International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395 -0056
Volume: 03 Issue: 06 | June-2016 www.irjet.net p-ISSN: 2395-0072

Novel Cross Layer Fuzzy Based Efficient Multipath Routing for Wireless Mesh Network

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Abstract - *Wireless Mesh Networks are used as backhaul to join various nets to the internet. The existence of numerous-radios in this systems growths the network capacity but introduces lot of interference. Wireless Mesh Network has gain momentum and popularity over last few years. Since Wi-Fi driven internet access has increases across domains, organization and application. A Mesh net is a form of Ad-Hoc network and it extends the internet service to the local nodes through Wi-Fi routers. The nodes can get connected either with 3g, ISDN lines and extend the services of internet to the local nodes. Routing is not a measure challenge in mesh network as the mobility of nodes limited, however the mesh network routes suffers from tremendous power loss due to excessive interference variable bandwidth, loss of bandwidth in the local network. Numerous past techniques are proposed. Different routing techniques for wireless network. Most of the techniques are based on the network layer observation of the bandwidth. As the overall performance of path is effected by different layers (energy, power from physical layer, bandwidth from MAC layer, window size from transport layer), the network layer best routing does not yield efficient result. In this work, we have planned a novel technique by collaborating control information obtained from other layers and obtaining optimal path using cross layer fuzzy base technique or fuzzy cross layer (FCL). We are simulated the proposed protocol in OMNET ++, our result shows that proposed system delivers better packet delivery ratio with less latency and better throughput.*

Keywords: WMN, Cross-layer, Fuzzy based technique, latency, throughput, packet delivery ratio, energy loss.

1. INTRODUCTION

A network designed by using radio signals to communicate with other nodes. There is no wired connection between the devices. Therefore it is extremely important to understand the structural design of the other setups to understand how the mesh network occupation and what differences in design methodology are needed to be adopted for designing a suitable technology for mesh network. The objective of mesh network is *to connect the nodes to internet. If node want to connect to internet a gateway is used to connect. A traditional way of connecting node to the internet is 3g technique but there is a difficultly of several number of devices want to connect to internet and every device does not have 3g. So create a new phenomenon by means of which is to create a local network, in local network create a separate node called as "Access Point". This access point given connection from the modem, all nodes want to connect to internet just gets connect with access point. Ex: Wi-Fi hotspot. As number of nodes increases one access point will not be able to allow the internet connection to all the nodes, one access point gives service to 4 to 5 nodes. So allowing more access points in the network and each access point is connected to each other, the each access point will able to allow internet connection to all the nodes. Finally one access point is connected to multiple access points this whole network is known as Wireless Mesh Network*

2. PREVIUOS WORK

In previous work there is no optimal path for the nodes in the mesh network, to allocate a correct path a rate adaptation algorithm and routing metric was used [2]. There are multiple radios in the network because of multiple radios the network capacity is enlarged but there is a lot of interference. Thus, they designed a well routing to all the signals to find optimal path. The route selection was done by routing metric which makes routing decisions and in addition to routing, a rate adaptation also important for multi-radio WMNs. A cross layer design (CLD) technique also used to extract the parameters from various layers and some of these parameters are used for rate adaptation to improve the QoS parameters of the network.

CLD perceived for reducing the energy consumption. To implement routing metric an AODV protocol is used. Thus, the network capacity can be increased based on the number of nodes. The difficult is that, there is a deficiency of synchronization among the routing metrics and rate adaptation decisions to select an optimal path. The cross-layer is designed to estimate the link quality successfully using delay and interference.

2.1. Routing metric and rate adaptation algorithm

RICE metric used that captures the inter-flow and intra-flow interferences and transmission delay.

$$RICEp = \beta \times \sum_{i=1}^{n} \left(ETTi \times (1 - IRi)\right) + \alpha \times \sum_{i=1}^{n} (CSCi) \quad (1)$$

Where RICEp is routing metric cost on path p, CSCi is channel switching cost on link i, ETTi is expected transmission time on link I, IR is interference ratio on link i. α and β are constant parameters. Expected transmission time is the of a packet needed to be transmitted on link successfully and is given by

$$ETT = ETX * \left(\frac{S}{B}\right) \quad (2)$$

Where ETX is the expected number of retransmissions of packets, S is packet size and B is the bandwidth. Rate adaptation is implemented at MAC layer and used to determine the data transmission rates for transmission of data packets in wireless network. AODV is used for implementing these.

3. PROPOSED METHODOLOGY

In the proposed FCL technique, the goal of this work is to create a wireless mesh network with nodes having cross layer reference model. In this reference model, lower layers (MAC, PHY) can alleviate observed information (like Bandwidth and power) to higher layer (network). Network layer then can use the information obtained from lower layers into routing decision [2]. In a mesh network, the goal is to provide seamless internet connectivity to mobile nodes through Wi-Fi access points. This is called a hybrid network as laptops, mobiles tablets and other devices can get connected with the network. This network is also mixture of mobile and fixed nodes. Access points are generally fixed, mobile nodes may move from one place to another within the network. Therefore the link quality from different access points largely varies. The objective is to create a routing in such a way as to provide the best of the link quality to the nodes all the time. The correct route is selected from multiple routes by using Dynamic Source Routing (DSR) Algorithm, in addition to this a Fuzzy based technique also used.

3.1 Routing protocol and Fuzzy based technique

DSR [3] is a Dynamic source routing, it will allow a network to completely self-organizing and self-configuring. The source routing consists of two apparatuses and are, Route Discovery and Route Maintenance, which will allow nodes to discover and maintain route from source to destination in a network. DSR uses a source routing but it requires the statement of each nodes between source and a destination in a network, this gives the high overhead for long path. To avoid this overhead the DSR optionally defines a flow id option, this allows packet to forward on basis of hop by hop. Fuzzy logic is mainly used to obtain an optimal path solution for a set of data that has multiple thresholds. However threshold based technique yields binary classification of a metric where in general the metrics will be having several quality values. For example, bandwidth could be classified into very low, low, medium, high and very high. As conventional binary fails to handle such kind of data that can be categorized to be multiple classes, we take the help of Fuzzy logic [4]. Fuzzy logic is a mathematical solution for obtaining a cost from different metrics.

Cross layer mechanism also used to make the coordination between different layers and this is utilized to decrease volatility of the system by separating the whole system into little module with different functionalities [5].By using this cross layer approach the energy loss is very less. For fuzzy base technique we require a different parameters for that a cross layer is used to extract the parameters from different layers. A Fuzzy based technique is used to solve this problem, in this writing a table called solve fuzzy. In table taking the bandwidth and converting it into kbps and this function is called as solve fuzzy. The solve fuzzy does,

```
if(rb>=2000 &&rb<2100)
        {
                mfb=r2;
        }
        .
        .
        .
        if(rd>=25 &&rd<100)
        {
                mfd=l;
```

Similarly for delay also given the ratings as,

```
        if(mfd==s &&mfb== r1)
        {
```

```
FRR=HIGHER;
}
.
if(mfd==l &&mfb== r5)
{
FRR=HIGHER;
}
```

Like this type solve fuzzy does. If delay is small and bandwidth is high then the resultant result FRR is also high. To calculate the link quality from multiple parameters we are using a fuzzy technique. Cost is the result of the fuzzy output and for every path checking the cost so finding the minimum cost. By using this proposed FCL system we can also show that the video transmission [6] in wireless mesh network.

3.2 Simulation model and parameters:

We used OMNET++ to simulate our proposed algorithm. In our simulation, minimum 22 nodes are used and simulation time kept constant as 500s and some of the nodes are movable nodes. The simulation settings are tabulated in table1.

Table 1: Simulation settings

No. Of Nodes	Min 22
Area size	900m- 900m
Topology	Mesh
MAC	802.11b
Packet size	4096 b
Simulation time	100-500s
Mobility Model	Random Waypoint
Route Algorithm	DSR
Network Type	Hybrid/ Mesh
Radio Model	Free Space
MAC Buffer	8 Mb
Emax	1000 mJ
Ptx	.003 mJ/bit/meter
Prx	.001 mJ/bit/meter

4. SIMULATION RESULTS

As shown in figure (4.1), the packet delivery ratio as a function of load. After a load range 3, the packet delivery ratio of both the systems are same but initially there is a slight difference. Figure (4.2) shows that throughput is a function of load, throughput of proposed system is greater than the throughput of present system at load. Thus the proposed work gives the better throughput. Figure (4.3) the energy loss during packet transmission and reception from source to destination is very less in the proposed system compared to present system because the cross layer technique with that a fuzzy based technique also used so energy loss in the proposed system is low. Figure (4.4) shows Latency as a function of load. Latency is the required time to deliver packet from source to destination node. In proposed system, a shortest route is preferred for data transmission.

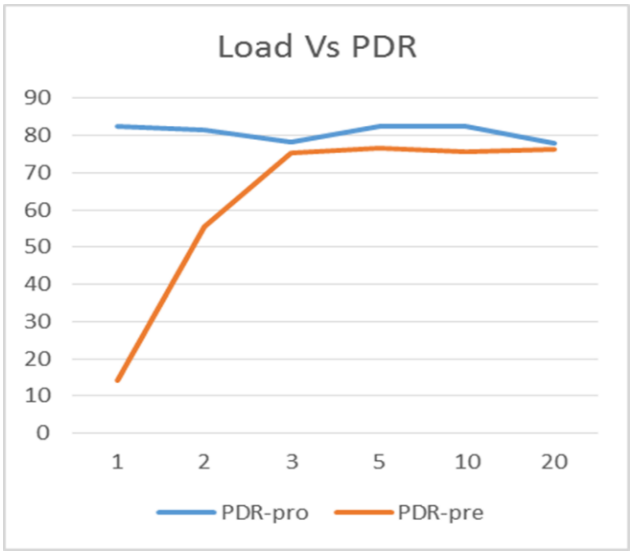

Chart-1: Load Vs Packet Delivery Ratio

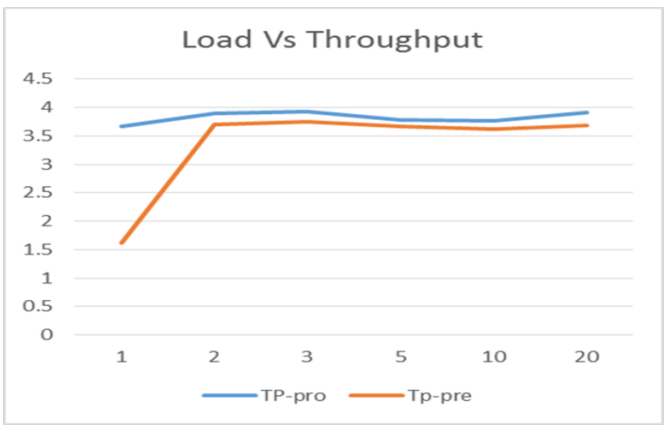

Chart-2: Load Vs Throughput

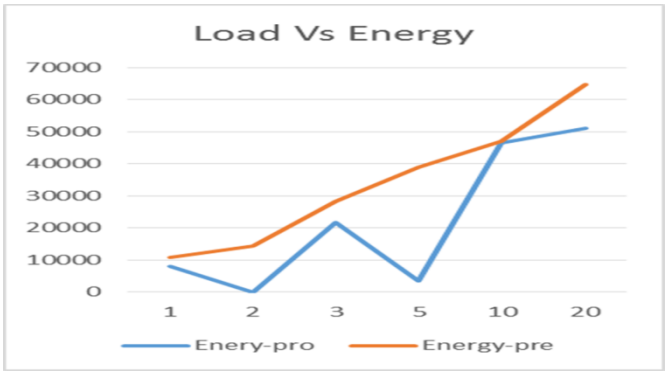

Chart-3: Load Vs Energy

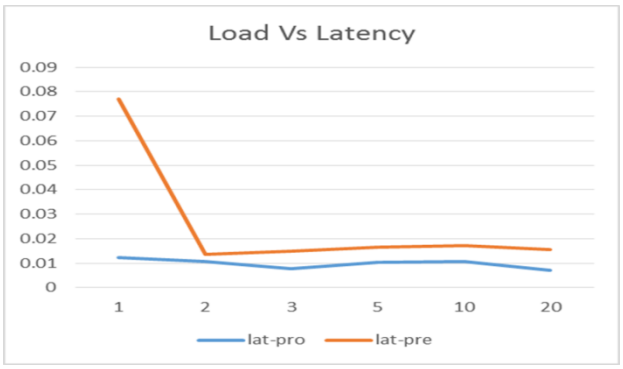

Chart-4: Load Vs Latency

5. CONCLUSION

In a mesh network due to continuously accessing the data, the network suffers from lot of packet loss, delay and power loss. Many past challenges have proposed different routing and data transmission technique for mesh network. However, as mesh network is unlicensed radio and different nodes are operated with different link and some of the nodes are movable nodes. Such a network performance depends largely on different layer. Therefor we are combined the information from physical layer, MAC layer and take this information into routing layer. As it is difficult to combine multiple metrics into a single cost so we have used fuzzy logic technique with cross layer approach to combine different metrics, coming from different layers into a single cost value based on the performance. However there are many other metrics like ISR, ICI, Rayleigh fading these metrics can also be combined with the proposed work for future work.

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[6] Cross Layer Routing and Rate Adaptation for Video Transmission in Multi-Radio WirelessMesh Networks Kiran Patil1, Narayan D.G2, Uma Mudenagudi3, Jyoti Amboji4 B.V.Bhoomaraddi College of Engineering & Technology, Hubli, Karnataka, India 978-1-4799-8792-4/1.