Impact of Intermediate Bottleneck Nodes on the QoS Provision in Wireless Infrastructure less Networks

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Abstract. Wireless Infrastructure less networks consist of wireless mobile nodes with heterogeneous and constrained resources, to establish internet connectivity regardless of the location. The applications the networks are disaster relief, health care and military. These applications are sensitive, and demands the reliable, and best quality of communication. Routing is one of the resources to enable the communication. Routing is acceptable in an infrastructure less networks if it satisfies the quality of service requirements. Thus the paper aims to investigate the existing QoS routing protocol performance in various conditions. The aim is to achieve a broad understanding of QoS routing protocol designed for Wireless Infrastructure less networks, and further pave the pathway for future research. The paper analyses the QoS routing protocol performance in presence of bottleneck intermediate node, and it is the novel aspect of the work.

1. Introduction

Wireless Infrastructure less networks is an infrastructure free network that aims to establish the internet connectivity regardless of the location. The network is composed of wireless mobile nodes communicate on the fly with dynamic unpredictable network topology. The node can directly communicate with another node if both are in the radio range of each other, otherwise the communication happen in multi hop manner by relying on intermediate nodes. Thus intermediate nodes play a vital role to provide quality of service in communication [2].

The characteristics of Wireless Infrastructure less networks are adaptation, self-forming and autonomous [4]. These characteristics make it suitable to deploy in sensitive and critical applications such as healthcare, military and disaster recovery. These applications demands the reliable and quality of service in communication. One of the resources to enable communication in Wireless Infrastructure less networks is routing, that creates the path between communicating parties and forward the information through computed path. Existing routing protocols of Wireless Infrastructure less networks assume that the nodes present in the route are cooperative for communication, but it is not always true [6].

The nodes present in the routing path may become the bottleneck and cannot cooperate for communication. For instance consider the node that act as an intermediate node for multiple communication paths, then it face extra overload in terms of either buffer or energy, and cannot cooperate for communication. Then bottleneck node unintentionally drops the information due to
insufficient resources, such as buffer overflow and/or constrained energy [8]. Thus the considering the intermediate nodes for communication is an important considerable issue by routing protocol, as the network performance greatly impacted by intermediate nodes [3].

The aim of the paper is to define the bottleneck situation in Wireless Infrastructure less networks. Further, how its presence impacts on the QoS routing protocols designed for Wireless Infrastructure less networks. The aim is to achieve a broad understanding of QoS routing protocol designed for Wireless Infrastructure less networks, and further pave the pathway for future research. The paper analyses the QoS routing protocol performance in presence of bottleneck intermediate node, and it is the novel aspect of the work.

2. Bottleneck Node

The nodes present in the Wireless Infrastructure less networks need to act in a peer to peer manner that means they need to act as a router as well as host. In order to act as a router, the nodes are designed with network intelligence to make the decision about the communication, and equipped with buffer to hold the information, and energy to receive and forwarded the information [7]. But the resources of the nodes are heterogeneous and constrained, particularly buffer space, and energy. Moreover, these resources cannot renovate during the mission, as missions of wireless infrastructure less networks are either disaster relief or military. Thus intermediate nodes play a vital role in communication [8].

One of the resources to enable communication in Wireless Infrastructure less networks is routing, that creates the path between communicating parties and forward the information through computed path. Existing routing protocols of Wireless Infrastructure less networks assume that the nodes present in the route are cooperative for communication, but it is not always true. For instance consider the node that act as an intermediate node for multiple communication paths, then it face extra overload in terms of either buffer or energy, and cannot cooperate for communication. Then bottleneck node unintentionally drops the information due to insufficient resources, such as buffer overflow and/or constrained energy [5]. Thus the considering the intermediate nodes for communication is an important considerable issue by routing protocol, as the network performance greatly impacted by intermediate nodes.

![Figure 1: bottleneck due to limited energy](image)

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Quality of service is considered as the performance level of the service provided by the Wireless Infrastructure less networks to its mobile users [1]. QoS routing is the procedure to enable the routing path, which must be loop free, and assure appropriate QoS parameters like efficient resource utilization, less delay, and higher bandwidth. QoS parameters varies based on the mission in which Wireless Infrastructure less networks installed. In literature various QoS routing protocols have been designed [9,13,14].

The paper analyzed the one of the QoS routing protocol designed for Wireless Infrastructure less networks, i.e., RCRP [1] (Reactive Congestion aware multipath routing). RCRP is a QoS routing protocol designed for Wireless Infrastructure less networks to enable the QoS. The protocol achieved the QoS parameters such as network lifetime, and avoid the congestion. The RCRP designed by two parameters such as 1). Energy reduction rate of the node during the communication, and 2). Packet delivery of the node, based on these parameters protocol decides whether the intermediate node to be a part of communication or not. The authors conclude that the two parameters are very efficient to present capability of the node regarding its residual energy and buffer. Thus the paper aims to investigate the RCRP performance in the presence of the bottleneck node in communication path.

### Table-1: Simulation Parameters

| Network-Parameters | Values                  |
|--------------------|-------------------------|
| Simulation-Time    | 1000 s                  |
| Nodes              | 150                     |
| Link Layer         | Logical Link            |
| MAC                | 802.11                  |
| Mobility           | Random                  |
| Network layer      | RCRP                    |
| Communication      | Two-Ray-Ground           |
| Queue              | Drop-Tail               |
| Energy             | 100j                    |
| Traffic            | CBR                     |
| Area of Network    | 1200m x 1000m           |

Network simulator [10, 11,12] is used for performance computation of RCRP in the presence of the bottleneck. The parameters considered for simulation are shown in table 1. The performance evaluation metrics considered are the packet drop, and lifetime of the network. The results are shown in figure 3, and 4.

The results are clearly indicating that, there is a huge number of packet drops occur in the network in the presence of the bottleneck network. The lifetime of the network also very less, as bottleneck
intermediate node is going to exhaust soon due to energy depletion, as it is handling very huge traffic. Thus RCRP is one of the QoS routing protocol works well in a Wireless Infrastructure less networks when there is no bottleneck node in the communication path. The protocol designed based on the energy reduction rate of the node during the communication, Packet delivery ability, but do not considered the bottleneck intermediate node. Thus performance of the RCRP could be further improved by the consideration of bottleneck intermediate node presence in the communication path during the route finding process.

Figure 3-: PDF Performance of RCRP QoS routing protocol degradation of wireless infrastructure less network in the presence and absence of bottleneck intermediate node

Figure 4-: Network life time Performance of RCRP QoS routing protocol degradation of wireless infrastructure less network in the presence and absence of bottleneck intermediate node

4. Conclusion

Wireless Infrastructure less networks consist of wireless mobile nodes with heterogeneous and constrained resources, to establish internet connectivity regardless of the location. The applications the networks are disaster relief, health care and military. These applications are sensitive, and demands the reliable, and best quality of communication. Routing is one of the resources to enable the communication. Routing is acceptable in an infrastructure less networks if it satisfies the quality of service requirements. Thus the paper investigated the existing QoS routing protocol performance in various conditions to get broad understanding of QoS routing protocol designed for Wireless Infrastructure less networks, and further pave the pathway for future research. The paper analyzed the QoS routing protocol performance in presence of bottleneck intermediate node, and it is the novel aspect of the work. Finally the work concluded that the bottleneck node presence in the
communication path is a considerable factor to enhance the QoS routing protocols performance. The performance of the RCRP could be further improved by the consideration of bottleneck intermediate node presence in the communication path during the route finding process.

References

[1] Sana, Afreen Begum, Farheen Iqbal, and Arshad Ahmad Khan Mohammad. "Quality of service routing for multipath manets." In 2015 International Conference on Signal Processing and Communication Engineering Systems, pp. 426-431. IEEE, 2015.

[2] Siddiqua, Ayesha, Kotari Stridevi, and Arshad Ahmad Khan Mohammed. "Preventing black hole attacks in MANETs using secure knowledge algorithm." 2015 International Conference on Signal Processing and Communication Engineering Systems. IEEE, 2015.

[3] Sultana, Towheed, Arshad Ahmad Khan Mohammad, and Nikhil Gupta. "Importance of the Considering Bottleneck Intermediate Node During the Intrusion Detection in MANET." In Research in Intelligent and Computing in Engineering, pp. 205-213. Springer, Singapore, 2021.

[4] Mohammad, Arshad Ahmad Khan, Ali Mirza Mahmood, and Srikanth Vemuru. "Intentional and unintentional misbehaving node detection and prevention in mobile ad hoc network." International Journal of Hybrid Intelligence 1, no. 2-3 (2019): 239-267.

[5] Mohammad, Arshad Ahmad Khan, Ali Mirza Mahmood, and Srikanth Vemuru. "Energy-Aware Reliable Routing by Considering Current Residual Condition of Nodes in MANETs." In Soft Computing in Data Analytics, pp. 441-452. Springer, Singapore, 2019.

[6] Mohammad, Arshad Ahmad Khan, Ali Mirza, and Srikanth Vemuru. "Cluster based mutual authenticated key agreement based on chaotic maps for mobile ad hoc networks." Indian Journal of Science and Technology 9 (2016): 26.

[7] Mohammad, Arshad Ahmad Khan, Ali Mirza, and Mohammed Abdul Razak. "Reactive energy aware routing selection based on knapsack algorithm (RER-SK)." In Emerging ICT for Bridging the Future-Proceedings of the 49th Annual Convention of the Computer Society of India CSI Volume 2, pp. 289-298. Springer, Cham, 2015.

[8] Mohammad, Arshad Ahmad Khan, Ali Mirza, and Srikanth Vemuru. "Analytical Model for Evaluating the Bottleneck Node in MANETs." Indian Journal of Science and Technology 9 (2016): 31.

[9] Mohammad, Arshad Ahmad Khan, Ali Mirza, and Srikanth Vemuru. "Energy aware routing for manets based on current processing state of nodes." Journal of Theoretical and Applied Information Technology 91, no. 2 (2016): 340.

[10] Belghith, Aymen, and Loutfi Nuaymi. "Design and implementation of a QoS-included WiMAX module for NS-2 simulator." In SIMUTools 2008, International ICST conference on simulation tools and techniques, March 3-7, Marseille, France. 2008.

[11] Mahida, P. T., Kinjal Patel, Nayan Vanza, and Siddharth Patel. "A comparative analysis of queue management techniques using NS-2 simulator." International Journal of Computer Applications 65, no. 6 (2013).

[12] Shailendra Mishra and Mayank Singh, “An improved Energy Efficient Communication Protocol (IEECP) for Wireless Sensor Networks,” International Journal of Engineering and Advanced Technology (IJEBT), vol. 8, no. 4c, April 2019.

[13] Mohammed Abdul Bari, Arshad Ahmad Khan Mohammad, “Performance Evaluation of Reactive Routing Protocol Using Simulation Knowledge .” Materials today Proceedings. Elsevier, 2021.

[14] M.A.Bari, Sunjay Kalkal, Shahana Ahamad, “A Comparative Study and Performance Analysis of Routing Algorithms”, 3rd International Conference ICCIDM, Springer - 978- 981-10-3874-7_3 Dec (2016)