Internship Report

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FTTH Fiber To The Home High Speed Internet Broadband

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Acknowledgement

Firstly, I am grateful to the Asia Pacific University College of Technology and Innovation (UCTI) for having the internship program included in the curriculum. This gave me the opportunity to work before completion of my studies hence preparing me for the future when I actually start working.

I am also grateful to the manager of AND KL Telekom Malaysia, Ms.Khairiah, for giving me the opportunity to work in her company, for letting me work on the FTTH project and for trusting me with the work. My thanks go to Mr. Ibrahim, my industrial supervisor, for his assistance. My time at AND KL Telekom Malaysia gave me the exposure in the field of Internet telecommunication and this would be very helpful in the future for my career.

Furthermore, I am grateful to my fellow intern colleagues at AND KL Telekom Malaysia without whose dedicated work, the project would not have completed within the internship period.

Lastly, I am grateful to Mr. Sathish Kumar, my Acadimic supervisor, for taking his time to visit me while I was working.

Abstract/ Summary

Telekom Malaysia Berhad (TM) is a key player in the establishment, maintenance and provision of telecommunication and related services under the license issued by the Ministry of Energy, Water and Communications. It is the dominant player in the fixed line telephony market in Malaysia, offering local call, long distance call and data services through a range of platforms. TM's mobile communications business operates under the Celcom brand while its Internet access business operates under the TM net and Streamyx brands. TM also operates a wireless broadband Internet access network through TM net Hotspot.

On commencing the industrial training, the manager assigned me at the planning department. At that time the company had just started working on a project by the name "FTTH- Fiber to The Home high speed internet". As the name suggests, this was a fiber optic network project that provide high speed internet to 320 customers.

I was part of the planning team in the AND bukit anggrik TM exchange. I was given the task of designing network routing. Together with my colleague Mr. Ibrahim, we came up with different routing for the network at first and then discussed them with the whole planning team. After a number of discussions, we came up with the final network routing design. Two software programs have been used to achieve our task. The first one was the Geographical information system, this software was very useful because it helped us to know the street topology information, including sidewalks, crossings, etc; and building locations, ideally including the number of living units and/or businesses per fiber-termination point.the second program was the AutoCAD.

FTTH network structure planning also was part of our task, after a number of discussions with the planning team we have decide to make passive fiber network, because the distance between the OLT/Central office and the end users was less than 20 km.Passive fiber optic network technology consist of many parts, the first part of the network was the OLT, some engineers call it central office. In order to provide high speed internet to new house complex, it was necessary to expand our OLT. The next step was to find the nearest chamber to the OLT and the nearest chamber to the house complex as well. The implementation team will deploy the fiber optic cables through these chambers. After

assigning the nearest chamber we made a plan for the splitter installation. These splitters will divide each cable came from the central office up to 32 cables. We use these splitters to reduce the number of the fiber optic cables. So instead of connect 320 fiber optic cables in the central office we just need 10 fiber optic cables to be connected with the central office and then they will be divided to 320 cables near the home complex, so we reduced the number of the cables thus reduce the project cost. The final part of the structure planning was to plan the installation of the ONU; this includes the type of the ONU, the location and the number of the ONU needed for our project. Using the ONU was very important since it will convert the fiber optic light signal to electrical signal to be ready to be used by the customers.

The four months I spent at Telecom Malaysia Bhd helped me to further develop the skills I had learnt in the university. As stated earlier, I was responsible for network routing designing and drawing the routing using AutoCAD software,. In designing the network, a lot of what I had learnt had to be applied, such as, the type of materials to use, the types of fiber optic cables, find the chambers and manhole locations what type of joined has to be used, and etc. The FTTH's planning followed by the implementation stage. Tow implementation team work on this project one was working during the morning and the other during the night. The implementation teams were responsible of equipments' installations. The last stage of the project was the testing and the troubleshooting and Mr. Ibrahim was responsible of the system testing.

In conclusion, the industrial training gave me exposure to how things work in the 'real world' and helped me improve the communication and designing skills I had, as well as being responsible.

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1.1 Introduction

Telekom Malaysia Berhad

Figure 1: Tlelcom Malaysia Logo

Telekom Malaysia Berhad (TM), Malaysia's broadband champion and leading integrated information and communications group, offers a comprehensive range of communication services and solutions in broadband, data and fixed-line. As a market leader, TM is driven by stakeholder value creation in a highly competitive environment. The Group places emphasis on delivering an enhanced customer experience via continuous customer service quality improvements and innovations, whilst focusing on increased operational efficiency and productivity.

I did my internship in one of TM divisions which is AND KL TM Bukit Anggerik. When I started my internship, the company had just started preparing on a project whereby a FTTH network had to be designed and constructed. The project team was divided into three categories; planning, implementation and testing. The task assigned to me was that of the planning of the network. Different routes had to be designed followed by 2D drawing.

1.2 The Organization:

Telekom Malaysia Berhad, DBA TM, is the largest integrated solutions provider in Malaysia, and one of Asia's leading communications companies, with a market capitalization of RM13.9 billion and a workforce of 26,629 employees. Established as the

Telecommunications Department of Malaya in 1946, it was privatized in 1987, and listed on Bursa Malaysia in 1990. Subsequent growth led to a demerger in 2008 of TM's mobile and fixed services, allowing the company to focus more intently on its core businesses of Internet and multimedia, data and fixed-line services.

TM is engaged in providing a wide range of services for the telecommunications industry, include the following:

Voice services

Data services

Access services

Managed services

Value added services

Application services

Content services

Infra services

Project management and consultancy

Telekom Malaysia (TM) is engaged in providing integrated telecommunications solutions. It offers information and communication services and solutions in broadband, data, and fixed-line. The group primarily operates in Malaysia. The group operates through four segments: retail, global, wholesale and shared services/others. The retail segment provides various telecommunication products, services and communication solutions to consumers, small and medium-sized enterprises, corporate and government customers.TM offers a range of voice services, internet/broadband services, data services and information communication technology services. The global segment is engaged in providing inbound and outbound services for a wide range of telecommunications services including the fixed network operations of the group's worldwide subsidiaries. The segment offers data services including virtual phone network services, IP services, international bandwidth services, and Ethernet services. Its voice services include bilateral services, wholesale voice services, and international value added services. Global owns extensive submarine cable systems including the APCN2, CUSCN, JUSCN, SMW3, SMW4, DMCS, SAFE, SAT3/WASCAND BRCS which connect Malaysia to the rest of the

world. The wholesale segment provides various telecommunication products and services through its direct networks to other licensed network operators. This segment, which comprises of Fiberail and Fibrecomm, offers a range of telecommunications facilities and services to licensed network operators such as network facilities providers (NFP), network service providers (NSP) and applications service providers (ASP) for mobile, fixed line, WiMAX, broadband and internet. The segment offers a range of services encompassing voice, data, and access and infra services. The voice services include wholesale voice over internet protocol (VoIP) and interconnect services. Its data and access services include high speed broadband (transmission) service, wholesale Ethernet, domestic bandwidth, digital subscriber line (DSL) wholesale, IP wholesale, interconnect bandwidth services, and regulated services such as wholesale local leased circuit, wholesale line rental and a suite of local loop unbundling services. The shared services/others segment comprises of the group's shared services divisions, networks and other subsidiaries.

1.3 The Environment

Telekom Malaysia Berhad (TM), Malaysia's leading integrated information and communications group, offers a comprehensive range of communication services and solutions in broadband, data and fixed-line. As a market leader in the broadband and fixed-line businesses, TM is driven to deliver value to its stakeholders in a highly competitive environment. The Group places emphasis on continuing customer service quality enhancements and innovations. With its extensive global connectivity, TM is poised to position Malaysia as a regional Internet hub and digital gateway for Southeast Asia. In line with this, TM is evolving into a Next Generation Network service provider, enabling the Group to enhance its efficiency and productivity while providing enriched products and services.

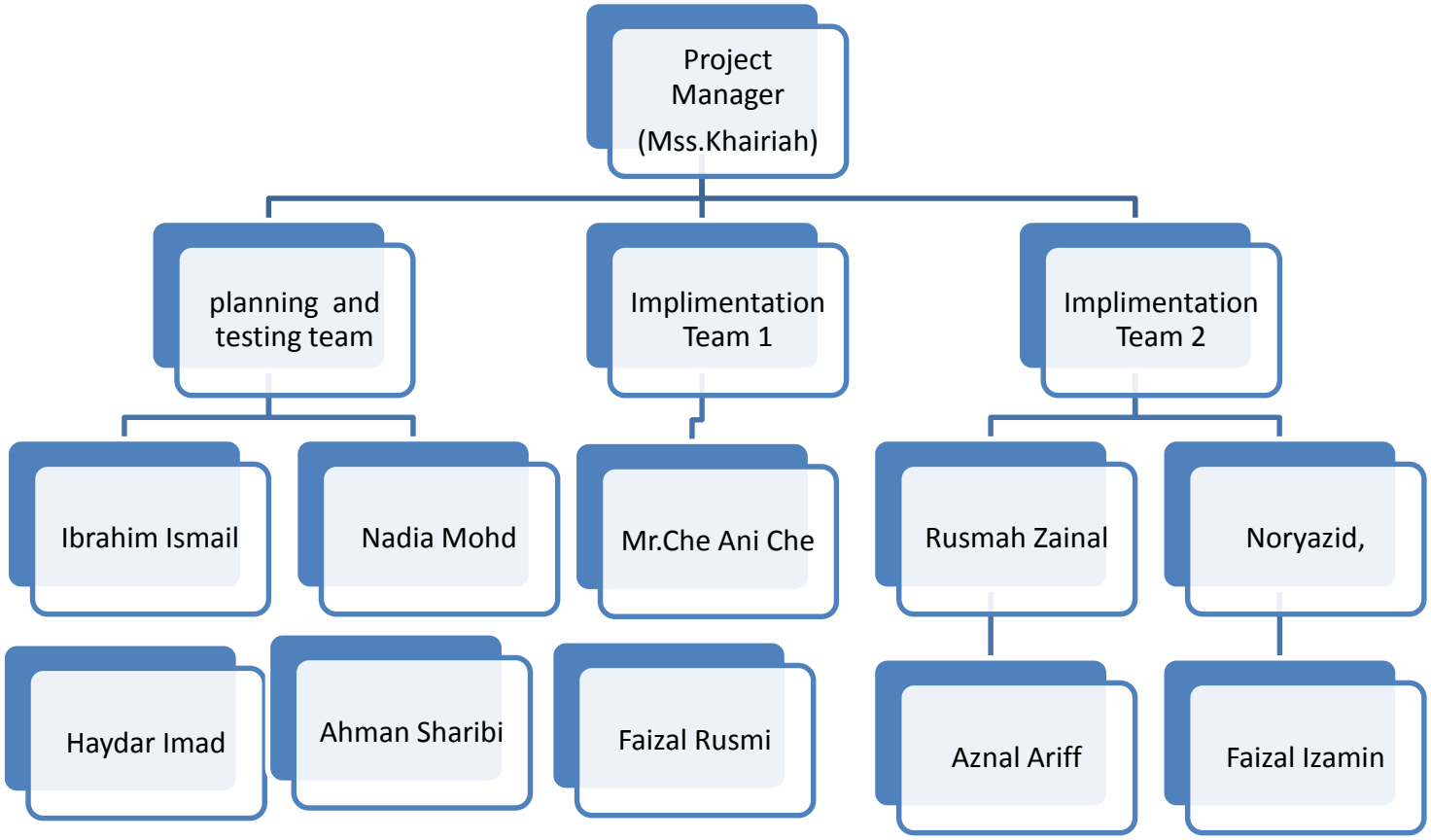
Telekom Malaysia Bhd (TM), the former telecommunications monopoly in Malaysia, since privatization remains Malaysia's top telecom group and a fast-growing international player in the Asian region. The company continues to hold the *defact* monopoly on the

country's fixed-line telecom market, with more than 4.6 million access lines. However, the relatively low penetration rate of just 17.2 lines per 1 00 population (compared with nearly 65 per 100 in the United States) provides room for TM's future growth, as well as a potential entry point for competitors. In addition to its fixed line business, TM is on e of Malaysia's leading cellular telephone provider, a position solidified following the company's 2003 acquisition of Technology Resources Industry (TRI) and its Celcom mobile telephone unit. Celcom is a long-time leader in the Malaysian cellular market, with a market share approaching 30 percent. TM also operates the country's leading Internet provider, TMNet, which is also the sole broadband provider in the country. In addition to its operations in Malaysia, TM has developed a network of subsidiaries and investments internationally, with a focus on the Asian region. The company is present in Sri Lanka (where it holds more than 90 percent of Dialog Telekom), Cambodia, Indonesia, Bangladesh, Guinea and Malawi. As part of its future international expansion plans, the company formally adopted a new brand identity, TM, in 2005. The company is listed on the Kuala Lumpur Stock Exchange. I n 2004, TM posted revenues of MYR 13.25 billion ($3.2 billion).

1.4 The Functions

I did my internship in one of TM divisions which is called Access network development Kuala Lumpur, located at AND bukit anggerik . Miss. Khairiah Md Tahir is the asst general manager; she is the head of the Access network development Kuala Lumpur division. There is seven more managers, work under the asst general manager each one responsible for one of the organization departments. The organization consists of four

departments, the fundamental planning, the detail planning, the Admin & support office and the implementation. The Implementation department consists of two sections, network implementation one and two. More than 30 employees work in each department. The total number of the employees are about 200.most of the employees are telecommunication engineers and while few of them have IT Bachelor. Access network development Kuala Lumpur organizational chart illustrated in the diagram below;


Project Manager (Mss.Khairiah)
planning and testing team
Implimentation Team 1
Implimentation Team 2
Ibrahim Ismail
Nadia Mohd
Mr.Che Ani Che
Rusmah Zainal
Noryazid,
Haydar Imad
Ahman Sharibi
Faizal Rusmi
Aznal Ariff
Faizal Izamin

This TM division responsible of whole Kuala Lumpur's fixed line phone and Internetnetworks and. That makes the organization in a tough pressure due to the huge number of project need to be done each month. Each project must go through all the departments starting with the fundamental planning department ending with the Implementation department. As was mentioned the project start must be from fundamental planning, this department has two main outputs. First, the general business case decision whether and, if positive, to what extent network should be rolled out. Second, the major strategic decisions are made, for instance, what architecture will be implemented, and which cable and duct technologies will be used. While the detail planning Department where I did my internship, is responsible of the structural decisions for a particular geographical planning area are made. These include the placement of network functions (distribution points) and connectivity decisions (which location serves which area) and a preliminary bill of materials, including the installation lengths of cables and ducts as well as quantities for the various types of hardware. I worked in this division as a planning engineer I made a plan of the FTTH network routing starting from the pop ending with the user's end points. Once we are done with the planning, the planning details were submitted to the implementation department. The implementation department curried out the networks instruction and implementation by supervising and guidance the contractors, make sure that work takes place as planned and makes sure that the work going as the scheduled time. Once the implementation of the FTTH network was complete, the planning team surveys the site in order to test and check the effectiveness of the network and to prepare for the handover of the project.

1.5 Department

I was placed in the detail planning department together with my colleagues, Nadiah, Ahmad Sharibi and Ibrahim Ismail. We were responsible for all the detail planning work involved in the project. When the 'FTTH project started, we had to come up with a different plans of the FTTH project which would satisfy the tasks to be performed. The plan should contain the work stapes from A to Z, the cables and equipments clustering, duct analysis, duct request, the network routing plan and finally preparing a check list.

I and Mr. Ibrahim had responsibility of design the fiber optic routing plan. We first came up with a number of routing plans and sketched them using AutoCAD. Then we classified the designs we made into two categories according to the efficiency and cost (high efficiency high cost plans and high efficiency low cost plans) to make it easy for us to pick the best one .The high efficiency low cost designs were selected and uploaded to the server. The high efficiency low cost plan has been designed by taking the shortest possible rout from the Central Office to the users end using high quality equipments, so we achieved the high efficiency and low cost which was our goal.

After we got the approval of our routing planning, the routing sketch was sent to the implementation department.

While the implementation team start construct the network at the work site, we started going to the work site to check the work progress identify the workers' mistakes, fill out our checklist, prepare daily situation report and submit it to the manager by the end of our business day .

While I was working on the network routing design, I was assigned the task of programming a projects database manager system using MySQL , php and html programming languages. This system has been designed to help TM employees to access to the projects database online from anywhere and check the projects detail such us the project name, project number, file accepted, contractor detail, scheme, project start and end date, project remark and project attached files.

1.6 Communication/ IT

In terms of the physical space used by Access network development Kuala Lumpur, it is a relatively small organization. It is one building consists of 4 flours. Therefore, within the organization, simple communication methods are used. Face to face communication is mostly used for both the horizontal and vertical types of communication channels. At other times, telephones are used to convey the messages; hence, all phones in the office are connected together. The use of telephones reduces unnecessary movement and noise in the office.

In order to keep the employees in the loop at all times, the company meets twice weekly to discuss project progress. This usually happens at the end of every week. The employees meet again at the end of the week to discuss the progress. This helps the employees to stay focused at all times.

Communication with other companies is usually formal written communication, mostly by use of electronic mails (e-mails). This is whenever information such as prices of products is required.

The computers in the company are all networked together to ease the transfer of documents between different computers. Also, there is internet in the office so that the employees can retrieve any type of information required from the World Wide Web.

2.1 Introduction

Telekom Malaysia Berhad (TM), Malaysia's broadband champion and leading integrated information and communications group, offers a comprehensive range of communication services and solutions in broadband, data and fixed-line. As a market leader, TM is driven by stakeholder value creation in a highly competitive environment. The Group places emphasis on delivering an enhanced customer experience via continuous customer service quality improvements and innovations, whilst focusing on increased operational efficiency and productivity. Once I reported to TM bukit angreek division, the asst operation manager Miss. Khairiah placed me at planning department as planning engineer under the supervision of Ms. Enguik Antan. They were working on a project of implementing FTTH fiber to the home network. Fiber to the home is an advanced telecommunications technology that uses glass fibers to transmit video (CATV), data (Internet), and voice (telephone), at very high speeds and large volume to homes and businesses. FTTH will be able to send many future services to the customers' home as these services develop. As the name states, the aim of the project was to develop a FTTH network in order to provide high speed internet service for TM customer. The objective of the project was to supply new residential complex with high speed broadband internet access.

In order to successfully complete such a project, it has to be divided into different stages starting with the planning ending with project handover. The project stages, as follows;

- Planning
- Actual component selection
- Installation and practices
- Testing and troubleshooting

Network route planning which is part of the planning stage was assigned to me. This involved designing the network, and making two dimension drawings. Survey the work site during the implementation is part of my responsibilities, to make sure that the network implementation matches the routing plane.

2.2 Fiber to the home network construction

FTTH, or Fiber to the Home, refers to fiber optic cable that replaces the standard copper wire of the local Telco. FTTH is desirable because it can carry high-speed broadband services integrating voice, data and video, and runs directly to the junction box at the home or building. For this reason it is sometimes called Fiber to the Building, or FTTB.

Traditional copper telephone wires carry analog signals generated by telephone equipment, including fax machines. Analog technology is by nature a less precise signaling technology than digital technology. Though multiplexing has allowed digital signals to be transmitted across multiple channels over copper lines, fiber optic cable is superior for relaying these signals and allows for faster transfer rates and virtually unlimited bandwidth. This opens the door to better Internet speed, streaming video, and other demanding applications.

The Internet utilizes a backbone of fiber optic cables capable of delivering incredible bandwidth. This inherent ability makes the Internet a prime source for advancing network technologies that can be brought to the home or business. Most subscribers, however, log on to this network through copper lines with limited capacity. This creates a bottleneck for advancing technologies that increasingly require greater bandwidth. FTTH bridges this gap.

Fiber optic cables are made of glass fiber that can carry data at speeds exceeding 2.5 gigabits per second (gbps). FTTH services commonly offer a fleet of plans with differing speeds that are price dependent. At the lower end of the scale, a service plan might offer speeds of 10 megabits per second (mbps), while typical DSL (Digital Subscriber Line) service running on existing copper lines is 1.5 mbps. A more expensive FTTH plan might offer data transfer speeds of over 100 mbps. That’s about 66 times faster than typical DSL.

FTTH is cost-prohibitive in many cases. Installing FTTH can be expensive, and the monthly charge for broadband services thereafter can also be off-putting, though these

figures vary widely. Expense is likely to drop with time as FTTH becomes more common.

Because of the cost involved and the logistic difficulty in replacing existing copper lines in some neighborhoods, FTTH is more often being installed in newly built communities as an added selling feature. Installing FTTH raises the value of existing property.

FTTH can be installed as a *point-to-point* architecture, or as a passive optical network (PON). The former requires that the provider have an optical receiver for each customer in the field. PON FTTH utilizes a central transceiver and splitter to accommodate up to 32 clients. Optical electric converters, or OECs, are used to convert the signals to interface with copper wiring where necessary.
FTTH differs from Fiber to the Curb (FTTC) in that FTTC does not run directly to the home or building. Instead it runs to the curb, and the last leg of wiring to individual buildings remains copper wire.

There are two important types of systems that make fiber-to-the-home broadband connections possible. These are active optical networks and passive optical networks. TM planning team must choose the most suitable one for our project. Each technology offers ways to separate data and route it to the proper place, and each has advantages and disadvantages as compared to the other. An active optical system uses electrically powered switching equipment, such as a router or a switch aggregator, to manage signal distribution and direct signals to specific customers. This switch opens and closes in various ways to direct the incoming and outgoing signals to the proper place. In such a system, a customer may have a dedicated fiber running to his or her house.

A passive optical network, on the other hand, does not include electrically powered switching equipment and instead uses optical splitters to separate and collect optical signals as they move through the network. A passive optical network shares fiber optic strands for portions of the network. Powered equipment is required only at the source and receiving ends of the signal. In some cases, FTTH systems may combine elements of both passive and active architectures to form a hybrid system. Passive Optical Networks, or PONs, have some distinct advantages. They're efficient, in that each fiber optic strand

can serve up to 32 users. PONs has a low building cost relative to active optical networks along with lower maintenance costs. Because there are few moving or electrical parts, there's simply less that can go wrong in a PON. Passive Optical Networks also have some disadvantages. They have less range than an active optical network, meaning subscribers must be geographically closer to the central source of the data. PONs also makes it difficult to isolate a failure when they occur. Also, because the bandwidth in a PON is not dedicated to individual subscribers, data transmission speed may slow down during peak usage times in an effect known as latency. Latency quickly degrades services such as audio and video, which need a smooth rate to maintain quality. Active Optical Networks offer certain advantages, as well. Their reliance on Ethernet technology makes interoperability among vendors easy. Subscribers can select hardware that delivers an appropriate data transmission rate and scale up as their needs increase without having to restructure the network. Active Optical Networks, however, also have their weaknesses. They require at least one switch aggregator for every 48 subscribers. Because it requires power, an active optical network inherently is less reliable than a passive optical network. According to the above details and because the distance between the central office and the end user is less than 20 KM the planning team had decide to make passive optical network, and they did choose all the needed equipments such as they type of the PON, OLT, OLN and the cabinets, and all these equipments will be described later.

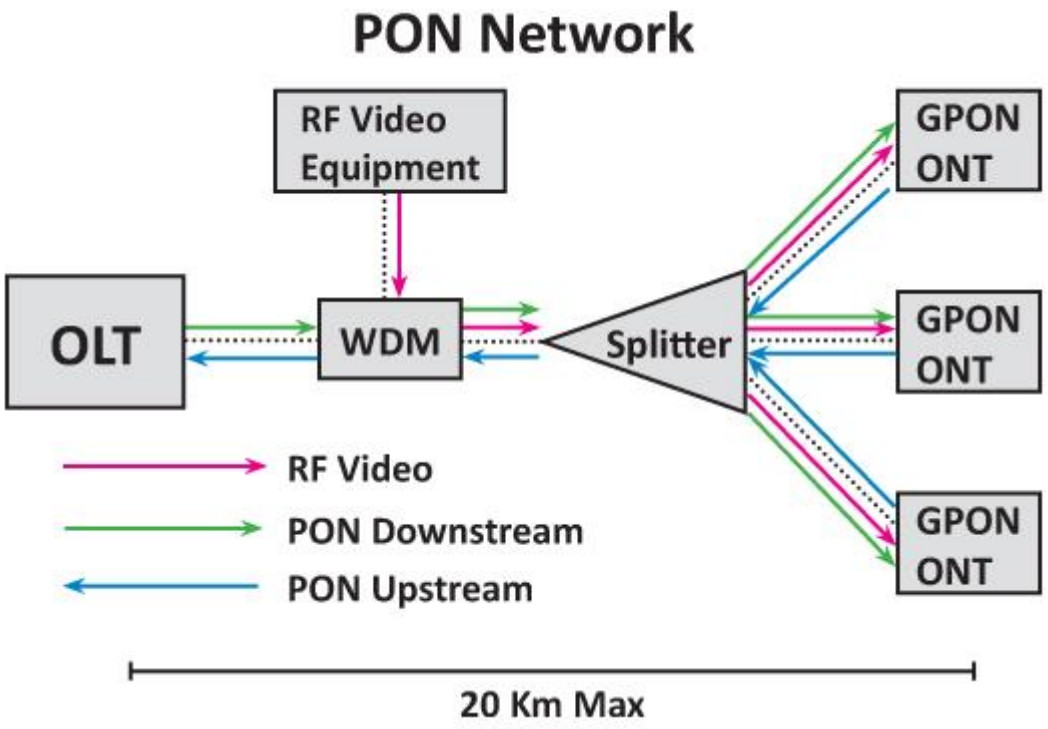


Figure 2:Passive network

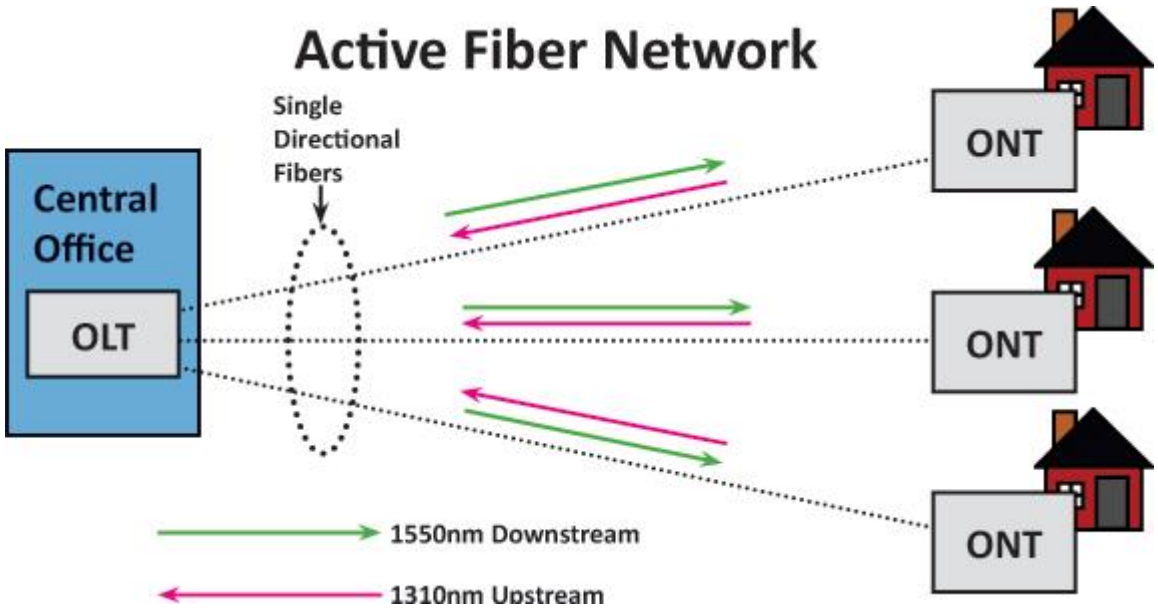


Figure 3: Active network

A PON consists of OLTs (Optical Line Terminals) at the CO side, passive splitters in the distribution network, and an ONU (Optical Network Unit) or ONT (Optical Network Terminal) at each subscriber home. OLT is a line card which has several optical ports. As its name implies, the splitter divides the fiber into several branches directed toward subscriber homes. The (maximum) split ratio is usually 1:32 or 1:64. In real life network, the number of splits is decided based on the bandwidth cap for each subscriber in a cluster.

An ONU is used to distribute services to MDU (Multiple Dwelling Unit) or MTU (Multiple Tenant Unit) while an ONT is used to serve a single-family home. ONT is an outdoor unit that serves as a demarcation point between a FTTH operator's network and a subscriber home.

The ONT may have these interfaces: POTS/VoIP and RJ-45 for Internet, set top box, and/or T1/E1/T3/E3. A FTTH service provider may give an Internet router to each subscriber to enable network monitoring and provide bundled services portal. The distribution of services in a subscriber home may be left to each subscriber or done by the service provider technician as an additional service. Cat 5e cable is commonly used to distribute triple play services throughout the home, but existing coaxial cable installation for distributing cable HappyTV service and power lines are considered as alternatives for in-home distribution network

2.2.1 Outline

The project has to be divided into different stages starting with the planning ending with project testing. By the end of each stage start one by one. Once finish the first stage the second stage begins and so on until the end of the project.

The tasks were divided as follows;

- Planning
- Implementation and Installation
- Testing and trouble shooting

This report aims to explain in detail all the tasks done and how these stages integrated together. These stages come one by one from the first stage which was the planning ending by the last step which was the testing of the project. It will explain the step by step development of each process, the problems encountered and how they were solved.

The planning task is further divided into the following sub-categories;

- Strategic network planning
- High- level network planning
    - Choosing the OLT
    - Choosing the chambers
    - Fiber optic cables installation method
    - Selecting the fiber optic cables types
    - Selecting the equipments
- Geo referenced data and routing planning

The implementation task was divided into the following;

- OLT implementation
- Open the manhole and clean it from the toxic air
- Fiber optic cable deployment

- Splitter installation
- ONU installation

The GUI development consisted of;

- Check the system from A to Z
- Test the system
- Troubleshoots the problem if there is any

On completion of all the tasks, the system will be turned on and ready to supply all the end users with TM fiber optic high speed broadband internet.

2.2.2 Brief

These tasks were assigned to the team members as shown in the chart below;

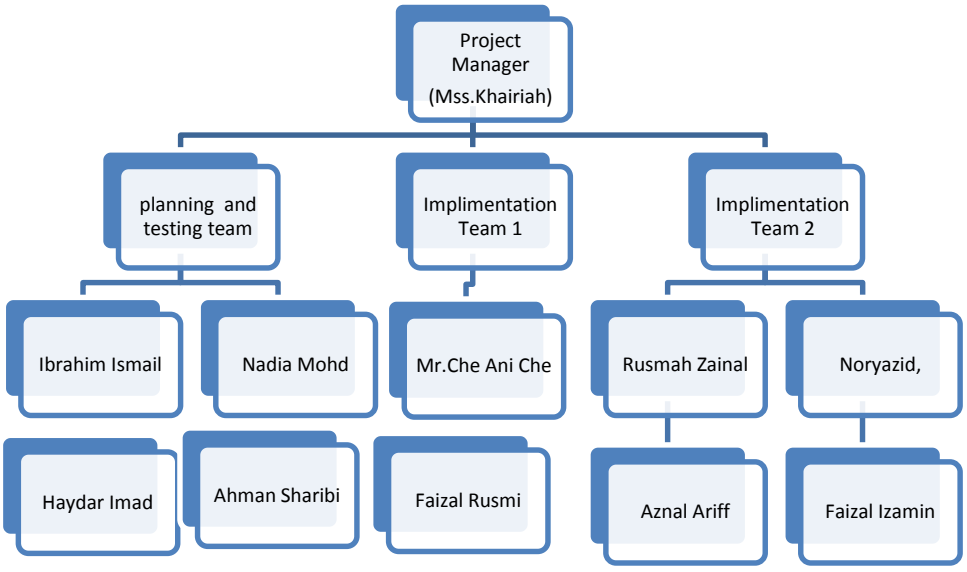


Figure 4:Chart showing tasks

As shown in the figure above, the project was managed by the manager of the Access network development Kuala Lumpur department, Miss. Khairiah. Her task was to head all the meetings and to overlook the progress of the project.

The planning team consisted of two members; Nadia Mohd, Ahmad Sharibi, Ibrahim Ismail and I. our task was to come up with the network routing design, and to make AutoCAD drawings.

The Actual component selection task was handled by Mr. Zahhid. He had to select suitable component.

The Installation and practices was handled by two teams; the morning shift team and the night shift team. The morning team consist of three technical officers Mr.Che Ani Che and Faizal Rusmi and while the night shift team consist of four technical officers Rusmah Zainal,Mohd Noryazid,Aznal Ariff, and Faizal Izamin. The testing team was handled by the planning team.

2.2.3 Solutions

The machine consists of combination of hardware integrated with the fiber cables. The hardware consists of the following;

- OLT which can fit up to 10 fiber optic distribution cables:
- Two chambers
- Fiber optic cables 20 Km
- OND, Splitters can fit up to 320 end users.
- 230 ONU, one for each end user.

The software consists of;

- Geographical information system.
- AutoCAD to draw the fiber cable routing.

The operation of the FTTH is as follows;

i. Signal converted to light peak in the OLT

ii. From the OLT output will flow through 10 fiber optic cables
iii. 10 fiber optic cables will be connected to 10 splitters, each cable to one splitter
iv. Each splitter will divide the E-side cable to 32 D-side cables
v. Each D-side cable will connect to one ONT
vi. The ONT will recive the light from the fiber optic cable and convert it to electrical signal
vii. The output of the ONT will go directly to the end user modem and router.
viii. The user can access the internet.

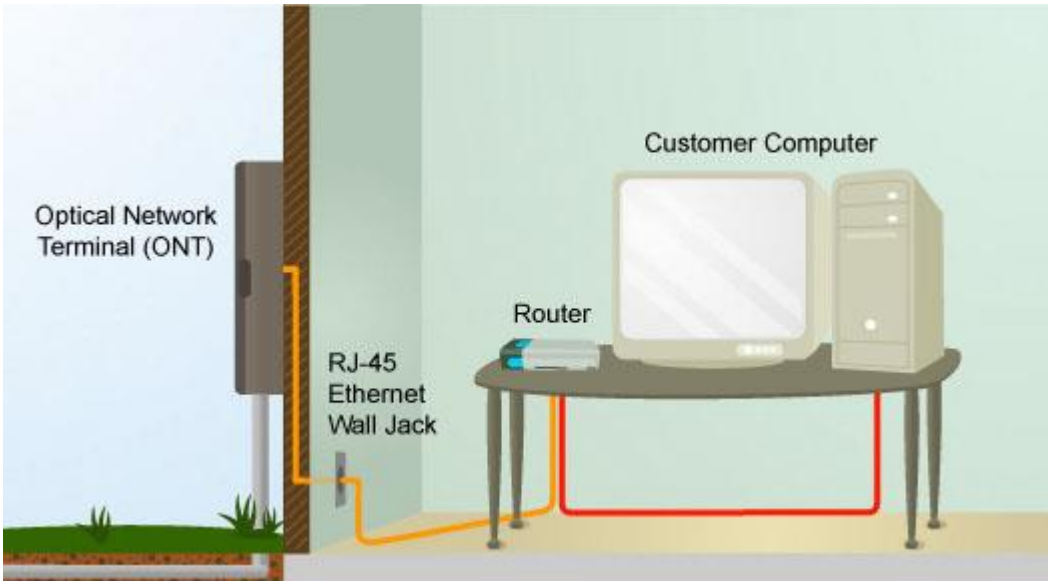


Figure 5: ONU and end user

2.2.3.1Network planning

As stated earlier, the planning team consisted of Ibrahim Ismail and me. Our task was to design the network routing such that it would operate as required. A number of stages were involved before completion of the planning task. These have been explained below in detail;

2.2.3.1.1. Strategic network planning

It is the first step of the planning process and the most important one. All the next planning and implementation steps depend on this one. During the strategic network planning the TM planning team had decide what optical network strategy will be use.

2.2.3.1.2. High-level network planning

High level network planning is the phase when structural decisions for a particular geographical planning area are made. These include the placement of network functions (distribution points) and connectivity decisions (which location serves which area) and the installation lengths of cables and ducts as well as quantities for the various types of hardware. Our planning team took a detailed view of the hardware, during this stage of the planning process, since the details can have a significant impact on the optimal network topology. The hardware includes passive components (for example optical distribution frames, chambers, PON splitters, conventional duct and/or micro duct systems, cables and fiber termination units). This includes: what cables and ducts can be installed in the feeder, distribution and drop areas; which (inner) cables and ducts fit into which outer ducts. Finally we have generated the lowest cost network plan within the boundaries of the strategic network planning and it will be discussed later.

Geo-referenced data and routing planning

In all planning phases the features of the geographic area must be taken into account. Two main types of geo-referenced data are required for a planning exercise:

- street topology information, including sidewalks, crossings, etc; and
- Building locations, ideally including the number of living units and/or businesses per fiber-termination point.

In this step the planning team surveys the work site and collects the desire data. All the collected data have been submitted to the routing planning team

The planning team assigns the routing plane for me. So I did four different routing plans, Using geographic information system and AutoCAD software. Mr. Ibrahim chooses the one shows below because it met all the requirements.

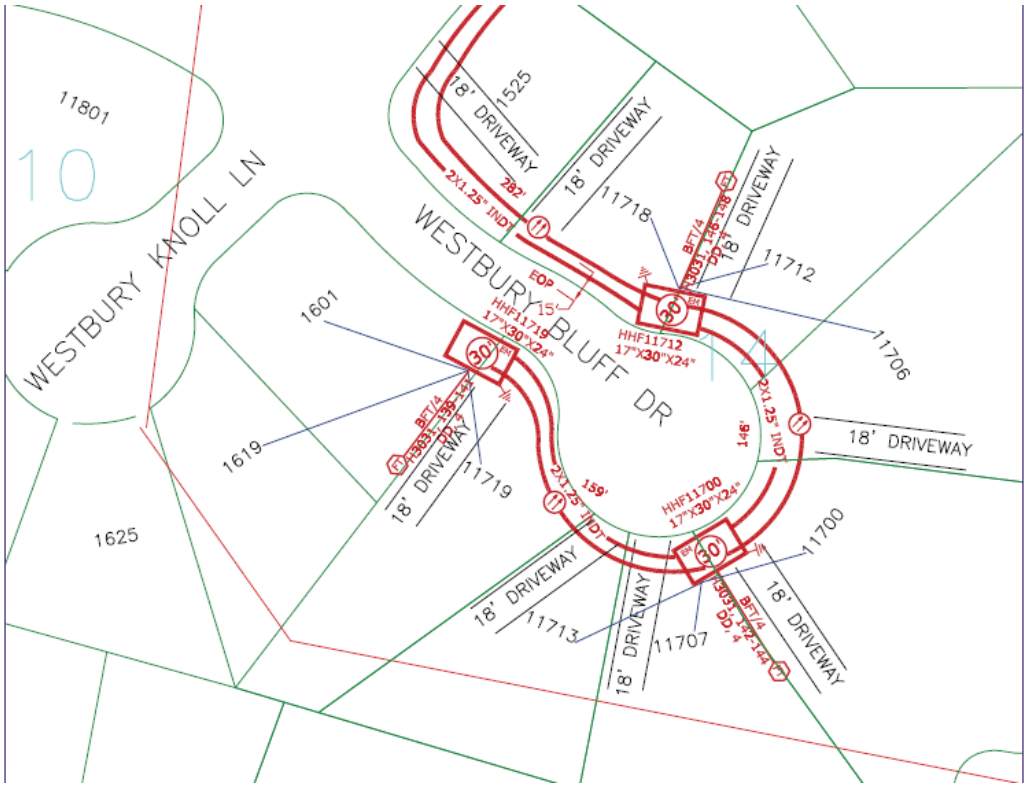


Figure 6: The chosen routing design

Choosing the nearest OLT:

During this step our planning team have decide to choose the nearest OLT to the house complex (end users). To reduce the distance between the provider and the users in order to reduce the equipments need to be used and the long of the fiber cables thus reduce the cost of the whole project.

Choosing the Chambers:

In this step we had to assign the nearest chamber to the OLT as well as the nearest chamber to the end users. These chambers will provide access to the ends of ducts and the cables running through them. We have two types of chambers, Box and manhole. In our case the chamber which was near to the OLT was manhole while the one near to the end user was Box. This will help the implementation team to install the fiber cables from between the OLT and the end users using different routings since the manhole is large and can fit number of ducts inside it.

Fiber optic installing method:

Installing the cables inside the ducts can be done either by installing new duct or using of an existing duct. We did survey to the work site to check whether there is old unused duct or not. During the survey we did find a duct ready to be used. In order to use the old duct we have to choose what installing technology suitable in our case. Basically there are more than 7 different fiber cable installing method and we are as a planning team have to choose the most suitable on for our project. Pulling, air blowing, floating, micro-duct, de-coring, flexible inner duct and direct burial are common installation methods. Each one has its advantage and disadvantages. Pulling method was our final decision since this technology can reduce the friction between the cable and the duct, hence reducing the tensile load.

Choosing the type of the fiber optic cables:

In this stage we are as planning team must choose the type of the fiber optic cables for the D-side and the E-side. We have decided to use three different types of fiber optic cables. These cables have been chosen according to their features as shown below

Stranded Loose Tube Non-armored outdoor Fiber Optic Cable:

The coloring fibers are positioned in a central loose tube and fillers are stranded around the metallic central strength member. The APL is longitudinal covering. The cable is completed with PE sheath. In the loose tube, the gaps of the cores are filled with the water-resistant filling compound.

Characteristics:

- Good mechanical and temperature resistant performance
- Crush resistance, water blocking and flexibility

Figure 7:outdoor Fiber Optic Cable

Distribution Fiber Optic Cable :

Characteristics:

- Excellent stripping performance of tight buffer fiber
- Small cable diameter, small bending radius and light weight
- Easy installation, maintenance and management
- Content with different requirements of indoor installation, including: buildings, lift well and FTTX

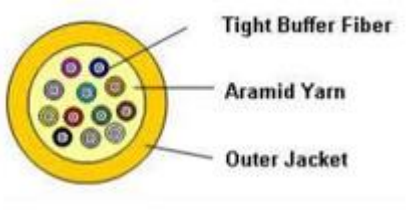


Figure 8: Distribution Fiber Optic Cable

Access Fiber Optic Cable

Characteristic:

- Suited to SM fiber and MM fiber (50μm and 62.5μm)
- Gel-filled or gel-free loose tube
- Ideal choice for fibre optic access project

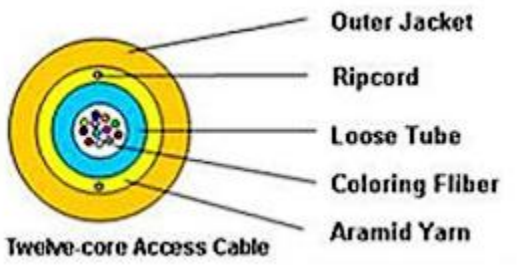


Figure 9: Access Fiber Optic Cable

Choose of the Equipments:

The hardware includes the passive components (optical distribution frames, PON splitters, and fiber termination units). TM planning team had decided to use SUN-GE8100 Series GEPON System due to its unique features and the stability which were mentioned earlier.

TM planning team had decided to use SUN-GE8100 Series GEPON System due to its unique features and the stability which were mentioned earlier.

TM planning team have been choose SUN-GE8100 series (Ethernet Passive Optical Network) because it is suitable for supplying high-speed, wide overlay fiber access network which was the our project goal. It consists of SUN-GE8100 series OLT (Optical Line Terminal), SUN-GE8200 series ONU (Optical Network Unit) and ODN (Optical Distribution Network).

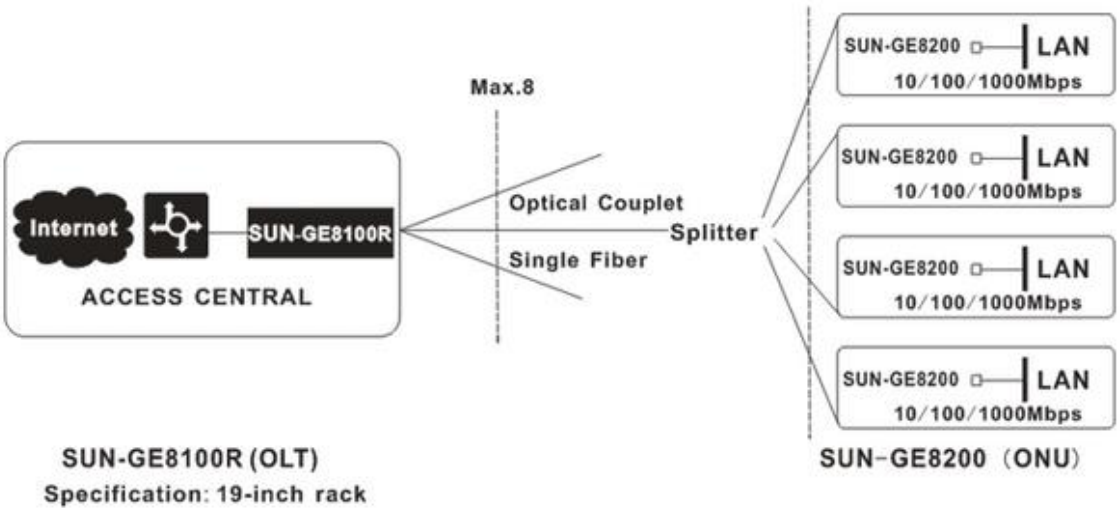


Figure 10: Application of SUN-GE8100 OLT

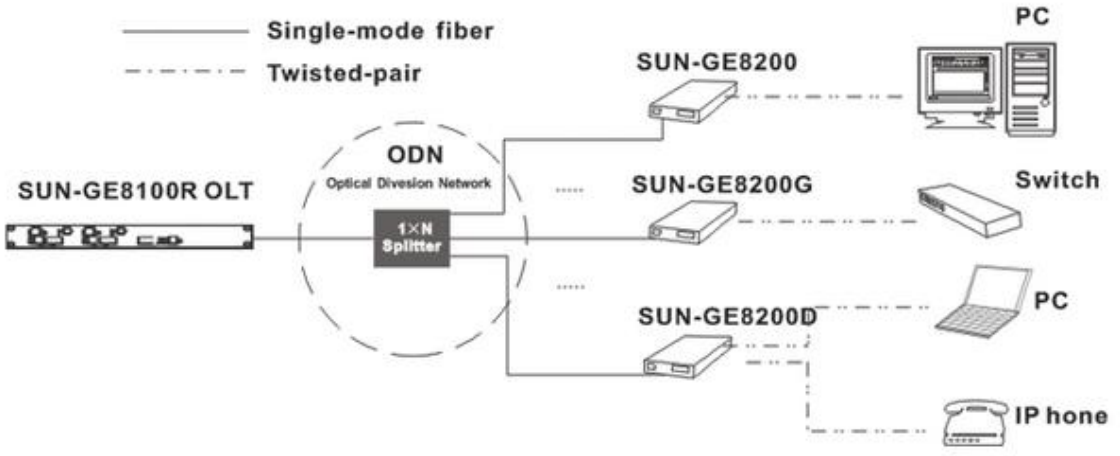


Figure 11: Structure of SUN-GE8100 Series EPON System

1. OLT

For the OLT the planning team has been choose SUN-GE8100 because it is medium-sized OLT with rack structure, and because It can cooperate with SUN-GE8200 series remote equipment (ONU) to form an EPON connect through fiber and Passive Optical Distribution Network (ODN), supporting maximum 8 PON systems.

SUN-GE8100 adopts 19-inch width and 3U height rack with 16 slots among which every two is offered to one OLT module, supporting maximum 8 OLT module cards and 1 network management card. It has a concentrated power supply with active and standby power systems, supporting automatic switching.

Figure 12: SUN-GE8100 OLT (Optical Line Terminal)

2. ONU

Since the SUN-GE8200 series ONU is cost effective customer device with Ethernet interfaces, specially designed for FTTH (Fiber to the House) and FTTB (Fiber to the Building) we decided to use it for our FTTH project.

SUN-GE8200 series ONU (Optical Network Unit) is the user equipment of EPON. It can end the operation from OLT (Optical Line Terminal) by PON and provide all kinds of broadband services cooperated with OLT. It is configured and managed remotely by OLT.

SUN-GE8200 series ONU is cost effective customer device with Ethernet interfaces, specially designed for FTTH (Fiber to the House) and FTTB (Fiber to the Building).

Figure 13:2-6 SUN-GE8208

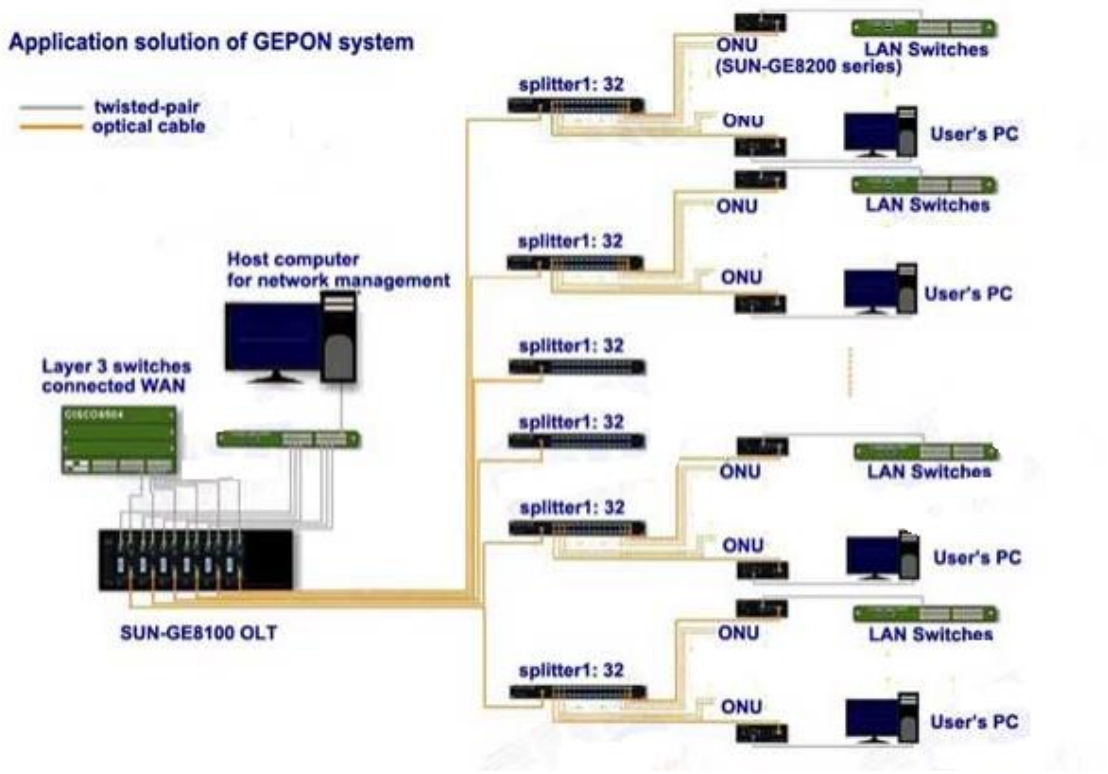


Figure 14: Complete FTTH network

2.2.3.2. Implementation:

During the implementation stage the implementation team has divided into two teams, morning and night teams, in order to complete the project faster and because some time it's difficult to work during the morning especially with the jam. The responsibility of the implementation team was the implementation of the FTTH network from A to Z.so that the implementation has been divided into stages, which will be described below.

OLT implementation:

During this stage the implementations teams decide to expanded the nearest central office and install the new OLT equipments and make it handle up to 320 customers as shown in the picture below.

Figure 15: OLT installation

The OLT installation manar will be added in the appendix.

Splitter Installation:

10 fiber optic cables will come from the E-side (OLT), and then it will be divided to 320 tiny fiber optic cables in order to serve 320 end users. In order to divide the E-side fiber cables the Implementation team install 10 splitters, each one can divide one of the E-side fiber cables into 32 D-side fiber cables. The picture below shows the splitters.

Figure 16:1-32 splitter

The implementation teams have been installed 10 splitters each one has one input came from the OLT and 32 outputs goes to the ONU.

ONU installation:

During this stage the implementation teams installed the ONU devises, one device for each house.

Figure 17:ONU installation

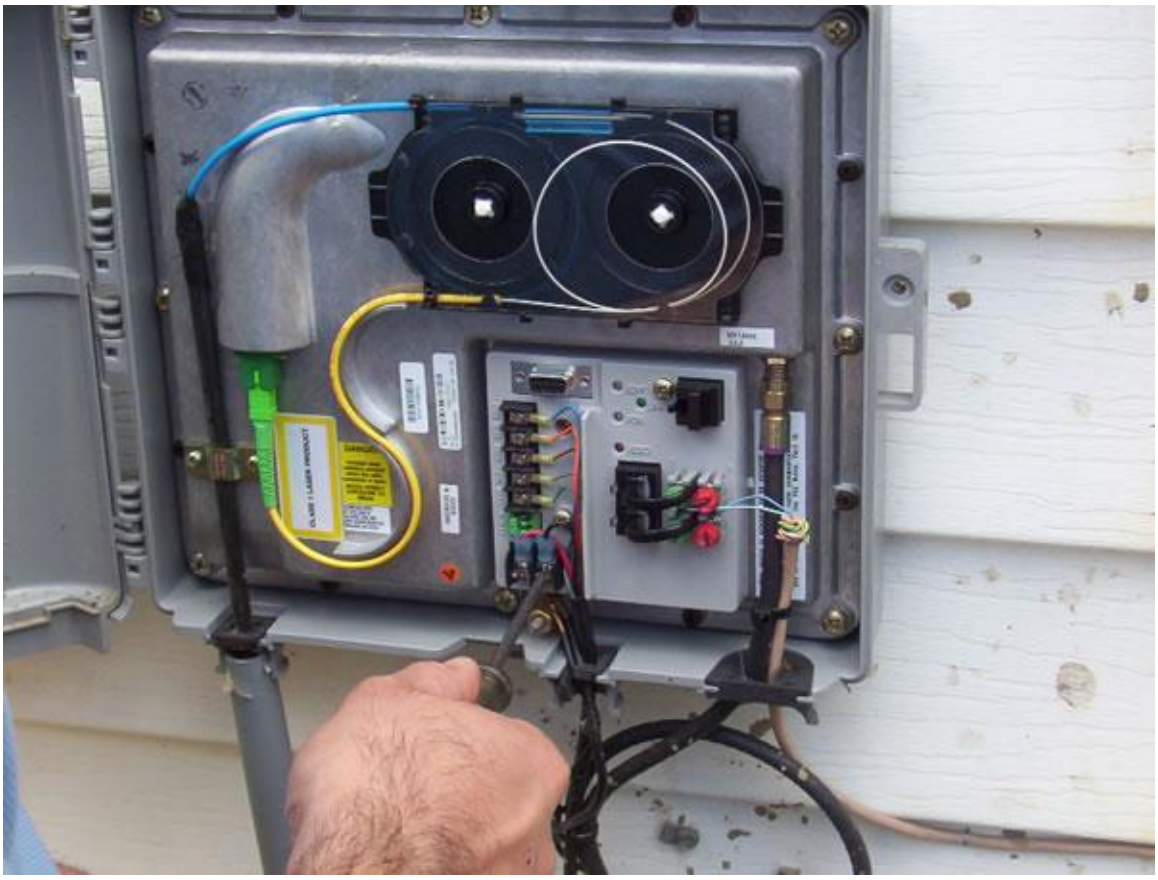


Figure 18: ONU installation 2

Fiber Optic cables:

The night implementation team handle this stage because they pull the cables in the chambers and ducts which are located on the street, and it is very difficult to work during the morning because the traffic jam .

The implementation team used the pulling method to deploy the fiber cables. A draw rope has been be installed into the duct prior to cable winching, were the cable is fitted with a swivel that allows the cable to freely twist as it is installed. A mechanical fuse rated below the cable's tensile strength is used to ensure that the cables rated pulling strength is not exceeded. Installation along long sections can has been achieved by the use of the intermediate pull mechanisms.

Figure 19: Implementation 2 team night work

Figure 20: Remove toxic air

Figure 21: Cable deployment

Connecting the equipments:

The last implementation step was to connect the OLT with the E-side fiber optic cables. Then connect these cables with the splitters and connecting the splitters with the D-side fiber optic cables, and finally connect the D-side cables with the ONU.

By the end of this stage the system being ready to go th the next and the final stage which was the testing of the system.

2.2.3.3. Testing and troubleshooting:

Use of optical loss test sets

Testing involves using an optical loss test set (OLTS), comprising two test sets that share data to measure insertion loss (IL) and optical return loss (ORL). First, the two units should be referenced prior to measuring IL.

Figure 22: Test sets should be referenced prior to measurement.

Next, ORL sensitivity is set by calibrating the minimum ORL that the units can measure. The limitation comes from the weakest part of the test setup, which is most likely to be the connector between the units and reference test jumper.

The purpose of the test is to identify whether there are any transposed fibres, and measure the IL and ORL to make sure that the loss budget has been met.

The test's result as shown below

Table 1: illustrates the ORL values for the network:

Length (metres)	1310nm (dB)	1490nm (dB)	1550nm (dB)
50	53	56	57
300	46	50	50
500	44	47	48
1000	41	45	46

We have measured the loss of the splitter and the cumulative link loss, as well as identified whether any unexpected physical event has occurred before, or after, the splitter.

The result was as shown in the picture below.

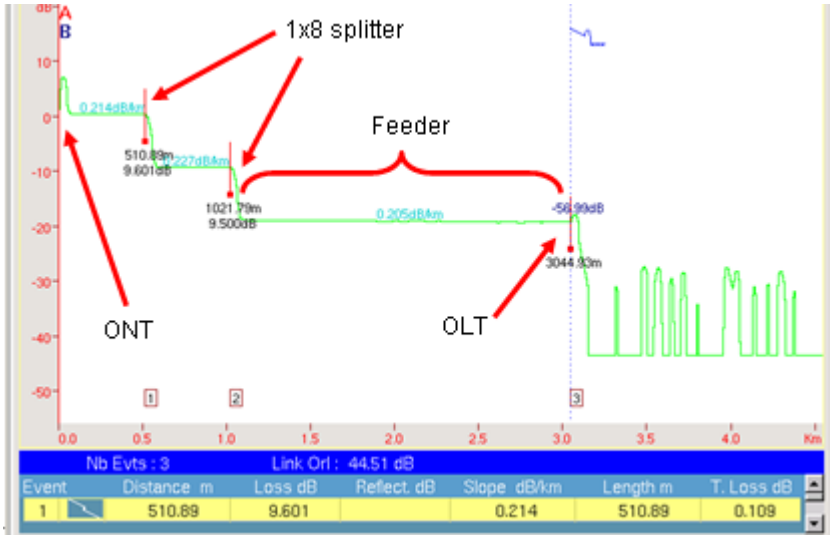


Figure 23: PON optimized OTDR test from the ONT to the OLT.

2.2.4. Project Results

As stated earlier, the hardware testing was done individually. However, the signal testing had to be done once the FTTH network was constructing.

All the necessary components were installed and the network was tested. The following problems were found;

- Signal loss in dome end user
  And after checking we find that there is dust on some of the fiber cables and the solution was by cleaning these cables and remove the dust

- Simple PON - Customer is affected

Only one subscriber cannot receive service due to fault in the ONT equipment

The solution for this problem was change the ONT equipment for this customer.

Once the necessary modifications were made, the FTTH network was found to be working in a good condition and met the company standers.

The picture below shows the equipment testing done by me.

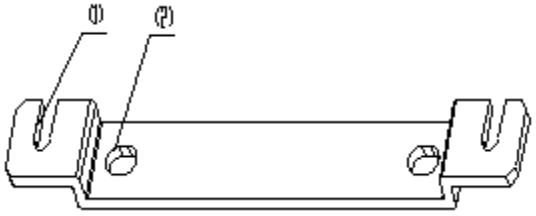
3. Conclusion:

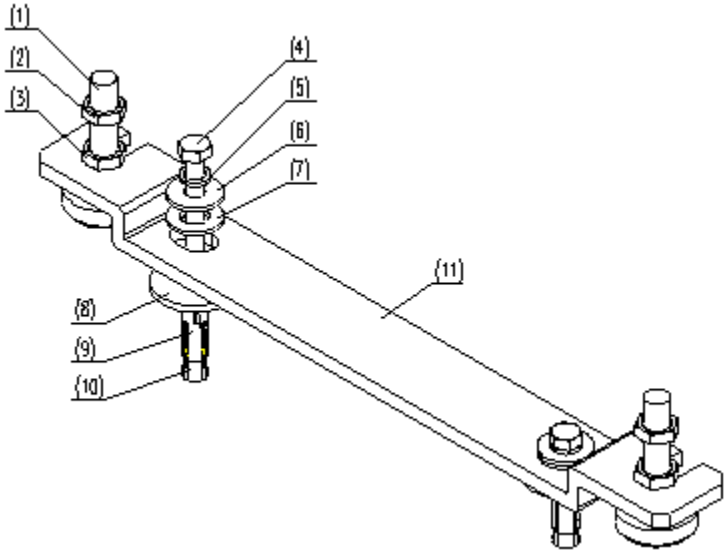
The project was a success since the FTTH was found to be working as required and was completed in the given timeframe.

Working at Telecom Malaysia was a great experience. I am thankful to A.P.U for having the internship program in the curriculum and to Telecom Malaysia for accepting me as a trainee.

In the four months that I spent at Telecom Malaysia,I have gained a lot of knowledge in the Telecommunication field; both theoretical and practical.

OLT installation manual:





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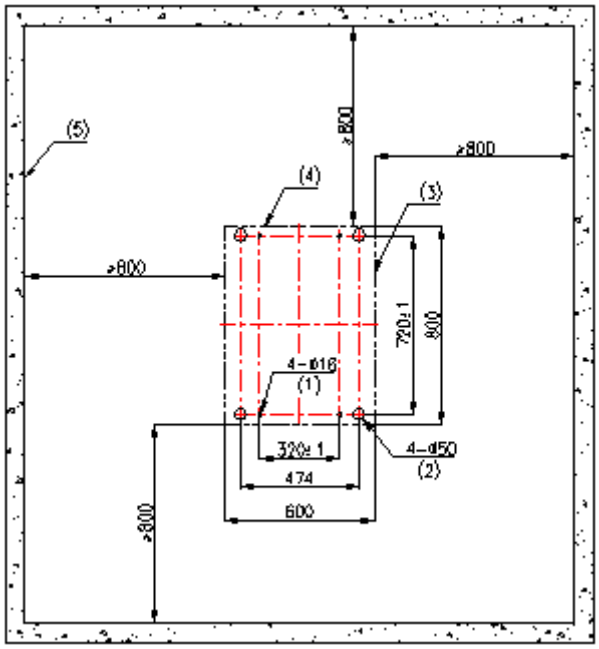
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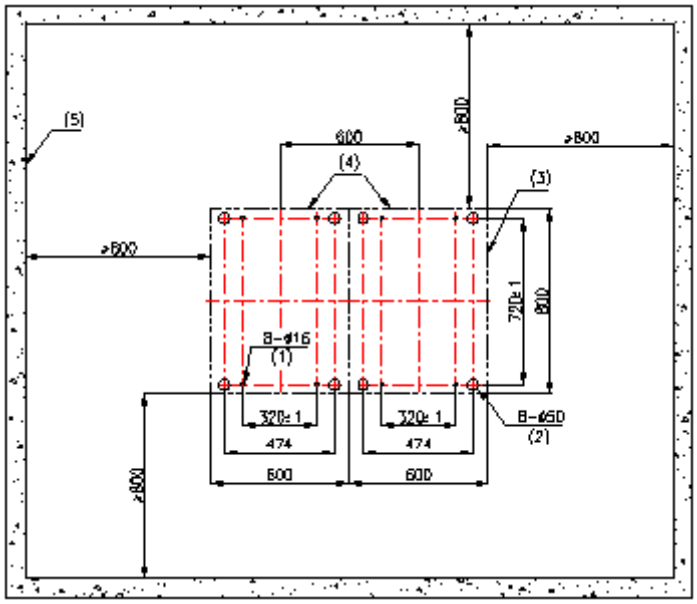
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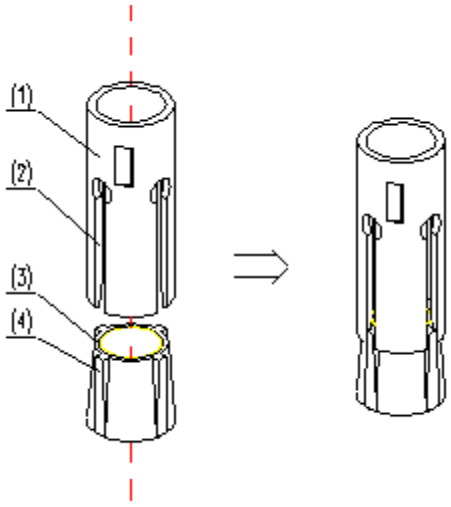
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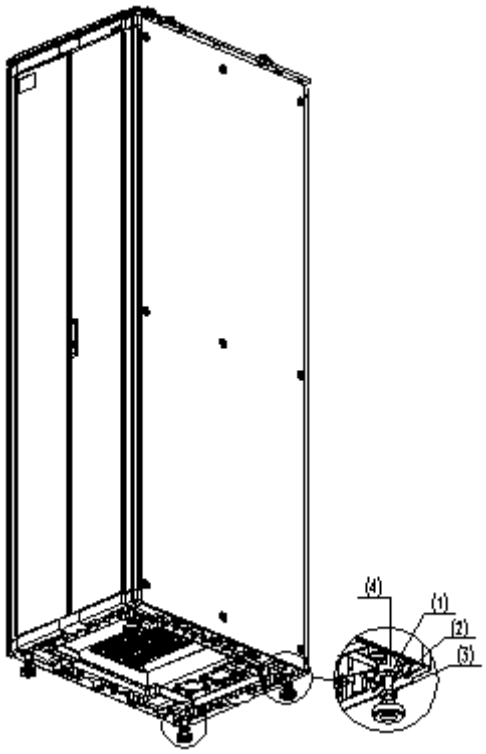
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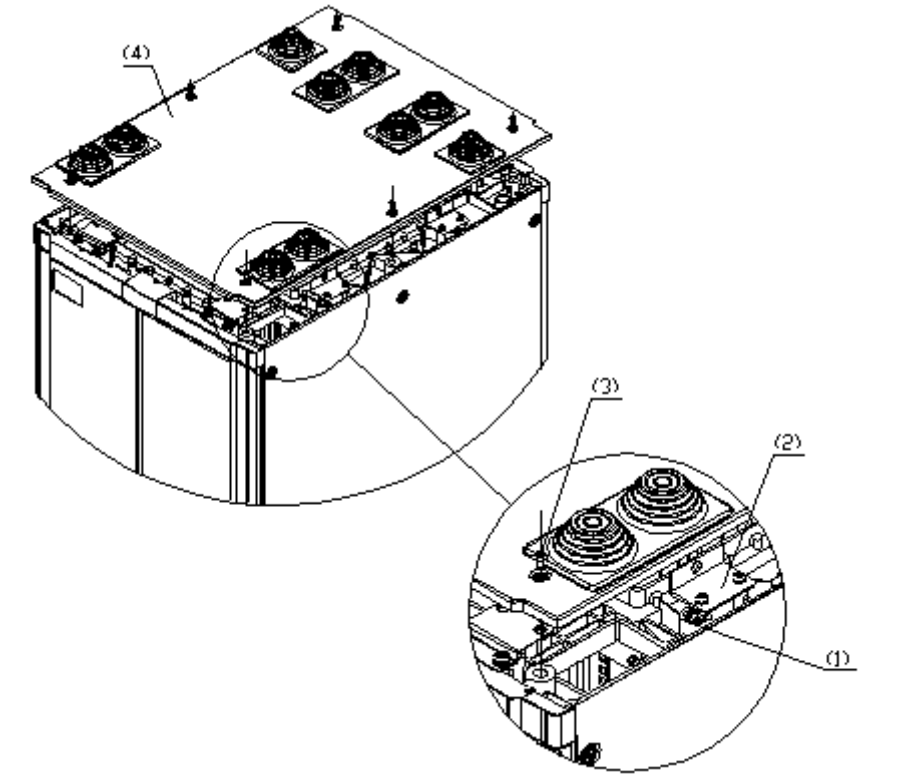
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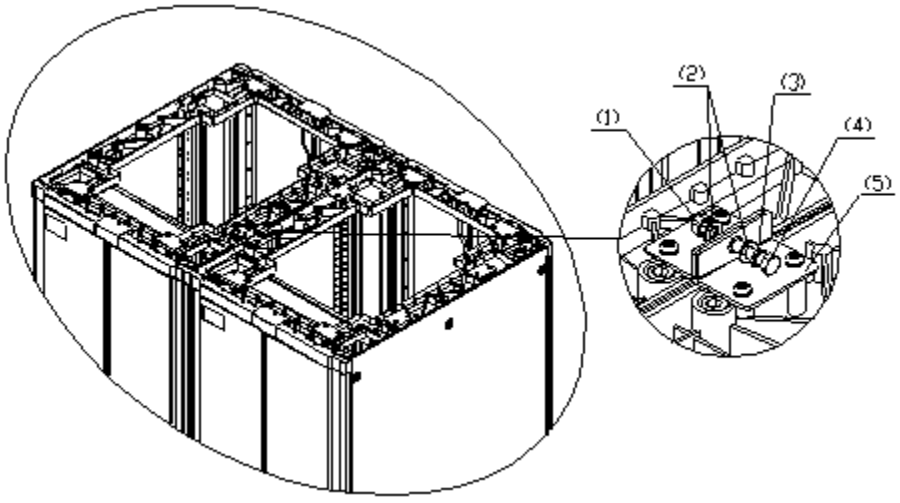
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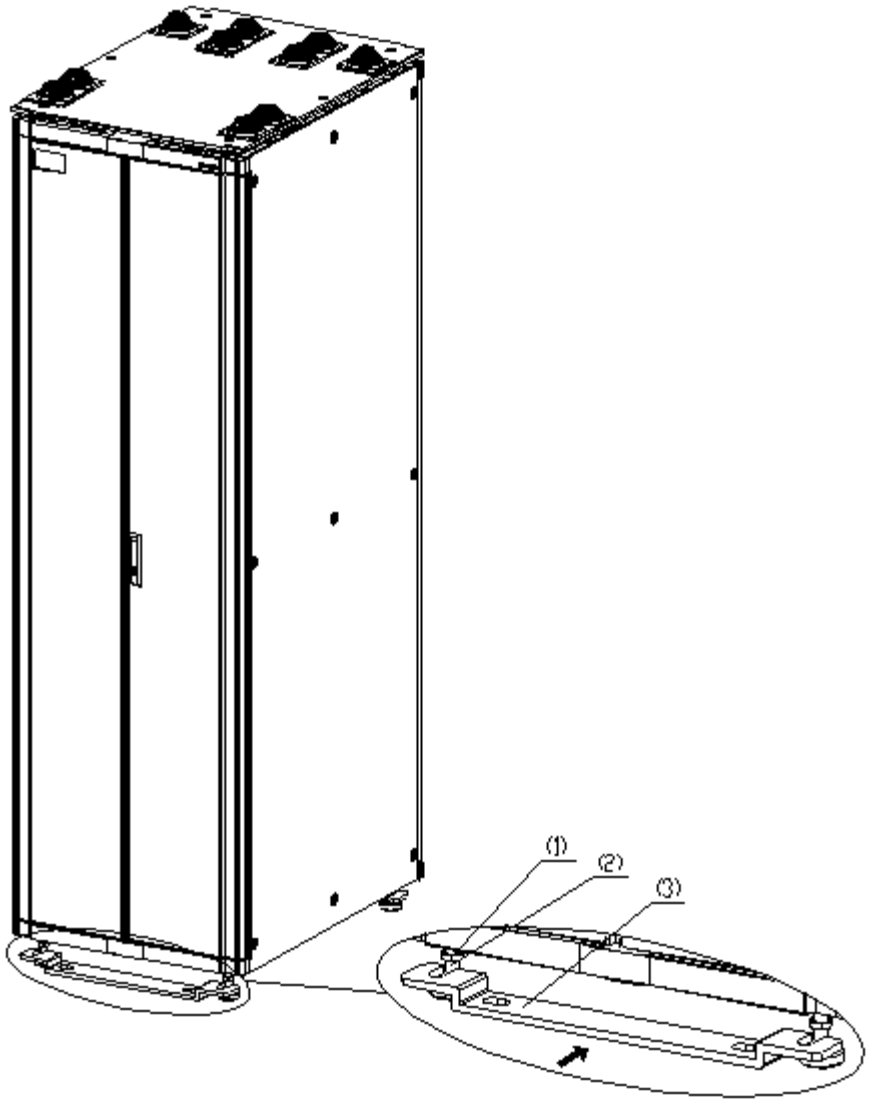
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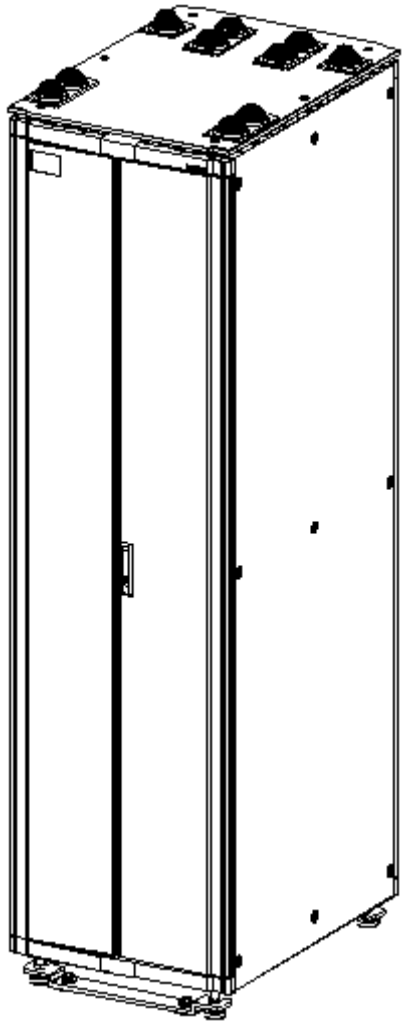

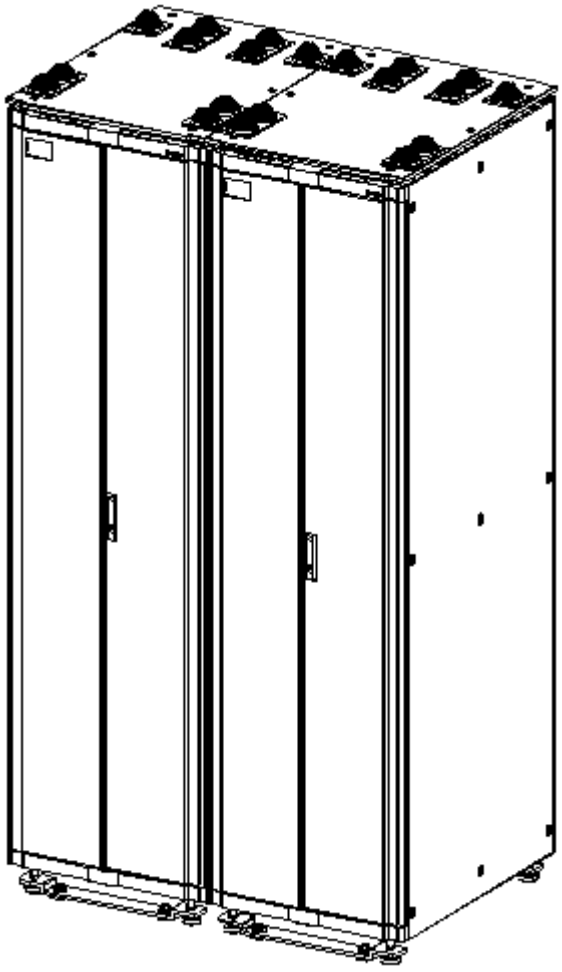

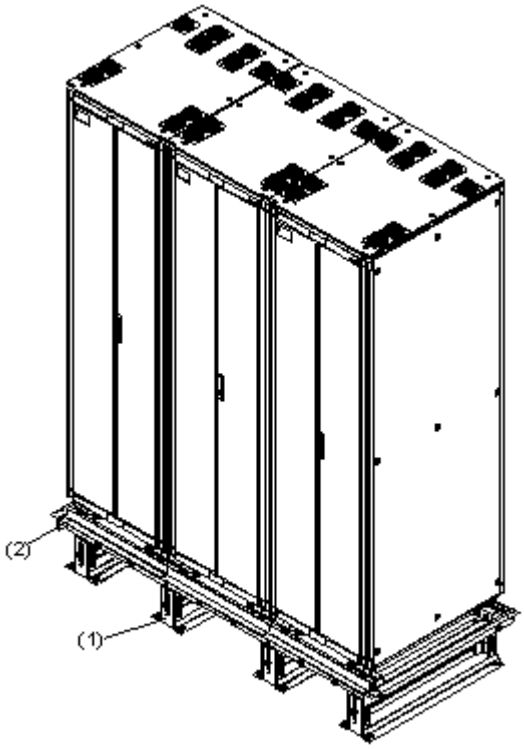
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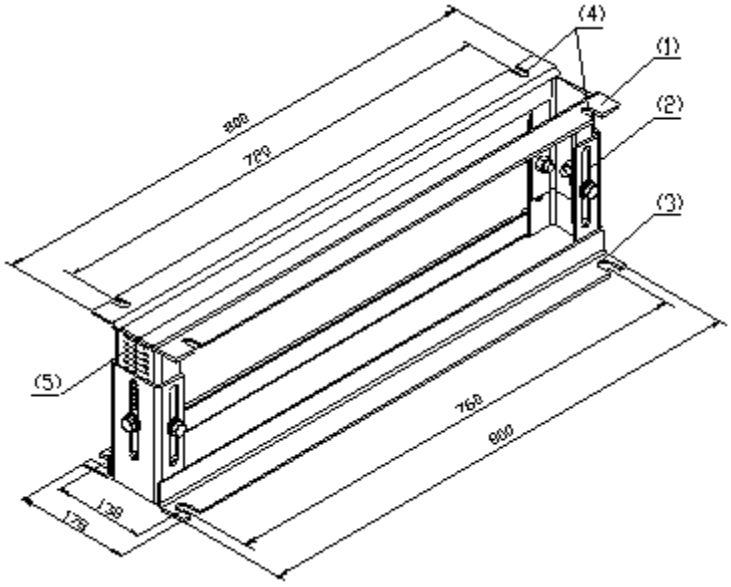
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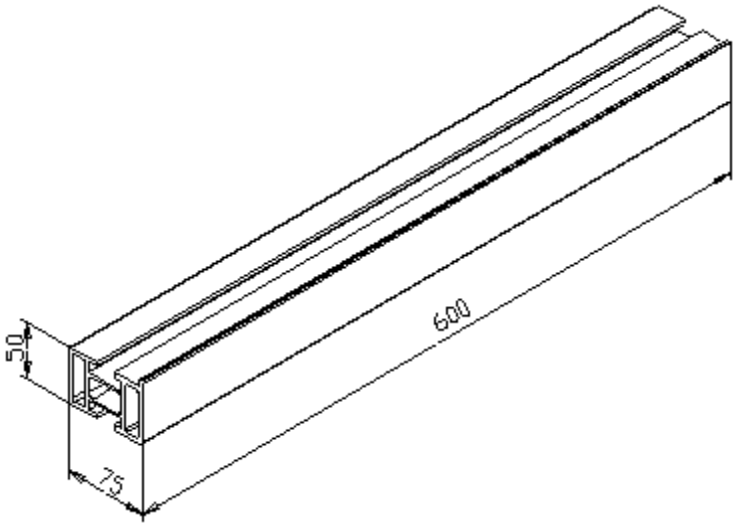
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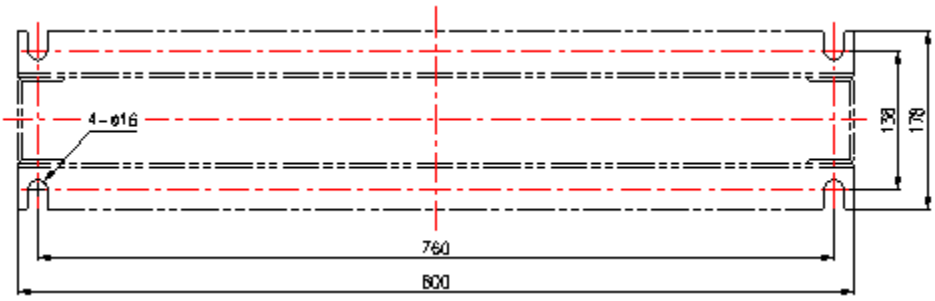
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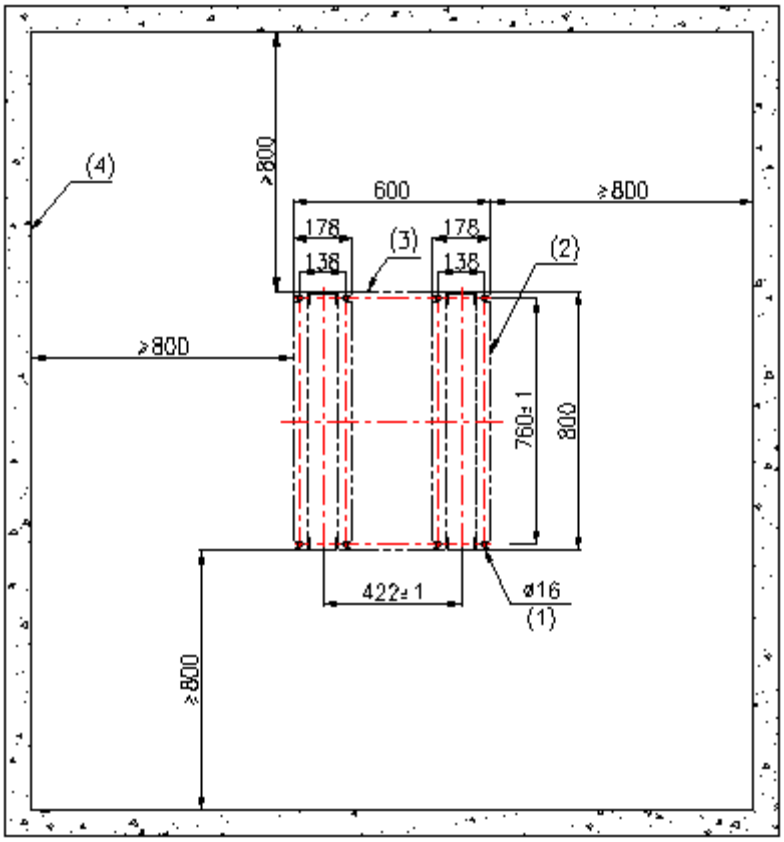
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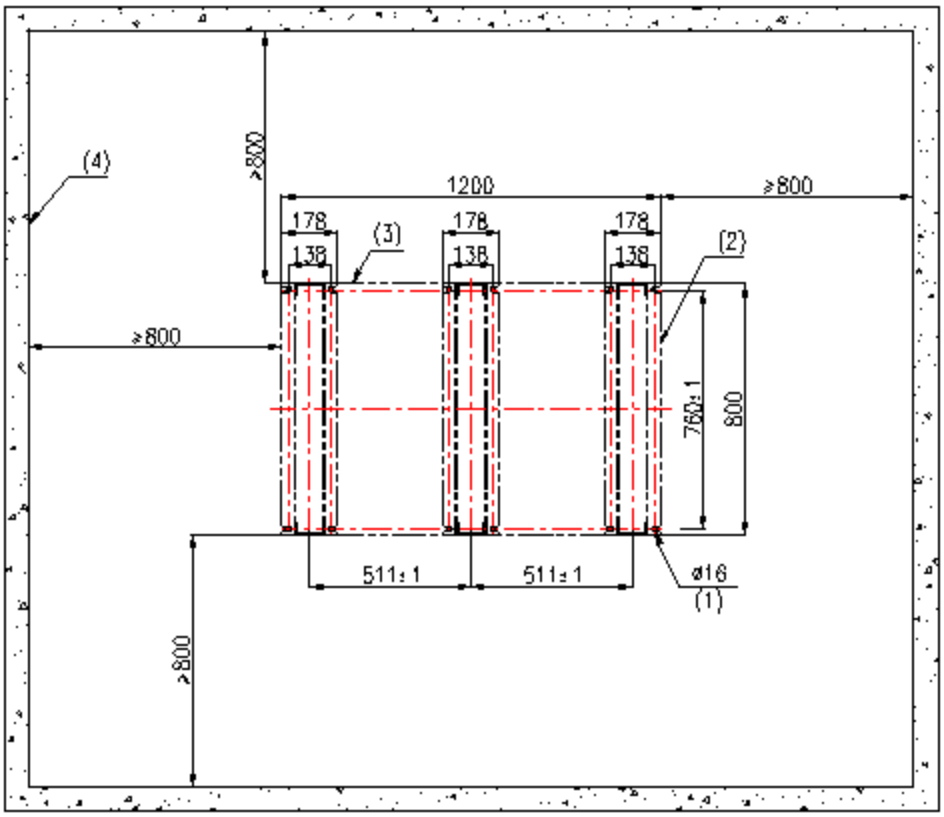
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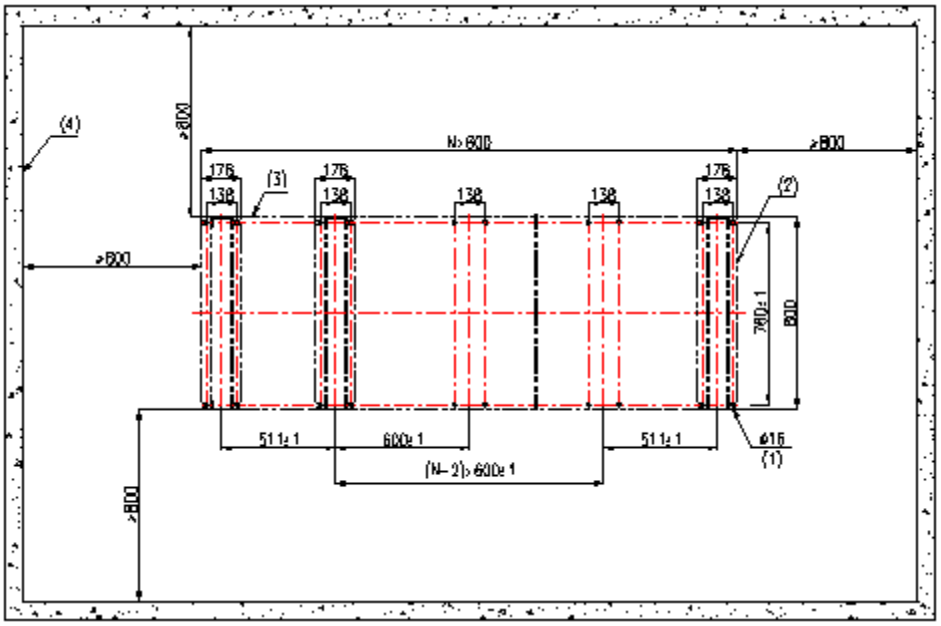
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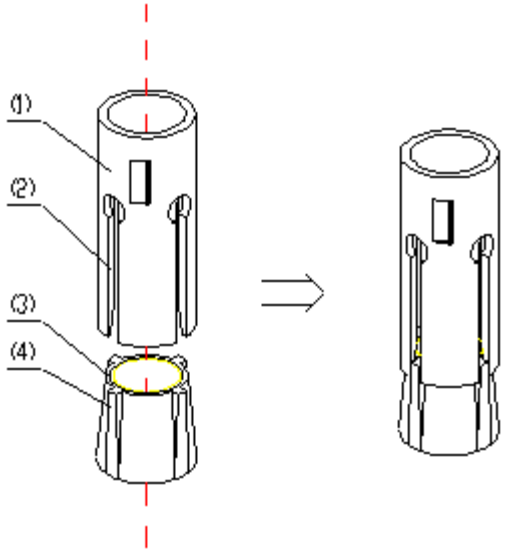
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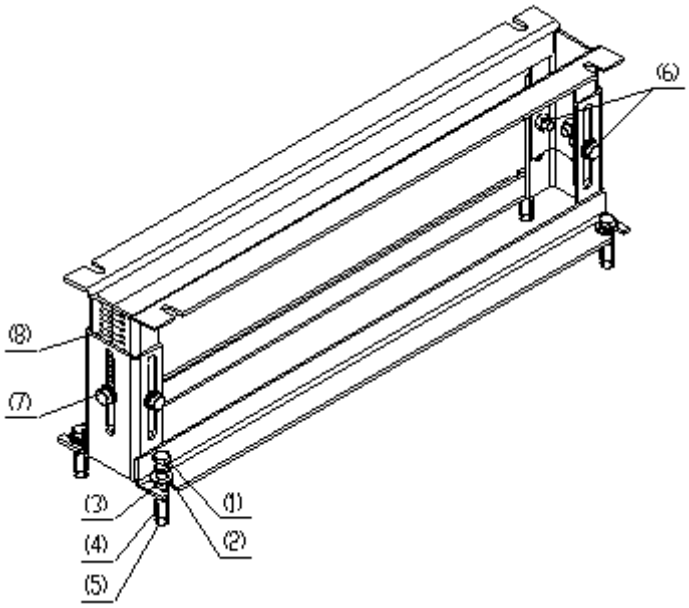
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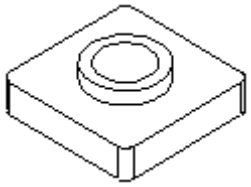

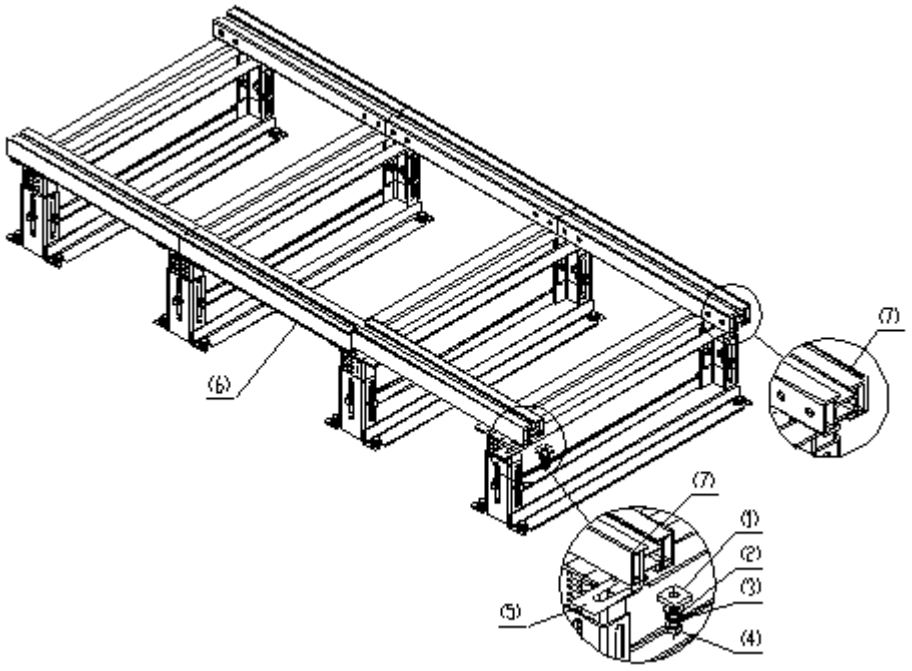
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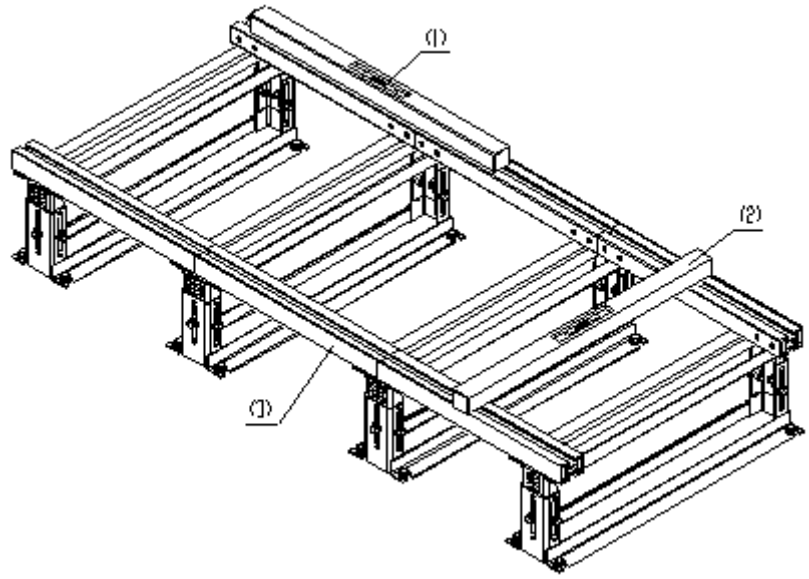
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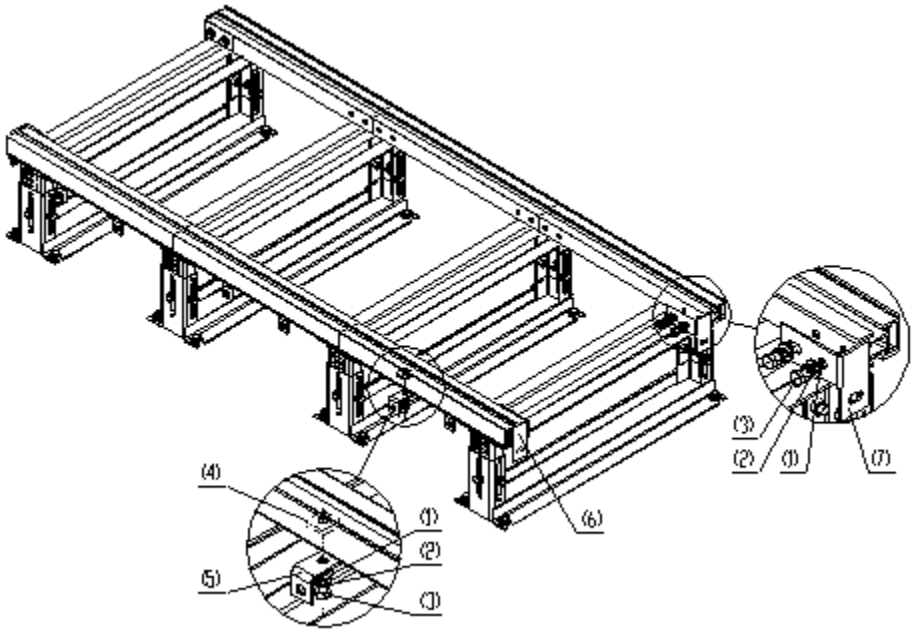
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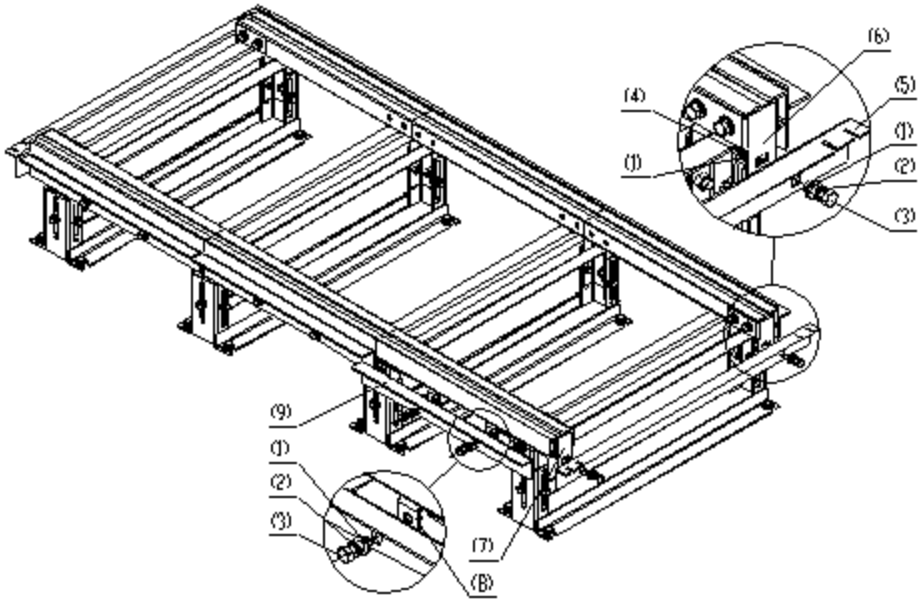
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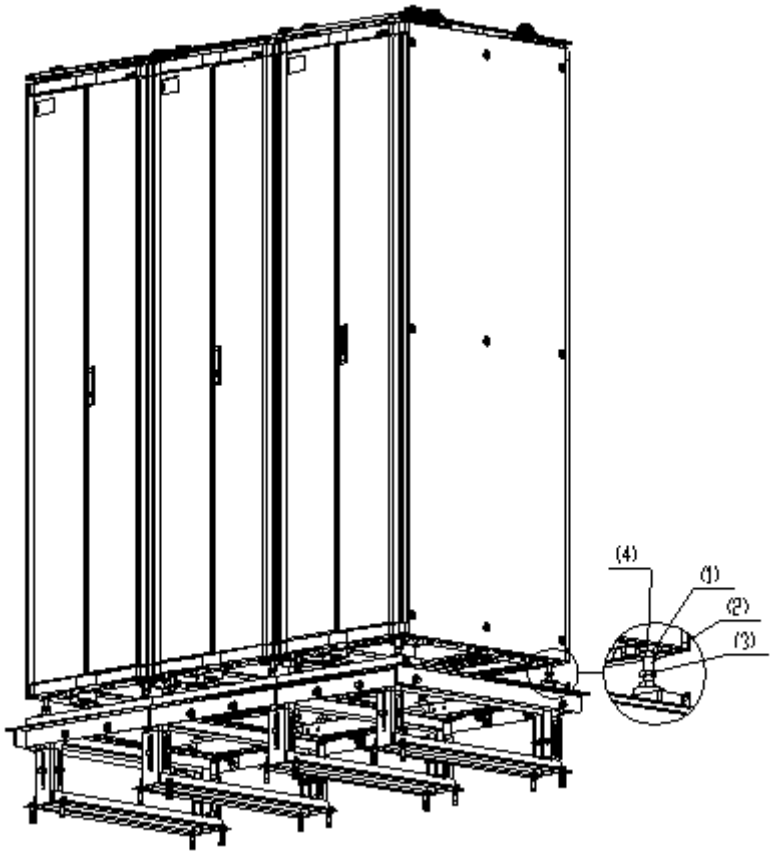
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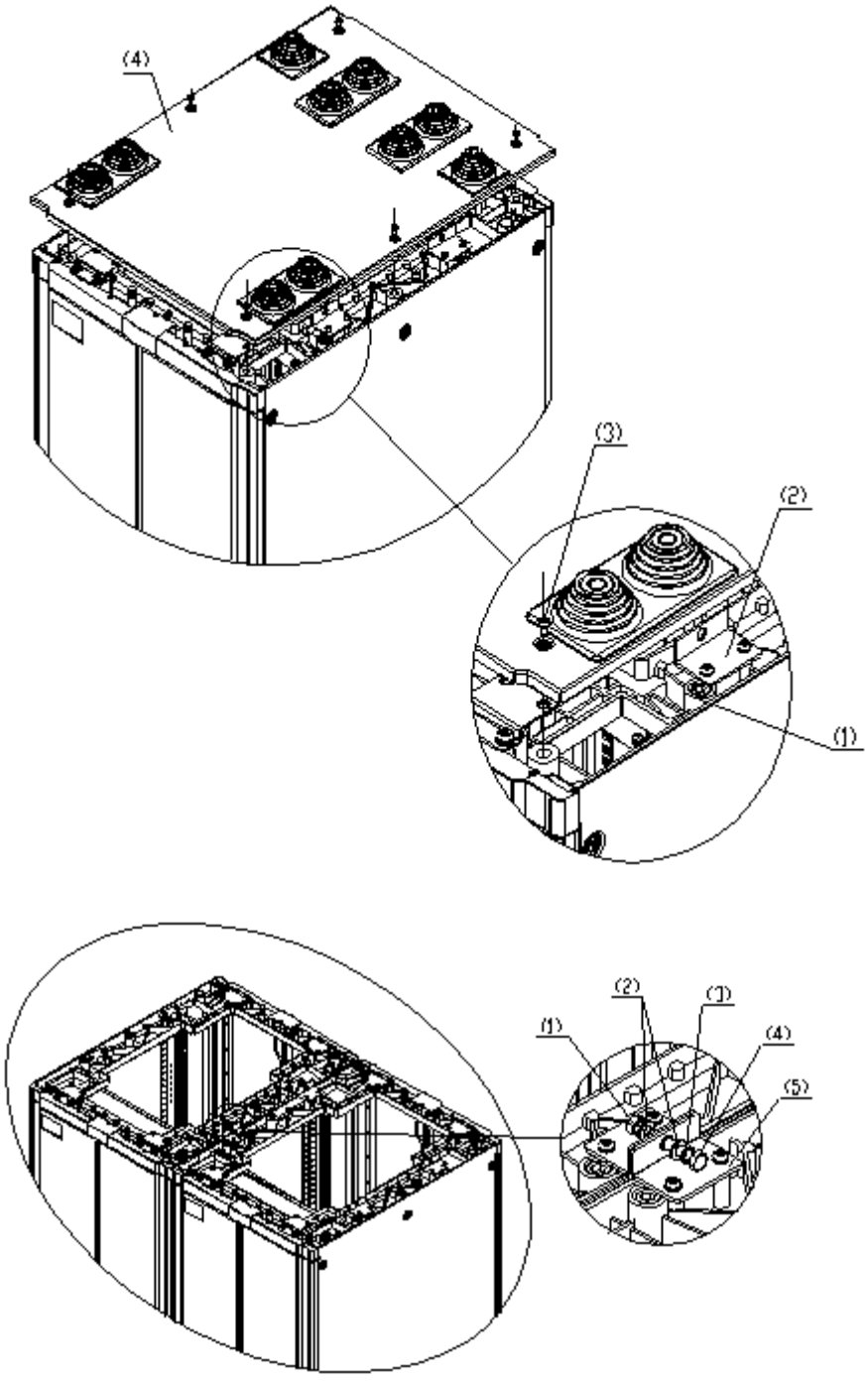
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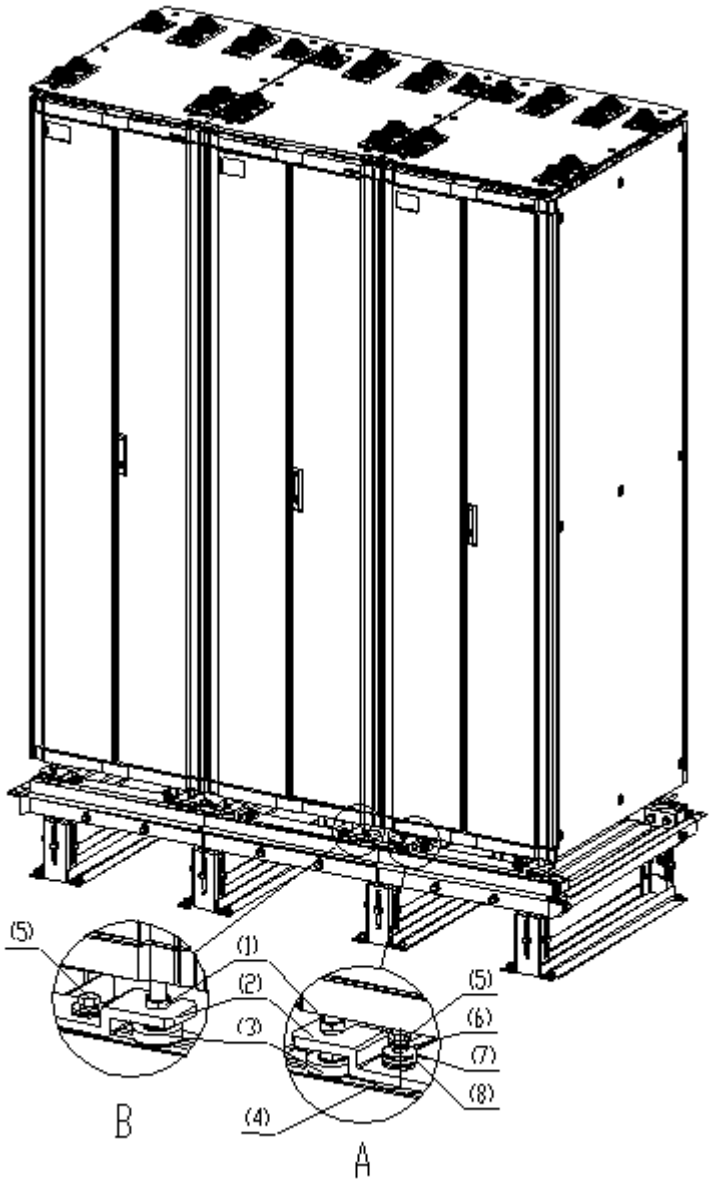
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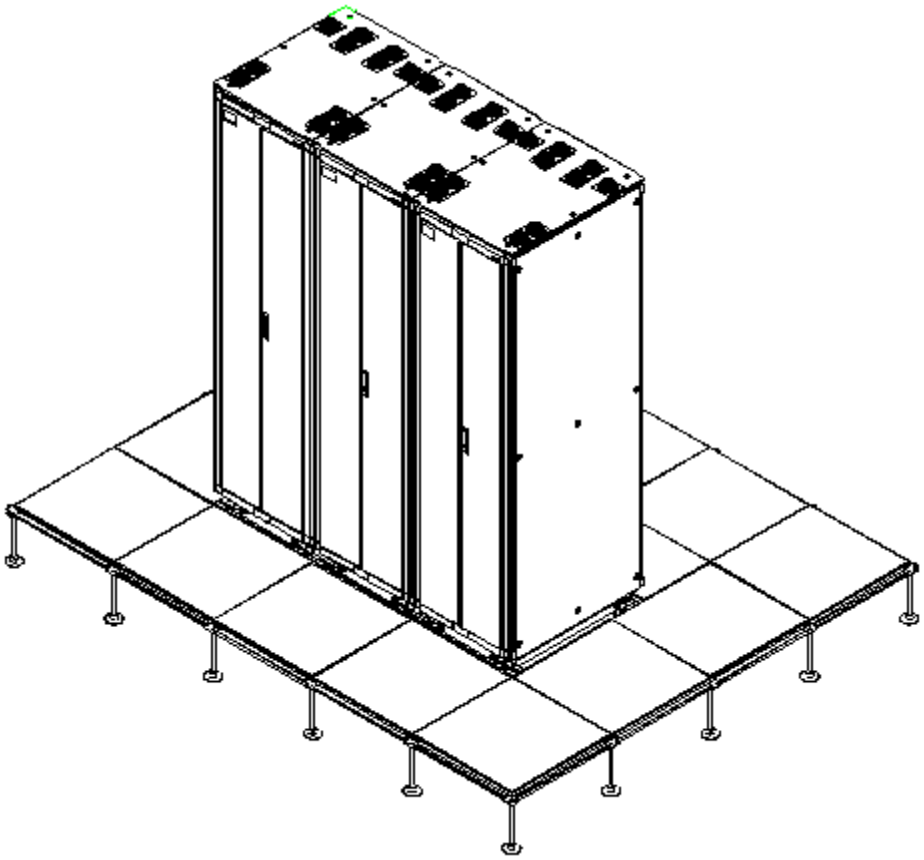

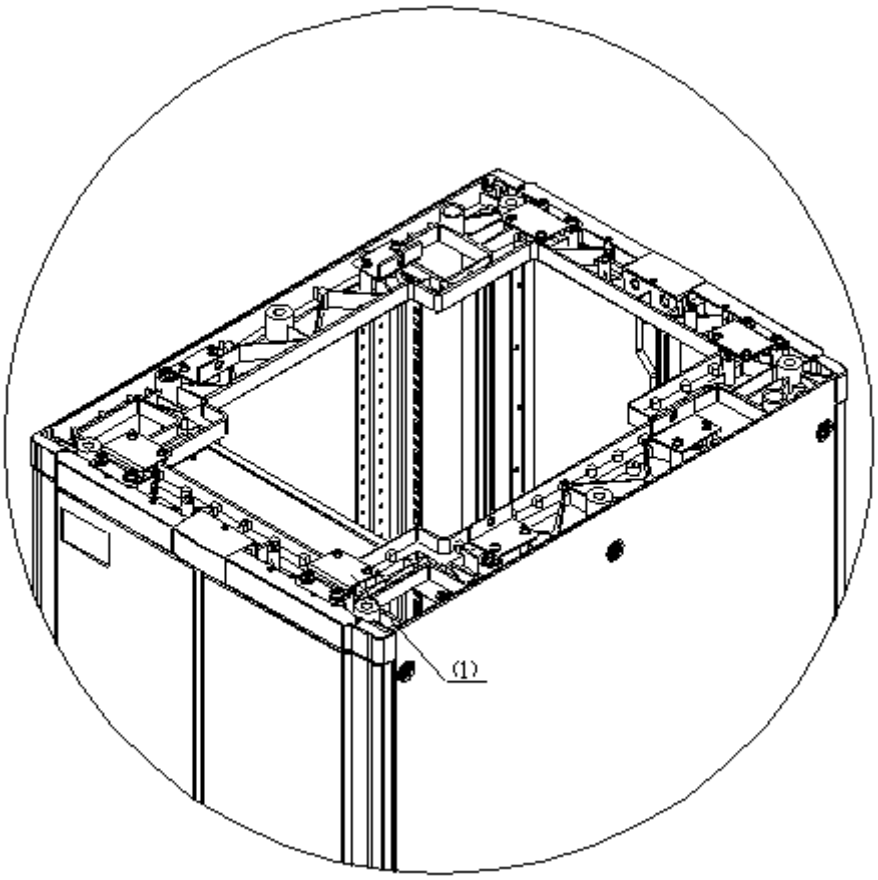
(1)

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