



Cabling Infrastructure Choice for 2.5 and 5BASE-T over Copper

Introduction

The Next Generation Enterprise Access BASE-T (NGEABT or NBASE-T) refers to the development of intermediate speeds of 2.5G and 5G over twisted-pair copper cabling, with the goal of being able to run over installed Category 5e and 6 cabling. This work is being standardized in the IEEE by the P802.3bz 2.5/5GBASE-T Task Force, with an expected completion date in 2016-2017. Leading equipment vendors have already announced products that have this feature.

The main purpose of these intermediary speeds between 1000BASE-T and 10GBASE-T is to allow brownfield sites to use their existing Category 5e and 6 cabling infrastructure to support higher data rate needs of next generation wireless access points (APs). Rather than replacing the cabling, all that needs to be done is to upgrade the switch and the AP to products that can run at 2.5 or 5GBASE-T.

The TIA TR42.7 group has also been working on a technical service bulletin, TSB-5021, *Guidelines for the Assessment and Mitigation of Installed Cabling to Support 2.5GBASE-T and 5GBASE-T*. This document provides information on how to assess and mitigate existing brownfield Category 5e and 6 installations to determine if they can support 2.5 and 5GBASE-T.

The goal of this document is to provide guidance for people thinking of using these new speeds in their brownfield installation.

Category 6A Cabling is recommended for all applications > 1000BASE-T

It is important to understand that for greenfield installations, Category 6A cabling is recommended because it provides the only true upgrade path from 1000BASE-T to 2.5GBASE-T to 5GBASE-T to 10GBASE-T. It has no potential for issues, mitigation, or additional field testing. It is important to note the following facts about Category 6A:

- It is required to run 10GBASE-T
- It mitigates alien crosstalk, or coupling between adjacent cables or connectors, *by design*.
- It is a time-tested technology, with first generation Category 6A products available since about 2005

The differences between the various categories is summarized in Table 1.



Table 1: Comparison of Category 5e, 6, and 6A Cabling Standards

Category	Class	Specified Bandwidth	Major Improvements over Prior Category	Designed to Mitigate Alien Crosstalk
5e	D	100 MHz	Not applicable	No
6	E	250 MHz	Internal to channel (NEXT, ACR-F, Return Loss)	No
6A	E _A	500 MHz	External to channel (Alien Crosstalk)	Yes

Alien Crosstalk

Alien crosstalk refers to unwanted signal coupling from adjacent channels. This noise can also be called external crosstalk, meaning that the noise is coming from sources external to the channel such as bundled cables or adjacent connectors, as shown in Figure 1.

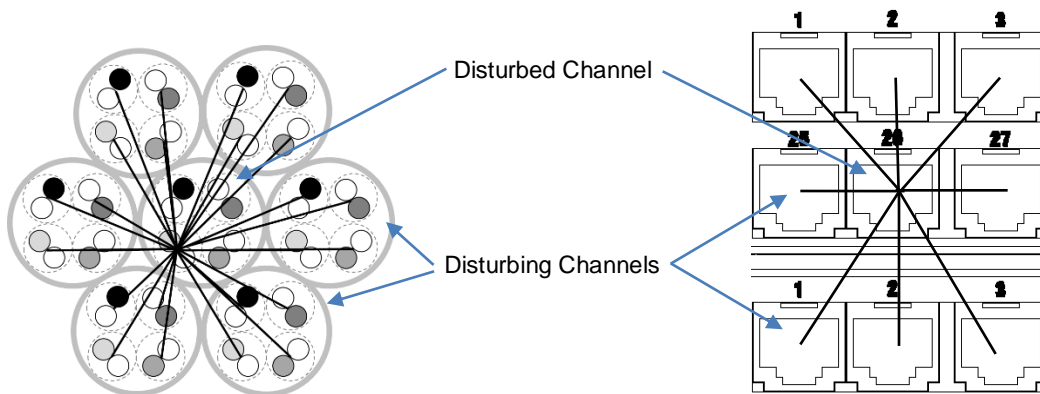


Figure 1: Alien Crosstalk Illustration for Cable and Connectors

Alien crosstalk requirements must be met by the cabling. It is critical to meet these requirements because the equipment cannot compensate for it due to the fact the noise is unpredictable since it is from external sources. Therefore, the cabling must mitigate it and meet any requirements by design.

Because 1000BASE-T data rates were not high enough for alien crosstalk to become an issue, Category 5e / Class D and Category 6 / Class E were not designed to mitigate it. When alien crosstalk became an issue for 10GBASE-T, Category 6A / Class E_A cabling systems were developed. Category 5e / Class D and Category 6 / Class E cabling systems have no requirements for alien crosstalk, and thus, alien crosstalk is much worse on Category 5e and 6 than for Category 6A cabling systems. Additionally, the measured alien crosstalk performance can vary greatly between different manufacturers and even between lots from the same manufacturer. The reason for the variability has to do with the fact the parameter is not controlled because there is no specification for it. Much of the challenge that went into designing Category 6A rated connectors and cables was to make it capable of meeting these stringent Category 6A / Class E_A alien crosstalk requirements.



The IEEE 802.3bz standard and the TIA TSB-5021 determine whether or not your existing cabling can support it by using a parameter called alien limited signal-to-noise ratio (ALSNR). This is a complicated calculation, but it is essentially a ratio of the insertion loss to the alien crosstalk. The calculated ALSNR is different if you are determining if the system can support 2.5GBASE-T or 5GBASE-T due to the different bandwidth requirements. After performing that calculation, if the ALSNR is greater than 28 dB for 2.5 or 5GBASE-T, the system will support that speed.

Running 2.5GBASE-T and 5GBASE-T on Category 5e and 6 Cabling

2.5GBASE-T and 5GBASE-T Impose Requirements on Unspecified Parameters

2.5 and 5GBASE-T will impose requirements out of the specified cabling and connector bandwidth as well as requiring an acceptably low amount of alien crosstalk coupling between channels. These specifications are given in TSB-5021. For Category 5e and 6 cables and connectors, internal parameters are not specified beyond the bandwidth of 100 MHz for Category 5e and 250 MHz for Category 6. *Alien crosstalk is not specified at all for Category 5e or 6.* When testing parameters either out of the bandwidth or for one that is not specified, the performance can vary significantly between different manufacturers and even different lots of cable from the same manufacturer. This is shown in Figure 2.

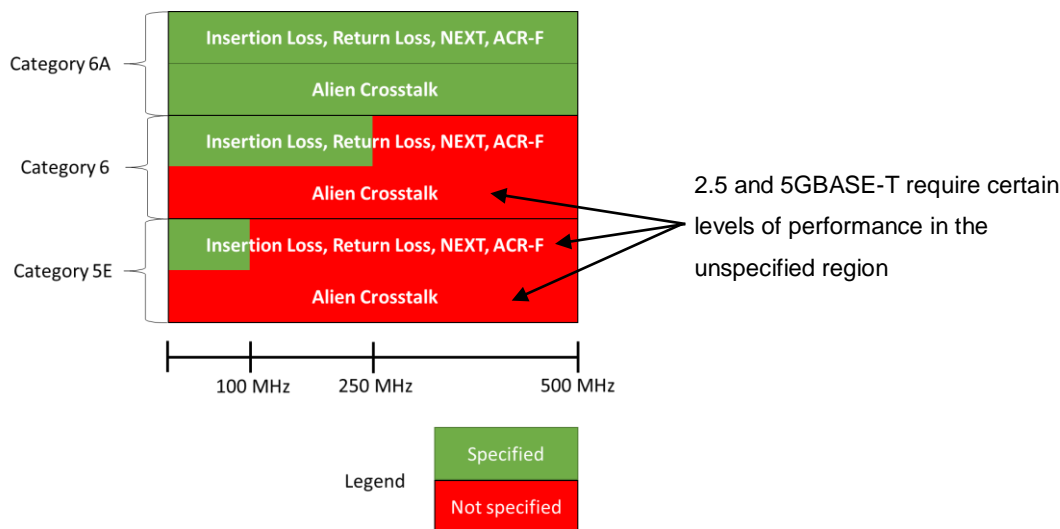


Figure 2: Comparison of Specified and Unspecified Parameters for Category 5e, 6, and 6A

The IEEE P802.3bz and TSB-5021 have defined specifications for both internal and external parameters. 2.5GBASE-T uses the Category 5e requirements up to 100 MHz. 5GBASE-T extends those parameters up to 250 MHz. What can be noted is that:

- Category 5e will meet the internal requirements of a 2.5GBASE-T system, and *might* meet it for 5GBASE-T
- Category 6 will meet the internal requirements for both 2.5 and 5GBASE-T
- Category 6 will have better alien crosstalk than Category 5e, meaning it will more likely meet the ALSNR requirement, particularly at shorter channel lengths



Autonegotiated Speed

The new equipment will be capable of running at 1000BASE-T, 2.5GBASE-T, and 5GBASE-T. Therefore, it is important to understand that installed equipment will autonegotiate down to 1000BASE-T if 2.5 and 5GBASE-T are not working. This means that unless one uses a method to monitor the data rate, the new switches and Wi-Fi may actually be operating at a significantly reduced data rate if Category 5e and 6 cabling and connectors are used.

Wireless Data Rate Requirements

It is important to note that the data rate needs of wireless access points are increasing at a much faster rate than the underlying wired Ethernet speeds. Per the trend shown in Figure 3, by 2017 there will be high end APs that require at least 10GBASE-T running to them. Therefore, an infrastructure built using Category 6 could at best only support the data rate needs through the next few years. Category 6A is recommended due to the fact it provides a true 1000BASE-T → 2.5GBASE-T → 5GBASE-T → 10GBASE-T upgrade path with no limitations on length, bundling, or additional field testing.

802.11ac Enterprise AP Segments and Trends

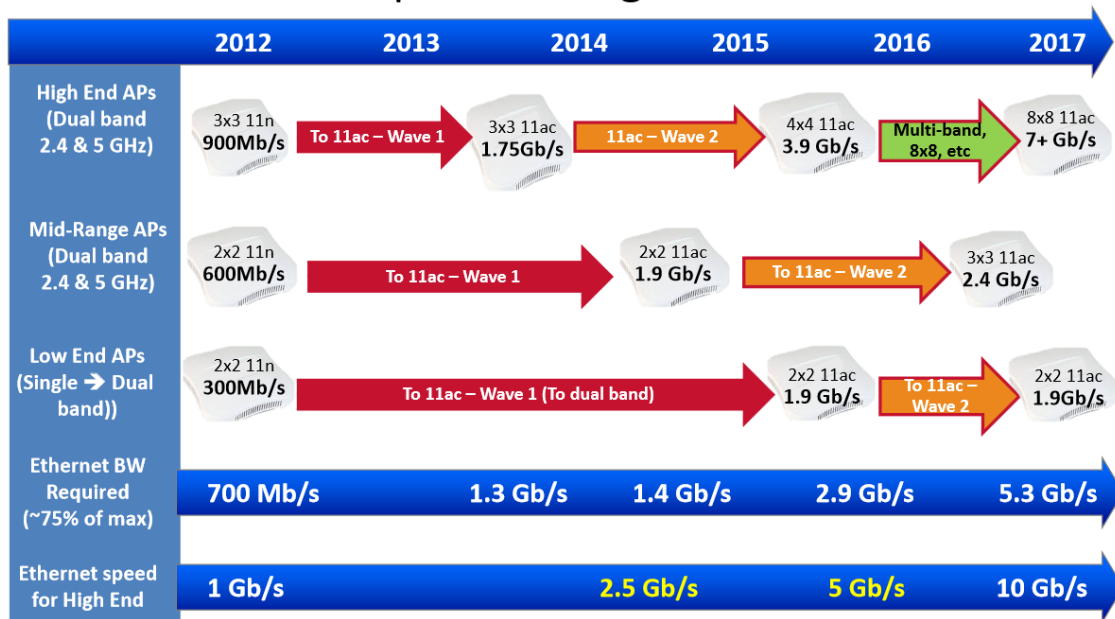


Figure 3: Data Requirements for Low, Mid, and High End Wireless Access Points

Source: IEEE 802.3 Call For Interest – November 2014 San Antonio, http://www.ieee802.org/3/cfi/1114_1/CFI_01_1114.pdf



Considerations for Running 2.5GBASE-T and 5GBASE-T with Category 5e and Category 6 / Class D and Class E

Currently there are no known field tests or requirements to validate an installation for 2.5 or 5GBASE-T. As of now the only way to know if 2.5 or 5GBASE-T will work over an installed base of Cat 5e or Cat 6 cabling is to hook up the equipment and try it. If it drops data or downshifts to a lower data rate, certain mitigation techniques are recommended. TIA is working on TSB-5021, which will provide guidance on how to best implement 2.5GBASE-T and 5GBASE-T. TSB-5021 will describe the different use cases and give a risk assessment for whether or not the cabling will support it.

IEEE 802.3bz recently set the pass / fail criteria for 2.5GBASE-T and 5GBASE-T networks to be equal to or greater than 28dB of Alien Limited Signal to Noise Ratio (ALSNR). ALSNR parameters require knowledge of alien crosstalk performance in the existing cabling. As Category 5e and 6 components have existed for over 15 years and were never designed to handle Alien Crosstalk, cable manufacturers do not have test data to predict if a link segment will support the 28dB limit. It is also difficult to predict the performance by the Category of the cable as performance can vary widely between different manufacturers' designs. However, in order to give customers the best overall estimate of how their existing cabling could perform, TIA TSB-5021 created the below Risk Guidance table based on actual test data.

Bundled length <= 50 m	Category 5e	Category 6	Category 6A
2.5GBASE-T	Green	Green	No risk
5GBASE-T	Green	Green	No risk
50 < Bundled length <= 75 m	Category 5e	Category 6	Category 6A
2.5GBASE-T	Light Green	Green	No risk
5GBASE-T	Yellow	Light Green	No risk
75 < Bundled cabling <= 100 m	Category 5e	Category 6	Category 6A
2.5GBASE-T	Light Green	Light Green	No risk
5GBASE-T	Red	Yellow	No risk
Risk of bundled cables configurations not supporting an ALSNR greater than or equal to 28 dB.	High	Medium	Low

The risks can be mitigated by the following techniques:

- Unbundle cables to reduce alien crosstalk, particularly in patch fields where the cables are accessible
- Use only on channels where lengths are less than 50 meters
- Replace Category 5e or 6 components with Category 6A components



Using Panduit Category 5e and 6 Rated Cables and Connectors for 2.5GBASE-T and 5GBASE-T

Panduit offers Category 5e and 6 cabling systems with significant headroom over the Category 5e and 6 / Class D and E channel requirements. However, internal and industry studies indicate that users may need to carefully test, assess, and possibly mitigate the cabling network, especially on long bundled links, to ensure they can achieve data rates above 1000BASE-T.

There is no uncertainty to certify 2.5G, 5G, and/or 10G on Category 6A cabling.

Recommendation

Panduit understands the desire to try to get higher data rate wireless access points to run over legacy Category 5e and 6 cabling networks. As part of our drive to ensure customers get maximum performance, Panduit has conducted testing to provide the best recommendation on how to implement 2.5 and 5GBASE-T. This data has helped shape the TIA TSB-5021.

Brownfield: When upgrading your wireless to 2.5 or 5GBASE-T, understand that there is a risk associated with achieving this performance based on cable quality, channel length, and bundled length. Follow the guidelines and mitigation steps per the upcoming TIA TSB-5021.

Greenfield: Panduit recommends that all new installations use Category 6A cabling and components. This recommendation is shared by the entire cabling community and the NBASE-T Alliance, a group developed to promote 2.5 and 5GBASE-T. This consensus is due to the fact that Category 6A rated products have immunity to alien crosstalk, and that they are the only cabling systems that are guaranteed to work on all data rates up to 10GBASE-T. Depending on the bandwidth requirement of the APs deployed, 10GBASE-T, which requires Category 6A cabling, may also be needed much sooner than expected, which makes Category 6A the best option for future proofing. Lower Category cables, such as Category 5e and Category 6 should only be considered where the cabling is already in place and testing or mitigation can easily be performed.

About Panduit

Panduit offers an end-to-end network infrastructure solution that delivers best-in-class network performance with superior quality, operational efficiency and easy installation. Innovative network infrastructure offerings from Panduit help you maximize your space and network investment, while providing the connectivity that businesses demand in today's global world. Our robust partner ecosystem, global staff, and unmatched service and support make Panduit a valuable and trusted partner. For more information, visit www.panduit.com.

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