IMPACT OF SLEEPING NODES ON THE PERFORMANCE OF PROACTIVE AND REACTIVE ROUTING PROTOCOLS IN MOBILE AD HOC NETWORK

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ABSTRACT: *Mobile ad hoc network is a self-configurable, temporary and limited resources network. Each device works as a host as well as a router. It is a decentralized network that has no single point of failure. It is scalable network and the nodes can easily join and leave the network. This research has conducted a simulation based investigation of four prominent protocols DSR, DSDV, AODV, and OLSR using NS2 in the presence of sleeping nodes percentage. The performance metrics considered are packet delivery fraction, end to end delay, normalized routing load, average overhead and packet drops. The result produced shows that reactive routing protocols having higher packet delivery in the presence of sleeping node. So it is desirable for the situation in which there are low power devices and the nodes can be deployed with reactive routing protocols. The reactive routing protocols shows higher delay as compared to proactive routing protocols because it established routes on demand basis but advantages of reactive routing protocols is lower packet drops.*

Keywords: MANET, Routing Protocols, AODV, Sleeping nodes, Proactive, PDR.

1. INTRODUCTION

MANET (Mobile Ad hoc Network) is a collection of wireless nodes that can form a network dynamically to communicate information without using any pre-defined network infrastructure [1]. It is a self configurable, adaptive and does not require human intervention. Devices must be able to sense other devices easily and work cooperatively. It is a distributed approach that has no single point of failure and hence scalable. The network can be joined and leaved freely by the Nodes it can move freely. The ad-hoc networking got importance with the production of lightweight handheld devices. With the wide spread applications of MANETs, they can be applied in situations, where there is no pre-installed framework or the infrastructure is expensive to use. Mobile ad hoc network is suitable for the scenarios like a battlefield, special military operations, for commercial uses, for personal area network, etc. due to these characteristics.

Mobile ad hoc network is a multi-hop network and where the intermediate nodes are used to performed end to end communication, where the topology changes frequently and unpredictably due to mobility and ad hoc nature. To link and connect such power limited devices some more systematic and fruitful routing protocols are required. In order to keep routes by means of very less overhead and converges quickly routing protocols should be adaptive, flexible and reactive. To minimize such issues we need several routing protocols.

Figure 1: MANET [2] (Sharma *et al.,* 2012)

2: AD-HOC ROUTING PROTOCOLS

Routing protocols in MANET possess distinguished properties and characteristic almost the way they exchange information and establish communication. The protocols developed in recent years are classified into three broad classes. These are: flat, hierarchical and geographical routing. This research focuses on flat routing protocols. The flat routing is further classified into two main categories such as proactive routing protocols and reactive on-demand routing protocols [3]. Traditional protocols similar link state and distance vector protocols are improved to create on demand routing algorithm. It is also termed as proactive protocols since it maintains a table that contain route to all destination in its routing table. It maintains routing information on each node and refreshes its table periodically because the route is changing dynamically. However, proactive routing protocols have lower latency due to maintenance of routes all the time, but results into higher overhead due to frequent route updates. The protocols which perform proactive routing are DSDV [4], WRP [5] etc.

On demand routing protocols are also termed as table driven routing protocols hence it find route to the destination when it is needed to reduce the control overhead. A source node broadcast route request message to the network when discovering route. Each node maintains route discovered in routing table. It maintain only valid route and delete stale route after an active time out. However, reactive routing protocols may have higher latency due to route discovery. On the other hand it produces less overhead as routes are maintained only on demand basis. The protocols which use this mechanism are DSR [6], AODV [7]. Routing is defined as a process through which a device discovers path towards a specific destination.

2.1: Table-Driven Routing Protocols

The Table driven routing protocols try to preserve consistent, update and fresh routing information from each node in the network topology. Each node need to store partial or complete routing information to find route to a destination. Due to this reason the routing protocols are divided into further two classes.

2.2: On-Demand Routing Protocols

When the route is needed by the source on such demand the reactive routing protocols create and maintain routes. Whenever the route is required the source node first finds out the route or using some global searching procedure. At the start broadcast initiated by the sender specifying the require path function this path detection procedure. After the completion of route request and route selection procedure the message is transmitted. Due to dynamic topology during the communication the route may be lost. Some mechanism is require that rebuilt the lost and broken link such mechanism is known as route maintenance.

The routing information which are never used are not communicated that result into reducing the overhead to maximum point which is the main benefit of on-demand routing protocol. Periodic updates are also reduced as the state of link change. Disadvantage of on demand routing is its latency during the route discovery. The examples of reactive routing protocols consist of GEDIR, SSR, WAR, AODV, ABR, CEDAR, DREAM, LAR and DSR.

a) Dynamics Source Routing (DSR) Protocol

In Dynamic Source Routing protocol (DSR) [6], each node contains a route cache and with new route the cache is updated. This protocol works in two phases: route discovery and route maintenance. When a node want to send data to some destination it consult its route cache, if the route to the destination exist and the route is fresh it will use that route to send data. If the node does not have any route then it will initiate a route discovery and broadcast a route discovery and broadcast a route request packet, this broad cast will be received by all nodes within the transmission range. Each route request message will have the initiator and the destination of the route discovery and also unique request id. The route request message also contains the record of the addresses of intermediate nodes through which this route request message passes. When a node receive this route request message and it is the destination or intermediate node that contains an intermediate node that contains an unexpired route to the destination, it sends a route reply message to the initiator with route reply for route discovery with a copy of record route from the route request. As the initiator receives this router reply it store this route in its route cache for sending further data.

b) Ad-hoc On-Demand Distance Vector (AODV) Routing Protocol

Based on the DSDV protocol the Ad-hoc On-Demand Distance Vector (AODV) routing protocol that is a table driven routing protocol, however compare to DSR it keeps the next hop information by every hop of a route [8]. Route establishment occurs in binary phases, route discovery and route maintenance. Initially each and every node sends "hello" packet while the "hello" packet of all other nodes is captured, which makes the neighbors connected. Source sends Route Request packet toward the neighbors to find path to some destination. The neighbors resend this message in case the path to destination is not available and the Process is repeated till path discovery. A node with information about the path on receiving the message transmits route reply packet toward source. Devices which forward this route reply packet stores in formations regarding this destination as well as address of the neighbors that send this route request message. Here in such mechanism, by the time when a node receive the Route Request packet that has routing information to the node; and similarly the nodes in the middle keep and record the path. The route is termed as reverse path. This path is called reverse path. Each route request message is assigned a unique id at the initiator node, when a node receive this message it check this id, if it is already processed then it is discarded because this message is forwarded by each node to its neighbors, therefore more than one copy is received by a node. By employing reverse path the Route Reply Message going back, this route is selected as forward route and store information about the node form the message has been sent. The initiator can start sending data by receiving the Route Reply Message and route is ready. In case of link failure new Route Reply Message is created and all the nodes that using this path are informed from link failure to avoid link breakage. To inform the neighbors the message is sent again and again. If the source node wants to transmit further data it sends new Route Request Message.

c) Destination-Sequenced Distance-Vector Routing Protocol

The Destination-Sequenced Distance-Vector Routing protocol (DSDV) [9],[4] with extension that made it appropriate for mobile ad hoc networks. In DSDV each node keeps a routing table which contains route to every possible destination, number of hop to the destination and a sequence number assigned by the destination node. This sequence number is used for routing loop avoidance and whenever a change occurs in the node's neighbor the sequence number is increases. The old route is replaced every time with higher sequence number when route is updated. Whenever a route is selected a route with the highest sequence number is selected for most recent information.

d) Optimized Link State Routing (OLSR) Protocol

The OLSR [10] is a proactive routing protocol that provides routes directly as soon as it is necessary. OLSR is an extension for MANET using classical link state protocols by using selected nodes for flooding called MPRs which are minimizing the control traffic overhead. Moreover, partial link states are broadcasted by OLSR that guarantee shortest path. MPR are used to establish routes from source to destination in the network and also they forward control traffic and declare links to their MPR selectors in the network. Nodes with bidirectional links are chosen as MPR from one hop neighbors. To minimize the maximum time interval for periodic controls packet transmission OLSR similarly enhance the reaction to the changing topology. Furthermore, MPR optimization reduces overhead by two ways, and provides better bandwidth for useful data transmission. i) As the packet size is small therefore, Only MPR selectors are advertised. ii) The broadcast packet is only forwarded by MPR. However, in some OLSR options, control messages are forwarded before of their deadline for small, temporary and local control traffic increase against topology changes.

3: REVIEW OF LITERATURE

Rajeswari and Venkataramani [11] analyzed the performance of Reliable Adaptive Gossip routing protocols and Energy Efficient and Gossip Routing protocol. Using metrics like average End-to-End Delay, packet delivery ratio and throughput under TCP and CBR based traffic models the performance of theses protocols were investigated. The change in numbers of nodes and simulation time were also investigated using routing protocols in MANET. Simulations are performed using ns-2 simulator. The proposed protocol assured the increased delivery ratio, better reliability and high energy conservation for power managed routing. From the simulation they have observed that the proposed protocol achieves good delivery ratio and good throughput with less End to End Delay and energy consumption.

Patel [12] Network of nodes whose main function is to forwards data, which result into terminal nodes and forwarding nodes. They evaluate the performance of the network when the nodes sleep. They presented a new network in which the devices builds a cloud of communication devices that works like transmission medium they called this network as M^2 ANET Mobile Medium Ad hoc Network. They define quality of service only in term of delivery ratio. They varied the number of nodes in their simulation and the sleeping time of nodes in the network. The time for sleeping of a node is arbitrarily selected. With irregular sleeping nodes the performance of nodes is foreseeable. Decreasing the number of nodes in network has the same effect as increase in nodes sleep time. They showed that with the redundant nodes and variable sleeping nodes has negligible effect on the performance.

Mukilan and Wahi [13] developed and designed the node mobility and efficient energy based data replication procedure to balance the , energy consumption ,Query delay and data availability in mobile ad hoc networks. Mobile data in one partition is not accessible from the other partition Due to the presence of the network partition. Due to this reason the performance and efficiency of the network and data access is reduced. In the proposed method they focused on balancing between the node's delay, energy consumption and data availability. Finally they concluded from the simulation results they demonstrated that the suggested approach attains better performance than the existing approaches.

Nema et al. 2012 [14] focused on the existence of a node active as long as. They set the minimum energy level when the node reaches that level it become sleep. The time in which the energy is consumed is called the wake up time. When the energy of node is lost it disconnect from the network and alternative route is made on the basis of the remaining energy of the neighbor nodes. When the energy of the neighbor node is larger than 50 update node's cache and transfer traffic through that. If the neighbor nodes residual energy is lower than 50 then search for node that has maximum residual energy and update the cache according to that node and made the traffic through it.

Waoo et al [15] focused on different power saving mechanism for MANET using AODV routing algorithm. They proposed ad hoc on demand routing protocols which is Energy based that main focus to maintain network life time by consuming less power. They define a threshold value and search for alternate route for the data and sleep. The performance of the proposed scheme is evaluated using performance metrics like network life time, packet delivery fraction and discrepancy of node remaining energy. They showed through their simulation results that the survivability of the network is increased.

Malhotra and Dureja [16] presented to provide security as well as save power therefore in modern schemes clustering and routing algorithms are particularly developed. To achieve both objectives security as well as low power consumption is difficult that is only one is achieved as counterpart of the other. Various clustering algorithms that are weight based are surveyed by them.

Malhotra and Dureja [17], to reduce message overhead and congestion for cluster formation and maintenance they presented a clustering scheme. The developed algorithm is dependent with the sleep state of on Ad-hoc On Demand Distance Vector (AODV) Routing algorithm. Node complexity, power consumption and data packet overhead is minimized by the automatic creation of clusters. The algorithm is designed with the objective such as increase lifetime of mobile nodes, reduce the number of cluster formation as well as maintain stable clustering. As the nodes in MANET are resource constrained that are using their battery power to work therefore they are power limited devices. To increase the lifetime of network and utilize minimum amount of the energy they proposed an Energy based Ad-Hoc on-Demand Routing protocol that balances energy among all nodes. All the work is performed using network simulator NS2. They showed through simulation that the total of clusters designed is in ratio with the total of nodes in MANET.

Bade et al., [18] focused on the reactive power-alert technique for communication between ad hoc network nodes by constantly alerting their energy condition to neighbor nodes. The concentration was on reducing the energy consumption by proposing optimal path selection method. A threshold value is set on the energy consumed by mobile nodes in ad-hoc network. When the energy level of any node/s in the network reaches a threshold level then such nodes are made inactive and inform other nodes not to establish connections with it in this sleep state. Finally, experimental results and a comparative analysis are presented based on the use of this threshold. They concluded that the results shows significant improvement in the throughput and routing load which in turn increases the lifetime of the network.

Singh and Chadha [19] as power consumption becomes an important issue and this lack of power with nodes leads to selfish behavior among nodes in case of commercial MANET. Author work provides an in-depth analysis of literature for routing protocols in MANETs and their effect on selfish behavior of nodes.

4) PARAMETERS USED FOR SIMULATION

With a haphazard spreading of source –destination pairs Constant Bit Rate (CBR) traffic sources will be used. Furthermore, the size of data packets will be 64 Bytes. Also, we will select a sending rate of 4 packets per seconds. The simulations use random waypoint mobility model (Johnson and Maltz 1996) [20], that describes the nodes mobility in the simulated space. As stated by this model, the motion of each node is started from an arbitrarily selected source to a arbitrary destination. Once the node reaches its destination, it stops for a pause time p and then randomly selects another destination. The simulation will consist with 50 nodes and simulation time 900 sec and simulation area 1000m^2 with mobility of 10m/sec. The pause time will be 100 second. Parameters used for this research are mentioned in table 3.1.

TABLE 1: Simulation Parameters

Protocol	AODV, DSR, DSDV, OLSR
Sleeping node	0% to 50%
Mobility Model	Random Waypoint
No of nodes	50
Simulation time	900 seconds
Simulation Area	1000 m x 1000 m
Pause time	100 seconds
Mobility	10 m/second
Traffic	Constant Bit Rate (CBR)

i) Throughput (bits/s):- per unit time the total amount of messages received by the destination is called throughput.

ii) Packets received: - it is the total number of packets received at destination.

iii) Delay: it is the time from source node to destination by a packet**.**

iv) Packet Drop: when the packet arrives to the buffer of Nodes (routers) in MANET the packet may drop due to full buffers. Considering the condition of the network e.g. the packet of nodes drop all, some or none of them and congestion. By subtracting total amount of received packet from the total amount of transmitted packets.

v) Packet Delivery ratio: PDR is the ratio between the packet sent and the packet received.

vi) Routing overhead: routing overhead is the total amount of messages transmitted at network layer.

vii) Normalized routing load: Normalized routing load is the proportion of amount of messages transferred on network layer and amount of CBR messages collected by the receiver on the application layer.

5: RESULTS AND DISCUSSIONS

In this research have discussed different protocols such as proactive and reactive routing protocols and pick two protocols from each e.g DSDV, OLSR, AODV, DSR. Then select different metrics such Packet delivery ratio, End to End delay, packet drops, normalized routing load, average overhead. These graphs shows the percentage of each metrics. The X axis side show average percentage and Y axis show sleeping nodes percentage. The reactive protocols show higher packet delivery in the presence of sleeping node. So it is desirable for the situation in which there are low power devices we need to deploy as the nodes with reactive routing protocols. The reactive protocols shows higher delay compared to other protocols.

5.1: Packet Delivery Ratio

Packet delivery ratio is the amount packet received by the receiver node to the amount of packet sent by the sender node. PDR is calculated with unit as Packets per second. Formula used to calculate the PDR is given below.

$$PDR = \frac{(Total\ Packets\ Received)}{(Total\ Packets\ Sent)} * 100$$

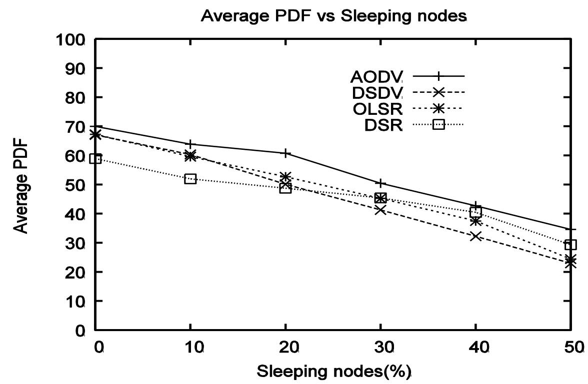

Figure 2: Packet Delivery Ratio

Figure 2 shows the packet delivery ratio against sleeping nodes percentage that is 0%, 10%, 20%, 30%, 40% and 50%. It can be realized from the graph as the amount of sleeping nodes raises the average packet delivery also reduces. The reason behind this is that the nodes sleeps and the packets are not received by the nodes and the packets are dropped. All the protocols show the same behavior in presence of sleeping nodes that the PDR is decreased. However the AODV shows better performance comparatively but it also shows the same trend with the increase in sleeping nodes percentage. It can also be observed that the DSR also show high Packet delivery when the number of sleeping nodes increase. This trend of On demand routing protocols is because that, the reactive routing protocols does not maintain the table for routes to its destination but discover it when the route is needed. It can be concluded from this graph that the reactive routing protocols are suitable for such situation as it show good packet delivery.

5.2 End TO End Delay

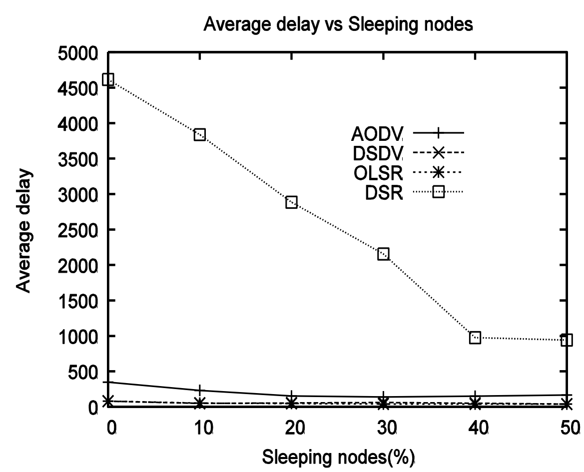

Figure 3: End to End Delay

It comprises of all probable delays like retransmission delay, queuing delay and buffering during route discovery and propagation.

D = (Tr –Ts) Where Tr is received Time and Ts is sent Time

The Figure 3 depicts the behavior of routing protocols in the presence of sleeping nodes versus the end to end delay. The graph clearly demonstrates that the delay of DSR is higher as compared to other routing protocols. It is because of the DSR high latency due to its route discovery process. All the other protocols show lower delay it is because of maintaining routing table. As the number of sleeping nodes increase the delay of all the protocols decrease. Its reason is due to the number of nodes decreases and the paths established directly with the destination nodes. Both of the reactive protocols shows higher delay as compared to other protocols because they use fresh path to send it data so as the nodes sleep it discover new path for the destination that increases it delay. On the other hand Proactive routing protocols show lower delay because they do not search for fresh path establishment when the nodes sleep.

5.3 Packet Drops

It can be calculated by subtracting the total amount of data Packet reached to receiver form the total amount of data packets sent by the sender.

Packet drops = (Ps –Pr) Where Ps is the number of packet sent and Pr is packet received

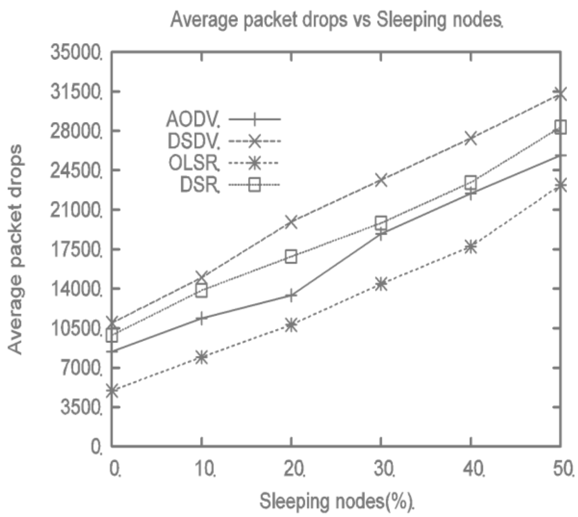

Figure 4: Packets Dropped

The average packet drops against the sleeping nodes is shown in the Figure 4. It can be clearly observed from the graph that the packet drops increases with the increase in sleeping nodes percentage. All the protocols show the same trend with the increase in sleeping nodes percentage. The DSDV protocol shows higher packet drop comparatively it is because it does not use fresh route for the packet to reach its destination and therefore the packet drops in the path not reaching its destination. However, the reactive routing protocols show less packet drops comparatively in the presence of sleeping nodes, the logic behind this trend of reactive routing protocols is that they do not use stale route that become disconnected due to sleeping node. But the OLSR protocol shows comparatively low packet drops, it is because it uses MPR that advertises the route to the destination and if it sleeps the other MPR select path to the destination.

5.4 Normalized Routing Load

NRL is the proportion between the amounts of messages transmitted at the network layer to the amount of CBR messages collected by the destination at the application layer. The behaviour of routing protocols in the presence of sleeping nodes against normalized routing protocols is depicted in Figure 5. The graph shows that the NRL decreases with the increase in the sleeping nodes percentage. However the OLSR shows higher delay as the number of sleeping nodes increase. It is because that the number of packet at network layer increases because the nodes sleep.

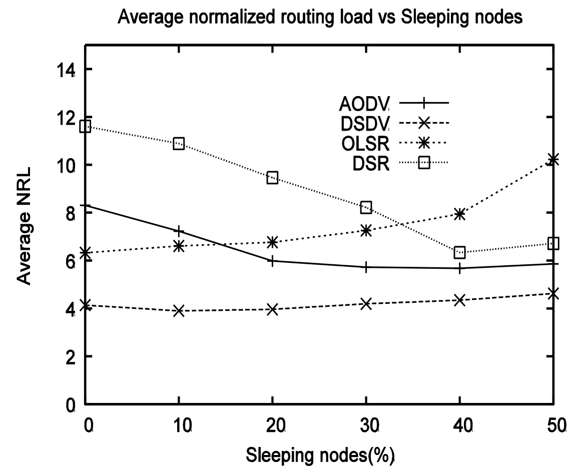

Figure 5: Normalized Routing Load

5.5 Average Overhead

Average overhead is the sum of all the messages sent on network layer. Here average overhead of four routing protocols against the sleeping nodes percentage is depicted in the Figure 6. As the number of sleeping nodes increase the overhead decrease for all of the protocols. This trend in the behaviour of these protocols is due to the decrease in number of nodes and the routing packet for less number of nodes is propagated. Nodes in the network declare the link of sleeping node down and using new routes to send its data. Initially the DSR has higher overhead but with the increase in number of sleeping nodes the overhead decrease. It is because that the DSR overhead in initially high due to fresh route establishment for all destinations but as the nodes sleep the route establish for the destination decrease. Both the reactive protocols show the same trend. However, the OLSR and DSDV show lower overhead and it is absolutely due to route in its routing table.

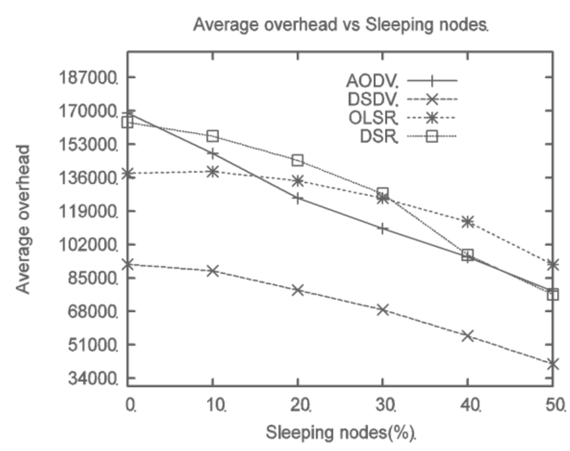

Figure 6: Average Overhead

6: CONCLUSION

From all the results shown in the chapter 4 it can be concluded that the reactive protocols shows higher packet delivery in the presence of sleeping node. So it is desirable for the situation in which there are low power devices and the nodes can be deployed with reactive routing protocols. The reactive protocols shows higher delay as compared to other protocols but however the protocols show lower packet drops so for a network high delivery and low packet drops is essential so from the overall investigations it is observed that the reactive routing protocols are suitable for such networks.

8: FUTURE WORK

The future strategy of this research is to design a system which is light weight, produce minimum overhead and work in such a way that work best in the presence of sleeping nodes as well as consume less energy during its operation.

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