Impact of queue tree and layer 7 filtering combination to bandwidth management in 802.3 Network

Aulia Ichsan¹, Suherman¹*, Erna B Nababan¹, Marwan Al-Akaidi²

¹Universitas Sumatera Utara, Medan-Indonesia
²American University in the Emirates, Dubai, UAE

*suherman@usu.ac.id

Abstract. Bandwidth management on commercial local area network should be maintain as efficient as possible so that users connections experience best performances and are treated equally and fairly to support business activities. Unsuitable bandwidth management may cause unstructured user management and lead to bandwidth degradation during busy hours. Some users may occupy network more than the others. Some existing works have proposed bandwidth management approaches. This paper combines queue tree and layer 7 filtering by applying traffic priority, committed information rate (CIR) as well as applying specific data pattern to preserve bandwidth. As results, at the evaluated network, the combined method guarantees in average 2 mbps bandwidth for upload/download traffic with average CIR 250 kbps per client. The ICMP test produces average 20 ms delay which is in excellent category. Average jitter 18 ms and packet loss is zero. Further, specific data pattern implementation is able to preserve the total 20 mbps available bandwidth without omitting the CIR guarantee in each client.

1. Introduction

Bandwidth management is aimed at giving the best user performances that fulfils some network parameter criteria. Since user applications change dynamically, information flow into network also change dynamically even growing in speed. Among the information flow is not necessary and some data are dangerous. Therefore, it is necessary to maintain network resources, in this case, network bandwidth as good as possible. Bandwidth management allocates network slots to provide demands as well as to maintain fair services among users so that the quality of services (QoS) is guaranteed [1].

Existing works have explored solutions to manage local area network to achieve best performance. Healthy internet and bandwidth preservation can be achieved by applying web filtering [2]. The rule violated traffic can be blocked to reduce unintended network usage. In order to achieve fair bandwidth for each client, bandwidth allocation is applied [3]. Meanwhile, for incoming traffic accessing server on local area network, load balancing is the perfect choice [4]. This paper applies priority queue [5] and layer 7 filtering [6] to enhance bandwidth usage among users.

2. Methodologies

In order to evaluate the effectiveness of bandwidth management, experimental evaluations were performed. Experiments took place in the computer network within Islamic University of Sumatera Utara, Indonesia. Evaluation is performed on controlled part of network that uses mikrotik router [7] with some computers connected in the same local area network (the 802.3 network). The assessment was performed to find the network parameters such as delay, jitter.
and packet loss as well as maximum/committed information rates (MIR/CIR) [8] when queue tree and layer 7 filtering are implemented.

In order to implement queue tree and layer 7 filtering, the following steps should be performed: data pattern definition for layer 7 filtering, firewall implementation in mangle, and classifier setting for queue tree. Data pattern definition is applied for the unique locator language (URL) to decide whether traffic is passed or dropped, by implementing regular expression script as shown in Figure 1.

![Sample of regular expression implementation](image1.png)

**Figure 1. Sample of regular expression implementation**

Firewall in mangle [9] is to mark incoming/outgoing traffics. Parameters should be set including chain, src address, dst address, action and new packet mark for the queue tree implementation as shown in Figure 2.

![Firewall setting in mangle](image2.png)

**Figure 2. Firewall setting in mangle**

Queue tree set up includes type queue for classifier and kind to avoid client overlap. The queue tree makes use marking traffics in mangle and employs the structure for queue parent and child queue as shown in Figure 3.
Figure 3. Queue tree structure

The total 20 Mbps bandwidth is divided symmetrically into upload and download bandwidth. Child traffic has 8 Mbps for MIR and 1 Mbps for CIR. Streaming and social media is limited to 1 Mbps and 250 kbps. CIR clients will be prioritized, but when traffic is scarce, all users will have the same opportunity with the defined MIR. Figure 4 shows the queue tree implementation.

Figure 4. Queue tree Implementation

3. Assessment results

Figure 5 shown the average rates for upload and download for both CIR and MIR traffics. Both MIR and CIR have similar rates 250 kbps, however, upload rate is slightly higher than download rates for MIR. Each user has almost similar upload and download bitrates. Meanwhile, compared to system without bandwidth management, upload and download rates are varied significantly from 90 kbps to 12 Mbps and about 43 kbps to 1 Mbps. Without bandwidth management, some users dominate the usage of network resources (Not shown in Figure 5).

Figure 5. Average upload and download rates
In term of delay, the bandwidth management is able to reduce the average packet delay significantly from 281.75 to 20 ms. Bandwidth management makes delay in an excellent range of the acceptable delay standard \[10\]. This also happens for jitter and packet loss. Jitter variation drops from 289 ms to 20 ms, much lower than without bandwidth management. In term of packet loss, bandwidth management reduces losses from 23\% to 0\%.

![Network parameters](image)

**Figure 6. Network parameters**

### 4. Conclusions

This paper has reported the implementation of tree queue along with layer 7 filtering to manage bandwidth of 802.3 networks. Tree queue is achieved by setting firewall mangle and applying classifiers for each traffic types. Meanwhile data pattern definition is made by using regular expression to URL. The bandwidth management is able to manage upload and download bandwidth, dropped non important traffics and limits social media traffics. In average, MIR upload and download are distributed evenly about 2018.15 kbps and 1977.6 kbps. It is much better than without bandwidth management where bandwidth varies significantly from only 90 kbps to 12 Mbps. Delay reduces from 281.75 ms to 20 ms. The same pattern occurred for jitter and packet loss, reduced about 249 ms and 23\%.

### References

[1] Lesiak, J., Robles-Roji, F., Simoni, N., & Tohmé, S. (2016). Bandwidth Management for LAN. *Information Networks and Data Communication*, 148.

[2] Hartama, D., Gunawan, I., Tambunan, H. S., & Irawan, E. (2019, August). Optimization of Network Security Using Website Filtering With Microtic Routerboard. In *Journal of Physics: Conference Series* (Vol. 1255, No. 1, p. 012076). IOP Publishing.

[3] RAA Amin, RE Indrajit. 2016. Analysis of Effectiveness of Using Simple Queue With Per Connection Queue (PCQ) In The Bandwidth Management (A Case Study At The Academy Of Information Management And Computer Mataram (Amikom), Mataram. *Journal of Theoretical and Applied Information Technology*. Vol. 83 No.3, 31st January 2016. Pp : 319-326.

[4] Suherman, S., Aziz, M., & Nababan, E. B. (2019, June). Load balancing algorithm for a local video network. In *Journal of Physics: Conference Series* (Vol. 1235, No. 1, p. 012018). IOP Publishing.

[5] Chen, Z. (2019). Research on TSN Real-Time Priority Queue Scheduling Algorithm for Industrial Wireless Networks. *Software Engineering and Applications*, 8(6), 326-333

[6] Peng, B. H., Liu, H. J., & Wei, H. Y. (2009, December). Performance improvement over linux layer-7 content filtering. In 2009 Fifth International Conference on Mobile Ad-hoc and Sensor Networks (pp. 522-527). IEEE.

[7] Dorbe, N. (2014). Analysis of Microtik Router Implementation in Laboratory. Riga Technical University

[8] Heinanen, J., & Guérin, R. (1999). A two rate three color marker (Vol. 999). RFC 2698, September

[9] Boucher, M., Josefsson, M., Kadlecisk, J., Morris, J., Welte, H., & Russel, R. (1999). Netfilter: Firewall, NAT, and Packet Mangling for Linux. *UNIX, man page*.

[10] TYPHON, E. (2002). Definition of Quality of Service (QoS) Classes. ETSI