CommScope®

A Guide to Networks and Connectivity

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SYSTIMAX® SOLUTIONS

Connectivity for Today and Tomorrow

This guide is intended for those who need to know about communications infrastructure as part of their work, but who are not necessarily specialists in this subject. Facilities and property managers, architects, design consultants and departmental heads are among those who now have to consider connectivity issues, and will benefit from the information on these pages.

Cabling for data networks differs significantly from the more familiar power and telephone networks. An understanding of networks that can carry data and video, as well as voice transmissions, will help you ensure that **cabling** installed today can meet the demands of tomorrow.

The guide focuses on key strategic and practical factors in planning and implementing connectivity networks in the private or local network. Communications are rapidly becoming the most important business resource as rapid advances in computing and **telecommunications** are altering the way people work, impacting overall productivity. As this happens, it is vital for organizations to have a network infrastructure that can turn these developments to their advantage.

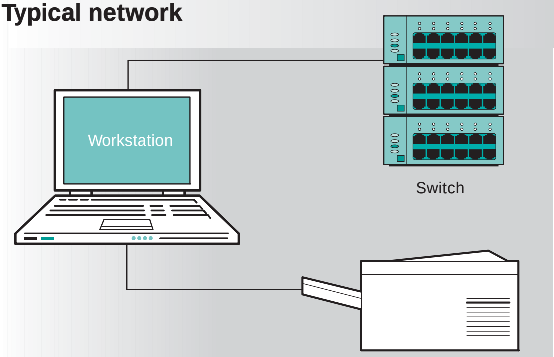
The various sections of this guide give an appreciation of the principles of connectivity and the issues involved. Cross references (in bold) to the Glossary section enable the reader to deal with the specialist infrastructure terminology that is so often a barrier to understanding the subject.

The priority in this publication is to provide information in a form that is easy to assimilate. It is not an exhaustive study of communications networks.

1 The need for networks

Electronic equipment for tasks ranging from computing and building security to environmental control, can produce greater benefits as part of integrated systems. The advantages of individual devices working together grow as their numbers multiply. At the same time, the challenges of providing the necessary links also increase.

Typical network



Network Basics
Networks are a collection of systems and/or end point devices that allow sharing of information and resources such as servers, workstations and peripherals. A properly designed and implemented network will give the speed and reliability of communication essential to an efficient system.

Networks should also conform to accepted national and international standards and be able to evolve with a business' changing needs.

Growing Need for Networks

Dramatic growth in the use of computers has focused attention on networks and cabling. Where once telephones were the only concern, managers now have to deal with the complex and rapidly changing requirements of computing and information systems.

In the past, it was common for desktop PCs to operate in isolation. Today, the vast majority of business PCs are part of Local Area Networks (LANs), enabling them to work productively together.

LANs can connect PCs to servers and peripherals, or provide links between transducers, cameras, monitors, sensors and almost any other electronic device. When such links are made on an ad hoc basis, work areas can soon become cluttered with unidentified cabling, making fault-finding and basic maintenance more difficult.

Network Trends

The use of networks and supported infrastructure is extending to new areas. The move from traditional mainframe and minicomputer terminals and consoles to client/server systems resulted in the replacement of proprietary networks by open OSI - compliant network transport systems. And many IT professionals are faced, for the first time, with the need to develop cabling strategies for security and building management systems, video conferencing, multimedia information systems, Voice over IP (VoIP), Power over Ethernet (PoE), and new eBusiness applications. And the evolution of networks continues at a rapid pace, enabling network-wide applications to be deployed that can take advantage of networked computing resources in new and innovative ways that can improve efficiency and productivity if properly deployed and managed, including peer-to-peer networks, clustering, and grid computing.

A new aspect to enterprise networking is the introduction of mobility. Wireless LANs (WLANs) have become popular not only for residential use but also in the enterprise. A WLAN provides flexibility and improves the productivity of the workforce. The integration of WLANs places additional requirements on network planning.

With the role of networks having expanded in this way, knowledge of networks and the infrastructure that enables them has become essential at all levels of management.

2 Network strategy

Load Estimating and Planning

The choice of network and cable types (described in sections 4 and 5) depends on the types of devices to be connected, their location and the way they are used. At the planning stage, it is important to consider future as well as present requirements.

Load estimating has become increasingly difficult due to the unpredictable nature of bandwidth requirements associated with current technologies. Applications such as Internet access, email (and email attachments), VoIP, video, real time streaming media and file transfers offer diverse challenges to the network planner in the form of unpredictable traffic patterns.

Target Life Span

The target life cycle of an average cabling installation is up to 20 years (The ISO/IEC IS 11801 cabling standard for customer premises, states that a cabling system is anticipated to have a usable life in excess of 10 years). Over this time, several generations of networking hardware and software will be installed, and network throughput requirements will certainly increase, as will the importance of reliability and security.

Specifying a Network
Underspecifying networks and cabling systems is a common error. Since the expense and disruption of a premature replacement is so great, trying to cut corners at the installation stage may be unwise and frequently results in ongoing rearrangements at a much higher financial cost and with associated disruptions or delays in deployment of services.

Some key factors to consider in specifying a network may be summarized as follows:

- Usage patterns, including combined size and duration of peak loads for all applications
- Expected increase in bandwidth demands
- The number of users and anticipated growth
- Location of users and maximum distances from these locations to the network switch
- Expected use of VoIP and PoE applications
- Expected use of wireless applications and anticipated changes in technology and applications
- The likely rate of change in users' locations (churn)
- Connectivity with current and future devices and software
- Space available for cable runs
- Total cost of ownership
- Regulations and safety requirements
- Importance of protection against loss of service and data theft

3 Alternative network configurations

Network Types

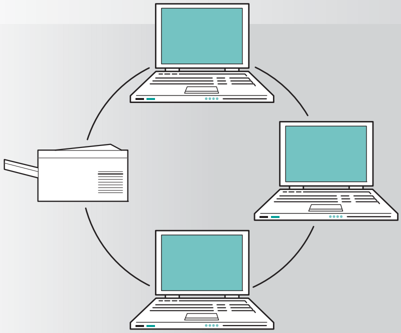
There are three main physical network topologies in common use. These topologies are the ring, bus and star.

Ring Networks - Ring networks, as the name suggests, have a continuous loop that passes every device. This ensures that signals from one device are seen by all other devices on the ring. In a simple ring, a break in any part of the network, caused by a fault or system maintenance activity, will disable the whole system. More advanced implementations have largely overcome this problem. The Token Ring LAN is an example of a ring network.

Bus Networks - The bus network connects devices along the length of a cable, which is, essentially, a high-speed communications link. Devices can be removed from the bus without disabling the rest of the system. The original Ethernet LAN is an example of a bus network.

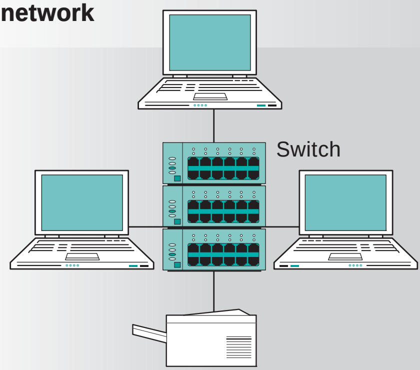
Star Networks - Star networks incorporate many point-to-point links radiating from central equipment. In voice networks this could be the PABX and in data networks this could be the switch. Devices connected to a telecommunications outlet in a star network can be added or removed easily without disturbing the rest of the network.

Ring network

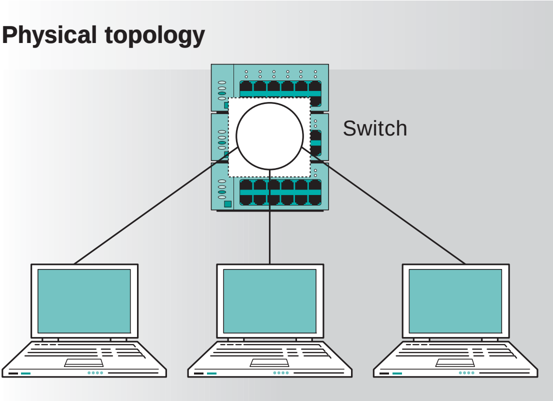


Bus network

Star network



Topologies: Logical and Physical
The descriptions refer to the physical topologies of networks. In practice, however, the physical topology of all these networks is usually adapted to a star layout that provides a much more flexible method for moving users of the network. This is a major advantage when systems are growing or there is a significant degree of churn.



An example of this can be seen in the diagram above. The system shown has the appearance of a star, but its logical topology remains a true ring, with the loop completed within the central switch. Networks based on star, bus and ring type logical topologies all have their advocates, and the final choice largely depends on the application. The star physical topology, however, is now almost universally accepted within commerce and industry.

Ethernet LANs
The original Ethernet networks worked over coaxial cable. The development of 10BASE-T, designed to operate over balanced unshielded twisted pair (UTP) cable at data transmission rates of 10 Mb/s, contributed to the widespread adoption of Ethernet as the preferred LAN in most office and industrial applications. Today, 100BASE-T (100 Mb/s) is commonplace, and 1000BASE-T (1 Gb/s) is already being deployed on desktops, while 10 Gigabit Ethernet has emerged as the preferred option to support aggregation of desktop speeds between switches in the backbone and for connections to servers in data centers. 10 Gigabit Ethernet deployments in Data Centers, backbones, and ultimately to the desktop are expected to accelerate as equipment compliant with the 10GBASE-T (10 Gb/s) standard for twisted pair cabling becomes available.

100BASE-T and subsequent (faster) versions of Ethernet have a star physical topology. As with all LAN systems, PCs and other active devices connected to the network must be equipped with Network Interface Cards (NICs) or LAN-on-motherboard (LOM) technology.

Older protocols such as Asychronous Transfer Mode (ATM) and Fiber Distributed Data Interface (FDDI) are still in use, although they have been overtaken by the expansion of Ethernet into most areas of corporate networks.

ATM
ATM uses fast packet switching techniques to transmit delay sensitive data, over star networks, at up to 155 Mb/s for twisted pair cabling and up to 2.5 Gb/s over optical cabling.

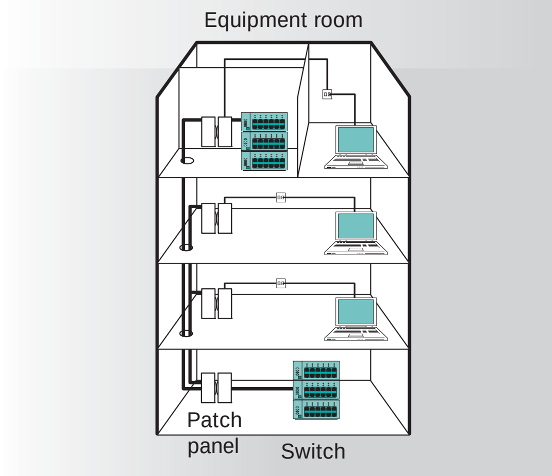
FDDI
The FDDI is a higher speed version of the Token Ring, operating over optical fibers at 100 Mb/s. FDDI systems can have two complete fiber loops, providing a degree of redundancy that is useful in critical applications.

Proprietary Networks
Proprietary systems are a third common form of networking. Introduced before standards-based networks were established, proprietary systems were exclusive to a particular manufacturer. Among the most numerous were systems from IBM and Wang. Today however, proprietary networks have been replaced by standards-based, open architecture networks.

Serial Communication
Another type of cabling that may be encountered is serial communications. This is often used to link terminals and PCs directly to minis, mainframes and peripherals at relatively low speed. This type of link is not true networking. However, serial connections can be interfaced with structured cabling systems and routed via switches and backbones. To do this, a passive adaptor or active interface device is required.

There are two principal forms of serial communications (asynchronous, and synchronous). Both types interconnect with communications devices via their serial ports.

Wireless LANs
Wireless LANs, sometimes also called Wireless Ethernet, have a cell-based architecture where a Wireless Access Point (AP) serves as the base station supporting mobile devices in that cell. APs are typically connected to a wired Ethernet backbone via a horizontal cable in a star topology.



Backbones and Network Links

Multiple segments of a network, joined by a backbone cable, can create networks serving large areas, without excessive cabling. The backbone is a high-speed link that enables separate hubs or switches to work together as a unit. If a backbone fails, the individual subnets may continue to operate autonomously.

Backbone cables can be coaxial, balanced twisted pair or optical fiber cable. Generic cabling standards, however, recommend the use of multimode fiber or balanced twisted pair cables in the backbone.

To form large networks, individual LANs of any type can be linked together via backbone cables, bridges or routers. With Ethernet, switches are often grouped in a single room for security and convenience. In this case, the backbones are short, and the system is referred to as a collapsed backbone network.

Refurbish or Replace?

In many installations, there will be the option to install a completely new network or refurbish one already in place. The latter alternative usually offers major savings, but its viability depends on the existing cabling and the approach chosen for the new network. However, ad hoc networks, which use mixed cabling for historic or cost reasons, have inherent drawbacks.

Today's structured cabling systems are available with ranges of adaptors for interconnection with all major hardware types. These will allow established systems, as well as newer ones, to benefit from the latest cabling techniques.

4 Cabling alternatives

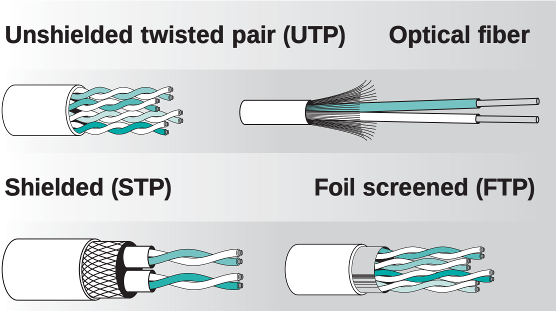
Importance of Cabling

Cabling is a key component of any networked system, so decision makers should be prepared to commit up to 15% of the total cost in this area. Failures in badly designed and implemented cabling are both common and expensive, so investment in high quality cabling and network design is easily justified.

Cable Choice

The equipment connected to a network and the communications load it imposes are key factors in cable choice. There are, however, other considerations:

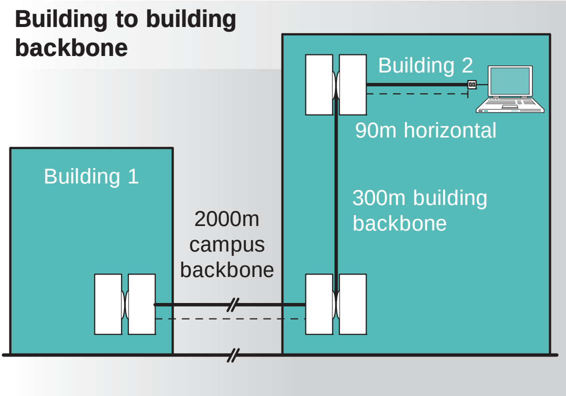
- Maximum distance between network switches and end point devices
- Space available in ducting and floor/ceiling cavities
- The levels of Electromagnetic Interference (EMI) present
- Cable fire risk assessment (regulations and insurer requirements)
- Likely changes in equipment served by the system and the way it is used
- Level of resilience required
- The required life span of the network
- Restrictions on cable routing that dictate cable bend radius
- Existing cable installations with potential for reuse



Cable Alternatives
Taking the points on the previous page into account, the first cabling decision is the choice between UTP, shielded and/or foil screened cable types, optical fiber or a combination of these.

Cables other than optical fiber invariably have copper conductors insulated and protected by one or more plastic sleeves. These are often formed into cables containing anything from two to hundreds of pairs. The higher pair count cables are usually used in the backbone and especially for traditional voice and very low speed data applications.

The maximum lengths over which these cables can run in backbone and horizontal (Hub-to-desk) applications are specified in cabling standards such as the International Standard ISO/IEC IS 11801. These are summarized in the diagram below:



It is important to note that these maximums apply to all media. They do not take into account the performance differences between cable types and transmission protocols used by the network. In practice, maximum cable lengths will depend on the application, the type of network used (e.g. 1000BASE-T) and the cable's quality. Good cable suppliers and installers will advise on a cabling system's capabilities in a particular network.

Size Restrictions
It is important to check the space available for cable runs before making decisions on cable type. The size, weight and flexibility of shielded and screened cables depends on whether foil or braided sleeving is used, and how many conductors they have. These factors, together with the shielding/screening material, will also determine the cable's resistance to EMI. It is, therefore, very important to consider the method of shielding/screening before choosing such cables.

Shielded Cables
Shielded cables, referred to as STP, use an expensive and bulky construction consisting of individually shielded twisted pairs with an additional overall shield. This is a robust and bulky cable that is far less flexible than unshielded types.

Foil Screened Cables, usually referred to as FTP or ScTP, are constructed of four twisted pairs with an overall foil sleeve. FTP cables can be more compact than STP, but generally have much lower resistance to EMI than STP types.

Both shielded and screened cables have metal sleeves that must be grounded well to cancel the effect of EMI on the signal carried by the conductors, requiring special grounding and termination considerations.

Unshielded Twisted Pair Cable
Advances in UTP cabling over the last 15 years have enabled it to carry data reliably at speeds of up to 10 Gb/s. This allows the use of more cost effective cabling in applications that were previously considered the reserve of other media types (i.e. coaxial cable, optical fiber). UTP has become the preferred media worldwide for transmission to the desktop. The latest developments in UTP cabling technology, coupled with advances in networking equipment, that now enable UTP cabling to carry data at speeds up to 10 Gb/s ensure that UTP will continue to be the preferred copper media worldwide.

UTP cables minimize EMI by closely matching each conductor of a cable pair such that any interference is cancelled out. This is known as a balanced circuit.

Balance of Circuits

In a perfectly balanced circuit, the sum of noise voltages induced in the conductors is zero, so there is no interference with the signal being transmitted. UTP cable is designed to support cost-effective balanced transmission.

Shielded cable can be less balanced due to the presence of the shield, thus shield integrity and grounding are vital. High quality UTP cables achieve a well-balanced circuit without a need for shielding the entire circuit.

Alien Crosstalk and 10 Gigabit Transmission on UTP

Compared to the requirements up to 1 Gb/s, the IEEE 10GBASE-T standard for 10 Gigabits over twisted pair cabling places additional demands on the cabling infrastructure, including the need to support extended frequencies and the requirement to minimize Alien Crosstalk. Alien Crosstalk is the coupling of signals between adjacent cabling links or channels. While traditional and cumbersome shielding techniques may be used to minimize Alien Crosstalk, developments in UTP cabling technology have already been shown to achieve the required performance and reliability, and it can be expected that the market preference towards UTP will continue.

Optical Alternative

For high-speed applications in backbone cabling and over extended distances, optical fiber is the most commonly used alternative. Optical fiber occupies little space and is very robust but remains more expensive to install and connectorize than other cable types. Additionally, the optical fiber transmission equipment carries a significant premium over the copper alternatives.

Most optical fiber cable used in LANs within the building is of the multimode type. Compared to the higher performance singlemode fiber used in campus deployments, multimode allows for the use of less expensive electronic equipment and is easier (less expensive) to install and connectorize.

Since the optical fiber transmission equipment carries a significant premium over the copper alternatives, in most networks optical fiber is used for backbones (where higher speeds or longer distances are required), while balanced UTP provides the link to the desktop. Because optical fiber transmits signals via light waves, it is inherently resistant to virtually all forms of electronic interference.

5 Planning for growth and flexibility

Major cable manufacturers specify their products and warranties assuming a 15- or 20-year life. Over this time, change is both inevitable and impossible to predict accurately. The only solution is to specify a network that is inherently able to accommodate change, growth and more bandwidth-intensive applications.

Future Readiness

In normal circumstances, a new network should not become the factor that restricts system upgrades within the 20-year building refurbishment cycle. Well-designed cabling systems will have the potential to handle data 10-15 times faster than most commonly installed LANs. This allows new networking technology to be introduced without replacing the cabling.

The applications it serves define a network's minimum specification. However, in some situations where Category 5e cable is considered adequate, it often makes sense to install better cabling (such as cabling with significant performance margin to Category 6, or Category 6A cabling) to provide for future needs.

With the shift from proprietary to open computer systems has come a move from proprietary to standards-based cabling. The latter can serve many different types of devices, ranging from PCs and printers to video cameras and thermostats or Wireless Access Points.

Standards-Based Cabling

Standards-based cabling is a major advance, offering users freedom to connect equipment from a variety of suppliers. It also gives users the potential to employ the same network to serve several separate systems, for example, telephones, computers and building controls.

Saturated Wiring

The flexibility offered by standards-based cabling is enhanced with the use of saturated wiring. This is the installation of sufficient cabling and outlets in a work area to maximize flexibility of the location for devices connected to the network. IT departments then have similar freedom in how they arrange their work areas.

Wiring for Mobility

Standards-based cabling is also required to support mobile applications such as WLANs today. A Wired for Mobility outlet grid, with a cabling network end point at regular intervals, makes the wired infrastructure ready for growth and new wireless infrastructure requirements in the future. With the Wired for Mobility grid in place, there is maximum flexibility for adding wireless infrastructure devices in a cost effective way.

Structured Cabling

Standards-based cabling and saturated wiring are central elements in structured cabling, an approach pioneered by SYSTIMAX® Solutions, from CommScope. This uses an open system approach, supporting major proprietary and non-proprietary standards and protocols. SYSTIMAX Solutions™ uses balanced UTP and optical fiber cabling deployed in a star topology and terminated with standard outlets.

Use of standards-based structured cabling, forming a modular network, makes it easy to extend or change a system with minimum disruption to users. In high growth companies, structured cabling allows smooth, controlled expansion, with addition of new equipment and cable runs at reduced incremental cost.

Network Components

Patch panels located in each zone of a building or campus allow PCs, peripherals, network switches and other devices to be connected and disconnected quickly. In companies with high rates of churn, this gives considerable savings. When new cable is laid and outlets added, UTP structured cabling simplifies the task through its use of standard components throughout. UTP cabling is easier to handle and install than shielded or coaxial types.

6 Avoiding interference

Every active electrical and electronic device has potential to produce electromagnetic flux that can disrupt network communications. This problem has increased alongside the growth in the use of electronic equipment. Both cable selection and cable routing are vital in safeguarding communications against interference.

In addition to the potential for interference from external sources, the active pairs in a multi-pair cable can interfere with each other. This is known as crosstalk.

There are two methods of measuring crosstalk performance, pair-to-pair and PowerSum. The pair-to-pair method only measures the maximum interference caused by any other single active pair in the cable. When many pairs in a multi-pair cable are active, the loss of performance will be greater than that indicated by the pair-to-pair method.

PowerSum is a more realistic way of measuring crosstalk. It is based on the measurements taken when all pairs in a multi-pair cable are active. For cables containing more than four pairs, PowerSum is the only appropriate method for testing crosstalk performance.

External Noise Sources
All network components, including switches, PCs and cabling must be designed to perform adequately in the presence of external noise. Particular care is needed when cabling components are produced by different manufacturers.

Routing of cable should conform to cable manufacturers' recommendations and should always avoid potential sources of interference. Potential sources of EMI are lift motors, automatic doors and air-conditioning units. The older this equipment, the more likely it is to produce EMI. Closed metal conduits and ducting will give cabling extra protection against sources of EMI that cannot be remedied or avoided.

Where shielded cabling is used, correct termination and grounding of the shield at patch panels and outlet connectors is vital. The potential benefits of the shield must be weighed against complications related to grounding and safety. Any lack of shield integrity can render the potential benefits totally ineffective, and large currents may flow in the shield due to improper grounding.

When deploying twisted pair cabling for 10 Gb/s transmission, particular attention must be paid to Alien Crosstalk, the coupling of signals from adjacent links of channels. Recent advances in UTP cabling technology allow UTP cabling to minimize Alien Crosstalk and are an integral part of emerging standards for Category 6A and Class E_A cabling.

For most indoor cabling environments, balanced transmission over UTP offers excellent protection against external noise.

In particularly electromagnetically hostile or sensitive environments, use of optical fiber cabling may be the only alternative.

EMC Regulations

Both the installer and system user are responsible for ensuring their networked systems have electromagnetic compatibility (EMC) with other electronic devices. European EMC Directives have been mandatory in all European Union countries from 1 January 1996, and penalties against network owners are specified for non-compliance. In Asia, many countries have adopted requirements set by IEC CISPR for EMC compliance. In the US, the FCC maintains stringent directives for EMC compliance.

Reputable installers will ensure that cabling specifications, routing and ducting are designed to eliminate interference problems. Some manufacturers also provide warranties on the EMC performance of certified installations using their cabling.

7 Standards, categories and regulations

Cabling standards not only encompass communications performance, they also cover areas ranging from routing and fire resistance to EMC. The greatest value of cabling standards is in defining terminology and general approaches. They are not intended to provide a detailed specification for building a network.

ISO/IEC and TIA/EIA

Both the ISO/IEC and TIA/EIA standards organizations have defined generic cabling systems suitable for medium and large offices. Details of these can be found in the ISO/IEC IS 11801 standard for Customer Premises Cabling and TIA/EIA 568B.

ISO/IEC IS 11801, TIA/EIA 568B and the European version, EN 50173-1, are all key standards for cabling installation. These cover similar areas, but use different approaches to conformity. ISO/IEC IS 11801 is a global standard that has evolved to meet the needs of all geographic areas. As a result, some of its requirements are very broad.

Cable Categories

TIA/EIA 568B and ISO/IEC 11801 specify several cabling categories. The first two categories are suited only to voice and data communications up to 4 Mb/s and are seldom used in data networking applications. While both TIA/EIA and ISO/IEC refer to components in terms of “categories”, TIA/EIA also uses “categories” for end-to-end channel performance, while the ISO/IEC standard refers to the end-to-end performance in terms of “Classes”.

Category 3 cabling is generally regarded as suitable only for networks operating up to 16 Mb/s using active equipment. Primary usage is for backbone cabling to support voice (but not VoIP). ISO/IEC refers to the end-to-end Category 3 channel as a Class C channel.

Category 4 cable was developed to support communications at 16 Mb/s over runs up to 100 meters, but is now considered obsolete. ISO/IEC never introduced a matching specification for Category 4.

Category 5 cabling was designed to support applications up to 100 Mb/s. Reliable support for 1 Gb/s requires additional performance specifications, and existing installations may not comply. Category 5 cabling is now also considered obsolete. A superseded edition of ISO/IEC 11801 referred to the end-to-end Category 5 channel as a Class D channel.

Category 5e (Enhanced Category 5) is an upgrade to Category 5 specifications that was targeted as minimally compliant support of Gigabit Ethernet (1000BASE-T). The maximum frequency specified for Categories 5 and 5e is 100 MHz. 1 Gb/s signalling is accomplished via PAM5 encoding scheme transmitted over all cable pairs. ISO/IEC refers to the end-to-end Category 5e channel as a Class D channel.

Category 6 cabling was designed with a significant improvement in bandwidth, which is nearly double the bandwidth of Category 5e for robust support of Gigabit Ethernet (1000BASE-T) over the maximum frequency specified of 250 MHz. Category 6 cabling is also recommended if mid-span PoE is required to be supported as an application since the additional connections introduced by the mid-span equipment may have a detrimental effect on the crosstalk and return loss performance of the end-to-end 'channel'. ISO/IEC refers to the end-to-end Category 6 channel as a Class E channel.

Category 6A cabling is designed to meet or exceed the requirements of 10 Gb/s Ethernet (10GBASE-T). It extends the cabling bandwidth beyond Category 6 by specifying the frequency range out to 500 MHz and includes the Alien Crosstalk specifications that are vital for the support of 10 Gb/s Ethernet. ISO/IEC is developing the Class E_A specification, offering better performance than Category 6A for certain parameters.

Category 7 cabling is specified only in ISO/IEC 11801 and CENELEC EN50173-1 (Class F), but not in TIA-568B. It is specified to a frequency of 600 MHz and requires the use of bulky and expensive individually paired shielded cables. The connector for Category 7 is a complex switched version of an RJ45 that does not seem to have gained significant share in the Category 7 market. A non-RJ45 version is also allowed when the customer is prepared to give up compatibility with

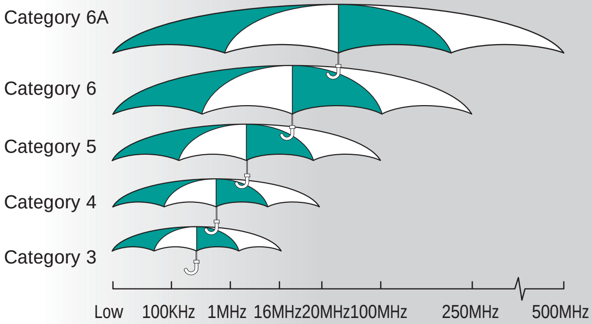
RJ45 plugs. Class F is not expected to gain wide market acceptance and its market share was predicted to reach 0.4% worldwide by 2006. Class F[A] specifications to 1000 MHz have recently been added in ISO/IEC.

Cabling for 10GBASE-T

The IEEE developed the 10GBASE-T standard with the intent of targeting the installed base of Category 6/Class E cabling. However, although Category 6/Class E cabling is the minimum requirement in the 10GBASE-T standard, achievable distances over Category 6/Class E cabling are highly dependent on the Alien Crosstalk environment as well as the cabling performance at frequencies not specified for Category 6/Class E. Shielded Category 6/Class E cabling may exhibit improved Alien Crosstalk, but without a normative specification and without the necessary standards specifications for higher frequency performance.

Guidelines for the verification of 10GBASE-T requirements have been developed by EIA/TIA (TSB-155) and ISO/IEC (TR 24750), but do not provide improved specifications for Category 6/Class E and are not intended for new installations. Achieving useful distances over UTP is likely to require multiple mitigation steps ranging from unbundling of cables to component replacement, since the Category 6/Class E cabling standards fall considerably short of the 10GBASE-T requirements and do not specify Alien Crosstalk.

Transmission characteristics of UTP



For new installations, Category 6A or Class E_A cabling guarantees 10GBASE-T support to 100 m over UTP. Since the international Class E_A specification is more stringent, cabling for new installations intended to support 10GBASE-T should be specified to meet the Class E_A requirements.

Network Standards

Two major LAN types, Ethernet and Token Ring, are also defined by standards. The IEEE, the Institute of Electrical and Electronic Engineers, sets standards for the implementation of Ethernet defined through its 802.3 Committee. Token Ring standards were developed by the 802.5 Committee.

The work of the IEEE committees aims to ensure a high degree of consistency and interoperability between systems implemented by different suppliers. Conformance with their standards is important to network buyers, since non-standard elements can lead to disruption and extra cost when networks are modified or extended.

The evolution and widespread acceptance of Ethernet has ensured that the 802.3 Committee continues to be active, having developed Ethernet specifications up to 10 Gb/s over laser-optimized 50 micron multimode fiber, and currently working on a 10 Gb/s specification for 4 connector twisted pair cabling channels over 100 m.

Fire Prevention

Standards that are of particular practical interest to network users are those relating to fire. These differ from country to country, but invariably cover both flame spread and smoke emission.

Conforming to a minimum local standard will ensure that fire officers do not order removal of a network. However, the key is to install 'the right cable in the right environment' so as to reduce risk to fire hazard. Data cables that conform to the highest North America and international standards should be installed in areas where the risks of fire occurrence and business loss/interruption are the highest, for example in data centers and communication rooms. These cables have very high fire retardance (and low smoke emission) that will prevent the fire from spreading to other parts of the room or building.

In relation to this impact of a widespread fire, any extra cost in buying cable to the highest standard is minimal. Specifying cable with low fire retardance can incur higher insurance premiums. Insurers often set additional requirements to complement statutory building regulations. These increased standards required by the insurers are designed not only to provide safety for the people affected in the fire, but also to protect the assets of the business, to minimize the cost of fire damage to buildings and their contents, and to improve business continuity.

In Europe, a common approach to attempt to minimize the impact of fire in cabling is to use Low Smoke Zero Halogen (LSZH) cabling. When this cable burns, less smoke will be produced (compared with traditional PVC cables) to hinder evacuation of the building. However, the use of LSZH materials does not ensure that the cables will have low flammability. Cables compliant with the IEC 60332 Part 3 specifications offer better fire performance than the less expensive IEC 60332 Part 1 compliant cables. A much better fire-performing alternative (commonly used in North America, and now also included in the Construction Product Directive in Europe) is to use plenum rated (also known as enhanced fire performance) cable, which is a low smoke and highly fire retardant cable. In North America, plenum rated cable has long been recognized as a safer cable and is defined by the National Fire Protection Association in the National Electrical Code (NFPA 70), which is revised and published every 3 years.

8 Network architecture, design and installation

Once network configuration and cabling types are decided, there remains the practical task of designing and installing the system. The first step, deciding network architecture, is usually a straightforward task. Examples of network architecture for typical buildings and sites are shown in the diagram on page 25.

Collapsed Backbones

Variations on the typical architectures are possible. For instance the backbones may be collapsed so that servers, switches and patch panels can be contained within a compact, secure area. This can save space and improve the system's physical security.

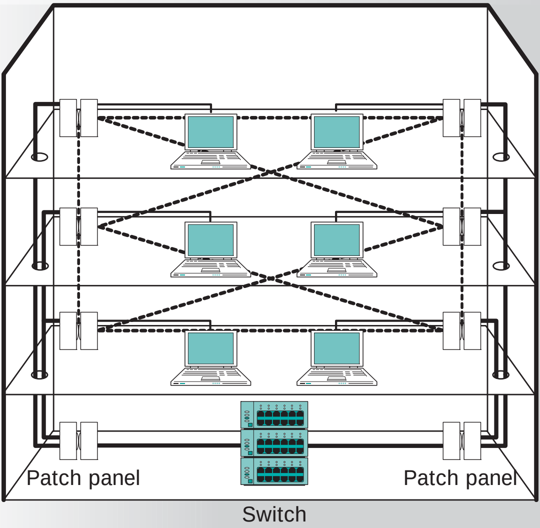
Redundancy

Where systems are mission critical, redundant backbones and risers may be needed to implement a mesh designed network which will give the required level of system fault tolerance.
In these situations, duplicate pathways should be as far from each other as possible.

Physical Limitations

Decisions on the type of cable needed for risers, backbones, horizontal runs and saturated wiring will have been made at an early stage of planning. At installation, design and planning stages, it is important to work within the physical limitations of the chosen cable type.

Network architecture



Cable Routing
Cable manufacturers will specify minimum bend radii and maximum pull-through forces. They will also give advice on proximity to sources of heat, vibration, EMI and pathway fill.

Routing Diagram
A comprehensive cable routing diagram must be produced before installation begins. This will be a guide to installers and a reference point for future maintenance, expansion and fault tracing.

Cable Labeling
The diagram should be cross referenced to physical labels on each cable run. Producing plans and labeling can be undertaken by the installer or handled by an in-house systems department. A number of software packages are available to assist in these tasks.

Installation and Access
Networks should be designed for easy installation and access while giving cables adequate support and protection. Manufacturers' guidelines are designed to ensure that all these criteria are met. They also take into account national and international standards applying to cable pathways. It is, however, the installer's responsibility to ensure that the requirements of building codes and standards are met in full.

Alternative methods of cable support and protection include:

- Underfloor Ducts
- Access (Raised) Floors
- Conduit
- Trays and Wireways
- Ceiling Distribution
- Perimeter Raceways

Conduits and Conduit Ceiling Distribution
Conduit and ceiling distribution are usually implemented according to industry-based standards. EIA/TIA 569B, for instance, specifies that conduit sections should be a maximum of 30 m long and have no more than two 90 degree bends between pull points. Inside bend radii must be six times conduit diameter, or at least ten times for conduits over 50 mm.

Wireways
Using suitable equipment and procedures when installing cable will minimize tension and avoid damage. Wireway and raceway manufacturers guidelines and code requirements must also be followed in determining cable fill for these types of pathway.

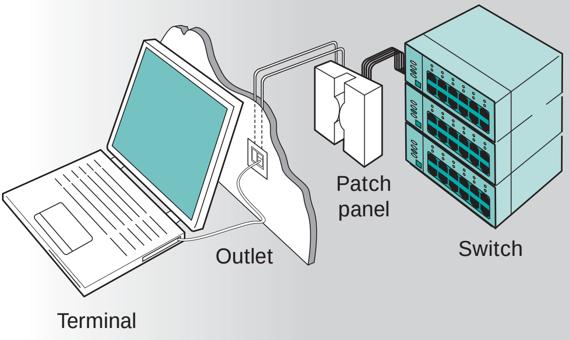
Cable Support
Ceiling distribution, conduits, trays and other pathway hardware can be used above suspended ceilings. Alternatively, the cable can be hung loosely using J-hooks, rings or other means of suspension, at spacings of no more than 1.5 meters. Unless they are designed for the purpose, ceiling tiles, rails and supports should not carry cables. Communication cables should not be tied to power cables for support.

Large bundles of over 140 cables may require special attention to prevent overstressing cables at the bottom of the bundle.

Cable to the Desk
The final leg of a network connection may include cabling that is built into office furniture or partitioning, or laid under carpets. The consolidation points where the final cable run joins the permanent building network are potential vulnerable spots. IT professionals should take special care to ensure consolidation points are well protected from impact, crushing and tension loading. The total length of the building network's horizontal cable and the final leg to the active device must also be kept within manufacturers specified limits.

Telecommunications Outlets
At the end of every network cable is an outlet into which the cords connected to the devices are plugged. Outlet locations, quantity and mounting hardware are important aspects of network design.

Terminal, patch panel and switch



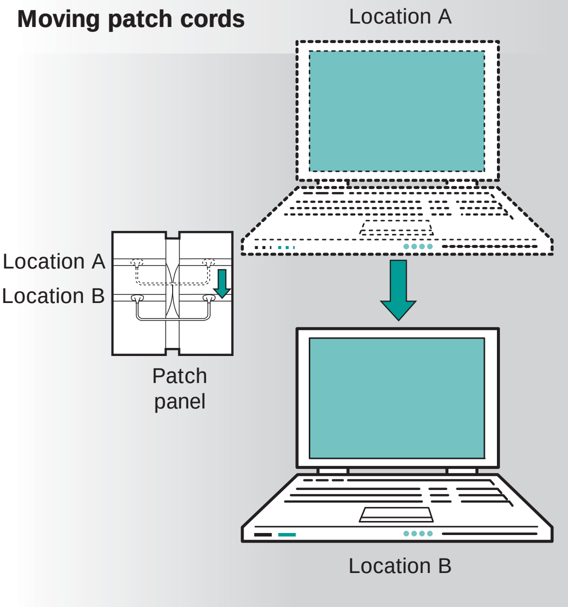
CENELEC EN50174 and TIA/EIA 569 cover many aspects of outlet location for mounting in walls, floors and furniture. In addition to standards criteria, accessibility must be considered.

Administration of cabling in general is covered by TIA/EIA 606 and ISO/IEC 14763-1.

High quality and good design are of special importance in **outlets** and connectors. Over the course of a network's life, these may be connected and disconnected many thousands of times, and any weakness will result in a poor connection. Bad connections and poor connector performance are, by far, the greatest cause of cable network faults.

In **shielded cable**, the quality, location and integrity of grounding and bonding connections are particularly important and often difficult to achieve and monitor, and any loss of shielding integrity will have an effect on the cable's resistance to EMI.

Moving patch cords



Between the **outlets** at the periphery of a network and the switches at its center there will invariably be **patch panels**. These allow cable runs to be connected and disconnected very quickly, simply by moving **patch cords**.

Patch Panels

In a network that never changed, patch systems would not be necessary. In practice, every network is subject to movement of people or provision of new services, and it is the patch panel that allows this to take place quickly with minimum effort and disruption. Patch panels also make it easier to detect and bypass network faults.

Patch panels are generally located near network hubs in a position that minimizes the total cabling distance to outlets.

Power over Ethernet (PoE)

More and more network endpoint devices (e.g. IP phones, Wireless Access Points, IP cameras) are able to be powered over the standards-based copper cabling, so that no local power for these end devices is required. The DC power is injected into the data pairs of the horizontal cabling by a PoE-enabled switch (end-span) or to the pairs of the horizontal cabling by a mid-span PoE device. PoE has been standardized in the IEEE 802.3af. Mid-span PoE devices are available with 6, 12 and 24 ports. A new PoE Plus specification is in development to support the additional current requirements of devices such as Pan-Tilt-Zoom cameras and dual radio access points..

Eliminating the labor costs associated with contracting an electrician to run wiring for new AC outlets, saves significantly on the installation cost of the end devices.

Overall, PoE simplifies the installation of the network, improves the speed of installation, and ultimately saves time and money. In addition to powering end devices, the mid-span PoE device can provide continuous service during power outages when utilizing the same centralized UPS that provides back-up power to the network.

9 Selecting a supplier

In practice, the most important network decision for most users is the selection of a supplier. Besides implementing the network, good suppliers can offer valuable advice and information.

Since networking is a specialist subject, many organizations call on suppliers and independent consultants to help with networking specifications and strategy. In this situation, it is vital to select a supplier or consultant with skills and experience that can be trusted.

Selection Criteria

Some of the questions that should be asked of a cabling supplier are given in the list below.

- Size - does the supplier have the resources to handle the job?
- Skill set - does the supplier have all the necessary skills and have installers received adequate training from the cabling manufacturer?
- Quality - does the supplier have quality processes in place to cover all aspects of design, materials, installation and testing, e.g. as per ISO 9001:2000 and TL 9000 certification?
- Warranty - does the supplier provide a comprehensive warranty backed by the cabling system manufacturer? Does the warranty cover the applications that will run on the network as well as the cabling components? Does the warranty cover labor to replace any defective components? Is the warranty based on fully documented testing by a qualified organization?

- Materials - will cable and components be to the highest standards and produced by a single manufacturer? Are all the cables and components quality tested and verified by independent test laboratories with follow-up verification programs?
- Authorization - is the supplier fully trained and authorized by the cabling manufacturer?

Suppliers

Suppliers authorized by leading cabling manufacturers are required to meet comprehensive technical and business standards. They are also provided with full training in network planning and installation.

Systems installed by authorized suppliers, and subsequently certified, are usually backed by manufacturers warranties, ranging from five to 20 years. It is important to note that not all suppliers using cabling from a particular manufacturer are authorized. Even a network exclusively using one manufacturer's product will not be guaranteed by the manufacturer unless it is installed by an authorized supplier.

10 Cost of network ownership

Total cost of ownership is a key factor when assessing bids to supply and install a network. Since a network can be expected to have a 20-year life, the accumulation of re-occurring costs and the cost of upgrades can equal or exceed the original capital investment.

Network Evolution
Adding, removing and changing devices connected to the network is usually the greatest cost after initial installation. Structured cabling systems were developed to reduce this cost, allowing new sections to be added to a network with minimum effort.

The Ad hoc Alternative
The alternative to integrated structured cabling is ad hoc cabling. This can take various forms, some of which fall within the definition of structured cabling, but none can be described as integrated. Different types of cabling components can be linked in ad hoc cabling to create a system that functions, but may result in high operating costs and frequent communications problems.

Ad hoc cabling systems usually have a lower initial cost than fully integrated, structured cabling systems but do not offer the benefits of a guarantee backed by a single manufacturer. This includes the guarantee of the cabling systems' EMC performance. It is unlikely that ad hoc cabling systems will be fully tested to prove EMC performance and there is then some debate as to who is responsible for the EMC conformance.

Compatibility

Maintenance costs in ad hoc cabling systems can be higher, since new components must be obtained from multiple sources, creating extra overheads. There are also greater risks of incompatibility as the components may not have been tested together as a system.

Incompatibility problems may only manifest themselves when changes are made to the system or higher speed networks are implemented.

Network Faults

Operational faults are potentially an even bigger problem and one that is difficult to predict. Fault-finding can be particularly expensive in badly designed and implemented networks.
Full documentation of paths and easy access to cables and connectors is essential to minimize the cost of preventive and corrective work.

Warranties

The quality of a network's warranty is the best assurance that system faults will not result in unexpected costs. Ideally, the warranty should cover the full 20-year life expectancy of a cabling system and cover the cabling components from end-to-end, as well as the labor that may be required to replace any defective components.

To avoid disputes in the event of a claim, the warranty should cover the cabling components and the applications the system has been designed to support. Only cabling suppliers that have fully tested and documented supportable applications on their systems can offer such a warranty with confidence.

A network designed and implemented by a company authorized by the manufacturer of all its components will have fewer areas of doubt in its warranty. In these situations, there can be no argument as to which particular supplier is responsible for a fault.

11 High-speed networking

Preparing for the Future

Demand for networking capacity is growing relentlessly. New communications-dependent systems are being installed and these are used more intensely than their predecessors. Even greater communication demands are created by a new generation of multimedia applications. These require simultaneous video, voice and data transmission that can exceed 100 Mb/s or even 1 Gb/s for each workstation. Network technologies and data rates considered unwarranted only a few years ago must now be considered a distinct possibility for the future of any network.

Various LAN and WAN technologies and approaches have been developed in response to increased demand for communications and the Ethernet family (including specifications spanning from 10 Mb/s to 10 Gb/s) has been the most successful technology in the LAN. The shift to 10 Gigabit networking is already apparent in backbone implementations, and in the increased deployment of storage area networks (SANs). As bandwidth demands continue, the next migration will be 40+ Gb/s for enterprise and data center backbones.

Gigabit Ethernet

LANs are rapidly migrating from fast Ethernet to Gigabit Ethernet in the horizontal, due to increased bandwidth demands and reduced prices for 1 Gb/s network equipment and interface cards. The worldwide acceptance of Category 5e and Category 6 UTP cabling has facilitated the migration to 1000BASE-T now under way and it can be expected that Category 6A UTP cabling will facilitate the migration to 10GBASE-T in the near future.

Switched LANs

A dramatic increase in network performance has been achieved by implementing switched LANs, which is now commonplace in today's enterprise networks. Switching improves performance between workstations and servers, but places additional demand on building backbones.

10 Gigabit Ethernet

Network backbones and data centers are already migrating to 10 Gigabit Ethernet over optical fiber. The type of optical fiber selected for the backbone will determine the type, complexity and cost of the networking equipment that may be deployed. OM3 laser-optimized 50 micron multimode fiber utilizing low cost VCSEL technology provides a more economical alternative to singlemode fiber implementations. The 10GBASE-T standard for twisted pair cabling is expected to accelerate deployment of 10GBASE-T with lower cost technology that will eventually deliver 10 Gigabits to the desktop.

Storage Area Networks

The data explosion experienced in the LAN has also resulted in increased requirements for server-to-server and server-to-storage networks. Data rates of 10 Gigabit are common in these networks, which extend to the building backbone. Commonly deployed for storage area networks, Fiber Channel technology operates at various data rates up to 10 Gb/s, and the InfiniBand™ architecture has been designed for wire speeds of 2.5 Gb/s and beyond. The latest improvement in signaling rates has extended the available bandwidth to up to 120 Gb/s.

Grid Computing

Grid computing makes "spare" desktop CPU horsepower available across the network to large jobs that require it. There are many scientific applications that need the computing power of arrays, but up to now the cost of a supercomputer or a massively parallel array was prohibitive. Grid computing is a technique that effectively provides the horsepower "across the network" to support these kinds of applications. Grid computing is highly dependent upon very fast interconnections among all of the participating computing platforms. Present successful implementations of this are found in the form of clusters of servers that are set aside and tied together, often in the data centers, via a fast fiber or other types of optical interface.

The network is being populated right now with workstations that offer unprecedented computing power. The simple ability to harness these common appliances together with a very fast, cost-effective interconnection scheme would make it possible to deploy grid computing across an organization.

12 Cabling for the multi-gigabit era

With no end in sight to the bandwidth explosion, and given the current growth rates, Gigabit LANs are the norm for many organizations. Gigabit desktop connections and 10 Gigabit backbones are becoming the common requirement for many organizations while 10 Gb/s UTP connections will be initially implemented in data centers, low rise backbones and for mission critical applications. Although the exact timing of the migration to higher speeds for a given organization is not easily predicted, the selection of a suitable infrastructure today can determine the ability to react in a speedy and cost-effective manner whenever the need arises.

In anticipation of future needs, SYSTIMAX® Labs has developed leading-edge connectivity solutions to enable the smooth and cost-effective migration to the high-speed applications of the 10 Gigabit Era.

Horizontal Cabling

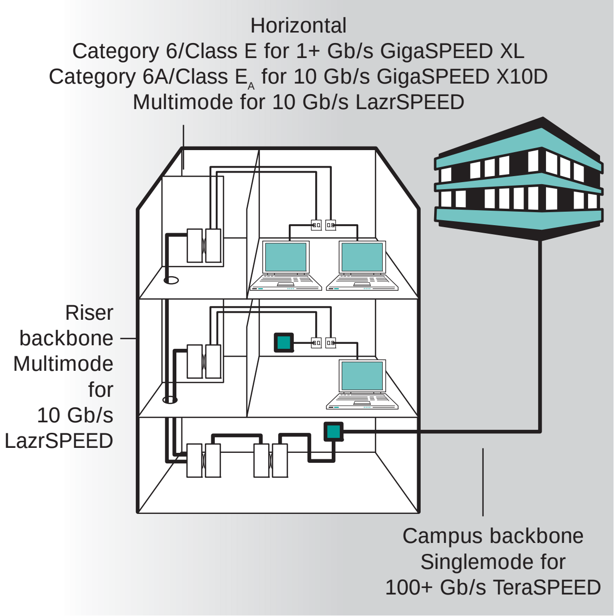
In the horizontal subsystem, cabling that meets Category 6/ Class E specifications offers inexpensive insurance against demands up to 1 Gb/s. The SYSTIMAX GigaSPEED® Solution was the blueprint that drove the standards developments of Category 6/Class E.

If 10 Gigabit Ethernet is expected to be deployed to the desk within the lifetime of the cabling installation, UTP cabling that meets the specifications for Class E_A and Category 6A offers unparalleled application support over UTP. The SYSTIMAX GigaSPEED X10D Solution quickly became the blueprint for the new cabling channel specifications early in their development.

Building Backbone
In the riser backbone, a combination of multimode and singlemode fiber cables may be required. The LazrSPEED® Solution offers next generation support for 10 gigabit technology, virtually eliminating the need for singlemode fiber in buildings.

Campus Backbone
Since the campus backbone often provides the most difficult installation conditions, network planners need to consider the highest capacity cable plant available. Singlemode fiber is the recommended media. The SYSTIMAX TeraSPEED™ singlemode solution provides a wide range of options for outdoor environments.

Media Recommendations
SYSTIMAX Solutions media recommendations based on these developments are summarized in the diagram below.



13 Cabling for BAS, security and other low voltage systems

Recent advances in technology and adoption of industry-wide standards have resulted in efforts to improve communications between the various low-voltage systems in commercial office buildings. Over a decade of industry evolution has resulted in a compelling business case to integrate these systems onto a common cabling system, or onto a common IP-based network, and the development of the ANSI/TIA/EIA-862 Building Automation Systems Standard for Commercial Buildings. This standard endorses the star-based design approach of using UTP cabling for all low-voltage building systems and permits common closets and pathways for all five of the low-voltage building systems including office automation, HVAC, Fire/Life/Safety, Security and Energy Management Systems. An international version of this North American standard is under development at this time.

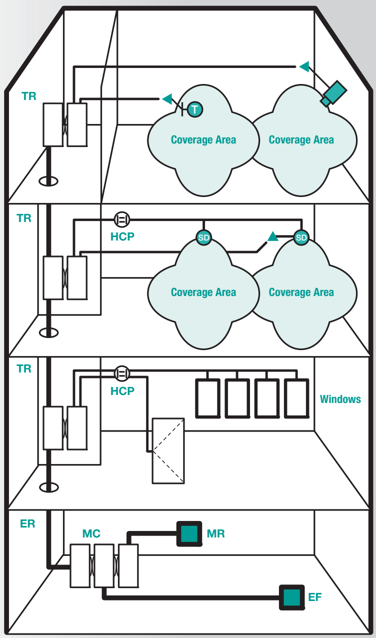
Deployment of a cabling system in accordance with TIA-862 can result in reduced installation cost and time to deployment and, perhaps more importantly a drastic reduction in ongoing management expenses related to, cabling-related moves, adds and changes.

Early data “networks” were not generally interconnected or compatible, and utilized dissimilar cabling and communications protocols that prevented the exchange of data without complicated and expensive hardware. Their evolution and integration has been led by the deployment and market dominance of Ethernet and UTP-based structured cabling, accompanied by significant improvements in performance and reduction in total system cost. The same trend is already apparent in the area of Building Automation, and the benefits of the integrated cabling approach should be considered when planning for a new cabling infrastructure.

Most buildings feature between 10 to 46 low voltage systems, each requiring its own control, management and monitoring. Without a common infrastructure that can link them together, these dozens of systems can create a lifetime accumulation of unnecessary cost. But with a single backbone supporting all of these systems—from security to lighting, from HVAC to communications—building operations can become high performing and cost-effective.

Intelligent Buildings—and their requisite infrastructures—are quickly becoming the new standard for owners/operators and tenants who want high-performing, easily-managed, efficient spaces. Deploying an Intelligent Building Infrastructure Solution (IBIS) facilitates convergence of a building's systems, from Building Automation Systems and Communications Systems, to video surveillance and access control, over the same, common standards-based cabling infrastructure, providing an enhanced level of efficiency and cross-system performance.

IBIS cabling



EF Entrance facility
ER Equipment room
HC Horizontal cross-connect
HCP Horizontal connection point
TR Telecommunications room
MR Mechanical room
MC Main cross-connect
SD Smoke detector (a BAS device)
T Thermostat (a BAS device)
◀ BAS outlet
Camera (a BAS device)

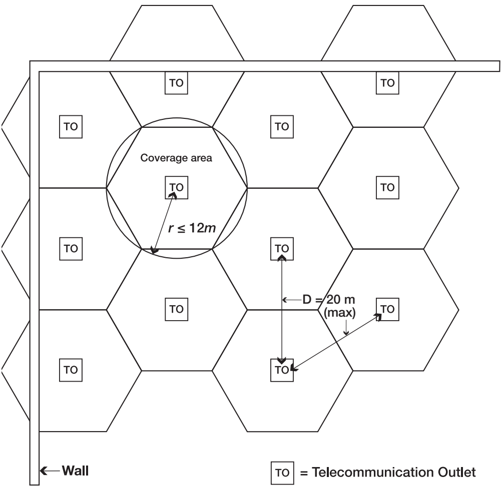
14 Wiring for mobility

As wireless infrastructure technology continues to evolve, the wired infrastructure that supports the wireless network needs to be proactively designed to future-proof the network investment. In order to be prepared for wireless technologies that potentially have a much smaller range and require dense wireless infrastructure (i.e. dense spacing of the Access Points), pre-wiring the enterprise with a relatively dense grid of outlets future-proofs the wired infrastructure.
This is the 'Wired for Mobility outlet grid.

Initially, a subset of the installed outlets will be used to support today's IEEE 802.11a/b/g APs for data. When new technologies become available, moving or adding APs becomes relatively simple and cost effective. In addition to the wireless infrastructure, pre-wiring based on the grid future-proofs for the rollout of other IP based applications such as BAS, IP cameras, security or other applications.

The ISO/IEC Technical Report 24704 “Customer premises cabling for wireless Access Points” specifies minimum cabling requirements for wireless coverage, and recommends an overlay “honeycomb” grid for TOs to be placed in the ceiling in cells with 12 meter (40 ft) radius as per the drawing below. When the outlets are placed in a more rectangular fashion, the recommended distance between the outlets is 20 meters.

Grid of telecommunications outlets for wireless coverage areas



15 Intelligent Infrastructure Solutions

It is clear that today, more than ever, the network is the heart of the enterprise. The cabling infrastructure is its central nervous system. Typically, more than 20% of network connections are moved, added, changed or disrupted annually. Traditionally, the physical connectivity layer is administered through manual re-arrangement of cabling connections, and this makes it susceptible to human errors that can prove costly. In today's world of complete integration of data networks into corporate bu There are numerous network management software products available on the market to enable management of network components. These sophisticated programs easily integrate components from a multitude of vendors and are capable of monitoring data traffic, generating alarms, and providing diagnostic reports to help troubleshoot network failures. However, these software products lack one function that is an integral part of any network - they are not capable of either documenting or monitoring the actual physical layer connectivity between devices on the network.

The technology to address this market need is already available and is commonly referred to as an intelligent infrastructure solution. It typically consists of intelligent copper or fiber patch panels that are preferably designed to recognize the insertion of standards-compliant patch cords, with a controller unit that communicates with infrastructure management software via the LAN. An intelligent infrastructure solution is capable of monitoring and communicating any change in the network's physical connectivity to network administrators, thus providing them with the missing piece of critical data necessary for effective management of their network.

Through SNMP integration with network management software, the Intelligent Infrastructure Solution allows network administrators to consolidate all the information-gathering tools that are essential for maintaining reliable and healthy networks.

The Intelligent Infrastructure Solution also streamlines administration of cabling connections to minimize the effect of human errors. Each intelligent patch panel can be provided with LED indicators and trace buttons at every port to enable quick and easy identification of the ends of each connection, thereby saving considerable time in troubleshooting and/or moves and changes. Additionally, intelligent controllers can be equipped with interactive LCD screens that facilitate the implementation of electronic work orders with step-by-step instructions, greatly speeding up accurate provision of services.

A “truly intelligent” Intelligent Infrastructure Solution also allows the IT manager to schedule and provide connectivity for specific services without having to manually select the specific ports and patching connections. Service provisioning can be made as easy as selecting the type of service to be provided and selecting the end point (or person) to deliver it to, with the real-time infrastructure management system working out all the connectivity details and only alerting the administrator if any blocking conditions are found.

Yet another level of intelligence can be activated in intelligent systems with the integration of device discovery functions. The intelligent system can be configured to monitor activity and specific devices at the switch port level, and to tie in any network alarms to the physical layer ports. Port activation/deactivation can be made an integral part of the electronic work orders, increasing the overall security of the network.

Intelligent Infrastructure Solution functions such as automated service provisioning and device discovery can also be integrated with external packages designed to manage work flow and deployment of resources and equipment, especially in data centers, where accurate record keeping and detailed auditing are essential.

An Intelligent Infrastructure Solution provides vision, knowledge and control to enhance a network's effectiveness. In any environment where high employee productivity and /or reliable service provisioning are a necessity, the benefits of a Intelligent Infrastructure Solution provide significant advantages that should not be overlooked.

Glossary of Terms

The following glossary offers explanations for a number of terms used in this guide.

10BASE-T	10 Mb/s Ethernet using 2 pairs of Category 3 cable.
100BASE-T	100 Mb/s Fast Ethernet using 2-pair Category 5 cable.
1000BASE-T	1000 Mb/s (1 Gb/s) Ethernet using 4 pairs of Category 5e cable.
10GBASE-T	The IEEE standard for 10 Gigabit Ethernet over Twisted Pair Cabling. Ratified in June 2006, it includes cabling requirements for Alien Crosstalk and channel performance to 500 MHz.
Access Point (AP)	A Wireless LAN base station that supports a wireless cell. The Access Point is typically connected to the wired infrastructure.
Ad hoc Cabling	Cabling scheme where different types of cabling components from different vendors are linked together to form a cabling system.
Alien Crosstalk	Signal coupling between adjacent cabling components (cables, connectors) or between adjacent links or channels.
AP	See Access Point.
Application	A system, with its associated transmission method which is supported by Telecommunications Cabling.
Asychronous	Two or more signals sourced from independent clocks, therefore having different frequency and phase relations.
Asychronous Transfer Mode (ATM)	A high-speed cell-based switching and multiplexing technology based on segmentation of voice, data and video into fixed packets (cells). These cells are transferred along switched paths and are not received on a regular basis (hence the term Asychronous).
ATM	See Asychronous Transfer Mode
Backbone(s)	The part of a premises distribution system that includes a main cable route and facilities for supporting the cable from the Equipment Room to the upper floors, or along the same floor to the wiring closets.
Balanced Circuit	A circuit where equal and opposite signals are generated and sent on to two conductors. The better the balance of a circuit, the lesser is its emissions and the greater is its noise immunity (hence the better is its EMC performance).
Balanced Twisted Pair Cable	A cable consisting of one or more metallic symmetrical cable elements (Twisted Pairs or quads).
Bandwidth	The range of frequencies that can be used for transmitting information on a channel. It indicates the transmission-carrying capacity of a channel. Thus, the larger the bandwidth, the greater the amount of information that can pass through the circuit. Measured in Hertz or bits per second or MHz.km (for fiber).
Bridge(s)	A device used to link two sub networks using the same communications method and sometimes the same kind of transmission medium.
Bus	Consists of a common transmission path with a number of nodes attached to it. Sometimes referred to as linear network topology.

Cable Fill	The ratio of cable installed into a conduit/trunking against the theoretical maximum capacity of the conduit/trunking.
Cable Routing Diagram	A detailed drawing showing the layout of the cable routes.
Cabling	A system of telecommunications cables, cords and connecting hardware that can support the connection of information technology equipment.
Campus	A premises containing more than one building adjacent or near to one another.
Campus Backbone Cabling	A cable that connects the campus distributor to the building backbone distributor(s). Campus backbone cables may also connect building cabling distributors directly.
Category 3	Industry standard for cable and connecting hardware products with transmission characteristics specified to 16 MHz, designed to support digital transmission of 10 Mb/s.
Category 4	Industry standard for cable and connecting hardware products with transmission characteristics specified to 20 MHz, designed to support digital transmission of 16 Mb/s.
Category 5	Industry standard for cable and connecting hardware products with transmission characteristics specified to 100 MHz, designed to support digital transmission of 100 Mb/s.
Category 5e	Enhanced Category 5 specifications for cable and connecting hardware products with transmission characteristics specified to 100 MHz, minimally compliant to support digital transmission of 1 Gb/s.
Category 6	Industry standard for cable and connecting hardware products with transmission characteristics specified to 250 MHz, designed for robust digital transmission support of 1 Gb/s.
Category 6A	Identified as Augmented Category 6 or Class E_A, the specification currently in draft to become an industry standard for cable and connecting hardware products with transmission characteristics specified to 500 MHz and Alien Crosstalk requirements, designed to support digital transmission of 10 Gb/s over balanced pair UTP.
Category 7	Standard for cable and connecting hardware products with transmission characteristics specified to 600 MHz and requiring individually shielded pair cables. Requires either a switched "RJ45" or a non-RJ45 connector and is not standardized by EIA/TIA. Although Category 7, also known as Class F, has been standardized internationally since 2002, due to the requirement for individual pair shielding and choice of connector, it has not found worldwide acceptance and is not widely used.
Ceiling Distribution	Distribution system that uses the space between the false or suspended ceiling and the structural ceiling for housing horizontal cable routes.
CENELEC EN 50173	The European standard for generic cabling for customer premises.
Channel	The end-to-end transmission path connecting any two pieces of application-specific equipment. Equipment cables and work area cables are included in the channel.
Churn	The relocation of an individual or a group of individuals within a building such that the workspace or services to the workspace require change.

Client/server	A technique by which processing can be distributed between nodes requesting information (clients) and those maintaining data (servers).
Collapsed Backbone	This architecture is a backbone topology where wiring concentrators located at floor levels are attached in a star configuration to a central high performance switching concentrator.
Consolidation Point	An interconnection point in horizontal cabling, typically used to support the re-arrangement of furniture cloisters.
Cords	A short length of copper wire or fiber-optic cable with connectors on each end. Used to connect equipment to cabling, or to connect cabling segments (cross-connection).
Crosstalk	An electromagnetic coupling between two physically isolated circuits in a system. This coupling causes a signal on one circuit to induce a noise voltage on adjacent circuits, thereby causing signal interference.
Electromagnetic Compatibility (EMC)	The ability of a system, equipment or device to operate satisfactorily in its environment without introducing unacceptable electromagnetic disturbance, or being affected by that environment.
Electromagnetic Flux	Electric and magnetic fields (commonly referred to as emissions) generated by equipment or system.
Electromagnetic Interference (EMI)	The interference in signal transmission or reception caused by the radiation of electric and magnetic fields.
EMC	See Electromagnetic Compatibility.
EMI	See Electromagnetic Interference.
Ethernet	A LAN originally developed by DEC, Xerox and Intel. It uses the CSMA/CD Protocol.
FDDI	See Fiber Distributed Data Interface.
Fiber	See Optical Fiber.
Fiber Distributed Data Interface (FDDI)	An American National Standards Institute standard for fiber-based token passing access protocol that operates at a 100 Mb/s (FDDI) data transfer rate.
Foil Screened Twisted Pair Cable (FTP)	A cable that uses a metallic foil to surround the conductors in a twisted pair cable.
FTP	See Foil Screened Twisted Pair Cable
Generic Cabling	A structured telecommunications cabling system, capable of supporting a wide range of applications. Generic cabling can be installed without prior knowledge of the required applications. Application-specific hardware is not a part of generic cabling.
Grid Computing	Grid computing makes "spare" CPU horsepower available across the network to large jobs that require it, by harnessing the capabilities of dispersed devices across the network.
Horizontal Cable	A cable connecting the floor distributor to the telecommunications outlet(s).
Horizontal Runs	See Horizontal Subsystem.
Horizontal Subsystem	The part of the premises distribution system installed on one floor that includes the cabling and distribution components connecting the riser backbone or equipment wiring to the information outlet.
Hub	A concentrator or repeater in a star topology at which node connections meet.

IEC 60332	The international standard covering fire performance of cables.
IEEE	Institute of Electrical and Electronic Engineers in the USA. This organization is also involved in producing Local Area Network standards such as Ethernet.
InfiniBand™ Architecture	A high bandwidth switched network topology developed for Storage Area Networks (SANs).
Interconnect	A location at which equipment cables are terminated and interconnected to the cabling subsystems without using a patch cord or jumper.
Interface Cards	See Network Interface Cards.
Interference	A signal impairment caused by the interaction of another unwanted signal.
ISO/IEC 14763-1	The international standard for basic administration of generic cabling
ISO/IEC IS 11801	The international standard for generic cabling for customer premises.
LANs	See Local Area Networks.
Local Area Networks (LANs)	A LAN allows users to share information and computer resources. Typically, a local area network is limited to a single building.
Multimedia	A means of conveying information with components in different media such as voice, music, text, graphics, image and video.
Multimode Fiber	Optical fibers that have a large core and that permit multiple rays or modes to propagate through the core.
Network Architecture	Network topology and design.
Network Interface Cards (NICs)	The piece of equipment that is installed into the expansion port of a personal computer and allows communication between the PC and the network.
Node(s)	A piece of communications equipment on the network.
Noise	The term used for spurious signals produced in a conductor by sources other than the transmitter to which it is connected. Noise can affect a legitimate signal to the extent that it is inaccurate or indecipherable when it reaches the receiver. The higher the speed of data transmission, the worse the effects of noise become.
Optical Fiber	A transmission medium consisting of a core of glass or plastic surrounded by a protective cladding. Signals are transmitted as light pulses, introduced into the fiber by a light transmitter i.e. Laser or an LED.
Outlets	A term used to describe the sockets provided in the work location of a structured cabling system. These are usually 8 pin modular sockets which can support a variety of services e.g. voice, video and data.
PABX	Private Automatic Branch Exchange. A private switching system that switches calls both internally within a building or premises and outside to the telephone network.
Packet Switching	A type of exchange or network which conveys a string of information from origin to destination by cutting it up into a number of packets and carrying each independently. A packet-swtiched effect could be achieved by sending individual pages of a book through the post separately. The receiving device reassembles the message. Thus a direct connection between origin and destination does not exist at any point.

Patch Cord(s)	Flexible cable unit or element with connector(s), used to establish connections on a patch panel.
Patch Panel(s)	Termination and administration hardware designed to accommodate the use of patch cords. It facilitates administration for moves and changes.
Pathway(s)	Designated cable routes and/or support structures in a false floor or ceiling.
Peripheral(s)	Additions to a system, a resource (e.g. printer, scanner, etc).
Physical Layer	Layer 1 of the open systems interconnection (OSI) model. The physical layer protocol is the hardware and software in the line terminating device which converts the databits needed by the datalink layer into the electrical pulses, modem tones, optical signals or other means which will transmit the data.
Physical Topology	Physical cabling layout i.e. ring, bus, star wired etc.
PoE	See Power over Ethernet.
Ports	A computer interface capable of transmitting and or receiving information.
Power over Ethernet (PoE)	A method of providing power to an end device (e.g. a Wireless Access Point) via the data or spare pairs of the Ethernet cable. PoE has been standardized in IEEE 802.3af.
PowerSum	A method of testing and measuring crosstalk in multi-pair cables that accounts for the sum of crosstalk affecting a pair when all other pairs are active. This is the only method of specifying crosstalk performance that is suited to cables with more than four pairs.
Proprietary	Systems that are not standards-specific and therefore are not interoperable with standards-based equipment.
Protocol(s)	A rule of procedure by which computer devices intercommunicate. Thus a protocol is the equivalent of a human language, with punctuation and grammatical rules.
Raceway	Any distribution method designed for holding cables, e.g. conduit, metal or plastic trunking, cable trays, etc.
Ring	A closed loop network topology.
Riser(s)	The term used to describe a space utilized by backbone cabling to house communications cabling and other building services. This space should preferably be specified, or allowed for, at the time of the building design.
Router(s)	An intermediate system between two or more networks capable of forwarding data packets at the network layer (layer 3).
Screened Cable	See Foil Screened Twisted Pair Cable.
Serial Communications	See Serial Data Transmission.
Serial Data Transmission	Data transmission between computer devices using only a single circuit path. Whole bytes of information (8 bits) are sent in sequential pattern. Compares with parallel transmission. Parallel transmission is often used internally within computing devices because of the higher processing speeds which are possible, but for long-distance telecommunication, serial transmission is more economic in terms of line plant.
Server(s)	Host Computer(s).

Shielded Twisted Pair Cable (STP)	An electrically conducting cable comprising one or more elements each of which is individually shielded. STP usually also incorporates an overall shield.
Singlemode	Optical fiber with a small core diameter in which only a single mode of light is capable of propagation. 8.3 micron is the common standard core size.
Star	A physical point-to-point network topology.
Storage Area Network (SAN)	A high speed network or sub network of shared storage devices.
STP	See Shielded Twisted Pair Cable.
Switching	A function carried out by a switching hub, alleviating traffic by making virtual connections between transmitting and receiving nodes.
Synchronous	Signals that are sourced from the same timing reference and hence are identical in frequency.
Telecommunications	A branch of technology concerned with the transmission, emission and reception of signs, signals, writing, images and sounds; that is, information of any nature by cable, radio, optical or other electromagnetic systems.
Token Ring	The transmission medium used for IEEE 802.3 10BASE-2 LANs (Sometimes referred to as CheaperNet). It is a 50 ohm thin coax cable.
Token Ring LAN	A 4 or 16 Mb/s LAN standard based on token passing access protocol originally developed by IBM. Sometimes referred to as IEEE 802.5 or ISO 8802-5 standard which uses a token-passing scheme where the information frame circulates the ring until it reaches the intended destination station.
Topology	The physical or logical configuration of a telecommunications system.
Transducer	A sensing device that converts a signal from one form to another e.g. mechanical to electrical.
Twisted Pair(s)	A cable element which consists of two insulated conductors twisted together in a determined fashion to form a balanced transmission line.
Unshielded Twisted Pair Cable	An electrically conducting cable comprising one or more pairs none of which is shielded.
UTP	See UnShielded Twisted Pair Cable.
VCSEL	Vertical Cavity Surface Emitting Laser
Video Conferencing	Real time communications via video between two or more users at separate locations.
Wireless LAN (WLAN)	Local area network that communicates using radio technology.
Wiring for Mobility	Provisioning of a grid with telecommunications outlets placed at regular distances for connecting wireless infrastructure devices (e.g. Wireless LAN Access Points).
WLAN	See Wireless LAN
Work Area	A building space where the occupants interact with telecommunications terminal equipment. A user's work area which is typically 9 sq. meter or 100 sq. ft.

Notes

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