University of New Hampshire InterOperability Laboratory
Ethernet Consortium

Superseded

As of November 7th, 2001 the Ethernet Consortium Clause # 28 Auto Negotiation Next Page Exchange Conformance Test Suite version 1.0 has been superseded by the release of the Clause # 28 Auto Negotiation Next Page Exchange Conformance Test Suite version 2.0.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Please refer to the following site for both current and superseded test suites: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/ethernet/archive.html

FAST ETHERNET
&
GIGABIT ETHERNET

Clause 28 Auto-Negotiation
Next Page Exchange Test Suite

Technical Document

Last Updated: June 27, 2000 11:40 p.m.

Fast/Gigabit Ethernet Consortium
InterOperability Laboratory
Research Computing Center
University of New Hampshire

Jere Chase OE, Room 201
Durham, NH 03824
Phone: (603) 862-0166
Fax: (603) 862-1915
http://www.iol.unh.edu/consortiums/fe
http://www.iol.unh.edu/consortiums/ge

The University of New Hampshire
InterOperability Laboratory

MODIFICATION RECORD

- June 27, 2000 Version 1.0 Released

Initial Release

Test Group 1: Next Page Functionality

Test #28.1.1 - Transmitted Next Pages
Test #28.1.2 - Next Page Consistency Matchs
Test #28.1.3 - Null Message Page
Test #28.1.4 - Next Page Bit
Test #28.1.5 - Toggle Bit
Test #28.1.6 - Message and Unformatted Pages
Test #28.1.7 - Reception of Next Pages
Test #28.1.8 - Transmit Disable
Test #28.1.9 - Priority Resolution Following Next Page Exchange

ACKNOWLEDGMENTS

The University of New Hampshire would like to acknowledge the efforts of the following individuals in the development of this test suite.

Andy Baldman	University of New Hampshire
Jeremy Kent	University of New Hampshire
Roy Lavender	University of New Hampshire
Eric Lynskey	University of New Hampshire
Bob Noseworthy	University of New Hampshire
Jake O'Dell	University of New Hampshire
Ben Schultz	University of New Hampshire
Karen Tuttle	University of New Hampshire
Ben Verschueren	University of New Hampshire

INTRODUCTION

Overview

The University of New Hampshire's InterOperability Laboratory (IOL) is an institution designed to improve the interoperability of standards based products by providing an environment where a product can be tested against other implementations of a standard. This suite of tests has been developed to help implementers evaluate the functioning of their Clause 28 Auto-Negotiation based products. The tests do not determine if a product conforms to the IEEE 802.3 standard, nor are they purely interoperability tests. Rather, they provide one method to isolate problems within an auto-negotiating device. Successful completion of all tests contained in this suite does not guarantee that the tested device will operate with other auto-negotiating devices. However, combined with satisfactory operation in the IOL's interoperability test bed, these tests provide a reasonable level of confidence that the Device Under Test (DUT) will function well in most auto-negotiating environments.

Organization of Tests

The tests contained in this document are organized to simplify the identification of information related to a test and to facilitate in the actual testing process. Each test contains an identification section that describes the test and provides cross-reference information. The discussion section covers background information and specifies why the test is to be performed. Tests are grouped in order to reduce setup time in the lab environment. Each test contains the following information:

Test Number

The Test Number associated with each test follows a simple grouping structure. Listed first is the Test Group Number followed by the test's number within the group. This allows for the addition of future tests to the appropriate groups of the test suite without requiring the renumbering of the subsequent tests.

Purpose

The purpose is a brief statement outlining what the test attempts to achieve. The test is written at the functional level.

References

The references section lists cross references to the IEEE 802.3 standards and other documentation that might be helpful in understanding and evaluating the test and results.

Resource Requirements

The requirements section specifies the hardware, and test equipment that will be needed to perform the test. The items contained in this section are special test devices or other facilities, which may not be available on all devices.

Last Modification
This specifies the date of the last modification to this test.

Discussion
The discussion covers the assumptions made in the design or implementation of the test as well as known limitations. Other items specific to the test are covered here.

Test Setup
The setup section describes the configuration of the test environment. Small changes in the configuration should be included in the test procedure.

Procedure
The procedure section of the test description contains the step-by-step instructions for carrying out the test. It provides a cookbook approach to testing, and may be interspersed with observable results.

Observable Results
The observable results section lists observables that can be examined by the tester to verify that the DUT is operating properly. When multiple values are possible for an observable, this section provides a short discussion on how to interpret them. The determination of a pass or fail for a certain test is often based on the successful (or unsuccessful) detection of a certain observable.

Possible Problems
This section contains a description of known issues with the test procedure, which may effect test results in certain situations.

TABLE OF CONTENTS

GROUP 1: NEXT PAGE EXCHANGE

Scope: The following tests cover Auto-Negotiation operation specific to the Next Page exchange process.

Overview: These tests are designed to verify that the device under test properly implements the media independent interface (MII) register set as it pertains to the Auto-Negotiation function. Register functions explored are defined in Clause 22 (MII), Clause 28 (Auto-Negotiation) and Clause 40 (1000BASE-T) of IEEE 802.3 and 802.3ab. Many of these tests are aimed at verifying the critical link between a conformant Auto-Negotiation state machine implementation and the overall system's management and control software.

NOTE: THESE TESTS CANNOT BE PERFORMED IF THE DUT DOES NOT SUPPORT A NEXT PAGE EXCHANGE OR ALLOW A NEXT PAGE EXCHANGE TO BE INITIATED.

Test #28.1.1: Next Page Exchange Restart

Purpose: To verify that the device under test enters the TRANSMIT DISABLE state from the NEXT PAGE WAIT state if flp_receive_idle becomes true.

References:

[1] IEEE Std 802.3, 1998 Edition: Sections 28.3.1, Figure 28-16 Arbitration state diagram

Resource Requirements:

- Line Monitor: A system capable of detecting, time-stamping, and recording normal link pulses (NLPs) on both the receive and transmit channels of the DUT. The channel signaling should pass through the line monitor with minimal distortion.
- Traffic Generator: A system capable of generating and transmitting normal link pulses (NLPs) and fast link pulses (FLPs) while connected to the receiver of the DUT.

Last Modification: July 28, 1999

Discussion: Once the Next Page exchange process has begun, if a device's link partner for some reason stops sending Next Pages, the device should cease transmission as well. When in the NEXT PAGE WAIT state, if a device detects flp_receive_idle=true, then it should immediately transition to the TRANSMIT DISABLE state. This test is designed to verify that the device under test exits the Next Page exchange process if flp_receive_idle becomes true.

Test Setup: Using a Cat 5 cord, connect the DUT's transmitter to the Line Monitor. Terminate the DUT's transmit channel with a 100Ω line termination. Using a Cat 5 cord, connect the DUT's receiver to the Traffic Generator using a 100Ω line termination.

Procedure:

1. Establish a connection (not a link) to the DUT
2. Use the Traffic Generator to send the DUT enough FLPs to put it through the COMPLETE ACKNOWLEDGE state (see test #28.2.2)
3. Send the DUT a message page with the NP bit set to 1 (going through the COMPLETE ACKNOWLEDGE state), then cease transmission of Next Pages
4. Verify that the DUT enters the TRANSMIT DISABLE state

Observable Results:

- After the expiration of nlp_max_timer, the device should enter the TRANSMIT DISABLE state and cease transmission of Next Pages

Possible Problems: If the DUT does not support a Next Page exchange, then this test cannot be performed.

Test #28.1.2: Next Page Consistency Match

Purpose: To verify that the device under test still performs a consistency match test on received Next Pages.

References:

[1] IEEE Std 802.3, 1998 Edition: Section 28.3.1

Resource Requirements:

- Line Monitor: A system capable of detecting, time-stamping, and recording normal link pulses (NLPs) on both the receive and transmit channels of the DUT. The channel signaling should pass through the line monitor with minimal distortion.
- Traffic Generator: A system capable of generating and transmitting normal link pulses (NLPs) and fast link pulses (FLPs) while connected to the receiver of the DUT.

Last Modification: July 28, 1999

Discussion: This test is virtually identical to test #28.2.3, but is repeated here to verify that the consistency match test is carried through to the Next Page exchange process and is performed on Next Pages. See test #28.2.3 for full details.

Test Setup: Using Cat 5 cords, connect the DUT and the Traffic Generator to the Line Monitor such that the traffic generator's signaling will be seen by the DUT's receiver. Terminate the DUT's transmit channel with a 100Ω line termination.

Procedure:

1. Establish a connection (not a link) to the DUT
2. Use the Traffic Generator to send the DUT enough FLPs to get it through the COMPLETE ACKNOWLEDGE state (see test #28.2.2)
3. Send a series of message pages- first some with the Acknowledge bit not set (enough to put the DUT into the ACKNOWLEDGE DETECT state- refer to results of test #28.2.1) followed by 3 with the Acknowledge bit set to logic one and bit D10 holding the opposite value as the initial 4 message pages
4. Monitor the transmit line coming from the DUT

Observable Results:

- The DUT should cease transmitting Next Pages immediately once the inconsistent message pages are received

Possible Problems: If the DUT does not support a Next Page exchange, then this test cannot be performed.

Test #28.1.3: Reception of Toggle Bit

Purpose: To verify that the device under test checks the value of the Toggle Bit when transitioning from NEXT PAGE WAIT to ACKNOWLEDGE DETECT to see if the received Next Pages correctly alternate the value of the Toggle Bit.

References:

[1] IEEE Std 802.3, 1998 Edition: Sections 28.2.1.2, 28.2.3.4, 28.2.3.4.1, 28.2.3.4.6

Resource Requirements:

- Line Monitor: A system capable of detecting, time-stamping, and recording normal link pulses (NLPs) on both the receive and transmit channels of the DUT. The channel signaling should pass through the line monitor with minimal distortion.
- Traffic Generator: A system capable of generating and transmitting normal link pulses (NLPs) and fast link pulses (FLPs) while connected to the receiver of the DUT.

Last Modification: July 28, 1999

Discussion: During Next Page exchange, the toggle bit (bit D11) of the received Next Pages serves a simple purpose. The value of this bit alternates between 0 and 1 in consecutive pages, and therefore provides the receiving station with a quick and easy check to verify that it is receiving Next Pages in the proper order. If a device receives consecutive pages without the toggle bit toggled, it should sit in the NEXT PAGE WAIT state until it receives a Next Page with the proper toggle bit value. This test is designed to verify that the device under test makes sure that its received Next Pages are toggled properly.

Test Setup: Using Cat 5 cords, connect the DUT and the Traffic Generator to the Line Monitor such that the traffic generator's signaling will be seen by the DUT's receiver. Terminate the DUT's transmit channel with a 100Ω line termination.

Procedure:

1. Establish a connection (not a link) to the DUT
2. Use the Traffic Generator to send enough FLPs to put the DUT through the COMPLETE ACKNOWLEDGE state (see test #28.2.2)
3. Send the DUT enough Next Pages to allow it to send all of its message and unformatted pages with the following modification: reverse the values of the toggle bit of the last 2 pages (by doing this, you end up with toggle values of either 0 0 1 or 1 1 0 for the last 3 pages)
4. Monitor the transmission from the DUT.

Observable Results:

- The DUT should not leave the NEXT PAGE WAIT state on reception of the second to last page, but should accept the last page and conclude the Next Page exchange

Possible Problems: If the DUT does not support a Next Page exchange, then this test cannot be performed.

Test #28.1.4 Transmitted Toggle Bit Value

Purpose: To verify that the device under test properly alternates values of 0 and 1 in the toggle bit position (bit D11) of its Next Pages.

References:

[1] IEEE Std 802.3, 1998 Edition: Sections 28.2.1.2, 28.2.3.4, 28.2.3.4.1, 28.2.3.4.6

Resource Requirements:

- Line Monitor: A system capable of detecting, time-stamping, and recording normal link pulses (NLPs) on both the receive and transmit channels of the DUT. The channel signaling should pass through the line monitor with minimal distortion.
- Traffic Generator: A system capable of generating and transmitting normal link pulses (NLPs) and fast link pulses (FLPs) while connected to the receiver of the DUT.

Last Modification: July 28, 1999

Discussion: During Next Page exchange, the toggle bit (bit D11) of the transmitted Next Pages serves a simple purpose. The value of this bit alternates between 0 and 1 in consecutive pages, and therefore provides the receiving station with a quick and easy check to verify that it is receiving Next Pages in the proper order. Therefore, it is important that the DUT sets these bits properly, starting with its first Next Page, whose toggle bit value takes the opposite value of bit D11 in the device's Link Code Word. This test is designed to verify that the device under test sets the toggle bit properly throughout the exchange of Next Pages.

Test Setup: Using Cat 5 cords, connect the DUT and the Traffic Generator to the Line Monitor such that the traffic generator's signaling will be seen by the DUT's receiver. Terminate the DUT's transmit channel with a 100Ω line termination.

Procedure:

1. Use the Traffic Generator to send enough FLPs to put the DUT through the COMPLETE ACKNOWLEDGE state (see test #28.2.2)
2. Send the DUT enough Next Pages to allow it to send all of its message and unformatted pages.
3. Monitor the transmitted Next Pages
4. Verify that the DUT sets the toggle bit properly in all of its Next Pages

Observable Results:

- The value of the toggle bit in the first Next Page should have the opposite value of bit D11 in the DUT's Link Code Word
- The value of the toggle bit of the Next Page transmitted by the DUT's should always take the opposite value of the toggle bit of the previous Next Page (if the previous value was a 0, it should be a 1, and vice versa)

Possible Problems: If the DUT does not support a Next Page exchange, then this test cannot be performed.

Test #28.1.5: Reception of rx_link_code_word[NP]=0

Purpose: To verify that the DUT will properly complete a Next Page exchange when rx_link_code_cord[NP]=0 while tx_link_code_word[NP]=0 in the ACKNOWLEDGE DETECT state.

References:

[1] IEEE Std 802.3, 1998 Edition: Sections 28.3.1, 28.3.4, Figure 28-16

Resource Requirements:

- Line Monitor: A system capable of detecting, time-stamping, and recording normal link pulses (NLPs) on both the receive and transmit channels of the DUT. The channel signaling should pass through the line monitor with minimal distortion.
- Traffic Generator: A system capable of generating and transmitting normal link pulses (NLPs) and fast link pulses (FLPs) while connected to the receiver of the DUT.

Last Modification: August 4, 1999

Discussion: When a device has finished transmitting Next Pages, and its link partner still has more Next Pages to send, the device should set its Next Page bit to zero and transmit null message pages. Once the device receives the last Next Page from its link partner, which will have the Next Page bit set to zero, the two devices can exit COMPLETE ACKNOWLEDGE and enter FLP LINK GOOD CHECK. It is possible that a device that has its Next Page bit set to zero, while in COMPLETE ACKNOWLEDGE, will begin to receive a page from its link partner with the Next Page bit also set to zero. Once the device has sent its remaining abilities with the acknowledge bit set, ack_finished=true, tx_link_code_word[NP]=0, and rx_link_code_word[NP]=0. This could possibly cause a premature transition to FLP LINK GOOD CHECK. The link partner would still have its last Next Page to send, and the device would have ended the Next Page exchange to attempt to establish a link. A device should not act on reception of rx_link_code_word[NP]=0 until the NEXT PAGE WAIT state has been entered. Only if a page received here has the Next Page bit set to zero should the DUT then transition to FLP LINK GOOD CHECK after exiting COMPLETE ACKNOWLEDGE.

Test Setup: Using Cat 5 cords, connect the DUT and the Traffic Generator to the Line Monitor such that the traffic generator's signaling will be seen by the DUT's receiver. Terminate the DUT's transmit channel with a 100Ω line termination.

Procedure:

1. Establish a connection (not a link) to the DUT
2. Send a series of FLPs to the DUT such that the DUT proceeds to transmit all of its Next Pages, and sets its Next Page bit to zero
3. Send a null message page with the Next Page bit set to one enough times to put the DUT in COMPLETE ACKNOWLEDGE
4. Before the DUT exits COMPLETE ACKNOWLEDGE, send the DUT a null message page with the Next Page bit set to zero

5. Observe transmissions from the DUT

Observable Results:

- The DUT should not enter FLP LINK GOOD CHECK

Possible Problems: If the DUT does not support a Next Page exchange, then this test cannot be performed.