

## Supplemental Material of

# A Novel Heuristic Data Routing for Urban Vehicular Ad-hoc Networks

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**Description:** This document is a supporting content for the manuscript (A Novel Heuristic Data Routing for Urban Vehicular Ad-hoc Networks, Digital Object identifier: xxx), given the limited number of pages allowed by the publisher. We provided an illustrative numerical example for Intra-Path and Inter-Path, explained in the Section 4 of the main manuscript.

## 1. SIMULATION ENVIRONMENT

The source code of this work is implemented online in the [Link](#). To start the simulation, click on the top-right menu “Experiments” as shown in Fig.1.

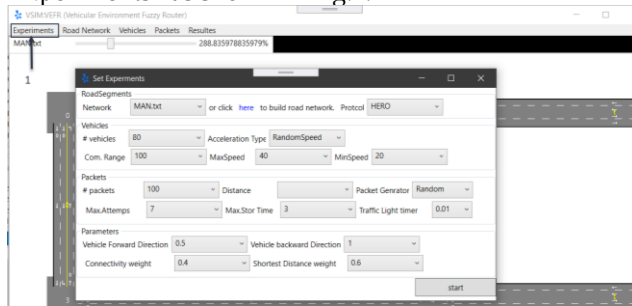


Fig.1: Main Window

The user can select the number of vehicles, the speed, the topology, the communication range, the number of packets and other parameters. After setting the parameters as in Fig.1, click on “Start”. The vehicles will start running as in Fig.2.

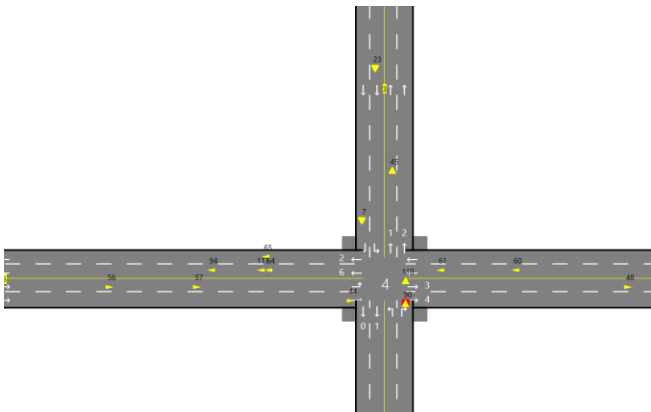


Fig.2: Simulation Screen-shot.

After managing all the packets, you can print the results by click on “Results->Print Results” menu. You will see a grid-list results as in Fig.3.

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Par	Val
Network Name	MAN.txt
Junctions Count	12
Rows Count	0
Cols Count	0
Road Segments Count	17
H.Length(m)	0
V.Length(m)	0
Road-ways	2
Lanes	4
Number of Vehicles	150
Average Speed(km/h)	30
Max Speed(km/h)	40
Min Speed(km/h)	20
Comm Range(m)	200
Packet Size	1024
Generated Packets Count	100
Delivered Packets Count	96
Average Success Ratio(%)	96.00
In Queue Packets	0
In Queue Packets Ratio(%)	0.00
Dropped Packets Count	4
Dropped Packets Ratio(%)	4.00
Average Queue Delay (s)	6.28
Average Store Times	2.09375
Average Propagation Delay (s)	0.0088
Average Delay (s)	6.290
Average Hops	17.18
Average Routing Distance(m)/path	925.667316219605
Redundant Packets/total	4602
Average Com. Overhead/Path	47.94
Max. Attempts	7
Max. Store Time	3
Distance Between Source and Destination (m)	0
Traffic Signaling (s)	0.01
Transmission Rate(bps)	2000000
Frontward Par	0.5
Backward Par	1
Connectivity Par	0.4
Distance Par	0.6
Protocol	HERO

Fig.3: Results.

### 1.1 Creating A topology

You can create your own topology in two ways.

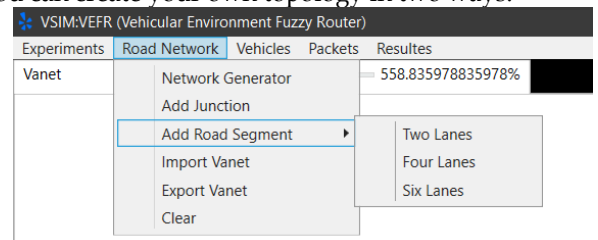


Fig.4: Create a topology 1.

First you can select the road elements from the menu “Road Network”. You can junction or other elements. You

need to move and link such elements manually. In the second way, you create a topology dynamically by “Road Network->Network Generator” as in Fig.5. You just need to select the number of row and columns to generate a Grid topology, see an example in Fig.6.

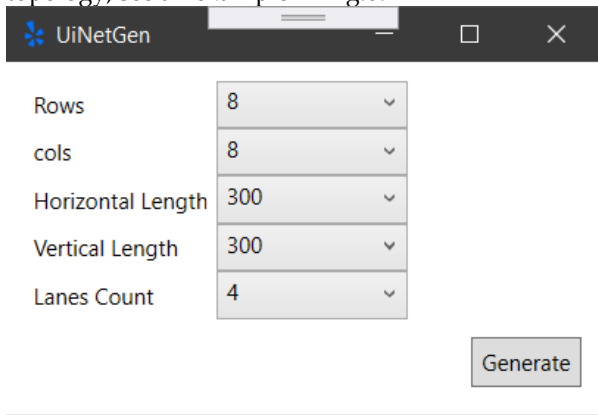


Fig.5: Network Generator

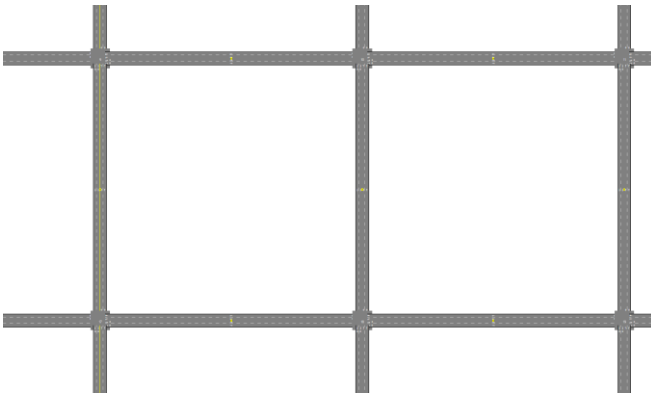


Fig.6: An example.

To save the topology you can go through “Road Network->Export” as in Fig.7. You should put the name and press OK. The topology files are saved in the main directory “\bin\Debug\topologies”.

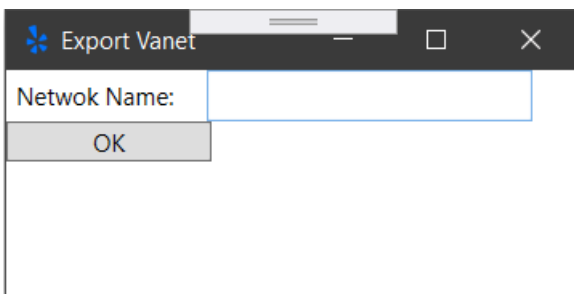


Fig.7: Export topology.

The topologies are saved in “.txt” files for simplicity as shown in Fig.8. You can import the Topologies by going to the menu “Road Network->Import”. The exported Topologies will be listed as in Fig.9. Note that to do an experiments you should follow screen-shoot in Fig.1. The labels above the vehicle on the simulator can show multiple information. See Fig.10. to change the label, you can go throw the menu “Vehicles->Display Info”. You can select any as in Fig.11.

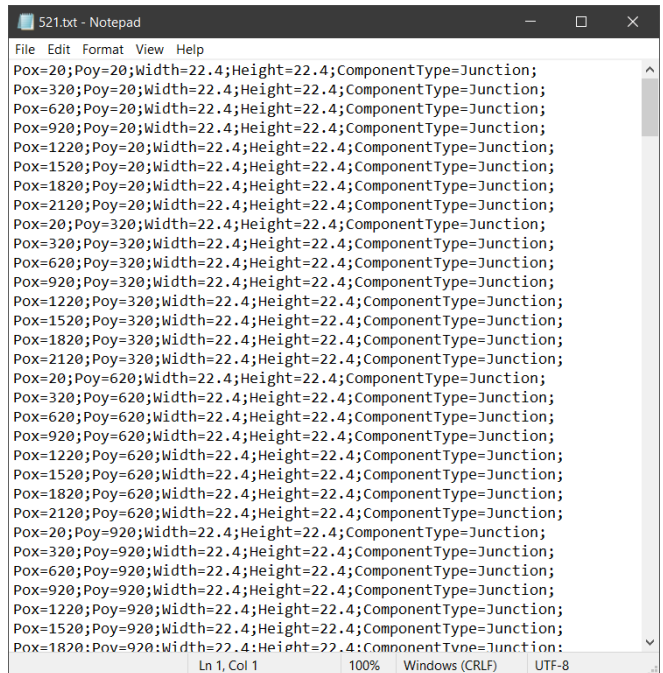


Fig.8: Topology generated files.

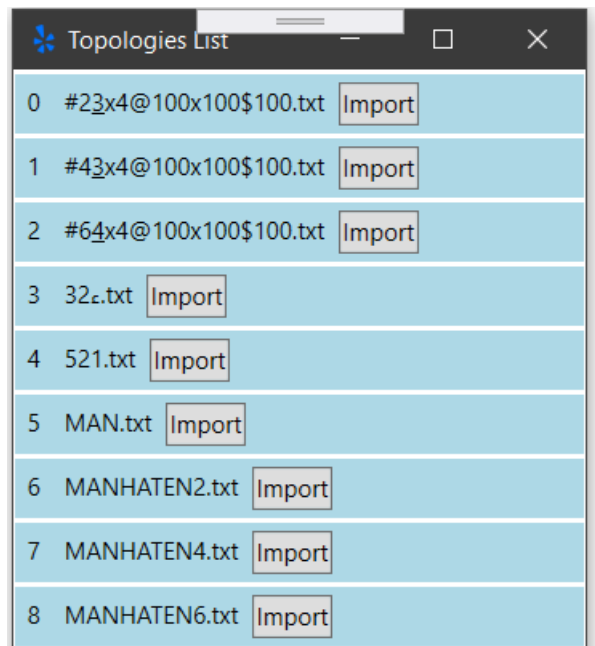


Fig.9: List of Topologies.

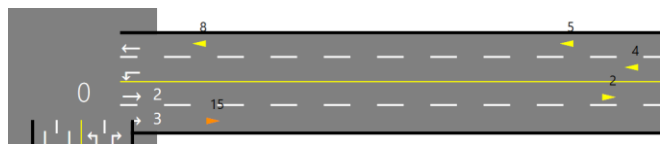


Fig.10: Vehicles Label.

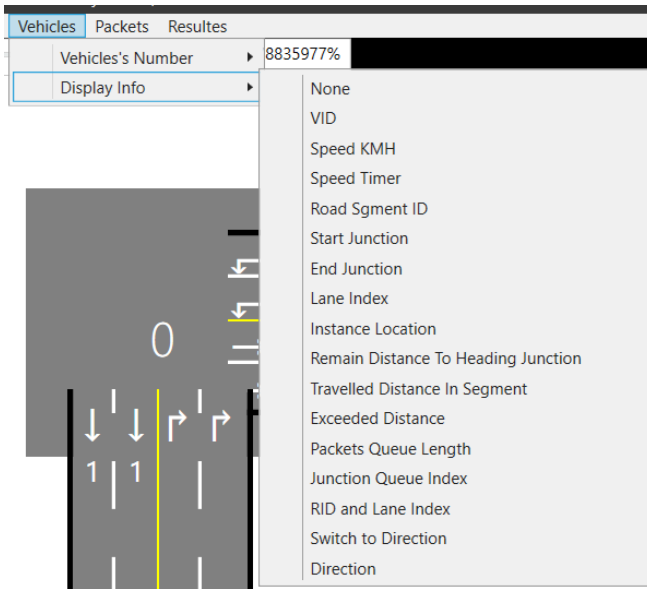


Fig.11: Vehicles display information

## 1.2 Develop Your Protocol

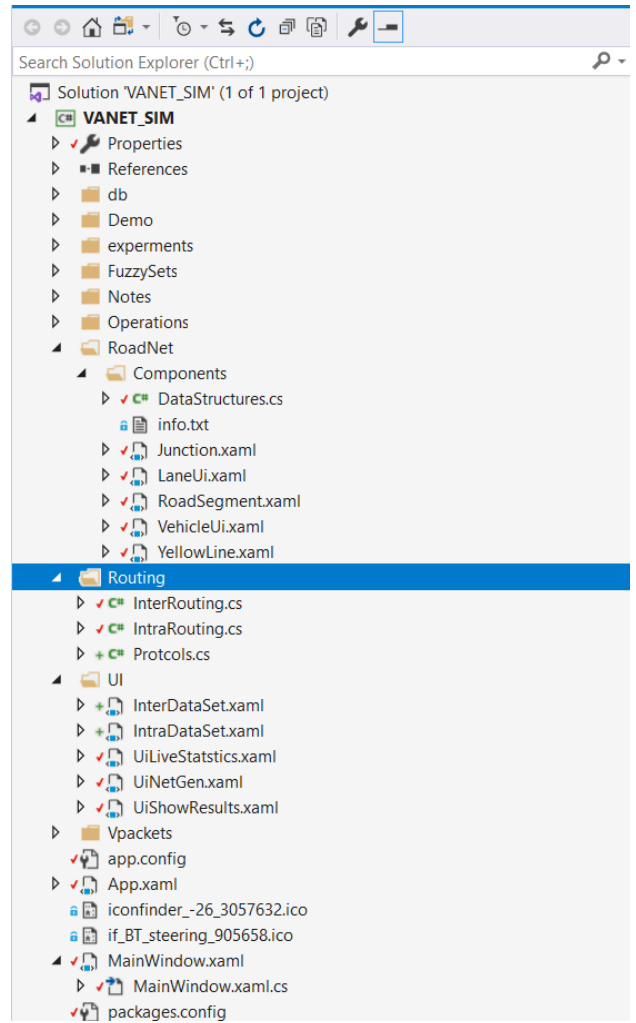


Fig.12:

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