# ENTS 749C

# Vehicular Networks

# Final Project Report
# VANET Simulation

**Submitted by**:
Sneha Bommireddy
Anusha Jamkhandi

**Abstract**: Vehicular mobility is an important challenge that needs to be addressed while designing Vehicular Adhoc NETworks with V2V and V2I connectivity. The first part of this project aims to study the impact of vehicular mobility and traffic volume on V2V connectivity. It successfully implements the freeway mobility model, the car following model, the lane changing model and border effects in Matlab for a 4-lane scenario with 3 entry and 3 exit ramps. The simulations run for 5 trials of 10 minutes duration each, for every traffic density.
We have observed linear variation in our graphs with traffic densities and the values seem to be feasible and practical. With the change in communication range, the output also changed.

# Data Plots for VANET Mobility

**All the plots below are for 5 simulations run for 5 minutes. The communication range is 50 meters.**

1. Plot shows the average number of communication nodes within 50 meters from the target.

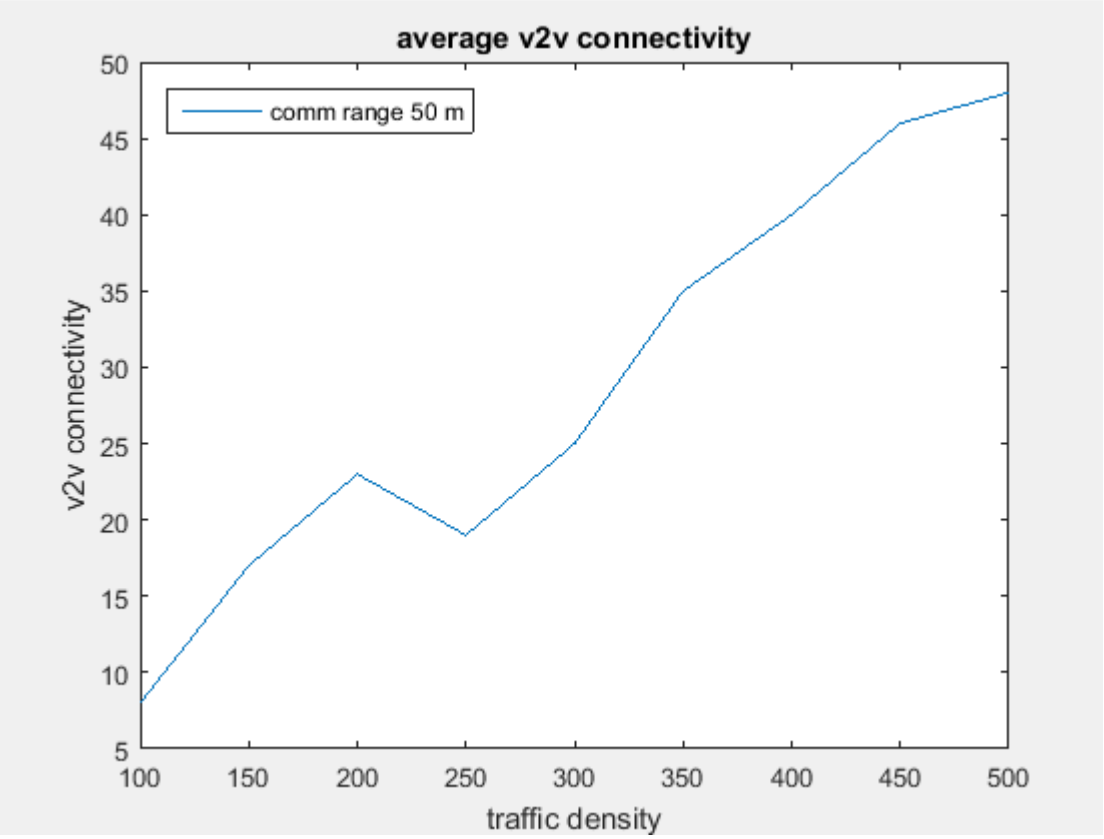


Figure 1

2. Plot shows the average duration the target node maintains the same 3 communication neighbors that are within 50 meters.

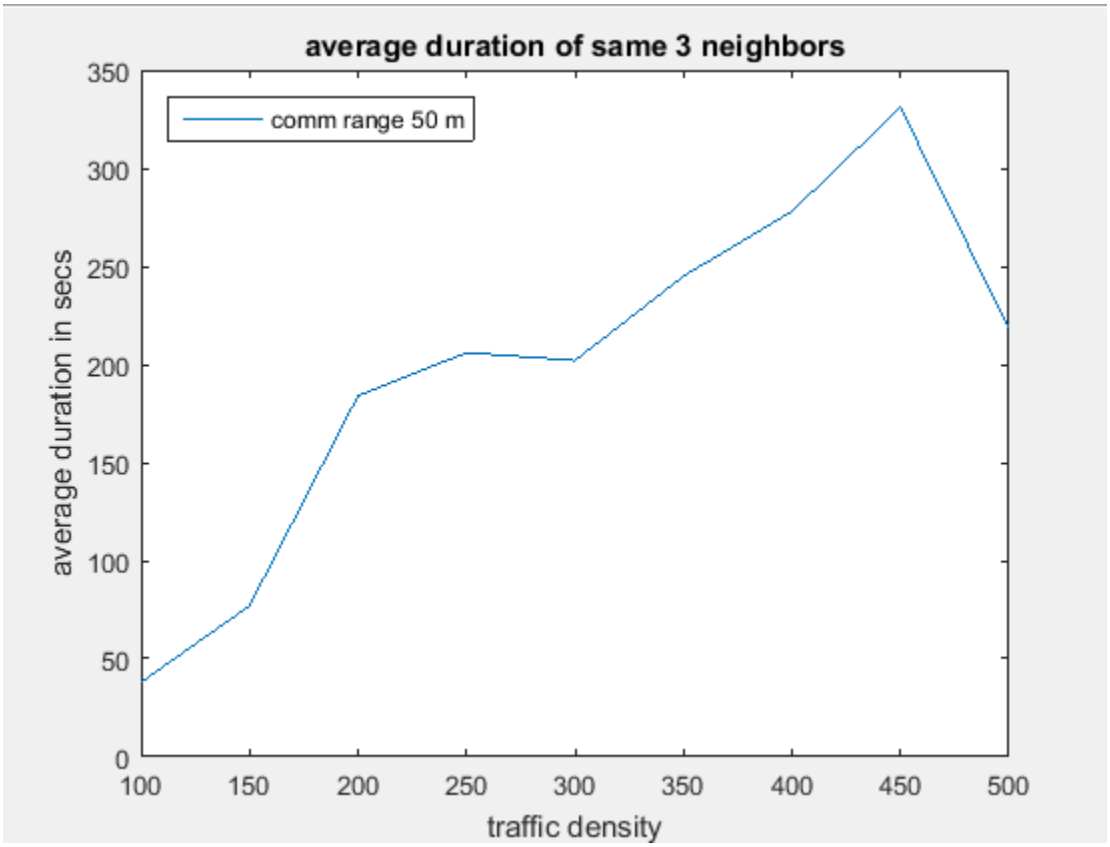

Figure 2

3. Plot shows the average number of same neighbors for 30 seconds

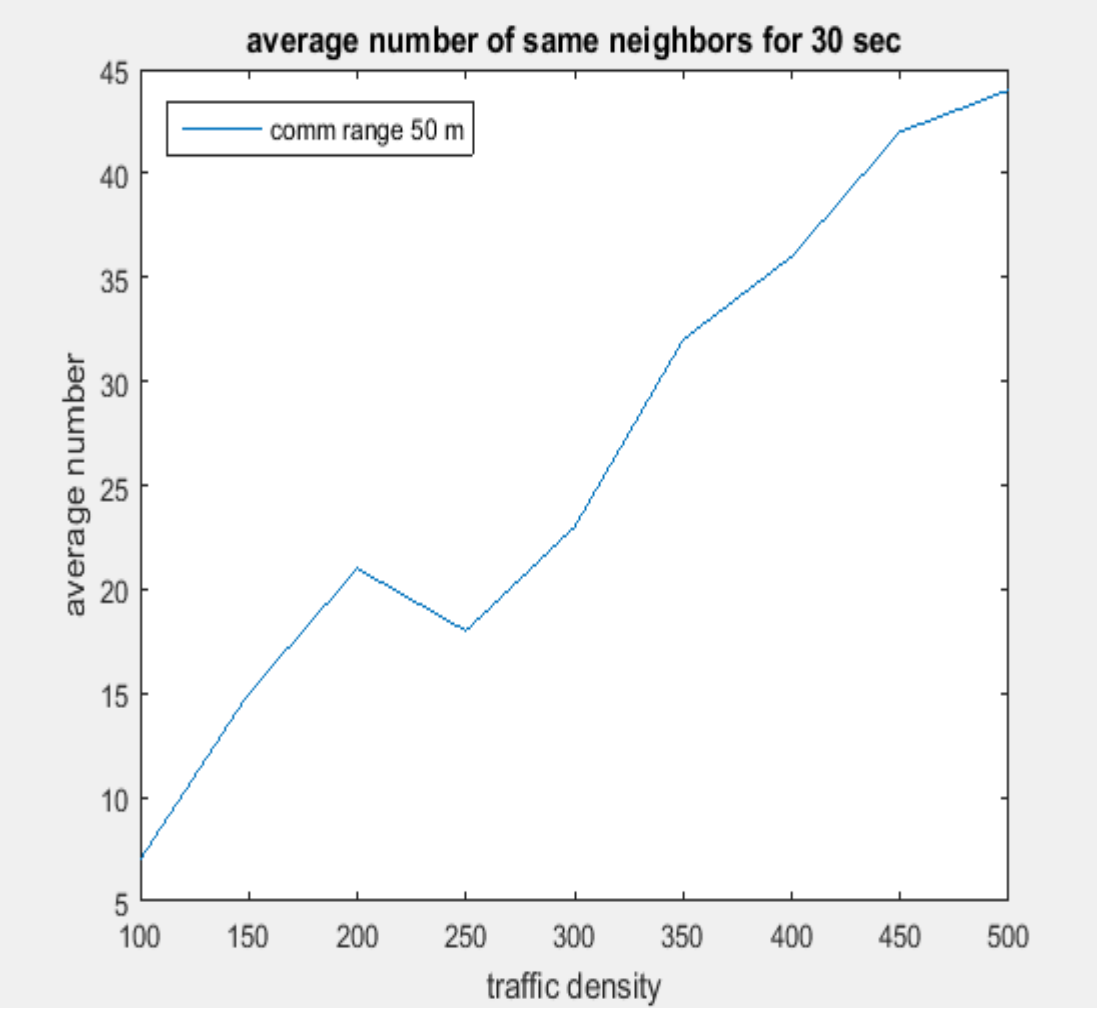


Figure3

The figures below show the different plots for both 50 meters and 100 meters. The simulations are run for 2 minutes for both 50 meters and 100 meters. The plots are obtained after 5 simulations for each and help see the difference when the communication range increases to 100 meters.

1. Plot shows the average number of communication nodes within 50 meters (red) and 100 meters (in blue) from the target.

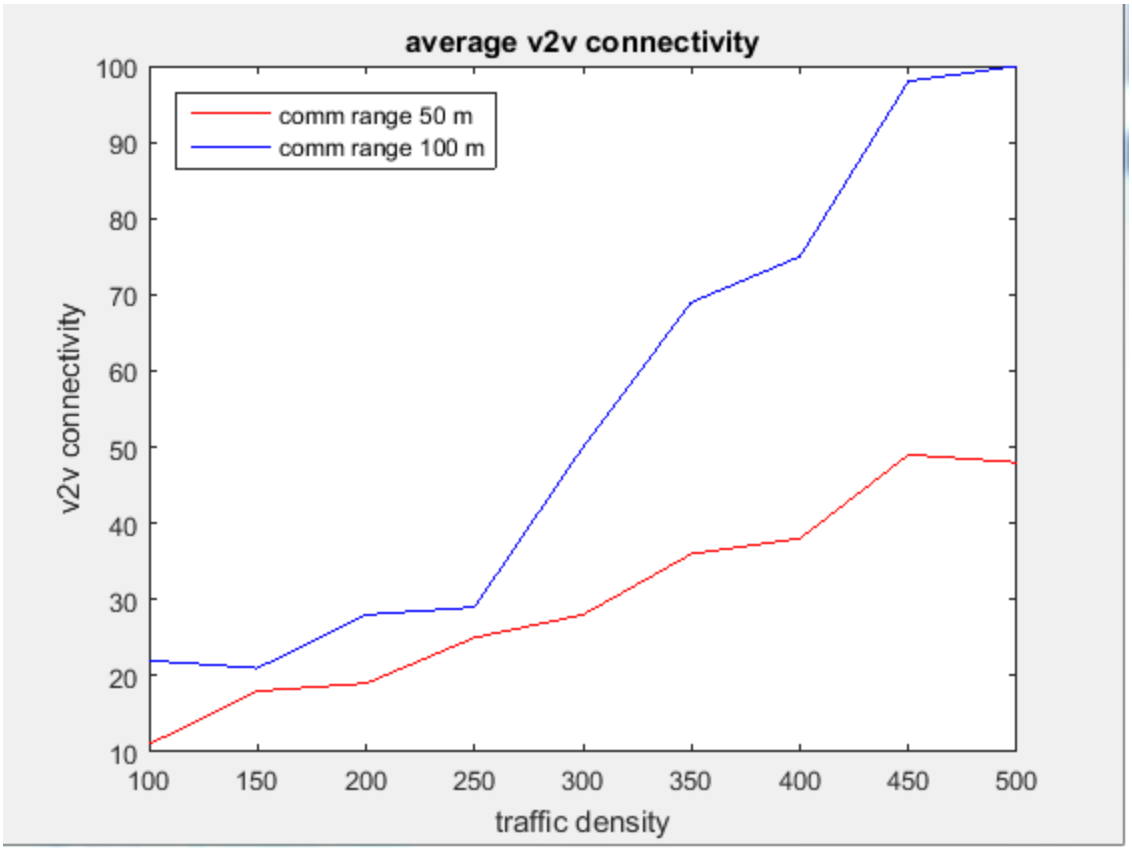


Figure 4

2. Plot shows the average duration the target node maintains the same 3 communication neighbors that are within 50 meters (red) and 100 meters (blue).

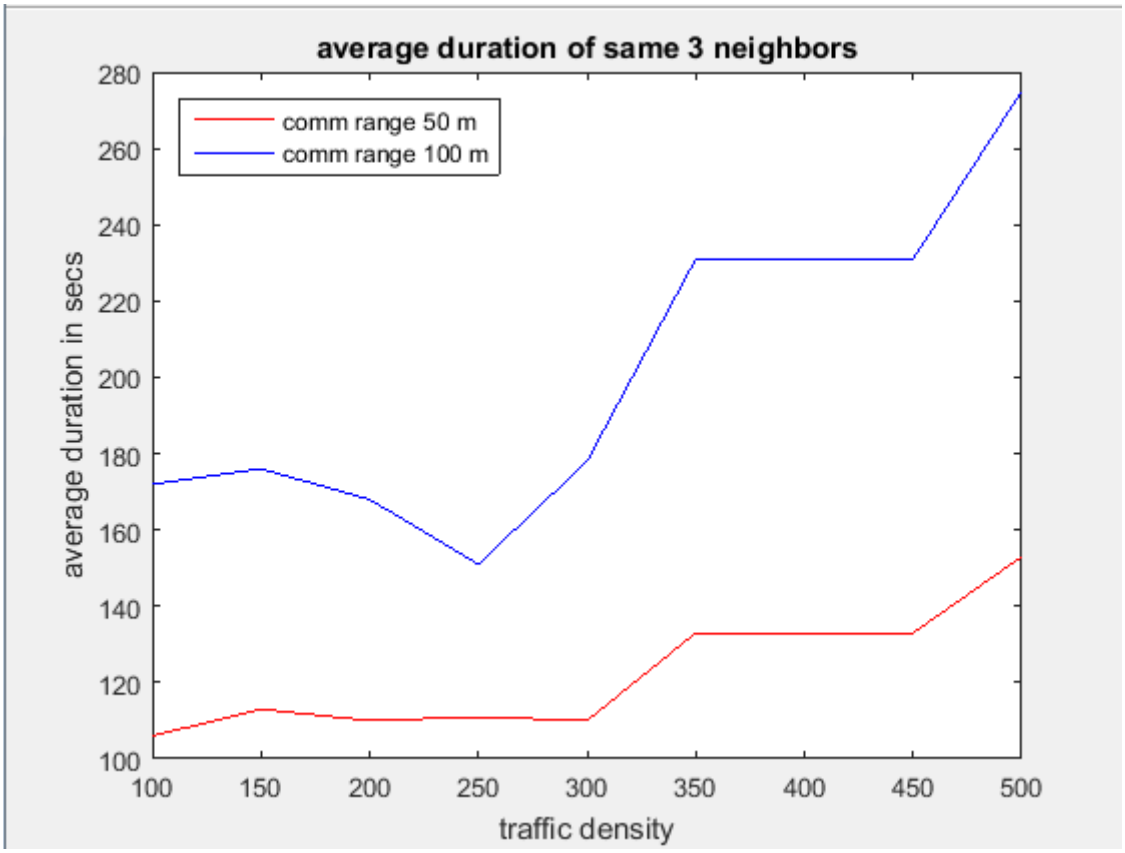


Figure 5

3. Plot shows the average number of same neighbors for 30 seconds for 50 meters (red) and 100 meters (blue) communication ranges.

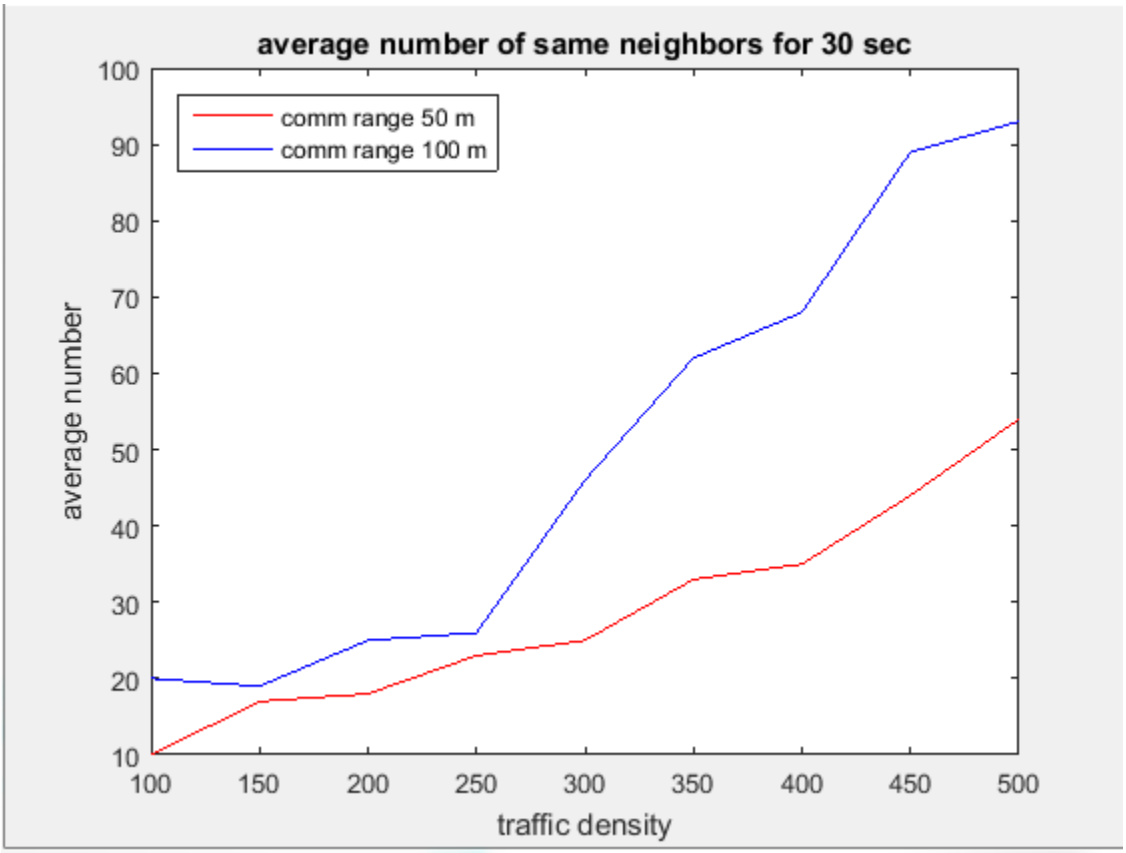


Figure6

# Observations on VANET mobility simulation

Figure 1:

- The number of neighbors increases as the traffic density increases since the vehicles move closer to each other due to congestion. As a result, the average V2V connectivity increases linearly with traffic density.
- Considering 100 -500 vehicles on each lane of 5km and 50 meters communication range, when uniformly distributed, each node have connectivity with 8-40 vehicles. Our graphs give the same results.

Figure 2:

- As expected the average duration of same 3 neighbors also increases linearly with traffic density because the same neighbors tend to stay together longer with increasing traffic. Increasing traffic would lead to congestion and control the way the vehicles move. The vehicles change lanes less often because the possibility of vehicles being beyond safety distance is less likely due to congestion in other lanes as well.
- Duration is varying from 1min(60 seconds) to 6 minutes as traffic density increases. This means we can rely on this model for transmitting non-safety applications also
- Abnormalities in the graphs are not repeatedly occurring for same densities but are randomly occurring. The reason could be the random allocation of speeds and distances which keep changing every 100msecs making the simulation unpredictable even on taking average values.

Figure 3:

- Again, as expected the average duration of 3 neighbors for a fixed duration also increases linearly with traffic density. Like the explanations for previous observations, Increasing traffic would lead to congestion and reduce the likelihood of lane changing.
- For 30 secs, average number of same neighbours vary increase from 4 to 40.

Figures 4-6 compares 100m and 50 m plots. We can see that the results are almost doubled.

# VANET Visualization and Assessment Tool Output

**Simulation for 4-Way Road Intersection and V2V Connectivity of Approaching Vehicles**

1. The user draws two intersecting roads and three vehicles start moving with random speeds towards the intersection.

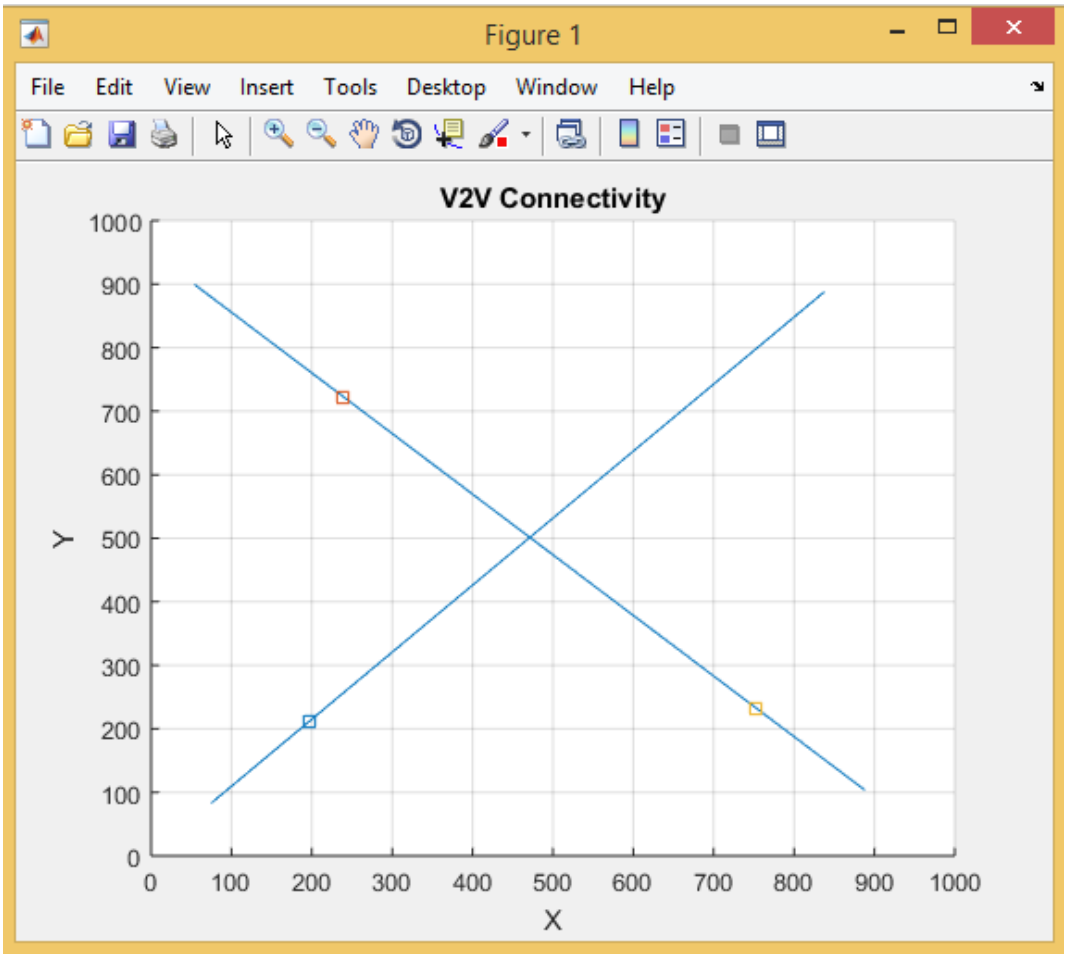


Figure7. Three vehicles approaching the intersection

2. A connection is established if the distance between the vehicles is less than 100m. The connection is shown by the green dashed line.

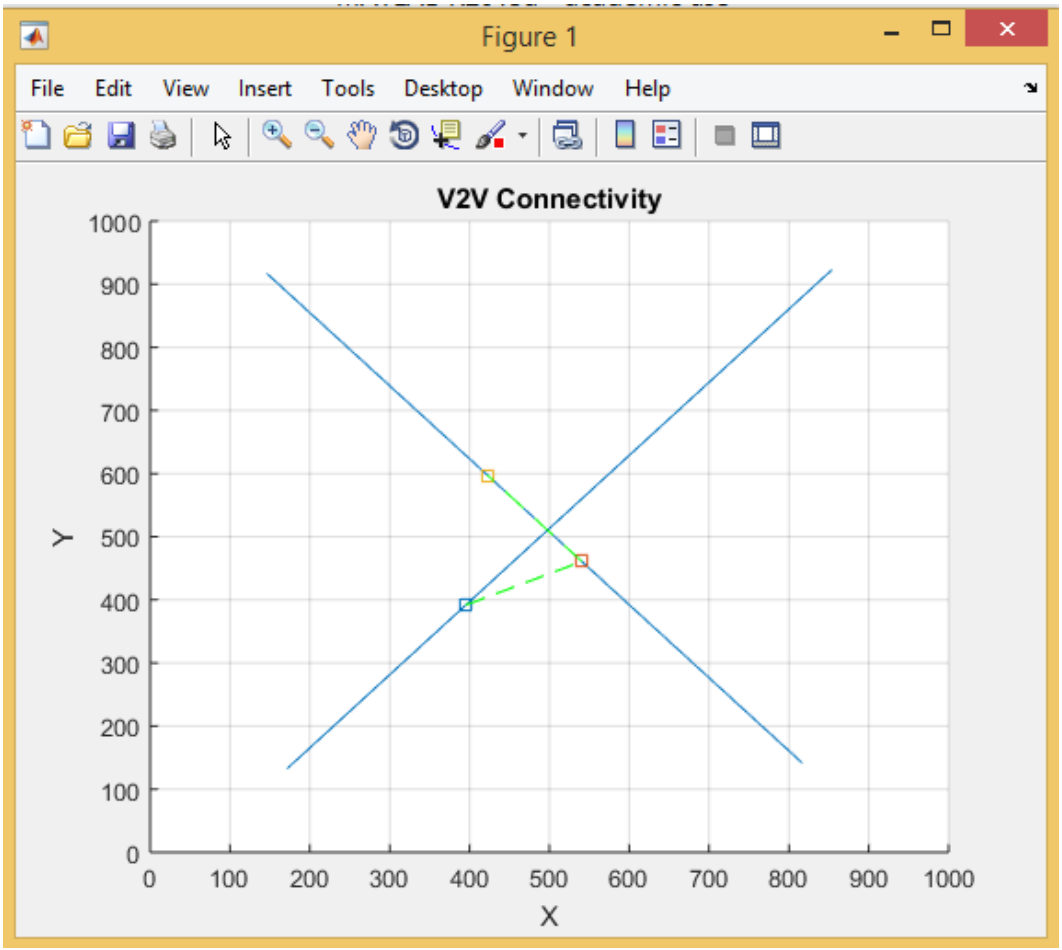


Figure 8. Connection established between two vehicles that are within 100m.

3. Connection is established between all the three vehicles when they are close to the intersection.

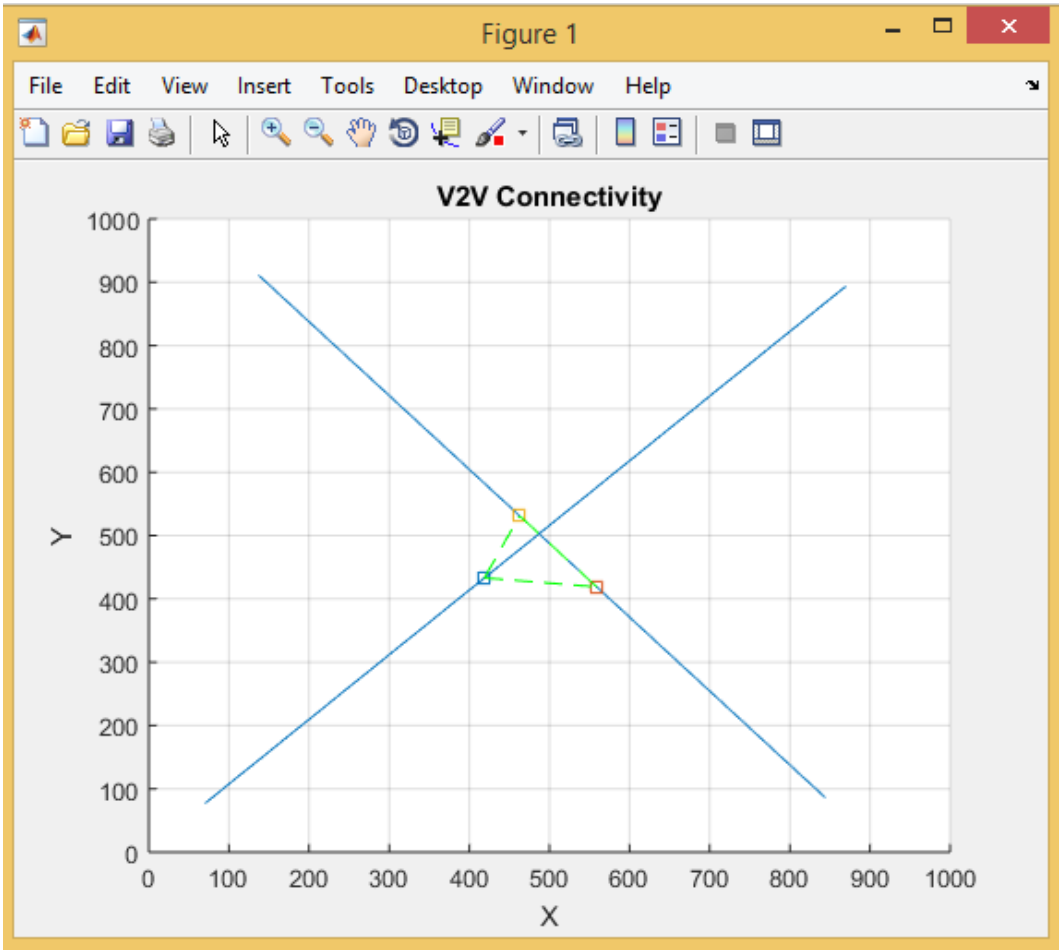


Figure 9. Connection established between all the three vehicles.

**Simulating V2I Coverage for a Vehicle in a Road Map with a RSU Deployment**

1. The user draws three connected roads and places 2 RSUs along the path. The vehicle moves along the path and if the distance from any RSU is less than 100m, it establishes a connection. The red part of the road indicates path with no connection and the green part indicates connection.

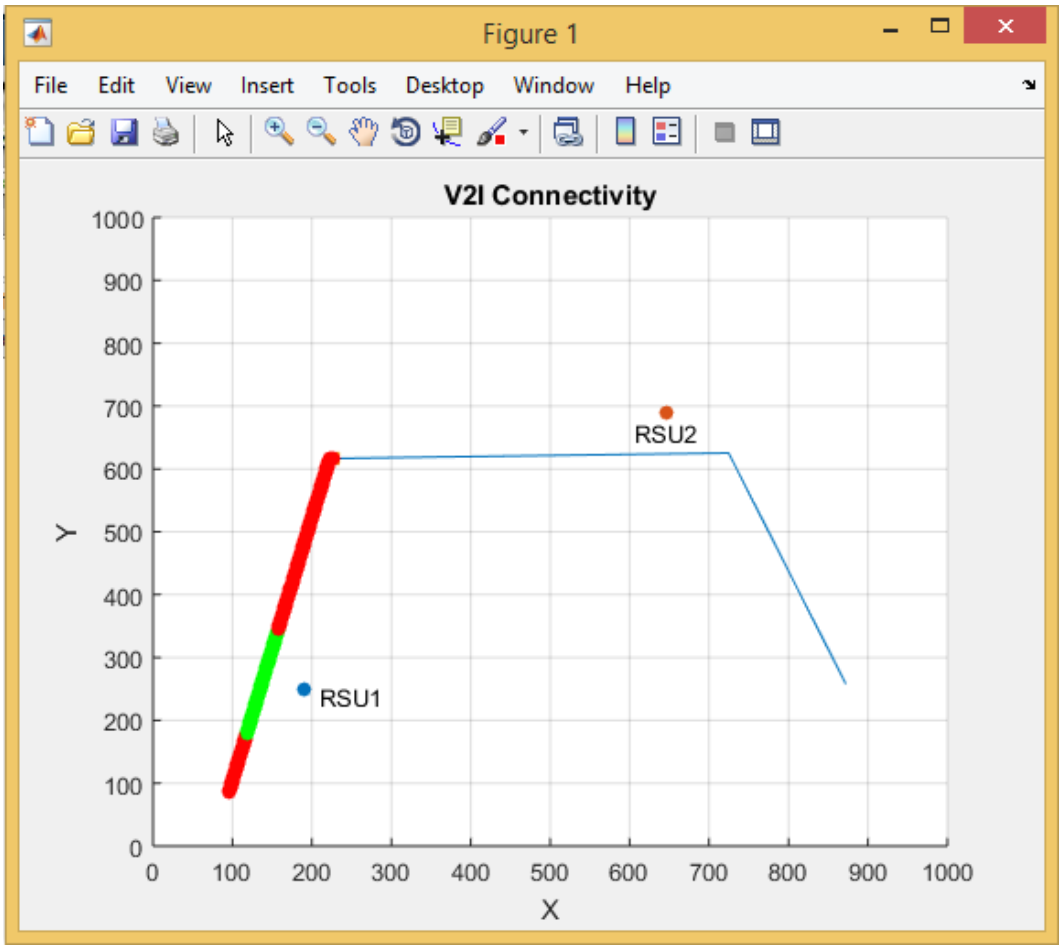


Figure 10. Coverage map showing connectivity with vehicle and RSU1.

2. As the vehicle reaches the end of the path, the coverage map is shown with the red and green colors.

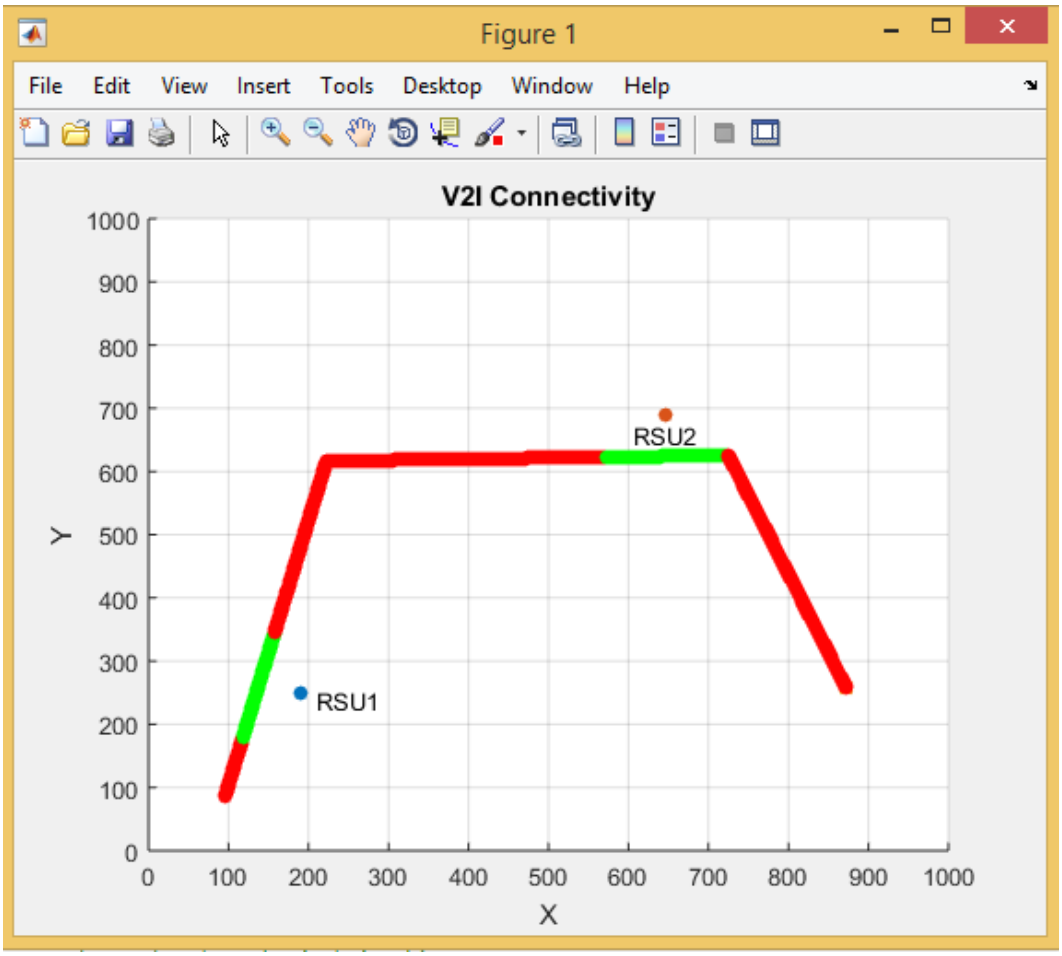


Figure 11. Coverage map showing connectivity regions with RSU1 and RSU2.

# Instructions for running the code

**Part1:**

Run the VANET_mobility.m file. The output is 3 required graphs.
The communication range value can be changed in line 12.
The duration of each simulation can be changed in line 11. If number of simulation are to be changed, go to line 59.
This code gives the plots for 50 metres range. You can print the x_axis values on command prompt for both 50 and 100 metres and use them for comparision plots.

**Part 2:**

1. **V2V connectivity**

   Run the V2V.m matlab file. A dialogue box will appear asking the user to click on two points for first road. Next another dialogue box will appear for the next two points for second road. Two intersecting roads are drawn and the simulation begins with three randomly placed vehicles (squares) that start moving towards the intersection with random speeds. The simulation stops when one of the vehicles reaches the end of the road.

2. **V2I connectivity**

   Run the V2I.m matlab file. A dialogue box will appear asking the user to click on two points for first road. Next another dialogue box appears for next point that connects this road to the next. Another dialogue box appears for third road. Next, the user is asked to place two RSUs. The vehicle starts moving along the path with a random speed. The simulation stops when the vehicle reaches the end of the path.