

Traffic Signal Operations

Presentation for: Ped/Bike/MV Commission
Date: April 2017

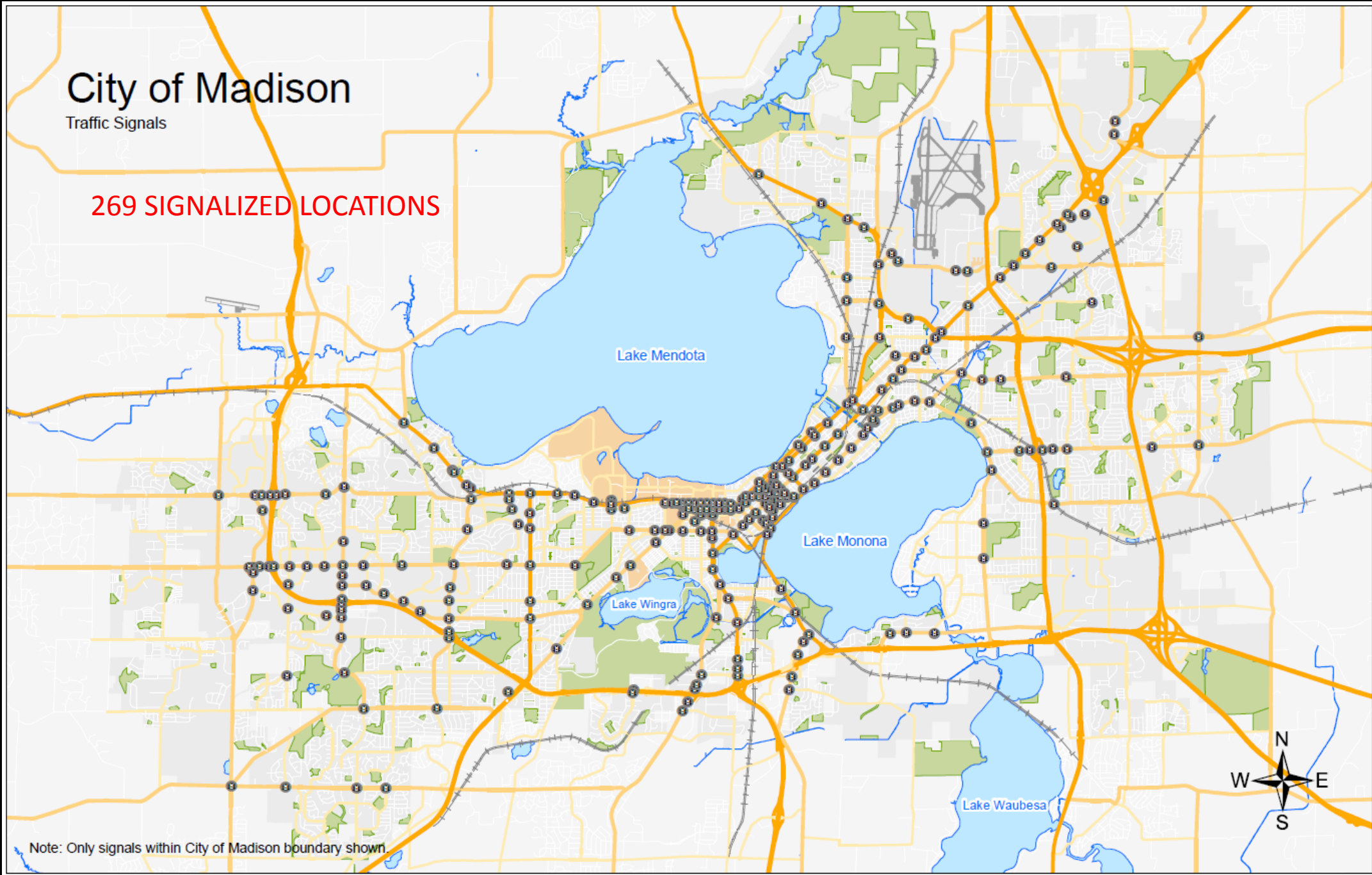
Purpose

- Traffic signals:
 - Assign right of way at intersections
 - When sited correctly signals can provide for the safe and efficient movement of pedestrians, bicyclists and motorists.
 - When misused can worsen safety and increase all user delay and congestion
- Traffic signals are funded:
 - Through special assessment districts
 - Through the general fund
 - Through State & Federal STP funds
 - Traffic signals cost \$120,000 and upwards. Cost is a function of pavement type, underground work required, intersection geometry etc.

City of Madison

Traffic Signals

269 SIGNALIZED LOCATIONS



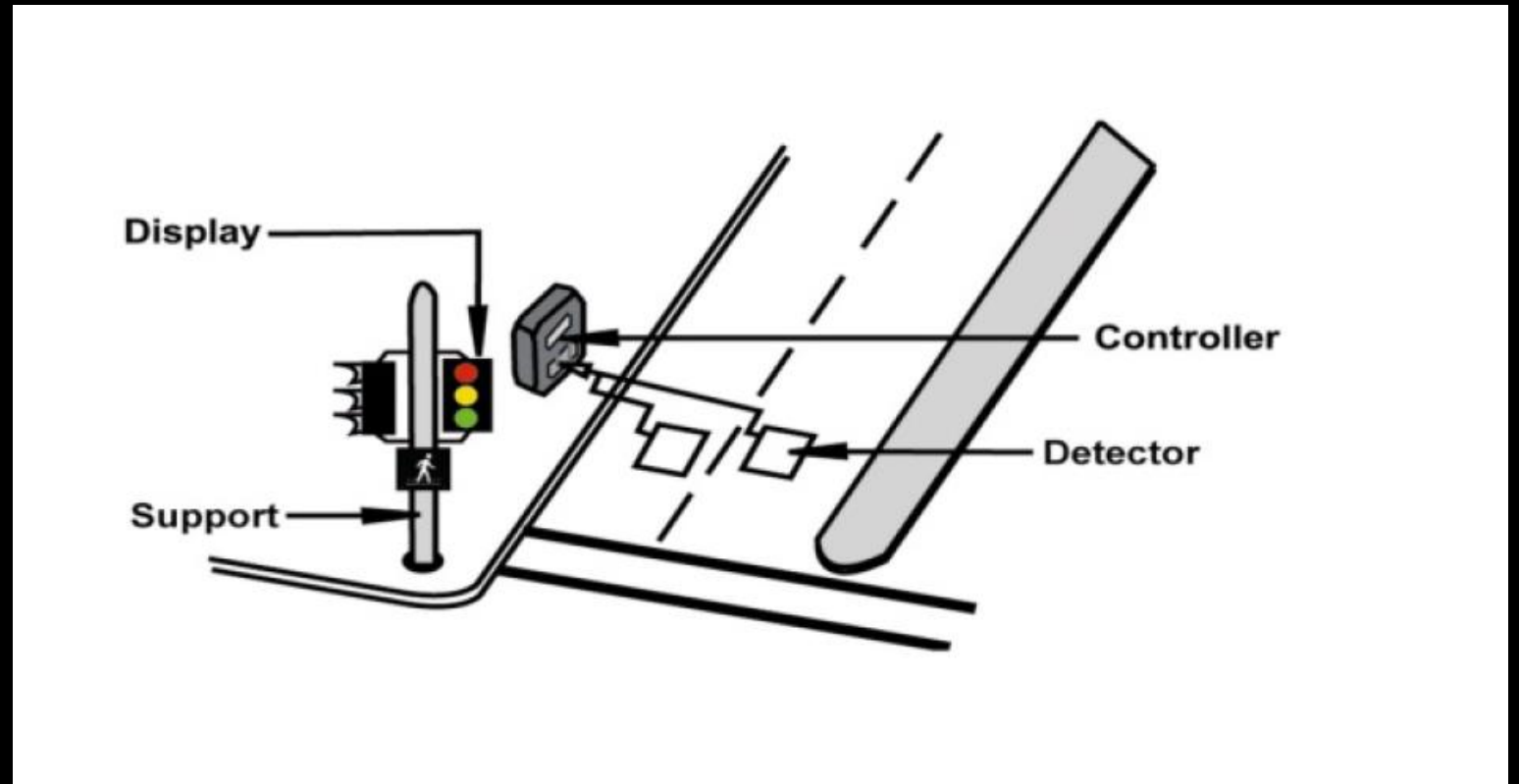
Note: Only signals within City of Madison boundary shown

What Comprises a Traffic Signal?

- There are four main parts:

- 1) Controller
- 2) Display
- 3) Detector
- 4) Support

And then of course
It is important in how
the signal is operated



Signal Controller

- The signal controller is the “brain” at an intersection—it tells each signal display when and what color to display.
- Computerized signal controllers get real-time information about the presence of users from sensors in the roadway and on poles.
- Controllers adjust the time for movements based on sensor information.
- More sophisticated controllers allow for the coordination of signals along a street, so that users can travel through a succession of intersections, minimizing stops, reducing crashes pollution and wasted fuel.

Modern digital controller



Signal Controller

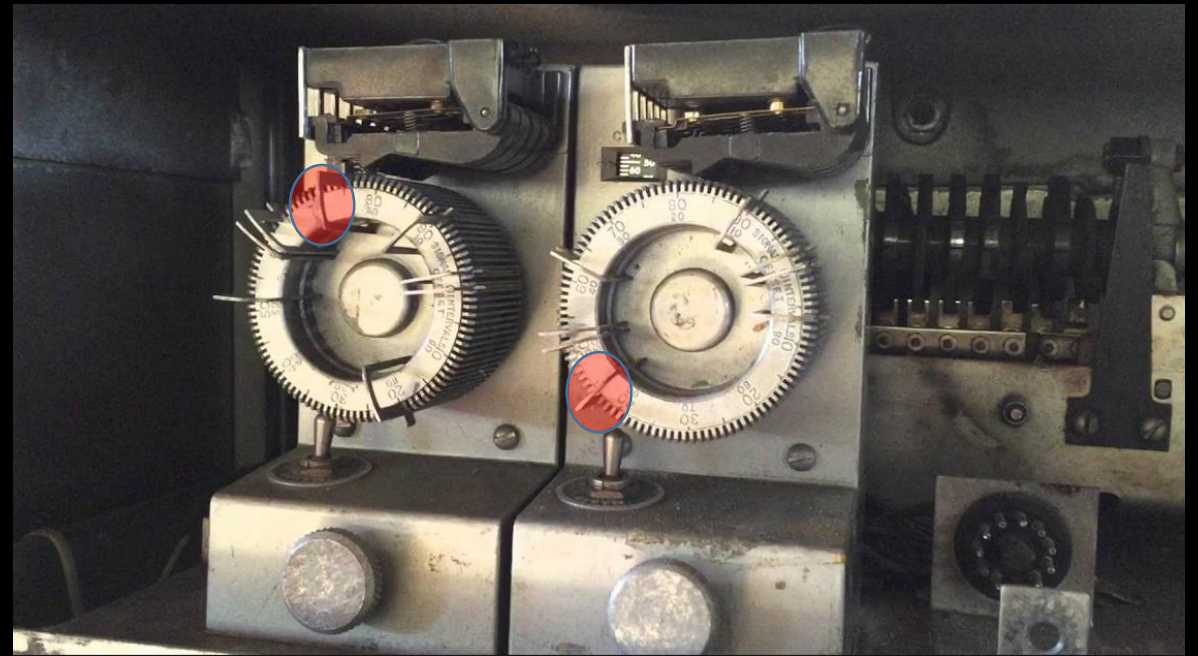
Digital controller in its streetside cabinet



Signal Controller

- Many years ago, traffic signals were controlled by simple electric mechanisms that made the display operate in “pre-timed mode.” The display would change every so many seconds like a clock. These simple mechanisms were not very efficient and could not adjust to varying demands and uses throughout the day.

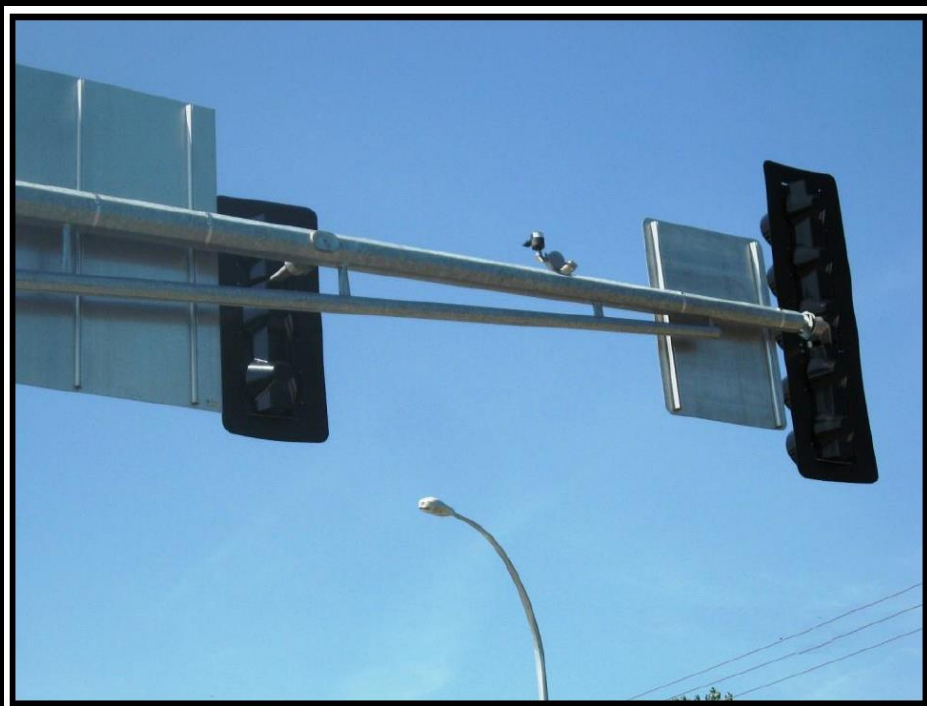
Old electro-mechanical controller



Concept still used today in consumer electronics



Displays & Supports



3) Detection

- Loop Detectors are used to identify the presence of a vehicle. Often the square black lines you may see in the roadway as you approach an intersection are the visible part of the loop detector.
- The loop is a thin wire buried in the roadway. When a vehicle drives over the loop a magnetic field is changed which an amplifier records as a vehicle and sends a message to the controller. The signal controller's software evaluates the "message" from detectors at the intersection and adjusts and changes the signal timing appropriately.
- Machine vision/cameras are used frequently today to detect vehicles and is based on technology transferred from the US military.



Detection

In-pavement inductive loop vehicle detector



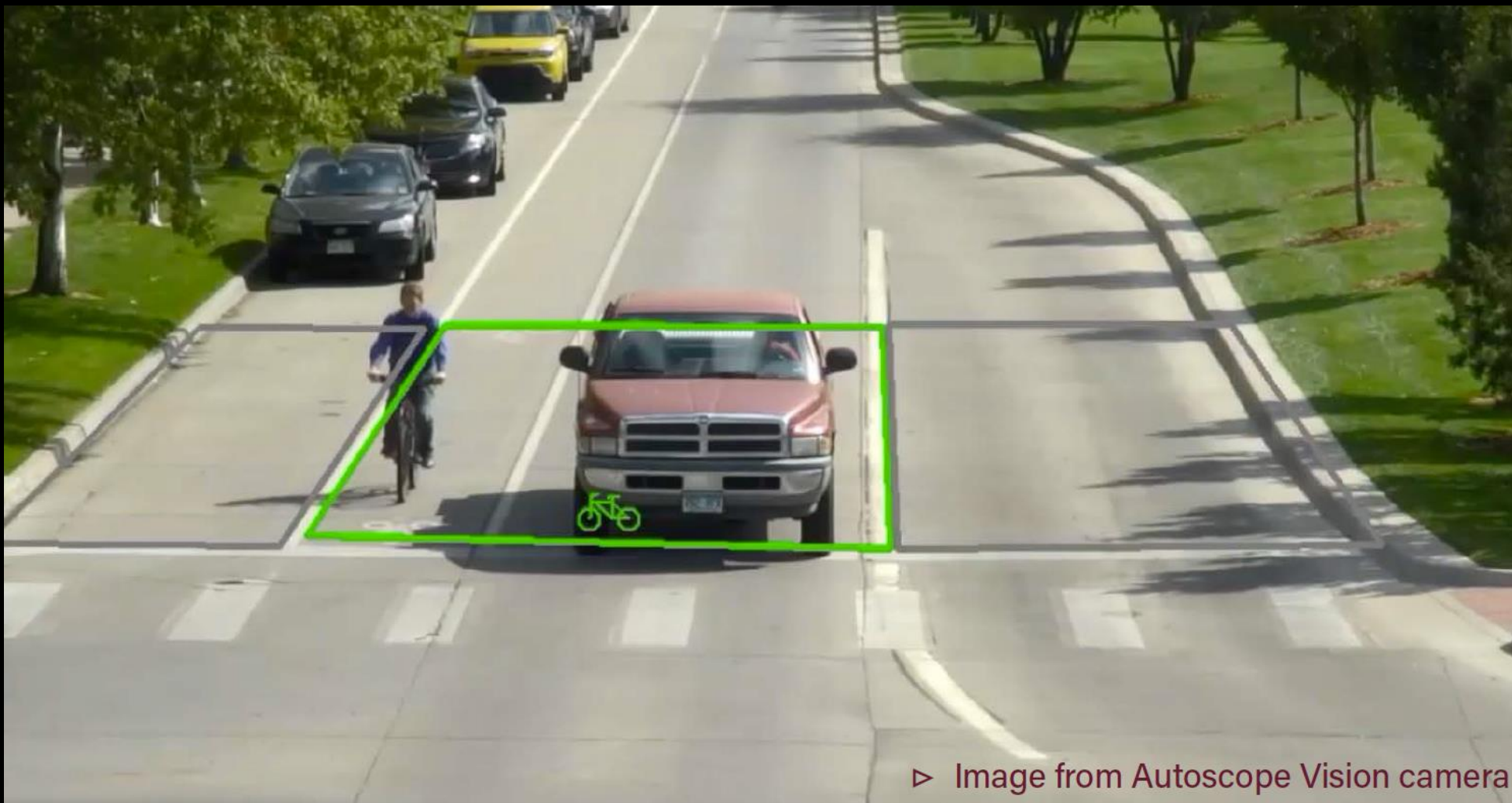
Loop Detection has:

- Pros
 - Successful in detecting bikes and motorized vehicles
- Cons
 - Pavement intrusive
 - Can be easily damaged by Utilities
 - Can't be easily changed
 - Maintenance intensive

Detection

- Cameras
Some intersections use traffic cameras which detect vehicles. Video detection offers advantages including more flexibility in the placement of vehicle detection zones.





▷ Image from Autoscope Vision camera

Infra-red Thermal Imaging Detectors



TrafiSense

The World's First Intelligent Thermal
Traffic Sensor

IR Machine Vision JND & Willy St



Video Detection has:

- Pros
 - Potential to detect bikes and peds
 - Less intrusive or passive detection
- Cons
 - Missed calls
 - Challenged with--rain, fog, snow, glare and occasional visual obstructions
 - Can be costly

Signal Timing

Traffic signals are timed with two goals in mind:

- 1) To make the system safe for users;
- 2) To minimize the impact of traffic by controlling each traffic signal with different timing;

Signal settings vary, depending on time of day (morning or afternoon rush hour) or according to what is happening at an intersection at that moment (special events, UW Football, Snow event, crash diversion etc...

There are three basic types of signal timing:

1. Fixed time or pre-timed
2. Actuated
3. Coordinated

Signal Timing

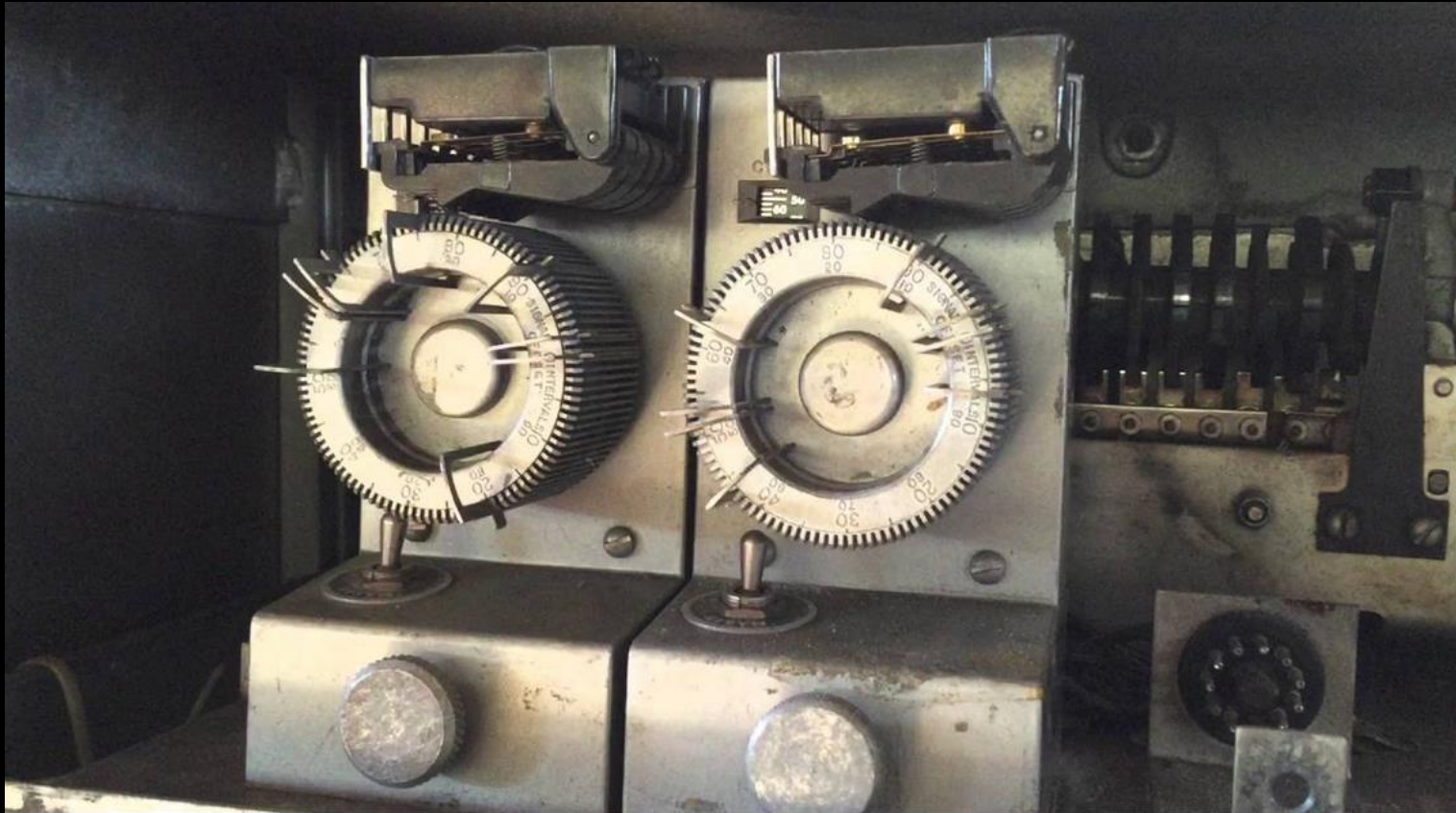
- FIXED or PRE-TIMED

Fixed-time signal control uses preset time intervals that are the same every time the signal cycles, regardless of changes in traffic volumes or who is present. They give the most time to the higher movement based on historic data.

Some fixed-time systems use different preset time intervals for morning rush hour, evening rush hour, and other predictable times.

Fixed time signal control has no vehicle detectors and no ped buttons. Signal and pedestrian phases are called every time regardless of whether there are people waiting or not.

Signal Controller



Signal Timing

- 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 used where user volumes fluctuate considerably during the day or when there is very light side-street use.

Signal Timing

- COORDINATED

In addition to timing an individual traffic signal, some signals are timed as a coordinated network. The goal of signal coordination is to minimize crashes and reduce overall delay. Sometimes, the signal at an intersection turns green just as you arrive or it will turn green in advance of your arrival to clear out stopped traffic before upstream traffic arrives. Sometimes coordination is not possible because poor signal spacing and varying traffic flow in two or more directions prevents it.

Pedestrian Button

A Ped pushbutton is an switch used by pedestrians to alert the controller that a pedestrian is present—this is to change the traffic signal timing so sufficient time can be provided to cross the street.



Why not just do away with the Ped Button?

We know: ped pushbuttons increase the time provided to cross a street.

Often this walk time is more time than is necessary to serve concurrent motorized traffic or bicycles.

To operate pre-timed and expend time when no pedestrian, bicyclist or motorist is present or needs it wastes time, fuel and causes congestion on the other legs of the intersection. This is the inherent problem with pre-timed signals—when misused they result in inefficiencies for all users.



Ped Buttons-are the most reliable mechanism we have to detect presence of pedestrians.

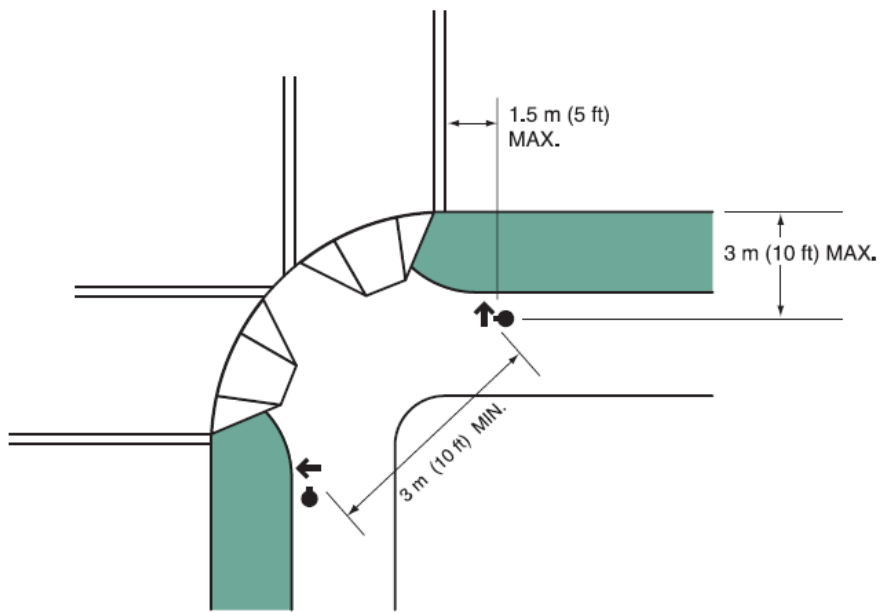
Contrary to popular belief, ped buttons are not placebos. They are not “beg buttons” nor “nuttin buttons”

They are a reliable mechanism to detect pedestrian presence—when there currently is no cost effective way to do this.

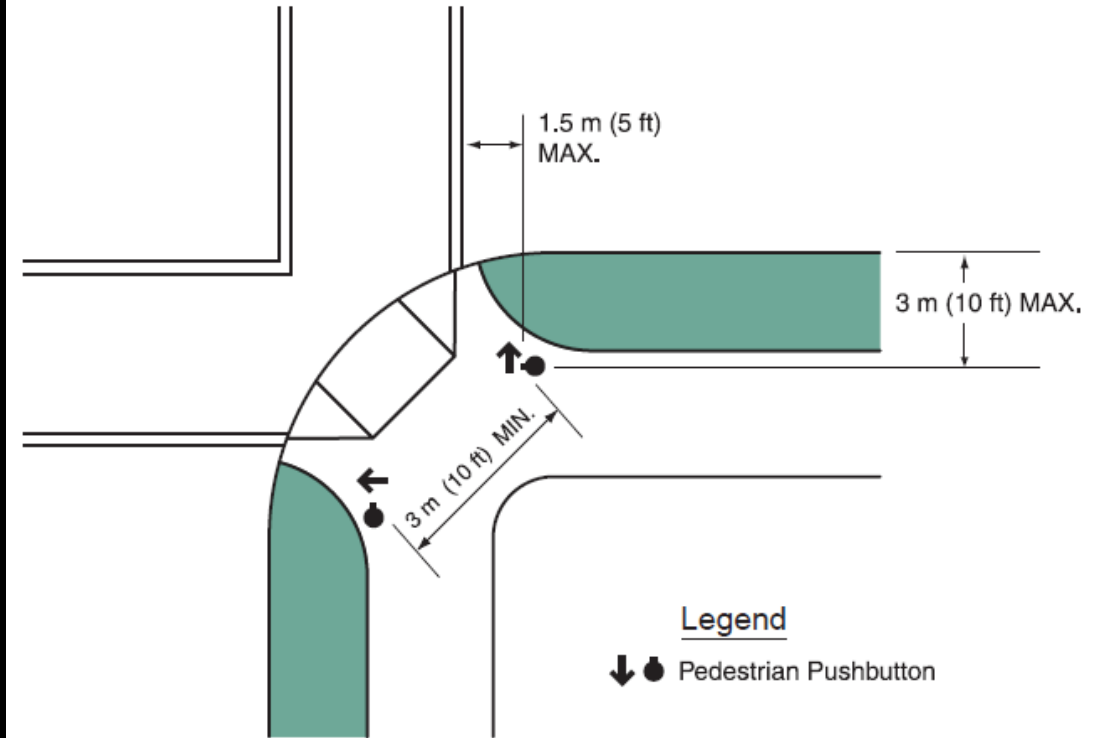
As technology advances we expect this will change and there will be cost effective and reliable ways to do detect pedestrians for example using passive sensors-video and IR.

Pedestrian Button Location per FHWA

Figure 4E-2. Typical Pushbutton Locations for Accessible Pedestrian Signals



Two Curb-Cut Ramps



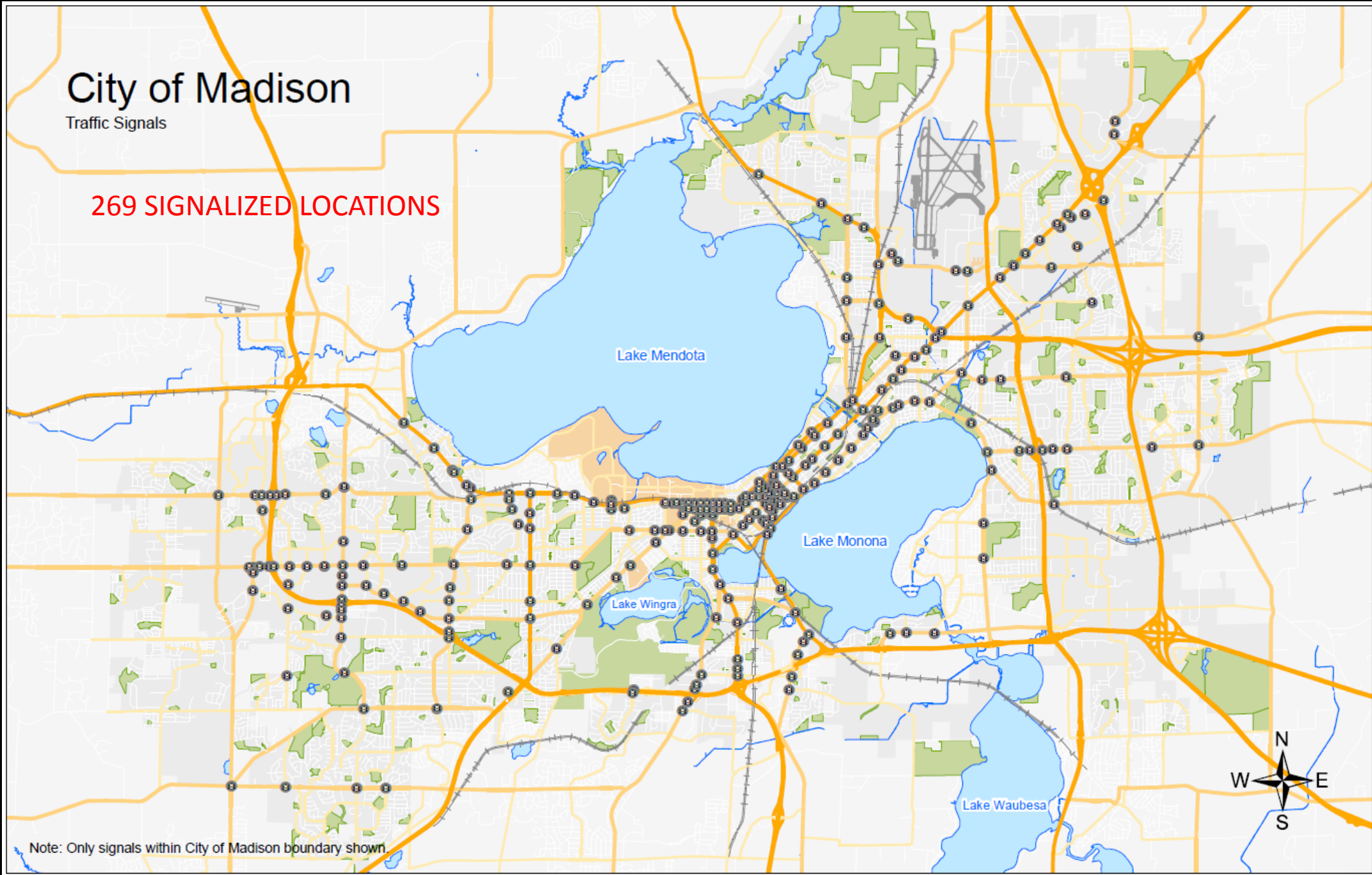
Legend
↓ ● Pedestrian Pushbutton

One Curb-Cut Ramp

City of Madison

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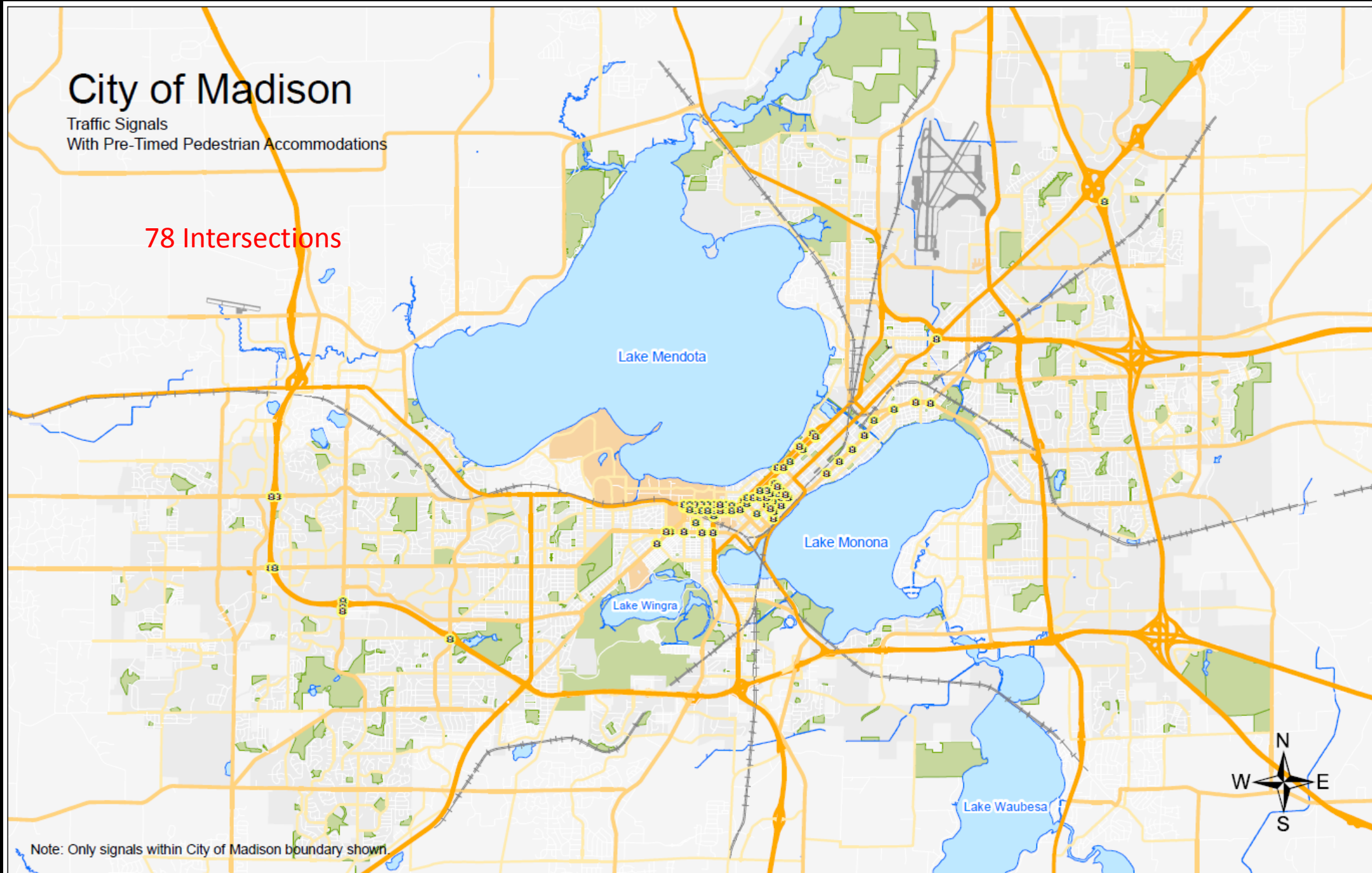


Note: Only signals within City of Madison boundary shown.

City of Madison

Traffic Signals
With Pre-Timed Pedestrian Accommodations

78 Intersections



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Questions

