Analysis QoS Parameters for MANETs Routing Protocols

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***Abstract-* A Mobile Ad-Hoc Network (MANET) is a decentralized network of autonomous mobile nodes able to communicate with each other over wireless links. We selected three routing protocols DSDV, DSR and AODV for measuring QoS parameters. We have used the network simulator ns-2 for simulating routing protocols using group mobility model, and present the results of simulations of networks of 40 wireless mobile nodes.**

Keywords- Routing, Wireless, Mobile, Group Mobility, Simulation.

I. Introduction

Mobile ad hoc network (MANET) is a wireless network without any fixed infrastructure such as base station. Mobile nodes are connected by wireless links and each node acts as a host and router in the network. Mobile ad hoc networks allows people and devices to seamlessly inter network in areas without any preexisting communications infrastructure, have wide applications ranging from military operations, natural disaster, search-and-rescue operation and other applications such as meeting in a room, airport, stadiums and virtual classroom, etc.,

The Transmission Control Protocol (TCP) is one of the most widely used end-to-end transport layer protocol in the Internet today. The TCP ensure reliable data transfer over unreliable networks. The TCP is a complex protocol, it performs congestion and flow control algorithms. The TCP establishes a connection between two applications and once connection is established between two applications, it provides many useful services to the application layer such as reliable delivery of data packets, end-to-end connection. The sender writes stream of bytes in the connection and receiver reads from connection. And now TCP/IP has emerged as the global Internet-working protocol. The TCP performs three major tasks i) Connection Establishment ii) Data Transfer iii) Connection Termination. Major problems of TCP degradation in mobile networks are mobility, high bit error rate, hidden and exposed node problem, Scalability, etc. Impact of mobility for TCP performance may by observed in terms of a) Route Failure b) Route Reconfiguration c) Network Partition. At present, traditional wired network are being replaced by wireless networks. The main reasons may be the tremendous technical growth in the wireless communication area and the reducing cost of wireless devices. Now-a-days in every home we can see people using more cell phones rather than wired phones.

Cellular and ad hoc networks: cellular network consists of collection of wireless mobile nodes coordinated by central coordination entity base station. In ad hoc networks, mobile hosts establish a network without any infrastructure. The source and destination communicate with each other through single or multi-hop paths. All mobile nodes are cooperative in nature and each node acts as the host as well as router so that they can forward packets for other nodes. Original motivation of MANET started for military application, in battlefield military cannot rely on access to a fixed infrastructure. In battle field military moves in group, and they communicate inside the group as well as outside the group (inter group communication). Due to dynamic topology MANET may not use the traditional wired routing algorithms. Therefore, it requires specialized routing [4, 8] algorithms, which are classified into three categories based on topology update: i) Table driven, ii) On-demand, iii) Hybrid routing protocols. The table driven routing protocol is also known as proactive routing protocol, in this protocol route to every node in the network is maintained in the routing table. Even if route is not required each node maintains the route to other nodes in the network. In case of reactive routing protocol source discovers the route to the destination only if it has some data to send. In hybrid it combines the best features of proactive and reactive routing protocol.

Our simulation environment consists of a set of wireless and mobile networks extension that we created based on open source Network Simulator (NS-2) [1, 2] from University of California at Berkeley and the VINT project at LBL, Xerox PARC, and USC/ISI. These extensions provide a detailed model of the physical and link layer of a wireless networks and allow arbitrary movement of nodes within it. Two ray ground reflection propagation model is used in the physical layer. AT the link layer Distributed Coordination Function (DCF) MAC protocol of the IEEE 802.11 wireless LAN protocol standard along with the standard Internet ARP[]. These wireless and mobile networking extension are available from the Carnegie-Mellon University Project Monarch [], and have been widely used by other researchers.

The layout of the paper is as follows: Section 2 describes the routing protocols. Section 3 describes the simulation environment. Section 4 describes the conclusion

II. ROUTING PROTOCOLS FOR MANETs

Destination Sequenced Distance Vector (DSDV):

The DSDV Routing Algorithm is based on classical Bellman-Ford Routing Algorithm. This is proactive [7] routing protocol and routes are always available. In DSDV periodically each node advertises its own routing table to its immediate neighbors. Every node maintains a routing table that stores all available destinations, the number of hops to reach destination and the sequence number assigned by the destination. The routing table updates can be sent in two ways: a full dump or an incremental update. A full dump sends the full routing table to its neighbors, but in case of incremental update only the changed information since the last full dump is sent. Whenever the network is relatively stable, incremental updates are sent to avoid extra traffic and full dump are relatively infrequent. Routes with more recent sequence numbers are always preferred as the basis for making forwarding decisions, but not necessarily advertised. If two or more routes have the same sequence number, then it selects route with the smallest metric. All routes are loop free and hello messages are periodically exchanged to know new members.

Dynamic Source Routing (DSR):

The DSR is a reactive [6, 9] protocol that explores the concept of source routing, in which the sequence of nodes composing a route is informed in the header of each packet. Hence, the source node ought to know the complete route to destination nodes. All nodes maintain a route cache that contains previously identified routes. When a node has a packet to send to a particular destination, if it does not know a valid route, it broadcasts a route request packet, indicating the destination address and a route record that contains the source address only. Each neighbor without a valid route to the destination includes its own address in the route record and then also broadcasts the packet. After reaching the destination or an intermediate node with a valid route to the destination in its cache, a route reply packet is generated containing the route record identified in the route request. If the node generating the route reply is an intermediate node, it appends its cached route [3] to the route record before answering the route request. DSR can be adopted in networks that support symmetric and asymmetric links. When the ad hoc network support symmetric links, route reply packets are always propagated through reverse paths, which are the inverse of the routes indicated in request packets. As a consequence, route request and reply packets establish routes in both directions. DSR can also maintain multiple routes to each destination.

Ad-Hoc On-Demand Distance Vector Routing (AODV):

The AODV is a reactive [3, 4] protocol derived from Dynamic Source Routing and DSDV [7, 9], and DSR it combines the advantages of both protocols. Its route discovery procedure is similar to DSR. When a node has a packet to send to a particular destination, if it does not know a valid route, it broadcasts a route request packet, by specifying the destination address. The neighbors without a valid route to the destination establish a reverse route and rebroadcast route request packet. Destination on reception of route request it sends the route reply to the source. The route maintenance is done by exchanging beacon packets at regular intervals. This protocol adapts to highly dynamic topology and provide single route for communication. The major dis advantage is large delay for large networks.

The objective of the work is to compare the performance of routing protocols namely DSDV, DSR and AODV against the two Quality of Service (QoS) parameters, packet delivery ratio and routing overhead. This study has been carried out under group mobility model which is a very common phenomena in the battle field operation or disaster rescue operations.

III. SIMULATION ENVIRONMENT

We used open source ns-2 simulator tool running on Open SUSE 11. It is discreet event simulator mostly used for network simulation. To support multi-hop wireless networks & mobile extensions in ns-2, complete physical, data link layer MAC protocols are developed by monarch research [5] group developed at Carnegie Mellon University. This simulation is carried out for 900 seconds, using group mobility model. For generating Reference Point Group Mobility (RPGM) we used IMPORTANT [8] tool developed by USC. Each group consists of set of nodes, and group leader decides their group mobility. We used 802.11 DCF MAC protocol and File Transfer Protocol (FTP) traffic.

Performance Metrics:
The following metrics ware used for performance comparison of on-demand routing protocols protocols:

Packet Delivery Ratio: This is the ratio of the number of packets received by the destination to the number of packets sent by the sources.

Routing Overhead: The total number of routing (route request, route replay, route error) packets transmitted during the simulation. This does not include MAC, and ARP packets.

All the above metrics are calculated from the trace file generated when the simulation is done. After getting the above metrics, graphs are plotted using Matlab.

Simulation Parameter: We experimented for different offered loads (FTP traffic) by varying the no of source-destination pairs 1, 5, 10, 15, 20 and mobility varied up to 60 m/s, keeping the packet size constant. Simulated 40 mobile wireless nodes forming ad hoc network moving over 1000x1000 flat space. The movement of the nodes was based on the RPGM model, we considered Speed Deviation Ratio (SDR) = 0.1 and Angle Deviation Ratio (ADR) = 0.1. Other simulation parameters are shown in table 1.

Table 1.

Parameter	**Value**
Simulator	ns-2.33
Wireless MAC	802.11
Channel bandwidth	10 Mbps
Transport protocol	TCP
Mobility model	Group Mobility
Groups	1, 4
Node speed	1-60 m/s
Number of connection	1, 5, 10, 20

IV. RESULTS AND DISCUSSION:

Packet Delivery Ratio:

In this experiment we analyze how the increasing node speed and traffic load influences the performance of routing protocols. Figure 1, 2, 3 and 4 summaries the performance of DSDV, DSR and AODV as a function of nodes movement speed for two groups (single and four): Figure 1 and 3 shows the show the performance of single group mobility model, and Figure 2 and 4 shows the performance for four groups mobility. For both the group mobility model, the PDR see Figure 1 an 2 – is the overall percentage of the TCP data packets originated by source nodes that ware successfully delivered by DSDV, DSR, and AODV. For routing overhead – see Figure 3 and 4- is the number of control overhead packets are generated by DSDV, DSR, and AODV routing protocols to achieve this level of data packet delivery. In the graph nodes movement increase from left to right, the average node movement in the network increase.

In both group mobility models for single FTP connection Figure 1a and 2a all routing protocols deliver all most all data packets regardless of nodes movement speed.

At low traffic single and five connections DSDV, DSR, and AODV are able to deliver greater than 99.4% of all packets, most cases DSR delivers greater than 99.8%. In case of single connection both DSR and AODV are giving highest performance approximately 100%. The PDR with different speeds, lower traffic load achieved a higher packet deliver ratio than higher traffic load shown in Figure 1 and 2. Only traffic is affecting the PDR, mobility and number of groups has little impact on it. In both (single and four groups) the scenarios DSR performs better than DSDV, AODV (up to 2%), as the traffic increases PDR reduces in all four cases and mobility has very low or no impact on the routing performance. In case of high data traffic in both mobility model DSR and AODV vary the performance difference 1-2% PDR. Overall DSR emerges as the best for PDR.

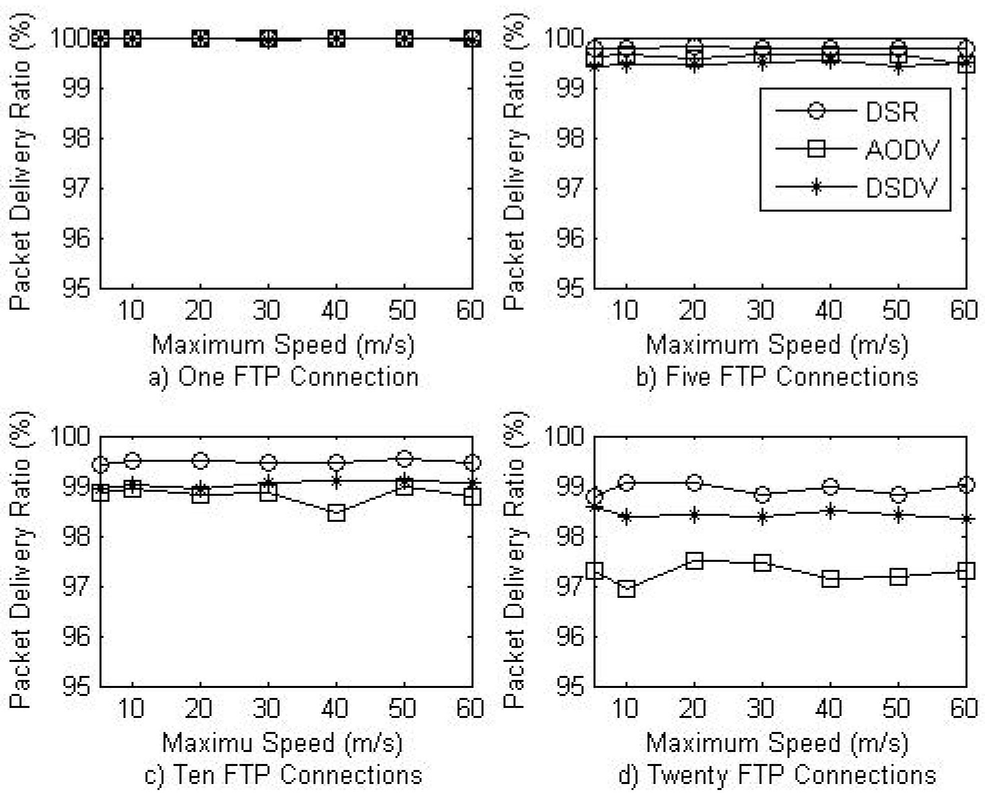

Figure 1. Performance comparison between routing protocols using single group mobility model

Routing Overhead:

In both cases the performance of three routing protocol overheads are shown in Figure 3 and 4, as the number of routing packets as a function of number of node speed. In single and four group mobility DSR routing overhead is lower than DSDV and AODV. The nodes mobility is not much influencing the routing overhead, it is almost constant shown in Figure 3, and 4. Mainly traffic is influencing control overhead. In case of low number of traffic sources both the reactive routing protocol demonstrate all most high performance compared to proactive. Whereas, large traffic, AODV results in high routing overhead compared to DSDV and DSR. Overall DSR and AODV are performing better than DSDV in single and five FTP connections. DSR generated less control traffic than DSDV and AODV. The routing protocol that generates less control traffic, it uses less energy and scalable. In case of 10 FTP connections DSR and DSDV performs 10, 2-3 times better compared to AODV as shown in Figure 3.

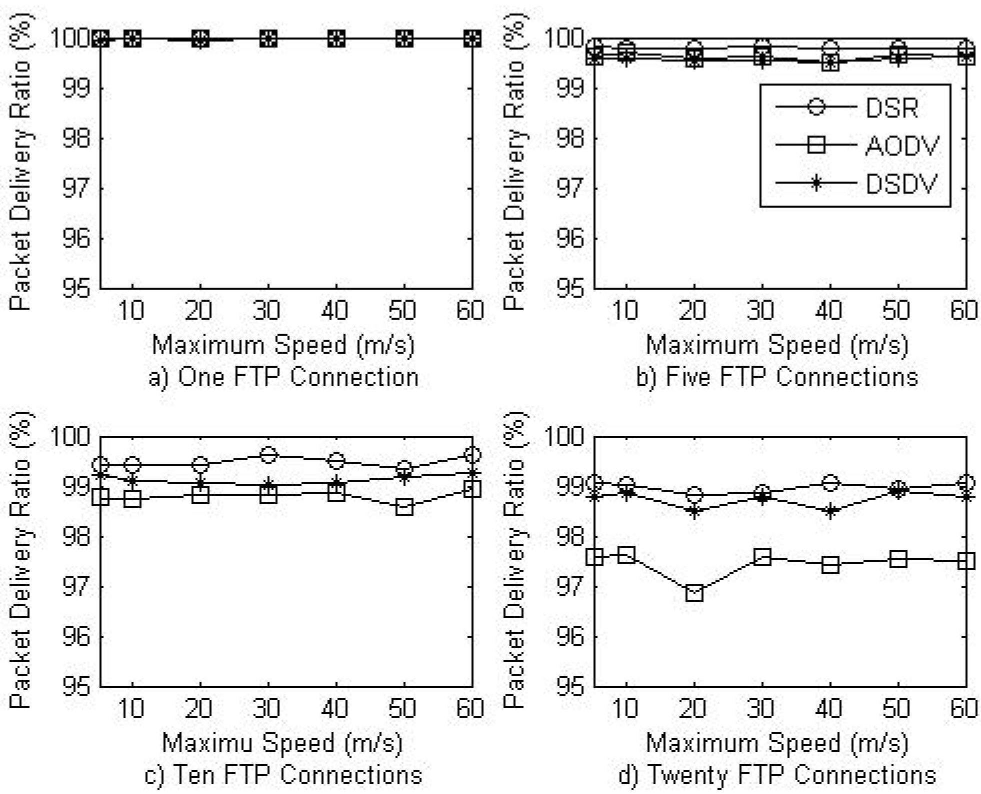

Figure 2. Performance comparison between routing protocols using four groups mobility model

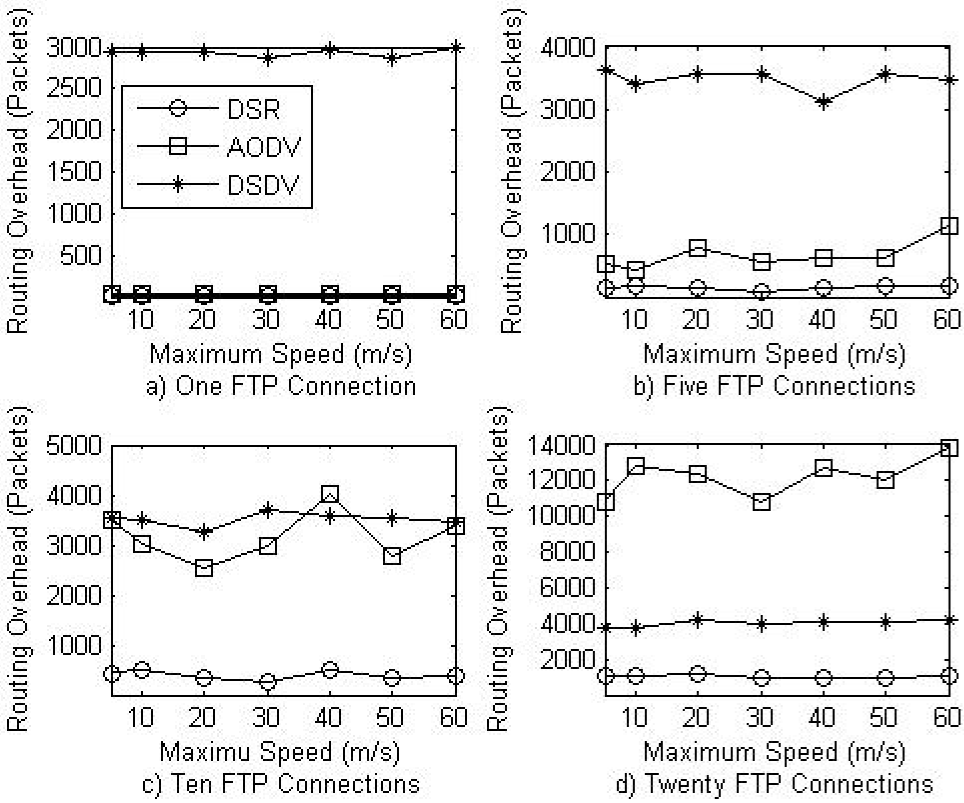

Figure 3. Performance comparison between routing protocols using single group mobility model

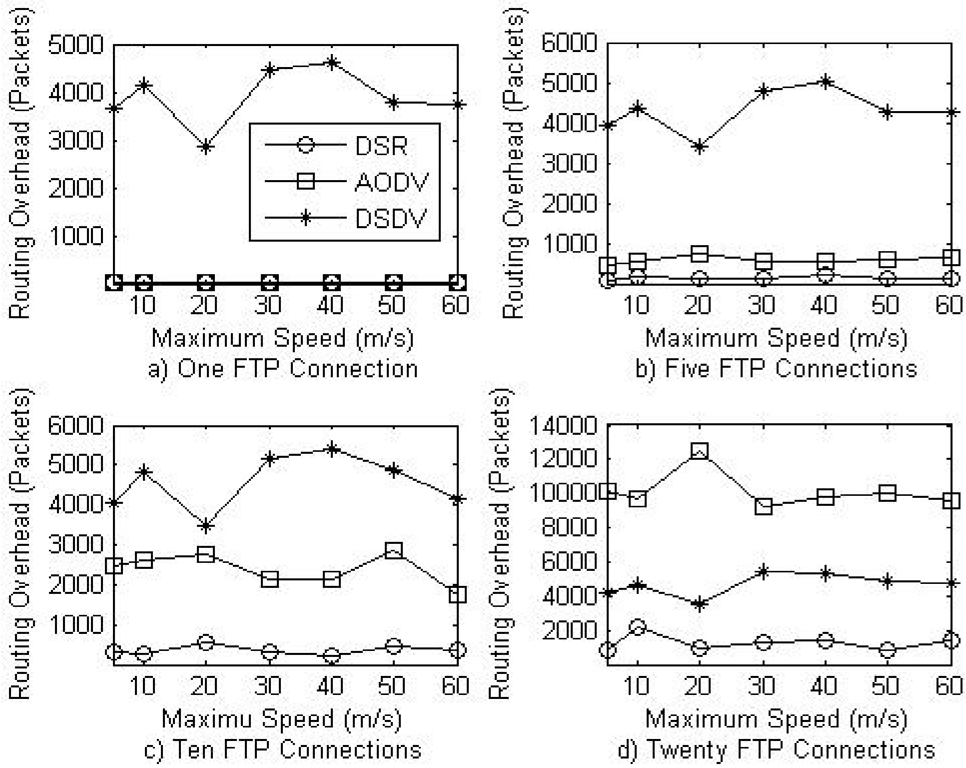

Figure 4. Performance comparison between routing protocols using four groups mobility model

V. CONCLUSION

In this paper, we analyze the MANET popular routing protocols namely DSDV, DSR and AODV. For low traffic the PDR is almost same in all routing protocols, whereas high traffic DSR emerging as the best. The control overhead of AODV is much higher than DSR for high traffic. Overall we conclude that under group mobility model, node's velocity has little impact, but number of FTP connections has significant impact on the performance of the routing protocols from QoS perspective. The DSR protocol emerges as the best in all respect.

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