TECHNICAL CODE

FIXED NETWORK FACILITIES - IN-BUILDING AND EXTERNAL (FIRST REVISION)

Developed by

Malaysian Technical Standards Forum Bhd

Registered by

MCMC

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MCMC MTSFB TC G024:2024

Development of technical codes

The Communications and Multimedia Act 1998 (Laws of Malaysia Act 588) ('the Act') provides for a 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 requirements for network interoperability and the promotion of safety of network facilities.

Section 96 of the Act also provides for the Commission to determine a technical code in accordance with Section 55 of the Act if the technical code is not developed under an applicable provision of the Act and it is unlikely to be developed by the Technical Standards Forum within a reasonable time.

In exercise of the power conferred by Section 184 of the Act, the Commission has designated the Malaysian Technical Standards Forum Bhd ('MTSFB') as a Technical Standards Forum which is obligated, among others, to prepare the technical code under Section 185 of the Act.

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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Digi Telecommunications Sdn Bhd

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Malaysia Digital Economy Corporation Sdn Bhd

Maxis Broadband Sdn Bhd

Measat Broadcast Network System Sdn Bhd

MYTV Broadcasting Sdn Bhd

TM Technology Services Sdn Bhd

TIME dotCom Berhad

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Foreword

This technical code for the Fixed Network Facilities - In-building and External ('this Technical Code') was developed pursuant to Section 185 of the Communications and Multimedia Act 1998 (Laws of Malaysia Act 588) by the Fixed Network Facilities Sub Working Group under the Network and Broadcast Infrastructure and Facilities Working Group of the Malaysian Technical Standards Forum Bhd (MTSFB).

Major modification in this revision is the inclusion of requirements for landed strata development in related clauses.

This Technical Code replaces the MCMC MTSFB TC G024:2020, *Fixed Network Facilities - In-building and External*. The latter shall be deemed to be invalid to the extent of any conflict with this Technical Code.

This Technical Code shall continue to be valid and effective from the date of its registration until it is replaced or revoked.

FIXED NETWORK FACILITIES - IN-BUILDING AND EXTERNAL

0. Introduction

Fixed Network Facilities means the fixed infrastructure and optical network elements required to provide telecommunication services comprising voice, broadband and/or any interactive service networks based on Internet Protocols (IP) such as Internet Protocol Television (IPTV), Voice over Internet Protocol (VoIP) etc.

A fixed network may be provisioned through Point-To-Point or Point-To-Multipoint network by Network Facilities Provider.

This Technical Code is intended as a reference for architects, consulting engineers, property owners, developers and others who are responsible for planning and erecting buildings. This is in line with the objective to meet the requirements of end users for fixed telecommunications services with minimum disruptions to all services offered by the service providers.

1. Scope

This Technical Code specifies the requirements for in-building and external fixed network facilities for Single Dwelling Unit (SDU), Multi-Dwelling Unit (MDU) and campus and complex type.

Fixed network facilities include all infrastructure and cablings required for fixed network services for new development (greenfield).

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.

Refer Annex A.

3. Abbreviation

For the purposes of this Technical Code, the abbreviations in Annex B apply.

4. Terms and definitions

For the purposes of this Technical Code, the following terms and definitions apply.

4.1 Access seeker

A network facility provides, a network service provider, an applications service provider, or a content applications service provider who is a licensee as defined in the Communication and Multimedia Act 1998 (Act 588) and who makes a written request for access to facilities or services, listed in the Commission Determination on Access List, Determination No. 1 of 2005.

4.2 Broadband

High-speed internet access where data, e-mail, videos, music and other applications can be downloaded at speeds significantly faster than those available through dial-up modems.

4.3 Campus and complex development

A combination of SDU and/or MDU property located within the same compound with single or multiple Telecommunication Room (TR). Examples of campus and complex development property type includes (but not limited to) the following:

a) School.

b) University.

c) Hospital.

d) Public transportation facilities (e.g., bus station and airport).

e) Shopping complex.

4.4 Common infrastructure

The infrastructure except individual parcels inclusive of the external and internal telecommunication infrastructure outside of the individual units.

4.5 Concrete kicking block

A pole accessory to prevent the pole from slanting on sandy or soft soil environment, and it is designed for outdoor use in area with high humidity and heavy rainfall. The kicking block is designed to tie to pole by using a U-bolt and nuts.

4.6 Developer

In relation to a development area, means any person or body of persons, by whatever name described, who develops any land for the purpose of residential, commercial or industrial use, or a combination of such uses.

In relation to a subdivided building or land, includes the original proprietor of the lot before the subdivision and includes the executors, administrators and successors-in-title and permitted assigns of such person or body of persons, and in a case where the person or body of persons is under liquidation, includes such person or body appointed by a court of competent jurisdiction to be the provisional liquidator or liquidator.

4.7 Fibre Optic Cable (FOC)

A high-speed data transmission medium. Fibre is a future proof technology which has the ability to accommodate any new technologies and applications that require higher bandwidth with much lower maintenance and operational cost than any legacy technologies.

4.8 Fibre-To-The Premises (FTTP)

A generic term of providing fixed network services via Fibre Optic Cable (FOC) from Network Facilities Provider (NFP) Central Office (CO) direct to end user premises. Fibre-To-The Premises (FTTP) is an enhancement of legacy technologies such as using a metal cable network via Public Switched Telephone Network (PSTN) or Digital Subscriber Line (DSL) technology.

4.9 Housing scheme

A group of houses and other buildings built together as a single development. A housing scheme is usually built by a developer and may consist of residential and/or business, SDU and MDU type of properties.

4.10 Internet Protocol Television (IPTV)

A protocol which delivers the contents using the internet 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.

4.11 Joint Management Body (JMB)

The body established under Section 17, Strata Management Act 2013 (Act 757) is an interim or temporary body established to manage and maintain strata properties from the beginning of development until the ownership status of this strata is issued by the land office.

4.12 Landed strata development

A strata title is a form of ownership, usually meant for MDU, and horizontal subdivisions with shared areas and facilities. A strata scheme is thus defined as a property development that divides buildings or land into parcels and common property under a management system.

A landed strata property is basically a landed house or SDU, but with MDU-style facilities such as a swimming pool and gym. These developments may consist of bungalows, semi-detached or terrace houses, ranging from single storey to 3-storeys in height.

The strata rules only apply to infrastructure except individual parcels inclusive of the external and internal telecommunication infrastructure outside of the individual units.

Landed strata property with strata titles fall under the protection and governance of the Strata Management Act 2013 (Act 757) and the Strata Titles Act 1985 (Act 318).

4.13 Management Corporation (MC)

The management corporation which has come into existence upon the opening of a book of the strata register in respect of subdivided building or land under subsection 17(3) of Strata Titles Act 1985 is a corporate body having perpetual succession and a common seal. The Management Corporation (MC) consists of all the strata unit owners.

4.14 Multi Dwelling Unit (MDU)

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

a) High rise residential (e.g., condominium and apartment).

b) Office building.

c) Commercial building.

An MDU is a strata-titled building and shall adhere to all the strata requirements as stated in this Technical Code.

4.15 Network Facilities Provider (NFP)

The owners or providers of network facilities licensed under the Communication and Multimedia Act 1998 (Act 588).

4.16 Network Services Provider (NSP)

An entity who provides network services licensed under the Communication and Multimedia Act 1998 (Act 588).

4.17 Point-to-Multipoint Fibre (P2MP) FTTP network

A fibre network technology known as Passive Optical Network (PON) with a single FOC core from CO. It can be split into a few single FOC core to serve multiple users as shown in Figure 1.

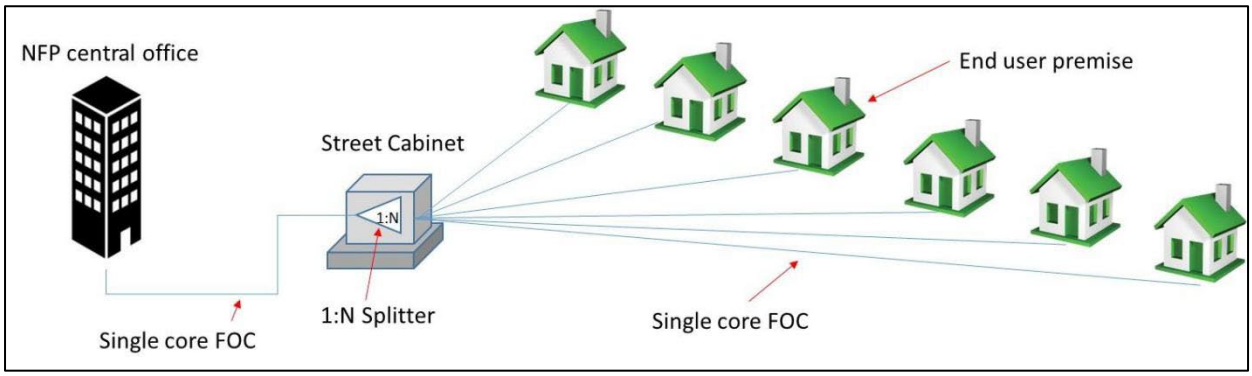

Figure 1. Point-to-Multipoint Fibre (P2MP) network design

4.18 Point-to-Point (P2P) FTTP network

A fibre network technology designed with a dedicated FOC core between CO and end users as shown in Figure 2.

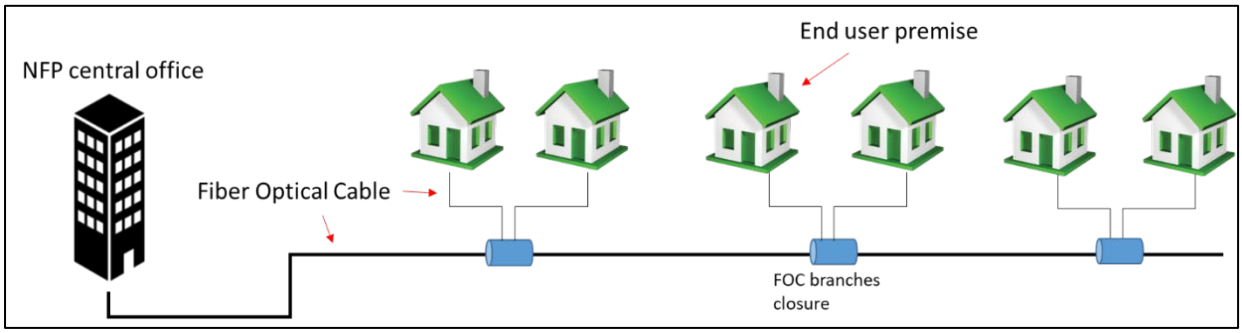

Figure 2. P2P fibre network design

4.19 Private Property Line (PPL)

A legal property development boundary as specified in land title. This boundary shall determine the separation between public or other personal and private areas.

4.20 Property owner

Any person or body for the time being registered as the proprietor of any alienated land.

For strata scheme, the property owner is defined as specified in the Strata Management Act 2013 (Act 757) and Strata Titles Act 1985 (Act 318).

Property owner is responsible to maintain the infrastructure provided within Private Property Line (PPL) is in good condition. It may include the developer, an individual owner, a Joint Management Body (JMB), MC, Subsidiary Management Corporation (Sub-MC) or parcel owner.

4.21 Subsidiary Management Corporation (Sub-MC)

A Sub-MC is in relation to limited common property means the subsidiary management corporation created under Section 17A, Strata Titles Act 1985 (Act 318).

4.22 Parcel owner

The purchaser or the developer in respect of those parcels in the strata development area which have not been sold by the developer.

4.23 Simple development properties

The commercial or public amenities property with less than 2 acres of land size and the building built-up is not more than 1 acre (1 acre is 4 046.9 m²). Distance of the developer's premises access manhole or pole from NFP's infrastructure is within 150 m. Subscribed service is limited to 10 telephone lines and/or 1 broadband only. Example of the properties are as listed as follows:

a) Warehouse.

b) Factory.

c) Petrol station.

d) Restaurant.

e) Showroom.

f) Community hall.

g) Worship house.

h) Guard house.

4.24 Single Dwelling Unit (SDU)

A landed property or building with less than 6 storeys which is generally not equipped with TR. Example of SDU are as follows:

a) Terrace houses.

b) Bungalows.

c) Shop lots.

4.25 Telecommunication Room (TR)

A dedicated room with a security lock to secure all fixed network equipment and cables.

4.26 Voice service

Communication of sound over a distance using wire or wireless telephones. Voice service may be offered via analogue signal or VoIP.

5. Infrastructure requirements

5.1 Building type

There are several categories of buildings that can be categorised as shown in Table 1.

Table 1. Categories of building

Type	SDU	MDU	Campus and complex
Residential	Bungalow	Condominium or apartment	Combination of SDU and MDU (e.g., university, hospital, complex, school), Public transport facilities (e.g., airport, bus station, railway station, jetty), shopping complex or amusement park
	Semi-detached		
	Terrace single or double or triple storey		
	Town house		
Commercial or industrial	Office building or shop house less than 6 floors	Office building or shop house equal or more than 6 floors	
	Industrial or commercial lot	N/A	
	Simple development	N/A	

5.2 Fixed network services

The minimum services, also known as essential communications services, that a fixed network facility shall support are voice and broadband.

Typical connection between NFP network and customer premises is as shown in Figure 3.

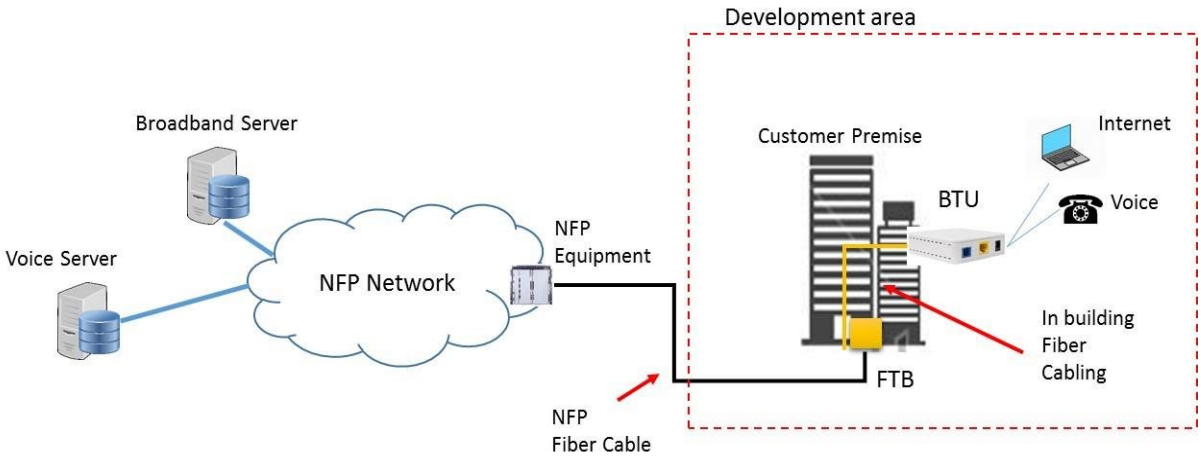

Figure 3. Typical network connection between NFP network and customer premises

5.3 Infrastructure demarcation

The PPL serves as the boundary demarcation point for infrastructure between the developer, property owner, and NFP. The developer is responsible for providing the infrastructure within the PPL. Once provided, ownership and responsibility for this infrastructure will be transferred to the property owner

The developer is also recommended to prepare the link-up access infrastructure to ensure smooth service provision. However, the best option for this can be discussed with the NFP through a commercial arrangement.

The demarcation and responsibilities of the developer, property owner, and NFP can be divided into the following two phases:

a) Phase 1: Development.

b) Phase 2: Post development.

5.3.1 Phase 1: Development

The developer is required to provide the infrastructure within the PPL for the SDU during the development phase, as illustrated in Figure 4. It is the developer's responsibility to ensure that all necessary infrastructure and facilities needed to support fixed network services are provided.

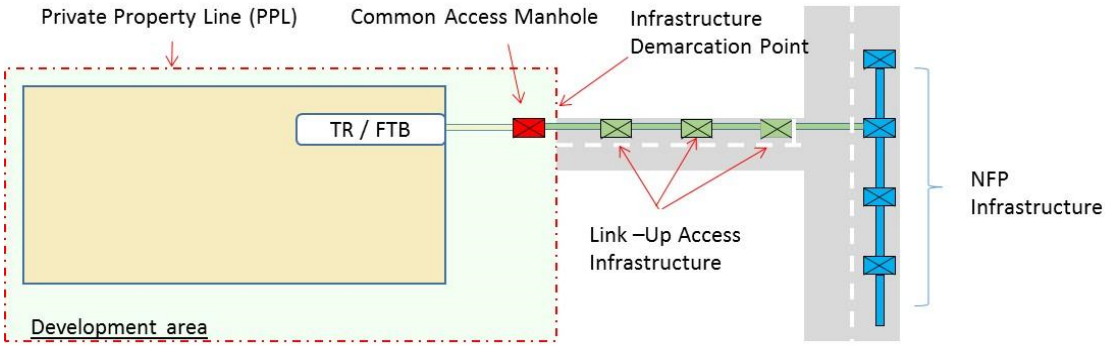

Figure 4. SDU infrastructure demarcation point

Upon completion of the development phase, the ownership of the infrastructure within the PPL shall be transferred to the JMB, MC, parcel, premises owner or any relevant parties with a formal handover agreement. Details of the agreement shall be mutually agreed between the responsible and developer.

The developer shall provide the infrastructure within the PPL for MDU and landed strata development during the development phase. The MDU infrastructure demarcation point is illustrated in Figure 5.

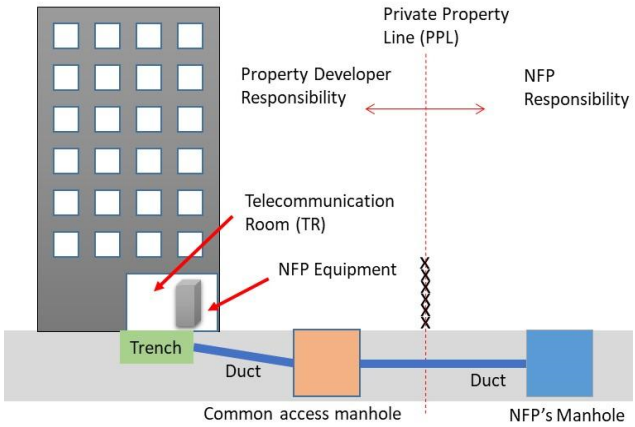

Figure 5. MDU infrastructure demarcation point

The developer shall provide the infrastructure within the PPL for housing schemes, campuses, and complex types during the development phase, as illustrated in Figure 6.

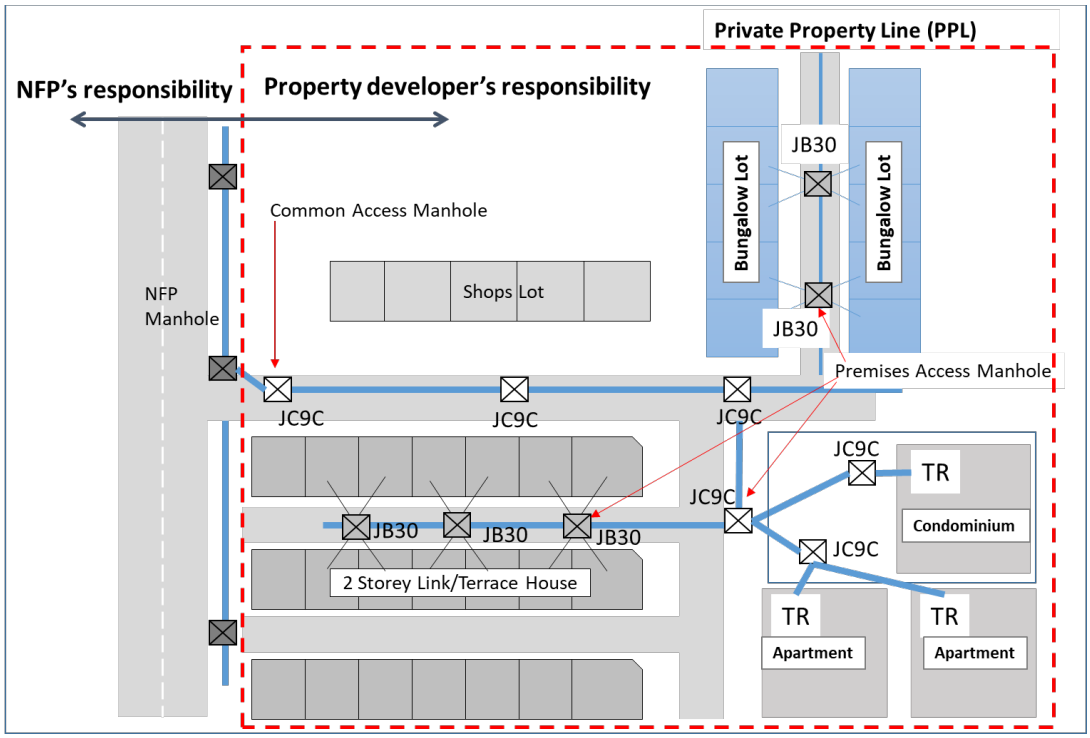

Figure 6. Housing scheme, campus and complex type infrastructure demarcation

The developer shall provide the infrastructure inside the PPL of strata development during the development phase, as illustrated in Figure 7.

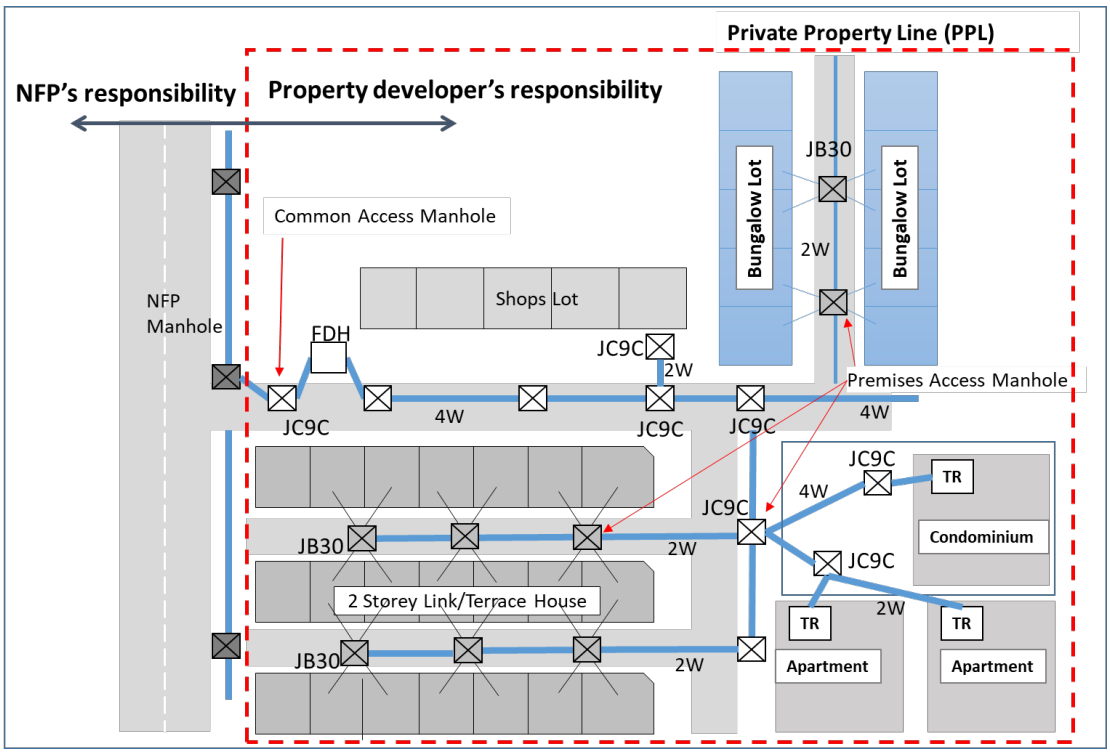

Figure 7. Strata development area infrastructure demarcation

5.3.2 Phase 2: Post development

Upon completion of the development phase, the ownership of the infrastructure within the PPL shall be transferred to the JMB, MC, parcel, premises owner or any relevant parties.

In the event the infrastructure is transferred to NFP, the selected NFP shall ensure the infrastructure is always in good condition to ensure a smooth service provision to the end-users. Other parties who wish to utilise any of the infrastructure within the PPL are required to notify and obtain permission from the selected NFP.

The infrastructure owner shall be responsible to maintain all infrastructure within the PPL and ensure that it is in good working condition.

5.3.3 Permission to access the infrastructure

Access seeker shall obtain the permission to use any infrastructure inside the PPL from related infrastructure owner. Access seeker shall ensure existing network services are not disrupted when accessing the infrastructure.

5.4 In-building infrastructure requirement

In-building infrastructure refers to the essential components located inside the building, running from the TR all the way to the Fiber Termination Splice (FWS) in individual dwelling units.

5.4.1 Telecommunication Room (TR)

The developer shall generally provide a TR for an MDU.

A TR is compulsory for an MDU to terminate all fibre cabling and act as an interface with the NFP fibre connection during service activation.

The NFP requires a TR to locate communications equipment and related elements in order to deliver communication services to all properties.

The TR shall remain locked at all times to ensure the security of the network elements inside. Only parties permitted by the infrastructure owner shall be allowed access to the TR. The developer shall consult with the NFP to determine the appropriate type of connector for fibre termination.

5.4.1.1 Space requirement

Adequate floor space area shall be provided to cater to both immediate and future demand. A minimum clear floor space of 750 mm in front of all accessible points of the equipment is essential to provide sufficient working space for installation, testing, and maintenance services. The TR shall be situated in the ground-floor area and connected to the manhole and duct-ways as required.

The room shall be situated in a location free from perceptible vibration. Elements such as ducting, sewage pipes, and air-conditioning pipes shall not pass through the TR. The floor of the TR shall be made from a material that is easy to clean and does not accumulate dust, with the flooring requirement being an anti-static vinyl type mat bonded to the earth bus bar. The room shall remain flood-free. To prevent water from entering the room, a 150 mm kerb across the doorway is required. The floor space dimensions for the TR in each type of building shall be as specified in Table 2.

Table 2. TR floor space

Building type	Floor space (L x W x H) (m)	Floor/wall opening (W x D) (m)	Door opening (W x D) (m)
Condominium and apartment			
x < 6 floors	4 x 4 x 3	0.4 x 0.15	2.5 x 1
6 ≤ x < 16 floors	5 x 4 x 3	0.6 x 0.15	2.5 x 1
x ≥ 16 floors	7 x 4 x 3	0.9 x 0.2	2.5 x 1
Low-cost flats			
x < 6 floors	N/A	N/A	N/A
6 ≤ x < 16 floors	4 x 4 x 3	0.6 x 0.15	2.5 x 1
x ≥ 16 floors	5 x 4 x 3	0.9 x 0.2	2.5 x 1
Office building			
x < 6 000 m^2	4 x 3 x 3	0.7 x 0.15	2.5 x 1
6 000 m^2 ≤ x < 20 000 m^2	4 x 4 x 3	1.0 x 0.2	2.5 x 1
20 000 m^2 ≤ x < 60 000 m^2	5 x 5 x 3	1.1 x 0.2	2.5 x 1
x ≥ 60 000 m^2	7 x 6 x 3	1.1 x 0.2	2.5 x 1
Shop house			
x < 6 storey	The requirement to be determined case by case	The requirement to be determined case by case	The requirement to be determined case by case

Table 3. TR floor space *(continued)*

Building type	Floor space (L x W x H) (m)	Floor/wall opening (W x D) (m)	Door opening (W x D) (m)
Others			
Industrial Lot	The requirement to be determined case by case	The requirement to be determined case by case	The requirement to be determined case by case
Hotel			
School			
Hospital			
Club house			

5.4.1.2 Electrical requirement

The TR shall be equipped with an electrical Alternating Current (AC) supply from the utility supplies, at either a nominal 415 V, 3 phase, 4 wires, 50 Hz system or a nominal voltage of 240 V AC single-phase system with a solid earth system. The type and rating of the AC supply shall depend on the expected load.

The TR shall be equipped with a 20 A Three Phase and Neutral (TPN) metal clad Distribution Box (DB) of 20 A. The DB should be equipped with the following:

a) Earth Leakage Circuit Breaker (ELCB).

b) Automatic Restoration System (ARS) is an auto re-closure device that works with the ELCB.

c) To normalise the power system for ensuring minimum system downtime and site attendance.

d) Surge protection system of 40 kA.

e) 20-way Main Circuit Breaker (MCB) for buildings with 6 floors and above.

The electrical supply should be connected to the essential power generator, if available. An earth leakage circuit breaker shall be installed inside the room. The TR shall be equipped with daylight lighting capable of providing a minimum of 300 lux luminance at floor level.

5.4.1.3 Earthing

The earthing system shall have a resistance to earth not greater than 10 Ω or as stipulated in BS EN 62305-4 and IEC 60364-1, and shall terminate on an earth bus bar inside the room. The main earth conductor shall have a cross-section of not less than 70 mm^2 and follow the shortest routing. The earthing system shall be connected to the building's main grounding. The termination of the grounding system is illustrated in Figure 8.

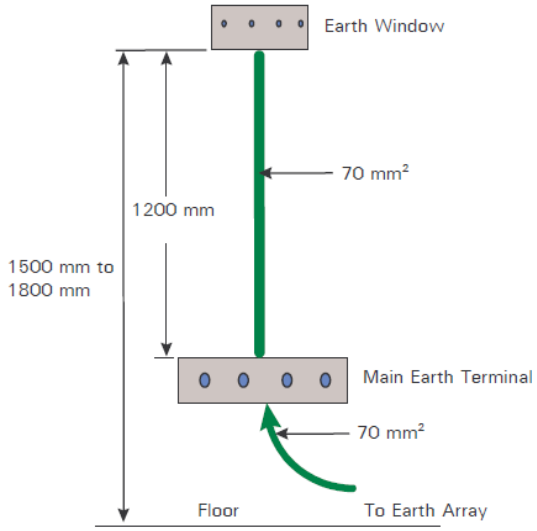

Figure 8. Grounding system termination

5.4.1.4 Temperature and ventilation

The TR shall be fitted with a ventilation fan system of 30 air change/min capability to maintain humidity at 30 % to 50 %. The room temperature shall be maintained below 30 ºC at all times. The ventilation fan system shall be activated automatically when the room temperature rises above 35 ºC. It is highly recommended the room to be equipped with air-condition all the time.

5.4.1.5 Security

There should be no opening in the TR except for the door, the ventilation and cabling ducts. The door dimension shall be 2.5 m x 1 m. All windows shall be shut and sealed along the frames to keep out water and dust, and blind shall be provided to avoid direct sunlight. Solid walls shall be provided for heavy equipment mounting. The walls and ceiling shall be of normal finishing or painted with light-coloured vinyl emulsion or gloss paint.

The TR shall be locked at all times and only NFP authorised personnel shall be allowed to access. The key for this room shall be kept by the owner or the JMB or MC and made available to authorised personnel when required.

No water tank, main water drainage pipes shall be installed directly above the room. The developer shall observe all relevant ordinance and regulation regarding the fire safety requirements during the design of the TR, by having:

a) portable hand-operated fire extinguisher; and

b) emergency lighting connection to a backup power supply.

Smoke detection device shall be installed inside the TR and shall be connected to the central control of the JMB or MC office. The room shall be fitted with a fire door as per *"Jabatan Bomba dan Penyelamat Malaysia"* approval.

5.4.1.6 Floor loading

The TR shall be designed for a minimum distributed load of 500 kg/m^2 and concentrated floor loading of 910 kg/m^2.

5.4.1.7 Room height

The clear ceiling height of TR shall not be less than 3 m, to enable installation of equipment, cabinets and cabling.

5.4.1.8 Room arrangement

The recommended TR arrangement is shown in Figure 9. The Fibre Termination Box (FTB) that connects cabling to individual premises must be installed at the rightmost position as this is the nearest point leading to the internal riser as illustrated in Figure 9.

The NFP's network elements may be located adjacent to the FTB. The FTB shall be connected to the building internal cabling and become a connection point with the NFP's network element. The size of the FTB depends on the number of premises inside the building.

NFP's network elements shall be located in the same row or adjacent to the FTB less than 20 m distance.

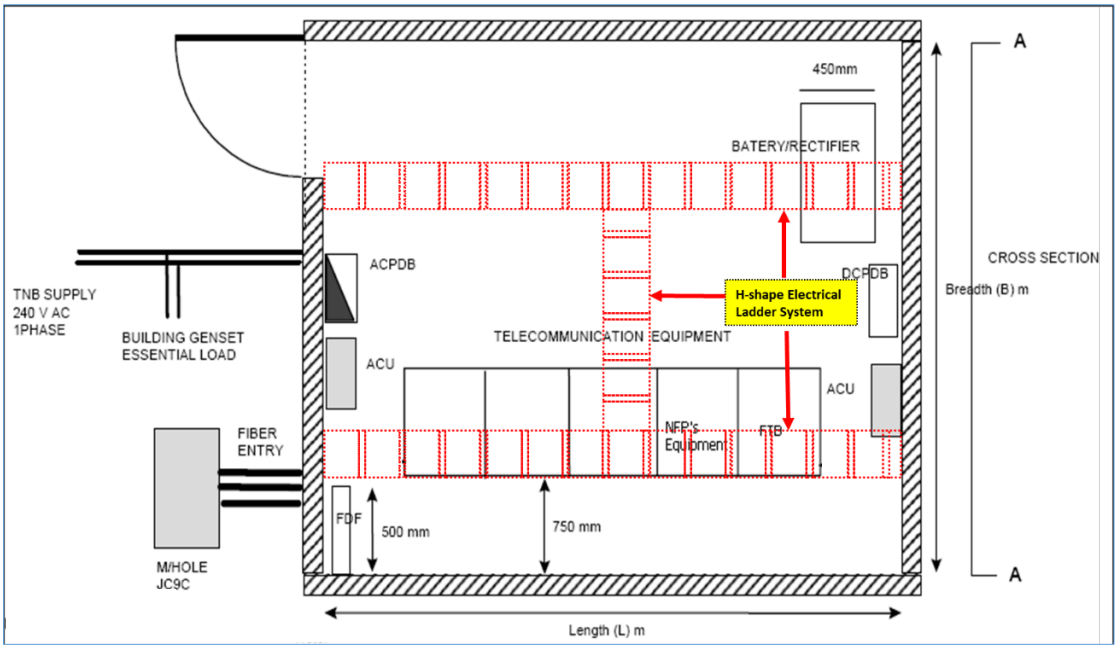

Figure 9. TR arrangement

5.4.1.9 Trunking system

5.4.1.9.1 Fibre Optic Trunking System (FOTS)

A proper Fibre Optic Trunking System (FOTS) shall be prepared inside the room to provide the proper cable route. The 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 depends on the building capacity. The recommended minimum FOTS size is 6 inch (150 mm) medium size of the building (less than 100 units). For bigger size of building multiple FOTS system shall be provided. Sample of FOTS as shown in Figure 10. The developer is recommended to design the FOTS with clearance of 100 mm above the FTB.

Figure 10. Sample of FOTS

5.4.1.9.2 Electrical ladder system

An electrical ladder system shall be prepared inside the room to provide a proper cable route for cable other than patch-cords. This includes the routing for electrical cable between racks in the room. The developer is recommended to design the electrical ladder system with clearance of 150 mm above the FOTS. This electrical ladder system shall be installed 750 mm away from the nearest wall with Fibre Distribution Frame (FDF) rack with H-shape design as illustrated in Figure 11 with a proper earthing termination.

Figure 11. Sample of electrical ladder system

5.4.2 Riser

The riser duct shall be positioned centrally with respect to the distribution in which it is to serve. The distance between the riser duct and the outlet point in the home unit shall be minimised to facilitate the installation and maintenance of horizontal cables. A 150 mm high kerb shall be provided across the doorway to prevent water ingress.

For building without TR, the cable riser shall be sited in an easily accessible area inside the building like staircase landing area. The riser shall be fitted with sufficient fluorescent lighting to facilitate work and the word “Telecommunications Services” shall be displayed on the door of the riser closure. A minimum of 2 units of 13 A power sockets shall be provided at the alternate building floor in the riser to cater for the need of fixed network services distribution equipment. However, if needs arise for larger blocks (i.e., more than 10 apartments units per floor), 2 units of 13 A switch socket-outlets for every floor is recommended.

The riser shall be used exclusively for fixed network services. The services that are not permitted to share this riser include the following:

a) Water piping.

b) Firefighting.

c) Building electrical system.

d) Gas distribution.

e) Any other services that may cause moist, danger or any harmful effect on human life.

Access to each riser is necessary on each floor and shall always be available from a corridor or other common area to prevent undue disturbance to occupants. Each riser shall be equipped with a hinged, locked door on every floor and shall be fireproof. The key to the riser door shall be kept by the building owner for safekeeping.

The size of the riser shall be based on the type of building as in Table 3.

Table 4. Riser size

Building type	Riser		
	Cable trunking (L x W x H) (m)	Floor opening (W x D) (m)	Closet space (W x D) (m)
Condominium and apartment			
x < 6 floors	0.1 x 0.075 x 3	0.4 x 0.15	0.9 x 0.6
6 ≤ x < 16 floors	0.15 x 0.1 x 3	0.6 x 0.15	1.2 x 0.6
x ≥ 16 floors	0.15 x 0.1 x 3	0.9 x 0.2	1.5 x 0.8
Low-cost flats			
x < 6 floors	0.1 x 0.075 x 3	N/A	N/A
6 ≤ x < 16 floors	0.15 x 0.1 x 3	0.6 x 0.15	1.2 x 0.6
x ≥ 16 floors	0.15 x 0.1 x 3	0.9 x 0.2	1.5 x 0.8
Office building			
x < 6 000 m^2	0.15 x 0.1 x 3	0.7 x 0.15	1.2 x 0.9
6 000 m^2 ≤ x < 20 000 m^2	0.15 x 0.1 x 3	1.0 x 0.2	1.5 x 0.9
20 000 m^2 ≤ x < 60 000 m^2	0.15 x 0.1 x 3	1.1 x 0.2	1.8 x 1.2
x ≥ 60 000 m^2	0.15 x 0.1 x 3	1.1 x 0.2	1.8 x 1.2
Shop house			
x < 6 storey	0.1 x 0.075 x 3	N/A	N/A
Others			
Industrial lot	Requirement to be determined case by case		
Hotel			
Schools			
Hospital			
Club house			

5.4.3 Vertical trunking

The trunking is required for laying the cable inside the building and acts as the protection and cable guide. The trunking located inside the riser is referred as vertical trunking. Open ladder, cable tray and closed trunking are the types of trunking that can be used as a vertical trunking.

The example of vertical trunking location for the MDU is shown in Figure 12.

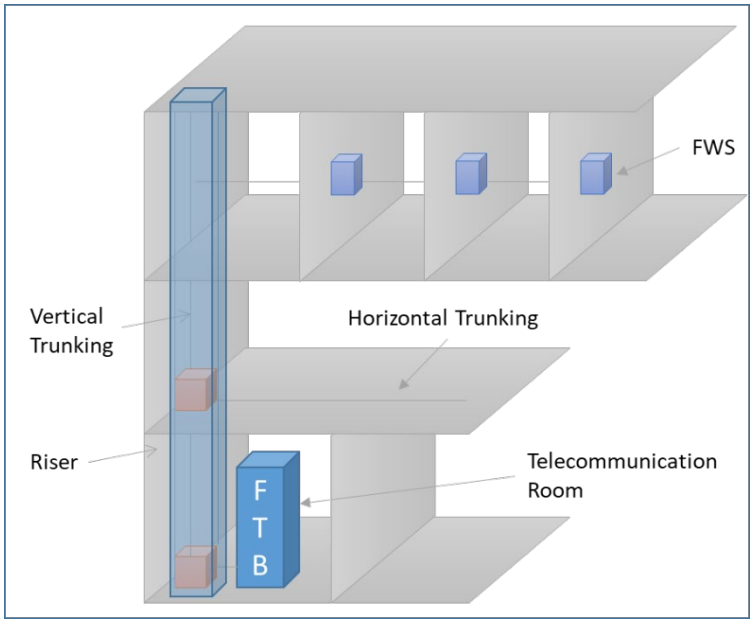

Figure 12. Trunking for MDU

The trunking bending radius shall be greater than 10 times of the trunking size to ensure that the fibre cable meet the minimum bending radius.

Vertical closed cable trunking and the riser can be shared between broadcast and other communication services. The arrangement of these cables in the riser shall be as follows:

a) From the left is for radio communications (cellular network) services.

b) The centre is for communication (fixed network) services.

c) From right side is for broadcast services.

Closed trunking shall be used and solidly grounded to provide shielding between different services. The trunking shall be galvanised steel plate, epoxy powder coated against corrosion with a finishing of light blue paint.

5.4.4 Horizontal trunking or conduit

Horizontal trunking or conduit shall be provided to connect from riser on each floor to every Fibre Wall Socket (FWS).

The horizontal trunking or conduit shall be made from Polyvinyl Chloride (PVC) or harder type. All conduits or cable enclosure shall be completely concealed and shall not protrude to reduce the aesthetics either within or outside of the premises.

The fixed network horizontal trunking shall be separated and dedicated to related services and type of cabling such as follows:

a) Fibre optic cable for broadband and voice services.

b) Fibre optic or metal-based cable for LAN.

c) Extra Light Voltage (ELV) services such as Closed-Circuit Television (CCTV), alarm system, etc.

Sharing of services apart from those listed above is strictly prohibited.

The size of the horizontal trunking shall be 100 m x 25 m for on wall or floor and 100 m x 50 m for on ceiling along the corridor shall be according to the number of cables as shown in Table 4.

Table 5. Horizontal trunking

Number of cables	Number of trunkings on wall/floor (100 m x 25 m)	Number of trunkings on ceiling (100 m x 50 m)
Less than 10	1 unit	1 unit
10 to 20	2 units	2 units
More than 20	N/A	Comply with 50 % space factor

The trunking bending radius shall be greater than 10 times of the trunking size to ensure that the fibre cable meets the minimum bending radius.

5.4.5 Fibre Termination Box (FTB)

FTB shall be provided as the connection point between in-building and external fibre. It shall be located as follows:

a) MDU with TR - inside the TR (as shown in Figure 13).

b) High-rise SDU - riser or staircase area (as shown in Figure 14).

c) Landed SDU - outside the premises wall (as shown in Figure 15).

d) Strata SDU with FDH - outside the premises wall and inside the TR (as shown in Figure 16).

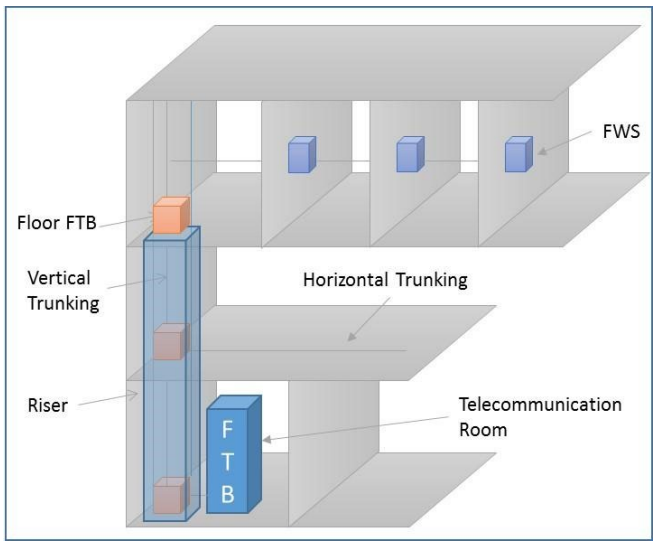

Figure 13. FTB locations for MDU

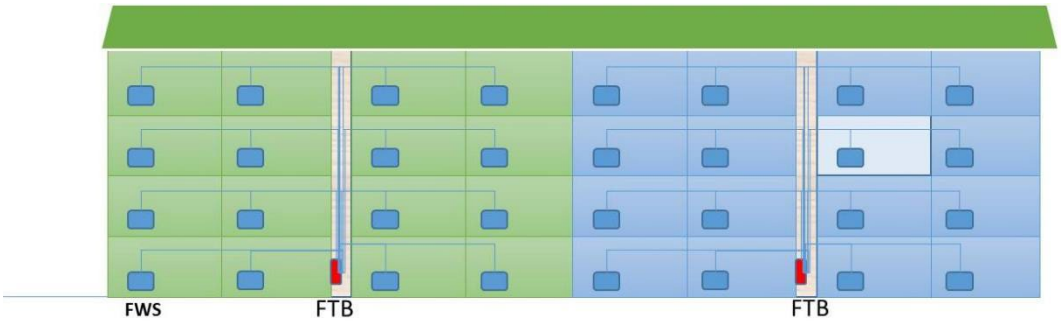

Figure 14. FTB locations for high-rise SDU

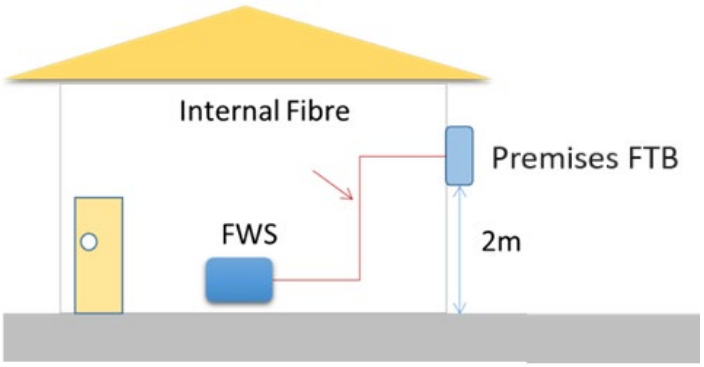

Figure 15. FTB locations for landed SDU

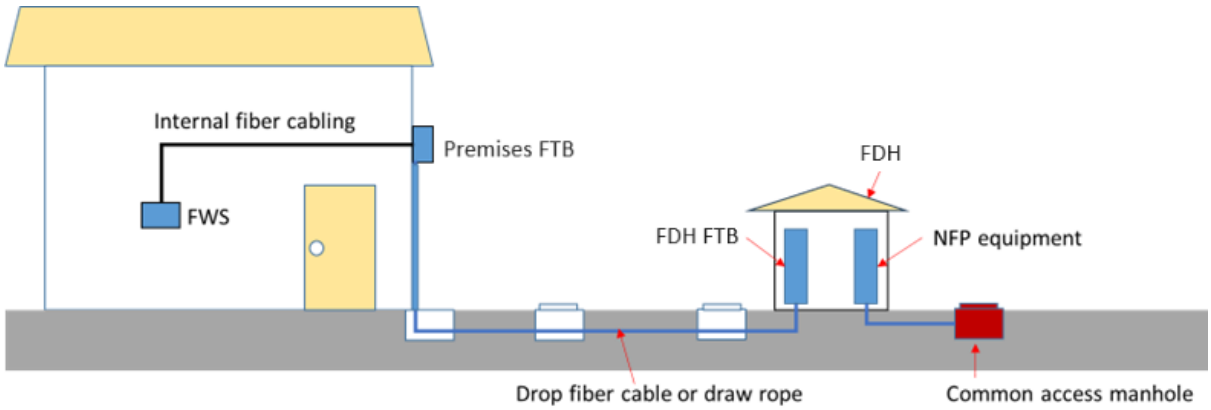

Figure 16. FTB locations for strata SDU

The FTB for SDU shall be positioned at a height of 2 m (± 0.05 m) from the ground level, on the outside wall. An intermediate FTB may also be installed at a riser for MDU as a distribution point for transitioning from high to smaller capacity fibre. The FTB shall always remain locked and secured to prevent damage or contamination. Samples of FTB for MDU, high-rise or landed SDU, and strata SDU are depicted in Figure 17, Figure 18, and Figure 19, respectively.

Figure 17. FTB for MDU

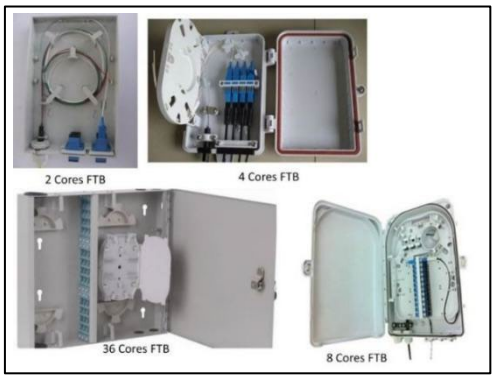

Figure 18. FTB for SDU

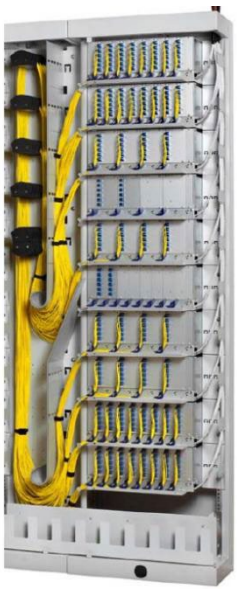

Figure 19. FTB for strata SDU

The minimum of 2 sets of Standard Connector/Ultra Polished Connector (SC/UPC) or Standard Connector/Angle Polished Connector (SC/APC) connectors shall be provided inside the FTB for each premises unit. Both types of connectors shall be connected with the internal fibre to the FWS.

Detailed specifications for the FTB are provided in Annex C.

5.4.6 Fibre Wall Socket (FWS)

The FWS shall serve as a termination point for the internal fibre cable and function as a connection point to the Broadband Termination Unit (BTU) or Optical Network Unit (ONU). The locations for the FWS shall correspond to those depicted in Figure 20.

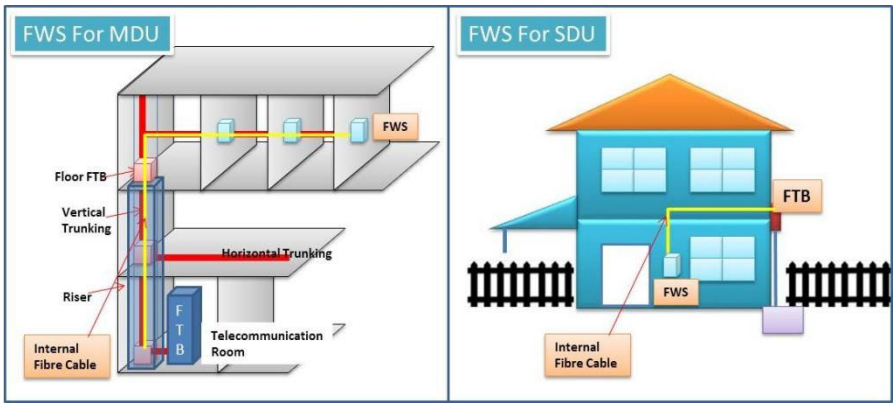

Figure 20. FWS locations for MDU and SDU

A minimum of 1 unit of FWS shall be provided inside each premises.

FWS shall meet the requirements as follows:

a) The minimum of 2 sets of SC/UPC or SC/APC connectors shall be provided inside the FWS. Both fibre shall be terminated at the FWS.

b) Equipped with shutter and dust cap to protect the connector.

c) Made from non-corrosive material or treated metallic material to resist corrosion.

d) Located 300 mm above the floor level and 300 mm from the corner of the wall.

e) Located adjacent to electrical points.

f) FWS shall support a minimum of 2 fibre cores.

Sample of FWS is shown in Figure 21.

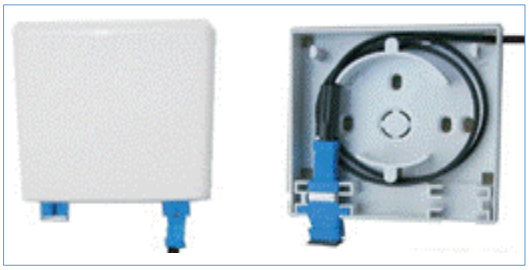

Figure 21. Sample of FWS

5.4.7 Customer Premises Equipment (CPE) outlet

Customer Premises Equipment (CPE) outlet is used to connect the internal cabling system with the dedicated service equipment. The type of outlet is depending on CPE type. The minimum type of CPE outlet shall be provided as follows:

a) Registered Jacket type 45 (RJ45) outlet socket for internet-based CPE which connected via Category 5 Enhance (CAT5e) or higher cable.

b) Registered Jacket type 11 (RJ11) outlet socket for analogue telephone which connected via Category 3 (CAT3) or higher cable.

CPE outlet is recommended to be located at the living room's adjacent power socket and FWS to facilitate upcoming interactive services which will require feedback channel over the BTU.

Wall outlet boxes and plates shall be fabricated from non-corrosive material or from metallic material treated to resist corrosion.

5.5 External infrastructure requirement

External infrastructure refers to the essential components located outside the building and running from the common access manhole all the way to the TR or FTB of the premises.

5.5.1 Fibre Distribution House (FDH)

In general, the developer shall provide external Fibre Distribution House (FDH) for strata SDU type of buildings. The requirements of FDH shall follow the TR requirements as specified in 5.4.1.

FDH is required for strata SDU properties for termination of all fibre cabling and act as interface with NFP fibre connection during service activation.

FDH is required for the NFP to locate communications equipment and related elements to deliver the communication services to all properties.

FDH shall be locked all the time to ensure security of the network element inside. Only permitted parties shall be allowed to access the FDH by the JMB or MC.

The developer shall consult with NFP for the appropriate type of connector for fibre termination.

FDH for strata SDU shall be located nearest to the common access manhole for easier connection and minimise the fibre attenuation loss.

The recommended size of FDH is as shown in Table 5.

Table 6. Sample of FDH size

Building type	Floor space (L x W x H) (m)	Floor/wall opening (W x D) (m)	Door opening (W x D) (m)
Strata SDU	4 x 4 x 3	0.4 x 0.15	2.5 x 1

5.5.2 Underground infrastructure

The requirements of underground infrastructure shall follow as below. Detailed specifications of trenching method and requirement as specified in MCMC MTSFB TC G025-1 and MCMC MTSFB TC G025-2.

5.5.3 Manhole

Manhole shall be installed with the following particular attention:

a) Minimum hazards to traffic and personnel.

b) Easily accessible at any time.

c) Not to be covered by any obstacle or landscape.

d) Adequate size to accommodate all equipment including repeater housings and cable joints.

The distance from the centre of one manhole to the centre of the next shall be within a range of 50 m to 150 m. Each manhole shall be built to last for up to 20 years.

For manholes located on the main road, applying anti-theft features, such as installing double layer manhole covers, is strongly recommended to protect the system from theft. The developer shall consult with the NFP on the appropriate selection of location and size for the manholes to be constructed. The recommended manhole size, number of duct ways, and location are detailed in Table 6. Samples of manhole types, locations, and the number of duct ways in a development area are illustrated in Figure 22.

Table 7. Manhole size and location

No	Type of manhole	Recommended size (L x W x D) (m)	No. of duct way	No. of premise linked duct way	No of premises	Location or criteria
1	JB30 with heavy-duty cover	850 x 850 x 650	2	4	< 4	a) Last connection to premises units. b) Premises access manhole.
2	JRC7	1 160 x 855 x 850	2	N/A	< 72	a) On small roadside to link up with JB30. b) Common access manhole. c) TR linked manhole.
3	JC9C	1 960 x 1 260 x 1 020	4	N/A	> 576	a) On heavy roadside to link up with JB30/JRC7. b) Common access manhole. c) TR or FDH linked manhole.
4	R1A	2 200 x 1 615 x 1 680	6 or 8	N/A	< 576	TR or FDH linked manhole.

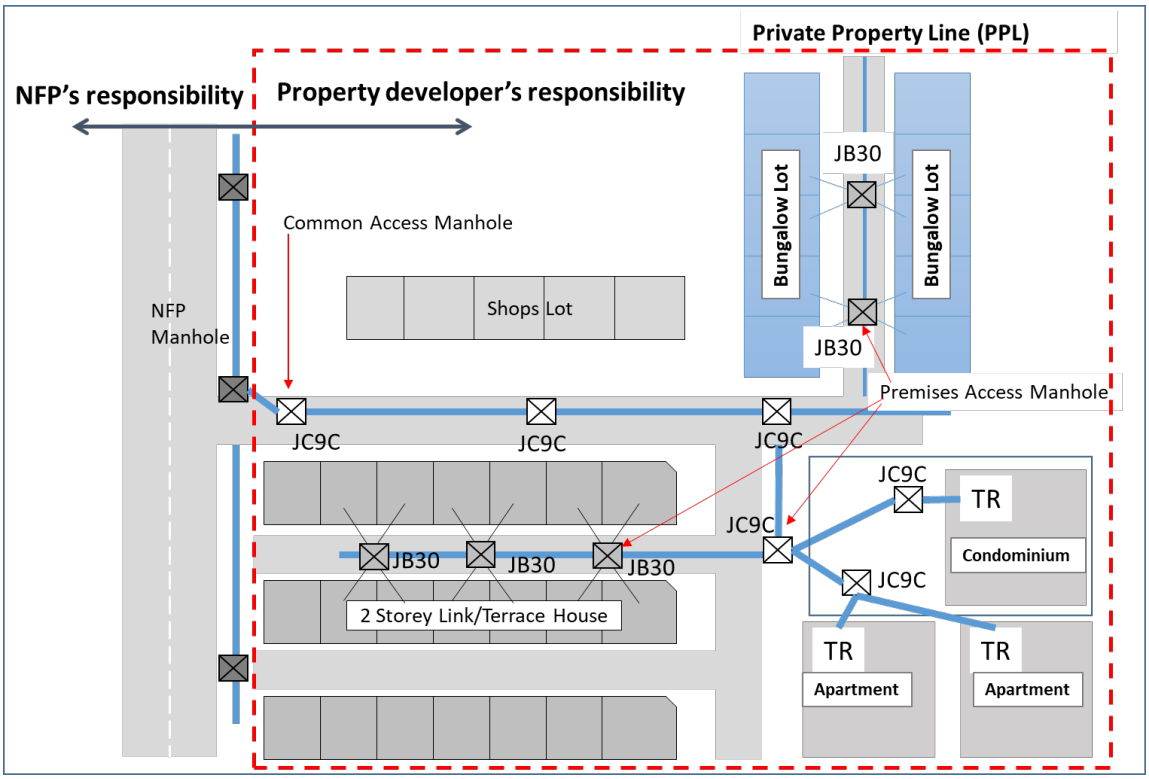

Figure 22. Manhole types and locations

5.5.3.1 Common access manhole

The common access manhole is the developer's final manhole, which connects to the NFP's manhole. All connections from the NFP network into the development area within the PPL shall pass through this common access manhole. Depending on the design of the underground ducting and the number of NFP connections to the development area, there may be more than one common access manhole.

The developer shall provide separate ducts from the common access manhole to every NFP's manhole, otherwise a separate common access manhole shall be provided for every NFP in case of multiple NFPs are required to provide the services.

For strata landed property, common access manhole is connected to FDH as shown in Figure 22.

In a residential area, a minimum of a JRC7 manhole size with 2 duct ways shall be provided. For a business area with a large number of properties, a minimum of a JC9C common access manhole size with 4 duct ways shall be provided. The developer should consult with the NFP to determine the appropriate size.

Manhole covers inside the development area, which are prepared by the developer, shall be without any NFP logos.

5.5.3.2 Premises access manhole

The premises access manhole is a manhole that connects the premises to the underground ducting. This can be a dedicated manhole for every premises or one that is shared by multiple premises, as illustrated in Figure 22.

The premises access manhole shall be at least a JB30 with a heavy-duty cover for SDU and a JC9C for MDU.

5.5.4 Underground duct

The duct size for connecting the premises access manhole to properties such as bungalows or linked houses shall be at least 40 mm in diameter. The duct size for connecting premises access manholes to other types of properties, including MDU, SDU, and all commercial properties, shall be between 100 mm to 110 mm in diameter.

The duct material shall be made from PVC or harder material with minimum thickness of 2 mm. For road crossing, the minimum class B or equivalent Galvanised Iron (GI) pipe shall be used.

Each duct or subduct shall be installed with a pull string or draw rope for cable installation.

The duct is recommended to be installed with sub-ducts. The specification of the sub-ducts shall be as follows:

a) 3 High-Density Polyethylene (HDPE) sub-ducts with 40 mm in diameter; or

b) 4 HDPE sub-ducts with 32 mm in diameter.

The number of duct-ways shall depend on the forecast requirement of the premises for a period of 20 years. The developer should consult NFP on the appropriate design and number of duct-ways.

The developer shall ensure that the constructed ducting system has minimal risks from natural disasters such as flood, landslides and etc. The developer shall ensure the ducting system is always in a good working condition.

The duct routes shall be as straight as possible without sharp bends. The bending radius shall not be less than 10 times of duct diameter as shown in Figure 23.

The installation of underground ducts shall be according to MCMC MTSFB TC G025-1.

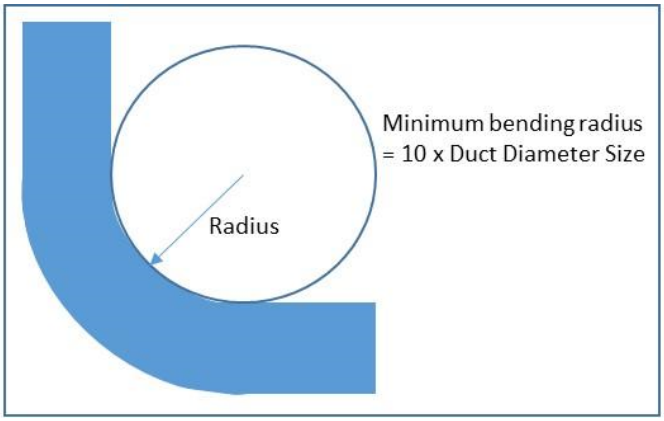

Figure 23. Duct bending radius

5.5.4.1 Concrete encasement

For four duct ways and above, the duct shall be encased in concrete with a minimum mix ratio of cement, sand, and aggregate of 1:4:3. These specifications shall be as illustrated in Figure 24.

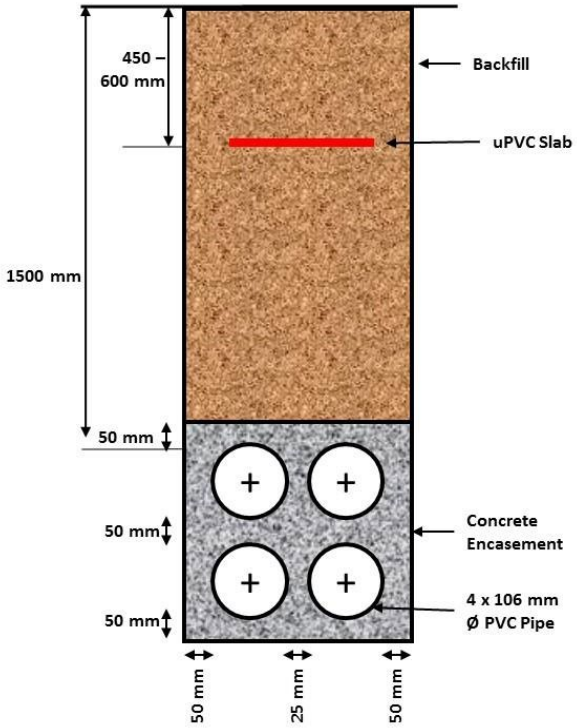

Figure 24. Duct depth specification

5.5.4.2 Unplasticised Polyvinyl Chloride (uPVC) slab

Unplasticised Polyvinyl Chloride (uPVC) slab shall be installed with the minimum depth of 440 m from the ground surface as a warning indication as illustrated in Figure 24.

5.5.4.3 Duct and cable arrangement

The arrangement of ducts and cables shall adhere to the layout depicted in Figure 25. The first duct to be used shall be the lowest one on the bottom left, and usage should continue to the right. The allocation and management of duct space shall be overseen by the JMB, MC, or selected NFP.

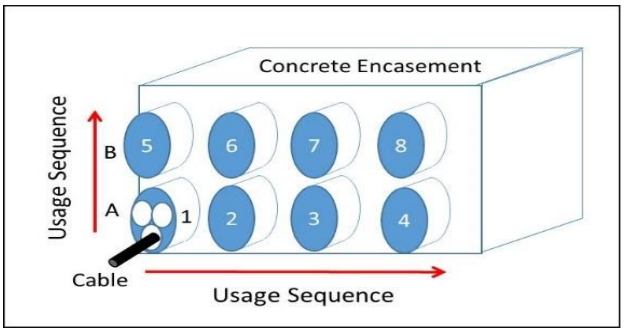

Figure 25. Ducts and cables arrangement for underground

5.5.4.4 Ducting crossing the drain

For ducting that crosses a drain, the construction shall adhere to the guidelines presented in either Figure 26 or Figure 27, depending on the depth of the drain.

If the drain depth is more than 450 mm (1.5 ft), the duct may be installed through the drain by using GI pipe with a minimum diameter of 100 mm to protect from damages. The GI pipe shall be placed in such a way to avoid trapping of garbage and water blockage.

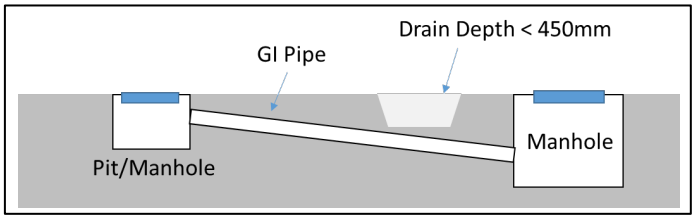

Figure 26. Ducting installation under the drain

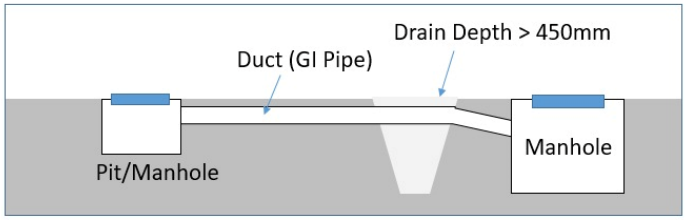

Figure 27. Ducting installation through the drain

5.5.5 Access to premises

5.5.5.1 Connection to SDU premises

Dedicated ducting shall be prepared for each connection from premises access manhole to each premises. Sharing of the duct for multiple premises is not allowed. The location of premises access manhole can either be at premises back lane or in front of the premises.

Before entering the wall section of the premises, a small pit with minimum dimensions of 300 mm x 300 mm x 300 mm shall be prepared to facilitate easy access during maintenance work. The FTB shall be placed outside of the wall at a height of 2 m to simplify future operation and maintenance. These details are illustrated in Figure 28. Each duct shall be installed with a pull string or draw rope to facilitate easier installation of the drop cable.

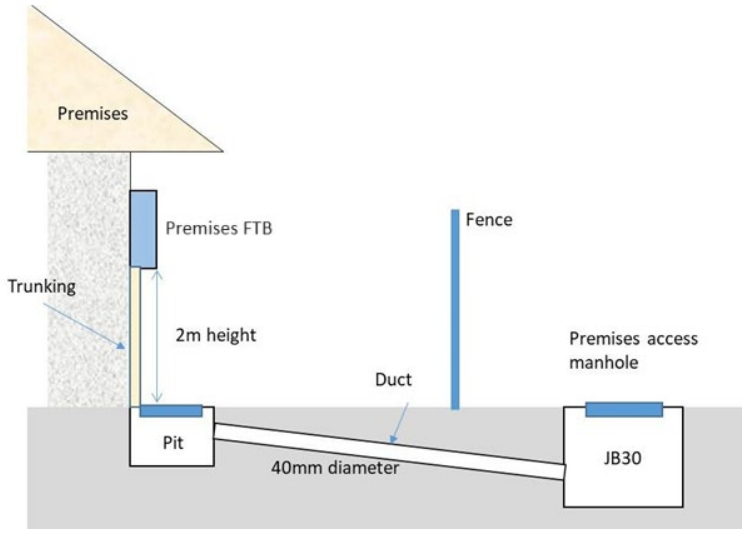

Figure 28. Access to SDU premises

The duct route shall not be installed inside individual premises compound as shown in Figure 29.

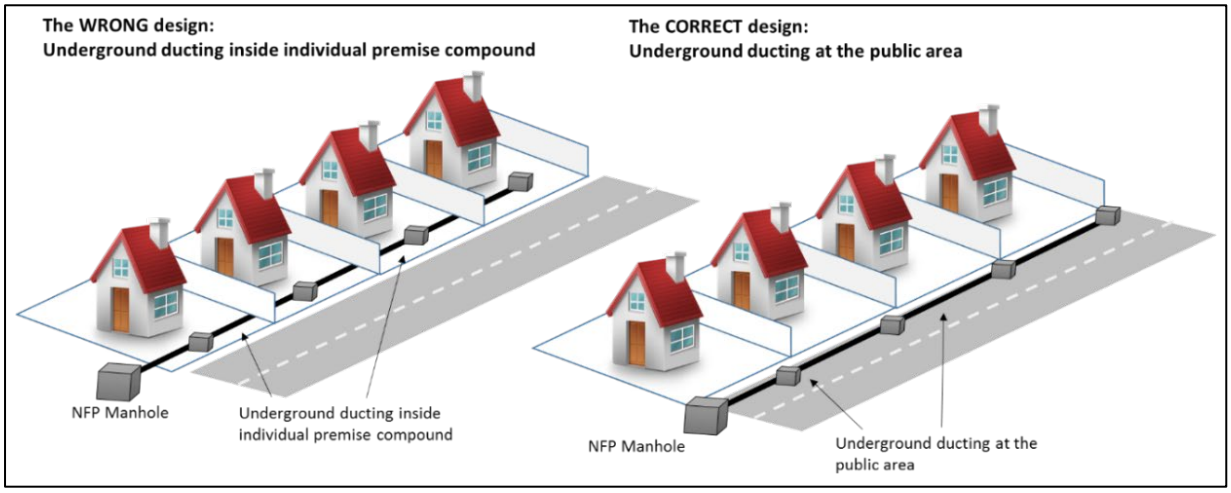

Figure 29. Duct route for premises compound

The installation of ducts to each SDU premises shall follow the layout depicted in Figure 30. Each premises shall be equipped with a dedicated premises access duct that originates from the nearest manhole.

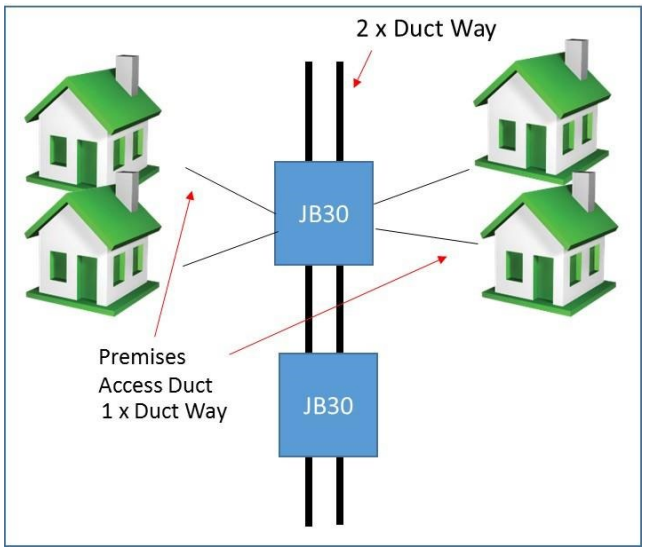

Figure 30. Duct way connection for SDU

The manholes situated between the common access manhole and premises access manhole shall be at least a JC9C with two duct ways (2W), as depicted in Figure 31. The developer should consult with the NFP to determine the appropriate size of the manhole for larger developments.

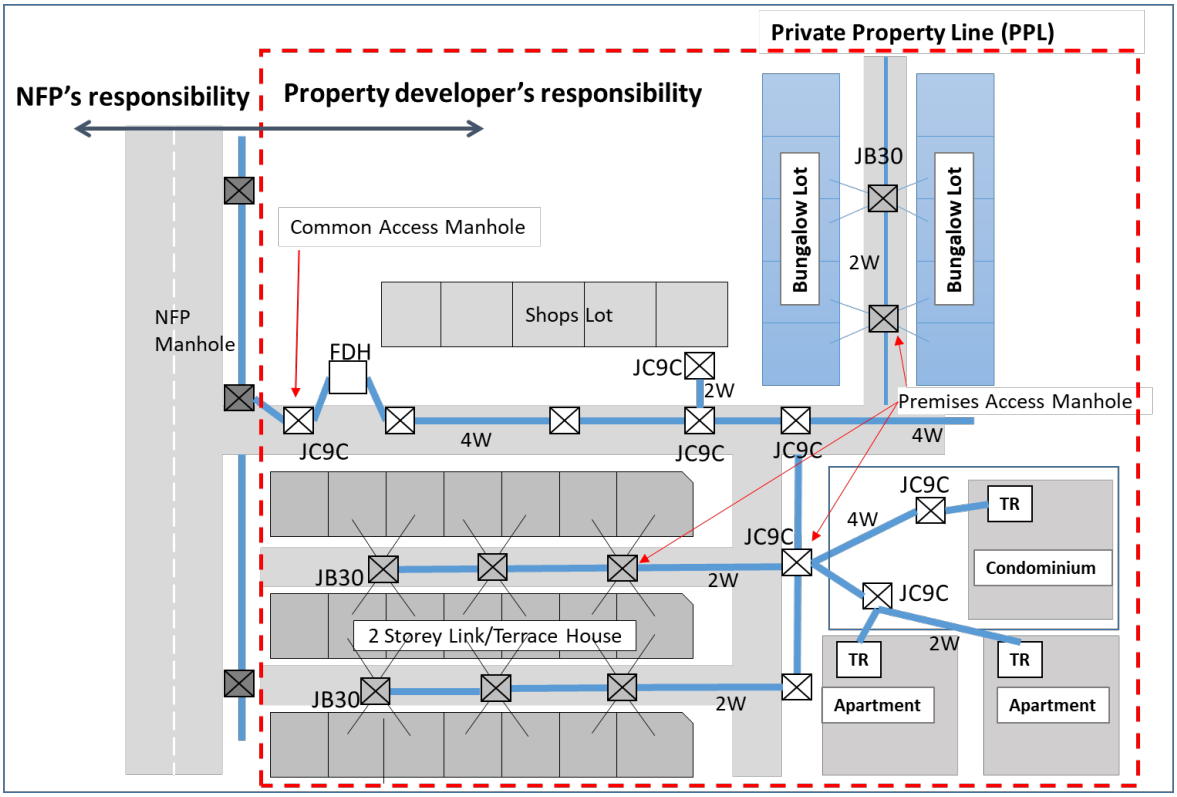

Figure 31. Connection for housing estate and campus and complex type premises

5.5.5.2 Connection to Multi-Dwelling Unit (MDU) premises

A minimum of 2 ways ducting shall be prepared for connection from the premises access manhole to the building, as illustrated in Figure 32. Each duct shall be equipped with a pull string or draw rope to facilitate easier installation of the drop cable.

A pit with size 600 mm (W) x 600 mm (D) x 600 mm (H) shall be prepared before entering the TR of the building.

Depending on the capacity of the building, a wall-mounted or rack-type FTB shall be installed inside the TR.

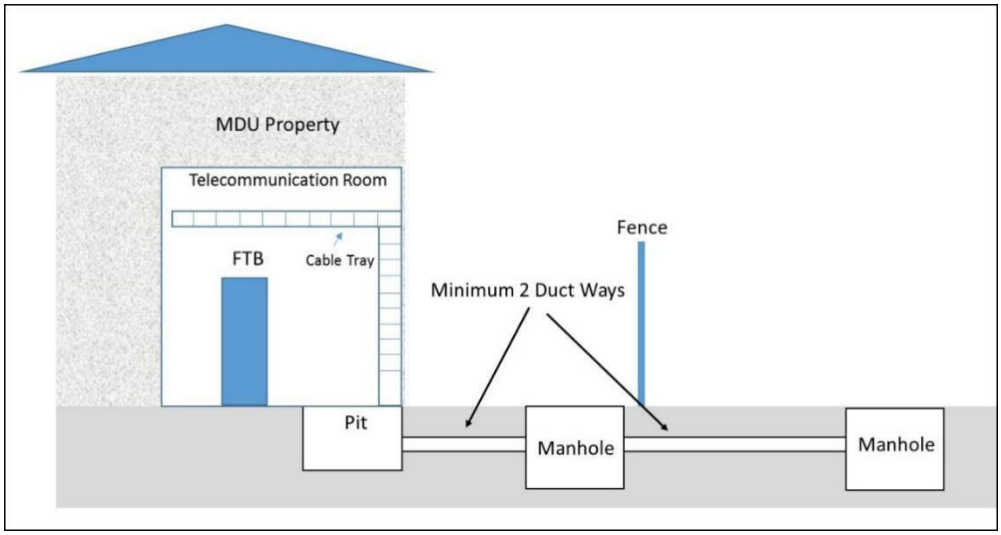

Figure 32. Manhole connection to the building

5.5.6 Overhead infrastructure

5.5.6.1 Connection with NFP infrastructure

Development area designed with pole infrastructure and connected to NFPs pole shall be constructed as shown in Figure 33. The distance of the first pole that will connect with NFP pole shall be placed as closed as possible with maximum of 50 m from NFP pole. Any requirement for additional poles outside PPL, the developer may discuss with NFP through commercial arrangement for the best option. A proper handover agreement shall be carried out between developer and NFP upon completion of the construction.

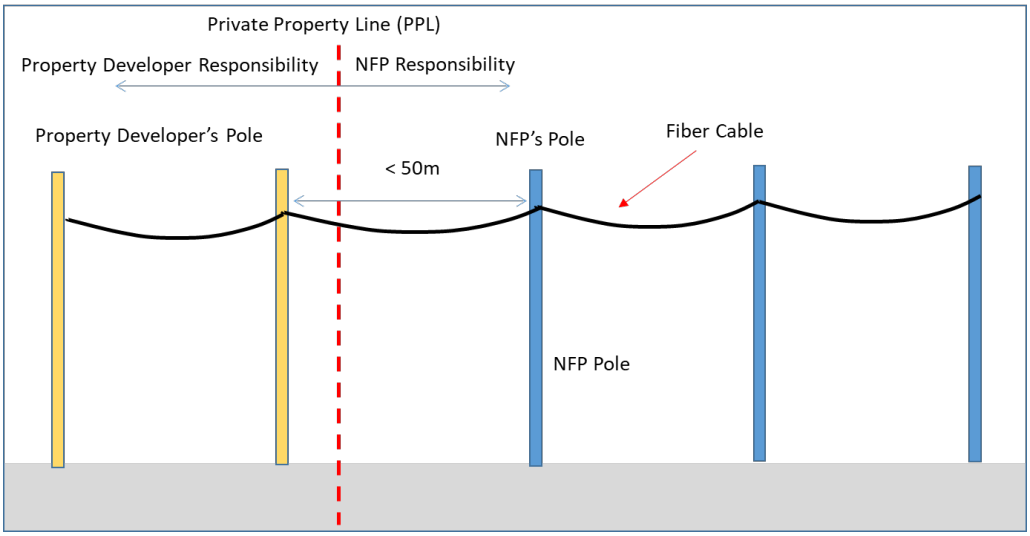

Figure 33. Overhead connection with NFP's pole

Development area designed with pole infrastructure and connected to NFPs underground infrastructure shall be constructed as shown in Figure 34. A common access manhole adjacent to the first developer's pole shall be provided by the developer.

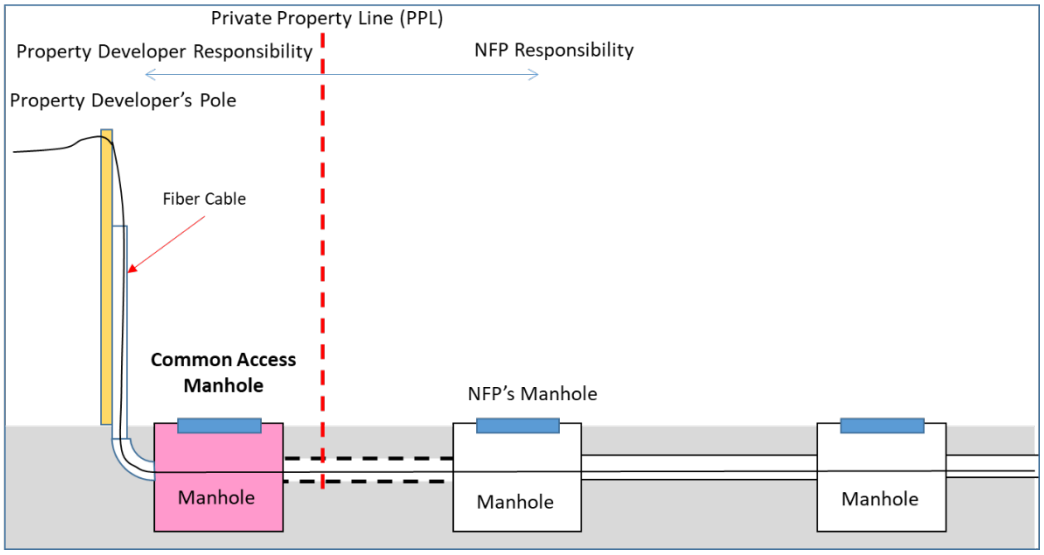

Figure 34. Overhead connection for pole type deployment

5.5.6.2 Pole distribution design

Only landed residential SDU is recommended to be served via pole.

Industrial or commercial properties is highly recommended to be served with underground infrastructure as the premises access connection.

Development area designed with pole infrastructure for connection via NFP's pole shall be prepared as shown in Figure 35.

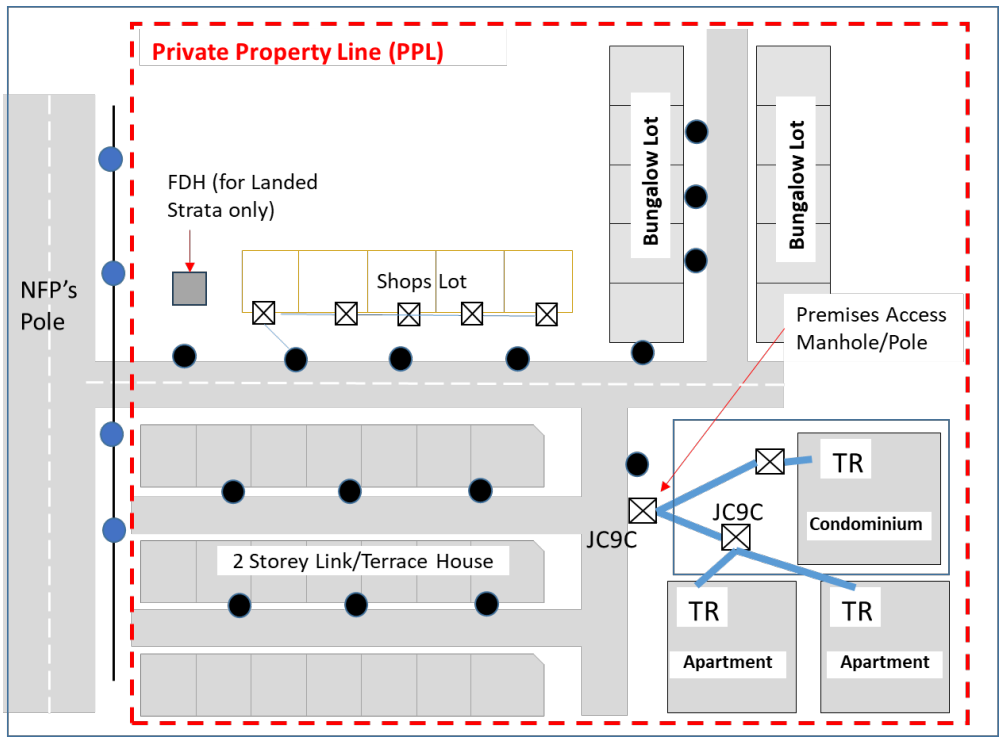

Figure 35. Pole distribution for connection via NFP's pole

Development area designed with pole infrastructure for connection via NFPs underground infrastructure shall be prepared as shown in Figure 36.

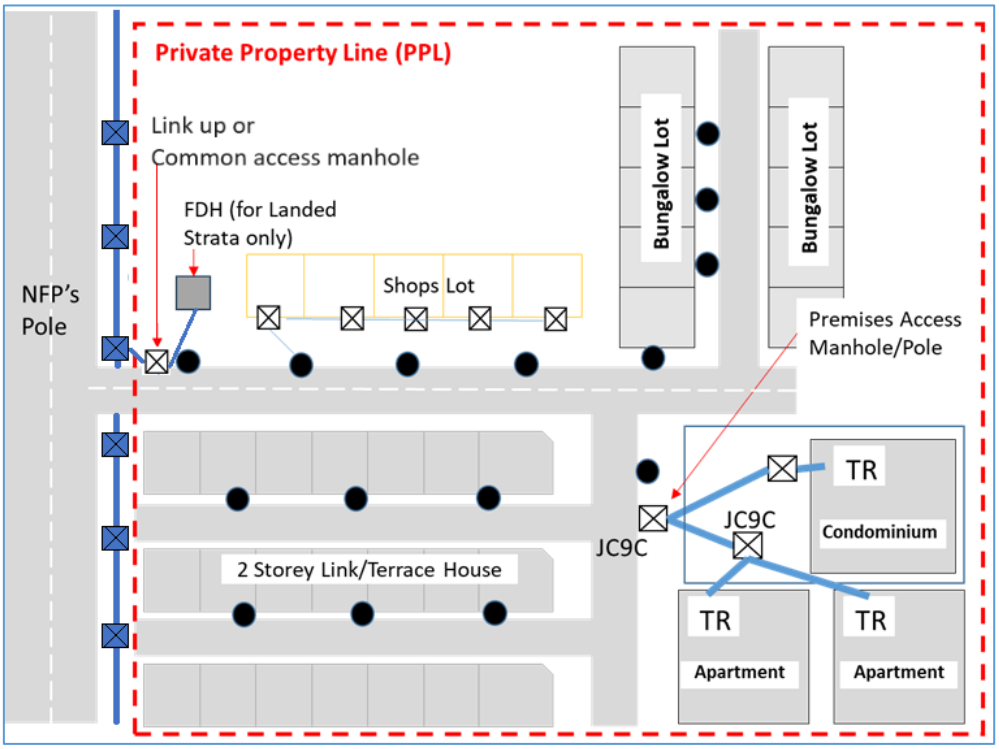

Figure 36. Pole distribution for connection via NFP's underground infrastructure

5.5.7 Premises access pole

Premises access pole refers to the pole that is used to connect with the customer premises. Every pole shall be located to serve 8 premises with maximum distance of 50 m as shown in Figure 37. The distance shall be measured between pole and premises FTB.

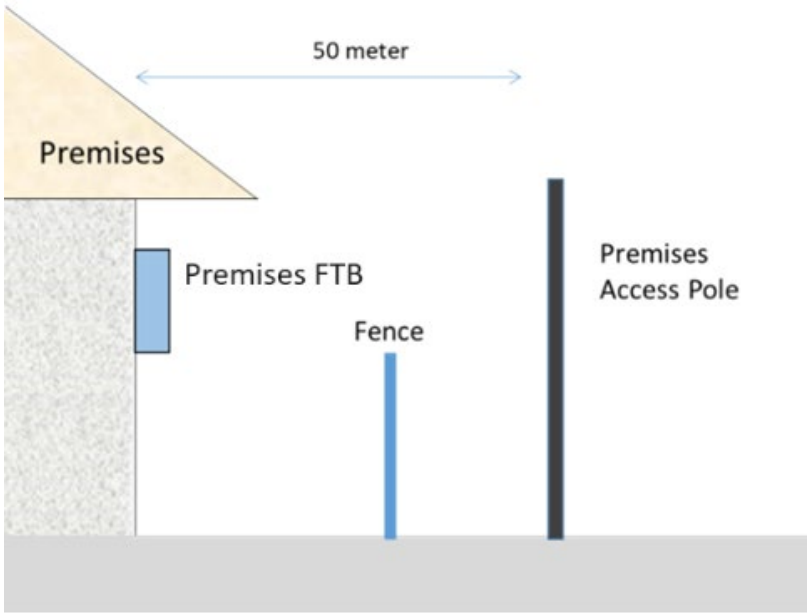

Figure 37. Premises access pole

5.5.8 Pole specification

All poles shall meet the specifications outlined in Telcordia GR-3159. Generally, the NFP is responsible for the installation of these poles. However, under certain commercial arrangements with the NFP, the developer may provide the poles.

For strata SDU, the developer shall supply and install the poles based on the arrangement with NFP.

The pole specification and installation procedure shall follow as recommended by the selected NFP. The length of the pole depends on the application. The minimum length of pole shall be as specified in Table 7.

Table 8. Pole length and application

Pole length (m)	Application
6.7	a) Premises access pole b) Premises back lane
7.5	Low traffic road
9.0	Road crossing

Concrete type of pole shall be used in development area. Every pole shall have a minimum of 8 points which shall be able to support with a minimum of 8 fibre cables. The load specifications shall be as specified in Table 8.

Table 9. Pole load specification

Specification	Minimum value
Maximum load or point	200 kg
Maximum total load	1 600 kg
Permanent bending load	30 %
Minimum bending load	224 kg

5.5.9 Pole installation

Distance between poles shall be as shown in Table 9 and illustrated in Figure 38.

Table 10. Distance between poles

Location	Distance between poles (m)
a) Premises access pole b) Premises back lane	20 - 30
a) Along the road b) Road crossing area	30 - 50

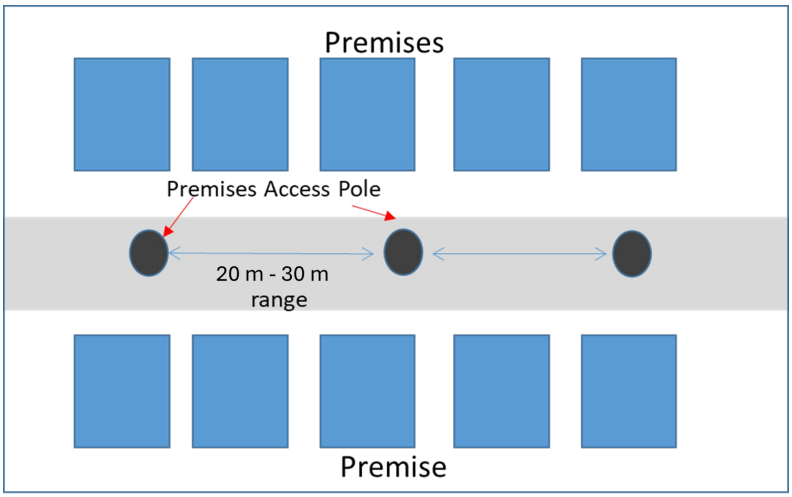

Figure 38. Distance for premises access poles

For the case of non-flat ground level, the maximum difference of height between 2 poles shall be kept less than 300 mm as illustrated in Figure 39. If the distance cannot be met, distance between poles shall be reduced.

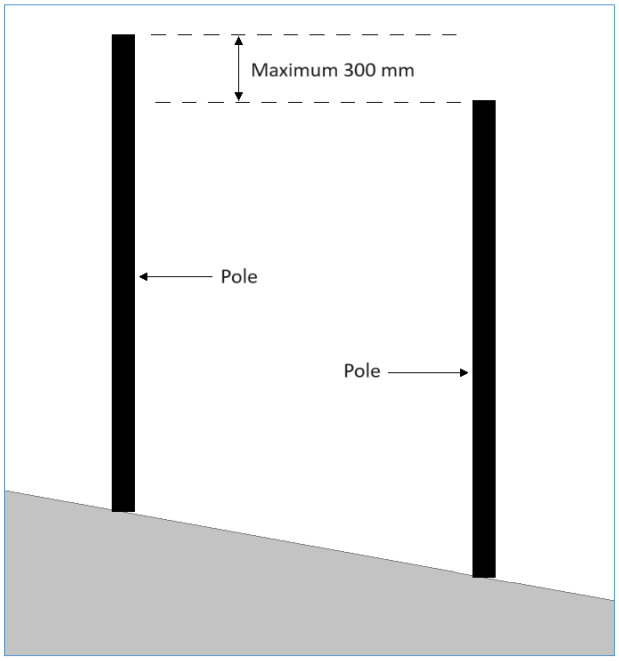

Figure 39. Non-flat ground pole installation

The pole shall be installed at the minimum of 1 500 mm depth from ground surface. The concrete kicking block shall be used to support the pole. The top edge of concrete kicking block shall be installed at 150 mm from the surface level.

5.5.10 Accessibility

Only authorised personnel by the NFP or the NSP shall be allowed to access in-building and external infrastructure.

Property owner for strata and non-strata shall establish controlled procedure to allow access to those infrastructure.

As an amendment to the Uniform Building By-Laws 1984 recognises telecommunications as a public utility alongside electricity and water, developers or property owners shall not impose any charges on NFPs for access to any in-building and external infrastructure, including the installation of any equipment for fixed network facilities.

6 Cabling requirements

Detailed requirements on the fibre type and specifications are as specified in Annex D and Annex E.

6.1 Cable distribution requirement

The design for cable distribution for strata SDU, non-strata SDU, MDU, campus and complex type is illustrated in Figure 40.

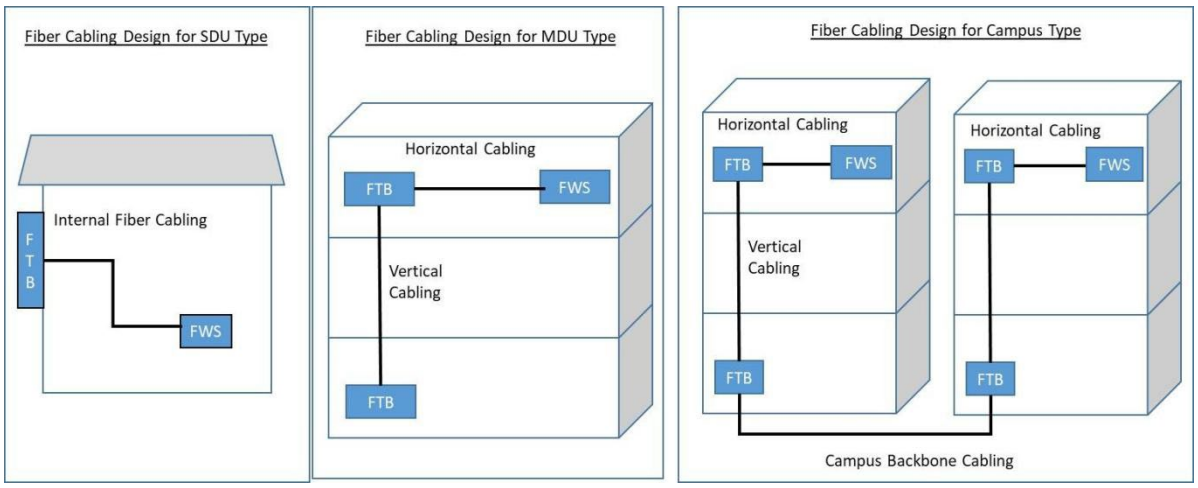

Figure 40. Cable distribution for SDU, MDU and campus and complex type

The fibre cable for SDU, MDU and campus and complex type shall be laid as follows:

a) Fibre cable from the NFP will be laid via their manholes and duct-ways and finally to the customers building via the customer manhole and duct-ways.

b) Fibre cable will be terminated onto the FTB.

c) Cables from the FTB will be connected to the FWS of the individual premises' units such as via the vertical and horizontal distribution.

Developer is required provide the cabling from FTB until FWS as illustrated in Figure 41.

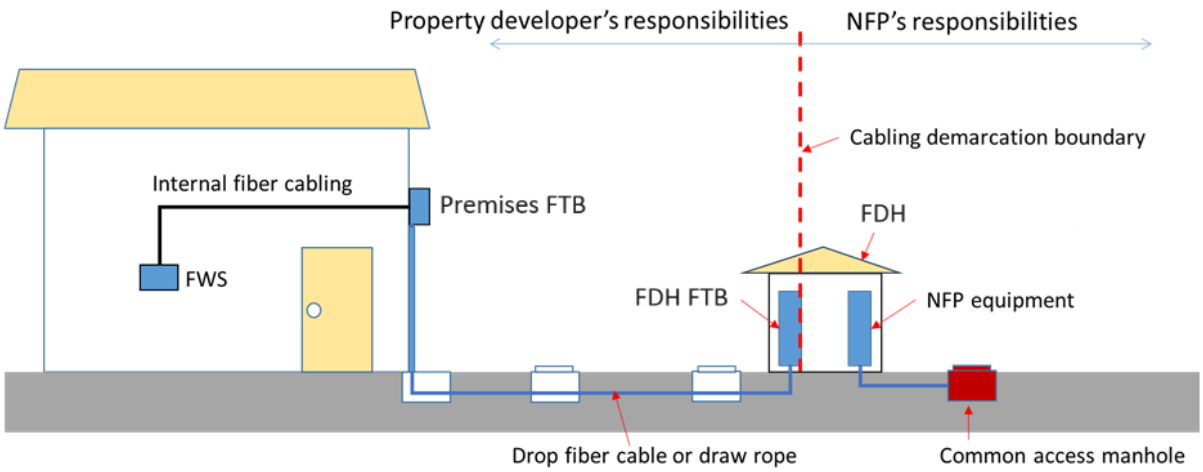

Figure 41. Cabling demarcation and distribution for landed strata

The fibre cable for landed strata shall be laid as follows:

a) Fibre cable from FDH to the customer premises will be laid via developer's manholes and duct-ways.

b) Fibre cable will be terminated onto the FTB.

c) Cables from the FTB will be connected to the FWS of the individual premises' units via internal Fibre cabling.

The cabling requirement for every premises shall be as follows:

a) Number of fibre core required.

   i) minimum of 2 cores for residential type.

   ii) minimum of 4 cores for business type, however property developer should consult the NFP for the appropriate number of cores based on the actual requirement.

b) The connector type shall be SC/UPC or SC/APC which depends on the NFP and type of services, therefore developer shall consult with the NFP for the appropriate type.

c) The cable type shall be single mode fibre and comply with ITU-T G.657.A1 specifications.

6.2 Cabling for Single-Dwelling Unit (SDU)

6.2.1 Cabling for non-strata SDU served via pole

FTB at the customer premises will be the cabling demarcation boundary between the NFP and the developer as shown in Figure 42.

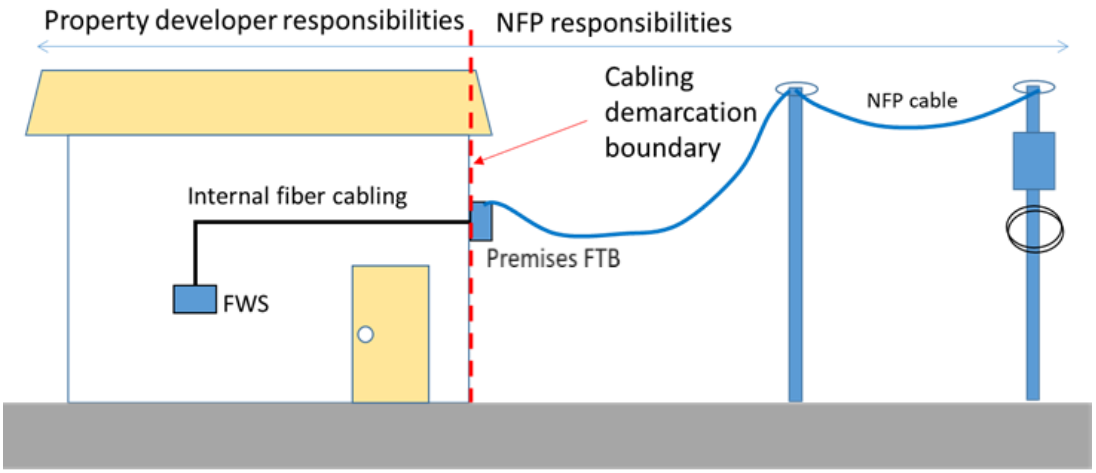

Figure 42. Non-strata SDU cabling demarcation boundary for pole type

The NFP shall be responsible for cabling between NFP's pole to FTB which will be installed during service activation.

The Developer shall be responsible to provide the internal cabling from FTB to FWS inside of every premises unit whereby property owner to own and maintain the internal cabling.

The Developer shall be responsible for internal cabling from FTB to FWS inside of every premises unit.

6.2.2 Cabling for strata SDU served via pole

The demarcation cabling boundary between NFP and developer will be at FDH as shown in Figure 43.

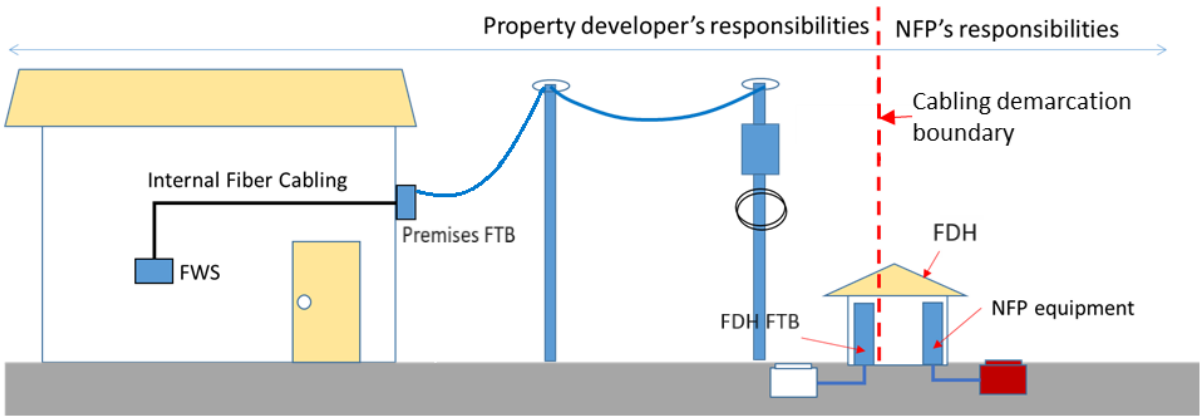

Figure 43. Strata SDU cabling demarcation boundary for pole type

Developer shall be responsible for the cabling from FDH to FWS whereby property owner to own and maintain the cabling between FTB and FWS. JMB or MC shall responsible to maintain the cabling between FDH and FTB.

6.2.3 Cabling for non-strata SDU served via underground

The pedestal manhole will be the cabling demarcation boundary between NFP and developer as shown in Figure 44.

Developer shall be responsible for the cabling from FWS to the pedestal manhole.

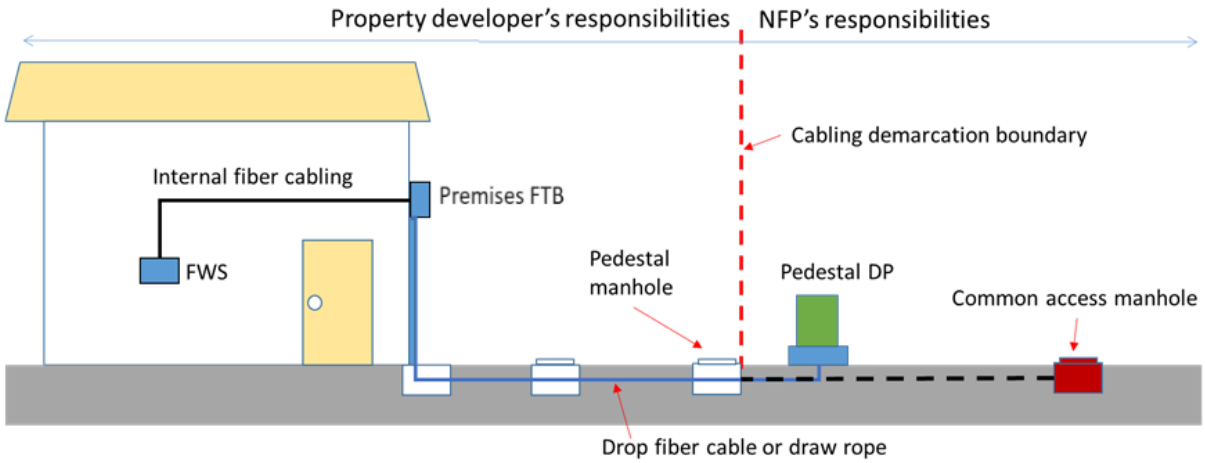

Figure 44. Non-strata SDU cabling demarcation boundary for underground type

6.2.4 Cabling for strata SDU served via underground

The TR will be the cabling demarcation boundary between NFP and developer as shown in Figure 45.

The developer shall be responsible for the cabling from FDH to FWS (refer 5.5.1 for FDH requirements) whereby property owner to own and maintain the cabling.

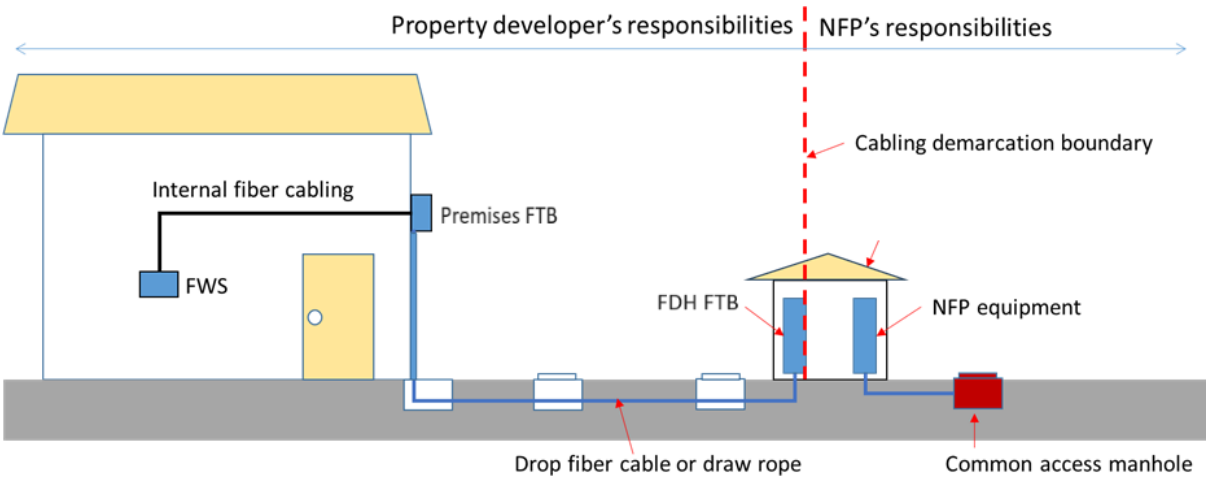

Figure 45. Strata SDU cabling demarcation boundary for underground type

6.2.5 Drop fibre cable for SDU served via underground

For SDU served via underground, drop fibre cable shall be prepared by developer between FTB and pedestal manhole and property owner to own and maintain the cabling, where it shall be:

a) terminated inside the FTB with connector (on FTB side); and

b) coiled inside the pedestal manhole without any connector (on the pedestal manhole side).

Pedestal Distribution Point (DP) should be installed by NFP during activation by pulling and terminating the drop fibre to the pedestal DP. The drop fibre shall fulfil the following requirements:

a) Properly stored inside the pedestal manhole.

b) Coiled inside the plinth or pedestal manhole with around 10 m length (developer may consult with NFP for the accurate length).

c) Labelled with each unit of premises number for easy identification and the label shall be made from polyethylene or any material which is able to sustain up to 10 years or more to avoid faded or damaged tag.

d) Not exceeding 50 m length to ensure power attenuation loss is within allowable budget and easy to be maintained.

e) Minimum of 2 cores for each unit of premises.

6.2.5.1 Draw rope

As an option, for property whereby the distance between FTB and the pedestal manhole is less than 20 m, draw rope is allowed to replace the drop cable. Developer shall ensure the draw rope is in smooth condition and able to be used to pull drop fibre later.

Each draw rope shall be tagged and labelled with premises number, properly and securely stored inside the pedestal manhole.

All conduits or cable jointing closures shall be completely concealed to avoid any water leakage and shall not protrude to maintain the aesthetics either within or outside the customer premises. The sample connection for drop fibre is shown in Figure 46.

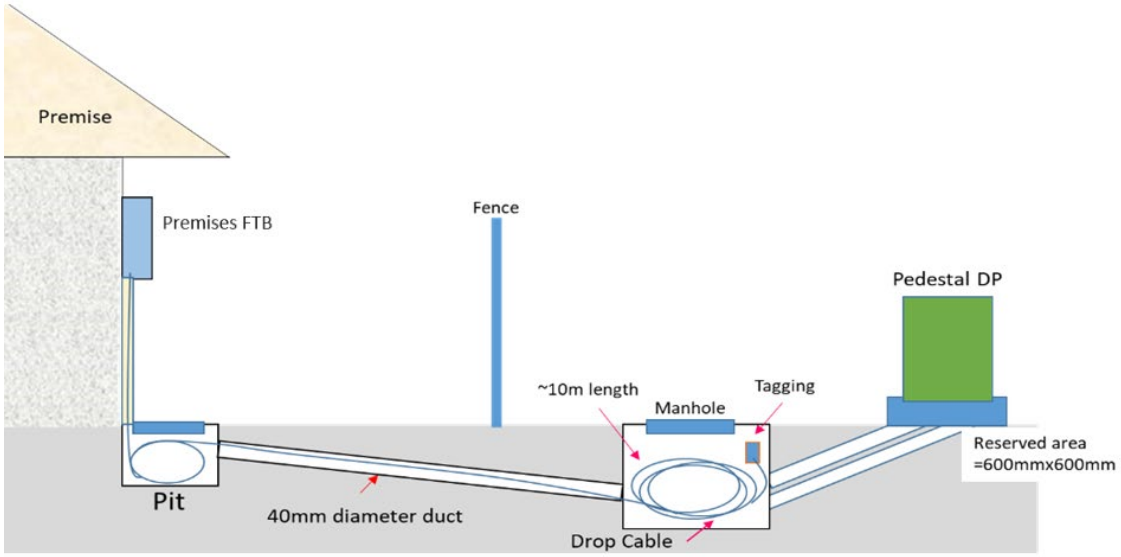

Figure 46. Connection of underground drop fibre

6.2.6 Cabling for town house type

Town house refers to the premises or properties that have multiple units inside the building with a single access.

The cabling design and demarcation points for town house served via pole and underground are as shown in Figure 47.

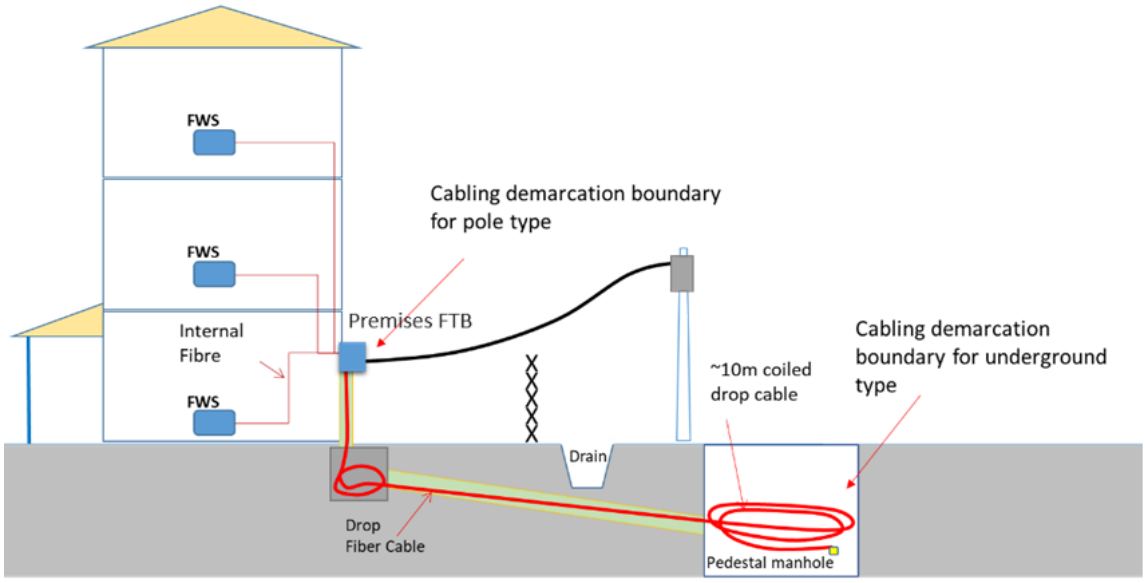

Figure 47. Cabling for town house type

Cabling requirements for town house shall be as specified in 6.2.1 and 6.2.2. FTB shall be installed at a common area and be accessible at all times.

6.2.7 Cabling for high-rise SDU

High-rise SDU is the premises less than 6 floors and generally not equipped with TR. The example of high-rise SDUs are shop lots, apartment and business building. The cabling for high-rise SDU without TR is shown in Figure 48.

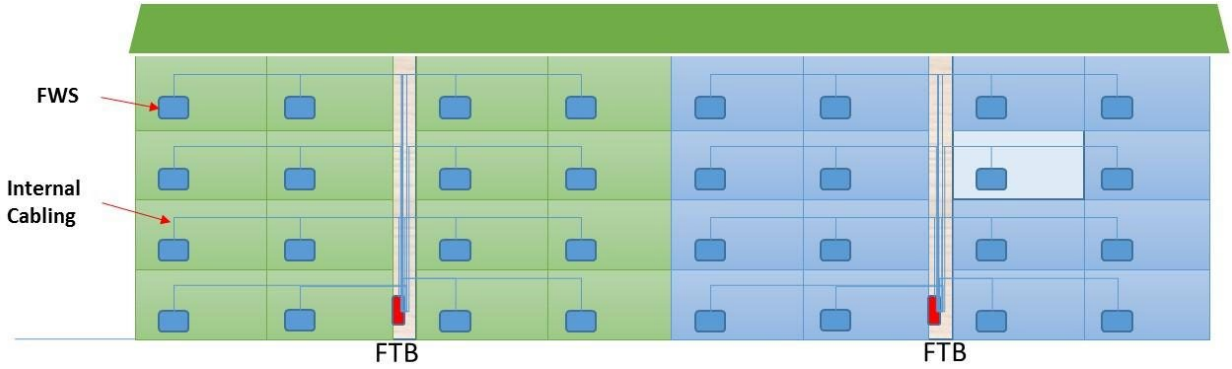

Figure 48. Cabling for high-rise SDU without TR

Developer and property owner shall prepare and maintain the FWS inside each premises unit and connected to FTB via internal fibre. FTB shall be placed in a common area and have easy access at all the time. FTB will act as connection point between NFP and each individual premises unit. A reserved space of minimum 600 mm x 600 mm beside the FTB shall be provided as shown in Figure 49.

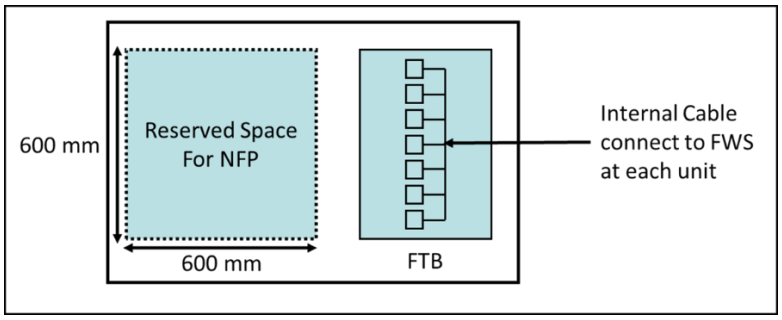

Figure 49. Reserved space near FTB

The reserved space shall be used by NFP to locate related network elements. NFP will connect the prepared cabling with the network element inside the FTB during the service activation.

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 premises number.

6.2.8 Power link budget for SDU cabling

Power link budget refers to the total attenuation loss allowable in certain portion of the network. Power link budget for SDU is measured as follows:

a) Between FWS and FTB for SDU served via pole.

b) Between FWS and pedestal manhole for SDU served via underground.

Developer shall perform the attenuation loss measurement of cabling for each premises and provide the test results to NFP during the acceptance process.

Total attenuation loss shall not exceed the following requirements:

a) 1.6 dB for non-strata SDU served via pole.

b) 2.3 dB for non-strata SDU served via underground.

6.2.8.1 Power link budget estimation for SDU served via pole

Sample calculation of allowable power link budget for SDU served via pole is shown in Table 10.

Table 11. Sample of cabling attenuation loss calculation for non-strata SDU served via pole

Location	Item	Unit loss (dB)	Unit/ length	Total loss (dB)	Details
FTB	FA-SC connection point	0.7	2	0.7	1 unit of FA-SC connector = 0.3 dB ~ 0.5 dB
Internal fibre	Cable 1 310 nm = 0.4 dB/km	0.4	50 m	0.02	Horizontal cable (50 m) = 0.02 dB
FWS	FA-SC connection point	0.7	1	0.7	1 unit of FA-SC connector = 0.3 dB ~ 0.5 dB
Other	Other marginal loss	0.2	1	0.2	N/A
			Total	**1.62**	**Total = 1.62 dB**
NOTE: For further details of internal fibre, please refer ITU-T G.652.D or G.657.A1					

In the sample, connector type at FTB and FWS uses the Field Assembly Standard Connector (FA-SC) which generally has higher attenuation loss. As an alternative, the use of Splice on Connector (SOC), fusion splicing or other method that may provide lower attenuation is highly recommended.

The length of fibre also contributes to the attenuation loss and shall be managed properly to ensure the total power link budget does not exceed the requirements.

6.2.8.2 Power link budget estimation for non-strata SDU served via underground

Sample calculation of allowable power link budget for SDU serve via underground is shown in Table 11. The measurement is between the drop fibre's end inside the pedestal manhole and FWS inside the premises.

Number of connectors, joints or length of cable are not specified and may be designed according to developer's preference.

In the sample as per Table 11, the connector type at FTB and FWS is FA-SC which generally has higher attenuation loss. As an alternative, the use of SOC, fusion splicing or other method that may provide lower attenuation is highly recommended.

Table 12. Sample of cabling attenuation loss calculation for non-strata SDU served via underground

Location	Item	Unit loss (dB)	Unit/ length	Total loss (dB)	Detail
Drop fibre end (inside pedestal manhole)	FA-SC connection point	0.7	1	0.7	1 unit of FA-SC connector =0.3 dB ~ 0.5 dB
Drop fibre	Cable 1 310 nm = 0.4 dB/km	0.000 4	50 m	0.02	Drop fibre (50 m) = 0.02 dB
FTB	FA-SC connection point	0.7	1	0.7	1 unit of FA-SC connector = 0.3 dB ~ 0.5 dB
Internal fibre	Cable 1 310 nm = 0.4 dB/km	0.000 4	50 m	0.02	Internal fibre (50 m) = 0.02 dB
FWS	FA-SC connection point	0.7	1	0.7	1 unit of FA-SC connector = 0.3 dB ~ 0.5 dB
Other	Other marginal loss	0.2	1	0.2	Other = 0.2 dB
			Total	**2.34**	**Total = 2.34 dB**
NOTE: For further details of internal fibre, please refer ITU-T G.652.D or G.657.A1					

6.3 Cabling for Multi-Dwelling Unit (MDU)

Internal cabling for MDU covers the elements from the FTB inside TR to the FWS inside the individual premises.

Cabling for MDU consist of 3 main elements as follows:

a) Vertical cabling.

b) Horizontal cabling.

c) Campus backbone cabling.

6.3.1 Cabling demarcation

Cabling demarcation for MDU is as shown in Figure 50.

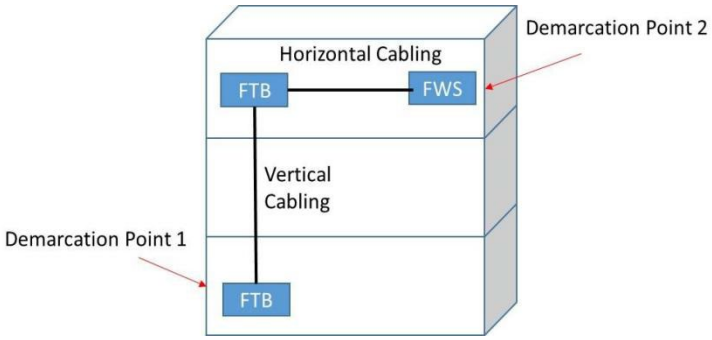

Figure 50. Network boundary for MDU

The responsible entities for MDU are NFP, developer, JMB or MC and individual premises owner. The cabling demarcations are as follows:

a) Demarcation point 1 (FTB)

The cabling from Demarcation point 1 to the outside of the building shall be provided by NFP and the cabling to the inside of the building until FWS shall be provided by developer, which then will be owned and maintained by the premises owner or JMB or MC.

b) Demarcation point 2 (FWS)

The cabling from Demarcation point 2 to the CPE is between premises owner and NFP. NFP will install the cable and CPE during service activation. The ownership of both elements depends on the service agreement between NFP and premises owner.

NFP shall install their equipment inside the TR. The connection between NFP's network and developer's FTB will only be performed upon service subscription where NFP will do the provisioning process at customer premises.

6.3.2 Vertical cabling

Vertical cabling refers to the cabling between FTB inside the TR and FTB on each floor within the same building. Vertical cabling shall be provided by the developer. After completion of the building construction, the ownership of the vertical cabling will be transferred to the JMB or MC. JMB or MC shall maintain and ensure all the cablings are in good and working condition. Minimum number of fibre cores for vertical cabling shall follow the rules as tabulated in Table 12.

Table 13. Number of fibre cores for vertical cabling

Type of building	Minimum number of fibre cores
Residential	2 x total premises unit + 30 % extra
Commercial	4 x total premises unit + 30 % extra

Example calculation of minimum number of vertical fibre cores capacity for residential building are as follows:

Number of units in the building : 100 units
Minimum number of vertical fibre cores : (2 cores x 100 units) + (30 % x 100 units)
= 200 + 30
= 230 cores

6.3.3 Floor Fibre Termination Box (FTB)

Floor FTB is a connection point between vertical cabling and horizontal cabling on every floor. Floor FTB is highly recommended to be prepared for easier expansion and maintenance of the vertical cabling.

The connection between vertical cabling and horizontal cabling inside the floor FTB can be done through direct splice joint or using the SC/UPC or SC/APC connector and pre-connected upon completion of the development.

Vertical cabling can also be directly terminated at FWS inside the individual premises without using the floor FTB.

6.3.4 Horizontal cabling

Horizontal cabling refers to the floor distribution cabling between floor FTB to every premises FWS with the capacity as follows:

a) Minimum of 2 cores for each premises for residential type.

b) Minimum of 4 cores for each premises for business type. However, 10 % extra cores are recommended to be prepared. Developer is recommended to consult with NFP for the appropriate capacity planning.

The cabling for horizontal fibre cabling should be secured through the following:

a) Exposed wall or surface ducting or trunking.

b) Concealed ducting inside the wall.

c) Concealed ducting under the floor.

d) Conduit ducting through the ceiling.

The size of the trunking and ducting depends on the capacity and size of the cable. The trunking or ducting of horizontal cabling shall be made from PVC or higher material. The minimum diameter of the trunking is as follows:

a) PVC conduit size of 50 mm diameter.

b) PVC casing size of 100 mm x 25 mm.

c) Metal clad trunking size of 100 mm x 25 mm.

6.3.5 Campus backbone cabling

Campus backbone cabling refers to the cabling from the NFP's interface TR to the link-up property's TR. All campus backbone cablings shall be directly terminated or pre-connected at NFP interface TR with clear and proper tagging and labelling. No additional patching shall be allowed to connect the link-up building during the service activation process. The use of high-capacity fibre cable (48 cores and above) is recommended for campus backbone cabling.

Campus backbone cabling shall be prepared by the developer and terminated at both property's FTB inside the TR The number of cores required shall be the same as specified in 6.3.2 for vertical cabling. A sample of campus backbone cabling is shown in Figure 51.

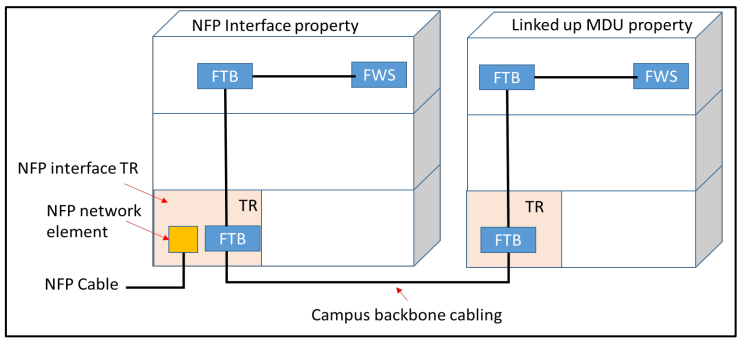

Figure 51. Campus backbone cabling

Total insertion loss between NFP interface TR's FTB and FWS inside the premises at link-up property shall not exceed 2.3 dB. If the insertion loss exceeds the requirement, the link-up property shall be designed to allow NFP to install the equipment inside the link-up property's TR. NFP should be allowed to use the campus backbone cabling for this purpose if applicable.

6.3.6 MDU internal cable distribution design

Cabling distribution design inside the development area depends on property type, capacity, type of material, competency of the contractor, and developer preferences. The developer is recommended to discuss with the NFP for the best design and method to be adopted. Sample designs that may be adopted by the developer are specified 6.3.6.1 until 6.3.6.4.

6.3.6.1 High capacity vertical cable (design 1)

Design 1 is highly recommended for high-capacity type of building. The example of design is as shown in Figure 52.

The methods for design 1 are as follows:

a) Several high capacity cables (96 cores and below) erected from TR main FTB through each floor and tapping out several cores at each level. It requires high skilled installation technique to tap out the related fibre cores at each floor.

b) At every floor, vertical cable is terminated depending on the number of cores required at that floor.

c) The erected vertical cable cores shall be jointed with horizontal cable through direct splicing or using a connector inside the floor FTB.

d) It is recommended to use drop cable or indoor cable type for horizontal cabling which generally consists of single or multiple cores.

e) Each horizontal cable shall be terminated at individual FWS.

f) Each unit shall use a different horizontal cable.

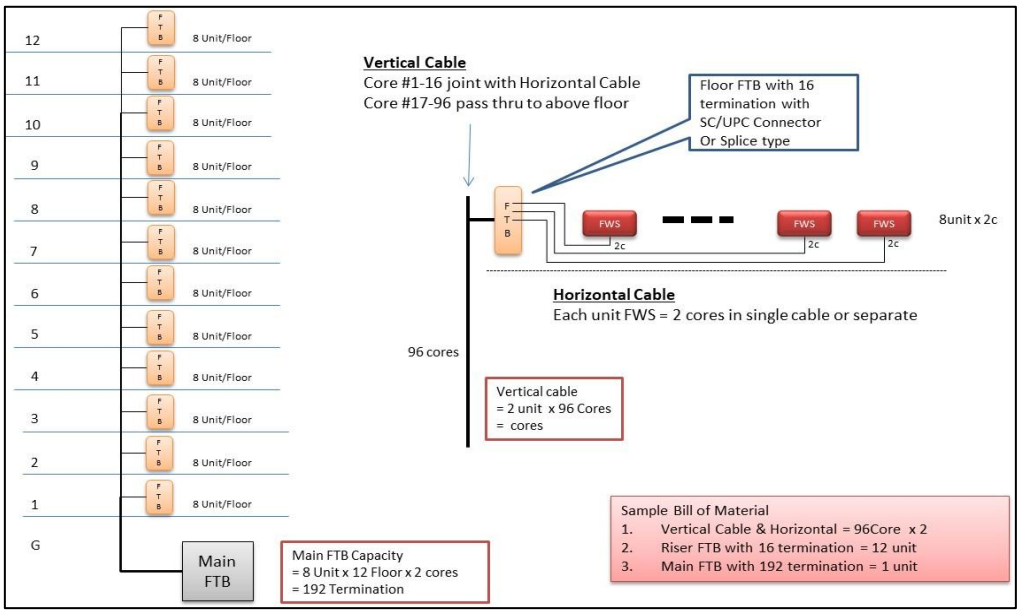

Figure 52. High-capacity vertical cable (cabling design 1)

6.3.6.2 Medium capacity vertical cable (design 2)

Design 2 is highly recommended for high or medium capacity building. The methods for design 2 are as follows:

a) Several medium (24 cores - 96 cores) capacity cables erected from TR's main FTB to every 3 floors.

b) The vertical cable cores shall be jointed with every floor's horizontal cable through direct splicing or using a connector inside the floor FTB. A single floor FTB is not allowed to be shared with more than 3 floors and shall be placed in the centre floor. Every floor FTB is only allowed to serve 1 floor above or 1 floor below the horizontal cabling.

c) The erected vertical cable cores shall be jointed with horizontal cable through direct splicing or using a connector inside the floor FTB.

d) It is recommended to use drop cable or indoor cable type for horizontal cable which generally consists of single or multiple cores. Each horizontal cable shall be terminated at individual FWS.

e) Each unit shall use different horizontal cable.

The example of design is as shown in Figure 53.

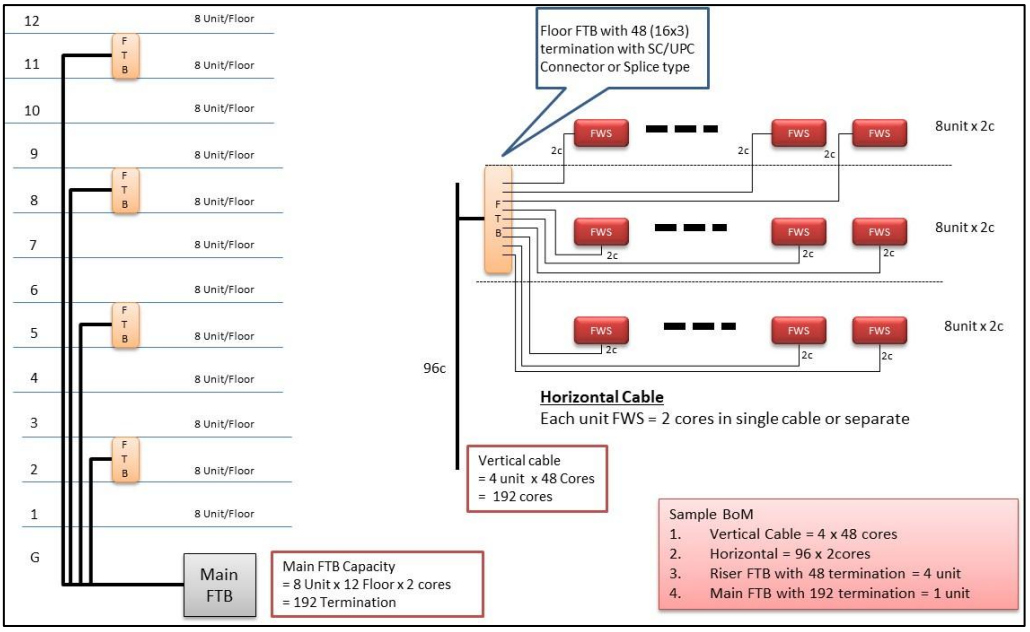

Figure 53. Medium capacity vertical cable (high capacity) (cabling design 2)

6.3.6.3 Single vertical cable to every floor (design 3)

Design 3 is highly recommended for low and medium capacity building. The methods for design 3 are as follows:

a) Single medium capacity of vertical cable (12 cores - 48 cores) erected from TR main FTB to every floor and jointed with horizontal cable at each floor.

b) At every floor, one vertical cable is erected depending on the number of cores required at that floor.

c) The erected vertical cable cores shall be jointed with horizontal cable through direct splicing or using a connector inside the floor FTB.

d) It is recommended to use drop cable or indoor cable type for horizontal cable which generally consists of single or multiple cores.

Each horizontal cable shall be terminated at individual FWS. Each unit shall use different horizontal cable. The example of design is as shown in Figure 54.

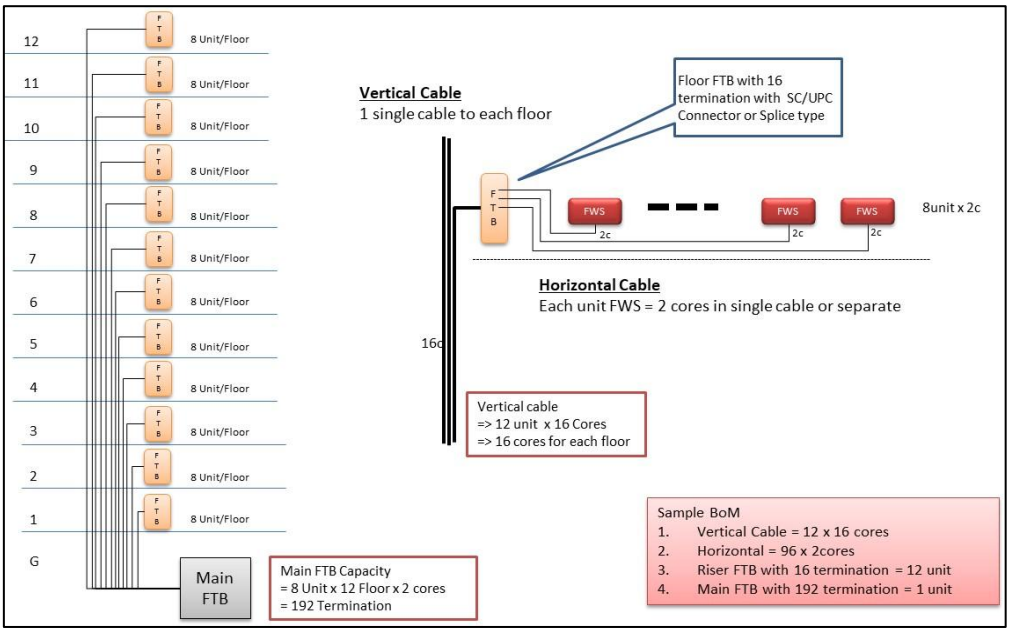

Figure 54. Single vertical cable to each floor (cabling design 3)

6.3.6.4 Single cable direct to each premises unit (design 4)

Design 4 is highly recommended for low-capacity building. A single 2 cores of indoor drop cable is erected from TR's FTB directly to each individual premises FWS. The example of design is as shown in Figure 55. The methods for design 4 are as follows:

a) Each unit shall use different cable.

b) No floor FTB is required. However, for better cable maintenance and management in future, it is also recommended to have the floor FTB.

c) Blown fibre system is an optional method with minimum 3.5 m micro duct inner diameter size that can be considered. Detailed specifications of micro duct are specified in Annex F.

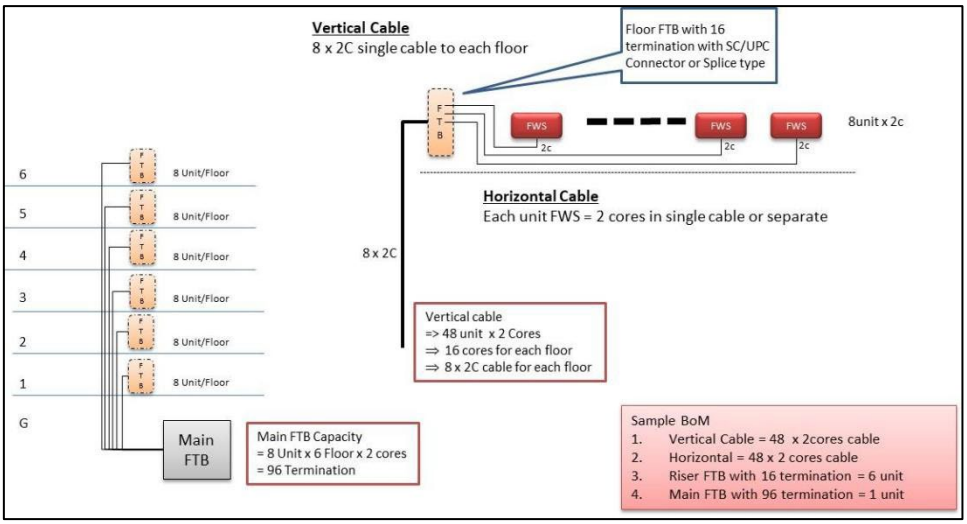

Figure 55. Single cable directly to premises unit (cabling design 4)

6.4 Cabling for campus and complex

Generally, for campus and complex property type, all the properties are connected to a single NFP interface FTB through campus and complex backbone cabling. The sample is as shown in Figure 56.

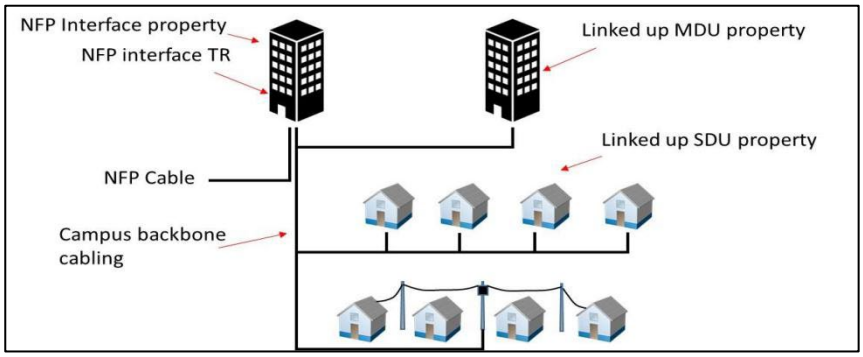

Figure 56. Sample of cabling for mixed property development area

Campus backbone cabling shall be prepared by developer to link up all the buildings with the NFP interface property. The cabling shall be prepared and pre-connected from NFP interface property FTB inside the TR to every individual unit FWS. The total loss between FTB and FWS shall be maximum 2.3 dB.

6.5 Cabling for landed strata development area

Cabling and all network elements in the landed strata development area shall be prepared by the developer. Sample of cabling for landed strata development area is as shown in Figure 57.

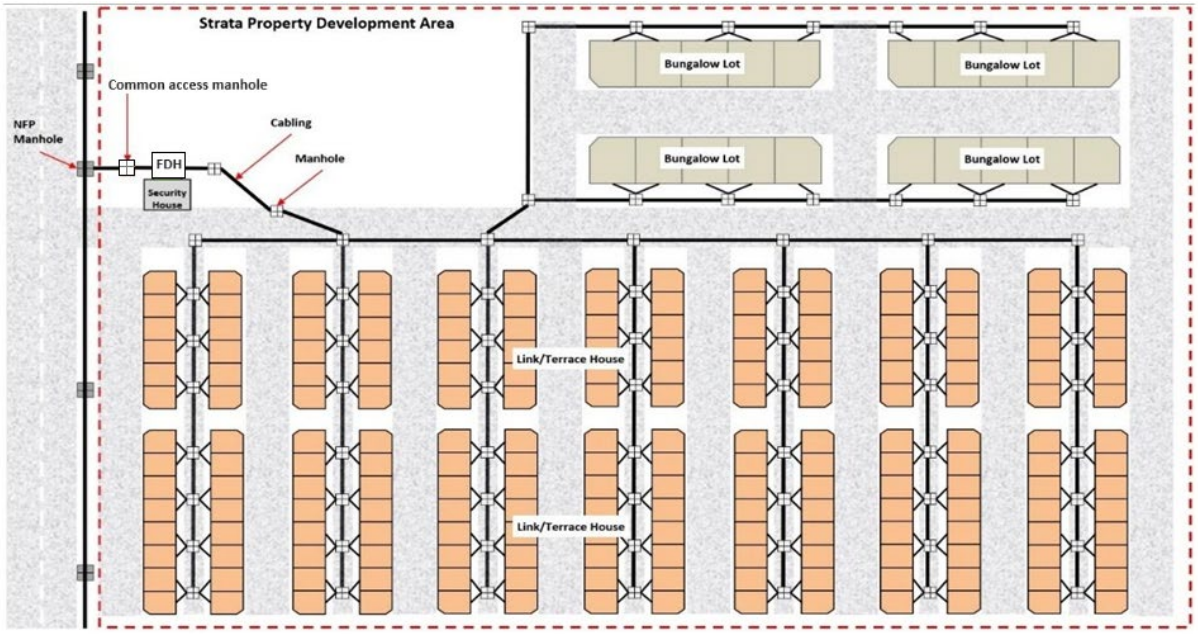

Figure 57. Cabling for landed strata development area

For landed strata development area, the cabling shall be pre-connected from FTB inside the FDH to the FWS inside the individual premises. The cabling can be through underground or on pole distribution.

All the cablings are highly recommended to be pre-connected from FTB inside the FDH to the FWS inside the individual premises to provide better network quality. The cabling shall be properly tagged and labelled accordingly.

NFP shall install their network element inside the FDH. The connection between NFP's network element and developer's FTB in the FDH will only be performed upon service fulfilment by NFP.

Sample of cabling and network elements are as shown in Figure 58.

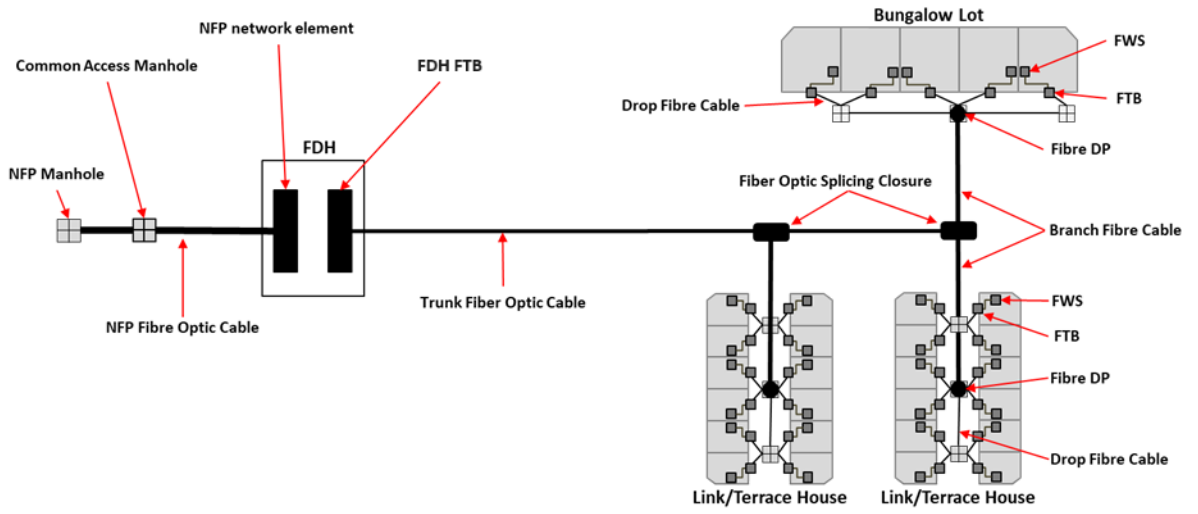

Figure 58. Cabling and network elements for strata development area

6.5.1 Fiber Optic Splicing Closure (FOSC)

Fibre Optic Splicing Closure (FOSC) is required to split and branch out from 1 fibre optic cable to multiple fibre optic cables as shown in Figure 58. FOSC can be installed in manhole or on pole.

All connection of fibre cable in the FOSC shall be connected via fusion splice. Size of FOSC shall be according to the number of cables which depending on size of development and number of premises.

Detailed requirements on the FOSC and specifications are as specified in Annex G.

6.5.2 Fiber Distribution Panel (FDP)

Fibre Distribution Panel (FDP) is required to distribute the drop fibre cable to each of the premises. The FDP shall be installed without any splitter. This is to ensure the power link budget is within the requirements as specified in 6.5.5.

FDP can be the underground, pedestal or pole type. Developer to ensure the security and sustainability of the FDP. All connections in the FDP are recommended to be connected through fusion splice or using SC/UPC or SC/APC connector. Every FDP is recommended to serve 8 to 16 premises.

Detailed requirements on the FDP and specifications are as specified in Annex H.

6.5.3 Trunk and branch cables

Trunk and branch cables are fibre optic cable which the capacity that can be in any size including but not limited to 384C, 144C, 96C, 48C or 24C. All trunk and branch cables shall be pre-terminated or pre-connected from the FTB in the FDH until the FDP during project development.

Single or multiple fibre optic cables can be used as the trunk and branch cable. The cables can be underground or overhead type. The total number of fibre cores connected to the FTB shall match the total number of premises in the development area.

For future and maintenance purposes, it is recommended to provide a spare of 20 % extra fibre core for trunk cable and 10 % extra fibre core for branch cable.

The fibre type and specifications are as specified in 6.7.2.

6.5.4 Drop fibre cable

Standard 2-core drop fibre cable shall be pre-installed or pre-connected from the FDP to the FWS in the premises. It can be connected through fusion splice or using SC/UPC or SC/APC connector in the FDP.

Detailed requirements on the drop fibre type and specifications are as specified in Annex J.

6.5.5 Power link budget estimation for strata development area

Power link budget refers to the total attenuation loss allowable in certain portion of the network. Power link budget for strata development area is measured between FTB in FDH and FWS in the premises.

The developer shall perform the attenuation loss measurement for each premises and provide the test results to NFP during the acceptance process.

Total attenuation loss shall not exceed 1.46 dB with maximum distance between FTB and furthest FWS is 1 km. If the distance is more than 1 km, it is recommended to construct another FDH.

Sample calculation of allowable power link budget for strata development area is as shown in Table 13.

Table 14. Sample of cabling attenuation loss calculation for strata development area

Location	Item	Unit loss (dB)	Unit/ length	Total loss (dB)	Details
FTB in FDH	SC UPC or APC connector	0.3	2	0.6	1 unit of connector = ~ 0.3 dB
Trunk and branch fibre cable	Cable 1 310 nm = 0.4 dB/km	0.4	1 000 m	0.4	Maximum distance from FTB to FDP
Drop fibre cable	Cable 1 310 nm = 0.4 dB/km	0.4	250 m	0.1	Maximum distance from FDP to FWS
FWS	SC UPC or APC connector	0.3	1	0.3	1 unit of connector = ~ 0.3 dB
Other	Other marginal loss (e.g., Splicing)	0.2	2	0.4	N/A
			Total	**1.8**	**Total = 1.8 dB**
NOTE: For further details characteristic of fibre cable, please refer ITU-T G.652.D or G.657.A1					

6.6 CPE cabling design

CPE cabling refers to the cabling between BTU and CPEs to provide other value-added services. CPE cabling may be considered for better customer experience to enjoy the broadband and value-added services provided by NFP. With a proper design of CPE socket and cabling, the end user may have the flexibility to provision their services at various locations depending on their preference.

The recommended CPE cabling types and designs are as follows:

a) CAT3 or higher cabling with RJ11 socket type for normal analogue voice services. However, if VOIP is used, the cabling type shall be Category 5 (CAT5) with RJ45 socket.

b) CAT5e or higher cabling with RJ45 socket for broadband services. The cabling is from BTU to CPE which may inclusive of Wi-Fi access point, internet switch, computer, IPTV Set-Top Box, or any device terminal that requires internet connection.

c) Single mode or multi-mode fibre for higher broadband speed or other type of CPE that may support fibre interface.

CPE cabling design connecting FWS and BTU to CPE sockets according to the type of services are shown in Figure 59.

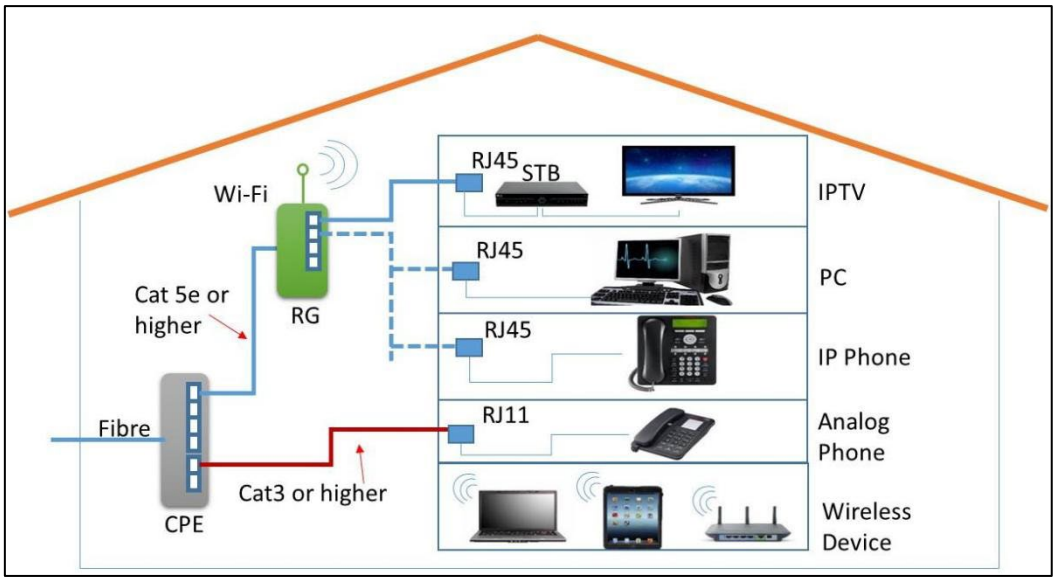

Figure 59. CPE cabling design

6.7 Cable specification

Cable specification for premises internal fibre shall be as shown in Table 14. All fibre cables shall be made from Low Smoke Zero Halogen (LZSH). For business area, anti-rodent or Fibre Reinforced Plastic (FRP) material is recommended to prevent the fibre breakdown in future.

Table 15. Specification of premises internal fibre

Cable	Cabling portion	Specification
Campus backbone	Main building's FTB TR or FDH to other building's FTB	Single mode ITU-T G.652.D
Trunk and Branch Cables	FDH until FDP	Single mode ITU-T G.652.D
Vertical cable	FTB at TR to each floor FTB	Single mode ITU-T G.652.D or ITU-T G.657.A1
Horizontal cable and premises internal cable	FTB or floor FTB to individual unit premises FWS	Single mode ITU-T G.657.A1
Drop cable	Individual unit premises and underground type premises	Single mode ITU-T G.657.A1

6.7.1 Internal fibre cable

Internal fibre cable is used for corridor and indoor cabling. It is suitable to be used for the following:

a) MDU horizontal cabling.

b) Premises internal cable.

c) Drop cable for underground type of deployment.

The structure of internal fibre is shown in Figure 60. The fibre shall be single mode type and comply with ITU-T G.657.A1. Detailed specifications are provided in Annex D.

Internal fibre cable is suitable for aerial, underground duct, inside the under-floor trunking, over ceiling trunking or exposed fixing along the wall. The characteristics are as follows:

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

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

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

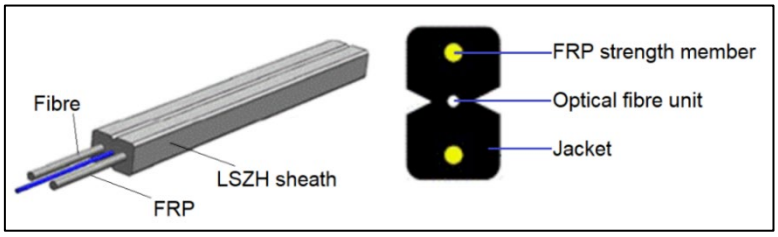

Figure 60. Structure of internal fibre cable

In addition, there are 3 specifications for this type of cable (1 cores, 2 cores or 8 cores), configured according to different requirements.

The main advantages of the indoor flexible fibre cables are as follows:

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 and IEC standards.

e) Multi-fibre core version of the same cable can be used as distribution cable (aerial or underground).

All cables shall be made from LZSH and anti-rodent material and shall be installed through the open or closed riser trunking. FRP or Aramid/Kevlar reinforced type is recommended.

6.7.2 Outdoor, vertical and campus backbone cable

Cable specification for campus backbone cable and vertical cable are usually the same. However, for campus backbone, it is usually erected through underground. Therefore, the underground type of cable shall be used.

The types of cable that can be used for vertical cabling are as follows:

a) normal conventional FOC or generally known as round cable.

b) indoor tight buffer cable.

c) loose tube cable.

d) blown fibre (detailed specifications are provided in Annex E).

All cables shall be single mode type and comply with the specifications of ITU-T G.652.D or ITU-T G.657.A1. Sample of campus backbone and vertical cable is shown in Figure 61 and Figure 62.

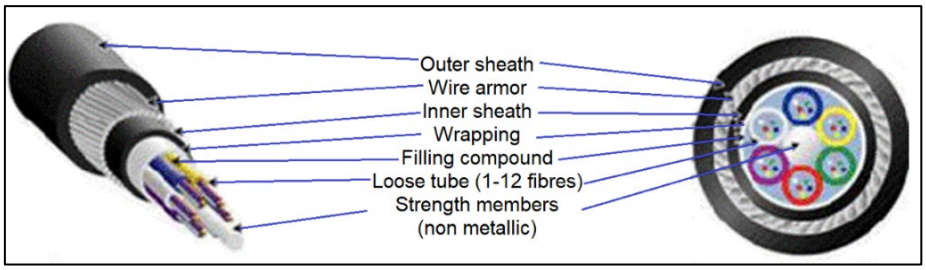

Figure 61. Possible vertical fibre cable design (loose tube)

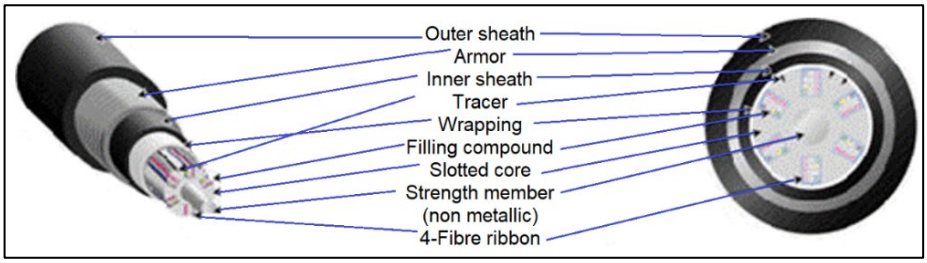

Figure 62. Possible vertical fibre cable design

Underground cables are designed for high pulling tension and lubricants are used to reduce friction on longer pulls. Automated pulling equipment that limits pulling tension shall able to protects the cables.

For very long runs or those with more bends in the conduit may require intermediate pulls through the manhole or any suitable pit.

Blown fibre technique may be used as an alternative to install the vertical and campus backbone cabling. It requires a special low friction with vacuum duct and shall be used together with micro cable type. Blown cable solution is as show in Figure 63.

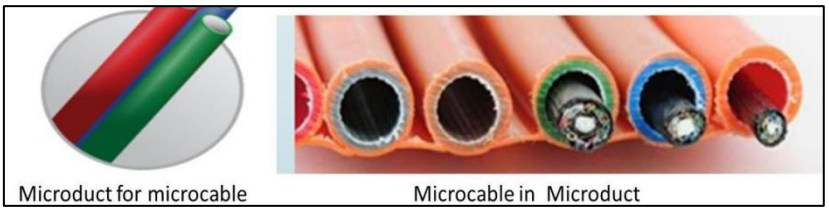

Figure 63. Possible micro cable with micro duct

Connection of underground cables using fusion splice method 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 tray, and the storage of excess cable shall be considered in the planning stage.

6.7.3 CPE cabling

The cable type for CPE outlet cabling depends on the CPE port interface, type of service and required bandwidth. The services are categorised by the various signal, frequency bandwidth, and data transmission speeds. The minimum specification of the cabling type to be prepared by developer is

Cat5e type for the broadband services and Cat3 for analogue telephone service. For other type of services, it shall be as shown in Table 15.

Table 16. CPE cable types and related supported services

Cable type	Bandwidth	Application limit	Remark
Cat 3 (ISO/IEC 11801 Class C TIA/EIA 568 B)	16 MHz	For voice telephony and ADSL in building or inter building	Minimum requirement
Cat 5e (ISO/IEC 11801 Class D TIA/ EIA 568 C)	> 100 MHz	For data transmission up to 1 GB/s transmission rate	For distance up to 100 m
Cat 6a ISO/IEC 11801 Class D (TIA/ EIA 568 C)	250 MHz to 500 MHz	For data transmission up to 10 GB/s transmission rate	For distance up to 100 m
Cat 7 ISO/IEC 11801 Class D (TIA/ EIA 568 C)	600 MHz	For data transmission up to 10 GB/s transmission rate	For distance up to 100 m
Cat 8 ISO/IEC 11801 Class D (TIA/ EIA 568 C)	2 000 MHz	For data transmission up to 40 GB/s transmission rate	For distance up to 100 m
Fibre optic (Multi-mode OM2/OM3/OM4)	> 200 MHz/km Depends on light source	For data transmission up to 10 GB/s transmission rate	For distance beyond 100 m
Fibre optic (Single-mode)	Depends on light source	For data transmission > 10 GB/s transmission rate	For distance beyond 100 m

6.8 Labelling and tagging

6.8.1 Tag material and specification

Cable tag is used to identify the cable information such as core number, origin and destination of the cable. All fibre cables shall be tagged properly at every termination point and cable end. All tags shall be stated clearly and sealed with transparent material for easy to read. Sample of recommended tagging method is as shown in Figure 64.

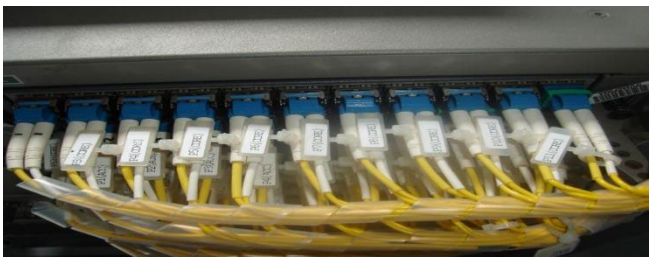

Figure 64. Sample of recommended tagging system

Cable tag shall use clear and strong material such as plastic, nylon, vinyl or PE. The tag shall comply with UL 94 V. All information on tag shall be machine printed and can easily be read. The printed material shall sustain, not paled or faded for a minimum 10-year. Usage of paper or market pen is strictly not allowed. Suitable tag size shall be used according to cable, pigtail or fibre core size. The generic recommended size is 1 cm x 2 cm flag type as shown in Figure 65.

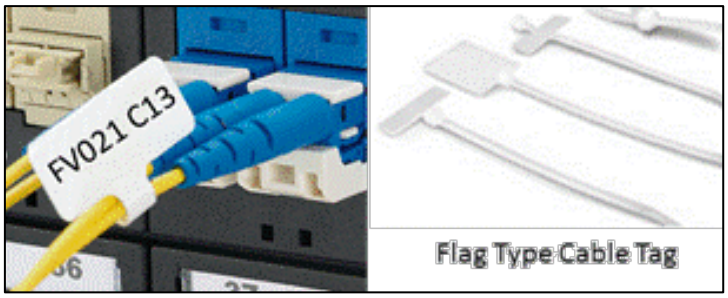

Figure 65. Cable tag

Tag colour shall be white background with black font. Sample of vertical cable tag is shown in Figure 66

Figure 66. Vertical cable tag

6.8.2 Labelling and tagging for SDU cabling

All internal cabling fibre cores shall be tagged and labelled with core number or any relevant information. The sample is as shown in Figure 67.

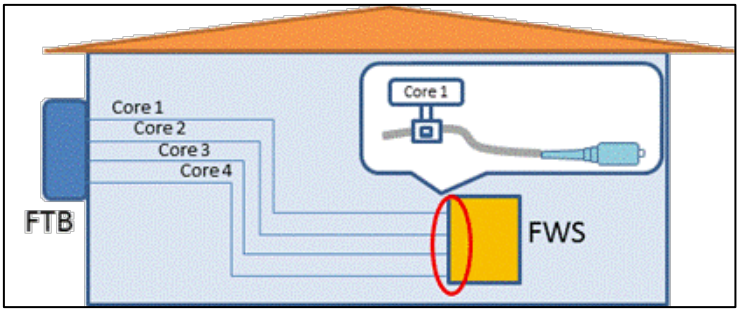

Figure 67. Labelling and tagging for premises internal cabling

However, if a single 2 cores of drop cable type is used inside individual premises, the labelling and tagging may not be required since it can be identified with the fibre core colour code; blue and yellow. Blue is for core 1 and yellow is for core 2. Each fibre core needs to be correctly connected as both ends to avoid the reverse core symptom. The sample is as shown in Figure 68.

Figure 68. Colour code for 2 cores of drop cable

Tagging and labelling of drop cable are required at the pedestal manhole interfacing with the NFP network side for SDU served via underground infrastructure. The tagging information shall clearly state a premises unit number for easier identification. The sample is as shown in Figure 69.

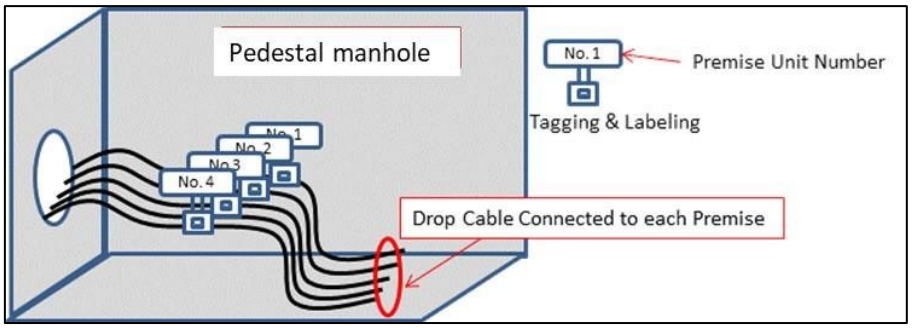

Figure 69. Labelling and tagging for SDU served via underground

6.8.3 Labelling and tagging of FWS and FTB

The identification shall be stated clearly at FWS and FTB port as shown in Figure 70.

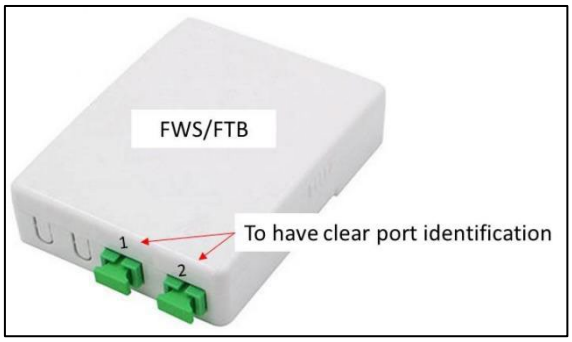

Figure 70. FTB and FWS port identification

6.8.4 Labelling and tagging for MDU cabling

All cablings for MDU shall have a code or naming convention and shall be tagged properly for smooth service activation and restoration process. All cable information also needs 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. JMB or MC shall record and update the information whenever there are any changes.

Code or naming convention for vertical and horizontal cabling shall follow as shown in Table 16. The table shall be placed inside the TR's FTB.

Table 17. Code for internal vertical and horizontal cable

Item	Vertical cable		Riser info	Horizontal cable	
	Cable number	Core number	Floor	Cable number	Core number
Code	FVxxx	xxx	FLxxx	FHxxx	xxx
Example	FV001 - FV999	000 - 999	FL020	FH001 – FH999	000 - 999

Vertical cable with FHxxx code shall be tagged at the following areas:

a) Entrance of FTB inside TR.

b) Entrance to the duct or riser inside TR.

c) Each floor riser.

Horizontal cable with FVxxx code shall be tagged at inside floor FTB (if any).

6.8.5 Labelling and tagging for landed strata cabling

All cablings for landed strata shall have a code or naming convention and shall be tagged properly for smooth service activation and restoration process. All cable information also needs 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 FDH or FTB for easier reference. JMB or MC shall record and update the information whenever there are any changes.

Code or naming convention for vertical and horizontal cabling shall follow as shown in Table 17. The table shall be placed inside the FDH's FTB.

Table 18. Code for trunk and branch cable

Item	Trunk cable		Branch cable	
	Cable number	Core number	Cable number	Core number
Code	FTxxx	xxx	FBxxx	xxx
Example	FT001 - FT999	000 - 999	FB001 - FB999	000 - 999

Trunk cable with FTxxx code shall be tagged at the following areas:

a) Entrance of FTB inside FDH.

b) Entrance to the duct or riser inside FDH.

c) Each FOSC.

d) FDP.

6.9 Testing and commissioning

All fibre cores shall be tested upon the completion of end-to-end cabling system. Minimum test parameter is total insertion loss of every fibre core. Other parameters such as optical return loss, component insertion loss, splice loss and distance may also be considered to ensure the cabling is at the best condition.

Total attenuation loss shall be measured using Optical Time Domain Reflectometer (OTDR), Optical Loss Test Set (OLTS) or set of light source and power meter. All test equipment shall be configured with wavelength of 1 310 nm.

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. Each link that does not conform to the standard requirement shall be brought into compliance.

Total attenuation loss between FTB and FWS shall follow as show in Table 18. All measurements shall be performed using 1 310 nm wavelength.

Table 19. Test location and maximum allowable loss

Property type	Test point A	Test point B	Maximum loss (dB)
SDU - pole type	Each individual premises FWS	FTB outside the premises	1.6
SDU - underground type	Each individual premises FWS	NFP interfacing manhole	2.3
MDU - single building	Each individual premises FWS	FTB inside TR	2.3
MDU - multi-building and landed strata	Each individual premises FWS	FTB inside NFP interfacing TR	2.3

6.9.1 Optical Loss Test Set (OLTS) test method

OLTS is a tool to measure point to point attenuation loss in a single cabling. OLTS is able to perform the bi-directional insertion loss measurement with multiple wavelengths together with other parameters such as optical return loss and distance. OLTS shall be used in pair and required to be placed at both ends. Details of the test procedure using OLTS is explained in TIA-568B or TIA/TSB 140. The test setup is as shown in Figure 71.

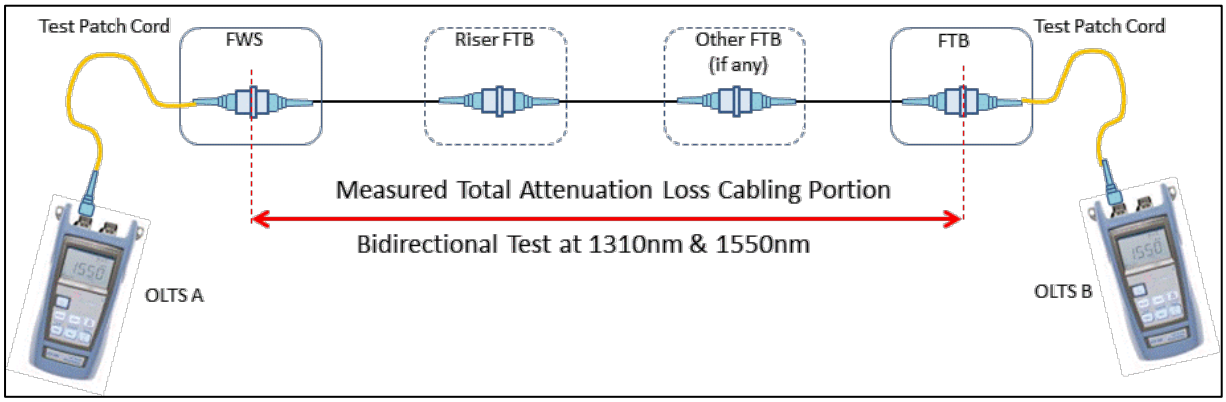

Figure 71. OLTS testing method

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.

6.9.2 Optical Time Domain Reflectometer (OTDR) test method

OTDR is a single ended measurement which is able to provide a total insertion loss, every event loss, distance, bi-directional result and ORL through a single measurement. Using the OTDR measurement, the following items should be considered:

a) To obtain the accurate measurement, the open end side shall be closed properly to avoid entering of the light that may contribute to the false light reflection to the test environment.

b) To measure the first connector that connected to the test patch cord, a minimum of 10 m dummy fibre shall be used between OTDR and the test adaptor. However, to get a better result the longer dummy fibre, i.e. 100 m length is recommended to be used.

c) At the open-end side, another minimum of 10 m length of dummy fibre also needs to be used to obtain the accurate measurement of the last connector.

d) A high quality of test patch cord shall be used to get the accurate measurement.

OTDR can provide each event measurement in the tested network and should be used during troubleshooting process. The sample test setup for OTDR measurement is as shown in Figure 72 which to add dummy patch cord at the end.

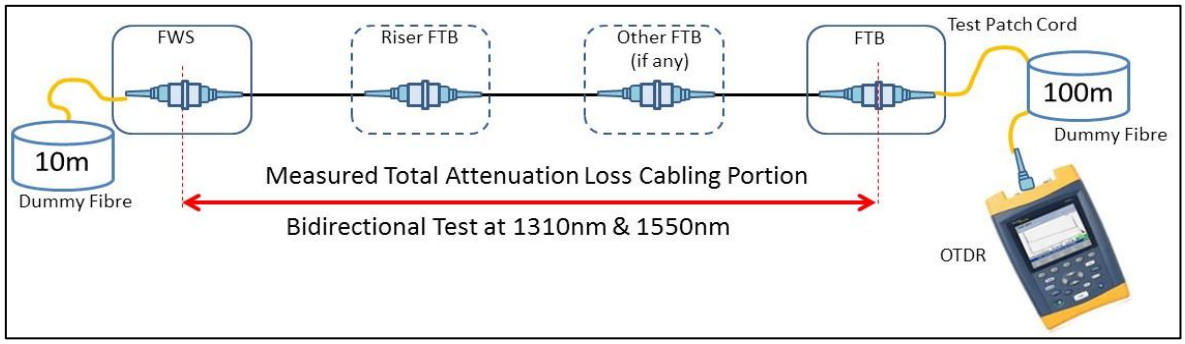

Figure 72. OTDR testing method

6.9.3 Power meter and light source test method

Power meter and light source is a single ended insertion loss measurement method and is able to provide the total insertion loss only.

To obtain the bi-directional result, both test equipment needs to be swapped and re-performed the test. The test setup shall follow as shown in Figure 73.

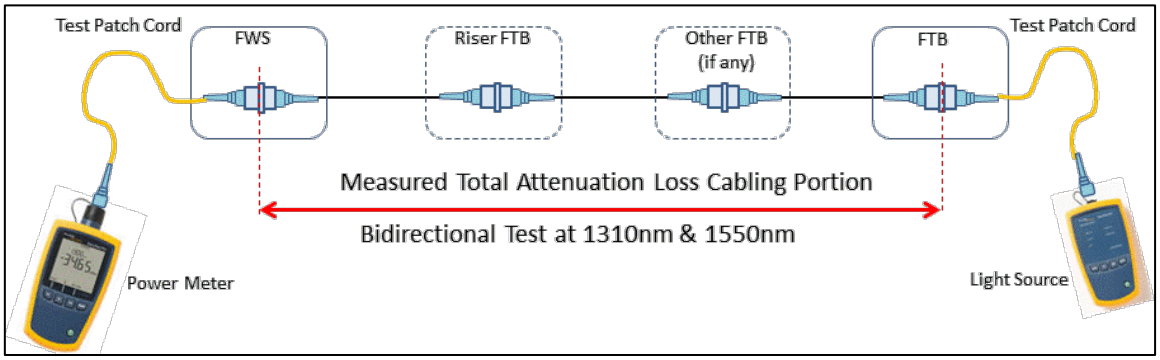

Figure 73. Power meter and light source testing method

Before performing any test, reference process using test patch cord is needed to reset the connection between power meter and light source. A high quality of test patch cord shall be used to get the accurate measurement.

6.9.4 Test result

Test result shall be provided to the NFP during acceptance procedure. All results presented to the NFP shall meet all the minimum requirements.

Test results are recommended to be printed in test equipment original version with the information of total bi-directional insertion loss at 1 310 wavelength.

The sample of recommended test results format is as shown in Table 19.

Table 20. Sample of recommended test results format

Building name	Seri Pinang Apartment						
Vertical cable no.	FV001						
FTB rack no.	Rack 1						
FTB sub-rack no.	Sub-rack 1						
Test item			**Insertion loss**		**Optical return loss (optional)**		
Test direction			**Downstream**	**Upstream**	**Downstream**	**Upstream**	
Rise FTB adaptor no.	**Premises unit no.**	**Floor no.**	**1 310 nm (dB)**	**1 310 nm (dB)**	**1 310 nm (dB)**	**1 310 nm (dB)**	**Distance (m)**
No. 1	A-1-01	1	1.1	1.1	33	33	100
No. 2	A-1-02	1	1.1	1.1	34	34	110
No. 3	A-1-03	1	1	1	36	36	120
No. 4	A-1-04	1	0.9	0.9	34	34	130
No. 5	A-2-01	2	1.1	1.1	34	34	100
No. 6	A-2-02	2	1.1	1.1	35	35	110
No. 7	A-2-03	2	1	1	34	34	120
No. 8	A-2-04	2	0.9	0.9	34	34	130
Remarks							
Tester							
Verified by NFP representative name							

NFP shall perform a random sampling test to ensure the test results submitted by developer is correctly captured. The sampling tests shall be done by the developer during the acceptance procedure with the witness of NFP's representative.

6.9.5 Test equipment calibration

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

6.10 Quality of the material

All cables and materials shall adhere to the relevant standards and specifications as defined in this Technical Code. The relevant documents to demonstrate compliance to the requirements shall be presented during acceptance procedure.

7 Infrastructure and cabling acceptance procedure

7.1 Infrastructure acceptance

7.1.1 NFP infrastructure acceptance request

The developer shall engage with selected NFP for infrastructure acceptance request at least 90 working days before the target date of infrastructure connection between common access manhole or pole and the NFP's infrastructure.

The acceptance procedure is recommended to be performed once the development of the external infrastructure as specified in 5.5 has reached 95 % of completion. Figure 74 illustrates the infrastructure acceptance procedure.

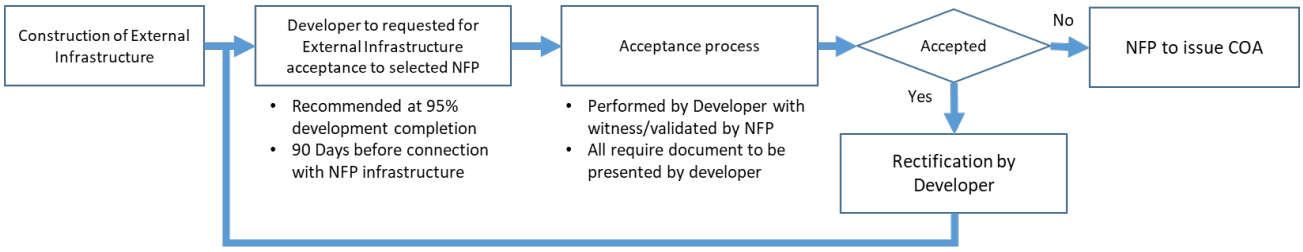

Figure 74. Infrastructure acceptance procedure

7.1.2 Documentation during infrastructure acceptance

For the purpose of infrastructure acceptance procedure, the developer is required to submit the following documents to NFP as defined below.

a) NFP infrastructure acceptance checklist endorsed by consultant or contractor **(**the sample is as shown in Annex K).

b) Relevant plan endorsed by the local authority during "*Kebenaran Merancang*" which illustrates the external infrastructure layout.

Upon completion of the acceptance process, NFP shall issue proof of acceptance e.g., Certificate of Acceptance (COA), if all the requirements as specified in this Technical Code are fulfilled.

7.2 Cabling acceptance

7.2.1 NFP cabling acceptance request

The developer shall engage with selected NFP for cabling acceptance request at least 14 working days before the target date of cabling or service connection.

The acceptance procedure is to be performed upon completion of the in-building infrastructure and cabling as specified in Clause 6. Figure 75 illustrates the cabling acceptance procedure.

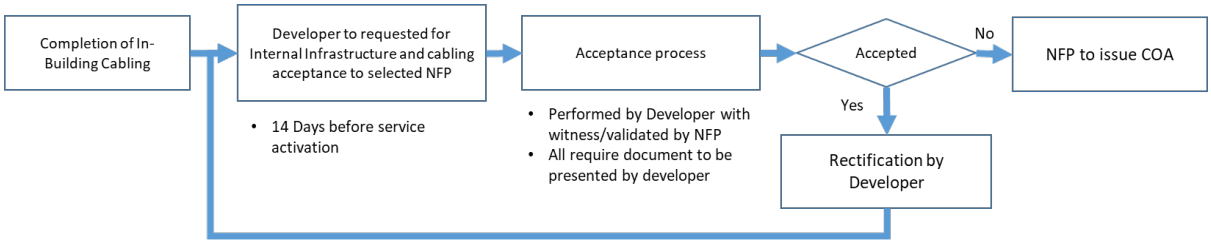

Figure 75. Cabling acceptance procedure

7.2.2 Documentation during cabling acceptance

For the purpose of cabling acceptance procedure, the developer is required to submit the following documents to NFP as defined below.

a) NFP cabling acceptance checklist endorsed by consultant or contractor **(**the sample is as shown in Annex K).

b) Relevant plan endorsed by the local authority during "*Kebenaran Merancang*" which illustrates the cabling layout.

c) As-built and cabling schematic line diagram.

d) Fibre core assignment (the sample is as shown in Annex L).

e) Cabling test results as specified in 6.9.4.

f) Calibration certificate of test equipment as specified in 6.9.

Upon completion of the cabling acceptance process, NFP shall issue proof of acceptance e.g., COA, if all the requirements as specified in this Technical Code are fulfilled.

7.3 Rules and regulations

The developer shall comply with all rules and regulations as follows:

The developer shall engage a trade contractor with proficiency certification on cabling provider by MCMC registered certifying agency, certification on Occupational Safety, Health and Environment (OSHE) by National Institute of Occupational Safety and Health (NIOSH) and registration by Construction Industry Development Board (CIDB).

a) The developer and NFP shall adhere to the agreed acceptance procedure.

b) The developer to prepare all the documentations required for all the processes for the acceptance procedure.

c) The developer to prepare all the necessary tools and test equipment.

d) All the relevant officers/personnel are required to be present during the acceptance procedure.

e) The developer to ensure all relevant permits are obtained and to be in compliance with all the relevant safety requirements.

f) All the non-complied items during acceptance procedure shall be rectified by the developer. The developer shall request a new acceptance test procedure to verify the rectified items.

8 Safety and precautions

Equipment and construction environment shall strictly adhere to the guidelines and standards issued by the relevant authorities.

8.1 Personal Protective Equipment (PPE)

All workers shall be equipped with Personal Protective Equipment (PPE) such as safety helmet, safety boot and safety vest, and the equipment shall be in good condition.

8.2 Construction environment

The construction environment and work area shall be in safe working conditions as follows:

a) Firefighting apparatus and material (i.e., smoke induction, temperature induction and other alarm devices) shall be prepared and in good working condition.

b) Power supply sockets for different voltages in the machine room must have clear identification.

c) Hazardous goods such as flammables and explosives are forbidden in machine room.

d) Reserved holes in the building must be fitted with safety cover.

e) Any additional safety precautions shall be considered to ensure the safety of work area.

Annex A
(Normative)

Normative references

Communication and Multimedia Act 1998 (Act 588)

Strata Management Act 2013 (Act 757)

Strata Titles Act 1985 (Act 318)

Uniform Building By-Laws 1984

MCMC MTSFB TC G025-1:2020 *Basic Civil Works - Part 1: General Requirements*

MCMC MTSFB TC G025-2:2020 *Basic Civil Works - Part 2: Open Trench*

IEC 60364-1 *Low-voltage electrical installations - Part 1: Fundamental principles, assessment of general characteristics, definitions*

IEC 60529 *Degrees of protection provided by enclosures (IP Code)*

IEC 60794-1-21 *Optical fibre cables - Part 1-21: Generic specification - Basic optical cable test procedures - Mechanical tests methods*

IEC 60794-1-22 *Optical fibre cables - Part 1-22: Generic specification - Basic optical cable test procedures - Environmental test methods*

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

IEC 61300-2-12 *Fibre optic interconnecting devices and passive components - Basic test and measurement procedures - Part 2-12: Tests - Impact*

IEC 61300-2-1 *Fibre optic interconnecting devices and passive components - Basic test and measurement procedures - Part 2-1: Tests - Vibration (sinusoidal)*

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.652.D *Characteristics of a single-mode optical fibre and cable*

ITU-T G.657.A1 *Characteristics of a bending-loss insensitive single-mode optical fibre and cable*

EN 60529 *Degrees of protection provided by enclosures (IP Code)*

ANSI/ICEA S-104-696 *Indoor-Outdoor Optical Fiber Cable*

BS EN 62305-4 *Protection against lightning - Electrical and electronic systems within structures*

GR-771 *Generic Requirements for Fiber Optic Splice Closures*

TIA/EIA 455-53 *FOTP-53 Attenuation by Substitution Measurement for Multimode Graded-Index Optical Fibers or Fiber Assemblies Used in Long Length Communications Systems*

TIA/EIA 455-61 *Measurement of Fiber or Cable Attenuation Using on ODR*

TIA/EIA 568 *Commercial Building Telecommunications Cabling Standard*

TIA/TSB 140 *Additional Guidelines for Field- Testing Length, Loss and Polarity of Optical Fiber Cabling Systems*

UL 94 V *Tests for Flammability of Plastic Materials for Parts in Devices and Appliances*

UL 746C *Standard for Polymeric Materials - Use in Electrical Equipment Evaluations*

Annex B
(informative)

Abbreviations

AC	Alternating Current
ARS	Automatic Restoration System
BTU	Broadband Termination Unit
CAT3	Category 3
CAT5	Category 5
CAT5e	Category 5 Enhance
CCTV	Closed-Circuit Television
CO	Central Office
COA	Certificate of Acceptance
CPE	Customer Premises Equipment
DB	Distribution Box
DP	Distribution Point
DSL	Digital Subscriber Line
ELCB	Earth Leakage Circuit Breaker
ELV	Extra Light Voltage
FA-SC	Field Assembly Standard Connector
FDF	Fibre Distribution Frame
FDH	Fibre Distribution House
FDP	Fibre Distribution Panel
FOC	Fibre Optic Cable
FOSC	Fibre Optic Splicing Closure
FOTS	Fibre Optic Trunking System
FRP	Fibre Reinforced Plastic
FTB	Fibre Termination Box
FTTP	Fibre To The Premises
FWS	Fibre Wall Socket
GI	Galvanised Iron
HDPE	High-Density Polyethylene
IP	Internet Protocols
IPTV	Internet Protocol Television
JMB	Joint Management Building
LAN	Local Area Network
LZSH	Low Smoke Zero Halogen

MC	Management Corporation
MCB	Main Circuit Breaker
MDU	Multi-Dwelling Unit
NFP	Network Facilities Provider
NSP	Network Service Provider
OLTS	Optical Loss Test Set
ONU	Optical Network Unit
OSHE	Occupational Safety, Health and Environment
OTDR	Optical Time Domain Reflectometer
P2MP	Point-to-Multipoint Fibre
P2P	Point-To-Point
PMD	Polarisation Mode Dispersion
PON	Passive Optical Network
PPE	Personnel Protective Equipment
PPL	Private Property Line
PSTN	Public Switched Telephone Network
PVC	Polyvinyl Chloride
RJ11	Registered Jacket type 11
RJ45	Registered Jacket type 45
SC/APC	Standard Connector/Angle Polished Connector
SC/UPC	Standard Connector/Ultra Polished Connector
SDU	Single Dwelling Unit
SOC	Splice on Connector
Sub-MC	Subsidiary Management Corporation
TPN	Three Phase and Neutral
TR	Telecommunication Room
uPVC	Unplasticised Polyvinyl Chloride
VoIP	Voice over Internet Protocol

Annex C
(Normative)

Specifications of Fibre Termination Box (FTB)

a) The FTB shall be suitable for attachment to inside or outside wall of a building.

b) The material shall be able to protect the component against harsh, high heat and humidity environment. The FTB shall be designed and conforms to IP44 of IEC 60529 Ed. 2.1 or better for indoor application and IP54 of IEC 60529 Ed. 2.1 standards or better for outdoor application.

c) The FTB shall be suitable for 19-inch rack-mount and/or wall mounted. The offered FTB shall complete with its respective mounting kits.

d) The frame of the high density and medium density FTB shall be fabricated from electro-galvanised steel or rust proof steel plating of thickness not less than 2.0 m and the design shall conform to ISO 2081 or other recognised standards.

e) The frame of the premises FTB and FWS 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 UL94.

f) The FTB shall be designed with built-in splitter or without splitter.

g) All edges shall be rounded.

h) Total weight of the FTB including full accessories shall be suitable for wall mounting.

i) For high density FTB, the maximum overall dimension shall be 406 m (H) x 457 m (W) x 152 m (D).

j) For premises FTB, the maximum overall dimension shall be 203 m (H) x 127 m (W) x 38 m (D).

k) The developer shall propose different sizes and capacity to provide cable management and connection of fibre installation for high, medium, low and single number of premises including FWS.

l) The developer shall furnish detailed specification and characteristic of the various sizes of the FTB and FWS offered during the submission of proposal for evaluation by selected NFP.

m) The developer shall submit proposed technical drawings complete with dimensions for the product offered.

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

o) The FTB design shall have suitable splice tray and cable management area to provide for minimum bending radius and for storage ruggedised splitter pigtails.

p) Suitable number of splices organised 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.

q) 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.

r) The FTB shall have pre-assembled plates with Standard Connector/Ultra Polished Connector (SC/UPC) or Standard Connector/Angle Polished Connector (SC/APC) type of adaptor coupling for fibre patching.

s) It shall be designed with 2 physically separated compartments to isolate the incoming cable (capable of accommodating splitter where needed) from the drop fibre compartment.

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

u) The FTB shall be provided with various sizes of cable entries at both top and bottom. All cable entries shall be provided with rubber gromets to protect the cable and prevent pest and dirt entry.

v) The rubber gromets shall have suitable guides for different cable sizes to permits pass through of additional fibres.

w) The FTB design shall be economical, effective, robust and compact to provide access point for drop fibre and internal fibre.

x) Each FTB 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 FTB.

y) Approved laser caution signs as per IEC 60825-1 Ed 2.0 requirements shall be provided as standard for every FTB.

z) An inventory list containing lists of components or parts supplied and operation and installation manual shall be provided with each FTB.

aa) For strata with FDH, the FTB should be able to support maximum number of fibre terminations capacity. Multiple FTB is acceptable if the number of fibre terminations are more than a standard closure.

bb) The FTB design shall support cable and patch cord management to allow full radius of bending protection.

Annex D
(Normative)

Specifications for in-building fibre cable

D.1 In-building fibre cable

a) In-building fibre cable shall be single-mode type reinforced with FRP for indoor applications.

b) Fibre characteristic are as follows:

   i) The fibre characteristic shall be in accordance with the ITU-T G.657.A1 (bend insensitive fibre ≤ 15 m bending radius).

   ii) Macro bending loss performance at 1 550 nm and 1 625 nm regions km in accordance with Clause 7 of ITU-T G.657.A1 Class A .

   iii) In order to ensure low loss operation at 1 550 nm and 1 625 nm regions, the increase in loss for 10 turns of the loosely wound fibre using a mandrel with 15 m radius shall be less than 0.5 dB.

   iv) Maximum loss at 1 550 nm shall be 0.25 dB and at 1 625 nm shall be 1.0 dB.

c) Proof stress shall not be less than 0.69 Gpa.

d) Chromatic dispersion coefficient shall be as follow:

   i) Zero dispersion slope shall be less than and equal to 0.092 ps/nm^{2}km.

   ii) Zero dispersion wavelength shall range from 1 300 nm to 1 324 nm.

e) The attenuation coefficient of the fibre shall be as follows:

   i) Maximum 0.35 dB/km – from 1 310 nm to 1 625 nm regions.

   ii) Maximum 0.4 dB/km in the 1 383 nm ± 3 nm region.

   iii) Maximum 0.3 dB/km in the 1 550 nm region.

f) Polarisation Mode Dispersion (PMD) Coefficient - PMD link design value shall be maximum of 0.2 ps/√km in accordance with Clause 7 of ITU-T G.657.A1 Class A.

g) Optical fibre shall be placed in between 2 strength members. The construction of the in-building drop fibre shall be 1 fibre or 2 fibre cores.

h) The colour coding shall be as Table D.1.

Table D.1. In-building fibre cable colour coding

Number	Fibre
1	Blue
2	Yellow

i) The cable shall contain FRP material as cable strength member. Nominal diameter for FRP shall be 0.4 m.

j) The in-building drop fibres nominal outer diameter shall be 3.1 m x 2.0 m.

k) The in-building drop fibres shall be sheathed with polyethylene and flame-retardant characteristic. Performance on oxygen index of sheath shall be ≥ 27.

D.2 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 in-building 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.

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

D.3 Bend test

a) The cable shall be unwound and 10 turns shall be wrapped in a close helix around a mandrel of radius 15 m.

b) The turns shall be applied at a uniform rate of 1 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. Finally, measurement shall show no change to the optical characteristics of the cable.

Annex E
(Normative)

Specifications for blown fibre

Blown fibre is an alternative for in-building fibre cabling system of which the specifications are as follows:

a) In-building fibre cable shall be single-mode in-building fibre using blown fibre distribution system for in-building applications.

b) Fibre characteristic shall be in accordance with ITU-T G.657.A1 (bend insensitive fibre ≤ 15 m bending radius).

c) Macro bending loss shall comply to the following requirements:

   i) The loss performance at 1 550 nm and 1 625 nm regions shall be in accordance with Clause 7 of ITU-T G.657.A1 Class A.

   ii) In order to ensure low loss operation at 1 550 nm and 1 625 nm regions, the increase in loss for 10 turns of the loosely wound fibre using a mandrel with 15 m radius shall be less than 0.5 dB.

   iii) Maximum loss at 1 550 nm shall be 0.25 dB and at 1 625 nm shall be 1.0 dB.

d) Proof stress shall not be less than 0.69 Gpa.

e) Chromatic dispersion coefficient shall be as follow:

   i) Zero dispersion slope shall be less than and equal to 0.092 ps/nm^2.km.

   ii) Zero dispersion wavelength shall range from 1 300 nm to 1 324 nm.

f) The attenuation coefficient of the fibre shall be as follows:

   i) Maximum 0.4 dB/km – from 1 310 nm to 1 625 nm regions.

   ii) Maximum 0.4 dB/km in the 1 383 nm ± 3 nm region.

   iii) Maximum 0.3 dB/km in the 1 550 nm region.

g) PMD coefficient – PMD link design value shall be maximum of 0.2 ps/√km in accordance with Clause 7 of ITU-T G.657.A1 Class A.

h) Optical fibre shall be placed within fibre micro ducts having properties such as follows.

   i) Low flammability.

   ii) Low smoke.

   iii) Low acid or fume.

   iv) Low halogen.

i) The construction of the in-building fibre shall be 1 fibre or 2 fibre cores.

j) The colour coding shall be as Table E.1.

Table E.1. Blown fibre cable colour coding

Number	Fibre
1	Blue
2	Yellow

Annex F
(Normative)

Specifications for micro duct

F.1 Micro duct

a) The micro ducts shall be numbered.

b) The micro duct nominal outer diameter shall be 5 m.

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

d) The micro duct shall be ivory colour and shall not promote the growth of fungus.

e) The micro duct 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 micro duct 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 micro duct. The preferred marking colour will be white.

h) The general cable performance test of the offered in-building 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.

i) The tensile strength of the micro duct shall be in excess of 70 N.

F.2 Bend test

a) The fibre shall be unwound and 10 turns shall be wrapped in a close helix around a mandrel of radius 15 m.

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.

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

Annex G
(Normative)

Specifications for Fibre Optic Splicing Closure (FOSC)

G.1 Design and construction

Items		Requirements	
a)	Type	The FOSC shall be able to store up to 240 fibre optic splices.	
b)	Concept	Butt configuration closure for single fibre splice.	
c)	Material	a) The outer components of the enclosures are made of high impact thermoplastic material equipped with ultraviolet protection. b) All the polymeric and sealant material should be resistant to solvents, stress cracking and creep and not support mould growth under Malaysia weather condition. c) Enclosure's sealant system (excluding cable sealant system) shall be reusable type. d) All the metallic parts and accessories should be made of corrosion resistance material.	
d)	Ingress protection rating	IP 68 of IEC 60529 or EN 60529	
e)	Cable entry main port style	Oval	
f)	Cable entry branch port style	Round	
g)	Cable Entrance, capacity	Minimum 5 (1 oval and 4 rounds)	Maximum 7 (1 oval and 6 rounds)
h)	Cable compatibility, diameter	Oval	2 x Ø 18.7 mm
j)		Round	Up to Ø 18.7 mm
k)	Cable sealing type	Heat shrink	
l)	Closure sealing type	Dome-to-base mechanical clamp with O-ring	
m)	Splicing type	Single splice	
n)	Splicing capacity	24 splice per tray	
o)	Storage or bucket tray	Support up to 15 uncut tubes (Ø 2.0 mm - 2.5 mm) with total 1.5 m each in length	
p)	Mounting	i) Pole mount ii) Manhole wall	

G.2 Mechanical and environmental performance

Physical test		Standards	Requirements
a)	Cable retention	GR-771-Core	No mechanical damage either to the cable clamping hardware or components within the FOSC
b)	Cable flexing		
c)	Cable torsion		
d)	Impact		No mechanical damage to the enclosure and its components
e)	Compression		
f)	Vertical drop	IEC 61300-2-12	
g)	Accelerated thermal aging	GR-771-Core	No visible deterioration, deformation, melting or cracking
h)	Vibration	IEC 61300-2-1	No mechanical damage to the enclosure and its components

Annex H
(Normative)

Specifications for Fibre Distribution Panel (FDP)

H.1 Design and construction

Type		Fibre distribution point
a)	Description	An enclosure that house 1 x 1:8 micro splitter that serves as a connection point between distribution cable and drop cable.
b)	Application	The FDP shall be able to be mounted on pole, wall, aboveground pedestal or underground
c)	Material	Pole or wall-mount and above ground pedestal i) The enclosures are made of polymeric material with minimum f2 rating when tested for UV test under UL 746C. ii) All the polymeric and sealant material should be resistant to solvents, stress cracking and creep and not support mould growth under Malaysia weather condition. iii) Enclosures and cable's sealant system should be reusable type. iv) All the metallic parts and accessories should be made of corrosion resistance material. Underground i) The outer components of the enclosures are made of high impact thermoplastic material equipped with ultraviolet protection. ii) All the polymeric and sealant material should be resistant to solvents, stress cracking and creep and not support mould growth under Malaysia weather condition. iii) Enclosures and cable sealant system should be reusable type. iv) All the metallic parts and accessories should be made of corrosion resistance material.
d)	Ingress protection (IP) rating	IP rating for pole or wall-mount and aboveground pedestal shall be at minimum IP54 and for underground shall be at minimum IP68.
e)	Cable entry configuration and capacity	Pole or wall-mount and aboveground pedestal i) 1 dual port (uncut tube or cable) + 1 individual port for distribution cable side. ii) 16 ports for drop cable side. Underground i) 1 dual port (uncut tube or cable) for distribution cable side. ii) 4 ports for drop cable side.
f)	Cable termination hardware	i) Strain relief bar + cable clamping at each distribution cable side. ii) Cable clamping at drop cable side.
g)	Cable compatibility	iii) Distribution cable ports: 10.00 mm to 13.05 mm iv) Drop cable ports: pre-connectorised 2 mm x 3 mm drop cable with standard SC connector
h)	Splice organiser (min splitter slot)	3
i)	Splice organiser (min Sps and slots)	12
j)	Splice organiser (adapter panel)	18 SC adapter and slot
k)	Splice organiser (general information)	i) Minimum 30 mm bending radius for fibre coil. ii) Support minimum 1.5 m length of distribution cable fibre slack. iii) Sperate coil for fibre slack and input/output splitter cord.

H.2 Mechanical and environmental performance

Physical test		Standards	Requirements
a)	Cable retention test	GR-771-Core	No mechanical damage either to the cable clamping hardware or components within the FOSC.
b)	Cable flexing test		
c)	Cable torsion test		
d)	Impact test - UG enclosure		No mechanical damage to the enclosure and its components.
e)	Compression test		
f)	Impact test - pole or wall-mount and pedestal enclosure	IEC 61300-2-12	
g)	Accelerated thermal aging test	GR-771-Core	No visible deterioration, deformation, melting or cracking.
h)	Vibration test	IEC 61300-2-1	No mechanical damage to the enclosure and its components.

Annex J
(Normative)

Specifications for drop fibre cable

J.1 Fibre attributes

Items		Requirements
a)	Fibre type	ITU-T G.657.A1 category A.
b)	Transmission wavelength	1 310 nm, 1 490 nm, 1 550 nm and 1 625 nm.
c)	Mode Field Diameter (MFD)	8.6 µm to 9.2 µm with ± 0.4 µm at 1 310 nm wavelength.
d)	Cladding diameter	125 µm ± 0.7 µm.
e)	Core concentricity error	0.5 µm (maximum).
f)	Cladding non-circularity	1.0 % (maximum).
g)	Cut-off wavelength	Cable cut-off wavelength (λ_{cc}) shall be maximum 1 260 nm.
h)	Macro bend loss	**Parameter** / **ITU-T G.657.A1**: Radius (mm): 15, 10; Number of turns: 10, 1; Maximum at 1 550 nm (dB): 0.25, 0.75; Maximum at 1 625 nm (dB): 0.1dB, 1.5
i)	Proof stress	0.69 GPa (minimum).
j)	Chromatic dispersion	i) Zero dispersion slope (S_{0max}) shall be less than and equal to 0.092 ps/nm^2.km. ii) Zero Dispersion Wavelength shall range from 1 300 nm (λ_{0min}) to 1 324 nm (λ_{0max}).

J.2 Cable attributes

Items		Requirements
a)	Attenuation coefficient	Maximum from 1 310 nm to 1 625 nm is 0.4 dB/km. Maximum at 1 550 nm is 0.3 dB/km. Maximum at 1 383 nm is 0.4dB/km.
b)	PMD	0.2ps/√km (maximum)

J.3 Cable construction

Items		Requirements
a)	Design	i) Bow type drop cable (underground application) ii) Bow type drop cable comes with Integral Bearer (IB) Wire (overhead application)
b)	IB wire diameter	Nominal Ø 1.2 mm
c)	Capacity (core)	2 (blue, yellow)
d)	Dimension (diameter)	i) 2.0 ± 0.2 mm x 3.1 ± 0.2 mm (without IB) ii) 2.0 ± 0.2 mm x 5.3 ± 0.2 mm (with IB)
e)	Strength member	FRP or Kevlar Fiber Reinforced Plastic (KFRP)
f)	Jacket material	i) Polyethylene flame retardant material ii) Oxygen index sheath shall be ≥ 27 iii) Carbon black for ultraviolet protection

J.4 Cable mechanical and environmental performance

Test type and method		Test condition	Requirements
a)	Tensile test Test method: IEC 60794-1-21/Method E1	i) Load: 80 N (sub-duct or micro-duct), 600 N (aerial pole). ii) Length under tension: ≥ 50m.	i) Change in attenuation ≤ 0.05 dB/km. ii) No residual elongation. iii) No damage to sheath, cable element and fibre.
b)	Cable bend test Test method: IEC 60794-1-21, Method E11	i) Load: 2 200 N/100 mm. ii) Mandrel or plate: 100 mm mandrel. iii) Duration: 1 min.	i) Change in attenuation ≤ 0.05 dB/km. ii) No damage to sheath, cable element and fibre.
c)	Crush test Test method: IEC 60794-1-21, Method E3	i) Mandrel Diameter: 30 mm (drop cable), 60 mm (HFDC). ii) No. of turn: 5 iii) No. of cycle: 3	
d)	Temperature cycle test Test method: IEC 60794-1-22, Method F1	i) Temperature range: - 30 °C to 70 °C ii) No of cycle: 2	

Annex K
(Normative)

Infrastructure acceptance checklist

The external infrastructure acceptance checklist is as shown in Table K.1.

Table K.1. External infrastructure acceptance checklist

No	Items	Type	Size	Excepted	Remark
1	Manhole	R2A/JC9C/JRC7			
2	Manhole ladder	R2A and above			
3	Manhole cover	7E			
4	Accessories	Pump / Blower			
5	Ducting	GI Pipe / PVC Pipe			
6	Draw rope	Nylon			
7	Ducting test	Mandrel			
8	Pit	PIT 18X30X18			

The internal infrastructure acceptance checklist is as shown in Table K.2.

Table K.2. Internal infrastructure acceptance checklist

No	Items	Excepted	Remark
1	SDF room		
2	Riser room		
3	FDP/FTB		
4	Riser/trunking		
5	Internal Wiring Test Result (OLTS)		
6	FWS		
7	Grounding test		

Annex L
(Informative)

Sample of core assignment

The sample core assignment as shown in Table L.1.

Table L.2. Sample of core assignment

FTB number	1														
FTB subrack	1														
FTB Port	Vertical Cable			FTB Port	Vertical Cable			FTB Port	Vertical Cable			FTB Port	Vertical Cable		
	Cable number	Core number	Cable number		Cable number	Core number	Cable number		Cable number	Core number	Cable number		Cable number	Core number	Cable number
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

Table L.1. Sample of core assignment *(continued)*

FTB number	**1**														
FTB subrack	**2**														
FTB Port	**Vertical Cable**			**FTB Port**	**Vertical Cable**			**FTB Port**	**Vertical Cable**			**FTB Port**	**Vertical Cable**		
	Cable number	**Core number**	**Cable number**		**Cable number**	**Core number**	**Cable number**		**Cable number**	**Core number**	**Cable number**		**Cable number**	**Core number**	**Cable number**
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

Table L.1. Sample of core assignment *(continued)*

FTB number	**1**
FTB subrack	**3**

FTB Port	**Vertical Cable**			**FTB Port**	**Vertical Cable**			**FTB Port**	**Vertical Cable**			**FTB Port**	**Vertical Cable**		
	Cable number	**Core number**	**Cable number**		**Cable number**	**Core number**	**Cable number**		**Cable number**	**Core number**	**Cable number**		**Cable number**	**Core number**	**Cable number**
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

Table L.1. Sample of core assignment *(concluded)*

FTB number	1													
FTB subrack	4													
FTB Port	Vertical Cable			FTB Port	Vertical Cable			FTB Port	Vertical Cable			FTB Port	Vertical Cable		
	Cable number	Core number	Unit number		Cable number	Core number	Unit number		Cable number	Core number	Unit number		Cable number	Core number	Unit number
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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