Operations Manual

For

Transit / Light Rail Priority

Using controllers with Version 80.x, V85.x/Scout or V76.15H or later Software

October 2021

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1 Transit Priority Overview

Cubic | Trafficware controllers provide six high-priority and four low-priority preempt requests. In addition, the four low-priority requests may be programmed for Transit / Light Rail priority service. Preemption is documented in Chapter 8 of the Cubic | Trafficware controller manual. The purpose of this manual is to supplement Chapter 8 for users wishing to apply Transit / Light Rail Priority service rather than preemption for transit operations. This chapter will detail transit priority and describe the features of the transit priority module for software versions beginning with V76.15H.

In this document, the notation **[LRT]** labels features specific to Light Rail Transit Priority. Performing a search on this document for the string "[L" will find all occurrences of features that are unique to Light Rail Transit Priority.

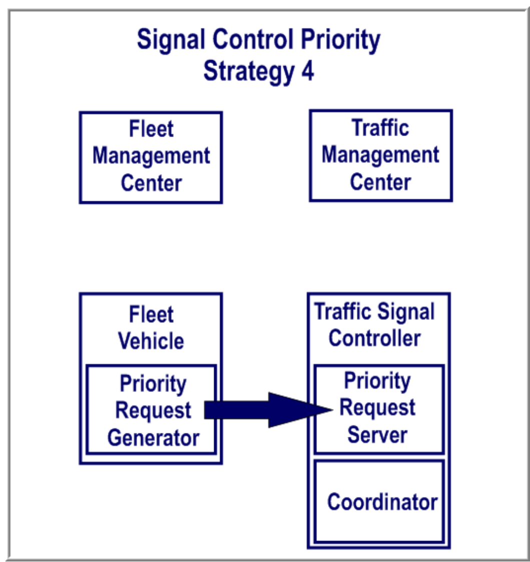
1.1 Preemption Compared With Priority Service

Preemption is defined by NEMA TS2-2003 and NTCIP 1202 – "Object Definitions for Actuated Traffic Signal Controllers". When a preempt request is received, the controller terminates the active phase to service any track clearance intervals associated with the preemption. The controller then moves to the dwell state in flash, free or coordinated operation to service the programmed dwell phase(s) until the preempt input is released.

Transit priority is described in the latest draft of NTCIP 1211- "Object Definitions for Signal Control and Prioritization" available from http://www.ntcip.org. Priority service differs from preemption in that the controller never leaves coordination and phase skipping is optional based on a user defined strategy used to service the priority request. In addition, the software goes beyond the operation described in NTCIP 1211 by providing priority service in free operation as well as during coordination.

1.2 NTCIP 1211 Signal Control Priority Scenario 4

Cubic | Trafficware controllers implement NTCIP *Signal Control Priority Scenario 4*. In this case, the *Priority Request Server (PRS)* is embedded within the local controller logic and no data exchange takes place between the *PRS*, fleet management and the traffic management center. In other scenarios, requests are forwarded to a central system before priority service is granted at the local level. This is often done to identify the vehicle and determine if it is behind schedule before granting the priority request.



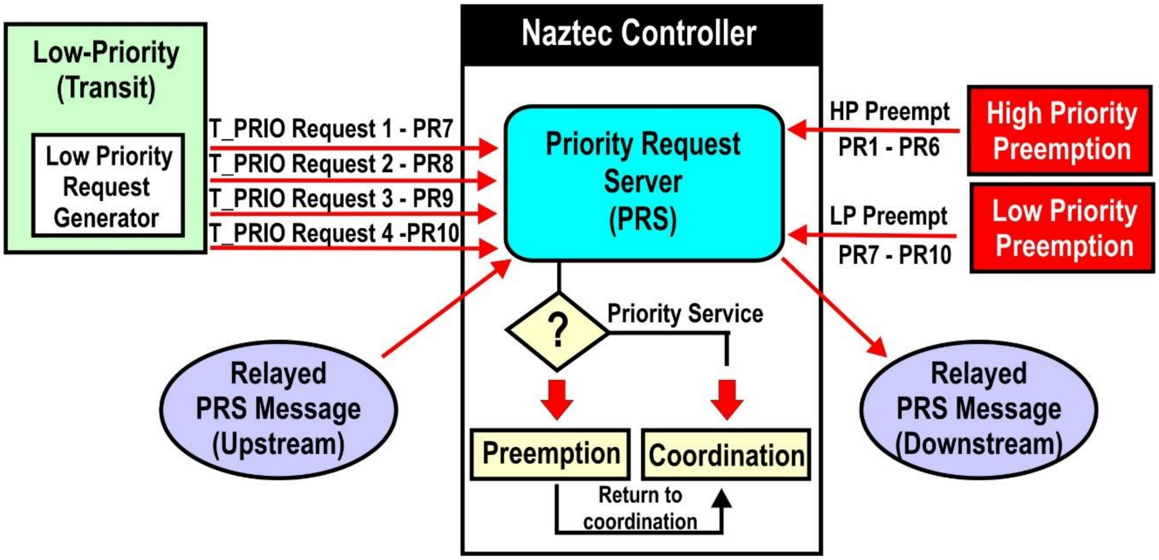
The *Priority Request Server* is tightly coupled within the controller logic so decisions can be made in real-time to service the transit vehicle. This approach does not impose any time latencies compared with other scenarios which expect a reply message before priority service can be granted at the local level.

The disadvantage of Scenario 4 is that the decision to service the request is not conditioned on whether the transit vehicle is "early" or "late" compared to a predefined transit schedule. Many agencies are now placing this decision within the *Fleet Vehicle* and conditioning the *Priority Request Generator* to initiate the request only if the vehicle is behind schedule.

The software does allow priority requests from one controller to be relayed to controllers downstream. This can be accomplished either through a dedicated hardwire interconnect or as a Central (ATMS.now or StreetWise) GENERATED software trigger to allow the central system to act as the *Priority Request Generator*. An example is provided in Chapter 8 to show how the Central software triggers can forward priority service requests (PRS Messages) for Transit/ Light Rail operations.

1.3 The Cubic | Trafficware Preemption / Transit Priority Model

The *Cubic | Trafficware Preemption / Transit Priority Model* below extends the *Priority Request Server* from NTCIP 1211 to include preemption as well as transit priority.



- High-priority inputs PR1-PR10 are reserved for rail and emergency vehicle preemption
- Low-priority inputs LP1-LP4 may be assigned to low-priority preemption or transit priority
- Low-priority inputs LP1-LP4 activate transit priority if **ENABLE** is set to **TRANS**
- Low-priority inputs LP1-LP4 activate preemption if **ENABLE** is set to **EMERG** (emergency vehicle preemption)
- Higher priority preempts always override lower priority preempt requests (PR1 overrides PR2)
- PR1 and PR2 always override lower priority requests PR3-PR6 and LP1-LP4
- Requests within a priority group (PR3-PR6 or LP1-LP4) are handled on a first-come first-served basis; however, there is an option to disable this for PR3-PR6
- The controller returns from preemption to the programmed exit phase(s) or to the phase currently being serviced in the coordination background cycle (if COOR+PRE is set)
- The controller never leaves coordination during priority service (**TRANS**)
- **TRANS** is built to work in association with coordination. The coordinated Phase is always served in the cycle.
- The *NTCIP* method provides an early return or extension of the *priority service phase.*
- The TSD and TED provide a window for which the transit phase will try to be served. Consider the end of green coordination reference (ENDGRN). Once the coord phase is released by the coordinator, the TSP will try to reduce all phases before the transit phase to get transit in into the green window. If not, it will try to extend the window or do the early return. Always keep in mind that the coord phase is sacred.
- Preemption and priority messages may be relayed between intersections using an external hardwire interconnect or from a StreetWise or an ATMS.now generated (software) trigger.

1.4 The NTCIP Transit Priority Method

A *Priority Service Request* is normally an oscillating 6.25 Hz signal applied to inputs PR7-PR10 when the emitter from a transit vehicle is detected. Otherwise an isolated input can be mapped to LP1-LP10, to detect the call.When the request is received, the *Priority Request Server (PRS)* initiates countdown timers to project the arrival and departure of the vehicle at the intersection. The *Priority Request Server* will then select one of the following actions to modify the *Coordinator* and service the projected arrival of the transit vehicle.

1. Reduce phases to provide an early return to the priority service phase
2. Do nothing, or
3. Extend the priority service phase to service the late arrival of a transit vehicle

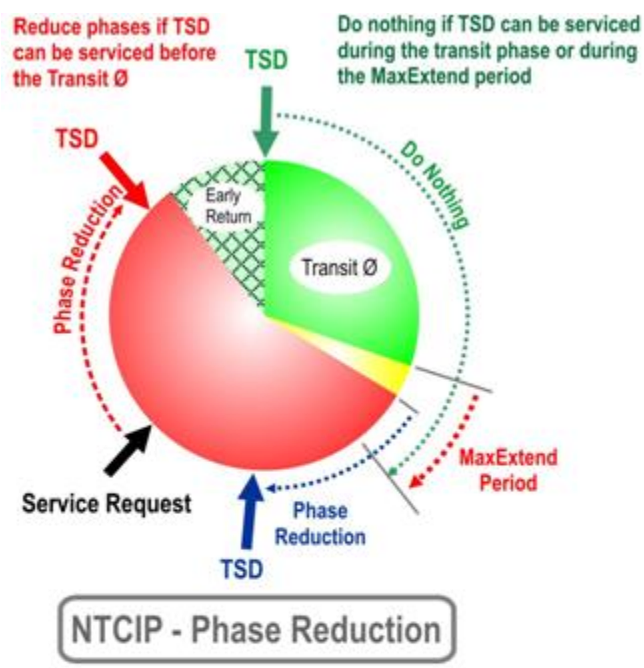
1.4.1 NTCIP Phase Reduction (Early Return)

The *Time of Service Desired (TSD)* is the arrival time of the transit vehicle at the stop-bar after it is first detected by the *Priority Request Server*. The *TSD* includes any dwell time to discharge and load passengers at a nearside stop and any expected congestion delay in the estimate of the arrival time. The *TSD* counter begins counting down when the vehicle is first detected. The vehicle is expected to be at the stop bar at *TSD* = 0.

An *early return* is provided if the *TSD* is projected prior to the start of the priority service phase. If the *TSD* lies within the green portion of the priority phase, the response is “do nothing”.

Early return is accomplished with user *MaxReduce* and *MaxExtend* values. NTCIP calls for these values to extend the *Split Table*. The software provides separate *MaxReduce* and *MaxExtend* values for every split time in each *Split Table*. *MaxReduce* and *MaxExtend* are used to calculate *Priority Max (PrMx)* times for each phase to reduce phases and provide an early return to the priority phase.

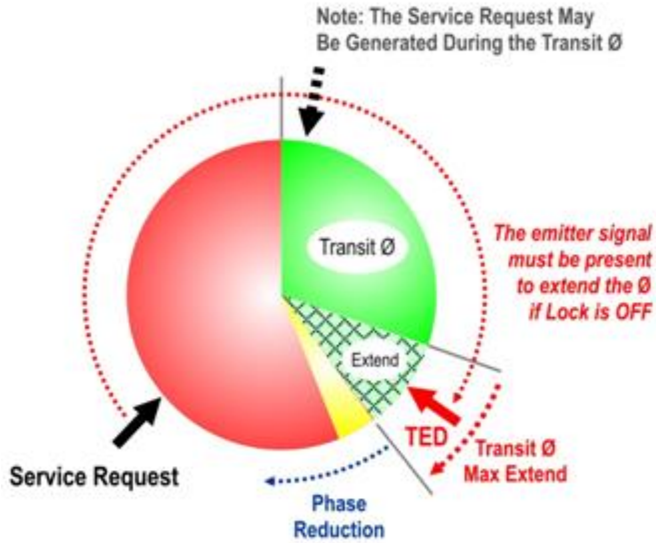
The controller insures that phases are not reduced below minimum phase requirements and that splits are balanced at the barriers. Therefore, it is not possible to fail the coordinator by specifying inappropriate *MaxReduce* and *MaxExtend* values. Phase reduction is accomplished by imposing a transit max time on the phase which guarantees that slack time from previous phases moves to the Early Return of the transit phase.



1.4.2 NTCIP Based Phase Extension

NTCIP defines *Time of Expected Departure (TED)* as the time required for the transit vehicle to clear the intersection after it is first detected (in seconds). The controller begins separate *TSD* and *TED* countdown timers when the service request is received. Many times the *TSD* and *TED* times are typically set to the same value because the arrival at the stop-bar and the departure time are essentially the same after the vehicle is detected.

The transit phase is extended at the force-off by the max extend time of the transit phase to accommodate any TED time remaining. Transit extension stops the Local cycle counter at the force-off and releases it when TED reduces to zero. Phase reduction is provided by the Shortway percentage to maintain coordination during the next signal cycle. Therefore, it is recommended that the user assign MaxExtend times that are less than or equal to the cycle length times Shortway percentage. This insures that phase reduction can be applied in the cycle following extension. When setting MM->2->5 parameters if the Coord Reference point to set to ENDGRN and your transit phase is the Coord phase, the user should consider setting RETHLD to ON. This will insure that the Transit/Coord phase is held to the end of the cycle which will assist in extending through the TED.



NTCIP - Phase Extension

1.4.3 Assigning Transit Phases to TSP

There is some confusion among users where to assign the transit phases for TSP. “Prior Phases” are assigned under MM->3->4->1 if the low priority type is EMERG. However, for TSP (type TRANS), the transit phases must be assigned in the TSP *Strategy Tables* under controller menu MM->2->9->5.

The order of the transit phases listed in the *Strategy Table* is significant because the phases may not begin and end at the same point in the signal cycle. TSP considers the first phase listed in the *Strategy Table* as the primary transit phase to provide early return and extension. For example, assume transit phases are assigned to the coordinated arterial as phases 2 and 6. If lead/lag left-turn sequences apply, the transit phases do not begin or end at the same point in the signal cycle. Therefore, separate low-priority inputs should be provided with separate *Strategy Tables* for transit phase. This insures that *TSD* and *TED* time correctly for each transit phase.

TSP applies a max recall and *Inhibit Max* on all transit phases listed in the *Strategy Table*. Max Inhibit until TSP ends and the phase is not green. *Max Inhibit* insures that the transit phases do not terminate until their force-off point if FLOAT is in effect and the transit phase is not the assigned coord phase.

1.4.4 Servicing Multiple TSP Requests

TSP stores multiple requests in a FIFO (First-In-First-Out) buffer. This allows multiple requests to be serviced on a first come first served basis. Secondary requests will not be serviced if their transit green has already passed the TSD time stored on the buffer.

1.4.5 TSP Free Operation

TSP during free operation is not required by NTCIP 1211. Set *FreeMod* ON to allow TSP to adjust max times with transit reduce/extend times assigned to a "free pattern". A "free pattern" is defined as a pattern with a 0" cycle length with max times provided as non-zero split values in the split table. If desired, the user may run coordinated patterns with TSP during peak periods and "free patterns" during off-peak periods to provide transit early return and extension during both coordinated and free operation.

The response to a TSP request for service during coordination is as follows:

A. *Provide Early Return*

   The primary transit phase is not active and the *TSD* is projected to start before the start of the transit phase. In this case, the non-transit phase max times from the active split table are reduced by the transit reduce times in the active *Strategy Table*.

B. *Do Nothing*

   The primary transit phase is active and *TED* is projected to expire by the end of the active max time.

C. *Extend Transit Phase*

   The primary transit phase is active and the *TED* is projected after the current transit max time. In this case, the active max time is adjusted to insure the max timer and *TED* end together.

1.4.6 [LRT] Light Rail Transit Priority Enhancements

Included in the standard v76.x Transit priority software is Light Rail Transit (LRT). LRT enhances the basic concepts of transit priority, described above, for use with Light Rail Vehicles (LRV). Specifically:

- LRT uses transit detectors and links them to the Transit Priority input channels in the controller.
- The controller then times Light Rail service requests in the same manner as it would for a normal Transit vehicle (bus).
- LRT operations can be combined with controller I/O logic for more advanced applications.
- LRT software operates differently in FREE than in COORD.
    - In FREE the controller will utilize the normal Low Priority Preemption programing.
    - In COORD mode the controller with utilize Transit Preemption programming which uses Extend/Reduce programming from the active Split Table to provide early service.
- If Transit or Emergency "Preemption" service is desired for the LRT operation, then the Strategy Table and Split Table programming will not be required.
- LRT supports bi-directional train service but serving two trains within a cycle can cause the controller to leave "Sync" and force transition. If the controller cannot remain in sync, it will use the pattern's Short/Long programming to get back in sync

2 Transit Priority Programming

2.1 High-Priority and Low-Priority Inputs

Low-priority inputs are shared with high-priority preempts 3-6 (see chart below). The controller recognizes high-priority as a steady ground true input and low-priority as an oscillating 6.25 Hz input on these inputs. This is an industry standard set by *3M Corporation.*

Preempt #	Preempt Input	Type (typical)	Programming Shared With Other Preempt
HP 1	HP 1 (steady low)	RAIL	No
HP 2	HP 2 (steady low)	RAIL	No
HP 3	HP 3 (steady low)	RAIL or EMERG – H Prior	No
HP 4	HP 4 (steady low)	RAIL or EMERG – H Prior	No
HP 5	HP 5 (steady low)	RAIL or EMERG – H Prior	No
HP 6	HP 6 (steady low)	RAIL or EMERG – H Prior	No
HP 7	HP 7 (steady low)	RAIL or EMERG – H Prior	No
HP 8	HP 8 (steady low)	RAIL or EMERG – H Prior	No
HP 9	HP 9 (steady low)	RAIL or EMERG – H Prior	No
HP 10	HP 10 (steady low)	RAIL or EMERG – H Prior	No
HP 11	HP 11 (steady low)	RAIL or EMERG – H Prior	No
HP 12	HP 12 (steady low)	RAIL or EMERG – H Prior	No
LP 1	LP 1 (steady low) or 3 (oscillating)	ON, EMERG, TRANS	EMERG shares programming with preempt 3
LP 2	LP 2 (steady low) or 4 (oscillating	ON,EMERG, TRANS	EMERG shares programming with preempt 4
LP 3	LP 3 (steady low) or 5 (oscillating)	ON,EMERG, TRANS	EMERG shares programming with preempt 5
LP 4	LP 4 (steady low) or 6 (oscillating	ON, EMERG, TRANS	EMERG shares programming with preempt 6
SP 1	SP 1 (Steady Low)	Special Event 1	No
SP 2	SP 2 (Steady Low)	Special Event 1	No

2.2 Enabling Transit Priority (MM->3->4)

Enter Transit Priority by choosing selection #3 , Preemption from the main menu. Then choose selection 4, low Priority and then the appropriate Low priority preemption number, LP1-LP4. The controller menu below enables Transit Priority for preempts # 7 through #10 by setting ***Enable*** to **TRANS**.

```
            Preemption Menu
1.HiPriority  4.LowPriority
2.Events
3.Sequences
```

```
#1  Bus Preempt    Times     Prior.Phases
 Enable    TRANS  Min     5    0  0  0  0
 Coor+Pre  OFF    Max     0    --- TSP ---
 LockMode  FIX    Lock    5    Headway   0
 NoSkip    OFF    AltTbl  0    GrpLock OFF
 QJmp      OFF HoldDwell OFF   FreeMod OFF
```

2.2.1 Enable Parameter (OFF / ON / ENERG / TRANS)

The enable parameter selects which type of low priority preemption that will be selected when the transit input is detected.

ENABLE Parameter	Description
OFF	Disables the Low priority or Transit Preemption
ON	Enables the Standard Low priority Preemption
EMERG	Enables the corresponding High Priority Preemption
TRANS	Enables the standard Transit Preemption

The primary difference between the **ON** (bus preempt) option and the **EMERG** (low-priority emergency vehicle) or **TRANS** options lies in the preempt response during coordination. To run the standard transit preemption the user will select **TRANS**.

Please ensure if **Enable** is set to ON, EMERG or TRANS that at least one non-zero priority phase is programmed.

[LRT] Under Light Rail Transit (LRT) operation, set to **TRANS** to enable Light Rail vehicle (LRV) service to Extend/Reduce from the active Split Table. When in *FREE* operation the preemptor will automatically shift to “the standard Low Priority” mode. Set to “ON” to enable LRV service to preempt using Preemption functionality.

2.3 Low Priority Features That Apply When Enable Is Set to ON

The following features apply only when the low priority *Enable* is set to ON. The *Priority Phases* in this section specify the transit phases for Enable set to ON or EMERG. If Enable is set to TRANS (NTCIP based TSP), the transit phases are set in the *Strategy Table* assigned to the pattern and none of the features listed in this section apply to that pattern. The next section defines the features that apply to TSP (Headway, GrpLock and FreeMod).

2.3.1 Coor+Preempt

```
#2  Bus Preempt     Times     Prior.Phases
 Enable    ON      Min     5    4  8  0  0
 Coor+Pre  ON      Max    15    --- TSP ---
 LockMode  MAX     Lock    5    Headway    0
 NoSkip    OFF     AltTbl  0    GrpLock  OFF
 QJmp      OFF HoldDwell  OFF   FreeMod  OFF
```

The Coord+Preempt parameter allows coordination to proceed in the background during the preempt sequences. This allows the controller to return to the phase(s) currently active in the background cycle rather than the next phases in rotation. This option allows the controller to return from preemption to coordination in SYNC without going through a transition period to correct the offset. Many agencies utilize the Coor+Preempt option when coordination is interrupted frequently by preemption.

Please note that because preemption is an emergency operation, there are times that the coordinator must go FREE to insure the safety of the motoring public. One example is during railroad preemption track clearance phase timing. If Track Clearance phases and timing are programmed, the coordinator will go free to insure that the vehicles will move off the track. Once the dwell phases begin timing, the coordinator will begin to transition back to being in SYNC.

[LRT] Set Coord+Preempt to **OFF** for Light Rail Transit Priority.

2.3.2 Lock Mode (Max Lockout Type) Parameter (MAX/FIX)

The ***LockMode*** parameter only applies to low-priority requests (Enable=**ON**). This locks out any other low pre call. The ***LockMode*** will tell how the controller uses the ***Lock*** (lockout) timer. Selecting ***FIX*** will lock out all low priority requests for the duration of the ***Lock*** time. Selecting ***MAX*** will lock out low priority requests based on the ***Lock*** time and demand. With ***LockMode*** set to **MAX**, a ***Lock*** time greater than zero will inhibit a new service request until the lock out period expires **or** all phases with demand when the lockout period begins have been serviced. In other words, a ***LockMode*** set to **MAX** is provided to insure that all demand phases have been serviced before a new request is serviced.

[LRT] Set Lock to **FIX** for Light Rail Transit Priority.

2.3.3 NoSkip (ON/OFF)

The ***NoSkip*** parameter only applies to low-priority requests (Enable=**ON**). Setting ***NoSkip*** to **ON** services only the minimum times for all phases with calls prior to serving the transit phase(s). Think of it as "a poor man's transit" because in effect, it reduces each phase to the phase minimum prior to serving the transit phase(s). Based on when the call occurs, as well as the sequence and concurrency that is currently running, the algorithm will move to the LP phases as soon as it can. This setting does **not** guarantee that all phases run prior to rotating to the LP preemption phase(s). Setting ***NoSkip*** to **OFF** will time out (gap out, max out or force off) the phase it is currently in and immediately move to the LP preemption phase(s).This parameter has no effect when ***Enable*** is set to **TRANS** and should be set to **OFF** for Standard Transit priority.

[LRT] ***NoSkip*** should be set to **OFF** for Light Rail Transit priority.

2.3.4 QJmp (ON / OFF)

This parameter is used with bus preemption and should be set to **OFF** for Transit priority. It enables a transit overlap output (sign or indication) to display a Queue Jump signal (output) to the public.

[LRT] Set QJmp to **OFF** for Light Rail Transit Priority

2.3.5 Transit Priority Min and Max Times

The ***Min*** time (0-255 sec) insures that the priority request is active for the minimum period specified even if the oscillating input drops before the end of the period. This feature is useful to mask calls from an emitter that drops in and out when the phase selector is set to maximum sensitivity.

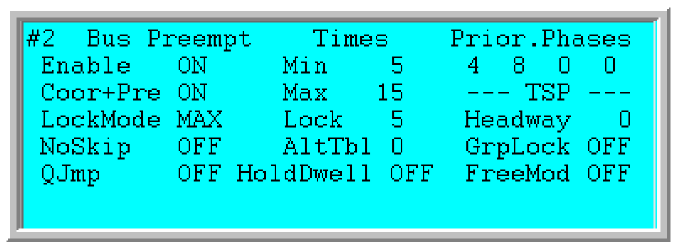
The ***Max*** time (0-255 sec) limits the time that a transit service can be active. If ***Max*** is zero, then no maximum limit is applied. The priority service will end after the ***Max*** time and will not reservice until the max lockout period ends to insure all phases with demand have been serviced.

2.3.6 Lock (Max Lockout Time) Applied to Transit Priority

The ***Lock*** time period (0-999 seconds) limits the duration of the lockout period following any preempt or priority service. A value of zero disables the lockout, thereby allowing a new priority request to be serviced 3" after another preemption or priority service ends. This inherent 3" lockout insures that the last service is complete and all affected values, including status screens have been updated before initiating the new service request. This timer is used in association with the ***LockMode*** parameter.

2.3.7 AltTbl

This feature allows the low priority preemption to run different phase minimum times by calling an alternate timing table during the preemption interval. This function is used in association with the ***NoSkip*** parameter. When ***NoSkip*** is set to **ON**, this allows increased minimum times to be serviced only during the preemption.



2.3.8 Prior Phases

For low priority preemption types **EMERG** or **ON**, whenever a 6.25 Hz oscillating signal is applied to high priority inputs 3-6 (PR7-10), the controller will either dwell in the Prior *Phases* specified if these phases are active, or move immediately to the *Prior Phases* without violating the min times and pedestrian times of the phases currently being serviced. With the exception of ***FreeMode*** being set to **ON**, the user typically does not program this variable for transit priority (**TRANS**) because the priority phase programming will be done in the strategy tables. However, it is advised to program the transit phase in case the **Enable** type is modified by the user to a type other than **TRANS**. The next chapter will discuss programming of the priority phases.

Please ensure if **Enable** is set to ON, EMERG or TRANS that at least one non-zero priority phase is programmed.

[LRT] This is a mandatory setting for Light Rail Transit Priority when running in *FREE* operation.

2.3.9 Hold Dwell

The **Hold Dwell** parameter only applies to low-priority requests (Enable=**ON**). When set to **ON**, Hold Dwell causes the controller to maintain the dwell interval while the preempt call is active. This feature may be used to cause a low-priority preempt to operate similar to an emergency vehicle (high-priority) preempt.

2.4 Low Priority Features That Apply When Enable Is Set to TRANS

2.4.1 Headway (Maximum headway Time) (0-255 minutes)

```
#2  Bus Preempt    Times     Prior.Phases
 Enable   ON      Min     5    4  8  0  0
 Coor+Pre ON      Max    15    --- TSP ---
 LockMode MAX     Lock    5    Headway    0
 NoSkip   OFF     AltTbl  0    GrpLock  OFF
 QJmp     OFF HoldDwell OFF    FreeMod  OFF
```

Each low priority preemption has an independent internal headway timer which counts up from zero whenever a low priority preempt input occurs. While this timer is running, the low priority preempt in question is "locked out" until the headway timer exceeds the time programmed under the ***Headway*** parameter. It is used in association with the ***GrpLock*** parameter.

2.4.2 GrpLock (ON / OFF)

The ***GrpLock*** parameter is used in association with the headway timer. When ***GrpLock*** is **OFF**, the specific headway timer for the existing low priority preemption will be run and not allow any new preemption call for the current running low priority preemption channel to occur until the maximum headway time is reached. When ***GrpLock*** is **ON** the specific headway timer for the existing low priority preemption will be run and will not allow a new preemption call for **any** low priority preemption to occur until the maximum headway time is reached for the current running preemption.

2.4.3 FreeMod (ON/OFF)

Set FreeMod to ON if you wish to run TSP during a free pattern as described in section 1.4.5.

In summary, each low priority preemption type allows the above programming features to be enabled as shown below.

FEATURE	TRANS	EMERG	ON	OFF
Coor+Pre			x	
Lock Mode / Lock Time			x	
No Skip			x	
QJump			x	
Min			x	
Max			x	
AlTbl			x	
Prior Phases		x	x	
Hold Dwell			x	
Headway	x			
GrpLock	x			
FreeMode	x			

2.5 [LRT] Light Rail Transit Specific Detection

Detection is used for Light Rail Transit Priority to check the Train in and out. Transit Detection is programmed under the MM->5->9 screen. The following screen and definitions are used for Light rail Transit Priority.

```
     Transit Light Rail Detectors
Transit      ..1...2...3...4
AdvancedDet   10  20   0   0
CheckInDet    11  21   0   0
CheckOutDet   12  22   0   0
MaxCheckIn   200 200   0   0
CheckInDelay  50  50   0   0
LockOut        .   .   .   .          +

LockoutTime    0   0   0   0
OutputTime     0   0   0   0
```

Advanced Detector – This is the detector (1-64) number that will place the initial call to the Transit Phase. It will initiate the TSD (Time-of-Service-Desired) counter to the Light Rail Transit Priority service phase.

Check-In Detector – This is the detector (1-64) number that tells the controller that the train has arrived for service. This detector will place a call to the Transit Phase if there is not one existing from the Advanced Detector.

Check-Out Detector – This is the detector (1-64) number that tells the controller that the train has cleared the intersection.

Max Check-In – The maximum amount of time that the Check-In detector will apply an input before it is automatically checked out. This is to avoid "Stuck Detection" from holding the Green.

Check-In Delay – This acts like the Preemption Delay timer in FREE mode. This is the delay time for the Advanced Detector Input while in FREE operation, because in FREE mode the Light Rail Vehicle (LRV) is serviced with Transit Preempt service. This parameter must be set and should be the same value as the Time of Service Desired (TSD) value in coordination.

Lockout – Enables the assigned Lockout timer value to be used

Lockout Time – The amount of time in seconds that must elapse between requests to be serviced for that direction

Output Time – Drives Output Function Code #138 (LRV Warning Status Output) such as a "Train Coming" sign as shown above. This value sets the amount of time in seconds that the LRV sign display is activated BEFORE the LRV is serviced. In Coordination, the output is activated prior to the end of the TSD value by the Output Time value. The output will remain active until the Check-Out detector is activated. In FREE operation the output is activated prior to the end of the "Check-In Delay" value by the Output Time value. To drive this output function a Special Function Output Load Switch channel, or equivalent, must be assigned to this function through I/O Logic.

Typical Logic programming under MM->1->8->7 for flashing (O113) and driving Special Function Output 1 (O103) from the LRV Warning Status Output (O138) is as follows:

O 103 = O138 AND O113

2.6 Transit Priority Parameters

All programming required for transit priority service is accessed from coordination menu MM->2.

```
Coord Parms |    Pattern     |
1.Modes,+     4.Pattern Tbl  7.Splits
2.Ext. I/O    5.Tran,CoorPhs 8.Status
              6.Alt Tables+  9.More
```

```
Strategy-1
SvcPhases   #   0   0   0
Phs Omits   0   0   0   0   0   0   0   0
   (more)   0   0   0   0   0   0   0   0
Ped Omits   0   0   0   0   0   0   0   0
   (more)   0   0   0   0   0   0   0   0
MinRecall   NO
```

Eight *Priority Strategy Tables* are programmed under MM->2->9->2. Each table allows the user to assign the priority strategy phase and any vehicle or pedestrian phases omitted while the strategy table is active. The eight *Priority Strategy Tables* may be assigned to any of the 4 priority requests (LP1-LP4) under the *Split* programming.

Note that the order of the transit service phases (*SvcPhases*) is significant as discussed in section 1.4.3. The *TSD* and *TED* times apply to the first phase listed in the strategy table. Therefore, if the *SvcPhases* do not begin and end at the same point in the signal cycle, they should be specified in separate *Strategy Tables*.

If vehicle phase(s) are omitted during TSP, it should be noted that the corresponding ped phase(s) will also be omitted. When omitting phases from TSP calls, consider using the Headway function to prevent successive phase skips.

Note: a parameter has been added **ONLY** for V76 Software versions created after V76_12 named ***MinRecall***. It is used to control the Recalls of the service phases. Setting this to ***YES*** will place Min Recalls on the service phases whereas setting this to ***NO*** will place Max Recalls on the service Phases. The default setting for versions V80.x, V85.x/Scout and those prior to V76_13 is place Max Recalls on the Service Phases.

NTCIP calls for the ***MaxExtend*** and ***MaxReduce*** times to be an ***extension*** of the split tables, so these values are programmed under MM->2->7->3.

```
Spl- 1   P..1...2...3...4...5...6...7..8>
MaxReduc    6   0   6   8   6   0   6   8
MaxExtnd    0  20   0   0   0  20   0   0

                 Request   ..1...2...3...4
                 Strategy     1   2   3   4
                 TimSvcDes    0  57   0  57
                 TimEstDep    0  57   0  57
```

The ***MaxExtend*** and ***MaxReduce*** times specified are applied without consideration of the current traffic demand of the phase. It is the user's responsibility to weigh the trade-off involved between vehicle and transit demands.

Transit phases are typically the same as the coordinated phases assigned the major street with non-coordinated phases typically reduced and the coordinated (transit phases) extended. TSP does allow TSP to be assigned to the non-coordinated street with *MaxReduc* and *MaxExtend* times assigned accordingly. To reduce the coordinated phase, specify an *Early Yield* value for the pattern (MM->2->5 right menu)

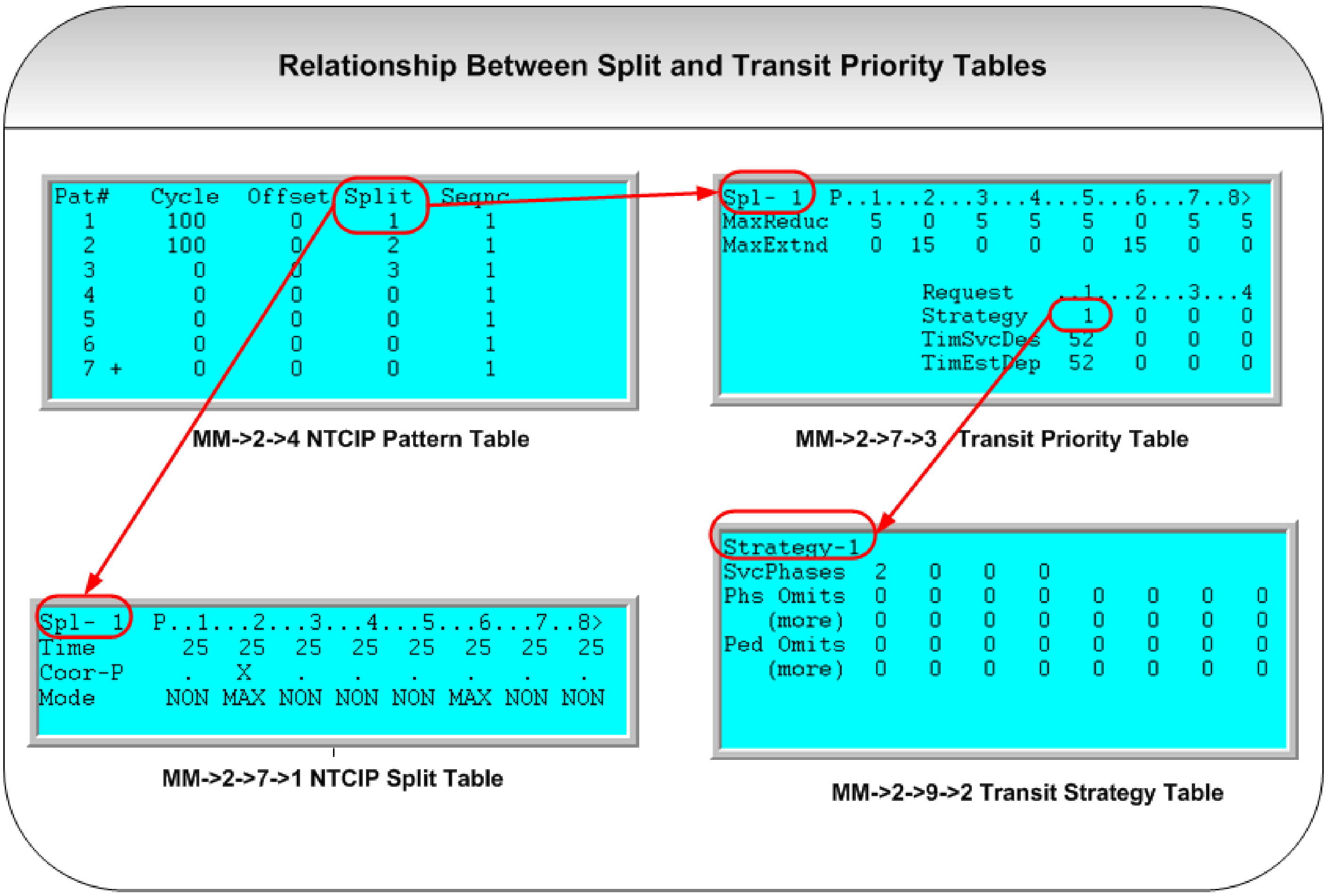
```
<Pat# EarlyYld Offset RetHold Flt MinV/P
   1         0 BegGRN X        .      . .
   2        25 EndGRN .        .      . .
   3         0 EndGRN X        .      . .
   4         0 EndGRN X        .      . .
   5         0 BegGRN .        .      . .
   6         0 BegGRN .        .      . .
   7 +       0 BegGRN .        .      . .
```

MM->2->5: Early Yield Adjustment for Non-Coord Phase Yields

Set the *Early Yield* equal to the sum of the ***MaxReduc*** times applied prior to the force-off of the designated coord phase. For example, if *Pattern# 2* is active during a priority service request, the coord phase can leave 25" prior to the force-off if the *ErlyYld* parameter is assigned as shown above. If *Early Yield* is not assigned, then the ***MaxReduc*** times applied prior to the force-off of the coord phase will not allow the coord phase to leave early.

2.6.1 Programming the NTCIP Method

The programming illustration below shows the relationship between the *Split Table* and *"Plus" Features* associated with the table and any *Priority Strategy Tables* assigned to the split table.



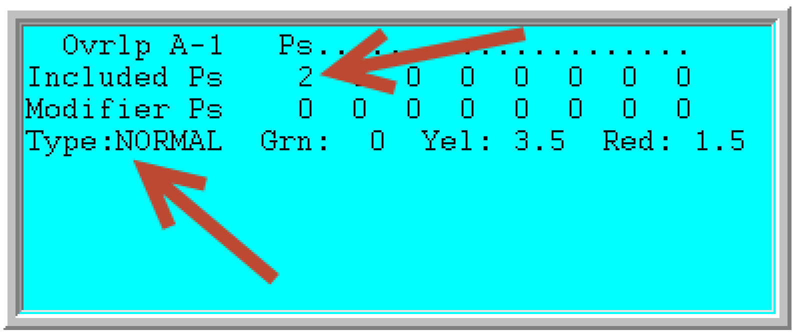
MaxReduce and ***MaxExtend*** values are in seconds. Many users program the sum of the ***MaxReduce*** times to be equal the sum of the ***MaxExtend*** times in the same ring to evenly distribute time shifting between the phases. However, be aware that the software allows uneven distribution but all phases are subject to servicing minimum times.

The *Priority Plus* menu above assigns a separate *Priority Strategy Table* to ***Request*** 1-4 (LP1-LP4). A separate ***TimSvcDes*** (*TSD)* and ***TimeEstDep*** (*TED)* value (in seconds) may be assigned to each request. If you want to disable a transit priority request while a split table is active, simply program a zero *Priority Strategy Table* for the request.

A separate *Priority Plus* menu is provided for each *Split Table* in the controller. This allows the user to vary priority service by pattern under time-of-day, traffic responsive or adaptive control.

2.7 [LRT] Light Rail Transit Priority Overlaps

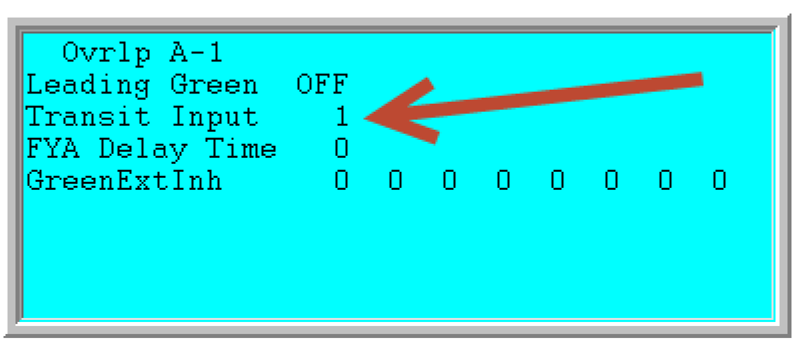
The Light Rail Indicator will be driven from the corresponding Light Rail Transit Priority input via overlap programming. Go to MM->1->5->2-> [olp #]->1 to program the Transit priority Phase under the Included Phase parameter. Also program the Type as **NORMAL**.



To program the Transit Input go to MM->1->5->2-> [olp #]->3, the Overlap Program Parameters+ screen.. This parameter matches the Low Priority Preemption input to the LRV channel, as shown in the table below:

Low Priority Preemption Channel Number	Light Rail Input Number
7	1
8	2
9	3
10	4

In other words, it drives the Light Rail Indicator from the corresponding priority input. The programming screen under MM->1->5->2-> [olp #]->3 is shown below:



2.8 [LRT] Light Rail Transit Priority Recommendations and Fail-safes

The user should consider the following recommendations and Fail-safes when implementing Light Rail Transit Priority.

2.8.1 Recommended Settings- PREEMPT Mod

The "Advanced Detector" for both approaches need to be sourced to Emergency Vehicle Preemption (EVP) Channels through I/O logic. When the Advanced Detector is activated, it will preempt a channel that is assigned to the LRV vehicle phases. Program this with a Preempt Delay time to allow for the train to come closer to the Check-In point. Once the Preempt finishes timing it will give way to the lower-priority LRV channel. The Check-In and Check-Out detectors will activate normally through the Low-Priority channels.

2.8.2 TRANSIT Mode Recall Considerations

When the controller is running TSP (TRANSIT mode) there is a relationship between the Check-Out detectors and the Time of estimated Departure (TED). When TSP goes active it places calls and max recalls on the transit phase(s). These calls/recalls stay in place until TSP terminates. Termination of theses recalls is determined by the TED timer and not the checkout detector.

2.8.3 Fail Safes

MAX2 (programmed under Phase Timing, MM->1->1->1)

This parameter MUST be used for the LRV operation. With the LRV functionality, MAX2 serves as a failsafe value in FREE operation. If it is determined that the train had not cleared the intersection, the indication will be held just as in normal operation, but all phases will be allowed to operate to the MAX2 time. Therefore, the MAX2 time for the transit phase(s) represents the maximum amount of time the phase will be held green for the train, assuming that there is a train sensor error.

TIME-of-ESTIMATED-DEPARTURE (TED)

Unlike in Bus Transit operation, the signal will not necessarily yield/terminate the phase associated with the train until the Check-Out detector has been activated or the MAX2 value has expired.

> If the Advance Detector call is skipped for some reason (faulty, etc), and the Check-In detector is called, a call will be placed to the Light Rail phase.
>
> In FREE mode, if an Advanced Detector call is placed and the Check-In detector is called before the Preempt Delay Timer expires, the timer is immediately terminated and the transit preempt channel is called.

2.9 [LRT] Light Rail Transit Priority Alarms

The following alarms are generated by Light Rail Transit Priority and can be programmed by the user under MM->1->6->1 (Events) and MM->6->4 (Alarms).

Alarm#62: This alarm is defined as "Alarm Rail Check".
It is activated if any of the following detector conditions exist:

- Train activates Check-In detector without activating Advanced Detector
- Train waited too long (MaxCheckIn value expired)
- Train activated Check-Out detector without activating the Check-In Detector

Note: When ATMS.now collects this alarm information from #62, there is an additional parameter called "Data" that will come in. The Data value is the assigned detector number that registered a fault.

Alarm 65: This is the detector stuck alarm.

To activate a stuck alarm, time must be programmed into the Detector On times. Any advanced, check-in, or check-out detectors will activate this alarm. The status as to which detector caused the alarm can be found in the detector data associated with the alarm. The following is a list of the data assignments

- D1 Advanced Norm. or Rev.
- D1 Check Out
- D1 Check In
- D2 Advanced Norm. or Rev.
- D2 Check Out
- D2 Check In

Alarm 66: This is the out of sequence alarm.

This means that a Check Out came before a Check In or a Check in came before an Advanced. The rail line number is in the data field of the alarm indicating which line had the alarm.

Data equal to one (1) indicates direction 1 and data equal to two (2) indicates the other line.

Alarm 67: This is failed to arrive at the check in detector in the proper amount of time.

This alarm is generated when the trail passes over the advance detector and fails to reach the check in after the arrival time plus the minimum time expires. Again, as in alarm 66, the rail line number is stored in the data field.

Alarm 68: This is failure to arrive at the check-out detector.

This alarm is activated when the train reaches the check in detector but fails to clear the intersection. Again, as in alarm 66, the rail line number is stored in the data field

2.10 [LRT] Light Rail Transit Priority Programming Summaries

2.10.1 Programming Option # 1

PREEMPT LRV SERVICE

PREEMPTS #3 & #4		
Enable	ON	
Type	Emerg	
Flash In Dwell	OFF	
Delay	10	
DwellCycVeh	X and Y	Assign both vehicle phases parallel to Rail

PREEMPTS #7 & #8		
Enable	ON	
Coord+Pre	OFF	
LockMode	FIX	
NoSkip	OFF	
Qjump	OFF	
Priority Phs	X and Y	Assign both vehicle phases parallel to Rail
Headway	0	
FreeMode	ON	

I/O Logic	
O 103 = O 138 AND O 113	Links the LRV output to Special Function #1 output
I 200 = I 10	I 10 is the Advanced Detector channel for Rail#1 direction
I 201 = I 20	I 20 is the Advanced Detector channel for Rail#2 direction

PHASE TIMES		
MaxII	100 *	Sets the Maximum amount of time the phase will serve the LRV while in FREE operation. Failsafe against intersection lockup

TRANSIT DETECTORS	LRV Input1	LRV Input2
Advanced Det	10*	20*
Check-In Det	11*	21*
Check-Out Det	12*	22*
MaxCheck-In	60	60
Check-In Delay	15*	15*
Lockout	-	-
Lockout Time	0	0
Output Time	5*	5*

OVERLAPS	OLPA	OLPB
Parent Phases	X	Y
Transit Input	1	2

*Indicates a subjective value based on desired time or detector channel

The remainder of programming is on the Transit Priority section of theSplit Tables for each Pattern

X & Y - Indicates thru phases that are parallel to the LRV phase

2.10.2 [LRT] Programming Option # 2

PRIORITY LRV SERVICE

PREEMPTS #7 & #8

Enable	TRANS	
Coord+Pre	OFF	
LockMode	FIX	
NoSkip	OFF	
Qjump	OFF	
Priority Phs	X and Y	Assign both vehicle phases parallel to Rail
Headway	0	
FreeMode	ON	

I/O Logic

O 103 = O 138 AND O 113	Links the LRV output to Special Function #1 output

PHASE TIMES

MaxII	100 *	Sets the Maximum amount of time the phase will serve the LRV while in FREE operation. Failsafe against intersection lockup

TRANSIT DETECTORS	LRV Input1	LRV Input2
Advanced Det	10*	20*
Check-In Det	11*	21*
Check-Out Det	12*	22*
MaxCheck-In	60	60
Check-In Delay	15*	15*
Lockout	-	-
Lockout Time	0	0
Output Time	5*	5*

OVERLAPS	OLPA	OLPB
Parent Phases	X	Y
Transit Input	1	2

*Indicates a subjective value based on desired time or detector channel

The remainder of programming is on the Transit Priority section of theSplit Tables for each Pattern

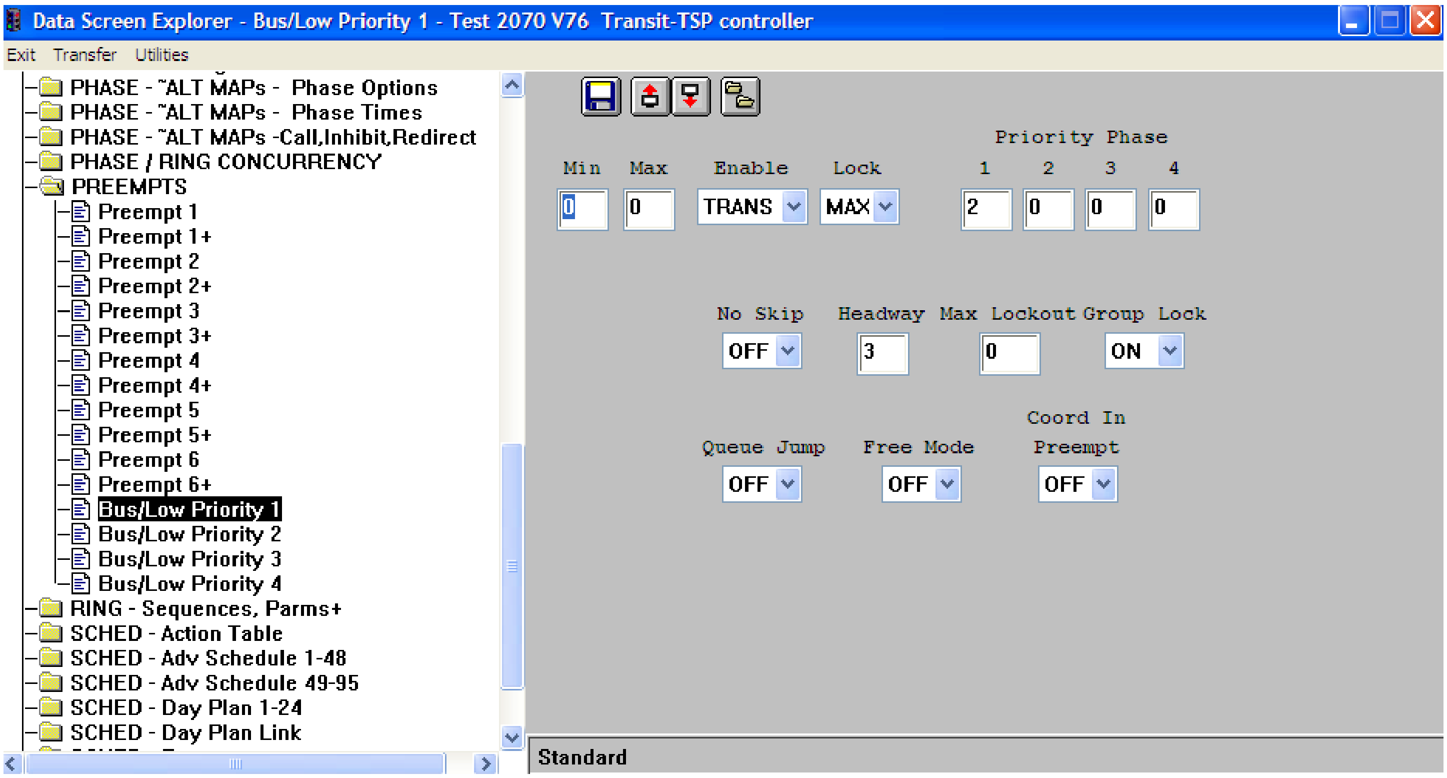
X & Y - Indicates thru phases that are parallel to the LRV phase

3 Central Programming Screens

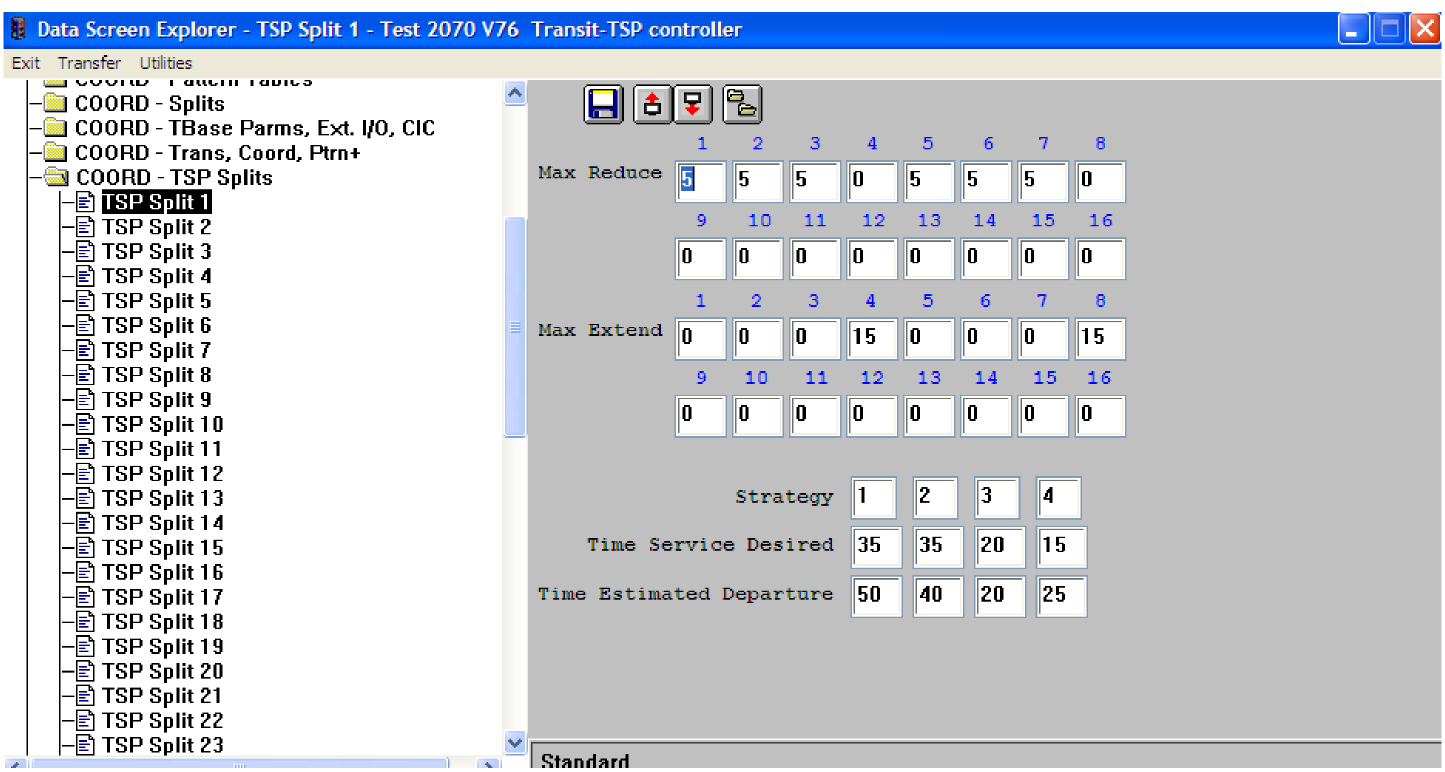
3.1 Streetwise Programming Screens

The following screens are displayed for user information

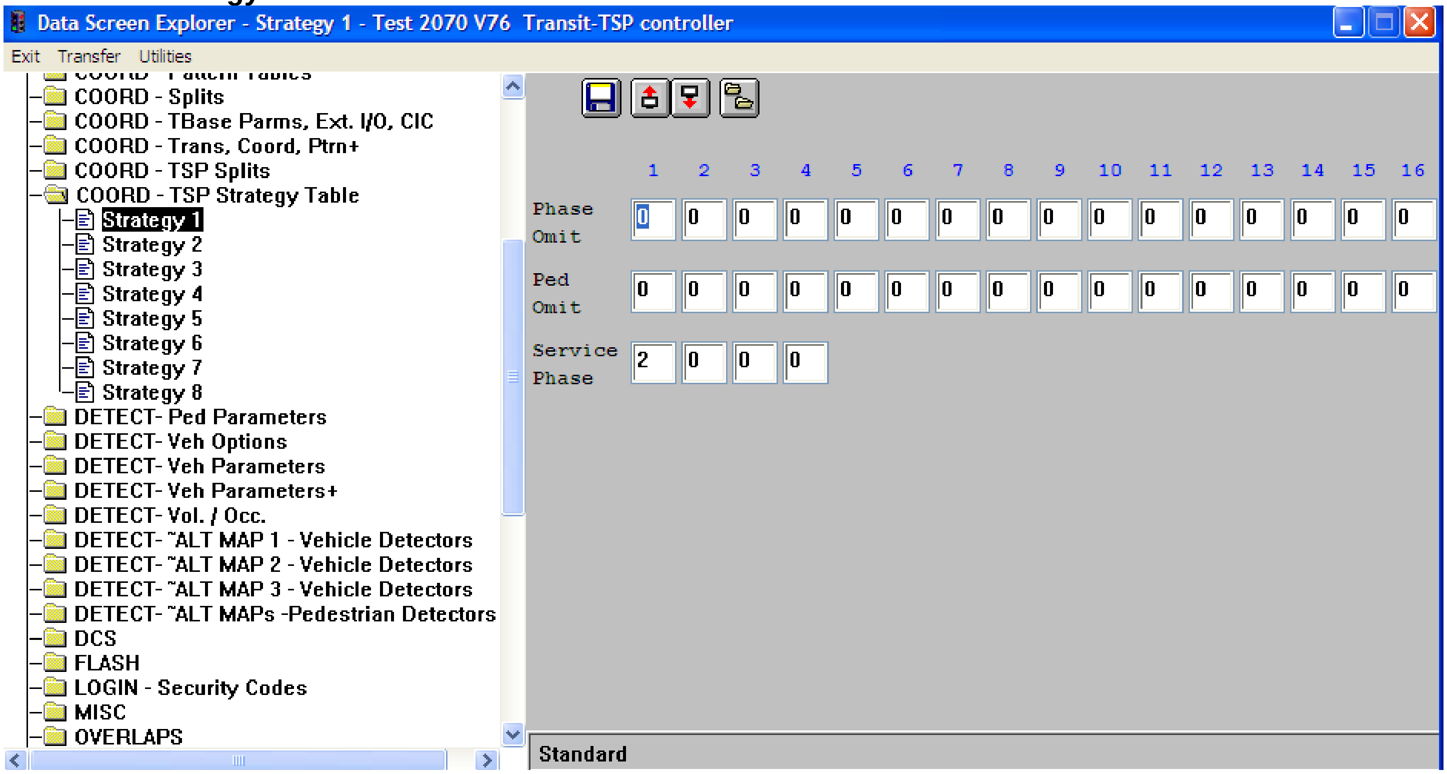
3.1.1 Low Priority Preemption Programming



3.1.2 TSP Split screen



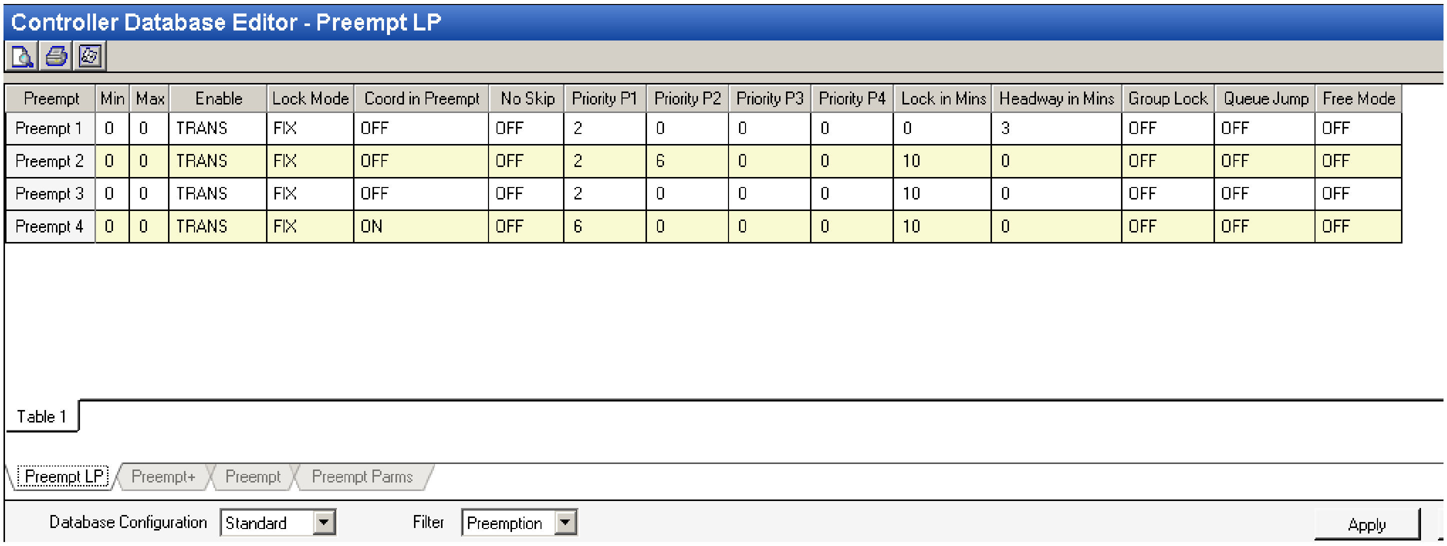
3.1.3 TSP Strategy tables



3.3 ATMS.now Programming screens

The following screens are displayed for user information.

3.3.1 Low Priority Preemption Programming



Preempt	Min	Max	Enable	Lock Mode	Coord in Preempt	No Skip	Priority P1	Priority P2	Priority P3	Priority P4	Lock in Mins	Headway in Mins	Group Lock	Queue Jump	Free Mode
Preempt 1	0	0	TRANS	FIX	OFF	OFF	2	0	0	0	0	3	OFF	OFF	OFF
Preempt 2	0	0	TRANS	FIX	OFF	OFF	2	6	0	0	10	0	OFF	OFF	OFF
Preempt 3	0	0	TRANS	FIX	OFF	OFF	2	0	0	0	10	0	OFF	OFF	OFF
Preempt 4	0	0	TRANS	FIX	ON	OFF	6	0	0	0	10	0	OFF	OFF	OFF

3.3.2 TSP Split screen

Controller Database Editor - TSP Splits

Splits	Max Reduce 1	Max Reduce 2	Max Reduce 3	Max Reduce 4	Max Reduce 5	Max Reduce 6	Max Reduce 7	Max Reduce 8	Max Reduce 9	Max Reduce 10
Splits 1	5	0	5	5	5	0	5	5	0	0
Splits 2	5	0	5	5	5	0	5	5	0	0
Splits 3	2	0	2	6	2	0	2	6	0	0
Splits 4	0	0	0	0	0	0	0	0	0	0
Splits 5	0	0	0	0	0	0	0	0	0	0
Splits 6	0	0	0	0	0	0	0	0	0	0
Splits 7	0	0	0	0	0	0	0	0	0	0
Splits 8	0	0	0	0	0	0	0	0	0	0
Splits 9	0	0	0	0	0	0	0	0	0	0

Table 1

TSP Splits | TSP Strategy

Database Configuration: Standard   Filter: TSP   Apply

Controller Database Editor - TSP Splits

Splits	Max Reduce 11	Max Reduce 12	Max Reduce 13	Max Reduce 14	Max Reduce 15	Max Reduce 16	Max Extend 1	Max Extend 2	Max Extend 3	Max Extend 4
Splits 1	0	0	0	0	0	0	0	15	0	0
Splits 2	0	0	0	0	0	0	0	15	0	0
Splits 3	0	0	0	0	0	0	0	10	0	0
Splits 4	0	0	0	0	0	0	0	0	0	0
Splits 5	0	0	0	0	0	0	0	0	0	0
Splits 6	0	0	0	0	0	0	0	0	0	0
Splits 7	0	0	0	0	0	0	0	0	0	0
Splits 8	0	0	0	0	0	0	0	0	0	0
Splits 9	0	0	0	0	0	0	0	0	0	0

Table 1

TSP Splits | TSP Strategy

Database Configuration: Standard   Filter: TSP   Apply

Controller | By Entry

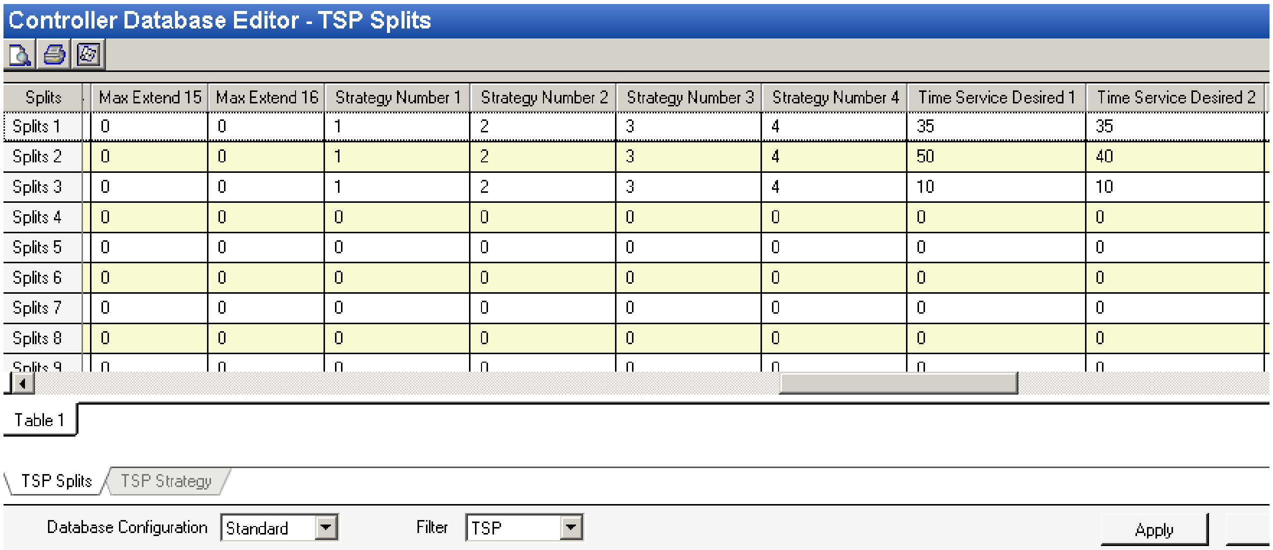
Controller Database Editor - TSP Splits

Splits	Max Extend 5	Max Extend 6	Max Extend 7	Max Extend 8	Max Extend 9	Max Extend 10	Max Extend 11	Max Extend 12	Max Extend 13	Max Extend 14
Splits 1	0	15	0	0	0	0	0	0	0	0
Splits 2	0	15	0	0	0	0	0	0	0	0
Splits 3	0	10	0	0	0	0	0	0	0	0
Splits 4	0	0	0	0	0	0	0	0	0	0
Splits 5	0	0	0	0	0	0	0	0	0	0
Splits 6	0	0	0	0	0	0	0	0	0	0
Splits 7	0	0	0	0	0	0	0	0	0	0
Splits 8	0	0	0	0	0	0	0	0	0	0
Splits 9	0	0	0	0	0	0	0	0	0	0

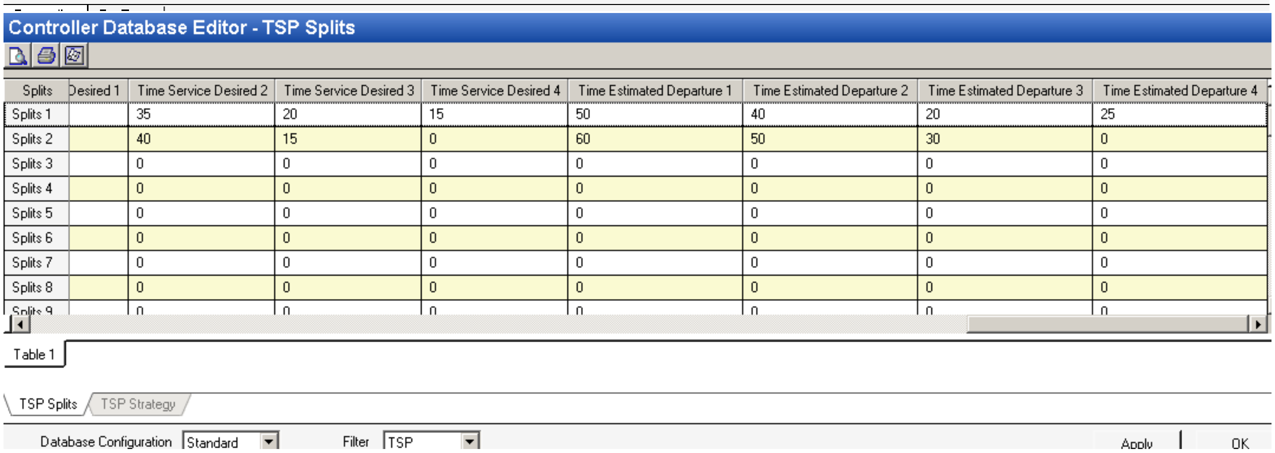
Table 1

TSP Splits | TSP Strategy

Database Configuration: Standard   Filter: TSP   Apply

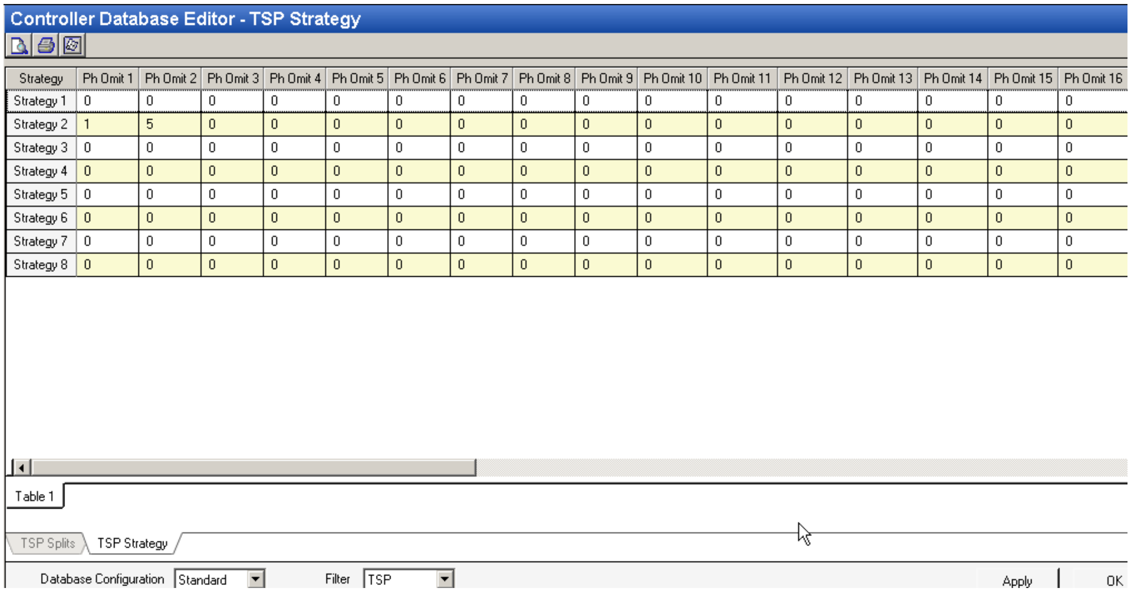


Splits	Max Extend 15	Max Extend 16	Strategy Number 1	Strategy Number 2	Strategy Number 3	Strategy Number 4	Time Service Desired 1	Time Service Desired 2
Splits 1	0	0	1	2	3	4	35	35
Splits 2	0	0	1	2	3	4	50	40
Splits 3	0	0	1	2	3	4	10	10
Splits 4	0	0	0	0	0	0	0	0
Splits 5	0	0	0	0	0	0	0	0
Splits 6	0	0	0	0	0	0	0	0
Splits 7	0	0	0	0	0	0	0	0
Splits 8	0	0	0	0	0	0	0	0
Splits 9	0	0	0	0	0	0	0	0

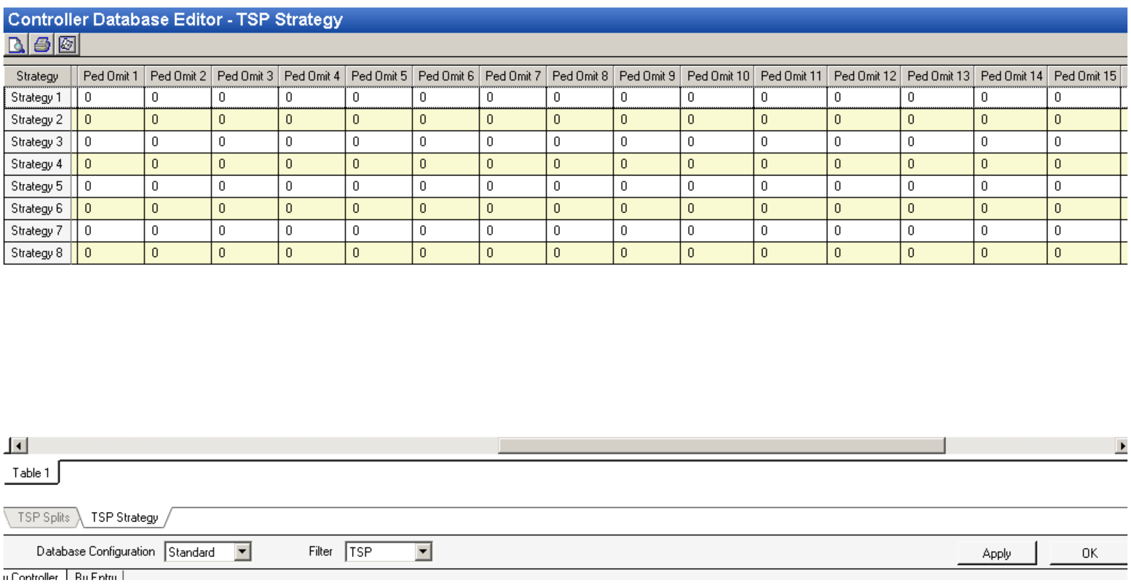


Splits	Desired 1	Time Service Desired 2	Time Service Desired 3	Time Service Desired 4	Time Estimated Departure 1	Time Estimated Departure 2	Time Estimated Departure 3	Time Estimated Departure 4
Splits 1		35	20	15	50	40	20	25
Splits 2		40	15	0	60	50	30	0
Splits 3		0	0	0	0	0	0	0
Splits 4		0	0	0	0	0	0	0
Splits 5		0	0	0	0	0	0	0
Splits 6		0	0	0	0	0	0	0
Splits 7		0	0	0	0	0	0	0
Splits 8		0	0	0	0	0	0	0
Splits 9		0	0	0	0	0	0	0

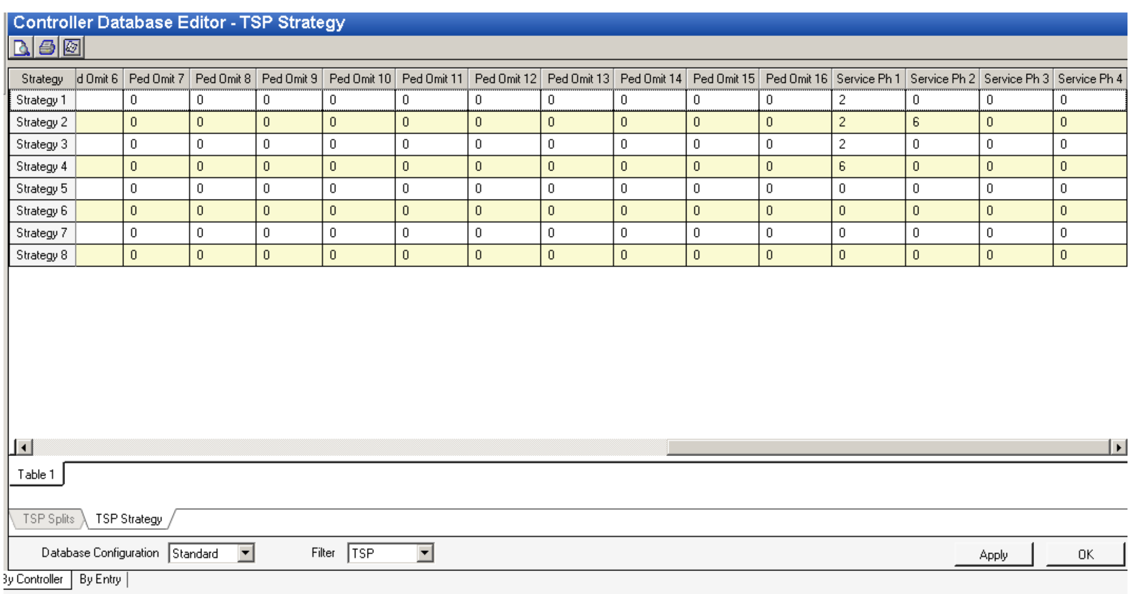
3.3.3 TSP Strategy Tables



Strategy	Ph Omit 1	Ph Omit 2	Ph Omit 3	Ph Omit 4	Ph Omit 5	Ph Omit 6	Ph Omit 7	Ph Omit 8	Ph Omit 9	Ph Omit 10	Ph Omit 11	Ph Omit 12	Ph Omit 13	Ph Omit 14	Ph Omit 15	Ph Omit 16
Strategy 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Strategy 2	1	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Strategy 3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Strategy 4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Strategy 5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Strategy 6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Strategy 7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Strategy 8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0



Strategy	Ped Omit 1	Ped Omit 2	Ped Omit 3	Ped Omit 4	Ped Omit 5	Ped Omit 6	Ped Omit 7	Ped Omit 8	Ped Omit 9	Ped Omit 10	Ped Omit 11	Ped Omit 12	Ped Omit 13	Ped Omit 14	Ped Omit 15
Strategy 1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Strategy 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Strategy 3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Strategy 4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Strategy 5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Strategy 6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Strategy 7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Strategy 8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0



Strategy	d Omit 6	Ped Omit 7	Ped Omit 8	Ped Omit 9	Ped Omit 10	Ped Omit 11	Ped Omit 12	Ped Omit 13	Ped Omit 14	Ped Omit 15	Ped Omit 16	Service Ph 1	Service Ph 2	Service Ph 3	Service Ph 4
Strategy 1		0	0	0	0	0	0	0	0	0	0	2	0	0	0
Strategy 2		0	0	0	0	0	0	0	0	0	0	2	6	0	0
Strategy 3		0	0	0	0	0	0	0	0	0	0	2	0	0	0
Strategy 4		0	0	0	0	0	0	0	0	0	0	6	0	0	0
Strategy 5		0	0	0	0	0	0	0	0	0	0	0	0	0	0
Strategy 6		0	0	0	0	0	0	0	0	0	0	0	0	0	0
Strategy 7		0	0	0	0	0	0	0	0	0	0	0	0	0	0
Strategy 8		0	0	0	0	0	0	0	0	0	0	0	0	0	0

4 Estimating Transit Vehicle Arrival Times

The key to implementing an efficient Light Rail Transit Priority system is accurate arrival time estimates of the Light Rail Transit vehicle. These estimates can vary greatly by time-of-day, especially if a nearside transit stop is included in the estimate. Arrival times should be estimated during coordination pattern development because transit priority programming is simply an extension of the pattern.

4.1 Time of Service Desired (TSD)

NTCIP defines *Time of Service Desired (TSD)* as the arrival time of the transit vehicle at the stop bar. This arrival time is compared with the start of the next transit priority phase to determine if phases should be reduced to provide an *early return* to the transit phase. The *TSD* estimate is based on the free flow speed of the transit vehicle and any deceleration, lost-time or dwell time expected prior to the vehicle arrival at the stop bar.

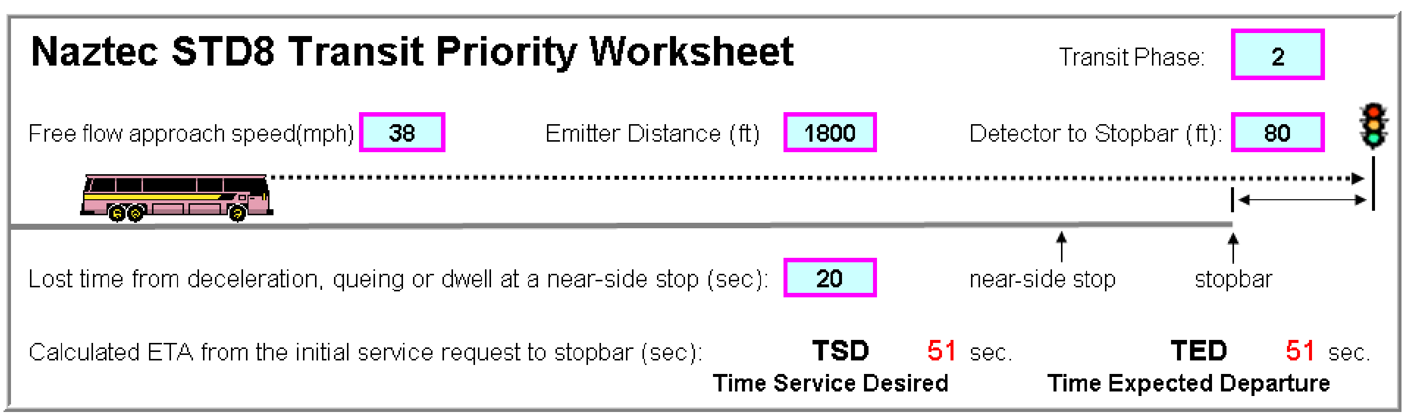
4.2 Time of Estimated Departure (TED)

NTCIP defines *Time of Estimated Departure (TED)* as the departure time of the vehicle clearing the intersection. This is also the point in the cycle when the emitter signal used to detect the transit vehicle is expected to drop out. The *TED* timer begins counting down when the priority request is received and this timer along with the presence of the emitter signal is used to make a decision to extend the transit phase at the force-off point.

The *TSD* and *TED* estimates are typically set to the same value because the decision to extend the priority phase is made one second before the force-off. If the *TSD* and *TED* countdown timers have timed to zero before this decision point, the transit phase does not need to be extended. However, if the *TED* countdown timer is greater than zero and less than *MaxExtend*, the transit phase should be extended because the vehicle has not reached the stop bar.

4.3 STD8 Transit Priority

The example below estimates *TSD* and *TED* arrival times for a transit vehicle approaching the intersection at 38 mph with an emitter distance of 1800 ft. The vehicle is expected to either dwell at a nearside stop or experience 20 seconds of delay before entering the intersection.



For the example above, the following calculations produced a TSD equal to 51 seconds.

a) 1 mi/hr is equivalent to 1.4667 ft/second, therefore a speed of 38 mph is equal to 55.73 ft/second.

b) The travel distance to the stop bar, once the transit priority preemption is detected, is 1800 ft – 80 ft or 1720 ft.

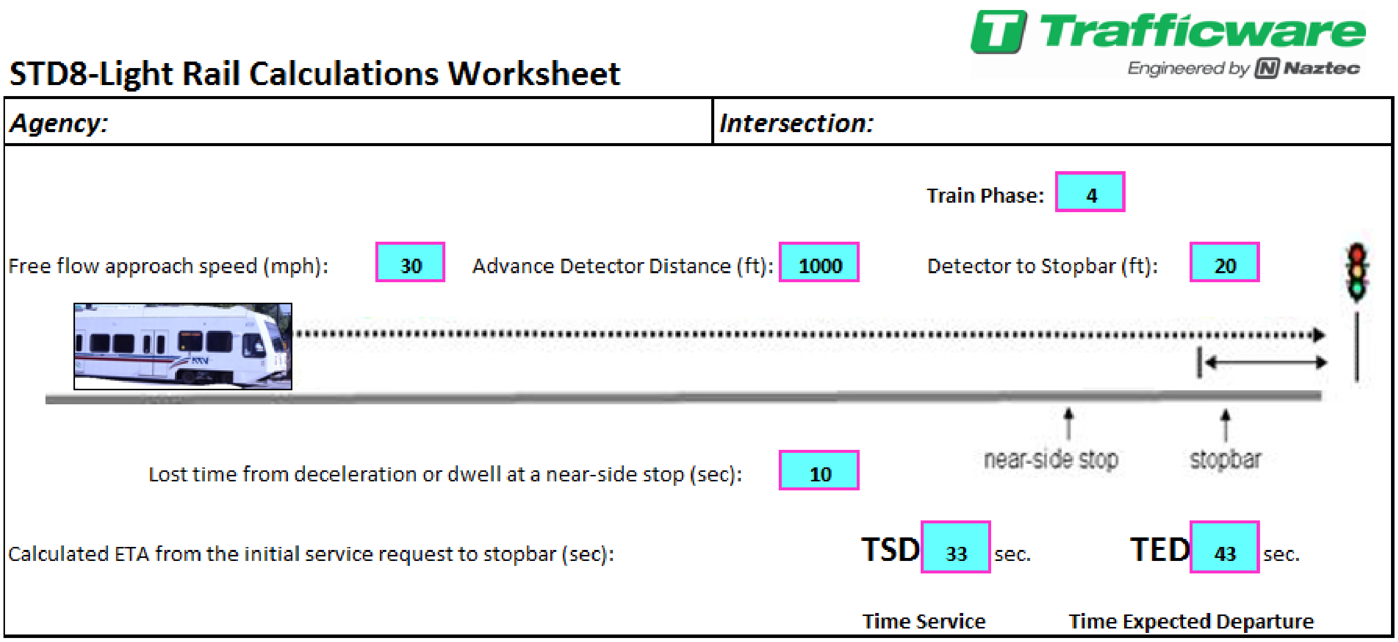
c) Therefore the travel time to the stop bar is 1720ft divided by 55.73 ft/second or 30.86 seconds

d) Add the lost time of 20 seconds and round up to get the TSD of 51 seconds. TED can be the same or greater based on agency practices and demands.

The calculated *TSD* and *TED* arrival times can be associated with the priority request (LP1-LP4) that use transit phase 2. *TSD* and *TED* times can be varied by pattern and by time-of-day because a separate *Priority Plus Features* table is provided with each *Split Table*.

4.4 [LRT] STD8 Light Rail Transit Priority

The example below estimates *TSD* and *TED* arrival times for a Light Rail Transit vehicle approaching the intersection at 30 mph with an emitter distance of 1000 ft. The vehicle is expected to either dwell at a nearside stop or experience 20 seconds of delay before entering the intersection.



For the example above, the following calculations produced a TSD equal to 33 seconds.

e) 1 mi/hr is equivalent to 1.4667 ft/second, therefore a speed of 30 mph is equal to 44 ft/second.

f) The travel distance to the stop bar, once the transit priority preemption is detected, is 1000 ft – 20 ft or 980 ft.

g) Therefore the travel time to the stop bar is 980 ft divided by 44 ft/second or 22.27 seconds

h) Add the lost time of 10 seconds and round up to get the TSD of 33 seconds. TED can be the same or greater based on agency practices and demands.

The calculated *TSD* and *TED* arrival times can be associated with the priority request (LP1-LP4) that use transit phase 2. *TSD* and *TED* times can be varied by pattern and by time-of-day because a separate *Priority Plus Features* table is provided with each *Split Table*.

5 Modeling MaxReduce and MaxExtend Times

The next step in the evaluation is to model *MaxReduce* and *MaxExtend* and insure that transit diagnostics pass when the transit strategy table is requested.

5.1 Maximum Phase Reduction and Extend Times

The controller's internal *Coord Diagnostics* calculates minimum vehicle and pedestrian times shown below as *Min Phase Times(sec)*. These *min times* are guaranteed during priority service even if *MaxReduce* values exceed these minimums. However, the user should attempt to set *MaxReduce* that do not violate the *Min Phase Times* to understand the true *early return* and *extension* for each pattern. *MaxExtend* and *MaxReduce* must also balance to satisfy the transit diagnostics (section 7.4).

In the STD8 example below, a 60" cycle is programmed for pattern# 1 and split table #1. The coord phase and priority service phase 2 associated with the arterial is given a 24" split. Split times for non-transit phase splits are 12". The *Min Phase Times* calculated by the spreadsheet are 16" for the transit/coord phase and 8" for the non-transit phases. The calculated *Phase Time MaxReduce* value is the split time minus the min phase time.

1 Pattern # from Diagnostics Sheet
60 Cycle (sec)
1 Split # 1 Sequence #

Copy Phase MaxReduc to Specified MaxReduc

	1	2	3	4	5	6	7	8
Pattern Split (sec)	12	24	12	12	12	24	12	12
Min. Phase Time (sec)	8	16	8	8	8	16	8	8
Phase Time MaxReduc	4	8	4	4	4	8	4	4

Note: controller will not reduce the split time below minimum phase time requirements

Constant Split Reduction (%) **10%**

Copy Constant Split Reduc to Specified MaxReduc

	1	2	3	4	5	6	7	8
Specified MaxReduc	**4**	**8**	**4**	**4**	**4**	**8**	**4**	**4**
MaxExtnd		**20**				**20**		

Recommended MaxExtnd = 20

If you adjust the *Specified MaxReduce* for phases 2 and 6 to zero, notice below that the *Recommended MaxExtend* value changes from 20" to 12". In this case, *MaxExtend* for phase 2 and 6 should be set to this recommended value as shown below.

1 Pattern # from Diagnostics Sheet
60 Cycle (sec)
1 Split # 1 Sequence #

Copy Phase MaxReduc to Specified MaxReduc

	1	2	3	4	5	6	7	8
Pattern Split (sec)	12	24	12	12	12	24	12	12
Min. Phase Time (sec)	8	16	8	8	8	16	8	8
Phase Time MaxReduc	4	8	4	4	4	8	4	4

Note: controller will not reduce the split time below minimum phase time requirements

Constant Split Reduction (%) **10%**

Copy Constant Split Reduc to Specified MaxReduc

	1	2	3	4	5	6	7	8
Specified MaxReduc	**4**	**0**	**4**	**4**	**4**	**0**	**4**	**4**
MaxExtnd		**12**				**12**		

Recommended MaxExtnd = 12

If the *Specified MaxReduce* value is less than the calculated *Phase Time MaxReduce*, then this is an error. Even though the controller will not reduce the split times below minimum phase time requirements, you should attempt to adjust *Phase Time MaxReduc* to correct any errors to understand the true benefit of transit priority.

This example is more complex than it would first appear because minimum phase time calculations take into consideration not only minimum phase times requirements, but, also shortway transition specified for the pattern, no-shortway phases and the stop-in-walk parameter.

5.2 “Practical” Phase Reduction and Extend Times

Maximum reduction times are rarely used in practice because the benefit of transit priority must be weighed against the reduction in capacity expected when non-transit split times are reduced. “Practical” phase reduction and extend times must balance the trade-off between transit delay reduction and driver delay associated with the non-transit phases.

Consider a *constant split reduction factor* which can be used as an aide in reducing split times by a constant value. This approach is helpful if you assume that the split times used equalize drive delay and you wish to penalize the non-transit phases equally.

In the example below, a 20% reduction was copied to *Specified MaxReduce* by clicking the button labeled *“Copy Constant Split Reduc to Specified MaxReduce”*.

1 Pattern # from Diagnostics Sheet
60 Cycle (sec)
1 Split # 1 Sequence #

Copy Phase MaxReduc to Specified MaxReduc

	1	2	3	4	5	6	7	8
Pattern Split (sec)	12	24	12	12	12	24	12	12
Min. Phase Time (sec)	8	16	8	8	8	16	8	8
Phase Time MaxReduc	4	8	4	4	4	8	4	4

Note: controller will not reduce the split time below minimum phase time requirements

Constant Split Reduction (%) **20%**

Copy Constant Split Reduc to Specified MaxReduc

	1	2	3	4	5	6	7	8
Specified MaxReduc	**2**	**0**	**2**	**2**	**2**	**0**	**2**	**2**
MaxExtnd		**6**				**6**		

Recommended MaxExtnd = 6

Early Return Calculation STD8 - Seq# 1

Note: Max Reduction will not violate Mins
Max Early Return Assumes Seq# 1

	1	2	3	4	5	6	7	8
MaxReduc Used (sec)	2	0	2	2	2	0	2	2
Max Early Return		6				6		
Capacity Reduction (% Split)	-17%		-17%	-17%	-17%		-17%	-17%

Note: Capacity Reduction (non-transit phases) vs. Early Retun is a tradeoff !!

STD8 FloatMx Calculations (MM->2->8->6 Status Screen)

Note: This is a simplied case for Seq# 1 when
the transit phase is 2/4/6/8

	1	2	3	4	5	6	7	8
Reduced Split (sec)	10	24	10	10	10	24	10	10
Yellow+All-red Clearance	3	3	3	3	3	3	3	3
Priority Based FloatMax	7	27	7	7	7	27	7	7

Specified MaxReduce values for coord phase 2 and 6 were manually adjusted to zero because in this case phase 2 is the priority service phase. *MaxExtend* for phase 2 and 6 were set to the *Recommended MaxExtend* value as in the last example. The maximum early return for this example is 6” assuming that the *TSD* can be projected far enough in advance of the priority phase to accumulate max reduction times from the non-transit phases.

Capacity Reduction is calculated for each phase based on reduced split times. In the example above, the 20% *Constant Split Reduction* yields a 17% *Capacity Reduction*. These values differ by 3% because the constant reduction% is rounded to the nearest second. *Constant Split Reduction* factor is only provided as an aide to assist the user while specifying *MaxReduce* and *MaxExtend* values.

<u>Capacity reduction</u> of the non-transit phases is a very complex issue that not only depends on the *Specified Max Reduc* times, but also the frequency of the priority requests and the accuracy of the transit arrival times. A “poorly timed” system can actually provide a negative impact to both transit operation and drivers serviced by the non-transit phases if the projected arrival times are inaccurate.

For example, suppose priority requests are generated every 10 minutes using a *TSD* that estimates a 30 second dwell time at a nearside transit stop, but, the transit vehicle only stops 25% of the time. In this case, a significant reduction in capacity for drivers serviced by the non-transit phases could be experienced with little benefit to the transit vehicle. The *Transit Priority Worksheet* was designed to provide a visual while assigning *MaxReduce* and *MaxExtend* values to the split table.

The *Transit Priority Worksheet* also calculates *Floating Max* (PrMx) times. These are for educational purposes only, because the controller automatically asserts priority max times as needed. Floating max, or *Priority Max (PrMx)* times are used to reduce or extend split times while a priority service request is active.

5.3 MaxReduce Times and Barrier Requirements

One final example is in order before we leave this section on *MaxReduce* and *MaxExtend* times. The illustration below shows that *Recommended MaxExtend* can never be more than the sum of the *MaxReduce* times with barrier constraints applied.

Suppose the following *MaxReduce* and *MaxExtend* times are applied to the 60" pattern below.

1 Pattern # from Diagnostics Sheet
60 Cycle (sec)
1 Split # 1 Sequence #

Copy Phase MaxReduc to Specified MaxReduc

	1	2	3	4	5	6	7	8
Pattern Split (sec)	12	24	12	12	12	24	12	12
Min. Phase Time (sec)	8	16	8	8	8	16	8	8
Phase Time MaxReduc	4	8	4	4	4	8	4	4

Note: controller will not reduce the split time below minimum phase time requirements

Constant Split Reduction (%) **10%**

Copy Constant Split Reduc to Specified MaxReduc

	1	2	3	4	5	6	7	8
Specified MaxReduc	**4**	**0**	**4**	**4**	**4**	**0**	**4**	**4**
MaxExtnd		**12**				**12**		

Recommended MaxExtnd = 12

If *Min Phase Time (sec)* for phases 1 and 4 is raised from 8" to 12", the maximum reduction changes from 4" to 0". This changes the *Recommended MaxExtend* from 12" to 4". Even though non-transit phases in ring 2 can be reduced by 12", ring 1 limits the reduction to 4" because phase 1 and 4 can no longer be reduced.

1 Pattern # from Diagnostics Sheet
60 Cycle (sec)
1 Split # 1 Sequence #

Copy Phase MaxReduc to Specified MaxReduc

	1	2	3	4	5	6	7	8
Pattern Split (sec)	12	24	12	12	12	24	12	12
Min. Phase Time (sec)	12	16	8	12	8	16	8	8
Phase Time MaxReduc	0	8	4	0	4	8	4	4

Note: controller will not reduce the split time below minimum phase time requirements

Constant Split Reduction (%) **10%**

Copy Constant Split Reduc to Specified MaxReduc

	1	2	3	4	5	6	7	8
Specified MaxReduc	**0**	**0**	**4**	**0**	**4**	**0**	**4**	**4**
MaxExtnd		**4**				**4**		

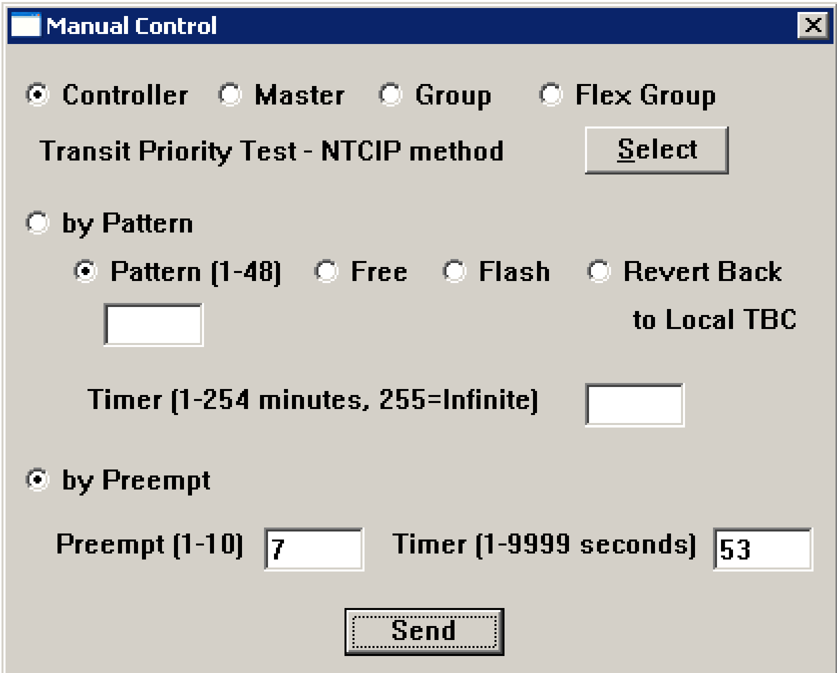
Recommended MaxExtnd = 4

The *Recommended MaxExtend* value calculated by the spreadsheet considers these barrier constraints. Therefore, the spreadsheet becomes a valuable aid when developing patterns because new *MaxReduce* and *MaxExtend* values should be considered whenever the split table is changed.

NOTE: Max Reduction cannot be programmed for the COORD Phase (or the Pseudo-COORD phase) when running end-of-green coordination.

6 Transit Priority During Coordination

The following examples demonstrate the *NTCIP* method during coordination. Each example assumes the transit phase (priority service phase) and the coord phase are the same because this is the most common situation in practice. However, either method can assign the priority service phase to any phase in the sequence.



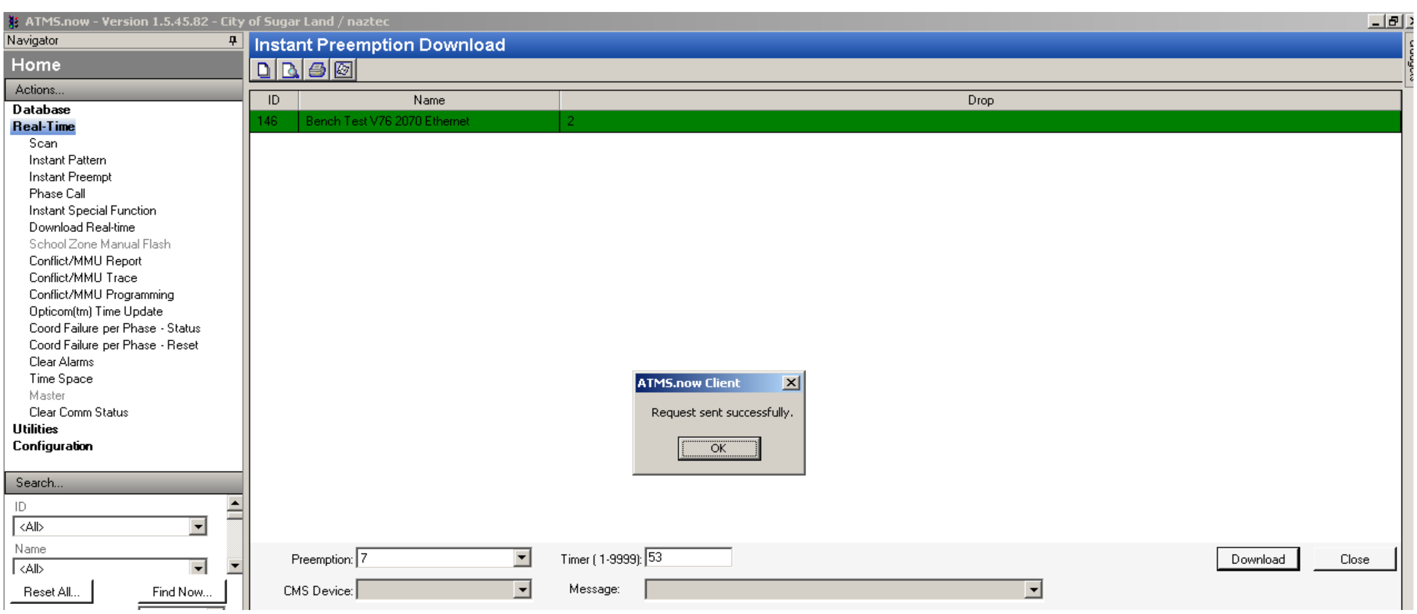
The user is encouraged to follow through the examples with a controller and observe the response when transit priority requests are generated from StreetWise or ATMS.now using *Manual Control*.

The *Manual Control* screen below is accessed from the StreetWise *Utilities* pull-down menu. In this example, service request PR7 (LP1) is downloaded with a 53" duration timer to simulate an emitter that holds a low-priority call for 53".

Please set Lock to ON for the examples in this manual to make sure the service request does not drop out before the controller returns to the transit phase (see section 2.2.1).

For ATMS.now, the *Manual Control* screen is accessed from the Home module's Real-Time Action menu by accessing *Instant Preempt*. In this example, service request PR7 (LP1) is downloaded with a 53" duration timer to simulate an emitter that holds a low-priority call for 53".

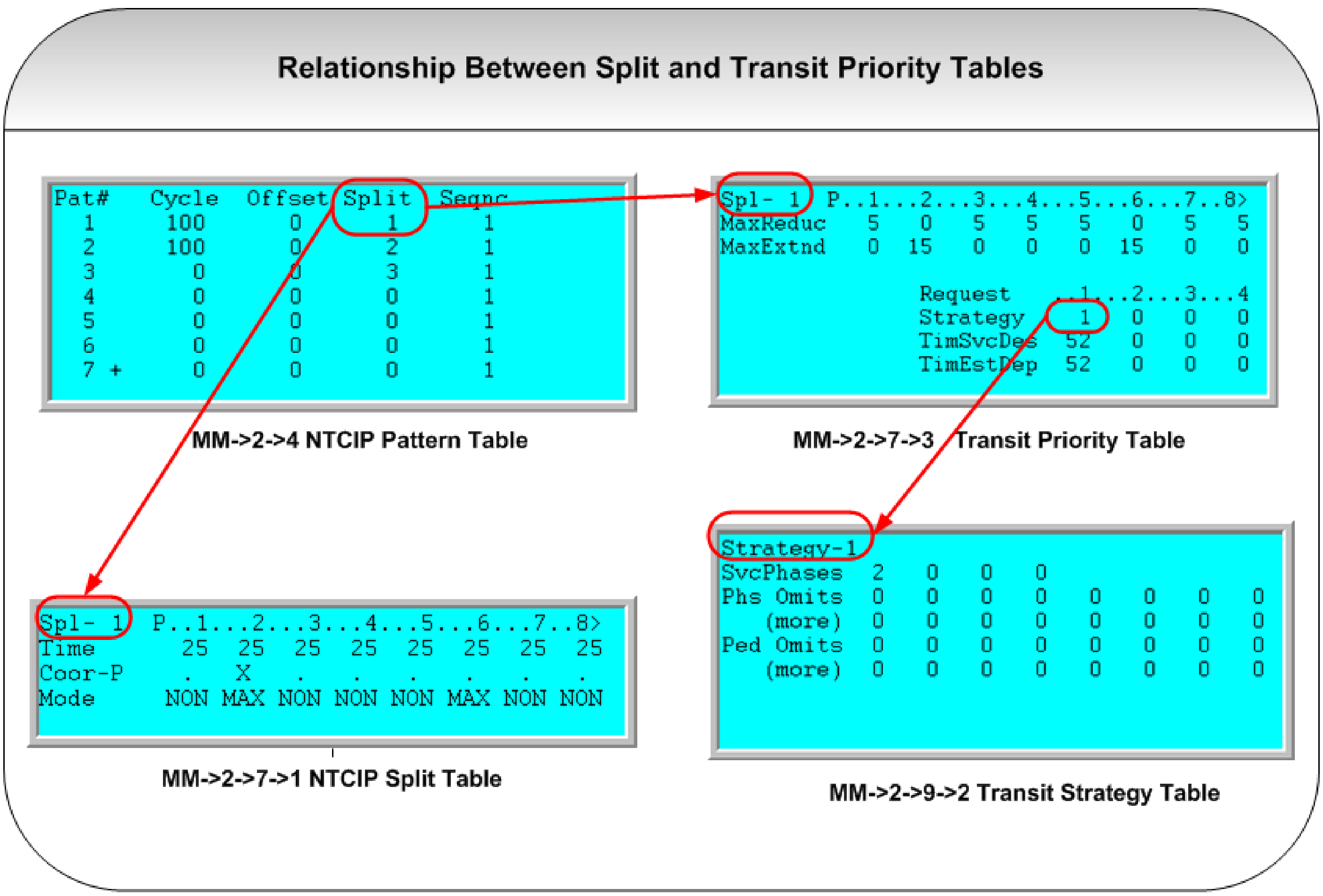
Please set Lock to MAX for the examples in this manual to make sure the service request does not drop out before the controller returns to the transit phase.



6.1 Initialize the Test Controller

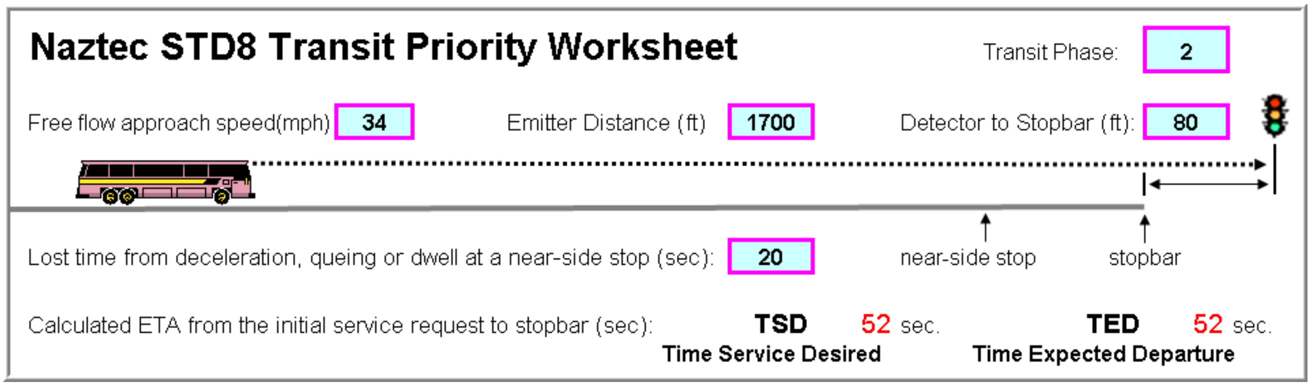
Please perform the following initialization to insure that the your results are consistent with those presented in this chapter.

1. Turn OFF the *Run-Timer* (MM->1->7) and initialize the controller as STD8 (MM->8->4)
2. Turn ON the *Run-Timer* (MM->1->7)
3. Set *Max Recall* on phases 1-8 under MM->1->1->2
4. Enter the values shown on the menus below. Make sure Coordination synch is referenced to BegGrn (MM->2->5) for pattern 1.
5. Set *Test OpMode* to 1 under MM->2->1. Verify that your controller is in pattern# 1 running a 100" cycle with max recalls on all phases from the MM->7->1 and 7->2 menus.
6. Define a controller in StreetWise or ATMS.now with the same ID address under MM->6->1
7. Select this controller from the *Manual Control* screen above and verify that LP1 is received by looking at the controller timing status screen M->7->1 (this menu displays LP1 in the lower right corner when LP1 becomes active)



6.2 NTCIP Priority Examples

In this example, assume that a transit vehicle is approaching at 34 mph and the emitter is detected at 1700 ft. There is also a 20” dwell time expected at a nearside bus stop. Therefore, the *TSD/TED* estimated time of arrival is 52” after the emitter is detected at the cabinet.

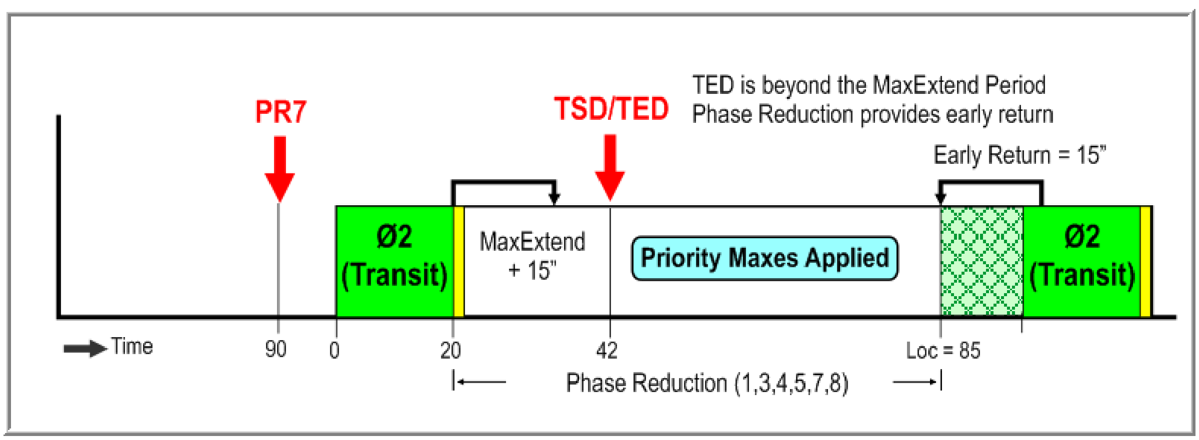


6.2.1 NTCIP Early Return Example (Priority Request in the Previous Cycle)

Please set Lock to ON for the examples in this manual to make sure the service request does not drop out before the controller returns to the transit phase (see section 2.2.1).

Issue a PR7 or LP1 request from StreetWise or ATMS.now so that the preemption begins when the local cycle counter reaches Loc=90. You may need to click the “Send” button on the StreetWise *Manual Control* screen several seconds early depending on your communication setup to insure that Preemption 7 (Pr7) appears at Loc=90.

Because the *TSD/TED* times are set to 52”, the arrival time of the vehicle at the stop bar is projected to be at Loc=42 (90” + 52” – 100” = 42”). In this case, TSD/TED is projected into the next signal cycle.



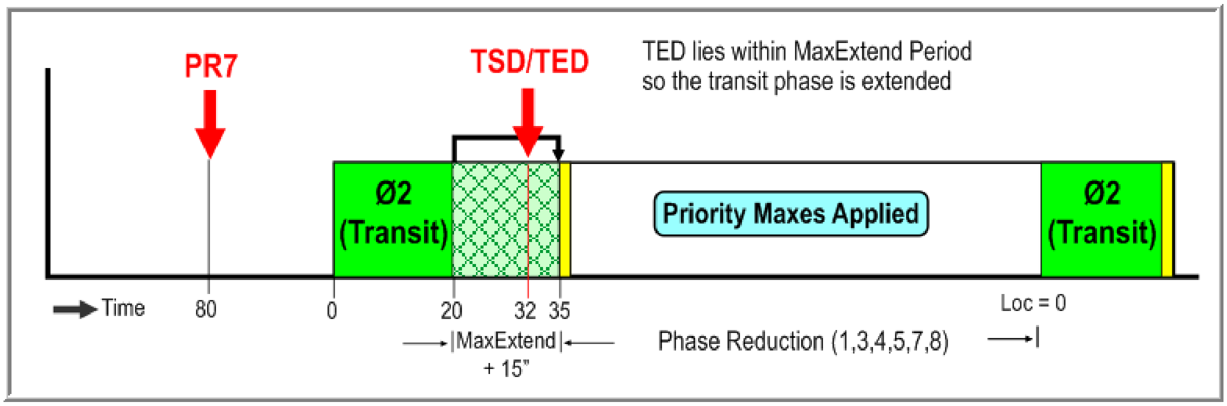
Phase Reduction (NTCIP Method) – Priority Max Times Provide Early Return to the Transit Ø

Note that the *TED* is projected after the ***MaxExtend*** period of the transit phase, so the non-transit phases must be reduced to provide an *early return* in the next signal cycle. Phase 2 normally begins at Loc=0 and ends at the force-off at Loc=22. However, during priority service, phase 2 returns 15” early at Loc=85 because the non-transit phases are reduced by applying *Priority Max (PrMx)* times.

Run this simulation several times observing the max times operating in each ring on status screen MM->7->1. Before LP1 is applied, you will notice *Max1* timing in each ring because this is the default max time in coordination under MM->2->1. However, when "Pr7" is active and phases are being reduced, you will see *PrMx* in effect which limits the phases from developing the 25" split time assigned in the *Split Table* for each phase. You can view the calculated *Priority Max* times under the *Trans Calcs* menu (MM->2->8->7, labeled as "*FloatMx"*).

6.2.2 NTCIP Phase Extension Example

Now, issue a LP1 request at Loc=80. The *TSD/TED* time is 52" and projects the vehicle arrival at Loc=32. The arrival is within the *MaxExtend* period as shown below. The controller recalculates the force-off and yield points at Loc=19 to extend the transit phase and reduce the phases that follow.



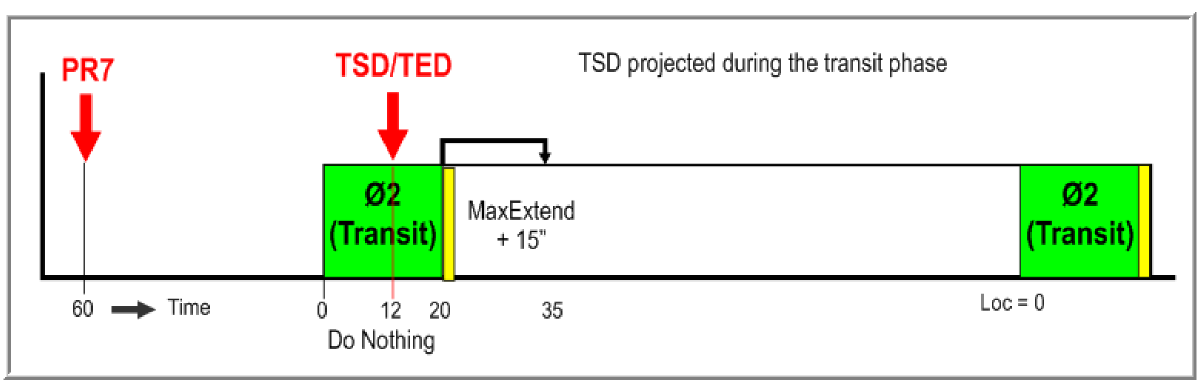
Phase Extension (NTCIP Method) – Force-offs Are Re-calculated to Extend the Transit Ø

Priority Max times (PrMx) are also applied to the phases that follow the transit phase to insure that any slack time developed in the non-transit phases is forwarded to coord phase.

In most cases, the transit phase is the same as the coordinated phase because transit typically operates on the major street. However, any phase may be assigned as the priority service phase. It is suggested that only one priority service phase be assigned to each request because if lead/lag left-turn phasing is in use, the begin and end points of the two phases may be at different points in the cycle.

6.2.3 NTCIP "Do Nothing" Example

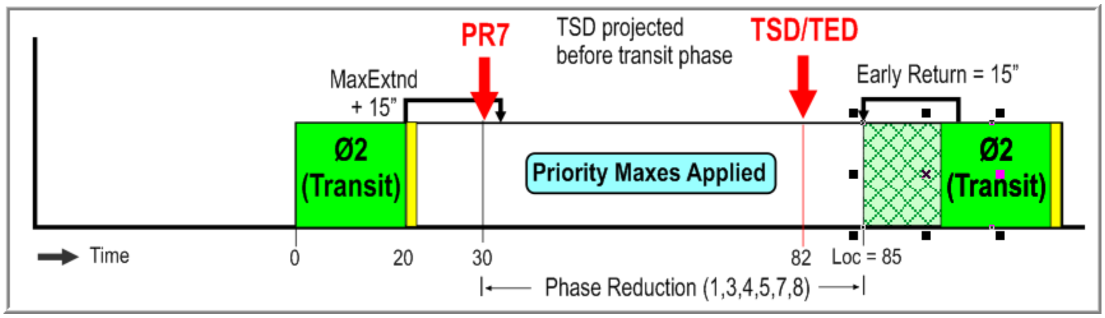
Next, issue a LP1 request at Loc=60 and verify that phase reduction and extension is not applied during the "Do Nothing" case below. Even if no action is taken, LP1 will lock out any new priority service request until the *TSD/TED* timers and the ***MaxL/O*** timer associated with the request have expired. The ***MaxL/O*** timer insures that all phases with calls at the time the request is received have been serviced before honoring another low-priority request (see section 2.2.3).



Do Nothing (NTCIP Method) – TSD/TED Projected During the Transit Ø

6.2.4 NTCIP Early Return Example – Service Request and TSD/TED in the Same Signal Cycle

Finally issue a LP1 request from StreetWise at Loc=30 and observe the early return to the transit phase at Loc=85. Note that *priority max times (PrMx)* are applied immediately when LP1 is detected even though phases 3 and 7 are already timing. Phase reduction provides an *early return* of 15" to the transit phase at Loc=85 to service a transit vehicle projected to arrive at Loc=82.



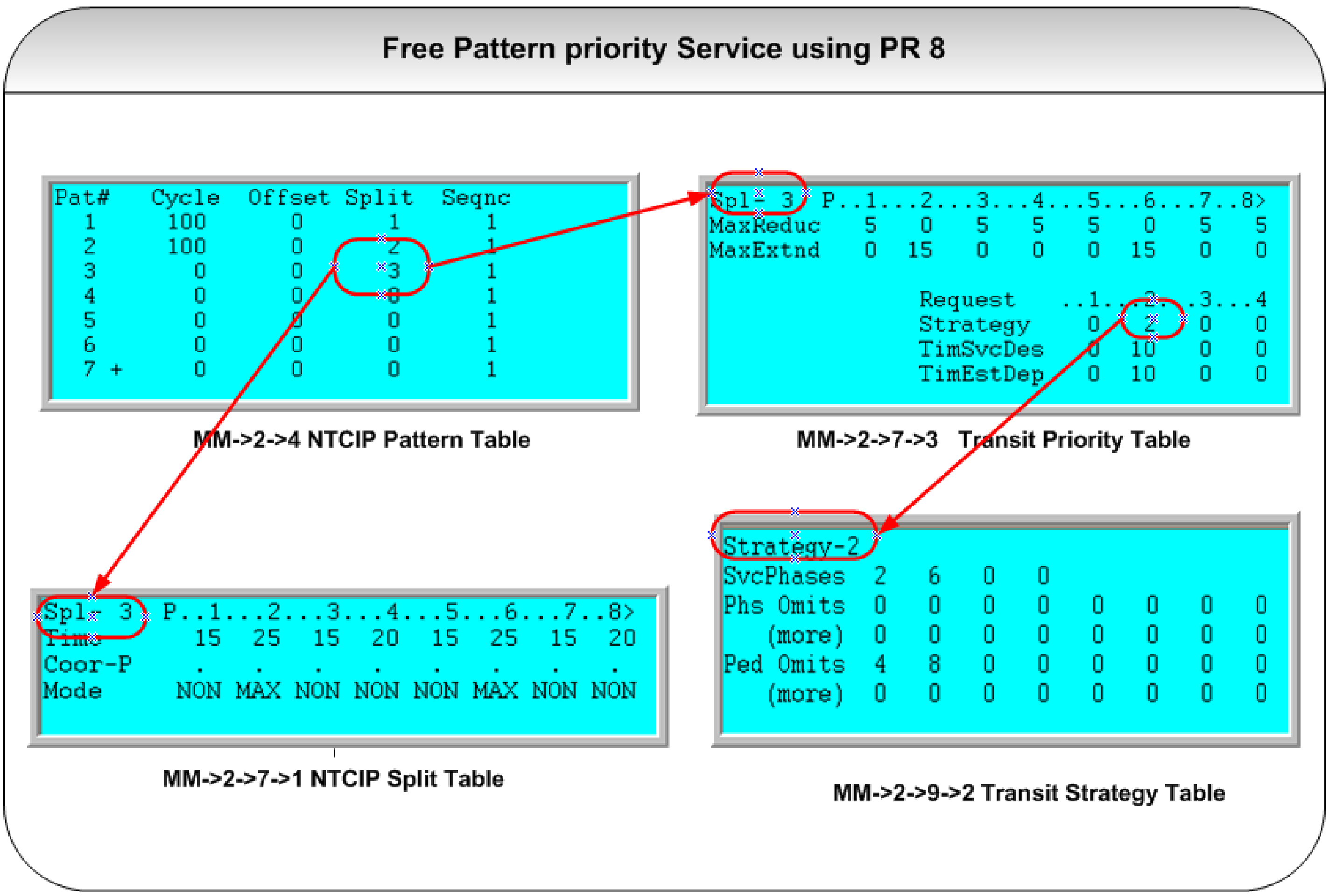
Phase Reduction (NTCIP Method) – Service Request and TSD/TED Occur Before Transit Ø

7 Transit Priority in Free Operation

NTCIP 1211 defines transit priority only during coordinated operation. The software extends the *NTCIP* method during free operation using *Priority Max* times to provide an early return or extend the priority phase. In addition, the *Priority Strategy Table* may be used to selectively omit vehicle and/or pedestrian service. Even if you only plan to use transit priority during free operation, you should still familiarize yourself with this chapter to learn more about the *Priority Strategy Table* and the controller status displays related to transit priority.

7.1 Free Patterns and Priority Service

NTCIP 1202 – "ASC (Actuated Traffic Signal Controllers)" defines *free operation* as pattern# 254 and *automatic flash* as pattern# 255. In addition, any of the 48 controller patterns may be set to *free* by coding a 0" cycle length in the pattern table. This approach allows additional features associated with the pattern to be active during free operation. For example, transit priority is active during free *pattern # 3* below:



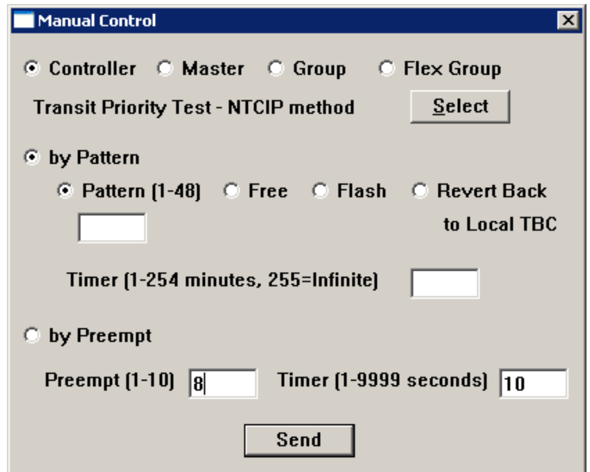
For these examples, set phases 1-8 on *Max Recall* and phases 4 and 8 on *Ped Recall* (MM->1->1->2).

Force the controller to *pattern # 254* in TEST mode (set *Test, OpMode* to 2 under MM->2->1). Then observe the operation of the controller under status screens MM->7->1 and MM->7->2. Note that the active *Max1* times for each phase match the *Max1* values programmed under MM->1->1->1. If you do not see ped recalls for phases 4 and 8, go back and program these recalls under MM->1->1->1.

Now, force the controller to *pattern # 3* in TEST mode (set *Test, OpMode* to 3 under MM->2->1). Note that the active *Max1* times change to the split times entered in *split table 2* under MM->7->1. During free operation, if a split time is zero, the *Max1* value from phase times (MM->1->1->1) is applied. However, if the split time is non-zero, the split value overrides the active max time while the split table is active.

This approach provides 32 combinations of *Max Times* (one combination for each split table) during free operation. You can still apply *Max1* or *Max2* using an external input to the controller or by setting *Max2* for the pattern (MM->2->6, right menu). However, setting max times through the split table is more powerful and lets you modify the max times for priority service under free operation.

7.2 Free Operation Priority Example



With the controller in free pattern# 3, place a priority service request for service request PR8 while the controller is in phase 2 yellow clearance.

Observe under MM->7->1 that the *Max1* times switch to *PrMx* when PR8 appears in the lower right hand corner of the menu. *PrMx* is applied until the controller returns to priority service phase 2. In this example, *Max1* times for phases 1, 3, 5 and 7 are reduced by their 5" ***MaxReduce*** values in *Split Table# 3*.

Pedestrian service is also skipped for phases 4 and 8 even though a ped recall exists for those phases. This can also provide an early return to *priority phase* 2.

Now, place a priority service request for PR8 from StreetWise or ATMS.now during the last 10 seconds of green during phase 2 (click the "Send" button when the *Max1* timer of phase 2 is 010 on menu MM->7->1). Note that the *Max1* timer for phase 2 switches to *PrMx* =35" when PR8 is received. This extends the transit priority phase 10" to service a "late" request. After the priority phase is extended, the non-transit phases are reduced by their ***MaxReduce*** values until the controller returns to phase 2.

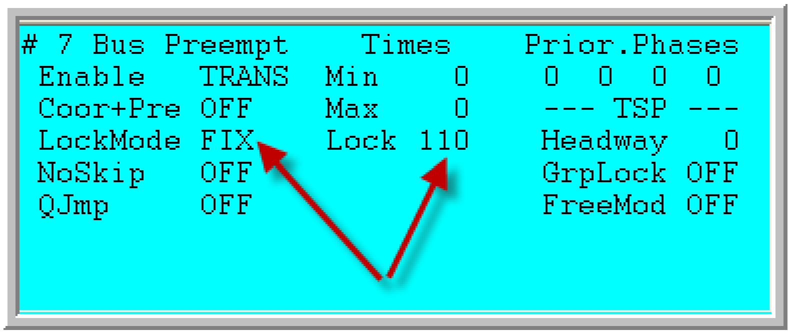
Think of *free operation* as a variable cycle length no greater than the sum of the active phase max times. If a split table is associated with a free pattern (cycle length 0"), the non-zero split values in the split table override the active max times. Transit priority extends or reduces these max times using ***MaxExtend*** and ***MaxReduce*** to provide an early return or extend the priority phase in free operation.

7.2.1 Fixed LockMode Time and Phase/Pedestrian Skipping

Vehicle phases and/or pedestrian service may be omitted during coordination or free operation using the NTCIP *Priority Strategy Table*. In the last example, *Priority Strategy Table #2 associated with PR8* omits pedestrian service on phases 4 and 8 while *pattern # 3* is active.

Eight separate *Priority Strategy Tables* are provided under MM->2->2. These eight tables may be assigned to priority Requests 1-4 : (LP1-LP4) in any split table in the controller.

Chapter 2 defined the ***LockMode*** parameter for each service request. If phase skipping is used as a strategy during priority service, consider setting the ***LockMode*** to the value of **FIX** and set the ***Lock*** time to a value larger than the greatest cycle length anticipated after a priority request. This will insure that all phases and pedestrian service skipped during a priority request will be serviced once before another priority request is serviced.



8 Priority Status Displays and Diagnostics

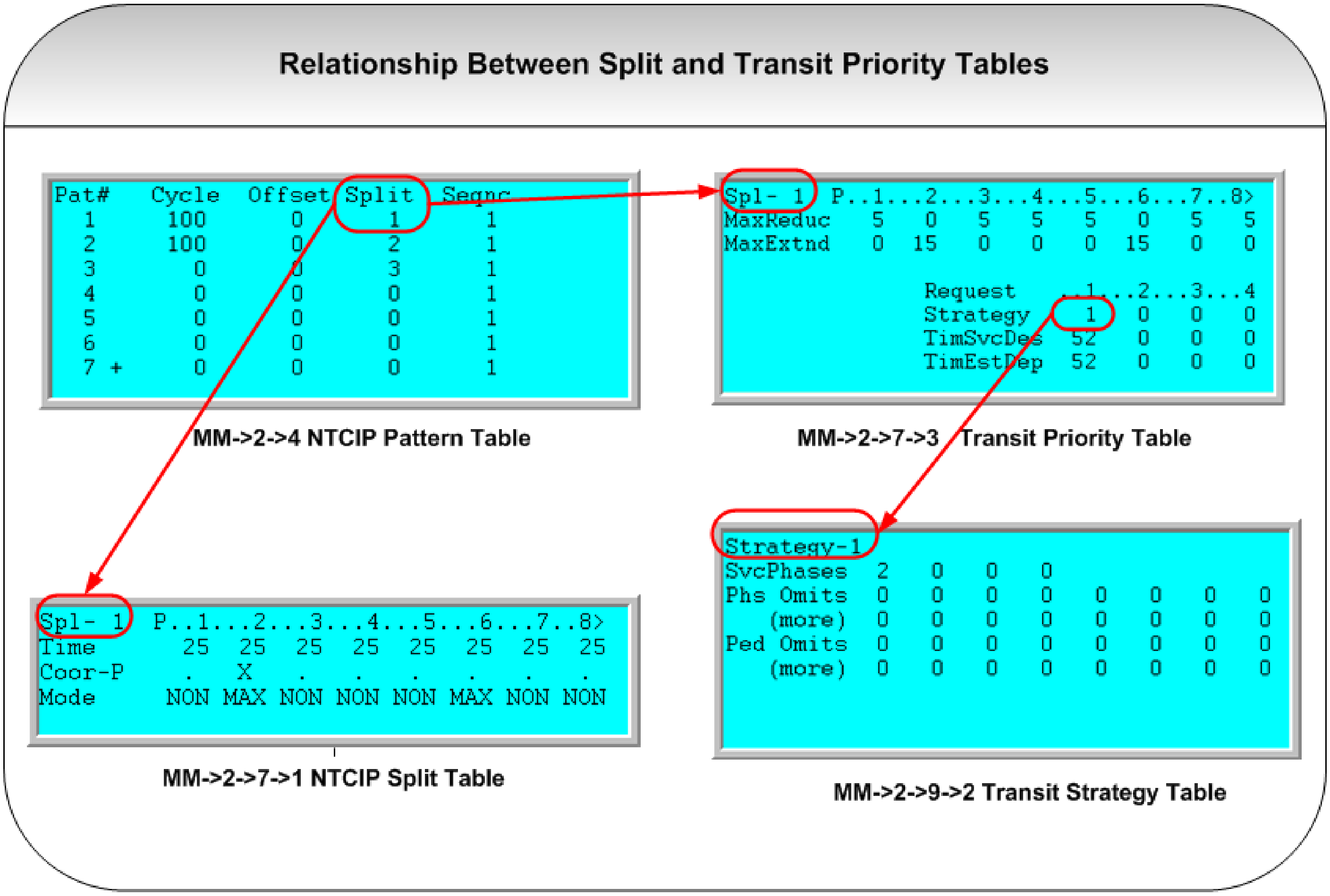
8.1 Transit Calcs Status Display

The *Easy Calcs* screen (MM->2->8->2) display force-off/yield calculations related to coordination.

The *Transit Calcs* screen (MM->2->8->7) displays priority service timers and calculations while a request is being serviced during coordination or free operation. The interpretation of this display varies with the method used.

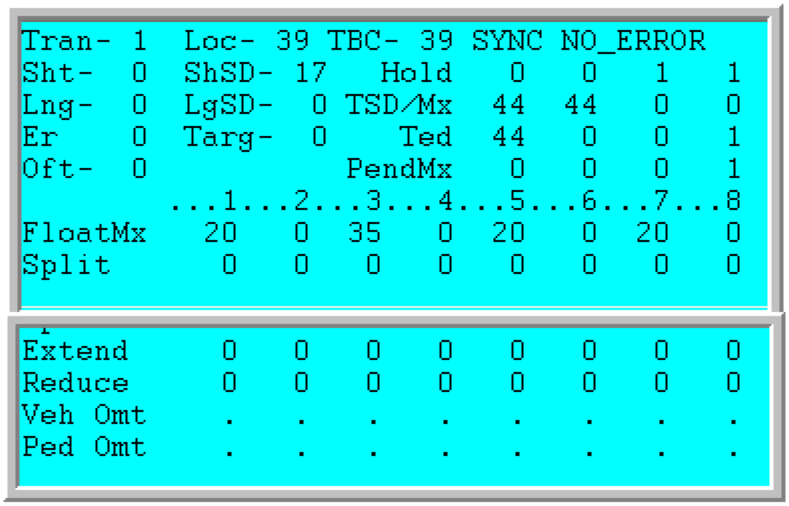
8.2 Transit Calcs Under the NTCIP Method

The following programming was presented in the example in chapter 2.



The *Transit Calcs* below are displayed when pattern # 1 is active and LP1 is received at Loc=30. In this case, *TSD* is projected before the start of the priority phase in the same cycle as the request (section5.2.4).

Note that the coordinator is in ***SYNC*** with ***oft*** (offset) = 0" and ***er*** (offset error) = 0". If the coordinator was in transition when the priority request was received, the display would display ***SHORT***, ***LONG*** or ***DWELL*** and the ***er*** value (offset error) would indicate how many seconds the controller was out of ***SYNC***.



MM->2->8->7 Transit Calcs

There are four columns corresponding with the four priority *requests* (LP1-LP4).

The *TSD* and *TED* times are 52" and the ***TSD/Mx*** and ***Ted*** counters begin counting down to zero when LP1 is first received.

The ***FloatMx*** values are the *PrMx* times used to reduce the non-transit phases. These max times are active when the value ***PendMx*** is equal to 1. ***PendMx*** resets to zero after the priority phase is serviced and the service request is complete.

The ***Split***, ***Extend***, ***Reduce*** and ***Omit*** values are the programmed values for the active strategy.

You can also watch the force-offs recalculate during phase extension under the *NTCIP* method. Place a LP1 service request during pattern# 1 between Loc = 75 and Loc=79. This will cause the controller to extend priority service phase 2 one second before the force-off at Loc=20. If you watch *Easy Calcs* (MM->2->8->2), you can see the force-offs recalculate at Loc=19. The new force-offs extend the priority service phase and reduce the non-priority phases so the controller never leaves coordination. It is not necessary to review the *Easy Calcs* screen to apply the NTCIP method. This information is only presented to help you understand how the controller accomplishes phase extension under the *NTCIP* method.

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8.3 Transit Priority Diagnostics

The *Transit Calcs* status screen (MM->2->8->7) provides a diagnostic check on the active transit priority request currently being serviced. If the request passes the transit priority diagnostics, the display in the top right corner of the screen displays NO_ERROR. Any other error message indicates the priority service request was ignored because the transit priority diagnostics failed.

```
Tran-  1   Loc- 39 TBC- 39 SYNC NO_ERROR
Sht-   0   ShSD- 17   Hold   0    0    1    1
Lng-   0   LgSD-  0 TSD/Mx  44   44    0    0
Er     0   Targ-  0    Ted  44    0    0    1
Oft-   0            PendMx   0    0    0    1
           ...1...2...3...4...5...6...7...8
FloatMx   20    0   35    0   20    0   20    0
Split      0    0    0    0    0    0    0    0

Extend     0    0    0    0    0    0    0    0
Reduce     0    0    0    0    0    0    0    0
Veh Omt    .    .    .    .    .    .    .    .
Ped Omt    .    .    .    .    .    .    .    .
```

MM->2->8->7: Transit Calcs

The following error messages indicate that a problem has been found in the active priority request.

1. NO_TRAN_PH

   No ***Priority*** phase is assigned in the *Priority Strategy Table* called by this request

2. TRAN_MAXEXTEND

   No ***MaxExtend*** values are specified (only applies to the *NTCIP* method)

3. RED/EXT

   No ***MaxReduce*** values are specified (only applies to the *NTCIP* method)

4. RINGS_BAL

   The sum of the ***MaxReduce*** times does not equal the sum of the ***MaxExtend*** times in a ring.

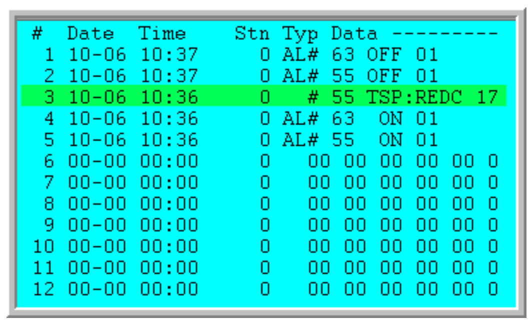
NOTE: Care must be taken when programming any Transit priority parameters to insure that the controller can transition properly to the priority phase. Strategy table 99 may be reported which has the effect of not running Transit Priority due to errors in user programmable data.

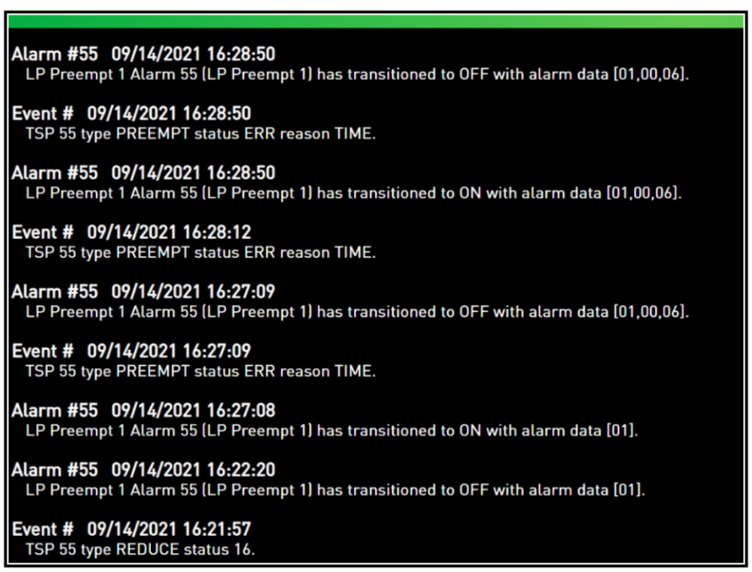
8.4 Transit Priority Specific Alarms and Events

The following alarms and Events are specific to Transit Priority and can be tracked by the user in the controller or ATMS.

Event / Alarm #	Alarm Name	Comments
55	LP Preempt 1	Low-Priority or Transit Priority Preempt 1
56	LP Preempt 2	Low-Priority or Transit Priority Preempt 2
57	LP Preempt 3	Low-Priority or Transit Priority Preempt 3
58	LP Preempt 4	Low-Priority or Transit Priority Preempt 4
62	Light Rail / Transit	Alarm Rail Check: One of the following detector conditions exist: • Train activates Check-In detector without activating Advanced Detector • Train waited too long (MaxCheckIn value expired) • Train activated Check-Out detector without activating the Check-In Detector
63	TSP Active Trigger	Used with ATMS to initiate download of TSP Data
65	Light Rail / Transit	Advance/Check-in/Check-out Detector Stuck
66	Light Rail / Transit	Advance/Check-in/Check-out detector inputs are out of sequence
67	Light Rail / Transit	Failed to arrive at the Check-in Detector in the proper amount of time
68	Light Rail / Transit	Failure to arrive at the Check-out Detector

LP Preempt Alarms 55-58 show specific data such as Extension times, Reduction times and errors, if they occur. In particular, the screen on the right displays the event buffer under MM->1->6->2. and shows that phase reduction occurred. As shown below, in Scout [V85.3] the reported events are also descriptive.





Besides Reduction and Extensions (and their times), errors may also be reported.

Error 1: Transit Phase is not programmed
Error 2: Transit Priority timing error
Error 3: Transit strategy table is not programmed.

8.5 ATMS.Now Transit Report

ATMS.now provides a report known under the Controller category known as the Transit Priority Report. Two samples of this report is shown below.

Report prior to ATMS 2.7

Transit Priority Report

ID: 72

Name: Santa Rita Rd @ Stoneridge Dr (72)

Corridor:

1/25/2012

Start Date/Time	End Date/Time	Direction	Type	Secs	Headway	Red	Cycle
1/25/2012 6:34:00AM	1/25/2012 6:34:00AM	N	REDUCE	44		17	120
1/25/2012 6:35:00AM	1/25/2012 6:35:00AM	N	LOCKOUT	0	0' 3"	0	0
1/25/2012 7:03:00AM	1/25/2012 7:04:00AM	S	REDUCE	51		8	120
1/25/2012 7:22:00AM	1/25/2012 7:22:00AM	S	REDUCE	1	18' 12"	13	120
1/25/2012 8:38:00AM	1/25/2012 8:38:00AM	N	EXTEND	0	123' 13"	25	120
1/25/2012 9:03:00AM	1/25/2012 9:05:00AM	S	REDUCE	44	100' 34"	0	120

Report after ATMS 2.6

Transit Priority Report

Report Date: 12/5/2018

Time: 12/04/2018 00:00:00 **To** 12/05/2018 23:59:59

ID	Name	Start Date/Time	End Date/Time	Direction	Priority	Sec (s)	Headway (mm:ss)	Red Time (s)	Cycle (s)
15	188th St SW & SR 99	12/4/2018 6:36:19 AM	12/4/2018 6:36:34 AM	N	EXTEND	11	15:08	10	140
15	188th St SW & SR 99	12/4/2018 7:14:27 AM	12/4/2018 7:14:42 AM	N	NONE	0	37:53	10	180
15	188th St SW & SR 99	12/4/2018 7:24:27 AM	12/4/2018 7:25:17 AM	N	REDUCE	16	09:41	50	180
15	188th St SW & SR 99	12/4/2018 7:54:29 AM	12/4/2018 7:54:44 AM	N	NONE	0	29:16	10	131
15	188th St SW & SR 99	12/4/2018 8:35:54 AM	12/4/2018 8:36:08 AM	N	NONE	0	40:54	10	167
15	188th St SW & SR 99	12/4/2018 9:16:02 AM	12/4/2018 9:16:17 AM	N	EXTEND	3	39:45	10	120
15	188th St SW & SR 99	12/4/2018 9:28:04 AM	12/4/2018 9:28:19 AM	N	EXTEND	4	11:52	10	120
15	188th St SW & SR 99	12/4/2018 10:04:46 AM	12/4/2018 10:05:01 AM	N	REDUCE	7	36:27	10	136
15	188th St SW & SR 99	12/4/2018 10:13:43 AM	12/4/2018 10:13:58 AM	N	REDUCE	19	08:35	10	130
15	188th St SW & SR 99	12/4/2018 10:46:13 AM	12/4/2018 10:47:03 AM	N	REDUCE	1	32:14	50	130
15	188th St SW & SR 99	12/4/2018 10:49:07 AM	12/4/2018 10:49:34 AM	N	REDUCE	37	04:27	20	150
15	188th St SW & SR 99	12/4/2018 10:55:00 AM	12/4/2018 10:55:15 AM	N	REDUCE	31	05:44	10	150
15	188th St SW & SR 99	12/4/2018 10:59:30 AM	12/4/2018 11:00:25 AM	N	REDUCE	18	12:29	50	150
15	188th St SW & SR 99	12/4/2018 11:04:01 AM	12/4/2018 11:05:00 AM	S	REDUCE	36	01:44	50	150
15	188th St SW & SR 99	12/4/2018 11:08:58 AM	12/4/2018 11:09:13 AM	N	EXTEND	14	13:48	10	150
15	188th St SW & SR 99	12/4/2018 11:09:14 AM	12/4/2018 11:10:14 AM	S	REDUCE	36	04:58	60	150
15	188th St SW & SR 99	12/4/2018 11:16:09 AM	12/4/2018 11:16:15 AM	S	NONE	0	06:40	0	150
15	188th St SW & SR 99	12/4/2018 11:18:49 AM	12/4/2018 11:19:05 AM	N	REDUCE	6	18:49	10	130
15	188th St SW & SR 99	12/4/2018 11:28:00 AM	12/4/2018 11:28:15 AM	N	REDUCE	1	08:43	10	130
15	188th St SW & SR 99	12/4/2018 11:38:41 AM	12/4/2018 11:39:30 AM	N	REDUCE	16	10:32	40	130
15	188th St SW & SR 99	12/4/2018 11:45:49 AM	12/4/2018 11:46:11 AM	N	REDUCE	11	06:10	20	130
15	188th St SW & SR 99	12/4/2018 12:11:15 PM	12/4/2018 12:11:21 PM	S	NONE	0	18:57	0	150
15	188th St SW & SR 99	12/4/2018 12:22:42 PM	12/4/2018 12:22:48 PM	S	REDUCE	24	11:17	0	150
15	188th St SW & SR 99	12/4/2018 12:23:53 PM	12/4/2018 12:24:08 PM	N	NONE	0	37:21	10	160
15	188th St SW & SR 99	12/4/2018 1:19:17 PM	12/4/2018 1:19:32 PM	N	REDUCE	3	55:06	10	144

The report displays the following information.

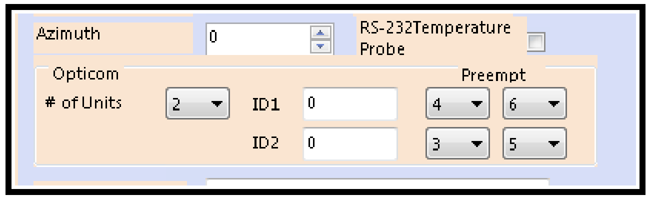
ID	is the controller ID number
Name	is the ATMS defined controller name
Start Date/Time	is the actual date and time that the transit priority request occurred.
End Date/Time	is the actual date and time that the transit priority request ended.
Direction	The direction of the transit vehicle when the transit priority request occurred
Priority (Type)	Type describes the chosen method to serve the transit vehicle within the TSD/TED parameters. The following are the reported types:

NONE	No phase reductions or extensions were required to serve the transit priority Phase(s)
REDUCE	Reduction of non-transit phases occurred. The Reduce time on the TSP report is based on the actual start time of the transit phase. This includes any reduction for TSP, as well as any time due to previous phases gapping out or getting skipped that cycle.
EXTEND	Extending the transit phases occurred. Please note that an EXTEND time of zero seconds indicates that the transit vehicle was successfully serviced during the expected window in the current cycle (i.e. **DO NOTHING** service).
LOCKOUT	Transit priority is not run because the headway timer programmed has not been exceeded.
FREE	The controller was in free operation when the transit call occurred.

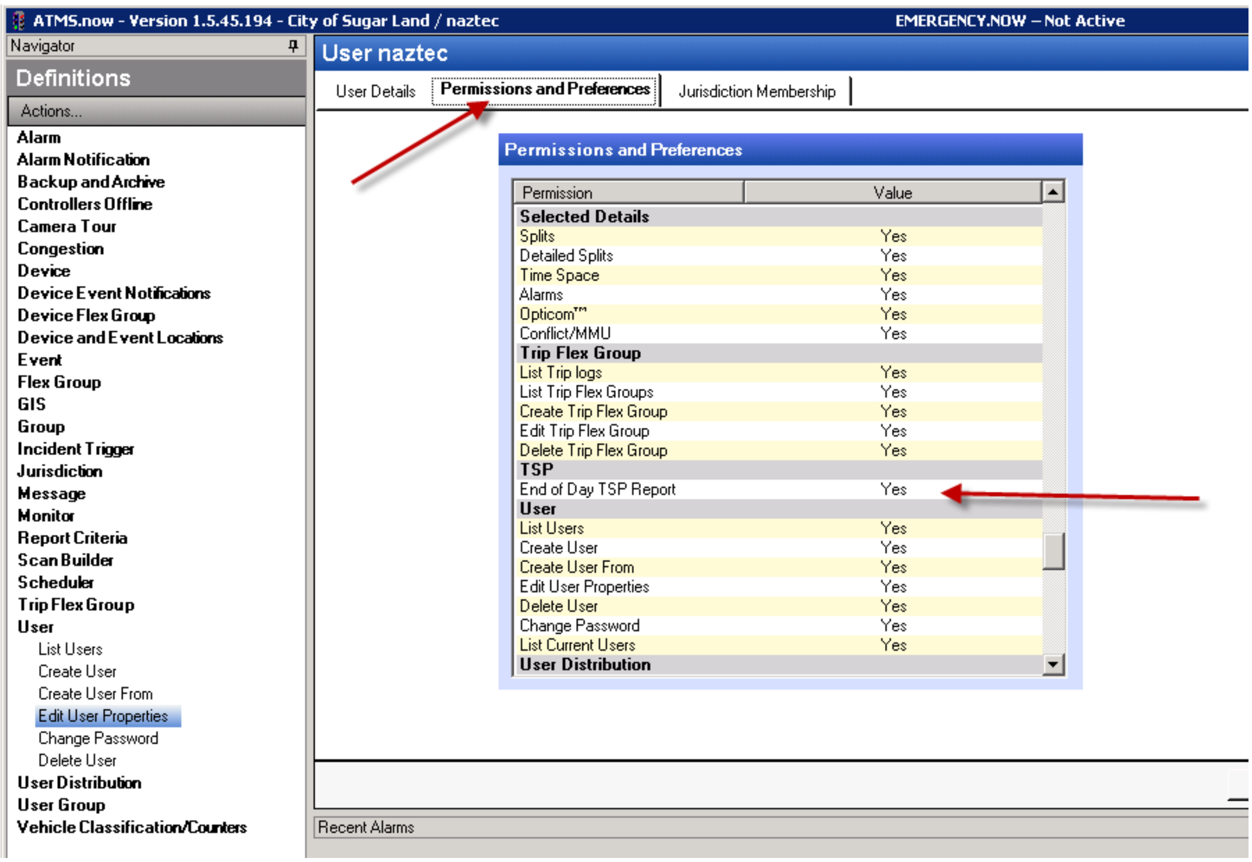
Sec	is the time that was reduced or extended in seconds
Headway	this time is displayed in minutes and seconds and indicates the time that occurred between transit priority actuations.
Red Time(Duration)	is the amount of time that occurred when the transit call was received by the controller and when the controller actually started running the transit phase. It basically displays how much time it took to get to the transit phases once the call occurred. This is displayed in seconds.
Cycle (Length)	is the coordination cycle length that was running when the transit priority request occurred. When running in FREE operation a cycle length of 30 seconds will be displayed. This is displayed in seconds.

8.6 ATMS.now End of Day TSP Report

ATMS.now also has the capability of sending designated users a daily TSP report via e-mail **if the agency utilizes Opticom Discriminator Serial cards (Models 752 / 754)**. The opticom device(s) is set up in ATMS using the controller's definition as where each unit ID and preemption direction is set.



To generate this report, the ATMS.now administrator must turn on *The End of Day TSP Report* function under the designated user's Permission and preferences as shown below:



Once this occurs the following report will be sent via e-mail to the designated user:

Transit Report - Mon Jan 30 23:30:22 2012

Bus ID 314

Intersection	Start Time	End Time	Date	Dir	Type	Secs	Headway	Red Time	Cycle
First St @ Ray - Vineyard (93)	20:52:06	20:52:39	01/30/2012	N	FREE	0	96'26"	00	030
First St @ Neal St (95)	20:49:40	20:50:57	01/30/2012	W	FREE	0	67'48"	05	030
First St @ Kottinger (94)	19:58:11	19:58:44	01/30/2012	S	FREE	0	88'51"	00	030
First St @ Kottinger (94)	16:55:30	16:55:30	01/30/2012	S	LOCKOUT	0	21'55"	00	000
Main St @ Ray St-St John St (79)	16:55:28	16:55:28	01/30/2012	S	LOCKOUT	0	0'3"	00	000
Foothill Rd @ Laurel Creek Way (3)	16:07:51	16:08:10	01/30/2012	S	FREE	0	14'4"	00	030
Foothill Rd @ Stoneridge Dr (4)	16:07:33	16:07:50	01/30/2012	W	FREE	0	14'8"	00	030
Santa Rita Rd @ Amador HS (77)	16:07:01	16:07:01	01/30/2012	S	LOCKOUT	0	0'3"	00	000
Santa Rita Rd @ Amador HS (77)	16:06:48	16:06:59	01/30/2012	S	FREE	0	185'24"	00	030
Santa Rita Rd @ Stanley-Del Valle (78)	16:06:48	16:06:58	01/30/2012	N	FREE	0	65'33"	00	030
Stoneridge Mall Rd @ Canyon Way (9)	15:59:38	16:00:19	01/30/2012	S	FREE	0	15'45"	00	030
First St @ Kottinger (94)	15:59:48	16:00:07	01/30/2012	S	REDUCE	1	63'55"	18	120

Bus ID 320

Intersection	Start Time	End Time	Date	Dir	Type	Secs	Headway	Red Time	Cycle
Santa Rita Rd @ Amador HS (77)	18:30:23	18:30:35	01/30/2012	N	FREE	0	37'38"	00	030
Santa Rita Rd @ Black Ave (76)	18:29:58	18:30:09	01/30/2012	S	FREE	0	37'50"	00	030
First St @ Kottinger (94)	18:29:27	18:29:27	01/30/2012	S	LOCKOUT	0	0'6"	00	000
Santa Rita Rd @ Valley Ave (74)	18:28:28	18:29:37	01/30/2012	S	REDUCE	4	38'15"	17	120
First St @ Kottinger (94)	18:29:03	18:29:20	01/30/2012	S	EXTEND	0	115'28"	17	120
First St @ Ray - Vineyard (93)	18:28:41	18:29:07	01/30/2012	E	REDUCE	1	115'21"	00	120
First St @ Old Stanley (92)	18:27:51	18:28:18	01/30/2012	S	FREE	0	115'26"	00	030
Stanley Blvd @ California - Reflection	18:27:15	18:27:33	01/30/2012	W	FREE	0	115'36"	00	030
Owens Dr @ W Las Positas Blvd (65)	17:20:54	17:22:01	01/30/2012	S	FREE	0	15'54"	00	030
First St @ Ray - Vineyard (93)	17:19:07	17:19:34	01/30/2012	N	EXTEND	0	41'25"	01	120
Santa Rita Rd @ Valley Ave (74)	17:21:50	17:23:19	01/30/2012	N	REDUCE	30	18'22"	12	120
Owens Dr @ East Bart Ent (46)	17:14:03	17:14:03	01/30/2012	E	LOCKOUT	0	0'3"	00	000
Owens Dr @ East Bart Ent (46)	17:13:45	17:14:01	01/30/2012	E	FREE	0	19'50"	15	030
Owens Dr @ Rosewood Dr (60)	17:19:51	17:20:09	01/30/2012	E	FREE	0	17'8"	00	030
First St @ Neal St (95)	17:17:25	17:17:25	01/30/2012	W	LOCKOUT	0	0'0"	00	000
Stanley Blvd @ California - Reflection	17:20:31	17:20:31	01/30/2012	E	LOCKOUT	0	25'23"	00	000
Santa Rita Rd @ Black Ave (76)	17:20:42	17:20:42	01/30/2012	N	LOCKOUT	0	9'1"	00	000
Santa Rita Rd @ Black Ave (76)	17:20:42	17:20:43	01/30/2012	N	FREE	0	0'0"	00	030
Santa Rita Rd @ Black Ave (76)	17:20:28	17:20:42	01/30/2012	N	FREE	0	17'59"	00	030
Foothill Rd @ Deodar Way (2)	17:20:27	17:20:27	01/30/2012	N	LOCKOUT	0	0'3"	00	000
Foothill Rd @ Deodar Way (2)	17:20:15	17:20:24	01/30/2012	N	FREE	0	20'29"	00	030
Foothill Rd @ Laurel Creek Way (3)	17:20:12	17:20:12	01/30/2012	S	LOCKOUT	0	20'4"	00	000
Foothill Rd @ Laurel Creek Way (3)	17:20:12	17:20:12	01/30/2012	S	FREE	0	0'0"	00	030
Foothill Rd @ Laurel Creek Way (3)	17:19:51	17:20:11	01/30/2012	S	FREE	0	20'22"	00	030
Santa Rita Rd @ Amador HS (77)	17:19:59	17:19:59	01/30/2012	S	LOCKOUT	0	0'3"	00	000
Santa Rita Rd @ Amador HS (77)	17:19:45	17:19:57	01/30/2012	S	FREE	0	19'9"	00	030
First St @ Old Stanley (92)	17:19:56	17:19:56	01/30/2012	N	LOCKOUT	0	0'3"	00	000
First St @ Old Stanley (92)	17:19:41	17:19:54	01/30/2012	N	FREE	0	113'36"	09	030
Foothill Rd @ Stoneridge Dr (4)	17:19:14	17:19:49	01/30/2012	W	FREE	0	11'30"	00	030
Hacienda Dr @ Owens Dr (55)	17:18:06	17:19:21	01/30/2012	E	FREE	0	15'13"	07	030
Santa Rita Rd @ Stanley-Del Valle (78)	17:19:10	17:19:10	01/30/2012	N	LOCKOUT	0	0'3"	00	000
Santa Rita Rd @ Stanley-Del Valle (78)	17:18:56	17:19:07	01/30/2012	N	FREE	0	18'52"	00	030
First St @ Kottinger (94)	17:18:13	17:18:52	01/30/2012	N	REDUCE	1	41'17"	12	120
Owens Dr @ Oracle (47)	17:17:30	17:17:50	01/30/2012	E	FREE	0	15'24"	05	030
First St @ Neal St (95)	17:17:07	17:17:20	01/30/2012	W	FREE	0	18'41"	00	120
Stoneridge Mall Rd @ Canyon Way (9)	17:14:03	17:14:03	01/30/2012	S	LOCKOUT	0	0'0"	00	000
Stoneridge Mall Rd @ Canyon Way (9)	17:13:25	17:13:25	01/30/2012	S	LOCKOUT	0	0'0"	00	000
Main St @ Ray St-St John St (79)	17:13:50	17:13:50	01/30/2012	S	LOCKOUT	0	0'2"	00	000
Main St @ Ray St-St John St (79)	17:13:28	17:13:48	01/30/2012	S	FREE	0	18'3"	19	030
Santa Rita Rd @ Stanley-Del Valle (78)	17:13:10	17:13:27	01/30/2012	S	FREE	0	19'11"	00	030
Santa Rita Rd @ Amador HS (77)	17:12:32	17:12:54	01/30/2012	N	FREE	0	19'22"	00	030
Owens Dr @ W Las Positas Blvd (65)	16:36:17	16:36:31	01/30/2012	S	FREE	0	16'34"	00	030
First St @ Kottinger (94)	16:36:20	16:36:55	01/30/2012	N	REDUCE	1	76'24"	09	120
First St @ Kottinger (94)	16:34:10	16:34:10	01/30/2012	S	LOCKOUT	0	0'35"	00	000
First St @ Neal St (95)	16:29:43	16:35:56	01/30/2012	W	FREE	0	44'45"	00	120
Owens Dr @ Rosewood Dr (60)	16:34:30	16:34:41	01/30/2012	E	FREE	0	16'22"	00	030
First St @ Kottinger (94)	16:33:14	16:33:34	01/30/2012	S	EXTEND	0	33'7"	20	120
First St @ Ray - Vineyard (93)	16:32:46	16:33:20	01/30/2012	E	REDUCE	1	97'10"	07	120
First St @ Old Stanley (92)	16:31:56	16:32:24	01/30/2012	S	FREE	0	89'3"	08	030
Stanley Blvd @ California - Reflection	16:31:23	16:31:40	01/30/2012	W	FREE	0	89'19"	00	030
Stoneridge Mall Rd @ Fabian Ct (10)	15:27:51	15:29:35	01/30/2012	E	FREE	0	12'17"	04	030
Foothill Rd @ Deodar Way (2)	15:26:59	15:26:59	01/30/2012	N	LOCKOUT	0	0'3"	00	000

8.7 TSP Updates for V85/Scout

TSP was updated as of V85.2. Below is a summary of the updates

8.7.1 TSP algorithm Updates

Prior to this release the TSP algorithm ran as follows:

1) The controller never leaves coordination during priority service. In contrast, the controller ensures to remain the coordination synchronization within one cycle.
2) Under phase reduction, the split times of the non-transit phases are decreased by the programed "MaxReduction" time to enable the early return to the transit phase. However, the force-off point of the transit phase still remains unchanged. In this case, even when the coordinator's local zero time is set to BEGGRN, the controller is still considered to be in-sync with TBC counter because the synchronization can be recovered soon at the force-off.
3) However, under phase extension, the controller stops the local counter at the force-off until the TED is reached (in ideal cases). Thus, the controller goes into out-sync status since local counter stops. When the local counter resumes at the end of the transit phase, the controller starts short-way transition to catch up the time consumed for the transit extension. The total the recoverable time that comes from the remaining non-transit phases in a cycle is calculated as follows (with an assumption that the transit phase is the coord phase):

   if Force-off of the transit phase == 0

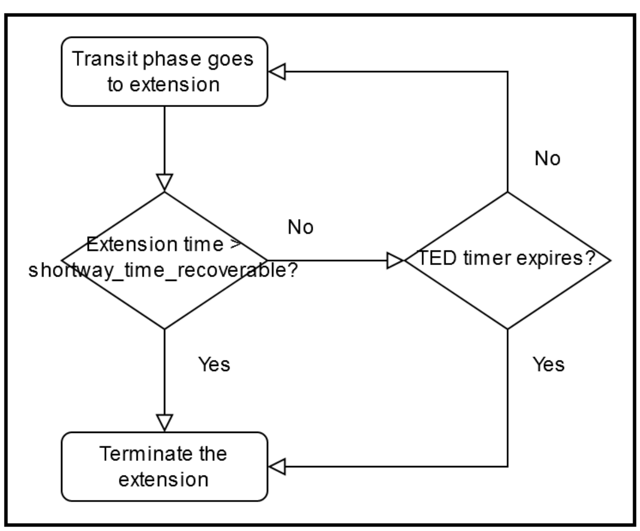
   shortway_time_recoverable = Cycle length * short-way percentage / 100;

   else

   shortway_time_recoverable = Local counter * short-way percentage / 100.

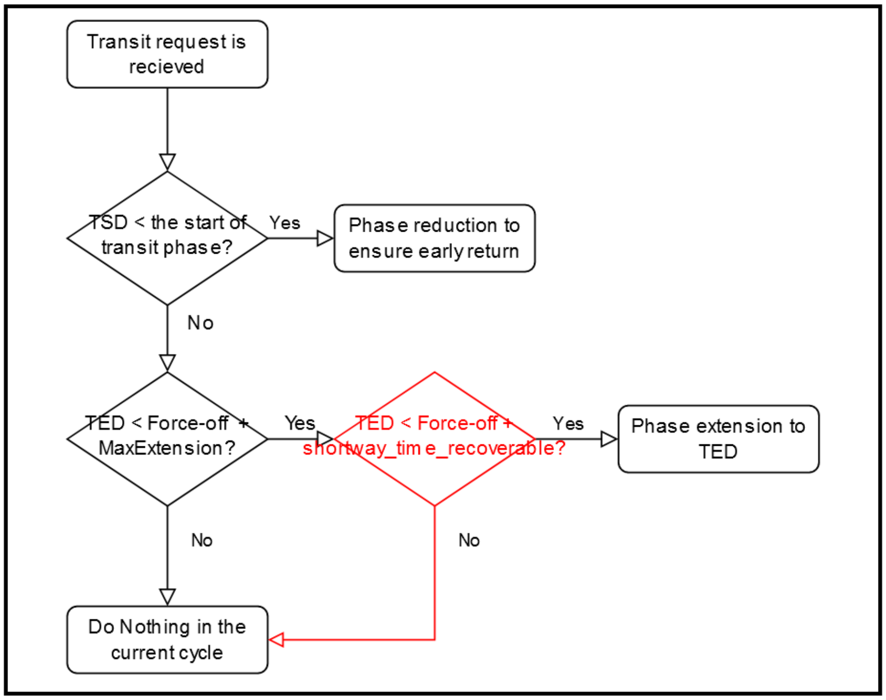
   Note: if the transit extension excels the "shortway_time_recoverable", the extension terminates anyway and the transit phase leaves the green even if the TED timer is not reached. It also means that the transit extension is allowed to be terminated within the period of MaxExtension and before TED counter going down to zero.

   The flowchart of the transit phase extension operation is illustrated as below:



As of V85.2 the algorithm was modified as follows:

1) If the TED falls within the window between the force-off point and the force-off plus MaxExtension., the algorithm will attempt to use the the MaxExtension to serve the TSP request as shown in the flowchart below:

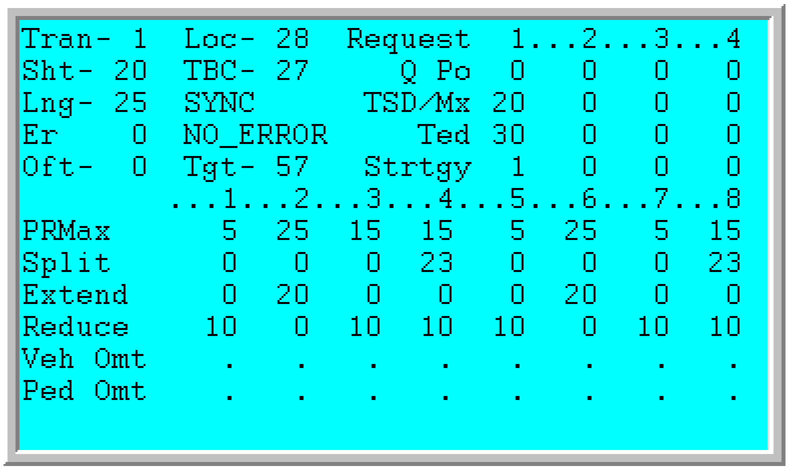


2) If the TED is projected after the Force-off plus the recoverable shortway time, the algorithm will do nothing in the current cycle. However, it will provide an early return in the next signal cycle using phase reduction.

8.7.2 TSP Status Screen Updates

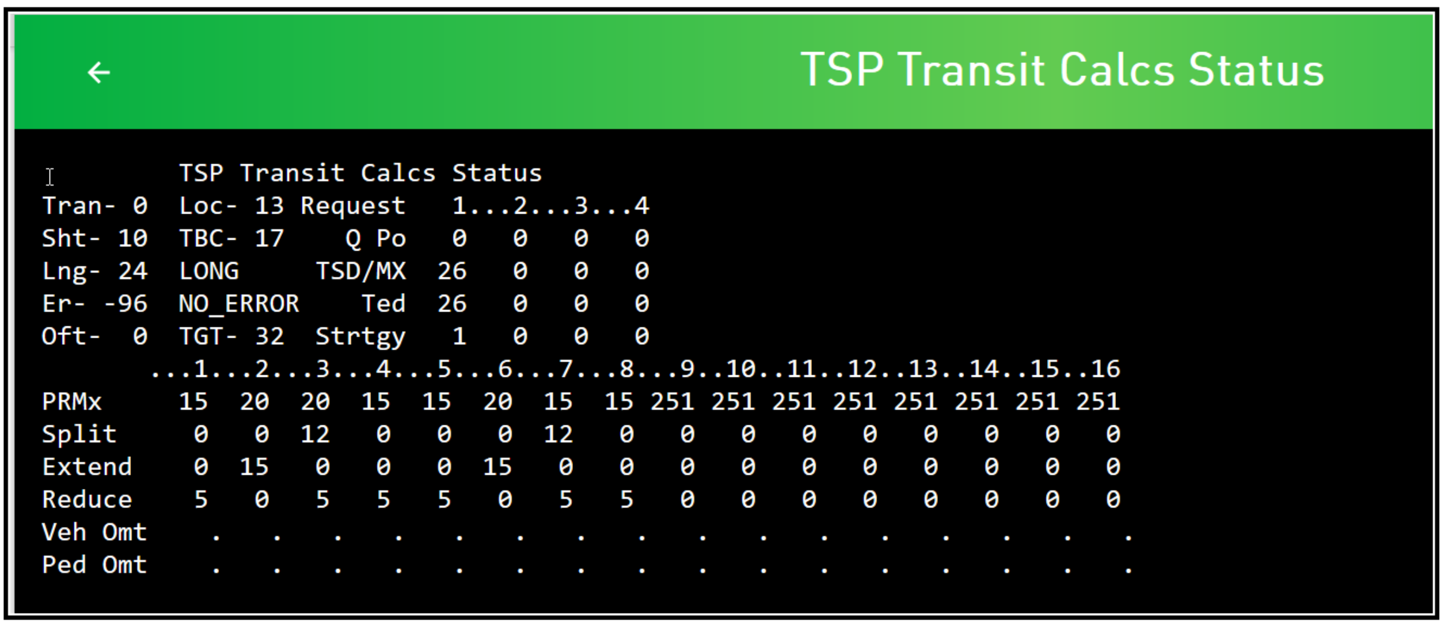
The status screen for controllers using V85.2/Scout and later have also been updated.

Classic View:



```
Tran- 1  Loc- 28  Request  1...2...3...4
Sht- 20  TBC- 27      Q Po  0   0   0   0
Lng- 25  SYNC      TSD/Mx 20   0   0   0
Er     0  NO_ERROR     Ted 30   0   0   0
Oft-   0  Tgt- 57   Strtgy  1   0   0   0
         ...1...2...3...4...5...6...7...8
PRMax       5  25  15  15   5  25   5  15
Split       0   0   0  23   0   0   0  23
Extend      0  20   0   0   0  20   0   0
Reduce     10   0  10  10  10   0  10  10
Veh Omt     .   .   .   .   .   .   .   .
Ped Omt     .   .   .   .   .   .   .   .
```

Graphical View:



```
TSP Transit Calcs Status

         TSP Transit Calcs Status
Tran- 0  Loc- 13 Request   1...2...3...4
Sht- 10  TBC- 17     Q Po   0   0   0   0
Lng- 24  LONG      TSD/MX  26   0   0   0
Er- -96  NO_ERROR     Ted  26   0   0   0
Oft-  0  TGT- 32  Strtgy    1   0   0   0
       ...1...2...3...4...5...6...7...8...9..10..11..12..13..14..15..16
PRMx     15  20  20  15  15  20  15  15 251 251 251 251 251 251 251 251
Split     0   0  12   0   0   0  12   0   0   0   0   0   0   0   0   0
Extend    0  15   0   0   0  15   0   0   0   0   0   0   0   0   0   0
Reduce    5   0   5   5   5   0   5   5   0   0   0   0   0   0   0   0
Veh Omt   .   .   .   .   .   .   .   .   .   .   .   .   .   .   .   .
Ped Omt   .   .   .   .   .   .   .   .   .   .   .   .   .   .   .   .
```

9 Summary

Cubic | Trafficware controllers implement an *NTCIP* method based on *Scenario 4* of the latest draft of NTCIP 1211- “Object Definitions for Signal Control and Prioritization”. NTCIP based phase reduce and extend times extend each split table to accomplish priority phase reduction and extension for STD8, QSeq, 8Seq and USER phase sequences. In addition, the *EZ Transit m*ethod provides an “easy” alternative for USER mode applications by applying uniform reduction and extension times using longway and shortway transition.

The *Priority Strategy Table* can be applied to either method to assign the priority service phase for each priority request and to selectively omit phases and/or pedestrian service. *TSD* (Time Service Desired) and *TED* (Time of Estimated Departure) project the arrival of the transit vehicle. *TSD*, *TED* and the *Priority Strategy Table* are assigned to each request through the split table. This approach allows the strategy to vary by pattern and by time-of-day.

Cubic | Trafficware identified 5 primary goals in the design of a transit priority system:

1. Provide the NTCIP method to reduce and extend phases with the ability to omit vehicle phases and pedestrian service from the *Priority Strategy Table.* Also, provide the ability to vary these parameters by pattern and by time-of-day.
2. Provide an *EZ* method to simplify coding for USER configurations (16 phases assigned to 4 rings)
3. Insure that minimum phase times and ring/barrier requirements for STD8, QSeq or 8Seq phase modes are not compromised without placing the responsibility for these checks on the user
4. Provide transit priority during free operation as well as coordination
5. Provide a mechanism to forward requests through the central system without adding to the communication overhead of the system

The Transit Priority system accomplishes these goals by building upon the objectives of NTCIP 1211 *Scenario 4* and providing priority service during free operation as well as coordination. Phase reduce and extend times are provided as an extension to the split table rather than assigning additional phases in the sequence. The software design insures that transit priority values supplied by the user do no fail the active coordination pattern under coordination. In addition, priority requests may be relayed to the central ATMS (StreetWise) and forwarded to downstream intersection using software triggers without adding to the communication bandwidth.

We at Cubic | Trafficware believe that the transit priority features in our controllers are easy to setup and configure, but also flexible enough to handle any application the user may require during coordination or free operation.

10 Annex

The following is excerpted from NTCIP 1211, Annex E - NTCIP Tutorial

In a Signal Control and Prioritization System, a Fleet Vehicle, Fleet Management, or Traffic Management initiates priority service by instructing the Priority Request Generator to send a Priority Request to a Priority Request Server. The Priority Request Server prioritizes and sorts all requests based upon Class Type and Class Level.

It then sends its queue of requests to the Coordinator that resides in a Traffic Signal Controller. Based upon the strategy (or strategies based upon the implementation), the Coordinator will attempt to adjust the split timing in the Coordinator to accommodate the service request(s).

Based upon pre-programmed entries, the Coordinator applies phase and ped omits, and increases or decreases non-priority phase splits to extend the priority split time up to some maximum. The following figures illustrate the operation:

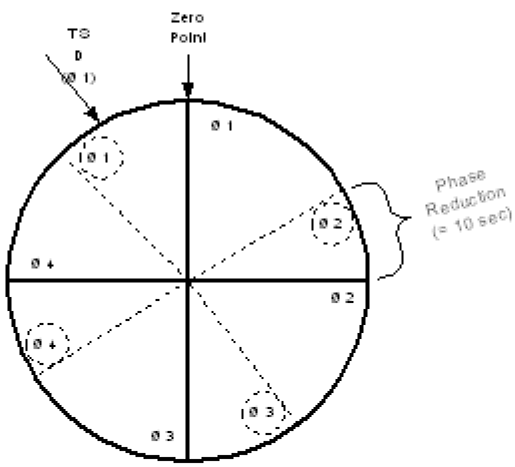


Figure E-1
Early Return to Coordinated Phase

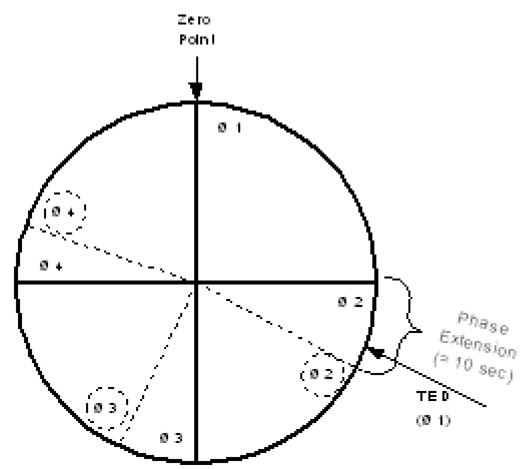


Figure E-2
Late Departure from Coordinated Phase

In the first figure, a priority request message for priority service on Phase 1 is received at some point prior to the "zero point". Projecting the priority Request Time of Service Desired (TSD) into the anticipated timing sequence, the phase 1, 2, 3 and 4 split times are reduced by the priority Strategy Maximum Reduction Time to ensure an early return to Phase 1 green at TSD. [The split times for phases 2, 3, and 4 could have also been reduced to zero (0) by application of priority Strategy Phase Omits and/or priority Strategy Ped Omits.]

All coordinator calculations that project TSD and TED into a future timing position shall be based upon the current pattern. The calculations are not required to take into consideration a future change in pattern and any transitioning to that new pattern.