A Survey on Path Weight Based routing Over Wireless Mesh Networks

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Abstract – A Wireless Mesh Network (WMN) is a mesh network made up of radio nodes installed at each network user location. Each network user provides data to the next node. The area covered by radio nodes is called mesh clouds. Wireless Mesh Network (WMN) has many applications like video on demand, public security system, broadband internet for home and campus networking. Routing is a technique which selects the path in a network and forwards a packet through the network to a device on a different network. Routing metrics are a crucial part of routing protocols affecting the performance of wireless mesh networks (WMN). When the routing protocols are implemented, the routing metrics are allocated to various paths. They compute the best routing path. The problem of identifying the maximum available bandwidth path a fundamental issue in supporting quality-of-service in WMNs. This paper presents a survey on routing protocol and routing metrics in wireless mesh network.

Keywords*:* Wireless mesh network, AODV, routing protocol, routing metrics.

I. INTRODUCTION

Wireless mesh networks (WMNs) consist of nodes that make an ad hoc network and maintain the mesh connectivity. WMNs consist of two types of nodes: mesh clients and mesh routers. WMNs has router that consist of routing function. A mesh router covers the same area with less transmission power using hop method. Mesh router is usually combined with multiple wireless interfaces to improve the flexibility. Hardware platform is similar in Mesh and wireless routers.

Mesh routers and mesh clients are known as mesh nodes which act as the backbone for the network. Configuration of nodes is done automatically and dynamically. Characteristics of mesh network are self-forming and self-healing so there is no need for centralized management. Mesh routers are stationary. End users can connect to these routers, which act as backbone. All wireless network use multihop routing technique

Routing metrics are very important for calculating the best quality path. Routing is performed in each and every relay node so as to find the next hop for the packet. Due to interference between the links the designing of routing metrics is very difficult. Interference occur both in single channel and multi channel. In a multi-channel wireless network, interference exists when two transmissions interfere with each other if they are using the same channel Routing has significant impact on overall network's performance as it can enhance the capability of communication system.

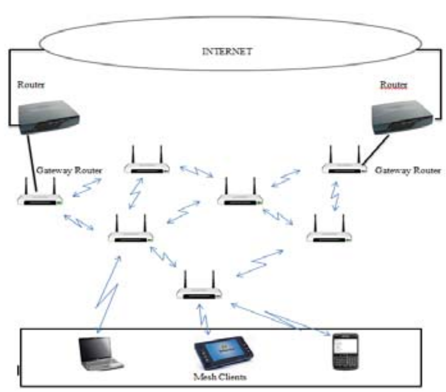

Figure 1. Wireless mesh backbone structure [3]

The remainder of this paper is organised as follow. In section 2 the review of routing protocol for WMN has been discussed. In section 3 the design and characteristics of routing metrics discussed. Section 4 discusses the review for routing metrics followed by the conclusion.

II. REVIEW OF ROUTING PROTOCOL

Routing protocol specify how data is transferred between two nodes. Routing protocol determine the route from source to destination. Some of the important protocols in these categories have been discussed below.

2.1 Proactive Routing

This type of protocols maintains fresh lists of destinations and their routes by periodically distributing routing tables throughout the network. This type of routing is useful for real time applications since the route is created beforehand. Some of the examples are Destination sequenced distance vector routing (DSDV), Optimized Link State Routing Protocol (OLSR)

2.1.1 Destination Sequenced Distance Vector Routing (DSDV)

Destination-Sequenced Distance-Vector Routing (DSDV) is used for ad hoc mobile networks .Routing was solved using DSDV. Each entry in the routing table contains a sequence number, the sequence numbers are generally even if a link is present; else, an odd number is used. The number is generated by the destination, and the emitter needs to send out the next update with this number. Routing information is distributed between nodes by sending full dumps infrequently and smaller incremental updates more frequently. If a router receives new information, then it uses the latest sequence number. If the sequence number is the same as the one already in the table, the route with the better metric is used. Stale entries are those entries that have not been updated for a while. Such entries as well as the routes using those nodes as next hops are deleted. DSDV requires a regular update of its routing tables, which uses up battery power and a small amount of bandwidth even when the network is idle.

2.1.2 *Optimized Link State Routing Protocol (OLSR)*

The Optimized Link State Routing Protocol (OLSR) is an IP routing protocol optimized for mobile ad hoc networks, which can also be used on other wireless ad hoc networks. OLSR is a proactive link-state routing protocol, which uses hello and topology control (TC) messages to discover and then disseminate link state information throughout the mobile ad hoc network. Individual nodes use this topology information to compute next hop destinations for all nodes in the network using shortest hop forwarding paths. The major advantage of OLSR over other proactive is that it broadcasts its link state information rather than routing tables and messages can be delivered node in any order due to the sequence number. This protocol is good for large and dense networks.

2.2 Reactive Routing

This protocol sends packets from source to destination then from destination to source on the basis of on demand topology. A route is made when request is made for sending packets from one node to another node in the network. When the destination node receives the data it replies back to the source node that it had received the data and route is stored in the destination node cache. Destination node uses this cache to send reply back to the source. The advantage of reactive routing is that it only maintains the used route table and minimizes bandwidth overhead. Some of the examples are Destination source routing (DSR). Ad hoc on demand distance vector (AODV), Link quality source routing algorithm (LQSR)

2.2.1 Destination Source Routing (DSR)

In Destination source routing the source note the sequence number of the node used to send data to the destination. Path discovery and path maintenance are the two phases of the protocol. When the source want to send data from the source to destination without any valid path the path discovery phase starts. DSR provide the valid source route consist of source id, destination id, an empty route record and unique request id. When the data reaches the destination node it replies back to the source. The destination cache store the route address and reply back to the source using this cache route about the successful receiving of data. DSR works mainly on the on demand basis. It mainly uses the hop by hop technique. Whenever destination doesn't receive the data successfully it generates the error message with the help of the path maintenance method. DSR decreases the bandwidth overhead.

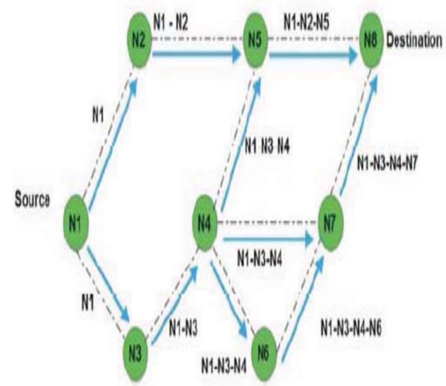

Figure 2. Constructing route cache during node discovery [1]

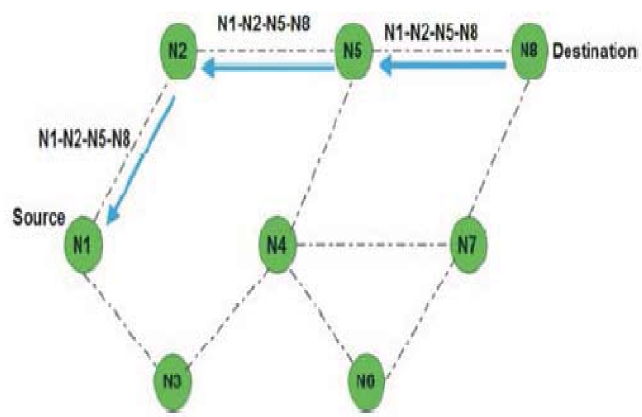

Figure 3. Route Reply [1]

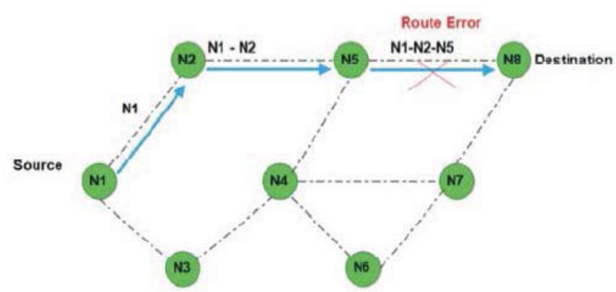

Figure 4. Route Error between Node 5 and Node 8 [1]

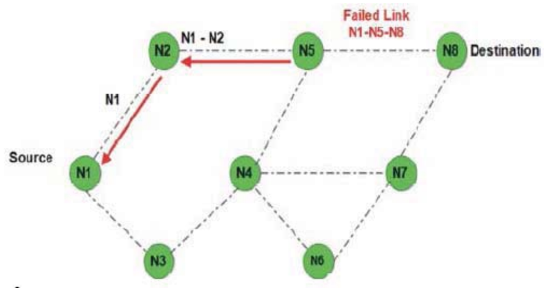

Figure 5. Route Error sent from N5 to N1 [1]

2.2.2 *Ad-Hoc on Demand Distance Vector Routing Protocol (AODV)*

AODV contain route of only the active nodes. It does not store information of the any other node. When source node want to send data to the destination it initiate the route discovery phase. Source node then sends the route request which consist of the source address, destination address and broadcast id. Broadcast id contains the current sequence number of the source and destination node. When destination node is not found time to live value is incremented by one. Cache maintains the record for the received request. Route request with the largest sequence number is saved and cache also records the address. Destination reply back to the source with the value of largest sequence number

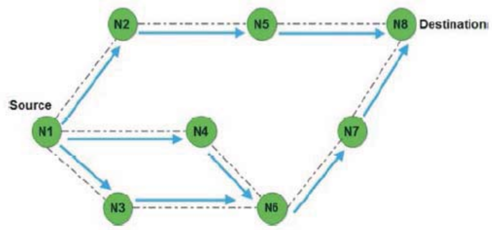

Fig. 6. Broadcasting RREQ Packets

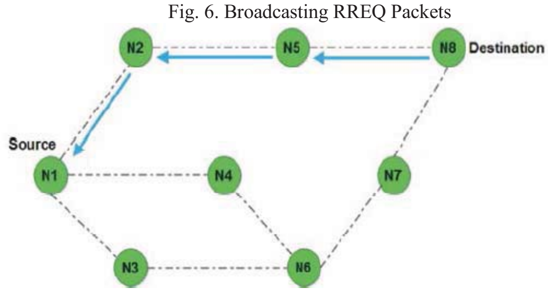

Figure 7. Route of the RREP to the Source [1]

2.2.3 *Link Quality Source Routing Algorithm (LQSR)*

LQSR is developed by the Microsoft on the basis of dynamic state routing (DSR). In LQSR weight is allocated to the link between the nodes. The bandwidth loss and channel are calculated with the help of this weight. The routing path is calculated with the help of weight cumulative expected transmission time (WCETT). If no node exist between source and destination then the path is one hop otherwise the path depend upon the number of nodes exist between the source and destination. If the three nodes exist between source and destination then the path is three hops. Route request packets contain information about link state and node. Link sate is calculated by broadcasting hello message over the adjacent nodes.

2.3 *Hybrid Routing*

Hybrid Routing is the combination of both reactive and proactive routing. For nearby route it implements proactive routing and for far away routes it implements reactive routing. Control overhead is delayed in proactive and delay is less in case of reactive routing. Some of the examples of hybrid routing protocols are hazy sighted link state routing (HSLS), zone routing protocol (ZRP).

2.3.1 Hazy Sighted link State Routing (HSLS)

Hazy sighted link state routing is a type of hybrid routing which is a combination of both reactive and proactive routing developed at BBN technologies by the cowing foundation. Transmission capacity is saved since link states updates are done once in time and space domain. HSLS is a combination of both near sighted link state (NSLSR) and discretized link state routing (DSLR).NSLSR limited the number of hops and DSLR limits the attempts for routing information. In case of failing using nearby node the reactive routing is needed. The reactive routing then finds the new route for routing. HSLS provide good routes and scalability properties.

2.3.2 Zone Routing Protocol (ZRP)

Zone routing protocol is a type of hybrid protocol and is a combination of both reactive and proactive routing. It works on the neighboring node hop distance called routing zone. It consist of two routing zone inside is called intra zone and outer is called inter zone. Intra zone send packets from the starting node to the other node and inter zone on which packets delivered to the sink node. ZRP is combinations of both inter zone routing protocol (IERP) and intra zone routing protocol (IARP). The path from origin to sink node is made by IARP. Generally, all the current proactive routing algorithms can be used as the IARP for ZRP. For the inter zone paths, it uses IERP to find the route. The originating node generates a route request to peripheral nodes. Peripheral nodes check their zone for the sink node. If the destination node is not a part of this zone, the peripheral node appends its own address to the route request packet and forwards the packet to its peripheral nodes [1].

III. ROUTING METRICS

Routing metrics are designed to compute the best routing path. Routing metrics increase the efficiency of wireless mesh network in terms of error rate, delay and throughput. The various routing metric are as follow:

3.1 Hop Count

Hop count is one of the simplest routing metrics. It selects the shortest path route from source to destination for sending packets. It is stable but it has a disadvantage that it cannot handle the issue of interference between the different links. It considers the entire link identical. It produces the path having low throughput and high packet loss ratio.

3.2 Expected transmission count metric (ETX)

ETX is defined as the number of transmission needed to send packets from source to destination. ETX overcomes the problems of hop count. In mathematical terms ETX is defined as:

$$P = 1-(1-Pf)\ (1-Pr)$$

Where
P = Probability of unsuccessful transmission of packet in a link from node a to node b.
Pf = Probability of path loss in forward direction.
Pr = Probability of path loss in reverse direction. [1]

3.3 Expected Transmission Time (ETT)

ETT is the time taken to send packets from source to destination ETT is measured by:

$$ETT = ETX * S \div B$$

Where
S= Packet size
B= bandwidth of current packet [1]

ETT increase the network efficiency by increasing the path throughput. Interferences are not avoided by the ETT, ETX since they are not designed for multi radio networks.

3.4 Weighted Cumulative Expected Transmission Time (WCETT)

WCETT is designed to avoid intra flow interferences. WCETT of a path p is defined as:

$$WCETT_p = (1-\alpha) * \sum ETT + \alpha * MaxX_j$$

Xj = Summation of links ETT values which are on channel j in a system having orthogonal channels.

$$X_j = \sum_{hops\ on\ channel\ j}^{n} ETT_i \quad 1 \le j \le k$$

[1]

The limitation of WCETT is that it does not consider the inter flow interferences.

3.5 Interference Aware Routing Metric (iAWARE)

The iAWARE routing metric captures the effects of variation in link loss-ratio, differences in transmission rate as well as inter-flow and intra-flow interference. Interference ratio for a node u in a link i= (u, v)

$$IR_i(u) = \frac{SINR_i\ (u)}{SNR_i\ (u)}$$

Where SINR is the signal to interference and noise ratio of link i. The link metric iAWARE of a link j as follows

$$iAWARE_j = \frac{ETT_j}{IR_j}$$

[4]

IV.CONCLUSION

This paper presents the various routing protocols and routing metrics used in wireless sensor networks. Different routing metrics were compared ETT, ETX, WCETT, and IAWARE. Hop count is having the worst performance and IAWARE is most efficient one. Hybrid routing protocols along with reactive and proactive protocols are discussed.

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