National Transportation Operations Coalition

Traffic Signals 101

Purpose of Traffic Signals

Traffic signals manage the right of way at signalized intersections to provide for the safe and efficient movement of vehicles and pedestrians. Traffic engineers and technicians develop and implement signal timing at each intersection to distribute green time amongst the competing traffic flows to provide for efficient operations.

Who Handles the Operation of Traffic Signals?

There are more than 3,000 local and state agencies responsible for the management and operation of the nation's estimated 311,000 traffic signals. These agencies utilize professionals from the public and private sectors to design, construct, manage, operate, and maintain signalized intersections.

Who Funds Traffic Signal Operations?

Funding for all forms of traffic and highway projects stems from local, State, and Federal funds—in other words, from taxpayer dollars. However, it is up to the individual localities and/or states to decide how to spend that money and what portion of the money is used for traffic signal timing and operations.
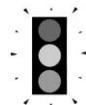
What Are the Parts of a Traffic Signal?

Traffic signals have four main parts:

1. Display
2. Controller
3. Detector
4. Support
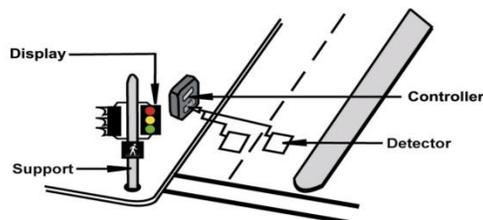
Signal display: The signal display is what the motorist sees. A simple signal display consists of three colors: red, yellow, and green.

 Did you know that in a typical traffic display, the circular indication is 12 inches in diameter? A typical signal display is more than 3 feet tall and weighs up to 50 pounds.

Signal controller: The traffic signal controller is the "brain" at an intersection that tells each signal display when to change colors. Years ago, traffic signals were controlled by a simple electric mechanism that made the display change every so many seconds, like a clock. These simple mechanisms were not able to adjust when traffic changed during the day.

Later in the pre-computer era, electromechanical controllers were developed that could be adjusted for the time of day. These controllers were much like the switch timers in the local hardware store that have green and red pins to set lights to go on and off on a predetermined schedule.

Now, computerized traffic signal controllers get real-time information about the presence of vehicles from sensors in the roadway and on poles. Controllers adjust the amount of green time for different movements based on sensor information. The most sophisticated controllers and software programs allow for the coordination of signals along a roadway, so that vehicles can travel through a succession of intersections without having to stop.

Detector: Detectors are used to identify the presence of a vehicle, so that the controller knows how to adjust the amount of green time to provide. There are many types of detectors. One type is known as the loop detector. The square black lines you may see in the roadway as you approach an intersection are the visible part of the loop detector, which is a thin wire buried in the roadway. When a vehicle drives over the loop, it sends a message to the signal controller. The signal controller's software evaluates the messages from all the loops at the intersection and changes the signal timing appropriately. Small TV cameras can also be used to detect vehicles.

What Is Signal Timing?

Traffic signals are timed with two goals in mind: 1) to make the traffic system as safe as possible for all users; and 2) to improve traffic flow. Each traffic signal controller is programmed with different timing settings, depending on time of day (morning or afternoon rush hour) or according to what is happening at the intersection at that moment.

There are three basic types of signal timing:
1. Fixed time
2. Actuated
3. Coordinated

Fixed time: Fixed-time signal control uses preset time intervals that are the same every time the signal cycles, regardless of changes in traffic volumes. They give the most green time to the heaviest traffic movement based on historical information. Some fixed-time systems use different preset time intervals for morning rush hour, evening rush hour, and other busy times.

Actuated: An actuated signal controller is able to change the amount of green time for each cycle, based on information from the detectors. Actuated signals are best where traffic volumes fluctuate considerably during the day, when interruptions to major-street traffic flow must be minimized, or when there is very light side-street traffic.

Coordinated: In addition to timing an individual traffic signal, some signals are timed as a coordinated network. The goal of signal coordination is to help traffic flow through a series of signals at a predetermined speed to minimize or avoid stops. In other words, the signal at an intersection turns green just as you arrive. This isn't always possible because of the need to provide smooth flow in two or more directions. This is why traffic engineers use computer programs to determine the best compromise among all the competing directions of traffic.

Who Created the First-Ever Traffic Signal?

The first electric traffic signal was installed in Cleveland, OH, USA, in 1914 by the American Traffic Signal Company. Now there are more than 311,000 traffic signals nationwide. The man credited with inventing the traffic signal and applying for the 1923 patent is Garrett Morgan. Said to be the first African American to own an automobile in Cleveland, Morgan also invented the gas mask and the zigzag attachments for sewing machines.