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A Survey on Routing Protocols of MANETs by Using QoS Metrics

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Abstract: ***MANET is a self organized and self configurable network where the mobile nodes move arbitrarily. Routing is a critical issue in MANET and hence the focus of this paper along with the performance analysis of routing protocols. He growing interest in mobile ad hoc network technique has resulted in many routing protocol proposal. The objective of this paper is to create taxonomy of the mobile ad hoc routing protocols, and to survey and compare representative examples for each class of protocols. We compared three types of routing protocols i.e. proactive, reactive and hybrid. The performance of all these routing protocols is analyzed by Q0S parameters. All the MANET routing protocols are explained in a deep way with QoS metrics***.

***Keywords**: MANET, Q0S, Routing, Routing protocols, Time Complexity.*

I. INTRODUCTION

A mobile ad hoc network (MANET) is a self-organizing and self configuring multihop wireless network, where the network structure changes dynamically due to member mobility. Ad hoc wireless network are self creating and self organizing and self administrating. The nodes are free to move randomly and organize themselves arbitrarily; thus, the network's wireless topology may change rapidly and unpredictably. Such a network may operate in a standalone fashion, or may be connected to the larger Internet [1]. Mobile nodes that are within each other's radio range communicate directly via wireless links, while those far apart rely on other nodes to relay messages as routers. In ad hoc network each node acts both as a host and a router which forwards the data intended for some other node.

An ad hoc network might consist of several home-computing devices, including laptops, cellular phones, and so on. Each node will be able to communicate directly with any other node that resides within its transmission range [2]. For communicating with nodes that reside beyond this range, the node needs to use intermediate nodes to relay the messages hop by hop.

Routing approaches in Mobile Ad Hoc Network

- In ad hoc mobile networks, routes are mainly multi hop because of the limited radio propagation range and topology changes frequently and unpredictably since each network host moves randomly. Therefore, routing is an integral part of ad hoc communications.
- Routing is to find and maintain routes between nodes in a dynamic topology with possibly uni-directional links, using minimum resources.

II. Taxonomy for Routing Protocols in MANET

1. Table-driven or Proactive Protocols: Proactive routing protocols attempt to maintain consistent, up-to-date routing information between every pair of nodes in the network by propagating, proactively, route updates at fixed intervals. Representative proactive protocols include: Destination-Sequenced Distance- Vector (DSDV) routing, Clustered Gateway Switch Routing (CGSR), Wireless Routing Protocol (WRP), Optimized Link State Routing (OLSR)and *The Fisheye State Routing (FSR)*.

2. On-demand or Reactive Protocols: A different approach from table-driven routing is reactive or on- demand routing. Reactive protocols, unlike table-driven ones, establish a route to a destination when there is a demand for it, usually initiated by the source node through discovery process within the network. Reactive protocols, unlike table-driven ones, establish a route to a destination when there is a demand for it, usually initiated by the source node through discovery process within the network. Representative reactive routing protocols include: Dynamic Source Routing (DSR), Ad hoc On Demand Distance Vector (AODV) routing, Temporally Ordered Routing Algorithm (TORA) and Associativity Based Routing (ABR).

3. Hybrid Routing Protocols: Purely proactive or purely reactive protocols perform well in a limited region of network setting. However, the diverse applications of ad hoc networks across a wide range of operational conditions and network configuration pose a challenge for a single protocol to operate efficiently. Researcher's advocate that the issue of efficient operation over a wide range of conditions can be addressed best match these operational conditions [5]. Representative hybrid routing protocols include: Zone Routing Protocol (ZRP) and Zone-based Hierarchal Link state routing protocol (ZHLS)**.**

1. Table-driven or Proactive protocols

1.Destination-Sequenced Distance- Vector (DSDV) routing

Destination-Sequenced Distance-Vector Routing (DSDV) is a table-driven routing scheme for ad hoc mobile networks based on the Bellman-Ford algorithm. The main contribution of the algorithm was to solve the Routing Loop problem. DSDV works in the following way. Each routing table entry carries hop distance and next hop for all available destinations (as in B-F). In addition, each entry is tagged with a sequence number which originates from the destination station. The routing information is advertised by broadcasting periodically and incrementally. Upon receiving the routing information, routes with more recent sequence numbers are preferred as the basis for making forwarding decisions of the paths with the same sequence number; those with the shortest hop distance will be used. That information (i.e. next hop and hop distance) is entered in the routing table, along with the associated sequence number tag. When the link to the next hop has failed, any route through that next hop is immediately assigned a 1 infinite hop distance and its sequence number is updated. When a node receives a broadcast with an infinite 1 metric, and it has a more recent sequence number to that destination, it triggers a route update broadcast to disseminate the important news about that destination.

The **advantage** is it is quite suitable for creating ad hoc networks with small number of nodes. The DSDV protocol is proven to guarantee loop-free paths to each destination at all instants. 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. DSDV is not suitable for highly dynamic networks. There is no commercial implementation of this algorithm.

2.Cluster-head Gateway Switch Routing (CGSR)

Cluster-head Gateway Switch Routing (CGSR) Protocol is a hierarchical protocol based upon the DSDV Routing algorithm using a cluster head to manage a group of action nodes. The algorithm works in a very simple manner. Then which in turn transmits it to the gateway of the destination cluster. The destination cluster-head transmits it to the destination node. There are numerous optimized cluster-head election mechanisms. On receiving a packet, a node finds the nearest cluster-head along the route to the destination according to the cluster member table and the routing table. Then the node consults its routing table to find the next hop in order to reach the cluster-head selected in step one and transmits the packet to that node. The node consults its routing table to find the next hop in order to reach the cluster-head selected in step one and transmits the packet to that node.

3.Wireless Routing Protocol (WRP)

The Wireless Routing Protocol (WRP) [7] is a proactive unicast routing protocol for mobile ad hoc networks. WRP uses improved Bellman-Ford Distance Vector routing algorithm. Using WRP, each mobile node maintains a distance table, a routing table, a link-cost table and a Message Retransmission List (MRL). An entry in the routing table contains the distance to a destination node, the predecessor and the successor along the paths to the destination, and a tag to identify its state, i.e., is it a simple path, a loop or invalid. Storing predecessor and successor in the routing table helps to detect routing loops and avoid counting to infinity problem, which is the main shortcoming of the original distance vector routing algorithm. A mobile node creates an entry for each neighbor in its link-cost table. In WRP, mobile nodes exchange routing tables with their neighbors using update messages.

The update messages can be sent either periodically or whenever link state changes happen. The MRL contains information about which neighbor has not acknowledged an update message. Additionally, if there is no change in its routing table since last update, a node is required to send a Hello message to ensure connectivity. On receiving an update message, the node modifies its distance table and looks for better routing paths according to the updated information. In WRP, a node checks the consistency of its neighbors after detecting any link change.

WRP has the same **advantage** as that of DSDV. In addition, it has faster convergence and involves fewer table updates. Algorithm is simple in functionality. The complexity of maintenance of multiple tables demands a larger memory and throughout the entire network, this increases the protocols bandwidth usage.

4.Optimized Link State Routing (OLSR) Protocol

The protocol is an optimization of the classical link state algorithm tailored to the requirements of a mobile wireless LAN. The key concept used in the protocol is that of multipoint relays (MPRs). MPRs are selected nodes which forward broadcast messages during the flooding process. This technique substantially reduces the message overhead as compared to a classical flooding mechanism, where every node retransmits each message when it receives the first copy of the message. In OLSR, link state information is generated only by nodes elected as MPRs. Thus, a second optimization is achieved by minimizing the number of control messages flooded in the network. As a third optimization, an MPR node may chose to report only links between itself and its MPR selectors. Hence, as contrary to the classic link state algorithm, partial link state information is distributed in the network. This information is then used for route calculation. OLSR provides optimal routes (in terms of number of hops). The protocol is particularly suitable for large and dense networks as the technique of MPRs works well in this context.

Advantages of OLSR is it is a flat routing protocol, it does not need central administrative system to handle its routing process Due to the OLSR routing protocol simplicity in using interfaces, it is easy to integrate the routing protocol in the existing operating systems, without changing the format of the header of the IP messages. The one great advantage of the OLSR protocol is that it

immediately knows the status of the link and it is possibly to extend the quality of service(QoS) information to such protocol so that the hosts know in advantage the quality of the route. The proposed protocol is best suitable for large and dense ad hoc networks. OLSR protocol needs that each host periodic sends the updated topology information greater processing power from nodes in the ad hoc wireless network.

5.The Fisheye State Routing (FSR)

The Fisheye State Routing (FSR) is a proactive unicast routing protocol based on Link State routing algorithm with effectively reduced overhead to maintain network topology information. As indicated in its name, FSR utilizes a function similar to a fish eye. The eyes of fishes catch the pixels near the focal with high detail, and the detail decreases as the distance from the focal point increases.

Similar to fish eyes, FSR maintains the accurate distance and path quality information about the immediate neighboring nodes, and progressively reduces detail as the distance increases. In Link State routing algorithm used for wired networks, link state updates are generated and flooded through the network whenever a node detects a topology change. In FSR, however, nodes exchange link state information only with the neighboring nodes to maintain up-to-date topology information. Link state updates are exchanged periodically in FSR, and each node keeps a full topology map of the network. To reduce the size of link state update messages, the key improvement in FSR is to use different update periods for different entries in the routing table. Link state updates corresponding to the nodes within a smaller scope are propagated with higher frequency.

The **advantage of FSR is** it exhibits a better scalability concerning the network size compared to other link state protocols. But Traffic Overhead is there.

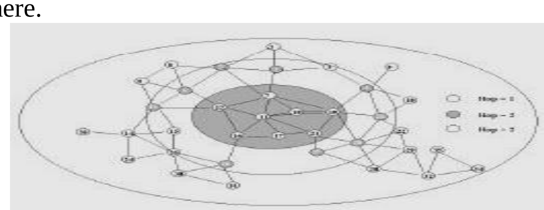

Fig 1: Scope of FSR

Comparison of WRP, DSDV and FSR

Control traffic overhead and loop-free property is two important issues when applying proactive routing to mobile ad hoc networks. Although belonging to the same routing category for mobile ad hoc networks, WRP, DSDV and FSR have distinct features. Both WRP and DSDV exploited event-triggered updates to maintain up-to-date and consistent routing information for mobile nodes. In contrast to using event-triggered updates, the updates in FSR are exchanged between neighboring nodes and the update frequency is depended on the distance between nodes. In this way, update overhead is reduced and the far-reaching effect of Link State routing is restricted. Different mechanisms are used in WRP, DSDV and FSR for loop-free guarantee. WPR records the predecessor and the successor along a path in its routing table and introduces consistence-checking mechanism. In this way, WRP avoids forming temporary route loops but incurs additional overhead. In DSDV, a destination sequence number is introduced to avoid route loops. FSR is a modification of traditional Link State routing and its loop-free property is inherited from Link State routing algorithm.

Both periodic and triggered updates are utilized in WRP and DSDV; therefore, their performance is tightly related with the network size and node mobility pattern. As a Link State routing protocol, FSR has high storage complexity, but it has potentiality to support multiple-path routing and QoS routing, mobility pattern. As a Link State routing protocol, FSR has high storage complexity, but it has potentiality to support multiple-path routing and QoS routing.

2. On-demand or Reactive Protocols:

1. Dynamic Source Routing (DSR)

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. There are 2 major phases:-

Route discovery – uses route request and route reply packets.

Route maintenance–uses route error packets and acknowledgments.

The protocol allows multiple routes to any destination and allows each sender to select and control the routes used in routing its packets, for example for use in load balancing or for increased robustness. Other advantages of the DSR protocol include easily guaranteed loop-free routing, support for use in networks containing unidirectional links, use of only "soft state" in routing, and very two hundred nodes, and is designed to work well with even very high rates of mobility.

The **advantage** is route maintenance in this protocol is fast and simple. In case of a fatal error in the data-link layer, a route-error packet is generated from a failing node. When the route-error packet is received, the failing node is removed from its route cache, and all routes containing that node are truncated.

Figure 2 shows an ad-hoc wireless network with eight nodes and a broken link (3-7). Node 1 wants to send a message to the destination, node 8. Node 1 looks at its routing table, finds an expired route to node 8, and then propagates route-request packets to

nodes 3 and 2. Node 3 finds no route to the destination and so appends the route record 1-3 to the route-request packet and forwards it to node 4. On receiving this packet, node 7 finds a route to the destination and so stops propagating any route-request packet and instead sends a route-reply packet to the source. The same happens when a route-request packet reaches the destination node 8 with a route record 1-2-4-6. When the source, node 1, compares all the route-reply packets, it concludes that the best route is 1-2-4-6-8 and establishes this path.

Example:-

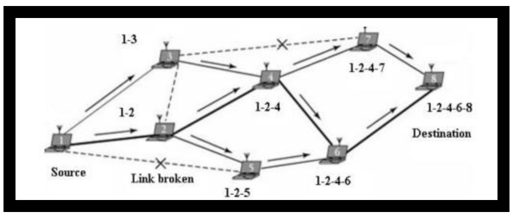

Figure 2: DSR Communication signaling from node 1 to node 8.

2. Ad hoc On Demand Distance Vector (AODV) routing

The AODV is a reactive [3, 4] protocol derived from Dynamic Source Routing and DSDV and DSR it combines the advantages of both protocols. Its route discovery procedure is similar to DSR. When a node has a packet to send to a particular destination, if it does not know a valid route, it broadcasts a route request packet, by specifying the destination address.

The neighbors without a valid route to the destination establish a reverse route and rebroadcast route request packet. The route maintenance is done by exchanging beacon packets at regular intervals. This protocol adapts to highly dynamic topology and provide single route for communication.

Example:-

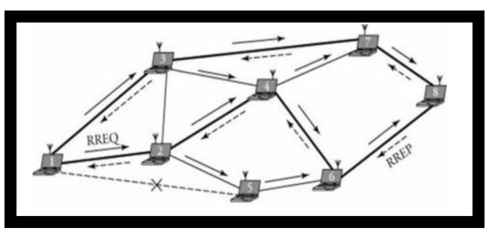

Figure 3: shows the process of signals with AODV from node 1 to node 8.

To establish a connection, source node 1 searches in its table for a valid route to destination node 8. RREQ reaches the destination for the first time through path 1-2-4-6-8. The destination then issues a RREP packet to the source. After a while, the destination receives another RREQ, this time through path 1-3-7-8. The destination evaluates this path, and finds that path 1-3-7-8 is better, and then issues a new RREP packet, telling the source to discard the other reply.

The **advantage** of AODV is it reduces control overhead. The connection setup delay is lower and provide loop free Routing. Periodic beaconing leads to unnecessary bandwidth consumption. It has high route discovery latency for large network (Scalability problem). Delay caused by route discovery process**.**

3. Temporally Ordered Routing Algorithm (TORA)

Temporally Ordered Routing Algorithm (TORA) is a uniform, destination-based, reactive protocol. A destination- oriented directed acyclic graph is built for each destination. If connectivity changes result in a node losing its entire outbound links, the node "reverses" the direction of some or its entire inbound links. TORA assumes that each node is informed of link-status changes for any of its immediate neighbors. When a source has no route to a destination, it broadcasts a route request for the destination. The request is rebroadcast until it reaches the destination, which is de need to have zero height with respect to itself. The destination broadcasts an update message, indicating its height. Each node that receives the update message updates its height to be one higher than the height in the update message and broadcasts an update message, indicating its new height. The updates must be broadcast reliably and ordered by a synchronized clock or logical timestamp in order to prevent long-lived loops. This process creates a DAG from the source to the destination, which is used for hop-by-hop routing. A route failure is propagated only when a node loses its last downstream link. TORA distinguishes nodes whose height already reflects a link reversal ("reflected"). Again reliable, ordered broadcast is required in order to prevent long-lived routing loops. The destination is the only node with no outgoing link. The maintenance of DAG provides loop free communication to the destination.

The **advantage is** it supports multiple routes, so multiple paths created.This provide good reliability and possible QoS extension support by selecting paths with particular characteristics and that can support pre-specified QoS constraints. Good in dense networks. But it is not scalable by any means. Paths may not be the shortest.

4. Associativity Based Routing (ABR)

Associativity Based Routing (ABR) is a uniform, destination-based, reactive protocol. ABR uses end-to-end topology information in route selection, preferring routes that react long-lived associations. However, only destination-vectors are maintained during routing. When an intermediate node receives the request, it appends Route discovery is as follows: When a source has no route to a destination, it broadcasts a route request's ID to the route request and re-broadcasts it (silently ignoring duplicates). The associatively of each hop is accumulated in the route request. Routes with high threshold and aggregate associatively are considered superior, even if there are shorter routes. The destination sends a route reply back to the source along the selected route. Each intermediate node activates the appropriate forwarding information in its routing table. The route maintenance process is quite complex.

Nodes downstream of the link failure send route error messages toward the destination, deleting invalid route entries. If the query fails to find a new partial route, the next node upstream is so informed and initiates a local request. If the process traverses too much of the distance back to the source, it is abandoned and a route error is sent to the source, which reinitiates the route discovery process. Consistent behavior is dependent on the most recent request suppressing earlier attempts. Fewer paths will break which reduces flooding (bandwidth).

The **advantage** is in ABR a broken link is repaired locally, so the source node won't start a new path-finding-process when a broken link appears. Stability information's are only used during the route selection process. Sometimes the chosen path may be longer than the shortest path, because of the preference given to stable paths, which are not necessary. Local query broadcasts may result in high delays during the route repair.

Comparison of DSR, AODV and TORA

As reactive routing protocols for mobile ad hoc networks, DSR, AODV and TORA are proposed to reduce the control traffic overhead and improve scalability. In the appendix, their main differences are listed. DSR exploits source routing and routing information caching. A data packet in DSR carries the routing information needed in its route record field. DSR uses flooding in the route discovery phase. AODV has less traffic overhead and is more scalable because of the size limitation of route record field in DSR data packets. Both DSR and TORA support unidirectional links and multiple routing paths, but AODV doesn't. In contrast to DSR and TORA, nodes using AODV periodically exchange hello messages with their neighbors to monitor link disconnections. This incurs extra control traffic overhead. AODV uses sequence numbers to avoid formation of route loops. Because DSR is based on source routing, a loop can be avoided by checking addresses in route record field of data packets. A loop-free property can be guaranteed in TORA. However, TORA has an extra requirement that all nodes must have synchronized clocks [13]. When the number of source nodes is large, the performance of TORA decreases. The general result was that DSR performs better than AODV when number of nodes is small, lower load and /or mobility, and AODV outperforms DSR in more demanding situations.

3. Hybrid Routing Protocols:-

1 .Zone routing protocol (ZRP)

The Zone Routing Protocol (ZRP) is a hybrid routing protocol, where the network is divided into routing zones according to the distances between nodes and the routing zone defines a range (in hops) that each node is required to maintain network connectivity proactively. The proactive part of the protocol is restricted to a small neighborhood of a node and the reactive part is used for routing across the network. This reduces latency in route discovery and routing zone is k, each node in the zone can be reached within k hops from S. The minimum distance of a peripheral node from S is k (the radius). All nodes except L are in the routing zone of S with radius 2.

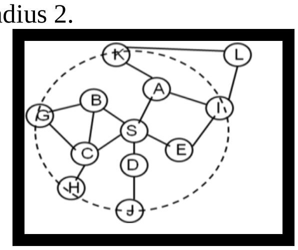

Fig 4: ZRP routing protocol

In this proactive routing approach-Intra Zone Routing Protocol (IARP) is used inside routing zones and reactive routing approach-Inter Zone Routing Protocol (IERP) is used between routing zones. Therefore, for nodes within the routing zone,

routes are immediately available. For nodes that lie outside the routing zone, routes are determined on-demand (i.e. reactively), and it can use any on-demand routing protocol to determine a route to the required destination. Route creation is done using a query-reply mechanism. The destination in turn sends back a reply message via the reverse path and creates the route.
Advantage of ZRP is since uses both reactive and proactive schemes, it exhibits better performance. Since hierarchical routing is used, the path to a destination may be suboptimal. Since each node has higher level topological information, memory requirement is greater.

2. Zone-based Hierarchical Link State (ZHLS) Routing Protocol
State routing (ZHLS) is a hybrid routing protocol. In ZHLS, mobile nodes are assumed to know their physical locations with assistance from a locating system like GPS. The network is divided into non-overlapping zones based on geographical information. ZHLS uses a hierarchical addressing scheme that contains zone ID and node ID. A node determines its zone ID according to its location and the pre-defined zone map is well known to all nodes in the network. It is assumed that a virtual link connects two zones if there exists at least one physical link between the zones. A two-level network topology structure is defined in ZHLS, the node level topology and the zone level topology. Respectively, there are two kinds of link state updates, the node level LSP (Link State Packet) and the zone level LSP. A node periodically broadcast its node level LSP to all other nodes in the same zone. In ZHLS, gateway nodes broadcast the zone LSP throughout the network whenever a virtual link is broken or created. Consequently, every node knows the current zone level topology of the network. Before sending packets, a source firstly checks its intra-zone routing table. If the destination is in the same zone as the source, the routing information is already there. Otherwise, the source sends a location request to all other zones through gateway nodes. After a gateway node of the zone, in which the destination node resides, receives the location request, it replies with a location response containing the zone ID of the destination [10]. The zone ID and the node ID of the destination node will be specified in the header of the data packets originated from the source. During the packet forwarding procedure, intermediate nodes except nodes in the destination zone will use inter -zone routing table, and when the packet arrives the destination zone, an intra-zone routing table will be used.
The **advantage** is no overlapping zones are here. The zone-level topology information is distributed to all nodes. Reduces the traffic and avoids single point of failure. But additional traffic produced by the creation and maintaining of the zone-level topology is difficult.

Comparison of ZRP and ZHLS
As zone based mobile ad hoc network routing protocols, ZRP and ZHLS use different zone construction methods, which have critical effect on their performance. In ZRP, the network is divided into overlapping zones according to the topology knowledge for neighboring nodes of each node. ZHLS assumes that each node has a location system such as GPS and the geographical information is well known, and the network is geographically divided into non-overlapping zones. The performance of a zone based routing protocol is tightly related to the dynamics and size of the network and parameters for zone construction. However, because zones heavily overlap, ZRP in general will incur more overhead than ZHLS.

III. Quality of Service (QoS)
QoS is usually defined as a set of service requirements that needs to be met by the network while transporting a packet stream from a source to its destination. The network is expected to guarantee a set of measurable pre-specified service attributes to the users in terms of end-to-end performance, such as time, bandwidth requirement, probability of packet loss, the variation in latency (jitter), Route acquisition Delay, Communication Overhead, Scalability etc. Quality of services for a network is measured in terms of guaranteed amount of data which a network transfers from one place to another in a given time slot. The size of the ad-hoc network is directly related to the quality of service (QoS) of the network. If the size of the mobile ad-hoc network is large, it might make the problem of network control extremely difficult. Quality of service (QoS) is the performance level of a service offered by the network to the user [8]. The goal of QoS provisioning is to achieve a more deterministic network behavior, so that information carried by the network can be better delivered and network resources can be better utilized.

IV.QoS parameters in mobile ad hoc networks
As different applications have different requirements, the services required by them and the associated QoS parameters differ from application to application. For example, in case of multimedia applications time, bandwidth requirement, power requirement, probability of packet loss, the variation in latency (jitter), Route acquisition Delay, Communication Overhead, Scalability are the key QoS parameters, whereas military applications have stringent security requirements. For applications such as emergency search and rescue operations, availability of network is the key QoS parameter. In WNs the QoS requirements are more influenced by the resource constraints of the nodes. Some of the resource constraints are battery charge, processing power, and buffer space.
Time complexity is defined as the largest time that can elapse between the moment T when the last topology change occurs and the moment at which all the routers have final shortest path and distance to all other routers.

Delay is the time elapsed from the departure of a data packet from the source node to the arrival at the destination node, including queuing delay, switching delay, propagation delay, etc.

Jitter is generally referred to as variations in delay, despite many other definitions. It is often caused by the difference in queuing delays experienced by consecutive packets.

Scalability: It is the ability of a computer application or product (hardware or software) to continue to function well when it (or its context) is changed in size or volume in order to meet a user need.

Packet loss rate is the percentage of data packets that are lost during the process of transmission.

V. Comparison of routing protocols in mobile ad hoc networks

Now we will show the comparison between Table Driven, Demand Driven and Hybrid protocol. Table 1 the protocols and comparison between their QoS parameters, Demand Driven (On-Demand) with four types of protocols such as TORA, DSR, AODV and ABR and comparison between them shows in table 2.Table. Table 3 shows the Table Driven for four kind of protocols such as WRP, CGSR, DSDV, OLSR and comparison between them, 4 shows Time complexity of MANET Routing protocol and then Table-4: Time complexity of MANET Routing protocol

Table 1: Shows the Table-Driven four kinds of protocols and comparison between them.

Table 2: Shows the Demand Driven (On-Demand) with four types of protocols and comparison between them.

Table 3: Shows the protocols and comparison between their QoS parameter.

Parameter	**Table Driven(Proactive)**	**Demand Driven(Reactive)**	**Hybrid**
Routing Structure	Flat and hierarchical structure	Mostly Flat	Hierarchical
Bandwidth requirement	High	Low	Medium
Power requirement	High	Low	Medium
Route acquisition delay	Lower	Higher	Lower for Intra-zone; Higher for Inter-zone
Control Overhead	High	Low	Medium
Communication Overhead	High	Low	Medium
Scalability	Up to hundred nodes	Up to few hundred nodes	Designed for up to 1000 or more nodes
Topology dissemination	Periodical	On-Demand	Both

On-Demand	**TORA**	**DSR**	**AODV**	**ABR**
Routing Structure	Flat	Flat	Flat	Flat
Overall complexity	High	Medium	Medium	High
Frequency of update transmissions	Event driven	Event driven	Event driven	Periodically
Updates transmitted to	Neighbors	Source	Source	Source
Overhead	Medium	Medium	Low	High
Loop Free	Yes	Yes	Yes	Yes
Utilize hello messages	No	No	Yes	Yes
Multiple route support	Yes	Yes	No	No
Routing metric	Shortest path	Shortest path	Freshest & Shortest path	Associatively & shortest path & others

Protocol	**Type**	**Time Complexity**
DSDV	Table Driven	O (d)
CGSR	Table Driven	O (d)
WRP	Table Driven	O (d)
OLSR	Table Driven	O (d)
DSR	Demand Driven	O (2d)
AODV	Demand Driven	O (2d)
TORA	Demand Driven	O (2d)
ABR	Demand Driven	O(d+z)
ZRP	Hybrid	O (2d)

Table Driven	**CGSR**	**WRP**	**DSDV**	**OLSR**

Routing Structure	Hierarchical	Flat	Flat	Flat
Overall complexity	High	Low	High	Low
Frequency of update transmissions	Periodically	Periodically and as needed	Periodically and as needed	Periodically
Updates transmitted to	Neighbors and cluster Head	Neighbors	Neighbors	Neighbors
Scalable	No	Yes	Yes	Yes
Loop Free	Yes	Yes but non instantaneously	Yes	Yes
Utilize hello messages	NO	YES	YES	YES
Critical nodes	Cluster head	NO	NO	MPRs
Multiple route support	NO	NO	NO	NO
Routing metric	Shortest path	Shortest path	Shortest path	Shortest path

Table-4: Time complexity of MANET Routing protocol

VI. Conclusion

Mobile ad-hoc networks (MANETS) are expected to play an important role in the deployment of future wireless communication systems. Routing is an essential component of communication protocols in mobile ad hoc networks. The design of the protocols are driven by specific goals and requirements based on respective assumptions about the network properties or application area. Therefore, it is extremely important that these networks should be able to provide efficient quality of service (QoS) that can meet the vendor requirements. To provide efficient quality of service in mobile ad-hoc networks, there is a solid need to establish new architectures and services for routine network controls. The time delay is the main concern for QoS of routing protocols demanding that real time data be transmitted within a definite time interval. QoS support is essential for supporting time critical traffic sessions. In this chapter we have comparison of proactive and reactive and hybrid routing protocols based on significant QoS parameter like throughput, bandwidth, time complexity, Power requirement, Route acquisition delay, Control overhead, Routing Structure, Communication Overhead, Scalability etc. The survey tries to review typical routing protocols and reveal the characteristics and trade-offs.

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