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A Study the Performance of Wireless Mobile Ad Hoc Networks Routing Protocols

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Abstract- The explosive reputation of Ad Hoc Network and the availability of wide variety of computing and communicating devices over the past few years lead to superior degree of demand for MANET in computer and communication field. It has been found that MANET has been under stable resource of interest among the researchers for the last two decades. Several researches have been carried out to improve the performance, but there are still some notable improvements to be performed in Mobile Ad Hoc Network on various aspects. MANET is a collection of arbitrarily movable mobile nodes that build a temporary infrastructure less network without any support from the centralized controller. The mobile nodes can move around but they are still remaining connected with the rest of the world. The study helps to understand the research on the performance of the MANET.

Keywords- MANET, Routing Protocol, Application, Challenges

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INTRODUCTION

Mobile ad hoc wireless networking, which encompasses both infrastructure-based & infrastructure-less mobile networks, is a comparatively recent a multi-hop wireless networking approach that is rapidly gaining popularity & will soon become an essential feature of the computer environment MANET is a no-frills multi-hop network in which each node communicates explicitly or implicitly with the others via mobile node. The self-organizing and self-configuring features of ad-hoc networks are responsible for their rapid expansion. A MANET's nodes all act as mobile routers, deciding and maintaining routes using some sort of routing protocol. Because MANETs are infrastructure-free, self-organizing, and quickly portable wireless networks, Special outdoor events, communication in areas without wireless infrastructure, environmental catastrophes, intelligence deployments, mines operations, emergency business meetings, and robot data collecting are all applications that they are ideal for. An ad hoc network's routes across nodes might have a lot of hops, so these networks are known as "multi-hop" Wireless Ad hoc Networks.

The routers have total authority in terms of how they move and organise themselves. As a consequence, the wireless topology of the network may change quickly and without warning. It is possible for such a network to run alone or to be connected to the Internet. The creation of appropriate routing protocols is a big difficulty due to multi-hop, mobility, and enormous network size, as well as device heterogeneity, bandwidth, & battery power limits.

MANET

MANET is a self-configure network of mobile routers connected by wireless connection and forming an arbitrary topology. However, because there is no fixed infrastructure, it is difficult to exploit current routing techniques for network services, & this poses some significant challenges in providing communication security, that is not done without difficulty, as a number of network security demands clash with the demands of mobile networks, owing to the nature of mobile devices, that include low power consumption & low processing load.

MANETs do not rely on any pre-existing infrastructure or base stations, as shown in Figure 1. MANET network nodes are free to move around at will. As a result, the topology of a MANET's network might change quickly and without warning. All network functions, such as topology discovery and data packet delivery, must be performed by the nodes themselves, either individually or collectively. A MANET's structure can range from a tiny, static, energy network to large-scale, mobile, and extremely dynamic network, depending on its purpose. It is a group of self-contained mobile nodes or devices associated by wireless networks but not by a communications infrastructure. The network's topology changes dynamically when nodes move and reorganise themselves to permit connections by nodes outside their instant wireless communications range by transmitting messages for one alternative, a process known as multihop. MANET depends on the collaboration of all of the nodes that make up the

network. A MANET becomes more powerful as more nodes cooperate to transport traffic. However, maintaining a MANET is an expensive activity for a mobile node. Network bandwidth, local CPU time, memory, & energy are all consumed while detecting routes and forwarding messages. As a result, there is a strong a node's desire to restrict packet forwarding to others while simultaneously leveraging their services to send its own data.

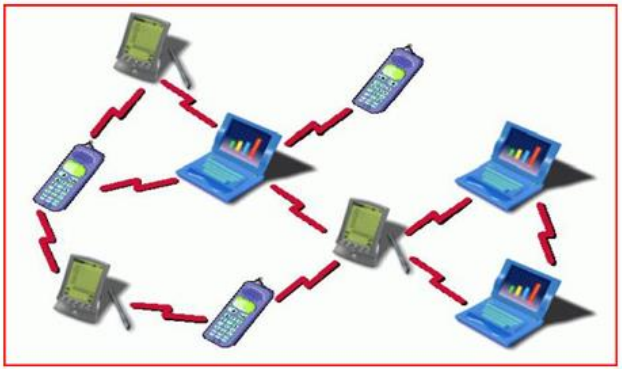

Figure 1 Infrastructure less Networks

MANET includes a variety of applications that are typically set up in emergency scenarios for temporary operations or simply because there aren't enough resources to set up complicated networks. Emergency search-and-rescue operations, meetings, conferences, and combat communication amongst moving vehicles & soldiers are just a few instances. The MANET has a bright future because of its ability to address the new need for mobile processing.

TYPES OF WIRELESS NETWORKS

The three types of network are:

- Wireless LAN,
- Wireless MAN and
- Wireless WAN

The wireless local area network (WLAN) connects two or more devices via a wireless distribution technique (often spread-spectrum or OFDM radio) and usually provides access to the internet via an access point. Users can move around inside a limited coverage area while still remaining connected to the network. While Wi-Fi is officially a certification of compatibility between 802.11 devices, it is commonly used as a shorthand for 802.11 WLANs. This uses specialised microwave or laser beams over line of sight pathways to establish point-to-point communications between computers or networks at two sites. It's commonly used in cities to link networks in two or more buildings without physically connecting them.

WMAN (Wireless Metropolitan Area Network) is a wireless network that connects many Wireless LANs. The term Wi-MAX can be used to describe to wireless MANs, as IEEE 802.16d/802.16e covers them.

ROUTING IN MANETS

Routing in MANETs is one of the main challenges, i.e., finding a suitable and efficient route for sending data from source to destination. The network is highly dynamic so, finding and maintaining a path from source to destination is challenging. Mobile devices are battery-operated. Higher power consumption due to transmission, computation, retransmission, and reception needs to be managed. Lower bandwidth availability and higher data management is a challenge [S. Corson 1999]. As the use of various services and applications like VOIP, Online Games, Cloud Services, Online Streaming, etc., have increased in MANETs. It is essential to develop efficient protocols to improve the battery life for enhanced performance of the system. When we talk about routing in ad hoc networks, they are classified into two categories, as shown in Figure 2.

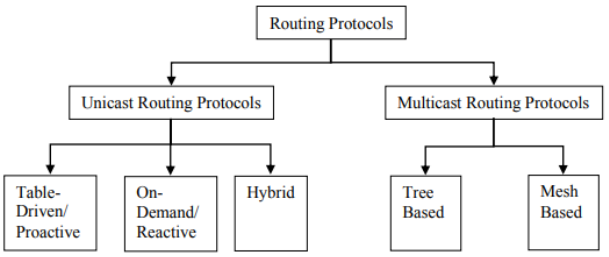

Figure 2 Terminology of routing protocols

Unicast routing protocols

Unicast routing protocols are used when there is one-to-one communication. A source is communicating with a single destination at a time. The path from source to destination is decided and maintained in every node's routing table in the network. Other information regarding the neighbouring nodes or battery is also stored in the routing table. Depending on how a route is found for the destination and its management, unicast routing protocols are divided into three categories: Proactive/table-driven routing protocols, Reactive/on-demand routing protocols, and Hybrid routing protocols, as shown in Figure 3. This routing protocols store routes in a routing table and update them periodically by exchanging information with their neighbours. The on-demand routing protocols find the routes when requested instead by initiating a route discovery algorithm. These protocols select routes based on a minimum hop count to the destination. The hybrid routing protocols use both the approaches used in proactive & reactive routing protocols[T. D. Dyer 2001]. It uses the features of proactive protocols when the communication is local, i.e. within one or two hops, and features of reactive when the communication is global, i.e. for the far-away nodes.

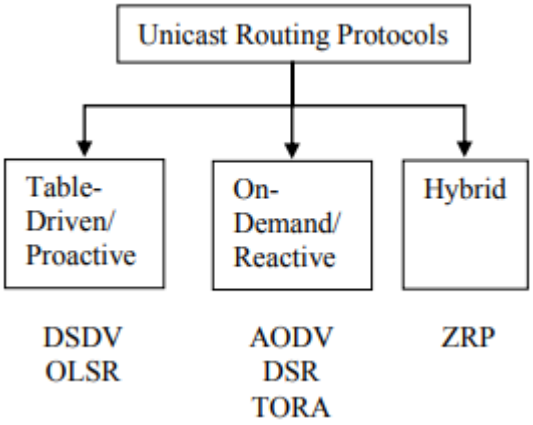

Figure 3 Taxonomy of Unicast Routing Protocols

Table-Driven/Proactive Routing Protocols

In table-driven protocols, every node has a table that stores the route to other nodes. Whenever a route is required, the node looks up into its table and sends it along that path. The routing tables updated with the new routes due to nodes' mobility. Different tabledriven protocols update the table differently. There are two ways for updating tables: periodic updating and triggered updating. These protocols are not ideally used in a network that has high mobility of nodes or large area. Because of the requirement to update the routing table, they tend to waste much energy. DSDV [P. Bhagwat 1994], Wireless Routing Protocol, and Optimized LinkState Routing Protocol (OLSR) [P. Jacquet, 2001] are examples of this class of routing protocols. DSDV is the one that is used more frequently by researchers for their work. It is a proactive protocol based on a distance vector. Bellman-ford algorithm is used for its working; from the traditional algorithm, it uses one new attribute in its routing table, which gives loopfreedom by differentiating between old routes with new ones.

On-Demand/Reactive Routing Protocols

On-demand protocols do not store any previous routes to the nodes. Instead, reactive protocols commence route discovery anytime a node wants to transfer data to another. Protocols have three steps. The source node broadcasts an RREQ to its neighbours for the destination node. The destination node broadcasts a Route Reply packet (RREP) to the source node in the discovery phase after receiving the RREQ packet. Upon receiving the RREP, a link is established, and data transfer begins in the maintenance phase. The route is maintained till the transmission is over and it is no longer required. In the third phase, i.e. the teardown phase route is torn down and is made unavailable for use when it is no longer required. Reactive routing protocols are better for ADHOC as they are resource-limited, and the nodes are mobile. It is crucial to track the nodes' mobility in the network and discover the routes whenever required. It is improbable that the current topology information will stay intact over time in a highly mobile environment.

Hybrid Routing Protocols

Hybrid protocols use proactive & reactive routing protocols. Hybrid routing systems operate well in big networks with many nodes. This protocol class uses on-demand routing for the nodes that are far away. It uses the proactive method for the neighbourhood nodes, so as to make these protocols suitable for more extensive networks. Zone Routing Protocol (ZRP) is an example of this class [Z. J. Haas 2001]. However, Hybrid routing protocols are not very popular because of their limited usage and implementation complexities.

Multicast Ad hoc Networks

Multicast ad hoc networks are those where the same data is sent to multiple locations. The transmission of packets to a group of nodes lead by a single node is called multicasting [S. S. Manvi 2007]. Multicasting in MANETs creates many challenges such as multicast routing management, route maintenance, resource management, synchronization and energy management. The lead node for a group of nodes is called a multicast group leader. The members in this class communicate by means of multicast routing methods and by discovering and maintaining multicast routes. All the nodes in a multicast group receive data from a single source node. An energy-efficient and QoS supported multicast communication is essential and must be provided for the nodes communicating in groups for all applications. Either it is a real-time or non-real-time application [D. T. Ahmed 2005]. Figure 4 presents the traditional approaches to multicasting, which are typically based on forming and maintaining trees known as multicast trees, which are not entirely helpful in this environment. So, new protocols have to be proposed, which will be highly adaptive to cope with the degrees of dynamism that is typical of these environments. In recent, researchers have provided many routing protocols that support multicasting.

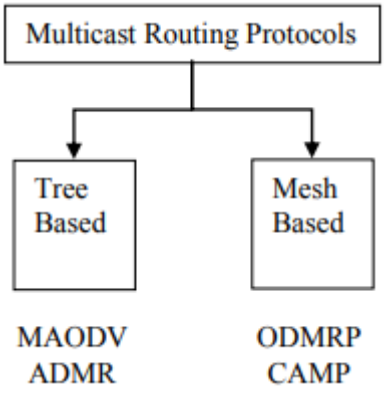

Figure 4 Taxonomy of Multicast Routing Protocols

Tree- based multicast routing protocol

This protocol maintains a tree-based shared structure that supports multicast routing to deliver data from source to destination members of the multicast group, as shown in Figure 5. Various tree-based protocols are MAODV and Adaptive Demanddriven Multicast Routing Protocol (ADMR). This type of multicast structure is susceptible to high mobility, high load, and large multicast group.

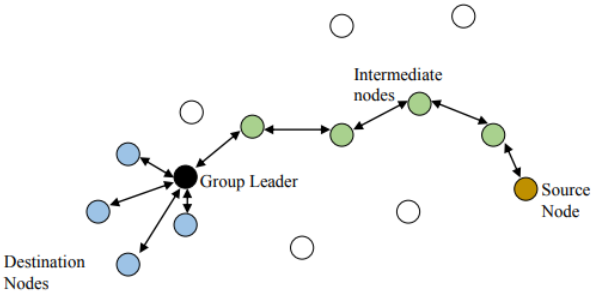

Figure 5 Tree structure of a multicast routing protocol

MAODV is a prevalent multicast routing protocol. Multicast receivers join and exit MAODV's bi-directional shared trees. Multicast receivers join and exit MAODV's bi-directional shared trees. The difference being AODV communicates using a unicast approach, whereas MAODV communicates using a multicast system. NS2 is a simulation tool available widely and free of cost. It comes with a basic implementation of the AODV routing protocol [Y. Zhu 2004]. MAODV have all the components of AODV but with few additions needed for multicasting, like the Multicast Routing table and Multicast Request table. For a multicast group, a bi-directional tree is created. Multicast group has two types of members. Members are either the nodes in the multicast tree who have joined a group to receive data or the group leader, those who create the group and forward data packets to all the multicast members of the tree.

MAODV uses four types of messages for creating a multicast routing table as below.

- Route request (RREQ)
- Route reply (RREP)
- Multicast activation (MACT)
- Group hello (GRPH)

RREQ and RREP are the same as used in AODV routing protocol. The purpose of these messages to create a unicast route between the source and multicast group leader as shown in Figure 6. The other two messages are only used in MAODV. As AODV have a routing table to keep the information in unicast routes

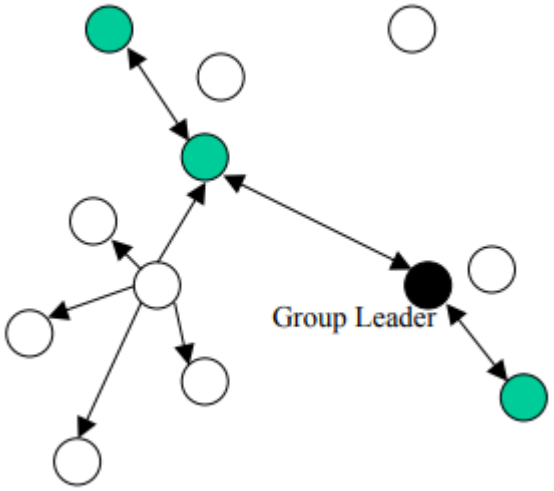

Figure 6 Route creation in multicast routing protocol

Mesh-based multicast routing protocol

In Mesh-based multicast routing protocol, there is a mesh containing all the group members connected directly. Each node in the multicast group is related to every other node in the group. A node can have multiple parents in a mesh-based structure. Multiple redundant paths are also available to avoid frequent mesh reconfigurations. It also causes unnecessary forwarding of multicast packets along all routes. Mesh-based systems have many control messages to keep the mesh connected and consume a lot of energy, which is a big problem in this structure. Moreover, the mesh-based system is more complex and requires more energy to control messages. Examples for mesh-based protocols are OnDemand Multicast Routing Protocol (ODMRP), and CAMP. Due to this multicast communication, a lot of control and data packets are sent. Since, there is a limited operating wireless frequency available, these packets cause network congestion and results in a delay of data transfer.

TECHNICAL CHALLENGES IN MANET

The technical challenges associated with the MANETs are (Hoebeke et al 2004):

Routing: Due to mobility, efficient routing protocols are required to establish paths for communication between nodes, without causing excessive control traffic overhead or computational burden to the nodes.

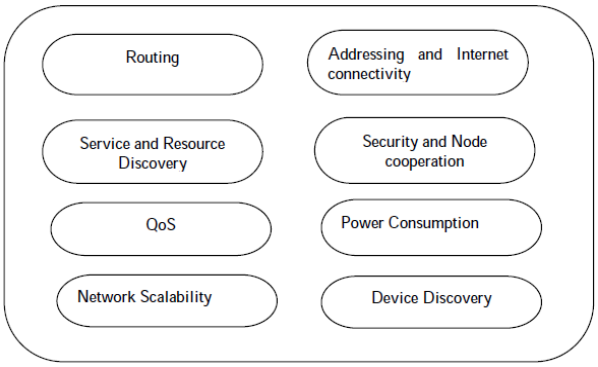

Figure 7 Technical Challenges in MANET

- **Addressing and Internet connectivity:** To activate the communication between nodes within the ad hoc network, each node needs an address.
- **Service and resource discovery**: Nodes in the MANET have a very limited or no knowledge about the capacity of the neighbouring nodes and the service offered by them.
- **Security and node cooperation:** MANETs are subject to passive & active security attacks since the wireless network is eavesdroppable & ad hoc network functionality is established by node cooperation.
- **QoS**: Ad hoc network provides a different quality of service levels in a dynamic environment will be a challenging one (Sun 2001).
- **Power consumption**: Mobile nodes in the network have a restricted power supply which leads to several problems.
- **Network scalability:** Due to the mobility of the node, the nodes may join or leave the network in an arbitrary manner.
- **Device discovery:** Identifying the presence of new nodes in the network and informing about their presence need dynamic update to facilitate automatic optimal route selection.

APPLICATIONS OF MANET

The aim of MANET is to rapidly deploy a robust, mobile and reactive network, under any state of affairs. Mobile Ad-Hoc Networks are impromptu wireless communication, proved to be useful in commercial and industrial fields, military, private sector, first aid operations and exploration missions and are not limited to it (Hoebeke et al 2004), (Guarnera et al 2002). Number of the nodes in the network depends on the application in which MANET is used.

Table 1. Applications of MANET

APPLICATION	POSSIBLE SCENARIOS/SERVICES
Tactical networks	Military communication and operations between soldiers, tanks, planes etc. Automated battlefields.
Emergency operations	Search and rescue, police and fire fighting, Disaster recovery, replacement of fixed infrastructure in case of environmental disasters.
Sensor Networks	Used in home applications like smart sensors and actuators embedded in consumer electronics. Data tracking of environmental conditions, animal movements.
Civilian and Commercial environments	Used in sports stadium, trade fairs, shopping malls, boats, small aircraft etc. Used in electronic payments anytime and anywhere, businesses like dynamic database access, mobile offices. It also used in the transmission of road and weather conditions, taxi cab network, road or accident guidance.
Home and enterprise networking	Used in the place of home/wireless networking, meeting rooms, conference, personal area networking such as cell phone, laptop, ear phone wrist watch. Network at construction sites.
Education	Virtual classrooms, universities and campus settings.
Entertainment	Multi-user games, robotic pets, theme parks.

CONCLUSION

MANET is a collection of self-governing distributed mobile nodes. Every node in a MANET acts as a terminal and also a router to relay the packets for other nodes. MANET has its own merits and demerits such as decentralized network nature, multi-hop routing, dynamic network topology, dynamic node mobility, limited bandwidth, limited power constraints and exposure to malicious attacks. Since the majority of the devices of the MANET are powered by limited capacity batteries, the need of energy efficiency in MANET becomes the most crucial constraint.

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