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REVIEW ON ROUTING PROTOCOLS IN MOBILE AD HOC NETWORKS

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Abstract: A mobile ad hoc network (MANET) is a continuously self-configuring, infrastructure-less network of mobile devices. The primary challenge in building a MANET is equipping each device to continuously maintain the information required to properly route traffic. Devices are able to communicate directly using the wireless spectrum in a peer-to-peer fashion, and route messages through intermediate nodes, however the nature of wireless shared communication and mobile devices result in many routing and security challenges which must be addressed before deploying a MANET. In this paper we investigate the range of MANET routing protocols available and discuss the functionalities of protocols such as DSDV to more advance such as AODV, TORA and DYMO. Efficient routing protocols are required for efficient communication. In the given paper, we surveyed various MANETs protocols and reached its merits and demerits.

Index Terms: AODV, DYMO, MANET, routing protocols, TORA.

I. INTRODUCTION

A Mobile Ad hoc Network (MANET) is a system of wireless mobile nodes that dynamically self-organize in arbitrary and temporary network topologies. People and vehicles can thus be internetworked in areas without a pre-existing communication infrastructure. In the mobile ad hoc network, nodes can directly communicate with all the other nodes within their radio ranges; whereas nodes that are not in the direct communication range use intermediate node(s) to communicate with each other. In these two situations, all the nodes that have participated in the communication automatically form a wireless network, therefore this kind of wireless network can be viewed as mobile ad hoc network.[11] These nodes may be computers or Devices such as laptops, PDAs, mobile phones, pocket pc with wireless connectivity are commonly used. Due to the fact that MNs change their physical location by moving around, the network topology may change unpredictably. This causes changes of link status between each MN and its neighboring. Thus, MNs which join and/or leave the communication range of MN in the network will surely change its relationship with its neighbors by detection of a new link breakages and/or link additions. In the same way, the change of the all routes printed by this MN is also based on the relationship. This change of routes is made with an overhead traffic in the process of maintenance routes assured by the implemented routing protocol in a MANET. The performance of a MANET is closely related to the capability of the routing protocols to adapt them-selves to unpredictable changes of topology network and link status. An important aspect of the communication process is the design of routing protocols used to establish and maintain multi-hop routes to allow data communication between nodes. Several researches have been done in this area, and many multi-hop routing protocols have been developed. There are three main categories of MANET routing protocols: Proactive (table-driven), Reactive (on-demand) and Hybrid.[1] This paper is organized as follows. Section II lists the characteristics and applications of MANET. Section III presents the routing protocols. The last section concludes the paper.

II. CHARACTERISTICS AND APPLICATIONS OF MANET

A. Characterstics

1) Autonomous behavior- In MANET, each node acts as both host and router. It means that a node has ability of host and can perform switching functions.
2) Multi-hop transmission- MANETs are capable of multi-hop transmission that is they can deliver data packets out of the direct wireless transmission range, the packets have to be forwarded through one or more intermediate nodes.
3) Distributed nature of operation- In MANET there is no centralized control so the control and operation of the network is distributed among the nodes.
4) Dynamically changing topology- MANET consist of the mobile nodes so change in topology is dynamic and frequent that is connectivity between nodes varies with time and when they move about they dynamically establish the routes among themselves.
5) Inferior link capacity- The reliability, scalability, efficiency and capacity of wireless links are often Inferior when compared with wired links.. The communication channel is subject to noise, fading, interference and has less bandwidth than a wired network.
6) Symmetric environment- Every node can function as a router or host and hence it forms completely symmetric environment.
7) Light weight features- MANET nodes are mobile devices with less CPU processing capability, small memory size, and low power storage.
8) Absence of Infrastructure- MANET has absence of any fixed infrastructures. [12]

B. Applications

1) Military battlefield

2) Commercial sector
3) Local level- Ad hoc networks can autonomously link an instant and temporary multimedia network
using notebook computers or palmtop computers to spread and share information among participants at
a conference. Another appropriate local level application might be in home networks where devices
can communicate directly to exchange information
4) Personal Area Network (PAN)- Short-range MANET can simplify the intercommunication between
various mobile devices (such as a mobile phone, laptops, and wearable computers).[12]

III. ROUTING IN MANET

One of the major issues that affects the performance of an ad hoc network is the way routing is implemented in a network. Generally, routing is the process of discovery, selecting, and maintaining paths from a source node to destination node deliver data packets. This is a main challenge in MANET, because the MANET possesses dynamic and random characteristics. Nodes move in an arbitrarily manner and at changing speed, often resulting in connectivity problems. The high mobility and the arbitrarily movement of nodes in MANET causes links between hosts to break frequently.
Routing can be classified as-

A) Proactive Routing Protocol
In proactive routing (table-driven), each node has one or more tables that contain the latest information of the routes to any node in the network. Various table-driven protocols differ in the way the information about a change in topology is propagated through all nodes in the network.[12]
Advantages: Information is always available. Latency is reduced in the network.
Disadvantages: Overhead is high; Routing information is flooded in the whole network. There are various proactive routing protocols. Example: DSDV, OLSR, WRP etc.

B) Reactive Routing Protocols
Reactive routing protocol is also known as on demand routing protocol. In this type of protocol, route is discovered whenever it is needed. Nodes initiate route discovery when demanded. A route is acquired by the initiation of a route discovery process by the source node. This routing protocol has two major components:
1) Route discovery- Source node initiates route discovery on demand basis. Source nodes looks for the available route from source to destination, if no route is present it initiates route discovery. The packets include the address of the destination node as well address of the intermediate nodes to the destination.
2) Route maintenance- Due to dynamic topology, route maintenance is required when there is route failure between the nodes due to link breakage etc, Reactive protocols have acknowledgement mechanism due to which route maintenance is possible. Example: DSR, AODV, TORA and LMR. [1]
Advantages: Path available when needed overhead is low and free from loops.
Disadvantages: Latency is increased in the Network.

C) Hybrid Routing Protocol
Hybrid protocols combine the features of reactive and proactive protocols. These protocols have the advantage of both proactive and reactive routing protocols to balance the delay which was the disadvantage of Table driven protocols and control overhead (in terms of control packages). Main feature of Hybrid Routing protocol is that the routing is proactive for short distances and reactive for long distances. The common disadvantage of hybrid routing protocols is that the nodes have to maintain high level topological information which leads to more memory and power consumption. Examples: ZRP (Zone Routing Protocol), CEDAR (Core Extraction Distributed Ad Hoc Routing). [1]
Advantages: Suitable for large networks and up to date information is available.
Disadvantages: High complexity
Large overlapping of routes.
Longer delay if route not found immediately.
Core nodes movement affects the performance of the protocol.

Some existing routing protocols
1) Ad-Hoc on-Demand Distance Vector (AODV)
Source broadcast route request packet to find path to destination, further neighbor node broadcast the packet till it reaches the intermediate node containing recent information about the destination or the destination. The route request packet uses sequence number so that they are loop free and nodes reply to route request with latest information. Every node maintains its routing table. AODV utilizes sequence numbers and routing beacons from DSDV but performs route discovery using on-demand route requests (RREQ); the same process as the DSR protocol. AODV uses distance vector routing; in which every node in the route maintain a temporary routing table for the duration of the communication which makes it different from DSR. AODV uses an expanding ring search mechanism based upon incrementing time-to-live (TTL) which prevent excessive RREQ flooding .Nodes maintain their routing tables by recording senders address, sequence number and source/ destination IP address within active routes so that information can be used by RREP to construct reverse paths. Using sequence numbers to identify and discard outdated routes, and the route error (RERR) messages, AODV deals with node mobility RERR packets travel to the source informing nodes to delete the broken links and trigger new route discovery if alternative routes are not available. AODV protocol has no security mechanisms so the researchers developed a number of security and authentication schemes for MANETs also extensions of AODV to increase security such as Security-aware Ad-hoc On-demand Distance Vector (SAODV) and Adaptive Secure Ad-hoc On-demand Distance Vector (A-SAODV). These protocols contain digital signing of routing traffic and data so that integrity and authenticity is achieved.[2]

. Characteristics of AODV
1 Unicast, Broadcast, and Multicast communication.
2 On-demand route establishment with small delay.
3 Multicast trees connecting group members maintained for lifetime of multicast group.
4 Link breakages in active routes efficiently repaired.
5 All routes are loop-free through use of sequence numbers.
6 Use of Sequence numbers to track accuracy of information.
7 Only keeps track of next hop for a route instead of the entire route.
8 Use of periodic HELLO messages to track neighbors.[3]

Advantages:

- The connection setup delay is less.
- The HELLO messages supporting the routes maintenance are range limited, so they do not cause unnecessary overhead in the network.[3]

Disadvantage:

- The intermediate nodes can lead to inconsistent routes if the source sequence number is very old and the intermediate nodes have a higher but not the latest destination sequence number, thereby having stale entries.
- Also multiple Route Reply packets in response to a single Route request packet can lead to heavy control overhead.
- The periodic beaconing leads to unnecessary bandwidth consumption.[3]

2) Temporally Ordered Routing Algorithm (TORA)
(TORA) is a highly adaptive, efficient and scalable distributed routing algorithm based. It is proposed for highly dynamic mobile, multihop wireless networks. It is a source-initiated on-demand routing protocol and based on the link reversal. It finds multiple routes from a source node to a destination node. [2] The control messages in the TORA are localized to a very small set of nodes which are near the occurrence of a topological change. Nodes maintain routing information about neighbor nodes. The protocol has three basic functions: Route creation, Route maintenance, and Route erasure.
Each node has a quintuple associated with it –

- Logical time of a link failure
- The unique ID of the node that defined the new reference level
- A reflection indicator bit
- A propagation ordering parameter
- The unique ID of the node

The first three elements represent the reference level. When the node loses its link due to link failure, a new reference level is defined. The last two values define a delta. Route is created using QRY and UPD packets. It starts with the height (propagation ordering parameter in the quintuple) of destination set to 0 and all other node's height set to NULL (i.e. undefined). The source broadcasts a QRY packet which is having destination node's id in it. A node having a non-NULL height responds with a UPD packet. A node receiving a UPD packet sets its height to one more than that of the node that generated the UPD. The higher height node is considered upstream and lower height node is downstream. A cyclic graph is constructed from source to the destination. DAG route is broken, when the node moves and it requires to reestablish a DAG for the destination. When the last downstream link of a node fails, it generates a new reference level. TORA sends a broadcast clear packet (CLR) throughout the network to erase invalid routes during the route erasure phase. In TORA oscillations may occur, as TORA uses intermodal coordination, its instability problem is similar to the "count-to-infinity" problem in distance-vector routing protocols, only difference is that such oscillations are temporary and route convergence will ultimately occur.[4]

The advantage of TORA

- It has reduced the far-reaching control messages to a set of neighboring nodes, where the topology change has occurred.
- It supports multicasting; however this is not incorporated into its basic operation. TORA can be used in conjunction with lightweight adaptive multicast algorithm (LAM) to provide multicasting.[2]

The disadvantage of TORA

- It may also produce temporary invalid routes .[2]

3) Dynamic Manet On Demand (DYMO)
The DYMO routing protocol is successor to the AODV protocol. It is slightly easier to implement. DYMO can work as both a pro-active and as a reactive routing protocol, i.e. in this protocol, routes can be discovered just when they are needed. To discover new routes the following two steps take place: “Route Request” (RREQ) messages are broadcast through the MANET. Each RREQ message has the ordered list of all nodes it passed through, so every node receiving an RREQ message can easily record a route back to the origin of this message. When an RREQ message arrives at its destination, a "Routing Reply" (RREP) message will immediately get passed back to the origin, as the RREQ has the ordered list of all the intermediate nodes Thus RREP message simply reaches the source following the list of the RREQ message. [8]

So as soon as the RREP message reaches its destination, a two-way route was successfully recorded by all intermediate hosts, and exchange of data packets is complete.

Advantages:

- High throughput.
- Low routing overhead.
- High packet delivery fraction.
- Very low average end to end delay.[7]

IV. CONCLUSION

MANET is self-organized, "anytime, anywhere" network which provide cheap communications. They have the ability to deploy a network where as traditional network infrastructure environment cannot be possibly deployed. A review is done on the routing protocols used in the mobile ad hoc networks. The global routing protocols are derived mainly from the traditional link state or distance vector algorithm, which maintain network connectivity proactively, and the on demand routing protocols determine routes whenever are needed. The hybrid routing protocols has both reactive and proactive properties by maintaining intra-zone information proactively and inter-zone information reactively. Battery power is the limited resource in MANET so we should work on more energy efficient routing protocols. For further energy efficiency optimization techniques can be deployed.

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