## Contents

**Section 1**

Introduction .................................................................................................................. 1

**Section 2**

LAN Installation .......................................................................................................... 3

  Overview .................................................................................................................... 4

  Types of installations ............................................................................................... 4
    100Mbit/s Ethernet Networks .............................................................................. 4
    Rules for cable length and repeater usage in 100BaseT networks ............... 4
    100BaseT Uplinks .................................................................................................. 6
    100BaseT Switched Links ...................................................................................... 7
    1000Mbit/s Ethernet Networks .......................................................................... 7

  Laying of Cable ........................................................................................................ 9
    Horizontal Wiring ................................................................................................. 9
    Backbone Wiring .................................................................................................. 10
    Installation Practices ............................................................................................ 12
    Interference avoidance, Earthing and Grounding ........................................... 15

  Terminations ............................................................................................................ 17
    Steps to terminate a patch panel ................................................................. 17
    Steps to terminate an RJ45 with split 110 (I/O) ..................................... 17
    Steps to terminate a clip style RJ45 I/O ...................................................... 18
    Steps to terminate a male RJ45 ..................................................................... 18
    Steps to terminate a Cross over Cable ......................................................... 19

  Testing & Certification ........................................................................................... 22

  Glossary ............................................................................................................... 24
SECTION 1

INTRODUCTION
Today’s building LAN cabling must provide quality, flexibility, value and function not only for current needs, but also to meet future requirements. Business survival today depends on reliable and cost-effective information exchange. The explosion of digital LAN, PBX, Internet and e-mail technologies created unmanageable networks comprised of numerous protocols, media types and signalling technologies. IT engineers and technicians have the difficult task of assessing, implementing and maintaining these complex systems.

Physical media cabling is the basic building block for most local area networks. Cabling challenges arise as these networks reach 100Mbps and beyond, especially for unshielded twisted pair (UTP) networks. International standards are rapidly evolving, and the quality of today’s cabling and connecting hardware far exceeds the best products of only a few years ago.

New, bandwidth-intensive applications are being deployed over Fast Ethernet and Gigabit Ethernet networks. These applications include the following:

- Internet and intranet applications that create any-to-any traffic patterns, with servers distributed across the enterprise and users accessing Web sites inside and outside the corporate network. These applications tend to make traffic patterns and bandwidth requirements increasingly unpredictable.

- Data warehousing and backup applications that handle gigabytes or terabytes of data distributed among hundreds of servers and storage systems.

- Bandwidth-intensive, latency-sensitive groupware applications such as desktop video conferencing or interactive white boarding.

- Publication, medical imaging, and scientific modelling applications which produce multimedia and graphics files that are exploding in size from megabytes to gigabytes to terabytes.

Bandwidth pressures are compounded by the growing deployment of switching as the desktop connection of choice. Switching at the edge tremendously increases the traffic that must be aggregated at the workgroup, server, and backbone levels.

This handbook which is based on national and international best practices provides key instructions, house keeping rules on the design and installation of Local Area Networks (LAN) as well as other tips.
SECTION 2

LAN INSTALLATION
Overview

Any cabling system, regardless of how much thought and planning goes into its design and the quality of its components, will only operate properly and meet expectations when it is properly installed.

A well thought-out design of a cabling system is essential. Neat design and a correct installation are critical. This is particularly true when the cabling system is required to support the ever increasing data transmission rates of today’s emerging technologies, and still has to be ready for the next generation.

Types of installations

100Mbit/s Ethernet Networks

Rules for cable length and repeater usage in 100BaseT networks

When connecting two 100BaseT nodes in full duplex mode the maximum distance aggregates to 100 metres for twisted pair and to 400 metres for fibre cabling. Refer to Figure 1 below.

Figure 1 - Connecting network nodes in 100BaseT full duplex mode
Within a single collision domain, a maximum of two class 2 repeaters, or one class 1 repeater is allowed. Class 1 repeaters are able to connect several different 100BaseT media types (e.g. 100BaseTX, 100baseT4 and 100BaseFX), whereas class 2 repeaters can only be used for either 100BaseTX or 100baseT4 in combination with 100BaseFX. Therefore class 1 repeaters are more flexible on the one hand, but are slow on the other hand, and therefore not more than one of these repeater types must be used per transmission path. With class 1 repeaters the maximum segment diameter for two twisted pair segments is 200 metres, for two fibre segments 240 metres, and for a mixed twisted pair fibre segment 230 metres. Refer to Figure 2 below.

![Figure 2 - Design rules for 100baseT networks with class 1 repeaters](image)

The corresponding limits for segments with one class 2 repeaters are 200 metres (twisted pair), 318 metres (fibre) and 285 metres (fibre and twisted pair). Refer to Figure 3 below.

![Figure 3 - Design rules for 100baseT networks with one class 2 repeaters](image)
When two class 2 repeaters are used the segment diameters shall not exceed 205 metres (twisted pair), 226 metres (fibre) and 212 metres (fibre and twisted pair). Refer to Figure 4.

![Diagram of class 2 100BaseT repeater](image)

**Figure 4 - Design rules for 100baseT networks with two class 2 repeaters**

### 100BaseT Uplinks

Uplinks to LAN Switches must not exceed a length of 100 metres using twisted pair cabling, and 163 metres when using fibre and class 1 repeater. If fibre and class 2 repeaters are used instead, the maximum uplink distance can be extended to 189 metres.
100BaseT Switched Links

Connections between 100BaseT switches are limited to a length of 100 metres when using twisted pair cables, and to 400 metres when fibre cabling is used. Therefore with the help of two 100BaseT switches and fibre cabling two segments can be connected over a distance of 778 metres. (2 x 189 metres fibre uplink + 400 metres switch interconnection).

Refer to Figure 5 below.

![Diagram](image)

Figure 5 - Connecting workgroups via 100baseT switches

1000Mbit/s Ethernet Networks

802.3z Gigabit Ethernet increases the transmission speed to 1Gbps and reaches 2Gbps in full duplex mode. Gigabit Ethernet uses the same frame formats as 10 and 100 Mbit/s Ethernet and can be operated like the other Ethernet variants either in half- or in full duplex mode.

However, in half duplex mode the smallest packet size is artificially being extended to 512 bytes to extend the segment diameter per collision domain to 200 metres. Otherwise the collision detection mechanism would not function any more for short packets since they could get lost in collisions without being notified by the sending station. The collision signal would only arrive at the sending station after the transmission process had been finished. The station would not correlate the collision event with the successfully transmitted packet and would not even try to retransmit the packet.
In full duplex mode, where CSMA/CD as an access mechanism is not needed, this packet extension is not used, and the minimum packet size remains 64 bytes. As transmission media the Gigabit Ethernet standard specifies multimode and mono mode fibre. Figure 6 lists the distance limitations for Gigabit Ethernet.

<table>
<thead>
<tr>
<th>standard</th>
<th>cabling (MM multimode, SM single mode, UTP unshielded twisted pair)</th>
<th>fiber diameter</th>
<th>maximum and minimum distance</th>
</tr>
</thead>
<tbody>
<tr>
<td>1000 Base-SX</td>
<td>MM</td>
<td>62,5</td>
<td>2 m – 220 m</td>
</tr>
<tr>
<td>1000 Base-SX</td>
<td>MM</td>
<td>62,5</td>
<td>2 m – 275 m</td>
</tr>
<tr>
<td>1000 Base-SX</td>
<td>MM</td>
<td>50</td>
<td>2 m – 500 m</td>
</tr>
<tr>
<td>1000 Base-SX</td>
<td>MM</td>
<td>50</td>
<td>2 m – 550 m</td>
</tr>
<tr>
<td>1000 Base-LX</td>
<td>MM</td>
<td>62,5</td>
<td>2 m – 550 m</td>
</tr>
<tr>
<td>1000 Base-LX</td>
<td>MM</td>
<td>50</td>
<td>2 m – 550 m</td>
</tr>
<tr>
<td>1000 Base-LX</td>
<td>MM</td>
<td>50</td>
<td>2 m – 550 m</td>
</tr>
<tr>
<td>1000 Base-LX</td>
<td>SM</td>
<td>9</td>
<td>2 m – 5000 m</td>
</tr>
<tr>
<td>1000 Base-T</td>
<td>UTP-5 (four pairs)</td>
<td>—</td>
<td>100 m</td>
</tr>
</tbody>
</table>

Figure 6 - Distance limitations for IEEE 802.3z Gigabit Ethernet
Laying of Cable

Horizontal Wiring

The horizontal wiring is the portion of the cabling system that extends from the work area outlet to the rack. The horizontal wiring includes the telecommunications outlet in the work area, the mechanical termination for the horizontal cable and cross-connections located in the racks.

To satisfy today’s telecommunications and applications requirements, the horizontal cabling shall facilitate ongoing maintenance and relocation, and accommodate further equipment and services.

The horizontal wiring shall be a star topology, i.e. each single wall port shall be connected to the rack individually. The maximum distance between the patch panel and the wall port shall be 90m. Refer to Figure 7 below.

![Figure 7 - Distance recommendations for horizontal cabling](image-url)
Backbone Wiring

The function of the backbone wiring is to provide interconnections between telecommunications closets, equipment rooms, and entrance facilities in the telecommunications wiring system structure. The backbone wiring consists of the transmission media, intermediate and main cross connects, and mechanical terminations, for interconnection of telecommunications equipment. Telecommunications closets, equipment rooms and demarcation points may be located in different buildings. The backbone wiring includes transmission media between buildings.

It is typically not possible or economically justifiable to preinstall backbone wiring for the entire life of a telecommunications wiring system. The useful life is therefore expected to consist of one or several planning periods, each period spanning in three to ten years. During each planning period, growth and changes in service requirements are intended to be accommodated without installation of additional wiring.

In planning the routing and support structure for the backbone cabling care shall be taken to avoid areas where sources of high levels of Electro Magnetic Interference (EMI), such as motors and transformers may exist.

Always install more than two cables to be used as backbones interconnecting the telecommunications closets. Also SSTP or STP must be used were the length is less than 90m and indoor. Were the length is more than 100m or the cable path is passing from outside multimode fibre optic must be used. This choice of media is preferred since the bandwidth could be increased without the need of changing the cable.
Some points specified for the backbone cabling subsystem include:

- Equipment connections to backbone cabling shall be made with cable lengths of 30m (98 ft.) or less.

- The backbone cabling shall be configured in a star topology. Each horizontal cross connect is connected directly to a main cross-connect or to an intermediate cross-connect, then to a main cross-connect.

- The backbone is limited to no more than two hierarchical levels of cross-connects (main and intermediate). No more than one cross-connect may exist between a main and a horizontal cross-connect and no more than three cross-connects may exist between any two horizontal cross-connects.

- A total maximum backbone distance of 90m (295 ft.) is specified for high bandwidth capability over copper. This distance is for uninterrupted backbone runs. (No intermediate cross-connect).

- Recognised media may be used individually or in combination, as required by the installation. Quantity of pairs and fibres needed in individual backbone runs depends on the area served. Recognised backbone cables are:

  1) 100 Ω UTP
  2) 150 Ω STP
  3) 62.5/125µm multimode fibre
  4) Single mode fibre
Installation Practices

It is very important to establish the environmental conditions within the routes and to determine whether the installation methods that will be used are suitable for the cable to be installed.

A site survey and analysis of the available site documentation such as site plans, floor plans, is fundamental when installing a structured cabling system.

It is also very important to review all the possible routes, to check for problem areas such as bends, sharp corners, cutting edges that might damage the cable.

Cables in ceiling spaces: - Individual outlet cable must be tied to ceiling suspension rods or cable trays, and not just draped across ceiling.

Cables surface run: - Enclose in clip-on cover rectangular ducting of dimensions adequate to meet specified immediate and future requirements. The ducting shall be firmly fixed to walls with screws every 50cm in a zig-zag pattern.

Ducts shall be used where the cable is buried and ground conditions shall be given careful consideration. It is recommended that the depth of the duct shall be more than 350mm. When the cable is going to be passed in a duct, it is better to use conduit for further protection.

Before pulling the cable make sure that these are labelled at both ends. When pulling the cables special attention must be paid. It is important to start with the longest cables. Do not try to pull too long lengths in one haul; the cable may be over stressed because friction builds up with length. Also, when pulling the cable, you must respect the minimum bending radius and the maximum pulling forces of the twisted pair cable.
**DOs**

Maintain a **maximum** bending radius of 4x the cable diameter (4-pair cables)

Apply cable ties **loosely** and at **random intervals**

Try to **minimise** the amount of jacket twisting

**DON’Ts**

Never exceed a 90 degree bend

**Don’t** over-tighten cable ties

**Don’t** over twist cable, it can lead to torn jackets
**Avoid** stretching the cable

**Use** appropriate methods for dressing and securing cables

- Cable ties
- Wire management panels
- Cable support bar
- Releasable Velcro straps

**Don’t** exceed 25 lbs (11.34Kg) of pulling tension

**Don’t** use a staple gun to position cables
Interference avoidance, Earthing and Grounding

When installing twisted pair cable it must be separated from electrical power wiring either by placing them in separate raceways or by respecting a physical distance in a common raceway.

The table below specifies the Minimum Separation Distance from Power Source at 480V or less:

<table>
<thead>
<tr>
<th>CONDITION</th>
<th>DISTANCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unshielded power lines without ground plate separation from data cable</td>
<td>30.5 cm</td>
</tr>
<tr>
<td>Unshielded power lines or electrical equipment in proximity to grounded metal conduit pathway</td>
<td>15.2 cm</td>
</tr>
<tr>
<td>Power lines enclosed in a grounded metal conduit (or equivalent shielding) in proximity to grounded metal conduit pathway</td>
<td>30.5 cm</td>
</tr>
<tr>
<td>Transformers &amp; electric motors</td>
<td>1.02 m</td>
</tr>
<tr>
<td>Fluorescent lighting</td>
<td>30.5 cm</td>
</tr>
</tbody>
</table>

When the network paths are going to interfere with voltages and/or high frequency transmitting equipment, STP/FTP/SSTP cable needs to be used. In this type of installation, ground connection is obligatory. They aim to avoid voltages between the screen and other metallic parts.

All earth connections both from patch panels and from the cabinet must be connected to the earth key. By isolating the earth key form the frame of the cabinet it is possible to disconnect the earthing system from the ground formed by the metallic parts inside the cabinet. This makes it possible to detect potential problems on the earthing network.

To avoid voltages between the cabinet and other metallic parts, a connection is required to the protective earth. The earth conductor has to be connected to the earth key at a point of the protective earth in the neighbourhood of the cabinet. Where a protective system exists, the dimension of the earth conductor must be 6mm² when the conductor is protected against corrosion and 10mm² when the conductor is not protected against corrosion.
If no or only poor protective earth system is present in the building, a signal ground is required. When a new earthing installation is going to be installed, the dimensions of the earth conductor must be 16mm$^2$ when the conductor is protected against corrosion, and 25mm$^2$ when the conductor is not protected against corrosion.
Terminations

To meet category 6 standards, all cable connections are allowed a maximum of 13 mm (0.5 in) of untwisted conductors at the point of termination.

Do not use screw type terminations. Use clip or barrel IDC (insulation displacement contact) connections such as those used in IDC blocks.

Pay very careful attention to termination practices. Maintain a tight wire twist up to the point of termination at punch blocks, wire plates, and connectors.

Steps to terminate a patch panel

1. Remove 7cm of sheathing from the cable.

2. Using the colour-coded notches spread apart the orange pair using the orange nub with the white/orange wire toward the blue notch. Push in firmly as far as you can. Remember to keep the distance less than 2.54cm (1 inch) from the edge of the cable sheathing to where the cable is terminated and cut.

3. Install the other 3 pairs in the cable the same way with the whites of each pair always toward the blue end of the 110.

4. Using the punch down tool slide the blade into each notch and push till the spring in the tool releases. Push to tool in as level and square as possible.

Steps to terminate an RJ45 with split 110 (I/O).

1. Remove 7cm of sheathing from the cable.

2. Using the colour coded notches spread apart the orange pair using the blue nub with the white/blue wire toward the blue notch. Push in firmly as far as you can. Remember to keep the distance less than 2.54cm (1 inch) from the edge of the cable sheathing to where the cable is terminated and cut.

3. Install the other 3 pairs in the cable the same way with the whites of each pair always toward the blue end of the split 110.
4. Using a punch down tool slide the blade into each notch and push till the spring in the tool releases. Push to tool in as level and square as possible.

**Steps to terminate a clip style RJ45 I/O**

1. Remove 7cm of sheathing from the cable.
2. Using a small screwdriver insert the blade between each pair of cable at the sheathing and move toward the end. This will untwist the pairs and straighten the individual wires out at the same time.
3. Put each wire of cable in the colour order as identified for on the clip.
4. Using scissors cut the wire on a steep angle with the shortest wire not to be shorter than 3cm. The angle can start from either side.
5. Making sure the wires are straight and insert them into the clip until the sheath of the cable is well into the clip.
6. Cut off the excess wire and mate the clip with the RJ45, squeeze together firmly until you hear one click.
7. Using the tool that comes with the jack insert it in the top part over the clip and squeeze it firmly until you hear the second click or the 2 parts are as tight as they can be. Pliers can also be used.

**Steps to terminate a male RJ45**

1. Remove 3cm of sheathing from the cable.
2. Using a small screwdriver insert the blade between each pair of cable at the sheathing and move toward the end. This will untwist the pairs and straighten the individual wires out at the same time.
3. Arrange the cables in order of the 568B wire map which is W/O, O, W/G, B, W/B, G, W/Br, Br:

<table>
<thead>
<tr>
<th>Points</th>
<th>Wire's Colour</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>White/Orange (W/O)</td>
</tr>
<tr>
<td>2</td>
<td>Orange (O)</td>
</tr>
<tr>
<td>3</td>
<td>White/Green (W/G)</td>
</tr>
<tr>
<td>4</td>
<td>Blue (B)</td>
</tr>
<tr>
<td>5</td>
<td>White/Blue (W/B)</td>
</tr>
<tr>
<td>6</td>
<td>Green (G)</td>
</tr>
<tr>
<td>7</td>
<td>White/Brown (W/Br)</td>
</tr>
<tr>
<td>8</td>
<td>Brown (Br)</td>
</tr>
</tbody>
</table>

4. Using the male RJ45 as a guide cut the ends if the cable off straight with the sheathing being 1cm (¼ inch) inside the jack.

5. You have to know where pin # 1 is, with the clip of the jack down and looking into the back of the jack, pin # 1 is on your left. The W/O end will go to pin number 1.

6. Insert the cable into the jack until you can see the copper of all eight conductors at the end of the clip.

7. Check to see if the sheathing is inside the jack far enough so when it is terminated the clamp that comes down to secure the sheath will hit it.

8. Using the crimping tool, insert the jack with the cable in it completely and squeeze firmly.

Steps to terminate a Cross over Cable

The only time you cross connections in 10BaseT or 100BaseT is when you connect two Ethernet devices directly together without a hub or switch. This can be two computers connected without a hub, or two hubs via standard Ethernet ports in the hubs. Then you need a "cross-over" patch cable, which crosses the transmit and receive pairs, the orange and green pairs in normal wiring. In a cross-over cable, one end is normal, and the other end has the
cross-over configuration. Remember you can only network two computers together with CAT5 cable. To add extra PC's to your network you will require a hub.

**REMEMBER**

To hold the RJ45 connector with the 'clip' on the bottom. To have to the 'opening' (where you insert the cable) facing you.

<table>
<thead>
<tr>
<th>End 'A'</th>
<th>End 'B'</th>
</tr>
</thead>
</table>

T568B/T568A “cross-over” Cable

a) You will need a length of network cable (UTP-CAT5e), preferably a factory assembled straight through cable that comfortably reaches each computer.

b) Cut off the RJ45 connector from one end of the cable and prepare the end for the new RJ45 connector.

c) Remove 3cm of sheathing from the cable.
d) Arrange the cables in order of the wire map which is W/G, G, W/O, B, W/B, O, W/Br, Br:

<table>
<thead>
<tr>
<th>End A</th>
<th>End B</th>
</tr>
</thead>
<tbody>
<tr>
<td>White/Orange (W/O)</td>
<td>White/Green (W/G)</td>
</tr>
<tr>
<td>Orange (O)</td>
<td>Green (G)</td>
</tr>
<tr>
<td>White/Green (W/G)</td>
<td>White/Orange (W/O)</td>
</tr>
<tr>
<td>Blue (B)</td>
<td>Blue (B)</td>
</tr>
<tr>
<td>White/Blue (W/B)</td>
<td>White/Blue (W/B)</td>
</tr>
<tr>
<td>Green (G)</td>
<td>Orange (O)</td>
</tr>
<tr>
<td>White/Brown (W/Br)</td>
<td>White/Brown (W/Br)</td>
</tr>
<tr>
<td>Brown (Br)</td>
<td>Brown (Br)</td>
</tr>
</tbody>
</table>

e) Using a small screwdriver insert the blade between each pair of cable at the sheathing and move toward the end. This will untwist the pairs and straighten the individual wires out at the same time.

f) Using the male RJ45 as a guide cut the ends if the cable off straight with the sheathing being 1cm (¼ inch) inside the jack.

g) You have to know where pin # 1 is, with the clip of the jack down and looking into the back of the jack, pin # 1 is on your left. The W/G end will go to pin number 1.

h) Insert the cable into the jack until you can see the copper of all eight conductors at the end of the clip.

i) Check to see if the sheathing is inside the jack far enough so when it is terminated the clamp that comes down to secure the sheath will hit it.

j) Using the crimping tool, insert the jack with the cable in it completely and squeeze firmly.
Testing & Certification

Testing of the installed cabling is critical in the UTP cabling system. Testing verifies the cable has been installed and terminated correctly and that the manufacture of the products was up to ANSI standards. Just because the cable has continuity does not mean that a data packets, which is transmitted over the cable, is readable. There are 2 tests to consider with CAT5 cable.

**CAT5e Link Certification**
This is a test from the patch panel to the information outlet. This is the certification that most people are aware of and the type of test recommended.

**CAT5e Channel Certification**
This test includes the patch cords to the information outlet and the patch panel and the horizontal run. This test is used for troubleshooting.

Both certifications are going to test the following 4 areas.

1) Continuity of wire map – If a cable fails this test, the problem is at the terminations and a wire is either loose, crossed, or one end is a 568A and the other is a 568B. Other options are a bad RJ-45, a bad cable, or a cable that has been damaged during installation.

2) Length – It shall be installed per ANSI 568-A recommendations. If the cable fails this test there are a number of options. One option is to reduce the cable to bring it into standards (if possible).

3) Attenuation – If a cable fails this test it is recommended that the cable be replaced. The cable was damaged during installation and a new cable shall be installed. A unlike problem is that the cable was damaged during the manufacturing process. In either case the cable need to be replaced.

4) Near-end cross talk (NEXT) – If a cable fails this test, check to see if the terminations are untwisted more than 13mm and the length of the exposed conductors is longer than 2.54cm (1 inch). If both ends are within their measurements, then either the RJ-45 is bad or the cable has been damaged and untwisted during installation.
EMI may or may not show up during the testing process. If the cable has been installed too close to a source of EMI and the EMI source is active, the tester will not allow the test to be run. If the source of EMI is not active during the testing of the cable but is active during the operations of the LAN, there will be an intermittent problem to troubleshoot.
GLOSSARY
Asynchronous Transfer Mode (ATM)
A form of very fast packet switching in which data is carried in fixed length units called "cells". Each cell is 53 bytes in length, with 5 bytes used as a header in each cell. ATM employs mechanisms that can be used to set up virtual circuits between users, in which a pair of users appear to have a dedicated circuit between them.

Attenuation Crosstalk Ratio (ACR)
The difference between attenuation and crosstalk, measured in dB, at a given frequency. A quality factor for cabling to assure that signal sent down a twisted pair is stronger at the receiving end of the cable than any interference imposed on the same pair by crosstalk from other pairs.

AWG
American Wire Gage - A wire diameter specification. The smaller the AWG number, the larger the wire diameter.

Backbone
A cable connection between telecommunication or wiring closets, floor distribution terminals, entrance facilities, and equipment rooms either within or between buildings. In star networks, the backbone cable interconnects hubs and similar devices, as opposed to cables running between hub and station. In a bus network, the bus cable.

Bandwidth
The range of frequencies required for proper transmission of a signal. Expressed in Hertz (cycles per second). The higher the bandwidth, the more information that can be carried. A continuous range starting from zero is said to be "baseband", while a range starting substantially above zero is "broadband".

Baud
The number of changes in signal per second. A given baud rate does not necessarily transmit an equal number of bits/sec. For example, a signal with four voltage levels may be used to transfer two bits of information for every baud.
Bend Loss
A form of increased attenuation in an optical fiber caused by an excessively small bend radius. The attenuation may be permanent if microfractures caused by the bend continue to affect transmission of the light signal.

Bend Radius
Radius of curvature that a fiber optic or metallic cable can bend before the risk of breakage or increased attenuation occurs.

Broadband
A transmission facility having a bandwidth sufficient to carry multiple voice, video or data channels simultaneously. Each channel occupies (is modulated to) a different frequency bandwidth on the transmission medium and is demodulated to its original frequency at the receiving end. Channels are separated by "guardbands" (empty spaces) to ensure that each channel will not interfere with its neighboring channels. This technique is used to provide many CATV channels on one coaxial cable.

CSMA/CD - Carrier Sense Multiple Access with Collision Detect
A network access method used by Ethernet in which a station listens for traffic before transmitting. If two stations transmit simultaneously, a collision is detected and both stations wait a brief time before attempting to transmit again.

Category 1, CAT1
Unshielded twisted pair used for transmission of audio frequencies. Used as speaker wire, door bell wire, etc. Not suitable for networking applications.

Category 2, CAT2
Unshielded twisted pair used for transmission at frequencies up to 1.5 Mhz. Used in analog telephone applications. Not suitable for networking applications.

Category 3, CAT3
Unshielded twisted pair with 100 ohm impedance and electrical characteristics supporting transmission at frequencies up to 16 MHz. Defined by the TIA/EIA 568-A specification.
Category 4, CAT4
Unshielded twisted pair with 100 ohm impedance and electrical characteristics supporting transmission at frequencies up to 20 MHz. Defined by the TIA/EIA 568-A specification.

Category 5, CAT5
Unshielded twisted pair with 100 ohm impedance and electrical characteristics supporting transmission at frequencies up to 100 MHz. Defined by the TIA/EIA 568-A specification.

Category 5e, CAT5e, Enhanced CAT5, CAT5+
Category 5e is a new standard that will specify transmission performance that exceeds CAT5. CAT5e has improved specifications for NEXT, PSELFEXT, and Attenuation. Like CAT5, it consists of unshielded twisted pair with 100 ohm impedance and electrical characteristics supporting transmission at frequencies up to 100 MHz. To be defined in the TIA 568-A-5 update.

Category 6, CAT6
Category 6 is a proposed standard that aims to support transmission at frequencies up to 250 MHz over 100 ohm twisted pair.

Category 7, CAT7
Category 7 is a proposed standard that aims to support transmission at frequencies up to 600 MHz over 100 ohm twisted pair.

CATV
Community antenna television, or "Cable TV". CATV is a broadband transmission facility which generally uses a 75 Ohm coaxial cable to carry numerous frequency-divided TV channels simultaneously.

Crosstalk
The coupling of unwanted signals from one pair within a cable to another pair. Crosstalk can be measured at the same (near) end or far end with respect to the signal source.
Customer Premises
Buildings, offices, and other structures under the control of a telecommunications customer.

EIA
Electronic Industry Association (formerly RMA or RETMA). An association of manufacturers and users that establishes standards and publishes test methodologies.

Ethernet
A local area network (LAN) protocol defined in the IEEE 802.3 standard in which computers access the network through a Carrier Sense Multiple Access / Collision Detect (CSMA/CD) protocol.

Far End Cross Talk (FEXT)
Crosstalk that is measured on the quiet line at the opposite end as the source of energy on the active line. FEXT is not typically measured in cabling, with Near End Cross Talk (NEXT) being the preferred crosstalk measurement.

Fast Ethernet
Ethernet standard supporting 100 Mbps operation.

FDDI
Fiber Distributed Data Interface. An ANSI Standard (ANSI X3T12) for a 100 Mbps token passing network based on fiber-optic (FDDI) and twisted-pair (CDDI) cabling.

Fiber Optics
The technology in which communication signals in the form of modulated light beams are transmitted over a glass fiber transmission medium. Fiber optic technology offers high bandwidth, small space needs and protection from electromagnetic interference, eavesdropping and radioactivity.

Horizontal Cabling, Horizontal Wiring
The portion of the cabling system that extends from the work area outlet to the horizontal cross connect in the telecommunications or wiring closet.
IDC
Insulation Displacement Contact/Connector

IEEE
Institute of Electrical and Electronics Engineers. A professional organization and standards body. The IEEE Project 802 is the group within IEEE responsible for LAN technology standards.

Interference
Undesirable signals which interfere with the normal operation of electronic equipment or electronic transmission.

ITU
International Telecommunications Union. An international organization that develops communications standards.

Near-End Crosstalk
Crosstalk between two twisted pairs measured at the same end of the cable as the disturbing signal source. NEXT is the measurement of interest for crosstalk specifications.

Network
An interconnection of computer systems, terminals or data communications facilities.

Node
End point of a network connection. Nodes include any device connected to a network such as file servers, printers, or workstations.

Optical Time Domain Reflectometry.
A method for evaluating optical fiber based on detecting and measuring backscattered (reflected) light. Used to measure fiber length and attenuation, evaluate splice and connector joints, locate faults, and certify cabling systems.

Patch Panel
A passive device, typically flat plate holding feed through connectors, to allow circuit arrangements and rearrangements by simply plugging and unplugging patch cables.
PSELFEXT
Power Sum Equal Level Far End Crosstalk

PSNEXT
Power Sum Near End Crosstalk

Repeater
A device that receives, amplifies (and sometimes reshapes), and retransmits a signal. It is used to boost signal levels and extend the distance a signal can be transmitted. It can physically extend the distance of a LAN or connect two LAN segments.

Riser
The conduit or path between floors of a building into which telephone, networking, and other utility cables are placed to bring service from one floor to another.

Riser Cable
A type of cable used in vertical building shafts, such as telecommunications and utility shafts. Riser cable typically has more mechanical strength than general use cable and has an intermediate fire protection rating.

RJ-45
A USOC code identifying an 8-pin modular plug or jack used with unshielded twisted pair cable. Officially, an RJ-45 connector is a telephone connector designed for voice grade circuits only. RJ-45 type connectors with better signal handling characteristics are called 8-pin connectors in most standards documents, though most people continue to use the RJ-45 name for all 8-pin connectors.

Screened Twisted Pair (ScTP) cable
Four pair UTP, with a single foil or braided screen surrounding all four pairs in order to minimize EMI radiation or susceptibility. Screened twisted pair is sometimes called Foil Twisted Pair (FTP). ScTP can be thought of as a shielded version of the Category 3, 4, & 5 UTP cables.
Screened/Shielded Twisted Pair (SSTP)

Four pair cabling, with each pair having its own individual Shield, in addition to an overall shield surrounding all four pairs. SSTP offers similar performance to Type 1 STP except with 4 pairs (rather than 2) and in a 100 ohm impedance (rather than 150).

Segment

On Ethernet a media segment may be made up of one or more cable sections joined together to produce a continuous cable for carrying Ethernet signals.

Shielded Twisted Pair (STP)

A type of twisted pair cable in which the pairs are enclosed in an outer braided shield, although individual pairs may also be shielded. STP most often refers to the 150 ohm IBM Type 1, 2, 6, 8, & 9 cables used with Token Ring networks.

Signal to noise ratio

The ratio of received signal level to received noise level, expressed in dB. Abbreviated S/N. A higher S/N ratio indicates better channel performance.

Single Mode Fiber

An optical fiber that will allow only one mode to propagate. The fiber has a very small core diameter of approximately 8 µm. It permits signal transmission at extremely high bandwidth and allows very long transmission distances.

TIA

Telecommunications Industry Association. Body which authored the TIA/EIA 568-A "Commercial Building Telecommunications Wiring Standard" in conjunction with EIA.

Time Division Multiplexing (TDM)

A technique for combining many signals on a single circuit by interleaving bits or bytes of data from successive channels.
Time Domain Reflectometry
A technique for measuring cable lengths by timing the period between a test pulse and the reflection of the pulse from an impedance discontinuity on the cable. The returned waveform reveals many undesired cable conditions, including shorts, opens, and transmission anomalies due to excessive bends or crushing. The length to any anomaly, including the unterminated cable end, may be computed from the relative time of the wave return and nominal velocity of propagation of the pulse through the cable. See also Optical Time Domain Reflectometry.

Transmission Media
Anything such as wire, coaxial cable, fiber optics, air or vacuum, that is used to carry a signal.

Twisted Pair
A multiple conductor cable whose component wires are paired together, twisted, and enclosed in a single jacket. Each pair consists of two insulated copper wires twisted together. When driven as a balanced line, the twisting reduces the susceptibility to external interference and the radiation of signal energy. Most twisted-pair cabling contains either 2, 4, or 25 pairs of wires.

Unshielded Twisted Pair (UTP)
Twisted pair cabling that includes no shielding. UTP most often refers to the 100 ohm Category 3, 4, & 5 cables specified in the TIA/EIA 568-A standard.

WAN
Wide Area Network. A network connecting computers within very large areas, such as states, countries, and the world.

1Base5
IEEE 802.3 shorthand term for StarLAN at 1Mbps data transfer rate.

10Base2
IEEE 802.3 shorthand term for 10 Mbps Ethernet based on Manchester signal encoding over thin coaxial cable. Also called "Thinnet" or "Cheapernet".
**10Base5**
IEEE 802.3 shorthand term for 10 Mbps Ethernet based on Manchester signal encoding over thick coaxial cable. Also called "Thicknet".

**10Base-F**
IEEE 802.3 shorthand term for 10 Mbps Ethernet based on Manchester signal encoding over fiber optic cable.

**10Base-T**
IEEE 802.3 shorthand term for 10 Mbps Ethernet based on Manchester signal encoding over category 3 or better twisted pair cable.

**10Broad36**
IEEE 802.3 shorthand term for 10 Mbps Ethernet on broadband cable.

**100Base-FX**
IEEE 802.3 shorthand term for 100 Mbps Fast Ethernet based on 4B/5B signal encoding over fiber optic cable.

**100Base-T**
IEEE 802.3 shorthand term for entire 100 Mbps Fast Ethernet system.

**100Base-T2**
IEEE 802.3 shorthand term for 100 Mbps Fast Ethernet based on PAM5x5 signal encoding and using two pairs of category 3 twisted pair cable.

**100Base-T4**
IEEE 802.3 shorthand term for 100 Mbps Fast Ethernet based on 8B6T signal encoding and using four pairs of category 3 twisted pair cable.

**100Base-TX**
IEEE 802.3 shorthand term for 100 Mbps Fast Ethernet based on 4B/5B signal encoding and using two pairs of category 5 twisted pair cable.

**100Base-X**
IEEE 802.3 shorthand term for any 100 Mbps Fast Ethernet system based on 4B/5B signal encoding. Includes 100Base-TX and 100Base-FX.
1000Base-CX
IEEE 802.3 shorthand term for 1000 Mbps Gigabit Ethernet based on 8B/10B signaling over copper cable.

1000Base-LX
IEEE 802.3 shorthand term for 1000 Mbps Gigabit Ethernet based on 8B/10B signaling using long wavelength laser transmitters over fiber optic cable.

1000Base-SX
IEEE 802.3 shorthand term for 1000 Mbps Gigabit Ethernet based on 8B/10B signaling using short wavelength laser transmitters over fiber optic cable.

1000Base-T
IEEE 802.3 shorthand term for 1000 Mbps Gigabit Ethernet over twisted pair cable.