Telecommunications Industry Association

Cabling Standards

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Compiled by Scott Stephenson

Cabling Standards

Standards are sets of rules or procedures that are either widely used, or officially specified to provide a model of excellence. A single vendor specifies some standards. Industry standards support multi-vendor interoperability in the following ways:

- Standardized media and layout descriptions for both backbone and horizontal cabling
- Standard connection interfaces for the physical connection of equipment
- Consistent and uniform design that follows a system plan and basic design principles

Numerous organizations regulate and specify different types of cables. Local, state, county, and national government agencies also issue codes, specifications, and requirements.

A network that is built to standards should work well, or interoperate, with other standard network devices. The long term performance and investment value of many network cabling systems has been diminished by installers who do not comply with mandatory and voluntary standards.

These standards are constantly reviewed and periodically updated to reflect new technologies and the increasing requirements of voice and data networks. As new technologies are added to the standards, others are phased out. A network may include technologies that are no longer a part of the current standard or will soon be eliminated. These technologies do not usually require an immediate changeover. They are eventually replaced by newer and faster technologies.

Many international organizations attempt to develop universal standards. Organizations such as the IEEE, ISO, and IEC are examples of international standards bodies. These organizations include members from many nations, which all have their own process for creating standards.

In many countries, the national codes become the model for state and provincial agencies as well as municipalities and other governmental units to incorporate into their laws and ordinances. The enforcement then moves to a local authority. Always check with local authorities to determine what codes are enforced. Most local codes take precedence over national codes, which take precedence over international codes.

Cabling Standards

ANSI/TIA/EIA-568-B and ISO/IEC 11801:2002 2nd Edition, IEC 61156-5, -6

The latest edition of the Commercial Building Telecommunications Cabling Standard is ANSI/TIA/EIA-568-B. The Telecommunications Industry Association (TIA) TR42 Technical Committee has broken the standard into a series of documents known as B.1, B.2 and B.3. The B.1 document contains the information needed for designing, installing, and field testing a generic structured cabling system. The B.2 and B.3 documents contain manufacturing and component reliability test specifications for cable, patch cords and connecting hardware. The B.3 document was published in April 2000 dealing with optical fiber. The B.2 document addresses electrical and mechanical requirements of balanced twisted-pair UTP and ScTP. Both B.1 and B.2 were published in June 2001.

Also, the International Organization for Standardization (ISO) JTC1 SC 25/WG 3 Working Group on telecommunications cabling has published the second edition of the ISO/IEC 11801:2002 standard. The publication of this standard replaces Edition 1.2. The second edition of the standard addresses class E and F cabling as well as category 6 and 7 connecting hardware and cables. Items of interest are the work area interface for category 7 and coupling attenuation for copper systems. In optical fiber, the document has standardized on three classes of optical fiber cabling to service existing and future networking applications for channel lengths of 300m, 500m and 2000m.

For cabling requirements, ‘11801:2002 references the IEC cable specifications for horizontal (IEC 61156-5) and work area (IEC 61156-6). With a few exceptions detail in the cable clause of ‘11801:2002, all requirements for cable can be found in these two specifications.

Following are highlights of the ’568-B series standard which has incorporated Telecommunications System Bulletins (TSB’s) TSB 67, TSB 72, TSB 75, TSB 95, Addendum’s TIA/EIA-568-A-1, ’A-2, ’A-3, ’A-4, and ’A-5 and TIA/EIA/IS-729. For clarity and consistency, ’568-B based terminology is used in the following overview with notes on differences in terminology and technical requirements with respect to ’11801:2002.

Purpose

- To specify a generic telecommunications cabling system that will support a multi-product, multi-vendor environment.
- To provide direction for the design of telecommunications equipment and cabling products intended to serve commercial enterprises.
- To enable the planning and installation of a structured cabling system for commercial buildings that is capable of supporting the diverse telecommunications needs of building occupants.
- To establish performance and technical criteria for various types of cable and connecting hardware and for cabling system design and installation.

Cabling Standards

Scope

- Specifications are intended for telecommunications installations that are “office oriented”.
- Requirements are for a structured cabling system with a usable life in excess of 10 years.
- Specifications addressed:
    - Recognized Media
    - Cable and Connecting Hardware
    - Performance
    - Topology
    - Cabling Distance
    - Installation Practices
    - User Interfaces
    - Channel Performance

Cabling Elements:

- Horizontal Cabling:
    - Horizontal Cross-connect (HC)
    - Horizontal Cable
    - Consolidation Point (optional)
    - Telecommunications-Outlet/Connector (TO)
- Backbone Cabling:
    - Main Cross-connect (MC)
    - Interbuilding Backbone Cable
    - Intermediate Cross-connect (IC)
    - Intrabuilding Backbone Cable
- Work Area (WA)
- Telecommunications Room (TR)
- Equipment Room (ER)
- Entrance Facility (EF)
- Administration*

*Although administration is addressed to a limited extent, the governing specification on telecommunications administration is ANSI/TIA/EIA-606-A and ISO/IEC 14763-1

Cabling Standards

B.1
A. Centralized optical fiber cabling (Normative).
B. Shared sheath guidelines for multi-pair UTP cables (Informative).
C. Other cable specifications (Informative)
D. Category 5 cabling transmissions (Informative).
E. Optical fiber applications support information (Informative).
F. Bibliography (Informative).

B.2
A. Reliability testing of connecting hardware used for 100 Ohm balanced twisted-pair cabling (Normative).
B. Test equipment overview (Normative).
C. Testing of cable (Normative).
D. Testing of connecting hardware (Normative).
E. Testing of cabling (Normative).
F. Testing of patch cords (Normative).
G. Multi-port measurement considerations (Normative).
H. Measurement accuracy (Informative).
I. Test instruments (Normative).
J. Comparison measure procedures (Normative).
K. 100 W screened twisted-pair (ScTP) cabling (Normative).
L. Derivation of propagation delay from insertion loss equation (Informative).
M. 150 W shielded twisted-pair cabling (Normative).
N. Category 5 cabling (Informative).
O. Development of channel and component return loss limits (Informative).
P. Bibliography (Informative).

B.3
A. Optical fiber connector performance specifications (Normative).
B. Bibliography and references (Informative).

Cabling Standards

Rules of Structured Cabling for LANs

Structured cabling is a systematic approach to cabling. It is a method for creating an organized cabling system that can be easily understood by installers, network administrators, and any other technicians that deal with cables.

There are three rules that will help ensure the effectiveness and efficiency of structured cabling design projects.

Rule #1 - Look for a complete connectivity solution. An optimal solution for network connectivity includes all the systems that are designed to connect, route, manage, and identify cables in structured cabling systems. A standards-based implementation is designed to support both current and future technologies. Following the standards will help ensure the long-term performance and reliability of the project.

Rule #2 - Plan for future growth. The number of cables installed should also meet future requirements. Category 5e, Category 6, and fiber-optic solutions should be considered to ensure that future needs will be met. The physical layer installation plan should be capable of functioning for ten or more years.

Rule #3 - Maintain freedom of choice in vendors. Even though a closed and proprietary system may be less expensive initially, this could end up being much more costly over the long term. A non-standard system from a single vendor may make it more difficult to make moves, adds, or changes at a later time.

Cabling Standards

Scalability

A LAN that can accommodate future growth is referred to as a scalable network. It is important to plan ahead when estimating the number of cable runs and cable drops in a work area. It is better to install extra cables than to not have enough.

In addition to pulling extra cables in the backbone area for future growth, an extra cable is generally pulled to each workstation or desktop. This gives protection against pairs that may fail on voice cables during installation, and it also provides for expansion. It is also a good idea to provide a pull string when installing the cables to make it easier for adding cables in the future. Whenever new cables are added, a new pull string should also be added

Backbone scalability

When deciding how much extra copper cable to pull, first determine the number of runs that are currently needed and then add approximately 20 percent of extra cable.

A different way to obtain this reserve capability is to use fiber-optic cabling and equipment in the building backbone. For example, the termination equipment can be updated by inserting faster lasers and drivers to accommodate fiber growth.

Work area scalability

Each work area needs one cable for voice and one for data. However, other devices may need a connection to either the voice or the data system. Network printers, FAX machines, laptops, and other users in the work area may all require their own network cable drops.

After the cables are in place, use multiport wall plates over the jacks. There are many possible configurations for modular furniture or partition walls. Color-coded jacks can be used to simplify the identification of circuit types, as shown in Figure 1. Administration standards require that every circuit should be clearly labeled to assist in connections and troubleshooting.

A new technology that is becoming popular is Voice over Internet Protocol (VoIP). This technology allows special telephones to use data networks when placing telephone calls. A significant advantage of this technology is the avoidance of costly long distance charges when VoIP is used over existing network connections. Other devices like printers or computers can be plugged into the IP phone. The IP phone then becomes a hub or switch for the work area. Even if these types of connections are planned, enough cables should be installed to allow for growth. Especially consider that IP telephony and IP video traffic may share the network cables in the future.

To accommodate the changing needs of users in offices, it is recommended to provide at least one spare cable to the work area outlet. Offices may change from single user to multi-user spaces. This can result in an inefficient work area if only one set of communication cables was pulled. Assume that every work area will accommodate multiple users in the future.

Cabling Standards

Demarcation Point

The demarc is where the outside service provider cables connect to the customer cables in the facility. It represents the boundary between the responsibility of the service provider and the responsibility of the customer. Backbone cabling is the feeder cables that are routed from the demarc to the equipment rooms and then on to the telecommunications rooms throughout the facility. Horizontal cabling distributes cables from the telecommunication rooms to the work areas. The telecommunications rooms are where connections take place to provide a transition between the backbone cabling and horizontal cabling. In many buildings, the demarc is near the point of presence (POP) for other utilities such as electricity and water.

These subsystems make structured cabling a distributed architecture with management capabilities that are limited to the active equipment, such as PCs, switches, hubs, and so forth. Designing a structured cabling infrastructure that properly routes, protects, identifies, and terminates the copper or fiber media is absolutely critical for network performance and future upgrades.

The service provider is responsible for everything from the demarc out to the service provider facility. Everything from the demarc into the building is the responsibility of the customer.

The local telephone carrier is typically required to terminate cabling within 15 m (49.2 feet) of building penetration and to provide primary voltage protection. The service provider usually installs this.

The Telecommunications Industry Association (TIA) and Electronic Industries Alliance (EIA) develop and publish standards for many industries, including the cabling industry. To ensure that the cabling is safe, installed correctly, and retains performance ratings, these standards should be followed during any voice or data cabling installation or maintenance.

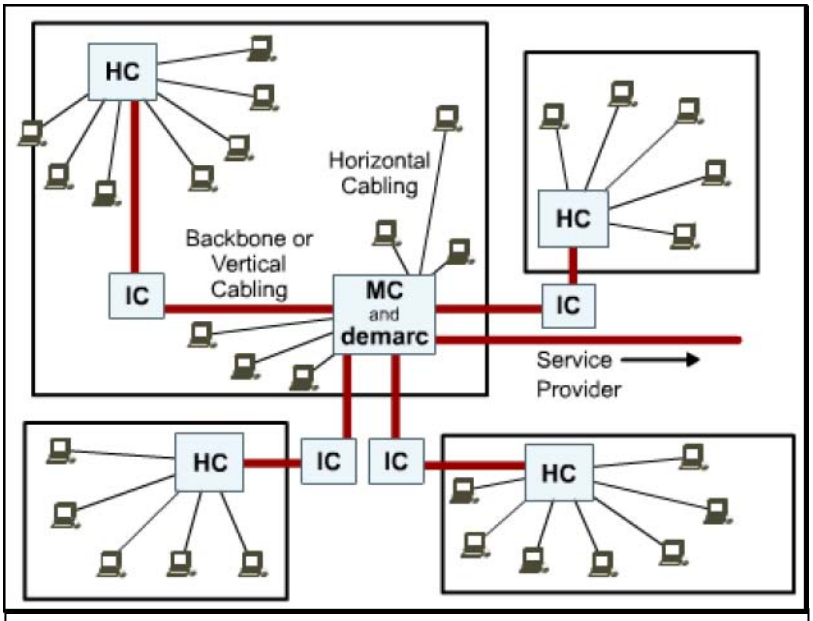
The TIA/EIA-569-A standard specifies the requirements for the demarc space. The standards for the structure and size of the demarc space are based on the size of the building. In buildings larger than 2,000 square meters (21,528 sq ft), a locked, dedicated, and enclosed room is recommended.

The following are general guidelines for setting up a demarcation point space:

- Allow 1 square meter (10.8 sq feet) of plywood wall mount for each 20-square meter (215.3-sq feet) area of floor space
- Cover the surfaces where the distribution hardware is mounted with fire-rated plywood or plywood that is painted with two coats of fire retardant paint
- Either the plywood or the covers for the termination equipment should be colored orange to indicate the point of demarcation.

Cabling Standards

MC, IC, and HC



MC, HC, and IC Planning

Most networks have multiple TRs for various reasons. If a network is spread over many floors or buildings, a TR is needed for each floor of each building. Media can only travel a certain distance before the signal starts to degrade or attenuate. Therefore, TRs are located at defined distances throughout the LAN to provide interconnects and cross-connects to hubs and switches to assure desired network performance. These TRs house equipment such as repeaters, hubs, bridges, or switches that are needed to regenerate the signals.

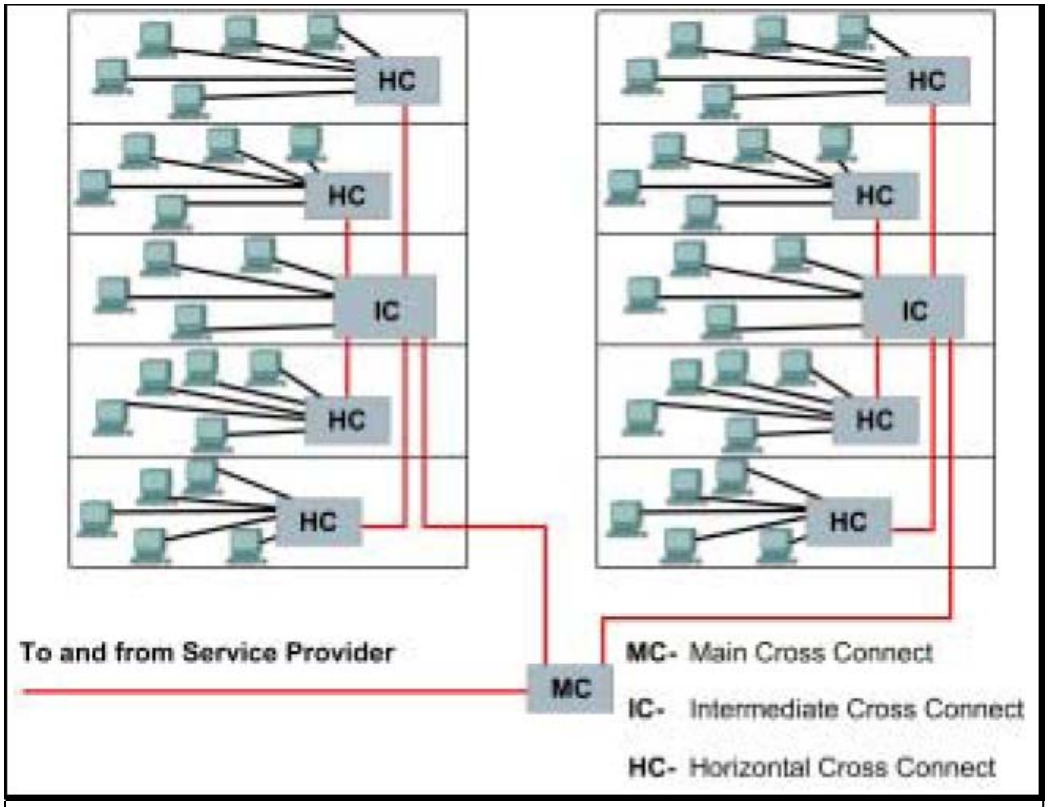
The primary TR is referred to as the main cross-connect (MC). The MC is the center of the network. This is where all the wiring originates and where most of the equipment is located. The intermediate cross-connect (IC) is connected to the MC and may hold the equipment for a building on a campus. The horizontal cross-connect (HC) provides the cross-connect between the backbone and horizontal cables on a single floor of a building.

Main cross-connect (MC)

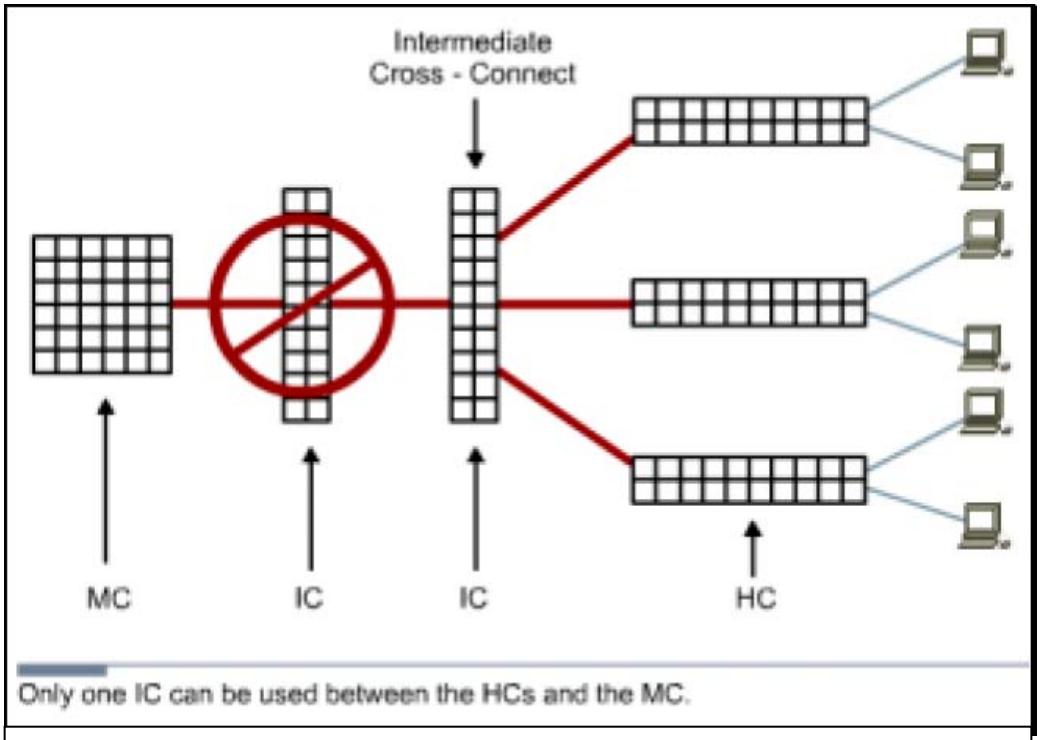
The MC is the main concentration point of a building or campus. It is the room that controls the rest of the TRs in a location. In some networks, it is where the cable plant connects to the outside world, or the demarc.

All ICs and HCs are connected to the MC in a star topology. Backbone, or vertical, cabling is used to connect ICs and HCs on different floors. If the entire network is confined to a single multistory building, the MC is usually located on one of the middle floors, even if the demarc is located in an entrance facility on the first floor or in the basement.

Cabling Standards



MC, HC, and IC



Connecting the MC to the IC and HCs

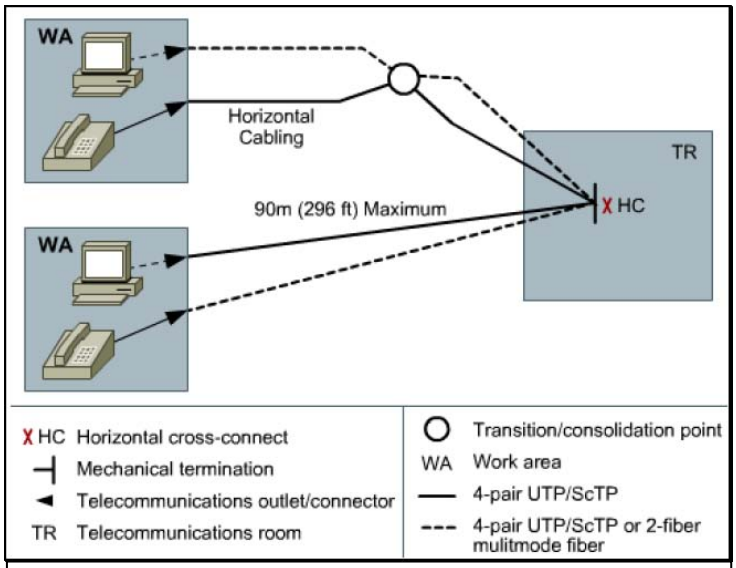
Cabling Standards

The backbone cabling runs from the MC to each of the ICs. The red lines in the chart represent the backbone cabling. The ICs are located in each of the campus buildings, and the HCs serve work areas. The black lines represent horizontal cabling from the HCs to the work areas.

For campus networks in multiple buildings, the MC is usually located in one building. Each building typically has its own version of the MC called the intermediate cross-connect (IC). The IC connects multiple HCs within the building. It also enables the extension of backbone cabling from the MC to each HC because this interconnection point does not degrade the communications signals.

There may only be one MC for the entire structured cabling installation. The MC feeds the ICs. Each IC feeds multiple HCs. There can only be one IC between the MC and any HC.

Horizontal cross-connect (HC)



Horizontal Cabling and Symbols

The horizontal cross-connect (HC) is the TR closest to the work areas. The HC is typically a patch panel or punch down block. The HC may also contain networking devices such as repeaters, hubs, or switches. It can be rack mounted in a room or in a cabinet. Since a typical horizontal cable system includes multiple cable runs to each workstation, it can represent the largest concentration of cable in the building infrastructure. A building with 1,000 workstations may contain a horizontal cable system with 2,000 to 3,000 cable runs.

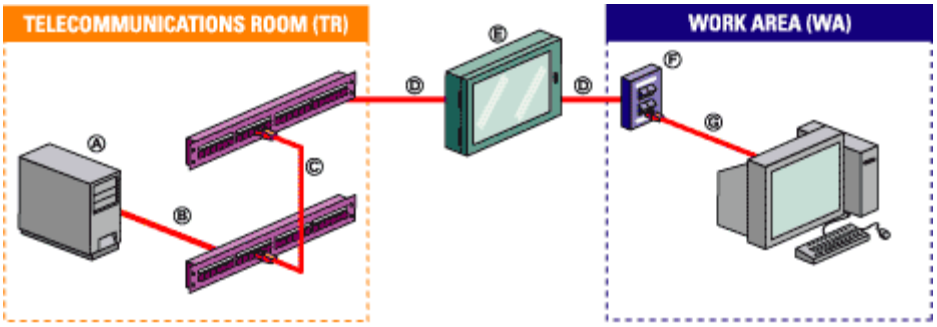
Horizontal cabling includes the copper or optical fiber networking media that is used from the wiring closet to a workstation, as shown in Figure 1. Horizontal cabling also includes the networking media that runs along a horizontal pathway that leads to the telecommunications outlet, and the patch cords, or jumpers in the HC.

Any cabling between the MC and another TR is backbone cabling. The difference between horizontal and backbone cabling is defined in the standards.

Cabling Standards

Horizontal Cabling System Structure

The horizontal cabling system extends from the telecommunications outlet in the work area to the horizontal cross-connect in the telecommunications room. It includes the telecommunications outlet, an optional consolidation point or transition point connector, horizontal cable, and the mechanical terminations and patch cords (or jumpers) that comprise the horizontal cross-connect.



A. Customer Premises Equipment
B. HC Equipment Cord
C. Patch cords/cross-connect jumpers used in the HC, including equipment cables/cords, should not exceed 5m (16 ft.)
D. Horizontal cable 90m (295 ft.) max. total
E. TP or CP (optional)
F. Telecommunications outlet/connector (TO)
G. WA Equipment cord

Notes:
**An allowance of 10m (33 ft.) has been provided for the combined length of patch cords/cross-connect jumpers and equipment cables/cords in the HC, including the WA equipment cords.*
**In ISO/IEC 11801:2002, the equivalent cabling element to the horizontal cross-connect (HC) is called the floor distributor (FD).*
ISO/IEC 11801:2002 specifies a max. patch cord/cross-connect length of 5m (16.4 ft.), which does not include equipment cables/cords.
An allowance is made for WA equipment cords of 5m (16 ft.)

Some points specified for the horizontal cabling subsystem include:

- Recognized Horizontal Cables:
  4-pair 100 W unshielded twisted-pair or screened twisted-pair
  2-fiber (duplex) 62.5/125µm or 50/125µm multimode optical fiber

- Multi-unit cables are allowed, provided that they satisfy the hybrid/bundled cable requirements of TIA/EIA-568-B.2, ISO/IEC 11801:2002.
- Grounding must conform to applicable building codes, as well as ANSI-J-STD-607-A.

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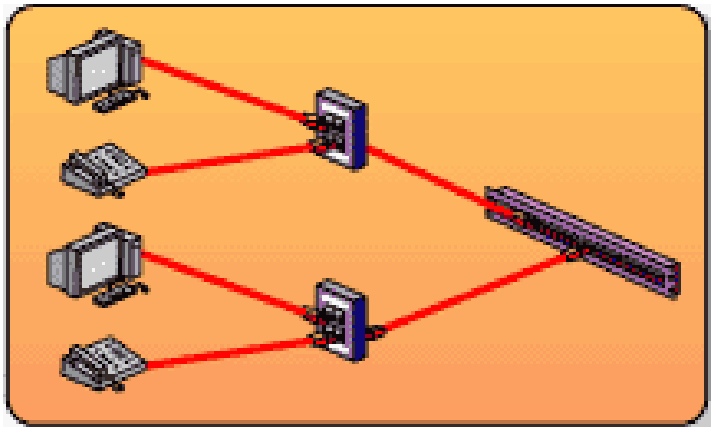
- A minimum of two telecommunications outlets are required for each individual work area.
  First outlet: 100 W twisted-pair (category 5e is recommended).
  Second outlet: 100 W twisted-pair category 5e, or two-fiber multimode optical fiber either 62.5/125µm or 50/125µm.
  One transition point (TP) or Consolidation Point (CP) is allowed. The term “transition point” was removed from the second edition of ISO/IEC 11801:2002. Under carpet cabling is no longer covered by that standard.
- Additional outlets may be provided. These outlets are in addition to, and may not replace, the minimum requirements of the standard.
- Bridged taps and splices are not allowed for copper-based horizontal cabling. (Splices are allowed for fiber.)
- Application specific components shall not be installed as part of the horizontal cabling. When needed, they must be placed external to the telecommunications outlet or horizontal cross-connect (e.g. splitters, baluns).
- The proximity of horizontal cabling to sources of electromagnetic interference (EMI) shall be taken into account.



Topology
The horizontal cabling shall be configured in a star topology;
each work area outlet is connected to a horizontal cross-connect (HC) in a telecommunications room (TR).

Cabling Standards

Backbone Cabling System Structure

The backbone cabling system provides interconnections between telecommunications rooms, equipment rooms, main terminal space, and entrance facilities. The difference between horizontal and backbone cabling is clearly defined in the standards. Backbone cabling is also referred to as vertical cabling. It includes backbone cables, intermediate and main cross-connects, mechanical terminations, and patch cords or jumpers used for backbone-to-backbone cross-connections. The backbone also extends between buildings in a campus environment. Backbone cabling includes the following:

- TRs on the same floor, MC to IC, and IC to HC
- Vertical connections, or risers, between TRs on different floors, such as MC to IC cabling
- Cables between TRs and demarcation points
- Cables between buildings, or inter-building cables, in a multibuilding campus

The maximum distance for cabling runs depends on the type of cable installed. For backbone cabling, the maximum distance can also be affected by how the cabling will be used. For example, if single-mode fiber-optic cable will be used to connect the HC to the MC, then the maximum distance for the backbone cabling run is 3000 m (9842.5 feet).

Sometimes the maximum distance of 3000 m (9842.5 feet) must be split between two sections. For example, if the backbone cabling will connect the HC to an IC and the IC to the MC. When this occurs, the maximum distance for the backbone cabling run between the HC and the IC is 300 m (984 feet). The maximum distance for the backbone cabling run between the IC and the MC is 2700 m (8858 feet).

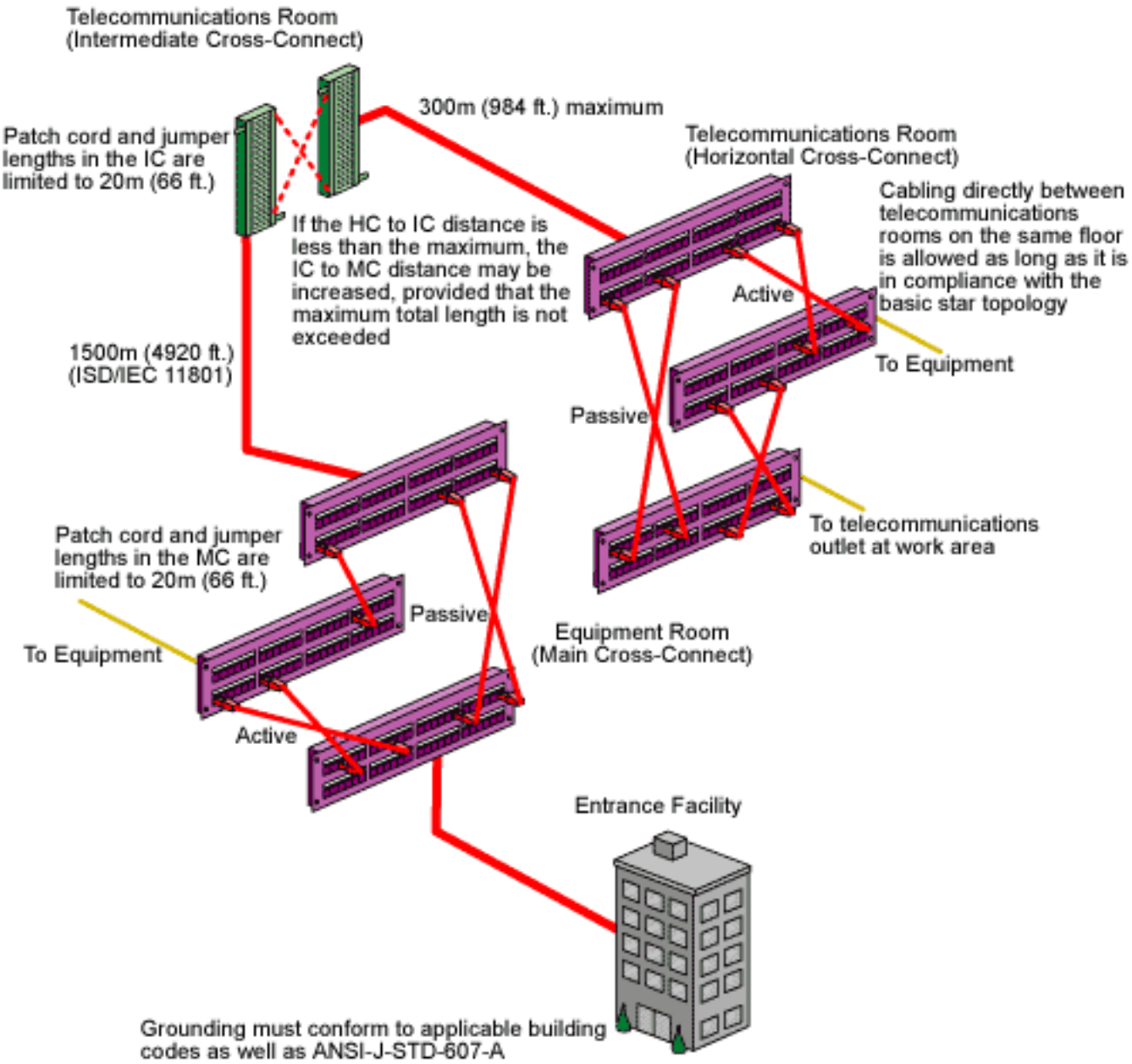
The use of fiber optics is an effective way to move backbone traffic for three reasons:

- Optical fibers are impervious to electrical noise and radio frequency interference.
- Fiber does not conduct currents that can cause ground loops.
- Fiber-optic systems have high bandwidth and can work at high speeds.

A fiber-optic backbone can also be upgraded to provide even greater performance when the terminal equipment is developed and becomes available. This can make fiber optics very cost effective.

An additional advantage is that fiber can travel much farther than copper when used as a backbone media. Multimode optical fiber can cover lengths of up to 2000 meters (6561.7 feet). Single-mode fiber-optic cables can cover up to 3000 meters (9842.5 feet). Optical fiber, especially single mode fiber, can carry signals much farther. Distances of 96.6 to 112.7 km (60 to 70 miles) are possible, depending on terminal equipment. However, these longer distances are beyond the scope of the LAN standards.

Cabling Standards

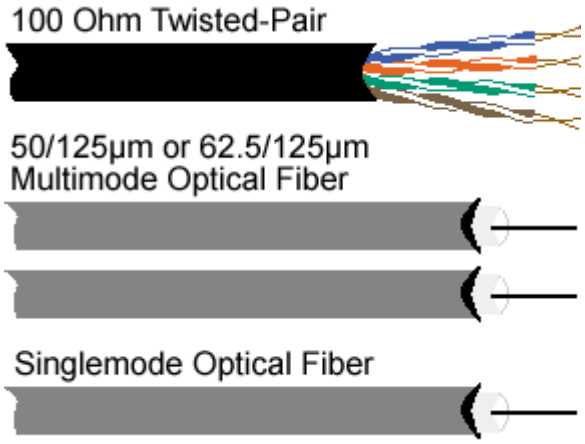


TIA Backbone Cable Distances (MC to HC)	
Singlemode Fiber	3000m (9840 ft.)
50/125µm or 62.5/125µm Multimode Fiber	2000m (6560 ft.)
Twisted-Pair Copper Applications <5 MHz	800m (2625 ft.)

Cabling Standards

Some points specified for the backbone cabling subsystem include:

- Equipment connections to backbone cabling should be made with cable lengths of 30m (98 ft.) or less.
- The backbone cabling shall be configured in a star topology. Each horizontal cross-connect is connected directly to a main cross-connect or to an intermediate cross-connect, then to a main cross-connect.
- The backbone is limited to no more than two hierarchical levels of cross-connects (main and intermediate). No more than one cross-connect may exist between a main and a horizontal cross-connect and no more than three cross-connects may exist between any two horizontal cross-connects.
- A total maximum backbone distance of 90m (295 ft.) is specified for high bandwidth capability over copper. This distance is for uninterrupted backbone runs. (No intermediate cross-connect).
- The distance between the terminations in the entrance facility and the main cross-connect shall be documented and should be made available to the service provider.
- Recognized media may be used individually or in combination, as required by the installation. Quantity of pairs and fibers needed in individual backbone runs depends on the area served. Recognized backbone cables are:

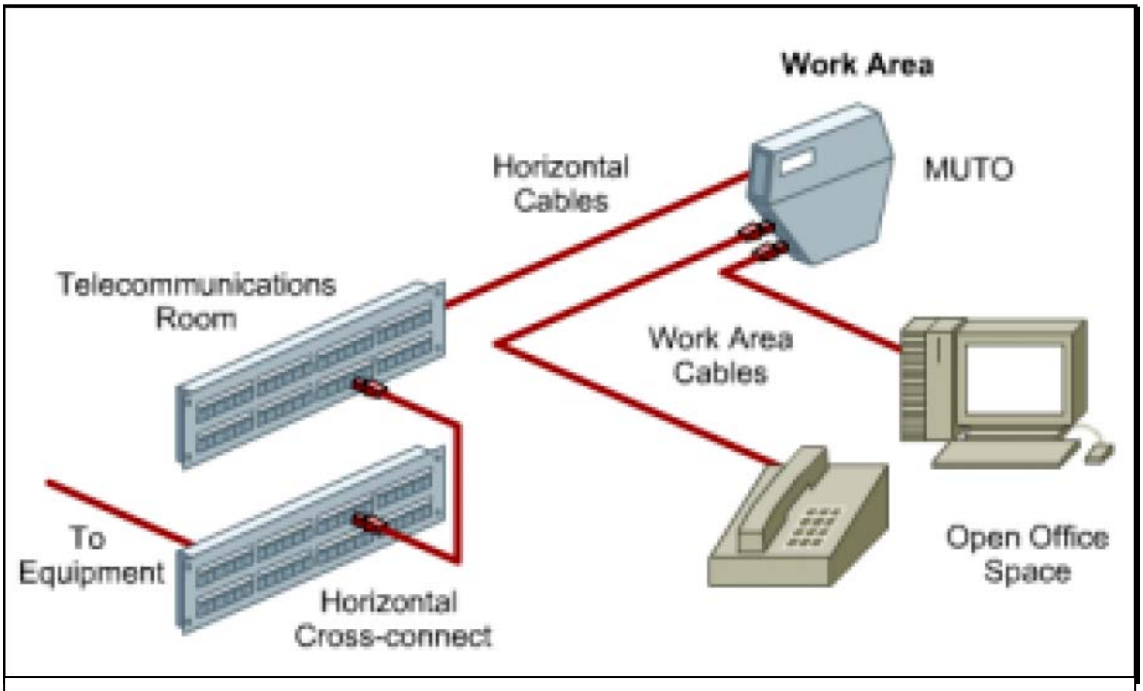


- Multi-pair cable is allowed, provided that it satisfies the power sum crosstalk requirements.
- The proximity of backbone cabling to sources of electromagnetic interference (EMI) shall be taken into account.
- Cross-connects for different cable types must be located in the same facilities.
- Bridged taps and splitters are not allowed.

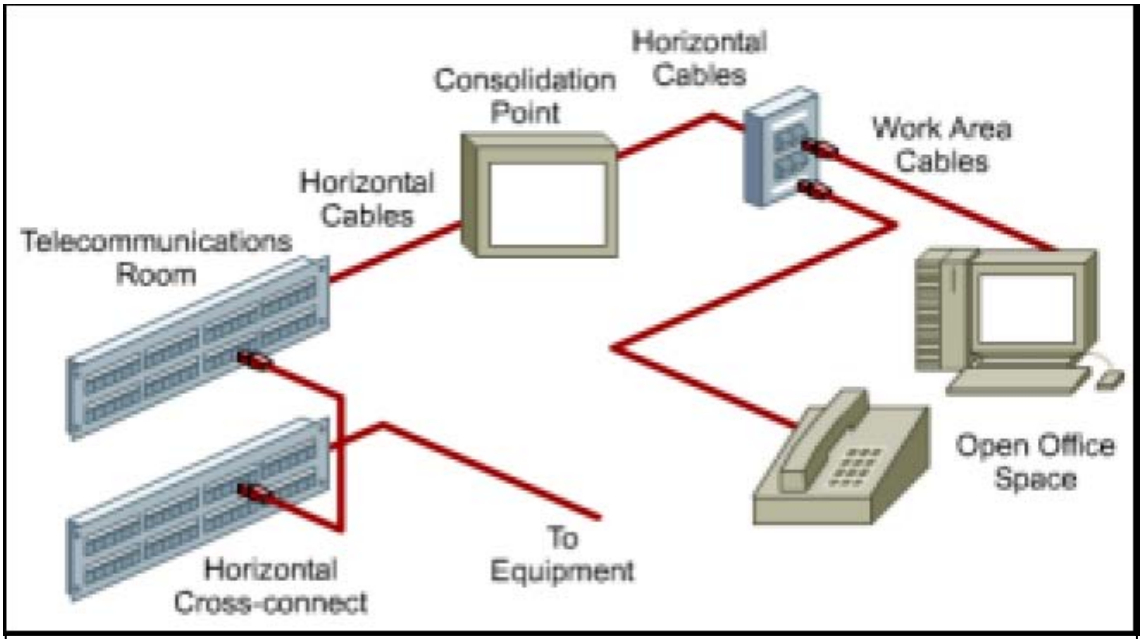
Notes: In ISO/IEC 11801:2002, the equivalent cabling elements to the main cross-connect (MC) and intermediate cross-connect (IC) are called the campus distributor (CD) and building distributor (BD) respectively.

Cabling Standards

MUTOAs and Consolidation Points



Typical MUTOA Installation



Typical Consolidation Point Installation

Cabling Standards

Additional specifications for horizontal cabling in work areas with moveable furniture and partitions have been included in TIA/EIA-568-B.1. Horizontal cabling methodologies using multi-user telecommunications outlet assemblies (MUTOAs) and consolidation points (CPs) are specified for open office environments. These methodologies provide increased flexibility and economy for installations that require frequent reconfiguration.

Rather than replacing the entire horizontal cabling system feeding these areas, a CP or MUTOA can be located close to the open office area and eliminate the need to replace the cabling all the way back to the TR whenever the furniture is rearranged. The cabling only needs to be replaced between the new work area outlets and the CP or MUTOA. The longer distance of cabling back to the TR remains permanent.

A MUTOA is a device that allows users to move, add devices, and make changes in modular furniture settings without re-running the cable. Patch cords can be routed directly from a MUTOA to work area equipment, as shown in Figure 1. A MUTOA location must be accessible and permanent. A MUTOA cannot be mounted in ceiling spaces or under access flooring. It cannot be mounted in furniture unless the furniture is permanently secured to the building structure.

The TIA/EIA-568-B.1 standard includes the following guidelines for MUTOAs:

- At least one MUTOA is needed for each furniture cluster.
- A maximum of 12 work areas can be served by each MUTOA.
- Patch cords at work areas should be labeled on both ends with unique identifiers.
- The maximum patch cord length is 22 m (72.2 feet).

Consolidation points (CPs) provide limited area connection access. Permanent flush wall-mounted, ceiling-mounted, or support column-mounted panels are generally used in modular furniture work areas. These panels must be unobstructed and fully accessible without moving fixtures, equipment, or heavy furniture. Workstations and other work area equipment do not plug into the CP like they do with the MUTOA, as shown in Figure 2. Workstations plug into an outlet, which is then connected to the CP.

The TIA/EIA-569 standard includes the following guidelines for CPs:

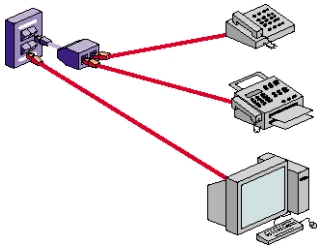
- At least one CP is needed for each furniture cluster
- Each CP can serve a maximum of 12 work areas
- The maximum patch cord length is 5 m (16.4 feet)

For both consolidation points and MUTOAs, TIA/EIA-568-B.1 recommends a separation of at least 15 m (49 feet) for equipment between the TR and the CP or MUTOAs. This is to avoid problems with crosstalk and return loss.

Cabling Standards

Work Area

The telecommunications outlet serves as the work area interface to the cabling system. Work area equipment and cables used to connect to the telecommunications outlet are now included within the scope of ’568-B.1 and ’11801:2002.



Some specifications related to work area cabling include:

- Equipment cords are assumed to have the same performance category as the horizontal cable to which they connect.
- When used, adapters are assumed to be compatible with the transmission capabilities of the equipment to which they connect.
- Horizontal cable lengths are specified with the assumption that a maximum cable length of 5m (16 ft.) is used for equipment cords in the work area.

Note: For establishing maximum horizontal link distances, a combined maximum length of 10m (33 ft.) is allowed for patch cables (or jumpers) and for equipment cables in the work area and the telecommunications room.

Twisted-Pair Cabling Installation Practices

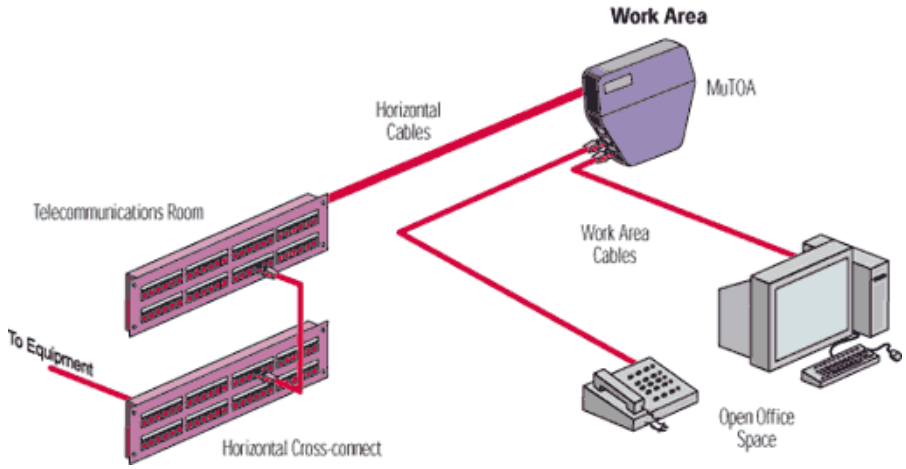
- To avoid stretching, pulling tension should not exceed 110N (25 lb$f$) for 4-pair cables.
- Installed bend radii shall not exceed:
    - 4 times the cable diameter for horizontal UTP cables under no load conditions.
    - 8 times the cable diameter for horizontal ScTP cables.
    - 10 times the cable diameter for multi-pair backbone
    - Twisted-pair cables under no load conditions.
- Horizontal cables should be used with connecting hardware and patch cords (or jumpers) of the same performance category or higher.
- Avoid cable stress, as caused by:
    - cable twist during pulling or installation
    - tension in suspended cable runs
    - tightly cinched cable ties or staples
    - tight bend radii
- Important Note: Installed twisted-pair cabling shall be classified by the least performing component in the link.

Cabling Standards

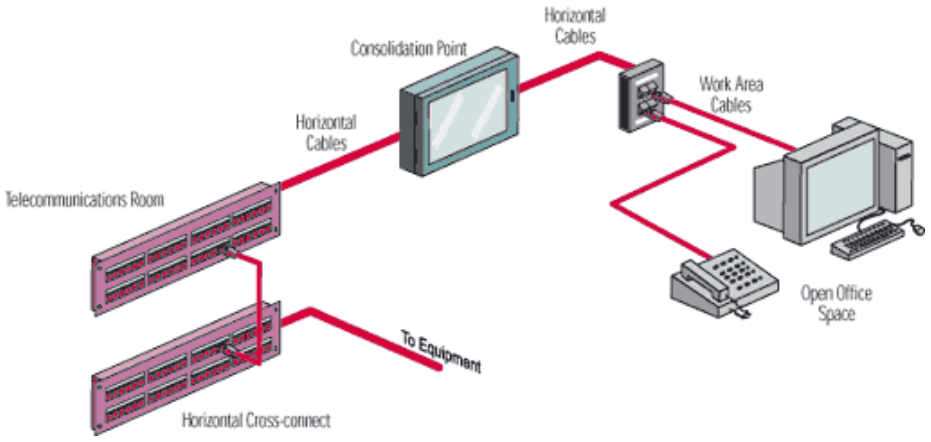
Open Office Cabling

Additional specifications for horizontal cabling in areas with moveable furniture and partitions have been included in TIA/EIA-568-B.1. Horizontal cabling methodologies are specified for “open office” environments by means of multi-user telecommunications outlet assemblies and consolidation points. These methodologies are intended to provide increased flexibility and economy for installations with open office work spaces that require frequent reconfiguration.

This is an example of Open Office Implementation using the MuTOA - Multi-user Telecommunications Outlet Assembly MuTOA: A telecommunications outlet scheme intended to serve multiple work areas in an open office environment.



This is an example of Open Office Implementation using a Consolidation Point Connector Consolidation Point: An interconnection scheme that connects horizontal cables from building pathways to cables that extend to TOs through open office pathways.



Note: To reduce the effects of multiple connections in close proximity, the CP should be located at least 15 meters from the HC (FD).

Cabling Standards

Horizontal Distances of Copper Links (Open Office)

Copper work area cables connected to a MuTOA, shall meet the requirements of ’568-B.1. The maximum length of copper work area cables shall be determined according to:

C = (102 – H) / 1.2*
W = C – 5 22m(72 ft.)

Where:
C is the maximum combined length (m) of the work area cable, equipment cable, and patch cord (m).
W is the maximum length (m) of the work area cable.
H is the length (m) of the horizontal cable.

The above equations assume that there is a total of 5m (16 ft.) of patch and equipment cables in the telecommunications room. Table 1 shows the application of these formulae assuming the use of 24AWG cable. The length of work area cables shall not exceed 22m (72 ft.), 20m (66 ft.) per ISO/IEC 11801:2002. The MuTOA shall be marked with the maximum allowable work area cable length.

Length of Horizontal Cable	Maximum Length of Work Area Cable	Maximum Combined Length of Work Area Cables, Patch Cords, and Equipment Cable
H m (ft.)	W m (ft.)	C m (ft.)
90 (295)	5 (16)	10 (33)
85 (279)	9 (30)	14 (46)
80 (262)	13 (44)	18 (59)
75 (246)	17 (57)	22 (72)
70 (230)	22 (72)	27 (89)

Table 1 - Maximum Length of Work Area Cable

**Note: The preceding equation and table are based on patch cables having 20% more attenuation than horizontal cables. If higher gauge (e.g. 26 AWG) cables are used that have 50% higher attenuation than solid, as allowed by ISO/IEC 11801:2002, these lengths must be reduced accordingly.*

Cabling Standards

Horizontal Distances of Optical Fiber Links (Long Work Area Cables)

For optical fiber cables, any length combination of horizontal cables and work area cables is acceptable, as long as the total combined length of the horizontal channel does not exceed 100m (328 ft.). When deploying a centralized fiber cabling topology, the general guidelines of 568-B.1 shall be followed.

Advantages and Features

- It is preferable to use MuTOAs only when the entire length of the work area cord is accessible to facilitate tracing and to prevent erroneous disconnection. Up to 22m (72 ft.) of work area cable are allowed.
- MuTOAs are subject to the same interface requirements specified for each media type.
- Consolidation point requirements are performance based. There is no physical interface requirement for the CP except those required to meet functional requirements.
- Implementations using either MuTOAs or CPs are subject to the same end-to-end UTP/ScTP performance requirements.
- Consolidation points have the advantage that they deliver dedicated TOs to individual work areas and do not require provisions for extended cord lengths.

Cabling Standards

ANSI/TIA/EIA-569-A

Commercial Building Standard for Telecommunications Pathways and Spaces

The TIA TR42.3 Working Group on Telecommunications Pathways & Spaces published the ANSI/TIA/EIA-569-A (’569-A) Standard in 1998.

Following are highlights of the ’569-A Standard:

Purpose

- Standardize design and construction practices.
- Provides a telecommunications support system that is adaptable to change during the life of the facility.

Scope

- Pathways and spaces in which telecommunications media are placed and terminated.
- Telecommunications pathways and spaces within and between buildings.
- Commercial building design for both single and multi-tenant buildings.

Elements

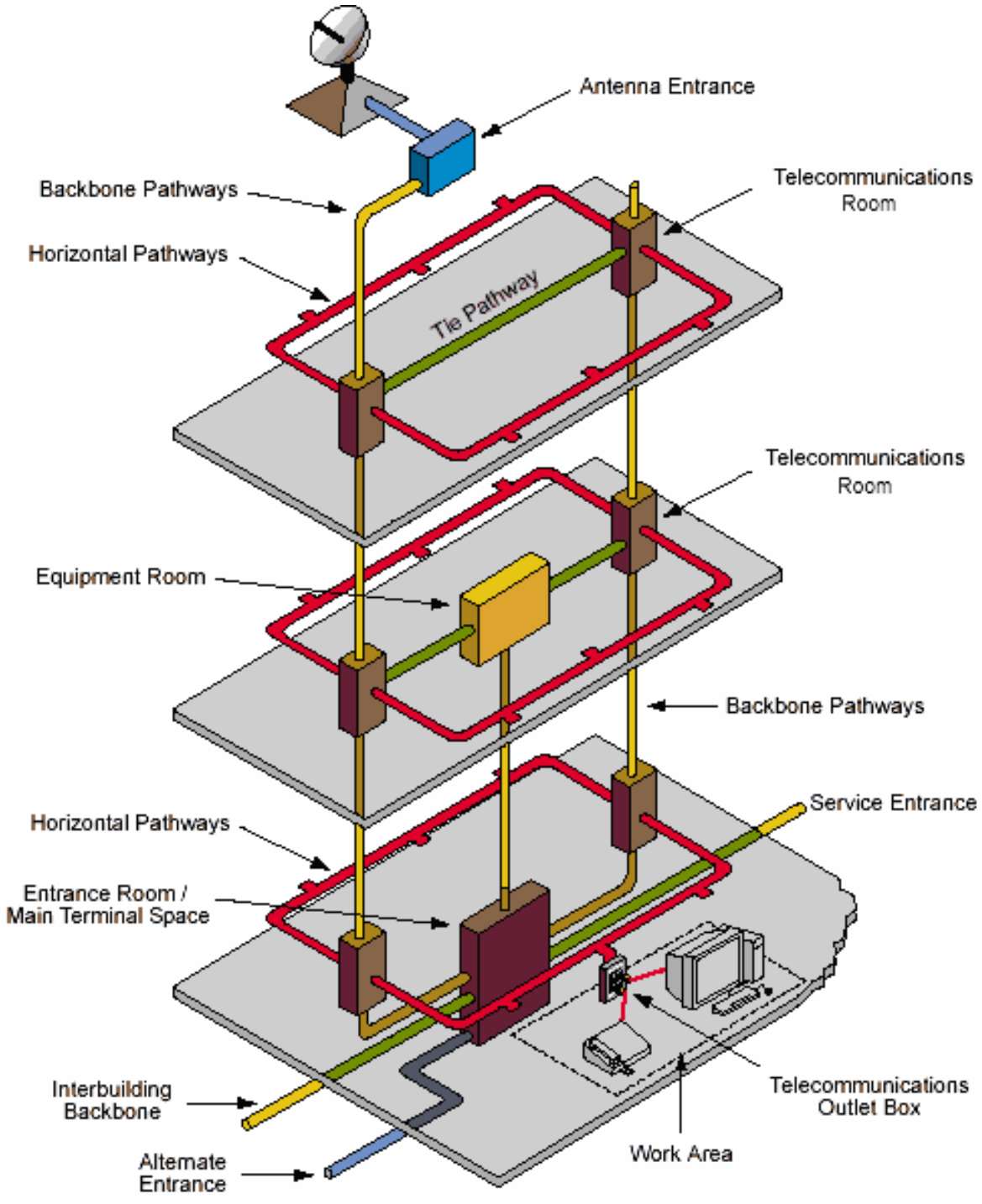
- Horizontal
- Backbone
- Work Area
- Telecommunications Room
- Equipment Room
- Main Terminal Space
- Entrance Facility

Annex Information

The following normative and informative annexes are provided in ANSI/TIA/EIA-569-A:

1. Fire stopping (Normative)
2. Additional section information (Informative)
3. Interbuilding Backbone Pathways and Related Spaces (Normative)
4. References (Informative)

Cabling Standards



Cabling Standards

Horizontal

Pathways from telecommunications room to work area.

Includes:

Pathway Types:

- Underfloor — Network of raceways embedded in concrete consisting of distribution and header ducts, trenches, and cellular systems.
- Access Floor — Raised modular floor tile supported by pedestals, with or without lateral bracing or stringers.
- Conduit — Metallic and nonmetallic tubing of rigid or flexible construction permitted by applicable electrical code.
- Tray & Wireway — Prefabricated rigid structures for pulling or placing cable.
- Ceiling — Open environment above accessible ceiling tiles and frame work.
- Perimeter — Surface, recessed, molding, and multi-channel raceway systems for wall mounting around rooms or along hallways.

Space Types:

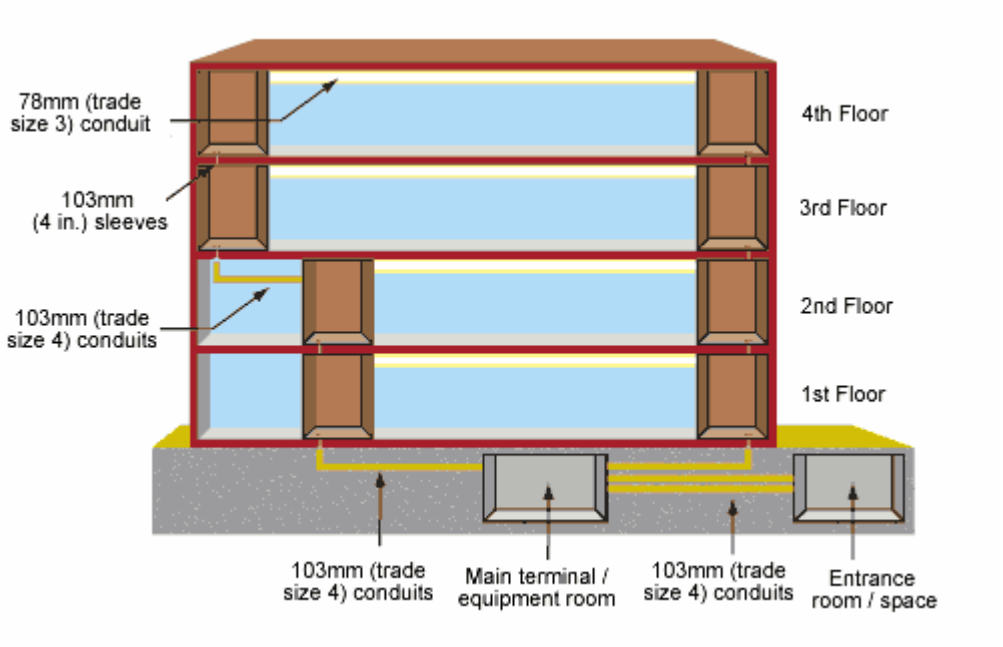
- Pull Boxes — Used in conjunction with conduit pathway systems to assist in the fishing and pulling of cable.
- Splice Boxes — A box, located in a pathway run, intended to hold a cable splice.
- Outlet Boxes — Device for mounting faceplates, housing terminated outlet/connectors, or transition devices.

Design Considerations:

- Grounded per code and ANSI-J-STD-607-A (’607-A)
- Designed to handle recognized media as specified in ANSI/TIA/EIA-568-B series
- Not allowed in elevator shafts
- Accommodate seismic zone requirements
- Installed in dry locations

Cabling Standards

Backbone



Pathways routed from closet-to-closet.

Building Backbone Types:

- Ceiling
- Conduit
- Sleeves - An opening, usually circular, through the wall, ceiling, or floor.
- Slots - An opening, usually rectangular, through the wall, ceiling, or floor.
- Trays

Typically the most convenient and cost effective backbone pathway design in multi-story buildings, is to have stacked closets located one above the other, connected by sleeves or slots.

Design Considerations:

- Grounded per code and ’607-A
- Accommodate seismic zone requirements
- Water should not penetrate the pathway system
- Tray, conduits, sleeves, slots penetrate closets minimum 25mm (1 in.)
- Designed to handle all recognized media (as specified in ’568-A)
- Integrity of all fire stop assemblies shall be maintained

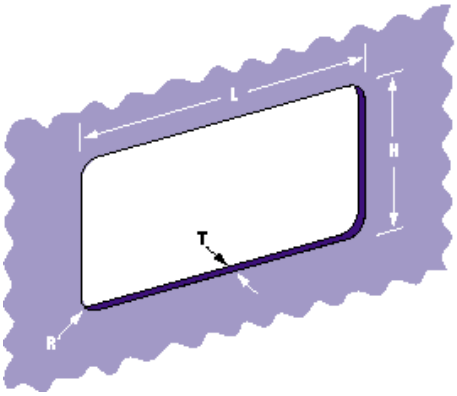
Cabling Standards

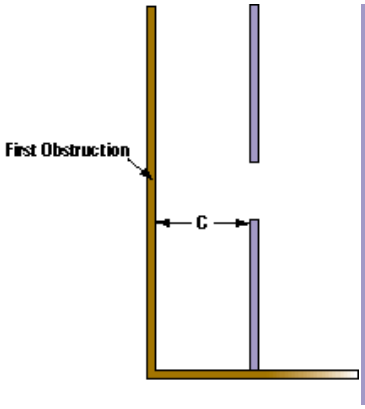
Work Area

Primary location where the building occupants interact with dedicated telecommunications equipment.

Design Considerations:

- At least one telecommunication outlet box location shall be planned for each work area.
- This location should be coordinated with the furniture plan. A power outlet should be nearby.
- Control center, attendant, and reception areas shall have direct and independent pathways to the serving telecommunications room.
- Furniture System Design:
    - Cable access via walls, columns, ceilings, or floors. Fittings that transition between building and furniture pathways require special planning.
    - Furniture pathway fill capacity is effectively reduced by furniture corners, and connectors mounted within the furniture pathway systems.
    - Furniture pathways bend radius shall not force the installed cable to a bend radius of less than 25mm (1 in.).
    - Furniture spaces designed to house slack storage, consolidation points, or multi-user telecommunications outlet assemblies shall provide space for strain relieving, terminating, and storing slack for the horizontal cables.
    - Slack storage and furniture pathway fill, shall not affect the bend radius and termination of the cable to the connector.
    - Furniture pathway openings shall comply with either of two sizes:
- Standard NEMA opening (NEMA OS 1 [Ref D.14], WD-6 [Ref D.15])
- Alternate opening:



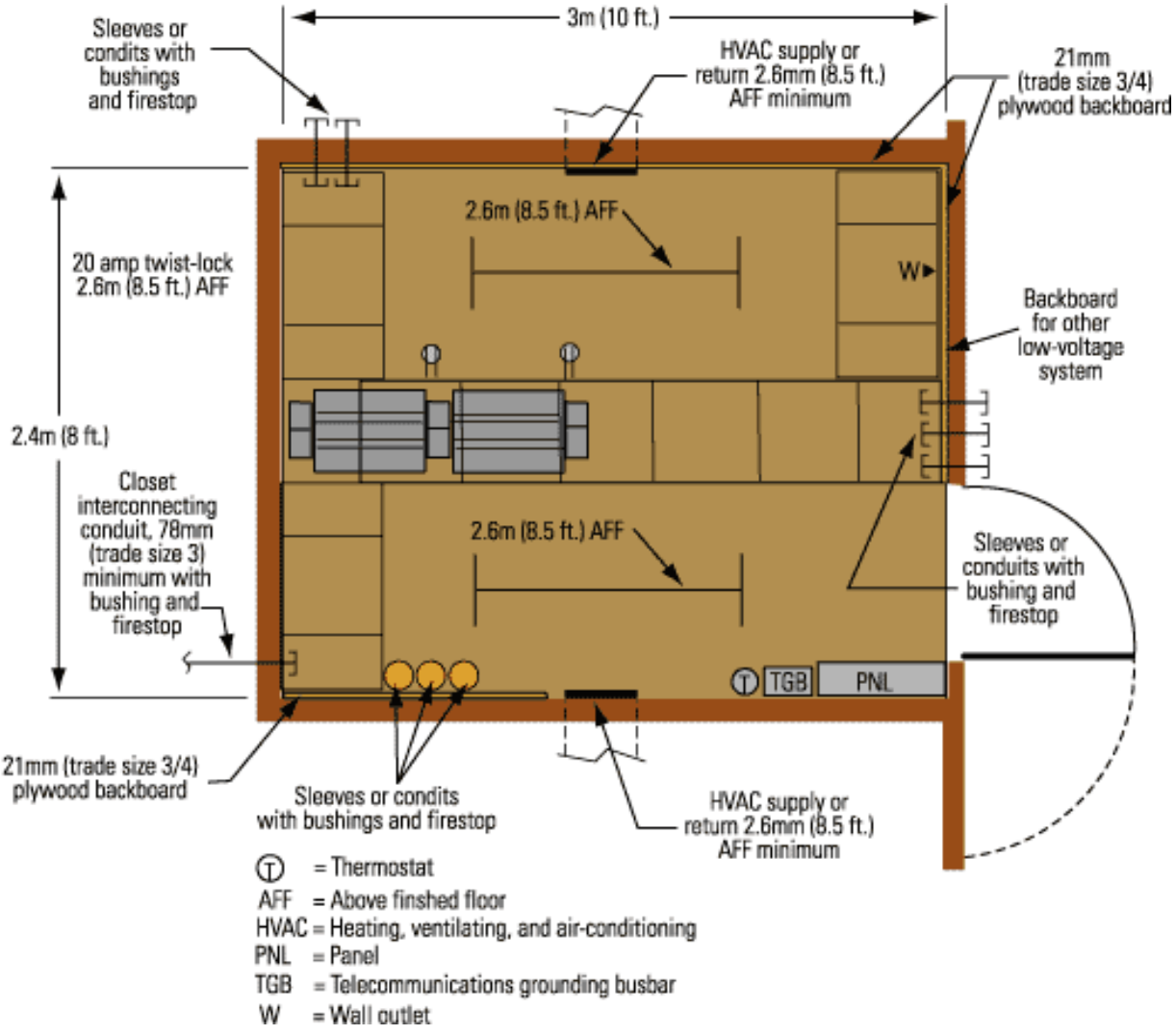


Power/telecommunication separation requirements are governed by applicable electrical code for safety. Minimum separation requirements of Article 800-52 of ANSI/NFPA 70 (National Electric Code) shall be applied.

	Dimension	Tolerance
L (length)	68.8mm (2.71 in.)	1.02mm (0.040 in.)
H (height)	35.1mm (1.38 in.)	0.90mm (0.035 in.)
T (depth)	1.40mm (0.055 in.)	0.64mm (0.025 in.)
R (corner radius)	4.06mm (0.160 in.) max .	-
C (distance to 1st obstruction)	30.5mm (1.2 in.) min.	-

Cabling Standards

Telecommunications Room



Design:

- Dedicated to telecommunications function.
- Equipment not related to telecommunications shall not be installed, pass through or enter the telecommunications room.
- Multiple closets on the same floor shall be interconnected by a minimum of one 78mm (trade size 3) conduit, or equivalent pathway.
- Minimum floor loading 2.4 kPA (50 lbf/ft2).

Cabling Standards

Design Considerations:

- Minimum one closet per floor to house telecommunications equipment/cable terminations and associated cross-connect cable and wire.
- Located near the center of the area being served.
- Horizontal pathways shall terminate in the telecommunications room on the same floor as the area served.
- Accommodate seismic zone requirements.
- Two walls should have 21mm (0.75 in.) A-C plywood 2.4m (8 ft.) high.
- Lighting shall be a minimum of 500 lx (50 foot candles) and mounted 2.6m (8.5 ft.) above floor.
- False ceilings shall not be provided.
- Minimum door size 910mm (36 in.) wide and 2000mm (80 in.) high without sill, hinged to open outwards, or slide side-to-side or removable, and fitted with a lock.
- Minimum of two dedicated, non-switched, duplex electrical outlet receptacles or equivalent, each on separate branch circuits.
- Additional convenience duplex outlets placed at 1.8m (6 ft.) intervals around perimeter, 150mm (6 in.) above floor.
- Access to the telecommunications grounding system as specified by ANSI-J-STD-607-A.
- HVAC requirements to maintain temperature the same as adjacent office area. A positive pressure shall be maintained with a minimum of one air change per hour or per code.
- A hinged wall bracket must be attached to the plywood panel so that it covers the underlying wall surface. The hinge allows the assembly to swing out so that technicians can easily access the backside of the wall. It is important to allow 48 cm (19 inches) for the panel to swing out from the wall.
- A distribution rack must have a minimum of 1 meter (3 feet) of workspace clearance in the front and rear of the rack. A 55.9-cm (22inch) floor plate is used to mount the distribution rack. The floor plate will provide stability and determine the minimum distance for the final position of the distribution rack. A distribution rack is shown in Figure 2.
- A full equipment cabinet requires at least 76.2 cm (30 inches) of clearance in front for the door to swing open. Equipment cabinets are generally 1.8-m (5.9-feet) high, 0.74-m (2.4-feet) wide, and 0.66-m (2.16-feet) deep.

Cabling Standards

Equipment Room

A centralized space for telecommunications equipment that serves specific occupants of the building. Any or all of the functions of a telecommunications room or entrance facility may alternately be provided by an equipment room.

Location

- Site locations should allow for expansion
- Accessible to the delivery of large equipment.
- Not located below water level.
- Away from sources of EMI.
- Safeguards against excessive vibration.
- Sizing shall include projected future as well as present requirement.
- Equipment not related to the support of the equipment room shall not be installed in, pass through, or enter the equipment room.

Design Considerations

- Minimum clear height of 2.4m (8 ft.) without obstruction.
- Protected from contaminants and pollutants.
- Access to backbone pathways.
- HVAC provided on a 24 hours-per-day, 365 days-per-year basis.
- Temperature and humidity controlled range 18° C (64° F) to 24°C (75° F) with 30% to 55% relative humidity measured 1.5m (5 ft.) above floor level.
- Separate power supply circuit shall be provided and terminated in its own electrical panel.
- Minimum lighting 500 lx (50 foot candles). Switch location shall be near entrance door to room.
- Minimum door same as telecommunications room. Double doors without center post or sill is recommended.
- Access to ground per ANSI-J-STD-607-A.

Cabling Standards

Main Terminal Space

Centralized space that houses the main cross-connect. Commonly used as a separate space in multi-tenant buildings to serve all tenants.

- Location considerations are as specified for equipment room.
- Provisioning area as specified for telecommunications closets except power is reduced to convenience receptacles.

Entrance Facility

Consists of the telecommunications service entrance to the building and backbone pathways between buildings.

Location

- Providers of all telecommunications services shall be contacted to establish requirements.
- Location of other utilities shall be considered in locating the entrance facility.
- Alternate entrance facility should be provided where security, continuity or other special needs exist.
- Equipment not related to the support of the entrance facility should not be installed in, pass through, or enter the telecommunications entrance facility.
- Dry location not subject to flooding and close as practicable to building entrance point and electrical service room.

Design Considerations

- Accommodate the applicable seismic zone requirements.
- A service entrance pathway shall be provided via one of the following entrance types: Underground, Buried, Aerial, Tunnel.
- Minimum one wall should be covered with rigidly fixed 21mm (0.75 in.) A-C plywood.
- Minimum lighting same as telecommunication room.
- False ceilings shall not be provided.
- Minimum door same as telecommunications room.
- Electrical power same as telecommunications room. No convenience receptacles mentioned.
- Grounding same as telecommunications room.

Cabling Standards

Miscellaneous

- Fire stopping per applicable code
- Horizontal pathway separation from Electromagnetic interference (EMI) sources:
    - Separation between telecommunications and power cables (Article 800.52 of ANSI/NFPA 70)
    - Building protected from lightning (ANSI/NFPA 780 (Ref D.4)
    - Surge protection (Article 280 of ANSI/NFPA 70 and 9.11 of ANSI/IEEE 1100 [Ref D.1])
    - Grounding (ANSI/TIA/EIA-607)
    - Corrected faulty wiring (Section 7.5 of ANSI/IEEE 1100)
- Reducing noise coupling:
    - Increase separation from noise sources
    - Electrical branch circuit line, neutral, and grounding conductors should be maintained close together
    - Use of surge protectors in branch circuits
    - Use fully enclosed grounded metallic raceway or locate cabling near grounded metallic surface

Recommended Cabling Practices

Do’s:

- Terminate each horizontal cable on a dedicated telecommunications outlet.
- Locate the main cross-connect near the center of the building to limit cable distances.
- Maintain the twist of horizontal and backbone cable pairs up to the point of termination.
- Tie and dress horizontal cables neatly and with a minimum bend radius of 4 times the cable diameter.

Dont's:

- Do not use connecting hardware that is of a lower category than the cable being used.
- Do not create multiple appearances of the same cable at several distribution points (called bridged taps).
- Do not over-tighten cable ties, use staples, or make sharp bends with cables.
- Do not place cable near equipment that may generate high levels of electromagnetic interference.

Recommended Color-Coding Scheme

Siemon Color #	Color Code		
02	white		1st Level Backbone (MC/IC or MC/TC Terminations)
03	red		Key Telephone Systems
04	gray		Second Level Backbone (IC/TC Terminations)
05	yellow		Miscellaneous (Auxiliary, Security, Alarms, etc.)
06	blue		Horizontal Cable Terminations (a.k.a. Station Cable)
07	green		Network Connections (customer side of demarc)
08	purple		Common Equipment (PBX, Host, LANs, Muxes)
09	orange		Demarcation Point (Central Office Terminations)
60	brown		Interbuilding Backbone (Campus Cable Terminations)