A Testing Packet Delay Variation and Packet Loss Problem on Local Area Network Based on ITU-T Standard

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Abstract. A good computer network will always be the mainstay of its users. All traffic are aiming to come in/out to device with shortest delay. However, there will be times where our router, switch or access point (AP) start dropping packets because the traffic coming to fast in/out that device can process. The Quality of Service (QoS) computer network traffic is an effort to maintain or manage propagation traffic from source to destination. There are several telecommunication organizations such ETSI and ITU. They have been released recommendation standards. According to TIA/EIA-568-A, the maximum allowed length Cat 5e, Cat 6 cable is 100 m solid horizontal cable between the patch panel and wall jack. However, our research showed the length Cat5e above 130m for connecting router gateway to bridge free from Packet Delay Variation (PDV) and PL problem. The shortest length below 100m does not guarantee will free from PDV and PL problem.

Keyword: Computer network traffic, telecomunication, PDV, PL, ETSI standard, ITU standard

1. Introduction
A good computer network will always be the mainstay of its users because there are benefits as being able to share resources sharing data, information and devices. In terms of efficiency, it is able to save financing like purchasing a device because the devices in the network can be used together. Besides that, the devices in the network can be controlled remotely and are able to be used in field such as management and security information system. Nowadays many computer networks or Local Area Networks (LANs) has been connected to the internet. This situation will absolutely increase the value of resource sharing, efficiency and high reliability of computer networks.

To maintain their high reliability, it is necessary to manage network traffic such as configuration of firewall, routing, Network Address Translation (NAT), Domain Name System (DNS), bandwidth management and so on. All traffic are aiming to come in/out to device with shortest delay but there will be times where our router, switch or access point (AP) start dropping packets because the traffic coming to fast in/out that device can processed. On this situation our streaming are going to suffer both of the situation really need the QoS helps.

The first priority of managing traffics network is to shorten the delay come in/out of the devices. After that, the device was monitored whether it has the ability to process the traffic. High specification of device
such as quad core Central Processing Unit (CPU), high memory, or might be Gigaport Ethernet are highly needed. Since it is not always working with perfect situation such low specification of device, finite amount of bandwidth, a lot user in network and other issues, the traffic need to be prioritized.

2. Standard QoS Traffic Telecommunication

The QoS computer network traffic is an effort to maintain or manage propagation traffic from source to destination in shortest delay. There are two telecommunication organization has release recommendation standards. First standard was released by European Telecommunication Standard International (ETSI) who issued a European standards for for global use [1]. The other standard was released by International Telecommunication Union (ITU-T). The study groups of ITU’s Telecommunication Standardization Sector (ITU-T) assemble experts from around the world to develop international standards known as ITU-T that recommends an act to define elements in the global infrastructure of information and communication technologies (ICTs). Standards are critical to the interoperability of ICTs and so that whenever the exchange of voice, video or data messages are done, standards may enable global communications by ensuring that countries’ ICT networks and devices are speaking the same language [2]. These two telecommunication organizations have released recommendation in telecommunication areas. Several of them have range of response time in millisecond for delay, latency, throughput and so on. By referring the recommendation, we hope interoperability of ICTs meet confidence to deliver a good network service.

As mentioned above, the QoS is the process of managing propagation network traffic between node to node. First of all, traffic testing needed to be done some as sample in order to figure out the real condition of network. In this research, ITU-T recommendation is followed since it was agreed about what ITU-T mentioned about Packet Delay Variation (PDV) definition in recommendation Y.1540 [3].

Since measurement of PDV with kind type of packet selection is not specified in RFC 3393[4] assumption could be made that the packet with impact the largest variation will be in delay in selected time period. The example of the packet such as packet Internet Control Message Protocol (ICMP) traffic, packet User Datagram Protocol (UDP) traffic, packet Transmission Control Protocol (TCP) traffic and so on. ITU-T mentioned that the delay is specified from the start of packet being transmitted at the source to the start of the packet being received at destination, or the packet arrival time at destination instead of the time the end of the packet is received. This situation figures out about the difference between PDV traffic with successive packet.

There are two objective traffic that are used in this research. The first one are PDV traffic and Packet Loss (PL) traffic. Definition of PDV as mentioned in above paragraph. The next objective is PL traffic which occurs when one or more packets traffic from source fail to reach their destination which may be caused by many reason. For example, it might be due to the error transmission on wireless network [5-6] and network congestion [7].

In this research, ICMP and UDP traffic were used to figure out PDV and PL. Both of traffic definitely has largest variation of delay in period of time by the arrangement the size of traffic packet from the smallest to the biggest The ICMP and UDP traffic easily generated using ping and iperf3 application. The main purpose of generated the traffic is to observe propagation of PDV and PL from node to node in network. The summarized of PDV based ITU-T written in table 1 and PL written in table 2.
Table 1. Recommendation For PDV ITU-T Y.114 [8].

| Value (ms) | Status   |
|------------|----------|
| 0 < x < 20 | Good     |
| 20 < x < 50| Accepted |
| x > 50     | Worst    |

Table 2. Recommendation For PL ITU-T Y.541. [3].

| Value (%) | Status      |
|-----------|-------------|
| 0 < x < 0.5 | Accepted   |
| 0.5 < x < 1.5 | Worst    |
| 1.5 < x | Unaccepted |

3. iKOS.NET Hotspot Internet
The iKOS.NET Hotspot Internet is an internet hotspot network to obtain internet access for people using Wi-Fi technology. The iKos.NET network implements integration multi-hop wireless and wired network. The Multi-hop routing was chosen due to the focus on efficiency and low cost infrastructure but fast deployed access network in rural and suburban area [8]. Then, the wired node is connected to the radio POE AP 2.4GHz and radio POE 5GHz while some indoor AP has Power Supply Unit (PSU) 12/24V DC is placed inside the house. Figure 1 below shows the topology overview of iKOS.NET Hotspot.

![Topology of iKOS.NET Hotspot](image)

4. The QoS Testing Process
The QoS testing is the proses of observing propagation of traffic from source to target destination. The observation is conducted inside iKOS.NET network or LAN because of the needs to check the PDV and PL problem whether they faced our network path or not. This is for having more reliable test. Generally, the QoS process is about calibration process after maintain daily routine.

In order to check PDV and PL problem, ICMP and UDP traffic are generated using ping and iperf3 application. The QoS process was divided into two process. First, ICMP and UDP traffic are generated using
ping and iperf3 from user device to the gateway to observe ICMP and UDP PDV. Secondly, UDP traffic was generated from user device to user device to observing PL. Each QoS testing taken in 6 location of AP. Each testing took 5 times to get the average of response time (millisecond). The next process is to correlate the QoS data with ITU-T standard.

The main reason of taking ICMP and UDP traffic are because both of traffic are sensitive to delay. Also, they are vulnerable to being contaminated with daily routine jobs such as configuring firewall, routing, Domain Name System (DNS), and so on. Both of traffic usually propagated simultaneously from node to node. The example of propagation from Gateway to bridge, Gateway to user device, or user device to user device is shown in figure 2. According to ITU-T, the most reliable network usually have small number of PDV, latency and PL.

![Propagation of ICMP and UDP Traffic Testing inside of iKOS.NET Hotspot.](image)

Table 3 shows a CLI command that sends ICMP traffic from the user's device to the iKOS.NET gateway device. This CLI command is done through the terminal window of the operating system.

| Gateway iKOS.NET | User Devices |
|------------------|--------------|
| IP Address       | 172.16.*.1   |
| CLI              | ping 172.16.12.1 -n (n) -l (l) |
| Example          | Ping 172.16.12.1 –n 10 –l 64 |

- n count: Number of echo requests to send.
- l size: Send buffer size.

**Explanation** ping to 172.16.12.1 for 10 times by sending 64 bytes

Table 4 shows a CLI command that sends UDP traffic from the user's device acts server to another user's device acts as client on the iKOS.NET network. This CLI command is done through the terminal window of the operating system using the iperf3 software.
Table 4. CLI command that sends UDP traffic from the user's device acts server to another user's device acts as client on the iKOS.NET network.

| User Devices | User Devices |
|--------------|--------------|
| IP Address   | 172.16.*.*    |
| CLI          | iperf3 -s     |
|              | -u 172.16.12.5-u |
| Note:        | -s as server  |
|              | -c as client  |

**Explanation** Send UDP traffic to 172.16.12.5

The TIA/EIA-568-A [9-10], shows set of telecommunication standard from telecommunication Industry standard (TIA). The length of cable for telecommunication product and services when using 10/100/1000BASET, state the maximum allowed length for Cat 5e, Cat 6 cable to be 100 m (328 ft). This consists of 90 m (295 ft) of solid horizontal cable between the patch panel and wall jack. It is must be 100 m or less in length to certified.

5. The iKOS.NET Propagation Traffics

The summary of all propagation traffic of PDV and UDP QoS from six locations of iKOS.NET AP Hotspot are shown in table 5. Based on the table 5, code P is the abbreviation of Problem and NP is the abbreviation of No Problem. Each AP Hotspot related to their distance to the gateway local.

The radio AP2A, AP2B and AP1 having PDV problem while AP3A, AP3B does not having PDV problem except for radio AP3C that only have PDV UDP problem. The radio AP3B having PL UDP problem. The distance of AP2A, AP2B and AP1 to the gateway is the shortest compared to another iKOS.NET AP. The power supply of AP2A, AP2B and AP1 are using CAT5e POE 12 volt DC but another iKOS.NET AP is using 12 volt DC adaptor power supply.

Table 5. Summarized of PDV and UDP QoS from six location iKOS.NET AP.

| Area      | QoS Results | PDV ICMP | PDV UDP | PL ICMP | PL UDP |
|-----------|-------------|----------|---------|---------|--------|
| AP2A 25 m | P           | P        | NP      | NP      |
| AP2B 45 m | P           | P        | NP      | NP      |
| AP3A 147.8 m |          | NP       | NP      | NP      |
| AP3B 140 m | NP          | NP       | NP      | P       |
| AP3C 140 m | NP          | P        | NP      | NP      |
| AP1 60 m  | P           | P        | NP      | NP      |
Based on this findings, the perspective of users in each iKOS.NET Hotspot AP were asked. The users in location of AP2A, AP2B and AP1 felt sometimes the internet connection is disconnected and becomes slower. The users in location of AP3B felt sometimes internet is disconnected but the internet speed is going fast.

From this finding, it can be assumed the shortest length of CAT 5e cabling does not guarantee the connection will be free from PDV and PL problem in network, but those radios, which are having problem; they used POE mechanism to power up the radio. The problem might come from POE mechanism and might be not because of the tested radio AP1 is supplied by 12 volt DC adaptor and the problem still come up. This situation needs to be rechecked if further research is to be conducted. The results if PDV in ICMP and UDP protocol are shown in figure 3 and figure 4 respectively. Figure 5 and 6 shows the results of PL in ICMP and UDP while figure 7 shows the locations of the propagation problems.
Figure 5. The result of PL in protocol ICMP.

Figure 6. The result of PL in protocol UDP.

Figure 7. Location of propagation problem.
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