NBASE-T Performance and Cabling Guidelines

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Overview

The NBASE-T Alliance is a consortium of over 35 companies with the goal of breathing new life into enterprise network infrastructure. The Alliance has released PHY specifications that define 2.5 and 5 gigabit per second (Gb/s) speeds at up to 100 meters using the large installed base of Category 5e, 6, and 6A copper cabling in enterprise networks. This paper describes the evaluation of cabling infrastructure for network owners and designers looking to implement NBASE-T™ technology on existing cabling, as well as expected NBASE-T performance under worst case cabling configurations, and mitigation techniques to provide the best opportunity for cabling channels to support NBASE-T. This paper also outlines the current work developing measurement procedures to qualify installed cabling for NBASE-T support.

Introduction

NBASE-T technology supports rates greater than 1 Gb/s that are needed by advanced wireless technologies such as 802.11ac. The introduction of protocols that provide higher data transmission rates is often associated with new categories of cabling, however NBASE-T specifies two new data transmission rates of 2.5 Gb/s and 5 Gb/s that will take advantage of much of the installed base of Category 5e and Category 6 cabling at lengths of up to 100m. This technology is the basis for a new IEEE standard, 2.5GBASE-T and 5GBASE-T, in draft as IEEE P802.3bz™.

While Category 6A cabling can assure NBASE-T operation, and installed Category 5e and 6 cabling will likely work well in most cases, Category 5e and 6 specifications may not be sufficient to assure NBASE-T operation under worst case cable-bundling conditions. Both the quality of the installed cabling and the installation conditions can limit performance of NBASE-T technology, so additional requirements for installed cabling are being developed to support NBASE-T rates. These additional requirements do not define new categories, but utilize performance that has generally been available, although outside the scope of cabling standards. Nonetheless, there will be situations where specific cabling channels do not meet the needs of NBASE-T and mitigation techniques may be needed to enable the enhanced speeds that NBASE-T offers.

Performance beyond original specifications

NBASE-T has not defined link specifications, but three draft standards have cabling specifications that are based on an extension of the Category 5e cabling standards, and additional performance is needed if the user intends to operate at the 5G rate. Full details of cabling requirements are being developed in the draft standard IEEE P802.3bz and in TIA TSB 5021 and ISO TR 11801-9904. The following provides an overview of the guidance being developed in these documents.[1] IEEE P802.3bz, a draft physical layer standard that defines 2.5GBASE-T and 5GBASE-T, is aligned with NBASE-T's technology as well as the 2.5 Gb/s and 5 Gb/s rates. At both 2.5G and 5G rates, an assessment of two performance factors is required: internal cabling parameters, and alien crosstalk.

Internal cabling parameters

Certification of Category cabling requires measurement of "internal" parameters such as insertion loss, return loss, and crosstalk. These standards use the Category 5e internal cabling specifications for 2.5GBASE-T, specified to 100 MHz. Cabling requirements for 5GBASE-T extrapolate these requirements to 250 MHz which is within the frequency range specified for Category 6. This means that Category 6 cabling supports the internal parameter requirements of both 2.5GBASE-T and 5GBASE-T. It does not mean that 5GBASE-T cannot operate over Category 5e, only that additional testing may be needed for assurance.

Table 1: Internal cabling parameters to support 2.5G and 5G applications

	2.5G BASE-T	5G BASE-T
Installed Cat 5e	✓	Extended frequencies required
Installed Cat 6	✓	✓
Installed Cat 6A	✓	✓

Assessment of Category 5e channels for the internal cabling requirements of 5GBASE-T may require re-testing, or if originally measured to 250 MHz or above, those results may be reevaluated to establish support.

ALSNR – The new alien crosstalk requirement

Today internal crosstalk and return loss are significantly compensated by PHY signal processing, and the alien crosstalk noise becomes the dominant influence on received signal quality. To estimate the effect of alien crosstalk on PHY performance, these standards specify a formulation called ALSNR, Alien Limited Signal to Noise Ratio. ALSNR is a calculation that combines insertion loss, alien NEXT and alien FEXT to estimate the response of the PHY. This determines if the channel has adequate

1. The IEEE P802.3bz standard is expected to be ratified in September 2016.

SNR for supporting the new data rates under worst-case conditions. ALSNR is calculated from measurements taken the same way that alien crosstalk is currently measured. The ALSNR result provides a single numerical value for cabling performance to indicate support for 2.5GBASE-T or 5GBASE-T. Category 6A cabling is fully specified with more traditional alien limits, and the ALSNR requirement is fully supported.

Meeting these requirements for Category 5e and 6 installations depends not only on the quality of the cabling and installation, but also on the length of cable bundling. Cables that are bundled together have alien crosstalk (both ANEXT and AFEXT), and longer, tighter and more consistent bundles have more alien crosstalk. Actual installations comprise a number of aspects that must be identified and understood, not only for making an assessment of capability but also for determining suitable mitigation if it is needed.

Assessment of alien crosstalk risk

In order to establish 2.5GBASE-T and 5GBASE-T support it is necessary to make an assessment of the cabling installation to establish which channels are at risk of too much alien crosstalk. Where a risk is identified, this may be mitigated to improve performance or tested to certify its compliance. An initial assessment can be done by a qualified cabling expert using as-built cabling documentation, test results, and inspections of the cabling. This can be used to determine which channels might need further assessment. Where the risk is higher, field testing may be performed to certify application support. An example of such risks is shown at right.

In general, the longer cables run together in a bundle, the higher the risk to achieving peak performance, but risk can be reduced by implementing mitigations described in the next section of this paper. Verification is recommended for longer bundling lengths and longer channels.

Mitigation

To reduce the risk of the application not being supported, the following steps may be taken to provide the best possible performance from cabling channels.
1. Separate the equipment cords.
2. Enable NBASE-T "Downshift" feature to negotiate the best rate that can be supported on a particular configuration.
3. Unbundle the horizontal cables.

4. For selective deployments of 2.5GBASE-T or 5GBASE-T applications, utilize nonadjacent patch panel positions.

In the event that performance expectations are not met by the prior mitigation steps, then the alien crosstalk may be mitigated using one or more of the following:
   a. Replace equipment cords and patch cords with Category 6A cords.
   b. Reconfigure cross-connect cabling to more direct inter-connection.
   c. Replace connectors with Category 6A connectors.
   d. Replace the horizontal cable with Category 6A horizontal cable.

Because these mitigation strategies may disturb cable layouts or change components in the channel, the channel performance after mitigation may need to be assessed for required performance.

Table 2: ALSNR support risk for 2.5G and 5G applications

0m <= Bundled cabling length <= 50m	Category 5e	Category 6	Category 6A
2.5GBASE-T			Assured
5GBASE-T Assured			Assured

50m <= Bundled cabling length <= 75m	Category 5e	Category 6	Category 6A
2.5GBASE-T			Assured
5GBASE-T Assured			Assured

75m <= Bundled cabling length <= 100m	Category 5e	Category 6	Category 6A
2.5GBASE-T			Assured
5GBASE-T Assured			Assured

ALSNR Risk	High	Medium	Low

Summary

- 2.5GBASE-T and 5GBASE-T applications will be supported without exception by the installed base of previously certified Category 6A cabling.
- 2.5GBASE-T and 5GBASE-T applications will be supported by most of the installed base of previously certified Category 5e and Category 6 installations, but is not assured in all cases. Cable quality, bundle size, and link length affect the ability of existing infrastructure to operate at these higher data rates. A risk assessment can indicate where problems may occur and it is possible to perform field testing to certify support where assurance is needed.
- Guidance from cabling standards, as well as cabling and field tester manufacturers will improve as the standards become established and equipment becomes readily available.