

CIVIL-349 Traffic Engineering

Traffic Studies & Data Collection

System Monitoring and ITS

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Systems Laboratory (LUTS)**



Traffic Studies

- A traffic engineer's laboratory is the surrounding roadway system
- This system must be continually monitored, evaluated, and managed



Guiding Principles

- “If you cannot tell the system performance yesterday, you cannot hope to manage your system today.”
 - Data Collection/Analysis
- “Data are too valuable to only use once.”
 - Data Archive
 - Real Time and Historical



Traffic Studies

- Traffic demand/patterns will change over time, monitoring of system will enable necessary system changes to be identified
- The effects of system “improvements” must be justified, e.g.,
 - Signal timing changes
 - Lane additions or reconfigurations



Traffic Studies

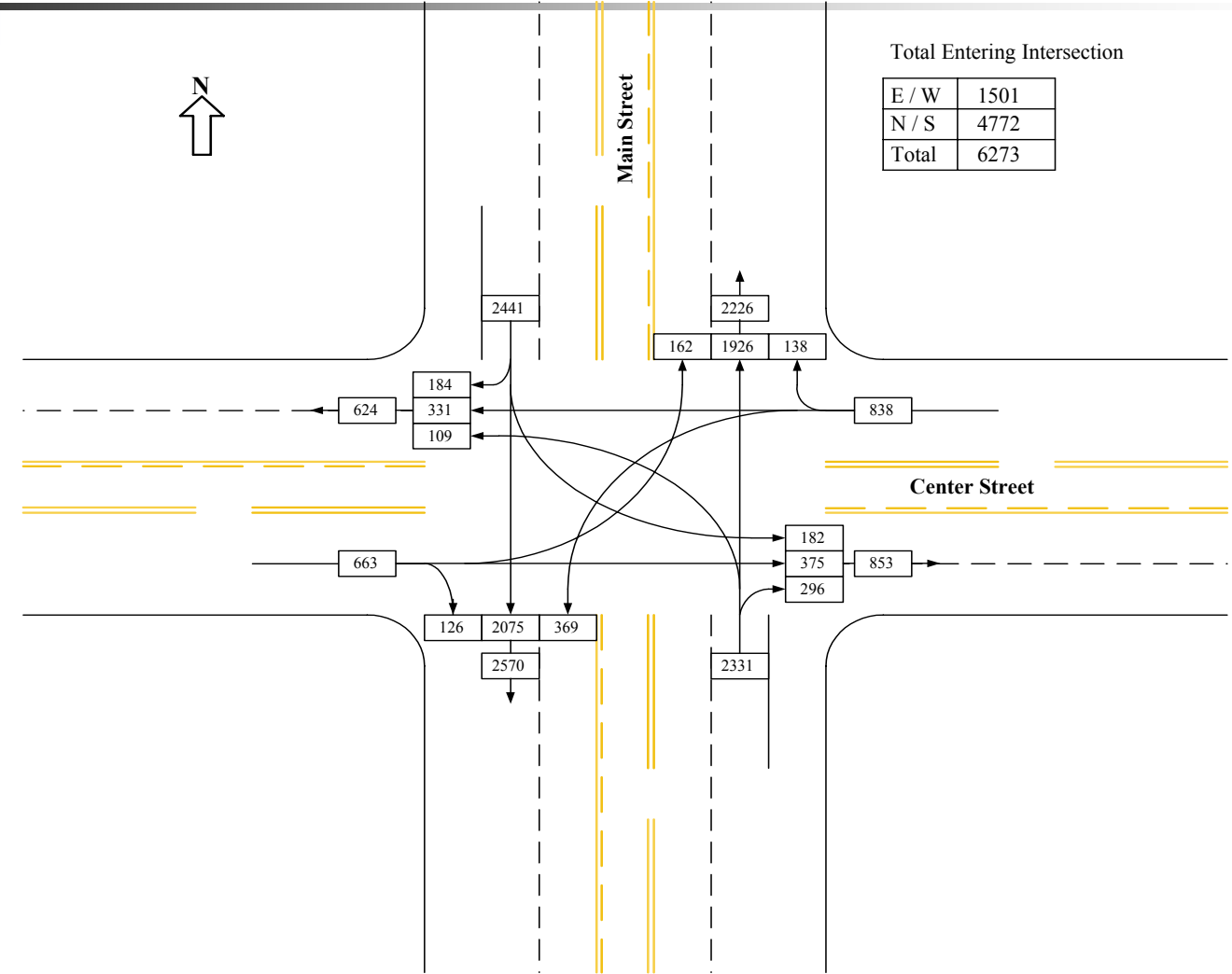
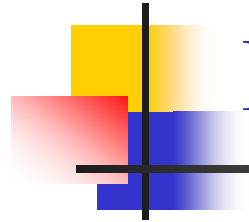
- Data collection is the key foundation
 - What kind of data?
 - How much data?
 - How to collect it?
- The study characteristics must be considered in answering these questions, e.g.,
 - Short-term or long-term study
 - Statistical confidence level



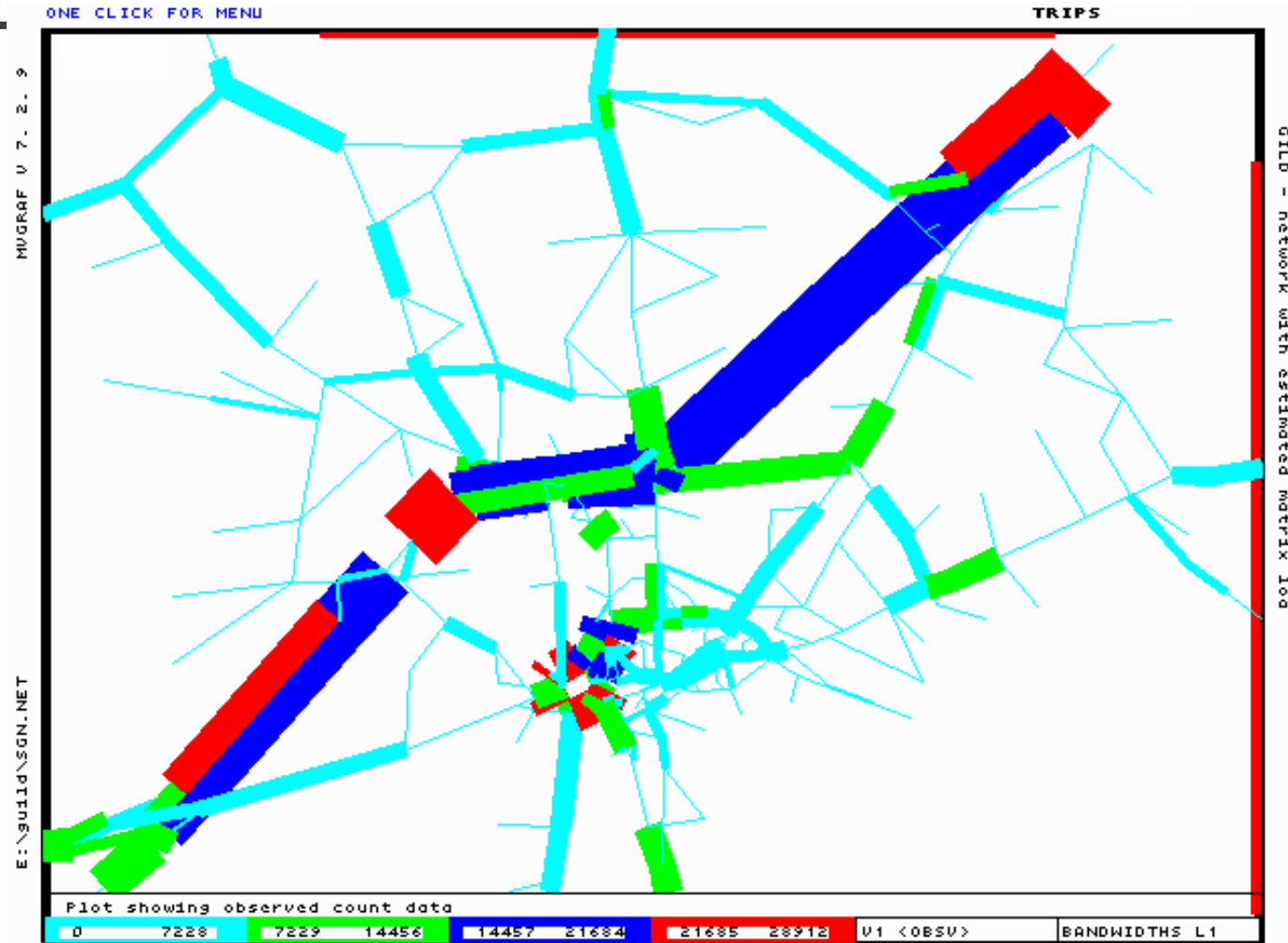
Temporal Variation

- Monthly (Jan. – Dec.)
- Daily (Sun. – Mon.)
- Hourly (12:00 AM – 11:59 PM)
- K values (e.g., K_{100} , K_{30})
 - The ratio of the X^{th} highest traffic volume hour of the year to the AADT (Average Annual Daily Travel)
 - Historically, 30^{th} has been used in rural planning, design and operations. (generally flatten out from this point)

Graphic Summary of Vehicle Movements



Traffic Counts Displayed in a Network



Measurement methods

- measurements at a (cross-sectional) point
- measurements along a short distance
- measurements along a length
- measurements along an arterial or small area (by e.g. moving observer method)
- other realtime large-scale monitoring methods

Measuring means

Measuring passage times, time headways, and flow

- manual counting, using a form and a stopwatch. Advantage: simple method; Disadvantage: labour costs and inaccuracies.
- Pneumatic tubes. Advantage: can accurately determine passage times and time headways; Disadvantage: relatively short time survival.
- Induction loops.
- Infrared detector.
- Instrumented vehicles (moving observer method).

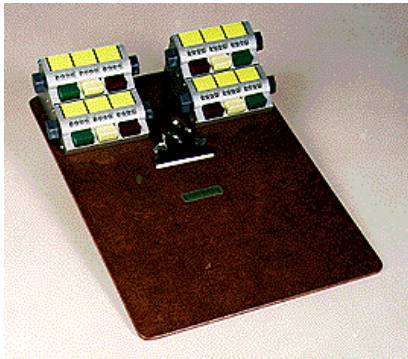
Individual speeds, instantaneous, and local mean speed

- Radar speedometers at a cross-section.
- Induction loops or double pneumatic tubes.
- vehicle recognition.
- Probe vehicles.
- Remote-sensing techniques.

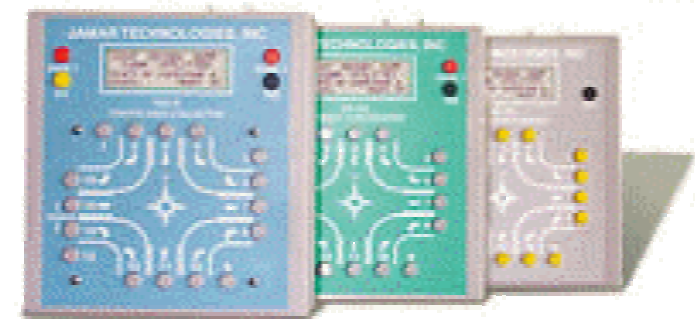
“Manual” counting



Manual Count Board



JAMAR Handheld Devices



Pneumatic tube



Pneumatic Road Tubes





Inductance Loops

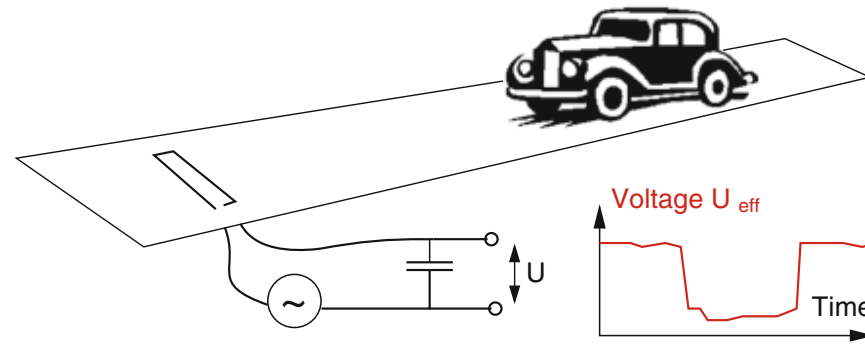
Vehicle Loops



Bike Loops

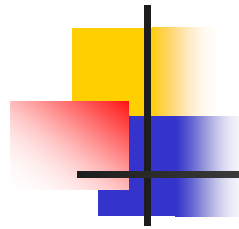


Microscopic measurement at induction loops



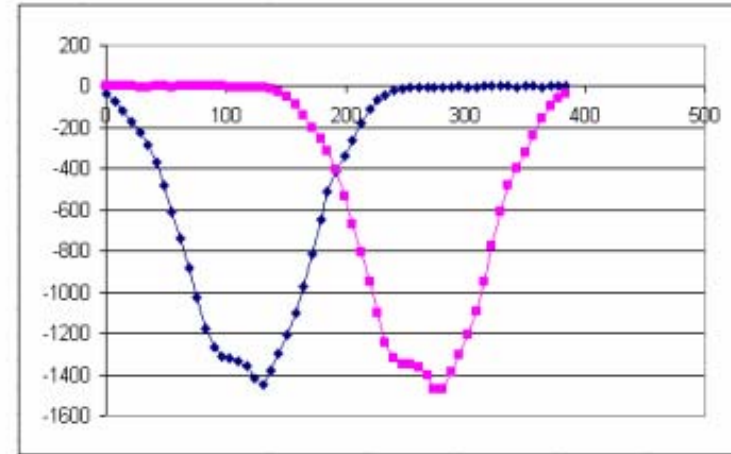
A single-loop detector can directly measure (only):

- The time t_{α}^0 at which the front of vehicle α passes the detector (voltage drop),
- The time t_{α}^1 at which the rear end of the vehicle passes the detector (voltage rise)

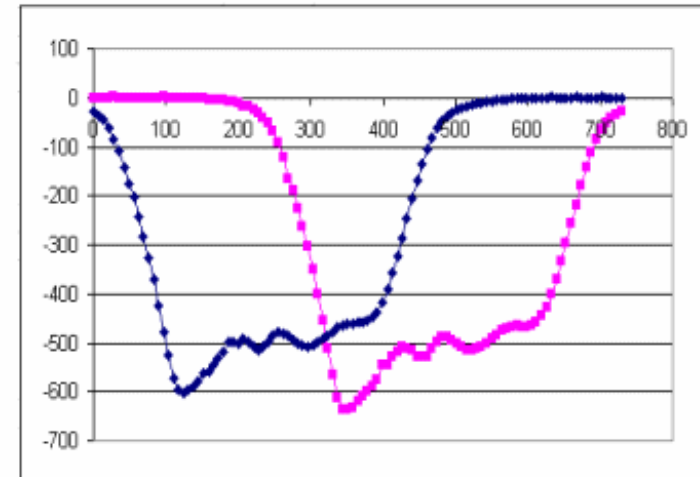


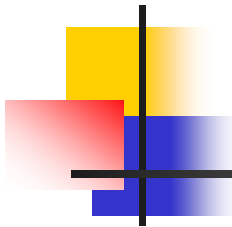
Inductance Loop Signatures (1)

Sport Car



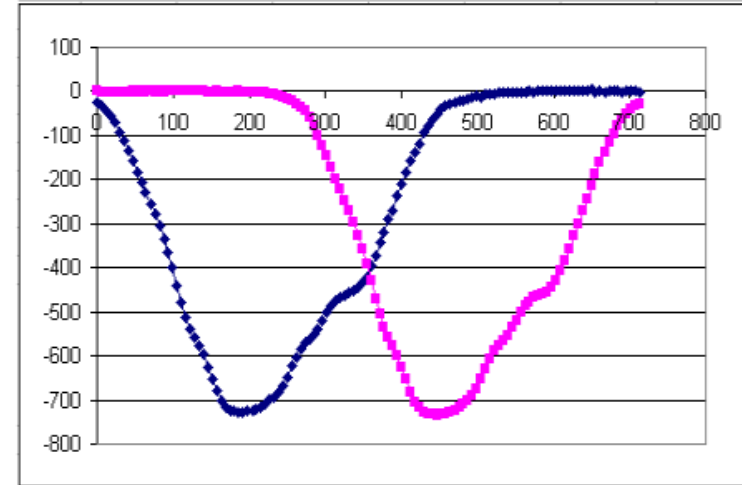
Truck



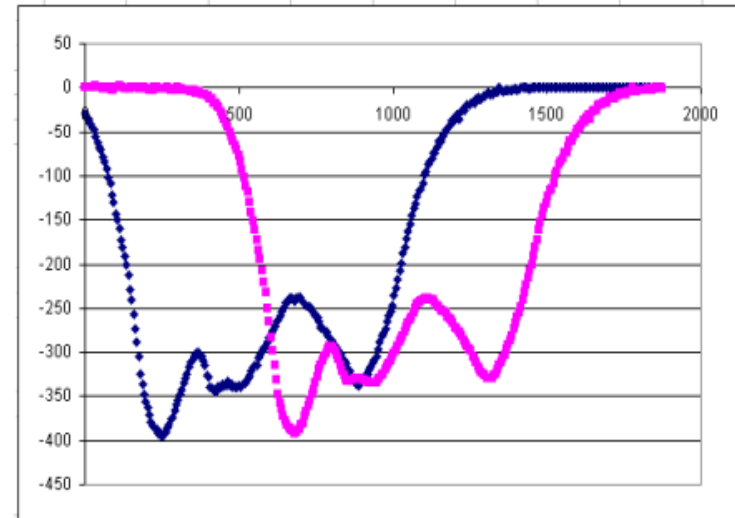


Inductance Loop Signatures (2)

Pickup Truck



Trash Truck





Density

- Aerial photographs
- Volume / Speed
- Surrogate measure from inductance loop detectors
 - Ratio of occupied time to total observation time, expressed as a percent, is termed ‘lane occupancy’, denoted by ϕ (phi)

$$\phi = \frac{\text{total occupied time}}{\text{total observation time}} * 100$$

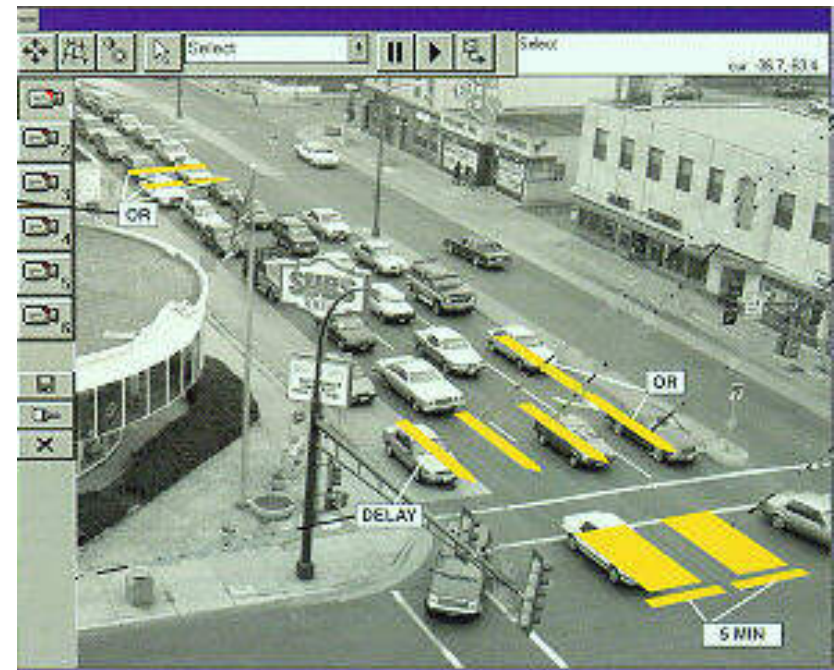
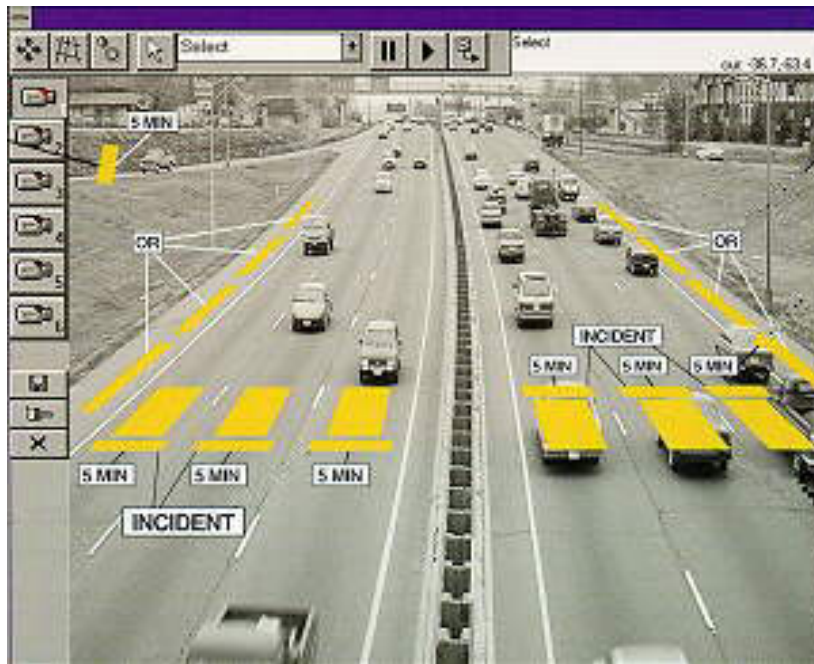
- To use lane occupancy for estimation of density, we must know vehicle length, then density can be estimated by

$$k = \frac{\phi}{100} \frac{1}{L_e} \quad L_e \text{ is the effective vehicle length}$$

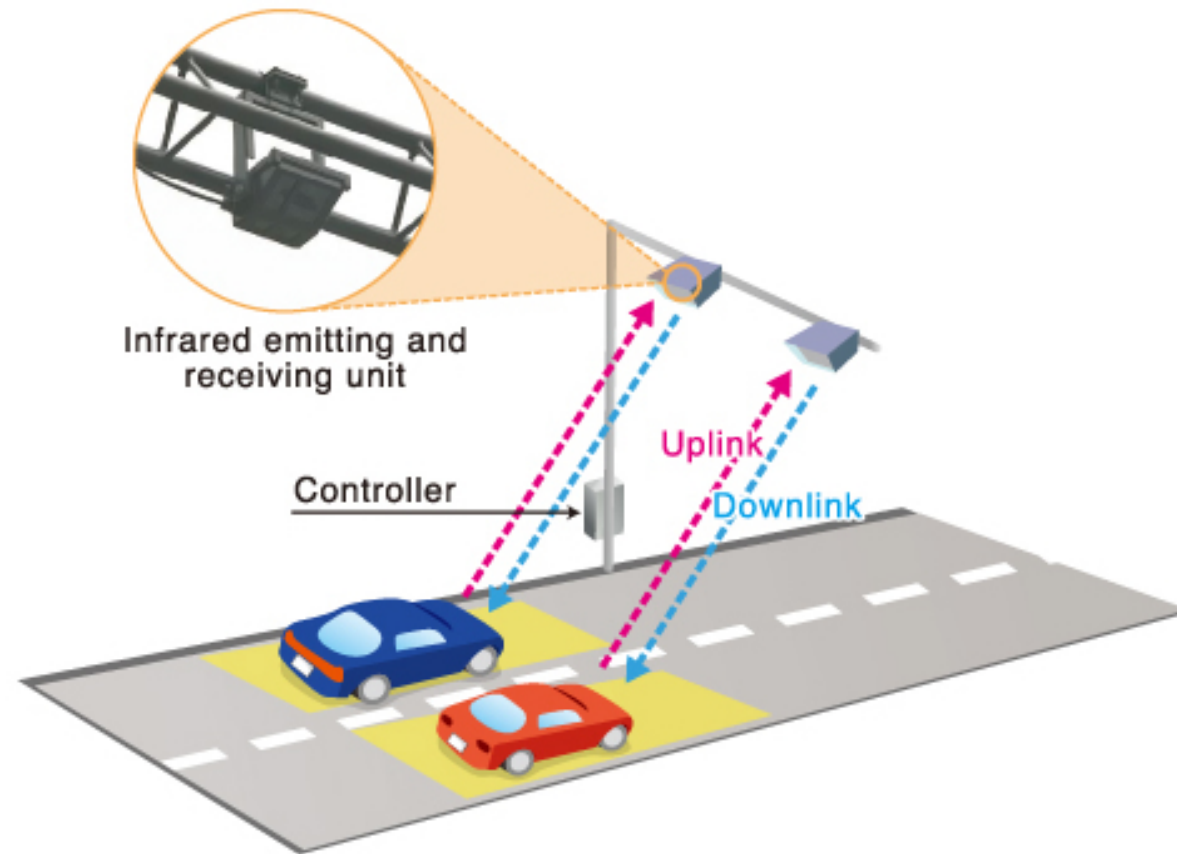
Video Imaging



- Autoscope software



Infra-red sensors



Vehicle Plate Recognition

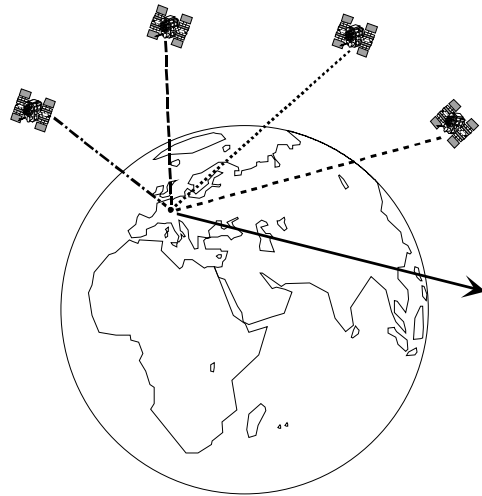
The screenshot displays the CSR Surveillance software interface, which is used for monitoring and analyzing video feeds from multiple cameras. The interface is divided into several panels:

- Servers Devices:** A panel on the left showing the start and end times for the search (Thursday, April 14, 2011) and the camera number (1). It includes a search button and tabs for Time Stamp Interval, Statistics, and Graphs.
- ANPR Detectio:** A table listing detected vehicles with columns for ID, time stamp (ts), license plate number (plateNr), and camera ID (idCamera). The entry for ID 9615114 is highlighted.
- ID Record:** A detailed view of the selected vehicle, showing the ID Record (9615114), Time Stamp (4/14/2011 9:40:37 AM), License Plate Number (B43CSX[ws]), and Camera (1). Below this is a small image of the vehicle.
- Timeline:** A central panel showing a timeline of events from 10:00 AM to 12:00 PM. The timeline is represented by horizontal bars with colored markers indicating detected vehicles.
- Camera Tree:** A panel on the right showing the camera configuration, including Camera 1 and Camera 2, both of which are turned on.
- Alarm Log:** A panel on the right showing a list of alarms, including the date, time, camera, and user. The log shows multiple entries for the date 04/14 at 12:00 PM, all from Camera 1.
- Server List:** A panel on the right showing the status of the server (csr-dev2) as Connected.
- Video Feed:** A large central window showing a live video feed from Camera 1. The feed shows a street scene with several cars. A red box highlights a dark car, and a yellow arrow points to it. The video feed includes a timestamp (12:16:41 04/14/2011) and a status bar (In: 102, Out: 0). Below the video feed is a control bar with various icons for navigation and playback.

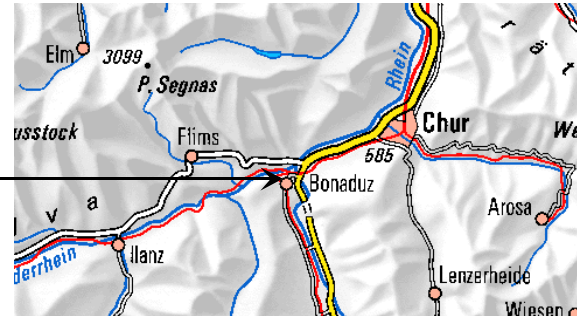
Session ID: 1563 | CSR SESSION STARTED... successfully loaded

12:19 PM
4/14/2011

GPS receivers

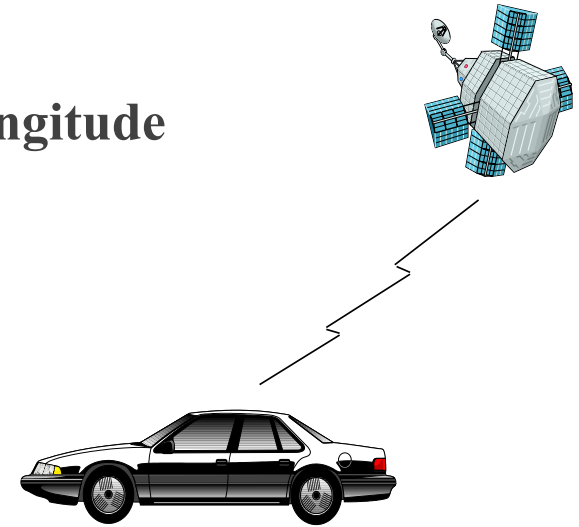


Longitude: 9°24'23,43"
Latitude: 46°48'37,20"
Altitude: 709,1m
Time: 12h33'07"



Global Positioning System (GPS)

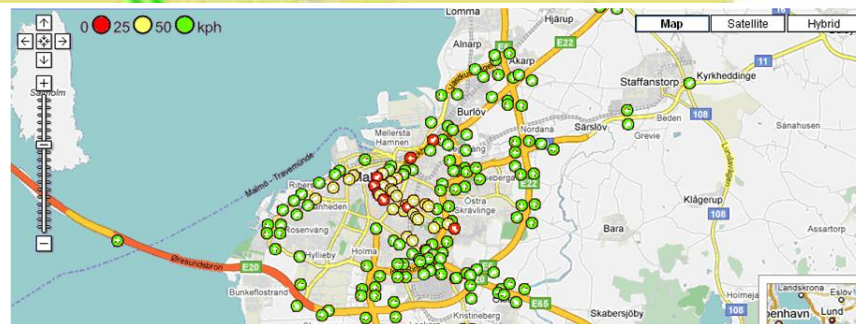
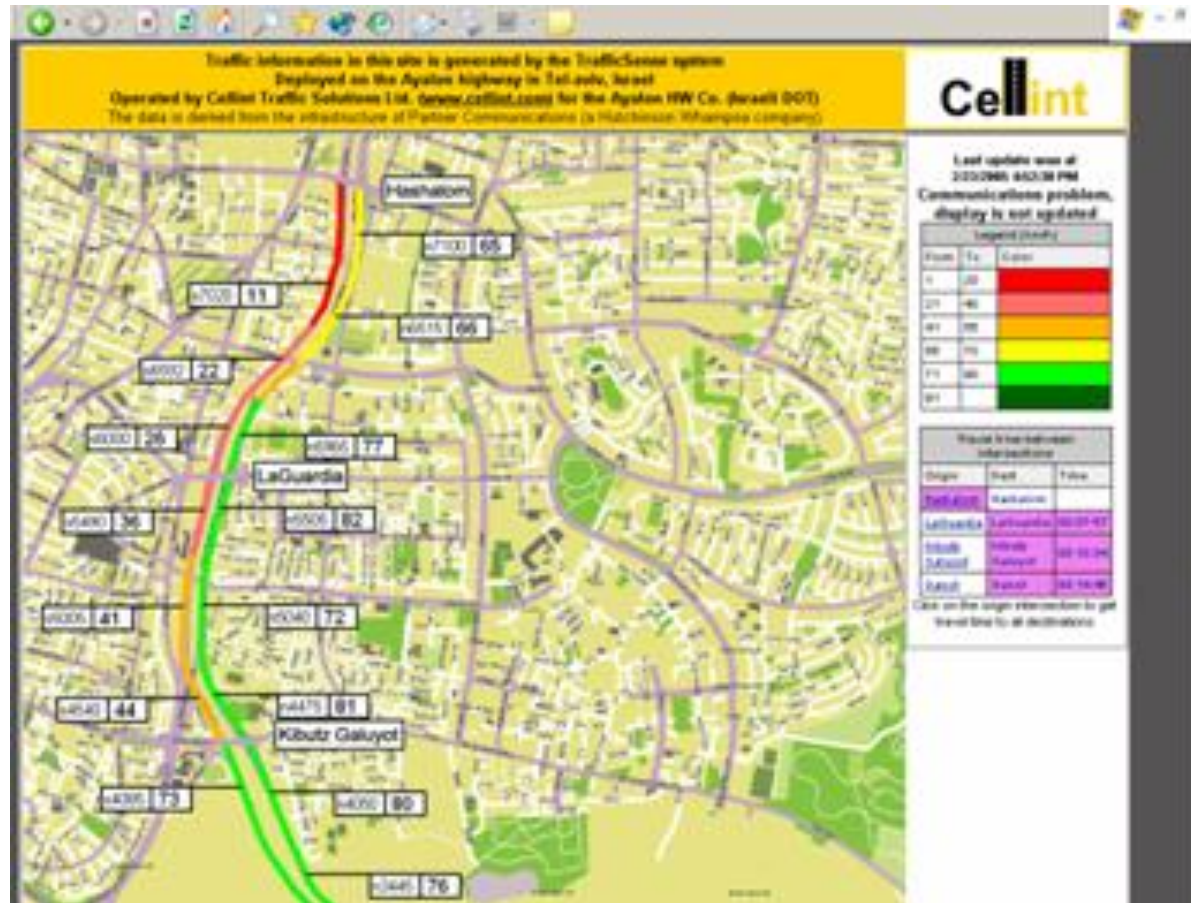
- GPS Time
- Latitude and Longitude
- Speed



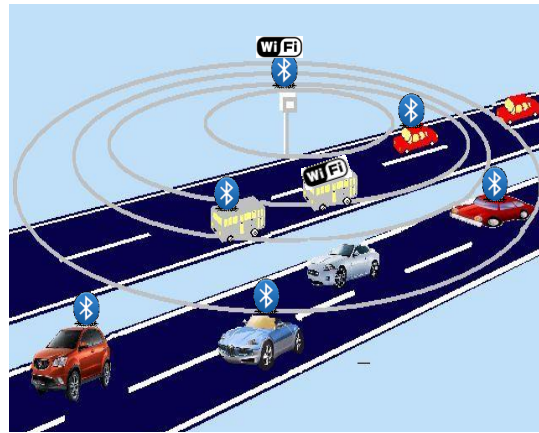
Typical GPS Data

Time (UTC)	Latitude (°)	Longitude (°)	Speed (mph)
16:27:39	30.389885	-91.242426	40.0
16:27:40	30.390090	-91.242276	40.6
16:27:41	30.390159	-91.242225	40.7
16:27:42	30.390298	-91.242122	41.0
16:27:43	30.390507	-91.241966	41.8

Cellular antennas



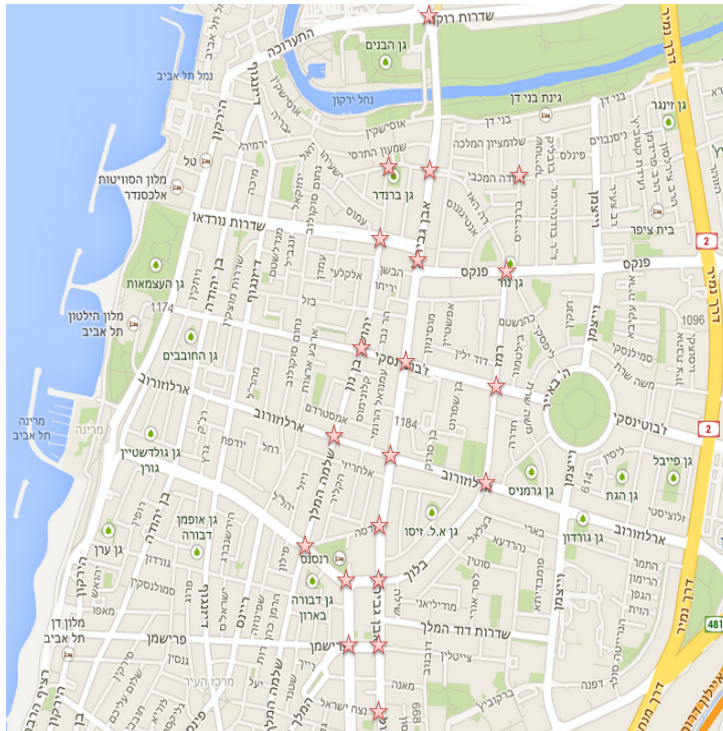
Bluetooth sensors



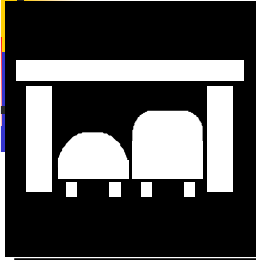
Estimate travel times between sensor points

Estimate O-D tables

Estimate average speeds



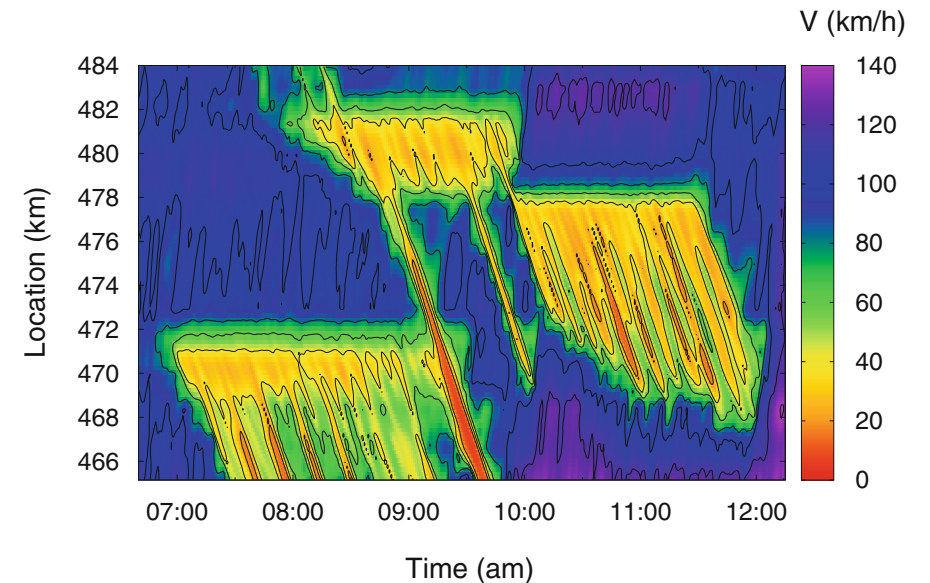
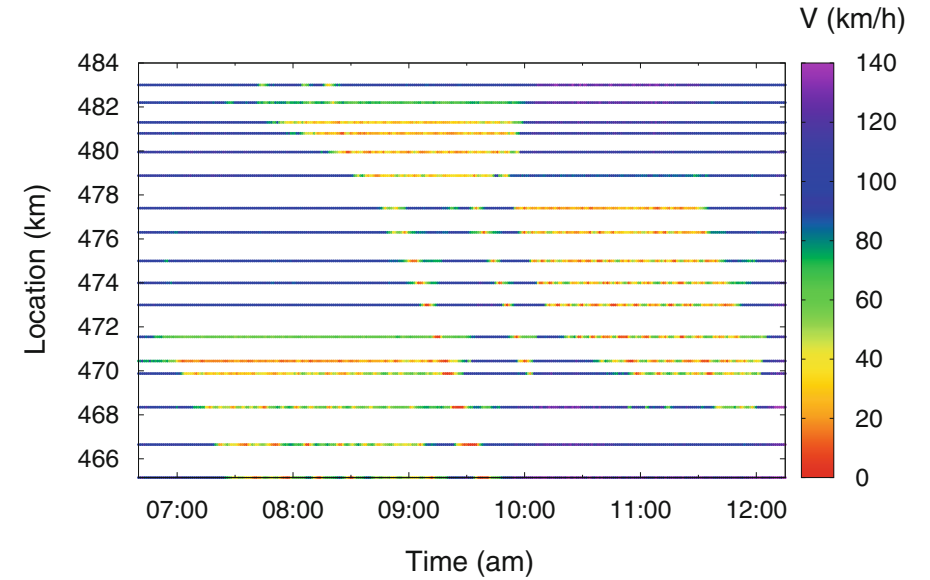
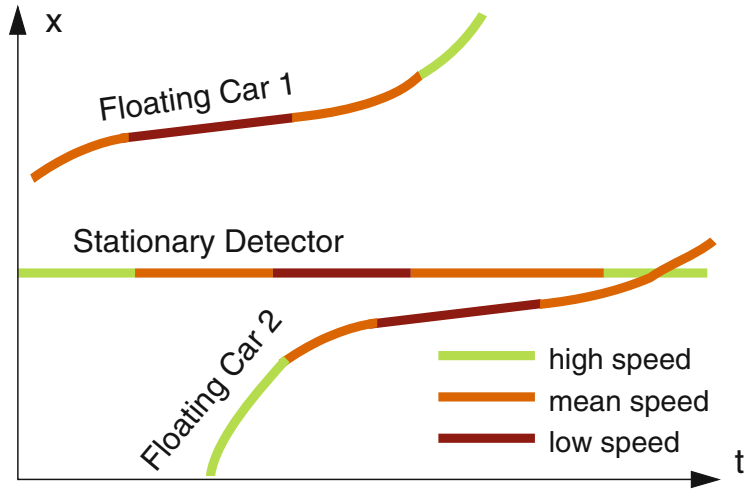
Electronic Toll Collection (AVI)

A photograph of a toll sign with a table of toll rates. The sign is green with white text. The table is titled "TOLLS CASH" and lists various toll rates for different vehicle types and distances.

TOLLS CASH		
1	\$0.75	\$0.40
2	\$1.00	\$0.75
3	\$1.50	\$1.15
4	\$1.00	\$0.75
5	\$1.25	\$0.95
6	\$1.75	\$1.20
7	\$2.25	\$1.75
8	\$2.75	\$2.10

Data Fusion

- the process of combining data from multiple, heterogeneous data sources such as cross-sectional data, floating-car data, police reports, etc.
- each of these categories of data describes different aspects of the traffic situation and might even contradict each other.
- the goal of data fusion is to maximize the utility of the available information.



Data: Autobahn A5 near Frankfurt/Main, Germany (source: [https://www.trafficdata.de/](#))