IJCAT - International Journal of Computing and Technology, Volume 7, Issue 7, July 2020
ISSN (Online) : 2348-6090
www.IJCAT.org
Impact Factor: 0.835

Minimizing the Effect of Mobility Rate on the Bandwidth of Mobile Unicast Data Network

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Abstract - Unicast in data networks is the exchange of IP packets between a single sender and a single receiver over a network using Transmission Control Protocol (TCP). The effect of the mobility rate on the bandwidth is largely pronounced in such a network which generally reduces the overall performance of the network. In this paper, an experimental procedure was implemented to actually determine the effect of mobility rate on the bandwidth and how to minimize the effect to the minimum attainable for improved performance of Mobile Unicast Data Network. We adopted two test scenarios involving two hosts connected to each other through (801.11g) wireless adapter; we run iperf on both laptops and used it to configure one as the server and the other as the client. In the first section, the mobility rate of the client is varied while the server is given a fixed position. However, in the second section, we kept all the configurations the same as in the first except that the server is now the mobile host and the client is the fixed host. We sent traffic from the client to the server for 10secs at 2secs interval and used iperf to measure the bandwidth at each designated mobility rate and observed how the bandwidth varies successively when moving either the server or client in each section of the experiment. The measurements indicated degradation in the performance of the network by reducing the bandwidth as the mobility rate increased when either of the hosts is in motion. We also observed that the effect was more adverse on the bandwidth when the client was in motion as there is a wider variation in the measured bandwidth. However, we also observed that the measured bandwidth became narrower when the server is in motion. Therefore, to minimize the effect of the mobility rate on the bandwidth of the network, we recommend that the server should be the mobile host while the client should be the stationary host.

Keywords - *Bandwidth, Unicast, Mobility rate, Minimize, Iperf, Server and Client.*

1. Introduction

The rates at which either of the nodes moves in Mobile Unicast Data Network (MUDNET) affect the key performance indicators of the network such bandwidth and throughput negatively. For many data-intensive applications, such as file transfers or multimedia streaming, the bandwidth available to the application in the network directly impacts the application performance [1]. The idea of bandwidth is fundamental to data networks, as it defines the amount of data that a link or network path is theoretically able to deliver per unit of time. [8] defines network bandwidth as the theoretically maximum transfer throughput capacity of a network. Moreover, It's a measure of how much data can be exchanged between source and sink which can be measured in bits, megabits, or gigabits per second. It's imperative to know that bandwidth doesn't actually increase the speed of a network; it just appears to make the network faster [8]. On the other hand, network throughput denotes the size of data that can be achievably transferred from source to destination within a given time frame. Throughput is a measure of the amount of packets that arrive at their destinations successfully. According to [9], the maximum throughput is defined as the maximum feasible arrival rate. In a simulation scenario, throughput is the rate at which the packet is transmitted effectively in a total simulation time [12]. Below are descriptions of the Factors that affect throughput of ad-hoc network:

1.1 Network Congestion

When a network is flooded with too many packets by the sender beyond the capability of the receiver, network congestion occurs. On such instances, the network fails to handle the traffic properly, leading to poor quality of service (QoS) [13]. Generally, the degree of congestion on a network also affects the throughput of the network. Also, the TCP attempt to fully utilize the network bandwidth easily leads to congestion in ad-hoc networks [17], thereby affecting the throughput. As a general rule, network congestion relates indirectly with throughput. Therefore, to avoid congestion-related losses in ad-hoc networks, it is necessary to provide proper and efficient management of the data rate [15], such as Bandwidth Probe [2], Dual bandwidth estimation method [3] etc.

1.2 Latency

Latency (or delay) is the total time a packet takes to travel from sender to destination. The throughput of TCP traffic decreases at higher network latency. This is because, before another stream of packets can be sent from source to destination, the previous stream must be acknowledged. Therefore, if the acknowledgment is delayed, the average throughput measured over time will also reduce [8]. However, the throughput of other kinds of traffic such as UDP is not necessarily affected by latency. According to [14] broadcast latency is the maximum time taken by any node to receive the message. In Simulation environment, latency does not vary much with the number of nodes but only on the length of the simulation square and the transmission range.

1.3 Packet Loss and Errors

Similar to latency, the throughput of a wireless network can be affected by packet loss and errors. Retransmission of lost packets reduces the average throughput between communicating devices. [16] Shows that mobility is always the dominant cause for packet loss in ad-hoc networks. However, mobility-related packet loss increases with communication request. However, congestion-related packet loss increases relatively higher with communication request. According to [18] it is possible to determine packets lost due to a malicious node in the network. So it is helpful to identify such nodes and then exclude these nodes from being part of the network configuration. Also [19] proposes that Packet losses could be minimized by using warning message sent to the source node by low energy node when 10% of its total energy remains. This will reduce losses due to disconnection of nodes whose energy reduces to zero level.

2. Related Works

Several factors in the literatures account for the degradation of key performance indicators in mobile adhoc data network such as bandwidth and throughput. Such factors include the number of active nodes in the network, security protocols, number of Resource Consumption Attack**,** and average distance between source and destination (Transmission Range).

Mostafa Fazeli et al. [10] compared the throughput parameters for different scenarios when the numbers of hosts were 5, 10 and 15. They observed through the analysis of simulation graphs that as the number of hosts increase then throughput also increases.

The literature is flooded with scholarly studies on factors that degrade performance of mobile adhoc networks and how to improve it. Paschal A. Ochang and Phil Irving [4]through an experimental procedure determined that introduction of security protocols such as WPA2-PSK reduces the performance of wireless networks. The result of the study shows that the network performs better in terms of throughput in an unsecured scenario than in a secured scenario. Similar result was observed in [5], they observed that increase in the number of resource consumption attack located near the receiver (from 2 – 10hosts) degrades the throughput by reducing the packet delivery ratio and increasing the delay. These effects generally degrade the performance of the entire network.

Moreover, [7] examined the effect of 802.11 MAC interactions and ad-hoc forwarding on capacity of the network for several simple configurations and traffic patterns. Their result show that for total capacity to increase with network size the average distance between source and destination nodes must remain small. Also, in Non-local traffic patterns the capacity of each node decreases rapidly when the average distance grows with the network size. Therefore, increase in transmission range has a negative effect on the network capacity.

3. Materials and Methods

This section involves the implementation of experimental test scenarios for the purpose of testing for the relationship between bandwidth and mobility rate in a mobile unicast data network using iperf. Two tests scenarios are actually adopted; the first involves measuring the bandwidth of a network where the client is enabled to move at a given mobility rate while keeping the server stationary, on the other hand, the second test scenario involves measuring the bandwidth of a network where the server is enabled to move at a given mobility rate while keeping the client stationary. The bandwidth of the wireless adapter is set at 54Mbps in other to provide enough bandwidth for the traffic, and the wireless network standard used was 802.11g

3.1 Mobile Client Test Scenario

In the first test scenario tagged net1, the two laptops are connected together using their wireless network adapter set to ad-hoc mode. The client is put to motion using a car. In other to generate network traffic, iperf which is software capable of generating network traffic was used to generate TCP traffic from the client to the server for 10secs. The iperf which is also a network analyzer software is used to analyze the TCP traffic and measure the available bandwidth at the mobility rate of 2,8m/s, 5.6m/s, 8.3m/s, 11.1m/s, 13.9m/s, and 16.7m/s .

3.2 Mobile Server Test Scenario

In this test scenario also tagged net2, the same process carried out in the Client in Motion test scenario is also applied, but in this case the server is put to motion while the client is kept stationary. TCP traffic is generated from client to server while measuring the bandwidth at same nodal velocities respectively.

4. Results and Discussion

In this section the experimental results are presented and analyzed. Experimental data are presented when client is in motion and when server is in motion.

Table 1. Average Bandwidth of TCP Traffic for both Test Scenarios

Mobility rate	Net 1	Net 2
2.8	19.85	18.1
5.6	17.4	17.5
8.3	14.1	16.95
11.1	8.08	16.95
13.9	16.95	16.95
16.7	16.95	16.95

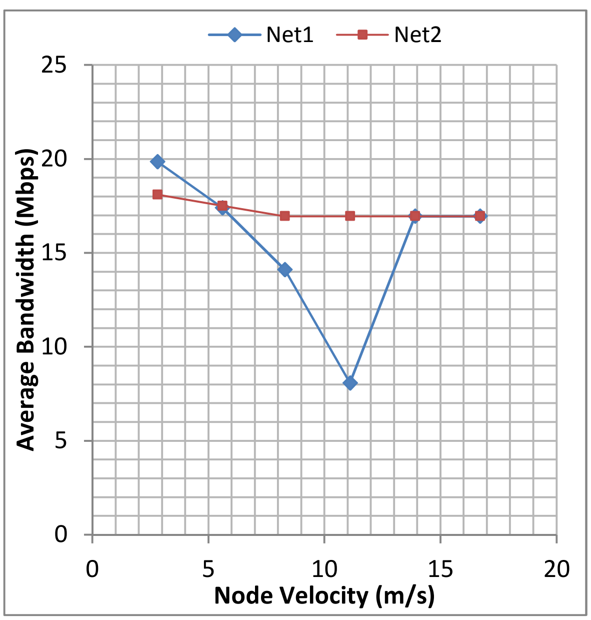

Fig. 1 Average Bandwidth Vs Mobility rate

The default target bandwidth for TCP connections in iperf is unlimited, so it reports the bandwidth used per connection. From Table 1 above showing the bandwidth of Net1 and Net2 at the corresponding mobility rate, one will notice a descendent variation in the measured bandwidth of the network in both scenarios as the mobility rate increases. The variation in the bandwidth is more pronounced in the first scenario where the client is the mobile host than in the second scenario where the server is the mobile host as shown in figure 1. The reduction in the bandwidth of the two scenarios as the mobility rate increases shows that increase in the rate of movement reduces the throughput of the network which also led to a degradation effect on the general performance of the network.

4.1 Statistical Analysis

The averages of the bandwidth in the first and second scenario are 15.56 and 17.23 respectively. Moreover, the standard deviations of both scenarios are 4.09 and 0.48 respectively. By statistical analysis, the measured bandwidth of the first test scenario are widely spread when compared to the average value, this is validated by its higher standard deviation of 4.09. The measured bandwidths in the second test scenario are very close to the average as a result of its very low standard deviation of 0.48. The high standard deviation of the measured bandwidth in the first scenario shows a much higher impact of speed on the bandwidth of the network when the client is in motion than when the server is in motion.

5. Conclusion

In this paper an experimental procedure was implemented to actually determine the effect of mobility rate and how to minimize the effect on the performance of Mobile Unicast Data Network. We adopted two tests scenarios; in the first, the bandwidth of a network (Net1) where the client is enabled to move at a given mobility rate while keeping the server stationary were measured at designated mobility rates, on the other hand, in the second test scenario we took measurement of the bandwidth of the network (Net2) where the server is enabled to move at corresponding mobility rate while keeping the client stationary. We observed that as the mobility rate increases, the bandwidth of both networks decreased resulting to general performance degradation. Moreover, the impact was more pronounced when the client was put to motion than when the server was in motion. On this premise, we conclude that to minimize the effect of mobility rate on the bandwidth of a mobile unicast data network, the client should be stationary while the server could move.

Moreover, the statistical analysis show that the effect of movement could be masked to a very good percentage since the standard deviation of Net2 is as low as 0.48. This study did not consider the effect of the distance between the server and the client which could form the bases of our next study.

References

[1] R. S. Prasad, M. Murray, C. Dovrolis and K. Claffy "Bandwidth estimation: metrics, measurement techniques, and tools" IEEE Network November/December 2003.

[2] A.K. Singh and J.K. Deka "A Study of Bandwidth Measurement Technique in Wireless Mesh Networks "International Journal of Ad hoc, Sensor & Ubiquitous Computing (IJASUC) Vol.2, No.3, September 2011.

[3] B. M Nyambo, G.K. Janssens, L. Wim "Bandwidth Estimation in Wireless Mobile Ad Hoc Networks" *Journal of Ubiquitous Systems & Pervasive Networks Volume 6, No. 2 (2015) pp. 19-26*

[4] P. A. Ochang and P. Irving "Performance Analysis of Wireless Network Throughput and Security Protocol Integration" International Journal of Future Generation Communication and Networking Vol. 9, No. 1 (2016), pp. 71-78

[5] M. Abdelhaq, R. Alsaqour, M. Al-Hubaishi, T. Alahdal, and M. Uddin "The Impact of Resource Consumption Attack on Mobile Adhoc Network Routing" International Journal of Network Security, Vol.16, No.4, July 2014. PP.399-404

[6] I. Cardei, S. Varadarajan, A. Pavan, L Graba, M. Cardei And M. Min "Resource Management for Ad-Hoc Wireless Networks with Cluster Organization" Cluster Computing Vol. 7, 2004. 91–103,

[7] J. Li, , C. Blake, D.D. Couto, H.I. Lee, and R. Morris, "Capacity of adhoc wireless networks" In Proceedings of ACM Mobicom. 2001. 61--69.

[8] What Is Throughput in Networking? Bandwidth Explained. https://www.dnsstuff.com/network-throughput-bandwidth. September 19, 2019

[9] Y.F.B Yang, and X. Yu. "The Actual Maximum Throughput of Mobile Ad Hoc Networks with Reed-Solomon Coding" Volume 2015 |Article ID 361256 | 9 pages | https://doi.org/10.1155/2015/361256

[10] M.F.H. Vaziri, "Assessment of Throughput Performance under OPNET Modeler Simulation Tools In Mobile Adhoc Networks (MANETS)", Third International Conference on Computational Intelligence, Communication Systems and Networks, 2011. 328-331

[11] S. E. Eleje, N. C. Asogwa, R. I. Hart, M. T. Pepple "Experimental assessment of the impact of velocity on UDP end-to-end delay of mobile unicast data network (MUDNET)" IJCAT - International Journal of Computing and Technology, Volume 7, Issue 6, June 2020

[12] B. Bhatia, M.K. Soni, P. Tomar "Extended Bandwidth Optimized and Energy Efficient Dynamic Source Routing Protocol in Mobile Ad-hoc Networks" International Journal of Electrical and Computer Engineering (IJECE) Vol.8, No.3, June 2018, pp. 1460~146

[13] *S.E. Eleje, N. C. Asogwa, , and H. O. Ndubueze,* "Effects of TCP Window Size and Transmission Range on the Throughput of Mobile Adhoc Data Network (MADNET)" European Academic Research - Vol. VIII, Issue 3 / June 2020

[14] R. Gandhi, S. Parthasarathy and A. Mishra. "Minimizing Broadcast Latency and Redundancy in Ad Hoc Networks". In Proceedings of the Fourth ACM International Symposium on Mobile Ad Hoc Networking and Computing (MobiHoc 2003), June 2003. Pages 222--232,.

[15] H.B Liaqat, A. Ali, J. Qadir, A.K. Bashir, M. Bilal and F. Majeed "Socially-aware congestion control in ad-hoc networks: Current status and the way forward" https://doi.org/10.1016/j.future.2019.02.017. 0167-739X/© 2019 Elsevier

[16] Y. Lu, Y. Zhong, B. Bhargava "Packet loss in mobile ad hoc networks" Computer Science Technical Reports, Paper 1558, Report Number: 03-009. 2003

[17] S.M. Mirhosseini. and F. Torgheh "ADHOCTCP: Improving TCP Performance in Ad Hoc Networks" Mobile Ad-Hoc Networks: Protocol. DOI: 10.5772/13510

[18] S.A Shilpa, M.S. Sannidhan "Packet Drop Detection in Wireless Ad Hoc Networks" International Journal of Computer Science and Mobile Computing, Vol.5 Issue.5, May- 2016, pg. 656-661.

[19] R. Shahariar and A. Naser "Reducing Packet Losses in Mobile Ad Hoc Network Using the Warning Message Generated from a Routing Node". Dhaka Univ. J. Sci., 62(2), 141-145. 2014.

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