Simulation Study of Online Game Performance over Mobile Ad-Hoc Network (MANET)

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***Abstract*-----**In this paper, a simulation study for online gaming over MANET. The industry of online gaming has increased for the past few years since the start of broadband network that able to transfer data with higher capacity. However, many gamer preferred to play their online game by using a cable connection instead of wireless network and often they are fixed in place or static. A simulation study of this paper is to simulate the performance of online game when played over MANET, and will be using a TCP type agent in NS2. A different number of clients that will be connected to a server concurrently will also be compared as well as three different node densities. The packet size set for this simulation are based on Counter-Strike game, based on an average packet size and the metrics to be measured would be the number of hops, throughput and average delay or end-to-end delay.

Categories and Subject Descriptors

D.3.3 [Programming Languages]: Language Constructs and Features – *abstract data types, polymorphism, control structures.* This is just an example, please use the correct category and subject descriptors for your submission. The ACM Computing Classification Scheme: http://www.acm.org/class/1998/

General Terms

Your general terms must be any of the following 16 designated terms: Algorithms, Management, Measurement, Documentation, Performance, Design, Economics, Reliability, Experimentation, Security, Human Factors, Standardization, Languages, Theory, Legal Aspects, Verification.

***Keywords*---**Networking, online gaming, mobile ad-hoc network (MANET), performance.

I. Introduction

ONLINE gaming has increased over the past few years with the technological advancement of the network speed especially broadband [3] and wireless network usage also increases with the introduction of smartphones [7]. Wireless network ease up the connection problem by eliminating the need of physical cable to connect to the network and also offers the wireless network users to enjoy mobility while still connected to the network.

There are several types of games has been released and most of them requires low latencies to provide best playing experiences for players especially these genres; First Person Shooter (FPS), Real Time Strategy (RTS), racing and Massive Multiplayer Online Game (MMOG). MMOG type has different scenarios of the performance because this type of games often enables player to trade, questing, party raid, boss raid, player vs. player (PvP) and chatting. Trading, questing and chatting often do not require low latencies because in these mode of gameplay, they often idle in most of the towns while party raid, boss raid and PvP requires a very low latencies because the player is very active for example coordinating their avatars to use a certain action and items to ensure their avatar able to survive throughout the process. RTS, racing and FPS genres also fall under the requirement of low latencies and unlike MMOG genres, these types of games can be played through peer to peer (P2P) networks or client-server mode.

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II. Related Research

In [12], a research team from Seoul National University has conducted a research on characterizing the gaming traffic of World of Warcraft (WoW). In this research paper, they conducted several scenarios on getting the statistics based on the connection; by using an Ethernet, Wi-Fi and wimax connections. While the game scenarios are hunting, downtown and battling. In each of the internet connection mode, they test out these three scenarios; downtown, hunting and battling and while playing, they would capture the data for each session. In overall for playing scenarios, the highest bandwidth requirements of all three of them are downtown. In this scenario, they only stayed on a city or town with lots of other players either moving around or standing still with some chatting, movements of their characters and coordination as well as the environment of the town that makes the downlink requirement is quite high. But in this scenario, downtown, the performance requirements are not that critical since the players will be moving around the town, chatting, trading and other types of activities that are allowed in the town and there are no battles inside the town as well and that would explain why the performance requirement are low. In the next scenario, hunting, the downlink requirement is the lowest amongst them because the players are hunting in the field with most of them are monsters that are generated on the server side and when the players move around giving some command, their data transfer are between client and server only. Lastly, the third scenario is battling, players will go into a specific map designed for them to battle with each other and the downlink requirement are in the middle of downtown and hunting scenario. This is because the coordinate, character, animation, movement, skills of the player are updated to all surrounding players and the data transfers amongst them are from client to server, then the server will send again to other clients who participates in this mode.

Their performance statistics shows that by using Ethernet connection, they achieved the best result at the cost of mobility while Wi-Fi is the first runner up at the cost of limited area coverage and lastly wimax with another three additional scenarios; traveling via car (within campus), subway and bus (public transport). The highest packet loss rate are travelling via bus followed by travelling via subway and lastly within campus. This is because the hand-offs between the wireless transmitter and receiver that would contribute more packet loss due to shifting from another wireless transmitter to another and when the hand-offs occurred, the packet should be sent during that time cannot be sent due to there are no connectivity for a short period of time. In terms of game experience, scenario travelling via subway and bus would have worst gaming experience especially within battling game modes due to high Round Trip Time (RTT) which contributes directly to the delay of their gameplay and packet loss rate also correlates with the game experience as well.

Claypool [34] has suggested a range of threshold for each online game scenario vs. latency because each online game characteristic is not the same especially the online game type. A First Person Shooter (FPS) game need to have a very low latency because it is a real time game, same goes for a Real Time Strategy (RTS) game that requires constant interaction between the gamers. While other game such as racing simulation game [27] does not need a very low latency requirement. Massive Multiplayer Online (MMO) games such as World of Warcraft (WoW) [12] need a lower latency and optimal bandwidth (bits/s) to play the game smoothly without any interruptions while some other MMO games does not need a specifications like WoW.

III. Methods

A. Simulation Setups

The methods used for this research is by using a network simulator software; NS2. The simulation setups are mobile and then compared with a static, non-mobile node that has only four nodes like the following figures

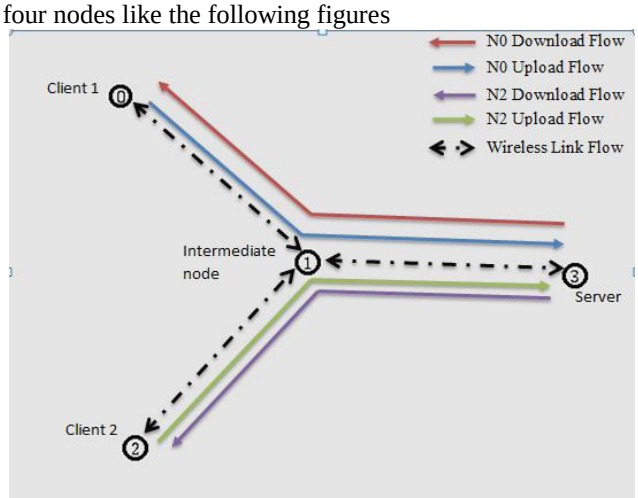

Fig.1 Static node topology

The node placements in the Fig.1 above are placed to the edge of their transmission range. This is also necessary to avoid node 0 and 2 from being transmitting data to each other directly

B. Traffic

Since some of the games used TCP and UDP [15], this research used TCP traffic because of the reliability of TCP traffic that able to request for a retransmission. However, a game traffic has upload and download traffic (client's perspective) and with this, each client will have 2 traffics going to the server. The server which is also a mobile node, will have to handle twice the traffic per client connected to it. For example in a scenario; this paper has 3 clients, it would mean there are 6 traffics for that simulation. There are an option called Two-Way TCP implemented into NS2 but this feature does not work on wireless network. Therefore an individual TCP traffic has to be generated to simulate the Two-Way TCP.

Packet size for the traffic would be 140 bytes for upload (client to server) and 40 bytes (server to client) and this model is based on a counter strike packet size reference in [16].

C. Nodes

All the mobile nodes using a default parameter as follow

TABLE I
NODE PARAMETERS

Property	Value
Transmission Range	250 meter
Carrier Sense	550 meter
Frequency	2.4Ghz
MAC Type	802.11
Routing Protocol	AODVUU
Mobility	Yes, speed averaged at 1.5m/s, using setdest v2
Antenna	Omni Directional
Packet size	From client: 140 bytes From Server: 40 bytes
Number of Nodes	20,40, 60
Number of traffics	6 (3 clients, 1 server with 3 traffic to clients)
Start Time	Client: 1.0 second Server: 3.0 second
End Time	43200 second (12 hours)

Mobility setdest v2 are used to generate the movement for all the nodes in this simulation and the topography for the nodes to move are 1000 x 1000 meter.

IV. Results

It is important to see the results for all the simulation studies because we are able to see if the game is playable under these circumstances or not. There are 3 metrics that will be evaluated; throughput (bandwidth in bits/s), end-to-end delay and number of hops.

A. Throughput

Throughput plays an important part in most networks especially exchanging data. Higher throughput would mean a node able to send more data at once and thus will require lesser time to complete the data transfer depending on the data size as well.

In online games however, there should be an optimal throughput to play the game without any disturbance. Optimal throughput referenced from [16] while [12] has a very high optimal throughput requirement of about 450kb/s due to huge

data exchange between the server and clients but different game has different optimum throughput requirement.

TABLE II

SUMMARY OF THROUGHPUT

		average	stdev
20 nodes	Upload	46.24726	87.12875
	Download	35.27529	72.64056
40 nodes	Upload	50.58574	83.50584
	Download	36.99129	69.54414
60 nodes	Upload	48.80749	82.14436
	Download	37.30652	68.26773
Static	Upload	35.287	20.492
	Download	25.544	12.293

Based on table 4-1, it is the data summarization of all the simulations. Note that each client will have upload and download, and there are 3 clients connecting to the server in each of the scenarios. There are total of 6 traffics and they are grouped together to their respective upload and download traffics.

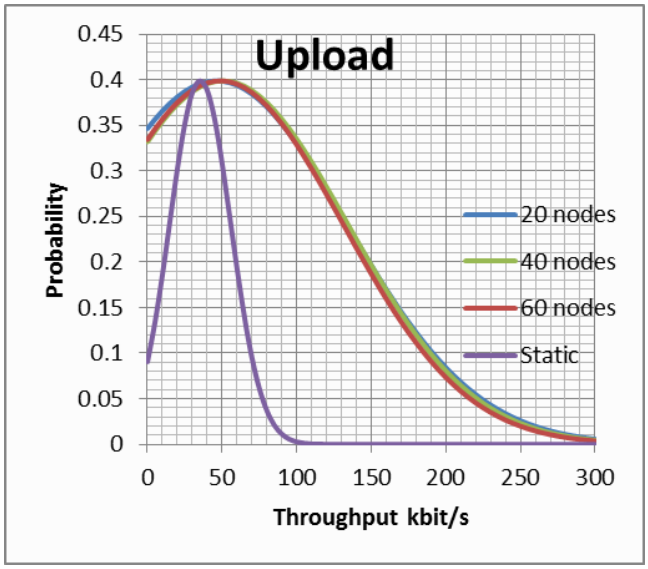

Fig.2 PDF of throughput upload

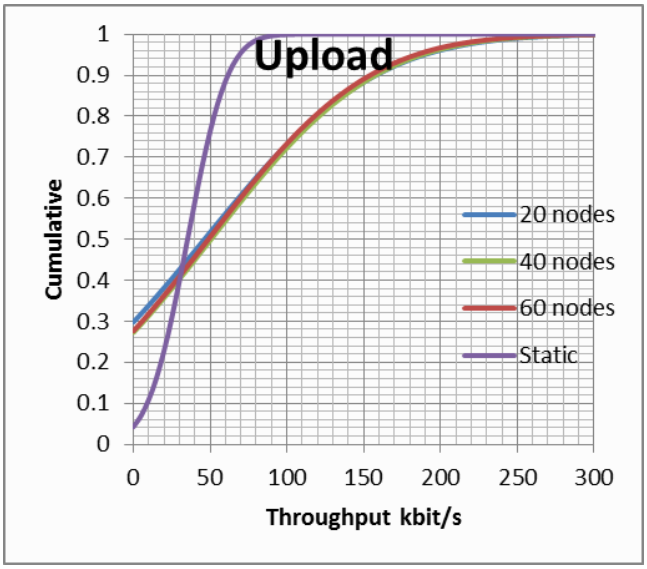

Fig.3 CDF of throughput upload

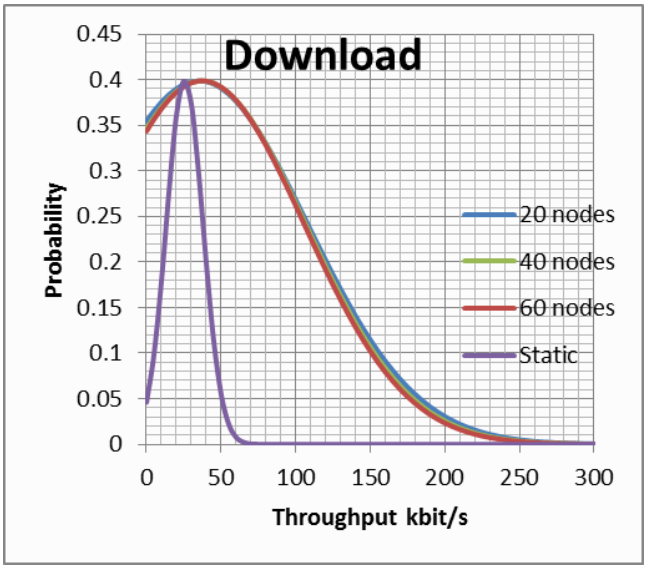

Fig.4 PDF of throughput download

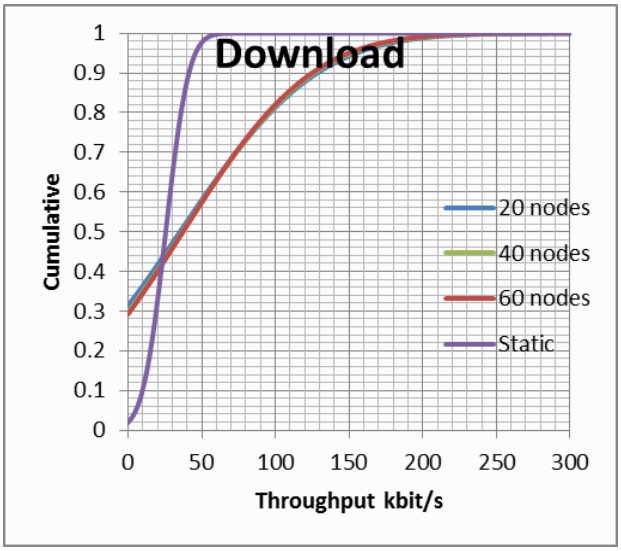

Fig.5 CDF of throughput download

In comparison between all the figures from Fig.2 to Fig.5, the throughput performances are quite identical for all simulation scenarios. Based on [16], the threshold for the throughput bandwidth is ranging from 25kbit/s to 50kbit/s and for the results in the Fig.2 to Fig.5; it is feasible to play counter strike under these circumstances.

B. End-to-End Delay

End-to-End delay is one of the most important aspects of most media especially for online game, VoIP, video conferencing and other media that requires a faster packet delivery from one end to another to ensure interactions are smooth. In counter strike, the threshold end-to-end delay would be around 100ms (millisecond) in [34] and around 200ms in [27] for RC simulator game.

TABLE III

SUMMARY OF END-TO-END DELAY

		average	stdev
20 nodes	Upload	0.476	7.416328
	Download	0.9682	2.115103
40 nodes	Upload	0.479969	2.161796
	Download	1.203968	2.322943
60 nodes	Upload	0.428507	3.078754
	Download	1.220871	3.759147
Static	Upload	0.346	0.072
	Download	0.360	0.075

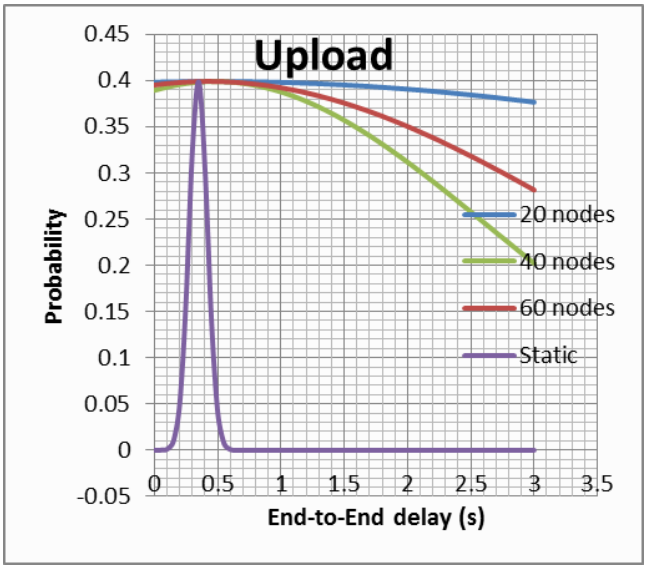

Fig.6 PDF of end-to-end delay upload

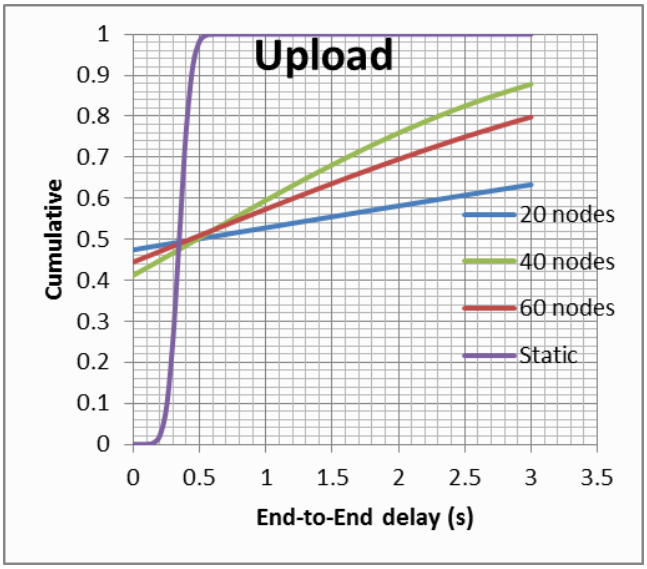

Fig.7 CDF of end-to-end delay upload

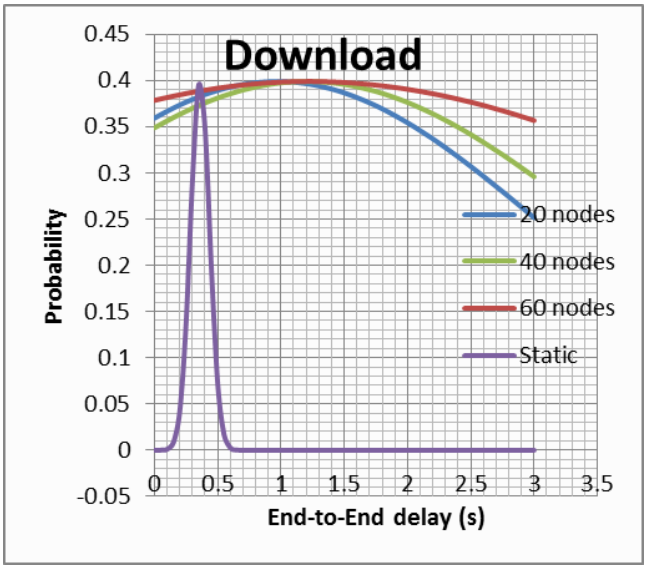

Fig.8 PDF of end-to-end delay download

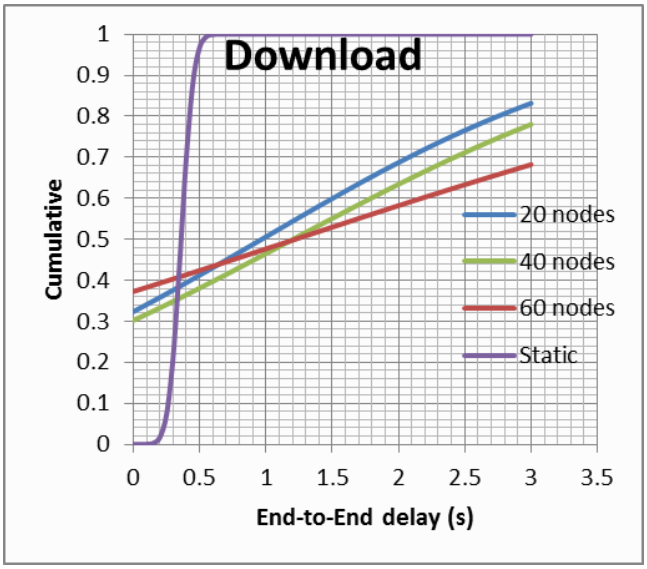

Fig.9 CDF of end-to-end delay download

In comparison to all scenarios, the differences can be seen for all node densities. Their average all above 400ms for upload while download are at least 900ms. These results are not suitable for playing a game that needs lower latency such as 100ms for games like counter strike that requires real time interactions. Even the static node scenario, is around 350ms for both upload and download and it is not suitable to play counter strike game too. In [34], it is suggested that the threshold for FPS (first person shooter) and racing game would be around 100ms, sports and RPG (Role-Playing Game) is 500ms while RTS (Real Time Strategy and simulation game is 1000ms. As for static scenario it falls under the RPG and sports categories while the mobile nodes scenario fall on RTS and simulation. With these thresholds and games that player wants to play, it is not suitable to play a real time game or FPS type with these latency results.

C. Hops

Number of hops also plays important role in MANET performance as more hops would mean longer time to reach the destination. Some of the nodes might be handling multiple traffics at once and a reduced throughput as well as discussed in [29].

In this paper, a mean and standard deviation will be used to compare between the node density scenarios

TABLE VI
SUMMARY OF NO. OF HOPS

		average	stdev
20 nodes	Upload	1.079095	1.320262
	Download	1.081325	1.360156
40 nodes	Upload	1.254223	1.247104
	Download	1.216322	1.37082
60 nodes	Upload	1.216129	1.250388
	Download	1.23501	1.331812
Static	Upload	2.000	0.019
	Download	2.000	0.019

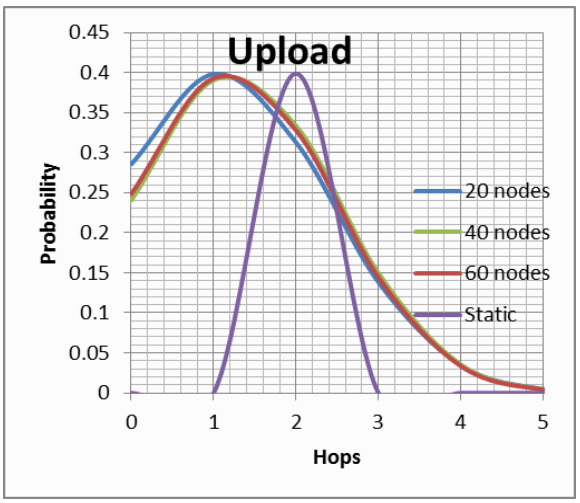

Fig.10 PDF of number of hops upload

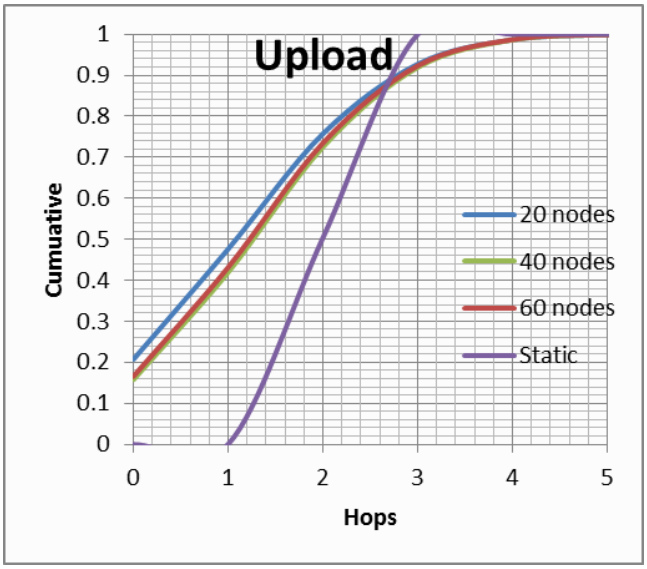

Fig.11 CDF of number of hops upload

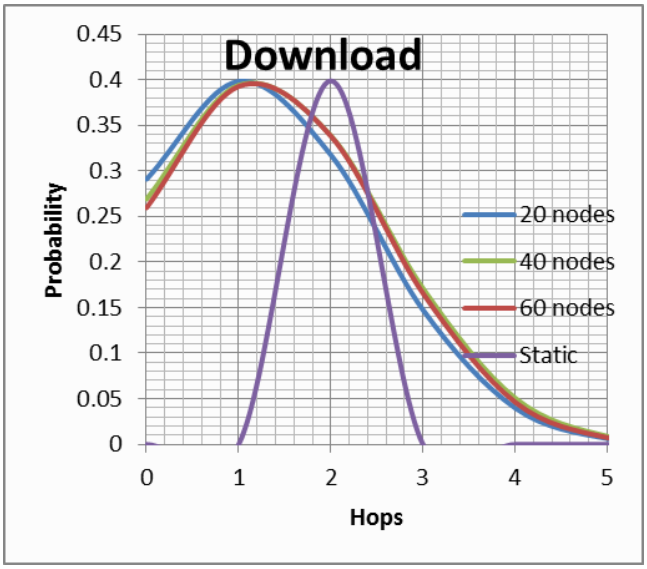

Fig.12 PDF of number of hops download

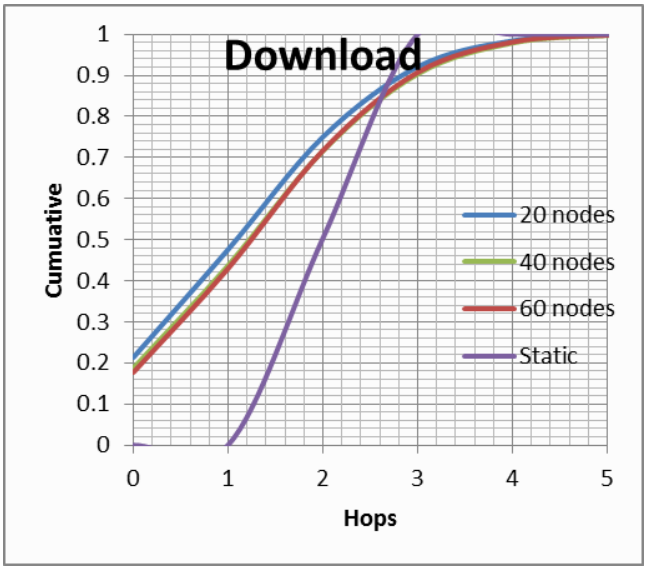

Fig.13 CDF of number of hops download

Number of hops also plays an important role in determining the connections of the clients to the server. With average hops of around 1 hop, it is a good indication that there are about 50% probabilities of that client has a direct connection to the server to exchange data. With a standard deviation around 1.3 hops, there are also chances of about 20-30% of the time that there will be no connection or no routes to send the data to the destination.

V. CONCLUSION

With all these results compared with the real data by other researchers, this scenario is subjective. The throughput is within the threshold of 20 to 50kbit/s as Claypool measured in a counter strike server and possibly in most online game based that has not been benchmarked yet. Throughput alone cannot be used to measure the overall performance of the game since the packet size for different game has different packet size for both upload and download while each game has a range of packet sizes depending on the player action too.

Latency or end-to-end delay plays the most important role of online game performance measurement. Even though the throughput is in the acceptable threshold, latency will be the one to determine if the game can be played under such circumstances or not. With such a high latency, static scenario included, they fall under the class of RPG and simulation game. An RPG game has different type of game types for example World of Warcraft (WoW), the requirement for bandwidth or throughput are high at around 450kbit/s and none of these scenario able to achieve that high. With the game fall under the RPG class as Claypool has stated, it would vary depending on the play mode such as hunting in the field, trading in the city, player vs player (pvp), guild wars, doing a quests with other players. With these scenario inside an RPG, the latency and throughput requirement would be different as well as the varying packet size. In the simulations, the upload latency are faster than download latencies because upload traffic were initiated earlier than download traffic. There are also high probabilities that some of the nodes or destination nodes have to handle other traffic in relaying the data to other nodes because that node is the only reachable node at that moment. With that, the node has to divide the packet path to the next node through a wireless signal, which is a one way data transfer; the node had to isolate the signal to the destination or next hop. Interference was never set in all of the scenarios as well.

Number of hops would be dependent on the reachability itself with the limitation of 250meter range of wireless transmission. With a limited reachability, these clients would have to compete with the other client to transmit the data to their destination and more delays will be added since the intermediate node has to handle more than one traffic at that time. With the overall results of the hops data, the clients often has connections to the destination or the neighbouring nodes to transmit the data.

ACKNOWLEDGMENTS

Our thanks to ACM SIGCHI for allowing us to modify templates they had developed.

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