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# Enhance Routing in HWMP for Congestion Avoidance Mechanism in the Wireless Mesh Network

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**Abstract -** To support interactive, high speed, mobility and low cost infrastructure, the wireless technology is used for different applications. Wireless Mesh Network is the best suitable application for ongoing data connectivity to wireless nodes. This network provides additional functionality like self-reliable, self-configuring and self-healing capabilities. HWMP (IEEE 802.11s) uses MAC Layer 2 Routing protocol for path selection. Congestion avoidance is a very relevant part in enhancing overall performance of Wireless Mesh Networks. An Enhance Routing 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 path before congestion scenario and after 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 Enhance Routing Mechanism with congestion avoidance technique to improve throughput using NS-3 Simulator.

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

## 1. INTRODUCTION

Wireless Mesh Network (WMN) provides continuous data connectivity to mobile users, low cost applications and high bandwidth through efficient utilization of resource for wired connectivity. These networks also support self-configuring, self-healing and self-organizing capability. IEEE 802.11 standard is a Wireless LAN protocol, which is heavily dependent on a infrastructure data transmission. There are series of standards under IEEE802.11, including a, b, g, n etc. which are related to various wireless medium. This standard comprises of two different types of modes i.e. Infrastructure mode where access point is present and Ad-hoc mode where definite access point is absent and two nodes can communicate directly.

IEEE 802.11s is a modified standard of present IEEE 802.11 that resolves many problems in the wireless network. This standard works on a data link layer of OSI model uses MAC address instead of IP address which resolves hidden terminal issue. The HWMP standard comprises of two different protocols i.e. on demand reactive routing and proactive tree based routing. Hybrid Wireless Mesh Protocol Standard removes most of the disadvantages of present protocol and provides Ad-hoc, Infrastructure, Reactive, Proactive and mobile networking solution for remote, hidden area and congested areas.

HWMP protocol provides reliable and 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. The main limitation in HWMP protocol is insufficient to cope up with congestion.

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. These methods are insufficient in more congested scenario. 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 at congestion scenario than congestion control mechanism which takes the decision when network is already experiencing congestion. When a queue size reaches above threshold value then that node broadcasts the CCNF frame to immediate node. Then neighboring nodes search the new path to send their packet

to destination and avoid the more congested path which is proposed in Congestion Avoidance Algorithm CA-HWMP. Thus the congestion is avoided.

In this paper, an Enhance Routing 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. The sequence number is used to avoid flooding in the network this added advantage in this algorithm.

## 2. RELATED WORK

Mohiuddin Ahmed and KM Arifur Rahman presented "A distributed fair scheduling proposed algorithm in Wireless Mesh Network". This paper aims at fair utilization of bandwidth and airtime to get fairness in Wireless Mesh Network. Fairness problem occurs due to sharing of throughput among different channel links originated from different nodes. The direct communication between nodes to gateway has higher throughput. The indirect communication between two or more hops to gateway has lower throughput. In this approach unfair channel sharing causes congestion due to high transmission rate of packet then we require technique to reduce arrival rate on specific node rather than apply bandwidth share algorithm on specific node. [5]

Ashish Raniwala, D Pradipta, and Srikant Sharma have presented "The Coordinated algorithm with end to end congestion control technique in WMN". This paper shown that transport layer protocol performs better fairness even if top MAC layer is unfair. According to author mesh portal act as a central coordinator entity to perform traffic issues. They provides end to end flow fairness algorithm for each flow. Due to more buffer size in the network the throughput gets reduced. [20]

Barbara Staehle, Michael Bahr, Deshang Fu, and Dirk Staehle, 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 algorithm congestion node broadcast the congestion frame to limit specific flow in CCNF. [4]

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 .This approach gives weak response for interactive application. [2]

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. [1]

## 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 Enhance Routing in HWMP for Congestion Avoidance Mechanism in the Wireless Mesh Network. Our proposed routing protocol Enhance Routing 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 9$^{th}$ 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 9. 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 4 and 2 are immediate neighbor of node 1. Node 1 sends packet to node 9, the desired path selected by its routing protocol HWMP is 1-4-5-8-9. As proposed routing protocol monitor the queue size at every mesh node. At node 5, there

is congestion due to queue size approaches above maximum buffer size value, then routing protocol at node 5, broadcast CCNF frame to its immediate nodes and CCNF forwarded to all whichever receive CCNF, i.e. when CCNF received at source 1 it sends PREQ for new path. Then PREQ forwarded to all and dropped by node 5.When PREQ received at node 9 it sends PREP. PREP reaches source 1 from new path except node 5. Now data flow will be ongoing through new path i.e. 1-4-7-8-9.The packet that was queued in the absence of enhance routing congestion avoiding mechanism, will now forward to destination node using this established path. This mechanism enhances throughput. This mechanism allows packet transmission on the rerouting path instead of existing path.

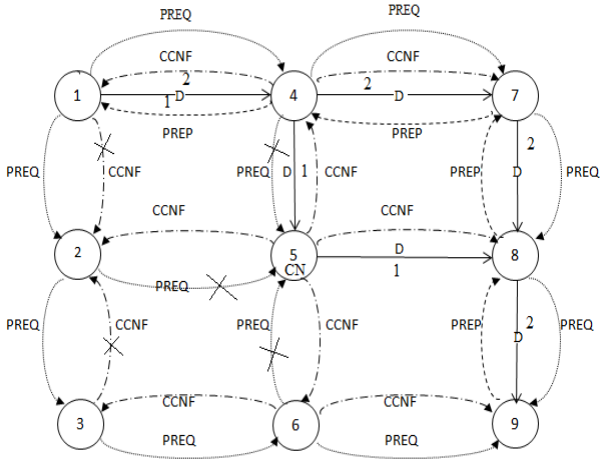


**Fig -1**: Enhance Routing in HWMP

## 4. SIMULATION SETUP

For the performance analysis of HWMP, NS3 simulator 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 enhance routing congestion avoidance mechanism compared with present CA-HWMP protocol. Fig2 shows throughput for two algorithms, ERHWMP 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 ERHWMP while in CAHWMP throughput is degraded as number of nodes increases due to congestion path cannot deleted in the network

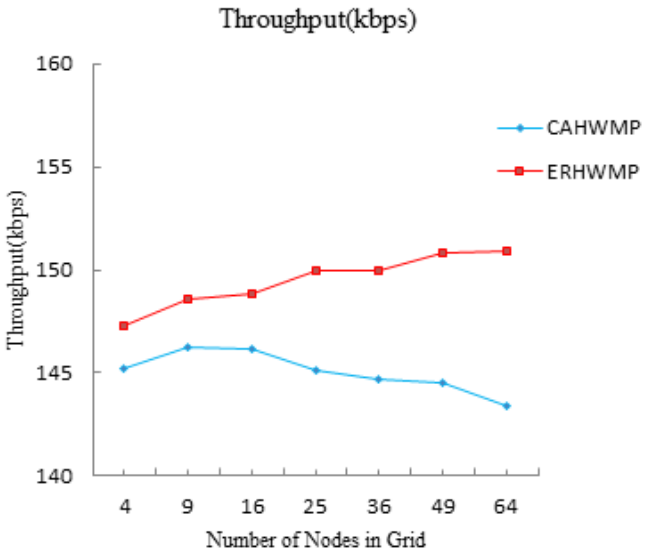


**Fig -2:** Throughput

## 6. CONCLUSIONS

In this paper, we have proposed an Enhance Routing in HWMP for Congestion Control Mechanism in the Wireless Mesh Network. The algorithm proposed continuous flow of packets in the congested path until it rerouting to a new 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.

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