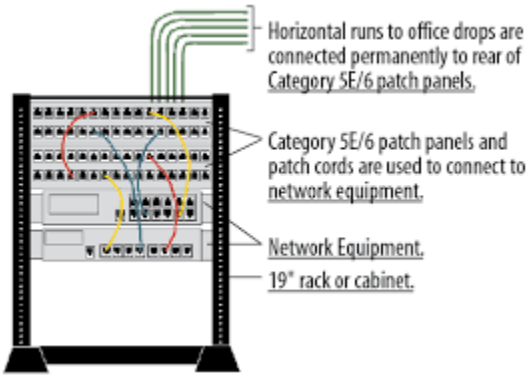
Copper Data Cabling

Structured Cabling System

A structured cabling system is a general-purpose cabling infrastructure which can be flexibly used and re-used to connect a range of low voltage applications. The cabling used to implement a structured cabling system is one of two types, copper or fibre. This section discusses the copper cabling.

As well as providing the infrastructure through which computers and peripherals can communicate, the same cables can be used for a variety of other applications such as telephones and AV applications.

In a well designed structured cabling system, general purpose outlets are provided throughout the building wherever a service may be required. These are cabled back to a nearby communications room or services cupboard, where network switches, computers servers and other equipment is located. For larger building, there will be several such communications rooms, all interconnected in some topology with backbone cables.



Copper Cabling Technology

Components

Copper structured cabling is formed from the following main components:

- **Cable**. The fixed cable which runs between the outlets and the comms room, between enclosures in the comms room or between comms rooms.

- **Outlets**. The outlets mounted in walls or in the ceiling to serve user equipment (such as computers or telephones) or peripheral devices (such as

printers or Wifi points).
- **Patch Panels**. The 'array of outlets' which mount in racks and allow user outlets to be flexibly patched through to whichever equipment or service as

required.
- **Patch Leads**. The leads (typically about 3 metres) which plug into patch panels and/or equipment ports to allow the connection of user outlets to services. The same patch leads, then often called fly leads, may also be used by the user to connect their computer or telephone to the wall outlets.

Note the following definitions:

- **Permanent Link.** This is the fixed link between an outlet and patch panel or between two patch panes. It consists of one continuous length of cable, terminated at both ends. The permanent links are installed as part of the building services and use the first three components above.
- **Channel**. This is the complete cable path between two devices and may include several permanent links and patch leads. Most (but not all) ethernet standards are specified to operate on a maximum channel length of 100m.
- **Connection**. A connection is where a patch cord plugs into an Outlet or Patch Panel. An important quantity is the number of connections in a Channel. For most (but not all) copper cabling systems, the maximum number of connections supported in a channel is four. Some systems can offer more. Note that the patch lead connections at the ends, that is into the user device or equipment, do not count.

The Cable

All copper data cabling standards are based on a 4-pair data cable. The cable is composed of 8 x cables, grouped as four pairs. While these cables are designed to

run ethernet networking traffic, they can be equally used as general-purpose cables for low voltage applications. For example, even when being used to carry network traffic, the same cable can be simultaneously used to carry power to a device at the other end of the cable (PoE = Power over ethernet).

The Connector

Most copper cable system are based on the RJ45 connector, an 8-wire connection. Patch panels and devices (such as computers, telephone sand network switches) come with RJ45 sockets. Patch leads come with RJ45 plugs at both ends.

Sheath Types

Copper Data cables come in two types, shielded and unshielded.

The shielded cable uses a copper foil or braid to enclose either/both the individual pairs and the overall cable. This copper, which needs to be centrally earthed, acts as a screen and provides the cable with immunity to electrical interference from other devices or between data cables. If a shielded cable is used, all the other components (patch panels, outlets and patch leads) also need to be screened so that the entire system has a common Earth.

The unshielded cables have no screening and rely on the twist of the individual pairs to eliminate excess noise.

Cable sheaths are classified as follows, with a general progression towards more comprehensively shielded cables:

- **U/UTP**. Unshielded cable.
- **F/UTP**. Shielded. Overall foil, but the pairs are not screened.
- **U/FTP**. Shielded. No overall screen, but the pairs are individually screened.
- **F/FTP**. Shielded. There is an overall foil and the pairs are individually screened.
- **S/FTP**. Shielded. There is an overall copper braid and the pairs are individually screened.
- **S/STP**. Shielded. There is an overall copper braid and the pairs are individually braided.

As a final note, most data cables are not designed to get wet and to maintain warrantees should be replaced in the event of significant exposure to water. For external use an external data cable should be used.

Fire Ratings

It is important to understand the characteristics of a data cable when it is exposed to a fire. Does it burn, does it give of smoke etc.

Traditionally data cables have been one of two types:

- PVC.

- LSZH (low smoke, zero halogen).

However, this simple binary classification has been effectively superseded by the Construction Product Directive (CPR), which provides a much more comprehensive performance specification of how the cable react to fire. The relevant CPR categories are as follows in order of improving performance:

- Fca. Not classified!
- Eca. The old PVC cable will typically fit this category.
- Dca. The old LSZH cable will typically fit this category.
- Cca. New standard for UK – see more below.
- Bca. Minimum standard in some European counties.

The key point is that the Nov 2017 amendment to the British Standard BS6701:2016+A1:2017 (Telecommunications Equipment and Cabling – Specification for installation, operation and maintenance) specifies that the minimum CPR rating for a fixed data cable should be Cca s1b d2 a2 (the letters after Cca denoting specific fire characteristics).

There is therefore likely to be a rapid transition to new installations requiring Class Cca cable. It may even become law. At the time of writing (Jan 2018) Cca cables, where available, are at least 50% more expensive than the LSZH equivalent. However, this gap will inevitably reduce as Cca become the new standard.

Cabling Categories

The cabling category defines the performance characteristics which a cabling installation must meet. These categories are carefully specified by standards bodies, so that equipment designers and manufacturers can guarantee that suitably designed equipment will operate on any properly installed cabling of that category.

Generally, all components of an installation must be of the required category. However, there is a concept of backwards compatibility and interoperability. So, for example, a Cat6a installation, but using Cat6 patch leads, will perform to at least Cat6 standards.

Testing

A structured cabling system should always be fully tested to comply with whatever cabling category is applicable. That means that every permanent link should be tested with a signal tester, which measures and records various properties of the link to ensure they meet the minimum standard for the required cable category.

Inevitably, a small proportion of links will fail because of installation errors or problems, which can normally be easily corrected.

Less commonly failures will occur because of manufacturing faults with the components, which can be less easy to sort out. The more up market systems will often claim significant 'head room' above the standards. This means that their system has been designed to outperform the standard and therefore will be more likely to pass even if manufacturing or installation is slightly compromised.

A third type of failure can be caused by interoperability problems with components from different manufacturers. Although components should be certified to be interoperable with other components of the same category, in practice this is often not the case. As a rule, an installation should only use approved components from one manufacturer.

Warranty

Most mainstream manufacturers will provide a 20-year or 25-year warranty on a properly installed and tested system. This means that the manufacturer will resolve any cabling caused problems with an application designed to run a system of that category.

In practice a warranty is very rarely exercised. However, its very existence provides much confidence in the competence of the installer and long term reliability of the cabling system.

The Categories

Category 5e

Since Cat5e superseded Cat5 in 1999, it has been the baseline structured cabling system. It is still adequate for basic installations, supporting 10BaseT, 100BaseT and 1000BaseT. However, it will not support 10GBaseT Ethernet and should therefore only be installed where there will be no requirement to support 10GBaseT during the lifetime of the cabling system.

There is also doubt whether manufacturers will make the investment to develop a CPR Class Cca version of the Cat5e cable. So as that becomes a requirement, it is likely that Cat5e will no longer be an option for new installations.

Category 6

Cat6 has been the enterprise cabling system of choice for many years. Although only designed to run the same Ethernet protocols as Cat5e, it is a higher performance system, supporting more than double the frequency and running to a tighter specification. This gives it significant performance headroom to support the faster protocols like 1000BaseT and is therefore considered more reliable than Cat5e.

A properly installed Cat6 system will potentially run 10GBaseT over lengths of up to between 30 and 45 metres. However, this is not guaranteed and may depend on the installation being 'tweaked' to pass. More than 95% of Cat5e and Cat6 installations in the UK are unshielded (U/UTP).

Category 6a

Cat6a is designed to meet all the requirements of 10GBaseT over the full 100 metre channel length. It is therefore an attractive solution when there is a requirement for future proofing the installation for five or more years. It is especially suitable for data centres, where the higher bandwidths are likely to be used at the earliest opportunity and in backbone links of less than 100m. Cat6a cables also have less DC resistance than Cat5e/Cat6, so are more efficient for POE use.

To achieve the high performance, the Cat6a system is specified to run at frequencies of up to 500MHz, which imposes serious constraints on its design in terms of the cable size (it can be a hefty cable). For this reason, most manufacturers produce shielded solutions, where it is easier for the manufacturer to guarantee meeting the standards.

Category 7/7a

Cat7/7a is a high-performance system, specified to run at frequencies up to 600MHz (Cat7) and 1GHz (Cat7a). It is mandatory that Cat7 systems are shielded, with both the individual cables and the overall cables being screened (S/FTP).

Cat7 has been around since Cat6, but is only popular in some European countries, where shielded solutions are required to meet the local electromagnetic regulations. Cat7 and Cat7a fully support 10GBase-T.

Cat7/7a uses non-standard connectors (i.e. not RJ45) either the Tera or GG45.

Category 8

Cat8 supports high speed 25GBase-T and 40GBase-T standards over short distances. Aimed specifically for Data Centres, to link Servers to Access layer network switches, the standard supports 40Mbits/sec over a channel of 30m through 2 connectors, running over a shielded 2GHz 4-pair cable. The standard comes in two flavours allowing multiple connector types, the RJ45 (Cat8.1) and Cat7 derived Tera/GG45 (Cat8.2).