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ROUTING PROTOCOL PREFERENCES TO MOBILE AD HOC NETWORK APPLICATIONS

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Abstract— Mobile Ad Hoc Network applications are manifold. MANET applications vary from Emergency services such as rescue operations, military communications and operations to education, entertainment to home appliances. MANET applications have diverse Quality of Services (QoS) requirements. This paper is an attempt to provide MANET routing protocol evaluation and analysis from applications QoS requirements point of view. We provide list of applications with its QoS priorities. Next choice of protocol for each application is suggested.

Keywords—MANET QoS, MANET Applications, Single Path Routing, Multi Path Routing, Proactive Routing Protocol, Reactive Routing Protocol, Hybrid Routing Protocol.

I. INTRODUCTION

Unparalleled growth of mobile network applications is apparent to the fact that in recent time mobile devices are replacing portable computers. This replacement is having an advantage of mobile devices. Wide range of applications for mobile networks or wireless sensor networks is due to mobility of devices. Mobile Ad Hoc Network (MANET) is a flavor of wireless sensor networks. The ad hoc nature of the network is due to frequent entry and exit of nodes in the network space. Mobile Ad Hoc Network is self organizing, dynamically reconfigurable wireless network without fixed infrastructure or central management [1]. It is collection of autonomous nodes [2] that are free to move in any directions. This unpredictable node movement set up complicated network organization.

Mobile Ad Hoc Network applications are manifold. MANET applications vary from Emergency services such as rescue operations, military communications and operations to education, entertainment to home appliances [3].

Mobile Ad Hoc Network applications Quality of Services (QoS) requirements are diverse. Achieving desired quality of services is challenging task in mobile ad hoc network (MANET). Node mobility has strapping effect on the quality of services (QoS) in MANET. It distress factors such as Throughput, delay and packet loss that determine high level dynamics of MANET. Route discoveries by MANET routing protocols are done reactively or proactively. Irrespective of its requirement routs are discovered periodically in proactive routing. From this periodically exchanged information network topology is constructed by mobile nodes. This adds up more control overheads. Reactive routing is a solution to the problem of massive information exchange happening in proactive routing. Multi path routing protocols attend significantly the active session failure problem. Availability of backup routes reduces the route discovery frequency by substantial amount. Route discovery frequency and routing overheads are additional QoS addressed by Multi-path routing [4] [5] [6] [7].

The paper aims at providing performance evaluation of MANET routing protocols and to suggest choice of routing protocol for applications. The paper is organized as follows. Next section provides overview of MANET applications from the point of view of QoS, followed by problem definition. Next the simulation experimental setup is provided along with results and analysis. Finally we provide protocol choice as per application.

II. MANET APPLICATIONS OVERVIEW

MANET applications have diverse Qualities of services requirements. Mobility, Data load and Network sizes at various applications are different. MANET applications and feasible scenarios/services are provided in [3]. Greater delays for Tactical networks, Education, Sensor networks and Context aware services are not going to serve the purpose of these applications. Throughput and packet losses can be negotiated. Similarly packet losses are not bearable in emergency services whereas throughput becomes the highest priority parameter in applications such as Commercial and civilian environments, Home and enterprise networking, Entertainment and Coverage extension. The application list of [3] is extended with their QoS main concern in Table1.

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Table 1 : MANET applications with QoS Requirements

Applications	Scenarios/services	Priority of Preferred QoS
Tactical networks	• Military communication and operations • Automated battlefields	P1. Delay P2. Throughput P3. Packet Loss
Emergency services	• Search and rescue operations • Disaster recovery • Replacement of fixed infrastructure in case of environmental disasters • Policing and fire fighting • Supporting doctors and nurses in hospitals	P1. Packet Loss P2. Delay P3. Throughput
Commercial and civilian environments	• E-commerce: electronic payments anytime and anywhere • Business: dynamic database access, mobile offices • Vehicular services: road or accident guidance, transmission of road and weather conditions, taxi cab network, inter-vehicle networks • Sports stadiums, trade fairs, shopping malls • Networks of visitors at airports	P1. Throughput P2. Packet Loss P3. Delay
Home and enterprise networking	• Home/office wireless networking • Conferences, meeting rooms • Personal area networks (PAN), Personal networks (PN) • Networks at construction sites	P1. Throughput P2. Packet Loss P3. Delay
Education	• Universities and campus settings • Virtual classrooms • Ad hoc communications during meetings or lectures	P1. Delay P2. Packet loss P3. Throughput
Entertainment	• Multi-user games • Wireless P2P networking • Outdoor Internet access • Robotic pets • Theme parks	P1. Throughput P2. Delay P3. Packet Loss
Sensor networks	• Home applications: smart sensors and actuators embedded in consumer electronics • Body area networks (BAN) • Data tracking of environmental conditions, animal • movements, chemical/biological detection	P1. Delay P2. Packet Loss P3. Throughput
Context aware services	• Follow-on services: call-forwarding, mobile workspace • Information services: location specific services, time dependent services • Infotainment: touristic information	P1. Delay P2. Packet Loss P3. Throughput
Coverage extension	• Extending cellular network access • Linking up with the Internet, intranets, etc.	P1. Throughput P2. Packet Loss P3. Delay

III. PROBLEM DEFINITIONS

Application performances are primarily affected by mobility, offered load and network size. Network performance is mainly dependent on routing protocols. This means the MANET applications quality of service are based on routing protocols. Routing protocol performances are assessed as per its throughput, Delay and packet loss. This work investigates the performances of MANET routing protocols with respect perceived quality of services for a range of applications. The performances of routing protocols are examined through dependencies of QoS on one another.

Node mobility plays an important role in analysis. Investigations are based on Random Walk mobility models. Random Waypoint mobility model is avoided due to the pause time problem. Based on investigation of MANET routing protocols the evaluation scheme is prepared. Single path and Multi path routing protocols of proactive, reactive and hybrid types are investigated for Random walk mobility model. Best effort routing does not provide any kind of QoS support during routing. Designing routing protocol to meet desired QoS is challenging. Following metrics are used to specify QoS for routing protocols in MANET.

3.1 Throughput

Reflects the data processing capacity of networks [6], the number of packets delivered to the receiver provides the throughput of the network [7].

$$\lambda = \frac{\sum_{n \in N}(P_{received-size})}{T_{stop} - T_{start}} \times \frac{8}{1000}$$

Where N – Set of Active nodes, $P_{received\text{-}size}$ – Packet Received size, T_{stop} –Stop time, T_{start} – Start Time.

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3.2 Average end-to-end delay

The end-to-end delay is averaged over all surviving data packets from the source to the destinations [6].

$$\alpha = \frac{\sum_{n\in N}(P_{receive-time} - P_{sent-time})}{\sum_{n\in N}(P_{received})}$$

Where N – Set of Active nodes, $P_{received-time}$ – Packet Receive time, $P_{sent-time}$ – Packet send time, $P_{received}$ – Received Packets.

3.3 Packet Delivery ratio

The ratio of the data packets delivered to the destination to those generated by the source [7].

$$DPR = \frac{P_{dropped}}{P_{sent}}$$

Where $P_{dropped}$ – Dropped Packets, P_{sent} – Sent Packets

IV. SIMULATION ENVIRONMENT

Routing protocol performances are evaluated using the ns-2 [4] simulator. Our main objective is to perform extensive study and evaluate various QoS for routing protocols. The protocols are analyzed extensively using the network simulator (NS-2) version 2.34 [4]. Network Simulator is a discrete event simulator that provides substantial support for simulating wireless ad hoc networks. The IEEE802.11 is used as the medium access control (MAC) layer protocol in the simulation. The protocols are examined for 200 nodes. This examination shows the protocol performances for large networks. The network nodes are randomly placed in a 1000m X 1000m grid. Multiple sources and destinations used.

Constant bit rate (CBR) traffic is analyzed with a random walk mobility model. CBR traffic commonly encompasses real time traffic. CBR traffic most effectively stresses a network as there are no control mechanisms to consider when flows are delayed or packet lost. TCP can be unsuitable for most real time applications because the protocol needs extra time to verify packets and request retransmission [7]. While each of mobility, the offered load and network size vary others are assumed to be constant. Table2 summarizes the simulation parameters.

Table 2 : Simulation Parameters

Parameters	Values
Topology size	1000 X 1000
No of Nodes	200
No of Sources	Multiple
No of Destinations	Multiple
Packet size	512 bytes
MAC protocol	IEEE 802.11
Simulation time	200s
Traffic Types	CBR
Simulation runs	200s for each Mean Node Speed/packet rate/No of Connections

V. SIMULTION RESULT AND ANALYSIS

Effect of variations in nobilities, offered loads and network size on routing protocols in Random Walk mobility model are measured. The mobility variations are achieved by varying mean node speed. To show variations in offered load packet sending rates are varied. Different numbers of connections are used to accomplish network size variations. The protocols are analyzed for different QoS. The QoS is Throughput, Average Delay, and Drop Packet Ratio. Large networks are investigated.

Choice of routing protocol depends on its quality of service requirements. Effects of mobility, offered load and network size on throughput in different routing protocols are shown in Fig 1. Mostly protocols shows consistent drop in throughput with increasing mobility and offered load. Many routing protocols show improvement in throughput with increasing network sizes. Compared with its identical protocols AODV, DSDV and AOMDV show better throughput. Therefore these protocols are better choices for the applications with throughput as highest priority.

Another important quality of service issue is end to end delay. Fig 2. Show the result of investigation of protocols with respect to Average delay. Hybrid (Combination of features of reactive and proactive) routing protocols show very high delays; even if the scheme state to have better functionalities of both reactive and proactive routing. OLSR have better delays compared to other protocols. AODV and AOMDV demonstrate average delay next to OLSR.

Fig 3 show performance measures of drop packet ratio. Third primary factor affecting quality of service of routing protocol is packet loss. Packet loss is considered in terms of drop packet ratio. It is ratio of packets dropped to packet sent. With

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increasing mobility, offered load and network size the drop packet ratio increases for all types of routing protocols. The increase seems to be consistent in all cases. AODV and OLSR demonstrates low packet drop. The hybrid variant AntHocNet show low packet drop ratio. Choice of a routing protocol for an application can be done from these estimations.

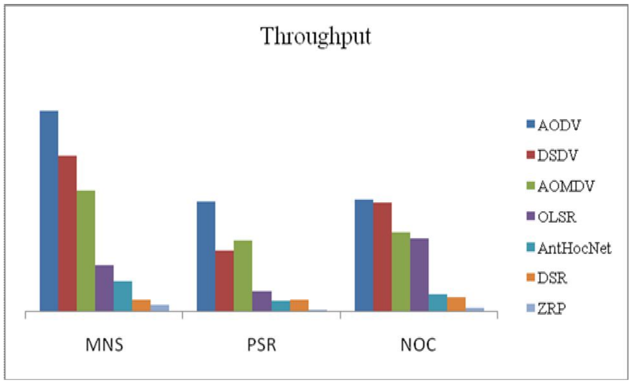

Fig 1 : Throughput

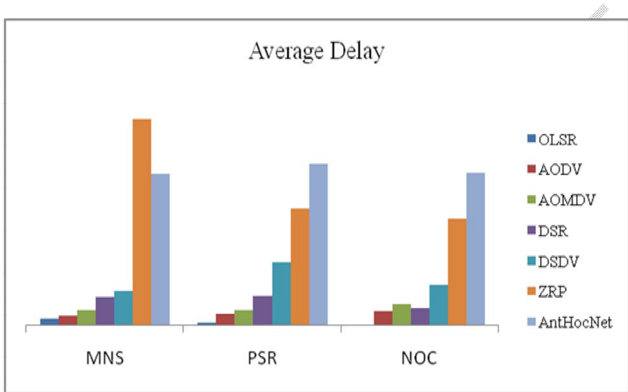

Fig 2 : Average Delay

Choice of MANET routing protocol primarily depends on its performance with respect to QoS need of application. Tactical networks require lowest delay, moderate throughput and low packet loss. It implies that OLSR makes a best choice followed by AODV as next for tactical networks from the single path options whereas AOMDV and ZRP are better choices on multipath front. More packet loss hampers emergency services to the most part and hence it requires protocol that has lowest packet loss. Moderate delay can be considered and any throughput is fine for emergency services. The single path routing protocols OLSR & AODV and multipath routing protocol AOMDV & ZRP are best choices.

AODV & OLSR out of single path and AOMDV & AntHocNet out of multipath seem to be better protocol choices for applications under considerations.

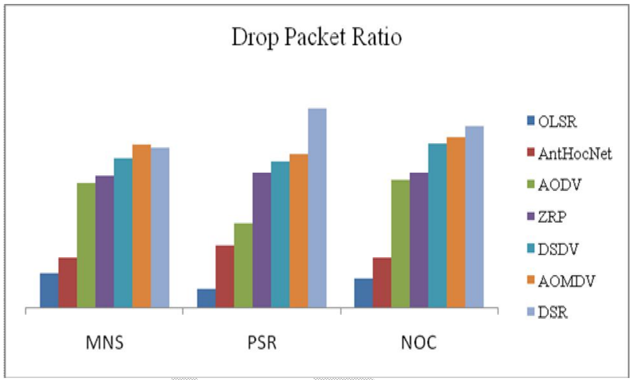

Fig 3 : Drop Packet Ratio

VI. CONCLUSION

MANET routing protocols play key role in achieving desired quality of service for any application. First overview of MANET applications and their quality of service priorities is provided. General idea about primary quality of services on which a routing protocol is evaluated is provided next. This paper presents examination of MANET routing protocols from various applications QoS requirements. This paper is an attempt to suggest routing protocol choice for different applications.

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