University of New Hampshire InterOperability Laboratory
Ethernet Consortium

Superseded

As of July 25th, 2002 the Ethernet Consortium Physical Layer Interoperability Conformance Test Suite Version 2000_08_02 has been superseded by the release of the Physical Layer Interoperability Conformance Test Suite Version 2.0. This document along with earlier versions, are available on the Ethernet Consortium test suite archive page.

Please refer to the following site for both current and superseded test suites:
http://www.iol.unh.edu/testsuites/fe/

FAST ETHERNET

InterOperability
Test Suite

Technical Document

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Test #1.1: Link Speed Detection

Purpose: To determine if the DUT establishes the best possible link with a reference set of stations.

References:

- IEEE P802.3-1998 clause 28

Resource Requirements:

- A reference set of stations that can be used as link partners.
- Link monitoring facilities that are able to determine the signaling being used on the link.
- Local management indicators on the DUT and reference set that indicate the state of the link as perceived by the different stations.
- A physical signaling channel with known compliant properties

Last Modification: August 1, 2000

Discussion: The ability to detect and establish a link at the optimal speed is dependent on the two devices that make up the link segment providing and detecting the signaling technique or connection information being passed. A portion of the FE products use IEEE 802.3-1998 clause 28 compliant auto negotiation. The rest use different proprietary schemes to detect the link partners' speed or do not detect link speed at all. This test procedure addresses three conditions in which link speed detection should work. The first is when the DUT comes up and there is no inbound signal. The second is when the DUT comes up and there is a signal from the remote station. The third is when the DUT is fully up, has its drivers loaded and is connected to a station that is fully up and has its drivers loaded. These three conditions are checked, as there may be different signals on the line during the boot up sequences of the devices that could cause the DUT to detect and establish a link at the wrong speed.

This test is an interoperability test. Failure of this test does not mean that the DUT is non-conformant. It does suggest that a problem in the ability of two devices to work "properly" together exists and further work should be done to isolate the cause of the failure.

Test Setup: The DUT is connected to another device via a Category-5 compliant channel.

Procedure:

<u>Case 1: The DUT receives no input signal during power up.</u>

1. Power off the DUT and the testing station.
2. Connect a compliant Category-5 channel between the two devices.
3. Power on the DUT and ensure that the device is fully up and all needed drivers are loaded.
4. Power on the test testing station and verify that it is fully up.
5. Check local management information to verify that the link came up at the proper speed and that link auto-negotiation, if supported, negotiated the optimal common values for the two devices.

<u>Case 2: The DUT receives signal from the testing station during power up.</u>

1. Power off the DUT and the testing station.
2. Connect a compliant Category-5 channel between the two devices.

   Power on the testing station and ensure that the device is fully up and all needed drivers are loaded.
3. Power on the test DUT and verify that it is fully up.

Check local management information to verify that the link came up at the proper speed and that link auto-negotiation, if supported, negotiated the optimal common values for the two devices.

Case 3: The DUT establishes link with a fully powered and operational testing station.

1. Power off the DUT and the testing station.
2. Power both devices back on and allow them to come fully up.
3. Connect a compliant Category-5 channel between the devices.
4. Verify that a proper link is established as in cases I and II.
5. Remove and hold the cable for a few seconds, then reinsert. Repeat five times. Verify that the link is still proper.
6. Connect the DUT to a 10 Mbps link for 10 seconds.
7. Reconnect the DUT to the testing station. Verify that the link is proper again.

Observable Results:

- The DUT and testing station must be examined for indicators of proper link speed and type. This is typically a LED that lights when link is established. Many devices provide some indication of link speed as well. Local management may provide information about configuration such as link duplex status as well as link speed.

Possible Problems: None.

Test #1.2: Packet Error Rate Estimation

Notice: This testing procedure represents the current practice of the IOL relative to the measuring of bit error rates between different Fast Ethernet devices in the lab. This procedure is expected to change as more experience is gained.

Purpose: To determine if the DUT can exchange packets with a link partner such that the 10BASE-T bit error rate is achieved.

References:

- ANSI X3.263-1995 section 11 and appendix A
- ISO/IEC 8802-3: 1993 Clause 14.1.3.1
- IEEE Std 802.3-1998 clause 24.1.4.3, and clause 25

Resource Requirements:

1. A set of reference stations that can be used as link partners.
2. Two test stations, one that can be used to source packets, and one that can be used to respond or echo the sourced packet. These stations must be able to provide detailed counts of packets transmitted, received, as well as information on errors associated with link level operation.
3. Local management indicators on the DUT that provide information on link level errors such as CRC errors, and frame counts. (optional)
4. Physical signaling channels with well known compliant properties or equipment that can measure NEXT, attenuation, and impedance mismatches. An example device is the Fluke DSP-2000 Lan Cablemeter.

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Discussion: This test is designed to verify the ability of a DUT to exchange packets with another station over the cable model defined in ANSI X3.263-1995. The exchange of packets must produce a packet error rate that is low enough to meet a desired bit error rate. The IOL uses a bit error rate specification of one bit in error in 10^8 bits. This is achieved by sending 470,000 packets of length 64 and 20,000 packets of length 1518, this will insure that the bit error rate is less than $1E^{-8}$ with a 95% accuracy. The 490,000 packets sourced by the testing station are then sent back to the DUT or an echo responder. If more than 14 packets are lost in the exchange the bit error rate criterion have not been met and the test fails. In addition to packets lost local management information may make it possible to isolate the packet loss to either the transmit side or the receive side of the test channel relative to the DUT. If more than seven packets are lost in either side of the channel, then the DUT has violated the bit error rate and the DUT has failed the test.

The observable in this testing process is one or more packet counters. Since a single packet contains many bits, the measurement technique does not really measure the bit error rate. The pass/fail criteria assume that no more than one bit is in error in a lost packet. Thus a device may in theory pass a test with a bit error in excess of 1 in 10^8. However, given that any one bit in error will corrupt the packet, multiple errors within a packet do not in practice make a difference in the number of packets that must be retransmitted on real links. Thus a short-term clock deviation that causes a bit error rate of 5 bits in a stream of 10^8 bits will, under most conditions, cause as many packet errors as a device with a bit error rate of 1 in 10^8.

Since equalizers often tend to be optimized for particular cable conditions the test procedure uses both low attenuation and a high attenuation environment. The high attenuation testing is broken into the worst case cable as
defined in ANSI X3.263-1995 and the Category 5 spec.

Known Problems: The underlying issues which cause bit errors in the transmission of packets in this testing process are not well understood at the present time. In past testing the IOL has observed a significant variance in the number of packets in error for a given set up. The results obtained from this testing process should therefore not be seen as a true measure of the bit error rate but as information that may suggest the need for further analysis.

Test Setup: The DUT is tested against a link partner. The link partner is the device at the other end of the channel being used for interoperability testing. There are four possible setups depending on the type of device being tested and the type of link partner. Both the DUT and the link partner may be either an end station or an internetworking device. For our purposes an internetworking device is any device that receives packets on one port and forwards them out another port. End stations are those devices that respond to an ICMP echo request packet. When the DUT can play both the role of an end station and an internetworking device it is treated as an internetworking device.

The following three figures show the respective setups for end stations and internetworking devices. In figure one the DUT is an end station such as a PC NIC card. It is being tested against another device that is an end station, such as another PC NIC card. In figure two the DUT is still an end station but the link partner is an internetworking device. In this case the link partner connects a third station into the network, which either sources or sinks the packets. This device is called the echo source/responder or simply, testing station. The channel between the link partner and the testing station must be known to be good and not a source of packet loss. Figure three documents the set up for a DUT that is a internetworking device with an end station link partner, and figure four covers the final case of the DUT being an internetworking device as well as the link partner being an internetworking device.

For simplicity of presentation, the DUT and its link partner will be categorized as either a DTE or a DCE. For the purposes of this explanation, the term DTE will be used to indicate a network interface card, a managed switch, or a router. The term DCE will be used to indicate a repeater, a buffered distributor, or an unmanaged switch.

<u>Case 1: DTE to DTE</u>

Connect the DUT to its link partner through the reference environment as shown in figure 1. The reference environment is a channel appropriate

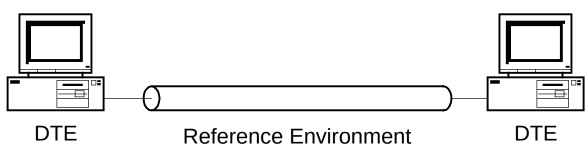

Figure 1: Both the DUT and link partner are DTEs.

<u>Case 2: DTE to DCE</u>

Connect the DUT to its link partner through the reference environment as shown in figure 2. The testing station will exchange packets with the DTE. The link between the testing station and the DCE must be error free.

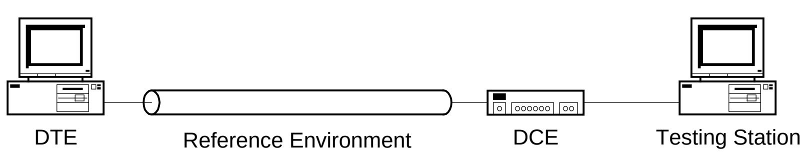

Figure 2: The DUT is a DTE and the link partner is a DCE, or vice versa.

Case 3: DCE to DCE

Connect the DUT to its link partner through the reference environment as shown in figure 3. The testing stations will exchange packets. The links between the testing stations and the DCEs must be error free.

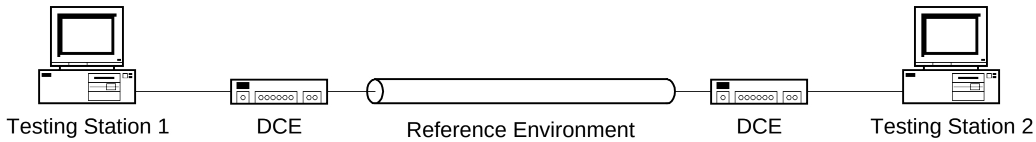

Figure 3: Both the DUT and link partner are DCEs.

There are two different media channels to test. The first is the worst case Category Five compliant channel at 60 degrees. The second is a low attenuation channel comprised of a 3-meter segment of Category 5 cable. Each of these channels must be tested to ensure that they meet the expected characteristics as defined by the associated standards.

Procedure:

1. Configure the media channel to be the Category Five channel.
2. Reset all counters that will be used to measure or monitor the exchange of packets between the DUT and the testing station. Configure software as needed.
3. Using the echo source transmit 470,000 64 byte ICMP echo request packets to the IP address of the echo responder.
4. Using the echo source transmit 20,000 1518 byte ICMP echo request packets to the IP address of the echo responder.
5. Replace the current media channel with the low attenuation channel and repeat steps two through four.

Observable Results: Using the counters on the echo source station, identify the number of ICMP echo reply packets received. The difference between the number of ICMP echo request packets sent and the number received is the number of lost packets. An ARP request and response may have occurred during the testing, adjust as needed. This value should be examined with other information gathered during the testing process to ensure that the failure is due to bit errors and not resource errors on the DUT or testing stations. In the ideal case all lost packets are identified on one of the testing stations or the DUT as either an FCS error, or some other type of receiver error. If the local information gathered from the DUT is reliable it is often possible to isolate the failure to either the transmitter channel or the receiver channel.

Possible Problems: Some of the adapter cards will generate DMA underrun conditions causing the testing station or DUT to generate truncated packets. This information is available under the MLID counters in an ODI testing environment. A number of devices may transmit packets during the testing process that are not associated with the testing. These frames are often multicast frames but not always.