



A MAiSPACE WHITE PAPER

An Introduction to High Performance Office Cabling Systems

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MAiSPACE, Inc.
330 Waterloo Valley Road
Mount Olive, NJ 07828
973-446-2300
www.maispace.com

Introduction

The massive increase in intelligence being accessed from the workplace puts severe demands on office planners and managers as they work to resolve two somewhat conflicting objectives. On one hand they want a robust voice and data cabling system capable of accurate high-speed transmissions and to avoid network down time that can be extremely costly¹. On the other hand they must accommodate an increasingly dynamic and constantly changing workplace where ongoing moves, adds and changes (MACs) to work areas reflect a trend toward office reconfigurations that best support the types of work being done. These MACs traditionally meant disruptions to the workplace as cabling systems were taken down, rerouted and reconnected to serve a revised floorplan.

This paper will familiarize office planners and managers with advances in cabling technology and selected industry standards useful in crafting requests for proposals (RFPs) and evaluating claims made by vendors of office cabling systems. A companion white paper “Advances in Modular Office Furniture Systems” provides a similar reference to guide the specification and purchasing of systems designed to the realities of today’s office practices.

Cost of Upgrades vs. Cost of Obsolescence

The explosive growth of the Internet, coupled with high-capacity company-wide (intranet) networks and links to key suppliers and customers (extranets) can play havoc with underpowered cabling systems. Tempers fray and costs mount as employees wait impatiently for file downloads or to complete on-line transactions. Indeed, underpowered networks can come crashing down when too many people try to do too many tasks at the same time. The World Wide Web becomes the “World Wide Wait.”

¹ According to LAN Technology, the average network crashes 20 times a year, and 70% of the time it is due to issues with inferior cable systems. Infonetics reports that network downtime costs can range from \$1,000 to more than \$50,000 per hour.



As bandwidth-intensive data and video applications continue to push the need for high-performance networks, companies must grapple with the cost of upgrade vs. the cost of obsolescence. The question is not so much whether to upgrade the cabling infrastructure but to what extent. The obvious answer, that is to install the highest speed network available, can be rendered less obvious when costs and performance standards enter the picture. The following paragraphs will look at these issues.

With the advent of Gigabit Ethernet (1000Base-T), vendors are now offering cabling and connectivity products capable of transmitting data at a billion bits per second across companies' Local Area Networks (LANs). In addition to accommodating massive file downloads, Gigabit Ethernet supports full-motion video to the desktop. Gigabit Ethernet is provided over two categories of copper cabling systems designated by the TIA/EIA² as category 5e³ and category 6⁴. Category 6 systems generally cost from 25% to 30% more than category 5e systems. This poses two questions. What are the added benefits to be gained by a category 6 system, and is there a risk in specifying a system having unpublished standards.

We will simplify the highly complex answer to the first question. Cabling system performance is specified over a frequency bandwidth expressed in units of megahertz (MHz). Cabling system bandwidth is determined by the maximum upper frequency limit at which the system can still support greater signal strength (what you want) than noise strength (what you don't want). This condition is called Positive Sum Attenuation (signal) to Crosstalk (noise) Ratio or PSACR. Category 6, Class E cabling provides 2.5 times the bandwidth and can deliver as much as 300% better PSACR performance at 100 MHz than category 5e cabling. Put another way, the question becomes "Is 2.5 times better noise isolation and double the range of information capacity worth a 25% to 30% cost premium?" If a company's information throughput is doubling at an exponential rate, the answer to this is an unqualified "yes."

² Telecommunications Industry Association/Electronic Industries Association

³ TIA/EIA-568-A-5

⁴ TIA/EIA 568-B.2-1

Exercising Due Diligence

Having examined their requirements and satisfying themselves that category 6 cabling is the best solution to their network requirements, office planners should prepare themselves to evaluate the offerings of various vendors' responses to an RFP. This will equip them to sort through various marketing hype and find out if, indeed, the proposed components deliver a network that is up to spec. Here the key word is components. There are several that together make up the office LAN. In addition to the cabling itself, there are connectors, jacks, patch cords and other components that contribute to connectivity.

For example, while some manufacturers claim to have a category 6 product, these claims may be based on channel performance and may not reflect actual connecting hardware performance. Diligence is also required when reviewing how performance claims are phrased. Terminology such as "average" or "90th percentile" should be rejected. The only acceptable low-end parameters are "worst pair" or "worst link" indicators. Claims of "zero bit error rate" cannot be verified by test. Furthermore, testing equipment cannot correct for bad cable, and no cabling system can correct errors. High-quality cabling can only reduce the incident of errors.

Risk is further reduced when warranties are provided. Manufacturers should warranty category 6 performance and applications support especially because they are selling a product prior to formal standards body acceptance. If they are unwilling to assume this risk in writing, chances are the performance margins of their product do not exceed those of the proposed category 6 standard.

Performance verification by independent third-party testing laboratories showing "worst case" configurations is an essential ingredient in a response to an RFP. As noted above, these tests should show that both the channel (cable) and individual components pass the proposed category 6 standards. Moreover, vendors must verify that they offer a complete range of category 6 products, that all of them are backward compatible with lower performing categories such as 5 and 5e, and that they will not degrade the performance of these lower categories. An assurance of full technical support by certified installers is non-negotiable.

A Macro Look at Premise Cabling Systems

High-bandwidth cabling systems are no longer confined to large corporate offices. Today companies of any size must provide an infrastructure capable of supporting all employees' voice and data requirements. Since office planners or managers in smaller organizations frequently wear several hats, they should have a basic understanding of a premise (office) cabling system. The following paragraphs serve as a primer.

Starting with the basics, and largely under the control of a building owner or manager and telecommunications service provider is the entrance facility. It is here where service provider cabling enters and interconnects with a building's backbone cabling system via the main cross connect. Somewhat like a building's water supply system, the backbone cabling system (also called riser cable because it rises vertically) is the primary conduit carrying communications traffic between a building's occupants and the outside world. Various standards apply to the design and construction of a riser cabling system. Well-planned buildings will have separate but parallel riser systems for voice, data and video circuits in order to facilitate expansion or modification of services. These systems should not share space with a building's electrical supply system.

Riser cable terminates in one or more telecommunications closets on each floor, and it is here where office planners start getting involved. The telecommunications closets serve as access points to the outside world, and provide connectivity between office occupants. Through horizontal cross connects the closets are transition points between the vertical riser system and horizontal cabling system serving occupants of each floor.

Before the onslaught of high-speed data networks and LANs, cabling offices was a relatively straightforward process with no distance limitations, no pathway constraints and no closet requirements. Telephones, fax and telex machines were hard wired into the network, and that was that. But with the advent of the computer and the proliferation of equipment to be accessed within and from the office, standards were called for. These are embodied in TIA/EIA-568A and 569A. They require installers to meet more stringent installation standards to protect the integrity of the cable system and eliminate the need for constant re-cabling with the addition of each new application.

A Micro Look at Open Office Cabling

More recently, and in response to the growth of modular open office designs, the TIA/EIA issued Technical Services Bulletin TSB75⁵. TSB75 directly addresses difficulties that arise with constant Moves, Adds and Changes (MACs) characteristic of today's office environment.

An open office is defined as one where floor space division is provided by furniture, movable partitions or by means other than traditional fixed walls. While office reconfiguration is simplified by open office designs, it can create havoc on the structured cabling system. Existing cables can become mixed and damaged; management of slack cable storage is difficult. When distances are increased, new cabling is required to extend all the way to the telecommunications closet. All of these issues could result in added expense and workplace disruptions.

TSB 75 provides two innovative cabling installation solutions to help minimize these difficulties in environments characterized by frequent MACs. These are Multi-User Telecommunications Outlet Assemblies (MUTOAs) and Consolidation Points (CPs). They can add real value when installing structured cabling systems in such environments.

A MUTOA provides a single outlet assembly to serve multiple users in a modular furniture cluster. Patch cords installed through furniture system pathways connect intelligent peripherals such as phones, terminals, PCs and printers directly to the MUTOA which, in turn, has a fixed connection to the horizontal cross connect in the telecommunications closet. Because MUTOAs are hardwired to the horizontal cross connect, their placement and load capacity (number of functions or workstations supported) require careful consideration early in the design stage. For example, limiting the number of work areas served by a single MUTOA alleviates the need for long lengths of work area patch cord cable while facilitating the location and administration of work area connections. For this reason, it may be wise to install more MUTOAs than may be needed at the outset if growth is anticipated.

Consolidation points differ from MUTOAs in that they provide interconnection points within the horizontal cabling. While MUTOAs are the logical termination of the horizontal cabling (the point to which work area patch cords connect); consolidation



points extends horizontal cabling to work area outlets located with individual office spaces. Like the MUTOA, the CP is located in close proximity to the furniture clusters or, more ideally, concealed within the furniture panels themselves. This allows the bulk of horizontal cabling to remain intact during MACs. The furniture panels also serve as the cable pathway and provide adequate space for storing and managing slack cable. Short horizontal runs connect the CP to workstation outlets. CPs should be specified to support the maximum number of work areas that can be installed in the space they are intended to serve.

A Practical Solution

A clear intent of TIA/EIA TSB 75 was encouraging innovation among suppliers in order to simplify and lower the cost of MACs in today's technology-packed offices. When incorporated with appropriate cabling and connecting hardware, CPs and MUTOAs can be impressive time and money savers in environments where MACs are a way of life and where network reliability is a key concern.

MAiSPACE was the first system to fully comply with all applicable TIA/EIA standards including TSB-75 for open office designs as well as modular floor-to-ceiling wall systems.

The design incorporates a series of interconnect brackets mounted directly within furniture or wall panels. These brackets can be configured in various port sizes and can accommodate either a Consolidation Point (CP) supporting a zoned infrastructure or a MUTOA type of architecture. Cabling interconnections are concealed behind removable panel tile segments to provide a neat appearance, but allow convenient access. Ample space is provided for lay in cabling and to fan it out in order to facilitate cable management. Cable service loops support future relocation efforts.

In a typical office installation, horizontal cabling is extended from work area outlets to consolidation points – the interconnect brackets located within panels that make up the workstation clusters in each office area. The CPs, in turn, inter-connect with the office horizontal voice and data cabling infrastructure within telecommunications closets. The “plug-and-play” design is so simple it can be quickly mastered, meaning that office

⁵ TSB75 “Additional Horizontal Cabling Practices for Open Offices”



managers and planners can handle in very short order the MACs that previously required hours or days by trained technicians. This translates into a significant cost benefit by significantly lowering operating costs over the lifetime of the installation.

Conclusion

Category 6 cabling is a viable solution for companies where information throughput is doubling at an exponential rate. The higher costs of these systems can be recouped through increased efficiency and productivity, and provide a solution that should meet a company's needs over a substantial period of time. Further efficiencies result when office furniture systems incorporate a standards-compliant cable management system that lowers the cost of Moves, Adds and Changes without impacting network performance. Office managers and planners should have a basic understanding of cabling systems and the standards that govern system design and performance. They must be assured that all vendor claims are verified before making the investment in a new cabling infrastructure.

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MAiSPACE Inc. gratefully acknowledges the assistance of The Siemon Company in the preparation of this paper. Further information on category 6 cabling, standards and common industry terminology is available at www.siemon.com. Visit www.maispace.com for information on standards-compliant modular office furniture systems.

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Mount Olive, NJ 07828
973-446-2300
www.maispace.com

A Selected Glossary of Terms

Attenuation: A reduction in power or amplitude in the transmitted signal. In cables, it is generally expressed in decibels (dB) per unit length.

Attenuation-to-Crosstalk Ratio (ACR): The difference between attenuation and crosstalk measured in decibels.

Backbone Cabling: Cable and connecting hardware that comprises the main and intermediate cross connects as well as cable runs that extend between telecommunications closets, equipment rooms and entrance facilities.

Balance: An indication of signal voltage equality and phase polarity on a conductor pair. Perfect balance occurs when the signals across a twisted pair of copper wires are equal in magnitude and opposite in phase with respect to ground.

Bandwidth: A range of frequencies, usually the difference between the upper and lower limits of the range, expressed in hertz (Hz). It is used to describe the information-carrying capacity of a medium. In copper and optical fiber systems, the bandwidth decreases with increasing length. This is why TIA/EIA standards address cable length limitations.

Bus Topology: A linear configuration where all network devices are placed on a single length of cable. It requires one backbone cable to which all network devices are connected.

Cabling: A combination of cables, wire, cords and connecting hardware used in the telecommunications infrastructure.

Campus Backbone: Cabling between buildings that share telecommunications facilities.

Category:

1. ANSI/TIA/EIA-568-A, the North American standard for cabling describes mechanical properties and transmission characteristics of unshielded twisted-pair (UTP) cables and screened twisted pair (ScTP) cables and assigns a unique number classification such as Category 3, Category 4 and Category 5.
2. ISO/IEC IS 11801, the international standard for cabling and local standardization documents define cabling component categories based on transmission performance parameters such as attenuation and NEXT loss, over a specified frequency range.

Channel: the end-to-end transmission path connecting any two points at which application specific equipment is connected. Equipment and work area cables are included in the channel.

Consolidation Point: A location for interconnection between horizontal cables that extend from building pathways and horizontal cables that extend into work area pathways.

Cross-Connect: A facility enabling the termination of cables as well as their interconnection or cross connection with other cabling or equipment. Also known as a distributor

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

Crosstalk: Noise or interference caused by electromagnetic coupling from one signal path to another. Crosstalk performance is generally expressed in decibels.

Decibel: a standard unit for expressing transmission gain or loss as derived from a ratio of signal amplitudes or power.

Demarcation Point: A point where operational control or ownership changes, such as between a telecommunications service provider and a building network service provider

Ducting: See pathway

Electronic Industries Alliance an organization that sets standards for interfaces to ensure compatibility between data communications equipment and data terminal equipment.

Equipment Cable: A cable or cable assembly used to connect telecommunications equipment to horizontal or backbone cabling systems in the telecommunications closet and equipment room. Equipment cables are considered to be outside the scope of cabling standards.

Equipment Room: A centralized space for telecommunications equipment that serves the occupants of the building or multiple buildings in a campus environment. An equipment room is considered distinct from a telecommunications closet because it is considered to be a building or campus serving (as opposed to floor serving) facility and because of the nature or complexity of the equipment that it contains.

Fiber Optic Transmission: A communications scheme whereby electrical data is converted to light energy and transmitted through optical fibers.

Horizontal Cabling: The cabling between and including the telecommunications outlet and the horizontal cross-connect.

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

Inter-building Backbone: Telecommunications cable(s) that are part of the campus subsystem that connect one building to another.

Interconnection: A connection scheme that provides direct access to the cabling infrastructure and the ability to make cabling system changes using equipment cords.

Intermediate Cross-connect: A cross-connect between first level and second level backbone cabling.

Intermediate Distribution Frame (IDF): In a central office or customer premises, a frame that (a) cross connects the user cable media to individual user line circuits and (b) may serve as a distribution point for multipair cables from the main distribution frame (MDF) to individual cables connected to equipment in areas remote from these frames. (Source BICSI Telecommunications Dictionary)

Intrabuilding backbone: Telecommunications cable(s) that are part of the building subsystem that connect one closet to another.

Main Cross-connect (MC): A cross-connect for first level backbone cables, entrance cables, and equipment cables.

Modular Jack: A female telecommunications interface connector as specified in IEC 603-7 and FCC Part 68 Subpart F. Modular jacks are typically mounted in a fixed location and may have 4, 6, or 8 contact positions. Not all positions need be equipped with contacts. See also Outlet, Telecommunications.

Modular Plug: A male telecommunications interface connector as specified in IEC 603-7 and FCC Part 68 Subpart F. Modular plugs may have 4, 6, or 8 contact positions. Not all positions need be equipped with contacts.

Multimedia: 1) An application that communicates to more than one of the human sensory receptors. 2) Applications that communicate information by more than one means or cabling media.

Multimode Optical Fiber: An optical fiber that will allow many bound modes to propagate. The fiber may be either a graded-index or step-index fiber. Multimode optical fibers have a much larger core than single-mode fibers. See also Optical Fiber Cable.
Multi-user Telecommunications Outlet Assembly (MuTOA) - A grouping in one location of several telecommunications/outlet connectors.

Open Office Cabling: The cabling that distributes from the telecommunications closet to the open office area utilizing a consolidation point or multi-user telecommunications outlet assembly. (Source BICSI Telecommunications Dictionary)

Outlet, Telecommunications: A fixed connecting device where the horizontal cable terminates. The telecommunications outlet provides the interface to the work area cabling. Sometimes referred to as a telecommunications outlet/connector.

Outlet/Connector, Telecommunications: A connecting device in the work area on which horizontal cable terminates. (Source ANSI/TIA/EIA-569-A)

Patch Cord: A length of cable with connectors on one or both ends used to join telecommunications links at a cross-connect.

Patch Panel: Connecting hardware that typically provides means to connect horizontal or backbone cables to an arrangement of fixed connectors that may be accessed using patch cords or equipment cords to form cross-connections or interconnections.

Pathway: A facility (i.e. conduit) for the placement and protection of telecommunications cables. Same as raceway or ducting.

Raceway: See Pathway.

Screened twisted-pair (ScTP): A balanced twisted-pair cable surrounded by metallic braid, foil (screen) or both and bound in a single cable sheath.

Shielded twisted-pair (STP-A): A cable surrounded by a metallic braid, foil or both and bound in a single plastic sheath containing balanced twisted-pair conductors that are individually shielded.

Single-Mode Optical Fiber: An optical fiber that will allow only one mode to propagate; this fiber is typically a step-index fiber. (Source ANSI/TIA/EIA-568-A)

Star Topology: 1) A method of cabling each telecommunications outlet/connector directly to a cross-connect in a horizontal cabling subsystem. 2) A method of cabling each cross-connect (HC and IC) to the main cross-connect (MC) in a backbone cabling subsystem.

Surge: A rapid rise in current or voltage, usually followed by a fall back to a normal level. Also referred to as transient.

Telecommunications Closet: An enclosed space for housing telecommunications equipment, cable terminations and cross-connect cabling used to serve work areas located on the same floor. The telecommunications closet is the typical location of the horizontal cross-connect and is considered distinct from an equipment room because it is considered to be a floor serving (as opposed to building or campus serving) facility.

Telecommunications Industry Association (TIA): An organization that sets standards for cabling, pathways, spaces, grounding, bonding, administration, field testing and other aspects of the telecommunications industry.

Topology: The physical or logical layout of links and nodes in a network. These include star, ring and bus configurations.

Transition Point: A location in the horizontal cabling subsystem where flat undercarpet cabling connects to round cabling.

Unshielded Twisted-Pair (UTP): A cable with multiple pairs of twisted insulated copper conductors bound in a single sheath.

Work Area: The area where horizontal cabling is connected to the work area equipment by means of a telecommunication outlet. A station/desk which is served by a telecommunications outlet. Sometimes referred to as a workstation.

Work Area Cable: A cable assembly used to connect equipment to the telecommunications outlet in the work area. Work area cables are considered to be outside the scope of cabling standards.

Acronyms & Abbreviations

ANSI	American National Standards Institute
ATM	Asynchronous transfer mode
AWG	American wire gauge
BD	Building distributor
b/s	Bits per second
CD	Campus distributor
CDDI [®]	Copper Distributed Data Interface
CM	Common mode
CP	Consolidation point
CPE	Customer premises equipment
CSA	Canadian Standards Association
DB	Decibel
EF	Entrance facility
EIA	Electronic Industries Alliance
ER	Equipment room
FCC	Federal Communications Commission
FD	Floor distributor
FDDI [®]	Fiber Distributed Data Interface
ft.	Feet
Gb/s	Gigabit per second
GHz	Gigahertz
HC	Horizontal cross-connect
HVAC	Heating, ventilation and air conditioning
Hz	Hertz
IC	Intermediate cross-connect
IDF	Intermediate distribution frame
IEC	International Electro-technical Commission
IEEE [®]	Institute of Electrical and Electronic Engineers
ISDN	Integrated Services Digital Network
ISO	International Standards Organization
LAN	Local area network



Mb/s	Megabits per second
MC	Main cross-connect
MDF	Main distribution frame
MHz	Megahertz
mm	Millimeter
MuTOA	Multi-user Telecommunications Outlet Assembly
NEC®	National Electrical Code®
NEMA®	National Electrical Manufacturers Association®
PBX	Private branch exchange
RF	Radio frequency
ScTP	Screened twisted-pair
STP	Shielded twisted-pair
TIA	Telecommunications Industry Association
TO	Telecommunications outlet
UL®	Underwriters Laboratories Inc.®
UPS	Uninterruptible power supply
UTP	Unshielded twisted-pair
µm	Micron or micrometer

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