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High Throughput Multicast Routing Algorithms in Wireless Mesh Networks-A Survey

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Abstract— ***Wireless Mesh Network (WMN) is a network made of radio nodes arranged in a mesh topology. Multicasting is an effective way to send a packet to a set of receivers which helps to conserve bandwidth. Inefficient design and improper selection of multicast routing algorithm in a wireless mesh network lead to degradation of network performance by causing congestion, increase in delay, packet loss etc. As a result degradation in network throughput occurs. In this article we describe various multicast routing algorithms to achieve high throughput in wireless mesh networks.***

Keywords— ***Wireless mesh networks, Multicasting, Hop count, Load, Airtime link metric, ETX and PDR.***

I. INTRODUCTION

A WMN is a combination of radio nodes [1] which forms a mesh topology as shown in Fig.1. It consists of mesh routers, mesh gateway, and mesh clients. Mesh clients are the end user devices. Mesh routers routes data from the mesh clients to the mesh gateway. In a wireless mesh network only few nodes require direct connection to the internet and the internet connection is expanded to other nodes which are connected wirelessly. Due to the self-configurable and self-healing nature WMN is applied in many applications such as extended WLAN access, mobile internet access, emergency response, remote monitoring and control, military communication, etc. [2]

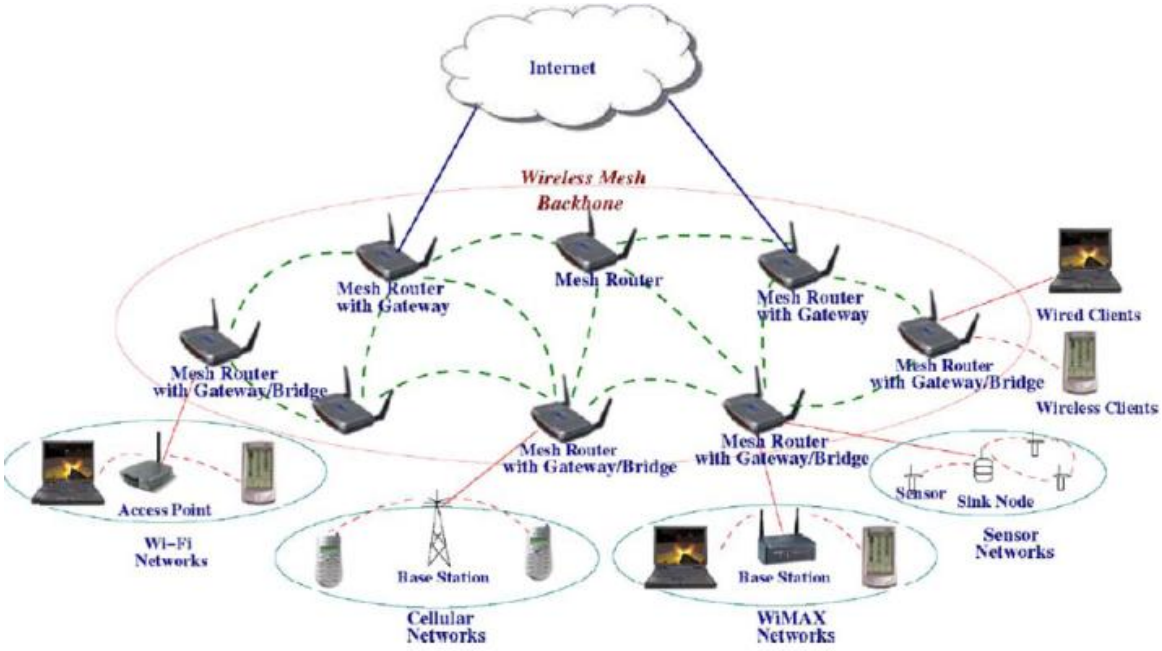

Fig 1. Wireless mesh network [1]

A. Multicasting in mesh network

Multicasting is a method of sending data to a set of receivers in a single transmission. Sender sends a single packet to the multicast IP address and the multicast router creates multiple copies of that packet to be sent to receivers [3] so as to conserve bandwidth. If multiple receivers require same information then multicast is the best way for sending packets instead of unicast. Multicast routing algorithms are broadly classified into tree based and mesh based .In general tree based method is used for static network and mesh based, for mobility based network. Mesh based multicast routing is

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used in mobile network because of unstable nature of its link. In mesh based routing algorithms there are multiple links to reach a destination than a tree based routing approach [4].

The two tree based approaches for multicasting are Shortest path trees (SPTs) and Minimum cost trees (MCTs).The SPT algorithms focus on minimizing the distance from source to destination. Most commonly used SPT algorithms are Dijkstra's algorithm and Bellman ford algorithm. These algorithms reduce the distance from source to destination thereby reduce the end to end delay. Distance are calculated using Hop Count (HC).Unlike SPT algorithms, MCT algorithms focus on reducing the overall cost of transmission of packet from source to destination. Distance from source to destination in this method may be more than SPT algorithm but cost of flow is reduced by selecting route with good quality for the transmission. The link quality depends on load, stability of the link, ETX of that link etc.

Two basic approaches used for multicast routing are proactive and reactive [5]. Proactive is a table driven routing concept where routing table maintains the updated information on the available routes. A large amount of memory space for maintaining the routing table is required in this approach. Reactive approach is an on-demand routing, where routing information is calculated when there is a need. It requires less memory than a proactive approach. Only required information is stored in the routing table. In proactive approach there is less delay for finding a path than the reactive approach.

In section II we have discussed various multicast routing algorithms, in section III we have discussed Summary of the routing algorithms, in section IV we have discussed conclusion of the article, in last section V contains references.

II. VARIOUS MULTICAST ROUTING ALGORITHMS

A. EMRAW: EFFICIENT MULTICAST ROUTING ALGORITHM FOR WMN [6]

EMRAW is a tree based reactive multicast routing protocol derived from the basic features of SPT and MST. It aims to reduce the overall transmission count (ETX) for the transmission of successive packet. The number of transmissions can be reduced when multiple shortest paths in mesh network forms a tree. EMRAW consist of three phases; request, reply and commit. Request phase is initiated by the source [6]. Source sends a request message whenever it needs to update its route or to find a new route. Source flood the request packet containing Multicast Address(MA),Sequence Number (SN),Source Address (SA), Transmitter Address (TA),Hop-Count (HC),Metric value and Time-to-Live (TTL) as shown in the fig 2.

Type	TTL	HC	SN	MA	SA	TA	METRIC

Fig 2. Request message format [6]

Intermediate nodes after receiving the request message will update its routing table using the entry in the request packet. Then these packets are rebroadcasted. Reply phase is initiated by the receiver. If the receiver receives multiple request packets then a route selection process takes place. The node with better metrics is selected as the forwarding node. In the reply packet extra two fields are added; effective hop count (ECH) and next hop address (NH). The EHC value which is set as 0 initially is incremented by 1 as it passes from one node to another. If the next hop address matches with the IP address of that node then that node will become the forwarding node. Reply packet is forwarded only when it satisfies the condition; HC >= EHC else packets are dropped. Finally the source selects the route by sending a commit message to receiver.

B. GLBM: A new QoS aware multicast scheme for wireless mesh networks [7]

In wireless mesh network, the gateway nodes experience high load in some peak hours leading to congestion. More packets are lost which leading to degradation of the network performance [8] [9]. So load balancing is crucial in the gateways. In Gateway-cluster based Load Balancing Multicast algorithm (GLBM) a load balancing mechanism has been proposed for the gateway node. The gateway node records the total number of packets sent and received. This technique is divided into 4 phases such as starting of multicasting session by sender, joining of the receiver, leaving of the node from the group and maintenance of the multicasting group [7].

In phase 1, each node has to register with one of the gateways and source node initiates the transmission process by sending Multicast Sender request (MSR) to its gateway. When a gateway node receives a MSR request it broadcasts Hello Message (HM) periodically to all the gateways in that network. This hello message contains the routing details such as sequence number, node ID etc. Gateway node which receives hello message starts to record the route to the source. If a new route is found out then the gateway deletes the existing route from its routing table. Else the routing information is unaltered.

In phase 2, receiver node which is interested to join the multicast group broadcasts a multicast route request with join flag (MRQ-J).The intermediate node after receiving the request packets adds the interface queue length (IFQ) to the packet header so as to calculate load in each path. This packet is then forwarded to the gateway node. The gateway node will choose a path with lowest IFQ value. Then this path information is sent to the sender for transmitting the multicast packet.

In phase 3, the member which leaves the multicast group sends a multicast route request with leave flag (MRQ-L) to its gateway. After receiving the MRQ-L, the gateway deletes the entire route to this member from its routing table.

In phase 4, if any link breakage happens between the source and receiver then a multicast route request with repair flag (MRQ-R) message is sent to the gateway node for creation of a new route.

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C. Efficient Layer-2 Multicasting for IEEE 802.11s based Wireless Mesh Networks [10]

This is a multicasting approach based on MAC layer which consists of two approaches namely Layer2 Multicast-Simple (L2M-S) and Layer2Multicast-Enhanced (L2M-E). Both scheme aims to reduce the data transmission overhead and the network throughput. L2M-S scheme is a simple proactive tree based routing protocol which constructs a multicast tree using a unicast approach.L2M-S approach does not contain any additional paths and so the additional overhead to find a redundant path is minimized. Since each node can recognize their next hop, there is no need of sending an additional packet to create a multicast path. If a node want to join a multicast tree then a multicast join message is transmitted to the source to find its path. MPC-join message is shown in the fig 3.

Multicast group MAC address	Flag	Source MAC address	Destination MAC address

Fig 3. MPC-join message [10]

After receiving the join message from the child node the root node (source) creates a new path or update its routing table for its multicasting. Here a mapping between MAC and IP address will be takes place.

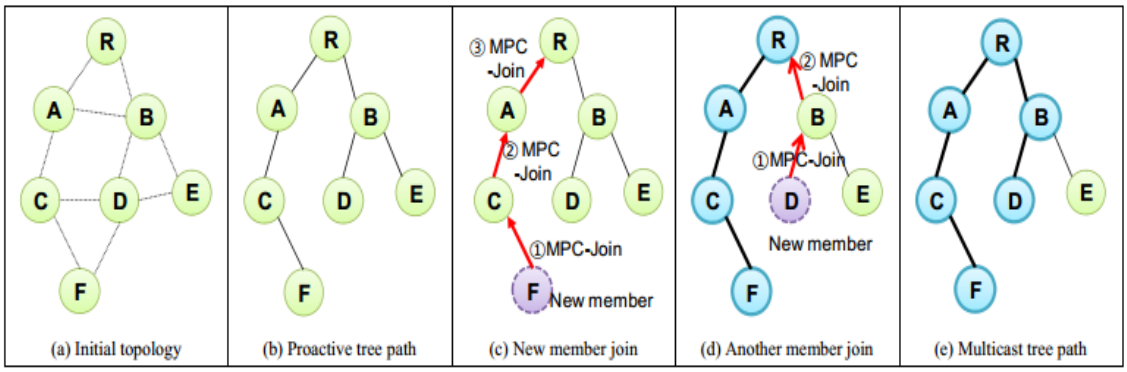

Fig 4. Construction of multicast tree in Layer2Multicast-Simple (L2M-S) [10]

The construction of multicast tree in L2M-S is shown as in Fig.4. R is a root node which creates a proactive multicast tree using air time link metric of each links. The air time link metric which considers both transmission bit rate and error rate. A, B, C, E, are the child nodes. D and F are newly joining nodes.

L2M-E scheme uses broadcasting features for finding a path and it maintains redundant routes to improve the performance of multicasting. Path selection is done based on degree of the neighbour node. It defines three kinds of nodes; free, parent and child. Parent node is one which is close to the root node and the child node is the one which is far from the root node. Free nodes are neither parent nor be a child. Here path selection is based on degree, where degree is the number of nodes which participates in the same multicasting group. MANN messages which contains degree of each parent node and their information [10] are broadcasted periodically

D. MARS: Link-layer rate selection for multicast transmissions in wireless mesh networks [11]

MARS is a rate adaptation algorithm. Better bandwidth conservation occurs in multicasting than unicasting. But the multicast frames are fixed to be low bit rate modulation of 1Mbps resulting throughput reduction. MARS acts as a rate adaptation algorithm which helps to select a transmission bit rate for multicasting. Higher throughput achievement demands higher modulation rates. Based on each link quality MARS selects different transmission rate for each multicast group to achieve a best transmission. To calculate the bit rate for each link MARS performs a quality check in each link. Packet delivery ratio (PDR) is used as a link metric. PDR of that link can be calculated by sending probe message. Each node updates its PDR information in its routing table for the calculation of bit rate of that link.

In Bit-rate selection [11] the sender will be an upstream node which receives a feedback on the number of packets received at each bit-rate, from all of its downstream nodes. Let δ be a maximum tolerable loss rate for each multicast group, M be the maximum bit rate for each group with PDR greater than (1-δ).The calculation of each bit rate is done periodically.

III. SUMMARY OF DIFFERENT MULTICAST ROUTING ALGORITHMS

Protocols	**Proactive or Reactive**	**Metrics**	**Advantages**	**Issues that not been addressed**
EMRAW	Reactive	ETX and hop count	Redundant route and minimized computational	Delay and interference

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			overhead	
GLBM	Reactive	IQL	Congestion is less.	Interference, RTS and CTS problems
L2M-S	Proactive	Airtime link metric	Less overhead	scalability
L2M-E	Reactive	Airtime link metric and degree	Low end to end delay	Security
MARS	Reactive	PDR	varying bit rates and reliability	Computational Overhead

IV. CONCLUSIONS

Achieving high throughput in multicasting is an important issue that must be addressed in wireless mesh network. In wireless mesh network there are redundant paths to a single destination. Packet drops and congestion in multicast routing leads to degrade network throughput. Hence the selection of right multicast routing metric and algorithm is required for errorless transmission. In this article we discussed various multicast routing algorithms and its routing metrics that can employed to improve the network throughput.

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REFERENCES

[1] Ian F. Akyildiz, Xudong Wang. (2005)"A Survey on Wireless Mesh Networks", IEEE Radio Communications.
[2] I. Akyildiz, X. Wang, and W. Wang, "Wireless Mesh Networks: A Survey," Elsevier Computer Networks, March 2005.
[3] LuoJunhai, Ye Danxia, Xue Liu, and Fan Mingyu (2009) "A Survey of Multicast Routing Protocols for Mobile Ad-Hoc Networks", IEEE communications surveys & tutorials, vol. 11, NO. 1.
[4] UyenTrang Nguyen and Jin Xu (2007) "Multicast Routing in Wireless Mesh Networks: Minimum Cost Trees or Shortest Path Trees", IEEE Communications Magazine.
[5] http://blog.protogenist.com/?p=805.
[6] RakeshMatam, SomanathTripathy (2013). "Improved heuristics for multicast routing in wireless mesh networks", Springer Science wireless networks.
[7] Liang Zhao, Ahmed Y. Al-Dubai, Geyong Min (2010). "GLBM: A new QoS aware multicast scheme for wireless mesh networks", Elsevier, the Journal of Systems and Software (83) 1318–1326.
[8] DeeptiNandiraju, Lakshmi Santhanam, NageshNandiraju, and Dharma P. Agrawal (2006). "Achieving Load Balancing in Wireless Mesh Networks through Multiple Gateways", IEEE.
[9] Zhao, L., Al-Dubai, A., Min, G., (2009). "A QoS aware multicast algorithm for wireless mesh networks". IEEE International Symposium on Parallel and Distributed Processing, pp. 1–8.
[10] Sung-Jun Bae and Young-BaeKo (2010)."Efficient Layer-2 Multicasting for IEEE 802.11s based Wireless Mesh Networks", IEEE.
[11] Acharya, P. A. K. and Belding, E. M. (2011). "MARS: Link-layer rate selection for multicast transmissions in wireless mesh networks", Ad Hoc Networks, 9(1), 48–60.

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