# Traffic Detection Systems



CEE 320
Steve Muench

# Outline

1. What are traffic detectors?
2. Traffic detector importance
3. Detector types
4. Use Example

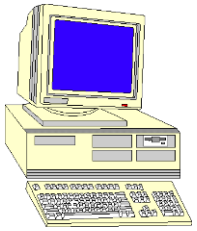
# What Are Traffic Detectors?

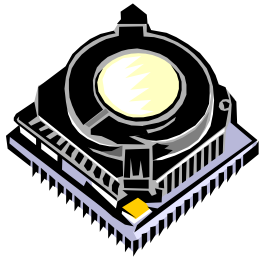


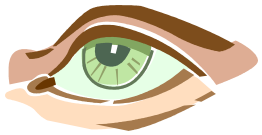
# Traffic Detection Systems Structure

Detector ⟹ Processor/Controller ⟹ Storage





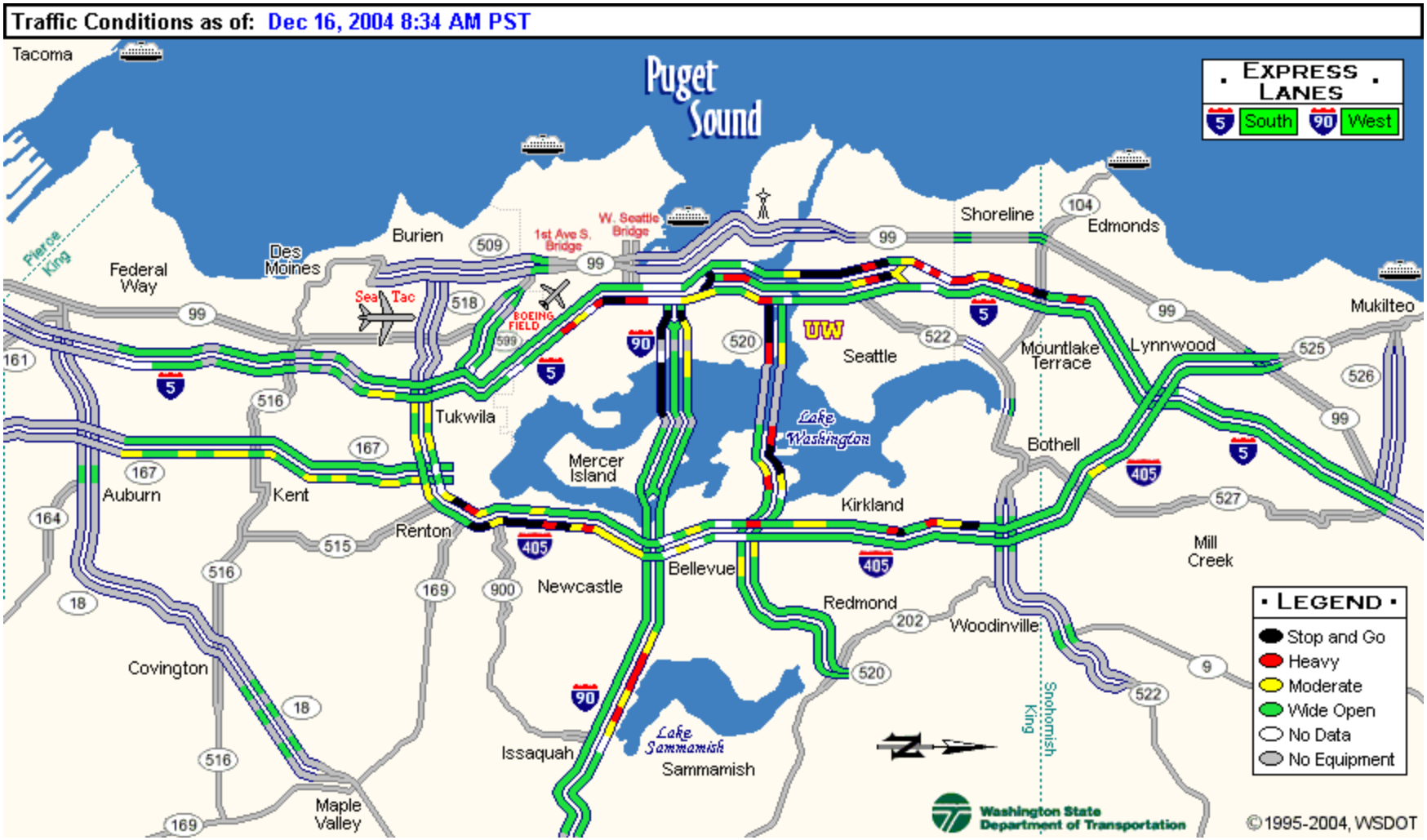




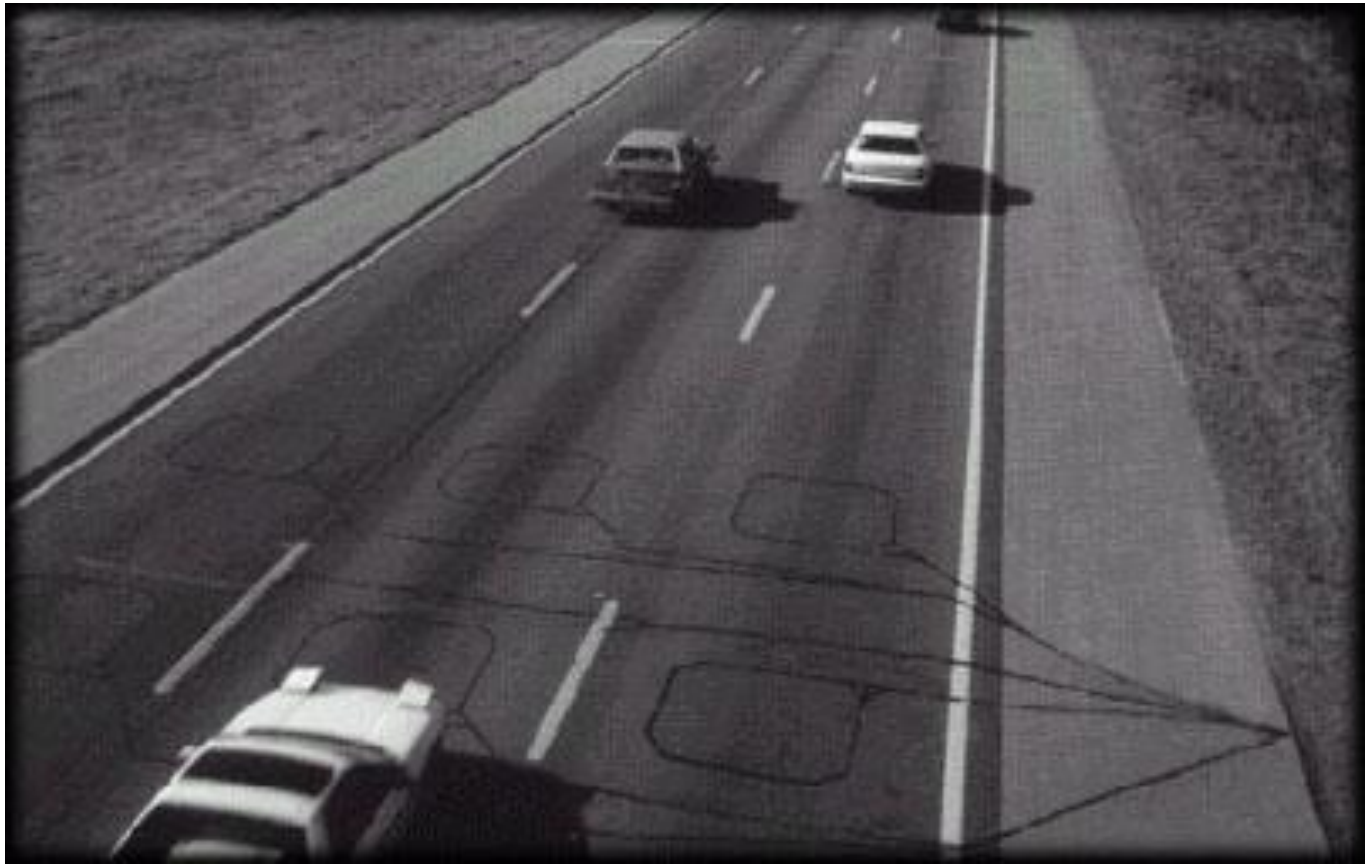




# Why Is Traffic Detection Important?



# Why Is Traffic Detection Important?



Freeway Monitoring

# Why Is Traffic Detection Important?



Actuated Signal Control

# Why Is Traffic Detection Important?






Ramp Meter Control

# Why Is Traffic Detection Important?



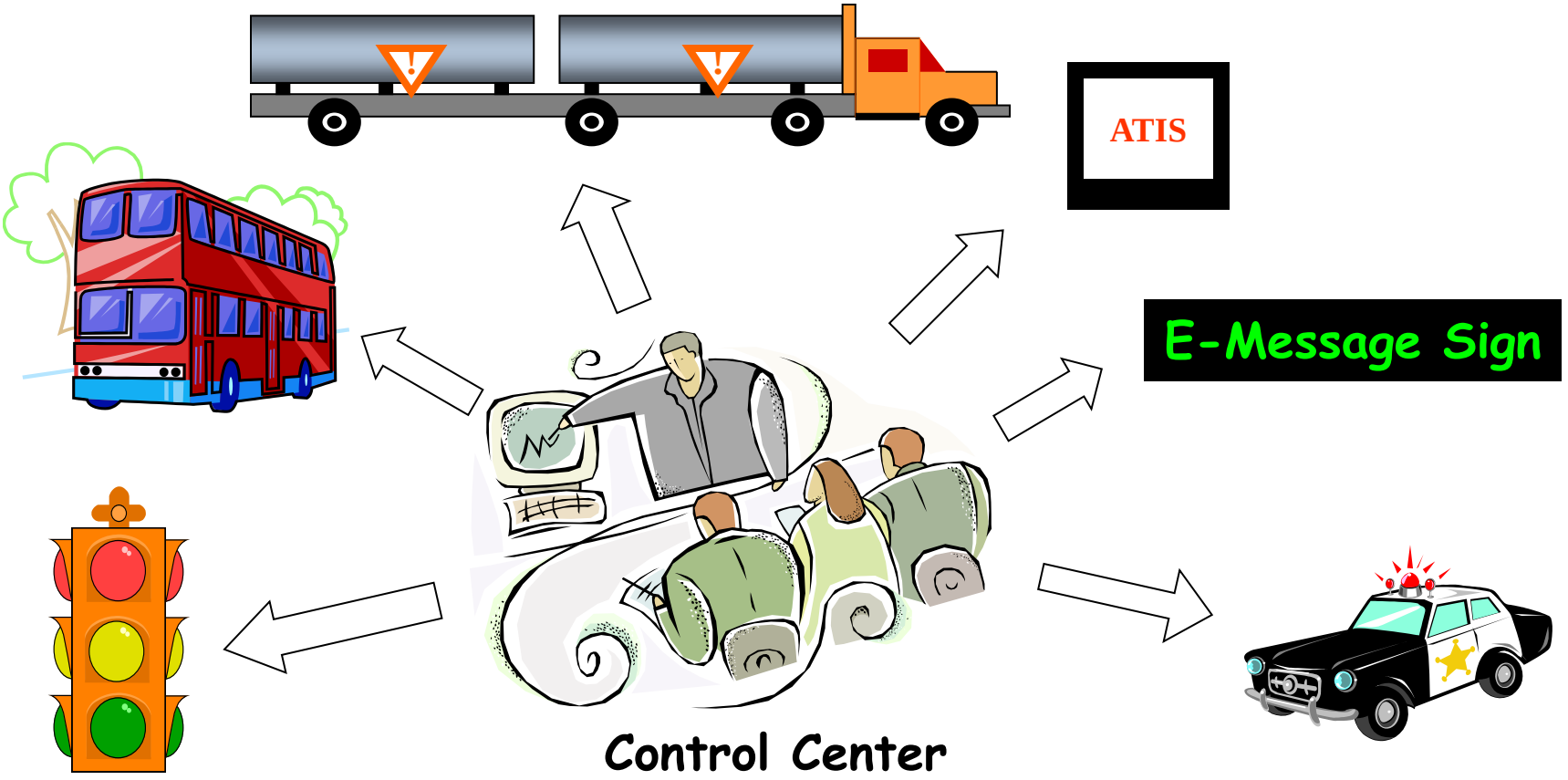
Road Discipline Enforcement

# Why Is Traffic Detection Important?




Dynamic Traffic Assignment

# Why Is Traffic Detection Important?

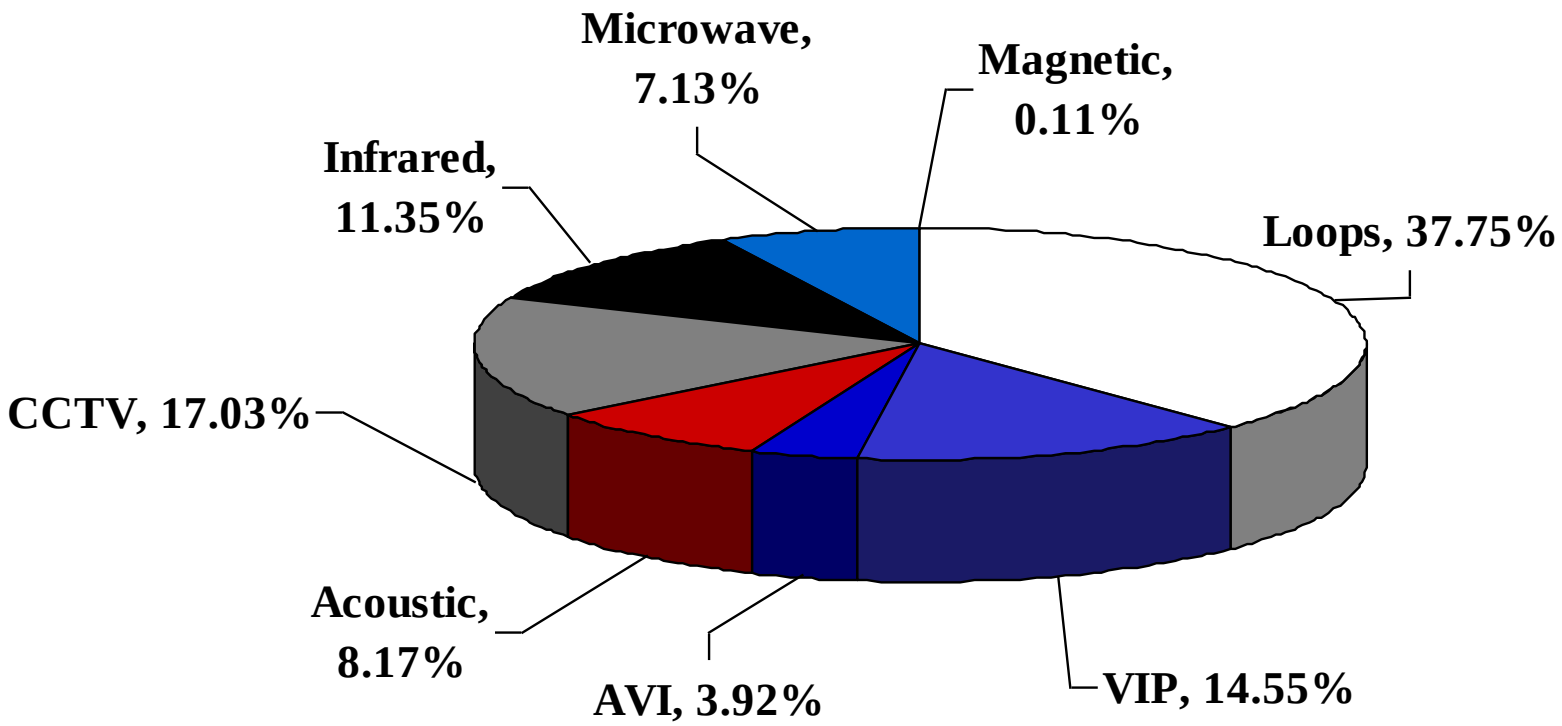



Quality Data

# Traffic Detector Types

- Inductive loops
- Video
- Microwave
- Infrared
- Acoustic
- Radar
- Magnetic
- Radio frequency
- Global positioning system (GPS)

# Share of Detector Types at new ATMS Sites



# Popular Traffic Detector Types



Inductive loops



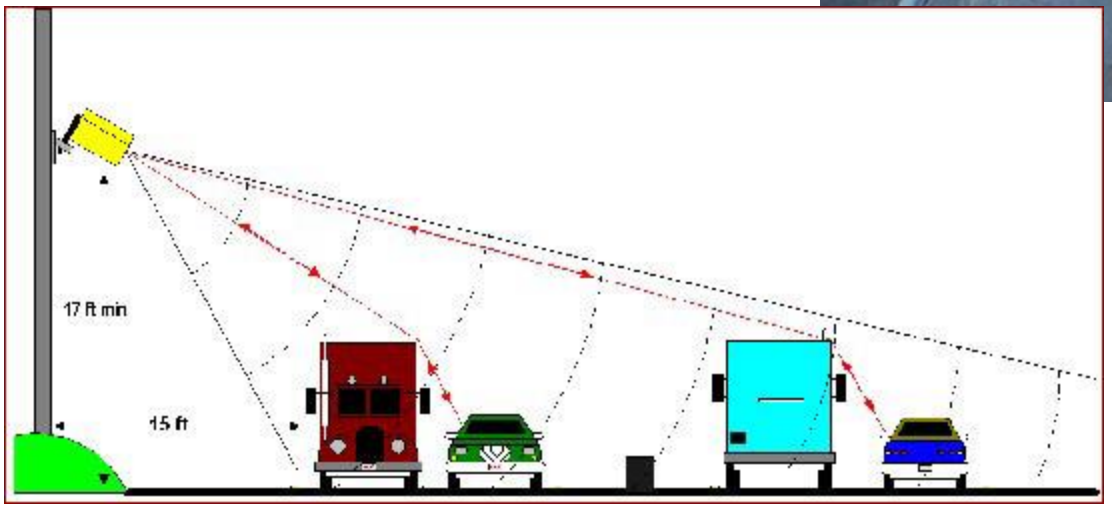
Video Image Processors (VIPs)

# Popular Traffic Detector Types





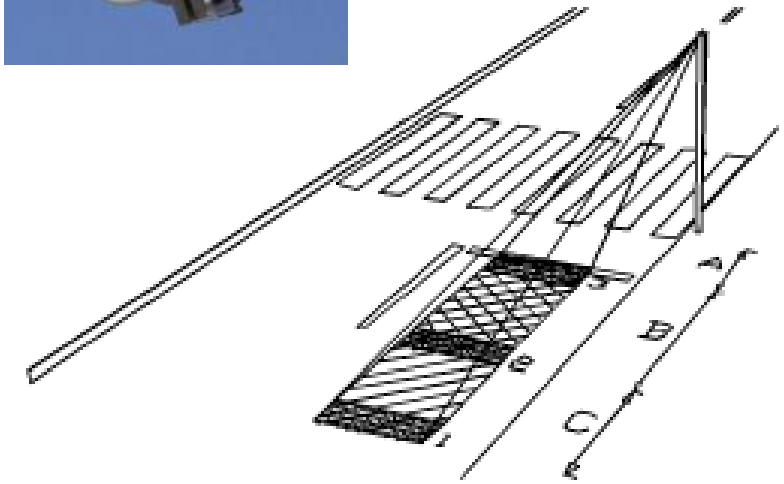
**Remote Traffic Microwave Sensor (RTMS)**




Photos and picture from Electronic Integrated Systems, Inc.

# Popular Traffic Detector Types





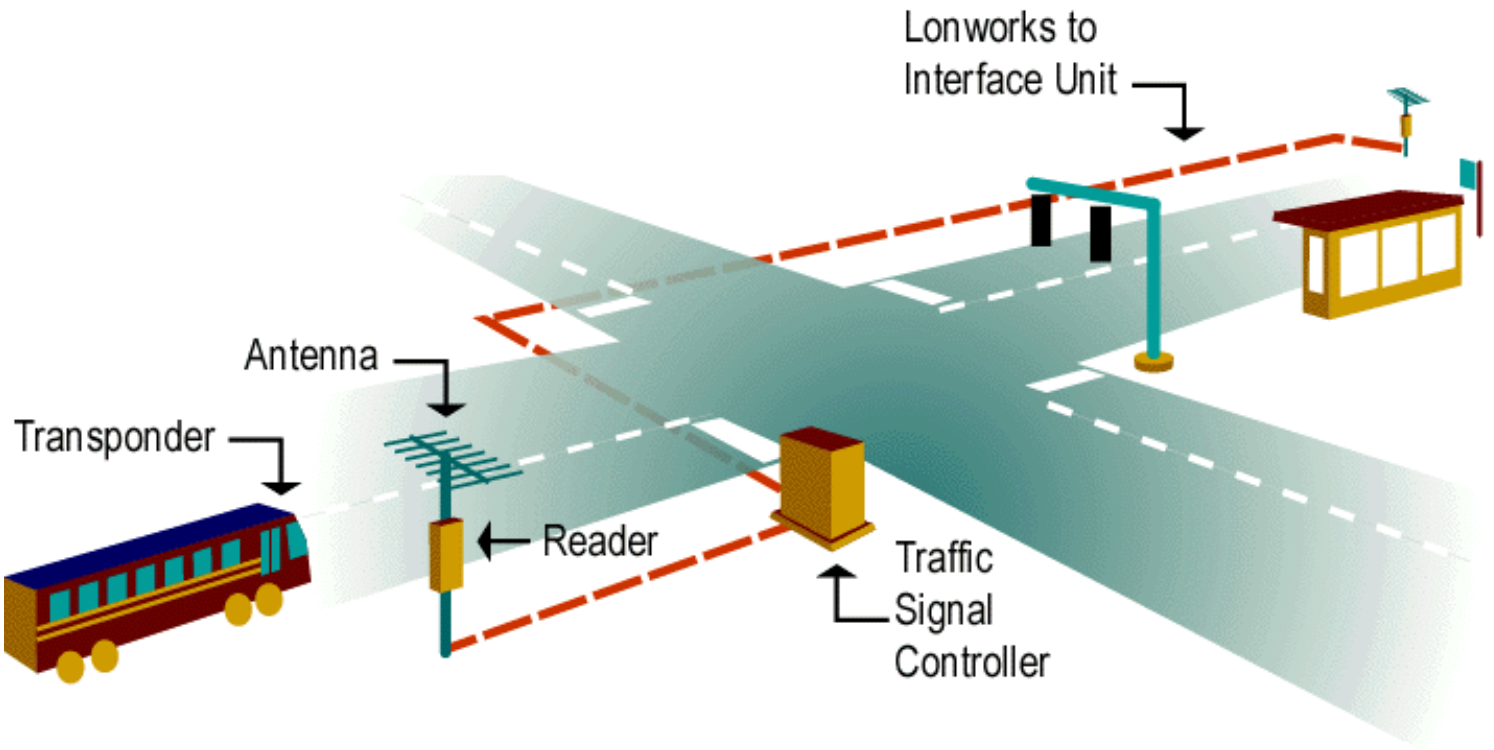
Infrared Sensors





Magnetic Sensors

# Popular Traffic Detector Types




**Radio Frequency Tag**

# Popular Traffic Detector Types

ASIM TT 298: Doppler RADAR, ultrasonic, passive infrared.

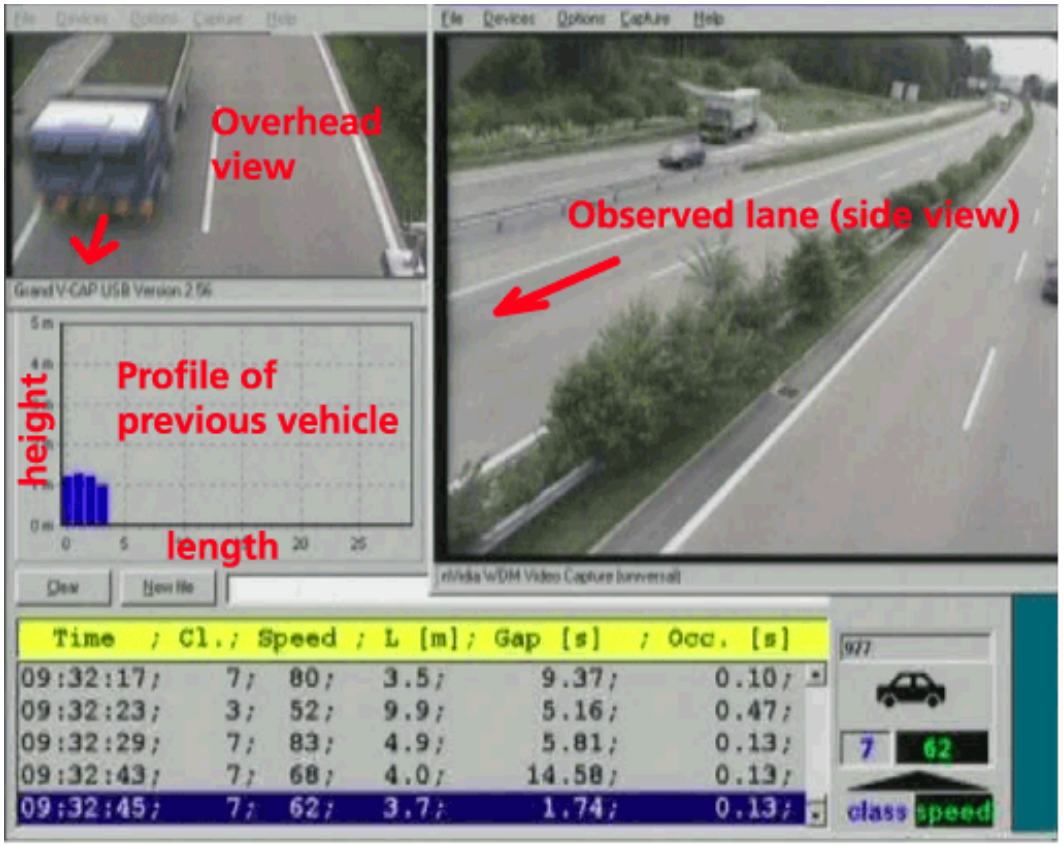




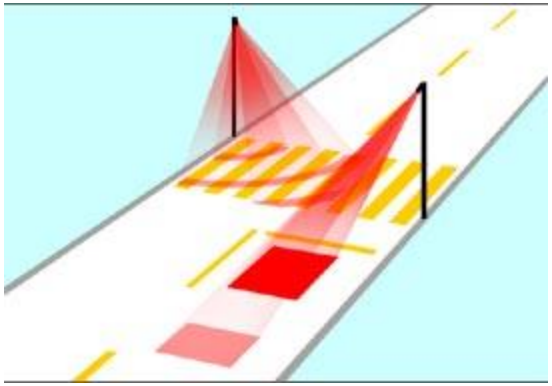
Volume, classification, speed, occupancy, queue detection, wrong-way

# Popular Traffic Detector Types

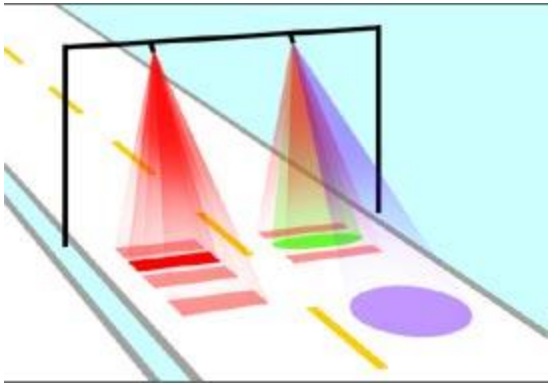
ASIM TT 298: Doppler RADAR, ultrasonic, passive infrared.



# Popular Traffic Detector Types



Intersection Control



Traffic Data Acquisition

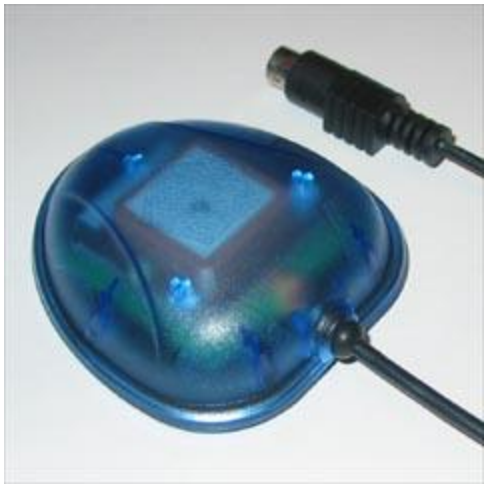
= infrared (counting)

= ultrasonic (vehicle height)

= microwave doppler radar (speed)

# Popular Traffic Detector Types

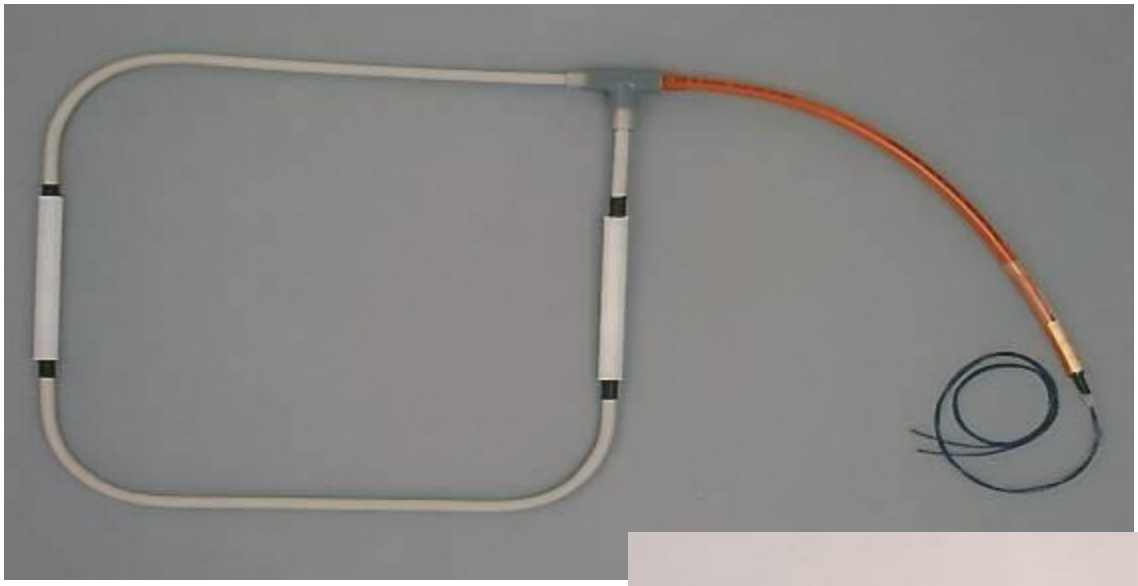




**GPS-Based Tracking Systems**

# Inductance Loop Detectors



Photos from Never
Fail Loop Systems, Inc.

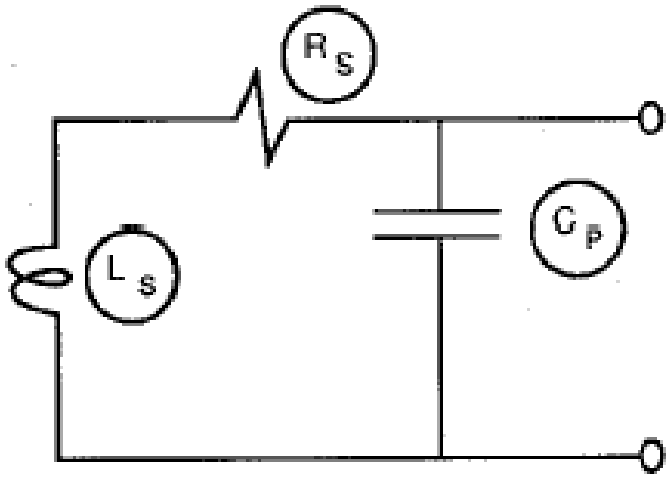


# Inductance Loop Detectors



# Inductance Loop Detectors

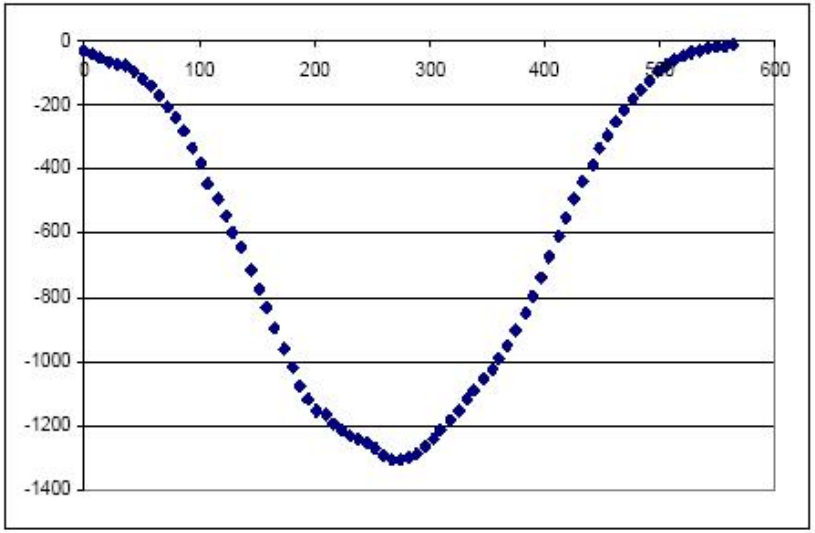
- A Schematic Diagram




- The inductance seen at the loop terminals is modified by the capacitance and results in an inductance which increases with increased operating frequency.

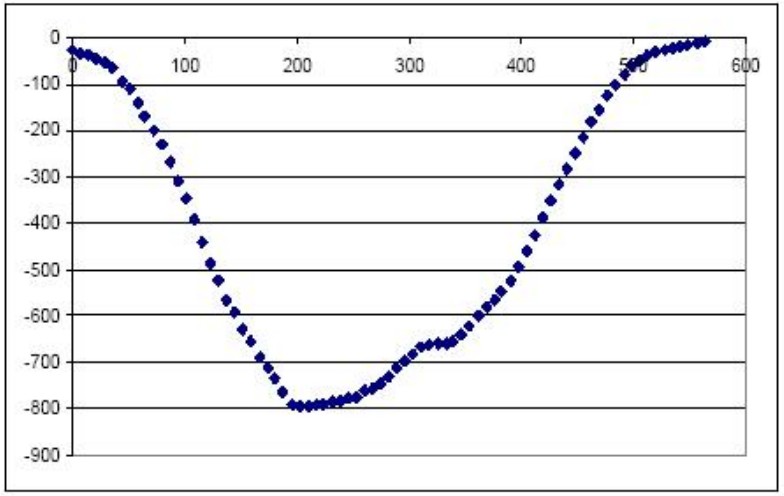
# Loop Detector Signatures



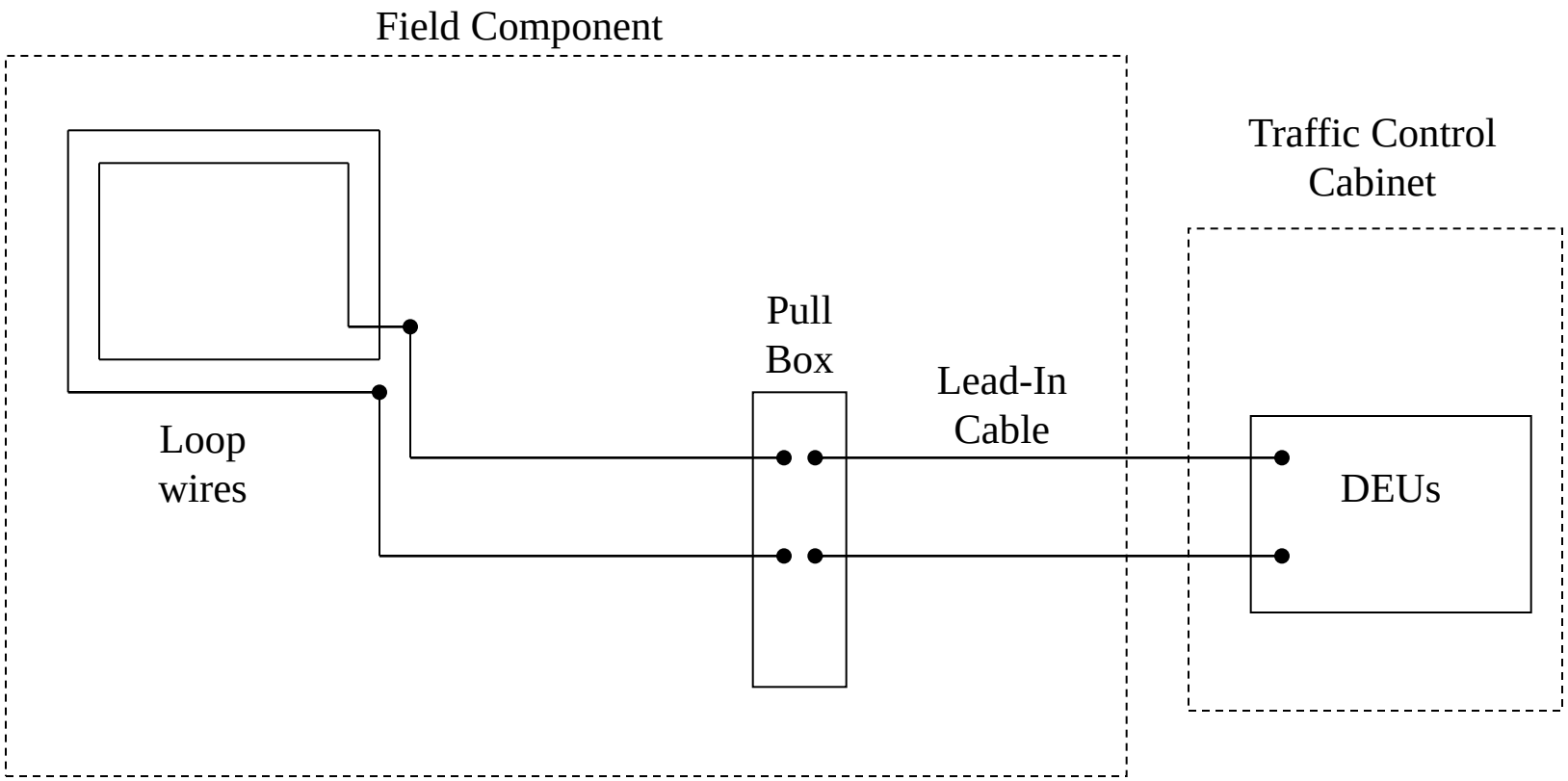









# Inductance Loop Detectors



# Inductance Loop Detectors



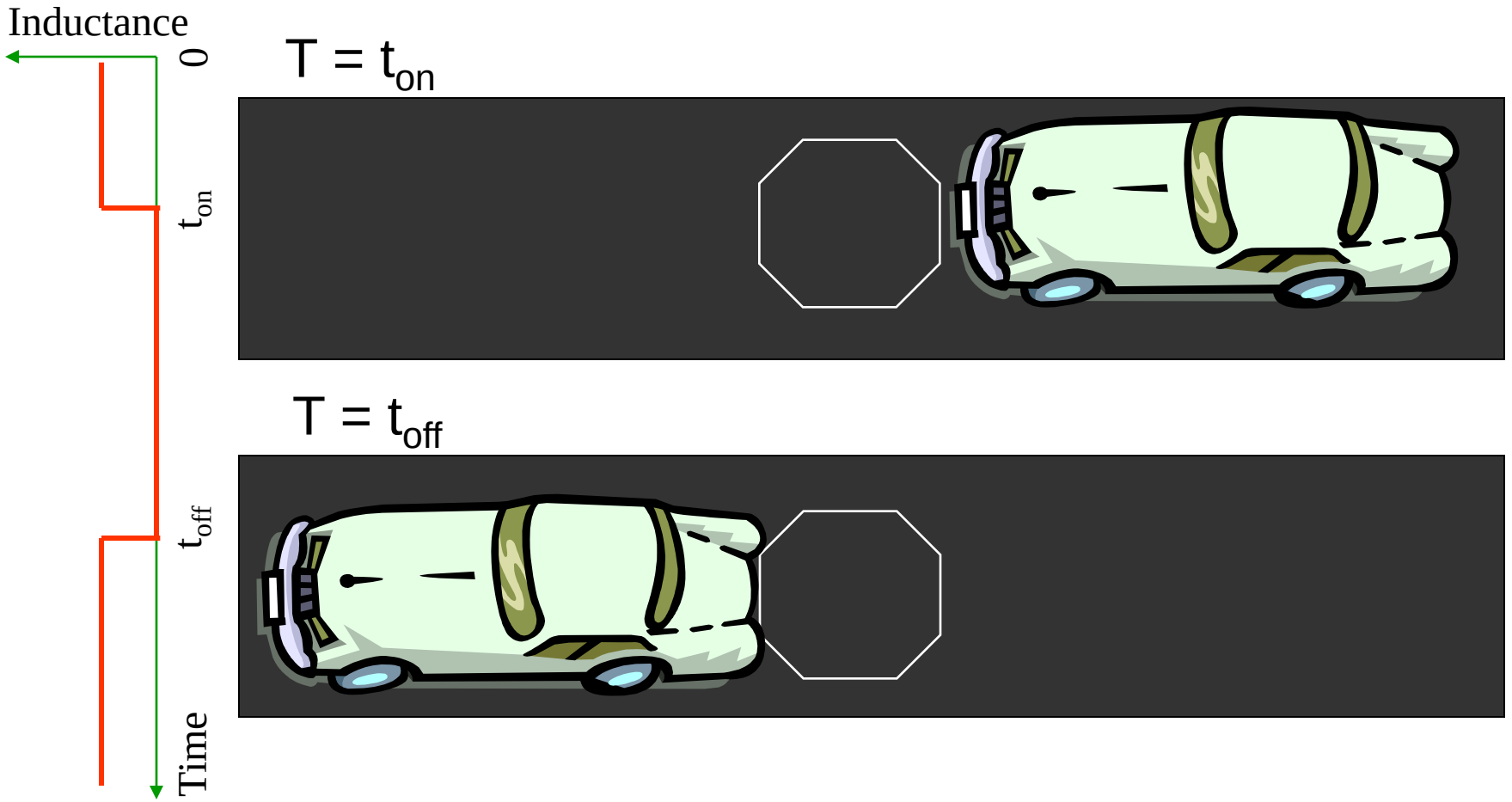




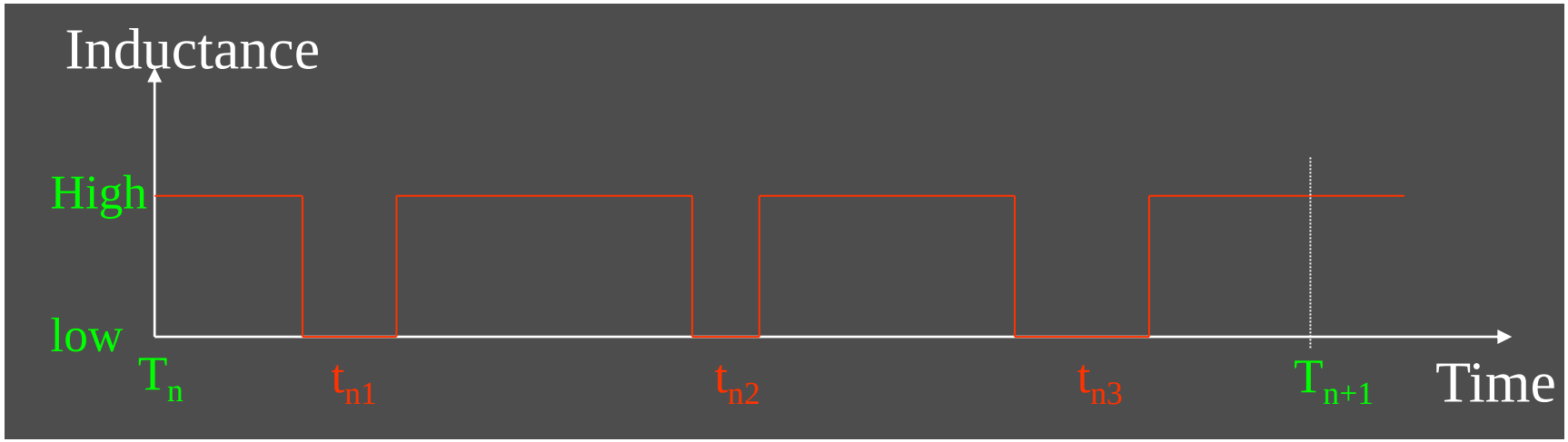



# Inductance Loop Detectors

Loop inductance decreases when a car is on top of it.



# Inductance Loop Detectors



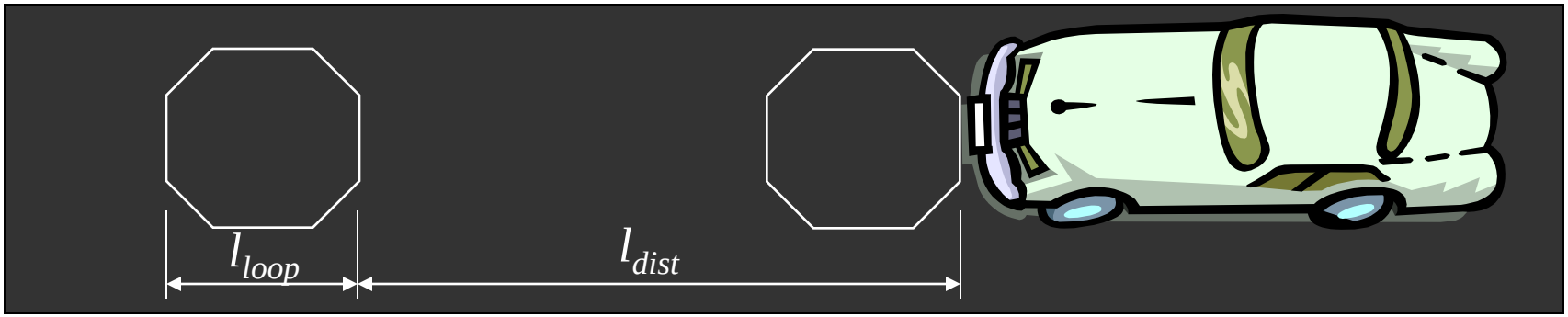

- Single loops can measure:
  - Occupancy (*O*): % of time loop is occupied per interval
  - Volume (*N*): vehicles per interval

# Dual Loop Detector

- Formed by two consecutive single loop detectors placed a short distance apart



# Dual Loop Detectors




T = $t_2$ T = $t_1$

- **Dual loop measurements**

$$Speed = \frac{l_{dist}}{t_2 - t_1} \qquad L_{vehicle} = \frac{Speed(ot_2 + ot_1)}{2}$$

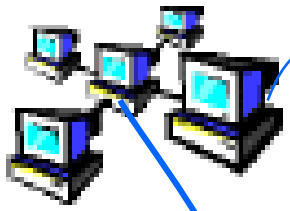
$ot_i$ = on-time for loop detector i

Measured vehicle lengths are used to classify vehicles into different categories, such as long and short.

# Inductance Loop Detectors

**Only 20 sec aggregated data are available from TSMC**

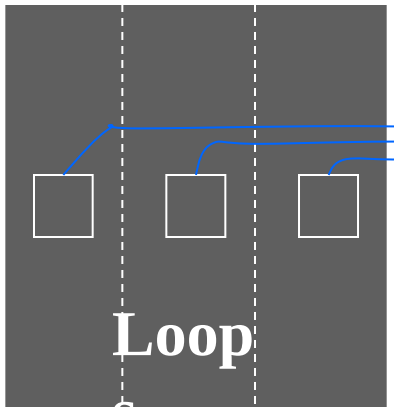




TSMC

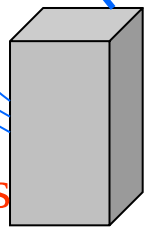
measured data
per 20 sec.

queried
20 sec data
(e.g. 0:00:00 3, 0.98
0:00:20 2, 0.65)



Loop

real time
measurements



Station
cabinet



User

# Can We Get Speed from a Single Loop?

- **Perhaps…**

$$s = \frac{EVL}{t_o}$$

s = speed (ft/sec)

EVL = effective vehicle length (ft)

$t_o$ = occupancy time (s)

EVL ~ vehicle length + detector length

# Can We Get Speed from a Single Loop?

- **Using typical traffic data**

$$s = \frac{N}{T \times O \times g} \times 3600 \quad \frac{\text{sec}}{hr}$$

s = speed (miles/hr)

N = number of vehicles in the observation interval

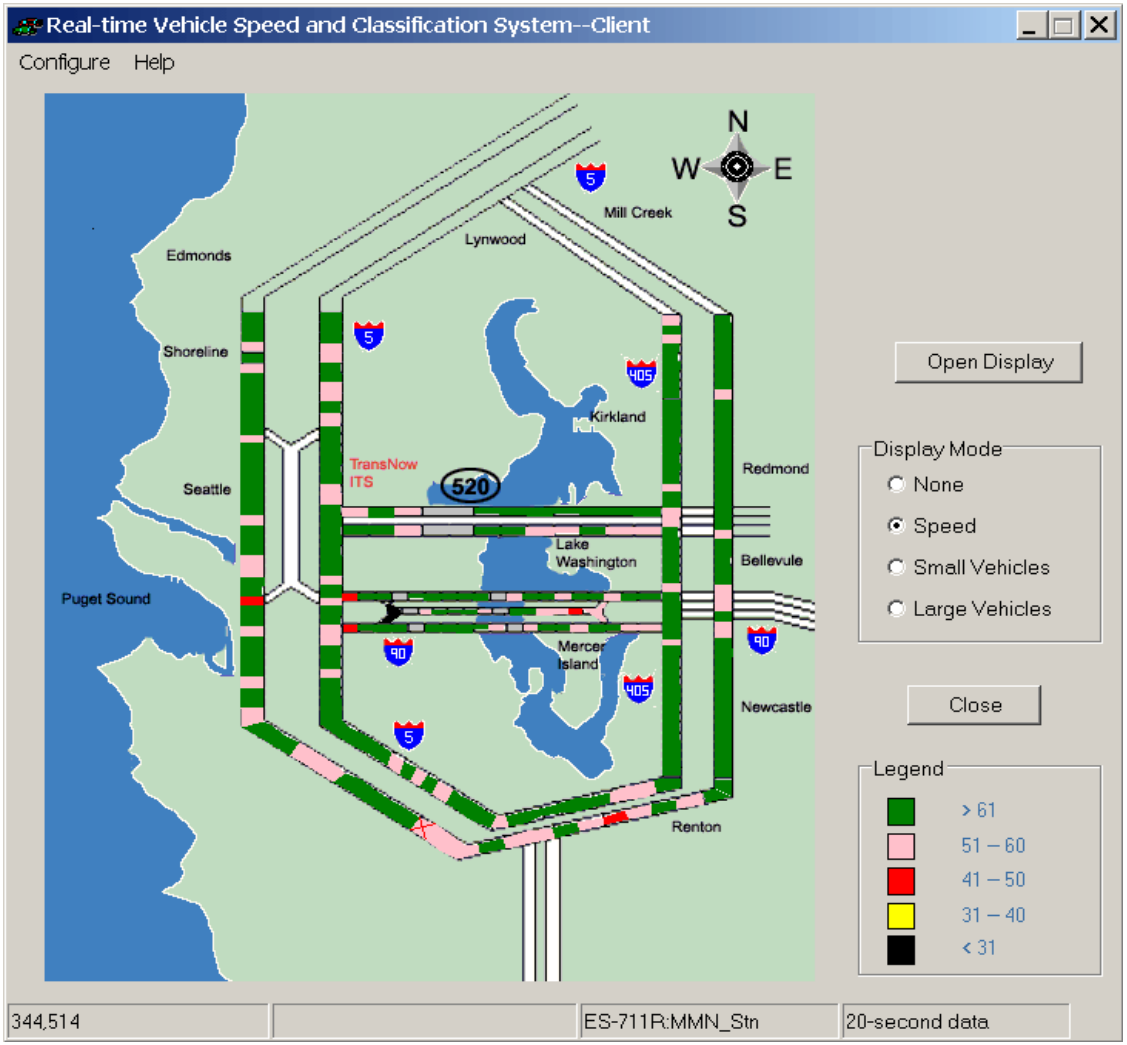
T = observation interval (s)

O = percentage of time the loop is occupied by vehicles during the observation interval (occupancy)

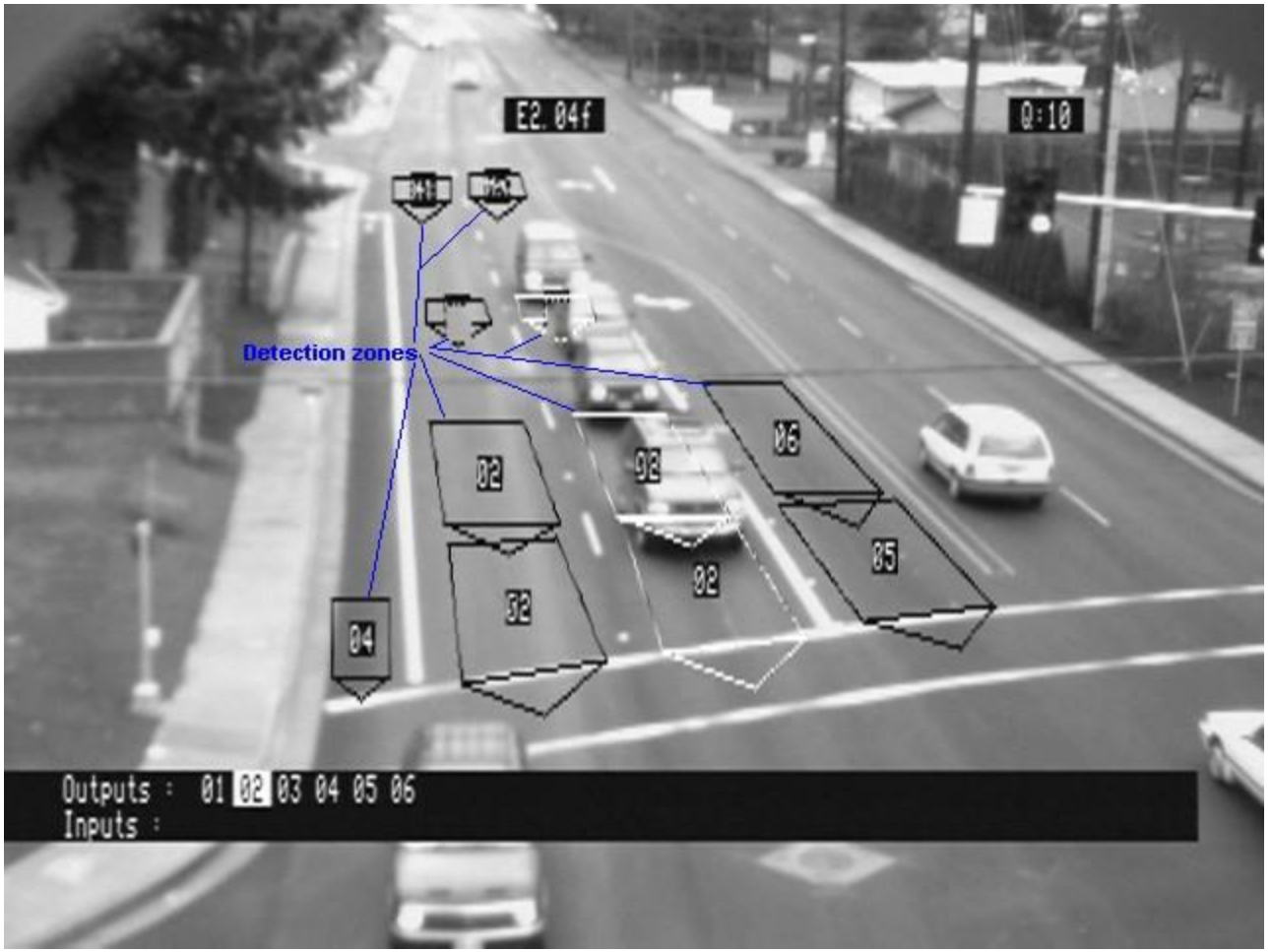
g = speed estimation parameter

$$g = \frac{5280 \quad ft/mile}{EVL \times 100}$$ ← 100 converts percent to decimal

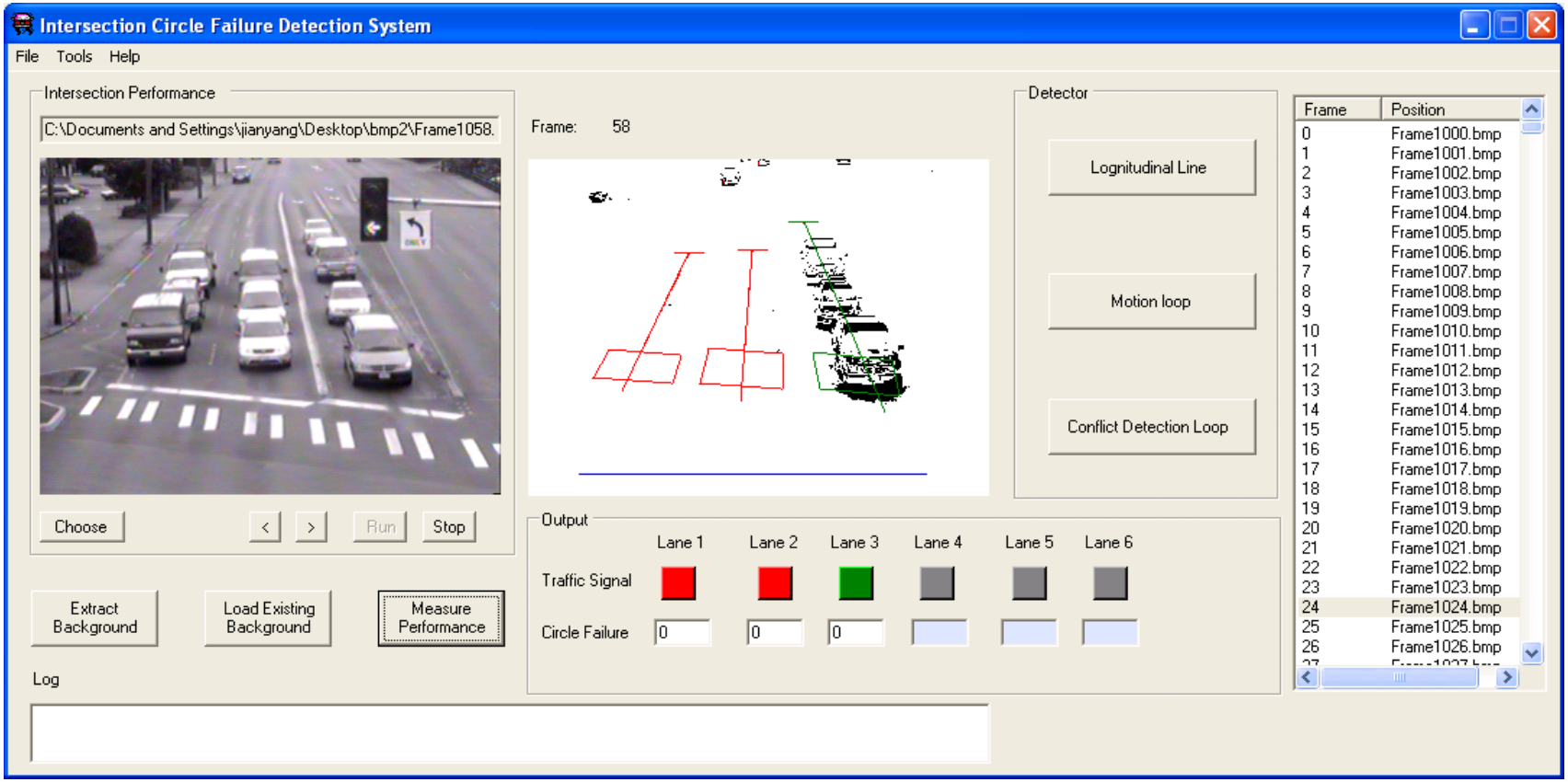
# Inductance Loop Detectors



# Video Image Processors



# Video Image Processors



# A Use Example: Ramp Metering



# Ramp Meter Schematic

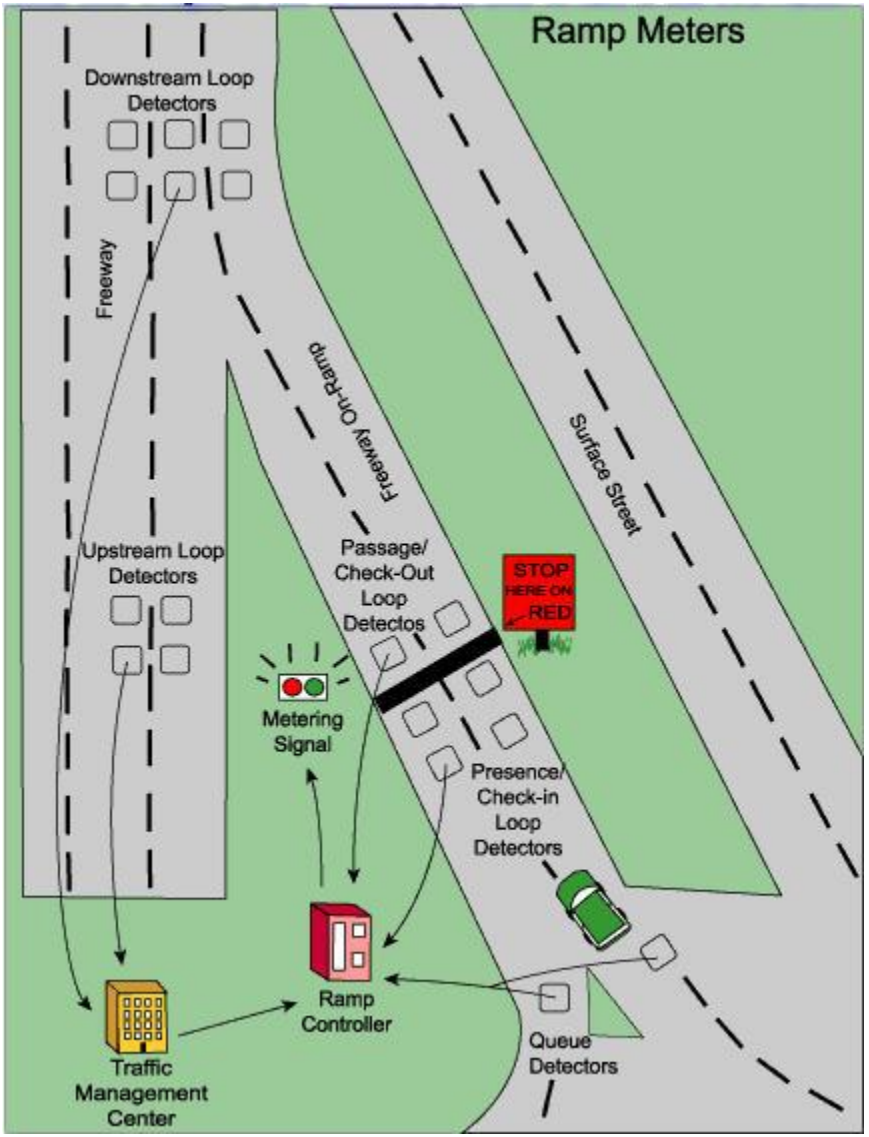
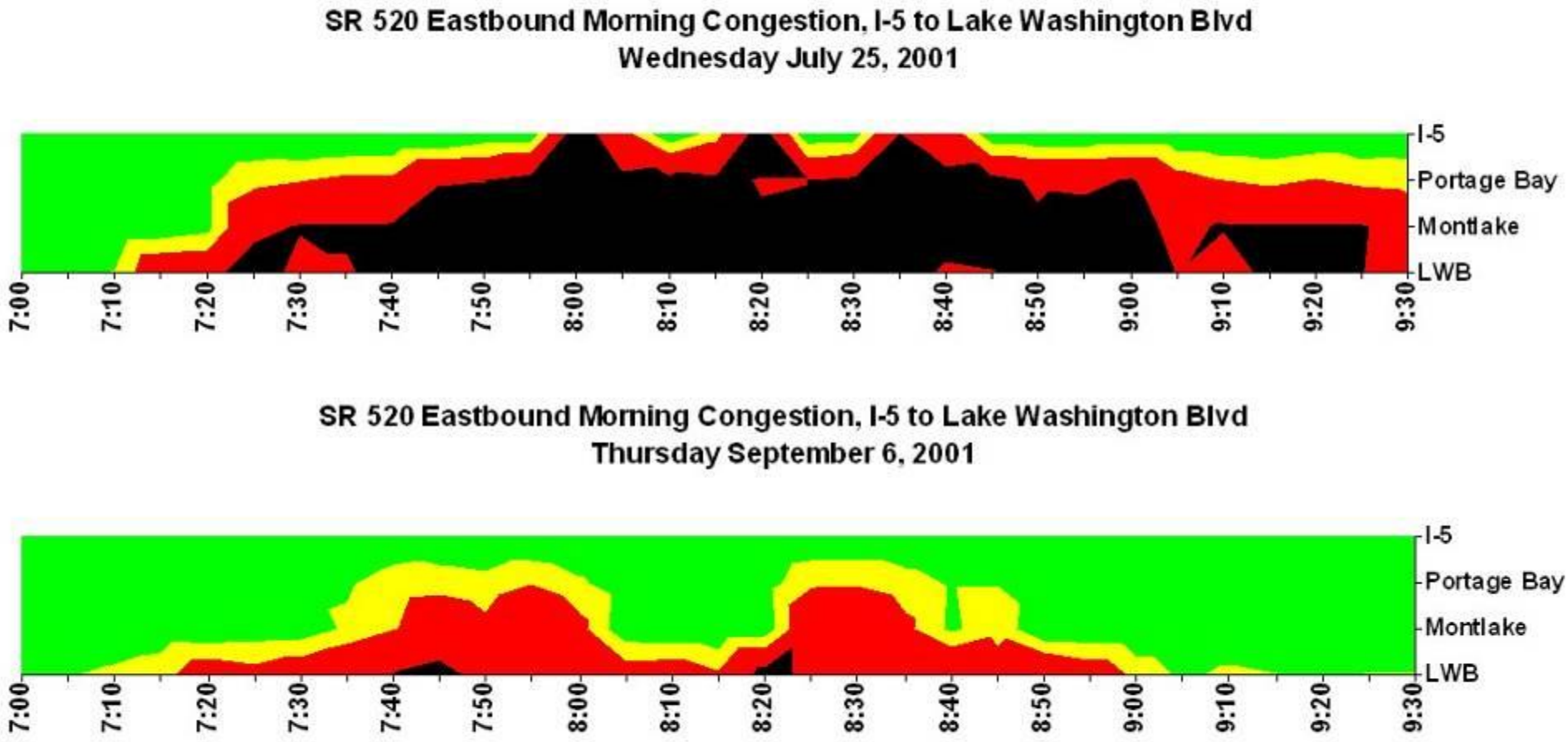



Diagram from
ITS Decision website

# Example: SR 520



# What is the Difference?



# Primary References


- Cosgrove, C. and Cutchin, C. (2003). *ITS Decision*. Website hosted by the California Center for Innovative Transportation at the University of California and Berkeley and Caltrans. http://www.calccit.org/itsdecision

- Wang, Y. (2004). *CEE 599F, Advanced Traffic Detection Systems* Course Pak. Civil and Environmental Engineering, University of Washington.