Performance of Multimedia Traffic in OLSR Routing Protocol with Weighted Fair Queuing

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ABSTRACT
An Ad hoc wireless network consists of mobile terminals communicating with each other without the help of traditional infrastructure for communication. Optimized Link State Protocol (OLSR) is a proactive routing protocol, wherein routes are discovered and updated continuously and available when required. Hello messages are generated by each node to seek information about its neighbor's. If a neighboring node does not respond for specified number of hello messages specified by the neighborhood hold time, the node assumes the neighbor is not in its range. In this paper it is proposed to evaluate OLSR routing protocol in a random mobility network with different neighborhood hold time intervals. The throughput and delivery ratio are also studied to evaluate the efficiency of the routing protocol for multimedia loads. Investigations are specifically carried out for G.711 Codec based packets and compared with AODV routing protocol.

Keywords
Ad hoc Network, Ad Hoc On Demand Routing Protocol, Optimized Link State Routing Protocol, Multimedia traffic.

1. INTRODUCTION
Mobile Ad hoc Network(MANET) is a collection of wireless mobile nodes with dynamic changing topology forming a temporary network without infrastructure or centralized administration[1]. Mobile Ad hoc Network has become an active research area in the domain of wireless networking because of their distinctive advantages which includes easier set up, saving in hardware cost[2]. Each node can move independently in any direction and also act as a router for communication between nodes which are not within radio distance. The Mobile Ad hoc Network, because of its fast and economically less demanding service, find applications military, collaborative and distributed computing, emergency operations, wireless mesh networks, wireless sensor networks, hybrid wireless network architectures and educational environments. In MANET privacy of the nodes are ensured by Anonymous communication which also enhances the security of the network[3].

Traditional routing protocols used in wired networks are ineffective for ad hoc networks because of the intrinsic qualities of wireless media and the dynamic changing topology of the network[4]. Most of the proposed routing protocols in an Ad hoc network are enhancement of their wired counterpart and can be broadly classified into Proactive, Reactive and Hybrid routing protocol[5,12]. Pro active routing protocols are also known as table driven routing protocols. These protocols create routing table as the network is formed and dynamically updates the routing table when the network topology changes. Examples of pro active protocols are Destination-Sequenced Distance- Vector (DSDV)[6, 13] Optimized link state routing protocol (OLSR) [7] and Clusterhead Gateway Switch Routing Protocol(CGSR)[8]. When the size of the network is very large, the size of the corresponding routing table is also large which is a disadvantage for memory constraint nodes. However these problems have been overcome in some of the pro active routing protocols including OLSR and CGSR. Reactive routing protocols are also known as on demand routing protocols. Reactive protocols discover route only when data is to be transmitted between two nodes. Examples of re active protocols are Dynamic Source Routing (DSR)[9,11], Ad hoc On demand Distance Vector (AODV)[10,12]. Typical problems in reactive routing protocols include higher latency for route discovery and network congestion due to excessive flooding. Hybrid routing protocols combine the advantage of both proactive and reactive routing. Initially routes are established using some proactive technique and subsequently updated as and when required using reactive technique. The choice for one or the other method needs predetermination for typical cases. Some of the issues in hybrid routing protocols are high latency for new route discovery.

Optimized Link State Protocol (OLSR) is a proactive routing protocol, so the routes are always immediately available when needed. OLSR is an optimization version of a pure link state protocol [14]. So the topological changes cause the flooding of the topological information to all available hosts in the network. To reduce the possible overhead in the network protocol uses Multipoint Relays (MPR). The idea of MPR is to reduce flooding of broadcasts by reducing the same broadcast in some regions in the network, more details about MPR can be found later in this chapter. Another reduce is to provide the shortest path. The reducing the time interval for the control messages transmission can bring more reactivity to the topological changes

OLSR uses two kinds of the control messages: Hello and Topology Control (TC). Hello messages are used for finding the information about the link status and the host's neighbors. With the Hello message the Multipoint Relay (MPR) Selector set is constructed which describes which neighbors has chosen this host to act as MPR and from this information the host can calculate its own set of the MPRs. the Hello messages are sent only one hop away but the TC messages are broadcasted throughout the entire network. TC messages are used for broadcasting information about own advertised neighbors which includes at least the MPR Selector list. The TC messages are broadcasted periodically and only the MPR hosts can forward the TC messages[12].

The reactiveness to the topological changes can be adjusted by changing the time interval for broadcasting the Hello messages or increasing the neighborhood holding time which determines whether a link is present between a node and its neighbor. It increases the protocols suitability for ad hoc network with the rapid changes of the source and destinations pairs. Also the

OLSR protocol does not require that the link is reliable for the control messages, since the messages are sent periodically and the delivery does not have to be sequential. Due to the OLSR routing protocol simplicity in using interfaces, it is easy to integrate the routing protocol in the existing operating systems, without changing the format of the header of the IP messages. The protocol only interacts with the host's Routing Table[13].OLSR protocol is well suited for the application which does not allow the long delays in the transmission of the data packets. The best working environment for OLSR protocol is a dense network, where the most communication is concentrated between a large number of nodes.

The soft state approach to signaling is used in OLSR. The routing state times out and is removed unless periodically refreshed by the receipt of routing updates. Soft-state signalling does not require explicit state removal or orphaned state removal when the state installer crashes since non-refreshed state will finally time-out. Also, periodic refresh messages make the system robust to node failure, to loss/corruption of refresh messages and there is no requirement for guaranteed delivery of refresh messages [8]. Soft state approaches have been widely implemented in numerous protocols , including RSVP, IGMP, SIP as well as OLSR. OLSR relies heavily on the soft state approach to maintain the consistency of topology information, and the consistency of routing tables amongst network nodes. So, apart from normal periodic messages, the protocol does not generate extra control traffic in response to link failure and node join/leave events. In OLSR, the soft state timers have two types of usage: message generation and state maintenance. Message generation timers (HELLO and TC interval timers) are used to send periodic HELLO and TC messages, while state-maintenance timers are to keep updated the state information in OLSR internal tables and remove obsolete state by time-out. By default, OLSR the neighbour state holding time is set to be 3 times the value of the default OLSR HELLO interval; the OLSR TIB holding time is 3 times the default value of the TC interval. . TIB and link tuple timers' expiry interval equals the TIB holding time interval. When new nodes join the network, a node detects its new neighbours with a link-sensing process by sending periodic HELLO message [15]. When nodes leave the network, or links between nodes go down, the corresponding link state in the link set and neighbour state in the neighbour set will be removed after the state holding timers expire. In addition, periodic topology control (TC) messages help recover from loss of topology information caused by state corruption or nodes restarting. It is clear that the internal state maintenance in each node is related directly to the refresh intervals and so changing these will impact the protocol as a whole[16].

In this paper the effect of tuning the neighborhood hold time in a random mobility network with G.711 based traffic is extensively studied.

2. METHODOLOGY

The simulation environment consisted of 20 nodes. Each node runs a multimedia application over UDP. The data rate of each node is 11 Mbps with a transmit power of 0.005 watts. The nodes are distributed 2000 meter by 2000 meter with the trajectory of each node being random. Video packets are queued based on priority by assigning four times the weight of normal packets. The parameters used in the OLSR routing protocol is shown in Table 1.

Table 1.OLSR Parameters used in experimental set up

Hello interval in seconds	2
TC interval in seconds	6
Neighbor hold time in seconds	4,6,8
Topology hold time in seconds	15
Duplicate message hold time in seconds	30
Addressing mode	IPV4

Traffic shaping is achieved using The Weighted Fair Queuing (WFQ) mechanism such that multimedia traffic is given double the priority of normal traffic.

Traffic is shaped to represent Pulse Code Modulation (PCM) using G.711 codec.G.711 compresses 16-bit linear PCM data down to eight bits of logarithmic data. The *ITU-T Rec. G.711* presents two PCM audio codecs called A-law and U-law. They both transform linear PCM signal into logarithmic PCM. They both operate on single samples. A-law uses 13-bit linear PCM vector and transforms it into 8-bit logarithmic PCM vector while encoding process. U-law uses 14-bit linear PCM, transforming it into 8-bit. Non-professional sound devices cannot generate either 14-bit samples. In this implementation 16-bit samples are passed and the input of coder. Every sample is converted into 14-bit sample by cutting off the less significant bits. In a node, if all packets are queued in single queue and forwarded using First In First Out (FIFO), it faces the head of line blocking preventing other packets in the queue from being transmitted. Thus fair queuing is used, which allows for multiple packet flows by sharing the link capacity fairly. Fair queuing forwards packets from a buffer, wherein the data packets are stored temporarily until transmission. Generally, the buffer space is divided into multiple queues, with each containing packets of one flow. The order of packet transmission in fair queuing depends on the estimated finish time; the packet with earliest finish time is selected for next transmission. Weighted fair queuing (WFQ) calculates weights for each packet by multiplying the packet size with the inverse of a weight for the associated queue.For each arriving packet at node, it is tagged with a start tag $start_{i,n}$ and finish tag $finish_{i,n}$ by the WFQ algorithm as follows:

$$start_{i,n} = \max\left\{v\left(A\left(t_{i,n}\right)\right), finish_{i,n-1}\right\}$$

$$finish_{i,n} = s_{i,n} + P_{i,n} / r_i$$

where *n* is sequence number of the packet of flow *i* arriving at time $A\left(t_{i,n}\right)$ $P_{i,n}$ is the packet size and weight r_i. The virtual time $v\left(A(t)\right)$ is calculated as follows:

$$\frac{dv(t)}{dt} = \frac{C}{\sum_{i \in B_{FFQ(t)}} r_i}$$

where C is the channel capacity in bits/sec and $B_{FFQ(t)}$ is the set of backlogged flows at time t in error-free fluid service.

The average data rate achieved using WFQ is given by

$$data\ rate = \frac{Rr_i}{(r_1 + r_2 + ... +_N)}$$

R being the link data rate and N active data flows.

3. RESULT

Simulations in each scenario were carried out for 6 minutes with no traffic being for the first 140 seconds. The results obtained are tabulated in figure 1,2 and 3. The dark blue graph in all the three figure indicate the AODV routing protocol. For multimedia traffic it can be observed that the jitter is higher in AODV routing protocol from Figure 1. Similarly the delay in packet delay is higher in AODV routing compared to OLSR routing protocol for different network hold times as shown in Figure 2. From Figure 3 it can be observed that the delay variation for voice packets is highly random for AODV routing protocol.

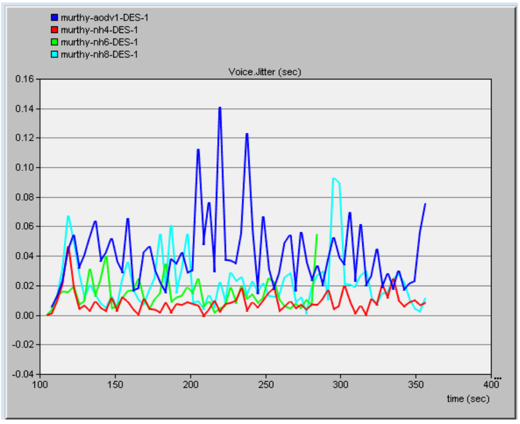

Figure I : Mean voice jitter in seconds. nh4, nh6, nh8 and AODV are the respective neighbor hold time in seconds

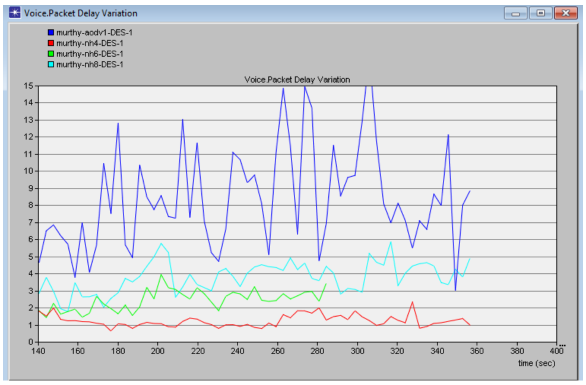

Figure 2: Voice packet delay.

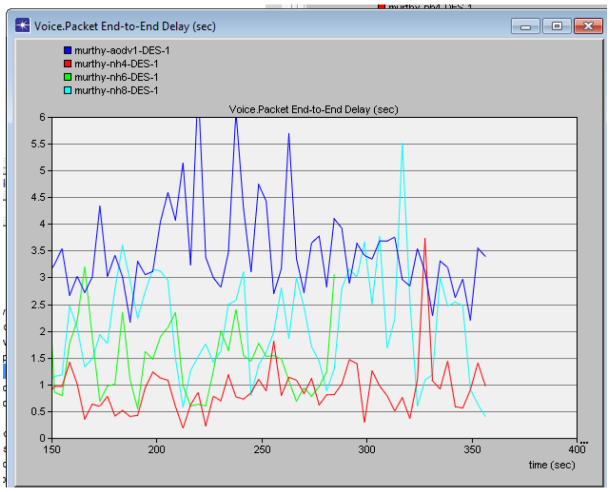

Figure 3: Voice packet delay variation

From figure 1-3 it is observed that in a small network having random mobility OLSR outperforms AODV for voice traffic. It is also seen that for multimedia traffic lower network hold time (NH=4) decreases the jitter compared to the RFC specification of OLSR which specifies the network hold time as 6 seconds which is three times the hello message interval. The variations within OLSR for lower NH time is lower than AODV routing protocol.

Figure 4 shows the media access delay under different network hold times and using AODV routing protocol. AODV shows higher media access delay compared to OLSR routing protocol. Figure 5 shows retry threshold levels for different routing protocols.

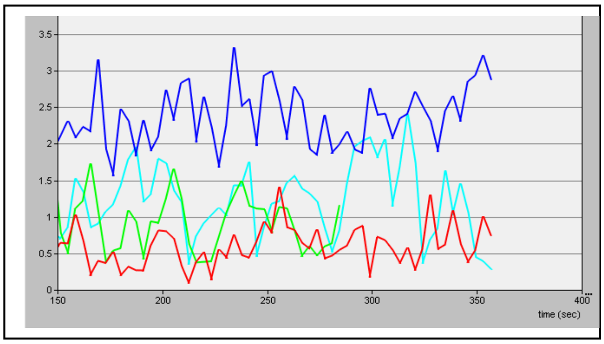

Figure 4. Media access delay in seconds

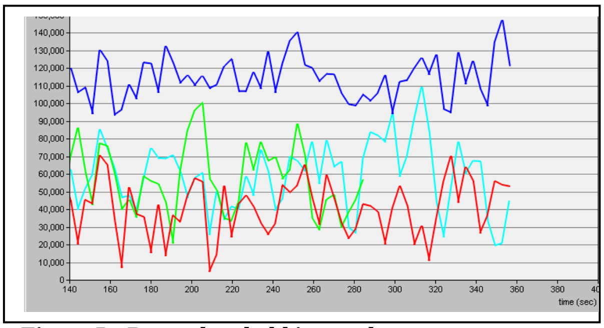

Figure 5 : Retry threshold interval

AODV being a reactive routing protocol, routes are discovered dynamically when a source needs to open a communication channel with a specific destination node.

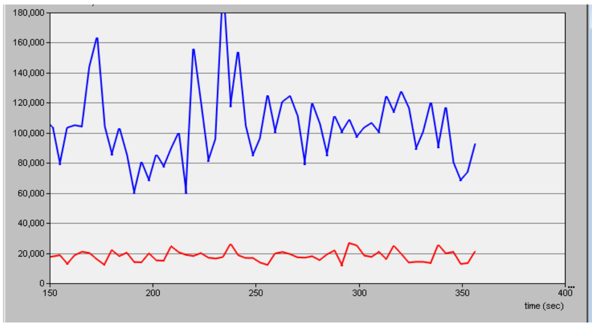

Figure 6 : The average routing traffic received in bits/seconds

The control overheads are higher when nodes are changing positions dynamically. Figure 6 shows the average routing traffic received by each protocol. The dark blue graph is for AODV and red indicates the routing traffic for OLSR routing protocol. The average throughput and data dropped in bits per second is shown in figure 7.

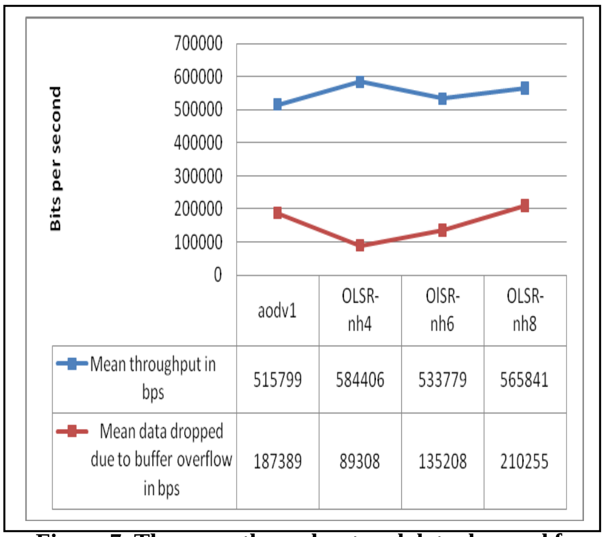

Figure 7. The mean throughput and data dropped for multimedia traffic under different experimental setup.

The mean voice jitter is shown in figure 8.

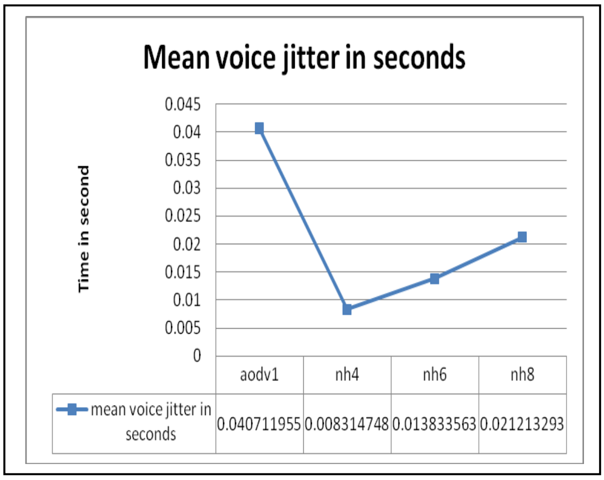

Figure 8: Mean jitter over six minutes of simulation

4. CONCLUSION

In this paper it was proposed to investigate the performance of OLSR routing protocol for multimedia intensive network with varying neighborhood hold time and compare the performance with AODV routing protocol. The RFC for OLSR specifies the neighborhood hold time as 6 seconds. Investigations was carried out with 4,6,8 seconds and with AODV routing protocol. Though throughput remains relatively high in each scenario, the end to end delay in packet increases linearly which can affect the quality of service drastically. Further work needs to be carried out with tuning of hello messages to reduce jitter and end to end delay. However it is observed for multimedia traffic, the performance of OLSR routing protocol is superior to AODV routing protocol when the network size is small.

5. REFERENCES

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