may vary by cycle and is determined by the occurrences of vehicle calls, pedestrian calls, the initial green intervals and successive vehicle actuations until a gap-out or a max-out occurs. During the coordination mode when a gap-out occurs on the intersecting local or collector street, the unused remaining time within the applicable cycle is given to the arterial street.

For arterial street approaches with advance detection in addition to limit line detection, the green intervals depend on whether the sub-system is operating in FREE Mode or coordination mode. During FREE Mode the arterial street green interval is on recall and the variable green time is determined by the initial green interval, any pedestrian calls and subsequent vehicle calls.

During the coordination mode where arterial streets intersect, the green intervals are based on the proportion of volumes (or volume combined with occupancy) in the highest volume lane. The green interval settings are equal to or greater than the parallel pedestrian-related time.

Phases for which there are vehicle calls are not skipped during any time period.

2.6 OFFSETS

The offset of a signal is the delay of the center of the green period of that signal, compared to the center of the green period of the reference signal. On an isolated one-way street, the only factor affecting the offset is the time it takes vehicles to travel from one signal to the next.

The *Transparity* Adaptive offset optimization routine utilizes system detector speed and volume in conjunction with the cycle length and phase splits for each sub-system intersection to calculate offsets.

Upon the configuration of an Adaptive command profile, users may elect to utilize design speed or link speed (real-time speeds of system detectors within each link). When utilizing real-time speeds from link detectors, the user can elect to utilize the highest or average speed.

Adaptive command profiles are configured with unique flow mode options permitting system operators to control the progression mode (i.e. maximum, preferential, semi-preferential or balanced flow). Directional volume ratios are used to calculate or select user-defined offset progression weighting factors. Data utilized in the directional volume ratios is collected from arterial system detectors.

The control/critical intersection for a given sub-system maintains a fixed offset (which can be set to zero); thus, the remaining intersections within the sub-system have offsets relative to the control/critical intersection. The offset optimization algorithm can utilize posted speed or real-time speeds collected by system detectors as the speed of progression.

Sub-system offsets are determined from system detectors, which measure spot speeds, volumes, and occupancies for each approach lane in each direction at one designated location for each corridor. Offsets for each sub-system are based on the selected cycle length, directional volumes, and the average of the measured directional spot speeds. Offsets are based on either a reliable algorithm that maximizes flow (minimizes stops and/or delays) or thresholds of percentage directional volume splits. (See “Coordination”). During coordination at the control intersection for a given sub-system, the offset effectively operates at “zero” relative to other signalized intersections in that sub-system with their offsets based on the coordination plan. Links that are part of the sub-system have offsets that are based on directional progression downstream using the posted speed limit as the speed of progression.

Determined from data from the System Detection in terms of progressive speed and directional volume splits:

- The directional volume splits measured at the System Detection determine whether progression is preferential (theoretically perfect progression) for a given direction, semi-preferential (less delay/stops or a favored progressive band) for a given direction or balanced (equal delay/stops or equal progressive band) for each direction. Thus, there are five progression possibilities. An approved algorithm determines the offsets for each.

- Users define the percentage of directional split for each progression mode. For example, preferential offsets may be provided when the directional split reaches 67%. Balanced offsets may be provided when the directional split is between 46% and 54%. Semi-preferential offsets may be provided when the direction split is between 55% and 66%.

2.7 System Detection

System detection is used to sample traffic for coordination of signals, such as for counting, occupancy, and speed of approach vehicles. Advance detectors may be used as system detection, although ideally, system detectors may be separate detectors that do not call or extend a phase.

System detection is applied at a representative location near the middle of the coordinated street at a point where traffic is free-flow and not slowed by downstream queues or nearby traffic signals.

2.8 FREE Running

In FREE operation, the signal is running with its own demand and timing parameters based on the information provided by its detectors. It is not operating under any background cycle length. In COORD operation, short for coordination, the signal is running a background cycle length.

FREE running intersections are used during those times on the otherwise coordinated street when the highest lane volume is less than 100 vehicles per hour (vph), as measured by the system detection.

It is used only at designated times where there are significant turning volumes and highly fluctuating demand on two or more approaches and where the storage distance to the next traffic signal would not be an issue. At other times the location is to be coordinated with adjacent traffic signals in the system.

2.9 Transit Priority

Transparity Adaptive can operate in conjunction with Transit Signal Priority (TSP). TSP strategies can be programmed in the controller and operate independently from the Adaptive split calculations. McCain Omni eX® traffic controller software supports 4 sets of 16 unique TSP strategies which can be uniquely configured to implement a wide variety of control over transit signal priority operations.

On approaches with transit priority, the splits may be modified for an early or extended green. Transit Priority timing is provided when the transit bus is sufficiently behind schedule and there is available time to allow an advancement or an extension of the green interval for the bus approach.

2.10 Emergency Vehicle Priority

Transparity Adaptive accommodates and incorporates Emergency Vehicle Priority at all intersections.

2.11 FALLBACK OPERATION

Whether scheduled, commanded via volume thresholds, or due to a failure in the communication system, *Transparity* Adaptive operations permit traffic controllers to return to default coordination timing for each sub-system.

Each traffic controller is programmed with a communication timeout. When a loss in communication between the central system and the traffic controller exceeds the communication timeout, the traffic controller assumes local control of the operating mode. Adaptive operations resume once communications are re-established.

The system has a fallback state that allows coordination using a common cycle length for all signals within a coordinated group. There is a default coordination timing plan for each sub-system when Adaptive is temporarily inoperative.

The system has 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.

2.12 OPERATOR ACCESS

Security administrators have authority to provide staff with various roles/responsibilities at different levels of system authority and access. The client server architecture permits the installation of the Traffic Management System (TMS) user interface, including *Transparity* Adaptive Traffic Control System (ADAPTIVE). *Transparity* TMS and ADAPTIVE are compatible with and often deployed in environments with VPN access for use outside of the agency.

Operators, traffic engineering and maintenance staff are assigned different levels of authority, and access to equipment for which they are authorized, based on their roles and responsibilities. This allows them to control, view, monitor and analyze the operation of the system as appropriate. The system is accessible at workstations and mobile laptops/tablets. The system is connected to the agency's LAN, allowing access to all authorized users.

The system allows access by authorized users outside the agency.

2.13 COMPLEX COORDINATION AND CONTROLLER OPERATION

The traffic controller software, *Omni eX*, is an NTCIP compliant controller software which supports:

- 16 phases, 4 rings, and auto-calculated ring barriers given the user-defined phase concurrency.
- 16 phase sequences controlled by coordination pattern and time-of-day.
- The ability to omit a phase based on command to a smaller cycle length or external

input or logic.
- The ability to use flashing yellow protected/permissive and permissive only phasing.
- The ability to enable/omit phases or overlaps by time-of-day schedule or external input.
- The ability to designate any phase as coordinated phases.
- The ability to monitor each lane on an approach and take different action depending on the conditions measured in each lane.
- 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. Additionally, the *Omni eX* controller software provides the user with various options for auto-calculated permissive windows or manual permissive windows per phase.
- Protected/permissive and permissive only phasing.

3. DETECTORS

Configuring detectors enables the system to collect data such as speed, occupancy, and volume. Collected data can then be used for the following:

- Traffic responsive coordination
- Adaptive coordination
- Congestion level monitoring

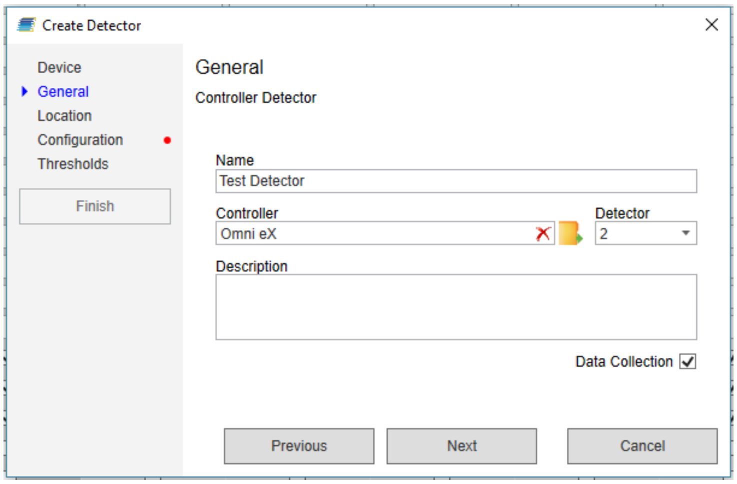
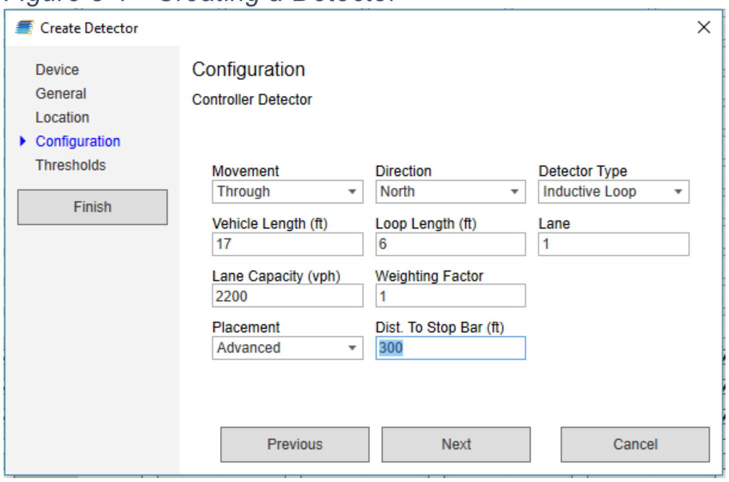


Figure 3-1 - Creating a Detector



3.1 CREATE A DETECTOR

To create a detector:

1. **Home > Devices > Create Detector**
2. Complete the Detector Properties (see table on next page)
3. Click each of the expander + buttons to ensure all entries are complete
4. Click Save once all the expanded fields are completed

Table 3-1: Detector Properties

Name	Describes the Detector. Typically specifies movement/controller/lane#/placement
Type	Select the type of detector.
Description	The description can be used to augment existing descriptor-type fields such as "Detector Name" and "Controller Name."
Controller	Pairs the detector with a particular traffic controller.
Detector #	Select a detector number from a dropdown list.
Disable	Disables volume and occupancy data collection. Allows the user to configure detectors for use in SPM reports without populating the database with excessive VOS data.

Configuration	• **Movement** - The selectable type of movement through a lane.
	  ○ Right - for right turn movement
	  ○ Left - for left turn movement
	  ○ Through – for through movement
	• **Direction** – Dropdown used to designate the direction of the traffic flow in the lane the detector is located in. (i.e. north, southwest, east, etc.)
	• **Detector Type** – Dropdown allowing the user to select the type of detector (i.e. inductive-loop, video-image, etc.).
	• **Vehicle Length** - Default Value=17 (feet)
	• **Loop Length** - Default value = 6 (feet)
	• **Lane** – Lane#
	• **Lane Capacity (vph)** – This value determines the 100% saturation value for the Lane. This value will be used as a baseline for Adaptive/responsive thresholds, i.e. if the Lane Capacity is set to 1000 vph, a threshold of 20% would be 200 vph.
	• **Placement** – Advanced, Stop Bar, Midblock.
	• **Dist. to Stop Bar –** feet from stop bar if advanced or midblock.

Threshold	Data outside the configured range will be flagged as invalid (not used in calculations)
	• **Volume (vph)** - Volume threshold boundaries
	  ○ High Limit = 2000 (Default Value)
	  ○ Low Limit = 0 (Default Value)
	• **Occupancy (%)** - Occupancy (%) threshold boundaries
	  ○ High Limit = 100 (Default Value)
	  ○ Low Limit = 0 (Default Value)
	• **Speed (mph)** - Speed threshold boundaries
	  ○ High Limit = 150 (Default Value)
	  ○ Low Limit = 0 (Default Value)

3.2 CREATE A TRAFFIC RESPONSIVE PROFILE

Creating a Traffic Responsive profile is easy with the *Transparity* Command Profile:

1. **Home > Arterial > Create Profile**

3.2.1 General

1. Complete the General fields
   a) **Name** – Create a name to the traffic responsive profile
   b) **Group** – The control group created to represent the traffic controllers included in the traffic responsive profile
   c) If desired, include a brief **Description** to help better identify the profile
2. Click **Next**

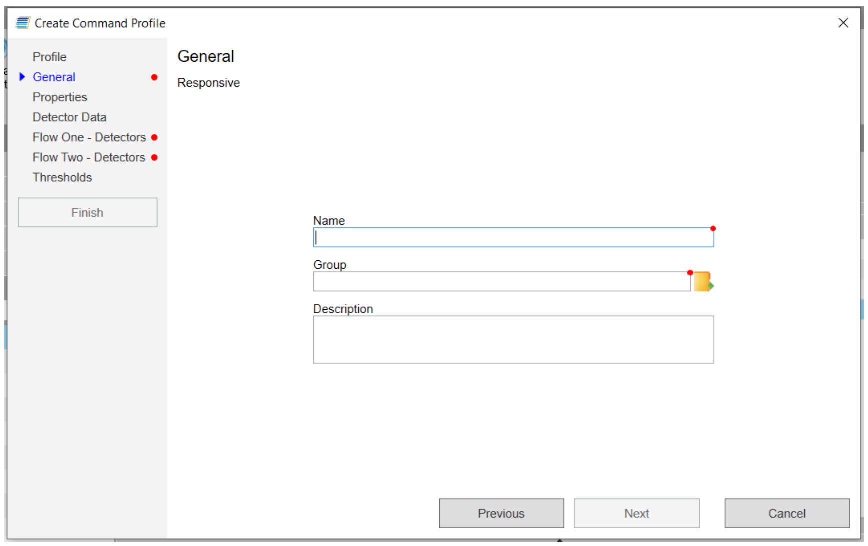


Figure 3-2 - Create Profile - General

3.2.2 Properties

1. **Pattern Update Interval** - the number of minutes (1 through 30) to indicate the time that must expire before a pattern can be updated

3.2.3 Detector Data

1. **Calculation Source**
   - **Volume Capacity %** - percentage of Lane Capacity as configured in the System Detector properties
   - **Weighted Occupancy** – percentage of detector occupancy (max 100%)
2. **Data Sample Mode** – Calculations can be based on Average of all detectors per direction or Highest detector per direction
3. **Data Sample Period** – How often the system averages detector data and makes calculations

3.2.4 Flow 1 – Detectors (Forward Direction)

1. **Flow Direction** – Approximate direction of forward flow (N, S, E, W)
2. **Valid Detectors** – minimum # of detectors that must be valid for a calculation to be executed
3. **Add Detectors** – Select System Detectors from the specified Direction and Group for use in threshold calculations

3.2.5 Flow 2 – Detectors (Reverse)

1. **Flow Direction** – Approximate direction of reverse flow (N, S, E, W)
2. **Valid Detectors** – minimum # of detectors that must be valid for a calculation to be executed
3. **Add Detectors** – Select System Detectors from the specified Direction and Group for use in threshold calculations

3.2.6 Thresholds

1. Click the **Add Threshold** 

button to add additional thresholds to the increasing or decreasing percentages. The current highest Flow is used.
    a) **Percentage** – This indicates at what volume or occupancy level the associated pattern will be commanded for all the traffic controllers in the traffic responsive control group
    b) **Pattern –** Use the dropdown menu to select the pattern to be associated with the threshold percentage. Different Patterns can be specified for each flow (Flow 1 vs Flow 2)
    c) **Increasing** – Sets the thresholds for each pattern change to be triggered as the volume or occupancy increases
    d) **Decreasing** – Sets the thresholds for each pattern change to be triggered as the volume or occupancy decreases
2. Click **Finish** to create the traffic responsive profile

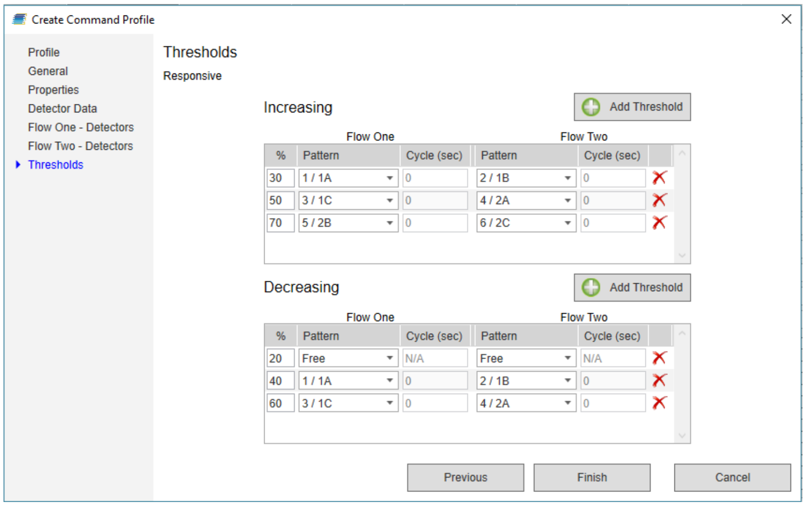


Figure 3-3 - Add Threshold

4. OPERATIONAL SCENARIOS

The following operational scenarios describe how the system is expected to operate under various conditions. The proposed ADAPTIVE system is expected to manage the following operational scenarios:

- Typical heavy congested conditions
- Moderate balanced flows
- Demand affecting event
- Fault conditions
- Signal priority and preemption
- Pedestrians

4.1 TYPICAL HEAVY CONGESTED TRAFFIC

4.1.1 Example: Arterial with Critical Intersections

4.1.1.1 *Traffic conditions*

At times when traffic conditions are very heavy, at least one intersection is the critical intersection. This varies depending on the level of demand on crossing arterials or activity in adjacent land use. When traffic is very heavy, it is typically heaviest on main arterial in one direction. In these conditions, the main arterial carries higher volumes than the crossing streets.

4.1.1.2 *Operational objectives*

The operational objectives for the arterial under these conditions are to:

- Maximize the throughput along main arterial
- Accommodate the traffic at the critical intersection with a minimum of phase failures
- Provide smooth flow along the arterial through other intersections

4.1.1.3 *Coordination and Signal Timing Strategies*

The signal timing strategies used by the system to accommodate this situation are:

- Determine the critical intersection
- At the critical intersection, select phase times that eliminate phase failures
- At the critical intersection, select phase sequence that eliminates queue overflow in left turn bays
- At the critical intersection, distribute green time to maximize the throughput on main arterial
- At the non-critical intersections, provide enough time to serve all turning and side street traffic without phase failures
- At the non-critical intersections, provide green on the arterial road phases in a manner that minimizes the stops for through traffic along the arterial

4.1.1.4 *Summary of Operation*

Under these conditions, the ADAPTIVE determines the critical intersection and selects a phase arrangement and calculates phase times that accommodate traffic at that intersection. It then sets the timing at the other intersections to provide a green band in the direction of heaviest traffic along the arterial, to minimize the number of stops in that direction. The green time for the non-arterial phases at those intersections is set to accommodate the traffic using those phases, while allocating the remaining time to the arterial road. The system determines the sequence of phases on the arterial (lead-lead, lead-lag or lag-lag) that minimizes the stops in the non-coordinated direction under these conditions.

4.2 MODERATE BALANCED FLOWS

4.2.1 Example: Arterial Road with One Critical Intersection

4.2.1.1 *Traffic Conditions*

During business hours traffic is not congested and the flows along main arterial 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 except at a cross street where there are bus stops and local shops. There is enough side street and turning movement traffic that most signal phases are called every cycle. The left turn volumes are sufficiently high that they need protected turn phases to provide sufficient capacity and prevent phase failures.

4.2.1.2 *Operational Objectives*

The operational objectives for these conditions:

- Provide smooth flow along main arterial
- Provide signal timing that prevents phase failures

4.2.1.3 *Coordination and Signal Timing Strategies*

The coordination approach for these conditions is to provide progression, maximizing bandwidth while providing two-way coordination. The strategies applied while maintaining the cycle length are:

- Provide enough time to serve all turning and side street traffic without phase failures
- 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 the specified intersection, select phase times that accommodate frequent use of all pedestrian phases
- At other, select phase times that accommodate occasional use of pedestrian phases

4.2.1.4 *Summary of Operation*

The critical intersection determines the minimum cycle length that can be used for the entire group. This cycle length accommodates all phases and all pedestrian movements. The ADAPTIVE detects the balanced flows and selects offsets that provide a reasonable compromise between the two directions of travel. At the non-critical intersections, the non-coordinated phases are set to accommodate pedestrians and vehicles, and all spare time is 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 is provided to those phases within the overall cycle length, at the expense of the coordinated phases on main arterial.

4.3 DEMAND AFFECTING EVENT

4.3.1 Example: High Travel Day

During periods of major activity within or close to the ADAPTIVE's area of operation, the traffic characteristics are often like the peak periods, either oversaturated or unsaturated. The system behaves in a similar fashion to those periods, and the detection system determines whether unsaturated or oversaturated conditions prevail. If there is heavily directional traffic before or after the activity, the system determines the predominant direction and coordinates accordingly, with an appropriate cycle length and offset. If the event traffic is not as heavy as peak hours, but the traffic on the corridor is still highly directional, then the system recognizes this and provides coordination predominantly in the heaviest direction, even though the cycle length may be similar to business hours (with balanced flows) cycle lengths.

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.

4.4 FAULT CONDITIONS

4.4.1 Example: Communications Fault Condition

Upon failure of the communication system, *Transparity* Adaptive operations permit traffic controllers to return to default coordination timing for each sub-system.

Each traffic controller is programmed with a communication timeout. When a loss in communication between the central system and the traffic controller exceeds the communication timeout, the traffic controller assumes local control of the operating mode. Adaptive operations resume once communications are re-established.

4.4.2 Example: Detection Fault Condition

For local detector failure, the controller software places either a minimum or maximum recall on the appropriate phase, issue, and alarm, and removes the phase from consideration in the Adaptive algorithm if no other viable phase detector is available to measure phase demand. This does not prevent the Adaptive operation from continuing; it merely ensures this phase is not responsible for a request for time. By continuing operations and issuing an alarm to system operators/technicians, this approach allows the system to continue to provide benefit to the rest of the sub-system without impacting operations due to a single-phase detector issue. Upon restoring the health of the detector, the phase demand status is also restored, and the phase subsequently participates in the Adaptive algorithm.

4.5 Priority and Preemption

4.5.1 Example: Bus Signal Priority

Upon receiving a transit signal priority request, the local controller software (*Omni eX*) provides options to truncate non-priority phase green time, omit non-priority phases, extend priority phase green time or run a phase exclusively called by the priority request.

In the basic setup of a priority strategy, the *Omni eX* software acknowledges user-defined rules when determining if the request is to prevail. These rules include length of time and priority level. *Omni eX* also supports a highly advanced setup of priority strategies that allows the program to use complex logic in the priority request generation, which could include rules such as number of cycles. The advanced TSP parameters are not accessible to users via the front panel.

4.5.2 Example: Emergency Vehicle Preemption

When an intersection responds to an emergency vehicle preemption, other signals within the sub-system continue to run in Adaptive.

4.6 Pedestrians

Upon configuration of an Adaptive sub-system profile, system operators define the minimum phase split times, which can be set to accommodate pedestrian crossing times.

5. EXAMPLE TRAFFIC ADAPTIVE GUIDE

The purpose of the guide is to provide some basics on the tools available to make sure the system is running optimally, and how to recognize and manage any possible issues.

5.1 MONITORING ADAPTIVE OPERATIONS

5.1.1 Web Map

The primary display is the City Web Map. The web map shows the current status of all intersections.

- Intersections running coordinated Adaptive will be **Green**, with a number 5 in the middle of the dot, indicating that the intersection is running coordinated pattern 5, which is the pattern we are using for Adaptive. Occasionally the dot will flash, indicating that the controller is in transition. This occurs at least once every 5 cycles as the Adaptive system adjusts cycles and offsets.
- **Blue** dots indicate intersections running FREE. A number 5 in the dot indicates that this intersection is running peer-to-peer coordination with the adjacent corridor.
- **Red** indicates a controller that is offline, due to either a communications disruption or critical controller failure.
- **Yellow** indicates an intersection in Flash
- **Fuchsia** indicates that an emergency vehicle preemption is active at that intersection

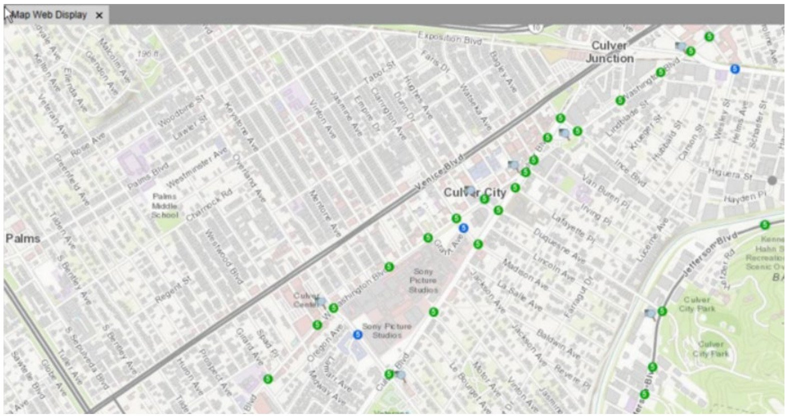


Figure 5-1 - Web Map

- Hover over any icon on the map to see the details for that intersection. Right click to open the action menu. From here you can open displays, view logs, and change config or timing.
- A Flashing Ring around an intersection indicates some sort of alarm condition.

- **Detector Failure** is shown as a **blue** flashing ring. Opening the Intersection or Suitcase Display will allow you to see which detector is failing.
- **Cabinet Flash** is shown as a **red** flashing ring
- **Manual Control** is indicated as a **gray** flashing ring

5.1.2 Command Profile Display

This is the main display for monitoring Adaptive calculations. Here you can see the cycle length, offset, and split adjustments over time, as well as monitor the traffic volumes.

1. Go to **Arterial > Command Profile Display**

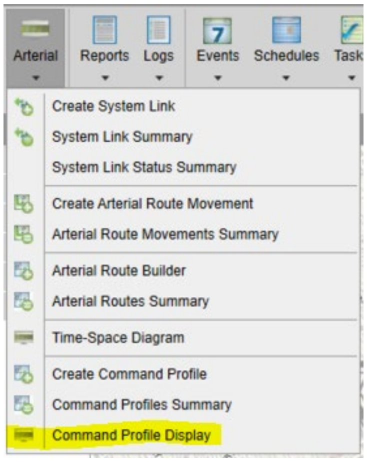


Figure 5-2 - Command Profile Display

2. Select the Adaptive Command Profile you wish to observe, as well as the Date, Time and Duration.
3. If the Adaptive Profile is Advanced Adaptive you will have the option to select **Cycle Length** or **Pattern Threshold.**
4. Click **Update Diagram** After selecting the Command Profile and Date/Time/Duration.
5. Checking the **Real Time** box will cause the display to automatically update once every cycle.

5.2 CYCLE LENGTH DISPLAY

This Display shows the cycle length over time. The display is updated once per cycle, at the Master Cycle Zero point. Clicking on any dot in the display will show the calculation results for that cycle. It also shows the max cycle and min cycle for the current Adaptive pattern.

The lower Data portion of the display shows what the calculated cycle time is for the chosen master cycle zero time. For that calculation point it shows each controller's cycle request, current and next offset, and whether the controllers were in Transition or Preemption. A

Status of Active means that the controller's Adaptive split calculation routine is running and Adaptive is engaged. Active Pending means the controller has suspended split adjustment and is attempting to get back into active mode (usually due to recovery from a transition or preemption). Unknown means the controller is not communicating. Error Cycle or Error Split means that there was an error in the calculation; normally, this is due to a miscalculation when setting up the Min Splits.

Clicking on any controller in the list brings up the split calculation display on the right side. This will show you for each phase what the previous Adaptive split was versus what the phase actually used, and the minimum split. Demand shows whether the demand has increased or decreased based on gap/max out. Trend shows once a phase has reached its consecutive max count or consecutive gap count. If an upward trend has been established the system will increase the split time for that phase, likewise a decreasing trend will decrease the split time. The new split time will show up in the Issued column.

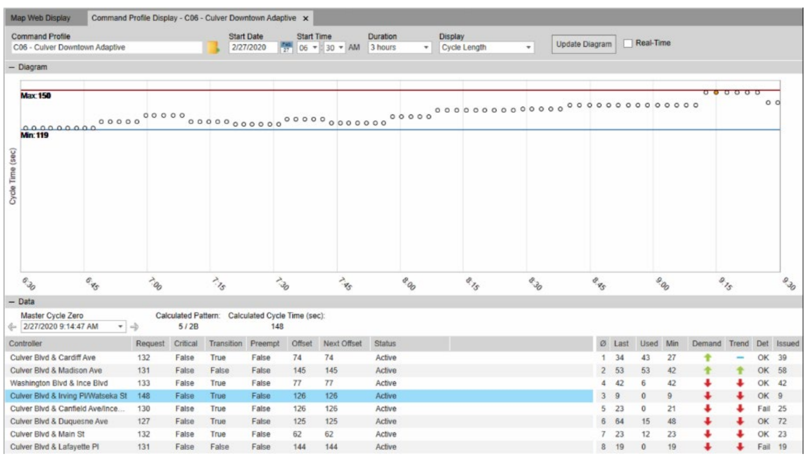


Figure 5-3 - Cycle Length Display

5.3 Pattern Threshold Display

From the Command Profile Display, change the **Display** source from Cycle Length to **Pattern Threshold**. The Pattern Threshold Display will show the results of the system detector calculations. Each dot in the diagram corresponds to a calculation point, which will show you the percentage of volume relative to 1000 vehicles per hour, as measured by the System Detectors assigned to that Command Profile. At each calculation interval the detector that has the highest volume will be used to determine the threshold % and direction of travel.

You can observe where the calculation falls with respect to the 100% threshold (1000 vph) for each pattern change. The yellow dotted lines represent increasing thresholds, while the blue dotted lines represent decreasing thresholds.

The data section below shows the primary directional flow for each calculation point, as well as the associated Pattern. The percentage of lane capacity for each flow is shown. The difference between flow one % and flow two % is used to determine the primary direction, as well as directional volume %.

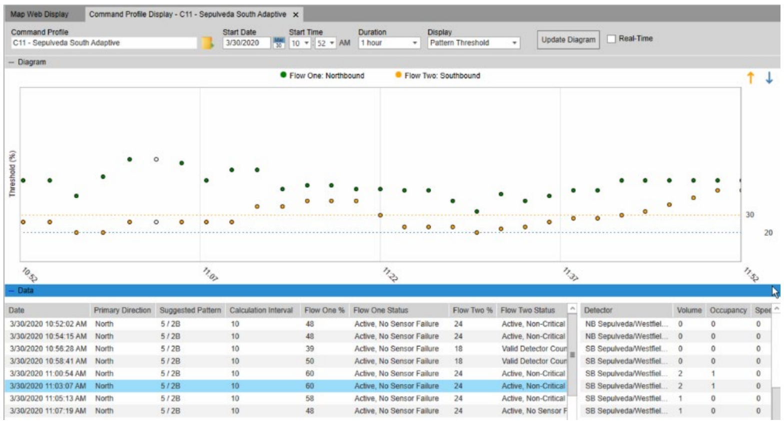


Figure 5-4 - Pattern Threshold Display

5.4 Time-Space Diagram

The Time-Space Diagram allows you to view the green band progression through the associated Route. This is valuable for analyzing offset effectiveness.

Go to **Arterial > Time-Space Diagram**

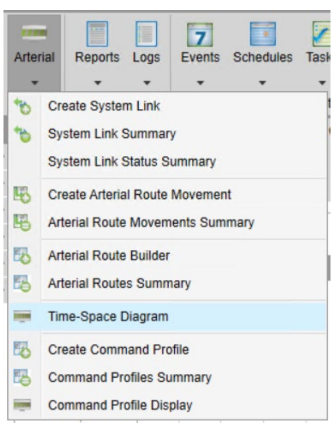


Figure 5-5 - Arterial > Time-Space Diagram

Select the Arterial Route you wish to evaluate. The display shows distance vertically and time horizontally. The green band in each direction is shown as a green or blue colored band from one intersection to the next. The slope of the band is determined by the speed of that link.

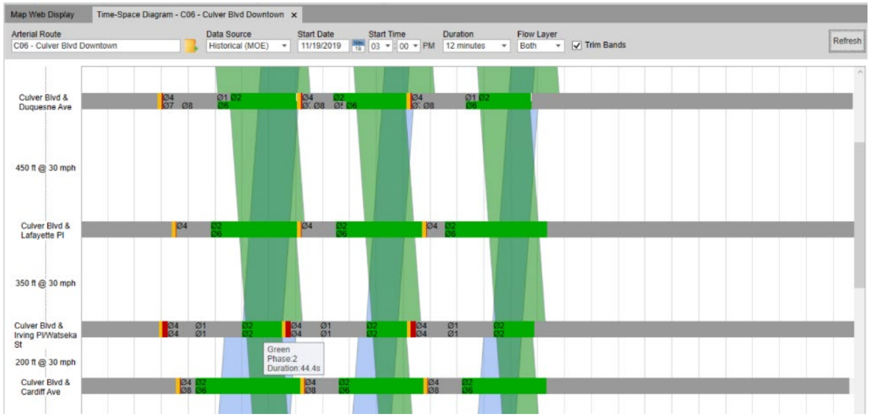


Figure 5-6 - Time-Space Diagram

Data Source: Historical Measure of Effectiveness (MOE) is based on MOE Logs collected from each controller. Real time measures are collected from the current status, and updates in real time. Programmed allows you to evaluate the green band for any coordination pattern in the controller timing.

Flow Layer: This allows you to select either the Forward, Reverse, or Both directions

Trim Bands: Checking this box will show only the portion of the starting green band that makes it though each intersection. When disabled you can see the actual untrimmed green band from one to the next.

5.4.1 Detection Faults

Good detection is the key to optimal Adaptive operations. Detectors are the controller's way of knowing whether it needs to increase or decrease the split time. Also, they are used to determine the directionality of the corridor. Once a failed detector is identified a signal tech will need to address the issue in the field.

Detector Faults are indicated by a Flashing Blue Ring around the intersection dot. This indicates that at least one of the detectors at that intersection has failed. A detector is reported as failed if it has been stuck on continuously longer than the Max Presence time (usually 7 minutes).

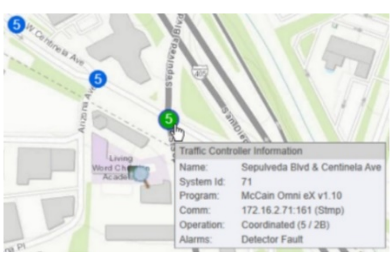


Figure 5-7 - Detection Faults

To identify the specific detector that has failed you can check the Intersection Display. Right Click on the intersection and go to Aerial Display. The detectors that have failed will be Red.

Figure 5-8 - Fault Detector

Phases with failed Adaptive detectors will not adapt. These phases will run at their minimum split until the detector failure is corrected. You can see which phases have failed detectors from the Command Profile Display.

Ø	Last	Used	Min	Demand	Trend	Det	Issued
2	116	29	80	⬇	⬇	OK	116
4	34	12	33	⬇	⬇	OK	34
5	18	0	18	⬇	⬇	OK	18
6	98	0	62	⬇	⬇	Fail	98

Figure 5-9 - Command Profile Display

5.4.2 Communications

Reliable communication is critical to system performance. If the system is experiencing communications issues one of the following things can happen:

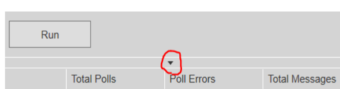
- If a controller does not receive a command from central for 60 seconds, it will drop out of Adaptive and back to its local time of day schedule
- If a controller in any Adaptive group is offline for more than 60 seconds all controllers in the group will return to their local time of day schedules
- If a communication to a controller is intermittent the corridor may get into a suspended state, due to too many failed attempts to gather the Adaptive data necessary for calculations

5.4.3 Identifying Basic Communications Issues

- First, check the System Web Map for Offline intersections (indicated by a RED dot)
    - The system can be configured to send an email when a controller goes offline
- Any controllers running Adaptive should be running Pattern 5, with a couple exceptions: Pattern 3 is the special AM Adaptive pattern on South Sepulveda, and Pattern 6 is the special PM pattern on the Downtown and East Corridors
    - The center of the green dot on the system map will display the number of the active Pattern. You can also verify the active pattern by hovering over the intersection, opening an intersection display, or using the Pattern Control interface
    - **If any controller is running Pattern 1 or Pattern 2 the controller is not in Adaptive**

5.4.3.1 Comm Error Log

- If you suspect that a corridor is in the suspended mode, check the Comm Error Log for excessive errors
    - Go to **Logs > Comm Error Log**. Find the controllers in question on the list. You can use the Filter to narrow the list to the controller or corridor you are interested in:



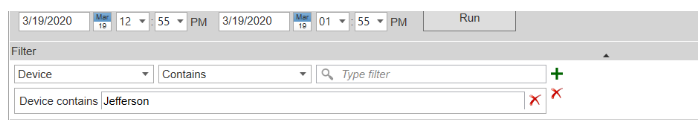


Figure 5-10 - Error Log

- Check for intersections that have a higher than normal # of Poll and Message Errors. Each entry in the log shows the number of errors over the last hour. Anything higher than 30 poll errors per hour indicates a possible problem and may require field troubleshooting.

![McCain A SWARCO Company]

6. Advanced Adaptive Operations

6.1 Initial Conditions

Robust communications are critical to the optimal performance of the Adaptive system. Make sure all controllers are online and communicating in *Transparity*.

Timing: Make sure the timing in the system matches the timing in the field. The group that will run Adaptive should have at least one coordination pattern to use as a starting point, where all controllers use the same pattern # and have the same cycle length.

Detection is critical to the optimal performance of the Adaptive system.

All detectors at each intersection should be identified by phase, location, approach and lane, (i.e. Vehicle Detector 2 = Phase 2 EB Advance, lane 1).

System Detectors are used to monitor traffic volumes that are in a location where we will get the best indication of traffic volume and speed on the corridor.

6.2 Detection

Map out your detectors at each intersection. The ideal detection for Adaptive is advanced detectors for through lanes, one discrete input per lane. If advanced detection is not available, limit line can be used.

Identify detectors on the corridor that can be used as System Detectors. For the best performance these should be midblock or advanced detectors on discrete inputs.

Designating Adaptive Detectors: Open the **Timing Editor** and go to the **Vehicle Detectors** page. Check the detectors which have been identified as Adaptive detectors (ideally advanced detectors)

Vehicle Detectors   Detector 1-16

Detector	Call Phase	Switch Phase	Delay	Extend	Queue Limit	No Activity	Max Presence	Erratic Counts	Fail Time	VOS Length (ft)	Volume	Occupancy	Yellow Lock	Red Lock	Passage	Added Initial	Queue	Call	Alt Passage	Alt Min Green	Adaptive	T
1	1		0.5	0	0	0	0	0	0	0.0	☐	☐	☐	☐	☑	☐	☐	☑	☐	☐	☐	
2	2		0	0	0	0	0	0	0	0.0	☐	☐	☐	☐	☑	☐	☐	☑	☐	☐	☑	
3	2		0	0	0	0	0	0	0	0.0	☐	☐	☐	☐	☑	☐	☐	☑	☐	☐	☑	
4	2		0	0	0	0	0	0	0	0.0	☐	☐	☐	☐	☑	☐	☐	☑	☐	☐	☐	
5	2		0	0	0	0	0	0	0	0.0	☐	☐	☐	☐	☑	☐	☐	☑	☐	☐	☐	
6	2		0	0	0	0	0	0	0	0.0	☐	☐	☐	☐	☐	☐	☐	☑	☐	☐	☐	
7	3		0.5	0	0	0	0	0	0	0.0	☐	☐	☐	☐	☑	☐	☐	☑	☐	☐	☑	
8	4		0	0	0	0	0	0	0	0.0	☐	☐	☐	☐	☑	☐	☐	☑	☐	☐	☑	
9	4		0	0	0	0	0	0	0	0.0	☐	☐	☐	☐	☑	☐	☐	☑	☐	☐	☐	

Figure 6-1 - Vehicle Detectors Page

6.3 Adaptive Group

1. Go to **Groups > Create Group**

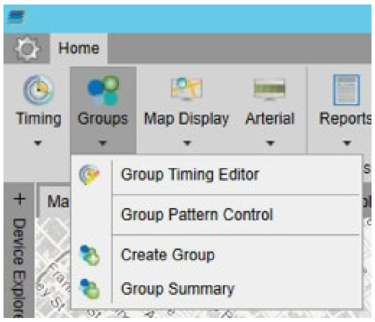
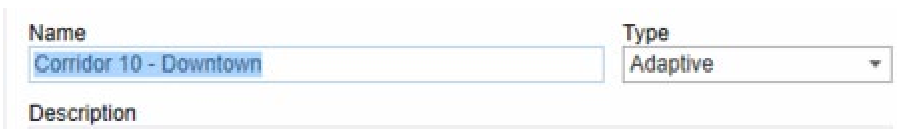


Figure 6-2 - Groups > Create Group

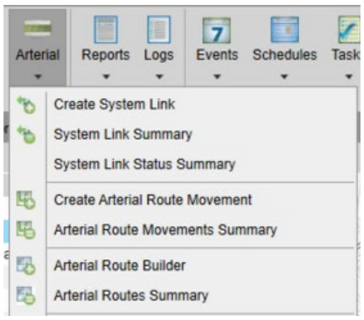
2. Name the Group and select Type Adaptive



3. Add Controllers to the Group

6.4 CREATE ARTERIAL ROUTE

1. Go to **Arterial > Arterial Route Builder**



Go to

2. Select the controllers in your group along the corridor that will be added to the Arterial Route in order. The selected controllers (Arterial Route Nodes) will turn blue.

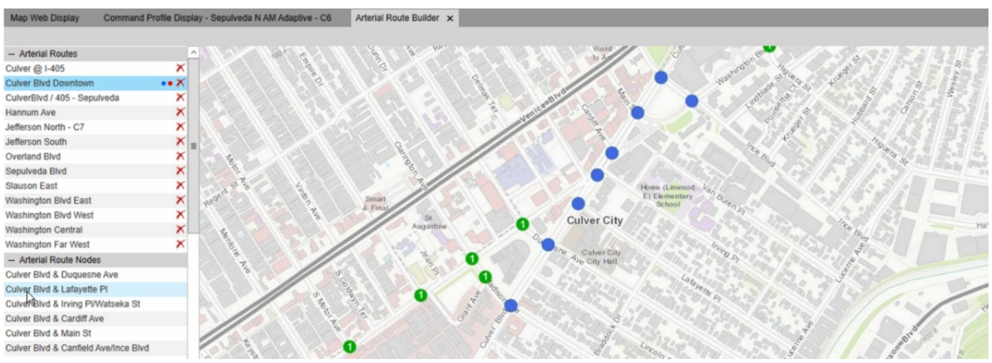


Figure 6-3 - Arterial Route Nodes

3. As you select the Nodes in order the Route Builder will automatically create Forward System Links on the left side

Figure 6-4 - Forward System Links

4. Open the Details Pane by clicking the grey ribbon at the bottom of the Window

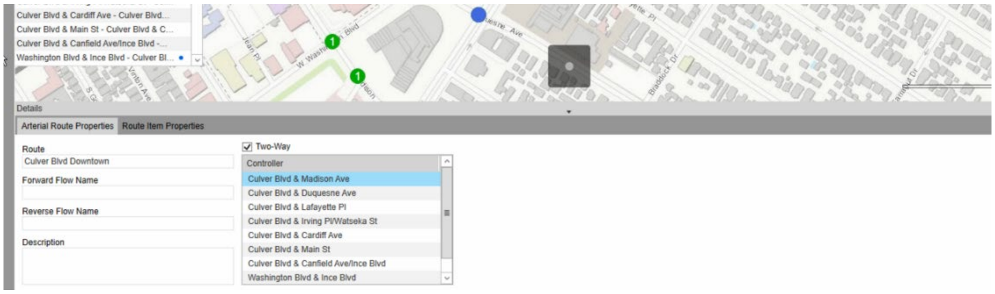


Figure 6-5 - Details Pane

5. **Arterial Route Properties:** Here you can name the Route. Make sure to select Two-Way. When Two-Way is selected it will create Reverse System Links.
6. **Route Item Properties:** As you click on Links on the left side above you will have the opportunity to select the Movement, Direction, Lanes, Design Speed, Capacity and Length (in feet). You can also set Congestion Properties and Assign Detectors to the Link, but it is not necessary for Adaptive.

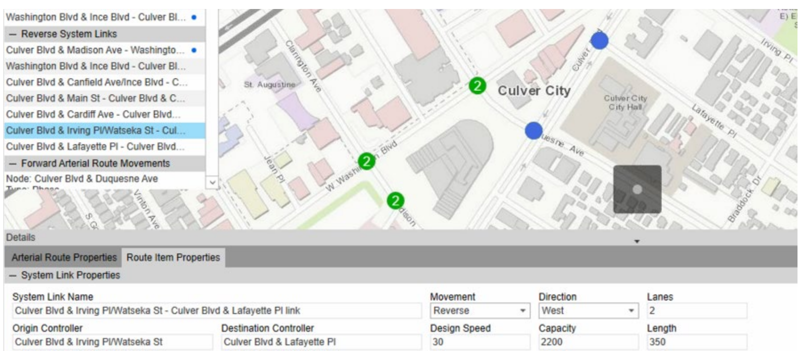


Figure 6-6 - Route Item Properties

7. **Arterial Route Movements:** An Arterial Route Movement specifies the phase (or overlap) that is traversed through when travelling from one system link to the next.

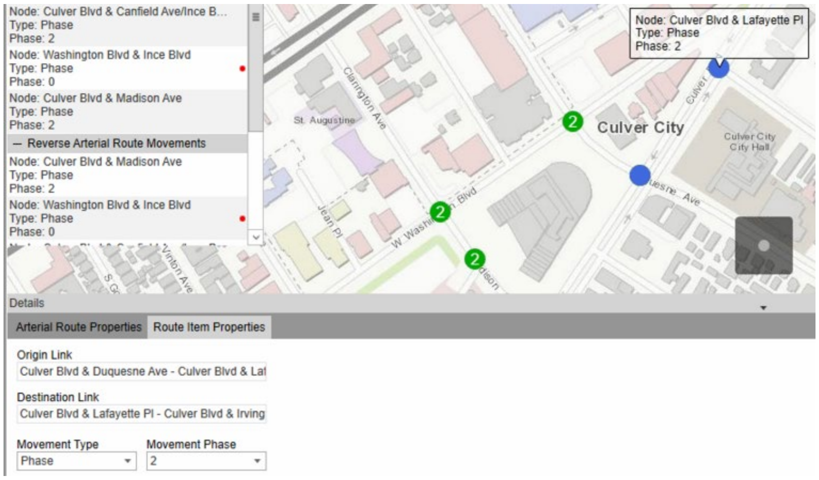
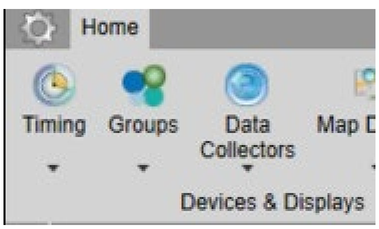


Figure 6-7 - Arterial Route Movements

Save the Arterial Route.

6.5 CREATE SYSTEM DETECTORS

1. Click **Create System Detector** under **Data Collectors**



2. Name the Detector and select the appropriate controller. Assign the detector number in the controller that is associated with the field detector.

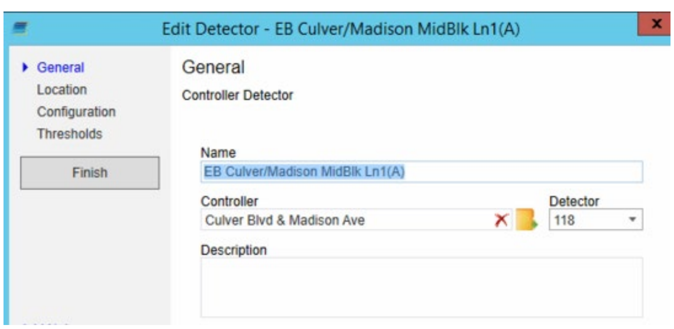


Figure 6-8 - Edit Detector

3. **Location** can be left blank unless you want an icon on the map.

4. Assign the **Movement**, **Direction**, **Detector Type** and **Lane**. Lane Capacity relates to what has will be used as 100% Threshold. This number is multiplied by the Weighing Factor. Thresholds can be set to determine a reasonable range for valid data (usually left default)

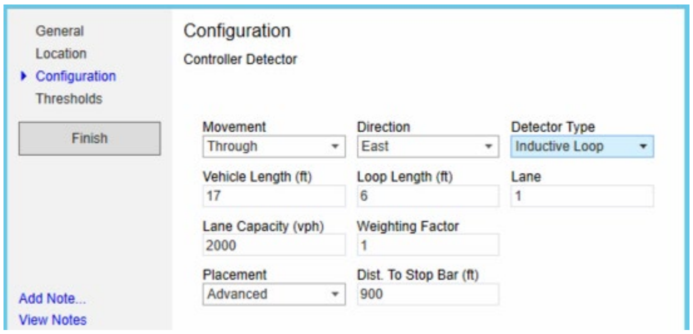
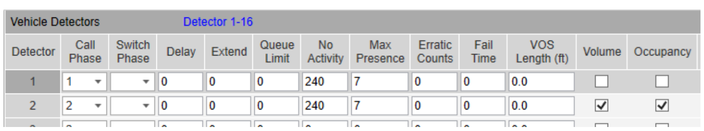


Figure 6-9 - Assign Detector Properties

5. To run Advanced Adaptive there must be at least 4 system detectors (2 per direction).
6. Any controller detector that will be used a system detector must be configured for Volume and Occupancy in the controller timing.



Vehicle Detectors — Detector 1-16

Detector	Call Phase	Switch Phase	Delay	Extend	Queue Limit	No Activity	Max Presence	Erratic Counts	Fail Time	VOS Length (ft)	Volume	Occupancy
1	1		0	0	0	240	7	0	0	0.0	☐	☐
2	2		0	0	0	240	7	0	0	0.0	☑	☑

Figure 6-10 - Configure System Detector

6.6 CREATE THE TRU-TRAFFIC DIAGRAM

1. Create the a KML file in **Google Earth**
2. Under **Places >** Right click **My Places > Add > Folder**

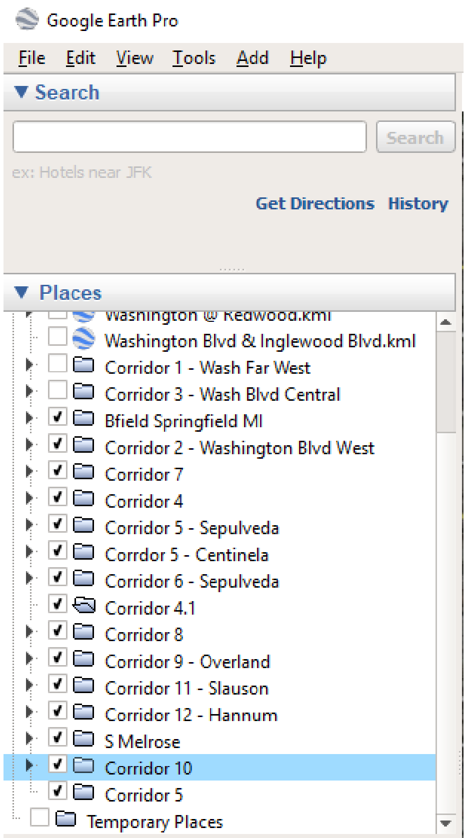


Figure 6-11 - Create Tru-Traffic Diagram

3. Once you have added and named the folder click **add Placemark** to begin adding intersections

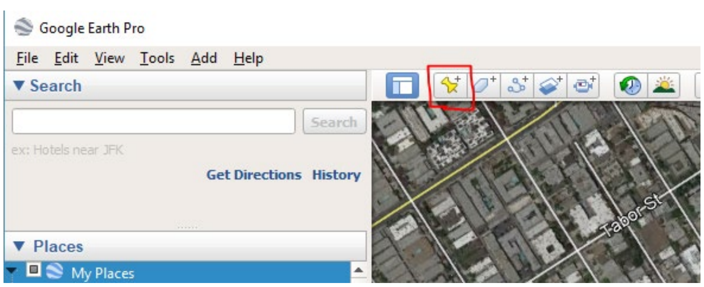


Figure 6-12 - Add Placemark

4. Add a Placemark at each intersection in your corridor and name it appropriately. Once all Placemarks have been added use the Places section on the left to drag the new Placemarks into the folder you created on the previous step. Right Click on the folder and **Save Place As**. Name the file and save as type: Kml.

6.7 TRU-TRAFFIC ID

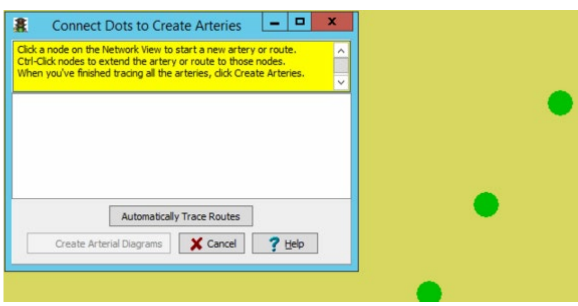
1. Ensure that each controller in your corridor is assigned a unique **Tru-Traffic ID**.

Figure 6-13 - Assign Tru-Traffic ID

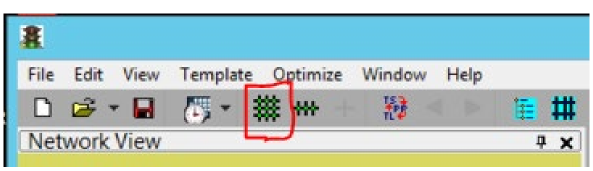
2. If not installed on the server already download and install the latest Tru-Traffic software from www.tru-traffic.com. Make sure you obtain a valid license.
3. Create the Tru-Traffic DGM file

   Open Tru-Traffic and go to **File > Open**. Select type KML and open the file you created.

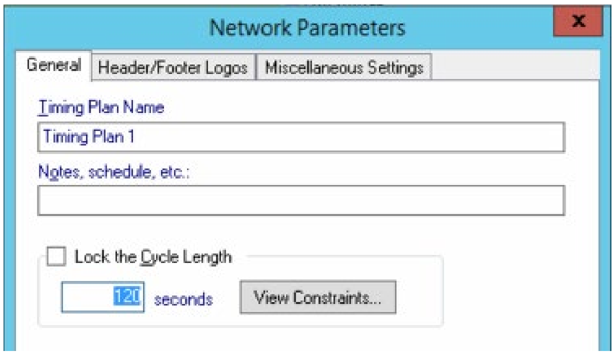
   Connect dots to create arteries or click **Automatically Trace Routes** and **Create Arterial Diagram**.



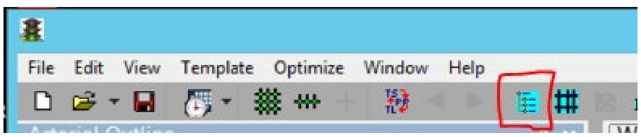
Click on View Network Parameters



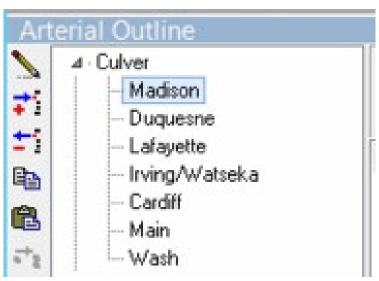
4. Set the Cycle Length (this should match the cycle length of the Adaptive base pattern)



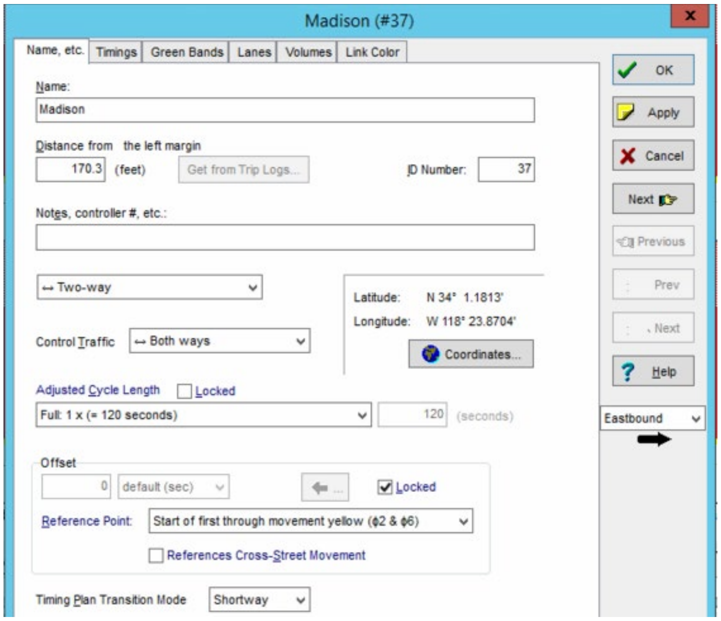
5. Click on View Outline



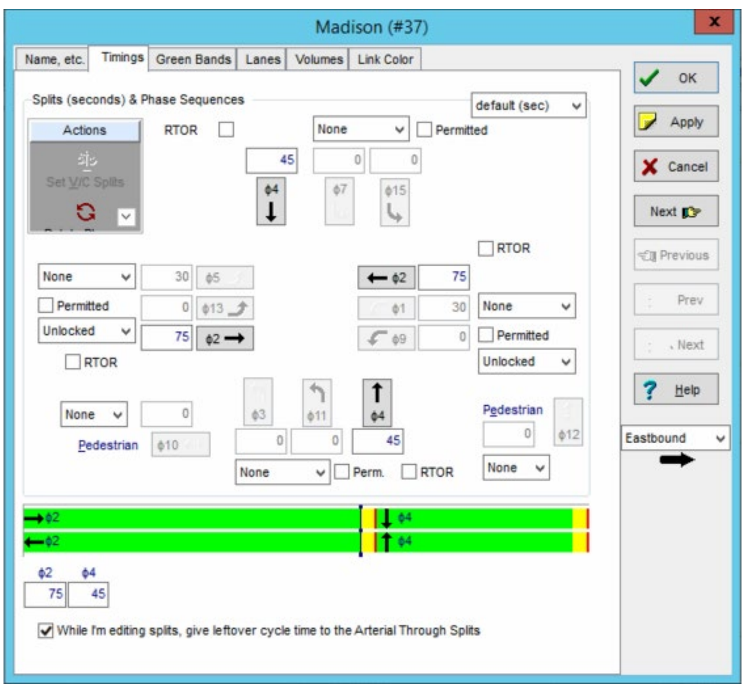
6. Click on the first intersection in the Arterial Outline.



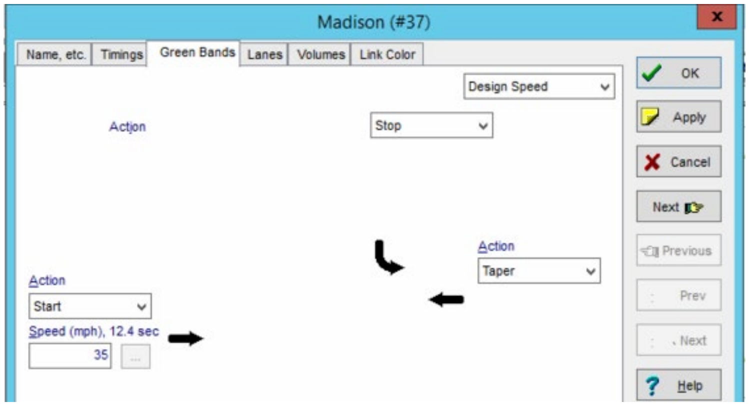
7. Set the **Id Number** (this should match the Tru-Traffic Id in *Transparity*). Set the **Reference Point** to **Start of first through movement yellow.** Choose one of the intersections in the corridor to have Offset **Locked**.



Open the **Timings** tab and set the phasing and split times. It helps to have the **Group Timing Editor** open.



8. Go to the **Green Bands** tab and set the Speed to your design speed. The other tabs are not necessary.



9. Repeat for each intersection in the arterial. Once all changes have been applied, save the file as type DGM. DGM files should be saved to the *Transparity* Data folder.

6.8 Command Profile

1. Go to **Arterial** > **Create Command Profile**

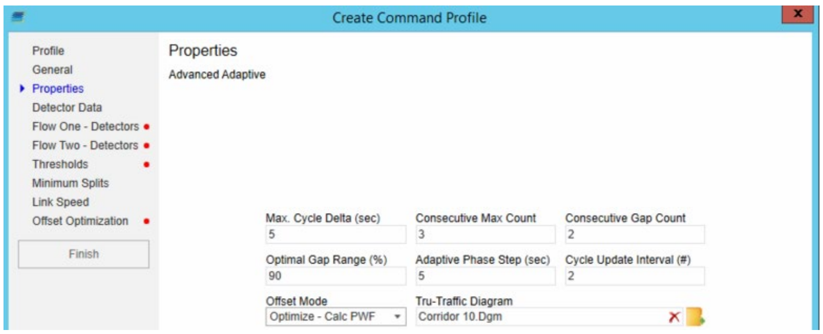
   Profile Type: Advanced Adaptive

2. Name Profile and assign the appropriate Group. Set the following:

   Max Cycle Delta: Maximum # of seconds the cycle length can change from previous
   Consecutive Max Count: The # of times a phase must consecutively max out/force off before requesting more time
   Consecutive Gap Count: The # of times a phase must consecutively gap out before requesting less time
   Optimal Gap Range: Percentage of the split time in which a gap out will be recognized for requesting a decrease. i.e. an Optimal Gap Range of 90% means that a gap will not be considered for a split decrease if it happens within the last 10% of the split
   Adaptive Phase Step: Maximum # of seconds by which the split can be increased/decreased
   Cycle Update Interval: Minimum # of consecutive cycles between cycle changes
   Offset Mode:
   - Locked Pattern Offsets - The offsets will not change from the offsets in the base pattern
   - Optimize – Fixed PWF: The Tru-Traffic diagram will use a fixed Progression Weighting Factor

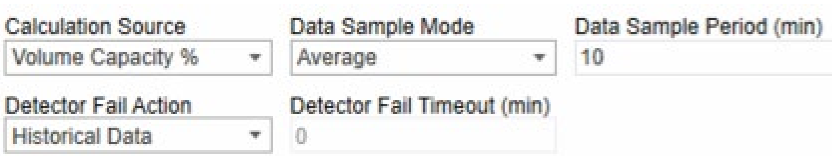
- Optimize – Calc PWF: The Tru-Traffic DGM calculates PWF based on Flow1/Flow2 detectors

Tru-Traffic Diagram: Browse to the diagram previously created – you may need to add as a resource

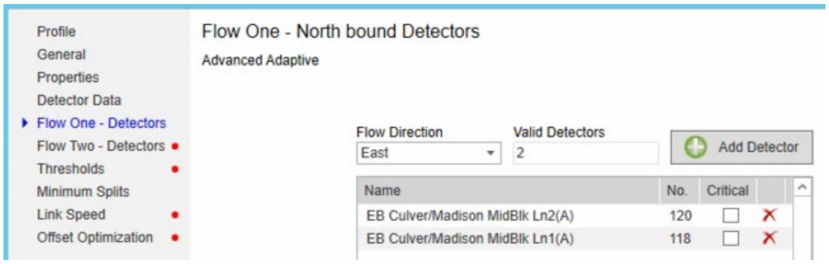


3. Detector Data

Calculation Source:
Volume Capacity %: Percentage of the Lane Capacity value configured in Detector Configuration
Weighted Occupancy: Percentage of Sys Detector Occupancy
V+kO: Volume + (occupancy times a constant (k))
Data Sample Mode: Average of all system detectors per flow or Highest system detector
Data Sample Period: How often the data will be aggregated and used for calculation
Detector Fail Action: Determines what happens upon detector failure. Historical Data is last known good data, Terminate Adaptive will return the corridor to base pattern, Suspend Adaptive will retain last Adaptive cycle and offset
Detector Fail Timeout: The # of minutes a detector is in a failed state before the Detector Fail Action is applied



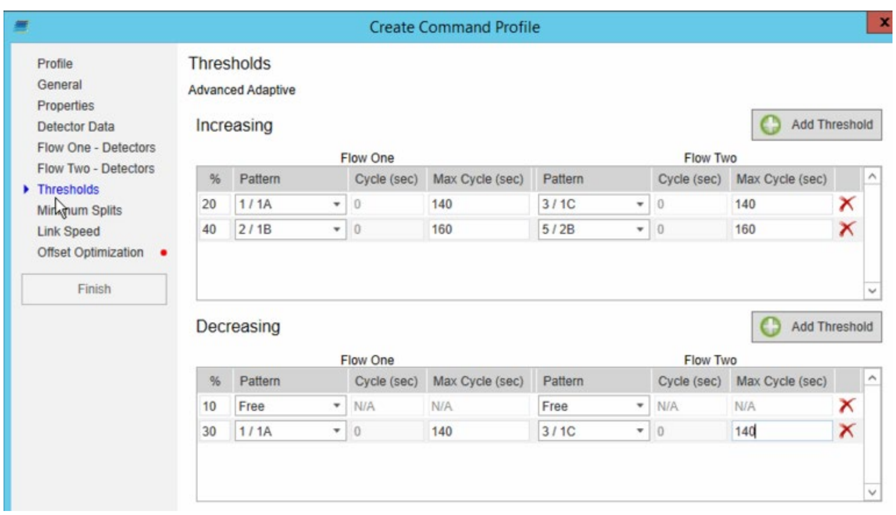
Flow One and Flow Two – Detectors: First select the flow direction. Add the correct system detectors. You must have at least 2 Valid Detectors per flow. If the number of valid detectors drops below the Valid Detectors Threshold or if one of the detectors flagged as Critical has failed the detector fail action will be taken.



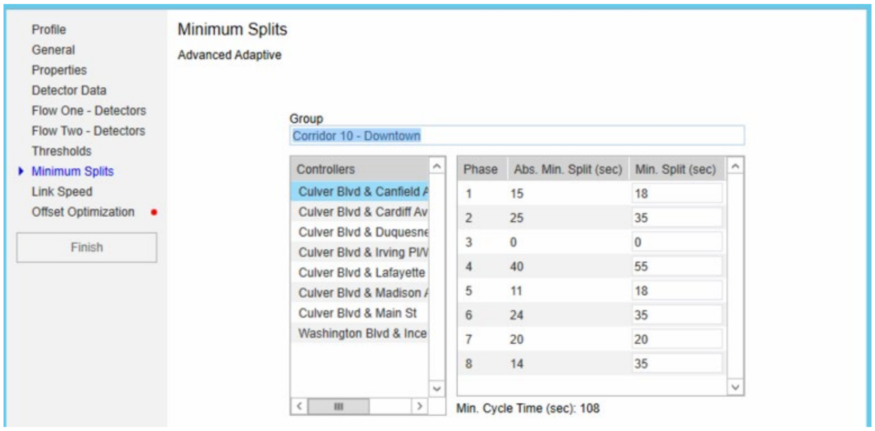
4. Thresholds

Increasing: When the Flow One or Flow two detectors reach the configured percentage (defined by the Calculation Source configured in Detector Data) the specified pattern will be commanded. Whenever a threshold is crossed the system will jump to the base pattern specified and that base pattern will begin to adapt from there. This allows the system to make cycle changes greater than the previously configured cycle max delta when volumes or occupancy change quickly. The highest Flow will be used. The cycle increase will be limited to the max cycle value specified.

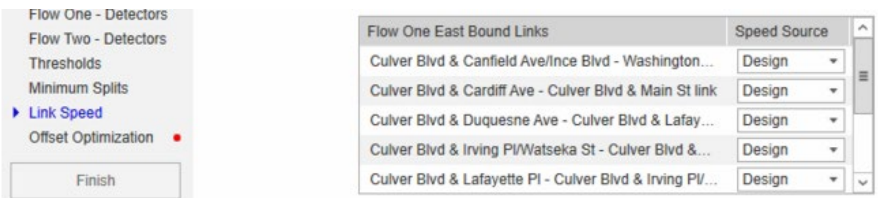
Decreasing: When the Flow One of Flow 2 Detectors drop below the configured percentage the specified pattern will be commanded. It is advisable to use hysteresis by setting the decreasing threshold for a pattern to less than the increasing threshold for the next highest pattern to prevent the system from toggling back and forth if the measured data hovers around the threshold value.



Minimum Splits: For each controller in the group this sets the lowest possible split that each phase can be reduced to in Adaptive. It is important to make sure the Min Split is not greater than the actual split in the Adaptive base pattern. It is helpful to have the Group Timing Editor open to verify split times. Also, it is important that the sum of split times for concurrent ring barrier groups add up to the same value, i.e. the sum of phases 1 & 2 should add up to the same as the sum of phases 5 & 6.

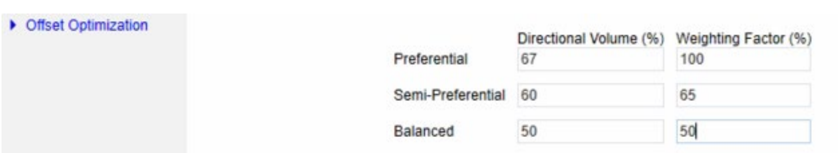


Link Speed: For each Link the offset will be calculated based on either the Design speed for that Link or the speed as measured by the system detectors assigned to that link.



Offset Optimization: If your Offset Mode is set to Fixed PWF then this is where you set the Progression Weighting Factor that will be used in Tru-Traffic when optimizing the Offset.

If the Offset mode is set to Calc PWF then the system will analyze the difference between the Flow One and Flow Two Detectors. The percentage of difference as referenced to the highest flow determines the Directional Volume. The system will send the associated Weighing Factor to the Tru-Traffic diagram for offset optimization.



6.9 Create the Schedule

1. Go to **Schedule** > **Create Schedule**

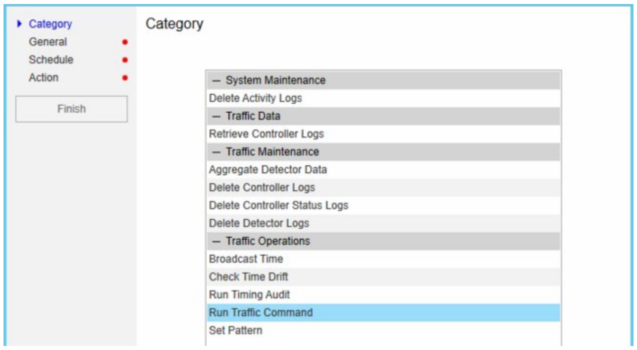


Figure 6-14 - Create Schedule

2. Select **Run Traffic Command**.
3. Name the Schedule, select **Recurring TOD and DOW** and make sure the schedule is **Enabled**.
4. Set the Days of Month, Months of Year and Days of Week, as well as, the start time and end time.
5. **Action:** Select the Traffic Command Profile that was previously created and set the Priority. If multiple traffic command profiles are active for a certain group at the same time the Traffic Command with the highest priority will be the active one.

6.10 Run Adaptive Manually

1. Go to **Schedules** > **Schedule Summary**
2. To immediately start the Adaptive profile, click on the schedule that runs the command profile and select Run Schedule.

6.11 Terminate Adaptive Manually

1. Go to System Options in upper left corner  and go to **Processes**. Select the process that corresponds to the Command Profile and click End Process.

6.12 Observing Adaptive Operations

6.12.1 Command Profile Display

1. Go to **Arterial > Command Profile Display**

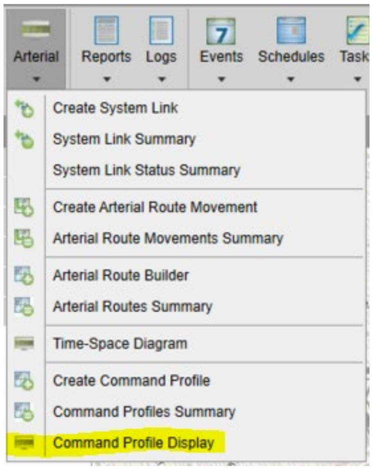


Figure 6-15 - Command Profile Display

2. Select the Adaptive Command Profile you wish to observe, as well as the Date, Time, and Duration.

   If the Adaptive Profile is Advanced Adaptive you will have the option to select **Cycle Length** or **Pattern Threshold.**

3. Click **Update Diagram** after selecting the Command Profile and Date/Time/Duration.

Checking the **Real Time** box will cause the display to automatically update once every cycle.

6.13 Cycle Length Display

This Display shows the cycle length over time. The display is updated once per cycle, at the Master Cycle Zero point. Clicking on any dot in the display will show the calculation results for that cycle. It also shows the max cycle and min cycle for the current Adaptive pattern. The lower Data portion of the display shows what the calculated cycle time is for the chosen master cycle zero time. For that calculation point it shows each controller's cycle request, current and next offset, and whether the controllers were in Transition or Preemption.

A Status of Active means that the controller's Adaptive split calculation routine is running and Adaptive is engaged. Active Pending means the controller has suspended split adjustment and is attempting to get back into active mode (usually due to recovery from a transition or preemption). Unknown means the controller is not communicating. Error Cycle or Error Split means that there was an error in the calculation, normally this is due to a miscalculation when setting up the Min Splits.

Clicking on any controller in the list brings up the split calculation display on the right side. This shows you for each phase what the previous Adaptive split was versus what the phase used, and the minimum split. Demand shows whether the demand has increased or decreased based on gap/max out. Trend shows once a phase has reached its consecutive max count or consecutive gap count. If an upward trend has been established the system increases the split time for that phase; likewise, a decreasing trend will decrease the split time. The new split time shows up in the Issued column.

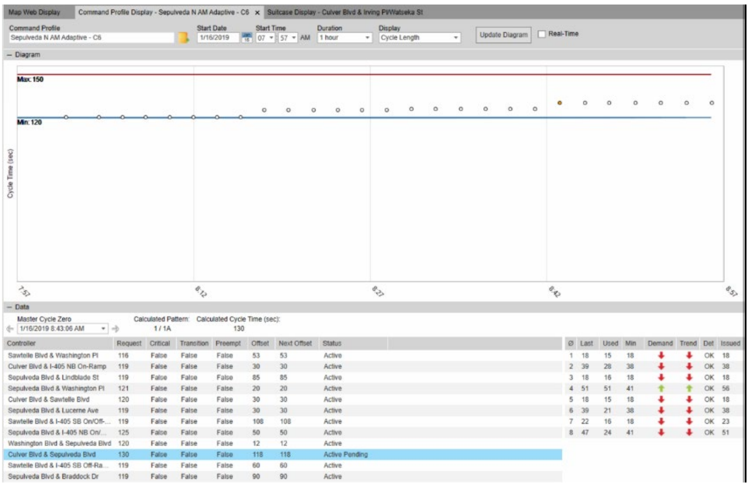


Figure 6-16 - Cycle Length Display

6.14 Pattern Threshold Display

If running Advanced Adaptive mode, the Pattern Threshold Display shows the results of the system detector calculation. Each dot in the diagram corresponds to a calculation point (based on what you have configured for Data Sample Period). The calculation point shows you the percentage of the Lane Capacity value configured in Detector Configuration. This value is either the average of all flow detectors or a highest of all flow detectors depending on what is configured in the profile. The calculation for each flow is shown.

You can observe where the calculation falls with respect to the configured thresholds for each pattern change. The yellow dotted lines represent increasing thresholds, while the blue dotted lines represent decreasing thresholds.

The data section below shows the primary directional flow for each calculation point, as well as the associated Pattern. The percentage of lane capacity for each flow is shown. The difference between flow one % and flow two % is used to determine the primary direction, as well as directional volume %.

The right display shows the data collected for each detector. The VOS period is configured in the controller timing in Log Configuration.

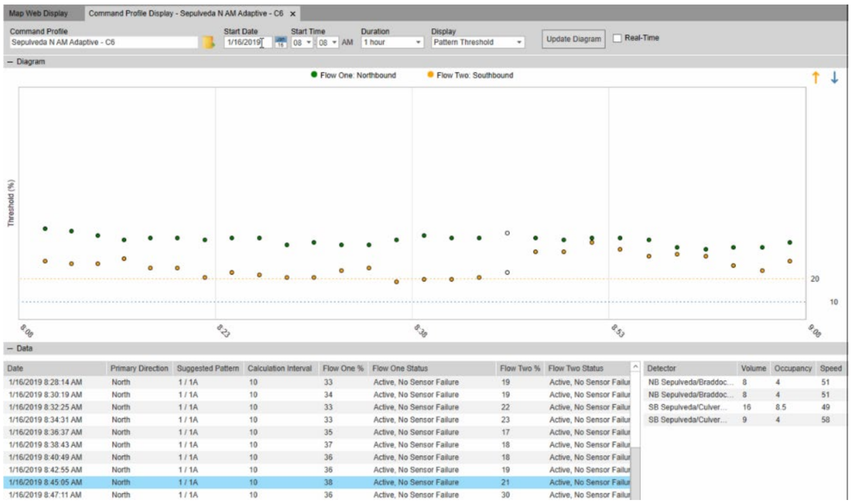


Figure 6-17 - Pattern Threshold Display

6.14.1 Scheduled Timing Audits

It is possible that timing changes can be made in the field without being uploaded to *Transparity*. If that happens the timing in the controller will not match the timing in *Transparity*. In order for a user to be notified of any and all changes the user can set up a scheduled timing audit. A scheduled Timing Audit will periodically run an audit and send a report to specified uses. The audit can be run on a specified group of controllers, or all controllers in the system. If any differences are found the selected users will be emailed a report showing all differences.

1. **Schedules > Create Schedule**

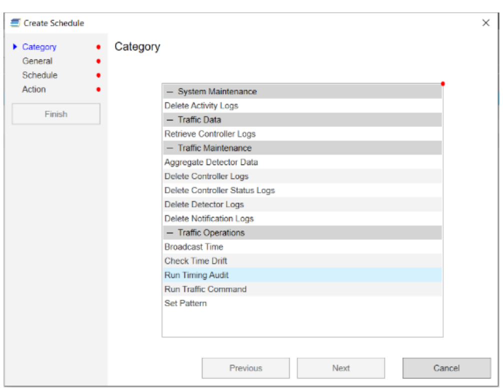


Figure 6-18 - Create Schedule

2. Follow the next steps to set the schedule for when you would like the system to perform the audit and send the email. For example, many agencies schedule it for every Monday at 3AM.

3. Next select the *Transparity* Users that will receive the email.

   At the scheduled time the system will send an email that lists every intersection where the differences were found, and what timing parameter is different. The user can then use the Timing Editor to compare the differences make changes if desired.

7. TRANSPARITY® ADAPTIVE CONTROL SYSTEM COMPONENT REQUIREMENTS

7.1 SERVER REQUIREMENTS

The field communications processor/remote access server (and file server in peer-to-peer networks) consist of a microcomputer system with the following recommended configuration:

- Minimum 2.4 GHz Dual Core Processor (AMD or Intel)
- 8 GB RAM
- SVGA color graphics adapter with 128 MB of vRAM or greater
- SVGA 18" color monitor or greater
- 500 GB hard drive or greater*
- Available serial ports or Portserver required**
- 1200 baud or greater for each serial communications channel
- A minimum of 2 standard network adapters
- Windows Server 2008 R2 or greater
- SQL Server Standard 2008 R2 or greater
- An active internet connection is required to take advantage of *Transparity*'s live web map capabilities (optional)
- *Transparity* client workstations may run on Windows 7 or greater

*Hard drive space requirements may vary based on the intended use of the system. Environments with large amounts of signals may require additional hard drive space due to log files, data captures, aerial graphics, and configurable map data.

**Not applicable in Ethernet-only based environments

7.2 ADAPTIVE COMPONENTS

- Any McCain *Omni eX* controller with *Omni eX* Software
- *Transparity* Traffic Management System

7.3 NETWORK REQUIREMENTS

- Ethernet

7.4 DETECTION REQUIREMENTS

7.4.1 Stop-Bar and/or Advanced Detection

- Detector type: Inductive loops, video detection, wireless sensors, and radar.

- For optimal performance of Adaptive operations, detection providing actuated signal control is required for each approach; however, if detection is not available, Adaptive operations may resume with a phase recall placed on phases without detection.

7.4.2 System Detection

- Mid-block system detection is not required for all modes of operation; however, system detection is required for the measurement of directional volumes (which are used in the calculation of preferred direction of travel / offset optimization).
- The agency may utilize third party mid-block detection systems if an API for the collection of mid-block data is available from the third-party system.
- Advanced detection zones may be used as system detectors.

8. NETWORK ENVIRONMENT

8.1 SYSTEM CONNECTIVITY (TRAFFIC MANAGEMENT CENTER)

The *Transparity* Traffic Management System provides a user-friendly interface, designed to operate on multiple screens within the Agency's traffic management center.

8.2 SYSTEM CONNECTIVITY (AGENCY SIGNAL SHOP)

The client/server architecture permits the installation of the *Transparity* user interface on workstations and/or laptops throughout the organization.

8.3 SYSTEM CONNECTIVITY (AGENCY LAN)

There is no additional licensing fee for additional client workstations within the Agency's LAN. The *Transparity* traffic management system is compatible with and often deployed in environments with VPN access for use outside of the agency.

8.4 SYSTEM CONNECTIVITY (FIELD)

Any McCain *Omni eX* controller, ATC2070, 2070LX, ATCeX NEMA, ATCeX2 NEMA, and FLEX, in addition to the proposed Ethernet equipment, provides operators with full access to the system from each controller or on-street communications hub.

8.5 CENTRAL SERVER

The *Transparity* central server is housed at Agency TMC in an air-conditioned environment.