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White Paper

DATA CENTER CABLING DESIGN FUNDAMENTALS

Telecommunications Cabling Infrastructure Requirements according the Availability Classes I-IV of EN 50600-2-4

Introduction

With the completion by end of Q1 2016, the new European standard series (EN 50600-x) covering the design of "Data Centre Facilities and Infrastructures" will be a new a comprehensive European reference for all parties involved in designing, building and operating data centers. Developed by CENELEC, an in dependent, non-profit European standards organization, it is commercially neutral and internationally applicable by referencing ISO/IEC standards.

As part of this standard series, the EN 50600-2-4 standard, officially released in January 2015, covers the "Telecommunication Cabling Infrastructure". It is mainly focusing on design requirements for the different DC availability classes with strong emphasis on migration and growth.

This white paper explains the EN 50600-2-4 in the context of the EN 50600-x standard series. Furthermore, the document highlights the requirements for fixed cabling infrastructures, cross-connect cabinets, equipment row cabinets, cable management and pathway systems according the data center availability classes.

Contents

The European Standard Series EN 50600-x

EN 50600-2-4: Telecommunications Cabling Infrastructure

The European Standard Series EN 50600-x

Introduction & Structure

This series of European standards specifies requirements and recommendations to support the various parties involved in the design, planning, procurement, integration, installation, operation and maintenance of facilities and infrastructures within data centers. These parties include:

- Owners, facility managers, ICT managers, project managers, main contractors
- Consultants, architects, building designers and builders, system and installation designers
- Suppliers of equipment
- Installers, maintainers

It has been developed to address European demands regarding DC Design:

- A European DC design standard was required with European applicable requirements
- Demand for a universally applicable DC design standard series which adopts a holistic approach covering all aspects of the design of DC facilities & infrastructures including management and operational information
- Support of European Commission's Code of Conduct on Data Centers Energy Efficiency
- Existing design schemes were driven by design resilience concepts rather than offering a business oriented assessment approach using a design vs. cost perspective
- The EN 50600-x series covers all design requirements for the entire set of facilities and infrastructures of a data center in separate standards. The following graphic shows the structure and the relationships between all EN 50600-x standards.

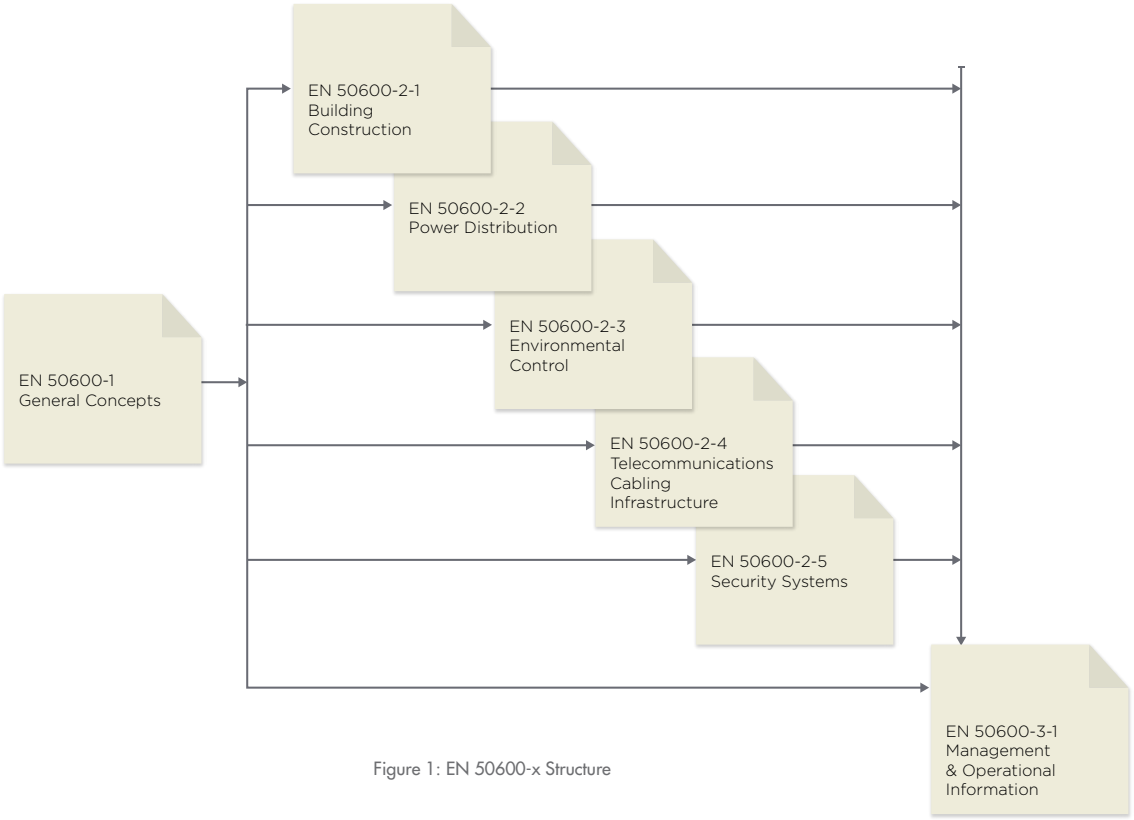

Figure 1: EN 50600-x Structure

Key Advantages

The EN 50600-x standard series has been developed by CENELEC (European Committee for Electrotechnical Standardization), an independent, non-profit European standardization organization.

EN 50600-x is a European standard series that:

Offers independent and comprehensive definitions & requirements for DC design and operation for all facilities & infrastructures

- Is commercially neutral without inherent assessment system
- Is internationally applicable for international DC owners/managers/operators by
  - Replacing the European normative references with international counter parts
  - Replacing European security standards by local counter parts

Furthermore, the EN 50600-x:

- Offers as sole DC design standard an energy efficiency enablement approach that provides a basis for all energy efficiency KPI concepts, available or currently in development
- Gives guidance about the selection process for the required overall data center design parameters
- Provides design principles for DC designers and DC owners
- Defines non-profit oriented certification criteria

In order to maintain and control the selected design as well as the energy efficiency criteria during operation, the supporting EN 50600-3-1 specifies processes for DC management and operations.

Additionally, the modularity of the EN 50600 standard series enables the future integration of additional standards about management and operation resp. data center KPIs.

Comparison with other Standards/Design Concepts

The following graphic has been developed in order to compare EN 50600-x with other standards in the data center environment including concepts from commercial assessors (for example the Uptime Institute, Data Center Alliance or TÜVIT):

	50600-x	TIA-942-A	ANSI/BICSI 002	Commercial Assessors
Scope	All DC facilities & Infrastructures	Cabling only	All DC facilities & Infrastructures	Mainly Power & Environmental Control
European Standard	☑	☒	☒	☒
Regional Application	Europe/Internationally applicable by using ISO/IEC standards as references	United States	United States	International
Energy Efficiency Enablement	☑	☒	☒	☒
Management & Operation	☑	☒	☒	?
Inclusion of global KPIs (ISO/IEC 30134-x))	☑	☒	☒	?
Commercially Neutral	☑	☑	☑	☒
Independent Assessment	☑	☑ (Cabling Only)	?	☒
Business Approach (design vs cost)	☑	☒	☒	☑

Figure 2: EN 50600-x vs. other design standards/design concepts

Key Benefits per Target Group

The availability of the EN 50600-x standard series is late in time compared to other standards or design concepts covering data centers. Nevertheless, EN 50600-x offers a lot of advantages to all parties involved in designing, building and operating data centers. The key advantages per interest group are:

The **DC Owner/Manager/Operator** can use EN 50600-x series to translate business demands via risk assessment in terms of infrastructure availability vs. cost in order to:

- Identify & select appropriate outline design requirements to provide the desired availability
- Apply concepts which are standards-based, business oriented and product/technology agnostic

For **DC Consultants**, EN 50600-x series is a normative reference for the assessment of an appropriate DC design including defined design processes and design principles for all data center facilities and infrastructures.

Architects & engineers get a suite of integrated standards for the design of data center facilities & infrastructures including defined design processes and design principles.

EN 50600-1: General Concepts & Availability Classes

EN 50600-1 describes the general concepts of the standard series and has the following scope:

EN 50600-1:

- Details the issues to be addressed in a business risk and operating cost analysis enabling application of an appropriate classification of the data center
- Defines the common aspects of data centers including terminology, parameters and reference models (functional elements and their accommodation) addressing both the size and complexity of their intended purpose
- Describes general aspects of the facilities and infrastructures required to support effective operation of telecommunications within data centers
- Specifies a classification system, based upon the key criteria of "availability", "security" and "energy-efficiency" over the planned lifetime of the data center, for the provision of effective facilities and infrastructure
- Describes the general design principles for data centers upon which the requirements of the EN 50600 series are based including symbols, labels, coding in drawings, quality assurance and education

Furthermore, it functions as a base for all other standards of the series because their infrastructures have to be designed according to the chosen overall data center availability class, derived from EN 50600-1.
The following graphic shows the main design criteria according to the chosen availability class for the infrastructures power distribution, environmental control and telecommunications cabling.

	Availability of overall set of facilities and infrastructures			
	Low	Medium	High	Very High
	AVAILABILITY CLASS			
Infrastructure	1	2	3	4
Power supply/distribution EN 50600-2-2	Single-path (no redundancy of components)	Single-path (resilience provided by redundancy of components)	Multi-path (resilience provided by redundancy of systems)	Multi-path (fault tolerant even during maintenance)
Environmental control EN 506000-2-3	No specific requirements	Single-path (no redundancy of components)	Single-path (resilience provided by redundancy of components)	Multi-path (resilience provided by redundancy of systems). Allows maintenance during operation
Telecommunications cabling EN 50600-2-4	Direct Connection or Single-path fixed infrastructure	Single-path using fixed infrastructure with ENI-redundancy	Multi-path using fixed infrastructure with ENI-redundancy and diverse pathways	Multi-path using fixed infrastructure with ENI-redundancy, diverse pathways and redundant distribution areas

Figure 3: Availability Classes according EN 50600-1

The architectural and design requirements of the different availability classes for the telecommunications cabling infrastructure are subject of the next chapters of this document.

EN 50600-2-4: Telecommunications Cabling Infrastructure

Content and Structure

The telecommunications cabling within the data center serves to support the following:

- Data center information technology and network telecommunications
- Monitoring and controlling of other data center infrastructures
- Building management and automation

Therefore, EN 50600-2-4 addresses the wide range of telecommunications cabling infrastructures within data centers based upon the criteria and classifications for "availability" within EN 50600-1.

EN 50600-2-4 specifies requirements and recommendations for the following:

- Information technology and network telecommunications cabling (e.g. SAN and LAN)
- General information technology cabling to support the operation of the data center
- Telecommunications cabling to monitor and control, as appropriate, power distribution, environmental control and physical security of the data center
- Other building automation cabling
- Pathways, spaces and enclosures for the telecommunications cabling infrastructures

The following graphic highlights the topics covered by EN 50600-2-4:

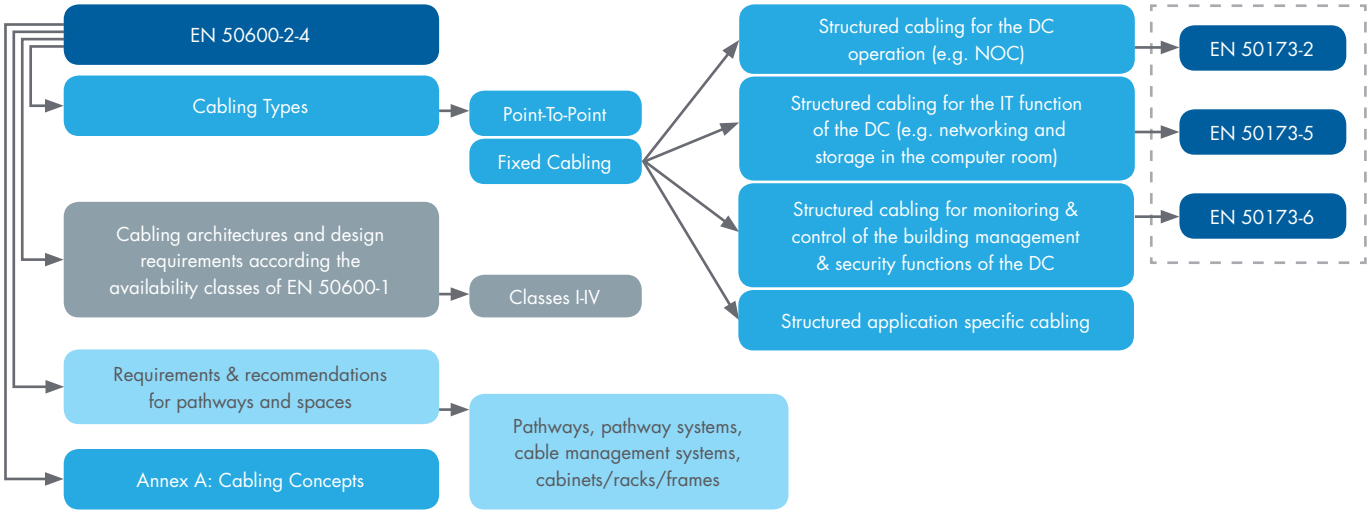

Figure 4: Content & Structure of EN 50600-2-4

The main focus when developing the EN 50600-2-4 was, in addition to the architectures and requirements for the availability classes, on migration and growth. The growth of IT capacity and the migration of applications towards higher speed are very dynamic in data centers. The cabling infrastructure of a data center has to be able to support these dynamics by enabling quick and easy extension of the data center (e.g. commissioning of additional equipment) and by offering migration paths for the network and storage applications used in the DC.

EN 50600-2-4 supports migration and growth by defining appropriate requirements for cabling architectures, cross-connects and pathway systems. These requirements will be explained in the following chapters.

Cabling Types

Although EN 50600-2-4 is covering several types of cabling (see figure 4), it does not define any requirement for the structured cabling itself. It has not been created to supersede existing European cabling standards but it points to those for cabling definitions. The EN 50600-2-4 defines basically 2 cabling types:

Point-to-point: Direct connection of two pieces of IT equipment using a dedicated cable rather than a generic cabling system. The point-to-point connection method uses discrete cords (typically factory-produced) that directly connect the active equipment.

Fixed Cabling: Structured cabling including the generic cabling solutions of the EN 50173 series between closures which have either peer-to-peer or hierarchical structure and which enables the installation of cross-connects or interconnects at those closures.

Point-to-Point Cabling

Although point-to-point cabling seems to be the simplest and most cost effective method of providing connections, for several reasons this cabling type should only be used for connections within the same or two adjacent cabinets, frames or racks. Point-to-point cabling is often not reusable as the data center evolves and equipment types and locations change and may have a limited life time expectation. Continuous changes to the required interconnections increase both the planning and the operational resources required for each change (see Figure 5 and Figure 6) and increases the risk of interfering with other infrastructures - including those for environmental control. Hence, it can be said that **point-to-point cabling is not supporting migration and growth well.**

The following figures show the negative impact of using point-to-point cabling when the data center grows.

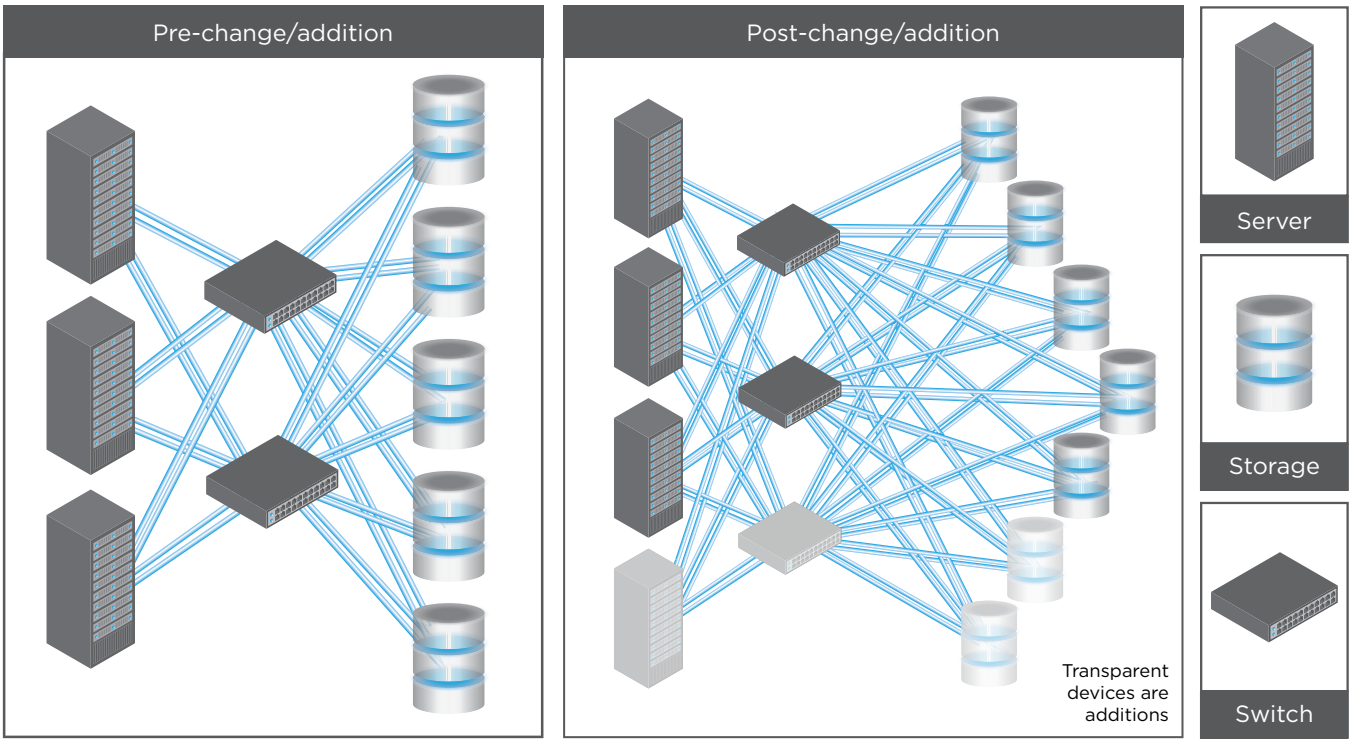

Figure 5: Impact of growth in an unstructured point-to-point cabling infrastructure (Source: EN 50600-2-4)

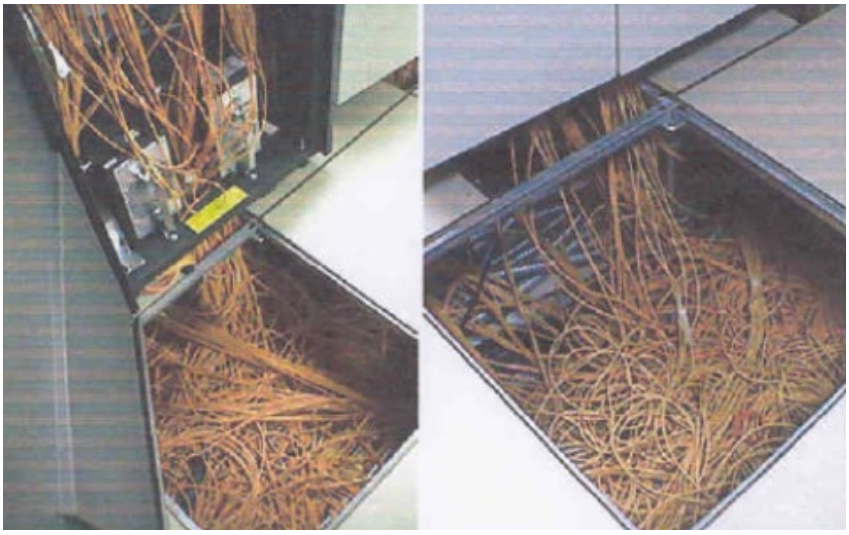

Figure 6: Example of unstructured growth of point-to-point cabling (Source: EN 50600-2-4)

Fixed Cabling

A much better approach for the telecommunications cabling infrastructure in a data center is the usage of fixed cabling.

A structured cabling system approach, illustrated in Figure 7, shows the equipment ports presented at remote central patching locations (CPLs). Server-to-storage connections are made using short, easily managed, cords within the CPL. The use of distributed zone patching locations (ZPL), connected to the CPLs with fixed cables provides additional flexibility for managing changes. Figure 7 shows how a fixed cabling implementation isolates the change activity to the defined areas. New equipment is connected to a CPL or ZPL without impacting active systems so no scheduled downtime is required. The equipment can then be connected to the active systems during the scheduled downtime by simply reconfiguring the cords at the CPL or ZPL. If a change causes a problem, it is only necessary to reconnect the cords into their pre-change configuration. The fixed cabling implementation enables more accurate predictions of the time required to implement system changes (and recovery) resulting in easier, faster changes that introduce less risk and enable improved overall system operation.

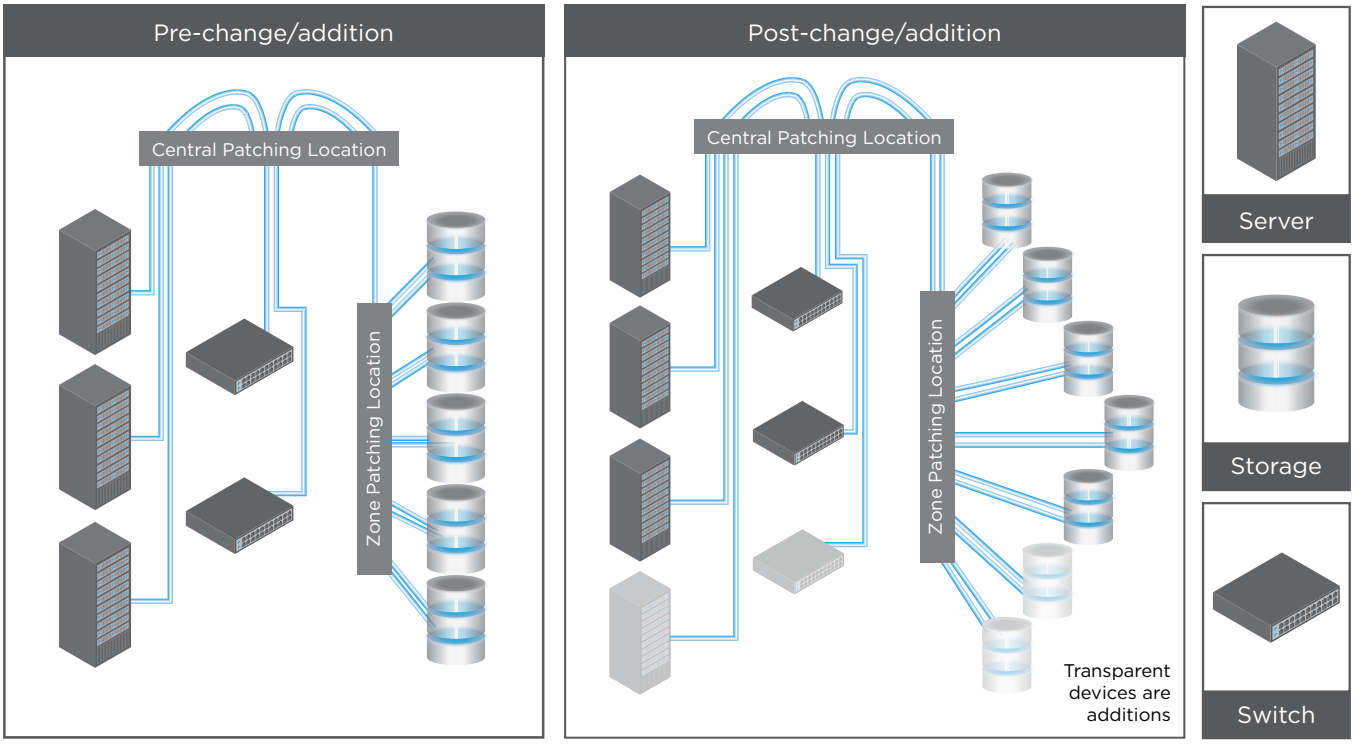

Figure 7: Structured cabling infrastructure: setup and growth (Source: EN 50600-2-4)

Availability Classes and resulting Cabling Architectures

Although EN 50600-2-4 defines several cabling types depending on the cabling use, this paper covers only the telecommunication cabling for the computer room space, the area of a data center where all function elements for the IT function of the data center are hosted.

Data center space	Cabling type	Overall data center facilities & infrastructure - Availability Class 1	Overall data center facilities & infrastructure - Availability Class 2	Overall data center facilities & infrastructure - Availability Class 3	Overall data center facilities & infrastructure - Availability Class 4
Computer room space	Inter-cabinets	EN 50600-2-4 Class 1	EN 50600-2-4 Class 2	EN 50600-2-4 Class 3	EN 50600-2-4 Class 4
	Intra-cabinets	EN 50600-2-4 Class 1	EN 50600-2-4 Class 1	EN 50600-2-4 Class 1	EN 50600-2-4 Class 1
	Adjacent cabinets	EN 50600-2-4 Class 1	EN 50600-2-4 Class 1	EN 50600-2-4 Class 1	EN 50600-2-4 Class 1
	Monitoring & control	EN 50173-6	EN 50173-6	EN 50173-6	EN 50173-6
	Office style cabling	EN 50173-2	EN 50173-2	EN 50173-2	EN 50173-2
Control room space	Office style cabling	EN 50173-2	EN 50173-2	EN 50173-2	EN 50173-2
	Monitoring & control	EN 50173-6	EN 50173-6	EN 50173-6	EN 50173-6
Other spaces	Office style cabling	EN 50173-2	EN 50173-2	EN 50173-2	EN 50173-2
	Monitoring & control	EN 50173-6	EN 50173-6	EN 50173-6	EN 50173-6

Figure 8: Cabling requirements for different data center spaces and availability classes (Source: EN 50600-2-4)

Basically, the telecommunications cabling in the computer room of a data center can be of 2 different kinds:

- Cabling within a cabinet (Intra-cabinet) or between 2 cabinets directly next to each other (adjacent-cabinet)
- Cabling between cabinets (Inter-Cabinet)

These 2 computer room cabling types are defined for all four availability classes for the overall data center. While intra- and adjacent cabinet can always be designed according to class 1 (independent from the DC availability class), the inter-cabinet cabling in the computer room has to follow different cabling architectures according to the DC availability class as defined in figure 8.

Cabling Class 1

The telecommunications cabling infrastructure for Availability Class 1 uses either a point-to-point connection (i.e. equipment cords) for the transmission channel (see Figure 9) or a fixed cabling infrastructure in a single-path configuration according EN 50173-5 and a single-telecommunications provider scenario as shown in Figure 10.

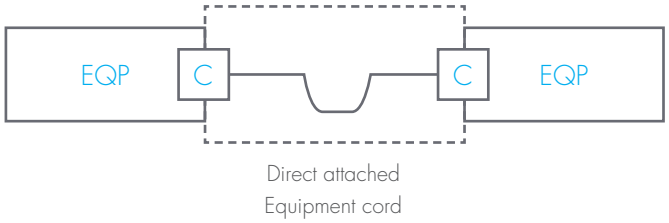

Figure 9: Telecommunications Cabling Class 1 using direct attached cords (Source: EN 50600-2-4)

TELECOMMUNICATIONS PROVIDER A

CLASS 1

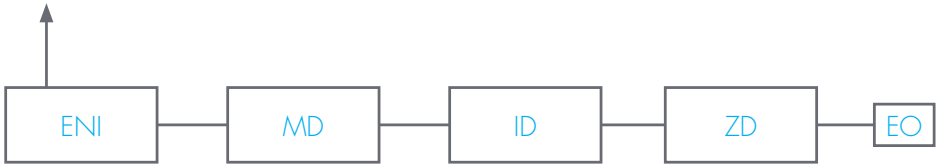

Figure 10: Telecommunications Cabling Class 1 using direct attached cords (Source: EN 50600-2-4)

Cabling Class 2

The telecommunications cabling infrastructure for Availability Class 2 shall use a fixed cabling infrastructure (e.g. according to EN 50173-5 or application-specific) in cabling subsystems defined in EN 50173-5 with a single-path architecture with redundancy on the ENI as shown in Figure 11. Furthermore, all requirements of figure 14 shall be met.

TELECOMMUNICATIONS PROVIDER A TELECOMMUNICATIONS PROVIDER B

CLASS 2

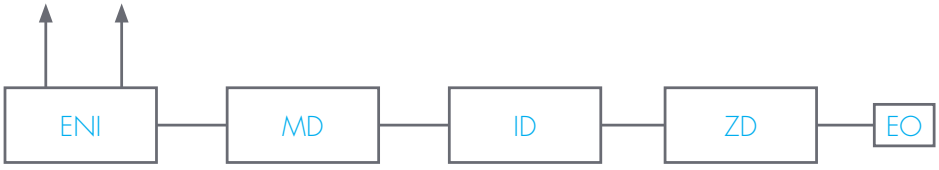

Figure 11: Fixed Telecommunications Cabling Class 2 (Source: EN 50600-2-4)

Legend

C = Connection
EQP= Equipment
ENI= External Network Interface
MD= Main Distribution
ID= Intermediate Distribution
ZD= Zone Distribution
EO= Equipment Outlet

Cabling Class 3

The telecommunications cabling infrastructure for Availability Class 3 shall use a fixed cabling infrastructure (e.g. according to EN 50173-5 or application-specific) in cabling subsystems defined in EN 50173-5 with a multi-path redundancy configuration using diverse physical pathways as shown in Figure 12. Furthermore, all requirements of figure 14 shall be met.

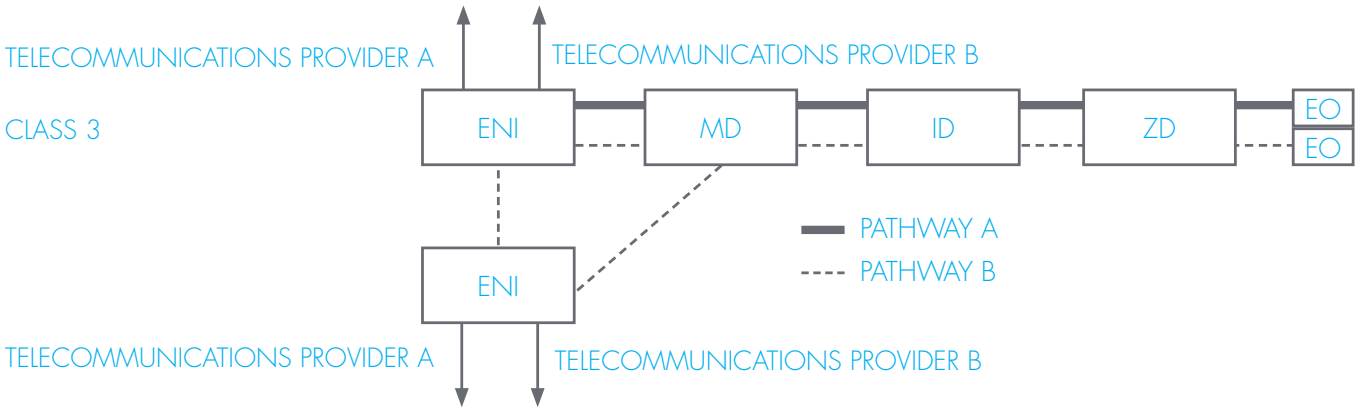

Figure 12: Fixed Telecommunications Cabling Class 3 (Source: EN 50600-2-4)

Cabling Class 4

The telecommunications cabling infrastructure for Availability Class 4 shall use a fixed cabling infrastructure (e.g. according to EN 50173-5 or application-specific) in cabling subsystems defined in EN 50173-5 with a multi-path redundancy configuration using diverse physical pathways and redundant distribution areas as shown in Figure 13. Furthermore, all requirements of figure 14 shall be met.

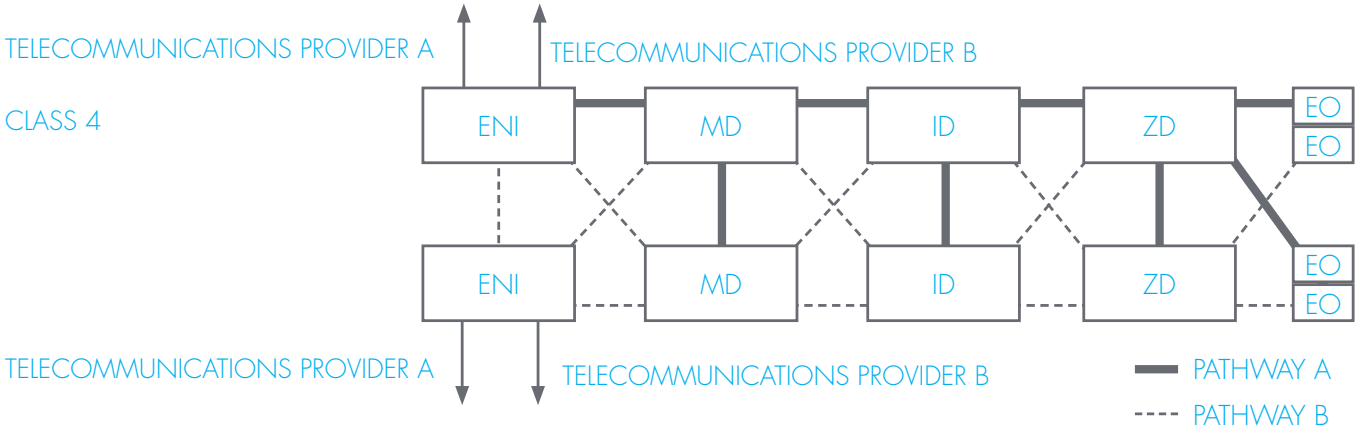

Figure 13: Fixed Telecommunications Cabling Class 4 (Source: EN 50600-2-4)

Legend

C = Connection
EQP= Equipment
ENI= External Network Interface
MD= Main Distribution
ID= Intermediate Distribution
ZD= Zone Distribution
EO= Equipment Outlet

Specifications & Requirements for the Cabling Classes

The following figure summarizes all requirements for the computer room cabling classes. These requirements must be implemented in order to meet the selected Availability Class.

CABLING CLASS	CABLING TYPE	PREFERRED INSTALLATION	CONFIGURATION	CROSS-CONNECT	CROSS-CONNECT FEATURES	PATHWAY SYSTEM	PATHWAY SYSTEM FEATURES
Class 1	Direct attached or EN 50173-5	N/A	• Single-path • Single-pathway • Single-provider • Single-ENI	Optional	N/A	Optional	N/A
Class 2	EN 50173-5 or application specific	N/A	• Single-path • Single-pathway • Multi-provider • Single-ENI	Mandatory	• rear cable management • side patch cord management • Preferred: Cross-Connect cabinets/frames/racks > 800mm width	Optional	N/A
Class 3	EN 50173-5 or application specific	Pre-terminated	• Multi-path • Diverse-pathway • Multi-provider • Dual-ENI	Mandatory	• rear cable management • side patch cord management • bend radius control • bend radius controlled slack storage • Preferred:Cross-Connect cabinets/frames/racks > 800mm width	Mandatory	• Sufficient capacity to cater for the defined maximum capacity level • Slack storage capabilities • Bend radius control
Class 4	EN 50173-5 or application specific	Pre-terminated	• Multi-path • Diverse-pathway • Multi-provider • Dual-ENI • Redundant distribu-tion areas	Mandatory	• rear cable management • side patch cord managment • bend radius control • bend radius controlled slack storage • Preferred:Cross-Connect cabinets/frames/racks > 800mm width	Mandatory	• Sufficient capacity to cater for the defined maximum capacity level • Slack storage capabilities • Bend radius control

Figure 14: Cabling Class Requirement

In order to allow quick moves, adds and changes, central and local patching/cross connect locations in MD, ID and ZD as shown in Figure 15:

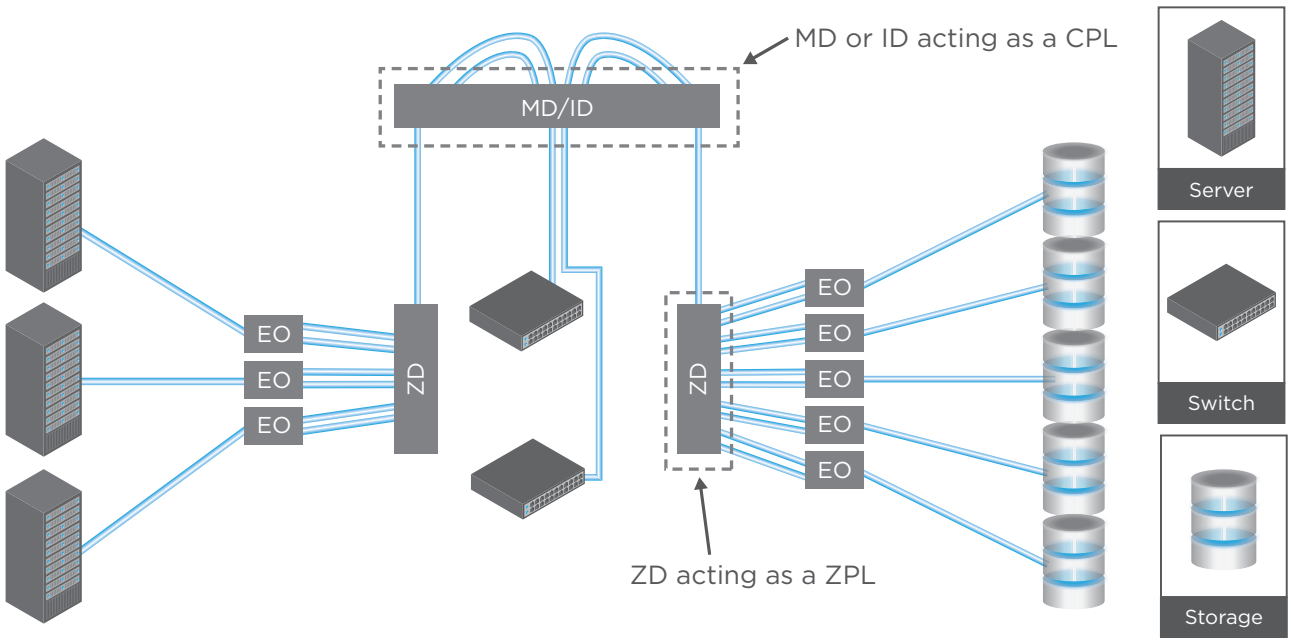

Figure 15: Moves, Adds & Changes using Cross-Connects

Using a Cross-Connect, for example, in the main distribution of a data center (as shown in figure 16) leads to transmission channels consisting of more than one cabling-subsystem, which demands the use of high performance cabling solutions capable of supporting any applications that are intended to be used. Additionally, the number of connections and the total length of the channel must be taken into account.

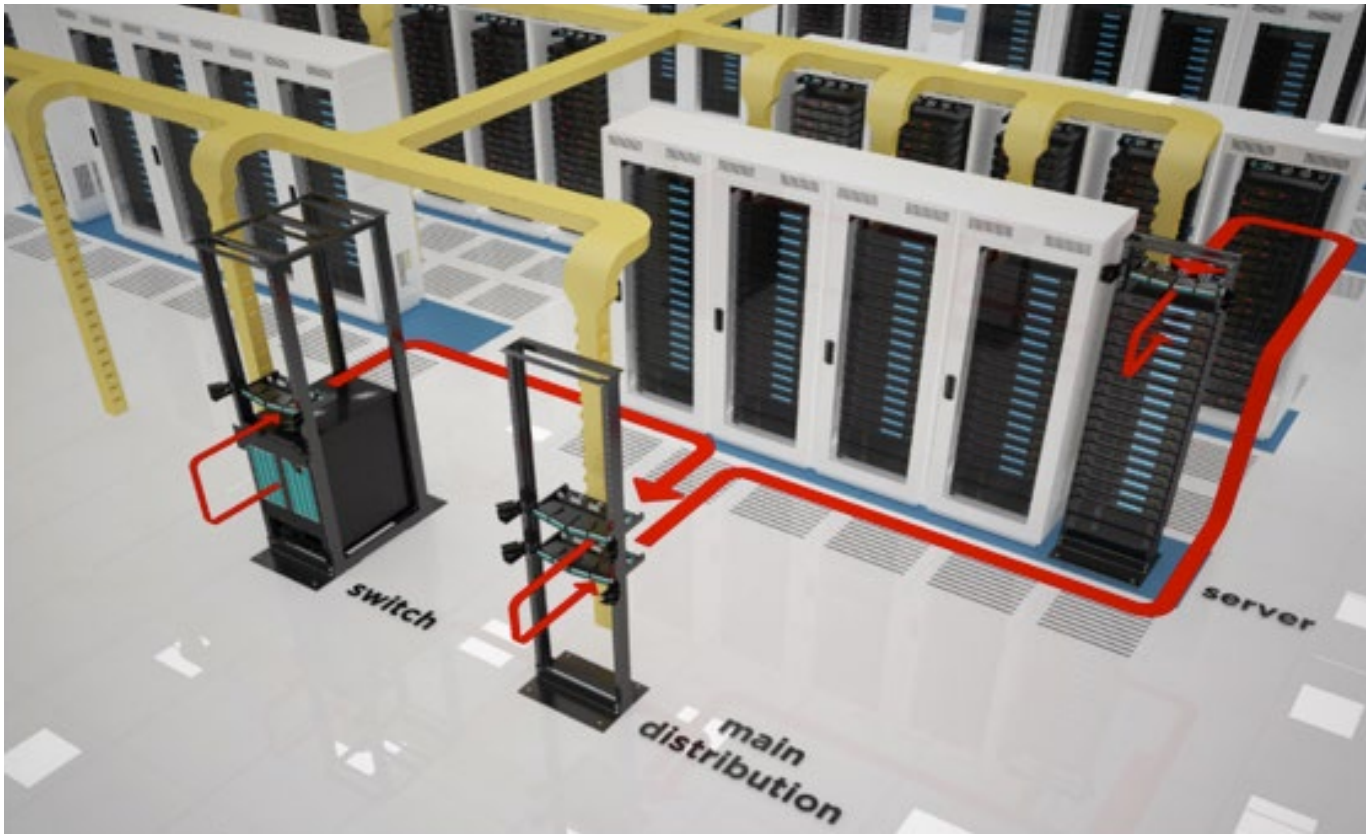

Figure 16: Computer Room Cabling using Cross-Connects

For the Classes 3 and 4, the **use of pre-terminated cabling systems** is preferred for the following reasons:

- On-site termination of cabling is impractical (e.g. field terminable connectors are not available)
- Operational constraints dictate that the time taken to install cabling shall be minimised (e.g. cabling needs to be in use as quickly as possible)
- Security concerns dictate that the presence in the data center of third-party labor is minimized.

Requirements for Cabinets, Racks & Frames

In addition to the requirements for the cabling, the cross-connect cabinet and the pathways systems, EN 50600-2-4 defines also requirements for other cabinets, racks or frames in the computer room.

General Requirements

Cabinets and racks must be selected to provide:

- A growth path for future technologies and data center capacity demands;
- Adequate cable management and bend radius functionality;
- Adequate ventilation and cooling for the equipment they will house (see EN 50600-2-3)

Cabinets, racks and frames must be provided with cable and cord management fittings.

Requirements for Dimensions

The minimum width of the cabinets/racks used for CPL and ZPL shall be 0,8 m with a preference for a larger width.

The minimum width of the cabinets/racks used for equipment must cope with the current and future cable management requirements. A width of 0,8 m is recommended.

The minimum depth of the cabinets/racks used for equipment must cope with the current and future equipment dimensions. A depth of 1,2 m is recommended.

Cabinets and racks must not be located under piping systems (both for reasons of breakage or aggregation of condensation), except piping systems used for cooling and fire extinguishing systems

Recommendations for Cable Management

1. The following cable management methods must be considered:
2. For low density systems, there should be one rack unit of horizontal cable management for each rack unit of termination points
3. For high density applications, horizontal cable management systems that required rack units should be replaced with cable management without rack unit usage
4. The capacity of the vertical cable management within cabinets should be twice the cross-sectional area of the cables to be installed when the cabinets/racks are at full capacity
5. Cabinets may require additional depth or width to provide adequate vertical cable management
6. Blanking panels should be installed in unused cabinet positions in order to avoid mixing of hot and cold air

Recommendations for Overhead Cabling

The use of overhead telecommunications cabling is proven to improve cooling efficiency and is recommended where ceiling heights permit because it can substantially reduce airflow losses due to airflow obstruction and turbulence caused by under floor cabling and cabling pathways.

SUMMARY

The EN 50600-2-4 is part of a new European standard series which is supposed to be the new Go-To-Standard for the design of DC facilities and infrastructures. It is mainly focused on supporting the overall DC availability class chosen from EN 50600-1 with the definition of appropriate cabling architectures.

With a strong focus on application migration and growth, the EN 50600-2-4 favorites fixed cabling as the best choice for a data center. The mandatory use of cross-connects in MD, ID and ZD (cabling Classes 3 and 4) and the detailed specifications for these are based on best practices of the last 15 year of data center cabling design.

Requirements and recommendations for cabinets/racks/frames, cable management and pathways systems complete a full set of cabling design specifications for state-of-the-art data centers.

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