MULTIMEDIA CONNECT

GUIDE

DATA CENTER

TKH GROUP SOLUTION OF TKH GROUP

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INTRODUCTION

Data centers, (or to be more precise, data processing centers), represent the nerve center of the modern business, which depends completely on their digitized data for invoicing, customer accounts, stock management, etc. There are two main types of data centers: those that are specific to one company - generally a bank, a consulting firm, or all multinationals; and those that are specific to telecommunications companies (Internet access, hosting providers and operators).
In this case, the data centers constitute the primary source of the company's business and are generally designed to achieve an availability rate close to 100%. So, depending on the strategic importance of the data centre, different design and installation principles will need to be respected. However, common rules can be applied: the data centre must be efficient, reliable and secure. Data centers are also subject to economic and environmental considerations, aiming to offer the lowest possible level of energy consumption, with maximum performance.
Lastly, data centers are in operation 24 hrs a day, 7 days a week, so even the shortest outage can represent a significant risk for the company, with the possibility of a substantial drop in productivity.

STANDARDS

There are three different standards defining the rules concerning Data centers:

In the USA the TIA standards committee has produced a complete guide to data centers, from 2005 onwards. The TIA 942 standard constitutes the international reference in terms of design and installation. The TR42.1 standards committee is in the process of revising and improving this document. A new edition, TIA942-A, is expected to be published.

In 2006, the European standardization committee produced EN50173-5, specifically concerning data centers and less exhaustive than the TIA version. This document is not widely used.

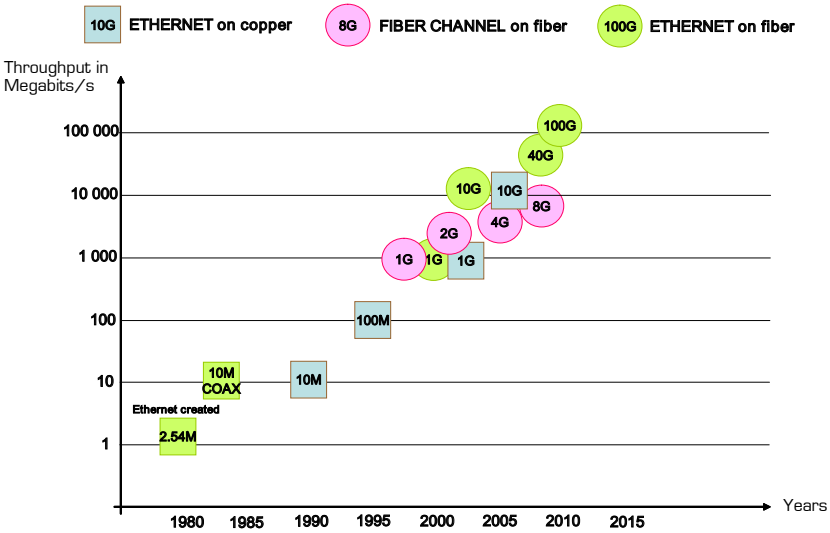
The ISO is still in the process of writing standard ISO/IEC 24764 specifically concerning data centers. Publication is scheduled for June 2010.

In conclusion, TIA 942 is the current reference document.

TECHNOLOGICAL CONTEXT AND PERFORMANCE

The choice between copper or optical infrastructure is made on the basis of two main criteria: the network applications used and the operating lifetime envisaged. The communication protocols used in data centers are increasingly converging with those used in LANs and are generally of the Ethernet type.
In the case of use of a SAN (Storage Area Network), the cabling must be appropriate to the protocol chosen. The interfaces may be 'proprietary' as with the Infiniband connector, for example.

History of LAN and SAN networks



LAN (Local Area Network)

Acronym defining the internal local network of a company. This allows interconnection between the various users of a site, within a limited geographical area (max. 2km). 99% of LAN protocols are ETHERNET configurations offering a higher or lower throughput and, most importantly, a high level of ease of implementation.

SAN (Storage Area Network)

This term is used to describe a dedicated network for data storage. SANs are generally used within a limited area around the Data Center (max. 100m). SAN Protocols, such as iSCSI, FIBER CHANNEL or FCoE, have a particular ability to offer a very high throughput for a large number of connections, combined with a very high service level.
The SAN differs from the LAN in not taking up user bandwidth when saving data.

Type of cabling in relation to protocols used

Type	Year of release	Protocol	Throughput	Minimum cabling
LAN	1983	10 BASE 5 / 2	10 Megabits/s	Coaxial cable
	1991	10 BASE T	10 Megabits/s	CAT3 twisted pairs
	1995	100 BASE TX	100 Megabits/s	CAT5 twisted pairs
	1998	1000 BASE S/L	1 Gigabit/s	Mono/Multi fiber optic
	1999	1000 BASE T	1 Gigabit/s	CAT5e twisted pairs
	2002	10G BASE S/L/E	10 Gigabits/s	Mono/Multi fiber optic
	2006	10G BASE T	10 Gigabits/s	CAT6 10G twisted pairs
	2008	40G BASE S/L/E	40 Gigabits/s	Multi/Mono optical fibre
	2009	100G BASE S/L/E	100 Gigabits/s	Multi/Mono optical fibre
SAN	1997	1G Fiber Channel	1 Gigabit/s	Fiber optic
	2001	2G Fiber Channel	2 Gigabits/s	fFber optic
	2004	10G BASE CX4	10 Gigabits/s	Infiniband copper cable
	2005	4G Fiber Channel	4 Gigabits/s	Fiber optic
	2008	8G Fiber Channel	8 Gigabits/s	Fiber optic
	2009	10G FC over Ethernet	10 Gigabits/s	Twisted pairs

Redundancy level - TIERs in accordance with TIA 942

The TIA standard defines 4 different data center levels or tiers, depending on their availability capacity. Since a 100% operational rate cannot be achieved, a default tier will be chosen in relation to the size of the data center.

The Tier 1 data center is the most basic. It is installed with consideration of the minimum characteristics of its component parts (basic air conditioning, raised floor with low load rate, shorter lifetime cabling).

Tier II and III data centers benefit from a physical (copper and optical cabling in parallel) and logical (spanning tree) redundancy system. The risk of malfunctions is minimized by using backup systems such as inverters or generators.

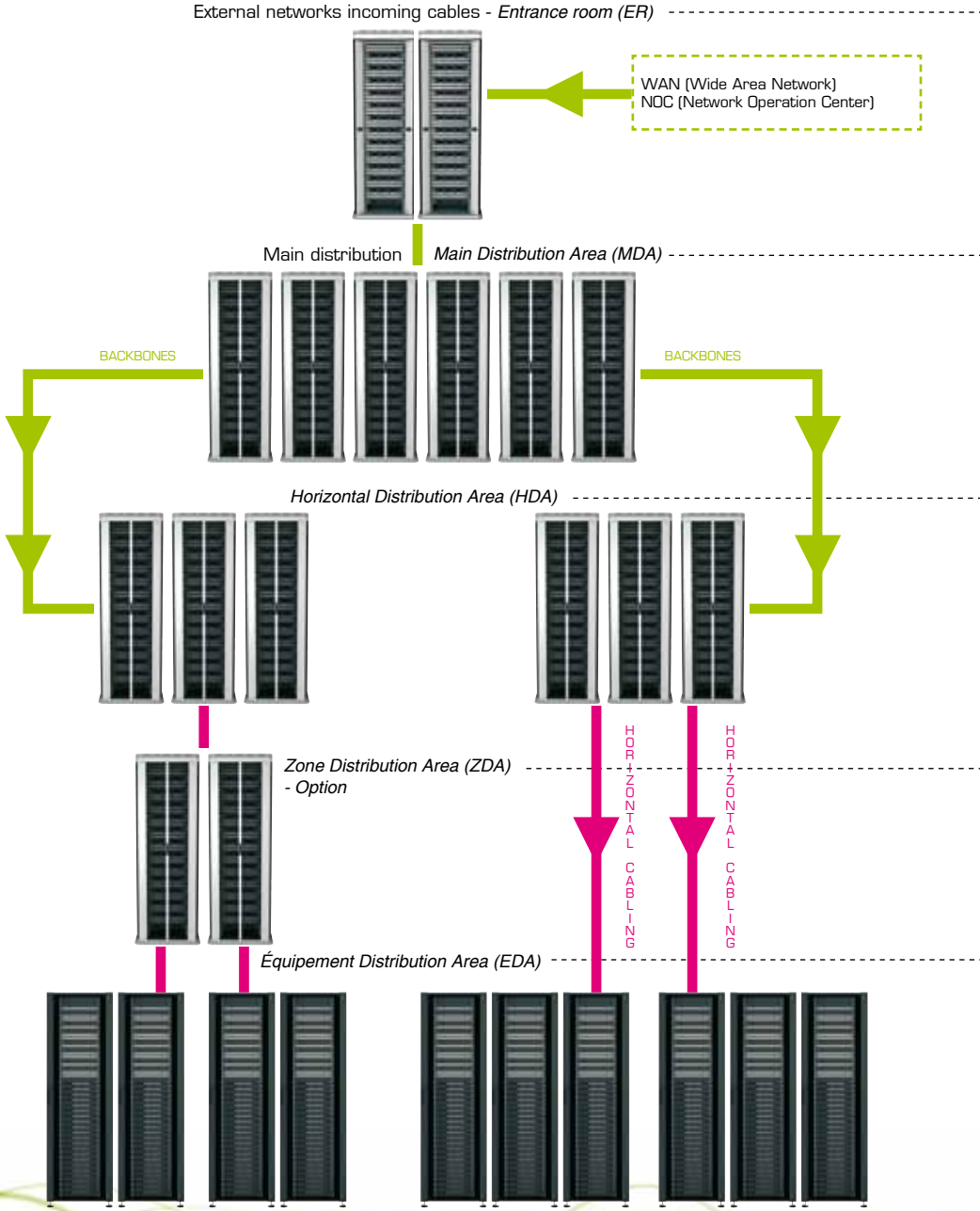
The Tier IV data center does not need to be shut down for maintenance. All of its component parts are duplicated to minimize the time needed for restarting, in the event of a malfunction. Security is provided by a highly efficient video surveillance and alarm system.

The choice of tier is given by the required availability rate:

Tier I – 99.671% availability – 29hrs downtime/yr
Tier II – 99.741% availability – 23hrs downtime/yr
Tier III – 99.982% availability – 1hr 45 mins downtime/yr
Tier IV– 99.995% availability – 0hrs 25 mins downtime/yr

GENERAL ARCHITECTURE

The general topology is defined by the diagram below (TIA 942)



External networks incoming cables – *Entrance Room (ER)*

The Entrance Room is the room reserved for the incoming cables from external networks that give remote access to the data center. This is where the long-distance copper or fiber optic cables are generally connected, running throughout the operating area of the data center. It is also here that the control centre is interconnected: NOC (Network Operation Center). The Entrance Room consists of telephone systems and modems.

Main distribution - *Main Distribution Area (MDA)*

This is the first section of the data center itself.
The network gateways are installed in this section in order to ensure interconnection to the external network incoming elements. This zone is composed of a very high density patch panel and very powerful switches. This is really the central core of the data center, particularly in the case where the building has multiple floors.

Horizontal Distribution Area (HDA)

This zone is reserved for distribution of cables.
The racks are generally mixed – i.e. composed of active and passive components. In small data centers this zone is included in the main distribution area.

Zone Distribution Area (ZDA) - Option

This optional zone can provide greater flexibility in the event of the data center topology being modified. As a genuine intermediate connection, the zone distribution allows better administration of the data center, particularly if it is used by several companies.

Equipement Distribution Area (EDA)

This is where data storage is implemented. It is the most sensitive section of the data center because it groups together the highest density of active equipment (server, KVM).

Depending on the size of the data center, this diagram can be adapted. It is nevertheless essential to maintain a physical separation between the main distribution and the horizontal distribution areas in order to ensure a high level of security.

PLANNING A DATA CENTER

6 successive phases are defined by TIA 942 for construction of the data center

1. Definition of general requirements

The first stage of the project consists of quantifying the following:
- Surface area, space available
- Electrical power supply
- Access to telecommunication networks

In this initial phase, a reserve capacity of 25% is necessary to ensure a long lifetime for the site.

2. Calling on the services of a specialist consultant

With the consultant, the following are defined:
- The dedicated area of the data center
- The electrical power required, the capacity of the UPSs
- The required security level
- The load capacity of the raised floors
- The ground connection and electrical safety

3. A general site plan should be produced showing the main incoming systems: telecommunications, electrical and heating/air conditioning.

4. A general layout plan is created, showing the location of the items of equipment, in accordance with the principle of the general architecture of the data center (See page 6)

5. A definitive plan is prepared, bringing together all the following information

- Area plan
- Telecommunications networks
- Electrical systems
- Heating, Air conditioning
- Location of items of equipment
- Cable routing

6. The technical characteristics of the items of equipment are defined:

- Performance of active components
- Performance of structured cabling
- Type of rack, mechanical characteristics
- Performance of air conditioning
- Setting up of supervision and security systems

IMPLEMENTATION OF A DATA CENTER

1. Choice of distribution topology

There are several available methods for arranging the racks within the rows, each with its own advantages and drawbacks:

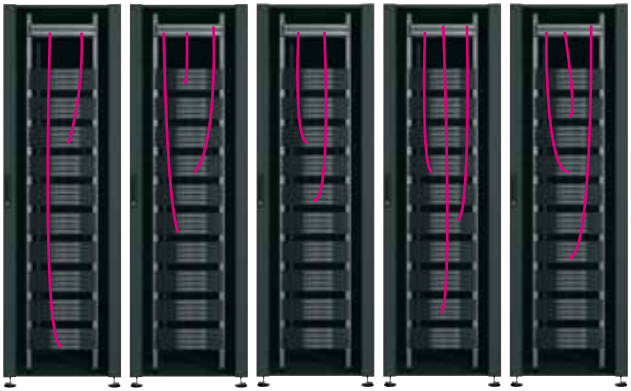
EOR (End Of Row) – The cabling rack is positioned at the end of the row

- \+ High/low cables incoming
- − Heterogeneous power cords
- − 4/5 server racks for 1 cabling rack, maximum

MOR (Middle Of Row) – The cabling rack is positioned in the middle of the row

- \+ High/low cables incoming
- \+ Homogeneous cables
- \+ 8 server racks for 1 high-density cabling rack

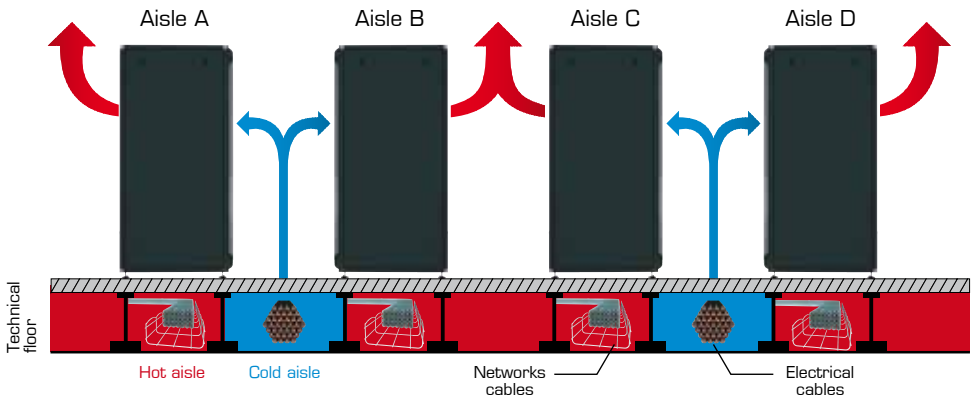
TOS (Top Of Server) – The cabling comes in via the top of the rack



- \+ Density of servers per square meter
- \+ Homogeneous cables
- − Cables incoming at top only
- − Cross connection not very accessible

2. Organization of aisles and cabling

The cable routing, when not in raised floors, must respect the hot aisles and cold aisles created by the flow of air from the active components. The (very numerous) data cables are generally placed in the hot aisles in order not to take up the cold aisles. The power cables can be installed in cold aisles.



It is necessary to prioritize use of Nx4 pairs cable assemblies, in order to facilitate organization of the cabling and racks. In data centers, it is essential to respect the rack front/rear ventilation flows. For this reason, it is preferable that the multi-assembly cables come in at the sides of the rack.

3. Rack characteristics

CABLING RACKS

Major characteristics:
- Ability to access cables via false ceiling or raised floor
- Obtaining the highest density of ports per m^2
- Cabling management equipment to reduce time needed for maintenance and other operations
- Ability to mark connections at front and rear

Cabling rack with 10 inch V-shaped arrangement

- Central and side grommets for better organization of power cables.
- Capacity for 1008 RJ45 or 2016 LC connectors on 42U

Rear cable management system

This cable path system provides a high level of ease of management of the cables at the rear of the rack.

SERVER RACKS

- Able to bear high loads in the order of 1,500 kg
- Natural ventilation provided
- Adaptation to the various depths of the servers

19 inch rear risers divided into three sections

The risers are divided into three independent sections by means of an innovative anchoring principle, for supporting servers of different depths. The numbering on the risers facilitates assembly of the equipment.

Roof with brush grommets and retractable door

The roof is composed of two brush grommets and two sliding doors facilitating access.

4. System characteristics

Choice of type of cabling system - shielded or unshielded?

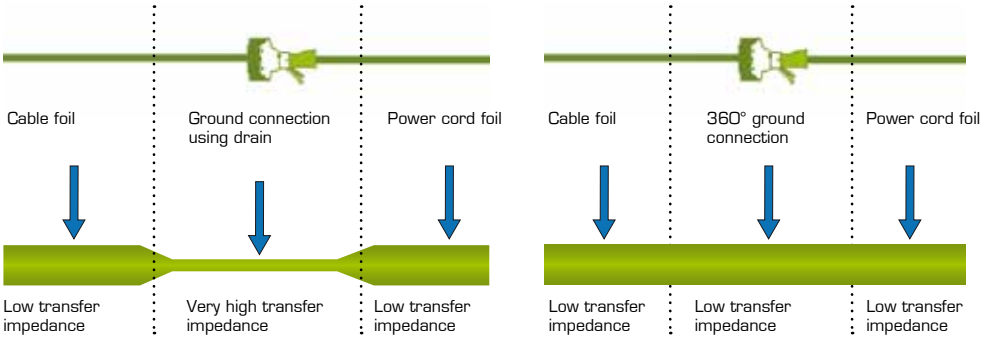
A Data Center groups together a very high number of connections. Alien Crosstalk created by the proximity of the strands to each other is a major source of interference for the system which must operate with the best possible signal-to-noise ratio.

Since alien crosstalk is unpredictable, it is necessary to ensure that the items of equipment installed benefit from an appropriate method of protection.

Shielded systems with a strong electromagnetic immunity are therefore recommended in order to ensure a high level of electromagnetic compatibility for the cabling system. In order to achieve this, it is necessary to prioritize systems for which attenuation exceeds 65 dB.

Connectors with 360° grounding are also necessary for optimum shield efficiency. The electrical parameter that defines the quality of the shielding is transfer impedance (Ohms).

TRANSFER IMPEDANCE IN RELATION TO TYPE OF CONNECTOR



ALIEN CROSSTALK is a characteristic of electromagnetic couplings between pairs from the direct cabling environment. The main source of interference is the proximity of the communication cables to each other. **ALIEN CROSSTALK is unpredictable** (types and organization of cables, characteristics of signals carried, ambient noise). **ALIEN CROSSTALK is a mandatory measurement for validation of** 10 gigabits and CAT6A.

ATTENUATION is the parameter compiling the symmetry compensation and shielding efficiency. It defines the immunity level of the system. The larger its value the more effective its action against capacitive and inductive couplings will be.

Choice of category of cabling system

Since operating lifetime is a major condition for the implementation of the data center, use of the most advanced technologies must be considered during the design phase. It should be noted that all active equipment is currently fitted with RJ45 connectors. Category 6A must be recommended (Category 7/7A, a non-RJ45 solution, is not easy to implement).

APPLICATIONS	Cat. 6	Cat.6 10G	Cat. 6A
10/100 Mbits/s IT networks	●	●	●
1000 Mbits/s IT networks	●	●	●
10 Gigabits/s IT networks	O	●	●
40 Gigabits/s IT networks	O	O	⊙ *
100 Gigabits/s IT networks	O	O	⊙ *

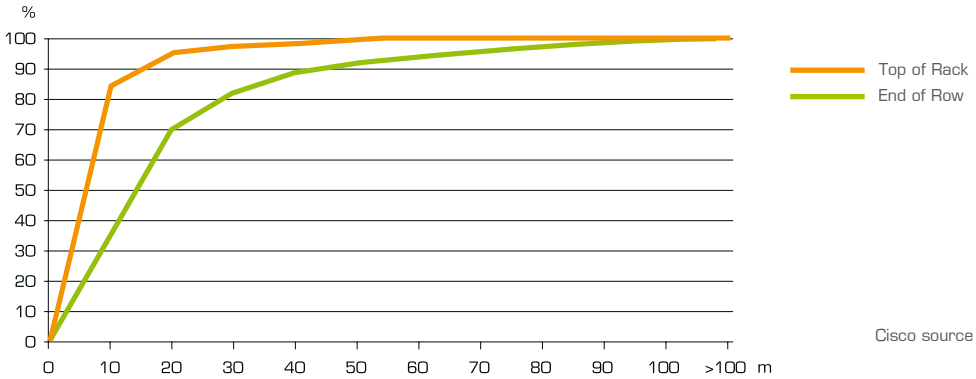
● : fully appropriate ⊙ : appropriate O : not very appropriate

*40G and 100G are under discussion within the HSSG (Higher Speed Study Group) of the IEEE.

Lengths

In general, the maximum length of the cables in a data center does not exceed 45 meters. The length is also defined by the choice of cabling topology envisaged.

CUMULATIVE TOTAL LENGTHS FROM SERVER TO SWITCH



Cisco source

Patch panels

The patch panels must benefit from a 2-level labelling system: colour and alphanumeric identifier.
V-shaped panel versions can be used to increase the density of cabling whilst facilitating organization of the cross-connection cables.

5. Optical system characteristics

Due to the issues of the cost of active components and of the operational lengths, multimode fibers are to be prioritized for data center installations. The choice of performances (OM1, OM2, OM3 or OM4) will be made in relation to the application and the required operating lifetime.

For example, an OM3 fiber optic is completely appropriate for a 10 Gigabits/s application. Where a 40G or 100G application is to be implemented, the OM4 fiber (newly standardized) with its bandwidth of 4700 MHz per km must be installed for lengths greater than 125 m.

Applications	Wavelength (nm)	OM1 62.5µm	OM2 62.5µm	OM2 50µm	OM3 50µm	OM4 50µm
100 BASE SX	850	300m	300 m	300m	300m	300m
1000 BASE SX	850	220m	275m	550m	550m	550m
1000 BASE LX	1300	550m	550m	550m	1000m	1000m
10G BASE SX	850	32m	32m	86m	300m	550 m
10G BASE LW	1300	220m	220m	220m	220m	220m
10G BASE LX4	1310	300m	300m	300m	300m	300m
40G BASE SR4	850	-	-	-	100m	125m
100G BASE SR4	850	-	-	-	100m	125m

Choice of connectors

Standard connectors
The ST is now abandoned in favour of the SC connector, particularly the duplex version. Their Zircon ferrule is 2.5 mm. With a large overall dimension, they are not used in data centers.

SFF (Small Form Factor) connectors
This new generation of connectors is based on a 1.25 mm ceramic ferrule. The most well-known and used of these is the LC connector. The LC is now the connector of choice in data center environments. Efficient and compact, it corresponds, in many cases, to the connector installed on the active equipment frame.

'Array' connectors
The most well-known and used are the MPO (Multifiber Pull Off) and MTP (Mechanical Transfer Pull off). These connectors can receive 12 to 24 fibers and are generally connected to ribbon cables. Since they are pre-connected in the factory, they have the advantage of being very easy to implement. They are associated with optical drawers that can be configured as LC or SC.

Choice of Cables

Free structure cables are prioritized to benefit from a large fiber optics capacity for low overall cable dimensions. In addition, their structure provides a better level of mechanical protection.

SPECIAL PRECAUTIONS FOR FIBER OPTIC CABLES

In order to prevent excessive loss, fiber optic cables must be installed with a curvature radius of 10 times the cable diameter. It will therefore be necessary to ensure that the site topology and the cable routing have been implemented carefully.

6. Characteristics of other equipment

Electrical power supply

The power slaves must be of 19 inch size (or vertical over the rack height) so they can be integrated perfectly into the server racks - Characteristics: 230 V – 16A/20A.

Ground connection

This must be implemented carefully. An overvoltage or other electrostatic discharge could interfere with or even damage the active components.

Technical Floor

The definition of the maximum load is very important, with some racks weighing up to 1,500 kg once loaded with servers. The TIA defines a minimum load capacity of 1,219 kg/m² corresponding to a pressure of 12 kilopascals.

Cable path

It is highly recommended to use cable paths of different colours for interconnection of the various zones of the data center. This technique is used for rapid identification of the flow (backbone/distribution) in the event of troubleshooting or maintenance. Fastening fittings must support 243 kg/m² or 2.4 kilopascals of pressure. A spare capacity of 40% should be included, for additional cables.

Identification and marking

Labelling must be detailed and well-organized. The American standard TIA 606 is the reference in this regard. It defines various classifications that facilitate marking.

Heat sink

Power per Rack	Ventilation capacity	Rack characteristics
< 3kW	206 m³/heure	Front doors with a minimum of 40% perforation Solid rear doors Solid side panels Authorized cover plates Aerated roof No electric fans
3 – 6kW	412 m³/heure	Front doors with a minimum of 40% perforation Solid rear doors Solid side panels Authorized cover plates Aerated roof Roof ventilators
6 – 15kW	706 m³/heure	Front doors with 80% perforations Ventilated rear door Ventilated side panels Roof and vertical ventilators (minimum of 4 extractors) (minimum 6 extractors) Liquid cooling system (optional)

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