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To Analysis of Mobility Models against MANET Routing Protocols under the Node Density and QoS Issue for CBR and VBR Traffics

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Abstract—*In this paper we present a set of IEEE WLANs standards used for multimedia traffic in MANETs (i.e. IEEE 802.11). A mobile ad hoc network (MANET) involves of moveable nodes in wireless medium that are communicated and exchange the information to each other without any access point. In most of the case TCP in the current form can't support the MANETs in case of route failures and in terms of congestion control methodologies. In general performance of MANET depends on few attributes like scalability, traffic load and mobility. Extensive research has been done towards the performance of MANETs across the Constant Bit Rate (CBR) against file transfer protocol (FTP), TCP and User datagram protocol (UDP). In this paper we analysis the two Mobile Ad Hoc Network (MANET) routing protocols – AODV and TORA under the different traffic condition and mobility model for multimedia application. To identify the impact of CBR and VBR traffic routing protocols performance based upon the throughput, delay, network load. According to simulation results is also showed that TORA hybrid routing protocol is the best suitable for IEEE 802.11 in ad hoc network in case of WLAN standard with multimedia data in real time transmission.*

Keywords: *MANET, AODV, TORA, Mobility Models, CBR and VBR Traffic.*

1. INTRODUCTION

MOBILE wireless networks are receiving an increasing interest due to the possibility of ubiquitous communications they offer. In particular, mobile ad hoc networks (MANETs) [1] enable users to maintain connectivity to the fixed network or exchange information when no infrastructure, such as a base station or an access point, is available. This is achieved through multihop communications, which allow a node to reach far away destinations by using intermediate nodes as relays. The selection and maintenance of a multihop path, however, is a fundamental problem in MANETs. Node mobility, signal Interference and power outages make the network topology frequently change; as a consequence, the links along a path may fail and an alternate path must be found. To avoid the degradation of the system performance, several solutions have been proposed in the literature, taking into account various metrics of interest. A method that has been advocated to improve routing efficiency is to select the most stable path [1], [2], [3],[4], so as to avoid packet losses and limit the latency and overhead [5] due to path reconstruction (routing instability). Routing protocol plays a crucial role to send the data from source to destination that discovers the optimal path between the two communication nodes. Each protocol has its own rules (algorithm) to finds the route or maintenance the route. There are various routing protocol proposed by researchers. MANETs [1] are facing various challenges for e.g. No central controlling authority, Mobility models, limited power ability, continuously maintains the information required to properly route traffic. Mobility models are also a factor that puts a deep impact over the performance of a MANET and need to be concerned.

MANET is wide network so different node may communicate over the same limited bandwidth. So there may be the problem of congestion, so to cover such problem appropriate routing is required to be done. Good routing can be done by different routing protocols which find out the path between two nodes. There are many type of routing nodes in MANET are shows in the Fig. 1.

MANET routing protocols are traditionally divided into three categories which are Proactive Routing Protocols, Reactive Routing Protocols, Hybrid. The most popular routing protocols [2] [3] in MANET are AODV (reactive) [4] [5], DSR (reactive) [6], OLSR [7] [8] (proactive) and TORA (hybrid) [9]. Reactive protocols find the routes when they are desired. Proactive protocols are table driven protocols and discovery best routes before they need it. And finally hybrid routing protocols offer an efficient framework that can concurrently draw on the strengths of proactive [9] and reactive routing protocols [10]. Proactive Routing protocol, a node is closely able to route (or drop) a packet. Examples of proactive protocols include the Optimized Link State Routing Protocol OLSR. Reactive Routing protocols are characterized by node gain and maintain routes on demand. i.e., a route to a destination is not acquired by anode until packet is not received by a destination node. Examples of reactive protocols are Ad-Hoc on Demand Distance Vector Routing Protocol (AODV) [11]. In this paper, we focus on two MANET routing protocols AODV, OLSR and TORA. We consider three parameters to evaluate the performance of these routing protocols: Throughput, Delay and Network Load by multimedia traffic and retransmission of VBR and CBR.

The rest of this paper is planned as follows. In section 2 we briefly describe the traffic in MANET. In Section 3 presents related work. In section 4 the Simulation environment and research Methodology used for evaluation of the said protocols and traffic. In Section 5 we analysis our simulation results and observations. Finally, section 6 concludes the paper.

2. TRAFFIC IN MANET

In MANETs, several factors influences the performance of the routing protocols that are selected to use across the MANETs, and these factors include security level employed across the network, maintenance of the route, configuration of router, various types of applications supported by MANETs and different kinds of traffic that are sent throughout the network. MANETs supports different types of traffics and the most important and frequently used traffics are TCP, VBR and CBR traffics here VBR means Variable bit rate and CBR means Constant bit rate. The traffic type selected across the routing procedure will influence the routing protocol performance. The performance of the routing protocol is also based on the nodes selected in the MANETs generally two types of nodes can be used in MANETs and they are mobile nodes and fixed nodes.

MANETs are basically dynamic in nature and so it supports a large variety of applications and the most important and most commonly used applications of MANETs are FTP, video conferencing, VOIP, Email, voice and web applications. The characteristic of the traffic sent across the MANET is decided by the selected type of application. The application selected is also used to influence the performance of the routing protocol similarly the selected traffic type also influence the performance of routing protocol that may be reactive or proactive that is used throughout the MANET. The issues related to these MANETs are discussed in many existing studies and researches which also includes the comparison of performance of routing protocols in various aspects which are done mostly among the selected routing protocols when compared to the selected kind if traffic. MANETs are basically dynamic in nature and so it supports a large variety of applications and the most important and most commonly used applications of MANETs are FTP, video conferencing, VOIP, Email, voice and web applications. The characteristic of the traffic sent across the MANET is decided by the selected type of application. The application selected is also used to influence the performance of the routing protocol similarly the selected traffic type also influence the performance of routing protocol that may be reactive or proactive that is used throughout the MANET. The issues related to these MANETs are discussed in many existing studies and researches which also includes the comparison of performance of routing protocols in various aspects which are done mostly among the selected routing protocols when compared to the selected kind if traffic.

3. RELATED WORK

We also studied performance evaluation of AODV and TORA protocols also describe the degree of variability and node density in packet arrivals, which can be caused by network data traffic and mobility model. In this section literature survey regarding the previous work and related approaches about the routing protocols in ad hoc network. MANET have a dynamic nature, a large number of applications make them ideal to use. Quick deployment and minimal configuration of MANET in emergencies such as natural disaster makes them more suitable. The growth of technology makes increase in Wi-Fi capable laptops, mobile phones, MP3 players and other small portable devices becomes a genuine reason for MANET popularity.

Zhan Huawei et. al. [4] describe the characteristic of the ad hoc network and explained how does it differs from the original fixed wired network. The characterization was given for the ad hoc routing protocols. AODV and OLSR protocols were introduced and their core architecture was described. Surayati Mohamad Usop et. al. [5] give different kind of conclusions about the MANET routing protocols i.e. DSDV, AODV and DSR were simulated in NS2. The reactive protocol AODV outperforms than DSDV and DSR in maintaining connection by sequentially exchange of information for TCP based traffic. The packets were delivered when the node mobility is low and failed to deliver at high mobility. DSR perform well than DSDV at all mobility. In DSR performs well than DSDV and AODV for packet dropping rate (PDR), delay and throughput. DSR generates less network load than AODV. Harminder S. Bindra et. al. [6] conclude that in Group mobility model with CBR traffic sources AODV perform better. But in case of TCP traffic, DSR perform better in stressful situation (high load or high mobility). DSR routing load is always less than AODV in all type of traffic. Priti Garg et. al. [7] that the results of the both DSR and TORA routing protocol on various mobility, packet size and time interval metrics. The performance metrics to evaluate performance of DSR and TORA routing protocol includes routing load, average delay, packet delivery ratio and throughput. Muhammad Ahmed Khalid [8] proposed that from all the simulations performed on real-time and non-real-time traffic types which are required for e-Health, It can be concluded that OLSR is the better choice for small and large networks as it has the best performance. The modified version of AODV can be used which have increased performance as compared to the original AODV protocol. As the traffic increase delay also increases. Mobility has very little or no impact and the average delay is all most constant. But network traffic influences a lot on average delay (up to 30 Seconds). Overall AODV performs better than DSDV. Reactive protocols average delays are less than 80s and DSDV delay are greater than 80s.

4. SIMULATION ENVIRONMENT AND RESEARCH METHODOLOGY

We used Network Simulation OPNET (optimized Network Engineering Tool) Modeler version 14.5 in our evaluation. The OPNET is a discrete event driven simulator. OPNET is a commercial package, which employs a hierarchical modeling architecture consisting of three levels. The top level consists of the network model where topology is design, the second level consists of data flow models and the third level consists of the process editor which handles control data flow. These levels are significant in modeling, evaluating and amendments of routing protocols. The simulation on the performance of routing protocol with increase the mobility and scalability at real time data. It allows the users to design and study communication networks, devices, protocols, and applications with flexibility and scalability. It simulates the network graphically and its graphical editors mirror the structure of actual networks and network components. The users can design the network model visually. The modeler uses object-oriented modeling approach. The nodes and protocols are modeled as classes with inheritance and specialization. The development language is C.

The simulation of network attributes are summarized in table 1.

Table 1: Network Attributes for Multimedia Application

Wireless LAN MAC Address	Auto Assigned
BSS Identifier	Auto Assigned
Physical Characteristics	Direct sequence
Date Rates	11 Mbps
Channel setting	Auto Assigned
Transmit Power	0.050
AP Beacon interval(sec)	0.02
Maximum Receive life time(sec)	1.0
Buffer size(Bits)	102400000
Large packet processing	Fragment
HCF	Promoted

In this paper simulation scenario consisting of 100 nodes is considered. The nodes were randomly placed within certain gap from each other in 3.5*3.5 kilometres campus environment from 100 nodes respectively.

The VBR traffic as generated in the network explicitly i.e. user defined via Application configuration and Profile configuration. Every node in the network was configured to execute AODV and TORA respectively. The simulation time was set to 300 seconds again 600 seconds for traffic. All the nodes were configured with demand path trajectories for mobility in space. The trajectory basically defines the path for nodes to move in space in given periodic interval of time. In Fig. 1 shows a sample network created with 100 Nodes with process model, application configuration and profile configuration and VBR traffic for the network. Simulation environment consists of 100 wireless mobile nodes which are placed uniformly and forming a Mobile Ad-hoc Network, moving about over a 3.5 X 3.5 km area for 300 and 600 seconds of simulated time. The network metrics are the parameters used to observe the performance of the designed networks. There are a number of network metrics considered depending on the network traffic or applications. For VBR traffics, we considered throughput, delay, and Network Load. Here, by observing the throughput and delay we can get overall performance of the designed network scenarios. The output or the average rate of successful message delivery is known as throughput. It is measured in bit/sec. The latency or delay time i.e., the time taken to carry the data packet between two nodes somewhere along the path. Therefore, to get correct simulation results from our designed MANET scenarios, we run the scenarios for 300 seconds for routing protocol and 300 seconds for multimedia traffic.

(a) Ad Hoc Nodes- Each node [11] in the ad hoc network functions as both a client and a server. As clients, the nodes complete two tasks - send requests to the network and receive information from the network. As servers, the nodes process information received from the network and determines whether packets require forwarding.

(b) MAC Layer Protocol - IEEE 802.11g. A MAC [12] layer protocol provides coordinated access to the network. The MAC layer is responsible for the transport of frames at the data link layer.

(c) Throughput of Ad Hoc Network-Throughput is defined as; the ratio of the total data reaches a receiver from the sender. The time it takes by the receiver to receive the last message is called as throughput. Throughput is expressed as bytes or bits per sec (byte/sec or bit/sec).

(d) Packet End-to-End Delay-The packet End-to-End delay is the average time that packets take to traverse the network. This is the time from the generation of the packet by the sender up to their reception at the destination’s application layer and is expressed in seconds. Hence all the delays in the network are called packet end-to-end delay [11], like buffer queues and transmission time. Sometimes this delay can be called as latency; it has the same meaning as delay.

$$d_{end\text{-}end} = N[d_{trans} + d_{prop} + d_{proc}]$$

Where

$d_{end\text{-}dend}$= End to end delay

d_{trans} = Transmission delay

d_{prop} = Propagating delay

d_{proc} = Processing delay

(e) Network Load- When there is more traffic coming on the network, and it is difficult for the network to handle all this traffic so it is called the network load.

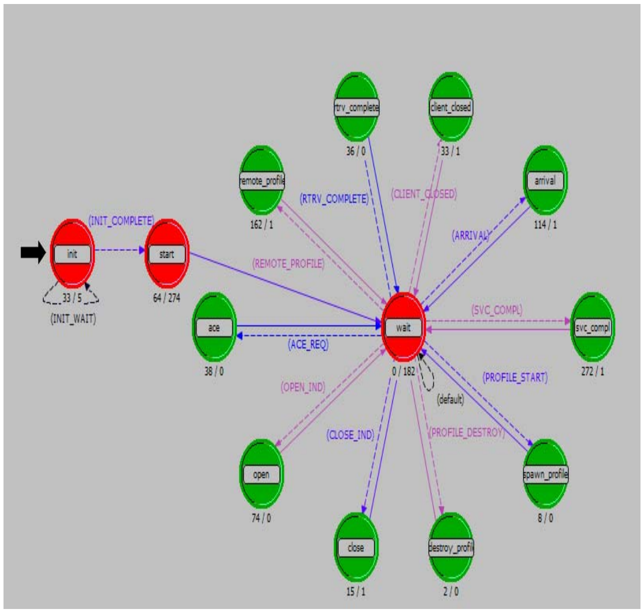

Fig. 1: Process Model for MANET system

OPNET modeler 14.5 is used to investigate the performance of routing protocols AODV and TORA with varying network sizes, data rates, traffic and network load. We evaluate three parameters and show of these applications is estimated beside the quality of service requirements using the VBR, CBR and wireless LAN metrics and based on the results it is clear that multimedia quality has shown the maximum QoS standards when compared to the other scenarios.The simulation parameters are summarized in table 2.

Table 2: Simulation Parameters

Statistic	Value
Simulator	OPNET 14.5
Application Traffic	CBR and VBR
Physical Medium	DHCP
Simulation Time	300 seconds for Routing and 300 seconds for Traffic
Data rate	11 Mbps for 802.11
Buffer Size	256000
Encoder scheme	GSM FR
Scenario Size	3.5*3.5 km
Channel Type	IEEE 802.11 Wireless channel
MANET Nodes	100 nodes
Transmit Power	0.005
Routing Protocols	AODV and TORA
Receiver Life Time	0.5 second
Performance Parameter	Throughput, Delay, Network Load

It allows the users to design and study communication networks, devices, protocols, and applications with flexibility and scalability. It simulates the network graphically and its graphical editors mirror the structure of actual networks and network components. The simulation video application parameters are summarized in table 2.

Fig. 2, Shows a sample network created with 100 Nodes, one application configuration and one profile configuration with multimedia traffic for the network.

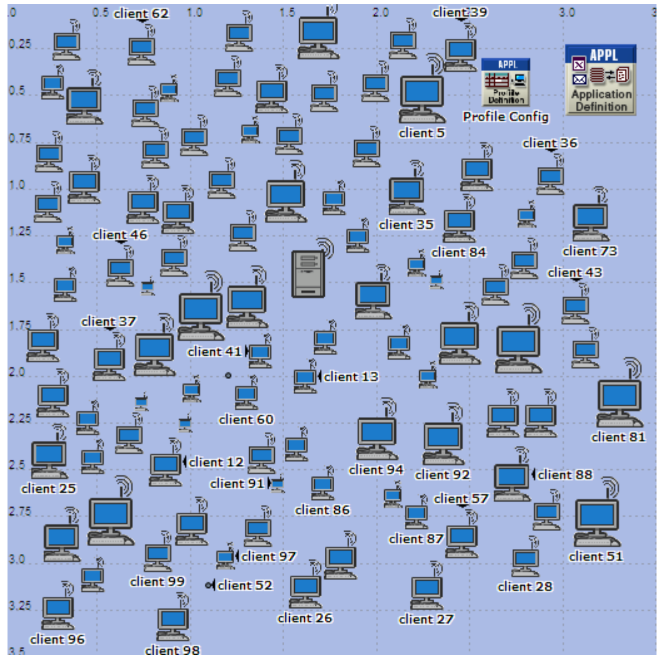

Fig. 2: MANET Simulation of100 nodes with Multimedia Traffic (CBR & VBR)

5. SIMULATION RESULT AND OBSERVATIONS

We carried out simulations on OPNET simulator [20]14.5. The results show differences in performance between considered routing protocols, which are the consequence of various mechanisms on which protocols are based. We carried out our simulations with 100 nodes [21].

Figures 3, 4 and 5 shows the throughput, delay and network load of this network with respect to total simulation time which is taken as 300seconds for which the simulation was run. In this simulation, the networks is set to 100 nodes, the multimedia traffic with VBR and CBR data transmission rate is 11 Mbps, IEEE 802.11 Wireless channel and the simulation time is 300 seconds for voice and video traffic.

A.Throughput:

In this Fig. 3 shows that throughput of AODV is the higher than TORA in terms of random walk mobility model.

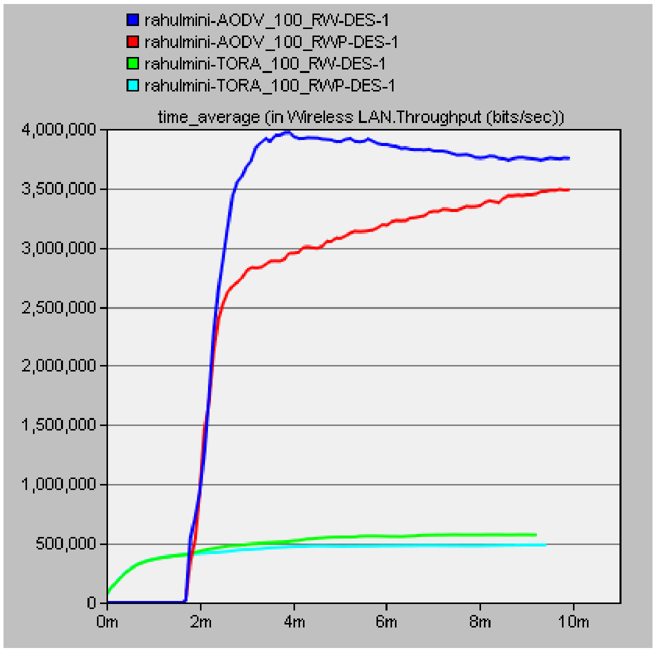

Fig. 3: Throughput comparison in routing protocols AODV and TORA with 100 nodes

AODV shows same performance for 100 node simulation setup both Random Walk and Random Way Point Mobility Model remains at 4,000,000 bps and then for random Walk it starts decreasing but for Random Way Point it gradually increases.

Table 3: Comparison table of throughput with mobility models

Throughput (bits/sec)	AODV		TORA	
	Random Walk	**Random Way Point**	**Random Walk**	**Random Way Point**
100 Nodes	4,000,000	3,500,000	600,000	500,000

On the other hand for TORA performance degrades in Random Way Point Mobility model than Random Walk in both 100 node simulation setup and for 100 node setup throughput is below 1,000,000 bps for Random Way Point and random Walk mobility model. Thus we see that Random Way Point model gives slightly better throughput for AODV and Random Walk for TORA.

B. Delay:

We observe in Fig. that TORA consistently presents the lowest delay, regardless of network size. This may be explained by the fact that TORA, as a Hybrid protocol, has a faster processing at intermediate nodes. When a packet arrives at anode, it can immediately be forwarded or dropped because TORA protocol holds routes to all destinations in its table, regardless of topology changes.

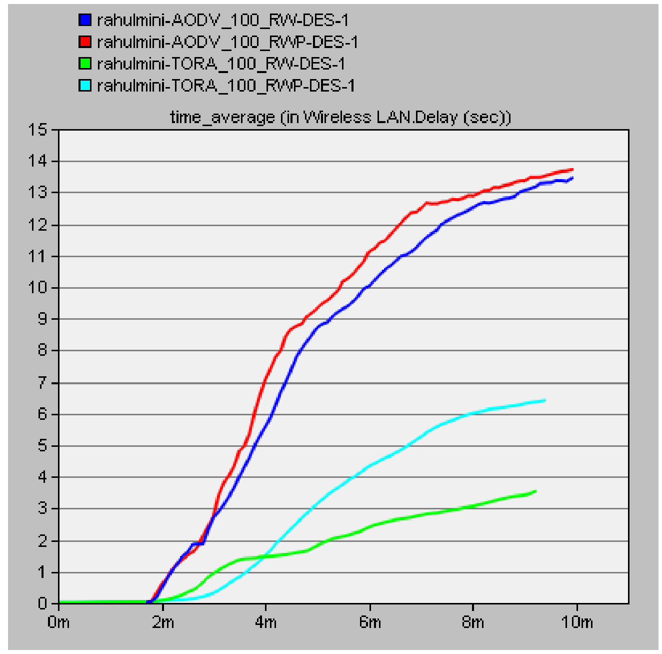

Fig. 4: Delay comparison in routing protocols AODV and TORA with 100 nodes

Table 4: Comparison table of delay with mobility models

Delay (seconds)	AODV		TORA	
	Random Walk	**Random Way Point**	**Random Walk**	**Random Way Point**
100 Nodes	14	4	13.5	6.5

AODV induces highest delay on with random way point mobility model at opnet simulation. It gradually increases when node density increases. Thus we see that Random Walk Mobility model performs better than Random Way Point in terms of delay and TORA remains more consistent than other one protocols. Again TORA outperforms in terms of end to end delay experienced in the network.

C. Network Load

In fig. 5 Network load of AODV has the high performance with irrespective of network size and mobility. That stable behaviour of AODV is a desirable property of a protocol as it indicates that it can scale well in networks in which the mobility changes over time. Network load for TORA falls to an heavy extent when number of nodes are increased. It also shows better performance for Random Walk than Random Way Point Mobility model. TORA on the other hand performs excellently with higher node density.

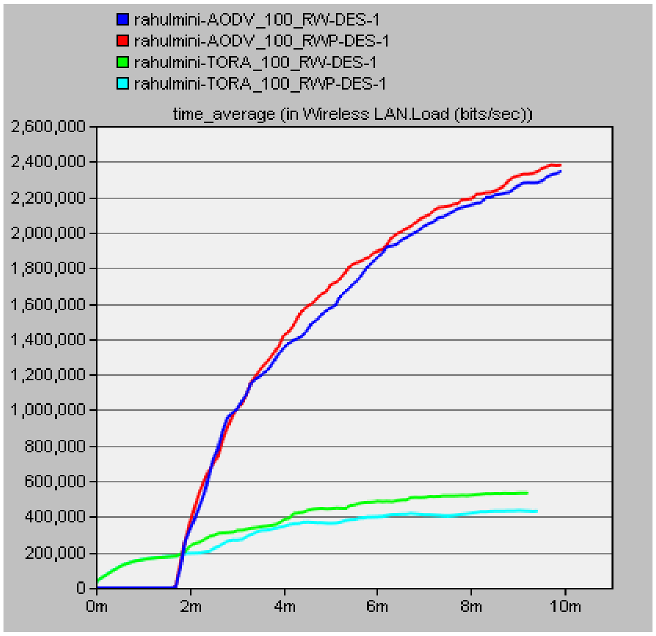

Fig. 5: Network load comparison in routing protocols AODV and TORA with 100 nodes

The AODV protocol tries to minimise this traffic by making only the hosts that participates in the communication to periodically send Hello messages with the hop limitation of the one hop and TORA tries to minimise this flooding allowing only MPR to broadcasting these messages through the network. In AODV protocol although each node sends out periodic Hello message to monitor connectivity, it is limited and the size of the control message is smaller than those used by AODV, hence using less bandwidth for route maintenance thus create less network load. TORA perform less network load in term of random way point mobility.

Table 5: Comparison table of network load with mobility models

Load (bits/sec)	AODV		TORA	
	Random Walk	Random Way Point	Random Walk	Random Way Point
100 Nodes	2,300,000	2,400,000	500,000	450,000

The overall results observations are summarized in table 6.

Table 6: Comparison table of overall scenario of 100 nodes

Nodes	Parameter	AODV	TORA
100 Random Walk	Throughput	4,000,000	600,000
	Delay	14	4
	Network Load	2,300,000	500,000
100 Random Way Point	Throughput	3,500,000	500,000
	Delay	13.5	6.5
	Network Load	2,400,000	450,000

6. CONCLUSION

In this paper, according to simulation study of this work has been done for two routing protocols AODV and TORA deployed over MANET using multimedia traffic. We see that Random Way Point model gives slightly better throughput for AODV and Random Walk for TORA scenarios with varying traffic loads with case of multimedia and mobility scenarios. Performance analysis of AODV (Ad Hoc On-demand Distance Vector) and TORA (Temporally Ordered Routing Algorithms) with respect multimedia traffic to throughput, end-to-end delay and network load.

Again TORA outperforms in terms of end to end delay experienced in the network in terms of variable bit rate of nodes salability and density. In this research no single routing protocol is visibly superior in terms of overall network concert and multimedia traffic. One protocol TORA may be superior in terms of average end-to-end delay and network load of multimedia traffic and AODV may be superior in terms of throughput along with random walk mobility model.

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