Open-ONT Implementation for Fiber-To-The-Home

1st David Christian
Tel. and Elect. Engineering Faculty
Institut Teknologi Telkom Purwokerto
Purwokerto, Indonesia
16101203@ittelkom-pwt.ac.id

2nd Dadiek Pranindito
Tel. and Elect. Engineering Faculty
Institut Teknologi Telkom Purwokerto
Purwokerto, Indonesia
dadiek@ittelkom-pwt.ac.id

3rd Dodi Zulherman
Tel. and Elect. Engineering Faculty
Institut Teknologi Telkom Purwokerto
Purwokerto, Indonesia
zulherman.dodi@ittelkom-pwt.ac.id

2020 IEEE International Conference on Communication, Networks and Satellite (Comnetsat) | 978-0-7381-2517-6/20/$31.00 ©2020 IEEE | DOI: 10.1109/Comnetsat50391.2020.9328952

***Abstract*—Recently, the deployment of optical fiber-based technology with the concept of triple-play services has become public interest. The interest increasing has not been in line with network equipment such as Optical Network Terminal (ONT) devices by service providers. This research aims to overcome the above problem by implementing an open-ONT system where the ONT device can be connected or compatible with different Optical Line Terminal (OLT) types and brands. Open-ONT system implementation was carried out on a customer network in the Sokaraja area, with five chosen randomly. The performance test used the QoS parameter to access three web addresses. Based on the test results, the quality of optical access network services using open-ONT obtained the throughput of about 1.395 Mbps, the delay about 19.45 ms, jitter about 0.042 ms, and packet loss about 4.57%. These found proved that the implementation of Open-ONT in the Sokaraja area can meet the access network's standard.**

***Keywords*—ONT, OLT, FTTH, triple play, QoS**

I. Introduction

In recent years, information and communication technology had developed rapidly to meet user demand. Communication services for subscribers shifted from legacy services (telephone and SMS) to data services such as video streaming, requiring large bandwidth and high-speed data transfer [1]. Large bandwidth requirement was one of the problems in fast access services. Fiber optic is a transmission medium with massive bandwidth to overcome the bandwidth problem experienced [1]. The increasing need for large bandwidth and high data transfer rates drove fiber optic-based networks to the home services or fiber-to-the-home (FTTH) [2].

FTTH services providing for customers required compatible network devices or the same type and brand. The optical link with OLT and incompatible ONT faced connection problems due to the device license [3]. The limited ONT devices with brands that are compatible with OLT devices impacted customer compliance and connection targets. Due to the insufficiency of ONT devices, the provider needed implementation of open-ONT on the existing OLT. Open-ONT on the OLT technology platform can overcome the drought ONT with the same brand as OLT[3]. This work analyzed the effect of open-ONT implementation in an area with existing OLT devices. The ONT device that was implemented had to be compatible with the OLT though the type and brand did not match. The implementation of the open-ONT also gave a simplified process for configuring and monitoring devices remotely used web.

Performance evaluation of a wireless or wireline network employed the Quality of Services (QoS) parameters [4]. The service quality of fiber optic networks with GPON technology was better than copper networks [4]. The quality measurement used QoS parameters such as throughput, delay, jitter, and packet loss. Based on [5], the average value of the QoS parameters for fiber optic networks was better than copper networks, especially for access to the web address, for instance, Yahoo, Facebook, and Kompasiana. The measurement of open-ONT implementation on fiber-optic networks in this study used an approach such as [5] where the web addresses being tested are Youtube, Facebook, and Kompasiana. This paper is divided into several sections, such as introduction, method, result, and conclusion. The introduction gives a brief description of the reason to implement open-ONT. The method discusses the system design and the procedure to evaluate the system. The result shows all of the finds from this work. At last, we conclude our work in several sentences.

II. Method

This work was realized in five stages: assessment, design, implementation, evaluation, and analysis. Firstly, the initial stage of conducting a literature review and feasibility study of the open-ONT system is to select five customers to be the object of research. For the second stage, designing an open-ONT system for five customers used a network simulator. After obtaining the design results, the customer's implementation process was accomplished using two scenarios (before and after Open-ONT installation). The evaluation stage aims to test the system reliability and get the system performance based on QoS parameters. The test results became an object to analyze the feasibility of open-ONT implementation. In the last, the final stage summarized the finding into a conclusion. Fig. 1 shows the research design in this work.

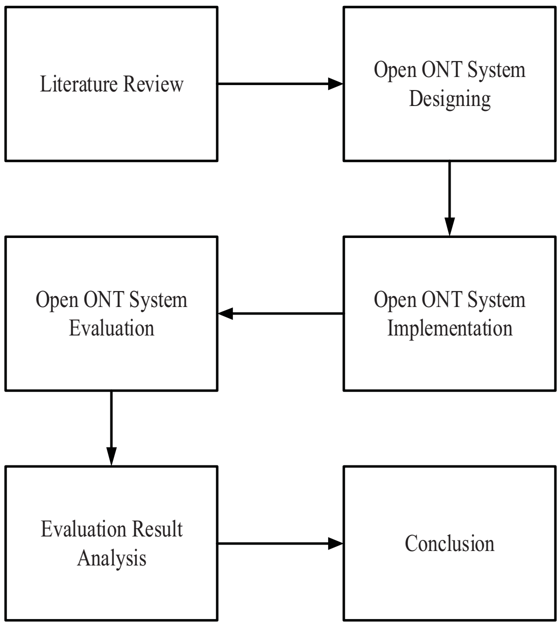

Figure 1 The research design

FTTH is a form of FTTx architecture where the optical conversion point is on the side of the customer's house. The devices commonly used in FTTH configurations consist of Optical Line Terminal (OLT), Optical Distribution Cabinet (ODC), Optical Distribution Point (ODP), and Optical Network Terminal (ONT). In the current condition, FTTH architecture uses OLT devices and ONT devices from the same brand. This condition is intended so that triple-play services for customers can be carried out well. The different types of OLT and ONT devices cause problems in providing triple-play services for customers. Fig. 2 shows the FTTH architecture using the FiberHome device. In this system, the Fiberhome OLT was used with ONT Fiberhome.

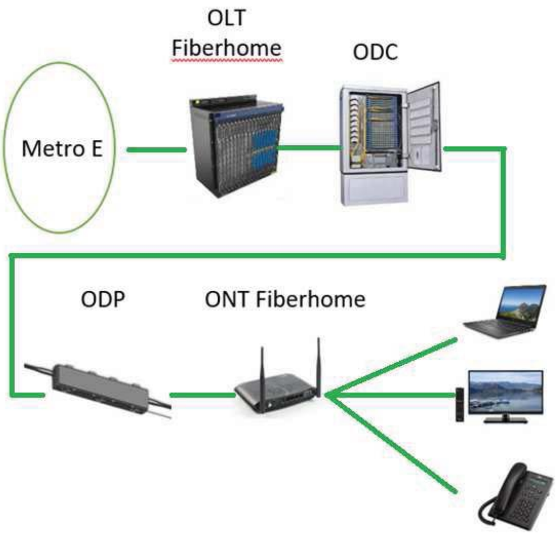

Figure 2 The conventional FTTH architechture

The configuration in Fig.2 was used as a comparison model to compare the system performance that used open-ONT. Active devices in Fig.1 using one brand, both OLT and ONT. Open-ONT implementation was not different from Fig.2. Open-ONT configuration used a typical FTTH architecture like ODC and ODP as passive components and OLT and ONNT as active equipment. The difference between the open-ONT system and the conventional system is only using ONT devices with a different brand from OLT devices. Fig. 3 shows an FTTH open-ONT architecture using a Fiberhome OLT device and a non-Fiberhome ONT device. Apart from the differences in the architecture components, the implementation of open-ONT also has differences when it comes to setup the ONT device. The open-ONT implementation uses a configuration only for the tunnel or OLT interface with the ONT on the Network Management System (NMS) or the OLT side. Unlike conventional services where GPON services such as POTS, VOIP, and IPTV are carried out on the OLT side using NMS. The ONT and OLT tunnel configurations are carried out on the NMS function to open a way so that the auto-configuration server (ACS) can remote the ONT on the customer side.

QoS is an indicator of a network's ability to provide traffic passing services through it [6] that contains several technical parameters such as throughput, delay, jitter, and packet loss [7]. One of the QoS parameters is throughput, indicating the total number of packet arrivals that made it to the destination during a specific time interval. End-to-end delay describes the duration of time required to transmit a packet from one point to another. The variation of the delay is described as a jitter parameter. Packet Loss describes the failure of IP packet transmission to reach its destination. Determination of network performance levels based on these four parameters refers to the technical report telecommunication and internet protocol harmonization over network (TIPHON) issued by ETSI [8]. The four categories of network degradation are defined as in table I.

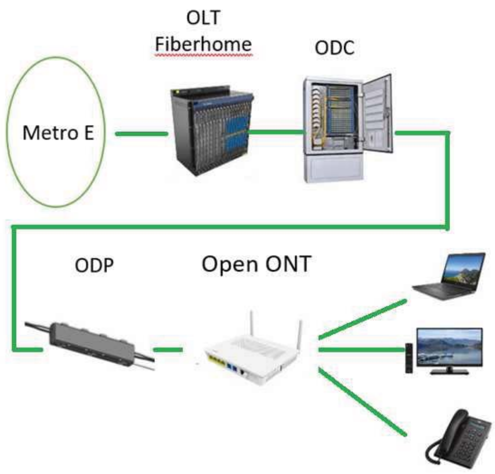

Figure 3 The Open-ONT FTTH architechture

TABLE I. QoS PARAMETER BASED ON TIPHON

Category	QoS Parameter	
	Packet Loss[a]	*Peak Jitter*[b]
Perfect	0	0 ms
Good	3 %	75 ms
Medium	15 %	125 ms
Poor	25 %	225 ms

a. Assuming the packet loss distribution is Gaussian

b. Assuming the jitter distribution is Gaussian (with a standard deviation of half the peak)

System performance analysis used a comparative approach between open-ONT systems and conventional systems. The system test used five randomly selected customers who have various power link budgets. Observation of data traffic used three websites: Youtube, Facebook, and Kompasiana with a duration of observation for 1 minute. Table II shows the details of the scenarios used in this study.

TABLE II. EVALUATION SCENARIO

Category	Customer Parameter	
	Length Optical Link	*Website*
Non Open-ONT	1699 m	Youtube, Facebook, and Kompasiana
	1749 m	
	2108 m	
	3774 m	
	3894 m	

Category	Customer Parameter	
	Length Optical Link	*Website*
Open-ONT	1699 m	Youtube, Facebook, and Kompasiana
	1749 m	
	2108 m	
	3774 m	
	3894 m	

The test used two laptops where one laptop was connected to a wireless LAN-based network from non-Open-ONT devices, and the other laptop was connected to WiFi Open ONT devices for each customer. Each experiment used Wireshark tools to capture data. The performance parameters used in the analysis stage were obtained from the Wireshark tool. The performance analysis used the average value of the measurement results from five customers. Data results comparing from the five customers with different distance and attenuation conditions tend to have the same value.

III. Result and Discussion

This section shows the result and discussion of system performance using QoS parameters. The result is showed in this section contain throughput, delay, jitter, and packet loss. Throughput used the total packet data received when access Youtube, Facebook, and Kompasiana, both Open ONT and conventional system. Fig. 4 shows the throughput comparison between Open-ONT and conventional systems when access Youtube, Facebook, and Kompasiana.

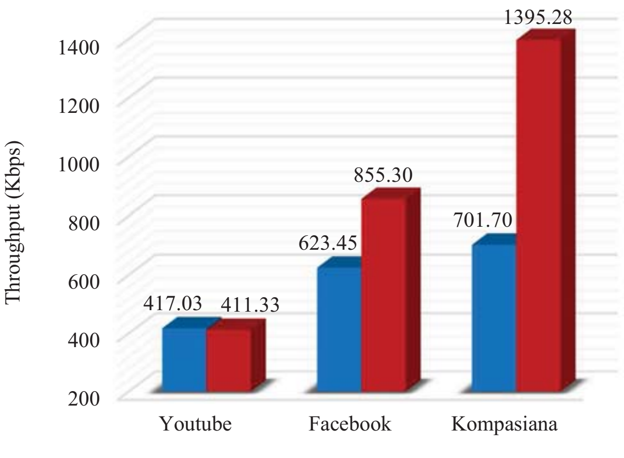

Figure 4 Average Throughput Comparison for YouTube, Facebook, and Kompasiana

The throughput depends on the number of packets that were successfully delivered to the destination. An enormous throughput value indicates the massive number of bits sent successfully from source to destination. The throughput value is expressed in the form of bps. For instance, the test for YouTube got an average throughput of about 417.03 Kbps for a conventional system and 411.33 Kbps for an Open-ONT system. The average throughput when accessed Facebook about 623.45 Kbps for a conventional system and 855.30 Kbps for an Open-ONT system. There were about 232 Kbps differences between conventional and open-ONT system. Kompasiana brings massive differences between the conventional and open-ONT system with about 99% improvement. OpenONT gave 1395.28 Kbps for Kompasiana content. Whereas the conventional one just gave 701.70 Kbps for Kompasiana. Open-ONT implementation gave an outperformed throughput for Facebook and Kompasiana, but slightly lower than the conventional system for YouTube. Based on throughput, the system that used Open-ONT outperformed the conventional system.

The most significant delay value was the YouTube website using conventional with an average of about 19.57 ms. Considerable delays when accessing YouTube were due to video and audio content that required large bandwidth compared to Facebook or Kompasiana. Based on the test results, the highest delay is 70.14 ms, which is still low from the best category of TIPHON standard. The overall value of delay in testing shows perfect results and meets category 4 of TIPHON standards. Implementation Open-ONT outperformed the conventional system due to the lower delay value for all scenarios. For instance, the delay in accessing YouTube was 0.12 ms less than the delay value that results in the conventional system. For Facebook and Kompasiana, the open-ONT system's delay value is also less than the conventional system's result. The illustration for the delay comparison was shown in Fig. 5.

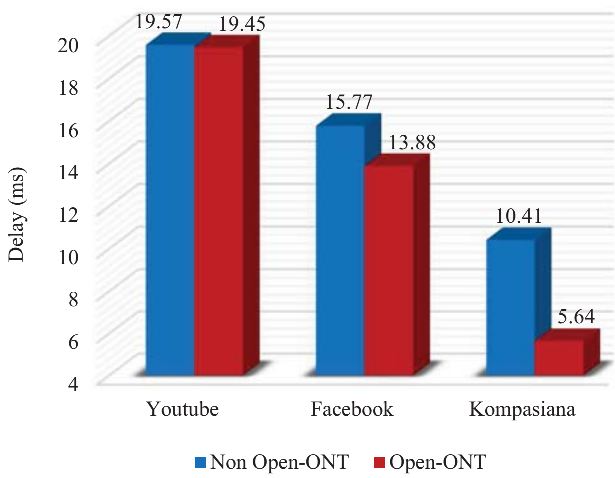

Figure 5 Average Delay Comparison for YouTube, Facebook, and Kompasianan

The outperformed of the Open ONT system compared to conventional systems were also supported by the jitter value. Based on the test results, the average jitter value when accessing YouTube, Facebook, or Kompasiana, the open-ONT system was lower than the conventional one. The immense jitter value obtained about 0.782 ms, which meets the perfect category of TIPHON. It indicates all the system jitter met the perfect category. Based on the test result, the average jitter value was accessed by YouTube for Open-ONT less than the conventional one. The equal result for Facebook and Kompasiana. Based on this result, the Open-ONT implementation can be replaced by the FTTH conventional system in Sokaraja area.

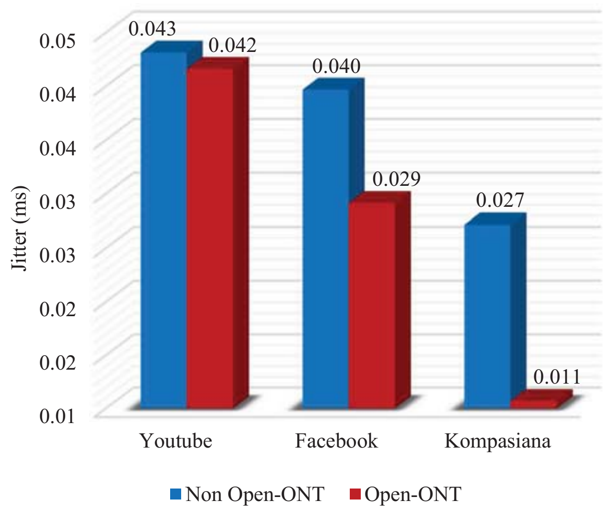

Figure 6 Average Jitter Comparasion for YouTube, Facebook, and Kompasiana

Factors that cause packet loss were traffic congestion in sending data packets from sender to receiver or the number of connected users, causing congestion, problems with transmission media, and insufficient capacity. Based on the test results, the most considerable packet loss obtained was 10.88%. This value is less than 15%, which is the boundary on the good category.

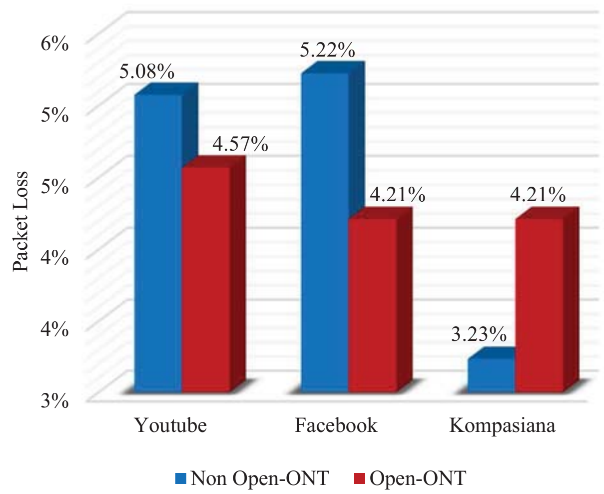

Figure 7 Average Packet Loss Comparasion for YouTube, Facebook, and Kompasiana

The Open-ONT system's packet loss value when accessing YouTube and Facebook was lower than the conventional system. However, the Open-ONT system's packet loss when accessing Kompasiana was lower than that of conventional systems. YouTube's packet loss for open ONT about 4.57% and less than the conventional system, with about 5.08% loss during data transfer. Facebook's likely result was that the open-ONT gave 4.21% packet loss, and the conventional got about 5.22% packet loss during the data transmission. Kompasiana showed the different result of packet loss. The Open-ONT had a more considerable packet loss than the conventional system. The conventional got about 3.23% packet loss, and the open ONT got about 4.21%. Even though the packet result's loss was still low, the open-ONT underperformed for packet loss parameter access to the Kompasiana site. Although not all packet loss values for open-ONT systems were lower than conventional systems, open-ONT systems' performance was still better than conventional systems because two of the three web sites provide better performance than the conventional one.

The throughput, delay, jitter, and packet value of open-ONT for Youtube, Facebook, Kompasiana showed the feasibility of open-ONT to implement as FTTH equipment. Not only feasible, but also the system performance of open-ONT outperformed in almost all QoS Parameter when compare with the conventional system. Implementation of the open-ONT system in Sokaraja link brings a way to overcome the limited equipment for FTTH deployment.

IV. Conclusion

The open-ONT configuration for the FTTH network allows it to be implemented on an optical-based access network. The open-ONT system's performance based on the parameter values of QoS Throughput, Delay, Jitter, and Packet Loss has a better value than conventional systems. Open-ONT implementation is appropriate to solve the scarcity of FTTH network equipment with a specific brand so that the triple play service installation process can be carried out without waiting for the same branded device. For further study, we suggest clarifying the various protocols for transmitting data packets in the open-ONT platform and comparing several open-ONT brands.

Acknowledgment

Thanks to PT Telkom Akses Purwokerto, which supports this work, we use the FTTH Sokarja area equipment to implement our design.

References

[1] I. G. D. Prastiwi, Sugito, and A. R. Bermano, “Perancangan Jaringan Akses Fiber To The Home (FTTH) dengan Teknologi Gigabit Passive Optical Network (GPON) di Private Village, Cikoneng,” E-Proceeding Eng., vol. 2, no. 3, pp. 7116–7124, Desember 2015.

[2] F. Rosanto, D. Zulherman, and F. Khair, “Analisis Perancangan Jaringan Fiber To The Home Area Jakarta Garden City (Jakarta Timur) dengan Metode Link Power Budget dan Rise Time Budget,” Tegal, 2017, pp. 105–111.

[3] T. Sanjaya, T. N. Damayanti, and B. Uripno, “Kajian Open ONT pada Jaringan GPON,” Universitas Telkom, Bandung, 2019.

[4] A. N. W. Wardhana, M. Yamin, and L. F. Aksara, “ANALISIS QUALITY of SERVICE (QoS) JARINGAN INTERNET BERBASIS WIRELESS LAN PADA LAYANAN INDIHOME,” SemanTIK Tek. Inform., vol. 3, no. 2, pp. 49–58, Jul. 2017.

[5] S. Sitohang and S. A. Setiawan, “IMPLEMENTASI JARINGAN FIBER TO THE HOME (FTTH) DENGAN TEKNOLOGI GIGABIT PASSIVE OPTICAL NETWORK (GPON),” Simetris J. Tek. Mesin Elektro Dan Ilmu Komput., vol. 9, no. 2, pp. 879–888, Nov. 2018, doi: 10.24176/simet.v9i2.2430.

[6] Y. K. Ningsih, T. Susila, and R. F. Ismet, “Analisis Quality of Service (QoS) pada Simulasi Jaringan Multiprotocol Label Switching Virtual Private Network (MPLS VPN),” JETri, vol. 3, no. 2, pp. 33–48, Feb. 2004.

[7] R. Wulandari, “ANALISIS QoS (QUALITY OF SERVICE) PADA JARINGAN INTERNET (STUDI KASUS : UPT LOKA UJI TEKNIK PENAMBANGAN JAMPANG KULON – LIPI),” *J. Tek. Inform. Dan Sist. Inf.*, vol. 2, no. 2, pp. 163–172, 2016.

[8] ETSI, "Telecommunication and Internet Protocol Harmonization Over Network (TIPHON)," ETSI, France, TR 101 329 V2.1.1 (1999-06), 1996.