The Weakest Link in High-Performance Cabling Systems

Imagine putting shopping cart wheels on a high-performance car? Or how about putting only 16 MB of RAM in that new 1.2 GHz Pentium 4 laptop system? Think of the money you’d save! Intuitively, you know that this is a false economy, and that the tires you buy should match the performance of the vehicle for which they’re intended. Similarly, the memory in your laptop should be appropriate for the processor, speed, and hard disk of the system. Yet, many network installers and owners will carefully review structured cabling systems, go through lengthy evaluations, do a performance “bake off” with sample links, and then after the best system is selected and installed, use any old patch cord. While patch cords have often been considered non-differentiated commodities, it’s time they get the respect they deserve.

A new-found respect

Cabling is normally installed long before furniture or active equipment, and more than 95% of all new installations are tested to the Permanent Link model, which excludes the patch cords at both ends. The idea is that the link is tested and certified for the promised level of performance (normally Category 5e or 6), and then patch cords are added later when the network is installed. This model works well if the performance of the patch cords meets the performance of the installed link – which often is not the case.

Most cabling professionals know that the TIA published TIA 568B in April of 2001, and that this standard includes performance requirements for Category 5e cabling. What many don’t know is why the standard took so long to be finished. One reason was the discovery that patch cord performance could vary in unpredictable ways.

Tests of Return Loss were made on Category 5 patch cords. Fluke Networks, a manufacturer of cable test equipment in Everett, Wash., measured the same patch cord in two different positions as shown below. There was no kinking, sharp bends, or cable abuse - just a simple re-positioning of the patch cord. This is just the sort of repositioning that end users would commonly do as they move a cord between their PC and the wall outlet. The results were surprising.

Return Loss of position A was more than 4 dB better than in position B! This was enough to mean one link passed and the other failed. This is a common error because in the TSB-67 days, installers weren’t required to measure Return Loss. This was a “new” measurement, so its effects were not considered when patch cords were designed and manufactured.

The weakest link

If you consider the entire structured cabling Channel, from the PC to the switch, the weakest link is the modular plug. This is the point that has the potential for the lowest performance. Why? Pairs get untwisted and jammed into a small space, they are crossed over each other and split, and then they are put in parallel with flat plates. Often, mechanical
crimps are used to hold the cable in the plug. These crimps can crush and deform the conductors, creating impedance changes that contribute to Return Loss. Cords take a lot of abuse; they are pulled around desks and run over by chair wheels, stretched tight around fixtures and flattened by heavy furniture.

When you consider that the goal is to try to continue the same matched electrical performance of the horizontal cable, it’s a marvel that manufacturers of patch cords can mimic the transmission of the cable so well through two modular plugs and a length of stranded cable.

And just where are these patch cords located? They are the closest parts of the structured cabling system to the active components. They are placed where the outbound signals strengths are highest, and inbound signals are weakest. A small impedance anomaly that causes a 3 or 4% reflection does a lot more damage to the integrity of the signal transmission when it is located at a few feet from the end (in patch cords) versus somewhere in the middle of a link. This is also true for NEXT anomalies.

End users need to consider Channel performance, not Permanent Link performance, when they are specifying structured cabling requirements. The cable plant is likely to have a much longer life cycle than the active equipment, so planning should anticipate all future needs for bandwidth and capacity. Marginal cords might be okay today for 10/100BASE-T Ethernet, but not for Gigabit Ethernet or future applications. Advanced applications tend to use multiple pair transmission schemes and bidirectional communication on the same pair(s), which makes the performance of the patch cord vital to the quality or error rate of the application.

The need for speed
Category 6 installations have some special requirements. The performance of Category 6 is much higher than Category 5 or 5e, especially for NEXT and Return Loss. For optimum performance plugs and jacks must be “centered” and well matched. As a result of the many studies to define component specifications, the variability between plug and jack is now much better understood, and incompatibility issues are diminishing. However, it is still vital that for Category 6 systems you follow the recommendation of the supplier and use only approved patch cords. Otherwise there is a real risk you will have a “good cord” that is not well matched to your system and suffer degraded Channel performance.

What can end users do? How can you tell if you have a good cord? They all appear similar, and all have official-looking certification stamps along the sides. Clearly, a wiremap test is not enough. Testing in the Channel is much better, but not sufficient either. Why? Permanent Links with sufficient headroom can use marginal patch cords and still pass Channel requirements, but if the same patch cord is added to a marginal Permanent Link, the Channel would fail.

Aside from continuity testing, patch cords should be tested on every pair combination for both NEXT and Return Loss. They should be tested according to TIA guidelines for patch cord tests (special fixtures and limits, NOT a Channel test!). This means they must be tested on a standards-compliant fixture. Otherwise, you could “pass,” but if the jack in the fixture wasn’t properly centered, your pass means nothing.

Then there is the issue of repeatability, and how well the cords stand up to being flexed or coiled or run over by chair wheels. For years, Fluke Networks made field tester cords from patch cords sent by different suppliers. The company found performance varied widely, and began to perform 100%
incoming inspection to ensure the performance matched its high internal standards (which were admittedly tougher than necessary for normal office use). Did these cords all pass wiremap? Sure. Did they work fine for a 10/100 application? Yes. What about their performance after a great deal of flexing, coiling, and uncoiling on Gigabit Ethernet? Many didn’t make the grade.

**Tests for success**

End users really only have a couple of options. First you can follow the recommendations of your supplier, and only choose to buy approved cords that are designed to go with the installation specified. In most cases this is the simplest way to avoid potential performance degradation, especially on Category 6 installations.

Another alternative is to test the cords yourself. Field testers are now available, such as the Fluke Networks DTX CableAnalyzer™ Series and the DSP-4000 Series, that have optional patch cord adapter fixtures designed with special hardware and software to exactly meet TIA patch cord test requirements. In fact, these products are already in use at many patch cord manufacturing facilities worldwide. This provides a means to check legacy cords, as well as verify incoming product to meet requirements consistency from cord to cord.

Don’t treat your patch cords with indifference. They are a vital part of your network. If you take the time and spent a little more to ensure you have a good quality cord, you will enjoy fewer bit errors, greater channel throughput, more system margin and less network downtime.