Investigation of Architecture and Characteristics with Various Protocols Associated with MANET

Poonam Kumari

M.Tech. Scholar, Department of Computer Science and Engineering,

Suraj College of Engineering and Technology, Mohinderharh

Abstract—MANET is a special type of wireless mobile network in which mobile hosts can communicate without any aid of established infrastructure and can be deployed for many applications such as battlefield, disaster relief and rescue, etc. Broadcasting is to transmit a message from a source to all the other nodes in the network. It is widely used to resolve many network layer problems. In a MANET, in particular, due to host mobility, broadcastings can be applied to many areas, such as paging a particular host, sending an alarm signal, and finding a route to a particular host, etc. Several ad hoc network protocols assume that the broadcasting service is basically available. For instance, AODV (Ad Hoc On-demand Distance Vector Routing) protocol adopts broadcasting mechanism as a route request in MANET. Broadcasting is a fundamental communication primitive for route discovery in routing protocols in MANETs.

Keywords—MANET, PAN, HSDV, AODV.

I. INTRODUCTION

Mobile ad hoc networks (MANETs) are becoming more essential to wireless communications due to growing popularity of mobile devices [1]. Their ability to be self-configured and form a mobile mesh network using wireless links, makes them suitable for a number of cases that other type of networks cannot fulfill the necessary requirements. MANETs offer the freedom to use mobile devices and move independently of the location of base stations (and outside their coverage) with the help of other network devices [1]. The integration of mobile ad hoc devices inside vehicles has led to another type of networks, called Vehicular Ad hoc Networks (VANETs). In this type of network, the end points are mainly vehicles that communicate among each other and sometimes with static devices/stations. Up to now, the main use of VANETs, is to transmit road and traffic information, but they can also be used for any application that utilize wireless ad hoc connections. The topology of these networks can be considered as extremely dynamic due to the fact that the nodes are constantly moving. That means that a connection between two nodes may be interrupted several times during the transmission period. The reestablishment of a new connection requires the discovery of any available path from the source to destination node [1]. In simple ad-hoc network with 3 nodes. Node 1 and node 3 are not within range of each other; however the node 2 can be used to forward packets between node 1 and node 2. The node 2 will act as a router and these three nodes together form an ad-hoc network [2].

II. MANET ARCHITECTURE

The architecture of Mobile Ad-hoc Network (MANET) is shown in figure 1. The network architecture is grouped into main three categories:

- Enabling technologies;
- Networking;
- Middleware and applications

Depending on their coverage area, these technologies are classified into several classes:

- Body (BAN),
- Personal (PAN),
- Local (LAN),
- Metropolitan (MAN) and
- Wide (WAN) area networks [10].

The Personal area networks (PAN) connect the mobile devices which are carried by users to other mobile and stationary devices. A PAN communicating range is typically up to 10 m. Wireless LANs (WLANs) support 100–500 m communication range for a single building, or a cluster of buildings.

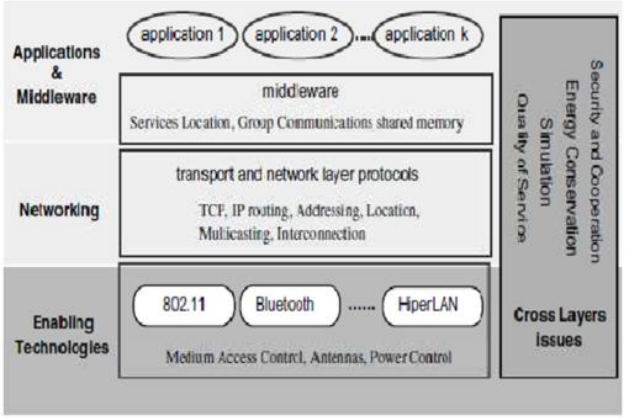

Fig.1 MANET architecture [3]

Wide- and Metropolitan-area (WAN-MAN) ad hoc networks are mobile multi-hop wireless networks that face many challenges which are still to be solved (e.g., addressing, routing, location management, security, etc.), and their availability is not on immediate horizon. In MANET, most of the main functionalities of the Networking protocols need to be redesigned for the self-organizing, dynamic, volatile, peer-to-peer communication environment. The main aim of a location service is to dynamically map the logical address of the (receiver) device to its current location in the network.

The introduction of new technologies like as the WiFi, Bluetooth, IEEE 802.11, WiMAX and HyperLAN greatly facilitates the deployment of ad hoc technology, and new ad hoc networking applications appeared mainly in specialized fields such as emergency services, disaster recovery and environment monitoring.

III. ISSUES IN DESIGNING MANET AND ITS FEATURES

Mobile Ad-hoc Network is highly dynamic in nature and no fixed infrastructure in this type of network. Due to this, issues in designing Mobile Ad-hoc Networks using a routing protocol are explaining as error-prone channel state, hidden problem, exposed terminals, bandwidth-constrained, variable capacity links, energy-constrained operation, security issues, routing, quality of service. Various characteristics of MANET are as explained below.

In MANET, each mobile terminal is an autonomous node, which may function as both a host and a router. There is no background network for the central control of the network operations and so the control and management of the network is distributed among the terminals. Single-hop MANET is simpler than multi-hop in terms of structure and implementation, with the cost of lesser functionality and applicability. The mobile nodes in the network dynamically establish connectivity among themselves as they move about, forming their own network on the fly. Moreover, a user in the MANET may not only operate within the ad hoc network, but mat require access to a public fixed network (e.g. Internet). The nature of high bit-error rates of wireless connection might be more profound in a MANET. One end-to-end path can be shared by several sessions. The channel over which the terminals communicate is subject to noise, fading, and interference, and has less bandwidth than a wired network. In most cases, the MANET nodes are mobile devices with less CPU processing capability, small memory size, and low power storage. Such devices need optimized algorithms and mechanisms that implement the computing and communicating functions. The wireless communication medium is accessible to any entity with the appropriate equipment and adequate resources.

IV. ROUTING IN MANET

"Routing is the process of information exchange from one host to the other host in a network."[4]. Routing is the mechanism of forwarding packet towards its destination using most efficient path. Efficiency of the path is measured in various metrics like, Number of hops, traffic, security, etc. In Ad-hoc network each host node acts as specialized router itself [2]. The routing protocols that have been developed for Mobile Ad hoc Networks are directly affecting data transmission, the performance of network applications and the end user experience. Each protocol has its own routing strategy that is used in order to discover a routing path between two ends [1]. The performance varies, depending on network conditions like the density of nodes in a specific area, their speed and direction. As the mobile and handheld devices are becoming even more popular, and the use of ad hoc networks is increasingly perceived as significant, there is substantial relative work by the research community, regarding the differences among the existing ad hoc routing protocols [1].

V. PROACTIVE PROTOCOLS

Proactive or table-driven routing protocols. In proactive routing, each node has to maintain one or more tables to store routing information, and any changes in network topology need to be reflected by propagating updates throughout the network in order to maintain a consistent network view [2]. Example of such schemes is the conventional routing schemes: Destination sequenced distance vector (DSDV). They attempt to maintain consistent, up-to-date routing information of the whole network. It minimizes the delay in communication and allows nodes to quickly determine which nodes are present or reachable in the network.

Destination-Sequenced Distance-Vector Routing protocol is a proactive table driven algorithm based on classic Bellman-Ford routing. In proactive protocols, all nodes learn the network topology before a forward request comes in. In DSDV protocol each node maintains routing information for all known destinations. The routing information is updated periodically.

WRP [15] belongs to the general class of path-finding algorithms defined as the set of distributed shortest path algorithms that calculate the paths using information regarding the length and second-to-last hop of the shortest path to each destination. WRP reduces the number of cases in which a temporary routing loop can occur. CGSR [16] considers a clustered mobile wireless network instead of a flat network. For structuring the network into separate but

interrelated groups, cluster heads are elected using a cluster head selection algorithm. In GSR protocol [13], nodes exchange vectors of link states among their neighbors during routing information exchange. Based on the link state vectors, nodes maintain a global knowledge of the network topology and optimize their routing decisions locally. FSR [8] is built on top of GSR. The novelty of FSR is that it uses a special structure of the network called the ‘‘fisheye.’’ This protocol reduces the amount of traffic for transmitting the update messages. The basic idea is that each update message does not contain information about all nodes. HSR [9] combines dynamic, distributed multilevel hierarchical clustering technique with an efficient location management scheme. This protocol partitions the network into several clusters where each elected cluster head at the lower level in the hierarchy becomes member of the next higher level. Optimized Link State Routing [17] is a proactive protocol that is based on the link state algorithm. OLSR has been modified and optimized to efficiently operate MANET routing. The main concept of the protocol is to adapt the changes of the network without creating control messages overhead due to the protocol flooding nature

VI. REACTIVE PROTOCOLS

Dynamic Source Routing [18] is a reactive protocol that is based on two main mechanisms: route discovery and route maintenance. Both mechanisms are implemented in an ad hoc fashion and in the absence of any kind of periodic control messages. The main concept of the protocol is “source routing”, in which nodes place in the header of a packet the route that the packet must follow from a source to a destination. Each node “caches” the routes to any destination that has recently used, or discovered by overhearing its neighbors’ transmission. When there is no such route, a route discovery process is initiated.

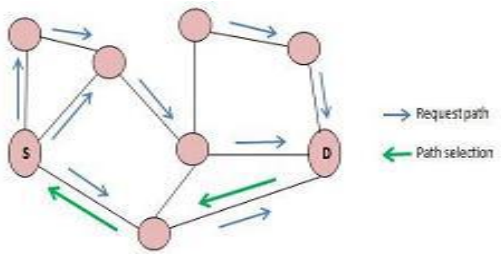

Fig.2. Route Discovery process in AODV

For route maintenance, when a source node moves, it can reinitiate a route discovery process. Figure 2 shows Route Discovery process in AODV. If any intermediate node moves within a particular route, the neighbour of the drifted node can detect the link failure and sends a link failure notification to its upstream neighbour. This process continues until the failure notification reaches the source node. Based on the received information, the source might decide to re-initiate the route discovery phase [13]. ABR [19] protocol defines a new type of routing metric “degree of association stability” for mobile ad hoc networks. In this routing protocol, a route is selected based on the degree of association stability of mobile nodes. Each node periodically generates beacon to announce its existence. SSA [20] protocol focuses on obtaining the most stable routes through an ad hoc network. The protocol performs on demand route discovery based on signal strength and location stability. Based on the signal strength, SSA detects weak and strong channels in the network. SSA can be divided into two cooperative protocols: the Dynamic Routing Protocol (DRP) and the Static Routing Protocol (SRP). The DRP reverses the selected route and sends a route-reply message back to the initiator of route request. The DRPs of the nodes along the path update their routing tables accordingly. In case of a link failure, the intermediate nodes send an error message to the source indicating which channel has failed. The source in turn sends an erase message to inform all nodes about the broken link and initiates a new route-search process to find a new path to the destination [13].

TORA [13] is a reactive routing protocol with some proactive enhancements where a link between nodes is established creating a Directed Acyclic Graph (DAG) of the route from the source node to the destination. This protocol uses a ‘‘link reversal’’ model in route discovery. A route discovery query is broadcasted and propagated throughout the network until it reaches the destination or a node that has information about how to reach the destination.

VII. HYBRID PROTOCOLS

There is a trade-off between proactive and reactive protocols. Proactive protocols have large overhead and less latency while reactive protocols have less overhead and more latency. So a Hybrid protocol is presented to overcome the shortcomings of both proactive and reactive routing protocols. Hybrid protocol is suitable for large networks where large numbers of nodes are present. In this large network is divided into set of zones where routing inside the zone is performed by using reactive approach and outside the zone routing is done using reactive approach. ZRP [21] is suitable for wide variety of MANETs, especially for the networks with large span and diverse mobility patterns. In this protocol, each node proactively maintains routes within a local region, which is termed as routing zone. Route creation is done using a query-reply mechanism. Neighbour discovery information is used as a basis for Intra-zone Routing Protocol (IARP), which is described in detail in [22]. SHARP [23] adapts between reactive and proactive routing by dynamically varying the amount of routing information shared proactively. This protocol defines the proactive zones around some nodes. The number of nodes in a particular

proactive zone is determined by the node-specific zone radius. DHAR [24] uses the Distributed Dynamic Cluster Algorithm (DDCA) presented in [20]. The idea of DDCA is to dynamically partition the network into some non-overlapping clusters of nodes consisting of one parent and zero or more children. Routing is done in DHAR utilizing a dynamic two level hierarchical strategy, consisting of optimal and least overhead table-driven algorithms operating at each level.

ADV [25] routing protocol is a distance-vector routing algorithm that exhibits some on-demand features by varying the frequency and the size of routing updates in response to the network load and mobility patterns. ADV uses an adaptive mechanism to mitigate the effect of periodic transmissions of the routing updates, which basically relies on the network load and mobility conditions. To reduce the size of routing updates, ADV advertises and maintains routes for the active receivers only. A node is considered active if it is the receiver of any currently active connection. There is a receiver flag in the routing entry, which keeps the information about the status of a receiver whether it is active or inactive. To send data, a source node broadcasts network-wide an init-connection control packet. All the other nodes turn on the corresponding receiver flag in their own routing tables and start advertising the routes to the receiver in future updates. When the destination node gets the init-connection packet, it responds to it by broadcasting a receiver-alert packet and becomes active.

The protocol is designed for a MANET of up to two hundreds nodes with high mobility rates and is loop-free. AODV [10] is basically an improvement of DSDV. But, AODV is a reactive routing protocol instead of proactive. It minimizes the number of broadcasts by creating routes based on demand, which is not the case for DSDV. When any source node wants to send a packet to a destination, it broadcasts a route request (RREQ) packet.

VIII. CONCLUSION

Due to the broadcasting nature of radio transmission, the most fundamental task in MANETs is the broadcast operation. Moreover, due to this transmission all the nodes within the sender's transmission range will be affected, when a sender transmits a packet. The cost of information exchange during route discovery is higher than the cost of point to-point data forwarding after the route is established

REFERENCES

[1] George Adam et. al., "Performance Evaluation of Routing Protocols for multimedia transmission over Mobile Ad hoc Networks", IFIP WMNC'2011, 978-1-4577-1193-0/11/$26.00 ©2011 IEEE.

[2] Aartiet. al., "Study of MANET: Characteristics, Challenges, Application and Security Attacks", Volume 3, Issue 5, ISSN: 2277 128X International Journal of Advanced Research in Computer Science and Software Engineering, May 2013.

[3] SwetaKaushiket. al., "Analysis of MANET Security, Architecture and Assessment", International Journal of Electronics and Computer Science Engineering, ISSN: 2277-1956, /V1N2-787-793.

[4] M. Conti, Body, personal, and local wireless ad hoc networks, in: M. Ilyas (Ed.), Handbook of Ad Hoc Networks, CRC Press, New York, 2003 (Chapter 1).

[5] Gurpinder Singh et. al., "MANET: Issues and Behavior Analysis of Routing Protocols", International Journal of Advanced Research in Computer Science and Software Engineering, Volume 2, Issue 4, April 2012 ISSN: 2277 128X.

[6] Kenneth Holter, "Wireless Extensions to OSPF: Implementation of the Overlapping Relays Proposal",Masterthesis,Department of Informatics, University of Oslo,Norway, 2nd May

[7] S. Corson & J. Macker "Mobile Ad hoc Networking:Routing Protocol Performance Issues and Evaluation Considerations", RFC 2501, Oct. 1999. Available: http://tools.ietf.org/html/rfc2501.

[8] Mukesh Kumar et. al., "Issues And Challenges Of Quality Of Service In Mobile Adhoc Network", International Journal of Computer Science & Engineering Technology (IJCSET) ISSN : 2229-3345 Vol. 1 No. 3.

[9] T. Chen, M. Gerla, and J. T. Tsai, "QoS Routing Performance in a Multi-Hop, Wireless Network," Proc. IEEE ICUPC '97.

[10] Sun, Jun-Zhao. "Mobile ad hoc networking: an essential technology for pervasive computing." Info-tech and Info-net, 2001. Proceedings. ICII 2001-Beijing. 2001 International Conferences on. Vol. 3. IEEE, 2001.

[11] PriyankaGoyal, VintiParmar and Rahul Rishi, "MANET: Vulnerabilities, Challenges, Attacks, Application", IJCEM International Journal of Computational Engineering & Management, Vol. 11, January 2011.

[12] C. Perkins, E. Belding-Royer and S. Das, "Ad-Hoc On-Demand Distance Vector (AODV) Routing", RFC3561, July 003.

[13] G.Vijaya Kumar et. al., "Current Research Work on Routing Protocols for MANET: A Literature Survey", (IJCSE) International Journal on Computer Science and Engineering Vol. 02, No. 03, 2010, 706-713.

[14] Divecha, Bhavyesh, et al. "Impact of node mobility on MANET routing protocols models." Journal of Digital Information Management 5.1 (2007): 19.

[15] Dr.S.S.Dhenakaranet. al., "An Overview of Routing Protocols in Mobile Ad-Hoc Network", ISSN: 2277 128X International Journal of Advanced Research in Computer Science and Software Engineering, Volume 3, Issue 2, February 2013.

[16] Chiang C-C, Wu H-K, Liu W, Gerla M (1997) Routing in Clustered Multihop, Mobile Wireless Networks with Fading Channel. Proceedings of IEEE SICON:197–211.

[17] T. Clausen and P. Jacquet, “Optimized Link State Routing Protocol (OLSR)”, RFC 3626, October 2003.

[18] D. Johnson, Y. Hu and D. Maltz., “The Dynamic Source Routing Protocol (DSR) for Mobile Ad Hoc Networks for IPv4”, RFC 4728, Febryary 2007.

[19] Toh C-K et. al. , “A Novel Distributed Routing Protocol to Support Ad- Hoc Mobile Computing”. Proceedings of the 1996 IEEE 15th Annual International Phoenix Conference on Computers and Communications:480–486, 1996.

[20] Dube R, Rais CD, Wang K-Y, Tripathi SK (1997) Signal Stability- Based Adaptive Routing (SSA) for Ad Hoc Mobile Networks. IEEE Personal Communications, Volume 4, Issue 1:36 45.

[21] Pearlman MR, Samar P (2002) The Zone Routing Protocol (ZRP) for Ad Hoc Networks. IETF draft, July 2002, available at http://tools.ietf.org/id/draft-ietf-manetzone-zrp-04.txt. Accessed.

[22] February 2008 94 A.-S.K. Pathan and C.S. Hong Haas ZJ, Pearlman MR, Samar P (2002) Intrazone Routing Protocol (IARP). IETF Internet Draft, July 2002.

[23] Spector, A. Z. 1989. Achieving application requirements. In Distributed Systems, S. Mullende