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TIA STANDARD

Commercial Building Telecommunications Cabling Standard

TIA-568-C.1

February 2009

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Commercial Building Telecommunications Cabling Standard

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FOREWORD

(This foreword is not considered part of this Standard.)

This Standard was developed by TIA Subcommittee TR-42.1.

Approval of this Standard

This Standard was approved by TIA Subcommittee TR-42.1, TIA Engineering Committee TR-42, and the American National Standards Institute (ANSI).

ANSI/TIA reviews standards every 5 years. At that time, standards are reaffirmed, withdrawn, or revised according to the submitted updates. Updates to be included in the next revision should be sent to the committee chair or to ANSI/TIA.

Contributing organizations

More than 60 organizations within the telecommunications industry contributed their expertise to the development of this Standard (including manufacturers, consultants, end users, and other organizations).

Documents superseded

This Standard, in part, replaces ANSI/TIA/EIA-568-B.1 dated April 12, 2001 and its addenda.

This Standard incorporates and refines the technical content of:

- ANSI/TIA-568-B.1-4, Addendum 4, *Recognition of Category 6 and 850 nm Laser-Optimized 50/125 µm Multimode Optical Fiber Cabling*
- ANSI/TIA-568-B.1-5, Addendum 5, *Telecommunications Cabling for Telecommunications Enclosures*

Significant technical changes from the previous edition

- Reorganization of content addressing cabling system requirements for commercial buildings
- Incorporation of generic nomenclature found in ANSI/TIA-568-C.0, *Generic Telecommunications Cabling for Customer Premises*
- Inclusion of category 6 and category 6A balanced 100-ohm cabling
- Inclusion of 850 nm laser-optimized 50/125 µm multimode optical fiber cabling
- Inclusion of telecommunications enclosures
- Inclusion of centralized cabling in the main body of the document
- Removal of generic requirements, which have been moved to ANSI/TIA-568-C.0, *Generic Telecommunications Cabling for Customer Premises*
- Removal of 150-Ohm STP cabling
- Removal of category 5 cabling
- Removal of balanced twisted-pair cabling performance and test requirements which have been moved to ANSI/TIA-568-C.2
- Removal of 50-ohm and 75-ohm coaxial cabling

Relationship to other TIA standards and documents

The following are related standards regarding various aspects of structured cabling that were developed and are maintained by Engineering Committee TIA TR-42. An illustrative diagram of the ANSI/TIA-568-C Series relationship to other relevant TIA standards is given in figure 1.

- *Generic Telecommunications Cabling for Customer Premises* (ANSI/TIA-568-C.0)
- *Commercial Building Telecommunications Cabling Standard; Part 2: Balanced Twisted-Pair Cabling Components* (ANSI/TIA/EIA-568-B.2)
- *Optical Fiber Cabling Components Standard* (ANSI/TIA-568-C.3)
- *Commercial Building Standard for Telecommunications Pathways and Spaces* (TIA-569-B)
- *Residential Telecommunications Infrastructure Standard* (ANSI/TIA-570-B)
- *Administration Standard for Commercial Telecommunications Infrastructure* (ANSI/TIA/EIA-606-A)
- *Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications* (ANSI-J-STD-607-A)
- *Customer-Owned Outside Plant Telecommunications Infrastructure Standard* (ANSI/TIA-758-A)
- *Building Automation Systems Cabling Standard for Commercial Buildings* (ANSI/TIA/EIA-862)
- *Telecommunications Infrastructure Standard for Data Centers* (ANSI/TIA-942)
- *Telecommunications Infrastructure Standard for Industrial Premises* (ANSI/TIA-1005)

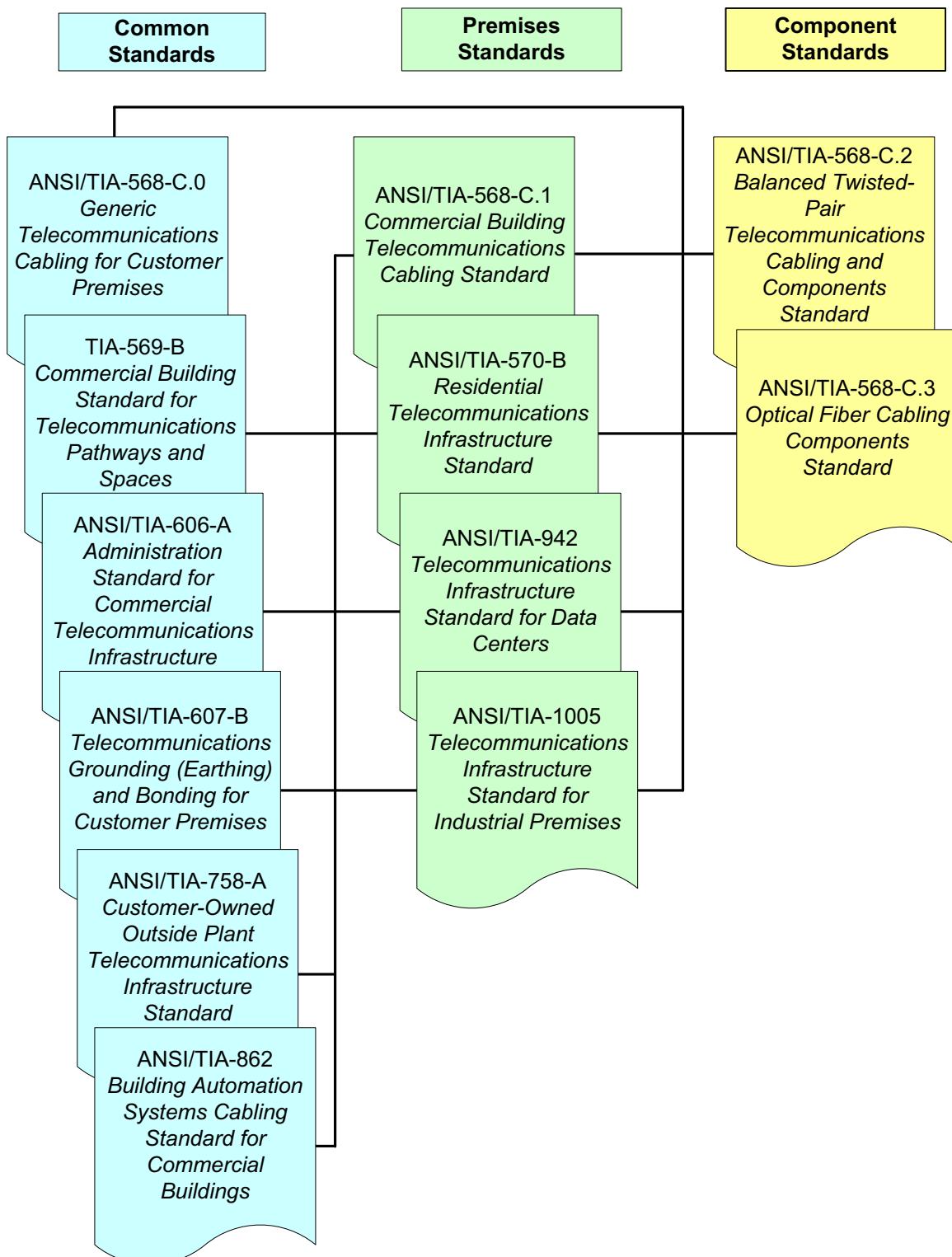


Figure 1 – Illustrative relationship between the TIA-568-C Series and other relevant TIA standards

The following documents may also be useful to the reader:

- *National Electrical Safety Code® (NESC®) (IEEE C2-2007)*
- *National Electrical Code® (NEC®) (NFPA 70-2008)*

Useful supplements to this Standard are the following BICSI documents: *Telecommunications Distribution Methods Manual*, the *Customer-owned Outside Plant Design Manual*, and *Information Transport Systems Installation Manual*. These manuals provide practices and methods by which many of the requirements of this Standard are implemented.

Other references are listed in Annex A.

Annexes

Annex A is informative and not considered a requirement of this Standard.

Introduction

This Standard specifies a telecommunications cabling system for commercial buildings that will support a multi-product, multi-vendor environment. It also provides information that may be used for the design of telecommunications products for commercial enterprises.

Purpose

The purpose of this Standard is to enable the planning and installation of a structured cabling system for commercial buildings. Installation of cabling systems during building construction or renovation is significantly less expensive and less disruptive than after the building is occupied.

This Standard establishes performance and technical criteria for various cabling system configurations for accessing and connecting their respective elements. In order to determine the requirements of a generic cabling system, performance requirements for various telecommunications services were considered.

The diversity of services currently available, coupled with the continual addition of new services, means that there may be cases where limitations to desired performance occur. When applying specific applications to these cabling systems, the user is cautioned to consult application standards, regulations, equipment vendors, and system and service suppliers for applicability, limitations, and ancillary requirements.

Stewardship

Telecommunications infrastructure affects raw material consumption. The infra-structure design and installation methods also influence product life and sustainability of electronic equipment life cycling. These aspects of telecommunications infrastructure impact our environment. Since building life cycles are typically planned for decades, technological electronic equipment upgrades are necessary. The telecommunications infrastructure design and installation process magnifies the need for sustainable infrastructures with respect to building life, electronic equipment life cycling and considerations of effects on environmental waste. Telecommunications designers are encouraged to research local building practices for a sustainable environment and conservation of fossil fuels as part of the design process.

Specification of criteria

Two categories of criteria are specified; mandatory and advisory. The mandatory requirements are designated by the word "shall"; advisory requirements are designated by the words "should", "may", or "desirable" which are used interchangeably in this Standard.

Mandatory criteria generally apply to protection, performance, administration and compatibility; they specify the minimally-compliant requirements. Advisory or desirable criteria are presented when their attainment will enhance the general performance of the cabling system in all its contemplated applications.

A note in the text, table, or figure is used for emphasis or offering informative suggestions, or providing additional information.

Metric equivalents of United States customary units

The dimensions in this Standard are metric or United States customary with soft conversions to the other.

Life of this Standard

This Standard is a living document. The criteria contained in this Standard are subject to revisions and updating as warranted by advances in building construction techniques and telecommunications technology.

Telecommunications cabling system structure

This standard establishes a structure for commercial building cabling based on the generic cabling system structure in ANSI/TIA-568-C.0. Figure 2 of ANSI/TIA-568-C.0 provides a representation of the functional elements that comprise a generic cabling system. Figure 4 of this Standard provides an example of how these functional elements are depicted in a commercial building cabling system.

Figure 2 of this Standard illustrates a representative model for a commercial building telecommunications cabling system. The elements of a commercial building telecommunications cabling system structure (see also figure 4) are listed below.

- a) Entrance facilities
- b) Equipment rooms (space typically containing Distributor C, but may contain Distributor B)
- c) Telecommunications room (space typically containing Distributor A, but may contain Distributor B and Distributor C) or, in some implementations, telecommunications enclosures (space containing Distributor A)
- d) Backbone cabling (Cabling Subsystem 2 and Cabling Subsystem 3)
- e) Horizontal cabling (Cabling Subsystem 1)
- f) Work area (space containing the equipment outlet)

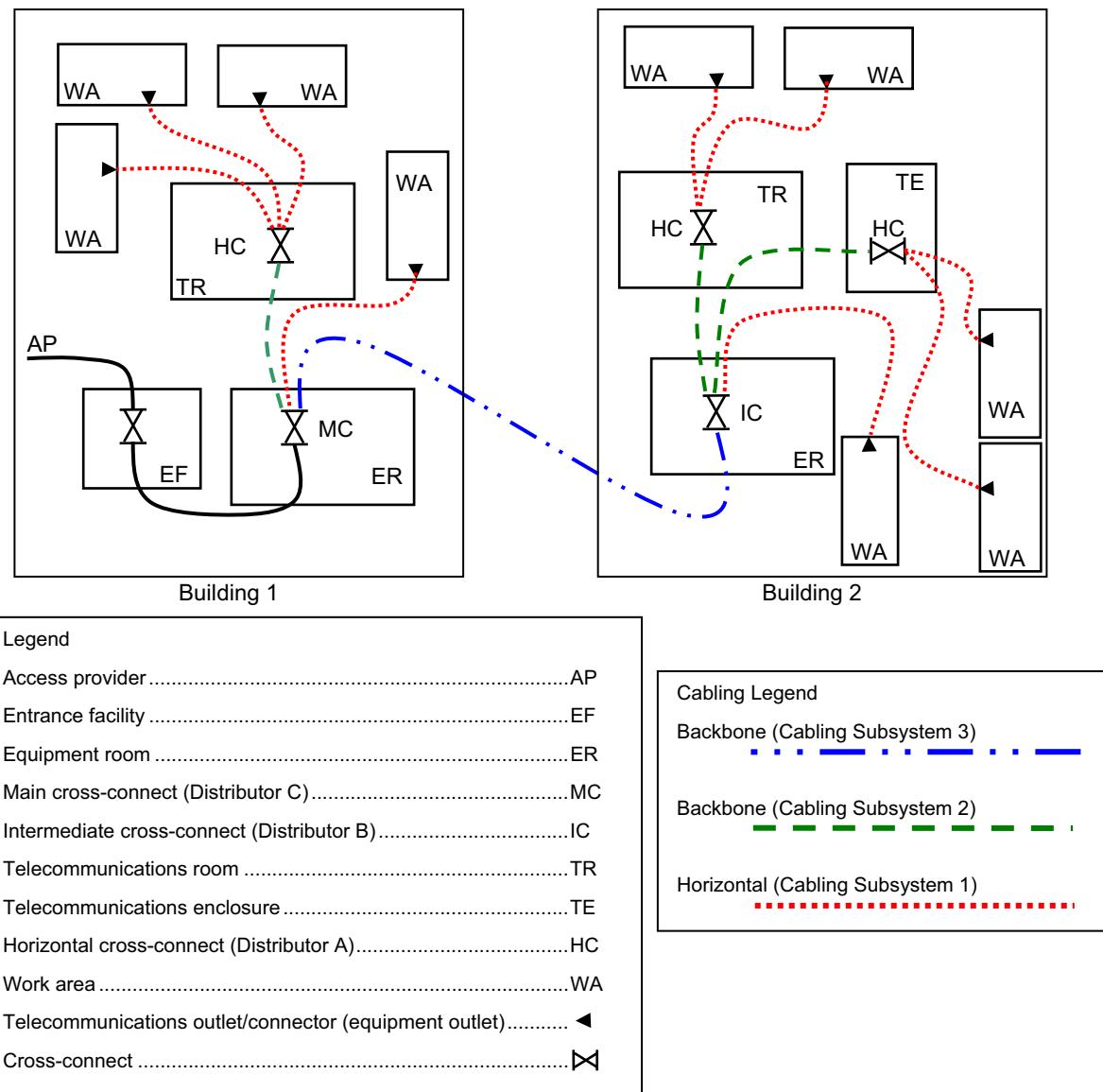


Figure 2 – Representative model for a commercial building telecommunications cabling system

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1 SCOPE

This Standard specifies requirements for telecommunications cabling within a commercial building and between commercial buildings in a campus environment. It defines terms, specifies cabling topology, lists cabling requirements, establishes cabling distances, sets telecommunications outlet/connector configurations and provides additional useful information.

Telecommunications cabling specified by this Standard is intended to support a wide range of different commercial building sites and applications (e.g., voice, data, text, video, and image). Typically, this range includes sites with a geographical extent from 3000 m (approximately 10 000 ft), up to 1 000 000 m² (approximately 10 000 000 ft²) of office space, and with a population of up to 50 000 individual users.

2 NORMATIVE REFERENCES

The following standards contain provisions which, through reference in this text, constitute provisions of this Standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this Standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. ANSI and TIA maintain registers of currently valid national standards published by them.

- a) ANSI/TIA-568-C.0-2008, *Generic Telecommunications Cabling for Customer Premises*
- b) ANSI/TIA/EIA-568-B.1-2001, *Commercial Building Telecommunications Cabling Standard; Part 1: General Requirements*

NOTE – Cabling requirements (permanent link and channel) for category 3 and category 5e 100-ohm balanced twisted-pair cabling are currently contained in ANSI/TIA/EIA-568-B.1. When ANSI/TIA-568-C.2 is published the cabling requirements for category 3 and category 5e 100-ohm balanced twisted-pair cabling will be specified in that document.

- c) ANSI/TIA/EIA-568-B.2-2001, *Commercial Building Telecommunications Cabling Standard; Part 2: Balanced Twisted-Pair Cabling Components*
- d) ANSI/TIA-568-C.3-2008, *Optical Fiber Cabling Components Standard*
- e) TIA-569-B-2004, *Commercial Building Standard for Telecommunications Pathways and Spaces*
- f) ANSI/TIA/EIA-606-A-2007, *Administration Standard for Commercial Telecommunications Infra-structure*
- g) ANSI/TIA-758-A-2004, *Customer-owned Outside Plant Telecommunications Infrastructure Standard*

3 DEFINITION OF TERMS, ACRONYMS AND ABBREVIATIONS, AND UNITS OF MEASURE

3.1 General

For the purposes of this Standard, the following definitions, acronyms, abbreviations and units of measure apply.

3.2 Definitions

access provider: The operator of any facility that is used to convey telecommunications signals to and from a customer premises.

adapter: A device that enables any or all of the following:

- (1) different sizes or types of plugs to mate with one another or to fit into a telecommunications outlet,
- (2) the rearrangement of leads,
- (3) large cables with numerous conductors to fan out into smaller groups of conductors, and
- (4) interconnection between cables.

administration: The method for labeling, identification, documentation and usage needed to implement moves, additions and changes of the telecommunications infrastructure.

backbone: A facility (e.g., pathway, cable or bonding conductor) for Cabling Subsystem 2 and Cabling Subsystem 3.

backbone cable: See **backbone**.

bonding: The permanent joining of metallic parts to form an electrically conductive path that will ensure electrical continuity and the capacity to conduct safely any current likely to be imposed.

bundled cable: An assembly of two or more cables continuously bound together to form a single unit.

cable: An assembly of one or more insulated conductors or optical fibers, within an enveloping sheath.

cable run: A length of installed media, which may include other components along its path.

cabling: A combination of all cables, jumpers, cords, and connecting hardware.

Cabling Subsystem 1: Cabling from the equipment outlet to Distributor A, Distributor B, or Distributor C.

Cabling Subsystem 2: Cabling between Distributor A and either Distributor B or Distributor C (if Distributor B is not implemented).

Cabling Subsystem 3: Cabling between Distributor B and Distributor C.

campus: The buildings and grounds having legal contiguous interconnection.

centralized cabling: A cabling configuration from an equipment outlet to a centralized cross-connect in the same building using a continuous cable, an interconnect, or a splice.

channel: The end-to-end transmission path between two points at which application-specific equipment is connected.

commercial building: A building or portion thereof that is intended for office use.

connecting hardware: A device providing mechanical cable terminations.

consolidation point: A connection facility within Cabling Subsystem 1 for interconnection of cables extending from building pathways to the equipment outlet.

cord (telecommunications): An assembly of cord cable with a plug on one or both ends.

cross-connect: A facility enabling the termination of cable elements and their interconnection or cross-connection.

cross-connection: A connection scheme between cabling runs, subsystems, and equipment using patch cords or jumpers that attach to connecting hardware on each end.

customer premises: Building(s), grounds and appurtenances (belongings) under the control of the customer.

data: Electronically encoded information.

demarcation point: A point where the operational control or ownership changes.

Distributor A: Optional connection facility that is cabled between the equipment outlet and Distributor B or Distributor C in a hierarchical star topology.

Distributor B: Optional intermediate connection facility that is cabled to Distributor C in a hierarchical star topology.

Distributor C: Central connection facility in a hierarchical star topology.

enclosure, telecommunications: A case or housing that may contain telecommunications equipment, cable terminations, or horizontal cross-connect cabling.

end user: The owner or user of the premises cabling system.

entrance facility (telecommunications): An entrance to a building for both public and private network service cables (including wireless) including the entrance point of the building and continuing to the entrance room or space.

equipment cord: see **cord**.

equipment outlet: Outermost connection facility in a hierarchical star topology as shown in figure 4.

equipment room (telecommunications): An environmentally controlled centralized space for telecommunications equipment that usually houses a main or intermediate cross-connect.

fiber optic: See **optical fiber**.

furniture cluster: A contiguous group of work areas, typically including space divisions, work surfaces, storage, and seating.

ground: A conducting connection, whether intentional or accidental, between an electrical circuit (e.g., telecommunications) or equipment and the earth, or to some conducting body that serves in place of earth.

horizontal cabling: Cabling Subsystem 1.

horizontal cross-connect: A cross-connect of horizontal cabling to other cabling, e.g., horizontal, backbone, equipment.

hybrid cable: An assembly of two or more cables, of the same or different types or categories, covered by one overall sheath.

infrastructure (telecommunications): A collection of those telecommunications components, excluding equipment, that together provide the basic support for the distribution of information within a building or campus.

insertion loss: The signal loss resulting from the insertion of a component, or link, or channel, between a transmitter and receiver (often referred to as attenuation).

interconnection: A connection scheme that employs connecting hardware for the direct connection of a cable to another cable without a patch cord or jumper.

intermediate cross-connect: Distributor B.

ANSI/TIA-568-C.1

jumper: 1) An assembly of twisted-pairs without connectors, used to join telecommunications circuits/links at the cross-connect. 2) A length of optical fiber cable with a connector plug on each end.

link: A transmission path between two points, not including equipment and cords.

main cross-connect: Distributor C.

media (telecommunications): Wire, cable, or conductors used for telecommunications.

mode: A path of light in an optical fiber.

multimode optical fiber: An optical fiber that carries many paths of light.

multi-user telecommunications outlet assembly: A grouping in one location of several telecommunications outlet/connectors.

open office: A floor space division provided by furniture, moveable partitions, or other means instead of by building walls.

optical fiber: Any filament made of dielectric materials that guides light.

optical fiber cable: An assembly consisting of one or more optical fibers.

outlet/connector (telecommunications): The fixed connector in an equipment outlet.

outside plant: Telecommunications infrastructure designed for installation exterior to buildings.

patch cord: 1) A length of cable with a plug on one or both ends. 2) A length of optical fiber cable with a connector on each end.

pathway: A facility for the placement of telecommunications cable.

permanent link: A test configuration for a link excluding test cords and patch cords.

single-mode optical fiber: An optical fiber that carries only one path of light.

space (telecommunications): An area used for housing the installation and termination of telecommunications equipment and cable, e.g., common equipment rooms, equipment rooms, common telecommunications rooms, telecommunications rooms, telecommunications enclosures, work areas, and maintenance holes/handholes.

splice: A joining of conductors, meant to be permanent.

splice closure: A device used to protect a splice.

star topology: A topology in which telecommunications cables are distributed from a central point.

telecommunications: Any transmission, emission, and reception of signs, signals, writings, images, and sounds, that is, information of any nature by cable, radio, optical, or other electromagnetic systems.

telecommunications enclosure: See **enclosure, telecommunications**.

telecommunications entrance facility: See **entrance facility (telecommunications)**.

telecommunications equipment room: See **equipment room (telecommunications)**.

telecommunications infrastructure: See **infrastructure (telecommunications)**.

telecommunications outlet: An assembly of components consisting of one or more connectors mounted on a faceplate, housing or supporting bracket..

telecommunications room: An enclosed architectural space designed to contain telecommunications equipment, cable terminations, or cross-connect cabling.

terminal: (1) A point at which information may enter or leave a communications network. (2) The input-output associated equipment. (3) A device by means of which wires may be connected to each other.

topology: The physical or logical arrangement of a telecommunications system.

transition point: A connection between round cable and flat undercarpet cable in Cabling Subsystem 1.

wire: An individually insulated solid or stranded metallic conductor.

work area: A building space where the occupants interact with telecommunications terminal equipment.

work area cord: see cord.

3.3 Acronyms and abbreviations

ANSI	American National Standards Institute
AP	access provider
AWG	American Wire Gauge
CER	common equipment room
CP	consolidation point
CTR	common telecommunications room
EF	entrance facility
EIA	Electronic Industries Alliance
ER	equipment room
HC	horizontal cross-connect
IC	intermediate cross-connect
IEEE	The Institute of Electrical and Electronics Engineers
ISDN	integrated services digital network
MC	main cross-connect
MUTOA	multi-user telecommunications outlet assembly
NEC®	National Electrical Code®
NESC®	National Electrical Safety Code®
NFPA	National Fire Protection Association
SP	service provider
TE	telecommunications enclosure
TIA	Telecommunications Industry Association
TO	telecommunications outlet
TR	telecommunications room
UL	Underwriters Laboratories Inc
WA	work area

3.4 Units of measure

ft	feet, foot
m	meter
nm	nanometer
μm	micrometer (micron)

4 ENTRANCE FACILITIES

4.1 General

The entrance facility (EF) consists of the cables, connecting hardware, protection devices, and other equipment that connect to access provider (AP) cabling (see figure 2). These components may be used for regulated APs (e.g., local telephone companies), private network customer premises services, or both.

4.2 Design

The EF pathway(s) and space(s) shall be designed and installed in accordance with the requirements of TIA-569-B.

4.3 Functions

4.3.1 Network demarcation point

The demarcation point between APs and the customer premises cabling may be part of the EF. The location of this point for some APs is determined by federal/state regulations. The AP should be contacted to determine the location policies in effect.

4.3.2 Electrical protection

Protection devices for campus backbone cables and antennas may be located in the EF. AP cabling may be located in the EF, so APs should be contacted to determine the electrical protection needs and policies for their cabling. Electrical protection is governed by applicable electrical codes.

4.3.3 Connections to outside plant cabling

The EF includes connections between cabling used in the outside plant (e.g. an AP) and building cabling. This connection may be accomplished via a splice or other means. Outside plant cabling shall comply with ANSI/TIA-758-A.

5 EQUIPMENT ROOMS

5.1 General

Equipment rooms (ERs) are considered to be distinct from telecommunications rooms (TRs) and telecommunications enclosures (TEs) because of the nature or complexity of the equipment they contain. An ER may alternatively provide any or all of the functions of a TR or TE (see figure 2). The main cross-connect (MC; Distributor C) of a commercial building is located in an ER. Intermediate cross-connects (ICs; Distributor B), horizontal cross-connects (HCs; Distributor A), or both, of a commercial building may also be located in an ER.

5.2 Design

ERs shall be designed and provisioned according to the requirements in TIA-569-B.

5.3 Functions

An ER houses telecommunications equipment, connecting hardware, splice closures, grounding and bonding facilities, and appropriate protection apparatus.

From a cabling perspective, an ER may contain either the MC or the IC used in the backbone cabling hierarchy. The ER provides for the administration and routing of the equipment cords from the main or IC to the telecommunications equipment.

An ER may also house equipment terminations and may contain horizontal terminations for a portion of the building. In many cases, the ER contains AP (e.g., local telephone company) service terminations, premises network terminations, and other terminations.

5.4 Cabling practices

Cabling cross-connections and interconnections described in clause 6.4 for TRs and TEs are also applicable to ERs.

6 TELECOMMUNICATIONS ROOMS AND TELECOMMUNICATIONS ENCLOSURES

6.1 General

Telecommunications rooms (TRs) and telecommunications enclosures (TEs) provide a common access point for backbone and building pathways (see figure 2). TRs and TEs may also contain cabling used for cross-connection. The horizontal cross-connect (HC; Distributor A) of a commercial building is located in a TR or TE. The main cross-connect (MC; Distributor C) and intermediate cross-connects (IC; Distributor B) of a commercial building may also be located in a TR. The TR and any TE should be located on the same floor as the work areas served.

6.2 Design

TRs and TEs shall be designed in accordance with TIA-569-B.

The use of TEs is a specific implementation and not a general case. TE's may be used in addition to one TR per floor and in addition to an additional TR for each area up to 1000 m² (10 000 ft²). Thus, the number of TRs is not reduced by the use of TEs.

A TE is intended to serve a smaller floor area than a TR. TE's may also be used for serving environments like entrance lobbies, or historic buildings where the construction of a TR is not allowable.

6.3 Functions

A TR or TE houses the terminations of horizontal and backbone cables to connecting hardware. The cross-connection of horizontal and backbone cable terminations using jumpers or patch cords allows flexible connectivity when extending various services to telecommunications outlet/connectors. Connecting hardware, jumpers, and patch cords used for this purpose are collectively referred to as "horizontal cross-connections".

TRs may also contain the IC or the MC for different portions of the backbone cabling system. Sometimes backbone-to-backbone cross-connections in the TR or TE are used to connect different TRs or TEs together in a ring, bus, or tree configuration as described in clause 7.2.2.

A TR or TE also provides a controlled environment to house telecommunications equipment, connecting hardware, and splice closures serving a portion of the building. The TR or TE provides for the administration and routing of the equipment cords from the HC to the telecommunications equipment. In some cases, the demarcation point and associated protection apparatus may be located in a TR.

6.4 Cross-connections and interconnections

Horizontal and backbone building cables shall be terminated on connecting hardware that meets the requirements of ANSI/TIA/EIA-568-B.2 (for balanced twisted-pair cable) or ANSI/TIA-568-C.3 (for optical fiber cable) as appropriate. These cable terminations shall not be relocated to implement cabling system moves, adds, and changes.

6.5 Centralized optical fiber cabling

Centralized cabling (see figure 3) shall meet the requirements of ANSI/TIA-568-C.0. Centralized optical fiber cabling is designed as an alternative to the optical cross-connect located in the TR or TE when deploying recognized optical fiber cabling in the horizontal in support of centralized electronics.

Centralized cabling provides connections from work areas (WAs) to centralized cross-connects by allowing the use of pull-through cables and the use of an interconnect or splice in the TR or TE. The maximum allowed distance for a pull-through cable is 90 m (295 ft).

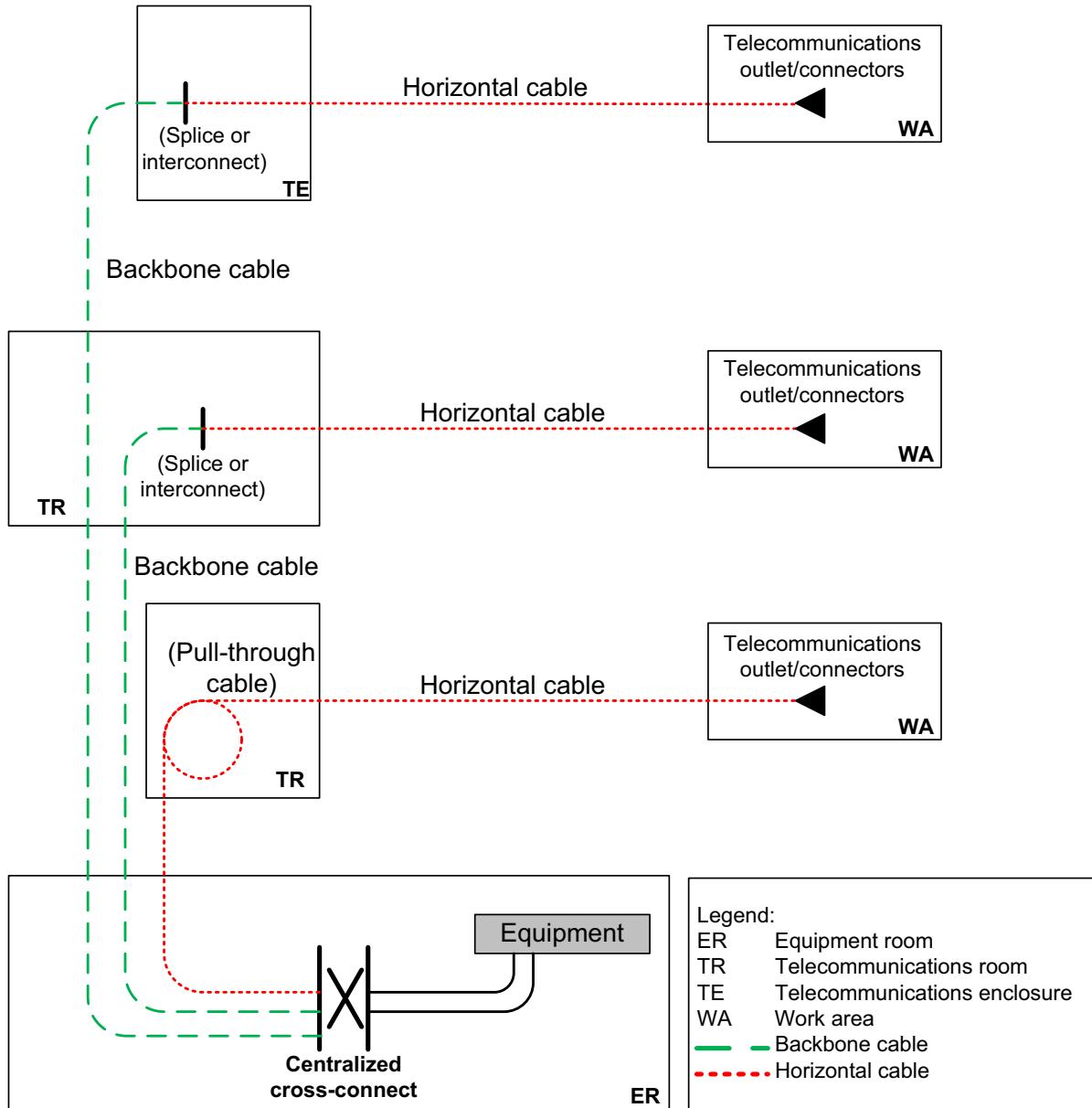


Figure 3 – Centralized optical fiber cabling

7 BACKBONE CABLING (CABLING SUBSYSTEM 2 AND CABLING SUBSYSTEM 3)

7.1 General

Backbone cabling is the portion of the commercial building telecommunications cabling system that provides interconnections between entrance facilities (EFs), access provider (AP) spaces, service provider (SP) spaces, common equipment rooms (CERs), common telecommunications rooms (CTRs), equipment rooms (ERs), telecommunications rooms (TRs) and telecommunications enclosures (TEs) (see figure 4). As such, the backbone cabling shall meet the requirements of ANSI/TIA-568-C.0 Cabling Subsystem 2 and Cabling Subsystem 3. Backbone cabling consists of the backbone cables, intermediate and main cross-connects (ICs and MCs), mechanical terminations, and patch cords or jumpers used for backbone-to-backbone cross-connection. The pathways and spaces to support backbone cabling shall be designed and installed in accordance with the requirements of TIA-569-B.

NOTE - "Backbone" is used as a descriptor since the cable in this part of the cabling system typically runs vertically within a building.

The cabling should be planned to accommodate future equipment needs, diverse user applications, ongoing maintenance, service changes and relocation.

7.2 Topology

7.2.1 Star topology

The backbone cabling shall meet the hierachal star topology requirements of ANSI/TIA-568-C.0. There shall be no more than two hierarchical levels of cross-connects in the backbone cabling. From the horizontal cross-connect (HC), no more than one cross-connect shall be passed through to reach the MC. Therefore, connections between any two HCs shall pass through three or fewer cross-connect facilities.

NOTE: The topology required by this Standard has been selected because of its acceptance and flexibility in meeting a variety of application requirements. The limitation to two levels of cross-connects is imposed to limit signal degradation for passive systems and to simplify moves, adds and changes. This limitation may not be suitable for facilities that have a large number of buildings or those that cover a large geographical area.

Centralized optical fiber cabling (see clause 6.5) is designed as an alternative to the optical cross-connection located in the TR or TE when deploying recognized optical fiber to the work area (WA) from a centralized cross-connect.

The requirements of ANSI/TIA-568-C.0 shall apply to non-star backbone configurations that are accommodated by the star topology.

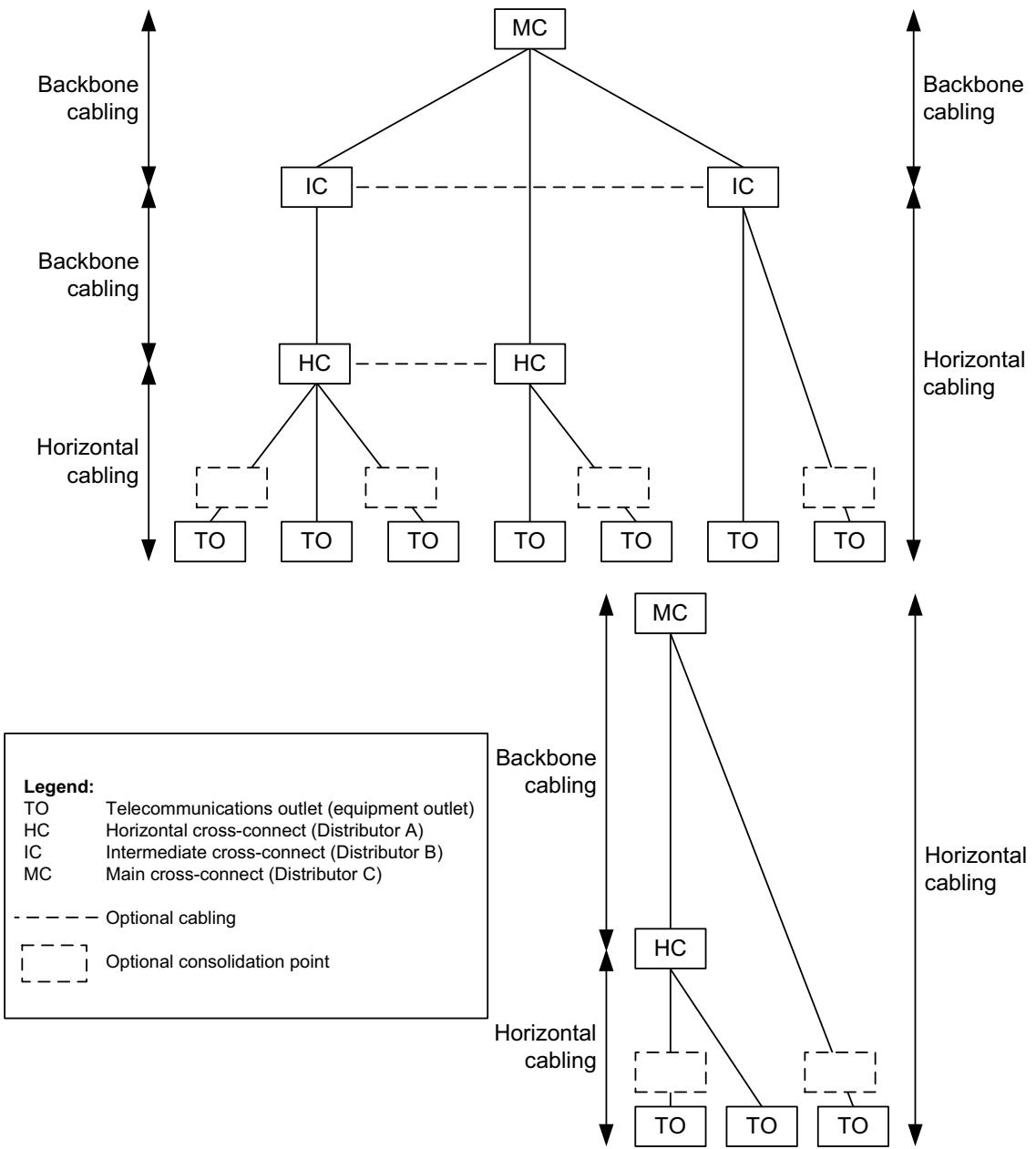


Figure 4 – Commercial building hierarchical star topology examples

7.2.2 Cabling directly between telecommunications rooms/telecommunications enclosures

If requirements for "bus" or "ring" or "redundancy/fault tolerant" configurations are anticipated, then cabling directly between TRs or TEs is allowed. Such cabling is in addition to the connections for the star topology specified in clause 7.2.1. See TIA-569-B for pathway considerations.

7.3 Length

The backbone cable length extends from the termination of the media at the MC to an IC or HC. To minimize cabling distances, it is often advantageous to locate the MC near the center of the

commercial premises. Cabling installations may be divided into areas, each of which can be supported by backbone cabling within the scope of this Standard.

Cabling lengths are dependent upon the application and upon the specific media chosen (see ANSI/TIA-568-C.0 and the specific application standard). The backbone length includes the backbone cable, patch cords and cross-connect jumpers. Applicable balanced twisted-pair de-rating factors (see ANSI/TIA/EIA-568-B.2) for cross-connect jumpers and cords shall be taken into account.

The length of the cross-connect jumpers and patch cords in the MC or IC should not exceed 20 m (66 ft).

The length of the cord used to connect telecommunications equipment directly to the MC or IC should not exceed 30 m (98 ft).

7.4 Recognized cabling

This Standard specifies transmission media, which shall be used individually or in combination in the backbone cabling. The recognized media are:

- a) 100-ohm twisted-pair cabling: category 3, category 5e, category 6 or category 6A (ANSI/TIA/EIA-568-B.2)
- b) multimode optical fiber cabling: 850nm laser-optimized 50/125 μm is recommended; 62.5/125 μm and 50/125 μm (ANSI/TIA-568-C.3)
- c) single-mode optical fiber cabling (ANSI/TIA-568-C.3)

Each recognized medium has individual characteristics that make it useful in a variety of situations. One medium may not satisfy all end user requirements. It is then necessary to use more than one medium in the backbone cabling.

8 HORIZONTAL CABLING (CABLING SUBSYSTEM 1)

8.1 General

Horizontal cabling (see figure 5) includes horizontal cable, telecommunications outlet/connectors in the work area (WA), mechanical terminations and patch cords or jumpers located in a telecommunications room (TR) or telecommunications enclosure (TE), and may incorporate multi-user telecommunications outlet assemblies (MUTOAs) and consolidation points (CPs). The pathways and spaces to support horizontal cabling shall be designed and installed in accordance with the requirements of TIA-569-B.

Some networks or services require applications-specific electrical components (such as impedance matching devices). These application-specific electrical components shall not be installed as part of the horizontal cabling. When needed, such electrical components shall be placed external to the telecommunications outlet/connector. Keeping application-specific components external to the telecommunications outlet/connector will facilitate the use of the horizontal cabling for varying network and service requirements.

A minimum of two permanent links shall be provided for each work area. The cabling should be planned to accommodate future equipment needs, diverse user applications, ongoing maintenance, relocation and service changes. Indeed, horizontal cabling is often less accessible than backbone cabling and adding or changing horizontal cabling may cause disruption to occupants and their work once the building walls and ceilings are closed after the initial installation. The time, effort, and skills required for these subsequent changes are significant and make the choice and design layout of the horizontal cabling very important to the building occupants and to the maintenance of the telecommunications infrastructure. Therefore, it is incumbent on the designer to accommodate user needs and to reduce or eliminate the probability of requiring changes to the horizontal cabling as user requirements evolve.

Each 4-pair cable at the equipment outlet shall be terminated in an eight-position modular jack. The telecommunications outlet/connector for 100-ohm balanced twisted-pair cable shall meet the requirements of ANSI/TIA/EIA-568-B.2.

Optical fibers at the equipment outlet shall be terminated to a duplex optical fiber outlet/connector meeting the requirements of ANSI/TIA-568-C.3.

8.2 Topology

The horizontal cabling shall meet the star topology requirements of ANSI/TIA-568-C.0. Each WA telecommunications outlet/connector shall be connected to the horizontal cross-connect (HC) as shown in figure 5.

NOTE: In addition to a HC being located in a TR or TE, it may be co-located with an intermediate cross-connect (IC; Distributor A) or a main cross-connect (MC; Distributor C) where they are deployed. See clause 6.1, figure 2 and figure 4.

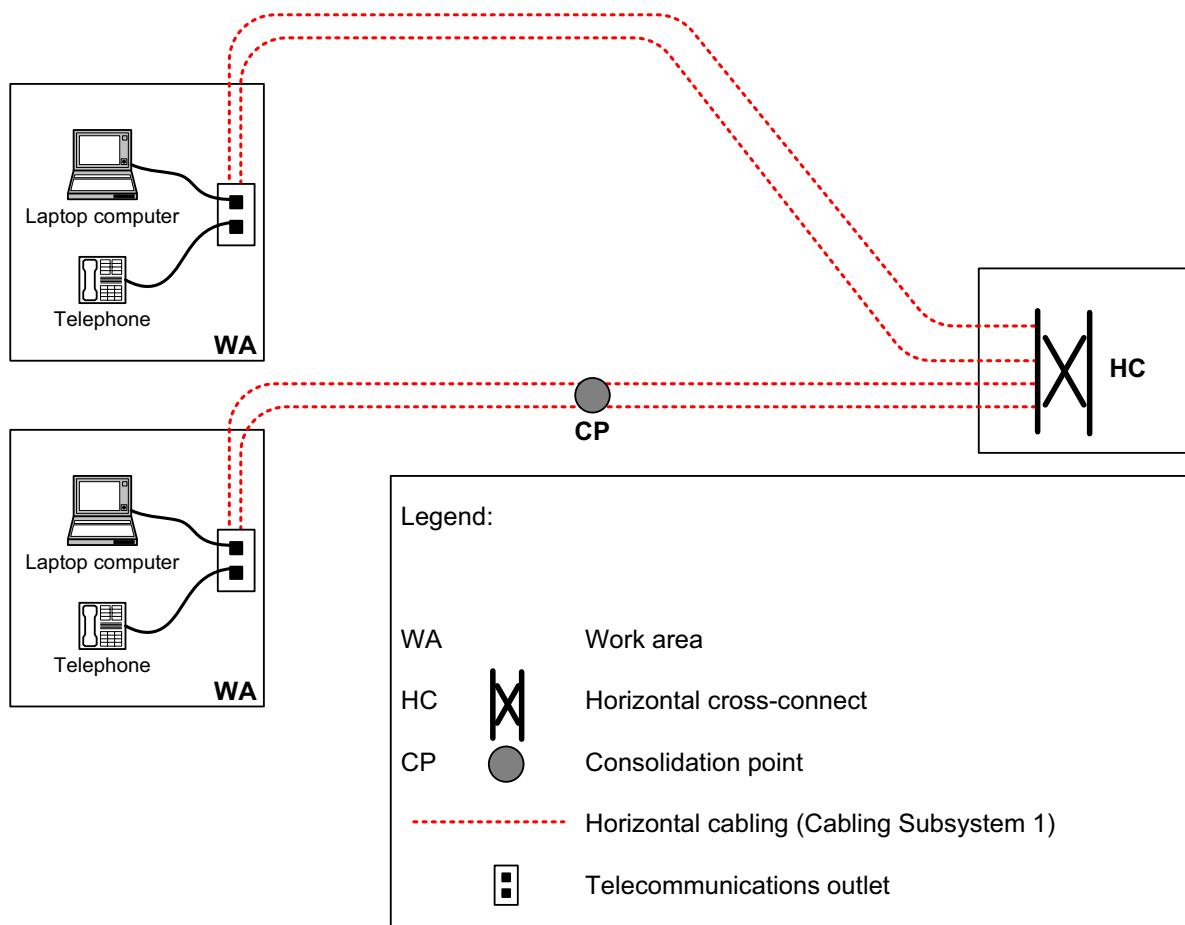


Figure 5 – Typical horizontal and work area cabling using a star topology

8.3 Length

The horizontal cable length extends from the termination of the media at the HC in the TR or, when used, the TE to the telecommunications outlet/connector in the work area. The maximum horizontal cable length shall be 90 m (295 ft), independent of media type. Where a MUTOA is deployed, the maximum horizontal balanced twisted-pair copper cable length shall be reduced in accordance with clause 9.3.1.4.1.

The length of the cross-connect jumpers and patch cords in the cross-connect facilities, including HCs, jumpers, and patch cords that connect horizontal cabling with equipment or backbone cabling, should not exceed 5 m (16 ft). For each horizontal channel, the total length allowed for cords in the WA, plus patch cords or jumpers, plus equipment cords in the TR or TE shall not exceed 10 m (33 ft) unless a MUTOA is used (see clause 9.3.1).

NOTE – In establishing the maximum distance for each horizontal channel, an allowance was made for 5 m (16 ft) from the telecommunications outlet/connector to the work station.

8.4 Recognized cabling

Three types of media are recognized and recommended for use in the horizontal cabling system. These media are:

- a) 4-pair 100-ohm unshielded or shielded twisted-pair cabling: category 5e, category 6 or category 6A (ANSI/TIA/EIA-568-B.2)
- b) multimode optical fiber cabling (ANSI/TIA-568-C.3), 2-fiber (or higher fiber count)
- c) single-mode optical fiber cabling (ANSI/TIA-568-C.3), 2-fiber (or higher fiber count)

8.5 Bundled and hybrid cables

Bundled and hybrid balanced twisted-pair cables used for horizontal cabling shall meet the requirements for bundled and hybrid cables detailed in ANSI/TIA/EIA-568-B.2. These requirements apply to hybrid cables and bundled cables assembled prior to installation, sometimes referred to as loomed, speed-wrap, or whip cable constructions.

NOTE – Hybrid cables consisting of optical fiber and copper conductors are sometimes referred to as composite cables.

9 WORK AREA

9.1 General

The work area (WA) components extend from the telecommunications outlet/connector end of the horizontal cabling system to the WA equipment. The telecommunications outlet/connector shall meet the requirements of ANSI/TIA-568-C.0. To simplify relocations, consider a single style of outlet/connector for all work area outlets of the same media type.

9.2 Work area cords

The maximum horizontal cable length is specified in clause 8.3 and is based on a maximum length of 5 m (16 ft) of WA cord. WA cords used in the WA shall meet or exceed the performance requirements in ANSI/TIA/TIA-568-B.2 or ANSI/TIA-568-C.3.

WA cabling may vary in form depending on the application. When application-specific adaptations are needed at the WA, they shall be external to the telecommunications outlet/connector (see clause 8.1). Some of the most commonly encountered adaptations at the work area are listed below.

- a) a special cable or adapter is required when the equipment connector is different from the telecommunications outlet/connector
- b) a "Y" adapter is required when two services run on a single cable
- c) passive adapters that may be needed when the cable type in the horizontal cabling is different from the cable type required by the equipment
- d) active adapters that may be needed when connecting devices that use different signaling schemes
- e) pair transposition adapters that may be necessary for compatibility
- f) termination resistors required for ISDN terminals

NOTE – When used, cabling adapters in the WA may have detrimental effects on the transmission performance of the telecommunications cabling system. Therefore, it is important that their compatibility with premises cabling, equipment and applications be considered before they are connected to the telecommunications network.

9.3 Open office cabling

Open office design practices use multi-user telecommunications outlet assemblies (MUTOAs), consolidation points (CPs), or both to provide flexible layouts. Such spaces are frequently rearranged to meet changing requirements of the end-users. An interconnection in the horizontal cabling allows open office spaces to be reconfigured frequently without disturbing horizontal cable runs.

9.3.1 Multi-user telecommunications outlet assembly

MUTOAs may be advantageous in open office spaces that are moved or reconfigured frequently. A MUTOA facilitates the termination of single or multiple horizontal cables in a common location within a furniture cluster or similar open area. The use of MUTOAs allows horizontal cabling to remain intact when the open office plan is changed. WA cords originating from the MUTOA should be routed through WA pathways (e.g., furniture pathways). The WA cables shall be connected directly to work station equipment without the use of any additional intermediate connections (see figure 6).

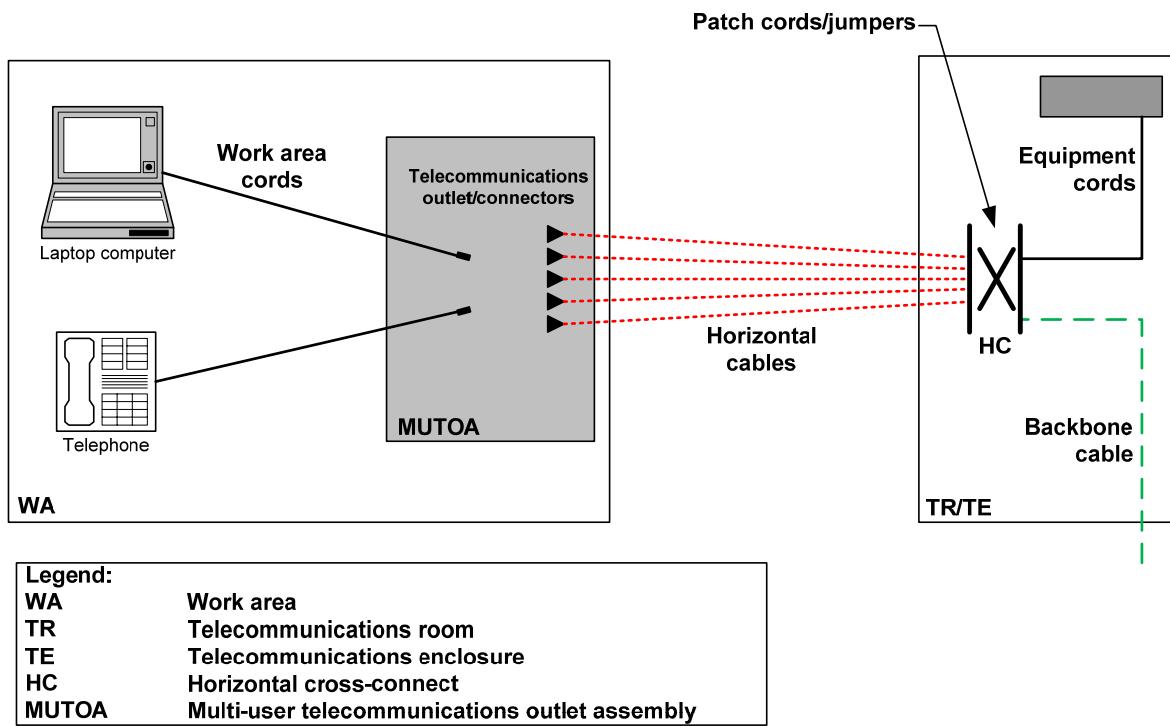


Figure 6 – Application of a multi-user telecommunications outlet assembly

9.3.1.1 Application planning

MUTOAs should be located in an open area so that each WA cluster is served by at least one MUTOA. The MUTOA should be limited to serving a maximum of 12 work areas. Maximum WA cable length requirements (see clause 9.3.1.4) shall also be taken into account. Spare capacity should also be considered when sizing the MUTOA.

9.3.1.2 Installation practices

MUTOAs shall be located in fully accessible, permanent locations such as building columns, and permanent walls. MUTOAs shall not be located in ceiling spaces, or any obstructed area. MUTOAs shall not be installed in furniture unless that unit of furniture is permanently secured to the building structure.

9.3.1.3 Administration

In addition to the requirements of ANSI/TIA/EIA-606-A, the WA cords connecting the MUTOA to the WA equipment shall be labeled on both ends with a unique cord identifier. The end of the WA cords at the MUTOA shall be labeled with the WA equipment it serves, and the end at the WA equipment shall be labeled with the MUTOA identifier and a port identifier. The MUTOA shall be marked with the maximum allowable WA cord length.

9.3.1.4 Maximum work area cord lengths

9.3.1.4.1 Balanced twisted-pair cabling

Balanced twisted-pair WA cables used in the context of MUTOAs and open office furniture, shall meet the requirements of ANSI/TIA/EIA-568-B.2. The maximum length in meters shall be determined according to:

$$C = (102 - H)/(1+D) \quad (1)$$

$$W = C - T \quad (2)$$

Where:

- C is the maximum combined length (m) of the WA cord, equipment cord, and patch cord.
- H is the length (m) of the horizontal cable ($H + C \leq 100$ m).
- D is the insertion loss de-rating factor for the cord type (0 for solid conductor cords, 0.2 for 24 AWG stranded cords and 0.5 for 26 AWG stranded cords).
- W is the maximum length (m) of the WA cord
- T is the total length of patch and equipment cords in the telecommunications room (TR) or telecommunications enclosure (TE).

Table 1 illustrates the results of the above formulae assuming that there is a total of 5 m (16 ft) of 24 AWG or 4 m (13 ft) of 26 AWG patch cords and equipment cord in the TR or TE.

Table 1 – Maximum length of horizontal cables and work area cords

Length of horizontal cable	24 AWG cords			26 AWG cords		
	H m (ft)	Maximum length of work area cord	Maximum combined length of work area cord, patch cords, and equipment cord	W m (ft)	Maximum length of work area cord	Maximum combined length of work area cord, patch cords, and equipment cord
		m (ft)	m (ft)		m (ft)	m (ft)
90 (295)	5 (16)	10 (33)	4 (13)	8 (26)		
85 (279)	9 (30)	14 (46)	7 (23)	11 (35)		
80 (262)	13 (44)	18 (59)	11 (35)	15 (49)		
75 (246)	17 (57)	22 (72)	14 (46)	18 (59)		
70 (230)	22 (72)	27 (89)	17 (56)	21 (70)		

9.3.1.4.2 Optical fiber cabling

Optical fiber work area cords used in the context of MUTOAs and open office furniture, shall meet the requirements of ANSI/TIA-568-C.3. The maximum horizontal cabling length is not affected by the deployment of a MUTOA.

9.3.2 Consolidation point

The CP is an interconnection point within the horizontal cabling using ANSI/TIA/EIA-568-B.2 or ANSI/TIA-568-C.3 compliant connecting hardware installed in accordance with the requirements of clause 10. It differs from the MUTOA in that a CP requires an additional connection for each horizontal cable run. Cross-connections shall not be used at a CP. No more than one CP shall be used within the same horizontal cable run. A transition point and CP shall not be used in the same horizontal cabling link. Each horizontal cable extending to the WA outlet from the CP shall be terminated to a telecommunications outlet/connector or MUTOA, provided the requirements of clause 9.3.1.4 and the transmission performance of clause 11 are met. The cables and connections

ANSI/TIA-568-C.1

used at a CP shall meet the requirements of ANSI/TIA/EIA-568-B.2 or ANSI/TIA-568-C.3 and be installed in accordance with the requirements of clause 10 (see figure 7).

For balanced twisted-pair cabling, in order to reduce the effect of multiple connections in close proximity on NEXT loss and return loss, the CP should be located at least 15 m (49 ft) from the TR or TE.

A CP may be useful when reconfiguration is frequent, but not so frequent as to require the flexibility of the MUTOA.

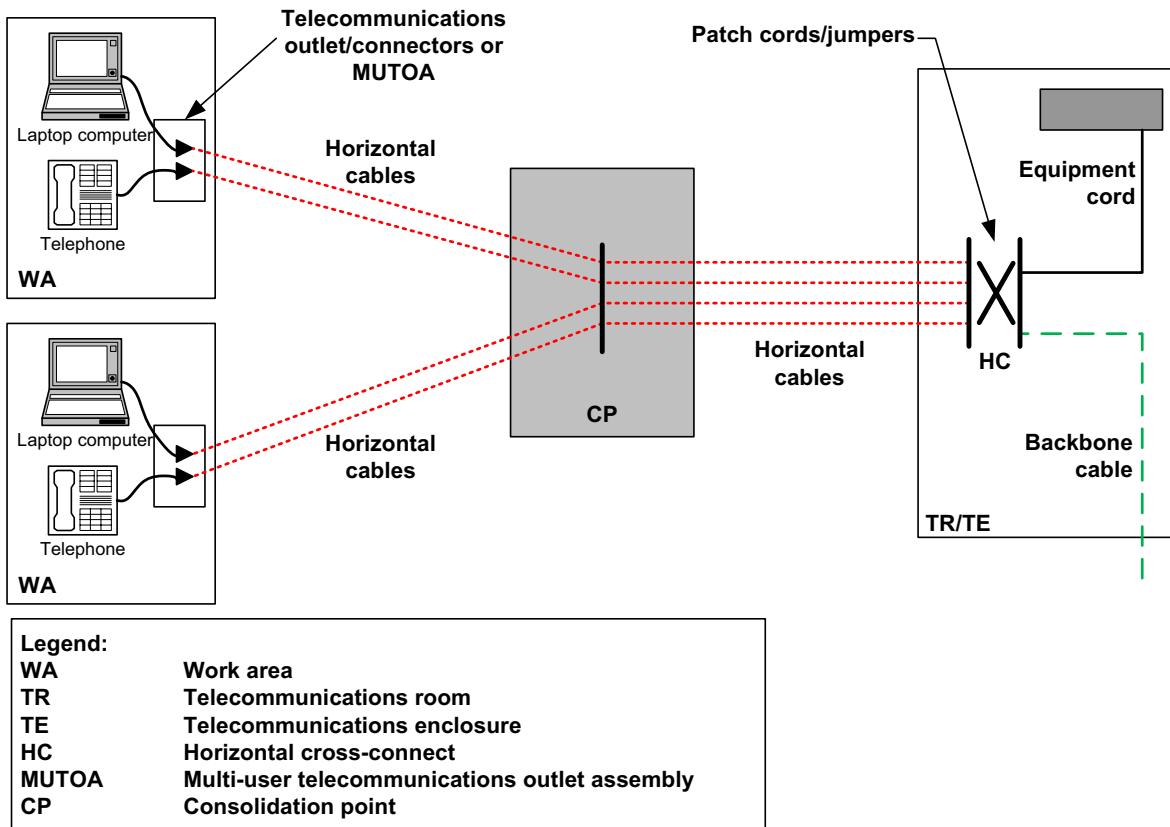


Figure 7 – Application of consolidation point

9.3.2.1 Application planning

CPs should be located in an open work area so that each WA cluster is served by at least one CP. The CP should be limited to serving a maximum of 12 work areas. Spare capacity should also be considered when sizing the CP.

9.3.2.2 Installation practices

CPs shall be located in fully accessible, permanent locations such as building columns, and permanent walls. CPs shall not be located in any obstructed area. CPs shall not be installed in furniture unless that unit of furniture is secured to the building structure. CPs shall not be used for direct connection to active equipment.

10 CABLING INSTALLATION REQUIREMENTS

10.1 General

The installation requirements in ANSI/TIA-568-C.0, in addition to the other clauses of this Standard, shall be followed. Cabling shall comply with applicable codes and regulations.

10.2 Grounding and bonding

Grounding and bonding shall meet the requirements of ANSI/TIA-568-C.0.

11 CABLING TRANSMISSION PERFORMANCE AND TEST REQUIREMENTS

The transmission performance requirements of ANSI/TIA-568-C.0 shall be met.

ANNEX A (INFORMATIVE) BIBLIOGRAPHY

This annex is informative only and is not part of this Standard.

The organizations listed below can be contacted to obtain reference information.

ANSI

American National Standards Institute (ANSI)
11 W 42 St.
New York, NY 10032
USA
(212) 642-4900
www.ansi.org

ASTM

American Society for Testing and Materials (ASTM)
100 Barr Harbor Drive
West Conshohocken, PA 19428-2959
USA
(610) 832-9500
www.astm.org

BICSI

BICSI
8610 Hidden River Parkway
Tampa, FL 33637-1000
USA
(800) 242-7405
www.bicsi.org

CSA

Canadian Standards Association International (CSA)
178 Rexdale Blvd.
Etobicoke, (Toronto), Ontario
Canada M9W 1R3
(416) 747-4000
www.csa-international.org

FCC

Federal Communications Commission (FCC)
Washington, DC 20554
USA
(301) 725-1585
www.fcc.org

Federal and Military Specifications

National Communications System (NCS)
Technology and Standards Division
701 South Court House Road Arlington, VA 22204-2198
USA
(703) 607-6200
www.ncs.gov

ANSI/TIA-568-C.1

ICEA

Insulated Cable Engineers Association, Inc. (ICEA)
P.O. Box 1568
Carrollton, GA 30112
USA
www.icea.net

IEC

International Electrotechnical Commission (IEC)
Sales Department
PO Box 131
3 rue de Varembe
1211 Geneva 20
Switzerland
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www.iec.ch

IEEE

The Institute of Electrical and Electronic Engineers, Inc (IEEE)
IEEE Service Center
445 Hoes Ln., PO Box 1331
Piscataway, NJ 08855-1331
USA
(732) 981-0060
www.ieee.org

ISO

International Organization for Standardization (ISO)
1, Rue de Varembe
Case Postale 56
CH-1211 Geneva 20
Switzerland
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www.iso.ch

NFPA

National Fire Protection Association (NFPA)
Batterymarch Park
Quincy, MA 02269-9101
USA
(617) 770-3000
www.nfpa.org

TIA

Telecommunications Industry Association (TIA)
2500 Wilson Blvd., Suite 300
Arlington, VA 22201-3836
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UL

Underwriters Laboratories, Inc. (UL)
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