AGENDA
Coordination Overview
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Platooning
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Coordinator
Background Cycle
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SEPAC Coordination
Global Setup
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Programming
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Performance Metrics
Coordination is primarily used to maintain speed, decrease stops, and decrease delays along an arterial route.
Coordination Objectives

DON’T
- Maximize coord phase bandwidth in all cases
- Create long streams of arterial traffic
- Totally sacrifice side street traffic
- Grid-lock downtown intersections

- Group traffic into platoons on arterial in most cases
- Move both arterial and side-street traffic efficiently
- Control size of platoons
- Avoid stopping platoons in most cases
Platooning

Without Platooning

16 arterial cars moved in 5 seconds,
BUT NO SIDESTREET MOVEMENT!
Platooning

With Platooning

Same 16 arterial cars in 5 seconds,
PLUS
plenty of time to move side street traffic!
Platooning

Takes 4 times as long to stop and start a platoon as it does to keep it moving!!
General Coordination Goals

Good Platooning

1) Create platoons
2) Don’t stop platoons once started
3) Control platoon size
Platooning

DOWNTOWN GRID LOCK

Platoons being stopped and/or Platoons too large
### Intersection Reference Models

Examples reference these types of intersections and the illustrated traffic flow goals during high-volume arterial flow. Note that sometimes the system goal requires stopping the arterial flow.

<table>
<thead>
<tr>
<th>Type</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>FRINGE</strong></td>
<td>Keep traffic moving somewhat equally in both directions, but as the intersections get closer to the system, increasingly favor the arterial.</td>
</tr>
<tr>
<td><strong>FEEDER</strong></td>
<td>Creation and maintenance of arterial platoons if key. Cut arterial traffic into bite-sized pieces. Do not extend coord phase or early return.</td>
</tr>
<tr>
<td><strong>CRITICAL</strong></td>
<td>Arterial platoons must proceed without stopping and starting or grid lock will occur.</td>
</tr>
<tr>
<td><strong>CROSS-ARTERIAL</strong></td>
<td>Heavy volume in all directions, so platoon progressions must also be maintained in all directions to avoid total system gridlock.</td>
</tr>
</tbody>
</table>
• Engineering studies
• Study traffic patterns
  • Times, directions, speeds
  • Size of platoons, etc.
• Result
  • Time / distance plot
  • Initial timings
  • Modes, corrections
1) Visually identify the concept of Offset and Delay
2) Understand Traffic Flow
3) Describes the relationship between the location of vehicles in a traffic stream and the time as vehicles progress along the highway

Time - Horizontal Axis
Distance - Vertical Axis
Sloping Lines - Trajectories of individual vehicles in motion
Horizontal Lines - Stationary Vehicles
Curved - Vehicles undergoing speed changes

Time-space diagrams are created by plotting the position of each vehicle, given as a distance from a reference point, against time. The first vehicle will probably start at the origin, while the vehicles that follow won't reach the reference point until slightly later times. Reductions in speed cause the slopes of the lines to flatten, while increases in speed cause the slopes to become greater. Acceleration causes the time-space curve for the accelerating vehicle to bend until the new speed is attained. Curves that cross indicate that the vehicles both shared the same position at the same time. Unless passing is permitted, crossed curves indicate collisions.
Time-Space Diagram
Time-Space Diagram for timing plan development
Time-Space Diagram for timing plan development
Important Terminology

**Coord phases**
The user can specify one coordinated phase for each ring in the controller. This will be the set of phases that the “coordinator” guarantees to be in a fixed “location” in the cycle. Please note that, depending on which coordination mode is use, the coordinated phases may extend past, or begin before, their location in the cycle, but they will always be guaranteed to be green during a specified period.

**Cycle length**
The total length of time (in seconds) that the intersection takes to make it from a particular point (beginning of coord green for example) all the way around and back to the same point.

**Permissive Period**
A period of time after the yield point where a call on a non-coordinated phase can be serviced without delaying the start of the coordinated phase.

**Yield Point**
A point in a coordinated signal operation that defines where the controller decides to terminate the coordinated phase.

**Early Return to Green**
A term used to describe the servicing of a coordinated phase in advance of its programmed begin time as a result of unused time from non-coordinated phases.

**Offset**
The time relationship between coordinated phases defined reference point and a defined master reference (master clock or sync pulse).
• **SE-PAC** (*Siemens Eagle Programmable Actuated Controller*) takes all data entry in second (or fractions of a second in some cases). It does not require the user to convert to percentage.

• Force-off points, described later, are automatically calculated.

• The coordinator, in general, is very powerful and flexible.

• The operation of coordination is consistent across the entire controller product offering.
Important Note

- While Siemens/Eagle Equipment uses the Dial/Split/Offset notation, it is NOT directly analogous to the old fixed-time dial. Any comparisons are used for convenience -- as a fixed time dial is very easy to visualize.

- Important Major differences
  - All times are in seconds in SE-PAC.
  - Each dial/split combination can have a totally different cycle length. This, in itself, effectively makes the D/S combination just a “timing plan”.
  - SE-PAC is actuated.
Timing Plans

- A timing plan consists of a unique set of data describing the movement of traffic through an intersection, relative to other intersections in the direction of coordination.

- The active timing plan (being used by the local controller) can be selected a number of different ways.

- All intersections to be coordinated together must, in general, be running the same timing plan (number) with the same cycle length.

- A timing plan does not change the order in which phases get serviced, but does changes (sometimes dramatically) the time constraints placed upon the various phases.
Equipment (and local software) produced by Siemens (Eagle), uses the terminology “Dial, Split, and Offset” to uniquely identify particular timing plans.

The regular SE-PAC software supports 4 dials and 4 splits for a total of 16 unique cycle lengths. Each of these combinations may have up to three different offsets *(explained in the next slide)* yielding a total 48 timing plans.

The NTCIP version of the SE-EPAC software supports 6 dials and 6 splits (and three offsets) for a total of 108 timing plans.
Timing Plans (Offsets)

- In coordinated operation, every intersection will reference an imaginary clock representing the cycle length.

- The moment in time in which the green for the coordinated phase begins (or ends) is determined by the value of the offset.

- The correct offset from cycle-zero for each controller is determined by the distance between the intersections and the speed at which the vehicles should be traveling. In this manner, a “Green band” is formed which allows platoons of vehicles to travel the arterial without stopping.
"Now take them big birds, Barnaby... Never eat a thing... Just sit and stare."
Within SE-PAC, the coordinator receives inputs from detectors, looks at its active timing plan, and applies force offs, holds, and omits to the otherwise “free” operation of the controller.

While this actually occurs all inside of the same software program (SE-PAC) it is helpful to think of it as two separate parts.
The “background cycle” is an “ideal model” of the cycle taking into account all things concerning cycle length, phase data, coordination data, force-off mode, and etc.

The CU runs this model in software and uses it as a reference when deciding what to do when controlling actual traffic. This is a fundamental part of the coordinator software running in the CU.

The background cycle runs internally at each CU, it does not run in the master controller or in the central system – however, these two things are able to send a signal to one, or more, CU(s) to indicate where “Cycle Zero” is supposed to occur. This will be described in detail in subsequent slides.

This is the key conceptual idea to understanding all other aspects of coordination.
In this particular example, the background cycle is 100 seconds in length, the coordinated phases begin and end concurrently, and there is no offset (i.e. the coord phases begin at cycle zero).
When an offset is used, the Cycle Zero stays in the same place in the background cycle but the beginning, or end, of the coordinated phases are delayed by a specific amount of time – the offset.
Background Cycle (Offset)
Platoon Progression

TIME 0

CYCLE = 120
COORD PHASE = 40
OFFSET = 30
OFFSET = 70
Platoon Progression

CYCLE = 120
COORD PHASE = 40
OFFSET = 30
OFFSET = 70
TIME 8
Platoon Progression

CYCLE = 120
COORD PHASE = 40
OFFSET = 30
OFFSET = 70

TIME 20
Platoon Progression

Cycle = 120
Coord Phase = 40
Offset = 30
Offset = 70

Time 30
Platoon Progression

CYCLE = 120
COORD PHASE = 40
OFFSET = 30
OFFSET = 70
TIME 40
Platoon Progression

Cycle = 120
Coord Phase = 40
Offset = 30
Offset = 70

Time 47
Platoon Progression

CYCLE = 120
COORD PHASE = 40
OFFSET = 30
OFFSET = 70

TIME 70
Platoon Progression

CYCLE = 120
COORD PHASE = 40
OFFSET = 30
OFFSET = 70
TIME 75
COORD SETUP

School for the Mechanically Declined

You

Me Again
Data that generally affects all coordination plans. Some of this data can be overridden by an active timing plan.

Used to manually run a pattern. This overrides all other forms of control.

This is where the actual coordination data is entered.

### Coordination Menu Options

1. **Setup Coord**
2. **Manual Control**
3. **Dial/Split Data**
4. **Copy Dial/Split Data**
   - **Load Default**
Global Coord Setup (Operating Mode)

Operating Mode – This controls the activation of the coordinator.

(0) – Free
The coordinator is deactivated. The CU will run free based on its phase timings.

(1) – Auto
This is the primary mode of operation for an interconnected intersection. This mode is described in the following slide

(2) – Manual
The coordinator will run whatever timing plan you specify. If the timing plan is bad, or nonexistent, the CU will run free.
Global Coord Setup (operating Mode)

Operating Mode (1) -- AUTO

When auto is selected, the coordinator will “listen” for system commands through the communications port. These can come from TACTICS or a MARC master. If present, and valid, the controller will run the plan as specified by the system.

If there is no system command – the coordinator will then look at its local time base data (TBC). If there is a valid time base command that would be applicable, it will run that plan. If there are no applicable TBC entry, the CU will run free.

In either the case of a valid system command, or a valid local time base plan -- *if the timing plan is bad, or nonexistent, the CU will run free.*

*If the CU is receiving, or ever received, a valid system command AND it stops receiving that command for a specified amount of time, it will fall back to local TBC or free, in this order. The main ring status display will indicate “BACKUP” instead of “SYSTEM.”*
Global Coord Setup (Max Mode)

Max Mode defaults to 2 when default data is loaded into the CU.

(0) – Inhibit
The maximum times in phase data are ignored. The split time (phase time in coord) is controlled by the coordination data.

(1) or (2) – Max1 or Max2 The maximum split time will be determined by the Max 1 (or Max 2) time in phase data. The programmed split time in coord data must be larger than this time.
Global Coord Setup (Max Mode)

WHY?

The entire concept of Max Mode is a holdover from the early days of internally coordinated controllers. It was primarily meant as a safeguard in case the coordinator portion of the software failed.

Today, there is no “normal” situation in which the use of anything but max inhibit is justified. This setting tends to be a potential source of problems and should usually be set to 0. However, if there is a special case where the user may need two non-coord phases in a single split, this may be used.
The offset reference is the where the offset time from cycle zero is measured to.

End of green is historically based on the operation of electromechanical controllers. Some NEMA controllers did not, and most 170 controllers do not, support beginning of green referencing. Therefore, a lot of timing plans are based on end of green coordination. This is ok, just be careful not to mix the two along the same coordinated route.
The beginning of green (cycle zero) is always the beginning of the green indication of the FIRST coord phase encountered in either ring when using “beginning of green” coordination.
The beginning of green (cycle zero) is always the beginning of the green indication of the FIRST coord phase encountered in either ring when using “beginning of green” coordination.
End of Green

The end of green (cycle zero) is always the end of the coord phase green period (beginning of yellow indication) IN RING #1 WHEN THE COORD PHASES START AT THE SAME TIME -- when using "end of green" coordination. IT DOES NOT MATTER WHICH COORD PHASE ENDS FIRST.

Example of end of green when the coord phases start at the same time, but do not end at the same time and are not up against a barrier.
The end of green (cycle zero) is always the end of the coord phase green period (beginning of yellow indication) IN RING #1 WHEN THE COORD PHASES START AT THE SAME TIME -- when using "end of green" coordination. IT DOES NOT MATTER WHICH COORD PHASE ENDS FIRST.

Example of end of green when the coord phases start at the same time, but do not end at the same time and are not up against a barrier.
The end of green (cycle zero) is always the end of the coord phase green period (beginning of yellow indication) of whichever coord phase began first (in either ring) -- when using “end of green” coordination. IT DOES NOT MATTER WHICH COORD PHASE ENDS FIRST.

Example of end of green when the coord phases do not start at the same time and are not up against a barrier.
Global Coord Setup (Force off Mode)

Force off mode
0 – Plan
1 - Cycle

The offset reference is the where the offset time from cycle zero is measured to.
In a fully saturated condition, force offs will be issued by the coordinator as needed to “force” each ring to move its currently active phase to its clearance interval. The background cycle keeps up with when these force offs need to occur.
In this case, phase 3 only runs for 10 seconds (even though it has 20 seconds of split time) and gaps out. Phase 4 and 5 max out, but are forced off by the coordinator based on the fact that they have run all of their programmed split times. The extra 10 seconds winds up being given back to the coord phase which begins early. This tends to maximize early return to green in lightly loaded conditions.
Plan Mode (Floating Force Off)

In this case, phases 3, 4, and 1 only run for 10 seconds (even though each has 20 seconds of split time) and gap out. The extra 30 seconds are given back to the coord phase which begins early – possibly excessively early.

<table>
<thead>
<tr>
<th>Phase</th>
<th>Split Time</th>
<th>Actual time</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>40</td>
<td>40</td>
</tr>
<tr>
<td>3</td>
<td>20</td>
<td>10</td>
</tr>
<tr>
<td>4</td>
<td>20</td>
<td>10</td>
</tr>
<tr>
<td>5</td>
<td>20</td>
<td>10</td>
</tr>
<tr>
<td>2</td>
<td>Early Ret</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td>(Next cycle)</td>
<td></td>
</tr>
</tbody>
</table>
In this case, phases 3 gaps out and allows phase 4 to begin. Phase 4 has constant calls, and maxes out. Unlike plan mode, it is not forced off after its programmed split time, but instead is forced off based on where its force off point falls in the background cycle. Effectively, this allows phase 3 to give its excess time to phase 4 (or any of the subsequent non coord phases) instead of back to the coord phase.
In this case, phase 3 had no calls so 2 stays green during phase three's time in the background cycle. Phase 4 and 1 have some calls, but gap out. Any remaining time is given back to the coord phase.

**Fixed Force off** – if the non coord phases do not max out, it is still possible to return to the coord phases somewhat early.
Remember that the force off mode is only relevant if there is any excess time to reallocate. Both modes work the same in a fully saturated intersection.

Plan -- floating

Floating force offs are heavily weighted towards early return to the coordinated phases.

In light traffic, this mode is useful if the goal is to stay in the coordinated phases as much as possible.

In medium density traffic, this mode ensures that no side street takes up any more than its programmed split time and returns all excess time to the coordinated phases. In other words, this is a reasonable mode to use for critical intersections where the side street traffic is either predictable, or is not favored.

This is a poor mode for forming up a platoon at fringe or feeder intersection at the beginning of a run – unless used with permissive omit.
Cycle -- Fixed

Fixed force offs are much more evenly weighted and generally allow for better servicing of the side streets in moderately heavy traffic.

In light traffic, this mode can produce highly variable results, but will result in lengthening the coord phases in the total absence of side-street traffic. If left turn traffic (in the same direction of the coord phase in a standard intersection) occurs, it will provide little, or no, early return to the coordinated phases.

In heavy, but not saturated, traffic, this mode becomes obviously useful as it allows non-coordinated phases to pass their excess time to the next set of non-coordinated phases needing it instead of returning all of it to the coord phases.

This mode can be used as a possible way to form up a platoon at a feeder intersection — especially if leading left turns are used and are expected to get some percentage of their corresponding through phase’s traffic.
Fixed force off sounds good in theory, BUT it has the following drawbacks, which can be serious:

• You cannot change the force off mode by plan, or by time of day – it is what it is – this is actually the main drawback.

• Most intersections do not have medium to high (but not saturated) density traffic all day long. These are the main two scenarios where fixed force off works well.

Because of these limitations, many agencies will use floating force off. If side street “fairness” is a concern, they will develop a number of different timing plans to optimize side street usage for different conditions. You can also use coord adaptive split (described later).
Correction Mode – Getting Back in step after a pattern change

(1) – Dwell
(2) – Max Dwell
(3) – Short Way
(4) – Short Way +
(5) – Short Way 2

All of the correction modes deal with the method that the controller used to move from one timing plan to another. Obviously, when changing between plans with cycle lengths, the size of some of the phases will have to be adjusted up or down.

In any case, a new background cycle is established, and the coordinator will adjust the currently running cycle to match the background cycle. The cycle zero points are aligned by adjusting the “rotation” of the running cycle to match the background cycle. There are several ways of accomplishing this.
Dwell (0)

The most primitive form of correction is dwell. Dwell simply waits in the coordinated phases while the background cycle counter moves forward until the cycle zero points are aligned. This takes a variable length of time, depending on where the cycle was when the process was started. It could possibly sit in the coord phases up to the entire length of the new cycle.

This method is primarily a holdover from the days of electromechanical controllers, and is almost guaranteed to generate telephone calls from irritated side street drivers. It is not recommended to use this mode.
Max Dwell (1)

This is also a holdover from the days of electromechanical controllers. It improves upon dwell by adding an “interrupter” which specifies a maximum time that the coordinator will dwell in the coord phases. When that time is expired the controller goes on, and corrects some more (if needed) in the next cycle(s).

While this is an improvement (from the viewpoint of the drivers) over dwell, it is also not recommended to use this mode.
Shortway (2)

This is the method that most Siemens equipment users choose. In most cases, it will produce complete correction in three cycles or less.

It can either add time, or subtract time, to adjust the relationship of the background cycle to the running cycle.

It will never move the offset more than 50% of the new cycle length and will limit the change to the running cycle length to no more than 18.75% per cycle.

When adding time, it adds time only to the coordinated phases. When subtracting time, it subtracts time from all phases proportional to their split times, subject to minimum times.

If the shortest path is by subtracting time, and the coordinator sees that correction cannot be achieved in five cycles, it will add time instead (go long).
Correction Modes

Shortway+ (3)

This operates the same as max dwell, but instead of the user entering a max dwell time, the coordinator automatically sets it to no more than 18.75% of the cycle time.
Shortway2 (4)

This operates the same as shortway, but instead when adding time (going long) the coordinator adds time to all phases (proportional to their split times) instead of just the coordinated phases.
MINIMUM SPLIT TIMES

Training

The Far Side
In this example: the MINIMUM split time will be the sum of the vehicle green, the vehicle yellow clearance, the vehicle red clearance, and an extra second.

**Please note:** This example assumes that the pedestrian walk and clearance equal the vehicle green time. If it is not the case (and no extended ped clearance options are used) the vehicle green will automatically be extended to fit the total ped time.
Minimum Split Times

In this example: the MINIMUM split time will be the sum of the Pedestrian walk, the pedestrian clearance, the vehicle red clearance, and an extra second.

Please note: This example assumes that the pedestrian walk and clearance are larger than the vehicle green time. No extended ped clearance options are used, so the vehicle green is extended to fit the total ped time.
In this example: By using extended pedestrian clearance option “2”, the MINIMUM split time will be the sum of the pedestrian walk, the pedestrian clearance, the vehicle red clearance, and an extra second.

Please note: This example demonstrates how to pick up a few seconds without lengthening the split time. This is somewhat controversial, and many agencies will not allow this.
In this example: By using extended pedestrian clearance option “1”, the Minimum split time will be the sum of the pedestrian walk, the pedestrian clearance, and an extra second.

Please note: This example demonstrates how to pick up a few seconds without lengthening the split time. As this technically allows pedestrians to be in the road right up until the moment that the conflicting vehicle phase turns green, most agencies will not allow this.
Minimum Split Times

Important Notes

• All volume density, including added initial and max initial are still fully functional on the non-coordinated phases when running in coordination. This can be used to your advantage, and are required in certain states on high-speed intersections, but be perfectly clear on the implications of doing this.

• The green time (as far as the split is concerned) will be either the programmed min green or somewhere between the min green and max initial (if added initial is used).

• When running in coord, you cannot have a minimum green time of less 5 seconds. If you program in less than three seconds SE-PAC will adjust it to five seconds during coordinated operation.

• Because of the minimum 5 second green, you cannot have a split time of less than 10 seconds if you run any red clearance at all. In general all splits should be 10 seconds or more.
The EPAC supports an extremely robust set of coordination modes allowing the traffic engineer to smoothly regulate traffic in practically every conceivable circumstance.

SE-PAC software supports six modes of coordination, which may be different for each timing plan if desired.

The different modes affect the following:
- The way the coordinator “looks” at detectors when determining how to leave the coordinated phase for a non-coordinated phase
- In one case, the way the non-coordinated phases return to the coordinated phases
- The way detectors on the coordinated phases are considered
- The way pedestrian movements are serviced
In the yield and permissive modes, detectors along the arterial are not considered in the operation of the intersection. The coord phases are completely non-actuated. In all of the other modes, detectors placed on the arterial may be used to affect the operation of the coordinator.
Intersection Parameters

Parameters for coordination examples

Min Green all phases: 10 Sec
Passage time all phases: 5 Sec
Yellow Change: 4 Sec
Red clearance: 1 Sec
Walk phases 2 and 6: 5 Sec
Ped Clear 2 and 6: 10 Sec

<table>
<thead>
<tr>
<th>1 (15 Sec)</th>
<th>2 (40 Sec)</th>
<th>3 (15 Sec)</th>
<th>4 (30 Sec)</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 (15 Sec)</td>
<td>6 (40 Sec)</td>
<td>7 (15 Sec)</td>
<td>8 (30 Sec)</td>
</tr>
</tbody>
</table>
Intersection Parameters

Ring 1
Ø1, Coord Phase Ø2, Ø3, Ø4

Ring 2
Ø5, Coord Phase Ø6, Ø7, Ø8
When the coord phases are active, the coordinator has certain periods where it can “see” the input from the side street detectors. The time span in which it is able to “see” a detector call and decide to leave the coordinated phase is called a “permissive” window.

While in the coordinated phases, the coordinator “opens” and “closes” the windows for the side street phases according to the mode and the position in the background cycle.
**Gap Out**
Termination of a green interval because the passage timer has reached zero. It is the termination of a green interval, before reaching the maximum green, due to lack of demand.

**Max Green**
Maximum green, the programmed maximum allowable duration of a green interval. This value is programmed for each active phase. The max green period does not begin timing until a call is received on a conflicting phase.

**Force-off**
A point within a cycle where a phase must end regardless of continued demand. These points in a coordinated cycle ensure that the coordinated phases are provided a minimum amount of green time.
“Fair is fair, Larry...We’re out of food, we drew straws—you lost.”
Yield Mode

Yield Mode Maximizes early return to coordinated phases because the windows to leave the coordinated phases for each of the non-coordinated phases ALL open at the same time.
Example 1 - Saturation

**ALL** windows open at the end of the coordinated phases

The length of each permissive window (vehicle or pedestrian) is based on being able to service the minimum green times for each phase.

In this example, all phase windows (for phases 3&7, 4&8, 1&5) open immediately before the beginning of the clearance interval for the coord phases. There are already vehicle detector calls on phases 3&7, so the coordinator decides to leave the coord phases. The 2&6 clearance intervals run and service passes to phases 3&7.
Example 2 – No Calls on 3&7, Cycle Force Off, Max Inhibit

ALL windows open at the end of the coordinated phases

In this example, all the permissive windows (for phases 3&7, 4&8, 1&5) open immediately before the beginning of the clearance interval for the coord phases. Since there are no vehicle detector calls on phases 3&7 and there are on 4&8 so the coordinator will leave the coord phases. The 2&6 clearance intervals run and service passes to phases 4&8.

The force off for phases 4&8 will occur at 80 seconds (2&6 split=40 sec, 3&7 split=15 sec, 4&8 split=30 sec minus 5 Y&R Clearance=5 sec.

Ø4/8 Force Off-Cycle
Ø1/5 Force Off-C/P
**Yield Mode**

Example 3 – No calls phase 3&7, Plan Force Off, Max Inhibit

**ALL** windows open at the end of the coordinated phases

In this example, all the permissive windows (for phases 3&7, 4&8, 1&5) open immediately before the beginning of the clearance interval for the coord phases. Since there are no vehicle detector calls on phases 3&7 and there are on 4&8 so the coordinator will leave the coord phases. The 2&6 clearance intervals run and service passes to phases 4&8. The force off for phases 4&8 will occur at 65 seconds (2&6 split=40 sec, 4&8 split=30 sec minus 5 Y&R Clearance=5 sec.

<table>
<thead>
<tr>
<th>CALLS</th>
<th>VEH</th>
<th>PED</th>
</tr>
</thead>
<tbody>
<tr>
<td>3+7</td>
<td>3+7</td>
<td>3+7</td>
</tr>
<tr>
<td>4+8</td>
<td>4+8</td>
<td>4+8</td>
</tr>
<tr>
<td>1+5</td>
<td>1+5</td>
<td>1+5</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>PHASE</th>
<th>PROG SPLIT</th>
<th>CYCLE TIME COUNTDOWN</th>
</tr>
</thead>
<tbody>
<tr>
<td>VEHICLE PED</td>
<td>WALK</td>
<td>FDW</td>
</tr>
<tr>
<td>Coord 2+6</td>
<td>MIN</td>
<td>MIN</td>
</tr>
</tbody>
</table>

**PERMISSIVE WINDOWS**

<table>
<thead>
<tr>
<th>Coord 2+6</th>
<th>4+8 30 Sec</th>
<th>1+5 15 Sec</th>
<th>2+6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ø4/8 Force Off-Plan</td>
<td>Ø1/5 Force Off-Plan</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The 2&6 clearance intervals run and service passes to phases 4&8. The force off for phases 4&8 will occur at 65 seconds (2&6 split=40 sec, 4&8 split=30 sec minus 5 Y&R Clearance=5 sec.
Example 4 – No Calls on 3&7, Cycle Force Off, Max2

ALL windows open at the end of the coordinated phases

In this example, all the permissive windows (for phases 3&7, 4&8, 1&5) open immediately before the beginning of the clearance interval for the coord phases. Since there are no vehicle detector calls on phases 3&7 and there are on 4&8 so the coordinator will leave the coord phases. The 2&6 clearance intervals run and service passes to phases 4&8. The force off for phases 4&8 doesn’t occur until 80 seconds (2&6 split=40 sec, 3&7 split=15 sec, 4&8 split=30 sec minus 5 Y&R Clearance=5 sec. HOWEVER phases 4&8 will max out before the force off occurs.

Max 2 settings
Phase 4/8 – 30 seconds
Phase 1/5 – 20 seconds
Example 5 – No Calls on 3&7, 4&8 Late call on 1+5, Cycle Force Off, Max Inhibit
Example 6 – Splitting unused exclusive pedestrian time between multiple phases

Phase 1 main St – 50 second split
Phase 2 Exclusive ped – 20 second split
Phase 3 Side St – 30 second split, 35 second Max

With Pedestrian

<table>
<thead>
<tr>
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<th>5</th>
<th>10</th>
<th>15</th>
<th>20</th>
<th>25</th>
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<th>35</th>
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<tr>
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<td>Ø3</td>
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<tr>
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<td>FDW</td>
<td>DW</td>
<td>WALK</td>
<td>FDW</td>
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Without Pedestrian

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<tbody>
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<td>COUNTDOWN</td>
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<tr>
<td>PROG SPLIT</td>
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<td>Ø3</td>
<td>Ø1</td>
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<tr>
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<td>Ø1</td>
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</tbody>
</table>
Dogs and alcohol: The tragic untold story.
Permissive mode is the most commonly used coordination mode in the EPAC. Its operation also forms the foundation of four of the other coordination modes. It would be impossible to understand coordination as implemented in the EPAC without understanding permissive, so we will go into its operation in some detail.
General Behavior
The Coord phases are non-actuated. The non-coordinated phases are actuated. The Permissive windows occur at fixed points in the cycle. The coord phases are extended until first window with call. Once the coord phases are terminated, the non-coord phases are handled normally in sequence – minimum green and volume density applies. Once the non-coord phases are serviced in sequence the coord phase might be able to return early if there is left over in the cycle.

Pedestrian Behavior
The Coord phase peds are non-actuated. Coord phase peds will be serviced, time normally, and rest in DW if the vehicle coord phase is extended. If the coord phases return early, then the coord peds will dwell in Walk during the early period, then begin timing normally at cycle 0. The non-coordinated phase peds will be serviced when actuation is sensed during ped permissive window for that phase.

Miscellaneous
Min green or volume density max initial (basic phase data) is used in calculating minimum vehicle service time (shown as “MIN” in the graph). “Oversized” peds will never be forced off once triggered, even if they exceed the split time.

When To Use
Good for most medium to heavy flows where you want to increase coord phase time if there is low turn traffic; also where 4+8 traffic is platooned and doesn't arrive until the permissive window opens. This is not a good mode for downtown areas when low side-street volume allows long coord times that can cause grid lock at adjacent intersections. Don't use when trying to create platoons and feed them into a critical system – see permissive omit.

Cautions
Can cause system grid lock when side-street traffic is light. In saturated scenarios, oversized peds will force correction cycles – i.e. loss of coordination and inability to correct for long periods, eventually dropping out of coord completely.
Non-saturated condition *(in saturation, all phases simply run their split time)*

The placement of the windows is fixed based on where the clearance would normally begin for each phase in the background cycle.

The length of each permissive window (vehicle or pedestrian) is based on being able to service the minimum green times for each phase.

In this example, the first permissive windows (for phases 3&7) open immediately before the beginning of the clearance interval for the coord phases. There are already vehicle detector calls on phases 3&7, so the coordinator decides to leave the coord phases. So the 2&6 clearance intervals run and service passes to phases 3&7.
In this example, there are no calls on 3&7 or 1&5.

Permissive Mode

The 3&7 permissive windows open and close with no calls.

The coordinator extends 2&6 until the next permissive windows opens.

The coordinator looks through the 4&8 permissive windows and sees calls. The coordinator decides to leave the coord phases, the clearance intervals run, and 4&8 become active.

The excess time (from 3&7) is given back to the coord phases, which begin early.

The excess time (from 3&7) is given back to the coord phases, which begin early.

A

The 3&7 permissive windows open and close with no calls.

B

The coordinator extends 2&6 until the next permissive windows opens.

C

The coordinator looks through the 4&8 permissive windows and sees calls. The coordinator decides to leave the coord phases, the clearance intervals run, and 4&8 become active.

D

The excess time (from 3&7) is given back to the coord phases, which begin early.
3&7 and 4&8 have minimal calls and gap out.
1&5 has constant calls and begins early.
Due to the plan force mode, it gets forced off after its programmed split time.

In this example 1&5 could have used the extra time from the proceeding non-coordinated phases but doesn’t get it. The time goes, instead, back to the coord phases.
3&7 and 4&8 have minimal calls and gap out. 1&5 has constant calls and begins early. Due to the cycle force mode, it does not terminate until its force off point in the background cycle.

In this example 1&5 gets the extra time from the proceeding non-coordinated phases because it needs it.
PERMISSIVE YIELD MODE (2)

OH, DON'T BE SUCH A CYNIC. I'M SURE THE GOVERNMENT HAS A PERFECTLY GOOD REASON, AND THAT IT'S FOR OUR OWN GOOD.
Permissive Yield Mode

**General Behavior**
This mode is very similar to the standard permissive mode except for the following:

Towards the end of the split time in the coord phases, just before the first permissive window opens (when not going short during an offset correction) the coordinator starts looking at the vehicle detectors associated with the coordinated phases. If there are calls on the coordinated phases, the coordinator can extend the coordinated phases by a certain amount of time. Volume density gap reduction works during this period as if the phases were fully actuated.

**Pedestrian Behavior**
The coord pedestrian movements are actuated and do not automatically run with the vehicle coord phases. If they are required to run every cycle then they must be recalled. The non-coordinated phase peds will be serviced when actuation is sensed during ped permissive window for that phase.

**Miscellaneous**
The extension time for the coordinated phase can be calculated two different ways:
- If the cycle length is equal to the sum of the splits, the extension period will essentially “steal” time from the side streets down to their minimums.

- If you enter a cycle length longer than the sum of the splits, then the coordinator will proportionally distribute the “extra” time to the non-coordinated phases. The coord phases can then “steal” this extra time as possible extension time. If the coord phases do not need this time, then it can be used by the non-coord phases.
Permissive Yield Mode

When To Use
Good for intersections where platoon movements are nearly coincidental, not sequential. If the platoons are sequential, then enough time should be programmed in the coordinated phase to allow the late platoon to fit within the normal green (not the extended part).

The real advantage of this mode is that it allows a very short cycle length (by programmed split times) that is extendable (by programming in a larger cycle length value). This effectively develops “virtual” splits among the different phases allowing actual demand to be serviced -- while still ensuring that you will be back in the coord phases on time.

This mode is especially useful in off peak periods, where it is desirable to run the lowest cycle length possible while still maintaining coordination.

Cautions
Try not to extend the coord phase to the point where it causes excessive backup at adjacent intersections.

Also note: if non-coordinated phase demand is light and pattern is set to handle heavy non-coordinated phase demand, the excess early release of coordinated phase may cause problems.
Permissive Yield Mode

No additional cycle time programmed

Coord Phases 2&6 run normally

Coord phases detectors become active. Calls are observed, so the coord phases are extended. The extension time is "stolen" from the side streets.

Even though there are constant calls on the non-coordinated phases, the coord phases have stolen all but their minimum time, so they are effectively shortchanged.
Permissive Yield Mode

Additional cycle time programmed

Coord phases detectors become active. One calls is observed, the passage time is 3 seconds, so the coord phases are extended slightly an gap out. 1 second is “stolen” from the side streets.

Even though there are constant calls on the non coordinated phases, the coord phases have stolen all but their minimum time, so they are effectively shortchanged.

<table>
<thead>
<tr>
<th>Phase</th>
<th>Prog Split</th>
<th>Virtual Split</th>
<th>Time after coord ext</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
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</tr>
<tr>
<td>3</td>
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</tr>
<tr>
<td>5</td>
<td>20</td>
<td>26</td>
<td>25</td>
</tr>
</tbody>
</table>

Sum of splits = 84
Cycle length = 100

Coord Phases 2&6 run normally

Coord 2+6

Coord 3+7:

Coord 4+8:

Coord 1+5:
Permissive Omit Mode

**General Behavior**
This mode is very similar to the standard permissive yield mode (PYP period, virtual splits, and etc.) except for the following:

In single ring configurations, the coordinated phase, once terminated to service a call, will not occur again until the last permissive is over. In dual ring configurations, the coordinated phase, once terminated to service a call, will not occur again until servicing a phase in the coordinated phase sub-cluster, or after the last permissive. Further, any actuated phases in the coordinated phase sub-cluster which precede a coordinated phase shall not be serviced prior to their normal time in the background cycle.

What did this just say? What's a sub-cluster? Actually, what is a cluster for that matter?

**Pedestrian Behavior**
The coord pedestrian movements are actuated and do not automatically run with the vehicle coord phases. If they are required to run every cycle then they must be recalled.
The non-coordinated phase peds will be serviced when actuation is sensed during ped permissive window for that phase.
These two rings are locked together by common barriers (as defined in the compatibility area of the ring structure). Two, or more, rings interlocked like this form a "cluster".

This is a very simple example with only two rings. Keep in mind that barriers can shift with each set of phases that become active (which is difficult to represent visually).

Also the EPAC supports four rings, so the combinations can quickly become non-trivial.

The phases in between barriers that are part of two, or more, rings in a cluster are called a sub-cluster.
When To Use
Applications where side street demand is sporadic or complaints are received concerning excessive delay are where this mode excels. During AM start up coordination, patterns are normally started 15 to 30 minutes prior to the start of flow generation to allow sync of the whole system. At these times traffic is also sporadic at side streets and some cycles non-existent. The use of recalls places excessive delay on the coordinated phase(s) without warrant. But release to side street on demand holds the phase after the vehicle like a sloppy passage time selection or a hung detector without recall. This allows side street traffic to get a call at the last possible point in cycle or maintain the Green after a minimum service call. The coordinated phase(s) do not experience excess delay since the demand is from an adjacent intersection or early release platoon that will be in step after one stop.

The main use of this mode is at fringe or feeder intersections when it is desirable to stop all early arrivers (and stragglers) in order to form up a platoon for the beginning of a run. This needs to be done at an intersection that does not have side-street demand at critical levels. Older designs used dual-coord functions to accomplish this operation, leading to complaints of terminating the main street when there was no demand on the side streets. This mode avoids this problem by requiring at least one call on the side street in order to terminate the coord phases.

Cautions
Understand the implications and operation of this mode before using it in a design.
3&7 has minimal calls and gaps out. 1&5 has a call, but cannot be serviced prior to its time in the background cycle. Consequently, the controller dwells in 3&7 until 1&5 can be serviced. 1&5 runs its minimum time and the remaining time (1&5's remaining time).

In this example 1&5 could have used the extra time from the proceeding non-coordinated phases but doesn't get it. This small amount of time goes, instead, back to the coord phases.

### Permissive Omit Mode

<table>
<thead>
<tr>
<th>CYCLE TIME COUNTDOWN</th>
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<th>90</th>
<th>85</th>
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</table>

<table>
<thead>
<tr>
<th>PROG SPLIT</th>
<th>Coord 2+6: 40 seconds</th>
<th>3+7: dwell</th>
<th>1+5: 15 sec</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
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<th>PYP</th>
<th>MIN</th>
<th>Coord 2+6</th>
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<tbody>
<tr>
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<td>FDW</td>
<td>DW</td>
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</tbody>
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<table>
<thead>
<tr>
<th>CALLS</th>
<th>2+6 N/A</th>
<th>3+7</th>
<th>4+8</th>
<th>1+5</th>
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</thead>
<tbody>
<tr>
<td>VEH</td>
<td>ped</td>
<td>ped</td>
<td>ped</td>
<td>ped</td>
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<tr>
<td>PED</td>
<td>ped</td>
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</table>
Permissive Omit Mode

Coord Phases 2&6 run normally and are extended

An omit is applied to the coordinated phase during this entire period

The call on 3&7 is serviced.

Calls on 1&5 are not seen until here. 1&5 runs and gaps out

<table>
<thead>
<tr>
<th>Cycle Time Countdown</th>
<th>Coord 2+6: 40 seconds</th>
<th>3+7: dwell</th>
<th>1+5: 15 sec</th>
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<td>3+7</td>
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<td>31-40</td>
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Coord Phases 2&6 run normally and are extended.

An omit is applied to the coordinated phase during this entire period.

The call on 3&7 is serviced.

Calls on 1&5 are not seen until here. 1&5 runs and gaps out.

<table>
<thead>
<tr>
<th>Prog Split</th>
<th>Coord 2+6</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>3+7</td>
</tr>
</tbody>
</table>

2+6 N/A

Permissive Omit Mode

Calls on 1&5 are not seen until here. 1&5 runs and gaps out.

The call on 3&7 is serviced.
SEQUELNTIAL OMIT MODE (4)
Sequential Omit Mode

Sequential omit works just like permissive omit, except each permissive window opens coincidentally with the closing of the prior one.

This allows the coordinator extend the coordinated phase, but to also see and service calls without the potentially long gaps that are usually present in the permissive yield mode.

The coord peds are fully actuated. This mode cannot be used with more than two rings in a cluster.
FULLY ACTUATED MODE (5)
**General Behavior**
This mode is very similar to the standard permissive yield mode (PYP period, virtual splits, and etc.) except for the following:

Following the Permissive Yield Period, any phase may be served in the standard sequence provided the permissive period for that phase has not expired. Following the Permissive Yield Period, any phase may be re-serviced in the standard sequence provided the permissive period for that phase has not expired. Following the Permissive Yield Period and prior to the end of the permissive for the phase before the first coordinated phase, the coordinated phase shall operate as a actuated phase.

**Pedestrian Behavior**
The coord pedestrian movements are actuated and do not automatically run with the vehicle coord phases. If they are required to run every cycle then they must be recalled.

The non-coordinated phase peds will be serviced when actuation is sensed during ped permissive window for that phase. This mode cannot be used in units running with no more than two rings in a cluster.
Fully Actuated Mode – Vehicle demand on 2&6

**ALL** windows open at the end of the coordinated phases (A) controller will look to see if there is demand on 2&6. If there is it will time up the yield period (B). It will steal the time from all other phases.

If no demand at point A the controller will act as Yield Mode

Coord Phases 2&6 run normally

Coord phases detectors become active. Calls are observed, so the coord phases are extended. The extension time is “stolen” from the side streets.
**FULLY ACTUATED MODE – PEDESTRIAN DEMAND ON 2&6**

**ALL** windows open at the end of the coordinated phases (A) controller will look to see if there is demand on 2&6. If there is it will time up the yield period (B). It will steal the time from all other phases.

If no demand at point A the controller will act as Yield Mode

Coord Phases 2&6 run normally

Coord phases detectors become active. Calls are observed, so the coord phases are extended. The extension time is “stolen” from the side streets.

![Diagram of traffic signal cycles](image-url)
Coordinated Adaptive Split

Is it a coord mode?
Coord adaptive split is not a coordination mode. It is a modifier that can be potentially placed upon any of the coord modes.

Coord adaptive split ONLY AFFECTS NON-COORDINATED PHASES.

What it does
The operation is fairly simple; CAS keeps a running table of the gap-outs and max outs of non-coordinated phases. It redistributes small amounts of time between non-coord phases according to demand. This is different than the “virtual split” concept found in some of the permissive modes.

Here are the rules:
If a phase gaps out twice in a row, with more than one second left, then it is designated as a “giving phase”.
If a phase maxes out twice in a row, with more than one second left, then it is designated as a “wanting phase”.

When more phase(s) are Wanting (forced) than are Giving (gapped), then time will distributed based on the number of cycles the phase has been Wanting.
When more phase(s) are Giving than are Wanting, then time will be taken from the lowest number of Giving phase. Time is only reallocated among the phases, the cycle length is never changed.

There are a few more found in the manual, but this should give you the idea.
**Background Cycle Monitoring**

<table>
<thead>
<tr>
<th>EPAC ACTIVE STATUS</th>
<th>PRESS # DESIRED</th>
</tr>
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<tbody>
<tr>
<td>1 - RING TIMERS</td>
<td>6 - DETECTORS</td>
</tr>
<tr>
<td>2 - COORD TIMERS</td>
<td>7 - INTERSECTION</td>
</tr>
<tr>
<td>3 - PREEMPT TIMERS</td>
<td>8 - PORT 1/ITS FRAMES</td>
</tr>
<tr>
<td>4 - TIME BASE</td>
<td>9 - INPUT / OUTPUT</td>
</tr>
<tr>
<td>5 - COMMUNICATIONS</td>
<td>0 - MMU MONITORING</td>
</tr>
<tr>
<td></td>
<td>F - PRI OR MENU</td>
</tr>
</tbody>
</table>

Press 2 (COORD TIMERS)
## Background Cycle Monitoring

### Current Plan

**STATUS**
- TIME BASE: BACKUP
- INTERCONN: MANUAL
- SYSTEM: STANDBY

**COORD MODES**
- PRM – Permissive
- PYL - Permissive Yield
- SOM - Sequential Omit

**MAX MODES**
- INH - Max Inhibited
- MX1 - Max 1
- MX2 - Max 2

**FORCE OFF MODES**
- PAT - Time In Pattern
- CYC - Time In Cycle
- OTHER
- AS - Adaptive Split

**OFFSET MODES**
- BEG - Beginning Of Green
- END - End Of Green

### Time Base - 2/2/3 > YLD/INH/END/CYC

<table>
<thead>
<tr>
<th>CYC</th>
<th>OFF</th>
<th>RING</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
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</thead>
<tbody>
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<td>100</td>
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<tr>
<td>62</td>
<td>1</td>
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</tr>
<tr>
<td>-10</td>
<td>010</td>
<td>ADJUST</td>
<td>05</td>
<td>05</td>
<td></td>
<td></td>
</tr>
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</table>

SYNC: 090 PHE 2-1 6-1
CORR: SW PERM 3-P 7-P
Background Cycle Monitoring

<table>
<thead>
<tr>
<th>Cycle length</th>
<th>Point in cycle</th>
</tr>
</thead>
<tbody>
<tr>
<td>Programmed split times for phases in the background cycle</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Phase in Background cycle</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phase timer for current phase in background cycle</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Permissive status</th>
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</thead>
</table>

<table>
<thead>
<tr>
<th>EPAC COORD TIMERS</th>
<th>F-PRI OR MENU</th>
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<tbody>
<tr>
<td>TIME BASE - 2/2/3</td>
<td>YLD/INH/END/CYC</td>
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<tr>
<td>CYC OFF RING......</td>
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<tr>
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<tr>
<td>-10 010 ADJUST 05 05</td>
<td></td>
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<tr>
<td>SYNC:090 PHSE 2-1 6-1</td>
<td></td>
</tr>
<tr>
<td>CORR:SW PERM 3-P 7-P</td>
<td></td>
</tr>
</tbody>
</table>
Adjustment this Cycle
System Cycle count up
Correction Mode in Effect
From the Main Menu 6 Coord Data

COORD DATA

1-SETUP COORD
2-MANUAL CONTROL
3-DIAL/SPLIT DATA
4-COPY DIAL/SPLIT
D-LOAD DEFAULT

EPAC DIAL/SPLIT
DIAL: 1 SPLIT: 1 LEVEL: 1
CYCLE LENGTH : 0
ENTER A DIAL, SPLIT, & LEVEL #
CYCLE - PHASES : 0
LEVEL CODE:
1-OFFSET+SEQUENCE  2-PH TIME+MODE
<table>
<thead>
<tr>
<th>Offset</th>
<th>Alternate</th>
<th>Pattern</th>
<th>Max</th>
<th>Coord</th>
<th>Special</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time</td>
<td>Sequence</td>
<td>Mode</td>
<td>Mode</td>
<td>Mode</td>
<td>Function</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>DIAL 1 SPLIT 1 PARAMETERS</th>
</tr>
</thead>
<tbody>
<tr>
<td>PAT - O T I M A L T PAT MAX COR S P R 2 R 3 R 4</td>
</tr>
<tr>
<td>#   #   SEC SEQ MOD MOD MOD MOD FN LAG LAG LAG</td>
</tr>
<tr>
<td>002-1 0 0 0 0 0 0 0</td>
</tr>
<tr>
<td>002-2 0 0 0 0 0 0 0</td>
</tr>
<tr>
<td>002-3 0 0 0 0 0 0 0</td>
</tr>
</tbody>
</table>
Coordination Programming - Splits

From the Main Menu 6 Coord Data

COORD DATA
1-SETUP COORD
2-MANUAL CONTROL
3-DIAL/SPLIT DATA
4-COPY DIAL/SPLIT
D-LOAD DEFAULT

EPAC DIAL/SPLIT
DIAL: 1 SPLIT: 1 LEVEL: 2
CYCLE LENGTH : 0
ENTER A DIAL, SPLIT, & LEVEL #
CYCLE - PHASES : 0
LEVEL CODE:
1-OFFSET+SEQUENCE 2-PH TIME+MODE
Coordination Programming

_modes_

(0) – Actuated Phase
(1) – Coordinated Phase
(2) – Vehicle Recall
(3) – Max Recall
(4) – Ped Recall
(5) – Max/Ped Recall
(6) – Phase Omit
(7) – Dual Coordinated Phase
Timing programs are evaluated prior to being set to control coordination. Valid programs must have:

- A cycle length equal to or greater than the sum of Ring 1 phase times, and
- A coord phase in the first ring in each cluster and the other rings in the same cluster that have a compatible phase must also have a coord phase, and

Phase times greater than the minimum service requirement that is:
- On actuated (non-coord) phases equal to the vehicle minimum service
- On coord phases as follows
  - For perm yield, perm omit, seq omit, and full act modes equal to the vehicle minimum service
  - For perm and yield modes equal to the pedestrian and vehicle minimum service

Split Times must be equal to or greater than Min Grn + Yel Clr + Red Clr + 1 sec

Phase modes set to six when the phase time equals zero on active phases.
Dual Coordinated Phases

What is this?

Sometimes when you have major crossing arterials that are both coordinated, it is advantageous to try to include the crossing intersection in both coordination schemes.

The EPAC coordinator does not allow more than one coordinated phase in any ring, nor would this really make any sense, because in all likelihood, one of the systems will have a different cycle length than the other.

However, the coordinator does provide a way to specify that a second set of (non-coord) phases should be non-actuated and always be green during a certain time in the background cycle. They may begin early, but will stay on for their full allocated “slice” of the background cycle. Using this, it is possible to make a green-band “hole” for the platoons on the other arterial to fit through.

This has obvious limitations, but it is far better than nothing at all.

If you have a two phase (or possibly four phase) intersection with one phase being the coord phase and the other being a dual-cord phase, then the intersection will run as a fixed time intersection. This is a useful bit of knowledge for certain downtown grids.
In this example, the side street ped movement is going to require a lot more time than the associated vehicle phase. This will result in an excessive amount of the overall split being allocated to a ped movement.
Example situation

what can be done?

There are two choices in this example situation:

1. Based on the rules governing minimum split times, the timing engineer can allocate enough split time for the side street to cover the pedestrian time and preserve coordination. If the peds are actuated and there is no ped call, the vehicle phase might gap out and the return the excess time to the coordinated phases. However, this can also result in an undesirably long time until the next permissive window is seen resulting in excessive dwell in the coord phase – (this is explained later). Please note: this depends on the cord mode, the peds not being on recall, and etc.

2. The timing engineer can program in more ped time than will actually fit in the split time. If the ped is called, the intersection will drop out of coordination, service the ped movement, and return to coordination using whatever transition method is specified. This might be an acceptable choice for intersections (like the one on the previous slide) provided that the ped calls are infrequent – perhaps a few times a day.
In this example: The pedestrian movement will be longer than the programmed split time. This will work, but will cause the coordinator to drop out of coordination when the ped is called. A transition back into coordination will have to occur.

Please note: This example demonstrates how an infrequently used pedestrian movement (usually associated with a minor side street crossing a major arterial) might be handled.
Cautions

• The timing engineer will have to make a determination about the value of staying in coordination, the number of times a day that the ped movement is called, the coord mode used, and the overall effect on traffic of dropping out of coord occasionally.

• This cannot be done on a ped movement associated with a coord phase in yield or permissive modes as they have non-actuated peds (this would cause the coordinator to fail every cycle). This is mostly an academic concern as the coordinated phase is usually the wider street. Note: if you have problems running a coordination plan, this is an area to check for programming problems.

• The ped movement cannot be placed on recall, it must have a working push button.
Innovative Controller Applications

Topics

Large Pedestrian Clearance Times

Green Band Optimization

Heavy Rail Preemption

Minor Intersection Coordination

Ramp Queue Management
Use Partial Priority Routine

Assign Ped Detector to Priority Routine

Extends Assigned Phase

Reduces Split Timing of Unassigned Phases

PRED (Phase Reduction): Seconds phase will be reduced with priority call

PEXT (Phase Extend Seconds): Phase will be extended with priority call. This is the total of all PRED times
Green Band Optimization

Use Priority Routine

   Early Return to Green

   Platoon Detection and Peer-to-Peer to inform Downstream Intersection of Early Return to Green

   Downstream Intersection uses Peer event to trigger Priority Routine
Heavy Rail Preemption

Peer the Heavy Rail Preempt between intersections

Follow the Rail Preempt with a Priority Routine to flush the Queues
Minor Intersections

Set Minor Intersection Free

Use Peer commands to keep minor intersection in step.
Flush Ramp with Preempt/Priority Routine

Peer Preempt/Priority to adjacent Signals to clear flush

Jump back to Coordination
Traffic Responsive

Pick the Critical Intersection

Assign up to 8 System Detectors (1-Assign Sys Det)
Set the V+O Parameters (2-V+O Parameters)

Assign System Detectors to a Queue Assignment (5-Queue Assign)

Set the Queue Levels (6-Queue Select)

Adjust
**Traffic Responsive-V+O Parameters**

**VPHR** - Lane capacity in Vehicles Per Hour

**AVGT** - Averaging Time

**CTFC** - Occupancy Correction Factor - Allows user to increase or decrease importance of actual Occupancy.

**MVOL%** - Minimum volume required prior to using occupancy in the V+O.
Traffic Responsive-Queue Assignments

<table>
<thead>
<tr>
<th>EPAC QUEUE ASSIGNMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>NO. 1</td>
</tr>
<tr>
<td>DETECT... 1...2...3...4</td>
</tr>
<tr>
<td>SYSD      0 0 0 0 0 0 0 0</td>
</tr>
<tr>
<td>WTFC      0 0 0 0 0 0 0 0</td>
</tr>
<tr>
<td>INPUT SELECT 0 0 (O-AV/1-HI)</td>
</tr>
<tr>
<td>FAILED LEVEL 0 0 (# TO FAIL)</td>
</tr>
</tbody>
</table>

**SYSD**-System Detector Number

**WTFC**-Weighting Factor (0-100)
Percentage to be applied to the detected V+O Data

**INPUT SELECT**-Average of Highest of all operational assigned detectors

**FAILED LEVEL**-Number of assigned detectors that must remain operational
### Traffic Responsive-Queue Select

<table>
<thead>
<tr>
<th>EPAC QUEUE SELECT</th>
<th>----- NO. 1 -----</th>
<th>----- NO. 2 -----</th>
</tr>
</thead>
<tbody>
<tr>
<td>LEVEL</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>% ENTER (UP)</td>
<td>00 00</td>
<td>% ENTER 00 00</td>
</tr>
<tr>
<td>% LEAVE (DN)</td>
<td>00 00</td>
<td>% LEAVE 00 00</td>
</tr>
<tr>
<td>DL/SPL/OFF</td>
<td>00 00</td>
<td>D/S/O 00 00</td>
</tr>
</tbody>
</table>

| A | UP | B | DN | C | LT | D | RT | E | ENTER | F | PRIOR | MENU |

- **% ENTER** - V+O percentage required to enter the level
- **% LEAVE** - V+O percentage required to leave the level
- **D/S/O** - Pattern to be operational when the V+O percentage matches that required to maintain the level
Controller -
Additional Standard Features

4 Phase Banks-
  8 Max Settings
  4 Dynamic Max Settings

12 Preemption Routines

4 Peer-to-Peer Banks

108 Pattern Selections
Live Traffic Data
madot@sigpat.com
Ma%9989

Iteris SPM
“Mr. Osborne, may I be excused? My brain is full.”