Performance and safety of VANET

Group3
Jimmy(Chenjie) Yao
Jeremy Borys
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Roadmap

- **Introduction/Motivation**
- Technology Overview
- Project Design and Tools
- Simulation Scenarios and Results
- Conclusion

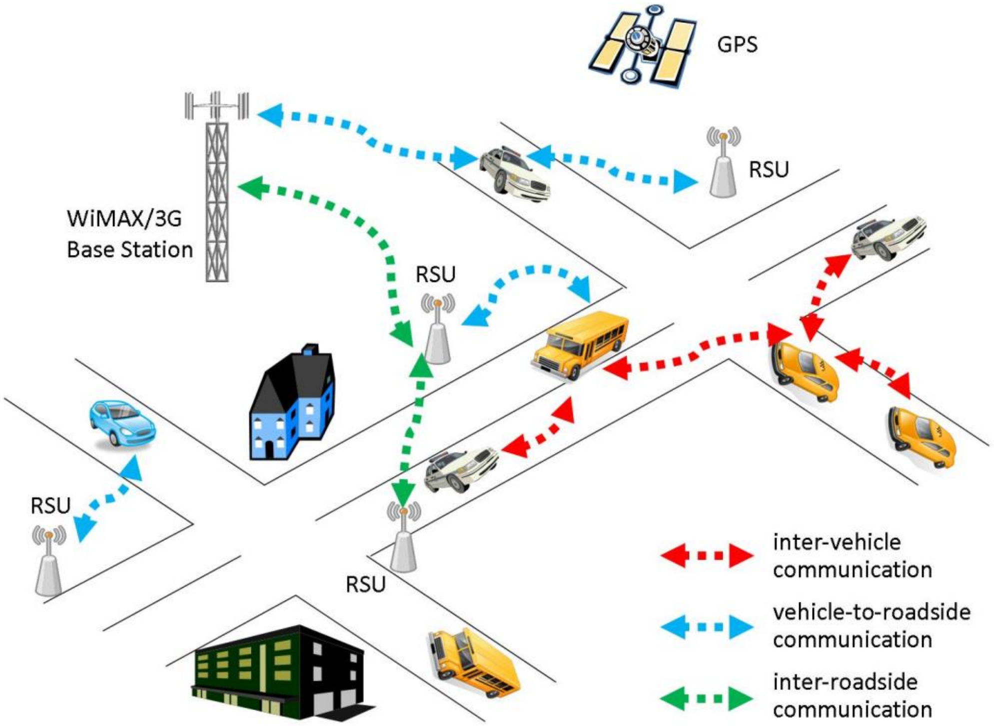
VANET Overview

Introduction

- World is moving towards automate driving
- Communication between cars can share important safety information
- Volvo Trucks in Sweden is using Vehicle-to-Vehicle communication for truck drivers [1]

Motivation

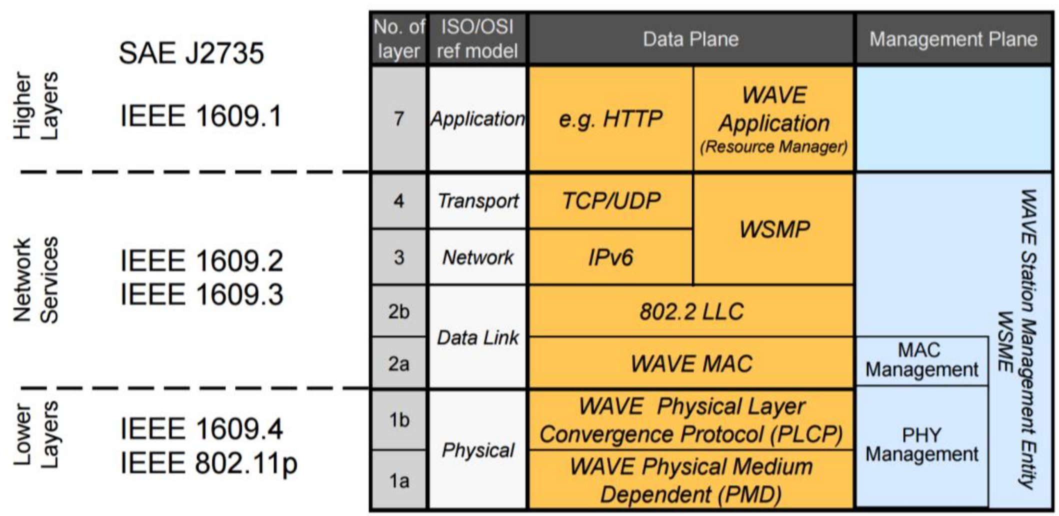
- Implementation on a large scale
- Little errors add up
- Where does V2V communication begin to have difficulties scaling



[9] http://www.brunel.ac.uk/cedps/electronic-computer-engineering/research-activities/wncc/student-profiles/shariq-mahmood-khan

Wireless Access Overview

- Modification of IEEE 802.11 standard
- Supports for much longer ranges
  - NS2 implementation seems to stop at about 250 m even though it is supposed be up to 1 Km
- Optimized for high speed nodes (upto ~500 km/hr)



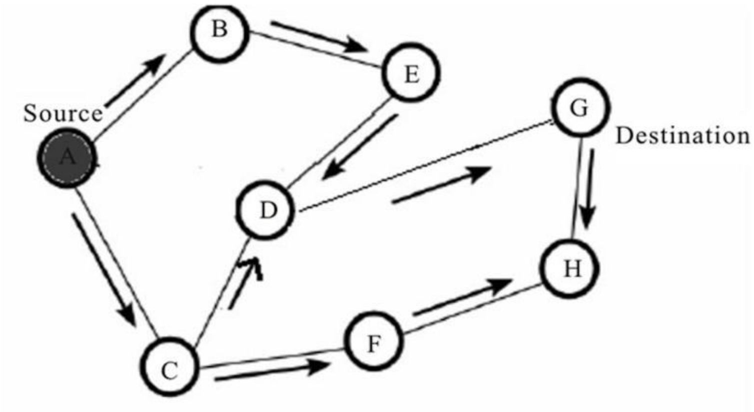
[3] http://www.sti-innsbruck.at/sites/default/files/courses/fileadmin/documents/vn-ws0809/11-VN-WAVE.pdf

IEEE 802.11p

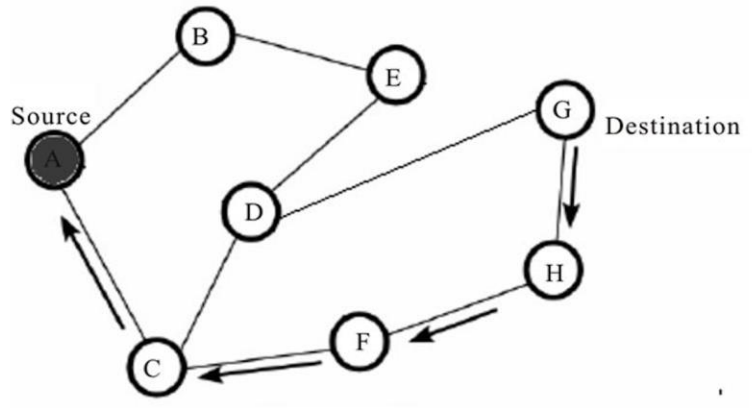
- Dedicated Short Range Communications (DSRC)
- Modification of IEEE 802.11 standard
- Supports for much longer ranges
  - NS2 implementation seems to stop at about 250 m even though it is supposed be up to 1 Km
- Optimized for high speed nodes (upto ~500 km/hr)
- Data transmission reliability is important, decreased BW from 20 to 10 MHz to double the time it takes to transmit a symbol
- Implements
  - IEEE 802.11a PHY: Orthogonal Frequency Division Multiplexing (OFDM) modulation
  - IEEE 802.11 MAC: Carrier Sensing CSMA/CA

AODV Protocol

- The AODV Routing Protocol uses an on-demand approach for finding routes, that is, a route is established only when it is required by a source node for transmitting data packets. It employs destination sequence numbers to identify the most recent path.
- A RouteRequest carries the source identifier (SrcID), the destination identifier (DestID), the source sequence number (SrcSeqNum), the destination sequence number (DestSeqNum), the broadcast identifier (BcastID), and the time to live (TTL) field.
- The validity of a route at the intermediate node is determined by comparing the sequence number at the intermediate node with the destination sequence number in the RouteRequest packet



(a) RREQ Broadcast



(b) RREP Forwarded Path

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VANET

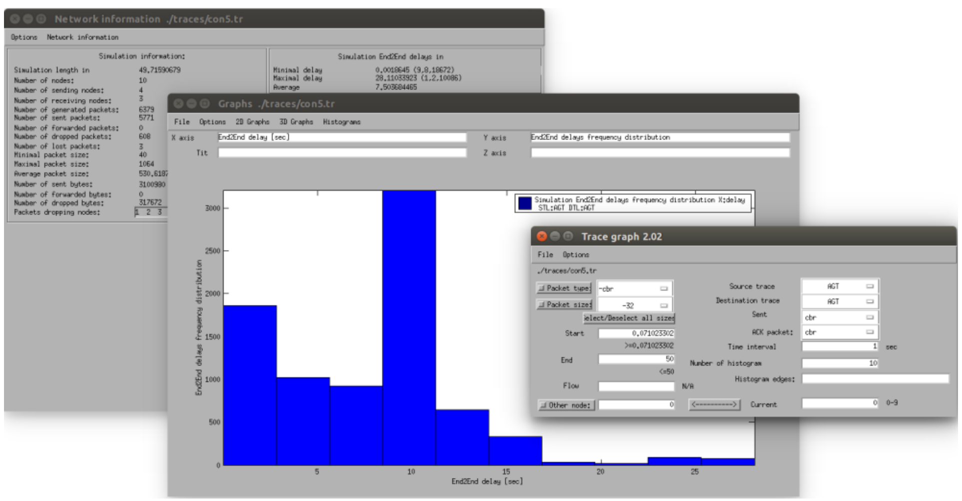
Simulation Tools

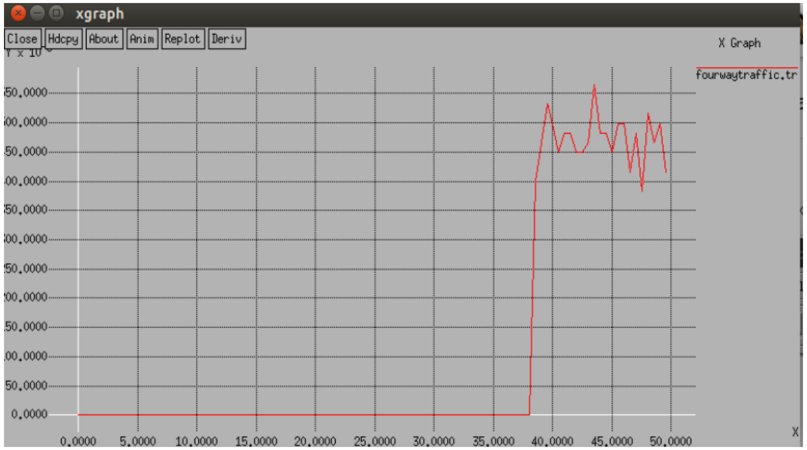
Tracegraph

- Allows a user to quickly parse through a NS2 trace log
- Extracts a wide variety of various different network information
- Can do node to node and many different plots

Xgraph

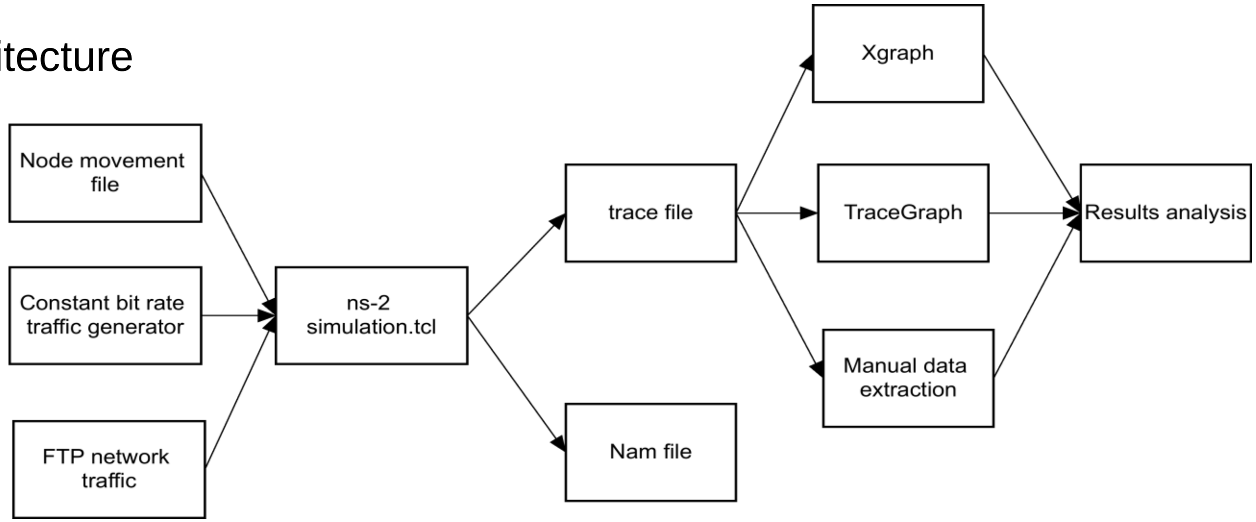
- Used as a sanity check to quickly confirm Tracegraph results
- Also provided a quick overview for the simulation
- Unfortunately time consuming as we need figure out how to parse logs ourselves





VANET

High level simulation architecture



Requirements to use our simulation environment

- Auto/manual generated node movement files
- Automatically generated constant bit rate background traffic
- Specifically written FTP network traffic node connection

Once the three scenarios are set the simulation is started with simulation.tcl

- Simulation.tcl produces trace files that can be read by an external program
- Data is analyzed using a combination of Xgraph, Tracegraph, Manual data extraction

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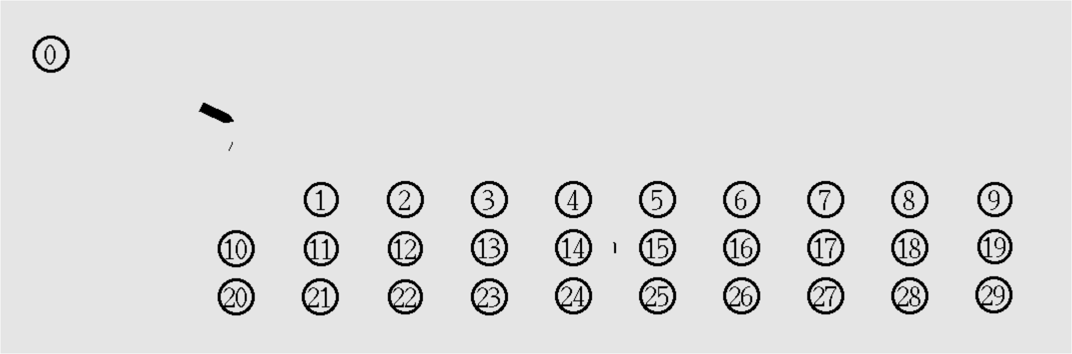
Highway Scenario: Increasing Background Network Traffic



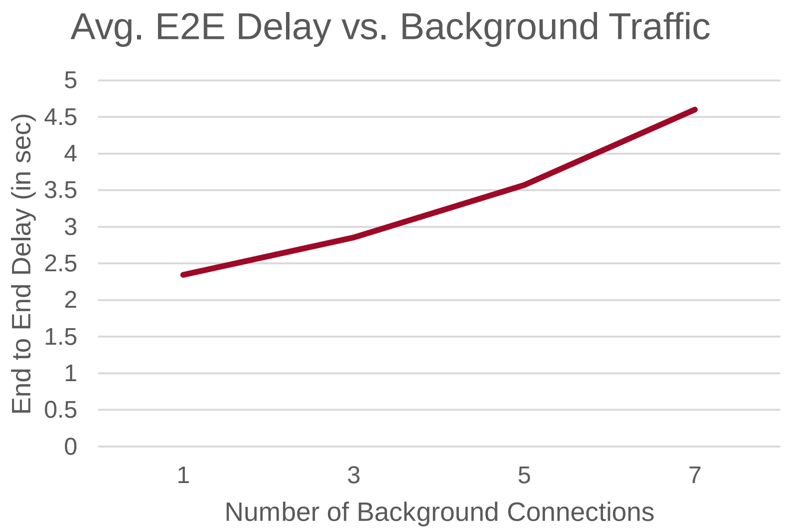
Scenario Layout

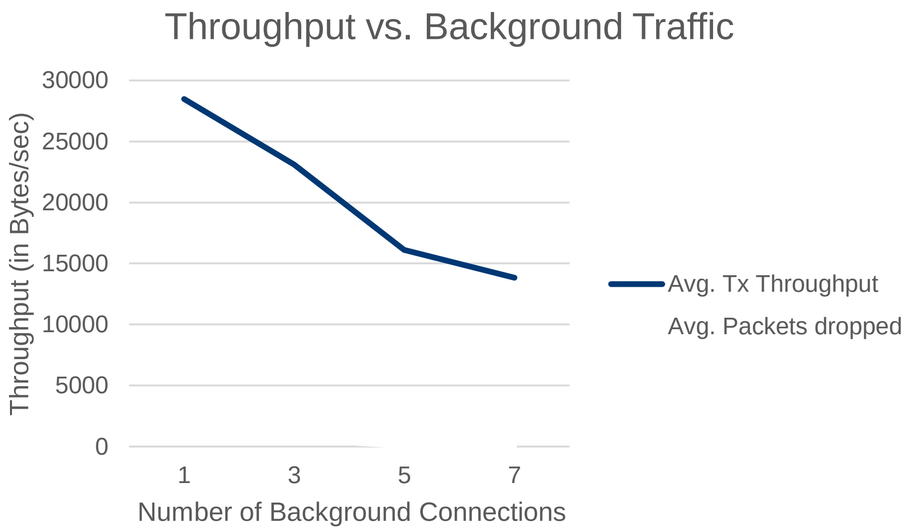
- Created 30 vehicles all moving at 100 km/hr
- Modelled cars in each lane is 25 meters apart
- Added a new lane for every 10 cars

Scenario NAM Snapshot

- Node 0 is the car we are sending FTP/TCP traffic from to Node 9
- Node 0 is offset to confirm that AODV Protocol is being used

Highway simulation results





- Avg. delay increased with increasing background traffic
- Avg. Tx Throughput dropped by almost a half

Highway Scenario: Increasing Car-to-Car Distance

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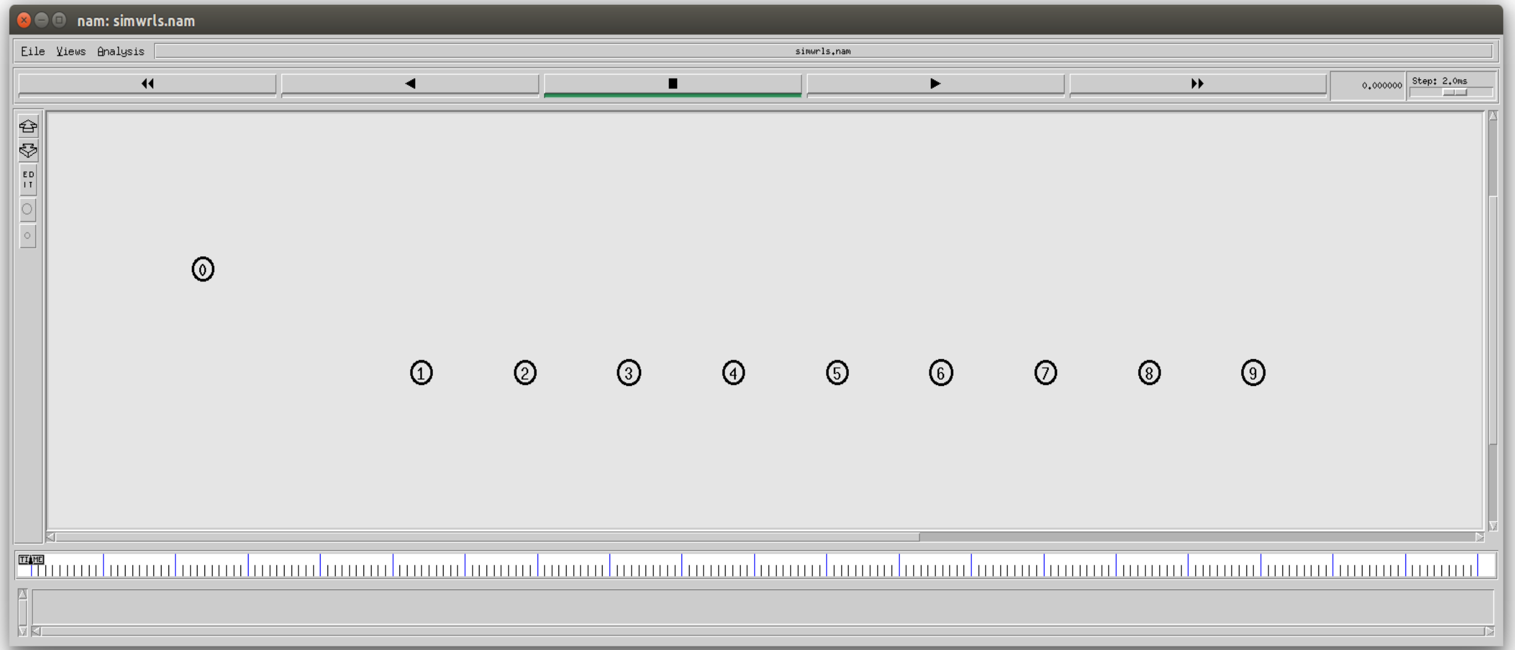
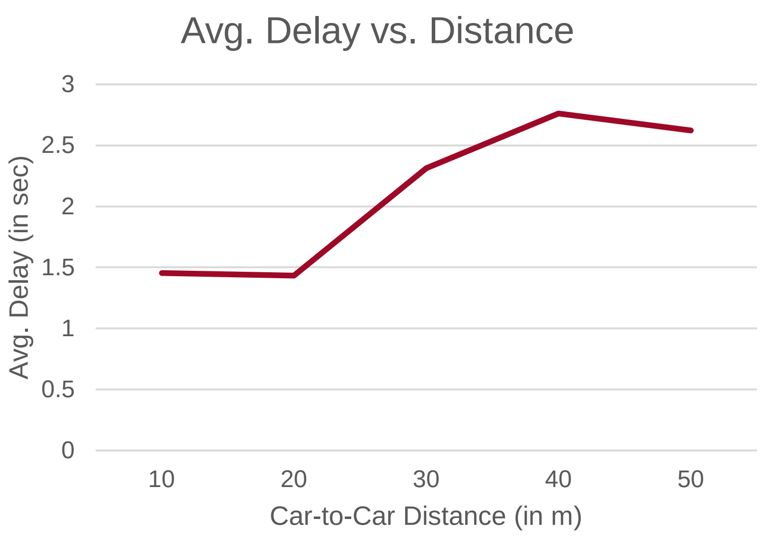
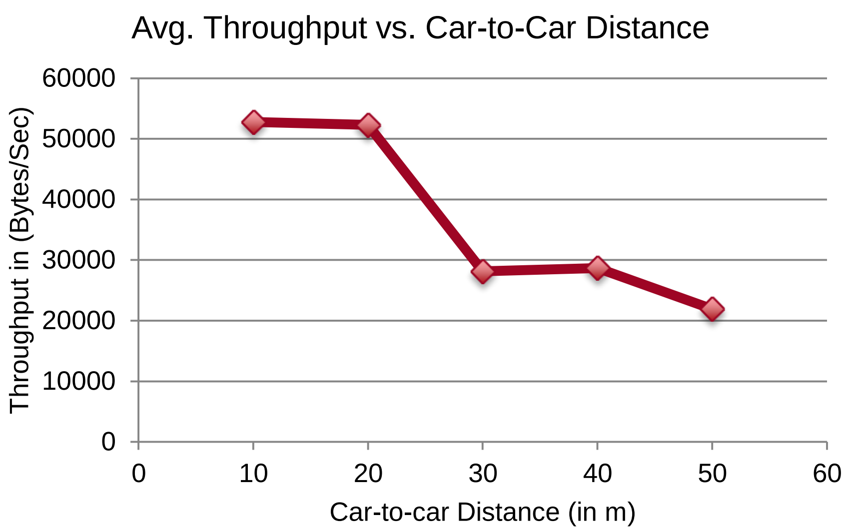


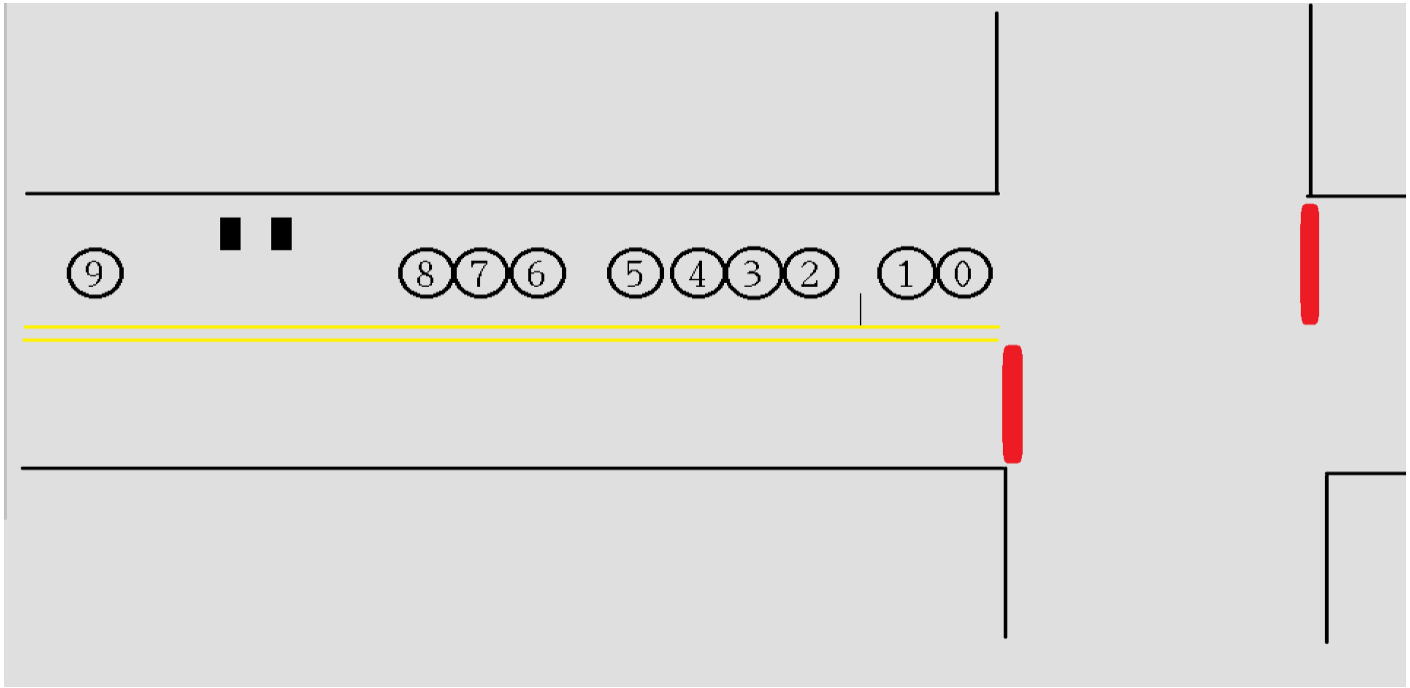
Car-to-Car Distance Results





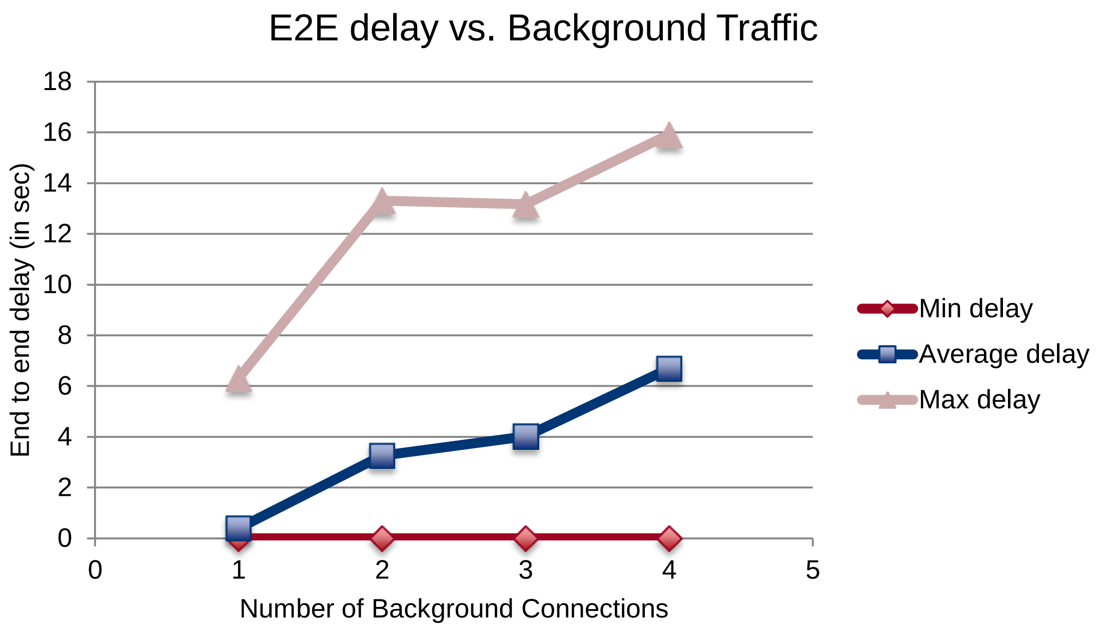
- Avg E2E delay almost doubles
  - Considering that Car-to-Car Distance increases 5X
- Avg Tx Throughput drops by half
  - Less data can be sent with increasing inter car distances
- Better to have cars closer together

Stop Sign Scenario



- Model 10 Cars, Moving at 50 km/hr
- After 40 seconds the cars approach a stop sign
- Measure the avg. delay from car 8 telling car 9 to stop
- Repeat each test with increasing the background traffic

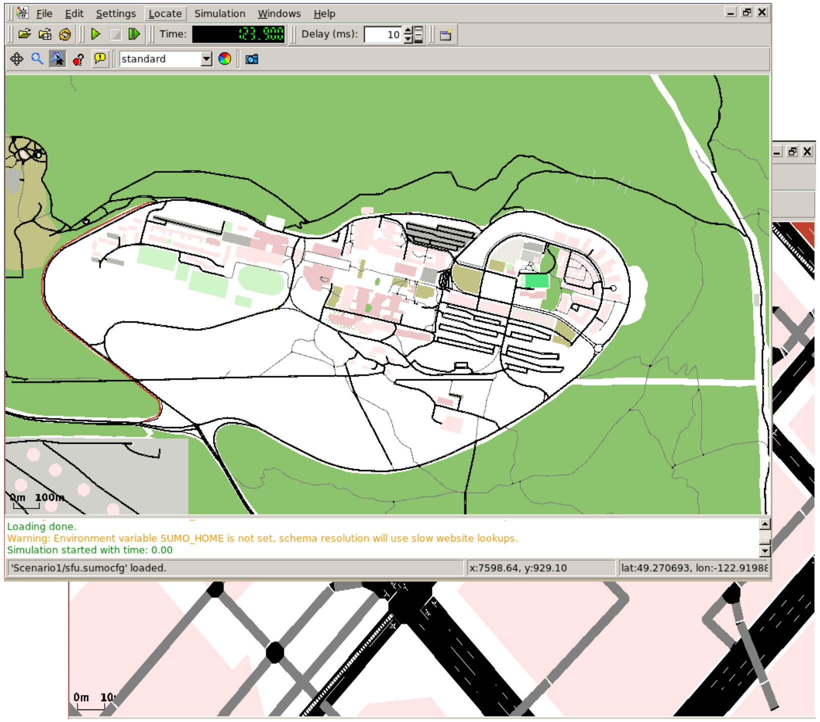
Stop Sign Scenario Results



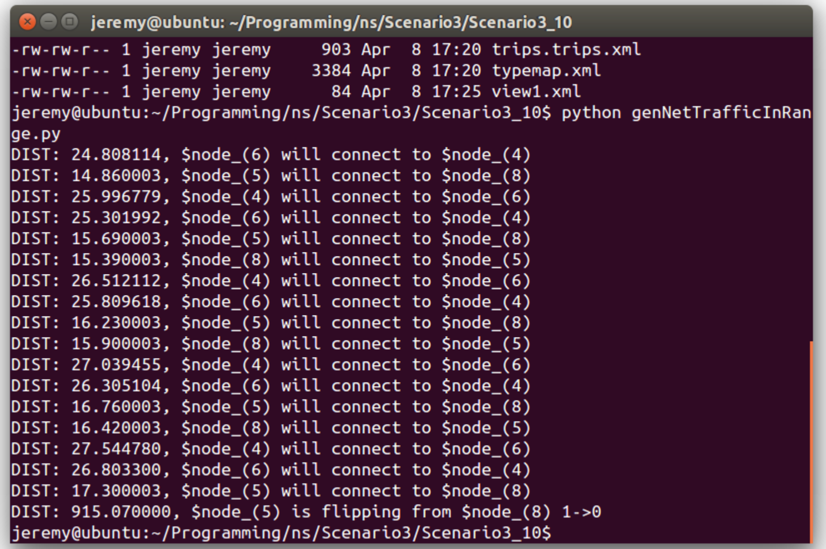
Scenario 3 simulation results

The average delay increases as the number of background connections increase. This is because the bandwidth is been consumed by other nodes.

Future Work



SUMO



Python script generate connection based on distance

- Integrate Simulation of Urban Traffic Mobility (SUMO)
- Generate network traffic files off of the files generated from SUMO

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In this VANET performance and safety analysis, ns2 is used along with tracegraph to simulate AODV routing protocol with realistic mobility model for VANET. Graphs are plotted using Excel for evaluation. The performance is analyzed for up to 30 nodes with respect to various parameters like car to car distance and number of background connections.

In the future, higher number of nodes can be simulated and analyzed. SUMO could be a potential tool to generate realistic mobility files. It would be interesting to see how ADOV performs when in high node density network.

References

[1] M. Vassiliadis, "Volvo Trucks," 11 March 2015. [Online]. Available: http://www.volvotrucks.com/trucks/NewZealand-market/en-nz/newsmedia/pressreleases/Pages/pressreleases.aspx?pubID=14543.

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[10] "Information Sciences Institute," 2 April 2015. [Online]. Available: www.isi.edu/nsnam/ns/tutorial/nsindex.html.

Thank You

Questions?