PERFORMANCE EVALUATION OF VIDEO COMFERENCING OVER AD HOC WIRELESS NETWORKS USING DIFFEREENT ROUTING AND QUEUING TECHNIQUES

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ABSTRACT

In this paper we present a comparative study using OPNET simulation tool for video conferencing over wireless ad hoc networks. The study performed using three different routing protocols (DSR, AODV, TORA) and three queuing techniques (FIFO, PQ, WFQ). Different scenarios exploiting a combination of routing and queuing are produced. A quality of service is measured by means of packet delay variation, packet end-to-end delay and network throughput.

INTRODUCTION

Recently, the usage of the Internet has been experienced huge growing all over the world. The Internet is becoming an essential thing in people's life via using multimedia communications everywhere (e.g. VoIP, video on demand and video conferencing, and e-commerce). Multimedia streaming over the Internet requires greater transmission bandwidth than any other communication types. That is due the huge data included into multimedia continuous flows. In another side, modeling and simulation is one of the most main assessment and validation techniques that are used in exploring communication systems due to the complexities of such systems and because of the higher cost values of constructing such systems. Communication systems include variety of architectures, standards, protocols and technologies for wire, wireless, satellite networking. Ad hoc wireless networking is one of such emerging technologies. Ad hoc wireless network is a set of randomly located mobile devices that have neither organized structure nor centralized control, but it may have access to stationary infrastructure such as central network or the Internet (Azzedine 2009).
This paper is organized as follows: ad hoc networks are briefly described in section 2. Routing in ad hoc networking is illustrated in section 3. Multimedia streaming over networking is outlined in section 4. Section 5 briefly describes quality of service (QoS) with multimedia. Finally, practical simulation results are given in section 6.

WIRELESS AD HOC NETWORKS

Wireless ad hoc networks can be realized by different wireless communication technologies such as Bluetooth, IEEE 802.11, and Ultra-Wide Band (UWB) (Azzedine 2009). Wireless ad hoc networks can be deployed quickly so it can be used in disaster recovery, scientific conferences and military operations. In an ad hoc network, links between nodes are typically made temporarily according to individual node operations and nodes may be added or removed either according to the network's requirements. Wireless ad hoc networks differ from other networks by the following features: decentralized control, each node has wireless interface, mobility of nodes, network topology changes, the nodes have limited resources (power, memory, etc.), nodes participate in routing by forwarding data for other nodes, and data forwarding is made dynamically based on the current status of the network connectivity.

ROUTING IN WIRELESS AD HOC NETWORKS

The most significant characteristic of the wireless ad hoc networks is the dynamic topology that resulted from node mobility. Nodes mobility imposes routing protocols to quickly respond and adapt to topology changes. In wireless ad hoc networks the routing made to destinations through a series of nodes making-up a path to the specified destination. Routing protocols for wireless ad hoc networks can be classified into two main categories: *proactive or table-driven routing protocols* and *reactive or on-demand routing protocols*. Other classifications do exist; the intended reader can find more in (Azzedine 2009; Kai-Wei 2006; Sunil 2004).

A- Table driven routing protocols (proactive)

In this kind, each node continuously maintains up-to-date routes to all other nodes in the network and each node required to maintain one or more tables to store that routing information. Routing information is periodically transferred all over the network to keep routing tables consistent and reliable (Anuj 2010). This enables these protocols to quickly respond to topology changes by propagating updates throughout the network. Some proactive routing protocols are: Destination-Sequenced Distance Vector (DSDV), Wireless Routing Protocol (WRP), Global State Routing (GSR) and Cluster-head Gateway Switch Routing (CGSR).

B- On-demand routing protocols (reactive)

In reactive protocols, route search is necessary for every unknown destination and nodes need to retain the routes to all active targeted nodes. However, this is done by each node by initiating a route discovery process all over the network, once it requested to send data to another node. Then, once the node determined its selected effective route; the route is then kept by the maintenance process until the desired route is no more needed either because of the transfer is finished or the route is no more applicable. Some reactive protocols are: Dynamic Source Routing (DSR), Ad hoc On-Demand Distance Vector (AODV), and Temporally Ordered Routing Algorithm (TORA) (Anuj 2010).

DSR ROUTING PROTOCOL

DSR is a reactive, source-routed routing protocol designed for extremely dynamic networks. In DSR, each node preserves route collection information that keeps all routing paths from the node itself to all other nodes in the network. Basically, in DSR routing the source node introduces the "Route Discovery" method in order to discover a routing path to a required node when there is no entry about that node in the route collection. Moreover, DSR uses "Route Maintenance" technique to retain the routes when there are connection failures in the routes or when any topology changes happened; thus; renews broken routes rapidly to make the node reachable by other nodes. However, when a route is found, the sending node sends packets with headers holding full path information toward the receiving end. Moreover, each node along that path forwards packets to the next node in the network according to control information contained in the packet's header. DSR maintains only routes for nominated nodes, and does not make any periodic advertisements with other unwanted nodes. DSR as source routing protocol can make the usage of discovery messages information dissemination unpractical due to node routing cache overhead in large networks. Therefore; DSR is not scalable for large networks (Kai-Wei 2006).

AODV ROUTING PROTOCOL

AODV is a reactive, distance-vector routing protocol suitable for highly dynamic networks. By deploying the AODV, every node in AODV holds a routing table that contains only active routing entries. Furthermore, the AODV builds and preserves routes in the similar way of DSR protocol. However, the AODV keeps only its local connections with close neighbors and it is not using periodic advertisement and it keeps only routing information about needed routing entries in which it takes the advantage of DSR protocol (Kai-Wei et al 2006). In another words, AODV searches route entries for nods only when needed and are kept in route cache only as long as they are necessary for current communication. Therefore, AODV does not play any role when the endpoints of the current communication have effective routes to each other. AODV protocol has loop freedom feature and when link failures occurs immediate notifications is issued to the set of affected nodes only. This in turn, reduces the number of routing messages in the network significantly (Anuj 2010).

TORA ROUTING PROTOCOL

TORA is a reactive, greatly adaptive distributed routing protocol designed to operate in a dynamic multihop networks. TORA is based on link reversal algorithm and it uses a directed acyclic graph (DAG) to generate multiple routing paths upon requests from sender to receiver. TORA is designed to reduce reaction to topologies changes. One important thing with TORA is that control messages are normally localized to a minimal set of nodes; this will assures that all routes are loop-free and offers multiple routes for any two communicating nodes. TORA provides only routing task and rest on Internet MANET Encapsulation Protocol (IMEP) for other underlying functions; which further increases the overhead to the protocol (Anuj 2010).

MULTIMEDIA STREAMING

Multimedia streaming contains audio and video content ("continuous media"). In practice, networks supporting video conferencing services should typically be designed for very close to zero percent packet loss for both the VoIP and video streams (Evans 2007; Balakrishnan 2008). Moreover, QoS mechanisms and suitable capacity planning procedures may be engaged to ensure that no packets are lost due to congestion, with the only actual packet loss being due to layer one bit errors or network element failures. When packet loss occurs, the impact of the loss on voice streams should be reduced to acceptable levels using concealment techniques. The loss rates tolerated for video conferencing are likely higher than those acceptable to broadcast video services. The end-to-end delay from streaming server to the client is the significant delay metric in the case of video streaming. Digital video decoders used in streaming video receivers need to receive a synchronous stream, typically with jitter tolerances of only +-500 ns, in order to decode without visible impairments (Evans 2007; Balakrishnan 2008). However, in IP networks which transfer VoIP and video broadcasting, the jitter tolerances are not feasible. Therefore, de-jitter buffers are usually used in receivers to remove delay variation caused by the network elements; to make it capable of meeting VoIP and video broadcast services. Jitter is defined as the delay variation between two consecutive packets belonging to the same traffic stream. Although queuing is the main cause of traffic jitter, lengthy reroute propagation delays and additional processing delays can also affect traffic jitter. Packet delay is defined as the difference in the time at which the packet enters the network and the time at which it leaves the network; from synchronized sender to destination (Evans 2007; Balakrishnan 2008)

QUALITY OF SERVICE

A network that offers QoS is a network that provides definite guarantee level for delivering the transmitted packets in steady and safe way; especially in multimedia streaming. In a wireless networking, the quality may include packet transfer delay (one-way end-to-end delay), delay variation (Jitter), and packet loss ratio. Nowadays, all Internet service providers are estimated to provide personalized media-rich application services and migrating toward offering all multimedia-intensive applications over a single infrastructure composed of mixed wire/wireless networks. To apply a QoS model, many QoS features are required such as traffic classification, queuing and buffering, scheduling, rate limiting, policing, marking, and traffic filtering (Evans 2007; Balakrishnan 2008). Bear in mind, packets flowing through a node may wait before being serviced by a scheduler toward their corresponding destinations. However, waiting in networking referred as queuing delay or latency. Moreover packets belonging to different classes of services are queued in distinguished queues. The packet belonging to a high priority traffic class is assured of buffering space. On the order hand, overflow may occur in the queues assigned to low priority traffic classes. Schedulers and queues are used together to conform the required stream's bandwidth while keeping queueing delays at the desired values for the given application. However, scheduling function is applied within a node where it decides the order in which queues are serviced and how data-streams allocated to different forwarding classes (Evans 2007; Balakrishnan 2008). First in first out (FIFO), priority queuing (PQ) and weighted fair queuing (WFQ) are considered in this paper as a measure for QoS. FIFO is one of the simplest techniques which consists of buffering and forwarding of packets in the same order of their arrival. With PQ, packets are classified into a definite priority classes; then; packets that belonging to higher priority class are sent before all lower priority traffic. In turn, this guarantees their delivery in timing and prevents packets loss as much as possible. In WFQ, the service is set according to the queue weight, i.e. each queue is given a slice from the link proportional to its prearranged weight. WFQ employs sorting and interleaving of individual packets by flow and then queue each flow based on the volume of traffic in this flow. However, by using this technique, larger flows are prevented from consuming network's bandwidth. However, WFQ is max-min fair technique and it provides some QoS control, and it is used in some industrial routers, but it is relatively complex to realize and it involves heavy computational overhead per packet in the flow (Evans 2007; Balakrishnan 2008).

SIMULATION RESULTS

This section gives an overall description of a wireless ad hoc network case study as seen in figure (1) using OPNET 14.5 (OPNET 2004). OPNET Modeler is the industry's leading is a discrete-event simulator specialized for supporting network research and development. The model network consists of 15 wireless nodes distributed in 1000mx1000m area; and the video application configuration as follows: frame size information (bytes) equal to 128x120 pixels with frame inter-arrival time information with 10 frames/sec, simulation time is 3600 second, and with heavy traffic load introduced.

- Results of comparing video conferencing for the three routing protocols (AODV, DSR, TORA) with FIFO queuing is illustrated in figures (2) till figure (4). It is clear from figure (2) that the TORA has the worst packet delay variation value and from figure (3) TORA has also the worst packet end-to-end delay value; while AODV has the lowest packet end-to-end delay value. Furthermore, the AODV showed the highest throughput than the other two protocols with FIFO queuing; as seen in figure (4).
- Results of applying PQ queuing with the video conferencing application using three different routing protocols for wireless ad hoc networks are seen in figures (5) through (7). From figure (5) we can conclude that AODV has the lowest packet delay variation, and from figure (6); AODV has also the lowest packet end-to-end delay with PQ queuing; while TORA has the worst value (much higher than the others) for both packet delay variation and packet end-to-end delay. In this case also the AODV protocol granted the highest throughput than TORA or DSR as seen in figure (7).
- Results of using three different routing protocols with video conferencing application using WFQ queuing technique are shown in figures (8), (9) and (10). In this case, DSR protocol has the lowest both packet delay variation and packet end-to-end delay; but, AODV comes in the second place with values less that 1; while TORA has much worse values. AODV has got the highest throughput value with WFQ queuing as seen in figure (10).

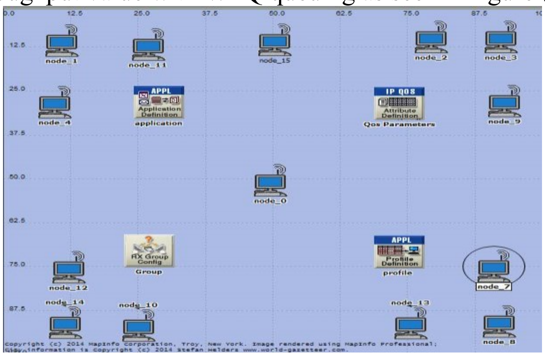
Figure 1: wireless ad hoc network model

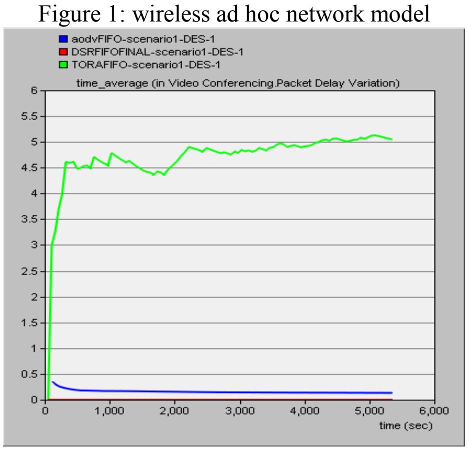

Figure 2: Video conferencing packet delay variation for FIFO queuing; Red: AODV, Blue: DSR, Green: TORA

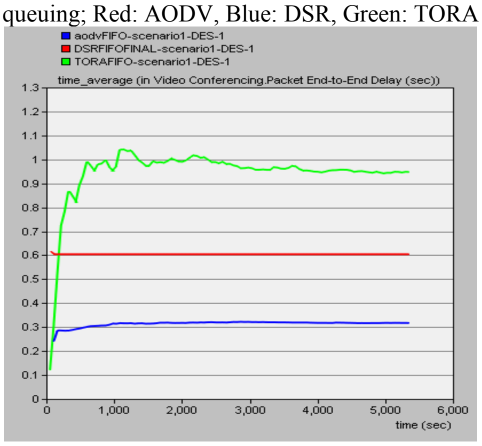

Figure 3: Video conferencing packet end-to-end delay for FIFO queuing; Blue: AODV, Red: DSR, Green: TORA

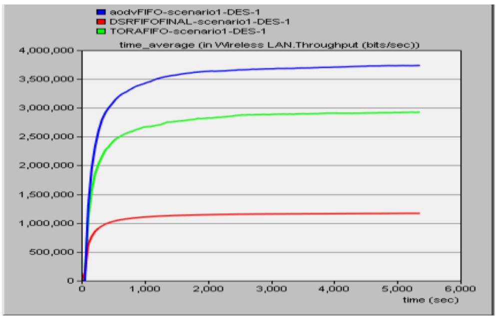

Figure 4: Video conferencing; wireless LAN throughput with FIFO queuing; Blue: AODV, Red: DSR, Green: TORA

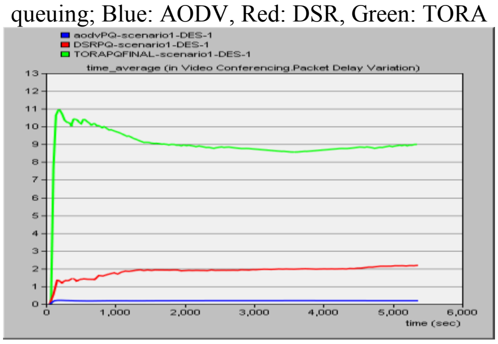

Figure 5: Video conferencing packet delay variation for PQ queuing; Blue: AODV, Red: DSR, Green: TORA

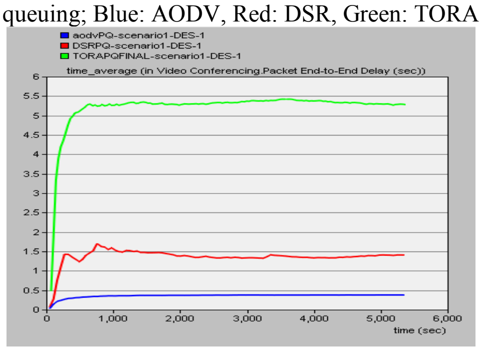

Figure 6: Video conferencing packet end-to-end delay for PQ queuing; Blue: AODV, Red: DSR, Green: TORA

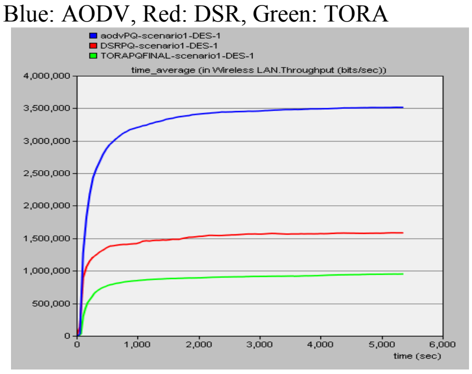

Figure 7: Video conferencing; wirelessLAN throughput with PQ queuing; Blue: AODV, Red: DSR, Green: TORA

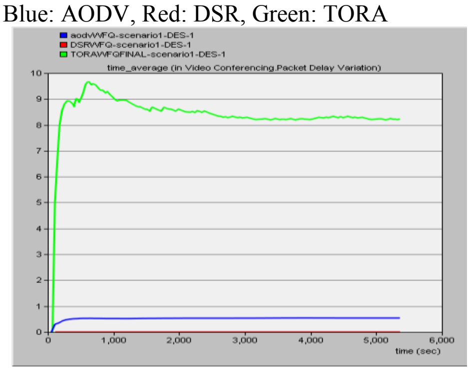

Figure 8: Video conferencing packet delay variation for WFQ queuing; Up: AODV, Middle: DSR, Down: TORA

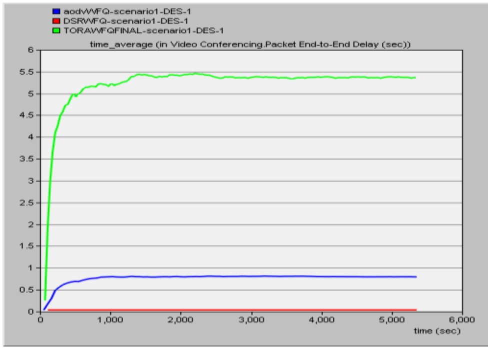

Figure 9: Video conferencing packet end-to-end delay for WFQ queuing; UP: AODV, Middle: DSR, Down: TORA

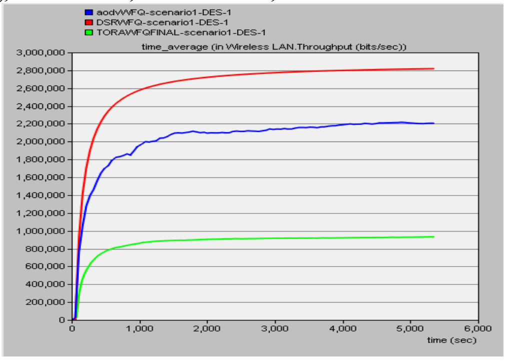

Figure 10: Video conferencing; wireless LAN throughput with WFQ queuing; Blue: AODV, Red: DSR, Green: TORA

CONCLUSION

In this paper the effect of routing (DSR, AODV and TORA), and queuing (FIFO, PQ and WFQ) for video conferencing over wireless ad hoc networks has been studied using OPNET tool. The results showed that AODV presented good results with different scenarios.

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