ANALYSIS OF QUALITY OF SERVICE (QOS) PARAMETERS FOR REACTIVE AND PROACTIVE ROUTING PROTOCOLS THROUGH MODIFIED RANDOM DIRECTION MOBILITY MODEL

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ABSTRACT

Wireless technology based on the IEEE 802.11 standard is widely deployed. This technology is used to support multiple types of communication services (data, voice, and image) with different QoS requirements. MANET (Mobile Adhoc NETwork) does not require a fixed infrastructure. Mobile nodes communicate through multihop paths. The wireless communication medium has variable and unpredictable characteristics. Furthermore, node mobility creates a continuously changing communication topology in which paths break and new one form dynamically. The routing table of each router in an ad hoc network must be kept up-to-date. MANET uses Distance Vector or Link State algorithms which insure that the route to every host is always known. However, this approach must take into account the ad hoc networks specific characteristics: dynamic topologies, limited bandwidth, energy constraints, limited physical security etc. Two main routing protocols categories are studied in this paper: proactive protocols (e.g. Optimized Link State Routing - OLSR) and reactive protocols (e.g. Ad hoc On Demand Distance Vector - AODV, Dynamic Source Routing - DSR). The proactive protocols are based on periodic exchanges that update the routing tables to all possible destinations, even if no traffic goes through. The reactive protocols are based on on-demand route discoveries that update routing tables only for the destination that has traffic going through. The present paper focuses on study and performance evaluation of these categories and conclusion is studied using NS2 simulations.

Keywords – *Mobile Ad Hoc Networks (MANETs), Quality of Service (QoS), AODV, OLSR, DSR, Routing.*

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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) [2] enable users to maintain connectivity to the fixed network or exchange information when no infrastructure, such as 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. To meet the quality of service requirements of mobile users, several metrics can be considered for selecting a source destination routing path. Here, we focus on route stability [1], which is an aspect of fundamental importance as one can judge from *Stable routes, Efficient route repair, Network connectivity and Performance evaluation.* The performances achieved by high-layer protocols, such as transport and application protocols, heavily depend on the quality of service metrics obtained at the network layer. As an example, the duration and frequency of route disruptions have a significant impact on TCP behavior, as well as on video streaming and VoIP services. Thus, characterizing route stability is the basis to evaluate the quality of service perceived by the users.

Providing suitable quality of service (QOS) support for the delivery of real-time audio, video and data in mobile ad hoc networks presents a number of significant technical challenges. QoS is sometimes used as a quality measure, with many alternative definitions, rather than referring to the ability to reserve resources. Quality of service [3] sometimes refers to the level of quality of service, i.e. the guaranteed service quality. High QoS is often confused with a high level of performance or achieved service quality, for example high bit rate, low latency and low bit error probability. The research on QoS support in MANETs spans over all the layers in the network: QoS models specify an architecture in which some kinds of services could be provided. It is the system goal that has to be implemented. QoS Adaptation hides all environment-related features from awareness of the multimedia application above and provides an interface for applications to interact with QoS control. Above the network layer *QoS signaling* acts as a control center in QoS support. The functionality of QoS signaling is determined by the QoS model. QoS routing is part of the network layer and searches for a path with enough resources but does not reserve resources. QoS MAC protocols are essential components in QoS for MANETs. QoS supporting components at upper layers, such as QoS signaling or QoS routing assume the existence of a MAC protocol, which solves the problems of medium contention, supports reliable communication, and provides resource reservation. Many things can happen to packets as they travel from origin to destination, resulting in the following problems as seen from the point of view of the sender and receiver:

1. Low throughput: Due to varying load from other users sharing the same network resources, the bit rate (the maximum throughput) that can be provided to a certain data stream may be too low for real time multimedia services if all data streams get the same scheduling priority.

2. Dropped packets: The routers might fail to deliver (*drop*) some packets if their data is corrupted or they arrive when their buffers are already full.

3. Errors: Sometimes packets are corrupted due to bit errors caused by noise and interference, especially in wireless communications and long copper wires.

4. Latency: It might take a long time for each packet to reach its destination, because it gets held up in long queues, or takes a less direct route to avoid congestion. This is different from throughput, as the delay can build up over time, even if the throughput is almost normal.

5. Jitter: A packet's delay varies with its position in the queues of the routers along the path between source and destination and this position can vary unpredictably. This variation in delay is known as jitter and can seriously affect the quality of streaming audio and/or video.

6. Out-of-order delivery: When a collection of related packets is routed through a network, different packets may take different routes, each resulting in a different delay. The result is that the packets arrive in a different order than they were sent. This problem requires special additional protocols responsible for rearranging out-of-order packets to an isochronous state once they reach their destination.

The two main routing protocols categories that are studied in this paper are: Reactive protocols and Proactive protocols.

1. Reactive Routing Protocols: Reactive protocols or on-demand routing protocols rather than relying on periodical broadcasts of available routes, discover routes as needed, build and maintain routes. In this case, route to every mobile is not known at any given time. Two different protocols are studied: DSR (Dynamic Source Protocol) and AODV [10] (Ad hoc On-demand Distance vector).

2. Proactive Routing Protocols*:* Proactive protocols exploit the periodic exchange of control messages between routers ensuring that the route to every host is always known. This needs high bandwidth overhead. Ad hoc Link state routing algorithm attempts to conserve bandwidth by reducing both the size and the number of control messages. OLSR (Optimized Link State Routing) is the proactive protocol we have studied in this paper.

In order to thoroughly simulate the protocols for an ad hoc network, it is imperative to use a mobility model that accurately represents the mobile nodes (MNs) that will eventually utilize the given protocol. Only in this type of scenario is it possible to determine whether or not the proposed protocol will be useful when implemented [5]. Currently there are two types of mobility models used in the simulation of networks: traces and synthetic models. Traces are those mobility patterns that are observed in real life systems. Traces provide accurate information, especially when they involve a large number of participants and an appropriately long observation period. However, new network environments (e.g. ad hoc networks) are not easily modeled if traces have not yet been created. In this type of situation it is necessary to use synthetic models. Synthetic models attempt to realistically represent the behaviors of MNs without the use of traces. In this paper, we have presented the analysis through the use of a synthetic mobility model [6] i.e. Random Direction Mobility Model and slight modification to the Random Direction Mobility Model is the Modified Random Direction Mobility Model [4]. In this modified version, Mobile Nodes (MNs) continues to choose random directions but they are no longer forced to travel to the simulation boundary before stopping to change direction. Instead, an MN chooses a random direction and selects a destination anywhere along that direction of travel. The MN then pauses at this destination before choosing a new random direction. This modification to the Random Direction Mobility Model produces movement patterns that could be simulated by the Random Walk Mobility Model with pause times.

RELATED WORK

The issues surrounding the provision of reliable QoS and consistent reviews of the existing dominant schemes in MANETs have been provided. After investigating the existing schemes, a quasi-exposed node problem has been designed, a novel distributed channel assignment control algorithm has been proposed, and a mathematical analysis technique has been provided. Through simulations and mathematical analyses, it was illustrated that a novel solution could guarantee reliable QoS when interference exists in MANETs. To solve the problems addressed, a channel assignment with power control capability has been added to the algorithm. The proposed algorithm locally assigns channels to nodes in such a way that interference and connection loss among nodes are avoided; thus, the channel availability is maximized. The proposed algorithm is particularly useful in avoiding interference and path failures in high mobility environments since the number of messages involved was reduced. The analytical boundary used for the worst case estimation for bandwidth, total number of channels, and control packets [7]. This awareness includes knowledge of all QoS connections currently supported by each cluster member, each member's resource availability, and the cluster topology. With this scheme, when cluster node i leaves the cluster, due to mobility or failure, and the QoS paths supported by i are broken, the cluster-head has all information required to begin a renegotiating to reestablish the connection with minimal delay if possible. The cluster-head collects this knowledge via two processes: communication with the other clusters via clustered FSR and local clustered information exchange. These processes ensure, with high probability and low overhead, that knowledge of the systems' state is maintained both to repair existing paths and to initiate new ones [9]. When a source node wants to send data to a group of destinations, an efficient communication procedure is done between cell leaders to provide the source with all the nodes interested in this multicast session and their positions. Now the source will be able to divide the group members into manageable sub-groups and choose a coordinator for each subgroup to start the multicast [8] session. The QoS requirements that have been taken into consideration here are bandwidth and delay. Quality of Service [3] (QoS) refers to a set of mechanisms able to share fairly various resources offered by the network to each application as needed, to provide, if possible, to every application the desired quality [9] (the network's ability to provide a service). The QoS is characterized by a certain number of parameters (throughput, latency, jitter and loss, etc.) and it can be defined as the degree of user satisfaction. QoS model defines architecture that will provide the possible best service. This model must take into consideration all challenges imposed by Ad-hoc networks, like network topology change due to the mobility of its nodes, constraints of reliability [11] and energy consumption [12], so it describes a set of services that allow users to select a number of safeguards (guarantees) that govern such properties as time, reliability, etc. New requirements (needs) for multimedia and real-time applications require few delay [11] and very high data rates which require (oblige) the use of new routing protocols supporting QoS. The AODV [13] protocol (Ad-hoc on demand Distance Vector) is a reactive routing protocol based on the distance vector Principle, combining unicast and multicast [8] routing. In AODV, the path between two nodes is calculated when needed (if necessary), i.e. when a source node wants to send data packets to a destination, it finds a path (Discovery Phase), uses it during the transfer phase, and it must maintain this path during its utilization (Maintenance Phase). The finding and maintaining process of a path is based on the exchange of a set of control packets: RREQ (Route REQueset), RREP [10] (Route Reply), RERR (Route Error), RRepAck (Route Reply Acknowledgment) and Hello messages (Hello). RREQ is initiated by the source node to find a path in multicast mode [14]. RREP is used by an intermediate or destination node to respond to a request of path finding in unicast mode. Hello messages are used to maintain the consistency of a previously established path. Routing table is associated for each node in AODV protocol with containing: the destination address, the list of active neighbors, the number of hops (hop) to reach the destination, time of expiration after which the entry is invalidated, and so on. To avoid the formation of infinite loop, AODV uses the principle of sequence numbers, limiting the unnecessary transmission of control packets (problem of the overhead); these numbers allow the use of fresh routes following the mobility of nodes, as they ensure the coherence and consistency of routing information. The Dynamic Source Routing (DSR) is one of the purest examples of an on-demand routing protocol that is based on the concept of source routing. It is designed specially for use in multi-hop ad hoc networks of mobile nodes. It allows the network to be completely self organizing and self-configuring and does not need any existing network infrastructure or administration. DSR uses no periodic routing messages like AODV [15], thereby reduces network bandwidth overhead, conserves battery power and avoids large routing updates. Instead DSR needs support from the MAC layer to identify link failure. DSR is composed of the two mechanisms of Route Discovery and Route Maintenance, which work together to allow nodes to discover and maintain source routes to arbitrary destinations in the network. DSR has a unique advantage by virtue of source routing. As the route is part of the packet itself, routing loops, either short – lived or long – lived, cannot be formed as they can be immediately detected and eliminated. This property opens up the protocol to a variety of useful optimizations. Neither AODV nor DSR guarantees shortest path. OLSR makes use of "Hello" messages to find its one hop neighbours and its two hop neighbours through their responses. The sender can then select its multipoint relays (MPR) based on the one hop node that offers the best routes to the two hop nodes. Each node has also an MPR selector set, which enumerates nodes that have selected it as an MPR node. Reactive routing protocols do not maintain routes, but build them on demand. As link-state protocols require database synchronization, such protocols typically use the distance vector approach, as in AODV and DSDV, or more ad-hoc approaches that do not necessarily build optimal paths, such as Dynamic Source Routing. OLSR uses Topology Control (TC) messages along with MPR forwarding to disseminate neighbour information throughout the network.

OLSRv2 is currently being developed within the IETF. It maintains many of the key features of the original including MPR selection and dissemination. Key differences are the flexibility and modular design using shared components: packet format packetbb, and neighbourhood discovery protocol NHDP. These components are being designed to be common among next generation IETF MANET [2] protocols. Differences in the handling of multiple address and interface enabled nodes is also present between OLSR and OLSRv2.

OUR PROPOSAL

The traditional QOS approaches are loosely based on the virtual circuit model that requires explicit connection management and the establishment of hard-state in the network prior to communication. The virtual circuit model also assumes the route and the reservation between source-destination pairs remain fixed for the duration of a session. However, the virtual circuit lacks the intrinsic flexibility needed to adapt to the dynamics found in mobile ad hoc networks where the path and reservation need to dynamically respond to topology and resource changes in a timely manner. Thus, this proposed approach gives a comparative study of the proactive and reactive routing protocols and works for the most challenging aspects of QoS [6] support in mobile ad hoc networks as in the maintenance of service level. In this study, we focus on two mobile node mobility models to simulate their movement. The Modified Random Direction model which was create

d to avoid the clustering mobile node near the center of the simulation area. This behavior occurs in the random waypoint mobility direction. In the Modified Random Direction mobility model, each mobile node chooses a random direction and travels over a random distance at a random speed to it. After being arrived, it pauses for a specific time and then chooses a new direction. If it reaches the edge of the simulation area, it bounces. To ensure that sufficient bandwidth is available on the end-to-end path, the RREQ must traverse the complete route to the destination. For this reason, no intermediate node is allowed to reply to the RREQ; only the destination may respond. Also, traffic [4] from different sources to the same destination may need to be forwarded along different paths based on session requirements and resource availability. To provide quality of service [17] (QoS) through minimizing interference is particularly challenging for mobile ad hoc networks [20] (MANETs) due to frequent movement and formation of dynamic connections. Therefore, interference from mobility must be overcome to obtain practical QoS in ad hoc networks. In particular, for far away nodes, nodes in ad hoc networks directly communicate with other nodes in a multi-hop fashion: each node operates as a router (or a forwarder) if it is not the destination node. However, connection loss may occur due to interference, which can cause the transmission routes to become out-of-date and inaccurate. This can then result in a serious damage in terms of global network throughput and delay [11]. Different protocols are then evaluated based on measure such as the packet drop rate, the overhead introduced by the routing protocol, end-to-end packet delays, network throughput etc., thus it is quite necessary to study the performance of QoS [18] parameters for both types of routing protocols vis-à-vis reactive routing and proactive routing protocols . The main focus of our study is the analysis of AODV, DSR and OLSR routing protocols so that performance evaluation can be done effectively. The comparison between the three routing protocols is shown below in TABLE I.

TABLE I

COMPARISON BETWEEN AODV, DSR AND OLSR

Parameters	**AODV**	**DSR**	**OLSR**
Source Routing	No	Yes	No
Topology	Full	Full	Reduced
Broadcast	Full	Full	Local
Update Information	Route Error	Route Error	Node's Height
Update Destination	Source	Source	Neighbours
Method	Unicast	Unicast	Broadcast
Storage Complexity	O(E)	O(E)	O(Dd*A)

Abbreviations:

Dd – Number of maximum desired destinations

E – Communication pairs

A – Average number of adjacent nodes

SIMULATION RESULTS AND OBSERVATIONS

In this paper we focus on Constant Bit Rate (CBR) sources (i.e. voice sources) and ftp sources (i.e. file transfer) and all the simulations are performed using NS2 [19] simulator. The packet size is limited to 512 bytes. The source-destination pairs are chosen randomly over the network. The source-destination numbers are fixed (called connection number). self-contained. Some parameters are used in order to make performance evaluation of routing protocols in ad hoc mobile network environment.

A. Performance Indices

We have measured the following performance metrics [21] to evaluate the effectiveness and efficiency of the above mentioned protocols:

1) Packet delivery fraction: This is the fraction of data packets sent by the server that are received by the client. The higher the packet delivery fraction, the more effective the protocol in reducing network congestion.

2) Mean end-to-end packet delay: This is the average end-to-end delay of packets that are received by the client. As this value decreases, the congestion in the network is reduced, and packets are more likely to be received in time for playout.

3) Routing Load: It gives the number of routing packets over the number of received data packets. Each routing packet sent or forwarded by a mobile is counted.

4) Jitter: It gives the transmission delay variation. Packets from the source will reach the destination with different delays. A packet's delay varies with its position in the queues of the routers along the path between source and destination.

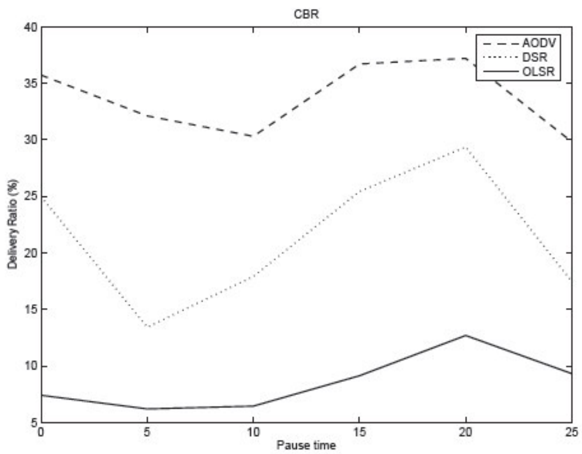
B. Results

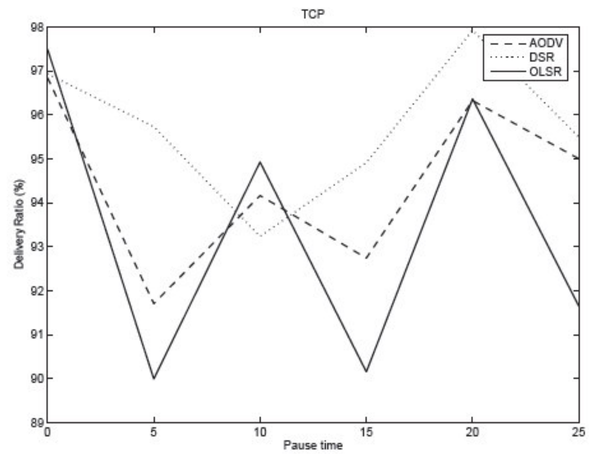
Several simulations are performed using NS2 network simulator. NS2 generates a big trace files analyzed using a statistical tools developed in java. The performance study concerns three routing protocols DSR, AODV [7] and OLSR described in the second section and both CBR and ftp traffic sources. We propose here to study the impact of traffic load by varying the number of connections (pair of source and destination). We also observe packet delivery ratio higher (about 98%) compared to CBR sources because ftp uses TCP protocol which insures packets retransmission when dropped.

The performance analysis graphs for the Modified Random Direction Mobility Model are as follows. Figure 1 and 2 shows delivery ratio v/s Pause Time for CBR and TCP respectively.

Figure 1. 40 connections, Modified Random Direction mobility model for CBR

Figure 2. 40 connections, Modified Random Direction mobility model for TCP

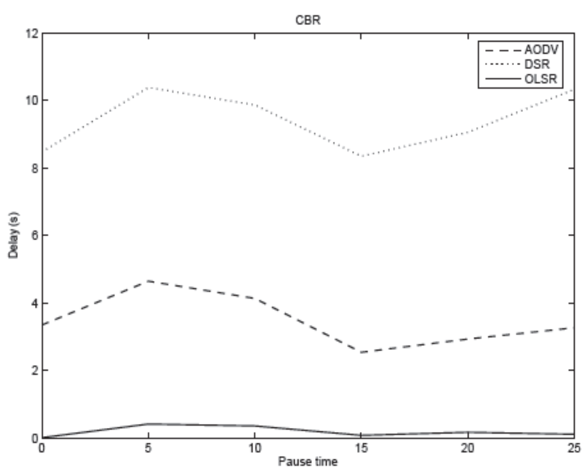


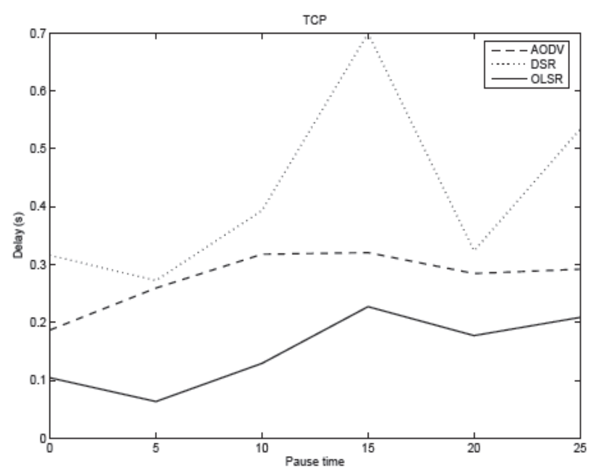


Where Figure 3 and 4 shows the Delay v/s Pause Time for CBR and TCP respectively.

Figure 3. 40 connections, Modified Random Direction mobility model for CBR

Figure 4. 40 connections, Modified Random Direction mobility model for TCP

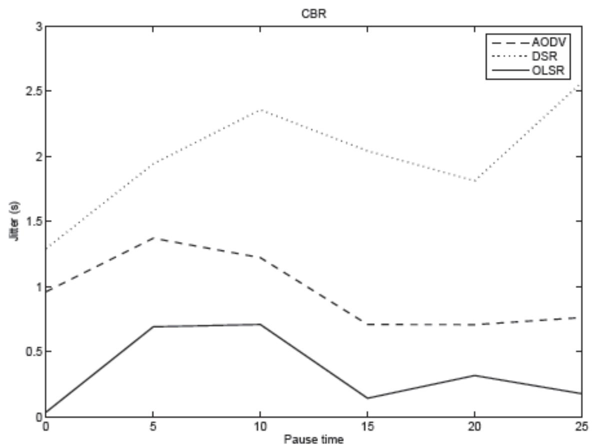


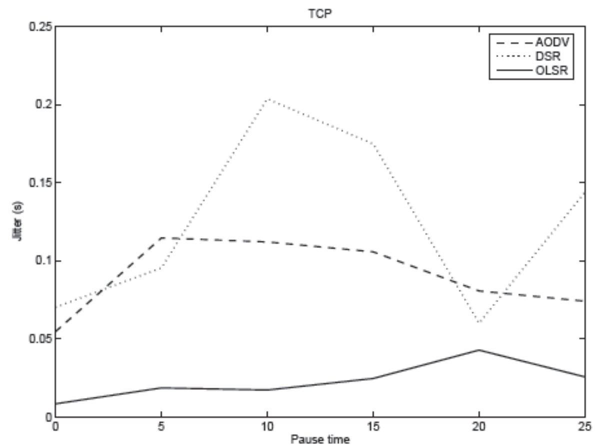


Here Figure 5 and 6 shows the variation of jitter with respect to pause time both for CBR and TCP respectively.

Figure 5. 40 connections, Modified Random Direction mobility model for CBR

Figure 6. 40 connections, Modified Random Direction mobility model for TCP

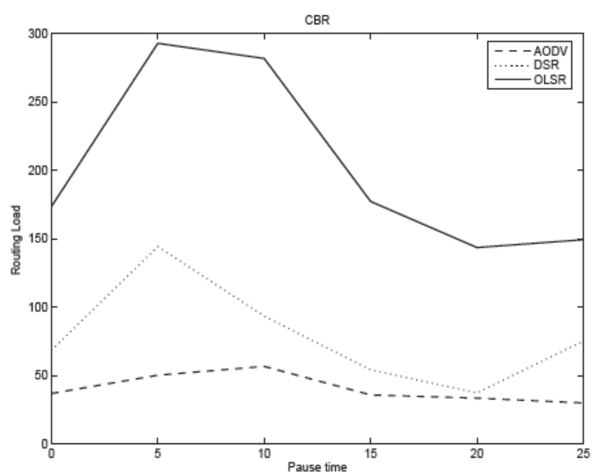


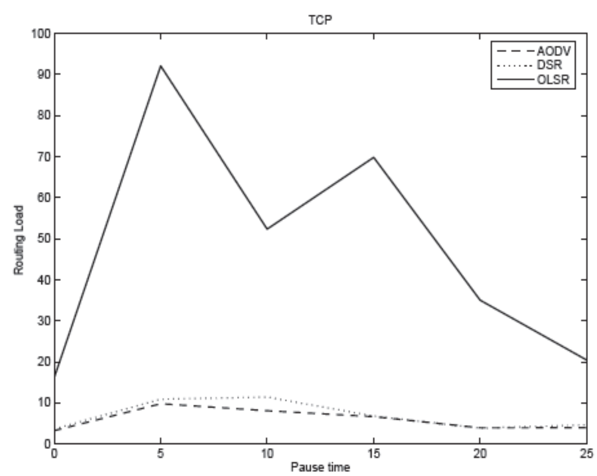


At last, of all the only parameter left with our performance indices is the routing load for the Modified Random Direction Mobility Model for 40 connections for CBR and TCP both as shown in Figure 7 and 8.

Figure 7. 40 connections, Modified Random Direction mobility model

Figure 8. 40 connections, Modified Random Direction mobility model





The best performance is given by the AODV protocol because it need lowest routing load for routes discovery. The most important criteria for real-time services is delay and jitter.

CONCLUSION AND FUTURE PERSPECTIVES

In this paper we have evaluated the performance of reactive (ie. DSR and AODV) and proactive (ie. OLSR) routing protocols in 802.11 ad hoc network environment. We have noticed the proactive protocol (OLSR) offers better performances for CBR sources (eg. voice services) given that it guaranties lowest delay and jitter. However it consumes much more bandwidth. Periodically, OLSR protocol sends routing packets to discover and to maintain routes to all destinations. That's why the number of delivered packets decreases when the traffic load (number of connections) increases. For 10 connections, the packet delivery ratio is about 53 %. The reactive routing protocols are more adapted for data services (_le transfer). They guarantee a packet delivery ratio of 80 % for 60 connections (480 kbit/s). There is no clear winner among DSR and AODV since routing load, delay and jitter are quite identical. We have also pointed out the influence of the node mobility model on the ad hoc routing protocols. The Modified Random Direction Mobility Model provides a wide direction range for research purpose. Furthermore, other Mobility Models can also be studied and compared with this model, so as to give finishing touch to the research and to enhance the performance of QoS parameters in MANETs.

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