VANET in Hilly Terrains for Evaluation of Ad hoc Routing Protocols in IP, Throughput and FIFO with Random Way Point mobility and High Weather Mobility using Qualnet

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ABSTRACT

VANET in hilly terrains is having few nodes and random way point mobility suffers frequent signal breakdown, interferences and other hinderances, affecting QoS (Quality of service). In this paper Ad hoc routing protocols are compared for IP, Throughput and FIFO taking in to consideration various parameters of real traffic scenarios like altitude, nodes, speed, data size & weather mobility model using Qualnet as a simulation tool. Since network layers covers IP, Throughput and FIFO, hence comparison of various Ad hoc routing protocols like AODV and DYMO (Reactive), OLSR (Proactive) and ZRP (hybrid) taking IP, Throughput and FIFO as comparison parameters helps to make right selection of protocols to improve QoS in hilly terrains. Varying parameters of VANET shows that in the real traffic scenarios proactive protocol performs more efficiently

KEYWORDS

Hilly Terrains, Nodes , Weather mobility , Ad hoc Routing, Qualnet

INTRODUCTION

Vehicular Ad hoc Network (VANET) is a new communication paradigm that enables the communication between vehicles moving at high speeds. It has been found that VANET in hilly terrains suffers frequent signal breakdowns as compared to pedestrians due to various reasons like altitudes, nodes speed, data size & weather mobility model. Hence in order to improve QoS (Quality of Service) in fast moving vehicles various light weight routing protocols needed to be studied in Network layer, so that Right selection of the protocol can be made. There are mainly three types of routing protocols, Proactive [1], Reactive [2], Hybrid [3]. These protocols are having different criteria for designing and classifying routing protocols [4] for wireless ad hoc network and their comparison in Mobile Ad hoc Network (MANET) is always useful [5]. The MANET working group of the Internet Engineering Task Force (IETF) [5] develops standards for routing in dynamic networks [6] of both mobile and static nodes. The protocols in focus now days are Hybrid protocols and others. Its use in the context of VANET's along with reactive and proactive has always been area under investigation. Routing protocols [7] are always challenging in the fast-moving nodes as their performance degrades [8] and such type of network is difficult to manage as fast handoff leads to signal distortion due to geographic constraints.Hence Interference maximizes as geographical factors like altitude, weather mobility maximizes [9-10].

In this work, the feasibility, the performance, and the limits of ad hoc communication using AODV, DYMO, OLSR, ZRP at Network layer [11] is studied for IP and FIFO Potentials along with Throughput for optimizing the deployed transport and routing Protocols is investigated using Quanlet [12] taking high weather mobility and random way point mobility in to account. Special care is taken in to provide Realistic scenarios of both road traffic and network usage [13-16]. This is accomplished by simulating a scenario with the help of simulation tool Qualnet. A micro simulation environment for road traffic, supplied vehicle movement information, which was then fed in to an event-driven network simulation that configured and managed a VANET model based on this mobility data. Here two busy roads of Nehru Chowk,Palampur, Himachal Pradesh, India has been taken and the protocols and their various parameters of the network layer were provided by well-tested implementations for the network's simulation tool, while VANET mobility is performed by our own implementation.

2. AD HOC ROUTING PROTOCOLS

Routing protocol is a standard that controls how nodes decide how incoming packets are routed between devices in a wireless domain & further Distinguished in many types. There are mainly three types of routing protocols. AODV [14], DYMO [2] and DSR [16] are the examples of reactive routing protocols whereas OLSR and TBRPF and FSR [4] are the examples of proactive routing protocols. ZRP etc. are the examples of Hybrid protocol. Here the protocols under considerations are AODV, DYMO, OLSR and ZRP.

2.1 Ad-hoc on-demand distance vector (AODV) Routing Protocol

AODV [14] shares DSR's on-demand characteristics in that it also discovers routes on an as needed basis via a similar route discovery process. However, AODV adopts a very different mechanism to maintain routing information. It uses traditional routing tables, one entry per destination. This is in contrast to DSR, which can maintain multiple route cache entries for each destination. Without source routing, AODV relies on routing table entries to propagate an RREP back to the source and, subsequently, to route data packets to the destination. AODV uses sequence numbers maintained at each destination to determine freshness of routing information and to prevent routing loops. All routing packets carry these sequence numbers.

2.2 Dynamic MANET On demand (DYMO) Routing Protocol

DYMO is another reactive routing protocol that works in multi hop wireless networks. It is currently being developed in the scope of IETF's [7] MANET working group and is expected to reach RFC status in the near future. DYMO is considered as a successor to the AODV routing protocols. DYMO has a simple design and is easy to implement. The basic operations of DYMO protocol are route discovery and route Maintenance was studied extensively [8] along with comparison of two on demand routing protocols.

2.3 Optimized Link State Routing (OLSR) Protocol

OLSR [15] is the proactive routing protocol that is evaluated here. Basically, OLSR is an optimization of the classical link state algorithm adapted for the use in wireless ad hoc networks. In OLSR, three levels of optimization are achieved. First, few nodes are selected as Multipoint Relays (MPRs) to broadcast the messages during the flooding process. This is in contrast to what is done in classical flooding mechanism, where every node broadcasts the messages and generates too much overhead traffic.

2.4. Zone Routing Protocol (ZRP)

Hybrid routing combines characteristics of both reactive and proactive routing protocols to make routing more scalable and efficient [4]. Mostly hybrid routing protocols are zone based; it means the number of nodes is divided into different zones to make route discovery and maintenance more reliable for MANET. The need of these protocols arises with the deficiencies of proactive and reactive routing and there is demand of such protocol that can resolve on demand route discovery with a limited number of route searches. ZRP limits the range of proactive routing methods to neighboring nodes locally; however, ZRP [7] uses reactive routing to search the desired nodes by querying the selective network nodes globally instead of sending the query to all the nodes in network. ZRP uses "Intrazone" and "Interzone" routing to provide flexible route discovery and route maintenance in the multiple ad hoc environments. Interzone routing performs route discovery through reactive routing protocol globally while intrazone routing based on proactive routing in order to maintain up-to-date route information locally within its own routing range. The overall characteristic of ZRP is that it reduces the network overhead that is caused by proactive routing and it also handles the network delay that is caused by reactive routing protocols and perform route discovery more efficiently. Normal routing protocols which work well in fixed networks does not show same performance in mobile ad hoc networks. In these networks routing protocols should be more dynamic so that they quickly respond to topological changes. There is a lot of work done on evaluating performance of various MANET routing protocols for constant bit rate traffic

3. NETWORK LAYER

The OSI [7] Reference Model's third layer is called the network layer [11]. This is one of the most important layers in the model; it is responsible for the tasks that link together individual networks into internetworks. Network layer functions include internetwork-level addressing routing, datagram encapsulation, fragmentation and reassembly, and certain types of error handling and diagnostics. The network layer and transport layer are closely related to each other**.**

3.1 IP (Internet Protocol)

Mobile IP [15] allows a node to move from one network to another without changing its IP address and without requiring all routers to propagate a host-specific route. When it moves from its original home network to a foreign network, a mobile node must obtain an additional, temporary address known as a care-of address. Applications use the mobile's original, home address; the care-of address is only used by underlying network software to enable forwarding and delivery across the foreign network. Once it detects that it has moved, a mobile either obtains a co-located care-of address or discovers a foreign mobility agent and requests the agent to assign a care-of address. After obtaining a care-of address, the mobile registers with its home agent (either directly or indirectly through the foreign agent), and requests the agent to forward datagrams. Once registration is complete, a mobile can communicate with an arbitrary computer on the internet. Datagrams sent by the mobile are forwarded directly to the specified destination. However, each datagram sent back to the mobile follows a route to the mobile's home network where it is intercepted by the home agent, encapsulated in IP, and then tunneled to the mobile.

3.2 FIFO (First-In-First-Out)

A queue in which the first item in is the first item out is called FIFO [15]. In this a packet waits in a buffer (queue) until the node (router or switch) is ready to process them. If the average arrival rate is higher than average processing rate, the queue will up and new packets will be discarded. Note that A FIFO queue holds the packet .if the traffic consists of fixed size packet (e.g. cells in ATM networks) ,the process removes a fixed number of packets from the queue at each tick of the clock. If the traffic consists of variable-length packets, the fixed output rate must be based on the number of bytes or Bits.

3.3 Throughput

Throughput is the average number of successfully delivered data packets on a communication network or network node. In other words throughput describes as the total number of received packets at the destination out of total transmitted packets [12]. Throughput is calculated in bytes/sec or data packets per second.

4. SIMULATION TOOL

The collaboration of imminent research objectives and its related scope in this study are also collapsed into same influence of simulation environment for generating some authenticated outcomes. For this purpose, the adopted methodology for the results of this research work (specifically comparative routing analyses) is based on simulations near to the real time packages before any actual implementation. QualNet is a comprehensive suite of tools for modeling large wired and wireless networks. It uses simulation and emulation to predict the behavior and performance of networks to improve their design, operation and management. QualNet enables users to Design new protocol models, optimize new and existing models, Design large wired and wireless networks using pre-configured or user-designed models, Analyze the performance of networks and perform what-if analysis to optimize them. QualNet (12) is the preferable simulator for ease of operation. So, we found QualNet be the best choice to implement our scenarios as we do not need every feature possible, just those for the token passing and message routing. QualNet is a commercial simulator that grew out of GloMoSim, which was developed at the University of California, Los Angeles, UCLA, and is distributed by Scalable Network Technologies [12]. The QualNet simulator is C++ based. All protocols are implemented in a series of C++ files and are called by the simulation kernel. QualNet comes with a java based graphical user interface (GUI).

QualNet enables users to:

- Design new protocol models.
- Optimize new and existing models.
- Design large wired and wireless networks using pre-configured or user-designed models.
- Analyze the performance of networks and perform what-if analysis to optimize them.
- Easy to use GUI allows users to simply drag and drop devices, links and applications
- Results analysis with graphs and statistics database
- Packet animation to visually understand protocol working.
- Faster speed enables model developers and network designers to run multiple “what-if” analyses by varying model, network, and traffic parameters in a short time.
- QualNet supports a Wide Range of Technologies including the latest in 802.11, 802.15.4, LTE, WiMax etc
- Easy installation and licensing
- Delivers sophisticated software products and professional services, backed up by comprehensive customer support.

Key features of QualNet

- **Speed-** QualNet can support real-time speed which enables model developers and network designers to run multiple “what-if” analyses by varying model, network, and traffic parameters in a short time.

- **Scalability-** QualNet can model thousands of nodes by taking advantage of the latest hardware and parallel computing techniques. QualNet can run on cluster, multi-core, and multi-processor systems to model large networks with high fidelity.

- **Model Fidelity**-QualNet uses highly detailed standards-based implementation of protocol models. It also includes advanced models for the wireless environment to enable more accurate modeling of real-world networks.

- **Extensibility-** QualNet can connect to other hardware and software applications, such as OneSAF Testbed Baseline (OTB), real networks, and third party visualization software, to greatly enhancing the value of the network model.

Table 1. Simulation Parameters

Simulator	Qualnet Version 5. o.1
Terrain Size	1500 x 1500
Simulation time	3000s
No. Of Nodes	15
Mobility	Random Way Point, Pause time=0 Sec
Speed of Vehicles	Min.=3m/s Max.=20m/s
Routing Protocols	AODV,DYMO,OLSR,ZRP
Network layer	IP, FIFO
Data size	512 bytes
Data Interval	250ms
No. of sessions	5
Altitude	1296m
Weather mobility model	100ms

5. DESIGNING OF SCENARIO

The scenario is designed in such a way that it undertakes the real traffic conditions. Here two busy roads of Nehru Chowk, Palampur, Himachal Pradesh, India has been taken We have chosen 15 fast moving vehicles in this region of 1500X1500 with the random way point mobility model and weather mobility 100ms and altitude is 1296m. There is also a well-defined path for some of the vehicles, so real traffic conditions can also be taken care of. It also shows wireless node connectivity of few vehicles using CBR application. The area for simulation is a Hilly area with an altitude of 1500 meters. Weather mobility intervals is 100ms.Pathloss model is two ray with max prop distance of 100m. Battery model is Duracell 1500-AA

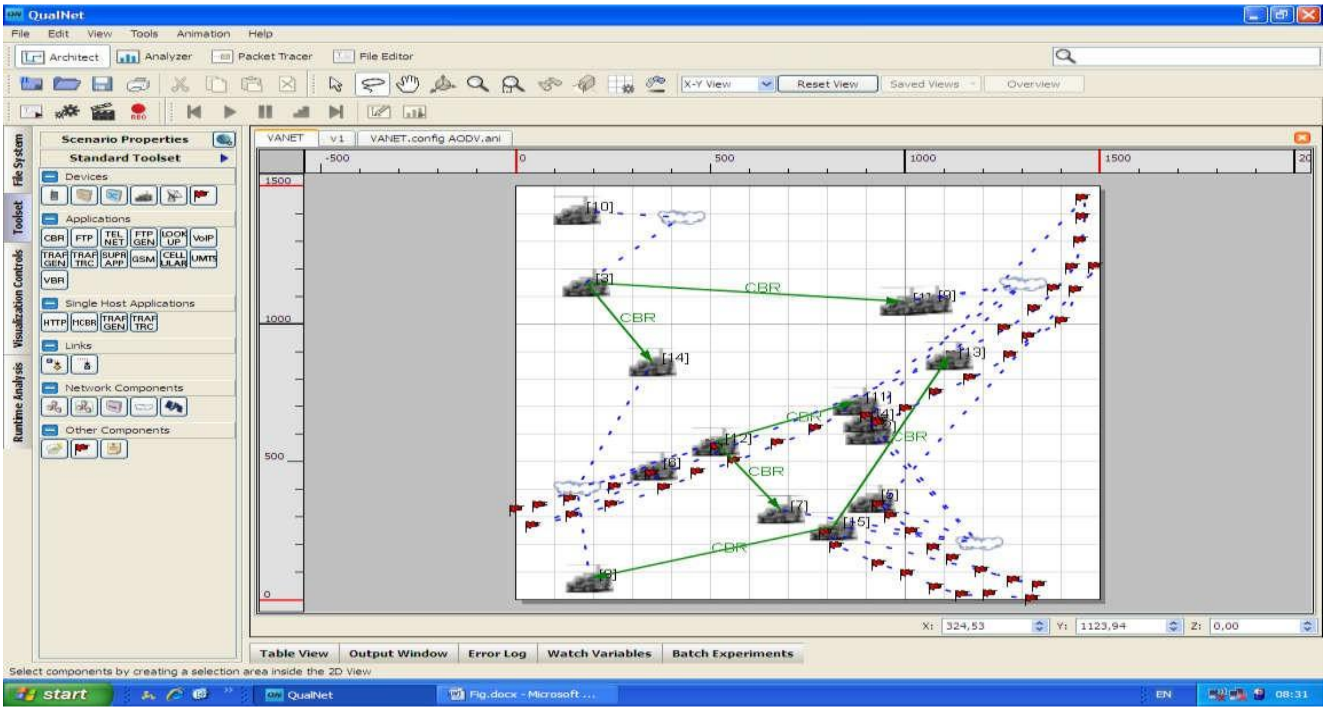

Fig. 1 Qualnet VANET Scenario

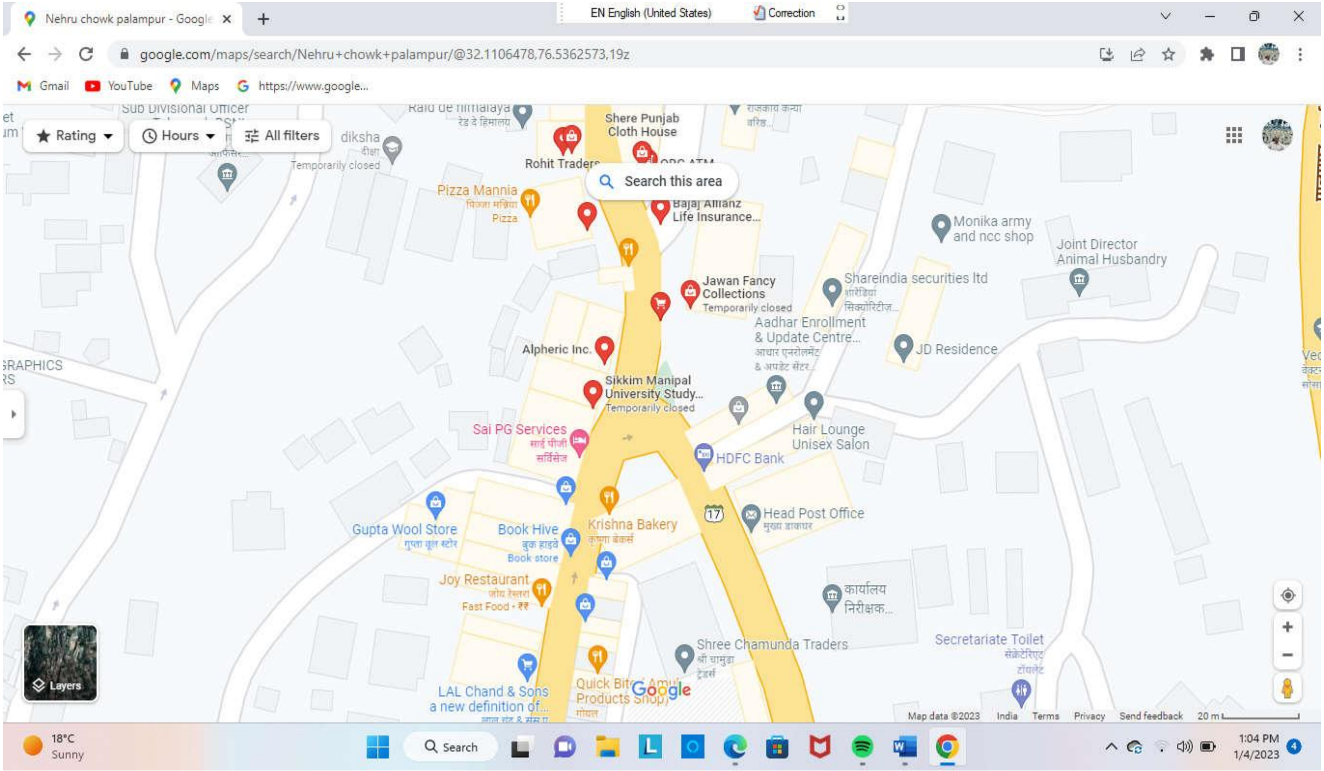

Fig. 2 Real Traffic Scenario

6. RESULTS AND DISCUSSION

The simulation result brings out some important characteristic differences between the routing protocols. It has been found that for IP (Comparison in/out receivers) and FIFO (Comparison Peak Queue size/Average Queue Length) OLSR outperforms the other protocols. This is because OLSR is a proactive protocol and it pre determines the route in well defined manner. It uses destination sequence numbers to ensure loop freedom at all times and it offers quick convergence when the network topology changes. Hence its performance at higher altitude is considerable as compared to others, where Predefined paths are far most necessary. Whereas AODV performs second best for IP (Comparison in/out receivers) and FIFO (Comparison Peak Queue size/Average Queue Length).This is because of its on demand behavior. Note that for FIFO (Comparison Peak Queue size/Average Queue Length) DYMO is second best because it is different in working although it is Reactive in nature. Besides route information about a requested target, a node will also receive information about all intermediate nodes of a newly discovered path. Therein lays a major difference between DYMO and AODV, the latter of which only generates

Route table entries for the destination node and the next hop, while DYMO stores routes for each intermediate hop. Note that throughput remains constant for all the protocols. Hence we conclude that Adhoc networks of vehicles and static highway infrastructure can be successfully setup, maintained, and used with this simulator and particularly at higher node densities. When the network became congested and new connections could not be established, simple retry mechanisms only further add to congestion Simulation results therefore seem to encourage an adaptation of the OLSR protocols in use, so problems perceived by lower Layers are reacted to in a sensible way and application requirements are taken in to account when the network becomes overloaded.

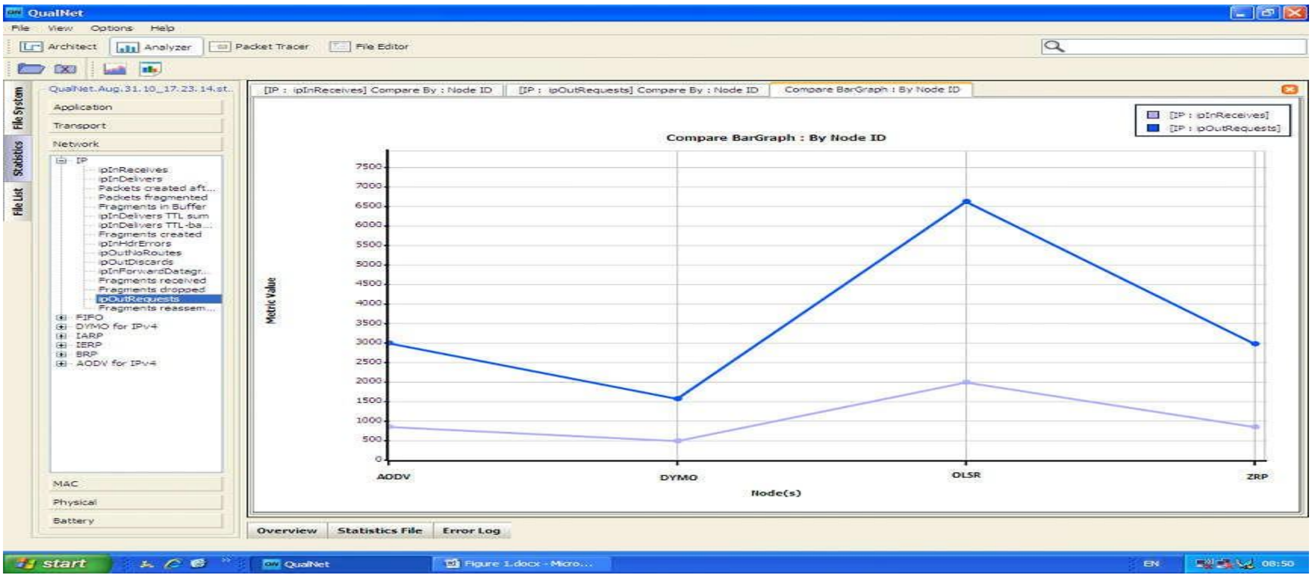

Fig.3 IP (Comparison in/out receivers) of AODV,DYMO, OLSR, ZRP

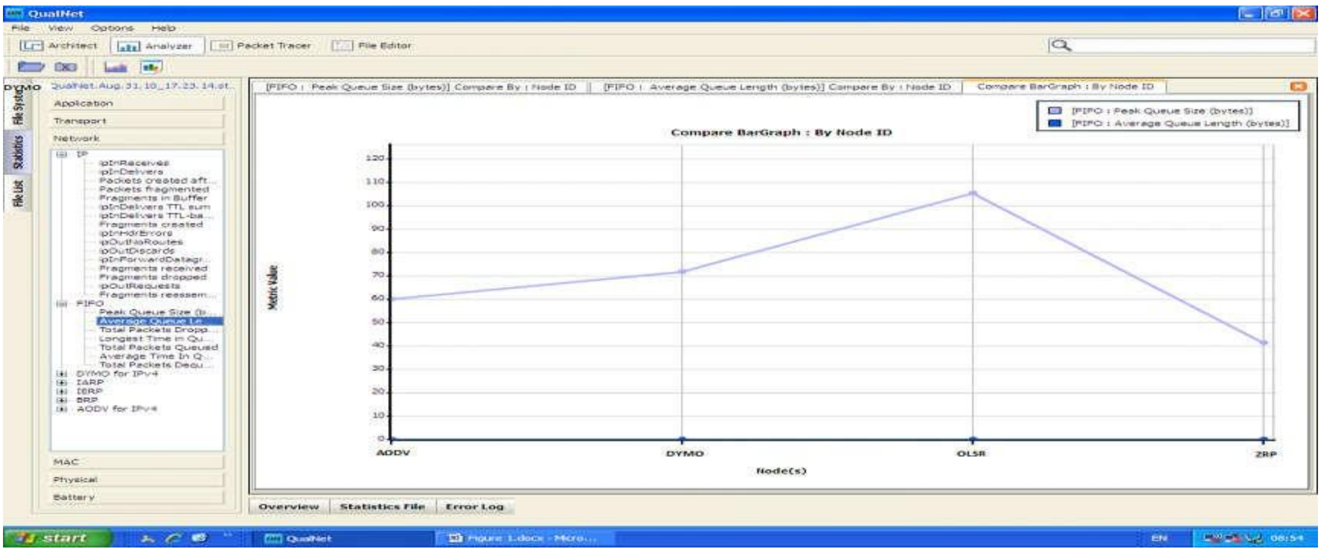

Fig.4 FIFO (Comparison Peak Queue size/Average Queue Length) of AODV, DYMO, OLSR, ZRP

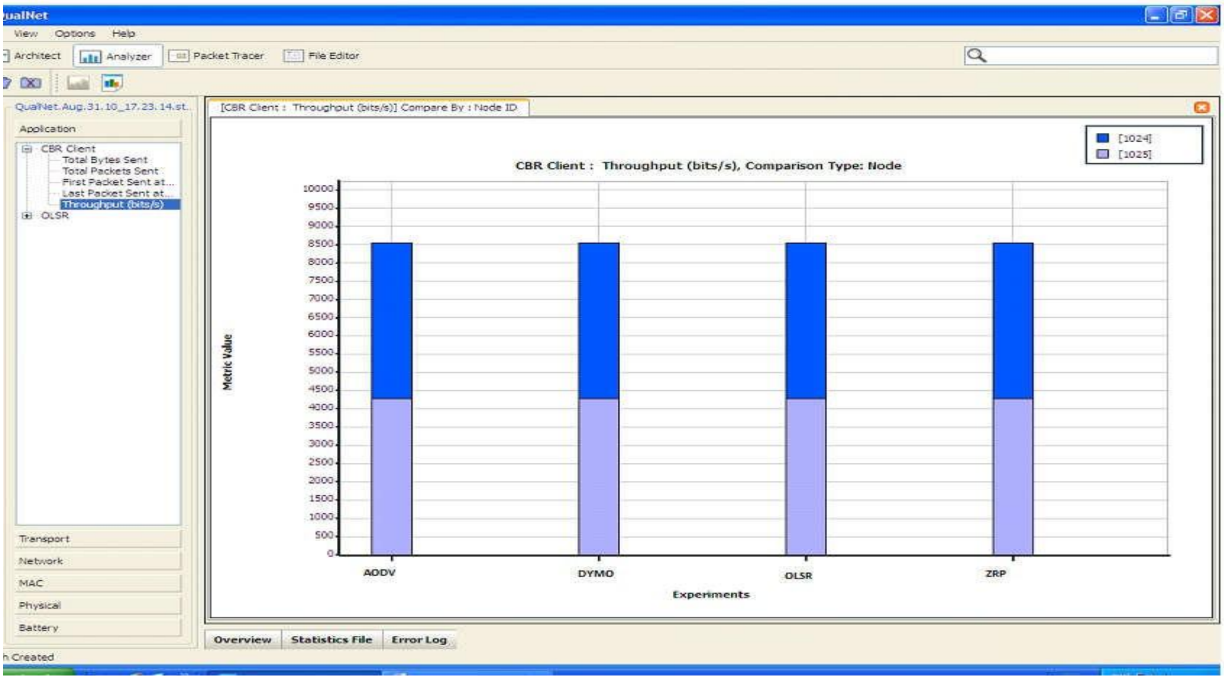

Fig. 5 Throughput of AODV,DYMO, OLSR, ZRP

7. CONCLUSIONS

Evaluation of the feasibility and the expected quality of VANETs operated at Network layer shows that the routing protocol OLSR at higher altitude performs well. Because of its proactive nature data sent/receive is better than reactive and hybrid protocols. There are also minimum errors in signal sent. Adhoc networks of vehicles and static highway infrastructure can be successfully setup, maintained, and used with this simulator and particularly at higher node densities. When the network became congested and new connections could not be established, simple retry mechanisms only further add to congestion Simulation results therefore seem to encourage an adaptation of the OLSR protocols in use, so problems perceived by lower Layers are reacted to in a sensible way and application requirements are taken in to account when the network becomes overloaded.

8. FUTURE SCOPE

In future many parameters like longitude, latitude, geographical location, traffic, data size, more no. of nodes etc. can also be considered so that results similar to real world can be achieved. The protocol selection again becomes important where congestion is high. Because The Ad hoc routing protocols for higher altitude in VANET has very high applications. In future designing of new protocol can be done keeping in view the geographical factors and choosing OLSR parameters.

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