# Utilization of Connected Vehicle Data to Support Traffic Management Decisions

**Presented by**

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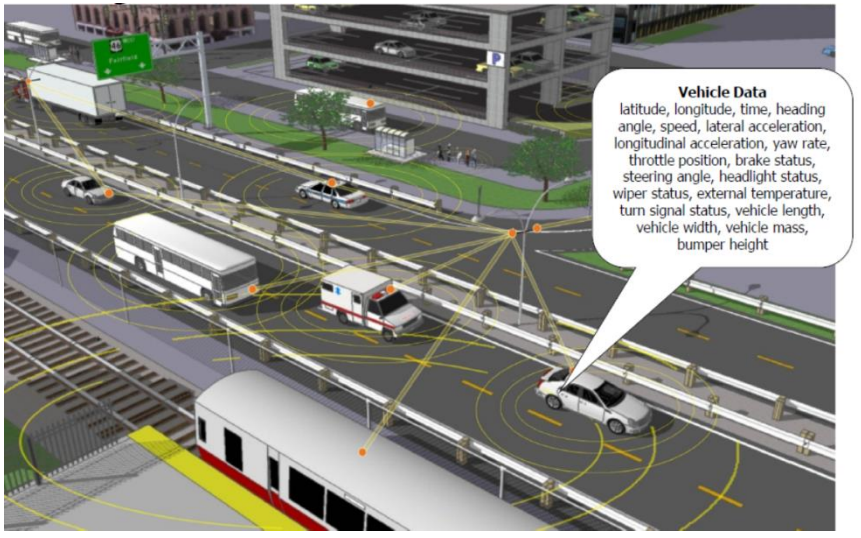
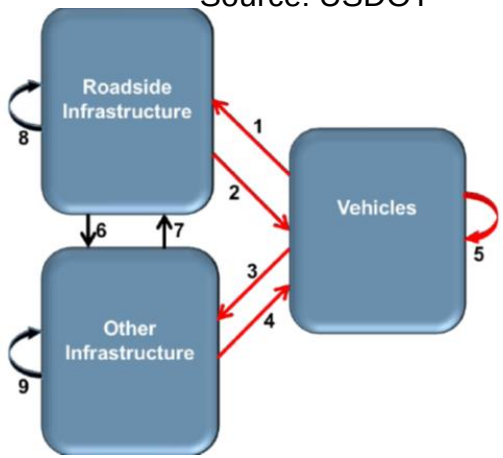


# Benefits of Connected Vehicle Data

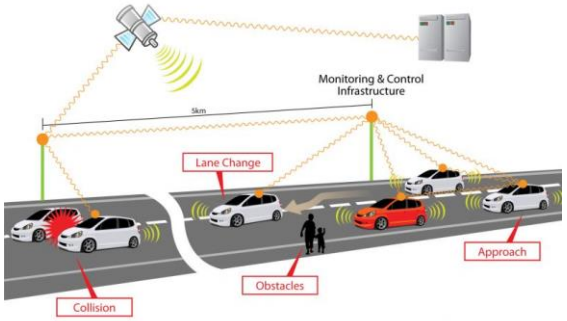
- Higher details and additional parameters allowing better management
- Better understanding of congestion and influencing factors
- Extended geographic coverage
- Better performance measurements
- Potentially lower data collection costs

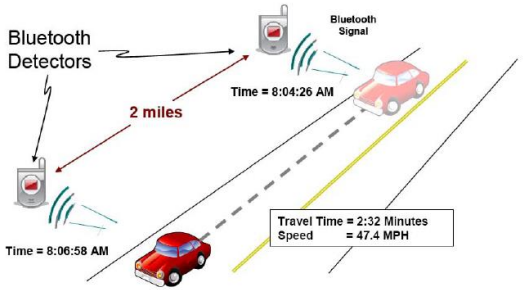
Source: USDOT



# Relevant Statements from AASHTO FootPrint Study

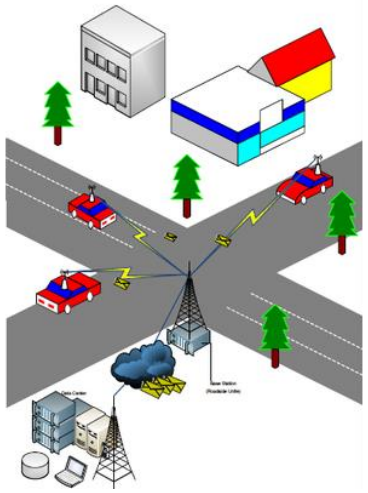
- CV provide opportunities to enhance current capabilities or to reduce ongoing costs of operating and maintaining existing ITS systems.
- Need for assessments and trade-off the use of CV probe data versus traditional ITS detection versus purchasing data
- Connected vehicle technology deployment may complement existing ITS capabilities




# Basic Safety Messages

- BSM Part 1 is transmitted at a rate of about 10 times/sec
- BSM Part 2 includes optional data elements transmitted at lower frequencies and when triggered by events
- No vehicle ID → trajectories and O-Ds cannot be generated
- No messages are stored on the OBU
- Can be captured when in the range of RSU or sent through cellular network for V2I applications

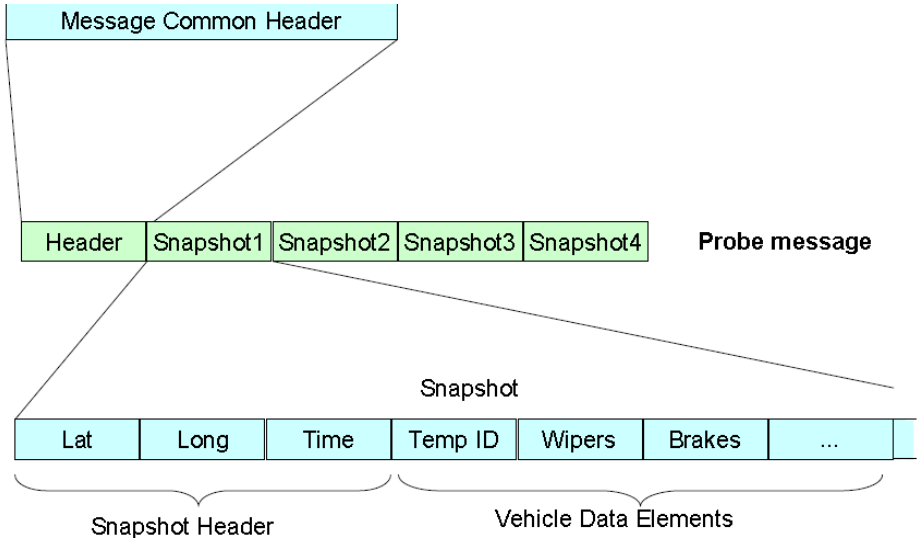


# J2735 BSM Message Sets

| BSM Message Sets | Messages |
|---|---|
| BSM Part 1 | • Vehicle position (longitude, latitude, elevation, position accuracy)<br>• Motion (speed, heading, acceleration)<br>• Control (status of brake, traction control, stability control, ABS, Brake Boost, and Auxiliary Brake)<br>• Size (vehicle length, vehicle width). |
| BSM Part 2 (Optional) | • Information about events as they occur, such as hard braking, flat tire, or activation of emergency response status, anti-lock brakes, air bag deployment, windshield wipers, etc.<br>• Information about the vehicle's immediate past trajectory; projections for the near-future trajectory<br>• Status of vehicle systems (wiper status, light status, braking status)<br>• Environmental sensor readings<br>• Vehicle physical dimensions<br>• Vehicle identification and description information<br>• Detailed physical information for trucks |

# Probe Data Management Messages

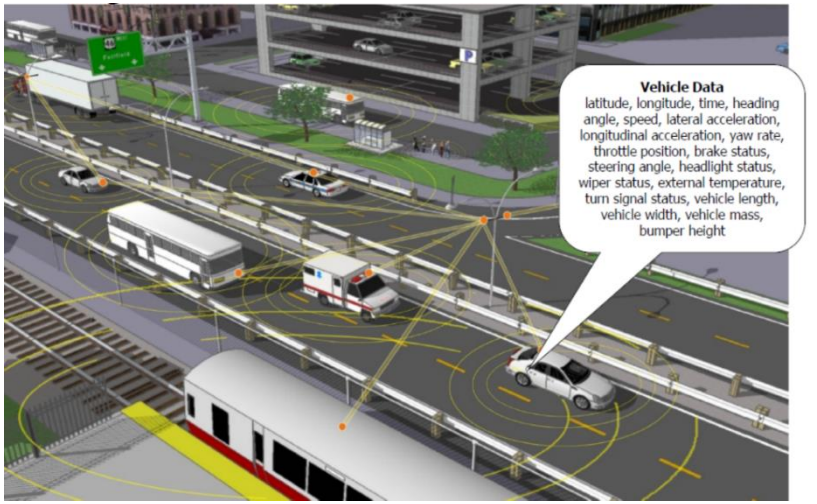
- Snapshots sent periodically
- Protects vehicle anonymity → trajectories and O-D cannot be generated
- Limited number of snapshots saved on OBU and purged after transmission.



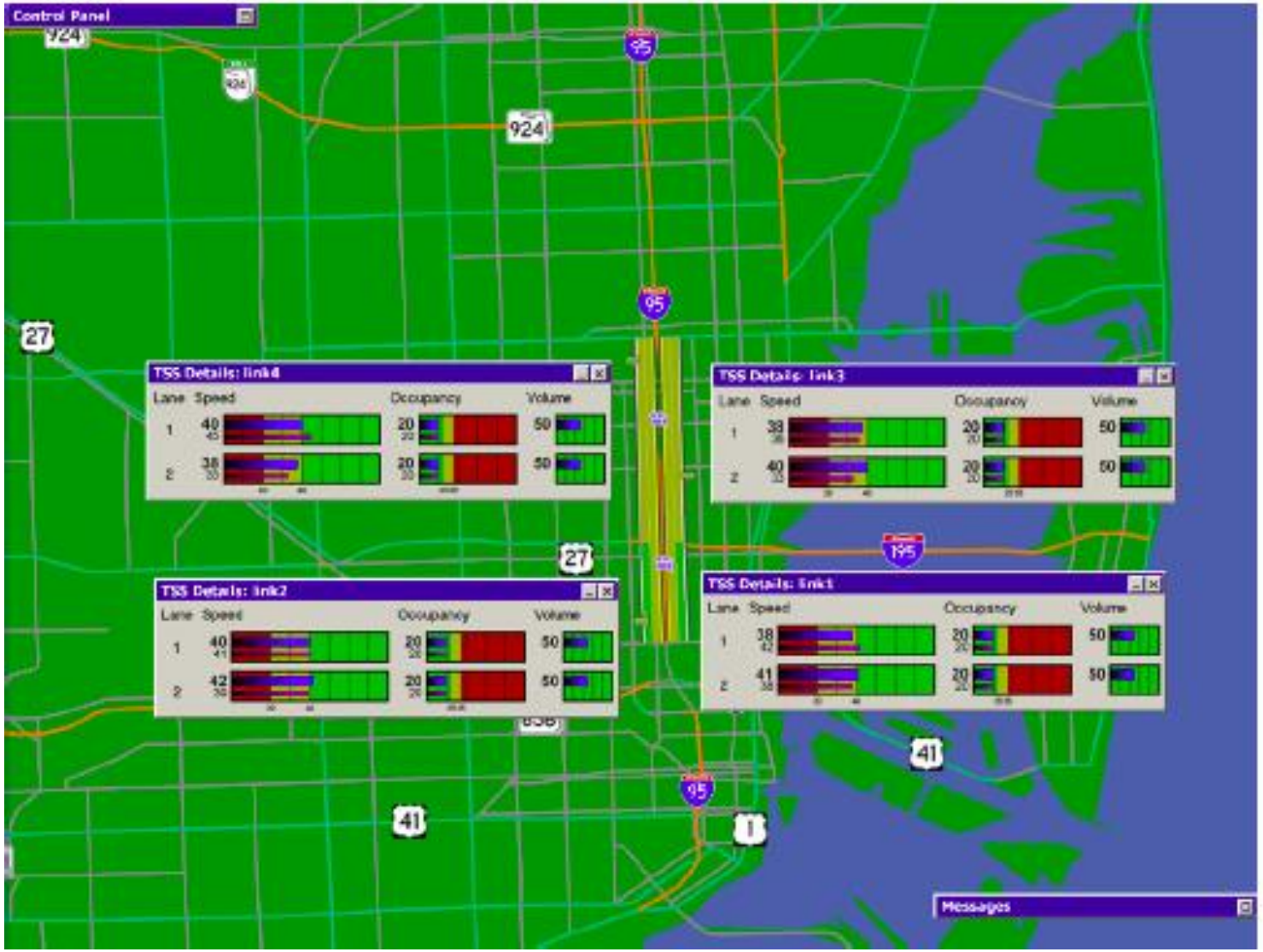
# FDOT Research Project

- Examination of the data that can be obtained from connected vehicles
- Identification of the SunGuide TMC processes and modules that will benefit from data
- Examination of the ability of real-world CV deployment to support TMC and potential updates
- Comparing the use of DSRC and cellular technologies

Source: USDOT

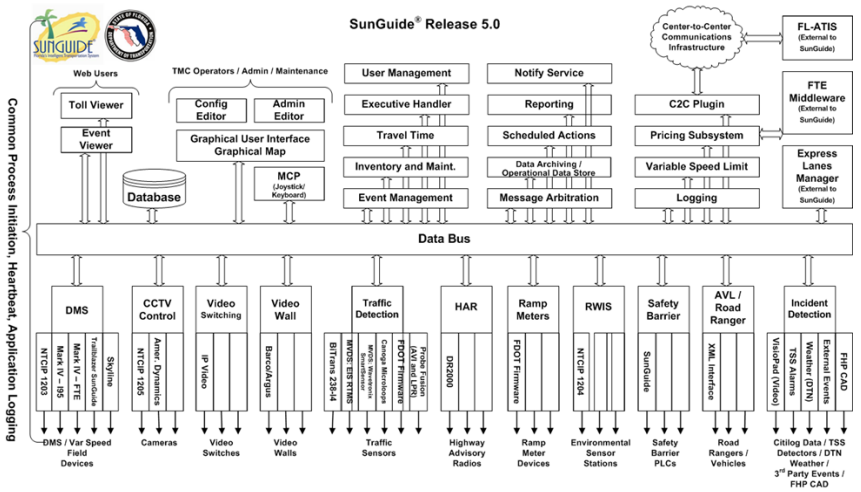


# SunGuide Software



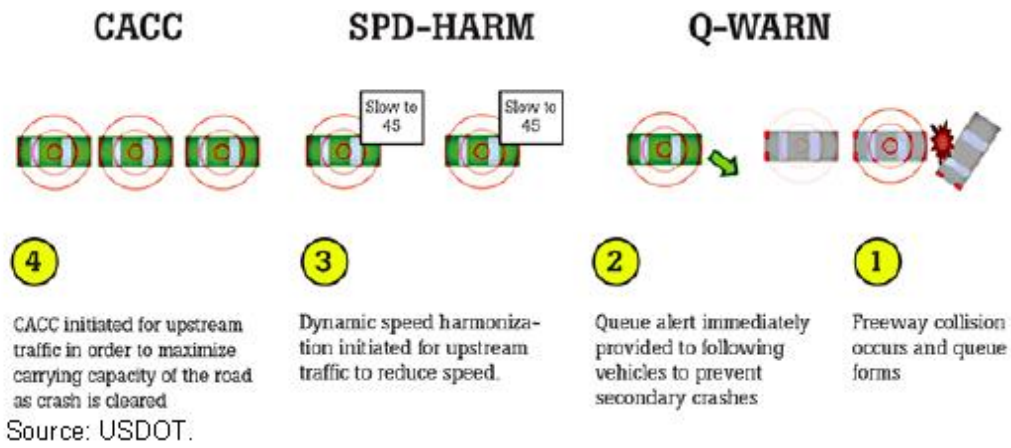
# Relation of CV to SunGuide Modules

- Traffic detection and travel time estimation →Real-time performance monitoring
- Data archiving → Performance measurement for planning
- Florida ATIS (FLATIS) → EnableATIS concepts
- Incident detection → faster with less number of false alarms
- Event Management → Event details, responder details and support/routing, and response/detour plans
- Ramp Meters → Next Generation Ramp Metering
- VSL → Speed Harmonization
- RWIS -> WRM
- Express lanes
- AVL / Road Ranger



# Potential Future Applications

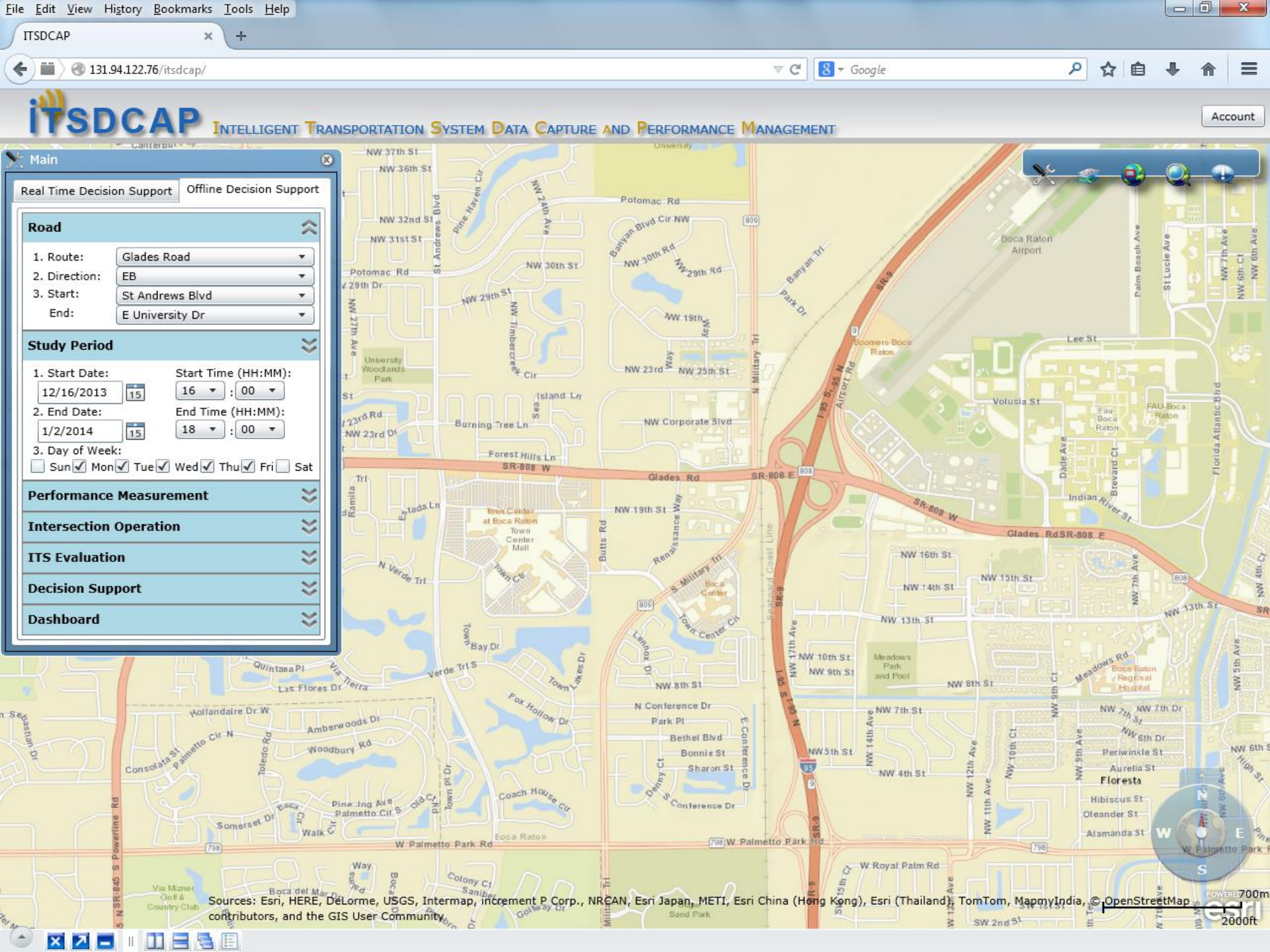
- Queue Warning
- Lane Control
- Cooperative adaptive Cruise Control



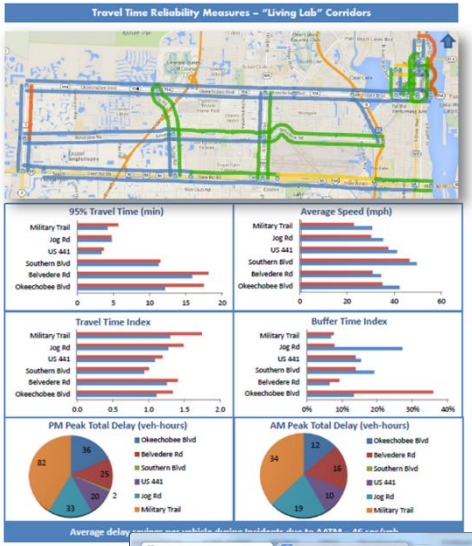
Source: USDOT.

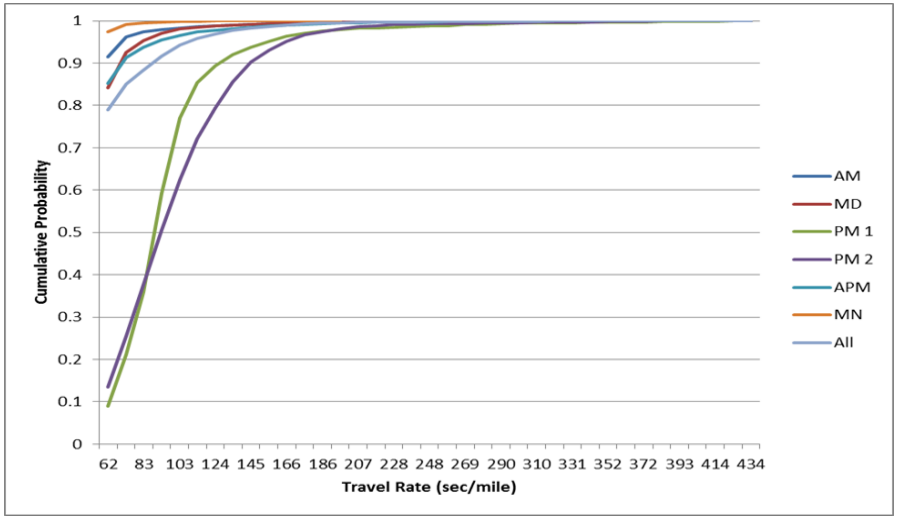
# Data Analytic Tools → ITSDCAP

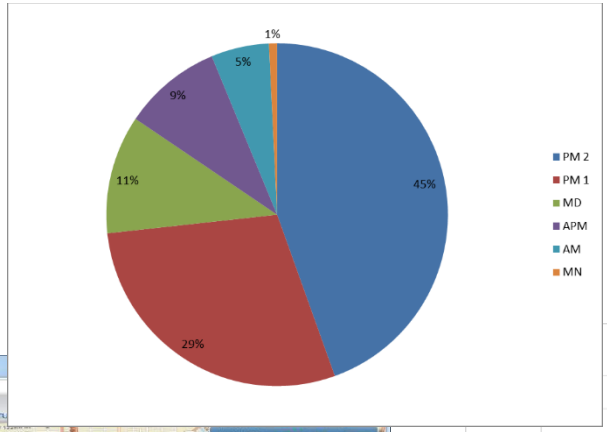
- Developed for FDOT by FIU to support planning and operations
- Aggregation and processing of data from multiple sources
- Performance measurements and dashboard
- Real-time information sharing
- Prediction of system performance and impacts
- Decision support tools
- Benefit-cost analysis of advanced strategies
- Transportation modeling support → development and calibration

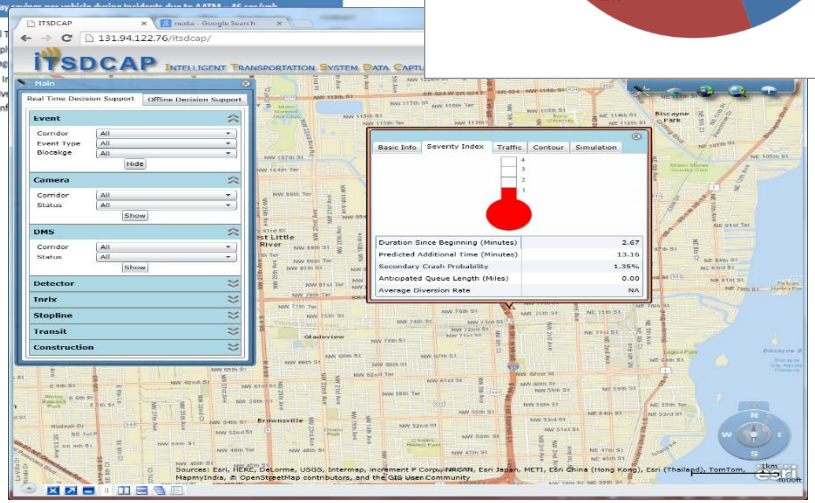

File Edit View History Bookmarks Tools Help
ITSDCAP
131.94.122.76/itsdcap/
Google
ITSDCAP
INTELLIGENT TRANSPORTATION SYSTEM DATA CAPTURE AND PERFORMANCE MANAGEMENT
Account
Main
Real Time Decision Support
Offline Decision Support
Road
1. Route: Glades Road
2. Direction: EB
3. Start: St Andrews Blvd
End: E University Dr
Study Period
1. Start Date: 12/16/2013
Start Time (HH:MM): 16 : 00
2. End Date: 1/2/2014
End Time (HH:MM): 18 : 00
3. Day of Week:
Sun Mon Tue Wed Thu Fri Sat
Performance Measurement
Intersection Operation
ITS Evaluation
Decision Support
Dashboard
Potomac Rd
NW 30th St
NW 29th St
NW 19th Way
NW 23rd Way
NW 25th St
NW Corporate Blvd
Glades Rd
SR-808 W
SR-808 E
NW 19th St
Boca Raton Airport
Lee St
Volusia St
Indian River St
NW 16th St
NW 15th St
NW 14th St
NW 13th St
NW 10th St
NW 9th St
NW 8th St
NW 7th St
NW 5th St
NW 4th St
W Palmetto Park Rd
W Royal Palm Rd
Floresta
Sources: Esri, HERE, DeLorme, USGS, Intermap, increment P Corp., NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), TomTom, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community
700m
2000ft
esri

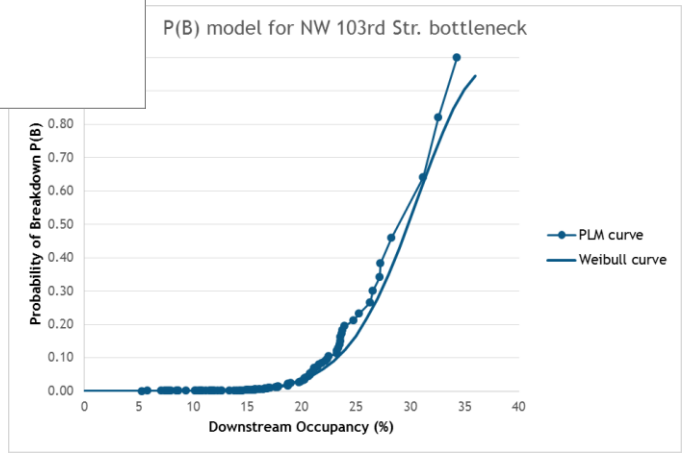
# ITSDCAP


Travel Time Reliability Measures – "Living Lab" Corridors
95% Travel Time (min)
Average Speed (mph)
Travel Time Index
Buffer Time Index
PM Peak Total Delay (veh-hours)
AM Peak Total Delay (veh-hours)
Military Trail
Jog Rd
US 441
Southern Blvd
Belvedere Rd
Okeechobee Blvd


Cumulative Probability
Travel Rate (sec/mile)
AM
MD
PM 1
PM 2
APM
MN
All


1%
5%
9%
11%
45%
29%
PM 2
PM 1
MD
APM
AM
MN

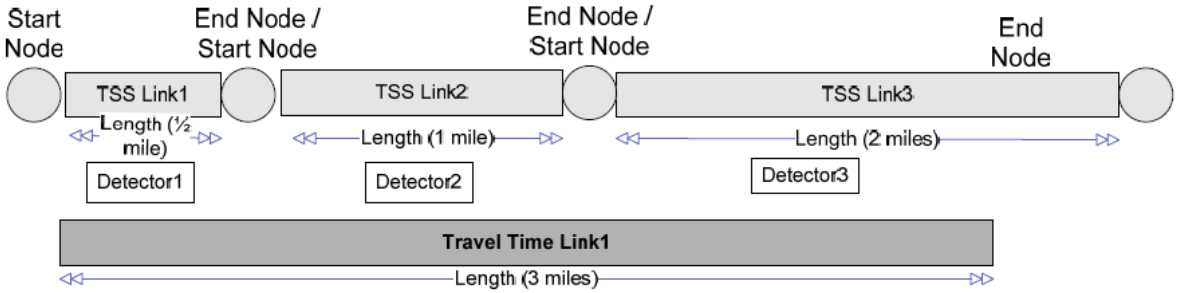

ITSDCAP
INTELLIGENT TRANSPORTATION SYSTEM DATA CAPTURE
Real Time Decision Support
Offline Decision Support
Event
Camera
DMS
Detector
Tmrlx
Stopline
Transit
Construction
Basic Info
Severity Index
Traffic
Contour
Simulation
Duration Since Beginning (Minutes) 2.67
Predicted Additional Time (Minutes) 13.16
Secondary Crash Probability 1.35%
Anticipated Queue Length (Miles) 0.00
Average Diversion Rate NA

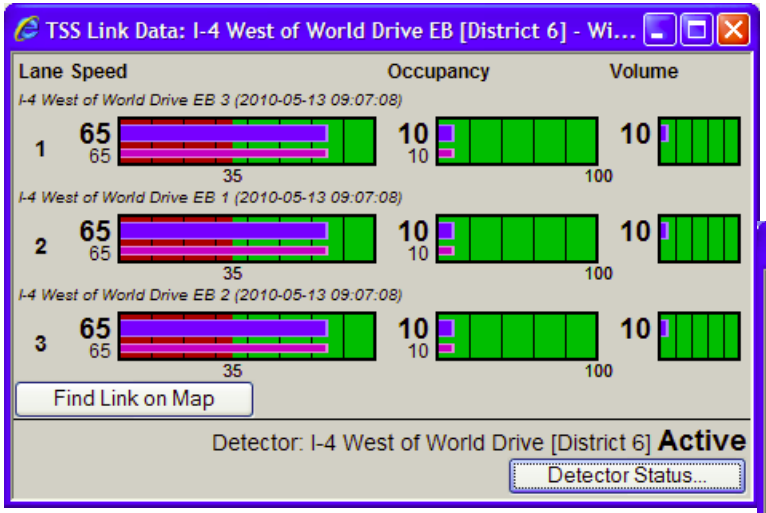

P(B) model for NW 103rd Str. bottleneck
Probability of Breakdown P(B)
Downstream Occupancy (%)
PLM curve
Weibull curve

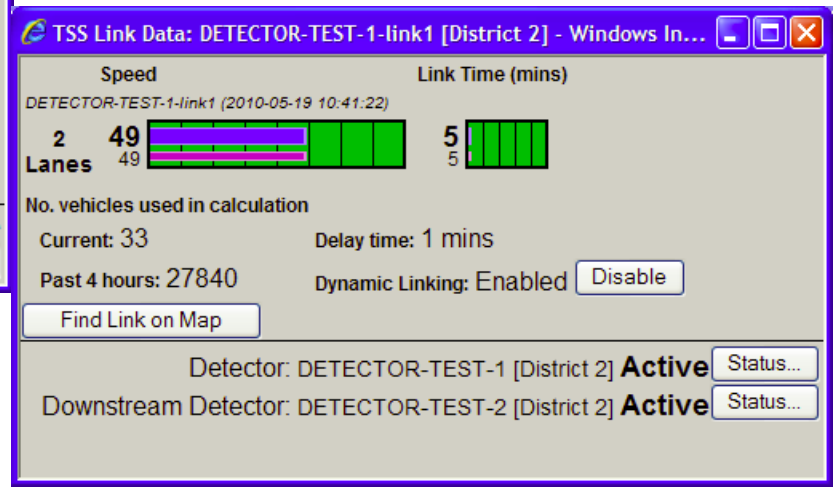
# Performance Monitoring for Planning and Operations

- Support estimating measures related to the main goals
  - Mobility
  - Reliability
  - Safety
  - Environmental impacts
- New measures will be possible in these areas
- Better clustering according to conditions and influencing factors
- Arterial and trip-based estimation of performance.

# Performance Monitoring in SunGuide



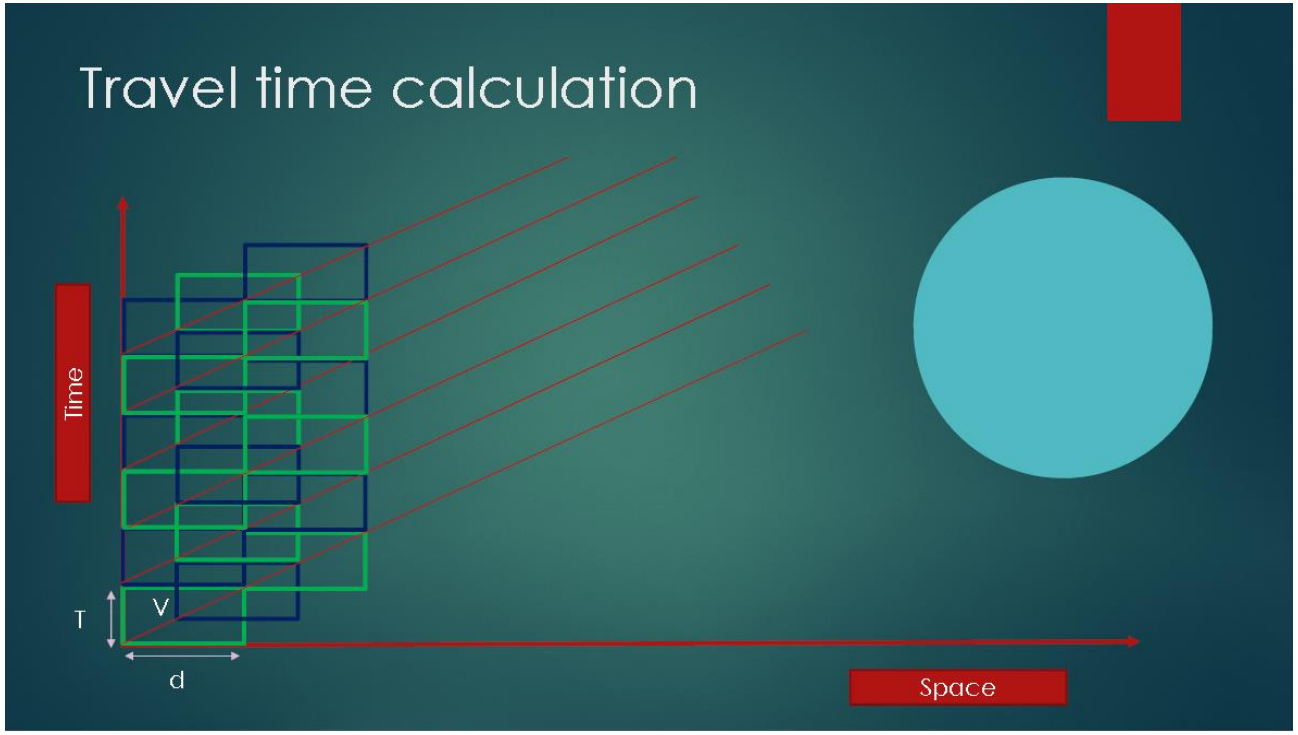



# Performance Monitoring based on CV

- Travel times/speeds/delays
- Queue length and back of queue
- Acceleration/ deceleration
- Shockwaves
- Travel time reliability
- Safety performance
- Environmental impacts
- Volume/throughput/density

# Travel Time Estimation

- Since vehicle trajectories will not be available, virtual trajectory will have to be constructed.

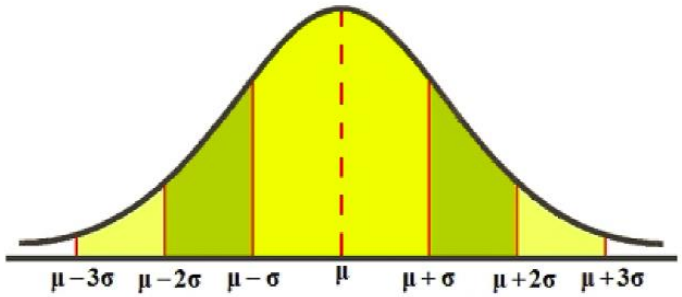


# Travel Time Accuracy

# Preliminary TT Error Results based on Real-World Trajectories

# Current Incident Detection in SunGuide

- Compare current conditions with historical data
- An alarm when speeds on a segment falls below thresholds associated with that segment
- Thresholds are configurable by segment, time of day, and day of week
- Some districts use video analytics to supplement point detection of incidents
- Other sources of detection (FHP, RR, etc.)



# Incident Detection based on Detectors

- Past research showed that for most algorithms, the MDT ranges from 0.5-5 minutes (2 minutes typical)
- Cannot detect incident until the queue reaches the upstream detector
  - May take a long time and even may never happen
- Algorithms were also found to produce large numbers of false alarms

# Incident Detection using Connected Vehicles

- Several parameters can be used including speed changes, acceleration and deceleration at a specific location,  hard brakes, when a vehicle's safety systems have been activated or deployed, or sudden vehicle turns.
- Location can be more accurately specified
- Two methods tested based on acceleration
  - First required only distribution during no incident conditions. Second also requires distributions during incidents
- Use of other parameters are being tested

# Preliminary Results

- Preliminary results based on acceleration from simulation is below. Confirmation and further analysis being conducted.

# Future Efforts

- Continue testing CV data support of SunGuide based on simulation and existing real-world data
- Examination of the ability of real-world CV deployment to support TMC
- Apply concepts to a real-world deployment of CV