University of Oxford IT Services
Infrastructure Installation Specification Strategy

IISS-00-002:
Infrastructure Installation Specification Strategy: Distributed building services

1 INTRODUCTION

This document addresses the use of common cabling infrastructure for distributed building services in accordance with BS EN 50173-6 (and the technically equivalent ISO/IEC 11801-6) - supporting multiple services and for use by multiple disciplines within the University “organisation”.

The contents of this document are predominantly non-technical and it describes the concepts and how they affect the building at the ownership level i.e. the options for shared pathways and spaces and the operational management of connections to that infrastructure.

The implementation of the cabling itself is assumed to be in accordance with the strategies and specifications of IISS-00-001.

The development of solutions providing the powering of remote end-devices over conventional structured cabling has led to a rapid growth in the type of end-devices and associated control equipment covering a wide range of non-user specific services such as:

- mobile telephony via distributed antenna systems (DAS);
- non-fixed IT connections via wireless access points (WAP);
- a substantial volume of building management services including:
  - energy management, e.g. lighting, power distribution, incoming utility metering;
  - environmental control, e.g. temperature, humidity;
  - personnel management, e.g. access control, cameras, passive infra-red (PIR) detectors, time and attendance monitoring, electronic signage, audio-visual (AV) projectors;
- personal information and alarms, e.g. paging, patient monitoring, nurse call, infant security.

The advantages offered by this convergence of service on to a single infrastructure are reviewed in clause 2.

The vast majority of these end-devices contain IP addressable circuitry and the communications systems adopt the standards developed by IEEE which have defined power levels. However not all such devices conform to these power levels and a degree of caution is required (see 3.2.1).

The specification of the cabling design and installation is predominantly a matter for the telecommunications department who are responsible for the IT services which are the technically most demanding services.

However, the diverse range of services which can be provided suggests that the personnel and/or departmental organisations selecting the systems will be equally diverse.

It is critical to realise that traditional IT services (fixed and mobile) will become a minor “customer” of the infrastructure and the dominant disciplines will be building management and security - but all the services have to retain their functionality independent of the mix of services within a given cable bundle or within a given pathway system.

The primary impacts of this radical change are:

1) the need to manage the loading on the infrastructure of remote powering to control potential cable heating which reduces transmission lengths for certain services;
2) the need to provision adequate capacity in infrastructure design in terms of shared pathways and spaces - since the number of building services capable of being supported is increasing rapidly due to the conversion of existing proprietary solutions to IP technologies and also by the development of new service opportunities such as building construction sensors;
3) the re-provisioning of the LV distribution cabling to the spaces served by the common infrastructure and the associated additional provision of LV supplies to the “comms rooms” to support the desired volume of remote powering solutions;
4) the heat dissipation from the infrastructure on the HVAC system.

Clause 3 of this document introduces these impacts and provides information on their management.

2 ADVANTAGES OF CONVERGENCE

The perceived degree of advantage offered by convergence of multiple systems on to a single infrastructure is very much dependent on the objectives of a given client. However, the following aspects have some traction in many cases.

The infrastructure (cabling component selection, design rules, acceptance testing etc.) is subject to national standards - in this case BS EN 50173-6. This simplifies the management of installation contracts.

The use of a common infrastructure, and normally a common communication protocol, greatly enhances the choices of system solution for each service rather than each service having its own proprietary cabling solution. This increases competition and reduces cost - and encourages system providers to differentiate their solutions by means of useful features rather than the “single-supplier dogma” resulting from clients having become trapped by a specific cabling solution.

The move from fixed IT infrastructures of the type specified in BS EN 50173-2, where outlets are dedicated to a “user” (or specific area) to a new structure in accordance with BS EN 50173-6 produces a grid structure of outlets which are no longer user-specific. As a result the outlets are “agile” in function and therefore may change, for example, from a providing a connection to a lighting fixture to controlling a camera as required by changing demands of the building space.

The system level management of the inputs from the various devices may support new ways of monitoring and managing space utilisation in buildings - which in many cases is the most expensive asset.

Energy efficiency is often mentioned with more granular control of devices allowing savings in power usage. However, there is a breakeven point between increased levels of power delivered over the common infrastructure and the reduced energy efficiency with which it is distributed. However, design decisions may address this point and ultimately the flexibility of the outlets in terms of service conversion may become more important than the efficiency aspects.

3 MANAGING THE IMPACT OF CONVERGENCE

3.1 General

The future implementation of common infrastructure within University premises with a preference for IP-enabled end devices - although other solutions will be considered if IP management is included at the “distributor’ level - is a natural progression and offers considerable benefits but requires radically new approaches in terms of infrastructure ownership.

Convergence of multiple services on to structured cabling is not new. The structured cabling that is now ubiquitous in the vast majority of buildings was initially established to allow multiple data networks to operate over a common communications medium. This could be considered to be Convergence: Stage 1. This resulted in a huge simplification of service levels agreements and maintenance contracts for the different networks.

Convergence: Stage 2 occurred when voice (in the form of both analogue and IP solutions) merged with data services over that single infrastructure.

Convergence: Stage 3 saw the overlay of wireless networking over the structured cabling infrastructure.

Finally, we have Convergence: Stage 4 - where the range of services supported by the structured cabling has moved outside the IT domain.

At each stage of convergence, the "network" managers within an organisation have had to consider how to manage the connections to the cabling infrastructure to ensure delivery of services - without risk to the other networks. This was perhaps most obvious at Stage 2 which frequently led to the establishment of new groups sometimes entitled "telecommunications infrastructure" formed from, but independent of, the voice and data departments.

However, despite the apparent similarities to this earlier "revolution", the present convergence process is fundamentally different because it affects participants who have limited understanding of the technologies involved and are not used to working with the other disciplines.

Nevertheless, the implications are the same - **the common infrastructure has to be managed by an access provider which is separate from the provider of the services supported**. In the case of the University this is the "Estates" function and where necessary they need to be trained to manage the design, planning and operational management processes necessary for this new environment.

3.2 Pathway design and power loading

3.2.1 Powering solutions

The recognised standards body producing standards for remote powering over structured cabling is IEEE.

Within their 802.3 series of standards:
- IEEE 802.3af: defined a power supply over 2 pairs (4 conductors) with 350 mA per pair (i_c = 175 mA);
- IEEE 802.3at: defined two solutions in which the IEEE 802.3af solution is re-defined as IEEE 802.3at Type 1 (sometimes referred to as PoE) and IEEE 802.3at Type 2 (sometimes referred to as PoEP or PoEplus) which is defined as power supply over 2 pairs (4 conductors) with 600 mA per pair (i_c = 300 mA).
- IEEE P802.3bt:2018 builds on 802.3at by using all four pairs to provide Type 3 and Type 4 powering with currents per pair of up to approximately 920 mA (i_c = 460 mA). No proposals are being made to amend the necessary cabling component specifications (to support backwards compatibility) and therefore careful consideration is being given to planning and operational requirements and recommendations.

In all these standards, a four pair cable will supply a load using either 2 or 4 pairs as shown in Figure 1.

A 2-pair powering solution supplies a current to the load using the two conductors of a balanced pair cable element and returns that current from the load using the two conductors of another pair.

A 4-pair powering solution supplies a current to the load using the four conductors of two balanced pair cable elements and returns that current from the load using the four conductors of two other pairs.

It has also to be pointed out that some remote powering solutions are specified to supply powers substantially above those offered or planned by IEEE. It is critical to note that solutions outside the IEEE domain include:
- **extra low voltage (ELV) circuits at higher currents than those described above**
  The term "Power over Ethernet" is not owned by IEEE and a number of solutions with i_c substantially above 500 mA use the term "Power over Ethernet" in their literature.
  The impact of cable bundle heating and damage to connecting hardware (see 3.2.3) is a cause for concern.
- **low voltage (LV) circuits**
  The cables and connecting hardware of Category 5 and above used in structured cabling systems in accordance with the BS EN 50173 series and equivalent standards are required to exhibit dielectric withstand of 1000 VAC and this sometimes encourages ill-informed users to consider their use for remote powering at mains voltages. As a general rule, such cables are only required to support sustained voltages of 75 VDC.

In both of the situations highlighted, **implementers are reminded of their responsibilities under the Electricity at Work Act and no such solution should be considered unless a full and detailed assessment has be undertaken in relation to the management of risk**.

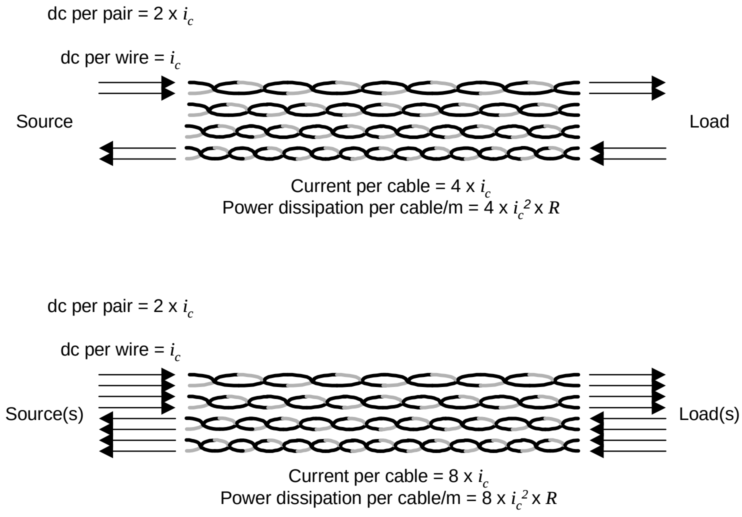


Figure 1: Basic current feeding schematic

3.2.2 Fundamental design and planning issues

3.2.2.1 BS PD CLC/TR 50174-99-1

A European Technical Report (CLC/TR 50174-99-1) was published by BSI in early 2015 which addressed the planning and installation issues associated with the increased use of cables and connecting hardware of the BS EN 50173 series standards for the distribution both standardised and proprietary implementations of ELV d.c.

It also contains testing protocols and mathematical modelling tools to support its contents. Some of its outcomes are detailed below.

3.2.2.2 BS EN 50174-1:2018 and BS EN 50174-2:2018

The design, planning and operational guidance resulting from the work on BS PD CLC/TR 50174-99-1 has been transposed and further developed into requirements and recommendations of BS EN 50174-1:2018 and BS EN 50174-2:2018. Later clauses in this document reflect those practices.

3.2.2.3 IET Code of Practice for Low and Extra Low Voltage Direct Current Power Distribution in Buildings

The IET has produced a document which contains, in part, the contents of BS PD CLC/TR 50174-99-1. However, this document has not been revised since its publication in 2015 and its contents are far behind the specification, planning and installation requirements of BS EN 50174-1:2018 and BS EN 50174-2:2018.

3.2.3 The technical impact of remote powering on structured cabling

3.2.3.1 General

Structured cabling was not originally intended to carry current other than signal current. As a result, the delivery of d.c. over those components raises two main issues:

- increases in the operating temperature of the cables:
    - channel performance degradation (the result of general heating along the entire length of the cable);

- component performance degradation (risking damage to the performance of the cable at a temperature "pinch-point");
- damage to connecting hardware contacts where mating and de-mating occurs while the power supply current is flowing.

3.2.3.2 Cable heating

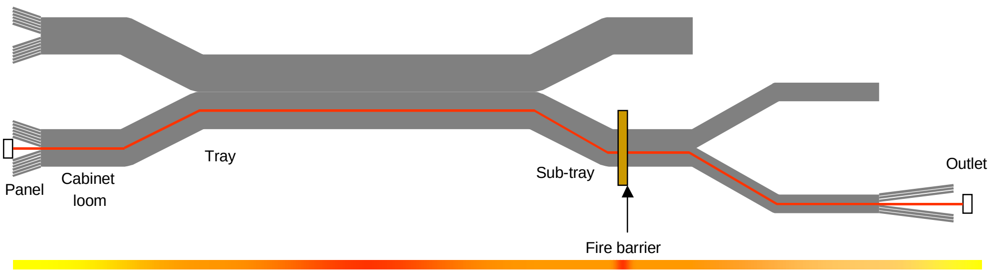
With regard to the heating of the cables:

- each metre of installed length becomes subject to some level of temperature increase but the actual temperature increase depends upon the current employed, the d.c. resistance of the cables, the number of cables in a bundle and the degree of ventilation (or worse, the presence of insulation) surrounding the cables and/or cable bundles;
- the temperature increase has a negative impact on the attenuation of the installed cabling which, unless managed, may reduce the distance over which networks can be delivered;
- if a localised temperature increase breaches the maximum operating temperature of the cable, the construction of the cable becomes permanently damaged.

Figure 1 shows the typical changes in bundle sizes as a cable starts at a patch panel (left-hand side), is bundled within the cabinet loom, then enters larger bundles (or bundles of bundles) along the main pathways infrastructure before the bundles begin to be diluted as the cable is routed towards its final destination.

At any point the cable bundles could be fully ventilated (perhaps running on wire basket), or lying on floors, or confined within trunking or conduit or even passing through fire barriers where the level of insulation is comparatively high. As a result, the temperature seen by the cables along the route may vary considerably - as may the ambient temperature before any cable heating is considered. In order to both limit the impact of length restrictions and also to prevent permanent damage, it is desirable to minimise the possible temperature increases.

It should be noted that in all cases, the relevant cable temperature is that any increases due to remote powering in addition to that of the ambient temperature (which is rarely as low as 20 ºC).



Unscreened cabling	$H = \dfrac{H_{20}}{1+\sum_{l=1}^{l=H} l_i \times \left(0.004\times\left(\left(T_{ambient}+T_{power}\right)-20\right)+0.006\times\left(\left(T_{ambient}+T_{power}\right)-40\right)\right)}$ for 20 ≤ T ≤ 40 °C for 40 ≤ T ≤ 60 °C
Screened cabling	$H = \dfrac{H_{20}}{1+\sum_{l=1}^{l=H} l_i \times \left(0.002\times\left(\left(T_{ambient}+T_{power}\right)-20\right)\right)}$ for 20 ≤ T ≤ 60 °C

Figure 1 - Impact of increased temperature

Global heating (channel performance degradation)

The commonly assumed 90 metre maximum length of installed cabling is actually only valid at temperatures of 20 ºC.

> The signal attenuation increase is assumed to be, for operating temperatures above 20 °C, 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.

In order for the cabling performance to meet a given performance Class at higher temperatures, the length of the channel has to be reduced accordingly. The reduction in length that should be applied is specified in BS EN 50173-6 and the more general form of this reduction is shown in the equations of Figure 1.

It should be pointed out that these length restrictions apply due to a combination of ambient temperature (T_{amb}) and the additional temperature caused by remote power supply ambient temperature (T_{power}).

Table 1 - The impact of temperature on channel length

	Total length of cords (m)		
	10	15	20
Temperature (ºC)	Channel length (m)		
20	100	98	95
25	98	96	93
30	97 (95*)	94 (93*)	91 (90*)
35	95 (93*)	92 (90*)	89 (87*)
40	93 (90*)	90 (88*)	87 (86*)
45	90 (88*)	87 (85*)	85 (83*)
50	86 (85*)	84 (83*)	82 (81*)
55	83	81 (80*)	79 (78*)
60	80	78	76
The values marked with an asterisk are those of a future ISO/IEC 14763-2 in which a modified calculation was applied. It is expected that this will be transposed into EN 50174-2 in a future amendment.			

Table 1 (taken from BS EN 50174-2:2018) provides general guidance on the reduction of channel and link lengths which can be applied to all cabling using cables specified in the reference implementations of the standards (i.e. independent of cable construction). BS EN 50174-2:2018 also contains information on the calculation of the applicable “global” temperature.

It should be noted that testing the transmission parameters of the installed infrastructure immediately following its installation will not show any impact of increased ambient temperature as the cables will not be “under load” so planning of cable lengths has to take into account the predicted temperature increases.

Localised heating (component performance degradation)

Cables specified in the reference implementations of the cabling standards are required to operate at temperatures of at least 60 ºC. Therefore, the selection of cables is critical if the cable design - and installation-related factors indicate that cable temperature will exceed this value due to the current levels specified.

Cable suppliers may provide products that have specified maximum operating temperatures in excess of this requirement. The current applied to cables, in conjunction with the intended ambient temperature, should not cause their operating temperature to rise above that specified by the cable supplier.

The temperatures reached by bundles of cables depend upon the power applied to the bundles, the number of cables in the bundle and on the installation conditions.

Obviously cables routed in insulation or where airflow is poor will experience higher temperatures than those in well ventilated conditions. It has been determined that bundles lengths in excess of 2,5 m will experience the full impact of the installation condition (since axial cooling along the cables does not occur) and this should be taken into account when planning cable pathways. If there are concerns about such temperature "pinch-points" it may be useful to consider the installation of a temperature sensor on the surface of the cable bundles which should be linked to an alarm set to an appropriate temperature limit (50 ºC would be a generalised limit).

3.2.3.3 De-mating under load

The connecting hardware of the cabling standards is required to support a continuous operating current of at least 0,75 A per conductor at 20 ºC falling to 0,5 A per conductor at 60 ºC

At this time, it is not considered likely that standards-based remote powering solutions will exceed the 0,5 A value - **but proprietary systems may do**. Connecting hardware suppliers may provide products that have specified maximum operating currents in excess of this requirement.

A more relevant concern is the risk of damage to the contacts of, or the circuitry embedded within, the connecting hardware when those contacts de-mated under load (i.e. when carrying current).

NOTE: this is not a problem during mating as the power source negotiates the delivery of the correct amount of power with the powered device.

Connector components in accordance with BS EN 60603-7-x (colloquially known as RJ-45) are required to have a proven lifetime of ≥ 750 mating/de-mating cycles without load. No specification existed for such a process under load so a separate test specification (IEC 60512-99-001) has been developed which acts as a "type test" at 300 mA per contact but only for 100 mating/de-mating cycles. As it is foreseen that current levels will increase IEC 60512-99-001 is being amended accordingly. However, as the current increases the number of mate/de-mate cycles will reduce.

Clearly, any connections to be used in a remote powered application and which may be routinely disconnected shall conform to this additional test.

Cabling designs should consider the impact of de-mating under load – particularly if the disconnection occurs at a piece of terminal equipment (e.g. a student's laptop or equivalent). Ideally, design solutions and/or administrative procedures should be employed to avoid or minimise the frequency of such actions. There are also mitigation actions which can be employed including the introduction of:

- sacrificial connections (i.e. ones that are expected to be replaced and that are designed, with adequate spare cable, to allow re-termination);
- additional connection points (without damaging overall transmission performance) which are specifically designed to enable replacement (by changing cords) - this may require the use of connectors of a higher Category to be used in particular locations.

In all circumstances, the connectors shall be specified to comply with IEC 60512-99-001 in addition to their basic design specification.

3.2.4 Temperature rise predictions

NOTE; The following text replaces the contents of the previous edition which was based upon the contents of the IET Code of Practice of 3.2.2.3. In addition the following text is based upon the use of Category 6_A cabling components which have replaced Category 5 in many document in this series.

BS EN 50174-1:2018 and BS EN 50174-2:2018 consider a number of remote powering "Categories" of installation. The universal approach (Category RP3, supporting the application of i_c = 500 mA to all conductors within the installation) requires substantial planning but no specific administration practices. Other approaches which are based on lower average current loading require those loads to be monitored and administered during operation (with increased operational risk).
BS EN 50174-2:2018 contains equations which predict temperature rises for a range of cable specifications, bundle sizes and installation conditions.

The “universal” Category RP3 approach results in a temperature rise equation of the form

$$\Delta T = (0,8 \times N + \frac{b \times \sqrt{N}}{D}) \times R$$

where

R = conductor resistance (Ω/m)
D= cable diameter (m)
N = no of cables in a bundle
b = depends upon the installation environment

IISS-00-001 recommend the installation of Category 6_A cables which typically have resistance values of 7,5 Ω/100 m and cable diameters of approximately 7 mm.

Figure 2 shows the results of this equation for these cables in a series of installation environments.

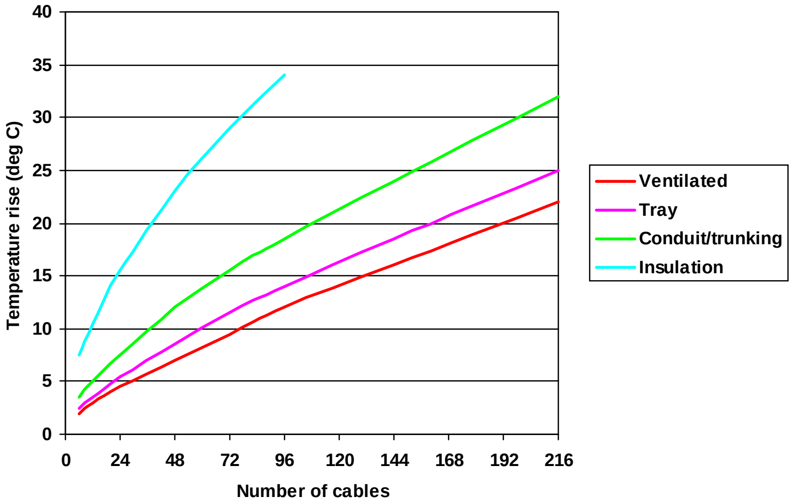


Figure 2: Temperature rises for Category II installations of a typical Category 6A cable

BS EN 50174-2:2018 provides more information about other approaches to remote powering specification (e.g. Category RP1 and Category RP2) and also addresses cables loose-laid rather than bundled.

3.2.5 Selection and erection of equipment (installation)

3.2.5.1 Legacy installations

In legacy installations it is important to avoid both the increases in attenuation associated with increases in temperature and the risk of damage to installed cabling.

3.2.5.2 New installations

Cables with the highest practicable operating temperature should be selected.

BS EN 50173-6:2018 specifies that the balanced cabling shall provide a minimum Class E_A performance, requiring the use of Category 6_A components in order to support future wireless access operating in excess of 1 Gbps.

Category 6_A cables will:

- exhibit lower insertion loss/attenuation performance and will provide additional performance headroom at elevated temperatures;
- typically (but not always) feature larger diameter conductors (lower d.c. resistance) and therefore exhibit lower levels of temperature increase for a given value of conductor current in a given installation environment.

The selection of pathway systems and the configuration of cables within those systems should seek to minimise thermal impact on the cables. Where cables are run in non-ventilated spaces or insulated containment, consideration should be given to installing mechanical ventilation.

BS EN 50174-2:2018 requires that bundle sizes are restricted to 24 cables.

Separators should be employed to allow ventilation between bundles (see 3.3.1).

The lengths and types of pathway and pathway systems (e.g. lengths of insulated pathway) and the installation configuration (e.g. presence of air gaps) of cable bundles within them should be documented for future reference.

The maximum lengths of installed cable may have to be reduced to take into account the increases in insertion loss/attenuation produced by the increased temperature associated distribution within the group or bundles of cables. This should be taken into account during any cabling acceptance tests.

Connecting hardware with stated compliance with the standards addressing performance during de-mating under load should be specified.

However, further measures should be considered to avoid damage to either third party equipment or to installed connections which may be subject to repeated disconnection under load including:

- the design of all cabling in new premises should consider the implementation of Consolidation Points (of BS EN 50173-2) or Service Concentration Points (BS EN 50173-6). These allow the replace of the TO or SO respectively by the replacement of CP or SCP cord (as opposed to the re-termination or re-installation of cable at the TO or SO.
- **"Bring Your Own Device" or equivalent concepts need to be implemented with clear instructions that all disconnections should be made at the TO/SO (e.g. wall socket) and not at the equipment (the University will accept no liability for damage to the RJ45 port of any third party equipment).**

3.2.6 Power management

Clause 3.2.4 refers to remote powering installations of Category RP3 as defined in BS EN 50174-2:2018 which base their design and planning requirements by assuming that all conductors could carry the maximum current of 0,5 A. Such an approach should be used wherever possible to provide the greatest operational flexibility - and supports minimal administrative controls during operation.

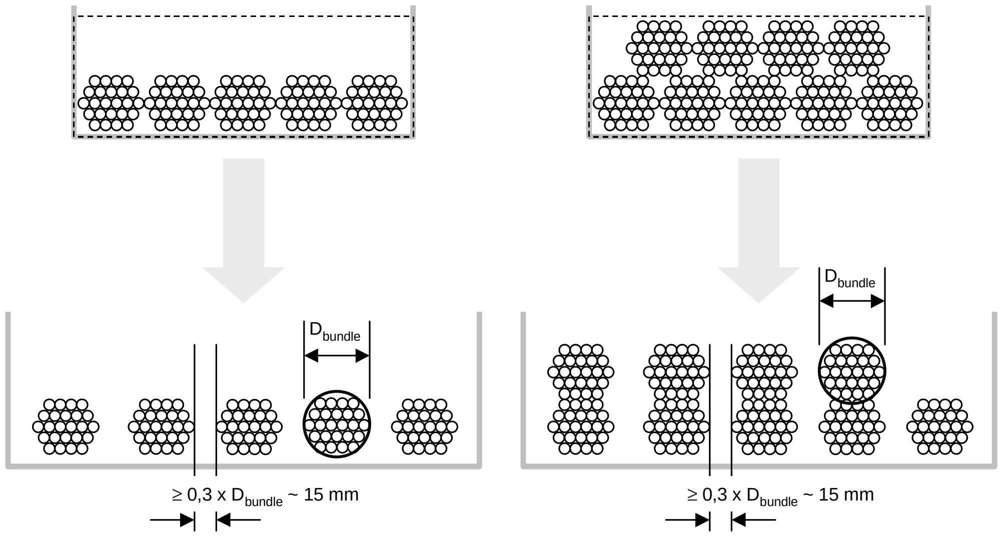
BS EN 50174-2:2018 also includes support for average current levels where groups or bundles of cables may contain a mix of applications - some of which have no remote powering content and others within which the levels of remote powering may be continuous or variable. As a result, the combined thermal impact should be considered for all the applications to be supported. To maximise the continuity of application support, the predicted thermal impact should be documented and appropriate planning should be employed in terms of selection of components, installation environment and installation techniques.

3.3 Pathway and spaces capacity

3.3.1 Pathways

Cabling in accordance with the BS EN 50173 series of standards requires the planning and installation of cabling to be in accordance with the BS EN 50174 series of standards which requires the application of manufacturers/suppliers instructions. Pathway systems and installation methods should be selected to maximise the opportunity for the outer surfaces of cables to be cooled by surrounding airflow whilst maintaining the requirements for segregation of section 6 of BS EN 50174-2 in relation to electromagnetic interference.

This increases the size of pathways for a given cable volume. An example of cable bundles within a tray is shown in Figure 3**Error! Reference source not found.**. A horizontal separation of bundles (creating a chimney effect) of at least 15 mm has been found to maintain temperature rises to that of a single bundle in single row of bundles. The same separation in stacked bundles of cables restricts the temperature rises to twice those of a fully ventilated bundle.



a) a single row of bundles

b) multiple rows of bundles

Figure 3: Example of airflow improvement in pathway system installation

3.3.2 Spaces

The most complex issue surrounding discussions of convergence of distributed building services on to a common infrastructure is the balancing of the required bundle power management, necessary for all services to be operate correctly, with the network control demands of the different disciplines.

The cleanest solution is to return to the cross-connect approach in which the different services i.e. IT, access control, lighting etc. have a connection from their “switch-equivalent” equipment (in a secure space perhaps dedicated their needs) to a presentation panel(s) in the “comms room”.

The distributed building services cabling is fed from the “comms room” to the service outlets (SO) and connected to the end-devices in accordance with BS EN 50173-6.

This leaves the “comms room” as the location at which services are patched to the SOs. This allows the control of power connected into the cable bundles to be managed by the appropriate team of personnel.

Such a solution is shown schematically in Figure 4.

3.4 Re-provisioning of LV power to “comms rooms”

One of the major issues is the re-allocation of LV power from the “floor” to the “comms room” i.e. how much extra LV capacity is required at the “comms room” to support the remote powering of the distributed building services.

In essence this follows the same analysis as is required to determine the probable distribution of service outlets to meet the expected demand of distributed building services.

One of the approaches adopted in large commercial buildings is to define profiles for spaces which define on a “per space” or “per unit area” basis the type and number of end-devices expected to be required in that space.

This then allows the calculation of the outlet grid required (quantities) and the power required to be delivered from the “comms room” servicing that space. Once this is done for all spaces served then the total power demand can be calculated and assessed against available capacity.

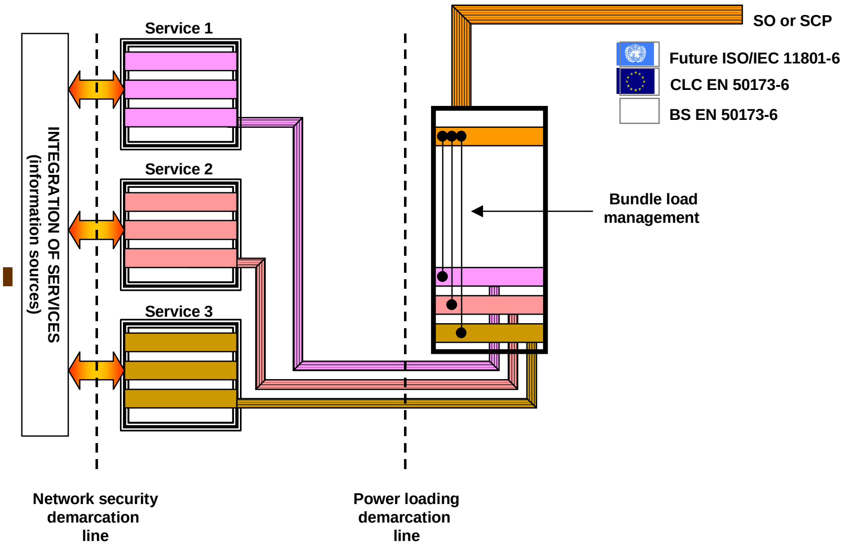


Figure 4: Example of service segregation and bundle power management

3.5 Heat dissipation

As a direct result of d.c. transmission with constant current, power is dissipated along the length of the cables.

Table 2 provides details of the power dissipation of various powering solutions. The relatively small levels of dissipation associated with IEEE P802.3bt Type 2 solutions rise rapidly with the implementations of Tyoe 3 and Type 4 solutions. It should also be realised that the values shown are for a metre length of a typical Category 6A cable and that the total dissipation for long lengths of groups or bundles of cables may represent a potential design and/or operational challenge to HVAC systems in the areas of distribution.

Table 2 - Power dissipation for $i_c \leq$ 750 mA, R = 0,075 W/m

	Power dissipation along cable length (mW/m and Type from IEEE P802.3bt)	
i_c (mA)	2-pair powering	4-pair powering
175	9,5 (Type 1)	-
300	27 (Type 2)	54 (Type 3)
~500	-	190 (Type 4)

4 SUPPLIER WARRANTIES AND GUARANTEES

One aspect that deserves some attention is close scrutiny of cable system supplier warranties and guarantees.

It should be determined if those warranties and guarantees take account of remote powering in terms of cable temperature and de-mating of connecting hardware under load.

In addition, what changes to those warranties and guarantees result under what circumstances of remote powering (e.g. changes to the supported channel lengths, reduced duration of those warranties and guarantees).

As always, installation instructions which contain implications in relation to remote powering should be understood and implemented.

5 OTHER DOCUMENTS IN THIS SERIES

IISS-00-001: Infrastructure Installation Specification Strategy: Overview
IISS-01-001: Assessment of balanced cabling test results
IISS-01-002: Installation and acceptance testing of singlemode optical fibre cabling

ISP-00-001: Overview
ISP-00-002: Access to University of Oxford IT Services facilities (later)
ISP-01-001: University of Oxford IT Services Entrance Facilities - Product and design specification
ISP-01-002: University of Oxford IT Services Entrance Facilities - Accommodation requirements
ISP-02-001: University of Oxford IT Services Intermediate cabling (INTI-ENTI) - Product and design specification
ISP-02-002: University of Oxford IT Services Intermediate cabling (INTI-ENTI) - Accommodation requirements
ISP-03-001: Distribution cabling - Recommendations: Overview
ISP-03-002: Direct-connect cabling - Recommendations: Telecommunications infrastructure
ISP-03-003: Distribution cabling - Recommendations: IT infrastructure
ISP-03-004: Distribution cabling - Recommendations: Distributed building services infrastructure

NORMATIVE REFERENCES

The following documents shall be applied in a normative manner (i.e. mandated) by the users of this document.

BS EN 50173-6:2018	Information technology - Generic cabling systems - Distributed building services
BS EN 50174-1:2018	Information technology - Cabling installation - Part 1: Installation specification and quality assurance
BS EN 50174-2:2018	Information technology - Cabling installation - Part 2: Installation planning and practices inside buildings

BIBLIOGRAPHY

The following documents are considered useful reference sources for the users of this document.

BS EN 50173-2:2018	Information technology - Generic cabling systems - Office premise
BS EN 60603-7-x	Connectors for electronic equipment
IEC 60512-99-001	Connectors for electronic equipment. Tests and measurements. Test schedule for engaging and separating connectors under electrical load. Test 99a: Connectors used in twisted pair communication cabling with remote power
IEEE P802.3bt	IEEE Standard for Information Technology - Telecommunications and Information Exchange Between Systems - Local and Metropolitan Area Networks - Specific Requirements - Part 3: Carrier Sense Multiple Access with Collision Detection (CSMA/CD) Access Method and Physical Layer Specifications - Data Terminal Equipment (DTE) Power Via Media Dependent Interface (MDI): Amendment 2: Power over Ethernet over 4 Pairs
BS PD CLC/TR 50174-99-1	Information technology - Cabling installation - Remote powering
ISO/IEC 11801-6:2018	Information technology - Generic cabling for customer premises - Distributed building services