Interoperability of Category 6 Cabling Systems

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Network Sciences

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History

Structured cabling existed long before the introduction of Category 6. The current entry-level of a structured cabling installation is Category 5 Enhanced (C5E). It is considered the minimum for Gigabit Ethernet deployment since additional tests have been implemented that determine the installed system's ability to transmit on all four pairs in both directions, simultaneously. While the maximum operating frequency has not been increased beyond 100 MHz (the same as Category 5) the requirements at these frequencies have been modified. The limits for NEXT have been made tighter (less near end cross talk is permitted in a Category 5e system than was in a Category 5 system). Category 5e sets the scene for Category 6 and our discussion of Interoperability.

Interoperability is an issue with Category 5e systems, as was it for Category 5 systems. However, the significant implications of meeting the requirements of interoperability with respect to Category 6 require further explanation.

Category 6 cabling systems were introduced by ISO in September 1997, and these were quickly followed by the TIA. Category 6 differs in many ways to Category 5 and Category 5e.

- Category 6 has a maximum operational bandwidth of 200MHz
- Category 6 has been designed to be tested to 250MHz
- Category 6 is available as a UTP and STP solution
- Category 6 includes all of the tests of Category 5e, plus new parameters
- ISO calls is Category 6 link and channels Class E

The early developments of Category 6 followed very similar roads to Category 5 and Category 5e. The development of the Category 6 connecting hardware, I.e. plugs and jacks involved the simultaneous development of both the plugs and the jacks. These two components were developed while connected together, or as a mated pair. Since there was no accurate way of developing an RJ45 plug or an RJ45 jack in isolation of its counterpart, this was an acceptable practice.

However, unlike Category 5 and 5e, Category 6 involved significant RJ45 plug and jack development. This led to a situation where, while the mated pairs of plugs and jacks complied with the requirements of the proposed Category 6 standards, the open system nature of previous cabling types was being eroded away. The entire topic of interoperability concerns the development of both RJ45 jacks and plugs in isolation, using a method called de-embedding that will permit an open nature for all Category 6 cabling systems.

Since each manufacturer developed their own test plugs and jacks, and their system worked well, everything seemed to be progressing in the right direction.

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Field Testing

The field-testing of Category 6 basic links was not a problem as most connectivity manufacturers were simply working with the field tester manufacturers to develop a basic link adapter that included an RJ45 plug that was configured to their requirements.

Initial Category 6 developments provided for manufacturer A's patch cord to work with their jack, manufacturer B's patch cord to work with their jack, and so on. Little consideration was given to how manufacturer A's patch cord would work with manufacturer B's jack. In fact, in the early days of Category 6, mixing manufacturer A and B could lead to performance levels that may only be Category 5e, or even Category 5.

Interoperability is the mechanism used to ensure that all compliant manufacturers' jacks work with all other compliant manufacturers' jacks.

The implications of the current Category 6 development affected the field-testing (permanent link) of installations as well as the future deployment of Category 6 active equipment. At the moment, no one worries about which Category 5e cabling systems work with which active hardware, I.e. hubs, switches, routers, NICs. However, once these devices begin to require 200MHz of bandwidth to operate, I.e. they need a Category 6 system, the absence of interoperability will mean that some manufacturers connecting hardware will only work with a few specific active products.

Once all of the facts have been identified, it does not take much convincing to agree that market wide interoperability is the only way to move forward with the development of Category 6 connecting hardware and patch cords. To meet this goal, a vast amount of effort has been expelled in devising procedures to independently develop plugs (patch cords) and jacks that will operate with all other plugs and jacks, assuming that they too comply with the performance requirements.

De-embedding Procedure

The introduction of reference plugs and reference jacks with the de-embedding procedure permits manufacturers to develop and then test their connectivity to ensure that it will work with the reference plugs and jacks. If all manufacturers' connecting hardware works with the reference plugs and jacks, then it is safe to assume that they will work well with each other.

There is a TIA task group that has been working very hard to develop the specifics of the de-embedding procedure. The variations from test set up to test set up, from lab to lab and even from test to test has made the development of the procedure a very time consuming one. This procedure is one of the last points of contention with respect to the ratification of the Category 6 standard.

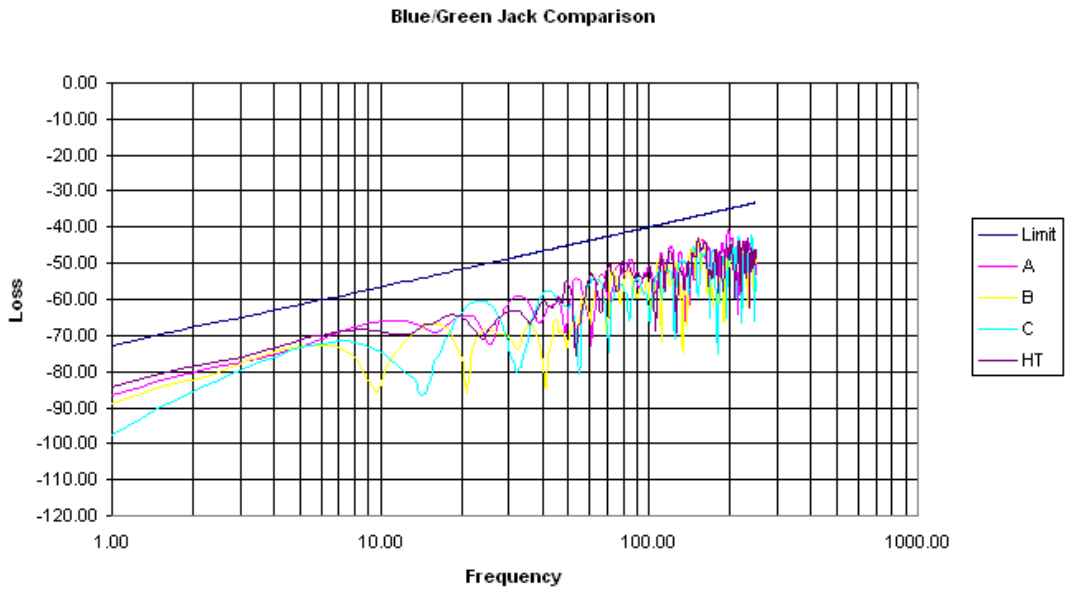
Both the real (magnitude) and imaginary (phase) components of the measurements are required to ensure that the plugs and jacks are compatible. Performance values of the plugs and

jacks for both vector magnitude and phase have been determined and compliance with these values is an indication that interoperability is achievable.

The use of reference plugs enables us to develop Category 6 jacks that will be interoperable.

The use of reference jacks enables us to develop Category 6 patch cords that will be interoperable.

The graph below shows the comparison between four different manufacturer's Category 6 jacks placed into a single channel configuration, one after the other, each with the same horizontal cable and the same patch cords used each all configurations. The closeness of the traces indicates a reasonable measure of interoperability.



The graph below shows the comparison between four different manufacturer's Category 6 patch cords placed into a single channel configuration, one after the other, with the same horizontal cable and same jacks used in each configuration. The closeness of the traces indicates a reasonable measure of interoperability.

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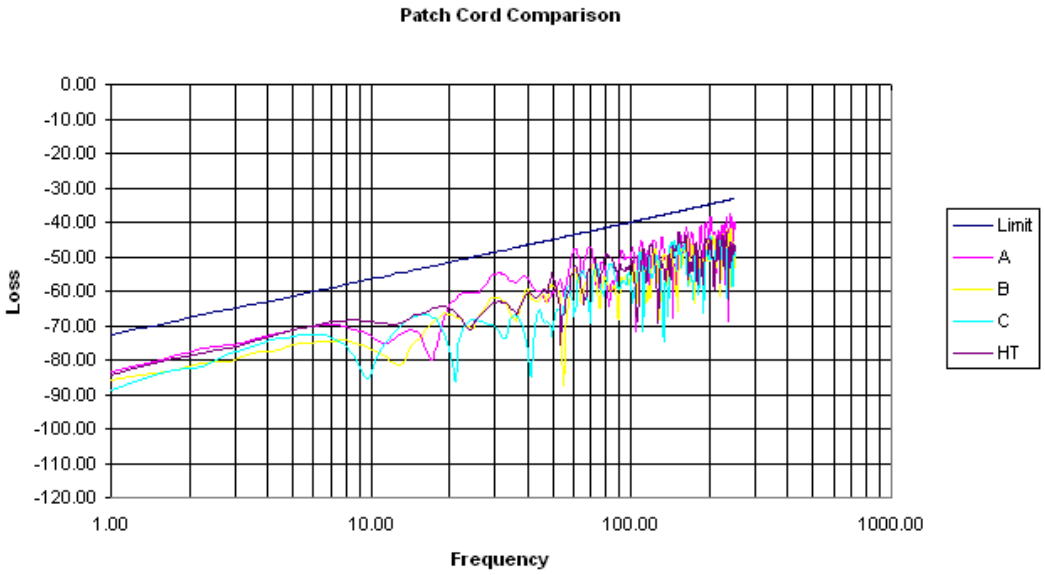

Permanent Link testing

All certified installations of Category 6 systems require that a permanent link test be performed with a level III tester. This test should, in theory, be a true test of the installed cable plant and exclude the effects of the cables and connectors that form part of the test equipment (These are known as permanent link adapters). The link adapters incorporate intelligence (in the form of a microchip) to calculate the effects of the adapter and cancel it's effect on the test results. For those adapters to work with a wide range of manufacturers' systems, the interoperability issue becomes important. While considerable effort has gone into obtaining a tightly controlled range of RJ45 plugs from different manufacturers, interoperability is still proving elusive. The result is that any single link adapter may work with a number of structured cabling systems, but not all. The customer is then posed with the question "which tester can be used to certify a particular cabling system" and would verification with another tester yield the same result?

The field tester manufacturer's initially offered their testers with connecting hardware manufacturer specific link adapters. This means that each cabling system has to have its own specific link adapter to perform the permanent link test required. This turned into to a headache for everyone involved – tester manufacturer, hardware manufacturer, distributor and installer.

The field tester manufacturers realised that there must be a better way to do permanent link testing for Category 6 systems. Most of the testers now offer Standard or Universal permanent link adapters that are supplied with the tester. This means that Category 6 connecting hardware must be interoperable with all these different link adapters – each adapter having a different manufacturer's plug on the end.

The graph below shows the comparison between four Category 6 permanent link adapters, used to test a single permanent link. The closeness of the traces indicates a reasonable measure of interoperability and shows little variance from one tester to another.

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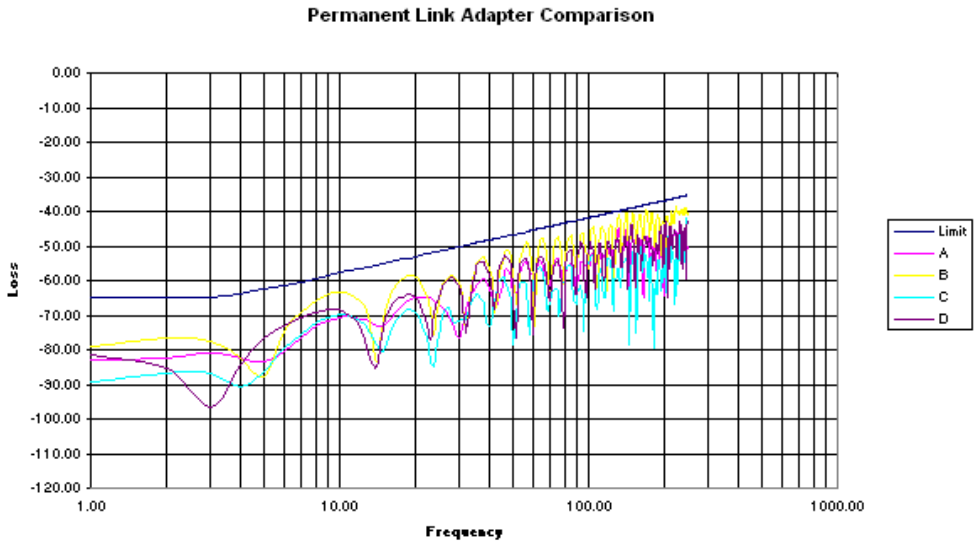

Conclusion

The data shows that it is possible to have interoperability between well-designed Category 6 connecting hardware. It also shows that it is possible to have very little variance in field-testing of Category systems among various level III testers as long as the components meet the TIA limits and are interoperable.

Category 6 systems need to be open in nature like Category 5 and Category 5e in order for the industry to fully accept the technology.

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