MultimediaConnect

member of the TKH Group

CONTENTS

THE STANDARDS

The cabling system standards have been created to define a uniform, standard quality throughout the world, regardless of the products used. It is therefore essential to know the meaning and the correspondence of these standards with respect to the products used (cables and connectors) and the applications to be supported.

STANDARDS BODIES

There are three standards organisations: the North American EIA/TIA standard that works in categories (Cat5e, Cat6, Cat6A, etc.), ISO, the international standard and the European EN standard that defines Classes (D,E,Ea. etc.)

COPPER: CORRESPONDENCE BETWEEN CATEGORIES AND CLASSES

EIA/TIA defines components and the communication link according to Categories.

MAX. FREQUENCY	100Mhz	250Mhz	500Mhz	600Mhz	1000Mhz
Components / Link	Cat. 5e	Cat. 6	Cat. 6A		
EIA/TIA	568-C.2	568-C.2	568-C.2		

ISO and EN standards, for their part define the components according to category and the communication chain according to Class.

MAX. FREQUENCY	100Mhz	250Mhz	500Mhz	600Mhz	1000Mhz
Components	Cat. 5e	Cat. 6	Cat. 6A	Cat. 7	Cat. 7A
Link	Class D	Class E	Class Ea	Class F	Class Fa
ISO/IEC	11801 ED2.0	11801 ED2.0	AMD 1.0 / AMD 2.0 1181	11801 ED2.0	AMD 1.0 / AMD 2.0 1181
EN	50173-1	50173-1	50173-1	50173-1	50173-1

COPPER: THE DIFFERENT TYPES OF SHIELDING

The shielding of cables and connectors protects them against electromagnetic interference (e.g. from power circuits).

The shielding of a cable is defined by 3 letters, «U» for unshielded, «F» for aluminium foil shielding and «S» for aluminium braid. The position of this shielding, either around the outside of the whole cable or around each of the twisted pairs is specified by the following symbol:

*** Twisted Pair**

Thus, an F/UTP cable is one with an overall aluminium foil shielding only.

There are three versions of RJ45 connector:
unshielded (or UTP), 9-pin shielded with earth (or FTP) and 360-degree EMC shielded (or STP)

OPTICAL FIBRE: MULTI-MODE AND SINGLE-MODE

ISO 11801 Edition 2 classes optical fibre into 4 main families: OM1, OM2 and OM3 for multimode and OS1 for single-mode.

	TYPE OF ETHERNET NETWORK					
TYPE OF FIBRE	**100FX**	**1000SX**	**1000LX**	**10GS**	**10GL**	**10GLX4**
NETWORK BIT RATE	**100Mbits**	**Gigabit**		**10 Gigabit**		
MULTI-MODE OM1 62.5/125MM	**2km**	**275m**	**550m**	**33m**	**N/A**	**300m**
MULTI-MODE OM2 50/125MM	**2km**	**550m**	**550m**	**82m**	**N/A**	**300m**
MULTI-MODE OM3 50/125MM	**2km**	**550m**	**550m**	**300m**	**N/A**	**300m**
SINGLE-MODE OS1 9/125MM	**N/A**	**N/A**	**5km**	**N/A**	**10km**	**10km**

WHICH PRODUCTS FOR WHICH APPLICATIONS?

A different type of cable and optical fibre will be used according to the applications and peripherals to be used.

	COPPER CONNECTIVITY				FIBRE CONNECTIVITY			
APPLICATIONS	**Cat 5e**	**Cat. 6**	**Cat.6 10G**	**Cat. 6A**	**OM1**	**OM2**	**OM3**	**OS1**
10/100MBITS NETWORK	●	●	●	●	●	●	●	●
GIGABITS NETWORK	●	●	●	●	●	●	●	●
10GIGABITS NETWORK	○	○	●	●	⊙	⊙	●	●
40GIGABITS NETWORK		○	○	⊙	○	○	⊙	●
100GIGABITS NETWORK	○	○	○	⊙	○	○	○	●
ANALOGUE TELEPHONY	●	●	●	●				
IP PHONE : VOIP	●	●	●	●	●	●	●	●
VOIP + POE	⊙	●	●	●				
XDSL	●	●	●	●	●	●	●	●
CCTV (WITH BALUNS)	⊙	●	●	●				
POE SYSTEM (EX: CAMERA)	⊙	●	●	●				
POEP SYSTEM	○	⊙	●	●*				
TNT TELEVISION	○	○	○	●				
IP TELEVISION	⊙	●	●	●	●	●	●	●
IP ALARM SYSTEM	⊙	●	●	●				

● : perfectly adapted ⊙ : adapted ○ : little adapted * With 900MHz cable

DESIGN

Pre-cabling a building or a campus consists in providing a network of cables and associated connectors to enable the occupants to interconnect any type of data-processing or telecommunication equipment.

The cabling system must therefore be:

- Systematic: Sockets must be provided in each office or room.
- Reconfigurable: Rapid reconfiguration must be feasible, without structurally altering the cabling.
- Standardised: The connection conventions used must be identical at all points throughout the building.
- Universal: The transmission performance of its components (cables, connectors, etc.) must be at least equal to those Specified in the standard.

GENERAL STRUCTURE OF A PRECABLING SYSTEM

The buildings' cabling is organised in a hierarchical «star» topology.
It comprises a main equipment room and several secondary equipment rooms linked together by «backbones».

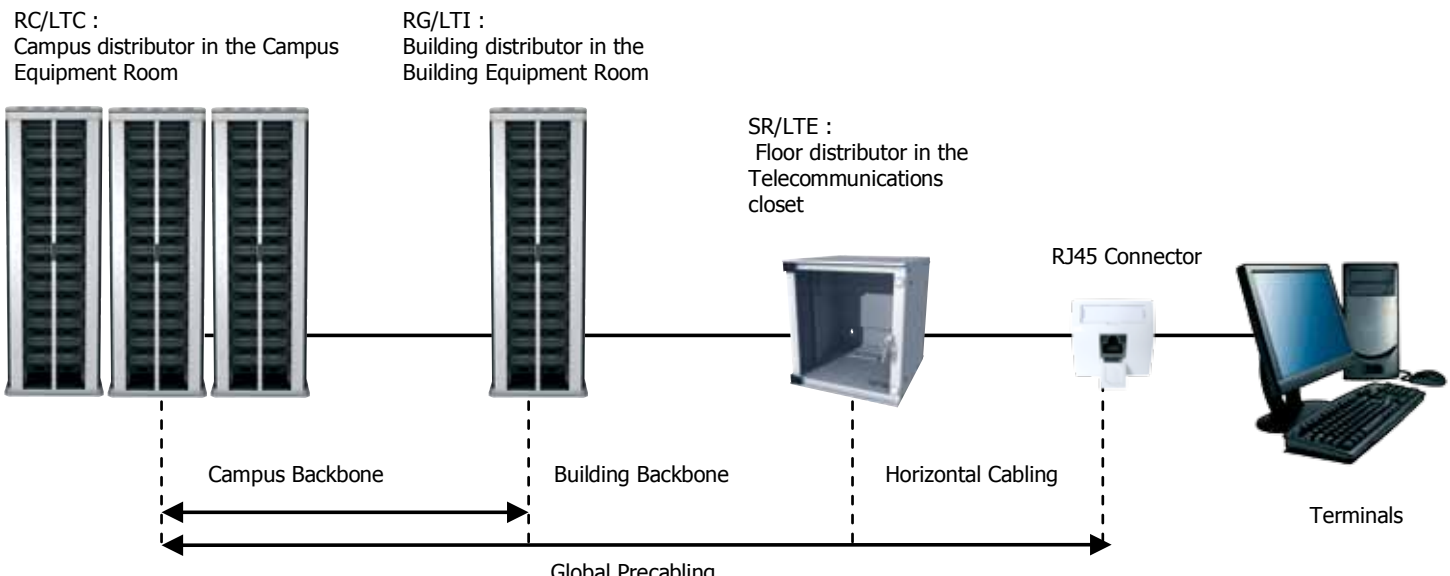
The architecture breaks down into two sets of cables:

«Vertical cabling» or «primary cabling» called Campus backbone and Building backbone, representing inter-building links.

«Horizontal cabling» covering the connections between the terminal outlets and the telecommunications closet. This is the standard distribution wiring over a floor of a building.

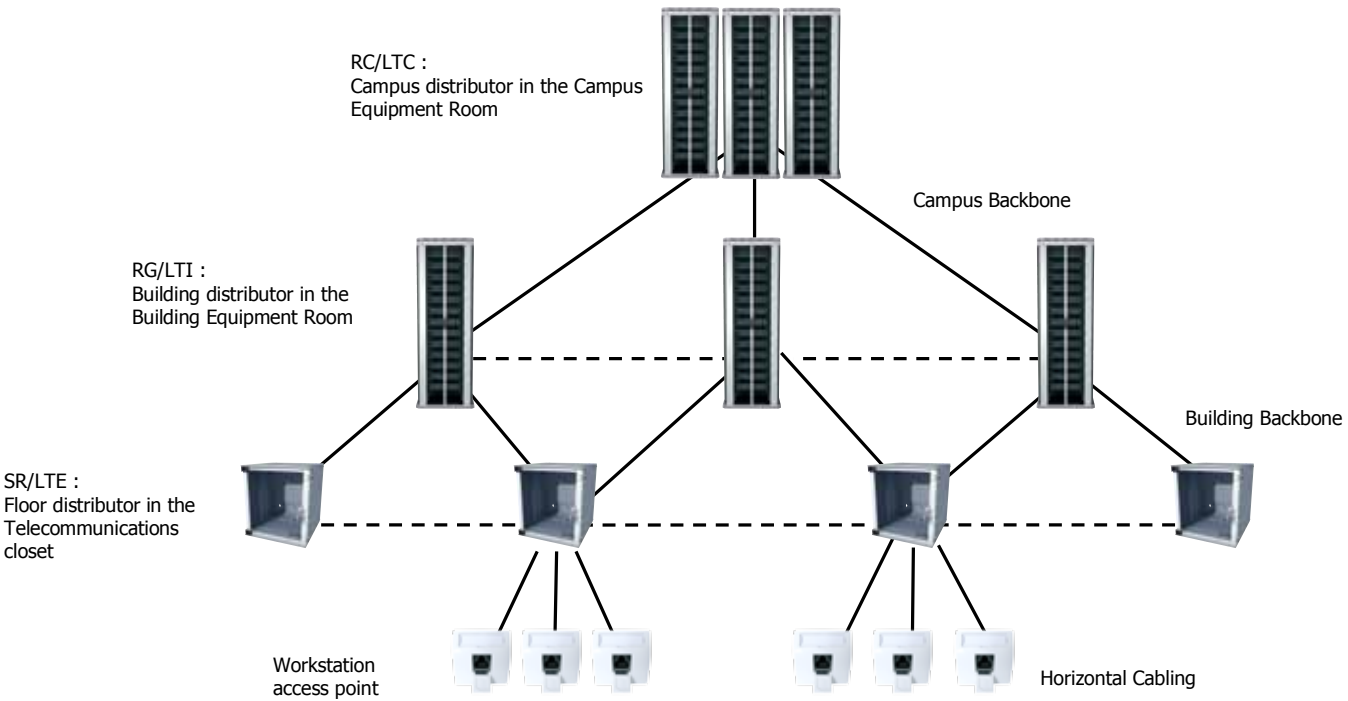
GENERAL ARRANGEMENT

■ **From the Campus distributor to the terminal outlet:**



The Campus and Building distributors are connected by a backbone, limited to a length of 100 m for twisted pair cables and several kilometres for optical fibre.
The links between the Building distributor and the Floor distributor can also be formed using optical fibre to meet data transmission security requirements.

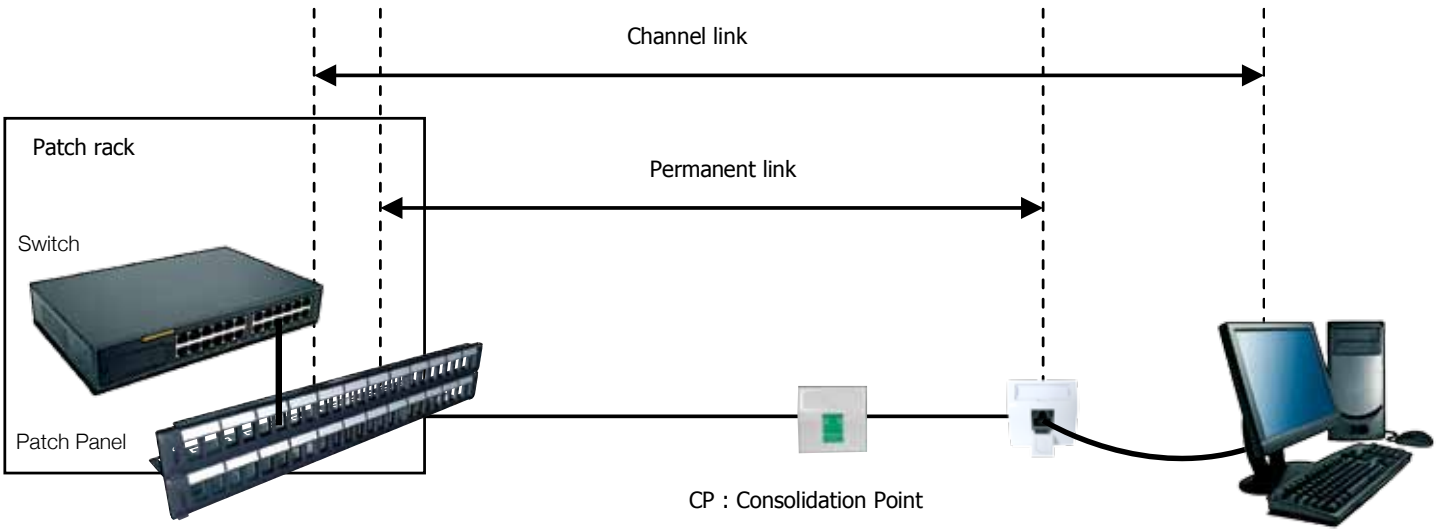
■ Distribution to several multi-storey buildings



The links between the Campus distributor and the Building distributor and Floor distributors may be made redundant to ensure continuity of service in the event of a loss of connection on one of the nodes.

■ Consolidation point

The consolidation point is an intermediate connection that provides flexibility in open office spaces without the need to modify the entire cabling infrastructure. It consists of a female RJ45 socket and one end and an RJ45 Male connector at the other.



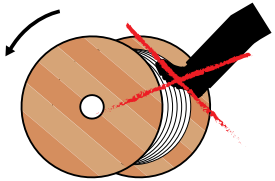
CHANNEL LINK = PERMANENT LINK + CORDS = 100 m maximum
PERMANENT LINK = 90 m maximum
CORDS = 10 m maximum (total for the two cords).

STORAGE OF NETWORK CABLES

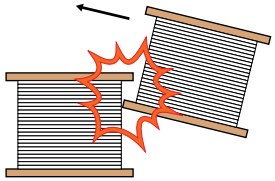
The network cables are generally stored on wooden, ply or plastic cable reels and reel-out boxes, in order to avoid mechanical stresses.

A few basic rules must be observed:

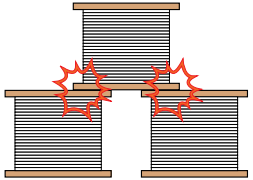
Store the cable in a warm, dry place away from frost



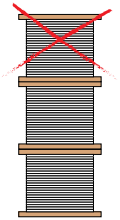
Do not push on the cable to roll the reel



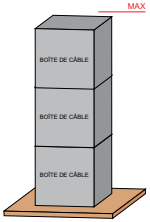
Avoid impact when rolling the reels



Set the reels down on the ground or a pallet



Reels must not be stacked more than two high

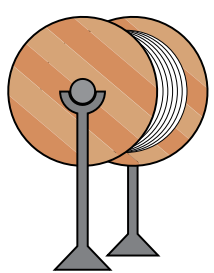


Similarly boxes must not be stacked more than three high

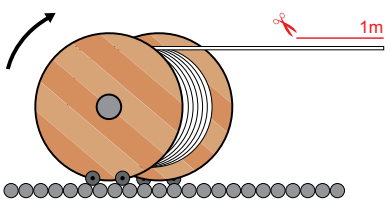
HANDLING OF NETWORK CABLES

■ Unwinding the cable

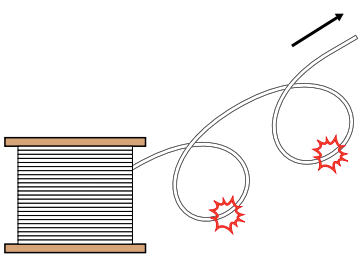
When laying the cable, the physical stresses on the cable must be minimized as much as possible. Reel stands are frequently used to mount the reel about a horizontal axis of rotation. Alternatively, a floor-mounted reel roller system can be used, consisting of two cylindrical bars mounted on roller bearings (rollers). The reel is rotated simply by gently pulling on the cable.



Reel stand system



Floor-mounted cable reel roller system

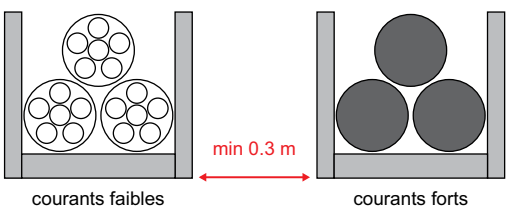


IT IS FORBIDDEN to unwind the cable from a reel that is laying flat, as this causes severe twisting of the cable

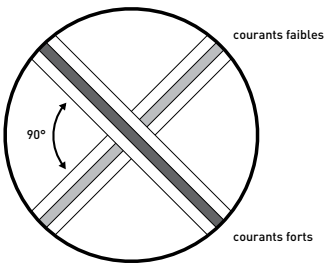
The cable must be unwound from the top, with a slight pulling force.
The end of the cable that has been gripped, and that has therefore suffered mechanical damage (tension, pinching), must be cut over a length of approximately 0.5 to 1 metre, once the desired length has been obtained.

■ Laying the cable

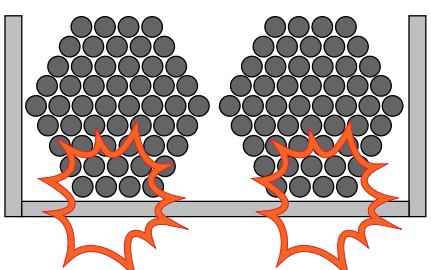
Certain rules are commonly applied and must be taken into account at the cabling system design phase, in particular with a good knowledge of the topology of the site and the different possible routes:



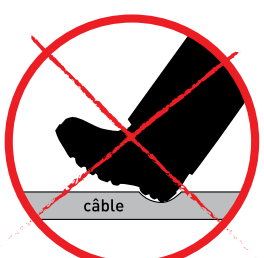
Power and low-voltage cables to be kept min. 30 cm apart



Cable crossovers should preferably be at 90°



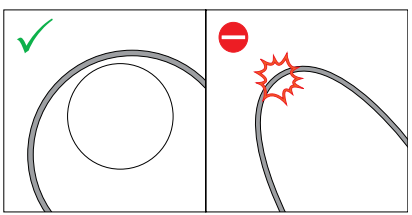
Not overload the cable tray



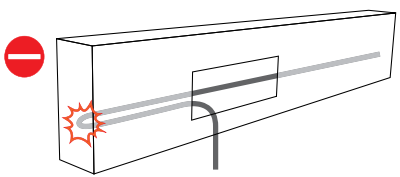
Similarly, do not walk on cables.

■ Installing network cables

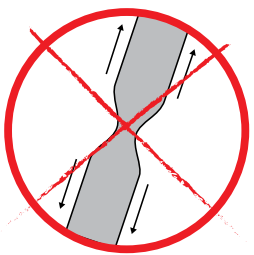
As a general rule, maximum care should be taken to avoid stresses on the cable that might impair its integrity.



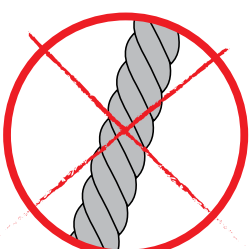
Comply with the specified bending radii



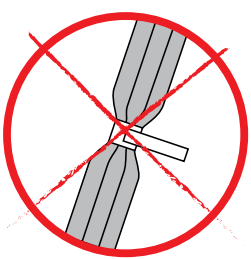
Avoid sharp angles such as loops in the wire ways



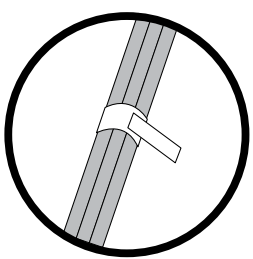
Handle cables with care during pulling



Do not twist the cable



Avoid plastic cable ties



Use flexible «Velcro» type self-gripping ties

HANDLING OF OPTICAL FIBRE CABLES

■ Horizontally laid internal cables

Internal optical fibre cables are not generally provided with a central strength member for pulling.
If they cannot be simply laid, strengthening elements must be used to pull the cable, such as:
- Aramid fibre (Yellow)
- Glass fibre.

The optical cable technical data sheets specify the tensile force that can be withstood by each cable (expressed in Newtons: 100 Newtons are approximately equivalent to 10 kg). The cable should not be pulled by its outer sheath, as this will cause it to stretch, transferring the mechanical stresses to the fibres themselves.

■ Vertically laid internal cables

The rules are identical to those explained above. When laying vertical cables, it is recommended to coil all loose-structure cables 2 turns at all floor levels to avoid the fibres dropping within the cable. This will also prevent vertical tensile forces in the cable due to the weight of the fibres.

■ External cables

External cables often have the disadvantage of being installed over very long distances.
All external cables are provided with a central strength member for pulling the cable during installation.

Because of their (flammable) PE sheath, it is strictly forbidden to install or lay external cables inside a building. For reasons of spread-of-fire, their penetration into a building is limited to max. 15 metres before fanning-out.

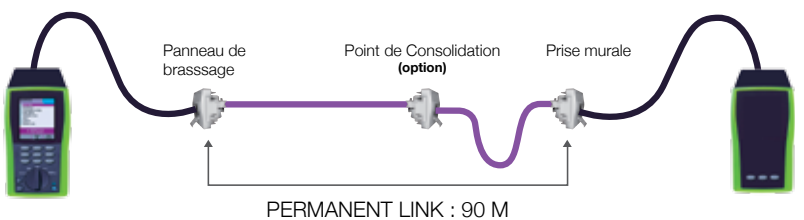
TEST PARAMETERS AND INTERPRETATION OF ERRORS

Once the cabling system has been laid, certification is systematically requested, confirming its level of performance. This confirms the quality of the work, from the choice or components to laying and forming the connections. A cable tester is thus needed to test and validate each link.

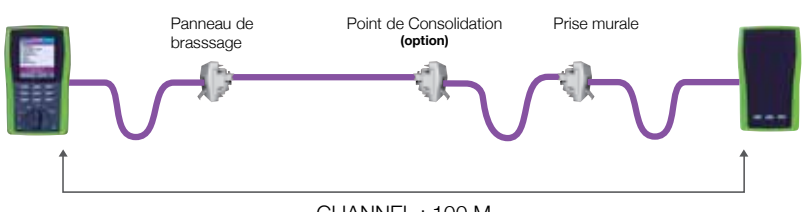
VISUAL INSPECTION

The initial inspection consists of a visual check of the installation. Attention must be paid to the basic rules of an installation, namely:
- Tightening of cables
- Folded cables at the end of wire ways and/or racks,
- Unsheathing and splitting of pairs at connections.

COPPER: TESTING OF PERMANENT LINK AND CHANNEL LINKS



This involves testing a link from the patch panel to the wall socket.



This involves testing a complete link, including the RJ45 cords.

COPPER: INTERPRETATION OF ERRORS

CONTINUITY TEST: Checking of pairs connected according to the colour code

	PROBABLE CAUSES OF FAILURE
OPEN CIRCUIT	Cut or broken cable, or wires broken by mechanical force in the connector
	Damaged RJ45 connector
	Wires incorrectly inserted in the self-stripping contact
	Cable for specific application (e.g. 2 Pairs)
SHORT-CIRCUIT	Conducting material between the pin and the wire (e.g.: the wire is touching the shielded cover)
	Damaged RJ45 connector
	Short-circuit in the cable (crushing)
	Specific application (e.g. PABX with shunting)
CROSSED PAIRS	Connection convention problem (Mixing of A and B)
	Crossed patch cord used
	Wires connected to the wrong contact
SPLIT PAIRS	Wires connected to the wrong contact

LENGTH: Tested over 90m in Permanent Link and 100m in Channel Link

	PROBABLE CAUSES OF FAILURE
ADDITIONAL-LENGTH	Cable is too long
	The NVP is incorrect
LENGTH TOO SHORT	Cable is cut
ONE OR MORE PAIRS TOO SHORT	Damaged cable
	Poor connection

MEASUREMENTS: Checking the different standard parameters

	DEFINITION	PROBABLE CAUSES OF FAILURE
DELAY-SKEW	Difference in delay. Max. difference between the propagation delay time of each of the pairs receiving a same signal transmitted over several pairs	Cable is too long
		Cable using different types of insulation according to the pairs
INSERTION LOSS	Weakening of the signal according to frequency and in proportion to the length of the link	Cable is too long
		The temperature exceeds 20°C
		Problem of resistance at the termination contacts
NEXT & PSNEXT	NEXT: Near-End Cross Talk between pairs (Application of a test signal to one of the pairs and reception of the induced signal at the same end on the other pair) PSNEXT: Power Sum Near-End Cross Talk (Application of a test signal to 3 pairs and reception of the induced signal on the 4th pair)	Problem of split pairs at the connector, poor connection
		Incorrect measuring head / Poor quality patch cords / Bad cable
		Compression linked to the clamping of the cables, the bending radius or failure to comply with cable geometry requirements
		External sources of interference
		Problem of compatibility between the plug and the connector
RETURN LOSS	Measurement of the reflected power of the signal echoes due to impedance mismatch along the link	Patch cord impedance problem (100Ω ?)
		Excessive handling of patch cords that has altered the impedance
		Cable handling problem, Failure to comply with cable geometry requirements
		Poor connection
		Excessive coiled length before the connector
		Non-uniform cable impedance - Mixture of 120Ω and 100Ω cables
		Problem of compatibility between the plug and the connector
		Defective test adaptor
		Insulation crushed in the socket

FIBRE: TESTING AND MEASUREMENT

All optical tests simply consist in measuring the overall optical loss or that at each component of the link. It does not involve measuring the bandwidth.

■ Field tester

All testers now have optional multi-mode or single-mode optical heads to validate an optical link. These testers measure Link Budget, allowing it to be validated against a desired reference standard. Some also check the operation of the main networks (Ethernet, ATM, etc.) over the link.

Where there are no problems on the link, they measure:
- metric dB losses
- the lengths of the links tested, validating the Link Budget.

■ Reflectometer (OTDR)

The reflectometer performs more detailed measurements of the optical link and, in particular, shows the distance and the losses of every event on the link (Connector, splice, etc.).
Each incident or each connector can be individually checked.
In the event of a problem on a link, this is the only means of identifying the fault encountered.

GLOSSARY

CATV: (Community Antenna TeleVision) transmission of TV signal by cable

CCTV: (Closed Circuit Television) analogue video-surveillance system.

Channel: Twisted pair link that includes the Permanent Link as well as the connecting cords at each end (e.g. from the computer switch to the user's PC)

Wiring convention type A et B: 2 methods of wiring RJ45 motors. In order to work, the same wiring convention must be used throughout the entire site. Version «B» is currently the most widely used.

Single-mode: Type of fibre that transmits signals by means of a single laser beam.

Multi-mode: Type of fibre that transmits signals by means of a multiple beam delivered by LEDs.

NVP: Nominal Velocity of Propagation of the signal in a twisted pair cable. Specified by the manufacturer.

Permanent Link: Twisted pair link with an RJ45 motor socket at each end. (e.g.: from the patch panel to the wall socket)

PoE: (Power over Ethernet) communication protocol for carrying electrical power in addition to data. (e.g.: The PoE IP cameras are powered and networked by a single cable)

PoEP: (Power over Ethernet Plus) improved PoE protocol able to transmit more power

Campus distributor: Wiring cabinet located in the campus equipment room for interconnecting several buildings

Building distributor: Located in the building equipment room, it interconnects all the floors of the building

Floor distributor: Located in the building equipment room, serves to distribute the wiring throughout the floor

VoIP: (Voice over Internet Protocol), communication protocol for carrying voice over the Ethernet

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