
# TECHNICAL STANDARD AND INFRASTRUCTURE REQUIREMENTS

## Part 1

## FIXED NETWORK INFRASTRUCTURE

## MTSFB 008 : 2005 (Revision 1)

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**Committee Representation**

The Fixed Network Infrastructure Sub Work Group operates under the wing of the main Multimedia Network Infrastructure (MNI) Work Group which is supervised by the Malaysian Technical Standards Forum Bhd (MTSFB) authorized by Malaysian Communications and Multimedia Commission (SKMM). The TSIR- Broadcast Network Infrastructure document was developed by various members whom are representatives from the following Broadcasters, Cabling manufacturer, Government Agencies, Manufacturer Associations and Professional Bodies, namely:

AMP Connectors Sdn Bhd

Association of Consulting Engineers, Malaysia

CableView Services Sdn Bhd (Mega TV)

Celcom Communication Sdn Bhd

Communication and Multimedia Commission, Malaysia

Construction Industry Development Board, Malaysia

Datacraft Malaysia Sdn Bhd

Department of Standards, Malaysia

Dewan Bandaraya Kuala Lumpur

Diamond Components Sdn Bhd

DiGi Telecommunications Sdn Bhd

Institution of Engineers, Malaysia

Jabatan Bomba Dan Penyelamat, Malaysia

Jabatan Kerja Raya, Malaysia

Leader Optic Fiber Cable Sdn Bhd

Malaysian National Computer Confederation

MAXIS Communication Sdn Bhd

Measat Broadcast Network Systems Sdn Bhd

MiTV Corporation Sdn.Bhd.

Natseven TV Sdn Bhd

SIRIM Berhad

Sistem Televisyen Malaysia Berhad (TV3)

Telekom Malaysia Berhad

Zettabits Technologies (M)SdnBhd

## Foreword

This Technical Standard and Guidelines was developed and recommended by the Cabling and Infrastructure Working Group in order to introduce Technical Codes and Standards for Broadcast Network Infrastructure. The development of this Technical Codes was carried out by this working group under the supervision of the Malaysian Technical Standards Forum Bhd (MTSFB) which has been authorized by Malaysian Communications and Multimedia Commission (SKMM).

The Technical Standard and Infrastructure Requirements (TSIR) documentation is intended as a reference for technical codes and standards for architects, consulting engineers, owners, Developers and others who are responsible for planning and erecting buildings. This is inline with the objective to meet the requirement of end users on broadcasting services (telecommunication) with minimum disruptions to all services offered by service providers.

TSIR consists of 5 main modules which are as follows:

Part 1: Fixed Network Infrastructure

Part 2: Broadcast Network Infrastructure

Part 3: Radio Communication Infrastructure

Part 4: Wireless Network

Part 5: Occupational, Safety and Health Work Practices (OSHWP)

***NOTE:***

*Compliance with a Technical Standard does not of itself confer immunity from legal obligations.*

## Working Group Objectives

a) To provide the **minimum technical specifications** necessary for the Fixed Network Infrastructure to function as required in buildings.

b) To recommend and provide standards for in-building infrastructure requirements applicable in Malaysia.

## Working Group Scope

a) To develop and recommend minimum requirements for in-building system infrastructure.

b) To include Security, Safety, Quality of Service, Performance Specifications, Installation Guidelines, Testing Procedures, Regulatory Requirements and other recommendations.

c) Reference standards to relevant Regulatory Bodies that has jurisdiction.

**TECHNICAL STANDARD AND INFRASTRUCTURE REQUIREMENTS**
**Part 1: FIXED NETWORK INFRASTRUCTURE**

## 1. Introduction

The Fixed Network Infrastructure forms a part of the Technical Standards and Infrastructure Requirements (TSIR) document which serves as guidelines and standards in support of the Uniform Building By-Laws (UBBL). This document was prepared with the common understanding and agreement among the Fixed Network Providers' representatives in Malaysia. This sub-working group committee called **Fixed Network Infrastructure** is formed under the Multimedia Network Infrastructure (**MNI) Working Group,** approved by **MTSFB**.

In the context of meeting the needs of Telecommunication (Fixed Network services) users, TSIR addresses the technical system and infrastructure requirements necessary for having the fixed network distribution system equipped in the building. This is important in view of Fixed Network Services which are used as a medium for delivery of Telephony and Multi Broadband Services to the public / customers.

### 1.1 Document Objective

As stated above, the Fixed Network Infrastructure in the TSIR document covers two primary objectives:

a) It outlines the *infrastructure requirements* (for the purpose of setting up a common and integrated fixed network distribution system) to consulting engineers, Developers, owners and other responsible parties for the *provisions* to be made available in the buildings.

b) It also provides the *minimum technical specifications* necessary for the Fixed Network Telephony and Multi broadband distribution system to function as required in buildings.

### 1.2 Document Scope

The Fixed Network Infrastructure covers the following focus areas:

a) System infrastructure requirement in building (condo/ apartment, low cost flats, single dwelling and office buildings).

b) Minimum installation guidelines and standards.

c) Minimum technical and performance specifications for the services (including test procedures).

### 1.3 Representation

The representatives in Fixed Network Infrastructure sub-workgroup are from various Telecommunication Operators namely, TM, TIME, MAXIS, DIGI, Consultants, MNCC and SIRIM as the national standards body.

## 2. Building Requirements for Fixed Network Infrastructure

### 2.1 Outdoor Requirement

#### 2.1.1 Manhole at Roadside

Manhole(s) on the road side outside the building / compound shall be provided by the building owner so that the Fixed Network Operator / Service Provider can connect their underground (manholes and ducts) network.

The Developer is strongly advised to consult the Fixed Network Operators on the appropriate selection of the location and size of manhole to be allocated.

### 2.1.2 Duct Way into Building

Underground duct-ways are required to connect the manhole mentioned above to the Telecommunications Room inside the building. The number of duct-ways is dependent upon the size and types of building and number of users/ customer.

The Developer is strongly advised to consult the Fixed Network Operators on the appropriate selection of the number of duct-ways to be provided.

## 2.2 Telecommunications Room

### 2.2.1 Space Requirement

The Developer must dedicate a room with security lock to locate all Fixed Network equipment and cables, identified as the Telecommunications Room.

The floor area is required for Telecommunications Room inclusive of the subscriber distribution frame and termination equipment shall depend on the type and ultimate demand of the building. A minimum clear floor space of 750mm is essential in front of all accessible points of the equipment in order to provide adequate working space for installation, testing and maintenance service.

The Telecommunications Room shall be placed on the Ground-floor area and connected to the manhole and duct-way mentioned in section 2.1 above and should be located free from perceptible vibration. Ducting, sewage pipes, air condition pipes etc. shall not pass through the Telecommunications Room. Refer to Table 1 for details.

The Telecommunications Room floor space dimension for each type of building can be referred as in Table 1 below:

Table 1: Telecommunications Room Floor Space

| Building Type | Floor Space (L X B X H) | # Floor / Wall Opening (W X D) | Door Opening (W XD) |
|---|---|---|---|
| a) Condo / Apartment | | | |
| x < 6 floors | 4m X 4m X 3m | 0.4m X 0.15 m | 2.5m X 1m |
| 6 < x < 16 floors | 5m X 4m X 3m | 0.6m X 0.15m | 2.5m X 1m |
| x > 16 floors | 7m X 4m X 3m | 0.9m X 0.2m | 2.5m X 1m |
| b) Low cost Flats | | | |
| x < 6 floors | 3m X 4m X 3m | NA | 2.5m X 1m |
| 6 < x < 16 floors | 4m X 4m X 3m | 0.6m X 0.15m | 2.5m X 1m |
| x >16 floors | 5m X 4m X 3m | 0.9m X 0.2m | 2.5m X 1m |
| c) Single Dwelling | | | |
| Bungalow | NA | NA | NA |
| Semi-Detached | NA | NA | NA |
| Terrace Single Storey | NA | NA | NA |
| Terrace Double Storey | NA | NA | NA |
| Low cost | NA | NA | NA |
| d) Office Building | | | |

| Building Type | Floor Space (L X B X H) | # Floor / Wall Opening (W X D) | Door Opening (W XD) |
|---|---|---|---|
| x < 6,000m$^2$ | 4m X 3m X 3m | 0.7m X 0.15m | 2.5m X 1m |
| 6,000m$^2$ < x < 20,000m$^2$ | 4m X 4m X 3m | 1.0m X 0.2m | 2.5m X 1m |
| 20,000m$^2$ < x < 60,000m$^2$ | 5m X 5m X 3m | 1.1m X 0.2m | 2.5m X 1m |
| x > 60,000m$^2$ | 7m X 6m X 3m | 1.1m X 0.2m | 2.5m X 1m |
| e) Shop house | | | |
| x < 6 storey | Requirement to be determined case by case | Requirement to be determined case by case | Requirement to be determined case by case |
| f) Others | | | |
| Industrial Lot | Requirement to be determined case by case | Requirement to be determined case by case | Requirement to be determined case by case |
| Hotel | | | |
| Schools | | | |
| Hospital | | | |
| Club house | | | |

***NOTES:***

1. *NA implies Not Applicable*

2. *# Two opening is required i.e. one serve the outdoor manhole duct-way access and the other serve the riser cable distribution.*

### 2.2.2 Electrical Requirement

The Telecommunications Room shall be provided with electrical AC supply from the utility supplies at a nominal of 415 V, 3 phase, 4 wires, 50 Hz system or at a nominal voltage of 240V AC Single-Phase system with solidly earth system. The type of AC supply and rating will be dependent on the expected load.

The Telecommunications Room shall be equipped with a 20A TPN metal clad DB of 20A. The DB should be equipped with the following:

a) ELCB (Earth Leakage Circuit Breaker)

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

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

d) Surge protection system of 40KA and

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

The electrical supply should be connected to the essential power generator if provided. An earth leakage circuit breaker shall be installed inside the room.

The Telecommunications Room shall be equipped with daylight type fluorescent lighting that can provide a minimum of 300 Lux luminance at floor level. The earthing system should have a resistance to earth of not greater than 10 ohm (Ref: BS6651 and IEC60364-1), and be terminated on an earth bus bar inside the room. The main earth conductor should have a cross section of not less than 70 mm$^2$ via the shortest routing. The earthing system shall be connected to the building main grounding. The grounding system termination is as Figure 1 below.

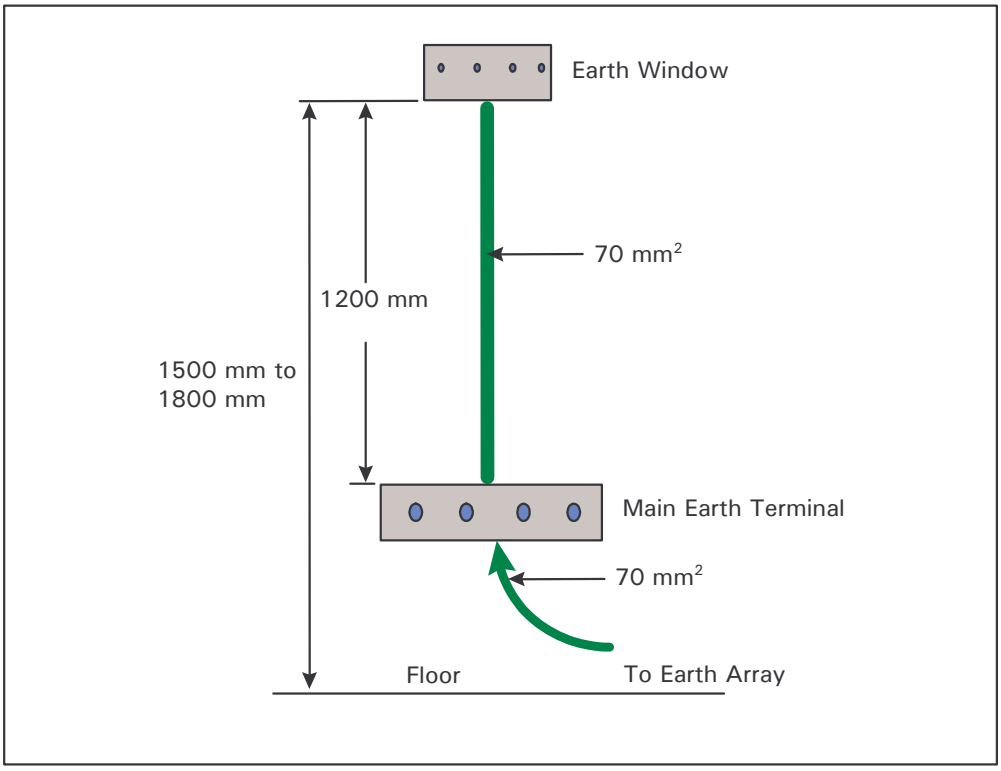


Figure 1: Grounding System Termination

### 2.2.3 Temperature/Ventilation

The Telecommunications Room shall be air-conditioned or equipped to maintain humidity and room temperature at 30 – 50 % relative humidity and below 30 $^{o}$C respectively under all conditions. The room shall be fitted with a ventilation fan system capable of 30 air change/min, activated when the room temperature rises above 35 ºC.

### 2.2.4 Accessibility

There should be no opening in the Telecommunications Room except for the door, the ventilation and cabling ducts. The door dimension shall be 1m X 2.5m. All windows if any must be shut and sealed along the frames to keep out water and dust and blind should be provided to avoid direct sunlight. Solid walls should be provided for heavy equipment mounting. The walls and ceiling should be of normal finishing or be painted with light-colored vinyl emulsion or gloss paint. Floor of the Telecommunications Room shall be of material that is easy to clean and not susceptible to accumulation of dust, flooring requirement is anti-static vinyl type mat and bonded to the earth bus bar. The room must be flood free. A 150 mm kerb across the doorway is required to prevent water from entering the room.

### 2.2.5 Security

The Telecommunications Room shall be locked at all times and only authorized personnel be allowed access. The key for this room shall be kept by the owner or the building manager of the building and made available to authorized personnel when required. No water tank, main water drainage pipes should be installed directly above the room. Developer should observe all relevant

ordinance and regulation regarding the fire safety requirements during the design of the Telecommunications Room, by having:

(a) portable hand-operated fire extinguisher; and

(b) emergency lighting connection to backup power supply.

Smoke detection device should be installed inside the Telecommunications Room and be connected to the central control of the building management office. The room should be fitted with a fire door as per “Jabatan Bomba dan Penyelamat Malaysia” approval.

### 2.2.6 Floor Loading

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

### 2.2.7 Room Height

The clear ceiling height of Telecommunications Room shall not be less than 3 meter, so as to enable installation of equipment, cabinets and cabling.

## 2.3 Riser

### 2.3.1 Riser Requirement

To obtain maximum benefit from the distribution system, the riser duct should be placed centrally with respect to the distribution in which it is to serve. To facilitate the installation and maintenance of horizontal cables, the distance between the riser duct and the outlet point in the home unit should be kept as short as possible that is less than 30 meters. A 150 mm high kerb shall be provided across the doorway to prevent water from getting in. For low cost building the cable riser shall be sited in easily accessible area inside the building like staircase landing area.

The following services are not allowed to share this riser:

a) Water piping.

b) Fire fighting.

c) Building Electrical System.

d) Gas distribution.

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

### 2.3.2 Riser Size / Working Space

The size of the riser shall be based on the type of building as in Table 2 below:

Table 2: Riser size

| Building Type | RISER | | |
|---|---|---|---|
| | Cable Trunking | Floor Opening (W x D) | Closet Space (W x D) |
| a) Condo / Apartment | | | |
| x < 6 floors | 100mm x 75mm x 3 | 0.4m x 0.15m | 0.9m x 0.6m |
| 6 < x < 16 floors | 150mm x 100mm x 3 | 0.6m x 0.15m | 1.2m x 0.6m |
| x > 16 floors | 150mm 100mm x 3 | 0.9m x 0.2m | 1.5m x 0.8m |
| b) Low cost Flats | | | |
| x < 6 floors | 100mm x 75mm x 3 | NA | NA |
| 6 < x < 16 floors | 150mm x 100mm x 3 | 0.6m x 0.15m | 1.2m x 0.6m |
| x > 16 floors | 150mm x 100mm x 3 | 0.9m x 0.2m | 1.5m x 0.8m |
| c) Single Dwelling | | | |
| Bungalow | NA | NA | NA |
| Semi-Detached | NA | NA | NA |
| Terrace Single Storey | NA | NA | NA |
| Terrace Double Storey | NA | NA | NA |
| Low cost | NA | NA | NA |
| d) Office Building | | | |
| x < 6,000 $m^2$ | 150mm x 100mm x 3 | 0.7m x 0.15m | 1.2m x 0.9m |
| 6,000$m^2$ < x < 20,000 $m^2$ | 150mm x 100mm x 3 | 1.0m x 0.2m | 1.5m x 0.9m |
| 20,000$m^2$ < x < 60,000 $m^2$ | 150mm x 100mm x 3 | 1.1m x 0.2m | 1.8m x 1.2m |
| x > 60,000$m^2$ | 150mm x 100mm x 3 | 1.1m x 0.2m | 1.8m x 1.2m |
| e) Shop house | | | |
| x < 6 storey | 100mm x 75mm x 3 | NA | NA |
| f) Others | | | |
| Industrial Lot | Requirement to be determined case by case | | |
| Hotel | | | |
| Schools | | | |
| Hospital | | | |
| Club house | | | |

### 2.3.3 Riser Arrangement

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

a) from the left is for Radio Communication (Cellular Network) services;

b) the center is for Telecommunication (Fixed Network) services; and

c) from right side is for Broadcast services.

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

The Fixed Network horizontal conduit / trunking shall be separated and dedicated to related services such as follows:-

a) Telephony Services.

b) Digital Leased Circuit Services.

c) Multimedia Broadband Services.

d) Local Area Network (LAN).

e) Extra Light Voltage (ELV) Services.

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

The size of the horizontal trunking along the corridor shall be according to the number of cables as shown in Table 3.

Table 3: Horizontal Trunking

| Number of Cables | Size of Trunking on Floor (mm x mm) | Size of Trunking on Ceiling (mm x mm) |
|---|---|---|
| Less than 10 | 1 no. 100 x 25 | 1 no. 100 x 50 |
| 10 to 20 | 2 nos. 100 x 25 | 2 nos. 100 x 50 |
| More than 20 | NA | Comply to 50 % space factor |

The size of the horizontal drop cable into the individual unit shall be using at least a PVC conduit of 19 mm diameter. All conduits or cable enclosure need to be completely concealed and should not protrude so as to reduce the aesthetics either within or outside the customer premise.

### 2.3.4 Accessibility

Access to each riser will be necessary on each floor and should always be available from a corridor or other common area to avoid undue disturbance to occupants. The riser shall have a hinged and locked door on every floor and it is important that it be fire proof. The riser door key shall be kept by the building owner for safe custody.

### 2.3.5 Electrical Requirement

The riser shall be fitted with sufficient florescent lighting to facilitate work and the word "TELECOMMUNICATIONS SERVICES" shall be displayed on the door of the riser closure. A minimum of 2 nos. of 13 Amp 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 apartment units per floor), 2 nos. of 13 Amp switch socket outlets for every floor is recommended.

## 2.4 Home Unit

### 2.4.1 Telecommunications Outlet

The recommended number of outlets shall be based on the type of building as in Table 4.

Table 4: Number of Telecommunications Outlet Socket for Home Unit

| Building Type | Recommended Number of Socket |
|---|---|
| a) Condo / Apartment | |
| x < 6 floors | 3 x Telephony / Broadband |
| 6 < x < 16 floors | |
| x > 16 floors | |
| b) Low cost Flats | |
| x < 6 floors | 2 x Telephony / Broadband |
| 6 < x < 16floors | |
| x > 16 floors | |
| c) Single Dwelling | |
| Bungalow | 5 x Telephony / Broadband |
| Semi-Detached | 3 x Telephony / Broadband |
| Terrace Single Storey | 2 x Telephony / Broadband |
| Terrace Double Storey | 3 x Telephony / Broadband |
| Low cost | 2 x Telephony / Broadband |
| d) Office Building | |
| x < 6,000$m^2$ | Requirement to be determined Case by Case |
| 20,000$m^2$ < x < 60,000$m^2$ | |
| x > 60,000$m^2$ | |
| e) Shop house | |
| x < 6 storey | Requirement to be determined case by case |
| f) Others | |
| Industrial Lot | Requirement to be determined Case by case |
| Hotel / Service apartment | |
| Schools | |
| Hospital | |
| Club house | |
| Shopping complex | |

Every Telecommunications outlet in the main/ living room must be adjacent to additional or parallel to Broadcast socket to facilitate upcoming interactive services which will require feedback channel over PSTN/ Broaband lines. The wall outlet points should be aesthetically installed with safety and convenience given consideration. The outlet point should be at least 0.3 m above the floor level and 0.3 m from the corner of the wall or from electrical points. Wall outlet boxes and plates shall be fabricated from non-corrosive material or from metallic material treated to resist corrosion.

### 2.4.2 Location of the Telecommunications Outlet

The locations of the Telecommunications outlets are defined in Table 5 below:

Table 5: Location of Telecommunications outlet Socket

| Building Type | Location |
|---|---|
| a) Condo / Apartment | |
| x< 6 floors | 1 X Living Room |
| 6 < x < 16 floors | 1 X Master Bed room |
| x > 16 floors | 1 X Bedroom |
| b) Low cost Flats | |
| x < 6 floors | 1 X Living room |

| Building Type | Location |
|---|---|
| 6 < x < 16 floors | 1 X Master bedroom |
| x > 16 floors | |
| c) Single Dwelling | |
| Bungalow | 1 X Living room , 1 X Master bedroom, 3 X Bedroom |
| Semi-Detached | 1 X Living room, 1 X Master bedroom , 1 X Bedroom |
| Terrace Single Storey | 1 X Living room, 1 X Master bedroom |
| Terrace Double Storey | 1 X Living Room , 1 X Master bedroom 1 X bedroom |
| Low cost | 1 X Living Room, 1 X Master bedroom |
| d) Office Building | |
| x < 6,000$m^2$ | Requirement to be determined case by case |
| 20,000$m^2$ < x < 60,000$m^2$ | |
| x > 60,000$m^2$ | |
| e) Shop house | |
| x < 6 storey | Requirement to be determined case by case |
| f) Others | |
| Industrial Lot | Requirement to be determined case by case |
| Hotel | |
| Schools | |
| Hospital | |
| Club house | |
| Shopping complex | Requirement to be determined case by case |

Developer should provide provision for additional wall socket in other location in the room, not already specified in Table 5 to meet the requirement of the occupant.

## 3. Technical Information

### 3.1 Service / Network Provider

The Service Provider is the entity that will provide the Fixed Network Services such as POTS (Plain Old Telephone Service) and ISDN (Integrated Switch Digital Network) and Broadband services etc. There can be more than one Service Provider giving service to the same customer.

The Service Provider can provide the above-mentioned services via their own network infrastructure or leasing from a Network Provider, as provided for in SKMM's Guidelines On Implementation of Access to Network Elements (SKMM/G/04/05 – 28th September 2005)

### 3.2 Service / Network Provider Infrastructure

Figure 2 illustrates the overall configuration showing the various modes of providing fixed network services:

a) On copper cable from service / network provider premises to customer premises to provide POTS and ISDN services

b) ADSL (Asynchronous Digital Subscriber Line) riding on copper cable from service / network provider premises to customer premises to provide broadband services.

c) On fiber optic cable from service / network provider premises to customer premises with various optical terminal / multiplexer equipment (such as AG – Access Gateway, DSLAM – Digital Subscriber Line Access Multiplexer, RDSLAM – Remote DSLAM, MSAN – Multi-

Services Access Node, FTTH – Fiber To The Home Etc.) To provide POTS, ISDN, broadband and other services.

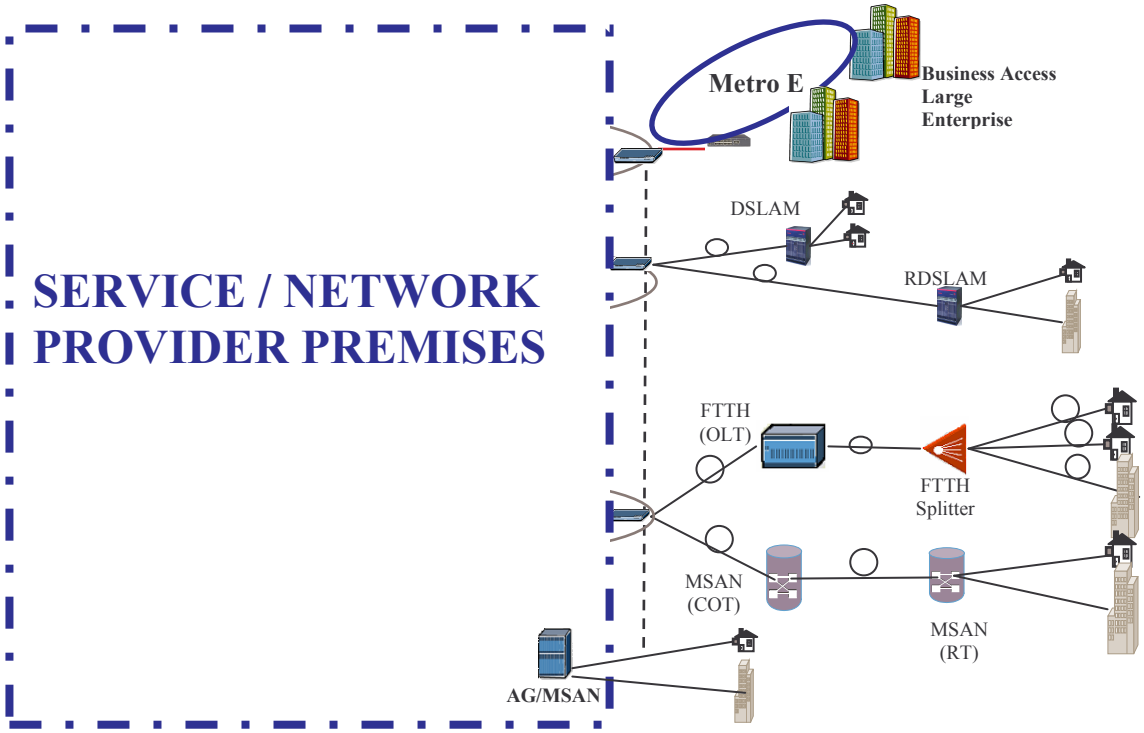


Figure 2: Modes of Access from Service / Network Provider to Customer

### 3.3 Design of Customer Building Infrastructure Requirement

Annex B illustrates the design of Building infrastructure required in providing fixed network services.

a) Service / network provider duct route (man-holes and duct-ways) system will finally be connected to the customers building via the customers manhole and duct-ways.

b) The Telecommunications Room will house the service / network provider equipment and cable. The room size is as per Table 1 of section 2.2.1.

c) The cable or terminations from the equipment will be connected to individual customer units via the riser (vertical distribution) and floor by floor (horizontal distribution).

### 3.4 Design of Cable Distribution Requirement

Annex C illustrates the design for cable distribution in buildings.

a) Cable (copper or Fiber Optics) from the service / network provider will go via their manholes and duct-ways and finally to the customers building via the customer manhole and duct-ways.

b) Copper cables will be terminated onto the SDF (Subscriber Distribution Frame) in the Telecommunications Room.

c) Fiber cable will be terminated onto the FDF (Fiber Distribution Frame) in the Telecommunications Room.

d) Cables from the Telecommunications Room will be connected to the individual units via the vertical and horizontal distribution

### 3.5 Cable Specifications

The cable required to be installed will depend very much on the services required.

The services are categorized by the various signal / frequency bandwidth or data transmission speeds related to the services. The cable type that can support the related services are as per Table 6.

Table 6: Cable Types and Related Services Supported

| Minimum Cable Type | Bandwidth | Application Limit | TSIR |
|---|---|---|---|
| Cat 3<br>(ISO/IEC 11801 Class C<br>TIA/EIA 568 B) | 16 MHz | For voice telephony &ADSL in building or inter building | Minimum Requirement |
| Cat 5e<br>(ISO/IEC 11801 Class D<br>TIA/ EIA 568 B) | >100 MHz | For Data transmission up to 1GB/s transmission rate | For distance up to 100m |
| Fiber Optic<br>(Multi mode OM2/OM3 & Single mode) | >200 MHz/km<br>Depends on light source | For Data transmission up to 1GB/s transmission rate | For distance beyond 100m |

### 3.6 Telecommunications Outlet (Wall Sockets)

The 3-connector wall outlet (POTS, Ethernet and Fiber Optics) shall be suitable for all Voice Telephony and Ethernet Broadband services. They shall be suitable for flush mounted and fully shielded. Based on international standards and specifications, common terms for these sockets are:

a) RJ11 (POTS) socket.

b) RJ45 (Ethernet) socket.

c) Fiber optics socket.

## 4. Tehnical Specifications

### 4.1 Manhole and Duct-ways

The manholes and duct-ways specifications are as per Annex D**.**

### 4.2 Structured Cabling

4.2.1 General

This guideline defines Service provider's requirements and specifications for generic / structured cabling for office buildings and it covers:

a) Planning, installation and administration of cabling systems.

b) Testing procedures.

c) Related pathways and spaces for office buildings.

This guideline is a living document and is in conformance with the ISO/IEC 11801, TIA/EIA 568-A, 569-A, 606 and 607, Electricity Regulations 1994 & Rules “Peraturan - Peraturan Elektrik 1994 & Kaedah-Kaedah Jabatan Bekalan Letrik” (as 20th August 1995). Cabling shall comply with other local codes and regulations.

### 4.2.2. Generic Structured Cabling System

#### 4.2.2.1 Structure

Generic / structured cabling comprises of the following elements:

a) Telecommunications Outlet (TO)

b) Transition Point (TP) – optional

c) Multi User Telecommunications Outlet Assembly (MUTOA) – optional

d) Consolidation Point (CP) - optional

e) Horizontal cabling

f) Floor Distributor (FD)

g) Building Backbone Cabling

h) Building Distributor (BD)

i) Campus Backbone cabling

j) Campus Distributor (CD)

Details describing the above and their recommended specifications are in Annex E**.**

### 4.2.3 Cabling Sub-systems

#### 4.2.3.1 General

The cabling sub-system comprises of campus backbone cabling, building backbone cabling and horizontal cabling. These sub-systems are connected together to form a generic structure as illustrated in Figure 3

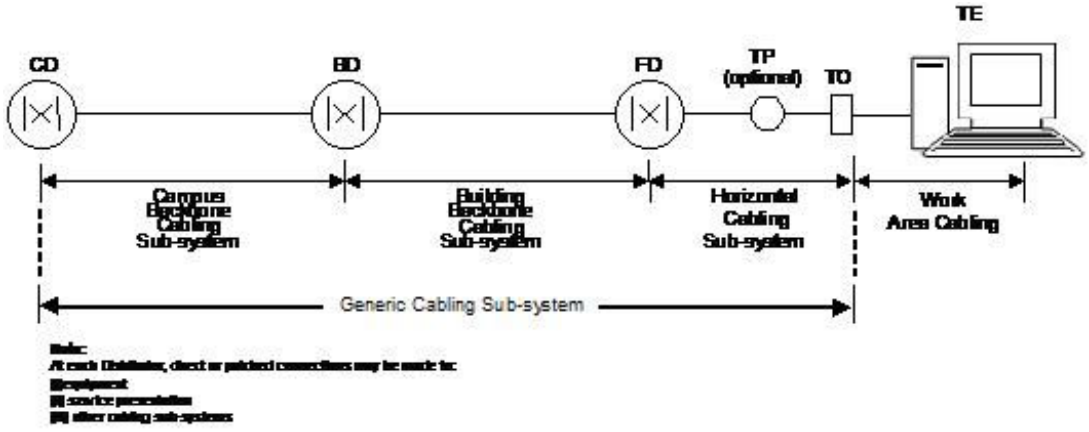


Figure 3: The Cabling Sub-System

These structure support different topologies, such as bus, star and ring topologies. In this guideline, star topology shall be used.

#### 4.2.3.2 Work Area Cabling

Work area cabling connects the TO to the terminal equipment.

The terminal equipment can be any of a number of devices including but not limited to telephones, data terminals and computers.

Each individual work area shall be served by a minimum of 2 TOs.

It is non-permanent and is application specific.

#### 4.2.3.3 Horizontal Cabling

Horizontal cabling runs from distributors at each floor (FD) to the TO. It shall include the horizontal cables, termination at either end or cross-connects at the FD and the TO.

Horizontal cable should be continuous from the FD to the TO. However, one Transition Point or Consolidation Point is allowed between a FD and any TO. The transmission characteristics of the horizontal cabling shall be maintained.

If an open office environment is required, then, a Multi-user TO Assembly (MUTOA) or a Consolidation Point (CP) can be used.

#### 4.2.3.4 Building Backbone Cabling

The building backbone cabling extends from the Telecommunications Rooms to the Floor Distributors (FD) at each floor.

It shall include the building backbone cables, termination of the building backbone cables at both the Floor Distributors and Telecommunications Rooms and mechanical terminations at both ends.

The building backbone shall not contain any TP and copper backbone shall not contain any splices.

#### 4.2.3.5 Campus Backbone Cabling

The campus backbone cabling extends from the Telecommunications Room in one building to the Telecommunications Room that is usually positioned in a different building.

It shall include the campus backbone cable, mechanical termination at both ends and cross-connects at the Telecommunications Room.

### 4.2.4 Distributors

Distributors interface the three cabling sub-systems. There are three types of distributors, namely Floor Distributors (FD), Building Distributors (BD) and Campus Distributors (CD).

FD interfaces horizontal cables to building backbone cables.

BD interfaces horizontal cables to building backbone cables and building backbone cables to campus backbone cables.

CD interfaces campus backbone cables from one building to another building. Both of these distributors are usually placed in a Telecommunications Room.

### 4.2.5 Interfaces to the Generic / Structured Cabling System

Interfaces to the cabling system are located at the end of each sub-system.

Figure 4 illustrates possible interfaces at the distributors and TO.

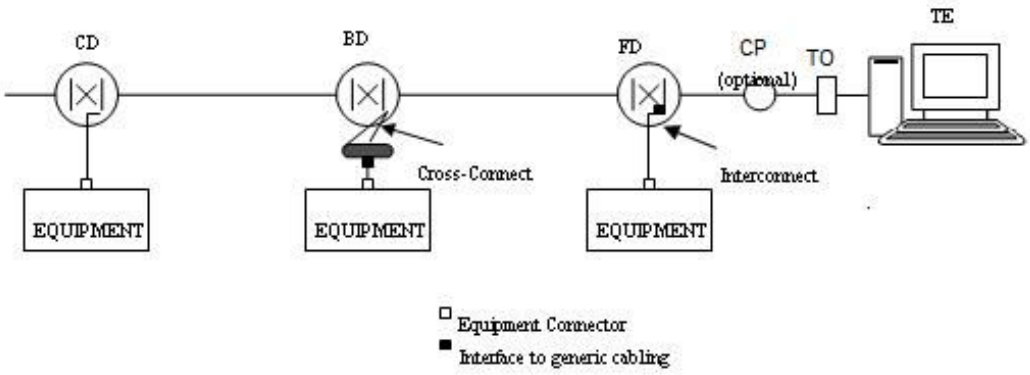


Figure 4: Possible Interfaces at the Distributors And TO

A distributor may have an interface to an external cable services cable and may use either direct connection (inter-connect) or indirect connection (cross-connect).

Connections to the public network for provision of public telecommunications services are made at the public network interface.

### 4.2.6 Overall Structure

Generic / structured cabling system is based on a star cabling topology arranged in a hierarchy. This structure provides a high degree of flexibility in accommodating a number of applications.

The number and type of cabling sub-systems that are included in a generic / structured cabling implementation shall depend on the geography and size of the campus or building.

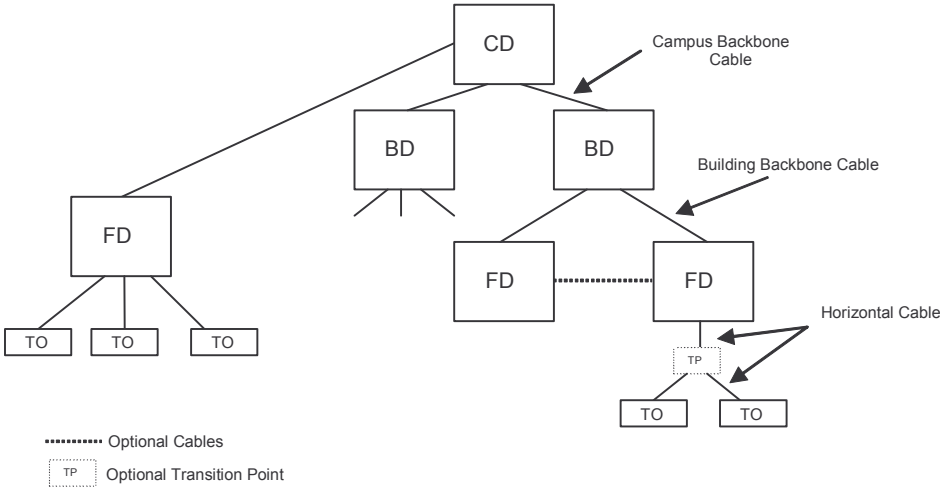


Figure 5: Inter-Relationship of Functional Elements

In some applications, additional direct connections between FD and BD are desirable and allowed. Building backbones may also interconnect FD.

A combination of functions of multiple distributors is permitted. An example of generic / structured cabling system is illustrated in Figure 4. Cables are placed in appropriate pathways which may be installed in ducts, tunnels and cable trays, depending on the design of the system.

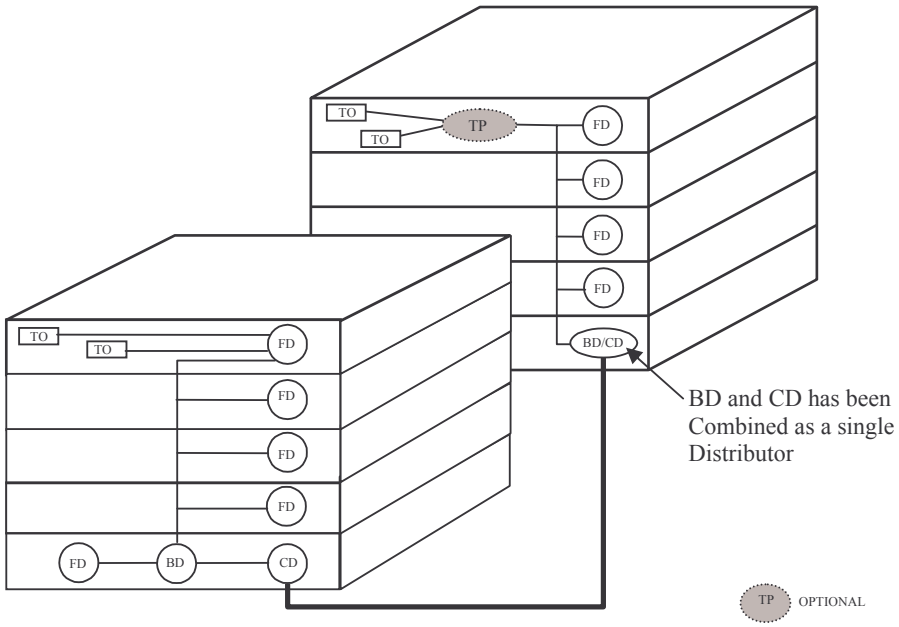


Figure 6: Example of Generic / Structured Cabling System

### 4.2.7 Design Consideration for Generic / Structured Cabling Systems

#### 4.2.7.1 General

In designing a generic / structured cabling system, preliminary information such as design consideration is useful. Hence, this section will discuss on some information that might assist in the design of generic / structured cabling system.

The areas covered by this section are:

a) Preferred cable types for pre-cabling and recommended use.

b) Decision criteria on possible locations of distributors.

With this preliminary information, one can proceed on to design and decide on the optimal cable technology for pre-cabling of generic / structured cabling system.

#### 4.2.7.2 Preferred Cable Types for Pre-Cabling and Recommended Use

This section gives a guideline on the recommended use of media in a particular sub-system for pre-cabling. Recommended cable medium is as per Table 7. Distance limitation for each type is as per Table 6.

Table 7: Recommended Media for Pre-Cabling

| Sub-System | Media Type | Recommended Use |
|---|---|---|
| Horizontal | Balanced UTP Cables | Voice and low to medium bandwidth data |
| | Optical Fiber | Medium to high bandwidth data |
| Building backbone | Balanced UTP Cables | Voice and low to medium bandwidth data |
| | Optical Fiber | Medium to high bandwidth data |
| Campus Backbone | Balanced UTP Cables | For voice applications- |
| | Optical fiber | Data - by using optical Fiber-ground potential differences and other sources of interference may be overcome |
| ***NOTES:*** *Under certain circumstances (for example high bandwidth application, environmental conditions, security concerns), installation of optical Fiber in the horizontal cabling subsystem should be considered.* | | |

The table summarizes the preferred applications for different types of cabling sub-systems.

### 4.2.8. Grounding and Fire-stopping

#### 4.2.8.1 Grounding

Bonding shall be according to applicable to the local codes. Horizontal cables shall be grounded in accordance to the latest edition of Electricity Regulations 1994 & Rules “Peraturan - Peraturan Elektrik 1994 & Kaedah-Kaedah Jabatan Bekalan Letrik” (as 20th August 1995).

All shields of cables should be bonded at each FD. Usually, the shields are bonded to the equipment racks, which in turn, bonded to building ground.
The bond shall be designed so that:

a) The path to ground shall be permanent and continuous. Each individual rack should be individually bonded, so that the continuity of the ground path is maintained.

b) The cable shields provide a continuous ground path to all parts of cabling system that are interconnected by it.

The bonding is to ensure that voltages induced into cabling are directed into building ground and do not interfere with the transmitted signals.

All grounding electrodes of different systems in the building shall be bonded together to reduce the impact of differences in ground potential.

The building grounding systems should conform to the grounding potential limits of 1Vr.m.s. and a low resistance between any two grounds on the network. If the 1 Vr.m.s. could not be complied, optical Fiber cabling should be used instead of twisted pair to eliminate the risk of high ground currents.

Metallic conduits used to reside ground conductors should be bonded to the ground conductor at both ends.

The bonding conductor shall be insulated and copper. The minimum conductor size shall be 6 AWG (16mm sq.) and of maximum size 3/0 AWG (95mm sq.). Each conductor shall be marked with green colour. Each bonding conductor shall be labelled with non-metallic labels as close to the point of termination as possible.

The protection and grounding of telecommunication equipment from the equipment to the master ground bar shall be the responsibility of the equipment provider.

#### 4.2.8.2 Power Separation

Close proximity of data cables, electrical cables and other communications media may result in high EMI level.

The separation of communications and power cables shall be as in Table 8.

Table 8: Separation of Data Cables from Power Cables

| Voltage Of Power Cables | Separation Distance |
|---|---|
| < 650 V | Min 50 mm |
| > 650 V | Min 300 mm |

Extra insulation with appropriate separation distance shall be provided at places where data and power cables cross.

Where data cables are routed specifically through ceiling cavities, the runs shall not be parallel with fluorescent light fittings. It shall cross the fittings at right angles wherever possible.

#### 4.2.8.3 Fire-stopping

##### 4.2.8.3.1 Installer's Responsibility

The installer shall be responsible for the sealing of openings between floors, through rated fire and smoke walls, existing or created by the installer for cable to pass through as per *"Jabatan Bomba dan Penyelamat"* requirements.

The installer shall bear the responsibility of creating such openings that are necessary for cable passage between locations as shown on the drawings.

Any openings created by or for the installer and left unused shall also be sealed.

#### 4.2.8.3.2 Fire-stopping Methods

Fire-stopping is used to contain and prevent the spread of fire through architecturally designed fire barriers.

Fire-stopping materials are rated by test (ASTM E 814, UL 1479). The fire-rating classification shall be as follows:

Table 9: Fire Rating Classifications

| **Classification** | **Characteristics** |
|---|---|
| F | • Ability to withstand the spread of fire through the firestop or auto ignition on the side opposite the fire.<br>• Ability to contain water stream from a fire hose without breach or dislodging |
| T | • Meets or exceeds the F rating<br>• Limiting temperature rise on the unexposed surface to no more than 180 $^{o}$C (325 $^{o}$F) |

They are two Fire-stopping methods, namely mechanical and non-mechanical.

a) Mechanical: involves factory manufactured elastomeric material designed to fit in and/or around the cables or conduit.

b) Non-mechanical: Involves a material that is capable of fitting around and or in irregular cables and pipes or openings.

Non-mechanical systems are widely used compared to mechanical system due to its practicality. Non-mechanical systems include caulk, intumescent wraps, pillows, cementitious compounds, foam and putties.

#### 4.2.8.3.3 Installation Guidelines

**a) Firestopping through a Concrete Barrier**

When firestopping through a concrete barrier, fill the opening with fire resistant packing material to within the manufacturer specified distance from the edge of the opening.

Fill the remainder of the opening with fire-stop material. Figure 7 illustrates this.

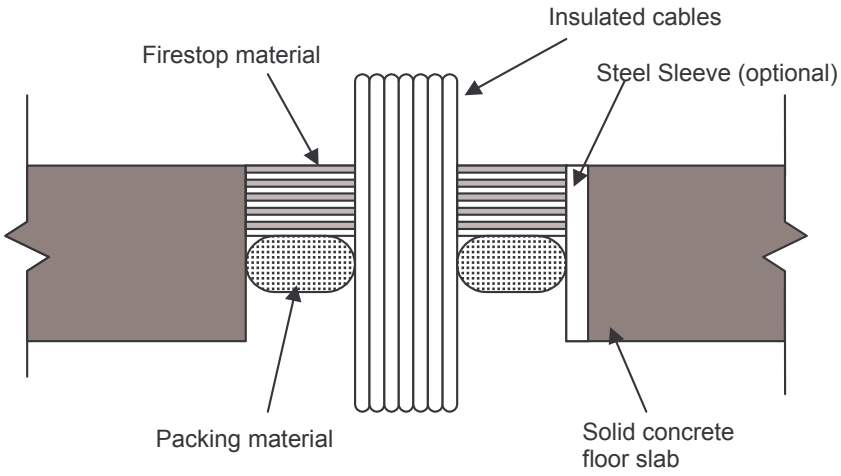


Figure 7: Fire-stopping Concrete Barrier

**b) Firestopping Wall Boxes**

When installing a wall box in a fire rated wall (membrane penetration), a non fire-rated box can be used provided that:

a) it does not create an opening in excess of 100 $cm^2$; or

b) if there are numbers of openings whose total area does not exceed 60 $cm^2$ per 9.3 $m^2$ of wall area.

The boxes must be: (Please refer to Figure 8 for the diagram)

a) Separated by at least 60 cm when there are 2 or more on opposite site of barrier.

b) Plaster-sealed to the surrounding surface if the opening between the box and the surface is more than 3 mm.

c) Sealed with fire-stop compound (such as putty or intumescent wrap).

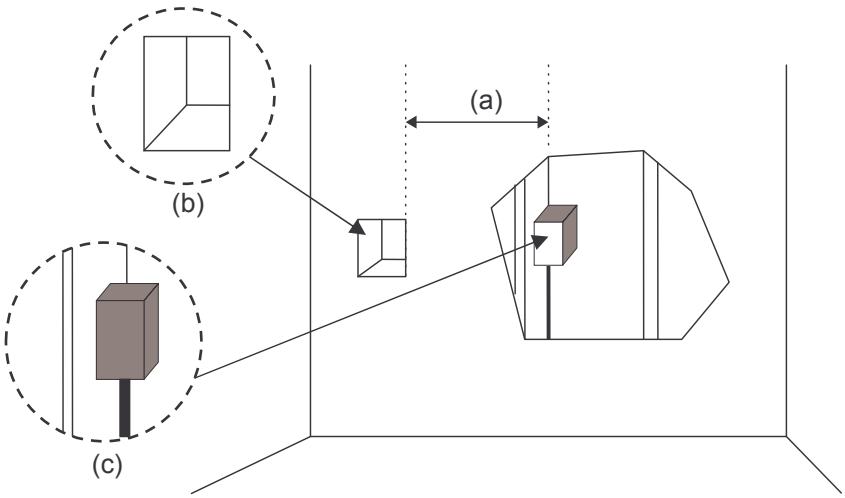


Figure 8: Fire-stopping Wall Boxes

**c) Firestopping Cable Trays**

For cable trays, intumescent wrap materials are commonly used since they are flexible at room temperature and when exposed to high temperatures, they swell and harden to fill the openings.

Place the wrap on each side of the breached wall, around the tray and cables, fillings any large openings between the cables and cable trays.

Place additional strips around the opening to ensure proper sealing in event of fire.

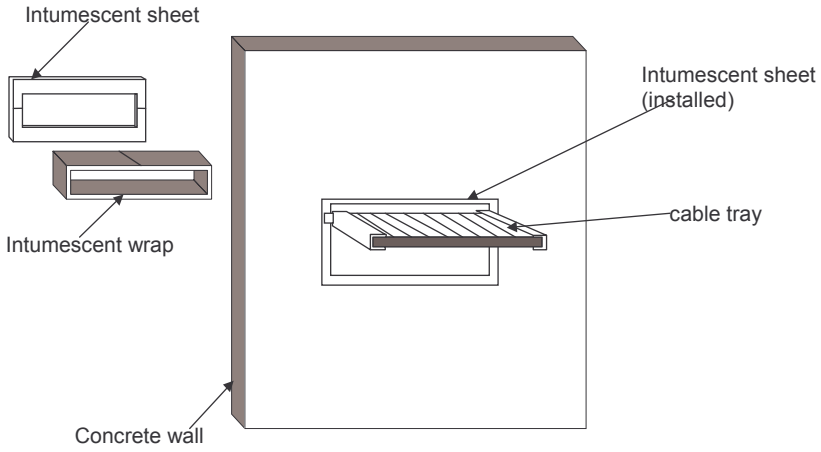


Figure 9: Fire-Stopping Cable Trays

### 4.2.9 Work Area

#### 4.2.9.1 General

The work area components extend from the telecommunications outlet (TO) to the application equipment. It shall be designed in a relatively simple way to allow easy management of moves, add and changes.

The work area components are:

Table 10: Work Area Components

| Application equipment | Computers, data terminals, telephones |
|---|---|
| Patch cables | Modular cords, PC adapter cables, Fiber jumpers |
| Adapters | Baluns |

#### 4.2.9.2 Telecommunications Outlet

TOs are located on the wall, depending on the design of the building. TOs shall be installed in readily accessible locations throughout the work area.

The minimum number of telecommunications outlet (TO) shall be two.

The two TOs in a work area shall be configured as follows:

a) One Telecommunication Outlet shall be supported by 100 Ω balanced cable category 5 or higher using TIA/EIA 568-A T568B wiring pattern outlet. (Category 5e minimum is recommended)

b) A second telecommunications outlet shall be supported by either a 100 Ω balanced cable of category 5 or higher or an optical Fiber cable.

Figure 10 and Figure 11 indicate the TO configuration and the pair assignment for 8 position modular jack connecting hardware using T568B wiring pattern respectively.

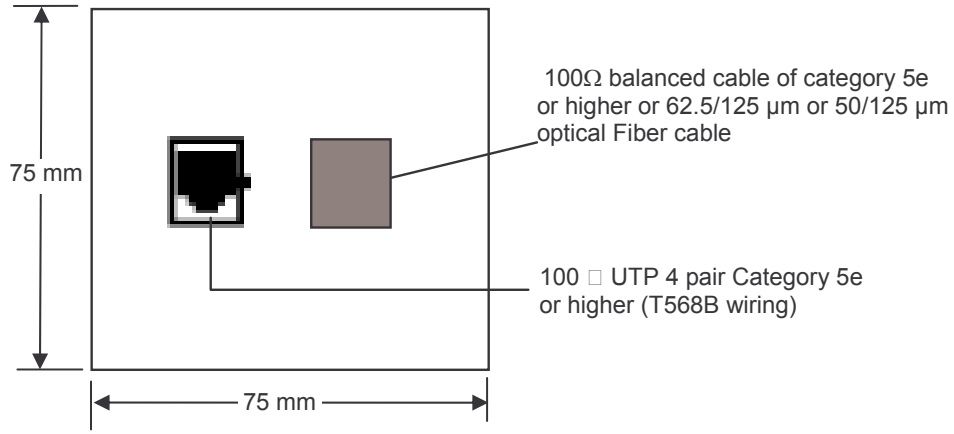


Figure 10: Configuration of TO

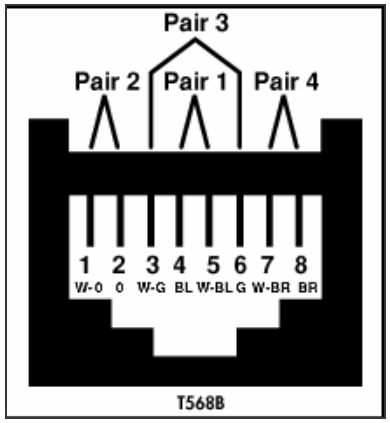


Figure 11: Pair Assignment for T568B

The designer shall have the final say on the number of TOs provided that the minimum number of TO rule is not violated. A high density of TO will enhance the flexibility of the cabling to cater for future changes.

If a TO is supported by balanced cable, 4 pairs shall be provided at each TO with all pairs being terminated. TO shall be marked with a permanent label that is visible to each user. The changes shall be recorded.

Devices such as baluns and impedance matching adapters shall be connected externally (if being used).

Horizontal optical Fibers at the work area outlet shall be terminated to a duplex SC optical Fiber connector (SC-D). Other connector styles, including those of a small form factor (e.g. MT-RJ) may also be considered.

#### 4.2.9.3 Work Area Sizing

The normal size of the work area is between 2 m² to 10 m².

The maximum length of the work area cabling from application equipment to the telecommunications outlet shall be 3m. This is as shown in Figure 12.

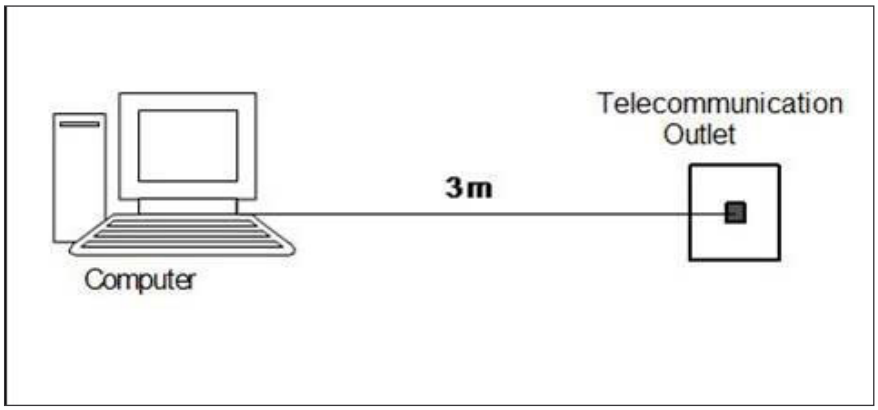


Figure 12: Maximum Cable Distance of Work Area

Work Area should form logical zones, which can be arranged to take advantage of one or more of the possible approaches to resilience that may be employed.

### 4.2.10 Horizontal Cabling Subsystem

#### 4.2.10.1General Requirement of Horizontal Cabling Sub-System

Cables should be terminated with connecting hardware of the same performance level or higher. The transmission performance of the link shall be determined by the category of the least performing component.

Cables of different characteristic impedance shall not be mixed within a cabling link.

Optical Fiber of different core diameters shall not be mixed within a cabling link.

#### 4.2.10.2 Horizontal Cabling Distance

The maximum horizontal cabling length from the mechanical termination of the cable in the FD to the TO in the work area shall be 90m regardless of the medium.

A total mechanical length of 10m is permitted for work area cables, patch cord or jumpers and equipment cables in any horizontal cable segment. These mechanical lengths vary according to requirements but shall be consistent throughout the premises.

The FD jumper or patch cord shall not exceed 5m.

Figure 13 illustrates the horizontal cable distance requirement for copper cable and figure 14 depicts the horizontal cable sub-system model for optical Fiber.

If a transition point is used, the transmission specifications of the 90m maximum horizontal cable shall be maintained.

The combined electrical length (with reference to attenuation and NEXT) shall be 7.5m for equipment and work area cables.

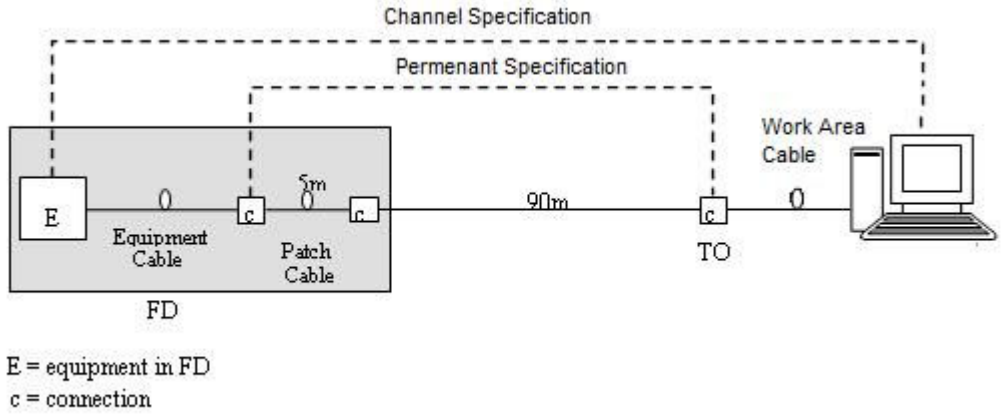


Figure 13: Horizontal Cable Distance for Copper Cables

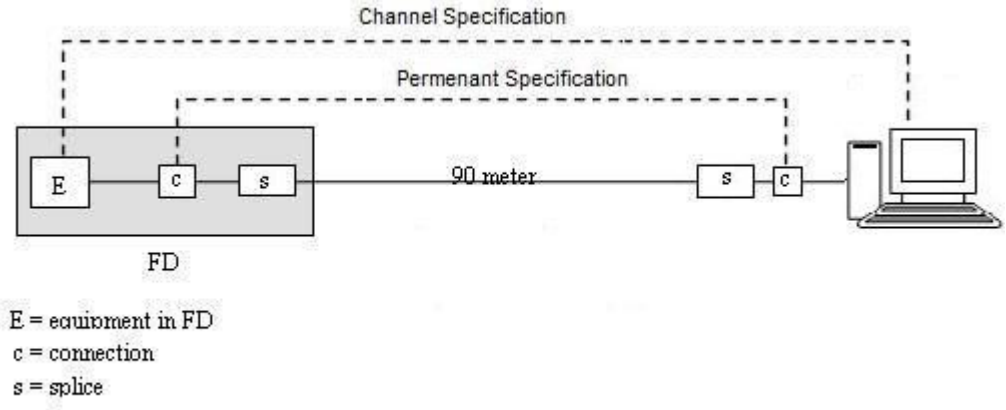


Figure 14: Horizontal Cable Distance for Optical Fiber Cable

#### 4.2.10.3 Preferred Cable Types

The preferred cables for horizontal cabling sub-system are as follows:

a) 100 Ω balanced cable.

b) 50/125 µm multi-mode optical fiber.

c) 62.5/125 µm multi-mode optical fiber.

#### 4.2.10.4 Multi User Telecommunications Outlet Assembly (MUTOA)

The MUTOA performs like a telecommunications outlet. However, it serves up to a maximum of 12 work areas.

The MUTOA shall be located centrally to serve a work group. Patch cords are installed at the MUTOA, through furniture pathways directly to the terminal equipment.

The MUTOA shall be located in an accessible area and not in ceiling or floor spaces.

The MUTOA shall be located in a permanent building structure or on furniture that is permanently fixed to the building structure.

In cases of optical Fiber, the total length for work area cable, patch cords and equipment cable shall be less than 100m. Centralized fiber cabling system shall follow the guidelines in TIA/EIA TSB 72. or ISO 11801

For UTP patch cords, the maximum lengths shall be determined in accordance to the following, as per Table 11.

Table 11: Maximum Length of Horizontal and Work Area Cables

| Length of horizontal cable (m) | Max. length of work area cable (m) | Max. length of combined patch cords, equipment cables (m) |
|---|---|---|
| 90 | 3 | 7 |
| 85 | 7 | 8 |
| 80 | 11 | 9 |
| 75 | 15 | 10 |
| 70 | 20 | 10 |

### 4.2.11 Colour Coding

#### 4.2.11.1 Colour Coding Rules

The following rules may be applied for colour coding.

Termination labels identifying the two ends of the same cable should be of the same colour. Cross-connections are generally made between termination fields of two different colours.

Table below indicates the rules for colour coding.

Table 12: Colour Coding

| Termination Type | Colour | Pantone | Comments |
|---|---|---|---|
| Demarcation point | Orange | 150C | Central office termination |
| Network connections | Green | 353C | Network connection on the customer side of the demarcation point |
| Common equipment, PBX, Host, LANs, MUX | Purple | 264C | All major switching and data equipment terminations |
| First level backbone | White | | Telecommunications Room to Intermedia Distribution cable termination |

| Termination Type | Colour | Pantone | Comments |
|---|---|---|---|
| Second level backbone | Grey | 422C | Intermedia Distribution to Floor Distributor cable terminations |
| Station | Blue | 291C | Horizontal cable terminations |
| Campus backbone | Brown | 465C | Campus cable termination |
| Miscellaneous | Yellow | 101C | Auxiliary circuits, maintenance, alarms, security |
| Key telephone systems | Red | 184C | |

The following diagram illustrates the colour-coding scheme.

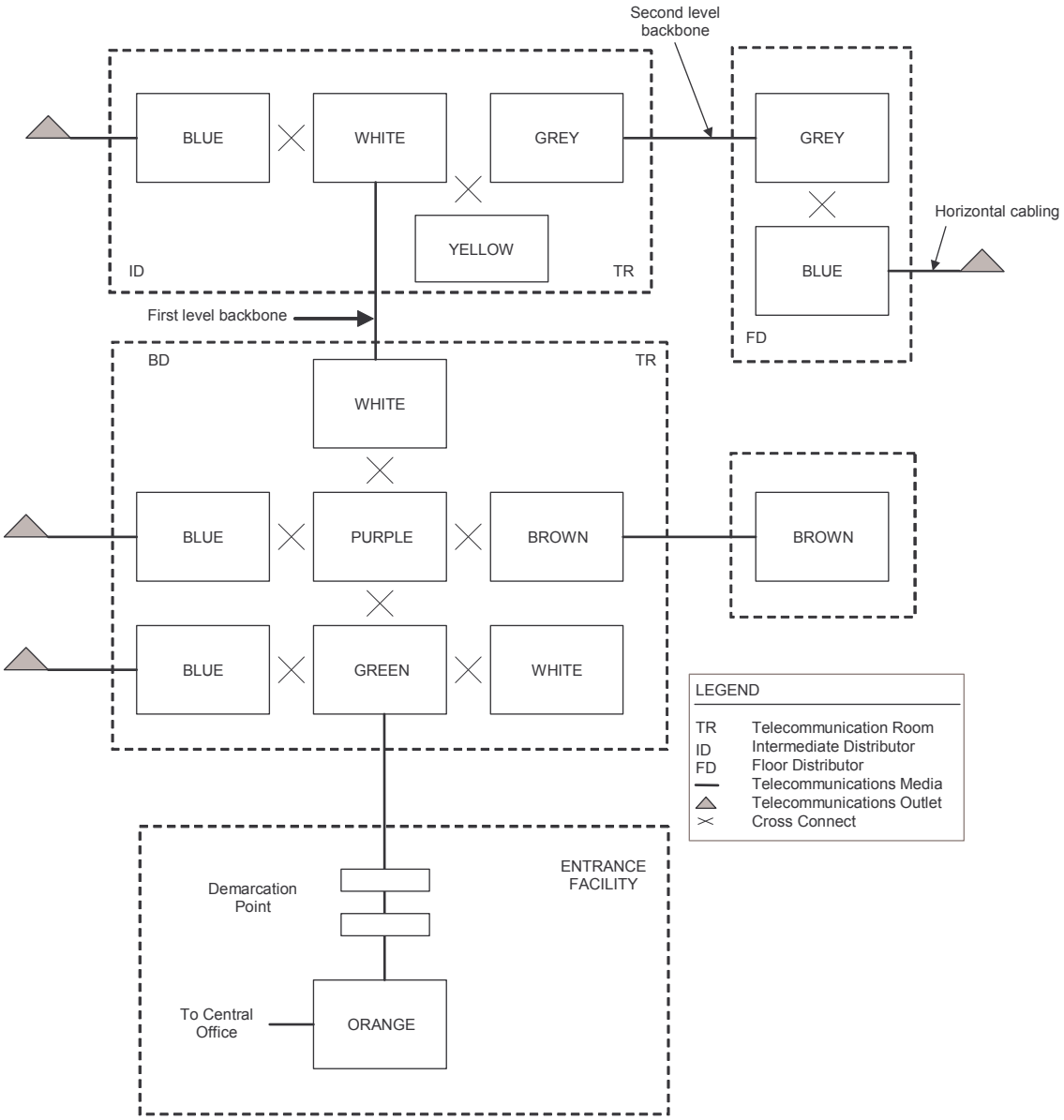


Figure 15: Illustration of Colour Coding

#### 4.2.11.2 Differentiation of Termination Field by Performance Category

If the cables used are of different performance classes, their termination should indicate this difference, by either using enhanced colour coding, or suitable marking.

Alternatively, the cables may be marked with the category of the terminating cable.

### 4.2.12 Cable Testing

#### 4.2.12.1 UTP Testing – Test Equipment

The Test Equipment for system certification should comply with Level IIE-Test Equipment. Level III Test Equipment is recommended.

The Test Equipment shall be initialized before use.

#### 4.2.12.2 UTP Testing – Procedures

Test shall be done on every single cable from point to point (patch panel to TO).

At the end of the installation, horizontal cabling cable pairs of Cat 5 cables shall be tested from the Telecommunications Closet to the telecommunication outlet (TO).

Permanent link configuration is as follows

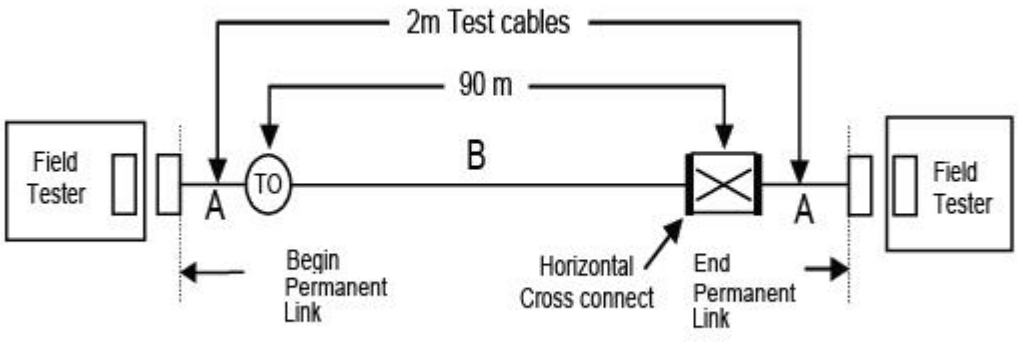


Figure 16: Permanent Link Testing Configuration

For Cat 5e cables, the following Permanent link test shall be performed:

a) Insertion Loss

b) NEXT

c) Powersum NEXT

d) ELFEXT

e) Powersum ELFEXT

f) Return loss

g) Delay Skew

h) Attenuation to Crosstalk ratio (ACR).

Any pairs not meeting the requirements of the standard shall be brought into compliance.

### 4.2.13 Fiber Optic Testing

#### 4.2.13.1 General

Fiber testing shall be done on all fibers in the completed end-to-end system.

Testing should comprise of a bi-directional end-to-end OTDR trace performed according to TIA/EIA 455-61 or ISO/IEC 11801 or a bi-directional end-to-end power meter test performed according to TIA/EIA 455-53A or ISO /IEC 11801

The system loss measurements shall be provided at wavelength of 850 and 1310 nanometers for multimode fibers and 1310 and 1550 for single mode fibers.

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

#### 4.2.13.2 Pre-Installation Testing

All fiber optic cables should be tested before the installation of the cable.

#### 4.2.13.3 Running cable

a) Obtain a complete test data from the cable manufacturer, including attenuation, bandwidth and geometry of the Fiber and cable construction details.

b) Check each fiber for continuity. This can be done by a simple light check if all certified data is in order. This is illustrated in Figure below.

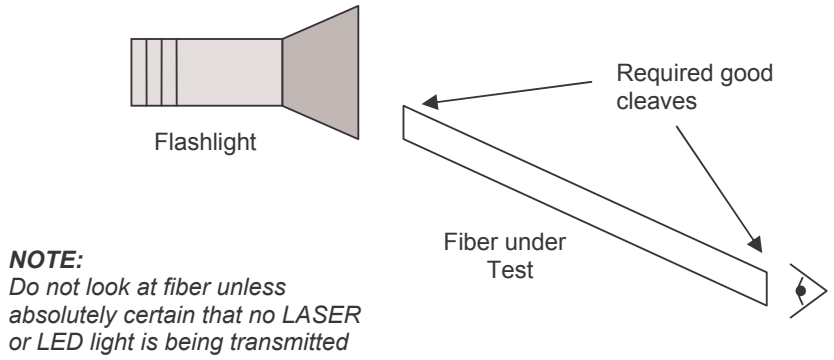


Figure 17: Fiber Optic Visual Check

c) Check the beginning and ending length markers for appropriate cable lengths.

#### 4.2.13.4 Pre-Terminated Patch Cords

a) Obtain the test data from the manufacturer regarding the insertion loss testing.

b) Each connector should be inspected with an inspection microscope of at least 100 times enlargement. The Fiber faces should be clean of chips and scratches.

c) Visually check the connector ferrules and make sure that they are free of epoxy or other contaminants. Check the moving parts of connector for free play.

d) All connectors shall be covered with dust cap.

#### 4.2.13.5 Post-Installation Testing

#### 4.2.13.5.1 Backbone Cables

a) Check all terminated Fibers for optical loss at the appropriate wavelength (please refer to Appendix for Fiber optic testing)

b) Compare actual loss with the design loss. The calculation of optical loss is as follows:

(Allowable cable loss per km) (km of Fiber in link) + (0.5 dB) (Number of connectors) = Maximum allowable loss

A mated connector to connector interface is defined as single connectors.

Check all the un-terminated Fibers for continuity. If a discontinuity or excessive loss is located, correct the problem.

If the system includes runs of cables over 400m or 500m, get OTDR traces on the installed Fibers. This is crucial should there be any problems in the link in the future.

#### 4.2.13.5.2 Patch Cords

Check the patch cords as outlined in Annex E.

If acceptable, the patch cords need only be cleaned with a wipe of reagent-grade alcohol before installation.

## 5. Definitions

For the purposes of this TSIR, the followings definitions apply.

| | | |
|---|---|---|
| Ablative | : | Developing a hard char that resists the spread of fire. |
| Access Floor | : | A system consisting of completely removable and interchangeable floor panels that are supported on adjustable pedestals or stringers to allow access to the area beneath. |
| Administration | : | Method for labeling, identification, documentation and usage needed to implement moves, add and changes of the telecommunication infrastructure. |
| Application | : | A system, with its associated transmission method which is supported by telecommunications cabling |

| | | |
|---|---|---|
| Approval Authority | : | It is embodied in the CMA, SDBA, UBBL and TCPA that approval from the State Authority or Local authority or any other authority is a must before any development or construction activities can be carried out. In approving a development or building plan, the State Authority or local authority must satisfy all requirements pertaining to essential services which should in accordance with the proposal above include public utility services in line with the CMA 1998. |
| Architectural structures | | Walls, floors, floor ceilings and roof that are load bearing |
| Attenuation | | Signal loss in a transmission medium or component expressed in dB.<br><br>The attenuation for 100m length of cable where the cable impedance is matched to the impedance of the test equipment, is defined as:<br><br>$A = (100/ L) \times 10 \log_{10} (p_1/p_2)$<br><br>Where<br>A = attenuation constant.<br><br>$p_1$ = input power where the load impedance is the source impedance.<br><br>$p_2$ = output power where the load impedance is the test specimen impedance.<br><br>L = length of test specimen in meters. |
| Backbone | : | A facility (e.g. pathway, cable or conductors) between Telecommunications Closets, or Floor Distributor terminals, entrance facilities and the equipment rooms within or between the buildings. |
| Backbone Bonding Conductor | : | A metal conductor that is a copper conductor extending from the telecommunications main grounding busbar to the furthest floor telecommunication grounding busbar |
| Balanced Cable | : | A cable consisting of one or more metallic symmetric cable elements (twisted pair or quads). |
| Barrier | : | Architectural structures and assemblies. |
| BBS (Broadband System) | : | Is a network of coaxial cables and components in the frequency range of 5 MHz – 2150 MHz. It receives broadcasting signals from a common antenna/dish or system of antennas, centrally integrates and distributes the signal and to all outlets within the building. |
| BER (Bit error rate) | : | Bit Error Rate - In a digital transmission, BER is the percentage of bits with errors divided by the total number of bits that have been transmitted, received or processed over a given time period. The rate is typically expressed as 10 to the negative power. |

| | | |
|---|---|---|
| Block | : | A device used to connect one group of wires to another. Each wire can be connected to several other wires in a bus/ common arrangement |
| Bonding | : | The permanent joining of metallic parts to form an electrically conductive path that will assure electrical continuity and the capacity to conduct safely any current likely to be imposed. |
| Broadcast Head-end Room | : | A dedicated secured room to locate all necessary receiving and processing equipment and components for the Broadband Broadband System |
| Building | : | Shall have the same meaning provided for the National Land Code 1965, and shall mean to include any structure erected on land. |
| Building Backbone Cable | : | A cable that connects the building distributor to a Floor Distributor. Building backbone cables may also interconnect Floor Distributors in the same building. |
| Building core | : | A three-dimensional space permeating one or more floors of the building and used for extension and distribution of utility services throughout the building. |
| Building Entrance Facility | : | A facility that provides all necessary mechanical and electrical services that complies with all relevant regulations, for the entry of telecommunications cables into a building. |
| Building module | : | The standard selected as the dimensional co-ordination of the design of the building (such as a multiple of 100 mm). |
| Building owner | : | The actual proprietor of a building, or its agents or its authorized personnel. |
| Buried cable | : | A cable installed under the surface of the ground in such as manner that it cannot be removed without disturbing the soil. |
| Cabinet | : | A container that may enclose connection devices, terminations, apparatus, cabling and equipment. |
| Cable | : | An assembly of one or more cable units of the same type and category in an overall sheath. It may include overall shield. |
| Cable sheath | : | A covering over the conductor assembly that may include one or more metallic member, strength members or jacket. |
| Cable Unit | : | A single assembly of one or more cable elements of the same type or category. The cable unit may have a shield. |
| Cabling | : | A system of telecommunications cables, cords and connecting hardware that can support the connection of information technology equipment. |
| Campus | : | A premise containing one or more buildings. |
| Campus Backbone Cable | : | A cable that connects the campus distributor to the building distributors. Campus backbone cables may also connect building distributors directly. |
| Campus Distributor | : | The distributor from which the campus backbone cabling emanates. |

| | | |
|---|---|---|
| Campus Style Property | : | A property with single document of title issued to a single proprietor of any land which parcel of land is not sub-divided. |
| Ceiling Distribution System | : | A distribution system that utilizes the space between a suspended or false ceiling and the structural surface above. |
| Cell | : | A single raceway of a cellular under-floor duct system. |
| Cellular floor | : | A floor distribution method in which cables pass through floor cells, constructed steel or concrete to provide a ready made raceway for distribution of power and telecommunications cables. |
| Cellular Network | : | A mobile communications network system. |
| Cementitious firestop | : | A fire-stopping material that is mixed with water, similar in appearance to mortar. |
| Channel | : | End-to-end transmission path connecting any two piece of application specific equipment. Equipment and work area cables are included in the channel. |
| Characteristic Impedance | : | At a given frequency, the characteristic impedance, $Z_c$ is defined as the input impedance of a homogeneous line of infinite length. Z~ is the asymptotic value the characteristic impedance approaches at high frequencies. |
| Civil infrastructure | : | Basic communications infrastructure installation needed for the establishment of fixed network communications network services such as pits, ducts, manholes and etc. but does not include a line. |
| CMA | : | Communication and Multimedia Act (1998) |
| CNR | : | Carrier-to-noise ratio is the ratio of the level of the carrier to that of the noise in the desired frequency band, expressed in dB. |
| Column | : | Connect one group of Fibers to another. A number of columns are grouped within a Fiber panel |
| Commercial Building | : | A building or portion thereof, which is intended for office use. |
| Concrete fill | : | A minimal depth concrete pour to encase single level underfloor duct. |
| Conduit | : | A raceway or circular cross-section of the type permitted under the appropriate electrical code. |
| Consolidation Point | : | An interconnection between horizontal cable extending from building pathways and cable extending into pathways to the work area telecommunication/connector. |
| Cross connect | : | A facility enabling the termination of cable elements and their connection, primarily by means of patch cords or jumpers |
| Cross over | : | The junction unit at the point of intersection of two cable trays, raceways, or conduit on different planes. |
| dB (decibel) | : | A unit of measurement which expresses changes in signal power levels along a logarithmic scale. 3 dB represents a multiplication factor of 2; 10 dB a factor of 10; 20 dB a factor of 100; 30 dB a factor of 1000; etc. |

| | | |
|---|---|---|
| Developer | : | Any person, body of person, company, firm or society (by whatever name described), who or which engages in or carries or undertakes or causes to be undertaking housing development. |
| Distributor | : | The term used for the functions of a collection of components (e.g. : patch panels, patch cords) used to connect cables. |
| Duct | : | An enclosed raceway for wires or cables usually used in soil or concrete an enclosure in which air is moved. |
| Entrance facility | : | An entrance to a building for both public and private network services cables including the entrance point at the building wall and continuing to the entrance room or space. |
| Entrance point | : | The point of emergence of telecommunication conductors through an exterior wall, a concrete floor slab or from a rigid metal conduit or intermediate metal conduit. |
| Entrance room or space | : | A space in which the joining of inter or intra-building telecommunications backbone facilities takes place. |
| Equipment cables | : | A cable connecting equipment to a distributor. |
| Equipment room | : | A room dedicated to housing distributors and application specific equipment. |
| Fiber panel | : | Collection of fiber columns. |
| Fire-stopping | : | The process of installing specialty materials into penetrations in fire-rated to re-establish the integrity of the barrier. |
| Floor Distributor | : | The distributor is used for generic / structured cabling in the commercial building. It is to connect between the horizontal and other cabling sub-systems or equipment. |
| Frame | : | Horizontal collection of blocks. |
| Frequency | : | The number of times in which an alternating current goes through a complete cycle of 360 degrees in one second of time. |
| Gain | : | The amplification factor for communications devices expressed in dB. For antennas, gain is expressed in dB, decibels referenced to an isotropic reference antenna. |
| Generic Structured Cabling | : | A structured communication cabling system, capable of supporting a wide range of applications. Generic cabling can be installed without prior knowledge of the required applications. Application specific hardware is not a part of the generic cabling. |
| Gbps | : | The prefix Giga means billion, and bps – bits per second is the speed of data transmission. |
| GHz | : | The prefix Giga means billion, and Hertz means cycles per second. Signals in the GHz range are often called microwaves. |
| Ground | : | A conducting connection, whether intentional or accidental, between an electrical circuit or equipment and earth, or to some conducting body that serves in place of earth. |

| | | |
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| Grounding electrode | : | A conductor, usually a rod, pipe or plate, in direct contact with the earth for the purpose of providing a low impedance connection to earth. |
| Handhole | : | A structure similar to a small maintenance hole in which it is expected that a person cannot enter to perform work. |
| Header duct | : | A raceway of rectangular cross-section placed within the floor to tie distribution ducts or cells to the Telecommunications Closet. |
| Horizontal cabling | : | Cable connecting the Floor Distributor to the telecommunications outlets. |
| Home runs | : | A pathway or cable between two locations without a point of access in between. |
| Housing Development | : | Develop or construct or cause to be constructed in any manner more than 4 units of housing accommodation and shop house in, on, over or under any land with the view of selling the same. |
| Hybrid cable | : | An assembly of two or more different types of cable units, cable categories covered by an overall sheath. It may be covered by an overall shield. |
| IEC | : | International Electrotechnical Commission.<br>An organization that sets international electrical and electronics standards. |
| Individual work area | : | The minimum building space which could be reserve for an occupant. |
| Infrastructure | : | Any telecommunications plant and shall include post, ducts, manholes, relay, rack, cable racks, cable ladders, terminal frames, backboards, concrete slabs, riser passage, risers and the like, but does not include a line. |
| Insertion Loss | | The decrease in transmitted signal power resulting from the insertion of a device in a transmission line or optical fiber. It is usually expressed relative to the signal power delivered to that same part before insertion. Insertion loss is usually expressed in decibels (dB). |
| Interactive Services | : | These enable subscribers to use the television to shop, bank, and make travel arrangements and play interactive games. They are provided independently or in conjunction with television and radio programs. Distance learning is another example of an interactive service supported by the system. |
| Interconnect | : | A location at which equipment cables are terminated and connected to the cabling sub-systems without using a optic or a jumper |
| Interface | : | A point at which connections are made to the generic cabling. |
| Internal telecommunication wiring | : | Any telecommunications line cable, wire, optical fiber, conduits or other physical media required to connect customer's terminal equipment and the network termination unit at the Private Property Boundary. |

| | | |
|---|---|---|
| IPTV | : | Internet Protocol Television.<br>Television and/or video signals are distributed to subscribers using Internet protocols. Often this is in parallel with the subscriber's Internet connection, supplied by a broadband operator using the same infrastructure. |
| Jumper | : | A cable unit or cable element without connectors, used to make a connection on a cross-connect. |
| Keying | : | A mechanical feature of a connector system, which guarantees the correct orientation of a connection, or prevents the connection to a jack or optical Fiber adapter to the same type intended for another purpose. |
| Line | : | A wire, cable, optical fiber, wave guide or other medium used or intended for use as a continuous guide for or in connection with carrying telecommunications, but does not include infrastructure. |
| Link | : | The transmission path between any two interfaces of generic cabling. It excludes equipment and work area cables. |
| Linkage | : | A connection between a record and an identifier or between records. |
| Mbps | : | The prefix mega means million, and bps means bits per second is the speed of data transmission. |
| MHz | : | The prefix mega means million, and Hertz means cycles per seconds. |
| Multi Network Provider | : | More than one Network Provider. |
| Multi Storey Building | : | Any building of multi levels which requires a telecommunication riser for the provision of internal distribution cables to the customers by the Network Providers. |
| Mutual capacitance of a pair | : | The mutual capacitance of a pair (or with respect to the side of a quad) is defined as:<br>$C_m = (C_1 + C_2)/ 2 - C_3/4$<br>Where<br>$C_m$ = the mutual capacitance of a pair.<br>$C_1$ = the capacitance between conductor a and conductor b with conductor b connected to all other conductors, screen and earth.<br>$C_2$ = capacitance between conductor b and a with conductor a connected to all other conductors, screen and earth.<br>$C_3$ = capacitance between conductors of the pair connected together and all other conductors connected to screen and earth. |

| | | |
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| Near-End Cross-talk (NEXT) | : | NEXT is defined as<br><br>$10 \log_{10} (P_{1IN}/P_{2IN})$ (dB)<br><br>where<br>$P_{1IN}$ = input power of the disturbing pair.<br>$P_{2IN}$ = output power of the disturbed pair at the near end. |
| Network Facilities | : | Any element or combination of elements of physical infrastructure used principally for, or in connection with, the provision of network services, but does not include customer equipment |
| Network Facility Provider | : | A person who owns or provides any network facilities. |
| Network Facility Provider's Equipment | : | An apparatus, device, line, infrastructure, interfacing device or equipment used or intended to be used in connection with a telecommunications network to supply telecommunication services. |
| Noise Figure(NF) | : | The noise figure is usually expressed in decibels (dB), and is with respect to thermal noise power at the system impedance, at a standard noise temperature (usually $20^{o}$ C, 293 K) over the bandwidth of interest. |
| Office Building | : | Any building that is intended for office use. |
| Optical fiber duplex adapter | : | A mechanical device designed to align and join two duplex connectors. |
| Outlet box | : | An enclosure into which telecommunication connector or jack may be installed to or from which wires may emerge. |
| Pair | : | A twisted pair or one side circuit in a star quad. |
| Pair or one side of a quad to earth capacitance unbalance | : | The capacitance unbalance to earth of a pair or one side of a quad is defined as<br><br>$C_e = C_1 - C_2$<br><br>Where<br>$C_e$ = pair to earth capacitance unbalance.<br><br>$C_1$ = capacitance between conductor a and conductor b with conductor b connected to all other conductors, screen and earth.<br><br>$C_2$ = capacitance between conductor b and conductor a with conductor a connected to all other conductors, to screen and earth. |
| Patch cord | : | Flexible cable unit or element with connectors, used to establish connections on a patch panel. |
| Patch panel | : | A cross connection designed to accommodate the use of patch cords. It facilitates administration for moves and changes. |

| | | |
|---|---|---|
| Pathway | : | A raceway, sleeve, or exposed location, for the placing of telecommunication cable that links telecommunication spaces together. |
| Position within a column | : | Physical co-ordination of terminated pair of Fibers. |
| Primary pathway | : | A facility to carry a number of cables and which secondary pathway exits. |
| Private Property Line | : | The boundary between the Network Provider and the customer's property to determine the termination point for the Network Provider for the provisioning of infrastructure. |
| Public network interface | : | A point of demarcation between public and private network. In many cases the public network interface is the point of connection between the network provider's facilities and the customer's premises cabling. |
| Raceway | : | See pathway. |
| Rack | : | Mounting place for equipment. |
| Residential Premise | : | A parcel of land consisting of buildings designed, adapted or used for residential habitation and shall include semi-detached buildings, detached building and terrace house. |
| Riser | : | An utility room specific to accommodate cabling, component for services related to Fixed Network, Broadcasting, Cellular and Wireless. |
| Resistance Unbalance | : | The resistance unbalance between conductors of a pair or in the same side of a quad is defined as:<br><br>$R_{(\%)} = (R_{max} - R_{min}) / (R_{max} + R_{min}) \times 100\ (\%)$<br><br>Where<br>$R_{(\%)}$ = resistance unbalance.<br><br>$R_{max}$ = Resistance of conductor with the higher resistance value (in □).<br><br>$R_{min}$ = Resistance of conductor with the lower resistance value (in □). |
| SDBA | : | Street, Drainage and Building Act, 1974 |
| Secondary pathway | : | The facility that carries cable from the primary pathway to the wall plate. |
| Semi-Detached House / Semi-D House. | : | Any building designed to be built as one pair having a party wall as one of its walls. |
| Network Service Provider | : | A person who provides network services such as fixed network communications services. |
| Shielded cables | : | An assembly of two or more balanced twisted pair cable elements, or one or more quad cable elements, wrapped by an overall screen or shield contained within a common sheath or tube. |

| | | |
|---|---|---|
| Shielded twisted pair cable | : | An electrically conducting cable comprising one or more elements, each of which is individually shielded. There may be an overall shield, in which case the cable is referred to as a shielded twisted pair cable with an overall shield. |
| Shop House | : | Any building or any part of the building designed, adapted or used for business purpose and shall be of four storey or less, and shall include any building of alight industrial nature, such as factories. |
| Splice | : | A joining of conductors and Fibers, generally from separate sheath. |
| Splitters | : | Divide the input signals equally, providing the same amount of signal at each output of the splitter. |
| Star Quad | : | A cable element, which comprises of four insulated conductors twisted together. Two diametrically facing conductors form a transmission pair. |
| Structured Cabling | : | Can be used interchangeably with generic cabling. |
| Subscribers Distribution Frame (SDF) | : | A connecting unit between external and internal lines. It allows for public or private lines coming into the building to connect to internal networks. |
| Tap-Off | : | Is a means of delivering signal from the distribution lines to the outlet, while providing enough isolation to prevent the sets from interfering each others |
| TCPA | : | Town and Country Planning Act, 1976 |
| Telecommunications Closet (TC) | : | An enclosed space for housing telecommunication equipment, cable terminations and cross-connect cabling. |
| Telecommunications Network | : | A system or series of systems for carrying, conveying or transmitting telecommunications. |
| Telecommunications Room | : | A space provided by building owner for a Network Providers to enable the supply of telecommunication service to the customer. |
| Telecommunications service | : | Any telecommunications service supplied or intended to be supplied to the customer by Network Service Provider. |
| Telecommunications outlet | : | A fixed connecting device where the horizontal cable terminates. The telecommunication outlet provides the interface to the work area cabling. |
| Telephony Cable | : | A plain old telephone system (POTS) cable. |
| Terrace House | : | Any residential building designed as a single dwelling unit and forming part of a row or terrace of not less than three such residential buildings. |
| Transition Point | : | A location in the horizontal cabling where a range of form takes place; for example flat cable connects to round cables with differing numbers of elements are joined. |
| Twisted pair | : | A cable element which consist of two insulated conductors twisted together in a regular fashion to form a balanced transmission line. |

| | | |
|---|---|---|
| UBBL | : | Uniform Building By Laws |
| Unshielded Twisted pair | : | An electrically conducting cable comprising one or more pairs none of which is shielded. There may be an overall shield, in which case the cable is referred to as unshielded twisted pair with an overall shield. |
| Velocity of propagation | : | Velocity at which the signal propagates in the cable and is expressed in km/s. It is derived from the measurement of velocity ratio and knowledge of the velocity of propagation in free space. Velocity of propagation in free space can be assumed to be 299,778 Km/s. |
| Wall plate | : | A single piece of assembly that contains one or more openings and carries the location identifier |
| Wall plate position | : | A location on the wall plate that provides the point of connection for the customer to the telecommunications infrastructure. The position starts with number one and go from left to right, top to bottom |
| Work area | : | A building space where the occupants interact with telecommunications terminal equipment |

**Annex A**
(Informative)

**Fiber Optic Testing Procedure**

## A1. Requirements of Test Equipment

The optical source for all the test measurements explained in this section shall conform to IEC 793-1.

The source may or may not be modulated, depending on the measurements being made.

The characteristic of optical receiver for all the tests described in this section shall conform to IEC 793-1.

## A2. Insertion Loss Testing

### A2.1 General

Insertion Loss tests shall be conducted on all installed links. Backbone links shall be tested in one direction, at two applicable wavelengths.

### A2.2 Test Equipment

The following are required for testing purposes:

a) A stable light source at the apt wavelength for either single mode or multimode Fiber, whichever is being tested.

b) An optical power meter, also designed to measure power over the appropriate wavelength.

c) At least two high quality test jumpers, one meter in length, of the same Fiber type and size, with the same connector type as the Fiber to be tested.

d) Forms for documenting the test.

e) Cleaning pads or other materials for maintaining the Fiber/connector ends during testing.

### A2.3 Test Procedures

A2.3.1 All components shall be clean before testing.

A2.3.2 Turn on the source and meter for recommended warm up period.

A2.3.3 Connect source to meter with both of the test cords with a coupler in between. Initialize the test instruments.

A2.3.4 Do not disconnects the reference jumper from the source at any time. This would invalidate the reference number.

Disconnect the reference jumper from the meter. Transport the meter and the second test jumper to the far end of the fiber to be tested. Using jumpers, connect the interconnect points at each end to the source and meter. Read the meter.

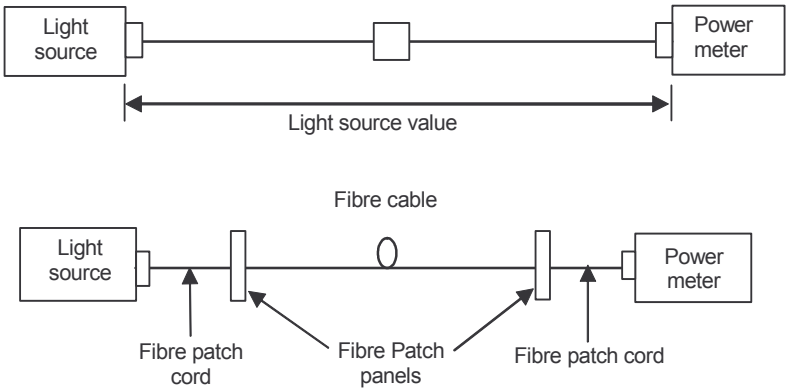



**Figure A.1. Insertion Loss Measurement**

Should any of the following happen, new test reading shall be taken:

a) The reference jumper becomes disconnected from the source.

b) The source is turned off.

c) The reference jumper becomes damaged.

d) Test readings are questionable.

**Annex B**
(normative)

**Recommended Building Infrastructure Design**

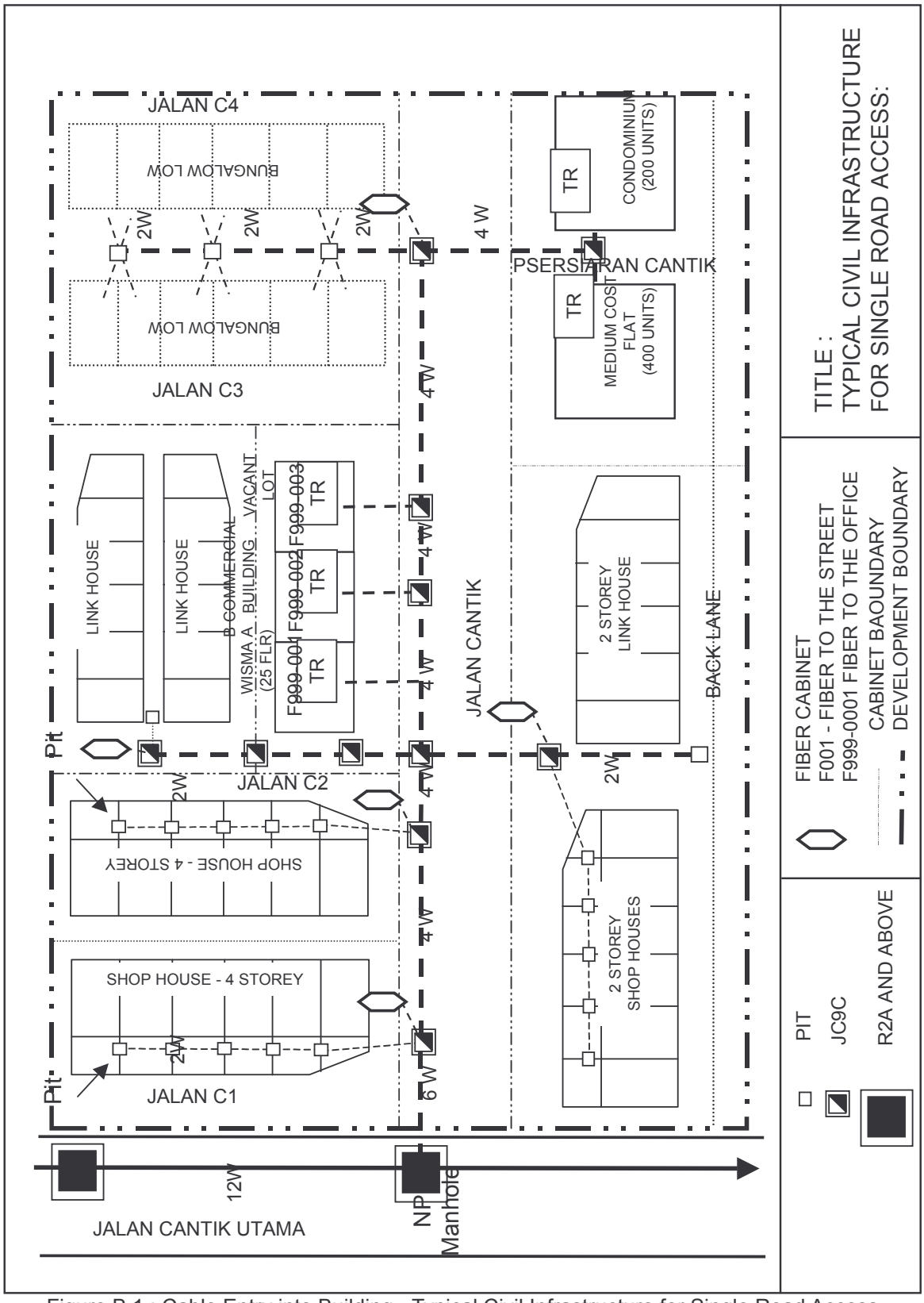



Figure B.1.: Cable Entry into Building - Typical Civil Infrastructure for Single Road Access

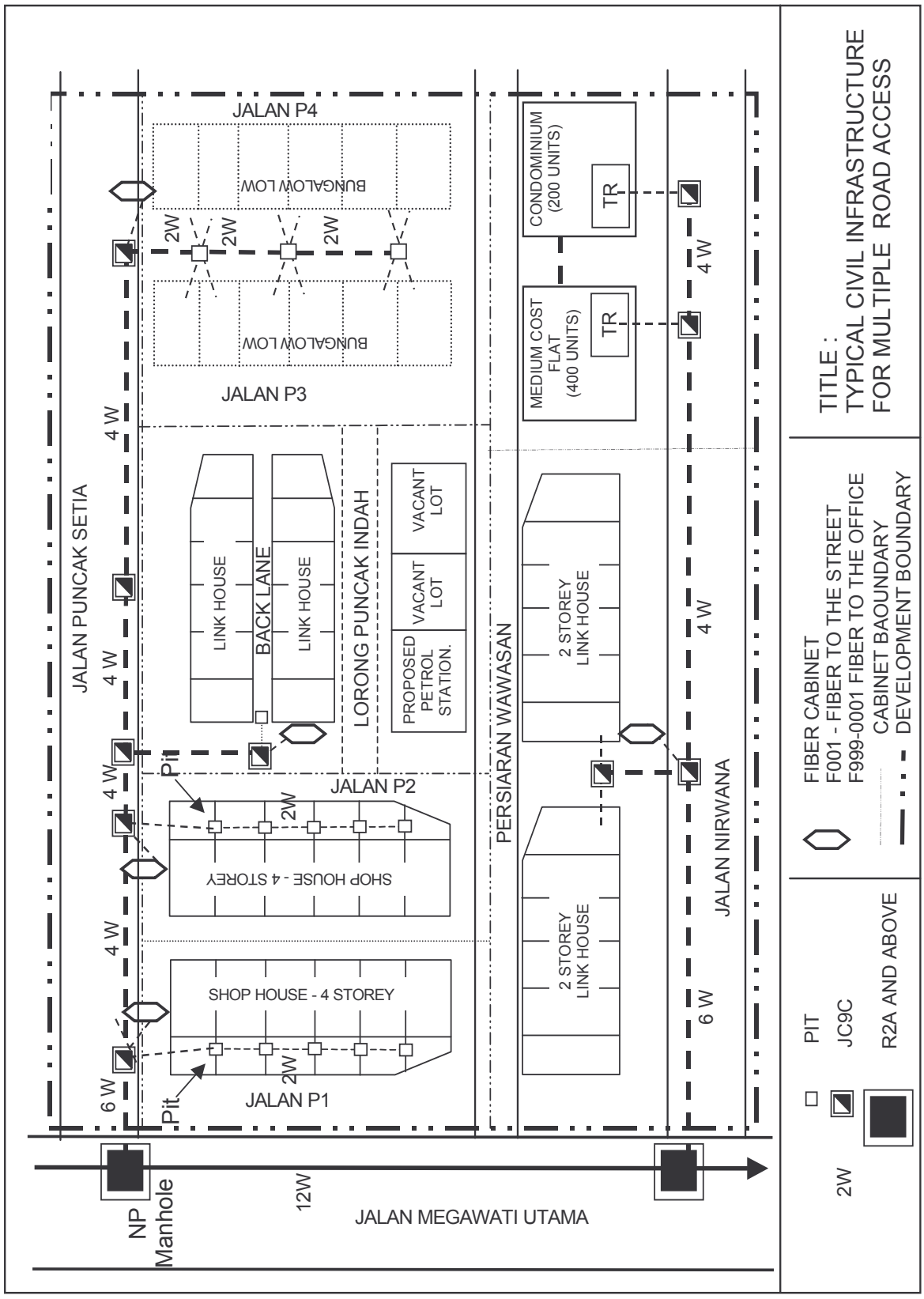



Figure B.2: Cable Entry into Building - Typical Civil Infrastructure for Multiple Road Access

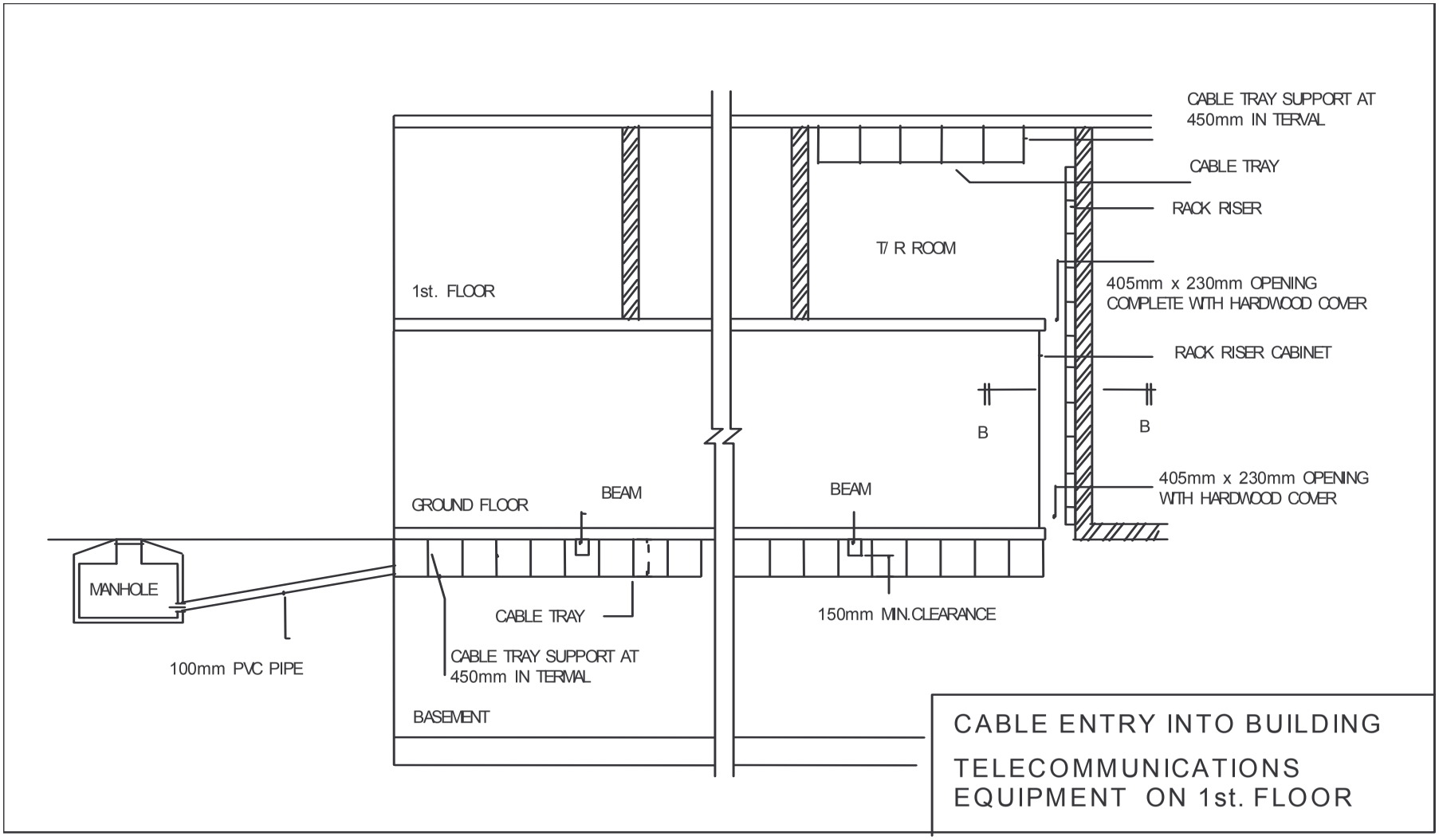



Figure B.3: Cable Entry into Building, Telecommunications Room on First Floor

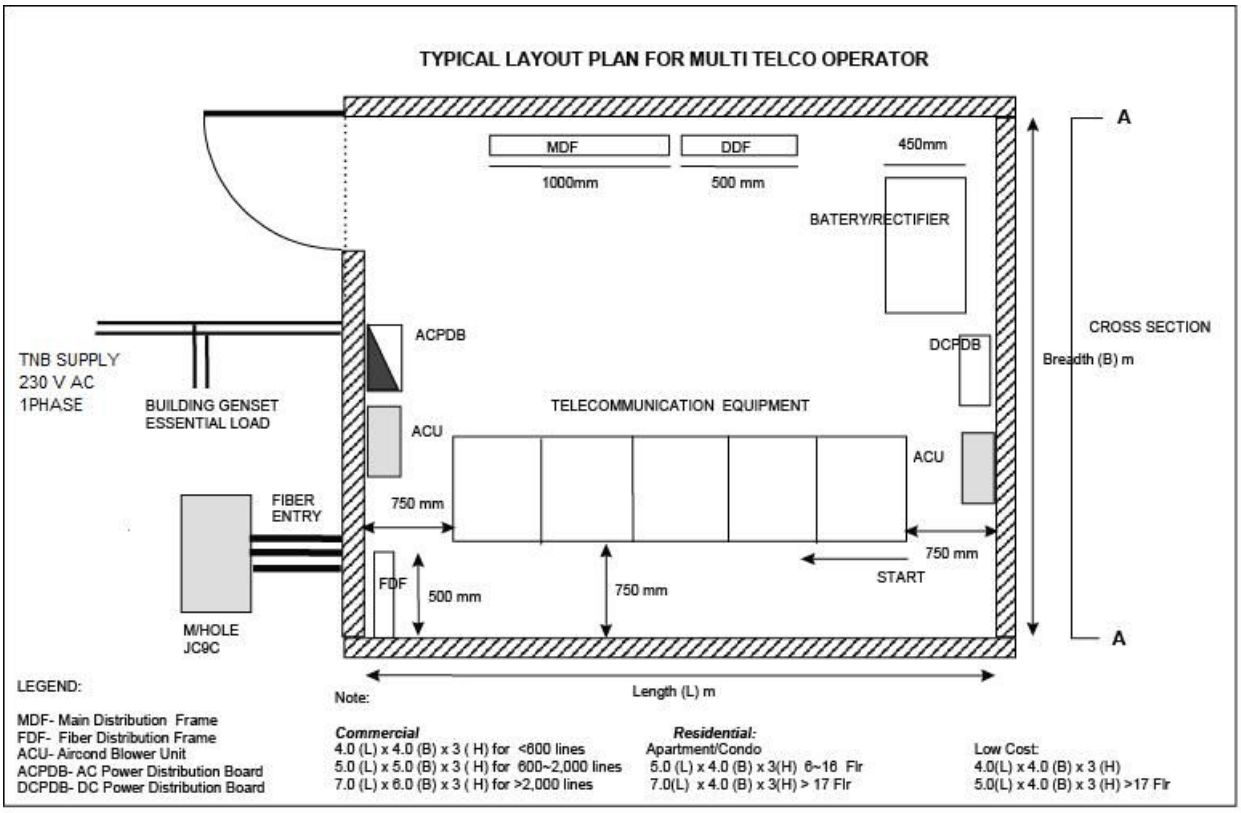



Figure B.4: Telecommunications Equipment Room - Typical Layout Plan

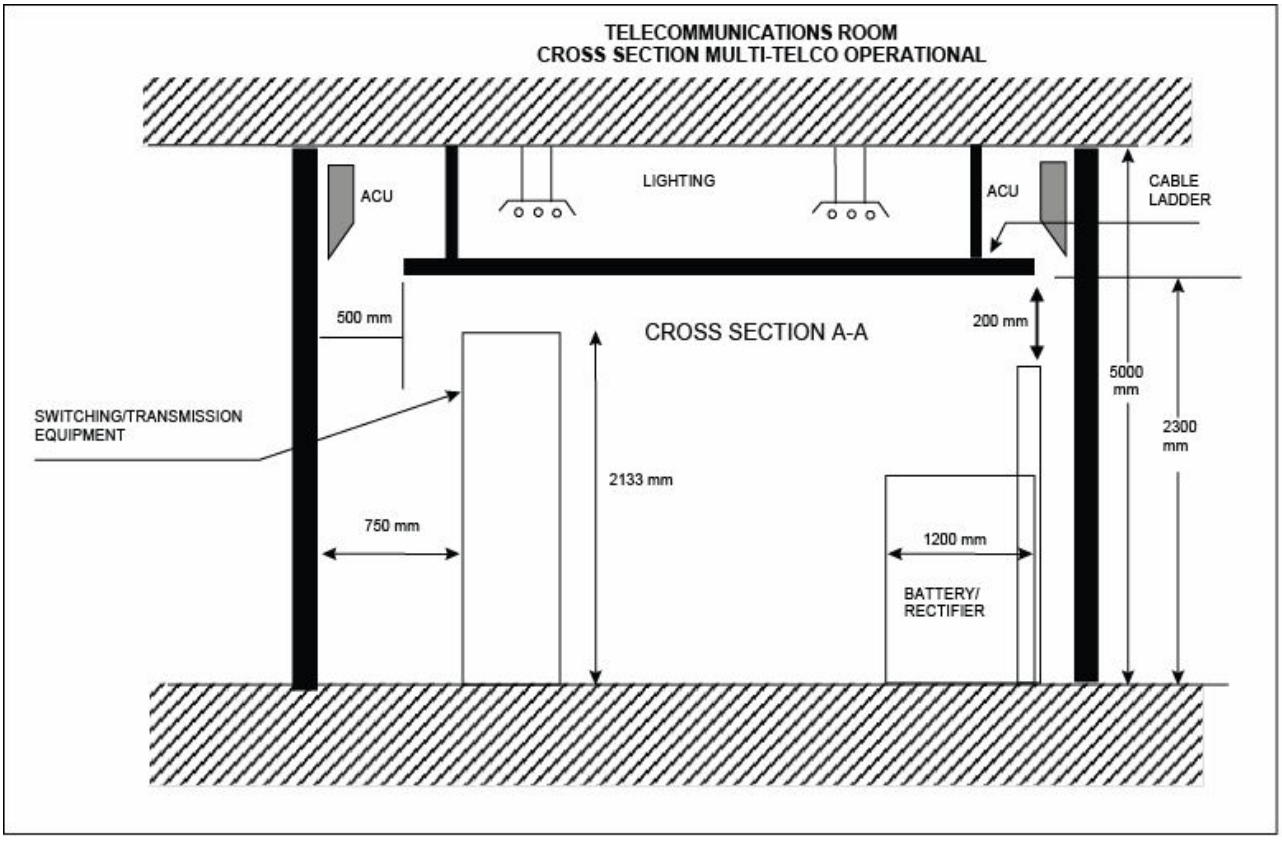


Figure B.5. Telecommunications Room - Cross Section

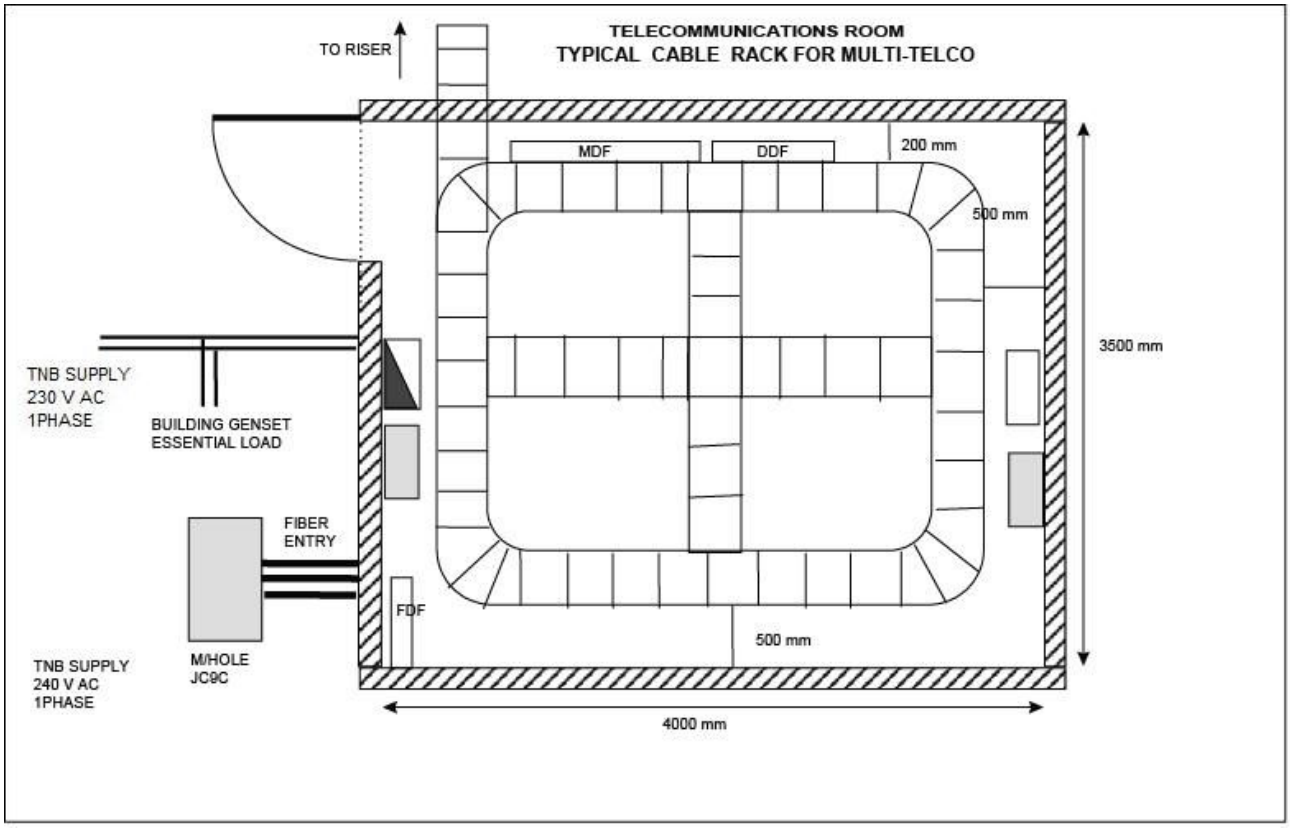



Figure B.6: Telecommunications Room - Typical Cable Rack

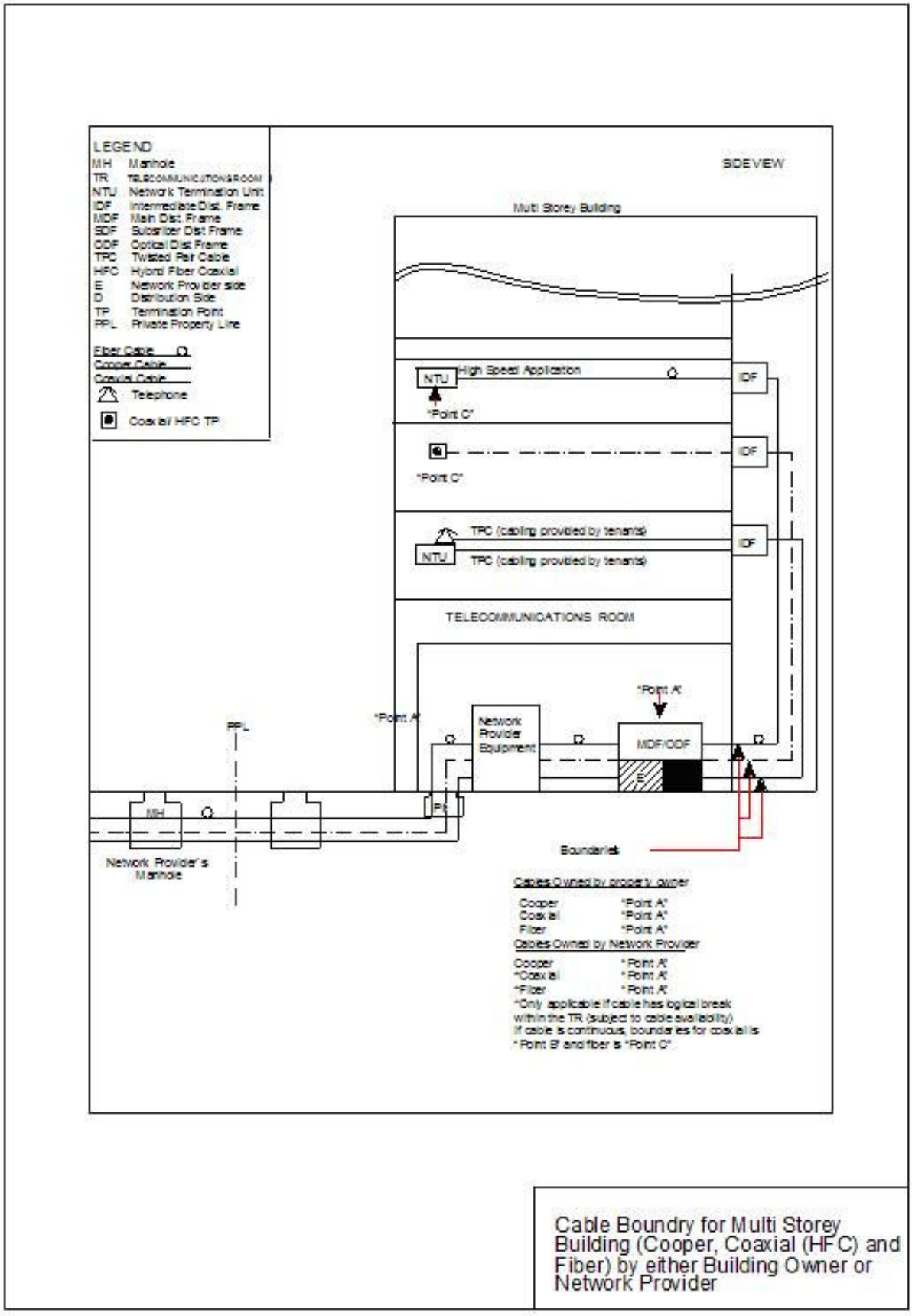



Figure B.7: Cable Boundary for Multi Storey Building (Copper, Coaxial (HFC) And Fiber) By Either Building Owner or Network Provider

## B.1. Riser Design & Allocation

### B.1.2 RISER

The riser may be shared with the other communication providers, all cables and equipment should be installed according to the space allocated. All cables and equipment should be properly tagged.

### B.1.3 Equipment Installation and Arrangement

All Fixed Network equipment inside the riser should be installed on the left-hand side of the wall (refer Figure B.8 & B.9. below). All equipment should be installed on a secured orderly manner.

Figure B.8: Equipment and Trunking Arrangement

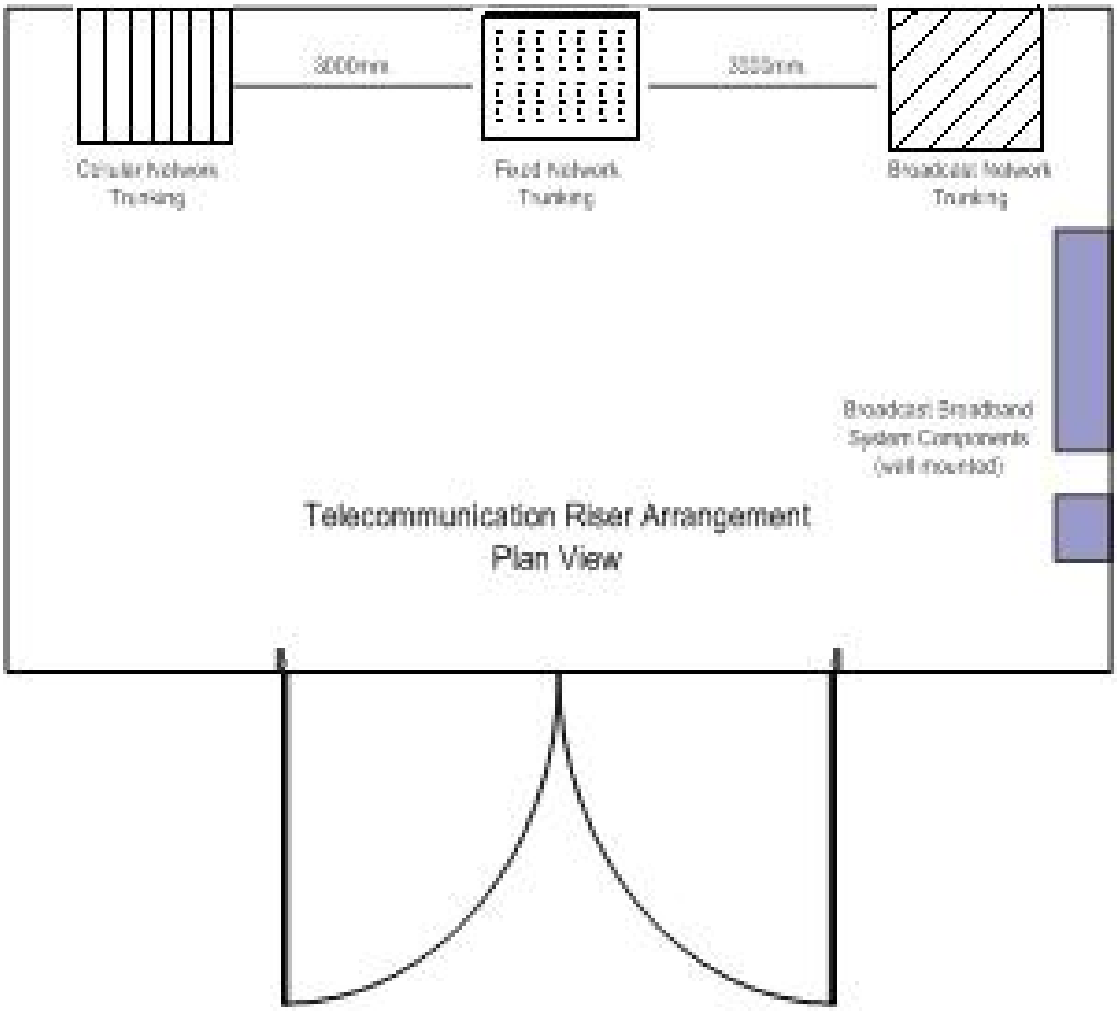
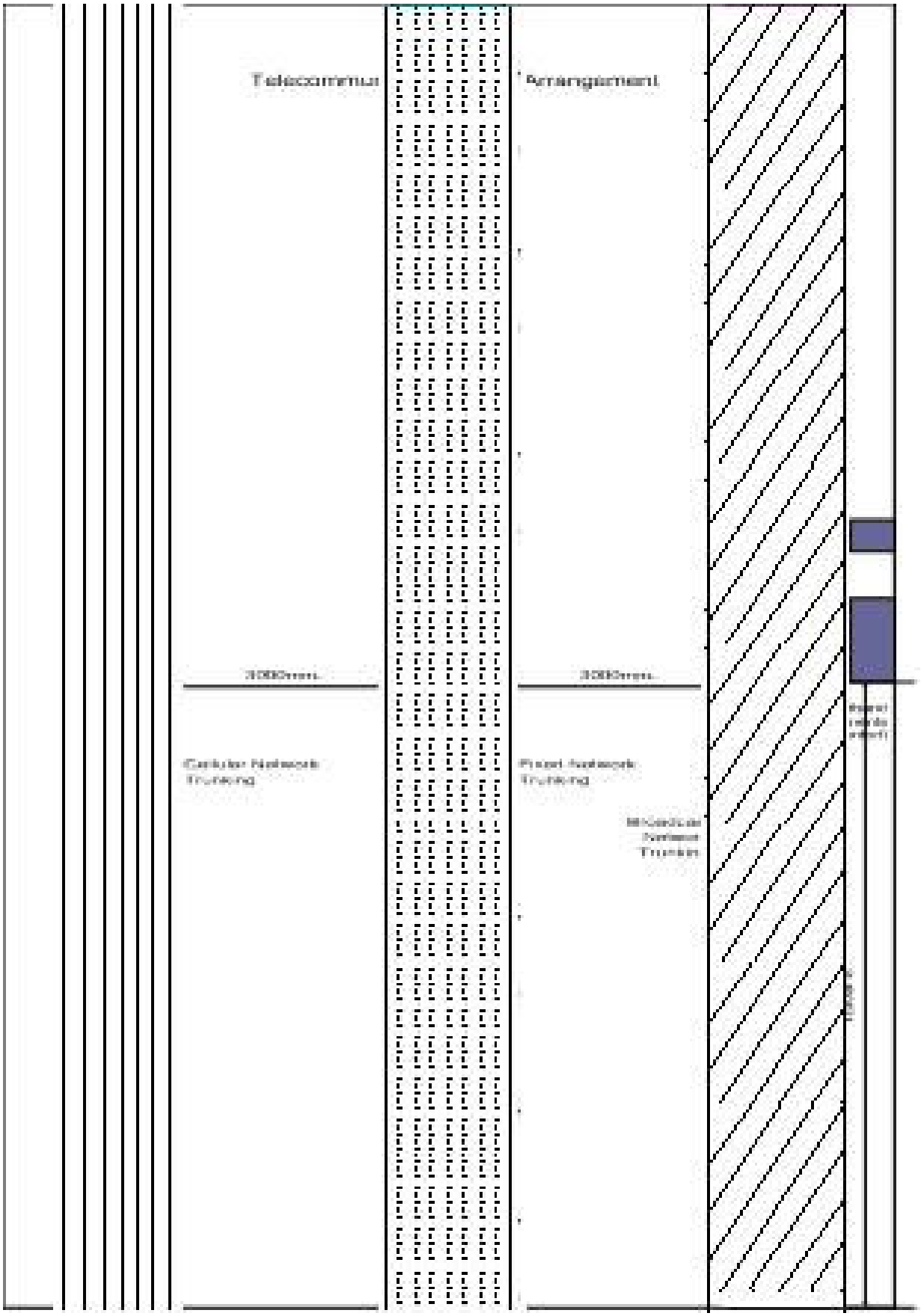


Figure B.9. : Telecommunications Riser Arrangements



**Annex C**
(normative)

**Recommended Cable Distribution Design**

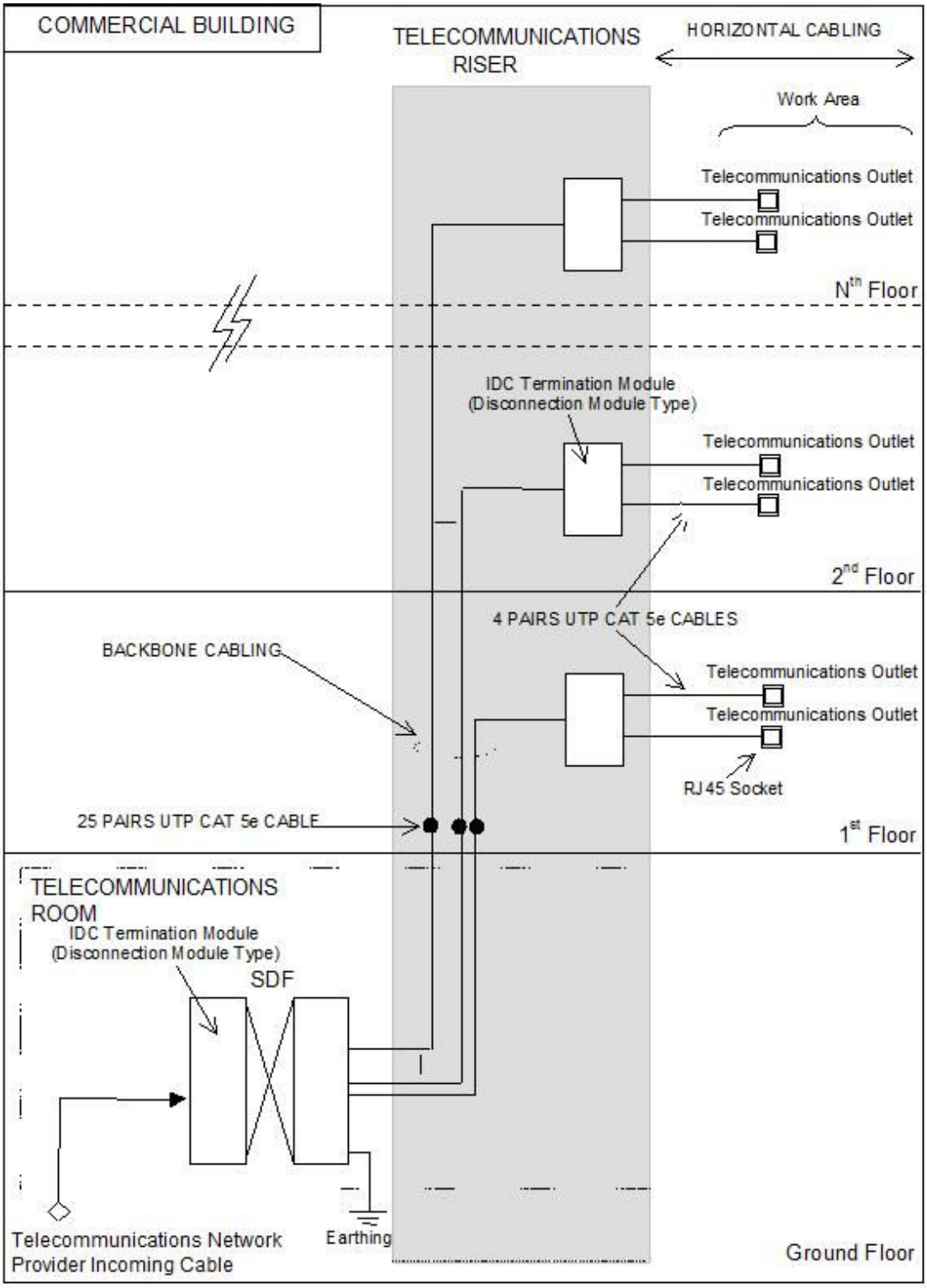



Figure C.1: Typical Structured Cabling In Commercial Building.

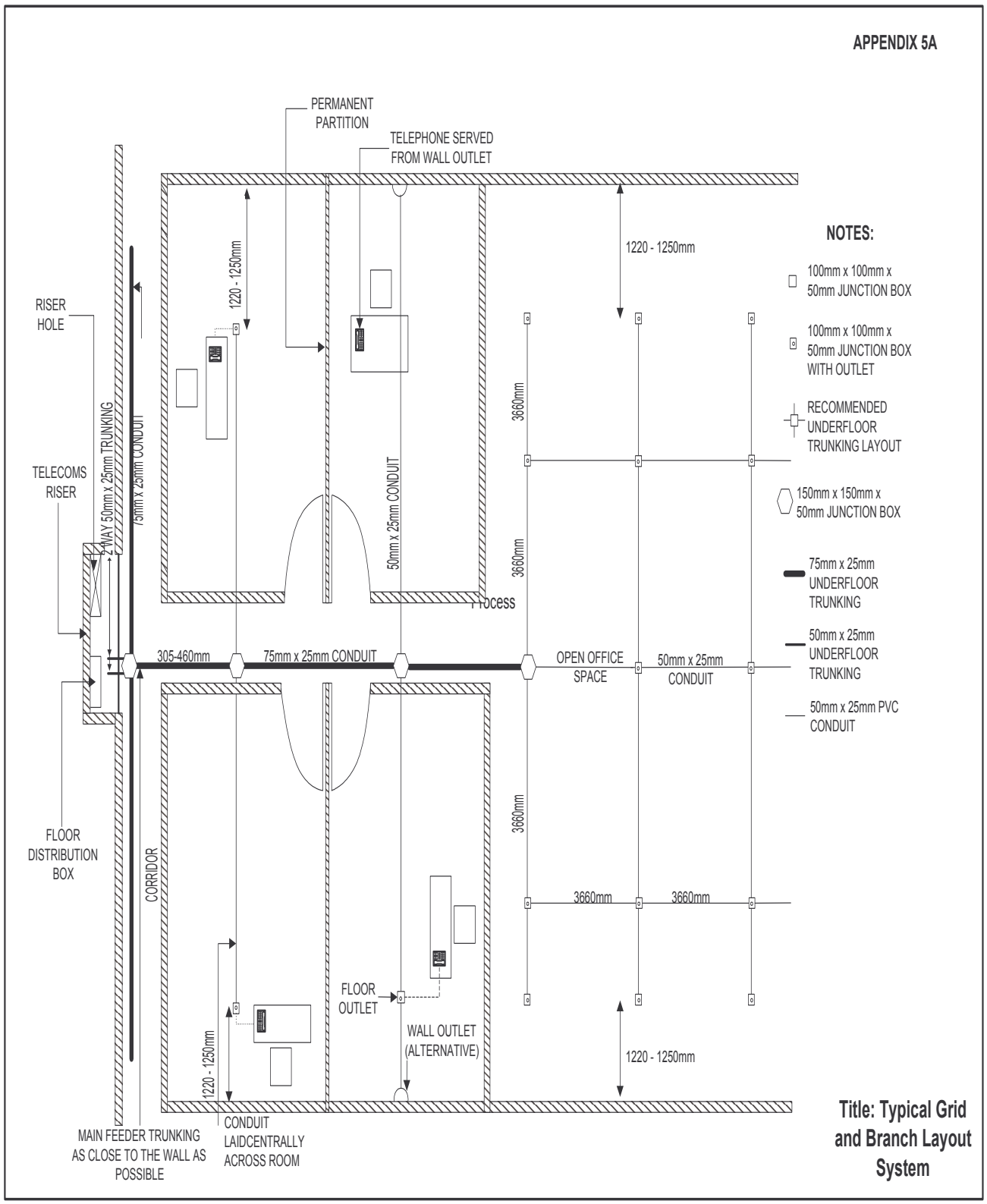
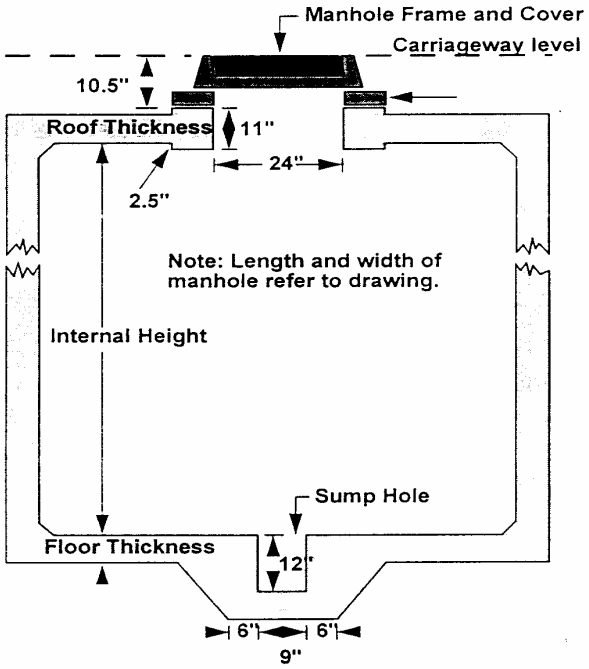



**Figure C.2. Horizontal Floor Distribution – Typical Grid and Branch Layout System**

## Annex D
(normative)

## Recommended Manhole Design

Figure D.1: Typical Manhole Design




| No. | Manhole Type | Size: LxWxH (mm) | M/H strength SIRIM Std w/safety Factor x2 | Tot No. Duct-Way 50+50 100mm PVC& 3HDPE | No. | qty | no | qty | qty | qty | qty | | M/H Cover, Existing size. | Ladder /Hook /Step | LOADING/ UNLOADING M/H (machinery use) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | JB30-PIT | 950x625x450 | 22.5 mt. ton | 2 -way | - | - | - | - | - | - | - | 1-hole | 3E | - | <BACKHOE EXCAVATOR |
| 2 | JRC7 | 1280x975x800 | 22.5 mt.ton | 2-way | 1 | 2 | 8 | 4 | 4 | 1 | - | 1-hole | 3E | - | <BACKHOE EXCAVATOR |
| 3 | JC9 (M) | 1570x660x1070 | 22.5 mt. ton | 4-way | 1 | 2 | 8 | 4 | 4 | 2 | 1 | 1-hole | 7E | existing | <BACKHOE EXCAVATOR |
| 4 | JC9C (M) | 1820x970x1440 | 22.5 mt. ton | 4-way | 1 | 4 | 8 | 8 | 8 | 1 | 1 | 2-holes | 3E | existing | <BACKHOE EXCAVATOR |
| 5 | R1B (M) | 1820x1220x1970 | 22.5 mt. ton | 6-way | 2 | 4 | 18 | 8 | 8 | 2 | 1 | 2-holes | 3E | existing | <BACKHOE EXCAVATOR |
| 6 | R2A | 3050x1220x1820 | 22.5 mt. ton | 12-way | 2 | 6 | 12 | 12 | 12 | 6 | 1 | 2-holes | 3E | existing | <BACKHOE EXCAVATOR |
| 7 | R2A (M) | 3660x1520x1820 | 22.5 mt. ton | 12-way | 2 | 6 | 18 | 12 | 12 | 6 | 1 | 2-holes | 3E | existing | <BACKHOE EXCAVATOR |
| | | NO CHANGE | NEW DESIGN | NEW DESIGN | | | | | | | | NEW DESIGN | NEW DESIGN | | NEW DESIGN GUIDELINE |

Table D1: Typical Manhole Specifications

**Annex E**
(normative)

**Recommended Structured Cable Design, Installation & Testing**

Details of Accessories part of the cabling infrastructure are as follows:

## E1. TRANSITION POINTS

### E1.1 General

Transition Points was used to provide a transition between cable types or configurations, for example from 25 pair to 4 pair or from round to flat cable.

It is a source of cross talk and attenuation and shall have impact on the performance of cable runs.

### E1.2 Configuring Transition Points

If required, one TP is allowed between any FD and any TO. The transmission characteristic of the 90m maximum distance of the horizontal cable shall be maintained.

Cable elements at the TP shall be mechanically terminated.

The TP shall not be used as cross-connect and application specific equipment shall not be located there.

The TP may comprise of only passive connecting hardware.

## E2. Horizontal Pathways

### E2.1 General

Horizontal pathways define facilities for the installation of telecommunications from the FD to the work area.

Horizontal pathways encompass underfloor, access-floor conduit, tray and wireway, ceiling and perimeter facilities.

Pull boxes and splice boxes may be considered as horizontal pathways. In this guideline, pull boxes and splice boxes are considered as spaces.

The pathway for horizontal cabling shall be designed to support all telecommunications media recognized by this standard.

Horizontal pathways should not be located in elevator shafts.

The designer should design a trunk and branch layout that allows the horizontal cables to be bundled along main corridors and office throughways, emanating from the Floor Distributor to all work areas. This would allow the installer to employ more efficient pulling methods and causes less disruption to the customer's daily operation.

## E3. Underfloor Ducting System

### *E3.1 General*

Horizontal cableways or runways are required from the Floor Distributor or Telecommunications Closets to all telecommunication outlets in all rooms.

There are a few methods in provisioning the ducting trunking :

a) Duct under the floor.

b) Pipes under the floor.

c) Hollow skirting along the wall.

d) Hollow dados along the wall.

e) Grooved picture rails or cable rails.

The one suitable in modern practice favours the use of (a) and (b) with the duct under the floor in rectangular shapes.

The material use for under floor duct shall be galvanized mild steel, Fiber type, aluminum alloy or PVC with a minimum thickness of 1.6mm.

The under floor duct shall be buried 20mm to 25mm below floor screed level and their size depend on their distribution and the number of nodes required on a particular floor.

During the construction of the building, when under floor trunking system is assembled and screed being poured, extra precautions must be taken to ensure that the ducting / trunking are not damage and free from dirt and rubble.

The whole system shall be left clean and free from obstruction and fitted with draw wires before communication cables are installed.

### *E3.2 Layout of Under floor Ducting System*

*E3.2.1 Grid System*

Grid system type is suitable for office and shopping complex with a large open space. Grid layout system using under floor duct with 3.6m x 3.6m grid type with floor outlets at the junction point.

The size of trunking is 50mm x 25mm (2” x 1”) for grids but a larger trunking will be required from the cable riser to the grid.

*E3.2.2 Branching Layout System*

Branching layout is suitable for the office building or shopping complex with a permanent partition and corridors. The branching layout system uses a central feeder trunking with branches at suitable position, normally 3m to 3.6m apart is recommended.

The telecommunication outlets shall be provided on these branches at every 3m apart.

The central feeder trunking must be designed and run along the public corridor as close to the wall as possible.

*E3.2.3 Perimeter Layout System*

Perimeter layout is using skirting duct with 4.5m x 3m (15’ x 10’) open floor grids with detachable covers.

## E4 Conduit

### *E4.1 General*

If conduit is requested by the customer, the installer shall provide conduit of required size and type where indicated on job drawings.

In addition, the installer shall provide accessories required for a complete conduit installation.

### *E4.2 Types of conduit*

All conduits shall comply with TIA/EIA 568A and 569. The types of conduit recommended are:

a) Metallic tubing
b) Rigid metal
c) High impact PVC

### *E4.3 Design Guidelines and Installation of Conduit*

Conduit runs installed by the installer should not exceed 30m or contain more than two 90o bends without using appropriately sized pull boxes.

In a run requiring more than 2 bends or in excess of 30m, a pull box shall be installed between the second and the third bend as close as possible to the second bend.

Any single conduit run extending from a Telecommunications Closet shall not serve more than three outlets.

Conduits shall be incrementally increased in size from the furthest outlet box toward the Telecommunications Closet.

Conduits protruding through the floor in the Telecommunications Closet shall be terminated 25 mm to 50 mm above the floor surface and should be labeled.

The bending radius shall be as follows:

Table E1: Bending Radius for Conduit

| Conduit Size | Bend Radius |
|---|---|
| Less or equal to 50mm | 6 times conduit size |
| Less or equal to 50mm | 10 times conduit size |
| Fiber optic cable | 10 times conduit size |

The conduit fill table is as follows:

Table E2: Conduit Fill Table

| Conduit size (mm) | 4 pair cable (units) | 25 pair cable (units) |
|---|---|---|
| 20 | 5 | - |
| 25 | 8 | 1 |
| 50 | 26 | 6 |
| 75 | 60 | 14 |

Conduits shall be reamed to eliminate sharp edges and terminated with an insulated bushing.
A fishtape or pullcord (nylon string) shall be placed in installed conduits.

### *E4.4 Outlet Boxes*

The following table depicts the size of outlet boxes for the numerous sizes of conduits.

Table E3: Outlet Box Sizes for Different Conduit Sizes

| Size of outlet box (mm) W x L x D | Conduit trade size |
|---|---|
| 50 x 75 x 64 | 21 |
| 120 x 120 x 64 | 35 |
| 100 x 100 x 57 | 27 |

### *E4.5 Pull Boxes*

Pull boxes shall be used for the following purposes:

a) Fishing conduit runs

b) Pulling the cable to the box and then looping the cable to be pulled into the next length of conduit.

## E5. Cable Trays and Wireways Installation

### *E5.1 General*

If requested by the customer, the installer shall provide cable trays of required size and types when indicated on job drawings. The installer shall also provide accessories required for complete installation.

Trays and wireways may be located below or above the ceiling or within access floor.

### *E5.2 Types*

The following are the example of cable trays and wireways:

a) Channel cable tray

b) Ladder cable tray

c) Solid bottom cable tray

d) Ventilated or through cable tray

e) Spine cable tray

f) Wireway

### *E5.3 Installation*

Cable trays shall be supported by three basic support devices, namely cantilever brackets, trapeze or individual rod suspension. A support should be placed within 610mm on each side of any connection to a fitting. Wireways shall be supported on 1500mm centers unless designed for greater lengths.

Abrasive supports (such as threaded rod) shall have the portion within the cable protected with a smooth, non-scratching covering so that the cable can be pulled without any physical damage.
All wireways shall be compliant with TIA/EIA 568-A and 569.

Cable bundles in wireway or cable trays should be tied every 300mm or less.

When installing the cable trays or wireways, the inside of them shall be free of burns, sharp edges or projections that can damage the cable insulation.

The wireway shall be an unbroken length when it passes through a partition or wall.

Cables shall be properly fire-stopped when passed through cable trays or wireways.

Cable trays and wireways shall not be used as walkways or ladders unless specifically designed and installed for that purpose.

A minimum of 300mm access headroom shall be provided and maintained above a cable tray.

Care shall be taken that other building components such as air-conditioning ducts do not restrict access to cable trays or wireways.

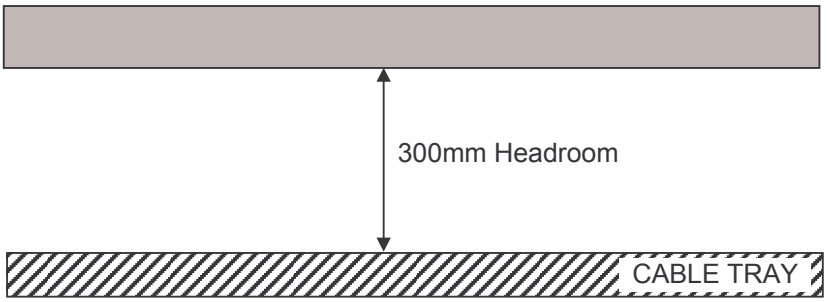



Figure E.1: Headroom above Cable Tray

Avoid excessive weight on cable at cable tray rungs to reduce compression of cables at the bottom.

Fiber cables shall be placed on top of copper cables.

## E6. Trunking

Cable trunking shall comply with the requirements addressed in TSIR (Technical Standards and Information Requirements).

## E7. Ceiling Pathway

### *E7.1. General*

Ceiling areas are sometimes used as pathways for telecommunications cable.

### *E7.2. Considerations*

Inaccessible ceiling areas, such as lock-in type ceiling tiles, drywall or plaster should not be used as distribution pathways.

The ceiling tiles are of the removable or lay in type and placed at a maximum height of 3.4 m above the floor.

Adequate and suitable space is available in the ceiling area for the distribution layout recommended

Raceways are provided where required by codes or design

### *E7.3. Design Guidelines*

The design shall provide suitable means for supporting cables from the Telecommunications Closet to the work area to be served.

Suspended ceiling support wire or rod shall not be used for this purpose.

Cable shall not be laid directly from the ceiling tile or rails.

A minimum of 75mm in clear vertical space shall be available above the ceiling tile for the distribution cabling and pathway.

### *E7.4. Utility Columns*

Utility column provide pathways for wires and cables from the ceiling to the work area.

Utility column should be attached to and supported by main ceiling support channel.

When utility columns are used, the main ceiling rails shall be rigidly installed and braced to overcome movement, both horizontal and vertical.

### *E7.5. Trays*

When a tray is used in the ceiling area, conduits from the tray to outlet zones shall be provided unless otherwise permitted by code.

### *E7.6. Telecommunications Closet Termination*

Trays and zone conduits within the ceiling shall protrude into the closet from 20 to 25 mm without a bend and above the 2.4m level.

### *E7.7. Hanging Pathways*

In suspended ceilings and raised floor areas where walker ducts, cable trays or conduits are not available, the cables shall be bundled with plastic cable ties with particular care taken so as to maintain the geometry of the cable.

The cable bundling shall be supported with J-hooks attached to the existing building structure and framework at a maximum of 1.5m intervals. The bending radius and pulling tension of the cables shall be complied at all times. The maximum height from the ceiling shall be 75mm. This is illustrated in figure below.

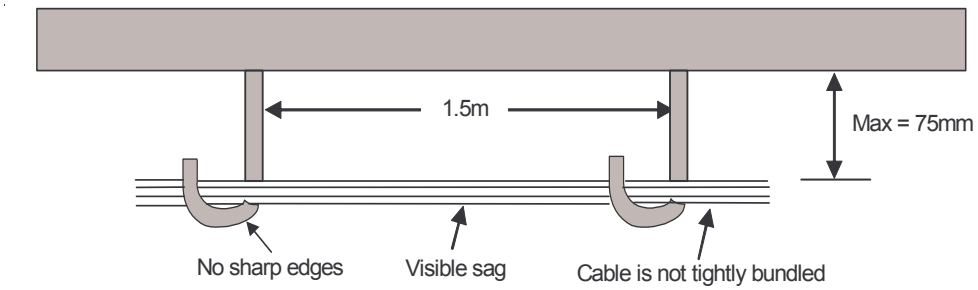



Figure E.2: Hanging Pathways

The cable bundle shall be less than 50 4-pair UTP cables.

The cable shall not be supported by attaching it to the ceiling support system in ceiling plenum environments.

In addition, the cable shall not rest on the ceiling tiles.

Plenum cable should be used in all appropriate areas.

## E8. Raceway Installation

If requested by the customer, the installer shall provide raceways of required size and types when indicated on job drawings. The installer shall also provide accessories required for complete installation. Figure below illustrates a typical raceway.

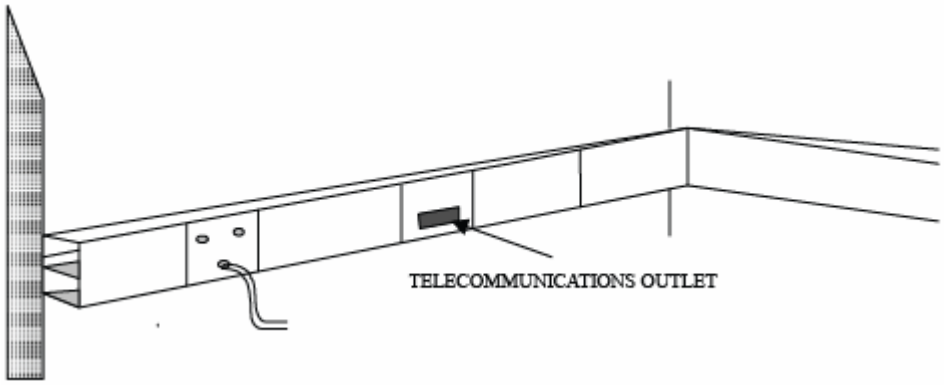



**Figure E.3. Typical Perimeter Raceway**

All surface metal and Fiber optic raceways shall comply with guidelines published by EIA/TIA 568-A and 569.

Raceways shall be routed in such a way so that interference with removal and installation of lighting fixtures and devices of other systems that require servicing or operation can be avoided.

Raceways shall be supported from concrete ceiling or ceiling beams at 1.5m maximum span intervals.

Raceways shall be provided to accommodate underfloor pedestal at 1.2m maximum span intervals.

Sharp burrs or edges shall be removed from raceways.

The raceways, when completed, shall have no cracks or openings at coupled sections.

Radius fittings shall be provided for turns and offsets to accommodate obstruction or elevation changes and maintain minimum cable bending radius.

## E9. Distributors: Floor Distributor

### E9.1 General

The Floor Distributor on each floor is the recognized location of the common access point for backbone and horizontal pathways.

The Floor Distributor shall be able to contain the telecommunication equipment, cable terminations and associated cross connect cabling.

The Floor Distributor shall be located as close as practicable to the center of the area served and preferably in the core area.

### E9.2 Design Consideration

#### E9.2.1 General

Floor Distributor space shall not be shared with electrical installation other than those for telecommunication.

Equipment that are not related to the support of Floor Distributor shall not be installed in, passed through or enter the Floor Distributor.

#### E9.2.2 Size and Spacing

There should be a minimum of one closet per floor. Additional closets should be provided when:

a) The floor area to be served exceeds 1000 $m^2$ or

b) The horizontal distribution distance to work area is more than 90 m

The additional Telecommunications Closet shall be one per 1000 $m^2$.

The multiple closets on a floor shall be interconnected by a minimum of one conduit of 3-trade size or equivalent pathway.

The table below indicates the Telecommunications Closet size. The size is based on the assumption that the work area size is 10$m^2$.

Table E4: Floor Distributor Sizing

| Serving area ($m^2$) | Closet size (mm) |
|---|---|
| 1000 | 3000 x 3400 |
| 800 | 3000 x 2800 |
| 500 | 3000 x 2200 |

#### E9.2.3 Floor Loading

The Floor Distributor shall be located on floor areas designed with a minimum floor loading of 2.4kPa.

### E9.3 Provisioning

#### E9.3.1 Lighting

The lighting should be a minimum of 540 lux, measured in 1.0m above the finished floor in middle of aisles between cabinets.

The lighting should be controlled by one or more switches located near the entrance doors to the room.

#### E9.3.2 Power

The building owner shall supply a minimum of 240V AC 1-phase or 415V AC 3-phase (from electricity utility supplier).

There shall be a minimum of two 240V AC duplex electrical outlets, each on separate circuits for equipment power.

If emergency power is available, consideration should be given to automatic switchover of power.

#### E9.3.3 Door

The door should be a minimum of 910 mm wide and 2000 mm high, without doorsill, hinged to open outward or slide side to side and fitted with an extra lock.
The door fitted to the room should be 2 hours fire rated doors as per *"Jabatan Bomba dan Penyelamat" approval*.

The door should be locked at all times and only authorized telecommunication personnel are allowed to access the room.

#### E9.3.4 Interior Finishing

The floor of the Telecommunications Room should be of a material that is easy to clean and not susceptible to accumulation of dust. The flooring should be of anti-static vinyl type mat.

### E9.4 Closet Penetration

Sleeves or slots through the closet floor should be near to the door. Sleeves or slot shall not be left open unless during cable installation and shall be properly fire-stopped.

Horizontal pathways are also considered as closet penetration. This will be covered in the respective section.

### E9.5 Security and Fire Protection

The Network Provider should care for its own equipment security and should take the necessary steps to protect the equipment.

Each Network Provider is required to ensure that any sub-installer, agent, representative or any third party representing that Network Provider should take care to not damage or harm another Network Provider's equipment.

Each Network Provider should also have the responsibility and duty to keep the telecommunications closet secure and protected from vandalism or theft of any kind or nature.

### E9.6 Environmental Consideration

The HVAC should be provided 24 hours a day, 365 days per year basis. If an emergency power supply is available in the building, consideration shall be given to connecting the HVAC system serving the Telecommunications Room to the emergency supply.

The temperature and relative humidity should be maintained between 20°C to 30°C and 30% - 80% respectively, at all times.

### E9.7 Connecting Hardware in FD

#### E9.7.1 General

A connector consists of a device or a combination of device to connect two cables or cable elements

#### E9.7.2 Installation Practices

The connecting hardware is installed in a FD to provide direct or indirect connection between backbone and horizontal cabling. It is also to provide connection to active equipment.

The connecting hardware shall be installed to permit minimal signal impairment and shield effectiveness (if shielded cables are used). Proper cable preparation, termination practices and well-organized cable management shall be employed.

The installation of connecting hardware shall allow room for mounting telecommunications equipment concerning the cabling system. Racks shall have adequate clearances for access and cable dressing space.

#### E9.7.3 Patching Options

There are two patching methods, namely direct patching (inter-connection) and indirect patching (cross-connection).

Direct patching performs a direct patch connection between the equipment ports and the horizontal cabling (patch panels). This method generates less crosstalk with the cabling, as a result of few connection points. Figure 34 illustrates the direct patching method.

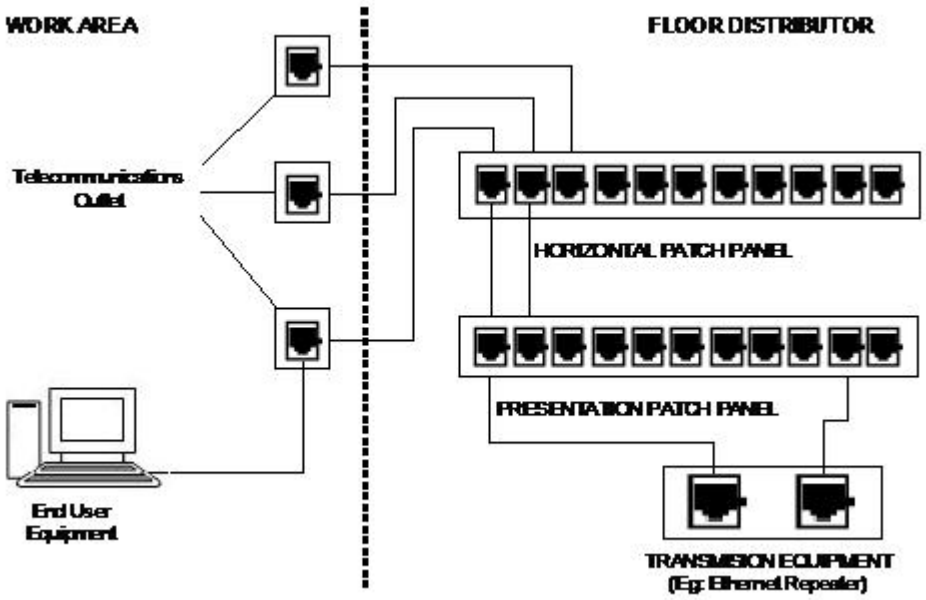



Figure E.4: Direct Patching Method

Indirect patching or cross connection uses and intermediate patch panel to present the equipment ports. Extra connection point in this method allows room for greater crosstalk which becomes prominent with applications

using the full signaling bandwidth of the cable at the maximum of 90m horizontal cable distance. Figure E.5 depicts the indirect patching method.

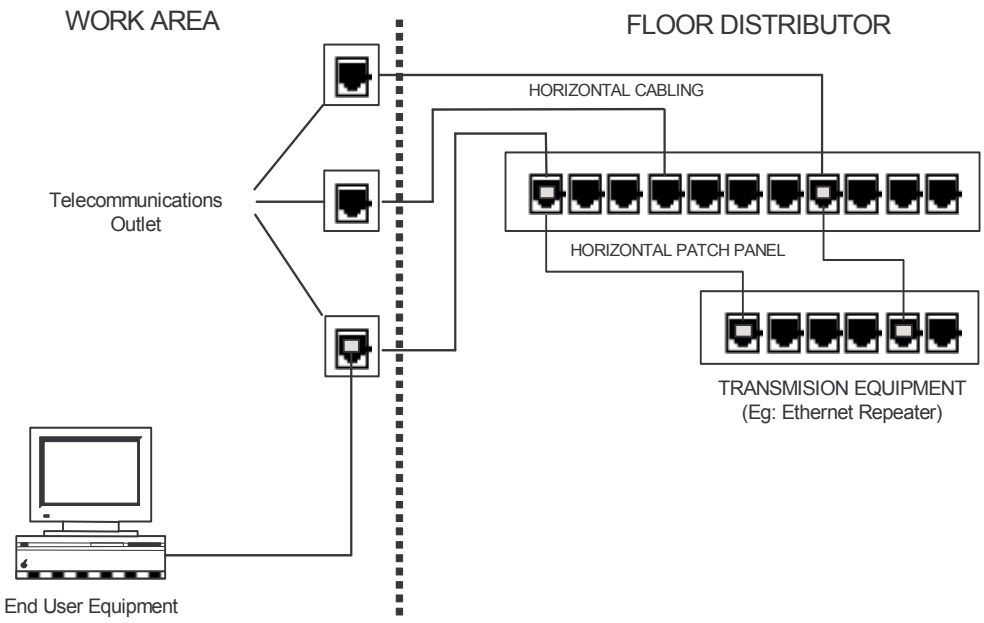



Figure E.5: Indirect Patching Method

## E10. Backbone Cabling and Pathways

### E10.1 Backbone Cabling

#### E10.1.1 Physical Topology

The hierarchical levels of cross-connects shall not exceed two in the building backbone cabling.

This is to restrict signal deterioration for passive systems and to simplify administration in keeping track of cables and connections.

A single backbone cabling cross-connect may meet the cross-connect requirements of the entire backbone sub-system.

Avoid installing in areas where sources of high levels of EMI/RFI may exist

Bridge taps shall not be used in the backbone cabling system. Cable elements that are terminated at different locations may be part of the same cable over a portion of distance or may use individual cables over the entire distance. Figure E.6 depicts an example of backbone star topology.

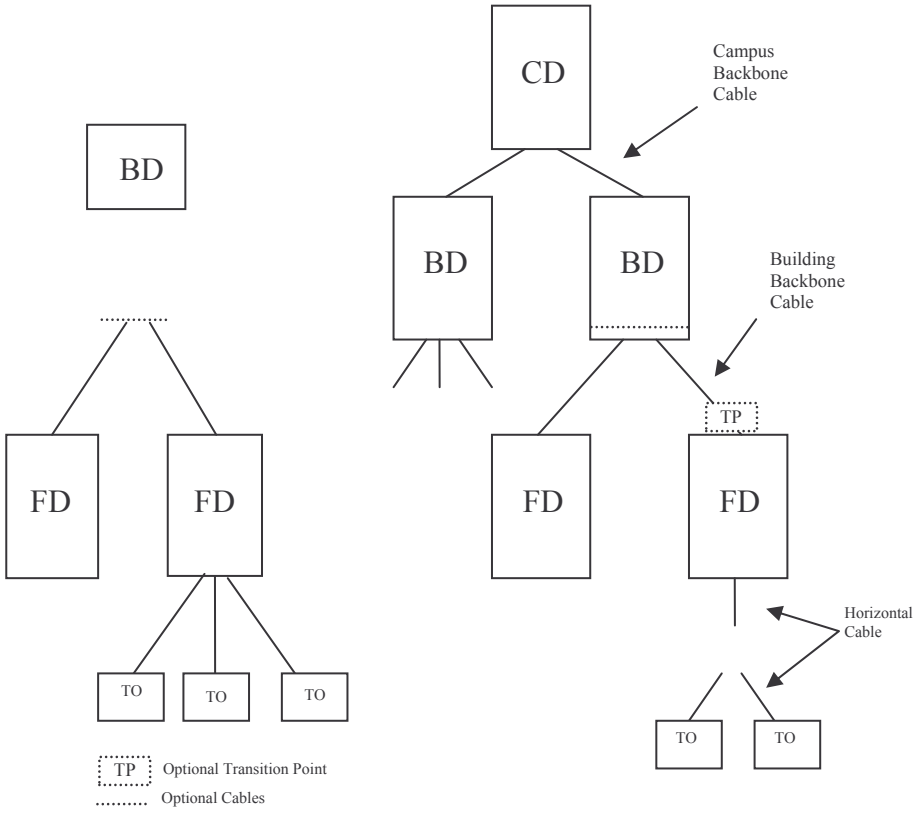



Figure E.6: Physical Topology Available For Backbone Topology

The star topology is applicable to the cable elements of the transmission medium, such as individual fibers or pairs.

**E10.1.2. Backbone Media Selection**

The preferred cable types are as follows:

a) 62.5/125μm multi-mode optical Fiber

b) 50/125μm multi-mode optical Fiber

c) 8/125μm single-mode optical Fiber

d) 100Ω balanced cable

Table E5: Backbone Media Selection

| Application Class | Backbone Length/Type of cable | | |
|---|---|---|---|
| | 0m to 90m | 90m to 160m | 160m to 500m |
| A | Cat 3-6 | Cat 3-6 | Cat 3-6 |
| B | Cat 3-6 | Cat 3-6 | Cat 3-6 |
| C | Cat 3-6 | Cat 5e,6 | Optical Fiber |
| D | Category 5e,6 | Optical Fiber | Optical Fiber |

### E10.2. Cable Distance

The maximum cabling distance between the FD to BD shall be 500m.
The jumper and patch cord lengths shall not exceed 20m. If the length exceeds 20m, the length shall be deducted from the maximum permissible backbone cable length.

The length of cables that connect telecommunications equipment, such as PBX, directly to a BD shall not exceed 30m. If the length exceeds this value, then the backbone distance shall be reduced accordingly.

### E10.3 Pathways

#### E10.3.1. General

Pathways may be defined within trunking, conduit, tray work or ducting. It provides the means of placing cables from:

a) The entrance room or space to Telecommunications Closet.

b) Telecommunications Rooms to either the entrance room or telecommunications closets.

It shall protect installed cabling, provide adequate capacity for the cable being carried and enable minimum bending radius to be maintained.

A separate cable shall be run from the Telecommunications Room to each floor except on the rare occasion when the smallest size of cable will surface for two floors.

Cable tray can be fixed for telecommunication cables (fixed networks), cellular cables and broadcast cables. The arrangements of these cables shall be as follows:

a) From left side is for telecommunication cables.

b) Center of cable tray is for cellular cables.

c) From right side is a broadcast cable.

#### E10.3.2. Design Guidelines

The Telecommunications Rooms shall be connected to the backbone pathway for cabling to the Telecommunications Closet.

For Telecommunications Closet termination, tray and zone within the ceiling shall protrude into the closet from 25 mm to 50 mm, without a bend, and above the 2.4m level.

Pathways shall not be routed through gaps between the floor or ceiling structure and a curtain wall.

Pathways should not be located in elevator shafts.

The integrity of all firestoping assemblies shall be maintained when penetrated by cables, wires and pathways.

The conduit fill for backbone cable should comply with the following table.

Table E6: Conduit Fill For Backbone Cabling

| Conduit | | Area of conduit | | | | | |
|---|---|---|---|---|---|---|---|
| Trade Size | Internal Diameter | Area = $79D^2$ | Max. Occupancy Recommended | | | Min. bending radius | |
| | | | A | B | C | D | E |
| | | Total 100% | 1Cable (53% fill) | 2 Cables (31% fill) | < 3 cables (40% fill) | Layers of steal within sheath | Other sheaths |
| | mm | $mm^2$ | $mm^2$ | $mm^2$ | $mm^2$ | mm | mm |
| 21 (3/4) | 20.9 | 345 | 183 | 107 | 138 | 210 | 130 |
| 27 (1) | 26.7 | 559 | 296 | 173 | 224 | 270 | 160 |
| 35 (1 ¼) | 35.1 | 973 | 516 | 302 | 389 | 350 | 210 |
| 41 (1 ½) | 40.9 | 1322 | 701 | 410 | 529 | 410 | 250 |
| 53 (2) | 52.5 | 2177 | 1154 | 675 | 871 | 530 | 320 |
| 63 (2 ½) | 62.7 | 3106 | 1646 | 963 | 1242 | 630 | 630 |
| 78 (3) | 77.9 | 4794 | 2541 | 1486 | 1918 | 780 | 780 |
| 91 (3 ½) | 90.1 | 6413 | 3399 | 1988 | 2565 | 900 | 900 |
| 103 (4) | 102.3 | 8268 | 4382 | 2563 | 3307 | 1020 | 1020 |
| 129 (5) | 128.2 | 12 984 | 6882 | 4025 | 5194 | 1280 | 1280 |
| 155 (6) | 154.1 | 18 760 | 9943 | 5816 | 7504 | 1540 | 1540 |

**E10.3.3 Pull Box and Splice Box Design Guidelines**

Pull boxes shall be used for the following purposes:

a) Fishing the conduit run.

b) Pulling the cable to the box and looping the cable to be pulled into the next length of conduit.

Pull boxes shall not be used for splicing cables.

Splice box are intended to be used for splicing in addition to pulling cable.

A pull box shall be placed in a conduit run where

a) The length is more than 30m.

b) There are more than two 90 degrees bend.

c) If there is a reverse bend in the run.

Pull and splice boxes shall be placed in a straight section of a conduit and not used in lieu of a bend. Conduits fittings shall not be used in place of pull or splice boxes.

The pull box and splice box sizing are as indicated in the tables below.

Table E7: Pull Box Sizing

| Conduit trade size | Width (mm) | Length (mm) | Depth (mm) | Width increase for additional conduit |
|---|---|---|---|---|
| 27 (1) | 102 | 406 | 76 | 51 |
| 35 (1 ¼) | 152 | 508 | 76 | 76 |
| 41( 1 ½) | 203 | 686 | 102 | 102 |
| 53 (2) | 203 | 914 | 102 | 127 |
| 63 (2 ½) | 254 | 1067 | 127 | 152 |
| 78 (3) | 305 | 1219 | 127 | 152 |
| 91 (3 ½) | 305 | 1372 | 152 | 152 |
| 103 (4) | 381 | 1524 | 203 | 203 |

Table E8: Splice Box Sizing

| Conduit trade size | Width (mm) | Length (mm) | Depth (mm) | Width increase for additional conduit |
|---|---|---|---|---|
| 27 (1) | 300 | 810 | 100 | 75 |
| 35 (1 ¼) | 355 | 915 | 125 | 100 |
| 41( 1 ½) | 450 | 990 | 150 | 100 |
| 53 (2) | 500 | 1065 | 175 | 125 |
| 63 (2 ½) | 60 | 1220 | 200 | 150 |
| 78 (3) | 760 | 1375 | 225 | 150 |
| 91 (3 ½) | 915 | 1525 | 255 | 175 |
| 103 (4) | 1065 | 1675 | 275 | 175 |

**E10.3.4. Establishment of Pathways**

The two methods for establishing a pathway when the backbone cable run between floors shall be sleeve and slots.

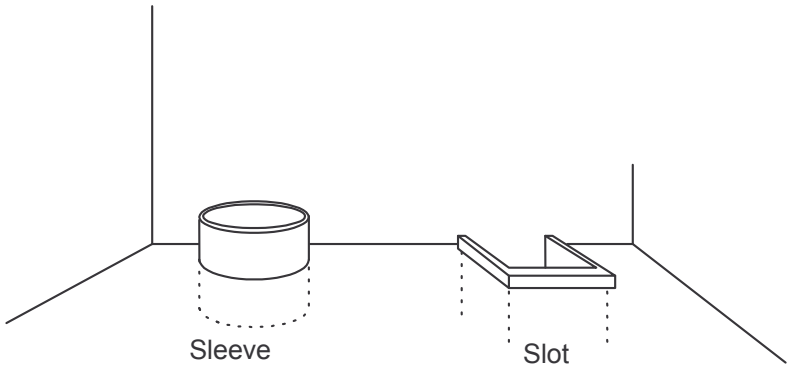



Figure E.7: Sleeve and Slot Designs

The minimum diameter of sleeves shall be 100 mm. The sleeve should extend form 25 mm to 100 mm above the floor height.

The minimum slot size should be 150 mm x 225 mm.

Table E9 below indicates the minimum size for slots and sleeves based on the size of the floor area serviced by the cables feeding that floor.

Table E9: Sleeve Requirements Based On Floor Area

| Sleeve requirements | |
|---|---|
| Floor area ($m^2$) | Number of sleeves |
| Up to 4500 | 2 |
| 4500 to 9000 | 3 |
| 9000 to 28 000 | 4 |
| 28 000 to 45 000 | 5 |

Table E10: Slot Requirements Based On Floor Area

| Slot requirements | |
|---|---|
| Floor area served by shaft ($m^2$) | Slot sizes (mm) |
| Up to 23,000 | 150 x 225 |
| 23,000 to 50,000 | 150 x 450 |
| 50,000 to 90,000 | 225 x 500 |
| 90,000 to 130,000 | 300 x 500 |
| 130,000 to 185,000 | 375 x 600 |

**E10.3.5. Securing Vertical Cable Runs**

The installer shall use an extra support for vertical cable runs when the length of run is more than 2 floors or when the cable is heavy (such as high pair counts cables),

The cable run can be supported via a support strand between the highest floor and the basement.

The installer shall strap the cable to the support strand every 900 mm with a minimum of three ties per floor, using cable ties.

To remove the stress of the bending radius at the top of the run, support the cables with a Kellum grip or similar device. The Kellum grip should grasp a minimum of 300 mm of cable length immediately below the bend.

If a support strength is not required or inappropriate, the installer shall follow the procedures below:

a) Affix a support collar around the cable where it passes down through a slot or sleeve.

b) Rest the support collar on the edge of the opening so that it supports the weight of the cable.

c) Wire-tie the cable between collar-supported points to supporting members on each floor.

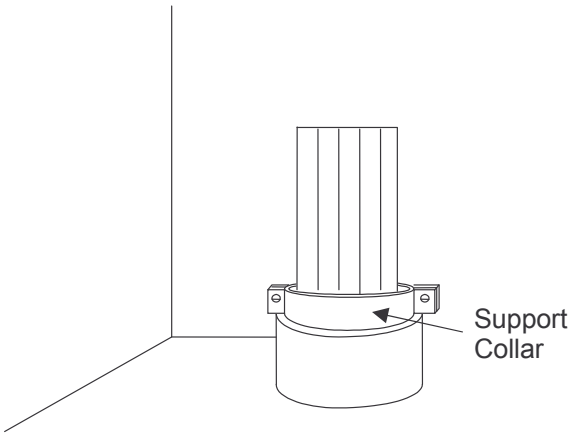



Figure E.8: Support Collar

Inadequate support of the cable over the length of the run will result in damage to the internal components of the cable, namely Fiber strands and copper conductors.

Care shall be taken so that there is no compression of the jacket of optical Fiber cables with ties or other support.

## E11. Campus Cabling

### E11.1 Physical Topology

Campus backbone cabling extends from the CD to the BD. Campus cabling may employ star topology. The campus cabling sub-system is as illustrated in Figure E.9.

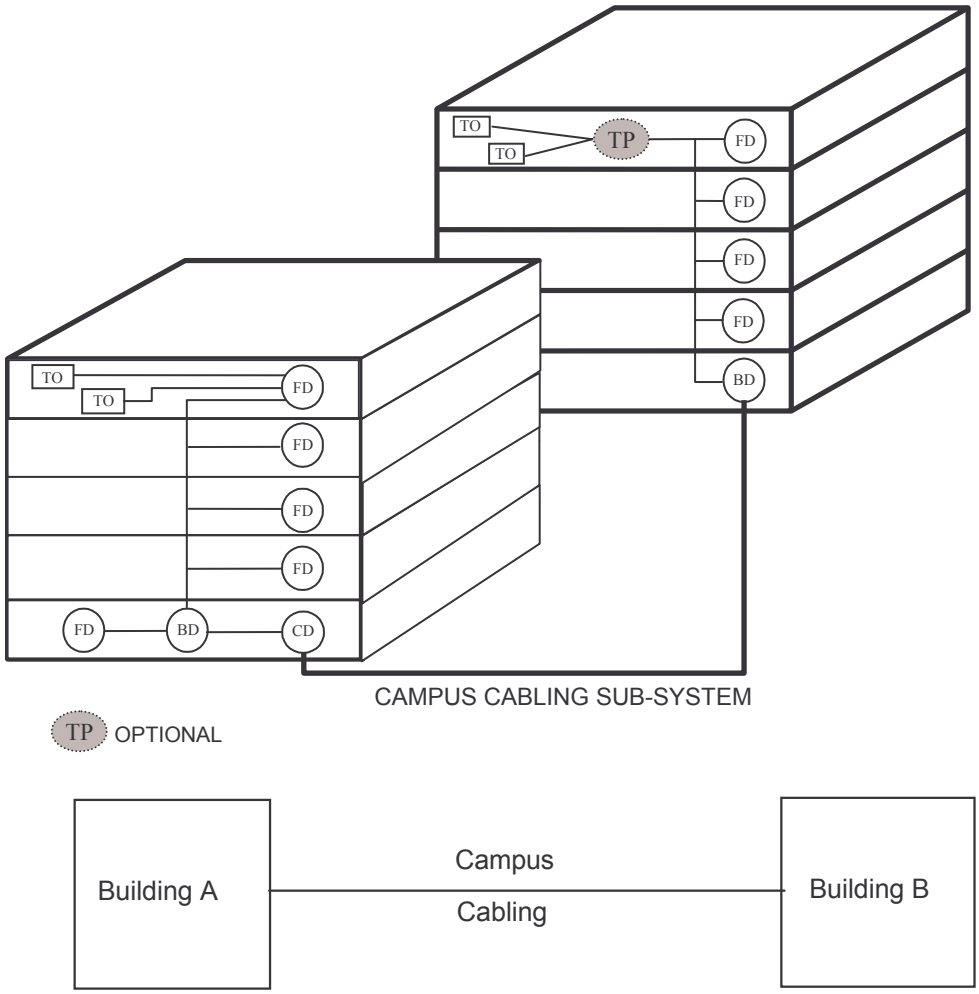



Figure E.9: Campus Cabling Sub-System

Depending on the physical characteristics of a site, cable elements that are terminated at different locations may be a part of the same cable over a portion of distance, or may use individual cable over the entire distance.

There shall be only one cross-connect from the BD to the CD.

Cross-connects for different types of cables must be located in the same facilities.

Installation shall not be done in areas where EMI and RFI sources are prominent. Bridge taps shall not be used in the backbone cabling system.

### E11.2 Cable Types

The preferred cable types shall be as follows:

a) 62.5/125μm multi-mode optical Fiber

b) 50/125μm multi-mode optical Fiber

c) 8/125μm single-mode optical Fiber

d) 100Ω balanced cable

Table below shows the cable technology selection for campus cabling.

Table E11: Technology Selection for Campus Cabling

| Data and Video | Voice and Control |
|---|---|
| Fiber Optic | UTP if medium distance, low EMI level and no differential ground potential problems |
| Fiber Optic | Fiber Optic if long distance, medium/high EMI levels, differential ground potential problems, high risk for lightning strikes |

### E11.3 Cabling Distance

The maximum cabling distance between the CD and the FD shall be as in Figure E.10.

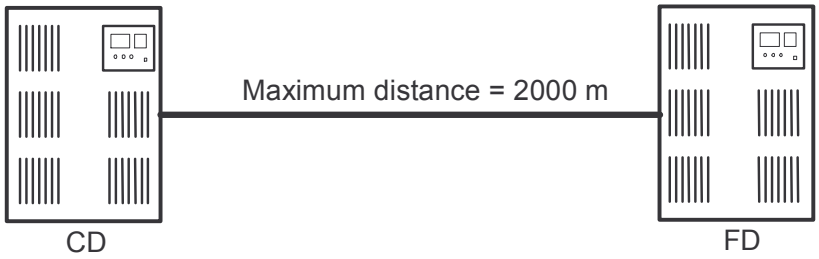



Figure E.10: Maximum Campus Cabling Distance

The maximum distance from the CD to FD for campus cabling shall be 2000m. However, if single mode optical Fiber cabling is used, this distance may be extended to 3km. Theoretically, it is permissible to extend the single mode cable capabilities up to 60km. CD to FD distances greater than 3Km are considered beyond the scope of this standard.

The jumper and patch cords shall not exceed 20m. Lengths exceeding this shall be deducted from the maximum permissible campus cabling length.

Cables connecting to telecommunications equipment shall not exceed 30m in length. If the length exceeds, then the backbone distance shall be reduced accordingly.

### E11.4 External Services

External services may enter a campus or building at locations remote from a Campus Distributor.

Building entrance facilities are required in this case. It comprises of an entrance point at the building wall and the pathway leading to campus or building distributor. The sizing of the termination wall space shall be as defined in Table E12. The sizing of the termination room space is as in Table E13.

Table E12: Minimum Equipment and Termination Wall Space

| Gross Floor Space | | Wall Length | |
|---|---|---|---|
| $m^2$ | $Ft^2$ | mm | in |
| 500 | 5000 | 990 | 39 |
| 1000 | 10 000 | 990 | 39 |
| 2000 | 20 000 | 1060 | 42 |
| 4000 | 40 000 | 1725 | 68 |
| 5000 | 50 000 | 2295 | 90 |
| 6000 | 60 000 | 2400 | 96 |
| 8000 | 80 000 | 3015 | 120 |
| 10 000 | 100 000 | 3630 | 144 |

Table E13: Minimum Equipment and Termination Room Space

| Gross Floor Space | | Room Dimensions | |
|---|---|---|---|
| $m^2$ | $Ft^2$ | mm | In |
| 7000 | 70 000 | 3660 x 1930 | 12 x 6.3 |
| 10 000 | 100 000 | 3660 x 1930 | 12 x 6.3 |
| 20 000 | 200 000 | 3660 x 2750 | 12 x 9 |
| 40 000 | 400 000 | 3660 x 3970 | 12 x 13 |
| 50 000 | 500 000 | 3660 x 4775 | 12 x 15.6 |
| 60 000 | 600 000 | 3660 x 5588 | 12 x 18.3 |
| 80 000 | 800 000 | 3660 x 6810 | 12 x 22.3 |
| 100 000 | 1000 000 | 3660 x 8440 | 12 x 27.7 |

## E12. Distributors - Telecommunications Room or Campus / Building Distributor

### E12.1 General

Telecommunications Room is a centralized space for telecommunications equipment, such as PABX, computing and networking equipment that serves specific occupants of the building.

The Telecommunications Room shall accommodate equipment directly related to the telecommunication system and its environmental support system.

### E12.2 Design Consideration

#### E12.2.1 Site Selection

The Telecommunications Room shall be placed in an area where it is flood free, to avoid dampness and dirt, preferably at the ground floor.

It shall be located away from refuge, rubbish area and chute.

In addition, it shall be located in a place that is free of perceptible vibration.

The Telecommunications Room equipment should not be installed in places where it will get direct sunlight. If this is unavoidable, a thick curtain of a Venetian blind shall be used to prevent the rays of sunlight from falling on the equipment.

**E12.2.2 Floor Loading**

The Telecommunications Room should have a floor loading capacity that is sufficient to bear both the distributed and concentrated load of the installed equipment.

The Telecommunications Room shall be designed for a minimum distributed load of 500 kg/$m^2$ and concentrated floor loading of 910 kg/$m^2$ is depending on the type and capacity of the telecommunication equipment.

If unusually heavy equipment is expected, the above specification may have to be increased.

**E12.2.3 Water Infiltration**

The Telecommunications Room shall not be located below water level unless preventive measurements against water infiltration are employed.

The room shall be free of water and flood.

A floor drain should be provided within the room if risk of water ingress exists.

**E12.2.4 HVAC**

The Telecommunications Room should be located with ready access to the main HVAC delivery system.

**E12.2.5 Electromagnetic Interference**

The room shall be located away from sources of electromagnetic interference at a distance which will reduce the interference to 3.0V/m throughout the frequency spectrum.

It is desirable to locate the equipment room close to the main backbone pathway.

**E12.2.6 Size**

The Telecommunications Room shall be sized in accordance to the requirements of specific equipment, and shall include future and current needs.

The floor area should include the termination and transmission equipment and depend on the type and ultimate demand of the building.

For special use building, such as hospital, laboratories and so on, the Telecommunications Room floor space shall be based according to the number of work areas and not on the usable floor area.

The TR floor space for a normal building and a special use building shall be as per Table E14.

Table E14: TR Floor Space for Normal Office Building

| Total Usable floor space (x) | Telecommunications Room space (length x base x height) in m |
|---|---|
| < 6000$m^2$ | 4 x 3.5 x 3 |
| 6,000$m^2$ to 20,000$m^2$ | 5 x 5 x 3 |
| 20,000$m^2$ to 60,000$m^2$ | 7 x 5 x 3 |
| > 60,000$m^2$ | 7 x 5 x 3 |

Table E15: TR Floor Space for Special Use Buildings

| Work areas | Area ($m^2$) |
|---|---|
| Up to 100 | 14 |
| 101 to 400 | 37 |
| 401 to 800 | 74 |
| 801 to 1200 | 111 |

### E12.2.7 Guidelines for Other Equipment / Furniture

Ducting, sewage pipes, air conditioning outlet pipes should not pass through the Telecommunications Room.

It is recommended that a table and chair be provided by the owner in the Telecommunications Room.

## E13. Provisioning

### E13.1 Layouts

A minimum of clear floor space of 750 mm is crucial in front of all accessible points of the equipment in order to provide adequate working space for installation, testing and maintenance service.

### E13.2 Clearance Heights

The clear ceiling height of the Telecommunications Room shall not be less than 2440 mm, so as to enable installation of equipment, cabinets and cabling.

### E13.3 Power

The building owner shall provide a electrical supply from electric utility supplier at a nominal voltage of 415V, 3 phase, 4 wire, 50 Hz system or at a nominal voltage of 230V, 1 phase, 2 wire, 50 Hz system with solidly earth system.

The building owner shall provide a minimum of two 13A, 3 pins outlet points on separate circuits.
Grounding bar that is connected to the building's master ground bar must have an earth resistance of less than 5 Ohms.

### E13.4 Contaminants

The Telecommunications Room shall be free from contaminants and pollutants that could affect the operation and material integrity of the installed equipment.

For information: If the contamination level is greater than the values listed in table below, vapours barriers, positive room pressure or absolute filter shall be provided.

Table E16 : Contamination Limits [1]

| Contaminant | Concentration |
|---|---|
| Chlorine | 0.01 ppm |
| Dust | 100 mg/$m^3$/24h |
| Hydrocarbon | 4 mg/$m^3$/24h |
| Hydrogen Sulphide | 0.05 ppm |
| Nitrogen Oxide | 0.1 ppm |
| Sulphur Dioxide | 0.3 ppm |

If the Telecommunications Room is situated on the car park floor, it must be completely enclosed to prevent dust from entering the room. Louver type of doors and windows shall be avoided.

### E13.5 HVAC Supply

The HVAC should be provided 24 hours a day, 365 days per year basis. If an emergency power supply is available in the building, consideration shall be given to connecting the HVAC system serving the Telecommunications Room to the emergency supply.

The temperature and humidity should be maintained between 20 $^{o}$C – 30 $^{o}$C and 30% - 80% respectively, at all times.

The Telecommunications Room should be provided with a minimum of two 2.5 Hp air-conditioning units. Should there be any expansion an incremental of 2.5 Hp unit each shall be added.

The ambient temperature and humidity shall be measured at a distance of 1.5m above floor level after the equipment is in operation, at any point along the equipment aisle center line.

### E13.6 Lighting

The lighting should be a minimum of 540 lux, measured in 1m above the finished floor in middle of aisles between cabinets.

The lighting should be controlled by one or more switches located near the entrance doors to the room.

### E13.7 Door

The door should be a minimum of 960 mm wide and 2000 mm high without doorsill and shall be fitted with a lock.

If it is anticipated that large equipment will be delivered to the Telecommunications Room, a double door (1820 mm wide by 2280 mm height) without doorsill and center post is recommended.

The door fitted to the room shall be 2-hours fire rated doors as per *"Jabatan Bomba dan Penyelamat"* approval.

The door should be locked.

The door shall be labeled accordingly and the words shall be clearly displayed on the door of the Telecommunications Room, e.g.**"BILIK TELEKOMUNIKASI"** as per *"Jabatan Bomba dan Penyelamat"* approval.

### E13.8 Fire Alarm System

A fire alarm system should be installed in the Telecommunications Room, as per “Jabatan Bomba dan Penyelamat” approval. The alarm should be connected to main building alarm.

### E13.9 Interior Finishes

The floor of the Telecommunications Room should be of a material that is easy to clean and not susceptible to accumulation of dust. The flooring should be of anti-static vinyl type mat.

The wall of the Telecommunications Room should be of white colour and preferably have impervious smooth glossy finish to minimize the accumulative of dust.

## E14. Telecommunications Room: Equipment Termination Layout

The BD/CD is located at the Telecommunications Room and is the hub of the generic / structured cabling systems.

The installer shall ensure that the layout of the Telecommunications Room is such that the interconnecting sections are near each other so as to ensure short cross-connect length and avoid overloading the wire management ring runs.

The Telecommunications Room or CD/BD consists of any or all of the five components:

a) Backbone cabling - The size depends on the type of transmission media. It can be relatively small for Fiber or large for UTP cables.

b) Horizontal cabling - There might be a sizeable number of horizontal cables terminating in the FD to serve users in the local area.

c) System cabling.

d) Inter building cabling - In campus or multi building networks, cabling between buildings originates and terminates at the BD.

e) Miscellaneous cabling - This includes the connections representing other services such as BMS, CATV, CCTV and security.

The installer shall not install the cabinets or distribution frames near high power electrical installations such as transformers, elevators or generators.

The recommended distribution frames component layout is as illustrated in Figure E10 below.

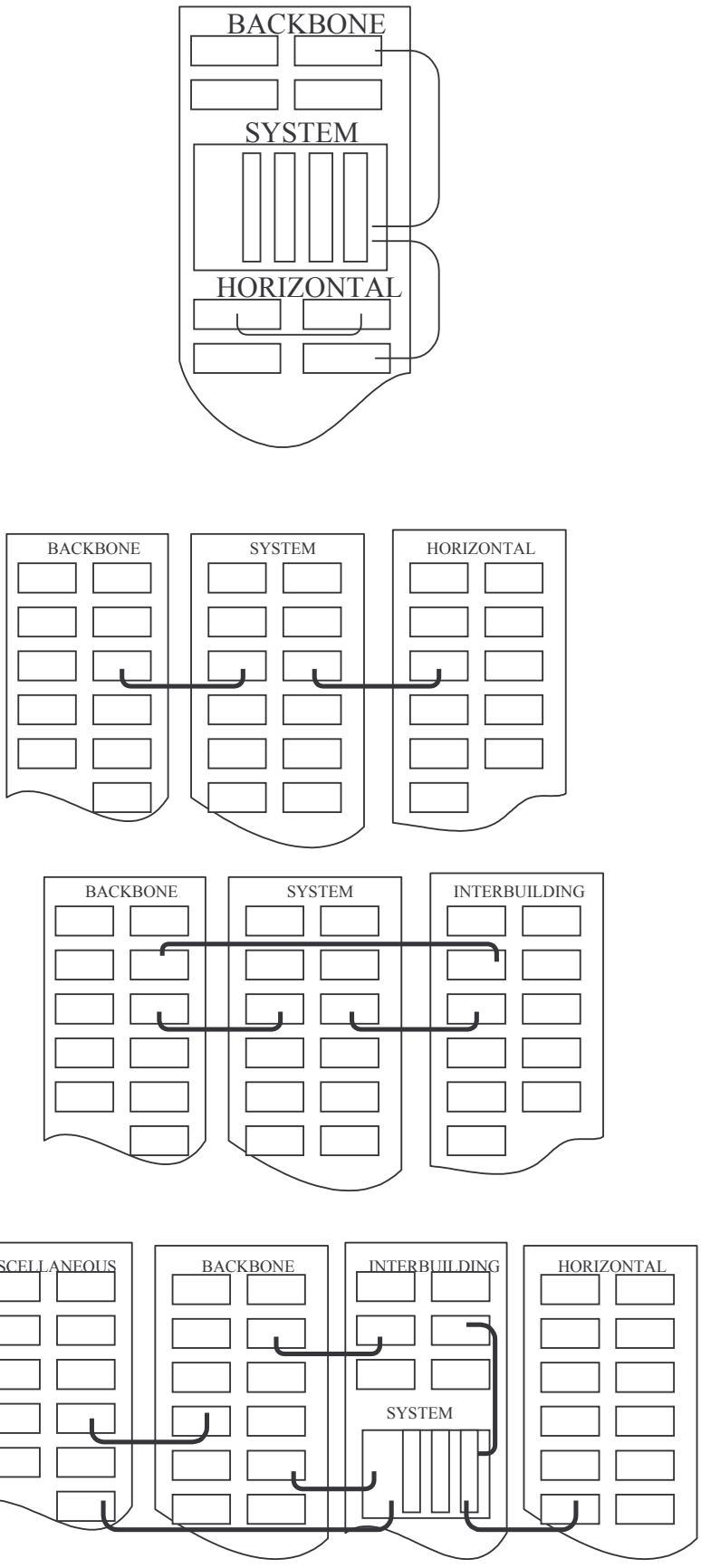



Figure E.11: Distribution Frame component Layout

## E15. Distributors: Common Installation Practice

### E15.1 General

This section discusses on the installation common practices for Telecommunications Closet and Telecommunications Room that should be done by installers provisioned by the network provider.

### E15.2 Supply and installation practice of distribution area components

#### E15.2.1 Patch Cords

Installers shall supply patch cords complete with termination.

The patch cord used shall be a minimum of 4-pair stranded, UTP Cat 5e, preferably factory-terminated cable.

Fiber optic patch cord should be of factory terminated buffered, graded index fiber multimode or single mode with Duplex SC type connectors. Other small form factor connectors (e.g. MT-RJ) may also be used.

Installers must adhere strictly to the bending radius and pulling tension rules at all times during handling and installation.

In addition, installer should be aware that patch cords need to be of the same performance category.

Installers should make sure that the connecting hardware used is of the same performance category.

#### E15.2.2 Cable Ties

The installer shall supply the cable ties (Velcro may be used) for proper administration of the distribution rack.

Staples shall not be used for category 5 installations.

The geometry of the cables shall not be changed during installation.

The cable shall be able to slide freely through the tie wrap and should be finger tight. If the wrap cable is too tight, the geometry of the pairs in the cable would be changed and this degrades the cable performance.

The installer should use the cable ties to manage the cable bundles and to provide a neat presentation. In addition, the cables should show no sign of distortion.

#### E15.2.3 Patch Panels

The installer shall supply the patch panels complete with both front and back cable management units.

The patch panel supplied should fit into 19” equipment rack.

#### E15.2.4 Cabinets/ Distribution Rack

The installer shall supply the distribution rack complete with the accessories needed to install the rack.

The distribution rack should be of 19” with the appropriate height as specified by the customer.

The installer shall make sure that the floor loading of the equipment is within the limit of 300 kg to 1000 kg per square meter.

## E16. Energy Conservation in Distribution Area

The installer should consider the importance of energy conservation in distribution areas/ equipment rooms by arranging the cabinets/ distribution rack so that the air circulation and the power usage are optimized.

Should there be more than one row of cabinet rack, the following rearrangement should not be followed, because this arrangement leads to short circulated airflow which in turn increases the energy consumption.

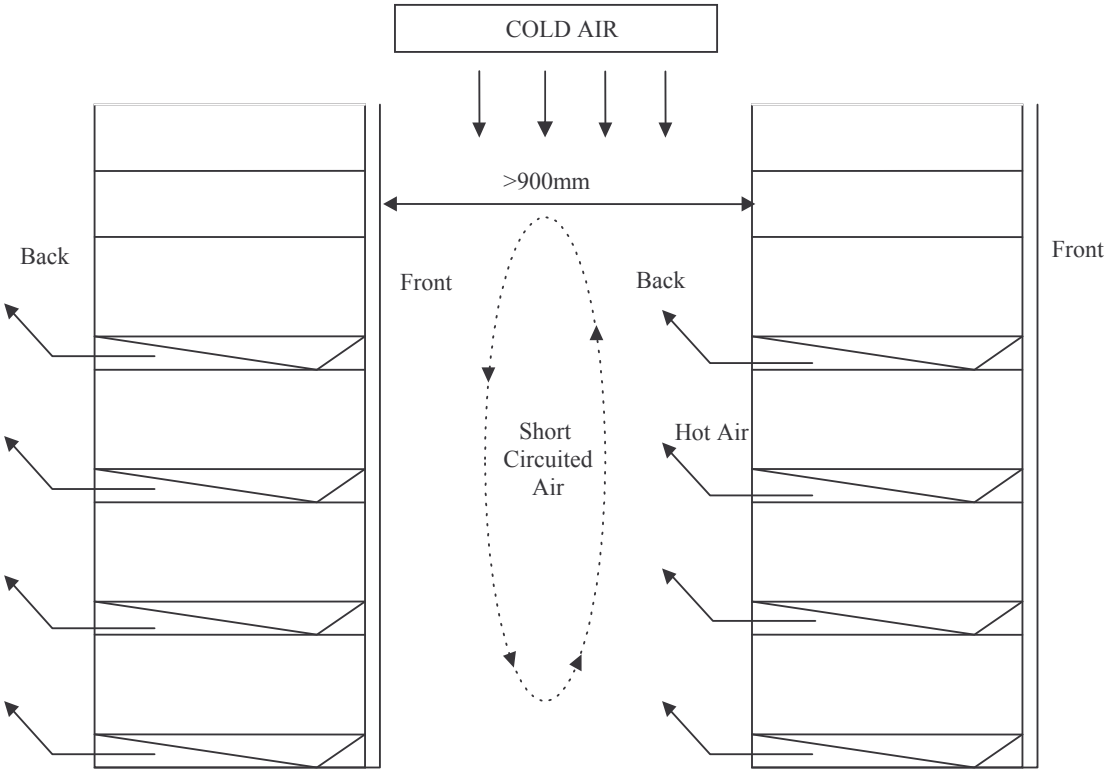



Figure E.12: Airflow before Re-Arrangement

Instead, the installer should use the following arrangement should there be more than one row of cabinets/ distribution racks. This arrangement eliminates short air circulation and in return, decreases power consumption.

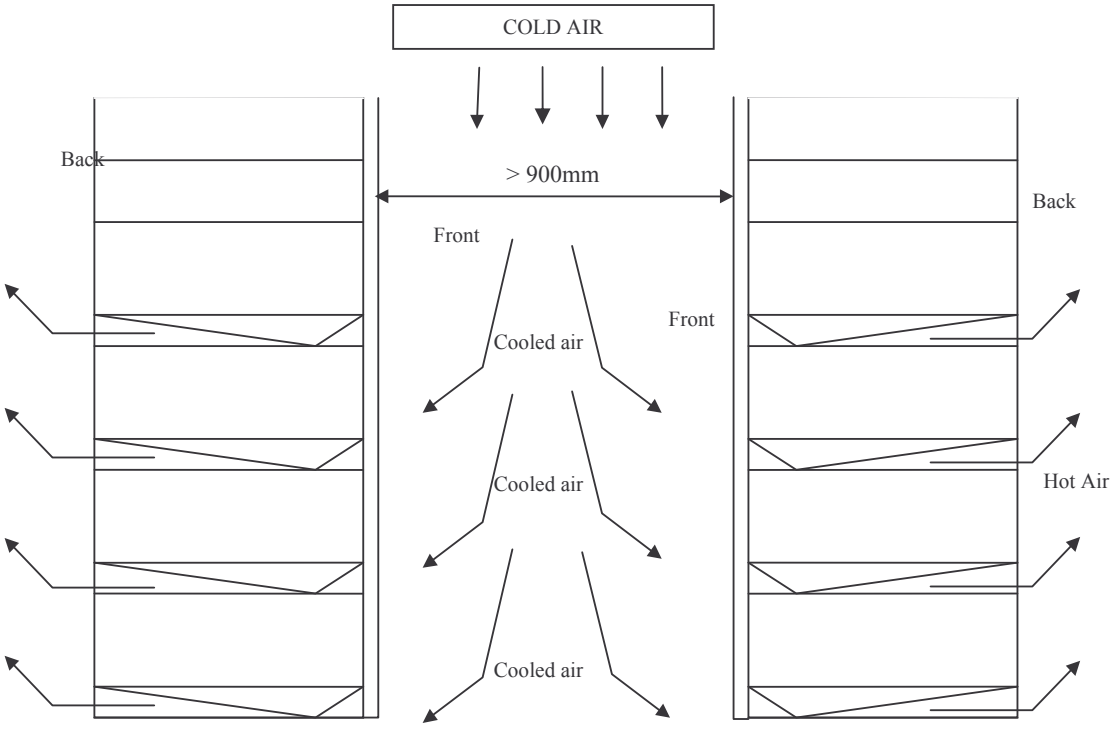



Figure E.13: Airflow after Re-Arrangement

### E17. Patch Panels Terminations Layout

Patch panels, when terminated on a rack, should have the appropriate layout for efficient use, maintenance and expansion of the patch field.

The rack should not be closer than 750 mm to any wall or equipment behind, front or to one side. Multiple racks may be ganged together side-to-side.

If open rack is used, anchor the racks to the floor using lag bolts in concrete and toggle bolts in raised floors. Anchor the top of the rack to the rear wall or ceiling. In the case of multiple rack ganged together, bolt all racks together and secure them at every second rack.

Place patch panels on the rack relative to the media type. Fiber patch panels should be placed at the near top of the rack to protect the terminations from potential harm.

Install a rack mount storage unit (such as the Fiber Management System) as well as any splice trays used, to protect and contain slack fiber strands.

The installer should install copper-based patch panels with a cable management ring run above and below every two horizontal rows of patch panel ports.

Locate vertical cable management ring runs on either side of the rack in the position directly below the horizontal ring run.

Figure E.13 illustrates the properly configured rack.

The installer should always route the cables equally to the patch panel from each side.

Select the appropriate IDC tools and terminate the wires to the panel.

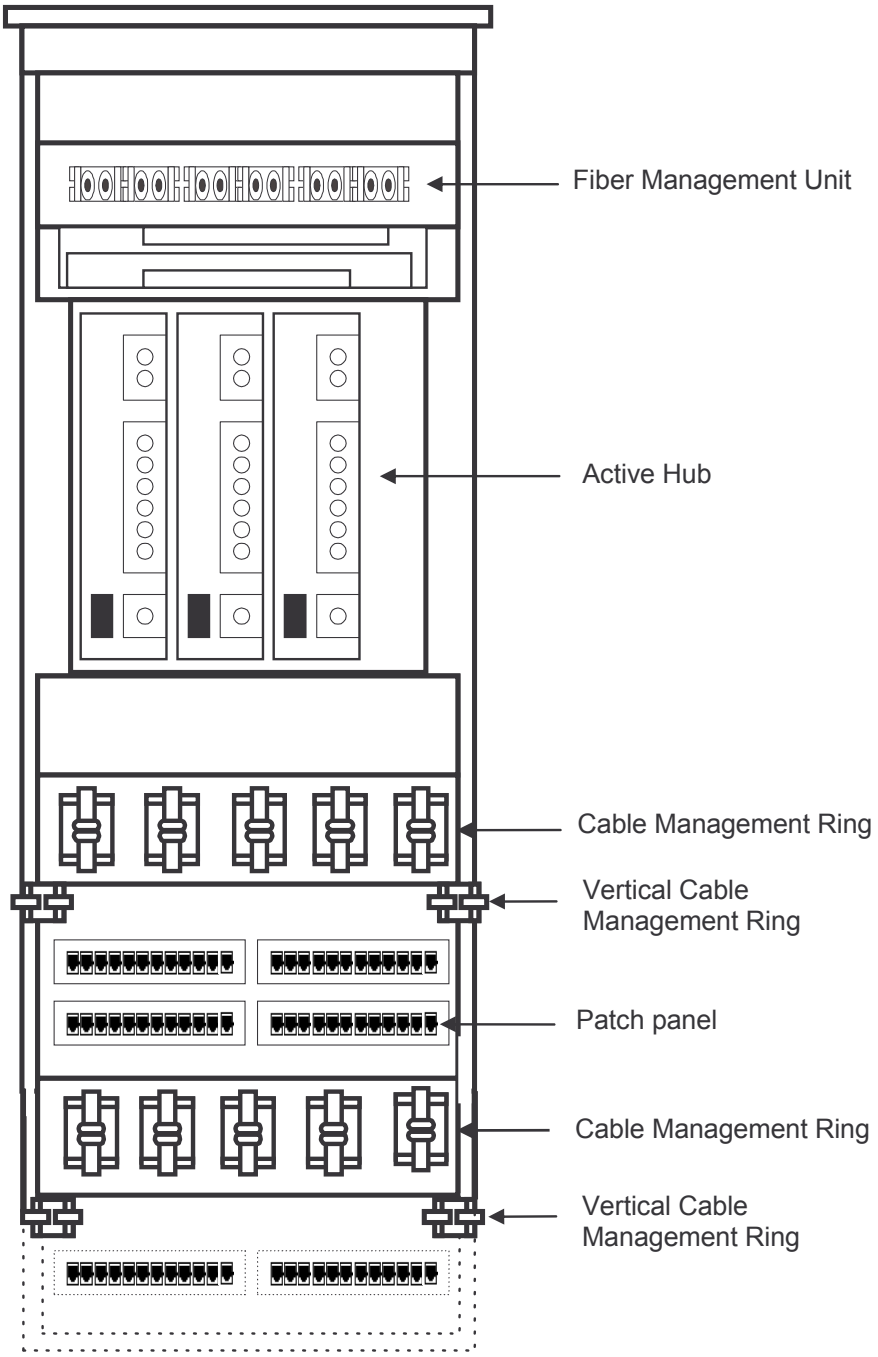



Figure E.14: An Example of a Configured Rack

## E18. Administration

### E18.1 General

This section discusses on the administration of pathways, spaces and cabling.

In addition, it will also discuss on the labeling, numbering scheme and colour coding.

## E18.2 Administration Concepts

### E18.2.1 General

Administration concept includes identifiers, records, linkage, reports and presentation of information. Figure below illustrates identifier/ record concept.

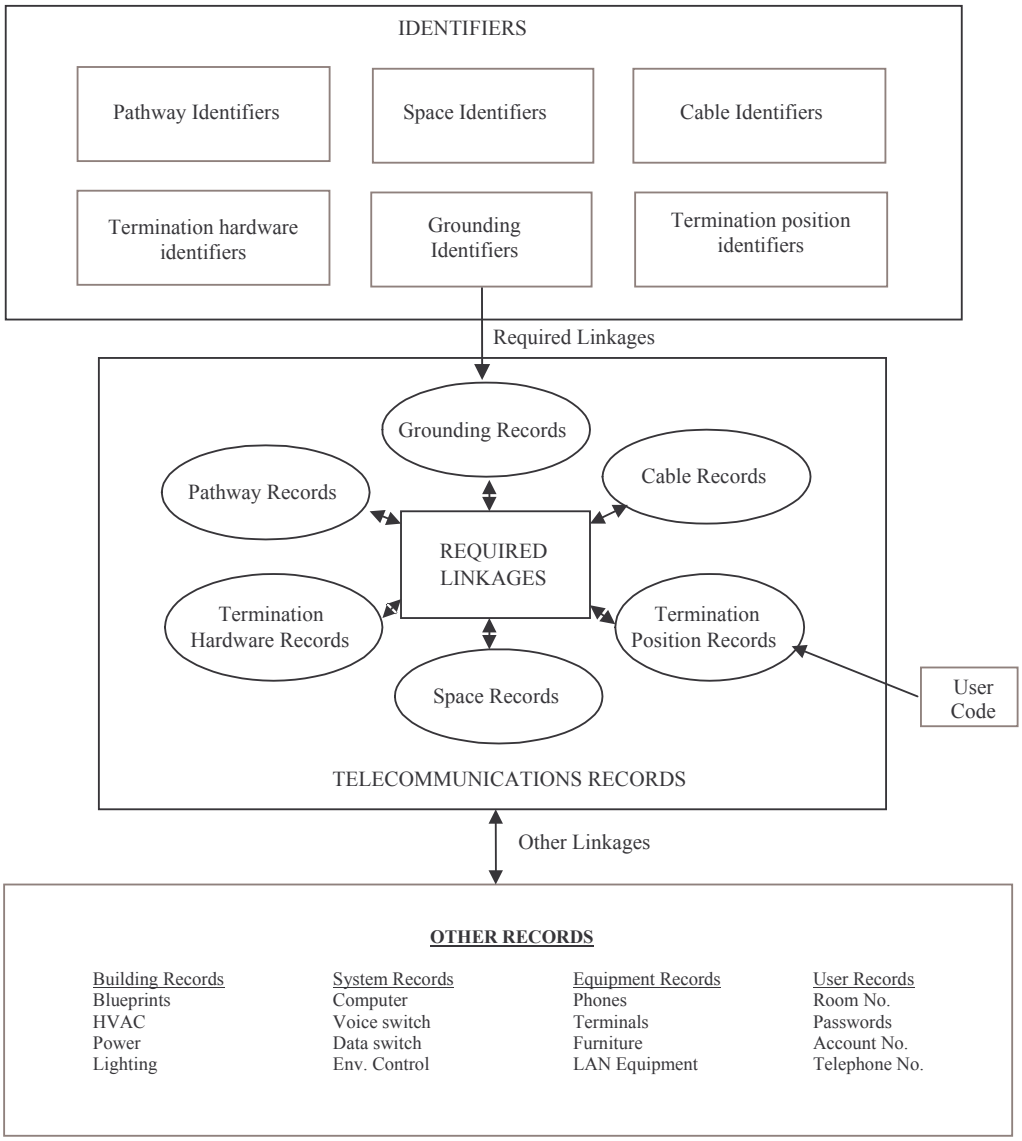



Figure E.15 : Identifier/Record Concept

### E18.2.2 Identifiers

An identifier is assigned to an element of the telecommunication infrastructure to link it to its corresponding record.

Identifiers should be marked at the elements to be administered.

Identifiers shall be unique, across all types of telecommunications records. For example, no cable identifier should be identical to any pathway record identifier. Please refer to Annex B for the identifier format used for this guideline.

Identifiers shall be marked at each of the telecommunication infrastructure by labeling.

### E.23.2.3 Records

A record is a collection of information related to a specific element of the telecommunications infrastructure.

For effective administration, telecommunication records are usually used in conjunction with other records such as building records, system records, equipment records and user records. Table below indicates a summary of record elements

Table E17: Summary of Required Records

| | Record | Required Information | Required Linkages |
|---|---|---|---|
| PATHWAY AND SPACES | Pathways | Pathways identifier<br>Pathway type<br>Pathway fill<br>Pathway loading | Cable records<br>Space records<br>Pathways records<br>Grounding records |
| | Space | Space identifier<br>Space type | Pathway record<br>Cable records<br>Grounding records |
| CABLING | Cable | Cable identifier<br>Cable type<br>Unterm. Pair/ cond. No<br>Damaged pair/cond. Nos.<br>Available pair/ cond no. | Term. position records<br>Splice records<br>Pathway records<br>Grounding records |
| | Termination Hardware | Term. Hardware identifier<br>Term. Hardware type<br>Damaged position no. | Term position records<br>Space records<br>Grounding records |
| | Termination Position | Term. Position identifier<br>Term. Position type<br>User code<br>Cable pair/ cond. nos. | Cable records<br>Other term. Position records<br>Term. Hardware records<br>Space records |
| | Splice | Splice identifier<br>Splice type | Cable records<br>Space records |

### E18.2.4 Linkages

Linkages are the logical connection between identifiers and records.

A linkage between records is achieved when an identifier in one record points to another record.

The records for infrastructure elements are interlinked, as depicted in Figure C.1.

### E18.2.5 User Code

A user code allows the association of the termination position record with one or more of the other records illustrated in Figure C.1.

The user code facilitates activities such as problem determination, moves, adds and changes.

User code can be telephone number or a circuit number.

### E18.2.6 Presentation of Information

A typical administration system includes labels, records, reports, drawings and work orders.

Report compiles the information selected from the various telecommunications infrastructure records. It may be generated from a single set of records or from several sets of inter-linked records.

Graphical information regarding the relationship of the telecommunication infrastructure to other infrastructure in the building is presented in drawings. The types of drawings are as stated in the table below.

Table E18: Summary of Drawings

| Drawings | Description |
|---|---|
| Conceptual | (a) Illustrates the proposed design intent.<br>(b) Does not include all telecommunication infrastructure elements or identifiers.<br>(c) Does not necessarily become part of administration documentation |
| Installation | (a) Used to document graphically the telecommunication infrastructure to be installed<br>(b) Should describe the means of installation and relevant elements |
| Record | (a) Graphically document installed telecommunication infrastructure through floor plan, elevation, detailed drawings<br>(b) Key elements of the telecommunication infrastructure must have identifiers assigned. |

## E19. Pathway and Space Administration

### E19.1 General

A pathway that is implemented by joining two or more different pathway types or sizes should have each segment administered as a separate pathway.

### E19.2 Pathway Identifiers and Labeling

A unique identifier should be assigned to each pathway to serve as a link to the pathway record.
This identifier should be marked on each pathway or on its labels.

Partitioned pathways such as duct bank or inner-duct should have unique identifiers assigned and labelled to each of them.

Pathway should be labelled at all endpoints located in Telecommunications Closets, equipment rooms or entrance facilities.

Closed loop should be labelled at regularly spaced intervals.

Intermediate points with three or more pathway endpoints, such as pull boxes, joined cable tray segments, should have each end point labelled.

Pathways in which labeling is impractical (such as grid and multi channel) should be identified on the record drawings.

### E19.3 Space Identifiers and Labeling

Space identifiers should be assigned to each space to serve as a link to the space record.

All spaces should be labeled. It is recommended that labels be affixed at the entry to the space.

### E19.4 Pathway Records

The following items should be recorded for each pathway:

a) pathway identifier;

b) pathway type;

c) pathway fill;

d) pathway loading and

e) Linkages to cable records, space records (end 1), space record (end 2), space record (access), other pathway records and grounding records.

Pathway fill indicates the current fill percentage of total pathways or to show the relationship of inner-ducts, pull boxes and handholds to conduit.

Pathway loading indicates the actual loading of the pathway.

The format for pathway record is depicted in table below.

Table E19: Format for Pathway Record

| **PATHWAY RECORD** | | |
|---|---|---|
| **RECORD NO:** | | |
| | **SAMPLE DATA** | **REMARKS** |
| **REQUIRED INFORMATION** | | |
| Pathway Identifier | | |
| Pathway Type | | |
| Pathway fill | | |
| Pathway loading | | |
| | | |
| **REQUIRED LINKAGES** | | |
| Cable records | | |
| Space record (End 1) | | |
| Space record (End 2) | | |
| Space records (access) | | |
| Pathway records (other) | | |
| Grounding records | | |
| | | |
| **OPTIONAL INFORMATION** | | |
| Pathway length | | |
| Pathway max. fill | | |
| Pathway max. load | | |
| Pathway condition | | |
| Pathway usage | | |

| | | |
|---|---|---|
| Number of bends | | |
| Drawing number | | |
| UPC | | |
| Misc. information | | |
| | | |
| **OTHER LINKAGES** | | |
| Other Record 1 | | |
| Other Record 2 | | |
| Other Record 3 | | |

The following indicates an example of pathway record for cable tray.

Table E20: Example of Single Space Record for Cable Tray

| **PATHWAY RECORD** | | |
|---|---|---|
| **RECORD NO:** | | |
| | **SAMPLE DATA** | **REMARKS** |
| **REQUIRED INFORMATION** | | |
| Pathway Identifier | CT64 | |
| Pathway Type | 300mm x 150mm ventilated tray | Physical description of pathway |
| Pathway fill | 30% | Present fill |
| Pathway loading | 22kg/m | Present load |
| | | |
| **REQUIRED LINKAGES** | | |
| Cable records | C0011 C0012 | Cable identifiers |
| Space record (End 1) | D307 | Identifier for office D307 |
| Space record (End 2) | 3A | Identifier for closet 3A |
| Space records (access) | N/A | (for intermediate service access spaces – manholes, handholes, pull/splice box) |
| Pathway records (other) | | Identifier for connecting pathways |
| Grounding records | N/A | |
| | | |
| **OPTIONAL INFORMATION** | | |
| Pathway length | 15m | |
| Pathway max. fill | 40% | |
| Pathway max. load | 110kg/m | |
| Pathway condition | Ok | |
| Pathway usage | Horizontal distribution | |
| Number of bends | N/A | Undamaged |
| Drawing number | C3 | Reference to record drawing |
| UPC | N/A | |
| Misc. information | | |
| | | |

| OTHER LINKAGES | | |
|---|---|---|
| Other Record 1 | | |
| Other Record 2 | B35 | Identifier for building B35 |

### E19.5 Space Records

The following items should be included in a space record:

a) Space identifier.

b) Space type.

c) Linkages: Pathway records, cable records, grounding records.

d) Optional information: Space size, space location, areas served, door lock key number, miscellaneous information.

e) Other linkages: Other records.

The following table depicts the format for space record.

Table E21: Single Space Record Format

| SINGLE SPACE RECORD | | |
|---|---|---|
| RECORD NO: | | |
| | SAMPLE DATA | REMARKS |
| REQUIRED INFORMATION | | |
| Space Identifier | | |
| Space Type | | |
| | | |
| REQUIRED LINKAGES | | |
| Cable records | | |
| Pathway record) | | |
| Grounding records | | |
| | | |
| OPTIONAL INFORMATION | | |
| Space size | | |
| Space location | | |
| Area served | | |
| Door lock key number | | |
| Misc. information | | |
| | | |
| OTHER LINKAGES | | |
| Other Record 1 | | |
| Other Record 2 | | |
| Other Record 3 | | |
| | | |

The following table depicts an example of single space record for manhole.

Table E22: Single Space Record for a Manhole

| SINGLE SPACE RECORD | | |
|---|---|---|
| **RECORD NO:** | | |
| | **SAMPLE DATA** | **REMARKS** |
| **REQUIRED INFORMATION** | | |
| Space Identifier | MH01 | Manhole MH01 |
| Space Type | A | Manhole type A |
| | | |
| **REQUIRED LINKAGES** | | |
| Cable records | CD01 | Pathway that terminate in this space |
| Pathway record) | F18 | Cable entering this space |
| Grounding records | N/A | |
| | | |
| **OPTIONAL INFORMATION** | | |
| Space size | 1800mm x 1800mm<br>2700 mm | |
| Space location | A6 | Campus grid location A6 |
| Area served | B35 | Building B35 |
| Door lock key number | K47 | Key number 47 |
| Misc. information | | |
| | | |
| **OTHER LINKAGES** | | |
| Other Record 1 | | |
| Other Record 2 | | |

### E19.6 Pathway and Space Reports

The following report should be made available:

a) Pathway summary report : listing all pathways and their types and present fill load

b) Pathway content report: showing the exact content of the pathways.

c) Space summary report indicating all spaces, their types and locations.

Table below indicates the format for these reports:

Table E23: Pathway Summary Report

| PATHWAY SUMMARY REPORT | | | | | | | |
|---|---|---|---|---|---|---|---|
| **RECORD NO:** | | | | | | | |
| Pathway type: | | | | | | | |
| Identifier | Length | Fill | | Load | | Space | Drawing |
| | | Max | Current | Max | Current | | |
| | | | | | | | |

Table E24: Pathway Content Report

| PATHWAY CONTENT REPORT | |
|---|---|
| **REPORT NO:** | |
| Pathway ID | Cable ID |
| | |
| | |
| | |
| | |
| | |

Table E25: Space Summary Report

| SPACE SUMMARY REPORT | | |
|---|---|---|
| **REPORT NO:** | | |
| Space ID | Type | Location |
| | | |
| | | |
| | | |
| | | |
| | | |

### E19.7 Drawings

The drawings for pathways and spaces should indicate the location and sizes of pathways and spaces.

The identifier for each pathway should appear on the drawing.

Space drawing should show plan and elevation view of all Telecommunications Closets, Telecommunications Room and entrance facilities.

Pathway drawing should illustrate routing, bend radius, pulled boxes, wall penetrations and fire-stopping details.

## E20. Cabling System Administration

### E20.1 General

Identical cables spliced together should be considered as a single cable.

### E20.2 Identifiers

#### *E20.2.1 Cable Identifiers*

A unique identifier should be assigned to each cable to serve as a link to the cable record.

The cable identifier should be marked on each cable or its label.

### *E20.2.2 Horizontal Cabling Identifier*

The horizontal cabling identifier should be based on the following formula, at each end of the run;

DF no. Group no. Channel

DF number is the terminating distribution frame the cable connects to.

Group number is the sequential in each distribution frame and represents a patch panel or punch block

Channel is a sequential within the group, as indicated by the logical or physical channel numbering on the components

An example of the horizontal cable identifier is as illustrated below.

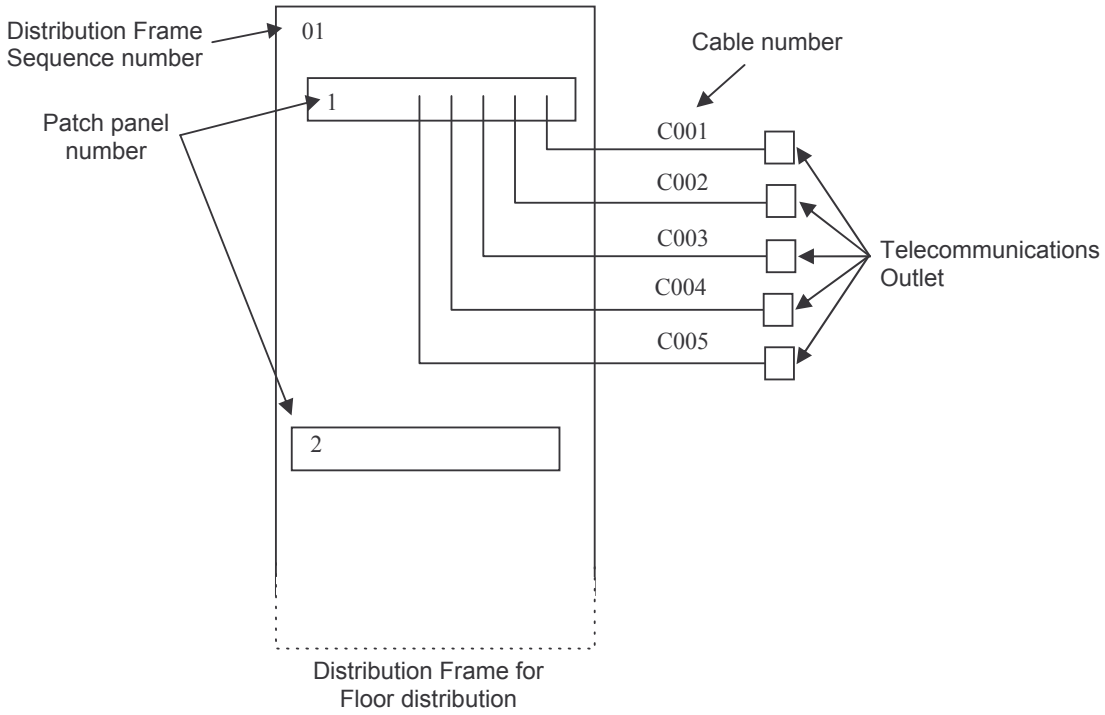



Figure E.16: Horizontal Cable Administration

From the above diagram, each cable is identified, shown on the first floor as DF101-G1-C001 to DF101-G1-C005, inclusive.

DF101 indicates that the distribution frame is on the first floor, and it is of sequence number 01. G1 indicates that it is of patch panel number 1 and C001 is the cable number. If it is a copper cable, then the cable numbering will start with C. If it is a fiber cable, then it will start with an F.

### *E20.2.3 Backbone Cabling Identifier*

The installer should label each riser cable, user outlet and patch panel with a designation, based on the following formula, at each end of the run:

ODF no. TDF no. Cable no. Channel

a) ODF number is the distribution frame the cable originates from.

b) TDF number is the distribution frame the cable terminates in.

c) Cable number is the sequential between each DF.

d) Channel is a sequential within the group, as indicated by the logical or physical channel numbering on the components.

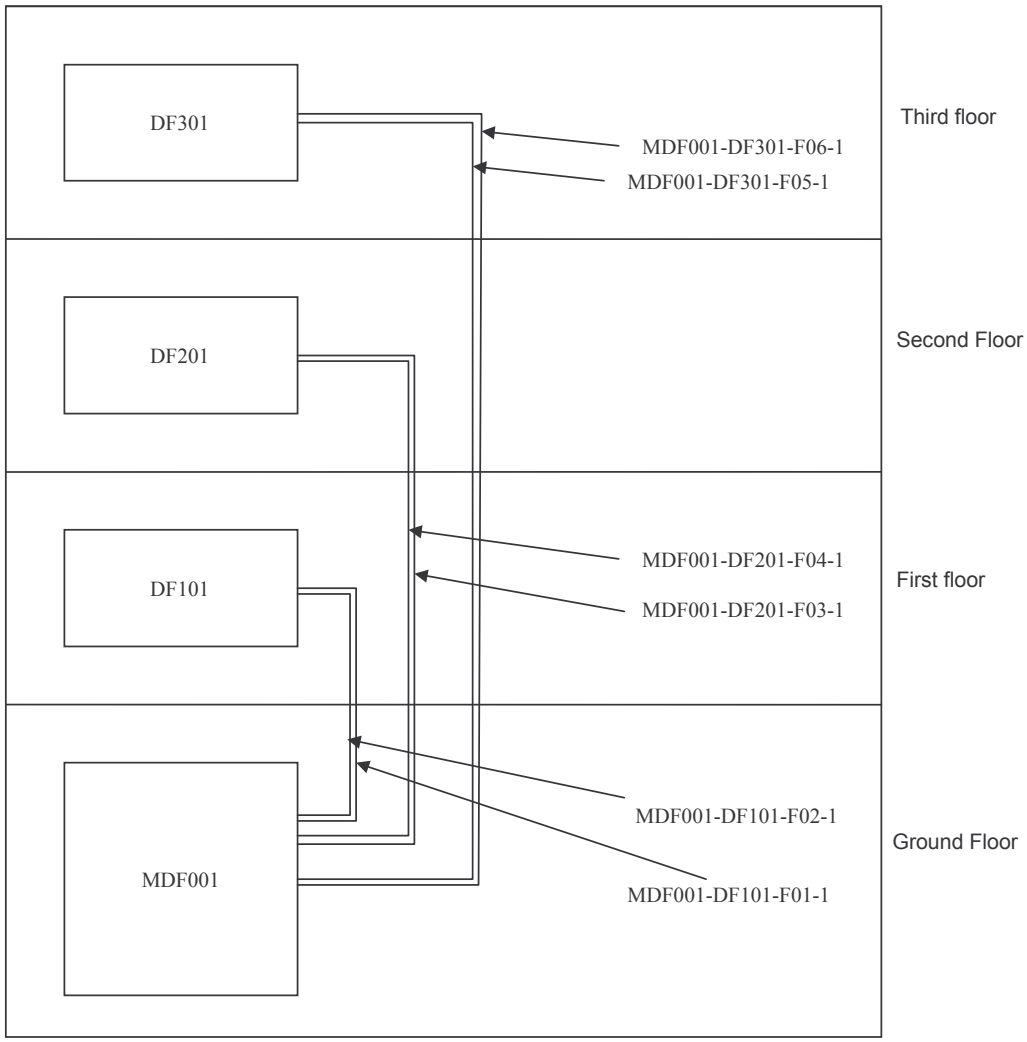



Figure E.17: Backbone Cable Identifier

The above illustrates an example for a three storey building. The cable numbering should be MDF001-DF101-F01-1 to MDF001-DF301-F06-1, inclusive.

MDF001 indicates the originating distribution frame (a main distribution frame at ground floor), DF 101 indicates the distribution frame in which the cable terminates, F01 indicates the cable number (fiber optic, core number 1) and 1 indicates the patch panel in which the cable terminates in.

### *E20.2.4 Cable Labeling*

Horizontal and backbone cable should be labelled at each end. The labels should be affixed at each end.

Additional labeling is required at each intermediate location such as conduit ends, backbone splice points, manholes and pull boxes.

Cables of different conductor counts that are spliced together are considered as separate cables.

Optionally, the different splice segments may be labeled with a single cable identifier provided that the pair/conductor count of the largest cable is maintained end-to-end and indicated on the cable labels.

If a cable is routed through multiple pathway segments, the pathway record linkage field should contain references to all pathway segments used.

#### *E20.2.5 Termination Hardware Identifiers*

An identifier should be marked on each of the termination hardware or its label.

#### *E20.2.6 Termination Position Identifiers*

A unique identifier should be assigned to each termination position to serve as a link to the termination position record.

#### *E20.2.7 Termination Position Labeling*

An identifier should be marked on each termination position label except in cases where high termination densities make labeling impractical.

In these cases, identifiers should be assigned to each termination hardware unit and to the actual termination position identifier determined by the conventions used for that unit.

#### *E20.2.8 Splice Closure Identifiers and Labeling*

A unique identifier should be assigned to each splice closure to serve as a link to the splice record.

An identifier should be marked on each splice closure or its label.

### E20.3 Records

#### *E20.3.1 Cable Records*

The following items should be included in cable record:

a) cable identifier, cable type, un-terminated cable pair;

b) damaged cable pair, available termination position record and

c) splice record, pathway record, grounding record.

The cable type should include the manufacturer and manufacturer’s designation.

The termination position linkage field is used to record the termination positions of every pair/ conductor or set of pairs/conductors of the cable. Each pair/conductor or set of pairs/conductors has a linkage to two termination position records.

The following table illustrates the format for a cable record.

Table E26: Format for Cable Record

| CABLE RECORD | | | |
|---|---|---|---|
| RECORD NO. | | | |
| | SAMPLE DATA | | COMMENT |
| REQUIRED INFORMATION | | | |
| Cable Identifier | | | |
| Cable type | | | |
| Damaged cable pair | | | |
| Available cable pair | | | |
| | | | |
| REQUIRED LINKAGES | | | |
| | End 1 | End 2 | |
| Pr 1, Term. Pos. Record | | | |
| Pr 2, Term. Pos. Record | | | |
| Pr 3, Term. Pos. Record | | | |
| Pr 4, Term. Pos. Record | | | |
| Pr 5, Term. Pos. Record | | | |
| Pr 6, Term. Pos. Record | | | |
| Splice Record | | | |
| Grounding Record | | | |
| | | | |
| OPTIONAL INFORMATION | | | |
| Cable length | | | |
| UPC | | | |
| Ownership | | | |
| Misc. Information | | | |
| | | | |
| OTHER LINKAGES | | | |
| Other record 1 | | | |

### *E20.3.2 Termination Hardware Records*

The termination hardware format should be as follows:

Table E27: Format for Termination Hardware Record

| TERMINATION HARDWARE RECORD | | |
|---|---|---|
| RECORD NO: | | |
| | SAMPLE DATA | COMMENT |
| REQUIRED INFORMATION | | |
| Termination hardware identifier | | |
| Termination hardware type | | |
| Damaged position nos. | | |
| | | |

| TERMINATION HARDWARE RECORD | | |
|---|---|---|
| **REQUIRED LINKAGE** | | |
| Term. Pos. record 1 | | |
| Term. Pos. record 2 | | |
| Term. Pos. record 3 | | |
| Term. Pos. record 4 | | |
| Term. Pos. record 5 | | |
| Term. Pos. record 6 | | |
| Space record | | |
| Grounding record | | |
| | | |
| **OPTIONAL INFORMATION** | | |
| Protection | | |
| Misc. Information | | |
| | | |
| **OTHER LINKAGES** | | |
| Other record 1 | | |

### *E20.3.3 Termination Position Record*

The following table illustrates the termination position record:

Table E28: Format for Termination Position Record

| TERMINATION POSITION RECORD | | |
|---|---|---|
| **RECORD NO:** | | |
| | **SAMPLE DATA** | **COMMENT** |
| **REQUIRED INFORMATION** | | |
| Termination position identifier | | |
| Termination position type | | |
| User code | | |
| Cable pr/cond. Numbers | | |
| | | |
| **REQUIRED LINKAGE** | | |
| Cable record | | |
| Other Term. Pos. record 1 | | |
| Other Term. Pos. record 2 | | |
| Other Term. Pos. record 3 | | |
| Term. Hardware record | | |
| Space record | | |
| | | |
| **OPTIONAL INFORMATION** | | |
| Signal carried | | |
| Cross connect type | | |
| End-end attenuation | | |

| TERMINATION POSITION RECORD | | |
|---|---|---|
| **RECORD NO:** | | |
| | **SAMPLE DATA** | **COMMENT** |
| Misc. information | | |
| NEXT at Patch Panel | | |
| NEXT at TO | | |
| | | |
| **OTHER LINKAGES** | | |
| Other record 1 | | |

### *E20.3.4 Splice Record*

The splice record formats should be as follows:

Table E29: Format for Splice Record

| SPLICE RECORD | | |
|---|---|---|
| **RECORD NO:** | | |
| | **SAMPLE DATA** | **COMMENT** |
| **REQUIRED INFORMATION** | | |
| Splice identifier | | |
| Splice type | | |
| | | |
| **REQUIRED LINKAGE** | | |
| Cable record | | |
| Space Record | | |
| | | |
| **OPTIONAL INFORMATION** | | |
| Splice equipment used | | |
| Misc. Information | | |
| | | |
| **OTHER LINKAGES** | | |
| Other record 1 | | |

## *E20.4 Reports*

### *E20.4.1 Cable reports*

It is recommended that a cable summary be made available. The content of the cable summary should be as follows:

a) Type of cable.

b) Termination positions.

c) Cable records or other interlinked records.

The following table illustrates the cable report.

Table E30: Cable Report

| CABLE REPORT | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Cable ID | Pathway | Term Pos. | | Space | | Cable | | | |
| | | 1 | 2 | 1 | 2 | Type | Length | Application | Equip. |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |

Table E31: User Master Report

| USER MASTER REPORT | | | | | |
|---|---|---|---|---|---|
| User | Room | Data Cable | Data Term. | Data Net. ID | Data Equip. |
| | | Tel. Cable | Tel. Term | Tel Ext./DEL | Tel. Equip. |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |

***E20.4.2 End-To-End Circuit Reports***

The end-to-end circuit report traces connectivity from end-to-end. It should list the following items:

a) User code

b) Associated termination positions

c) Cables connecting the work area to the other end of each circuit

Table E32: End-To-End Circuit Report

| END-TO- END CIRCUIT REPORT | | |
|---|---|---|
| USER CODE | TERM. POS. | CABLE ID |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |

### *E20.4.3 Cross-connect report*

The following table illustrates the end-to-end circuit report. Each termination space containing cross-connects should have a cross connect report.

Table E33: Cross Connect Report

| CROSS CONNECT REPORT | | | | |
|---|---|---|---|---|
| **Space** | **Cable ID** | **Cross-Connect 1** | **Cross-Connect 2** | **Type** |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |

## E21. Labeling

### E21.1 General

Labels may be divided into adhesive, insert and others.

### E21.2 Adhesive Labels

Adhesive labels should meet the legibility, defacement and adhesion requirements specified in UL 969 (Ref. D-16). Labels should also meet the general exposure requirements in UL 969 for indoor use.

Care should be taken in choosing the material/ substrate designed for use on specific surface upon which the labels are to be applied. In harsh environments, sleeving or tags are more appropriate for the equipment surface.

Cable labels should have a durable substrate, such as vinyl, suitable for wrapping. Horizontal and backbone cables should be labeled at each end. It is recommended that the labels are affixed at each end rather than marking the cable.

### E21.3 Insert Labels

Insert labels should meet the legibility, defacement and general exposure requirements specified in UL 969. An insert label should be securely held in place under the normal operating conditions and usage to which the labeled infrastructure elements are subjected.

### E21.4 Other Labels

Other labels include special purpose labels that may use a different method of attachment, such as tie-on labels.

Labeling practices for all infrastructure elements should be consistent across an installation.

### E21.5 Cable Labeling Rule

Cables of differing conductor counts that are spliced together may be administered as separate cables.

It is also preferred to have cable labeling on the cable at intermediate locations such as conduit ends, backbone splice points, manholes and pull boxes.

Horizontal and backbone cables should be labeled at each end. It is recommended that the labels are affixed at each end rather than marking the cable.

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