A traffic congestion analysis in urban networks

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Abstract. This paper aims at analysing traffic congestion in a base station site, Bandung city. We did experiments using iManager webLCT U2000. The connection test spans from a site using UTP cable to GPON, then to Telkom device using fiber optic, and finally to RNC. The tests are carried out before and after trouble shooting process. There are huge packet losses founded in the network so the traffic congestions are unavoidable. The key problem and solution are identified in this study. The assessment results after solving problems show that the data traffic experienced a decrease of 28.23% and the payload increased by 61.45%.

1. Introduction
Transmission system is an important concept in a telecommunications system so that a device can communicate with others. Data transmission for instances, from location A to B can be sent or received through wireless media. However, error in transmission may not be avoidable. The possibility of errors may come from modulation type, data rate, propagation type, distance between sender and receiver. Packet drop is one of error types in Quality of Service (QoS) in which a total number of all packets sent to the recipient that experience the congestion exceeds the maximum traffic load so the packet to queue very long to reach the destination [1,2].

Network congestion in data networks and queue theory is the reduced QoS that occurs when a node or network link carries more data than can be handled. Common effects include queue delays, packet loss or blocking new connections. Because of congestion is that the additional burden offered can lead to a decrease in network throughput. Therefore, long queue delays arise because different QoS requirements must be met using upstream bandwidth [3].

Packet drop recovery are also an important part of peer-to-peer video streaming networks because of the unavoidable loss of packets on the internet today and the interdependence of data units in compressed video streams. Besides, the streaming network architecture where data sent to the recipient through a peer chain can intensify the impact of the loss of internet packets on the video quality felt at the receiver [4]. In this paper, we conducted a packet drop analysis on the site BDK291 JLMERKURISELATAN, PT. Telekomunikasi Seluler, West Java regional. The remainder of this paper is organized as follows. The next session elaborates on our method, then results and discussion, and lastly concuss the work.

2. Method
This research is an observational and experimental research [5]. The stages of the observational method include field data collection, literature studies, packet drop troubleshooting, and preparation of packet drop analysis reports. At the data collection stage, observations were made to the BDK291 site location
JLMERKURISELATAN. The aim is to study the location and identify the problem of the causes of packet drop experienced at that site.

Figure 1. Schematic of the site transmission line before troubleshooting.

At the beginning of the inspection, we surveyed the BDM291 JLMERKURISELATAN site and looked at the transmission line scheme from the BDK291 JLMERKURISELATAN site to the RNC. As shown in Figure 1, transmission line is connected to the GPON device using a UTP cable. A Gigabit Passive Optical Networks (GPON) is the most widely used in FTTx networks (fiber to the house, fiber to the curb and fiber to the building). FTTx systems are established in a point-to-point or point-to-multipoint time division of a multiplex passive optical network architecture [6]. The Radio Network Controller or RNC is the governing element in the UMTS Terrestrial Radio Access Network (UTRAN) and is responsible for controlling the BS Nodes that are connected to it.

After the data arrives at GPON then the data is sent to the Telkom Metro-E device using optical fibre so that the JLMERKURISELATAN BDK291 site will be connected to Telkom Metro-E and finally arrives at the destination RNC.

Figure 2. Ping test results on the BDK291 JLMERKURISELATAN site.

The next step is to prepare the IP VLAN in the iManager webLCT U2000 application on 3G and 4G networks as illustrated in Figure 2. The ping test is carried out from site to RNC with several packets. After finishing the ping test, a problem was found on 3G and 4G networks where there were some packets that did not arrive at the RNC.

After learning about the packet drop on the site, a hardware and software check is performed to determine the cause. Observation results show that the packet drop that occurred on the BDK291 JLMERKURISELATAN site suffered damage to the UTP cable so that the data sent from the original site to the RNC did not arrive at its destination. Therefore, the cable on the transmission line between GPON and Metro-E must be replaced so that the Packet drop does not occur and all data packet reaches the RNC. After discovering the causes of packet drop, then troubleshooting packet drop on the BDK291 JLMERKURISELATAN site. UTP cable replacement as illustrated in Figure 3 is performed on the transmission line connecting BTS to GPON.
After replacing the new UTP cable, the next step is to prepare the IP VLAN on the BDK291 JLMERKURISELATAN site to do a ping test back from the site to the RNC. If the ping test is not successful, the damage may not only occur on the UTP cable and damage to the transmission line afterwards. When the ping test is successful, it then monitors BTS for 6 days. If there are problems with monitoring the BTS status within a few days, we conducted the ping test. When the BTS status is successful, the trouble shooting process is complete.

3. Results and discussion

We performed observation and experimentation about packet drop analysis in Bandung before and after troubleshooting. The data displayed is network quality and productivity. The data taken is 6 days packet drop checking before troubleshooting and 6 days after troubleshooting (Table 1). We obtained data as follows.

| Date       | Data Packet | Date       | Data Packet |
|------------|-------------|------------|-------------|
| 28/07/2018 | 19.791      | 3/08/2018  | 0.416       |
| 29/07/2018 | 29.270      | 4/08/2018  | 0.666       |
| 30/07/2018 | 17.187      | 5/08/2018  | 2.375       |
| 31/07/2018 | 17.208      | 6/08/2018  | 0.062       |
| 1/08/2018  | 20.5        | 7/08/2018  | 1.458       |
| 2/08/2018  | 18.458      | 8/08/2018  | 0.130       |
| Total      | 122.414     | Total      | 5.107       |

From the data before troubleshooting, the number of packet drops is very large even on 29 July 2018 can reach 29 packets. Packet drop can occur because the cable connecting from BTS to GPON is damaged so that the data packet experiences congestion. In this case, the solution to avoid packet drop is to replace a new UTP cable. When the cable replacement is complete, the packet drop immediately drops from August 3, 2018 and runs constant near zero so that the packet sent does not experience congestion. The behaviour of graph tends to decrease (Figure 4).
Network productivity data in our study consists of traffic (Erlang) and payload (Mbit/s). Traffic can be defined by the number of telephone calls (voice calls) and Short Message Services in a network. Erlang means the amount of traffic per hour (number of calls x average call duration). In Table 2, there is not much change when troubleshooting for changing transmission lines from IP radio to GPON.

**Table 2.** Data traffic (Erlang) before and after troubleshooting.

| Date      | Erlang | Date      | Erlang |
|-----------|--------|-----------|--------|
| 28/07/2018| 115    | 3/08/2018 | 109    |
| 29/07/2018| 91     | 4/08/2018 | 92     |
| 30/07/2018| 107    | 5/08/2018 | 93     |
| 31/07/2018| 100    | 6/08/2018 | 107    |
| 1/08/2018 | 104    | 7/08/2018 | 93     |
| 2/08/2018 | 85     | 8/08/2018 | 91     |
| **Total** | 602    | **Total** | 585    |

**Table 3.** Data Payload (Mbit) before and after troubleshooting.

| Date      | Mbit/s   | Date      | Mbit/s   |
|-----------|----------|-----------|----------|
| 28/07/2018| 1827874  | 3/08/2018 | 3115902  |
| 29/07/2018| 1888991  | 4/08/2018 | 3376556  |
| 30/07/2018| 1528585  | 5/08/2018 | 3763182  |
| 31/07/2018| 1371027  | 6/08/2018 | 2978790  |
| 1/08/2018 | 2619844  | 7/08/2018 | 2746282  |
| 2/08/2018 | 2350984  | 8/08/2018 | 2721846  |
| **Total** | 11587305 | **Total** | 18702558 |

Calculating the percentage of data traffic and payload as a sample can use formula as follows, respectively.

\[
T \ (\%) = \frac{\sum d \ a \ t; \ h_{0} - \sum d \ b \ t; \ h_{0}}{\sum d \ b \ tr \ h_{0}} = \frac{585 - 602}{602} = -0.2823 \times 100\% = -28.2392\%
\]
\[ T \quad (\%) = \frac{\sum P \cdot a \cdot t_i \cdot h_o - \sum P \cdot b \cdot t_i \cdot h_o}{\sum P \cdot b \cdot t_i \cdot h_o} = \frac{18702558 - 11587305}{11587305} = 0.6145 \times 100\% = 61.45\% \]

Payload is the amount of data (internet) usage consumed by cellular subscribers in Mbit/s units. Six days before troubleshooting the amount of payload in the example was 11,587,305 Mbit/s and six days after that the amount of the payload increased to 18,702,558 Mbit/s. There was a huge increase after troubleshooting from August 3, 2018. This proves that replacing transmission lines in our case may increase internet data usage and will maintain the performance reliability in the network.

4. Conclusion
The results of packet drop work on the BDK291 JLMERKURISELATAN site show changes in network quality and productivity after troubleshooting. Based on the damage analysis we concluded that it is necessary to replace a new UTP cable as a solution. The impact is that the quality of packet drop networks decreases so much that the packets sent arrive at their destination on time and do not experience congestion. In calculation, network productivity through traffic (Erlang) has decreased by 28.23% and increased payload (Mbit/s) by 61.45%.

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