A Literature Review on Parameters based MANET Routing Protocols

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Abstract: *In recent times, mobile ad-hoc network (MANET) has become a growing interesting field for researchers. Mobile ad hoc networks (MANETs) are infrastructure-less self configuring networks designed to support mobility. In mobile ad hoc network, nodes move arbitrarily; therefore the network may experience rapid and unpredictable topology changes. Because nodes in a MANET normally have limited transmission ranges, some nodes cannot communicate directly with each other. Hence, routing paths in mobile ad hoc networks potentially contain multiple hops, and every node in mobile adhoc networks has the responsibility to act as a router. This paper presents overview of MANET characteristics, routing protocols and its performance parameters.*

Keywords: MANET, Routing, DSDV, DSR, AODV, WRP, ZRP, SHARP, OLSR

1. Introduction

The Wireless networks have become an epitome of revolution in the communication industry as it enables the users to access information and services through various devices like laptops, mobile phones, personal computers, tablets etc, regardless of their location. In these networks, communication takes place through standard protocols without the requirement of any network cabling thereby offering an attractive number of benefits to the end users of technology. These networks can be classified as Infrastructure based or Infrastructure less
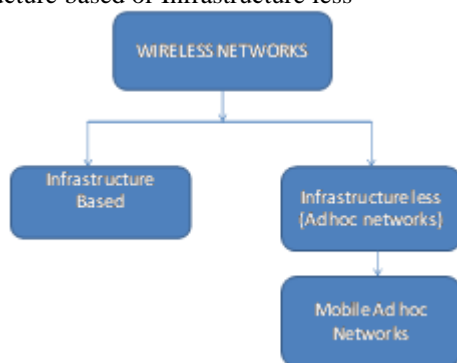

Figure 1: Classification of Wireless Networks

Infrastructure based wireless networks. The nodes in infrastructure based wireless networks relyon a centralized organized point to communicate with each other. This central coordinator is usually an Access point which is needed to be contacted in case any node wants to join the network.

Figure 2: Infrastructure based wireless networks

Infrastructure less wireless networks: Nodes in infrastructure-less wireless networks act as peers and share information with each other. Mobile adhoc networks (MANETs) are a kind of infrastructure less wireless networks that do not rely on an organized central point. AMANET is a collection of mobile users that communicate with each other over relatively bandwidth constrained wireless links.
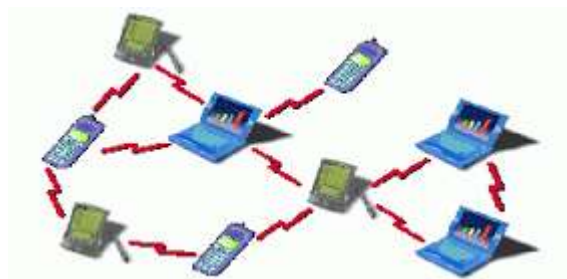

Figure 3: Infrastructure less wireless networks

Due to the mobility of nodes, the topology keeps on changing rapidly and without prediction over time. This kind of network is decentralized which means that the nodes discover the topology and execute the delivery of messages themselves. This implies that the routing functionality is inbuilt or incorporated externally inside the mobile nodes. Therefore it is a strong need of efficient routing protocols to carry out the communication between the mobile nodes inside MANET in reliable, confidential manner.

2. Applications of MANET

Mobile ad-hoc networks are the only choice for mobility support where there is no infrastructure or it is too expensive.

Some application areas of such use of MANET are:
- **Instant infrastructure:** Unplanned meetings, spontaneous interpersonal communications etc. cannot rely on any infrastructure; therefore, ad-hoc connectivity has to be set up.
- **Disaster relief:** Disasters break infrastructures and emergency teams have to rely on the infrastructure they set up themselves.

Volume 6 Issue 8, August 2017

Therefore, ad-hoc networks can be a solution.

- **Military Activities:** Many military activities are confidential and for security reasons it is good to use ad-hoc connectivity for communication.
- **Remote areas:** In sparsely populated and hilly areas it is too expensive to set up an infrastructure. Depending on the communication pattern, ad-hoc networks can be a solution

3. Characteristics of MANET

There are some characteristics that distinguish MANETs from infrastructure networks are

a) **Dynamic Network Topology:**
In MANETs, nodes might move resulting in change of the topology. Therefore, snapshot of network is valid only for a very small period of time. This makes classic protocols used for wired networks unsuitable for MANETs.

b) **Power Constraint**
Mobile nodes are mostly wireless devices running on battery power. Therefore, while designing protocols special power-saving modes and power management functions should be considered.

c) **Bandwidth Constraints**
In MANETs, mobile nodes use wireless links which have significantly lower capacity than their hardwired counterparts till date.

d) **Security**
No one should be able to read personal data during transmission and to track the person. Therefore, while designing a protocol for MANETs proper mechanisms for encryption and user privacy are to be considered.

e) **Robust transmission technology**
Transmission antennas are not unidirectional but Omni-directional, so transmission technology must reduce the effects of multiple access, fading, noise, interference conditions, etc.

f) **Storage Constraint**
In MANET, mobile nodes have limited computing and storage capacity.

4. Routing Protocols

To enable communication within a MANET, a routing protocol is required to establish routes between participating nodes. Because of limited transmission range, multiple network hops may be needed to enable data communication between two nodes in the network. Since MANET is an infrastructure less network, each mobile node operates not only as a host but also as a router, forwarding packets for other mobile nodes in the network. There are frequent unpredictable topological changes in these networks, which makes the task of finding and maintaining routes as difficult.
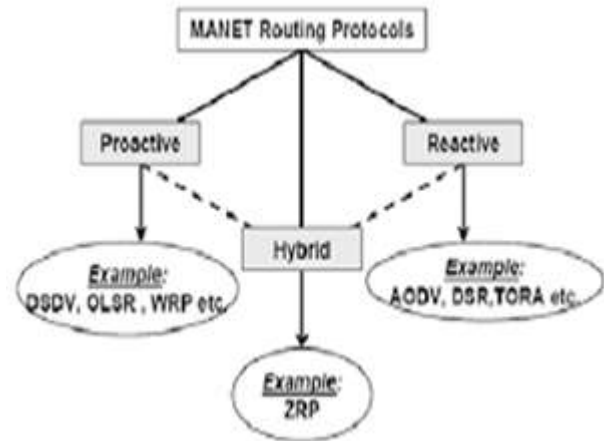

Figure 4: Classification of routing protocols in MANET

4.1 Proactive Routing Protocols

Proactive protocols are also called as table driven protocols that allow a network node to use the routing table to store routes information for all other nodes, each entry in the table contains the next hop node used in the path to the destination, regardless of whether the route is currently needed or not. The table must be updated frequently to reflect the network topology changes. These protocols cause more overhead especially in the high mobility network as they share routing information with the neighbors. However, routes to destinations will always be available when needed. Proactive protocols usually choose the shortest path algorithms to determine which route will be chosen. Proactive routing protocols use much of the bandwidth for sharing routing information with neighbors. And also size of the table is also quite big for large networks.

4.1.1 Dynamic Destination-Sequenced Distance-Vector Routing Protocol (DSDV):

DSDV is developed on the basis of Bellman–Ford routing algorithm with some modifications. During this routing protocol, every mobile node within the network keeps a routing table every of the routing table contains the list of all obtainable destinations and therefore the variety of hops to every. Every table entry is tagged with a sequence variety, that is originated by the destination node. Periodic transmissions of updates of the routing tables facilitate maintaining the topology data of the network. If there's any new vital amendment for the routing information, the updates area unit transmitted instantly. So, the routing data updates would possibly either be periodic or event driven. DSDV protocol needs every mobile node within the network to advertise its own routing table to its current neighbors. The promotion is completed either by broadcasting or by multicasting. By the advertisements, the neighboring nodes can comprehend any amendment that has occurred within the network due to the movements of nodes. The routing updates may be sent in 2 ways: one is termed a ''full dump'' and another is ''incremental.'' just in case of full dump, the whole routing table is sent to the neighbors, wherever as just in case of progressive update, only the entries that need changes area unit sent.

Advantages

- DSDV suitable for creating ad hoc networks with small number of nodes.

Disadvantages
- DSDV requires a regular update of its routing tables, which uses up battery power and a small amount of bandwidth even when the network is idle.
- It is not suitable for highly dynamic networks because whenever the topology of the network changes, a new sequence number is necessary before the network re-converges.

4.1.2 Optimized Link State Routing (OLSR)

Clausen and Jacquet proposed the Optimized Link StateProtocol, inherits the stability of link statealgorithm. This protocol performs hop-by-hop routing; thatis, each node in the network uses its most recent informationto route a packet. Hence, even when a node is moving, itspackets can be successfully delivered to it, if its speed is suchthat its movements could at least be followed in itsneighborhood. The optimization in the routing is donemainly in two ways. Firstly, OLSR reduces the size of the control packets for a particular node by declaring only asubset of links with the node's neighbors who are itsmultipoint relay (MPR) selectors, instead of all links in the network. Secondly, it minimizes flooding of the control traffic byusing only the selected nodes, called multipoint relays todisseminate information in the network. As only multipointrelays of a node can retransmit its broadcast messages, thisprotocol significantly reduces the number of retransmissionsin a flooding or broadcast procedure.

Advantages
- OLSR doesn't need centralized administrative system to handle the routing process.
- OLSR is best suitable in the highly dense network due to MPR.

Disadvantages
- Due to periodic interval of updating of routing table, so usage of bandwidth high
- Finding MPR is difficult for some times.

4.1.3 Wireless Routing Protocol (WRP)

The WRP was proposed by Murthy and Garcia-Luna-Aceves, is a table-based protocol similar to DSDV that inherits the properties of Bellman-Ford Algorithm. The main goal is maintaining routing information among all nodes in the network regarding the shortest distance to every destination. Wireless routing protocols (WRP) is a loop free routing protocol. WRP is a Path-finding algorithm with the exception of avoiding the count-to-infinity problem by forcing each node to perform consistency checks of predecessor information reported by all its neighbors. Each node in the network uses a set of four tables to maintain more accurate information: Distance table (DT), Routing table (RT), Link-cost table (LCT), Message retransmission list (MRL) table. In case of link failure between two nodes, the nodes send update messages to their neighbors. WRP belongs to the class of path-finding algorithms with an important exception. It counters the count-to-infinity problem by forcing each node to perform consistency checks of predecessor information reported by all its neighbors. This eliminates looping situations and enables faster route convergence when a link failure occurs.

Advantages
- WRP has faster convergence and involves fewer table updates.

Disadvantages
- The complexity of maintenance of multiple tables demands a larger memory and greater processing power from nodes in the wireless ad hoc network.
- At high mobility, the control overhead involved in updating table entries not suitable for a highly dynamic and for a very large ad hoc wireless network as it suffers from limited scalability.

4.2 Reactive Routing Protocols:

With on-demand driven routing, routes are discovered only when a source node desires them. Route discovery and route maintenance are two main procedures: The route discovery process involves sending route-request packets from a source to its neighbour nodes, which then forward the request to their neighbours, and so on. Once the route request reaches the destination node, it responds by unicasting a route-reply packet back to the source node via the neighbour from which it first received the route request. When the route-request reaches associate intermediate node that features a sufficiently up-to-date route, it stops forwarding and sends a route-reply message back to the source.

4.2.1 Dynamic Source Routing (DSR)

Dynamic Source Routing protocol (DSR) is designed for multi-hop wireless ad hoc networks. This protocol consists of two main mechanisms "Route Discovery" and "Route Maintenance" that makes it self-configuring and self-organizing. Route discovery is used to discover the routes from source node to destination. A node caches multiple routes to any destination which support rapid reaction to routing changes as another cached route can be tried if the one it has been using should fail. It also avoids the overhead of need to perform a new Route Discovery each time a route in use breaks. In DSR, data packets store information about all the intermediate nodes in its header to reach at a particular destination. Intermediate routers don't need to have routing information to route the data packets, but they save routing information for their future use. The intermediate node which detects broken link through route maintenance also notifies the source node using a route error packet identifying the link over which packet cannot be forwarded.

Advantages
- This protocol removes the need to periodically flood the network with table update messages.
- The intermediate nodes use the route cache information efficiently to reduce the control overhead.

Disadvantages
- The disadvantage of this protocol is that the route maintenance mechanism does not locally repair a broken link. Stale route cache information could also result in in consistencies during the route reconstruction phase.
- The connection setup delay is higher than in table driven protocols. Even though the protocol performs well in

static and low-mobility environments, the performance degrades rapidly with increasing mobility.

- Considerable routing overhead is involved due to the source routing mechanism employed in DSR. This routing overhead is directly proportional to path length.

4.2.2 Ad-hoc On Demand Distance Vector Routing (AODV)

AODV is on-demand extension of the dynamic sequenced distance vector (DSDV) protocol.

Route discovery: When a node finds that there is no available route to its destination then the source node start its route discovery process by broadcasting the RREQ query to all the neighboring nodes. This RREQ query includes source ID, destination ID, a sequence number of the source, a last known sequence number of the destination and max. number of hops the RREQ can be forwarded. Nodes receiving this RREQ query check whether they already have seen this RREQ, if so then they drop the RREQ query. If the RREQ query is not present before then they simply increments the hop count and rebroadcasts the RREQ query. If an intermediate node has the route to the destination having sequenced number equal to or greater than the last sequence number of the destination mentioned in RREQ query, then it generates the RREP query. Otherwise it just stores the information regarding the previous hop from which it receives the RREQ query. This information will be during RREP process. The destination node after receiving RREQ query, copy all the information included in RREQ query and generates a RREP query with updated sequenced number. This RREP query unicast back to the source node. This is the route discovery phase of AODV protocol. Route maintenance phase: The source node sends HELLO messages periodically to destination node to check its route activeness. If a HELLO from an active node is not received within specific time interval, the route is considered unreachable, a route error query (RERR) is broadcast to all nodes and another cycle of RREQ query is broadcasted. As only active routes can be used to send data packets, the route table also contains invalids routes for an extended period of time. These invalid routes can provide information for repairing routes and for later RREQ queries. After some time interval, these invalid routes will be deleted.

Advantages
- Less overhead in the network
- It used in both unicast and multicast routing purpose.
- Also, distance vector routing is simple, and doesn't require much memory or calculation.

Disadvantages
- AODV requires more time to establish a connection, and the initial communication to establish a route takes more time.
- Multiple Route Reply packets in response to a single Route Request packet can lead to heavy control overhead.
- Disadvantage of AODV is that the periodic beaconing leads to unnecessary bandwidth consumption.

4.2.3 Temporarily Ordered Routing Algorithm (TORA)
TORA is a highly adaptive loop free distributed routing protocol. In this, a Directed Acyclic Graph (DAG) rooted at the destination using query/reply process is created to represent the route from the source node to the destination. In TORA, it is assumed that all nodes have synchronized clocks for maintaining the temporal order of topological changes. TORA uses a parameter height for each node which is a measure of the distance in hops from node to the destination node. The source node uses the height parameter to select the best route toward the destination. It is a loop-free multipath routing to destinations minimizing communication overhead.

Advantages
- TORA doesn't need a periodic update, consequently communication overhead and bandwidth utilization is decreased.
- TORA provides the supports of link status sensing and neighbor delivery, reliable, in-order packet delivery and security authentication

Disadvantages
- TORA depends the clock synchronization among the nodes in the MANET.
- The application in the lower layer like security, authentication increases the over head in the packet of Tora protocol

4.3 Hybrid Routing

Need of these protocols arises with the deficiencies of proactive and reactive routing and there is demand of such protocol that combines good characteristics of both reactive and proactive routing protocols to make routing more scalable and efficient.

4.3.1 Zone Routing Protocol (ZRP)
ZRP for reconfigurable wireless networks is based on the idea of routing zones. Each node has a predefined zone centered at itself including other nodes whose distance is in predefined limits in terms of number of hops. Each node has to maintain up-to-date routing information only for nodes in its zone that reduces the network overhead that is caused by proactive routing protocols. Route Discovery is done to communicate with nodes not present in the zone of a node by forwarding query messages selectively only to the nodes in its zone rather than all the nodes in a network. This causes route discovery mechanism to be much faster than that of global reactive route discovery mechanism.

4.3.2 Sharp Hybrid Adaptive Routing Protocol (SHARP)
SHARP adapts between reactive and proactive routing by dynamically varying the number of routing information. This protocol defines the proactive zones around some nodes. The number of nodes in a proactive zone is decided by the node-specific zone radius. All nodes in the zone radius of a specific node become the member of that individual proactive zone for that node. If for a given destination a node is not present in a proactive zone, reactive routing mechanism (query-reply)is used to establish the route to that node. Proactive routing mechanism is used within the proactive zone. Nodes in the proactive zone maintain routes proactively with reference tothe central node. The proactive zones act as collectors of packets, which

Paper ID: ART20176483

forward the packets efficiently to the destination, once the packets reach any node at the zone periphery.

5. Performance Parameters

Throughput-Throughput is used for measuring efficiency and effectiveness of the system. It is measured in bps (bit per seconds). It may be defined as total number of data packet is received by the destination node.

Throughput = number of broadcast packets / total number of packets.

Packet Delivery Ratio (PDR) PDR represents ratio of total received packets at the destination to total initiated packets from source node. It represents both the completeness and correctness of the routing protocol.

$$PDR = (Pr/Ps) \times 100$$

Where Pr is the total packets received and Ps is the total packets sent.

• **Average Delay (Davg**$)$ indicates the time taken for a packet to travel from the source node to application layer of the destination node. It also includes the route discovery wait time that may be experienced by a node when a route is initially not available. The average delay is computed as:

$Davg= \_(tr- ts) / Pr$

Where ts is the packet send time and tr is the packet receive time for the same packet at destination.

• **Normalized Routing Load (NRL)**is the ratio of control packets to data packets in the network. It gives a measure of the protocol routing overhead; i.e. how many control packets were required (for route discovery/maintenance) to successfully transport data packets to their destinations. It characterizes the protocol routing performance undercongestion. NRL is determined as:

$$NRL = Pc/Pd$$

Where Pc is the total control packets sent and Pd is thetotal data packets sent.

6. Conclusion

In this paper, an overview on Mobile ad hoc networks (MANETs) is presented including need of MANETs, its applications characteristics and routing parameters that distinguish it from other wireless networks. Due to these characteristics, there is need of separate routing protocols for MANET. Classification of routing protocols for MANET has been done on the basis topology of the network i.e. proactive or table- driven and reactive or demand- driven. A summarized overview of routing protocols belonging to each type of classification has also been presented hoping that it will be useful and helpful to students and researchers in the field. From this, we concluded that MANET routing protocols are designed based on the application area and environment and it is not possible to design a single protocol, which is suitable for all MANETs.

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