



Network Design Guidelines for Construction

of information networks @Brown

General Design Guidelines

Communications infrastructure must be designed to allow replacement of cable infrastructure during the life of the building. The life time of a new building is over 80 years, renovations last 30 to 40 years, but advances in communication technology requires cable to be replaced every 7 to 10 years. Pathways must be accessible for non disruptive installation of new communications cabling without impact to architectural integrity or occupants use of the facility and must allow for growth in port density and cable sizes.

The system design must permit replacement and upgrade of system components while supporting present service. Technicians must be able to access the front and rear of electronics and network patch panels. They must be able to add new cable to existing drops without major disruption and expense. The design must anticipate growth by adding capacity for new communications outlets. This includes sizing of telecommunications rooms and raceway.

The communications system installed must function for current and near future communications standards for speed, reliability, and security. Transmission of information at higher speeds requires more energy closer to the consumer. The current generation of network equipment is hotter and larger than the previous generation.

The system must accommodate applications to new services such as telephone and video. Telephone service will eventually run on the data network and will require additional power for telephone handsets. Standards are being developed to permit laptops to recharge over the network cable. New services will require a substantial increase in power consumption in telecommunications rooms. The increased power will generate a corresponding amount of heat which must be dissipated to maintain operation of the equipment.

Design Engineer and Architect Qualifications

- The Construction and Design Engineer must have a BICSI (Building Industry Consulting Service International) Registered Communications Distribution Designer (RCDD) on staff that is thoroughly familiar with the cabling methods established by the current BICSI TDMM (Telecommunications Distribution Methods Manual).
- The successful bidder shall have at least 5 years experience designing telecommunications systems

Communication System Component Definitions

Modern communication systems are complex and delicate. There are eight major components that make up a communications system within a building. Item 1-6 below are defined by BICSI and are designed, built, and funded by the construction project. Item 7 is purchased and installed by CIS but funded by the project. Finally, 8 is the responsibility of the end user and program requirements and determine the quantity of components for items 1 through 7.

1. Building Entrance

The room or space inside a building where telecommunications cables enter and leave the building.

2. Equipment Room

An environmentally controlled centralized space for locating equipment that provide an essential service to multiple buildings or academic departments. Equipment have special environmental and security requirements and must be identified early in the design process. Equipment rooms for departments (server rooms) are always separate from central campus services provided by CIS.

Equipment vendors require temperature and humidity control for proper function of the tel/data equipment. Current industry standards must be followed when designing computing equipment rooms. Requirements must be addressed on a space by space basis, depending on the equipment being installed.

3. Backbone

A facility (e.g., pathway, cable, or conductors) between any of the following spaces: telecommunications rooms, entrance facilities, and equipment rooms.

4. Telecommunications Room (TR)

An enclosed space for housing telecommunications equipment, cable terminations, and cross-connect cabling for central campus services.

5. Horizontal Cable

The part of the cabling system that extends from (and includes) the work area telecommunications outlet/connector to the horizontal cross-connect (floor distributor) in the telecommunications room.

6. Telecommunications Outlet

A connecting device in the tenant work area on which horizontal cable terminates.

7. Network Electronics

Mounted in racks along with patch panels for horizontal data cable in the telecommunications room, each unit of electronics supports multiple data jacks and must be accessible from the front and rear. Adequate space should be provided for air flow on all sides of the electronics.

8. Work Area Equipment

Computers, printers, telephones, fax machines, copy machines, cash registers, time clocks, electric meters, lab freezers, vending machines, etc..

Telecommunications Outlets - quantity and type

Work area outlets should be as plentiful as power outlets

Telecommunications Outlets are also referred to as work area outlets or drops

Administrative Work Areas

- A minimum of one telecommunications outlet per workstation (per person).
- For building areas where it would be difficult to add telecommunications outlets later, a minimum of two separate outlets should be provided in the initial design.
- The outlets should be located to offer maximum flexibility for change in the work area, i.e., on opposing walls.
- Any office work area over 10Ft x 10ft in size should receive at least two outlets. There should be one work area outlet for every 100 square feet.
- The maximum length of a computer patch cord is 16 feet from the wall outlet.
- The work area telecommunications outlet box should be located near an electrical outlet.
(e.g., within 1 m [3 ft]) and installed at the same height if appropriate.
- The building occupants should be consulted for additional outlet locations.
- An administrative outlet consists of 1 voice and 2 data jacks (1V 2D).

Student Rooms

- Typically there shall be 1 outlet per occupant, "pillow" (1V 2D)
- 1 CATV added to one outlet per room

Large Classrooms (over 50 seats)

- Podium (1V 2D 2F¹)
- Perimeter (2D) for every 100 sqft.
- Wireless service (2D) per 25 seats
- Control booth (1V 2D 2F)
- Projectors (1D)

Small Classrooms

- Podium (1V 2D)
- Perimeter (2D) for every 100 sqft.
- Wireless service (2D)
- Projectors (1D)

¹ 4 strand single mode fiber, terminated.

Laboratories

- For each workspace along the bench (1V 2D)
- Wireless service outlet (2D) per 500 sqft

Waiting Areas, Study Spaces, and Lounges

- Convenience Outlets (2D) every 100 sqft.
- Vending and Point of Sale (1V 1D)
- Wireless service outlet (2D) per 500 sqft.
- Not required in corridors or stairways.

Special Use Outlets

All special outlets require a demarcation point
(A point where the operational control or ownership changes.)

- emergency telephones (1V)
- wall phone (1V)
- payphones (1V)
- energy management, HVAC, BAS (2D each)
- CCTV (closed circuit TV) (2D)
- Cash Net (Food Services cash registers) (2D)
- Time and Attendance (time clocks) (2D)
- card access controllers (2D)
- vending machines (1V 1D)
- copy machines (1V 1D)
- power meters (2D)
- gas meters (1V 1D)
- alarm panels (1V 1D)
- wireless access points (2D)
- fire alarm panel (1V 1D)
- elevator rooms (1V per car)
- Special event locations; for commencement or conferences, temporary set ups for registration and presentations. (2V 2D and sufficient raceway for event vendors)
- Locations for anticipated campus wide services. For example: engineering plans for more power meters, and future wireless access point locations.

The number of work area drops per floor determines the MEP (Mechanical Electric Plumbing) requirements of the telecommunication room.

Applying Design Guidelines to System Components:

Building Entrance

Connections between buildings are based on location and building size. CIS must be consulted for the quantity and location of the underground infrastructure.

Telecommunications Room

Typically one room per floor serving a maximum radius of 300 feet. Must be clean, secure and permit maintenance without disruption of services. TRs must meet the following requirements:

Location:

- There should be one TR per floor
- The location should be selected so that the room may be expanded.
- Located as close as practical to the center core of the building to minimize horizontal cable distances. (Maximum cable length is 295' (90m) from TR to drop location.
- In multiple floor buildings, TRs shall have all 4 walls vertically stacked.
- TRs may not be inside of or be part of a mechanical space, equipment room, washroom, storage area, janitor closet, public space, tenant office or closet.
- The room must be accessible off a common public corridor

Size:

- ER/TR Rooms for new construction projects shall be sized based on the following table.

Building Area Served (gross square feet)	Minimum Room Size	Minimum Ceiling Height
0 – 5000	10' x 8'	8' 6"
5,000 – 8,000	10' x 9'	8' 6"
over 8,000	10' x 11'	8' 6"

- Size requirements may be reduced for renovation projects to accommodate existing conditions.
- Each building, regardless of size, shall have a minimum of (1) full size Telecommunications Room.
- Additional rooms should be added if the floor is over 10,000 square feet

Room Parameters

- A minimum of two walls (a minimum of 12 linear feet on available interior walls) should be covered with AC grade or better, void-free fire rated plywood backboard, 2.4 m (8 ft)

high with a minimum thickness of 19 mm (3/4 trade size). The plywood should be installed with the grade "C" surface facing the wall. Securely fasten the plywood to wall-framing members to ensure that it can support attached equipment.

Although space on backboards for telephone equipment will migrate to racks, other new systems such as BAS and card access must be mounted on backboard in secure TR spaces.

- The height between the finished floor and the lowest point of the ceiling should be a minimum of 8'6". Equipment racks are 7', cable tray at 7'6", lighting at 8'6".
- Cable tray is required inside a TR and must be accessible.
- Floors, walls, and ceiling should be treated to eliminate dust.
- Finishes shall be light in color to enhance room lighting.
- Floor covering shall be an anti-static material and sealed to reduce dust.
- The room must be secured and accessible only by authorized personnel. Access from the building exterior to all TRs must be permitted 24x7x365 to permit maintenance and repairs.
- Room shall not have a false ceiling to permit maximum use of cable pathways both vertically and horizontally. In such cases where fire-proofing may be sprayed onto the exposed ceiling, the fire-proofing shall be treated to mitigate airborne dust.
- The TR shall be located on floor areas designed with a minimum floor loading of 2.4 kPa (50 lbf/ft²).
- Consideration should be given for the acoustic noise from fans and their proximity from building occupants.

Mechanical - Heating, Ventilation and Air Conditioning (HVAC)

- HVAC shall be available on a 24 hours-per-day, 365 days-per-year basis. A stand-alone unit should be considered for Telecommunications Rooms where central systems are not continuously available.
- The temperature and humidity shall be controlled to provide continuous operating ranges of 18 °C (64 °F) to 24 °C (75 °F) with 30% to 55% relative humidity. Temperature and Relative Humidity must be determined by the equipment being installed in the space.
- The ambient temperature and humidity shall be measured at a distance of 1.5 m (5 ft) above the floor level, after the equipment is in operation, at any point along an equipment aisle centerline.
- A positive pressure differential with respect to surrounding areas should be provided with a minimum of one air change per hour.
- Pressurization can be achieved with transfer air and adequate air filters. Air filtration should be provided at MERV #7.

Electrical

TRs must be equipped to provide adequate electrical power.

Requirements are as follows:

- Branch circuits for equipment power that are protected and cabled for 20 A capacity. Circuits must be dedicated to electronic equipment and must be isolated from cyclic power loads.
- A minimum of two dedicated non switched 3-cable 120 volt (V) alternating current (AC) duplex electrical outlets for equipment power, each on separate branch circuits.
- Separate duplex 120 Vac convenience electrical outlets (for tools, field test instruments, etc.), must be placed at 1.8 m (6 ft) intervals around perimeter walls.
- Coordinate light switch locations for easy access upon entry.
- All electrical outlets must be on non switched circuits (electrical outlet power must not be controlled by a wall switch or other device that may lead to inadvertent loss of service).
- Convenience electrical outlets should be identified.
- Additional electrical outlets or power strips may be required, depending on the amount and type of equipment planned for the TR.
- Consider providing emergency power to the TR with automatic switchover capability.
- In many cases, it is best to install a dedicated power panel to serve the TR.
- Distribution panels that serve telecommunications equipment should be separate from those that serve lighting fixtures.
- At least one electrical outlet should be on normal power, and one electrical outlet should be on emergency power, if available.

Lighting

- Shall be a minimum of 500 lx (50 foot candles) measured 1 m (3 ft) above the finished floor, mounted 8.5 ft minimum above the finished floor.
- Light fixtures must be independently supported from the ceiling to the building structure. Light fixtures shall not be mounted to, or supported by the cable tray.
- Lights shall be controlled by a wall switch located at the room entrance. Coordinate light placement with equipment rack and cable tray/ladder rack locations to maximize lighting and minimize EMI.

Bonding and Grounding

The installation conforms with applicable practices and codes (in the United States, ANSI J-STD-607-A, Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications, the NEC, and local building codes

Backbone

- Backbones must be designed in such a way to protect the cables from damage and to provide redundant communications paths to network equipment installed in TRs. Backbone capacity must be sufficient to connect each network device to two equipment rooms.
- The capacity and destination for backbone cable is determined by the location and purpose of the building.
- Typically outside plant fiber strand counts are 36 single mode and 36 multimode (62.5 μm) to a minimum of two Equipment Room locations. The strand count for fiber

between TRs within a building are between 12 and 24 single mode and 12 to 24 multimode (62.5 μm) based on network equipment count.

- The typical pair count for copper inside plant (ISP) riser for telephone is two pair for each four pair cable to the end user station (work area outlet). The outside plant (OSP) telephone cable count must match the riser total count pair for pair.
- All backbone cable must be protected and supported.

Horizontal cabling

- Horizontal cable must be protected from damage (crushing or twisting) during and after installation. Supporting race way must accommodate for growth and maintenance of the cable as well as non-disruptive installation of replacement cabling as cable standards change.
- 40% fill for new raceway provides replacement during the lifetime of the renovation.
- The requirements in this section are harmonized with the horizontal pathway and related space requirements specified in American National Standards Institute/Telecommunications Industry Association/Electronic Industries Alliance (ANSI/TIA/EIA)-569-B, *Commercial Building Standard for Telecommunications Pathways and Spaces*.
- When designing a building, the layout and capacity of the horizontal pathway system must be thoroughly documented in floor plans and other building specifications. The designer is responsible for ensuring that these systems have built-in flexibility to accommodate tenant movement and expansion. In addition, the horizontal pathway system should be designed to make the maintenance and relocation of cabling as easy as possible.
- All design and construction for pathway systems must meet or exceed national and local codes and standards.
- When grounding telecommunications pathways, ensure that the installation conforms with applicable practices and codes (in the United States, ANSI J-STD-607-A, *Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications*), the NEC, and local building codes.
- Use systematic methods and procedures for labeling and managing horizontal pathways and spaces. For details on guidelines and requirements for the color coding and administration of horizontal cabling systems, ANSI/TIA/EIA-606-A, *Administration Standard for Commercial Telecommunications*

Work Area Outlets

There are over 20 thousand work area telecommunications outlets on campus and they each must be named and labeled according to CIS labeling standards. This is to identify locations for Help support and security for network traffic.