DIGITAL TV GROUP
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THE CENTRE OF
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In-home Connectivity Guide

Technical advice for the best broadband connectivity in today's hybrid internet access, multi-screen world

Let's get fully connected with the hybrid internet access, multi-screen world.

The future of connectivity to homes for internet access, content viewing and communication will be hybrid Internet Protocol (IP). By that we mean a mixture of fixed (through the telephone line), satellite, wireless (in most cases Wi-Fi) and even mobile operator connections.

There will be seven billion new Wi-Fi devices in the next three years, and a typical family home could have as many 500 connected devices by 2022. All this extra wireless connectivity means increasing congestion in the airwaves that transmit data.

As a result, wired connections will become essential for maintaining a good level of connectivity in homes, so it's important to get their installation right. Wired connections are unaffected by wireless signals.

The best way to ensure a home has the best broadband connectivity possible is to take a smart and efficient approach to wiring at the earliest possible stage - ideally from the start. This is a general guide for building planners, equipment installers, home owners and occupants as well as local authorities. The guidance applies to individual homes as well as multiple home buildings like blocks of flats.

It pays to be well connected.

Broadband connectivity is a key consideration for many people when buying or renting a home. Providing reliable and fast connections around the home adds real value and can be an attractive selling point.

A **2015 report** found that broadband connectivity was the third biggest motivation or moving house, behind lifestyle change and closeness to amenities.

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1. Know your environment

Ensure you choose the best form of connection to your building wherever possible. You can check whether fibre is available in your area at https://www.openreach.co.uk/orpg/home/index.do

2. Think head ends

Having a control hub – also called a head end – close to the point where all external connections enter the building is the first step to an efficiently connected home, so don't leave it as an afterthought. The head end should have space for power connections, maintenance and the installation of the equipment necessary to bring great connectivity to a home.

3. Wire hard

Wireless connections can be used to improve coverage and boost signals throughout a building. However, the best way to ensure connectivity throughout any building is to have wired connections in every room in which you want to access the internet.

4. Avoid the cable monster

Running cables all over a property without proper planning means less connectivity, more interference and an unsightly, potentially dangerous mess. Plan ahead and follow industry-standard best practices to ensure you are cable smart.

5. Materials matter

Where possible, plan any wireless networks so that the loss of signal caused by building materials and other devices is minimised.

Connectivity to the building

1. Know your environment

Telephone line

Broadband connectivity via a telephone line is an increasingly popular way for households to access the internet, particularly when it comes to streaming content via on-demand services from broadcasters and other providers like Netflix.

Wireless services, like Wi-Fi, are integral to the digital home experience. However, experts agree that the best form of connectivity is directly through the phone line to the display device (still a television set, in most cases).

The problem for people considering how to maximise their internet experience is that the phone line is all too often seen as just for voice calls when it is so much more than that.

This guide will help you to think about your broadband connections as integral to the connectivity of your home, building project or place of work. Getting it right early won't just save you money, it's the difference between a poor user experience and an excellent one.

You can use this guide as an introduction to industry-standard guidance on maximising connectivity to a multiple home building such as a block of flats. Or just when you're connecting a single flat or house. It also provides installation and setup guidelines to ensure your security settings remain up-to-date.

Central Control Point

Types of cable

In the UK, 80% of households and businesses are classified as connected by fibre optic cable. It's true that some connections are full fibre from end to end, but in reality most of these fibre connections only run as far as an external cabinet somewhere near the property. The most common form of 'last leg' fixed telephone connection from cabinet to home is copper-pair cable or coaxial cable.

Internet speed depends greatly on the status and availability of fibre in a building's location. Where possible, it's important to check this before building to ensure there is enough connectivity to provide a good service to households and businesses in the area.

KEY RECOMMENDATION:

ENSURE YOU SELECT THE BEST FORM OF CONNECTION TO YOUR BUILDING WHEREVER POSSIBLE.
YOU CAN CHECK WHETHER FIBRE IS AVAILABLE IN YOUR AREA ONLINE AT: WWW.OPENREACH.CO.UK/ORPG/HOME/INDEX.DO

Telephony Connection Types

Telephony Connection Type	Description In Brief
Copper-Pair Cable	A pair of copper conductors is brought into the building from an external telephony cabinet close to the building.
Fibre-Optic Cable	A fibre-optic cable is brought into the building from an external cabinet. A router with a direct fibre-optic connection is required to connect this service.
Coaxial Cable	A coaxial cable is brought into the building from an external cable-company cabinet.

Good use of white space

In rural and remote areas, where fibre is not generally available, satellite and Television White Space (TVWS) signals can be used. TVWS is a technology where internet service providers (ISPs) make use of frequencies reserved for TV services nationally, but are not in use in every locality, to offer broadband services wirelessly.

This is incredibly useful in rural areas where it is, for example, not cost effective to lay fibre optic cables to a small village. Instead the broadband data is transferred wirelessly using TVWS from the nearest available cabinet to the rural area where it is needed. A receiving antenna can then pick up the TVWS signal for onward distribution of broadband services. An Ofcom-managed database ensures that broadband services and TV services don't cause interference to one another.

This potentially life-changing technology is starting to be deployed in rural areas around the UK, such as the isle of Arran in Scotland: h++

KEY RECOMMENDATION: WHAT IS A HEAD END?

HAVING A CONTROL HUB, ALSO CALLED A HEAD END, CLOSE TO THE POINT WHERE ALL EXTERNAL CONNECTIONS ENTER THE BUILDING IS THE FIRST STEP TO AN EFFICIENTLY CONNECTED HOME OR BUILDING. SO, DON'T LEAVE IT AS AN AFTERTHOUGHT. THE HEAD END SHOULD HAVE SPACE FOR POWER CONNECTIONS, MAINTENANCE AND THE INSTALLATION OF THE EQUIPMENT NECESSARY TO DELIVER GREAT CONNECTIVITY INTO THE HOME.

2. Think head ends

The head end should be close to an external wall.

There should be enough room for multiple types of equipment and their power supplies, leaving easy access for maintenance and enough space for professionals to carry out a high standard of installation.

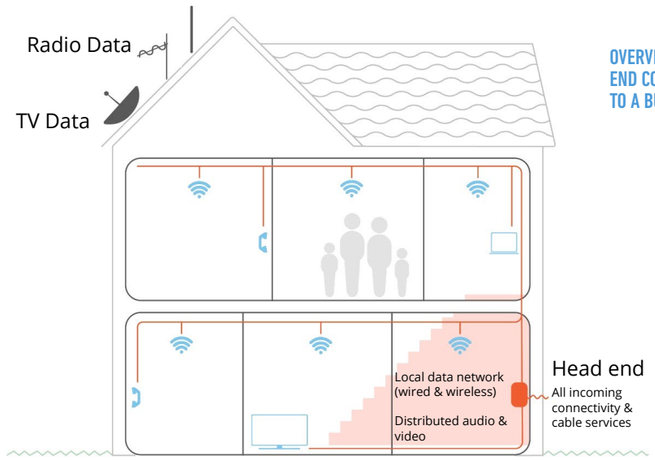
It should be well ventilated to make sure any equipment stays cool.

It should provide a point where cables can run throughout the building without obstruction.

Leave three metres of space between lighting equipment and other sources of interference like boilers. If this isn't possible, consider one metre as the minimum distance.

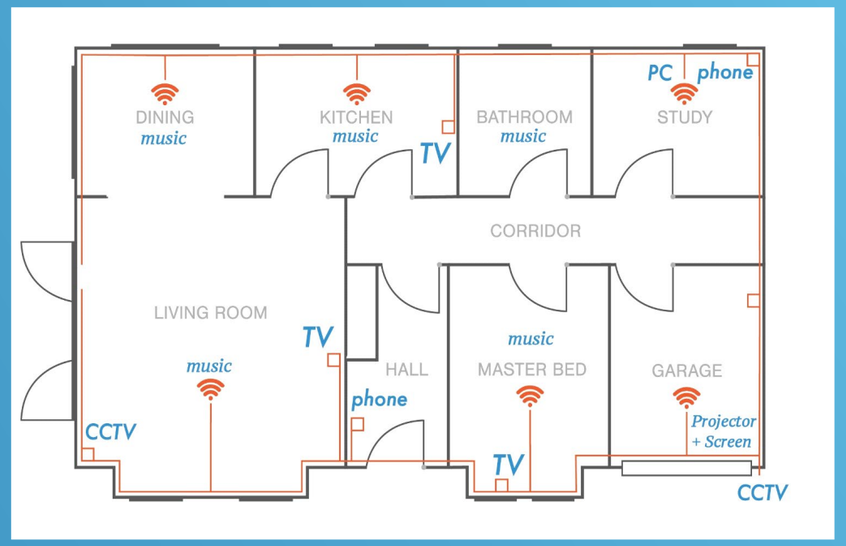
Leave some space for additional installations.

The diagram opposite shows an example of a head end and the types of connections that should be considered:



OVERVIEW OF HEAD END CONNECTIONS TO A BUILDING

Connectivity within the building



SAMPLE HOUSE PLAN FOR HOME CONNECTIVITY- PLANNING THE TYPES OF CONNECTIONS IN EACH ROOM IS KEY

3. Wire hard

Remember that you might need to keep cables separate from each other while running in the same direction. This is known as segregation and is sometimes necessary to prevent interference.

Professional guidelines cite that every room connected to the head end should have two ethernet and two aerial connection points.

The key thing is to plan and determine the types of connections needed in each room as shown in the example above.

Telephone and digital data should flow through the right cables. These should be a minimum of Cat5e cables. This type is classified as CEDIA Grade 1 cabling and can be used to connect multiple output sockets, including TV, satellite, telephone and data modules. Mains power should be located by each cable socket.

Cat6 cables should be used when cables need to run for longer lengths, (for example, in larger homes or blocks of flats). You can use the CEDIA guide for more detail.

CEDIA classification is not covered by any regulations governing electrical installations, so you may want to consider having your cabling plans certified by a qualified CEDIA assessor. You can access the CEDIA Guide online at https://www.cedia.co.uk/structured-cabling-assessor.

KEY RECOMMENDATION:

WIRELESS CONNECTIONS CAN BE USED TO IMPROVE COVERAGE AND BOOST SIGNALSTHROUGHOUT A BUILDING BUT THE BEST WAY TO ENSURE CONNECTIVITY THROUGHOUT ANY BUILDING IS TO HAVE WIRED CONNECTIONS IN EVERY ROOM IN WHICH YOU WANT TO ACCESS THE INTERNET.

Making sure cables are laid correctly and to a good standard will improve the appearance of the installation, promote a safer home environment and reduce the need for future maintenance. The Confederation of Aerial Industries (CAI) provides a Code of Practice for Installation of Home Networks, also giving details on the materials and processes to use for installations: https://www.cai.org.uk/

Manufacturers generally provide best practice standards, but, if in doubt keep in mind the following tips:

The radius of any cable bend should be at least 10 times the diameter of a cable.

Keep cabling to a minimum. Using the most direct route will keep the installation tidy and improve the efficiency of connections.

Use continuous lengths of cable wherever possible. If joints are necessary ensure you use the right connectors. More information on this can be found in the CAI Code of Practice for Installation of Home Networks.

KEY RECOMMENDATION:

RUNNING CABLE ALL OVER A PROPERTY WITHOUT PROPER PLANNING MEANS LESS CONNECTIVITY, MORE INTERFERENCE AND AN UNSIGHTLY, POTENTIALLY DANGEROUS MESS. FOR THE BEST RESULTS, PLAN AHEAD AND FOLLOW INDUSTRY STANDARD BEST PRACTICES.

Outlets should use Cat 5 face plate terminals. More information on cabling and hardware can be found in the CAI Code of Practice for Installation of Home Networks.

You can find detailed information on the best cabling practice in the Smart Home Infrastructure Recommended Guidelines on CEDIA's website: https://www.cedia.co.uk/

KEY RECOMMENDATION:

WHERE POSSIBLE, PLAN ANY WIRELESS NETWORKS SO THAT THE LOSS OF SIGNAL CAUSED BY BUILDING MATERIALS AND OTHER DEVICES IS MINIMISED.

4. Avoid the cable monster

There are many ways to strengthen the wiring to achieve a high level of internet coverage throughout the home. These include powerline communications (where signal is boosted along the mains supply of a building), mesh networks and Wi-Fi extenders. All these options have their drawbacks - see the FAQs for further information.

Mesh networks use up a lot of the limited airwave space available on useful frequencies and can get blocked due to congestion. This solution also encounters issues with dynamic frequency selection, neighbouring Wi-Fi, certain building types and interference from other technologies.

Wi-Fi extenders require logging on to different access points as the user moves through a building. Alternatively, if an extender is using the same network ID (SSID) as the main router, the user may have trouble handing over from one to the other at the boundary of coverage areas. Also, the connectivity generated by extenders is generally half that of the main router, as the bandwidth is divided between receiving and transmitting back to the main router.

Powerline communications rely on the broadband services being transmitted over the electrical power infrastructure. The user plugs in two or more powerline devices to build up a network, and data is transferred over the buildings' powerlines. However, if you don't have a powerline near a room that uses connectivity frequently, you won't get a signal. Additionally, powerline communications carry two main risks: Data transferring on the powerline may interfere with systems such as some lighting dimmers. In larger buildings, devices that share the same powerlines could cause interference - which may corrupt data and prevent reliable communications. Examples include electrical noise from heavy loads such as ventilation system motors or lifts.

Experts recommend that each room served by Wi-Fi should also be connected to a head end by cable. For more information on best practice in connecting your home, we advise you to consult the CAI and CEDIA extra guidance links at the end of this guide.

5. Materials matter

Manufacturers generally put 'best-case' specifications for the speed and distance of their equipment. For example, a wireless router that displays a speed of 100 mbps over a distance of 12 metres could perform at a much lower level, depending on the obstructions its signal encounters.

Unfortunately, many modern building materials do not help wireless connections to reach their optimum level. Walls, floors and even energy saving windows can all contribute to a weaker signal.

Materials that limit the reach of wireless signals include thick brick walls in older houses, plasterboard (typically foil-backed) in modern houses, underfloor heating systems, microwave ovens, baby monitors and other wireless gadgets.

Extra Guidance

The following organisations have a wealth of technical and practical guidance to help with in-home connectivity.

The Institute of Engineering and Technology (IET), Code of Practice for Connected Systems Integration in Buildings: https://www.theiet.org/

The Custom Electronic Design and Installation Association http://www.cedia.org/ (CEDIA)

Cedia smart home recommended guidelines: https://www.cedia.co.uk/

The Confederation of Aerial Industries (CAI) https://cai.org.uk/

CAI Code of Practice for Installation of Home Networks: https://www.cai.org.uk/

The UK Office for Communications (Ofcom) https://www.ofcom.org.uk/home

The DTG R-Book – installation guidelines for DTT and Satellite. Contact the DTG to request a copy: https://dtg.org.uk/contact/

Wireless router setup guide: https://routerguide.net/wifi-range-extender-best-setup-guide/

Frequently asked questions

Q: What is the recommended way to distribute broadband services around a building or home?

A: Experts recommend that network cabling from a central head end is the most robust way of distributing broadband around a building or within a home. Once the network connection is provided to a room, wireless technology can be used to connect to devices. The CEDIA Smart Home Recommended Guidelines provide details on head end design.

Q: Where can I get information on cabling and installations?

A: The Confederation of Aerial Industries (CAI) Code of Practice for Installation of Home Networks gives detailed information on the technical standards and recommended materials to use for home networking installations.

Q: What If cabling is not an option, how can I increase Wi-Fi coverage?

A: There are four main ways to increase Wi-Fi coverage: wireless repeaters, boosters, extenders, mesh networks, powerline communications (PLC), or additional wireless access points. Additional wireless access points need their own connection to the network source (ISP) and power supply - and will essentially be a totally separate network from the original.

In contrast, wireless extenders will re-transmit the existing network using its own radio to extend the coverage to dead spots. This can either be using the same SSID or a different SSID. You'll find further information on the implications of each here: https://routerguide.net/wifi-range-extender-best-setup-guide/ .

Extenders will provide less connectivity than the main router, as firstly they will divide the bandwidth between transmitting back to the main router and receiving from its clients. Secondly, they are essentially another Wi-Fi device and must share the overall bandwidth from the main router with all other Wi-Fi devices connected to it.
Mesh networks have one main router and several satellite nodes to provide a blanket of coverage. Instead of the remote nodes talking individually to the main router, each node acts as a hop to the next, helping to extend the coverage further. Mesh networks provide a level of coordination to manage traffic throughout, use the best channels, and allocate bandwidth to the nodes with the heaviest usage. They are also easy to set as they often use apps which automatically configure the nodes using the existing router's details.

The disadvantage of mesh networks is that they require a lot of Wi-Fi channels to operate so can suffer from congestion or interference from neighbouring Wi-Fi networks. They can also be blocked by many of the materials used in modern day homes which prevent the wireless signals travelling around the building. Here is a little more information on mesh networking: https://uk.pcmag.com/enmesh-whole-home-wi-fi-system-emr3000-kit/87178/guide/the-best-wi-fi-mesh-network-systems-of-2018.

Powerline communications use the mains power circuits to distribute data. Signalling can also be carried over the mains to enable an IP network to be built up with all the connected powerline nodes. The main drawback is that interference to the data communication can occur due to electrical devices connected to the mains and vice versa – the data communication can cause interference to some electrical devices.

Q: What should I consider when installing a powerline communication network?

A: According to the IET code of practice for connected buildings and integrated systems, there are four main questions when considering using powerline:
Is the powerline technology likely to be subject to electrical noise from heavy loads?
Is the data 'critical' to the operation of a system, such as security monitoring?
Are all items that are intended to communicate with each other on the same electrical phase?
Will the EMC properties of the system be affected by using PLC?

Q: What is the difference between 5 GHz and 2.4 GHz Wi-Fi?

A: Wi-Fi (and wireless technologies in general) uses electromagnetic spectrum to transmit data. The electromagnetic spectrum travels in waves and the number of waves transmitted in a second denotes the frequency (e.g. 2.4 GHz means 2.4 billion cycles/waves per second). Different technologies operate in different parts of the spectrum to avoid interfering with one another. Wi-Fi equipment uses a range of frequencies in what's known as the 2.4 GHz band and the 5 GHz band. Lower frequencies travel further as their characteristics mean they are less susceptible to being blocked by physical objects such as walls. Higher frequencies can carry more data as they have a greater bandwidth, due to the number of waves they transmit per second. However, higher frequencies are more likely to be blocked en-route.
So, in general: 2.4 GHz provides better coverage and 5 GHz provides more powerful connectivity.

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