

COMPARATIVE STUDY OF TABLE DRIVEN ROUTING PROTOCOLS IN AD HOC WIRELESS NETWORKS

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ABSTRACT : *The recent advancements in wireless technology have lead to the development of a new wireless system called Mobile Adhoc Networks. A Mobile Adhoc Network is a self configuring network of wireless devices connected by wireless links. The traditional protocol such as TCP/IP has limited use in Mobile adhoc networks because of the lack of mobility and resources. In this paper we have compared the most popular protocols which come under table driven adhoc routing protocols for wireless networks. These comparisons is based on the some of the basic properties of the routing protocol such as the method of route establishment, method of updating the table, maintaining one or more tables, efficiency and some metrics which defines the performance of the protocol.*

Keywords - CGSR, DSDV, FSR, GSR, Routing Protocol, WRP, HLS.

I. INTRODUCTION

Wireless networks is an emerging new technology that will allow users to access information and services electronically, regardless of their geographic position. Wireless networks can be classified in two types, first is infrastructured based network and second one is infrastructureless (adhoc) networks. Infrastructured network consists of a network with fixed and wired gateways. A mobile host communicates with a bridge in the network (called base station) within its communication radius. The mobile unit can move geographically while it is communicating. When it goes out of range of one base station, it connects with new base station and starts communicating through it. This is called handoff. In this approach the base stations are fixed.

In wireless adhoc networks to establish route is bit difficult as compare to wired network. Because of the mobility of the nodes the frequent link failure occurs. Therefore in table driven routing protocols it is necessary to periodically exchanging of routing information between the different nodes, each node builds its own routing table which it can use to find a path to a destination. The multi-hop support in adhoc networks makes communication between nodes outside direct radio range of one another possible. Mobile adhoc networks due to their dynamic nature suffer with frequent and unpredictable topology changes, moreover, in them not only limited network bandwidth is available but also in most of the cases mobile devices are operated on limited battery power. These all issues make routing problem an interesting challenge of this area. In this paper we have collected different routing schemes and have presented a brief overview with respect to their benefits and weakness. We have tried to gather as much as information as possible through the available literature in this area. We organized this paper as, In point 2 we will look at different adhoc table driven routing protocols in brief. Then in point 3 comparisons among protocols, point 4 will have conclusion and last section we included the references.

II. TABLE DRIVEN PROTOCOLS

In Table-driven routing protocols each node maintains one or more tables containing routing information to every other node in the network. All nodes update these tables so as to maintain a consistent and up-to-date view of the network. When the network topology changes the nodes propagate update messages throughout the network in order to maintain consistent and up-to-date routing information about the whole network. These routing protocols differ in the method by which the topology change information is distributed

across the network and the number of necessary routing-related tables. The following sections discuss some of the existing table-driven adhoc routing protocols.

2.1 Dynamic Destination-Sequenced Distance-Vector Routing Protocol (DSDV)

The Destination-Sequenced Distance-Vector routing protocol is based on the idea of the classical Bellman-Ford Routing Algorithm with certain improvements. Every mobile station maintains a routing

table that lists all available destinations, the number of hops to reach the destination and the sequence number assigned by the destination node. The sequence number is used to distinguish stale routes from new ones and thus avoid the formation of loops. The stations periodically transmit their routing tables to their immediate neighbors. A station also transmits its routing table if a significant change has occurred in its table from the last update sent. So, the update is both time-driven and event-driven. The routing table updates can be sent in two ways, a "full dump" or an incremental update.

A full dump sends the full routing table to the neighbors and could span many packets whereas in an incremental update only those entries from the routing table are sent that has a metric change since the last update and it must fit in a packet. If there is space in the incremental update packet then those entries may be included whose sequence number has changed. When the network is relatively stable, incremental updates are sent to avoid extra traffic and full dump are relatively infrequent. In a fast-changing network, incremental packets can grow big so full dumps will be more frequent. Each route update packet, in addition to the routing table information, also contains a unique sequence number assigned by the transmitter. The route labeled with the highest (i.e. most recent) sequence number is used. If two routes have the same sequence number then the route with the best metric (i.e. shortest route) is used. Based on the past history, the stations estimate the settling time of routes. The stations delay the transmission of a routing update by settling time so as to eliminate those updates that would occur if a better route were found very soon.

2.2 The Wireless Routing Protocol (WRP)

The Wireless Routing Protocol is a table-based distance-vector routing protocol. Each node in the network maintains a Distance table, a Routing table, a Link-Cost table and a Message retransmission list. The Distance table of a node x contains the distance of each destination node y via each neighbor z of x . It also contains the downstream neighbor of z through which this path is realized. The Routing table of node x contains the distance of each destination node y from node x , the predecessor and the successor of node x on this path. It also contains a tag to identify if the entry is a simple path, a loop or invalid. Storing predecessor and successor in the table is beneficial in detecting loops and avoiding counting-to-infinity problems. The Link-Cost table contains cost of link to each neighbor of the node and the number of timeouts since an error-free message was received from that neighbor. The Message Retransmission list (MRL) contains information to let a node know which of its neighbor has not acknowledged its update message and to retransmit update message to that neighbor. Node exchanges routing tables with their neighbors using update messages periodically as well as on link changes.

The nodes present on the response list of update message (formed using MRL) are required to acknowledge the receipt of update message. If there is no change in routing table since last update, the node is required to send an idle Hello message to ensure connectivity. On receiving an update message, the node modifies its distance table and looks for better paths using new information. Any new path so found is relayed back to the original nodes so that they can update their tables. The node also updates its routing table if the new path is better than the existing path. On receiving an ACK, the node updates its MRL. A unique feature of this algorithm is that it checks the consistency of all its neighbors every time it detects a change in link of any of its neighbors. Consistency check in this manner helps eliminate looping situations in a better way and also has fast convergence.

2.3 Global State Routing (GSR)

Global State Routing is similar to DSDV described in section 2.1. It takes the idea of link state routing but improves it by avoiding flooding of routing messages. In this algorithm, each node maintains a Neighbor list, a Topology table, a Next Hop table and a Distance table. Neighbor list of a node contains the list of its neighbors (here all nodes that can be heard by a node are assumed to be its neighbors.). For each destination node, the Topology table contains the link state information as reported by the destination and the timestamp of the information. For each destination, the Next Hop table contains the next hop to which the packets for this destination must be forwarded. The Distance table contains the shortest distance to each destination node. The routing messages are generated on a link change as in link state protocols. On receiving a routing message, the node updates its Topology table if the sequence number of the message is newer than the sequence number stored in the table. After this the node reconstructs its routing table and broadcasts the information to its neighbors.

2.4 Fisheye State Routing (FSR)

Fisheye State Routing is an improvement of GSR. The large size of update messages in GSR wastes

a considerable amount of network bandwidth. In FSR, each update message does not contain information about all nodes. Instead, it exchanges information about closer nodes more frequently than it does about farther nodes thus reducing the update message size. So each node gets accurate information about neighbors and the detail and accuracy of information decreases as the distance from node increases. Figure 1 defines the scope of fisheye for the center (red) node. The scope is defined in terms of the nodes that can be reached in a certain number of hops. The center node has most accurate information about all nodes in the white circle and so on. Even though a node does not have accurate information about distant nodes, the packets are routed correctly because the route information becomes more and more accurate as the packet moves closer to the destination. FSR scales well to large networks as the overhead is controlled in this scheme.

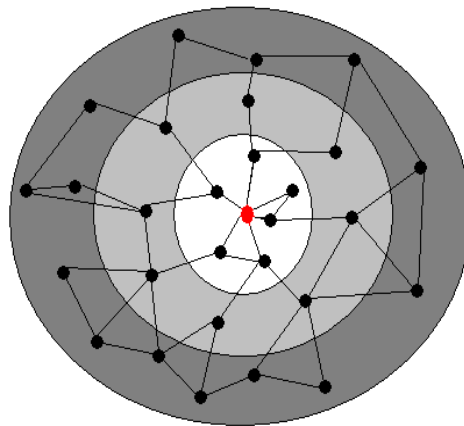


Figure 1: Accuracy of information in FSR

2.5 Cluster-head Gateway Switch Routing (CGSR)

Cluster-head Gateway Switch Routing uses as basis the DSDV Routing algorithm described in the previous point. The mobile nodes are aggregated into clusters and a cluster-head is elected. All nodes that are in the communication range of the cluster-head belong to its cluster. A gateway node is a node that is in the communication range of two or more cluster-heads. In a dynamic network cluster head scheme can cause performance degradation due to frequent cluster-head elections, so CGSR uses a Least Cluster Change (LCC) algorithm. In LCC, cluster-head change occurs only if a change in network causes two cluster-heads to come into one cluster or one of the nodes moves out of the range of all the cluster-heads.

The general algorithm works in the following manner. The source of the packet transmits the packet to its cluster-head. From this cluster-head, the packet is sent to the gateway node that connects this cluster-head and the next cluster-head along the route to the destination. The gateway sends it to that cluster-head and so on till the destination cluster-head is reached in this way. The destination cluster-head then transmits the packet to the destination. Figure 3 shows an example of CGSR routing scheme.

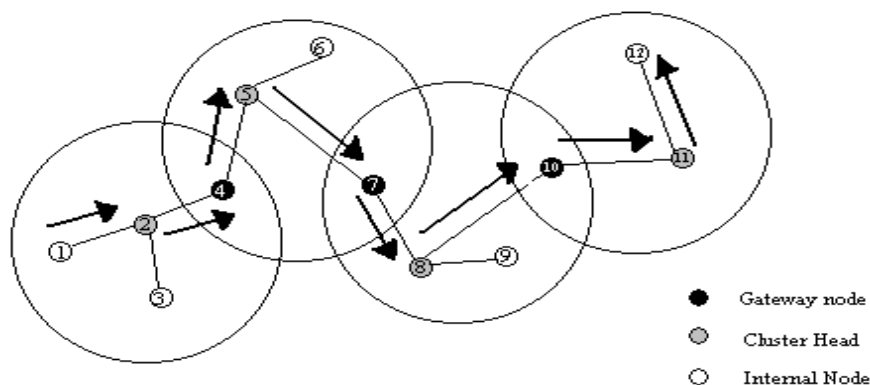


Figure 2: Example of CGSR routing from node 1 to node 12

Each node maintains a cluster member table that has mapping from each node to its respective cluster-head. Each node broadcasts its cluster member table periodically and updates its table after receiving

other nodes broadcasts using the DSDV algorithm. In addition, each node also maintains a routing table that determines the next hop to reach the destination cluster.

On receiving a packet, a node finds the nearest cluster-head along the route to the destination according to the cluster member table and the routing table. Then it consults its routing table to find the next hop in order to reach the cluster-head selected in step one and transmits the packet to that node.

2.6 Hierarchical State Routing (HSR)

The characteristic feature of Hierarchical State Routing (HSR) is multilevel clustering and logical partitioning of mobile nodes. The network is partitioned into clusters and a cluster-head elected as in a cluster-based algorithm. In HSR, the cluster-heads again organize themselves into clusters and so on. The nodes of a physical cluster broadcast their link information to each other. The cluster-head summarizes its cluster's information and sends it to neighboring cluster-heads via gateway. As shown in the figure 3, these cluster-heads are member of the cluster on a level higher and they exchange their link information as well as the summarized lower-level information among each other and so on. A node at each level floods to its lower level the information that it obtains after the algorithm has run at that level. So the lower level has hierarchical topology information. Each node has a hierarchical address. One way to assign hierarchical address is the cluster numbers on the way from root to the node as shown in figure 3. A gateway can be reached from the root via more than one path, so gateway can have more than one hierarchical address. A hierarchical address is enough to ensure delivery from anywhere in the network to the host.

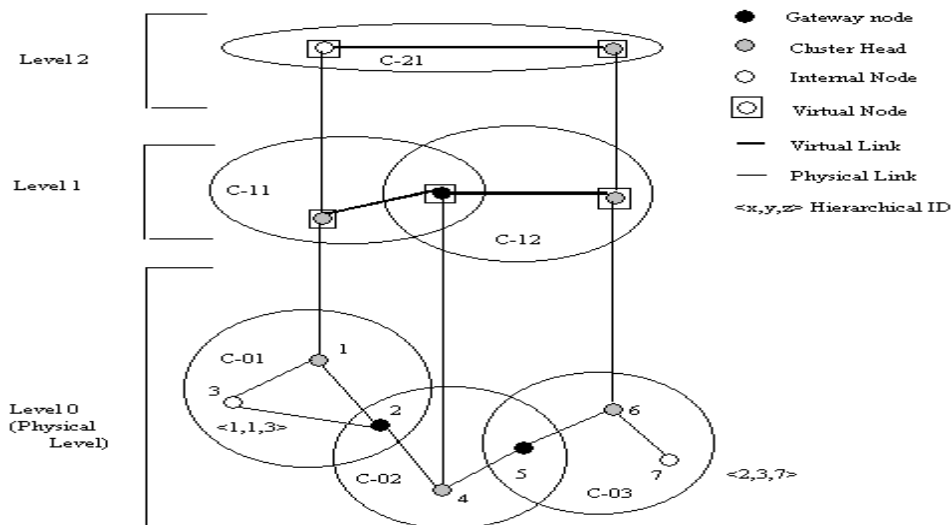


Figure 3: An example of clustering in HSR

2.7 Zone-based Hierarchical Link State Routing Protocol (ZHLS)

In Zone-based Hierarchical Link State Routing Protocol (ZHLS), the network is divided into non-overlapping zones. Unlike other hierarchical protocols, there is no zone-head. ZHLS defines two levels of topologies - node level and zone level. A node level topology tells how nodes of a zone are connected to each other physically. A virtual link between two zones exists if at least one node of a zone is physically connected to some node of the other zone. Zone level topology tells how zones are connected together. There are two types of Link State Packets (LSP) as well - node LSP and zone LSP. A node LSP of a node contains its neighbor node information and is propagated with the zone whereas a zone LSP contains the zone information and is propagated globally. So each node has full node connectivity knowledge about the nodes in its zone and only zone connectivity information about other zones in the network. So given the zone id and the node id of a destination, the packet is routed based on the zone id till it reaches the correct zone. Then in that zone, it is routed based on node id. A <zone id, node id> of the destination is sufficient for routing so it is adaptable to changing topologies.

III. COMPARISON

For comparing the protocols in table driven adhoc wireless routing the following issues may be taken into the consideration:

3.1. Issues

- 3.1.1. Normalized routing overhead: This is the number of routing packets transmitted per delivery of a data packet. Each hop transmission of a routing packet is counted as one transmission. This factor also tells us something about the scalability of the routing protocol. If routing overhead increases with the increase in mobility then that protocol is not scalable.
- 3.1.2. Packet delivery fraction: It is the ratio of data packets received to packets sent. This also tells us about the number of packets dropped and throughput of the network.
- 3.1.3. Average end to end delay: This is the difference between sending time of a packet and receiving time of a packet. 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 protocol should ensure that it is loop free because loops waste a lot OF bandwidth and packets in loops may never reach their destination.
- 3.1.4. Route Failure and recovery: Some mechanism should be defined to discover route failures and propagate that information. The new configuration should converge fast to a stable state.
- 3.1.5. Mobility of a node: The protocol should perform well for all speeds and types of node movements.
- 3.1.6. Partitioned Networks: As a consequence of the free movement of nodes, it is possible that few nodes become isolated from rest of the nodes that is they get out of the transmission range of the remaining nodes. In this manner, different groups of nodes will be formed and such a scenario is characterized as a partitioned network. The routing protocol should address this issue and suggest some appropriate strategy to handle this scenario.
- 3.1.7. Load Balancing: The protocol should not overload one node and should be designed to keep the load even on all nodes. This will also help in avoiding the occurrence congestion near certain nodes.
- 3.1.8. Scalability: The performance of the protocol should not be affected by increasing or decreasing the number of nodes in the network.

These issues help to define the parameters to compare the routing protocols. Based on above mentioned issues we prepare the parameters for comparing protocols:

3.2 Parameters:

- 3.2.1. Packet delivery Fraction: Throughput
- 3.2.2. Average delay
- 3.2.3. Optimal route
- 3.2.4. Routing overhead
- 3.2.5. Support for scalability in either condition

IV. CONCLUSION

All the algorithms have some pros and cons. Each algorithm performs differently under different circumstances. So, network context and goal must be kept in mind before choosing any routing protocol. In terms of metrics which may include throughput, end-to-end delay and routing load.

The table driven protocols vary in the way they maintain and update their routing tables, which directly affect the efficiency of each protocol. However, all the table driven protocols share their common advantage of the immediately available routes to the reachable destinations, along with the disadvantage of the required routing information update overhead.

We understand this type of studies could play an important role in filling the gaps of such studies in this area and can also be used to gain understating of the discussed techniques and in their further development.

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