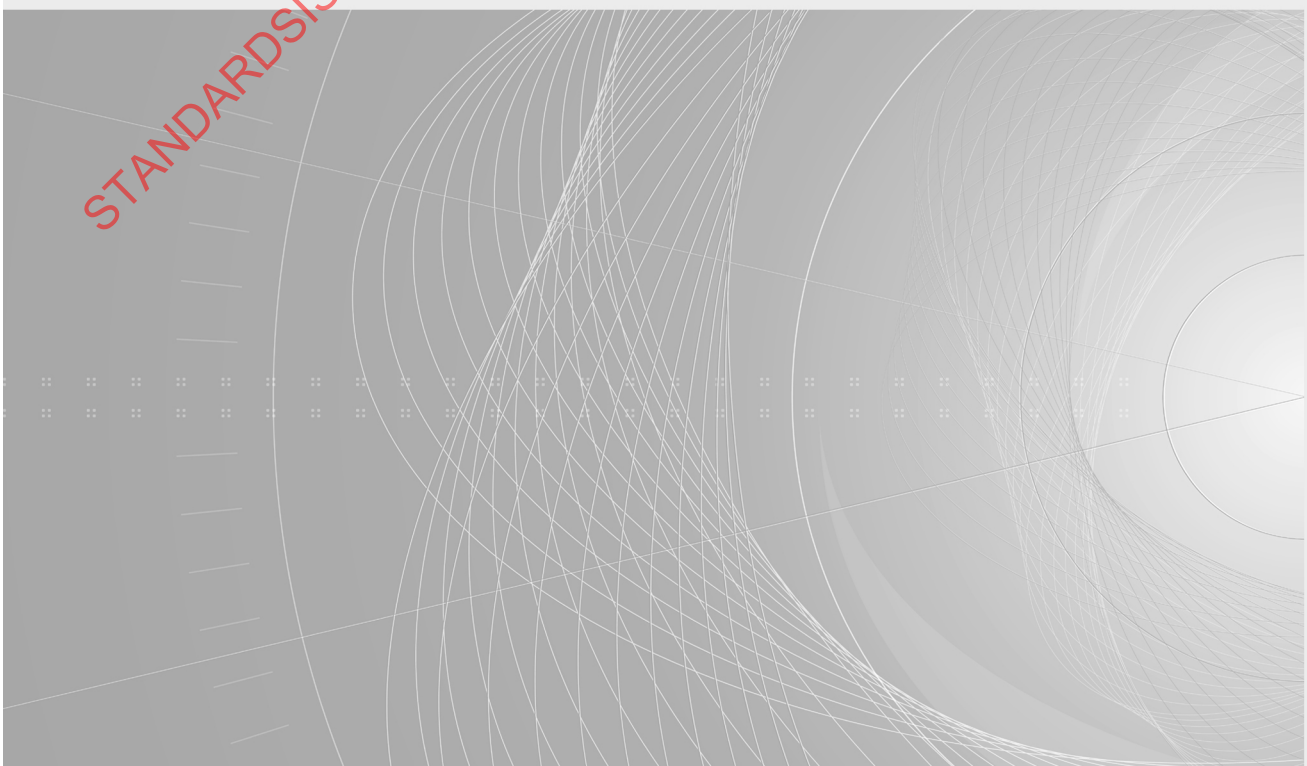
ISO/IEC 11801-6

Edition 1.0 2017-11

INTERNATIONAL STANDARD

Information technology – Generic cabling for customer premises – Part 6: Distributed building services



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IEC Central Office
3, rue de Varembé
CH-1211 Geneva 20
Switzerland

Tel.: +41 22 919 02 11
Fax: +41 22 919 03 00
info@iec.ch
www.iec.ch

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ISO/IEC 11801-6

Edition 1.0 2017-11

INTERNATIONAL STANDARD

Information technology – Generic cabling for customer premises – Part 6: Distributed building services

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INFORMATION TECHNOLOGY – GENERIC CABLING FOR CUSTOMER PREMISES –

Part 6: Distributed building services

FOREWORD

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International Standard ISO/IEC 11801-6 was prepared by subcommittee 25: Interconnection of information technology equipment, of ISO/IEC joint technical committee 1: Information technology.

ISO/IEC 11801-6 is to be read in conjunction with ISO/IEC 11801-1, which was created to consolidate general requirements for generic cabling into a single standard which allows the other standards in the ISO/IEC 11801 series to have a common reference.

This International Standard has been approved by vote of the member bodies, and the voting results can be obtained from the address given on the second title page.

This document has been drafted in accordance with the ISO/IEC Directives, Part 2.

A list of all parts in the ISO/IEC 11801 series, published under the general title *Information technology – Generic cabling for customer premises*, can be found on the IEC website.

INTRODUCTION

The importance of cabling infrastructure is similar to that of other fundamental utilities such as water and energy supply and interruptions to the services provided over that infrastructure can have a serious impact. A lack of design foresight, the use of inappropriate components, incorrect installation, poor administration or inadequate support can threaten quality of service and have commercial consequence for all types of users.

This document specifies generic cabling for distributed building services and can be used alone or in conjunction with all the premises-specific standards of the ISO/IEC 11801 series.

It has been prepared to reflect the increasing use of generic cabling in support of non-user specific services and the sharing of information between such services, many of which require the use of remote powered devices. The distribution of these services is implemented either as a stand-alone structure and configuration or as an overlay provided to locations other than those specified by premises-specific standards in the ISO/IEC 11801 series.

This document is not intended to replace the application of other premises-specific standards in the ISO/IEC 11801 series but has been prepared in recognition of the fact that, although certain functional elements of distributed building services cabling can be co-located with those of other generic cabling infrastructures, they can be

a) specified, installed and operated by different entities than those responsible for other generic cabling infrastructures that are installed within the premises,

b) specified and installed at a different time than other generic cabling infrastructures that are installed within the premises.

Figure 1 shows the schematic and contextual relationships between the standards relating to information technology cabling produced by ISO/IEC JTC 1/SC 25, namely the ISO/IEC 11801 series of standards for generic cabling design, standards for the installation, operation and administration of generic cabling and for testing of installed generic cabling.

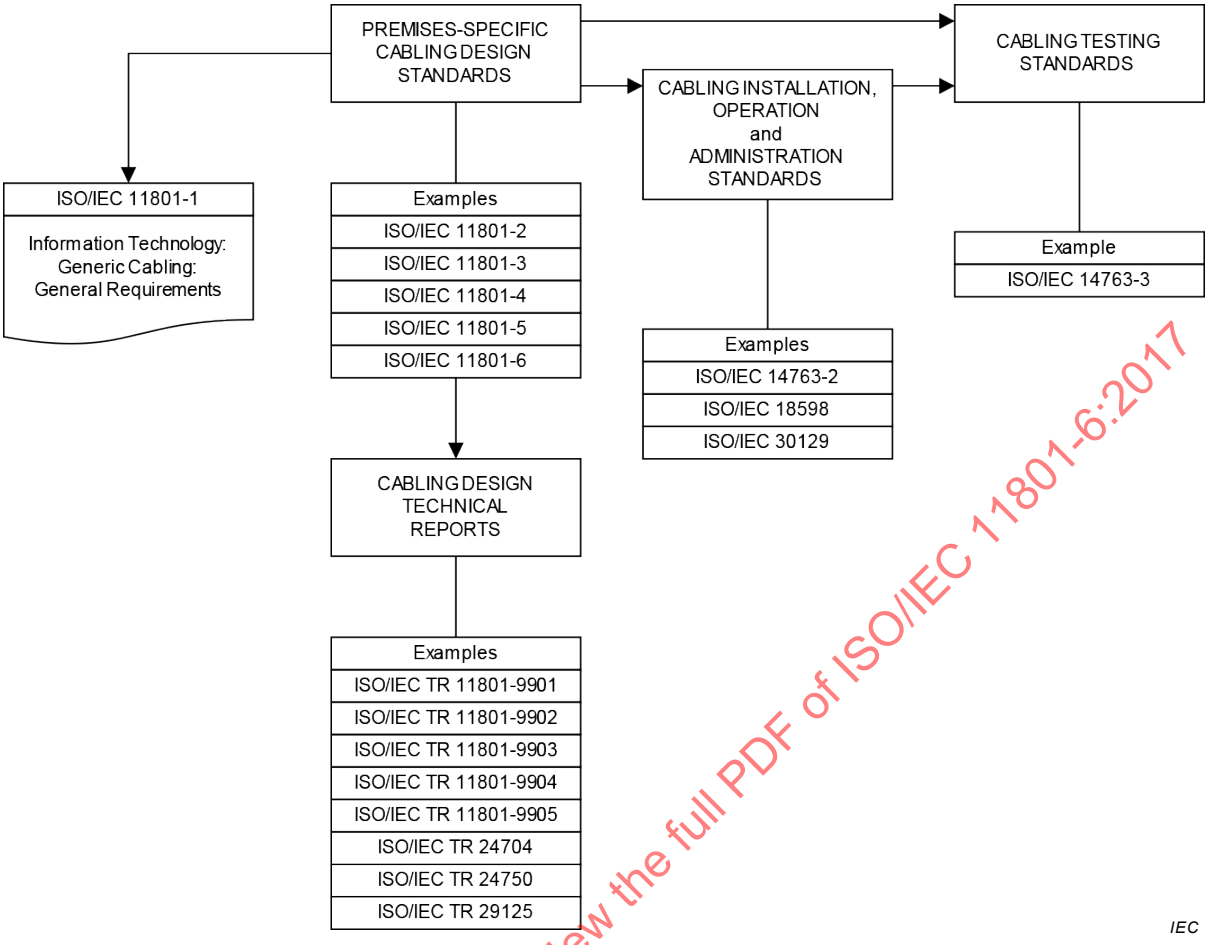


Figure 1 – Relationships between the generic cabling documents produced by ISO/IEC JTC 1/SC 25

The generic cabling specified by this document provides users with

a) an application independent system capable of supporting a wide range of applications in a range of installation and operating environments,

b) a flexible scheme such that modifications are both easy and economical,

c) a multi-vendor supply chain within an open market for cabling components.

In addition, this document provides

d) relevant industry professionals with guidance allowing the accommodation of cabling before specific requirements are known, i.e. in the initial planning either for construction or refurbishment and for further deployment as the requirements of areas are defined,

e) industry and standardization bodies with a cabling system which supports current products and provides a basis for future product development and applications standardization.

Applications addressed in this document include, but are not limited to those applications in ISO/IEC 11801:2017, Annex E, as used to support the following services:

1) telecommunications, e.g. wireless access points, distributed antenna systems;

2) energy management, e.g. lighting, power distribution, incoming utility metering;

3) environmental control, e.g. temperature, humidity;

4) personnel management, e.g. access control, cameras, passive infra-red (PIR) detectors, time and attendance monitoring, electronic signage, audio-visual projectors;

5) personal information and alarms, e.g. paging, patient monitoring, nurse call, infant security;

6) intelligent building systems;

7) communications between devices (i.e. “internet of things”).

Physical layer requirements for the applications listed in ISO/IEC 11801-1:2017, Annex E have been analysed to determine their compatibility with the cabling performance specified in this document and, together with statistics concerning premises geography from different countries and the models described in Clause 6, have been used to develop the requirements for cabling components and to stipulate their arrangement into cabling systems.

As a result, this document

- specifies a structure for generic cabling supporting a wide variety of applications including, but not restricted to, the applications in ISO/IEC 11801-1:2017, Annex E,
- adopts balanced cabling channel and link Classes E_A, F and F_A, specified in ISO/IEC 11801-1:2017,
- adopts optical fibre cabling channel and link requirements as specified in ISO/IEC 11801-1,
- adopts component requirements, specified in ISO/IEC 11801-1, and specifies cabling implementations that ensure performance of permanent links and of channels that meet or exceed the requirements of a specified group (e.g. Class) of applications.

Life expectancy of generic cabling systems can vary depending on environmental conditions, supported applications, aging of materials used in cables, and other factors such as access to pathways (campus pathways are more difficult to access than building pathways). With appropriate choice of components, generic cabling systems meeting the requirements of this document are expected to have a life expectancy of at least ten years.

This document has taken into account requirements specified in application standards listed in ISO/IEC 11801-1:2017, Annex E. It refers to International Standards for components and test methods whenever appropriate International Standards are available.

INFORMATION TECHNOLOGY – GENERIC CABLING FOR CUSTOMER PREMISES –

Part 6: Distributed building services

1 Scope

This part of ISO/IEC 11801 specifies generic cabling within premises that comprise single or multiple buildings on a campus. It covers balanced cabling and optical fibre cabling.

This document has been prepared to reflect the increasing use of generic cabling in support of non-user specific services and the sharing of information between such services that can also incorporate the supply of power, including

1) telecommunications, e.g. wireless access points, distributed antenna systems,
2) energy management, e.g. lighting, power distribution, incoming utility metering,
3) environmental control, e.g. temperature, humidity,
4) personnel management, e.g. access control, cameras, PIR detectors, time and attendance monitoring, electronic signage, audio-visual projectors,
5) personal information and alarms, e.g. paging, patient monitoring, nurse call, infant security,
6) intelligent building systems.

This document specifies directly or via reference to ISO/IEC 11801-1

a) the structure and configuration for generic cabling for distributed building services,
b) the interfaces at the service outlet (SO),
c) the performance requirements for cabling links and channels,
d) the implementation requirements and options,
e) the performance requirements for cabling components,
f) the conformance requirements and verification procedures.

Safety (e.g. electrical safety and protection, fire) and electromagnetic compatibility (EMC) requirements are outside the scope of this document, and are covered by other standards and by regulations. However, information given by this document can be of assistance.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO/IEC 11801-1:2017, *Information technology – Generic cabling for customer premises – Part 1: General requirements*

ISO/IEC 14763-2, *Information technology – Implementation and operation of customer premises cabling – Part 2: Planning and installation*

ISO/IEC 30129, *Information technology – Telecommunications bonding networks for buildings and other structures*

3 Terms, definitions and abbreviated terms

3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO/IEC 11801-1, ISO/IEC 14763-2 and the following apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at http://www.electropedia.org/
- ISO Online browsing platform: available at http://www.iso.org/obp

3.1.1
building service
non-user specific service within premises including, but not restricted to, building automation, security, access control, building management, wireless access points, information displays and alarm systems

3.1.2
distributed building service
building service provided to locations additional to those specified in premises-specific standards in the ISO/IEC 11801 series

3.1.3
network conversion interface
passive or active device allowing the attachment of cabling of different network topologies to a service concentration point

3.1.4
service area
area in a room or facility where non-user specific equipment is placed and connected to the same service concentration point or groups of service outlets

3.1.5
service area cord
cord connecting the service outlet to the terminal equipment

3.1.6
service concentration point
SCP
connection point in the Type A generic cabling between a service distributor and a service outlet or a connection point offering connections to terminal equipment at the end of Type B generic cabling

3.1.7
service concentration point cable
cable between a service concentration point and a service outlet

3.1.8
service distribution cable
cable connecting the service distributor to the service outlet(s) of Type A cabling or service concentration point(s) of Type A or Type B cabling

3.1.9
service outlet
SO
fixed connecting device where the service distribution cabling terminates

3.1.10
Type A generic cabling
service distribution cabling between the service distributor and the service outlet

3.1.11
Type B generic cabling
service distribution cabling between the service distributor and the service concentration point when a service outlet is not used

3.2 Abbreviated terms

For the purposes of this document, the abbreviated terms given in ISO/IEC 11801-1 and the following apply.

DAS	distributed antenna system
HVAC	heating, ventilation and air conditioning
MIMO	multiple input, multiple output
NFC	near field communication
OE EQP	opto-electronic equipment
PIR	passive infrared
PP	patch panel
RFID	radio-frequency identification
SCP	service concentration point
SD	service distributor
SO	service outlet
WAP	wireless access point

4 Conformance

For a cabling system to conform to this document the following applies.

a) The configuration and structure shall conform to the requirements outlined in Clause 5.

b) Channels shall meet the requirements specified in Clause 6 when subjected to environment conditions, local to the channels (see NOTE below), as defined by the applicable environmental Class(es) of Clause 6.

This shall be achieved by one of the following:

1) a channel design and implementation ensuring that the prescribed channel performance of Clause 6 is met;

2) attachment of appropriate components to a permanent link or service concentration point (SCP) link design meeting the prescribed performance class of Clause 7. Channel performance shall be ensured where a channel is created by adding more than one cord to either end of a link meeting the requirements of Clause 7;

3) for E_A environments, using the reference implementations of Clause 8 and compatible cabling components conforming to the requirements of Clauses 9, 10 and 11, this is based upon a statistical approach of performance modelling.

c) The interfaces to the cabling at the SO shall conform to the requirements of Clause 10 with respect to mating interfaces and performance when subjected to environment conditions, local to the connecting hardware (see NOTE below), as defined by the applicable environmental Class(es) of Clause 6.

d) Connecting hardware at other places in the cabling structure shall meet the performance requirements specified in Clause 10 when subjected to environment conditions, local to the connecting hardware (see NOTE below), as defined by the applicable environmental Class(es) of Clause 6,

e) The requirements of ISO/IEC 14763-2 and ISO/IEC 30129 shall be met.

This document does not specify which tests and sampling levels should be adopted. Test methods to assess conformance with the channel and link requirements of Clause 6 and Clause 7, respectively, are specified in ISO/IEC 11801-1. The test parameters to be measured, the sampling levels and the treatment of measured results to be applied for

particular installations shall be defined in the installation specifications and quality plan for that installation prepared in accordance with ISO/IEC 14763-2.

In the absence of the channel, the conformance of the link shall be used to verify conformance with this document.

Specifications marked "ffs" are preliminary specifications, and are not required for conformance to this document.

NOTE The applicable environment classification of ISO/IEC 11801-1:2017, 6.2.1, local to the cabling or cabling component(s), is that of the environment immediately adjacent to the cabling or cabling component(s).

5 Structure of the generic cabling system

5.1 General

Clause 5 identifies the functional elements of generic cabling, describes how they are connected together to form subsystems and identifies the interfaces at which application-specific components are connected. Channels, created by connecting application-specific cabling components to the generic cabling, are used to support applications (see ISO/IEC 11801-1).

5.2 Functional elements

5.2.1 Stand-alone structure

In addition to the functional elements specified in ISO/IEC 11801-1, this document specifies two implementations of generic cabling for distributed building services. This document enables

– Type A generic cabling to the SO,
– Type B generic cabling to the SCP, thereby providing the opportunity for
  - application-specific cabling to be installed between the SCP and terminal equipment,
  - application-specific equipment to be connected at the SCP.

The specification of application-specific cabling and equipment that CAN be connected to the SCP is outside the scope of this document.

Type A generic cabling uses the following functional elements and interfaces:

a) service distributor (SD) – equivalent to distributor 1 in ISO/IEC 11801-1;
b) service distribution cable – equivalent to fixed cable (cable Z) within cabling subsystem 1 in ISO/IEC 11801-1;
c) service concentration point (SCP) – equivalent to consolidation point in ISO/IEC 11801-1;
d) service concentration point cable (SCP cable) – equivalent to cable Y in ISO/IEC 11801-1;
e) service outlet (SO) – equivalent to TE outlet in ISO/IEC 11801-1.

Type B generic cabling uses the following functional elements and interfaces:

1) service distributor (SD) – equivalent to distributor 1 in ISO/IEC 11801-1;
2) service distribution cable – equivalent to fixed cable (cable Z) within cabling subsystem 1 in ISO/IEC 11801-1;
3) service concentration point (SCP) – equivalent to consolidation point in ISO/IEC 11801-1.

Groups of these functional elements are connected together to form cabling subsystems (see 5.3).

An SCP can support both Type A and Type B generic cabling.

5.2.2 Overlay structure

The structure of Type A and Type B generic cabling in association with generic cabling of other standards in the ISO/IEC 11801 series is described in Annex B.

The use of cabling in accordance with this document may supplement the connections to terminal equipment (TE) in the premises-specific standards and may affect the number of such connections (e.g. TO of ISO/IEC 11801-2) provided.

5.3 General structure and hierarchy

5.3.1 Type A generic cabling

Type A generic cabling systems contain up to three cabling subsystems: campus backbone, building backbone and service distribution cabling. The cabling subsystems are connected together to create a generic cabling system with a structure as shown in Figure 2. The composition of the cabling subsystems is described in 5.4.1 and 5.4.2. The functional elements of the cabling subsystems are interconnected to form a hierarchical star topology as shown in Figure 3.

Connections between cabling subsystems are either active, requiring application-specific equipment, or passive. Connection to application-specific equipment adopts either an interconnect or a cross-connect approach (see ISO/IEC 11801-1). Passive connections between cabling subsystems adopt either a cross-connect approach, by way of either patch cords or jumpers, or an interconnect approach.

NOTE "Active" equipment can include powered (e.g. network switches) or non-powered devices (e.g. optical fibre splitters). "Passive" equipment consists of connecting hardware (e.g. patch panels).

The SO shall use connecting hardware in accordance with Clause 10.

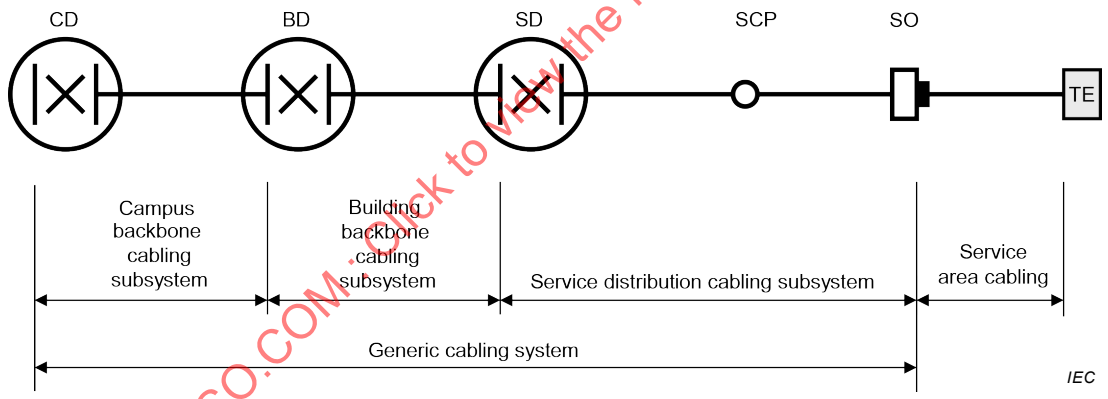


Figure 2 – Structure of Type A generic cabling

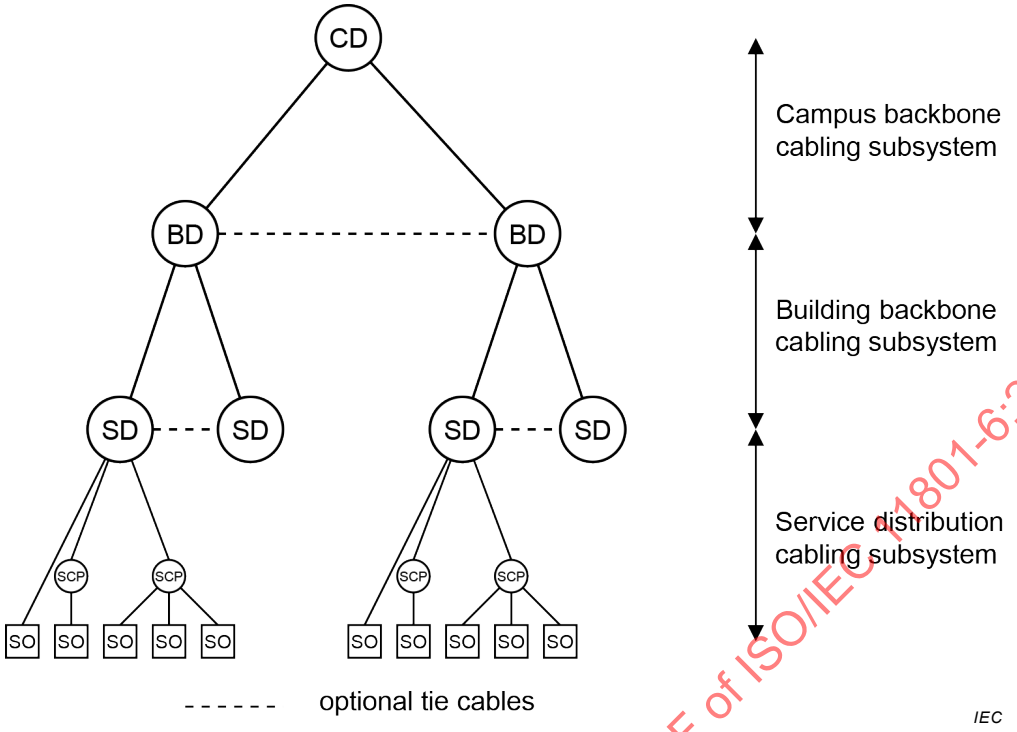


Figure 3 – Hierarchical structure of Type A generic cabling

5.3.2 Type B generic cabling

Type B generic cabling systems contain up to three cabling subsystems: campus backbone, building backbone and service distribution cabling. The cabling subsystems are connected together to create a generic cabling system with a structure as shown in Figure 4. The composition of the cabling subsystems is described in 5.4.1 and 5.4.3. The functional elements of the cabling subsystems are interconnected to form a hierarchical star topology as shown in Figure 5.

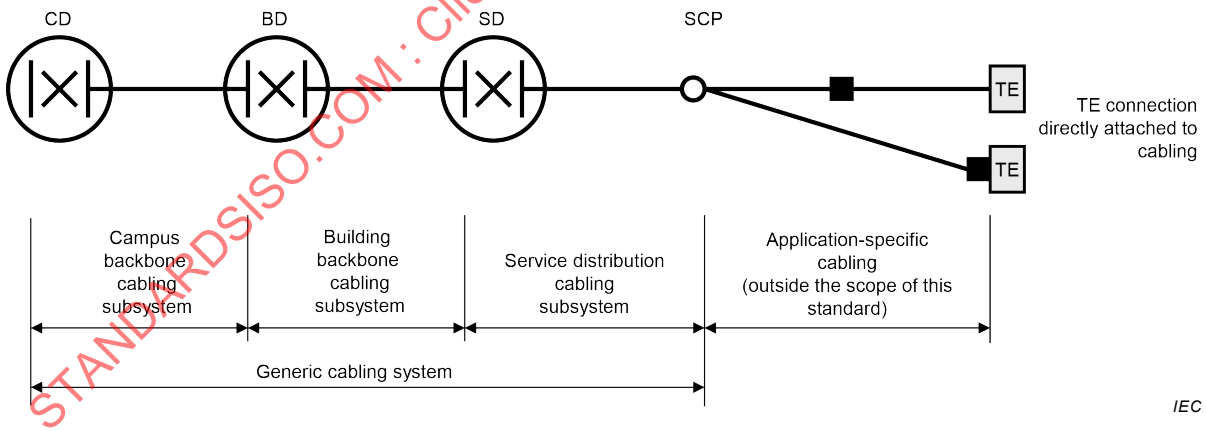


Figure 4 – Structure of Type B generic cabling

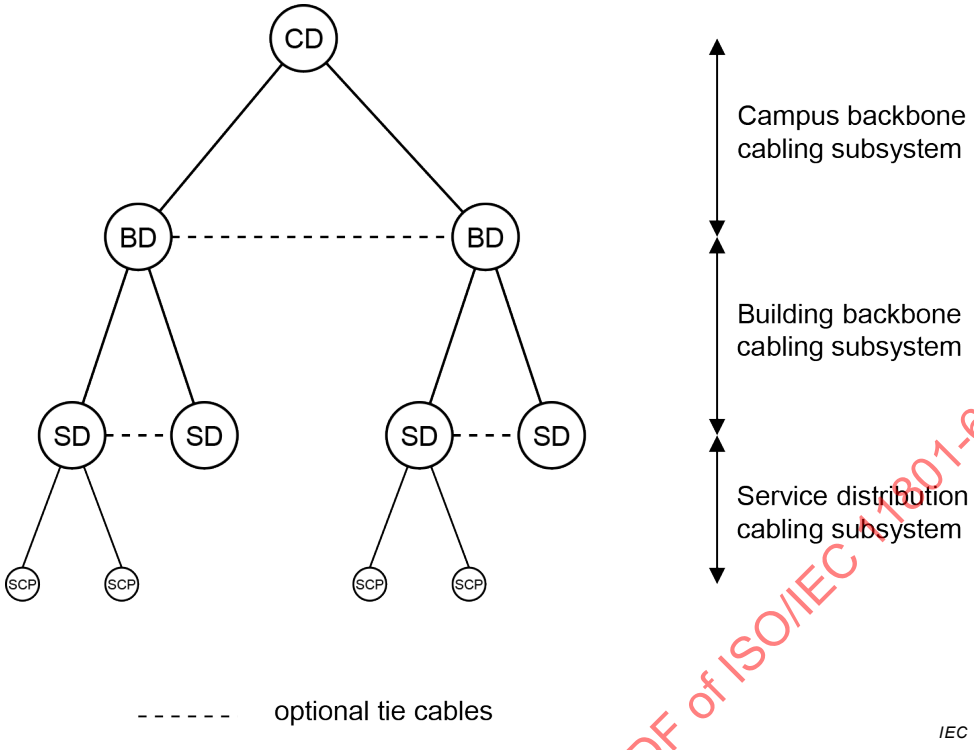


Figure 5 – Hierarchical structure of Type B generic cabling

Connections between cabling subsystems are either active, requiring application-specific equipment, or passive. Connection to application-specific equipment adopts either an interconnect or a cross-connect approach (see ISO/IEC 11801-1). Passive connections between cabling subsystems adopt either a cross-connect approach, by way of either patch cords or jumpers, or an interconnect approach.

5.4 Cabling subsystems

5.4.1 Campus and building backbone cabling subsystem

See ISO/IEC 11801-1:2017, 5.3.2.

5.4.2 Service distribution cabling subsystem (Type A generic cabling)

The service distribution cabling subsystem extends from an SD to the SO(s) connected to it. The subsystem includes

a) the service distribution cables,

b) the mechanical termination of the service distribution cables at the SO and the SD together with associated patch cords and/or jumpers at the SD,

c) SCP(s) optional),

d) the SCP cable(s).

Although service area and equipment cords are used to connect terminal and transmission equipment, respectively, to the cabling subsystem, they are not considered part of the cabling subsystem because they can be application-specific. Service distribution cables shall be continuous from the SD to the SO(s) unless an SCP is installed (see 5.7.4).

5.4.3 Service distribution cabling subsystem (Type B generic cabling)

The service distribution cabling subsystem extends from an SD to the SCP(s) connected to it. The subsystem includes

a) the service distribution cables,

b) the mechanical termination of the service distribution cables at the SCP and the SD together with associated patch cords and/or jumpers at the SD,

c) SCP(s).

Although equipment cords are used to connect transmission equipment to the cabling subsystem, they are not considered part of the cabling subsystem because they can be application-specific. Service distribution cables shall be continuous from the service distributor to the SCP(s).

5.4.4 Design objectives

5.4.4.1 Service distribution cabling

Service distribution cabling should be designed to support the broadest set of existing and emerging applications within the environmental conditions defined in Clause 6 and therefore provide the longest operational life. This will minimize operational impact and the need for re-cabling.

Pathways shall be selected and pathway systems shall be installed in accordance with ISO/IEC 14763-2 to support the predicted quantity of SCPs and SOs taking into account predicted growth in the number and type of services to be supported by the cabling. This will minimize the disruption and cost of cable installation to those locations.

Cabling should be installed to support the predicted quantity of SCPs and SOs.

See Annex A for further information regarding the distribution and location of SCPs and SOs for different services.

5.4.4.2 Backbone cabling

Building backbone cabling should be designed for the entire life of the generic cabling system. However, it is common to adopt short-term approaches that support current and foreseeable application requirements, particularly where there is good physical access to pathways. The selection of campus backbone cabling can require a longer-term approach than that adopted for the building backbone, particularly if access to pathways is more limited.

5.5 Accommodation of functional elements

5.5.1 General

Figure 6 shows an example of how the functional elements are accommodated in a building.

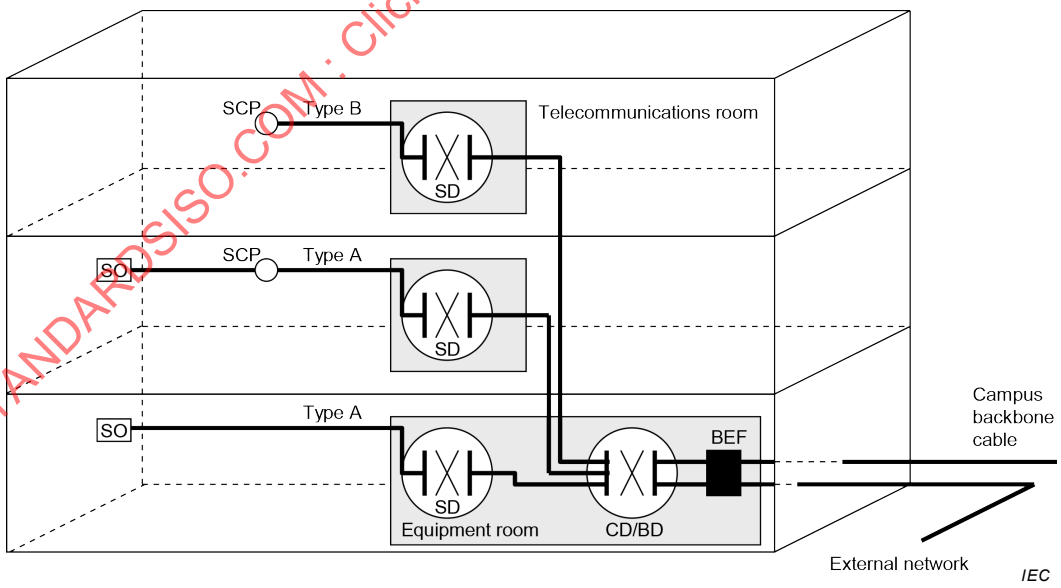


Figure 6 – Accommodation of functional elements

5.5.2 Accommodation of service outlets

SOs are located in the service area, depending on the design of the building.

5.5.3 Accommodation of service concentration points

5.5.3.1 Type A generic cabling

An SCP in generic cabling shall not be used to insert transmission equipment.

5.5.3.2 Type B generic cabling

An SCP may be used to insert transmission equipment. Any resulting cabling extending from the transmission equipment to the SO is not considered to be generic (i.e. outside the scope of this document). If the use of transmission equipment is anticipated, the location of the SCP shall take into consideration the availability of an adequate power supply and local safety regulations relating to the positioning of the transmission equipment.

If the terminal equipment (e.g. a security camera) is to be connected without the use of a plug-socket configuration of an SO (see Figure 2) then the SCP shall be implemented in close proximity to the terminal equipment to simplify maintenance should damage occur at or between the SCP and the terminal equipment (see Figure 7). This cabling is considered application specific.

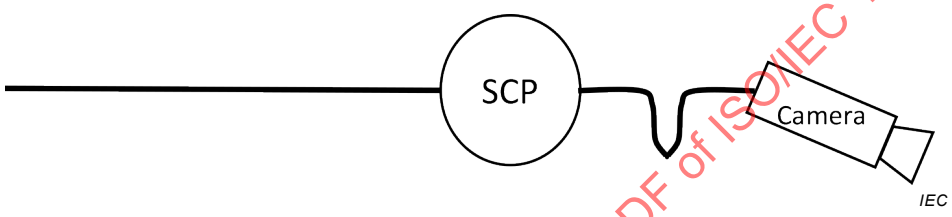


Figure 7 – Cabling without the use of an SO

Figure 8 shows examples of how terminal equipment can be interconnected to the network conversion interface installed at the SCP. For Type B generic cabling the configuration and type of cabling beyond the SCP is outside the scope of this document and Figure 8 is for information only.

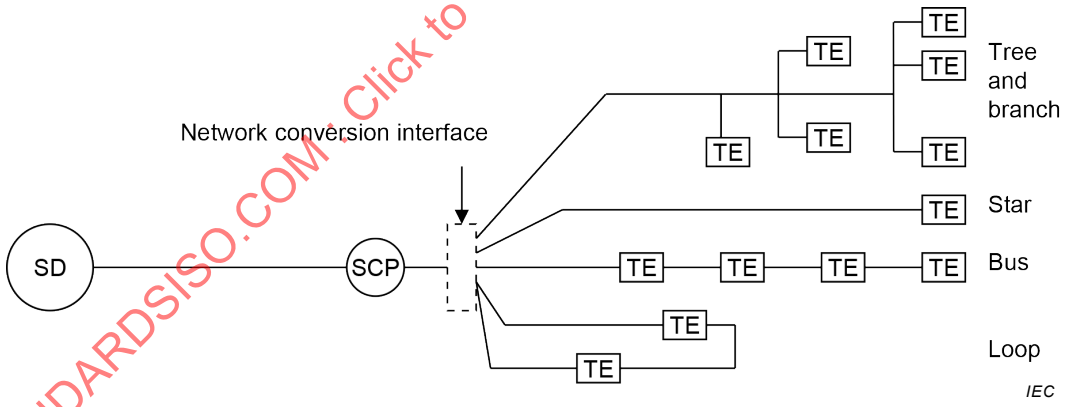


Figure 8 – Accommodation of TEs (Type B generic cabling)

5.6 Interfaces

5.6.1 Equipment interfaces and test interfaces

5.6.1.1 Type A generic cabling

In addition to the equipment interfaces specified in ISO/IEC 11801-1, potential equipment interfaces are located at the ends of the service distribution cabling subsystem (as shown in Figure 9). An SCP does not provide an equipment interface to the generic cabling system.

In addition to the test interfaces specified in ISO/IEC 11801-1, potential test interfaces are located at the ends of the service distribution cabling subsystem and at the SCP, if present. See Figure 9.

Figure 9 – Test and equipment interfaces (Type A generic cabling)

5.6.1.2 Type B generic cabling

In addition to the equipment interfaces specified in ISO/IEC 11801-1, potential equipment interfaces are located at the ends of the service distribution cabling subsystem (as shown in Figure 10).

In addition to the test interfaces specified in ISO/IEC 11801-1, potential test interfaces are located at the ends of the service distribution cabling subsystem (as shown in Figure 10).

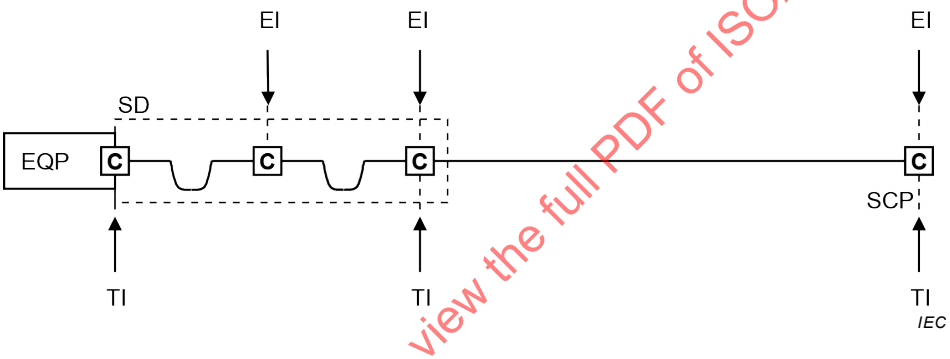


Figure 10 – Test and equipment interfaces (Type B generic cabling)

5.6.2 Channels and links

5.6.2.1 Type A generic cabling

The transmission performance of Type A generic cabling is detailed in Clause 6 in terms of the channel and in Clause 7 for links.

The channel is the transmission path between IT equipment such as a LAN hub (EQP in Figure 9) and the terminal equipment. A typical channel would consist of the service distribution cabling subsystem together with service area and equipment cords. For longer reach services, the channel would be formed by the connection of two or more subsystems (including service area cords and/or equipment cords). It is important that the generic cabling channel is designed to meet the required Class of performance for the applications that are to be run. For the purposes of testing, the channel excludes the connections at the application-specific equipment.

Links may be tested either during commissioning or for the detection of faults that are suspected in the cabling. For the purposes of testing, the link includes the connections at the ends of the cabling link under test.

5.6.2.2 Type B generic cabling

The transmission performance of Type B generic cabling is detailed in Clause 7 for links.

Links may be tested either during commissioning or for the detection of faults that are suspected in the cabling. For the purposes of testing, the link includes the connections at the ends of the cabling link under test.

5.7 Dimensioning and configuring

5.7.1 General

The number and type of subsystems that are included in a generic cabling implementation depends upon the geography and size of the campus or building, and upon the strategy of the user. Usually there would be one campus distributor per campus, one building distributor per building, and at least one service distributor per floor. If the premises comprise only a single building that is small enough to be served by a single building distributor, there is no need for a campus backbone cabling subsystem. Similarly, larger buildings may be served by multiple building distributors interconnected via a campus distributor.

The design of distributors should ensure that the lengths of patch cords, jumpers and equipment cords are minimized. The design lengths of the cords should be maintained during operation.

A minimum of one service distributor shall be provided for every floor; for floor spaces exceeding 1 000 m^2, a minimum of one service distributor should be provided for every 1 000 m^2 of floor space. If a floor space is sparsely populated (for example a lobby), it is permissible to serve this floor from the service distributor located on an adjacent floor.

If a floor area extends beyond 1 000 m^2, additional service distributors can be installed to more effectively service the service area.

It is possible to combine multiple functional elements into a single element.

For administration and maintenance of complex or large installations, an AIM system compliant to ISO/IEC 18598 should be considered.

Figure 11 shows an example of Type A generic cabling (the same general principles are applicable to Type B). The building in the foreground shows each distributor housed separately. The building in the background shows that the functions of a service distributor and the building distributor have been combined into a single distributor.

In certain circumstances, for example for security or reliability reasons, redundancy may be built into a cabling design. Figure 12 is a schematic diagram showing one of many possible examples of the connection of functional elements within the structured framework to provide such protection against failure in one or more parts of the cabling infrastructure. This might form the basis for the design of generic cabling for a building, providing some protection against such hazards as fire damage or the failure of the cables providing connection to external service provision.

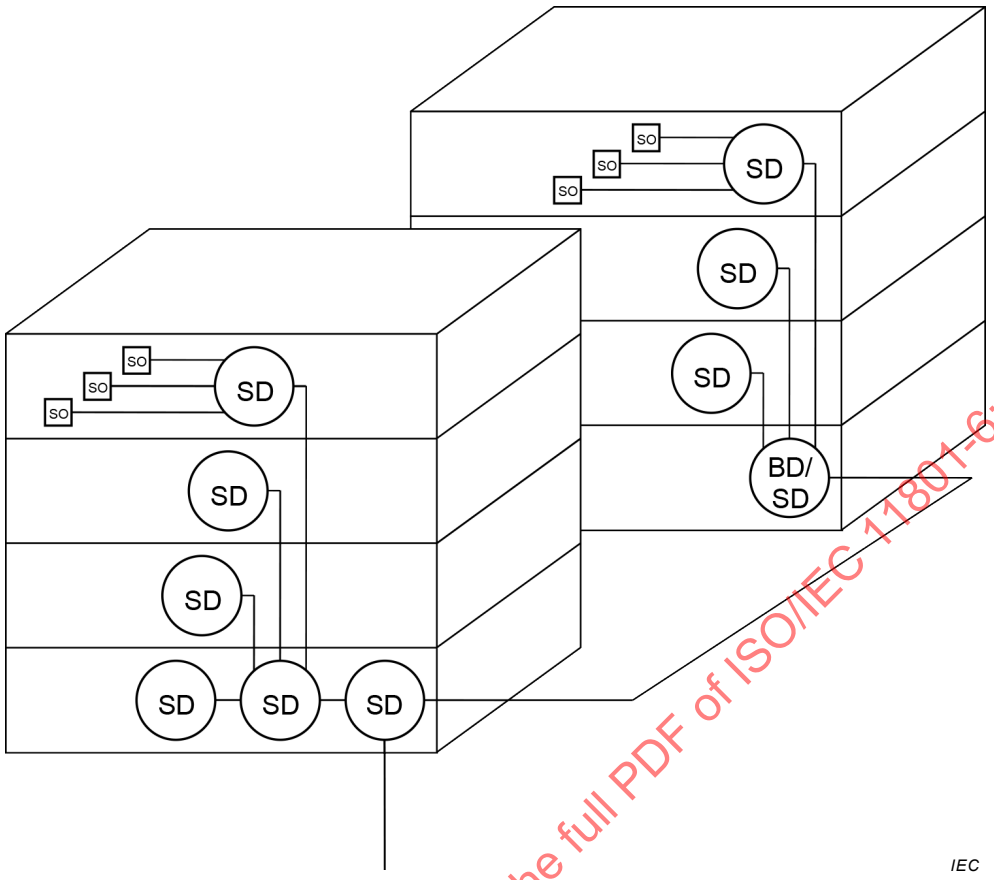


Figure 11 – Example of a Type A generic cabling system with combined BD and SD

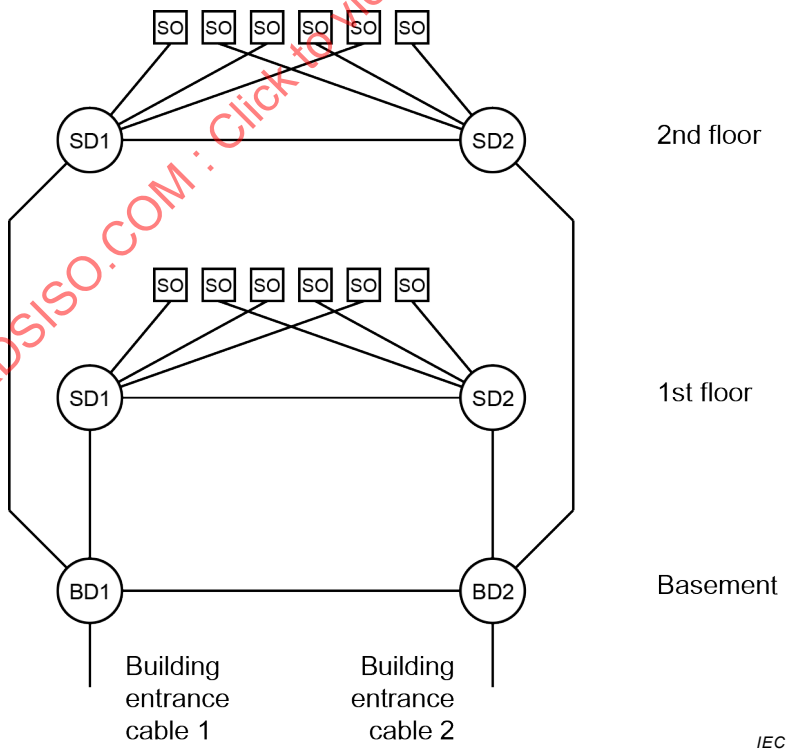


Figure 12 – Connection of functional elements providing redundancy for Type A generic cabling

5.7.2 Type A generic cabling

5.7.2.1 Balanced cabling

5.7.2.1.1 Distributors

Distributors should be located such that the resulting cable lengths are consistent with the channel performance requirements of Clause 6.

For the implementations described in Clause 8, using the components of Clause 9, Clause 10 and Clause 11, the maximum channel lengths in Table 1 shall be observed. In the case of the reference implementations described in Clause 8, distributors shall be located to ensure that the channel lengths in Table 1 are not exceeded.

Table 1 – Maximum channel lengths for Type A reference implementations

Channel	Length m
Service distribution	100
Service distribution + building backbone + campus backbone	10 000
NOTE In some implementations of the service distribution cabling subsystem in Clause 5, the SD might not support SOs up to the maximum distance shown.	

5.7.2.1.2 Service area cords and equipment cords

The service area cord connects the SO to the terminal equipment. Equipment cords connect transmission equipment to the generic cabling at distributors. Both are non-permanent and can be application-specific. Assumptions have been made concerning the length and the transmission performance of these cords; the assumptions are identified when relevant.

The performance contribution of these cords shall be taken into account in the design of the channel. Clause 8 provides guidance on cord lengths for reference implementations of generic cabling.

Where service area cords are located so that access to, and flexure of, the cords is uncommon during operation, the cords are not required to be constructed using flexible cables.

5.7.2.1.3 Patch cords and jumpers

Patch cords and jumpers are used within cross-connect implementations at distributors. The performance contribution of these cords shall be taken into account in the design of the channel. Clause 8 provides guidance on cord or jumper lengths for reference implementations of generic cabling.

5.7.2.1.4 Service outlet

The design of generic cabling should provide for SOs to be installed throughout the premises. A wide distribution of SOs will enhance the ability of the cabling to accommodate changes.

Each individual service area shall be served by a minimum of one SO and

a) the SO shall terminate a four-pair balanced cable in accordance with 10.2,

b) each SO shall have a permanent means of identification that is visible,

c) the location of the SO should take into account any need to prevent unauthorized access, disconnection or reconfiguration,

d) devices such as baluns and impedance matching adapters, if used, shall be external to the SO.

5.7.2.2 Optical fibre cabling

5.7.2.2.1 General

Type A generic cabling implemented using optical fibre cabling does not support remote powering.

5.7.2.2.2 Distributors

Distributors should be located such that the resulting cable lengths are consistent with the channel performance requirements of Clause 6. Maximum channel length is application dependent. See ISO/IEC 11801-1:2017, Annex E.

5.7.2.2.3 Service area cords and equipment cords

The service area cord connects the SO to the terminal equipment. Equipment cords connect transmission equipment to the generic cabling at distributors. Both are non-permanent and can be application-specific. The length of these cords shall be included in determining channel length.

5.7.2.2.4 Patch cords and jumpers

Patch cords and jumpers are used within cross-connect implementations at distributors. The length of these cords shall be counted in determining channel length.

5.7.2.2.5 Service outlet

The design of generic cabling should provide for SOs to be installed throughout the premises. A wide distribution of SOs will enhance the ability of the cabling to accommodate changes.

Each individual service area shall be served by a minimum of one SO and

a) the SO shall terminate an optical fibre cable in accordance with 10.3,

b) each SO shall have a permanent means of identification that is visible,

c) the location of the SO should take into account any need to prevent unauthorized access, disconnection and/or reconfiguration,

d) devices such as splitters, if used, shall be external to the SO.

5.7.3 Type B generic cabling

5.7.3.1 Balanced cabling

5.7.3.1.1 Distributors

Distributors should be located such that the resulting cable lengths enable the channel performance requirements of Clause 6 to be met, if SCP and SO connecting hardware, service concentration point cable and service area cord are installed.

For the implementations described in Clause 8, using the components of Clauses 9, 10 and 11, the maximum channel lengths in Table 2 shall be observed. In the case of the reference implementations described in Clause 8, distributors shall be located to ensure that the channel lengths in Table 2 are not exceeded.

Table 2 – Maximum channel lengths for Type B reference implementations

Channel	Length m
service distribution + distance to connected TE	100
service distribution + distance to connected TE + building backbone + campus backbone	10 000

5.7.3.1.2 Equipment cords

Equipment cords connect transmission equipment to the generic cabling at distributors and are non-permanent and can be application-specific.

5.7.3.1.3 Patch cords and jumpers

Patch cords and jumpers are used within cross-connect implementations at distributors. The performance contribution of these cords shall be taken into account in the design of the channel. Clause 8 provides guidance on cord or jumper lengths for reference implementations of generic cabling.

5.7.3.2 Optical fibre cabling

5.7.3.2.1 Distributors

Distributors should be located such that the resulting cable lengths are consistent with the channel performance requirements of Clause 6. Maximum channel length is application dependent. See ISO/IEC 11801-1:2017, Annex E.

5.7.3.2.2 Equipment cords

Equipment cords connect transmission equipment to the generic cabling at distributors. They are non-permanent and can be application-specific. The length of these cords shall be counted in determining channel length.

5.7.3.2.3 Patch cords and jumpers

Patch cords and jumpers are used within cross-connect implementations at distributors. The length of these cords shall be counted in determining channel length.

5.7.4 Service concentration point

Where an SCP is used

a) the SCP shall be located so that each service area is served by at least one SCP,

b) the SCP should be limited to serving a maximum of 36 SOs,

c) an SCP should be located in accessible permanent locations such as ceiling voids and under floors,

d) for balanced cabling, the effect of multiple connections in close proximity on transmission performance should be taken into consideration when planning the cable lengths between the service distributor and the SCP,

e) SCPs shall be labelled. Labelling and documentation shall comply with ISO/IEC 14763-2 requirements.

5.7.5 Connecting hardware

Connecting hardware shall only provide direct onward attachment for each conductor and shall not provide any contact between more than one incoming or outgoing conductor (e.g. bridge taps shall not be used).

5.7.6 Telecommunications rooms and equipment rooms

See ISO/IEC 11801-1.

5.8 Relevant building services

See Annex A.

6 Channel performance requirements

6.1 General

Clause 6 specifies the minimum channel performance of generic cabling at and between the connections to active equipment as shown in Figure 13 and comprises only passive sections of cable, connecting hardware, cords and jumpers.

The channel performance is specified as a combination of environmental performance and transmission performance.

The environmental classification of spaces served by generic cabling is described in 6.2.

The minimum requirements for the transmission of performance of cabling channels are specified in 6.3. The required transmission performance Class shall be met for all environmental performance Classes specified for the channel.

Compatibility between the structures and materials at the interfaces between these components and assemblies shall ensure that the required mechanical, environmental and transmission performance is maintained for the intended life of the cabling.

Where applications listed in ISO/IEC 11801-1:2017, Annex E are to be supported, the performance of the connections at the active equipment are the responsibility of the equipment supplier.

Application support depends on channel performance, which in turn depends on cable length, number of connections and performance of the components within the environments to which the channel is subjected.

Transmission and environmental performance shall be assured by the selection of cabling components suitable for the environmental Class(es) or by the use of pathway systems and installation practices that provide the required protection to the installed cabling.

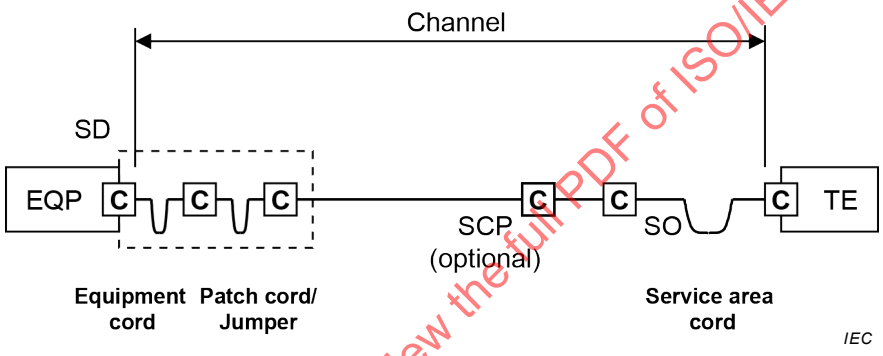


Figure 13 –Transmission performance of a service distribution channel

Channels are implemented using either

1) service distribution cabling only,
2) building backbone cabling only,
3) campus backbone cabling only,
4) combinations of the above.

Figure 14 shows an example of terminal equipment in the service area connected to transmission equipment using two channels: an optical fibre channel and a balanced cabling channel. The optical fibre and balanced cabling channels are connected together using an optical fibre to balanced copper cable converter. There are four channel interfaces; one at each end of the balanced channel, and one at each end of the optical fibre channel.

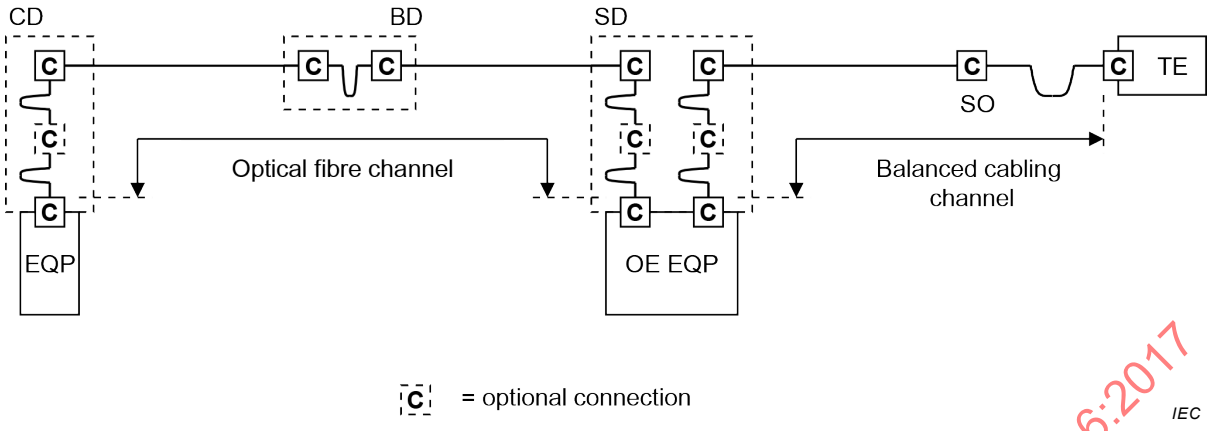


Figure 14 – Example of a system showing the location of cabling interfaces

6.2 Environmental performance

See ISO/IEC 11801-1.

6.3 Transmission performance

6.3.1 General

The channel transmission performance specifications of 6.3 allow for the transmission of the applications listed in ISO/IEC 11801-1.

The channel performance requirements described in 6.3 shall be used for the design and may be used for verification of any implementation of this document, using the test methods defined, or referred to, by 6.3. In addition, these requirements can be used for application development and troubleshooting.

The channel specifications in 6.3 allow for the transmission of defined Classes of applications over distances other than those of Clause 8, and/or using media and components with different transmission performance than those of Clause 9, Clause 10 and Clause 11.

Link performance requirements are specified in Clause 7.

6.3.2 Balanced cabling

6.3.2.1 Service distribution cabling (Type A generic cabling)

Service distribution cabling shall provide a channel performance as required from Classes E_A or higher as specified in ISO/IEC 11801-1, taking into consideration the requirements for application support over the lifetime of the cabling.

In the case of cable sharing, additional requirements shall be taken into account for balanced cabling. The additional crosstalk requirements are specified in ISO/IEC 11801-1:2017, 9.3.2.5.3.

6.3.2.2 Service distribution cabling (Type B generic cabling)

There are no channel performance requirements for Type B generic cabling. However, service distribution cabling shall provide link performance as required from Classes E_A or higher as specified in ISO/IEC 11801-1.

In the case of cable sharing, additional requirements shall be taken into account for balanced cabling. The additional crosstalk requirements are specified in ISO/IEC 11801-1:2017, 9.3.2.5.3.

6.3.2.3 Backbone cabling

Backbone cabling shall provide channel performance as required from Classes A to F_A as specified in ISO/IEC 11801-1:2017, 6.3.

In the case of cable sharing, additional requirements shall be taken into account for balanced cabling. The additional crosstalk requirements are specified in ISO/IEC 11801-1:2017, 9.3.2.5.3.

6.3.3 Optical fibre cabling

6.3.3.1 General

The selection of optical fibre components shall take into account the applications to be supported, and the required channel lengths, and should take into account any predicted changes to the applications to be supported during the expected life of the cabling.

Cabling shall be designed using the cabled optical fibres referenced in 9.3 to provide channel performance as required to support the relevant applications of ISO/IEC 11801-1:2017, Annex E for the following parameters:

a) channel attenuation;

b) channel length.

Channel performance shall meet the requirements of ISO/IEC 11801-1:2017, 6.5.

6.3.3.2 Service distribution cabling (Type B generic cabling)

Annex C describes the implementation of optical fibre cabling within the service distribution cabling of Type B generic cabling.

7 Link performance requirements

7.1 General

Clause 7 contains performance requirements for permanent links and SCP links as shown in Figure 15.

The cabling under test in Configurations A, B and C is termed the permanent link.

a) Configurations A and B comprise fixed cabling only.

b) Configuration C comprises fixed cabling and an SCP cable. Measurements made for this configuration are invalid if the SCP cable is changed.

The cabling under test in Configuration D contains fixed cabling only and is termed the SCP link.

In all configurations, the test configuration reference plane of a link is within the test cord cable next to, and including, the test cord connection which mates to the termination point of the link under test.

A link comprises only passive sections of cable and connections. Compatibility between the structures and materials at the interfaces between these components shall ensure that the required mechanical, environmental and transmission performance is maintained for the intended life of the cabling.

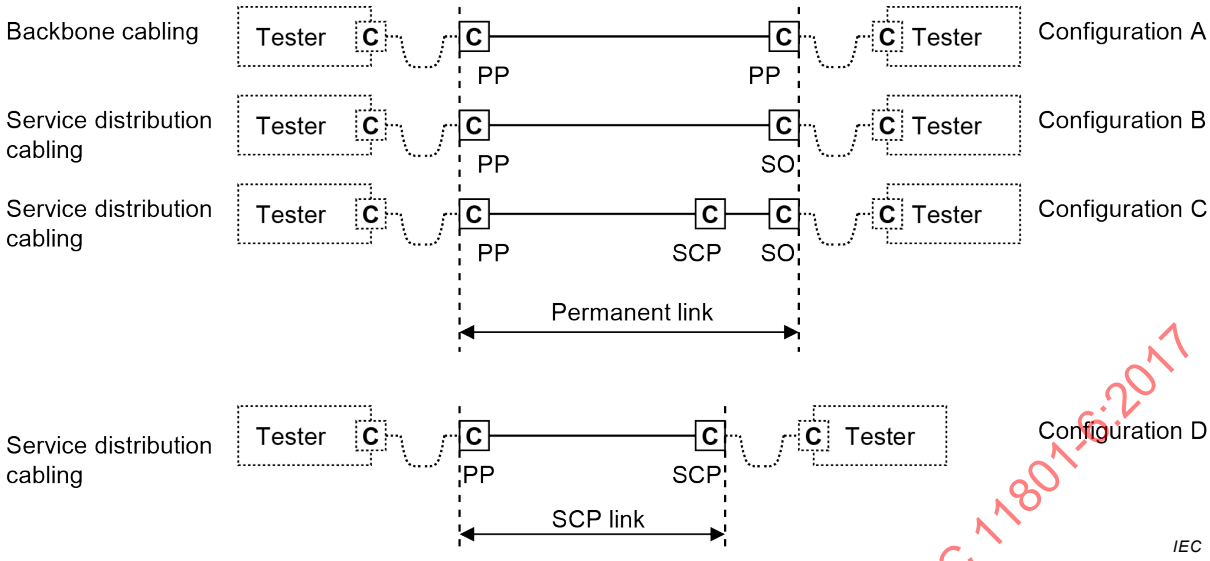


Figure 15 – Link options

7.2 Balanced cabling

Service distribution cabling shall provide link performance as required from Classes E_A or higher as specified in ISO/IEC 11801-1:2017, 7.2.

In the case of cable sharing, additional requirements shall be taken into account for balanced cabling. The additional crosstalk requirements are specified in ISO/IEC 11801-1:2017, 9.3.2.5.3.

7.3 Optical fibre cabling

Link performance shall meet the requirements of ISO/IEC 11801-1:2017, 7.4.

8 Reference implementations

8.1 General

Clause 8 describes implementations of generic cabling that utilize components referenced in Clause 9, Clause 10 and Clause 11. These reference implementations meet the requirements of 4 and, when installed in accordance with ISO/IEC 14763-2, comply with the channel performance requirements of 6.3, when subjected to the relevant environmental classifications of 6.2.

To ensure the integrity of the environmental performance of the cabling components, compatibility between cabling components shall be assured by design and in accordance with ISO/IEC 14763-2.

8.2 Balanced cabling

8.2.1 General

Balanced cabling components referenced in Clause 9, Clause 10 and 11 are defined in terms of Category. In the reference implementations of 8.2, the components used in each cabling channel shall have the same nominal characteristic impedance in accordance with ISO/IEC 11801-1.

The selection of balanced cabling components will be determined by the Class to be met. Refer to ISO/IEC 11801-1:2017, Annex E for supported applications by cabling Classes.

8.2.2 Service distribution cabling (Type A generic cabling)

8.2.2.1 Component choice

The Category of balanced cabling components within the service distribution cabling shall ensure that the channel achieves a minimum of Class E_A performance in accordance with 6.3.2.1.

Using the models of Figure 16

a) Category 6_A components or Category 8.1 components provide Class E_A balanced cabling performance,

b) Category 7 components provide Class F balanced cabling performance,

c) Category 7_A components or Category 8.2 components provide Class F_A balanced cabling performance,

d) Category 8.1 components cannot be used to provide Class F or Class F_A cabling performance.

The reference implementations described in 8.2.2 contain reductions in channel length where operating temperatures are in excess of 20 °C. In order to maintain specific channel lengths under such conditions (due to the effect of ambient temperature and/or the impact of applications supported by the cabling),

1) cables can be specified with lower insertion loss specifications than those detailed in 8.2.2.1,

2) appropriate protection can be provided to reduce the operating temperature of the channel.

Cables and connections of different Categories may be mixed within a channel; however, the resultant cabling performance will be determined by the Category of the lowest performing component.

8.2.2.2 Dimensions

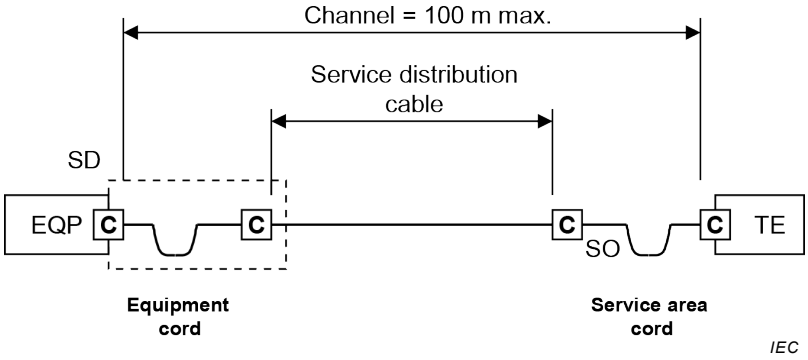
Figure 16 shows the models used to correlate service distribution cabling dimensions specified in 8.2.2.2 with the channel specifications in Clause 6.

Figure 16 a) shows a channel containing only an interconnect and an SO. Figure 16 b) contains an additional connection as a cross-connect. In both cases the fixed service distribution cable connects the SD to the SO. The channel includes cords comprising patch, equipment and service area cords. For the purposes of 8.2.2.2, jumpers used in place of patch cords are treated as cords.

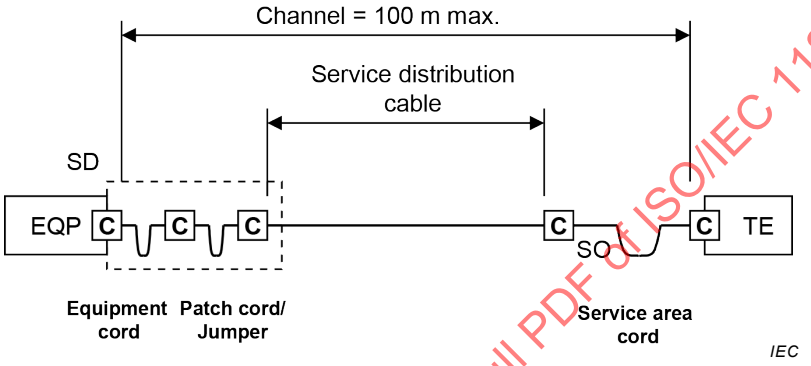
Figure 16 c) shows a channel containing an interconnect, an SCP and an SO. Figure 16 d) contains an additional connection as a cross-connect. In both cases the fixed service distribution cable connects the SD to the SCP. The channel includes cords comprising patch, equipment and service area cords. For the purposes of 8.2.2.2, jumpers used in place of patch cords are treated as cords.

In addition to the cords, the channels shown in Figure 16 c) and Figure 16 d) contain an SCP cable. The insertion loss specification for the SCP cable may differ from that of both the fixed service distribution cable and the flexible cables. The channel of Figure 16 d) is recognized as the maximum implementation used to define the channel performance limits of Clause 6.

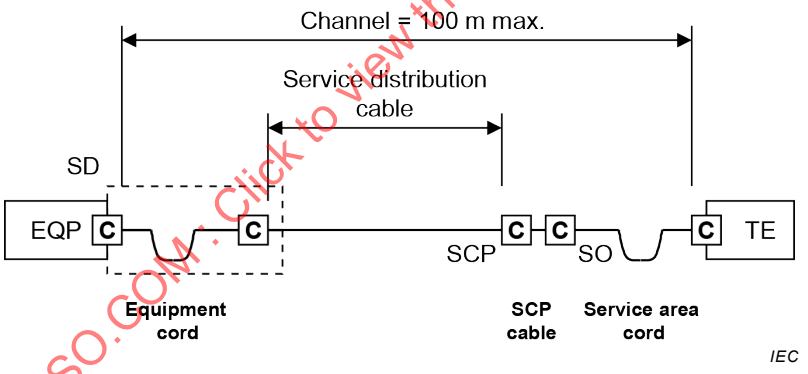
In order to accommodate cables used for service area cords, SCP cables, patch cords, jumpers and equipment cords with different insertion loss specifications, the length of the cables used within a channel shall be determined by the formulae shown in Table 3.



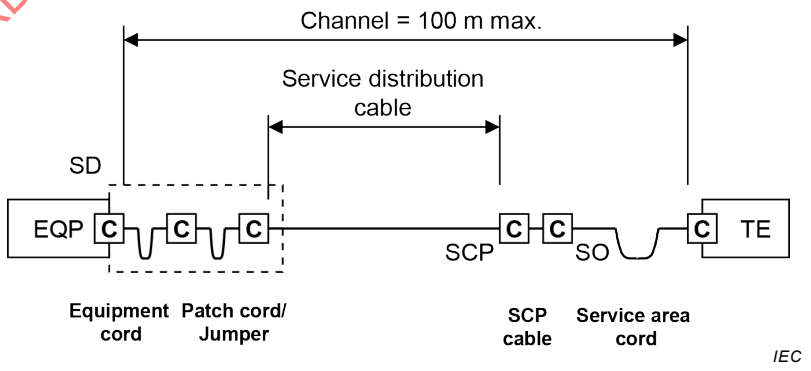
a) **Interconnect–SO model**



b) **Cross-connect–SO model**



c) **Interconnect–SCP–SO model**



d) **Cross-connect–SCP–SO model**

Figure 16 – Service distribution cabling models

In Table 3, it is assumed that

a) the flexible cable within these cords has a higher insertion loss specification than that used in the fixed service distribution cable (see 9.2),

b) the cables within these cords in the channel have a common insertion loss specification.

The implementations are based on component performance at 20 °C. The effect of temperature on the performance of cables shall be taken into account as shown in Table 3.

The following general restrictions apply.

- The physical length of the channel shall not exceed 100 m.
- The physical length of the fixed service distribution cable shall not exceed 90 m and can be less depending on the length of SCP cables and cords used and the number of connections.
- When an SCP is used, the fixed service distribution cable length should be at least 15 m in order to reduce the effect of multiple connections in close proximity on NEXT and return loss.
- The length of individual patch cords or jumpers shall not exceed 5 m.

The maximum length of the fixed service distribution cable will depend on the total length of SCP cables and cords to be supported within a channel. During the operation of the installed cabling, a management system should be implemented to ensure that the cords and, where appropriate, the SCP cables used to create the channel conform with the design rules for the floor, building or installation.

Table 3 – Service distribution channel length formulae in metres

Model	Figure	Implementation equations		
		Class E_A	Class F	Class F_A
Interconnect–SO	15a)	$l_s = 104 - l_a \times X$	$l_s = 105 - l_a \times X$	$l_s = 105 - l_a \times X$
Cross-connect–SO	15b)	$l_s = 103 - l_a \times X$	$l_s = 103 - l_a \times X$	$l_s = 103 - l_a \times X$
Interconnect–SCP–SO	15c)	$l_s = 103 - l_a \times X - l_c \times Y$	$l_s = 103 - l_a \times X - l_c \times Y$	$l_s = 103 - l_a \times X - l_c \times Y$
Cross-connect–SCP–SO	15d)	$l_s = 102 - l_a \times X - l_c \times Y$	$l_s = 102 - l_a \times X - l_c \times Y$	$l_s = 102 - l_a \times X - l_c \times Y$

l_s is the maximum length of the service distribution cable (m)

l_a is the combined length of patch cords, jumpers, equipment and service area cords (m)

l_c is the length of the SCP cable (m)

X is the ratio of the cable insertion loss (dB/m) within the cords/jumpers (see Clause 9) to the insertion loss of the service distribution cable (dB/m) of 7.2. Where the ratio differs in each cord/jumper, the value X shall take account of the relative lengths of the cords.

Y is the ratio of the insertion loss (dB/m) of the SCP cable – see Clause 9 – to the insertion loss (dB/m) of the service distribution cable of 7.2For operating temperatures above 20 °C, l_z should be reduced by 0,2 % per °C for screened cables and 0,4 % per °C (20 °C to 40 °C) and 0,6 % per °C (40 °C to 60 °C) for unscreened cables.

For operating temperatures above 20 °C, l_c should be reduced by

1) 0,2 % per °C for balanced screened cables up to 60 °C,
2) 0,4 % per °C for unscreened balanced cables up to 40 °C,
3) 0,6 % per °C for unscreened balanced cables between 40 °C and 60 °C.

These are default values and should be used where the actual characteristic of the cable is not known.

Manufacturer's or supplier's information shall be consulted where the intended operating temperature exceeds 60 °C.

8.2.3 Service distribution cabling (Type B generic cabling)

8.2.3.1 Component choice

The Category of balanced cabling components within the service distribution cabling shall ensure that the link achieves a minimum of Class E_A performance in accordance with 7.2.

Using the model of Figure 15, Configuration D

a) Category 6_A components or Category 8.1 components provide Class E_A balanced cabling performance,

b) Category 7 components provide Class F balanced cabling performance,

c) Category 7_A components or Category 8.2 components provide Class F_A balanced cabling performance,

d) Category 8.1 components cannot be used to provide Class F or Class F_A cabling performance.

The reference implementations described in 8.2.3 contain reductions in channel length where operating temperatures are in excess of 20 °C. In order to maintain specific channel lengths under such conditions (due to the effect of ambient temperature and/or the impact of applications supported by the cabling), it may be necessary to either

a) specify cables with lower insertion loss specifications than those detailed in 8.2.3.1,

b) provide appropriate protection to reduce the operating temperature of the channel.

Cables and connections of different Categories may be mixed within a channel; however, the resultant cabling performance will be determined by the Category of the lowest performing component.

8.2.3.2 Dimensions

The following general restrictions apply.

a) The physical length of the channel between the equipment located in the SD room and the terminal equipment shall not exceed 100 m.

b) The physical length of the fixed service distribution cable

   1) shall not exceed 90 m,

   2) should be at least 15 m in order to reduce the effect of multiple connections in close proximity on NEXT and return loss.

c) The length of individual patch cords or jumpers at the SD shall not exceed 5 m.

8.2.4 Campus and building backbone cabling

See ISO/IEC 11801-1:2017, 8.2.

8.3 Optical fibre cabling

8.3.1 Service distribution cabling (Type A generic cabling)

8.3.1.1 General

Optical fibre cabling does not support remote powering.

Optical fibre components are referenced in Clauses 9, 10 and 11. The optical fibres are defined in terms of physical construction (core/cladding diameter) and their transmission performance Category within a cable.

Within the reference implementations of 8.3.1, the optical fibres used in each cabling channel shall have the same physical construction specification and the cabled optical fibres shall be of the same Category.

When more than one physical construction or cabled optical fibre Category is used in a cabling subsystem, the cabling shall be marked to allow each cabling type to be clearly identified.

8.3.1.2 Component selection

The selection of optical fibre components shall be determined by the channel lengths required and the existing and anticipated applications to be supported. Refer to ISO/IEC 11801:2017, Annex E for guidance.

8.3.1.3 Dimensions

The model of Figure 16 is applicable to optical fibre cabling for service distribution cabling. The channel length is limited by channel length restrictions of the cabled optical fibre Category used (see ISO/IEC 11801-1:2017, Annex E). It should be noted that the connection system used to terminate optical cabling can contain mated connecting hardware and splices (permanent or re-useable) and that cross-connects can comprise re-useable splices.

In order to accommodate increased quantities of mated connections and splices used within a channel, the total length of the channel is typically to be reduced to accommodate the additional attenuation.

Additional connections may be used if the maximum channel insertion loss (or optical power budget, as applicable) of the application allows (see ISO/IEC 11801-1:2017, Annex E).

8.3.2 Service distribution cabling (Type B generic cabling)

See Annex C.

8.3.3 Campus and building backbone cabling

See ISO/IEC 11801-1:2017, 8.3.

9 Cable requirements

9.1 General

Clause 9 defines the minimum requirements for

a) cables installed in the service distribution and backbone cabling subsystems specified in Clause 5 and used in the reference implementations of Clause 8,

b) flexible balanced cables to be assembled as cords as specified in 11.2 and used in the reference implementations of Clause 8,

c) balanced cables or cable elements to be used as jumpers.

9.2 Balanced cables

Balanced cables shall meet the requirements of ISO/IEC 11801-1:2017, 9.3.1 and 9.3.2.

9.3 Optical fibre cables

Cabled optical fibres shall meet the requirements of 11801-1:2017, 9.5.

10 Connecting hardware requirements

10.1 General requirements

In addition to those locations specified in ISO/IEC 11801-1, connecting hardware is installed

a) at the SCP (if provided),

b) at the SO.

10.2 Connecting hardware for balanced cabling

10.2.1 General requirements

See ISO/IEC 11801-1:2017, 10.1.

10.2.2 Electrical, mechanical and environmental performance

10.2.2.1 Connecting hardware at the service outlet for Type A generic cabling

For implementations of the SO as a plug-socket connection, the SO shall be a fixed connector in accordance with ISO/IEC 11801-1:2017, 10.2 and 10.6 or 10.7.

NOTE For proper connectivity, care is needed to ensure that pairs are terminated consistently at the SO and SD. If pairs are terminated on different positions at the two ends of a link, although DC continuity can be maintained, transmission connectivity can be lost or compromised.

10.2.2.2 Connecting hardware at other locations

The following requirements apply to connecting hardware at all other locations than the SO.

See ISO/IEC 11801-1:2017, 10.1

10.3 Connecting hardware for optical fibre cabling

See ISO/IEC 11801-1:2017, 10.1, 10.5, 10.11, 10.12 and 10.13.

11 Cords

11.1 Jumpers

See Clause 9.

11.2 Balanced cords

See ISO/IEC 11801-1:2017, 11.3.

Factory terminated balanced cords should be used.

11.3 Optical fibre cords

See ISO/IEC 11801-1:2017, 11.5.

Annex A
(informative)

Services and applications

A.1 Overview

Annex A contains information to assist the implementation of cabling in accordance with this document to support a range of diverse services. In particular, it provides recommendations in relation to the distribution and location of SCPs and SOs for specific services.

Each service required for the project shall be considered in determining the density of SCPs and SOs. Depending on their applications or function, devices may have overlapping service areas. For example, devices supporting multiple intelligent building systems applications may serve the same building space. A floor space with adjacent service areas in an open office environment may be served with an SCP for several devices. Spare growth capacity should also be considered when designing the cabling infrastructure. The use of a wide variety of sensors in buildings is expected to grow rapidly over the years following the publication of this document.

If using the reference implementation of Clause 8, the maximum length of a cord should be limited to 5 m. SOs should not be placed more than 10 m apart to allow all positioning of equipment.

To calculate the needed number of SOs, a list of supported applications and numbers of SOs needed for each shall be prepared on a per room basis. Alternatively, the number of SOs can be calculated accordingly to A.4.

If SOs are widely distributed where equipment is to be placed, this will limit the length of cords used between SO and equipment but the result might also be that an SO needs to be moved at a later time to support replaced equipment with a different configuration. The deployment of SCPs on permanent building structures can assist to ensure more flexibility during the lifetime of the building.

The guidance in Annex A describes the deployment of SOs. When installing Type B generic cabling each SO should be substituted with a connection at the SCP.

A.2 Service sectors and services

A.2.1 Access control

A.2.1.1 Door entry controls

To allow communication to access control systems at least one SO should be placed above each door in the building. The outlet should be placed inside the room (e.g. on the secure side of the access control system).

A.2.1.2 Surveillance cameras

Security cameras are used for two basic purposes: investigation and deterrence, SOs should be installed

a) at entrances and exits to the building or building sections,

b) at transition points within the building,

c) in areas of business importance, high risk or valuables,

d) in secluded areas within or outside buildings.

When planning for outdoor cameras, at least one SO should be installed on each exterior wall of the building. It is often beneficial if the SOs can be installed inside the building. If additional illumination is required at a camera position, an additional SO should be installed for this purpose.

A.2.1.3 Time and attendance monitoring

To facilitate time and attendance systems, at least one SO should be installed inside employee entrance doors.

A.2.2 Burglar alarms

While it is possible to install a burglar alarm system utilizing a structured cabling system, local regulations might have installation requirements that prevent this type of installation.

To support a burglar alarm system, SOs should be installed at each opening (i.e. door or window) in the outer shell of the building as well as in main walkways and building sections within the building.

A.2.3 Asset management

A.2.3.1 General

Asset management systems can use many different types of communications including a wireless system as described in A.2.11.

A.2.3.2 Radio-frequency identification

To facilitate radio-frequency identification (RFID) systems, at least one SO should be placed at each antenna position. Antennas are often placed at the doors of rooms or between building sections, depending on the granularity of the system.

A.2.4 Audio-visual

A.2.4.1 Audio

To facilitate sound and music systems, at least one SO should be installed in rooms where multiple employees may be present.

A.2.4.2 Video projection

In all meeting rooms, at least two SOs should be installed to allow both video and network connections to projectors.

A.2.5 Building information systems

A.2.5.1 Central clock systems

To facilitate central clock systems, at least one SO should be installed in rooms where multiple employees may be present.

A.2.5.2 Electronic signage

To facilitate general electronic signage, SOs should be installed in reception areas and at transition points within the building. To facilitate electronic signage at meeting rooms, an SO should be placed outside each meeting room in the building.

A.2.5.3 Distributed sensor systems

To allow monitoring of the use of building spaces and rooms, sensors should be placed in a grid covering all building spaces. The grid should be dense enough to give detailed information on the use of the spaces. A radius of 1,5 m to 3 m is recommended.

A.2.6 Building well-being and structural sensor systems

Within building structures, sensors registering parameters such as vibration and structural stress can be installed to monitor events from earthquakes to excessive floor loading. As such sensors are often embedded within the building structure, more sensors than needed should be installed to allow for potentially defective sensors over the lifetime of the building.

A.2.7 Energy management

A.2.7.1 Utility meters

Utility metering is normally done where the service enters the building and where the service is delivered to separate tenants or parts of the building. This should be taken into account when planning the number of SOs in the building.

A.2.7.2 Power distribution monitoring and control

Modern power distribution panels are able to meter and control power, sometimes down to the "per fuse" level. To accommodate this, at least one SO should be located at each power distribution panel.

A.2.7.3 Lighting control

Lighting can be controlled per fixture, per row of fixtures or on a per-room basis dependent on the design of the lightning control system. In general, a more granular control system will give more accurate control and thereby higher comfort level and power savings. At least one SO should be installed per room to accommodate lighting control.

A.2.8 Environmental control

A.2.8.1 Heating and cooling

To monitor or control temperature, at least one SO should be installed per room.

A.2.8.2 Window and blind control

To support monitoring and control of window opening or window blinds, an SO should be installed at each window of the building.

A.2.8.3 Humidity monitoring

To monitor or control humidity, at least one SO should be installed per room.

A.2.8.4 Airflow monitoring

To monitor airflow in heating, ventilation and air conditioning (HVAC) systems, an SO should be placed at each damper position.

A.2.8.5 Air quality monitoring

To monitor and control air quality, carbon dioxide sensors are often deployed on a per-room basis. At least one SO should be installed per room.

A.2.8.6 Weather station

To support the deployment of a weather station to monitor outside conditions and supply data for other systems (e.g. HVAC, window blinds), at least one SO should be installed.

A.2.9 Fixed information technology services

In installations where cabling according to this document is the only structured cabling system deployed, there might be a need for SOs to service fixed IT equipment (e.g. personal computers, printers, telephones).

A.2.10 Personal well-being

A.2.10.1 Patient monitoring

To facilitate patient monitoring systems, at least one SO should be installed at each patient room or treatment location.

A.2.10.2 Nurse call

To facilitate nurse call systems, at least one SO should be installed at each patient room or treatment location.

A.2.11 Shared information technology services

A.2.11.1 General

A.2.11 is applicable to, but not restricted to, the wireless applications listed in Table A.1. Certain proprietary wireless equipment has a typical indoor range less than 12 m.