An Enhanced Queuing Model for Route Optimization in Ad-Hoc Networks Based on Simulation

Lalit Johari, Rahul Kumar Mishra

Abstract*: Nowadays, with an increased supply for service quality multimedia communication over MANETs. Increased bandwidth, increased data rate, decreased latency, and increased ad-hoc network performance are the key objectives of using the queuing model. In this paper, when considering queuing delay and server use, a queuing model is created to analyze the cellular network in terms of video, audio, and text content. In a tailored discrete-event environment, this framework helps us to conduct functional testing of suggested algorithms. Servers service both types of data packets inserted into the network without long queues in the simulation performance. A SimEvents-based architecture is implemented at the concrete level for traffic simulation. This structure explores the effect of traffic generation on the system's queuing delay and server utilization.

***Keywords* : Mobile Ad-hoc Network (MANET), MATLAB, Queuing Model, Services quality (QoS), optimization of the path, end-to-end delay..**

I. INTRODUCTION

MobileAd-Hoc Network (MANET) is a community of mobile wireless hosts that frame a short-lasting network without the assistance of any independent network or central management. Due to the agility of the nodes in the scheme, these nodes organize themselves and customize themselves. They work as hosts, but they also work as routers. You forward data to or from other network nodes[1]. Remote nodes are extraordinarily mobile and leave no other nodes in the network without any restrictions[2][3]. MANETs have a baseless correspondence approach where all nodes support each other to forward data packets. MANET uses the routing protocol to detect explicit paths between the source and destination for the transmission of these packets. Routing protocols aimed to find the shortest path, Standard of Services [4]. To improve service quality, each routing protocol focuses on QoS metrics such as network performance and end-to-end algorithms. Some other QoS metrics are discussed for a QoS metric in the Formula [5].

The end-to-end transmission period is when a sensor node takes to transmit from origin to destination over the network. It involves transmission timing, processing delay, processing timeliness, and queued up timing [6].

Revised Manuscript Received on September 25, 2020.

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End-to-end objectively illustrates the following::

dend-end= N [dtrans+dprop+dproc+dqueue]

The delay in queuing is connected to the queuing delay (trans) when the requirements are deduced.

dqueue = dtrans* lqueue

Here, the lqueue is the queue length. By limiting the queuing time, we can lower the end-to-end delay, which is essential for optimizing the route in QoS. MANET's efficiency analysis is tested in two ways: computational modeling or simulation [7]. In [8], the author proposed M / M/3 analytical model based on a statistical approach to minimizing the queuing period. In the present paper, this model's simulation is discussed as an extension of past work called a queuing model. This paper aims to simulate the queuing model by Sim-Events, a Mathworks tool for simulating, demonstrating, and dissecting dynamic frameworks. In implementing queuing architecture, three different servers are the used premise on the classification of input packets. The paper is divided into two sections. Section I starts with a literature review and gives an overview of the problem statement with the proposed solution model for route optimization. Section II discusses the experimental setup and implementation of the queuing model in the Simulink block diagram using MATLAB that improves the server use and limits the queuing delay, i.e., latency or end-end delay.

II. LITERATURE REVIEW

This A detailed overview of the methods that manage delays when considering the quality of service (QoS) implemented in MANETs is provided in this subsection.

Robin Groenevelt et al. suggested a model that accurately predicts communication latency for various relay strategies for many mobility models[9]. The model uses two parameter values: the number of nodes and the contact's length before two random mobiles. It shows that the model forecasts the message delay for various relay strategies for several mobility models accurately. Shiwen Mao et al. propose an empirical method for the optimum partitioning of data transmission in real-time that minimizes the overall delay[10]. This research implements optimum traffic division by using deterministic network calculus as a constrained optimization issue and provides a closed-shape solution. Shanghai et al . Implemented the MANET multi-path routing methodology for a fuzzy controller [11].

The proposed algorithm's main idea is to create fuzzy controllers to decrease the incidence of route rebuilding. Selecting multiple routes was successful, resulting in a higher average packet rate, lower routing packages, and a shorter delay. Zhang et al . Suggest a distributed cross-layer calculation for latency-compelled (ITCD) MANETs about interruption and the delay constraint [12] known as interference-based topology regulation. If transmitting power increases to minimize the time, the number of neighbors protected by the transmission range increases, and other active network nodes interfere more. Cheng et al. are designing a generic iterative way to approach the direction of achievable multi-radio bandwidth (MRAB). The MRAB is paired with the EED to create the metric weighted end-to-end (WEED) delay [13]. The link measurements are used for path selection with a minimum delay and a high network performance in the multi-channel wifi network. Sasikala et al. regarded data transmission speeds, queue management, routing routes, and packet preparation. A queue is maintained, and delay information for each flow is kept accordingly [14]. The flow is pre-processed only to the network layer. The source and destination information used to distinguish the flow, and the internet protocol information is also not used to mitigate the network delay. Yang et al. include a theoretical framework developed to completely characterize packet queuing processes and obtain the likelihood of blocking relay buffers[15]. This article discusses the end-to-end delay in a MANET two-hop relay. Each node equipment has an abundance of standard relay buffers to store and forward packets of all the other flows. Additionally, the 2HR networking algorithm includes a handshake feature to prevent packet loss. The Enhanced proactive Routing Protocol (OLSR) was proposed by the Song et al. to provide a structure and simulation based on mobile phase and cross-layer delay prediction (OLSR PMD)[16]. This study utilizes the Mean Queuing Delay prediction for routing. Matlab and NS-3 simulators use the simulation to reflect OLSR PMD's ability to efficiently reduce the end-to-end delay and increase the packets' distribution ratio. Gawas et al . Propose an innovative cross-layer solution in MANETs called CADM multi-rate congestion-adaptive and postpone-sensitive routing protocol[17]. The CADM convention uses the cross-cutting of the network layer, MAC, and physical layer. The CADM can connect data rate, complexity metric, and MAC latency in delay-sensitive applications so that device efficiency in MANETs is improved. Generally, the current delay avoidance work is performed based on the routing algorithm, while the type of data is a critical factor in evaluating a delay from end to finish. Therefore, the suggested framework focuses on the content type and the bandwidth allocation on a content type basis.

III. PROBLEM STATEMENT

Routing protocols are used to relay a packet to a network from source to destination. MANET routing is performed by routing protocols. Routing protocols are called Constructive protocols for routing, Reactive protocols for routing, and Geographical Protocols for routing. A constructive routing protocol uses a routing table, which stores data from other network nodes. Any node that needs to analyze a particular node in order and forward the incoming packets, nodes get the data from the route cache002E On the other hand, reactive routing protocols specify the route and create the connexion if a source node must send the data packet to the destination node. To decide the route request, packets are flooded into your network [18]. Geographic protocols use data from the region to improve the route from the origin to destination. Geographical routing is useful since it has the duplication of packets from several sources. The routing protocol should provide various levels of Service Quality (QoS) in various applications and users. A QoS is essential because not only does it consider transmitting packets from sender to receiver, but it also transfers the packet along the optimized path. Service quality specifications (QoS) mainly include bandwidth, delay, jitter, and packet loss[5]. For the QoS-aware routing protocol, the essential design issue is the Selection of Route with the least delay while utilizing the specific application by various clients. Every application has various necessities as far as QoS; however, it has a similar sort of data, such as text, audio, or video. If only a single processor serves all kinds of data, it requires more time to deliver the data packets. That increases the end-to-end delay, which bases on queuing delay. To tackle this issue, if it utilizes the three individual servers for every sort of data packets, then the time can be diminished in sending the packets from source to destination. A data packet classifier and data packet scheduler will be required; once the data are ordered, the transfer speed can be used as per the requirement of applications. For example, a text data packet, the lowest bandwidth, can be offered, while the highest bandwidth for video data packets can be maintained.

IV. MODEL DISCRIPTION

The proposed model application layer decides the content-type of application, and the content divides into three classes. These classes may be Class 1 (Video), Class 2 (Audio), and Class 3 (Text) and send the substance sort to orchestrate layer to pick the particular get-together of parameters. Count, end-to-end postpone, and data transfer capacity is used for picking the improved route. Among these parameters, the best possible parameters for certain application content are gathered to locate the improved routes, as shown in figure 1.

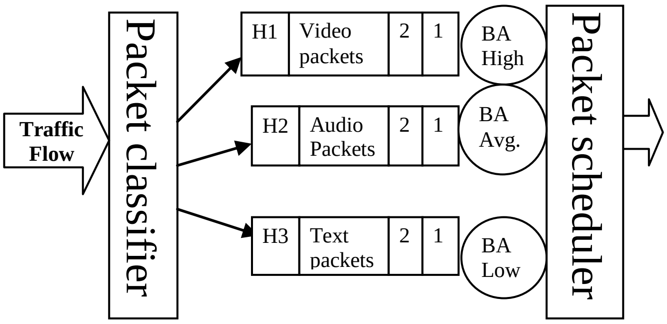

Fig. 1. Proposed System Model

Here the characterization of the data transmission limit is done according to the necessity of the substance. The most outstanding server throughput can be achieved, so a particular data transmission speed in terms of bandwidth is given to each content type. Proposed data transmission speed likewise guarantees the best routes for each sort of content type.

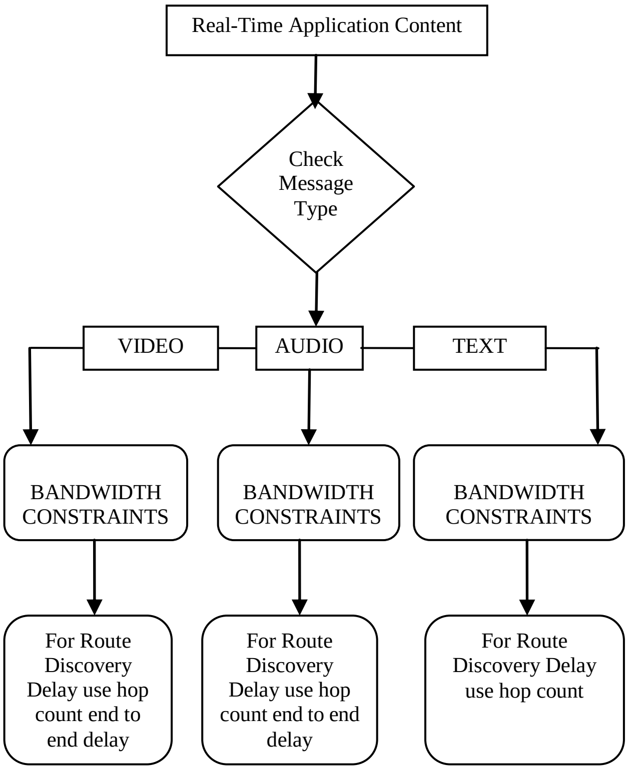

Fig. 2. Flowchart for Proposed System Model

These bandwidth suggestions are called bandwidth constraints for text hop count and utilize for course exposure. The audio proposes for the delay-sensitive application. For this, hop count and end-to-end defer parameters decide to choose the route. Likewise, for video type content is the delay-sensitive application, hop count, and end-to-end postpone utilization for picking the enhanced route among the bandwidth to ensure routes. Along these lines, by furnishing the particular and exact data transmission with three different servers that use the different route queuing delay can be limit. In this approach, the application layer uses the packet classifiers and packet scheduler.

V. IMPLEMENTATION USING MATLAB

The simulation structure model displayed for the queuing is based on MATLAB and Simulink, which provide a stage for running quick-prototype controllers widely used by MANET[19]. SimEvents fusion provides resources for producing discrete event components. Instead of using queues and servers to demonstrate the queuing model, a discrete event framework from MATLAB is developed. However, the model structure does not fit the real world's physical format. Its ability to transform as the MATLAB Discrete-Event system makes a data packet flow system powered by an event using object-oriented MATLAB (MathWorks ® 2015a) systems. The simulation model uses the SimEvents section of Simulink with many blocks. Simulink's simplified graphical interface presented a setup of a discrete-event simulation model (Figure 3). The main highlights include (1) Predefined block libraries such as queue (first-in-first-out (FIFO) queue), repositories (single server), and generators (temporary material generators), and sinks (entidad sink) for system architecture modeling[2].

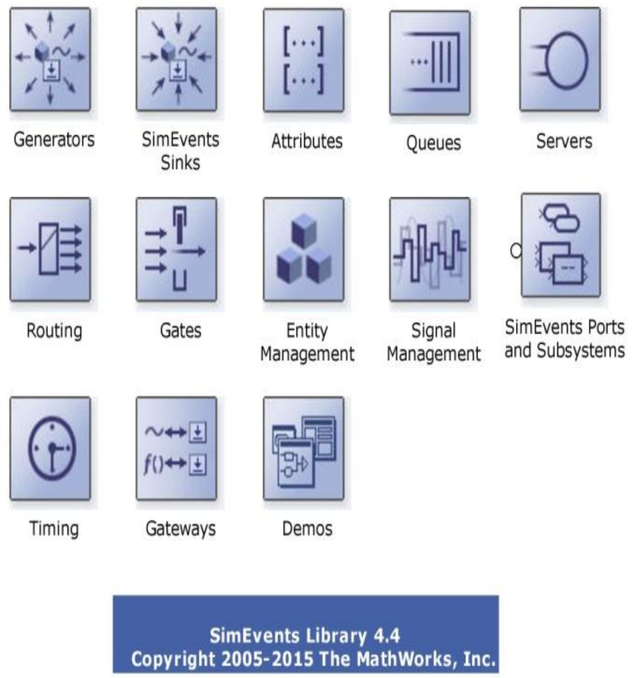

Fig. 3. SimEvents Block Library

Block Event-based Random Number generates a random number, parameter, and initial speed, from the defined distribution. Estimated values for arrivals and operation are statistically calculated according to the distribution determination [20]. Block time-based entity generators create entities that meet defined requirements using integration times. Start Timer block independently associates a named timer to and incoming entity and activates the timer. Read Timer Block reads the value of a timer previously associated with the Start Timer Block. FIFO Queue block stores entities for an undetermined period in a first-in, first-out chain. The Entity Sink block embraces all blocks and offers a way to end the entity path. The output Switch block receives entities that depart from the output port of one of several entities. During the simulation, the selected port will shift. The signal scope block generates a plot using event-based signal data. The vertical axis data is extracted from the signal connected to the input signal port of the block. The time of integration is the intervening time between two incremental events. The single server block represents a single entity for an amount of time and attempts to exit the institution through the Outward connection.

VI. EXPERIMENTAL SETUP

Using MATLAB SimEvents, we developed figure 4 as M/M/3 queuing model that uses three servers to manage the priority-based specific bandwidth for different kinds of data packets to minimize the queuing delay with increased throughput.

Here time-based entity Generator block generates the data packets; through start timer, these data packets reach the FIFO queue. Start timer associates timer with each data packet. After getting the FIFO queue, the queue's length can be measured in Queue length using a signal scope. The FIFO queue's output is given to the output switch that uses any function that works as a packet classifier. Packet classifier, classify the data packets into three categories: one for text, one for audio, and one for video. All three data packets queue reaches into three servers: Text server, Audio server, and Video Server, respectively. Every server is also connected to a random number block based on events that determine random numbers from the distributions, parameters, and initial speeds specified. Before sink data packets from each server, the read timer is attached, which read the time to calculate the queuing delay. We calculate the signal utilization of the different servers such as Text server utilization, Audio server utilization, and Video Server utilization in our work. The following results are discussed in the result analysis segment, generated when the simulation runs for three parallel servers having capacity 20 (Video Server), 15(Audio server), 12(Text server), Data packet-population 10000, and service discipline FIFO.

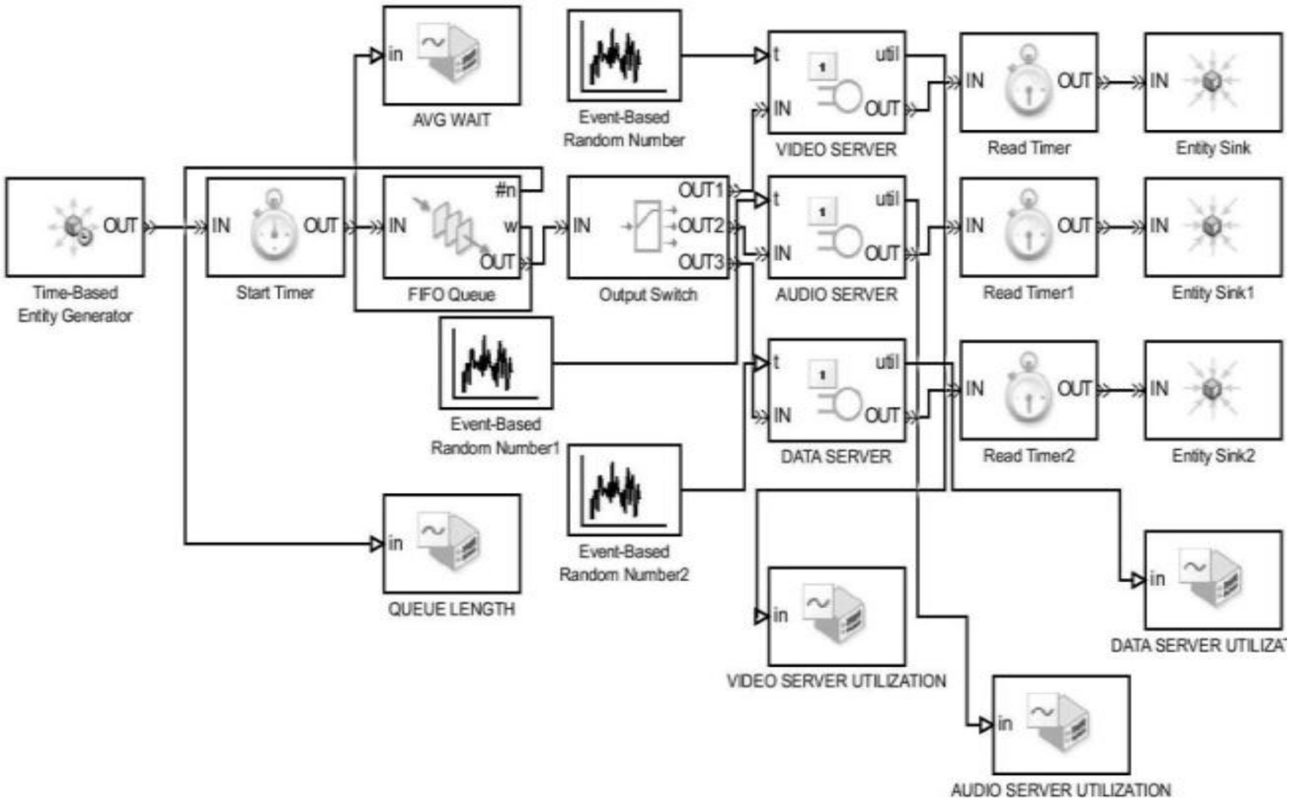

Fig. 4. Simulation Model based on M/M/3 with SimEvents

In the given Simulink model Event-based random number is used to specify data packets processed per second by three different servers, which is 20 data packets/sec. Fifteen data packets/sec and 12 data packets per sec. Respectively for video server, Audio server, and data or text server. The FIFO queue block parameter is used for the capacity parameter that is the number of entities that a queue can hold, which are 50. To find the utilization of each server activates the utilization option in each server's block parameter's statistics field. This utilization can be shown as until in the output section of each server in the above Simulink model. Now until each server is connected with signal scope. Each signal scope is named as video server utilization, audio server utilization, and data server utilization. Before this, a Time-Based Entity Generator is used, which generates entities using intergeneration times. Intergeneration time is represented by means in block parameters. The integration time is a time interval between two successive generation events. Between a Time-Based Entity Generator and different servers, single input and multiple outputs switch is used. This switch sends the input to three servers from its output ports and gets the FIFO queue's input. FIFO queue maintains the data packets generations in the FIFO order. Apart from providing the input to the output switch, the FIFO queue has two more output signal scopes. These two signal scopes use for performance metrics that is for Average wait and queue length. This complete structure provides a comprehensive Simulink framework that gives us various graphs.

VII. RESULT AND DISCUSSION

To represent the various visualization that captures the performance runs the M/M/3 queuing model for 10000 data packets. So that graphs that represent total wait, server utilization and Queue Length are generated. The work confirms that the packet transmission from sources to destinations for complete queue length has an Average effective wait and efficient server utilization. Before the simulation runs, link consistency and other block set configurations were verified. The simulation runs for 10000 data packets.

At the time of the simulation, the packet size, queue length, and bandwidth are assigned to each server. Finally, queue length and latency, utilization tests were carried out. In figure 5, the x-axis represents the no. of data packets, and the y-axis represents the time in seconds. Here when the data packets are increasing, the average wait decreasing correspondingly that represents the least queuing delay. While figure 6 shows the complete length of the queue. All the servers utilization remains constant in figure 7(a), 7(b) & 7(c).

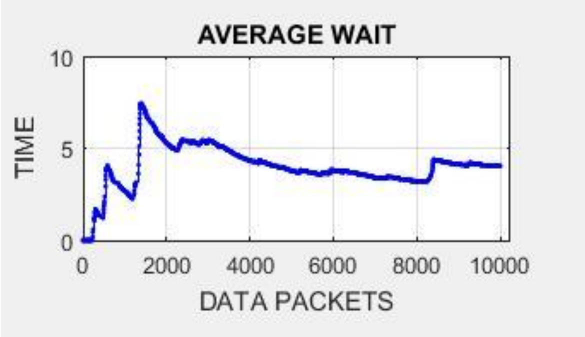

Fig. 5. Average Wait Plot

In the above figure it is clear that the average wait graph line is declining as more and more data packets reach in the system. This is suggested in the proposed system model.

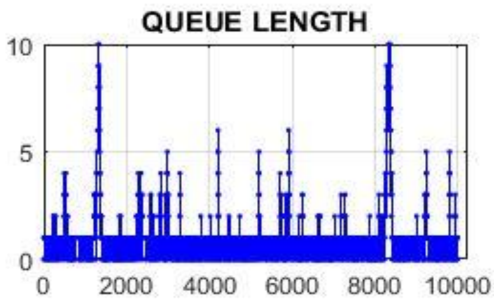

Fig. 6. Queue Length Plot

In the above figure, it notices that all the data packets reach in the system. Figure 5 and Figure 6 implies that when data packets reach at 8000, that time average wait graph line is really low. So again proves that queuing delay is minimizing while using more server as per the type of content.

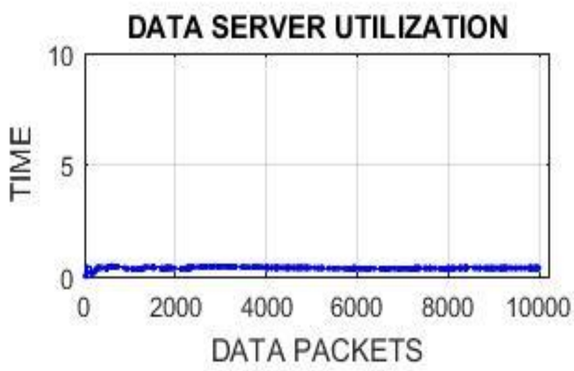

Fig. 7(a). Data Server Utilization Plot

In figure 7(a) when data or text server is considered, it is clear that the timeline which is representing delay is just above zero for all data packets. So Data/Text server utilization graph represents that server is ready to do more work.

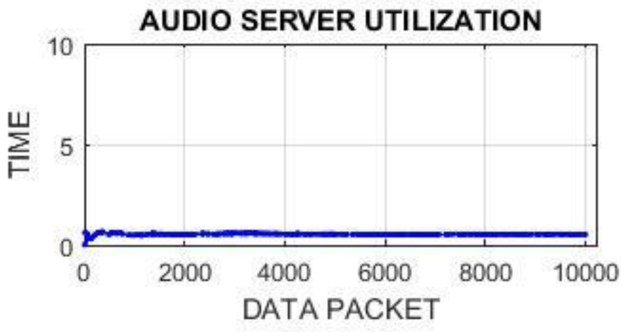

Fig. 7(b). Audio Server Utilization Plot

In the same manner, in figure 7(b) and Figure 7(c) timeline is between zero and one. This indicates better server utilization for both server, either audio or video server, while considering 10000 data packets.

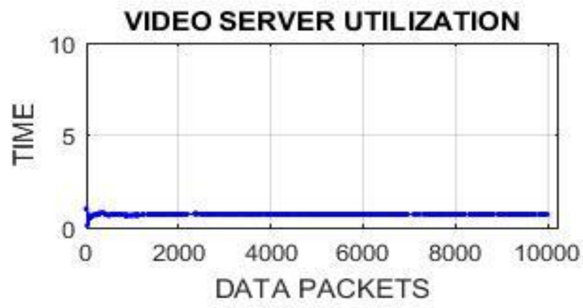

Fig. 7(c). Video Server Utilization Plot

So overall all simulation results show that the proposed system is more efficient and capable for handling different types of data packets with more time saving and more throughput increment that is claimed in the proposed model.

VIII. CONCLUSION

This paper has presented the MATLAB SimEvents approach for building up the model to limit the queuing delay. The created model gives end to end reliable packet delivery in a short timeframe and enhances throughput. A discourse on the QoS parameter and the significance of queuing delay in end-to-end delay with simulation is additionally exhibited in this work. The simulation plots for server utilization and average wait show that servers can be categorized based on the content of utilization to upgrade the entire framework's performance. Even though the simulation exhibited here is only for one case, clearly for any network or routing protocol present idea can be actualized. Future work can classifications the servers on thoroughly separate parameters, for example, based on populace density, where the low populace utilization required low transfer speed while the higher populace density may require a high limit transmission capacity. Base based on bandwidth given again, the route can be separate to deliver the data packets, and delay can be optimized on transfer speed given again. The course can be independent of conveying the information bundles, and deferral can be improved.

ACKNOWLEDGMENT

The authors acknowledge the support of IIT Roorkee where supportive MATLAB version and simulation work completed according to the proposed model.

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