International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 04 Issue: 07 | July -2017 www.irjet.net p-ISSN: 2395-0072

Modified PREQ in HWMP for Congestion Avoidance in Wireless Mesh Network

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Abstract - Wireless Mesh Network (WMN) have been visualized as an important solution to the next generation wireless networking which can be used in transportation systems, home networking and last-mile wireless internet access. Modified PREQ in HWMP for Congestion Avoidance Mechanism is a proposed technique in this paper we determine congested path using CCNF frame and to provide the rerouting less congested path before congestion scenario to reduce burden on congested node. Additional approach is to continue packets transmission on congested path until it gets the rerouting path in congestion scenario. When a packet transmitted from new path the previous path will be deleted to avoid any further delay. Also sequence number is to avoid flooding in the network. We are comparing our Modified PREQ Mechanism with congestion avoidance technique to improve throughput and average delay using NS-3 Simulator.

Key Words: Wireless Mesh Network, HWMP, Congestion Control, Congestion Avoidance.

1. INTRODUCTION

The IEEE 802.11 standard is a wireless local area network protocol, which is largely dependent on wired infrastructure for data traffic transmission. This standard was devised to extend wired network to wireless territory. There are a series of standards under IEEE 802.11, including a, b, g etc. which are related to different wireless medium. This standard specifies frequencies, mode of communication, modulation techniques and other specification for wireless mesh networks. This standard entails two different types of networks including infrastructure mode where a definite access point is present and ad hoc mode, where no specific access point is present and two stations connect to each other on demand. IEEE 802.11s standard is an essential modification to IEEE 802.11 standard that resolves wired infrastructure dependency problem of its predecessor. This standard works in link layer of OSI model and deals with physical address of the devices rather than IP address, which can be useful in layer-2, multi hop communication.

It is conceivable, and in fact quite desirable, that quality of service (QoS) guarantees can be offered to customers. If the network is designed carefully and enough Internet gateways are placed at key points, each customer can enjoy guaranteed bandwidth and/or delay (at least in the access network). The guarantees enable multimedia applications such as voice over IP and video on demand. Moreover, different classes of service (e.g., premium, enhanced, and basic) can be offered, each with different priorities and guarantees.

HWMP protocol provides dynamic and less congested transmission path. The main idea of implementing new protocol is to communicate devices effectively which are not in a communication area to each other i.e. hard area nodes. This algorithm provides both Reactive and Pro-active routing in the network. The reactive mode uses on demand routing i.e. Ad-hoc Distance Vector Routing Protocol. In Proactive mode uses tree based data structure which has Root node maintain routing table to keep routes to all destination.

Congestion Control Mechanism apply when congestion occur in the network. This mechanism provides limit the flow of packets when congestion occurs. This comprises operations which are monitoring, detection and then controlling of congestion. Only congestion signaling part is mention in HWMP where rest of congestion control mechanism is not specified. However, various congestion control mechanism are proposed in literature to resolve this problem but anyway these methods are not sufficient to derive efficient network performance.

However, congestion avoidance is better than congestion control because the latter is imposed when the network is already experiencing congestion. When the volume of queue at a specific node reaches to a pre-defined limit, it performs a buffer size check. If the queue size is near the buffer limit, the node starts broadcasting CCNF signals to its neighbors that use same path. The neighboring nodes then start searching alternative paths to send their packets to destination and avoid the path that is nearly congested as proposed in the Congestion Avoidance – HWMP (CA-HWMP). Thus, the congestion is avoided. One of the added advantage of this mechanism is that it is not only helps avoiding congestion but also helps in load balancing.

Also In this paper, Modified PREQ in HWMP for Congestion Avoidance Mechanism is proposed to provide continuous transmission on a congested path until it

rerouting to a new less congested path. When a packet transmitted from new path the previous path will be deleted to avoid any further delay. This technique ensures performance in the network which increases the network throughput, packet delivery fraction. The sequence number is used to avoid flooding in the network this added advantage in this algorithm.

2. RELATED WORK

Fawaz A. Khasawneh, Abderrahmane Benmimoune, Michel Kadoch , Mohammed A. Khasawneh proposed "Predictive Congestion Avoidance in Wireless Mesh Network." In this approach, an Enhanced Congestion Avoidance - HWMP (ECA-HWMP) is proposed which predicts the congestion in each link in the network by applying two statistical analysis methods which are Croston and Holt-Winter methods. The two methods rely on the historical data collected in advance to predict the future data. Since ECAHWMP predicts the congestion before it really happens in the network, the overhead produced by the congestion control signaling in HWMP protocol is reduced. However, the prediction process has some level of certainty (>95%) and in some cases (<5%) a congestion threshold will be reached and CCNF signals will be broadcasted. [1]

Kishwer Abdul Khaliqa, Sajjad Hussainb, Amir Qayyuma, J¨urgen Pannek presented "New data link layer encoding scheme for multi hop WMN" They use special feature of cut through switch that reduces delay in the network and also increases throughput reducing re-transmission in the network. This algorithm for some scenario not works well. [2]

Kishwer Abdul Khaliq, Muhammad Sajjad Akbar, Amir Qayyum, Ehsan Elahi, Amer Zaheer proposed "Congestion Avoidance Technique for Hybrid Mesh Protocol". In this approach when a number of packet gets more than specified queue size level then the CCNF broadcast to show congestion in network. The neighboring node search the new path to send packet to destination on receiving the CCNF and to avoid the path that has already a congestion. Thus, the congestion is avoided. One of the added advantage of this mechanism is that it is not only helps avoiding congestion but also helps in load balancing. This approach gives weak response for interactive application. [3]

Barbara Staehle, Michael Bahr, Deshang Fu, and Dirk Staehle, presented "Intra-mesh Congestion Control for IEEE 802.11 s Wireless Mesh Networks." There are different algorithm for intramesh congestion solving different issues using congestion notification. Total congestion control (TCC), Link selective congestion control and Path selective congestion control (PSCC) were proposed which resolved some scenario but in some issues these algorithm not working well. In TCC algorithm when congestion at node on receiving congestion frame then total traffic is blocked. In LSCC algorithm on congestion scenario it restricts the traffic for specific link by blocking data packets for specific node. In PSCC, congested node broadcast CCNF to limit the traffic for specific destination. The congested node provides this information by adding a destination address for a specific flow into CCNF. For the announcement of specific destination, this algorithm requires modification in the standard CCNF. On receiving modified CCNF, a node only blocks sending data for a specific destination, but it continuously receives data for that specific node. The scenario becomes more complicated when CCNF frame is further broadcast to immediate node in a continuous chain. These algorithms resolve congestion problems in some scenarios of multi-hop WMN uses IEEE 802.11s MAC. [4]

Raniwala, A. De, P. Sharma, S. Krishnan, R. Tzi-cker Chiueh, proposed "Globally fair radio resource allocation for wireless mesh networks," In this approach the protocol determines the resources distributed among the links under same collision domain and employs advanced topology discovery and max-min fair resource allocation technique to ensure lower congestion in the domain. A max-min fair is a technique of increasing resource allocation to a new flow by taking it from an existing flow having already a smaller share. In a single wireless domain, each link gets a share of available bandwidth proportional to the number of flows traversing it. In an asymmetric collision domain, where not all nodes can see the packets from other nodes, unnecessarily slows down their flow rate and creates congestion by reducing channel capacity. The proposed technique helps nodes in a collision domain estimate the traffic in the domain perfectly and allocates resources accordingly. This technique is useful because unlike symmetric collision domain, instead of allocating equal share of available resources, it distributes it based on queue build up. If a node sees a queue is building up, it decreases its channel capacity estimate and lowers its flow rate. On the other hand, if none of the nodes sees any queue build-up, the channel capacity estimate increases and flow rate increases. [7]

3. PROPOSED MECHANISM

Congestion control technique is used when congestion occurs into the network. Congestion Control has three operations monitoring, detection of congestion, processing of congestion control and control the flow of packets. When congestion occur packet drop from queue due to this performance of network is reduced and also increases the burden on a specific node. To avoid this problem they used Congestion Avoidance algorithm to avoid congestion before this occur i.e. comparing node queue level with specific threshold value to broadcast CCNF to its immediate node, but in congestion sensitive applications it is not a good idea because of it create extra packet overhead.

In our proposed technique, path selection is performed at MAC layer; instead of IP layer therefore we utilized new protocol for congestion avoidance using modified PREQ in

HWMP for Congestion Avoidance Mechanism in the Wireless Mesh Network. Our proposed routing protocol Modified PREQ in HWMP for Congestion Avoidance Mechanism in the Wireless Mesh Network is the new approach in the current mandatory Protocol CA-HWMP for IEEE 802.11s monitor queue size at congested node. The basic variables used in the proposed mechanism are same as used in the CA-HWMP i.e. PREQ, PREP, PERR and RANN. In our Enhance approach routing protocol when volume of packet in the queue at node reaches specified value then it monitor the maximum threshold value and then broadcast the CCNF frame to its immediate node. All the immediate nodes, who send data to P^{th} node i.e. destination, will send new PREQ to search the new less congested path to the destination skipping the old paths through the node P. In current CA-HWMP protocol re-routing new path from congested path at this scenario packet will stop transmission on congested link due to this more delay introduced in the network to route from congested path to new path. This situation definitely degrades the throughput so for sensitive application like crisis and safety management it is inadequate to handle the congestion scenario. For that our new proposed algorithm is to transmit continuously packet on congested path until it reroute to a new path. When a packet transmitted from new path the previous path will be deleted to avoid any further delay. This leads to higher throughput in the network. For this we utilized sequence number to avoid flooding in the network. This algorithm enhances capability of network.

Considering a scenario given in figure1 in which node B and E are immediate neighbor of node A. Node A sends packet to node P, the desired path selected by its routing protocol HWMP is A-E-I-M-N-O-P. As proposed routing protocol monitor the queue size at every mesh node. At node I, there is congestion because of queue size come near above maximum threshold value, then routing protocol at node I, broadcast CCNF frame to its immediate nodes and CCNF forwarded to all whichever receive CCNF, i.e. when CCNF received at source A it sends PREQ for new path. Then PREQ forwarded to all and dropped by node I. When PREQ received at node P it sends PREP. PREP reaches source A from new path except node I. Now data flow will be ongoing through new path i.e. A-B-C-D-H-L-P. The packet that was queued because of no present any enhance routing congestion avoiding mechanism, will now forward to destination node using this newly less congested established path. This mechanism enhances throughput. This mechanism allows packet transmission on the rerouting path instead of existing path.

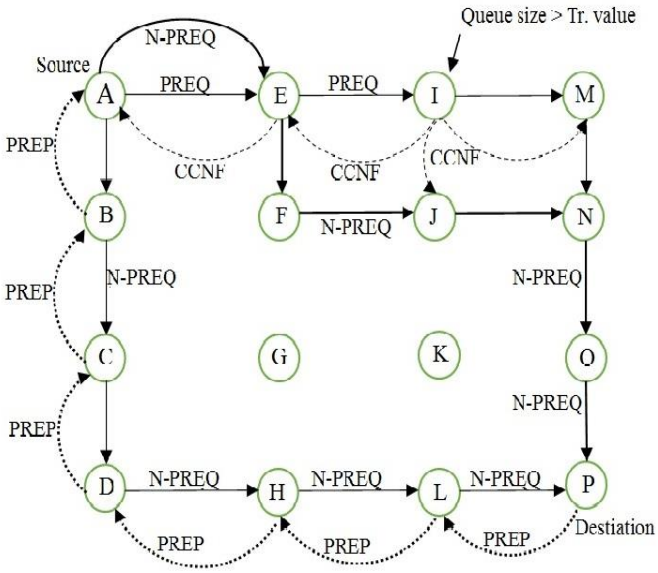

Fig -1: Modified PREQ in HWMP

4. SIMULATION SETUP

For the detailed examination of Hybrid Wireless Mesh Protocol, Network simulator (NS3) provides 802.11s module in the WMN. This simulator is open source and provides new functionality of implementation of new enhanced protocols into it, because of this advantage we analyses our enhance routing congestion avoidance protocol, we implement successfully into mesh module of NS3 using C++.

For implementation and comparative study analysis of both protocols, we have implemented UDP On-off application which transmit packet at a constant bit rate. For simulation we have consider transmission rate from 150Kbps to 350Kbps on UDP transport protocol. For Mesh topology we use HWMP grid topology (x*y) where number of node enhances in both axis where distance between two nodes is 170m.Initially, we consider 2*2 grid then increase the value of x and y.

For our approach analysis we consider effect of application Transmission Rate on throughput. We have considered different scenario by changing number nodes in the HWMP grid for simulation of different routing path.

5. SIMULATION RESULTS

Our algorithms Modified PREQ in HWMPP congestion avoidance mechanism compared with present CA-HWMP protocol. Fig2 shows throughput for two algorithms, MHWMP has better throughput than CAHWMP algorithms, because on congested path continuous transmission is occur until it rerouting to a new path and then path will be deleted while in CAHWMP there is no transmission at congested path. The throughput is increasing as number of nodes

increases in the MHWMP while in CAHWMP throughput is degraded as number of nodes increases due to congestion path cannot deleted in the network.

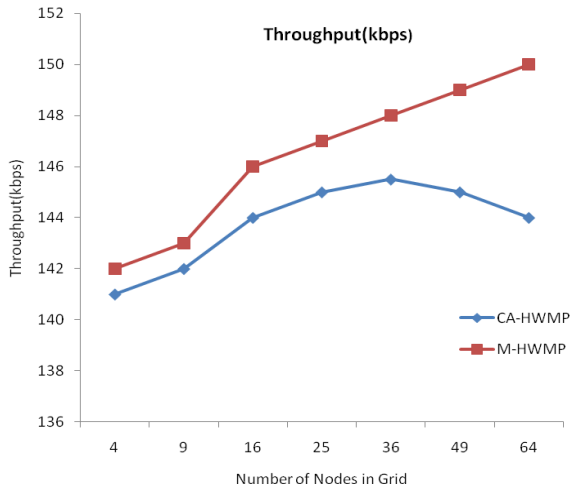

Fig -2: Throughput

Figure 3 shows the average delay. our proposed algorithm avoided the congestion and new less congested path is discovered to maintain the average delay.

6. CONCLUSIONS

In this paper, we have proposed Modified PREQ in HWMP for Congestion Avoidance Mechanism in the Wireless Mesh Network. The algorithm proposed continuous flow of packets in the congested path until it rerouting to a new less congested path and after that path will be deleted this comes an advantages of this proposed algorithm. This algorithm works better as number of nodes increases in the network. This algorithm outperforms other routing protocol i.e. CAHWMP in terms of throughput and Average delay.

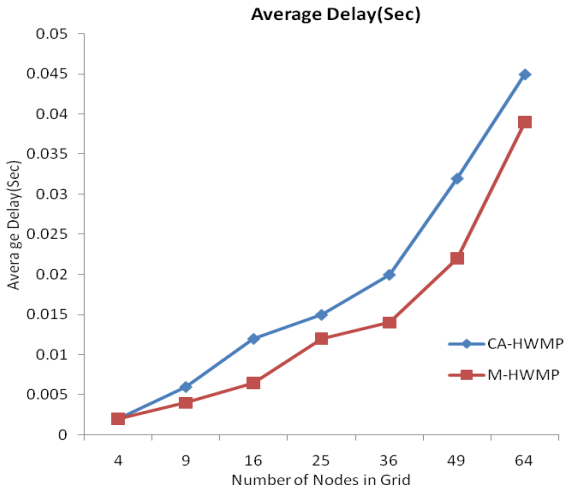

Fig -3: Average Delay

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