INCORPORATING THE CLASS-OF-SERVICE CONCEPT INTO LARGE SCALE URBAN NETWORK CONTROL

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Advancing Traffic Control through Big Data and Connectivity Workshop

New Directions in Mathematical Approaches for Traffic Flow Management

IPAM

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VT-SCORES Lab

VirginiaTech

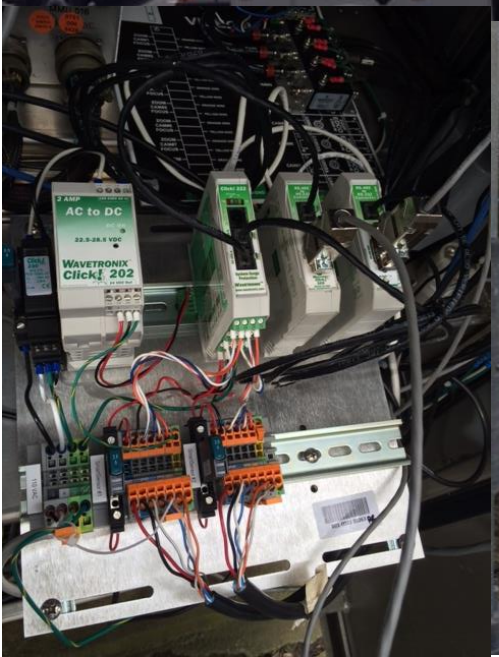
Virginia Tech Signal Control & Operation Research and Education Systems Lab

Background

- Congestion is a big problem in large-scale networks
- There are tools and techniques to design and evaluate control strategies based on aggregated network performance
- There are tools and techniques to simulate house-hold travelers in agent-based or activity-based models

Outline

- An introduction to arterial coordination and control parameters
- An introduction to freeway fundamental diagram
- What is the common link and what are the performance measures?
- A sample exploratory study


2 AMP
AC to DC
22.5-28.5 VDC
WAVETRONIX
Click! 202


2 AMP
AC to DC
22.5-28.5 VDC
WAVETRONIX
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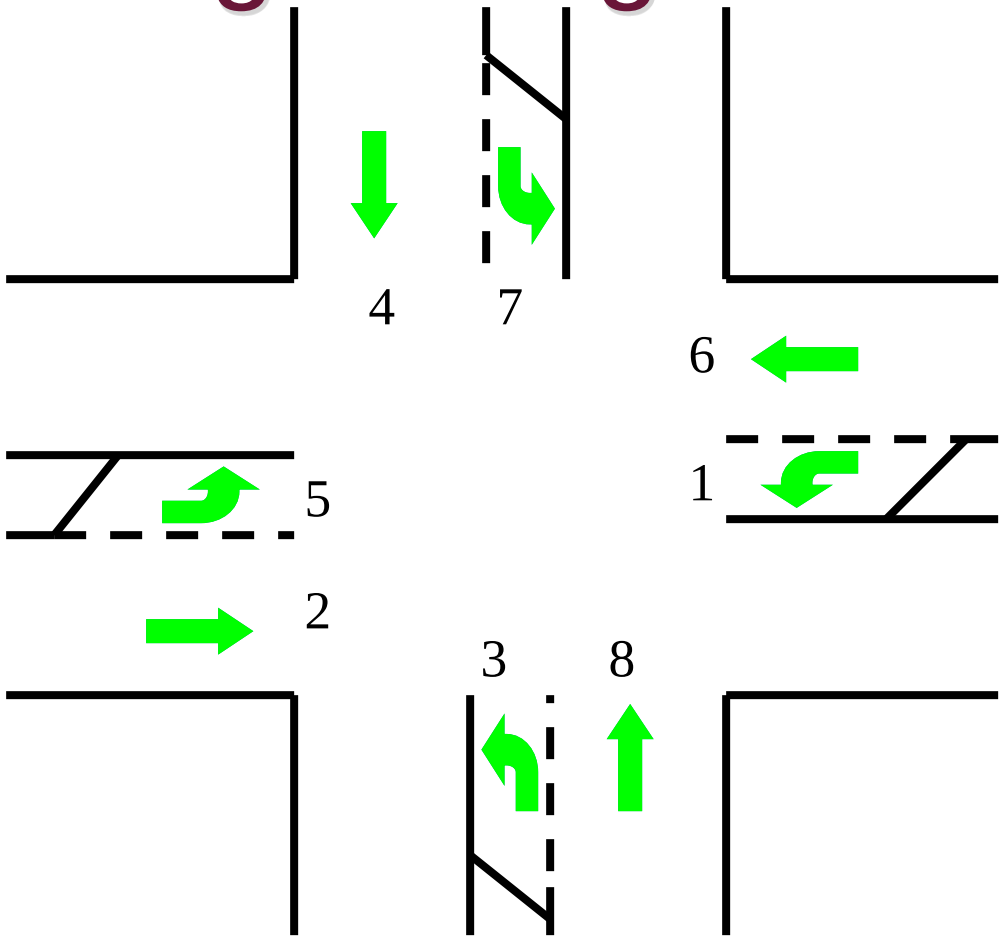
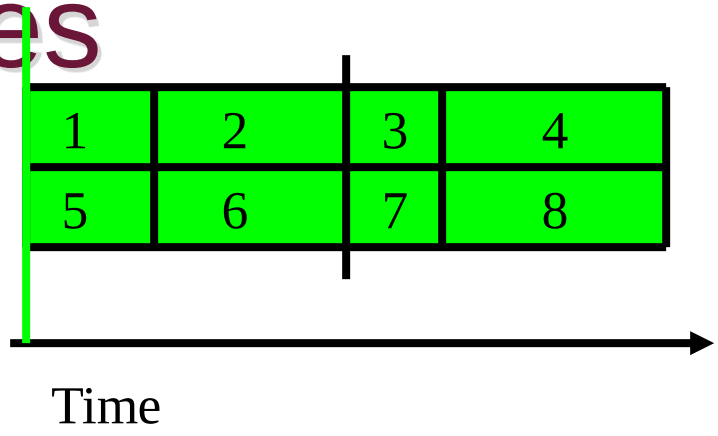
Click! 222
RS-485 to RS-232 Converter


Series 900
152

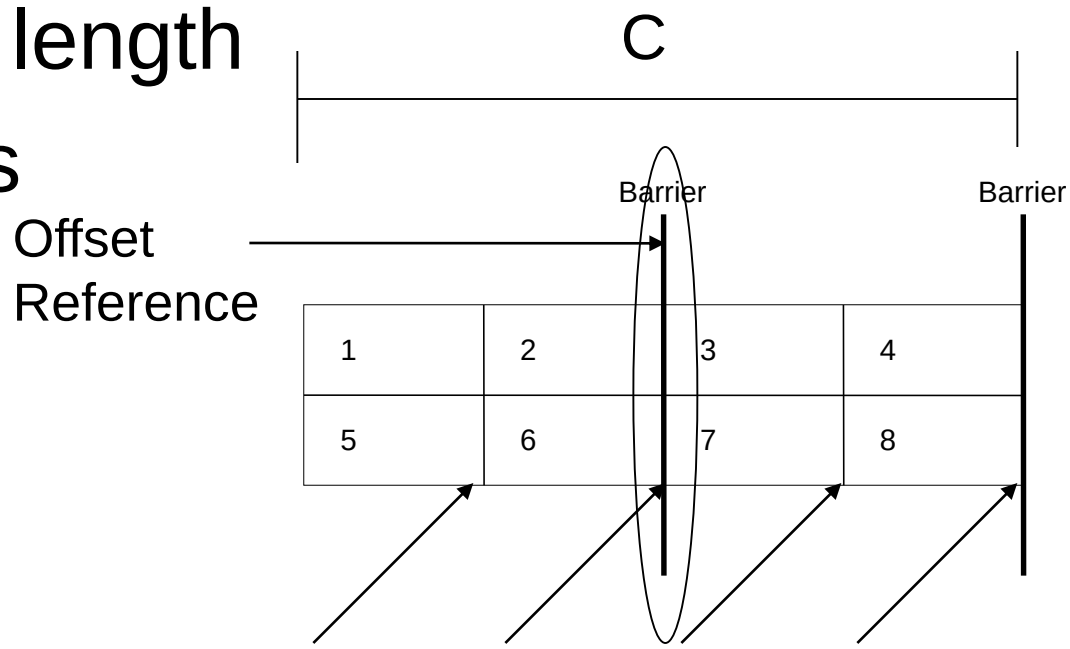
Signal Logic:Phases





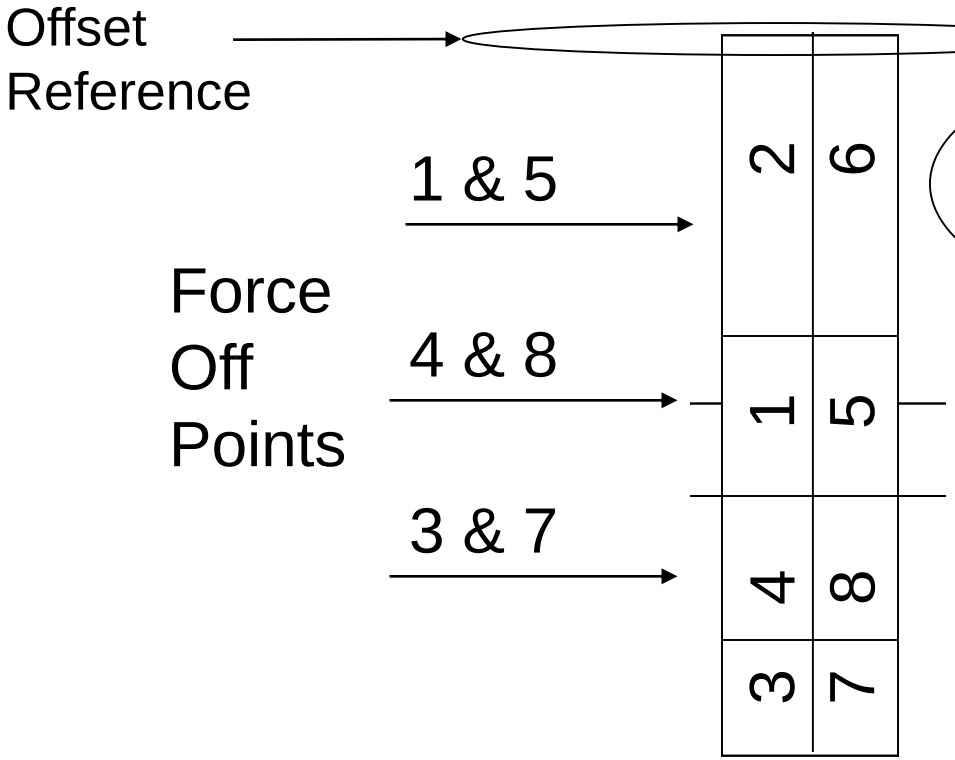
Actuated Signals Logic: Coordination Parameters

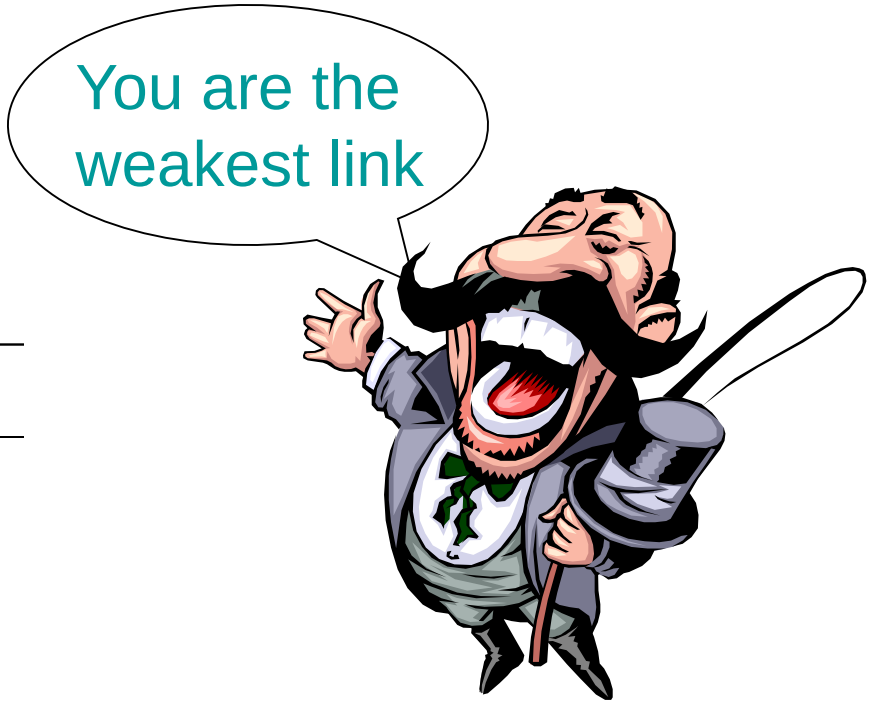
- Constant cycle length
- Force-off points
- Offsets



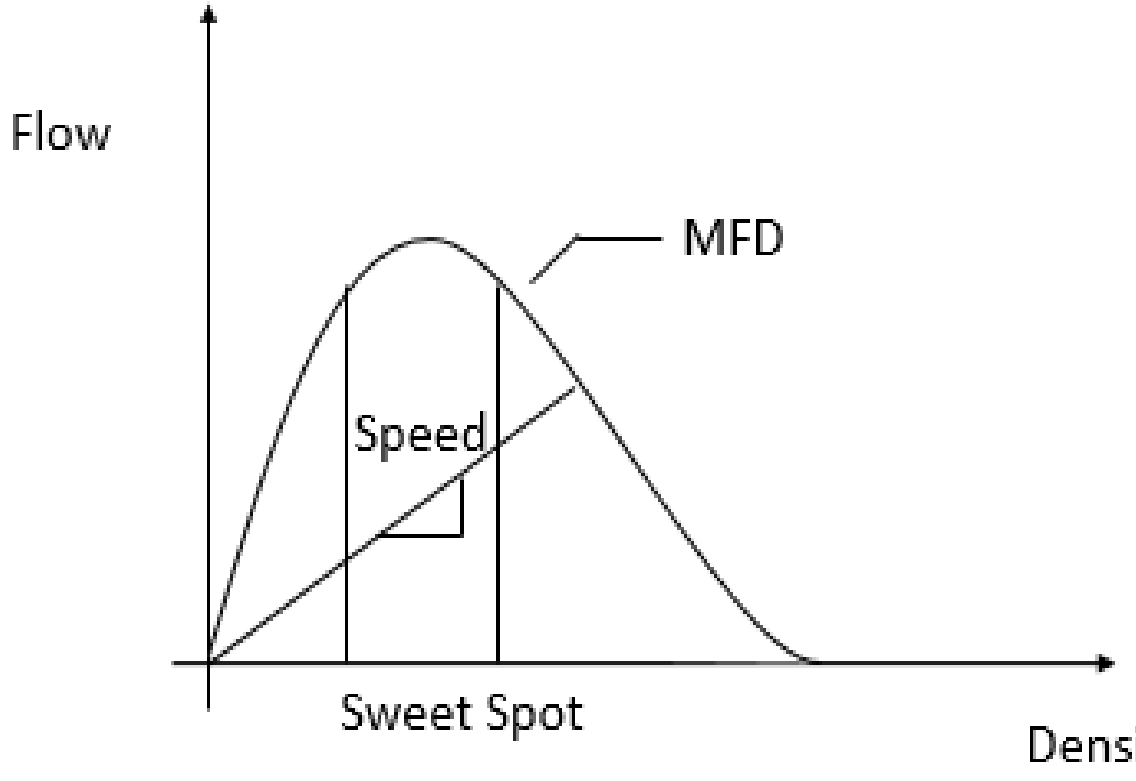
Force Off Points

The Offset Parameter

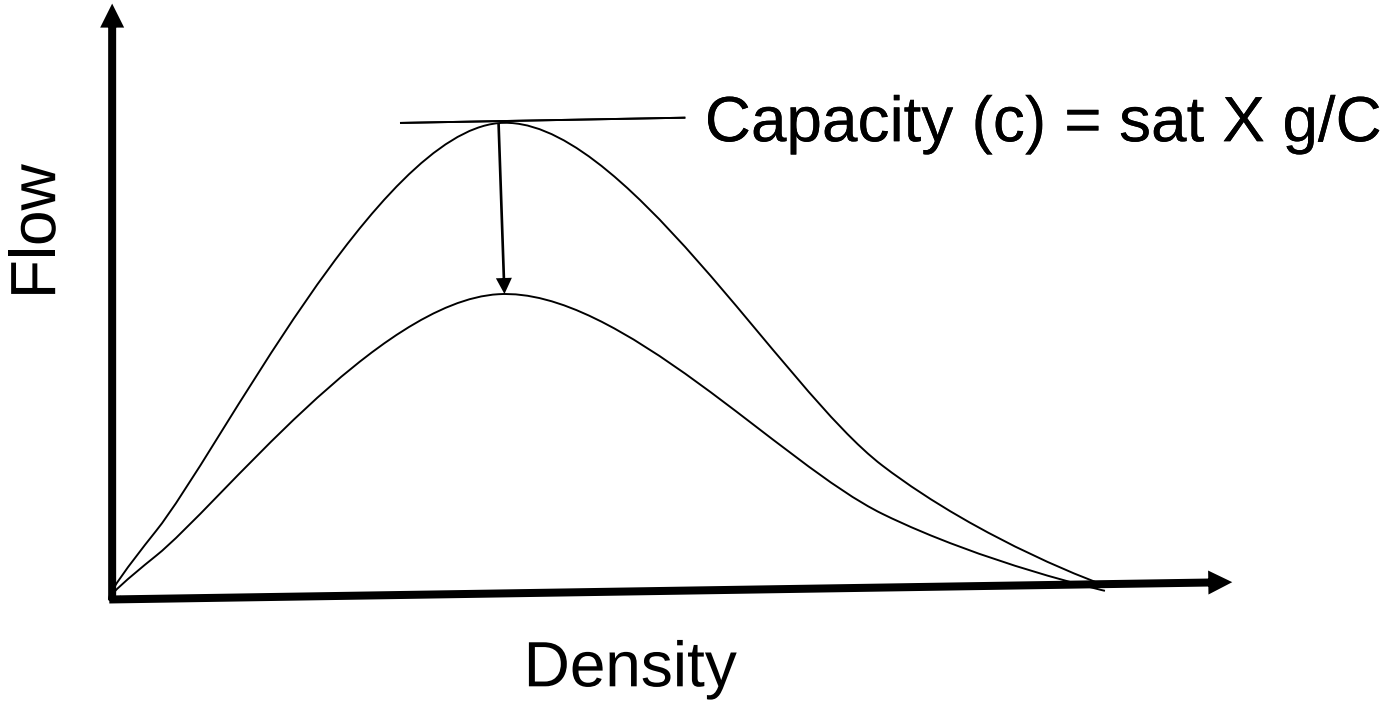




Macroscopic Fundamental Diagram (MFD)



MFD on Urban Networks



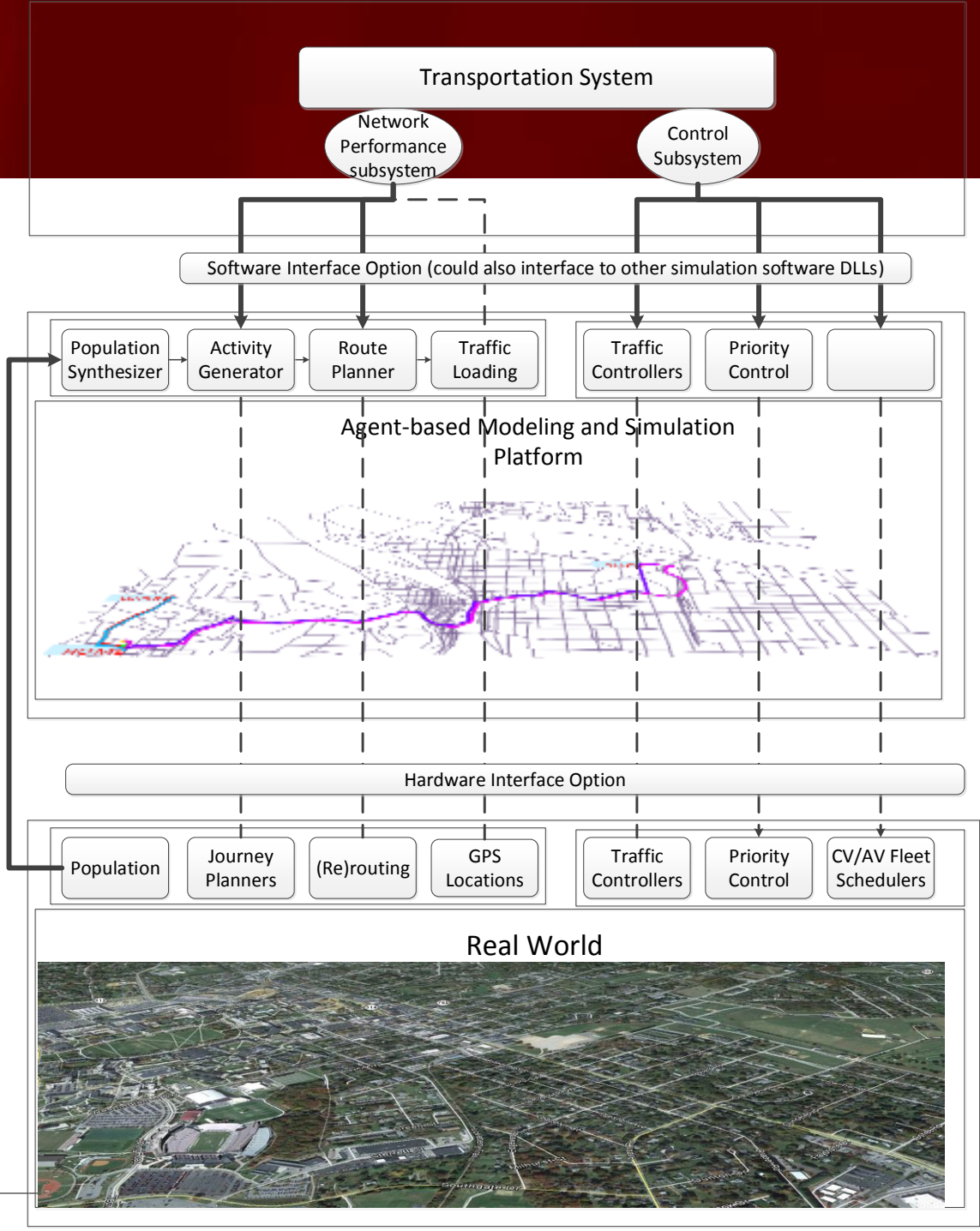
The Class of Service

- How many MFDs are in the network?
- Which routes are on which MFD?
- Who gets the highest MFD?
- An opportunity for coordination, and equity evaluation!

Exploratory Study

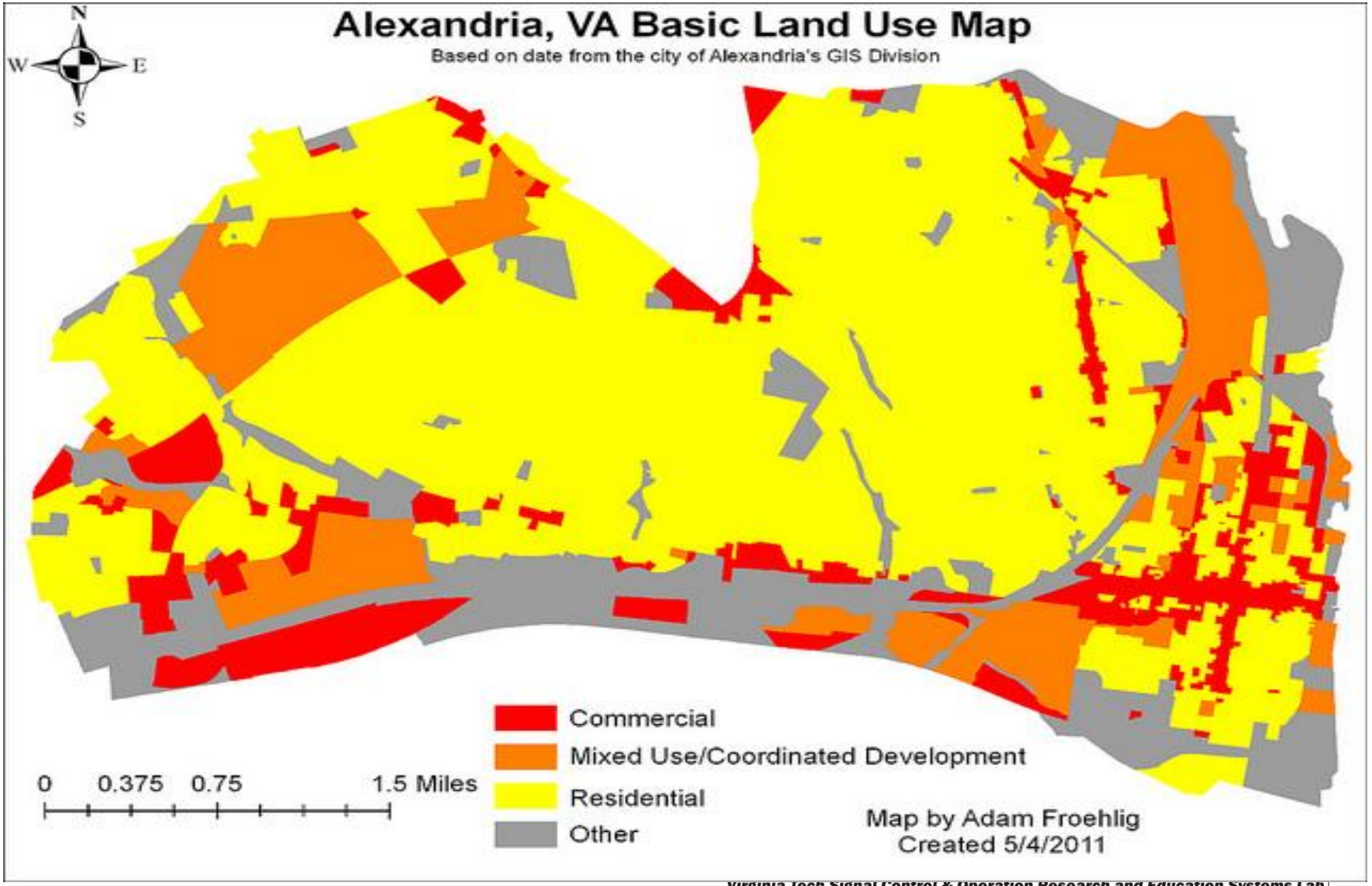
- Define a class of service (COS) based on MFD
- Evaluate the impact of different strategies on different economic groups using the COS concept
- Tabulate the change in COS for each economic group

- We use TRANSIMS and NEXTA in this example*



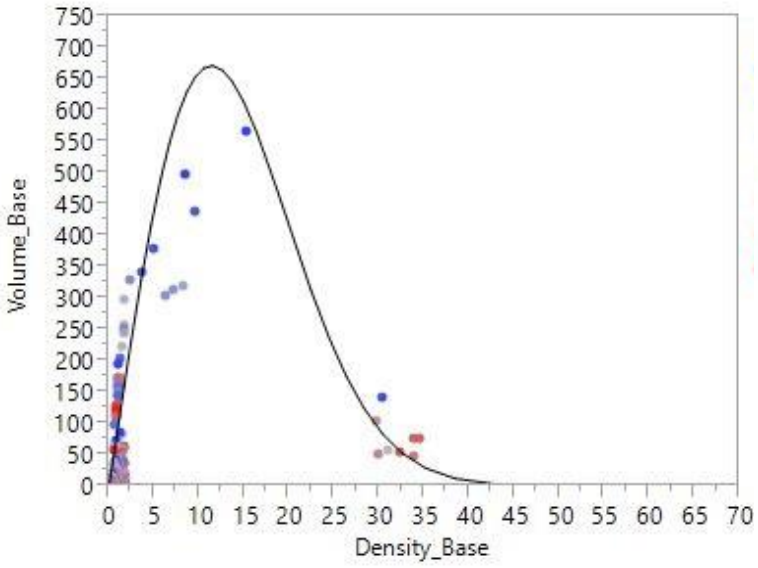
* Next figures from Rubi Han's MS work


Travel Time (m...
<2
2 - 4
4 - 6
6 - 8
8 - 10
>10

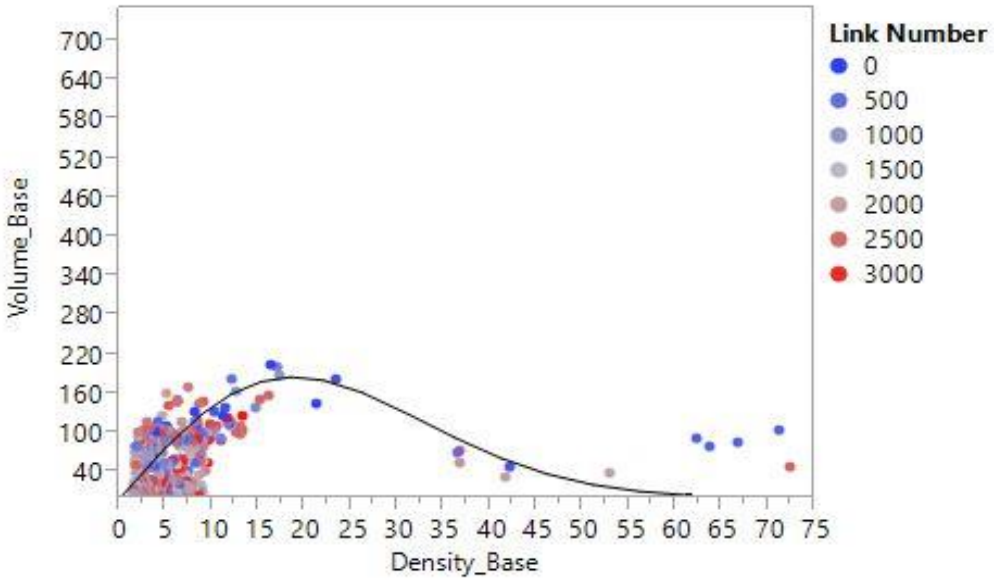

Alexandria, VA Basic Land Use Map
Based on date from the city of Alexandria's GIS Division
N
W
E
S
Commercial
Mixed Use/Coordinated Development
Residential
Other
0 0.375 0.75 1.5 Miles
Map by Adam Froehlig
Created 5/4/2011

MFDs (Northwestern model)

- Base Case

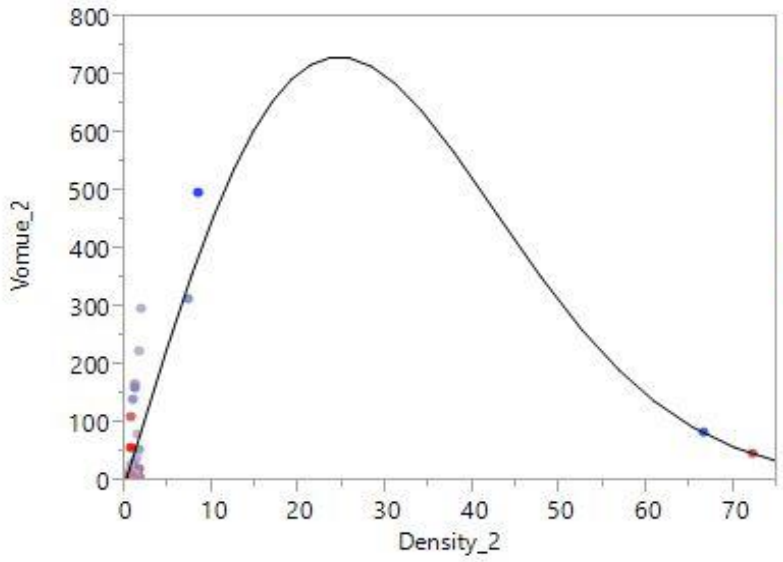


$$Volume = 72.647 * e^{-\frac{1}{2}*(\frac{Density}{11.967})^2} * Density$$

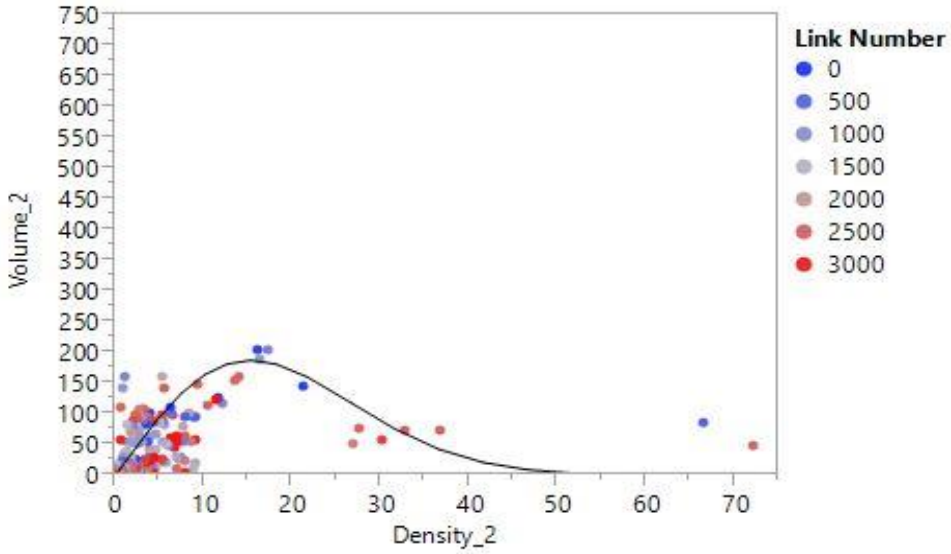


$$Volume = 16.275 * e^{-\frac{1}{2}*(\frac{Density}{18.824})^2} * Density$$

Signal Control Strategy 2: Along W Braddock Rd, thru traffic --, turning traffic ++

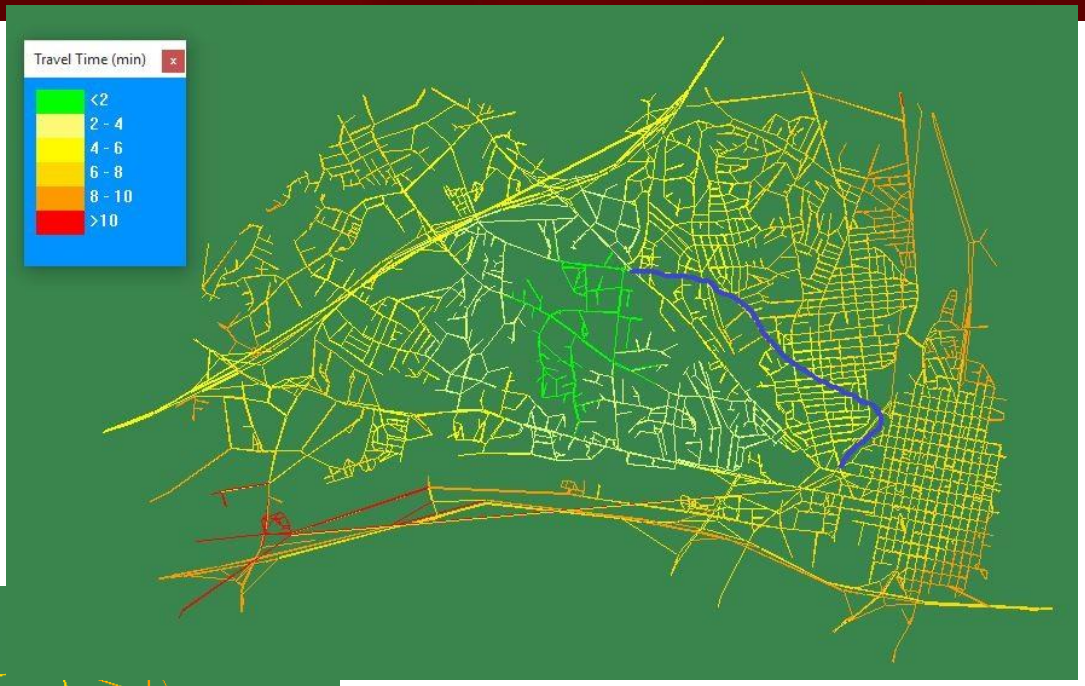


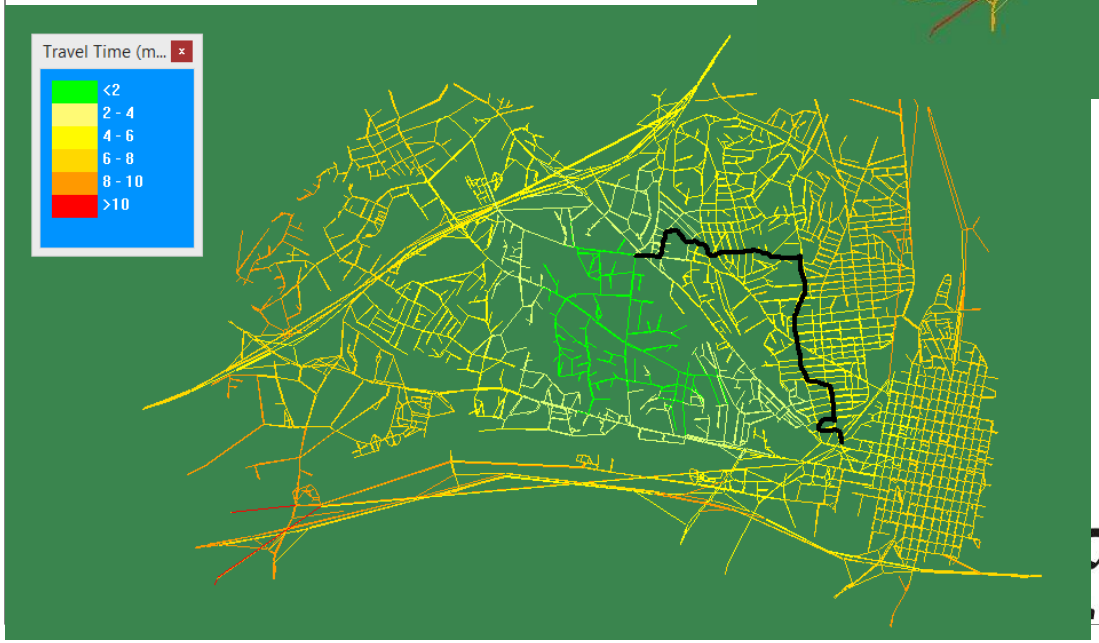
$$Volume = 49.216 * e^{-\frac{1}{2}*(\frac{Density}{24.510})^2} * Density$$



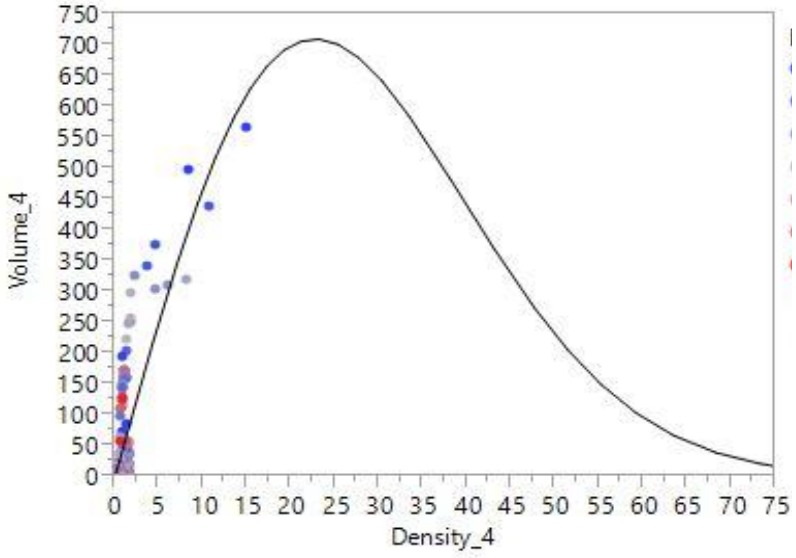
$$Volume = 20.196 * e^{-\frac{1}{2}*(\frac{Density}{15.294})^2} * Density$$

- 7.9min ->7min

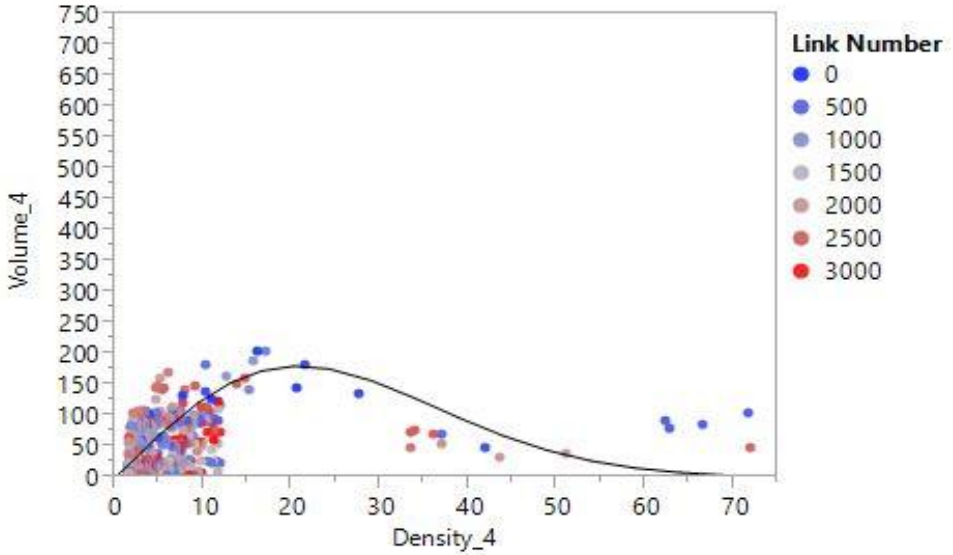




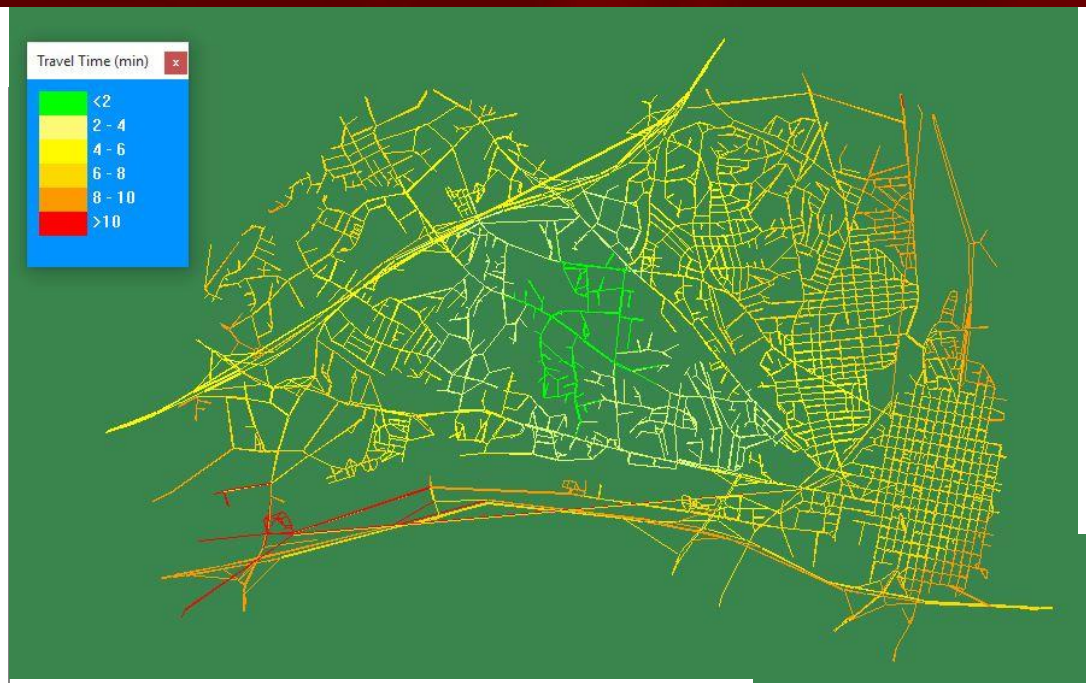
Pre-timed signalized intersections-> actuated signalized intersections



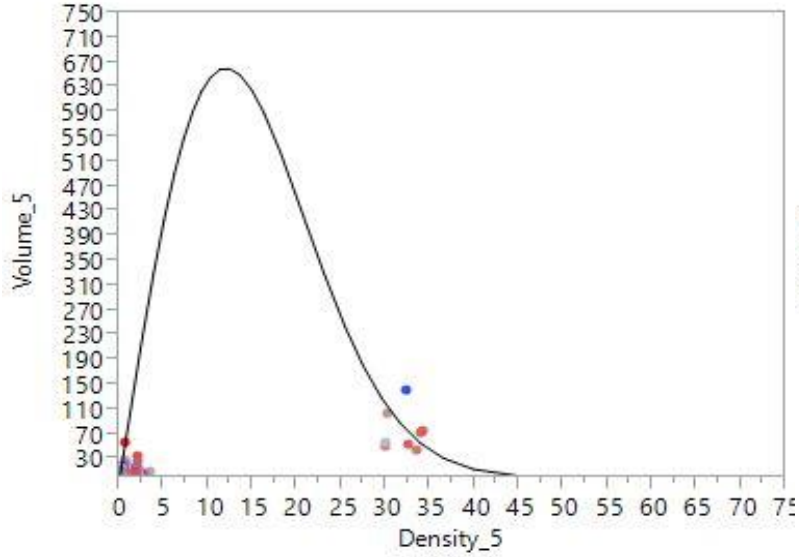
$$Volume = 51.471 * e^{-\frac{1}{2}*(\frac{Density}{22.745})^2} * Density$$

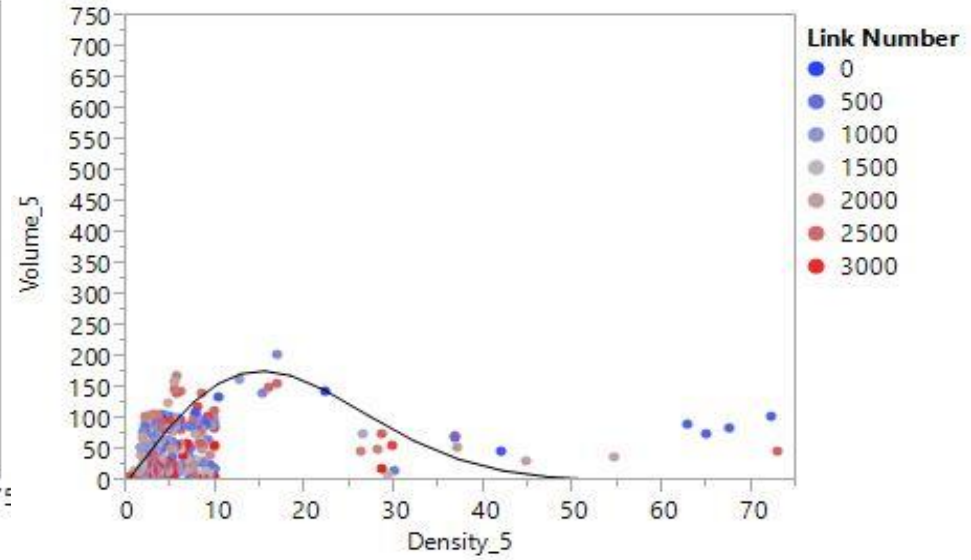


$$Volume = 19.804 * e^{-\frac{1}{2}*(\frac{Density}{16.667})^2} * Density$$


Travel Time (min)
<2
2 - 4
4 - 6
6 - 8
8 - 10
>10

Signal Control Strategy 5: Increase max green times on residential and commercial areas





$$Volume = 8.096 * e^{-\frac{1}{2}*(\frac{Density}{20.365})^2} * Density$$

$$Volume = 19.412 * e^{-\frac{1}{2}*(\frac{Density}{15.098})^2} * Density$$


Travel Time (min)
<2
2 - 4
4 - 6
6 - 8
8 - 10
>10

Socio-economic Groups

Signal Control Strategies	No. of Links from **First** class of MFD to **Second** class MFD	No. of Links from **Second** class of MFD to **First** class MFD
Signal control strategy 2	353	440
Higher Income Area	172	222
Lower Income Area	180	217
Signal control strategy 4	389	404
Higher Income Area	205	203
Lower Income Area	184	201
Signal control strategy 5	154	639
Higher Income Area	79	319
Lower Income Area	75	320

Conclusions

- Control strategies change urban network MFDs and can be linked to arterial control
- Existence of different MFDs on a network can be used/interpreted as different COSs
- Equity-related measures can be incorporated in the selection of implemented control strategies

Future Work

- Utilizing more agent-based modeling capabilities into current work
- Incorporating the COS concept into the simulation model as an objective function