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Choosing the best quality of service algorithm using OPNET simulation

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ABSTRACT

The concept of quality of service (QoS) is a new computer technology. Previously, there was a slow internet connection to access the sites and it was slow to send information. But now, it requires speeding up the traffic and increasing the efficiency for audio and video. In this study, we discuss the concepts of QoS provided over the network to achieve these goals. This study aims to compare six algorithms to control the QoS, then, the best algorithm will be selected to improve the traffic. These algorithms are named first in first out (FIFO), priority queuing (PQ), custom queuing (CQ), CQ with low latency queuing (LLQ), weighted fair queuing (WFQ), WFQ with low latency queuing (LLQ), so the behavior of these algorithms can be measured. The results obtained by comparing between them using OPNET simulation show that the best algorithm is the priority queuing algorithm, followed by CQ, then CQ with LLQ, then WFQ, then WFQ with LLQ and finally FIFO. All these results are plotted in the form of graphs to show the paths of these algorithms for the single state with an operation time of 5 minutes for each algorithm.

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1. INTRODUCTION

Quality of service (QoS) is the ability of the network to provide the best services to the user with high efficiency in addition to organize the traffic data, voice and video over the network with a good quality according to the priority and preference of what is required to speed up the network and prevent data delay. In other words, QoS measures the level of user satisfaction and network performance, so it refers to a set of measures to tune or quantify the performance of applications, systems and networks [1]. The provision of QoS guaranteed services is necessary to meet user requirements [2]. Quantitative assessment of application performance is required for QoS metrics. It is also defined as a ”set of quality requirements for the collective behavior of one or more objects”. There is a lack of deterministic guarantees of QoS because the security message can be dropped when the communication system and links are overloaded or fail [3]. In the past, QoS management generally focus on allocating radio resources to requested services, which are usually driven by some QoS parameters, such as access/transmission delay, jitter and packet loss rate [4]. One of ways to reduce overhead and build multiple pathrouting is to cluster network into some subnets [5]. QoS routing is the first step toward achieving end-to-end QoS guarantees [6]. The main objectives of network quality are to increase the reservation priorities for data, transmission control to access the data in the required time, control the contrast and improve the characteristics such as loss of data during transmission. it is possible to ensure the user requirements by using QoS such as high data rate and low delay [7]. Techniques

are used to enable network quality including the combination of transmitter and receiver. Even with a high degreeof overlapping between the sectors, the QoS demands of the subscribers can be appropriately met [8]. QoS Plays an essential role in ensuring that computer communication systems are reliable [9]. Cisco software makes it possible to control complex networks, predict various services, and deploy applications on the network. To interconnect dispersed computer networks, many organizations rely on service provider infrastructure and facilities. Voice over internet protocol (VoIP) network technology as an internet multimedia system (IMS) access [10]. The following algorithms have been used to control the quality of service provided over the network such as:

a) Algorithm 1: First in first out (FIFO). This algorithm works by sending packets in the same order in which they are processed. Set the preferences and the default order length in this case is greater than 2 Mbps at high speeds. (FIFO) is the simplest modality of queuing [11]. The incoming packets are served in the order of their arrival [12]. The job in the queue that comes first is served. This algorithm is simple and fast.
b) Algorithm 2: means priority queuing (PQ). Priority queuing is the basis for a class of queue schedul-ing algorithms designed to provide a relatively simple method of supporting differentiated classes of service [13]. The strategy has four types of classes with different priority levels. It gives priority to the movement of traffic. High priority data takes precedence over lower priority data and is therefore at the top of the transmission process. Imp as a drop-in frontend so its performance can be analyzed across five different commercial and open-source [14]. Real-time applications are treated preferentially by the PQ algorithms [15].
c) Algorithm 3: Custom queuing (CQ). Since the strategy PQ delays the transmission of packets in low priority lines. Priority row packets uses a separate queuing strategy that aggregates the transmission of the packets as indicated in Figure 1. Using CQ, up to 16 queues can be created by the network administrator to categorize traffic.

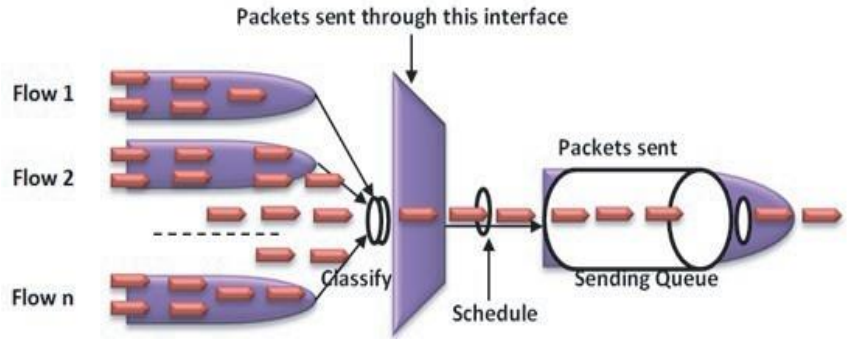

Figure 1. The flow of data packets according to priority

d) Algorithm 4: Custom queuing with low latency queuing (CQ with LLQ). Here the algorithm CQ with LLQ is used. The only addition here is low latency queuing, where priority is assigned according to mathematical calculations, taking into account the reduction of data loss in the queue during transmis-sion.
e) Algorithm 5: Weighted fair queuing (WFQ). WFQ is a dynamic process that allocates bandwidth among queues based on weights. This strategy works automatically at slow speed (Mbps2, 048) and this method assigns a flow to each row and the flows reach 256 flows. Since voice can be transmitted accurately using real-time transport protocol (RTP) protocol and VOIP technology com-pletely depends on internet protocol, we use WFQ mechanism which is useful for fast voice transmission since RTP does not support internet protocol (IP) function. WFQ works with data streams grouped into a maximum of 256 queues.
f) Algorithm 6: Weighted fair queuing with low latency queuing (WFQ with LLQ) here the data loss in the queue is reduced and hence the delay increases more than the WFQ algorithm and it increases continuously because if the packets increase continuously the congestion increases. The networks that use QoS technology, such as Cisco, are characterized by the following advantages: i) use of network resources with high efficiency; ii) control over sources (frequency-devices and equipment-wide areas). For example, you can set the required frequency for file transfer protocol (FTP) transfer to give priority to database access; iii) the ability of internet providers to carefully control and adjust quality levels and

provide the best customer service; iv) control wide area network with high efficiency and adjust frequency for audio and video so that users can vary greatly according to their quality of service requirements [16]; and v) to establish it as a fully integrated network in the future.

2. STUDY PROBLEMS

This work addresses many issues. Therefore aims to: i) know the behavior of quality-of-service algorithms, then determine the best quality-of-service algorithm; ii) use quality of service technology provided over the network; iii) control the transmission of data, audio and video packets; and iv) deal with audio delay problem.

3. RELATED WORK

Using QoS technology in networks is necessary to control the movement of data packets through the network and to provide new services and applications [17]. The equitable distribution policy for internet access was carried out in this study. OPNET software is a simulation program for networks that has been used to control quality levels, transmission priorities, and control data flow. OPNET provides four tools called editors to develop a representation of a system to be modeled. OPNET is an object-orientated simulation tool for making network modeling and QoS analysis of simulation of network communication, network devices and protocols [18]. Analyzing the behavior of the algorithms through the graphs shows the path of each algorithm. The comparison of the algorithms and knowing the best algorithm that should be used for the quality of service in terms of speed, prioritization of operations and distribution of packets in transmission in the different paths of the network. The scheduling algorithm must be able to select services that can guarantee QoS delivery to the users without violating the imposed constraints [19]. Real-time protocols take care of the requirements of applications with real-time characteristics and deliver audio and video over the IP network. The use of quality of service technology in the internet in general and in private networks is necessary because without it we cannot route data packets and provide new services and applications and we cannot secure the source, so the user needs the Internet for some services that are only achieved by using QoS technology, also the evaluation and measurement of QoS impact on network performance and real-time applications is very important [20]. In order to achieve optimal performance in the main Internet lines and prioritize the services to reduce cost and improve the available resources. The term service rate refers to the actual speed of the server in work units/s. The Internet relies on the transmission control system using the transmission control protocol (TCP), so computers detect congestion on the network and the transmission rate drops accordingly. The TCP system uses a primary field window to control congestion, and the window corresponds to the amount of data transferred between the sender and receiver. The TCP system detects the loss of a particular packet that slows down the transmission rate by halving the window size and then gradually increasing it. For scheduling algorithms, many optimization criteria can be considered, such as the maximum total data rate [21]. Each client requires the execution of a service, so a service consists of one or more tasks.

4. RESULTS AND DISCUSSION

The main problem in data traffic is to summarize the available network and the required traffic, i.e., how to organize the traffic in the network to achieve optimization. Therefore, it was necessary to use algorithms to control the QoS. The goal may be to expand the volume of usage or to reduce congestion in the network. Typically, the ideal operating point is reached when the traffic is evenly distributed over the network, the traffic distribution is balanced, and there are no queues in a particular row or delays in the packets. Considering that the packets are not lost and some of them are lost and this cannot be achieved. The objectives are through the primary IP where there is simply no information available in the IP for optimization. To know how to deal with applications of QOS. The QoS requirements for various applications, including voice, data, and real-time or streaming video/audio [22] This is to meet the requirements of quality of service.QoS requires routers to support some queuing configurations also to manage and control the packets according to priority and control the queue to reduce congestion and queuing [23]. The software used in this study is the famous OPNET simulation software which it is from OPNET Modeler. It is considered as the first program in the field of communication networks in general [24]. The program has a very great potential in several fields and is most used in all international universities for scientific research [25].

In Figure 2, the work environment is illustrated. Then, Figure 3 shows the scope of workspace. The application made in this paper deals with the comparison between the six algorithms which are FIFO, PQ, CQ, CQ with LLQ, WFQ, WFQ with LLQ. They are compared according to the desired application. An

example is the comparison between them in the END TO END data arrival delay, so they are combined and a suitable operation time is selected, then the program is executed. The final results appear in the diagrams that analyze each algorithm and its behavior. The Figure 4 shows the process of combining the six algorithms and choosing the operation time of 5 minutes for each algorithm.

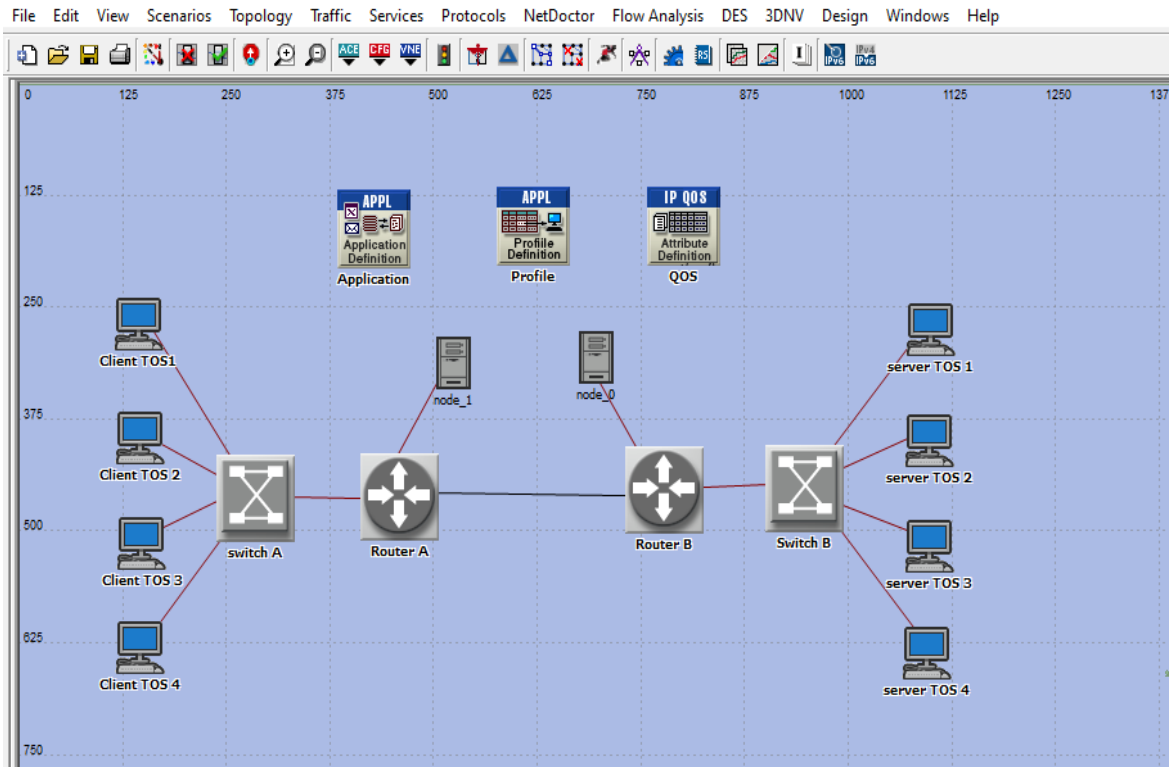

Figure 2. The work environment

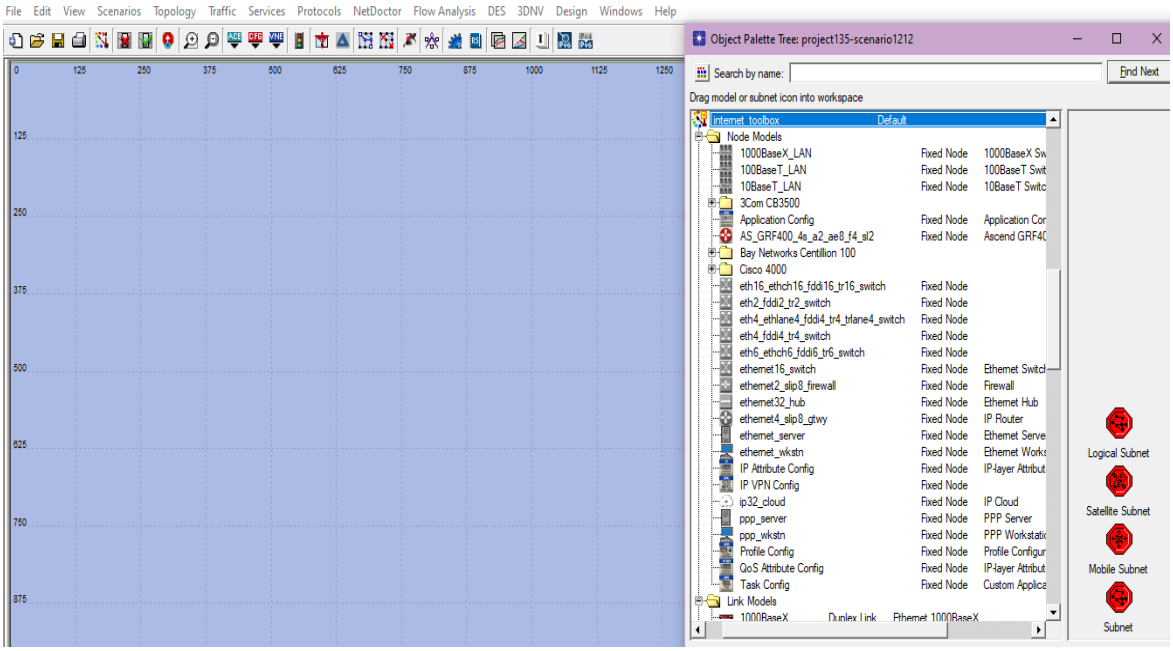

Figure 3. The scope of workspace

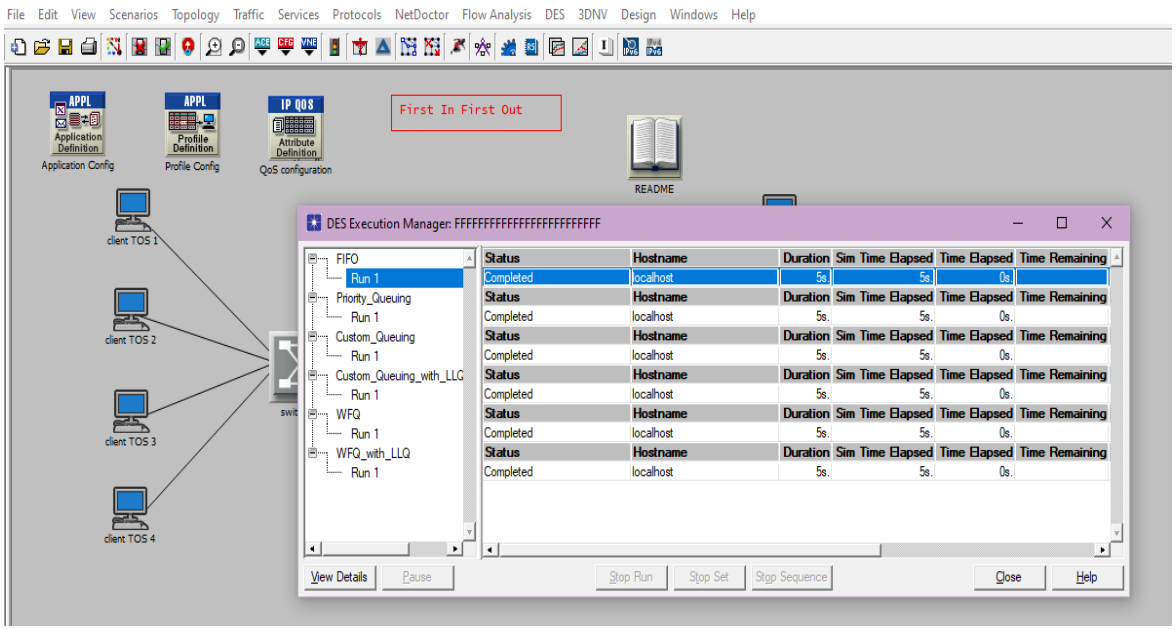

Figure 4. Configuration of the algorithms

The following Figure 5 shows a diagram of the six algorithms, each represented by a curve that takes on different characteristics. In order to avoid the cluttering of the figure having multiple curves and to improve the presentation of the figure without overlapping, we have plotted 6 different figures. Measuring the delay rate for each algorithm from the beginning of the transmission to the end of END TO END, we notice in the figure that each algorithm assumes a different rate than the others, depending on the amount of data sent and the basis on which the algorithm operates.

4.1. First: the algorithm FIFO

Indicated by the curve in the green graph in Figure 5 which named with FIFO. So it is operate according to the following rules: i) packets are sent in the same order in which they were processed, ii) there is no kind of preference, and iii) the default queue length in this case is greater than 2 Mbit/s at high speeds. From the figure, it can be seen that during the operation time (5 minutes), there is some delay at the beginning of the transmission, then the queue organizes itself and the data is forwarded regularly.

4.2. Second: in the Priority queuing algorithm

Indicated by the curve in the blue graph in Figure 5 which named with PQ, so we find that it operates on four types of lines that contain different levels of priority. It gives more priority to the traffic flow of high priority data than lower priority data and lets them advance in the transmission process. The high priority queue is relieved of packets first and implements the rule. If the application has priority, the traffic waiting for it will be sent high. So we can see from the figure the reduction of the delay rate to zero. This is better because it improves the transmission rate so it is required. The data sent will arrive at the required time. And it means that there is no congestion during the transmission of this data. It should be noted that the amount of data sent is relatively small because there is a direct proportionality between the amount of data sent. The delay rate means that as the amount of data sent increases, congestion occurs during transmission and thus there is an increase in delay time for lower priority data.

4.3. Third: in the custom queuing algorithm

The priority queuing strategy was addressed, which delays sending packets that are in the lowest priority rows. The algorithm CQ distributes the transmission of the sent packets among all rows by mathematical calculations. In this case: i) weighted round robin (WRR) is used to transition between the different rows and ii) many bytes from each row are processed according to the weights specified for each row. This method prevents distortion for each class, but is not practical for data that is classified as sensitive and cannot tolerate delay. In the figure, the regularity of the transfer can be seen without any noticeable delay.

4.4. Fourth, user-defined queue with LLQ algorithm

Which is indicated by the curve in the red diagram in Figure 5 named with CQ with LLQ. The CQ algorithm is used with LLQ, so here we have also used low latency queuing and the figure shows the algorithm. As the priority has been assigned according to mathematical calculations, considering the reduction of data loss in the row during transmission. Here we use compression strategy because by compressing the packets sent. It is possible to send a small number of bits to the concerned party so that it is of high quality and less cost and time. So the effect is that we send a large amount of data in a short time.

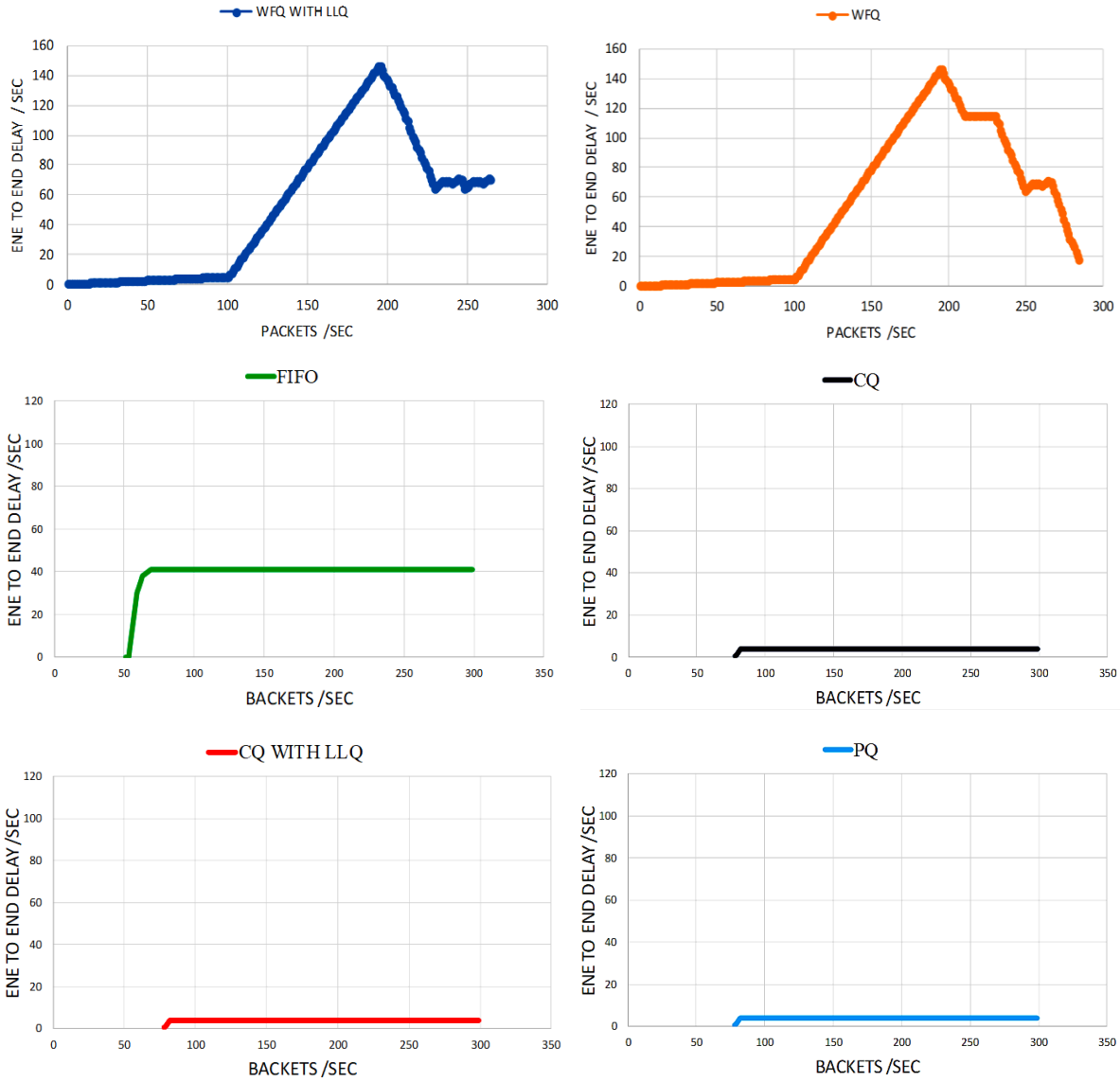

Figure 5. The rate of sending data to the algorithms

4.5. Fifth: weighted fair queuing (WFQ) algorithm

This algorithm is indicated by the curve in the graph in orange in Figure 5 named with WFQ. We note that this algorithm uses a slow speed strategy, which is 2.04 mbps, so it allocates the flow for each row. Moreover, the flows reach 256 flows because the audio is available for transmission exactly through IP RTP, also the VOIP depends entirely on the internet protocol (IP) [26]. The internet protocol uses a mechanism WFQ which is useful for fast audio transmission because RTP does not support the IP feature. From the diagram, it can be seen that the delay rate of data increases in this algorithm due to the transmission of a large amount of data. The audio affects congestion and delay. Despite all this, we find that this algorithm is good because it transmits all these data regardless of the delay that occurs during transmission [27].

4.6. Sixth: using WFQ with LLQ algorithm

This algorithm is indicated by the curve in the graph in dark blue in Figure 5 named with WFQ with LLQ. Here the loss of data in the series is reduced and hence the delay increases more than WFQ algorithm and it increases continuously because if the packets increase continuously here the congestion increases and hence the delay rate for the data increases [28]. However, if some packets are discarded, the congestion decreases and hence the delay rate decreases. Alternatively, if we measure the arrival rate of bytes/s, as in the Figure 6, we find the following:

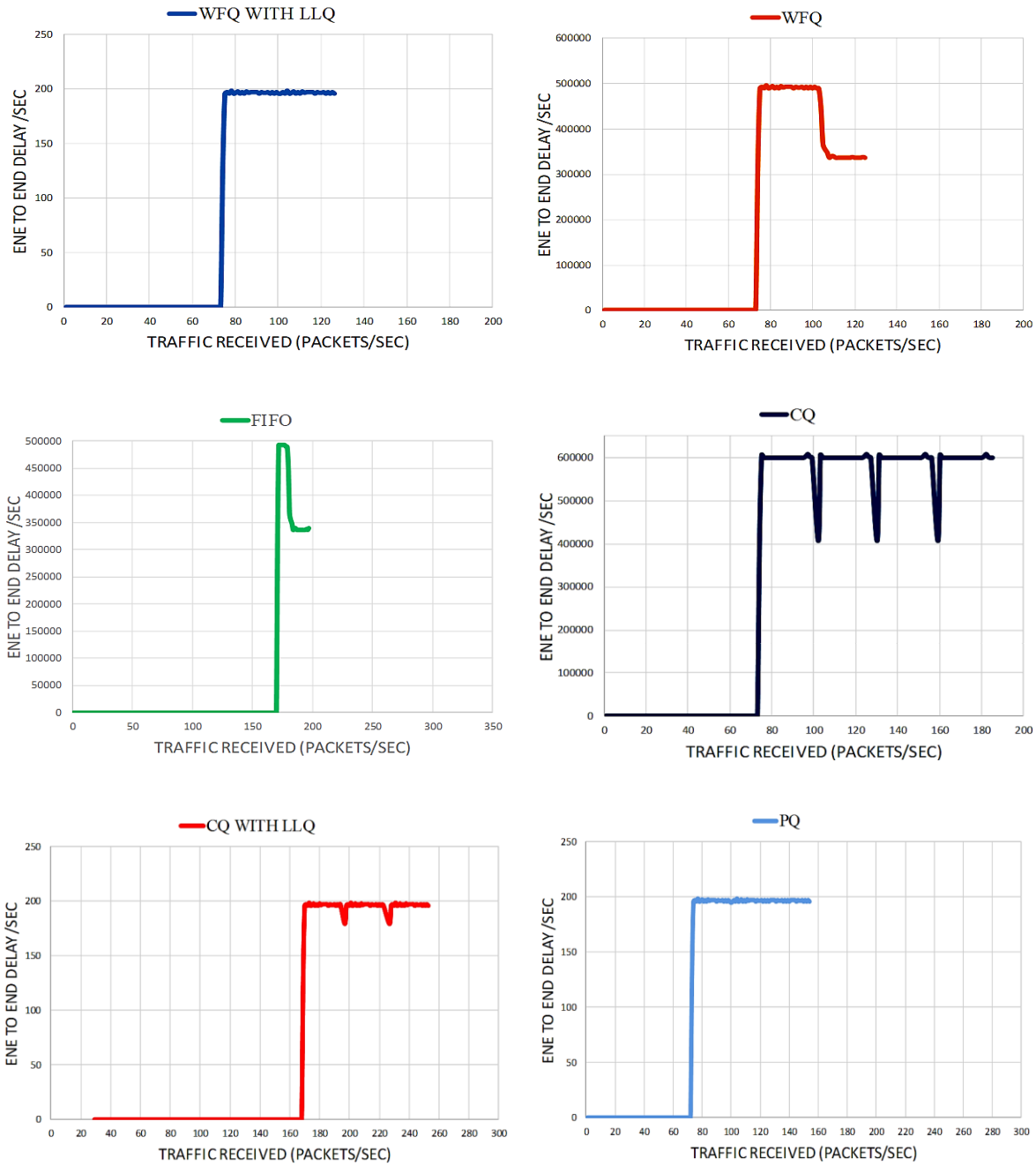

Figure 6. The rate of data arrival

In the green FIFO algorithm, the data access rate increases to more than 450 bytes, then this rate decreases, and then stabilizes and regulates. This means that there has been an increase in the number of bytes which has led to congestion and hence delay in access as a large number of bytes arrive in a short time and this time increases rapidly when the number of bytes decreases [29]. In priority queuing algorithm, there

is a regularity in the arrival of data in a short time and then the time increases and the data becomes regular in number. In custom queuing algorithm, there is also an increase in the number of bytes arriving in a short time, and then the number of bytes becomes constant and the latency increases [30]. In CQ with LLQ algorithm, there is also an increase in the number of bytes arriving in a short time, and soon this number stabilizes and the time increases, as is the case with CQ. In WFQ algorithm, the highest number of bytes arriving in a short time can be transmitted and then this number is regulated. The time increases, then the number of bytes decreases, then the access time increases and then the number decreases again. WFQ with LLQ algorithm the same as WFQ with less falling bytes than WFQ. We find that the best algorithm where the bytes arrive is priority queuing algorithm followed by CQ, CQ with LLQ, WFQ, WFQ with LLQ and finally FIFO as we show in Table 1.

Table 1. the comparison between the algorithms in terms of speed and delay during an operation time of 5 minutes

Algorithm	Packet transmission	Data transfer	The technique used
FIFO	Slow	delay when the transmission start	There is no type of Priority
WFQ with LLQ	Slower	Reduce the data loss in the row and thus increase the delay more from the WFQ algorithm	The data loss in the line is reduced. Thus, the delay increases and when some packets are dropped, the con- gestion is reduced and thus the de- lay rate is reduced
WFQ	Medium Slow	Useful in transferring the voice quickly, allocates the stream for each row and the streams reach 256 streams	It is useful in Transferring audio quickly. ”Because RTP does not support IP, it is good because it transmits all these data regardless of the delay that occurs during trans- mission
CQ with LLQ	Less Slow	Give the priority according to math-ematical calculations, taking into account the reduction of data loss	Prioritization according to math-ematical calculations, considering the reduction of data loss in the row during transmission
CQ	Medium Speed	Delay of transmission of packets in the lower rows Arranging the prior- ity	distributing the transmission of the sent packets to all the rows by doing mathematical calculations
Priority Queuing	High Speed	Reduction of delay rate to zero	the priority strategy according to the rule IF The application priority has traffic waiting high sent it

We note that the curves take the same paths as for the number of bytes arriving in Figure 7, contrary to the Figure 8 which shows the received video traffic (packets/s) and the rate of packets arriving in seconds with different paths. We take from the table: i) QoS algorithms simplify the transmission of packets through routers; ii) QoS algorithms have proven to be useful for traffic engineering and prioritization of voice traffic, as they must be received in real time over the RTP protocol and contribute to quality assurance; iii) the type of algorithm can be chosen depending on the number of applications used; iv) the difficulty of applying the quality of service in practice in networks; and v) improvement and development of the mechanism of work of these algorithms, because the FIFO algorithm has shortcomings, so it is difficult to use it when sending more than one application. Also, the algorithm priority queuing is biased for packets that have priority, such as sound, so there is a loss or delay for lower priority packets.

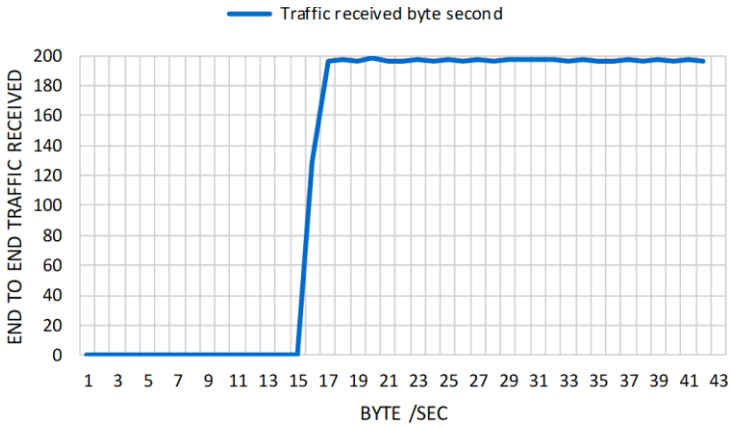

Figure 7. The number of byte received in seconds for video conferences

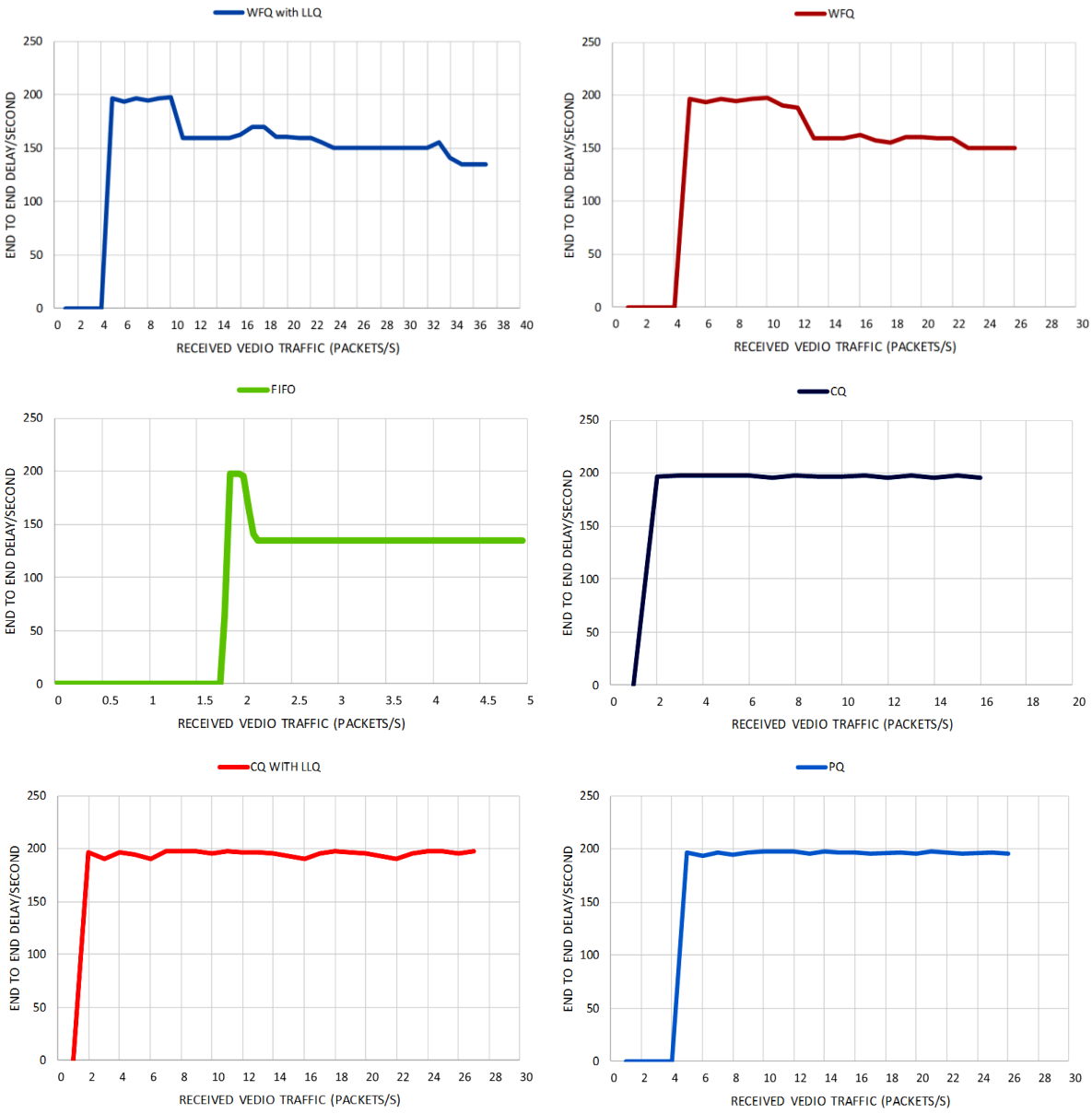

Figure 8. The traffic of the video

5. CONCLUSION

The use of QoS technology is one of the concepts that have emerged recently, charac-terized by high speed and efficiency in the transmission of voice, image and video by priority. To complete all these services, the control of the quality of service provided in the network is important. The behavior of the characteristics can be measured, such as the delay (packet distribution time), the change in delay. The transmission of sound and image is instantaneous, and the transmission of voice and video is useful in conducting conferences over the Internet. However, there are difficulties in operation due to the presence of audio frequency. The contrast makes the movement of sound and video difficult. This means that there is a great need to enable QoS technology throughout the network, considering the quality requirements of users and applications. We note that the network quality control manages the network resources and ensures that the transmitted data is terminated with QoS technology.

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