Primary Gateway Association PDR Analysis in Wireless Mesh Network with Multiple Gateways

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Abstract— **Recent number of deployments of Wireless mesh networks (WMN) has proven how it has become widely accepted technology in recent decade[1]. Among the few of the advantages that can be counted on for popularity of WMN, are its low cost, simplicity and access to backbone network by a mesh node. Mesh nodes get access to the Internet through a special device called Gateway. Even one gateway may be sufficient to provide broadband facility to a number of nodes in its range. The range of the Internet access by more nodes can be increased with introduction of additional gateways in the network. This scenario of multiple gateways leads to improvement in performance of overall network. But some criteria is required based on which the nodes are to be associated to a gateway. Associating to the nearest gateway may not be always the best choice. We present here an algorithm for associating a node to one of several available gateways. Packet Delivery Ratio (PDR) is one of the key performance metrics for many applications. In this paper we have analyzed the network on this performance metric for default nearest gateway scheme and for proposed scheme. The proposed scheme has shown better PDR even with higher number of active nodes near a gateway.**

Keywords- ***WMN; Gateway; Mesh Node; End to End Delay; PDR***

I. INTRODUCTION

Wireless mesh networks have seen enormous growth since its inception in [1], [2]. Wireless network and the Internet has become a new life line showing health and progress of a society. A node in wireless network can get access to the Internet through broadband services. With the advent of mesh technology, a node may access the same without having need of direct connection to the broadband services. Even if it is having one node, called the gateway node, with direct access to backbone network, any node in the range of the gateway get the facilities of backbone access. This simplicity and low cost of WMNs make them more popular amongst their counterparts but also pose a number of challenges [2].

This paper is organized as follows. Section II emphasizes the motivation for proposed scheme. In Section III, the proposed scheme is discussed. Section IV discusses comparison of outcomes and results of proposed scheme with basic default scheme. And the paper concludes in Section V.

II. MOTIVATION

In 802.11s WMN, a station (STA) is a client node. This STA can have access to the Internet only if it can reach to a Mesh Portal Point (MPP) which is also known as a gateway. Mesh Access Points (MAPs) or Mesh Points (MPs) are popularly known as mesh nodes through which an STA can approach to gateway, as shown in figure 1. If more than one gateway is available to a mesh node (here after referred simply as node), then decision regarding to which gateway the node be associated is to be taken.

One of the major issues with WMN are the resource sharing, i.e., sharing gateway capacity[2]. As number of clients goes on increasing, allocation of bandwidth becomes more tedious. This may lead to more complex problems like unfairness, starvation, congestion, packet drops and dropped throughput. Generally, the nodes get associated to the nearest gateway. This nearest gateway may be calculated on the basis of hop count. When nodes with different hop count get associated to a gateway, the nearer one gets hold on the gateway than the farther one in the competition of gaining access. This may lead to long waiting time on the part of nodes located at comparatively longer hop counts and may cause starvation. It may also lead to unfairness as the nodes nearer to gateway are most of the time keeping gateway unavailable to the distantly located nodes.

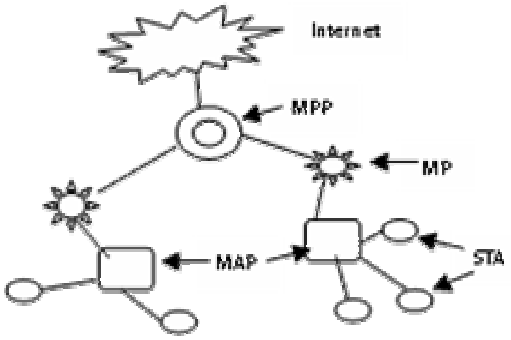

Figure 1. Example Wireless Mesh Network

TABLE I. PRIMARY GATEWAY ASSOCIATION ALGORITHM

Algorithm: Primary Gateway Association

1. *For each node*
2. *For each gateway in the range*
3. *Send hello from node*
4. *Find e2e delay and IFQ threshold for this GW, save in a list*
5. *End for*
6. *Sort list to find lowest e2e delay and higher IFQ threshold*
7. *Make gateway with lowest e2e and higher IFQ threshold as Primary gateway PG*
8. *End for*
9. *If new load*
10. *Send request to PG*
11. *If ack received*
12. *Send load to PG*
13. *Else*
14. *//If PG Signal waiting*
15. *Pick up next suitable gateway as PG from step 6 and 7*
16. *Perform step 10 onwards*
17. *End if*
18. *End if*

Many nodes trying to access backbone at the same time through the same gateway may further cause congestion and packet drops at the gateway which in turn may be the reason for decreasing packet delivery ratio. This has been a motivation to go for some scheme that may do better association of nodes to gateway.

III. PRIMARY GATEWAY ASSOCIATION SCHEME

In a WMN scenario with multiple gateways, there may be two or more gateways in the range of a node. A node will take decision to select a gateway as its primary gateway. This can be done by checking the delay from node to available gateways and the threshold value of the interface queue(IFQ) which holds packet in queue when the gateway already has packets to process. Higher value of IFQ makes less packet drops. The gateway with the lowest delay from the node and higher IFQ may be assigned as primary gateway (PG) for the node, as shown in table 1.

The algorithm in table 1, is for single gateway association, i. e., a node is associated to only one gateway at a time. This scheme is different from basic default gateway association in three ways:

- The decision of primary gateway is taken at the runtime.
- The primary gateway may not be the same designated one, but it may be changed.
- Even with the mobile nodes it may work effectively with little modification.

In the traditional scheme, primary gateway is a designated gateway allotted to node depending upon the hop count from the node to gateway. This works well in case of wireless infra-structure mesh networks, where the nodes are rather static and accessing the backbone network wirelessly through the gateway[1]. So as long as the network exists, the node has same gateway as its default or primary gateway. If more number of active nodes populated near a gateway, the performance of the overall network goes on decreasing. On the other hand, the other gateway in the range of these active nodes may be underutilized just because the hop-count from nodes to this gateway is not the lowest one. The freedom to choose best possible gateway at runtime and if it is not available selecting the second best as primary gateway assures maximum time availability of gateway services in the network. Once the list is sorted according to end to end delay and IFQ threshold, it may be utilized to take decision regarding the second or third best gateway for a node in case the first best gateway is overloaded. If the data regarding end to end delay from the node to every possible gateway in the range is gathered whenever there is denial of service from primary gateway to the node, this scheme may work effectively for wireless mesh network with mobile nodes.

IV. RESULTS AND DISCUSSIONS

The algorithm is implemented in network simulator NS-2 which is widely accepted amongst the researchers [3], [4]. As shown in figure 2, a 5X5 regular grid scenario is considered. The nodes are assumed to be static. The association of nodes to gateway using basic default association scheme is as shown in table 2. As more number of nodes associated to gateway G4, when the nodes try to send packets, most of the packets are dropped whereas, these nodes might have approached other gateways in the range.

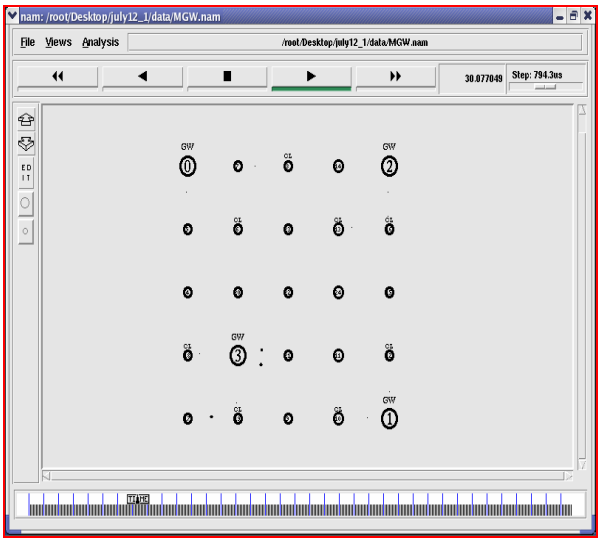

Figure 2. Experimental Scenario in NS-2

TABLE II. GATEWAYS AND ASSOCIATED NODES

Gateway number	**Associated node number**
G1 (4)	2, 3, 8, 9,14
G2 (20)	10, 15, 16, 21
G3 (24)	18, 19, 22, 23
G4 (6)	0, 1, 5, 7,10, 11, 12, 13

The scenario was observed for varying data rates. Packet Delivery Ratio (PDR) of the network was analyzed. As shown in figure 3, for 200Kbps CBR traffic, gateway G2 and gateway G3 have better PDR compared to gateway G1 and gateway G4. The reason is more number of active nodes associated to gateway G1 and gateway G4. Hence, there is competition for access and more packet drops are there leading to lowered throughput, especially at gateway G4 with eight associated nodes.

The same scenario is used for the proposed scheme of association listed in table 1, and the results of PDR were plotted as shown in figure 3. From figure 3, it can be observed that the packet delivery ratio in case of proposed scheme is better than the default scheme. The proposed scheme responds better for increasing data rate and also when the number of active nodes is increased.

Figure 3 shows that gateway G4 has given noticeably good improvement in packet delivery ratio. Also gateway G2 and G3 performed better in the proposed scheme. These two gateways were available to take load when gateway G1 and G4 were signaling wait. Hence, we have got better network PDR with the proposed scheme.

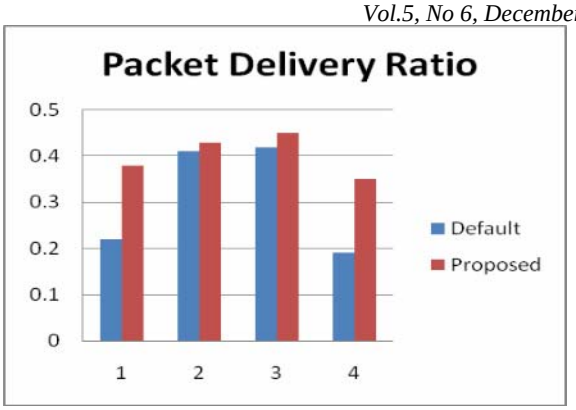

Figure 3. PDR comparisons for Default and Proposed Schemes

V. CONCLUSION

The proposed scheme of gateway association has shown better throughput than the general scheme. There are many other advantages of this scheme. When a node is denied for service from gateway, it does not sit idle starving. It tries to approach another gateway. As the traffic is diverted from busy gateway towards the comparatively less burdened gateway, congestion is avoided, which in turn may lower the packet losses. As the nodes are getting chance to communicate through another gateway, fairness is increased and better utilization of resources is done.

REFERENCES

[1] W.I.F. Akyildiz, X. Wang, “Wireless mesh networks: A survey,” in Computer Networks Journal 47 (Jan.) (2005) 445–487.

[2] M. L. Sichitiu, “Wireless mesh networks: opportunities and challenges”, in Proceedings of World Wireless Congress (May) (2005).

[3] S. Tajima, T. Higashino, N. Funabiki, S. Yoshida, “An internet gateway access-point selection problem for wireless infrastructure mesh networks”, Seventh International Conference on Mobile Data Management (MDM’06), 2006, pp. 112–118.

[4] P. Owczarek and P. Zwierzykowski, “Review of Simulators for Wireless Mesh Networks”, Journal of Telecommunications and Information Technology, March 2014.

[5] The network simulator ns-2 manual online available at http://www.isi.edu/nsnam/ns/.