# Co-Optimizing Speed Profiles and Signal Control Settings in Connected Vehicle Environment


**Presented by:**

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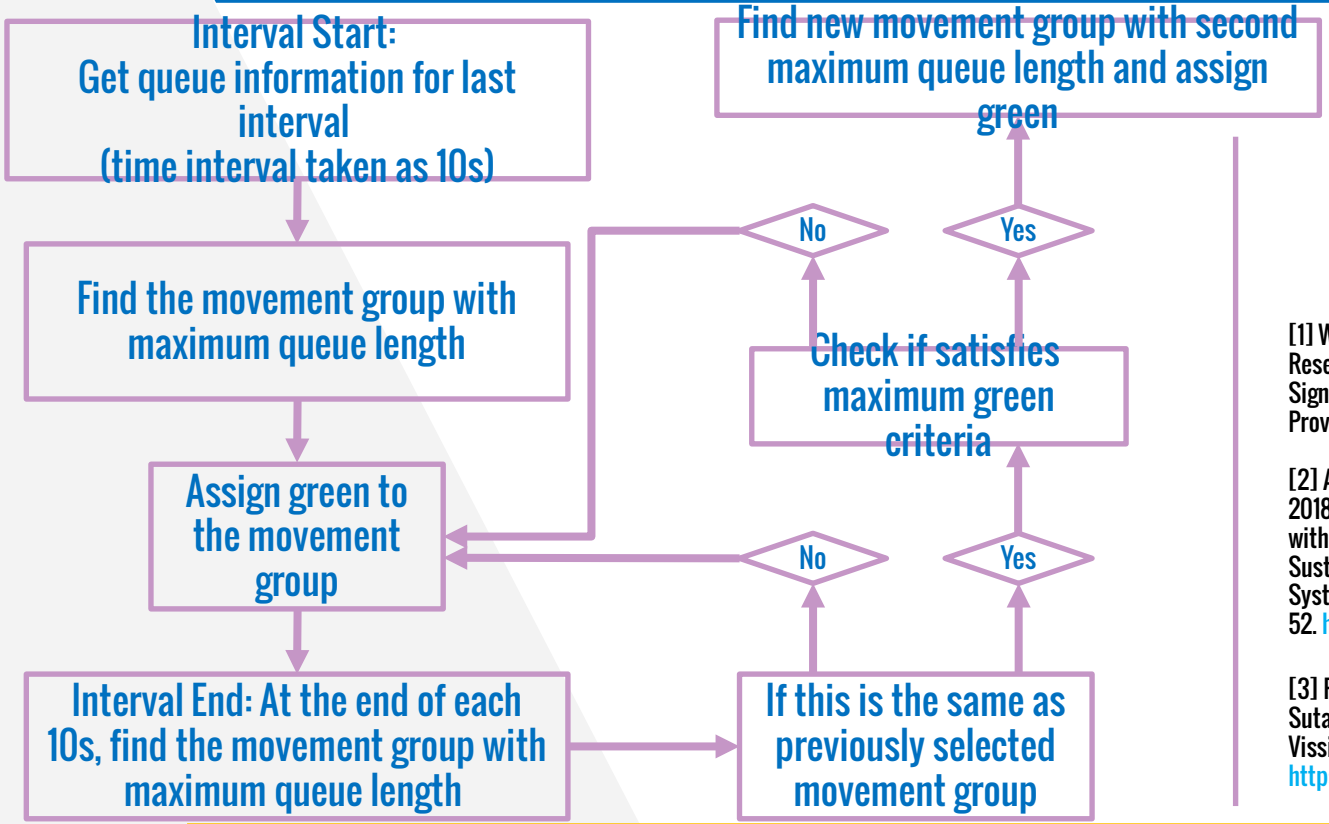
Location: Lincoln, Nebraska

# Signal Optimization and Speed Control

*Image Source: https://www.digi.com/getattachment/blog/post/what-is-connected-vehicle-technology-and-use-cases/gettyimages-1207768535-1280x720.jpg?lang=en-us&width=1220&height=720&ext=.jpg*

- Increasing market share of connected vehicles (CVs)
- C-V2X Technology Adoption
- Improving traditional signal optimization techniques
- Maximizing mobility benefits

# Signal Optimization: Longest Queue First (LQF)




LQF has been implemented in different forms in the existing literature

[1] Wunderlich, Richard James. 2007. "TRACE : Tennessee Research and Creative Exchange A Longest-Queue-First Signal Scheduling Algorithm with Quality of Service Provisioning for an Isolated Intersection."

[2] Aziz, H. M.Abdul, Feng Zhu, and Satish V. Ukkusuri. 2018. "Learning-Based Traffic Signal Control Algorithms with Neighborhood Information Sharing: An Application for Sustainable Mobility." Journal of Intelligent Transportation Systems: Technology, Planning, and Operations 22 (1): 40-52. https://doi.org/10.1080/15472450.2017.1387546.

[3] Ramadán, Satria A., Endra Joelianto, and Herman Y. Sutarto. 2019. "Simulation of Traffic Control Using Vissim-." Internetworking Indonesia Journal 11 (June). https://www.researchgate.net/publication/333659545.

# Speed Control Algorithm

Calculate distance to signal

Receive signal information (current signal state)

If there is as a green signal, calculate the minimum speed to reach the intersection before green ends and set as desired speed

If there is as a red signal, calculate the maximum speed to reach the intersection before the next green starts and set as desired speed

Speed Control

Either Fully Autonomous (SAE Level 3+ or CV-enabled with speed compliance

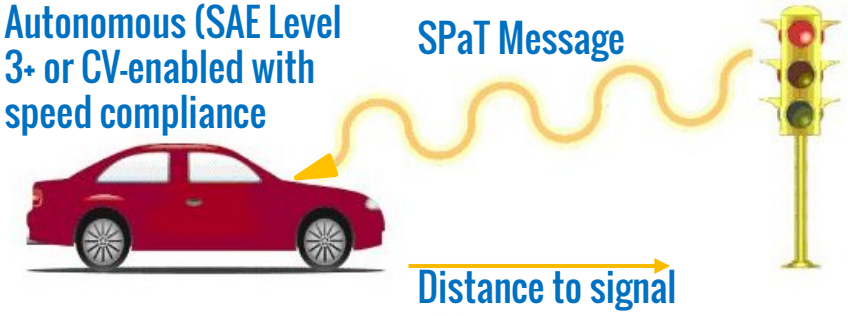


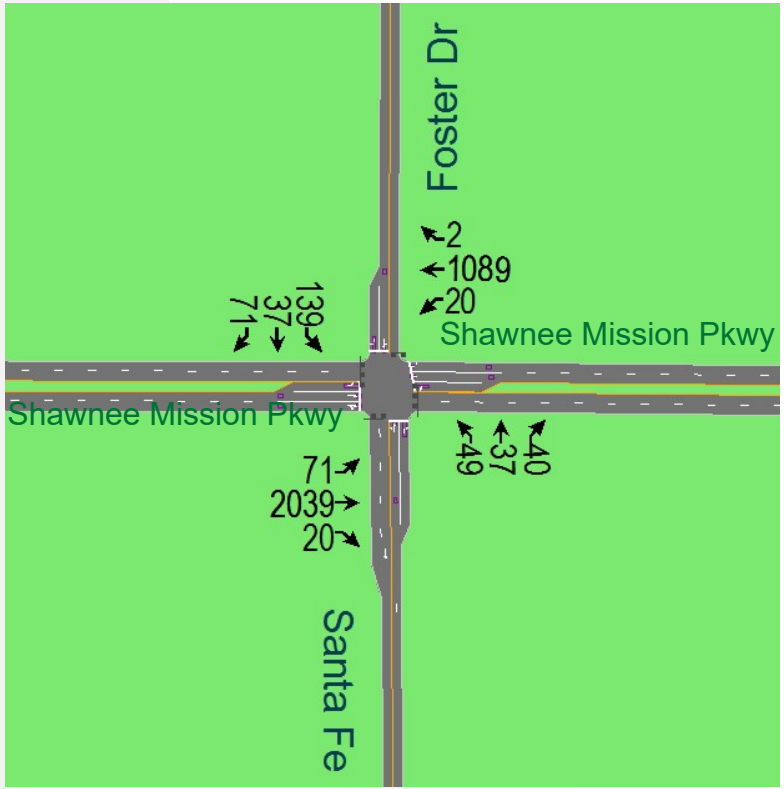

*Image Source: https://www.thecarconnection.com/news/1080042_vehicle-to-infrastructure-technology-on-the-road-in-germany.*

# Experimental Setup within PTV Vissim

- Data: AM Peak Hour; Existing signal timing plan
- Driving Behavior: Calibration Connected Vehicle (CV) technologies
  - Vissim COM Interface
  - Signal controllers and vehicles can communicate and share data
- Data Collection

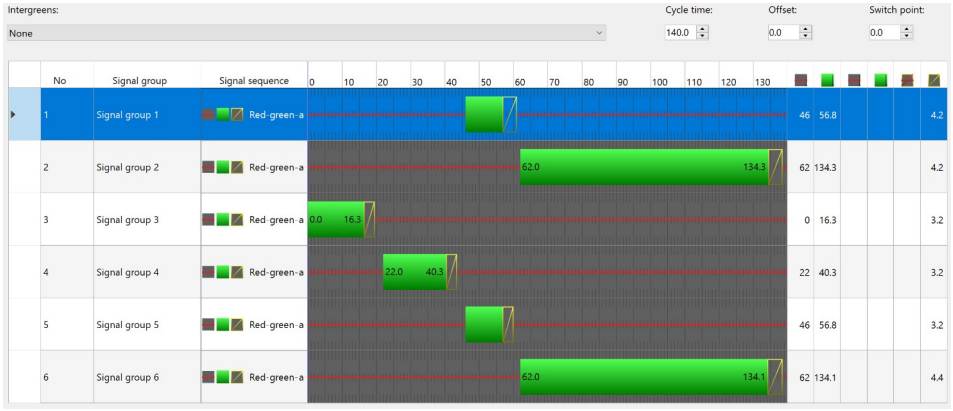
# Project Area

# Case Study

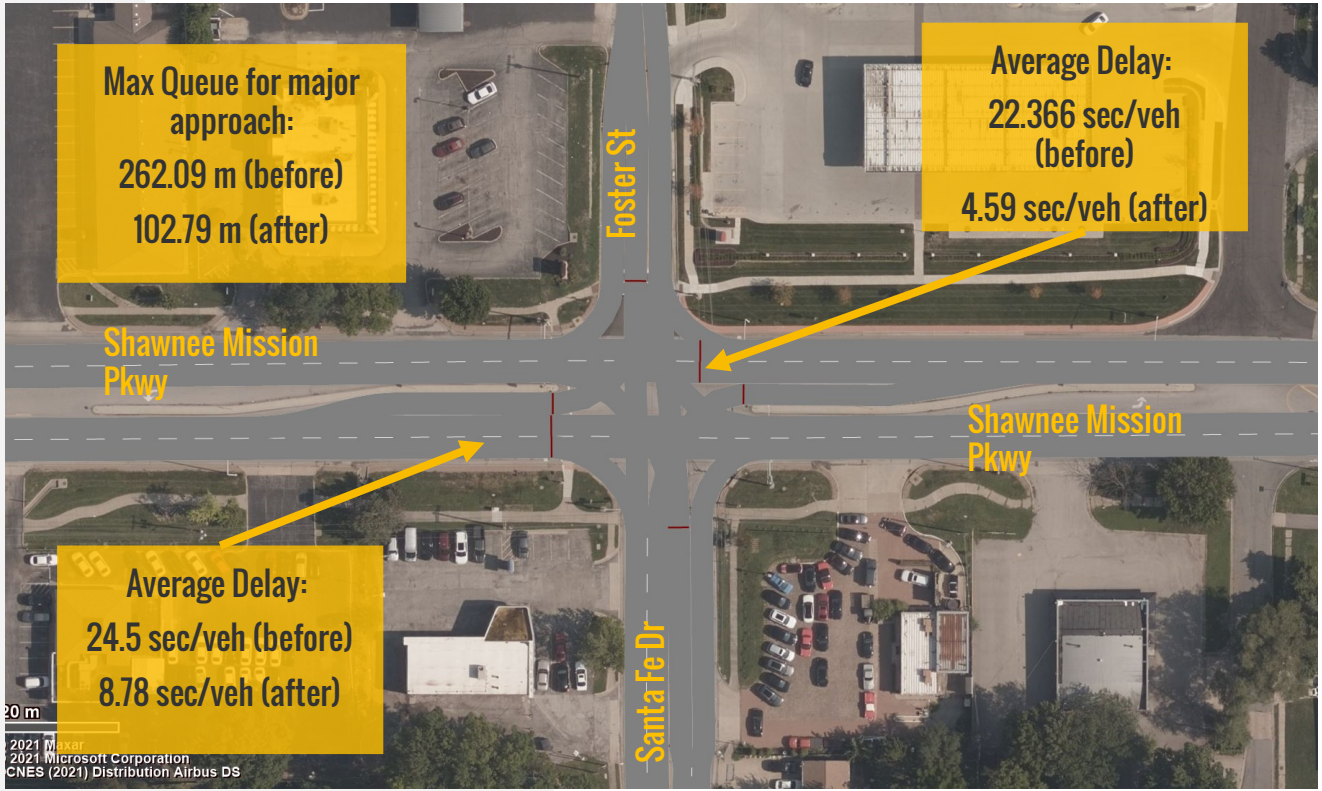



## Location: Merriam, KS

## Intersection of Santa Fe Dr and Foster St with Shawnee Mission Pkwy



# Results - LQF Algorithm




**For Shawnee Mission Pkwy Major Approach Through Traffic**

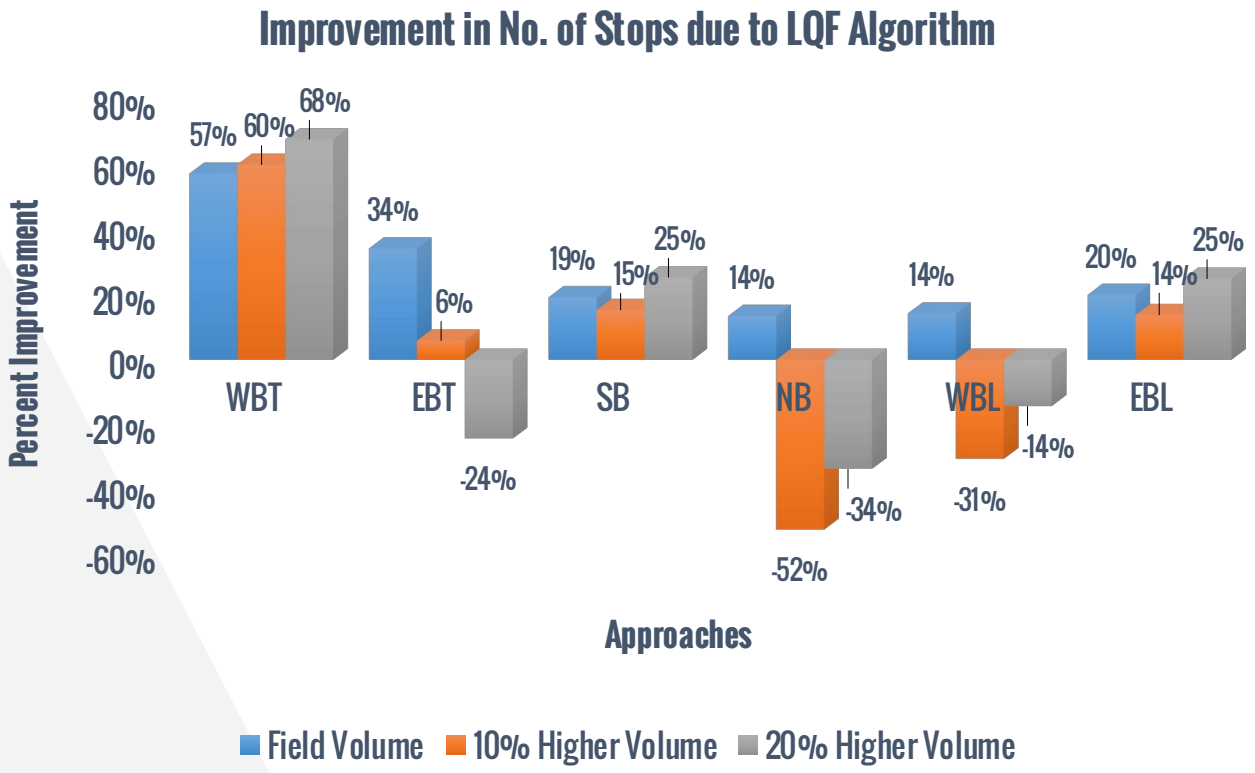
Avg Delay was reduced to 1/5 of previous delay

Avg Stopped Delay was reduced by 95% from previous stopped delay

Avg No. of Stops was reduced by about 57%

Max Queue Length became 2/5

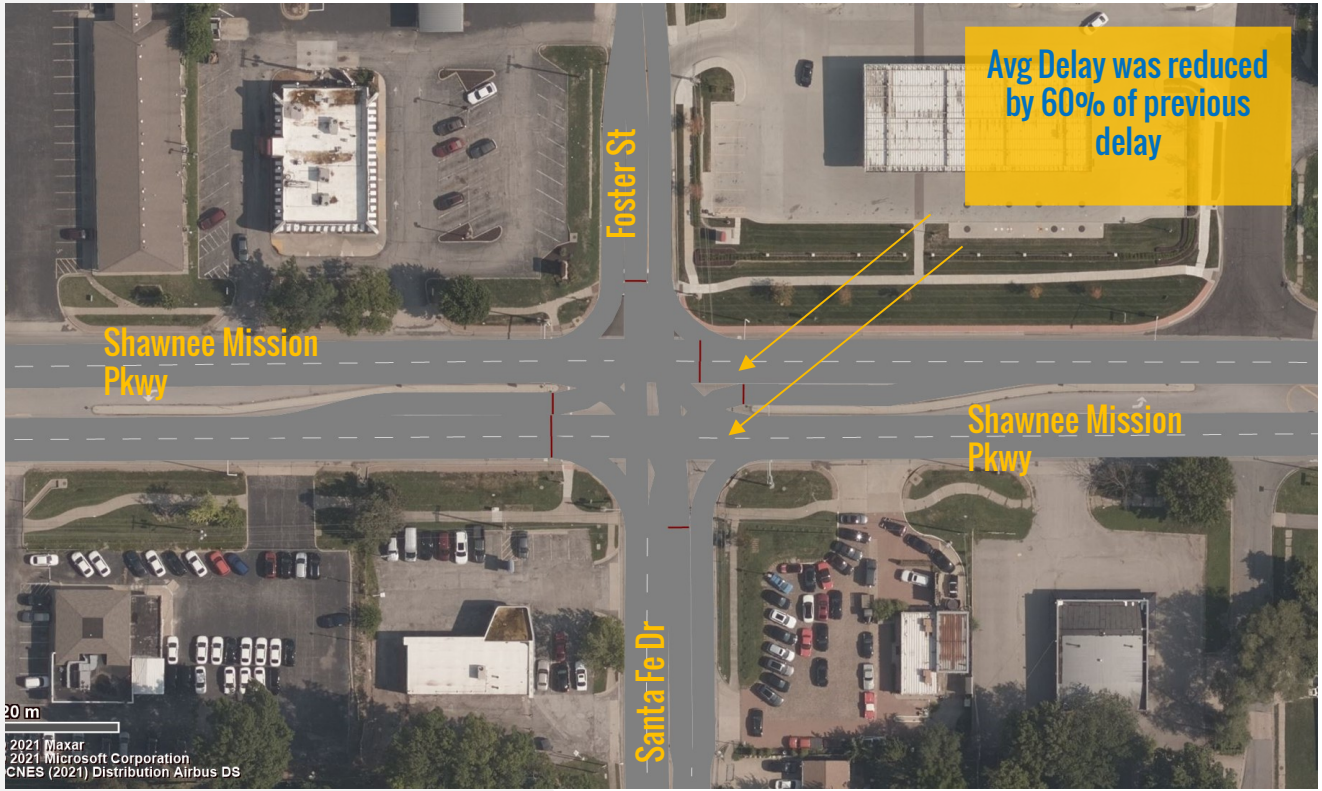
# Results - LQF Algorithm: No. of Stops



# Results - LQF Algorithm

| Maximum Queue Length (m) for Fixed Time Signal | | | | |
|---|---|---|---|---|
| | Major Through | Major Left | SB | NB |
| Field Volume | 262.09 | 28.54 | 82.51 | 84.87 |
| 10% Increased Volume | 480.49 | 28.29 | 78.71 | 83.04 |
| 20% Increased Volume | 504.74 | 22.47 | 82.52 | 84.87 |
| **Maximum Queue Length (m) for LQF Algorithm** | | | | |
| | Major Through | Major Left | SB | NB |
| Field Volume | 102.79 | 103.24 | 73.87 | 84.08 |
| 10% Increased Volume | 220.55 | 220.99 | 76.56 | 83.37 |
| 20% Increased Volume | 502.82 | 503.26 | 76.79 | 84.42 |
| **Changes in Maximum Queue Length (Percentage)** | | | | |
| | Major Through | Major Left | SB | NB |
| Field Volume | 60.78% | Queue exceeds left turn | 10.47% | 0.93% |

# Results - Dynamic Speed Algorithm



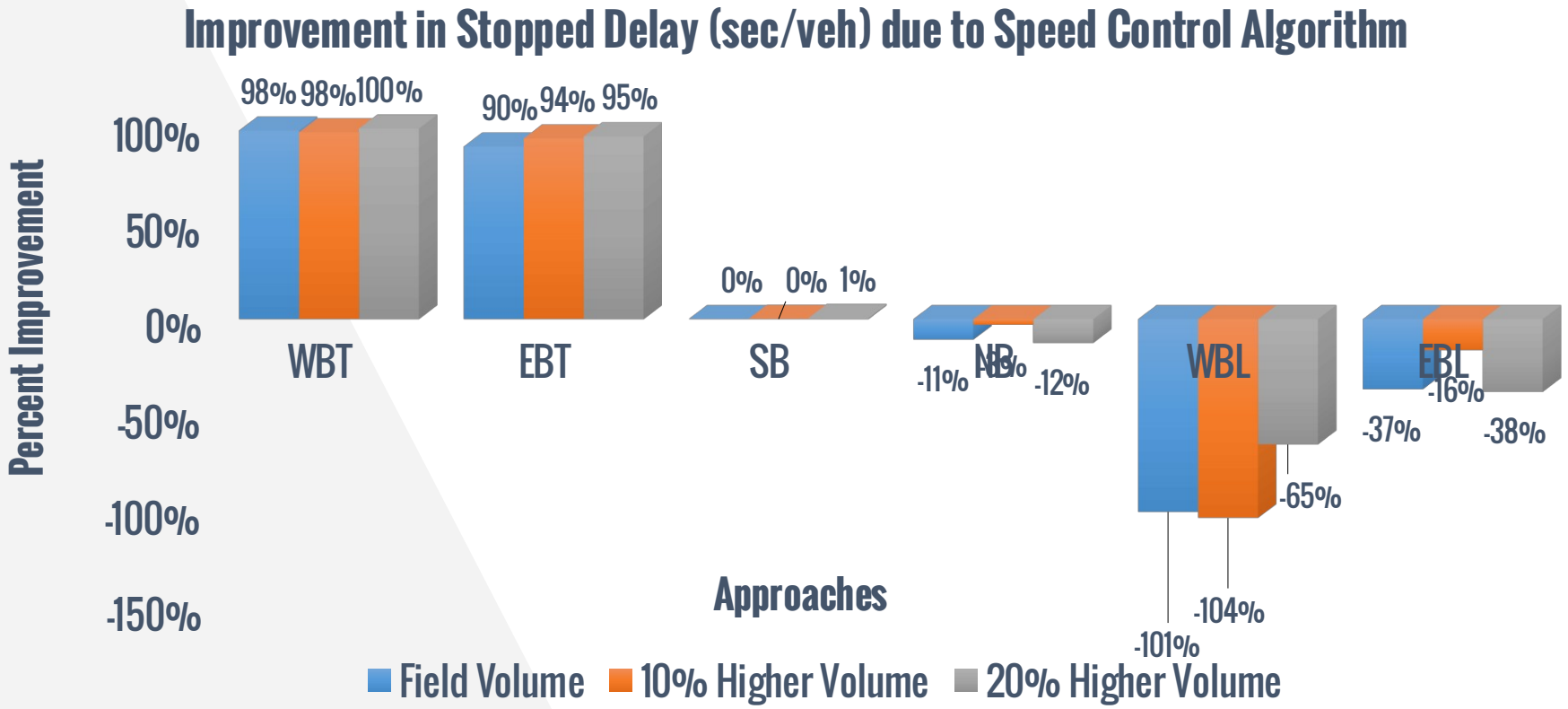

**For Shawnee Mission Pkwy Major Approach Through Traffic**

Avg Delay was reduced to 2/5 of previous delay

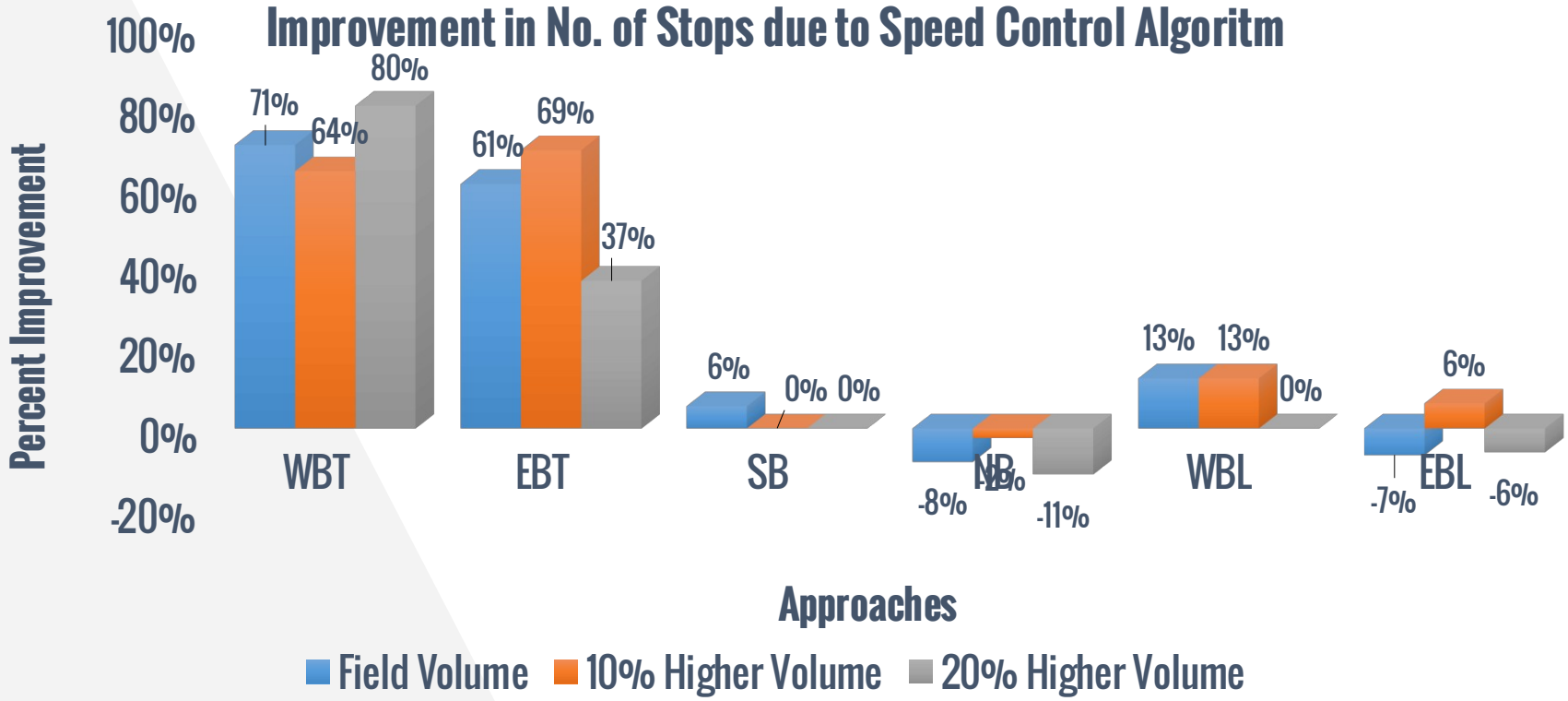
Avg Stopped Delay was reduced by 94% to 99% from previous stopped delay

Avg No. of Stops was reduced by about 73% to 80%

# Results -Speed Control Algorithm



# Results -Speed Control Algorithm



# Limitations and Ongoing Works

- Limitations:
  - Consideration for all red time
  - Poor performance at high demand volume
  - Algorithm works for fixed time signal control
- Ongoing Works:
  - Development of Connected-Vehicle based advanced algorithms
  - Coordinating dynamic speed control with variable signal timing settings
  - Market share of CVs
  - Prediction model
  - Environmental impact

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