TECHNICAL CODE

TECHNICAL STANDARD OF IN-BUILDING FIBRE CABLING FOR FIBRE-TO-THE-PREMISE

(REVISION 1)

Developed by

Malaysian Technical Standards Forum Bhd

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MCMC

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DEVELOPMENT OF TECHNICAL CODES

The Communications and Multimedia Act 1998 ('the Act') provides for Technical Standards Forum designated under section 184 of the Act or the Malaysian Communications and Multimedia Commission ('the Commission') to prepare a technical code. The technical code prepared pursuant to section 185 of the Act shall consist of, at least, the requirement for network interoperability and the promotion of safety of network facilities.

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A technical code prepared in accordance with section 185 shall not be effective until it is registered by the Commission pursuant to section 95 of the Act.

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Committee Representation

Fixed Network Facility Working Group (FNF WG) under the Malaysian Technical Standards Forum Bhd (MTSFB) which developed this Technical Code consists of representatives from the following organisations:

Jaring Communications Sdn. Bhd

Maxis Communications Sdn. Bhd

Telekom Malaysia Berhad

TIME dotCom Berhad

FOREWORD

This Technical Code was developed by the Fixed Network Facility Working Group (FNF WG) under the Malaysian Technical Standards Forum Bhd (MTSFB) in accordance with Section 185 of the Communications and Multimedia Act 1998 (CMA 1998).

This Technical Code forms a part of the Technical Standards and Infrastructure Requirements (TSIR) documents which serve as the minimum requirements in line with the CMA 1998 and other relevant legislations such as Town Country and Planning Act (TCPA) and Uniform Building By-Laws (UBBL). This document which is specifically developed for the deployment of Fibre-To-The-Premise compliments the MTSFB 008, 2005 (Revision 1) - Technical Standard and Infrastructure Requirements (TSIR) Part 1: Fixed Network Infrastructure

In the context of meeting the needs of telecommunication (fixed network services) users, TSIR addresses the technical system and infrastructure requirements necessary for having the fixed network distribution system equipped in the building.

This document intends to address the following primary objectives:

a) It outlines the infrastructure requirements for the purpose of setting up a common and integrated fixed network distribution system that shall be made available in the buildings for consulting engineers, developers, property owners and other responsible parties.

b) It provides the minimum technical specifications necessary for the fixed network telephony and multi broadband distribution system as required in buildings.

This Technical Code cancels and replaces MTSFB 002:2009 - Technical Standard of In-Building Fibre Cabling for Fibre-To-The-Premise.

This Technical Code shall continue to be valid and effective until reviewed or cancelled.

MCMC MTSFB TC G007:2016

TECHNICAL STANDARD OF IN-BUILDING FIBRE CABLING FOR FIBRE-TO-THE-PREMISE

1. Scope

This Technical Code covers the technical standards and infrastructure requirements for fibre-to-the-premise.

It defines the network boundary between Developers and Network Facilities Provider, infrastructure requirements within the development area and inside the premises (condo/ apartment, low cost flats, single dwelling and office buildings), cabling designs and specifications, and handover acceptance procedure.

2. Normative references

The following normative references are indispensable for the application of this Technical Code. For dated references, only the edition cited applies. For undated references, the latest edition of the normative references (including any amendments) applies.

See Annex A.

3. Abbreviations

For the purpose of this Technical Code, the following abbreviation applies.

BS	British Standard
CO	Central Office
COA	Certification of Acceptance
CPE	Customer Premise Equipment
DP	Distribution Point
FOC	Fibre Optic Cable
FOTS	Fibre Optic Trunking System
FRP	Fibre Reinforced Plastic
FTB	Fiber Termination Box
FTTP	Fibre-to-the-premise
FWS	Fiber Wall Socket
GI pipe	Galvanized Iron Pipe
ICEA	Industry Cabling Engineers Association
IEC	International Electrotechnical Commission
IL	Insertion Loss
IPTV	Internet Protocol Television
LSZH	Low Smoke Zero Halogen
MDU	Multi Dwelling Unit
NFP	Network Facilities Provider
ORL	Optical RVoDeturn Loss
OLTS	Optical Loss Test Set

OTDR	Optical Time Domain Reflectometer
P2MP	Point to MultiPoint
P2P	Point to Point
PE	Polyethylene
PON	Passive Optical Network
PPL	Private Property Line
PSTN	Public Switched Telephone Network
PVC	Polyvinyl chloride
RG	Resident Gateway
SC	Subscriber Connector
SDU	Single Dwelling Unit
SDF	Subscriber Distribution Frame
SOC	System on Chip
STB	Set Top Box
TR	Telecommunication Room
U/G	Underground
UPC	Ultra Physical Contact
UTP	Unshielded Twisted Pair
VoD	Video on Demand
VoIP	Voice over Internet Protocol

4. Fibre-To-The-Premise (FTTP)

4.1 General

FTTP is a generic term of providing telecommunication service via FOC from NFP CO direct to end user premise. FTTP is a new deployment method of providing telecommunication service which inclusive of voice and internet service with higher bandwidth capability and also other addition value added service such as IPTV, VoD. It is an enhancement technology of legacy technology using a metal cable network via PSTN or Digital Subscriber Line (DSL) technology.

The NFP may provision the FTTP services to the end users via P2P or P2MP configuration. From in-building cabling system point of view, it should be able to facilitate with both type of configuration.

NFP is a licensee authorised entity by the Malaysian Communications and Multimedia Commission (MCMC) to build and commercially operate telecommunication/electronic communications systems. The NFP can provide their services via their own network infrastructure or leasing from other NFP, as provided for in the *MCMC/G/04/05, Guidelines on Implementation of Access to Network Elements dated 28th September 2005.*

Developer is the entity that is responsible to provide the in-building infrastructure including the telecommunication infrastructure and fibre cabling system to ensure end user are able to subscribe FTTP services from NFP according to the standard requirement. For individual premise, Premise Owner is also identified as Developer.

Building Management is the entity that is responsible to maintain the in-building infrastructure provided by Developer is always in good condition and able to be used to provision the service by NFP accordingly. For individual premise, Premise Owner is also identified as Building Management.

4.2 Benefit of Fibre Optic Cable (FOC)

Fibre-optic technology is unique because it can carry massive amounts of information, called bandwidth, over long distances without degradation. Fibre transmission capacity is almost unlimited and unconditional compared to metal type cabling systems such as copper or coaxial.

Fibre is an alternate solution to metal type infrastructure such as twisted copper pairs and coaxial cable, as it is capable to offer faster and more reliable method of delivering not only the legacy voice and internet services, but also an interactive services such as High Definition (HD) TV, VoD, Smart Home and Home Surveillance which require a higher bandwidth.

Fibre is also less susceptible to outages caused by weather or electromagnetic interference, which can sometimes affect services provided over metal type cable.

Fibre is the future proof technology which has the ability to accommodate any new technologies and applications that requires higher bandwidth with much lower maintenance and operational cost.

4.3 Point to Point (P2P) FTTP Network

P2P FTTP network is referring to the dedicated FOC cores between NFP CO and end user. With dedicated fibre, it provides the flexibility and scalability to offer high end services such as Metro Ethernet and Leased Line service. However, P2P configuration required a large numbers of FOC which will introduce a very high cost to NFP. Figure 1 below shows the sample connection of P2P FTTP network configuration.

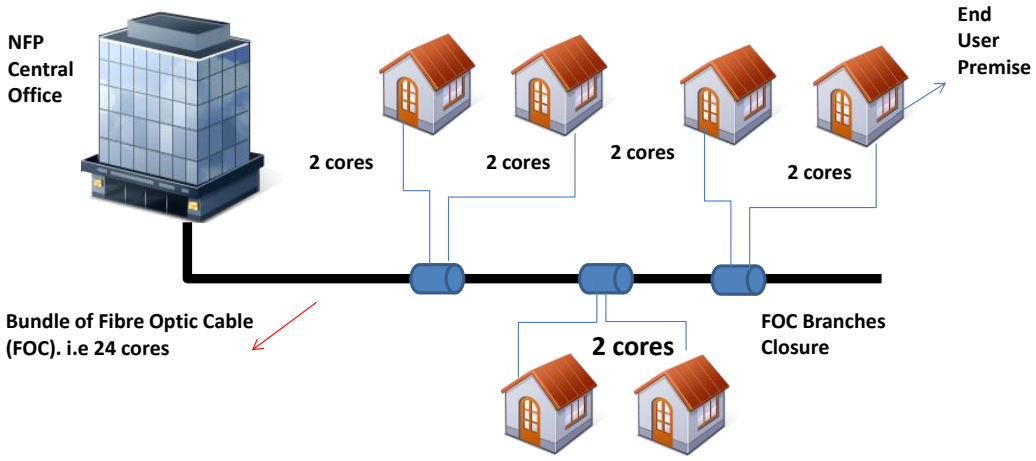


Figure 1. Point to point fibre network design

4.4 Point to Multipoint Fibre (P2MP) FTTP Network

P2MP FTTP network is referring to another topology of fibre network design. With a single FOC core from NFP CO, it can split into a few single FOC core to serve multiple user. The sample is as shown in Figure 2.

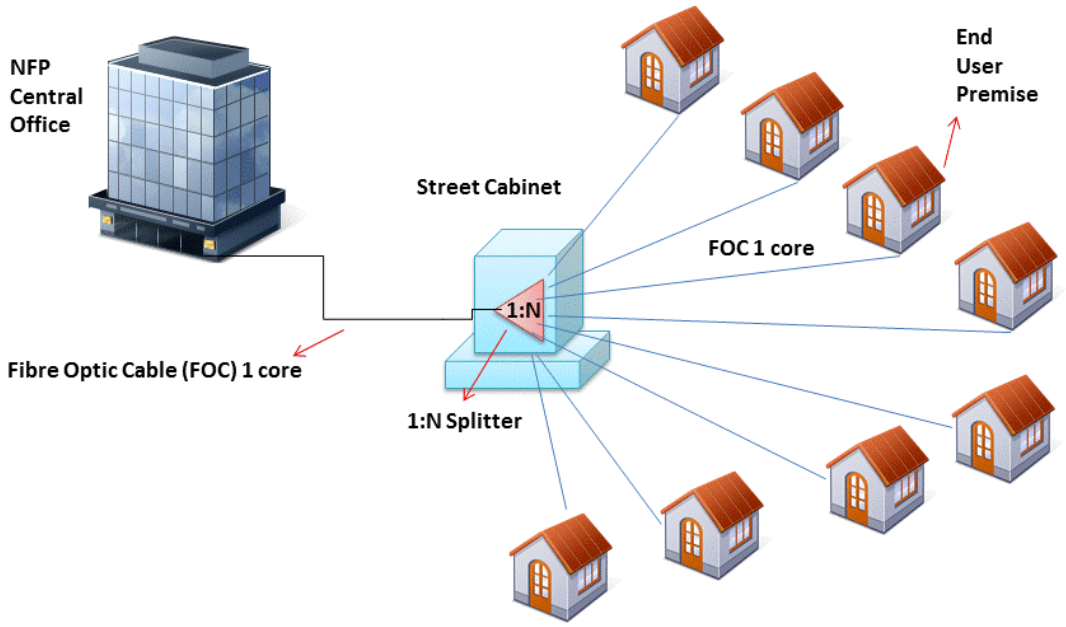


Figure 2. P2MP fibre network design

The most popular FTTP technology using P2MP network configuration is PON. The following Figure 3 shows the example of the generic end to end NFP's PON connection diagram.

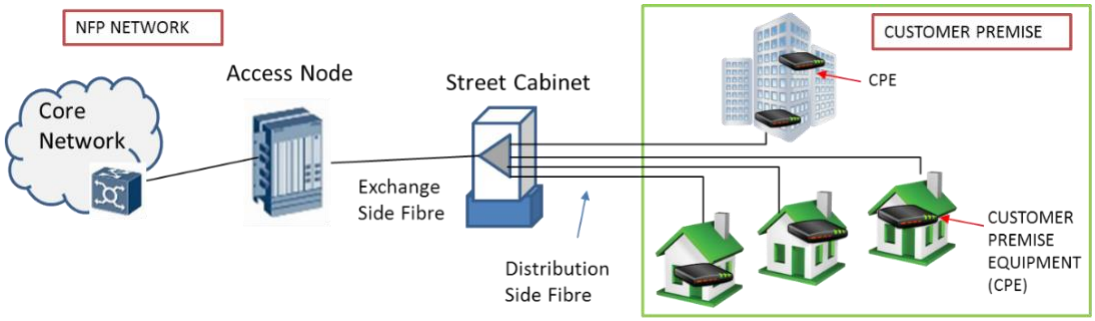


Figure 3. Sample of NFP's PON connection diagram

4.5 Type of Service

Type of services that able to be delivered via FTTP network is described in details as in Table 1.

The minimum services, also called as essential services, that shall be supported via the cabling as specified in this document are as below:

a) Voice Services – Analogue or Voice over Internet Protocol (VoIP); and
b) Broadband Service.

Table 1. Details of service delivery via Fibre

No	Services	Features
1.	Voices	a) Plain Old Telephone Service (POTS) b) Integrated Switch Digital Network (ISDN PRI)
2.	Broadband	High speed broadband access with unlimited capacity bandwidth for a variety of data and video applications such as: a) Uploading images and videos to the internet; b) Streaming live TV online and downloading movies; c) File sharing; d) Online gaming; e) Telemedicine; f) Distance Education; g) Tele-working; h) Closed-circuit television (CCTV); and i) Wi-FI.
3.	IPTV	IPTV is delivered using the Internet protocol suite over a packet-switched network such as a Local Area Network (LAN) or the Internet, instead of being delivered through traditional terrestrial, satellite signal, and cable television formats.
4.	Private Data Network	a) P2P or P2MP technology. b) Directly connects subscribers to clients and employees via: i. Channelized Leased Circuit; and ii. Ethernet Leased Circuit.
5.	Combination of services	Combination of multiple service as above which may include Voice, IPTV, Broadband etc in a single platform, i.e Triple Play Services

However, NFP may provide additional services through those two (2) essential services such as IPTV, VoIP and VoD service.

5. Building Type

5.1 General

There are several types of customer premises and can be categorized as shown in Table 2.

Table 2. Definition of building type

Single Dwelling Unit (SDU)	Multi Dwelling Unit (MDU)	Campus Type	MSC Status Building
Condo / Apartment/Low Cost < 6 floors without Telecommunication Room (TR)	Condo / Apartment/Low Cost ≥ 6 floors with TR	Combination SDU and MDU. Example: University, Hospital, Complex, School	Commercial Area/ Building
Bungalow			
Semi-Detached			
Terrace Single Storey			
Terrace Double Storey			

Table 2. Definition of building type *(continue)*

Single Dwelling Unit (SDU)	Multi Dwelling Unit (MDU)	Campus Type	MSC Status Building
Terrace Double Storey			
Office Building/Shop House < 6 floors without TR	Office building / Shop house ≥ 6 floors with TR	Public transport facilities Example: Airport, Bus station, Railway station, Jetty	
Industrial / Commercial Lot		Shopping Complex	
House of worship		Amusement Park	

5.2 Single Dwelling Unit (SDU)

SDU generally refers to a landed property or building with less than 6 stories and generally is not equipped with TR. Examples of SDU are as follows:

a) Terrace houses
In general, the character of terrace houses is high density, each unit connect to each other in one (1) line. The quantity of one (1) line normally 20 or above, every two (2) line regards as one (1) row. The distance between each line is close, about 3m. But the distance between each row is about 5m.

Normally NFP's pole exists on each four (4) houses between two (2) lines. At the headstream of each row, there has manhole resource which for U/G cable from CO to aerial cable through closure in it.

b) Bungalows
In general, the character of bungalows is moderate density, larger area for each house than terrace house, each two (2) houses has definite distance.

Normally NFP's pole exists on each two (2) houses. At the headstream of each row there has manhole resource also which for U/G cable from CO to aerial cable through closure in it.

c) Shop lots
The shop lots have two (2) to four (4) layers. Normally it has a manhole resource in front of each shop lot and without pole resource. The cabling for each unit is provided through expose trunking or conceal inside the wall.

d) Others
There are few other types of individual or community premises such as petrol station, apartments, etc.

5.3 Multi Dwelling Unit (MDU)

MDU generally refers to building constructed with more than 6 stories and generally equipped with TR. Examples of MDU are as follows:

a) High rise residential – Condominium, Apartment;
b) Office building;
c) Commercial building; and
d) Complex.

Each unit inside MDU type of property is connected with telecommunication cabling from TR via riser and trunking system. NFP's infrastructure is connected to the property via ducting through manhole to the TR

5.4 Campus type

Campus Type is a combination of SDU and/or MDU located within the same compound with single or multiple TR. Examples of Campus Type are as follows:

a) School;
b) University;
c) Hospital;
d) Public transportation facilities i.e airport, bus station;
e) Shopping complex; and
f) Port.

5.5 Multimedia Super Corridor (MSC) Malaysia status building

MSC Malaysia status building also known as MSC Malaysia designated premise.

The MSC Malaysia has areas that are designated by the government to provide a conducive business environment to ICT and MSC Malaysia status companies. The MSC Malaysia status building (MSC Malaysia designated premise) is the property, recognised by the government as such, constructed within the MSC Malaysia area which must follow the requirements outlined by Multimedia Development Corporation (MDeC).

In term of telecommunication infrastructure requirement, generally the MSC Malaysia status buildings are required to fulfil below requirements:

a) Building access infrastructure (duct route/manhole) to ensure connection redundancies and support multi providers environment; and
b) In building infrastructure (common room/telecommunication room) and internal cabling system (cable tray/riser) to accommodate multiple providers.

For the MSC Malaysia status building, the detail requirements shall follow as outlined in *MSC Malaysia Telecommunication Infrastructure Building Guidelines, Revision 2010.*

6. External Building Requirements for the In-Building Fibre Cabling

6.1 General

This section specifies the general requirements and specification for the external infrastructure requirement provided in accordance with the standard in the *MTSFB 008:2005 - Technical Standards and Infrastructure Requirements (TSIR): Fixed Network Infrastructure* and *SKMM/G/01/09 - The Provision of Basic Civil Works for Communications Infrastructure in New Development Area, February 2008,* including the segregation of communication facilities from other utilities or services, join inspection and acceptance of the space and facilities, and responsibilities of NFP and Developers.

This section focuses on the building U/G infrastructure requirement such as manhole and duct way planning including the overhead connection.

6.2 Infrastructure Demarcation

The infrastructure boundary demarcation must follow requirements explained in the document, *REG-T007 - Regulatory Framework for Telecommunications Network Boundaries by Jabatan Telekomunikasi Malaysia.* The Private Property Line (PPL) is the demarcation point between NFP and Developers.

For the MSC Malaysia status building, the requirements may be different with the standard requirements and shall follow the requirements outlined in *Guideline of Telecommunication Infrastructure and Facilities Provisioning for Building in MSC (Revision 2010) by Multimedia Development Corporation (MDeC).*

The demarcation and responsibility of NFP, Developer and Building Management can be divided into two (2) phases which are:

a) During Development - referring to development phase of the building or development area which generally between Developer and NFP

b) Over Build - after the completion of the building or development area which generally between NFP and Building Management

During Development - Developer and NFP

a) The infrastructure inside the PPL is under responsibility of the Developer including the Linked-Up Infrastructure, manhole and ducting that may be located at the outside of PPL to link up with NFP infrastructure. The sample is as shown in Figure 4 below..

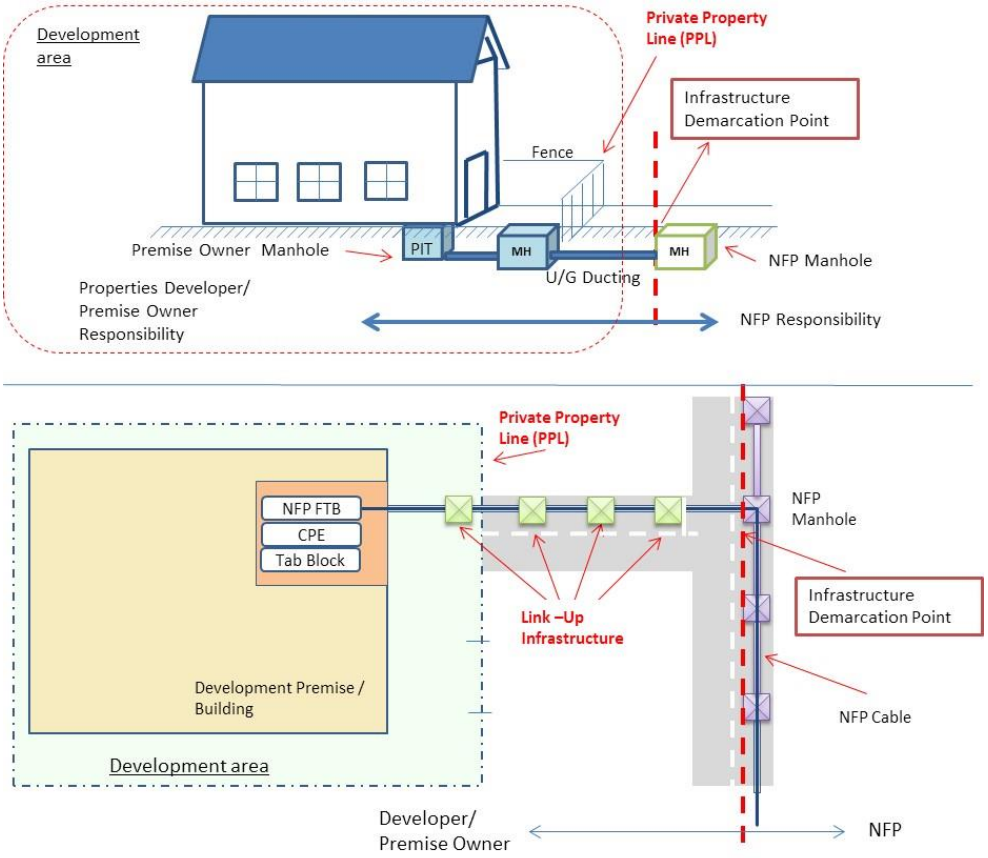


Figure 4. Infrastructure demarcation - Private Property Line

b) The Developer is responsible to ensure all require infrastructure and facilities to support telecommunication connection are available. The ownership of this infrastructure shall be handed over to the Building Management after completion of property.

c) Linked-Up Infrastructure which located at outside of the PPL shall be maintained by Developer/Building Management or handed over to select NFP with a proper handover agreement upon completion of the construction area.

d) PPL for MDU is the Common Access Manhole connected to TR or direct to the building and NFP's manhole as shown in Figure 5.

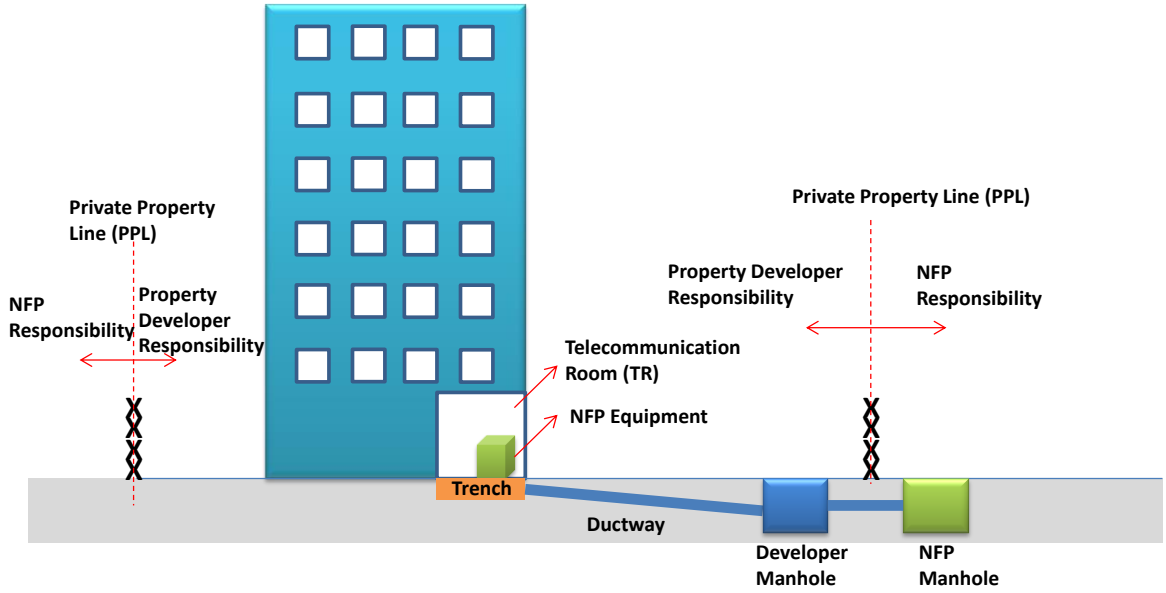


Figure 5. MDU infrastructure demarcation point

e) For SDU, the PPL shall be at the fence and/or drain, and/or its boundary mark, of the premise as shown in Figure 6.

f) Developer shall prepare the infrastructure to link up with NFP manhole

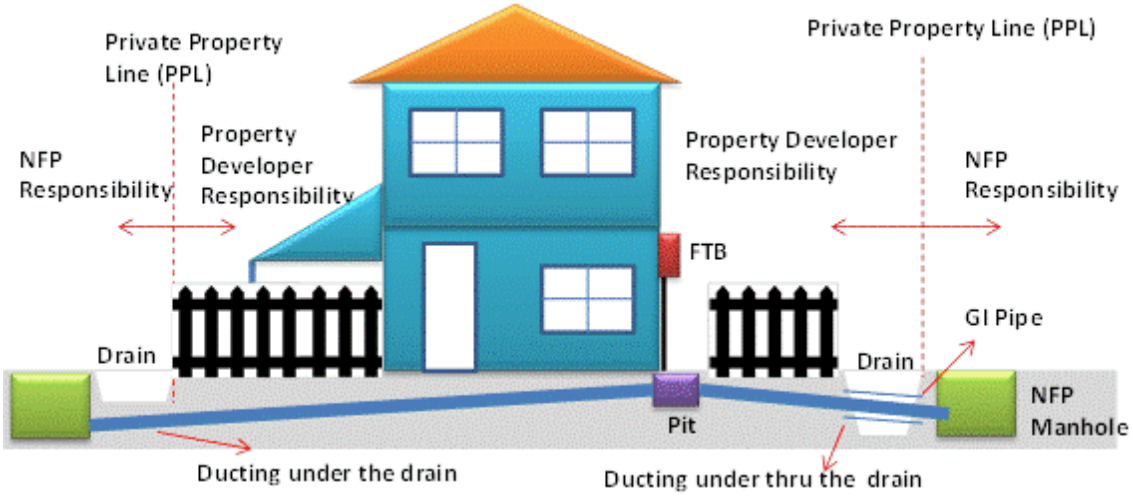


Figure 6. SDU demarcation point

g) PPL for Township is the Common Access Manhole connected to NFP manhole as shown in Figure 7.

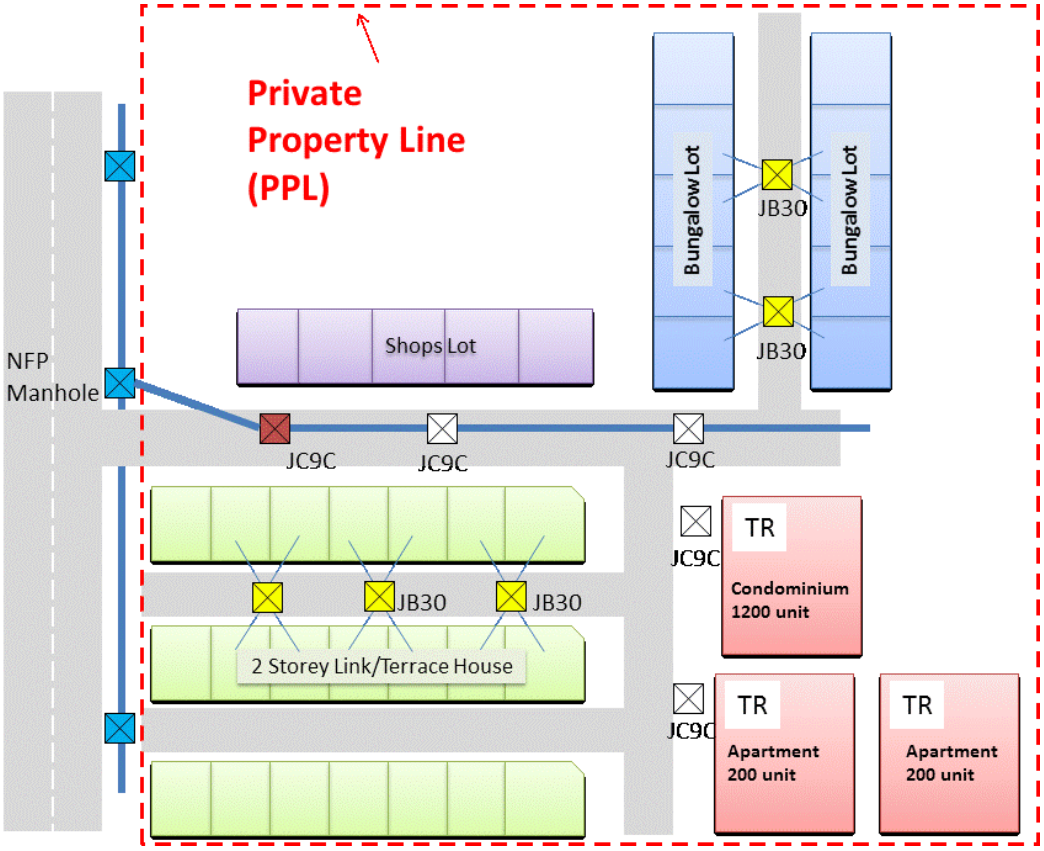


Figure 7. Sample demarcation point for township

Manhole size and number of duct way depend on the capacity of the development area as explain in Table 3.

Over-Build - Owner/Building Management and NFP

a) For MDU, Developer shall handover the facilities to Building Management that will be responsible to manage the infrastructure. Building Management is responsible to maintain all the facilities to ensure it's in working and good condition. Joint Management Building (JMB), Local Authority, etc, whose is fully responsible to the property, also define as Building Management.

b) For SDU, Premise Owner shall be responsible to maintain all the facilities to ensure it is in working and good condition.

c) For Township type of development, Developer might handover to local authority or selected NFP with the proper handover agreement.

Responsibilities of the Developers

a) The Developer shall be responsible at its own expense for the provision and maintenance of all the facilities within the building, including but not limited to the facility records, cable trays, trunkings, lead-in and U/G pipes, manholes, main distribution frame room, telecommunication equipment room, mobile deployment space and telecommunication risers, and for ensuring that they are in good serviceable condition and accessible to the NFP personnel at all times.

b) The Developer shall ensure at its own expense that adequate security measures are taken at the main distribution frame room, telecommunication equipment room TR, mobile deployment space and telecommunication risers to pre-empt trespassing by any unauthorised personnel. Under no circumstances should the main distribution frame room, telecommunication equipment room and telecommunication risers be used for any other purpose such as a store room.

c) The Developer shall hand over the main distribution frame room, telecommunication equipment room and telecommunication risers to the NFP upon acceptance of the facilities by the NFP, for their deployment of telecommunication services.

Responsibilities of the NFP

After handing over of the infrastructure and facilities to the NFP for their deployment of installation, plant and systems, the NFP shall be responsible for maintaining their installation, plant and systems and the general cleanliness of the space and facilities.

6.3 Overhead Infrastructure

For cases where property feeds via pole, the Developer must provide Access Manhole to the nearest NFP manhole. Figure 8 below shows the connection from the nearest NFP's manhole to properties manhole for pole type deployment. The manhole specifications shall follow specification as explained in Clause 6.4 below.

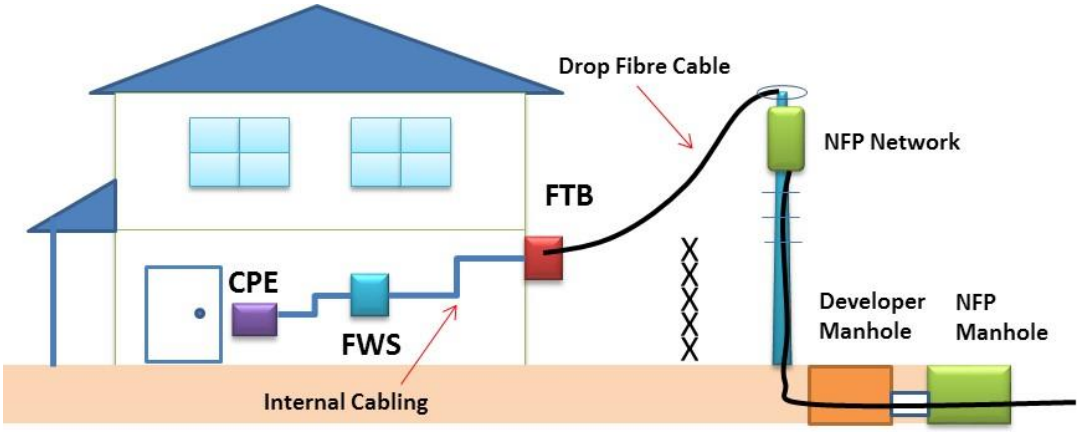


Figure 8. Overhead connection for pole type deployment

Generally, the pole will be installed by NFP. However, Developer is also allowed to provide and install the pole based on the recommendation and commercial arrangement with selected NFP. The pole specification and installation procedure shall follow as recommended by selected NFP.

6.4 Manhole

The manholes of the Link-Up Infrastructure which located on the road side or outside of the building's compound/development boundary shall be prepared by the Developer for NFP to connect their U/G ducting and manholes to Developer's infrastructure. The manhole inside the development area or PPL shall be constructed by Developer based NFP recommendation and follow the specification as outline in *SKMM/G/01/09 - The Provision of Basic Civil Works for Communications Infrastructure in New Development Area.*

Developer shall consult NFP on the appropriate selection of the location and size of manhole. The recommended manhole size and number of duct way require is as shown in Table 3. The selection of the manhole type is depended on the size of the development.

Table 3. Manhole size

No	Type of Manhole	Recommended Size (mm) (L x W x D)	No. of Duct Way	No. of Premise Linked Duct Way	No of Premise	Location / Criteria
1	JB30	850 x 850 x 650	2	4	<4	• Last connection to premise unit.; and • Premise access manhole.
2	JRC7	1160 x 855 x 850	2	N/A	<72	• On small roadside to link up with JB30; • NFP Link-Up Manhole; and • TR Linked manhole.
3	JC9C	1960 x 1260 x1020	4	N/A	>576	• On heavy roadside to link up with JB30/JRC7; • NFP Link-Up Manhole; and • TR Linked manhole.
4	R1A	2200 x 1615 x 1680	6/8	N/A	<576	TR Linked manhole

Figure 9 below shows the sample number of Duct Way and Premise Linked Duct Way

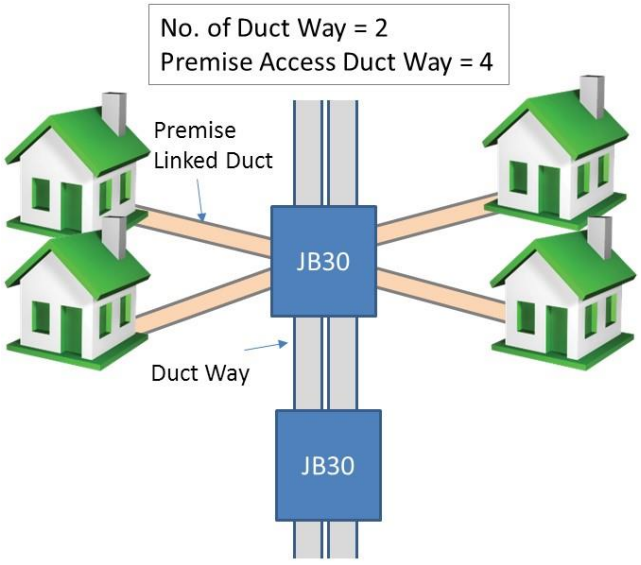


Figure 9. Duct way connection

The sample manhole type, manhole location and number of duct way in development area are as shown in Figure 10.

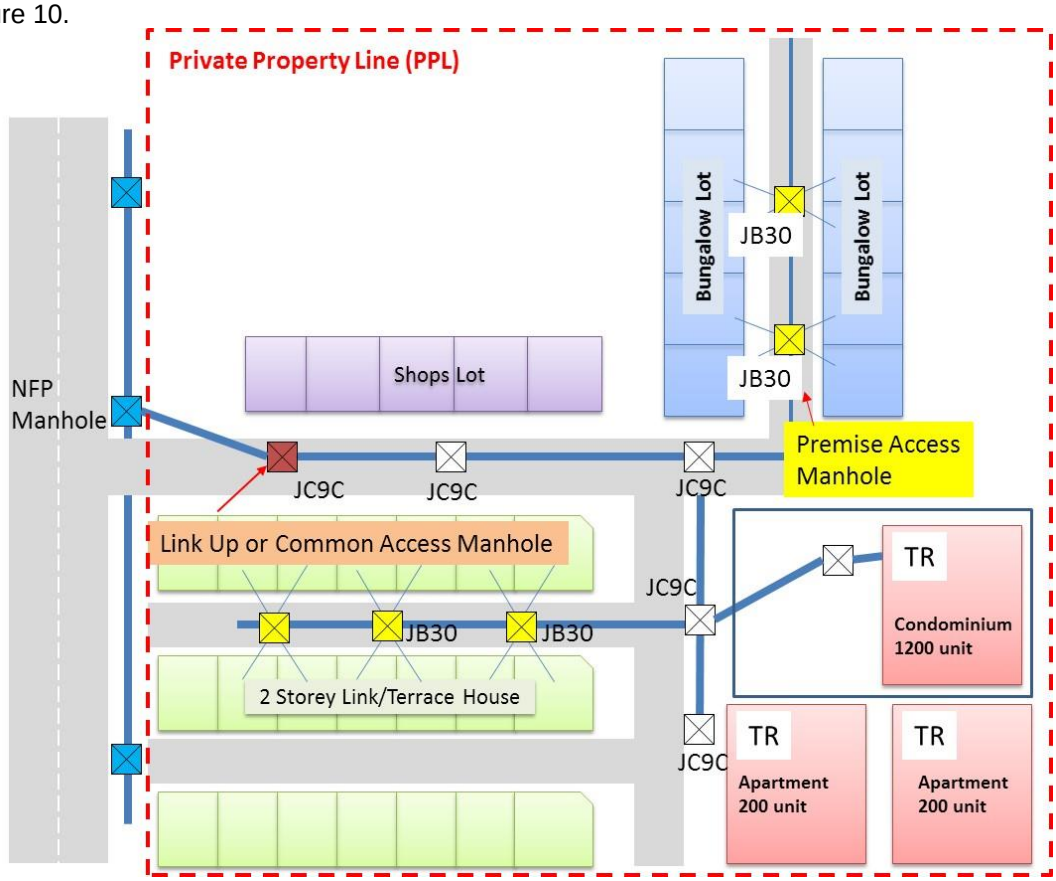


Figure 10. Manhole location

Link Up / Common Access Manhole

a) The Developer's last manhole that linked up with NFP is identified as common infrastructure to NFP. All connection to the premise is recommended to be connected through this Link Up Manhole and also known as Common Access Manhole. For business area with large number on property, minimum of Link Up Manhole size shall be JC9C with 4 ways duct. For residential area, minimum of JRC7 manhole size with 2 duct ways shall prepare. Developer is recommended to consult the NFP for the appropriate size; and

b) Common Access Manhole shall act as the interface point with NFP. Incase multiple NFP is required to provide the service, Developer shall provide the link up access to each NFP's infrastructure to the Common Access Manhole, or to provide separated Common Access Manhole to each NFP infrastructure. For connection to each NFP (incase of ≥ 2 NFP's), minimum of 2 duct ways shall be prepared to each NFP's manhole.

Premise Access Manhole

a) Premise Access Manhole is a manhole or pit which is the link up for the premise with the telecommunication U/G infrastructure;

b) Each premise shall be prepared by Developer for each house or shared with multiple premises. Specific ducting shall be prepared for each connection to each premise and sharing of the duct is not allowed;

c) The location of Premise Access Manhole can either be at the premise back lane or in front of the premise;

d) Minimum of JB30 manhole shall be provided to provide access to the premise;

e) For back lane cases, manhole cover shall be made from fibre or any light material type which should be possible to be accessed by 1 person only. The recommended manhole or pit size is JB30; and

f) For front cases, the manhole shall comply with general manhole requirement.

The manhole must be able to sustain up to 20 years.

Anti-theft with double layer manhole cover is highly recommended to protect the system from theft. Developer shall consult NFP for details.

The type of manhole cover type and specification is depending on NFP preferences. Developer shall consult NFP for details.

The manhole on the route shall be installed with particular attention to:

a) minimize hazards to traffic and personnel;

b) easy accessible at any time;

c) not to be covered by any obstacle, landscape, etc

d) provision of adequate size for the accommodation of all equipment including repeater housings and cable joints; and

e) having a duct sectional length (manhole centre to manhole centre distance) of 80 m to 100 m with maximum distance 150 m for fibre wherever practical. Barring factors such as obstructions in the line of duct route which can be avoided by bending ducts major changes in the direction of the duct route and future extension or cable.

6.5 Underground (U/G) Duct

The U/G duct are required for connection between manhole and also manhole at road side to

a) TR inside the building;

b) Direct to the building;

c) Common Access manhole inside the development area; or

d) Access to premise.

The number of duct-ways shall depends on the size and types of the building and number of users or customers or multiple service provider required in the building as explained in Clause 6.4, Table 3 above. The detail also explained in *SKMM/G/01/09 - The Provision of Basic Civil Works for Communications Infrastructure in New Development Area, February 2008.*

The Developer must consult the NFP on the appropriate selection of number and design of the duct-ways.

Duct size shall be 100mm and shall be made from PVC or harder material with 1.6mm thickness or higher grade.

For any major road crossing, minimum class C GI pipe is required.
It is highly recommended that each duct to be ready with 3mm x 40mm corrugated or High-Density Polyethylene (HDPE) sub-duct for easier accessed by NFP.

The duct provision shall be made to accommodate the local line installation envisaged for the period of 20 years.

The duct routes must be straight, without sharp bends and not obstructed. The maximum allowable bending radius is 20 times of duct diameter.

Whenever possible, laying duct routes under expensive paving should be avoided.

The Developer shall ensure that the constructed ducting system has a minimal risk from the nature disaster such as flood, earthquake etc. In the area where such condition cannot be avoided, the Developer shall construct resolution to ensure the ducting system will always be ensured in a good quality condition.

4 ways of duct and above shall be concrete encased with minimum mixer ratio of cement, sand and aggregate is 1:4:3. Unplasticized Polyvinyl chloride (uPVC) slab as a warning sign shall be installed minimum at 400mm from the ground level. The construction of the duct shall follow specification as shown in Figure 11 below:

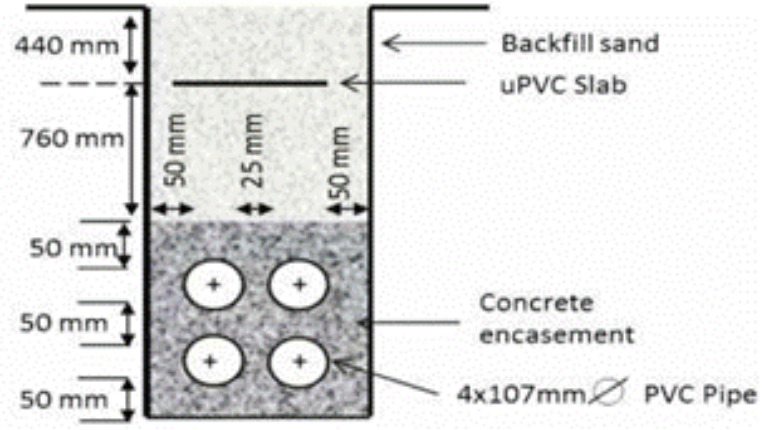


Figure 11. Duct depth specification

6.6 Cable and Ducting Management

The usage of the duct way shall follow as illustrated in below: The lowest duct on the right shall be firstly used and continue to the left. For diversity cable, the protection cable may use the higher located duct on the left side. The sample is as shown in Figure 12.

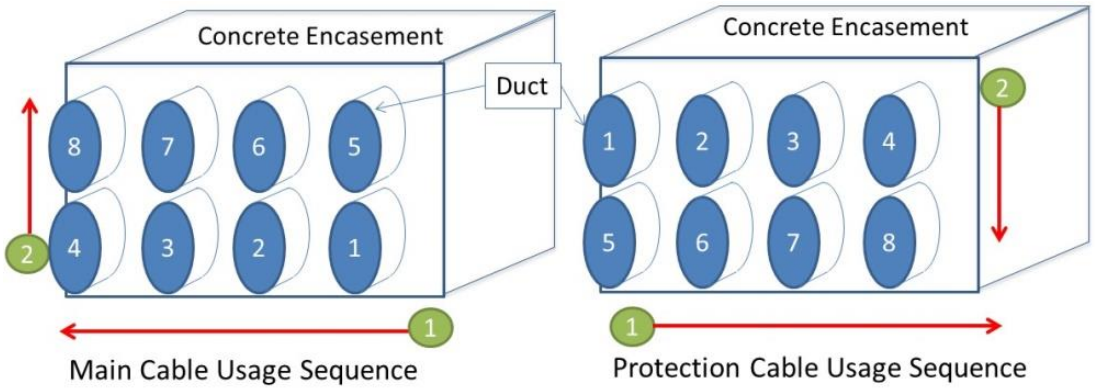


Figure 12. Sample of 8 ways of duct usage sequence

The allocation and duct space shall be managed by the appointed Building Management or selected NFP.

The manhole shall be exclusively for the NFP to deliver Fixed Telecommunication Services. Other type of services is not allowed to share the same manhole and ducting.

6.7 Underground access ducting for SDU

For SDU served via underground access, the recommended designs for the duct route are as shown in Figure 13 and Figure 14 respectively. If the depth of the drain is more than 450mm (1.5 feet), the recommended design is as shown in Figure 14. In this case, the duct must be protected by minimum 100 mm of GI pipe to cover the duct from broken and to be made available by the Developer. The GI Pipe shall be placed above the water level to avoid trapping of garbage and water stagnant.

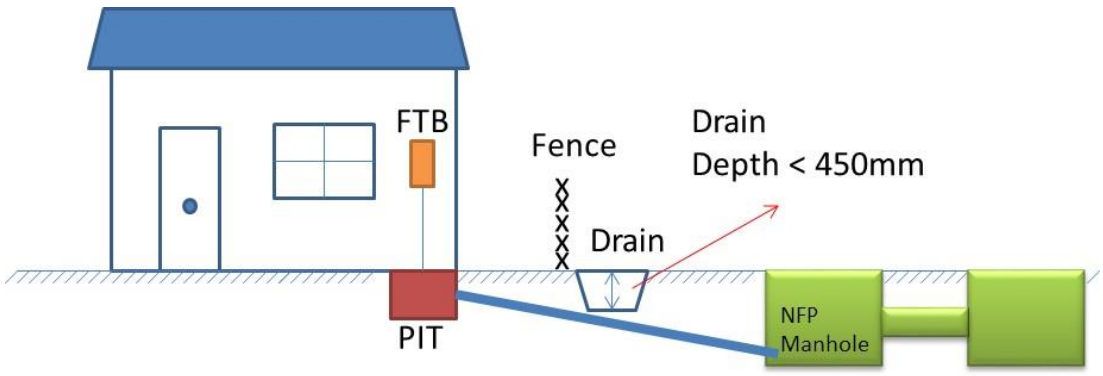


Figure 13. Design of under drain duct connection

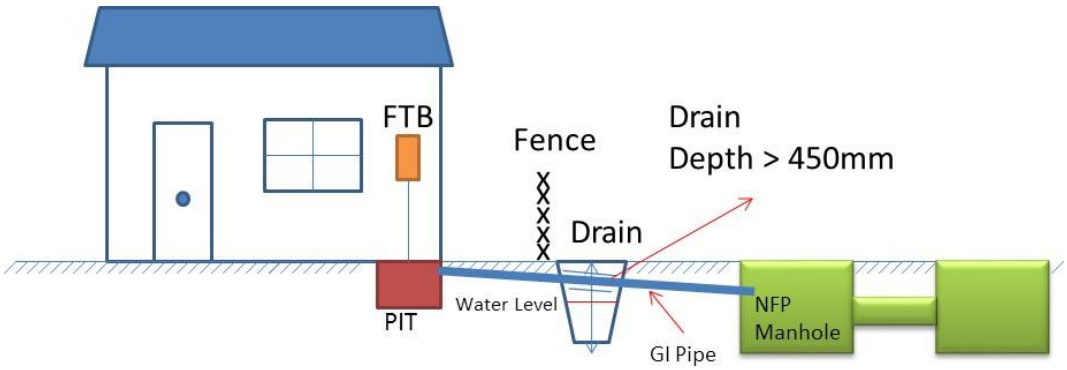


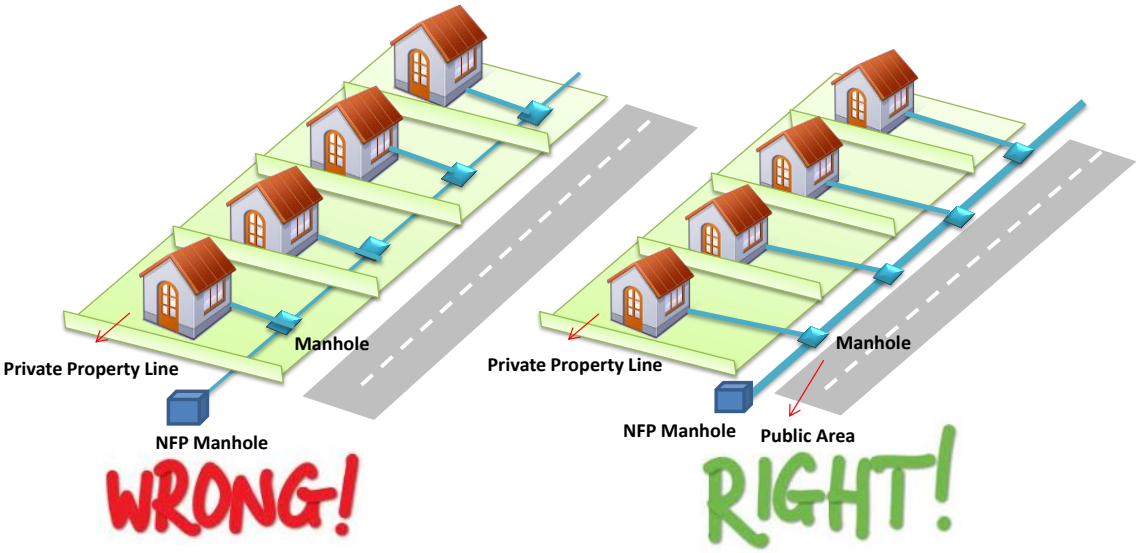
Figure 14. Design of through drain duct connection

Before entering the wall section of the premise, small pit with minimum size 300mm x 300mm x 300mm shall be prepared for easy access during the service activation and maintenance work.

The FTB at outside of the wall shall be provided for easier future operation and maintenance.

Each duct shall be prepared with pull string or draw rope for easier Drop Cable installation.

Duct route must be prepared dedicated to each premises. Developer must avoid from laying duct through other premise as shown in Figure 15. All pit or manhole to access the premises shall be located at common or public area for easy access by NFP and do not require any permission to access the pit or manhole at any time.



Access Manhole to connect each premise must be located at **public area** for easy access by NFP to provide connection to each of the premise without require a permission from other premise owner

Figure 15. Duct route for premise compound

The duct diameter size must >50mm with minimum bending diameter is 10 times of the duct diameter size. Figure 16 shows the recommended size and allowable bending radius for the premise accessing duct. Material of the duct shall be a PVC or harden material and must strong enough to protect the cable inside and able to sustain up to 20 years period.

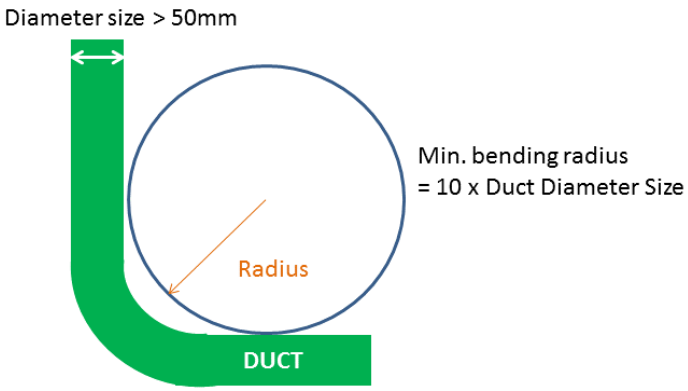


Figure 16. Design of premises entering duct

6.8 Underground access ducting for MDU

Developer shall provide the access ducting to the MDU building with minimum JC9C size of Common Access Manhole with 4 duct ways connection to the nearest NFP's manhole. However, the size of manhole and the number of duct depend on the capacity of the building as explained in Clause 6.4 above. Figure 17 below shows the connection between the NFP infrastructure and the building infrastructure.

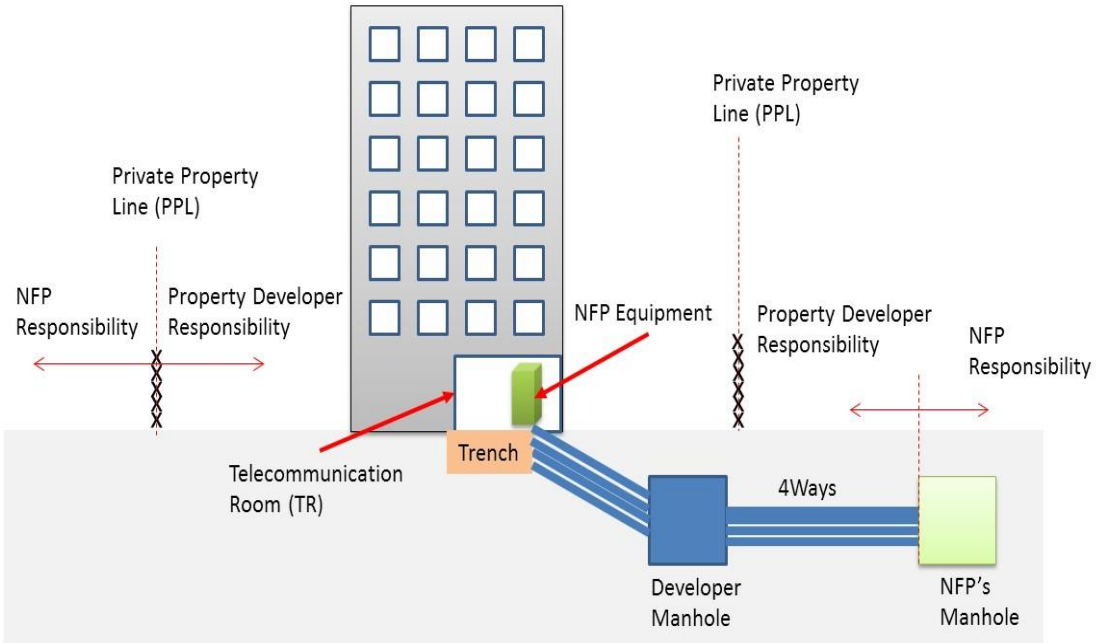


Figure 17. Connection between NFP and MDU infrastructure

6.9 Underground duct route design for township and campus type

Township is multiple of building build by Developer at one area consist of combination of multiple building with same type and various type.

Developer must provide the access of the infrastructure with minimum JC9C Common Access Manhole size and 4 duct ways for connection with the nearest NFP's manhole. However, the size of manhole and the number of duct depend on the capacity of the building. Figure 18 below shows the sample connection of Township infrastructure with the R1A size of Common Access Manhole connected to NFP manhole.

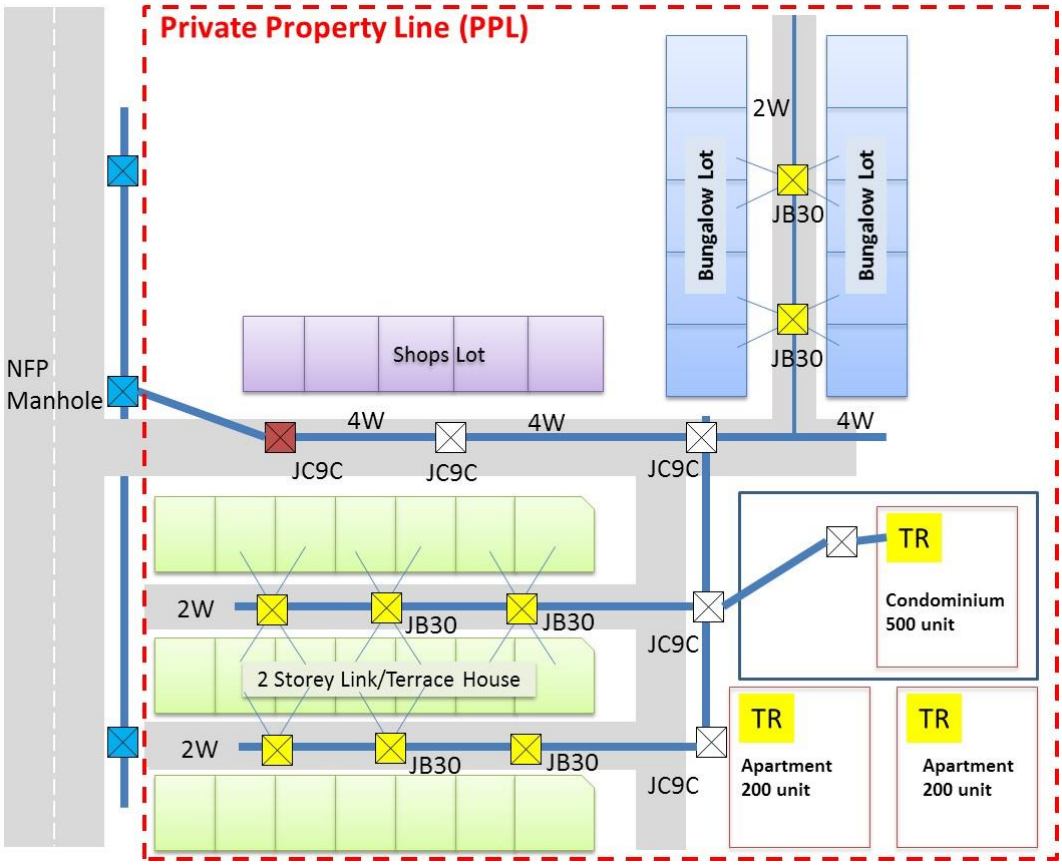


Figure 18. Common Access Manhole connection to Township type of property

6.10 Accessibility

Developer or Building Management shall not impose any accessibility charge to NFP to use all telecommunication infrastructures internal and external.

7. Internal Building Requirements for the In-Building Fibre Cabling

7.1 General

This section explains the requirement of fibre related infrastructure inside the building such as TR, floor riser and cable trunking. The other general infrastructure shall follow the requirement as explained in *MTSFB 008:2005 (Revision 1) - Technical Standards and Infrastructure Requirements (TSIR): Fixed Network Infrastructure*

7.2 Telecommunication Room (TR)

The minimum requirement for TR shall follow the specification as explained in *MTSFB 008:2005 (Revision 1) - Technical Standards and Infrastructure Requirements (TSIR): Fixed Network Infrastructure*

TR shall be equipped with daylight type fluorescent lighting and able to provide a minimum of 300 Lux luminance at floor level.

The earthing system shall be provided in the room with maximum 5 ohm resistance to earth.

AC Power Distribution Board (ACPDB) in TR should be equipped with Earth Leakage Relay (ELR) to fix the sensitivity setting reading.

The TR shall be air-conditioned or equipped to maintain humidity and room temperature at 30 % to 50 % relative humidity and below 30ºC respectively under all conditions at all times. The room shall be fitted with a ventilation fan system capable of 30 air change/min, activated when the room temperature rises above 35ºC. It is highly recommended that the room to be equipped with air-condition all the time.

No accessibility charges shall be imposed to NFP to install any telecommunication equipment in TR/Riser Room.

Developer and Building Management needs to inspect any individual or authorized personnel before allowing them to access into the TR.

FTB for high rise building occupied with TR shall be installed inside the TR. FTB is the internal cabling termination point and will become as connection interface point with NFP's network element. FTB shall be located at the right most position as illustrated in Figure 19. NFP's network elements shall be located in the same row or adjacent to the FTB with < 20m distance. The capacity of the FTB will depend on the number of premises inside of the building.

A proper FOTS shall be prepared inside the room to provide the proper cable route. Developer shall consult with NFP for the design and suitable route of the FOTS. All the cable and patch cord shall use the FOTS accordingly. The FOTS size is depend on the building capacity. The recommended minimum FOTS size is 150mm (6 inch) or medium size building (< 100 unit). Figure 19 shows the recommended floor space arrangement inside the TR.

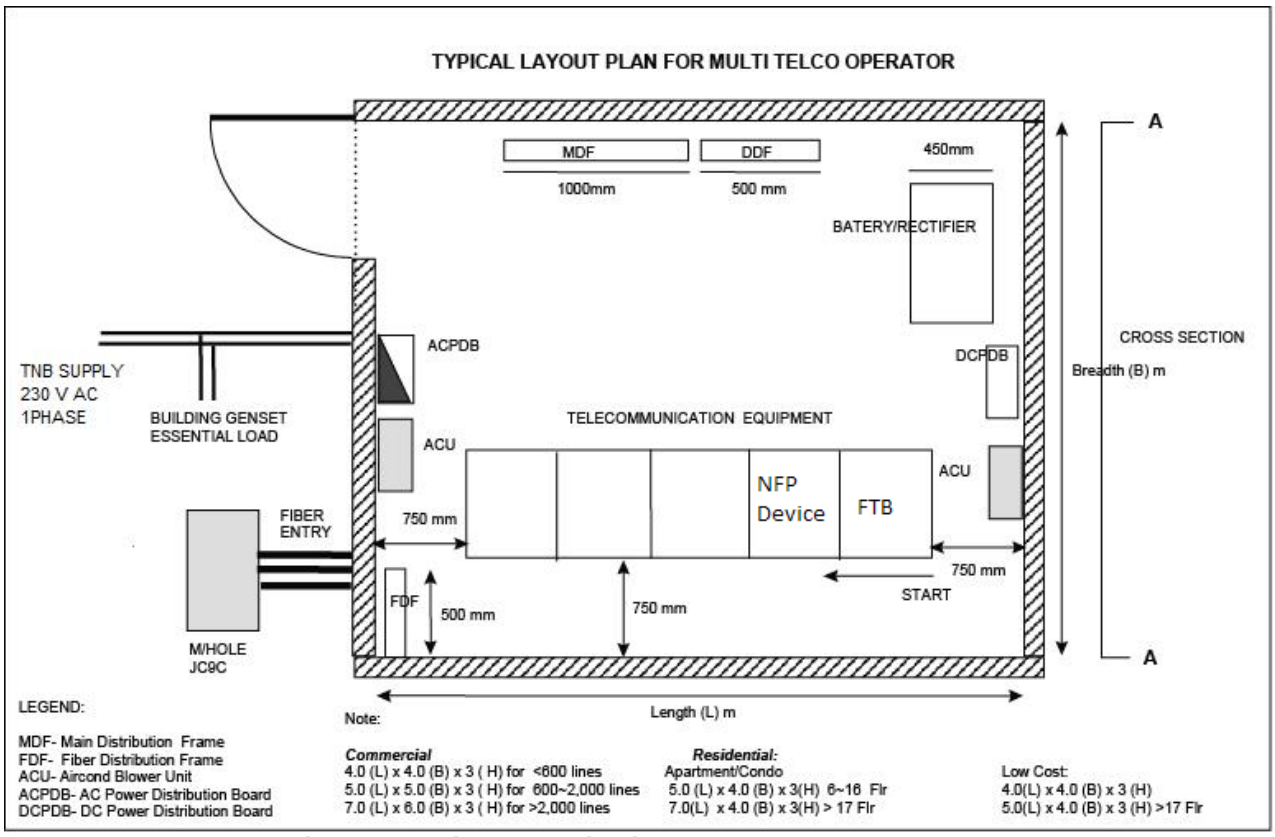


Figure 19. Telecommunication Room arrangement

7.3 Riser

The riser in the MDU properties shall be used as the cable route from the TR to each floor level. The minimum requirement for the riser and duct must follow requirements as explained in *MTSFB 008:2005 (Revision 1) - Technical Standards and Infrastructure Requirements (TSIR): Fixed Network Infrastructure*

7.4 Trunking

The trunking is required for laying the cable inside the building and acts as the protection and cable guide.

For the MDU, the trunking located inside the riser is referred as Vertical Trunking.

Open ladder type or cable tray is recommended for vertical trunking.

While the trunking located from the Riser room at each floor to the FWS inside each individual unit of premise is referred as Horizontal Trunking that uses PVC.

The Horizontal and SDU's trunking must be made from PVC or harder type of conduit with minimum 19 mm diameter. All conduits or cable enclosure need to be completely concealed and should not protrude so as to reduce the aesthetics either within or outside of the premise.

The Vertical and Horizontal Trunking must be provided in all MDU properties. For the SDU, the trunking must be used to lay the cable between the FTB, located at the outside wall, and the FWS located inside the premise.

Figure 20 below shows the example of trunking location for the MDU and Figure 21 shows the example of trunking location for the SDU.

The detail specification of trunking is as explained in *SKMM/G/01/09 - The Provision of Basic Civil Works for Communications Infrastructure in New Development Area.*

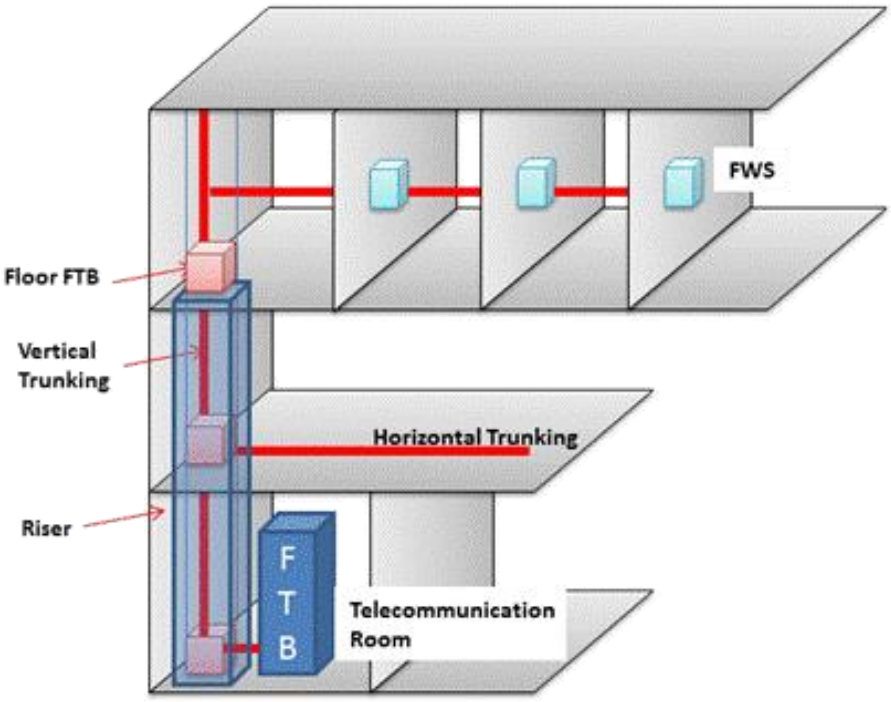


Figure 20. Trunking for MDU

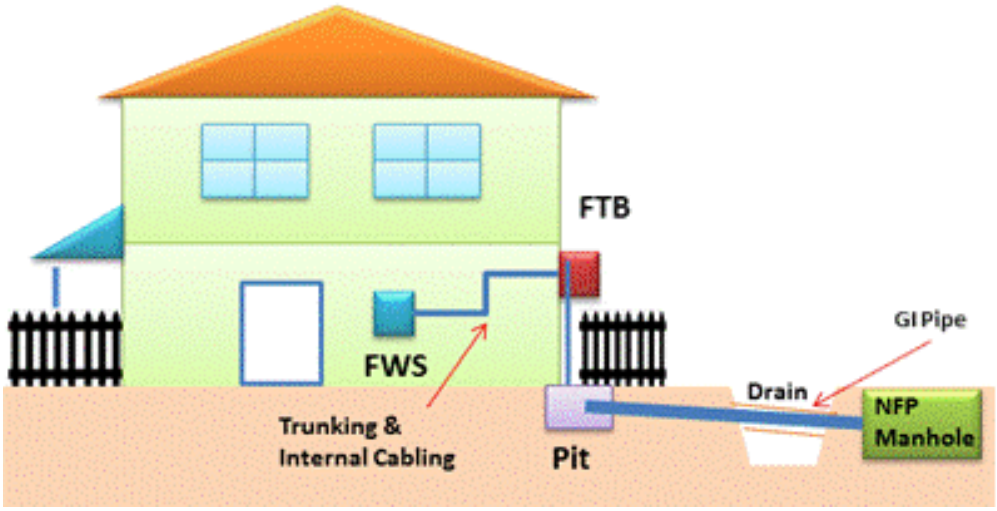


Figure 21. Trunking for SDU

The minimum requirement for trunking must follow the requirement as explained in *MTSFB 008:2005 (Revision 1) - Technical Standards and Infrastructure Requirements (TSIR): Fixed Network Infrastructure*. The riser, Horizontal and SDU's trunking bending radius must be greater than 10 times of the trunking size to ensure that the fibre cable meet the minimum bending radius.

7.5 Fibre Termination Box (FTB)

The FTB is referred to In-Building cabling termination facing the NFP infrastructure. FTB is TR and Riser Room for the MDU and normally at the outside wall for SDU properties. The FTB acts as the connection point between the NFP's fibre and the In-Building fibre cable. Sample of FTB to be used for MDU and SDU are as shown in Figure 22 and 23 below.

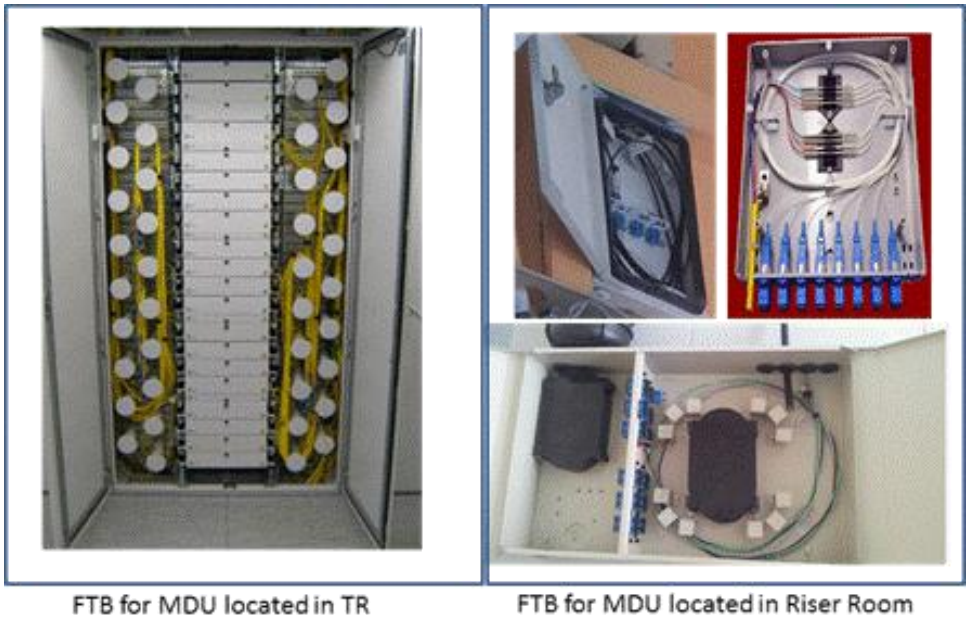


Figure 22: Fibre Termination Box (FTB) for MDU

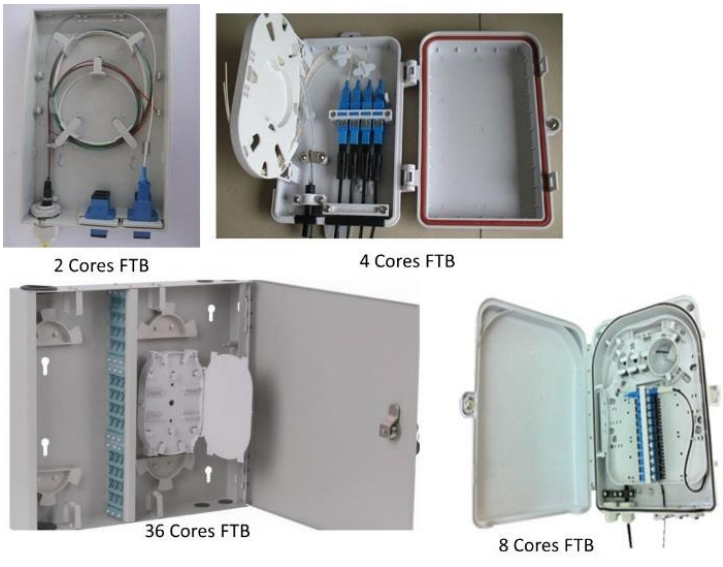


Figure 23: Fibre Termination Box (FTB) for SDU

FTB that interfacing with NFP shall be prepared with SC/UPC type of adaptor. Generally wall mounted FTB for SDU and high capacity FTB located inside the TR is interfacing NFP network.

Premise owner of Building Management shall ensure FTB is always locked and secured from any damage or contamination. Location of the FTB for SDU and MDU is as shown in Figure 24 below:

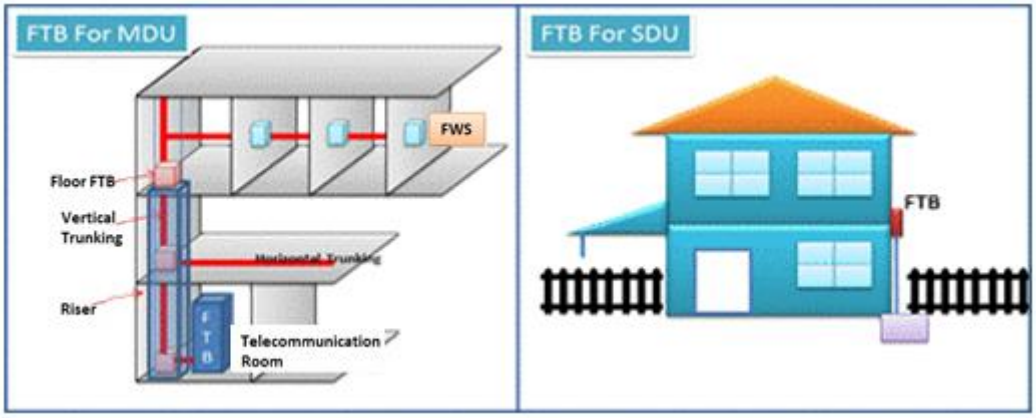


Figure 24. FTB location for MDU and SDU

FTB located at floor riser room or also known as Floor FTB acts as the connection point between the high or medium density fibre count distribution cables, i.e Internal Vertical Cable, and low density or single Drop Fibre into the customer premise, i.e Horizontal Cable. For this type of FTB, it is not interfacing with any NFP cable and shall be designed and configured based on individual preference. However, for any interconnect inside this FTB shall be pre-connected and well labelled for easier reference during maintenance work. The connection between FTB inside TR shall be continued until individual unit's FWS.

For the SDU, FTB is located at individual customer's premise either at a back or in front of the premise depend on the Developer's design. FTB acts as the demarcation point between the NFP's Drop Fibre Cable and the customer In-Building Fibre cable. The Developer must provide the FTB with SC/UPC connector typed. During the service activation, the NFP will terminate the Drop Cable at the SC/UPC adaptor inside FTB.

Minimum 2 set of SC/UPC adaptor and number of fibre cores of FTB shall be provided both for SDU and MDU.

For outdoor type FTB, it shall comply with IP55 of IEC 60529 and have minimum 10 years life span at outdoor environment.

The FTB must be provided by the Developer using the type approved by SIRIM. FTB must be robust and weather proof especially for outdoor installation. The details specification of the FTB is explained in Annex B.

7.6 Fibre Wall Socket (FWS)

The FWS is a termination point for the Internal Fibre cable and act as a connection point to the CPE Generally the FWS is structured same as the FTB and the specifications requirements is explained in Annex B. Figure 25 shows the location of FWS and FTB.

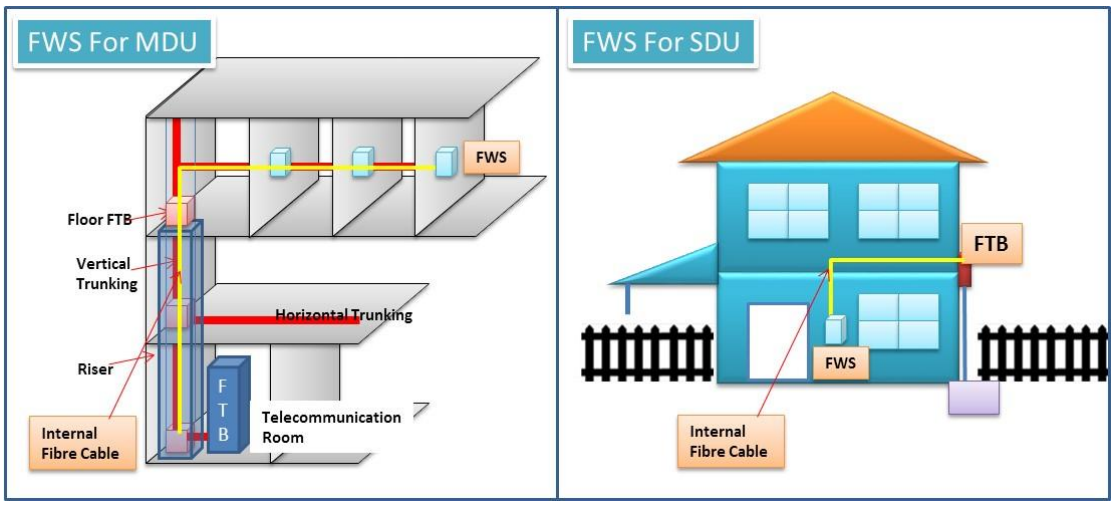


Figure 25. Fibre Wall Socket for MDU and SDU

The FWS must be provided by the Developer with SC output connector for connection with CPE's patch cord. The CPE patch cord will be provided by the NFP during the service activation. Figure 26 below shows the example of the FWS.

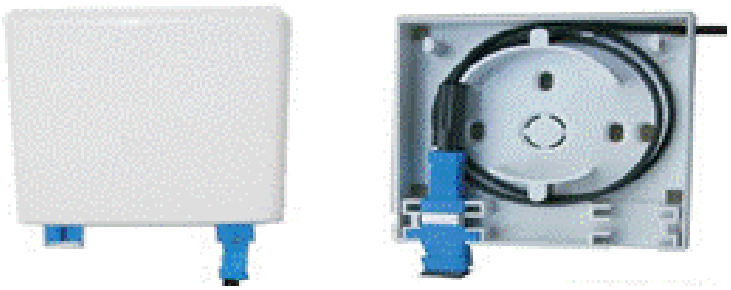


Figure 26. Sample of FWS

Minimum one (1) unit of FWS must be provided by the Developer in all premises. However the number of FWS can be more depends on the number of potential customer in each unit of premise. The FWS must be type approved by SIRIM and NFP licensors.

The FWS must be equipped with shutter at both end adaptor to protect internal SC/UPC connector and the other end of adaptor must be equipped with dust cap.

The FWS must be placed at 0.3m above the floor level and 0.3m from the corner of the wall or from electrical points. The FWS must be made from the non-corrosive material or treated metallic material to resist corrosion.

The FWS is highly recommended to be placed adjacent to the electrical power socket for FTTP CPE to function.

The effective core and SC/UPC adaptor inside FWS is minimum two (2) cores.

FWS must be cover from dust. Auto-shutter type of FWS is highly recommended for better protection of the adaptor inside FWS.

7.7 Customer Premise Equipment (CPE)

CPE will be connected to FWS inside each individual premise via fibre patch cord. CPE will be supplied by the NFP to individual customer together with standard length of fibre patch cord.

CPE generally has multiple type of output port such as RJ11 and RJ45. RJ11 port is for connection with normal telephone for Voice Services and RJ45 port is for internet or other interactive service connection. However, the CPE specifications will be various depend on the NFP preferences. Figure 27 below shows the sample of CPE interface called Optical Network Unit (ONU) which generally been used for PON Technology.

Figure 27. Sample of Optical Network Unit (ONU)

7.8 Accessibility

Developer or Building Management shall not impose any accessibility charge to NFP to use all telecommunication infrastructures internal and external.

Developer and Building Management needs to inspect any individual or authorized personnel before allowing them to access into the all internal and external infrastructure.

8. Telecommunication Outlet Cabling

8.1 General

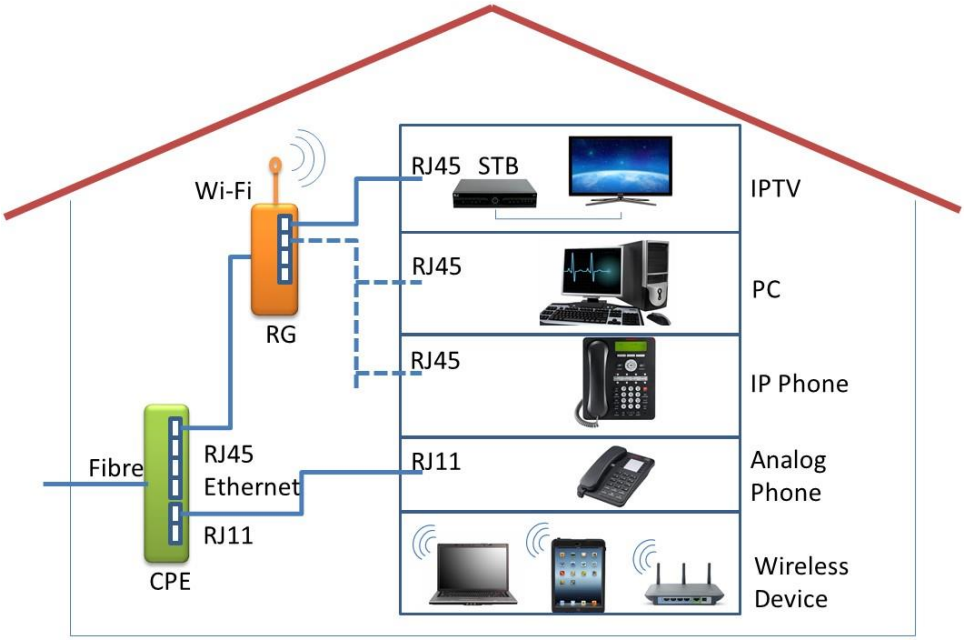
Telecommunication Outlet Cabling is referred to the cabling between CPE and other in-premise Telecommunication Outlet (TO). The numbers of cable required is depend on the number of TO in the premises.

The Fibre Internal Cabling is just required to connect NFP's network until the CPE. Generally, the cabling after CPE to other devices is via metallic cable such as Cat3, Cat5e or higher-grade such as Cat6 or Cat7.

Detail specifications on the Telecommunication Outlet Cabling shall follow as explained in in *MTSFB 008:2005 (Revision 1) - Technical Standards and Infrastructure Requirements (TSIR): Fixed Network Infrastructure*.

8.2 CPE and other devices connection cabling

The cable type for telecommunication outlet cabling depends on the CPE output interface type. However, it is strongly recommended that Developer to provide unshielded twisted pair (UTP) cable (Cat5, Cat5e or Cat6) for the telecommunication outlet cabling. Figure 28 below shows the sample of in-premise telecommunication outlet cabling.



CPE: Customer Premise Equipment, RG: Residential Gateway, IPTV: Internet Protocol TV, STB: Setop Box

Figure 28. Sample of Telecommunication Outlet Cabling

8.3 Cabling Design

Figure 29 shows the multiple Cat3 and Cat5e Telecommunication Outlet Cablings connecting FWS to the multiple of RJ11 and RJ45 Telecommunication Outlets Socket.

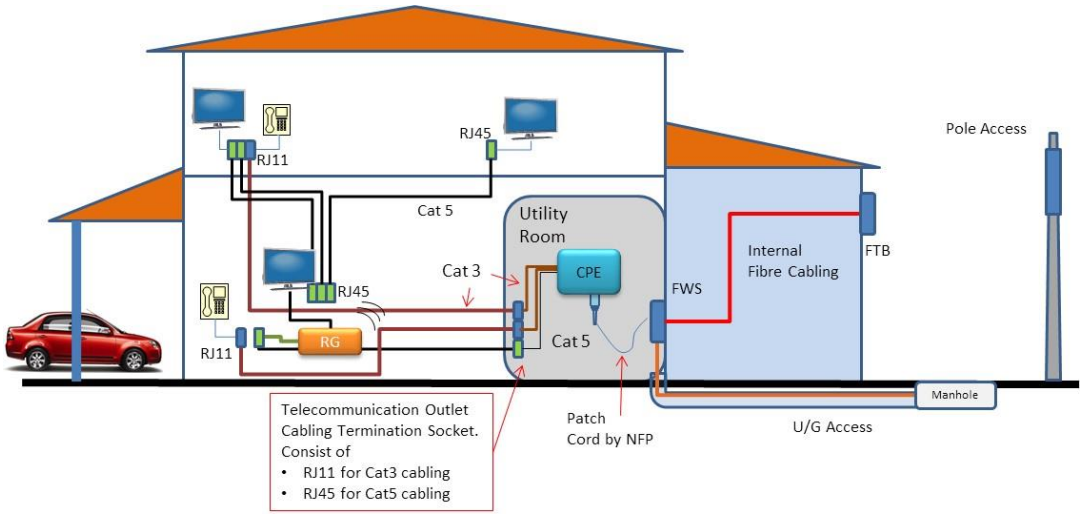


Figure 29. RJ45 and RJ11 Telecommunication Outlet Cabling

Figure 30 shows the top view of how the Telecommunication Outlet Cabling can be designed and linked each other. For this design, the CPE and RG (connection hub) is located at the same place. Another option is, to locate the CPE and RG at different place as shown in Figure 31 below.

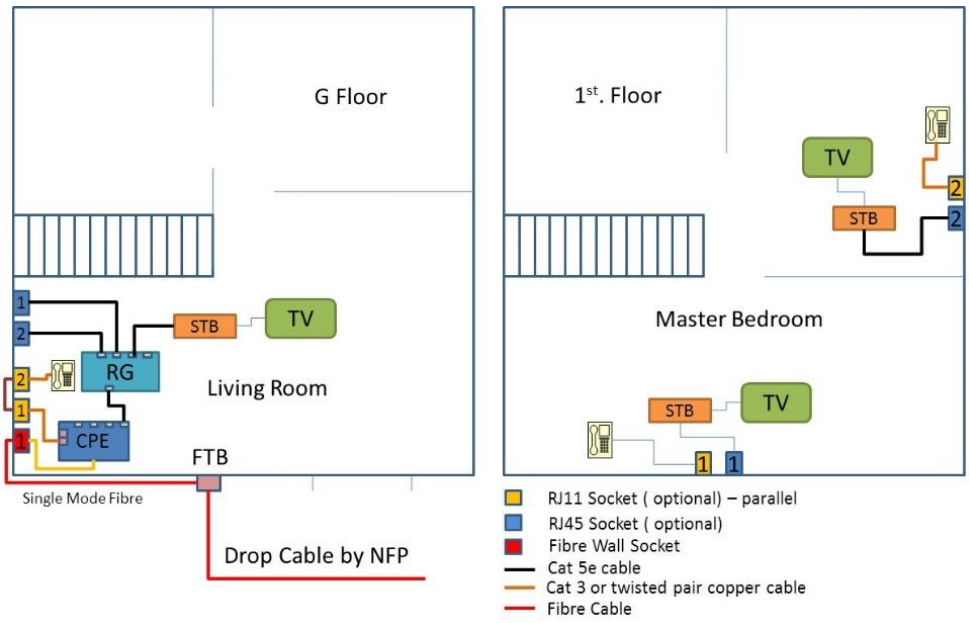


Figure 30. Telecommunication Outlet Cabling CPE and RG at same place - top view

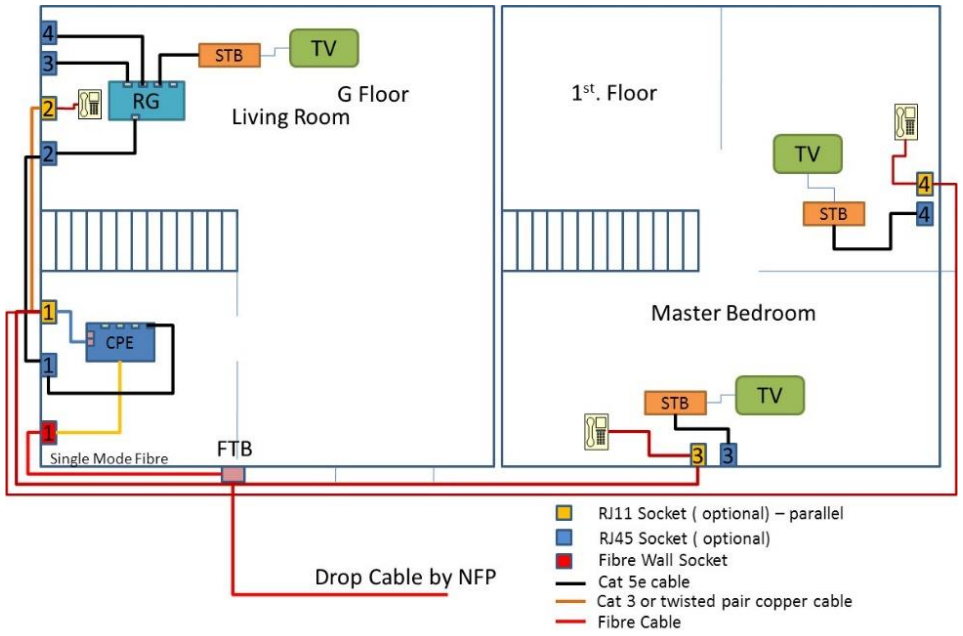


Figure 31. Telecommunication Outlet Cabling CPE and RG at different place - top view

With a proper design of Telecommunication Outlet Socket and Cabling, the user will have flexibility to provision their telecommunication services in various locations.

For normal analogue voice services connected to CPE, the cabling shall be Cat3 or twisted copper wire with RJ11 socket. However, if VoIP is used, generally the cabling type is Cat5 with RJ45 socket.

For internet connection from CPE to Internet Switch or Hub, computer or any device that require internet connection, the cabling type shall be Cat5 of higher cabling with RJ45 socket.

For IPTV services, generally the STB shall be connected via Cat5 or higher cabling with RJ45 socket. The connection between STB and TV is depending on type of connection which is either High-Definition Multimedia Interface (HDMI) or Rural Cellular Association (RCA) cable.

9. Cabling for Single-Dwelling Unit

9.1 General

Generally premise internal cabling covers the interconnections from the FTB to the FWS. For SDU, FTB is referred to the termination box at every individual premise and FWS is the socket located inside each individual premise for connection with CPE. Figure 32 shows the schematic diagram for all elements consist in internal cabling for SDU.

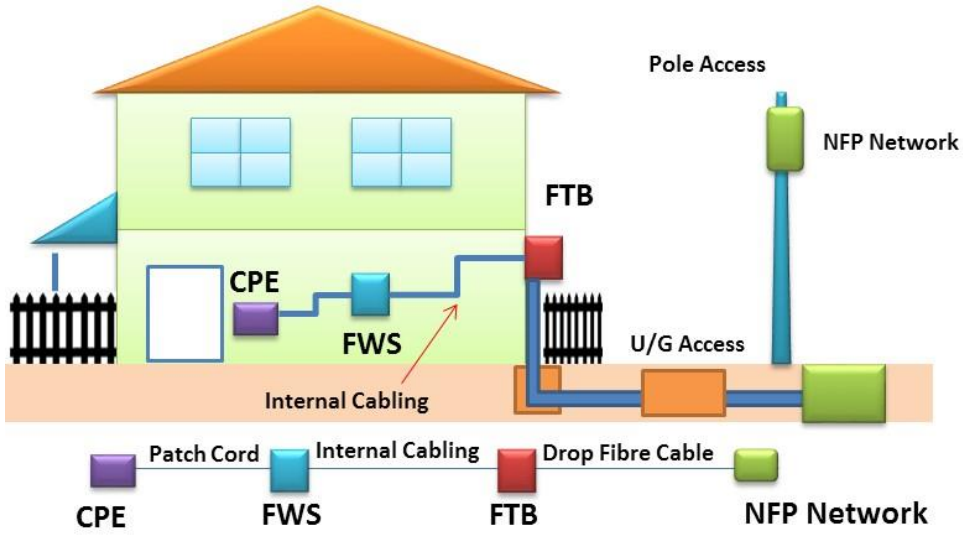


Figure 32. Schematic diagram for SDU cabling

9.2 Cabling and network boundary for SDU served via pole

SDU served via pole generally referred to housing estate housing such as linked house, semi-D or bungalow estate type of premise.

The FTB at the customer premises will be the point of separation between NFP and Developer or Premise Owner responsibility as shown in Figure 33.

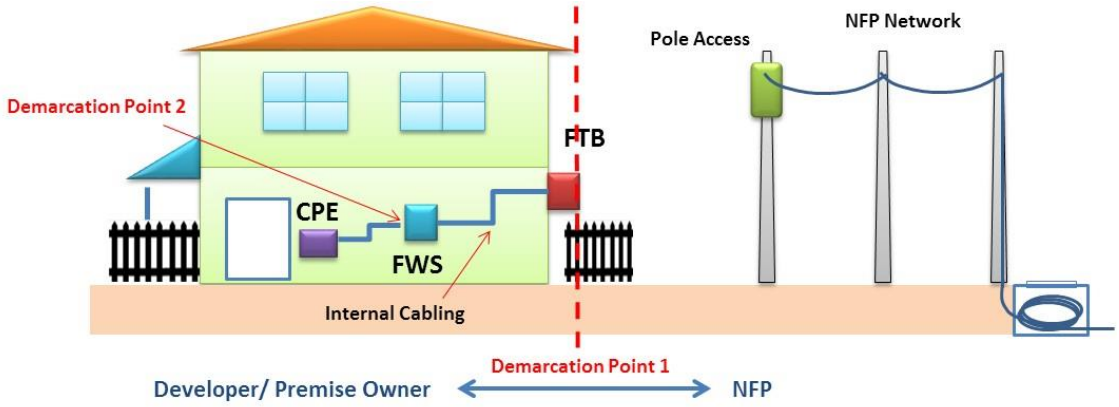


Figure 33. Network boundary for SDU (pole type)

FTB for SDU is normally terminated at the back lane of the premises. For SDU served via pole, FTB will became a network "Demarcation Point" between NFP and Premise Owner as shown at *"Demarcation Point 1"* in Figure 33 above. It includes the infrastructure, Internal Fibre cable and all related elements such as FTB, FWS and connector.

From FTB towards the NFP network is shall be under NFP responsibility. From FTB towards inside of the building will be Premise Owner responsibility and normally provided by the Developer. Generally, CPE together with patch cord, shown as *"Demarcation Point 2"* in Figure 33 above, is provided by NFP. The ownership and responsibility of the CPE and patch cord shall depend on the agreement between end user and NFP.

Internal Fibre cable for SDU is referred to the connection cable between FTB and FWS inside the premise as shown in Figure 33 above. For residential premises, minimum of two (2) cores of Internal Fibre is required to be provided in each unit. For commercial building, number of cores is minimum two (2) cores or higher depending on the type of business.

Internal Fibre layout inside the customer premises is depends on the customer preference.

9.3 Cabling and network boundary for SDU served via underground

SDU served via U/G generally referred to housing estate premise such as linked house, semi-D or bungalow estate type of premise.

For U/G access SDU, generally it will be served via NFP's Pedestal DP. However for some cases, the conventional U/G DP also been used depending on the suitability.

Demarcation point for U/G access property shall be the interface manhole that linked up to pedestal DP or been installed with U/G DP as shown at "Demarcation Point 1" in Figure 34. All the cabling and infrastructure from underground DP towards customer premise shall be provided by the Developer and shall be transferred to Premise Owner's responsibility.

FTB will be located either inside or outside of the building subject to approved Development Plan by the NFP. Building owner shall provide a small pit at outside of the building with a trunking connected to NFP Pedestal DP. For FTB located outside of the premise, FTB shall be located above the pit. For FTB design inside the premise, the pit is also required to be prepared at outside of the premise for easy access of Drop Fibre cable.

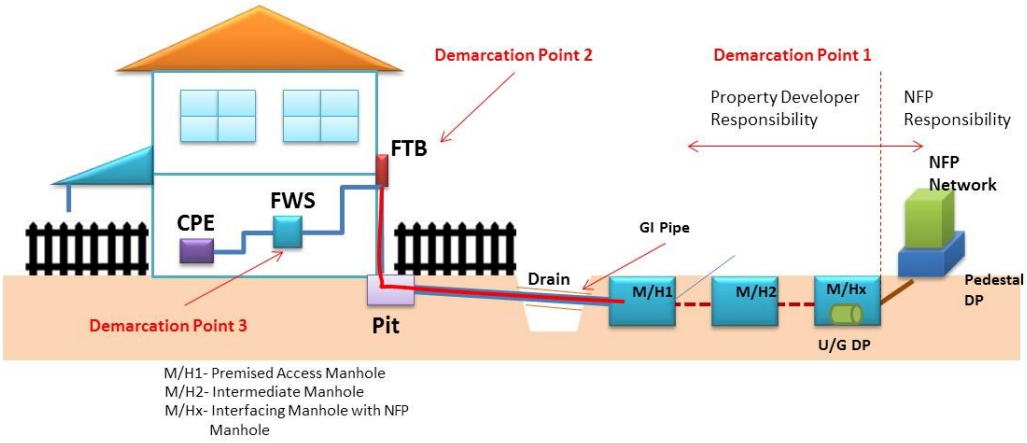


Figure 34. Network boundary for SDU (underground type)

The minimum specifications of the pit and the ducting are as below:

a) Minimum size for pit is 300mm x 300mm;
b) Minimum diameter of ducting between external pit and internal pit is 50mm; and
c) Trunking/conduit size is 50mm.

Drop Fibre shall be prepared and connected to the premise wall FTB on the one side and at shall be coiled inside the NFP interfacing manhole on the other side. The Drop Fibre end shall be covered with end cap or suitable protector, or terminated inside the cable jointing closure. The coiled portion inside the manhole shall be reserved with around 10m length to be linked up to the pedestal DP or U/G DP by NFP later. However, Developer may consult with NFP if 10m looks too long to be reserved and be advised for the correct length.

During service activation, NFP will do the connection between Drop Fibre and NFP DP. The premise number shall be labelled at the Drop Cable itself for easy identification. The label shall be made from polyethylene or any material which are able to sustain at up to 10 years or more to avoid faded or damaged tag.

Distance of Underground Drop Fibre generally shall not exceed 50m to ensure the power attenuation loss is within allowable range and easy to be maintained.

At every unit of premise, minimum two core of drop fibre shall be provided via single or different cable.

For property with the distance for FTB and NFP interfacing manhole is below 30m, as an optional, draw rope or draw wire is allowed to be prepared to replace the Drop Cable. Developer shall ensure draw rope is in smooth condition and enough trunking space is available for NFP to replace the draw rope with Drop Cable during service activation. Each draw rope shall be tagged and labelled with premise number and properly and securely stored inside the NFP interfacing manhole.

Underground Drop Fibre shall be laid inside underground duct. The underground duct or conduits shall be made from PVC or harder type of conduit with minimum size of 50mm diameter. All conduits or cable jointing closure need to be completely concealed to avoid any water leakage and shall not protrude to keep the aesthetics either within or outside the customer premise. The sample connection for Drop Fibre is shown in Figure 35.

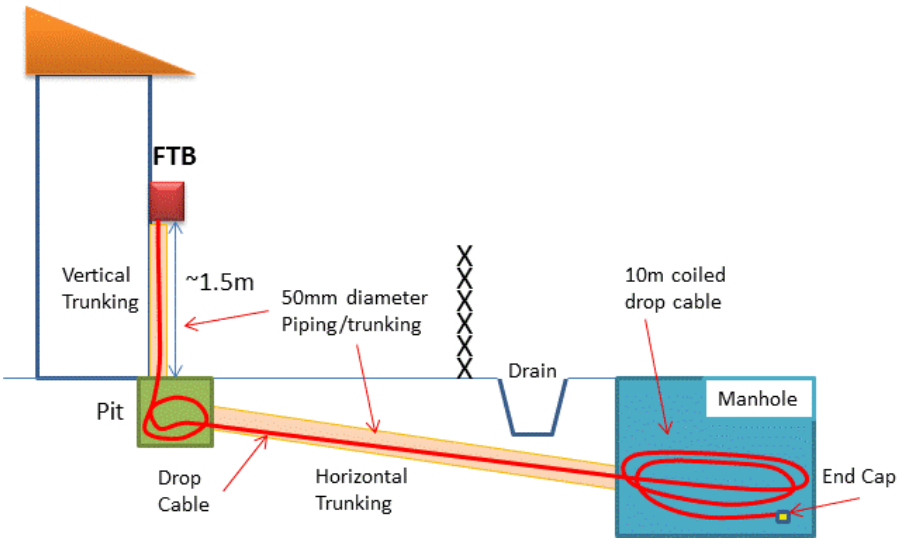


Figure 35. Connection of Underground Drop Fibre

From the horizontal trunking to be connected to vertical trunking which normally to connect with wall FTB, the small pit shall be provided for easier access to both trunking. Minimum size of pit is 600mm (W) x 600mm (L) x 600mm (D) and shall be treated same as general manhole.

For underground case, all NFP is recommended to provide the Pedestal DP instead of U/G DP. Developer shall reserve minimum 600mm x 600mm adequate space above and adjacent to the NFP interface manhole with the minimum 5m distance. Developer to provide the linked up riser from manhole to the reserved space as shown in Figure 36 below.

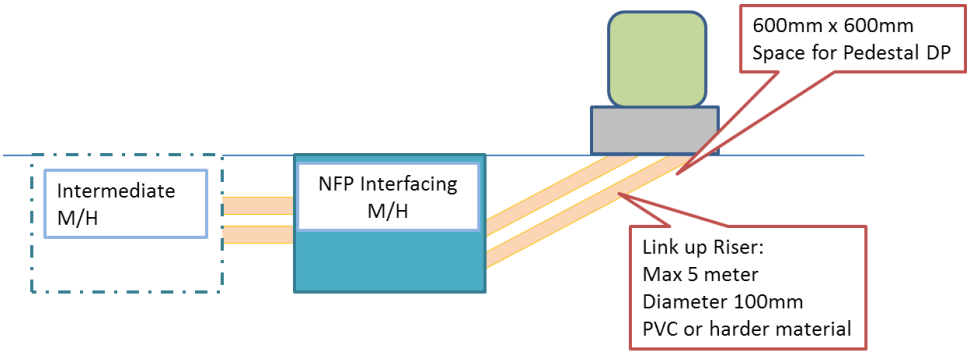


Figure 36. Link up riser for Pedestal DP

Dual cores of Internal Fibre are required for each unit of residential type of premise.

Layout of the Internal Fibre into the customer premises depends on the customer's preference.

9.4 Cabling and network boundary for bungalow type SDU

Generally, bungalow type SDU is similar to housing estate premise except for the ownership and responsibility which is the Premise Owner shall fully responsible for all infrastructures and cabling up to NFP infrastructure.

Cabling design for bungalow type generally is as shown in Figure 37 below. FWS, Internal Fibre, FTB, pit and trunking between FTB and NFP manhole shall be prepared by the Premise Owner. If premise location and NFP manhole is < 50m, as an option, Premise Owner is allowed to prepare just a draw rope between FTB and NFP Manhole. If the distance > 50m, Premise Owner shall replace the draw rope with the Drop Cable as explained in Clause 9.3 above. Draw rope or Drop Cable shall be tagged and labelled with premise unit number.

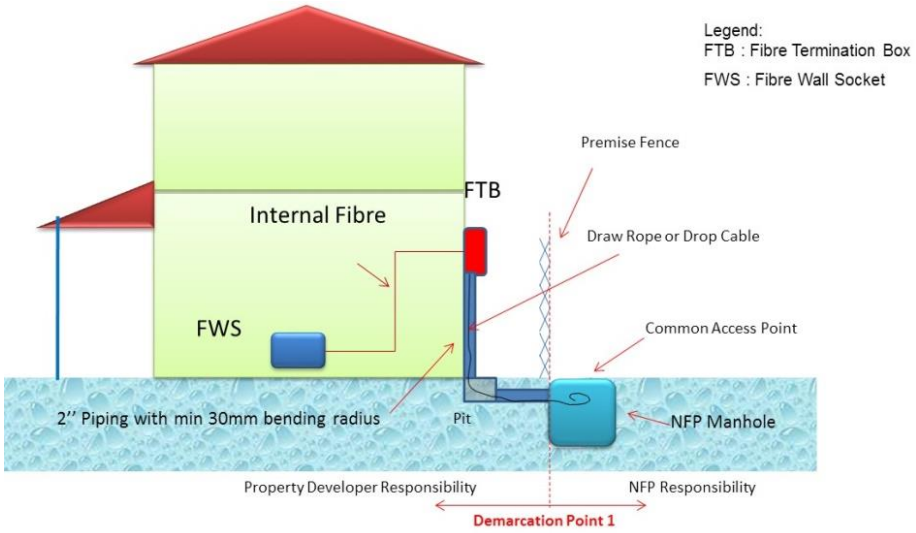


Figure 37. Cabling for bungalow type SDU

9.5 Cabling and network boundary for town house type SDU

Another type of SDU is a town house type. Town House is referring to the premise or properties that have multiple units inside with a single access.

The cabling design for town house premise is as shown in Figure 38. The diagram show how the town house premises are connected to NFP for either Pole or U/G access.

Demarcation point for town house shall follow general SDU serve via pole or underground as explained in Clause 9.2 and 9.3 above.

FTB shall be placed in a common area and have easy access at all time.

Two (2) cores of Internal Fibre cable shall be prepared between each FWS and FTB. Both cores shall be terminated with SC/UPC connector inside the FTB.

For underground access type, two (2) cores of Drop Fibre cable also require to be prepared until the nearest NFP interfacing manhole. The specification shall follow as explained in Clause 9.3.

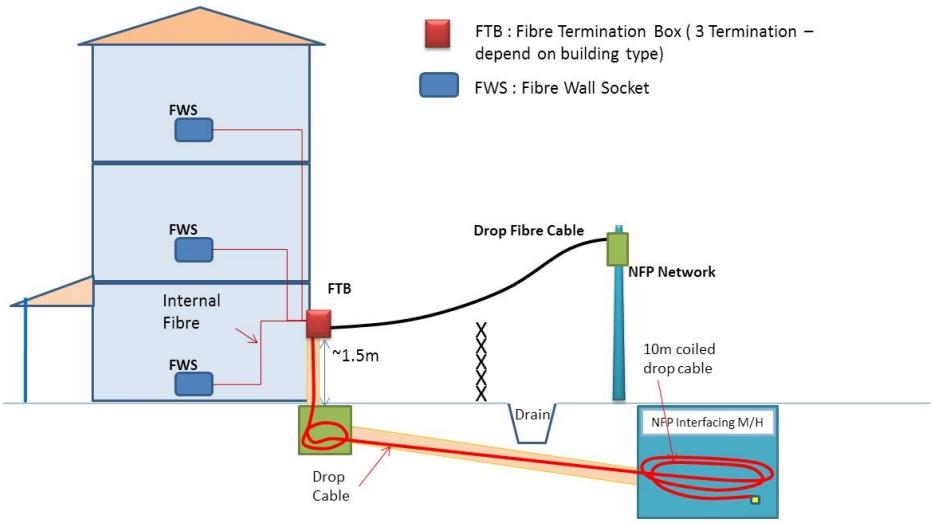


Figure 38. Cabling for bungalow type town house type

9.6 Cabling and Network Boundary for High Rise SDU

High Rise SDU generally is a property with < 5 floor and not occupied with TR.

The sample cabling for shop lot is shown in Figure 39 below. FTB that serves on the left and right side of vertical section shall be mounted on the wall at the upstairs access staircase area. The FTB shall acts as the demarcation point or network boundary between the Premise Owner and NFP as marked as *"Demarcation Point 1"* in Figure 39. FTB will act as connection point between NFP and each premise unit.

Developer shall prepare the FWS at each shop unit and connected to FTB via Internal Fibre. FTB, FWS, Internal Fibre and all related infrastructure shall be prepared by Developer and will be under Premise Owner's responsibility. The FTB and FWS shall follow the specifications as detailed out in Annex B.

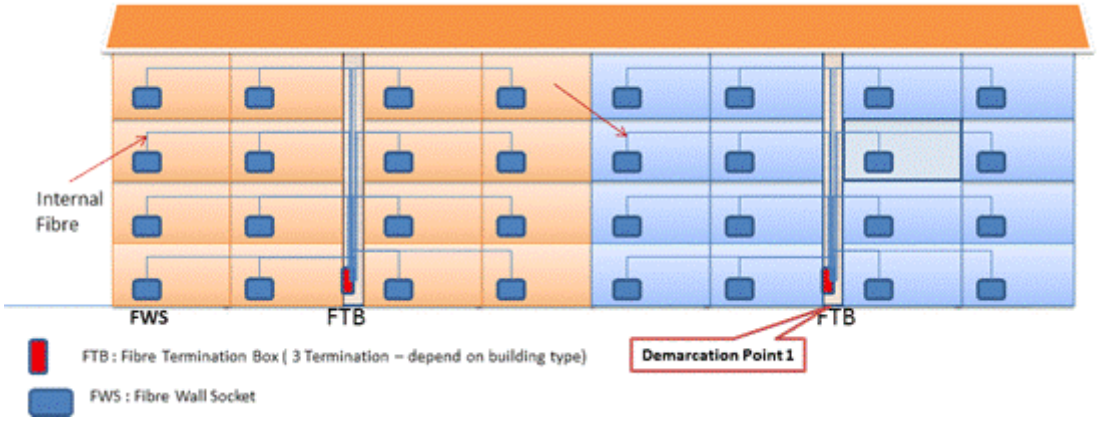


Figure 39. Network boundary for shop lot

Developer shall provide a space minimum of 600mm x 600mm beside FTB as shown in Figure 40. The space shall be used for NFP to locate their network element. NFP will do patching/jumpering with Internal Fibre inside the FTB during the service activation. For shop lots or business type of SDU, the number of Internal Fibre core must at least have two (2) cores together with SC/UPC adaptor. The

appropriate number of cores to provide shall depend on type of the business that will be occupied in the building. Developer may consult with NFP for the appropriate number of cores shall be provided.

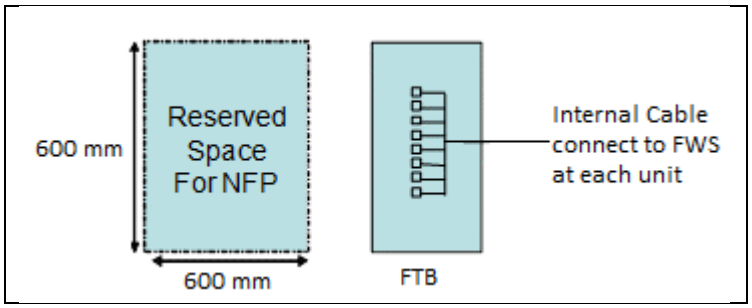


Figure 40. Reserve space near FTB

Internal Fibre between FTB and FWS shall be installed inside the trunking or fully concealed. The layout of the Internal Fibre into the customer premises depends on the customer's preference. Each Internal Fibre core terminated inside the FTB shall be tagged and labelled with the premise number.

The FTB shall be placed at easy access, opened public area and accessible at all the time. The height of FTB position is 1.5m to 2.0m height.

9.7 Specification for Underground Drop Fibre cable

Underground Drop Fibre is referred to the cabling between NFP's DP, which will be inside the manhole or pedestal type, and customer's FTB. As Developer shall prepare the Underground Drop Fibre and it will be under Premise Owner responsible.

The cable shall meet all applicable requirement stated in ICEA S-110-717-2003, ITU-T G.657.A, IEC or JIS Standard for Optical Fibre outside Plant Communication Cable, as well as those stated within this specification.

The Underground Drop Cable consists of two (2) cores fibre between two (2) strength members to protect fibre from damage due to the force such as bending, twisting, tensile stress, etc and surrounded by black LSZH sheath.

Figure 41 shows the sample structure of Underground Drop Fibre. The optical fibre that meet ITU G.657A standard is the most recommended for Underground Drop Fibre as shown in Figure 41 below.

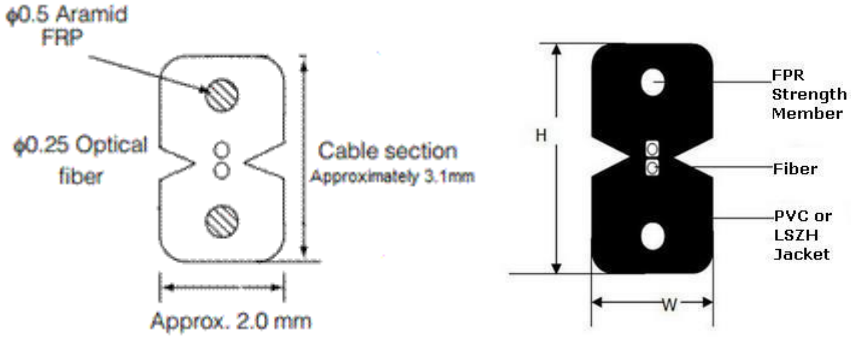


Figure 41. Sample for Underground Drop Fibre Structure

9.8 Specification for Internal Fibre Cabling

Internal Fibre Cable is referred to the in-building cabling from FTB to FWS. The Internal Fibre to be made available by the Developer.

The cable shall meet all applicable requirement stated in ANSI/ICEA S-104-696, ITU-T, IEC 60794-2 (2002-12) or JIS Standard for Optical Fibre outside Plant Communication Cable, as well as those stated within this specification. The details specification is in Annex C.

The Internal Fibre Cable consists of two (2) cores fibre between two (2) strength members to protect fibre from damage due to the force such as bending, twisting, tensile stress, etc and surrounded by white LSZH sheath.

Cable type must be from single-mode and meets specification ITU-T G.657.A General Specifications for indoor fibre cables is shown in Table 4 below:

Table 4. ITU-TG.657 category A attributes

Parameters	Description / Specification				
Mode Field Diameter	8.6 µm to 9.5 µm at 1310 nm				
Core Concentricity Error	Maximum 0.5 µm				
Cladding non-circularity	Maximum 1%				
Cladding diameter	125 ± 1 µm				
Attenuation Coefficient					
1310 nm to 1625 nm	Max. 0.40 dB/km				
1383 nm ± 3 nm	Max. 0.40 dB/km				
Zero Dispersion Slope	Max. 0.092 ps/nm2.km				
Zero Dispersion Wavelength	1300nm to 1324 nm				
Cable cut-off wavelength	Max.1260 nm				
Polarization Mode Dispersion (PMD)	Max. 0.2 ps/√km				
Fibre proof test level	Minimum 0.69 GPa				
Uncabled fibre macrobending loss	ITU-T G.657.A1		ITU-T G.657.A2		
Radius (mm)	15	10	15	10	7.5
Number of turns	10	1	10	1	1
Max. at 1550nm (dB)	0.25	0.75	0.03	0.1	0.5
Max. at 1625nm (dB)	1.0	1.5	0.1	0.2	1.0

Internal Fibre cable is used for corridor and indoor cabling. Its structure is shown in Figure 42.

Internal Fibre cable is suitable for aerial, duct, fixing along with wall, under carpet, installation ways, and its characteristics are as followings:

a) Small outer diameter, light weight, suitable for branching, indoor, limited room;

b) Reserved tearing gap of optical cable can separate the fibre easily without instruments, which is convenient to construct; and

c) Adopting small winding radius fibre with 15mm and even 10mm, suitable for indoor routing under the instance of sudden turning, for instance wall-pole corner and indoor smooth panel.

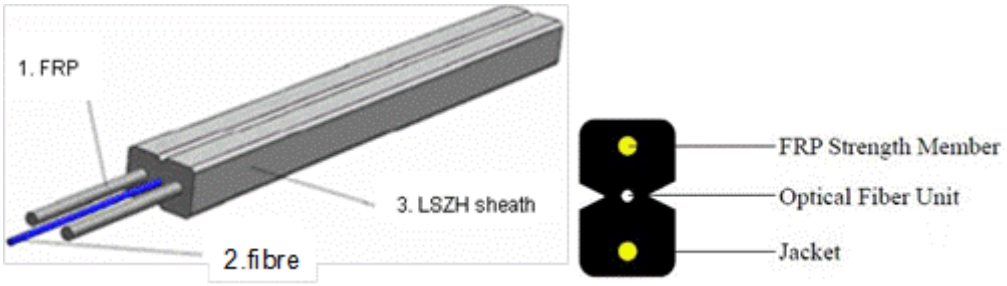


Figure 42. Structure of Internal Fibre Cable

In addition, there are two (2) specifications for this cable (1-core, 2-core), configuring according to different scene requirements.

The main advantages of the indoor flexible optical cables are:

a) Easy split construction where the jacket can be peeled to open without using any tool;
b) Fibre is stripped and cleaved using conventional tools;
c) Readily available compatible interconnection components from multiple international vendors;
d) Complies to ITU-T's IEC standards; and
e) Multi-fibre core version of the same cable can be used as distribution cable (aerial or underground).

10. Cabling for Multi-Dwelling Unit (MDU)

10.1 General

Generally, internal cabling for MDU covers the elements from the FTB inside TR to the individual premise FWS.

This section focus on the elements between FTB and FWS and the architecture of it is laid by the Developer depending on personal preferences.

10.2 Cabling and Network Boundary for MDU

Cabling for MDU consist of three (3) main elements as below:

a) Campus Backbone Cabling;
b) Vertical cabling; and
c) Horizontal cabling.

The sample of MDU cabling is shown as in Figure 43.

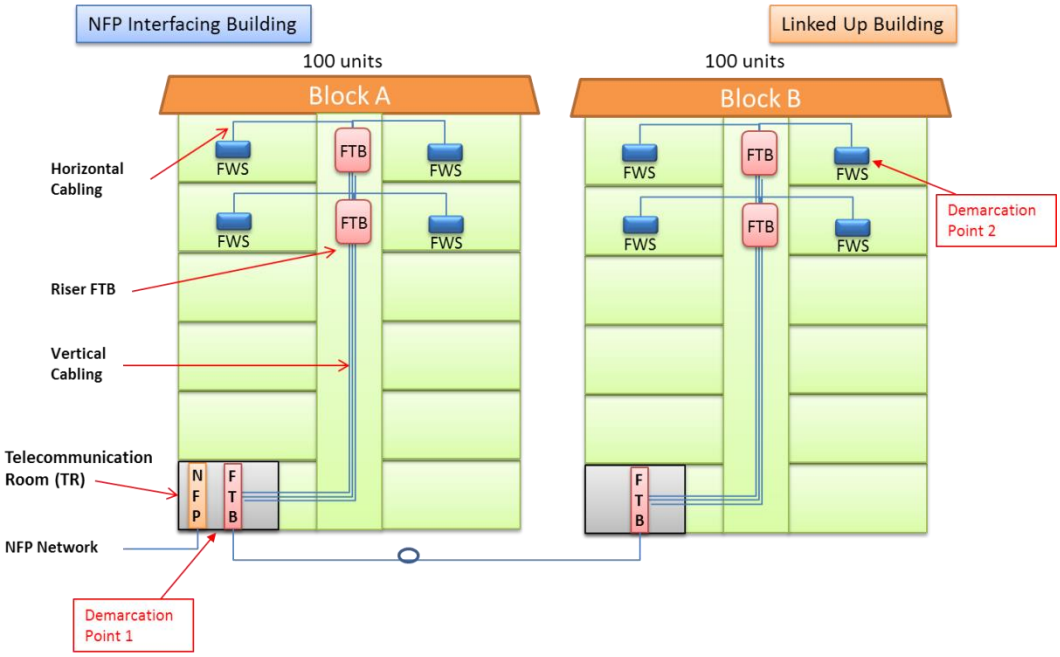


Figure 43. Indoor Fibre Cabling for MDU

Cabling demarcation point between NFP and Developer is at the TR as labelled with *"Demarcation Point 1"* in Figure 43 above. NFP to provide the telecommunication device including the cabling portion up TR. FTB and all the cabling up the FWS inside customer premise shall be prepared by the Developer. *"Demarcation Pont 2"* in Figure 43 indicates the demarcation point between NFP and customer during service activation.

For the case of multi building is connected to single building and NFP is allowed to enter to that single building only, Developer needs to prepare all the cabling connected to all the linked building.

For residential unit, minimum two (2) cores of Internal Fibre shall be provided between FTB inside the TR and each customer unit FWS. All cores shall be terminated at both FTB and FWS.

For business unit, minimum four (4) cores of Internal Fibre shall be provided between FTB inside TR and each customer unit FWS and all cores shall be terminated at both end. However it is highly recommended to have higher fibre count to cater multiple service providers. The actual number of cores for business unit shall depend on customer preference and shall be consulted with NFP for the appropriate numbers.

The Internal Fibre shall be terminated at both ends – FTB and FWS with SC/UPC type of connector.

Network boundary for MDU is as shown in Figure 44. The responsible entities for MDU are NFP, Developer, individual Premise Owner and Building Management. The demarcations are as follows:

a) Demarcation between the NFP and the Building Management / Developer – *"Demarcation Point 1"* to be the FTB inside the TR. Demarcation Point 1 to outside shall be provided by NFP and to the inside until the FWS, shall be provided by Developer and be owned and maintained by Premise Owner or Building Management; and

b) Demarcation between the Building Management/Developer and the individual customers – *"Demarcation Point 2"* to be the FWS at the individual premise unit. Demarcation Point 2 generally between Premise Owner and NFP. Generally NFP will install the CPE during service activation and shall be owned by NFP or Premise Owner depending on the service agreement between NFP and Premise Owner.

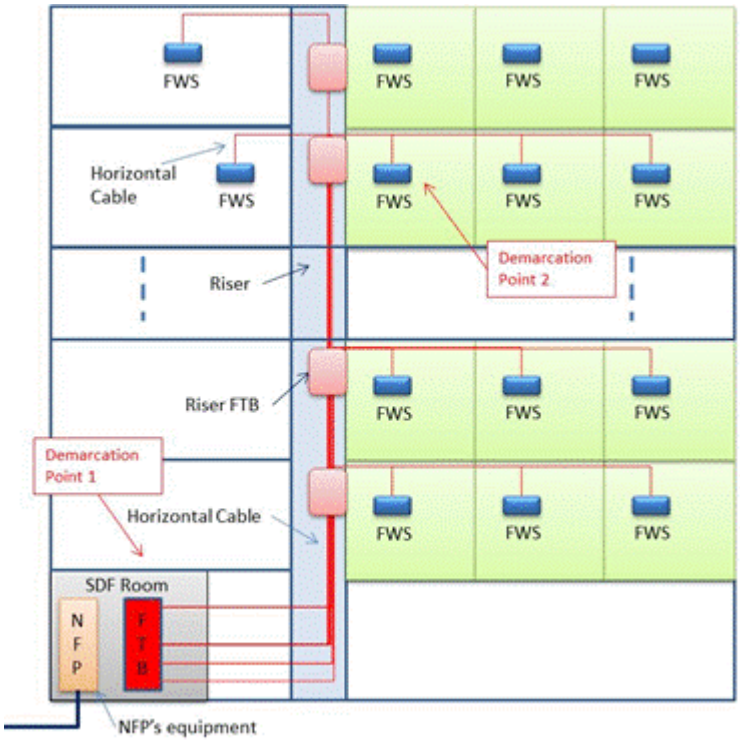


Figure 44. Network Boundary for MDU

All infrastructures inside the building and connection with NFP's infrastructure shall be made available by the Developer and to be maintained by the Building Management.

Interface to NFP network will be the FTB in TR. NFP will install their network element inside the TR. Generally, the connection between NFP's Network and Developer FTB will only be installed once customer subscribe to the service.

10.3 Vertical Cabling

The Vertical Cabling is referred to the cabling between TR and rise FTB at each floor riser in the same building. Vertical Cabling shall be provided by the Developer and shall be approved by NFP during infrastructure and cabling acceptance procedure.

Floor FTB is an optional to be used for connection between Vertical Cabling and Horizontal Cabling. However, Floor FTB is highly recommended to be provided for easier expansion and maintenance of the Vertical Cabling. The connection between Vertical Cabling and Horizontal Cabling inside the Floor FTB can be through spliced join or using the SC/UPC connector. Vertical Cabling can be directly terminated in FWS without the Floor FTB. For this case, the Vertical Cabling also acts as Horizontal Cabling.

After completion of the premise, generally the ownership of the cabling is transferred to the Building Management. Building Management shall maintain and ensure all the cablings are in good and working condition.

The Vertical Cabling shall be made from LSZH and anti-rodent material and shall be installed through the opened on closed riser trunking.

The types of cable that can be used for Vertical Cabling are:

a) normal conventional Fibre Optic Cable or generally known as “round cable”;
b) indoor tight buffer cable;
c) loose tube cable; or
d) blown fibre - detail specification for blown fibre system is explained in Annex D.

Minimum number of fibre cores for Vertical Cable shall follow the rules as below:

Number of minimum fibre core = 2 x number unit in the building + 30 % of number of unit in the building

Example:

Number unit in building	*= 100 units*
Minimum number of fibre core in backbone cable	*= (2 x 100) + 30 % (100)*
	= 200 + 30
	= 230 cores

10.4 Horizontal Cabling

Horizontal Cabling is referred to the Internal Fibre cabling between floors, FTB to FWS inside each individual premise unit.

For residential type of MDU, each of the premise unit shall be prepared with minimum two (2) cores of Internal Fibre. The Internal Fibre shall be terminated at both ends inside the FTB and FWS. Termination at the FWS side shall be SC/UPC connector type and termination inside the Floor FTB shall be either SC/UPC type or direct splice joint with Vertical Cabling.

For business type of MDU, minimum of four (4) cores Internal Fibre shall be provided up to the FWS. However it is recommended to have higher fibre count to cater multiple service providers at any one time, for maintenance and also for future expansion.

It is highly recommended to have additional of 30 % spare cores for business building and 10 % for residential building.

The responsibility of deployment and maintenance shall follow same as Vertical Cabling.

The cabling for Internal Horizontal Fibre Cable shall be secure through:

a) expose wall or surface ducting or trunking;
b) concealed ducting inside the wall;
c) concealed ducting underground floor; or
d) conduit ducting through the ceiling.

depending on the design of the building.

The size of the trunking and ducting shall depend on the capacity of the cable. The trunking or ducting of Horizontal Cabling shall be made from PVC or higher material such as metal clad trunking. The minimum diameter of the trunking is as below:

a) PVC Conduit size is 50mm diameter;
b) PVC Casing size is 100mm x 25mm; and

c) metal clad trunking size is 100mm x 25mm.

The minimum requirement for the riser, duct and conduit shall follow the requirements as explained in the *MTSFB 008:2005 (Revision 1) - Technical Standards and Infrastructure Requirements (TSIR): Fixed Network Infrastructure*

10.5 Campus Backbone Cabling

The Campus Backbone Cabling is referred to the Internal Fibre cabling from the TR at NFP interfacing building to the other linked up building's TR.

Minimum number of fibre core in Campus Backbone cable shall follow the rules as below:

Number of minimum fibre core = 2 x number unit in linked building + (30 % of total unit in linked building)

Example:

There are 2 blocks in the development area which are Block A and Block B.

Number unit in Block A (the main building)	*= 100*
Number unit in Block B (the subsequent building)	*= 100*
Minimum number of fibre core in backbone cable	*= (2 x 100) + 30% (100)*
	= 200 + 30
	= 230 cores

The 30 % portion of the cable shall be reserved for maintenance and future demand.

Campus Backbone Cabling shall be prepared by Developer and shall be terminated at both buildings TR's FTB. Numbers of core require is two (2) cores for every unit with some spare cores for maintenance and future expansion if any. Number of spare cores is 30 % of the total allocated cores in linked building.

All Campus Backbone Cabling shall be directly terminated or pre-connected at NFP's interfacing building with a clear and proper tagging and labelling. Only single point of connection is allowed to interface with NFP network. No addition patching or jumpering is allowed to connect the linked up building during the NFP's service activation.

It is highly recommended to use high capacity cable that > 48 cores for the Campus Backbone Cabling.

Total IL between NFP interfacing building's FTB and other building's FWS shall limited to 2.3dB. If the loss exceeds the allowed value, the building shall be design separately with NFP shall be allowed to install their equipment inside of each building's FTB. For this case, Campus Backbone Cabling is not applicable.

10.6 MDU internal cabling design

There are few methods and design of installation for Horizontal and Vertical Cabling. However Developer is strongly recommended to discuss in details with the NFP for the best method to be adopted.

Design 1: High capacity vertical cable

a) Highly recommend for high capacity building;

b) Several high capacity cables erected from SDF room through each floor and tapping out several core at each level;

c) It requires high skill installation technic to tap out the related fibre core at each floor;

d) At every floor, vertical cable is erected depend on the number of cores require at that floor;

e) The erected vertical cable cores then shall be jointed with horizontal cable through fusion splicing or connector inside the floor or Floor FTB;

f) It is recommended to use Drop Cable or Indoor Cable type for Horizontal Cable which generally consist of single or multiple cores;

g) Each Horizontal Cable shall be terminated at individual FWS; and

h) Each unit shall use different Horizontal Cable. The example design is as shown in Figure 45 below.

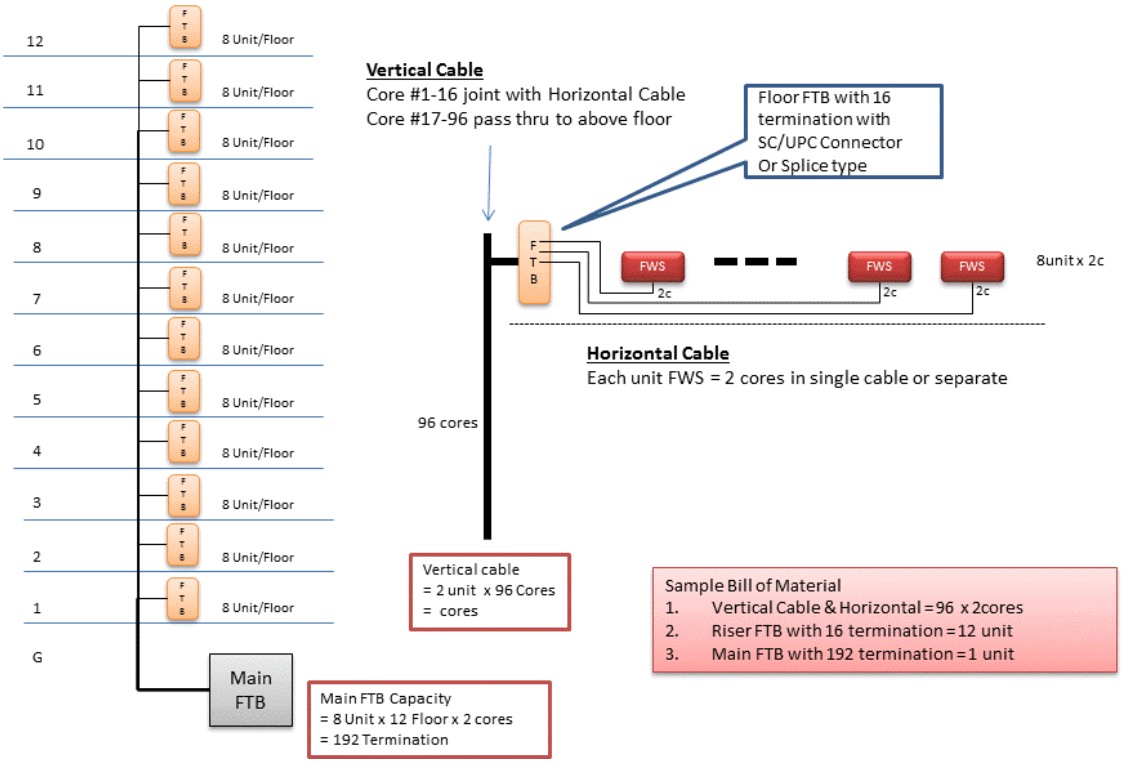


Figure 45. Cabling Design 1 – High capacity Vertical Cable

Design 2: Medium capacity vertical cable

a) Highly recommend for high or medium capacity building;

b) Several high capacity cables erected from SDF room through each floor and tapping out several cores at every 3 floor;

c) It requires high skill installation technic to tap out the related fibre core at each floor. At every terminated floor, vertical cable is erected out for 3 floor portion;

d) The erected vertical cable cores then shall be jointed with three (3) floor horizontal cable through fusion splicing or connector inside the floor FTB;

e) It is recommended to use Drop Cable or Indoor Cable type for Horizontal Cable which generally consist of single or multiple cores. Each Horizontal Cable shall be terminated at individual FWS. Each unit shall use different Horizontal Cable; and

f) The example design is as shown in Figure 46 below. One (1) floor FTB is not allowed to be shared with more than three (3) floor and shall be placed at the middle floor. From floor FTB, it is only allowed to be connected with one (1) floor above or one (1) floor below of the Horizontal Cabling.

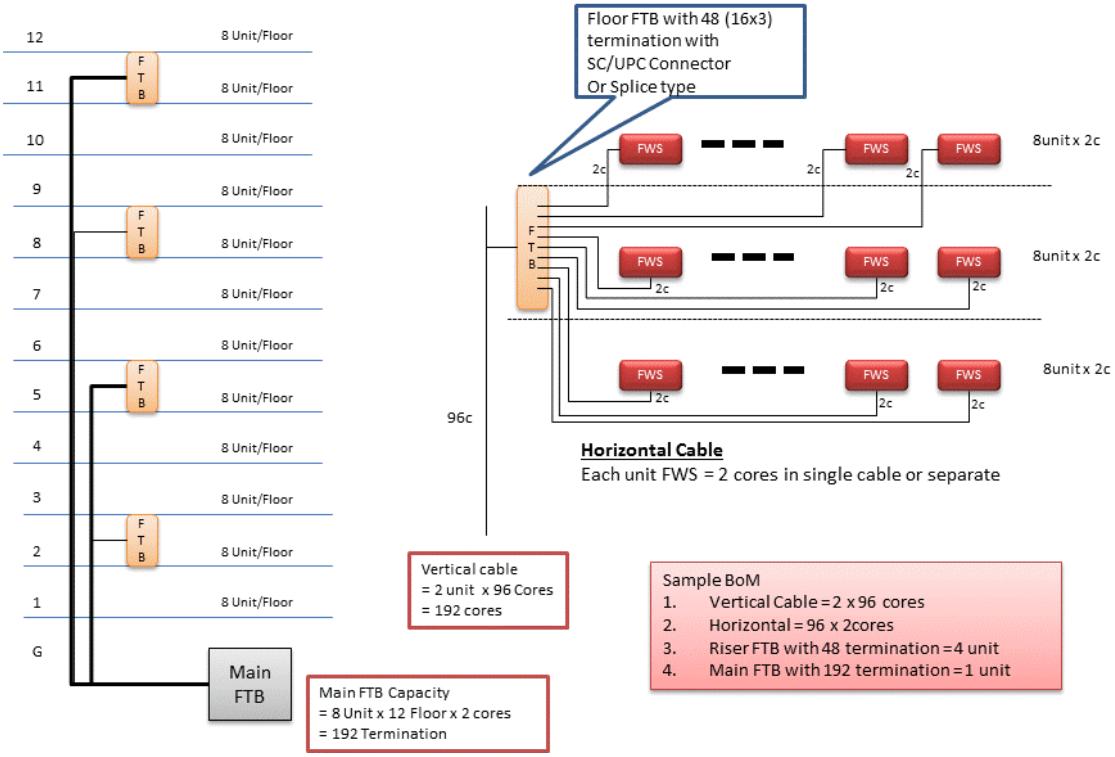


Figure 46. Cabling Design 2 – Medium capacity Vertical Cable (high capacity)

Another option is to use single Vertical Cable to every three (3) floor as shown in Figure 47.

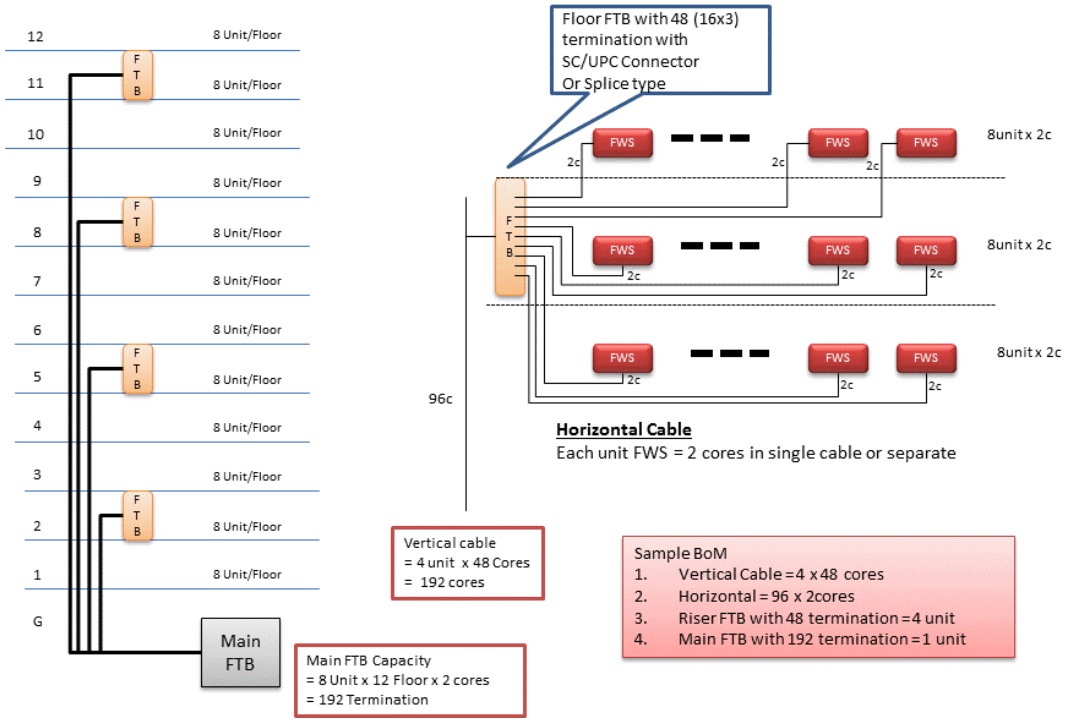


Figure 47. Cabling Design 2 – Medium capacity Vertical Cable (medium capacity)

Design 3: Single vertical cable to each floor

a) Highly recommend for medium capacity building;

b) Single medium capacity of Vertical Cable erected from SDF room to each floor and jointed with Horizontal Cable at each floor level;

c) At every floor, one (1) vertical cable is erected depend on the number of cores require at that floor. The erected vertical cable cores then shall be jointed with horizontal cable through fusion splicing or connector inside the floor FTB;

d) It is recommended to use Drop Cable or Indoor Cable type for Horizontal Cable which generally consist of single or multiple cores; and

e) Each Horizontal Cable shall be terminated at individual FWS. Each unit shall use different Horizontal Cable. The example design is as shown in Figure 48.

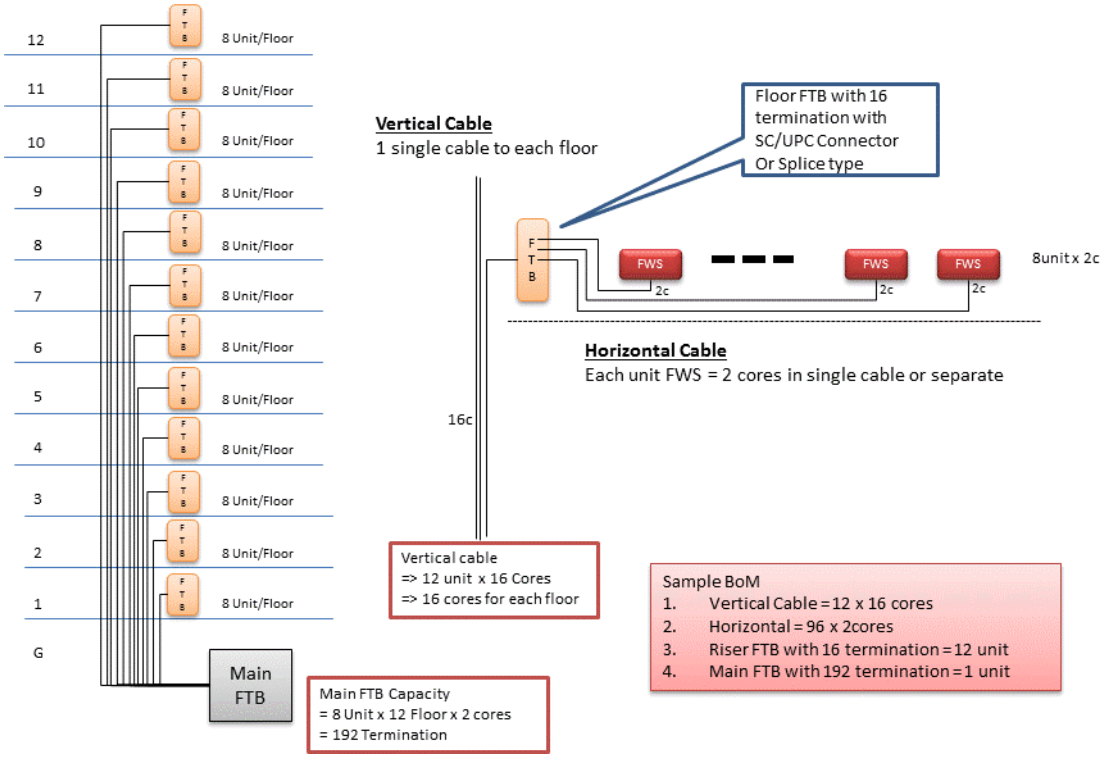


Figure 48. Cabling Design 3 – Single Vertical Cable to each floor

Design 4: Single cable direct to each premise unit

a) Highly recommend for low capacity building. Single two (2) cores Cable - Drop Cable or indoor type cable, erected from SDF room direct to each individual premise FWS;

b) Each unit shall use different cable. For this design, no floor FTB is required. However, for better cable maintenance and management in future, it is also highly recommended to introduce the Floor FTB; and

c) The example design is as shown in Figure 49. Blown fibre system is an optional method that can be considered and the minimum microduct size is 5/3.5mm.

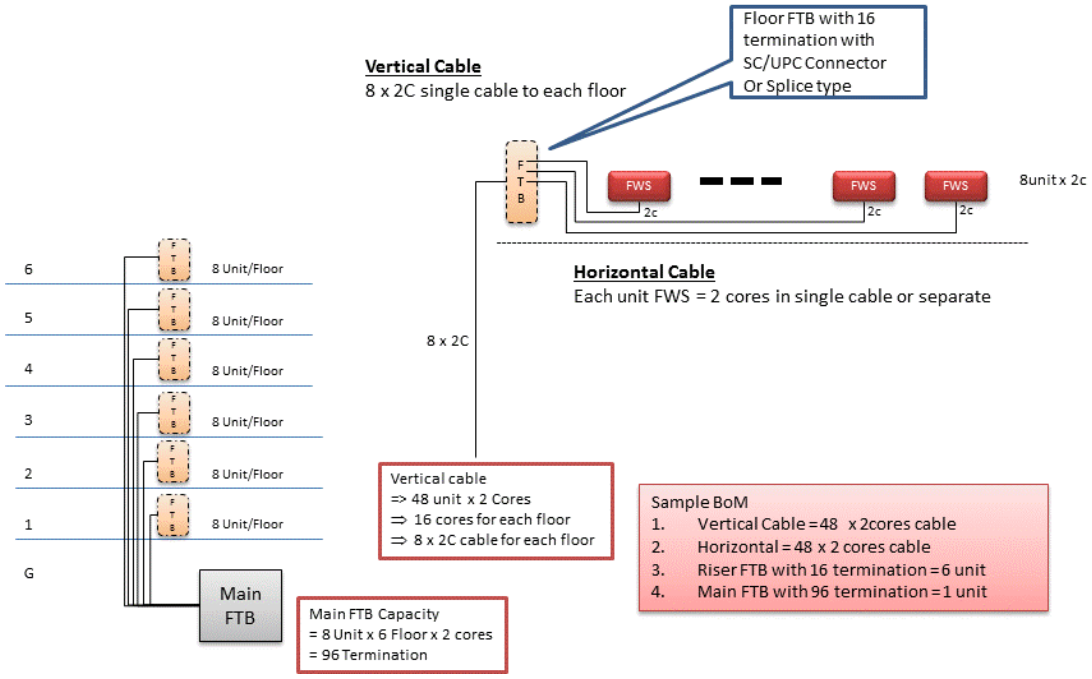


Figure 49. Cabling Design 4 – Single cable direct to premise unit

10.7 Multi MDU building cabling

Multi MDU building cabling is referred to cabling system that linked with multiple building and only one (1) building is interfacing with NFP network. The rest of the building is connected to the NFP interfacing building via Campus Backbone Cabling. Sample multi MDU building cabling is as shown in Figure 50 below.

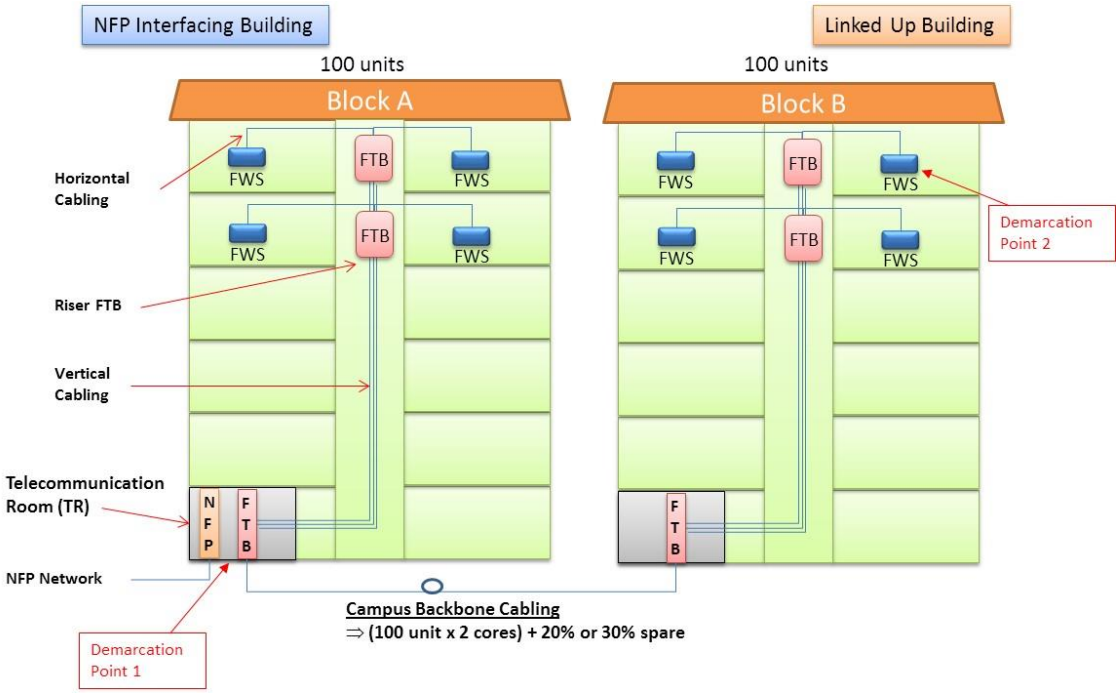


Figure 50. Multi MDU building cabling

Vertical Cabling and Horizontal Cabling is same as a single MDU building cabling. Each building shall be linked up to the NFP's interfacing building via Campus Backbone Cabling.

10.8 Mixed Building Cabling

Mixed building cabling is referred to a township development case which may consists of multiple MDU and SDU building connected together with single interfacing point with NFP network. The sample is as shown in Figure 51 below.

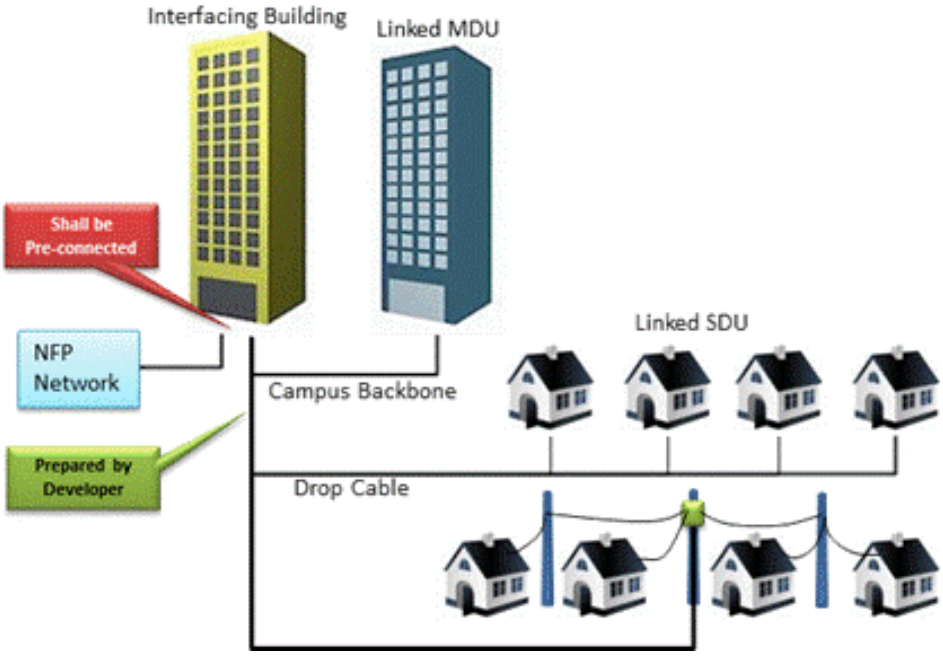


Figure 51. Sample of mixed building cabling

Campus Backbone or Drop Cable cabling shall be prepared by Developer to link up all the building with the NFP's interfacing building. The cabling shall be prepared and pre-connected from FTB inside the NFP Interfacing Building until each individual unit FWS. The total loss between those two (2) connection points shall remain as maximum 2.3dB.

10.9 Specification of MDU internal cabling

Specification for MDU Internal Fibre is shown as Table 5 below:

Table 5. Specification of MDU's Internal Fibre

Cable	Cabling Portion	Specification
Campus Backbone	Main Building's FTB TR to other building's FTB	Single Mode ITU-T G.652 D Indoor and Underground Cable
Vertical Cable	FTB at TR to each Floor FTB	Single Mode ITU-T G.652 D or ITU-T G.657 A Indoor Cable
Horizontal Cable	Floor FTB to individual unit premise FWS	Single Mode ITU-T G.657 A Indoor Cable
Drop Cable	SDU in Mixed Building	Single Mode ITU-T G.657 A Underground Cable

Cable specification for Campus Backbone cable and Vertical Cable are normally same. However, for Campus Backbone normally is erected thru underground. Therefore, the U/G cable shall be used. Cable type shall be loose tube, tight buffer or ribbon single mode (SM) fibre and complied with ITU-T G.652D or G.657A specification. Sample of Campus Backbone and Vertical Cable is shown in Figure 52 and Figure 53 below.

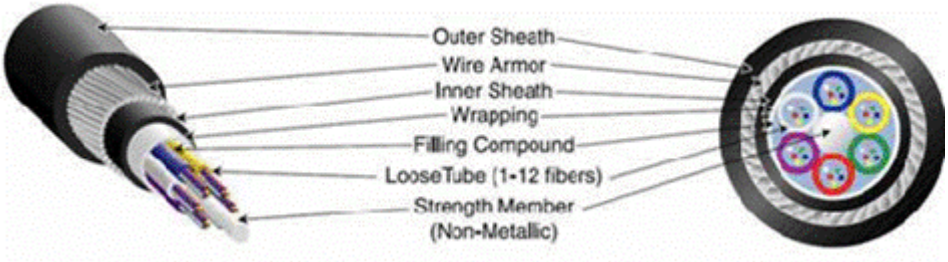


Figure 52. Possible Vertical Fibre Cable design – Loose tube

Figure 53. Possible Vertical Fibre Cable design – Ribbon

Underground cables are generally installed in duct which is usually a 10cm (4 inch) duct with several inner duct for pulling cables. Cables are designed for high pulling tension and lubricants are used to reduce friction on longer pulls. Automated pulling equipment that limits pulling tension protects the cables. Very long runs or those with more bends in the conduit may need intermediate pulls where cable is pulled, “Figure 8” and then pulled to the next stage or intermediate pulling equipment is used. An alternative is to install duct lines and blow special lightweight cables into the ducts which can be faster and less stressful on the cable.

Splices on underground cables are generally stored above ground in a pedestal or in a vault underground. Sufficient excess cable is needed to allow splicing in a controlled environment. Usually a splicing trailer and the storage of excess cable shall be considered in the planning stage.

Horizontal Cable typically shall follow the specifications same as Vertical Cable with lower capacity. It is highly recommended to use Drop Cable type for easier installation to each individual premise unit.

Internal Horizontal Cable will also become the individual in-premise Internal Fibre and it should flexible enough to be laid inside premise.

Recommended type of Horizontal Cable is FRP or Aramid/Kevlar Reinforced type and shall be bending-insensitive, small bending proof and high reliability single-mode fibre (ITU-T G.657 A). The specification is same with premise Internal Fibre for SDU as explained in Clause 9.8.

For premises telecommunications outlet, the cable type depends on the type of CPE interface and the most recommended type is UTP cable with specification of Cat3, Cat5e or Cat6 type.

Multimode Fibre Cable is not allowed to be used for any of cabling for MDU or SDU which will be connected to NFP network. It might be used for internal usage such as Wide Area Network (WAN) or Local Area Network (LAN) cabling.

10.10 Fibre Optic Cable

Fibre Optic Cable Construction - all cables are comprised of layers of protection for the fibres. Most all start with standard fibre with a primary buffer coating (250 microns).

10.10.1 **Tight buffer coating**

Tight buffer cables like simplex, zipcord, distribution and breakout types.

A soft protective coating applied directly to the 250 micron coated fibre to provide additional protection for the fibre, allowing easier handling, and even direct termination on the fibre.

10.10.2 **Loose Tubes** (loose tube cables)

Small, thin plastic tubes containing as many as a dozen 250 micron buffered fibres used to protect fibres in cables rated for outside plant use. They allow the fibres to be isolated from high pulling tension and can be filled with water-blocking materials to prevent moisture entry.

10.10.3 **Strength members**

Strength members are usually aramid yarn, the same used in bulletproof vests, often called by the Dupont trade name Kevlar, which absorbs the tension needed to pull the cable and provides cushioning for the fibres. Aramid fibres are used not only because they are strong, but they do not stretch. If pulled hard, they will not stretch but eventually break when tension exceeds their limits. This ensures that the strength members will not stretch and then relax, binding the fibres in the cable. The proper method of pulling fibre optic cables is always to attach the pull rope, wire or tape to the strength members.

Some cables also include a central fiberglass rod used for additional strength and to stiffen the cable to prevent kinking and damaging the fibres. When included, these rods should be attached to swivel pulling eyes for pulling and clamps in splice closures or patch panels when spliced or terminated. Few cables today use metallic strength members since it complicates installation by requiring the cable to be properly grounded and bonded.

10.10.4 **Cable Jacket**

Cable jacket is the outermost layer of protection for the fibres which is chosen to withstand the environment in which the cable is installed. Outdoor cables will generally be black polyethylene (PE) which resists moisture and sunlight exposure. Indoor cables use flame-retardant jackets that can be color-coded to identify the fibres inside the cable. Some outdoor cables may have double jackets with a tough layer of armor between them to protect from chewing by rodents or Kevlar for strength to allow pulling by the jackets.

Indoor cables usually have a flame-retardant PVC jacket for general or riser use and some other special plastic for plenum use in air handling areas. Indoor-outdoor cables usually have a PE outer jacket that can be removed to expose a flame-retardant inner jacket for use within buildings.

Protection against water and moisture - cables installed outdoors require protecting the fibres from water. Either a gel or as is becoming more common, absorbent tape or powder, is used to prevent water from entering the cable and causing harm to the fibres. Generally, this applies to loose tube or ribbon cables, but dry water-blocking is used on some tight buffer cables used in short outdoor runs, such as building to building on a Campus Backbone Cabling.

Protection Against Crushing or Rodent Penetration - Some cables have armor, usually metallic but sometimes hard plastic, under the outer jacket resist crushing loads, such as cables installed under floors in data centers or in rocky soil, as well as to prevent rodent penetration. Metallic armor requires that the cable be properly grounded and bonded.

10.10.5 **Tight Buffer Cable Types**

There are two (2) basic types of cables, generally defined as tight buffer and loose tube.

Tight buffer cables (simplex, zipcord, distribution and breakout) are primarily used in premises applications where cable flexibility and ease of termination are important, more so than ruggedness, weather sealing and pulling strength which characterizes loose tube and ribbon types of cable.

Generally, tight buffer cables are used indoors and loose tube/ribbon cables outdoors, but some tight buffer cables with moisture protection are used in short runs like on a Campus Backbone Cabling or between buildings. The sample is shown in Figure 54 below.

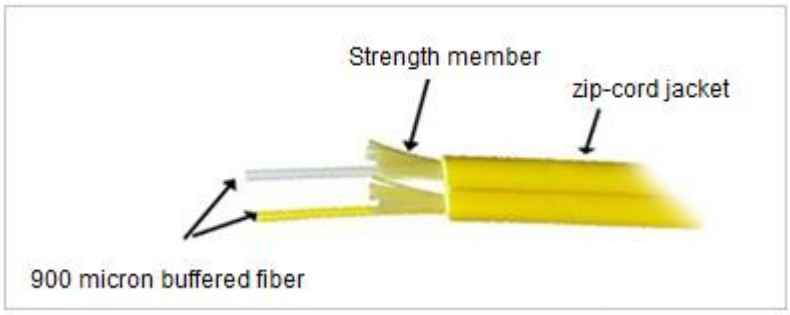


Figure 54. Sample of Tight Buffer Cable

10.10.6 **Distribution Cables**

The Distribution Cables generally been used for Vertical and Horizontal Cabling. Distribution cable is the most popular indoor cable, as it is small in size and light in weight. They contain several tight-buffered fibres bundled under the same jacket with Kevlar strength members and sometimes fiberglass rod reinforcement to stiffen the cable and prevent kinking. These cables are small in size, and used for short, dry conduit runs, riser and plenum applications.

The fibres are double buffered and can be directly terminated, but because their fibres are not individually reinforced, these cables need to be broken out with a "breakout box" or terminated inside a patch panel or junction box which been used for Floor FTB. Sample of Distribution Cable is as shown in Figure 55.

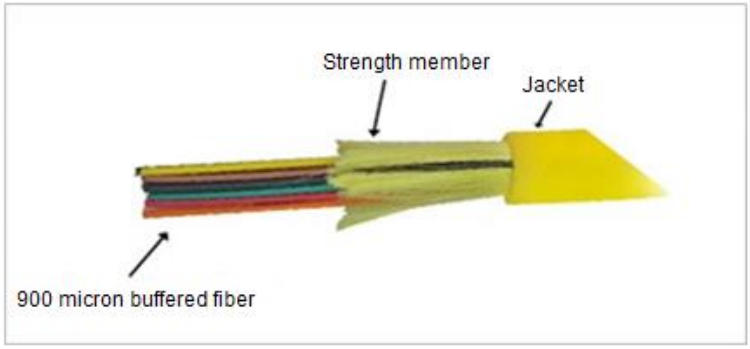


Figure 55. Sample of Distributed Cable

10.10.7 **Breakout Cables**

The Breakout cable is a favourite where rugged cables are desirable or direct termination without junction boxes, patch panels or other hardware is needed. They are made of several simplex cables bundled together inside a common jacket. This is a strong, rugged design, but is larger and more expensive than the distribution cables.

It is suitable for conduit or trunking runs, riser and plenum applications. It's perfect for industrial applications where ruggedness is needed. Because each fibre is individually reinforced, this design allows for quick termination to connectors and does not require patch panels or boxes. Breakout cable can be more economic where fibre count isn't too large and distances too long, because it requires so much less labour to terminate. Sample of Breakout Cable is as shown in Figure 56 below.

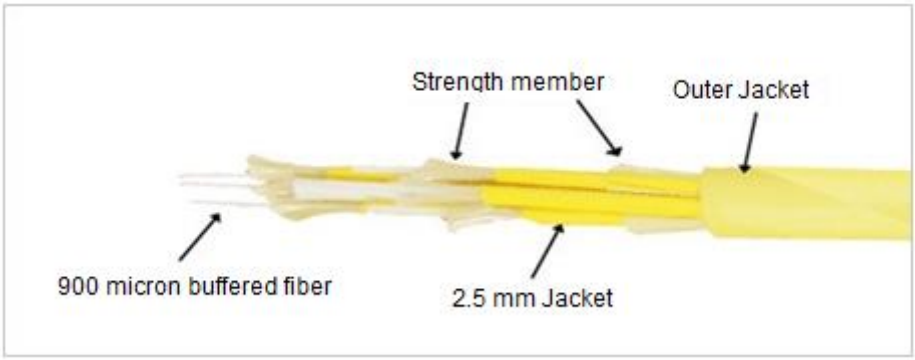


Figure 56. Sample of Breakout Cables

10.10.8 **Loose tube cables**

The most widely used cables for outside plant trunks because it offers the best protection for the fibres under high pulling tensions and can be easily protected from moisture with water-blocking gel or tapes.

These cables are composed of several fibres together inside a small plastic tube, which are in turn wound around a central strength member, surrounded by aramid strength members and jacketed, providing a small, high fibre count cable.

This type of cable is ideal for outside plant trunking applications, as it can be made with the loose tubes filled with gel or water absorbent powder to prevent harm to the fibres from water. It can be used in conduits, strung overhead or buried directly into the ground. Some outdoor cables may have double jackets with a metallic armor between them to protect from chewing by rodents or Kevlar for strength to allow pulling by the jackets. Since the fibres have only a thin buffer coating, they must be carefully handled and protected to prevent damage.

Loose tube cables with singlemode fibres are generally terminated by spicing pigtails onto the fibres and protecting them in a splice closure. Multimode loose tube cables can be terminated directly by installing a breakout kit, also called a furcation or fan-out kit, which sleeves each fibre for protection. Sample is as shown in Figure 57 below.

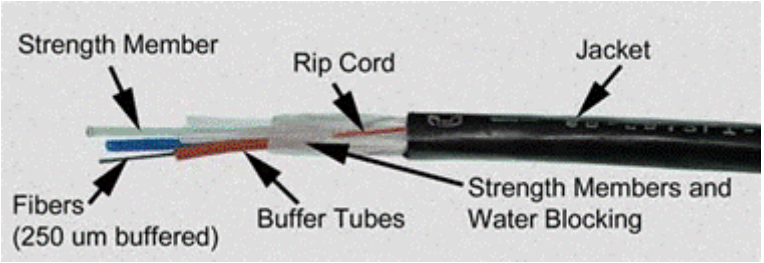


Figure 57. Sample of Loose Tube Cables

10.10.9 **Ribbon Cable** - Ribbon cable is preferred where high fibre counts and small diameter cables are needed. This cable has the most fibres in the smallest cable, since all the fibres are laid out in rows in ribbons, typically of 12 fibres, and the ribbons are laid on top of each other. Not only is this the smallest cable for the most number of fibres, it's usually the lowest cost. Typically 144 fibres in ribbons only have a cross section of about 6 mm (1/4 inch) and the jacket is only 13mm (1/2 inch) diameter. Some cable designs use a "slotted core" with up to 6 of these 144 fibre ribbon assemblies for 864 fibres in one cable. For U/G type, it is gel-filled for water blocking or dry water-blocked. Another advantage of ribbon cable is Mass Fusion Splicers can join a ribbon (12 fibres) at once, making installation fast and easy. Ribbon pigtails are spliced onto the cable for quick termination. Figure 58 shows the sample of Loose Tube Ribbon Cables.

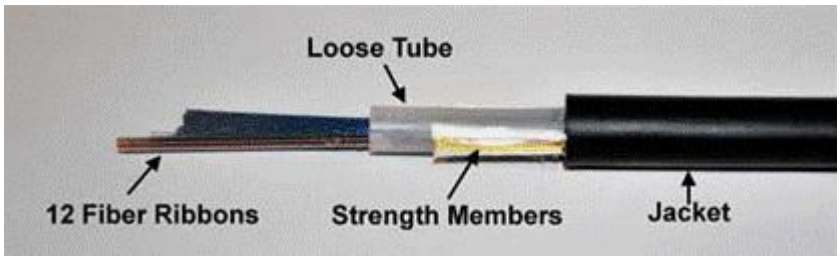


Figure 58. Sample of Loose Tube Ribbon Cables

10.10.10 **Armored Cable -** Armored cable is used in direct buried outside plant or outdoor applications where a rugged cable is needed and/or for rodent resistance. It is highly recommended to be used for Campus Backbone Cabling or highly potential rodent area. Armored cable withstands crush loads well, for example in rocky soil, often necessary for direct burial applications. Cable installed by direct burial in areas where rodents potential have usually had metal armoring between two jackets to prevent rodent penetration. Another application for armored cable is in data centers, where cables are installed under the floor and one worries about the fibre cable being crushed. Indoor armored cables may have nonmetallic armor. Metallic armored cable is conductive, so it must be grounded properly. As with other fibre optic components, there are different names or meanings used. “Armor” in some companies’ jargon denotes a twisted heavy wire rope type cable surrounding the entire poly cable sheath/jacket. Single or double armor (two opposite ply layers of the steel wire) is typically used underwater near shore and shoals. Inner metallic sheath members of aluminium and/or copper are used for strength and for buried cable locating with a tone set. Figure 59 the sample of Armored Cables.

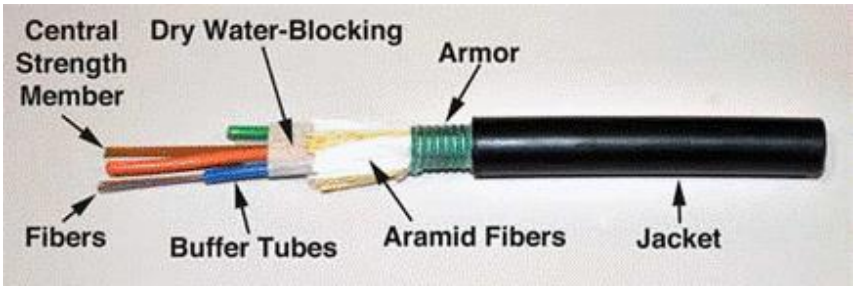


Figure 59. Sample of Armored Cables

10.10.11 **Aerial Cables** - Aerial cables are for outside installation on poles where consideration must be given to continual tension from the cable weight as well as wind and any other potential loads. Regular outdoor loose tube cables can be helically lashed to a messenger. Some cables have heavier jackets and stronger metal or aramid strength members to make them self-supporting. Self-supporting cables use special hardware to handle the installed tension on the cables caused by the weight of the cables and environmental factors like wind. Aerial hardware to store slack cable can be mounted on the cable itself or on utility poles. The cable known as a figure 8 cable, which also been used as a Drop Cable, has a cable bonded to an insulated steel or all dielectric messenger for support. The messenger is supported at each pole. Sample is shown as in Figure 60.

Figure 60. Sample of Aerial Cables

10.10.12 **Air-Blown Fibre -** Another "cable" type is not really cable at all. By installing a "cable" which is just a bundle of empty plastic tubes, the fibre then be blown into the tubes using compressed gas as needed. If it needed to upgrade, the old fibres can be blown out and the new fibre can be blown in to replace it. Both indoor and outdoor versions of air-blown fibre cables are available. Special Single Mode fibres are required that have been coated for easier blowing through the tubes. It's more expensive to install since the tubes must be installed, special equipment and trained installers are needed but can be cost effective for upgrades. Sample is as shown in Figure 61 below.

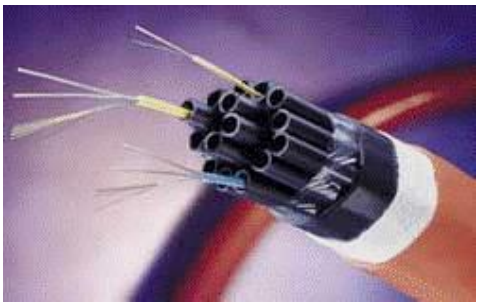


Figure 61. Sample of Air-Blown Fibre

Cable Colour Codes: Outdoor cables are generally black but premises cables are color-coded. Standard colour codes for cable jackets have been yellow jackets for singlemode. However, the black cable is also allowed for indoor usage. A more comprehensive industry standard for colour codes was required. It's important to follow the TIA-598 standards as shown in Table 6 below to prevent mixing up cables.

10.10.13 **Fibre Colour Codes**: Inside the cable or inside each tube in a loose tube cable, individual fibres will be colour coded for identification. Fibres generally follow the convention created for telephone wires except fibres are identified individually, not in pairs. Since most loose tube cables have 12 fibres per tube, colours are specified for fibres 1-12, and then tubes are colour coded in the same manner, up to 144 fibre cables. In ribbon cables, each ribbon is colour coded in this format then ribbons are stacked.

For splicing long cable runs from similar cables (called concatenation), like colour fibres are spliced to ensure continuity of colour codes throughout a cable run.

Table 6. Fibres colour code

TUBE (OR FIBER) NUMBER	COLOUR
1	Blue
2	Orange
3	Green
4	Brown
5	Slate
6	White
7	Red
8	Black
9	Yellow
10	Violet
11	Pink (Rose)
12	Aqua

11. Cabling Attenuation Loss

11.1 General rules

All the internal cabling shall be tested by the Developer. Developer may appoint the competence consultant or contractor whose have a fibre cabling knowledge to provide the test.

The test results shall be submitted together with NFP Type Approval Certificate and been accepted by the NFP technical representative during the infrastructure and cabling acceptance.

For any cabling which does not meet the specification or failure to obtain the Type Approval Certificate for any of used material will be rejected by NFP and Developer shall rectify the problem and proceed with re-verification procedure once it had been rectified.

11.2 Power Link Budget

Power Link Budget is referred to the total attenuation loss allowable in certain portion of the network elements. Power Link Budget generally is used as reference to cabling designer to plan the cabling layout and design to ensure it is not exceed the budget. Power Link Budget shall take the worst case scenario into the consideration. Therefore, the actual measurement normally is much lower compared with the Power Link Budget calculation if all the material and connection is done according to the standard practice and procedure.

Attenuation Loss is the decreasing of the power level during transmission of the signal from NFP network.

As a reference, Table 7 shows the estimated attenuation loss, according to ITU G.652 and Telekom Malaysia standard, for each of the related elements in In-Building Fibre Cabling:

Table 7. Attenuation Loss reference

No.	Item	Loss
1	FOC measured at 1310 nm wavelength	0.4 dB/km
2	Fusion Splice Loss	0.1 dB
3	Mechanical Splice Loss	0.5 dB
4	Factory fitted SC/UPC connector	0.2 dB
5	1 Pair of FA-SC/UPC connector	0.4 dB
6	SOC	0.3 dB

The usage of connection technique and material shall contribute to the main factor for total attenuation loss or link budget calculation. For example, if FA-SC connector which generally has higher attenuation loss is used, the overall attenuation loss will become higher compared to Factory fitted SC connector.

The fibre length also contributes to the total attenuation loss. Generally, 1310 nm wavelength is used to test the fibre because it has the highest attenuation compared to other wavelength.

For the cabling length limitation, there are not specific distance shall be specified in the document because it is depending on the total link budget which also contributed by other elements. In example, if only small numbers of splice joint or connectors were used, the extra loss budget shall be used to extend the fibre length.

11.3 Cabling Power Link Budget for MDU

The allowable total power attenuation loss for MDU cabling is measured from TR's FTB to FWS at each individual premise, including the Campus Backbone Cabling portion and the total attenuation loss shall not exceed 2.30 dB.

All fibre cores shall be tested at every termination. Table 8 below shows the sample of total power attenuation loss calculation.

Table 8. Cabling Power Insertion Loss for Single MDU

Location	Time	Detail
Campus Backbone Cable	Cable (1310 = 0.4 db/km)*	Campus Backbone Cable (200 m) = 0.08 dB
Telecommunication Room	FTB	Connector Loss = 0.7 dB
Riser	Cable (1310 = 0.4 db/km)*	Vertical Cable (100m) = 0.04 dB
	FTB	Mechanical Splice + Adaptor = 0.7 dB
Horizontal Trunking	Cable (1310 = 0.4 db/km)*	Vertical Cable (50m) = 0.02 dB
Inside Premise	FWS	FA – SC Connector = 0.7 dB
Other Marginal Loss	Others	Other loss = 0.16
		Total = 2.3dB

Notes
**ITU-T G.652 reference*

11.4 Power Link Budget for SDU cabling

For SDU, Power Link Budget is generally measured between FTB and FWS. All terminated fibre core in each premises shall be tested by the Developer.

Total attenuation loss between FTB until FWS shall not exceed 1.6dB. In the sample Table 9 below, connector type at FTB and FWS is using the FA-SC connector which generally has higher attenuation loss. As an alternative, the usage of SOC, pigtail connector or other method that might have lower attenuation is highly recommended to reduce the total attenuation loss. The total length of the fibre also contributes to the total attenuation loss

Table 9. Cabling Power Attenuation Loss for SDU

No.	Location	Item	Unit Loss (dB)	Unit	Total Loss (dB)	Detail
1	FTB	FA-SC Connection Point	0.35	2	0.7	1 Unit of FA-SC connector =0.3~0.5 dB
2	Internal Fibre	Cable (1310 = 0.4 dB/km) *	0.4	50m	0.02	Horizontal Cable (50m) = 0.02 dB
3	FWS	FA-SC Connection Point	0.35	1	0.7	1 Unit of FA-SC connector =0.3~0.5 dB
4	Other	Other marginal loss	0.18	1	0.18	
				Total	**1.6**	**Total = 1.6 dB**

FTB and FWS shall not exceed 1.6dB.

Table 10 shows sample calculation of the allowable Power Link Budget for SDU serve via pole.
The attenuation loss from FTB until FWS shall not exceed 1.6dB.

Table 10. Cabling Power Attenuation Loss for SDU – pole type

No.	Location	Item	Unit Loss (dB)	Unit	Total Loss (dB)	Detail
1	FTB	FA-SC Connection Point	0.35	2	0.7	1 Unit of FA-SC connector =0.3~0.5 dB
2	Internal Fibre	Cable (1310 = 0.4 dB/km) *	0.4	50m	0.02	Horizontal Cable (50m) = 0.02 dB
3	FWS	FA-SC Connection Point	0.35	1	0.7	1 Unit of FA-SC connector =0.3~0.5 dB
4	Other	Other marginal loss	0.18	1	0.18	
				Total	**1.6**	**Total = 1.6 dB**

Notes
**ITU-T G.652 reference*

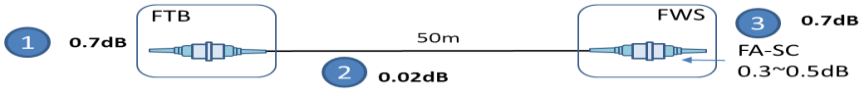
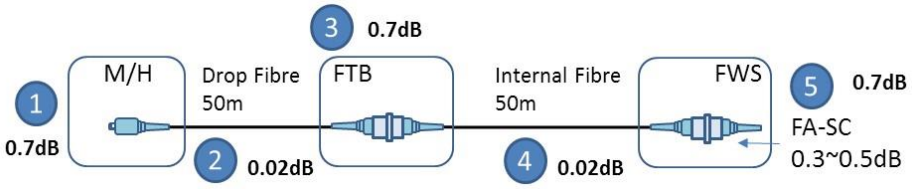


Table 11 below shows the sample calculation of allowable power attenuation loss for SDU serve via underground. The cabling starts from Drop Fibre end inside the NFP interfacing manhole until FWS inside the premise. The total attenuation loss shall not exceed 2.3dB**.**

Table 11. Cabling Power Attenuation Loss for SDU – underground

No.	Location	Item	Unit Loss (dB)	Unit	Total Loss (dB)	Detail
1	"Drop Fibre end (inside Manhole)"	FA-SC Connection Point	0.7	1	0.7	1 Unit of FA-SC connector =0.3~0.5 dB
2	Drop Fibre	Cable (1310 =0.4 dB/km)*	0.0004	50m	0.02	Drop Fibre (50m) = 0.02 dB
3	FTB	FA-SC Connection Point	0.7	1	0.7	1 Unit of FA-SC connector =0.3~0.5 dB
4	Internal Fibre	Cable (1310 =0.4 dB/km)*	0.0004	50m	0.02	Internal Fibre (50 m) = 0.02 dB
5	FWS	FA-SC Connection Point	0.7	1	0.7	1 Unit of FA-SC connector =0.3~0.5 dB
6	Other	Other marginal Loss	0.16	1	0.16	Other = 0.16
				Total	**2.3**	**Total = 2.3 dB**

Notes
**ITU-T G.652 reference*



12 Labelling and Tagging

12.1 Tagging material and specification

Cable is tag or cable identification tag is used to identify the cable or core number.

All the fibre cabling shall be tagged properly at all respective cable and core. Sample of recommended tagging system is as shown in Figure 62. All tag shall be stated clearly and sealed with transparent material for easy to read.

Figure 62. Sample of recommended tagging system

Cable tag shall use clear material such as plastic and can easily be read.

Cable tag shall comply with UL 94V Fire Retardant.

All information on tag shall be machine printed. The printed material shall sustain, not paled or faded for minimum 10 year time. Recommend material is nylon, vinyl or PE. Usage of paper or market pen is strictly not allowed.

The size of the tag shall suitable with the cable, pigtail or fibre core size. The generic recommended size is 1cm x 2cm flag type as shown in Figure 63 below.

Figure 63. Cable Tag

Tag colour shall be white background with black font.

MDU Vertical Cable needs to be tagged with cable code as shown in Figure 64 below.

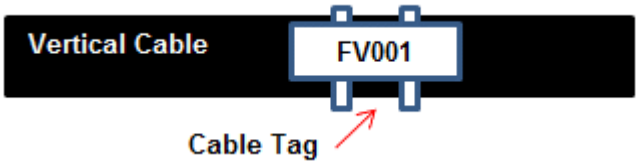


Figure 64: Vertical Cable Tag

12.2 Labelling and tagging for SDU Cabling

SDU served via U/G require tagging and labelling because multiple Drop Cable will be terminated at inside NFP interfacing manhole. Without the proper tagging and labelling, NFP will not able to identify the right Drop Cable which connected to the subscriber premise. The sample is as shown in Figure 65 below.

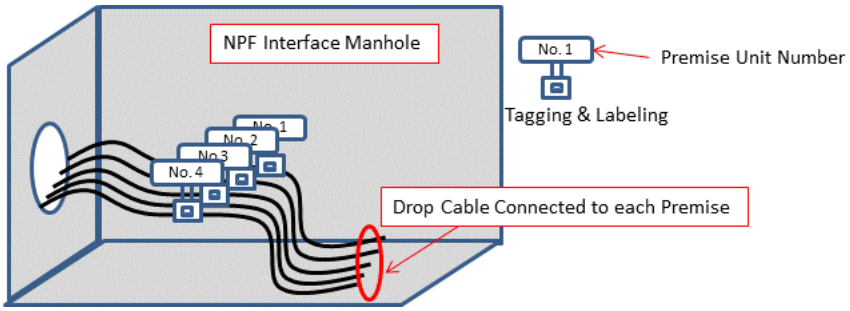


Figure 65. Labelling and tagging for SDU with U/G Access

The cabling for SDU served via Pole shall follow as premise internal cabling as explain in Clause 12.3 below.

12.3 Labelling and tagging for Premise Internal Cabling

The minimum number fibre core in each premise is 2. Therefore each of the cores requires be tagging and labelling accordingly. The sample is as shown in Figure 66 below.

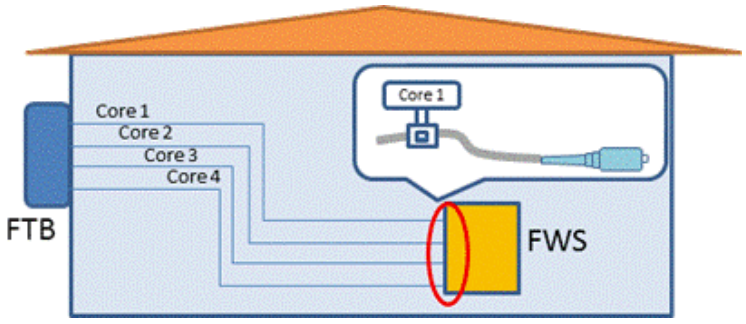


Figure 66. Labelling and tagging for Premise Internal Cabling

However, if two (2) cores of Drop Cable type is used, the labelling and tagging is not require and shall able to be identified with the fibre core colour code which is Blue and Yellow. Blue is for Core 1 and Yellow is for Core 2. Each fibre core need to be correctly connected as both end to avoid the reverse core symptom. The sample is as shown in Figure 67 below.

Figure 67. Colour Code for two (2) cores of Drop Cable

12.4 Labelling and tagging for MDU's Cabling

All the cabling for MDU shall have a code or naming convention and shall be tagged properly for smooth service activation and restoration process by NFP. It also will provide a clear record and reference that is requires for maintenance.

All cables need to be inventoried and a copy of inventory information shall be submitted to the NFP during cabling approval process.

All information of the cabling inventory shall be placed and indicated clearly inside TR or FTB for easier reference. Building Management shall update the information and record whenever there are any changes in the inventory.

The code or naming convention for the Vertical Cabling shall follow as shown in Table 12 below. The table shall be placed inside the TR's FTB:

a) Vertical Cable / Cable No. : Vertical Cable code number – FVxxx:
b) Vertical Cable / Core No. : Core number of Vertical Cable - xxx;
c) Rise info / Floor : Floor number of Vertical Cable terminated- FLxxx;
d) Horizontal Cable / Cable No : Horizontal Cable code number FHxxx;
e) Horizontal Cable / Core No : Horizontal Cable core number xxx

Table 12. Coding for Internal Vertical Cable

Item	Vertical Cable		Riser Info	Horizontal Cable	
	Cable No.	Core No.	Floor	Cable No.	Core No.
Code	FV xxx	Xxx	FLxxx	FHxxx	xxx
Example	FV001 – FV999	000-999	FL020	FH001-FH999	000-999

Code or naming convention for Horizontal Cabling shall follows as in Table 13 The table shall be place inside each Floor FTB box. However, this information only requires if the Floor FTB is used in the cabling design:

a) Horizontal Cable / Cable No : Horizontal Cable code number FHxxx;
b) Horizontal Cable / Core No : Horizontal Cable core number xxx
c) Vertical Cable / Cable No. : Vertical Cable code number – FVxxx:
d) Vertical Cable / Core No. : Core number of Vertical Cable - xxx;
e) Premise/ Premise Unit No. : Premise unit number that Horizontal Cable is laid;

Table 13. Coding for Intenal Horizontal Cable

Item	Horizontal Cable		Vertical Cable		Premise
	Cable No.	Core No.	Cable No.	Core No.	Premise Unit No.
Code	FH xxx	Xxx	FHxxx	xxx	xxx
Example	FH001 – FH999	000-999	FV001-FV999	000-999	005

Vertical cable with FHxxx coding shall be tagged at:

a) Entrance of FTB inside TR

b) Entrance to the duct or riser inside TR

c) Each Floor Riser

13 Testing and Commissioning

13.1 General

Fibre testing shall be done on all fibres in the completed end-to-end cabling system. Generally only total IL is compulsory to be measured. Other parameter such as ORL, Component IL, Splice Loss etc, is also recommended to be tested to ensure the cabling is at the best condition and able to work well for long term.

The total attenuation loss is measure using OTDR, OLTS or Set of Light Source and Power Meter. Testing should comprise of a bi-directional end-to-end OTDR trace performed according to TIA/EIA 455-61 or ISO/IEC 11801 or a bi-directional end-to-end power meter test performed according to TIA/EIA 455-53A or ISO/IEC 11801.

The cabling attenuation loss measurements shall be provided at wavelength of 1310 nm and 1550 nm for single mode fibres. Each link that does not conform to the standard requirement shall be brought into compliance.

13.2 Optical Loss Test Set (OLTS) Test Method

OLTS is a tool to measure point to point attenuation loss in the single cabling. Generally OLTS is able to perform bi-directional measurement with multiple wavelengths together with other parameter such as ORL and distance. OLTS shall be used in pair and require to be placed at both end. TIA-568B or TIA/TSB 140 document shall explained the detail on the test procedure using OLTS. The cabling shall be connected to the OLTS as shown in Figure 68 below.

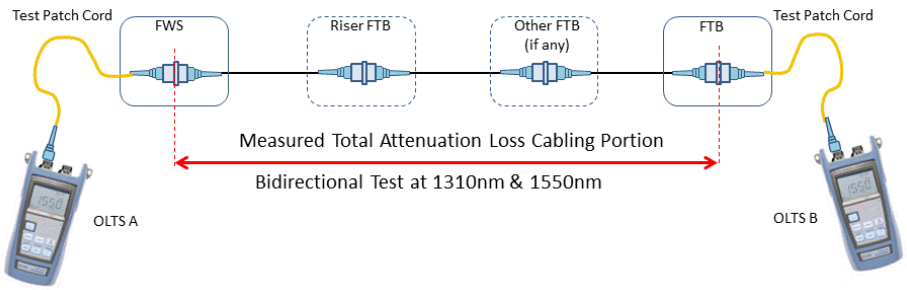


Figure 68. Optical Loss Test Set (OLTS) Testing Method

The total Attenuation Loss between FTB and FWS for each type of the building shall follow as shown in Table 14:

Table 14. Result testing for OLTS

No.	Property Type	Test Point A	Test Point B	Max Loss
1	SDU - Pole Type	Each Individual Premise FWS	FTB Outside The Premise	1.6dB
2	SDU – U/G Type	Each Individual Premise FWS	NFP Interfacing Manhole	2.3dB
3	MDU – Single Building	Each Individual Premise FWS	FTB inside TR	2.3dB
4	MDU – Multi Building	Each Individual Premise FWS	FTB Inside NFP Interfacing TR	2.3dB

Before performing any test, both OLTS require a reference using the Test Patch Cord to reset the connection.

A high quality of Test Patch Cord shall be used to get the accurate measurement.

13.3 Power Meter and Light Source Test Method

Another option of test gear that can be used is Power Meter and Light Source. Power Meter and Light Source is a manual measure, which only single wavelength with single wavelength measure at one time, and generally only can performed single parameter.

Power Meter need to be connected at one end and Light Source at the other end. Power Meter and Light Source shall be set at specific wavelength every time measurement.

The cabling shall be connected to the Power Meter and Light Source as shown in Figure 69 below.

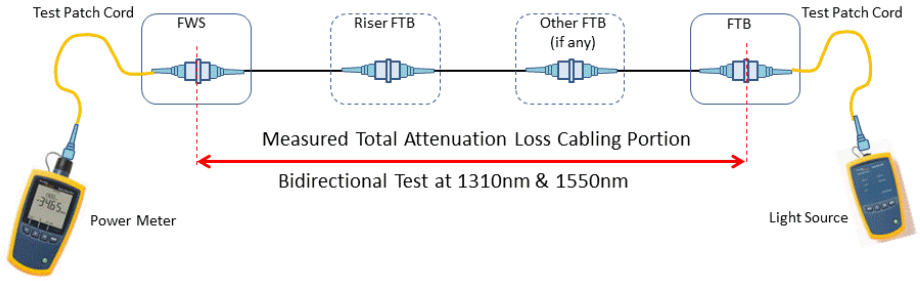


Figure 69. Power Meter and Light Source Testing Method

The total Attenuation Loss between FTB and FWS for each type of the building shall follow the same value as explained in Table 17.

Before performing any test, Power Meter and Light Source require a reference using the Test Patch Cord to reset the connection.

A high quality of Test Patch Cord shall be used to get the accurate measurement.

13.4 Optical Time Domain Reflectometer (OTDR) Test Method

Developer needs to perform the testing by using OTDR as shown in Figure 70 and the expected result as shown in Table 18.

Another option of test gear that can be used is OTDR. OTDR also a manual measurement test gear which only able to test a single wavelength at one time. However it can provide a distance, bi-directional result with single measurement. OTDR also can provide each event measurement in the test portion and shall be used during troubleshooting to identify which event or connection is giving the problem.

OTDR is only a single end measurement. To obtain the accurate measurement, the other end shall be closed properly to avoid entering of the light that might contribute to the false reflection to the measurement.

To obtain the first connector that connected to the Test Patch Cord, a minimum of 10m dummy fibre shall be used between OTDR and the test adaptor. However, to get a better result the longer dummy fibre, i.e 100m length is recommended to be used. At the other end, to obtain the accurate measurement of the last connector, another minimum of 10m length of dummy fibre also need to be used.

The total Attenuation Loss between FTB and FWS for each type of the building shall follow the same value as explained in Table 18.

Before performing any test, Power Meter and Light Source require a reference using the Test Patch Cord to reset the connection.

The sample test setup for OTDR measurement is as shown in Figure 70 below. (to add dummy patch cord at the end).

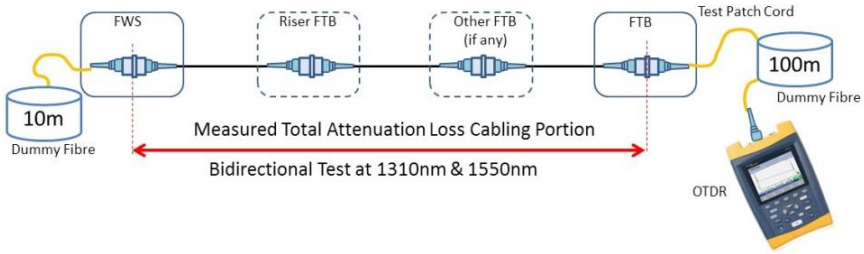


Figure 70. OTDR Testing Method

A high quality of Test Patch Cord shall be used to get the accurate measurement.

13.5 Test Result

Test result shall be provided to NFP during acceptance procedure.

All result presented to NFP shall passed the minimum requirement.

Test result is recommended to be printed in test gear original version with the information of Total Bidirectional IL at 1310nm and 1550nm wavelength. The sample of recommended test result format is as shown in Table 15 below.

Table 15. Sample of recommended test result format

Building Name	Sri Cempaka Condo										
Vertical Cable No.	FV001 / FV002										
FTB Rack / Sub-rack No.	Rack 1 / Subrack 1										
Test Item			Insertion Loss (IL)				Optical Return Loss (ORL) – Optional				
Test Direction			Downstream		Upstream		Downstream		Upstream		
Rise FTB Adaptor No.	Premise Unit No.	Floor No.	1310nm (dB)	1550nm (dB)	1310nm (dB)	1550nm (dB)	1310nm (dB)	1550nm (dB)	1310nm (dB)	1550nm (dB)	Distance (Meter)
No.1	A1-01	1	11	0.9	1.1	0.9	33	33	33	33	100
No.2	A1-02	1	11	0.9	1.1	0.9	34	35	34	35	100
No.3	A1-03	1	1	0.8	1	0.8	36	35	36	35	75
No.4	A1-04	1	0.9	0.8	0.9	0.8	34	34	34	34	75
No.5	A2-01	2	11	0.9	1.1	0.9	34	34	34	34	110
No.6	A2-02	2	11	0.9	1.1	0.9	35	35	35	35	110
No.7	A2-03	2	1	0.8	1	0.8	34	34	34	34	80
No.8	A2-04	2	0.9	0.8	0.9	0.8	34	34	34	34	80
Remarks											
Tester											
Verifies by NFP Representative name											

Table 15. Sample of recommended test result format *(continue)*

Building Name	Sri Cempaka Condo										
Vertical Cable No.	FV003 / FV004										
FTB Rack / Sub-rack No.	Rack 1 / Subrack 2										
Test Item			Insertion Loss (IL)				Optical Return Loss (ORL) – Optional				
Test Direction			Downstream		Upstream		Downstream		Upstream		
Rise FTB Adaptor No.	Premise Unit No.	Floor No.	1310nm (dB)	1550nm (dB)	1310nm (dB)	1550nm (dB)	1310nm (dB)	1550nm (dB)	1310nm (dB)	1550nm (dB)	Distance (Meter)
No.1	A3-01	3	11	0.9	1.1	0.9	33	33	33	33	100
No.2	A3-02	3	11	0.9	1.1	0.9	34	35	34	35	100
No.3	A3-03	3	1	0.8	1	0.8	36	35	36	35	75
No.4	A3-04	3	0.9	0.8	0.9	0.8	34	34	34	34	75
No.5	A4-01	4	11	0.9	1.1	0.9	34	34	34	34	110
No.6	A4-02	4	11	0.9	1.1	0.9	35	35	35	35	110
No.7	A4-03	4	1	0.8	1	0.8	34	34	34	34	80
No.8	A4-04	4	0.9	0.8	0.9	0.8	34	34	34	34	80
Remarks											
Tester											
Verifies by NFP Representative name											

NFP shall perform a random test to ensure the presented test result. Developer is required to re-perform the test again during the acceptance procedure with the witness of NFP representative person.

13.6 Test Gear Calibration

All the Test Gear and related tool shall be calibrated according to manufacturer recommendation and the calibration record shall be presented during acceptance procedure. It is to ensure all test gear and tools are in the best condition to be used for any measurement.

13.7 Certification of the Cabling Material

All the Test Gear and related tool shall be collaborating according to manufacturer specification. All collaboration certificates shall be presented to NFP during acceptance procedure.

All material be used in the cabling shall be type approved by SIRIM and selected NFP. The Type Approve Certificate shall be presented during the acceptance procedure. For any development that fail to present the certification shall rejected by NFP during acceptance procedure and will not recommended to be offered the service.

Generally NFP certification can be applied with validity of 3 years and can be renewable. Sample of type approval certificate is as shown in Annex E.

14 Infrastructure and Cabling Acceptance Procedure

The Developer shall engage a contractor certified by Occupational Safety and Health (OSHE) and Construction Industry Development Board (CIDB) certified contractor for all the telecommunications infrastructure and cabling works for the development areas.

The Developer to ensure all relevant permits are obtained and to be incompliance with all the relevant safety requirements.

14.1 Timeline to provide services

Developer or Premise Owner shall submit or engage with selected NFP for the NFP infrastructure connection 90 days before service installation target date.

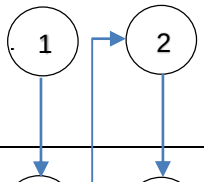
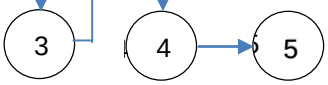
Upon the completion of the infrastructure and the cabling, Premise Owner shall submit the service application form to NFP 14 days before service installation target date.

The Developer to notify appointed NFP with 7 days written notice.

14.2 Service application process flow

The process flow of getting the approval and service from NFP is as shown in Table 16 below.

Table 16. Infrastructure Approval and Service Activation Process

Simple Development : Overall Process for Approval and Deployment		
DEVELOPER		a) Developer to inform selected NFP with Letter of Award (LOA) and submit the following: i. Telecommunication Infrastructure Plan; ii. Type and Quantity of Service; and iii. Proposed service date b) NFP to provide Letter of Confirmation (LOC) to provide the service
NFP		a) Developer to submit documentation according to the checklist in section 14.3, 2 weeks before service activation service date. b) NFP to process order: Set installation and appointment date e) Service Activation

Both parties shall adhere to the agreed acceptance procedure.

The acceptance procedures and processes should be performed and completed on the same day.

The Developer to prepare all the documentations required for all the processes for the acceptance procedure.

The acceptance procedure is to be performed once the development progress is 95% completed.

The NFP shall issue Certification of Acceptance upon completion of acceptance procedure.

The Developer to prepare all the necessary tools and test gear and all the relevant officials/ personnel are required to presence during the acceptance procedure.

14.3 Documentation

Developer or Premise Owner is required submitting all of document as listed below:

a) Acceptance checklist endorsed by consultant or contractor;

b) Internal infrastructure Development Plan – sample as shown in Annex F;

c) External infrastructure Development Plan – sample as shown in Annex G;

d) As Built and Cabling Schematic Line Diagram (SLD) – sample as shown in Annex H;

e) Fibre Core Assignment – Sample as shown in Annex J;

f) Cabling test result – as explained in Clause 13.5;

g) Calibration certificate of test gear; and

h) NFP Type Approve Certificate of each material used.

During the infrastructure acceptance process, NFP will issue the Certificate of Acceptance (COA) if all of the requirement were fulfilled according to the specification.

14.4 Infrastructure Handover

Selected NFP is recommended to have a proper agreement on the handover and maintenance of the infrastructure inside the related development area. Detail agreement shall be mutually agreed between NFP and Developer.

Plan approval by NFP should follow standards specified in this document and *MTSFB 008:2005 - Technical Standards and Infrastructure Requirements (TSIR) Part 1: Fixed Network Infrastructure*.

15. Safety and Precaution

15.1 Configuration of safety device

Safety facility for construction projects must strictly adhere to the NFP guidelines issued by relevant parties in NFP and/or any standard requirements issued by the government.

The use of safety equipment is strongly recommended during the installation and handling of optical fibre cable, for example gloves and safety glasses.

15.2 Other safety elements

Construction environment, safety requirements, safety condition is as following:

a) Effective fire-fighting apparatus and material must be prepared at the job location. Such as, smoke induction and temperature induction and other alarm device, and the performance must be in good condition;

b) Power supply sockets for different voltage in the machine room should have clear identification;

c) Hazardous goods such as inflammables and explosives and pigtails are forbidden in machine room;

d) Reserved holes in the building plate should configure with safe cover; and

e) Add safety device to the project to ensure the safety of construction.

Annex A
(normative)

Normative References

ANSI/ICEA S-104-696, *Standard for Indoor-Outdoor Optical Fibre Cable*

ICEA S-110-717-2003, *Standard for Optical Drop Cable*

IEC 60529 Ed. 2.1, *Degrees of protection provided by enclosures (IP Code)*

IEC 60794-2 (2002-12), *Optical fibre cables - Part 2: Indoor cables - Sectional specification*

IEC 60825-1 Ed 2.0, *Safety of laser products - Part 1: Equipment classification and requirements*

ISO 2081, *Metallic and other inorganic coatings -- Electroplated coatings of zinc with supplementary treatments on iron or steel*

ISO/IEC 11801, *Information technology – Generic cabling for customer premises*

ITU-T G.652D, *Characteristics of a single-mode optical fibre cable*

ITU-T G.657, *Characteristics of a bending-loss insensitive single-mode optical fibre and cable for the access network*

MDeC, Revision 2010, *Guideline of Telecommunication Infrastructure and Facilities Provisioning for Building in MSC*

MTSFB 008:2005 (Rev. 1), *Technical Standards and Infrastructure Requirements (TSIR): Fixed Network Infrastructure*

REG- T007, *Regulatory Framework for Telecommunications Network Boundaries*

SKMM/G/04/05, *Guidelines on Implementation of Access to Network*

SKMM/G/01/09, *The Provision of Basic Civil Works for Communications Infrastructure in New Development Area, February 2008*

TIA/EIA 455-53A, *FOTP-53 attenuation by substitution measurement for multimode graded-index optical fibers or fiber assemblies used in long length communications systems revision*

TIA/EIA 455-61, *Measurement of Fibre Cable Attenuation Using an OTDR*

TIA/TSB 140, *Additional Guidelines for Field Test Length, Loss and Polarity of Optical Fibres*

TIA-568B, *Commercial Building Telecommunications Cabling Standard*

TIA-598, *Optical Fibre Cable Colour Coding*

Annex B
(normative)

Fibre Termination Box (FTB) Specifications

B1. The termination box shall be suitable for attachment to inside or outside wall of a building.

B2. The material shall be able to protect the component against harsh, high heat and humidity environment. The Termination Box shall be designed and conforms to IP44 of IEC 60529 Ed. 2.1 standards or better for indoor application and IP55 of IEC 60529 Ed. 2.1 standards or better for outdoor application.

B3. Evidence (such as certificate, letter of conformance, etc) from SIRIM or authorized body shall be provided during approval process.

B4. The termination box shall be suitable for 19" rack-mount and/or wall mounted. The offered termination box shall be complete with its respective mounting kits.

B5. The framework of the high density and medium density fibre termination box shall be fabricated from electro-galvanised steel or rust proof steel plating of thickness not less than 2mm and the design shall conforms to ISO 2081 or other recognized standards.

B6. The framework of the premise fibre termination box and fibre socket shall be plastic injection moulded or thermoplastic and made of fire retardant material. All the plastic material shall have a rating of V-1 or better as determined by Underwriters Laboratories' UL94 standards.

B7. The fibre termination box shall be design with built-in splitter or without splitter.

B8. All edges shall be rounded.

B9. Total weight of the fibre termination box including full accessories shall be suitable for wall mounting.

B10. Maximum overall dimension shall be 16" (H) x 18" (W) x 6" (D) [406mm (H) x 457mm (W) x 15mm (D)] for high density termination box.

B11. Maximum overall dimension shall be 8" (H) x 5" (W) x 1.5" (D) [203mm (H) x 127mm (W) x 38mm (D)] for customer premise termination box.

B12. The Developer shall propose separate sizes and capacity to provide cable management and connection for high, medium, low and individual premise fibre installation including fibre socket.

B13. The Developer shall furnish details specification and characteristic of the various sizes of the fibre termination box and fibre socket offered during the submission of proposal for evaluation.

B14. The Developer shall submit proposed technical drawings complete with dimensions for the product offered.

B15. The fibre termination box shall consist of moulded inner fibre slack storage, sleeve holder and integral positive lock strain relief for cable and other accessories deem necessary.

B16. The fibre termination box design shall have suitable splice tray and cable management area to provide for minimum bending radius and for storage ruggedized splitter pigtails.

B17. Suitable number of splice organizes trays or splice trays shall be provided in the splice compartment. The splice tray shall be of cartridge or cassette types that are stackable and flappable or able to be opened sideways.

B18. The number of trays and other appropriate accessories provided shall suit the maximum number of cores of the fibres intended to be installed. The splice tray shall comply with GR-771.

B19. The fibre termination box shall have pre-assembled plates with SC coupling for fibre patching.

B20. It shall be designed with two (2) physically separated compartments to isolate the incoming cable (capable of accommodating splitter where needed) from the Drop Fibre compartment.

B21. The door opening shall be designed for suitable operation in confined space.

B22. The fibre termination box shall be provided with various sizes of cable entries at both top and bottom. All cable entries shall be provided with rubber grommets to protect the cable and prevent pest and dirt entry.

B23. The rubber grommets shall have suitable guides for different cable sizes to permits pass through of additional fibres.

B24. The fibre termination box design shall be economical, effective, robust and compact to provide access point for Drop Fibre and Internal Fibre.

B25. Each fibre termination box shall be provided with a table or label card for circuit identification purpose. The table shall be printed on durable material in such a manner as to be permanently legible, protected by an acrylic pocket and properly displayed on the inside cover of the termination box.

B26. Approved laser caution signs as per IEC 60825-1 Ed 2.0 requirements shall be provided as standard for every termination box.

B27. The termination offered and its associated hardware shall be commercially available (in current production) and already been commercially deployed. Any prototype and unproven System shall be disqualified. Developer to submit evidence to prove the systems are field proven and in current production.

B28. An inventory list containing lists of components or parts supplied and operation and installation manual shall be provided with each termination box.

Annex C
(normative)

Specification for Indoor Fibre Cable

C1. Indoor Fibre Cable shall be single-mode indoor cable reinforced with FRP for indoor applications.

C2. Fibre Characteristic:

a) The fibre characteristic shall be in accordance with the Recommendation of ITU-T G.657A (Bend Insensitive Fibre ≤ 15 mm bending radius).

c) Macro Bending Loss performance at 1550 nm and 1625 nm regions shall be in accordance with ITU-T Recommendation G.657 class A (12/2006) Clause 7.

d) In order to ensure low loss operation at 1550 nm and 1625 nm regions, the increase in loss for 10 turns of the loosely wound fibre using a mandrel with 15 mm radius should be 0.5 dB.

e) Maximum loss at 1550 nm shall be 0.25 dB and at 1625 nm shall be 1.0 dB

C3. Proof stress shall not be less than 0.69 GPa.

C4. Chromatic Dispersion Coefficient:

a) Zero Dispersion Slope shall be less than and equal to 0.092 ps/nm2km; and

b) Zero Dispersion Wavelength shall range from 1300 nm to 1324 nm.

C5. The attenuation coefficient of the Fibre shall be as follows:

a) Maximum 0.35 dB/km – from 1310 nm to 1625 nm regions;

b) Maximum 0.4 dB/km in the 1383 nm ±3 nm region; and

c) Maximum 0.3 dB/km in the 1550 nm region.

C6. PMD Coefficient – PMD link design value shall be maximum of 0.2ps/√km in accordance with ITU-T Recommendation G.657 class A (12/2006) Clause 7.

C7. Optical fibre shall be placed in between two strength members. The construction of the indoor Drop Fibre shall be 1Fibre or 2Fibre cores.

C8. The colour coding shall be as following table:

Number	Fibre
1	Blue
2	Yellow

C9. The cable shall contain FRP material as cable strength member. Nominal diameter for FRP shall be 0.4 mm

C10. The Indoor Drop Fibres nominal outer diameter shall be 3.1mm x 2.0mm.

C11. The Indoor Drop Fibres shall be sheathed with polyethylene and flame retardant characteristic. Performance on oxygen index of sheath shall be ≥ 27.

C12. The Sheath

a) The sheath shall be ivory colour and shall not promote the growth of fungus;

b) The sheath around the cable and bearer wire shall be free from pinholes, joints, mended places and other defects and able to provide adequate mechanical protection against impact and crushing;

c) The sheath shall be marked with the manufacturer's name, sequential meter, month and year of manufacturer, fibre count and fibre type;

d) The marking shall be in contrasting colour to the cable sheath. The preferred marking colour will be white;

e) The general cable performance test of the offered Indoor Drop Fibre shall be in accordance with ANSI/ICEA S-104-696 or equivalent to other international standards. It shall be verified through suitable test; and

f) Tensile Strength – The tensile strength of the indoor cable shall be in excess of 80 N. At this load, no residual fibre elongation and the increase in attenuation shall be less than 0.05dB/km.

C13. Bend Test

a) The cable shall be unwound and ten (10) turns shall be wrapped in a close helix around a mandrel of radius 15 mm;

b) The turns shall be applied at a uniform rate of one revolution in about 5 seconds and with sufficient tension to ensure that the specimen contours the mandrel; and

c) The turns shall be then unwound and the cycle repeated 3 times. Finally measurement shall show no change to the optical characteristics of the cable.

Annex D
(normative)

Specification for Blown Fibre - Alternative Indoor Fibre Cabling System

D1. Indoor Fibre cable shall be Single-mode Indoor Fibre using Blown Fibre Distribution System for indoor applications.

D2. **Fibre Characteristic**

The Fibre characteristic shall be in accordance with the Recommendation of ITU-T G.657A (Bend Insensitive Fibre ≤ 15 mm bending radius).

D3. Macro Bending Loss:

a) The loss performance at 1550 nm and 1625 nm regions shall be in accordance with ITU-T Recommendation G.657 class A (12/2006) Clause 7;

b) In order to ensure low loss operation at 1550 nm and 1625 nm regions, the increase in loss for 10 turns of the loosely wound fibre using a mandrel with 15 mm radius should be 0.5 dB; and

c) Maximum loss at 1550 nm shall be 0.25 dB and at 1625 nm shall be 1.0Db.

D4. Proof stress shall not be less than 0.69 GPa.

D5. Chromatic Dispersion Coefficient:

a) Zero Dispersion Slope shall be less than and equal to 0.092 ps/nm^2.km; and

b) Zero Dispersion Wavelength shall range from 1300 nm to 1324 nm.

D6. The attenuation coefficient of the fibre shall be as follows:

a) Maximum 0.4 dB/km – from 1310 nm to 1625 nm regions;

b) Maximum 0.4 dB/km in the 1383 nm ±3 nm region; and

c) Maximum 0.3 dB/km in the 1550 nm region.

D7. PMD Coefficient – PMD link design value shall be maximum of 0.2 ps/√km in accordance with ITU-T Recommendation G.657 class A (12/2006) Clause 7.

D8. Optical fibre shall be placed within fibre microducts having properties such as:

a) Low Flammability;

b) Low Smoke;

c) Low Acid/Fume; and

d) Low Halogen.

D9. The construction of the indoor fibre shall be 1Fibre or 2Fibre cores

D10. The colour coding shall be as following table:

Number	Fibre
1	Blue
2	Yellow

D11 **Microduct**

a) The microducts shall be numbered;

b) The microduct nominal outer diameter shall be 5 mm;

c) The microduct shall be constructed with polyethylene and flame retardant characteristic. Performance on oxygen index of sheath shall be ≥ 27;

d) The microduct shall be ivory colour and shall not promote the growth of fungus;

e) The microduct around the cable shall be free from pinholes, joints, mended places and other defects and able to provide adequate mechanical protection against impact and crushing;

f) The microduct shall be marked with the manufacturer's name, sequential meter, month and year of manufacturer, fibre count and fibre type;

g) The marking shall be in contrasting colour to the microduct. The preferred marking colour will be white;

h) The general cable performance test of the offered Indoor Drop Fibre shall be in accordance with ANSI/ICEA S-104-696 or equivalent to other international standards. It shall be verified through suitable test; and

i) Tensile Strength – The tensile strength of the microduct shall be in excess of 70 N.

D12. **Bend Test**

a) The fibre shall be unwound and ten (10) turns shall be wrapped in a close helix around a mandrel of radius 15 mm;

b) The turns shall be applied at a uniform rate of one revolution in about 5 seconds and with sufficient tension to ensure that the specimen contours the mandrel;

c) The turns shall be then unwound and the cycle repeated 3 times; and

d) Finally measurement shall show no change to the optical characteristics of the cable.

Annex E
(normative)

Sample of NFP Type Approval Certificate

Serial No : xxxxxxxxxx

COMPANY LOGO

TYPE APPROVAL CERTIFICATE FOR OUTSIDE PLANT ITEM
Sijil Kelulusan Jenis Outside Plant Item

COMPANY NAME
Nama Syarikat

ADDRESS
Alamat

APPROVAL NO
No Kelulusan

PREVIOUS APPROVAL
Rujukan Terdahulu

BRAND
Jenis

MODEL
Model

MANUFACTURER
Pengeluar / Pengusaha kilang

APPROVAL DATE
Tarikh Kelulusan

EXPIRY DATE
Tarikh Luput

ASST. GENERAL MANAGER **GENERAL MANAGER**

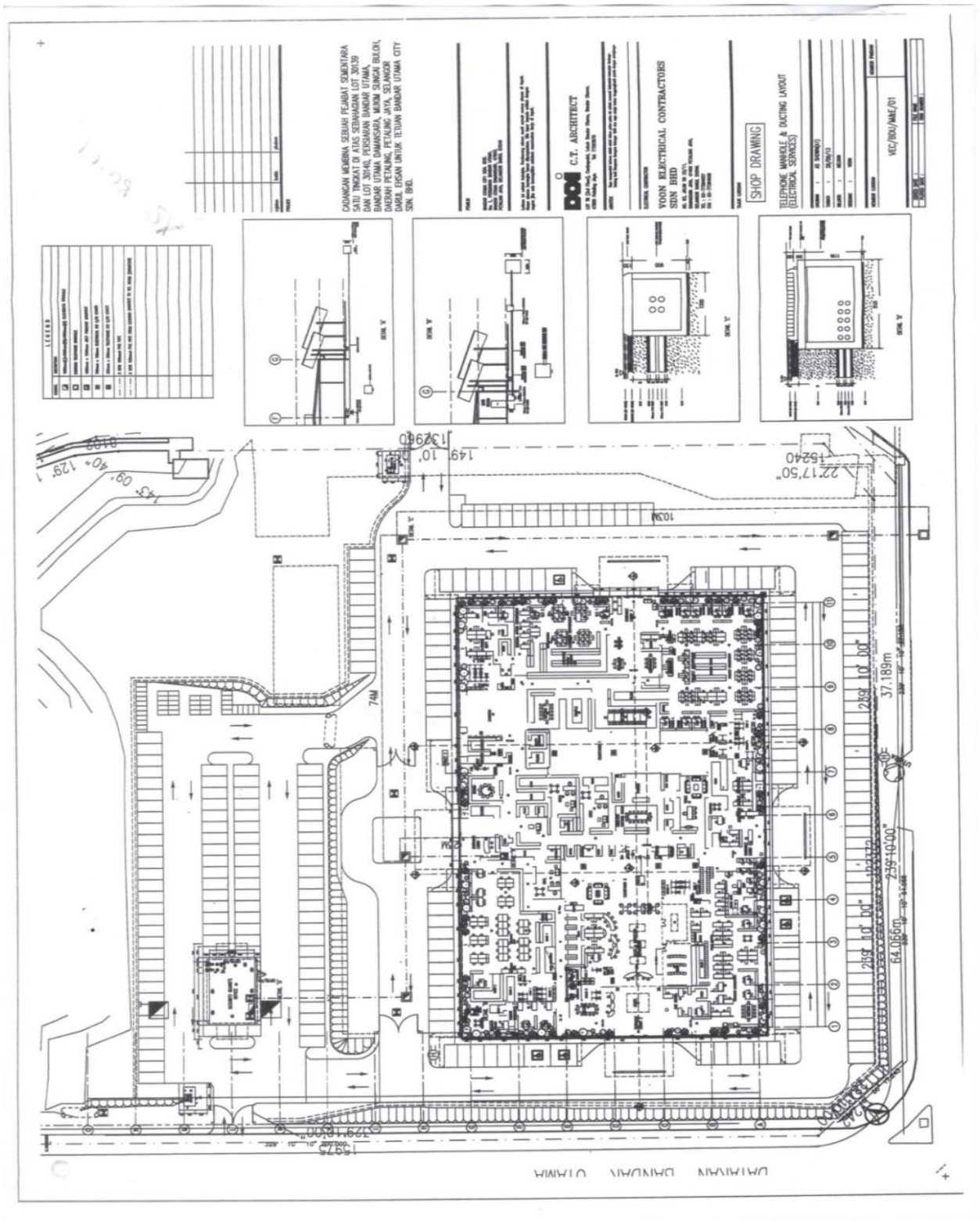
Annex F
(normative)

Sample of Internal Infrastructure Development Plan: Floor Plan

LEVEL 6 FLOOR PLAN

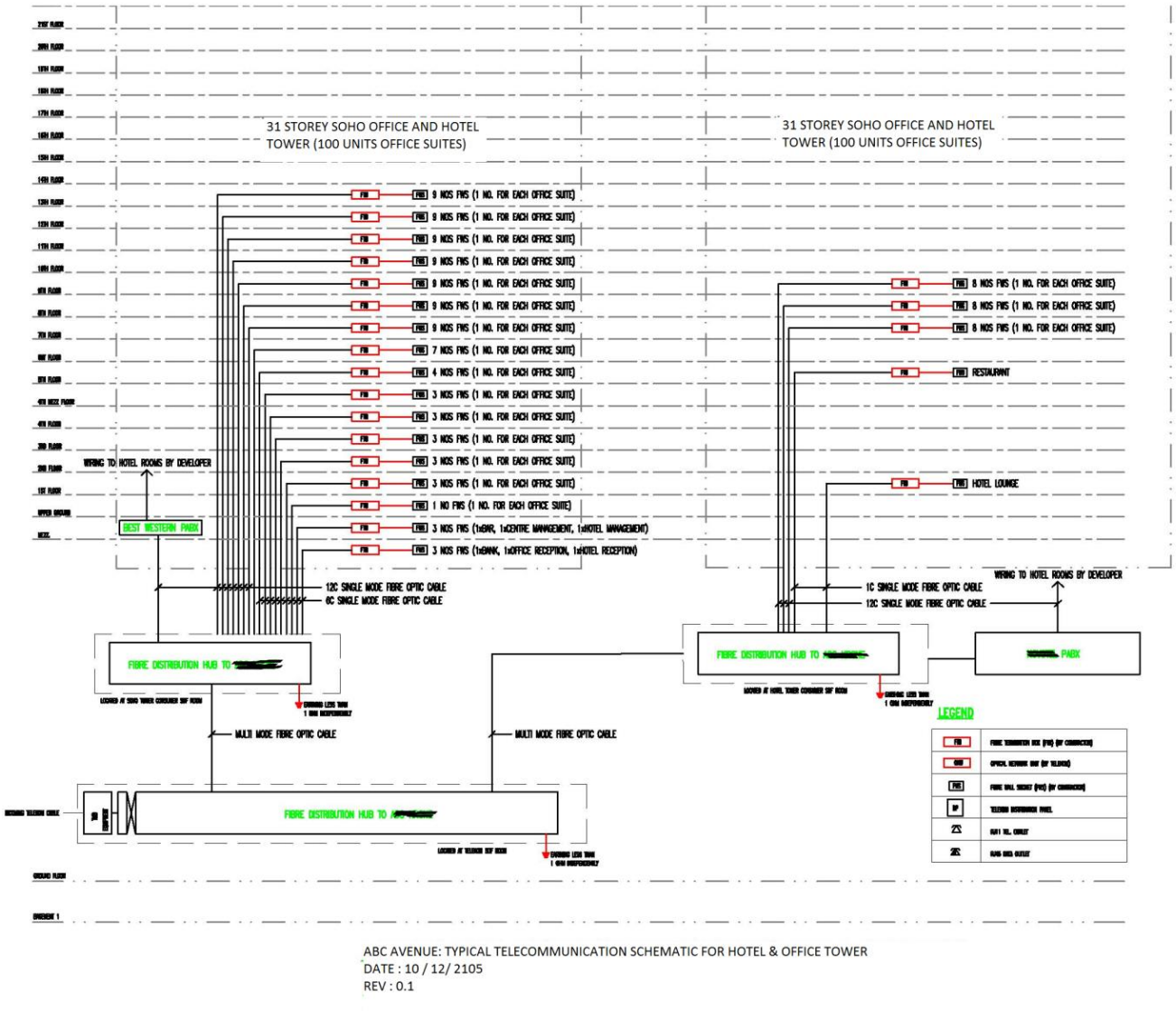
Annex G
(normative)

Sample of External Infrastructure Development Plan



Annex H
(normative)

As Built and Cabling Schematic Line Diagram (SLD)



ABC AVENUE: TYPICAL TELECOMMUNICATION SCHEMATIC FOR HOTEL & OFFICE TOWER
DATE : 10 / 12/ 2105
REV : 0.1

Annex J
(normative)

Sample of Fibre Core Assignment

Core Assignment

FTB No.	1
FTB Subrack.	1

FTB Port	Vertical Cable			FTB Port	Vertical Cable			FTB Port	Vertical Cable			FTB Port	Vertical Cable		
	Cable #	Core #	Unit #		Cable #	Core #	Unit #		Cable #	Core #	Unit #		Cable #	Core #	Unit #
1	FV001	1	101	13	FV001	13	201	25	FV001	25	301	37	FV001	37	Spare
2	FV001	2	101	14	FV001	14	201	26	FV001	26	301	38	FV001	38	Spare
3	FV001	3	102	15	FV001	15	202	27	FV001	27	302	39	FV001	39	Spare
4	FV001	4	102	16	FV001	16	202	28	FV001	28	302	40	FV001	40	Spare
5	FV001	5	103	17	FV001	17	203	29	FV001	29	303	41	FV001	41	Spare
6	FV001	6	103	18	FV001	18	203	30	FV001	30	303	42	FV001	42	Spare
7	FV001	7	104	19	FV001	19	204	31	FV001	31	304	43	FV001	43	Spare
8	FV001	8	104	20	FV001	20	204	32	FV001	32	304	44	FV001	44	Spare
9	FV001	9	105	21	FV001	21	205	33	FV001	33	305	45	FV001	45	Spare
10	FV001	10	105	22	FV001	22	205	34	FV001	34	305	46	FV001	46	Spare
11	FV001	11	106	23	FV001	23	206	35	FV001	35	306	47	FV001	47	Spare
12	FV001	12	106	24	FV001	24	206	36	FV001	36	306	48	FV001	48	Spare

FTB No.	1
FTB Subrack.	2

FTB Port	Vertical Cable			FTB Port	Vertical Cable			FTB Port	Vertical Cable			FTB Port	Vertical Cable		
	Cable #	Core #	Unit #		Cable #	Core #	Unit #		Cable #	Core #	Unit #		Cable #	Core #	Unit #
1	FV002	1	401	13	FV002	13	501	25	FV002	25	601	37	FV002	37	Spare
2	FV002	2	401	14	FV002	14	501	26	FV002	26	601	38	FV002	38	Spare
3	FV002	3	402	15	FV002	15	502	27	FV002	27	602	39	FV002	39	Spare
4	FV002	4	402	16	FV002	16	502	28	FV002	28	602	40	FV002	40	Spare
5	FV002	5	403	17	FV002	17	503	29	FV002	29	603	41	FV002	41	Spare
6	FV002	6	403	18	FV002	18	503	30	FV002	30	603	42	FV002	42	Spare
7	FV002	7	404	19	FV002	19	504	31	FV002	31	604	43	FV002	43	Spare
8	FV002	8	404	20	FV002	20	504	32	FV002	32	604	44	FV002	44	Spare
9	FV002	9	405	21	FV002	21	505	33	FV002	33	605	45	FV002	45	Spare
10	FV002	10	405	22	FV002	22	505	34	FV002	34	605	46	FV002	46	Spare
11	FV002	11	406	23	FV002	23	506	35	FV002	35	606	47	FV002	47	Spare
12	FV002	12	406	24	FV002	24	506	36	FV002	36	606	48	FV002	48	Spare

FTB No.	1
FTB Subrack.	3

FTB Port	Vertical Cable			FTB Port	Vertical Cable			FTB Port	Vertical Cable			FTB Port	Vertical Cable		
	Cable #	Core #	Unit #		Cable #	Core #	Unit #		Cable #	Core #	Unit #		Cable #	Core #	Unit #
1	FV003	1	701	13	FV003	13	801	25	FV003	25	901	37	FV003	37	Spare
2	FV003	2	701	14	FV003	14	801	26	FV003	26	901	38	FV003	38	Spare
3	FV003	3	702	15	FV003	15	802	27	FV003	27	902	39	FV003	39	Spare
4	FV003	4	702	16	FV003	16	802	28	FV003	28	902	40	FV003	40	Spare
5	FV003	5	703	17	FV003	17	803	29	FV003	29	903	41	FV003	41	Spare
6	FV003	6	703	18	FV003	18	803	30	FV003	30	903	42	FV003	42	Spare
7	FV003	7	704	19	FV003	19	804	31	FV003	31	904	43	FV003	43	Spare
8	FV003	8	704	20	FV003	20	804	32	FV003	32	904	44	FV003	44	Spare
9	FV003	9	705	21	FV003	21	805	33	FV003	33	905	45	FV003	45	Spare
10	FV003	10	705	22	FV003	22	805	34	FV003	34	905	46	FV003	46	Spare
11	FV003	11	706	23	FV003	23	806	35	FV003	35	906	47	FV003	47	Spare
12	FV003	12	706	24	FV003	24	806	36	FV003	36	906	48	FV003	48	Spare

FTB No.	1
FTB Subrack.	4

FTB Port	Vertical Cable			FTB Port	Vertical Cable			FTB Port	Vertical Cable			FTB Port	Vertical Cable		
	Cable #	Core #	Unit #		Cable #	Core #	Unit #		Cable #	Core #	Unit #		Cable #	Core #	Unit #
1	FV004	1	1001	13	FV004	13	1101	25	FV004	25	1201	37	FV004	37	Spare
2	FV004	2	1001	14	FV004	14	1101	26	FV004	26	1201	38	FV004	38	Spare
3	FV004	3	1002	15	FV004	15	1102	27	FV004	27	1202	39	FV004	39	Spare
4	FV004	4	1002	16	FV004	16	1102	28	FV004	28	1202	40	FV004	40	Spare
5	FV004	5	1003	17	FV004	17	1103	29	FV004	29	1203	41	FV004	41	Spare
6	FV004	6	1003	18	FV004	18	1103	30	FV004	30	1203	42	FV004	42	Spare
7	FV004	7	1004	19	FV004	19	1104	31	FV004	31	1204	43	FV004	43	Spare
8	FV004	8	1004	20	FV004	20	1104	32	FV004	32	1204	44	FV004	44	Spare
9	FV004	9	1005	21	FV004	21	1105	33	FV004	33	1205	45	FV004	45	Spare
10	FV004	10	1005	22	FV004	22	1105	34	FV004	34	1205	46	FV004	46	Spare
11	FV004	11	1006	23	FV004	23	1106	35	FV004	35	1206	47	FV004	47	Spare
12	FV004	12	1006	24	FV004	24	1106	36	FV004	36	1206	48	FV004	48	Spare

Acknowledgements

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