



Copper, Copper, Everywhere!

Which Category Cable Should I Choose?

As the need for higher bandwidth has grown and local area networking (LAN) speeds have increased, the copper based cabling systems to connect these networks and handle the bandwidth demand have evolved and become very tightly tuned. In today's market, there are three distinct cabling system segments – Category 5e, Category 6, and Category 6A, each with its own capabilities, characteristics, users, and installation requirements.

All three cabling systems share some basic characteristics and are fully forward compatible with one another. (i.e. Any application that will run on a Category 5e system will also run on a Category 6 or Category 6A system.) All three systems use insulated copper wires that are twisted together in pairs and then each pair of twisted wires is further bundled and twisted to produce a 4-pair core (8 color coded wires altogether). That core is then covered by a plastic casing or jacket. For added interference protection, an aluminum foil may be applied under the jacket, making it a shielded cable, but the vast majority of Category 5e, 6, and 6A cables are unshielded and referred to as Unshielded Twisted Pair (UTP) cable. In addition to the cables, there are connectors, jacks, patch panels, and patch cords that are all designed to match the cables, and minimize signal degradation, loss, and interference.

Choosing the appropriate system really comes down to evaluating several factors including:

1. What applications do I need to support today?
2. What applications do I think will need to be supported in the future?
3. What is my budget and what is the relative weighting of cost vs. performance?
4. Who is going to install, test, and certify the system?

Category 5e Cabling Systems

Category 5e cable officially replaced Category 5 cable in 1999, and now is the most common data cable used for residential and small business networking. Structured cabling systems using Category 5e components have become commonplace in the majority of new homes built. They are often installed by the electricians wiring the home or by a low-voltage wiring/systems installer. Application speeds within most homes fall at or below 100BASE-T and the distances in many homes do not even exceed 50 meters, or half of the standard maximum link length. Local Area Network (LAN) standards are typically specified for up to 100 meter links, and for the “XX”BASE-T standards, are specified for transmission speeds up to “XX” Mbps. So, 100BASE-T will handle transmission speeds up to 100Mbps for distances up to 100 meters.

Category 5e cables and connectors have become a commodity and as such, are relatively inexpensive to install without specially trained technicians, while still providing the bandwidth that most consumers need. Additionally, the testing performed on the great majority of consumer systems, is basic end-to-end link continuity, with some level of link performance testing at times, to verify the installation and help with any troubleshooting. When properly installed, a Category 5e cabling system will fully support transmission rates of 1000 Mbps. From a cost/benefit perspective, consumers get a good home system that will handle virtually all of their bandwidth needs for the current and foreseeable future, at a very low price point.

Of course, there are some larger, typically custom homes, that are taking the step now to install a Category 6 system for either specialty applications or to future-proof their homes, but due to their size and overall cost, the incremental cost of the Category 6 system is relatively insignificant.

Category 6 Cabling Systems

Category 6 Cabling Systems have become the defacto standard for the great majority of horizontal wiring installations in commercial, university, and military settings. Today, Category 6 systems represent more than 50% of the commercial cabling market. They are often complemented by Category 6A systems or optical fiber in the backbone, where multiple high-speed networks are joined together. Category 6 cabling systems were developed to provide better network performance than Category 5e for networks running gigabit data rates (1000BASE-T Ethernet). Even though both Category 5e and Category 6 systems both support 1000BaseT as their fastest application, Category 6 systems provide

additional performance “headroom” for optimal transmission speeds. Headroom in this case refers to the difference between the minimum cabling signal-to-noise ratio (SNR) required for the signal before distortion begins to occur and the actual, additional SNR provided by the cabling. In simple terms, greater headroom in a cabling system provides more protection against noise, which can cause transmission errors and result in slower data rates.

Because of the superior performance of Category 6 systems, they provide better throughput than Category 5e systems, even in the case of somewhat faulty installations. Throughput is perhaps the true goal of any cabling system. It measures the amount of data or information that is actually moving across the link in a given period of time. Some of the primary factors that affect throughput include the available bandwidth, noise in the form of crosstalk (often measured as signal-to-noise ratio) and hardware limitations.

While category cables up to Cat 5e have specified 24 AWG (American Wire Gauge) wires, Category 6 wires are slightly thicker at 23 AWG. The thicker wire has less resistance but is still small enough to be used in multi-pair cable assemblies. Additionally, Category 6 cables provide more headroom to allow DC (direct current) power up to approximately 25 watts to ride on the pairs, thereby providing remote power for devices where no local power is present, practical, or desired. One obvious advantage of this is that wireless LAN Access Points can now be placed anywhere on the network, not just where power is available. Category 5e and Category 6 cables were ratified as the new standard (IEEE 802.3at) for Power over Ethernet Plus (PoE Plus) on September 11, 2009.

A Category 6 cabling system will typically have an incremental cost of about 30% over a Category 5e system, is normally installed by network wiring specialist, and most links are tested and certified.

Category 6A Cabling Systems

Category 6A cabling systems are industrial grade and are the cabling system of choice for data centers, internet service providers, factories, and anywhere high-performance servers and switches calling for 10 Gigabit Ethernet speeds exist. The most well equipped installers who have been specially trained perform installation of Category 6A systems. The wires are slightly thicker than Category 6 (although they are still 23 AWG), the twist rates within and among the pairs are tighter, and very tight tolerance is required in both the manufacturing and installation processes. The devices that can provide reliable, high frequency testing are more expensive and than those used to test lower grade cabling systems.

A main driver for Category 6A cabling systems is the need for 10 Gigabit network connections for high-performance servers and switches typically found in data centers and network backbones. A Category 6A cabling system will cost about 30-40% more than a Category 6 cabling system, but is still the optimum choice over an end-to-end fiber system for high-speed links of less than 100 meters. While the fiber itself is relatively inexpensive, the opto-electronic converters, lasers, and electronics, will remain far more costly than the electrical Ethernet devices as 10 Gigabit devices soon become common. Copper connections are prevalent on printed circuit boards, backplanes, interconnects, and most local area network (LAN) devices.

Just as Category 6 cables provide better performance than Category 5e cables, Category 6A cables provide superior performance for throughput, near-end and far-end crosstalk, and external, alien crosstalk. Near-end crosstalk (NEXT) is a measurement of the electrical noise or disturbance present on a twisted pair at the transmission side of the link. Far-end crosstalk (FEXT) measures the level of disturbance at the receiving (or other end) of the link. Typically, these types of crosstalk are caused by other signals being transmitted on another pair within the same cable. Alien crosstalk is the measure of crosstalk occurring between two adjacent cables. This is not a technical issue for 1000BaseT and lower applications, but is important for 10 gigabit Ethernet. Through its design and improved physical properties, such as balance, a Category 6A cable blocks noise from outside the cable and minimizes alien crosstalk so that 10 gigabit transmission rates can be achieved even when multiple cables are laying side by side.

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