What is Signal Timing?

Signal timing is a process to "optimize" the operation of signalized intersections. The objective is to respond to the demands of all types of motor vehicles, bicycles and pedestrians in an optimum or balanced manner. Signal timing is one of the most cost-effective ways to improve traffic flow and safety. Signal timing is performed to:

- Improve traffic flow through a group of signals.
- Reduce overall delay time at an intersection (Note: does not always translate to an individual motorist's wait time).
- Account for changes in traffic characteristics due to growth or new developments
- Reduce motorist frustration by reducing stops and delay.
- Reduce response time for bus service and emergency vehicles.
- Postpone the need for costly road construction by improving traffic flow on the existing facility.

In addition to developing new coordination timing plans, there are several basic signal timing parameters that are typically reviewed and updated at each intersection as part of a signal timing revision. These include:

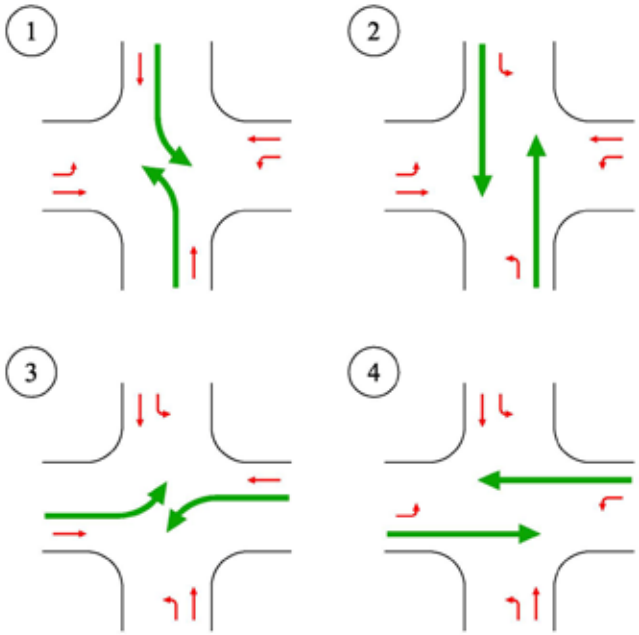
- The "yellow" interval.
- The "red" clearance interval.
- The pedestrian "Walk" symbol interval.
- The pedestrian "Don't Walk" hand symbol interval.
- The minimum "green" interval.
- Vehicle detection settings.

What is Signal Coordination?

Signal coordination is the process to synchronize the start of the "green light" along the major roadway/corridor (e.g., northbound and southbound Lyndale Avenue traffic), so that a group of vehicles can travel together ("platoon") through multiple signals with minimal or no stopping. There are three key timing parameters to make signal coordination work and are noticeable to the driver. These include the "cycle length," intersection "offset" or progression, and the individual traffic movement "green + yellow + red" phase (referred to as a movement "split").

Cycle Length

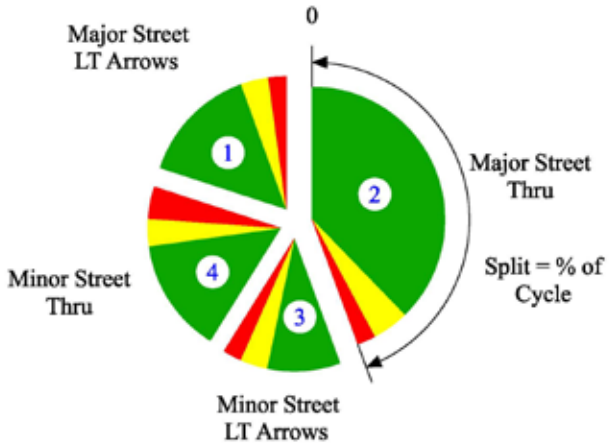
The cycle length is the total time to complete one sequence of all movements around an intersection. As shown in the illustration to the right, one cycle length is the total time required to complete Interval 1 through Interval 4.



The cycle length is the most important parameter. In order for signal coordination to work, all intersections along the corridor must have the same cycle length (or be a multiple of each other). Cycle lengths typically range between 80 seconds and 180 seconds depending upon the intersection design, spacing between intersections and traffic characteristics. Choosing the optimum cycle length for a system of several intersections is challenging and often requires the use of a traffic modeling software to help balance coordinated traffic flow on the major roadway and minimizing delay on the minor street.

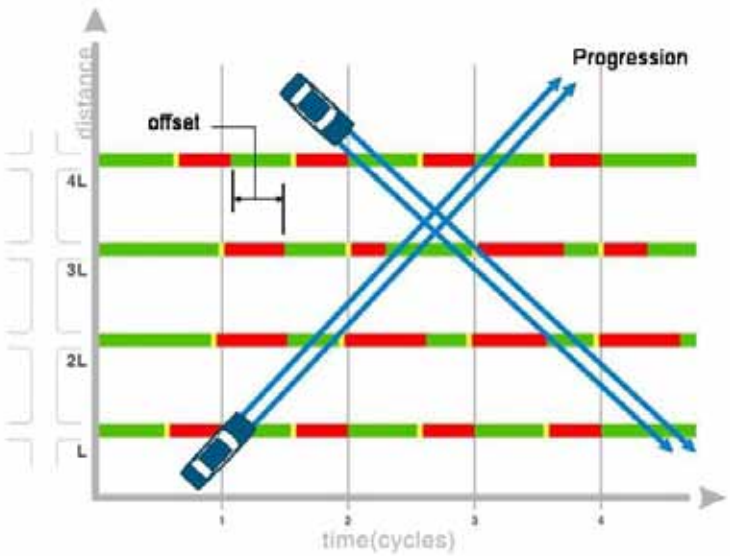
Split

An individual (movement) split (e.g., northbound left turn arrow at Lyndale Avenue/90th Street) is the sum of the green time + yellow interval + red clearance interval for that particular movement. The movement split represents a percentage of the total cycle length. The movement splits are timed to clear all waiting motorists on a typical day. The amount of time allocated to an individual (movement) split needs to work within the cycle length established for the intersection and is balanced with the needs of other conflicting movements within the intersection. Since traffic demand changes from day to day, and when special or unexpected events occur, there will be times where not all motorists will "make the green light."



Offset

The offset, illustrated to the right, is the time between the start of the "green light" at one intersection and the start of "green light" at another intersection. The offset defines the movement of traffic along the corridor/major road, also referred to as "progression." The offset is very important to observe and fine-tune in the field to real traffic speeds and conditions to help reduce stops and slowing.



Signal Coordination Considerations

Signal timing and coordination on the surface seems very easy; and in the end, appears to the motorist as simple as green lights and red lights. However, the nuts and bolts of developing signal coordination timing plans for a corridor can be very complex and challenging. The following generally highlights a few key considerations that may influence the signal coordination:

- **The traffic signal controller and communication between intersections.** The traffic signal controller is the brain of the intersection and operates the signal system. However, the controller has its own set of capabilities, functions and limitations. Signal timing plans must fit with the capability of the signal controller.
- **Traffic volumes in multiple directions and for multiple movements must be considered**. These volumes may vary by time of day, day of week, and as overall travel in the area changes.
- **Spacing between intersections**. The ability to maximize traffic flow is directly related to the spacing of the signals and the motorist vehicle speeds. This is especially true when trying to move traffic continuously in both directions along a roadway.
- **Number of cars stopped at an intersection.** The impact of vehicle queues (or line of cars) must be considered when setting the intersection offsets. It is desirable to time the offsets to minimize slowing of traffic approaching the intersection and to contain vehicle queue lengths such that no lanes or intersections are blocked.
- **Pedestrians and Bikes**. Pedestrian crossing times may be a critical component of the timing and influence the corridor progression. A signal may need to give more time than is required for the vehicles on an intersection approach in order to allow pedestrians to cross the street safely.
- **The location of high volume cross-streets**. Critical intersections (e.g., Lyndale Avenue at 90th Street) or those locations with high cross-street traffic volume and pedestrian demands greatly influences the progression. Vehicle platoons can be more difficult to serve at the critical intersections that must give more green time to cross-street movements.

What to Expect

Signal timing is one of the most cost-effective ways to improve traffic flow. However, signal coordination is also not perfect. Traffic flow and delays must be balanced throughout the system; therefore, trade-offs are always required. The biggest impact of signal coordination projects is the lower volume cross-street movements will often experience a slight increase in wait time. Why does this occur?

- **Signal coordination requires that each intersection have the same cycle length or be multiples of the same cycle length.** Typically, there are a few critical intersections that require a particular cycle length to accommodate the traffic and pedestrian demands, while others within the system must then be compatible to allow coordination. This can at times result in a longer wait at certain locations, than would be otherwise expected.
- **A primary goal of signal coordination is to efficiently move the majority vehicles through the system with the fewest stops and reduced travel time.** It would be ideal if every vehicle entering the system could proceed through the system without stopping. This is not possible. Therefore, in traffic signal coordination, the majority rules and the busiest traffic movements are given precedence over the smaller traffic movements. This means that side street traffic often experiences a slightly longer wait time. However, once on the main roadway, motorists should generally experience better flowing traffic conditions.

Other items to expect or things you might see include:

- **Some intersections may have a lagging left turn arrow (98th Street at Lyndale Avenue).** This means the left turn arrow comes up at the end of the through lane green light. This is done to improve the progression at upstream and downstream intersections. It also typically lowers the wait time for left turning motorists.
- **Planned stops.** Having a planned stop along the main roadway is usually necessary because the signal spacing prohibits non-stop progression in both directions. Logical locations are chosen to group vehicles.
- **Heavier flow in one direction**. The higher volume direction is favored, which may cause more stops in the lower volume direction.

Although there are always some trade-offs and there may be some individual cross-street movements experiencing a slight increase in wait time, significant performance improvements are generally made, especially when considering the entire length of a corridor and all the intersections within the system. Maintaining efficient signal coordination improves the environment and always results in an overall reduction of user costs. These include reducing air pollution (emission), reducing fuel consumption (improved gas mileage), reducing vehicles stops (wear and tear) and reduced delay (value of time).