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**व्यापक परिचालन मसौदा**

**हमारा संदर्भ :सीईडी 46/टी-26** **27 अक्टूबर 2015**

**तकनीकी समिति :राष्ट्रीय भवन निर्माण संहिता विषय समिति, सीईडी 46**

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**प्राप्तकर्ता :**

**1 सिविल इंजीनियरी विभाग परिषद् के सभी सदस्य**

**2 राष्ट्रीय भवन निर्माण संहिता विषय समिति, सीईडी 46 व**
**सूचना और संचार सक्रिय संस्थापन के लिए पैनल, सीईडी 46:P21 के सभी सदस्य**

**3 रूचि रखने वाले अन्य निकाय ।**

**महोदय/महोदया,**

निम्नलिखित मसौदा संलग्न है:

| प्रलेख संख्या | शीर्षक |
|---|---|
| **सीईडी 46(8055)WC** | **भारत की राष्ट्रीय भवन निर्माण संहिता का मसौदा: भाग 8 भवन सेवाएं, अनुभाग 6 सूचना और संचार सक्रिय संस्थापन [SP7 (भाग 8/अनुभाग 6)]** |

कृपया इस मसौदे का अवलोकन करें और अपनी सम्मतियाँ यह बताते हुए भेजें कि यदि यह मसौदा भारत की राष्ट्रीय भवन निर्माण संहिता के भाग के रूप में प्रकाशित हो तो इस पर अमल करने में आपके व्यवसाय अथवा कारोबार में क्या कठिनाइयाँ आ सकती हैं ।

सम्मतियाँ भेजने की अंतिम तिथि :**27 नवंबर 2015।**

यदि कोई सम्मति हो तो कृपया अधोहस्ताक्षरी को उपरिलिखित पते पर संलग्न फोर्मेट में भेजें । हो सके तो कृपया अपनी सम्मतियाँ ई-मेल द्वारा **sanjaypant@bis.org.in** पर भेजें ।

यदि कोई सम्मति प्राप्त नहीं होती है अथवा सम्मति में केवल भाषा सम्बन्धी त्रुटि हुई तो उपरोक्त प्रलेखों को यथावत अंतिम रूप दे दिया जाएगा । यदि सम्मति तकनीकी प्रकृति की हुई तो विषय समिति के अध्यक्ष के परामर्श से अथवा उनकी इच्छा पर आगे की कार्यवाही के लिए विषय समिति को भेजे जाने के बाद प्रलेख को अंतिम रूप दे दिया जाएगा ।

यह प्रलेख भारतीय मानक ब्यूरो की वैबसाइट **www.bis.org.in** पर भी उपलब्ध है ।

धन्यवाद ।

भवदीय,
ह0

**(बी.के. सिन्हा)**
**प्रमुख (सिविल इंजीनियरी)**

**संलग्न: उपरिलिखित**

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**DOCUMENT DESPATCH ADVICE**

| Reference | Date |
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| **CED 46/T-26** | **27 October 2015** |

**TECHNICAL COMMITTEE:**
**NATIONAL BUILDING CODE SECTIONAL COMMITTEE, CED 46**

**ADDRESSED TO:**

1. All Members of Civil Engineering Division Council, CEDC
2. All Members of National Building Code Sectional Committee, CED 46 and Panel for Information and Communication Enabled Installations, CED 46:P21
3. All other interests.

**Dear Sir/Madam,**

Please find enclosed the following draft:

| Doc. No. | Title |
|---|---|
| **CED 46 (8055)WC** | **Draft National Building Code of India: Part 8 Building Services, Section 6 Information and Communication Enabled Installations [SP 7(Part 8/Section 6)]** |

Kindly examine the draft and forward your views stating any difficulties which you are likely to experience in your business or profession if this is finally adopted as part of the National Building Code of India.

Last Date for comments: **27 November 2015**.

Comments if any, may please be made in the format as attached, and mailed to the undersigned at the above address. You are requested to send your comments preferably through e-mail to **sanjaypant@bis.org.in**.

In case no comments are received or comments received are of editorial nature, you may kindly permit us to presume your approval for the above document as finalized. However, in case of comments of technical nature are received then it may be finalized either in consultation with the Chairman, Sectional Committee or referred to the Sectional Committee for further necessary action if so desired by the Chairman, Sectional Committee.

This document is also hosted on BIS website **www.bis.org.in**.

Thanking you,

Yours faithfully,

Sd/-

**(B. K. Sinha)**
**Head (Civil Engg)**

Encl: as above

**FORMAT FOR SENDING COMMENTS ON THE DOCUMENT**

[Please use A4 size sheet of paper only and type within fields indicated. Comments on each clause/sub-clause/ table/figure, etc, be stated on a fresh row. Information/comments should include reasons for comments, technical references and suggestions for modified wordings of the clause. **Comments through e-mail in MS WORD format to sanjaypant@bis.org.in shall be appreciated**.]

**Doc. No.**: CED 46(8055)WC **BIS Letter Ref**: CED 46/T-26 **Dated**: 27 October 2015

**Title:** Draft National Building Code of India: **Part 8 Building Services, Section 6 Information and Communication Enabled Installations [SP 7(Part 8/Section 6)]**

**Name of the Commentator/ Organization**: ________________________________________

| **Clause No. with Para No. or Table No. or Figure No. commented** *(as applicable)* | **Comments / Modified Wordings** | **Justification of Proposed Change** |
|---|---|---|
| | | |

# *Draft* NATIONAL BUILDING CODE OF INDIA

## PART 8 BUILDING SERVICES

## Section 6 Information and Communication Enabled Installations

[SP 7(Part 8/ Section 6)]

**BUREAU OF INDIAN STANDARDS**

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Draft for comments only

Doc: CED 46(8055)WC
October 2015

**BUREAU OF INDIAN STANDARDS**

**DRAFT FOR COMMENTS ONLY**


# *Draft* NATIONAL BUILDING CODE OF INDIA

## PART 8 BUILDING SERVICES :

## SECTION 6 INFORMATION AND COMMUNICATION ENABLED INSTALLATIONS

[SP 7 (Part 8/Section 6)]

ICS: 01.120; 91.040.01

| **National Building Code Sectional Committee, CED 46** | Last Date for Comments: **27 November 2015** |
|---|---|

National Building Code Sectional Committee, CED 46

This Section describes the essential requirements for information and communication enabled installations, technology systems and cabling installations in a building. Telecommunication plays a vital role in modern society similar to electricity, water and transport systems. It would be difficult to imagine a life without telecommunication technologies. In a building, a broad variety of telecommunication systems are expected to be installed. Unlike traditional utilities, communication systems are constantly evolving.

This connectivity can be delivered through cable wire, optical fibre, fixed wireless and mobile wireless technologies. Each of these technologies when considered for use inside buildings, especially which are either commercial or multi-dwelling units or complexes, has its own requirement in terms of building space, power supply, internal extensions to various work areas/dwelling units. For example, for wire line services, broadband cable television, etc, the entry to the buildings/complexes will be through underground cables and the distribution of services further into the complexes will be from the bottom of the building to the upper stories. On the contrary, any wireless technologies, where antennas are to be installed at terrace along with a system which can distribute the signals flow through cables, the flow of cables will be from top storeys of the building to the bottom. It is also to be kept in view that there are multiple service providers for each type of service with similar or different technologies.

The requirements of telecom and its enabling infrastructure can be chosen by the user from the gamut of technologies and associated features options available based on the requirement, cost, service and maintenance convenience, future up-gradation etc. While providing telecom enabling infrastructure in the building, the provisions are to be made for making the infrastructure supportive for multiple technologies/ products and requirements of telecom service providers.

In order to facilitate installation/up-gradation of telecom systems, proper planning and understanding of enabling provisions of telecom technologies and physical infrastructure are necessary. Modern telecom technologies such as Distributed Antenna System, Wi-Fi and other in-buildings solutions are also to be considered during the building planning stage itself. The enabling infrastructure will include cable riser systems, conduits, cable trays etc. Appropriate space need to be earmarked for installation of equipment at the entry point of service and running the cables etc, through shafts and horizontal conduits inside the walls, centre of the corridors and centre of the work space etc. Thus cabling pathways infrastructure should be designed to be of general nature but flexible enough to accommodate a variety of telecom systems and emerging technologies.

Choice of service to be provided inside the complexes/ buildings will depend on the users. As already mentioned above, the service can be spread across technologies and across various service providers. Therefore, the arrangement for telecommunication infrastructure needs to be made in such a manner that the requirement brought out above and the challenges of at least near future can be met without disturbing the building infrastructure. This Section has been therefore formulated to cover these aspects.

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS 2:1960 `Rules for rounding off numerical values (*revised*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this Section.

**BUREAU OF INDIAN STANDARDS**

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# *Draft* NATIONAL BUILDING CODE OF INDIA

## PART 8 BUILDING SERVICES:

## SECTION 6 INFORMATION AND COMMUNICATION ENABLED INSTALLATIONS

[SP 7 (Part 8/Section 6)]

ICS: 01.120; 91.040.01

| | |
|---|---|
| **National Building Code Sectional Committee, CED 46** | Last Date for Comments: **27 November 2015** |

## 1 SCOPE

This Section covers the essential requirements for information and communication enabled installations, technology systems and cabling installations in a building. This Section covers the basic design and integration requirements for telecommunication spaces within building/buildings along with their cabling infrastructure, their pathway components and passive connectivity hardware.

This Section also includes general requirements relating to installation of different communication equipment, cable terminations, power connections and general guidelines required for planning and providing information and communication technology (ICT) services in the building at the planning and execution stages. The provisions given herein are basic requirements applicable to all residential and other buildings.

NOTE - In this Section, ‘Telecom’ has been used interchangeably with ‘ICT’, as most of the time there may be telecommunication hardware present only. Apart from the provision of telecommunication system, Information Technology (IT) system may be provided either common for the building or for the individual users. In case of common IT systems, the entire building is used by the same user and thus IT space for automation, CCTV etc, can be shared with telecom facilities. In case where individual IT systems owned by several users are provided, separate spaces may be earmarked inside telecom spaces for individual IT infrastructure. Sometimes, individual users may also use the common IT facilities. However, the cabling, wiring, etc, for IT systems shall use the same pathways, which are used for telecommunication hardware.

## 2 TERMINOLOGY

**2.0** For the purpose of this section, the following definitions shall apply:

**2.1 Access Point** – A hardware device or a computer's software that acts as a communication hub or as an interconnection port for users of wireless devices to connect them to a wired or wireless local area network (LAN).

**2.2 Antenna** – An electrical device designed to transmit or receive radio waves or more generally, electromagnetic waves for the purpose of radio frequency communication such as radio/television/satellite communication/radar communication/ mobile communication, etc. This is also called an aerial.

**2.3 Attenuation** – A general term that refers to any reduction in the strength of an electrical/electronic signal.

**2.4 Backbone** – A high-capacity facility (for example, pathway, cable or conductors) a major pathway within a network

**2.5 Backbone Cabling Media Distribution and Building Pathway** – A part of a building premises telecom cable distribution system that provides connection between telecommunications spaces. It typically provides building connections between floors in multi-story buildings as well as campus connections in multi-building environments.

**2.6 Bus Bar** – It refers to thick strips of copper or aluminium, in electrical power distribution, that conduct electricity within a switchboard, distribution board, substation, or other electrical apparatus.

**2.7 Cable Tray** – Raceways generally made of metal or hard plastic upon which cables are placed to facilitate their run from one point to another point in a building in an organized and properly supported manner.

**2.8 Co-axial Cable** – A type of wire that consists of a centre wire surrounded by insulation and then a grounded shield of braided wire. The shield minimizes electrical and radio frequency interference.

**2.9 Consolidation Point (CP)** – A location for interconnection between horizontal cables extending from building pathways and horizontal cables extending into furniture pathways.

**2.10 Cross-connect** – A facility enabling the termination of cable elements and their interconnection or cross-connection.

**2.11 Direct to Home (DTH)** – The direct reception of satellite programs using small dish (personal dish) placed on a roof or window of a house.

**2.12 Frequency** – The measurement of the number of times that a repeated event occurs per unit of time.

**2.13 Global System for Mobile Communication (GSM)** – A widely used digital mobile phone standard.

**2.14 Horizontal Cabling** – It includes (a) the cabling between and including the telecommunications outlet/connector and the horizontal cross-connect, and (b) the cabling between and including the building automation system outlet or the first mechanical termination of the horizontal connection point and the horizontal cross-connect.

**2.15 Horizontal Cabling Media Distribution and Building Pathway** – It consists of the horizontal cabling in the building, the horizontal pathways supporting the horizontal cabling, and the telecommunications spaces that support the horizontal pathways. The use of the term horizontal in the name of the element does not require that the elements be placed or installed parallel to the ground or floor.

**2.16 Horizontal Cross-connect (HC)** – A cross-connect of horizontal cabling to other cabling, for example, horizontal, backbone, and equipment.

**2.17 Inside Plant (ISP)** – Telecommunications infrastructure designed for installation interior to buildings.

**2.18 Intermediate Cross-connect (IC)** – A cross-connect between first level and second level backbone cabling.

**2.19 Local Multipoint Distribution System (LMDS)** – A broadband radio service designed to provide two-way transmission of voice, high-speed data and video (wireless cable TV).

**2.20 Local Area Network (LAN)** – A computer network covering a local area, like a home, office or small group of buildings.

**2.21 Main Cross-connect (MC)** – A cross-connect for first level backbone cables, entrance cables, and equipment cables.

**2.22 Main Distribution Frame (MDF)** – An interconnecting frame/structure where all the wires, fibre, copper wires, optic, or coaxial cables for a network terminates.

**2.23 Metropolitan Area Network (MAN)** – A network designed to carry data over an area larger than a campus, such as an entire city and its outlying area.

**2.24 Multichannel Multipoint Distribution System (MMDS)** – A method of delivering multiple data/television signals digitally by microwave transmission to subscriber households.

**2.25 Multi-user Telecommunications Outlet Assembly (MUTOA)** – A grouping in one location of several telecommunications outlet/connectors.

**2.26 Optical Fibre** – It refers to the medium and the technology associated with the transmission of signals/information as light pulses along a glass or plastic wire or fibre.

**2.27 Outside Plant (OSP)** – Telecommunications infrastructure designed for installation exterior to buildings.

**2.28 Propagation Delay** – In a communications system, it refers to the time lag between the departure of a signal from the source and the arrival of the signal at the destination.

**2.29 Radio Frequency** – A frequency range from 20 kHz and above, used for transmitting/receiving text, data, audio, or video signals.

**2.30 Server** – Any computer on a network that contains data or applications shared by users of the network on their client PES.

**2.31 Splicing** – The permanent joining of bare fibre end to another fibre by means of splicing tools.

**2.32 Telecommunication Spaces** – Telecommunication spaces are the rooms and areas where telecommunications cabling systems are terminated, cross connected, and interconnected to installed telecommunications equipment. Various examples of these based on the function and areas are, equipment room (ER), telecommunications room (TR), entrance facilities (EF) and telecommunication enclosures (TE).

NOTE – The definition of telecommunication spaces and workspace (*see* **2.39**) are for calculation of infrastructure requirements, facilities etc. This does not inhibit the utilization of space for any other purpose. Depending upon the requirements, number of telecom spaces in a given building may vary for the same area.

**2.33 Telecom Service Provider (TSP)** – A service provider who is authorized to operate telecom services by Government of India.

**2.34 Telecom Tower** – A vertical structure for installation of antenna(e) aerial that provide radio frequency air interface for telecommunications services. It can also be in the form of mast or multiple poles of varying height.

**2.35 Telecommunication Media and Connecting Hardware** – It consists of cables, equipment cords, patch cords, and connecting hardware components. All balanced twisted-pair, optical fibre, coaxial cabling and wireless systems are made up of such components. These cabling components and resulting cabling systems are used in outside plant (OSP) and premises cabling [also known as inside plant (ISP)] environments of the building telecommunication infrastructure.

**2.36 Very Small Aperture Terminal (VSAT)** – It usually refers to satellite terminal used to transmit and receive signal from satellites with an antenna installed in user premises.

**2.37 Wide Area Network (WAN)** – It is a network that is capable of spanning a geographical area larger than a city.

**2.38 Workstation** – An electronic device that performs some information processing or display function and connects to the communications network. Typically, this will be a desktop computer with keyboard and display but might also be a telephone, a printer, an access control terminal, or some data-gathering device.

**2.39 Workspace** – Any location and the space around where a workstation may be located. Typically there can be several workspaces in a room.

## 3 GENERAL REQUIREMENTS FOR TELECOMMUICATION SPACES AND CONNECTING HARDWARE

### 3.1 Telecommunication Spaces

**3.1.1** *General Considerations*

The following shall be the considerations for telecommunication spaces:

a) *Accessibility* – Telecom spaces that are intended to serve multiple users should be located in common spaces that should be accessible through a common corridor or outside door. The space for each telecom service providers may be separated to the extent feasible by partitions for security reason and controlled access to their equipment.

b) *Acoustic Noise Levels* – Acoustic noise levels in telecom spaces should be kept to a minimum by not collocating noise-generating equipment (for example, photocopy equipment, high-speed printers, and mechanical equipment).

c) *Administration* – All pertinent documentation of deployment of telecom equipment and cables should be maintained by owner or agent when the installation is completed. All telecom spaces shall have appropriate signs to identify the space and are included within the security plan of the building.

d) *Cable Separation* – Telecom cables should be separated from possible sources of electromagnetic interference (EMI) and from possible radio frequency interference (RFI). For safety purposes, power cables should be separated from telecom cables.

e) *Ceilings* – The general requirements for ceilings in telecom spaces should include the following:

   1) Generally, the minimum ceiling height shall be 2.4 m above finished floor (AFF). However, the consideration shall be given for having a 3 m ceiling height.
   2) If suspended ceilings are provided, necessary rodent protection may be provided.
   3) The ceiling finish should minimize dust and be light coloured to enhance the room lighting.

f) *Conduits, Trays, Slots, Sleeves and Ducts* – Slot/sleeve systems should be located in places where pulling and termination will be easy to achieve. Bend radius requirements and service loop guidelines shall be considered. Sleeves and slots shall not be left open after cable installation. All sleeves and slots should be fire-stopped in accordance with Part 4 ‘Fire and Life Safety’.

The size and number of conduits or sleeves used for backbone pathways depends on the usable floor space served by the backbone distribution system. However, sleeves in multiple of 100 mm are recommended to serve a TR, ER or EF. Multiple telecom spaces on the same floor shall be interconnected with a minimum of one 75 mm conduit or a pathway that provides equivalent capacity.

g) *Dust and Static Electricity* – Dust and static electricity should be avoided by:

1) Placing active printers outside of telecom spaces, and
2) Treating floors, walls, and ceiling to minimize dust.

h) *Electrical Power* – When active equipment of TSPs or the building equipment (for example, PABX) are installed in TR/ER etc, the telecom spaces shall be equipped to provide adequate electrical power. The recommendations are as under:

1) The telecom services are required on 24x7 basis. Therefore, uninterrupted electrical power for telecom services shall be provided from local or central uninterrupted power supply (UPS) with adequate battery backup. A diesel generator (DG) set may be considered if the building is not supported by DG or longer power interruption are expected for which the battery backup is not adequate.
2) Separate socket outlets for equipment, tools, test instruments etc.
3) Separate electrical distribution panels that serve telecom equipment/spaces from those that serve other purposes. These should be clearly identified with proper sign writing.

j) *Prevention from Flooding* – Telecom spaces should be located above any threat of flooding. When locating telecom spaces where a threat of flooding is unavoidable, rack elevations may be designed so that active equipment and telecom components are placed above the threat level. The locations that are below or adjacent to areas of potential water hazard (for example, restrooms, kitchens) should be avoided. Liquid carrying pipes (for example, water, waste, steam) should not be routed through, above, or in the walls encompassing the ICTs space.

k) *Lighting* –The recommendations for lighting in telecom spaces should include the following:

1) Locating light switches near the entrance(s) to the telecom space.
2) Dimmers and vacancy sensors are not recommended.
3) Coordinating the lighting layout with the equipment layout (especially overhead cable trays) to ensure that lighting is not obstructed.
4) Providing electrical power for the lighting which should not come from the same circuits as for the ICTs equipment.
5) Placing at least one light or set of lights on normal power and one light or set of lights on emergency/UPS power.
6) Using a light-coloured finish on walls, floors, and cabinets to

enhance room lighting.

7) Adequate task lighting illumination shall be provided at the point of cable termination.

m) *Location* – All telecom spaces shall be located in areas that are best suited to serve the occupants of a floor or building. The following shall be observed when locating the spaces:

1) Telecom spaces in multi-floor buildings should be aligned vertically.
2) Telecom spaces should be located in areas that are dedicated to telecom use. Equipment that is not related to the support of telecom spaces (for example, piping, duct work, distribution of building power) shall not be located in or pass through a telecom space.

n) *Environmental Control* – When active devices (for example, heat-producing equipment) are present, original equipment manufacturer (OEM) recommended temperature and humidity range should be maintained by adequate arrangement for heat dissipation. If environmental parameters are exceeded, an alarm should be activated.

p) *Fire Protection* – The telecom spaces shall be equipped with adequate fire detection, alarm and suppression systems as per Part 4 'Fire and Life Safety'.

q) *Bonding and Grounding* – All equipment and cable shields shall be properly bonded to the space's telecom bonding and grounding infrastructure. The grounding arrangement for telecom equipment should be separate from electrical power grounding.

**3.1.2** *Equipment Room (ER)*

**3.1.2.1** An equipment room is an environmentally controlled centralized space for telecom equipment that usually houses a main or intermediate cross-connect. Equipment rooms usually house equipment of higher complexity than telecommunication rooms. Any or all of the functions of a telecommunications room may be provided in an equipment room. ERs differ from TRs in the way, that, ERs are generally considered to serve a building, campus, tenant, or SP, whereas TRs serve a floor area of a building. In some cases, an ER may also contain the EF (for campus backbone, APs, or both) or it may serve as TR. ERs may be connected to backbone pathways that run both within and between buildings. Although an ER usually serves an entire building, many building designs may use more than one ER in order to provide separate facilities for different types of equipment and services or redundant facilities and disaster recovery strategies.

The initial assessment for design and specifications for an ER shall be based on detailed information about the site, including:

a) User requirements,
b) Telecom pathway locations,
c) Service provider's requirements,
d) Environment/facility conditions, and

e) Building requirements.

**3.1.2.2** *Space allocation and layout*

The space allocation and layout may be determined by following methods:

a) *Determining Size Based on Area Served* - When the telecom designer does not know what specific equipment will be used in an ER, the designer can use the amount of floor space that the room will serve, to determine the minimum size of the ER. If the usable floor space is also unknown, the usable floor space may be estimated by deducting 20 percent from the total floor area.
Generally, an area of 9.3 $m^2$ may be considered for calculating the work areas. If work areas are smaller, the size of the ER shall be increased accordingly. If there are fewer than 200 work areas, the ER shall not be less than 15 $m^2$. For special-use buildings, such as, hospitals and hotels, ER size requirements may vary.

b) *Telecom Service Provider Space Requirements* - If equipment or cable terminations that are owned or maintained by a TSP are to be located in the ER, then location and amount of space required shall be determined as per the space requirement of TSP.

c) *Telecom Equipment Locations* – As equipment and hardware for communication systems will be located in the various equipment rooms throughout the building, these rooms shall be physically secure, aesthetically provisioned and conveniently located. The communication equipment may be located with due consideration of the modular provision of building design and criteria for expansion joints matching to electrical distribution and maximum fire safety distance requirements. The other considerations for telecom equipment location include the following aspects:

1) Types of cables their uses, bending radius, turning radius, conduit radius etc.
2) *Provision for future expansion* - In view of the evolving nature of the communication technologies, provision for future expansion should be ensured by way of stand-by arrangements. The distribution infrastructure also should be as flexible as possible. Small conduits will quickly fill up and may not accommodate some technologies, for example, low loss broadband or high capacity fibre optic cables. The most flexible distribution design involves cable trays for horizontal (floor level) distribution with large conduit sleeves for wall penetration, where necessary. Vertical trunk distribution should also be achieved with conduit sleeves.
3) *Maintainability* - As it is difficult to remove or shift just a few cables from a crowded or convoluted conduit system for operational or maintenance requirements, steps should be taken to ensure easy access and maintainability of cable system right in the initial architectural design stage.

**3.1.3** *Telecommunications Room (TR)*

**3.1.3.1** A telecommunications room is the area within a building that houses the telecommunications cabling system equipment. This includes the mechanical terminators and/or cross-connects for floor-serving distribution facility for horizontal cabling and backbone cabling system. There shall be at least one TR or TE per floor. TR or TE can also house active equipment, like LAN switches, routers or passive equipment, like optical splitters. Most of these equipment are available in wall mount units. This reduces the demand on floor space requirements for TR/TE. Sometimes, a TSP with the consent of the building owner may require later on, to provide additional equipment for mobile signal booster etc, in TR/TE. Therefore, it is advisable to have additional space in advance specifically in tall buildings of five storeys or higher.

**3.1.3.2** Multiple rooms are required if the cable length between the HC (FD) and the ICTs outlet location, including slack, exceeds 90 m. If the usable floor space to be served exceeds 930 $m^2$ (10,000 $ft^2$), additional TRs will need to be considered. Following are the guidelines for TR size:

| *Area Served* | *Dimension of TR* |
|---|---|
| 465 $m^2$ or less | 3 m x 2.4 m |
| More than 465 $m^2$ and less than equal to 930 $m^2$ | 3 m x 3.4 m |

NOTE - The size of 3 m x 2.4 m has been specified to allow a centre rack, cabinet, or enclosure configuration.

In smaller buildings, less space is required to serve the telecom distribution needs of the occupants. The size guidelines for smaller buildings should be as below:

| *Building Smaller Than* | *Served as* |
|---|---|
| 465 $m^2$ | Shallow/Walk-in rooms (Walk-in rooms shall be at least 1.3 m x 1.3 m. Shallow rooms shall be at least 0.6 m deep by 2.6 m wide.) |
| 93 $m^2$ (1000 $ft^2$) | Wall cabinets, self-contained cabinets, enclosed cabinets |

NOTES - Installation of active equipment in shallow or walk-in rooms is not recommended because many types of equipment require environmental controls and a depth of at least 1 m.

**3.1.4** *Entrance Facilities (EF)*

Building entrance facilities (EF) provide the point at which outdoor cabling interfaces with the intra building backbone cabling. In cases, where the functions of the EF are combined with the functions of the ER in the same space, the room may house equipment that is owned and maintained by service providers. In these cases, requirements specified by the service providers shall be considered when designing the ER. If EF and ER are combined, the recommended dimensions of the room are specified in Table 1.

**Table 1 Recommended Dimensions of the Room When EF and ER are Combined**
(*Clause* 3.1.4)

| **Sl No.** | **Building Size** $m^2$ | **EF size** (m x m) |
|---|---|---|
| **(1)** | **(2)** | **(3)** |
| i) | 500 | 3.05 x 3.05 |
| ii) | 501 - 10 000 | 3.65 x 3.05 |
| iii) | 10 001 - 20 000 | 3.65 x 3.65 |
| iv) | 20 001- 40 000 | 3.65 x 4.0 |
| v) | 40 001 – 70 000 | 3.65 x 5.5 |
| vi) | > 70 000 | 3.65 x 7.3 |

If a separate space is required for service providers, it should be in or adjacent to the EF and may require a mesh partition or locked cabinet. A space of at least 1.2 m x 1.83 m shall be considered for each service provider. An entrance facility need not be an enclosed space if the building size is less than 9 300 $m^2$ and has no active equipment, however, having an enclosed area is suggested at all occasions, considering safety requirements.

The duct from the nearest communications vault (CV) will consist of four to twelve 100 mm conduits encased in reinforced concrete. The exact number will depend upon the size and use of the building. These conduits may be used for all communication systems serving the building including additional capacity and access cables and pathways capacity. To maintain the safety of the utility cable, it may preferably enter the building above the ground and then feed the equipment room. It is not recommended to feed service to any building via another building.

A separate 230 V, 16/6 A circuits with double outlets shall be provided (for plugging in temporary test equipment or power tools) every 2.4 m along the EF and ER combined wall. All wall outlets are to be located approximately 300 mm above the finished floor levels and clearly labeled with the breaker. In addition, two dedicated 230 V, 16/6 A sockets shall be provided for each (permanently installed) communication service rack.

**3.1.5** *Telecommunication Enclosures (TE)*

A TE is simply a case or housing for telecom equipment, cable terminations, and cross-connect cabling for distribution of telecom services on the floor. The TE is dedicated to the telecom function and related support facilities. The TE may contain access points for wireless services. Although, TEs serve much in the same capacity as that of a TR, a minimum of one TE must be located on each floor, if no TR is considered on the floor. The TEs shall be accessible, but the access to TEs should be controlled against unauthorized access (for example, with a lock and key held by the facility or property manager). The TE door(s) may be hinged or removable. If the enclosure consists of metallic components, it shall be earthed.

## 3.2 Telecom Communication Media and Connecting Hardware

**3.2.1** A cabling system consists of cables, equipment cords, patch cords, and connecting hardware components. All balanced twisted-pair, optical fibre, and coaxial cabling systems are made up of such components. There can be different topologies used in a building like star, tree, bus bar, ring etc, or a combination of these to suit different technological requirements. Within a building, the maximum amount of wiring will be between the work spaces and the equipment room connected through horizontal and vertical stacks of fibre optic cables etc.

The selection of appropriate style of cabling is important and accordingly, some of the user requirements to be considered before selecting the style of cabling for a telecom enabled building may include the following:

a) Number of user work areas and telecom spaces used to serve the building occupants;
b) Number of telecom outlets/connectors desired at each user work area;
c) Number and styles of user equipment (for example, telephony, LAN, building automation);
d) Cabling system transmission performance expectations;
e) Backbone distances involved in the building or campus design;
f) Future growth expectations (for example, 15 to 20 percent recommended minimum growth factor); and
g) Environmental conditions that may influence the selection of cabling components.

**3.2.2** Various cabling systems and connecting hardware components are described under **3.2.2.1** to **3.2.2.5**.

**3.2.2.1** ***Copper-twisted pair***

The transmission performance of balanced twisted-pair cabling and telecom associated components are based on a number of factors within the cabling or component design. These performance levels use the terms category and class. Standards developed internationally utilize both class and category, depending on the specific cabling element, as described in Table 2.

**Table 2 Balanced Twisted-Pair Cabling Channel Performance**

(*Clause* 3.2.1)

| Sl No. | ISO Category/Class | TIA Category | Frequency |
|---|---|---|---|
| (1) | (2) | (3) | (4) |
| i) | Category 3/class C | Category 3 | 16 MHz |
| ii) | Category 5/class D | Category 5e | 100 MHz |

| | | | |
|---|---|---|---|
| iii) | Category 6/class E | Category 6 | 250 MHz |
| iv) | Category 6A/class EA | Category 6A | 500 MHz |
| v) | Category 7/class F | * | 600 MHz |
| vi) | Category 7A/class FA | * | |

**3.2.2.2** *Optical fibre*

Optical fibre cables are used in backbone and horizontal cabling applications. When an all dielectric construction is desirable, optical fibre cable offers characteristics that can make them the media of choice. Transmission of information through optical fibre cables is not degraded by crosstalk, ambient noise, lightning, and most electromagnetic interference (EMI) problems. However, like balanced twisted-pair cables, attenuation (loss of signal) and environmental considerations are of concern for optical fibre cabling systems.

Optical fibres are classified as either single-mode or multi-mode. Single-mode optical fibres have a relatively small diameter featuring a core of 8 to 11 μm and a cladding diameter of approximately 125 μm. Multimode has a larger core diameter (for example, 50 μm or 62.5 μm) with the cladding of approximately 125 μm.

Fibre-to-the-home (FTTH) is a relatively new and fast growing method of providing higher bandwidth to consumers. It delivers communications signal over optical fibre from the operator's switching equipment to a home. It is an architecture in which the final connection to the subscriber's premises is on optical fibre. The fibre optic communications path is terminated in the customer's premises for the purpose of carrying communications (voice, video and data). In multi-dwelling units, commercial complexes and inside homes, further distribution of telecommunication signal can also be done using fibre connectivity. Connecting homes directly through fibre optic cable enables enormous improvements in the bandwidth that can be provided to consumers. Current fibre optic technology can provide two-way transmission speeds of up to 100 Gbit/s.

In FTTH, the optical fibre cable crosses the subscriber's premises boundary and terminates inside the premises or on an external wall of the subscriber's premises. Various types of cables may be required to be used in different segments in the building.

NOTE - The specifications of the optical fibre cables are available in Department of Telecommunications, Telecom Engineering Centre (TEC), Govt of India, the details of which can be seen from TEC website, www.tec.gov.in.

**3.2.2.3** *Coaxial*

The predominant coaxial cables are Series-6, Series-11, and radio grade (RG) 59. These coaxial cables have a characteristic impedance of 75 ohms. While the termination procedures may be similar, special attention shall be paid to the manufacturer's specific instructions for termination and connectors.

Coaxial cable is used for computer networks, CATV and video systems. Historically, coaxial cable was designated as RG cable. Coaxial cables used in broadband applications are now referred to as Series-X cables. The ‘X’ designates the construction of the cable with such factors as the:

a) Centre conductor diameter;
b) Centre conductor being solid or stranded;
c) Dielectric composition;
d) Outer braid’s percent of coverage; and
e) Impedance.

**3.2.2.4** *Wireless systems*

The wireless coverage area radius is impacted by a number of factors including the following and these factors are to be taken into account by using the site survey approach:

a) Building materials (concrete, sheetrock, wood, steel, etc)
b) Building configuration (closed, semi-closed, or open space)
c) Building furnishings (cabinets, partitions, furniture, etc)

Various wireless systems are described below:

a) *Wireless LAN (WLAN) Access Point (AP)* **-** A wireless LAN (WLAN) access point (AP) is a network device located in areas of a building or campus and placed in relatively close proximity to where users interact with their wireless enabled network devices. APs allow wireless enabled devices (for example, computer, printer) to connect to a wired network using Wi-Fi or related standards. AP network devices are typically mounted on walls or ceilings with structured cabling that provides a physical connection to a horizontal cabling (floor distribution).

b) *Wi-Fi Access Points with Centralized Controller* - Access point shall support 802.11 a/b/g/n. If there are large numbers of WAPs, user may prefer centralized controller. Centralized controller can be hardware or software based and may be provided at each site.

c) *WI-MAX/ Distributed Antenna Systems (DAS) -* IDS/IBS are signal distribution systems for strengthening the public mobile wireless signal inside the buildings or installations. They require cable and passive antenna to be installed in corridors/rooms, normally along the centre line. The active equipment, wherever required can be installed in ER/TR/TE.

**3.2.2.5** *Connecting Hardware*

Various connecting hardware are described below:

a) *Insulation Displacement Contact (IDC) Connectors* - The insulation displacement contact (IDC) is a gas-tight physical contact between two electrical conductors. The gas-tight contact is established by a cold weld with the elimination of the air gap between the conductor and the IDC and therefore the possibility of contact interface corrosion. Such contact creates a reliable, long-lasting connection with stable electrical properties. IDC connectors also eliminate conductor preparation (for example, insulation removal), reducing the termination time and the number of tools.

b) *Modular Plug* - Modular plugs have IDC contacts designed for either stranded or solid conductors as well as connectors having universal contacts that accept both stranded and solid conductors. Materials used to build modular plugs are typically flame retardant polycarbonate (body) and phosphor bronze with gold plating over nickel in contact area (contacts).

c) *Modular Jack* - Modular jacks are available in various sizes and shapes (keyed and unkeyed). The number of positions indicates the connector's width, while the number of contacts installed into the available positions indicates the maximum number of conductors the connector can terminate.

d) *Balanced Twisted-Pair Connecting Hardware* - Balanced twisted-pair connecting hardware represents assemblies of different styles of balanced twisted-pair connectors grouped in one unit to facilitate their installation, servicing, administration and maintenance. Basic connecting hardware styles are:

1) Telecom outlets/connectors, including multiuser outlets;
2) Patch panels;
3) Connecting (wiring) blocks;
4) Cable assemblies; and
5) Splices.

e) *Optical Fibre Connectors* - The most common optical fibre interfaces include:

1) *LC connector* — A simplex connector that can be converted to a duplex using a clip. It is keyed, low loss, pull proof and wiggle proof. It can be terminated many different ways, including anaerobic (quick cure) adhesive, cleave and crimp, and hot melt. This is often referred to as a small form factor (SFF) connector.
2) *Subscriber connector (SC)* — A simplex connector that can be converted to a duplex using a clip. It is keyed, low loss, pull proof, and wiggle proof. It can be terminated many different ways, including anaerobic (quick cure) adhesive, cleave and crimp, and hot melt.
3) *Straight tip (ST) compatible* — A simplex connector. It is a keyed, low loss connector. It can be terminated many different ways, including anaerobic (quick cure) adhesive, cleave and crimp and hot melt.

f) *Splices (Optical Fibre Connectors)* - There are two primary splicing methods for optical fibres, fusion and mechanical. Both methods are field proven and have excellent long-term reliability when completed according to the manufacturer's instructions. Splices and stripped optical fibre cables are protected and secured by a splice closure. When a splice enclosure is used for splicing inside a building, it is generally secured to a rack or wall. In both cases, the splice closure or enclosure contains the optical fibre splices in splice trays or organizers, typically in groups of 6, 12, 24, or more optical fibres per splice tray or organizer.

g) *Coaxial Connectors* - Connectors are installed on the end of a coaxial cable to provide electrical and mechanical connection to a system component. Either male or female connectors can be attached to coaxial cable, but most installations use male connectors on cable ends.

There are many styles of coaxial cable connectors available in the industry. Three popular styles are:

1) BNC-style connector,
2) F-style connector, and
3) N-style connector.

Coaxial connecting hardware represents assemblies of different styles of coaxial connectors grouped in a single unit to facilitate their installation, servicing, administration, and maintenance. The basic connecting hardware types are:

i) Telecom outlets/connectors,
ii) Patch panels, and
iii) Cable assemblies.

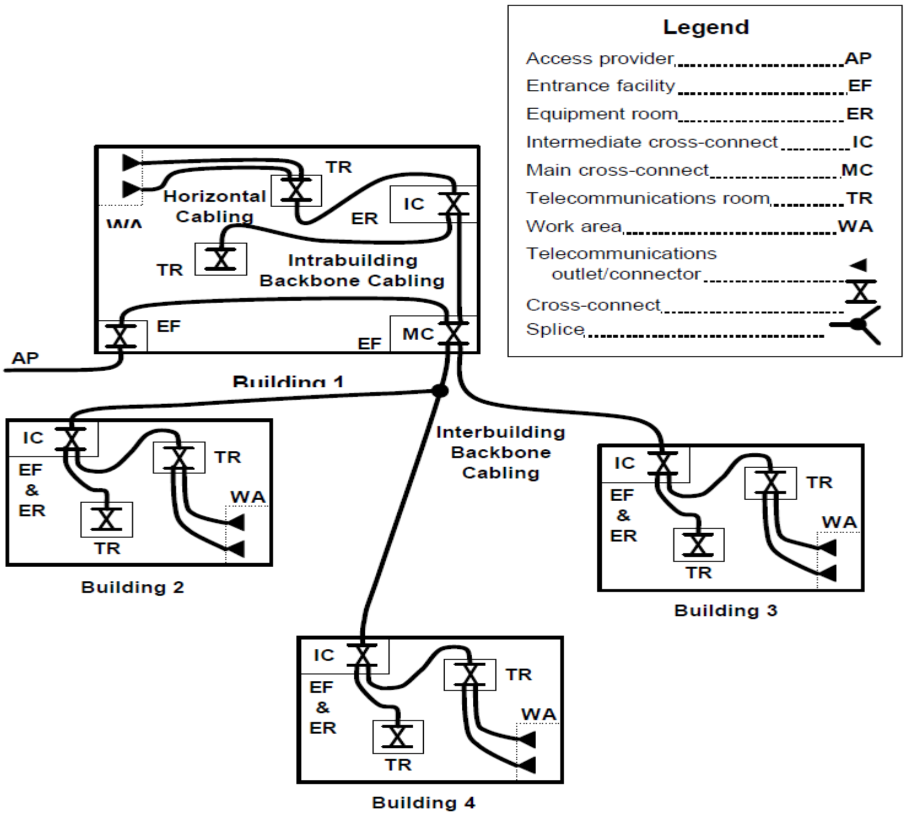
h) *Coaxial Outlets* - This type of connecting hardware serves as the end point of the horizontal cabling and is used to connect active ICTs equipment to the cabling at the work areas. Coaxial outlets usually are installed at the work area as a supplement to balanced twisted-pair and optical fibre connectors, but purely coaxial outlets can exist (for example, in video equipment rooms).

### 3.3 Backbone Cabling Media Distribution and Building Pathways

The backbone distribution system provides interconnection between telecom spaces, that is, telecommunication rooms, equipment rooms and entrance facilities. It consists of the backbone cables, intermediate and main cross connects, mechanical terminations and patch cords or jumpers used for backbone-to-backbone cross connection. This includes:

a) Vertical cable connections between floors (risers);
b) Cables between an equipment room and building cable entrance facilities; and
c) Cables between buildings (inter building).

A typical telecommunications cabling system is shown in Fig. 1.




NOTES
**1** This figure is not meant to be an all-inclusive representation of the telecommunications cabling system and is provided only as a typical example.
**2** All cross-connects located in the telecommunications rooms (TRs) in this figure are horizontal cross-connects (HCs).

**Fig. 1 Typical Telecommunications Cabling System**

### 3.3.1 *Backbone Topologies*

The design of a building backbone between the building cross-connect (main or intermediate) and the horizontal cabling (floor distribution) [HC (FD)] is usually straightforward. The two primary options are the:

a) Star, where the HC (FD) is connected directly to the main cross-connect (campus distributor) [MC (CD)].
b) Hierarchical star, where some or all of the HCs (FDs) are connected to an Intermediate cross-connect (building distributor) [IC (BD)], which in turn, is connected to the MC (CD).

The best design is the star design between the MCs building cross-connect and the HCs. However, in some extremely large buildings (for example, high-rises), a hierarchical star may be an option for consideration. The trade-offs between different size cables and labour is to be considered to determine a suitable cost effective solution. The direct connections between HCs are generally avoided. Although this kind of pathway might be of value in providing a redundant path, a user should design a link from HC to HC only in specific applications. The best design is the star design between the MCs building cross-connect and the HCs. However, in some extremely large buildings (for example, high-rises), a hierarchical star may be an option for consideration. The trade-offs between different size cables and labour is to be considered to determine a suitable cost effective solution. The direct connections between HCs are generally avoided. Although this kind of pathway might be of value in providing a redundant path, a user should design a link from HC to HC only in specific applications.

A typical cabling star configuration in a building is given in Fig. 2. An example of backbone hierarchical star topology is shown in Fig. 3

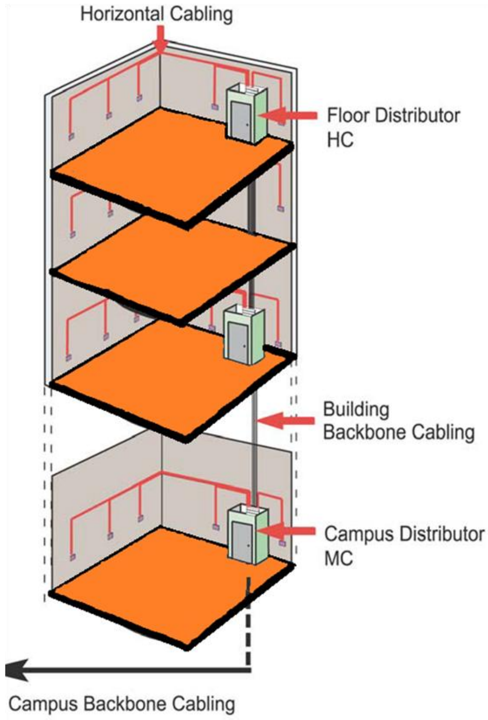



**Fig. 2 Typical Cabling Star Configuration in a Building**

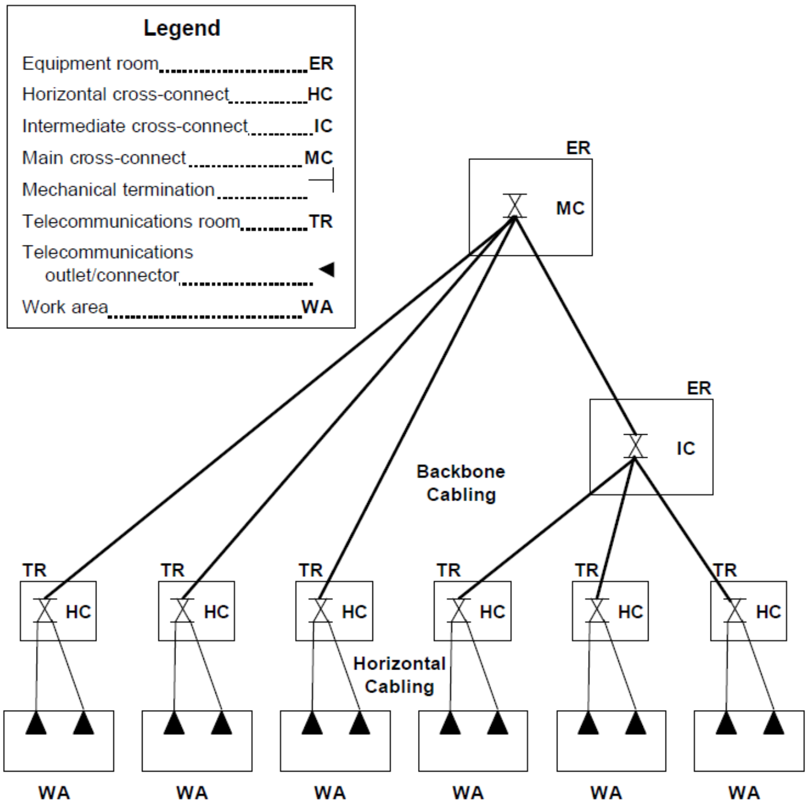



**Fig. 3 Example of Backbone Hierarchical Star Topology**

### 3.3.2 *Inter/Intra Building Backbone Cable Lengths*

As a general guideline in premises applications, optical fibre is recommended for backbone cabling, to support multiple applications with the lengths and data rates as shown below:

| *Subsystem* | *Backbone Lengths Up to* | *Data Rates Up to* |
|---|---|---|
| Campus backbones (OM1 fibre) | 2 000 m | 155 Mb/s |
| Campus backbones (OM2 fibre) | 550 m | 1 Gb/s |
| Building backbones (OM2 fibre) | 300 m | 1 Gb/s |
| Building backbones (OM3 fibre) | 300 m/100 m | 10 Gb/s/100 Gb/s |
| Campus/building backbones (OM4 fibre) | 550 m/150 m | 10 Gb/s/100 Gb/s |
| Campus/building backbones (OS1 fibre) | 10 000 m | 100 Gb/s |
| Campus/building backbones (OS2 fibre) | 10 000 m | 100 Gb/s |

### 3.3.3 *Backbone Building Pathways*

Various backbone building pathways including requirements/relating to them are described below:

a) *Vertically Aligned Telecom Rooms (TRs)* - Vertically aligned TRs with connecting sleeves or slots are the most common type of backbone pathway. They are desirable because the architect can stack them with other mechanical spaces, and they make distribution of telecom cables more efficient because of shorter conduits and cabling runs.

b) *Conduits, Trays, Slots, Sleeves, and Ducts* - All rigid conduit pipes shall be of steel and shall be conforming to relevant Indian Standard. The wall thickness shall be not less than 1.6 mm (16 SWG) for conduits up to 32 mm diameter and not less than 2 mm (14 SWG) for conduits above 32 mm diameter. These shall be solid drawn or reamed by welding, and finished with galvanized or stove enameled surface.
The vertical backbone pathway consists of telecommunications rooms located on each floor, which are vertically stacked one above the other and tied together by sleeves or slots. In this context, the term 'sleeve' refers to a circular opening in a wall, ceiling or floor to permit the passage of cables between adjacent spaces. A 'slot' is the same as a 'sleeve', except that the shape of the opening is usually rectangular. The cable sleeves or slots are positioned adjacent to a wall on which the backbone cables can be supported. The recommendation in respect of slots and sleeves are as under:

1) Slots with a minimum 25 mm high curb.
2) Sleeves to extend a minimum of 25 mm above the floor level and a maximum of 77 mm above the floor level. Sleeves should be located at a minimum of 25 mm from the wall or between adjacent sleeves to provide room for bushings, but not so far from the wall that it becomes a tripping hazard or create too large a cable span from the sleeve to the backboard/tray.

c) *Riser Systems*- From the building communications service EF, conduit or raceway should preferably be provided vertically above to the primary TR/TE on each upper floor of the building. Ideally, these TR/TE are stacked so that all that is required is a conduit sleeve between floors. Vertically mounted ladder rack must be mounted on the wall between incoming and outgoing sleeves within the TR/TE. The ladder rack will be used to provide strain-relief for cables transiting TR/TE within the riser system. If the building plan is large enough to require a second communications TR/TE on one or more floors, then the riser pathway must be duplicated from the service entrance room up through this second set of TR/TE.

d) *Vertical Pathway Size* - A minimum of three 100 diameter conduits, or equivalent raceway cross section, should be provided between the TR/TE on adjacent floors and between the EF and the first floor TR/TE.

e) *Vertical Pathway Topology*- If the TRs/TEs are not aligned vertically above one another, the conduits interconnecting them will have horizontal offsets. There shall be not more than two 90° bends in any such conduit run. Any bend must have an inside radius 10 times the diameter of the conduit (typically 1 m). If these conditions cannot be met, then intermediate pull boxes shall be used wherever a non-standard transition is required. This pull box shall at least 600 mm x 600 mm in the plane of the attached conduits, and 150 mm deep. All conduits other than simple sleeves between floors shall be fitted with a continuous 150 mm nylon pull rope, or a 0.6 mm steel fish wire or a 0.5 mm fibre composite fish wire.

f) *Access to the Roof* - For the installations like antenna, genset etc, which are provided on the roof, access shall be provided through suitable number of conduits. This connectivity from the roof should be seepage and rodent proof. A minimum of two 75 mm and one 20 mm conduit shall extend from the topmost TR/TE to the roof terminated in a weatherproof metal enclosure conforming to standard weather requirements for a feeder pillar.

g) *Pathway Finish Details* - Conduit shall be free of burrs or sharp edges. Sheet metal sleeves, if used, shall have rolled edges. Conduits or sleeves shall protrude at least 25 mm from the surface they penetrate but not more than 75 mm. Conduits shall be fitted with a smooth bushing.

h) *Fire Protection of Shafts* - All penetrations shall be filled with fire resistant material. Fire compartment plan and integrity of compartment should be maintained by either blocking permanently or by recognized systems automatically responding to temperature increase.

j) *Open Cable Shafts* - Open cable shafts are used when available and where large quantities of cables are required on a floor that is distant from the main ER.

k) *Elevator Shafts* - Backbone cable pathways shall not be located in elevator shafts.

m) *Enclosed Metallic Raceways or Conduits* - Enclosed metallic raceways or conduits are also used as vertical and horizontal cable pathways. It should be bonded to form a common bonding network.

n) *Cable Trays* - A cable tray can be used as a vertical cable pathway within shafts or as part of the pathway between vertically aligned TRs. A cable tray can be open or covered and provides a means for attaching vertical cable runs to the cable tray members.

#### **3.3.4** *Ethernet in the First Mile (EFM)*

Ethernet in the first mile (EFM), also known as ethernet to the last mile, describes the access network from the access point to the subscriber’s premise. The first mile is the critical connection between business and residential users and the public network. User demand for internet services has generated a proliferation of new types of subscriber access networks and their underlying technologies.

### 3.4 Horizontal Cabling Media Distribution and Building Pathways

A horizontal distribution system consists of the horizontal cabling, the horizontal pathways supporting the horizontal cabling, and the telecom spaces that support the horizontal pathways. As horizontal distribution systems, cabling, and pathways often change direction, elevation, or physical orientation to accommodate obstructions, barriers, and other building systems, the use of the term horizontal in the name of the element does not require that the elements be placed or installed parallel to the ground or floor.

**3.4.1** *Horizontal Cabling Systems and Pathways*

**3.4.1.1** The horizontal cabling is the portion of the telecommunications cabling system that extends from the work area telecommunications outlet/connector to the horizontal cross-connect in the telecommunications room. The horizontal cabling includes horizontal cables, telecommunications outlet/connectors in the work area, mechanical terminations, and patch cords or jumpers located in the telecommunications room, and may include multi-user telecommunications outlet assemblies and consolidation points.
The following media types can be considered as options for horizontal cabling, each capable of being extended up to a maximum distance of 90 m.

a) four-pair 100-ohm unshielded twisted-pair (UTP) or screened twisted-pair (ScTP) cables; and
b) two or more optical fibre multimode cable, either 62.5/125 mm or 50/125 mm.

In addition to the 90 m of horizontal cable, provision of a total of 10 m is to be kept for work area and telecommunications room patch and jumper cables.

**3.4.1.2** The requirements for horizontal pathways, measures for avoiding electromagnetic interference in the design of cabling pathways and topology for installation of horizontal cabling are described in **3.4.1.2.1** to **3.4.1.2.3**.

**3.4.1.2.1** *Horizontal pathways*

Horizontal pathways are used for distributing, supporting, and providing access to horizontal cabling and telecom associated connecting hardware between the telecom outlets/ connectors and the HC, typically located in the ER, TR or TE. Horizontal cabling is contained within horizontal pathways. Generally, the horizontal pathways are one of two types:

a) Continuous pathways (for example, conduit, cable tray, cable matting) used for containment of telecom cabling.
b) Non-continuous pathways (for example, the space between cable supports (for example, J-hooks) through which cables are placed between physical supports or containment components.

A pathway component shall accommodate all standards compliant cabling and address the potential need for change during the life cycle of the cabling system and building. The emphasis should be first on the design of pathway systems and then on the cabling systems design. This approach helps to ensure a robust pathway system that supports the cabling installation over the facility’s life cycle. As horizontal cabling is often less accessible than backbone cabling, making changes can become time intensive or expensive. As frequently accessing or changing the horizontal cabling leads to disruption to occupants, the choice and layout of horizontal cabling types are important to the design of the building structured cabling system. The following shall be considered for the horizontal distribution system’s design:

1) Allow for the accommodation of change over the facility's life cycle with the goal of reducing long-term maintenance and operational costs.
2) Utilize standardized cabling, components and systems.
3) Include appropriate pathway and cabling components to accommodate ease of access and a variety of user specified technology applications.

The horizontal cabling system should be designed in order to support various telecom applications, including:

i) Voice services;
ii) Data services;
iii) Audio and video services; and
iv) Building signaling systems [for example, building automation systems (BAS), fire, security].

It is preferable to have provision for conduits, junction box etc, during planning and construction stage for providing radio/wireless data equipment at the centre line of rooms and corridors to avoid adhoc provisions later on.

**3.4.1.2.2** *Avoiding electromagnetic interference (EMI)*

Avoiding electromagnetic interference (EMI) is an important consideration in the design of cabling pathways. Providing physical separation from sources of EMI for these elements of the telecom infrastructure inherently provides separation of their contents (for example, cable and connecting hardware).

The telecom pathways should be located away from sources of EMI, including:

a) Electrical power cabling and transformers;
b) RF sources;
c) Large motors and generators;
d) Induction heaters;
e) Arc welders;
f) X-ray equipment; and
g) Photocopy equipment.

**3.4.1.2.3** *Topology*

Horizontal cabling shall be installed in a physical star topology. Each telecom outlet/connector shall be cabled directly to an HC (FD) in the appropriate telecom space. Three exceptions to this practice are possible, when:

a) A consolidation point (CP) or multi-user telecommunications outlet assembly (MUTOA) is used to connect to open office cabling;
b) A transition point (TP) is required to connect to under-carpet cabling; or
c) Centralized optical fibre cabling is implemented from main cross-connect (campus distributor) [MC (CD)] to the work area(s).

Some applications may utilize a bus, ring, or tree topology, which can be implemented within a physical star topology. Typical horizontal and work area cabling using a star topology is shown in Fig. 4.

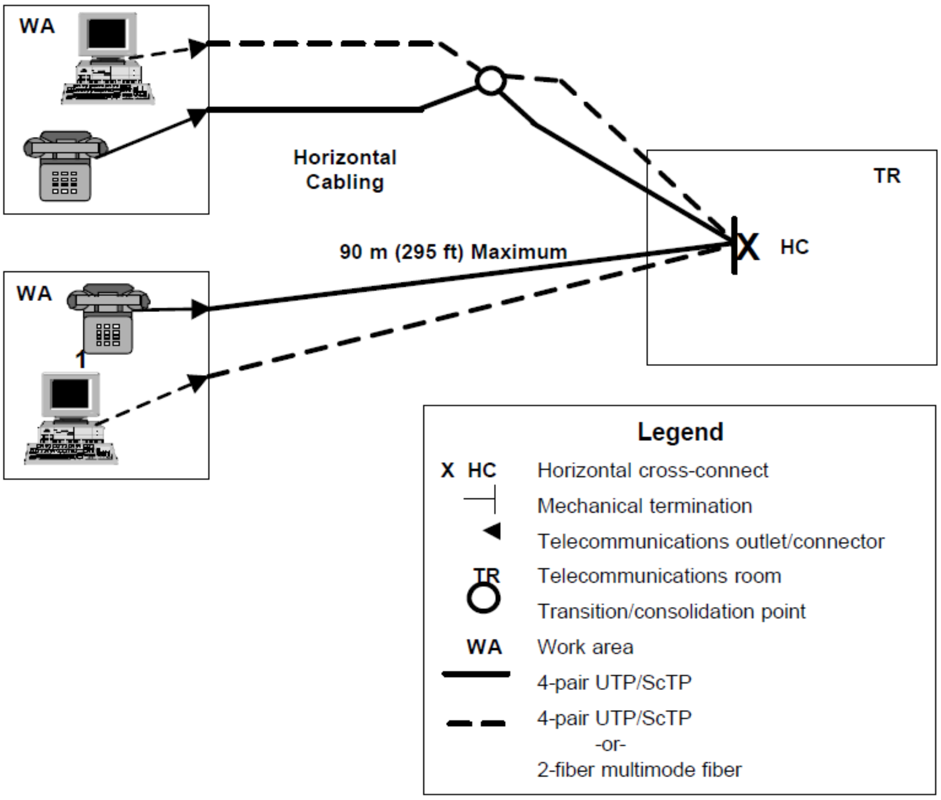



**Fig. 4 Typical Horizontal and Work Area Cabling Using a Star Topology**

**3.4.2** *Work Areas and Open Office Cabling*

The work area includes those spaces in a building where occupants normally work and interact with their telecom equipment. While work areas have traditionally been fixed, discrete locations, open office cabling design practices have introduced flexible layouts to support collaborative work by small teams. Such spaces are often rearranged to meet changing requirements of group work. Many other open office work situations also require frequent reconfiguration. An interconnection in the horizontal cabling allows open office spaces to be reconfigured frequently without disturbing horizontal system cabling runs. Work area equipment that may require access to the horizontal cabling includes:

a) Telephones;
b) Networking equipment;
c) Fax machines;
d) Computers;
e) Network peripherals; and
f) Any device plugged into a telecom outlet/connector that is located within the work area.

The key elements of open office cabling are the MUTOA and CP. To accommodate equipment in the work area, the following components are typically used as needed:

1) Telecom outlet/connector.
2) Work area equipment cords.
3) MUTOAs and CPs.
4) WAPs.

Some of these components and requirements or recommendations relating to them are described below:

a) *Multiuser Telecom Outlet Assembly (MUTOA)* - The MUTOA serves as a method of connecting more than one user (work area) to the horizontal cabling system. MUTOAs may be advantageous in open office spaces that are moved or reconfigured frequently. A MUTOA facilitates the termination of horizontal cabling system cables in a common location within a furniture cluster or similar open area. The use of MUTOAs allows the horizontal cabling to remain unchanged when the open office plan is changed. Work area equipment cords originating from the MUTOA should be routed through work area pathways (for example, furniture pathways). Each furniture cluster should have one MUTOA which serves a maximum of 12 work spaces. The work area equipment cords shall be connected directly to work area equipment without any additional connections. For optical fibre, any combination of horizontal, work area cables patch cords and equipment cords may not exceed 100 m. The work area cables shall be connected directly to work station equipment without the use of any additional intermediate connections (*See* Fig. 5).

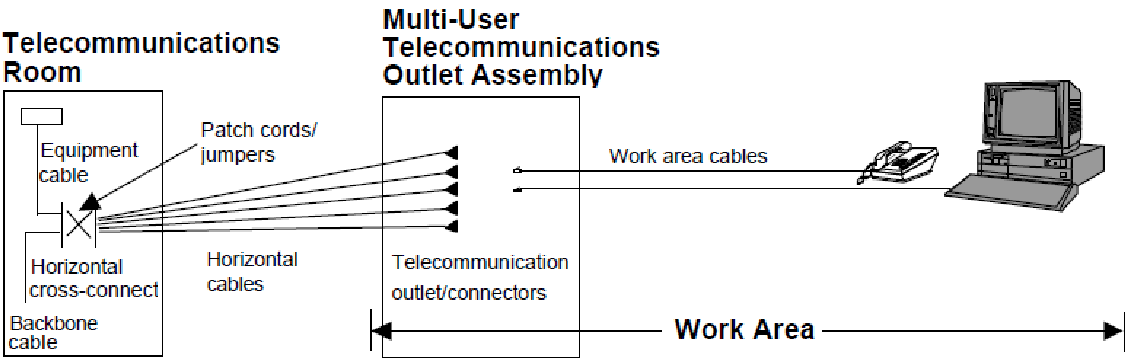



**Fig. 5 Application of Multi-User Telecommunications Outlet Assembly**

b) *Consolidation Point (CP)* - The consolidation point (CP) is an interconnection point within the horizontal cabling system. Like the MUTOA, a CP may be used for balanced twisted-pair cabling or optical fibre cabling. The functional difference between the CP and the MUTOA in the open office environment is that the CP introduces an additional connection for each horizontal cabling run. A CP may be useful when reconfiguration is frequent, but not so frequent as to require the flexibility of the MUTOA. The CP may be located in the suspended ceilings, access floors, modular office furniture or work area.

Some additional considerations and guidelines that apply specifically to the CP are as under:

1) CPs shall not be used for direct connection to active equipment. Cross-connections shall not be used at a CP. Not more than one CP shall be used within the same horizontal system cabling run.
2) For balanced twisted-pair cabling, the CP should be located at least 15 m from the HC (FD).
3) CPs shall be located in fully accessible and permanent locations. CPs shall not be located in an obstructed area.
4) The CP shall be sized and cabled so that it meets the telecom requirements of the zone it serves. If the floor space requirements change for an existing CP, then the CP should be reconfigured to accommodate the new requirements (*See* Fig. 6).

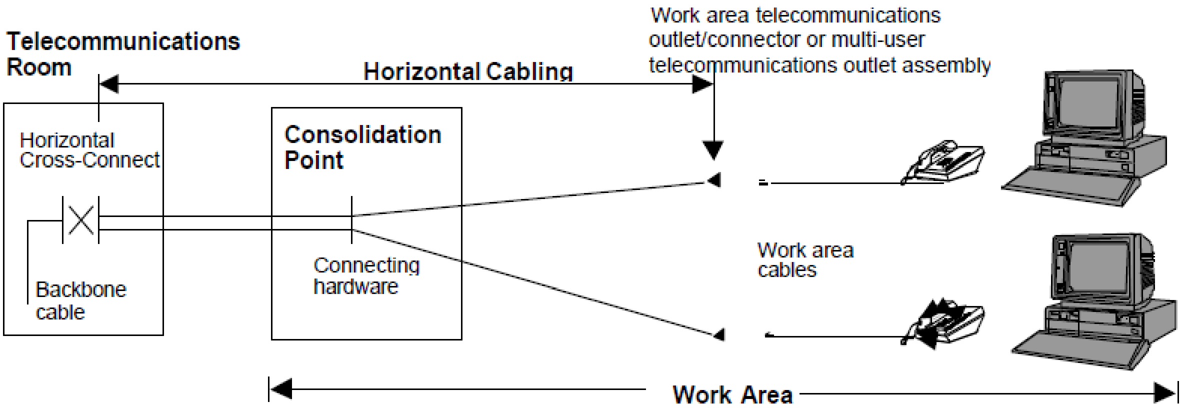



**Fig. 6 Application of Consolidation Point**

**3.4.3** *Centralized Optical Fibre Cabling*

The HC (FD), deployed throughout a building and located on each floor of a building, offers maximum flexibility to the user, especially in the deployment of distributed electronics or in multitenant buildings. In spite of the advantages of distributed cross-connections, many users of high-performance optical fibre cabling are implementing data networks with centralized electronics. A centralized optical fibre cabling topology is based on the principles of a centralized optical fibre network when using recognized optical fibre cabling in the horizontal system to support centralized electronics and fibre-to-the-desk technology. The centralized cabling provides connections from the work areas to the centralized cross-connect by allowing the use of any of the following methods:

a) Pull-through cabling from the centralized cross-connection;
b) Interconnection cabling in a floor-serving telecom space; and
c) Spliced cabling in a floor-serving telecom space.

**3.4.4** *Passive Optical Networks (PONs)*

A passive optical network (PON) is a point-to-multipoint network architecture in which unpowered optical splitters are used to enable a single optical fibre strand to serve multiple end-points. Passive optical LANs are an implementation of PON technology for the enterprise LAN (for example, large layer 2 ethernet networks). PON technology has successfully matured into a true enterprise network architecture capable of delivering voice, data, and video services to the end user via a single strand of single mode optical fibre cabling. A PON solution reduces physical cabling infrastructure, minimizes the telecom space requirements through the use of passive optical splitters, and reduces electrical power and heating, ventilation, and air-conditioning (HVAC) requirements in the floor serving TR.

## 4 SPECIFIC REQUIREMENTS FOR TELECOM INFRASTRUCTURE CABLING

### 4.1 Telecommunications Bonding and Grounding

The bonding and grounding infrastructure of a telecom installation is an essential part of an information technology systems (ICT) design. Grounding systems are an integral part of the signal or telecommunications cabling system that they support. In addition to helping protect personnel and equipment from hazardous voltages, a proper grounding system may reduce electromagnetic interference (EMI) to and from the telecommunications cabling system. Improper grounding can produce induced voltages and those voltages can disrupt other telecommunications circuits. Grounding and bonding shall meet the appropriate requirements and practices of applicable standards.

### 4.2 Installation and Workplace Safety

**4.2.1** *Cabling Installation Guidelines*

The installation of system components has a tremendous effect on the final performance level of the network; therefore, it is essential to ensure that the performance of the entire network is not diminished through improper installation. The cables can be easily damaged if they are improperly handled or installed. It is imperative that certain procedures be followed in the handling of these cables to avoid damage and/or limiting their usefulness.

Care shall be taken not to stretch or abrade cables during installation, that is, the pulling tension for cables shall not be exceeded. Cables that pass through the infrastructure of the building shall be suitably protected against damage. Through walls and floors, this shall involve an appropriate type of sleeve; through any form of metalwork or stiff plastic then a rubber grommet shall be used.

To ensure cable management and also strain relief, cables shall be properly dressed using velcro cable ties. However, cable’s ties should never be over tightened. On vertical runs, the cables shall be dressed and tied from the bottom up, thus putting minimum strain on the cables. In order that the system may be easily re-routed, or damaged sections quickly replaced, free access to the cable is there, where possible, it is important that draw cords shall be left in ducting, piping etc, for future use.

**4.2.1.1** *Improvement areas*

a) *Do not exceed the maximum tensile load* – On runs from 40 m to 100 m, use proper lubricants and make sure they are compatible with the cable jacket. On runs over 100 m, use proper lubricants and pull from the middle out to both ends. If possible, use an automated puller with tension control or at least a breakaway-pulling eye.

b) *Maintaining Minimum Bending Radius* – Sharp bends in the cable will damage the insulating material thus causing unacceptable losses in the transmission medium. Therefore, the internal radius of every bend in a cable shall be such as not to cause damage to the cable, nor impair the characteristics of the cable.

c) *Proper Cable Slack at Outlet Points and Patch Panels* – Install the system such that sufficient slack remains to enable re-termination of the outlets, a minimum of twice, and a limited scope for movement of the cabinets.

d) *Patch Panels and Cable Management* – Where possible, patch panels shall be installed within the communications units from the top, continuing downwards.

e) *Electromagnetic Compatibility (EMC)* – As a passive medium, structured cabling need not comply with the EMC regulations. However, telecom designers should be aware that cabling, when connected to transmission equipment, could radiate, receive and conduct electromagnetic disturbances and act accordingly. When crossing mains cables, this shall be done at right angles.

f) *Maintaining proper Cable Routes* – Cable shall not be routed over pipes, conduits, other cabling, ceiling tiles, etc, but shall rest directly on the supporting surface so as to minimize the potential for sharp bends, kinks, etc. Every cable used shall be supported in such a way that it is not exposed to undue mechanical strain and so there is no appreciable mechanical strain on the terminations.

g) *Labelling* – The cable shall be clearly labelled at both ends, as outlined in the documentation and/or drawing. Each 8P8C connector (information outlet) shall be individually labelled. The label shall contain a unique identification, as outlined in the documentation and/or drawing, and must be indelible and placed behind a transparent cover. At the patch panels, each socket shall be labelled according to its corresponding outlet identification.

**4.2.2** *Workplace Safety*

Following measures shall be ensured for workplace safety:

a) Lighting in telecom spaces shall be provided in an adequate amount such that continuing work operations, routine observations, and the passage of employees can be carried out in a safe and healthful manner. Certain specific tasks in centres, such as splicing cable and the maintenance and repair of equipment frame line-ups, may require a higher level of illumination and adequate provisioning should be provided for the purpose.

b) While working with optical fibre installation, the real issue of eye safety is getting fibre scraps into the eye. The broken ends of fibres and scraps of fibre created during the termination and splicing may also be dangerous. Further, fibre optic splicing and termination use various chemical cleaners and adhesives as part of the processes. Therefore, careful handling of fibre, cleaner and adhesive shall be ensured.

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