Performance of Clustered Wireless Mesh Network with Default Gateway Association

Geeta J. Tripathi
Research Scholar
G H Raisoni College of
Engineering, Nagpur (MS)

A.R.Mahajan, Ph.D
Professor
Priyadarshini Institute of
Engineering &Tech., Nagpur

ABSTRACT
Wireless Mesh Networks (WMNs) is gaining wide acceptance in wireless network users due to its unique features. It is also capturing major share of attention amongst researchers as it is in its evolutionary stage and its performance is still under observation. This paper discusses the performance of wireless mesh network where cluster of static nodes is associated with cluster head which serves as default Gateway for Internet access. The performance of static client scenario is evaluated on the basis of packet delivery ratio and end to end delay with varying transmission rate. A single cluster with one Gateway is compared with the case where the same number of nodes is forming around four clusters with each cluster head serving as a Gateway. Network Simulator NS-2 is used for evaluation. The results show that Multiple Gateway scenario provides better results as compared to Single Gateway.

General Terms
Packet Delivery Ratio, End to End Delay.

Keywords
Wireless Mesh Network, Gateway, Cluster, IEEE 802.11s.

1. INTRODUCTION
The concept of Wireless Mesh Networks, as mentioned in IEEE 802.11s, encompasses a wide variety of stations (STA) which may be stationary or mobile clients. Mobile phones, laptops and Wi-Fi enabled gadgets, etc may be examples of WMN stations. The STAs are connected through Mesh Access Points (MAP) to the wireless subnet. These MAPs in turn are connected to Mesh Portal Point (MPP), which is popularly known as Gateway, in one or more hops. Mesh Points (MPs) are used for intermediate hops. MPs do not have the capability provide service to the STA or MAP. It just facilitates the MAP to get connected to a distant MPP. Throughout this paper the term node is used. We use this term to refer to anything out of STA, MP or MAP. So we are having a simple structure where cluster of nodes is connected to the cluster head which acts as Gateway for getting access to the Internet.

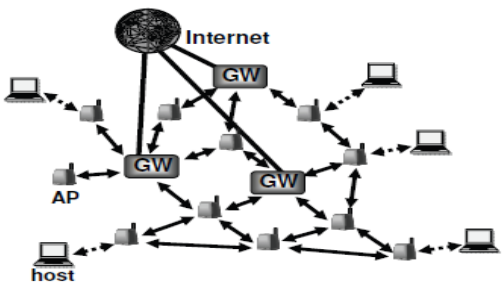

Figure 1. Wireless Mesh Network [11]

WMNs are increasingly being viewed for a variety of commercial applications like community networks, enterprise networks, etc. [2]. Ref. [1] presents a survey of wireless mesh networks, [3, 5] discusses some challenges that need to be overcome before the actual benefits of this technology can be leveraged. Much work on mesh networks has focused on routing [8, 9] and channel assignment [10]. The gateway selection problem has received little consideration in the literature [4, 6, 7].
The remainder of this paper is organized as follows: Section 2 presents the simulation scenarios experimented using NS-2 [12] for this paper; results are presented and discussed in Section 3 and Section 4 presents conclusion of the work.

2. SCENARIOS FOR SIMULATION
A 5X5 regular grid scenario is considered for first case where the nodes are assumed to be static, as shown in fig 2. The network is assumed to be cluster of nodes where the Gateway is the cluster head located at the center of the network, as shown in fig 2. Out of total 25 nodes, one is Gateway and total 8 active nodes are assumed. Active nodes are responsible for communication. Constant Bit Rate (CBR) traffic is used here for communication which is used for generally audio and video data communication. The channel model used is two-ray ground. The transmission range for each node is assumed to be 250m and the carrier sense range is considered to be 550m for simulation. The distance between the adjacent nodes is set to 200m. The routing protocol used here is DSDV. Interface queue length is assumed to be 50 and Packet size is 125bytes.

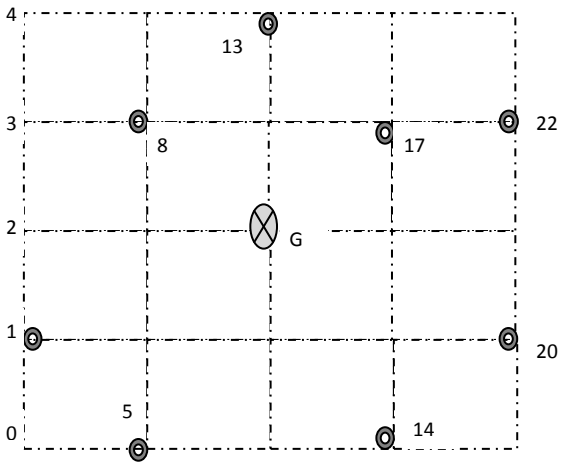

Figure 2. Single Gateway with eight active nodes in 5X5 Grid

With all these parameters, the simulation runs for an average data rate of 1.2Mbps for duration of 150s is done. The results are analyzed on the basis of packets generated, packets

received, packets dropped, end to end delay and packet delivery ratio (PDR).

For the second case, again 5X5 grid is used with set up almost similar to earlier case. Here, four clusters are formed with one Gateway each. There are around two to five nodes in each cluster. Figure 3 represents the scenario set up for this. As shown in figure, for experiment purpose, the scenario has two active nodes per cluster for communication. Remaining parameters are assumed to be same as for the first case with single gateway and result is analyzed based on again the same parameters viz., PDR and end to end delay. The performance of the WMN is dependent majorly on the number of packets delivered successfully and the delay in packet delivery.

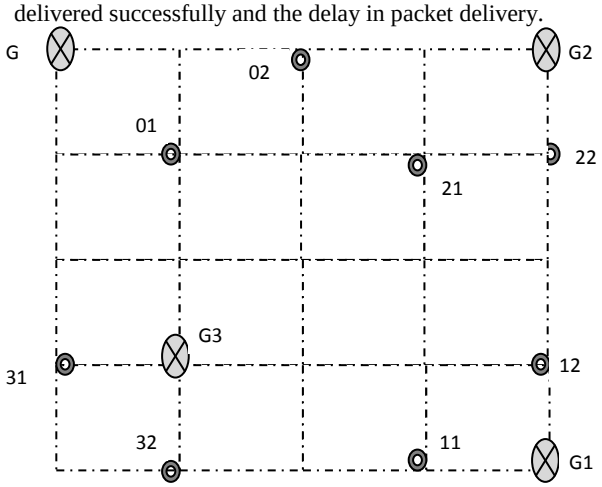

Figure 3. Multi-Gateway Scenario with 8 active nodes in 5X5Grid

The main feature of WMN is providing access to the Internet. Therefore, all the traffic is assumed to be directed towards the cluster head Gateway.

3. ANALYSIS OF SIMULATION RESULTS

For case 1, almost four of the active nodes are trying to access the gateway simultaneously at the same time. This creates congestion at the Gateway and there is loss of packets. As the data rate is increased slowly from 800Kbps to 1.6Mbps, then even more packets are dropped. And the successful Packet Delivery Ratio goes on reducing from 21.38 to 10.69. It means that more packets are lost than delivered successfully. The details are shown in the graph for Packet Delivery Ratio (SG) in figure 4.

The single gateway is unable to handle the heavy traffic from the active nodes and therefore major portion of the packets are getting lost due to bottleneck at the gateway side. The packets which are reaching the destination are reaching after a long delay of more than three seconds on an average which may not be desirable in voice of video communication. Figure 4 shows the End to End delay incurred when the data rate is increased from 800Kbps to 1.6Mbps.

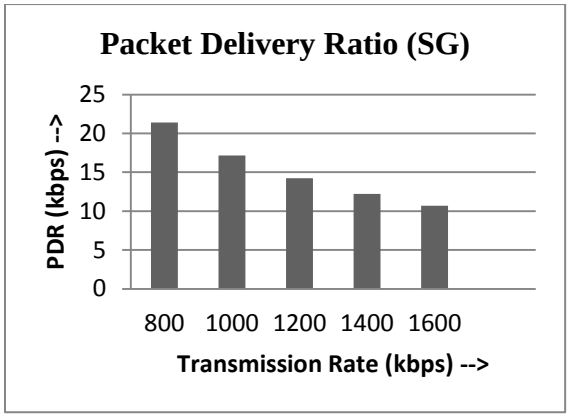

Figure 4. Packet Delivery Ratio in Single Gateway

The results are much better when the scenario is divided into four clusters with one Gateway each. Again the same active nodes are trying to get Gateway access. But, this time the competing nodes are relatively less and thus resulting in comparatively better performance of the overall network.

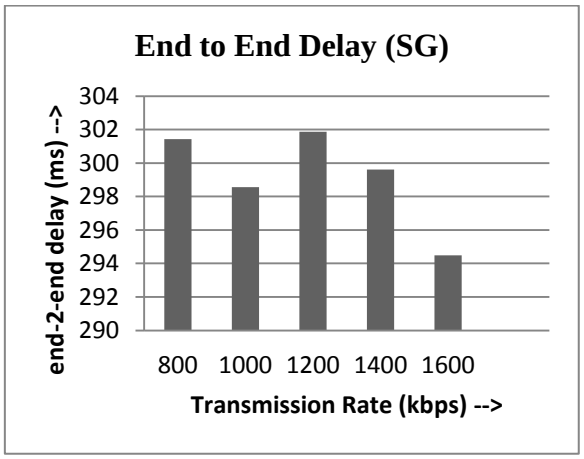

Figure 5. End to end delay in Single Gateway

The network is now having Multiple Gateways, each Gateway with its own cluster with relatively limited number of nodes. The load of the complete network is shared among the four Gateways in this case. Figure 6 and figure 7 show the results which are directly comparable with the earlier ones.

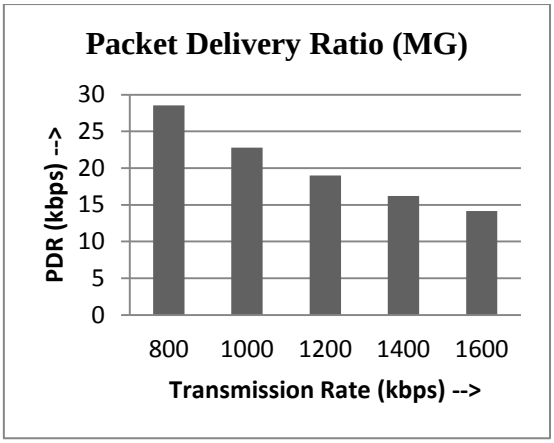

Figure 6. Packet Delivery Ratio with Multiple Gateways

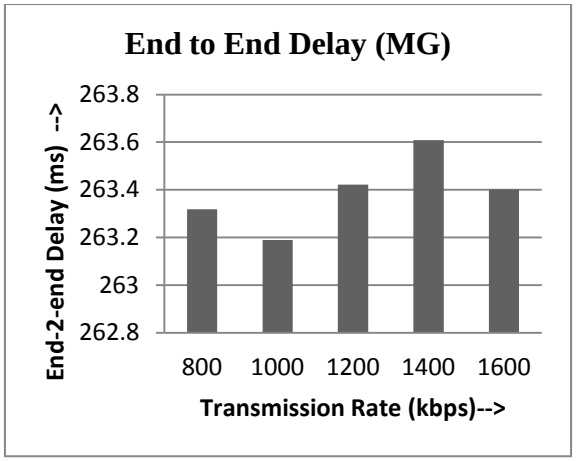

Figure 7. End to End Delay with Multiple Gateways

Packet Delivery Ratio increased considerably as each node is having less competition and congestion at the Default Gateway of its cluster. The packet losses are less as there is fair chance of getting the share for communication. This also leads to faster packet delivery resulting in lower End to End Delay on an average of 2.6 seconds as shown in figure 7.

4. CONCLUSION

The simulation discussed above verifies the performance of WMN with multiple clusters and with multiple Gateways outperforms that of a single Gateway in a cluster of nodes. This is obviously because of the reduced competition amongst the nodes for getting access in relatively smaller cluster. When more number of clusters are formed, each cluster head which is serving as Gateway has to manage relatively less traffic load. The nodes are at a closer distance from the Gateway, so number of hops may get reduced. The nodes have to share bandwidth within the smaller cluster which is resulting in better throughput of the overall network. Nodes get fairer chance for communication. Performance can be further improved by considering cluster head as a special node with IFQ length, Transmission range and other parameters different than a normal node in the cluster. Further the mobile nodes in the network or mobile plus static nodes may be used to better represent a wireless mesh network.

5. REFERENCES

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

[2] W. Arbaugh, Your 802.11 wireless network has no clothes, IEEE Wireless Communications Magazine 9 (2002) 44–51.

[3] K. Sundaresan, H.-Y. Hsieh, R. Sivakumar, IEEE 802.11 Over multi-hop wireless networks: problems and new perspectives, Ad Hoc Networks Journal 2 (2004).

[4] Rajesh Prasad, Hongyi Wu, Gateway deployment optimization in cellular Wi-Fi mesh networks, Journal of Networks (2006).

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

[6] Shigeto Tajima, Teruo Higashino, Nobuo Funabiki, Shoji 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.

[7] Bok-Nyong Park, Wonjun Lee, Choonhwa Lee, QoS-aware Internet access schemes for wireless mobile ad hoc networks, ACM Computer Communications 30 (2) (2007) 369–384.

[8] Richard Draves, Jitendra Padhye, B. Zill, Routing in multi-radio, multi-hop wireless mesh networks, ACM International Conference on Mobile Computing and Networking (MOBICOM), September 2004, pp. 114–128.

[9] A. Raniwala, T. Chiueh, Architecture and algorithms for an IEEE 802.11-based multi-channel wireless mesh network, IEEE International Conference on Computer Communications (INFOCOM), April 2005, pp. 2223–2234.

[10] K. Ramachandran, E. Belding, K. Almeroth, M. Buddhikot, Interference-aware channel assignment in multi-radio wireless mesh networks, IEEE International Conference on Computer Communications (INFOCOM), April 2006, pp. 1–12.

[11] Wireless Mesh Networks, free e-book at http://www.intechopen.com (Online).

[12] Network simulator. <http://www.isi.edu/nsnam/ns> (Online).