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# PERFORMANCE EVALUATION OF NETWORK LAYER PROTOCOLS FOR MULTIMEDIA STREAMING OVER AD-HOC NETWORKS

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## ABSTRACT
The Ad Hoc network is gaining popularity to support ubiquitous internet and multimedia applications. Unlike cellular networks, Ad Hoc network uses a shared channel resources to communicate the data packets in which routing protocols plays crucial role to determine the performance of Ad Hoc network. In order to thrive the data rates and suffice the stringent requirements of multimedia applications evaluating the performance of routing protocols are very essential prior to actual deployment. Hence in this work, an attempt has been made to study the performance of well know routing protocols such as Optimized Link State Routing Protocol (OLSR), Bellman Ford and Ad Hoc On-demand Distance Vector (AODV) Routing protocol using QualNet 6.1 Network Simulator. The simulation studies are carried out for increasing node densities and data rates by considering throughput and average delay as performance metrics.
**Keywords**: Ad Hoc Networks, AODV, OLSR, Bellman Ford, QualNet.

## I. Introduction
The rapid growth in wireless technology expedites billions of users to access high speed ubiquitous internet, web browsing and real-time multimedia applications. Inter-networking these wireless devices is accomplished either with centralized infrastructure-based networks such as cellular networks or distributed Ad Hoc networks such as MANETS and WSN. The cellular network uses a base station/central coordinator for establishing and controlling the data communication between the multiple wireless devices. Whereas, wireless Ad Hoc networks are the infrastructure free networks in which nodes coordinates with each other using routing and Media Access Control (MAC) protocols for establishing a data connection and forward data packets through many intermediate nodes [1]. Such multi-hop network is promises key solution that provides ubiquitous access to internet and multimedia applications along with enhanced coverage area all at same time [2].
In Ad Hoc networks, routing protocols are essential to determine the optimum paths between source and destination nodes. During route search, routing protocols must enhance the bandwidth utilization factor, power efficiency, reduce latency and to fulfil the QoS requirements to suffice the multimedia services [3]. Also, routing protocols should provide fault tolerance to support the dynamic nature of network topology and changing behaviour of the communication medium during data communication [4]. Thus, using an appropriate Routing protocol may leverage the performance of the Ad Hoc networks. In order to optimizing the performance of Multimedia streaming over Ad Hoc networks authors have attempted to study the performance of routing layer protocols for streaming multimedia over Ad Hoc Networks using QualNet 6.1 network simulator. The rest of this paper is organized: Section 2 outlines the related work, Section 3 overview of Routing for Ad Hoc networks, Section 4 describes the Simulation studies, and Section 5 concludes the work.

## II. Related Work
In literature several approaches have been proposed and developed to improve the system performance of the Ad Hoc networks. In [5], the main characteristics and requirements of Real-time Multimedia Monitoring applications are identified and then key research directions that may help to overcome those challenges are highlighted. In [6], authors develop energy efficient and angular routing protocol called Efficient Reactive and Angular - Optimized Link State Routing (ERA-OLSR). Proposed ERA-

OLSR is an enhanced protocol designed over the well-known Optimized Link State Routing (OLSR). The proposed protocol has been compared with well-established reactive protocols namely Ad-hoc On Demand Distance Vector Routing (AODV) and Dynamic Source Routing (DSR). Authors in [7] propose a novel routing protocol called neighbour-based Dynamic Connectivity Factor Routing Protocol (DCFP) that dynamically probes the status of the underlying network without the intervention of a system administrator based on a novel connectivity metric, while reducing the RREQ overhead using a new connectivity factor. Authors perform simulation experiments to evaluate the performance of the proposed DCFP, where the NCPR and AODV are used as a benchmark. Authors in [8] propose a new routing protocol named CHAMP (CacHing and Multiple Path) routing protocol. Proposed CHAMP uses cooperative packet caching and shortest multipath routing to reduce packet loss due to frequent route failures. Through extensive simulation results, authors show that these two techniques yield significant improvement in terms of packet delivery, end-to-end delay and routing overhead. In [9], authors propose an energy-efficient integrated MAC/routing (EEMR) protocol for event-driven and time-critical applications based on new logical coordinates. The optimal relay is elected in each hop dynamically, where the objective is to optimize forwarding energy-efficiency on the premise that end-to-end delay is restricted under the predefined upper bound. Analysis and extensive simulations are given to demonstrate the superiority of EEMR by comparing its performance against existing solutions. Authors in [10] propose a less remaining hop More Opportunity (LEMO) algorithm to improve the packet delivery ratio and fairness among flows for multi-hop ad hoc networks through cross-layer interaction between MAC and the routing layer. This paper compares the performance of LEMO algorithm by using DSR and AODV protocols at the routing layer and varying the mobility and the load conditions.

## III. Routing Protocols for Multimedia Streaming

In Ad Hoc networks, the routing protocols are vital to broadcast the routes and to select the best optimal path for data communication when needed. In particularly, routing schemes in Ad Hoc networks can classified as Link State Routing, Distance Vector Routing and Source Initiated Routing protocols. In link state routing protocols, optimal path is selected by analyzing the state of each and every link in routes towards the destination, whereas distance vector routing protocol selects the best optimal path by formative the distance between source and destination nodes. Whereas, in source-initiated routing protocols, routes are created on demand based on route request and reply control messages to route the data packet through hop by hop. Hence, in this paper well known routing protocols such as Optimized Link State Protocol (OLSR), Bellman Ford and Ad Hoc On demand Distance Vector routing protocol (AODV) are consider to study the performance in Ad Hoc Network scenarios.

### 3.1 Optimized Link State Protocol (OLSR) Routing Protocol

The OLSR is an optimized version of a pure link state protocol. The topological changes are updated to all available nodes in the network using flooding process. To reduce the flooding overhead in the network protocol multipoint relays (MPR) are used. These MPRs are used to broadcast only the control messages to neighboring nodes and to discover the shortest path between the source and destination. OLSR uses two kinds of control messages such as Hello and Topology Control (TC). Hello messages are used to find the information about the link status of the neighboring nodes. Whereas, TC messages are used for broadcasting information about its own advertised neighboring nodes which includes at least one MPR. The OLSR provides all the routing information to all participated nodes in the network. Thus, the routes are always available for all nodes when they are needed [11]. However, OLSR protocol requires each node periodically to broadcast hello messages and frequent topological information may increase bandwidth consumption.

### 3.2 Bellman Ford Routing Protocol

The Bellman-Ford Routing Protocol is a proactive routing protocol in which each node has to maintain the distance tables, which gives the information about the distances and shortest path to sending data packets to each destination in the network. The information in the distance table is updated by

exchanging control message with the neighboring nodes. The number of data entries in table is equals to number of nodes in networks. The columns of table store the information of neighboring node through which data has to be forwarded towards destination. Further, each node broadcast the hello messages to calculate the distance between itself and all other nodes within the network to disseminate the changes in network topology periodically [12].

### 3.3 Ad Hoc On-demand Distance Vector (AODV) Routing Protocol

The AODV is a source initiated routing protocol which creates route on-demand basis. It uses a route discovery process and sequence number to computer loop free path between source and destination. The AODV performs Route Discovery using Route Request (RREQ) and Route Reply (RREP) messages whenever a node wishes to send data packets to destination. AODV broadcasts the RREQs control messages network wide using expanding ring search optimization in route discovery phase. Later, in route establishment phase forward path is established between source to destination node through intermediate node using Route Reply messages (RREP) and the information about active next hop is stored in route table entries. During route maintenance phase, the Route Error (RERR) message is sent to the affected source node to invalidate broken route. When source node receives the RERR, it reinitiates the route discovery process again. Thus, AODV tends to reduce the control traffic messages overhead at the cost of increased latency in while discovering fresh routes [13].

## IV. Simulation Results And Discussions

The performance of Optimized Link State Routing (OLSR), Bellman Ford and Ad Hoc On demand Distance Vector (AODV) Routing Protocols are evaluated by considering CBR traffic source using QualNet 6.1 network simulator. Simulation scenarios are designed by considering IEEE 802.11 MAC and IEEE 802.11b radio. The remaining simulation parameters considered for the simulation studies are listed in Table I.

**Table I: Simulation Parameters**

| Parameter | Value |
|---|---|
| Area | 2500m x 2500m |
| Simulation Time | 300 seconds |
| Number of nodes | 49, 81, 121, 169 and 225 |
| Nodes Placement | Grid |
| Traffic type | CBR |
| Buffering Techniques | OLSR, Bellman Ford and AODV |
| MAC | IEEE 802.11 |
| Channel frequency | 2.412 GHz |
| Path Loss Model | Two Ray |
| Shadowing model | Constant |

The Figure 1 shows the snapshot of the scenario designed to study performance of Ad Hoc Network by considering OLSR, Bellman Ford and AODV routing protocols. In this simulation study, initially 49 nodes are placed in grid manner with a inter node distance of 150 meters and a CBR connection of 2 Mbps data rate is established between the source and destination node by considering OLSR routing protocol. Traffic is sent for 300s of simulation time and the performance metrics such as throughput and average delay are recorded. The simulation studies later repeated by increasing the node density to 81, 121, 169, 225 nodes. Similar simulation steps are repeated by replacing OLSR with Bellman Ford and AODV Routing Protocol. Also, Similar set of simulation studies are repeated by increasing the CBR data rate from 2Mbps to 4Mbps.

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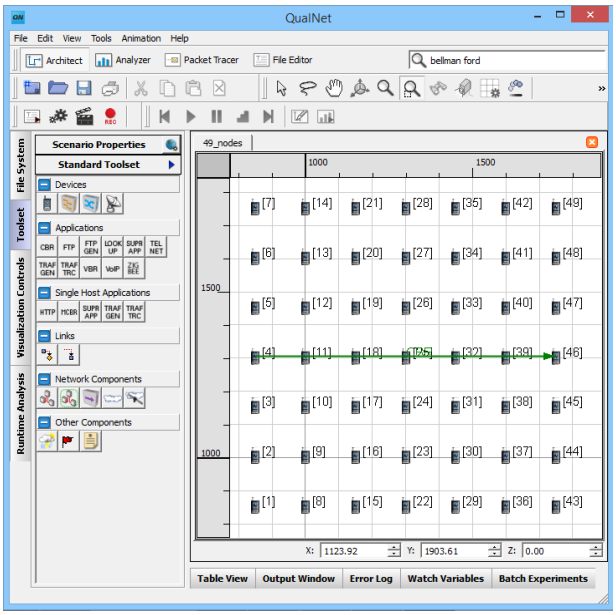


**Figure1: Snapshot of Simulation Scenario with 49 Nodes**

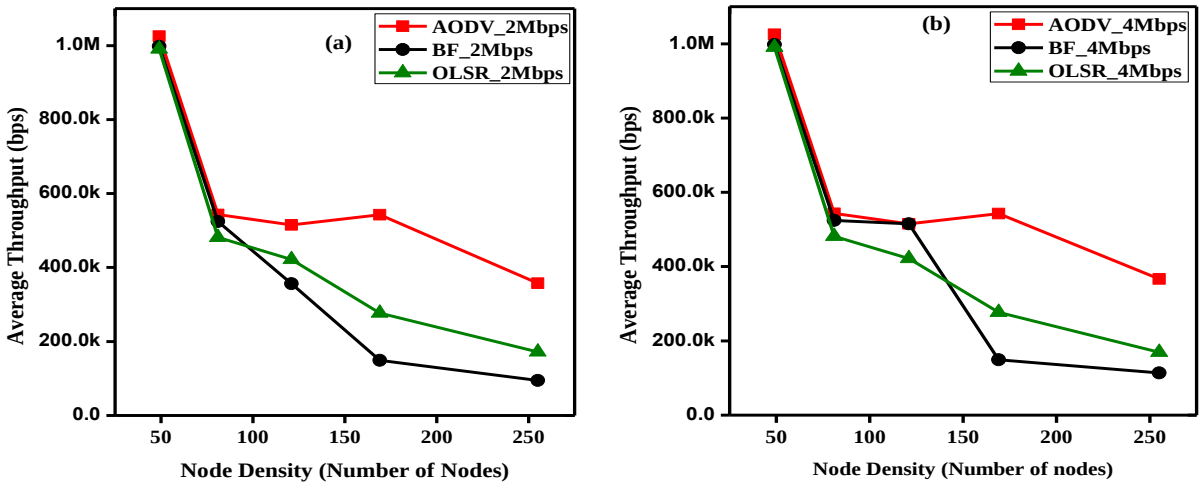


**Figure2: Throughput Performance of OLSR, Bellman Ford and AODV routing protocols with increasing Node Density for (a) 2Mbps and (b) 4 Mbps data rates.**

Figure 2(a, b) shows the throughput performance of OLSR, Bellman Ford and AODV routing protocols with increasing node density for 2Mbps and 4Mbps data rates respectively. From figure 2(a, b) it is evident that, the throughput performance of OLSR, Bellman Ford and AODV is almost similar for low density nodes (49 and 81 node density) since broadcast of control messages are limited. However, as the node density increases AODV performs better than OLSR and Bellman Ford routing protocols. Since, AODV is the on-demand routing protocol in which routes are established between the source and destination by flooding RREQ messages using ring search method and remains passive during data transmission, hence all the available network bandwidth is utilized for data transmission thereby enhance the throughput [11]. Also, it is evident from figure 2(a, b) that the OLSR is performing better than Bellman Ford, this is because in OLSR the periodic control messages are forwarded only through MPR thereby offering more bandwidth for services. Whereas, in Bellman Ford the periodic control messages are broadcast and forwarded through all nodes [11]. Hence, the bandwidth availability in Bellman Ford is limited leading to reduction in throughput performance. Same throughput performance trend is observed even after increased data rates from 2Mbps to 4Mbps.

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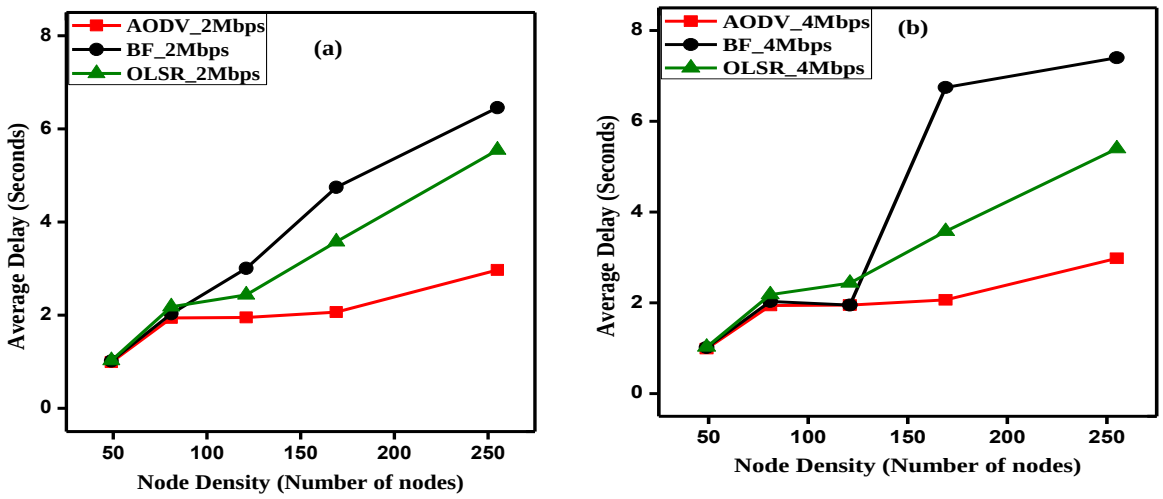


**Figure 3: Average Delay Performance of OLSR, Bellman Ford and AODV routing protocols with increasing Node Density for (a) 2Mbps and (b) 4 Mbps data rates**

Figure 3(a, b) shows the average delay performance of OLSR, Bellman Ford and AODV routing protocols with increasing node density for 2Mbps and 4Mbps data rates respectively. From the Figure 3(a, b) it is evident that the average delay of AODV is less than OLSR and Bellman Ford. This is because the network congestion is less in AODV which reduces the probability of data packet drop and number of retransmissions leading to decrease in average delay. It is also depicted from figure 3 (a, b) that the average delay performance of OLSR is less than Bellman Ford routing protocol, because in OLSR the data is transmitted to destination by computing the shortest path using routing table entries. Whereas, in Bellman Ford all the network nodes exchange topological information leading to higher network congestion and the probability of more route breaks that incurs high delay.

## V. Conclusion

In this paper, performance of the network layer protocols such as Optimized Link State Routing Protocol (OLSR), Bellman Ford, Ad Hoc On-demand Distance Vector (AODV) routing protocol have been evaluated using QualNet 6.1 Network Simulator. The simulation studies are carried out for various node densities and data rates by considering the throughput and average delay as performance metrics. Simulation results shows that Ad Hoc On-demand Distance Vector (AODV) routing protocol performs better than OLSR and Bellman Ford routing protocols in Ad Hoc network due to its reactive nature. Thus, the performance of multimedia streaming can be leveraged by using source-initiated routing protocols in Ad Hoc scenario.

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