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ABSTRACT

The ability to measure end-to-end Available Bandwidth (unused capacity) in the network path is useful for route selection in overlay networks, for QoS verification, network management and traffic engineering. This paper investigates at applying techniques and measurement of Available Bandwidth (AB) in the congestion control for the transmission of an efficient telemedicine content transport network by using an important ABETs tool such as Pathload. This paper discusses measurement and simulation results of wired and wireless networks for the unused capacity in the real telemedicine network path and normal network path. The results can assist an organization or country in estimating the network bandwidth requirements depending on the ability of exchange multimedia data of an organization or country. The logistics could cater implementation of low cost telemedicine applications. The telemedicine systems could include wireless and wired medical interface and communication infrastructure. A simulation has been done to investigate the network quality of service.

Keywords: Available Bandwidth; Measurement; Telemedicine; Quality of Service; Pathload

1   INTRODUCTION

THE motivation of this work is to estimate the bandwidth requirement for the telemedicine application that was still in the requirements stage, in order to be able to ensure that appropriate capacity was available using the existing industry supplied infrastructure. The objective of this paper is to provide a measurement and simulation of the applications of the available bandwidth estimation for wireless and wired for medical interface and communication infrastructure. We use extensive Internet and data connection for the existing telemedicine network measurements to show that these techniques estimate available bandwidth in wireless networks and wired networks. Finally, using both Internet and data connection measurements and MATLAB R2012b simulations, to explore how the measurement between wireless networks and wired networks differs, depending on that result an organization or country could estimate the network bandwidth requirements depending on the ability of exchange multimedia data of an organization or country.

Depending on the availability of required information, traffic from clients or patients' requests may need to traverse the local network or travel across the satellite link to the main central site. During its journey, traffic is subjected to the availability of networks and severs, and to the limited available bandwidth in each network link. The effect of these factors should be determined in order to adapt the system's design in such a way as to guarantee the required level of service. Many available bandwidth estimation tools have emerged such as Pathload [1], IGI/PTR [2] and Pathchirp [3].

Definition of ABE techniques

The available bandwidth (ABE) is defined as the maximum unused bandwidth at a link or end-to-end

path in a network, which depends on not only the link capacity, but also the traffic load, and is typically a time-varying metric. The definition of the available bandwidth ought to look at the average unused bandwidth over some time interval T. Thus,

$$A_i(t, T) = \frac{1}{T} \int_t^{T+t} (C_i - \lambda_i(t)) dt,$$

Where A_i (t, T) is the available bandwidth at link i at time t, is the link capacity, and λ_i is its traffic. The available bandwidth along a path is the minimum available bandwidth of all traversed links[4].

Why bandwidth is expensive

Bandwidth is a scarce resource. Bandwidth is an expensive due to the comparative weakness of the currencies of developing countries that have to pay in US dollars, Euros or other major currencies for most or all of their upstream international bandwidth. While the cost of the telecommunications link between two countries is generally shared, in the case of African countries (and possibly of many other developing countries) the cost of the international link is paid for entirely by the African country. This amounts to reverse subsidization of developed countries. The wired telecommunications networks in many developing countries reach only a small part of the population, and many areas (even parts of cities) are not covered at all. The development of wired networks cannot follow the same course as it did in industrialized countries owing to small populations or low population densities in some areas, poverty, the rise of mobile and satellite communications. Furthermore, data transmission over the air is currently monetarily expensive [5].

Why telemedicine

Telemedicine promises an improvement of health care service quality in rural, urban, dense and high mobile areas by reducing cost, optimizing communication resources utilization, providing medical expertise from a distance and addressing lack laboratory / x-rays expertise. In order to implement the telemedicine in these areas, a low cost telemedicine system with acceptable quality for medical data transfer is required [6].

Examples of the real network path of telemedicine network here in Tanzania, the telemedicine connection are Muhimbili national hospital, Mwananyamala Regional Hospital, Amana Regional Hospital, Temeke Regional Hospital, Bagamoyo District Hospital and Mbeya Referral Hospital, These are the regional hospitals and referral Hospitals, the services are offered from Muhimbili National Hospital these are the physical findings per a very week, therefore the session is conducted as per time table given below for demonstration and the instruction how to cure that diseases:

TABLE I.   Muhimbili   National   Hospital   Case Presentation Timetable – Weekwise

DAY	DEPARTMENT CASE PRESENTATION	TIME
MONDAY	SURGERY	7:00AM–9:00AM
TUESDAY	INTERNAL MEDICINE	8:00AM–9:00AM
WEDNESDAY	CARDIAC	8:00AM - 9:00AM
THURSDAY	EMERGENCY MEDICINE	7:30AM-8:30AM
FRIDAY	PEDIATRIC AND CHILD HEALTH	8:00AM - 9:00AM

This paper is organized as follows. We first discuss the related work in Section 2. In Section 3, we introduce Experimental approach for the Pathload. In Section 4, we present the significance of ABETs end to end telemedicine services. We conclude in Section 5

2   RELATED WORK

Several active end-to-end measurement tools have been proposed in the last years. Looking at the big picture, these systems assume the available bandwidth of a network path by sending a few packets and analyzing the effects on the probe frames of intermediate nodes and cross-traffic. Examples of probing tools which have emerged in recent years are Pathload [7], IGI/PTR [2], Abing [8], Spruce [4], pathChirp [9], DietTopp[9], Yaz [10], and ASSOLO[11]. These methods differ in the size and temporal structure of probe streams, and in the way the available bandwidth is derived from the received packets. Spruce uses tens of packet pairs having an input rate chosen to be roughly around to the capacity of the path, which is assumed to be known. Moreover, packets are spaced with exponential intervals in order to emulate a poissonian sampling process.

IGI[2] uses a sequence of about 60 unevenly spaced packets to probe the network and the gap between two consecutive packets is increased until the average output and initial gaps match. Similarly, PTR relies on unevenly spaced packets but the background traffic is detected through a comparison of the time intervals at the source with those found on the destination side. Abing relies on packet pair dispersion technique. Typically, 10 or 20 closely spaced probes are sent to one destination as a train. The evaluation of the observed packet pairs delays and the estimation of the available bandwidth are based on a technical analysis of the problems that the frames could meet in the routers or other network devices. Pathload and DietTopp use

constant bit-rate streams and change the sending rate every round.

Although both tools try to identify the turning point, DietTopp increases linearly the sending rate in successive streams while Pathload varies the probing rate using a binary search scheme. Pathload which should reports results more quickly and with increased accuracy with respect to its predecessor.

PathChirp sends a variable bit-rate stream consisting of exponentially spaced packets. The actual unused capacity is inferred from the rate responsible for increasing delays at the receiver side. ASSOLO [11] is a tool based on the same principle, but it features a different probing traffic profile and uses a filter to improve the accuracy and stability of results.

Other works like AB-Shoot [9], S-chirp [12], FEAT [13] , BART [14] or MRBART [15] have also been proposed in the past. However, the source codes of these tools have never been released publicly or the methods have been implemented only in simulations

Most of tools' proponents have compared the performance of their solution against that of others researchers. For example, in [16] compared Yaz with Pathload and Spruce in a controlled environment, while Strauss and his colleagues investigated the performances of Spruce against IGI and Pathload over hundreds of real Internet paths. For instance [3] tested pathChirp against Pathload and TOPP through emulation. In [9] the performance of pathChirp has been compared to that of ASSOLO in a laboratory network setup.

A more comprehensive evaluation has been performed by [17], who compared Abing, pathChirp, Pathload and Spruce on a high-speed testbed and on real world GigE paths. The specific features of the network paths also allowed the researchers to investigate timing issues related to high-speed links and network interfaces. A similar work has been carried out by [18] that tested Abing, Spruce, Netest/Pipechar, pathChirp and IGI over a real Internet path of the French national monitoring and measurement platform Metropolis.

In [17] compared IGI, pathChirp and Pathload in a testbed equipped with a proper measurement station. The adoption of a performance evaluation methodology relying on the use of electronic instrumentation for time measurements allowed the authors to focusing on concurrence, repeatability and bias of the results obtained from the test bed. Furthermore, an optimal setting of each tool has been identified thanks to the experimental activity.

In [19] the authors presented a comparative study of DietTopp, Pathload and pathChirp in a mobile transport network. However, all the results presented have been generated only from simulations using ns2. The ns2 network simulator has been used also in [20] to evaluate the performance of Pathload, pathChirp, Spruce, IGI and Cprobe under different network conditions.

We propose in this paper the platform of pathload, based on the past work of the comparison of the tool in terms of which should reports results more quickly and with increased accuracy and errors in the real time application. Our study is to measurement the available bandwidth in the performance of network in wired networks and wireless networks.

3 EXPERIMENTAL APPROACH

The performance of the experiment of measurement and estimation is performed in a network testbed with Poisson, burst and self-similar synthetic cross traffic and in a real network path at the Nelson Mandela African Institute of Science and Technology normal network and at Dar Es Salaam Institute of Technology (DIT) centre of excellence (CoEICT)- real telemedicine network [21].

3.1 Experiments

Using the testbed, the tools analyzed under this evaluation approach is Pathload according to their estimation time, accuracy and error measurement. Three main cases were studied. In the first phase, the tools are evaluated in a wired bandwidth environment. The second phase the tools evaluates in wireless bandwidth network conditions. The last phase evaluates the tools under variable load conditions[22].

3.2 Measurement results in wireless bandwidth networks environment

This section presents measurements done with Pathload in all wireless scenarios at the normal network. The measurements have been performed in a testbed containing wireless hops, but we believe that our results illustrate the measurement problem for larger ad-hoc networks, consisting of several wireless hops, as well
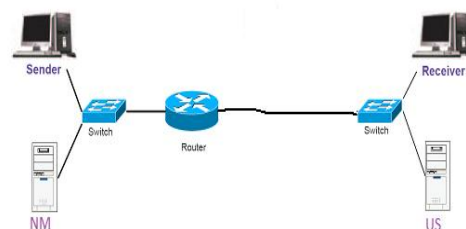

Figure 1. Architecture of Pathload

We have done measurements using Pathload, a tool that estimates the available bandwidth using 1472 bytes packets. The results obtained from using Pathload in our testbed with different cross-traffic distributions and intensities can be seen in figure 2.

We performed twenty four experiments for each tool. Both cross-traffic streams are exponentially distributed. The y-axis shows the measured Available bandwidth in Mbps, while the x- axis shows the twenty four hours experiments are carried out for each tool
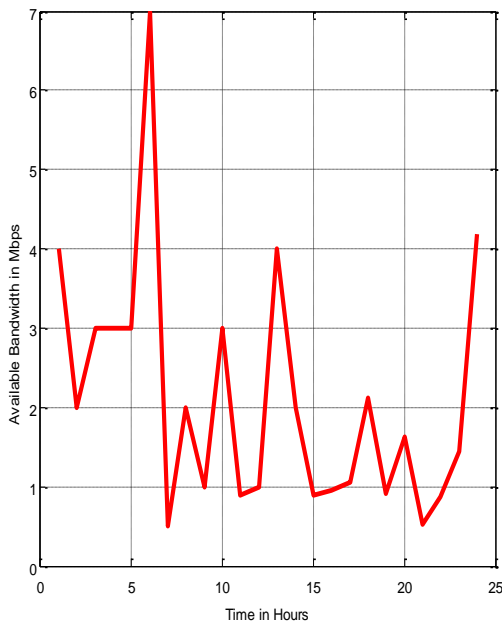
Figures 3 present the available bandwidth estimation (unused capacity in the real network path) for wired measurement the result obtained from the simulation experiments of Pathload with respect to time. It can be seen that the best measurements is obtained from 1:00 AM to 15:00 PM while on 16pm there was a drop up to 28.17Mbps, and hence from 17pm up to 24pm the average of unused capacity was good, using those values, we can obtain the best accuracy, convergence time and the application of that unused capacity.
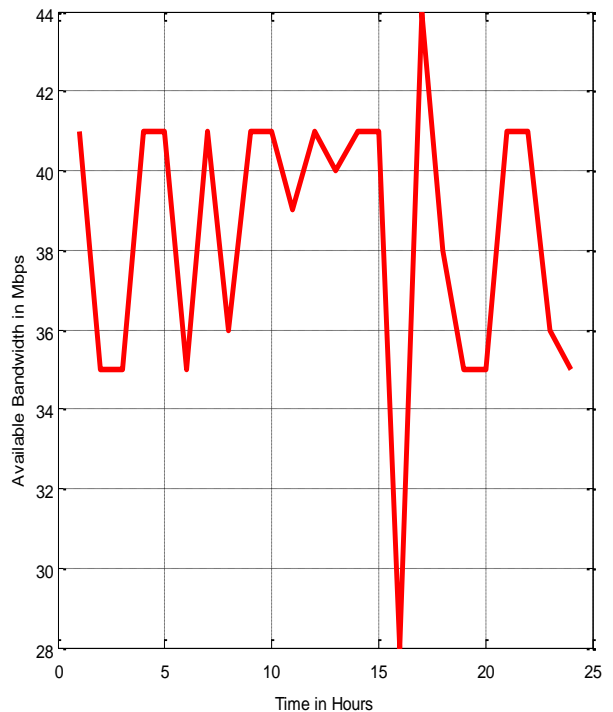

Figure 2.Pathload Measurement in Wireless Network

Figure 3.Pathload Measurement in Wired Network

Measurement results in wireless networks measurements in wireless networks are associated with frequent disconnections, predictable disconnections, physical support for broadcast, asymmetry, monetarily expensive, relatively unreliable, high bandwidth variability, and low bandwidth. These are the difficulties that can result in misleading bandwidth estimations for medical practice

3.3 Measurement results in wired bandwidth networks environment

This subsection presents our results from measurements using Pathload where the bottleneck is a wired link in the testbed as described in figure 1, which is the case in ad-hoc wireless networks. The measurements have been performed in a testbed containing wired hops, but we believe that our results illustrate the measurement problem for larger ad-hoc networks, consisting of several wired hops, as well.

3.4 Measurement results in wired Telemedicine bandwidth networks environment

The performance of the experiment of measurement and estimation is performed in a network testbed with Poisson, burst and self-similar synthetic cross traffic and in a real network path of telemedicine network at the Dar Es Salaam Institute of Technology (DIT) centre of excellence at (CoEICT) the telemedicine connection see table 1, above. Muhimbili National Hospital Case Presentation Timetable – Weekwise

We have done measurements using Pathload, a tool that estimates the available bandwidth using maximum packet size 1472 bytes. The results obtained from using Pathload in our testbed with different cross-traffic distributions and intensities can be seen in figure 4.
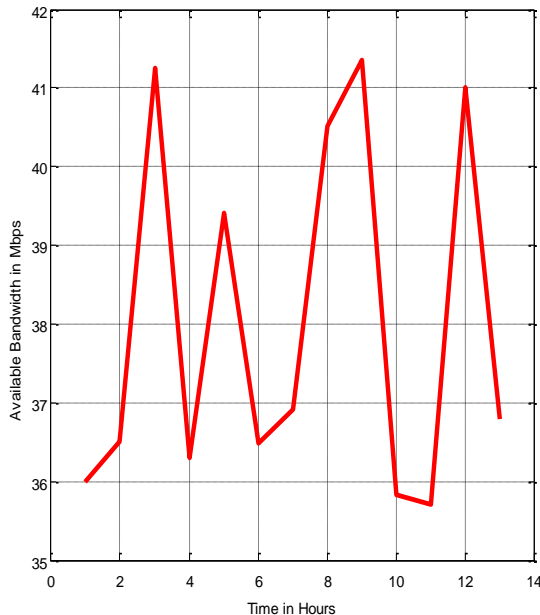
Figure 4. Testbed experiment using Pathload in Telemedicine Wired networks

Figures 4 present the available bandwidth estimation (unused capacity in the real network path) for wired measurement the result obtained from the simulation experiments of Pathload with respect to time. It can be seen that the unused capacity is above 35 Mbps, therefore there is a room of increasing the service activities and the QoS.

4 SIGNIFICANCE OF AVAILABLE BANDWIDTH INTO TELEMEDICINE

After the text edit has been completed, the paper is ready for the template. Duplicate the template file by using the Save As command, and use the naming convention prescribed by your conference for the name of your paper. In this newly created file, highlight all of the contents and import your prepared text file. You are now ready to style your paper.

Bandwidth: A measure of the information carrying capacity of a communications channel; a practical limit to the size, cost, and capability of a telemedicine service.

The amount of bandwidth required for your application is another important factor to take into account when choosing a telecommunication link. Bandwidth is the amount of information that can be transmitted over a telecommunications medium in a specified period of time. It is often measured in the number of bits of data that can be transmitted per second,

e.g. kilobits per second (kbps) or megabits per second (Mbps). Different telehealth applications require more bandwidth than others. For example, real-time medical videoconferencing often requires a minimum bandwidth of 384 kbps (provided by 3 ISDN lines,), whereas store and forward telemedicine (asynchronous transmission of still images, sounds or video) can be accomplished using a dial up 56 kbps modem connected on a POTS line. Usually the more bandwidth you require the higher the cost, that is the reason we want to employ the telemedicine through the unused capacity.

The best telecommunications link for your application depends on a number of factors such as what telecommunications infrastructure is available in your region, what bandwidth is required for the application and the cost. Not all telecommunications modalities are available in all areas. For example, ships at sea do not have access to land lines, making satellite and radiowave links the only telecommunications options. Often the best telecommunications link is the one that can be supported and serviced quickly by a local vendor. The cost of the telecommunications link (installation and on-going fees) is a key factor in the sustainability of a telehealth network.

The work in this paper is focused on applying ABETs to Telemedicine congestion control. We believe that telemedical applications may be of use in many, if not all, medical specialties. However this type of network facilitates learning through the exchange, transfer and distribution of medical information/knowledge, the generation and dissemination of new knowledge about how to collaborate effectively via telemedicine, and the application of this knowledge in telemedicine practice.

5 CONCLUSION

In this research works, all the results presented on this paper have been generated only from code using UNIX commands to measure the available bandwidth (unused capacity) by using the Pathload and several simulations have been carried out using MATLAB R2012b to determine the difference between wired and wireless networks available bandwidth, under different network conditions to be applied for the telemedicine transport network

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