Performance Analysis of ZHLS-GF Routing Protocol for MANETs through simulations

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Abstract— *Mobile Ad Hoc Network (MANET) is a collection of communication devices or nodes that wish to communicate without any fixed infrastructure and pre-determined organization of available links. The nodes in MANET themselves are responsible for dynamically discovering other nodes to communicate. Many routing protocols have been developed for MANETs over the past few years. This paper will help us in analyzing performance of ZHLS-GF routing protocol i.e. Zone-Based Hierarchical Link State Routing Protocol with Gateway Flooding (ZHLS-GF) in which a new flooding scheme, called Gateway Flooding was used. ZHLS-GF is based on ZHLS, a Zone-Based Hierarchical Link State Routing Protocol. ZHLS is a hierarchical protocol; the network is divided into non-overlapping zones. Each node only knows the node connectivity within its zone and the zone connectivity of the whole network. The zone level topological information is distributed to all nodes. All network nodes in ZHLS construct two routing tables, an intrazone routing table and an interzone routing table, by flooding NodeLSPs within the zone and ZoneLSPs throughout the network. This incurs a large communication overhead in the network.*

ZHLS-GF floods ZoneLSPs only to the gateway nodes of zones thus reduce the communication overhead significantly. Furthermore in ZHLS-GF, only the gateway *nodes store ZoneLSPs and construct interzone routing tables therefore the total storage capacity required in the network is less than ZHLS. Different performance aspects were investigated in this project including; packet delivery ratio, power consumption no. of hops and average end-to-end delay. A test bed has been developed for ZHLS routing protocol and the performance parameters of ZHLS-GF and ZHLS are compared. Power consumption parameter is discussed for power that is for simulation purpose. This test bed confirms that which protocol has the more power consumption. It also confirms that how simulation in ZHLS and ZHLS-GF differs. This thesis uses Windows operating system based platform and vb.net language to develop the test bed and to compare two hierarchical routing protocols.*

Keywords: *Mobile Ad-Hoc Network (MANET), Routing Protocols. Evaluation parameters.*

1. Introduction

The use of wireless mobile networks has strongly evolved in the previous couple of years, mainly through the growing popularity of the Internet and computer networks in general. To people it becomes more and more important to be flexible, independent from wires and workspace, but to be connected to the network, nevertheless. Different protocols have been developed and proposed for such purposes, but many of them still rely on cabled infrastructure such as wireless base stations, for instance. In those networks the routing between sender and receiver is not accomplished by the wireless network but still by the cabled components.

In the current scenario, the focus of research is being set on new technologies and routing protocols, which no longer require base stations, fixed routers, or any other infrastructure: Mobile Ad-Hoc Networks[1][2]. In a mobile ad-hoc network, all nodes may move randomly and are connecting dynamically to each other. This new type of network largely widens the operational area of computer networks. They may be used in areas with little or no communication infrastructure: think of emergency searches, rescue operations, places where people wish to quickly share information, like meetings, or avoidance of rear end collisions, if cars participate in such a network. One of the main problems in mobile ad-hoc networks is how the routing of data packets should be done. Because all the participant nodes may change their position frequently, the network topology changes quickly and therefore topology based routing algorithms may run into problems.There are various types of routing protocols designed for ad hoc networks. They can be divided into two categories: proactive and reactive. A good review of ad-hoc routing protocols can be found in [1] [2]. In proactive routing protocols [3], each node floods its link state packet (LSP) throughout the network. Based on the link state packets of all nodes in the network, each node calculates the shortest path to every node and constructs a routing table. When the topology (link state) changes, due to the mobility of the nodes, LSPs are flooded to reflect the changes and the routing table is updated. A source node refers to its routing table to send data to a destination node and forwards the data to the next hop node which forwards it to its next hop node and so on until the data reaches the destination node. In reactive routing protocols [3] [4], a source node, which wants to send data to a destination node, first broadcasts a destination node route discovery packet. When the destination node receives the packet, it sends back a route reply packet via the route it received the route discovery packet. When the source receives the reply packet it sends the data packet via the nodes which are included in the route reply packet. If the path is broken due to the mobility of the nodes in the path, the source node initiates the path discovery process again.In order to reduce the number of route discovery packets (in reactive protocol) or routing table building LSP packets (in proactive protocol), hierarchical design schemes which are both reactive and proactive such as the Zone Routing Protocol (ZRP) and Zone-Based Hierarchical Link State (ZHLS) routing protocol had been proposed. ZHLS is more robust and peer-to-peer hierarchical routing protocol which creates two routing tables, an intrazone routing table and an interzone routing table, by flooding NodeLSP and ZoneLSP which will be explained further in Chapter 3. A gateway Flooding Scheme had been proposed to reduce the number of control packets, specially ZoneLSP, in ZHLS to reduce the communication overhead. There is a need too test the simulation of ZHLS (for normal flooding and gateway flooding) and to evaluate the performance of ZHLS-GF routing protocols. This Thesis looks at the development of Test Bed that will run the simulation for both ZHLS and ZHLS-GF and tries to calculate the performance of both (ZHLS and ZHLS-GF) routing protocols.

Results and Discussions

Note: Simulation is done for 10 and 19 number of Nodes

Packet Delivery Ratio (PDR) -The PDR shows how successful a protocol performs delivering packets from source to destination. The higher for the value give us the better results. This metric characterizes both the completeness and correctness of the routing protocol also reliability of routing protocol by giving its effectiveness.

Hops- It provides an expected data route length. No. of Hops remains same in both cases of Normal Flooding and Gateway Flooding. While simulating a test bed total no of hopes are 38 in case of 10 nodes and 137 in case of 19 nodes. Hence there will not be any change in no of hops.

Power - A power of 1000 units to applied to each node. Thus in case of 10 node total initial power is 10000 units and in case of 19 nodes total power is 19000 units

Total initial power in case of simulation for 10 nodes = 1000 * 10 =10000
Total initial power in case of simulation for 19 nodes = 1000 * 19 =19000
As packets are transmitted or received power is reduced as shown in Figure 5.3 (for 10 nodes) at page no. 60 and Figure 5.4 (for 19 nodes) at page no. 61.

PDR simulation for 10 nodes Table 5.1 on the next page is for the packet delivery ratio for 10 nodes. Time is converted in to seconds as shown in third column of table 5.1. Simulation time for both the ZHLS and ZHLS-GF routing protocol are shown. When comparing results of both ZHLS and ZHLS-GF a graph like figure 5.1 is seen. From Figure 5.1 it is seen that packet delivery ratio is better in ZHLS-GF. Because in this case simulation takes less time.

PDR simulation for 19 nodes PDR Same procedure is applied here as above for 10 nodes. Table 5.2 and Figure 5.2 on page no 59 shows the results and graphs of comparison.

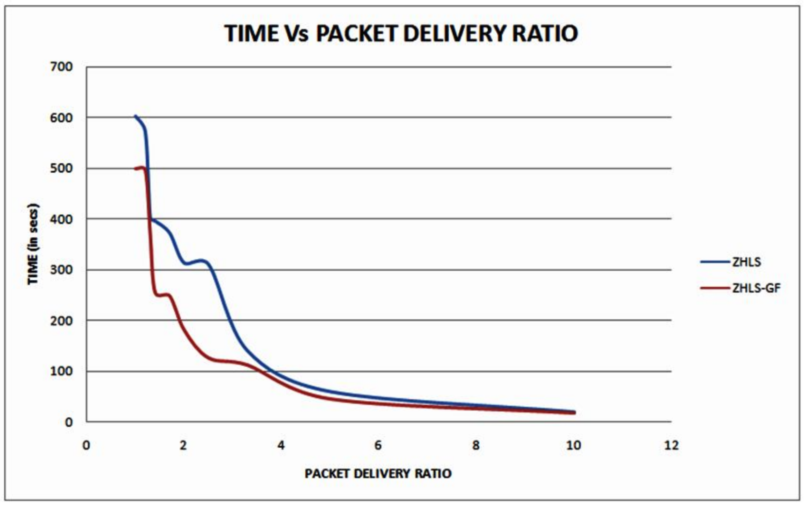

Figure 5.1: Time Vs Packet Delivery Ratio for 10 nodes

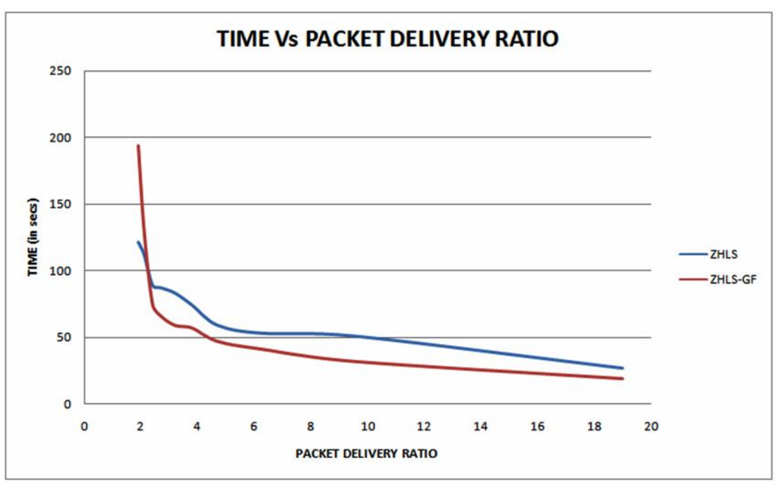

Figure 5.2: Time Vs Packet Delivery Ratio for 19 nodes

Power- is defined as the total energy used by the test bed to complete the simulation. When the energy will reduce to zero, than the simulation of test bed will stops. Power will show the performance of Test Bed. The higher for the value give us the better results. Figure 5.3 and Figure 5.4 shows that there will be less power consumption in ZHLS-GF simulation than the normal simulation.

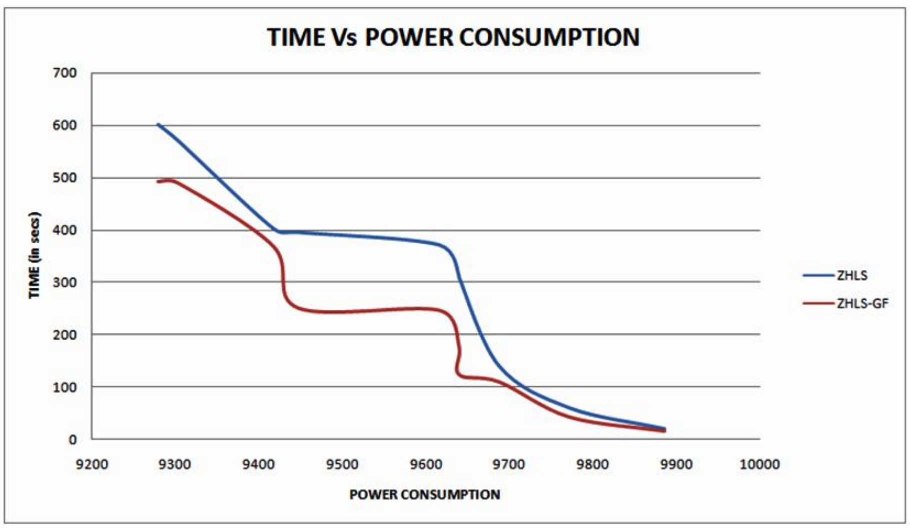

Figure 5.3: Time Vs Power remaining for 10 nodes

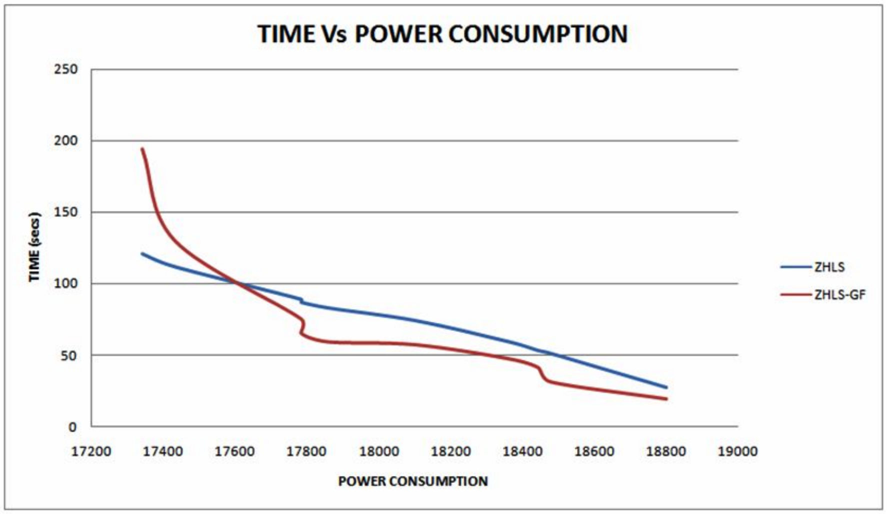

Figure 5.4: Time Vs Power remaining for 10 nodes

Average End To End Delay- There are possible delays caused by buffering during route discovery latency, queuing at the interface queue, retransmission delays at the MAC, and propagation and transfer times. Average end-to-end delay is an average end-to-end delay of data packets. It also caused by queuing for transmission at the node and buffering data for detouring. Once the time difference between every CBR (Constant Bit Rate) packet sent and received was recorded, dividing the total time difference over the total number of CBR packets received gave the average end-to-end delay for the received packets. This metric describes the packet delivery time: the lower the end-to-end delay the better the application performance.

Results from the first 10 packets transmission are taken with their transmission times and compared for both normal flooding and gateway flooding. From the results it is seen that end to and delay is less in gateway flooding. Results for the 10 nodes and 19 nodes are shown on next pages.

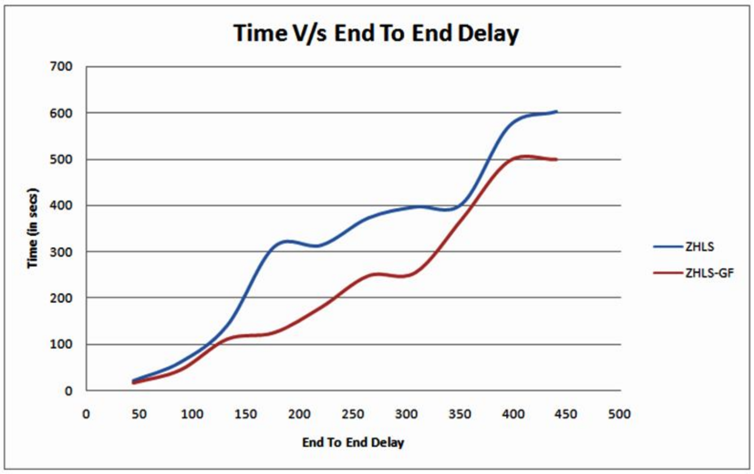

Figure 5.5: Time V/s End To End Delay For 10 Nodes

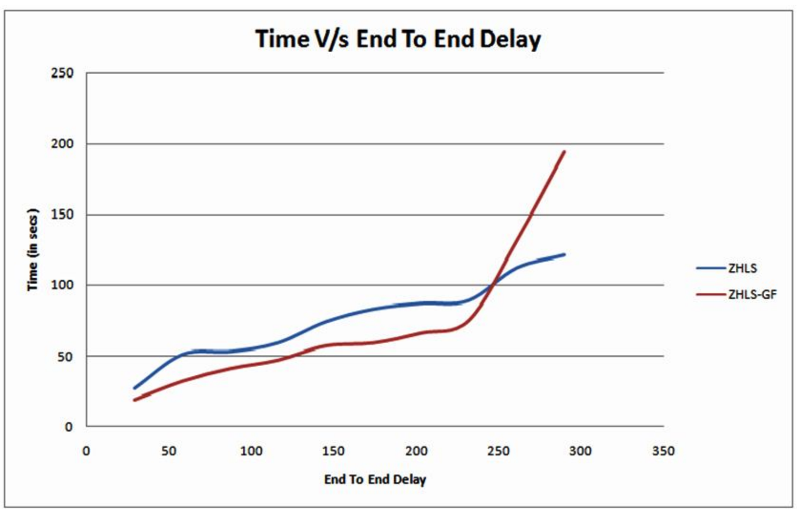

Figure 5.6: Time V/s End To End Delay For 19 Nodes

As shown in Figure 5.5(Simulation for 10 nodes) and Figure 5.6(Simulation for 19 nodes) it is clear that Average End to End Delay in ZHLS-GF is less than that in ZHLS.

2.1 Performance Metrics

This paper had considered several metrics in analyzing the performance of routing protocols. These metrics are as follows.

4.3.1 Packet Delivery Ratio

The ratio between the number of packets originated by source application layer and the number of packets received by destination application layer.

4.3.2 Power

Power is defined as the total energy used by the test bed to complete the simulation. When the energy will reduce to zero, than the simulation of test bed will stops.

4.3.3 *End to End Delay*

It measures the average end-to-end transmission delay by taking into account only the correctly received packets.

4.3.4 *Hops*

It provides an expected data route length.

3.0 Conclusion and Future Scope

In this thesis a Test Bed (a unique simulator) has been developed for calculating the performance parameters for both ZHLS and ZHLS-GF routing protocols in MANETs. This Test Bed randomly deploys the ZHLS Network for the given no. of nodes and thus simulating the network for both Normal Flooding and Gateway Flooding. From the results calculated from the simulation environment it is clear that performance of ZHLS-GF routing protocol is better than ZHLS routing protocol in terms of Packet delivery Ratio and Power Consumption and End to End Delay.

There is no change in number of hops in both ZHLS and ZHLS-GF Routing protocols for the same network. Hierarchical Routing is stable only for larger networks because in larger networks the reduction of routing information is realized through a hierarchical clustering of network nodes.

Though ad-hoc networks are presently studied, more research has to be done to deploy this technology in a large scale to the market. Not only about routing issues and performance parameters, but also about security risks, social acceptance, and selfishness. If a user declines to route packets for other hosts, and he only wants to use the network as transport for himself, other hosts will not get service. Research should be done to avoid this. Furthermore, security risks should be taken in account. For instance, a host, like a laptop or a PDA, can be compromised by malware; thus affecting communications between nodes. Due to the distributed routing, a node failure will not be critical, but has to be studied. Real experiments should be done with real laptops and PDAs devices. By doing some changes this Test Bed can also be used for simulation of reactive and proactive routing protocols.

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