Telecommunications Infrastructure Standard for Data Centers

802.3 Tutorial

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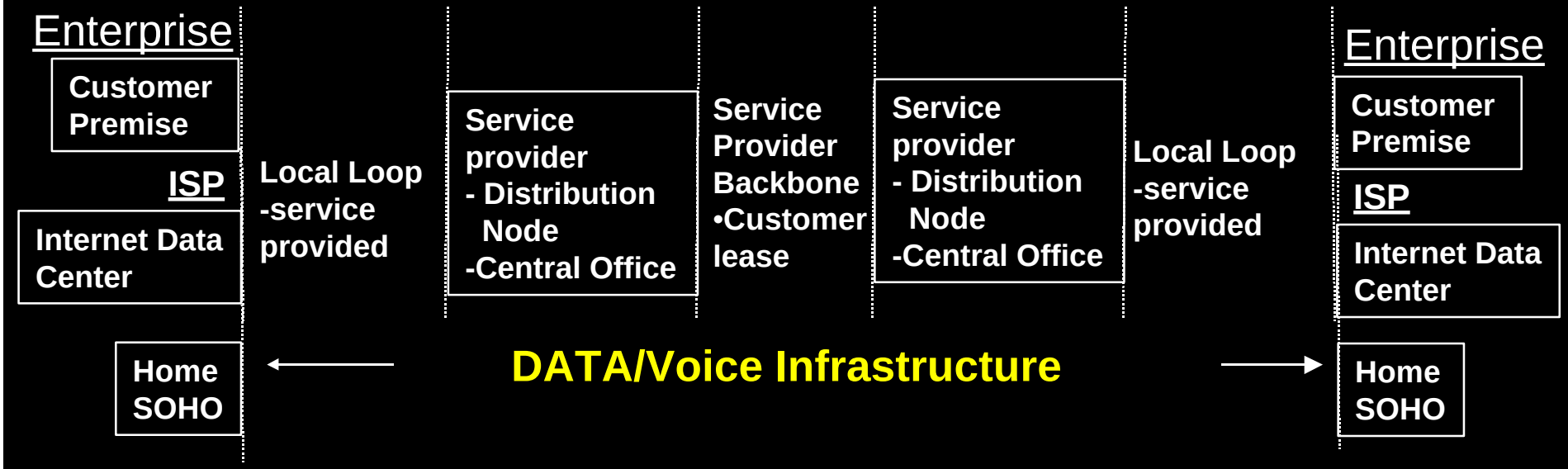
TR42: Data Center Standard

PN-3-0092
Telecommunications Infrastructure Standard for Data Centers
Draft 2.0
July 9, 2003

Telecommunication Infrastructure



- Data Center
- EFM- Access Networks

Campus Network: California State University Data Center -80's

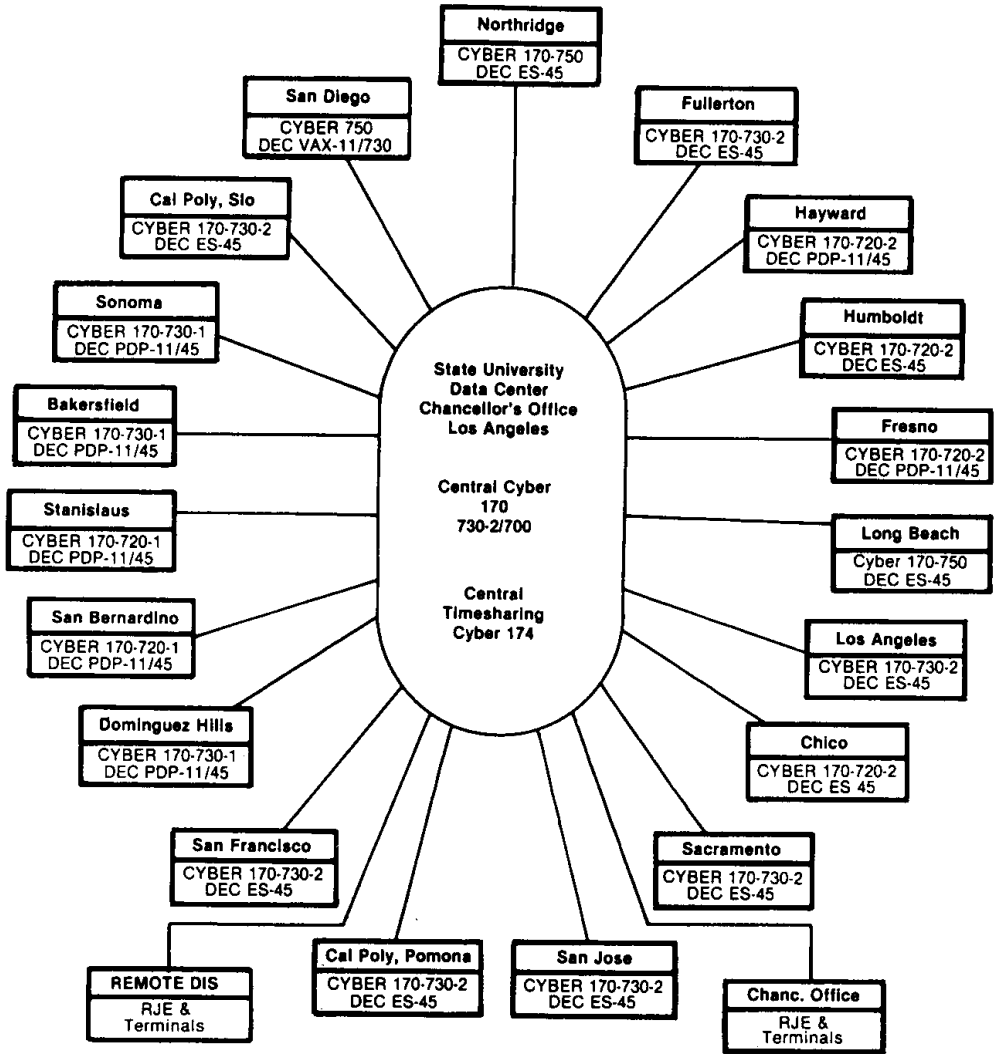
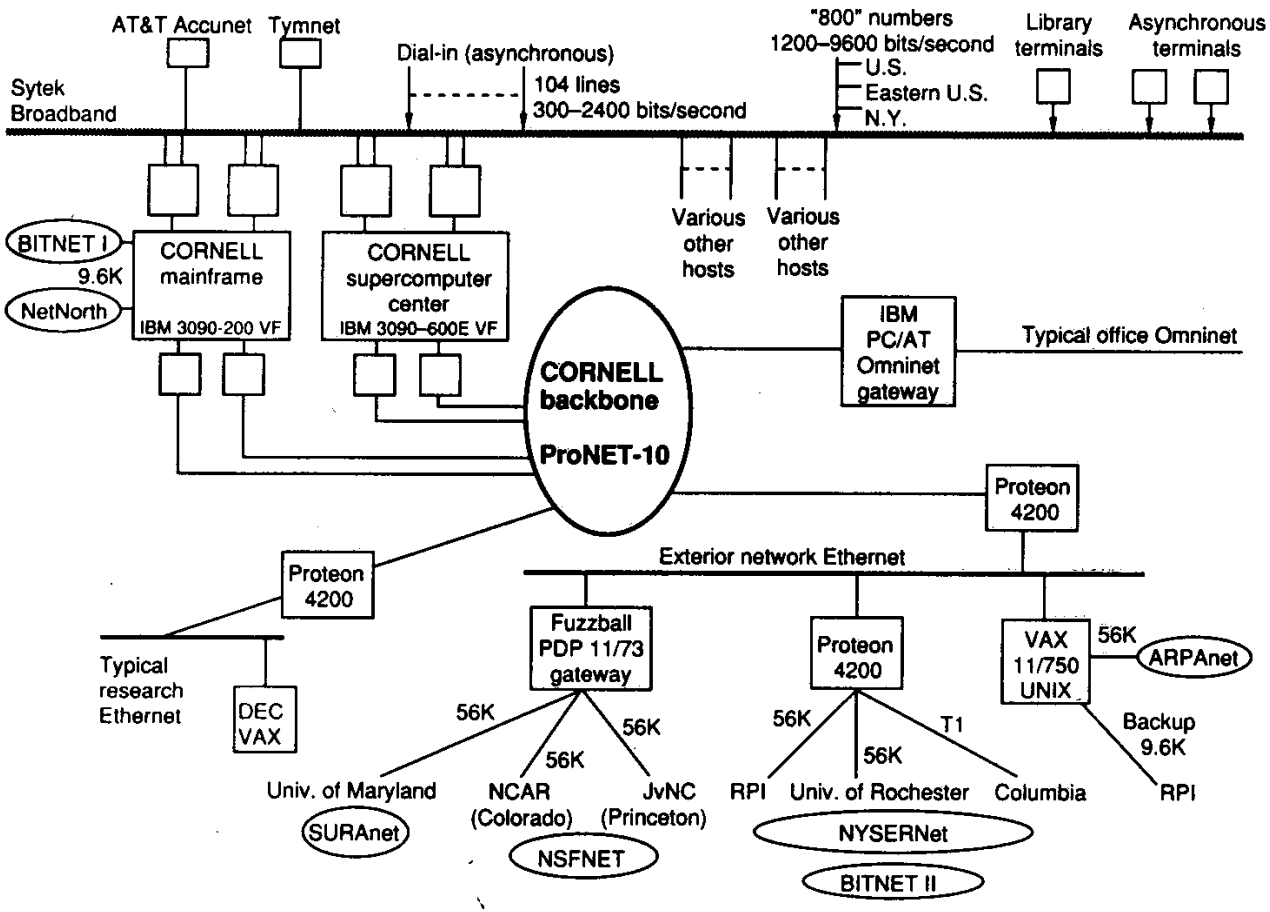


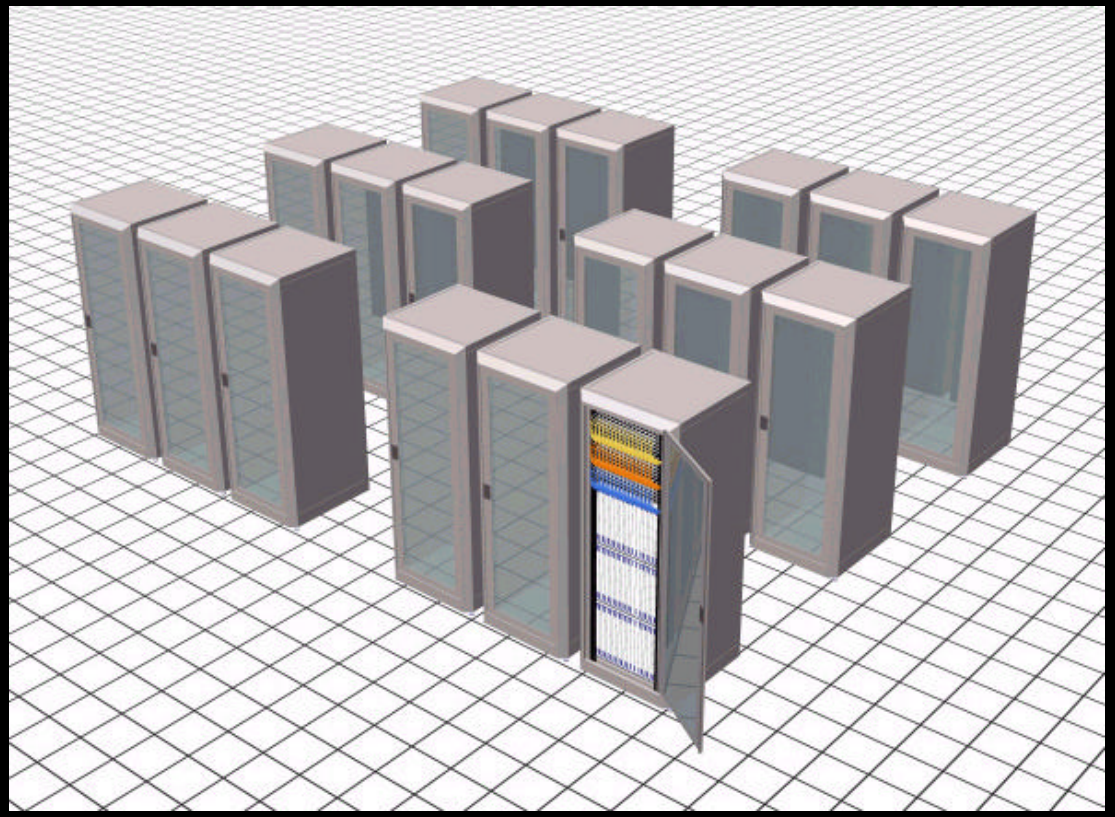
Figure 4. *The California State University System computing network.*

Cornell Campus Network, -87



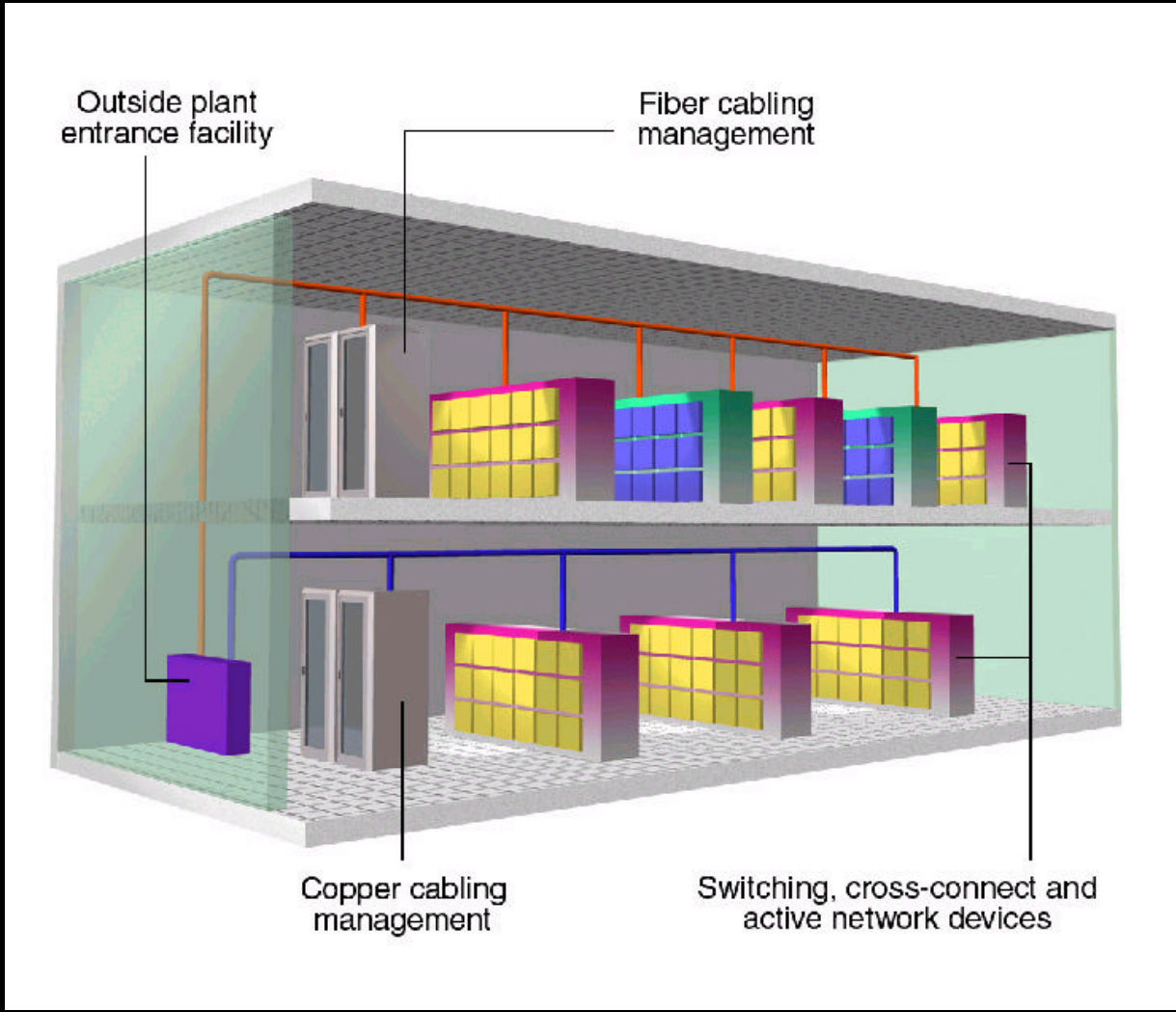
The Cornell campus network in September, 1987.

Internet Data Centers

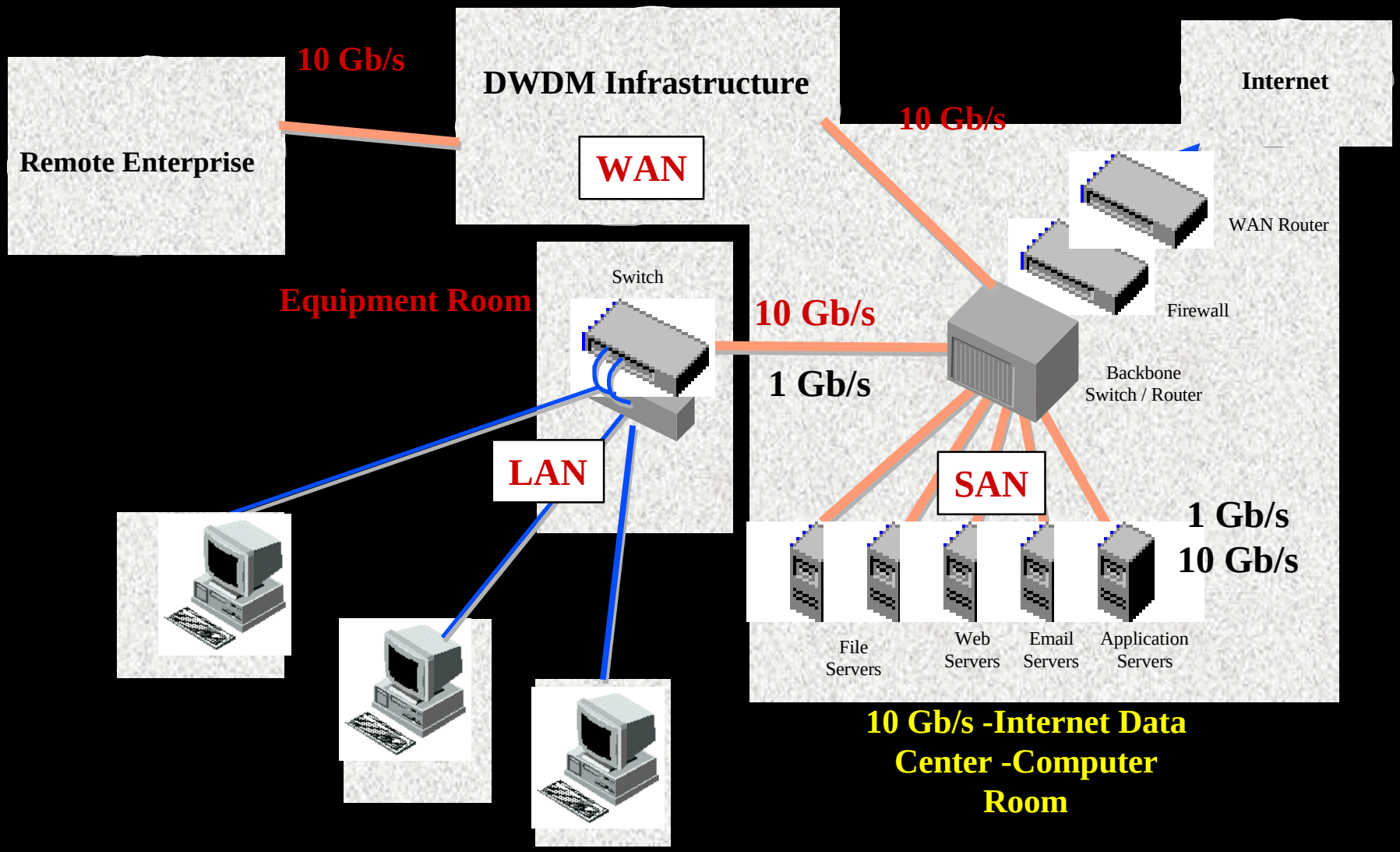


- Network infrastructure required to drive web hosted Internet applications.

Service Provider Distribution Node- Central Office



Ethernet Networking -LAN/WAN/SAN



Cabling Topologies and Distances

Cable Element	Customer Premises ISO/IEC 11801-TIA	Data Center	Central Office	Equipment Room
Horizontal Cabling	≤100 meters	≤100 meters	≤100 meters	NA
Equipment-to-Equipment		≤100 meters	≤100 meters	30 meter

Who is Developing the Standard

- The standard is being developed by the TIA/TR42 Engineering Committee - subcommittee-TR-42.1.1 Network Distribution Nodes - Project No. 3-0092
- Participants include:
  - Architecture & Engineering Firms
  - Consultants
  - End Users
  - Manufacturers
- The standard will become TIA-942
- To be submitted for approval by ANSI and CSA

Status of the Standard

- 2nd draft released for industry ballot July 2003.
- Draft posted to IEEE website
- Ballot comments to be resolved October 2003.
- Liaison with other standards organizations (IEEE, CENELEC, BICSI, ISO,ASHRE)
- Liaison with data center industry organizations (7X24 Exchange,Uptime Institute)
- Liaison with network and computer equipment manufacturers
- Final approval expected sometime in 2004

Purpose of the Standard

- Enabling planning for data centers to occur earlier in the building development process (architectural, facilities, and IT).
- Fill a void by providing standards for planning of data centers, computer rooms, server rooms, and similar spaces.
- The standard encompasses much more than just telecommunications infrastructure.
- Close to half of the technical content deals with facility specifications.

Purpose of the standard

- Specifications for data center telecommunications cabling, pathways and spaces
- Recommendations on media and distance and restrictions for data center applications over structured cabling system (TIA 232, TIA 561, T1, E1, T3, E3, 1 & 10 Gigabit Ethernet, Fibre Channel)
- Establish a standard for data center tiers to replace several proprietary standards. The TIA data center tier standard is:
  - A tool to evaluate existing data centers
  - A tool to communicate design requirements

TR42.1 Study Group: Telecommunications Cabling Infrastructure for Network Distribution Nodes

Scope: Develop cabling topology, recognized media types, cabling requirements, and requirements for pathways & spaces for data centers

- Cabling Design
- Network Design
- Facility Design

- Informative annex: Provide best practices

Design Elements:

Cabling Design:

- Copper and fiber cabling performance
- Connectors, cables, distribution hardware
- Cabling distances
- Space management

Facility Design:

- Data center sizing
- Power distribution methodologies
- Pathways and spaces
- HVAC, security, operations, and administration.
- Flexibility, scalability, reliability and space management

Design Elements:

Network Design:

- Support legacy systems
- Enable rapid deployment of new technologies such as the emerging 10 Gb/s applications.

Overview of key elements - Normative

Normative:

- **Clause 5.** cabling spaces - definitions
- **Clause 6.** Data center cabling
  - –definitions
  - –topology
  - –recognized media
  - –redundancy
- **Clause 7.** Data Center Cabling Pathways

Overview of key elements - Informative

Informative:

- **Clause 8:** Redundancy

- **Annex:**
  - application distances
  - administration
  - carrier information
  - site selection
  - infrastructure tiering
  - design examples

Distribution Areas - Spaces for cabling elements

Cabling elements

- Cross-connect
- Interconnect

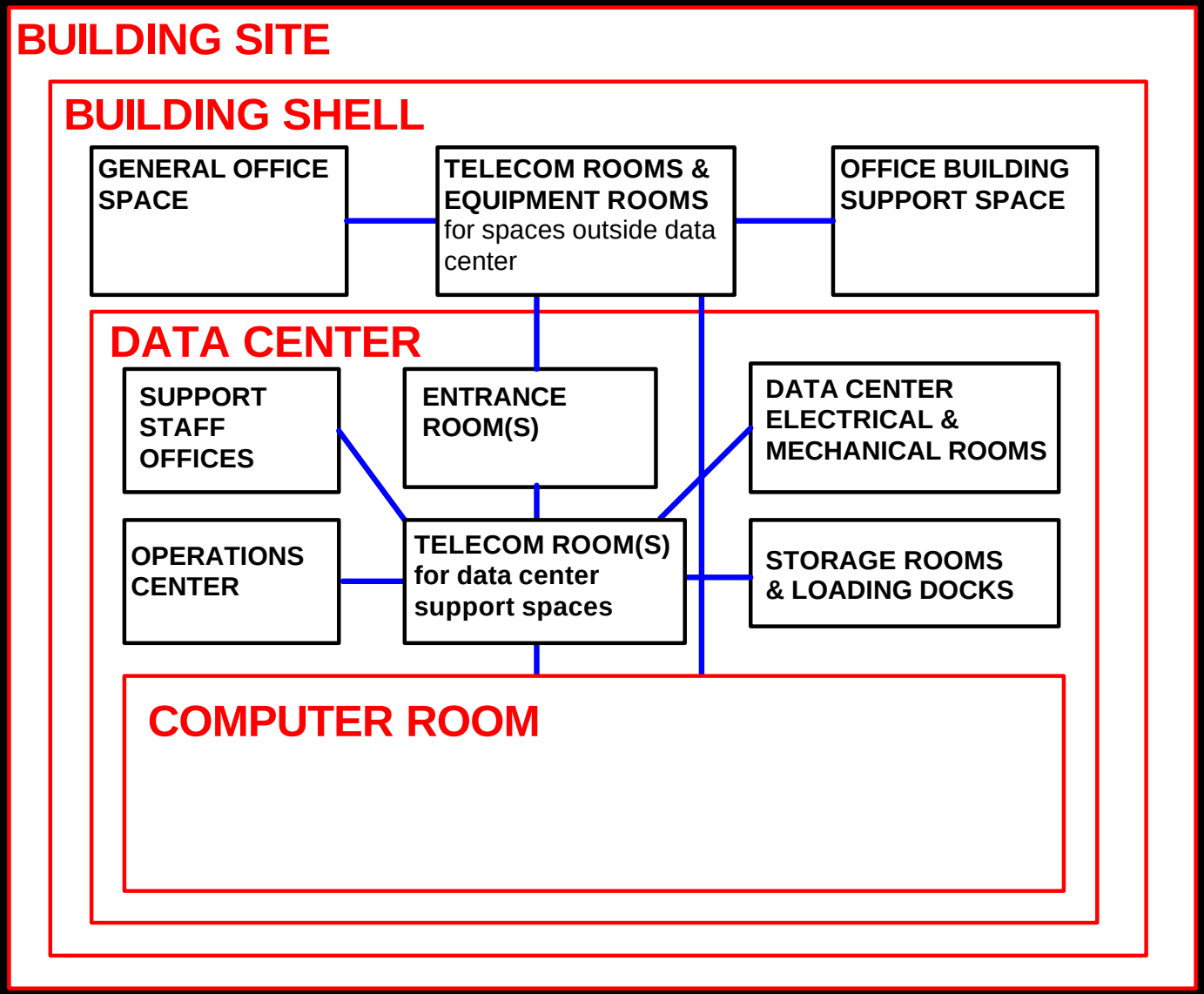
Distribution Areas

- Main Distribution Area -MDA
- Horizontal Distribution Area -HDA
- Zone Distribution Area - ZDA
- Equipment Distribution Area -EDA
- Entrance Room

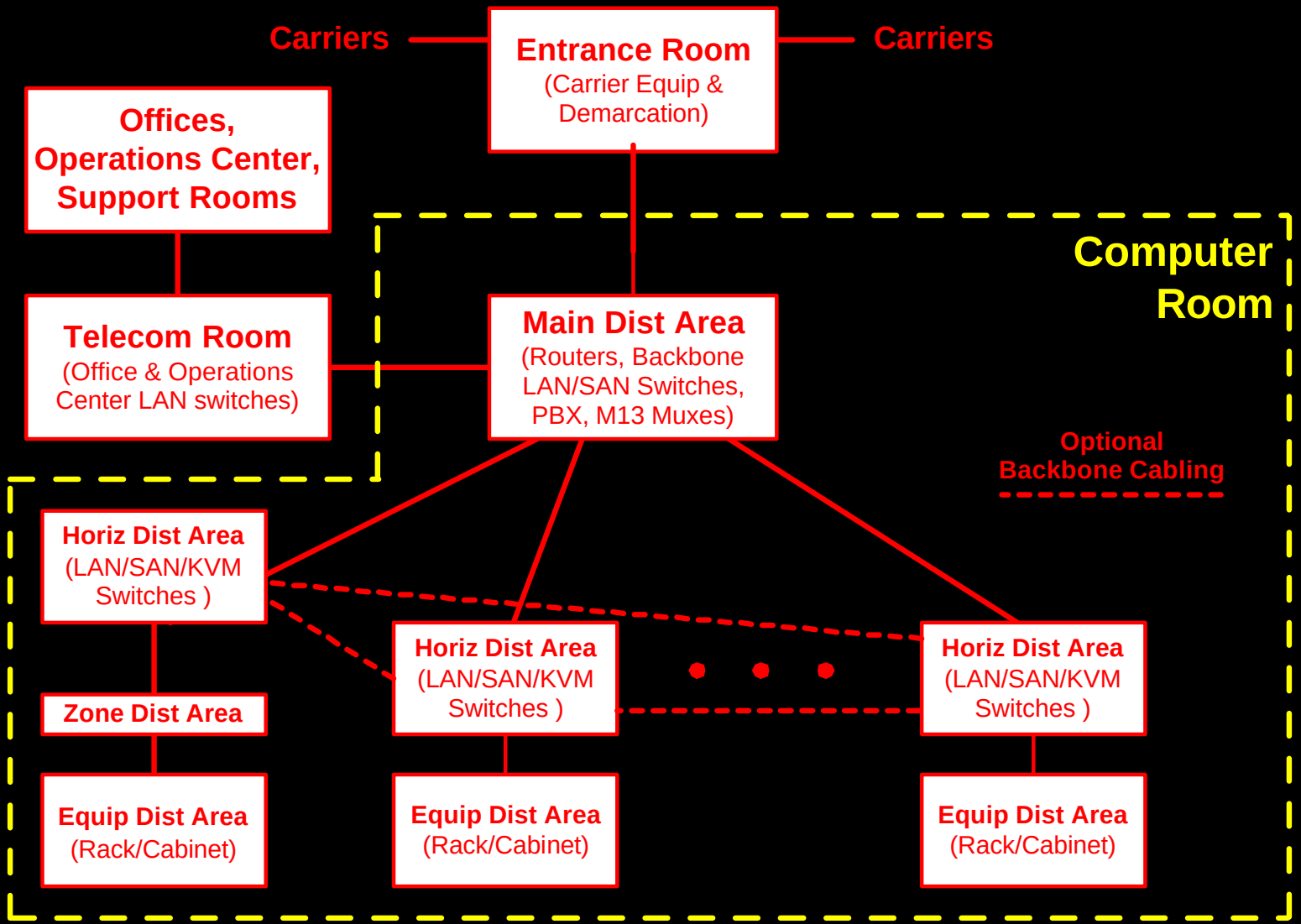
Purpose of the standard

- Define a standard telecommunications infrastructure for data centers
- Structured cabling system for data centers using standardized architecture and media
- Accommodates a wide range of applications (LAN, WAN, SAN, channels, consoles)
- Accommodates current and known future protocols (10 Gigabit Ethernet)
- Replaces unstructured point-to-point cabling that uses different cabling for different applications

Relationship of Spaces



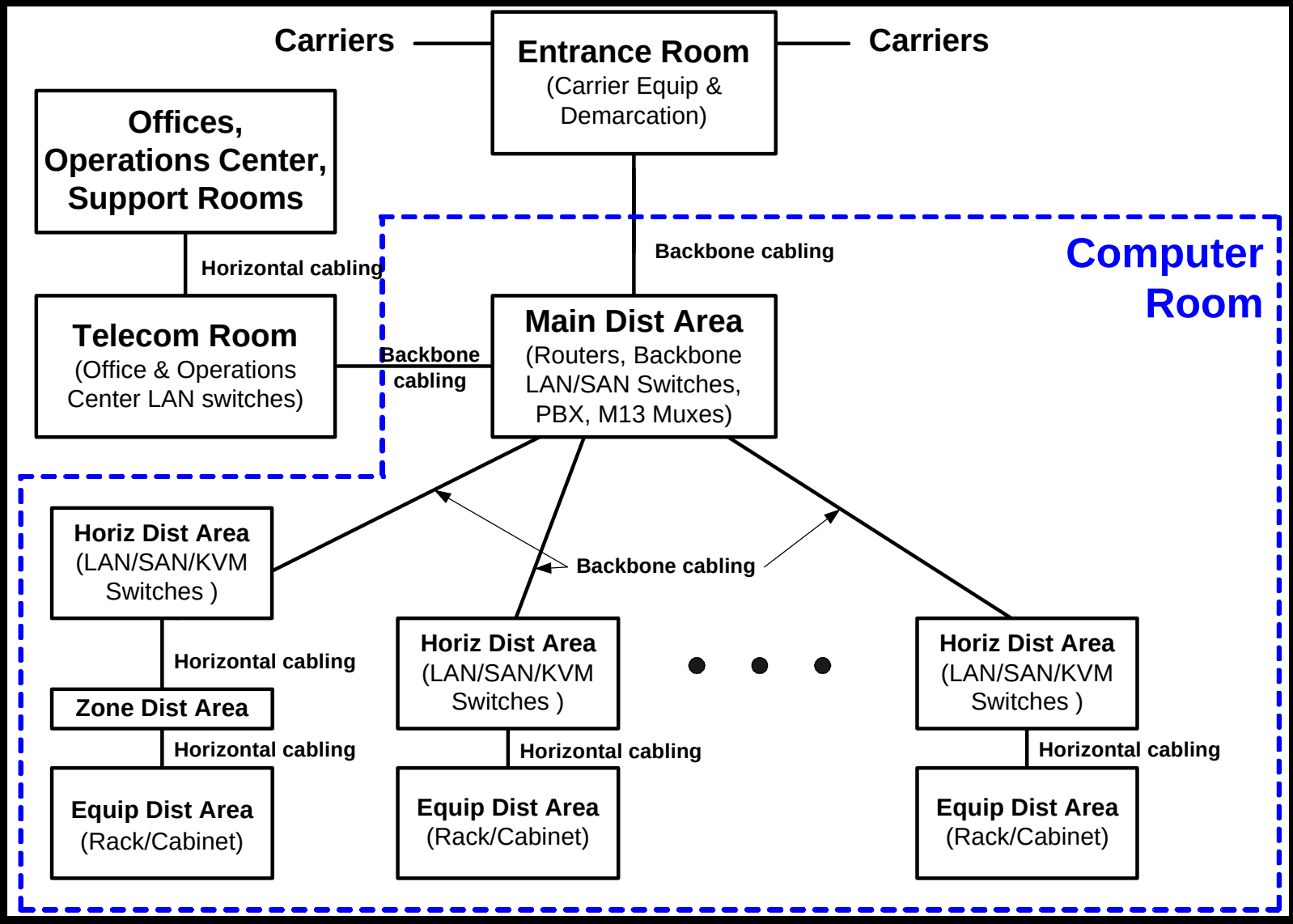
Data Center Telecommunications Spaces



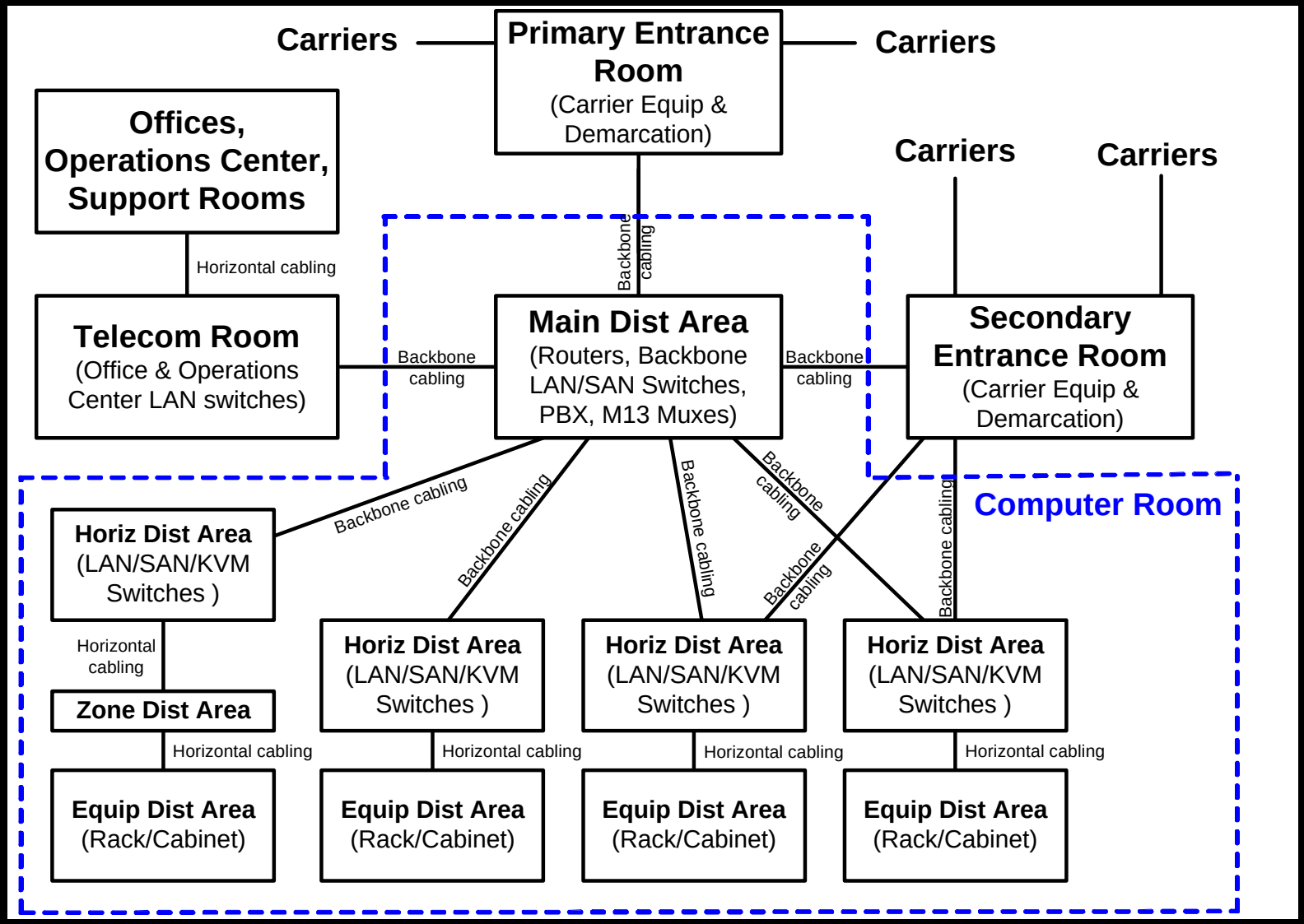
TIA-942 Spaces

- Entrance Room (ER) - location of interface with campus and carrier entrance facilities
- Main Distribution Area (MDA) – location of main cross-connect (MC)
- Horizontal Distribution Area (HDA) – location of horizontal cross-connect (HC)
- Zone Distribution Area (ZDA) – location of zone outlet (ZO) or consolidation point (CP)
- Equipment Distribution Area (EDA) – location of equipment cabinets and racks

Data Center Cabling Topology



Distributed Topology with Multiple ERs



Backbone Topology

- Includes cabling from MDA to ER, HDA, TR
- Optional cabling between HDAs allowed
- Maximum backbone cable lengths based on applications distances
- Centralized optical fiber cabling supported with interconnect, splice, or pull-through at the HDA
- Star topology with no intermediate cross-connects
- Various topologies permit redundancy and flexibility to support various data center sizes

Horizontal Topology

- Defined as cabling from horizontal cross-connect (HC) to the equipment distribution area (EDA)
- Star topology with termination on HC in HDA or MDA
- Max of one consolidation point in a ZDA

Horizontal and Backbone Cabling

- Recognized Cables:
  - a) 100-ohm twisted-pair cable (ANSI/TIA/EIA-568-B.2), category 6 recommended (ANSI/TIA/EIA-568-B.2-1)
  - b) multimode optical fiber cable, 50/125 micron (ANSI/TIA/EIA-568-B.3) and 62.5/125 micron or 50/125 micron (ANSI/TIA/EIA-568-B.3)
  - c) singlemode optical fiber cable (ANSI/TIA/EIA-568-B.3)
  - d) 75-ohm (734 and 735 type) coaxial cable (Telcordia Technologies GR-139-CORE)

Carrier Circuit Lengths in Data Centers

Maximum cable lengths for common circuits:

- E-1's over 24 AWG Cat 5/5e/6 UTP:

  532 ft (152 m) - 16.4 ft (5 m) per patch panel

- T-1's over 24 AWG Cat 5/5e/6 UTP:

  731 ft (223 m) - 16.4 ft (5 m) per patch panel

- E-3's over 734 coax:

  618 ft (188m) – 19.8 ft (6 m) per patch panel

- T-3's over 734 coax:

  513 ft (156m) – 15.4 ft (4.7 m) per patch panel

Distances are from carrier demarcation point to end equipment and assume no customer DSX.

Carrier Circuit Lengths in Data Centers

- Common data center configurations include 6 patch panels: 1 in ER, 2 in MDA, 2 in HDA, and 1 in the EDA
- Cat 3 instead of Cat 5 reduces circuit lengths for T-1s and E-1s significantly
- 735 coax (mini-coax) reduces circuit lengths for T-3s, E-1s, and E-3s significantly
- Circuit length restrictions may :
  - require additional ERs,
  - limit location of telecom equipment,
  - limit the size of the computer room

Computer Room Requirements

- Similar to Equipment Room reqts from TIA-569
- Min clear height of 2.6m/8.5 ft
- Min door size 1m/3ft wide 2.13/7ft high
- Min dist floor loading 7.2 kPA/150lbf/ft^2, recommended min 12 kPA/250 lbf/ft^2
- Dedicated HVAC system preferred
- 20^oC to 25^oC
- 40% to 55% relative humidity (reduces ESD)
- Signal reference grid –equipotential ground reference and reduces stray high frequency signals
- Any sprinkler systems must be pre-action system

Entrance Room

- Demarcation to carriers
- Telecom Entrance & Campus Conduits
- Carrier Racks
  - Coordinate power and space requirements with each carrier
  - Provide either AC or DC power to carriers.
  - If ER only has AC power, carriers install DC power from rectifiers to their racks & cabinets
- Plywood for protectors
  - Not required if no copper entrance cables or if carrier will install protectors on frames or racks

Entrance Room

- ER may be inside data center but, location outside data center provides best security
- ER may be consolidated with MDA
- ER requires the same redundancy for power and cooling as the computer room space
- Locate ER to avoid exceeding maximum cable lengths for circuits
- Cabling distances for carrier circuits may dictate multiple ERs in large data centers

Main Distribution Area

- Location of Main Cross-Connect (MC), the central point of distribution for data center structured cabling system
- Centrally located to avoid exceeding maximum distance restrictions (typically for E-1s, E-3s, T-1s and T-3s)
- Install separate racks for Fiber, UTP, and coaxial cable distribution

Main Distribution Area

- Data center size may dictate use of Cat 5e or 6 UTP for Fractional T-1, E-1, T-1, ISDN PRI
- Copper-pair cabling for LAN backbone cabling (in smaller data centers) and out-of-band management using Cat 5e or 6 UTP
- AT&T 734-type 75 ohm coaxial cable for E-1, E-3, T-3 cabling (two coax per circuit)
- Multimode and Single-mode fiber cabling for OC-3, OC-12, OC-48, MAN, LAN & SAN backbone.

Horizontal Distribution Area

- Location of Horizontal Cross-Connect (HC), the distribution point for cabling to equipment distribution area
- Distribution LAN, SAN, KVM switches and console servers located in HDA
- MDA may also include an HC for nearby equipment distribution area
- Number of HDAs depends on the density of cabling and the size of the data center

Horizontal Distribution Area

- The capacity of the cable tray system and the size of the cross-connect creates practical limits on the size of the HC
- Guideline is maximum of 2,000 4-pair UTP or coax cable terminations per HDA
- Arrange patch bays to minimize patch cable lengths and to simplify cable management
  - Separate racks for fiber, UTP, and coax
  - Locate switches and patch panels to minimize patch cord lengths

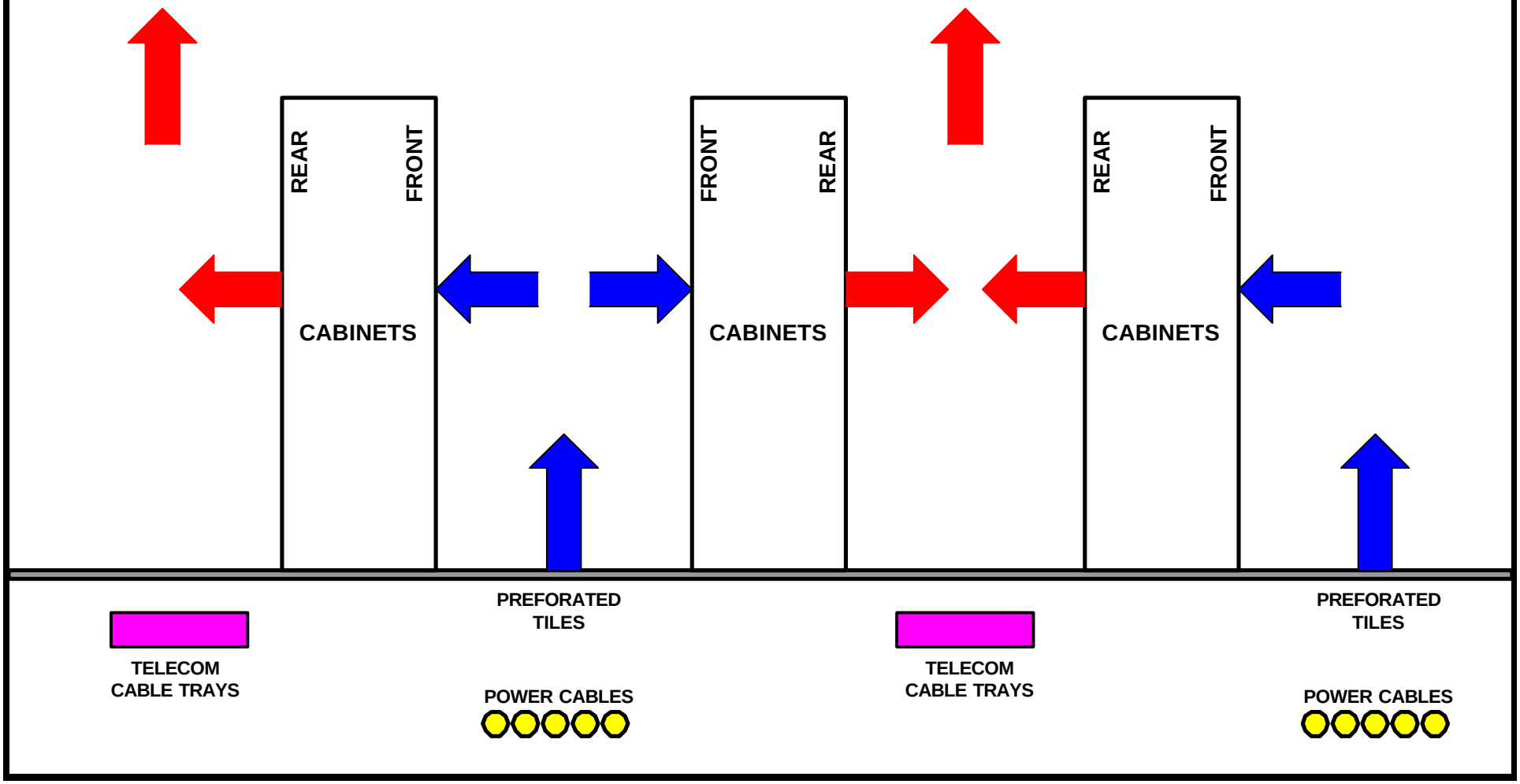
Zone Distribution Area

- Rack, cabinet, or under floor enclosure that houses a zone outlet (ZO) or consolidation point (CP)
- ZO - structured cabling termination for floor-standing equipment that cannot accept patch panels (e.g. mainframes and large servers).
- CP - intermediate termination point (e.g. cabling to areas where floor plan is uncertain or dynamic)
- No cross-connects within the ZDA
- No active equipment shall be located in the ZDA
- Maximum of 144 connections in a ZDA
- Maximum of one ZDA within a horizontal cable run

Equipment Racks & Cabinets

- Cabinets and racks should be arranged in an alternating pattern (with fronts of rows of cabinets/racks facing each other) to create hot and cold aisles
- Cold aisles are front of racks/cabinets – if there is a raised floor, PDU cables are run here on the slab.
- Hot aisles are rear of racks/cabinets – cable trays for telecom cabling are typically placed here.
- Perforated tiles should be placed in cold aisles.

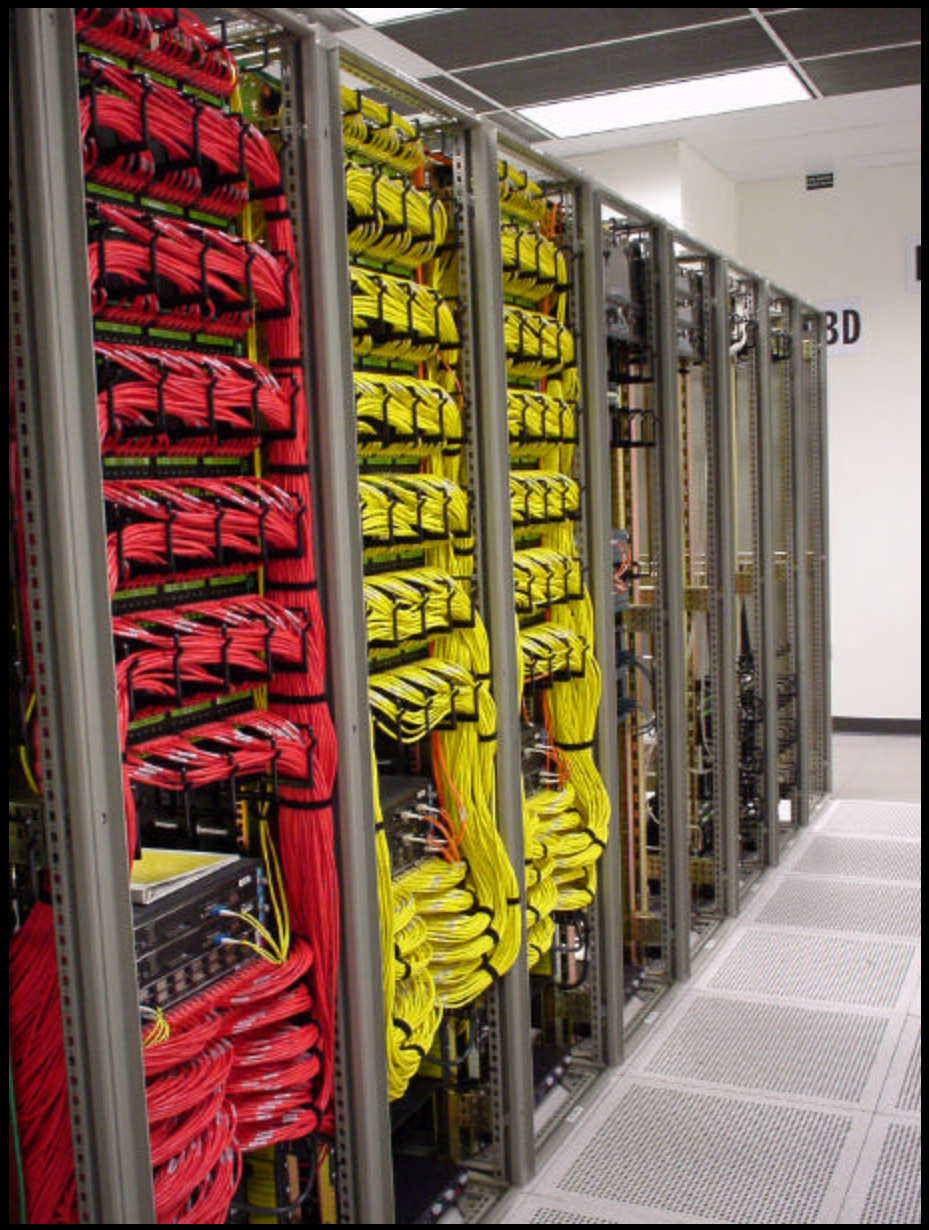
HOT AND COLD EQUIPMENT AISLES



Equipment Racks & Cabinets

- Equipment is mounted in racks & cabinets from the front – provide adequate clearance for installation of equipment (minimum of 3 feet, 4 feet is recommended).
- Cabinets should be aligned with one edge along the edge of the floor tile.
- Arrange cabinets and racks on raised floor to permit tiles along the front and rear of the cabinets to be lifted
- Floor tile cuts should be no larger than necessary to minimize air pressure loss.

Equipment Cabinets

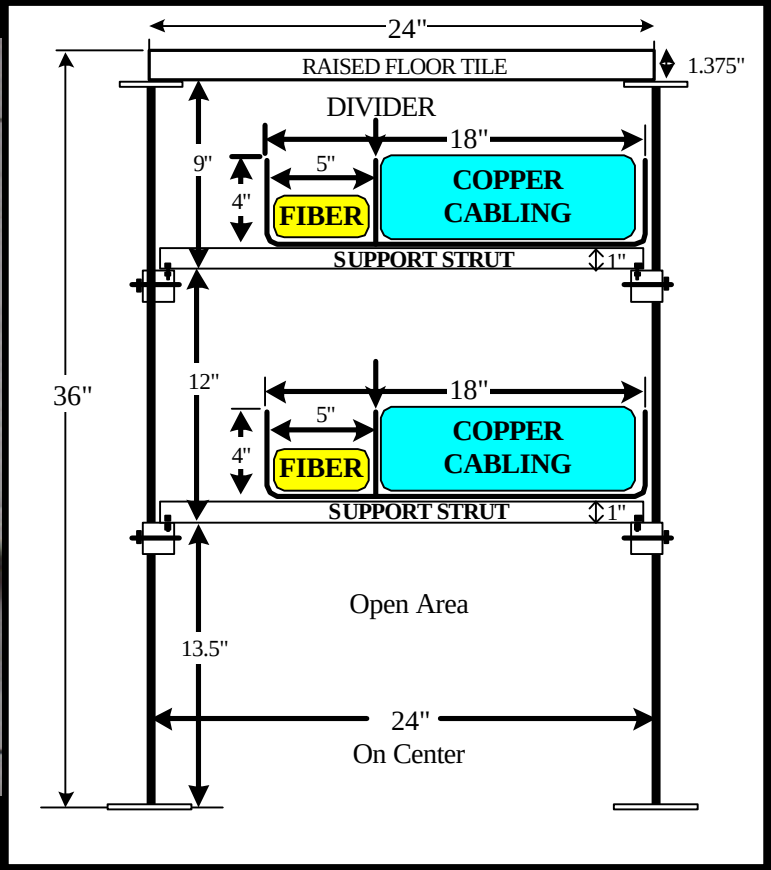


- Front rails of cabinets must be recessed to provide adequate room for patch cables and wire managers
- Adequate space for cable management
- Arrange switches and patch panels to minimize patching between cabinets & racks
- Perforated tiles at front of cabinets
- One edge of cabinets placed at edge of tile

Raised Floor

- More flexible cooling with raised floor than ducted air
- Most stand-alone computer systems are designed for cabling from below
- Coordinate under floor cabling with mechanical & electrical engineers
- Recommend wire basket cable trays in hot aisles for telecom cabling

Example of Wire Basket Cable Trays For Cabling Under Raised Floor



Under Floor Space Example

- Color-coded PDU cables in hot aisles each cabinet fed from 2 PDUs
- Locking electrical receptacles NEMA L5-20R
- Signal Reference Grid (SRG) using bare copper conductor
- Each cabinet bonded to SRG

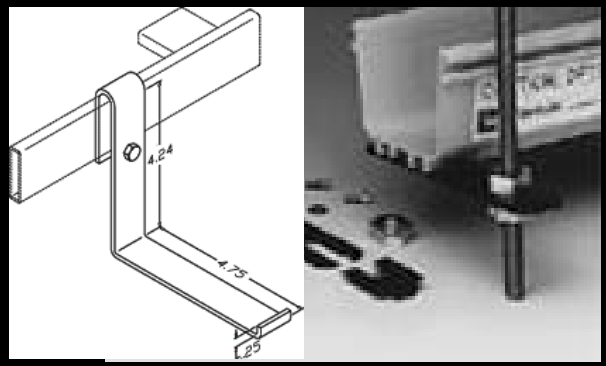
Overhead Cable Trays

- Less expensive than raised floor systems
- Cable trays can be attached to the top of racks and cabinets (if they are uniform in height)
- Cable trays suspended from the ceiling provides more flexibility for supporting cabinets/racks of various heights and for adding and removing cabinets/racks.
- Cable trays can be installed with several layers
- Coordinate location with lighting, ducts, overhead conduits, overhead power distribution

Overhead Cable Tray Example

3 Layer cable tray system:

- Bottom layer – copper
- Middle layer – fiber
- Top layer – power
- Signal Reference Grid in brackets attached to lower layer of trays
- Fiber patch cables may be in fiber duct attached to threaded rods



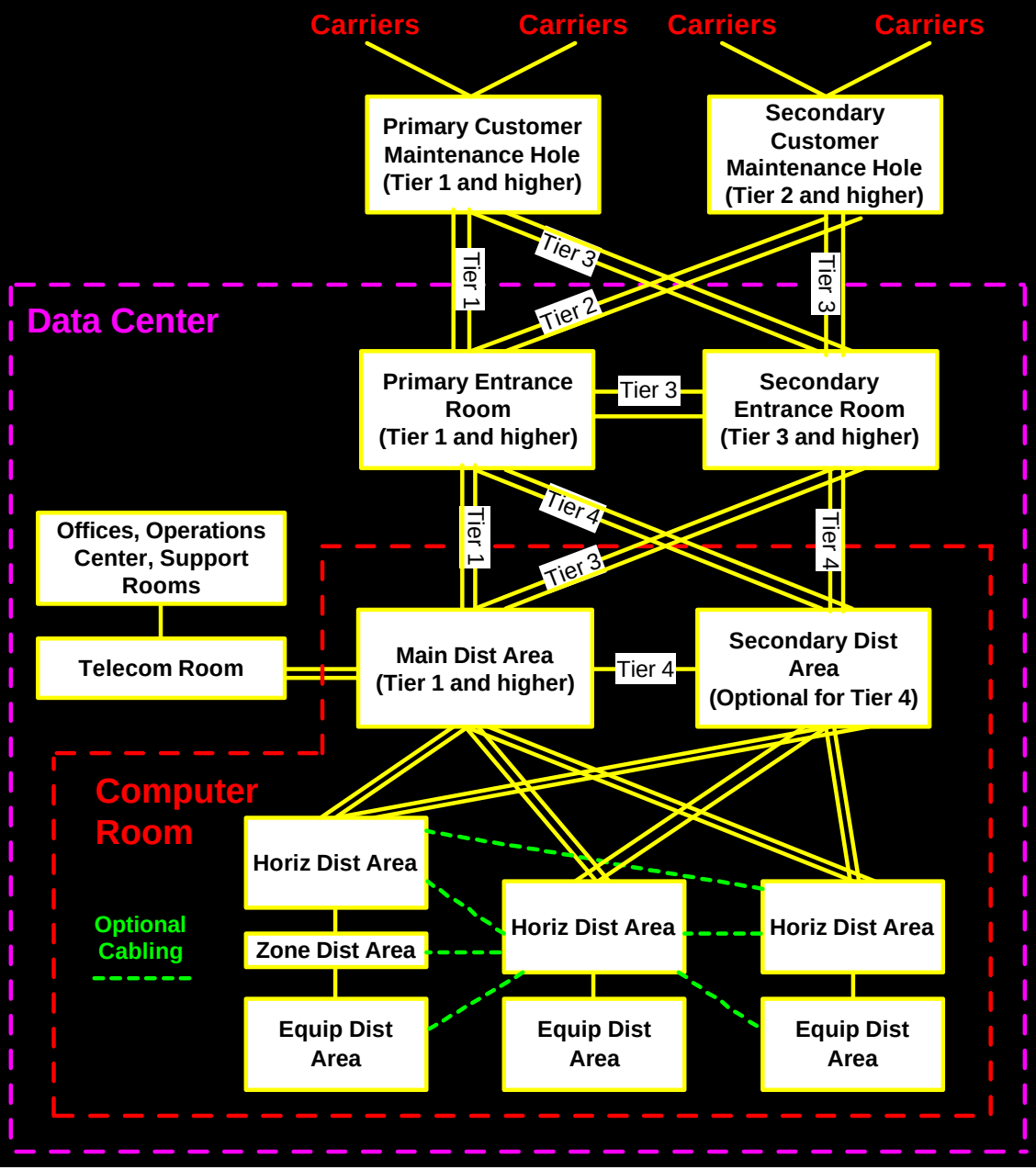
Infrastructure Administration

- Informative annex with TIA-606-A standards compliant labeling scheme for all components.
- Labeling scheme extended for use in data centers
- Cabinets and racks labeled by location using tile grid or row/position identifiers
- All cabinets, racks, patch panels, cables, and patch cords should be labeled

Facilities Specifications & Tiers

- Informative annex with general architectural, structural, electrical, mechanical, and telecommunications recommendations requirements
- Annex includes detailed architectural, security, electrical, mechanical, and telecommunications recommendations for each Tier
- Recommended specifications by tier are a uniform way to rate aspects of a data center design and are a starting point for initiating design requirements with qualified architects and engineers

Redundant Topologies



Conclusion

- TIA-942 is the first standard that specifically addresses data center infrastructure.
- Primarily a telecom infrastructure standard, but about half of the content deals with facility requirements.
- Provides a flexible and manageable structured cabling system using standard media.
- Builds on existing standards, where applicable
- Guidelines on a wide range of subjects useful to someone designing or managing a data center.
- An official tiering standard for determining the quality of a center. A way to objectively compare one center with another.