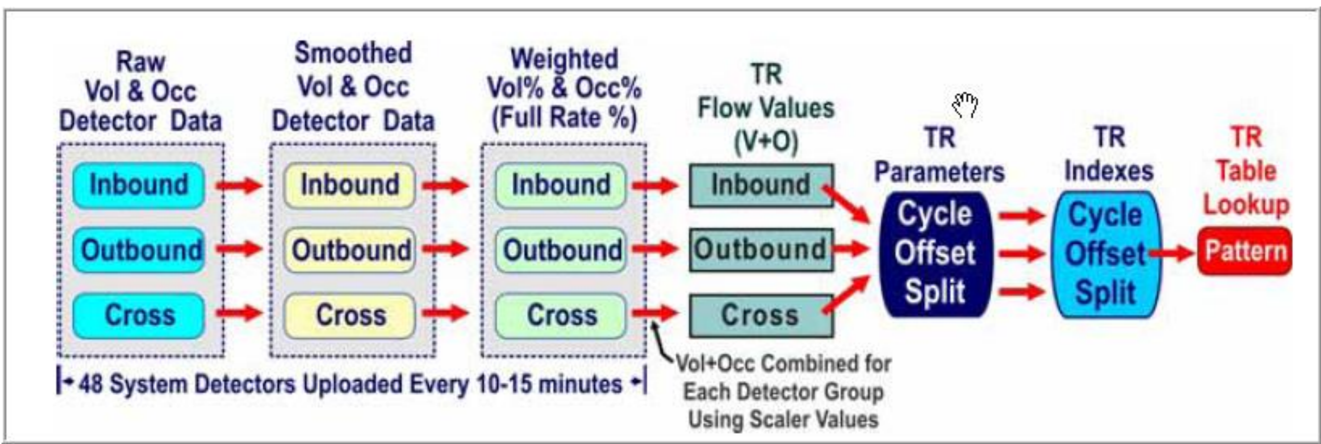
Traffic Responsive Operation Using ATMS.now Centralized Masters



February 2021

522 Gillingham
Sugar Land, Texas 77478
Phone: (281) 240-7233
Fax: (281) 240-7238

Terms of Use Agreement

USE OF THIS SOFTWARE MANUAL IS SUBJECT TO THESE TERMS OF USE.

Agreement

Please read this *User Agreement* carefully before using the information provided in this *Manual*. This Agreement explains the terms and conditions governing the use of this *Manual* ("Terms of Use"), and it is your responsibility to read and understand them. By using this *Manual*, you expressly agree to be bound by these *Terms of Use* and to follow them as well as all applicable laws and regulations governing the *Manual*. If you do not agree to be bound by these *Terms of Use*, you may not access or use this *Manual*. Cubic | Trafficware reserves the right to change these *Terms of Use* at any time, effective immediately upon posting the *Manual* from our company website. By continuing to use the *Manual* after we post any such change, you accept the revised *Terms of Use*. If you violate these *Terms of Use*, Cubic | Trafficware may terminate your use of the *Manual*, bar you from future use of the *Manual*, and take appropriate legal action against you.

Permitted Use

You agree that you are only authorized to read, view and retain a copy of pages of this *Manual* for your own personal use, and that you will not duplicate, download, publish, modify or otherwise distribute the material on this *Manual* for any purpose other than to review product information for personal use or the use of a government or non-profit organization.

No Commercial Use

Users may not use this *Manual* for any commercial purposes such as to sell merchandise or services of any kind. You must obtain our prior written consent to make commercial offers of any kind, whether by advertisements, solicitations, links, or by any other form of communication. Cubic | Trafficware will investigate and take appropriate legal action against anyone who violates this provision.

Copyright

All content included on this *Manual*, including text, graphics, logos, icons, images, and software is the property of Cubic ITS Inc. or its content suppliers and is protected by United States and international copyright laws. This compilation (that is, the collection, arrangement and assembly) of all content on this *Manual* is the exclusive property of Cubic ITS Inc. and is protected by U.S. and international copyright laws. Cubic ITS Inc. reserves the right to revise the pages of the *Manual* or withdraw access to them at any time.

Trademarks

The logo and trademarks that appear throughout the *Manual* belong to Cubic ITS Inc., its affiliates or third-party trademark owners, and are protected by U.S. and international trademark laws. Without express prior written permission, you may not display or use in any manner, the logos or trademarks. Nothing in this *Manual* shall be construed as granting any license or other right to the intellectual property or other proprietary rights of Cubic ITS Inc., its affiliates or any third party, whether by estoppels, implication or otherwise. All contents of the *Manual* are:

Disclaimer of Warranty

YOU UNDERSTAND AND EXPRESSLY AGREE THAT YOUR USE OF THE MANUAL AND THE INFORMATION FOUND THERE IS ENTIRELY AT YOUR RISK. CUBIC | TRAFFICWARE AND ITS AFFILIATES AND LICENSORS MAKE NO WARRANTIES OR ANY REPRESENTATIONS OF ANY KIND, EITHER EXPRESS OR IMPLIED, INCLUDING BUT NOT LIMITED TO WARRANTIES OF TITLE OR NON-INFRINGEMENT OR IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE, NON-INFRINGEMENT OR OTHER VIOLATION OF RIGHTS IN RELATION TO THE AVAILABILITY, ACCURACY, VALIDITY, COMPLETENESS, RELIABILITY OR CONTENT OF THESE PAGES AND/OR THE MANUAL. CUBIC | TRAFFICWARE SHALL NOT BE LIABLE FOR ANY DIRECT, INDIRECT, INCIDENTAL, SPECIAL OR CONSEQUENTIAL DAMAGES, LOST PROFITS OR FOR BUSINESS INTERRUPTION ARISING OUT OF THE USE OF OR INABILITY TO USE THIS MANUAL, EVEN IF CUBIC | TRAFFICWARE HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES. TO THE MAXIMUM EXTENT PERMITTED BY LAW, YOU HEREBY RELEASE AND FOREVER WAIVE ANY AND ALL CLAIMS YOU MAY HAVE AGAINST CUBIC | TRAFFICWARE, ITS AFFILIATES AND LICENSORS FROM LOSSES OR DAMAGES YOU SUSTAIN IN CONNECTION WITH YOUR USE OF THE MANUAL.

SOME JURISDICTIONS DO NOT ALLOW EXCLUSION OF CERTAIN WARRANTIES OR LIMITATIONS OF LIABILITY, SO THE ABOVE LIMITATIONS OR EXCLUSIONS MAY NOT APPLY TO YOU. THE LIABILITY OF CUBIC | TRAFFICWARE WOULD IN SUCH CASE BE LIMITED TO THE GREATEST EXTENT PERMITTED BY LAW.

Applicable Law

These *Terms of Use* and all legal issues related to the *Manual* shall be governed by the laws of the State of Texas, without regard to conflict of laws principles. You agree that any dispute involving these terms of use or this *Manual* will be heard in a court with jurisdiction in Fort Bend County, Texas. You further agree that the prevailing party in any legal action will be entitled to recover its reasonable attorney's fees incurred in connection with that action. If for any reason a court of competent jurisdiction finds any provision of these Terms of Use to be unenforceable, the remaining terms will continue in full force and effect.

Entire Agreement

These *Terms of Use* are the final and entire agreement between you and Cubic | Trafficware with respect to this subject and replace any and prior or contemporaneous understandings or agreements, written or oral, regarding the subject matter. Any waiver of any provision of these Terms of Use shall be effective only if in writing and signed by an authorized representative of Cubic | Trafficware.

Table of Contents

1 Overview

ATMS.now provides the ability to launch a *Central Master* from the ATMS.now *Scheduler* to implement traffic responsive operation for a subsystem of up to 32 local controllers. This feature is useful for systems that have **direct communication** to all units in the field, negating the need for on-street closed loop masters. The operation and database for the *Central Master* is identical to the TS2 981 and 2070 master except that *Central Masters* do not support sub-master features found in the on-street masters.

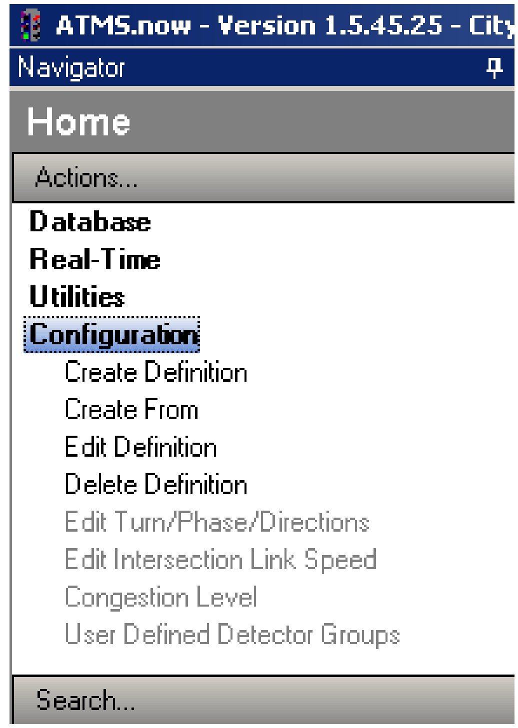
This manual provides an overview of the setup and configuration of a traffic responsive system using centralized masters. In addition, the CIC feature in TS2 controllers is also presented as a way to implement adaptive split control as an alternative to the *Split Index* adjustments under traffic responsive.

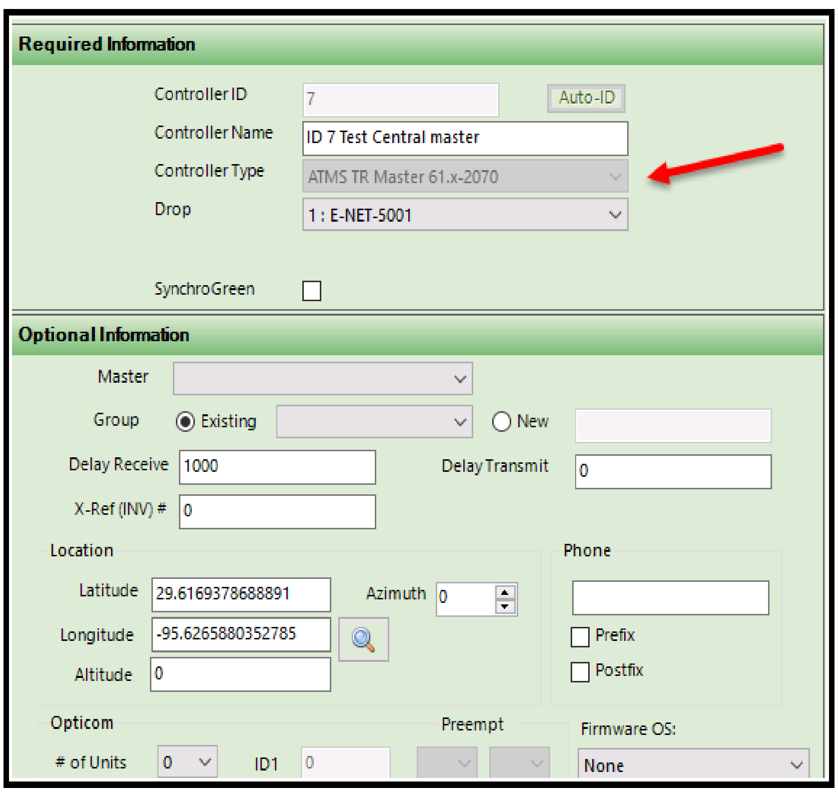
2 Central Master Definition and Setup

This chapter outlines the steps needed to define a *Central Master* in ATMS.now and how to configure the master database. Chapter 3 will show how to launch the *Central Master* from the ATMS.now *Scheduler*.

2.1 Defining the Central Master

You can define a central master from the ATMS.now main toolbar like you would define any other controller in your system. From the Home Module, simply select the Action : Configuration/Create Definition as shown below. This will create a new *Central Master* database. You will edit information on the ATMS Overview screen.





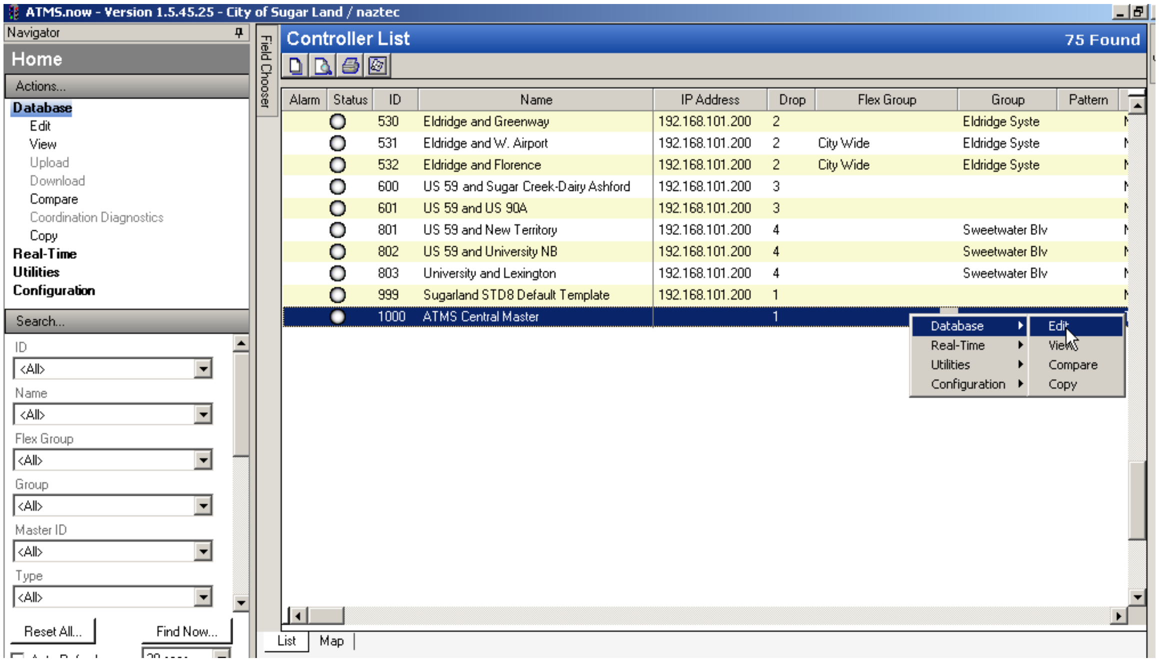
Provide a *Controller ID*, *Name* and *Controller Type* for the *Central Master* as shown to the right. You must select the *Controller Type*, "**ATMS TR Master 61.x 2070**".

It is not important to specify a com *Drop* as the *Central Master* will derive all communication setup from the local controllers assigned to it.

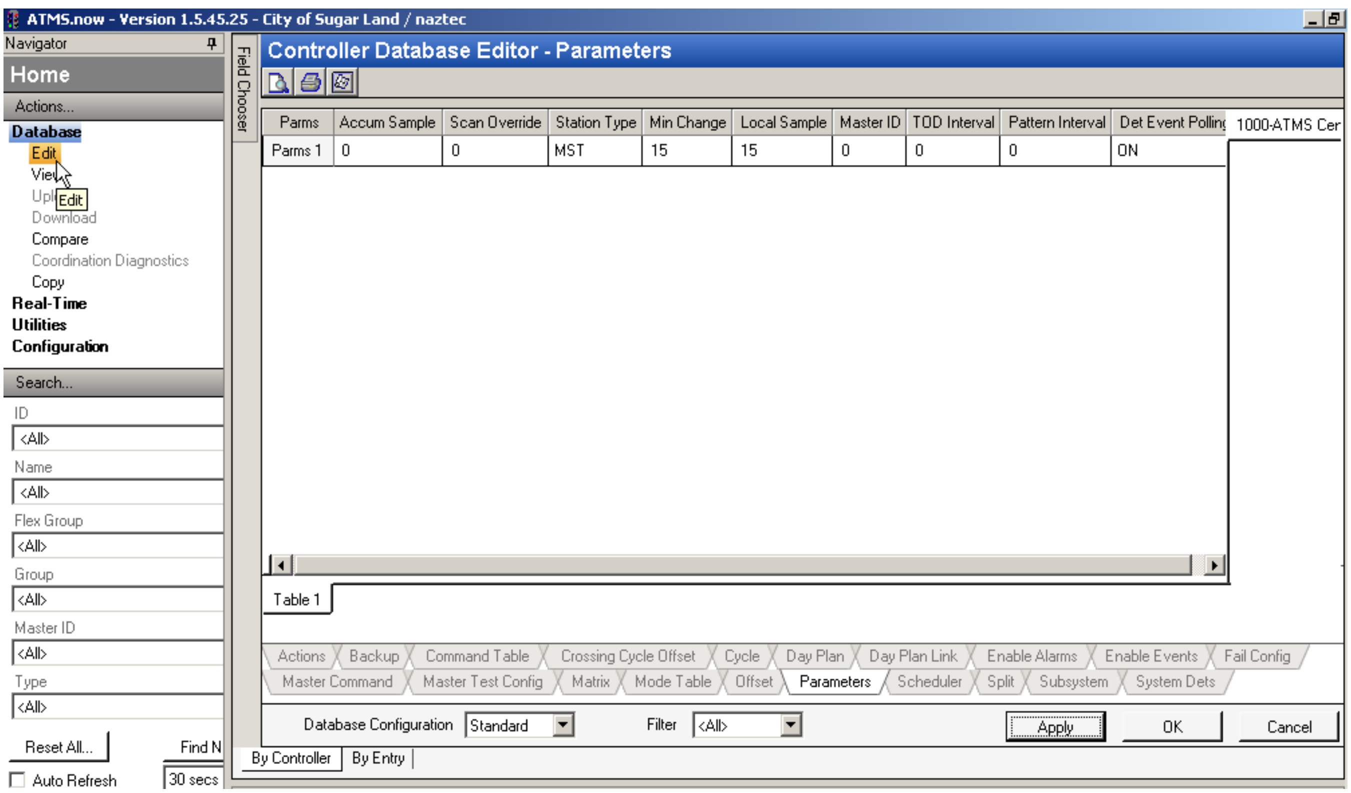
You also **do not need** to modify the controller definition of the local controllers assigned to the *Central Master*. TS2 locals must specify the "Master" field under definitions when they are assigned, but this is not necessary for locals assigned to *Central Masters*.

2.2 Central Master Parameters

Select the *Central Master* from ATMS.now like you would select any local database. Select the Central Master from the List view and select the Action : Database/Edit as shown below.



Note that when you edit the *Central Master* database, the menu tabs are different from the local intersection databases. Select the *Parameters* tab and the overview screen will display the various master parameters.



You must program the STATION TYPE to be MST to enable TR (Traffic Responsive) operation.

Make sure that the LOCAL SAMPLE TIME is set to the same value as the detector sample time programmed in your local controllers under MM->5->8->1 (5, 10 or 15 minutes are common values).

The MIN CHG TIME is the minimum amount of time that the *Central Master* will wait between pattern changes before making a new pattern change. If you set MIN CHG TIME equal to the LOCAL SAMPLE TIME, the master could potentially change patterns every sample time depending on the data uploaded from your system detectors and how you have configured traffic responsive. Therefore, you should set the MIN CHG TIME higher than the LOCAL SAMPLE TIME to make sure that the system is stable if your pattern changes become too frequent.

PATTERN INTERVAL is the minimum time that the *Central Master* will wait between pattern changes before making a new pattern change. You should program this in association with MIN CHG TIME.

Det Polling must be turned ON to enable system detector polling in the *Central Master*.

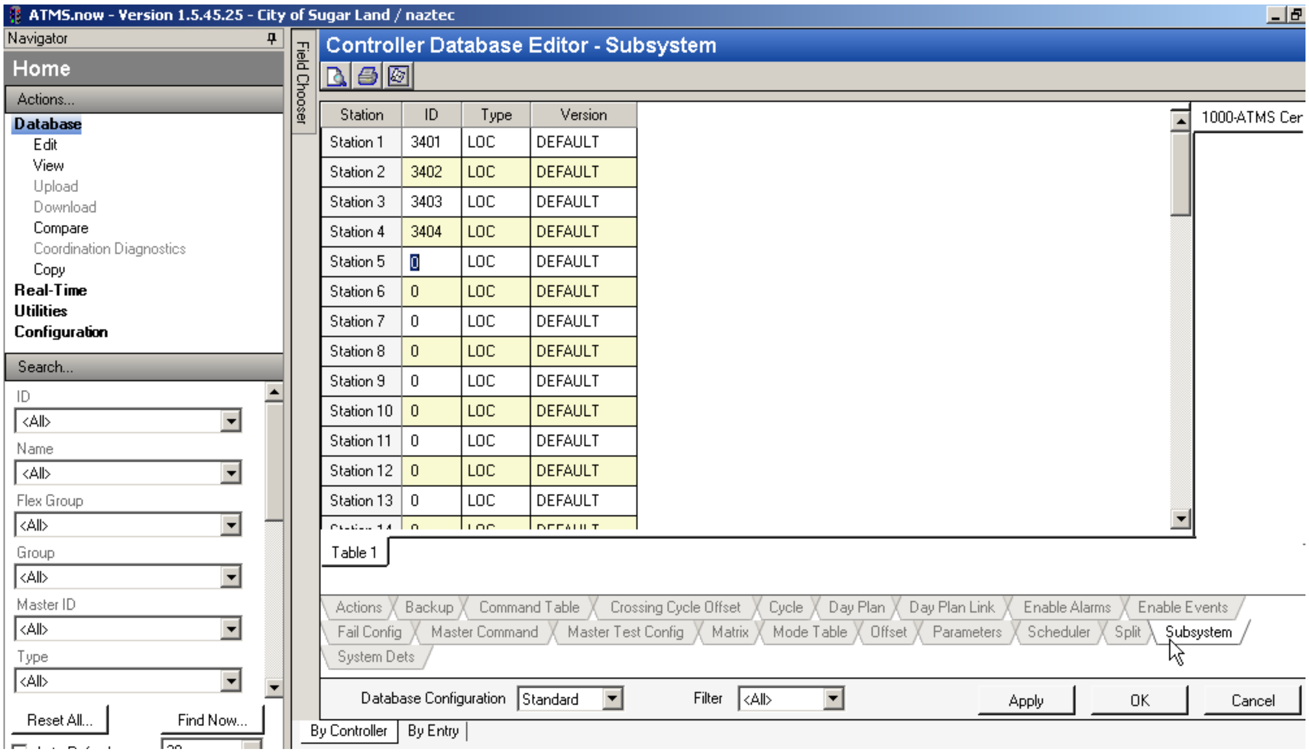
ACCUM SAMPLES only applies to system detector reports generated from an on-street master. Originally it was designed for a field master to save RAM by accumulating samples, **it is not required to be programmed for a *Central Maste***r and should be set to "0".

Note: Because the *Central Master* and the TS2 981 and 2070 on-street master share the same databases, you will need to ignore some of the programming in the database. This manual will become your guide as to which field is needed to configure the *Central Master* for traffic responsive operation.

2.3 Assigning Intersections to the Master Sub-System

The local *Station ID*'s are the only fields required to define the *Central Master* sub-system. The com interface for each ID (serial *Drop* or *IP Address*) is provided in the controller definition for each local. Therefore, the Central Master only requires the *ID* address of each local assigned to the sub-system.

The *Type* field is not required for *Central Masters*. This field only applies to on-street masters and sub-masters to maintain compatibility with legacy Cubic | Trafficware closed-loop systems.



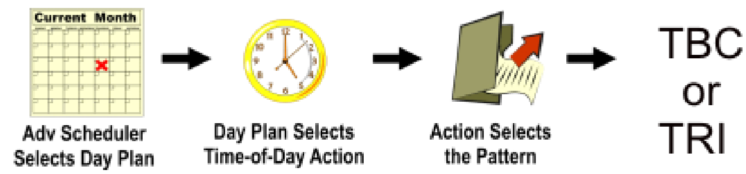
The version field is used to insure proper communications with the local. Selections include:

DEFAULT	This is the selection that you will most likely choose for ATMS.now versions prior to 1.5.45.70.
TSV61	Used if the local is a TS2 controller running version 61.x
2070V65	Used if the local is a 2070 controller running version 65.x
2070V76	Used if the local is a 2070/ATC controller running version 76.x
2070V85	Used if the local is a 2070/ATC controller running version 80.x or V85.x/Scout

2.4 The Master Scheduler – Selecting Master Actions by Time-of-Day

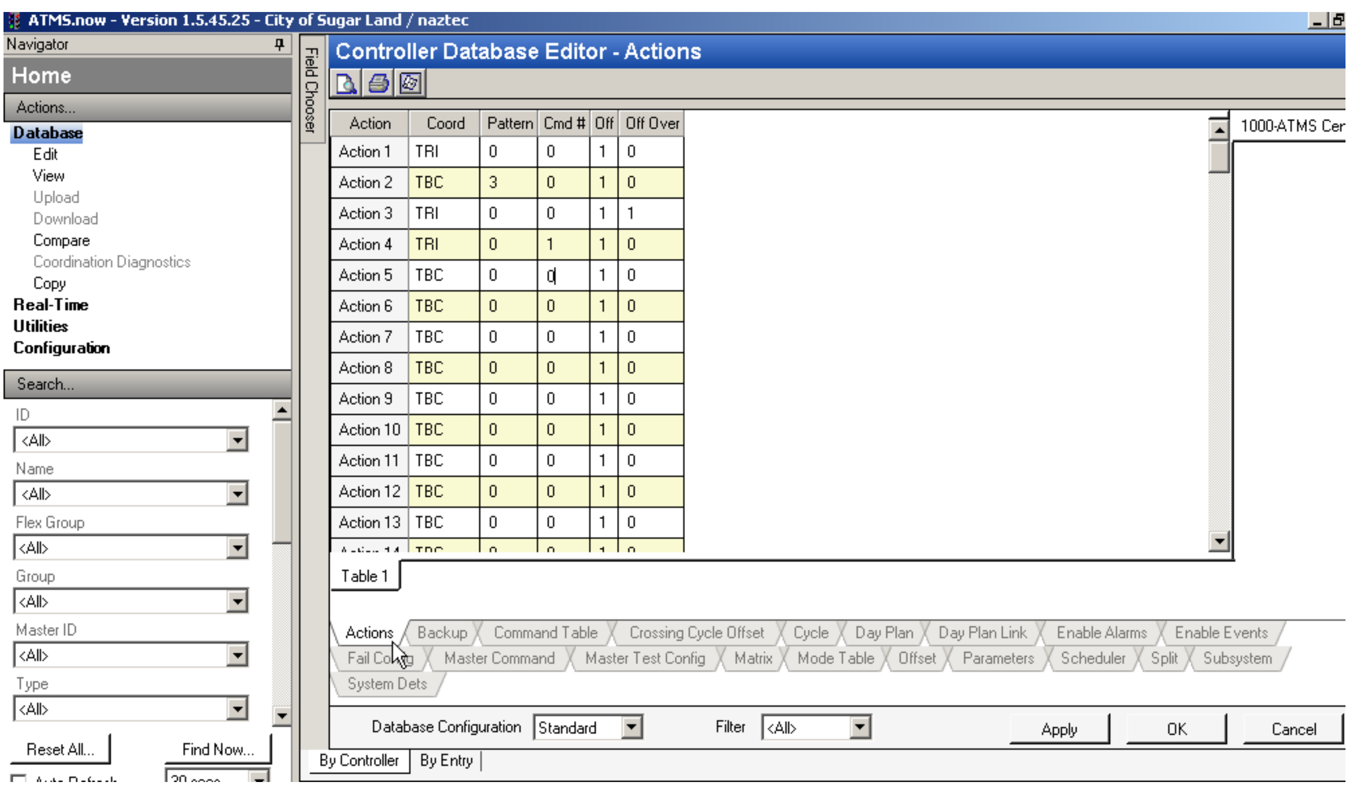
The *Master Scheduler* is identical to the *Local Scheduler* and follows the NTCIP ASC 1202 as discussed in the Cubic | Trafficware controller manual. The time-of-day schedule is evaluated once per minute and uses the system date to select a *Day Plan* from the annual schedule. Next, the master evaluates the *Day Plan* using the current time-of-day to find the time-of-day *Action* for the sub-system.

You vary the *Action* table in the *Central Master* schedule to control whether the master sets the SYS pattern by the time-of-day schedule (TBC) or from traffic responsive (TRI).



An example of *Action Tables* for the *Central Master* is shown below.

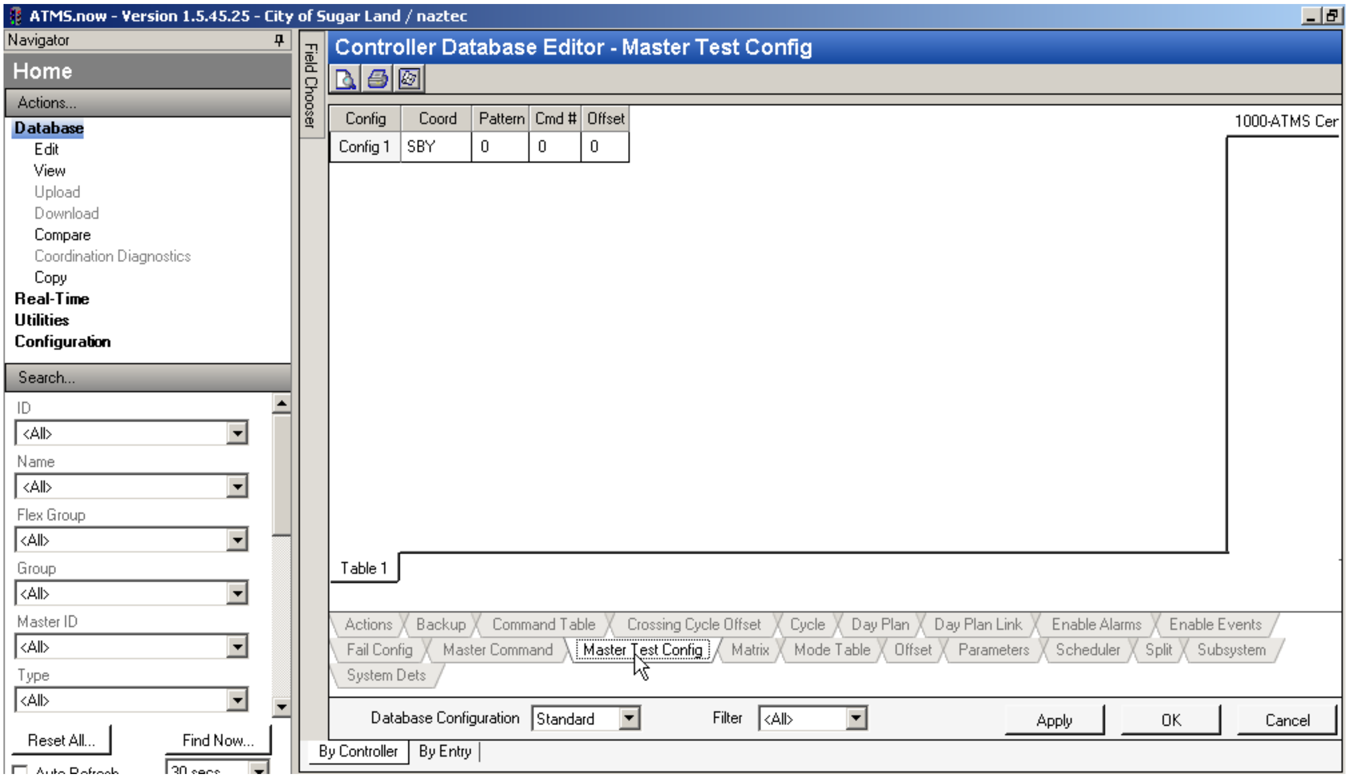
- Selecting Action 1 by Day Plan enables traffic responsive pattern selection (Coord=TRI)
- Selecting Action 2 by Day Plan enables master TBC and sets the master SYS pattern downloaded to the local controllers to pattern# 3 (Coord=TBC)
- Selecting Action 3 enables traffic responsive operation, but overrides the calculated *Offset Index* to 1 (Off Ovr = 1).
- Selecting Action 4 enables traffic responsive and overrides the CMD# (see section 4.1.5)



2.5 Central Master Test Configuration

Recall that TEST OpMode (MM->2->1) in the local controller overrides all other coord modes and sets the *Active* pattern. The on-street master and *Central Master* provides a similar TEST configuration to override the time-of-day (TBC) pattern of all of the secondary controllers assigned to the sub-system.

The *Master Test Configuration* is normally placed in stand-by (SBY) to pass control to the master *Scheduler*. However, you can override the system by setting *Coord Mode* and *Pattern* in *Master Test*.

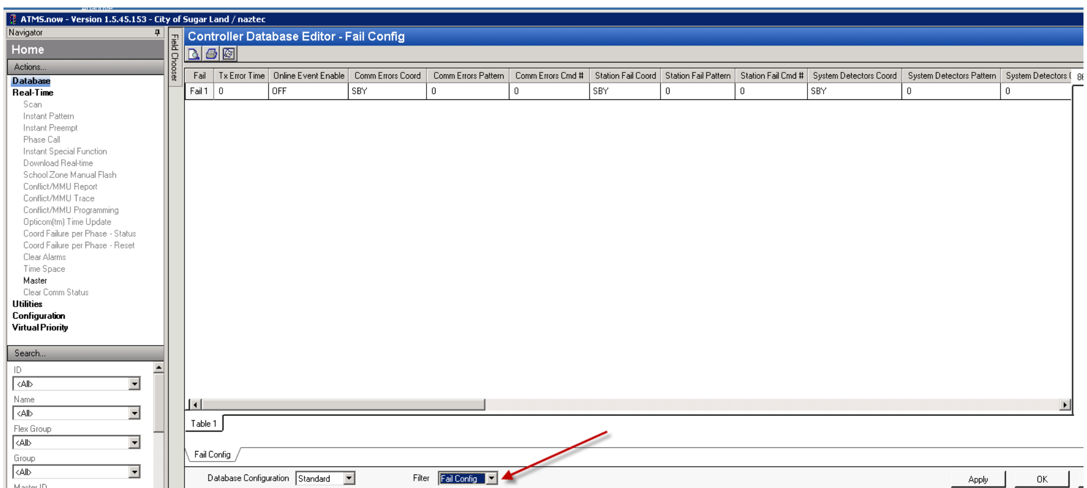


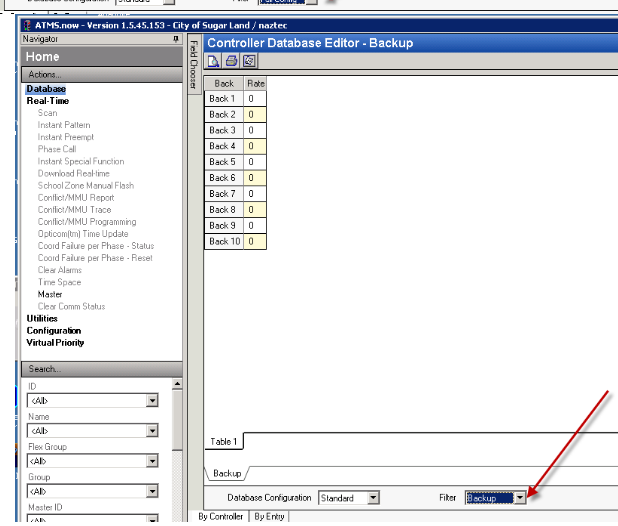
2.6 Central Master Fail Configuration

The *Master Fail Configuration* defines how the master sub-system responds to failure conditions. Typical master system failures included com fails, system detector failures, etc. The *Failure Override* configuration is set when the master detects a failure in the closed loop system. The threshold (number of failures) for each alarm and the fallback response for each failure condition are user selectable. A closed loop system failure is invoked for the following alarm conditions:

- **Communication Errors** – typically reverts all secondary's back to their to local time-of-day schedule
- **System Detector / Station Failures/ Station Offline** – the number of failures typically controls whether the system reverts back to time-of-day operation
- **Stop Timing** – the user can revert the system to free if enough stop time errors are detected
- **Local Alarm Failures** – Local Alarms can revert the system back to time of day operation
- **Coord Failure** – If coordination fails the master can revert the system back to time of day operation

The user must program 2 screens for Failure override to occur. They are the ***Fail Config*** screen and the ***Backup*** screens.





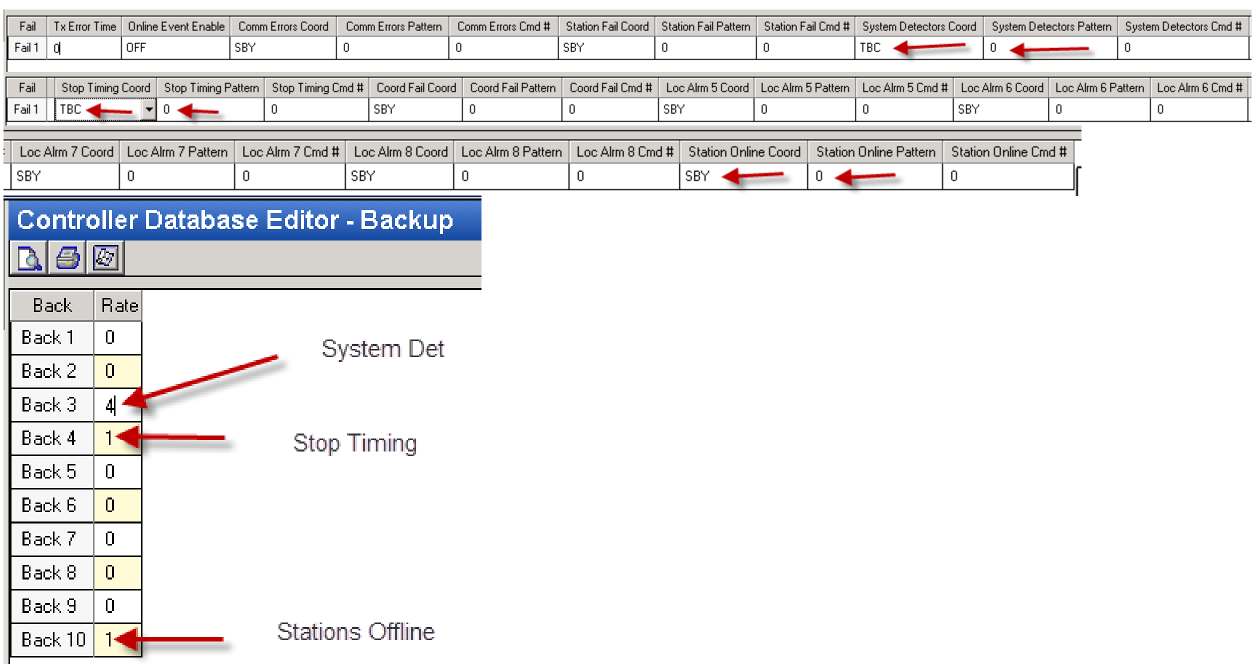
Please note that the Backup screen corresponds directly to the Failure Configuration Screen and the data that is programmed on this screen is the error threshold data. Once that threshold has been met or exceeded, the system will revert back to the operation (pattern) programmed in the Fail Config table. The following list shows the failure and the corresponding Backup number.

Backup #	Failure Mode
1	Comm Errors
2	Station Failure
3	System Det
4	Stop Timing
5	Coord Fail
6	Local Alarm #5
7	Local Alarm #6
8	Local Alarm #7
9	Local Alarm #8
10	Station Ofline

As an example the programmed data as shown below sets the *Central Master Fail Configuration* to TBC pattern# 0 whenever any of the following faults occur within the specified *TX Error Time* (in minutes):

- One or more Station ID's offline
- Four or more system detectors failed
- Stop timing alarm generated at one or more intersections

If any of these conditions occur, the master will send SYS pattern 0 down to each local controller in the sub-system. This effectively forces each controller to run STBC (System TBC) and revert back to the TBC schedules defined in the local time-of-day schedules. You should provide a backup time-of-day schedule in each local controller even if you plan to run traffic responsive all the time. This will allow the master to fail the system and revert it back to local TBC.



Fail	Tx Error Time	Online Event Enable	Comm Errors Coord	Comm Errors Pattern	Comm Errors Cmd #	Station Fail Coord	Station Fail Pattern	Station Fail Cmd #	System Detectors Coord	System Detectors Pattern	System Detectors Cmd #
Fail 1	0	OFF	SBY	0	0	SBY	0	0	TBC	0	0

Fail	Stop Timing Coord	Stop Timing Pattern	Stop Timing Cmd #	Coord Fail Coord	Coord Fail Pattern	Coord Fail Cmd #	Loc Alrm 5 Coord	Loc Alrm 5 Pattern	Loc Alrm 5 Cmd #	Loc Alrm 6 Coord	Loc Alrm 6 Pattern	Loc Alrm 6 Cmd #
Fail 1	TBC	0	0	SBY	0	0	SBY	0	0	SBY	0	0

Loc Alrm 7 Coord	Loc Alrm 7 Pattern	Loc Alrm 7 Cmd #	Loc Alrm 8 Coord	Loc Alrm 8 Pattern	Loc Alrm 8 Cmd #	Station Online Coord	Station Online Pattern	Station Online Cmd #
SBY	0	0	SBY	0	0	SBY	0	0

Controller Database Editor - Backup

Back	Rate
Back 1	0
Back 2	0
Back 3	4
Back 4	1
Back 5	0
Back 6	0
Back 7	0
Back 8	0
Back 9	0
Back 10	1

Intersections that lose communication with the master automatically "fall back" to TBC after the NTCIP *Fallback* timer expires. The locals still in communication with the master will revert back to TBC when the *Master Test Configuration* fails and the master sets the SYS pattern to pattern # 0. At that point, the entire system will revert back to TBC, but will be in SYNC off of the internal time base in each local. Cubic | Trafficware controllers can maintain acceptable clock accuracy for extended periods following a Comm failure allowing the sub-system to remain synchronized until communication is restored.

Keep in mind that the number of *Comm Errs* can be quite high if the interconnect system is "noisy" and the TX ERR TIM is assigned a long value (say 10 minutes). A *Comm Errs* threshold of 50 (5 com errors per minute during the 10 minute TX ERR TM) may be reasonable depending on the type of communications used if the number of retransmits is quite high. The thresholds for the other categories can vary greatly with the number of stations (secondary controllers) assigned to the closed loop system. Also, a system with a large number of redundant system detectors can tolerate more system detector failures than a system with a few critical detectors.

When a controller is properly communicating with the central master, you will see the controller report **S-TBC** Status to ATMS.now. When a controller reverts to TBC due to communications issues, you will see the controller report **B-TBC** Status to ATMS.now. Programming the NTCIP *Fallback* timer is critical to avoid **B-TBC** from occurring. The local controller's *Fallback* Timer should be programmed to insure that the central master has enough time to send the pattern down to the local. For example, if the master's *Min Change Time* is programmed to 15 minutes, the *Fallback* timer in the local has to be at least 15 minutes (900 seconds) to insure proper communication. If a local controller is operated by more than one central master scheduled consecutively, the *Fallback* Timer on the local has to be long enough to accommodate the communications time between masters. If both masters have a *Min Change Time* of 15 minutes, the *Fallback* timer in the local has to be at least 30 minutes (1800 seconds) to insure proper communication.

2.7 The ATMS.now Control Hierarchy

The user should be thoroughly familiar with the hierarchy of the ATMS.now control system as discussed under section 1.3 of the ATMS.now Operations Manual. In general, the SYS pattern passed down to the local intersection controllers can originate from either a *Central Master* or *Field Master* (but not both). The master SYS pattern will override the TBC pattern generated by the local time-of-day schedule if SYS is not in stand-by (SYS = 0).

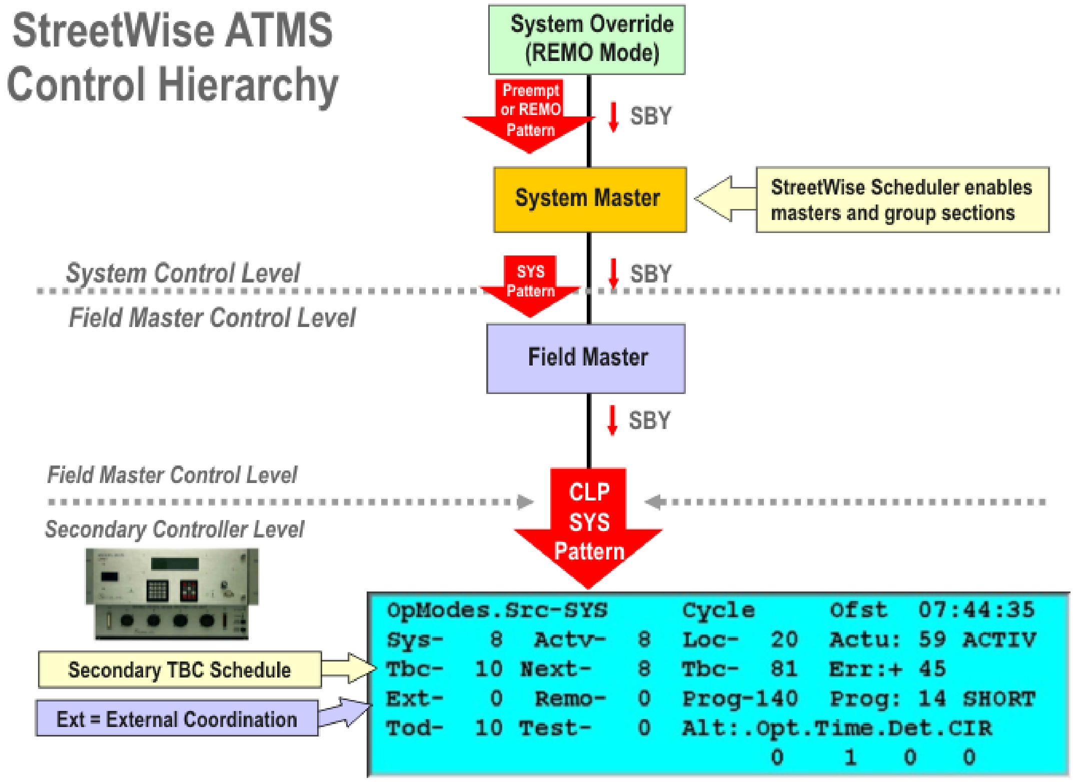
The hierarchy of control within a *Central* or Field Master is as follows:

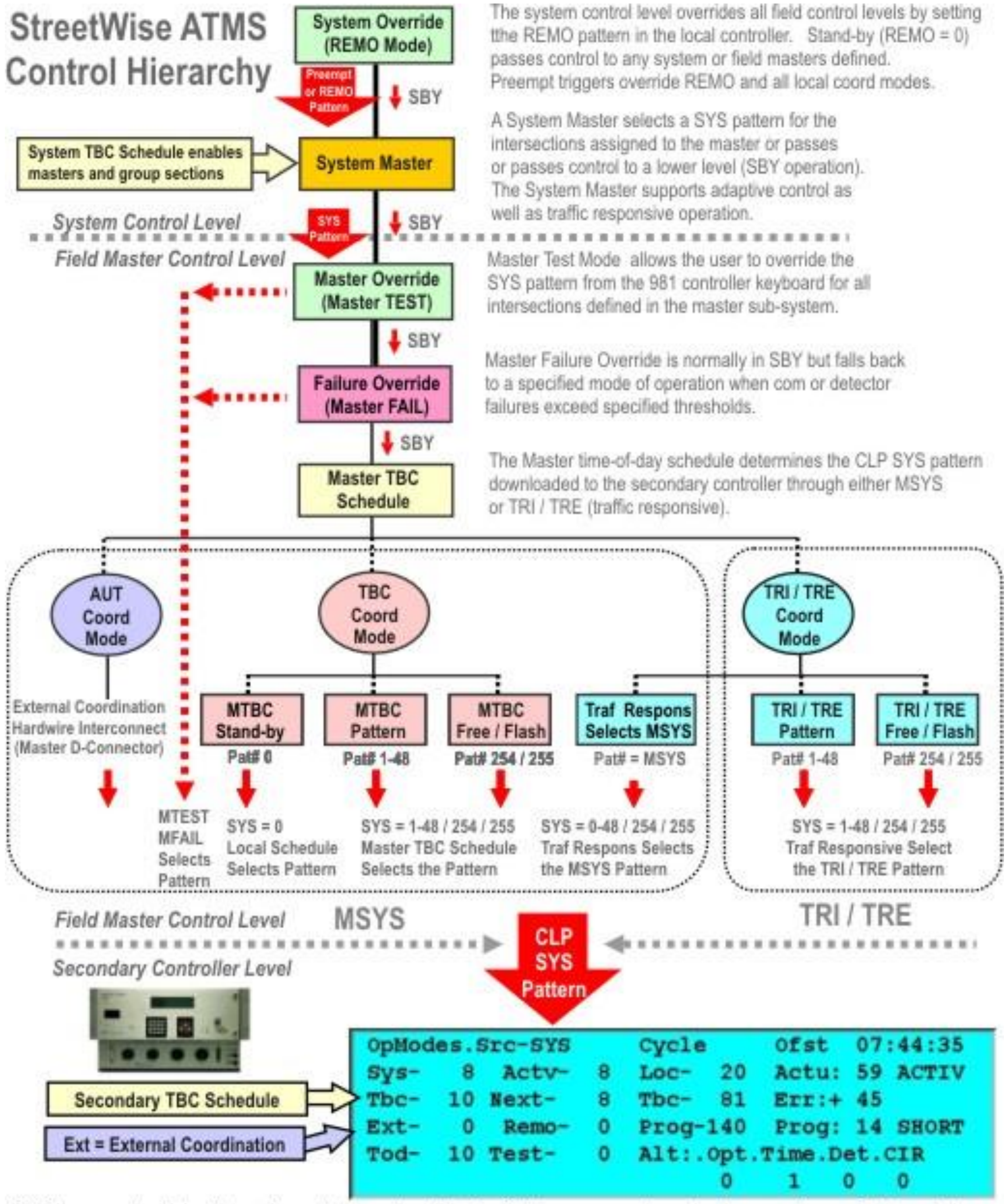
1) The *Master Test Configuration* drives SYS and overrides the *Master Fail Configuration* and the *Master Scheduler* if *Master Test* is not in stand-by, SBY (section 2.5).

2) The *Master Fail Configuration* drives SYS and overrides the *Master Scheduler* if any of the failure conditions are met and *Master Fail* is not in stand-by, SBY (section 2.6).

3) The *Master Scheduler* sets SYS to the pattern calculated by traffic responsive if the current *Action* is TRI (Traffic Responsive). Otherwise the *Master Scheduler* sets SYS to the TBC pattern# specified in the *Action* table for the current action.

4) If SYS is zero, then the *Central Master* is in standby and the locals are in STBC.


StreetWise ATMS
Control Hierarchy
System Override
(REMO Mode)
Preempt
or REMO
Pattern
SBY
System Master
StreetWise Scheduler enables
masters and group sections
System Control Level
SYS
Pattern
SBY
Field Master Control Level
Field Master
SBY
Field Master Control Level
CLP
SYS
Pattern
Secondary Controller Level
Secondary TBC Schedule
Ext = External Coordination
OpModes.Src-SYS Cycle Ofst 07:44:35
Sys- 8 Actv- 8 Loc- 20 Actu: 59 ACTIV
Tbc- 10 Next- 8 Tbc- 81 Err:+ 45
Ext- 0 Remo- 0 Prog-140 Prog: 14 SHORT
Tod- 10 Test- 0 Alt:.Opt.Time.Det.CIR
0 1 0 0



SYS is currently driving the active pattern on the MM->7->2 status screen above (under a system or field master). If the master goes to stand-by (SYS = 0), TBC will select pattern 10 as the active pattern. However, a REMO pattern from central will override both SYS and TBC but not local TEST mode. Preempt and preempt triggers have the highest priority over all coordination modes because preemption overrides all patterns.

Note that the hierarchy of control within the *Central Master* is essentially the same as the hierarchy within the Cubic | Trafficware *Field Master*.

3 Running the Central Master From ATMS.now

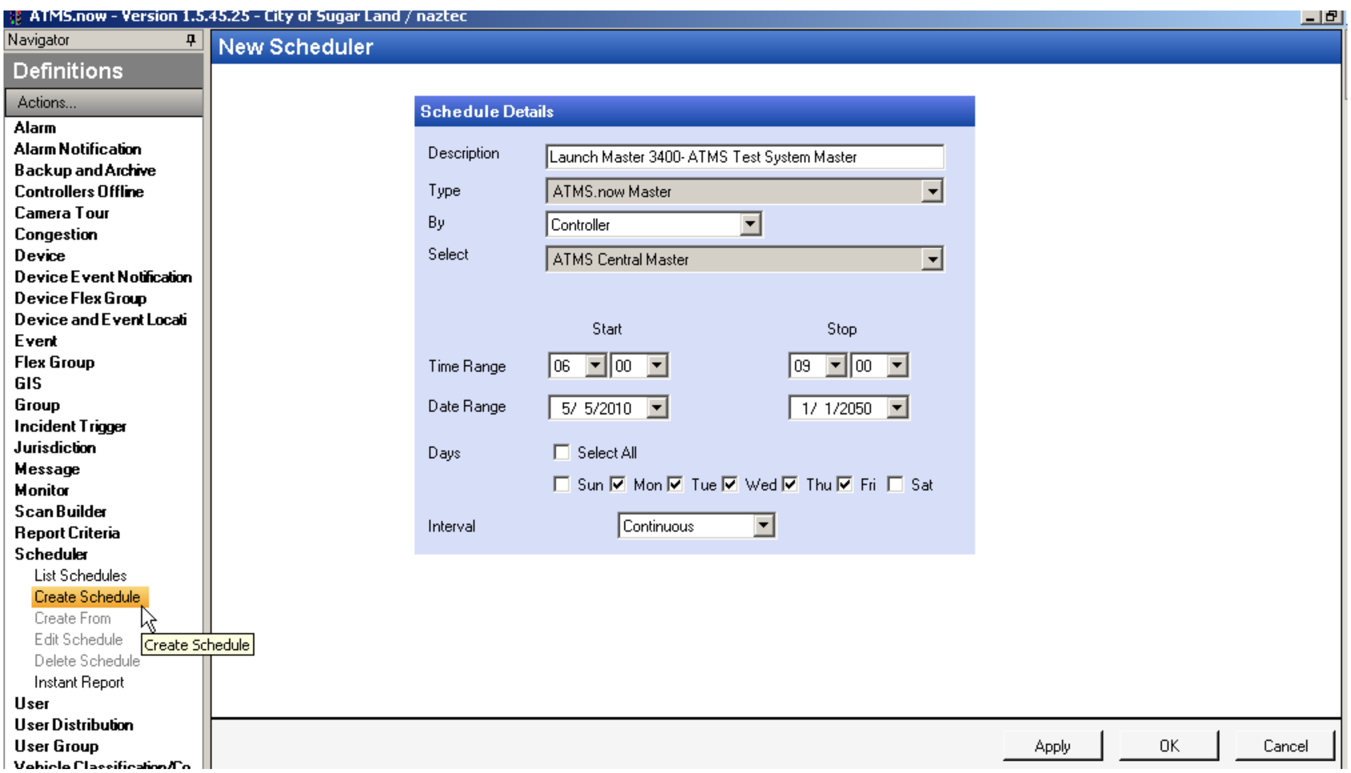
Chapter 2 outlined the steps necessary to define and configure a *Central Master* in ATMS.now.

The *Central Master* does not automatically run once it is created. It must be scheduled to run from the *ATMS.now Scheduler* by accessing the Definitions Module and choosing Scheduler/Create Schedule.

Note that the *Central Master* does not automatically set the date and time of the local controllers assigned to the master subsystem. You will need to provide a separate schedule in ATMS.now to update the local clocks (schedule "Download Real-Time").

In the example below, Master 3400 will be launched on weekdays between 06:00 – 09:00. Under this scheme, it is possible to define a separate master that runs at other times of the day. Therefore, it is possible to vary the intersections assigned to the sub-system (dynamic group assignment) and provide two independent traffic responsive lookup procedures by time-of-day.

Note that the *Type* selected must be *ATMS.now Master* and the database must be selected by *Controller* (not by *Master*).



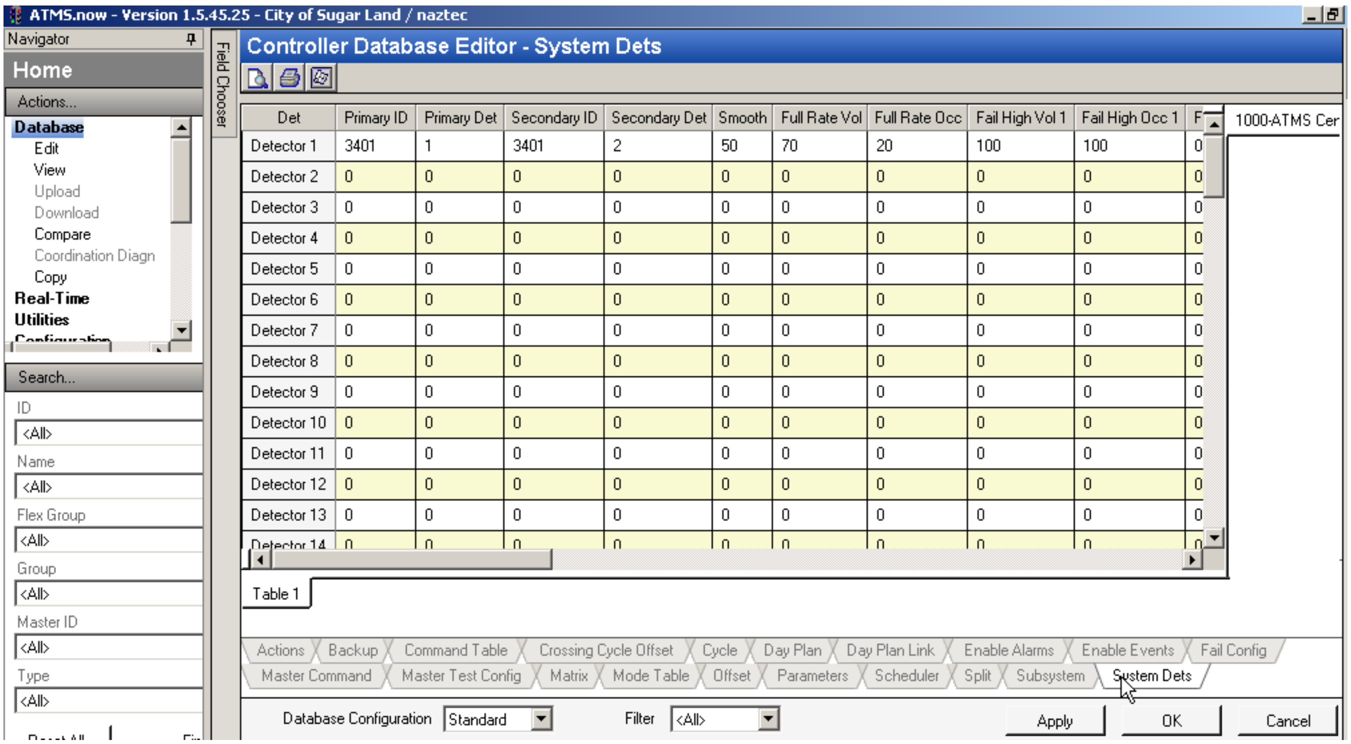
Once you hit Apply or OK, the Master will be scheduled to run as per the days of the week and time frame that was selected.

4 System Detectors

System detector volume and occupancy data is used in the traffic responsive calculations to generate the SYS pattern downloaded to the local controllers under TRI. The *Central Master* uses a table lookup procedure to select cycle, offset and split (COS) values for TRI calculation. Any of the 64 local intersection detectors may be assigned to any of the 48 system detectors in the *Central Master*.

4.1 System Detector Programming

The 48 system detectors are programmed from the following menu in ATMS.now. Each system detector is assigned one primary detector and an optional secondary (or backup) detector that is substituted if the master cannot upload the primary detector data.



Specific programming for System detector 1 is shown below:

Det	Primary ID	Primary Det	Secondary ID	Secondary Det	Smooth	Full Rate Vol	Full Rate Occ	Fail High Vol 1	Fail High Occ 1
Detector 1	3401	1	3401	2	50	70	20	100	100

Det	Fail Low Vol 1	Fail Low Occ 1	Fail High Vol 2	Fail High Occ 2	Fail Low Vol 2	Fail Low Occ 2	Fail High Vol 3	Fail High Occ 3
Detector 1	0	0	0	0	0	0	0	0

Det	Fail Low Vol 3	Fail Low Occ 3	Sub Vol 1	Sub Occ 1	Sub Vol 2	Sub Occ 2	Sub Vol 3	Sub Occ 3	Scaler Vol	Scaler Occ	Det Gr
Detector 1	0	0	30	30	30	30	30	30	1	1	IN

4.1.1 Station ID and Detector

Detectors are referenced by station *ID* and *Det #* (1-64). A station ID of 0 indicates that the detector is not active and will not be considered in the traffic responsive flow calculations. A primary (Pri) detector must be assigned if a secondary (Sec) detector is assigned. However, a secondary detector is not required. Note that primary and secondary detectors may be assigned from different local controllers.

4.1.2 Detector Group

System detectors can be assigned to the IN bound, OUT bound or CROSS street detector *Group*. This association is used in the traffic responsive calculation to calculate cycle, split and offset (COS) paramters.

4.1.3 Smooth

The *Smooth* value (0 – 100) controls how each volume and occupancy sample is averaged with the previous sample. An entry of 0 disables smoothing and each new detector sample replaces the previous detector sample. An entry of 100 does not average the current sample until the next sample is taken.

4.1.4 Full Rate Values

Separate *Full Rate* values are provided to scale volume and occupancy samples. The range of *Full Rate* is 0-255 vehicles per minute for the volume entry and 0-100 percent for occupancy entry. A zero *Full Rate* value can be used to disable either volume or occupancy (or both).

The *Full Rate* volume parameter will be used to calculate the normalized volume value by comparing the measured raw volume data to the Full Rate Volume parameter and expressing the ratio as a percent. Therefore, you should choose a Full Rate volume parameter value that is greater than the largest expected raw volume measurement. If however, you choose a Full Rate Volume parameter that is too high, you will limit your usable range of normalized values. Therefore, it is recommended that you choose a Full Rate value somewhere between the maximum measured raw volume and the maximum theoretical volume.

You can calculate the maximum theoretical volume using the saturation flow. In this case, the saturation flow rate of one travel lane is generally accepted as 1800 – 2000 vehicles/hour for one lane. This corresponds to a *Full Rate* value of 30 – 33 vehicles/minute at full saturation. Remember that the ratio of green/cycle length (g/C) will reduce the actual maximum volume to less than this theoretical rate.

For example, if you are measuring a maximum volume of 1200 vehicles per hour, this would correspond to a measured maximum value of 20 vehicles per minute. In this case, you should set your Full Rate Value somewhere between the maximum measured value of 20 vehicles/minute and the maximum theoretical value of 30-33 vehicles/minute. A rule of thumb that some agencies use, is to set the Full Rate Value at the maximum measured value divided by an adjustment factor of 0.8. In the given example, we would divide 20 vehicles/minute by 0.8 to calculate a Full Rate Volume parameter of 25. Using these values, we would observe a normalized volume value of 80% when system detectors are measuring 20 vehicles/minute. This allows some room for traffic growth over time and unexpected traffic events to exceed the maximum measured value of 20 vehicles/minute.

The occupancy entry should be chosen as the maximum expected occupancy for that system detector for each minute. The *Full Rate* occupancy parameter scales the measured occupancy value to 100%. Stop line detectors can be programmed to measure occupancy on green + yellow of the phase called by the detector. In these cases, *Full Rate* occupancy is a function of the split time of the phase associated with the detector. Therefore, values of 20 – 40% may be appropriate for stop line detectors if occupancy is measured during G+Y to estimate the degree of saturation of the phase.

Note that NTCIP requires that occupancy is measured with a 0.5" resolution, so the integer range of 0-200 represents a raw occupancy value of 0.0-100.0. The master compares the 0.5" precision value (< 100.0) with the specified *Full Rate* value to weight occupancy and calculate the *Full Rate %* value.

4.1.5 Detector Failure Thresholds

Failure “>” defines a threshold of volume or occupancy above which the detector is considered to be failed. Failure “<” defines a threshold of volume or occupancy below which the detector is considered to be failed. Keep in mind that smoothed values are used to test these failure ranges.

If you want to disable *Failure Thresholds* then accept the default “Failure > 100” and “Failure < 0” for volume and “Failure > 200” and “Failure < 0”occupancy. However, if you wish to test these thresholds, you must make sure that the substitution values are not zero unless you wish a failed detector to be permanently removed when it reaches the UNDEF state (see next section).

4.1.6 Substitution Values (Sub. Val)

Three sets of Substitution Values are provided for each system detector. MTBC actions can be used to select the Substitution Values by time-of-day. These volume and occupancy values are substituted in the traffic responsive calculations should both primary and secondary system detectors fail. If these values are zero when a detector fails, the detector will be removed from service.

If the *Central Master* polls a system detector and the raw volume of occupancy is outside of the *Failure Threshold*, then the first failure will be flagged as RETRY_1 and the substitution value used as the smoothed value. If the second poll also fails the thresholds, it will be marked as RETRY_2.

If the value from four successive system detector polls fails the *Failure Threshold,* the system detector will be permanently removed from the master poll and marked as undefined (UNDEF) if the substitution value is zero. **If the substitution value is not zero, then the master will continue to poll the detector and substitute values for the smoothed sample until the *Failure Thresholds* are satisfied.**

4.1.7 Scalar

Scalar values are provided to weight volume and occupancy for each detector. Scalar values in the range of 0 – 9 can be used to weight the relative importance of volume and occupancy for each detector and also can weight one detector’s V+O higher than another detector V+O.

Scalar values can be set to “0” to disable either volume or occupancy in the V+O calculation.

4.2 Relationship Between Volume and Occupancy

When setting up the *Central Master*, it is often useful to relate percent occupancy to percent scaled volume. This relationship can be found through the following equations:

$$\frac{\%\text{Occupancy} * 240 \text{ (veh / mile)}}{100} = \text{Density (veh / mile)}$$

$$\frac{\text{Volume (veh /min)}}{\text{Speed (Miles/min)}} = \text{Density (veh / mile)}$$

A density of 240 veh/mile is derived assuming an average vehicle length of 22 feet. (5280 feet / 22 (feet/veh) yields approximately 240 vehicles per mile at full-saturation).

Occupancy may be related to volume through the following formula:

$$\frac{100 * \text{Volume (veh/mile)}}{240 \text{ (veh/mile)} * \text{Speed (Miles/min)}} = \% \text{ Occupancy}$$

Typically, for a given speed, full-scale volume is correlated to full-scale occupancy if both are to be used to control traffic. At a speed of 30 miles per hour (30/60 = 0.5 Miles/min) :

Volume (Veh/Min)	%Occupancy
2	1.66
5	4.16
10	8.33
15	12.5
30	25

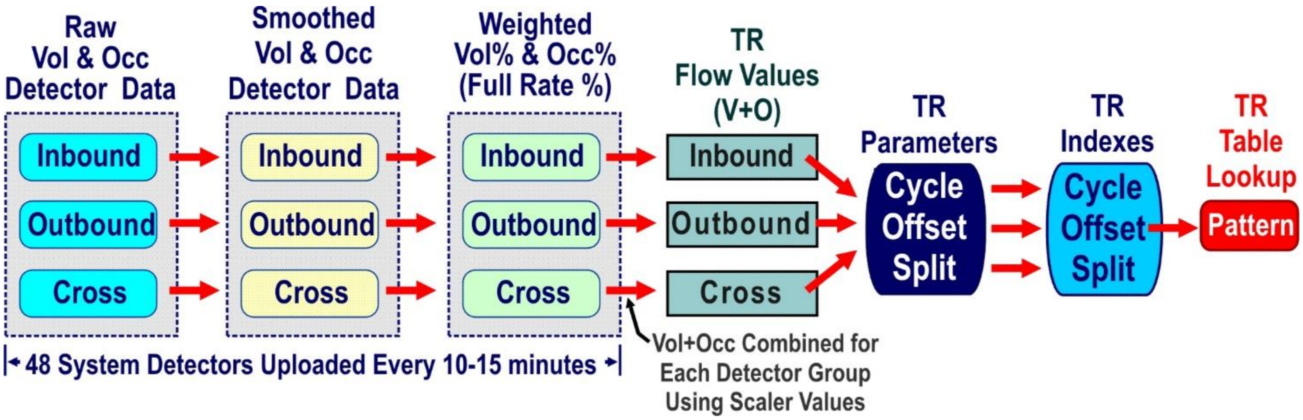
5 Traffic Responsive Operation

Traffic responsive control systems originated in the 1970's with the federal UTCS project. This project has set the standard for traffic responsive operation for the last 30 years. System detectors are defined as inbound, outbound or cross street. Volume and occupancy are combined using weighting factors to compute V+O for the inbound, outbound and cross-street approaches within the network. UTCS based systems use computed V+O values to select a traffic responsive pattern using a table lookup procedure.
Closed loop systems appeared in the 1980's and many of the centralized UTCS features were distributed to on-street masters. Most signal systems today continue to implement traffic responsive operation in essentially the way envisioned under UTCS.

5.1 TR Calculations From Volume + Occupancy (V+O)

Each master controller collects volume and occupancy data from up to 48 system detectors in the master subsystem. Raw volume and occupancy data is first smoothed to "average" the data with the previous sample. Then the smoothed data is weighted using the Full Rate% values supplied by the user to calculate Vol% and Occ% for each detector. Vol% and Occ% are then weighted using Scalers to compute *TR Flow Values* for the *Inbound*, *Outbound* and *Cross*-directions.

The *TR Flow Values* are used to calculate *Cycle*, *Offset* and *Split Parameters*, which are used to lookup a *Cycle*, *Offset* and *Split Index*. Lastly, the indexes are used to select a pattern from the TR pattern tables. These TR calculations are defined in this section and are summarized as follows:



5.1.1 Smoothed Vol% and Occ%

Traffic volume and occupancy measures vary greatly from one sample to the next, especially if the sample period is less than 10–15 minutes. Typically, 10 or 15-minute samples are "smoothed" or "averaged" with the last "smoothed" sample.

The *Smooth* value is assigned for each detector as discussed in section 4.1.3. The formula used to "smooth" each volume and occupancy sample is given below.

Note that if the *Smooth* value is "0", then the current sample is not averaged with the previous volume or occupancy sample and no smoothing takes place.

$$SmoothedValue = \frac{(NewValue * (100 - SmoothVal) + OldValue * SmoothVal)}{100}$$

Vol %

Volume % compares the sample volume (converted to a one minute flow rate) with the *Full Rate* value discussed in section 4.1.4. Volume *Full Rate* is a full-scale reading of flow rate (in vehicles / min). Since flow rate is also a function of a variable green time (g/C) provided over the detector, *Volume Full Rate %* must be approximated.

Assume that volume *Full Rate* is 18 veh/min for a smoothed 15-minute sample. The measured flow rate is 150 vehicles sampled over the 15-minute period. Note that volume must first be converted to a one-minute flow rate because *Full Rate* is expressed in vehicles per minute.

Vol (rate per minute) = 150 veh / 15 minutes = 10 veh / min

Vol % = measured flow rate / full rate % = 10 / 18 = 56%

Occ %

Occupancy % is a measure of total vehicle presence over the detector during the sampling period. Full occupancy at 100% is equivalent to a constant call on the detector during the entire sampling period. NTCIP calls for occupancy to be expressed as an integer value in the range of 0-200 so that the resolution of occupancy can be measured within 0.5 %. However, occupancy is always 100% if occupancy if a detector call is constant over the entire sample period.

Cubic | Trafficware controllers provide a "plus" detector feature called occupancy-on-green that allows occupancy to be measure only during the green or green + yellow clearance interval (G+Y). This feature allows occupancy to be measured from a stop-line detector during G+Y only when traffic should be moving over the detector. Occupancy is not accumulated during the red interval when standing queues are stopped over the detector. Occupancy-on-G+Y is measured during a portion of the sample time roughly equivalent to g/C.

Occupancy Full Rate% is a full-scale reading of occupancy expressed as 0-100%. Since occupancy is a function of the green time (g/C) over the detector and occupancy-on-G+Y feature, *Ocupancy Full Rate%* must be approximated.

For example, if a detector samples occupancy –on-G+Y for the phase called by the detector, then the maximum occupancy per cycle is roughly equivalent to the split time of this phase. If *Occupancy Full Rate%* is 60% and measured occupancy is 12%, then the Occ% value is calculated as follows:

Occ % = measured occupancy / full rate = 12 / 60 = 20%

5.1.2 TR Flow Values for the Inbound, Outbound and Cross Detector Groups

Each system detector is assigned to the *Inbound*, *Outbound* or *Cross* detector group and assigned an occupancy *Scalar* (kx) and a volume *Scalar* (cx).

TR Flow Values are computed for each detector group using the formula below. Each *TR Flow Value* (*Inbound*, *Outbound* and *Cross*) is a weighted average of the computed *Vol%* and *Occ%* values for the detectors sampled for each detector group.

$$FlowValue = \frac{(k1 * Occ_1 + k2 * Occ_2 + ... + kx * Occx) + (c1 * Vol_1 + c2 * Vol2 + ...cx * Volx)}{k1 + k2 + ... + kx + c1 + c2 + ... + cx}$$

Note: *Scalers* express the relative weight of Vol% and Occ% for detector assigned to a group (inbound, outbound and cross). Increasing a *Scalars* value for a detector does not increase the *TR Flow Values* the same amount. Increasing the *Scalar* value only increases the relative weight of that detector compared to the other detectors in the group.

Vol% and Occ% are combined to calculate a *TR Flow Value* for the *Inbound*, *Outbound* and *Cross*- detector groups. In the next two sections, we will see how the measured *TR Flow Values* are used to calculate a *Cycle*, *Offset* and *Split Parameter* for each detector group. A table lookup procedure is then used to select the *Cycle, Offset and Split (COS) Index* from these parameters.

5.1.3 Cycle, Offset and Split Parameters

The *Cycle*, *Offset* and *Split Parameters* are calculated from the *TR Flow Values* as follows. These parameters range from 0 to 100% and are used to perform a table lookup to select the *Cycle, Offset and Split Index.*

Cycle Index = Max. Inbound V+O <or> Max. Outbound V+O

Offset Index = ((Outbound – Inbound) / (Outbound + Inbound)) * 50 + 50

Split Index = ((Cross – Cycle Index) / (Cross + Cycle Index)) * 50 + 50

5.1.4 Cycle, Offset and Split Index

The TRI calculations perform a table lookup using the calculated *Cycle, Offset* and *Split Parameters* to select a *Cycle, Offset* and *Split Index.* Separate threshold tables are used depending on whether the *Cycle, Offset* and *Split Parameters* are increasing or decreasing to reduce the hysteresis or "bounce" in successive data samples.

Two threshold values are specified for each table lookup. One threshold is used if the *Parameter* is increasing compared with the last sample. The other threshold is used if the *Parameter* is decreasing compared with the last sample.

Below are example tables for the *Cycle Index* table lookup. Suppose the current *Cycle Index* is "4" and that *Cycle Parameter* has increased during the last 15 minute sample period from 52% to 55%. A table lookup will be made from the increasing table that will retain the *Cycle Index* at "4" because 55% is less than the threshold of 56% necessary to change to Cycle Index "5" in the increasing table.

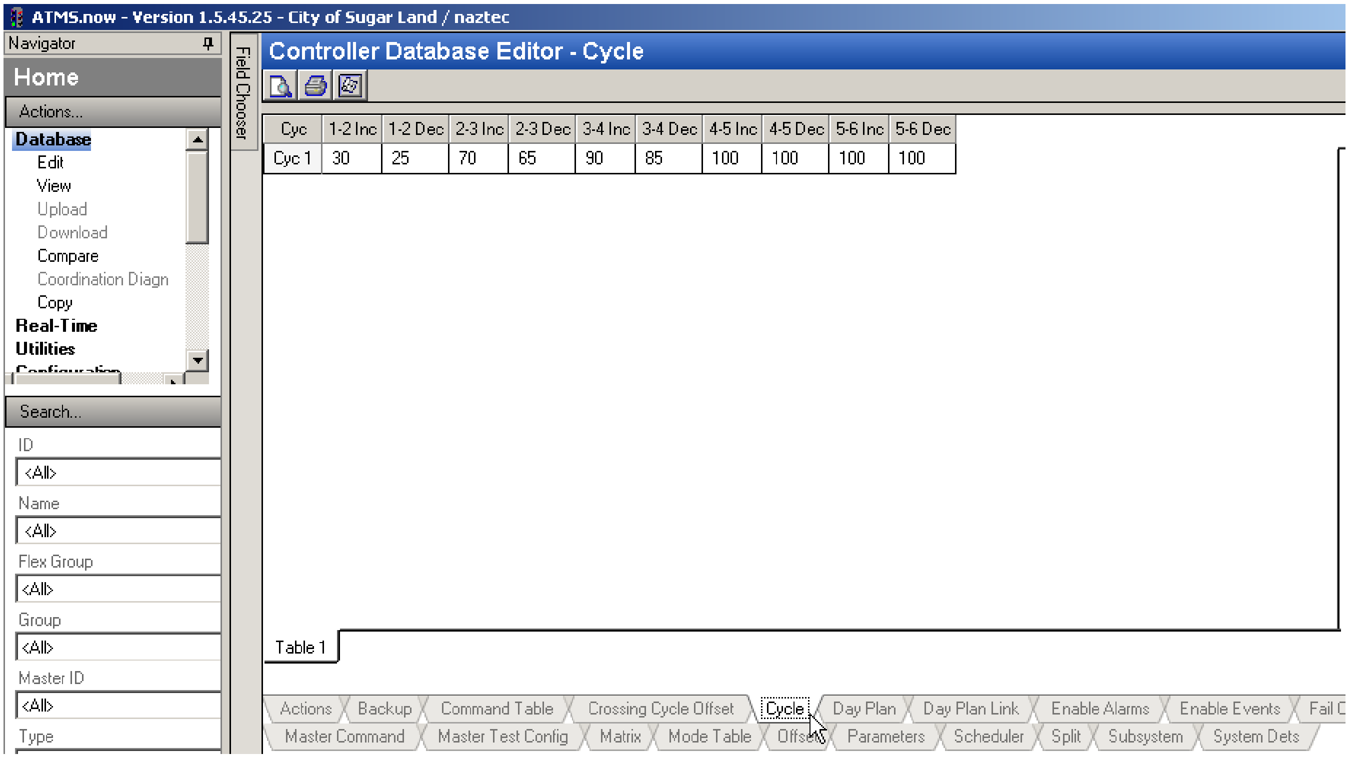
CYCLE LENGTH THRESHOLDS

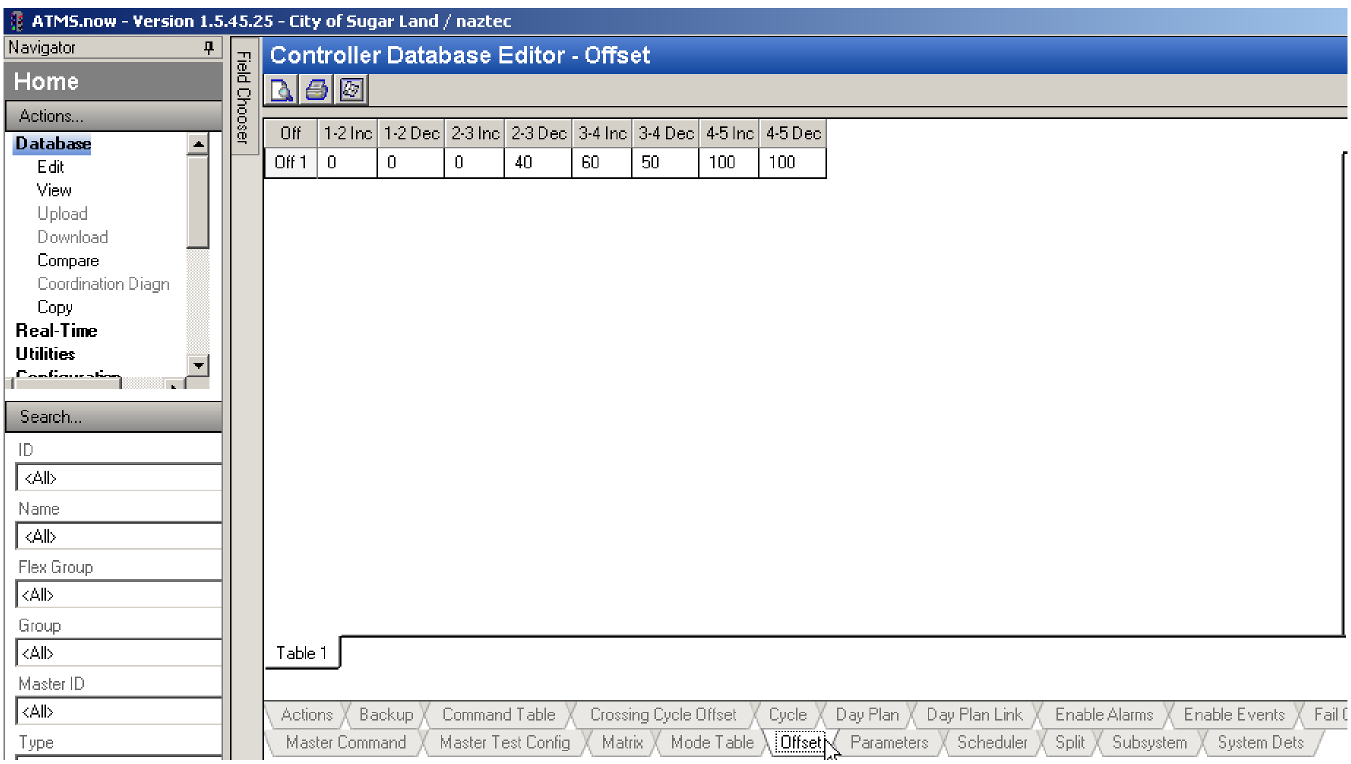
CYCLE LENGTH INCREASING
FREE to CYCLE 1 : 25
CYCLE1 to CYCLE2 : 35
CYCLE2 to CYCLE3 : 41
CYCLE3 to CYCLE4 : 48
CYCLE4 to CYCLE5 : 56
CYCLE5 to CYCLE6 : 99

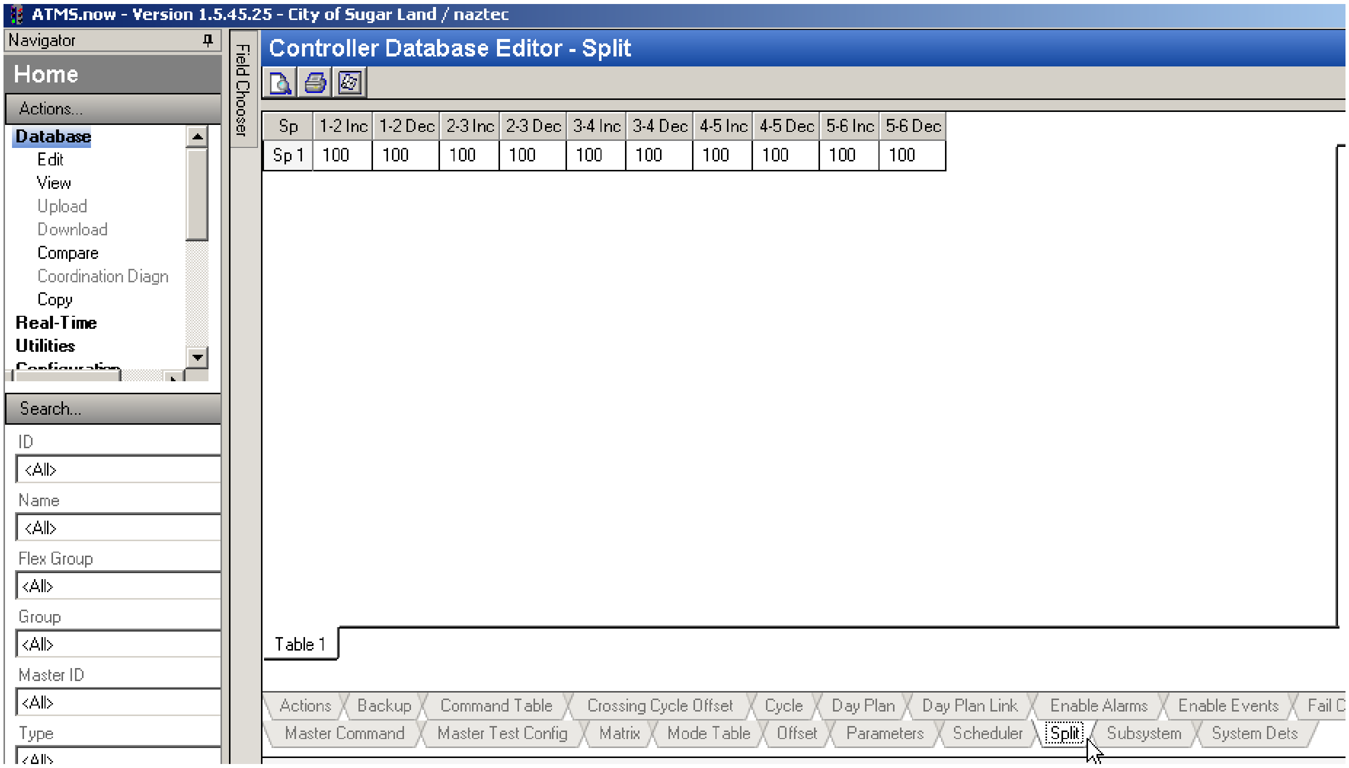
CYCLE LENGTH DECREASING
CYCLE1 to FREE : 17
CYCLE2 to CYCLE1 : 28
CYCLE3 to CYCLE2 : 36
CYCLE4 to CYCLE3 : 40
CYCLE5 to CYCLE4 : 49
CYCLE6 to CYCLE5 : 99

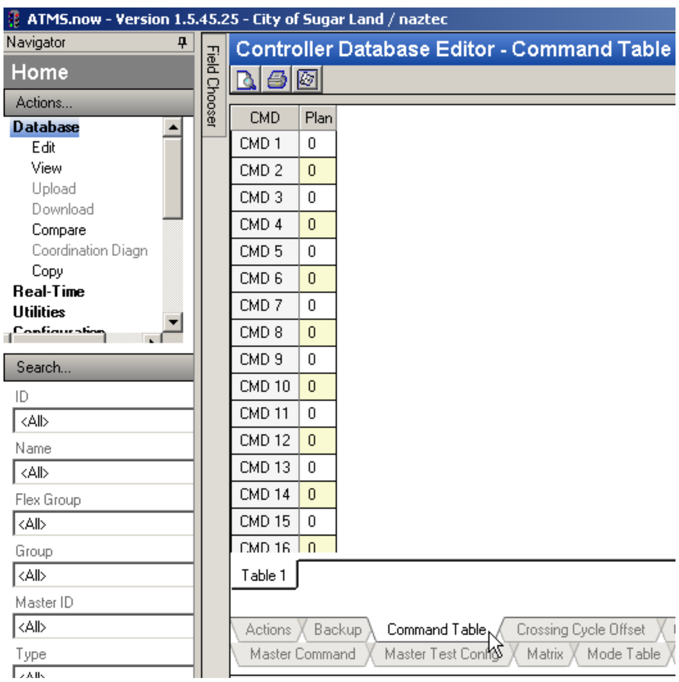
Note that once the *Cycle Index* moves to "5", that the *Cycle Parameter* would have to drop to 49% (from the decreasing table) to move back to *Cycle Index* "4". Without separate threshold tables, the TR system could become unstable if the calculated *Cycle Parameter* began oscillating between 55 and 56. Providing two thresholds reduces this "bounce" or hysterisis or "bounce" in the *Parameter* values.

The COS traffic responsive thresholds are edited in ATMS.now using four menu screen tabs: Cycle, Offset, Split and Command. They are shown on the next page.


ATMS.now - Version 1.5.45.25 - City of Sugar Land / naztec
Navigator
Home
Actions...
Database
Edit
View
Upload
Download
Compare
Coordination Diagn
Copy
Real-Time
Utilities
Search...
ID
<All>
Name
<All>
Flex Group
<All>
Group
<All>
Master ID
<All>
Type
Field Chooser
Controller Database Editor - Cycle
Cyc | 1-2 Inc | 1-2 Dec | 2-3 Inc | 2-3 Dec | 3-4 Inc | 3-4 Dec | 4-5 Inc | 4-5 Dec | 5-6 Inc | 5-6 Dec
Cyc 1 | 30 | 25 | 70 | 65 | 90 | 85 | 100 | 100 | 100 | 100
Table 1
Actions
Backup
Command Table
Crossing Cycle Offset
Cycle
Day Plan
Day Plan Link
Enable Alarms
Enable Events
Master Command
Master Test Config
Matrix
Mode Table
Parameters
Scheduler
Split
Subsystem
System Dets


ATMS.now - Version 1.5.45.25 - City of Sugar Land / naztec
Navigator
Home
Actions...
Database
Edit
View
Upload
Download
Compare
Coordination Diagn
Copy
Real-Time
Utilities
Search...
ID
<All>
Name
<All>
Flex Group
<All>
Group
<All>
Master ID
<All>
Type
Field Chooser
Controller Database Editor - Offset
Off | 1-2 Inc | 1-2 Dec | 2-3 Inc | 2-3 Dec | 3-4 Inc | 3-4 Dec | 4-5 Inc | 4-5 Dec
Off 1 | 0 | 0 | 0 | 40 | 60 | 50 | 100 | 100
Table 1
Actions
Backup
Command Table
Crossing Cycle Offset
Cycle
Day Plan
Day Plan Link
Enable Alarms
Enable Events
Master Command
Master Test Config
Matrix
Mode Table
Offset
Parameters
Scheduler
Split
Subsystem
System Dets





It is not required that every parameter of the lookup tables be used. In this example, only 4 *Cycle Indexes* are actually used because the *Cycle Parameter* will never reach a value of 100 (CYCLE5 and CYCLE6 will never be reached).

Also note that split thresholds are all 100. In this case, the system does not provide different patterns based on the difference between arterial and cross street detectors. These distinctions will become clear in the next section when we look at populating the lookup tables with patterns.

5.2 Example: Creating Indices using volumes

The following steps are done in order by the algorithm that creates the Cycle, Offset and Split indexes. The steps below represent how the volume index is chosen. Please note that the same steps are used to create the occupancy index.

5.2.1 Raw data

Raw data is gathered by counting actuations over your sample period. The reported value is counts per sampling period.

5.2.2 Normalized data

The raw data is normalized into a number that will vary between 0 and 100. It is a percentage of the full Flow Rate value, thus it is based on the Full Rate volume programming.

5.2.3 Smoothed value

The *Smooth* value (0 – 100) controls how each volume and occupancy sample is averaged with the previous sample The normalized data is smoothed using the detector smoothing factor. The first time the TR central master is turned on, only the raw data is used. Subsequent values are then calculated using the smoothing formula as discussed in section 5.1.1. Remember that a smoothing factor of "0" will always use the normalized data for each sampling period.

5.2.4 Threshold checks

Next detector failure thresholds are checked for each system detector. If a detector fails based on the thresholds programmed for each system detector, then the substitution value will be used for that detector, if programmed. The substitution value should be set up using flow percentages. Warning if your Full Rate values are set too low, your calculated normalized values will exceed the thresholds and substitution values will be used.

If the value from four successive system detector polls fails the *Failure Threshold*, the system detector will be permanently removed from the master poll and marked as undefined (UNDEF) if the substitution value is zero. If the substitution value is not zero, then the master will continue to poll the detector and substitute values for the smoothed sample until the *Failure Thresholds* are satisfied.

5.2.5 Scalars

Now the algorithm is ready to combine individual detector flow values to develop the overall flow values. The weight assigned to each detector is determined by its scalar. The first step is to rank each system detector's importance against the other system detectors in your corridor. Scalars are the mechanism to do this. The user should start by choosing the least used detector and setting its scalar to "1" and scale the other detectors form this base. Scalar values can range from 1-9. A scalar value of zero will eliminate the detector from this flow value calculation

5.2.6 Flow Parameters

Once scaled, flow parameters are calculated via the formula as shown in section 5.1.2.

5.2.7 Cycle, Offset, Split parameters

Next the cycle offset and split parameters are calculated using the formulas shown in section 5.1.3, once the Flow parameters are established. Their values will range from 1-100 percent.

5.2.8 Cycle Offset and Split indexes chosen via the Threshold tables

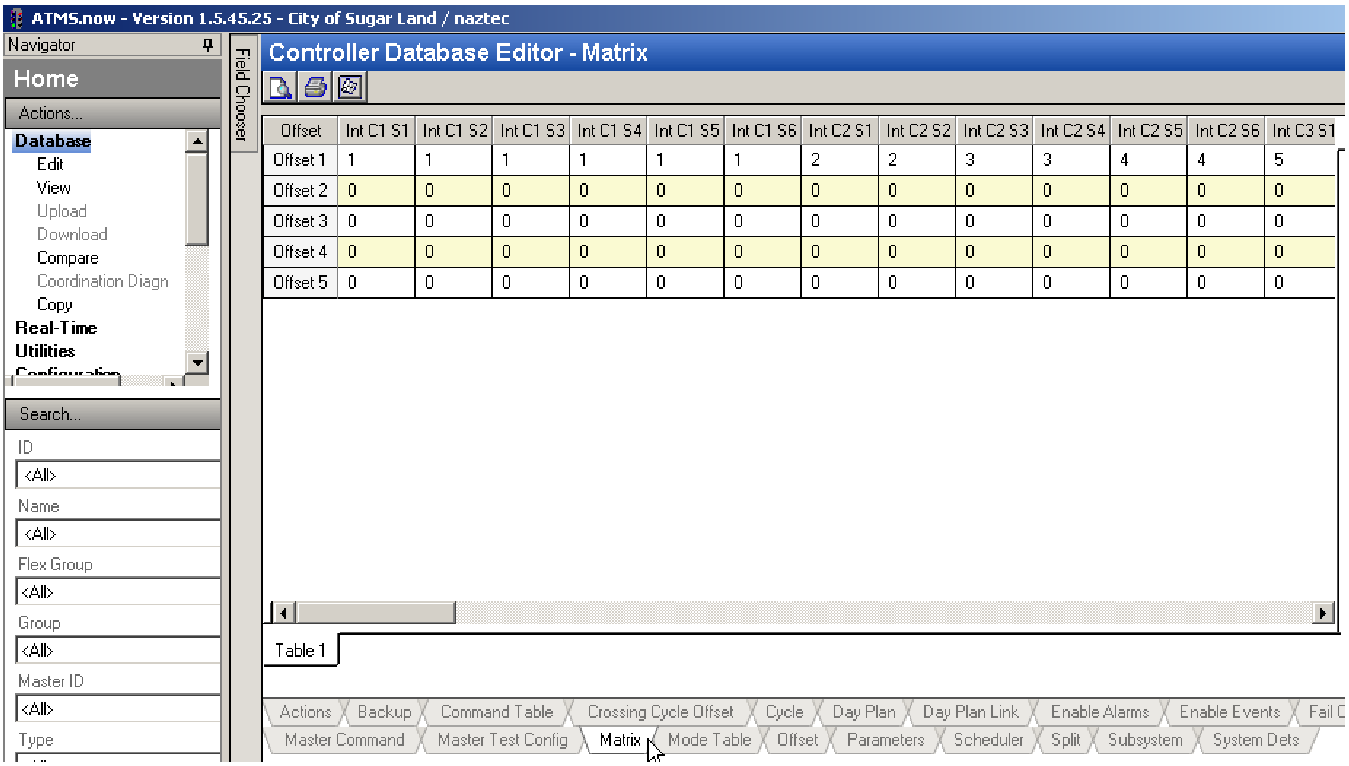
The user must program a threshold table to choose the Cycle offset and Split index. Each threshold table is set up to choose a index based on the Parameter percentages. Separate threshold tables are needed depending on whether the *Cycle, Offset* and *Split Parameters* are increasing or decreasing to reduce the hysteresis or "bounce" in successive data samples.

Two threshold values are specified for each table lookup. One threshold is used if the *Parameter* is increasing compared with the last sample. The other threshold is used if the *Parameter* is decreasing compared with the last sample.

5.3 TR Pattern Selection Using the Cycle, Offset and Split Index

The traffic responsive pattern is selected using a table lookup procedure once the *Cycle, Offset* and *Split Index* values have been calculated. The user is responsible for populating these tables with pattern numbers. The pattern selected by the lookup essentially becomes the SYS pattern that is downloaded to the controllers defined in the master sub-system.

Five separate *Offset Tables* (COS matrices) can be programmed from ATMS.now using any of the 48 pattern numbers provided in the controller *Pattern Table*. In addition, you may program pattern 254 for free operation and pattern 255 for automatic flash operation within these tables.



The example below assigns 16 patterns to *Offset Table* 1. This table is selected by the traffic responsive lookup procedure if the calculated *Offset Index* is “1”. The menu shown maintains compatibility with the TS2 and 2070 on-street master databases. Please ignore the TRE (*Traffic Responsive External*) programming parameters (i.e. columns that begin with “Ext”) which only applies to on-street sub masters. *Central Masters* only implement TRI (*Traffic Responsive Internal*) because sub-master operation from the central level is irrelevant.

Offset	Int C1 S1	Int C1 S2	Int C1 S3	Int C1 S4	Int C1 S5	Int C1 S6	Int C2 S1	Int C2 S2	Int C2 S3	Int C2 S4	Int C2 S5	Int C2 S6
Offset 1	1	1	1	1	1	1	2	2	3	3	4	4

Offset	Int C3 S1	Int C3 S2	Int C3 S3	Int C3 S4	Int C3 S5	Int C3 S6	Int C4 S1	Int C4 S2	Int C4 S3	Int C4 S4	Int C4 S5	Int C4 S6
Offset 1	5	5	6	6	7	7	8	8	9	9	10	10

Offset	Int C5 S1	Int C5 S2	Int C5 S3	Int C5 S4	Int C5 S5	Int C5 S6	Int C6 S1	Int C6 S2	Int C6 S3	Int C6 S4	Int C6 S5	Int C6 S6
Offset 1	11	11	12	12	13	13	14	14	15	15	16	16

Suppose the current *Cycle Index* is “4” and the *Split Index* is “2”. Using the table lookup above, the TR timing plan selected by this lookup would be pattern# 8.

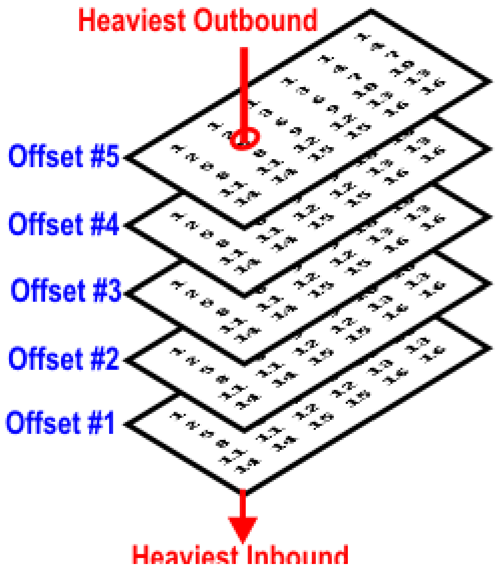
If the *Master Scheduler* selects a time-of-day *Action* calling for TRI (Traffic Responsive), then the master will download SYS=8 to all local controllers in the subsystem. All local controllers in the sub-system with *Closed Loop* turned ON will run SYS pattern# 8 overriding the local TBC schedules.

This traffic responsive (or SYS) pattern will remain in effect for the *Minimum Change Time* discussed in section 2.2. At the end of the *Minimum Change Time*, traffic responsive will be allowed to implement a SYS pattern based on updated *Cycle*, *Offset* and *Split Indexes*.

The calculation of the *COS Indexes* and the table lookup procedure is the essence of traffic responsive.

5.4 Relationship Between Inbound, Outbound and Cross Street Conditions

This section summarizes the relation between the *COS Indexes* defined in section 4.1.3 and the *Inbound*, *Outbound* and *Cross* detector groups.



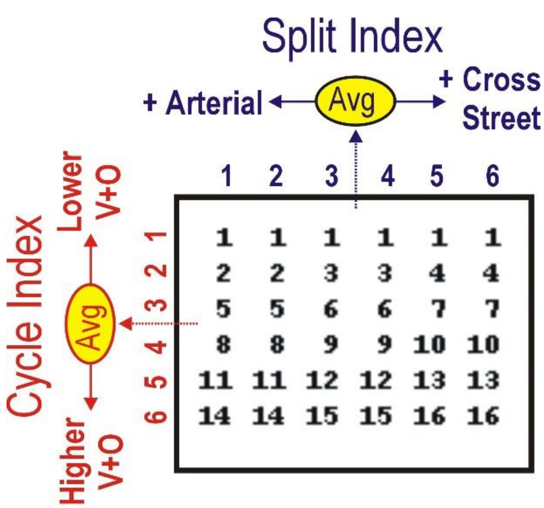
1) Offset Index Compares Inbound vs. Outbound Flow

The *Offset Index* is used initially to select the *Offset Table* for the table lookup.

Offset Index is the relationship between the highest *Outbound* compared with the highest *Inbound* V+O.

Patterns assigned to *Offset Table 1* should provide offsets that favor the inbound direction on the arterial.

Patterns assigned to *Offset Table 5* should provide offsets that favor the outbound direction on the arterial.



2) Cycle Index is a Function of Arterial V+O

Patterns within the same row typically share a common cycle length. The *Cycle Length* of the patterns assigned to each row increases as V+O of the *Inbound* and *Outbound* detectors increases.

3) Split Index Is Proportional to Arterial vs. Cross

Patterns within the same row share a common cycle length. The *Split Index* can be used to vary the split times in the patterns to favor the arterial or cross street movements.

In addition, CIC (*Critical Intersection Control*) provides an alternate way to adjust split times at the local controller level. .

5.4.1 Traffic Responsive Lookup Table Examples

The following lookup table examples illustrate ways to configure traffic responsive for different conditions. Keep in mind that if Pattern # 0 places SYS in stand-by (SBY) and reverts the locals to their local time-of-day schedules (STBC). Also, pattern 254 is reserved for free operation and Pattern 255 is automatic flash as specified by NTCIP.

No Inbound / Outbound Preference or Arterial / Cross Street Preference

Offset # 1

	1	2	3	4	5	6
1	1	1	1	1	1	1
2	2	2	2	2	2	2
3	3	3	3	3	3	3
4	4	4	4	4	4	4
5	5	5	5	5	5	5
6	6	6	6	6	6	6

Assume network volumes are “average” in all directions without an inbound/outbound or arterial/cross preference. In this case, you want traffic responsive to vary the cycle length based on the *Cycle Index*, but not vary the offsets or relative splits within the patterns.

You can force traffic responsive to use *Offset Table# 1* by setting all *Offset* thresholds to 100. In this case, Split Index does not matter because the patterns in each column of the table are the same.

No Inbound / Outbound Preference – 3 levels of Arterial vs. Cross Preference

Offset # 1

	1	2	3	4	5	6
1	1	1	1	1	1	1
2	2	2	3	3	4	4
3	5	5	6	6	7	7
4	8	8	9	9	10	10
5	11	11	12	12	13	13
6	14	14	15	15	16	16

Assume your arterial volumes are “average” in the inbound and outbound directions. However, in this case, there are significant fluctuations between arterial and cross street demand to warrant varying the splits in the patterns at the same cycle length.

You can force traffic responsive to use *Offset Table# 1* by setting all *Offset* thresholds to 100. However, in this case vary the splits in the patterns assigned to column 1 to favor the arterial and the splits assigned to column 6 to favor the cross street.

Medium Inbound / Outbound Preference – No Arterial vs. Cross Preference

Offset # 2

	1	2	3	4	5	6
1	1	1	1	1	1	1
2	2	2	2	2	2	2
3	3	3	3	3	3	3
4	4	4	4	4	4	4
5	5	5	5	5	5	5
6	6	6	6	6	6	6

Offset # 3

	1	2	3	4	5	6
1	1	1	1	1	1	1
2	7	7	7	7	7	7
3	8	8	8	8	8	8
4	9	9	9	9	9	9
5	10	10	10	10	10	10
6	11	11	11	11	11	11

Assume your arterial demand varies significantly in the inbound and outbound directions by time-of-day. In this case you have developed patterns that vary the offsets to favor either an inbound, average or outbound condition.

You can vary the Offset Thresholds to select Offset# 2 for the inbound, Offset# 3 for the average and Offset# 4 for the outbound condition.

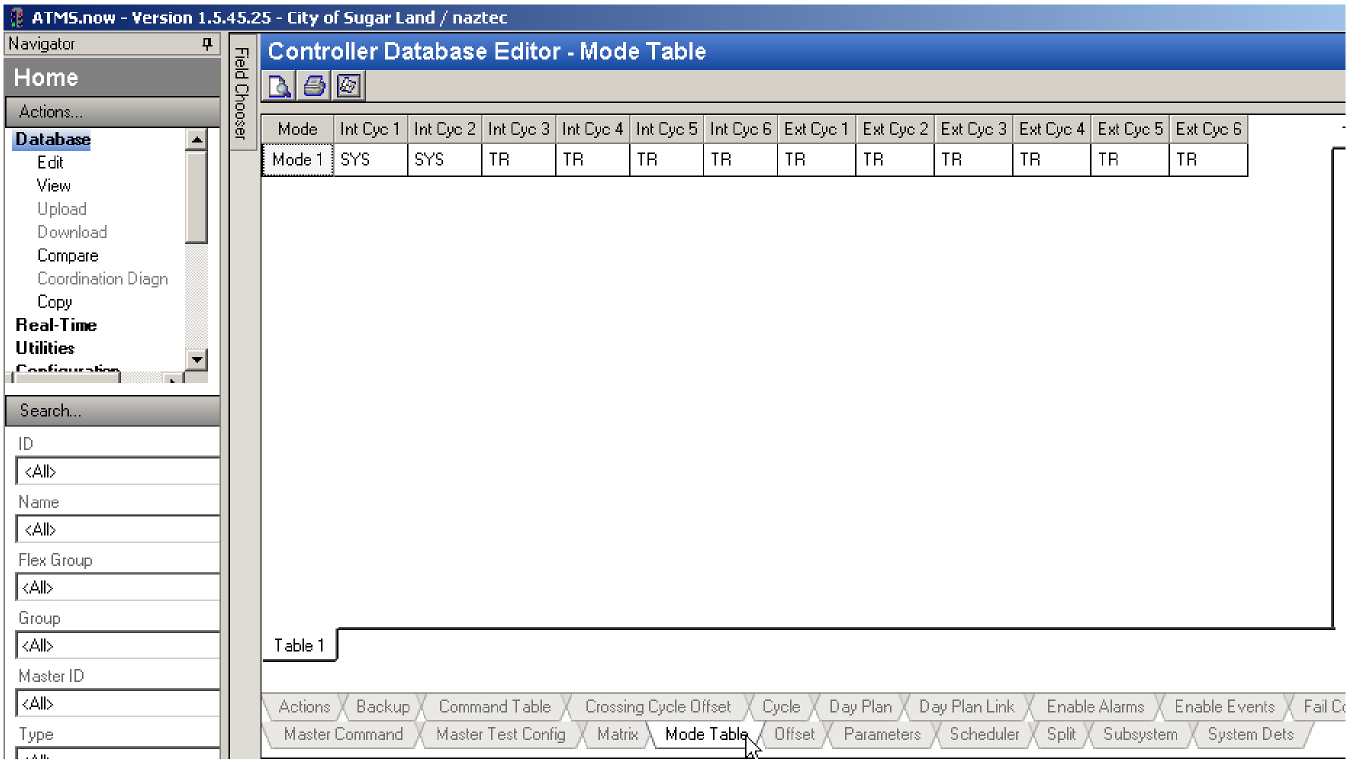
Offset # 4

	1	2	3	4	5	6
1	1	1	1	1	1	1
2	12	12	12	12	12	12
3	13	13	13	13	13	13
4	14	14	14	14	14	14
5	15	15	15	15	15	15
6	16	16	16	16	16	16

Assume that there is no significant difference in arterial vs. cross street demand by time-of-day. In this case, you could implement CIC locally to reassign available slack time based on phases maxing out or gapping out.

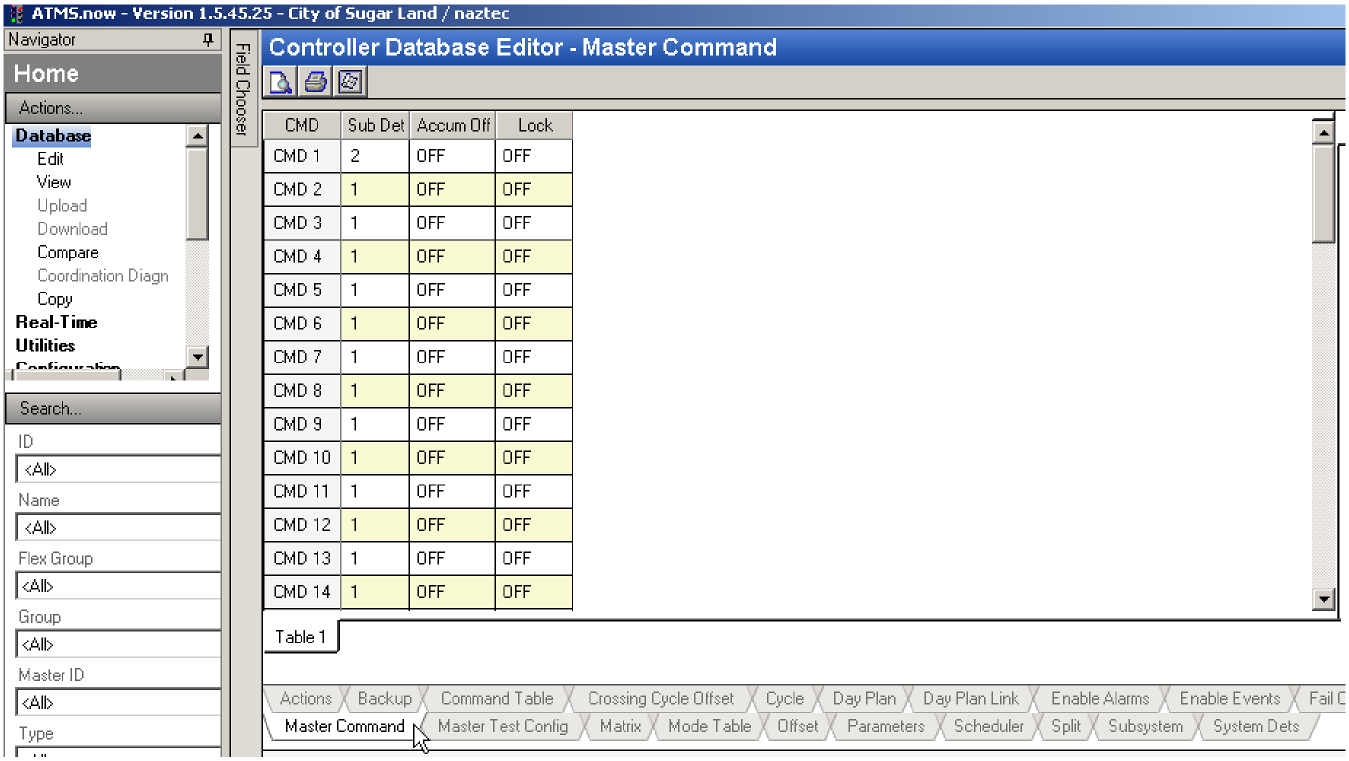
5.5 TR Mode Table

The traffic responsive lookup for *Coord Mode* is based on the *Cycle Index* as shown below. In the example, note how SYS (time-of-day coordination) is assigned to the lower levels of *Cycle Index* and how TR (traffic responsive) is assigned to the higher *Cycle Index* values. This allows the system to run time-of-day at the lower cycle lengths, but switch to traffic responsive as V+O increases. This scheme can be especially effective to provide and "incident response" when V+O rises unexpectedly. Please note that with a Central Master the user does not need to program the EXTERNAL column.



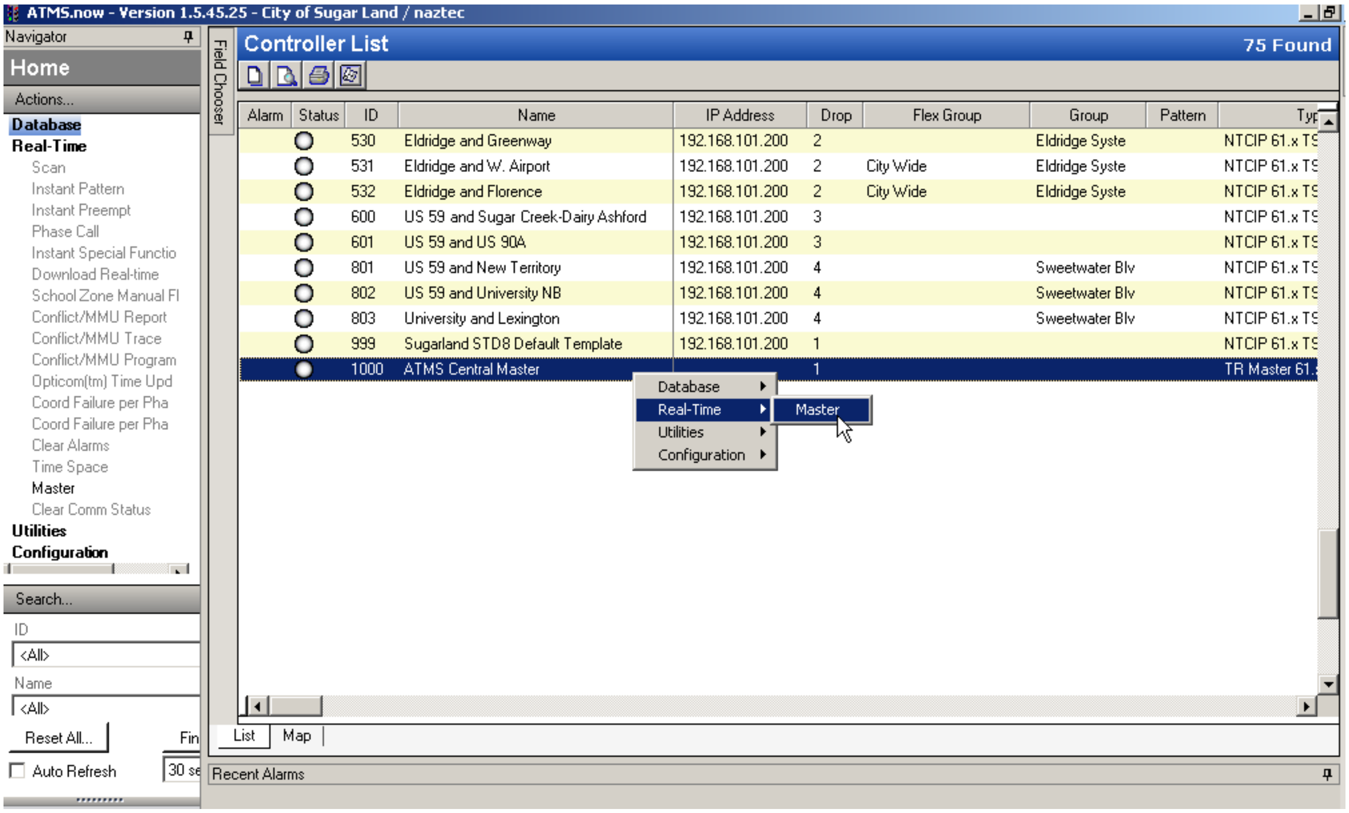
5.6 The Traffic Responsive Master Command Table

This traffic responsive table associates the *CMD#* with the *Cycle Index*, so that detector failure thresholds and substitution values can be varied as patterns change from the table lookup. The *Failure Threshold* and *Substitution Value* range from 1-3. This value can be varied by CMD# using the *Master Command Table*.



6 Central Master Status

ATMS.now provides a status screen summarizing traffic responsive operation for every *Central Master* active in the system. This status screen is accessed from the Home Module by highlighting the specific Central Master that you are interested in. Select under actions: Real-Time/Master.



A general status screen will be displayed as explained below.

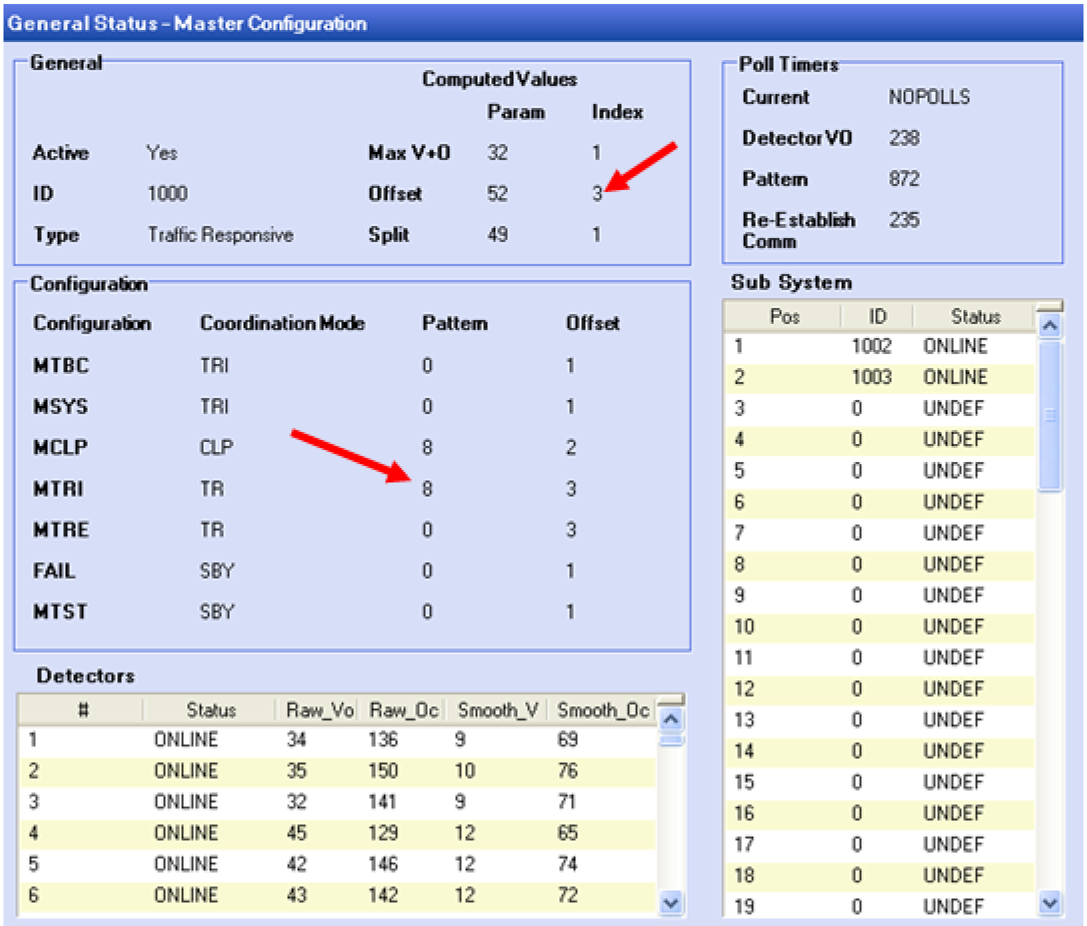
6.1 General Status

The *General Status* tab provides access to the current state of the traffic responsive system for the selected *Master ID*.

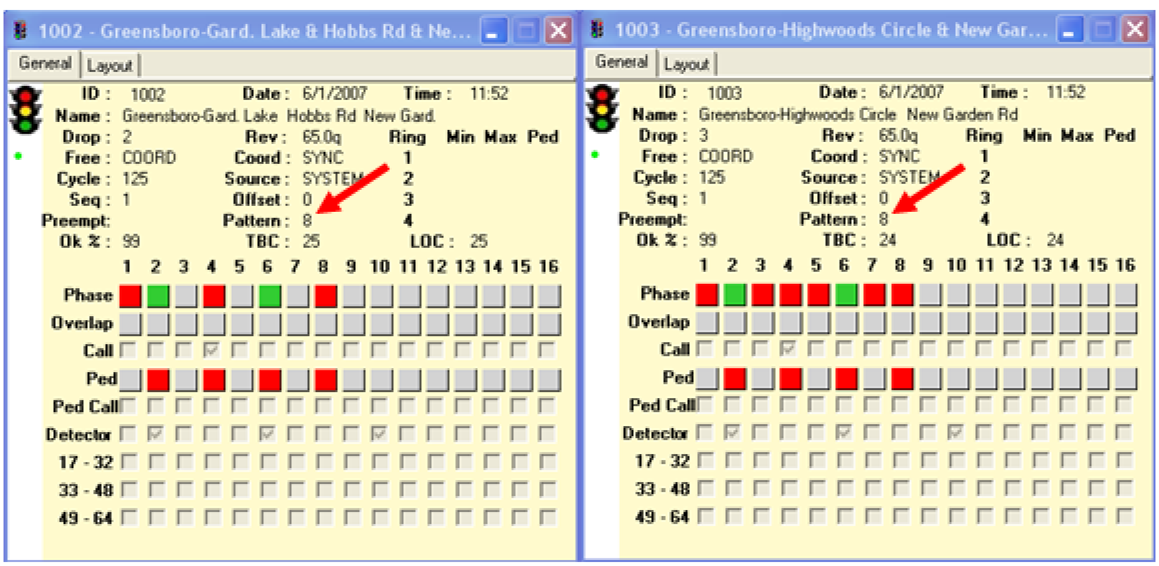
In the example below, Master 1000 has selected pattern # 8 under traffic responsive (TR). Pattern # 8 is currently downloaded to the master closed-loop (MCLP) system. The mode labeled CLP is always the SYS pattern downloaded to the local controllers.

The *Offset Parameter* is 52, which has selected *Offset Index* 3 based on the current threshold values. *Max V+O (Cycle Parameter)* has selected *Cycle Index* 1 and *Split Parameter* has selected Split Index 1.

Please note that on the screen below under the Configuration section that the column labeled "*Offset*" shows the generated External IO offset number, which is not used by the central master. It is not related to the Offset values generated under the general section.



When doing a Real-Time scan of the controllers you will see that pattern # 8 has been chosen.



6.2 Sub-System

The Sub-system section provides access to the current status of the 32 local controllers addressable by the master. In the status screen above, Master only has two Station ID's assigned to it , local controllers 1002 and 1003.

1000

Sub System

Pos	ID	Status
1	1002	ONLINE
2	1003	ONLINE
3	0	UNDEF
4	0	UNDEF
5	0	UNDEF
6	0	UNDEF
7	0	UNDEF
8	0	UNDEF
9	0	UNDEF
10	0	UNDEF
11	0	UNDEF
12	0	UNDEF
13	0	UNDEF
14	0	UNDEF
15	0	UNDEF
16	0	UNDEF
17	0	UNDEF
18	0	UNDEF
19	0	UNDEF

6.3 Detectors

The system *Detectors* area on the status screen above provides the current status of the 48 system detectors assigned to the *Central Master*. In addition the raw volume and occupancy is displayed for each detector. The smooth volume and occupancy includes any substitution values applied to a failed detector outside of the specified threshold values (see section 4.1.5 and 4.1.6).

If you test system detectors with thresholds and allow the detectors to fail, this menu will display the following STATUS each time the failed detector is polled:

- First successive failure (VOL or OCC threshold) – RETRY_1
- Second successive failure (VOL or OCC threshold) – RETRY_2
- Third successive failure (VOL or OCC threshold) – RETRY_3
- Fourth successive failure (VOL or OCC threshold) – RETRY_LM
- Fifth successive failure (VOL or OCC threshold) – UNDEF

Note: If you want a system detector to recover once it reaches the UNDEF state, you must set a substitution value other than zero.

Detectors

#	Status	Raw_Vo	Raw_Oc	Smooth_V	Smooth_Oc
1	ONLINE	34	136	9	69
2	ONLINE	35	150	10	76
3	ONLINE	32	141	9	71
4	ONLINE	45	129	12	65
5	ONLINE	42	146	12	74
6	ONLINE	43	142	12	72

6.4 TR History Report

An ATMS.now historical report is available using the Report Module, that reviews the computed coord modes, patterns, and offsets. In addition the cycle, offset and split parameters/indexes as well as the raw volume and occupancy counts will be printed for each analysis period after the user chooses the reported time frame.

TR Master Pattern Change Report

ID

NAME

5/7/2010

May 7, 2010 6:25 am

Computed Values

	Param	Index
Max V+O	26	2
Offset	50	4
Split	0	0

Configuration

	Coord Mode	Pattern	Offset
MTBC	TRI	0	1
MSYS	TRI	0	1
MCLP	CLP	11	2
MTRI	TR	11	5
MTRE	TR	0	5
FAIL	SBY	0	1
MTST	SBY	0	1

Detectors

	Raw_V	Raw_O		Raw_V	Raw_O		Raw_V	Raw_O		Raw_V	Raw_O
1	9	1	13	0	0	25	0	0	37	0	0
2	23	5	14	0	0	26	0	0	38	0	0
3	4	0	15	0	0	27	0	0	39	0	0
4	35	0	16	0	0	28	0	0	40	0	0
5	35	0	17	0	0	29	0	0	41	0	0
6	26	0	18	0	0	30	0	0	42	0	0
7	15	0	19	0	0	31	0	0	43	0	0
8	10	0	20	0	0	32	0	0	44	0	0
9	9	0	21	0	0	33	0	0	45	0	0
10	0	0	22	0	0	34	0	0	46	0	0
11	0	0	23	0	0	35	0	0	47	0	0
12	0	0	24	0	0	36	0	0	48	0	0

7 CIC (Critical Intersection Control)

The *Advanced Coordination* topics extend the *Basic Coordination* NTCIP methods discussed in Chapter 6 of the NTCIP Controller Manual. These advanced methods are purely optional and add more complexity to the programming required to define a coordination pattern. The *Basic Coordination* methods described in Chapter 6 are adequate for most situations and combine ease of use with extensive diagnostics to insure reliable operation. However, in some instances, *Advanced Coordination* methods may be desirable to provide:

- greater control over the management of "slack time" in the controller
- greater control over the permissive windows of opportunity for the non-coordinated phases
- the ability to force-off the same phase twice per cycle

CIC (Critical Intersection Control) is available **only on TS2 controllers using version 61.x firmware** and is easy to program and allows "slack time" to be managed by a dynamic split adjustment performed each cycle. The OTHER modes of *Advanced Coordination* discussed in chapter 6 of the NTCIP Controller manual require the user to manually program force-offs, permissive yield and apply points. The *Basic Coordination* methods defined in chapter 6 of the NTCIP Controller manual automatically calculate these *Easy Calcs* for you when the split times and sequence are specified for the pattern.

CIC (Critical Intersection Control) is an optional *adaptive split* feature used with NTCIP FIXED force-offs. This feature is enabled by programming one of four *CIC Plans* under menu MM->2->3 and associating the *CIC Plan* with a pattern in MM->2->6 as shown below.

CIC#	CoorØ	Grow	Ø.1	..2	..3	..4	..5	..6	..7	..8
1	OFF	0	0	0	0	0	0	0	0	0
2	P26	1	0	6	3	3	0	6	3	3
3	P48	2	3	6	3	3	3	6	3	3
4	P2468	1	3	6	3	6	3	6	3	6

MM->2->3: CIC Plans (Numbered # 1 - #4)

<- Pat#	Olp.Off:12345678	CIC	CNA1	Max2	Dia
1	....	0	.	.	DFT
2	....	2	.	.	DFT
3	....	3	.	.	DFT
......					
48	....	4	.	.	DFT

MM->2->6 (right menu): An Optional CIC# is Associated With Each Pattern #

CIC modifies split times by adjusting force-offs once per cycle in coordination using a method similar to the *Dynamic Max* in free operation. The *CIC* algorithm reduces *Split Times* for phases that gap-out after two consecutive cycles and distributes this time to the *Coord Ø(s)* or other "Grow" phases listed in the *CIC* table. CIC insures that "Slack time" from the non-coordinated phases moves to the end of the coord phase rather than the next phase in the sequence. CIC improves progression by moving "slack time" to the end of the Coord-Ø instead of at the beginning of the Coord-Ø.

7.1 Example Using CIC (Critical Intersection Control)

This section provides a step-by-step example setup of CIC in operation and explains how to interpret the *CIC Calcs* status display and observe the dynamic split adjustments cycle by cycle.

Step 1 – Initialize the controller and modify the STD8 defaults

a) Turn the *Run Timer* OFF (MM->1->7) and initialize the controller as STD-8Ø under MM->8->4->1. Don't forget to turn the *Run Timer* back ON (MM->1->7)

b) Change the *Min Green* times phases 1 - 8 to 2" under MM->1->1->1. Also, change the *Yellow* time of each phase to 2" and the *All-Red* clearance times to 0". These changes will allow you to observe CIC operation quickly using a 40" cycle.

c) Set STOP-IN-WALK to ON under MM->1->2->1 (right menu). This setting allows *Split Times* to run shorter than the pedestrian minimums set for the through phase defaults.

Step 2 – Create the timing patterns

a) Create three timing patterns in the Pattern Table (MM->2->4) as shown below.

Pat#	Cycle	Offset	Split	Seqnc
1	40	0	1	1
2	40	0	2	1
3	40	0	3	1

MM->2->4: Timing Patterns Used for CIC Examples

b) Create the three *Split Tables* shown below. Pattern 1 is an example of coordination provided along one street phased on 2 and 6 (notice the Coord-Ø setting and the MAX recall applied to 4 and 8). Pattern 2 provides coordination to phases 4 and 8. Pattern 3 provides coordination to both intersecting streets (2, 4, 6 and 8).

Spl-1	Ø..1	...2	...3	...4	...5	...6	...7	...8	->
Time	10	10	10	10	10	10	10	10	
Coor-Ø	.	X	.	.	.	.	.	.	
Mode	NON	MAX	NON	NON	NON	MAX	NON	NON	

Pattern 1 / Split Table 1: Major arterial is situated on phases 2 and 6

Spl-2	Ø..1	...2	...3	...4	...5	...6	...7	...8	->
Time	10	10	10	10	10	10	10	10	
Coor-Ø	.	.	.	X	.	.	.	.	
Mode	NON	NON	NON	MAX	NON	NON	NON	MAX	

Pattern 2 / Split Table 2: Major arterial is situated on phases 4 and 8

Spl-3	Ø..1	...2	...3	...4	...5	...6	...7	...8	->
Time	10	10	10	10	10	10	10	10	
Coor-Ø	.	.	.	.	.	X	.	.	
Mode	NON	MAX	NON	MAX	NON	MAX	NON	MAX	

Pattern 3 / Split Table 3: Two major arterials crossing on phases 2, 4, 6 and 8

Step 3 – Assign "slack time" from the actuated phases

In these examples, a single Coord-Ø is used in the split table to reference the pattern offset to the beginning of the Coord-Ø green. This is the standard default; however, the offset reference may be changed to *EndGrn* under MM->2->5 (right menu). In these examples, the offset (zero point in the cycle, or Loc = 0) is synched to the beginning of the Coord-Ø specified in the *Split Table.*

The Coord-Ø is typically "fixed" this is the portion of the cycle that needs to be guaranteed for the progression (green bands) along the major street. *Return Hold* may be set under MM->2->5 (right menu) to insure that when the controller returns to the Coord-Ø that it holds the phase until it is forced off. However, it is more convenient to simply place a MAX recall on the progression phases in the split table. Therefore, in these examples, the MAX mode setting indicates which phases are coordinated and the Coord-Ø is simply used to reference the offset to the beginning of one of these coordinated phases.

Non-coordinated phases are typically fully actuated, sot the Mode setting in the Split Table is typically set to NON (None) or MIN (Min recall). NTCIP coordination specifies that any unused (or "slack time") from the non-coordinated phases is either passed to the next phase in the sequence (FIXED force-offs) or to the Coord- Ø (FLOAT-ing force-offs). These concepts were discussed in section 6.3.2. Please review this section before continuing with this example because CIC operation builds upon these two methods.

CIC calls for FIXED force-offs, so “slack time” is always passed to the next available phase in the sequence. However, CIC constantly monitors whether phases gap-out or max-out each cycle and dynamically adjusts the fixed force-offs each cycle to move “slack time” to phases that continue to max-out each cycle and the Coord-Ø

FLOAT-ing force-offs move all “slack time” from the actuated phases to the Coord-Ø. However, CIC is often preferred over FLOAT-ing force offs because “slack time” is move to the end rather than the beginning of the progression band. This reduces the early return problem common with FLOAT-ing force-off methods because “slack time” at the beginning of the progression band varies the start of the platoon.

There are essentially 4 ways to manage “slack time” in a semi-actuated controller during coordination:

1) **FIXED Force-offs Without CIC** – Force-offs are fixed and “slack time” is provided to the next phase.

2) **FIXED Force-offs With CIC** – Force-offs are adjusted dynamically to allocate “slack time” to phases that continue to max-out each cycle. Any remaining “slack time” allocated to the end of the Coord- Ø.

3) **FLOAT-ing Force-offs Without CIC** – A separate max timer insures that the non-actuated phases never time more than their programmed split. This moves “slack time” to the beginning of the Coord- Ø.

4) **OTHER Force-off Methods** – The OTHER methods are discussed in the last section of this chapter.

Step 4 – Associate a CIC Plan with each pattern

Any of the four *CIC Plans* may be assigned to the 48 patterns from *Alt Tables+* (MM->2->6, right menu). For these examples, associate *CIC Plan* 1 with pattern 1, *CIC Plan* 2 with pattern 2 and *CIC Plan* 3 with pattern 3 as shown below:

<-	Pat#	Olp.Off:12345678	CIC	CNA1	Max2	Dia
	1	....	1	.	.	DFT
	2	....	2	.	.	DFT
	3	....	3	.	.	DFT

MM->2->6: Coordination Alt Tables+

Step 5 – Program CIC Plans 1-3 called by Patterns 1-3

Program the first three *CIC Plans* associated with patterns 1-3 under MM->2->3 as shown below.

CIC#	CoorØ	Grow	Ø.1	..2	..3	..4	..5	..6	..7	..8
1	P26	2	0	20	10	10	0	20	10	10
2	P48	2	10	10	10	30	10	10	10	30
3	P2468	1	10	20	10	20	10	20	10	20
4	OFF	0	0	0	0	0	0	0	0	0

MM->2->3: CIC Plans 1-3 called by Patterns 1-3

Note that the Coord-Ø specified in the *CIC Plan* table corresponds with the MAX mode settings set in the split tables. The MAX settings insure that split times for the coordinated (or progression) phases are guaranteed.

The "Grow" setting may range between 0 and 2 seconds (0 effectively defeats CIC). This parameter controls how much each split time is allowed to "grow" or "shrink" each cycle. The time specified under each phase is called the *Dynamic Max* because it controls the maximum adjustment (positive or negative) allowed for each phase. In the example above, the *Dynamic Max* for the coord phases in each ring is typically set to the sum of the *Dynamic Max* times for the non-coordinated phases. This allows all "slack time" from the non-coordinated phases to move to the end of the coord phases under CIC.

It is important to note that the *Dynamic Max* adjustment cannot reduce split times shorter than the minimum phase times. Note that split times in our example patterns are 10" while the *Dynamic Max* times are set 10-30". CIC insures that split times are not reduced short enough to fail the pattern. Therefore, the *Dynamic Max* settings do not need to be checked by the coordination diagnostics. This simplifies the use of CIC and allows the same CIC Plan to be used for any number of patterns each with varying split times and cycle length.

Step 6 – Test Pattern 1

Force the controller to *Test Pattern 1* by setting *Test, OpMode* to "1" under MM->2->1. Observe the *CIC Calcs* screen under MM->2->8->3. When CIC begins, the *CIC Calcs* screen appears as follows:

Dyn Coor	Ø.1	...2	...3	...4	...5	...6	...7	...8
Dyn Acc	0	0	0	0	0	0	0	0
Dyn Abs	0	0	0	0	0	0	0	0
Dyn Max	0	20	10	10	0	20	10	10
DynTerm	0	0	0	0	0	0	0	0
PRIM FO	37	7	17	27	37	7	17	27
VEH YLD	7	17	7	7	7	17	7	7

MM->2->8->3: CIC Calcs When Pattern 1 Begins

When CIC begins, the primary force-off and vehicle yield points under *CIC Calcs* are identical to the FIXED force-offs under *Easy Calcs*. The zero point of the 40" cycle is at the beginning of the phase 2 (the Coord-Ø). Because the *Split Time* for phase 2 is 10" and yellow clearance is 3", phase 2 is forced-off at 10" – 3" = 7" after the offset. The controller yields to all non-coordinated phases when the coordinated phase is forced off.

Initially, the controller rests in phase 2 and 6 because MAX recalls are set for these phases in *Split Table*

1 and there are no recalls present on the other phases. After 2 cycles, the *CIC Calcs* are recalculated and the "Grow" time of 2" is deducted from phases 3, 4, 7 and 8 and applied to phases 2 and 6 as shown below.

Dyn Coor	Ø.1	2	3	4	5	6	7	8
Dyn Acc	0	4	254	254	0	4	254	254
Dyn Abs	0	4	2	0	0	4	2	0
Dyn Max	0	20	10	10	0	20	10	10
DynTerm	0	0	0	0	0	0	0	0
PRIM FO	37	11	19	27	37	11	19	27
VEH YLD	7	17	7	7	7	17	7	7

MM->2->8->3: CIC Calcs Two Cycles After Pattern 1 Begins

The *Dynamic Accumulator (Dyn Acc)* tracks the "grow" and "shrink" accumulations each cycle. Positive "slack time" is added to zero which serves as a base reference for positive accumulations. Negative "slack time" is subtracted from 256 as the base reference for negative accumulations. Therefore, a *Dyn Acc* equal to 254 is equivalent to a *Dyn Acc* value of –2 seconds.

After two cycles with MAX recalls on phases 2 and 6 and all other phases skipped, phases 3, 4, 7 and 8 "shrink" by 2" and phases 2 and 6 "grow" by 4". Notice how the 4" accumulation added to phases 2 and 6 extend the force-offs of phase 2 and 6 from Loc=7 to Loc=11 to extend the end of the coordinated movement.

After the third cycle (at Loc=0), another dynamic adjustment is made as shown below. Cross street phases 3, 4, 7 and 8 have "shrunk" a total of 4" each and the coordinated phases have grown by 8". The split times for phases 1 and 5 have not changed because the *Dynamic Max* values for these phases in the *CIC Plan* table are zero. You can easily control which *Split Times* are allowed to "grow" and "shrink" through the *CIC Plan* table

Note that at the end of cycle 3, the force-offs for phases 1 and 5 are still applied at 37; however, the force-off for phases 2 and 6 are at Loc=15 compared with cycle 1 (at Loc=7). These dynamic adjustments begin the coordinated phases at the same point in the cycle (at the end of phase 1 and 5), but extend the end of the coord phases using the "slack time" from the cross street phases.

Dyn Coor	Ø.1	2	3	4	5	6	7	8
Dyn Acc	0	8	252	252	0	8	252	252
Dyn Abs	0	8	4	0	0	8	4	0
Dyn Max	0	20	10	10	0	20	10	10
DynTerm	0	0	0	0	0	0	0	0
PRIM FO	37	15	21	27	37	15	21	27
VEH YLD	7	17	7	7	7	17	7	7

MM->2->8->3: CIC Calcs Three Cycles After Pattern 1 Begins

If you continue to observe this display, you will notice that no further split adjustments are made even though the controller continues to rest in 2 and 6 which all other phases are skipped. CIC cannot reduce split times shorter than the phase minimums plus a one second buffer. The sum of the minimum vehicle times is given by:

Minimum Vehicle Time = Min Green + Yellow + All-Red + 1” Buffer = 2” + 3” + 0” + 1” = 6”

A 10” split cannot “shrink” more than 4” without violating this *Minimum Phase Time* even though the *Dynamic Max* values in the *CIC Plan* table are 10”. CIC guarantees the *Minimum Phase Times* are not violated, so the user need not be concerned about coord failures resulting from values in the *CIC Plan* table. Also, recall that STOP-IN-WALK was set ON in Step 1 c). If you turn STOP-IN-WALK OFF, all three patterns will fail the coord diagnostic to insure that the pedestrian min times are guaranteed:

Minimum Pedestrian Time = Walk + Ped Clear + Yellow + All-Red + 1” Buffer = 5” + 10” + 3 + 0” + 1” = 19”

Step 7 – Apply recalls to the non-coordinated phases in Pattern 1

Test Pattern 1 is currently resting in phase 2 and 6 with no calls on any of the non-coordinated phases. CIC has moved as much “slack time” as possible from phases 3, 4, 7 and 8 to the end of phases 2 and 6. In this step, we will observe how the “slack time” is transfers back to the non-coordinated phases as they are called into service.

Place MIN recalls on every phase but 2 and 6 using the Mode setting in *Split Table 1* as shown below. Confirm that these recalls are present from menu MM->7->1 and then watch the *CIC Calcs* from MM->2->8->3.

```
Spl-1   Ø..1...2...3...4...5...6...7...8 ->
Time       10  10  10  10  10  10  10  10
Coor-Ø      .   X   .   .   .   .   .   .
Mode      MIN MAX MIN MIN MIN MAX MIN MIN
```

MM->2->7->1: Split Table 1 With MIN Recalls Applied to the Non-coordinated Phases

Note that after 4 or 5 cycles, the *CIC Calcs* have not changed from our last example even though all the non-coordinated phases are being recalled instead of being skipped. CIC cannot reduce the split times below the *Minimum Phase Times* as discussed in Step 6. Therefore, no split adjustments are made when the actuated service their min times.

Now go to *Split Table 1* and place a MAX recall on phase 4. Go back to the *CIC Calc* screen and observe how the Dynamic Max changes as phase 4 begins to “grow” back to it’s original split time. These changes are summarized in the table below for 5 consecutive cycles.

Cycle #	Phase Recall Mode	CIC Dynamic Accumulator							
		1	2	3	4	5	6	7	8
1	4 MIN	0	8	252	252	0	8	252	252
3	4 MAX	0	6	252	254	0	6	252	254
4	4 MAX	0	4	252	0	0	4	252	0
5+	4 MAX	0	4	252	0	0	4	252	0

Example of Non-coordinated Phase 4 Regaining “Slack Time” and Growing Back to the Original Split

After 2 cycles with MAX recall applied to phase 4, the accumulated “slack time” provided to the end of the coordinated phases (phase 2 and 6) has been reduced and moved back to service phase 4. This dynamic split adjustment allows the *Split Times* to “grow” and “shrink” within the constraints of the *CIC Plan* table. This operation is similar to the *Dynamic Max* feature that allows max times to grow in a step-wise manner in free operation (see section 4.1.3).

Now, place a MAX recall on phase 3 in Split Table 1. You will observe the following dynamic split adjustment:

Cycle #	Phase Recall Mode	CIC Dynamic Accumulator							
		1	2	3	4	5	6	7	8
1	3 MIN and 4 MAX	0	4	252	0	0	4	252	0
3	3 & 4 MAX	0	2	254	0	0	2	254	0
4+	3 & 4 MAX	0	0	0	0	0	0	0	0

Example of Non-coordinated Phase 3 Regaining "Slack Time" Back to the Original Split

Step 8 – How CIC improves split utilization on the cross street

CIC can also make dynamic split adjustments to the non-coordinated phases to improve split utilization on the cross street. For example, assume the cross street left-turn movements are protected-only and that phases 3 and 8 max-out each cycle while phases 4 and 7 are running their *Minimum Phase Times*. We can simulate this condition by programming the *Mode* settings in *Split Table 1* as follows:

Spl-1	Ø..1	...2	...3	...4	...5	...6	...7	...8 ->
Time	10	10	10	10	10	10	10	10
Coor-Ø	.	X	.	.	.	.	.	.
Mode	MIN	MAX	MAX	MIN	MIN	MAX	MIN	MAX

Cross Street Phases 3 ad 8 are Max-out While Phases 4 and 7 Are Timing Their Mins

Observe the *CIC Calcs* until the dynamic splits adjustments come to rest as shown below.

Dyn Coor	Ø.1	...2	...3	...4	...5	...6	...7	...8
Dyn Acc	0	0	4	252	0	0	252	4
Dyn Abs	0	0	4	0	0	0	252	0
Dyn Max	0	20	10	10	0	20	10	10
DynTerm	0	0	0	0	0	0	0	0
PRIM FO	37	7	21	27	37	7	13	27
VEH YLD	7	17	7	7	7	17	7	7

CIC Improves Cross Street Split Utilization By Moving "Slack Time" Where It Is Needed

In this example, phases 1, 5, 2 and 6 continue to time their programmed *Split Times* (there is no dynamic split adjustment applied to the major street). However, phase 3 has gained an additional 4" from phase 4 and phase 8 has gained 4" from phase 7.

If FIXED force-offs without CIC was used in this example, phase 8 would receive the same unused "slack time" from phase 7 because phase 8 follows phase 7 in the sequence. However, phase 3 would never be allowed to "grow" by 4" using FIXED force-offs without CIC because phase 3 follows phase 2 in the sequence which is servicing it's MAXimum split. Therefore, CIC can improve split utilization for the first cross street phases serviced after leaving the coordinated street. This capability is especially useful if the cross street left-turns are protected only and max-out each cycle while "slack time" exists on the opposing through movements.

Step 9 – Test Pattern 2

Refer back to the *Split Table* for pattern 2 under Step 2. The Coord-Ø is phase 4 and MAX recalls are set on phases 4 and 8. This configuration would typically be used if the major street through movements are serviced on phases are 4 and 8 and the cross street is 2 and 6.

Now, force the controller into pattern 2 by setting *Test,OpMode* to "2" under MM->2->1.

Spl-2	Ø..1	...2	...3	...4	...5	...6	...7	...8	->
Time	10	10	10	10	10	10	10	10	
Coor-Ø	.	.	.	X	.	.	.	.	
Mode	NON	NON	NON	MAX	NON	NON	NON	MAX	

Pattern 2 / Split Table 2: Major arterial is situated on phases 4 and 8

This pattern calls for *CIC Plan # 2* as programmed under Step 5 and allows all non-coordinated phases to "grow" or "shrink" by 10". The coordinated phases can grow as much as 30" by applying "slack time" to the end of phases 4 and 8. Each phase is constrained by the *Minimum Phase Times* guaranteed for each phase.

CIC#	CoorØ	Grow	Ø.1	..2	..3	..4	..5	..6	..7	..8
1	P26	2	0	20	10	10	0	20	10	10
2	P48	2	10	10	10	30	10	10	10	30
3	P2468	1	10	20	10	20	10	20	10	20
4	OFF	0	0	0	0	0	0	0	0	0

MM->2->3: CIC Plans 1-3 called by Patterns 1-3

Test Pattern 2 rests in 4 and 8 because of the MAX recalls programmed for these phases in the *Split Table*. No other recalls are placed on any other phase in *Split Table 2*, so all the 12" of accumulated "slack time" is moved to the end of phases 4 and 8. This move the force-off points for phases 4 and 8 from Loc=7" to Loc=19".

Dyn Coor	Ø.1	...2	...3	...4	...5	...6	...7	...8
Dyn Acc	252	252	252	12	252	252	252	12
Dyn Abs	8	4	0	12	8	4	0	12
Dyn Max	10	10	10	30	10	10	10	30
DynTerm	0	0	0	0	0	0	0	0
PRIM FO	25	31	37	19	25	31	37	19
VEH YLD	7	7	7	17	7	7	7	17

In CIC Plan 1 we omitted the main street left-turns from the CIC split adjustment. *CIC Plan 2* allows the main street left-turn phases (3 and 7) to "grow" and "shrink" along with the cross street phases (3, 4, 7 and 8). If you place a MAX recall on phase 3 in *Split Table 2*, the *Dynamic Accumulator* changes as follows:

Dyn Coor	Ø.1	2	3	4	5	6	7	8
Dyn Acc	252	252	8	0	252	252	252	12

This example illustrates why you typically reduce or omit the main street left-turn phases from CIC. *Dynamic Max Time* for phases 3 and 7 should be constrained in *CIC Plan 2* to move more of the "slack time" to 4 and 8.

Step 10 – Test Plan 3 (Two Coordinated Intersecting Arterials)

This last example, both intersecting streets are coordinated. One of the phases is chosen as the Coord-Ø to reference the offset to the beginning of the Coord-Ø. MAX calls are placed on all through movements to guarantee cycle time to the progressed movements.

Spl-3	Ø..1	2	3	4	5	6	7	8 ->
Time	10	10	10	10	10	10	10	10
Coor-Ø	.	.	.	.	.	X	.	.
Mode	NON	MAX	NON	MAX	NON	MAX	NON	MAX

Pattern 3 / Split Table 3: Two major arterials crossing on phases 2, 4, 6 and 8

The Coord-Ø in CIC Plan # 3 is set to P2468 and the left-turn phases are set to "grow" or "shrink" a maximum of 10" compared to 20" for the progressed movements.

CIC#	CoorØ	Grow	Ø.1	2	3	4	5	6	7	8
1	P26	2	0	20	10	10	0	20	10	10
2	P48	2	10	10	10	30	10	10	10	30
3	P2468	1	10	20	10	20	10	20	10	20
4	OFF	0	0	0	0	0	0	0	0	0

MM->2->3: CIC Plans 1-3 called by Patterns 1-3

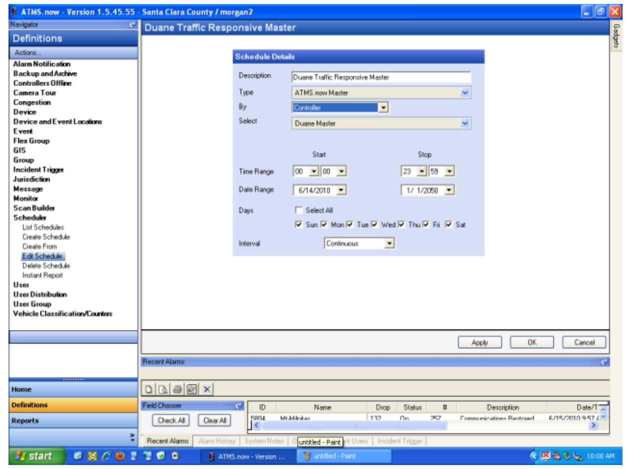
Force the controller into *Test Pattern 3* by setting *Test,OpMode* to "3" under MM->2->1. *Split Table 3* called by this pattern issues MAX recalls on phases 2, 4, 6 and 8 while phases 1, 3, 5 and 7 are skipped.

Observe the *CIC Calcs* under MM->2->8->3. Note that the *Dynamic Accumulator* adjustments are only 1" each cycle compared with the 2" adjustment in *Test Plans 1 and 2*. This is due to the difference in the *Grow* settings for these 3 CIC plans in the *CIC Plan* table.

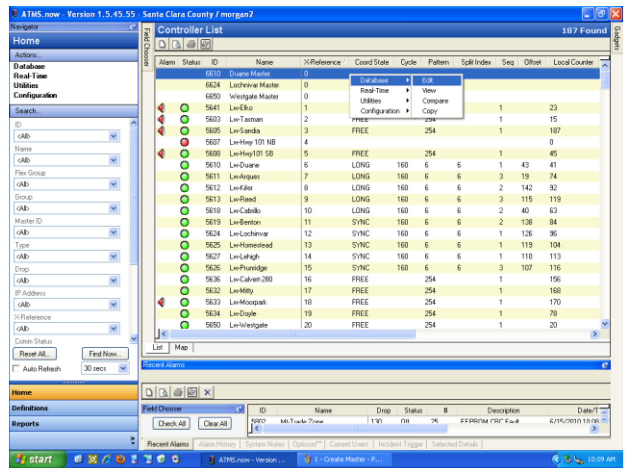
8 Setup Considerations

The following procedure and considerations were developed during training in Santa Cara County. They are referenced to assist the user when setting up Traffic Responsive. This is only a reference document that will assist your agency when setting up Traffic Responsive.

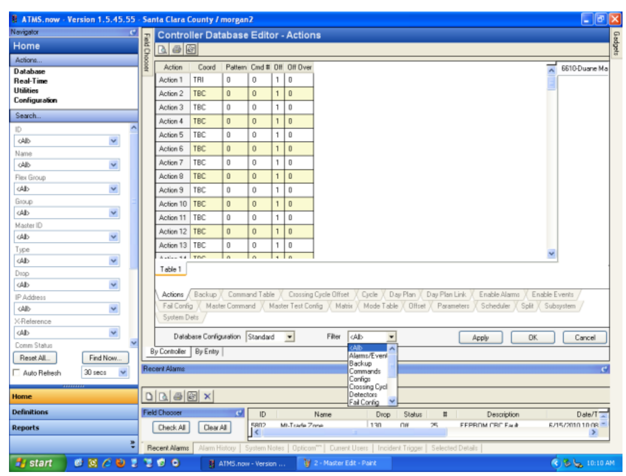
1. Create System Master
    a. Configuration > Create Definition
    b. Enter Controller ID
    c. Enter Controller Name
    d. Select Controller Type to “TR Master 6.1x”
    e. Select Drop Number (Suggest 1 or 255)



2. From Controller List, Selected Database Edit of newly created System Master

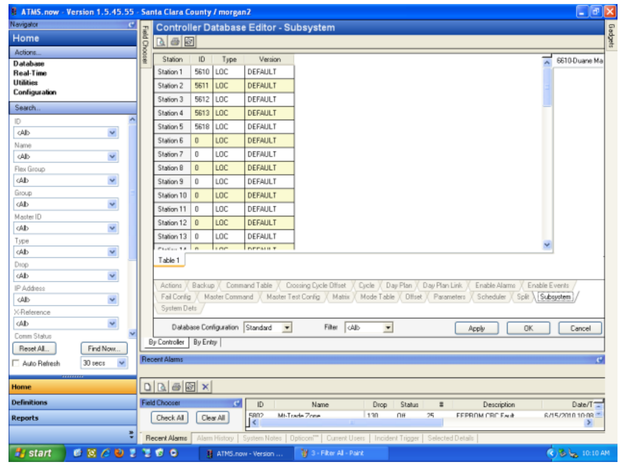


3. Check Filter to “ALL”



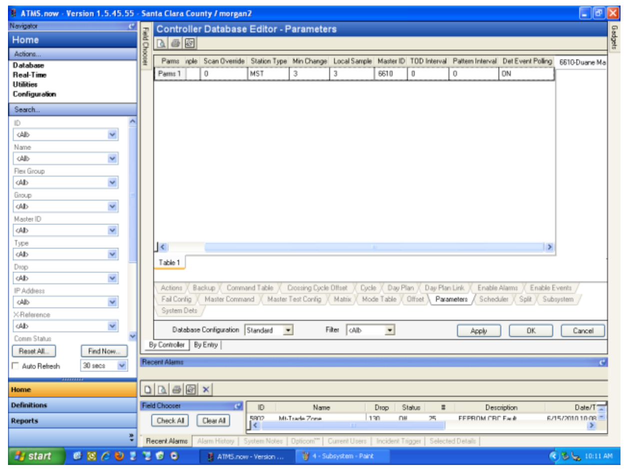
4. SUBSYSTEM Tab:

    a. Enter Local Controller ID number for all intersections that will be in Subsystem
    b. Set TYP to "LOC" for all local controllers added to the Subsystem
    c. Set Version to the particular type of controller that you are using for all local controllers added to the Subsystem.



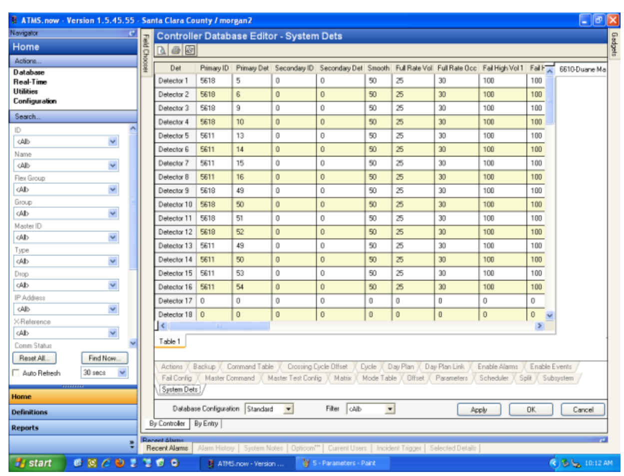
5. PARAMETERS Tab:

    a. Set Station Type to "MST"
    b. Enter Min Change time. Should match the local controller Detector Poll Time
    c. Enter Master ID No, should match the same Controller ID number assigned to the ATMS
    d. Enter Local Sample time to match Min Change time entered above
    e. Set Detector Event Polling to, "ON"
    f. Pattern Interval should be set to a Minimum of "1".



6. SYSTEM DETECTORS Tab:

    a. For each system detector that will feed the master enter the following info:
        i. Primary ID – The ATMS Local Intersection Controller No
        ii. Primary Det – The Local Intersection System Detector
        iii. Smooth – Smooth factor that identifies how each volume and occupancy data input is average in relation to the previous sample



iv. Full Rate Vol – vehicle/minute rate value for this lane. For a maximum value of 1,200 vehicle/minute this would correspond to 20 vehicle/minute

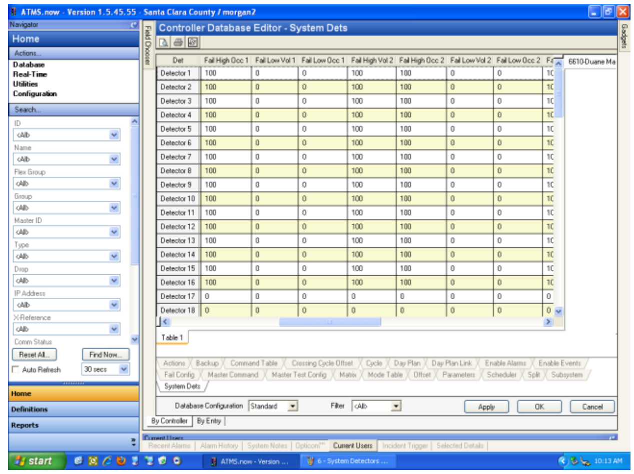
v. Full Rate Occ – vehicle/minute rate value rate for max saturation flow rate, generally accepted to be between 1,800 to 2,000 vehicles per hour which corresponds to 30 to 33 vehicle/minute

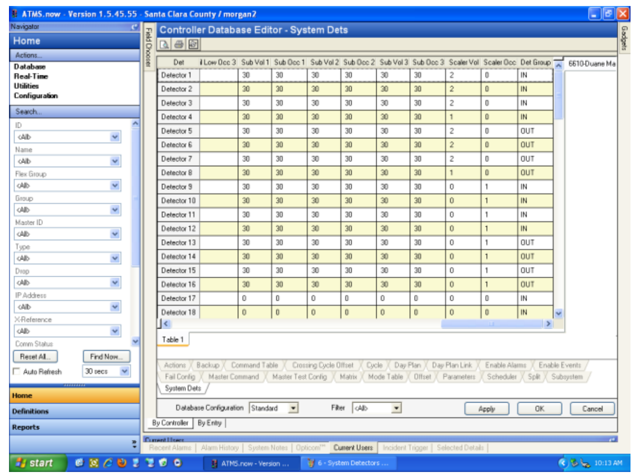
vi. Fail High Vol – Set to 100 to never fail the detector input

vii. Fail High Occ – Set to 200 to never fail the detector input

viii. Fail Low Vol and Fail Low Occ – Set to 0 to never fail the detector input

ix. Sub Vol and Sub Occ – This is the static value that will be used by the Master should the primary detector input fail. Because the Fail High Vol/Low Vol are set to 100 and 0 and Fail High Occ/Low Occ are set to 200 and 0 respectively, this fallback parameter will never be utilized because the detector is never allowed to fail.

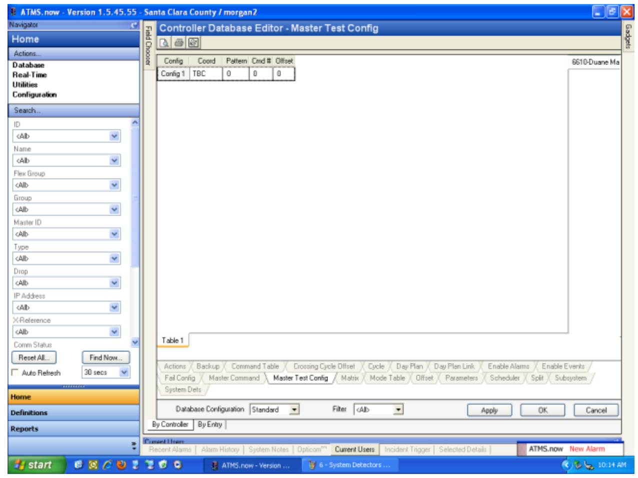




x. Scalar (Vol or Occ) – Desired weight of this detector input value in comparison to other detector inputs on the Subsystem. Suggest setting all Scalar values to 1. You can then do a ratio such as 2:1 if another detector input is twice as important as others on the Subsystem.

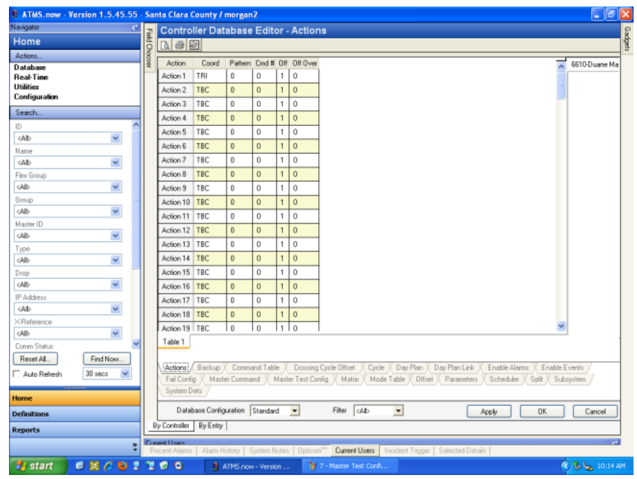
xi. Det Group – Set to either IN or OUT or CROSS (CRS) depending on whether the detector is providing Inbound data to the destination area, Outbound from the destination area or is a Cross Street along the corridor

7. MASTER TEST CONFIG Tab:



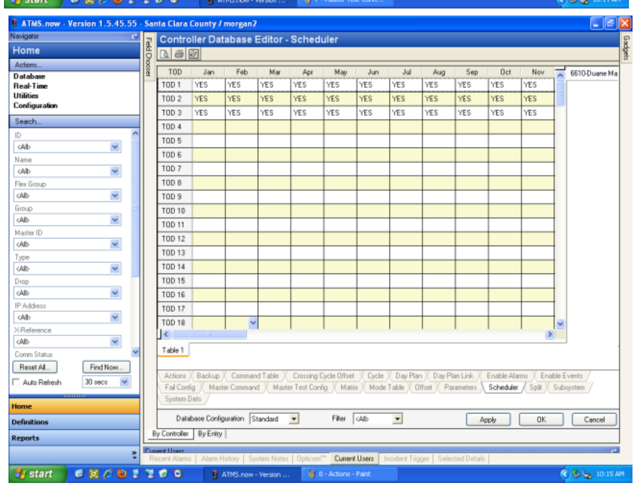
a. Set Coord Tab to "TBC" at start to let the subsystem run in normal Time-Based Coordination so that you can monitor what the system would do if running in Traffic Responsive mode. When you are ready to turn Traffic Responsive on, set the Coord Tab to "SBY" to pass control to the Master schedule
b. Set Pattern to "0"

8. ACTIONS Tab:

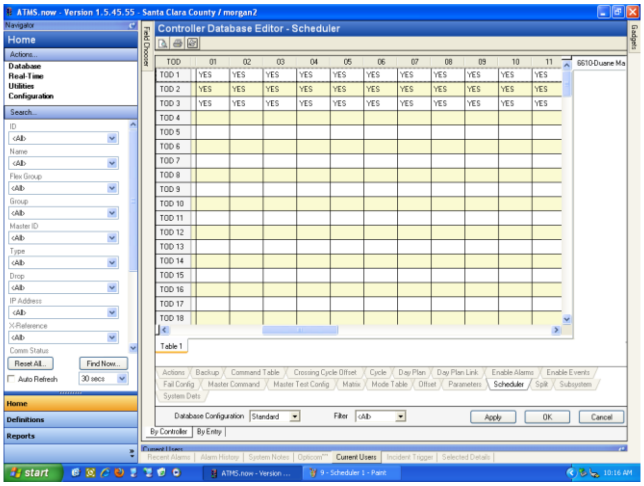


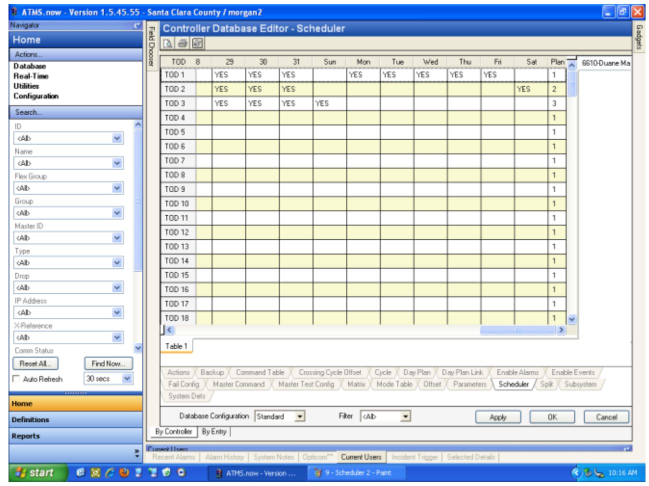
a. Set Action 1 Coord Type to "TRI". This will be the action that enables Traffic Responsive
b. Set Action 2 Coord Type to "TBC" and Pattern "0". This will be the action that enables Time-Based Coordination
c. Set Action 54 Coord Type "TBC" and Pattern "254". This will be the action that enables Free Mode
d. Set Action 55 Coord Type "TBC" and Pattern "255". This will be the action that enables Flash Mode.

9. SCHEDULER Tab:



Suggest reserving Day Plan 1 for Mon thru Fri operations, Day Plan 2 for Saturday operations, and Day Plan 3 for Sunday Operations. For each Day Plan enable the Month and Day and appropriate Day of Week. This will allow you flexibility to enable the Master at any Time in the ATMS Schedule at any time and your central master will already be set up to run at the desired time.



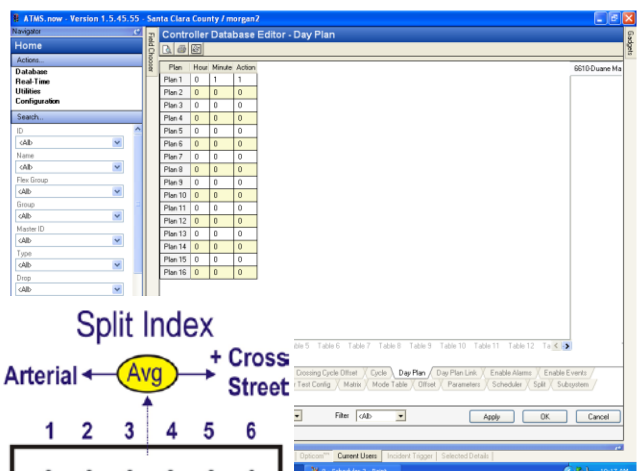


10. DAY PLAN Tab:

Because the Scheduler was set up to operate three different Day Plans, one for weekdays and one for each weekend day, the first three Day Plans must be programmed to run Traffic Responsive operations.

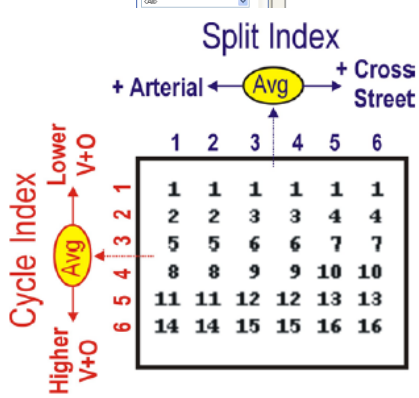
a. For each Day Plan set a Start Time of Hour “0” and Min “1”
b. For each Day Plan set an Action “1” to Run Traffic Responsive

11. MATRIX/CYCLE/OFFSET Tabs:



The Matrix is representation of the Cubic | Trafficware 3-dimensional Table of Patterns. The Table of Patterns represents the Patterns that will be selected by the Master, using Cycle and Offset parameters, and then directed by implementation by the Local Intersection Controllers.

Each Local Intersection Controllers on the Subsystem must be programmed with the same Pattern numbers for Traffic Responsive operations to functional properly.



The Matrix table represents strategies for managing varying traffic patterns. In the examples below, AM traffic is managed through Offset Tables1/2, Midday traffic by Offset Table 3, and PM traffic by Offset Table 4/5. For simplicity only one Pattern reference change option is provided to the system and Offset Tables 1/2 reference to morning and Offset Tables 3/4 both identify the same commute period is to allow the user to identify strategies later to manage mid-morning and mid-afternoon strategies.

Offset Tables 1/2 (AM)						Cycle		Offset	
1	2	3	4	5	6	Inc	Dec	Inc	Dec
254	254	254	254	254	254	-	7	-	10
7	7	7	7	7	7	10	25	15	36
8	8	8	8	8	8	33	45	38	35
9	9	9	9	9	9	50	60	40	75
2	2	2	2	2	2	65	80	80	-
4	4	4	4	4	4	85	-		

Pattern

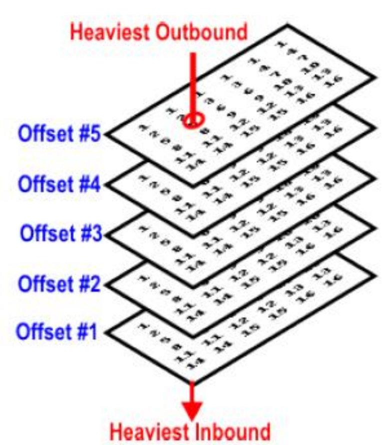
Offset Tables 3 (Midday)						Cycle		Offset	
1	2	3	4	5	6	Inc	Dec	Inc	Dec
254	254	254	254	254	254	-	7	-	10
17	17	17	17	17	17	10	25	15	36
18	18	18	18	18	18	33	45	38	35
22	22	22	22	22	22	50	60	40	75
19	19	19	19	19	19	65	80	80	-
19	19	19	19	19	19	85	-		

Pattern

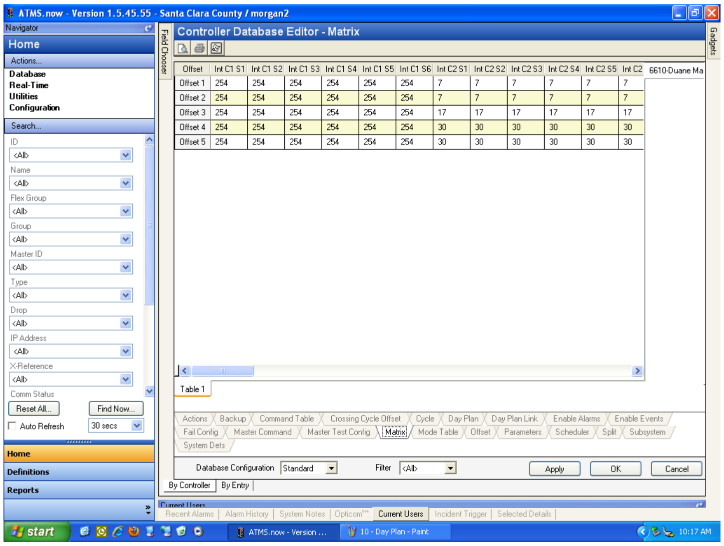
Offset Tables 4/5 (PM)						Cycle		Offset	
1	2	3	4	5	6	Inc	Dec	Inc	Dec
254	254	254	254	254	254	-	7	-	10
30	30	30	30	30	30	10	25	15	36
31	31	31	31	31	31	33	45	38	35
32	32	32	32	32	32	50	60	40	75
12	12	12	12	12	12	65	80	80	-
14	14	14	14	14	14	85	-		

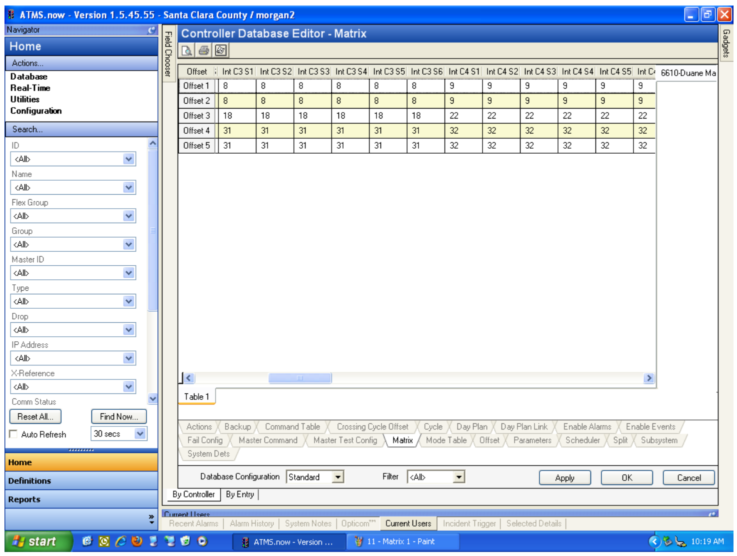
Pattern

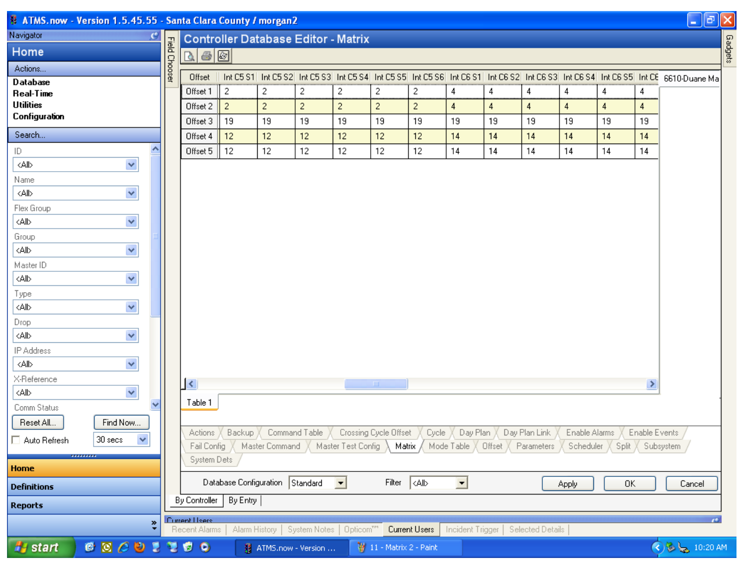
The Offset and Cycle percentage selection per step is an iterative process. As a suggestion, percentages that select the Patterns would Time-Based Coordination is a good starting consider using a Decrease percentage that is 5- the previous Increase percentage.



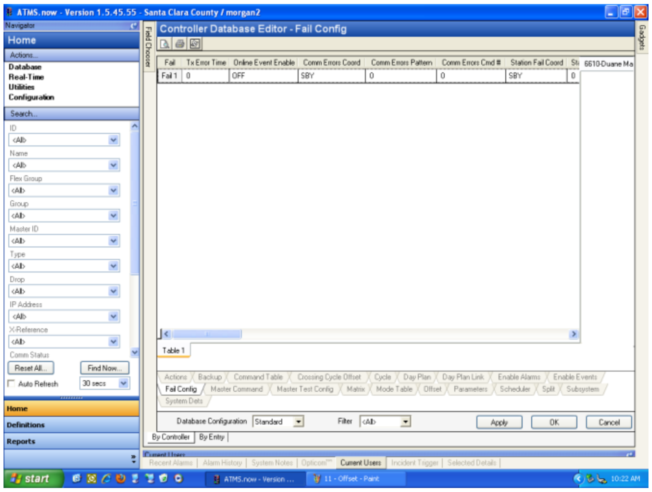
increase/decrease identifying normally run under point. In addition, points lower than


ATMS.now - Version 1.5.45.55 - Santa Clara County / morgan2
Controller Database Editor - Matrix


ATMS.now - Version 1.5.45.55 - Santa Clara County / morgan2
Controller Database Editor - Matrix


ATMS.now - Version 1.5.45.55 - Santa Clara County / morgan2
Controller Database Editor - Matrix

12. FAIL CONFIG Tab:

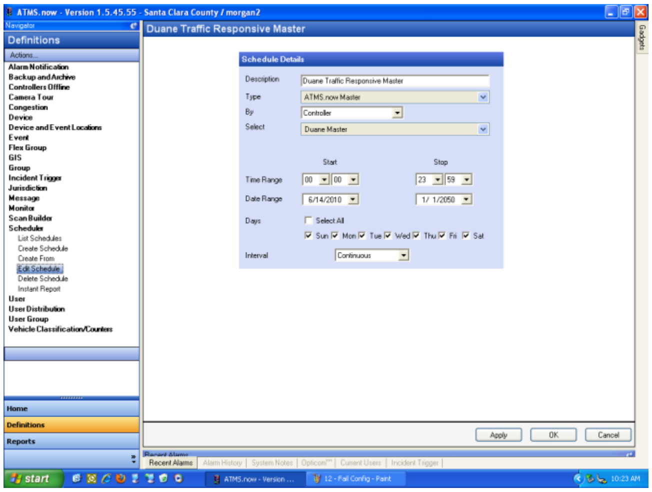


There should be no modifications necessary to this tab unless more rigid failure requirements are desired by the user.

a. TX Error Time, in seconds, represents the amount of time that the system will expect a reply before failing the Master.

13. Scheduling of the Master to Operate in ATMS.now:

Note: It is recommended that the user create a Flex Group within ATMS.now for the intersections that will be included in the Subsystem and that the Flex Group be scheduled to Poll for Status by the ATMS if the local intersection controllers are not already communicating to the central system.



a. Select the Definitions Tab located at the bottom left side of the ATMS.now home screen.
b. Select the "Scheduler > Create Schedule" link.
c. Assign a "Description" to the TR Master that will make is easy to reference.
d. Select "ATMS.now Master" Type
e. Select "by" – "Controller" since the Traffic Responsive Master is consider a local controller on the ATMS.now. **DO NOT SELECT "MASTER" Type.**
f. Leave Start/Stop and Time/Date ranges alone
g. Select the Days of the Week that the Traffic Responsive Master will operate.
h. Set "Interval" to "Continuous"