PERFORMANCE ANALYSIS OF AODV, OLSR, GRP AND DSR ROUTING PROTOCOLS WITH DATABASE LOAD IN MANET

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Abstract

Wireless Technology has an enormous use these days and is still becoming popular from times immemorial. It is at its peak when we talk about research. This is because of the latest technological demands now days arising from Laptops, Wireless devices such as Wireless local area networks (WLANs) etc. Because of its fast growing popularity day by day, it has led wireless technology data rates higher and it has made its price cheaper, which is why wireless Technology is growing so fast. In this paper we have presented some most commonly used routing protocols in MANET and compared the performance of AODV, OLSR, GRP and DSR routing protocol by using OPNET simulator 14.5. The performance is evaluated under different parameters like Delay, Load, and Media access delay, Network Load, Retransmission and Throughput for Database load.

Keywords*— MANET, Peak Value, Protocol, Drop value*

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1. INTRODUCTION

A Mobile Ad hoc Network (MANET) is a temporary wireless network in which mobile nodes are communicated with each other without an infrastructure. MANET is a fast growing area of research [1]. The communication among routes is difficult due to its frequent changing network topology and requires efficient and dynamic routing protocol [2]. In MANET, protocols are classification into three categories: (1) Proactive protocols provide fast response to topology changes by continuously monitoring topology changes and disseminating the related information as needed over the network [4] like Optimized Link State Routing (OLSR). Geographic Routing Protocol (GRP) is classified as proactive routing protocol [3]. In GRP the Global Positioning System is used to locate the location of node to collects network information at a source node with a small amount of control overheads. (2) Reactive routing protocols such as Ad hoc in demand distance vector (AODV), find the route only when there is data to be transmitted as a result, generate low control traffic and routing overhead. Dynamic Source routing protocol (DSR), each data packet contains complete routing information to reach its dissemination and each node uses caching technology to maintain route information. (3) Hybrid protocol could be derived from the two previous ones, containing the advantages of both the protocols. In this paper, we perform the comparison of AODV, DSR, GRP and OLSR routing protocols in terms of various traffic loads. This paper is organised as follows. In sec. 2, we describe the routing protocols in MANET. Sec 3, gives various parameters traffic loads in MANET. In sec 4, simulation environment in OPNET SIMULATOR 14.5 is given. Sec 5 shows the results and discussion about the performance of various parameters of AODV, DSR, GRP and OLSR protocols. Conclusion is given in Sec 6.

2. ROUTING PROTOCOLS IN MANET

Routing protocols in MANET are divided into three categories: proactive, reactive and hybrid routing protocols. The most popular ones are AODV, OLSR, GRP and DSR. This section describes the main features of three protocols AODV (Ad Hoc On-Demand Distance Vector Protocol) and DSR (Dynamic source routing), GRP (Geographic Routing Protocol) and OLSR (Optimized Link State Routing) deeply studied using OPNET 14.5. An ad-hoc routing protocol is a convention, or standard, that it improves the scalability of wireless networks compared to infrastructure based wireless networks because of its decentralized nature.

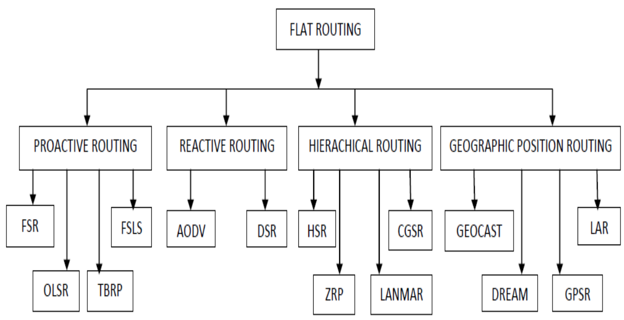

Figure 1: Classification of Protocols

2.1 AD-HOC ON DEMAND DISTANCE VECTOR (AODV)

AODV is reactive routing protocol. In this route is discovered or maintain according to node request. For loop freedom and freshness of route, AODV uses destination sequence number. It is capable for both unicast and multicast routing. Mobile nodes respond to the any change in network topology and link failures in necessary times. In case of the link failures the respective defective nodes are notified with the message, and then the affected nodes will revoke the routes using the lost link [5]. AODV uses the message types Route Request (RREQ), Route Replies (RREP) and Route Error (RERR) in finding the route from source to destination. AODV performs two operations: (1) route discovery and (2) route maintenance (3) Route Caching.

2.1.1 ROUTE DISCOVERY:

In AODV routing, when a source has data to transmit to a new destination, it broadcast a RREQ for that destination. A neighbour's node receiving the RREQ checks if it has not received the same request before using the ROUTE-ID. It is not the destination and does not have a current route to the destination, it rebroadcasts the RREQ and at same time backward route to the source is created [6]. If the receiving node is the destination or has a current route to the destination, it generates a RREP. The RREP propagates; each intermediate node creates a route to the destination. When the source receives the RREP, it records the forward route to the destination and begins sending data. If multiple RREPs are received by the source, the route with the shortest hop count is chosen. In case a link break is detected, a RERR message is sent to the source. As the RERR propagates towards the source, each intermediate node invalidates route to an unreachable destinations. When the source of the data receives the RERR, it invalidates the route and reinitiates route discovery.

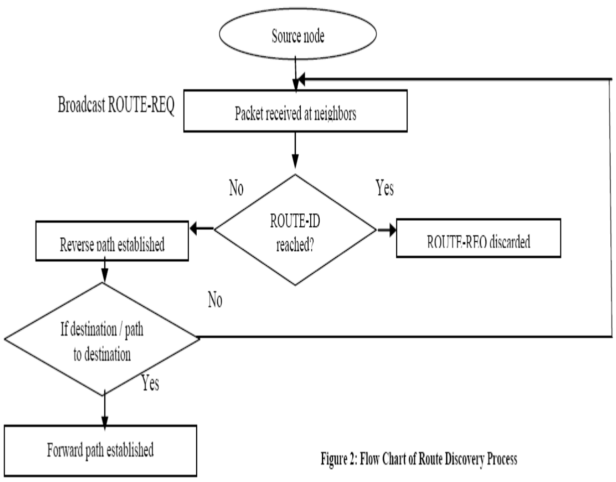

Figure 2: Flow Chart of Route Discovery Process

2.1.2 ROUTE MAINTENANCE

Once the route is established, a route maintenance protocol provides feedback about the links of the route and to allow the route to be modified [6]. Maintenance of the discovered /established route is necessary for two main advantages: (1) Achieve stability in the network. (2) To reduce the excessive overhead required in discovering new route.

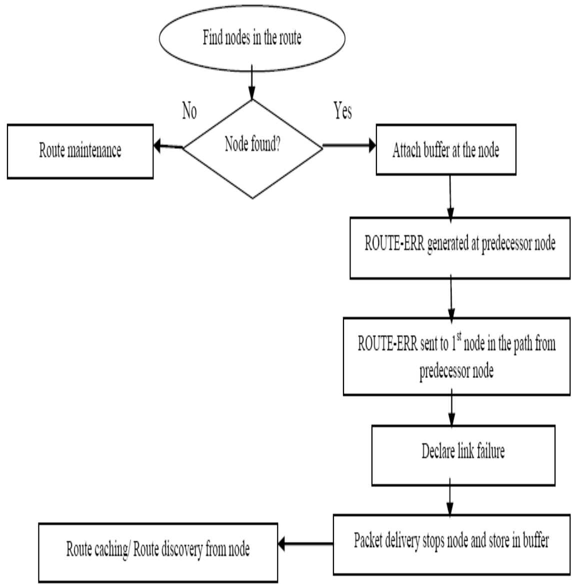

Figure 3: Flow Chart of Route Maintenance Process

2.1.3 ROUTE CACHING

Route caching is carried out for two purposes:

1. A cached route is available to the demanding node to reducing the routing latency significantly.
2. Route caching avoids route discovery process for reduces the control traffic that is required in searching for a new route.

   The caching mechanism in AODV allows one cache entry per destination, therefore, once the initial data packets get a valid cached route, the changes for successful delivery of subsequent packets is almost guaranteed [6]. In AODV routing protocol, a newly discovered route is cached for reused the next time when the same route is requested. AODV carries out route caching both at the source node and at intermediate node that has a cached route to the destination and reply to the source with the cached route.

2.2 OPTIMIZED LINK STATE ROUTING (OLSR)

OLSR is a proactive routing protocol. Every node of network maintaining information about all routes in route table When a route is needed, the route table is immediately available. OLSR uses the concept of Multipoint Relays (MPR) to reduce the overhead in the network. OLSR uses two control messages: (1) Hello and (2) Topology Control (TC). Hello message are used to find the link state and neighbouring nodes. In OLSR, nodes send HELLO messages to their neighbours at a predetermined interval. These messages are periodically sent to determine the status of the links [5]. TC message is used for broadcasting information for neighbours which includes at least the MPR selector list. It also handles the calculation of outing tables. The selection of MPR is done according to the algorithm. Notice that M1, M2 and D(y) are described as follows:

1. M1: Represents the 1-hop neighbours set of the node X which we want to determine its MPRs.
2. M2 : Represent the 2-hop neighbours set of node X. Using Hello message, all 1-hop neighbours of the node X declare their 1-hop neighbours that must request to transmit a packet to its 2-hop neighbours [7].
3. D(y): Represent the degree of 1-hop neighbour node y, is defined as the number of symmetric neighbours of node y, excluding all the members of M and y.

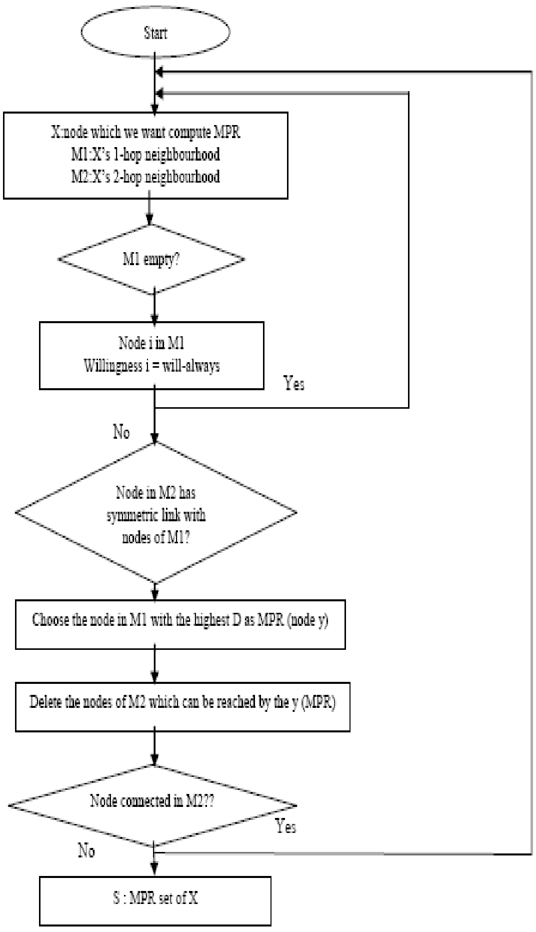

Figure 5: Flow Chart of MPR nodes selection

2.3 DYNAMIC SOURCE ROUTING (DSR)

DSR is also a reactive routing protocol. It uses the concept of source routing [8]. In source routing the sender knows all hop-by-hop routes to the destination. All the routes are stored in the route cache. When a node attempts to send a data packet to a destination it does not know the route. In DSR each node maintains a route cache with route entries which are continuously updated. The advantage of DRS is that no periodic routing packets are required. It is used to updates its route caches by finding new routes [9]. DSR has also the capability to handle unidirectional links. The sender of the packets selects and controls the route used for its own packets, which also supports features such as load balancing. All routes used are guaranteed to be free of loops as the sender can avoid duplicate hops in the selected routes. The following sections introduce state machines that implement a simple DSR routing protocol without caching. There are basically 4 separate state machines to implement that each handles one of the following events [10]:

1. SENDING DATA:

When a node wants to send data and data message is triggered as a send request then the next hop has be determined. A route request has to be broadcast to discover a route to the destination node. After receiving the route reply from the destination node the actual data message can be transmitted via the newly discovered.

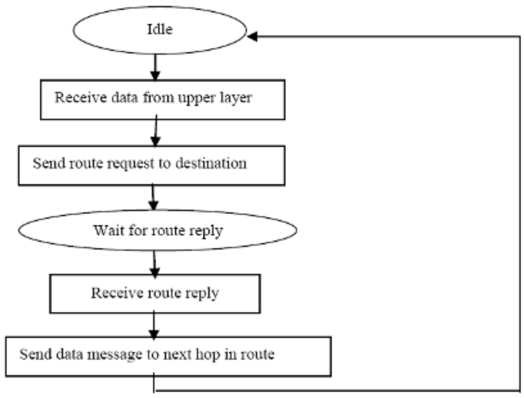

Figure 6: Flow Chart of sending activity diagram

2. INCOMING ROUTE REQUEST MESSAGE:

When a route request message is received by a node, several tasks have to be done depending on the content of the received message. Firstly, it is checked whether the message was already processed earlier by this node. If yes, the request is simply discarded and no action is taken. If the route request is addressed to the receiving node, a route reply message has to be created and replied to the request's sender. In all other cases the route request's node list is extended by the own node ID and broadcasted to all neighboring nodes.

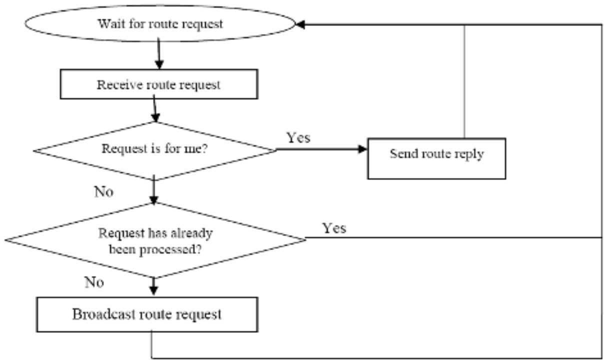

Figure 7: Flow Chart of Route Request

3. INCOMING ROUTE REPLY MESSAGE:

In case a route reply message is received there are two cases: The receiving node is the destination of the message or it is an intermediate node on the route between sender and destination. If it is the destination node the data transmission that caused the route discovery can be accomplished. In case the route reply is received by an intermediate node, it is forwarded to the next node in the reply's node list.

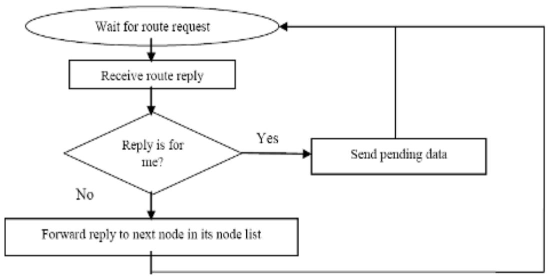

Figure 8: Flow Chart of Route reply

4. INCOMING DATA MESSAGE:

If the data message is addressed to the receiving node (it is the last hop of the route) the payload can be handed to the upper layer to be processed by any application. The routing mechanism has finished. If not, the next hop is determined from the data message's node list and the packet is forwarded to this node.

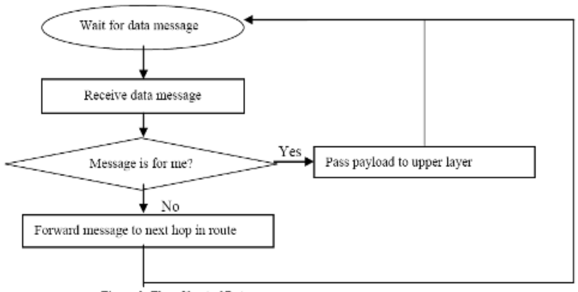

Figure 9: Flow Chart of Data message

DSR contains 2 phases:

2.3.1 ROUTE DISCOVERY (FIND A PATH)

If sender node has in his route cache a route to the destination node, this route is immediately used. If not, the route discovery protocol is started:

Step 1: sender node sends a route request packet by flooding the network. Each route request packet contains: route record, initiator address, request ID

Step 2: if the route discovery is successful the initiating host receives a route reply packet.

Step 3: when any host receives a route request packet, it processes the request accounting to the following steps.

a) If <initiator address, request id> is found I this host then discards the route request packet.

b) If this host's address is already listed in the route record discard the route request packet.

c) If the target of the request matches this host's address return a copy of this route in a route reply packet to the initiator.

d) Otherwise, append this host's address to the route record and re-broadcast the request.

After getting the route reply the sender send the data to the destination.

1. ROUTE MAINTENANCE

In DSR every node is responsible for confirming that the next hop in the source route receives the packet. Also each packet is only forwarded once by a node (hop-by-hop routing). If a packet can't be received by a node, it is retransmitted up to some maximum number of times until a confirmation is received from the next hop. Only if retransmission results in a failure, a Route Error message is sent to the initiator that can remove that source route from its route cache. So the initiator can check his route cache for another route to the target. If there is no route in the cache, a route request packet is broadcasted.

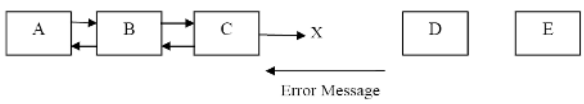

Figure 10: Example of DSR protocol

Step 1: if node C does not receive an acknowledgement form node D after some number of requests, it returns a Route Error to the initiator A.

Step 2: As soon as node receives the Route Error message, it deletes the broken-link-route from its cache. If A has another route to E, it sends the packet immediately using this new route.

Step 3: Otherwise the initiator A is starting the Route Discovery process again.

2.4 GEOGRAPHIC ROUTING PROTOCOL (GRP)

GRP is classified as proactive routing protocol. In GRP the Global Positioning System is used to locate the location of node to collects network information at a source node with a small amount of control overheads. Source node can finds routes and continuously transmit data even if the current route is disconnected. This approach is widely known as hybrid routing protocol, because it can simultaneously use the strengths of reactive routing and proactive routing protocols. A packet that named DQ is used continuously to forward to each node's neighbours until the destination is reached. When it reaches the destination, the destination node broadcasts a network information gathering (NIG) packet to its neighbours. The source node computes the best route according to collected information and then immediately starts to transmit data packets. In GRP two techniques are used. These are :

2.4.1 Geographic Forwarding:

In Geographic Forwarding, the sender node rebroadcast the packet and this packet receives by nearer sensor node. When receiver receives the packet it also receive the time period, it will first store the packet in buffer. At the end of the receive period and if the channel is clear, the packet at the head of the queue in the buffer will be transmitted [11].

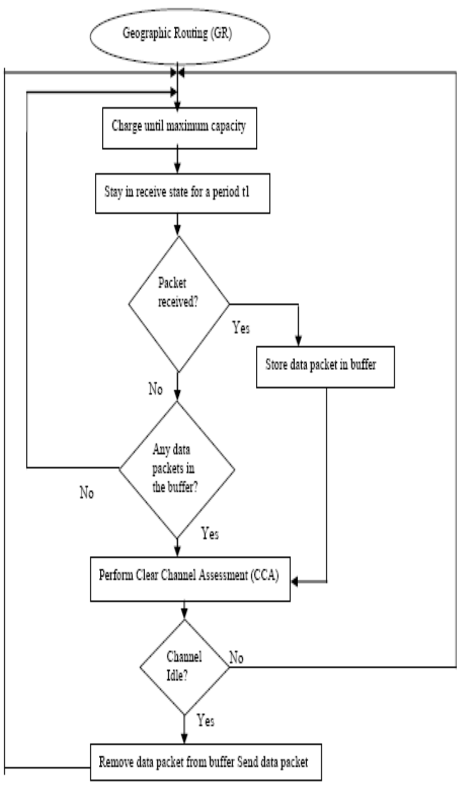

Figure 11: Flow Chart of Geographic Forwarding

2.4.2 Greedy Forwarding:

Greedy forwarding algorithms perform varied optimization techniques to choose the next-hop node near a destination node [12]. Source nodes send messages to destination nodes in greedy forwarding mode. When location service selects the next-hop adjacent to the destination For example, node A selects the next-hop using similar selection rules till the message reaches the destination node. When a next hop is unable to be located by a node, it uses void-handling mode where a node decides to route packets around a void due to the existence of a valid path from source to the destination node [12]. For example we find the shortest path in mesh graph by using flowchart [13].

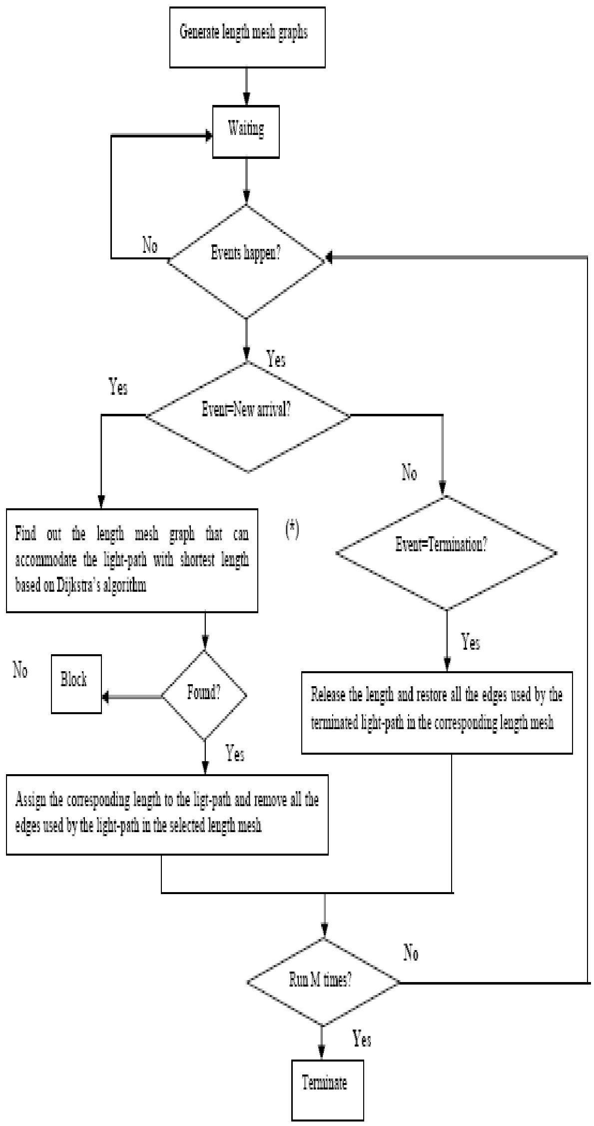

Figure 12: Flow Chart of Greedy Forwarding

3. VARIOUS PARAMETERS IN TRAFFIC LOADS

SR. NO.	PARAMETERS	DESCRIPTION
1	Delay(Sec)	Represents the end to end delay of all the packets received by the wireless LAN MACs of all WLAN nodes in the network and forwarded to the higher layer.
2	Load (Bits/Sec)	Represents the total load submitted to wireless LAN layers by all higher layers in all WLAN nodes of the network.(Global)
3	Media Access Delay (Sec)	For each frame, this delay is calculated as the duration from the time when it is inserted into the transmission queue, which is arrival time for higher layer data packets and creation time for all other frames types, until the time when the frame is sent to the physical layer for the first time.
4	Throughput (Bits/Sec)	Represents the total number of bits (in bit/sec) forwarded from wireless LAN layers to higher layers in all WLAN nodes of the network.
5	Network load (Bits/sec)	Network load represents the total load in bit/sec submitted to wireless LAN layers by all higher layers in all WLAN nodes of the network. When there is more traffic coming on the network, and it is difficult for the network to handle all this traffic so it is called the network load. The efficient network can easily cope with large traffic coming in, and to make a best network, many techniques have been introduced.(node network).
6	Retransmission (Packets)	The number of times data has to be retransmitting i.e called Retransmission Attempts. How many no of times data has to be retransmit by the Source node.

All these parameters help us to evaluate the best routing protocol between them. All the parameters that have taken play a very vital role to judge or evaluate the performance of the wireless network.

4. SIMULATION ENVIROMENT

Several researchers have done the qualitative and quantative analysis of ad hoc routing protocol by means of different performance metrics. They have used different simulators for this purpose which is one of several tools provided from the OPNET Technologies suite. For undertake the experimental evaluation, the most recently available version, namely OPNET MODELER 14.5 has been adopted in our study OPNET is one of the most extensively used commercial simulators based on Microsoft Windows Platform, which incorporates most of the MANET routing parameters compared to other commercial simulators available [11]. The network entities used during the design of the network model are wireless server, application configuration, profile configuration, mobility configuration and workstations (nodes). Table 1 shows the various simulation parameters.

Table 1: Simulation parameters

SIMULATION PARAMETER	VALUE
Simulator	OPNET MODELER 14.5
Area	800x800 (m)
Network Size	20 nodes
Protocol	DSR,OLSR,AODV,GRP
Mobility Model	Random Way Point
Traffic Type	DATABASE
Simulation Time	900 (Sec)
Address Mode	IPv4

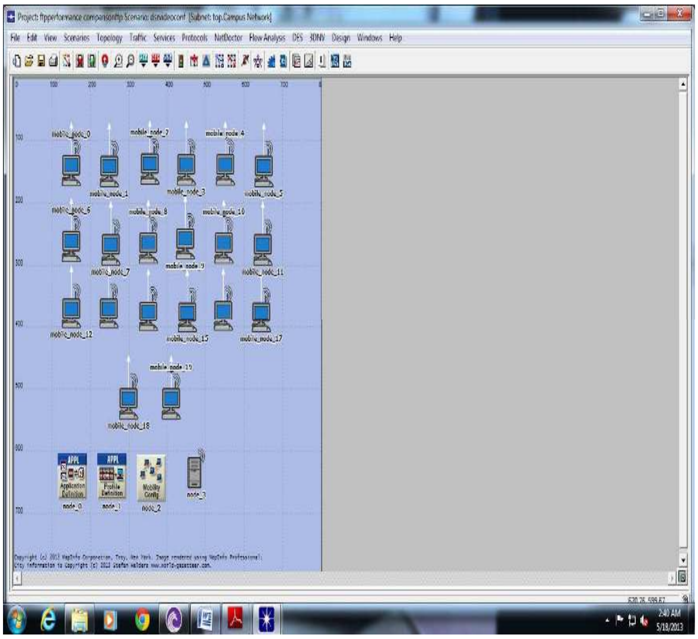

Figure 13: Environment Scenario of 20 Nodes

5. RESULTS AND DISCUSSION DATABASE LOAD

Figure 14: Comparison of DSR, AODV, GRP and OLSR Protocol for Delay in Database Load

In figure 14, X-axis denotes time in minutes and Y-axis is denotes time in seconds. It shows that the average peak value of delay is almost 0.007804 seconds for AODV, 0.008207 seconds for DSR, 0.008014 seconds for GRP and 0.008161 seconds for OLSR. After 15 minutes, it gradually drops and attains a constant value of approximately 0.007144 seconds for AODV, 0.006750 seconds for DSR, 0.007144 seconds for GRP and 0.006585 seconds for OLSR.

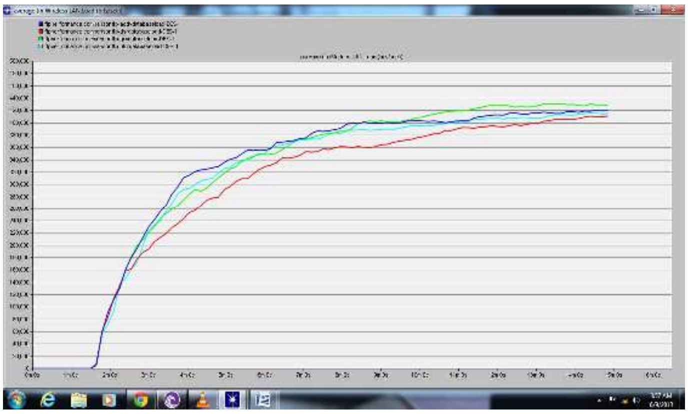

Figure 15: Comparison of DSR, AODV, GRP and OLSR Protocol for Load in Database Load

In figure 15, X-axis denotes time in minutes and Y-axis is denotes data rate which is in bits/sec. It shows that the average peak value of load is almost 420148 bits/sec for AODV, 410631 bits/sec for DSR, 430260 bits/sec for GRP and 415752 bits/sec for OLSR. After 15 minutes, it gradually drops to almost 5021 bits/sec for AODV, 7637 bits/sec for DSR, 5091 bits/sec for GRP and 7631 bits/sec for OLSR.

Figure 16: Comparison of DSR, AODV, GRP and OLSR Protocol for Media Access Delay in Database Load

In figure 16, X-axis denotes time in minutes and Y-axis is denotes time in seconds. It shows that the average peak value of Media access delay is almost 0.002924 seconds for AODV, 0.002832 seconds for DSR, 0.003001 seconds for GRP and 0.002810 seconds for OLSR. After 15 minutes, it gradually drops and attains a constant value of approximately 0.002344 seconds for AODV, 0.002157 seconds for DSR, 0.002344 seconds for GRP and 0.002130 seconds for OLSR.

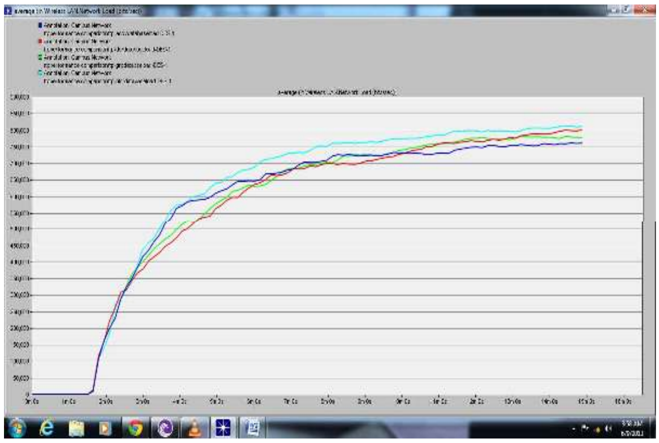

Figure 17: Comparison of DSR, AODV, GRP and OLSR Protocol for Network load in Database Load

In figure 17, X-axis denotes time in minutes and Y-axis is denotes data rate which is in bits/sec. It shows that the average peak value of network load is almost 761704 bits/sec for AODV, 800194 bits/sec for DSR, 781165 bits/sec for GRP and 813179 bits/sec for OLSR. After 15 minutes, it gradually drops to almost 10183 bits/sec for AODV, 15274 bits/sec for DSR, 10183 bits/sec for GRP and 15262 bits/sec for OLSR.

Figure 18: Comparison of DSR, AODV, GRP and OLSR Protocol for Retransmission attempts in Database Load

In figure 18, X-axis denotes time in minutes and Y-axis is denotes data rate which is in Packets/sec. It shows that the average peak value of retransmission is almost 0.04199 packets for AODV, 0.03657 packets for DSR, 0.04199 packets for GRP and 0.03450 packets for OLSR. After 15 minutes, it gradually drops as time progress and reaches to almost 0.01851 packets for AODV, 0.02469 packets for DSR, 0.01851 packets for GRP and 0 packets for OLSR.

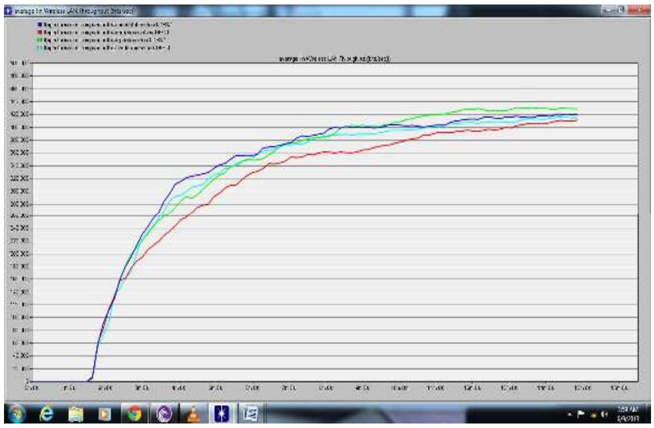

Figure 19: Comparison of DSR, AODV, GRP and OLSR Protocol for throughput in Database Load

In figure 19, X-axis denotes time in minutes and Y-axis is denotes data rate which is in bits/sec. It shows that the average peak value of throughput is almost 420148 bits/sec for AODV, 410569 bits/sec for DSR, 430260 bits/sec for GRP and 415752 bits/sec for OLSR. After 15 minutes, it gradually drops to almost 5091 bits/sec for AODV, 7637 bits/sec for DSR, 5091 bits/sec for GRP and 7631 bits/sec for OLSR.

Table 3 shows numeric values of various parameters taken into consideration for Email load in AODV, DSR and OLSR protocols. It gives the performance comparison of 3 protocols in terms of delay, load, media access, network load, retransmission attempts and throughput for email load.

Table 3: Values of various parameters corresponding to 4 protocols for Database load.

Protocols → Parameters ↓	AODV				DSR				GRP				OLSR			
	Peak value		Drop value		Peak value		Drop value		Peak value		Drop value		Peak value		Drop value	
	Seconds	Value	Seconds	Value	Seconds	Value	Seconds	Value	Seconds	Value	Seconds	Value	Seconds	value	Seconds	Value
Delay (Sec)	117	0.0078	99	0.0071	891	0.0082	99	0.0067	405	0.0080	99	0.0071	486	0.0081	99	0.0065
Load (Bit/sec)	873	420148	99	5021	891	410631	99	7637	792	430260	99	5091	873	415752	99	7631
Media Access Delay (Sec)	117	0.0029	99	0.0023	891	0.0028	99	0.0021	342	0.0030	99	0.0023	486	0.0028	99	0.0021
Network Load (Bit/Sec)	873	761704	99	10183	891	800194	99	15274	792	781165	99	10183	873	813179	99	15262
Retransmission Attempts (Packets)	126	0.0419	99	0.0185	828	0.0365	99	0.0246	126	0.0419	99	0.0185	522	0.0345	99	0.0000
Throughput (Bit/Sec)	873	420148	99	5091	891	410569	99	7637	792	430260	99	5091	873	415752	99	7631

As shown in Table 3, AODV performs better than DSR, GRP and OLSR protocol for delay. For load parameter GRP performs better than AODV, DSR and OLSR because it transfers large number of bits in second as compared to AODV, DSR and OLSR protocols. For Media Access Delay DSR and OLSR is better than AODV and GRP because in DSR and OLSR, the drop value is less than GRP and AODV For Network Load GRP is better than DSR, AODV and OLSR because in GRP transmission of bits are more than DSR, OLSR and AODV in seconds DSR is better than AODV, GRP and OLSR for retransmission attempts because the packet in DSR sends more packets than GRP, AODV and OLSR. For DSR, route discovery and route maintenance is done by using route cache for the retransmission of packets. So the DSR is better than GRP, AODV and OLSR. For throughput parameter GRP is better than OLSR, DSR and AODV because GRP transfer more data in bits from lower layer to higher layer.

CONCLUSIONS

In this paper, we performed the comparison between four protocols AODV, GRP, DSR and OLSR with traffic loads database in terms of Delay, Load, Media access delay, Network Load, Retransmission and Throughput. The results are taken in tabular form as well as graphical form by using OPNET Simulator 14.5. The results show that which protocol performs better than another corresponding to various traffic loads for some important parameters.

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