Structured Cabling Guidelines For The State Of Oregon

Compiled by;

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Introduction

The objective of this document is to assist **The State of Oregon, Department of Administrative Services** in the development of physical cabling infrastructure recommendations for accommodating present and future technologies. It should be understood that no one cabling infrastructure installation is the same and that customer needs will change from building to building.

It is expected that the system offered and quoted by low voltage installers, shall incorporate all features and facilities listed in this specification.

As you read through this, understand that the intent of this document is not to dictate every aspect of low voltage cabling and infrastructure installation to the reader. The expectation is that *the installation technicians should be at least under the supervision of a licensed journeyman* - as such, they should be very familiar with all applicable codes and standards and have the experience and resources to research any circumstance that might occur in the field.

The system shall:

Support analog and digital voice applications, data, local area networks (LAN), video and low voltage devices for building controls and management on a common cabling platform. The applications that shall be supported include, but are not limited to:

Data Processing - UNISYS, IBM 3270/ AS 400, Data Communications - EIA-232-D, EIA-422A, EIA-43-A, RS-485, Ethernet 10Mbs and 10Mbs, Fiber Distributed Data Interface (FDDI), 155Mbs ATM, Gigabit Ethernet, and 10Gigabit Ethernet.

Voice Applications - AT&T, Lucent, Northern Telecom, ISDN, VOIP

Video - Analog Video, Digital Video, Video Conferencing.

Building Control Services - Heating Ventilation and Air-Conditioning, Low Voltage Devices (Equipment Sensors, etc.) Wall Clocks, Security, Energy Monitoring and Control, Lighting, Fire Life Safety, Fire Sensors, Smoke Detection, Motion Detection, Public Address, Modular Wall Systems, Paging Systems.

The system shall:

Cover its capacity and functionality with minimum components; be flexible and capable of including new facilities or technologies as they become required or available.

In order to get a complete overview of the installation and develop a total list of materials for any renovation or new construction, many things have to be considered. Listed below are some of the issues that need to be addressed:

A) Needs assessment to determine the systems and networks to be supported.

B) Existing topologies or new topologies that will be required to be designed.

C) Material and equipment layouts.

D) Support of different types of building architectures and environments.

E) The number of data, voice, video and security locations. This includes any mission critical or special data applications.

F) Complete site surveys, walk throughs, and in-depth building blueprints must be made available.

As new technologies evolve, the need for a balanced and redundant cabling infrastructure to handle these high data rates will become more crucial. All new (as of 8-1-2004) structured cabling installations for ***the State of Oregon*** must meet or exceed all requirements of the ***ANSI/TIA/EIA/568B*** specifications**.**

Specification References;

- ANSI/TIA/EIA-568B “Commercial Building Telecommunications Cabling Standard”.
- ANSI/TIA/EIA-569B “Commercial Building Standard for Telecommunications Pathways and Spaces”.
- ANSI/TIA/EIA-606A “Administration Standard for Telecommunications Infrastructure of Commercial Buildings”.
- ANSI-J-STD-607A “Commercial Building Grounding/Bonding Requirements”.
- ANSI/NFPA 70 National Electrical Code.
- BICSI Telecommunications Distribution Methods Manuals.
- Any local building codes or municipal regulations.

➢ **Standards evolve - It is wise to always be sure and reference the latest version/revision of applicable standards prior to beginning work.**

The Six Subsystems of a structured cabling system (scs) shall consist of any or all of the following:

The subsystems of a Structured Cabling System are: Building Entrance/Entrance Facilities (EF), Equipment Room (ER), Backbone Cabling, Telecommunications Room (TR), Horizontal Cabling, Work Area (WA)

Building Entrance/Entrance Facilities (EF)

The entrance facility consists of the telecommunications service entrance to the building, including the entrance point through the building wall, and continuing to the entrance room or space. The entrance facility may contain the backbone pathways that link other buildings in campus situations. Antenna entrances may also constitute part of the entrance facility.

All carriers and telecommunications providers involved in providing service to the building shall be contacted to establish their requirements and explore alternatives for delivering service. The location of other utilities, such as electrical, water, gas and sewer shall be considered in the site selection of the telecommunication entrance facility.

A service entrance pathway shall be provided. The basic methods for provisioning are underground, buried, and aerial pathways.

In determining the total number of pathways required the planner shall consider the following:

- type and use of building
- growth
- difficulty of adding pathways in the future
- alternate entrance
- type and size of cables likely to be installed

The entrance room or space is the component of the entrance facility that provides space for the termination of the entrance backbone cable. In accordance with NEC Article 800 Section 800-50 exception No.3 the entrance or outside building cable shall be terminated and protected on a listed primary protector within 50 ft. of entering the building. Where telecommunications equipment (e.g. PBX) is located in the entrance room or space, the entire room or space shall meet the requirements for an equipment room as specified in ANSI/TIA/EIA-569B. If the network interface devices and telecommunication equipment are required in the entrance room, additional space will be needed.

The decision whether a room or open area is provided shall be based on security, quantity, type of termination and equipment, size of building and physical location within the building. For buildings exceeding (20,000 sq. ft.) usable floor space, an enclosed room should be provided.

In buildings (with up to 100,000 sq. ft.) of usable floor space, wall mounted terminating hardware may be suitable. Buildings of larger floor area may require free standing frames for cable termination. Refer to the appropriate tables in ANSI/TIA/EIA-569B to specify the space for all telecommunications equipment and associated cross-connections based on an 8 ft. wall or on free standing racks.

Listed below are some additional provisions:

- A minimum of two walls should be covered with rigidly fixed (3/4 trade size) A-C plywood preferably void free, 8 ft. high, capable of supporting attached equipment. Plywood should be either fire rated or covered with two coats of fire retardant paint.
- Lighting shall be a minimum of 50 foot candles measured 3 ft. above the finished floor.
- False ceiling shall not be provided.
- The access door shall be a minimum of 36 in. wide and 80 in. high and shall be fitted with a lock.
- Floors, walls and ceiling shall be treated to eliminate dust. Finishes shall be light in color to enhance room lighting.
- Electrical: A minimum of two dedicated 20A, 110V AC duplex electrical outlets, each on separate circuits, shall be provided for equipment power. Consideration should be given to identifying those outlets dedicated to telecommunications equipment. In addition, convenience duplex outlets shall be placed at 6 ft. intervals around the parameter walls, at a height of 6 in. above the floor. If emergency power is available, consideration shall be given to automatic power backup.
- If an emergency power source is available in the building, it is desirable that at least one of the duplex outlets be so supplied.
- Access shall be made available to the independent telecommunications grounding system specified by ANSI-JSTD-607A.
- ANSI/TIA/EIA-569B contains fire-stopping, miscellaneous pathways, telecommunications recommendations of separation from less than 480V power lines. Further information of entrance rooms can be found in ANSI/TIA/EIA-569B and the BICSI Telecommunications Distribution Methods Manuals.

Equipment Room (ER)

The equipment room is a centralized space for telecommunications equipment (e.g., PBX computing equipment, video switch) that serves occupants of the building. It is desirable to locate the equipment room close to the main backbone pathway and the equipment room shall be connected to the backbone pathway.

When selecting the equipment room site, avoid locations that are restricted by building components that limit expansion such as elevators, core, outside walls or other fixed building walls. Special attention for distance separation shall be given to electrical power supply transformers, motors and generators, x-ray equipment, radio, or radar transmitters, and induction sealing devices.

When designing the equipment room floor space, allowance should be made for non-uniform occupancy throughout the building. The practice is to provide 0.75 sq. ft. of equipment room space for every 100 sq. ft. of work station space. The equipment room shall be designed to a minimum of 150 sq. ft.

In special-use buildings, equipment room floor space shall be based on the known number of work stations (not on usable floor area) this can be found in TIA/EIA-569B.

Environmental control equipment, such as power distribution or conditioner, and UPS up to 100 kVA shall be permitted to be installed in the equipment room. UPS larger than 100 kVA should be located in a separate room.

The equipment room shall house only equipment directly related to the telecommunications systems and its environment support systems. Equipment not related to the support of the equipment room (e.g., piping, ductwork, pneumatic tubing, etc.) shall not be installed or pass through the equipment room. If lack of available space requires sharing the ER with electrical, HVAC, or plumbing facilities, serious consideration should be given to allocating a more appropriate location to allow adequate separation for the telecommunications and data equipment to minimize possible interference from other building utilities. Reference to additional provisions can be found in TIA/EIA-569B and BICSI Telecommunications Distribution Methods Manual.

Access shall be made available to the main telecommunications grounding system specified by ANSI-J-STD-607A.

Backbone Cabling

The function of the backbone cabling is to provide interconnections between telecommunications closets equipment rooms, and entrance facilities in the telecommunications cabling system structure (Diagram 1). In accordance with TIA/EIA-568B the backbone cabling consists of the backbone cables, intermediate and main cross-connects, mechanical termination, and patch cords or jumpers used for backbone to backbone cross-connection. Backbone cabling also includes cabling between buildings. During each planning period, growth and changes in service requirements should be accommodated without installation of additional cabling. The length of the planning period should be based upon the stability and growth of the user's organization. For each telecommunications closet, equipment room and entrance facility, the maximum number of connections over the planning period should be estimated. Sufficient backbone cabling for both copper and fiber media should then be installed to accommodate the maximum number of connections either directly or using auxiliary electronic devices.

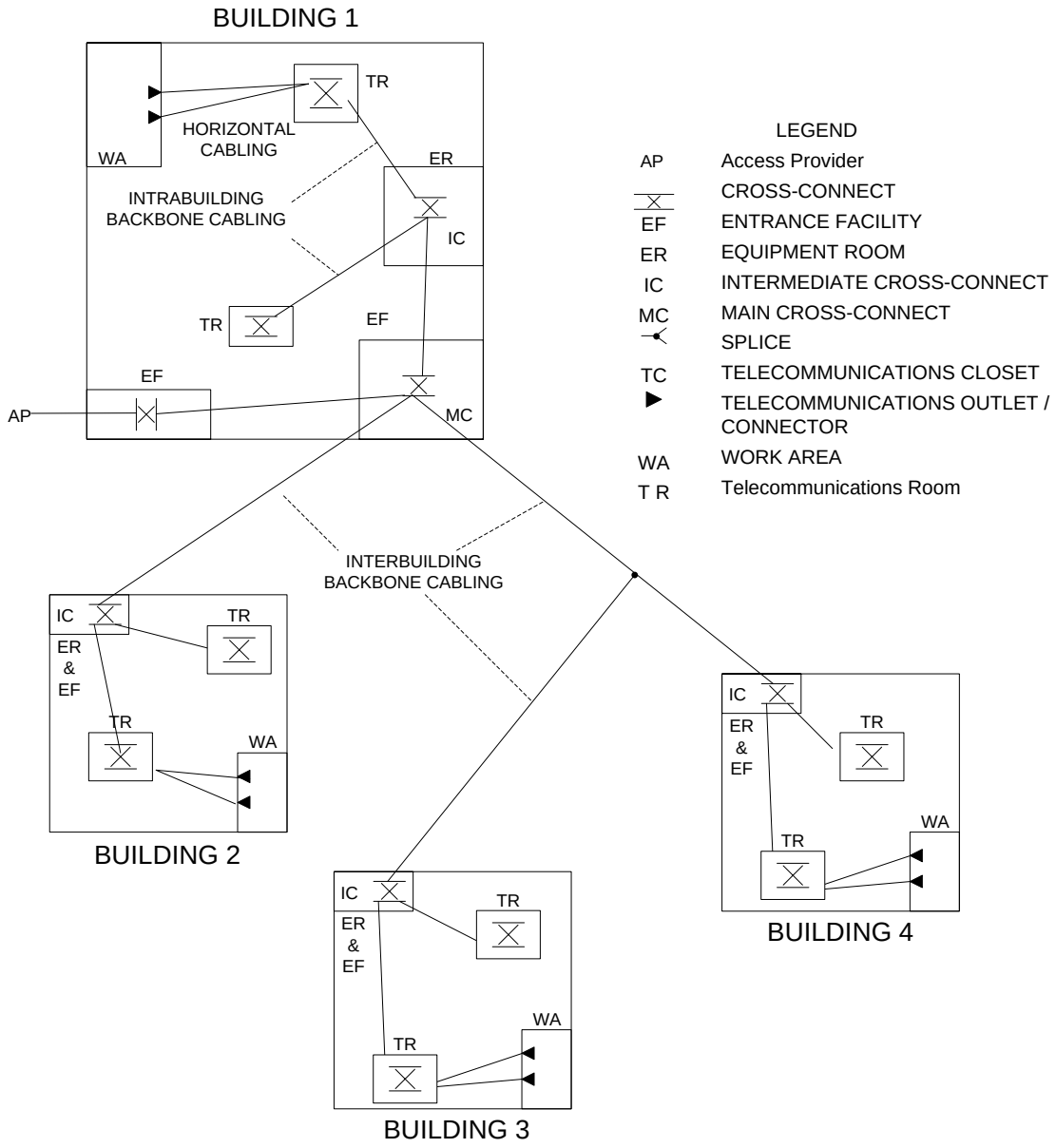
ANSI/TIA/EIA-569B specifies separation of the backbone cabling pathways from sources of EMI. Grounding of all metallic shields shall also be made to the main telecommunication ground.

The backbone cabling shall use the conventional hierarchical star topology as illustrated by Diagram 2 wherein each horizontal cross connect in a telecommunications closet is cabled to a main cross-connect or an intermediate cross-connect then to a main cross-connect. The exception to this is when bus or ring configurations are anticipated, cabling directly between telecommunications closets is allowed. Such cabling is in addition to the connections for the basic star topology. Consult TIA/EIA-569B for pathway and floor penetration and conduit stub heights for all topologies.

There shall be no more than two hierarchical levels of cross-connects in the backbone cabling. From the horizontal cross-connect, no more than one cross-connect shall be passed through to reach the main cross-connect. Therefore, interconnections between any two horizontal cross-connects shall pass through three or fewer cross-connects. Only a single cross-connect shall be passed through to reach the main cross-connect.

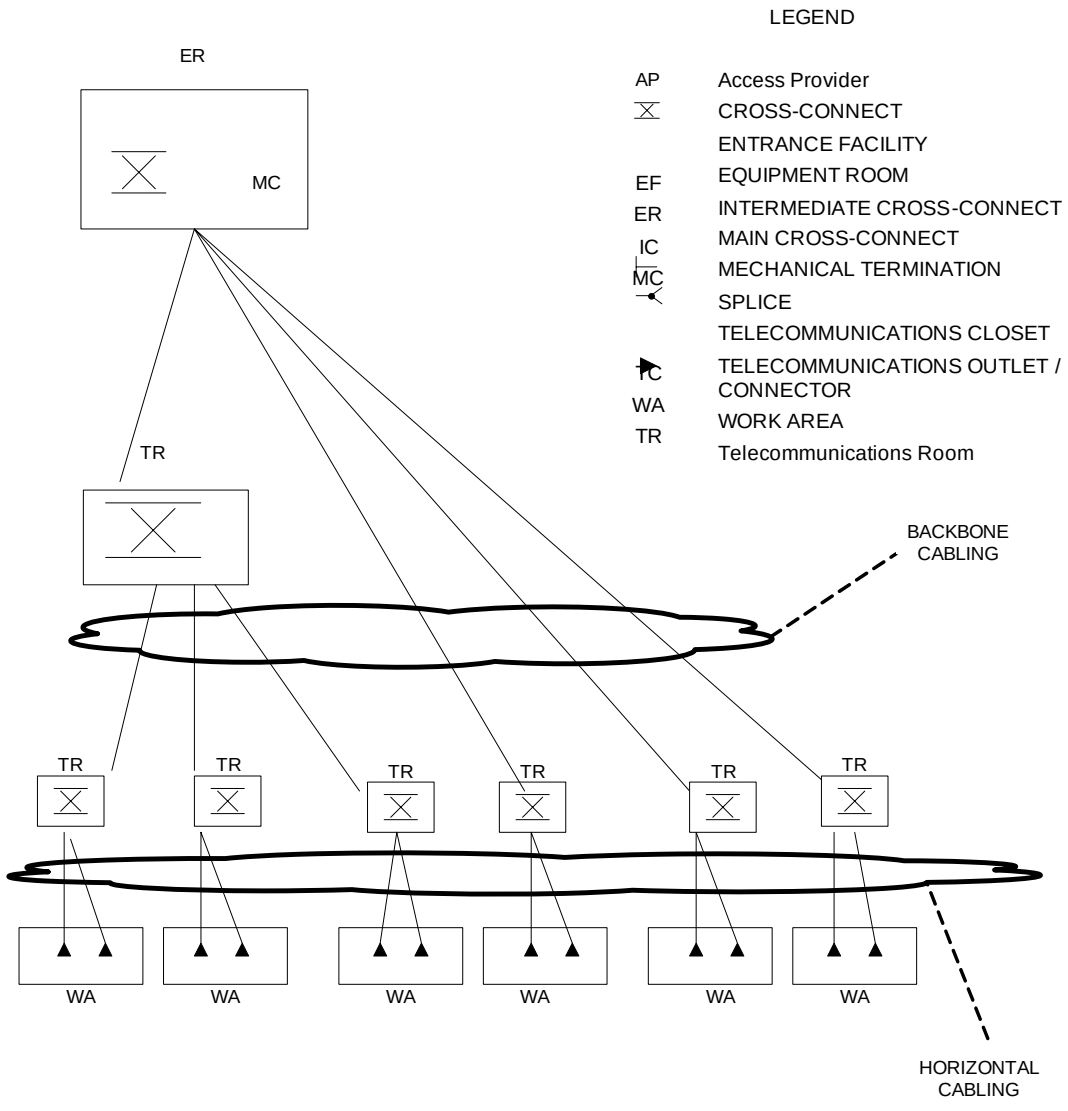
A single backbone cabling cross-connect (the main cross-connect) may meet cross-connect needs. Backbone cabling cross-connects may be located in telecommunications closets, equipment room, or at entrance facilities. Bridge taps shall not be used as part of the backbone cabling.

Diagram 1 - Typical Telecommunications Cabling System



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

Diagram 2 – Backbone Hierarchical Star Topology



Recognized Backbone Cables in accordance with ANSI/TIA/EIA 568-B are noted below.

These specified transmission media types shall be used individually or in combination in the backbone cabling.

- 100 Ohm UTP cable
- 50/125 μm Laser Optimized fiber
- singlemode optical fiber
- 75 Ohm coax CATV cable

All intra-building, backbone cables shall meet the appropriate NEC flame and smoke specifications. These include NEC Article 800 for copper cables and Article 770 for fiber optics. All cables shall meet or exceed the electrical specifications of ANSI/TIA/EIA 568B in addition all 100 Ohm UTP/ScTP (screened 100 Ohm twisted pair). All cables should be manufactured by an ISO 9000 series manufacturer.

*Installers should anticipate intra-building backbone fiber supporting data applications will be 50/125 LOF multimode fiber, unless otherwise specified by ***State of Oregon***. Inter-building backbone fiber supporting data applications will be singlemode fiber or a combination of 50/125 LOF if the distance is less than 300m., as specified by the requesting agency. Fiber counts will also be specified by the requesting agency, though it is suggested backbone cable should allow for a minimum 25% growth.

Optical Fiber Backbone Cable Specifications:

Maximum Fiber Loss (indoor multimode):

3.5 dB/km at 850nm

1.0 dB/km at 300nm

Minimum Bandwidth:

1500MHz km at 850 nm

500MHz km at 1300 nm

Transmission Parameters (outdoor singlemode):

Attenuation:

.50dB/km at 1310 nm

.50dB/km at 1550 nm

Operating Temperature Range: -40°C (-40°F) to 70°C (160°F)

The type of termination used for all fiber optic cabling shall also be determined by the requesting agency for any new installation.

Diagram 3

Optical Fiber Backbone Distances in accordance with TIA/EIA 568-B are as follows:

Application	Wave Length (nm)	Maximum Supportable Distance[1] (m)				Maximum Channel Attenuation[1] (dB)			
		Multimode[2]			Single-mode[9]	Multimode[2]			Single-mode
		62.5/125 µm	50/125 µm	850-nm Laser-Optimized 50/125 µm[3]		62.5/125 µm	50/125 µm	850-nm Laser-Optimized 50/125 µm[3]	
10/100BASE-SX	850	300	300	300	NST	4.0	4.0	4.0	NST
10G Ethernet									
10GBASE-S	850	26[4]	82[5]	300	NST	2.6[6, 7]	2.3[6, 8]	2.6	NST
10GBASE-L	1310	NST	NST	NST	10000[9]	NST	NST	NST	6.0
10GBASE-E	1550	NST	NST	NST	40000	NST	NST	NST	11.0[10]
10GBASE-LX4	1300	300	300[11]	300	-	2.5[6,12]	2.0[6,12]	2.0[6,12]	-
10GBASE-LX4	1310	-	-	-	10000	-	-	-	6.6[6]

1 "NST" (non-standard) entries indicate where this standard does not recognize use of the media, but where equipment may be available to convert the native application signals to a form compatible with the non-native media.

2 Specifications shown in this table are for TIA-568-B.1 recognized fiber types. Specifications for other non-recognized types of fibers are included in these footnotes where applicable.

3 850-nm laser-optimized 50/125 µm multimode fiber supports the same maximum channel distances and insertion losses as 500/500 MHz•km 50/125 µm multimode fiber for applications specified within TIA-568-B.1.

4 For 62.5/125 µm fiber, IEEE specifies 26 m (85 ft) for fiber with 160/500 MHz•km modal bandwidth and 33 m (108 ft) for fiber with 200/500 MHz•km modal bandwidth.

5 For 50/125 µm fiber, IEEE specifies 66 m (216 ft) for fiber with 400/400 MHz•km modal bandwidth and 82 m (269 ft) for fiber with 500/500 MHz•km modal bandwidth.

6 Includes maximum channel insertion loss plus additional allowable insertion loss.

7 For 62.5/125 µm multimode fiber, IEEE specifies 2.6 dB for fiber with 160/500 MHz•km modal bandwidth and 2.5 dB for fiber with 200/500 MHz•km modal bandwidth.

8 For 50/125 µm multimode fiber, IEEE specifies 2.2 dB for fiber with 400/400 MHz•km modal bandwidth and 2.3 dB for fiber with 500/500 MHz•km modal bandwidth.

9 Channels are specified within TIA-568-B.1 up to 3 km (9840 ft). Distances provided within this table are the maximum distances specified within IEEE 802.3 and invoke cabling specifications that may differ from TIA-568-B.3.

10 10GBASE-E channels are specified to have a minimum of 5 dB and maximum of 11 dB channel insertion loss.

11 For 50/125 µm multimode fiber, IEEE specifies 240 m (787 ft) for fiber with 400/400 MHz•km modal bandwidth and 300 m (984 ft) for fiber with 500/500 MHz•km modal bandwidth.

12 The maximum channel attenuation is allowed to be up to 0.5 dB higher than the value shown when including loss from mode conditioning patch cords.

While it is recognized that the capabilities of singlemode fiber may allow for backbone link distances of up to 37 miles, this distance is generally considered to extend outside the scope of TIA/EIA 568B.

When the Horizontal Cross-Connect (HC) to Intermediate Cross-Connect (IC) is less then maximum (300m), the IC to Main Cross-Connect (MC) distance for optical fiber can be increased accordingly but the total distance from HC to IC shall not exceed the maximum 300m (984ft.) for 50 µm fiber or 9840 ft. for single mode. If the HC to IC distance is less than maximum, the IC to MC distance for UTP cabling can be increased accordingly but the total distance from the HC to the MC shall not exceed the maximum of 2624 ft.

Telecommunication Room (TR)

Telecommunications Room (TR) provides many different functions for the cabling systems and is often treated as a distinct sub-system within the hierarchical cabling system.

The primary function of a telecommunication closet is for termination of the horizontal cable distribution. Horizontal cables of all recognized types are terminated in the telecommunications closet on compatible connecting hardware. Similarly, recognized types of backbone cable are also terminated in the TR on compatible connecting hardware. The cross-connection of horizontal and backbone cable using jumper 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-connect". The TR may also contain the IC or the MC connections for different portions of the backbone cabling system. Sometimes backbone to backbone cross-connections in the TR are used to tie different TR together in a ring, bus, or tree configuration.

Equipment cables that consolidate several ports on a single connector shall be terminated on dedicated connecting hardware. Equipment cables that extend a single port appearance may either be permanently or interconnected directly to horizontal or backbone termination. Direct interconnections reduce the number of connections required to configure a link but may reduce flexibility. See Diagram 4.

Diagram 4 - Cross-Connect/Inter-Connect

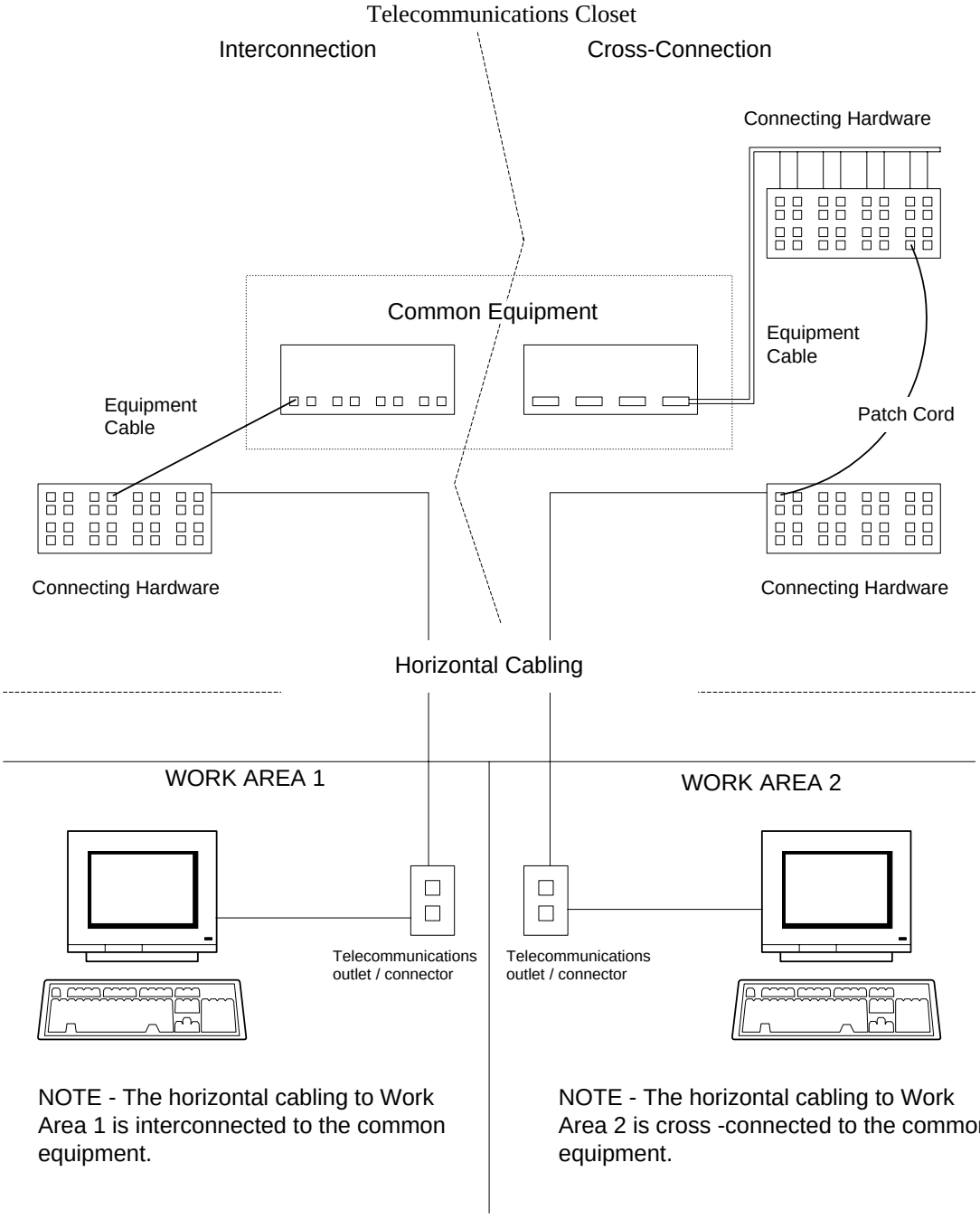


Illustration of Cross-Connection and Interconnection

Horizontal Cabling

Horizontal cabling is the cabling from the TC to the work area (WA). It includes the following:

- Horizontal Cabling
- Telecommunications outlet at WA
- Cable termination & Cross-Connects in the TC

Recognized media types are:

- Four pair 100 Ohm UTP (24 AWG solid conductor)
- Two fiber 50/125μm laser optimized
- 75 ohm coax CATV cable
- Hybrid cables are allowed if they meet the required specifications

For purposes of consistency the State standard color code scheme for voice and data wiring is as follows;

- Voice cable – White
- Data cable – Blue
- Voice jacks – White
- Data jacks – Orange

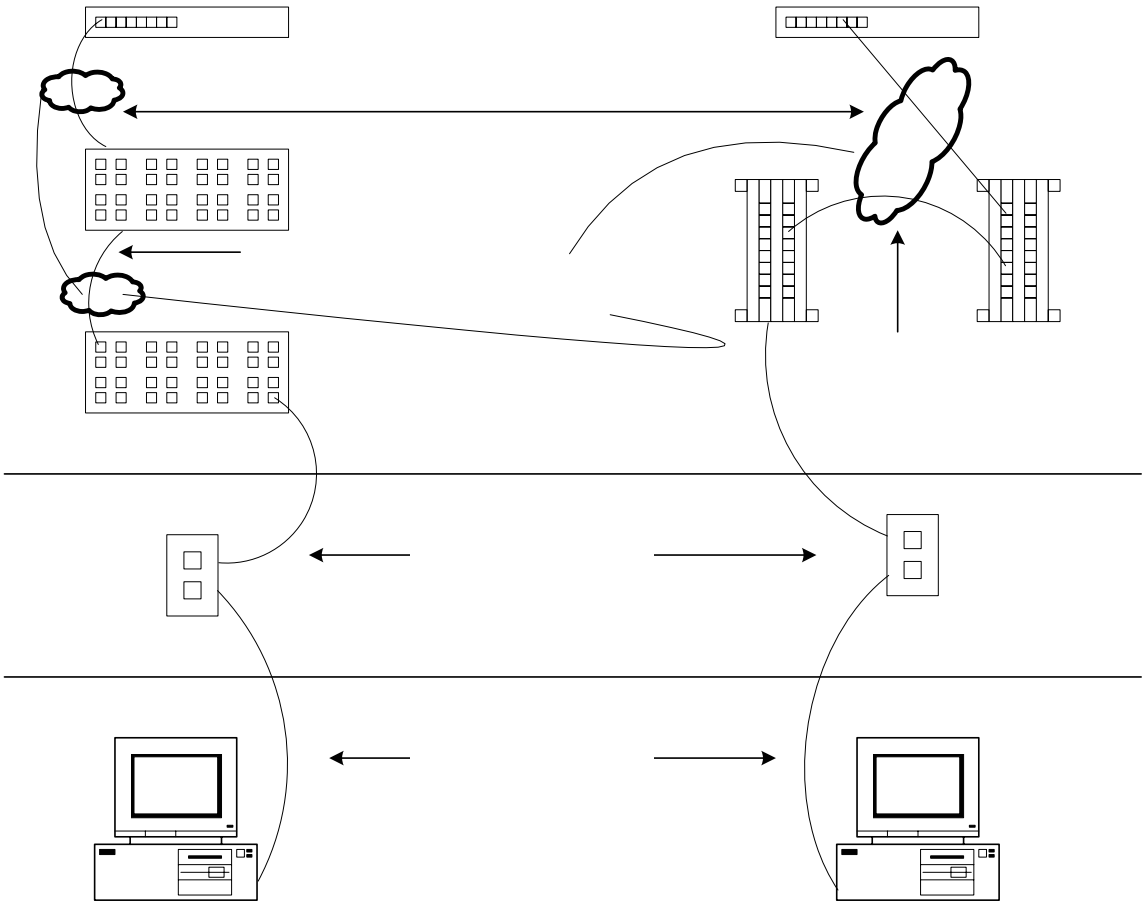
All cables shall meet the appropriate NEC fire and smoke regulations, NEC Article 800 for copper and Article 770 for optical fiber. All copper cables shall be enrolled in an **independent test laboratory category verification program**. All cables shall be manufactured by an ISO 9000 series manufacturer.

Maximum horizontal cable length from the mechanical termination of the cable in the TR to the telecommunication WA outlet is 90m (295 ft.), independent of media type.

Only one transition point is allowed in the horizontal cable

It is suggested that the maximum equipment cable length from the telecommunication outlet to the work area equipment be limited to 10 ft. In addition, it is suggested that the maximum cable length for jumpers and patch cords in the TR be limited to 20 ft. See Diagram 5 for distances.

Diagram 5 - Maximum Horizontal Distances
TIA/EIA-568B



There shall be a minimum of two outlets per work area

- The first cable shall be 4 pair 100 Ohm Enhanced Category 5 or greater.
- The second shall also be 4 pair 100 Ohm and meet the minimum performance requirements for Enhanced Category 5. Other approved cables are:

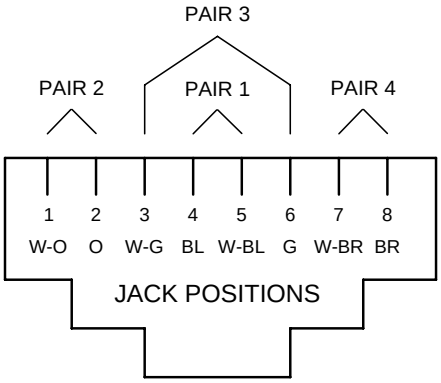
  - 4 pair 100 Ohm Category 6
  - 2 fiber 50/125µm laser optimized
  - Hybrid cables may be allowed if they meet the required specifications.

*It should be anticipated by all ***State of Oregon*** installers that all horizontal cable supporting data applications must meet at a minimum the Enhanced Category 5 performance requirements.

All 100 Ohm UTP shall be wired to 8 position modular jacks using the T568B pin-out unless otherwise specified by requesting agency. See Diagram 6.

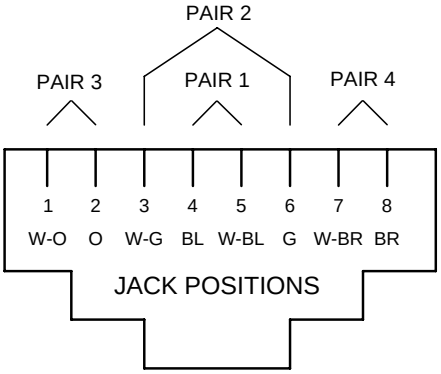
Diagram 6

T568B PINOUT (Most common application)



Optional Eight-Position Jack Pin/Pair
Assignments
(designation T568B)

T568A PINOUT (As requested)



Optional Eight-Position Jack Pin/Pair
Assignments
(designation T568A)

Approved Horizontal Cabling Components and Performance

All Enhanced Category 5 cables shall meet the requirements of:

ANSI/TIA/EIA-568-B Enhanced Category 5
ANSI/ICEA S-90-661
NEC
UL 444

Highest Test Frequency 100 MHz (all parameters)

Input impedance shall be measured per ASTM 4566-94, 43.2 Method 2, Option 2, (Method 3 will not be allowed)

Plenum-rated cables shall use 100% FEP for the insulation except where it is proven that the cable constructed with alternate materials meets or exceeds the electrical performance of FEP.

All Category 6 cables shall meet the requirements of:

ANSI/TIA/EIA-568-B Category 6
ANSI/ICEA S-90-661
UL 444

Highest Test Frequency: 250 MHz

UTP Termination Devices (Connectors and Patch Panels)

All connecting hardware and patch cords shall meet, as a minimum, all the requirements of the appropriate category grade being installed including the electrical and mechanical performance requirements of:

ANSI/TIA/EIA-568B
IEC 603-7
FCC PART 68 SUBPART F

All Enhanced Category 5 and Category 6 connectors shall meet the requirements of ANSI/TIA/EIA 568 B.

Appropriate Cable Management Shall Be Used At All Times.
Cable management shall be above, between and below each patch panel and provide the capability to manage cables on the front and rear of racks.. All 7 ft. racks will have vertical wire management on each side and between each rack and provide the capability to manage cables on the front and back of racks.

Work Area (WA)

The work area components extend from the telecommunication outlet/connector end of the horizontal cabling system to the station equipment which is outside the scope of ANSI/TIA/EIA-568B.

Approved Performance

Specifications

In addition to requirements stated for individual product specifications, the end-to-end interconnected and installed link/channel shall meet the requirements of ANSI/TIA/EIA-568 B permanent link and channel performance criteria.

Labeling and Administration

- Each cable shall be labeled.
- Each identifier shall be unique.
- Components shall be marked where they are administrated (label at all punch down points, panels, blocks, outlets, etc...).
- Moves, adds or changes - all labels, records, and reports shall be updated.
- All pathways labeled (conduit, trays etc...).
- All dedicated telecommunications grounding bus bars shall be labeled.

Cross-connect fields shall be labeled according to Diagram 7. For complete administration and labeling see ANSI/TIA/EIA 606A.

Diagram 7 - TIA/EIA 606A Color Coding

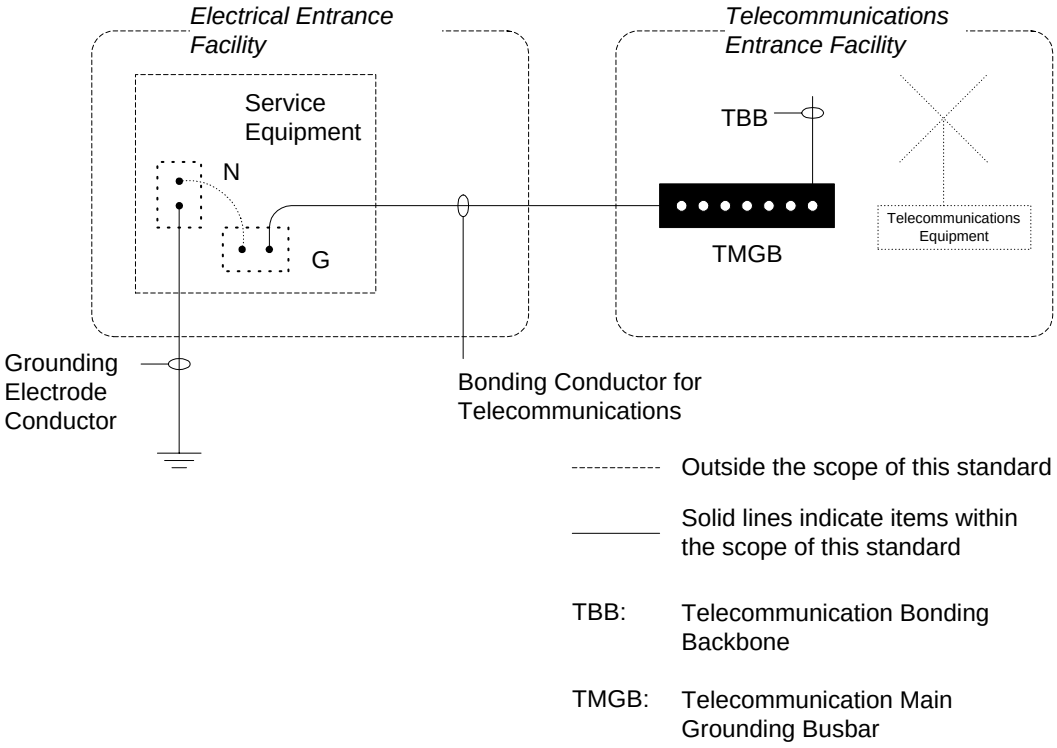
Termination Type	Color	Comments
Demarcation Point	Orange	Central office termination
Network connections	Green	Network connections or auxiliary circuit termination
Common equipment PBX, Host, LANs, Muxes	Purple	Used for all major switching and data equipment termination
First level backbone	White	MC-IC cable termination
Second level backbone	Gray	IC-TC cable termination
Station	Blue	Horizontal cable termination
Inter-building backbone	Brown	Campus cable termination
Miscellaneous	Yellow	Auxiliary, maintenance alarms, security, etc.
Key telephone systems	Red	

Grounding shall meet the requirements of the NEC and additionally grounding/bonding shall conform to ANSI/ -J-STD-607A. For example see Diagram 8.

Diagram 8
Example ANSI/ -J-STD-607A Grounding

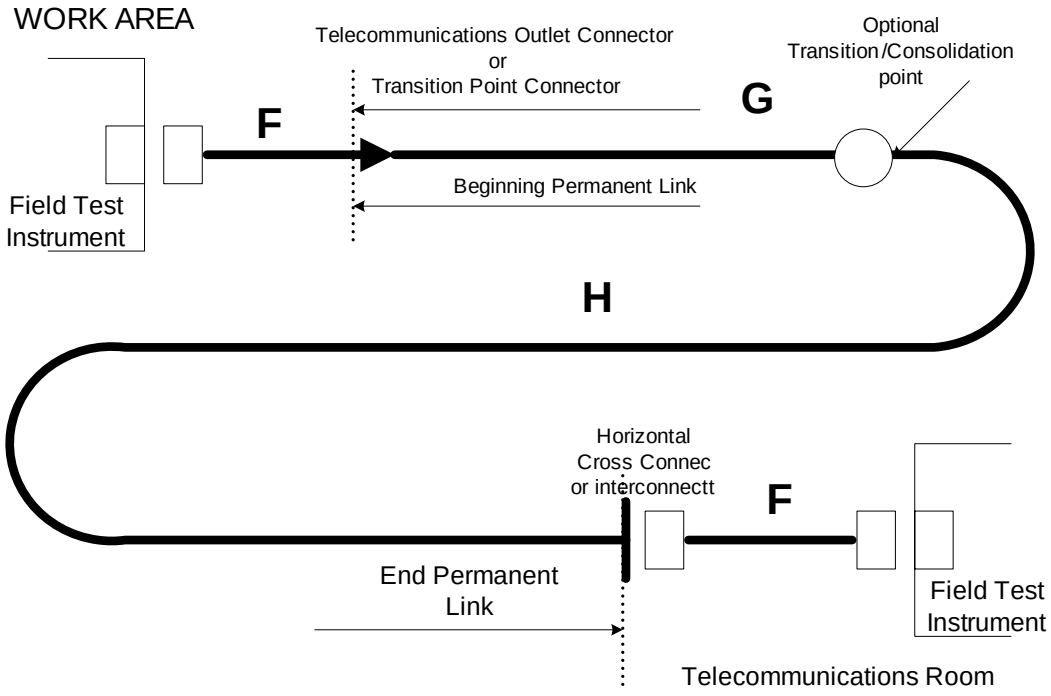
Bonding to the service equipment (power) ground

The bonding conductor for telecommunications shall bond the TMGB to the service equipment (power) ground. The figure below schematically depicts connectivity to the service equipment (power) ground.



Schematic of connectivity to the service equipment (power) ground

Diagram 9
Permanent Link



Legend	
Test equipment cords……	**F**
Optional Transition Cabling ……..	**G**
Horizontal Cabling……	**H**
Maximum length	
G+H ……...90M (295 ft)	

Schematic Representation of a Permenant Link

Installation guidelines/Tips

In order for unshielded twisted-pair cabling infrastructure to deliver high-speed performance, it is manufactured to very tight specifications. Consequently, to maintain the unshielded twisted-pair cabling system performance proper installation practices must be followed. Listed below are some guidelines and tips that shall be followed:

- Never crush the cable (by over cinching with cable ties or by using a staple gun). The use of Velcro cable ties in the closets is recommended.
- Try not to kink or knot, snag the cable while pulling. It can always be straightened it out, but the damage under the jacket could alter the performance.
- Pulling tension of 25lbs is not to be exceeded on any copper cable run.
- Do not exceed the minimum bend of 4 x O.D. for 4 pair UTP, 10 x O.D. for multi pair (more than 4 pair) UTP, and 1.18 in. for two fiber cable, and we recommend 10 x O.D. for multi fiber cable.
- Modular jacks shall be terminated using a non-impact termination tool to eliminate connector damage and promote consistent terminations.
- Per TIA/EIA 568-B never untwist the pairs of Enhanced Category 5 cable beyond 0.5 in. at the termination point, Cat. 6 cable beyond 0.25 in.
- Only strip back the jacket on UTP as much as is required to terminate on connecting hardware.
- Use cable management cable panels when terminating cable.
- Use the same performance grade for both cable and connecting hardware through the entire horizontal run. If you were to use a Category 6 cable and terminate to a Enhanced Category 5 jack you will have a Enhanced Category 5 system.
- Never exceed maximum cable lengths.
- The use of jumper wire (cross-connect) is acceptable depending on the application, but caution should be taken to make sure it is of the appropriate performance grade.
- Never use silver satin line cord.
- A 40% fill ratio for all conduit runs is recommended. (See Diagram 10)
- All fiber optic cables are to be run in inner-duct (or be armored) with the appropriate flame and smoke rating.
- Make sure you document all horizontal runs and all moves, adds and changes. We recommend the use of a software package if the budget allows.

- Connecting hardware for optical fiber installed at the following locations: main cross-connect, intermediate cross-connect, horizontal cross-connect, horizontal transition point, telecommunications outlet, shall not surpass minimum bend radius and shall be capable of storing 1m (3.28 ft.) of additional fiber.
- SC type connectors for fiber are recommended by TIA/EIA 568-B (beige for multi-mode and blue for single mode). Users that have installed ST type fiber connectors may remain with them for both existing and future additions. See addendum B for specifics.
- Place cable in modular furniture rather than fishing it through the panels. Fishing cable through the panels is more likely to cause damage.
- Recommend the use of different colored jacks to differentiate voice from data jacks where there is a dedicated voice and data jack (e.g., orange for data, and beige for voice). Also recommend different colored jacketed cables blue for data and white for voice. These are recommendations consistent with current installations.
- Do not share voice and data services under a single sheath at the outlet (e.g., 2 pairs of a 4 pair UTP for voice and the other 2 pairs for data).
- Maintain only one pin-out throughout the total installation (T568A or T568B).
- When sizing the house backbone cable (voice) allow for a minimum of 2 pairs per station. Allow for 30% to 40% growth and always move up to the next largest pair count cable (e.g., 250 pairs needed which includes growth, move to a 300 pair cable). Never specify smaller than 6 fibers in the backbone. Again, this is driven by the topology being implemented and should always allow for future growth.
- Recommend considering the use of a multi-user outlet for office areas that anticipate the frequent moving of their modular furniture. One major advantage is that when modular furniture is moved the complete horizontal run does not have to be removed. There are both copper and fiber solutions available. See Diagram 11.

Testing and Certification

Testing of all installed "Permanent Links" (see Diagram 9) shall be performed using a level III hand held tester and performed to the latest revision of TIA/EIA 568B. All reports shall be electronically recorded and presented to the end user before acceptance. This also includes all fiber runs that have been installed. Fiber will be tested for both wavelengths of multi mode and single mode fiber by power meter and light source (ANSI/TIA/EIA TSB 140 Level II testing). All reports shall be electronically recorded and presented to the end user before acceptance.

Testing

Testing of cabling shall be performed prior to system cut-over, 100 percent of the UTP horizontal and riser pairs shall be tested for opens, shorts, polarity reversals, transposition and presence of AC voltage. UTP voice, data and building control device horizontal wiring pairs shall be tested to TIA/EIA 568B from the information outlet to the TR and from the TR to the information outlet. In addition, all assigned circuits shall be tested from the information outlet/building control device to the MC.

All reports shall be electronically recorded and presented to the end user before acceptance.

Workmanship

Components of the premise distribution system shall be installed in a neat, orderly manner consistent with the best telephone and data installation practices. Wiring color codes shall be strictly observed and termination shall be uniform throughout. Identification marking and systems shall be uniform, permanent and readable. TIA/EIA 568B wiring codes as shown on the drawings shall standardize all twisted pair wiring.

Inspections

On-going inspections shall be performed during construction by the ***State of Oregon*** Project Manager and installation Project Managers. All work shall be performed in a high quality craftsman manner and the overall appearance shall be clean, neat and orderly. The following points will be examined:

A. Is the design documentation complete? Are all cables properly labeled from end-to-end?

B. Have all terminated cables been properly tested in accordance with the specifications for the required performance Level as well as tested for opens, shorts, polarity reversals, transposition and presence of AC and/or DC voltage?

C. Is the cable type suitable for its pathway? Are the cables bundled in neat bundles?

D. Have the pathway manufacturer's guidelines been followed? Are all cable penetrations installed properly and fire stopped according the code?

E. Have the contractors avoided excessive cable bending?

F. Have potential EMI and RFI sources been considered?

G. Is Cable Fill correct?

H. Are hanging supports within 1.5 meters (5 ft)?

I. Does hanging cable exhibit some sag?

J. Are telecommunications room terminations compatible with applications equipment?

K. Have Patch Panel instructions been followed?

a) jacket removal point

b) termination positions

c) all pair terminations tight with minimal pair distortions

d) twists maintained up to the Index Strip

L. Have Modular Panel instructions been followed?

a) cable dressing first

b) jackets remain up to the Connecting Block

c) all pair terminations tight and undistorted

d) twists maintained up to the Connecting Block

M. Are the correct outlet connectors used and turned right side up?

N. Are identification markings uniform, permanent and readable?

Warranty

Product Warranty and System Assurance Warranty for some Structured Cabling may be required if requested. If an agency requests a Product Warranty and System Assurance Warranty the installation vendor, upon successful completion of the installation and subsequent testing, will provide the requesting agency with a Warranty certificate registering the installation.

Diagram 10
Sizing of Horizontal Pathways

Cable Diameter

The following table lists typical ranges of cable diameter for recognized Horizontal cabling media. These values are provided for planning purposes only. It is strongly recommended that the distribution designer check the actual diameter of the cable being used before determining pathway size requirements.

Typical ranges of cable diameter:

Horizontal Cable Type…	**Typical range of Overall Diameter…**
Four-pair 100-ohm UTP	0.36 cm to 0.61 cm (0.14 in. to 0.25 in.)
Optical Fiber Cable	0.28 cm to 0.46 cm (0.11 in. to 0.18 in.)

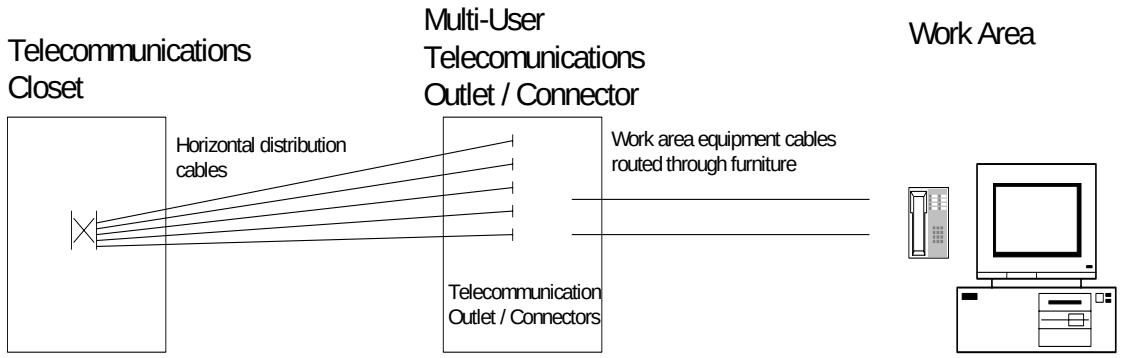
Number of cables

The following table provides guide-lines used by ANSI/TIA/EIA-569-B on cable capacity for conduits ranging from trade size ½ to trade size 4.

Conduit Capacity

Trade Size	Cable Outside Diameter Cm (in.)									
	0.33 (0.13)	0.46 (0.18)	0.56 (0.22)	0.61 (0.24)	0.74 (0.29)	0.79 (0.31)	0.94 (0.37)	1.35 (0.53)	1.58 (0.62)	1.78 (0.70)
½	1	1	0	0	0	0	0	0	0	0
¾	6	5	4	3	2	2	1	0	0	0
1	8	8	7	6	3	3	2	1	0	0
11/4	16	14	12	10	6	4	3	1	1	1
11/2	20	18	16	15	7	6	4	2	1	1
2	30	26	22	20	14	12	7	4	3	2
21/2	45	40	36	30	17	14	12	6	3	3
3	70	60	50	40	20	20	17	7	6	6
31/2	-	-	-	-	-	-	22	12	7	6
4	-	-	-	-	-	-	30	14	12	7

Diagram 11
Multi-User Outlet



Example Multi-User Telecommunications Outlet/Connector

Horizontal Distances of Copper Links (Long Work Area Cables)

When used in the context of multi-user telecommunications outlets/connectors and open office furniture, copper work area equipment cables of length up to 15 meters are permitted provided that building cable runs are not longer than allowed in Table 1:

Length of horizontal cable, meters	Maximum length of work area cable, meters
90	3
85	7
80	11
75	15

Table 1. Maximum length of work area cables.

Note: Field construction of UTP jumpers must be done carefully to ensure acceptable performance. Termination guidelines and transmission requirements are given in TIA 568A, Annex B.5

Closing Remarks

- As stated in the beginning of this document you will most likely never encounter any two installations that are the same. It has been our experience that there are many occasions where you may not be dealing with a TIA/EIA-569 B compliant building. However, not all requirements must be met for compliant channel performance. Examples of non-performance requirements are: door width, ceiling material, illumination, number of AC receptacles, etc. We would prefer to follow TIA/EIA-569B to the letter but the primary goal is to provide a truly balanced cabling infrastructure to the end user.

- Additionally it should be understood that the structured cabling system will usually only account for approximately 5% of the cost for installing a complete LAN. Since a structured cabling system should only be installed once, cutting cost in this area is not a good long term strategy. The network electronics and software could change 3 or more times during the life of the cabling infrastructure. It is our professional suggestion to, specify only requirements of ANSI/TIA/EIA 568-B, compliant components and channels in the horizontal which allow for a truly redundant and balanced system. This strategy will accommodate future upgrades in the horizontal to more bandwidth intensive network technologies.

APPENDIX A
Approved Cabling Components

The State of Oregon has chosen ***Amp*** products (www.ampnetconnect.com.) as the universal standard low voltage wiring component for all state installations. This is to ensure the maximum degree of compatibility, consistency and functionality throughout the state's facilities. Due to the inherent advantages of using a single manufacturer's products all low voltage wiring components, channel solutions, as well as backbone cabling components used on any low voltage wiring project are to be an Amp manufactured product. All other manufacturer's product lines and individual components must be reviewed and approved by DAS.

DAS acknowledges that other manufacture's components may be functionally compatible. However as stated above, the inherent advantages of using a single manufacturer's products from a statewide consistency standpoint generally preclude consideration of other manufacture's components. Unless a significantly compelling technological or cost saving consideration can be provided, it is expected that these approved components as specified will be used unless approval by DAS is obtained to use non-standard materials.