How to Choose the Right Cable Category

Why do I need a different category of cable?

Not too long ago, when local area networks were being designed, each work area outlet typically consisted of one Category 3 circuit for voice and one Category 5e circuit for data. Category 3 cables consisted of four loosely twisted pairs of copper conductor under an overall jacket and were tested to 16 megahertz. Category 5e cables, on the other hand, had its four pairs more tightly twisted than the Category 3 and were tested up to 100 megahertz. The design allowed for voice on one circuit and data on the other. As network equipment data rates increased and more network devices were finding their way onto the network, this design quickly became obsolete. Companies wisely began installing all Category 5e circuits with often three or more circuits per work area outlet. Often, all circuits, including voice, were fed off of patch panels. This design allowed information technology managers to use any circuit as either a voice or a data circuit. Overbuilding the system upfront, though it added costs to the original project, ultimately saved money since future cable additions or cable upgrades would cost significantly more after construction than during the original construction phase. By installing all Category 5e cables, they knew their infrastructure would accommodate all their network needs for a number of years and that they would be ready for the next generation of network technology coming down the road. Though a Category 5e cable infrastructure will safely accommodate the widely used 10 and 100 megabit-per-second (Mbits/sec) Ethernet protocols, 10Base-T and 100Base-T respectively, it may not satisfy the needs of the higher performing Ethernet protocol, gigabit Ethernet (1000 Mbits/sec), also referred to as 1000Base-T. Thus, those IT managers looking to increase their network's speed may be limited by the cable that was installed in their facility. Though testing of the Category 5e infrastructure could determine its efficacy, the quality of both the cable and its installation could play a role in whether or not 1000Base-T will operate properly over the cable. As demand for bandwidth quickly grew, so did the stain on the networks ability to accommodate it. Category 6 Cable was developed to ensure 1000Base-T performance as well as accommodate other protocols.

Why do I need Category 6 cabling?

10Base-T and 100Base-T operated over only two of the four pairs in the cable. One pair is dedicated to sending data while the other is dedicated to receiving data. Two pairs go unused. 1000Base-T, however, operates over all four pairs. There are two gigabit Ethernet protocols for copper cables currently in use, 1000Base-T and 1000Base-TX. 1000Base-T transmits and receives data at 250 Mbits/sec on each of the

four pairs, for a total transfer rate of 1000 Mbits/sec. The transfer of data is bi-directional on each of the four pairs. 1000Base-TX transmits data at 500 Mbits/sec on two pairs and receives data on the remaining two pairs at the same data rate. Well, Category 5e cable has four pairs. Why won't it work? Well, it may and it may not.

As the transfer speeds increase, so do the performance requirements of the cable being used. Delay skew, which is the difference between the slowest and fastest pairs within a cable, becomes increasingly important as data rates increase. In the past, shortages of some materials, including those used in making plenum rated cables, forced manufacturers to find alternative compounds and alternative construction methods that would allow them to continue manufacturing and to pass the appropriate UL burn tests required for plenum rated cables. Many manufacturers chose alternative compounds for use as insulation on two of the four pairs. These compounds have a direct impact on the speed at which a signal will travel down the conductor. This combined with the fact that the pairs are twisted differently to prevent crosstalk from one pair to another and are, therefore, of slightly different length, will have an impact on when signals arrive at the receiver end. With signals traveling on all four pairs, it is important that they signals all arrive with a finite period of time to ensure the electronics can decode them. This period of time, known as delay skew, is a maximum of 45 nanoseconds per the TIA-568-C.2 standard. Though typically not an issue with protocols that utilize only two pairs, such as 10Base-T and 100Base-T, it could have a negative impact on protocols that utilize all four pairs, such as gigabit Ethernet. The quality of the materials used and the manufacturing process will significantly impact cable performance. 1000Base-T and 1000Bas-TX may not work properly over cables of lower quality. For end users with these cables installed, new cabling will most likely have to be installed if protocols requiring all four pairs are desired.

Though they may be capable of carry gigabit Ethernet, Category 5e cables also limit the future uses of the infrastructure. Streaming media applications such as video and multi-media have created an ever-growing demand for bandwidth that shows no sign of slowing down. Today's data requirements have made Category 3 obsolete. With the speed at which electronics have advanced, it is quite likely that the bandwidth provided by Category 5e will be exceeded in the very near future, making it for all intents and purposes, obsolete as well. Bandwidth is the highest frequency to which a cable will perform. As frequency injected onto a conductor increases, so does the likelihood of noise on adjacent conductor. Once noise overcomes the signal, the cable will no longer function properly. This is important to keep in mind since the cabling infrastructure should be designed to last at least 10 years and accommodate three to four generations of electronics.

While Category 5e is tested to 100 MHz, Category 6 cabling is tested to 250 MHz. Test parameters such as near end crosstalk (NEXT), return loss, and insertion loss are elevated for Category 6 and as result, ensure better performance than Category 5e cables. Category 6 cabling is also physically different from Category 5e. A center filler or star filler is often used to separate the pairs from each other and the insulation on the

individual conductors is thicker than that of Category 5e cable. For those Category 6 cables that don't have a center filler, the pair twists and cable twists (how many twists per inch of the cable core) will differ significantly from Category 5e. These features allow it to accommodate higher frequencies as well as provide better immunity from external noise. As frequencies increase, so does the likelihood of alien crosstalk (crosstalk from adjacent cables). It is the case that Category 6 is more immune from alien crosstalk than Category 5e. However, as we will see, it is not immune enough for some applications.

Why are there different grades of Category 6 Cables?

The Honda Accord, one of the highest rated automotives on the road, is available in multiple levels of trim, LX-S, EX and EX-L. All are Accords, yet all offer slightly different features. The EX-L V-6, the most luxurious, offers features the others do not and comes equipped with a large V-6 engine that will get you there faster. Just like the auto manufacturers, cable manufacturers offer various levels of performance in their category cables. And just like the Accord EX-L V-6, some will get you there faster.

Hitachi Cable America, the first cable manufacturer to incorporate a center filler in a Category 6 cable, through constant development, has found ways to improve and otherwise modify Category 6 performance. As a result, HCA manufactures four grades of Category 6 cables. They are *ECO™*, *Plus™*, *Premium™* and *Supra 660™*. The E*CO™* is a fillerless cable that provides UL verified performance, and does so with a reduced outside diameter. The *ECO™* delivers entry level performance. The *Plus™* cable offers 3dB of guaranteed NEXT (near-end crosstalk) and 8.5dB of ACR (attenuation to crosstalk ratio) headroom at 250MHz. In contrast, the *Supra 660™* guarantees 9dB of NEXT and 15.5dB of ACR headroom at the same frequency. The *Premium™* offers performance characteristics in between the *Plus™* and the *Supra 660™*. *Supra 660™* and *Premium™*, due to their high level of performance, are considered *enhanced* Category 6 cables. Each cable, however, is engineered to provide a specific level of performance. The purpose behind offering multiple levels of performance is to ensure that a product is available to meet the needs of every potential customer. A customer's likely use of their cable infrastructure will help determine which level of performance they may want to select. End users who want to ensure that their network performs to the best of its ability often opt for the cable that offers the highest performance. This high performance, as we described early, is measured in headroom above the Category 6 standards' requirements. The *Supra 660™*, for example, guarantees a delay skew of 25 nanoseconds. The Category 6 standard requires a delay skew of 45 nanoseconds. *Supra 660*, because it is an enhanced Category 6 cable, gives its user greater assurances that data will not be lost or corrupted during exchanges. Unlike the electronics used in the network that are likely to change in only a couple years, the cable infrastructure you choose is likely to remain for ten or more years. When permissible, end users should always opt for the best possible cable.

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Do I need an enhanced Category 6 Cable?

Though a number of factors influence which grade of Category 6 cable a building owner or IT professional may choose, performance is typically the driving factor. Category 6 *Supra 660™*, HCA's highest performing Category 6 cable, has improved performance features that allow it to perform better than other Category 6 cables. These features enable the *Supra 660™* to provide a Zero Bit Error Rate. A zero bit error rate ensures all data packets reach their destination complete. As frequencies increase to accommodate the faster protocols, opportunities for dropped data packets increase. In TCP/IP, (Transmission Control Protocol/Internet Protocol) the basic communications language, if packets are dropped during communication, TCP/IP simply resends the packets until they all arrive. Voice-Over-Internet Protocol (VOIP), a technology that utilizes Ethernet technology to send voice signals, operates using UDP (User Datagram Protocol). While TCP/IP retransmits lost or corrupted packets, UDP does not. Due to the nature of voice communication, if packets of data are dropped, they are not retransmitted. Dropped packets in VOIP result in an inferior audio signal. For those end-users who anticipate using a VOIP telephone system, the performance of the cable will have a direct impact on the performance of the VOIP system. To ensure the best possible performance from the system, use of an enhanced Category 6 cable such as HCA's *Supra 660™* would be appropriate.

An enhanced Category 6 cable is also more capable for limited length runs where 10G Base-T, or 10 gigabit Ethernet (10,000 Mbps), is being utilized. The cabling standard addressing cable performance for 10G Base-T over Category 6 UTP cable, TIA TSB-155, permits the use of existing Category 6 cable for 10G Base-T up to a distance of 55 meters. The limited length is due to the high frequencies at which 10G Base-T will operate (up to 400MHz) and the greater likelihood of alien crosstalk. Category 6 cables used for 10G Base-T must be capable of exceptional performance in regards to both individual cable performance and cable performance in a bundle. The higher frequencies of 10G Base-T can induce alien crosstalk in adjacent cables and challenge the performance of a standard Category 6 cable. Just like 1000Base-T pushes the performance levels of Category 5e cabling, 10G Base-T will push the limits of standard Category 6 cabling. HCA's *Supra 660™*, however, is designed with high performance in mind. With its Zero Bit Error Rate, it will provide 10G Base-T performance to the full 55 meters and even beyond. HCA also just recently released a new Category 6 Cable, the *10G-RD™* that accommodates 10 gigabit Ethernet up to 90 meters in a channel, guaranteed. Though 10 meters less than the distance required by the TIA Category 6A standard, it is a small-diameter cable that can be used with both Category 6 and Category 6A connectivity. This allows the cable to perform as a Category 6 cable when mated to Category 6 connectivity, and as a Category 6A cable when mated to Category 6A connectivity. Though technically a Category 6 cable, the *10G-RD™* will perform and test to the Category 6A standard, which includes testing for alien crosstalk.

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Should I install Category 6A Cable?

A Category 6A solution is designed to accommodate 10G Base-T (10 gigabit Ethernet) to 100-meters in a channel configuration. Due to the interoperability of the network electronics for 10 gigabit Ethernet, it is fully backwards compatible with all previous Ethernet applications. Category 6A is the latest infrastructure performance level to be widely accepted. Accommodating network speeds that are 10 times that of the previous application (1 gigabit Ethernet), 10 gigabit Ethernet over a Category 6A infrastructure offers the throughput that many users now demand. If network speed is directly tied to the success of your company, as it is to so many businesses, then a Category 6A infrastructure would be ideal.

Category 6A cable, in accordance to the TIA/EIA 568-C.2 standard, is tested to 500MHz. As a result of the higher frequencies utilized by 10 gigabit Ethernet, alien crosstalk performance parameters are incorporated into the TIA/EIA standard for Category 6A cable. Alien crosstalk occurs when signal from a cable jumps to an adjacent cable. Alien crosstalk, like crosstalk that occurs between the pairs within a cable, will have a detrimental impact on cable's ability to send and receive data packets.

A Category 6A infrastructure will also accommodate other growing applications such as POE+ and HDBase-T. More powerful wireless devices can also benefit from a Category 6a infrastructure. As wireless access point speeds increase, they also demand higher performance cables to ensure maximum performance. New to the market, the wireless protocol 802.11ac will provide access speeds of up to 2.5 Gbps. For those devices, Category 6A cable would be appropriate.

There is also an abundance of Category 6A components on the market, versus only a few years ago. Virtually every well-known connectivity and cable manufacturer produces Category 6A components. Category 6A cables and connectivity have to be designed to overcome the performance hurdles that are a result of 10 gigabit Ethernet throughput, like alien crosstalk. Alien crosstalk can be overcome by creating space between the cores of adjacent cables, usually accomplished by means of adding internal space under the jacket in the case of UTP, or by using some type of physical barrier to block alien crosstalk, like a foil shield. The UTP designs tend to have larger diameters than their shielded counterparts due to the use of an air gap as a barrier to alien crosstalk versus a shield.

In addition to choosing between shielded or unshielded cables, there are multiple types of shielded cable designs to choose from. Some manufacturers offer a shielded cable with foil around each of the four individual pairs. This cable, known as U/FTP (overall unshielded, but foil over twisted-pairs), offers excellent shielding performance, but is more challenging to terminate than other constructions since each pair is individually wrapped in foil. F/UTP (foil shield over unshielded twisted pairs) cable, like that of HCA's Category 6A shielded cable, requires a more technologically advanced manufacturing process to build, but is significantly easier to terminate and has a smaller

outside diameter than the U/FTP cable. F/UTP cable utilizes a single foil shield wrapped around the cable core and includes a drain wire. In addition to helping with alien crosstalk mitigation, the shield offers immunity from signal generated by nearby electrical wiring and equipment. Known as EMI (electromagnetic interference) and RFI (radio frequency interference), this interference is generated by motors, light fixtures, electrical wiring and other electronic devises. As more and more devices become networked, data cabling is finding itself in physical locations that are detrimental to its performance. Though shielded cables require proper bonding and grounding to ensure performance, this is not an issue since good-practice installation methods (TIA-607-B standard) recommend bonding and grounding of all rack equipment regardless of whether the cable is shielded or unshielded. And, using shielded jacks and patch panels has never been easier since every leading connectivity manufacturer now has smartly engineered shielded components.

In summary, you should carefully evaluate your current and future throughput needs before selecting the appropriate network infrastructure. The infrastructure is the most complicated and costly to replace if upgrading is necessary. Don't let it become the bottleneck for network traffic. Basically, if you are installing a cable infrastructure, install the most advanced solution possible. You may not need it today, but the likelihood that you will absolutely need it down the road is virtually guaranteed.