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Fairness Based Dynamic Routing Technique (FsBDRT) in Wireless Mesh Network

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Abstract: This study aims to present a joint solution of routing and fair resource allocation which in terms of OSI layered architecture belongs to two different layers but both cannot be considered as individual problems. The routing problem in WMNs is concerned with finding “good and optimum path” from source to destination. The objective of this research is to provide a new dynamic technique for efficient and reliable self-path utilization and provision of better and efficient way of handling issues of load balancing and congestion control in WMN. For fairness of resource allocation, this study presents the method of load balancing, where multiple paths to destination are used to distribute the traffic. These multiple paths are ultimately figured out using dynamic routing, which not only improves performance but also provides reliability, especially in presence of lossy channels. In this study we propose a Fairness Based Dynamic Routing Technique (FsBDRT) a dynamic routing mechanism to adapt an optimal path, as well as identification of lossy channel becomes due to congestion.

Keywords: Congestion control, dynamic routing, fairness, quality of service

INTRODUCTION

In this study we consider the routing problems in wireless mesh networks. In the field of Wireless networks, the Wireless Mesh Networks (WMNs) have gained the pivotal status and thus they have become such an object on which many researchers are focusing, major reason being the WMNs have the advantage of increased coverage, low cost and easy deployment. WMNs have been identified as key technology to enhance and compliment existing network installations as well as provide access where traditional technology is not available or too costly to install. WMNs are such radio based networks for which minimal configuration and infrastructure is needed.

A WMN comprises of Mesh Routers (MRs), they have limited or less mobility and Mesh Clients (MCs) which are in most case dynamic. Mesh Routers play an integral part in network; as they allow clients to get access to the networks (Badis and Agha, 2005). Mesh Routers in a WMN transfer packets which are coming from Mesh Client (MC) nodes to Gateway (GW), which is connected to a wired network. A lot of wireless mesh networks system are considered in connection with throughput, delay or any other benefit which increases fairness. In the absence of fairness based routing for wireless mesh networks it would be a fairly hard task to create a general purpose network in which all clients have expected a proportionate service. At present many deployments of WMNs do not deal properly with the users demanding more flows, that may result in provision of extremely unequal service between clients (Biswas and Morris, 2005). The protocols in use at present are designed without keeping in mind the aspect of fairness. These protocols aim at providing other crucial characteristics such as delay, data rate and good put. The WMN deployments in use are optimized regarding throughput or load balancing which set little focus on fairness in dynamic routing.

A mesh router usually involves multiple wireless interfaces that are built on either the same or different wireless access technologies, to further increase the flexibility of mesh networking. In comparison to a conventional wireless router, a wireless mesh router can yield the same quantity of coverage consuming much lower transmission power by using multi-hop communications. Optionally, in a mesh router the medium access control protocol is increased with a better scalability in a multi-hop mesh environment (Raniwala and Chiueh, 2005).

Despite the existence of all these differences, usually the similar hardware platform makes the bases of design of mesh and conventional wireless routers. Mesh routers can be designed on the basis of embedded systems or dedicated computer systems. They can also be developed based on laptop/desktop PCs or general-purpose computer systems. Mesh Clients (MCs) also have the key functions for mesh networking and in this way can also work as a router in WMNs, but gateway or bridge functions are not present in these nodes. Furthermore only one wireless interface is involved in mesh clients. Consequently, the benefit of having

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hardware platform and the software for mesh clients is much simpler than those for mesh routers can be achieved. Mesh clients retain a greater variety of devices in comparison to mesh routers. These may include laptop/desktop PC, RFID reader, IP phone, pocket PC, PDA and many other devices (IAkyildiz and Wang, 2009).

Based on the functionality of the nodes the architecture of WMNs can be classified into three main groups (Sobrinho, 2003). Infrastructure WMNs are the most popular and the most frequently used type Wireless Mesh Networks (WMNs). Infrastructure meshing can be used to design community and neighborhood networks. The mesh routers are put on the upper layer of Wireless Mesh Networks (WMNs) and these can function as access points for clients in indoor and outdoor. Conventionally, router involves two types of radio, i.e., normal and for backbone communication. Long range communication techniques including the directional antennas can be used for establishing the mesh backbone communication.

Client meshing aims at the provision of benefit of peer-to-peer networks properties among client devices. In this type of framework, client nodes make the actual network to perform routing and configuration functionalities and at the same time it provides end-user applications to clients. In this way there is no need of mesh router for this type of network (Eriksson *et al*., 2006). In Client WMNs, a packet which is required to reach a node in the network hops between several nodes in the process of arriving at destination. Client WMNs are generally one type of radio or device is used in forming client WMNs. Beside this the requirements on end user devices are more in number than in infrastructure meshing, because, additional features such as self-configuration and routing are to be performed by the end users in Client WMNs.

A mixed up of infrastructure and client WMN is the Hybrid Wireless Mesh Network. The Mesh Clients can access the network through Mesh Routers as well as through directly meshing with other mesh clients. The communication with other networks, like Wifi, Cellular, Sensor networks, Wimax is facilitated by infrastructure.

According to the consulted literature sufficient research work has been carried out for efficient utilization of available resources but still there are number of issues regarding load balancing and congestion along with dynamic routing in wireless mesh network environment is still required improvement. By studying different techniques and methods to overcome congestion and efficient load balancing over wireless mesh network with respect to different routing protocols (Draves *et al*., 2004).

While considering WMNs over AODV, the performance of AODV routing protocol is to calculate all the paths form source to destination node (Francois and Bonaventure, 2007). As per AODV architecture, AODV selects best path from all available paths and also maintains its routing table. Then selected dedicated path is treated as WMNs shortest path and assign it labels and makes it a best path from one node to destination. Now all traffic between sender/receiver utilizes this path. So the utilization of this path is much more than others. There is higher probability for congestion occurrence over this path. This is currently burning issue of WMNs over AODV with respect to congestion and load balancing. Quality of Service, performance and throughput are other major issues in Wireless Mesh Networks. Due to congestion/malicious node packets are lost in Wireless Mesh Networks (Mohammed *et al*., 2011). By improving the equal resource sharing, load balancing and congestion control we can easily improve one of the features of Quality of Service which is fairness.

This study aims to present a joint solution of routing and fair resource allocation which in terms of OSI layered architecture belongs to two different layers but both cannot be considered as individual problems. For fairness of resource allocation, this study presents the method of load balancing, where multiple paths to destination are used to distribute the traffic. These multiple paths are ultimately figured out using dynamic routing, which not only improves performance but also provides reliability, especially in presence of lossy channels.

LITERATURE REVIEW

Yoshihiro (2010) proposed dynamic metrics for Wireless Mesh Networks (WMNs) to improve communication quality. They were aimed at reducing routing loops using dynamics metrics in WMNs. To make the existing dynamic metrics loops free by restricting the range of metrics values to change the mechanism called Loop-free Metrics Range (LMR) was proposed. The LMR work is planned in OLSR (Clausen and Jacquet, 2006) proactive link state routing. Here each node advertises the latest matrices values in each periodic message. The propagation delay occurring in this situation is the main reason for routing loop. The safe range formula is used to compute the new metric values.

Zhang *et al*. (2011) proposed a Smart Grid Communication Network (SGCN) for making the environment of communication more robust reliable and efficient. The SGNC is developed by developing wireless mesh network. The technology of this type of network comprises of 802.15.4 and WIMAX standard (Yang and Chen, 2008). With the arrival of the smart grid the management of consumption and energy supply is considered as an intelligent and efficient approach. This real time energy management can be benefited by the consumers and the energy suppliers alike.

Yoo and Kim (2009) highlighted the factors of the loss of TCP acknowledgement and proposed the idea of TCP fairness in wireless mesh network. The problem of removing the loss possibility and semi long term fairness in the same pack (SLU-SP) is addressed. Packet accurate Protocol Monitor (PaPMo) is observed over TCP which used Window Congestion Size (WCS) for decreasing TCP acknowledgement packet and the mechanism of delay acknowledgement is introduced. However TCP acknowledgement and TCP fairness could be dissolved through the design.

Omer *et al*. (2009) proposed the flow of congestion control which is a part of the general network of wireless mesh network nowadays. Resciults are taken by using the real time scenarios in simulator on which more bandwidth is received by the flow of one hop whereas the flow of two hops starves. It means the congestion control flows are starved after measuring the environment of wireless mesh network. The policy which is implemented by IEEE 802 is the proposed solution involved by a contention window's policy and it defined standard mechanism. Though it is a simple and the behavior of network is powerfully affected by the policy. The points of queuing the network creates the problem of behavior of transportation and Mac and ensure that for specific location the bandwidth of gateway is not constant and fair shared way taken by TCP flows they have.

Gomes *et al*. (2009) proposed the extension of the proactive routing protocol OLSR (Optimized Link State Routing). This design differentiates the data traffic and multimedia traffic for providing quality if support and service to those application in which the role of transport protocol is played by TCP.

Crichigno *et al*. (2008) designed an adaptive programming routing approach for WMN and MRA aimed at finding path and bounded end-to-end delay at a time. The remission power is fixed and the remission of Request-to-send/Clear-to-send mechanism is disabled at the DCF. The pact is high class and performance and QOS is not improved by the high cost.

Yang and Chen (2008) proposed a stable and fair algorithm of scheduling on heterogeneous Multi-Channel Multi-Radio Wireless Mesh Network (MCMR WMN) which balances the objectives of the network through put. Algorithm coloring multiple and matching maximum make the basic of scheduling algorithm here the interference and channels of wireless links corresponds to the nodes set in the graph of bipartite. For achieving a minimum period of scheduling multi channel and interface would be effectively colored. When the flow of data is congested Max-Min fairness could decrease the output of heterogeneous network. The fairness and the throughout would be degraded by the stable scheduling however, as the channel would possibly fail so the maximum throughput part maintained. Optimized network throughput can be effectively achieved by algorithm. The high throughput is improved by building a more stable scheduling algorithm.

The nodes in the networks are enabled by WECTT which are set up for finding the optimum path if the bandwidth of links and diversity of channel to IGWs. To improve WCETT, Floyd *et al*. (2008) improved the IGWs by concentrating on inner flow of traffic within the network and outer flow traffic between the paths which are adjacent. By using these interferences the updated and previous link with in a path are considered by it. If the new or updated link uses the channel which is used by previous link than a larger parameter values will be assigned by the MIC to the current link by the MIC to the current link by the MIC so the infra flow inference within each path is captured. While capturing inner flow traffic interference the communication on every link interferes with the set of nodes which are neighbor is monitored by the MIC. Through which the packets are routed by routers by less traffic load. Any how the issue of load balancing is not considered in all these routing metrics.

Xie and Hung-Yun (2007) presented the technique of partitioning the domain which provides load balancing among different IGWs domains, by the approach of mobility on internet to handle the mobility of inner domain for one hop or multiple hop mesh clients. Their works take into concentration of the heterogeneous characteristics of IGMs, the work approach focuses on increasing the relative fairness in the neighboring IGW domain and the elevation of whole fairness is not made.

An interworking wireless mess work performance characterization was proposed by Tsai and Hung (2007). It formulates the problem, it presents a normal linear programming formulation, if there is no any kind of inner domain is existed in a system the multiple wireless mesh network is overlapped and every individual mesh network is suffered from degradation of capacity so these wireless mesh network should inter work which allow inner domain traffic relay when bridge nodes are provided serious inefficiency and unfair problems may results if the bridges nodes are chosen without care full planning.

Asad *et al*. (2007) proposed a protocol which is an enhancement of AODV that involves the use of other new abilities offered by the mesh routers. It reduced the limitations and problems of hybrid wireless mesh networks in routing matter. By the addition of a new routing metrics it allow the different types of node which are present in the wireless mesh networks to contribute on the enhancement in the AODV routing protocol. With the effect of the new metrics is that the mesh routers and the mesh clients are involved only at the time of most necessarily in route preference. They have further suggested a mechanism in the route discovery process which allows selection of optimal

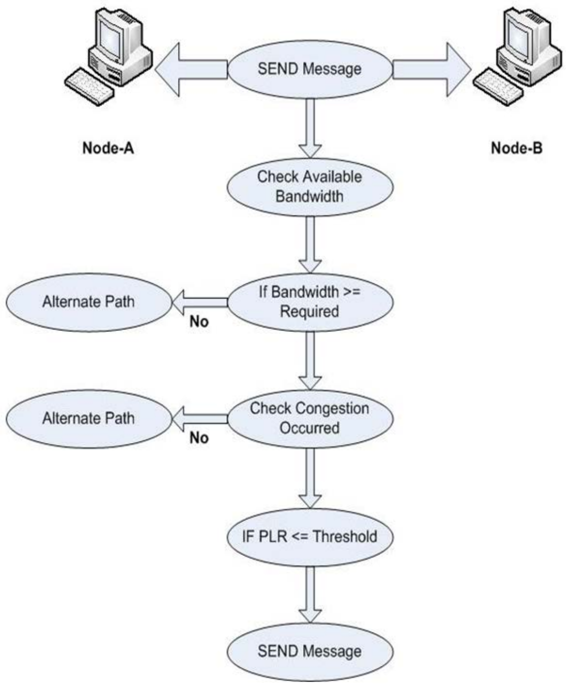

Fig. 1: Flow diagram of proposed technique

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Psuedocode
In coming Traffic
Check the available bandwidth
IF Bandwidth >= Required
Check Node Congestion
IF Packet Loss Ratio < = Threshold Then
        "Send Message"
Else
        Select the Alternate path
Else
        Select Alternate Path
IF Bandwidth >= Require
        Check_Congestion_at_Node
IF Packet Loss Ratio < = Threshold Then
        "Send Message"
Else
        Select the Alternate path
Else
        Select Alternate Path
END;
```

Fig. 2: Pseudo code of proposed technique

interface on multi home nodes resulting in high capacity with the least interference problem.

Proposed technique: In this study, we proposed Fairness Based Dynamic Routing Technique (FsBDRT), a dynamic routing mechanism to adapt an optimal path, when a channel becomes lossy. After identifying lossy channel (Faraz *et al.*, 2007), our proposed technique initially identifies threshold for the environment. When threshold occurs then alternate path will be identified on basis of queue and data will be sent by using alternate path, flow of which is shown in Fig. 1.

When a node receives any packet then first receiving buffer analyzer receives this and then sends that packet to routing table. Routing table maintains record about the sending array, receiving array also have the record about the packet looses, node do not have any cover up scheme that how to handle the congested nodes. So these all requirements are fulfilled in our research. Through fulfilling these requirements, we will improve our network layer and enhance Quality of Service due to minimize the packet drop ratio. The main function of the proposed technique is presented in Fig. 2.

RESULTS AND DISCUSSION

We consider a network of 10 nodes having topology as shown in Fig. 3. The simulation parameters are listed in Table 1. IEEE 802.11b physical layer standard with channel capacity of 2 Mbps was considered. AODV routing protocol was adopted with a simulation time of 15 min. Constant Bit Rate (CBR) was opted for traffic generation, with 5-10 packets per second were generated; having packet size of 512 bytes.

In this scenario we apply FsBDRT on two different cases that we will use 5 and 10 packets per second (pps.), to verify that our algorithm.

Case 1: Five packets per second load: In this case we establish a scenario of 10 nodes with packet transmission rate of 5pps, when we start the simulation of FsBDRT cumulatively observed the traffic between the nodes and identified the area where the nodes were dropping the packets selectively.

In Fig. 4 where 20% congestion rate existed, FsBDRT was applied. It was found clear that the overall packet transition of every node is subdivided and almost 50% data is sent by using the alternate path.

Table 1: Simulation parameters

Parameters	Values
Network size	300×300
Number of nodes	10
Packet size	512 byte
Packet transmission rate	5, 10pps
Routing protocol	AODV
Simulation time	15 min
Channel capacity	2 Mbps

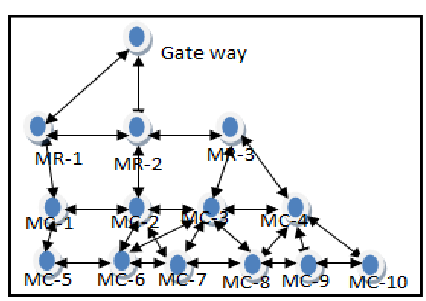

Fig. 3: Ten node network topology

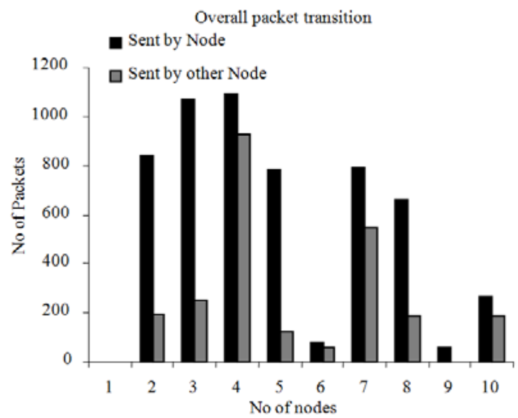

Fig. 4: FsBDRT performance on 20 % of congestion

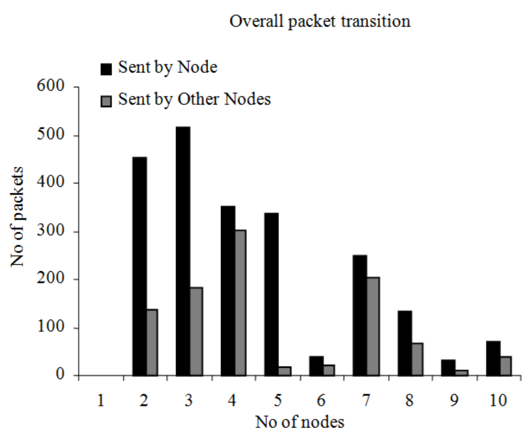

Fig. 5: FsBDRT performance on 50 % of congestion

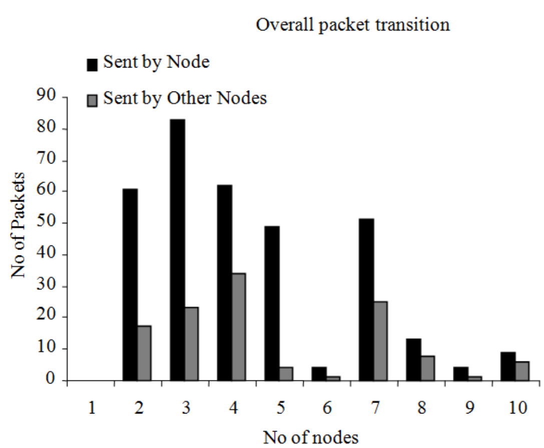

Fig. 6: FsBDRT performance on 80 % of congestion

In Fig. 5 the packet sent by the node and the packets which are sent by the alternate path is clearly shown.

In Fig. 6 after performing the 50% congestion rate and applying FsBDRT performance on 50% of congestion it is clear that the overall packet transition of every node is subdivided and almost 50% data is sent by using the alternate path.

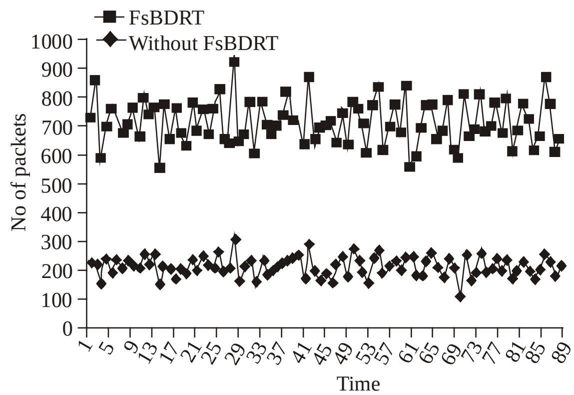

Fig. 7: Overall performance analysis of (Fs BDRT) 5 packet/sec

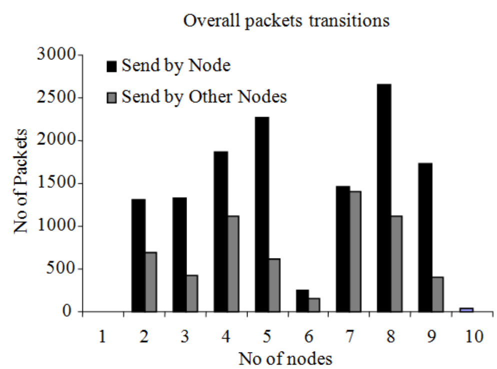

Fig. 8: FsBDRT performance on 20 % of congestion (10 packets/sec)

In Fig. 7 the packet sent by the node and the packets which are sent by the alternate path is clearly shown. The overall throughput by applying our technique FsBDRT on 5 Packet/Sec and without proposed technique and compared. We achieved that throughput of FsBDRT is found better than without FsBDRT.

Case 2: Ten packet per second load: In this case we establish a scenario of ten nodes with packet transmission rate of 10 pps.

In Fig. 8 after performing the 20% congestion rate and applying FsBDRT performance on 20% of congestion it is clear that the overall packet transition of every node is subdivided and data is sent by using the alternate path.

In Fig. 9 after performing the 50% congestion rate and applying FsBDRT performance on 50 % of congestion it is clear that the overall packet transition of every node is subdivided and data is sent by using the alternate path.

In Fig. 10 after performing the 80% congestion rate and applying FsBDRT performance on 80% of congestion it is clear that the overall packet transition of every node is subdivided and data is sent by using the alternate path.

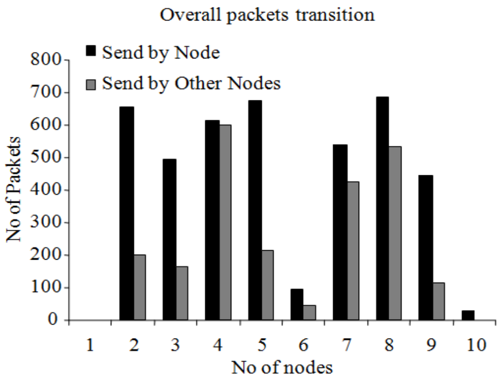

Fig. 9: Fs BDRT performance on 50 % of congestion (10 packets/sec)

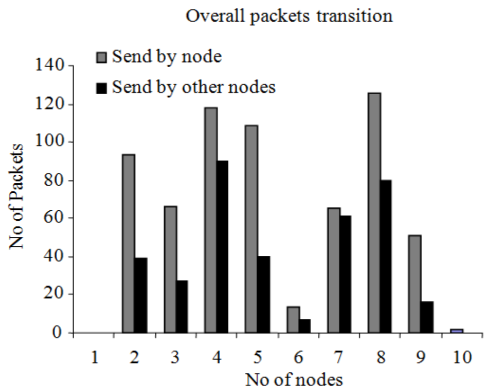

Fig. 10: FsBDRT performance on 80 % of congestion (10 Packets/sec)

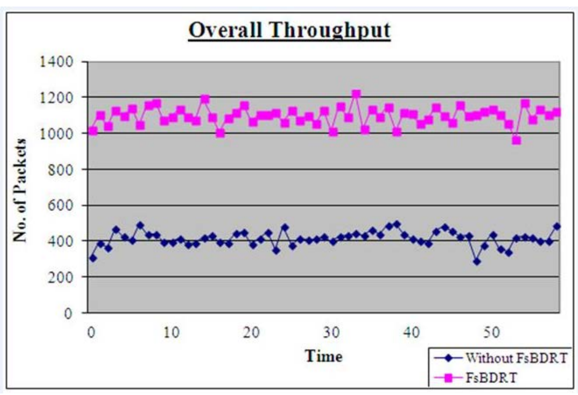

Fig. 11: Overall performance analysis of (FsBDRT) 10 packet/sec

The overall throughput by applying our technique proved that the throughput of FsBDRT is better than without FsBDRT, as shown in Fig. 11.

CONCLUSION

The proposed technique improves the performance of networks in such a way that overhead of packet loss is minimized. In this research we proposed a new technique FsBDRT for wireless mesh network. The objective of this research is to provide a new intelligent technique for efficient and reliable self-path utilization, a dynamic routing mechanism to adapt an optimal path, when a channel becomes lossy and provides a better and efficient way of handling the issues of load balancing and Congestion control in wireless mesh networks.

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