Student Smart Dormitory Traffic Management Model

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Abstract

As many universities in Jakarta do not have in campus dormitories, entrepreneurs regard dormitories as business opportunity. They renovate and sometimes build semi high rise building to cater the need of students of near-by universities. The dormitories are equipped with Internet infrastructure. The students can then subscribe the dormitory infrastructure. The onset of Covid-19 pandemic forced the dorm's owner to improve their service quality. Social distancing, work from home and other movement limitation naturally increase network traffic. Dormitory residents started to complaint concerning Internet accessibility. Traffic management become a must in order to provide better service. This research provides a model of traffic management can be economically implemented either on premise or remotely. It is also based on conventional on premise network hardware that has the facility to manage traffic of small to medium scale business. To test the model, PRTG is used as the monitoring system and MikroTik routers that have several choices shape Internet are selected. Traffic can be shaped according to user need. Implementing the model enables proactive network management.

Keywords
Dormitory, PRTG, traffic shaping, network management, service quality

1. Introduction

Most higher education institutions such as universities in Jakarta do not have dormitories for their students. The students attending these higher education institution have their home town outside Jakarta. They are coming regions around Jakarta and all over Indonesia. The better universities attract potential students. They can be financially or intellectually better off. They will need accommodation during their study period. There are also students who are residents of Jakarta self but have to commute to the higher education institution location. They have to take public transportation or privately owned transportation means. The heavy traffic could mean spending substantially traveling time and draining energy that could taxed intellectually. Students overcome these obstacles by living in a dormitory during the week. Hence; the demand of accommodation is created. House owners that can spare rooms or able to renovate their houses to add rooms started to rent out rooms. Private boarding houses grows within the perimeters of the higher education institutions. Considering renting out rooms is a business opportunity, some people with sufficient capital build dormitory like buildings that can accommodate up to hundreds of rental rooms. To attract potential renters the dormitories provide additional facilities that can cater the needs not only students but also commuting professionals. The dormitories does not rent out rooms on short term basis such as daily or weekly. Based on their market segment, the dormitories one of the essential services offered is fast Internet access. Even though there are several cellular communication provider that also offered Internet access at reasonable price, but traditional Internet access which is cable based is still highly demanded. Cable or fixed connection is considered more stable in terms of connection stability and speed. The dormitories owners naturally install and thrives to fulfill the demand of the market. These private owned dormitories are mostly not run professionally and only considered as revenue generator. As dormitories close to certain higher education institutions have students, working alumni and young professionals that are financially better off, the ad hoc management of essential needs such as Internet infra-structure is now not acceptable. The churn at certain dormitory is high due to perceived in adequate Internet access quality such as speed and stability.

It is therefore necessary for the dormitories business owners to realize that the use of Internet should be managed. The use of Internet connection need certain supervision whether the infra- structure occupancy, number of packet loads, or operational status of equipment, Care must be taken concerning users themselves such as accessing dubious sites

or unlawful activities, The development of on line applications that are Internet accessible using desk tops, note book computers or smartphones needs mind set changes. It is better to assume that dormitories residents are information technology savvy. To be on the save side especially legally and businesswise could be thriving, it would be advisable to understand and to know the traffic flow in and from the network.

1.1 Objectives

The objective of this research is to support dormitories owner in managing traffic (Wairisal and Surantha 2018) within their premises. Understanding traffic composition could avoid unpleasant surprises. It can be safely assumed that modern network equipment and their applications support TCP/IP network architecture in order to access the Internet. A monitoring system with network equipment that could fulfill traffic management within a dormitory is proposed (Paessler 2021), (Zobel 2013). The system starts with minimum management facility but it is modular to handle a growing demand. The model is designed to accommodate small to medium size dormitories. The concept itself can be easily adapted to large scale dormitories and multi-location if necessary with the caveat in terms of financial, legal, human resources and equipment.

2. Literature Review

The landscape of student learning activities are suddenly changing. Internet was transformed from a supporting role to an essential infra-structure due the pandemic. Some universities has been transforming their methods of delivery to more Internet based instead of traditional face to face. The Gen-Z students prefer being independent and student centric learning. Lecturer should become learning facilitator in obtaining knowledge instead of knowledge source. Consequently, Internet access is essential in student life. Prior to the pandemic, Internet traffic is mainly consists of traffic to support the students in finishing their assignments or projects. The pandemic increases Internet access tremendously as all traditional face to face meetings become on line meetings. Video conferences replaces face to face meetings. Broadband infrastructure is a must. Moreover; regulations to contain the spread of virus infections reduced direct social contacts and replace with virtual contacts. The time students are on line and generate traffic become longer. The Internet access infra-structure will be strained. The student dormitories is not spared from this phenomenon. Even though occupancy of dormitories are also decreasing tremendously, but still the remaining residents need the infrastructure. The dormitory management must keep the Internet access service satisfactory in order to retain the residents.

Corporate computer networks have always network management system that manage the sanity of its network. Depending the network size, it has functions that are essential and necessary to keep a corporate network running according to the need of a corporate. One of the function that must be properly managed is data traffic. Network traffic management is the process of managing network traffic particularly ensuring Internet bandwidth availability to users. It manages congestion latency and packet loss (Gevros 2001, Mo and Walrand 2000). It is often also known as bandwidth management (Sinha and Kumar 2013, Al-Masah and Al-Sharafi 2013). To work effectively, it must be able to measure the network traffic. Traffic measurements can determine the root causes of network congestion (Ryu et al. 2003), latency or packet loss and assisting the troubleshooting efforts.

Within the trouble shooting and managing the traffic, there is a need for traffic shaping and traffic policing (Zuberek and Strzeciwilk 2018, Kanuparthy et al. 2011). Traffic shaping could mean delaying of packets until the specified bandwidth is available. To delay generally queues are needed. Traffic shaping involves traffic policing as well. In traffic policing packets are dropped or discarded and sometimes reduced packets priority that exceed the specified infra-structure bandwidth. Disturbances leads to productivity loss, misinformation for the residents. These problems occur due the rate of data transfer. The rate is determined by a number of factors such as bandwidth, physical distance between the source and destination, and the number of devices that are involved. Infra-structure bandwidth is one of the most important factor. A complete control of the bandwidth determine data transmission rate through the. To improve network bandwidth will increase the rate of data transfer. Traffic shaping is one of the easiest choice. Traffic shaping is a technique for managing network bandwidth. It supports the optimalisation of a network's performance, increases the usability of the bandwidth in prioritizing certain data packets, and reducing latency. In principle the traffic can be shaped according to application traffic and according to route choice traffic shaping. The traffic shaping is implemented in a router. A router can be set to handle higher priority for certain applications. The data packets are sent quickly (Siahaan 2016).

Traffic shaping allows the prioritizing the transfer data packets. The importance of data packets of critical applications can be set over other data. The prioritization is needed to make the most of the available bandwidth. It then can limit the use of resources by certain sharing applications. It is considered as Internet Traffic Management best practices. Shaping helps normalizing traffic flow at certain peak times to ensure that the transmission rate does not exceed the configured rate of transmission. To implement traffic shaping quite often different device manufacturers implement the shaping differently, generally it is set-up through the router. It is essential to determine the rate of transmission.
Apart from traffic shaping there is also traffic policing. Traffic policing has different functions with different outputs. Traffic policing send out data packets in bursts and if the traffic reaches the maximum rate, other left over packets are dropped. An uneven flow of data will be created. Traffic policing could be harmful for certain applications. Traffic shaping only slows down the rate of transmission. No packets are dropped and the output is a smooth. Traffic shaping delays packets by queuing. Traffic policing can be used for incoming and outgoing packets. Traffic shaping is effective for optimization of the bandwidth. Delaying traffic ensures critical applications have priority. It is useful technique for organizations.

Mikrotik RouterOS implemented several queuing algorithm that can be selected for traffic management. They are among other FIFO or First In First Out that is use for traffic policing. If the queue is full that the packet will be dropped (Hasegawa et al. 1999). SFQ or Stochastic Fairness Queuing is used by RouterOS based on hash and round-robin. Incoming packet traffic will be hashed to separate in groups. Round robin algorithm is used to output the packets. The next algorithm is RED or Random Early Drop. RouterOS implement RED to avoid congestion in the network. It control the average queue size by comparing two thresholds minimum and maximum. If the average of the queue is less than the minimum size then no packets will be dropped. If the average queue is bigger than the maximum threshold all incoming packets will be dropped, whereas if the average queue is between the minimum and maximum size, packets will be dropped randomly. RouterOS also implement Per-Connection Queue or PCQ (Ramadhan et al. 2016), (Smansub et al. 2019) which is similar to SFQ but has selectable parameters to classify such as destination address, source address, rate, queue limit and others.

PRTG (Paessler Router Traffic Grapher) is an agentless monitoring system (Paessler 2021). It does not need agent software at target devices that will be monitored. It can monitor various traffic such as SNMP and traffic flow IPFIX and NetFlow. For each parameter that will be measured or monitored one probe is need. It also has other features supporting network monitoring. It also provides alerting choices such as email, push notification, audible alarm and SMS alert.

3. Methods

In order to ensure dormitory resident satisfaction and consequently reducing the possibility of churn the quality of Internet access must be managed. One of the determinant factor of Internet access is the traffic from and toward the dormitory itself. It is necessary to understand the traffic composition. It is assumed that internal traffic which consists traffic among rooms is negligible as among the dormitory residents there are negligible business or social relation. Among the residents there are only casual interaction and generally face to face. Based on this environment the traffic of interest are mostly Internet traffic. For a starting point it is assumed that download traffic is dominant. Residents of the dormitory are mostly students and young first time job holders. It is therefore necessary to understand the traffic composition of the dormitory. It could happen that different dormitories have different traffic composition as the nature of the residents are also different. Monitoring using PRTG could provide the needed information. Based on the information obtained, different traffic shaping and policing is applied and measured the result.

In a dormitory traffic monitoring must be a periodic activity as the resident composition could change have certain impact ta the traffic. It is also influenced by the environment especially the pandemic. During this pandemic the resident composition could be static, but regulations of the authority certainly will impact the traffic. Regulations require almost academic activities of the students performed on-line. The dynamics of dormitory residents could impact the traffic composition. The measurement results can be used to manage the traffic. The result of this research will provide indications which traffic control method should be applied. It will not be a one time effort but an iterative process. The method in this research is simple and can be implemented with a caveat that the gateway router is based on the availability of traffic shaping and policing features needed.

The gateway router that is selected is a MikroTik router that have several traffic control features. The gateway for the dormitory has just a simple basic configuration that route traffic as it is to the Internet. There is only a single line to

the Internet with a rated capacity of 100 Mbps. The gateway router under observation is physically connected to a cable modem with coaxial cable. No traffic management is performed before this study.

In order to determine if traffic control is needed at the dormitory under observation under current condition, the traffic should be known. PRTG was selected to collect data. PRTG monitored continuously in real time. As the current traffic has been established, traffic control will then be applied and the impact will be measured. To control the traffic, it must be classified and marked for further action, Both TCP and UDP need classification and marking before applying traffic shaping or traffic policing. TCP traffic need differentiation between browsing and downloading. It is advisable to provide higher priority to HTTP/HTTPS browsing in order that the user experience only slight disturbance or delay during their o internet browse. Meanwhile; at HTTP/HTTPS Download the traffic is marked to a certain amount. Traffic above that amount will marked and put to a lower priority. All responses relevant of TCP will have even higher priority than other applications. All other not marked TCP traffic have priority higher than download traffic. UDP traffic need also differentiation in the application traffic such as DNS, QUIC or Quick UDP Internet Connection and regular UDP Traffic. Special attention must be given to DNS packets that are small UDP packets but is essential for web site access. DNS packets should have the highest priority. A new standard in UDP is QUIC. QUIC that is defined in 2013 is created in order that UDP can run with TLS encryption. MikroTik with its RouterOS has Mangle proses that perform mark-connection and mark-packet. Mark-connection is used for Queue Tree which is suitable to control all traffic.

4. Data Collection

To determine what choices of traffic shaping or traffic policing is suitable for the type of traffic that are mostly running in the dormitory under observation, PRTG provided a report for each type of shaping and policing being run. The type of shaping or policing is determined by the queuing methods. MikroTik router with its RouterOS has PCQ, SFQ, RED, and FIFO as the queuing method for traffic control. The default configuration is no traffic control. Traffic control is needed to overcome traffic congestion. Traffic congestion happens if the output is overwhelmed data packets either incoming, outgoing or both. To compare the performance of traffic control due to the various queuing methods, a congested Internet access line must be created. A file that is within the line capacity around 100MB is uploaded or downloaded to the Internet to have a congested line. PRTG then measures latency, jitter, and packet loss, and delay. The result is then compared to uncongested line.

5. Results and Discussion

The experiment and measurement was performed for several days at different times to have consistent result. The measurements are performed to upload files of 0.1 MB, 1 MB and 10 MB to an idle line and congested line without traffic policing. The measurements are repeated with several types of traffic policing. The result is shown in Table 1. The same method of downloading file is also performed, but for of larger file (1 MB, 10 MB,and 25MB). The result is shown in Table 2. The graphical result can is shown in Figure 1 and Figure 2.

5.1 Numerical Results

Table 1. Upload Transfer Rate in Mbps

File Size MB	Without Traffic Policing		With Traffic Policing - Idle Line				With Traffic Policing - Congested Line			
	Idle	Congested	FIFO	PCQ	SFQ	RED	FIFO	PCQ	SFQ	RED
0.1	9.9	3.5	7.8	7.8	8.6	7.2	4.6	0.2	2.9	0.2
1.0	14.9	1.5	12.3	13.4	13.2	12.2	5.6	0.6	3.3	0.7
10.0	15.6	-	13.9	14.2	14.1	13.8	0.6	5.7	1.5	5.8

Table 2. Download Transfer Rate in Mbps

File Size MB	Without Traffic Policing		With Traffic Policing - Idle Line				With Traffic Policing - Congested Line			
	Idle	Congested	FIFO	PCQ	SFQ	RED	FIFO	PCQ	SFQ	RED

1.0	78.6	7.7		57.0	73.5	71.8	75.5	44.9	35.7	22.3	32.4
10.0	84.7	9.6		81.6	81.1	84.1	83.0	23.1	24.3	6.9	31.2
25.0	86.1	-		84.0	77.5	79.7	83.0	-			

5.2 Graphical Results

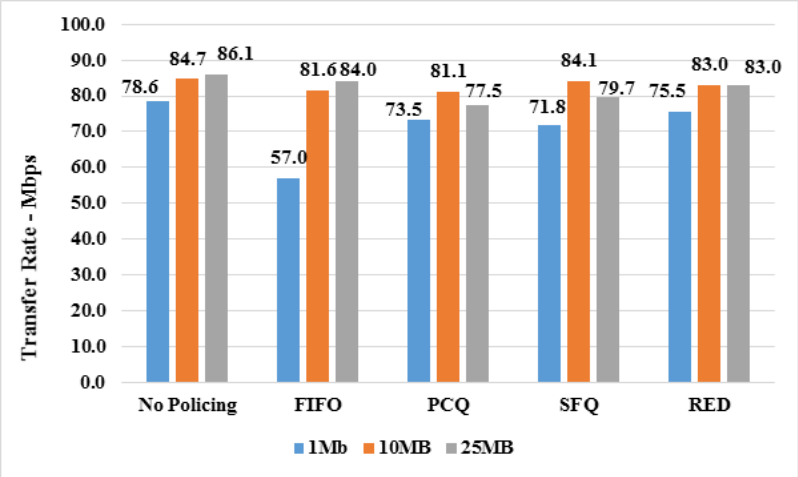

Figure 1. Download Transfer Rate in Mbps - Idle Line

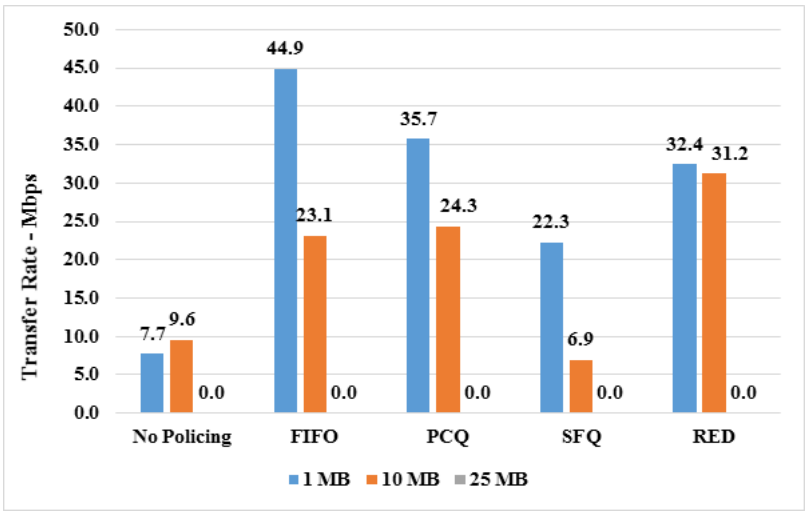

Figure 2. Download Transfer Rate in Mbps -Congested Line

Under congestion condition of different queue resulted in differences in performance. Continuous monitoring enable pro-active action on traffic control. Pro-active control for dormitory set-up need certain resources that will increase overhead cost with the advantage of a well-managed traffic that could satisfy residents as customer. Periodic monitoring enable the trouble shooting of resident complaints. The measurements results showed that traffic performance can be improved if traffic controls are applied. Depending on the applications there is certain control that improves its performance as the necessary parameters is improving. As shown RED has the best performance for download will small latency, jitter, and packet loss rate.

6. Conclusion

The traffic management system that make use MikroTik RouterOS shows its experimental capability of shaping and policing traffic that is suitable for the traffic that is being carried. In a student dormitory before implementing traffic control, the existing traffic must be known. PRTG could help dormitory management or third party understand what

to do. Based on the report extracted from PRTG, the traffic characteristics of the dormitory can be profiled. Prioritizing application data packet and implementing appropriate traffic control, would improve the traffic flow. Mangling could halved the delay time. Dormitory residents as customer could be satisfied with the traffic performance. Even though the model is based on MikroTik RouterOS, PRTG, and Internet access subscription with capacity of 10MB download and 1 MB upload for one dormitory, the concept can be slightly adjusted or modified to a larger system. The Student Smart Dormitory Traffic Management Model can be adapted for expanded centralized network management of multi building and multi-location dormitory system.

References

Al-Masah, A.S. and Al-Sharafi, A.M., Benefits of cloud computing for network infrastructure monitoring service. *Int. Jrnl of Adv in Eng & Tech, vol.* 5, no. 2, pp. 46, 2013.

Gevros, P., Crowcroft, J., Kirstein, P. and Bhatti, S. Congestion control mechanisms and the best effort service model. *IEEE Network,* vol. 15, no. 3, pp. 16-26, 2001.

Hasegawa, G., Murata, M. and Miyahara, H. Fairness and stability of congestion control mechanisms of TCP, *Proc.IEEE INFOCOM'99,* vol. 3, pp. 1329-36, 1999.

Kanuparthy, P. and Dovrolis, C., ShaperProbe: end-to-end detection of ISP traffic shaping using active methods. *Proc. of the 2011 ACM SIGCOMM conference on Internet measurement conference,* pp. 473-82, 2011.

Mo, J. and Walrand, J., Fair end-to-end window-based congestion control. *IEEE/ACM Trans. on networking,* vol.8, no. 5, pp. 556-57, 2000.

Paessler, A.G., PRTG network monitor user manual. Available: *https://www.paessler.com/manuals/prtg,* June 16, 2021.

Ramadhan, A., Indrajit, R.E, Rokhman, N., Subanar, W., Kumar, P.S., Rao, B.T. and Bossoufi Analysis of effectiveness of using simple queue with per connection queue (PCQ) in the bandwidth management *Jrn.l of Theoretical and Appl. Inf Tech,* vol. 83, no. 3, 2016.

Ryu, S., Rump, C. and Qiao, C., Advances in internet congestion control *IEEE Comm. Surveys & Tutorials,* vol. 5, no. 1, pp 28-39, 2003.

Siahaan, M.D.L., MikroTik bandwidth management to gain the users prosperity prevalent *Int. Jrnl of En. Trends and Tech.,* pp. 218-22, 2016.

Sinha, A. and Kumar, N., Bandwidth monitoring tools. *UACEE Int. Jrnl of Adv.in Computer Ntwrks and its Sec,* vol. 3, no. 2, pp. 116-20, 2013.

Smansub, C., Purahong, B., Sithiyopasakul, P. and Benjangkaprasert, C., A study of network bandwidth management by using queue tree with per connection queue *Jrnl of Physics: Conf. Series,* vol. 1195, no. 1, 2019.

Wairisal, M/, Surantha, N., Design and evaluation of efficient bandwidth management for a corporate network. *2018 ICIM Tech*, pp. 98-102, 2018.

Zobel, D., Monitoring applications and services with network monitoring. *White Paper, PRTG Network Monitor*, 2013.

Zuberek, W.M. and Strzeciwilk, Modeling traffic shaping and traffic policing in packet-switched networks *Jrnl of Comp. Sci and Appl,* vol. 6, no. 2, pp 75-81, 2018.

Biographies

Dr. Lukas Tanutama is an associate professor of communication and network systems in the Department of Computer Engineering of Bina Nusantara University Jakarta Indonesia. Prior to joining Bina Nusantara University he had vast experience in the telecommunications and data networks as well as network management industry as engineer and product manager. He started his career at Philips Telecommunicatie Industrie B.V. Project in Indonesia, Philips Development Corporation Jakarta, Transaction Services American Express, AT&T Network Systems Asia-Pasific and Lucent Technologies Asia Pacific and joined as full time academic in Bina Nusantara University. He graduated as Engineer (Ir.) from Universitas of Indonesia, B.A.Sc Faculty of Engineering University of Toronto, Magister Management IBII, and Doctor of Research in Management Bina Nusantara University. He is a Life Senior Member of IEEE. Currently he serves as Subject Content Coordinator for Communication and Network Systems.

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