Performance Modeling of Message Dissemination In Vehicular Ad Hoc Networks with priority
Project Report by

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***Abstract*—In this paper we are implementing the study of the performance of message dissemination in Vehicular Ad Hoc Networks(VANETs). VANETs has been widely used to increase safety of the passengers and reduce occurrence of traffic congestion. It is assumed that the message traffic generated by the event-driven safety applications has higher priority compared to the remaining network traffic. First, we are modeling the distribution of the number of concurrent transmissions of lower priority messages in the system at the steady state, through a birth-death process. We are also estimating the number of nodes that are present within the transmission area of a particular node. Then we calculate the number of concurrent transmissions, its average and how it is related to message arrival rate and the interrelation within other entities. We calculate the average number of nodes that receive the High Priority message and how many communication hops are needed. We also take into account the interference that plays a major role in propagating the High priority message and see how it varies as the transmission distance increases. We also infer that high Transmission range does not necessarily increase the delivery of High Priority Safety Message.**

***Index Terms*—Vehicular ad hoc networks, performance analysis, message dissemination, traffic limitation.**

I. Introduction

Vehicular ad hoc networks (VANETs) is a part of Mobile Ad-hoc Networks(MANET).In VANET the mobile nodes(vehicles) can communicate each other without central access points, this means that every node can move freely within the network coverage and stay connected and provide safety and comfort applications for the nodes which are within the range of network through wireless vehicle-to-vehicle communications. Inter vehicle communication includes relaying safety messages and dissemination of the traffic related information. A Safety message is broadcast to according notify neighbors as far as possible [2],[3]. But nothing has been done to help the driver know about his neighbors.

In this paper we are only considering information about vehicle present in the network. so that it can be know by driver that which vehicle is present at a particular position, but there is no issues related to the safety for driver. The major driving factor for the investigation and deployment of this new technology is safety by collecting accurate and up-to-date information about the status of the surrounding environment, a driver assistance system can quickly detect potentially dangerous situations, and notify the driver about the approaching peril. Since a relatively small reduction in the driver response time (in the order of a fraction of a second) can result in avoiding an accident, driver assistance systems based on vehicle-to-vehicle(V2V) communications have the potential of significantly improving the safety level on the road.

VANETs have some very specific characteristics and solutions to security issues are still in a very early stage of development. Especially the issue of trust between communicating vehicles (referred to as nodes) is an open question: How can one node trust a message it received from another node? Thus, trust establishment is a major challenge in vehicular ad hoc networks as the outcome of the trust establishment process is a trusted relation between nodes. Especially in critical applications like hazard warning a receiving node needs to ensure authenticity and trust ability of received messages before reacting so for that the network require trusted software components to ensure about message but in this paper we are not considering any security issues about vehicle and network our focus is just implemented message transmission between vehicle so that driver driving vehicle know about traffic status and position about vehicle Finally,[4] studies the influence of safety message generation rate on the mean delivery delay and the probability of successful message reception in one-hop communication scenario based on IEEE 802.11p VANET standard.

The main challenge in VANETs operation is the rapid and frequent changes in network topology due to the high mobility of the network nodes. In general, good VANET protocol design should take into account fast topology changes as well as different kinds of applications for which transmissions will be established. Moreover, VANETs protocols have to reduce the communication delay which is very important for safety applications. Lower reliability in broadcast communication due to higher collision rates and hidden-terminal activities is another challenge that needs to properly be handled in VANETs[5]. The IEEE 802.11 broadcasting mode considers no request-to-send/clear-to-send (RTS/CTS) handshaking process, because all of the nodes within the range of a sending node are assumed as recipients. Thus, the size of the potential hidden node activitys area is dramatically larger than the 802.11 unicast mode, which makes the communications more unreliable.

In this work, we present an analytical model to determine the main performance measure of VANETs with two priority classes of traffic. We assume that the traffic generated by comfort and periodic applications have low priority, while the event -driven safety messages have high priority. We assume that the message dissemination in VANETs is based on IEEE 802.11 broadcasting mode, Our modeling also takes a multi-hop perspective rather than generalization of single-hop results. In the network, interference may occur between two transmission ranges. If the transmitting nodes themselves are within the overlap area we refer to this interference as internal, otherwise as external interference, which are traditionally know as collision and hidden terminal activities, respectively. In our analysis, we carefully take care of the internal and external interferences. We assume that a destination can correctly receive a message as long as it is not exposed to the hidden terminal effect and that the message does not experience collision. First, we derive the probability of interference between two nodes. then, using a birth-death process analysis, we derive the probability distribution of the number of concurrent transmissions in the system at the steady-state, and the percentage of destination nodes population which cannot receive the message correctly due to interference.

We also study the performance of high-priority traffic which represents a relatively small component of the overall traffic volume in the presence of lower-priority traffic. We determine number of nodes(vehicles) present in the network area base on that we determine important performance measures such as the average number of nodes which receive the high-priority safety message, the average message forwarding distance per hop, and the average number of hops that the message will travel. Based on our analysis, we present numerical results which show that selection of a large transmission range does not necessarily improve the per-hop forwarding distances of high-priority safety messages, due to the fact that more receiving nodes may be exposed to interference. Further, the probability that a receiving node is exposed to interference is shown to increase with the network node density. we also present simulation result with graph that shows how our implementation is working.

II. Network model

In this study we have assumed a one-dimensional VANET modeling communication in a highway with length R meters. The nodes have constant transmission ranges of d meters, therefore, each transmission covers a section of highway with length 2d meters. We are assuming the message transmission occurs in both the direction of a vehicle forward and backward direction. Interference, both internal and external are taken into account. The vehicles arrive in Poisson distribution and are uniformly distributed along the highway. They generate message exponentially and randomly among those that are currently active in the highway . We assume that there can be at most one high priority message propagating in the traffic at any given time and there is not prediction related to arrival of high priority messages, they are non deterministic in nature.

III. Simulation and Analysis Model

We have used C++ for both Simulation and Analysis. For analysis we have kept the vehicle speed constant but in Simulation we have varied it to depict the real life scenario. We have set up the highway for 5000m and vehicle transmission range as 500m. Every vehicle will be part of a link list with which we can easily identify all the vehicles that are behind it and in front of it by just traversing the same in O(n) time. Interference is taken into account by polling mechanism where two vehicle polls for the transmission channel if both simultaneously poll for the medium then interference is assumed to take place, in that case the messages are consumed by that node and then the buffers are flushed out.The overall time complexity is polynomial in nature.

IV. Algorithm

```
//Main function
main()
{
SimulationTime <- 3000
SimulationStepTime <- 10
Initializer();
while currentTime < SimualationTime
{
Mobilityvehicle();
SimulationDisplay();
currentTime = currentTime + SimulationStepTime;
}
DisplayResults();
WriteToFile();
}


//initialises vehicle objects and message objects
Initializer()
{
//generation of vehicles
r <- Poission RV
obj <- Vechicleobject
obj.arrivalTime <- r
obj.VID <- vehicle ID ++;
//generation of vehicles ends
//generation of Messages
create a message object and assign it to that vehicle
r <- exponential RV following birth death rate
obj <- messageobject
obj.arrivalTime <- r
//set other message properties
obj.hopCount = 0
obj.distanceCovered = 0
obj.Priority = PriorityLogicGenerator()
obj.VID <- vehicle ID ++;
//generation of Message ends
}
```

```
//simulates actual movement of vehicles
Mobilityvehicle()
{
find all active vehicles
compute and update new distance using the speed that the vehicle is travelling
}


//simulates actual propagation of messages
MobilityMessage()
{
DiscoverNeighbour()
propagate the message in both directions front and back
and set the Hasmessage bit of the recieveing vehicle
// inteferance detector
if HasMessage bit = 1
// inteference has occured, consume the message and flush out the buffer else
// transmit the message and set HasMessage bit t0 1
}


//Dicoveres all vehicles that are within the transmitting range from a given vehicle
DiscoveryNeighbour()
{
in both direction front and back find all vehicles that fall under the
transmission range (within 500m) of the given vehicle and return the list
}


WriteToFile()
{
create fileobject
fileobject.open(filename.txt)
fileobject<- DumpResults
fileobject.close()
}
```

OOP's concept has been used to implement the network model and simulation using C++. The algorithm flows sequentially as shown in the flowchart (figure 1) figure 2 deciepts the initializer module components which creates message objects and vehicle objects and allocates a time of arrival for them. Figure 3 shows the simulation module components where the global timer is used to synchronize the overall simulation flow and the results gets captured in Access Database. Figure 4 shows the flow of data from the database to how the graphs have been generated. There is a manual intervention to run the SQL queries to query the data for analysis.

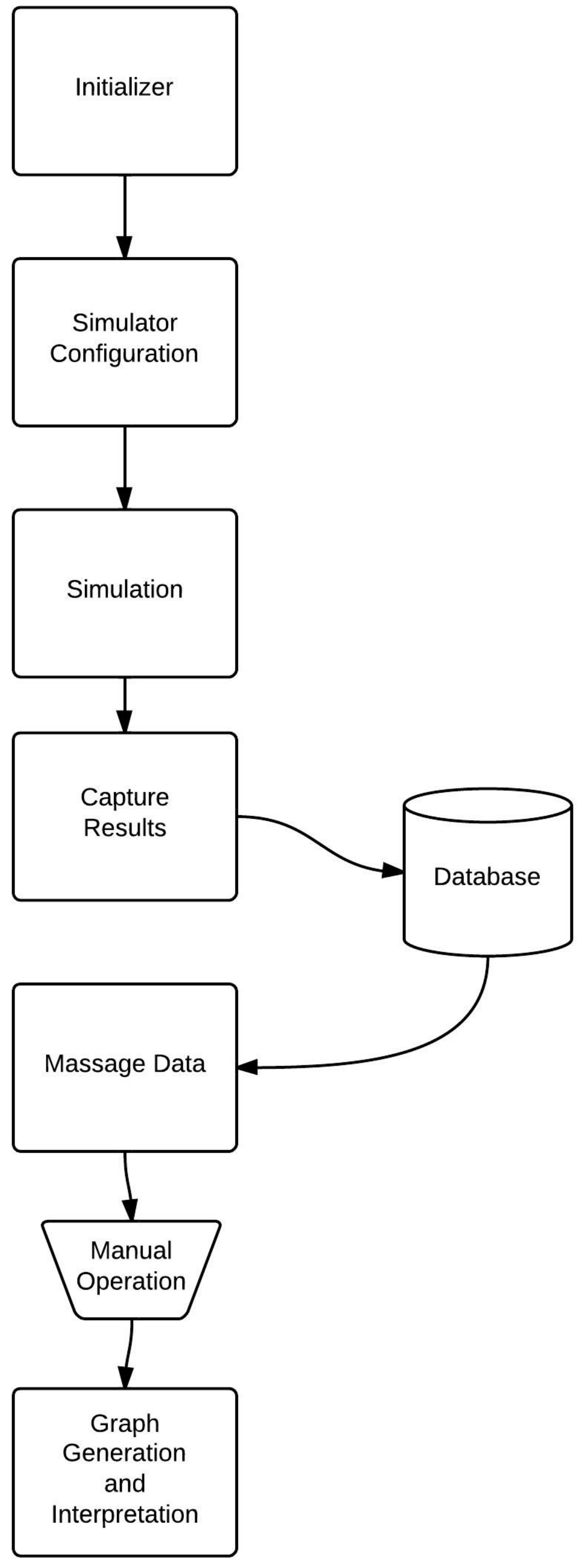

Fig. 1. Algorithm Flowchart

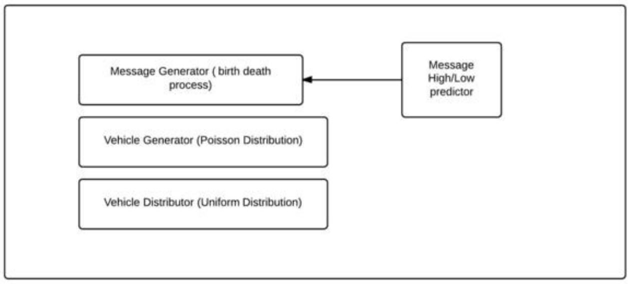

Fig. 2. Initializer Module Components

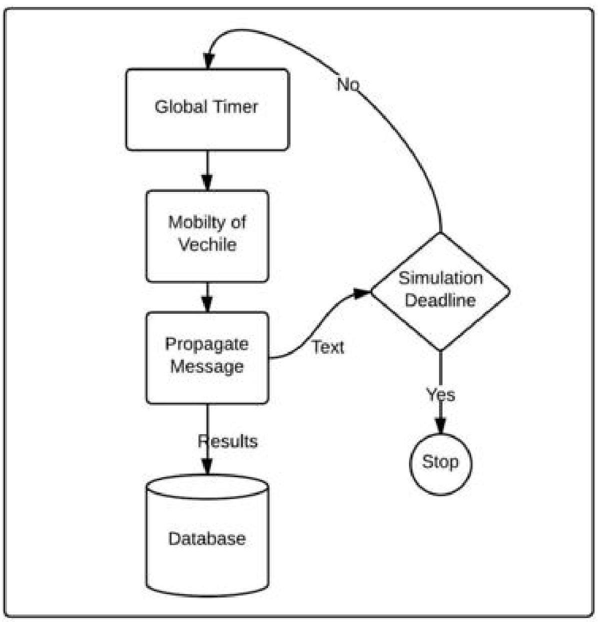

Fig. 3. Simulation Module Components

V. BIRTH-DEATH MODELING OF THE NUMBER OF TRANSMISSION

In this section, we determine the distribution of the number of low priority message since the arrival of these message is a poison distribution and their transmissions are exponentially distributed with parameter mu. Thus the arrival of message corresponds to the birth and the completion of the transmission of a message to a death. It is basically the time duration a message will be in the network after generation of the message from a particular vehicle. This process can be seen as Markov chain, where the nodes form the states and the messages travel from one state to another, the probability that the message is been received by a Node is directly proportional to the interference between them. If there is not interference then with probability p the message is received else with (1-p) it is lost. This is similar to birth death process.

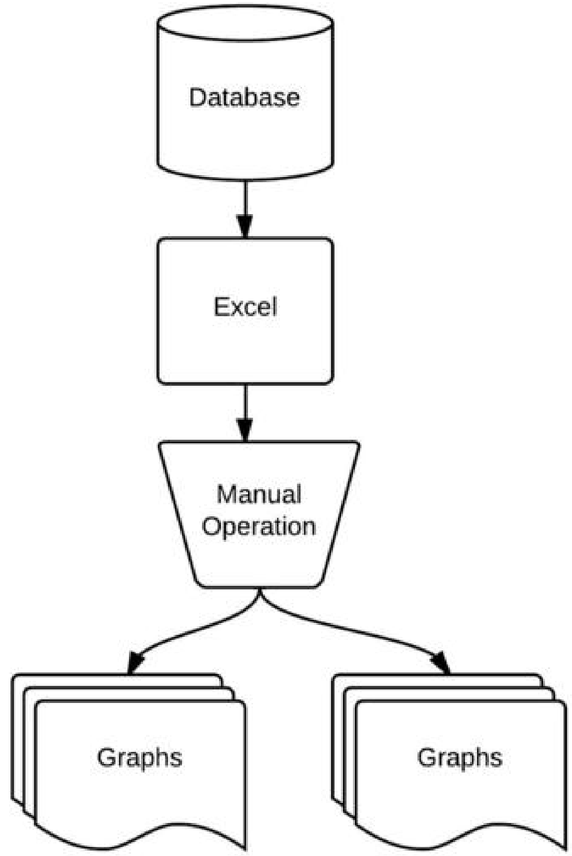

Fig. 4. Result Analysis Module Components

VI. RESULTS

This section is split in two parts where we will be describing the Analysis and Simulation part in parallel to understand the deveiations if they exist.

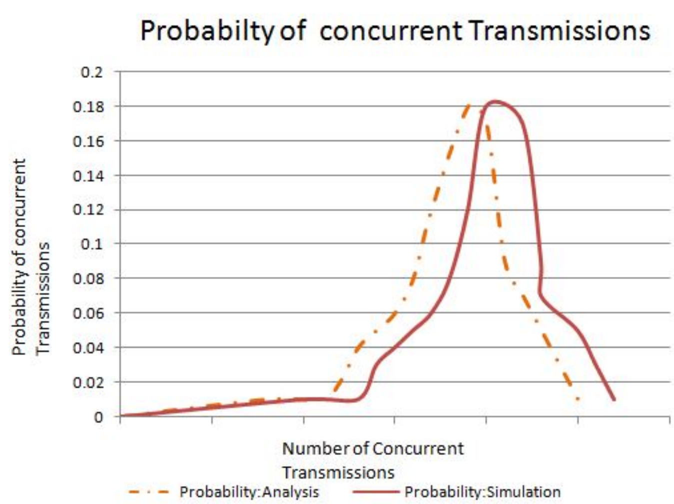

Fig. 5. Probability of having n concurrent transmissions, with the unit-length message rate lamda taken as parameter

Figure 5 represents the probability of having n concurrrent transmissions with unit length message rate, the analysis and simulation results are in sink. From the graph it is evident that for lamda 1 the maximum concurrent probality follows poission distribution which attains maximum value at 22 nodes. Figure 6 represents the Average Number of concurrent

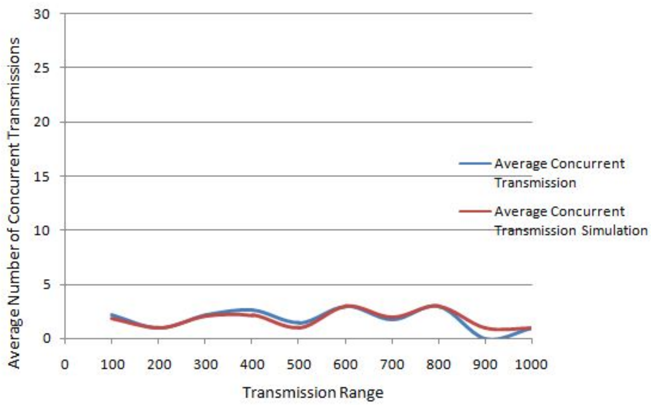

Fig. 6. Average number of concurrent transmissions versus the transmission range, with unit length message arrival rate

transmissions versus the transmission range (max 1000) with unit length message arrival rate, the analysis and simulation results are in sink, it is observed that the averege number of transmissions almost remains contant at low message arrival rate which directlty ties with the birth death rate of the messages.

Figure 7,8,9 correspond to average number of concurrent transmission at steady state as a function of unit lenth message arrival rate and with transmission range as parameter. Figure 7 has range parameter = 200m, Figure 8 has range parameter = 600m, Figure 9 has range parameter = 1000m, this indicates the capacity of the network, the higher range cures are well bounded by the lower range curves and then all then increase asymtotically.

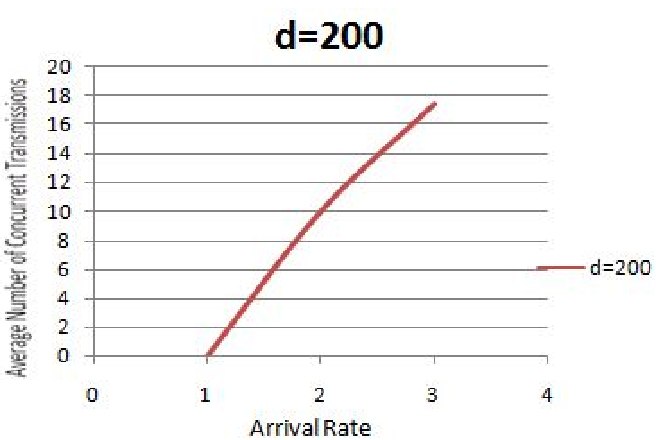

Fig. 7. Average number of concurrent transmissions versus the message arrival rate, with transmission range 200m

Figure 10 shows the Average number of nodes which recieve

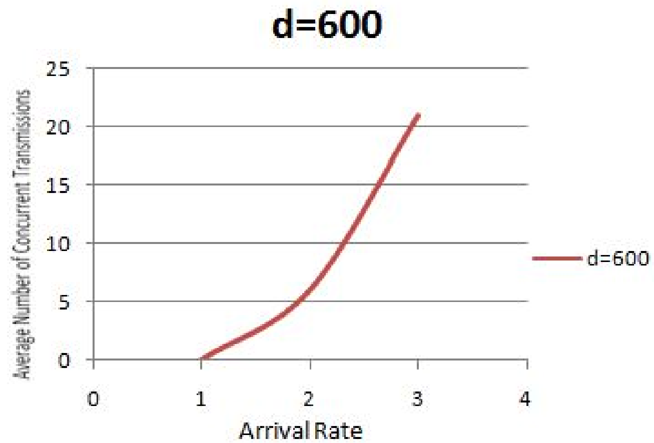

Fig. 8. Average number of concurrent transmissions versus the message arrival rate, with transmission range 600m

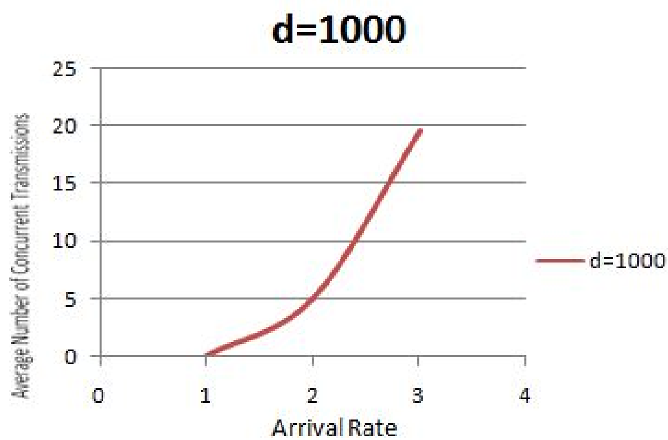

Fig. 9. Average number of concurrent transmissions versus the message arrival rate, with transmission range 1000m

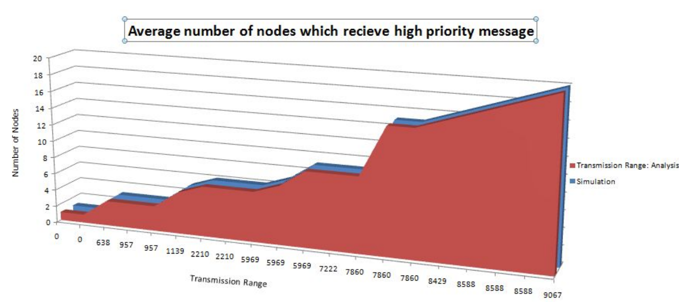

Fig. 10. Average number of nodes which recieve a high priority safety message as a function of transmission range for a network with light vehicle traffic

a high priority safety message as a function of transmission range for a network with light vehicle traffic.Again the simulation results and the analysis are in sink. The interpretation is that event at low message arrival rates by selecting high transmission range, propagation of high priority message is

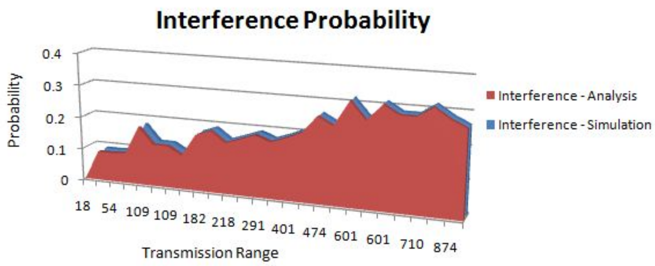

Fig. 11. Probability function of interference with respect to transmission range with unit length message arrival rate

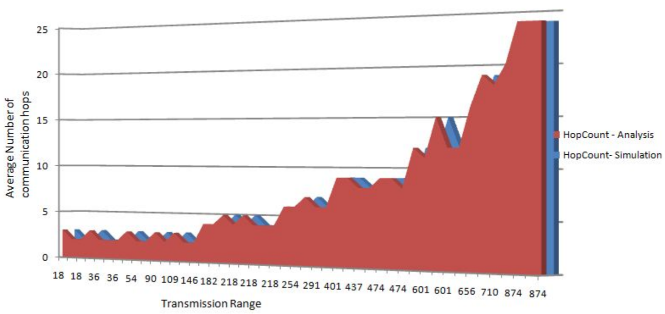

Fig. 12. Average Forwarding distance per hop that the high priority message propagates in the VANET

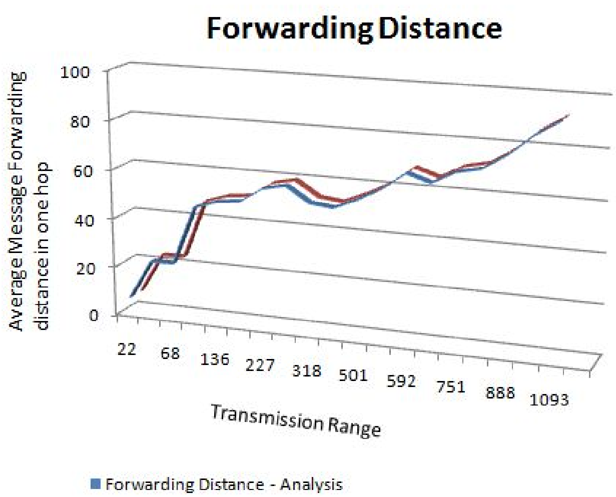

Fig. 13. Average number of communication hops versus Transmission Range

still possible with high throughput.

Figure 11 plots the probability function of interference as a function of transmission range, we note the the probability is high for higher message arrival rates since the buffers gets filled up fast and also the number of mesages increases exponentially as time proceeds which increases the interference.

Figure 12 plots the Average number of hop it takes for the high priority message to advance in the network. The simulation and the Analysis results are in agreement.

Figure 13 plots the Average Forwarding distance per hop that the high priority traffic will experence in the network. The simulation and the Analysis results are in agreement. The inference is that as the transmission range increases the average forwarding distance also increases this is directly affected by the vehicle density as time proceeds and also the transmisson range.

VII. Conclusion

In this work, we studied the performance of message dissemination in VANETs with two priority classes of traffic. The Performance modeling of multi-hop communication took a hit because of presence of non deterministic interference. All the analysis is done on the results were captured during regular intervals of time during simulation. We have estimated the average number of nodes that receive the high priority message, number of nodes that are affected by deterministic interference increases as the message arrival rate increase , the relation between communication hop and transmission distance which increase propositionally and the number of concurrent transmissions for a given message arrival rate and transmission range vary in direct proportion. The results in this simulation and analysis can be used to study non deterministic interference which will shed light on improving the performance of VANETs in the future

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