A scheme for identifying and correcting the network weaknesses by incorporating bandwidth measurements

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Abstract Measurements of the network bandwidth is a fundamental issue in the area of networking analysis. Hence, a great deal of research should be conducted for evaluating and understanding of network measurements since it is crucial and useful in many areas of enhancing network performance including; protocol development, evaluate network changes and discover of the network problems. This paper is concerned with the analysis of bandwidth measurements A scheme for detecting and identifying of network problems by measuring the characteristics of network bandwidth is proposed. The proposed approach is applied on the network infrastructure at the Hashemite University-Jordan (HU) as a case study. The network bandwidth is analyzed in terms of upload/download measurements where these two variables are extracted from the main university network gateway. The results are incorporated in the proposed approach to identify the university network problems. Furthermore, a formula describing internet traffic and the other sources of traffic is introduced and proved by using the outcome of monitoring the bandwidth on firewall gateway. The presented scheme is shown for its ability to, successfully, identifying and accordingly correcting the main weaknesses and shortcomings of the targeted network.

Keywords—Bandwidth measurements, Upload/Download traffic, Network monitoring, Network performance.

I. Introduction

THE Computer network is the infrastructure for all distributed applications. The internet technologies as one of the main network applications depend, directly, in all its aspects on the network behavior. Hence, measurement of the network behavior and collection of real information about bandwidth becomes a crucial process [1-15]. The evaluation of network activity needs more information about the dynamic behavioral and characteristics of the network. Such information supports the research field and the technical approach evenly. Anirban Mahanti in [1] has used the information discovered by set of measurements carried out in the University of Calgary to evaluate the network performance and to determine the types of distributed applications that be applied on the existence network. Technically, large number of tools used to measure the network characteristics (i.e., performance, reliability, and availability). Solar winds tool is one of the network management software used to monitor the network and to provide up-to-date information about the network bandwidth. A lot of research is carried out to measure the network characteristics for specific purpose. In [5], the internet infrastructure and the network performance requirements are studied. The P2P video streaming has been studied in [10], the study examines the network performance by simulating the broadcasting.

This paper will concern in measuring two factors that affect the network bandwidth, namely, the upload and download and examine the transmission rate of the two factor over the Hashemite University-Jordan network gateway (multilayer switch). Solar winds tool and network directory are used to perform the measurement. This paper illustrates the download as a function of upload from the internet request and from other recourse. A study of three possible situations is carried out. That is, the upload is more than download, upload is less than download, and upload and download are equal. Accordingly, we will study how each situation effect the network bandwidth and internet traffic.

Different types of measurements were used to discover various network properties. One type of measurements has been carried out in two ways: End-to-End network bandwidth estimation to define the network bottleneck and Hop-to-Hop to determine the maximum bandwidth between the network nods, the available bandwidth was the topic of studies for all this types of research problems. Recently, there is increasing use for application that optimized its performance to utilized the network recourses [3]. This in turn increases the need for generation of application less greed over the network resources. Further, there are many new applications depend in its execution on the network bandwidth (i.e., IP telephone, TV over IP and other), all of these applications create new network traffic form and in turn reshape the network traffic transitions. Moreover, new types of protocols founded and network algorithm have been developed, and hence, there is a significant need for understanding the behaviors of the network before applying any new types of applications. The information collected by network measurements is utilized to build a knowledge base to be used to determine the ability to run them. The current internet infrastructures capable for providing the performance requirements of IPTV [4], in this paper, the researchers apply a huge number of measurements to conclude the importance of network bandwidth measurements.

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Information about Packet lose, Round trip time Delay, Transmission rate and other network characteristic was the objective for types of organizational information seeking to improve its network infrastructure, the collection of such information aiming to build the organizational network knowledge level. Such information can enhance the organization ability to development its network infrastructure, efficiently. For example, the University of Calgary analyzed the traffic measurement to estimate several network characteristics in order to build knowledge base about its network infrastructure behavioral [1]. The information collected from network measurement help different organization to take place in market. In CISCO, as a leader in the field of network device manufacture and IOS (internetwork operating system) Developer, all its new network protocol development researches concentrate on the idea of utilizing and behavior of network traffic.

Whatever the way in which the measurement is carried out or type of network design to which measurements did over, all had the same objective. That is, there is a crucial need to build information about my network traffic and analysis this information to enhance its process of development, and to select the suitable application to run well in the targeted environment. Hence, the idea of network traffic measurement takes a considerable focus in recent research directions. The latter is the main focus of this paper.

Network traffic and the internet traffic importance factor determined the network behavioral and the way in which its resources are utilized. In this paper, the two main factors that affect the network and internet traffic is measured and studied. The paper illustrates three approaches in which data rate changes its direction, and accordingly internet traffic affected. The main objective is to investigate the network problems by measuring network bandwidth in terms of uploads and downloads over the Hashemite University multilayer switch gateway, determines how this characteristic affects the network bandwidth and internet traffic then present the differences between the three situation where the (upload > download, upload < download, and upload=download). The network monitoring software is installed over the server in the university data center on which solar winds and network directory are running. This software is used to determine the network bandwidth and data rate over the getaway. Furthermore, the GUI monitoring of PIX firewall 535 is used to measure the internet traffic over the university router gateway.

II. Literature Survey

The work presented in [1] performs an analytical procedure on the traffic collected over the network router gateway of the University of Calgary under different characteristics (packet loss, round trip, traffic burst, and protocol usage and transmission size) to provide knowledge about the characteristics and properties of the internet traffic, this study coming from the useful of this measurement in many areas like protocol development and evaluation, monitor the change in the nature of the network in many areas it's good to have full information about your network traffic its give you the ability to determine any type of application you want to develop over your network and give you the ability to controls the flow of traffic over your existence network ,for example one of the rising application depend on the network in its work VOIP (voice over IP) this type of application will reshape your network traffic if you have good knowledge about your network traffic you have to determine and take a decision about use or not this application or what's type of improvement needed to running this types of application.

Another characteristic of network have been studded the network bandwidth measurement focused on two approaches hop-by-hop and end-by-end bandwidth to observe the bottleneck which's determine the available bandwidth in the link and how this available bandwidth give you ability to measure the dynamic load on path and then examine the applications and types of applications and how that can be leveraged by the identification of shared bottleneck bandwidth [2].

Because of the importance of end-to-end available bandwidth estimation and present as importance metric of network performance. In [3], it is shown how to estimate available bandwidth distributed at a user specified time. Two techniques were used. The first iterative and non-parametric its more appropriate for short time and with limited flow. The second techniques is parametric its faster because not iterative. The two techniques implement over PATHVAR tool can track the available bandwidth with rang of (10-20%) and then define four factor effect the variation of available bandwidth, the selection between these two algorithm depends on measurement time, degree of multiplexing and situational of traffic the measurement satisfactory for most application.

An emerging internet application IPTV flood the ISP with new traffic, this lets researcher going over measurement study to determine the behavioral of access layer and backbone layer and how this type of application reshape the traffic of the network, the measurements done over popular P2P IPTV, the measurements study proof the capabilities of the network to running such application, the study show how to architect successfully large scale P2P IPTV application [4].

From the importance of measuring the network traffic, many tools implement and used for this purpose, researcher going to implement light –Weight tool (Spruce) and compare it with other tool (IGI) and (Path-Load) over 400 different internet paths the compare process focus on the accuracy, filer, overhead and implementation the paper verified the measurements of compare the result with multi-router traffic Grapher, and how each tool reply to the change occurring in

the traffic. The measurement shows Spruce tool more accurate than other tools. Path-load tends to overestimate the available bandwidth whereas IGI becomes insensitive when The bottleneck utilization is large [5].

Wireless networks become one of main network deployment beside of traditional wired network. Wired network with its measurement tools interact in the same behavioral with wireless scenario from the point of bandwidth measurement. Some researchers focus on the idea of measuring the capacity of available network bandwidth based on the end point measurement modeled as point-to-point link serving packet in FIFO order, the researchers in [6] use cable modem and 802.11 base wireless network and break the model depend on different constraint (token bucket rate, schedule the packet, multiple distinct rate) and how this characteristic effect capacity and bandwidth rate using special tool (Probe Gap), the result show problem in non-FIFO scheduling.

In [7], the bandwidth measurement problem when CSMA/CA systems is studied and presented complete chart of rate response of system in steady-state, it analyzes the transient-state behavior of the system considered, this study show the access delay of propping packet before reaching the steady state, some of this measurements used to implement new measurement tool [7].

Paper [8] presents the concept of network traffic streams (the way in which traffic flow in the internet), it describes a method of measuring size and lifetime of internet streams and using this method to describe the characteristic of traffic distributed at different site, and then it categorizes the streaming depend on (lifetime, size) and present the ISP as factor effect the streaming, as a result the scheme gain information about dominated packet size and the iterative change happen in the ISP and the bandwidth size provided. Internet traffic streaming happened over UDP protocols. This type of connection provides faster packet moving. Such technology used by video website, because we need to provide the internet user with faster streaming as much as possible.

The network performance while data movement is P2P video streaming is studied in [9]. the researchers examine new system and study the side effect of network performance by simulation the broadcasting and demonstrate the distribution systems and the network performance is mostly effected by the system behavioral. The researcher studied the network topology and how it effects the resource utilization and examine that the P2P network provide more flexibility than the IP multicast technology. The results of this work examine show that the network performance depends on the measurement.

The researcher in [10] proposed a method to estimate the end-to-end available bandwidth, this method employs multi-rate (MR) packet sequence with kalman filtering to generate the proposed method (MR-BART), this method extension of bandwidth available in real time (BART). The proposed method shows higher accurate and coverage quickly in comparing with bandwidth available in real time method.

Saverio Mascolo et al [11] proposed TCP Westwood which is modification of TCP window algorithm, end-to-end bandwidth estimation did in term of determine the lose packet depend on reply acknowledgment. The estimate is then used to compute congestion window and slow start threshold after a congestion episode, that is, after three duplicate acknowledgments or after time out. Proposed TCP Westwood aimed at improving performance under random or sporadic losses. TCPW has been tested through simulation, showing considerable throughput gains in almost all wireless scenarios.

The work in [12] uses ping trace route and other tools, it describes how to use these tools to find the bandwidth of the internet link identified the bottleneck link in path and detect the upstream and downstream. The work of [13] shows that the available bandwidth of network path affects the performance of network. Two tools were used either the Probe Rate Model (PRM) or the Probe Gap Model (PGM).

The works presented in paper [16-21] provide different approaches and procedures to measure and analyze the bandwidth and network characteristics and to trouble shoot network weaknesses and problems accordingly. In [16], The paper provides a comprehensive review study of the techniques for both types of networks, namely, wired and wireless. They have categorized the techniques into 4 categories probing techniques, namely, the active, passive, and techniques suitable only for wireless networks and other techniques. In paper [17], the focus to give analysis on ABW-measure on messages related to a given protocol (i.e., Open-Flow). Both analytical and experimental assessments of measurements related to error due to delay in network between the controller and SDN switches are carried out. They extend the Open-Flow with a timestamping scheme locally, and two different implementations were discussed. In [18], the main focus was to estimate the end-to-end AB based on delays of packet from a given sampled data which is contaminated by a defined source of noises. They propose an adaptive threshold scheme on which it can estimate and adjust a threshold for separating those packets that are affected with delays of queuing from the remaining packets to enhance the accuracy of measurements. The work of [19], a robust investigation is carried out on daily collected Internet traffic produced in a smart campus of a university for twelve consecutive months (2017 January–December). For the daily 1-year study, Internet download traffic and Internet upload traffic at Nigerian university monitored and logged for the required application software (i.e., FreeRADIUS and Mikrotik Hotspot). A huge data-set with is provided as supplementary to easy research and validation. Each month, detailed statistics of daily Internet-download and upload are shown in tables. Box-plot

and time-series plots are given to explain the different trends of download and upload volume in the given smart campus of the university within the twelve months. In [20], the work proposed try to verify the internet usages of students and the staff in a university campus. The weblog files of daily traffics are generated in Web servers of the campus. The study is carried out to understand the internet usage and accordingly to identify the internet behavior in the campus. To this end, a special JAVA based tool is designed in order to extract the useful data from the weblogs. The paper [21] presented a hybrid scheme to do active measurements of the throughput in a regularly run approach while a passive tool keeps monitoring the packets generated. This in turn, allows the researchers to correlate the measurements at the application-layer which are obtained by the given active tool using the more detailed characteristics of the passive monitor.

III. Proposed Scheme and Methodology

This study uses data collection from the main multilayer switch of the Hashemite University-Jordan (HU), data is collected using solar winds engineering edition 8.2 which running over a server stand in the same multilayer switch VLAN (virtual local area network) data center of HU, the results are taken weekly to enhance the process of comparison, this section presents a systematic study and methods used to cover the different aspects of this investigation.

A. The Context Diagrams Present the Work Flow of the Study.

Fig. 1 represents the context diagrams of the work flow of the study. The first step will be running independently, while the second and third process will synchronously happen, and the last one will be running independently as well.

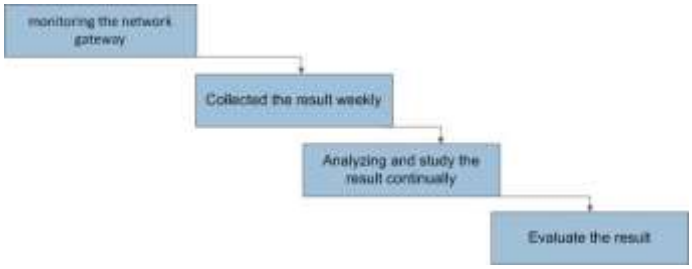

Fig. 1 The flow of the project processes.

B. Show Previous Network Monitoring Results

The previous collected measurements of the university are saved in special server to back track the network status. This play important role in building knowledge base for our study.

C. Use Special Software to Monitoring the Network.

The network measurements will have collected by using solar winds engineering edition 8.2 running over a server this software will determine the bandwidth traffic of the network happened over the main multilayer switch in terms of the upload and download rates over specific segment of the network. The network 3com directory software version 3.0 special 3com device discovery software will enhance the process of discovering the link utilization and helps in some measurements calculation.

D. Analyzing and Study the Collected Data Result.

The analyzing process is carried out by utilizing solar winds capabilities. This software provides us with the measurements and have features to analyze the resulted measurements by using flow chart analysis techniques. It is to be noted that SPSS software can be used if needed to enhance the analyzing process.

E. Evaluate the Network Behavioral in Terms of Special Characteristics (upload, download, and bandwidth) and its Impact on Internet Traffic.

The evaluation process is carried out in three major dimensions to reflect the result needed. The first one, evaluates the results given the upload equals the download traffic, and then study the impact on the internet traffic. The second, assuming the upload less than the download traffic and then study its effect on the internet traffic. And in the last one, when the upload greater than the download. The latter assumption is most important one to discover the network problems. The evaluation will have done in term of discover the problem will happen over the three status of the network mentioned above.

F. Clarification of the Results of Evaluation Associated with each Characteristic.

Presenting and clarifying the results will be shown over the reported network status. This paper will depict the effect of each status (upload and download changes) to the general network and internet traffic. This clarification will be concluded in mathematical equations and chart diagrams.

G. Using of the Monitoring Results for Future Evaluation Processes.

The monitoring result will be saved in special server in the data center to be utilized later to enhance the future evaluation process of the network traffic, and to assist any change may be happened in the network.

These systematical steps will be carried out during the business days and hours of HU, where at least 8-10 computer labs with at least 800 computers are running, and about 1500 network users in average connected over the network. This is very important to enhance the process of traffic estimation and measure by the software and to increase the measurement credibility.

IV. Experiments and Evaluation

This study describes the three situations in which the bandwidth changes its direction. The data collected by tools as described in Section 3 is used to determine the bandwidth equations. The variables of equations are expressed by upload and download measures. And hence, this study will present three equations of upload and download and identify problems associated with each related case.

A. Network Bandwidth

Network bandwidth represents the capacity of network connections, the greater capacity more likely to get higher network data flow, the realty of this data flow is important. However, it is hard to define flow data type, this study will present the data flow (bandwidth) as equation of internet traffic generated by internet request and other types of traffic generated by applications like FTP server.

$$\textit{Traffic flow} = \textit{internet traffic} + \textit{other traffic} \quad (1)$$

This formula will be proved by using the monitoring result over the GUI monitoring of PIX firewall 535, which founded as router gateway for HU.

Given:

1. Pix drop any inside connection if its destination not Http or www (internet connection protocols).
2. Some user officially adds as allowed Nat IP address over Pix firewall.
3. Pix firewall calculated the inside traffic and allowed internet traffic

Proof:

At given time the inside request size compared to that of outside (internet connection) was shown in the Fig. 2.

Interface Status

Interface	IP Address/Mask	Line	Link	Kbps
danty	87.236.232.194/27	up	up	50120
inside	192.168.10.2/29	up	up	51644
outside	213.139.46.195/27	down	down	0
servers	87.236.232.201/29	up	up	1892

Fig. 2 Present the state of HU pix interface.

Where

Danty interface = internet traffic = 50120/1024

Inside interface = all university traffic = (51644 kbps + 18644kbps)/1024

Then according to formula F1
68.64062 Mbps = 48.9453125 Mbps + other traffic **then**
Other traffic = 19.6953075 Mbps

Hence, this equation shows the actual university traffic in which not all traffic is internet request. In fact, there are unknown types of traffic generated as upload to the internal interface of multilayer switch (gateway), and this traffic send to the firewall and the pix firewall in turn drop it.

Hence, the other traffic size presents approximately 50% of the internet request. This generates high load and create different types of network latency. The flow of such traffic considers as a noise on the network (useless traffic). ***This shows that in such types of network (i.e., university's networks) the upload should be less than the download.***

The next section will study the three states of university gateway traffic to determine the traffic shape and to identify the generator of high upload problems. The measurement are done over interface F0/1 as shown in the Fig. 3.

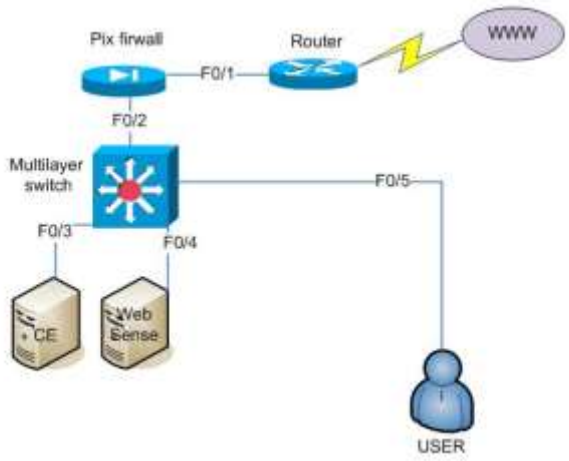

Fig. 3 The data center core layer

B The Networks Upload and Download

The term of Upload/Download that serve the area of this study "data send and receive over specific network interface". Download means to receive data to local system from remote system where Upload refer to send data from local system to remote system.

As mentioned in the previous section there are types of unknown upload generated. Such useless traffic causes problems in the network connection utilization. From this point, the paper will study the relationship between download and upload bandwidth from three points of views.

- ❖ The network upload equals the network download.
- ❖ The network uploads greater than the network download.
- ❖ The network upload less than the network download.

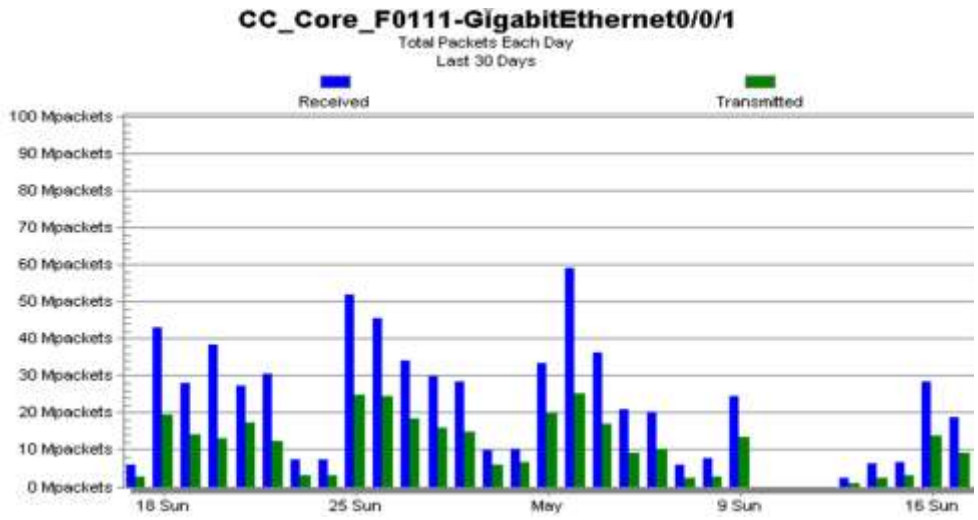

Fig. 4 The chart presents the bandwidth measurements over computer center core switch for 30 days

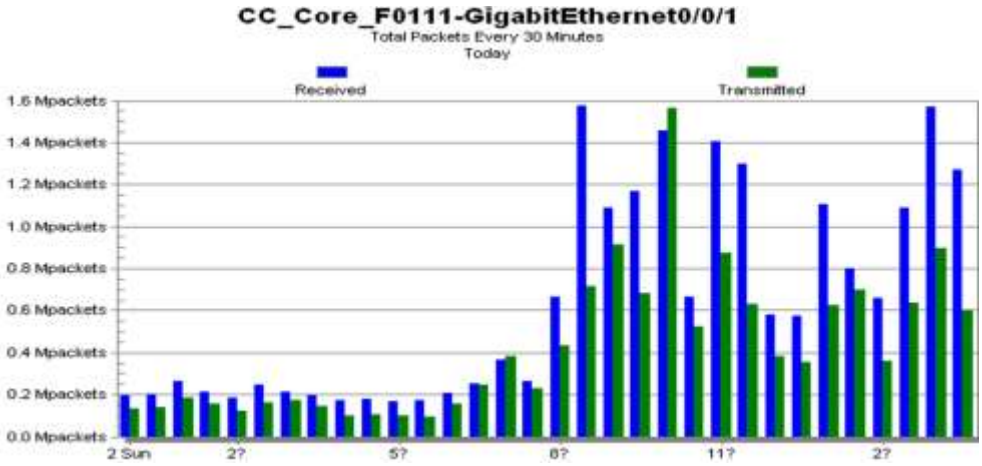

Fig.5 The received (upload) over the main interface compared to transmitted (download) packets

The measurements of the three cases will be carried over the internal gateway multilayer switch. In each of these situations, we will define the network problems associated and identify its generator.

a) The network upload equal the network download

In the reality, it is hard to define such situation; the network bandwidth is unsymmetrical where the value of upload and download continuously changes, and hence, this situation does not present any type of network weaknesses.

The chart shown in Fig. 4 presents the bandwidth upload and download over the university computer center core which proving the idea of unsymmetrical bandwidth.

b) The network uploads greater than the network downloads

According to the previous results shown in Section IV.A, the upload should be less than the download in the university networks or any similar networks.

In the natural of networks, the size of the requests always less than the size of receives packet, where the set number of requests for given user equal the upload generated by this user. Moreover, the set number of receives packet equal the download size of this user. Then the upload should be less than the download.

This section will show a network situation in which the uploads are more than the downloads and then identify the problem generator. Such problem will be discussed and a solution, as much as possible, will be provided.

- **The first problem**

  A device running server application and generates high upload traffic to the outside of the university.

  1. We measure the traffic of main core interface on which all traffic flows.

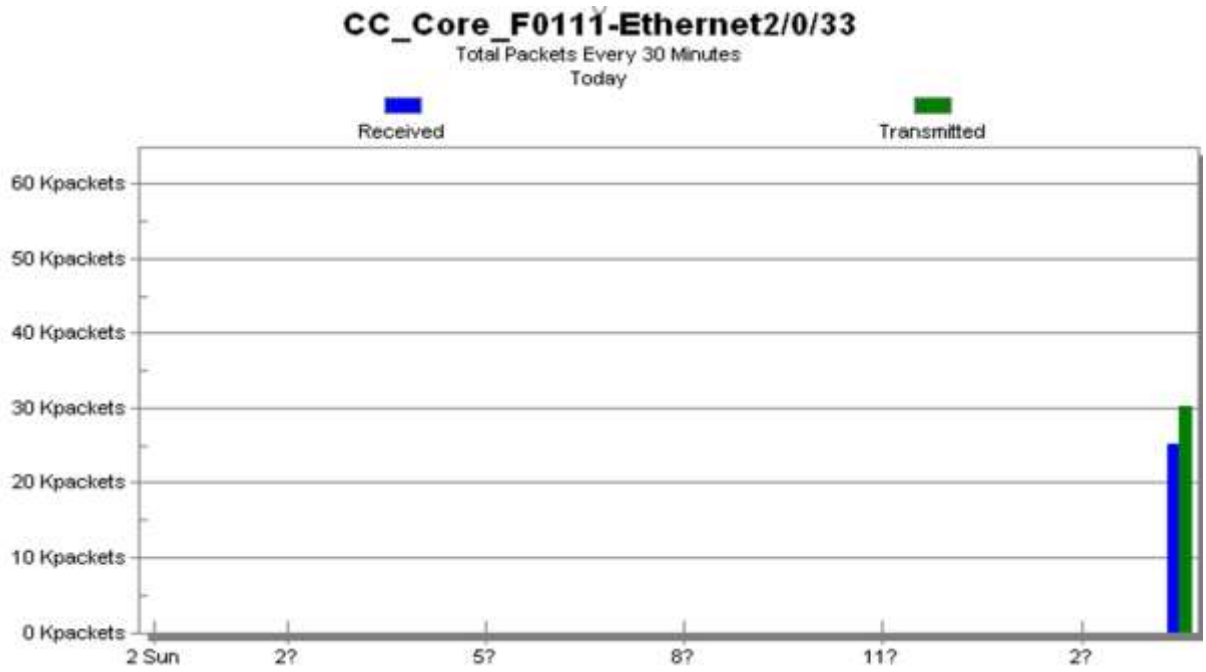

Fig. 6 Show the transmit (upload) over PC interface and the receives (download) packets

As shown in Fig. 5 there is some time during the day where the upload become higher than the download.

2. We applied tracking the all interfaces of the computer center which appear in Fig. 5 to determine the high upload generator.

Problem Discussion

We notice that, the cc-core appear in Fig. 5 which is one of the university main cores, receives on its interface high traffic. This means that the upload higher than the download.

In the Fig. 6, after tracking, a PC is discovered and by measuring the upload and download over its interface, it is found that the PC running server application (torrent), and generates such high upload.

- **The second problem**

The weaknesses in the execution of proxy server where it is the first gateway in the university on which the internet hits happened. The client request sends to the proxy server and the proxy in turn checks it and then forwards it to the main university core. The proxy position in the network present in Fig. 7 and the measurements done over interface f0/3.

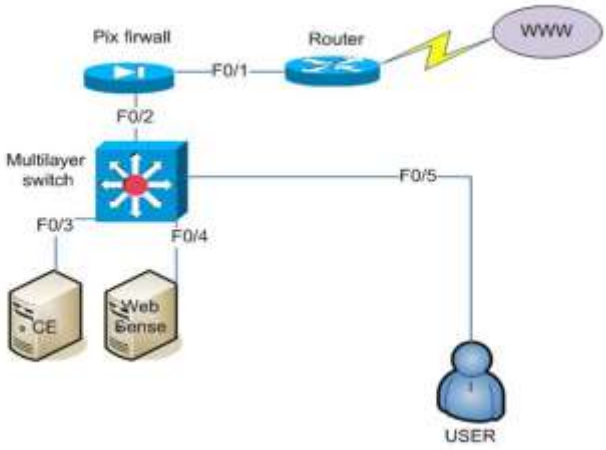

Fig. 7 The data center core layer

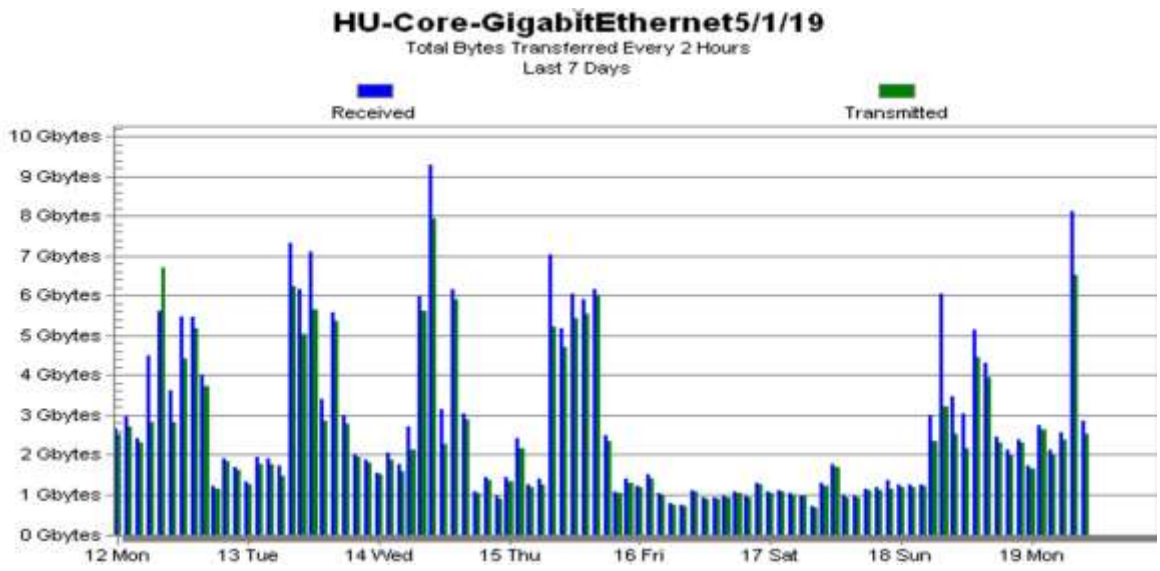

Fig. 8 The transmit (upload) over main core interface where proxy server connected and the receives (download) packets

1. We measure the traffic of main university core switch where the proxy server is connected.

Problem Discussion

The size of packet receives to the proxy server presented as upload are higher than the packet transmuted from the proxy as download, this indicates the existence of delay in the work of proxy in processing of data. Hence, the proxy must be reconfigured.

- **The third problem**

The huge amounts of data flow on the network may create types of flow-collision from layer 2 access switches to layer 3 core switches in the university, where layer 3 switches will prevent this type of corrupted data. This problem creates checksum error, that means the sending packet is corrupted during their travel over the network and become useless. Layer 3 switches faces this problem stay waiting which in turn makes the CPU of layer 3 switches loaded and suddenly restarted. This will create high interfaces traffic and lead to switch hanging.

Fig. 9 shows the log file of the switches where the measurements indicate high traffic.

```
Sys-health-check [EXT] checksum error (fast-path) on slot 3 prev=39 cur=3b
Sys-health-check [EXT] checksum error (fast-path) on slot 2 prev=8e cur=91
Sys-health-check [EXT] checksum error (fast-path) on slot 1 prev=aa cur=cd
Sys-health-check [EXT] checksum error (fast-path) on slot 3 prev=31 cur=39
Sys-health-check [EXT] checksum error (fast-path) on slot 2 prev=6d cur=8e
Sys-health-check [EXT] checksum error (fast-path) on slot 1 prev=fa cur=aa
Sys-health-check [EXT] checksum error (fast-path) on slot 2 prev=6b cur=6d
Sys-health-check [EXT] checksum error (fast-path) on slot 1 prev=ed cur=fa
Sys-health-check [CPU] checksum error (slow-path) on BPLNE
Sys-health-check [EXT] checksum error (fast-path) on slot 3 prev=28 cur=31
Sys-health-check [EXT] checksum error (fast-path) on slot 2 prev=5d cur=6b
Sys-health-check [EXT] checksum error (fast-path) on slot 1 prev=2f cur=ed
Sys-health-check [CPU] checksum error (slow-path) on BPLNE
```

Fig. 9 The log file of the university multilayer switches

Problem Discussion

The huge amount of traffic with corrupted data create problem for multilayer switches deal with. The network bandwidth measurements and analysis help us to discover such problem.

c) The network upload less than network download

The ideal and preferred situation is when network upload less than network downloads. In this case, the university network will be stable and the data moves smoothly over the network. In such situation, the network achieves high network resource utilization, high performance, and be highly available for users. Provided measurements made on the network, Fig. 10 shows the most prevalent situation for one of the building in HU campus in which most of the traffic problems detected after this study are solved.

C. Results Analysis and Assessment

Measuring of the network bandwidth is a crucial and fundamental process for the purpose of detecting of network problems and identifying its causes and generators. Moreover, the knowledge of the network behavior and its bandwidth (upload and download) characteristics gives the ability to determine the network problems and guiding the investigation of possible solutions:

In Section IV, a formula illustrating the university bandwidth as relationship between the internet request and the other requested traffic is provided. We have proved the formula using PIX firewall monitoring tool. The result shows the percentage of the other requested traffic (unknown traffic) present approximately 50% of the internet request. This type of useless traffic noises the network and generate higher load of the network paths which in turn decreases the network performance.

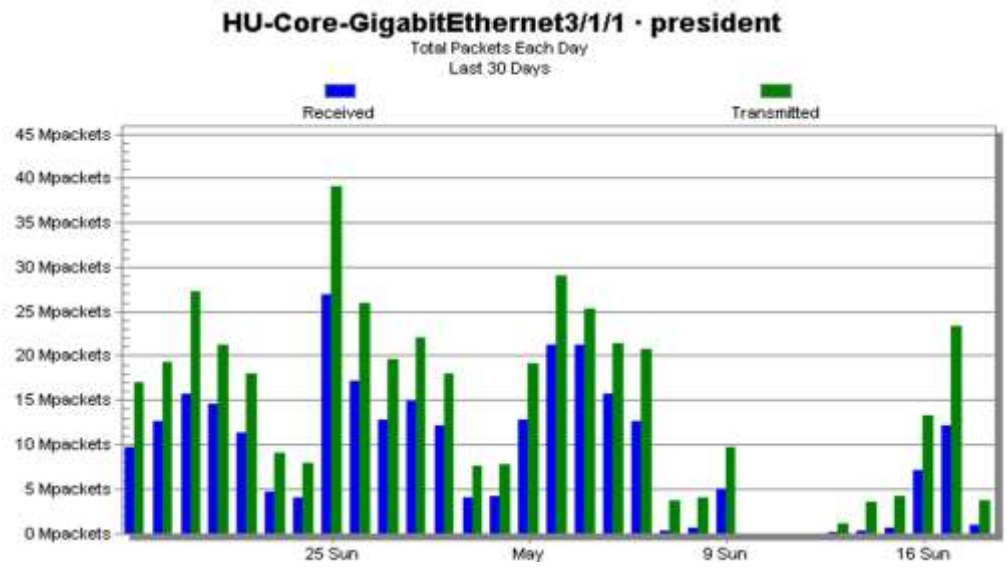

Fig. 10 The transmit (upload) over president building interface and the receives (download) packets for 30 days)

These measurements show that the size of upload traffic should be less than the download traffic. And that the direction of the bandwidth (upload and download) is an important metric in determines the network traffic shape. Section IV.B discusses three situations of the bandwidth and illustrates the problems associated with each situation.

The analysis of the measurements of the bandwidth is summarized as follows:

- **The Upload equal the download**

Network bandwidth is unsymmetrical where the value of upload and download continuously changes; it has been hard to define such situation in the university network.

- **The upload greater than the download**

Base on the previous results collected in section IV.A, the upload should be less than the download in the university network. We have discovered the network state in which the upload more than the download and show the problems generators.

The measurements performed and given in section IV shows three network problems as follows:

1. Device running server application and generate high upload traffic to the outside of the university. Any application server installed over the university user computer create type of our request, this generate upload traffic to outside the university were such traffic determine as useless traffic noise the network and create higher un-preferred network traffic. The bandwidth is undesirably sharable if user generates huge amount of traffic which in turn delays other connection request.
2. Weaknesses in the configuration of proxy server.
3. The measurements show the increasing numbers of hits over proxy server generate type of weakness in its work and long latency appear in its connection where the size of the request was much higher compared to its responses.
4. The huge amounts of data flow over the network creates types of flow-collisions from layer 2 access switches to layer 3 core switches in the university. The measurements show the huge amount of data generated from any network source will generate error over the core network layer. The upload coming from device has virus for example may interrupt the run of core layer and generate problems.

- **The upload less than the download**

After solving the soured of problems, the measurements show this preferred situation in which the university network be stable and the data moves easily over the network. Hence, in such situation the network achieves high network resource utilization, high performance, and high availability.

It is to be noted that the measurement was saved by using case reasoning techniques. This measurement will help us to determine any future problem have the same symptoms.

V. Conclusions and Future Work

A scheme for detecting and identifying of network problems by measuring the characteristics of network bandwidth has been proposed. The proposed approach has been applied on the network infrastructure at the Jordanian Hashemite University. The behavior of the network bandwidth

(upload/download) has been studied to explain the role of such measurements in discovering and correcting the network problems. In this paper, a formula describing the relationship between the main internet traffic and sources of other traffic has been introduced. Moreover, we have validated this formula using the measurements resulted by applying solar wind bandwidth measurement software tool.

The proposed scheme has been applied on different layers of the network and successfully detected the main problems happened in the university network. It has been shown that most of the detected problems were as follows: A PC running server application and generates high upload traffic, which in turn resulted in that the upload generated by such application affects the whole network. Accordingly, the correction action by the university was by periodically blocking such application and tuning the security configurations. Moreover, the study showed that the university proxy server doesn't treat will with huge amount of traffic generated by the different users on university network. Such problem generated a significant delay overhead on the overall network. Hence, a correction action has been carried out by reconfiguring the proxy accordingly. For future research direction, the proposed procedure will be applied to analyze wireless network problems by incorporating similar measurements.

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