

Not all cabling is created equal

An investment in the network cabling infrastructure will reduce down time and improve data throughput efficiency.

I am frequently asked about what category of cabling is recommended for new cabling installations. Is Category 5e sufficient or should I install Category 6 or Category 6A cabling? Furthermore, not all category cabling are created equal.

There are different cable and connector designs on the market that provide additional performance margins beyond the minimum requirements of the standard. What are the parameters that are really important to support your network? For this month's column I will examine the key criteria for making an informed decision about network cabling.

As a prerequisite, the first point is that Category 6A and Category 6 cabling is fully backwards compatible for all applications that specify a minimum of Category 5e or Category 5 performance. The essential elements are the same — same pin outs, same color code, same nominal impedance of 100 Ohms; it's all the same except for the performance. Higher category cabling provides better transmission performance, better noise immunity and less variance between components.

What are the major differences between Category 6A, Category 6 and Category 5e? From a network application perspective, the key difference is a higher Signal-to-Noise Ratio (SNR), which translates into fewer bit errors and higher data throughput. A white paper by Anixter together with Intel demonstrates the performance gains of Category 6 cabling compared with Category 5e for the Gigabit Ethernet application.

In it, the number of frame errors in a million frames transmitted is used as a measure of performance. The difference in data throughput efficiency can be quite dramatic under certain worst case conditions. Ideally, the number of frame errors should be close to zero. In order to achieve this requires better SNR margin.

Category 6 cabling provides about 12 dB (400%) improvement in SNR compared to Category 5e over the bandwidth employed for Gigabit Ethernet from 1 MHz to 100 MHz. In addition, Category 6A and Category 6 components are much better matched in Impedance compared to Category 5e. For example, the worst-case Return Loss for connecting hardware at 100 MHz is 28 dB for Category 6A (+/- 4 Ohms), 24 dB for Category 6 (+/- 6 Ohms) and 20 dB for Category 5e (+/- 10 Ohms).

Certain applications are less tolerant to frame errors than others. In particular, real time applications such as IP telephony or IP video cannot tolerate frame errors without a noticeable degradation in speech and picture quality.

For data transmission using TCP/IP protocol the effect of frame errors is a slow down in communications caused by retransmission of the corrupted frames. This slowdown in communications is not

Signal-to-Noise Ratio	SNR Calculations
SNR due to NEXT	PSACRN = (PSNEXT + XN) - IL
SNR due to FEXT	PSACRF = (PSFEXT + XF) - IL
SNR due to echoes	(RL + XE) - IL
SNR due to Alien NEXT	PSAACRN = PSANEXT - IL
SNR due to Alien FEXT	PSAACRF = PSAFEXT - IL

Signal-to-Noise Ratio for different noise sources
 PS = Power Sum, ACR = Attenuation-to-Crosstalk Ratio,
 AACR = Attenuation-to-Alien Crosstalk Ratio, IL = Insertion Loss,
 RL = Return Loss, XN = NEXT cancellation in dB, XF = FEXT cancellation in dB,
 XE = Echo cancellation in dB

always noticeable unless the frame error rate exceeds 1%.

Signal-to-Noise Ratio is derived from the measured transmission parameters for a channel as shown in the table above for different noise sources. It provides some interesting insights into the practical realization of a higher SNR. Some sources of self generated noise in a channel can be cancelled out at the transceiver using digital signal processing techniques, e.g., Near End Crosstalk (NEXT), Far End Crosstalk (FEXT) and echoes caused by impedance mismatch between components.

Other sources of noise such as alien crosstalk are not readily cancelable. For all SNR calculations, a lower Insertion Loss improves the SNR by a corresponding amount. For example, a 3 dB lower Insertion Loss represents a 100 % improvement in SNR whatever the noise source.

Another important reason to consider installing Category 6 or Category 6A cabling is higher noise immunity from noise sources in the environment such as radio frequency interference and power line transients. A study conducted by TIA TR 42.3 subcommittee on the effect of power line transients on the operation of 1000BASE-T Ethernet (see Annex C of TIA 569-B standard) showed that the noise reduction factor for Category 6 cabling is one half compared to Category 5e.

In conclusion, the network cabling is the foundation of the network. The lifetime of the cabling is expected to be a minimum of 10 years. The installed cabling needs to provide reliable, error-free transmission under worst case environmental conditions for the most demanding applications.

An investment in the network cabling infrastructure will pay dividends in reducing network down time and in improving data throughput efficiency and the quality of service. **CNS**



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