Reactive and Proactive Routing Protocols for Wireless Mesh Network using Multimedia Streaming

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ABSTRACT

Wireless mesh networks are the next step in the evolution of wireless architecture, delivering services for a large variety of applications in personal, local, campus, and metropolitan areas. Supporting multimedia services in wireless mesh networks is receiving more attention from the research community. While wired networks have mature infrastructure and protocols providing QoS for multimedia, supporting multimedia in multihop Wireless mesh Networks faces greater technical challenges. The unreliable nature and shared media of multi hop communications make the deployment of multimedia applications in wireless mesh networks a difficult task. In this paper, discussion and implementation of routing protocols in Wireless Mesh Network using Video and Voice streaming which enhances the reliability in the network. Routing protocols such as AODV, OLSR and DSR have been implemented using OPNET simulator.

Keywords:- Mesh, AODV, OLSR, DSR, Routing

1. INTRODUCTION

Wireless mesh networking has made significant advances in both research and practice in recent years. In addition to traditional data services, content-rich multimedia applications (such as video conferencing, VoD or VoIP) are increasingly being deployed in this type of networks [1]. However, multimedia services need QoS support to maintain user satisfaction, which is fairly difficult in multihop wireless mesh networks where dynamic environments cause fragile links and high packet loss ratios, having a great adverse impact on quality of multimedia. In WMNs, nodes are comprised of mesh routers and mesh clients. Each node operates not only as a host but also as a router, forwarding packets on behalf of other nodes that may not be within direct wireless transmission range of their destinations [2]. A WMN is dynamically self-organized and self-configured, with the nodes in the network automatically establishing and maintaining mesh connectivity among themselves (creating, in effect, an ad hoc network).
The architecture of WMNs can be classified into three main groups based on the functionality of the nodes:-

- Infrastructure/Backbone WMNs
- Client WMNs
- Hybrid WMNs

In Infrastructure/Backbone WMNs, the architecture is shown in Fig.1, where dash and solid lines indicate wireless and wired links, respectively. This type of WMNs includes mesh routers forming an infrastructure for clients that connect to them [1].

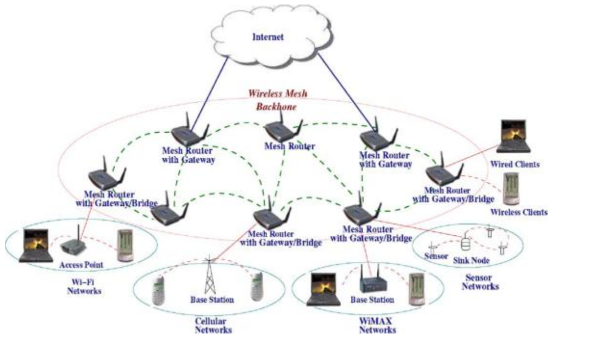

Fig.1 Infrastructure/backbone WMNs.

The WMN infrastructure/ backbone can be built using various types of radio technologies, in addition to the mostly used IEEE 802.11 technologies. The mesh routers form a mesh of self-configuring, self-healing links among themselves.

In Client WMNs, Client meshing provides peer-to-peer networks among client devices [3].

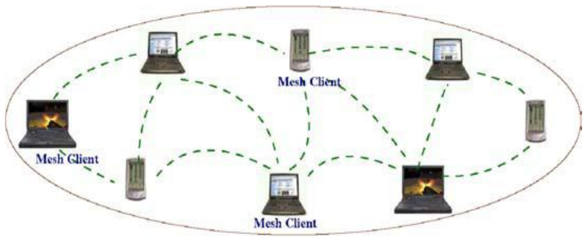

Fig.2 Client WMNs.

In this type of architecture, client nodes constitute the actual network to perform routing and configuration functionalities as well as providing end user applications to customers.

In Hybrid WMNs, is the combination of infrastructure and client meshing [1].

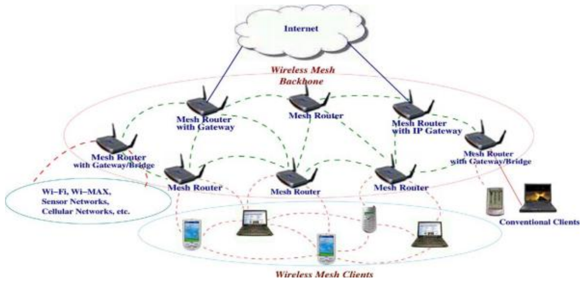

Fig.3 Hybrid WMNs.

Mesh clients can access the network through mesh routers as well as directly meshing with other mesh clients. While the infrastructure provides connectivity to other networks such as the Internet.

2. OVERVIEW OF ROUTING PROTOCOLS

Routing protocols can be classified in proactive, reactive and hybrid approaches. With proactive protocols the route information is periodically exchanged among hosts (e.g. DSDV, OSLR), allowing each node to build a global knowledge of the network independently of the actually used routes. Reactive approach limit the exchange of route information, building routes only towards nodes involved in higher layers communication (e.g AODV, DSR, and TORA). Proactive protocols do not scale with large networks, due to the amount of information needed to collect global routing decisions.

2.1 Ad-Hoc on-Demand Distance Vector Routing (AODV)

AODV is a Reactive routing protocol. AODV adopts a very different mechanism to maintain routing information. It uses traditional routing tables, one entry per destination. Without source routing, AODV relies on routing table entries to propagate an RREP back to the source and, subsequently, to route data packets to the destination. AODV [4] uses sequence numbers maintained at each destination to determine freshness of routing information and to prevent routing loops. All routing packets carry these sequence numbers. An important feature of AODV is the maintenance of timer based states in each node, regarding utilization of individual routing table entries. A routing table entry is expired if not used recently. A set of predecessor nodes is maintained for each routing table entry, indicating the set of neighboring nodes which use that entry to route data packets. These nodes are notified with RERR packets
when the next-hop link breaks. Each predecessor node, in turn, forwards the RERR to its own set of predecessors, thus effectively erasing all routes using the broken link. In contrast to DSR, RERR packets in AODV are intended to inform all sources using a link when a failure occurs. Route error propagation in AODV can be visualized conceptually as a tree whose root is the node at the point of failure and all sources using the failed link as the leaves.

2.2 Optimized Link State Routing Protocol (OLSR)

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. 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)[3]. 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. OLSR uses two kinds of the control messages: Hello and Topology Control (TC) [5]. Hello messages are used for finding the information about the link status and the host's neighbors. TC messages are used for broadcasting information about
own advertised neighbors which includes at least the
MPR Selector list.

2.2.1 Multipoint Relays

The Multipoint Relays (MPR) is the key idea behind the OLSR protocol to reduce the information exchange overhead. Instead of pure flooding the OLSR uses MPR to reduce the number of the host which broadcasts the information throughout the network. The MPR is a host's one hop neighbor which may forward its messages. The MPR set of host is kept small in order for the protocol to be efficient. In OLSR only the MPRs can forward the data throughout the network.

2.3 Dynamic Source Routing (DSR)

The key distinguishing feature of DSR is the use of source routing. That is, the sender knows the complete hop-by-hop route to the destination. These routes are stored in a *route cach*e. The data packets carry the source route in the packet header. When a node in the ad hoc network attempts to send a data packet to a destination for which it does not already know the route, it uses a *route discovery* process to dynamically determine such a route [6]. Route discovery works by flooding the network with route request (RREQ) packets. Each node receiving an RREQ rebroadcasts it, unless it is the destination or it has a route to the destination in its route cache. Such a node replies to the RREQ with a route reply (RREP) packet that is routed back to the original source. RREQ and RREP packets are also source routed. The RREQ builds up the path traversed across the network. The RREP routes itself back to the source by traversing this path backward. The route carried back by the RREP packet is cached at the source for future use. If any link on a source route is broken, the source node is notified using a *route error* (RERR) packet. The source removes any route using this link from its cache. A new route discovery process must be initiated by the source if this route is still needed. DSR makes very aggressive use of source routing and route caching.

3. SIMULATION ENVIRONMENT

The research is carried out using discrete event simulation software known as OPNET (Optimized Network Engineering Tool) Modeler version [7].

The simulation focused on the performance of routing protocols with increased in scalability and mobility. Therefore, two simulation scenarios consisting of 50 nodes and 100 nodes considered. The nodes were randomly placed within certain gap from each other in 1200 x 1200 m campus environment for 50 and 100 nodes respectively. The constant Video and Voice traffic was generated in the network explicitly i.e. user defined via Application and Profile Configuration. Every node in the network was configured to execute AODV, OLSR and DSR respectively. The simulation time was set to 600s.

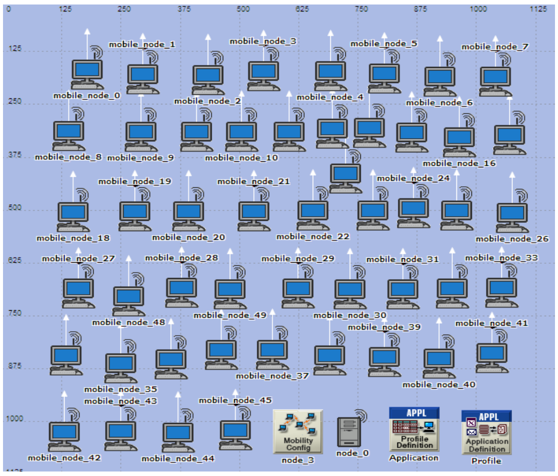

Fig.4 Scenario of 50 Nodes

Table I
Wireless Parameters

Type: workstation

Attribute	Value
Wireless LAN Parameters	(...)
BSS Identifier	Auto Assigned
Access Point Functionality	Disabled
Physical Characteristics	Direct Sequence
Data Rate (bps)	11 Mbps
Channel Settings	Auto Assigned
Transmit Power (W)	0.005
Packet Reception-Power Threshold...	-95
Rts Threshold (bytes)	None
Fragmentation Threshold (bytes)	None
CTS-to-self Option	Enabled
Short Retry Limit	7
Long Retry Limit	4
AP Beacon Interval (secs)	0.02
Max Receive Lifetime (secs)	0.5
Buffer Size (bits)	256000
Roaming Capability	Disabled
Large Packet Processing	Drop
PCF Parameters	Disabled
HCF Parameters	Not Supported
Mobility Profile Name	Default Random Waypoint

A. Wireless Parameters

The Wireless parameters were common to all of the four routing protocols as shown in table 1.

B. Traffic Flow Parameters

Traffic was generated in the network explicitly by configuring user defined application and profile definition

I. Application Configuration

A heavier application traffic flow in the topology was generated which each node will be processing from the respective application server in the network. High Resolution video traffic and PCM quality Speech Voice was generated.

II. Profile Configuration

The profile configuration for each application was defined as, Operation Mode: Serial (Ordered) and Start Time: 10 Seconds. In addition, the Video and Voice application start time was set to 10 seconds which is constant.

III. DES Configuration Parameter

The DES simulation criterion was configured and was run for total time of 600 seconds. The overall simulation was monitored within the following criteria:

- Duration: 6 minutes (600 seconds)
- Seed: 128
- Update Interval: 500000 events. (This specifies how often simulation calculates events/second data.)
- Simulation Kernel: Optimized ('Optimized' kernel was chosen because it runs faster than the remaining other two simulation kernel.)

4. RESULTS AND ANALYSIS

The work attempts to compare the protocols in two different scenarios 50 nodes and 100 nodes.

1. Wireless Delay

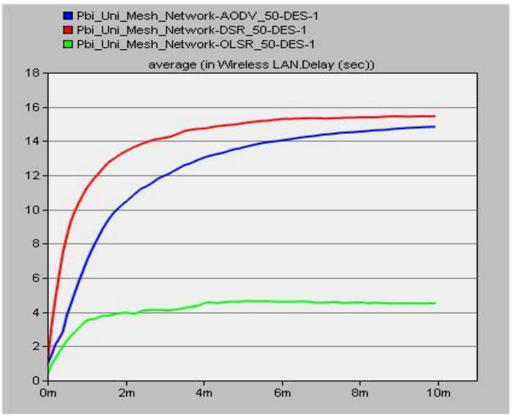

Fig-5 Wireless LAN Delay-50 Nodes

Fig 5 and Fig 6 shows the overall delay in the network for 50 and 100 nodes. Delay means time taken by a packet to go from source to destination. OLSR has the lowest Wireless LAN Delay in both scenarios. DSR and AODV show the average delay in both scenarios.

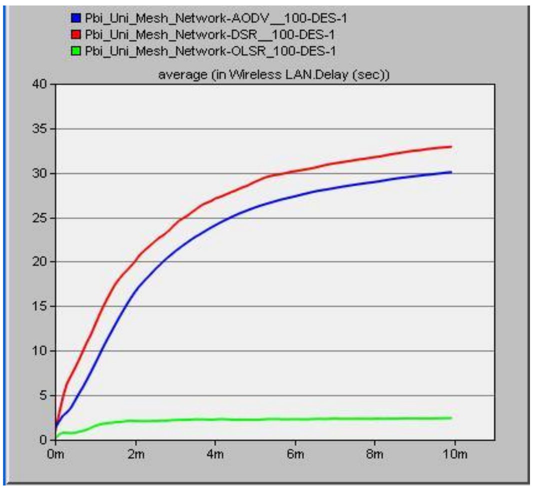

Fig-6 Wireless LAN Delay-100 Nodes

AODV produces better result than DSR in both scenarios. This is because DSR maintains a large cache (route information table) to store data transmission data. This result in higher delay in updating periodically with frequent changes occurring due to high mobility. In addition, the chance of using outdated or stale route information in forwarding packets is increased.

2. Network Load

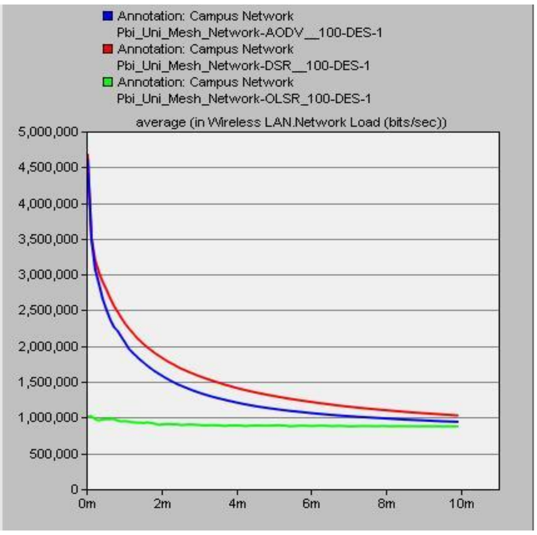

Fig-7 Network Load-50 Nodes

Fig 7 and Fig 8 show network load for OLSR, AODV and DSR. For AODV and DSR the routing load takes the peak at initial stage of the simulation with the drastic rise and drops down slowly as the simulation progresses. This is simply because of the constant mobility of the node. OLSR produces the best results in both scenarios. This is in turn results in periodic broadcast of 'hello' message and Topology Control (TC) messages in order to discover neighborhood nodes. In addition, OLSR is a link state protocol which uses a table driven approach. Therefore, it generates more communication overhead and takes more maintenance time which adds to the overall load in the network. AODV and DSR show the average results in both scenarios.

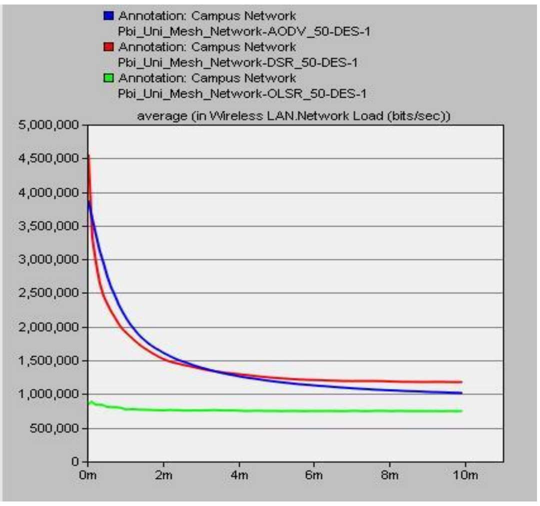

Fig-8 Network Load-50 Nodes

3. Wireless LAN Throughput (bits/sec)

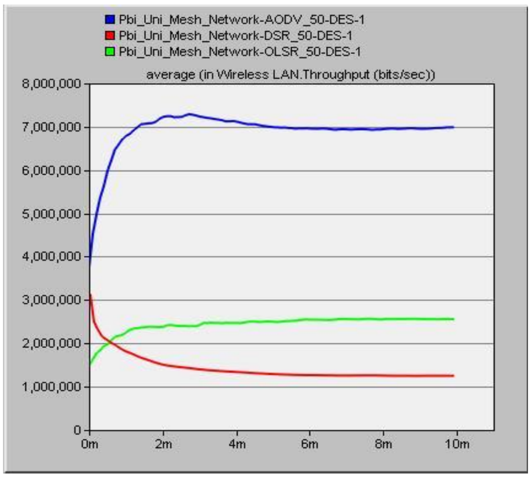

Fig-9 Network Load-50 Nodes

Fig 9 and Fig 10 show the throughput for each protocol. It is clear that AODV has shown increased throughput regardless of the routing load observed during initial routing process. Throughput is the main metric of any network. OLSR shows the better result than DSR in both scenarios. Finally DSR produces the worst results in throughput.

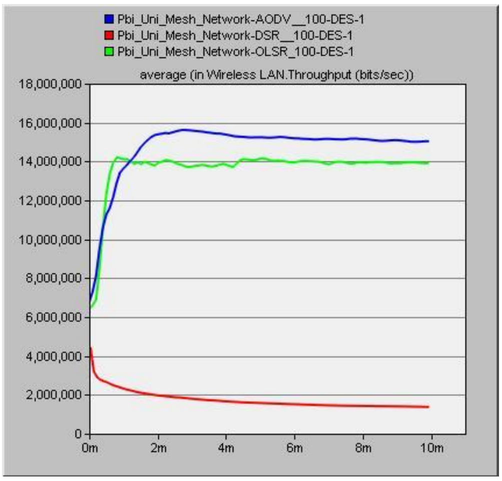

Fig-10 Network Load-50 Nodes

5. CONCLUSION

The multimedia and real time applications in the ad hoc network have an interest results in the research community. Designing of mesh network is hardly difficult because of multimedia and any kind of network topology. Routing protocols were tested using the same parameters with Video and Voice traffic flow and random mobility. Performance of protocols with respect to salability has also analyzed. Finally, when overall performance is compared, Throughput was considered as the main factor because it is the actual rate of data received successfully by nodes in comparison to the claimed bandwidth. AODV produces the highest throughput in wireless lan and OLSR lowest network delay in wireless lan. DSR again performed worst among the three analysed protocols, delivering much lower throughput than AODV and OLSR. AODV and OLSR performed pretty well showing average performance through the simulation which is equivalent to result generated by other researchers.

6. REFERENCES

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