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An Analysis of Reactive and Proactive Ad-Hoc Routing Protocols

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Abstract: An ad hoc network is a group of wireless moveable nodes dynamically establishing a temporary network deprived of the utilizing of any standing network infrastructure or centralized administration. A number of routing protocols like DSR, AODV, DSDV and TORA have been studied and evaluated in this paper. In this paper an attempt has been done to compare the two prominent on-demand reactive routing protocols for ad hoc networks: DSR and AODV, along with the traditional proactive DSDV protocol. The review has shown that the On-demand protocols, AODV and DSR perform significantly better than the table-driven DSDV protocol. Although DSR and AODV share similar on-demand behaviour, the differences in the protocol mechanics can lead to significant performance differentials.

Keywords: MANETs, DSR, AODV, TORA, DSDV, ad-hoc.

I. INTRODUCTION

Wireless networking is a rising technology that by which users can access information and services electronically, regardless of their geographic point. Wireless networks are of two types.

A. Infrastructure networks.

Infrastructure network has a network with permanent and wired gateways. A mobile host communicates with a bridge in the network (called base station) within its communication radius. The mobile unit can shift geographically at the same time as it is communicating. When it goes out of range of single base station, it connects with new base station and starts communicating through it. This is called handoff. In this system the base stations are fixed.

B. Infrastructure less or Ad hoc networks.

In Infrastructure less networks all nodes are mobile and are connected dynamically in an arbitrary manner. All nodes of these networks act as routers and take part in discovery and maintenance of routes to other nodes in the network. Ad hoc networks are very helpful in emergency search-and-rescue operations, meetings in which people wish to share information fast, and data gaining operations in inhospitable terrain.

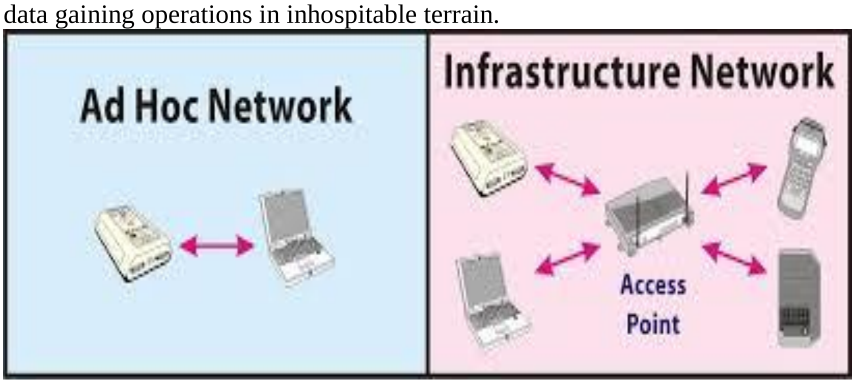

Fig 1. Ad hoc versus Infrastructure based networks. [2]

II. MANET

In MANET [1] the collection of wireless mobile nodes connected together to obtain temporary network in which the nodes are communicating with each other with no centralized control. The nodes are free to move randomly and systematize themselves arbitrarily. Hence the network's topology may change quickly and unpredictably. The nodes that are inside each other's radio range can communicate directly, whereas remote nodes rely on their neighboring nodes to forward packets as a router. Routing is a core difficulty in networks for sending data from one node to another. Routing protocols works fine in wired networks does not display the similar performance in mobile ad hoc networks due to the fast change of topology. A MANET includes many challenges and issues such as Dynamic topologies, Frequency of updates or network overhead, energy, speed, routing and security. The routing protocol is required whenever the source needs to send and receive the packets to the target. Many routing protocols have been proposed for the mobile ad hoc network and classified as Proactive or Table Driven routing Protocol, Reactive or On Demand Routing Protocol.

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C. Proactive (table-driven routing protocols)

In proactive protocols [1], every node handle every routing table consists of routing information for every node in the network. Every node maintains consistent and recent up-to-date routing information by transmitting control messages periodically between the nodes which update their routing tables. The proactive routing protocols use link-state routing algorithms which frequently flood the link information about its neighbors. The limitation of proactive routing protocol is that all the nodes in the network always maintain an updated table. Some of the existing proactive routing protocols are DSDV and OLSR.

D. Reactive (On Demand Routing Protocol)

In Reactive routing protocols [1], when a source wants to transmit packets to a target, it invokes the route discovery mechanisms to find the route to the destination. The route remains suitable till the destination is reachable or until the route is no longer needed. Unlike table driven protocols, all nodes need not maintain up-to-date routing information. Some of the most used on demand routing protocols are DSR and AODV.

E. Hybrid Routing Protocol

Hybrid routing protocol [1]includes the advantages of both proactive and reactive routing protocols. The routing is initially established with some proactively prospected routes and then serves the demand from additionally activated nodes through reactive flooding. Some of the existing hybrid protocols are ZRP and TORA.

III. ADHOC PROTOCOLS

A. Optimized Link State Routing Protocol

Optimized Link State Protocol (OLSR) [1] is a proactive routing protocol, all nodes have route table for containing routing information to every node in the network, and thus the routes are always immediately available when needed. OLSR is an optimization version of a pure link state protocol. Hence the topological changes cause the flooding of the topological information to all available nodes in the network. OLSR protocol uses Multipoint Relays to decrease the possible overhead in the network, the fig given below, illustrates the MPR utilization in packet transmission. The thought of MPR is to decrease flooding of broadcasts by reducing the identical broadcast in some regions in the network, and to provide the shortest path. OLSR uses the following control messages: Hello and Topology Control. Hello messages are used for finding the information about the link status and the neighbor nodes. TC messages are used for broadcasting information about own advertised neighbors which contains at least the MPR Selector list. OLSR may optimize the reactivity to topological changes by reducing the maximum time interval for periodic control message transmission. OLSR has also Multiple Interface Design to permit the nodes for having multiple OLSR interface addresses and provide the external routing information giving the possibility for routing to the external addresses. Based upon this information, nodes in the ad hoc network can act as gateways to another possible network. In addition, as OLSR continuously maintains routes to all destinations in the network, the protocol is helpful for traffic patterns where a large subset of nodes are communicating with another large subset of nodes in which the source, destination pairs are changing over time.

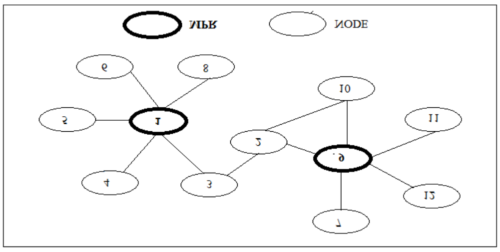

Fig 2. Packet transmission using MPR [1]

Advantages

- OLSR is a smooth routing protocol and it does not need central administrative system to handle its routing process.
- The link is reliable for the control messages, as the messages are sent periodically and the delivery does not have to be sequential.
- OLSR is suitable for high density network and does not allows long delays in the transmission of the packets.

Limitation

- OLSR protocol wants that each node periodically sends the updated topology information throughout the whole network.

B. Temporally-Ordered Routing Algorithm Protocol

Temporally-Ordered Routing Algorithm (TORA) [1] is a distributed, hybrid routing protocol which is also known as link reversal protocol. TORA uses an arbitrary height metric to set up a direct acyclic graph and the length of the route that physically rooted at the destination. As a result, multiple routes often exist for a given destination but none of them are necessarily the shortest route. Instead of using the shortest path for computing the routes, the TORA algorithm maintains

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the direction of the next destination to forward the packets. So a source node maintains one or more downstream. TORA reduces the control messages in the network by having the nodes to query for a path only when it needs to transmit a packet todestination. In TORA three ways are used to establish a network.

• Creating the routes from source to destination,
• Maintaining the routes
• Remove invalid routes.

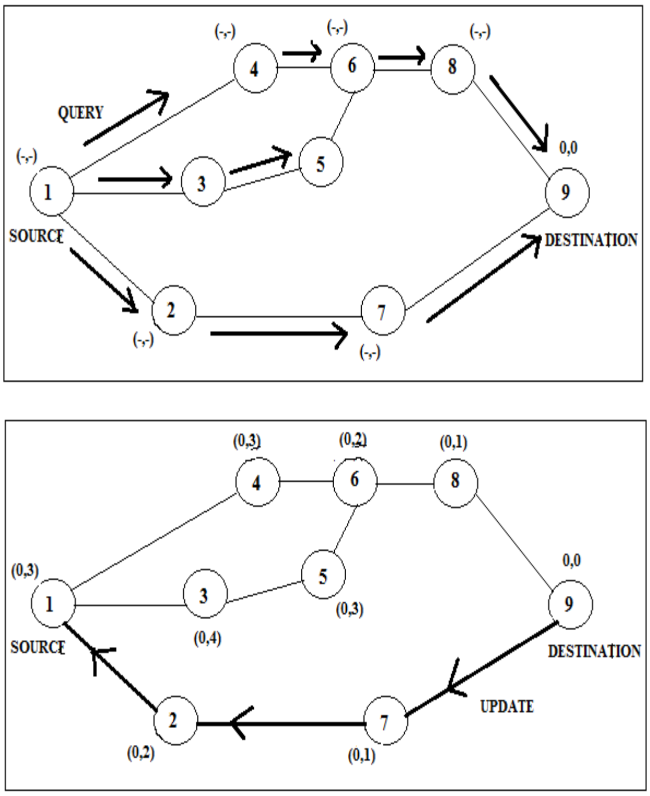

Figure.3 Route creation in TORA [1]

Firstly to establish a route, the node broadcasts a QUERY packet to its neighbours. This QUERY is rebroadcasted through the network until it reaches the destination or an intermediate node that has a route to the destination. The recipient of the QUERY packet then broadcasts the UPDATE packet which lists its height with respect to the destination. When this packet propagates in the network, each node that receives the UPDATE packet sets its height to a value greater than the height of the neighbor from which the UPDATE was received. This has the effect of creating a series of directed links from the original sender of the QUERY packet to the node that initially generated the UPDATE packet. When a node discovers that the route to a destination is no longer valid, it will adjust its height so that it will be a local maximum with respect to its neighbors and then transmits an UPDATE packet. If the node has no neighbors of finite height with respect to the destination, then the node will attempt to discover a new route. As shown in fig.3, node 6 does not propagate QUERY from node 5 as it has already seen and propagated QUERY message from node 4 and the source may have received a UPDATE each from node 2, it retains that height. When a node detects a network partition, it will generate a CLEAR packet that results in reset of routing over the ad hoc network. The establishment of the route is based on the DAG mechanism thus ensuring that all the routes are loop free. Packets move from the source node having the highest height to the destination node with the lowest height like top-down approach.

Advantages

- The multiple routes are supported by TORA between the source and destination node. So, failure or removal of any of the nodes is rapidly resolved without source intervention by switching to an alternate route to improve congestion.
- TORA does not require a periodic update, as a result communication overhead and bandwidth utilization is less.
- TORA provides the support of link status sensing and neighbor delivery, reliable in-order control packet delivery and security authentication.

Limitations

- TORA depends on synchronized clocks among nodes in the ad hoc network. The dependence of this protocol on intermediate lower layers for certain functionality presumes that the link status sensing, neighbor discovery, in order packet delivery and address resolution are all readily available. The solution is to run the Internet MANET Encapsulation Protocol at the layer immediately below TORA. This will make the overhead for this protocol complex to separate from that imposed by the lower layer.

C. Ad hoc On Demand Distance Vector Routing Protocol

AODV [1] is an improvement of Destination-Sequenced Distance-Vector routing protocol algorithm which holds the characteristics of DSDV and DSR. Each node handles a route table contains routing information but does not necessarily maintain routes to every node in the network and reduce the requirement of system wide broadcasts.

Advantages and Limitations

- This has less overhead over proactive protocols
- This supports both unicast and multicast packet transmissions even for nodes in constant movement.
- AODV responds fast to the topological changes in the network and updating only the nodes that may be affected by the change, using the RRER message. The Hello messages, which are responsible for the route maintenance, are also limited so that they do not create unnecessary overhead in the network.

Limitations

- All nodes in the broadcast medium can identify each other's broadcasts. There is a possibility that a valid route is expired and the determination of a reasonable expiry time is not easy. The reason for this is that the nodes are in mobility and their sending rates may be different widely. Furthermore, as the size of network grows, a variety of performance metrics begin lessening. A route discovered with AODV may no longer be the optimal route further along in time. This state can take place because of network congestion or the variable characteristics of wireless links.

D. Destination-Sequenced Distance-Vector (DSDV)

The Destination-Sequenced Distance-Vector (DSDV) Routing Algorithm is based on the idea of the classical Bellman-Ford Routing Algorithm with certain improvements. Every mobile station maintains a routing table that lists all available destinations, the number of hops to reach the destination and the sequence number assigned by the destination node. The sequence number is used to distinguish stale routes from new ones and thus avoid the formation of loops. The stations periodically send their routing tables to their immediate neighbors. A station also transmits its routing table if a significant change has occurred in its table from the last update sent. So, the update is both time-driven and event-driven. The routing table updates can be sent in two ways: - a "full dump" or an incremental update. A full dump sends the full routing table to the neighbors and could span many packets whereas in an incremental update only those entries from the routing table are sent that has a metric change since the last update and it must fit in a packet. If there is space in the incremental update packet then those entries may be included whose sequence number has changed. When the network is relatively stable, incremental updates are sent to avoid extra traffic and full dump are relatively infrequent. In a fast-changing network, incremental packets can grow big so full dumps will be more frequent.

E. Dynamic Source Routing (DSR)

The key distinguishing feature of DSR is the use of source routing. That is, the sender knows the complete hop-by-hop route to the destination. These routes are stored in a route cache. The data packets carry the source route in the packet header. When a node in the ad hoc network attempts to send a data packet to a destination for which it does not already know the route, it uses a route discovery process to dynamically determine such a route. Route discovery works by flooding the network with route request (RREQ) packets. Each node receiving an RREQ rebroadcasts it, unless it is the destination or it has a route to the destination in its route cache. Such a node replies to the RREQ with a route reply (RREP) packet that is routed back to the original source.

RREQ and RREP packets are also source routed. The RREQ builds up the path traversed across the network. The RREP routes itself back to the source by traversing this path backward. The route carried back by the RREP packet is cached at the source for future use. If any link on a source route is broken, the source node is notified using a route error (RERR) packet. The source removes any route using this link from its cache. A new route discovery process must be initiated by the source if this route is still needed. DSR makes very aggressive use of source routing and route caching. No special mechanism to detect routing loops is needed. Also, any forwarding node caches the source route in a packet it forwards for possible future use.

IV. LITERATURE SURVEY

Tariq A et.al (2013) [3] have studied and contrast the performance of the routing protocols AODV, DSR, DSDV, RAODV, AOMDV, and TORA. Network Simulator is used to study the relative performance of the routing protocols varying network traffic load and pause time. The results display that AOMDV has better performance than RAODV and AODV in terms of average end-to-end delay. AOMDV is better than RAODV and AODV in terms of delay. Whereas, RAODV and AODV are better than AOMDV in terms of throughput.

Reza Malekian et.al (2013) [4] have reviewed two routing protocols in mobile ad hoc networks i.e., AODV and OLSR and then compare them in terms of performance. This concludes that the OLSR enhances the end-to-end delay at least 22% in comparison with AODV. Although, OLSR decreases overhead of network, it desires more resources such as bandwidth than AODV protocol since it must maintain the routing tables for all possible routes.

B.A.S Roopa Devi et.al(2013)[5]have showed the features of ad hoc routing protocols OLSR, AODV and TORA based on the performance metrics like packet delivery ratio, end–to–end delay, routing overload by increasing number of nodes in the network. It has been concluded that performance ofTORA is better for dense networks. The AODV is better formoderately dense networks where as the OLSR performswell in sparse networks. The future work suggested that theeffort will be made to enhance ad hoc network routingprotocol by tackling core issues.

Thriveni H.B et.al (2013) [6] havestudied and analyzed theimpact of variations in node velocity and node densitycombined with the choice of routing protocol, on networkperformance. We have selected Destination-SequencedDistance Vector (DSDV) which is a proactive routing protocol,and Dynamic Source Routing (DSR) which is a reactiverouting protocol, for our study. The network performance ismeasured in terms of Packet Delivery Ratio (PDR), End-to-End Delay and Throughput. The simulations are carried out inNS2.34. It can be observedfrom obtained results that DSR protocol outperforms DSDVprotocol for chosen scenario specifications.

D. Loganathan and P. Ramamoorthy(2013)[7] havereviewed the Multicost ParametersBased DSDV Routing protocol andscheduling algorithm for selecting the optimal path in thenetwork nodes and along with some other QoS parametersrequirement.this is observed thatMulticost Parameters Based DSDV protocol outclasses is better because it has high packet delivery ratio and less dropped packets when nodes have high mobility.

Shujun Bi (2012)[8]haveconcluded that each protocol has its own characteristics and their obvious performance is totally different in different network environments through simulator NS2 under the Ad Hoc network simulation and through examining the stability, throughput, equity and other performance indicators to contrast the advantages and disadvantages of AODV and TORA routing protocols. Wecannot say which protocol is the finest in an absolute way. Ad Hoc is the 4thgeneration mobile communication technology, the viewof it is great, but there are still many problems to be solved,but it will play a more and more important role in the futurecommunication field.

RAJESWARI.M et.al (2012) [9] has presented a complete study on the performance of ad hoc network routing protocols with two Mac layer models. The routing protocols used in this study are AODV and ZRP which cover a good mix of proactive and hybrid routing protocols..The performance is checked on jitter, throughput, end-to end delay and total packets received measuring metrics by varying the number of nodes in the network using QualNet 5.0.2 network simulator. This shows that the performance of ZRP is average in both the cases. AODV performs good ,So it is done that for AODV ad hoc routing protocol is better.

PuneetDadral et.al (2012)[10] evaluate the simulation of MANET reactiverouting protocols that are AODV and DSR andTORA .Comparativeanalysis has been carried out based on the results obtainedby simulations with OFDM and Extended RatePHY physical characteristics in OPNET Modelerversion 14.5.Metrics used are Throughput, End to Enddelay, Routing load and Media Access Delay. It is concluded that thevalue of all metrics is higher for Extended Rate PHYthan OFDM for all the routingprotocols of MANET.

P.Kuppusamy et.al(2011)[1] have showed the characteristics of ad hoc routing protocols TORA, AODV, and OLSR based on the performance parameters like, end–to–end delay, packet delivery ratio, routing overload by increasing number of nodes in the network. Theperformance of all protocols was almost stable in sparsemedium with low traffic. The result is that performance ofTORA is better for dense networks. The AODV is better formoderately dense networks where as the OLSR performswell in sparse networks. The future work suggested that theeffort will be made to improve ad hoc network routingprotocol by tackling core issues.

VI. CONCLUSION AND FUTURE WORK

Various simulation methods has been used for developing wireless network to compare the Performance, Delay, Load or Routing Overhead by using various routing protocols. Because of some spiteful or misbehaving nodes, not much work is done to improve the performance. When user transmits the data in the network, it's not always sure that the nodes in a network is working properly i.e. there might be some spiteful or malicious nodes which doesn't receive the data or they don't transmit them. Therefore whenever there are spiteful nodes in a network; then which routing protocol provides us the best performance and how one can make wireless network more reliable and secure has found to be major area of research. This paper has reviewed some well-known routing protocols. The survey has shown that the no one is perfect for all scenarios.

In near future we will evaluate the performance of some well-known MANETs protocols by considering various scenarios. The work will also focus on detecting the malicious nodes in the given network.

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