The Effect of Concurrent Connection in the Fairness and Protection of Scheduling Mechanism in the Internet

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***Abstract*—Current advance in all type of live technology makes its users greedier in demanding more services with fewer prices. This also, applied for network users who increase their hunger to network resources as the technology increase. The purpose of this paper is to explore and examine the impact of greedy users who initiate simultaneous connections to acquire the same file but from different destination. This method is actually been used by P2P, download accelerator software and others. To approach the aim of verifying the impact of concurrent connection, OPNET simulator is used and the results achieved and accumulated from the simulation is analyzed. The result of the simulation shows side effects of such behavior in the delay variation, end-to-end delay and hence the QoS. This research provides verification and validation for the negative impact of the misbehaved users in network performance, QoS and real-time applications although it has the limitation of implementation in simulation environment with static behavior. However, this study uses reliable topology and the run time is reasonable and justified to proof it's significant. All findings which accumulated from the simulation is highly contributed to the knowledge of networking particularly in QoS enhancement since this result proof the importance of research in finding new solution to eliminate the miss-behaved effect and motivates scholar redirect their research toward fairer and protective network.**

***Index Terms*—Component; fairness, protection, concurrent connection, scheduling, queuing, shared link.**

I. Introduction

With the increase attractiveness of using the Internet, particularly Real Time Application (RTA) and the increase in occupying more bandwidth from application point of view, users intentionally, tend to be greedy in order to monopolize more bandwidth than the others regardless of the method [1]. RTA is divided in to three main categories: retrieval (on-demand) application, broadcasting service and interactive application [2].

The usage of such applications increase sharply and the diversity is blooming [3]. Novel application is regularly introduced and the previous application is been extended further and further. This introduces the issue of fairness and which to be scheduled to be sent first as most of these applications are delay sensitive even though there is a variation in the sensitivity [4].

From another side, Peer-to-Peer (P2P) application allows hosts to utilize more bandwidth. Furthermore, users deliberately, share and use P2P more frequent than any other application to break through some restriction such as copyright and so forth. Beside P2P issue, some greedy programs, such as download manager, have been spread which introduce decline in the protection of regular user [3].

This paper discusses the impact of concurrent connection which is been utilized be the greedy applications and software in the protection and fairness properties of scheduling mechanism. In Scheduling mechanism, user could be defined as the source, source-destination pair, destination, process and so on. As a consequence of such weak definition, protection and fairness provided by the scheduling mechanisms is likely to be breached. Therefore, it is important to realize the potential of the simultaneous connection in the network and application performance and hence this paper shall discuss such impact.

Next section comprehensively explains the definition and the importance of protection and fairness in a network. Third section demonstrates the procedure and the methodology of paper. Analysis, results and conclusion are presented in the last few sections.

II. Protection and Fairness

Designing scheduling algorithm required a potential consideration of some properties and the absence of any of these properties considered as a weakness in the scheduler. However, some of these properties play a critical role in the scheduler and its absence could demolish the entire mechanism. Generally speaking, there are five main properties namely; fairness, bounding delay, protection, flexibility and simplicity [5]. Since this paper is primarily concern about the protection and fairness properties, this is an explanatory section which defines the property and explain the boundaries of its importance and engagement in the scheduling algorithm and hence in the network performance and QoS augmentation [6].

A. *Fairness*

1) *Definition*

There are several definitions of the fairness in packet scheduling. One famous definition, which is adopted by most scheduling design, is introduced by Demers et al. [7] which is the max-min fairness. As Demers et al. stated that fairness according to max-min rules is tightened by three conditions. The first condition that is resource allocation should not exceed the request of each user. Then, all mechanisms satisfied first condition should not provide higher minimum allocation for each user. Finally, second condition remains algorithmically true as we remove the minimal User and reduce the total resource. All these rules are summarized in equation 2.1a and 2.1b.

$$S_i^n = \max(F_i^{n-1}, V \quad 2.1a$$

$$F_i^n = S_i^n + \frac{L_i^n}{\emptyset_i} \qquad 2.2b$$

Where,

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S = Virtual Start time, F = Virtual finish time for the previous packet, A = Virtual arrival time and L = packet length.

Other parameters are the updating equation and the δ which control the promptness of the packet.

2) *Importance*

First In First Out (FIFO) is the first and basic scheduling algorithm ever adopted in the routers. Its principle is significantly simple and no any mathematical or implementation complexity involved in its implementation. Nevertheless, according the previous definition of fairness, it harmfully, deals with this important property. It does not support QoS particularly for RTA [8]. Therefore, if this mechanism is the only one that is been occupied by the routers, RTA will experience long delay and no protection at all although it provides flexibility and simplicity which is considered as second in term of its importance.

3) *Example*

This section is more clarification for the importance of the fairness criteria in the performance of the network particularly in supporting QoS for RTA. Let take the following scenario which is presented in Fig. 2.1. Let assume that there are two queue one is running the Voice Over IP (VOIP) session and the other is running File Transfer Protocol (FTP). Table 1 summarizes the properties of each application (FTP and VOIP). Therefore, using simple calculation method; FTP packet with size of 512 bytes requires around 64ms to be sent over a link with 64 Kbps. By comparison, a VOIP packet with a size of 80 bytes requires about 10 ms to be sent using the same line. Therefore, the time required for sending one FTP packet is six times larger than the one sent by VOIP application [9].

TABLE 2.1: PROPERTIES OF INTERNET TRAFFICS

Behavior Application	Packet size	Traffic volume	Traffic rate
FTP	Large	High	High
HTTP	Large	High	High
SMTP	Large	High	High
Video	Medium	Medium	Low
Telnet	Very small	Low	Low
VOIP	Small	Low	Low

Referring to the definition of fairness the above mention situation which is certainly happen in the presence of FIFO mechanism as the dominance, the fairness criterion is insufficient for several reasons.

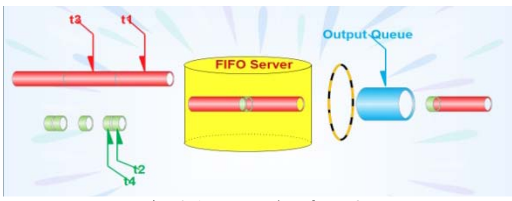

Fig. 2.1. Example of FIFO.

Firstly, since VOIP is smaller size it must be the first to be transmitted through the router. Secondly, since VOIP packet are delay sensitive, it also, the first in term of transmission. However, FIFO algorithm will allow this to be happened. Furthermore, FIFO by its mechanism breaches the rule of max-min which is essential in fairness definition.

B. *Protection*

4) *Definition*

According to well protected mechanism should be enforceable which means that the well behaved user should retain its allocation despite the presence of the greedy user. Protection is defined as the ability of the algorithm to efficiently protect the behaved users from misbehaved users. It would also, called as the efficiency of the scheduling mechanism [10].

5) *Importance*

Protecting network users from misbehaved users requires few steps before it could be achieved. One fundamental step is to insure the availability of a proper algorithm in the scheduling mechanism. Negle [11-13] raises this issue and addresses it by assigning a queue for each user and allocating the bandwidth fairly among all users or queues. Nevertheless, Demers et al. [7] contradict this by posing the priority and fairness concepts. According to Demers et al. some users deserve more bandwidth than others depending on max-min definition and hence deserve more protection.

This raises the demand for QoS which highly related to protection. If the protection level is down, network cannot guarantee the prompt reception of the RTA. The efficiency of the network shall suffer from critical degradation as the protection level decrease. Next section demonstrates an example which will illustrate and simplify the idea.

6) *Example*

Concurrent or parallelize download potentially influence the protection property as well as fairness by establishing multiple session to obtain larger allocation of bandwidth. Programs such as download manager and download accelerator attempts to bypass congestion control disciplines.Weighted Fair Queueing (WFQ) is the most famous scheduling mechanism used in today's routers or to be precise the only fair queueing mechanism used in routers ever. Network's users defined in WFQ as the source-destination pair [14, 15]. Fig. 2.2 present simple implementation of WFQ using source destination as a single queue.

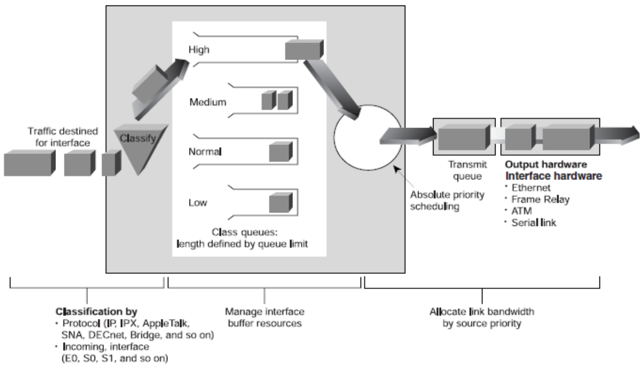

Fig. 2.2. Implementation of WFQ.

Fig. 2.3 explained the issue of establishing several sessions with multiple and different destination to obtain larger allocation of bandwidth which leads to less efficiency in the network performance.

In Fig. 2.3 we can see that as the number of connection of one source increase the allocated bandwidth will be increased as a consequence. P2P used establish at least 10 connections and sometimes it reaches 30 connections depending on number of users at the moment of download. Download accelerators software usually uses 10 connections which also significant.

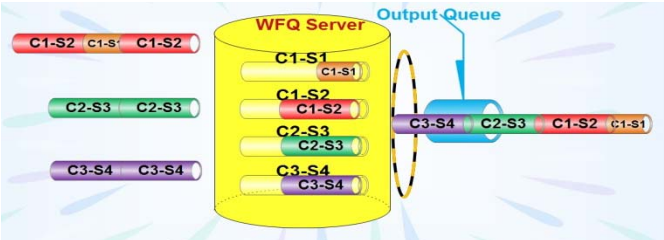

Fig. 2.3. Protection breaches in WFQ

III. Methodology and Implementation

This research is conducted in OPNET v14.5 under WIN 7 and with the aid of Microsoft Visual Studio 8 (professional edition). WFQ mechanism is used as a basis of the study since it is the most famous mechanism used in today's routers. Test case is evaluated using two scenarios. The first one, all users are identified as a normal user. Second scenario, identifies one of the users as a miss-behaved user which initiates multiple connection requesting the same file from multiple destinations.

The main objective of this paper is to emphasize in the potential impact of concurrent connection in the fairness and efficiency (protection) of a network and hence in QoS.

A. *Network Topology*

As stated in the previous section, there are two scenarios with the same topology. Our topology follows dumbbell topology which involves two routers and multiple source and destination clients. Fig. 3.1 shows network topology.

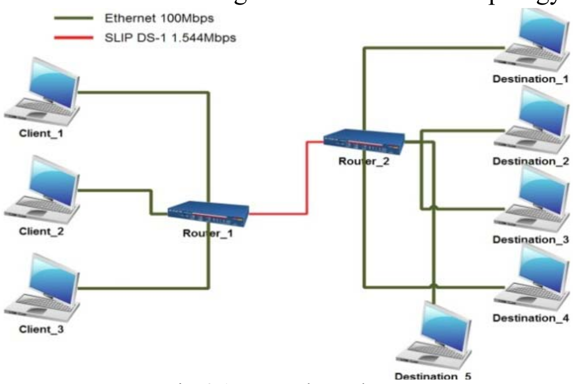

Fig. 3.1. Network topology.

There are three sources connected to first router with an Ethernet link with speed of 100Mbps. The connection between the first and second router is SLIP PPP DS-1 with data rate of 1.544 Mbps. Likewise, there are five destinations each connected to the second router with Ethernet link with data rate of 100Mbps all. All the previous mentioned parameters is been demonstrated in table 3.1. Links' data rates are been chosen carefully to simulate the current real-life connections.

TABLE 3.1. Configuration Parameters

Configuration Parameters	Value
FTP client to router	Ethernet 100Mbps
VOIP client to router	Ethernet 100 Mbps QoS with high priority
Router to router link	SLIP DA-1, 1.544 Mbps
Router to FTP client	Ethernet 100 Mbps
Router to VOIP client	Ethernet 100 Mbps

B. *Network Setup*

This section consists of the network setup including the characteristics of the File Transfer Protocol (FTP), Voice Over IP (VOIP), routers model and clients specifications. Before starting the description of network setup it would worth if it been mentioned that the entire implementation is accomplished over static network.

The first and second source clients (client_1 and client_2) are dedicated for sending FTP packets with constants bit rate of 500 bps and maximum size of 5GB. The third source client (client_3) establishes VOIP connection with destination_5. There are four FTP connections and one VOIP connection.

In first scenario, client_1 establishes one FTP connection with destination_1, client_2 establishes one FTP connection with destination_2 and client_3 establishes VOIP connection with destination_5. In the second scenario, client_1 establishes four FTP connection with destination_1,2,3 and 4. And rest is the same.

C. *OPNET Simulation*

Fig. 3.2 shows the OPNET simulation setup. The simulation is been ran for 5 simulation minutes for both scenarios. From the first glance it has been noticed that the second simulation took longer time than first one. Table 3.1 shows the running time.

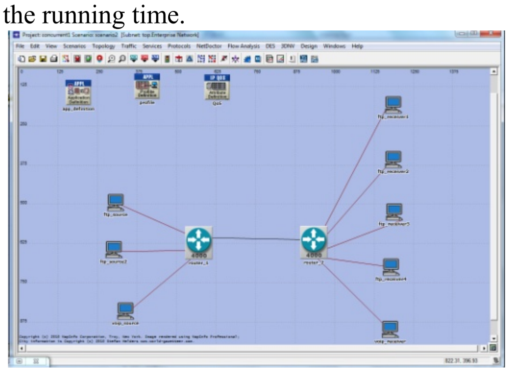

Fig. 3.2. OPNET simulation topology.

TABLE 3.1: Simulation Run Time

DES Execution Manager: concurrent1

	Status	Hostname	Duration	Sim Time Elapsed	Time Elapsed	Num Events	Total Memory	Avg Ev/s
scenario1 Run 1	Completed	localhost	5m 00s.	5m 00s.	31s.	5,650,843	40,478	179,426
scenario2 Run 1	Completed	localhost	5m 00s.	5m 00s.	1m 12s.	13,281,082	55,434	185,668

View Details | Pause | Stop Run | Stop Set | Stop S

We ran both simulations 10 times so we can collect more accurate results. The average elapsed time for the second simulation is all most two times the average elapsed time for the first. It can be easily noticed that number of discrete events in the later one is almost twice as the former. To sum up, there is an enormous difference in elapsed time and number of events although both scenarios execute similar applications and events.

D. Results and Analysis

This section analysis the results which are been collected from the simulation. There are number of statistics which is been demonstrated in Fig.s. We compare between packets received, packets sent, delay variation, and end-to-end delay in the first and second scenarios.

Fig. 4.1 present the comparison between delay variations.

The area covered by red color represents the delay variation at the presence of four connections from the greedy user client_1. The slop drawn with the red line shows that the delay variation is steeply increase whereas in the first scenario with one connection from client_1, delay variation has few effects.

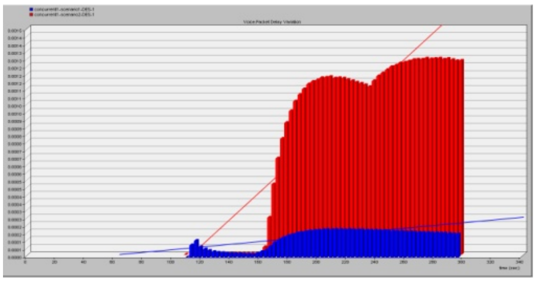

Fig. 4.1. Delay variation

Fig. 4.2 shows the impact of concurrent connection in the end-to-end delay.

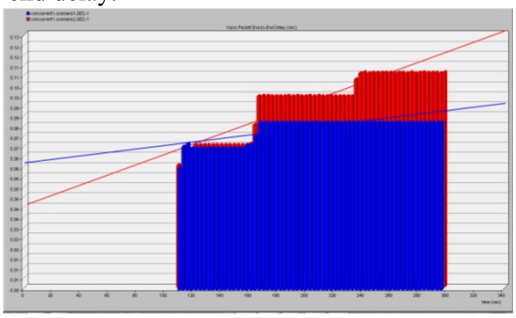

Fig. 4.2. End-to-End delay

The slop of the trend for the second scenario is more than the one for scenario_1 this prove that concurrent connection has a side effect on the end-to-end delay.

This delay variation and end-to-end delay are affected by the concurrent connection even though the number of packet sent and received in VOIP connections for both scenarios are almost the same which is been shown in Fig. 4.3.

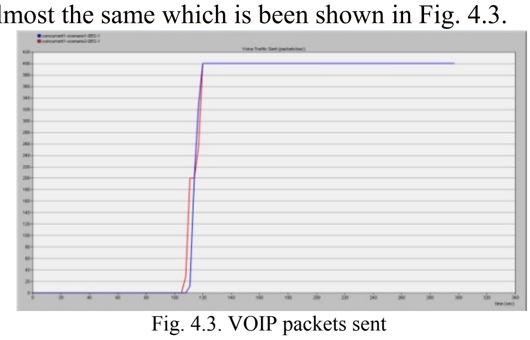

Fig. 4.3. VOIP packets sent

By comparison the number of packets sent and received in the system by FTP connection has dramatic increase as shown in Fig. 4.4.

Another diminution which is significantly influenced by such behaviors is the queuing delay particularly in the router. Fig. 4.5 presents the queuing delay in frouter_1 which is linked by 100Mbps Ethernet line to client_1, client_2 and client_VOIP. As a consequence to this queuing delay, VOIP packets will experience more delay and hence the QoS will be affected.

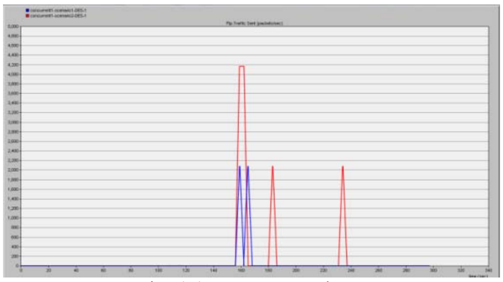

Fig. 4.4. FTP sent packets

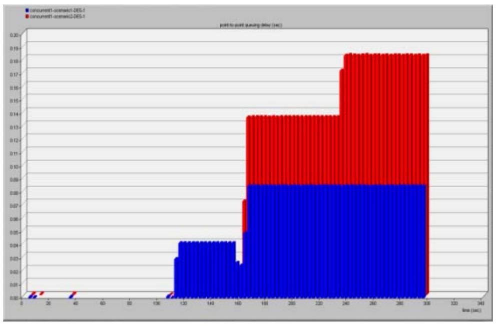

Fig. 4.5. queuing delay in reoutre_1

From Fig. 4.5 it can be obviously seen that the queuing delay in case of concurrent connection is almost double the one without such behavior.

IV. Conclusion

In this paper we analyzed the impact of simultaneous connection in the network performance particularly in delay variation, end-to-end delay, and queuing delay since these three parameters are has major influence in the performance of the network. Furthermore, any enormous increase in these three parameters has potential impact in the QoS and in the transmission rates of sensitive information such real-time applications.

We can summarize that those applications such P2P and download accelerators software shall increase their shares from the link with the sacrifice of others. This behavior is unfair and provides breaches in the protection proprieties which are essential in the network special in scheduling packets in the routers. The final recommendation from this paper is to provide more effective scheduling mechanisms which humble such un-pleased behavior.

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