A Case Study on Performance Analysis of Routing Protocols In Mobile Ad-Hoc Networks (Application In Medical Systems)

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Abstract- *Mobile Ad-hoc network (MANET) has a dynamic topology of nodes which is based on wireless links with no established infrastructure. The application is considered in a medical based project and therefore the most effective routing must be followed to send and receive information. In this project we compare the performance of the different routing protocols in MANET. Reactive routing protocols such as Dynamic Source Routing (DSR), Ad-Hoc on Demand Distance Vector (AODV) are evaluated using QualNet simulator 5.0. The criteria used for performance analysis are throughput, end-to-end delay (average), packet delivery ratio.*

Keywords- MANET, AODV, DSR, ZRP, OSLR, Routing

I. INTRODUCTION

Medical systems, being life critical domains, fast and reliable communication among mobile components has always been a major issue. For this purpose, we propose the most efficient protocol based on the performance analysis of certain protocols used in Mobile Ad Hoc Networks (MANETs). MANETs are self-configuring, infrastructure less and do not require any central administration. In these networks which one node communicates with the other using multi-hop links and each device in MANET is independent to move in any direction. Routing paths in MANETs potentially contain multiple hops, and every node in MANET has a responsibility to act as a router [1]. MANETs face routing as a challenging task ever since the introduction of wireless networks due to the fact that they have a high degree of node mobility. As nodes need to coordinate each other for being in a distributed environment to get a cumulative result, routing is main concern here. For attaining an optimal result, routing should be either proactive or reactive [2].

Routing Protocols

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A Routing Protocol states how routers communicate with each other, disseminating data enabling them to select routes between any two devices on a network. Each router has knowledge about networks which are connected to it directly, well beforehand. The protocol conveys this information first to the nearest neighbors, and then to the whole network. Hence, routers gain the knowledge of the network topology.

The following are the three types of routing protocols:

- Proactive Routing Protocols: These are table driven routing protocols in which each node maintains a routing table to each other node. These routing tales are updated frequently so that an up-to date network is maintained. A major advantage that these protocols face is that each node in the network should maintain an updated table at all times.
  Ex: DSDV, OLSR, etc.

- Reactive Routing Protocols: Unlike the Proactive protocols, these protocols do not maintain an updated routing table. Instead, they create routes whenever required and hence are known as on demand routing protocols. A route discovery is initiated when a source needs to connect to a destination and ceases to exist when it is no longer needed.
  Ex: DSR, AODV. Etc.

- Hybrid Routing Protocols: These protocols are a mixture of the advantages of both Proactive and Reactive routing protocols. These protocols enhances current routing protocols by creating a mesh and cater multiple alternate routes.
  Ex: ZRP, TORA, etc.

II. BACKGROUND

MANET have specific dynamic nature which makes it suitable for different applications. Certain areas of applications involving emergencies like natural disasters employ MANET due to their properties of quick deployment and minimal configuration. The advance in technology which has increased the number of Wi-Fi enabled mobile devices, laptops, and other portable devices, which is a genuine reason

for the popularity of MANET. Extensive research work has been carried out on the evaluation of routing protocols using the tool NS2. Considering the implementation of networks to medical applications, some issues need to be followed by the routing decisions which are related to energy resources in since energy sources are scarce. MANET best suits our area of application and this paper evaluates and compares performances of some dynamic source routing protocols to obtain a better performance in terms of end to end delay, network and throughput.

AODV: The Ad-Hoc on Demand Distance Vector Routing Protocol is an on demand or reactive routing protocol [3]. This protocol uses the method of broadcasting the route request packet to propagate through the network till it finds a node with the information about the destination or till it reaches the destination.

DSR: The dynamic source routing protocol is an on demand routing protocol, which uses source routing [4]. In DSR the routing information is contained in the packet header. Since the data is contained in the there is no need for the intermediary nodes to maintain the routing information. Another feature of DSR is that it preserves a root cache. This protocol is advantageous as it helps reduce the control overheads for the route discovery, using route cache. On the other hand, a disadvantage of DSR is that in case if it is used for large networks, the header size increases in turn increasing the overhead due to source routing.

ZRP: Zone Routing Protocol is hybrid routing protocol which effectively brings together the best features of both proactive and reactive routing protocols [5, 6]. In ZRP a zone is defined around each node itself which is the number of hops to the zone perimeter. Zone radius has to be chosen carefully so as to prevent a node from being in multiple zones and preventing zone overlapping.

OLSR: Optimized Link State Routing is a proactive link-state routing protocol, which uses hello and topology control (TC) messages to locate and then disseminate link state data all over the mobile ad hoc network. Individual nodes use this topology data to calculate next hop destinations for every node in the network using shortest hop forwarding paths.

Performance Metrics

There are a number of quantitative measures which can be used to analyze and compare the performance of the various routing protocols. For the purpose of our MANET application in medical systems, we have used the following metrics as the measures:

1) Packet Delivery Ratio
   This is the ratio of the number of packets received by the destination to that sent by the application layer on the sender's side. For the purpose of better performance, this ratio should be better.

2) Throughput
   It is defined as the total amount of data received by the receiver divided by the total time it takes to receive the last packet. It is measured in the unit of bits per second (bits/s).

3) Average End-to-End Delay
   This metric basically includes all the delay that might have occurred anytime between the data transmission and receiving which might include route discovery latency, propagation and transfer time, etc.

III. RELATED WORK

As the MANET is formed without any central access point, protocols engaged in this network have to face several challenges due to changes in topologies (dynamically), lower transmission power and asymmetric links in the network [7]. AODV routing protocol is suited for a large scale network and DSDV routing protocol suited for a small scale network, the AODV routing protocol is preferred more than the DSDV routing protocol.

OLSR has the least end-to-end delay and jitter [6]. DSR has the highest received throughput and total packet received compared to OLSR, DYMO and ZRP. Hence we can conclude that if Throughput is our main requirement, then DSR is better in high mobility case and if jitter and end-to-end delay is our requirement then OLSR is better than other routing protocols [9].

IV. SOFTWARE ENVIRONMENT

In the Architecture mode of the simulator the scenario is designed in an area of 5000m x 5000m. Number of nodes is kept as 20. Network traffic type is chosen as CBR (Constant Bit Rate) type, we have used 18 CBRs. The node mobility model is set up as Random Waypoint Mobility.

Table 1: Scenario Description

Parameters	Values
Area Size	5000 x 5000 m
Routing Protocols	AODV, DSR, ZRP, OLSR
No. of channels	1
Network Protocols	IPv4
Number of Nodes	20
Number of CBR	18
Mobility Model	Random Waypoint Mobility
Node Placement	Random
Radio Type	802.11b
Traffic Type	CBR

Model Setup

Before Simulation:

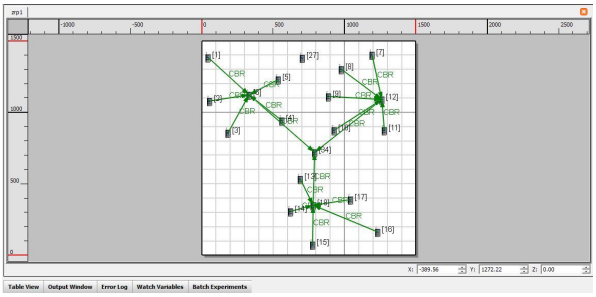

Fig.1: Model before Simulation

Moving Nodes:

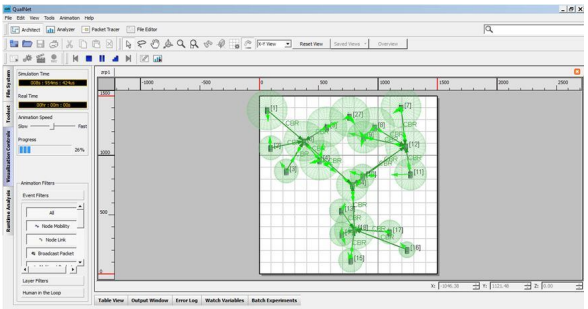

Fig.2: Nodes during Simulation

Nodes after Simulation:

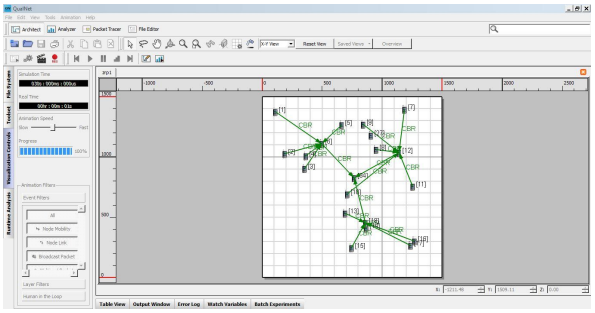

Fig.3: Nodes after Simulation

Nodes (1, 2, 3, 4; 7, 8, 9, 10, 11; 13, 14, 15, 16, 17) are considered to be the ambulances of a hospital which report about their positions to the repository nodes (6; 12; 18) respectively. The repository nodes reports to the main node - Hospital (34). This way the Hospital has all the data about its ambulances.

An analysis of the above network has been carried out to select the best protocol to communicate among different MANET routing protocols AODV, DSR, ZRP based on their performance. The performance metrics used for analysis are throughput, packet delivery ratio and average end to end delay.

V. ANALYSIS AND DISCUSSIONS

AODV

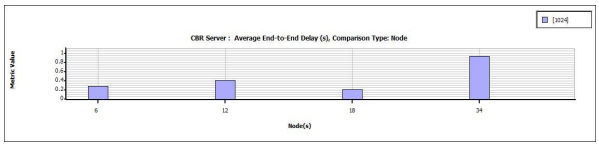

Fig.4: End to end delay (s) - AODV

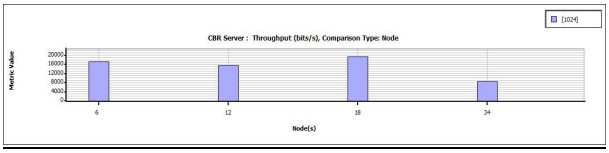

Fig.5: Throughput (bits/sec) - AODV

DSR

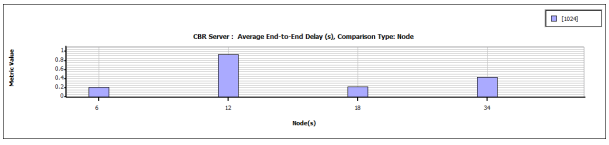

Fig.6: End-to-end Delay (s) - DSR

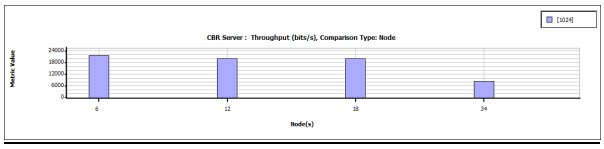

Fig.7: Throughput (bits/s) - DSR

ZRP

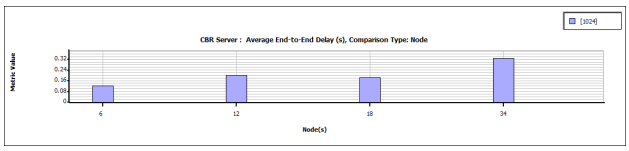

Fig.8: End-to-end delay (s) - ZRP

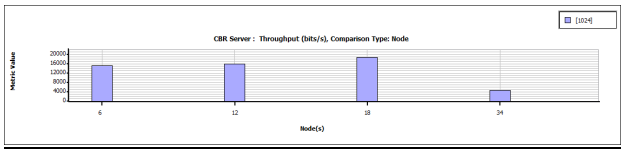

Fig.9: Throughput (bits/s) - ZRP

OSLR

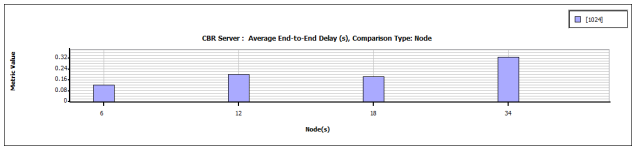

Fig.10: End-to-end delay (s) - OLSR

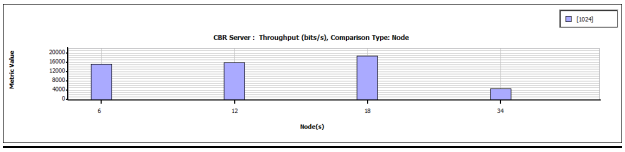

Fig. 11: Throughput (bits/s) - OLSR

Based on the performance metrics discussed earlier, we analyze the protocols mentioned and thus find the best and the most efficient one for the proposed system.

VI. RESULTS

Table 2: Result of Simulation

Property	AODV	DSR	ZRP	OLSR
Packet Delivery ratio	0.8032	0.9221	0.7083	0.7916
Average end-to-end Delay (s)	0.4483	0.4437	0.2074	0.1321
Throughput (bits/sec)	15062.75	17440	13564.25	16548.25

VII. CONCLUSION

According to the analysis carried out in the QualNet developer software based on the metrics discussed above, we find that Dynamic Source Routing (DSR) protocol is the most efficient and the most reliable protocol for medical and other life critical systems. This is further depicted using screenshots from the analysis and simulation.

As of now we have just analyzed the routing protocols in mobile ad-hoc networks and proposed the best one suited for the purpose of application in real time medical systems. However, there is further scope for research in the field where the nodes (ambulances) can communicate among themselves and thus act more efficiently in real time, saving a lot of time and energy in communication.
Thus, the next level of research will include discussing about the communication of the nodes among themselves.

VIII. ACKNOWLEDGEMENT

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CONFLICT OF INTEREST:

The authors declare no conflict of interest.

REFERENCES

[1] Elizabeth M. Royer and Chai-Keong Toh, “A review of Current Routing Protocols for Ad Hoc Mobile Networks”, *IEEE Personal Communications, pages 46-55, April 1999.*

[2] C. Perkins, Ad Hoc on demand Distance Vector (AODV) Routing", *RFC3561, July 2003.*

[3] C. Siva Ram Murthy and B.S. Manoj. Ad Hoc Wireless Networks Architectures and Protocol, volume ISBN: 81-297-0945-7. *Pearson Education, first Indian reprint, 2005 edition, 2005.*

[4] E. Topalis, S. Giannoulis, C. Antonopoulos and S. Koubias. ZRP versus DSR and TORA: A Compressive Survey on ZRP Perfoemance. *10th IEEE Conference, ETFA 2005, 1(ISBN: 0-7803-9401-1), Sept 2005.*

[5] D.Johnson, "The Dynamic Source Routing (DSR) Protocol", *RFC4728, Feb 2007.*

[6] Faria Farjana Khan, Tahesin Samira, Anindya Jana and KAZY NOOR E ALAM SIDDIQUEE, "Performance of Agro-Sensors: Assessment of Optimality in Routing Protocols in MANET in Wireless Sensor Networks" *ICICPI 2016.*

[7] M. V. V. and R. C. Thool, "Comparing the performance of proactive and reactive routing protocol in Mobile Ad-Hoc Network," in International Conference on Industrial Instrumentation and Control (ICIC), 2015 , Pune, 2015.

[8] Ashish Allen Roberts, Rajeev Paulus and A.K. Jaiswal "WSN Performance Parameters of AODV, DYMO, OLSR and IERP" in RWP Mobility Model through Qualnet'' International Journal of Computer Applications (0975 – 8887) Volume 65– No.22, pp:28-32, March 2013.

[9] Seema Pahal and Kusum Dalal, "Performance Evaluation of Routing Protocols in WSN using QualNet 5.3" International Journal of recent trends in Engineering and Research.