



FAQs on 10 Gigabit Ethernet Solutions: Fiber, Shielded Twisted Pair and Unshielded Twisted Pair

Why is there all this confusion about 10 Gigabit?

Since February of 2002, there was only one LAN solution for 10 Gigabit Ethernet media: optical fiber. With the addition of the newer 10GBASE-CX4 application standard, 10 Gigabit on copper media became a reality, although this reality was only for twinax (like a coaxial cable with two conductors in the center instead of one – not a traditional twisted pair cable). IEEE has now published the 802.3an application standard for 10GBASE-T, 10 Gigabit Ethernet on twisted pair cabling. Meanwhile TIA and ISO are still working to develop a cabling standard for the 10 Gigabit Ethernet on twisted pair cable application. Simultaneously, vendors and manufacturers are working to develop the products and markets for these twisted pair products.

Why even worry about 10 Gigabit? I'm not even running gigabit now...

10 Gigabit, for most locations, is not a need of today...but it's an expectation for the future. So, people looking to install cabling today want to make sure that they can support 10 Gigabit when they need to migrate to the faster data rate. Even if you think 10 Gigabit Ethernet won't be running on your network for 5 to 10 years, the cabling you install today will last at least that long. In most cases, it makes sense to install your network so you won't need to re-cable to migrate to 10 Gigabit data rates. If you think 10G data rates are a bit far-fetched, you'll need to recognize that those data rates are necessary for moving large files (like CAD files, MRI files, audio or video files, etc.) in a timely manner. Otherwise, employee productivity will decline with larger file sizes, as the wait time from request to review increases.

Well, I installed Category 5E cabling, so I'm OK...right?

Sorry, but the performance requirements for Category 5E are insufficient to support 10 Gigabit Ethernet. In fact, IEEE excluded Cat 5E from the list of recognized media, even for short distances.

How about me? I installed Category 6 cabling, so I'm OK, right?

Sorry, again, but the performance requirements for Category 6 are insufficient to support 10 Gigabit Ethernet to the full 100 meters. Frequency characterization beyond 250 MHz will be required to support 10 Gigabit Ethernet, but that's not all. Some new



performance requirements for Alien Crosstalk will also be established. IEEE has developed a solution that will support 100 meters, but the solution is limited to 55 meters on Category 6 cabling, and even 55 meters may require “mitigation”. TIA is saying in TSB-155 that expectations for distances on Category 6 are only 37m for the channel and 34m for the permanent link unless something is done to mitigate the Alien Crosstalk.

Um...what’s Alien Crosstalk, and what’s mitigation?

Alien Crosstalk is crosstalk between pairs in two different cables, thus the noise is “alien” from one cable into the other cable. 10 Gigabit Ethernet signals are self-disturbing and digital signal processing can’t eliminate Alien Crosstalk. Mitigation is the term used for methods to reduce or eliminate Alien Crosstalk. TIA has developed a TSB (TSB-155) that discusses testing and mitigation for Category 6 and 10 Gigabit Ethernet.

So, what are the options?

The only way to eliminate Alien Crosstalk is to use optical fiber (which is immune to crosstalk). The best way to mitigate alien crosstalk between twisted pair cables is to use a shield (a grounded metallic barrier) – this gives a substantial margin to the Alien Crosstalk limits and a high Shannon Capacity. Other mitigation techniques involve the use of space (as distance between cables will reduce the crosstalk intensity). Thus, the three options for 10 Gigabit are optical fiber, shielded twisted pair and larger-diameter unshielded twisted pair. Each offers some advantages and disadvantages, so there is not one answer for everyone. It’s best to look at each option and then make an informed decision.

What’s the difference between “shielded”, “screened” and “foil” twisted pair cable?

“Shielded” is an umbrella term for all cabling that incorporates some kind of shield or screen. A “screened” cable is generally a twisted pair cable with an overall braided-wire shield. A “foil” cable has a thin conductive metal foil shield. Both screened and foil twisted pair cables are considered “shielded” cables.

To standardize the terminology, ISO 11801 Ed. 2 changed the description of cables as shown in the table below.

New cable designations according to ISO/IEC-11801 (2002)

Old designations	New designations
UTP	U/UTP
FTP	F/UTP
S-FTP	SF/UTP
S-STP	S/FTP



Thus, the letters before the slash indicate the type of overall shield (U for unshielded, F for foil and S for braided screen), and the first letter after the slash indicates the type of shield on the individual pairs (U for unshielded, F for foil).

A PiMF cable is S/FTP cable, which is an overall braided shield with an individual foil shield on each pair. There is also a U/FTP which has no overall shield, but each pair is individually foil shielded. F/UTP means an overall foil shield around and unshielded 4-pair core.

OK...so where do we start? How about starting with the Standards?

From a standards perspective, optical fiber leads the pack since the 10 Gigabit Ethernet standards were published in 2002. That means standards-based, 10 Gigabit Ethernet cabling and electronics have been in use for over four years – so there's a significant head start on cost reductions and product development for 10-Gigabit fiber applications, including Fibre Channel.

The IEEE 10GBASE-T project (10 Gigabit Ethernet on Twisted Pair) was ratified in June of 2006, but the cabling standards are not yet complete. While, at this point, the cable performance specifications for Alien Crosstalk seem to be stable, there is still some uncertainty and refinement needed in the measurement methods for these specifications.

Since the main issue of concern (Alien Crosstalk) is mitigated by the shielding of twisted pair cabling, neither IEEE nor TIA seem to have any issues with 100 meters on a F/UTP Cat 6 cable (a Category 6 cable with an overall foil shield) or with an S/FTP cable, it is clear that shielded options are ahead of the game when compared to the developing UTP solution (Augmented Category 6), which has yet to be clearly defined in either TIA or ISO.

What about performance?

Here again, the optical fiber solution probably stands head and shoulders above the twisted pair solutions, since the XG fiber solution offers 10 Gigabit Ethernet up to 300 meters using the cheapest electronics option available today (10GBASE-SR). The TP solutions are being evaluated to support up to a 100m distance.

Comparing the F/UTP and UTP solutions, there also seems to be a performance advantage for shielded, since it offers a higher Shannon Capacity (about 20% better), a significant improvement in Alien Crosstalk (a 20dB margin over all characterized frequencies), enhanced security and RFI/EMI resistance, and a higher characterized bandwidth than the UTP solution. This performance premium for shielded cable is clearly evident, while the performance of UTP cable will be marginal even if properly manufactured, installed and terminated.



I see where this is going...so, what about the cost?

Yes, as in most cases, you don't get extra performance for free so you'll have to balance the performance advantages with the costs to make sure it makes sense for your installation. Further, you'll have to balance the costs of the products, the installation and the electronics to make the best decision – all three of these factors must be considered.

How do the product costs compare?

The optical fiber cabling has always been perceived to be the most expensive option; however the product costs have been declining over the years while copper cabling product costs have been going up. Before making any conclusions, it is advisable to fully consider the optical fiber option. There have been some substantial changes over the past few years that have made fiber a more cost-effective solution.

On the twisted pair side, the traditional UTP cable has been less expensive than its shielded counterpart – thus Cat 6 UTP cabling is less expensive than Cat 6 F/UTP cabling. However, the equation changes with 10 Gigabit Ethernet capabilities. Today, a shielded Category 6 cable is less expensive than an unshielded Category 6a cable. That, along with the proven performance premium and smaller size of F/UTP cable makes F/UTP the better choice from the product cost perspective.

What about installation costs?

Again, the optical fiber cabling has always been perceived to be the most expensive to install, and rightfully so in the past. However, the reasons for those higher costs have been eliminated over the past ten years or so. Advances in technology and newer, standards-based architectures now enable the optical fiber solution to be a much more competitive option. Again, you owe it to yourself and your customers to fully consider the fiber option before making a decision.

If we compare the installation costs of a Category 6 F/UTP solution to a Category 6 UTP solution, there is a premium in installation costs. This is due primarily to the slightly longer termination time for F/UTP cabling. However, it is important to note that, much like the case of optical fiber, advances in technology and now enable the installation of the AMP NETCONNECT STP solution, which is an F/UTP system, to be a much faster option than years ago – now with only a few seconds of extra time per termination.

If we evaluate the installation costs of the Cat 6a UTP solution, there is a hidden cost that goes beyond the termination – the cost of additional pathway and patch panel space. Because of the larger size of the Cat 6a cable, more space is needed for cable management and that space costs money in the form of additional pathways (cable trays, etc.) and in the form of lower density (more rack space for the same number of terminations). These space effects are not as severe for the STP solution, as the F/UTP cables are not as large as the Cat 6a UTP cables and the patch panel density is the same as traditional UTP solutions.



Isn't shielded product difficult to install?

Actually, the shielded components take most of the burden off the installer. Shielded patch panels require no additional bonding considerations than do UTP patch panels. Both versions of patch panels have the bonding built in, as do the shielded jacks and cable. When the cable is properly terminated to the jack, the shield is properly attached to the jack and the jack is properly mounted to the patch panel, the bonding and grounding will be complete.

Sure, sure...but isn't shielding only done in Europe?

Not any more. Some major national accounts in North America, including a major communications company, a casino and a major multimedia company have installed a shielded network because they made the comparisons and shielded made the most sense.

But isn't the bonding and grounding difficult and problematic?

Actually, the answer is "no". Again, the shielded components make it easy. The jacks make it easy to bond the jack shield to the cable shield with one additional step. The patch panels make it easy to bond the jack shield to the patch panel shield simply by mounting the jack in the panel. The patch panel bonds to the rack simply by mounting the panel in the rack with the normal screws. The most common problems with grounding occur due to improper bonding of the rack to the telecommunications grounding bus bar – and that problem applies to UTP and shielded systems.

Still, if a UTP solution is available, why not just "stick with UTP"?

There are some limitations to the UTP option, but that does not mean the UTP solution won't work. The main issue with UTP 10 Gigabit solutions today is simply that the old rule of thumb, that UTP is cheaper than STP, no longer applies. In most cases, UTP was selected because it was the least expensive option.

Today, especially considering 10 Gigabit applications, F/UTP may be the least costly option. Further, because Augmented Category 6 cabling solves the Alien Crosstalk problem through space, not through a shield, the AC6 solution will be less dense and take more rack and pathway space than either the Category 6 UTP or the optical fiber solutions of today. While the world is moving to lower cost and higher density solutions, Augmented Category 6 is, arguably, going the other direction.



Do F/UTP and UTP electronics cost the same?

Yes. In fact, the electronics used to support a UTP solution are the same electronics used for the STP solution. There is no difference from the switch perspective to run on an STP solution.

OK...so maybe fiber is the best solution from a standards and performance perspective. How can I make an intelligent cost comparison?

There are a lot of factors that weigh in on an analysis like that. It's best if you can make the comparison with your numbers and costs. The Fiber Optic LAN Section (www.fols.org) offers a free, downloadable spreadsheet that allows you to select a topology for your network then compare the costs, side-by-side, on a per port basis. You owe it to yourself and to your customers to run the numbers and draw your own conclusions. You might be surprised with the results. Still, there are other reasons to maintain a copper-based infrastructure such as Power over Ethernet (POE).

Thanks, but I've decided to stick with copper. Can I buy the XG STP today?

Yes, XG STP components are available today – offering quicker installation, better performance, and a significant space savings compared to an Augmented Category 6 UTP solution.

Is the XG STP solution guaranteed to support 10 Gigabit Ethernet when the complementary electronics are available?

Yes, Tyco Electronics has written 10 Gigabit support into its warranty statement.