INFRASTRUCTURE SHARING PLANNING IN DEF INDUSTRIAL AREA USING PPDIOO FRAMEWORK

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ABSTRACT

Initially, the Industrial Estate allowed each operator and service provider to pull cable Fiber Optic from outside the industry area to the tenant's factory location. This treatment makes utilities in the Industrial Estate full and difficult to maintain. As a result of the full utility, it results in a slow process of handling disturbances. So that 56% of tenants in industrial estates are dissatisfied with ICT services because the SLA delivered is not more than 90%. Therefore, it is necessary to study the interconnection method and the selection of devices that can meet the demands of customers and service providers. This study presents a step-by-step design and implementation of the network construction used as a Sharing Infrastructure. Researchers use the PPDIOO framework in designing the network to be implemented. This research is used to design a reliable, scalable and can be monitored. Furthermore, especially to meet the expectations of Industrial Estate Management, Service Providers and tenants.

Keywords*: Infrastructure Sharing, Network Planning, PPDIOO*

1. INTRODUCTION

In development, industrial estates have become synonymous with the industrialisation process. They are considered a powerful tool for generating employment, economic growth, and competitiveness. Industrial estates, in particular, can foster catch-up strategies by providing institutional frameworks, modern services, and infrastructure not available in other parts of the country.

Currently, industrial estates are required to provide land. The increasing number of tenants automatically causes a surge in the number of workers/labourers in the area. In addition, most of the tenants are production centres or factories, need a connection to the head office outside the industrial area, and must be connected to suppliers and logistics networks in other locations. Tenants require a guaranteed internet and intranet connection service to exchange data. Likewise, send information that is considered necessary in a production process to sales.

Furthermore, the more tenants in the area, the more significant infrastructure needs. Moreover, it is directly proportional to the number of services that must be supported. Moreover, this is a sweetener for Service Providers to sell their services in Industrial Estates.

The DEF industrial area is one of the leading areas in Indonesia, especially in the West Java area. With a reasonably large area and is occupied by tenants who are pretty well-known and bona fide. Every Tenant currently requires a reliable telecommunications service and guaranteed service with a high SLA. Now, the choice of access media using Fiber Optic is to be the best to meet the needs of tenants and data communication needs in the Bekasi Fajar area.

Several service providers available in the regional area deploy Fiber Optics unplanned, so utilities in the DEF area become untidy and tend to be congested. The service providers also seem to be limited to leased network services without having other solutions for the DEF industrial area managers in the context of the stages towards an intelligent industry or Industry 4.0 or intelligent industry [1].

The Estate Management, in this case, who holds the interests of the tenants, conducts studies and surveys on the existing ICT infrastructure. In the survey, there are things related to customer satisfaction with the current Service Providers. The survey proves that the information on

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achieving SLA by the service provider does not reach the target in the contract between the Tenant and the Service Provider.

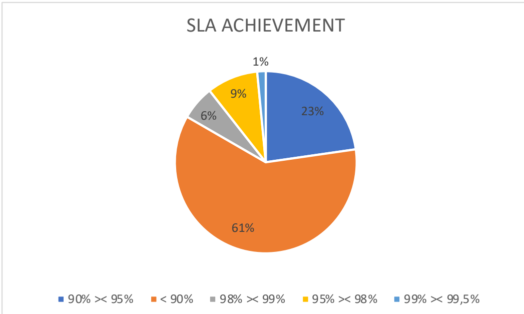

Figure 1 SLA Achievement

This is because poor handling of interference results in many SLAs is not achieved. As many as 56% of tenants admit that the handling of disturbances with the current infrastructure system is terrible.

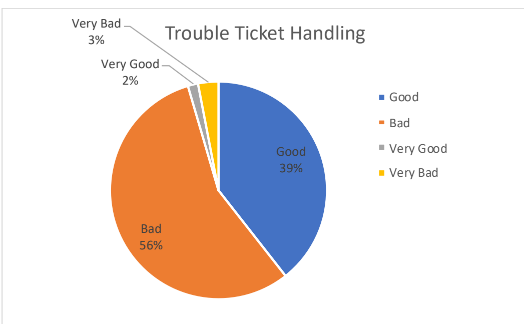

Figure 2 Trouble Ticket Handling

Based on the journal [2], related to Smart Infrastructure: an emerging frontier for multidisciplinary research said that one of the requirements for Smart Infrastructure is the sharing of ICT infrastructure in meeting the needs of ICT infrastructure to tenants.

Based on the several studies mentioned above, it is concluded that technically [3][4] and economically [5][6], the Estate Management should provide ICT infrastructure. Therefore, this research focuses on device design, configuration, and testing to support the study.

To address this, the Estate Management made a policy change related to ICT Infrastructure. Initially, the Service Provider who pulled the FO cable from their POP to the tenants changed to the Estate Management, who made the withdrawal. So that service providers only need to interconnect in the Meet-Me Room to deliver service to Tenants through the infrastructure built by the Industrial Estate.

The equipment provided by the Estate Management will be the Interconnection Device that delivers service from the Service Provider to the Tenant. The network design that will be made uses the PPDIOO framework created by Cisco.

And the DEF area will provide an information system network within the industrial area in the form of fibre optic networks, backbone networks, and access networks that can later be used together to serve and fulfil and guarantee ICT services to tenants will interconnect with the network. Existing providers. This is referred to as Sharing Infrastructure (Shared Infrastructure). Some of the issues in Infrastructure Sharing are SLA (Service Level Agreement) guarantees that cover network quality, availability, and maintenance processes.

A method is needed to help simplify problem-solving to find a device design solution. The technique used is PPDIOO (Prepare, Plan, Design, Implement, Operate, Optimize).

The PPDIOO method is a methodology from Cisco that defines a continuous cycle of services required by computer networks [7]. The consideration for using the PPDIOO method from Cisco is that Cisco can occupy the first position in the 2019 Gartner version of the data centre network, outperforming other competitors.

This Paper proposes to design a network topology according to the needs of tenants and service providers in the Industrial Estate, create network visibility, and create network documentation. Thus, the network is expected to be scalable, monitored, and scalable.

2. RELATED WORKS

The author also conducted a literature study on an area that implemented infrastructure sharing. Posted by [8], The author also conducted a literature study on a site that implemented infrastructure sharing—entitled *Accelerating Digital Connectivity Through Infrastructure Sharing*. This paper states that digital connectivity has enormous potential to support regional development. Yet today, some four billion people in developing countries remain offline, partly because of a lack of affordable Internet access. Sharing infrastructure between operators and across sectors is a potential solution. Sharing infrastructure also can accelerate digital connectivity at a lower cost, especially in less

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

developed markets where the return on investment can be limited. It can also reduce investment costs and operating costs for investors and operators and increase the sustainability of their balance sheets. The sharing model can also benefit consumers by increasing competition, lowering prices, and improving service quality.

The second Infrastructure Sharing literature study is the writing by Ricardo Martínez Garza, Enrique Iglesias Rodríguez, and Antonio García Zaballos in a book entitled *DIGITAL TRANSFORMATION: Infrastructure Sharing in Latin America and the Caribbean* [9] published by the Inter-American Development Bank. In this paper, it is stated that there are issues in implementation, namely the nature of infrastructure sharing, which means that many parties and stakeholders are involved, such as central and local government authorities and operators. The management of these different parties, with varying goals and targets, can significantly impact the project's overall success. If the governance of these stakeholders is not appropriately managed, disengagement and delays can occur. This can result in different targets and organisations trying to solve this problem, potentially resulting in infrastructure duplication and undermining the business model.

There is no mention of an effective and efficient methodology related to technology integration in the two studies above. Economically, sharing infrastructure has many benefits, but technical matters must also be considered to support this.

The author also conducted a literature study of case studies using the PPDIOO method. A case study conducted by Leonel Hernandez and Genett Jimenez, entitled Design and Validation of a Scheme of Infrastructure of Servers, Under the PPDIOO Methodology, in the University Institution – ITSA [10]. The case study conducted by Hernandez and Jimenez aims to help improve the performance of existing information technology infrastructure, especially communication networks. At ITSA University, the deployment of information technology systems is quite complex. There are servers used for web services, active directories, applications, databases, and virtual classes. Network communication services are set up and configured virtually through virtual servers. In the ITSA university communication network, several anomalies have been detected concerning certain services provided by the server; therefore, it is necessary to make a good design for the active directory structure and optimization of network services. This is the background for the case study by Hernandez and Jimenez. The technique used in the case study is descriptive and applied. In this descriptive technique, all infrastructure results from the review are documented. In applied engineering, the results of the proposed solutions are meant to solve practical problems in the current infrastructure. Furthermore, the PPDIOO framework obtains existing solutions starting from preparation, planning, design, and implementation.

3. METHODOLOGY / FRAMEWORK

This research focuses on fibre optic network design and network devices. From the literature study, the process of problem identification uses the PPDIOO framework by defining goals, defining requirements based on goals, assessing existing networks to support the proposed system, making designs based on needs, building techniques, operation, and monitoring systems, error detection, and correction for network topology design.

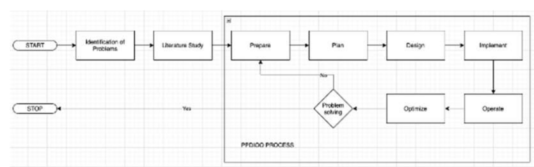

Figure 3 PPDIOO Phase

The first step is the identification of the problem. At the problem identification stage, a survey was conducted of the existing tenants in the Industrial Estate area. The result of problem identification is in problem formulation that must solve. A literature study [11] was carried out to determine the right technology and framework to solve the problem to solve this problem. The author used the PPDIOO framework to solve this problem from the literature study results. It is because PPDIOO is a Cisco output framework. Cisco is a company whose products occupy the best position in Gartner's 2019 version.

The next stage is to use the PPDIOO framework for troubleshooting. The phases of the PPDIOO framework are the preparing phase, planning phase, design phase, implement phase, operating stage, and optimize step. The preparation phase is to identify the network requirements. Meanwhile, network characterisation and access to existing networks will be carried out in the planning phase to support objectives. Furthermore, the researcher

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

will make a topological design from the characterisation and assessment results in the design phase.

Towards the implementation phase, researchers will build a topology that has been designed so that it is ready to operate. The topology will be running in the operating step, and monitoring will be carried out. The optimize phase will analyse and evaluate the results of the system. The optimize phase can also request a restart from the prepare phase if problems and errors occur.

4. PROPOSED METHOD

Proposed Methods that the researcher applied to this paper are:

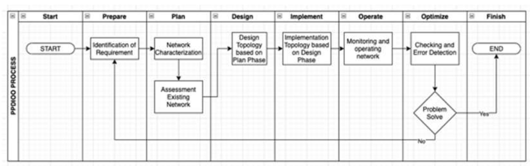

Figure 4 Proposed Method

In the design of the network topology design using the PPDIOO method are as follows:

1. Prepare Phase

In this phase, we will identify the requirements for topology design through surveys with stakeholders and tenants. Stakeholders of the tenants are:

a. IT Manager

b. Service Provider Technical Section

2. Plan Phase

This phase will accommodate the characterisation of the network to achieve the goals. These requirements include business requirements, SLA requirements, and infrastructure level requirements for tenants and service providers.

3. Design Phase

The network must be reliable in serving application systems used by tenants to achieve these goals. Network devices must be prepared so that congestion does not occur, which increases latency values. The increase in latency will result in decreased service performance. To design the topology, the steps are to collect bandwidth requirement information and perform backplane and forwarding plane calculations to meet requests from tenants and service providers.

i. Gather bandwidth requirement information

This process is carried out to determine which tenants will be delivered using what media and devices with what services. This information is obtained from the previous two phases, namely the Prepare and Plan phases. In the Prepare phase, it will be determined what tenants and service providers want. Meanwhile, there is information on the equipment and proposed solutions offered in the Plan phase.

ii. Perform backplane and forwarding plane calculations for active devices

This process is carried out so that the selected device does not become a bottleneck in services to tenants. Blockages can cause the performance of the service to decrease. Information from the previous process, namely the collection of bandwidth information, is used in this activity.

The initial topology design proposed is as shown in Figure III.4 as a solution to the objectives in the previous point. The figure is a logical topology. Logical topology provides an overview of the interconnection between the Region's network and service providers. The connection takes place in Meet-Me Room. That is the meeting place or point of interconnection of estate management network devices with service providers who want to sell service in the industrial area. The proposed network topology serves all IP-based services. The proposed topology is made simple but accommodates all the needs of tenants and service providers. And also keep latency low, and reduce loop risk, as well as scalable.

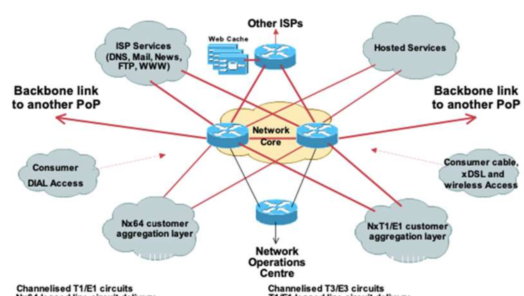

Figure 5 ISP General Design

Based on [12] [13], the topology design is divided into several hierarchies, namely:

i. Core layer routers and high-end Switches optimized for availability and speed

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ii. Distribution layer routers and switches that implement policy and data traffic
iii. Access layer that connects users via switches, and other devices

To start the topology design phase, the steps taken are [14] [15]:

1. Define the technology stack
2. Define the Network Hierarchy
    a. Core Routers
    b. Distribution Routers
    c. Access Routers
    d. Border Routers
    e. Service Routers

The above functions can use the same router.

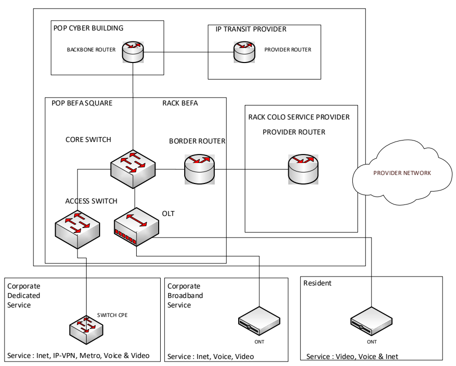

Figure 6 Network Logical Design

In addition, according to paper [16][17], several plans must be designed in this phase, namely:

1. Addressing strategies on the ISP side are:
2. IP address block for a loop-back router interface
3. Address block for infrastructure
    a. per PoP or all backbone devices
    b. allocate according to requirements
4. Addressing plans on the customer side are:
    a. Assigning customer IP addresses as needed
    b. Cannot be ordered or posted under which PoP
    c. ISP iBGP brings customer network
    d. aggregation is not required and usually not desired

3. Router security
    a. username, password, vty filter
    b. Disable telnet in vty, only use SSH
    c. vty filter should only allow NOC access, no external access

4. Implementation Phase

Networks are built, and additional components are included according to design specifications to integrate devices without disrupting the existing network or creating points of failure. In this phase is the implementation of the network topology made. Activities for design implementation are as follows:

a. Prepare network diagrams;
b. Prepare the device to be used;
c. Installation of the device used;
d. Implementation of cabling;
e. Device activation;
f. Commissioning to ensure the network is ready for operation.

5. Operate Phase

The operation phase involves maintaining the network through daily operations, including connection loss and congestion availability [18]. In this phase, all stakeholders have used the implementation network.
In the operation phase, performance monitoring is carried out parallel by measuring the network through the Ber Test RFC 2544 test tool. RFC2544 is focused on measuring the performance of network equipment, not remote networks such as the internet [19]. Based on [20][21][20], The parameters measured by this tool are Latency.

6. Optimize Phase

The Optimize phase of this research will focus on the results of network redesign and optimization , including:

a. Through interviews with area owners, tenants, and service providers, I am reviewing the network's initial condition, which is the data resulting from the preparation phase.
b. Performance monitoring is the measurement data from the operational phase compared with the network requirements. Thus it can be seen that the proposed network performance has met the requirements or still needs improvement.
c. The final condition of the proposed network. After knowing that the network performance meets the requirements, further interviews are conducted with the owner of the area, the tenants, and the service providers. This interview aims to determine whether network users have

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

felt that network services align with expectations.

d. If the proposed network does not meet the requirements or meets user expectations, the research will repeat in the preparation phase.

5. IMPLEMENTATION

a. Preparing Phase

The preparing phase is the first phase of the PPDIOO framework to identify requirements for redesign and optimization of the network to be built by conducting interviews with stakeholders in the Industrial Estate, determining organisational goals and technical objectives. Discussions were addressed to 2 groups, namely Service Providers and Tenants.

Table 1 . Correspondent Type

No	Corespondent Type
1	Tenant
2	Service Provider

The author analyses the results of the interviews to find out the tenant's experience in getting the network desired by the user.

From the interviews conducted, it can be defined that the technical objectives of the network resulting from network design and optimization are as follows:

1. The service level must be able to meet the requirements of 99%
2. The network must be monitored recorded and can be expanded to a larger scale
3. Maximum latency of 15ms.

In the preparation phase, it can be concluded that what is done is to survey to obtain data that constrains user needs, determine organizational goals and technical objectives, design backbone and access networks in the region.

b. Planning Phase

In this phase, the author performs network characterisation. The results of network characterisation are as follows:

1. Provide a network for interconnection with all providers to supply internet, intranet, IP-VPN, MetroEthernet and Voice need.
2. Backbone and access networks must accommodate a change in tenant needs.
3. Integration of configurable network monitoring tools allows operators to track resource usage and service performance.
4. Backbone and access networks can be measured and monitored in real-time to support network services [22].
5. Calculation of Forwarding Rate and Switching Capacity to expedite the transmission of incoming and outgoing packets from the device design Phase [23].

Because no tools were used previously, the results of the technology study resulting from this Planning Phase were to plan new tools and topologies to meet all stakeholder requests as stated in the previous phase.

This infrastructure share network design measures packet loss, latency, availability, and throughput to fulfil SLA needs.

In the Plan phase, it can be summarized that this phase resulted in the characterization of the network that must be built.

c. Design Phase

As shown in Figure 6, the topology design built is a logical topology. The existing network in the industrial area is grouped into four namely Backbone, Access, LAN and NMS server (network monitoring centre). This grouping aims to implement policies on the firewall. The network grouping is marked by

Journal of Theoretical and Applied Information Technology
15th July 2022. Vol.100. No 13

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

assigning different IP and VLAN segments.

1. Backbone
   In this segment, the backbone devices are used for interconnection with the operators/service providers' devices. Furthermore, the other uses the backbone device to interconnect with access devices.

Table 2 Backbone Segment IP Address

No	Device	IP Loopback	Cable Type
1	Core Switch	1.1.1.1/30	Fiber Optic

2. Access
   Segment Access is a path prepared to reach customers in the Region area. In this study, the cable used is fiber optic cable. According to (Ahmed & Islam, 2018), fiber optic cables have been widely used in backbone networks because the available bandwidth is enormous, and the DB loss is very low. The access network can be further divided between the feeder or distribution network and the last-mile network[24]. When the access network architecture uses fibre optic cables, it is called an optical access network, shown in Figure below.

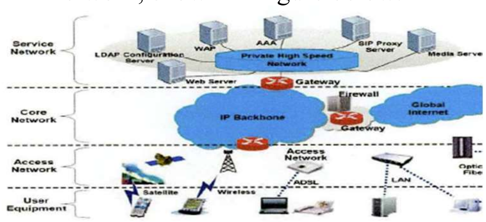

Figure 7 Best Practice

There are several types of customers to be served, namely:
a. Corporate Customers
b. Retail Customers
With the several types of customers above, there are two methods to deliver services to these customers, namely:
a. Access GPON
b. Access Point-to-point
Furthermore, for Access technology, retail customers will use GPON technology [25] [26].

Table 3 GPON Standard

Standard	ITU G.984
Downstream speeds	1244 or 2488Mbps
Upstream speeds	155 to 2488Mbps
Downstream wavelength	1480-1500 nm
Upstream wavelength	1260-1360 nm
Protocol	Ethernet and ATM
Voice Support	Ethernet over ATM
Video Support	RF overlay
Number of splits	64
Distance	< 60km

Table 4 Access Segment IP Address

No	Device	IP Loopback	Cable Type
1	Access GPON	2.2.2.2/30	Fiber Optik
2	Access P2P	3.3.3.3/30	Fiber Optik

3. LAN
   In the LAN segment, this segment includes:
   a. NMS Servers
   b. NOC computer
   c. Wireless Employee
   This segment is needed for employees' work channels to access the backbone, access and NMS device segments.

Table 5 LAN Segment IP Address

No	Device	IP Segmen	VLAN	Cable Type
1	LAN	172.16.20.0/24	1620	UTP

The NMS server group is a server group that can only be accessed via an intranet network. The systems included in the NMS server group include servers that are used to manage and monitor network systems, both WAN and LAN. Virtual LAN (VLAN) used is VLAN 1620.

Table 6 NMS Segment IP Address

No	Device	IP Segmen	VLAN	Cable Type
1	Server NMS	172.16.10.0/24	1610	UTP

The allocated IP Address is 172.16.10.0/24, which means that the

Journal of Theoretical and Applied Information Technology
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ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

number of servers accommodated is 252 servers, and the implementation of this NMS server will use Virtual Machine technology, which is discussed separately from this research. Furthermore, the Virtual LAN (VLAN) used is VLAN 1610.
The network devices used are:

1. Core Switch,
2. Access Switch,
3. Wireless Controller,
4. Router,
5. GPON,
6. Firewall,

d. Implementation Phase
In the implementation phase, the following steps are taken:

1. Create a network diagram.
2. Prepare the device to be used.
3. Install the device in use.
4. Pulling FO or UTP cable.
5. Implementation of the configuration that has been tried in the testing environment.
6. Implementation of the specified IP on the device.
7. Implementation of the specified VLAN on the device.
8. Implementation of predetermined routing.
9. Activate the device.
10. Test Commissioning to ensure the device is ready to go live.

The following are the results of the implementation of each network device:

1. Core Switch
In this implementation, the solution for devices that function as Core Switches is the Huawei CloudEngine S6730.

2. Access Switch
In this implementation, Huawei CloudEngine S5732 is used as an installed access switch to deliver Point-2-Point technology services to customers.

3. GPON
In this implementation, Fiberhome OLT type AN6001 and ONT type are used as access switches installed to deliver services with FTTx technology to customers.

4. Network Monitoring System (NMS)
NMS is one of the requirements in the design phase. This NMS will be used to measure and monitor the performance of network devices. The following are the results of the NMS implementation:

Table 7 IP NMS

No	NMS Software	IP Address	Remote
1	Cacti	http://172.16.10.23/cacti	via Web Admin
2	PRTG	http://172.16.10.24/nagios4	via Web Admin
3	Huawei iMaster	http://172.16.10.25/iMaster	via Web Admin
4	Fiberhome NMS	http://172.16.10.26/FHNMS	via Web Admin

The connection test tests ICMP packets from the LAN segment to the NMS server.

Looking at the results in a table, the LAN segment can be connected to the NMS server, which means the topology that has been built is running well. Thus the implemented topology is by the requirements in the design phase.
The evaluation results obtained in the prepare, plan, design, and implementation phases can be summarized as follows:

1. The interview results found that the purpose of the industrial estate is to have a network as a gateway centre in delivering services to existing tenants in the industrial area. With the requirement that the service level is maintained at 99%, the network must be monitored, recorded, and scalable to accommodate changes to the application system, and the maximum latency is 15 mS.

2. The planning phase results obtained network characterization, studies of installed devices that do not end of life and end of support from the device's principal in the next 3 to 5 years.

3. The design phase results obtained a network topology both physically and logically to accommodate the needs of service providers and

Journal of Theoretical and Applied Information Technology
15th July 2022. Vol.100. No 13

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

accommodate service needs to tenants.

4. The implementation phase results show that the topology installation has been running well, marked by a successful connection test and the implementation of the NMS as a tool for monitoring and measuring performance is active.

5. Thus, the built topology is ready to be operational.

In the Implement phase, it can be summarized that this phase produces a network system that refers to the design phase. Connection test results, all network devices are correctly connected, and NMS is active on the network that is built.

e. Operating Phase

In this phase, the network already uses the newly created topology. The network has accommodated all the needs of service providers and tenants. In this phase, monitoring of network performance is carried out.

1. Network availability

The measurement results in the operating phase indicate that the built topology has successfully connected all the required parts.

The operation phase can be summarized that the network has been used to manage industrial estates in this phase. Parallel performance measurement of network devices is carried out. The measurement results show that all network devices have 100% availability, Latency between 1 ms to 15 ms and data traffic is running marked by bandwidth usage.

2. Latency

The measurement results are each network device's average latency time, such as Core Switch, Access Switch and GPON for one month. The results show that all network devices have Latency ranging from 3.2 ms to 12.9 ms. This means that all network devices can meet the user's requirements, which is 15 ms.

While the measurement results are the average latency of each local network device such as NMS servers and Access Points for one month, from the measurement results, it is found that all access points have latency 1 ms. This means that all network devices can meet the user's requirements, which is 15 ms.

The measurement results in the operating phase indicate that the built topology has successfully connected all the parts required by the user.

Operate phase can be summarized that the network has been used for user operations in this phase. The measurement results show that all network devices have 100% availability, RTT between 1 ms to 3.5 ms and data traffic is running marked by bandwidth usage.

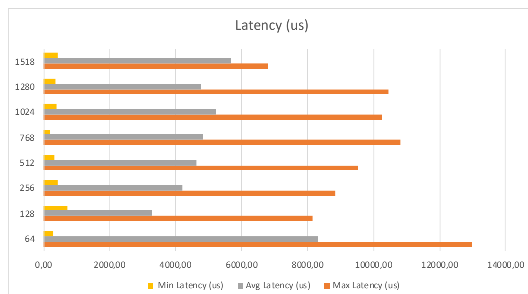

Figure 8 Latency (us)

f. Optimizing Phase

In this phase, network design and optimization results evaluation includes reviewing previous conditions and monitoring the performance of measurement results and final conditions. The review results will be analyzed whether the results of the design and optimization of this network have answered the needs of industrial estate management and have resolved the problem. As discussed in the previous chapter, the initial conditions in the Industrial Estate are:

a. There is chaos in the utility line because each operator draws their infrastructure.
b. It does not have a network monitoring system, so there is no visibility and no measurable

network of services delivered to tenants.

To overcome this problem, do:

a. Topology design for sharing infrastructure so that the network can meet the demands of Service Providers and Tenants.
b. Measuring network performance.

Meanwhile, the service provider's need for infrastructure sharing is to meet the following requirements:

1. The service level must be maintained at 99%.
2. The network must be monitored, recorded and scalable.
3. Able to accommodate changes to the application system.
4. Maximum latency of 15 ms.

The initial data in this case study is in the form of tenant experience data, and no measurements are taken due to the lack of documentation of the data centre network. By referring to Figure 2, the tenants were dissatisfied because trouble ticket handling was not optimal.

Monitoring of network performance results from measurements in the operating phase shows that performance has accommodated the needs of tenants and service providers, as shown in figure 8.

Thus, the results of the design of the infrastructure sharing network can accommodate the needs of service providers and tenants.

The optimize phase can be summarized in that in this phase, and a comparison is made between user requirements and the results of the network implemented and user experience interviews are conducted. The results obtained are that the network has met user needs, and the results of interviews stated that 96% and above users are satisfied with the implemented network.

6. RESULT & RECOMMENDATION

a. Result

Based on the evaluation in the optimize phase, it can be concluded that:

1. The designed network has been completed and meets the requirements set by the industrial estate, and the service provider is satisfied with the implemented topology.
2. The measurement results show that the availability of 100% and the Latency of 15 ms indicates that the network is scalable and meets the service provider's requirements.
3. One method used to perform network design is the PPDIOO cycle method from Cisco.
4. The stages in the PPDIOO framework are
    a. Preparation
    b. Planning
    c. Design
    d. Implementation
    e. Operation
    f. Optimization

   At the optimization stage, analysis and evaluation are carried out; if the results still do not meet the research requirements, the process starts from the initial stage, namely the preparation stage
5. Network performance can be measured and monitored via NMS devices. Availability, latency, and bandwidth usage can be measured and monitored.

b. Recommendation

The recommended suggestions from this research include:

a. To further configure Layer 3 to be more optimal in delivering services to tenants.
b. It is necessary to deepen the level of security to protect operational processes and systems used in the network.
c. Besides using PPDIOO, it can also use the System Development Life Cycle (SDLC) framework.

d. We can use the PPDIOO framework created in this research to develop scalable processes further.
e. The formation of this network is also accompanied by the knowledge of resources to operate the device.

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