# Application Specific Quality of Service (QoS) Centric Parameters Simulation in Wireless Mobile Ad hoc Networks

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**Abstract**— Wireless mobile ad hoc networks is a collection of mobile nodes communicating with each other without any existing infrastructure networks via wireless links. In this paper, modelling and simulation of Ad hoc On-demand Distance Vector(AODV) Routing Protocol is performed. Study and analysis of parameters for Vehicular Communication application is considered where a very highly mobile ad hoc networks scenario will be created. Simulation is performed in ns2 (Network Simulator 2) for Quality of Service (QoS) parameters such as throughput and delay. Throughput variation also results due to various other factors such as jitter, number of mobile node variation and so on. The simulations are then plotted on x-graph.

**Keywords**— Wireless mobile ad hoc networks, AODV, DSDV, Quality of Service (QoS) parameters, ns2.

## I. INTRODUCTION

Mobile adhoc networks (MANET) is a collection of wireless mobile nodes communicating with each other using wireless links without any existing network infrastructure as shown in Fig.1. There is no base station (BS) or access point (AP) in adhoc network. Each node in the network acts as a router, forwarding data packet for other nodes. Each node is free to roam about while communicating with others. The path between each pair of the nodes may have multiple links, and the radio between them can be heterogeneous. This allows an association of various links to be a part of the same network. The routing and resource management are done in a distributed manner in which all nodes coordinate to enable communication among them. Routing of data in adhoc network is a challenging task due to rapidly changing topology and high mobility of the nodes. The responsibilities for organizing and controlling the network are distributed among the terminals themselves.

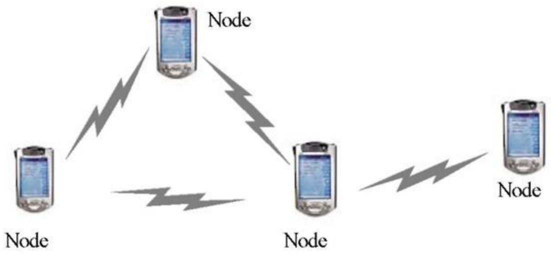

**Fig. 1** Mobile Ad hoc Networks Structure

In ad hoc networks, some pairs of terminals may not be able to communicate directly with each other and relaying of some messages is required, so that they are delivered to their destinations. Such networks are often referred to as multi-hop or store-and-forward networks. The network topology is dynamic, because the connectivity among the nodes may vary with time due to node departures, new node arrivals, and the possibility of having mobile nodes. Hence, there is a need for efficient routing protocols to allow the nodes to communicate over multi-hop paths in a way that does not use the network resources than necessary.

Mobile hosts and wireless networking hardware are becoming widely available and extensive work has been done recently in integrating these elements into traditional networks such as the Internet. Often sometimes, mobile users may want to communicate with each other without the barriers of fixed infrastructure like fixed backbones or confined within a certain area. For example, a group of students may want to communicate with each other to share some lecture notes, assignments and so on; crisis management services, applications, such as in disaster recovery, where the entire communication infrastructure is destroyed and resorting communication quickly is crucial; The military can track an enemy tank as it moves through the geographic area covered by the network; Bluetooth, which is designed to support a personal

area network by eliminating the need of wires between various devices, such as printers and personal digital assistants; vehicular communications where each vehicle is equipped with a communication device will be a node in the adhoc networks for applications such as collision warning, road sign alarms, traffic information and so on.

## II. APPLICATION: VEHICULAR COMMUNICATION

Vehicular communication is possible through wireless networks in which vehicles and roadside units are the communicating nodes. VANETs (Vehicular Ad hoc Networks) are highly mobile wireless ad hoc networks and will play an important role in public safety communications and commercial applications. Routing of data in VANETs is a challenging task due to rapidly changing topology and high speed mobility of vehicles. Fig. 2 shows Vehicular communication scenario in a Vehicular ad hoc networks where each of the vehicles which have mobility either is communicating with infrastructure network or in adhoc manner with another vehicle to exchange information. The growing mobility of people and goods incurs high societal costs: traffic congestion, fatalities and injuries. At the same time, vehicles have increasingly effective driver assistance and protection mechanisms.

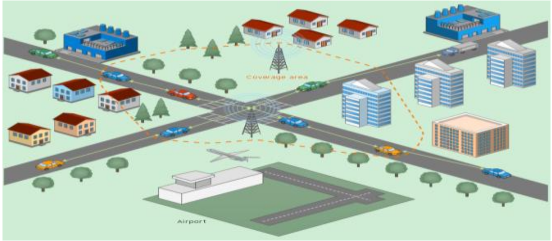

**Fig. 2**Vehicular Communication Scenario

Radio communication based solutions can operate beyond the line of sight constraints of radar and vision solutions, and they can enable cooperative approaches. Vehicles and infrastructure cooperate to perceive potentially dangerous situations in an extended space and time horizon. Vehicles will be equipped with novel computing, communication and sensing capabilities and user interfaces. These will support a spectrum of applications that enhance transportation safety and efficiency, but also provide new or integrate existing services for drivers and passengers. Wireless transmission and medium access technologiesadapted to vehicular communication environment are the primary enabling technology.

### A. *VANETs Characteristics*

The fundamental characteristics of Vehicular Ad hoc Networks are as follows [5]:

1. High computational capability: Operating vehicles can afford significant computing, communication and sensing capabilities.
2. Highly dynamic topology: Vehicular network scenarios are very different from classic ad hoc networks. In VANETs, vehicles can move fast. It can join and leave the network much more frequently than MANETs. The topology in VANETs changes much more frequently.
3. Mobility: Vehicles tend to have very predictable movements that are (usually) limited to roadways. The movement of nodes in VANETs is constrained by the layout of roads. Roadway information is often available from positioning systems and map based technologies such as GPS. Each pair of nodes can communicate directly when they are within the radio range.
4. Potentially large scale: vehicular networks can in principle extend over the entire road network and so include many participants.
5. Partitioned network: Vehicular networks will be frequently partitioned. The dynamic nature of traffic may result in large inter vehicle gaps in sparselypopulated scenarios and hence in several isolated clusters of nodes.
6. Network connectivity: The degree to which the network is connected is highly dependent on two factors: the range of wireless links and the fraction of participant vehicles, where only a fraction of vehicles on the road could be equipped with wireless interfaces.

### B. *Related Works*

Several protocols have been defined by researchers for vehicular networks. New protocols are also required with the improving technology. The history of VANET routing begins with the traditional MANET routing protocols.

Kakkasageri et .al [4] compared AODV and DSR with Swarm intelligence routing algorithm and have shown that AODV and DSR has less performance than swarm intelligence routing algorithm in VANET.

Jerome Haerri et.al [6] evaluated the performance of AODV and OLSR for VANET in city environment, in their study all the characteristics are handled through the Vehicle Mobility Model. Their study showed that OLSR has better performance than AODV in the VANET, as the performance parameters that they used have less overhead on the network as compared to OLSR.

Performance analyses of traditional ad-hoc routing protocols like AODV, DSDV and DSR for the highway scenarios have been presented in [3], and the authors proposed that these routing protocols are not suitable for VANET.

Their simulation results showed that these conventional routing protocols of MANET increase the routing load on network, and decrease the packet delivery ratio and end to end delay.

In this paper, modelling and simulation of Ad hoc On-demand Distance Vector (AODV) Routing Protocol and Destination-Sequenced Distance-Vector Routing (DSDV) Protocol is performed and parameters like jitter, number of mobile nodes are varied and the throughput variation is analysed.

## I. ROUTING CONSIDERATIONS

Since several hops may be needed for a packet to reach its destination, routing protocols are needed. There are two main functions of the routing protocols. First is finding the routes from the source to the destination and the second one is to deliver the messages or data packets from the source to the destination. The second process is more complicated as it also requires some control mechanism to assure the proper delivery of data packets so that the packets are not lost in the way. This process may also use a variety of protocols and data structures.In this paper, routing is carried out through AODV protocol.

### A. *AODV*

AODV (Ad hoc On-demand Distance Vector) Routing protocol is a reactive ad hoc routing protocol. It creates a new route only when necessary. Route discovery in AODV is by using Route Request (RREQ) and Route Reply (RREP). As long as the new route remains valid AODV would not act. When it has expired or becomes invalid AODV will only react when the route is needed again. AODV protocol is composed of two mechanisms: Route Discovery and Route Maintenance. One important feature in AODV is the use of sequence numbers to avoid counting to infinity problem. By maintaining sequence numbers in each node for each destination, the problem can be avoided. [8]

If there is no information in the routing table of the source then a route request is broadcasted. A node that receives the route request and has an up-to-date path to the destination will return it to the source and all nodes on the return path will update their routing tables. If no valid path is present in an intermediary node then the request is rebroadcasted. If a node receives multiple paths to the destination the one with the highest utility is chosen.

AODV specifies two different ways in which a link break can be detected. Either all nodes regularly broadcast a ‘hello’ message to its one-hop neighbours, which makes it possible for them to verify the link operation, or it is detected by a link signalling mechanism when the link is used. When a link break is detected the end nodes (source and destination) are informed and it is up to them to find a new path.[9]

### B. *DSDV*

DSDV [9] (Destination-Sequenced Distance-Vector Routing) is a table driven routing protocol that is an enhanced version of the distributed Bellman-Ford algorithm. In all table driven protocols each node maintains a table that contains the next hop to reach all destinations. To keep the tables up to date they are exchanged between neighbouring nodes at regular intervals or when a significant topology changes are observed.

In DSDV, each node maintains a routing table which is constantly and periodically updated (not on-demand) and advertised to each of the node’s current neighbours. Each entry in the routing tablehas the last known destination sequence number. Each node periodically transmits updates, and it does so immediately when significant new information is available. The data broadcasted by each node will contain its new sequence number and the following information for each new route: the destinations address the number of hops to reach the destination and the sequence number of the information received regarding that destination, as originally stamped by the destination. No assumptions about mobile hosts maintaining any sort of time synchronization or about the phase relationship of the update periods between the mobile nodes are made. Following the traditional distance-vector routing algorithms, these update packets contain information about which nodes are accessible from each node and the number of hops necessary to reach them. Routes with more recent sequence numbers are always the preferred basis for forwarding decisions. Of the paths with the same sequence number, those with the smallest metric (number of hops to the destination) will be used. The addresses stored in the route tables will correspond to the layer at which the DSDV protocol is operated. Operation at layer 3 will use network layer addresses for the next hop and destination addresses, and operation at layer 2 will use layer-2 MAC addresses [12].

## II. NETWORK SIMULATOR

After setting up the platform, software named NS-2 was set up on it which was used for all the analysis and simulation work apart from other tools used. NS-2 is the de facto standard for network simulation. Its behaviour is highly trusted within the networking community. It is developed at ISI, California, and is supported by the DARPA and NSF.

NS-2 is an object oriented simulator, written in C++, with an OTcl (Object Tool command language) interpreter as a frontend. This means that most of the simulation scripts are created in Tcl (Tool command language). If the components have to be developed for NS-2, then both Tcl and C++ have to be used. NS-2 uses two languages because any network simulator, in general, has two different kinds of things it needs to do. On the one hand, detailed simulations of protocols require a systems programming language which can efficiently manipulate bytes, packet headers, and implement algorithms that run over large data sets. For these tasks run-time speed is important and turn-around time (run simulation, find bug, fix bug, recompile, re-run) is less important. On the other hand, a large part of network research involves slightly varying parameters or configurations, or quickly exploring a number of scenarios. In these cases, iteration time (change the model and re-run) is more important. Since configuration runs once (at the beginning of the simulation), run-time of this part of the task is less important. [10]

NS-2 meets both of these needs with two languages, C++ and OTcl. C++ is fast to run but slower to change, making it suitable for detailed protocol implementation. OTcl runs much slower but can be changed very quickly (and interactively), making it ideal for simulation configuration.

The simulator supports a class hierarchy in C++, and a similar class hierarchy within the OTcl interpreter. The two hierarchies are closely related to each other; from the user's perspective, there is a one-to-one correspondence between a class in the interpreted hierarchy and one in the compiled hierarchy. The root of this hierarchy is the class TclObject. Users create new simulator objects through the interpreter. These objects are instantiated within the interpreter, and are closely mirrored by a corresponding object in the compiled hierarchy. The interpreted class hierarchy is automatically established through methods defined in the class TclClass. User instantiated objects are mirrored through methods defined in the class TclObject. There are other hierarchies in the C++ code and OTcl scripts, these other hierarchies are not mirrored in the manner of TclObject. [11]

## III. QUALITY OF SERVICE (QOS)

Quality of service (QoS) is the performance level of a service offered by the network to the user. A network or a service provider can offer different kinds of services to the users. Various parameters have to be resolved for an application. The parameters which affect the user end include delay, security, minimum bandwidth, jitter, maximum packet loss rate and so on. QoS does not create bandwidth, but manages it so it is used more effectively to meet the wide range of application requirements. The goal of QoS is to provide some level of predictability and control beyond the current Internet Protocol best effort services. Quality of service protocols uses a variety of complementary mechanisms to enable deterministic end-to-end data delivery.[12]

To support QoS, the link state information such as delay, bandwidth, cost, loss rate, and error rate in the network should be available and manageable. However, getting and managing the link state information in MANETs is very difficult because the quality of a wireless link is apt to change with the surrounding circumstances. Furthermore, the resource limitations and the mobility of hosts make things more complicated. The challenge is to implement thecomplex QoS functionality with limited available resources in a dynamic environment [13].

## IV. SIMULATION RESULTS

The evaluation is performed considering the scenario of 100 nodes being static and attaining mobility. Also evaluation is performed for 200 nodes scenario. Table 1 gives the values of various parameters listed below.

**TABLE I**

GENERAL SIMULATION PARAMETERS

| Sl. No. | Parameters | Values |
|---|---|---|
| 1 | Traffic type | Constant bit rate |
| 2 | Number of nodes | 100, 200 nodes |
| 3 | Speed | 50msec |
| 4 | Pause time | 0.5msec |
| 5 | Simulation time | 10, 20msec |
| 6 | Network Area | 1000x1000 meters |
| 7 | Routing Protocol | AODV |
| 8 | MAC Protocol | 802.11a |
| 9 | Packet size | 500bits/sec |
| 10 | Queue length | 50 |
| 11 | Simulator | ns-2.32 |

The throughput obtained for the 100 node in a static scenario is plotted in x-graph as shown below which is time vs. bits per second in Fig. 3.

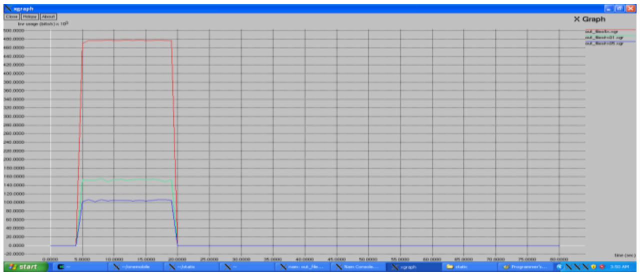

**Fig. 3**Throughput plotted inx-graph for all 100 nodes in static condition

The performance metrics of throughput for the 100 nodes with mobility being simulated is shown in Fig. 4 below in the x-graph.

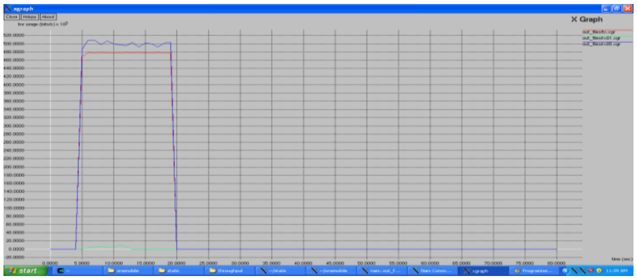

**Fig. 4** Throughput plotted inx-graph for all 100 nodes with mobility

Simulation performed in similar way for 200 nodes also gives the results and is plotted in the x-graph and also network animator is used to view the animation.

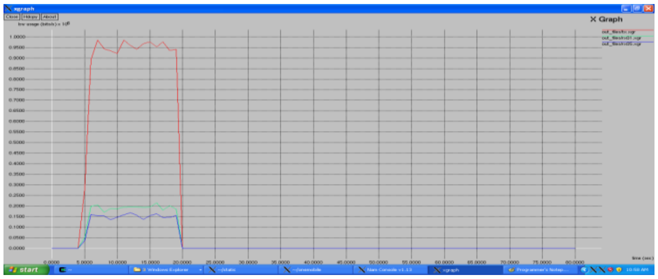

**Fig. 5** X-graph for 200 mobile nodes verifying throughput

Fig. 5 shows the x-graph for 200 mobile nodes scenario being simulated for throughput performance metrics. The network animator is used to show animation for the same scenario and the node movement here can be observed.

The network animator (NAM) is a Tcl/TK based animation tool for viewing network simulation traces and real world packet trace data. The first step to use NAM is to produce the trace file. The trace file should contain topology information, e.g., nodes, links, as well as packet traces. Usually, the trace file is generated by NS-2. During an NS-2 emulation, user can produce topology configurations, layout information, and packet traces using tracing events in ns2 [10].

When the trace file is generated, it is ready to be animated by NAM. Upon startup, NAM will read the trace file, create topology, pop up a window, do layout if necessary and then pause at the time of the first packet in the trace file. Through its user interface, NAM provides control over many aspects of animation.

Fig. 6 shows the NAM for 200 nodes simulation below.

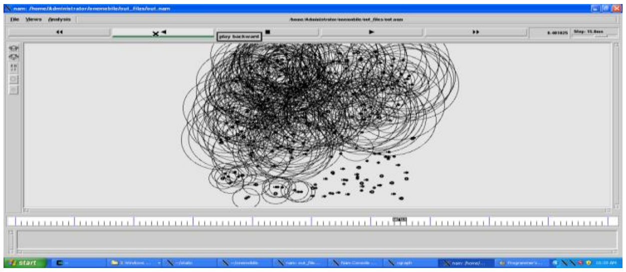

**Fig. 6** NAM representing 200 mobile nodes involved in packet transmission

Simulation is performed by jitter variation whichvaries the throughput for the scenario. The Fig. 7 below shows the throughput for the jitter variation in 100 mobile node conditions. Jitter being set to 0.5ms and the overall simulation time considered is 10ms.

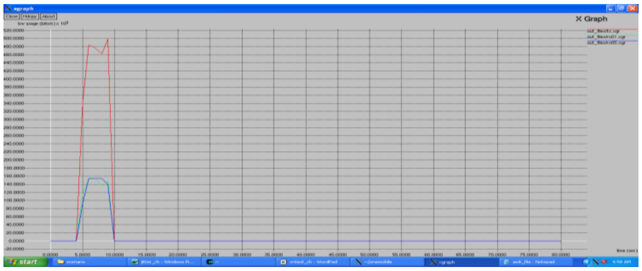

**Fig. 7** X-graph of throughput for jitter variation of 0.5ms for 100 mobile nodes

The parameter delay verified for the mobility conditions are also plotted on x-graph in Fig. 8 which on x-axis will be the time and on y-axis is the delay variation taking place with respect to the time in milli second condition. The delay variation also shows how important it is to know the delay happening in the packet transmission. Thus the simulation and analysis will help to understand the concept of study of various parameters to meet the user requirements.

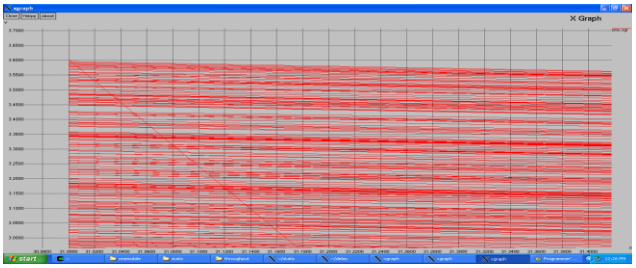

**Fig. 8** X-graph for delay variation with respect to time

## Vii. Conclusion

A systematic study and analysis of all the aspects of wireless mobile adhoc networks is carried out. Vehicular communication is considered and the comparison is made for transmission packet ratio.

The applications have a range of QoS requirements in terms of the granularity of determinism and the level of guarantee, there are also a variety of services and protocols available.The ns2 simulator is used to simulate all the results of performance metrics like throughput, delay and jitter and the various results are plotted on x-graph.

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