Good afternoon everyone, I'm Jian Deng, from Sun Yat-sen University. It’s my honor to be here with you, sharing my paper: Topology Analysis System for Vehicular Ad Hoc Networks.

I focus on four aspects. First, Background.

With the development of the automobile industry, the current Intelligent Transportation Systems face with more and more problems like traffic jam, exhaust pollution, road construction, and the application of entertainment.

And Vehicular Ad-hoc Networks -- VANETs is put forward so as to implement effective communication between vehicles. But VANET is faced with the following problems: short transmission duration, great probability of transmission failure, and great influence by the surrounding environment. In order to solve such problems, some people put forward a number of methods to be used in VANET, such as applying the Name Data Networking (NDN) or Software Defined Networking (SDN), and came up with Clustering in VANET and Navigation Route based Data Forwarding in VANET. Topology is the basis of network routing as well as various network applications. So far, the understanding of topology is not enough, which encourage us to turn out this paper to show the analysis of the topology of vehicular network.

This paper focus on two important evaluation condition, distance-based and transmission-based.

Distance-base means the vehicular transportation information which is simulated with SUMO, a tool developed for simulating traffic road as well as vehicle trace while simulating the position, speed and other information of each car.

Transmission-based means the vehicle transmission information exchange mechanism, which is implemented on NS-3 by adding heartbeat packet on application layer. In detail, the vehicle information that is exchanged between vehicles include ID, position, speed and so on.

Both simulation runs 10 times separately so as to provide the necessary information for statistical analysis.

Here are four aspects that we focus on statistical analysis.

Link duration: the longer the duration, the higher the stability of communication link;  
*•* Reconnect time: the shorter the reconnect time is, the higher stability of communication link is;  
*•* Transmission cluster information: it can show the network connectivity and test out the upper limitation of the network transmission;  
*•* The number of neighbors: the more the neighbors there are , the more intensive the vehicular density is

**Link duration:**

Blue represents maximum, green means minimum and yellow means average.

The ordinate axis is transmission duration between vehicles. The abscissa axis is the number of vehicles.

In left Fig. 1, we can see that the maximum of link duration increases as the number of vehicles increases, but the average of that changes little.

And in left Fig. 2, however, the average of link duration decreases as the number of vehicles increases

The probable reason is that as the number of vehicles increases, the transmission interference increases.

**Reconnect time:**

In left Fig. 3 is much larger than that in right Fig. 4. It means that the average reconnect time is not likely to relate to the number of vehicles.

In right Fig. 4, the maximum reconnect time increases as the number of vehicles increases, which may be also caused by the increasing transmission interference.

**Transmission cluster (average diameter):**

In these two figures, we can see that the average diameter in all clusters becomes more stable as the number of vehicles increases. At the same time, the difference between biggest diameter and smallest diameter also decrease. The main possible reason is that as the number of vehicles increases, the vehicles are more likely to be in the same cluster, so the average diameter in all clusters becomes more stable

**Transmission Cluster (maximum diameter)**

In these two figures, we can see that the maximum diameter in the largest cluster becomes the same as the number of vehicles increases. However, the maximum in left Fig. 7 is less than the maximum in right Fig. 8, which means that the real transmission distance is less than the theoretical one, so it requires more hops to reach the furthest vehicle.(6>4)

**Transmission Cluster (average number of vehicles)**

In left Fig. 9, the minimum of the average number of vehicles in all clusters increases as the number of vehicles increases. However, in right Fig. 10, the minimum varies little as the number of vehicles increases. Therefore, we can see that in the real environment, the transmission failures occur frequently so that some vehicles cannot transmit information to the other vehicle

**Transmission Cluster (maximal number of vehicles)**

In Fig. 11 and Fig. 12, the number of vehicles in the largest cluster increases as the number of vehicles increases, which shows that the wireless interference has little impact on the number of vehicles in the largest cluster. Also, the largest cluster has most of vehicles in the observation.

**Transmission Cluster (number of clusters)**

In these two figures, when the number of vehicles exceeds 150, the number of clusters are almost the same. Compared the number of cluster in these two figures, we can see that part of vehicles cannot transmit information to others, and the number of these vehicles is quite little

**Number of Neighbors**

In these tow figure, the number of neighbors increases as the number of vehicles increases, but the number in right increases much less than the number in left, which shows that the number of neighbors in the real environment is much less than the number in the hypothesized environment.

**Conclusion**

With the increasing number of vehicles, the vehicle density and the wireless interference also increases. These factors result in the decrease of the transmission duration and the increase of reconnect time.

Also, in the experiment, a minority of vehicles locate in the corner of the map, which may be the reason that some vehicles cannot transmit information to other vehicles usually.

In the whole experiment, we see all the vehicles as a whole network to simulate and analysis, which means that we ignore some specific vehicular behaviors in the analysis.

In the future, we want to improve the analysis based on the specific vehicle behaviors by using the information of vehicles, such as the speed and the direction, in order to have more concrete understanding of the transmission failure.