Indian Journal of Science and Technology, *Vol 9(45), DOI: 10.17485/ijst/2016/v9i45/102597, December 2016*
ISSN (Print) : 0974-6846
ISSN (Online) : 0974-5645

Shortest and Efficient Multipath Routing in Mobile ad hoc Network (MANET)

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Abstract

Objectives: In this paper, our work is intended to improve the nodes mobility within the network, as it is still in development stage. **Methods/Statistical Analysis** An automatic system for finding the efficient routing path is still a challenging task. In order to overcome the problem, we propose Short and Efficient Multipath Routing (SEMR) protocol which enables successful routing system by enabling minimum bandwidth in accordance with delay free networking system. **Findings:** This (SEMR) protocol applies on-demand routing protocols which find shortest route for communication-based on default parameters. The packet transmission consumes less packet loss ratio with minimum data rates. The implementation work is examined by means of performing simulations in NS2. Here the simulation parameters among every node were implemented based on the 802.11 standards according to the parameters. The test case is carried out with 200 nodes which compare the various factors like packet drops, testing the ability in finding the intermediate nodes, bandwidth and time delay. The best fact of Short and Efficient multipath routing (SEMR) methodology is the exchange of different parameters according to the protocol stack. It is also efficient in terms of security on finding the routes compared to the traditional or other mechanisms currently available in the industry. **Application/Improvements:**The SEMR protocol performance is tested with other existing protocols such as Ad-hoc On-Demand Distance Vector (AODV) and Destination –Sequenced Distance-Vector outing (DSDV). By which the obtained shows that the new scheme is free from fault tolerance with competent in achieving the networking system. Finally, the proposed system is well capable of decision making, especially in the network layers.

Keywords: Fault Tolerance, MANET, Multi-Path Routing, Routing Protocol, Shortest path

1. Introduction

Generally, Mobile ad hoc networks (MANETs) are a structure less network and forms networking by means of the nodes. It operates in this manner if any nodes fails in a network it selects a nearby node to establish a network connection and completes the communication by reaching the destination point. The nodes in the networking system are all energetic and based according to the arbitrary topology.[1] The mobile nodes are distributed which has the capability of moving independently in any region and organizing themselves as the network for communication. The resource restrictions like bandwidth, power, and processing should be improved among MANET nodes. By means of these three factors, the network performance can be estimated either as efficient or not. The conventional network has usual problems of wired and wireless networks are seen in MANET also. In addition to it, the standardization and lack of network architecture were also considered as a major drawback. As per the traditional networks, the impacts of wireless network security are based on two factors, one is based on trust establishment, key management, and controlling membership. The second one is dealing with the availability of network along with routing security.[2]

A common need in the industry is a MANET network without any limitation of nodes taking part in forming the network. In order to achieve this, considerable changes

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should be done to the existing protocols. Initially on a network routing is the important factor which transfers the message packets with the help of intermediate nodes. There is no direct connection between these nodes, which require some path finding mechanism and works by means of certain protocols. That is known as a routing protocol. Since MANET forms by means of mobiles nodes researches on routing has increased widely in which the ways were not connected. This shows a major drawback still available in maintaining the paths. This can be resolved by various protocols that have been proposed according to the applications diversity and nature. Routing protocols are of three types such as proactive, reactive and hybrid. Hybrid routing protocol withholds the functionalities of both proactive and reactive routing features. The path used by the hybrid routing protocol is in proactive manner by which remaining routes in the reactive fashion. Some of the well-known hybrid protocols wee ZRP (Zone Routing Protocol)[3] and ZHLS (Zone based Hierarchical Link State Routing)[4]. For a successful transmission, three factors are essential such as discovering route, maintenance, and data transmission. In a network if a packet is going to be send, it means initially, packet route request should be broadcasted based on that the routes were discovered. In response to it, the available routes were replied. In which multiple available routes were gained in the reply and the sender has to choose the best among them. The chosen path is said to best one only if it is the shortest path to the rest. As earlier work shows multiple protocols were proposed which provided various ways in choosing a single path.

The main issue in picking the single path routing is it reflects the bad performance on the aspect of throughput, delay, and bandwidth. They overcame this drawback by executing cross- layered routing protocol with the multipath design. Basically, in a network, shortest path is suggested for transmission between the nodes[5]. There is no fault tolerance problem in single path protocols but it still suffered from lack of capacity in load distribution within the network. This problem enables the research of multipath routing into existence. It is a traditional circuit switched network in which call blockages were reduced by diverting the call into another route. Next thing is if the sender knows all the paths, decision making in selecting the best path and distributing the load between the nodes is easier.

The Multipath approaches have types such as link disjoint and node disjoint multipath routing systems. The overall network performance is reduced based on delay and packet loss which is due to applying shared medium[6]. To apply a multi-hop communication proper analysis of physical, MAC, and routing layer is needed. For mobility node, new routes needed frequently still it reaches the transmission[7]. The link stabilization is achieved by shadowing environment feature RSS (Received Signal Strength) and the risk factor is judging the paths required in completing the transmission. Somewhat multiple paths have capable of overloading with some improvement in throughput. Generally, multipath scheme[8-9] applies two or three paths for transmission.

The above-discussed protocols have several advantages like load balancing, fault tolerance, bandwidth and minimizing delay which are considered as the major problems regarding the MANET. But even though these protocols still not considered as an efficient protocol due to such drawbacks like longer path, the requirement of special control messages and route request storm which considerably increases the time. The inefficient route along with lack in discovering the duplicate packet processing is still to overcome to make those protocols as well efficient ones.

Herewith we have discussed the various protocols like AODV, DSDV, DSR, Optimised Link State Routing (OLSR) and Predective Location-Based QoS Routing (PLBQR). Each protocol has advancement as well as drawback that enables the researchers in involving the establishment of a prominent protocol for a network. On this way AODV[10,11] imply the DSDV philosophy by which demand scheme is improved in several aspects. It enables up – to – date routes and minimize the route maintenance phase accordingly. These protocols were applicable for active nodes for sharing and controlling the control reports. The loops were avoided and routes freshness was stabilized by allocating the destination sequence number between the source nodes. According to the DSR, AODV broadcast the Route Request (RREQ) among its neighbouring nodes without the source node. The source node and intermediate nodes gather the next hop routing information from the routing table. Then the RREQ is rebroadcasted, if it reaches the destination point its reply with RREP. On that reply, it has the information about entries of reverse path and created by which intermediate nodes. The intermediate nodes which know the destination node, enables the RREP to check the sequence number if it is greater or equal according to the RREQ. If an error occurred it means a RERR (Route ERROR)

is generated and shared at both ends. The RERR also removes the route entries by means of the end nodes. The major drawback of AODV is the source node has very small sequence number those are used by the intermediate nodes. As a result, it enables stale route which causes RERR often.

DSR[12,13] is the most familiar on-demand routing protocol well known for maximum consumption of bandwidth in a proper way. It is entirely different from other protocols which use source routing without the knowledge on the routing table. The source node has no loop and there is no need to update information in order to save the time. The DSR protocol works with two factors such as Route Discovery and Route Maintenance. The DSR protocol does not use HELLO message and the route discovery phase is active by flooding the RREQ (ROUTE REQUEST). It is applicable for the destination node receives RREQ replies by means of RREP (Route Reply) in the same manner. The source routing is applied by route cache. If the intermediate nodes do not know the destination point it will fix their address in RREQ which are retransmitted to its neighbour's also. On converse it enables RREP to pass through them and updated on routing table, done accordingly by the intermediate nodes.

OLSR[12] is also known as the table driven protocol in which the nodes share the messages among the neighbor nodes at regular intervals. It has the updating of topological information regularly. The MPR (Multipoint Relay) reduces the classical mechanism flooding in a better manner. The knowledge between the neighbors' was shared by transmitting the HELLO messages among them. The MPR are subsets of nodes which broadcast the information by forwarding them instead of message transmitting when it received at first time. These MPR nodes generate linking information's that enables in controlling the control message flooding. The MPR nodes are efficient in analyzing the fine routes and operate in a perfect manner for huge and solid networks.

According to PLBQR[13] it predicted that the future physical location of nodes based on its previous locations which are updated. As per this, it will enable the future routes for those nodes. By means of the mechanism of future physical location, it avoids Stale routes which increased in path reliability. The updated protocol, location, and delay prediction methodology involve in achieving QoS routing. According to this protocol, the nodes geographical information's will broadcast along with the periodical information's. As per the Type 1 update and Type 2 messages the information's were updated before starting the communications. The source node estimates the intermediate nodes as well as destination nodes geographical information's in a better manner. The prediction of geographical information's enables minimum delay and achieves proper communication between intermediate as well as destination nodes[14,15]. The initial work in achieving the QoS routing, involves in understanding the depth of finding routes based on their requirements. By analyzing, the geographical information's shortest routes were suggested but the major drawback is there is no resources were available on the path. This leads to cause the mistake in predicting the delay[16,17].

2. Proposed System

The design of proposed work is structured by gathering information from different existing protocols. According to AODV is best for simple application but on multipath routing, it is not efficient due to the lack of security. The DSDV is a little bit advanced protocol than the AODV regarding the reduction in route maintenance phase and involves in showing up-to-date routes. But it is also not considered being effective due to the factor of time delay. On this way, the DSR is the most popular on-demand routing protocol but it requires more control messages that make it unpopular as delay in time management. The OLSR and PLBQR are the well-known table driven protocols were appreciated for the minimization in flooding of control messages. The problem is it does not have the resources about the available path; as a result, it leads to mistakes in forecasting the delay. Based on these factors, the proposed system SEMR is dealing with drawbacks as to prove our protocol is more efficient than the others.

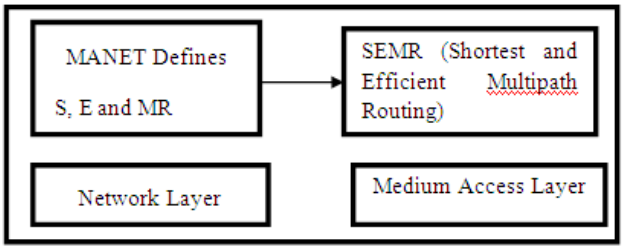

Figure 1. Architecture of SEMR protocol.

Figure 1: Architecture of SEMR protocol explain proposed mechanism analyzed to be effective in deciding the various routing path between the nodes as per applications. The proposed scheme architecture is as shown in

Source ID	Set of Neighbor Nodes	Set of Nodes N1,N2,N3…..N	Simulation Time	Destination ID

Figure 2. Packet format of route request and reply.

Application type	Number of nodes	Parameter used	Source ID	Destination ID	Path 1	Path 2	Path 3	Timer

Figure 3. Routing table format.

Figure 1, by which the application layer has S, E, and MR, where (i) Shortest Path; (ii) Efficient Route selection process; (iii) MR represents Multipath Routing Scheme.

1. S-Represents Shortest Path.
2. E- Represents Efficient Route selection Process.
3. MR- Represents Multipath Routing Scheme.

Some of the salient features in our proposed schemes are listed below;

(i) The application layer defines the application type.
(ii) The network layer has the working of Multipath routing.
(iii) The delay parameters of Bandwidth and end-to-end delay were accessed from medium access layer.

2.1 Basic Assumptions

Generally MANETs were well applicable for three kinds of applications such as Default, Mobility, SEMR applications. These applications have security issues widely.

2.2 Basic Design

For enabling a successful transmission the proposed routing mechanism has two kinds of control packets to monitor the routes between the communication nodes.

(i)A requesting for broadcast route.
(ii) reply for broadcast route.

From the Figure 1, it is clear about the formats of route request packet which contains several fields like source ID, destination ID, routing parameters, the number of intermediate nodes and timer. By adding the number intermediate nodes each individual intermediate nodes were increased. The parameters are up to *N*3, and the rest of subfields (*N*4, *N*5, and *N*6) are implemented for future. The parameter for the default routes will be null and if the timer expires it automatically discards the requested route for the packet transmission as shown in Figure 2. It is vice versa for the packet request also.

2.3 Routing Table

The information in the routing table plays a vital role based on which the path selection is done according to the applications. The major information available in the routing tables are the destination address, hop count, and a number of routes. The routing table is shown in Table 2. A per the information from the table three paths enables a proper route for communication. At least for sending a data two paths needs to select and Manet creates the path which also suspends regularly when it is required. As per this, our proposed methodology also junks the entries in the routing table after a period of time in the timer gets expired.

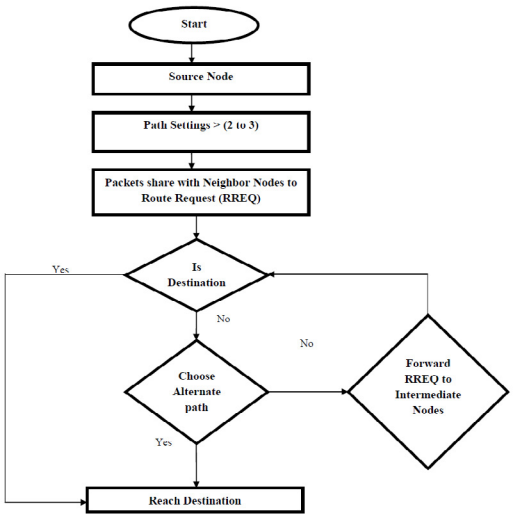

Figure 4. Default route.

2.4 Route Discovery Process (Default Route)

The default route discovery based on the on-demand philosophy based on that new route formed according to

the requirement on time. It is same as AODV[9] by which among the available paths multiple short routes were selected between the source and destination. The Figure 3 explains the performance of processing flow between RREQ and RREP clearly. According to the RREQ broadcast source node process started which also explain the necessary number of paths required for the completion of an application. The further broadcasting of RREQ to its neighboring nodes are done the intermediate nodes with one condition, those intermediate node should not be the destination node. Then a fresh path by means RREP is sending to reach the destination. On other side the reply is done by the destination node as per the number of paths required by the application. The N path in the communication model represents the replies of destination node as N RREQs and it unicast RREP still reaching the source node. A fresh RREQ in a case of REER is created by the source node at the time communication.

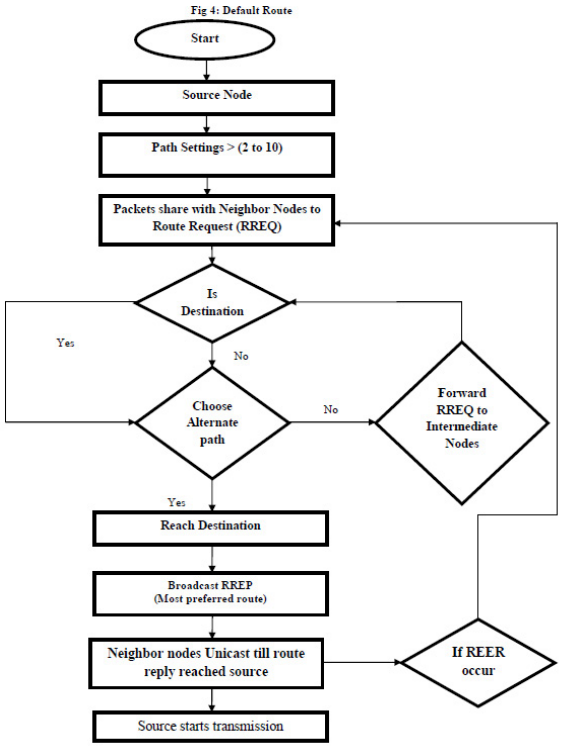

Figure 5. SEMR path.

2.5 Route Discovery Process (SEMR)

The Route discovery process by means of our proposed scheme follows same as default note on dealing with the multimedia application. The key point is as not like default route, it takes the parameter from the various layers as per cross layer according to the delay and bandwidth. The amount of maximum bandwidth and minimum delay by the destination node is counted by the reply thus achieving efficiency in overall network performance.

2.6 Route Selection Process

This section holds the Route selection process of the proposed mechanism clearly.

2.6.1 Default Route

At the time of transmission, the default routes gather normal data required to complete the transmission by means of two routes or multiple routes from source to destination. The selected route will be the shortest among the rest as per in terms of hops. In default route, path discovery is shown clearly in Figure 6 as per which the route request is sent by the source to its neighbors. If the destination node receives all ROUTE-REQ and the best path is selected based on the utilization of available parameters. As discuss earlier in default routes the preferences were given to the shortest routes and reply implies on the number of paths by the destination.

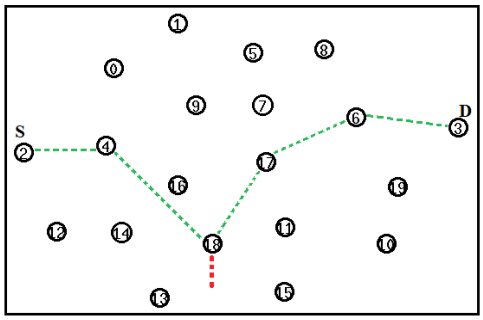

Figure 6. Path 1.

2.6.2 Application Route SEMR

In this section Figure 5, 6 and 7 represent the Path discovery process of our proposed scheme SEMR for an application.

The request route between source and destination is selected, by which once the request route is reached the destination it calculates maximum bandwidth and minimum delay among the all route request.

Algorithm for Proposed Path discovery

1. $\alpha S_{ik} \Rightarrow$ Source Formation
2. $\lambda R_{ik} \Rightarrow$ Alternate Path Selection

3. $\Delta D_{\alpha} \Rightarrow$ Destination
4. $\Delta P_t \Rightarrow$ Packets and ID's
5. $\Delta A_{th} \Rightarrow$ Alternate Path Chosen
6. $\Delta P_t \leftarrow \lambda R_{ik}$
7. {
8. For (λR_{ik} =0; $\lambda R_{ik} \leq n$; λR_{ik} ++)
9. If
10. {
11. $\lambda R_{ik} \leftarrow q_{ik}(x)$ The Path is Break
12. Else
13. $\lambda R_{ik} \leftarrow \Delta P_t(y)$ The Packet was Dropped
14. }
15. End if
16. End Process
17. Choose the SEMR Process to Rectify the unknown Packet
18. $\Delta P_t \leftarrow \Delta A_{th}$
19. {
20. For (ΔP_t =0; $\Delta P_t \leq N$; ΔP_t ++)
21. {
22. if
23. $\Delta P_t \leftarrow x(i)$ // Path is Busy Divert into Alternate Path
24. Else if
25. {
26. $\Delta P_t \leftarrow y(i)$ // Current path is Busy Choose Alternate Shortest Path
27. }
28. }
29. $\alpha S_{ik} \rightarrow q_{ik}(x) + \Delta P_t(y)$
30. $\Delta D_{\alpha} \rightarrow x(i) + y(i)$
31. end if
32. End Process

Figure 6, 7 and 8 clearly show the performance of path selection by proposed system in order to complete the transmission. Initially, the packet transmission starts from source node till destination node. From the Figure 5 it is clear that packet transmission between nodes 2 to node 3 implies source as well as a destination. For this transmission, the routing path is 2, 4,18,17,6,3. In which during the transmission a packet drop is occurred on intermediate node 18, here by means of improved mechanism our proposed protocol chooses an automatic alternative intermediate node 1 and creates a new path 2,4, 1, 7, 6,3 as shown in Figure 6. If it has some packet drops it again creates a new route of 2,14,18,11,19,3 considering the shortest path which is shown in Figure 7. This work happened routinely till all the transmitted packets reach destination node and successfully delivered the packets.

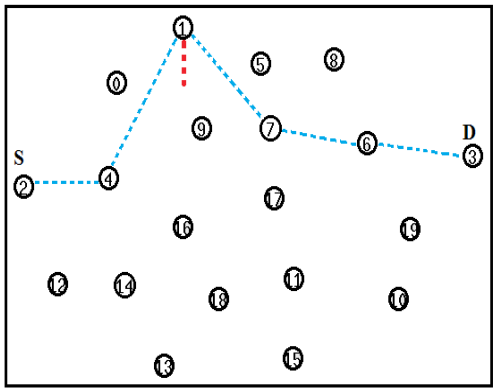

Figure 7. Path 2.

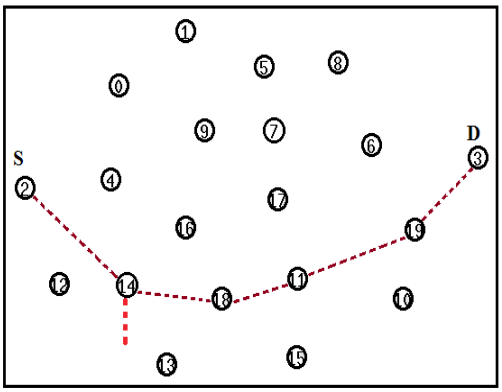

Figure 8. Path 3.

3. Experimental Results

In order to prove the efficiency of our proposed system, we undergo the overall performance under simulation. The implementation work is examined by means of performing simulations in NS2.

The Figure 9 shows the performance comparison of data rate VS packet deliver ratio between the three proto-

cols DSDV, AODV and SEMR. Here data rate is nothing but a bit rate consumed by nodes during transmission, all the nodes applied with three protocols to deliver a packet simultaneously. Here packet deliver ratio is a ratio of successfully received packet by the source in a network. And it is clearly shown in the above graph, SEMR's enormous performance with green bar representing in both speeds (mbps) and delivered ratio.

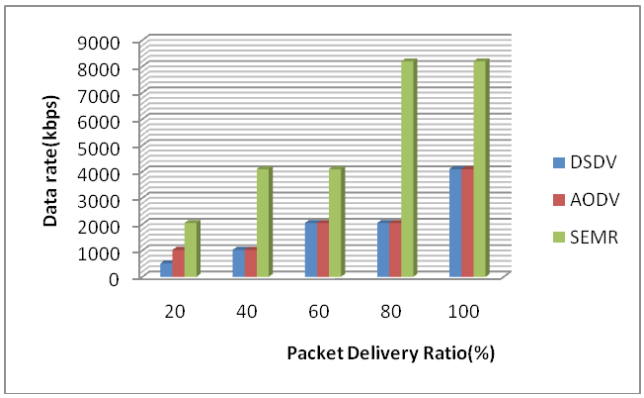

Figure 9. Packet Delivery Ratio (%) Vs Data Rate (Mbps).

In Figure 10the communication overhead and the transmission rate is compared between three protocols each represented by separate color such red (SEMR), green (DSDV) & blue (AODV). Communication overhead is the time taken for communicating between the same networks during transmission and result shown in X axis. The transmission rate is experimentally demonstrated in the Y axis for three protocols in the exponential form of Txrate $= 10^3$ .The result is shown in the red line resembling SEMR protocols performance is far better than the other two protocols.

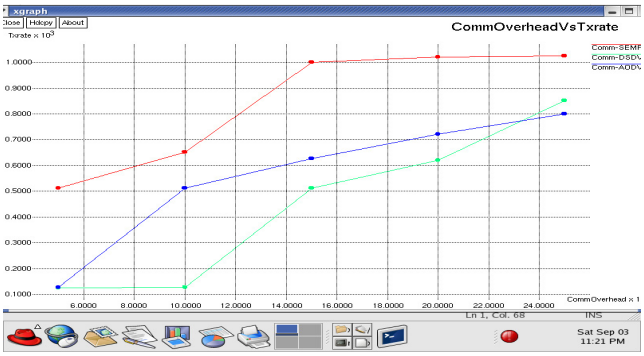

Figure 10. Communication overhead Vs transmission rate.

This graphical result Figure 11 shows packet deliver ratio with the time taken by the node in completing a transmission. Packet delivery is calculated in ratio and time consumption at second which is shown at x-axis and Y-axis respectively in above graph. By means of varied colors, the proposed protocol with red line grows excellent at regular intervals proving its efficiency among the two protocols in a network.

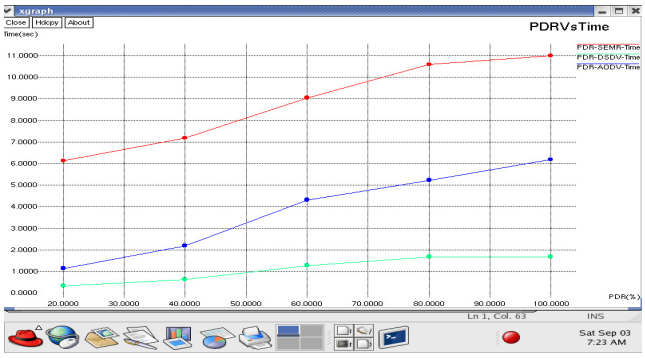

Figure 11. Packet deliver ratio Vs time.

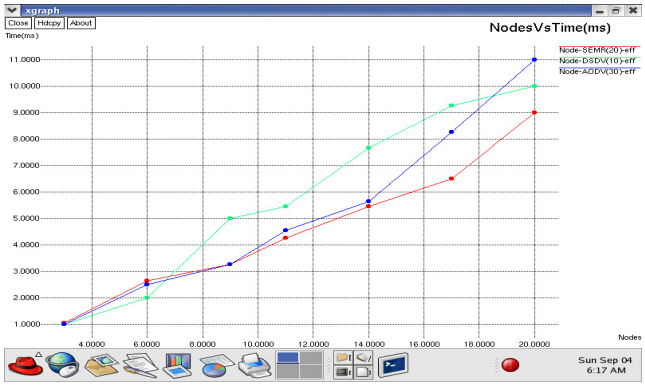

Figure 12. Performance evaluation of three protocols.

Figure 12 shows the result obtained by the proposed scheme Multimedia Split Equal –cost Multipath Routing (SEMR) compared with existing protocols AODV and DSDV. The transmission undergoes among 200 nodes which compare the various factors like packet drops, testing the ability in finding the intermediate nodes, bandwidth and time delay between the AODV, DSDV and our proposed protocol. It also experimentally shows the load balancing and in managing the network traffic by selecting the best route compared to the other protocols. Figure 12 shows the performance evaluation of three protocols in consuming bandwidth bit rate to the packet delivery ratio. By means of the improvised mechanism in our proposed scheme results in embarrassing performance compared to AODV and DSDV in the aspect of bit rate consumption. By the point of graphical view,

the effective balancing overhead and minimum delay in delivering the packet proves the proposed SEMR protocol is more prominent than the AODV and DSDV in all manners.

4. Conclusion

We presented a novel SEMR routing protocol for efficient routing in MANET. Security and adaptive capacity are some of the major key factors of the proposed system. By means of cross-layer interface, SEMR protocol achieves best routing path by choosing best among multipath based on their application type. It is achieved by employing multipath framework with cross- layer interface as mentioned above. The performance of proposed system is evaluated with traditional protocols such as DSDV and AODV in the application environment. The overall performance of these protocols is compared with various factors along with the security. The obtained results prove that the proposed system is more efficient in the factors like packet delivery ratio, average delay, and routing overheads compared to other protocols. Thus achieving the efficiency in all key factors is required for efficient transmission.

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