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Evolution of Performance Metrics between Routing Protocols for MANETS

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Abstract: In wireless communication networks Ad-hoc networks are plays dominant role, Mobile Ad-hoc network (MANET) is a collection of wireless mobile nodes that dynamically form a network temporarily without any central administration. The primary objective of this research work is to study and investigate the performance of Dynamic source routing (DSR) protocol and Energy efficient routing protocols like MBCR and MMBCR. Energy efficient routing is one of the important design criterions for MANET since mobile nodes are battery powered with limited capacity and which cannot be recharged whenever needed. So the MANET routing is challenged by power and bandwidth constraints. We use CBR based Traffic models to analyses the performance of routing protocols based on parameters of Packet Delivery Ratio, Average end to end Delay, Energy Consumption, Node Analysis, Network Lifetime and through put. We have used NS-2 Simulator for simulation.

Keywords: Ad-hoc Network, Avg end to end delay, Energy efficiency, Network Lifetime, Packet Delivery Ratio.

I. INTRODUCTION

Mobile Ad hoc networks (MANETs) are combination of mobile nodes without existence of any centralized control or pre-existing infrastructure. Such kind of networks generally use multi-hop paths and wireless radio communication channel. Thus, communication between nodes is established by multi-hop routing. Also, new nodes join or leave at any time. Owing to the dynamic nature, topology is often changing. Therefore performance of network deteriorates rapidly. Ad hoc is a kind of special wireless network mode. An ad hoc wireless network is a collection of two or more devices quipped with wireless communications and networking capability. Such devices can communicate with another device that is immediately within their radio range or one that is outside their radio range not relying on access point. A wireless ad hoc network is self-organizing, self-disciplining, and self-adaptive.

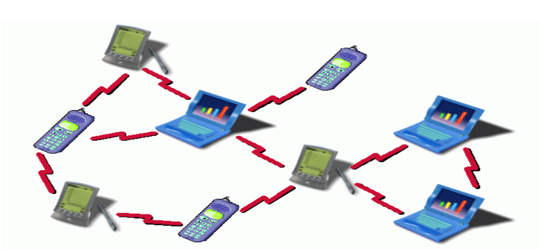

Fig.1.Genaral Ad-hoc Network

A mobile ad-hoc network consists of mobile hosts equipped with wireless communication devices. The transmission of a mobile host is received by all hosts within its transmission range due to the broadcast nature of wireless communication and Omni-directional antennae. If two wireless hosts are out of their transmission ranges in the ad hoc networks, other mobile hosts located between them can forward their messages, which effectively build connected networks among the mobile hosts in the deployed area. Due to the mobility of wireless hosts, each host needs to be equipped with the capability of an autonomous system, or a routing function without any statically established infrastructure or centralized administration. The mobile hosts can move arbitrarily and can be turned on or off without notifying other hosts. The mobility and autonomy introduces a dynamic topology of the networks not only because end-hosts are transient but also because intermediate hosts on a communication path are transient.

The communication between the nodes in a packet data network must be defined to ensure correct interpretation of the packets by receiving intermediate and end systems. Packet exchange between the nodes is called protocols. And the routing involves two things: Firstly determining optimal routing paths, secondly transferring the information groups (called packets) through an internetwork. Routing protocols use several metrics to calculate the best path for routing the packets to its destination. Unsurprisingly, designing good protocols with few packets collision will reduce power

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consumption. At the network layer, the routing protocols can be designed such that there is an increase in the network life time by distributes the forwarding load over multiple different paths. The main objective of this paper to investigate the performance of routing in ad-hoc network.

A group of mobile devices called as nodes, without any centralized network, communicates with each other over multi-hop links is called as an Ad-hoc Network (MANET). A MANET is a collection of self-organized mobile users which are free to act independently that communicate over relatively bandwidth constrained wireless links. Since the nodes are mobile, the network topology may change quickly and cannot be predicted over time.

The main characteristics of ad hoc networks are as follows:

Dynamic topology: Because nodes in the network can move arbitrarily, the topology of the network also changes.

The bandwidth of the link: it is unstrained, and the capacity of the network is also tremendously variable. Because of the dynamic topology, the output of each relay node will vary with the time, and then the link capacity will change with the link change. At the same time, compete-collision and interference make the actual bandwidth of ad hoc networks smaller than their bandwidth in theory.

Power limitation: it is in mobile devices is a serious factor. Because of the mobility characteristics of the network, devices use batteries as their power supply. As a result, advanced power conservation techniques are very necessary in designing a system.

The safety: it is limited in a physical aspect. The mobile network is more easily attacked than the fixed network. Overcoming the weakness in safety and the new safety trouble in wireless networks are on demand.

Each and every node has limited life spam. To maximize the life time of nodes in a network, the energy consumption rate of each node must be evenly distributed. Section II describes the Routing Protocols, Section III Theoretical Analysis of routing protocols, and Section IV presents Simulation Environment. Section V describes about the experimental results and lastly section VI gives the conclusion.

II. ROUTING PROTOCOLS

MANET routing protocols are having the responsibility to find and maintain routes between nodes in a dynamic topology by using minimum resources. They are classified into three main groups such as

1. Proactive routing protocols
2. Reactive routing protocols
3. Hybrid routing Protocols

Routing protocol has two significant functions:

- Selecting the routes for various source-destination pairs and among those choose the best path (least cost/ minimum distance/ more bandwidth).
- Routing each messages through that best path to their correct destination.

The second function is implemented by a variety of protocols with the help of routing tables. Ad-hoc routing protocols can be classified based on different criteria. Based on the routing mechanism used by a given protocol, it may fall under more than one class.

Routing protocols for Ad-hoc networking can be classified into four categories.

- Based on routing information which are updated by anyone of the routing mechanism (proactive or table-driven, reactive or on-demand and hybrid routing protocols).
- Based on that instantaneous time information (Both Past and Future time information) for routing
- Based on routing topology (Flat Topology, Hierarchical Topology)
- Based on the use of particular resources (Power Aware Routing and Geographical

Each node in these routing protocols in Mobile Ad hoc networks operates on constrained battery power. The power will start decreases with time even though the node is idle. Power management is an important concept which concentrates how to reduce the energy consumed in the wireless interface of battery-operated mobile devices. So Energy Conservation is taken as a prime factor since all wireless devices usually rely on portable power sources such as batteries to provide the necessary power.

Routing is important in MANET due to the following reasons:

- Host mobility: It is due to the dynamic topology that changes over time. The routing protocol must be capable of managing link failure/repair due to mobility.
- Distributed Environment: Minimum control overhead as there is no any centralized control
- Bandwidth constrained: Total bandwidth is shared.
- Energy constrained: Battery resource is constrained

An efficient routing protocol should maximize network throughput and lifetime, while minimizing delay in

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transmission. Routing protocols coming under energy awareness must balance delay constraints, battery lifetime and routing efficiency in order to achieve a better route discovery. The common means of energy consumption in routing occurs during exchange of route information. In case of route with small number of hops, energy is consumed significantly compared to a route with large number of hops. The lifetime of a node is degraded as it is used more frequently.

III. THEORITICAL ANALYSIS

Performance analysis between routing protocols for mobile ad-hoc networks we are considering different routing protocols like DSR-Dynamic Source Routing, MBCR-Minimum Battery Cost Routing, and MMBCR-Minimum Maximum Battery Cost Routing.

3.1 Dynamic Source Routing (DSR) Protocol:

The Dynamic Source Routing (DSR) protocol is a simple and efficient routing protocol designed specifically for use in multi-hop wireless ad-hoc networks of mobile nodes. Using DSR, the network is completely self-organizing and self-configuring, requires no existing network infrastructure or administration. Network nodes co-operate to forward packets for each other to allow communication over multiple "hops" between nodes which are out of wireless transmission range from one another. As nodes in the network move about or join or leave the network, all routing is automatically determined and maintained by the DSR routing protocol.

Since the number or sequence of intermediate nodes needed to reach any destination may change at any time, the resulting network topology may be quite rich and rapidly changing. In DSR protocol overheads are very low and able to react very quickly to changes in the network. The DSR protocol provides highly reactive service in order to help ensure successful delivery of data packets in spite of node movement or other changes in network conditions.

The DSR protocol is composed of two main mechanisms that work together to allow the discovery and maintenance of source routes in an ad-hoc network:

Route Discovery: It is the mechanism by which a node S wishing to send a packet to a destination node D obtains a source route to D. Route Discovery is used only when S attempts to send a packet to D and does not already know a route to D.

Route Maintenance: It is the mechanism by which node S is able to detect, while using a source route to D, if the network topology has changed such that it can no longer use its route to D because a link along the route no longer works. When Route Maintenance indicates a source route is broken, S can attempt to use any other route it happens to know to D, or it can invoke Route Discovery again to find a new route for subsequent packets to D. Route Maintenance for this route is used only when S is actually sending packets to D.

In DSR, Route Discovery and Route Maintenance each operate entirely "on demand". In particular, unlike other protocols, DSR requires no periodic packets of any kind. For example, DSR does not use any periodic routing advertisement, link status sensing, or neighbour detection packets. This entirely on-demand behaviour and lack of periodic activity allows the number of overhead packets caused by DSR to scale all the way down to zero, when all nodes are approximately stationary with respect to each other and all routes needed for current communication have already been discovered. As nodes begin to move more or as communication patterns change, the routing packet overhead of DSR automatically scales to only what is needed to track the routes currently in use.

In response to a single Route Discovery, a node may learn and cache multiple routes to any destination. This support for multiple routes allows the reaction to routing changes to be much more rapid, since a node with multiple routes to a destination can try another cached route if the one it has been using should fail. This caching of multiple routes also avoids the overhead of needing to perform a new Route Discovery each time a route in use breaks. The sender of a packet selects and controls the route used for its own packets, which, together will support for multiple routes.

3.2. The minimum battery cost routing (MBCR):

This protocol was proposed in which use remaining battery capacity of each host as a metric to describe the lifetime of each host.

$$f_i(c_i^t) = \frac{1}{c_i^t} \qquad \text{..... (3.2.1)}$$

Where, $f_i(c_i^t)$ is a battery cost function of a host n_i. Now, suppose a node's willingness to forward packets is a function of its remaining battery capacity. The less capacity it has, the more reluctant it is. As the battery capacity decreases, the value of cost function for node n_i will increase. The battery cost R_j for route i, consisting of D nodes, is

$$R_j = \sum_{i=0}^{D_j-1} f_i\left(c_i^t\right) \qquad \text{.....(3.2.2)}$$

Therefore, to find a route with the maximum remaining battery capacity, we should select a route i that has the minimum battery cost.

$$(R_j = \min\{R_j \mid j \in A\} \qquad \text{..... (3.2.3)}$$

Where, A is the set containing all possible routes.

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Advantage of MBCR: In MTPR, if the minimum total transmission power routes are via a specific host, the battery of this host will be exhausted quickly, and this host will die of battery exhaustion soon. Therefore, the remaining battery capacity of each host is a more accurate metric to describe the lifetime of each host. But, in MBCR since battery capacity is directly incorporated into the routing protocol, this metric prevents hosts from being overused, thereby increasing their lifetime and the time until the network is partitioned. If all nodes have similar battery capacity, this metric will select a shorter-hop route.

Disadvantage of MBCR: Because only the summation of values of battery cost functions is considered, a route containing nodes with little remaining battery capacity may still be selected. For example, in Figure 3.2.2 there are two possible routes between the source and destination nodes. Although node 3 has much less battery capacity than other nodes, the overall battery cost for route 1 is less than route 2. Therefore, route 1 will be selected, reducing the lifetime of node 3, which is undesirable.

3.1. The min-max battery cost routing (MMBCR):

This protocol was proposed in at first, in each possible route from source to destination, the maximum battery **cost** will be selected from Equation (3.3.1). Among this set of maximum battery costs, the minimum battery cost will be selected according to Equation (3.3.2). The battery of each host will be used more fairly than in previous schemes.

Battery cost R_j for route j is redefined as

$$R_j = \max_{i \in route\_j} f_i\left(c_i^t\right) \qquad \text{...... (3.3.1)}$$

Similarly, the desired route i can be obtained from the equation

$$R_j = \min\left\{R_j \middle| j \in A\right\} \qquad \text{..... (3.3.2)}$$

Advantage: Since this metric always tries to avoid the route with nodes having the least battery capacity among all nodes in all possible routes, the battery of each host will be used.

Disadvantage*:* The disadvantage is that since the minimum total transmission power is not considered in MMBCR, the power consumption may be more to transmit user traffic from a source to a destination, which actually reduces the lifetime of all nodes. In MMBCR (Min-Max Battery Cost Routing) we first find the node having minimum battery capacity in each node of the possible routes and select the route having the maximum value among the selected routes. That means the route having maximum life time is selected. But the main demerit of MMBCR is that it does not consider the transmission powers of the nodes. In MMBCR, the updated information is not considered for route selection. So, two mechanisms are proposed to overcome this disadvantage. The first is MMBCR-route reply, where the cost function is calculated in route reply phase instead of in route request phase for selecting the route. And the other is MMBCR with periodic route discovery to get more updated information about the routes. In this method periodically the route discovery process is done. If there are any changes in the route, the route information is updated. Because of this method, different routes are used for transmission of data packets and periodic shifting between the routes which avoids the over usage of nodes and node exhaustion leading to the increase of the life time of the network.

IV. SIMULATION ENVIRONMENT

The Proposed protocols are implementing with the object oriented discrete event simulator. In our simulation, 16 mobile nodes move in a 1000 meter x 1000 meter square region for 200 seconds simulation time. The Simulator Environment is created by using TCL Script with the help of following parameters included in the table.

Propagation	Two Ray Ground Propagation
No. of Nodes	16
Area Size	1000x1000 m^2
MAC	802.11
Simulation Time	200 Sec
Traffic Source	CBR
Packet Size	512 bytes
Antenna type	Omni directional
Packet Transmission Power	0.4 mw
Packet Receiving Power	0.1mw
Routing Protocols	DSR, MBCR, MMBCR
Initial Energy of nodes	X joules (Different Energies are used)

Fig: 4.1 Simulation Environment table

Simulation Network Models:

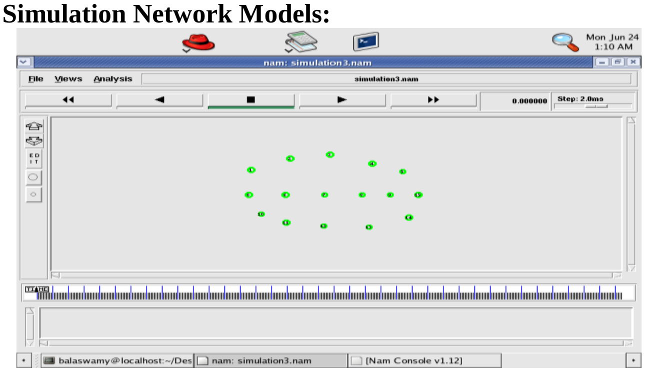

Fig.4.2 Network Scenario

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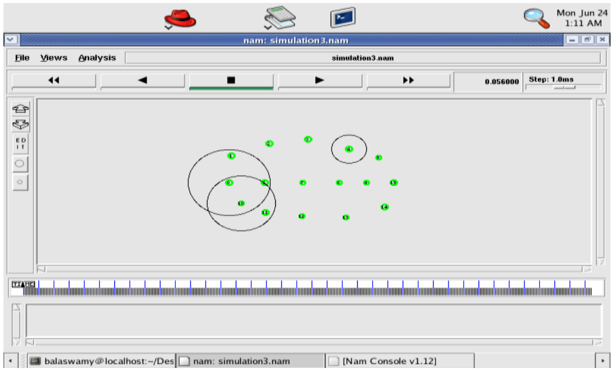

Fig.4.3.Brodcasting

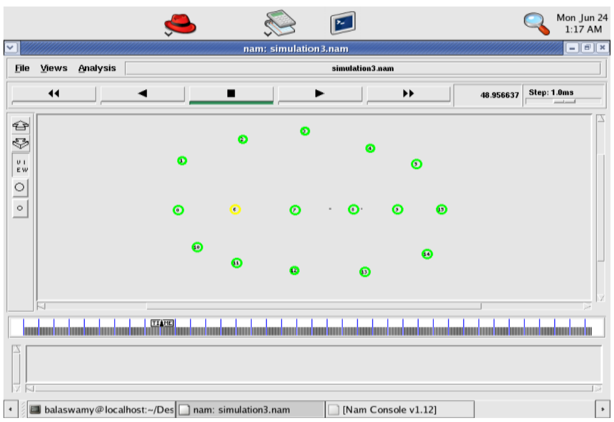

Fig.4.4. Data Transmission

Performance metrics:

Packet delivery ratio: The ratio of the data packets delivered to the destinations to those generated by the CBR sources. Received packets and sent packets number could be easily obtained from the first element of each line of the trace file.

Packet delivery ratio (%) = (received packets/sent packets)*100

Average end-to-end delay: This includes all possible delays caused by buffering during route discovery latency, queuing at the interface queue, retransmission delays at the MAC, and propagation and transfer times.

For each packet with id (Ii) of trace level (AGT) and type (cbr), we can calculate the send (s) time (t) and receive (r) time (t) and average it.

Routing overhead: It is the ratio of the routing packets sent and the total packets sent. Each hop-wise transmission of a routing packet is counted as one transmission.

Calculation of the routing overhead:

Routing overhead = routing packets sent / total packets sent

Network Lifetime:

It represents the lifetime of network when the all routes are fail.

Throughput:

Throughput refers to the performance of tasks by a computing service or device over a specific period. It measures the amount of completed work against time consumed and may be used to measure the performance of a processor, memory and network communications. It can be represents Bits per Second.

Packet

A packet is the unit of data that is routed between an origin and a destination on the Internet or any other packet switch network

A packet consists of two kinds of data: control information and user data (also known as payload). The control information provides data the network needs to deliver the user data,

Jitter:

Jitter is the variation in the time between packets arriving, caused by network congestion, timing drift, or route changes. A jitter buffer can be used to handle jitter.

Transmission time:

The transmission time, is the amount of time from the beginning until the end of a message transmission. In the case of a digital message, it is the time from the first bit until the last bit of a message has left the transmitting node. The packet transmission time in seconds can be obtained from the packet size in bit and the bit rate in bit/s as

Packet transmission time = Packet size / Bit rate

V.EXPERIMENTAL RESULTS

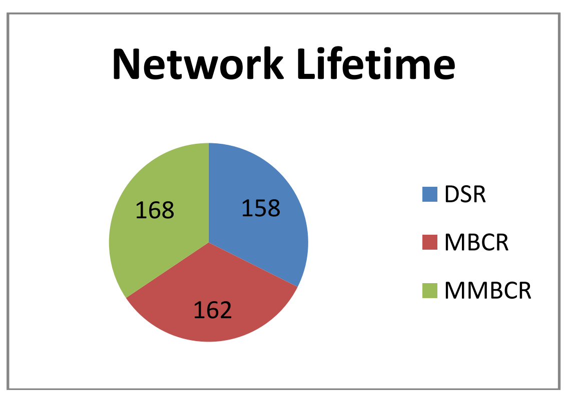

Fig: 5.1. Network Lifetime

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The diagram 5.1 shows Network Lifetime consider routing protocols like Dynamic Source Routing Protocol , Energy Efficient Routing protocols are MBCR and MMBCR.

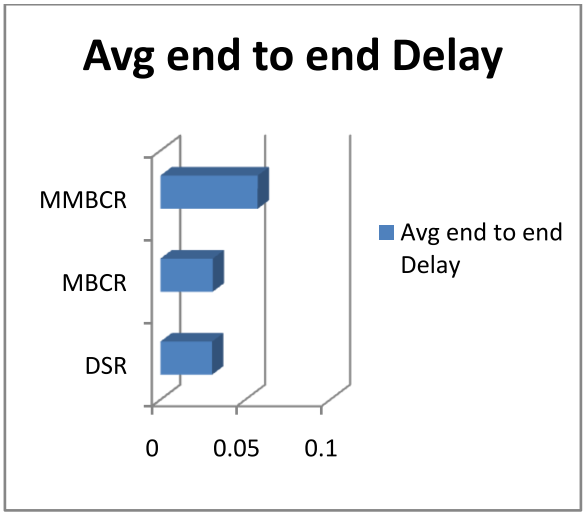

Fig :5.2. Avg end to end delay

The diagram 5.1 shows Average end to end Delay consider routing protocols like Dynamic Source Routing Protocol , Energy Efficient Routing protocols are MBCR and MMBCR.

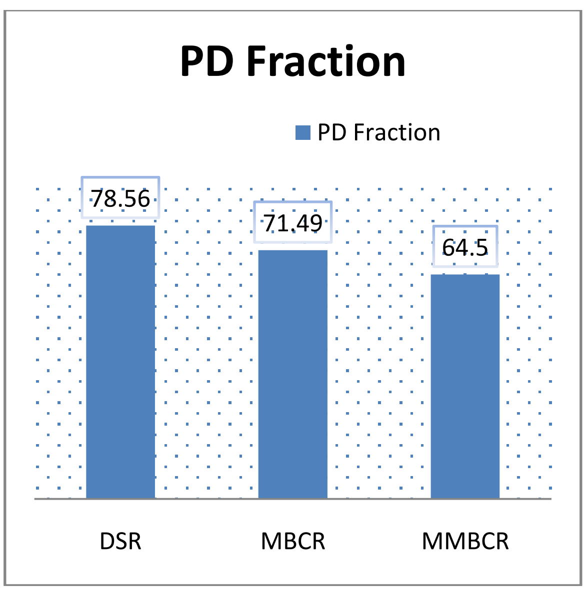

Fig: 5.3. PD fraction

The diagram 5.3 shows Packet Delivery Rato consider routing protocols like Dynamic Source Routing Protocol , Energy Efficient Routing protocols are MBCR and MMBCR.

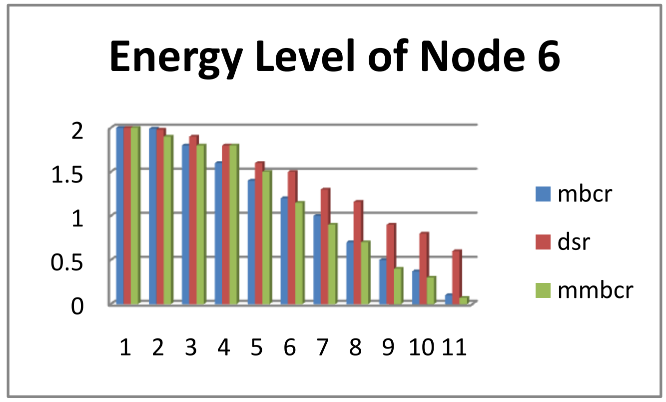

FIG: 5.4.ENERGY LEVEL

The diagram 5.4 shows Energy Level at the node 6 consider routing protocols like Dynamic Source Routing Protocol , Energy Efficient Routing protocols are MBCR and MMBCR.

VI.CONCLUSION

Generally in MANET the design of Routing protocols are very important criteria because the performance of network depends on the design of routing protocols. In this paper, we are using ad-hoc routing protocols like dynamic source routing protocol (DSR), Minimum Battery cost routing protocol(MBCR), minimum-maximum battery cost routing protocol (MMBCR) here MBCR and MMBCR are Energy Efficient routing Protocols considering the performance metrics Network Lifetime, Packet Delivery Ratio, First node failure time, Avg End to End Delay, Transmission time and Dropped Packet Information analysed the performance of the Mobile Ad-hoc Network with the help of CBR traffic. The simulation results shows that MMBCR performs better in case of node failure time and the Life time of the Network is investigated for MMBCR to get higher node failure time by using the Network Simulator Software.

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BIOGRAPHY

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