Cabling: Making The Best Of Limited Lifespan

Buddy Shipley

Keeping up with networking technology likely means new cabling every five years. How do you make the best buying decisions?

When organizations decide to install a new cable plant, they want to know that it will be able to support all their current network applications as well as future applications—in other words, they want an idea of its serviceable lifespan. The ANSI/TIA/EIA569-A Design Considerations states that "These standards are intended to provide for a generic structured cabling plant, capable of running any voice or data application foreseeable in the next 10 to 15 years." While this is certainly an admirable objective, it may not be realistic.

We know what current technologies demand of a cable plant. Provided that the cable and components meet the required electrical characteristics, that they are installed properly and all channels (cable runs) pass certification, the cable plant will work. Even the question of future applications is not too difficult as long as you don't need too much clairvoyance. Besides knowing which networking products are currently available, we usually can learn something about technologies that are being developed for deployment in the near future.

Today, the dominant LAN technology is IEEE 802.3u 100Base-TX Fast Ethernet, using existing Category 5 (Cat5) or a new installation of Cat5E unshielded twisted pair (UTP). If there's an issue with distance, environment or noise, products supporting the optical fiber implementation of 100Base-FX Fast Ethernet are readily available.

Enterprises that have saturated some of their Fast Ethernet connections are implementing Gigabit Ethernet. IEEE 802.3z defines a couple of different Gigabit Ethernet (GigE) standards, including 1000Base-SX, 1000Base-LX and 1000Base-CX. The short-wavelength SX and long-wavelength LX specifications support duplex multimode fiber and single-mode fiber, respectively. 1000Base-SX is more common and can support distances up to 2 km, while 1000Base-LX can support much greater distances. 1000Base-CX defines a short coaxial patch cable and is not very common.

Finally, a separate committee has defined the IEEE 802.3ab 1000Base-T standard for GigE over Cat5 UTP copper. The standard originally was to support existing Cat5 cabling, but GigE development efforts revealed deficiencies that prompted the ANSI/TIA/EIA to refine the Cat5 specifications. The new specifications are called Cat5 Enhanced, or Cat5E. TIA TR-41.8.1 now includes an addendum for Cat5E, while ISO/IEC 11801 simply upgraded its definition of Cat5 without adopting "Cat5E" as the new name. In other words, the ISO/IEC standard for Cat5E is still called Cat5. (See Table 1 for an overview of Ethernet cabling standards).

Beyond Cat5

It is unlikely that businesses wishing to continuously upgrade to the latest network technologies

TABLE 1 LAN Technologies & Cabling Requirements

Original Ethernet	**(10 Mbps)**
–10Base5	Thick coax
–10Base2	Thin coax
–10Base-T	2-pair DIW-24 UTP
–10Base-FL	2 strands of multimode optical fiber
Fast Ethernet	**(100 Mbps)**
–100Base-TX	2-pair Cat5 UTP
–100Base-T4	4-pair Cat3 UTP
–100Base-T2	2-pair Cat3 UTP
–100Base-FX	2 strands of multimode optical fiber
Gigabit Ethernet	**(1000 Mbps)**
–1000Base-SX	Short wavelength multimode optical fiber
–1000Base-LX	Long wavelength singlemode optical fiber
–1000Base-CX	Coaxial patch cable
–1000Base-T	4-pair Cat5 or Cat5e UTP
–1000Base-TX	2-pair Cat6 [TIA draft proposal]

Buddy Shipley is president of Shipley Consulting, based in Avon, CO. He is the author of the Ethernet Pocket Reference Guide, specializes in internetwork consulting and training, and is an instructor for a wide range of BCR training courses. He can be reached at Buddy@ Buddy Shipley.com

Use BCR's Acronym Directory at www.bcr.com/bcrmag

TABLE 2 ANSI/TIA/EIA Cabling Standards And LAN Applications

Category	Type	Spectral B/W	Channel Length	LAN Applications
Cat3	**UTP**	**16 MHz**	**100 meters**	**10Base-T, 4Mbps TRN**
Cat4	UTP	20 MHz	100 meters	16Mbps TRN
Cat5	UTP	100 MHz	100 meters	100Base-TX, ATM, CDDI, 1000Base-T
Cat5E	**UTP**	**100 MHz**	**100 meters**	**1000Base-T**
Cat6	UTP	250 MHz	100 meters	None available at this time
Cat7	ScTP	600 MHz	100 meters	None available at this time

Standards still in wide use are shown in bold. Cat4 & Cat5 are now defunct while Cat6 & Cat7 are not yet standards in the U.S.

At some point, it will be cheaper to use fiber than to “stretch” the UTP copper any farther

will ever see a cable plant with a lifespan of more than five years. Consider recent history. In 1985 we were still installing thick and thin coax to support 10-Mbps Ethernet. In 1987 we started using DIW-24 UTP to support 10Base-T, and in the early 1990s DIW-24 was replaced by Cat3 and soon thereafter by Cat4. By 1995 we were looking at 100Base-TX Fast Ethernet over Cat5. Cat4 was available for only a very brief time because Cat5 followed so quickly on its heels. In just 10 years we progressed through *five* cabling standards!

Five years later, in 2000, Gigabit Ethernet (1000Base-T) revealed deficiencies in some Cat5 installations. So, in early 2001, Cat5 has already been superceded by Cat5E. Cat4 and Cat5 are both defunct, and the development of Cat6 standards is well under way. Cat6 promises to replace Cat5E within a year or so, and there’s also talk of Cat7! What is a strategic planner to do?

“The five-year period [for cable plant lifespan] is probably right on target.” said Pete Lockhart, VP, technology and product design at Anixter. “Cable plants are being changed now to support the newer hardware, and later because the cabling [has become] obsolete. Also, most enterprises with modular furniture move that stuff an average of 2.7 times a year and have to [do some periodic] rewiring anyway.”

The long-term prospects for cabling standards are uncertain. Few people that I have spoken within the U.S. believe that Cat7 will ever be viable. If and when a version does arrive, it will not be UTP; existing proposals call for a shielded or screened twisted pair (STP or ScTP). Everything about Cat7 promises to be outrageously expensive and extremely difficult to install. The cable will be heavier and bulkier, costing more to ship and install, and if the shielding is not grounded properly it will create more problems than UTP ever had.

There are other problems with Cat7, most notably crosstalk and return loss, which are two of the biggest problems faced when attempting to support greater bandwidths. Crosstalk occurs when the energy transmitted over one pair is induced onto an adjacent pair; if this crosstalk is great enough, it will drown out the receive signal. It’s a particular pitfall at higher bandwidths, which often require transmitting higher energy levels over multiple pairs within a single cable.

This issue has already begun to arise in high-bandwidth applications. Although ANSI/TIA/EIA Cat5 defines a four-pair cable, it is actually specified to support just one energized pair at a time. Full-duplex 802.3u 100Base-TX Fast Ethernet actually exceeds the cable’s design specs, because two pairs may be energized simultaneously.

Now consider 802.3ab 1000Base-T Gigabit Ethernet, which always energizes all four pairs at once! The bidirectional dual duplex transmission scheme employed by 1000Base-T actually requires each end of a channel to transmit on one conductor of each of the four pairs simultaneously. The specifications for ANSI/TIA/EIA Cat5 come nowhere close to supporting such an application. This is one of the primary reasons for developing newer cabling Categories such as Cat6 and Cat7.

However, we’re probably reaching the point of diminishing returns: It actually would be cheaper to use existing multimode fiber technology than to “stretch” the UTP technology too far.

Cat6 Today

For now, the Cat6 standards are incomplete and still in flux, and so I am not confident enough to recommend Cat6 without a few caveats. While several vendors are already selling “Cat6” cable and components, it is often difficult to determine which Cat6 standard they are talking about.

In general, the term cable “Category” refers to the ANSI/TIA/EIA 568-A Commercial Building Telecommunications Cabling Standards. However, as I wrote in *BCR* last year (see July 2000, pp. 30–36), there are several standards bodies working to define their own Category 6 cable (ISO/IEC, NEMA, ICEA). All of these Cat6 standards define cabling that is superior to the existing ANSI/TIA/EIA Cat5, but until a consistent set of certification specifications is developed, the capabilities of the resulting cable plant installation remain dubious.

Another potential problem: Backward compatibility among cabling standards

In addition to defining the cable itself, the future ANSI/TIA/EIA Cat6 standard also will define the electrical characteristics of all of the components that constitute the entire channel, from patch panels and wall plates to patch cords and premises cables. None of the current cabling standards define patch cords—perhaps the weakest link in the channel. In summary, I am hesitant to recommend Cat6 until all its ANSI/TIA/EIA standards have been defined.

But this leaves us with a Catch-22: Existing Cat5E will support all network applications currently available, but we already know that Cat6 will eventually render it obsolete. Anyone looking to install a new cable plant today is painfully aware that Cat6 will soon eclipse Cat5E—certainly in less time than the anticipated lifespan of any brand new cable plant. So much for a future-proof design!

What To Do?

So what do you tell your clients or your boss when they ask for new cable plant recommendations? An easy choice today is to run a couple of Cat5E cables plus duplex multimode fiber to the desktop. The Cat5E will handle everything you can throw at it today, and the fiber will satisfy the requirements of virtually all network technologies in the foreseeable future.

Just keep in mind that all network cabling is not created equal: Some products barely pass certification, while others pass with ease.

What's more, cabling may not be backward compatible. "The [GigE hardware vendors] state that if the current cabling will run 100Base-TX, it will run 1000Base-T," said Anixter's Lockhart. "I agree; I also think that if they can run 1000Base-T, it does not necessarily mean they can run 100Base-TX. The 100Base-TX is harder to run because the [100Base-TX chips] don't have the same technology in them…that [the hardware vendors] have designed into their [1000Base-T] chips."

Simply put, don't assume that cabling components engineered to a newer cabling spec (e.g., Cat6) will be backward compatible with cabling components engineered to an older cabling spec (Cat5 or Cat5E). Furthermore, you cannot expect Cat6 components from different vendors to be interoperable!

"If you use products that just meet the letter of the Cat5E standard and then try to mix and match suppliers, you are playing with fire," Lockhart warned. On the other hand, "If you use Cat6 and get the stuff from folks who know how to make it right every time, and who designed the connectivity to work with the cabling, then this cable plant will blow away Gigabit Ethernet! It will give you a utility-like infrastructure with enough bandwidth headroom to last through at least one more hardware rev!"

Dealing With Bottlenecks

The impetus behind all these LAN technology and cabling advancements is, of course, to provide faster access to networked resources. Eliminating bottlenecks to high-speed networking in a single campus is a relatively simple matter of buying and installing readily-available, off-the-shelf products. Of course, when the bottleneck gets pushed to the wide-area connection, there's little that local or campus cabling can do to help.

Voice and data convergence can add to the confusion. Keep in mind that voice and data are converging onto *data* networks: Whether voice runs over IP or frame relay, the voice application does not define the cabling requirements. Voice and data both may be delivered over IP-based networks, but again, IP does not define cabling requirements. The Internet Protocol runs over just about any and all network technologies on the planet, and it is the network technologies that define cabling (or media) requirements.

These issues are further complicated by new wireless network technologies, such as IEEE 802.11b "WiFi", which currently can provide a maximum of 11 Mbps under the best of conditions. Although 802.11b provides just 11 Mbps and is not likely to have a significant impact on the performance of the rest of an enterprise's network infrastructure, it is yet another network application that must be included in network strategy planning. While wireless is a wonderful technology for certain niche applications, wireless networks still cost more and provide less capacity than wired networks and, in most configurations, the wireless access nodes rely on wired internetwork connections. This brings us full circle—ultimately wireless networks depend on a cabling infrastructure.

Conclusion

Given the historic trend of the last decade's cabling developments, it would appear that no new copper cable plant will last more than five years. Yet most businesses would probably like to realize a better return on their investment; it's about the money.

Given the limited lifespan of today's cabling technologies, it may not be realistic for enterprises to drastically improve their ROI in this area, but they can make prudent buying decisions. This means buying the *best,complete, cable plant solution* available.

The most cost effective network hardware available currently supports copper—Cat5/Cat5E. Most network technologies also support fiber interfaces (10Base-FL, 100Base-FX, 1000Base-SX & LX), but those interfaces still cost more than most copper interfaces. Fortunately, most of the copper implementations work just fine over the latest Cat5E cable plants, *provided* that the cable plants were installed properly and pass the required certifications.

Given the current state of the art, most future network technologies are likely to require fiber. There is some talk of 10-Gbps Ethernet over copper, but this would require something like *five* sets of four-pair cable! Perhaps it's time for a reality check.

To get the best return on a cable plant investment, do not cut corners. If you are installing a new cable plant and seek a lifespan greater than five years, buy the best copper cable and components available and add duplex fiber to cover your asset. Cat5E is a known quantity, a solid ANSI/TIA/EIA standard, it can be certified, and products are available from many suppliers.

Furthermore, although the various categories of cabling are standardized, it is highly recommended that you obtain all cabling (patch panels, wall plates, patch cords, and the cabling itself) from a single vendor; do not mix and match.

If you are planning to install a new cable plant, include at least two four-pair cables of Cat5E to every work area (desktop). You may use one four-pair Cat3 cable in place of one of the Cat5E cables, but it will not save you much money, and it's actually becoming difficult to find components certified for less than Cat5.

To ensure against future network developments requiring more bandwidth than your copper can provide, it's always a good idea to add a couple of strands of multimode fiber to your cable plant. While single-mode fiber is a superior medium, the electronics, connectors and other components cost more than for multimode. Most fiber LAN technologies require two fiber strands—one for transmit, the other for receive.

It may be entirely reasonable to opt for Cat6 (or Anixter's Level 6 or 7), as long as you know what you are getting. Remember, however, that while several Cat6 cable standards exist, as yet there is no ANSI/TIA/EIA Cat6 cabling or cable plant standard.

Cat6 is likely to cost a bit more, and the only way to be certain of the quality is to go with a vendor that offers a complete solution (not just the wire). Finally, keep in mind that there currently are no applications available that can exploit the increased bandwidth of a "Cat6" or higher cable plant, so there is no way to test or prove that such a cable plant will in fact be capable of supporting future network technologies. Maybe we should consult Kreskin….□

Companies Mentioned In This Article
Anixter (www.anixter.com)

It's a good idea to run some fiber alongside your copper installation