A Study of Effective Factors Over Routing Protocols for MANET

Aslam Khan
M.Tech Scholar
Department of CSE
ASCT, BHOPAL

Syed Imran Ahmed
Assistant Professor
Department of CSE
ASCT, BHOPAL

Abstract—A network which does not require any fixed pre-existing infrastructure and can be defined as a set of mobile nodes is called MANET. In MANET mobile nodes are communicating through wireless medium. In MANET all mobile nodes behaves as router and when required they takes part in discovery and maintenance of the route to the other node. One of the major challenges in designing a routing protocol for the MANET is to determine a packet route; a node needs to know at least about its neighbors. On the other hand in MANET wireless networks conditions changes frequently with time due to the mobile nodes thus routing becomes a challenging task. To serve this purposes various proactive, reactive and hybrid routing protocols are developed by researchers. Among all AODV, DSR, DYMO and ZRP are well known popular routing protocols and have been standardized by the IETF MANET WG. ZRP is a well known hybrid routing protocol. To understand its suitability we must understand its behavior under various real time conditions. This paper study some propagation model and fading model and also describes two main characteristic of wireless channel path loss and fading. This paper also focuses on some other important factors that affect the performance of MANET. These important factors are battery model, Radio Model, Queue model and Mobility model. Thus, the goal is to carry out a systematic performance comparison of ad-hoc routing protocols under these factors in terms of QoS metrics such as average end-to-end delay, throughput and average jitter.

Keywords—*MANET, Routing protocols, Propagation Model, Battery Model, Queue Model, Throughput, Average Jitter, End-to-End Delay.*

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I. INTRODUCTION

Adhoc network is a collection of mobile/semi-mobile nodes with no pre-established infrastructure, forming a network, in which nodes communicate with each other via radio or infrared. PC or laptops directly communicates with each other. Generally, in Adhoc network, nodes are mobile but also consists of stationary nodes [1]. An adhoc network has no centralized administration. This is to be sure that the network won't collapse just because one of the mobile nodes moves out of the transmission range of the nodes; multiple hops are needed to reach other nodes. Every node acts as a host or a router [2].

Over recent time Mobile Adhoc Network (MANET) are widely uses in many applications. Mobile Ad Hoc Networks are the self-organizing and self-configuring wireless networks which do not rely on a fixed infrastructure and has the capability of rapid deployment in response to application needs. Nodes of these networks function as routers which discover and maintain routes to other nodes in the network [3]. A MANET can be used for both unicast and multicast type of communication. Conventional protocols used for fixed infrastructure networks cannot be efficiently used for mobile ad-hoc networks, so that MANET requires routing protocol other than conventional ones[2].In MANETs some of protocols used for comparison are: AODV, DYMO, DSR, OLSR, ZRP, etc [5,6]. Among all AODV, DSR, DYMO and ZRP are well known popular routing protocols and have been standardized by the IETF MANET Working Group. The three most popular reactive routing protocols for MANETs namely Ad-Hoc On-demand Distance Vector (AODV), Dynamic Source Routing (DSR) and Dynamic MANET On-demand (DYMO), find route only when node have data to send. It avoids the need of frequent link and route updates therefore substantially reduces energy consumption when the traffic load is light or the network mobility is high [7]. All of the above discussed protocols are operating only in Network layer.

Despite the attractive applications of MANETs, these systems continue to face many challenges and constraints that require further investigation prior to the widespread commercial deployment of MANETs. The main constraints that can affect MANET design are as follows: (1) the limited energy and lifetime of the battery, quality of service (QoS),infrastructure-less and autonomous configuration, dynamic network topologies, the mobility of nodes, wireless link reliability, variation in node capabilities, multi-hop routing scalability, multicast support and security threats [8]. Therefore, routing protocol plays a significant role in such networks, and there remains a substantial need to consider the above constraints of MANETs in the development of new routing protocols to enable the efficient forwarding of packets over a wireless medium, mainly when the source and destination are non-neighboring nodes. The routing protocol must select the optimal route between pairs of source–destination nodes.

In MANET [3] [8] nodes are forwarding packets for each other, a particular type of routing protocol is required to make the routing decisions. Basically there are two categories of routing protocols, table-driven and on-demand routing protocols. In table-driven protocol, each node maintain up-to date routing

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information to all the nodes in the network where as in on-demand protocol a node finds the route to a destination when it desires to send packets to the destination. An important part in the design of ad hoc networks is the development of dynamic routing protocols that can efficiently find routes between two communicating nodes. The routing protocols must be able to cope up with the high degree of node mobility that often changes the network topology drastically and unpredictably [9]. The various ad-hoc routing protocols have their unique characteristics. Hence, in order to find out the most adaptive and efficient routing protocol for the highly dynamic topology in ad-hoc networks, the routing protocols behavior has to be analyzed by varying node mobility , speed, traffic and network size. In [12] author applied AODV, DYMO and ZRP routing protocols to the created mobility scenario with variable transmission range. AODV and DYMO shows low jitter and low end to end delay.Thus, the goal is to carry out a systematic performance comparison of ad-hoc routing protocols under mobility models in terms of QoS metrics such as available link bandwidth, average end-to-end delay, throughput and average jitter.

II. ROUTING PROTOCOLS IN MANET

According to the underlying network, three types: data-centric, hierarchical and location based as shown in figure 1.

A. Routing protocols based on functions

Proactive: A routing table is generated at each node, so that routing information is kept for every node in the network. Routing information is periodically updated [6].

Reactive: No routing table is generated and route discovery is done as needed or on an on-demand basis. The route information is kept for future reference.

Hybrid: Combines the characteristics of proactive and reactive routing. Furthermore, hybrid routing protocol is powerful in reducing the cost of the network. It first computes all routes and then improves the routes at the time of routing [7].

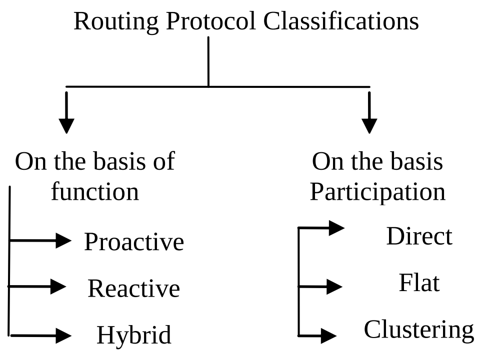

Figure 1: Classification of Routing Protocol

B. Routing protocols based on participation style of nodes

Direct: Allows nodes to send information directly to base station/s[8-10].

Flat: If any node needs to send data, primarily it will find a valid route to the base station and then forward it [8].

Clustering: The whole area is divided into a number of small clusters then each cluster will have a cluster head (CH) and only this cluster head will directly communicate with the base station [10].

On the basis of above three categories some important protocols are AODV, DYMO and ZRP, each one of them have specific quality in different aspects of routing.

AODV: It is Ad-hoc on Demand Distance Vector Routing protocol [11] it comes under reactive protocol and based on distance vector algorithm. This algorithm uses different messages to discover and maintain links among nodes, means whenever any node want to communicate or send data packets to other specific node then it first find out all possible routes, it send route request to all neighbor route and all node will reply with specific message to source node. When any node send route request (RREQ) to all other nodes, the sender node will maintain all acknowledged messages from other requested nodes which helps to find route for the destination node as well as it indicate that all nodes are alive. If any other node not giving acknowledgment to the sender’s request (request response: RREP) then sender node will remove that link as well as entry of that node from routing table.

*DYMO:*DYMO routing protocol has been proposed by Perkins &Chakeres [12] as advancement to the existing AODV protocol. It is also defined to as successor of AODV or ADOVv2 and keeps on updating till date. DYMO operates similar to its predecessor i.e. AODV and does not add any extra modifications to the existing functionality but operation is moreover quite simpler. DYMO is a purely reactive protocol in which routes are computed on demand i.e. as and when required. Unlike AODV, DYMO does not support unnecessary HELLO messages and operation is purely based on sequence numbers assigned to all the packets. It is a reactive routing protocol that computes unicast routes on demand or when required. It employs sequence numbers to ensure loop freedom. It enables on demand, multi-hop unicast routing among the nodes in a mobile ad hoc network. The basic operations are route discovery and maintenance. Route discovery is performed at source node to a destination for which it does not have a valid path. And route maintenance is performed to avoid the existing obliterated routes from the routing table and also to reduce the packet dropping in case of any route break or node failure.

*ZRP:*Zone Routing Protocol [13] is suitable for big range of MANETs, significantly for the networks with large coverage and numerous mobility patterns. Within this protocol, every node pro-actively maintains routes with a neighborhood region, which is thought as routing zone. Route creation is performed by employing a query-reply mechanism. For

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creating completely different zones inside network, a node first has got to recognize who its neighbours are. A neighbour suggests that a node with whom direct communication is sometimes established, that is among one hop transmission array of a node. Neighbour discovery facts are used as being a basis for Intra-zone Routing Protocol (IARP), which might be described in more detail in [13]. As an alternative to blind broadcasting, ZRP runs on the query control mechanism to cut back route query traffic by guiding query messages outward from your query source and far from covered routing zones. A covered node is basically a node that belongs to the routing zone of any node that has received a route query. Throughout the forwarding with the query packet, a node identifies be it via its neighbour or not. If yes, then it marks most of its familiar neighbouring nodes within the same zone as covered. Thus query is relayed until it reaches its final destination. The destination successively sends back a response message through the reverse path and helps to create the path.

III. PROPAGATION MODELS

The propagation model is the model which helps to predict and analyze the power of received signal of each packet on each node. In Network Simulator there are three main propagation models which are Two-ray model, free space model and Shadowing model [15]. At physical layer of each node there is one specific threshold value which indicates that if the received signal power of received packet on each node is below than that specific value then that packets are dropped by that node.

A. Two Ray Model

In this model direct path ray and ground reflected ray are used. The accuracy of this model is much greater than other models. This model is preferred for nodes which are separated by long distance. In this type of model the power of received signal is given by:

$$P_r = [P_t \times G_r \times G_t \times h^2_t \times h^2_r] / d^4 \times L$$

Where P_r is power of received signal, P_t power of transmitted signal, Gr and G t are gain of antenna in transmitted and receiving mode, d represent distance between two antennas, L is system loss which has specific value.

B. Free Space Model

The Free Space Model assumes ideal assumption that the sending and receiving of packets are done by line of site action. Basically in this model the Transmitting antenna send signals in circular form around it so the receiving antenna which is in the range, it will receive packets otherwise loose the packets. The power in free space model is given by following equation:

$$P_r (d) = [P_t \times G_t \times G_r \times \lambda^2 / [(4\pi)^2 \times d^2 \times L]$$

Where P_t and P_r are the power of transmitter and receiver Antenna, G_r, G_t are gain of transmitter and receiver Antenna, d is distance between transmitter and receiver, λ is wavelength.

C. Shadowing Model

As both the free space model and Two-ray model are using distinct function of distance to predict the strength of received signal although the power at different location on each node is varying. Both models are predicting the mean received power, so to get more accuracy in received signal power use Shadowing model. The Shadowing model has two parts, first part is Path loss Exponent and second is Log normal random variable.

D. Okumara Model

Okumaramodel is one of the most frequently used macroscopic propagation models. It was developed during the mid 1960's as the result of large-scale studies conducted in and around Tokyo. The model was designed for use in the frequency range 200 up to 1920 MHz and mostly in an urban propagation environment. Okumura’s model assumes that the path loss between the TX and RX in the terrestrial propagation environment can be expressed as:

$$L_{50} = L_{FS} + A_{mu} + H_{tu} + H_{ru} \tag{1.6}$$

where:

L_{50} = Median path loss between the TX and RX expressed in dB

L_{FS} = Path loss of the free space in dB

A_{mu} = “Basic median attenuation” – additional losses due to propagation in urban environment in dB

H_{tu} = TX height gain correction factor in dB

H_{ru} = RX height gain correction factor in dB

The free space loss term can be calculated analytically using:

$$L_{FS} = 32.45 + 20\log(d/1Km) + 20\log(\frac{f}{1MHz}) - 10\log(G_t) - 10\log(G_r) \tag{1.7}$$

IV. RADIO ENERGY MODELS

The Radio Energy Models [16] reads the energy consumption specifications of the radio where the specifications are defined by the configuration parameters which are the power supply voltage of the radio, electrical current load consumed in Transmit, Receive, Idle, and Sleep modes. Each state represents a different level of energy consumption such as in transmit mode, receive mode, idle mode and sleep mode.

A. Micaz Radio Energy Model

The MicaZ radio energy model is a radio-specific energy model which is pre-configured with the specification of power consumption of MicaZ motes (embedded sensor nodes).

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C. Generic Radio Energy Model

The main feature of the generic model is estimation of energy consumption for the radios with common modulation schemes (analog and digital) and common classes of amplifiers (class-A,B,C,D). Further, the model can estimate energy consumption in transmitter for the case of continuous transmits power level.

V. BATTERY MODEL

Battery models are used to predict the behavior of real life batteries under various conditions of charge/discharge, proving useful tools for battery driven system design approach. These models enable analysis of the discharge behavior of battery under different design choices. The state of charge of batteries attached to a battery-operated node is periodically checked and if the battery is out of charge, the node is shut down. For the battery model specification, the input parameters are configured initially for a given battery type from a battery manufacturer. In this dissertation simulation studies, Residual Life Estimator Battery Model and Linear Battery model is used [17].

VI. MOBILITY MODELS

In Mobile Ad-hoc Network to determine the performance of routing protocol Mobility model [13] [18] play an important role. Actually mobility model is used to set different parameter related to node movement like starting point of node, movement direction, velocity etc. At global level mobility model is divided in two parts Entity and Group. In Entity model the node move completely independently from each other but in group model they are dependent on each other.

A. Random Waypoint

It is commonly used mobility model [18] in simulation of Ad-hoc network. In this mobility model node has to be paused for certain amount of pre specified time while changing direction or speed, this time is called as pause time, once this time is over then node has to select other random destination and start travelling towards it with uniformly distributed speed.

B. Random Walk

In Random walk model mobile nodes are travelled in any direction with any speed but the value of speed and direction is chosen from predefined ranges from minimum to maximum, in this mobility model mobile node's direction will change after particular time of interval or specific amount of distance. The Random walk is memory less mobility pattern so it generates unrealistic movement such as sudden stop or sudden curve. In this model if mobile node touch boundary of simulation area it will bounce back with certain speed to its original position.

VII. QUEUE MODELS

A. First-In-First-Out (FIFO)

FIFO is an descriptor for initial in, first out, a way for organizing and manipulating a data buffer, wherever the oldest (first) entry, or 'head' of the queue, is processed initial. It's analogous to process a queue with first-come, first-served (FCFS) behavior wherever the folks leave the queue within the order within which they arrive. During this drawback is once a queue is stuffed the router begin to discard all further packets therefore dropping the tail of mechanism. The loss of packets causes the sender to enter slow begin that decreases the output and therefore will increase its congestion window [19].

B. Random early Detection (RED)

Random early Detection seeks to forestall the router's queue from changing into totally employed by randomly dropping packets, and send signals to the sender to prevent before the queue is entirely full. RED additionally performs tail drop, however will thus in a very a lot of gradual approach. Once the queue hits an explicit average length, packets en-queued have a configurable probability of being marked (which could mean dropped). This opportunity will increase linearly up to some extent known as the max average queue length, though the queue would possibly get larger [20].

VIII. PERFORMANCE MEASURES

A. Throughput

Throughput is one of the dimensional constraint of the system which gives the ratio of the channel capacity utilized for useful transmission. It represents the number of packets received within a given time interval. Hence, it is the average rate of successful information delivery over a communication channel. Throughput is expressed as bytes or bits per second (byte/s or bit/s).

B. End to End Delay

End to end delay stands for the holdup encountered between data packet transmission and reception. Buffering, queuing, propagation, transmission and re-transmission of packets are possible cause of end-to-end delay. Average end-to-end delay is obtained when total time duration for each individual packet transmission is divided over the total number of packets received. The unit of average end-to-end delay is seconds(s).

C. Average Jitter

Jitter signifies any unwanted variation in one or more signals generated during packet transfer due to network congestion, improper queuing or configuration errors. The unit for jitter is seconds.

VII. CONCLUSION

In conclusion, the evolution of sensor-enabled mobile devices toward smart environments has catalyzed the development of MANETs, which play a key role in providing users with a variety of IoT applications and services.This paper study some propagation model and fading model and also describes two main characteristic of wireless channel path loss and fading.This paper also focuses on some other important factors that affect the performance of MANET. These important factors are battery model, Radio Model, Queue model and Mobility model. These factors are considered to analyse their impact under different network scenarios.

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