

Guidelines

In-Building Telecommunications Access Facilities



Guidelines for In-Building Telecommunications Access Facilities

Final Version 1

26 March 2020

Ref: TUI/0320/059

Purpose: This Paper is intended to offer guidance to property developers, Licensed Operators and other interested stakeholders on the provisioning of spaces, facilities and cabling in residential and commercial buildings for the purpose of providing telecommunications services to consumers inhabiting those buildings.

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Legal disclaimer

This Consultation is without prejudice to the legal position or the rights and duties of the Authority to regulate the provision of telecommunications services. Any views expressed in this document are not binding on the Authority and are without prejudice to the final form and content of any decisions the Authority may make. This Consultation does not constitute legal advice. Inappropriate reliance ought to not therefore be placed on the contents of this document.

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Part One

Introduction

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1. Introduction

- 1.1. The Kingdom of Bahrain's 2030 Economic Vision promoted the development of public and private residential and business properties with a view to establishing Bahrain as a preferred location for international investment. This has resulted in the construction of an unprecedented number of new property developments, including new cities, high rise buildings, commercial compounds and industrial areas. In order to ensure the attractiveness of these developments, state-of-the art facilities and infrastructures, (including telecommunications infrastructures), are expected to be available.

The Authority in 27 May 2009 issued for consultation a draft regulatory position paper titled "Draft Position Paper on the Deployment of Telecommunications Networks in New Property Developments"¹ ("Draft Guidelines"). The Draft Position Paper outlined the Authority's proposed position in relation to the deployment of telecommunications networks and provision of telecommunications services and infrastructure in new property developments and placed emphasis on encouraging competition and ensuring choice for consumers.

The Draft Position Paper recommended that property developers play a significant role in respect of their properties by at least contributing to the provision of rights of way and passive infrastructure, i.e. ducts, co-locations and facilities to host active equipment, as appropriate. The Authority specifically proposed that developments should be built in a manner that facilitates an open access principle for the benefit of all Licensed Operators.

The Position Paper had not been adopted, nevertheless the Authority believes that a set of principles underscoring the Authority's position with regards to In-Building Telecommunications Access Facilities remains useful ("Paper"). This Paper aims to provide property developers, Licensed Operators and other interested stakeholders with recommendations on the provisioning of spaces, facilities and cabling in residential and commercial buildings for the purpose of providing telecommunications services for consumers inhabiting these buildings.

1.2. Purpose of this Paper

¹ <https://tra-website-content-prod-2019-do-not-delete.s3-eu-west-1.amazonaws.com/Media/mediafiles/document/PositionPaperNDDrafftfinal2.pdf>

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- 1.2.1.** The Authority has used reasonable efforts to include accurate and up-to-date information in this Paper, however, the Authority gives no warranty as to the accuracy of its contents.
- 1.2.2.** This Paper is a Guidelines document only. It is not binding upon the Authority and does not constitute legal advice.
- 1.2.3.** The Authority maintains the right to amend or update this Paper at its discretion.

1.3. Contact and Inquiry

- 1.3.1.** Upon request, the Authority would be amenable to provide further explanation to interested parties in respect of the contents of this Paper, including the design, construction and maintenance of telecommunications spaces, facilities, wires, cables and other relevant regulatory requirements.
- 1.3.2.** For information and advice, the Authority's Telecommunications Technical Office (TTO) can be contacted as per the following details:

Telephones: 81188 (Locally),
+973 17520040,
+973 17520000

Fax: +973 17532125

Postal address: Telecommunications Regulatory Authority
PO Box 10353
Manama, Kingdom of Bahrain

Street Address: 5th Floor
Building No. 852
Road No. 3618
Seef, 436

E-mail: tto@tra.org.bh

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Working Hours and days: From 08:00 a.m. to 04:00 p.m. Sunday to Thursday.

1.4. Objectives

The key objectives of this Paper may be summarized as follows:

- 1.4.1. To set out the Authority's views and provide recommendations on the provisioning of spaces, facilities and cabling in residential and commercial buildings for the purpose of providing telecommunications services to consumers inhabiting these buildings.
- 1.4.2. To set out the Authority's views on policies and practices with the aim of promoting performance and reliability of telecommunications services in residential and commercial buildings.
- 1.4.3. To provide building professionals, Licensed Operators and other relevant parties with a reference to international standards and applications to promote adherence to and compliance with those standards and applications.
- 1.4.4. To set out recommendations for establishing an in-building cabling system which supports a large variety of technologies and may be implemented with materials from single and multiple sources in accordance with technological neutrality and open access principles.

1.5. Scope

- 1.5.1. This Paper sets out the Authority's views pertaining to telecommunications spaces, facilities and cabling in respect of the following categories of premises:
 - a. Individual houses and villas;
 - b. Residential multi-story buildings;
 - c. Commercial and office buildings;
 - d. Buildings within Private Developments;
 - e. Campus-type buildings; (e.g. universities, hospitals)
 - f. Industrial buildings (e.g. warehouses, factories, etc)
- 1.5.2. This Paper is intended to be a reference for use by those parties involved in the provisioning of telecommunications in-building facilities and telecommunications infrastructure, including:

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- a. Property developers;
- b. Building construction professionals (architects, engineers, builders, technicians);
- c. Technology suppliers (vendors, telecom contractors, electrical contractors, equipment suppliers); and
- d. Licensed Operators.

1.6. Definitions and Abbreviations

Draft Position Paper or Paper – the Draft Position Paper on the Deployment of Telecommunications Networks in New Property Developments.

Generic Building – A commercial or residential building that is not used for telecommunications op

Licensed Operators – a person who is licensed to operate a telecommunications network or provide a telecommunications service under Article 25 of the Telecommunications Law

The Authority – the Telecommunications Regulatory Authority of Bahrain

The Telecommunications Law – the Telecommunications Law as promulgated by Legislative Decree No. 48 of 2002.

TO – Telecommunications Outlet

TTO – Telecommunications Technical Office

1.7. Compliance

- 1.7.1. Industry participants should make themselves familiar with the contents of this Paper and in addition, should comply with all laws, regulations and requirements of the Kingdom of Bahrain's Government planning authorities which may apply, as well as with any other applicable industry standards or codes.
- 1.7.2. While awareness of the contents of this Paper may assist in complying with legal and regulatory obligations, this Paper does not constitute legal advice or an exhaustive list of the legal issues that are relevant to the provision of in-building telecommunications access facilities in the Kingdom of Bahrain.

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- 1.7.3. The views set out in this Paper are based in part on recommendations made in certain industry standard documents. The list of documents below has a bearing on the standards for telecommunications in-building infrastructure in general and specifically on this Paper:
- a. ANSI/TIA/EIA 568.1-D: Commercial Building Telecommunications Cabling Standard;
 - b. ANSI/TIA/EIA 569-A: Commercial Building Standard for Telecommunications Pathways and Spaces;
 - c. ISO/IEC 11801: Generic Cabling for Customer Premises;
 - d. BS EN50173: Information Technology, Generic Cabling Systems, General Requirements and Office Areas.
 - e. Building Industries Consulting Services, International (BICSI) Telecommunications Distribution Methods Manual (TDMM) – 11th Edition;
 - f. ANSI/EIA/TIA-570, Residential and Light Commercial Telecommunications Wiring Standard;
 - g. ANSI/TIA/EIA-758 Customer –owned outside plant telecommunications;
 - h. AS/NZS ISO/IEC 15018:2005 Information technology - Generic cabling for homes.

1.8. Roles and Responsibilities

The below sections outline the Authority's views on the roles and responsibilities that should be borne by each of the parties involved in the provisioning of telecommunications in-building facilities and telecommunications infrastructure.

1.8.1. Property Developer's Roles

The Authority recommends that a property developer should:

- a. be responsible for the design, construction and maintenance of the telecommunications spaces, facilities, wires, cables and other related telecommunications components within their buildings up to and including the lead-in ducting to the building, in liaison with the licensed operators.

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- b. follow the recommendations set out in this Paper as well as other relevant international standards in the design, construction and maintenance of the telecommunications spaces, facilities, wires, cables and other related telecommunications components in their buildings;
- c. allow access to Licensed Operators and provide them with the necessary assistance for the provisioning of telecommunications networks in buildings for the purpose of providing telecommunications services to consumers;
- d. ensure that all telecommunications infrastructure including spaces, facilities, wires, cables and other related telecommunications components are for the exclusive use of telecommunications;
- e. implement reasonable measures to safeguard the security of the relevant telecommunications spaces and facilities; and
- f. submit to the relevant Licensed Operators telecommunications engineering drawings and documents for the purpose of providing in-building telecommunications access facilities and infrastructure in commercial and residential buildings.

1.8.2. Licensed Operator's Roles

The Authority recommends that Licensed Operators should:

- g. in providing telecommunications services to subscribers use, where appropriate, the telecommunications infrastructure (including spaces, facilities, wires, cables and other related telecommunications components) built by buildings developers in accordance with the views set out in this Paper as well as with other standards as specified within this Paper;
- h. provide and maintain all telecommunications equipment and facilities on its side of the demarcation point, as specified in this Paper, as well as the consumer's side of the demarcation point;
- i. adhere to the recommendations set out in this Paper as well as to relevant international standards in the provisioning of telecommunications equipment, facilities and other related telecommunications components in buildings; and
- j. liaise with the property developers and other related bodies for the professional and safe provision of telecommunications equipment, facilities and related telecommunications components.

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1.8.3. The Authority's Roles

Where required and appropriate, the Authority shall undertake to:

- a. provide further explanation in relation to this Paper to parties involved in the design, construction and maintenance of the telecommunications spaces, facilities, wires, cables and other related telecommunications components;
- b. provide further recommendations on the provisions of this Paper where appropriate;
- c. liaise with the competent governmental planning authorities, in particular the Ministry of Municipalities Affairs and Agriculture;

Part Two

Generic Building Conditions

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2. Generic Building Conditions

2.1. Generic Cable System Design Consideration

In addition to the international standards that apply to design requirements, it is recommended that generic cable systems be designed with the following requirements taken into consideration:

2.2. Generic cable systems should be designed to support the broadest set of existing and emerging applications.

- 2.2.1. Generic cable systems should be designed to provide users with a flexible cabling scheme such that modifications are both easy and economical.
- 2.2.2. The architecture of a generic cable system should be a star-wired architecture.
- 2.2.3. The useable life of a generic cable system should be in excess of 10 years.

2.3. Separation from Electrical Supply and Cables

- 2.3.1. The Authority recommends that all telecommunications copper cables, equipment and other system components should be adequately separated from any source of Electro-Magnetic Interference (EMI). The following table recommends the minimum separation between EMI sources and telecommunications copper cables.

Condition	Minimum Separation Distance
Unshielded power lines or electrical equipment in proximity to open or non-metal pathway.	610mm
Unshielded power lines or electrical equipment in proximity to a grounded metal conduit pathway.	300mm
Power lines enclosed in a grounded metal conduit (or equivalent shielding) in proximity to a grounded metal conduit pathway.	150mm
Fluorescent lighting	305mm
Electrical motors and transformers	1200mm

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- 2.3.2. Although fibre optic cables are immune to the effect of EMI, it is recommended that a minimum separation of 100 mm be provided for safety reasons.

2.4. Grounding and Bonding

- 2.4.1. Grounding and bonding are terms that are used to define the practice of connecting all metallic components of a system together to a main building ground electrode, for the purposes of reducing or eliminating the differences of potential between all of the utilities inside of the building structure.
- 2.4.2. Grounding and bonding shall be in accordance with the applicable electrical codes and international standards.
- 2.4.3. The Authority recommends that the bond be designed to ensure that:
- a. The path to earth shall be permanent, continuous and of low impedance. It is recommended that each equipment rack is individually bonded, in order to assure the continuity of the earth path.
 - b. The cable screens provide a continuous earth path to all parts of a cabling system that are interconnected by it.
- 2.4.4. It is recommended that ground conductors and a ground bus be installed so that they are not obstructed by cable trays, cables, or terminating hardware.
- 2.4.5. The Authority recommends that ground wires and bonding conductors should always be installed in the straightest and shortest route between the origination and termination point.
- 2.4.6. A minimum bending radius shall not be less than eight times the conductor diameter. A sharp bend may interfere with the effectiveness of the grounding system since it will modify the characteristics of the grounding path.

2.5. Fire-stopping

- 2.5.1. The Authority recommends that all telecommunications related penetrations through fire-rated walls and floors should be fire-stopped in

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accordance with the relevant local and international standards and requirements of the manufacturer of the fire-stopping materials.

- 2.5.2. The telecommunications designer should avoid, where possible, designing solutions calling for penetration of fire-rated walls and floors when other reasonable cable routing options exist.

2.6. Design and Construction of Underground Duct Network

- 2.6.1. It is recommended that the designing, deploying, operating and protecting of telecommunications networks infrastructure in both public and private roads be carried out in accordance with the general conditions and technical standards as specified in the Guidelines for Telecommunications Infrastructure Deployment² that have been issued by the Authority.
- 2.6.2. The Authority considers that the property developer should provide a complete set of drawings for the design of telecommunications networks within the roads of his development to the Authority for validation and approval before proceeding to construction.
- 2.6.3. It is recommended that the property developer provide telecommunications Rights of Way with a minimum width of one meter in respect of all private roads. This Right of Way should be used for telecommunications infrastructure only. Normally the Licensed Operators should be eligible to install their related infrastructure, when required, within this Right of Way in accordance with Article 61 of the Telecommunications Law.
- 2.6.4. In the Authority's view, the property developer should be responsible for providing and building all telecommunications ducting, jointing chambers and associated facilities within the private roads of the properties. The design and building of such should be carried out in accordance with the requirements of the Guidelines for Telecommunications Infrastructure Deployment issued by the Authority.

2.7. Building Telecommunications Spaces and Requirements

2.7.1. Entry Jointing Chamber

² <https://tra-website-content-prod-2019-do-not-delete.s3-eu-west-1.amazonaws.com/Media/mediafiles/document/Guidelinesfortelecominfradeployment-Final21.pdf>

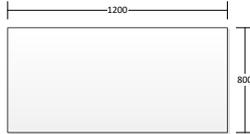
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Entry jointing chambers are underground joint boxes built exclusively to allow installation of telecommunications underground cable network to the customer's premises.

It is suggested that the following recommendations be considered during the design of buildings:

- a. All jointing chambers should be designed according to the specifications and standards as set by the Authority from time to time.
- b. The size and type of jointing chamber will normally depend on the number and type of telecommunications cables accessing the customer's premises. The following table provides information on the different sizes of jointing chambers.

Joint box	Shape	Size (LxWxH)	No of Ducts
TB1		800 x 700 x 750	1
TB2		1200 x 800 x 750	2
TB4		1400 x 800 x 900	4
TB6		1800 x 800 x 1250	6

- c. The jointing chamber should be constructed of suitable material, with a suitable frame and cover. The cover shall have marking as "Telecom".
- d. The location of the entry box depends on the location of existing / proposed telecommunications external line plant.
- e. The jointing chamber should be constructed at approximate distance of 1 meter from plot line.

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- f. Due to the variables involved, it is recommended that the Authority be consulted at the design stage, to advise the location of the jointing chamber and entry ducts.
- g. An earth rod must be provided at the jointing chamber. The required earth resistance should not exceed 5 Ohms.

2.7.2. Entry Pipes (Lead-in Ducts)

The entry pipes are normally uPVC ducts extended from entry jointing chambers towards premises and towards the Licensed Operator's line plant location.

The following recommendations should be considered during the design and installation of entry pipes:

- a. Entry pipes should be laid at a depth of 300 to 600 mm from the proposed finished paving level, depending on the type of surface. The Entry pipe should be protected with concrete to prevent damages.
- b. Entry pipe should be extended to the entry box and beyond to the nearest existing plant location or one (1) meter from plot limit or as advised by the Authority.
- c. The open ends of the entry pipe should be properly sealed to prevent entry of sub soil materials and ingress of water.
- d. Location of entry pipes should be clearly marked above ground for easy location.
- e. Building contractor should locate the installed entry pipes on site, if requested by the Authority.
- f. No right-angled sharp bends should be installed throughout the duct length except one wide-angle long radius bend (factory made) at the terminating end of the duct inside the main telecom room. Alternatively, at the location of the wide angle bend, a cable pull box of minimum size 600 (L) x 600 (W) x 800 (D) mm (internal) should be provided.
- g. Entry pipes should be assigned exclusively for telecommunication services.
- h. Entry pipes shall be provided with a draw rope made of nylon of minimum 6 mm diameter.

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- i. For the number and size of entry pipes for the various types of buildings, please refer to the following table.

2.7.3. Main Telecommunications Rooms

The main telecommunications room is essentially a large telecommunications room in high rise buildings that may house the present and future telecommunications equipment such as main distribution frame, PBXs, etc. The room is to be provided either on the ground floor or basement or in the first floor or mezzanine floor and should be dedicated for telecommunications use only.

The following recommendations should be considered during the design and construction of main telecommunications rooms:

- a. Normally provided in high rise buildings.
- b. The location of the room shall be within the vertical structure of the building to extend related facilities required such as 3-phase power (Distribution Board) D.B, three 16 Amp 240V AC power sockets per operator and one telephone socket.
- c. The equipment room should be sized to meet present and future requirements for cabling and equipment. The minimum size of the equipment room should be 14 m² with a clear height of 3 m
- d. The room must be easily accessible to telecommunications personnel 24/7 including weekends.
- e. The room must be clean, dry and free from dust and secured from unauthorized entry.
- f. Adequate lighting with a minimum of four 20 Amp and 240 Volt A.C. mains outlet from a dedicated circuit breaker should be provided.
- g. The room must be air-conditioned to maintain the temperature at 20 degrees Celsius. A "raised floor" of minimum 300 mm should be provided if required, depending on the telecommunications room usage.
- h. The room must be provided with a good earth of less than 5 Ohms.
- i. The door opening for the room shall swing outwards.

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- j. The floor, roof and surrounding wall of the telecom room, shall be free of any concealed water/drainage pipes and air-conditioning ducts passing through.
- k. The room must be provided with an emergency light, a smoke detector and a fire alarm.
- l. The telecommunications room should be located above ground level to avoid the risk of flooding and no neighboring to the electrical power rooms that house transformers and generators

If the telecommunications room is proposed in the basement, an automatic sump draining system shall be provided to handle water seepages.

- m. The duct entry to building shall be air sealed and water tight.
- n. A minimum of two perimeter walls of telecommunications rooms should be covered with 19mm plywood backboards capable of supporting attached equipment. This will allow cables to be installed and terminated around the walls of the room, now or in the future. It may also facilitate attaching cables that pass through vertically to rooms above or below.

2.7.4. Floor Telecommunications Rooms

Floor telecommunications room is a dedicated room that is required on each floor of high rise buildings for the purpose of accommodating internal conduits from every flat termination, routing and or terminating telecommunication cables and to accommodate the telecommunications equipment, if required. Floor telecommunications room shall be located close to risers and should be exclusively for the use of telecommunications.

The following recommendations should be considered during the design and construction of floor telecommunications rooms:

- a. Adequate lighting and minimum of three 16 Amp 240 volt AC mains outlet should be provided per operator.
- b. One (1) set of 2x40 watt fluorescent lamps are to be provided.
- c. The room must be readily accessible to telecommunications personnel and equipment 24/7, round the clock. The room should be clean, dry, and free from dust and secured from unauthorized entry.

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- d. The room must be air-conditioned. A “raised floor” of minimum height 300 mm should be provided if required, depending on the floor telecom room usage.
- e. The floor, roof and surrounding wall of the telecom room should be free of any concealed water/drainage pipes and air-conditioning ducts passing through.
- f. The floor Telecom room should be provided with good earth of not more than 5 Ohms.
- g. The floor telecom room should not be linked to or serve any other floor of the building.
- h. A Single conduit of at least 50mm internal diameter of uPVC material should be provided from each floor telecom room to the indoor equipment cabinet of each office, residence, flat and other independent areas in the same floor.
- i. The door opening for the room should be swing outwards when opened. The door should be minimum 900mm wide and 2100mm high.
- j. It is recommended that the Authority be consulted on any further recommended requirements, if the building is designed for commercial use.

2.7.5. Roof-Top Telecommunications Rooms

Roof top telecommunications room is a dedicated room to be provided on the roof top of highrise buildings with ten (10) stories and more, exclusively for telecommunications use and secured from unauthorized entry.

The following recommendations should be considered during the design and construction of roof top telecommunications rooms:

- a. The minimum roof top telecommunications room size should be 3(L) x 3(W) x 3(H) meter.
- b. The floor loading of this area should be as large as possible, to support future installation of telecommunications equipment.
- c. An opening of size 60x40 cm should be provided on the wall of the room, 50 cm below the room ceiling.
- d. The location of the room should be within the vertical structure or riser of the building, with due considerations for load safety provisions

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and to extend related facilities required such as Air-conditioning, 3-phase power (Distribution Board) D.B, earthling less than 5 Ohms, adequate lighting, one 13 Amp 240V AC power socket and one telephone socket.

- e. The room should be provided with an emergency light, a smoke detector and a fire alarm.
- f. The room should be readily accessible to telecommunications personnel 24 hours per day, every day, and the room must be clean, dry and free from dust.

2.7.6. Risers and Pathways

- a. Risers and pathways are part of the telecommunications cable support systems which are typically installed to provide a pathway and support for cables, thus minimizing stress that could cause damage to the copper pairs or fibre glass strands inside a cable sheath.
- b. The Authority recommends that telecommunications designers should provide all the information in their design documents that will allow the installer to select the necessary hardware and employ proper methods to install these structures.
- c. The risers are required in high rise buildings for the installation of telecommunications cables from the main telecommunications rooms to other floors, as detailed below:
 - i. Galvanized slotted iron cable trays (heavy duty, return flange) should be provided from the main telecommunications room, to each floor telecommunications room and extended up to the roof telecommunications room.
 - ii. The risers to each floor should be symmetrical and vertically in line from the main telecommunications room. However, where the main telecommunications room, floor telecommunications closet/room and roof telecommunications rooms are not located one below the other in vertical line, a continuous cable trays/conduits to be provided with pull boxes/access panels at every turning point and at interval of 15 meters each, up to the main telecommunications room. Right angle or sharp bends are to be avoided.
 - iii. In a campus environment where there is more than one building, all the above specified recommendations should be considered in respect of each building.

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- iv. The telecom cable trays should have adequate separation from electrical cable trays. Electrical cable trays should not cross the telecommunications cable trays.
- d. Horizontal Pathways (conduits, sleeves, cable trays etc) are used for running the cables from the floor distributors to the telecommunications outlets in premises.

A variety of methods are available for horizontal pathways and the choice of selection of method shall depend on the purpose of the floor area to be served (i.e. general office spaces, multi-story apartment, villas, etc.). Some of the mainly used methods are outlined as follow:

i. Conduits

- The use of conduits as a horizontal pathway system should only be considered when the outlet locations are permanent and flexibility is not required.
- The minimum size of a conduit pipe used as a horizontal pathway should be 25mm for villas and residential units, and 39mm (or 2x25mm) for commercial buildings from the floor distributors to the telecommunications outlets.
- For the conduits, the inside bending radius should always be at least 10 times the internal diameter.
- Minimum of one nylon draw wire of at least 6mm must be installed in a conduit.
- Pull boxes should be located such that they are readily accessible at all times. Pull boxes to be spaced at a maximum of 15 meters apart to minimize cable stress during installation and to provide serviceability in the future.
- Conduits must be free from sharp edges, to prevent cable damage during and subsequent to pulling.
- Conduits protruding through a floor should be terminated at a minimum of 50 mm from the floor to prevent water or other liquids from flowing into the conduits.

ii. Cable Trays

- Cable trays are mostly used for floors with raised tiles or raise floorings or overhead.

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- As a general guideline, cable trays that intersect should be provided with a transitional bend radius of 150mm in all directions.
 - Exposed sheet metal edges should be provided with bushings or other means of protection such that cables will not be damaged during or after installation. Since cable trays are usually metallic, all sharp edges, burrs and screw tips that may come into contact with cabling should be removed.
 - The minimum access space between the sub-floor and the underside of the floor tile shall be minimum 150mm.
- e. When the internal cable trays, risers and ladders etc, are designed, the maximum capacity cables should not exceed 75% of the tray or duct cross section size. This will need to be reduced in the case of bends.

2.7.7. Distribution Boxes

Floor distribution boxes are wall concealed boxes made of metal, PVC, or other suitable material for the purpose of housing and branching internal cables and conduits to every apartment in the floor. It is recommended that these empty boxes be located close to the risers and there can be more than one, depending upon the number of cables and conduits to be terminated.

It is recommended that the following minimum requirements be adhered to during the design and construction of high rise residential buildings:

- a. The distribution boxes should be of size not less than 300(L) X 300(H) X 150(D) mm flush mounted on wall and should be fixed in each floor. A suitable hinged cover should be provided.
- b. It should be installed at a height of 120cms above the finished floor level.
- c. The conduits leading from the floor distribution box towards each flat should not be less than 50 mm diameter.
- d. Adequate safe working space should be provided around each location.
- e. The distribution boxes location should not be located close to electrical junction box or bus bars. Adequate safe working space should be provided in front of each box.

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2.8. Equipment Racks

- 2.8.1. It is recommended that equipment racks should meet the requirements of the related international standards, i.e. Cabinets, Racks, Panels, and Associated Equipment (ANSI/EIA/310-D-92).
- 2.8.2. Equipment racks should be secured to the building structure and should be accessible from the front and rear.
- 2.8.3. Typical spacing is 914 mm (36 in) in front and back of the rack, and 762 mm (30 in) on the sides.
- 2.8.4. Where equipment racks are separated from a wall, cable trays should be installed from the wall to the top of the equipment racks. This provides a pathway for cables to be routed between equipment racks. Transitions between cable trays and equipment racks should be equipped with a means that ensures minimum cable bend radius is maintained.
- 2.8.5. All racks should be bonded to the telecommunications grounding busbar using a minimum 6 AWG copper conductor.
- 2.8.6. Cables should be routed on the rear sides of the rack using cable management accessories attached to the rear of the rack's vertical channels or in cable management channels on the sides of the rack.

2.9. Equipment Cabinets

- 2.9.1. There are two types of cabinets; the floor mounted type and wall mounted type cabinets. It is recommended to ensure that the floor-mounted cabinets will fit the footprint allocated for them prior to installation.
- 2.9.2. Cable access to floor mounted cabinets is normally provided by knockouts (pre-punched holes) in the cabinet side, top or bottom.
- 2.9.3. Cable trays and ladder racks provide a means of routing cables to the cabinet. Transitions between cable trays and cabinets should be equipped with a means that ensures minimum cable bend radius is maintained.
- 2.9.4. It is recommended that the cable installation methods specified by the manufacturer are verified prior to attempting to install cabinets.

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- 2.9.5. For all type of floor and wall mounted cabinets, the grounding and bonding instructions of the manufacturer should be followed.

2.10. Cable Pulling

- 2.10.1. For a good cable pulling practice the contractor should use specialized tools and equipment in addition to the employment of qualified and well trained workforce.

- 2.10.2. Before starting any cabling at the job site, the contractor is recommended to carry out the following preparation and verification works:

- g. When cable is received at the job site, the cable length should be verified to ensure the cable will reach between the end points.
- h. The cable should be identified, labeled, and the as built updated to reflect the work operation.
- i. The pathway of a cable should be free of sharp bends and turns.
- j. The manufacturer's recommended pulling tension and minimum bend radius (while under tension) should not be exceeded.
- k. The use of cable lubricants can significantly reduce friction and speed cable installation. It is advised that a lubricant is selected based on cable manufacturer's recommendations.
- l. Communication with co-workers is essential in every cable pull. Each of the co-workers should be prepared to alert the person pulling the cable, to ensure the cable is traversing the route smoothly without twisting, kinking, or getting bound up.

- 2.10.3. Pulling horizontal cables in conduits:

- a. Horizontal cable is installed between the telecommunications room and work area outlets. The cable should not be bent or kinked. Should the cable be damaged during installation, it is recommended that the entire cable is replaced, rather than attempting to repair it.
- b. It is recommended to label cables and their reels prior to pulling cable into place. It is easier to identify and label the cables before they are pulled through the conduit.

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- 2.10.4. Pulling Backbone in Vertical Pathway – from top down
- a. Due to gravity, it is generally easier to install cables from top down rather bottom up.
 - b. A reel brake mechanical device may be needed when pulling cables from top down in order stop or slow a freewheeling reel.
 - c. In the room where the cable will enter the vertical pathway, a bullwheel may be required to ensure that the jacket is not damaged as it enters the pathway.
- 2.10.5. Pulling Backbone in Vertical Pathway – from down top
- a. When pulling cable from bottom up, a winch may be needed.
 - b. Cable sheaves may be necessary to handle the cable from the reel location to the point where it will be pulled up to upper floors.
 - c. In the room where the cable will enter the vertical pathway, a bullwheel may be required to ensure that the jacket is not damaged as it enters the pathway.
- 2.11. Cable Termination**
- 2.11.1. It is recommended that wires should be terminated on TO's (Telecommunications Outlets), cables, equipment and cross-connect facilities only with the correct purpose-designed tool for the hardware concerned. IDC (Insulation Displacement Connector) terminations should be used wherever possible.
- 2.11.2. It is advised that all pairs are correctly terminated; the wires of a pair should be kept together and should be untwisted to the minimum practicable extent consistent with sufficient length for terminating them.
- 2.11.3. The following recommendations apply to wiring terminations in insulation displacement connectors:
- a. Only strip as much sheath from the cable as is required to terminate the paired conductors (maximum 25mm), leaving the sheath intact as close as practicable to the actual terminations.

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- b. Insulated wires should be inserted into the slots with the insulation undamaged in the vicinity of the actual connection.
- c. They should be inserted individually from the correct direction, specified by the hardware manufacturer.
- d. No attempt should be made to terminate wires of types other than those which are specified for telecommunications wiring.
- e. For shielded cable, whether foil or screened, the appropriate type of terminating hardware should be used in accordance with the manufacturer's recommendations.

2.12. Cable Installation Testing

- 2.12.1. Installation conformance is performed through a systematic method that ensures the installation has been completed in accordance with industry standards and the terms and conditions of the installation contract.
- 2.12.2. It is advised that any defective cables should be replaced, and termination faults remedied before handover to the developer.
- 2.12.3. It is recommended that the installer ensures conformance to the following:
 - a. visual examination of the cabling;
 - b. verification testing of the cabling;
 - c. qualification testing of the cabling; and
 - d. producing a report of results.

2.13. Cables Specification and Testing

- 2.13.1. Cable is the medium through which data usually moves from one network device to another. There are several types of cable, which are commonly used with generic cabling systems. In some cases, a network will utilize only one type of cable; other networks will use a variety of cable types. The type of cable chosen for a network is related to the network's topology, protocol and size. Understanding the characteristics of different types of cable and how they relate to other aspects of a network is necessary for the development of a successful network.

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2.13.2. It is advised that cables and associated components for providing in-building telecommunications services should be provided by developers. It is recommended that the cables comply with the technical specifications set out in this Paper.

2.13.3. The typical type of cables used for providing in-building telecommunications services includes copper and optical fibre. The Authority recommends that the cables comply with the relevant international specifications as follow:

a. Copper Cables

- i. The copper cables should be of balanced cabling type which conforms to the mechanical and electrical requirements of the generic specifications IEC 61156-1 and the relevant requirements of ISO/IEC 11801:2002(E) international standards.
- ii. The balanced cables should meet the basic requirements of Table 24 of the international standards ISO/IEC 11801:2002(E).
- iii. The balanced cables should meet the additional mechanical and electrical requirements given in the ISO/IEC 11801:2002(E) international standards, which include the following:
 - a. mechanical characteristics;
 - b. mean characteristic impedance;
 - c. attenuation;
 - d. ELFEXT and PS ELFEXT;
 - e. current carrying capacity;
 - f. coupling attenuation;
 - g. transfer impedance;
 - h. additional performance requirements for flexible cables;
 - i. additional crosstalk considerations for cable sharing in balanced cables
- iv. The cables to be installed for telecommunications services should be of suitable category. In order to meet the long term demand and the use of future telecommunications services, higher grade cables may be used.
- v. Balanced cables should be tested according to the generic specification IEC 61156-1.

b. Fibre Cables

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- i. It is recommended that all single mode and multi-mode optical fibre cables used for in building telecommunications services conform to the requirements as specified in the international standards ISO/IEC 11801:2002(E) and the ITU-T Recommendation G.651 and ITU-T Recommendation G.652.
- ii. The optical fibre cable attenuation should be in accordance with the Table 26 of ISO/IEC 11801:2002(E), indicated below:

Maximum cable attenuation dB/km				
	OM1, OM2, and OM3 Multimode		OS1 Single-mode	
Wavelength	850 nm	1300 nm	1310 nm	1550 nm
Attenuation	3.5	1.5	1.0	1.0

- iii. Star configuration is recommended for the wiring arrangement up to the respective service points. Suitable types of equipment should be chosen to suit the requirements of the specific types of cables and requirements of the building.
- iv. The minimum bending radius of optical fibre cable during installation should be 20 times of the cable diameter and the permanent turning radius for an optical fibre cable should at least be 10 times of its diameters.
- v. Attenuation test is required upon completion of the installation of optical fibre cables.

2.14. Labeling and Identification

- 2.14.1. It is advised that all floor outlets, patch frames and horizontal cables should be labeled. A typewritten standard labeling system is recommended.
- 2.14.2. Horizontal cables should be labeled at both ends using a self-laminating, wrap around label.
- 2.14.3. Each telecommunications outlet should be labeled with a unique identifier, typically using the agreed scheme.

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2.15. Record Keeping

2.15.1. The Authority recommends that the developer should maintain an updated record of the following:-

- a. Layout plan of all telecommunications rooms showing the locations of the lead-in ducts, risers, power points, etc.;
- b. Layout plan showing the route of the vertical risers, the lead out point and the sizes;
- c. Floor layout plans showing the horizontal distribution ducts, the connection points to the vertical riser, the locations and sizes of distribution boxes, etc.; and
- d. Other cabling facilities.

2.15.2. Upon request, the developer should supply one set of these drawings to the Authority in both soft and hard copy.

2.15.3. The up-to-date drawings should be kept in the building management office.

2.16. Security and Safety

2.16.1. It is advised that telecommunications cables should be segregated from electrical cables at all intersection points.

2.16.2. Insulation sleeves should be provided for telecommunications cables crossing electrical wires.

2.16.3. Items associated with the installation should be located so that they do not create a hazard to the occupants of the premises or to installation or maintenance staff.

2.16.4. Outlets for telecommunication should be fitted in locations that minimize the risk of damage.

2.16.5. It is advised that only materials that comply with the relevant international standards for telecommunication cables and ancillary accessories in

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residential and business premises should be used in any installation work.

- 2.16.6. It is recommended that only proper tools should be employed in installation work. Any attempt to misuse any tools will result in unwanted damage or even risk getting injured.
- 2.16.7. As soon as work is completed at any access point, all internal fittings, the cover and its fixing screws should be properly secured.

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Part Three
Residential Building
Generic Cabling System

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In-Building Telecommunications Access Facilities

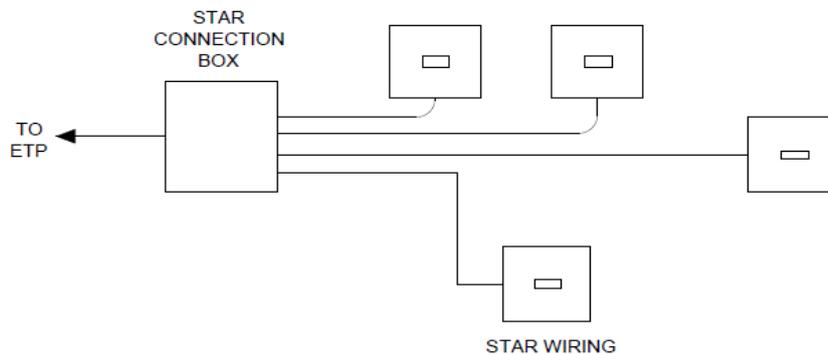
3. Part Three Residential Building Generic Cabling System

3.1. Cable System Design

3.1.1. The Authority recommends that all residential cable systems should be designed in a manner that ensures the provisioning of the following minimum services by plugging into any telecommunications outlet socket within a residential unit.

- a. Telephony services – PSTN, FAX, etc.
- b. Data services - Internet, LAN, etc.
- c. Wireless services – Wireless Telephony and WiFi.

3.1.2. The recommended architecture of a telecommunications wiring system within a residential unit is a star-wired architecture, as per the following diagram.

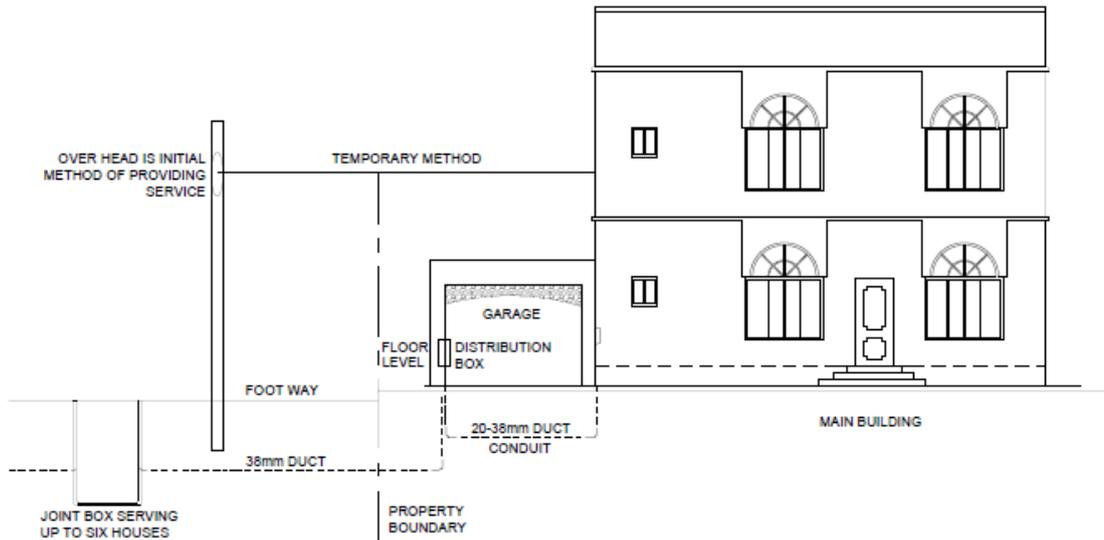


3.2. Cable System Overview

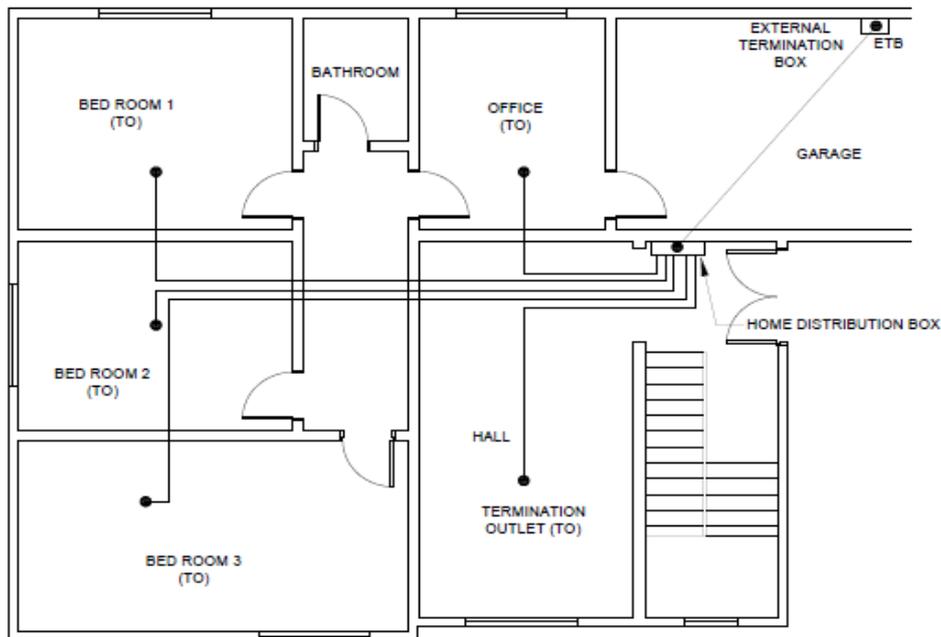
3.3.1. It is recommended that the typical overview of telecommunications connection to residential houses and units should be as illustrated in the following diagram.

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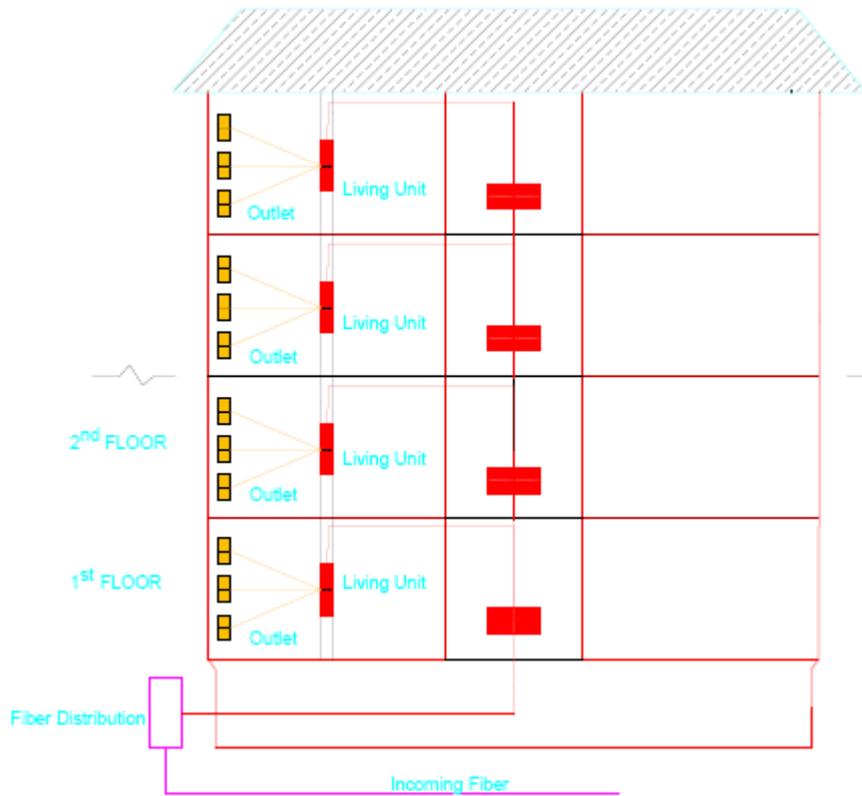
3.3.2. The Authority recommends that the generic architecture of telecommunications cable systems in residential houses, apartments and units should be as illustrated in the following diagram.



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3.3.3. It is advised that the generic architecture of telecommunications cable systems in residential multi-story buildings should be as illustrated in the following diagram.



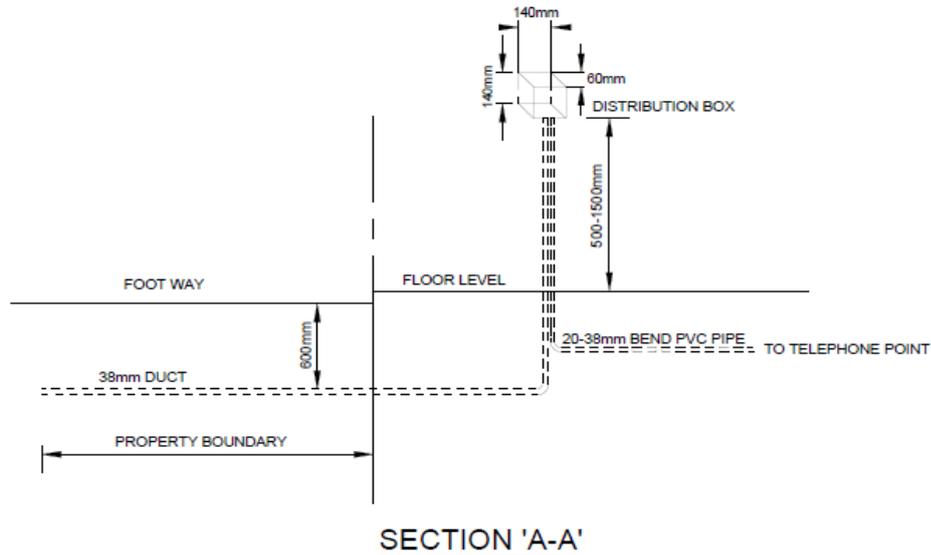
3.3. Home Cable System Components

3.3.1. Duct Entry (Lead-in)

- a. The purpose of a duct entry is to provide connection between the premises cabling and a Licensed Operator's network. The typical detail of a duct entry to a residential house is as illustrated in the following diagram.

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- b. The connection between the premises and Licensed Operators' networks may take the form of underground or over-head connection as illustrated under paragraph No. 3.2 of this document.
- c. The Authority recommends that the entry duct, bends, coupling and other material should be made from uPVC or other suitable material in accordance with the relevant international standards. The size and source of duct entry material should be as per the following table:

Material	Size	Thickness	Source	Diagram
Duct	38mm	1.5 mm	Local Market	
Bend 90°	38mm	1.5 mm	Local Market	
Female Adapter	38mm	1.5 mm	Local Market	

- d. The following recommendations should be considered when laying entry duct:
 - i. Duct should be laid in the ground at approximate depth of 600mm from the surface finishing level.
 - ii. Entry duct should be extended to an approximate distance of one meter into the public footpath.
 - iii. Suitable draw rope or pulling tape should be provided in each duct for the purpose of drawings cables at the time of installation.

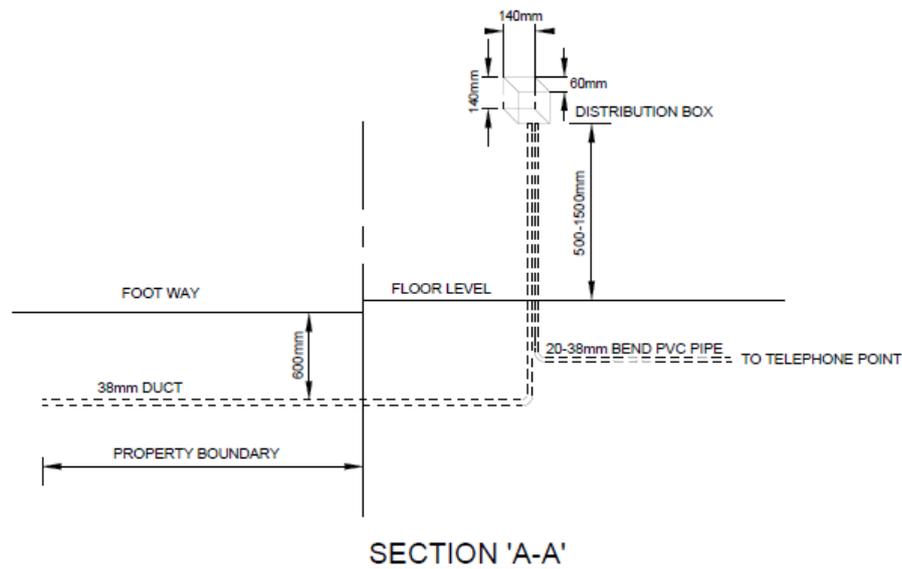
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- iv. The unconnected ends of all pipes should be capped with rubber caps to prevent entry of earth, debris or other material.
- v. Location of lead-in ducts shall be clearly marked above ground for easy locating.

3.3.2. External Termination Box

- a. The External termination Box is the point at which the Licensed Operator's cable connects with the building internal wires. The generic diagram of an external termination box is below:



- b. The purpose of external termination box is to provide a demarcation point between the Licensed Operator's entry cable and the building internal wiring.
- c. The external termination box should be located in the garage, the boundary wall or any other suitable location that enables a testing point for faults diagnosis without the need to access the home.
- d. The external termination box should be recessed in the wall and made of suitable material with a minimum dimension of 140mm W x 180mm H x 60mm D. A typical diagram of a box should be as follow:

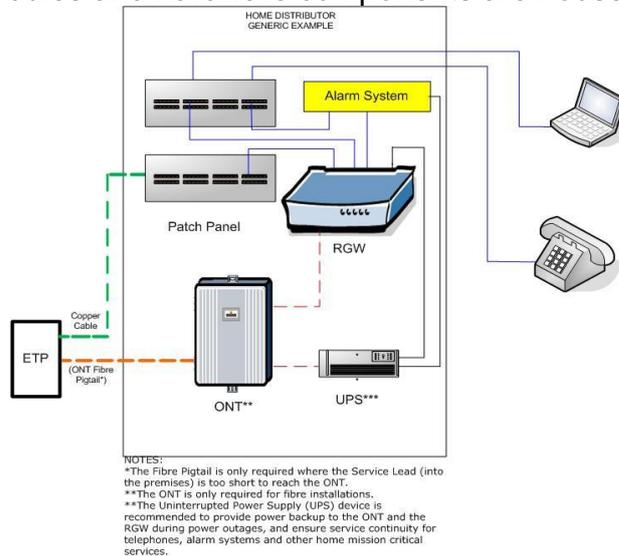
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3.3.3. Home Distribution Box (Point)

- a. The Home Distribution Box is the central point at which all internal wiring terminate and branch out from. It is normally a box made of suitable material as per the following diagram where the cable termination modules and hardware components are housed in.



- b. It is recommended that the distribution box should be located at the main internal entrance of the home or other suitable location that provides a minimum cable run to each TO. It should be easily accessible for making changes or additions to the equipment and cross-connections within it.
- c. The home distributor box will normally house the following:
- i. separate cable to each TO in the house;
 - ii. termination modules and cross-connect facilities;
 - iii. optical network termination (ONT) devices and residential gateway for fibre;
 - iv. power supply;
 - v. backup battery;
 - vi. any other hardware component.

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3.3.4. Power Supply

- a. It is recommended that a minimum of one 13 Amp 240V AC power socket should be provided inside or within a close proximity of the home distribution box.
- b. It is recommended that an Uninterrupted Power Supply (UPS) device with surge protection is installed to provide power backup during power outages, and ensure service continuity for telecommunications services.

3.3.5. Conduit

- a. The Authority recommends that the home distribution box should be connected with all telecommunications outlets "TOs" using PVC conduits or other suitable pathway. The prime use of conduits will be to run telecommunications wires and cables between the various telecommunications components.
- b. The recommended minimum size of conduit is 25mm. Consideration should be given to the number of wires to be installed in a conduit and the impact that future installations may have on the capacity of this conduit. A conduit in a straight run is considered to be at capacity when 50% occupied. If there are two bends up to 90° radius in the duct pull length, then it is considered to be at capacity when 40% occupied.
- c. The inside bending radius of conduits is recommended to always be at least 10 times the internal diameter.
- d. It is recommended that pull boxes should be located such that they are readily accessible at all times. That Authority advises pull boxes to be spaced at a maximum of 15 meters apart to minimize cable stress during installation and to provide serviceability in the future.
- e. Conduits should be free from sharp edges, to prevent cable damage during and subsequent to pulling.
- f. Where required, a minimum of one nylon draw wire 6 mm or a suitable pulling tape should be installed in a conduit for pulling cables.

3.3.6. Wiring

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- a. All cables, telecommunications outlets and hardware used in wiring residential premises should be compliant with the relevant industry standards and carry a recognized international independent assessment body of quality and safety.
- b. The Authority considers it to be the developer's responsibility to terminate the wires on telecommunications outlets, cross-connects, home distribution points and other telecommunications facilities within the premises. It is recommended that the developer hire competent personnel capable of executing works to the recognized standards.
- c. The Authority considers that the developer will be responsible for the termination of wires or cables between the external termination box and home distribution point.
- d. The Authority recommends that the following type and size of cables should be installed by developers within residential premises:
 - i. One 4-pair Cat 5e or higher performance should be extended using star architecture from the home distribution point to each telecommunications outlet (telephone socket) of the premises.
 - ii. Outdoor one 4-pair Cat 5e or higher performance cable and additional 2-pair fibre, manufactured to ITU-T Recommendation G.651. Cable should be extended from the home distribution point to the external termination box.
- e. All cable runs should be continuous without joints. In order to maintain performance the entire cable run should be replaced if it is damaged.
- f. One meter tails should be left at the external termination box and home distribution point for termination purposes. These cables will normally be connected by Licensed Operators.
- g. All cables should be suitably labeled at the external termination box, home termination point and telecommunications outlets.

3.3.7. Telecommunications Outlets

- a. The Telecommunications Outlet (TO) is a connecting device that connects the telecommunications devices with in building cabling system. One or more RJ45 sockets must be installed in any telecommunications outlet. The RJ45 socket assemblies used in telecommunications outlets should meet Cat5e or higher performance requirements and be marked with the relevant category rating.

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- b. The total number of TOs that may be installed in any premises is not restricted. It is suggested that a minimum of one TO should be installed in each occupant room of the premises. For larger rooms or halls the provision of more TOs should be considered to avoid the extension of long cords.

- c. It is recommended that all TOs should be individually labeled, with the same identification at the cable termination in the home distribution point, so that both cable and TOs termination can be clearly associated when connecting new services.

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Part Four
Commercial Building
Generic Cabling System

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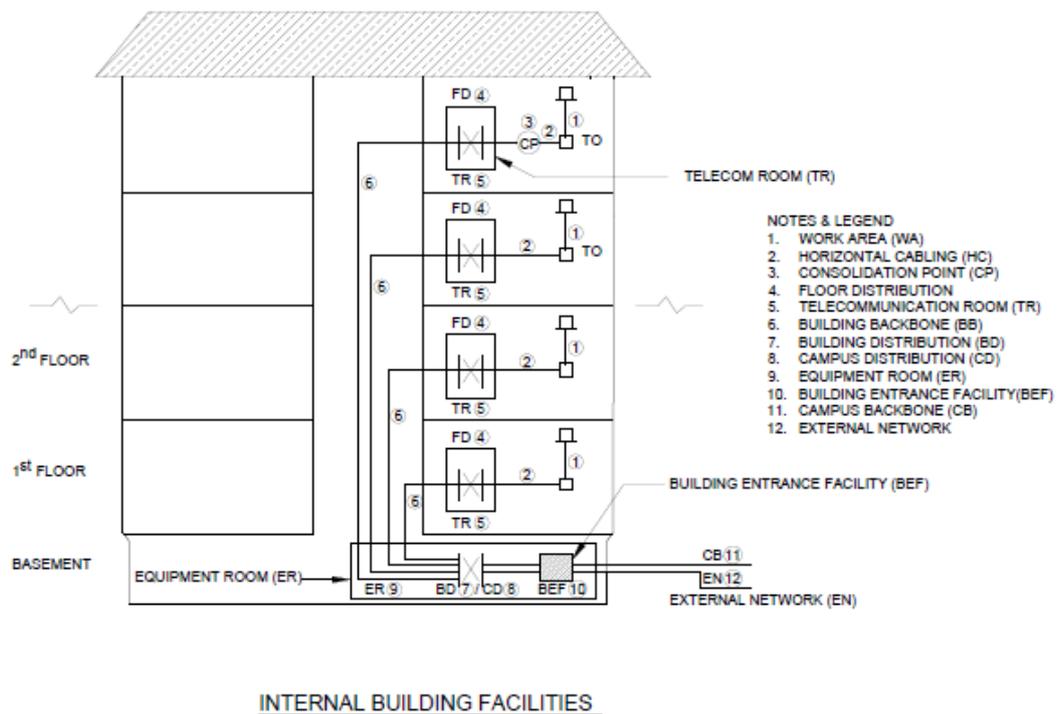
In-Building Telecommunications Access Facilities

4. Commercial Building Generic Cabling System

4.1. Cable System Overview

4.1.1. It is recommended that a commercial generic cabling system should be designed in a manner that interconnects telecommunications equipments for voice, data and video in a multi-product multi-vendor environment. It normally consists of several functional elements which in turn grouped to create modular subsystems that are independent, yet complementary. This approach facilitates growth, as changes in one subsystem do not affect the others.

4.1.2. The generic cabling system comprises all or some of the elements as shown the following diagram:



4.1.3. The commercial generic cabling system may contain up to three cabling subsystems; namely campus backbone, building backbone and horizontal cabling.

The following is a brief description of the generic cabling sub-systems:

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In-Building Telecommunications Access Facilities

a. Campus Backbone Subsystem

The campus backbone subsystem is the portion of the generic cabling system that links the campus distributor (also known as campus cross-connects) and building distributors (also known as building cross-connect) normally located in different buildings in a campus environment. The campus backbone will normally consist of the following:

- the campus backbone cable;
- any cabling components within the building entrance facilities;
- jumpers and patch cords in the campus distributor;
- the connecting hardware on which the campus backbone cables are terminated (at both the campus and building distributors).

Copper backbone cabling is used for voice and data applications while optical fiber backbone cabling is used for data application where the reach or data rate of copper backbone cabling is exceeded.

b. Building Backbone Subsystem

The building backbone subsystem is the portion of the generic cabling system that links the building distributor and floor distributors (also known as floor cross-connects) in the same building using a star topology. The building backbone will normally consist of the following:

- the building backbone cables;
- jumpers and patch cords in the building distributor;
- the connecting hardware on which the building backbone cables are terminated (at both the building and floor distributors).

Copper backbone cabling is used for voice and data applications while optical fiber backbone cabling is used for data application where the reach or data rate of copper backbone cabling is exceeded.

c. Horizontal Cabling Subsystem

The horizontal cabling subsystem is the portion of the generic cabling system which links the floor distributor to the telecommunications outlets. The horizontal cabling subsystem will normally consist of the following:

- the horizontal cables;
- jumpers and patch cords in the floor distributor;
- the mechanical termination of the horizontal cables at the telecommunications outlet;

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- the mechanical termination of the horizontal cables at the floor distributor including the connecting hardware;
- a consolidation point (optional);
- the telecommunications outlets.

Horizontal cables could be of copper or fibre type and shall be continuous from the floor distributor to the telecommunications outlets unless a consolidation point is installed.

4.2. Commercial Building Generic Cabling System Components

4.2.1. Building Entrance Facility

- a. The entrance facility is the interface between the outside plant and the inside building network. The entrance facility is the location where copper cables and/or optical fiber cables entering the building are terminated.
- b. It is recommended that electrical protection should be provided for copper conductors and should be located in the entrance facilities. The electrical protection should adhere to all applicable codes.
- c. When selecting the entrance facility site location, it is recommended that the on-site location of electricity, water, gas and other utilities be considered.
- d. It is advised that all copper cables entering the building are electrically protected. These electrical protection systems are mainly classified into two categories, over voltage protection and current limiter.
- e. Inter-building optical fiber cables do not require electrical protection hardware.

4.2.2. Campus Backbone Cable

- a. It is the cable of the generic cabling system that links the campus distributor with building distributors located in other buildings in a campus environment.
- b. It is possible for campus backbone cabling to provide direct connection between building distributors.

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- c. Where the building distributor does not exist, the campus backbone cabling subsystem extends from the campus distributor to the floor distributor.
- d.
- e. Copper backbone cabling is used for voice and data applications while optical fiber backbone cabling is used for data application where the reach or data rate of copper backbone cabling is exceeded.
- f.
- g. The selection of campus backbone cabling may require a longer-term approach than that adopted for the building backbone, particularly if access to pathways is more limited.

4.2.3. Equipment Room

- a. The equipment room is the centralised location for the campus distributor, building distributor, PBX, mainframe computer, and all the telecommunications equipment common to the occupants of the building.
- b. The equipment room should be sized to meet present and future requirements for cabling and equipment.
- c. The following table provides recommendations on the size of the equipment rooms:

Number of Workstations	Equipment Room Size (m ²)
1-100	14
101-400	37
401-800	74
801-1200	111
Note: Provide 0.07 sq m of equipment floor space for every 10 sq m of user workstation area.	

- d. The minimum requirements as outlined in the below table should be considered in the design and construction of equipments rooms:

Item	Requirements
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In-Building Telecommunications Access Facilities

Perimeters	No false ceiling; all surfaces treated to reduce dust; walls and ceiling painted white or pastel to improve visibility.
Access	Typically, single or double 1m x 2.44m lockable doors, with no door sills.
Ceiling Height	Minimum clear height in room shall be 2.4m, the height between finished floor and lowest point should be 3m to accommodate tall racks and overhead raceways. False ceilings should not be installed.
HVAC	All year round 18°C to 24°C, 30 to 55% humidity, positive pressure.
Lighting	Typically, 2.56m high, providing 500lux (50ft candles) at 1.0m above floor. With independent power from telecommunications equipment.
Electrical	Typically, a minimum of two dedicated 20 A, 230 V AC duplex outlets on separate circuits is required. Convenience duplex outlets should be placed at 2m intervals around the perimeter. Emergency power should be considered and supplied if available.
Bonding and Grounding	Access should be made available to the bonding and grounding as specified in J-STD-607-A or EN50310.
Dust	Less than 100 micrograms/cubic meter/24 hour period.
Floor loading	Rooms should be located on floor areas designed with a minimum floor loading of 4.8 kPa. This will depend on localised heavy loads and if unusually heavy equipment is anticipated this will need to be increased.
Other	No piping, ductwork, mechanical equipment or power cabling should be allowed to pass through the equipment room. No unrelated storage.
<p>Note: The requirements as outlined in this table are indicative only, it is the responsibility of the designer / developer to ensure exact requirements for telecommunications spaces.</p>	

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In-Building Telecommunications Access Facilities

- a. It is recommended that the following considerations are taken into account when selecting the location for the equipment room:
 - i. accessibility for the delivery of large equipment;
 - ii. expansion of the equipment room should not be restricted by building components such as elevators, outside or other fixed walls, and so forth;
 - iii. the location of the equipment room should not be below the water level, unless preventive measures against water infiltration are employed;
 - iv. the equipment room should be located away from electrical power supply transformers, motors and generators, X-ray equipment, radio and radar transmitters, and other sources of electromagnetic interference;
 - v. it is desirable to locate the main cross-connect in or as close as possible to the equipment room;

4.2.4. Campus Distributor

- a. It is the distributor from which the campus backbone cabling starts. Usually there should be one campus distributor per campus but the type and size of a campus distributor would usually depend on the geography and size of the campus.
- b. The campus distributor (main cross-connect) is the primary node of a building distribution network and is the cross-connection point for all building cables, PABX, connection to telephone company interfaces, and mainframe computers.
- c. In a campus environment, it is advised that the main distributor should be contained in one building and an intermediate cross-connect in each of the other buildings in order to maintain the star topology of the in building network. If necessary, a main and intermediate cross-connect can be provided to each tenant in a multi-tenant environment.

4.2.5. Building Distributor

- a. The building distributor (also known as main cross-connect) is the primary node of a building distribution network and is the cross-

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In-Building Telecommunications Access Facilities

connection point for all in-building cables, PABX, connection to telephone company interfaces, and mainframe computers.

- b. Depending on the number of cables to be terminated at the building distributor, the cross-connection hardware can be wall, rack or frame-mounted.
- c. It is recommended that an optical fiber frame be designed for terminating at least a 12-fiber optical fiber cable for every telecommunications room in the building.
- d. In the main and intermediate cross-connects, it is advised that wire and patch cord length should not exceed 20 m.
- e. Depending on the data equipment, the Authority suggests that the appropriate copper or fiber equipment cables should be used and should be terminated at the main cross-connect. The cable length between the equipment and the main or intermediate cross-connect should not exceed 30 m.

4.2.6. Building Backbone Cabling

- a. It is recommended that the building backbone cabling should consist of multi-pair copper or optical fiber cables and their supporting hardware. It should be used to link the building distributor (main cross-connect) to every floor distributor (horizontal cross-connect) using a star topology.
- b. Building backbone cabling are usually designed for the entire life of the generic cabling system. However, it is common to adopt short-term approaches that support current and foreseeable application requirements, particularly where there is good physical access to pathways.
- c. Separate backbone cables are recommended for voice and data for operational, administrative and maintenance reasons.
- d. For voice backbone, a 1:2 ratio of the number of pairs for the horizontal cabling plus an additional 25% allocated for growth should be acceptable. For example, the recommended backbone cable for a telecommunications room serving 100 voice outlets would be a 250 pair cable (100 outlets x 1 pair required/outlet x 2 backbone pairs/pair required + 25% = 250 pairs).
- e. For full flexibility, a 1:1 ratio number of pairs of the backbone cabling and number of pairs for the horizontal cabling could be considered.

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- f. For a data backbone, it depends upon the system to be installed. If the application requires high data rates, a minimum of 2 UTP cables is recommended only when the backbone channel length between two active equipment is less than 100 m. If the backbone channel length is greater than 100 m, optical fiber cable is recommended for the backbone needs.
- g. When optical fiber backbone is used, plan for a minimum 12-fiber optical fiber cable for each telecommunications room. Typically, the minimum allocation of optical fibers is as follows: 4 optical fibers for LANs, 4 optical fibers for redundancy and 4 spare optical fibers for growth.
- h. Backbone systems must comply with building, electrical, fire rating, and all other applicable standards. All pathways should be fire stopped according to this document and applicable standards.
- i. The maximum backbone distances for each media from various points should adhere to the applicable standards.

4.2.7. Telecommunications Room

- a. The telecommunications room normally houses floor distribution system (cross-connect and interconnect) hardware to provide circuit connection and administration between backbone cabling and horizontal cabling.
- b. Electronic equipment such as LAN hubs can be also placed in the telecommunications room, but should serve only the area covered by the telecommunications room.
- c. It is recommended that a telecommunications room provides all the facilities (space, power, environmental control etc.) for passive components, active devices, and external network interfaces housed within it. Each telecommunications room should have direct access to the backbone cabling subsystem.
- d. Each floor should have a minimum of one telecommunications room. Additional rooms should be provided when the total floor area to be served exceeds 1000 m² or if the maximum horizontal cable run exceeds 90m.
- e. Recommended telecommunications room sizes for various serving areas are shown in the following table.

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Serving Area (m ²)	Room Size (m)
1000	3 x 3.4
800	3 x 2.8
500	3 x 2.2

- f. It is recommended that rooms have sufficient space to accommodate two 475 mm (19 in.) relay racks for mounting electronic equipment, fiber patch panel, and other components. The equipment can be wall-mounted or rack-mounted. Electronic telecommunications equipment should be rack-mounted.
- g. A minimum of two walls shall be covered with 20 mm plywood, 2.44 m high, rigidly fixed and capable of supporting attached equipment.
- h. False ceilings shall not be used.
- i. A minimum of 2 duplex 110 volts AC power outlets with U-grounded receptacles and separately fused at 15 amperes (2 duplex 220 volts AC 13 amperes for European applications) shall be provided.
- j. For telecommunications grounding, the recommendations set out in this Paper and ANSI/TIA/EIA-607 (CSA T527) should be followed.
- k. The design and construction requirements for equipment rooms as outlined in other parts of this Paper should also be noted.

4.2.8. Floor Distributor

- a. It is recommended that floor distributor should be used to connect the horizontal cable with the building backbone cable. It provides the cross-connections between backbone and horizontal cabling.
- b. The design of the floor distributor should ensure that the lengths of patch cords/jumpers and equipment cords are minimised and administration should ensure that the design lengths are maintained during operation.
- c. A minimum of one floor distributor should be provided for every floor. For floor spaces exceeding 1000 m², a minimum of one floor distributor should be provided for every 1000 m² of floor space

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reserved for offices. If a floor space is sparsely populated (for example a lobby), it is permissible to serve this floor from the floor distributor located on an adjacent floor.

- d. The functions of multiple distributors may be combined.

4.2.9. Patch Cords and Jumpers

- a. It is recommended that patch cords and jumpers should be used within cross-connect implementations at floor distributors.
- b. The performance contribution of these cords should be taken into account in the design of generic cabling.
- c. The total length of equipment cords, patch cords and cross-connect wire should not exceed 10 meters.
- d. Cross-connect wires, patch cords and horizontal cables must be routed and dressed in a loose manner. Tightly wrapping or lacing the wires or cables may degrade performance.
- e. Fiber patch cord assembly consists of a length of breakout or zip cord cable equipped with a factory installed connector on each end. It is recommended to use factory made optical fiber patch cords which will provide a low insertion loss and high repeatability values since the assemblies are tested as per industry standards requirements, which is not always the case with field made optical fiber patch cords.

4.2.10. Horizontal Cable (HC)

- a. Horizontal cables link the distribution field in the telecommunications rooms to the outlets in the work area.
- b. It is recommended that the maximum horizontal distribution length should not exceed 90 meter limit. If there is a need to go beyond the 90 meter limit, there should be a provision for additional telecommunications rooms on the floor.
- c. It is recommended to provide horizontal cables to accommodate the maximum capacity of the floor size. This approach will facilitate easy moves, additions and changes (without additional costs for re-cabling).

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- d. It is recommended to provide the same number of horizontal cables to each work area.
- e. The selection of cable type will be determined by the class of applications to be supported. It is recommended to provide a minimum of two horizontal cables per work area to meet current and future service needs.
- f. One telecommunications outlet/connector should be a 4-pair, 100 Ω UTP cable, of suitable Category.
- g. The other/second telecommunications outlet/connector should be one of these 2 proposed horizontal media:
 - i. 4-pair, 100 Ω UTP cable, of suitable Category 5e or
 - ii. 2 multimode optical fibers either 62.5/125 μm , 50/125 μm or 850 nm Laser-Optimized 50/125 μm .
- h. A unique identifier should be assigned to each horizontal cable and should be marked on each end.

4.2.11. Consolidation Point (CP) (optional)

- a. The consolidation point is an interconnection point within the horizontal cabling. It performs a 'straight-through' intermediate interconnection between the horizontal cabling coming from the floor distributor and the horizontal cabling going to the telecommunications outlet TO.
- b. The consolidation point may be useful in the open office environment where the flexibility of relocation TOs in the work area is required.
- c. Only one CP is permitted between a floor distribution and TOs in the same floor.
- d. The consolidation point shall only contain passive connecting hardware and shall not be used for cross-connections.
- e. Where consolidation point is used, the following should be observed:
 - i. the consolidation point should be located so that each work area group is served by at least one consolidation point;
 - ii. the consolidation point should be limited to serving a maximum of twelve work areas;

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- iii. a consolidation point should be located in accessible locations;
- iv. for balanced cabling, the consolidation point shall be located so that there is at least 15 m from it to the floor distributor;
- v. a consolidation point shall be part of the administration system.

4.2.12. Telecommunications Outlet (TO)

- a. The telecommunications outlet is the interface between the horizontal cabling and the work area cables (modular cords) which are used to connect an end-user telephone, terminal, PC or workstation to the system.
- b. There are normally two types of TOs:
 - i. a single user TO assembly used to serves a single work area; and
 - ii. multi-user telecommunications outlet assembly (MUTOA) serves several work areas in an open space environment.
- c. The following recommendations should be observed when designing the number and location of TO:
 - i. TO assembly should be located in user-accessible locations;
 - ii. the performance contribution of work area cords, patch cords and equipment cords shall be taken into account when selecting the TO locations;
 - iii. a multi-user TO assembly should be limited to serving a maximum of twelve work areas;
 - iv. TO assembly shall not be installed in obstructed areas;
 - v. the length of the work area cord should be limited to ensure cable management in the work area.

Q3. Do you have any comments on or objections to the guidelines presented in this document