Research Journal of Applied Sciences 5 (6): 424-428, 2010
ISSN: 1815-932X
© Medwell Journals, 2010

Performance Analysis and Comparison of Mobile Ad-Hoc Network Routing Protocols

[1]S. Kannan, [1]S. Karthik and [2]V.P. Arunachalam
[1]Department of Computer Science and Engineering, SNS College of Technology, Sathy Main Road, Coimbatore-641035, Tamil Nadu, India
[2]SNS College of Technology, Coimbatore, Tamil Nadu, India

Abstract: Mobile Ad-hoc Networks (MANET) are self-organizing and self-configuring multihop wireless networks where the structure of the network changes dynamically. This is mainly due to the mobility of nodes. The nodes in the network not only acts as hosts but also as routers that route data to or from other nodes in network. In mobile ad-hoc networks a routing procedure is always needed to find a path so as to forward the packets appropriately between the source and the destination. The main aim of any ad-hoc network routing protocol is to meet the challenges of the dynamically changing topology and establish a correct and an efficient communication path between any two nodes with minimum routing overhead and bandwidth consumption. The design problem of such a routing protocol is not simple since an ad-hoc environment introduces new challenges that are not present in fixed networks. A number of routing protocols have been proposed for this purpose like Ad-Hoc On Demand Distance Vector (AODV), Dynamic Source Routing (DSR), Destination Sequenced Distance Vector (DSDV). In this study, we study and compare the performance of the following three routing protocols AODV, DSR and DSDV.

Key words: On-demand, table driven, DSR, AODV, DSDV, Ad-hoc, MANET

INTRODUCTION

The Internet Engineering Task Force (IETF) created a Mobile Ad-hoc Network (MANET) working group to standardize IP routing protocol functionality suitable for wireless routing application within both static and dynamic topologies with increased dynamics due to node motion and other factors. The vision of ad-hoc networks is wireless internet where users can move anywhere anytime and still remaining connected with the rest of the world.

The Mobile ad-hoc network is characterized by energy constrained nodes, bandwidth constrained links and dynamic topology. In real-time applications such as audio, video and real-time data, the ad hoc networks need for Quality of Service (QoS) in terms of delay, bandwidth and packet loss is becoming important. Providing QoS in ad-hoc networks is a challenging task because of dynamic nature of network topology and imprecise state information. Hence, it is important to have a dynamic routing protocol with fast re-routing capability which also provides stable route during the life-time of the flows.

MANET characteristics: The fundamental difference between fixed networks and MANET is that the computers in a MANET are mobile. Due to the mobility of these nodes, there are some characteristics that are only applicable to MANET. Some of the key characteristics are shown in (Fig. 1) (Karthik *et al*., 2008a).

Dynamic network topologies: Nodes are free to move arbitrarily meaning that the network topology which is typically multi-hop may change randomly and rapidly at unpredictable times.

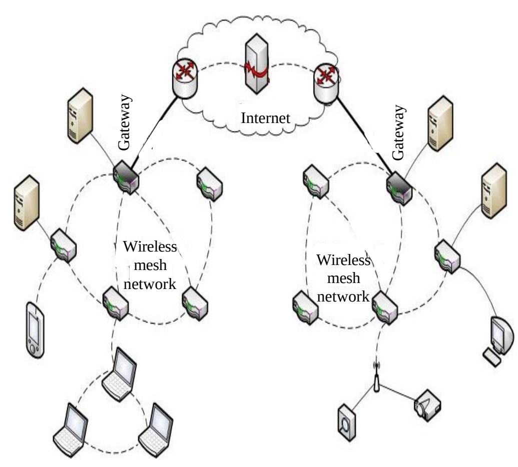

Fig. 1: MANET approach

Corresponding Author: S. Kannan, Department of Computer Science and Engineering, SNS College of Technology, Sathy Main Road, Coimbatore-641035, Tamil Nadu, India

Bandwidth constrained links: Wireless links have significantly lower capacity than their hardwired counterparts. They are also less reliable due to the nature of signal propagation.

Energy constrained operation: Devices in a mobile network may rely on batteries or other exhaustible means as their power source. For these nodes, the conservation and efficient use of energy may be the most important system design criteria.

The MANET characteristics described above imply different assumptions for routing algorithms as the routing protocol must be able to adapt to rapid changes in the network topology.

RELATED WORK

Several researchers have done the qualitative and quantitative analysis of Ad hoc routing protocols by means of different performance metrics. They have used different simulators for this purpose.

Broch *et al*. (1998) in their study have compared the DSDV, TORA, DSR and AODV Protocols using ns-2 simulator. The simulation was done with 50 nodes with varying pause times. The results were obtained for the metrics: packet delivery ratio, routing overhead, number of hops taken by the packet to reach the destination.

Das *et al*. (2000) evaluated the DSR and AODV on demand routing protocols with three performance metrics: Packet delivery fraction, Average End-End Delay and Normalized routing load with varying pause times. They have used ns-2 simulator. Based on the observations, recommendations were made as to how the performance of either protocol can be improved.

Raju and Garcia-Luna-Aceves (2000) in their study have compared WRP-Lite a revised version of Wireless Routing Protocol with DSR. The performance parameters used are end-end delay, control overhead, percentage of packets delivered and hop distribution. The evaluation of the performance metrics was done with respect to varying pause time. It was observed that WRP-lite has much better delay and hop performance while having comparable overhead to DSR.

CHALLENGES FACED IN MANET

Regardless of the attractive applications, the features of MANET introduce several challenges that must be studied carefully before a wide commercial deployment can be expected. These include (Schiller, 2003).

Internetworking: The coexistence of routing protocols for the sake of internetworking a MANET with a fixed network in a mobile device is a challenge for the mobility management.

Security and Reliability: An ad-hoc network has its particular security problems due to e.g., nasty neighbor relaying packets. Further, wireless link characteristics introduce also reliability problems because of the limited wireless transmission range, the broadcast nature of the wireless medium (e.g., hidden terminal problem), mobility-induced packet losses and data transmission errors.

Routing: Since the topology of the network is constantly changing, the issue of routing packets between any pair of nodes becomes a challenging task. Most protocols should be based on reactive routing instead of proactive.

Quality of Service (QoS): Providing different quality of service levels in a constantly changing environment will be a challenge.

Power consumption: For most of the lightweight mobile terminals, the communication-related functions should be optimized for less power consumption.

ROUTING PROTOCOLS IN MANET

There are different criteria for designing and classifying routing protocols for wireless ad-hoc networks. For example, what routing information is exchanged when and how the routing information is exchanged, when and how routes are computed etc.

Proactive vs. reactive routing: Proactive Schemes determine the routes to various nodes in the network in advance so that the route is already present whenever needed. Route Discovery overheads are large in such schemes as one has to discover all the routes. Examples of such schemes are the conventional routing schemes, Destination Sequenced Distance Vector (DSDV) (Karthik *et al*., 2008b, c). Reactive schemes determine the route when needed. Therefore they have smaller route discovery overheads.

Single path vs. multi path: There are several criteria for comparing single-path routing and multi-path routing in ad hoc networks. First, the overhead of route discovery in multi-path routing is much more than that of single-path routing (Karthik *et al.*, 2006). On the other hand, the frequency of route discovery is much less in a network which uses multi-path routing, since the system can still operate even if one or a few of the multiple paths between a source and a destination fail. Second, it is commonly believed that using multi-path routing results in a higher throughput.

Table driven vs. source initiated: In table driven routing protocols, up-to-date routing information from each node to every other node in the network is maintained on each node of the network. The changes in network topology are then propagated in the entire network by means of updates. Destination Sequenced Distance Vector Routing (DSDV) and Wireless Routing Protocol (WRP) are two schemes classified under the table driven routing protocols head.

The routing protocols classified under source initiated on-demand routing create routes only when desired by the source node (Karthik *et al.*, 2009a, b). When a node requires a route to a certain destination, it initiates what is called as the route discovery process. Examples include DSR and AODV.

Destination-Sequenced Distance Vector (DSDV) routing protocol: DSDV is a table-driven routing scheme for ad-hoc mobile networks based on the Bellman-Ford algorithm. It was developed by Perkins and Royer (1999). The main contribution of the algorithm was to solve the routing loop problem. Each entry in the routing table contains a sequence number, the sequence numbers are generally even if a link is present else, an odd number is used.

The number is generated by the destination and the emitter needs to send out the next update with this number. Routing information is distributed between nodes by sending full dumps infrequently and smaller incremental updates more frequently (Charles and Bhagwat, 1994).

Dynamic Source Routing (DSR) protocol: Dynamic Source Routing (DSR) is a routing protocol for wireless mesh networks. It is similar to AODV in that it forms a route on-demand when a transmitting computer requests one. However, it uses source routing instead of relying on the routing table at each intermediate device. Many successive refinements have been made to DSR in cluding DSRFLOW. Determining source routes requires accumulating the address of each device between the source and destination during route discovery. The accumulated path information is cached by nodes processing the route discovery packets. The learned paths are used to route packets. To accomplish source routing, the routed packets contain the address of each device the packet will traverse. This may result in high overhead for long paths or large addresses like IPv6. To avoid using source routing, DSR optionally defines a flow id option that allows packets to be forwarded on a hop by hop basis.

Table 1: Property comparison of DSDV, DSR and AODV

Protocol property	DSDV	DSR	AODV
Loop free	Yes	Yes	Yes
Multicast routes	No	Yes	No
Distributed	Yes	Yes	Yes
Unidirectional link support	No	Yes	No
Multicast	No	No	Yes
Periodic broadcast	Yes	No	Yes
QoS support	No	No	No
Routes maintained in	Route table	Route cache	Route table
Route cache/table timer	Yes	No	Yes
Reactive	No	Yes	Yes

A comparison of the characteristics of the above three ad-hoc routing protocols DSDV, DSR, AODV is shown in Table 1.

This protocol is truly based on source routing whereby all the routing information is maintained (continually updated) at mobile nodes. It has only two major phases which are route discovery and route maintenance. Route reply would only be generated if the message has reached the intended destination node (route record which is initially contained in route request would be inserted into the route reply).

To return the route reply, the destination node must have a route to the source node. If the route is in the destination node's route cache, the route would be used. Otherwise, the node will reverse the route based on the route record in the route reply message header (this requires that all links are symmetric). In the event of fatal transmission, the route maintenance phase is initiated whereby the route error packets are generated at a node. The erroneous hop will be removed from the node's route cache all routes containing the hop are truncated at that point. Again, the route discovery phase is initiated to determine the most viable route (Johnson and Maltz, 1996).

Ad-Hoc on Demand Distance Vector (AODV) routing protocol: The AODV Routing protocol uses an on demand approach for finding routes that is a route is established only when it is required by a source node for transmitting data packets. It employs destination sequence numbers to identify the most recent path. The major difference between AODV and Dynamic Source Routing (DSR) stems out from the fact that DSR uses source routing in which a data packet carries the complete path to be traversed.

However, in AODV the source node and the intermediate nodes store the next-hop information corresponding to each flow for data packet transmission. In an on-demand routing protocol, the source node floods the RouteRequest packet in the network when a route is not available for the desired destination.

It may obtain multiple routes to different destinations from a single RouteRequest. The major difference between AODV and other on-demand routing protocols is that it uses a destination sequence number (DestSeqNum) to determine an up-to-date path to the destination. A node updates its path information only if the DestSeqNum of the current packet received is greater than the last DestSeqNum stored at the node.

AODV is capable of both unicast and multicast routing. It is a reactive routing protocol, meaning that it establishes a route to a destination only on demand. In contrast, the most common routing protocols of the Internet are proactive meaning they find routing paths independently of the usage of the paths. AODV is as the name indicates, a distance-vector routing protocol. AODV avoids the counting-to-infinity problem of other distance-vector protocols by using sequence numbers on route updates, a technique pioneered by DSDV.

PERFORMANCE RESULTS OF AODV, DSR, DSDV

The Fig. 2 shown here are the performance analysis of the routing protocol with respect to different metric considered above. The x-axis shows the number of nodes and the y-axis shows the Metric considered.

In terms of packet delivery ratio (Fig. 2), DSR performs well when the number of nodes is less as the load will be less. However, its performance declines with increased number of nodes due to more traffic in the network.

The performance of DSDV is better with more number of nodes than in comparison with the other two protocols. The performance of AODV is consistently uniform.

For average end to end delay (Fig. 3), the performance of DSR and AODV are almost uniform. However, the performance of DSDV is degrading due to increase in the number of nodes the load of exchange of routing tables becomes high and the frequency of exchange also increases due to the mobility of nodes.

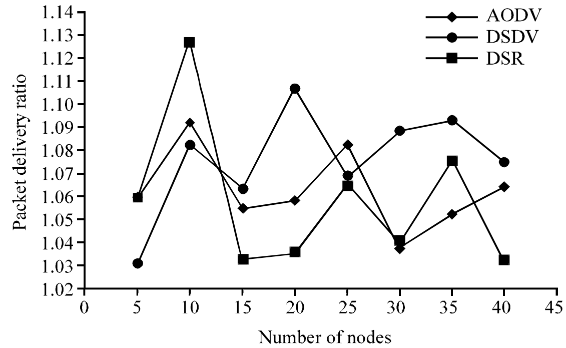

Fig. 2: Packet delivery ratio for AODV, DSR, DSDV

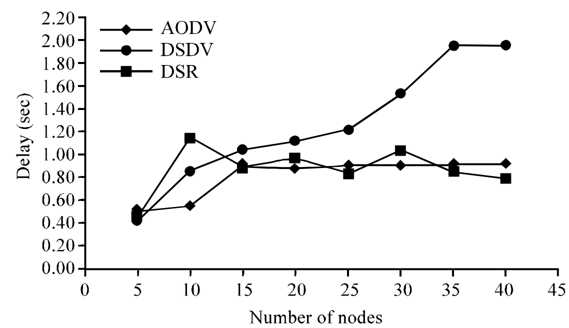

Fig. 3: Average end to end delay for AODV, DSR, DSDV

CONCLUSION

It is difficult for the quantitative comparison of the most of the ad hoc routing protocols due to the fact that simulations have been done independent of one another using different metrics and using different simulators.

In this study, we have presented comparison studies about On-Demand (DSR and AODV) and table-driven (DSDV) routing protocols. The comparison indicate that the performance of the two on demand protocols namely DSR and AODV is superior to the DSDV in conformance with the research done by other researchers. It is also observed that DSR outperforms AODV in less stressful situations, i.e., smaller number of nodes. AODV outperforms DSR in more stressful situations.

The routing overhead is consistently low for DSR and AODV than in comparison with DSDV especially for large number of nodes. This is due to the fact that in DSDV the routing table exchanges would increase with larger number of nodes.

The comparison also indicate that as the number of nodes in the network increases DSDV would be better with regard to the packet delivery ratio but it may have considerable routing overhead. As far as packet delay and dropped packets ratio are concerned, DSR/AODV performs better than DSDV with large number of nodes. Hence, for real time traffic AODV is preferred over DSR and DSDV. For less number of nodes and less mobility, DSDV's performance is superior. A general observation is that protocol performance is linked closely to the type of MAC protocol used. In conclusion, the design of the routing protocol must take into consideration the features of the lower layer protocols.

REFERENCES

Broch, J., D.A. Maltz, D.B. Johnson, Y.C. Hu and J. Jetcheva, 1998. A performance comparison of multi-hop wireless ad hoc network routing protocols. Proceedings of the 4th Annual ACM/IEEE International Conference on Mobile Computing and Networking, Oct. 25-30, Dallas, Texas, USA., pp: 85-97.

Charles, E.P. and P. Bhagwat, 1994. Highly dynamic Destination-Sequenced Distance-Vector routing (DSDV) for mobile computers. Proceedings of the Conference on Communications architectures, protocols and applications, Aug. 31-Sept. 2, England, UK., pp: 234-244.

Das, S.R., C.E. Perkins and E.M. Royer, 2000. Performance comparison of two on-demand routing protocols for ad hoc networks. Proc. IEEE Conf. Comput. Commun., 1: 3-12.

Johnson, D.B. and D.A. Maltz, 1996. Dynamic source routing in Ad hoc wireless networks. Mobile Comput., 353: 153-181.

Karthik, S., R.M. Bhavatharini and V.P. Arunachalam, 2008a. Analyzing interaction between denial of service (DOS) attacks and threats. Proceedings of the International Conference on Computing, Communication and Networking, Dec. 18-20, IEEE Computer Society, pp: 1-9.

Karthik, S., T. Ravichandran and V.P. Arunachalam, 2009a. Analyzing interaction between denial of service (DoS) attacks and threats. Int. J. Soft Comput., 4: 68-75.

Karthik, S., V.P. Arunachalam and T. Ravicahndran, 2008b. A comparative study of various IP trace back Strategies and simulation of IP trace back. Asian J. Inform. Technol., 7: 454-458.

Karthik, S., V.P. Arunachalam and T. Ravicahndran, 2009b. A novel Direction Ratio Sampling Algorithm (DRSA) approach for multi directional geographical traceback. Int. J. Comp. Sci. Sec., 3: 272-279.

Karthik, S., V.P. Arunachalam and T. Ravichandran, 2006. Implementation and application of location discovery in enterprise-based wireless networks. Natl. J. Eng., 8: 22-26.

Karthik. S., V.P. Arunachalam and T. Ravichandran, 2008c. Multi directional geographical trace back with n directions generalization. J. Comput. Sci., 4: 646-651.

Perkins, C.E. and E.M. Royer, 1999. Ad-hoc on-demand distance vector routing. Proceedings of the 2nd IEEE Workshop on Mobile Computing Systems and Applications, Feb. 25-26, New Orleans, LA., pp: 90-100.

Raju, J. and J.J. Garcia-Luna-Aceves, 2000. A comparison of on-demand and table driven routing for ad-hoc wireless networks. Proceedings of the IEEE International Conference on Communications, June 18-22, New Orleans, LA, USA., pp: 1702-1706.

Schiller, J.H., 2003. Mobile Communications. Addison-Wesley, New York, pp: 492.