

# Real-Time Arterial Traffic Performance Measures Using GPS-Equipped Vehicles

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**Civil  
Laboratory for  
Operations and  
Safety  
Engineering in  
Transportation**



# Objective

Design a viable data collection procedure for obtaining reasonably accurate GPS data to develop real-time arterial traffic performance measures

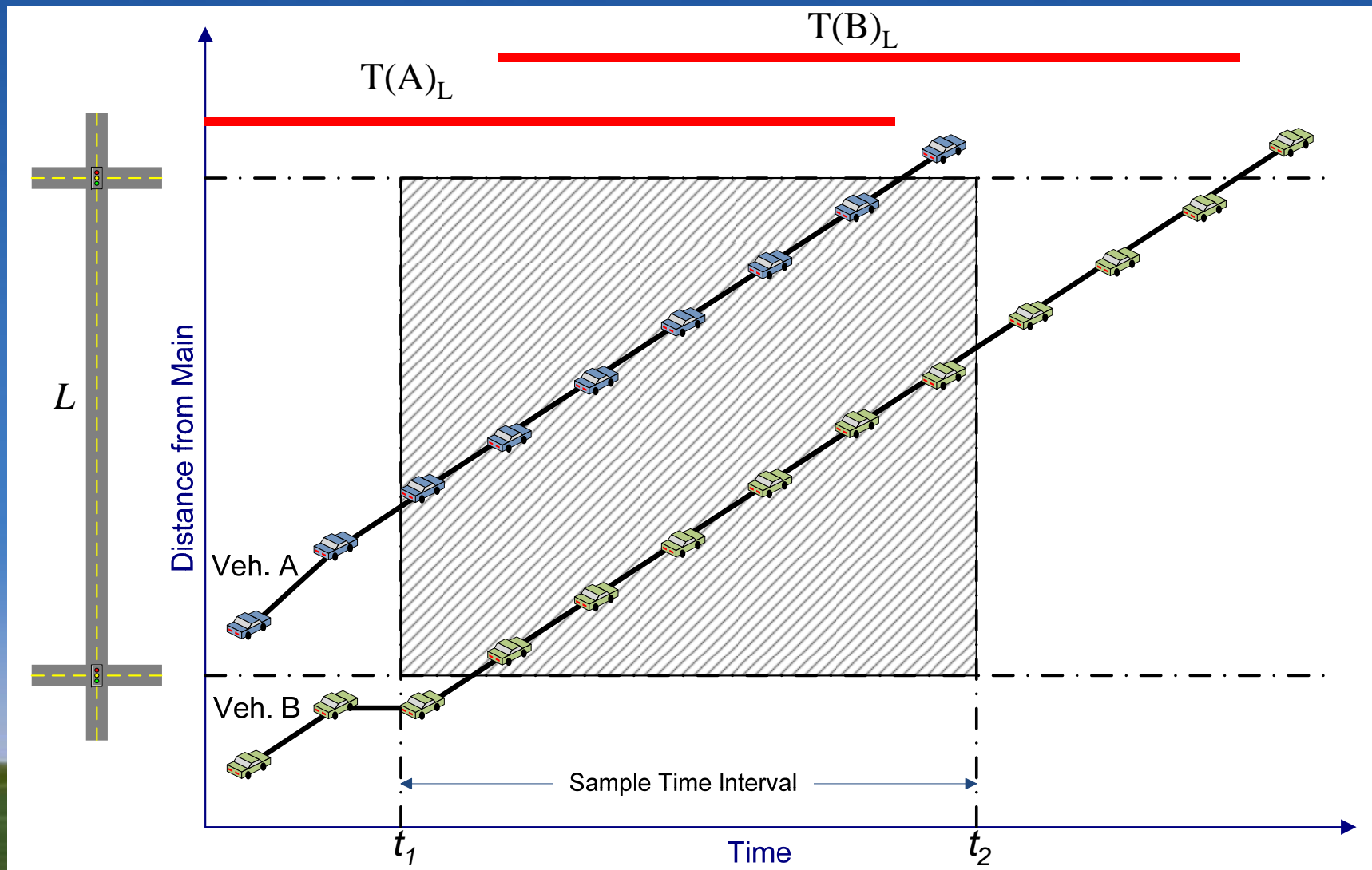


# Arterial Performance Measures

- Average Travel Time
- Travel Speed
- Control Delay
- Number of Stops
- Queue Length



# Methodology





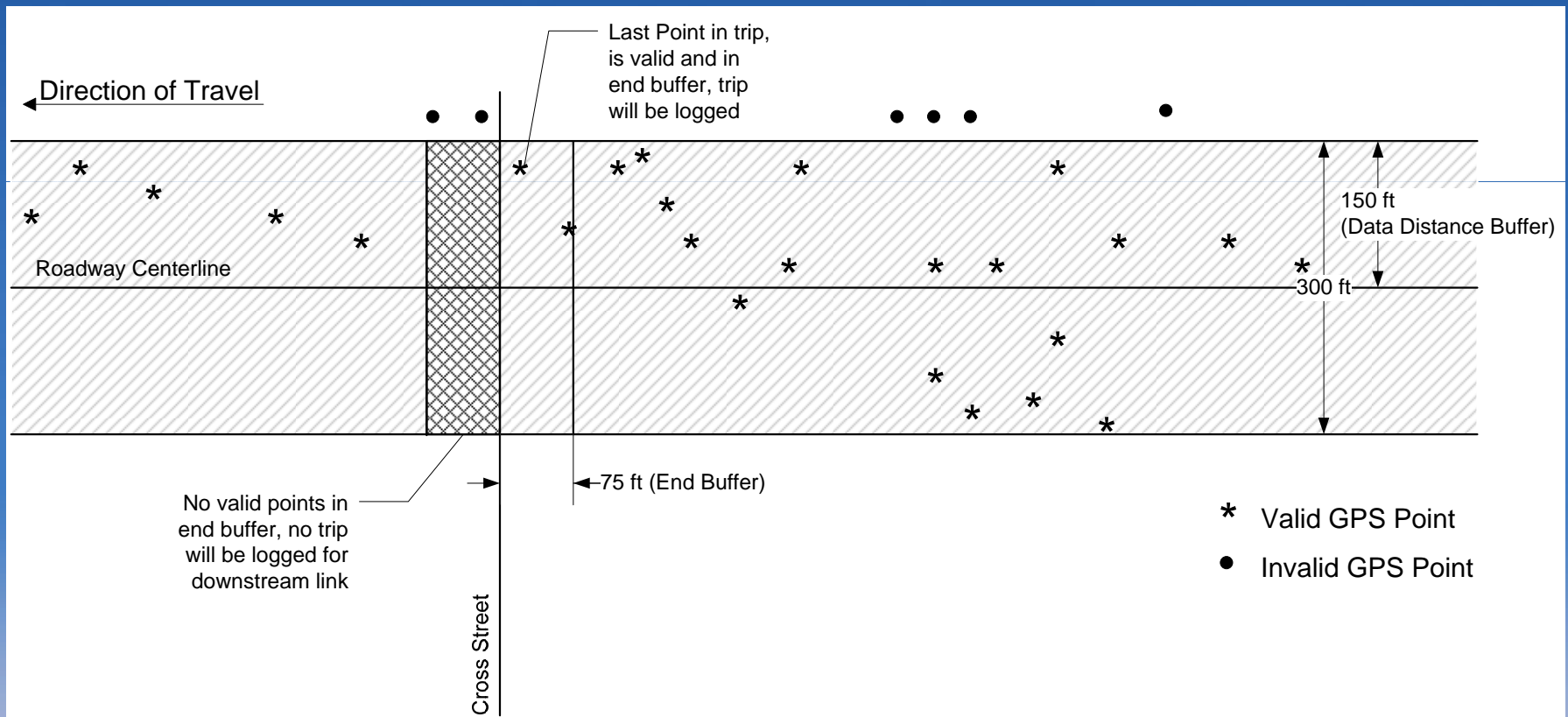
# GPS Receiver



- GeoStats  
GeoLogger™
- Second-by-second  
position & speed
- Position accuracy <  
3 meters
- Speed accuracy <  
0.12 mph.



# Data Reduction: Buffer Zones





# Quality Control

- Acceleration:
  - Acceleration 2.2 ft/s<sup>2</sup>
  - Deceleration 11.2 ft/s<sup>2</sup>(AASHTO)

$$a^i = \frac{v^{i+1} - v^i}{T}$$

where

$a^i$  = acceleration at point  $i$

$v^i$  = speed at point  $i$

$T$  = the time interval

- Velocity:

$$v^i = \frac{l^{i+1} - l^{i-1}}{2T}$$

where

$v^i$  = speed at point  $i$

$l^i$  = location of the  $i^{\text{th}}$  GPS record

$T$  = the time interval



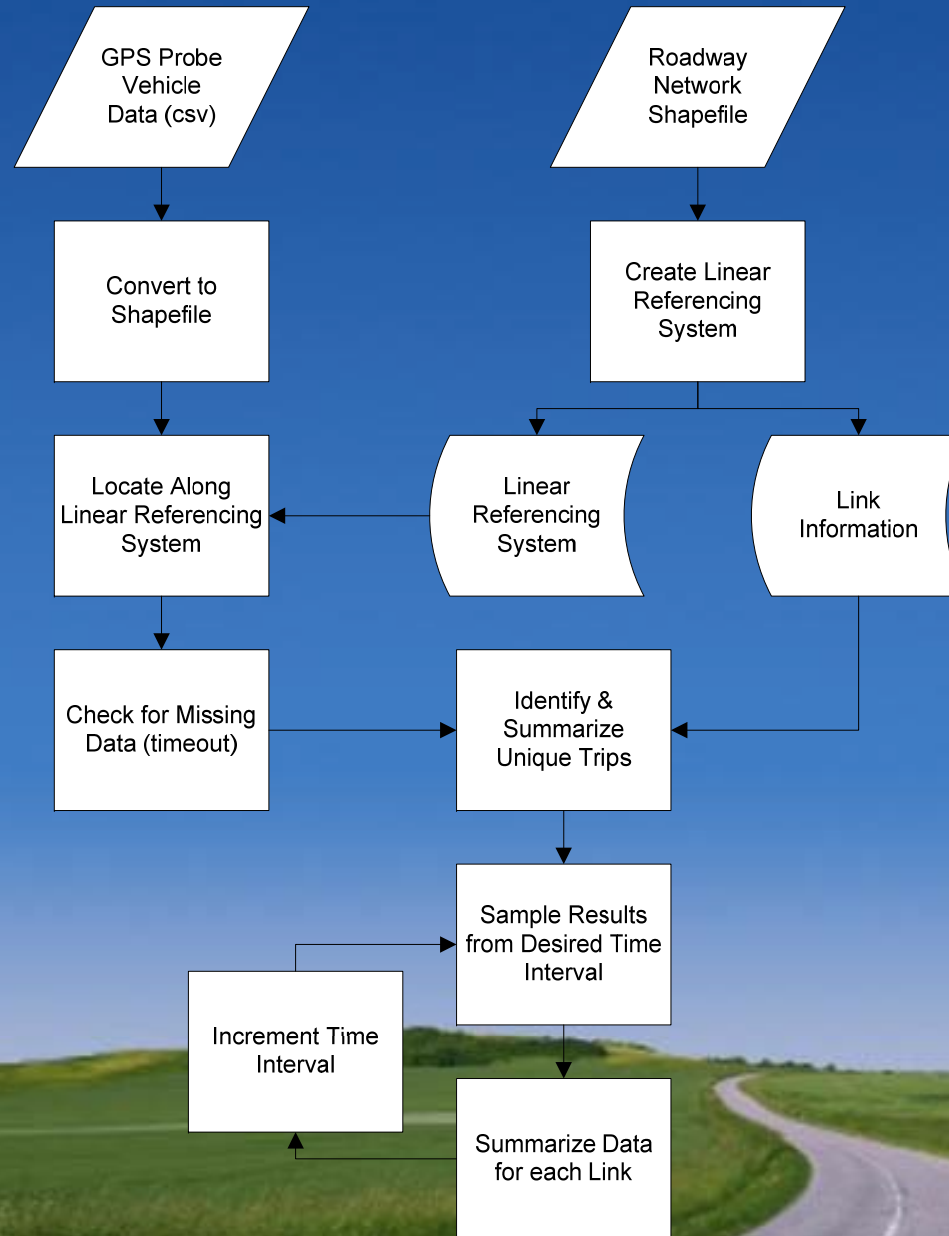
# Application

- ESRI ArcGIS geo-processing script was written in the Python Programming Language to process the GeoLogger GPS probe vehicle data
- Script provides arterial traffic data for individual links over user-specified time interval





# Algorithm Flow Chart





# User Interface

GPS Travel Time Logger

Workspace

Roadway Links

Route Feature Class

GPS Data (csv)

Timezone Conversion

GPS Data Timeout (seconds) -5

Stop Threshold Speed (mph) 120

Summary Interval (minutes) 5

Summary Start Time (hour)

Summary Start Time (minutes)

Summary End Time (hour)

Summary End Time (minutes)

Data Buffer Distance 150 Feet

Speed Check (% of Speed Limit) 100

Link Endpoint Buffer (feet)

GPS Coordinate System  
C:\Program Files\ArcGIS\Coordinate Systems\Geographic Coordinate Systems\World\WGS 1984.prj

OK Cancel Environments... Show Help >>



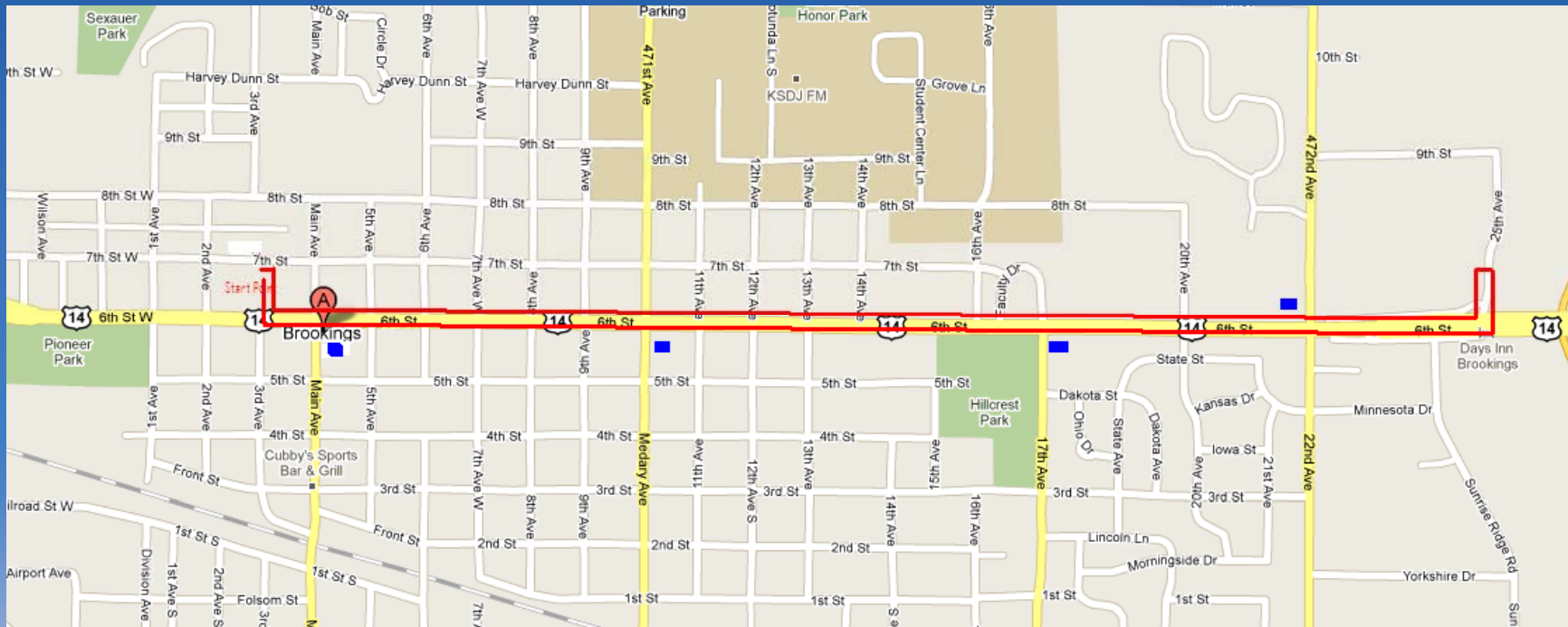
# Output Data

Field	Abbreviated	Units	Description
Travel Time	TT_ACT	Seconds	Time for a probe vehicle to traverse a link
Ideal Travel Time	TT_IDEAL	Seconds	Time for a vehicle, unstopped, to traverse a link at the user-defined speed limit
Delay	DELAY	Seconds	Difference between ideal travel time and the probe vehicle travel time
Number of Stops	STOPS	Count	Number of times a probe vehicle's speed falls below the user-defined "stop threshold" speed (speed where the vehicle is considered to have made a stop; defaulted to 5 mph)
Peak Speed	SPD_PK	Miles per hour	The greatest speed obtained by a probe vehicle on the trip
Average Speed	SPD_AVE	Miles per hour	The average speed of a probe vehicle during the trip
Average Speed While Moving	SPD_MOVE	Miles per hour	The average speed of a probe vehicle while it is moving (i.e. not considering time while vehicle speed is below stop threshold)
Number of Cars	NUM_CARS	Count	The number of probe vehicles that have traversed a specific link during the sample interval (only for summary table)



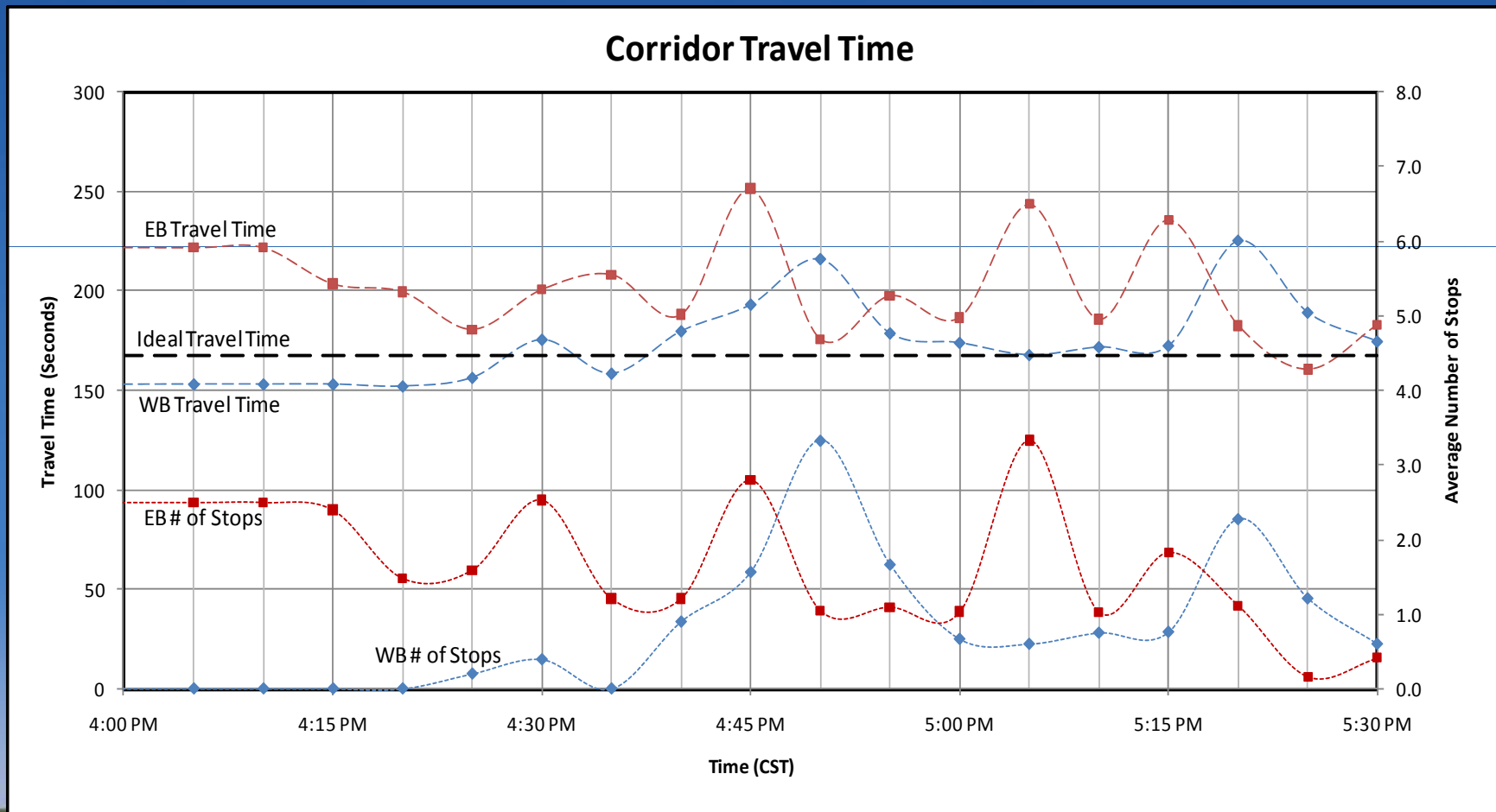
# Field Study: Brookings, SD

## Data Collection Route: 6<sup>th</sup> Street





# Results





# Conclusions

- This study shows a “proof of concept” that using GPS-based probe vehicle data is useful for identifying performance indexes for arterial roadways
- With minor modifications, the algorithm and method could easily be used to provide data to managers and users in real-time



# Questions?

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# User Interface Descriptions

Input	Data Type	Description
Workspace	Folder	Interim and output data storage
Roadway Links	Feature Class	Link information including geometry and ideal travel time information
Route Feature Class	Feature Class	A feature class for continuing the centerline of the roadway under consideration. The centerline should extend beyond the study area.
GPS Data	CSV File	Downloaded from the GPS Data loggers.
Timezone Conversion	Integer	The factor to be added to Greenwich Mean time produce local time
GPS timeout	Integer	The maximum time with missing GPS data that a link may be considered valid.
Stop Threshold Speed	Integer	The maximum speed at which a vehicle is considered stopped
Summary Interval	Integer	The number of minutes between records in the summary table
Summary Start Time	Integer	Both hour and minutes for the beginning of the study interval. Hour (24 hr clock) and minute are entered in separate boxes in the form.
Summary End Time	Integer	Both hour and minutes for the end of the study interval. Hour (24 hr clock) and minute are entered in separate boxes in the form.
Data Buffer Distance	Double	The maximum distance from the centerline at which data is considered valid
Speed Check	Integer	The percent above the speed limit a vehicle may travel before the data is disregarded. Ie. Max speed = Speed Limit x(1+Speed Check/100)
Link Endpoint Buffer	Double	The distance from the end of a link that a valid data point must be for a trip to be logged
GPS Coordinate System	Coordinate System	The Coordinate system that GPS data stored in the Data Logger CSV files