University of New Hampshire InterOperability Laboratory
Ethernet Consortia

Superseded

As of January 23rd, 2004 the Gigabit Ethernet Consortium Clause 4 MAC Conformance Test Suite version 2003_05_20 has been superseded by the release of the Ethernet Consortia Clause 4 MAC Conformance Test Suite version 4.1. This document along with earlier versions, are available on the EFM Consortium test suite archive page.

Please refer to the following site for both current and superseded test suites:

http://www.iol.unh.edu/testsuites/ge

GIGABIT ETHERNET

Clause 4
Media Access Control (MAC) Test Suite

Technical Document

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Ethernet Testing Services

Gigabit Ethernet Consortium

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MODIFICATION RECORD

- May 20, 2003 Combined all tests into a single document
  Mike Henninger: To be displayed on the IOL webpage.
- January 11, 2000 10BASE-T Version 3.0 Released
  Neal Starr: Added missing tests from the Fast Ethernet test suite and renumbered test suite.
- January 10, 2000 Gigabit version 1.1 Released
  Al Braga: Review test suite and update references to new version of the standard.
- October 13, 1999 10BASE-T Version 2.0 Released
  Neal Starr: Added Start of Frame Delimiter Error Reception and Recovery.
- May 5, 1999 Fast Ethernet Version 3.10 Released
  Pete Scruton: Fix typographical errors and renumbering tests.
- January 22, 1999 Fast Ethernet Version 3.01 Released
  Pete Scruton: Major revision, rewritten and added tests.
- January 3, 1998 Gigabit Version 1.0 Released
  Rupert Dance: Released initial version of the Gigabit MAC Test Suite.
- Date Unknown, Fast Ethernet Version 1.0 Released.
  Bob Noseworthy: Released initial version of the Fast Ethernet Test Suite.
- Date Unknown, 10BASE-T Version 1.0 Released
  Adam Healey: Released initial version of the 10BASE-T Test Suite.

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Aldobino Braga	University of New Hampshire
Cindy Bowman	University of New Hampshire
Rupert Dance	University of New Hampshire
Adam Healey	University of New Hampshire
Mike Henninger	University of New Hampshire
Stephen Kelsey	University of New Hampshire
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Pooja Patel	University of New Hampshire
Peter Scruton	University of New Hampshire
Neal Starr	University of New Hampshire
David Strohschein	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 4 Media Access Control (MAC) based products. The tests do not determine if a product conforms to the IEEE 802.3, nor are they purely interoperability tests. Rather, they provide one method to isolate problems within a MAC device. Successful completion of all tests contained in this suite does not guarantee that the tested device will operate with other 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 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 specific items that can be examined by the tester to verify that the DUT is operating properly. When multiple values are possible for an observable result, 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 result.

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

Group 1 – Collision Handling

Test 4.1.1 - Collisions during preamble or SFD and within slotTime.

Purpose: To test collision detection and enforcement when collisions occur in preamble and SFD and it is within slotTime (4096 bits).

References:

- IEEE Std 802.3, 1998 Edition - subclauses 4.1.2.2, 4.2.3.4, 4.2.3.2.3, 4.2.3.2.4 4.2.3.2.5, 4.2.4.2.2, 4.4.2.4, 35.2.2.10, Figure 4-4 (a): Transmit Frame State Diagram, and Figure 35-13
- Annex A - Table of Acronym Definitions

Resource Requirements:

- A testing station capable of encoding (decoding) 8 bit octets to (from) 10-bit code groups as specified in clause 36 and sending (receiving) these code groups using the signaling method described in clause 38 or clause 39.

Last Modification: 3rd January 2000

Discussion: Since an entire collision may occur during preamble generation, the MAC sublayer shall handle this possibility by monitoring collisionDetect concurrently with its transmission of outgoing bits. The collisionDetect signal is generated only during transmission and is never true at any other time; in particular, it cannot be used during frame reception to detect collisions between two or more other stations. While a station is transmitting and collisionDetect signal is asserted by the PCS sublayer, then a collision event has occurred. When a collision occurs during transmission of preamble or SFD, the station should complete transmission of preamble and SFD and then transmit a 32-bit "jam" signal to enforce the collision.

When a collision occurs during preamble or SFD, the content of the jam is unspecified. It may be any fixed or variable pattern convenient to the media access implementation. However, the pattern shall not be intentionally designed to be the 32-bit CRC value corresponding to the (partial) frame transmitted prior to the jam.

Upon completing transmission of the jam signal, the DUT transmits an EPD and then returns to transmitting an idle stream.

Test Setup: Connect the device under test (DUT) to the testing station (transmit to receive, receive to transmit) with the appropriate medium (i.e. balanced copper, multi-mode fiber, etc.).

Procedure:

1. The testing station is instructed to transmit a properly encapsulated, valid, 512-byte frame. This will cause the DUT to generate a response.
2. The testing station is instructed to create a collision at the DUT '*n*' octets after the DUT transmits the SPD. The initial value of '*n*' should be 0.
3. The activity captured by the testing station and the statistics gathered by the DUT are observed.
4. Steps 1 through 3 are repeated with the value of '*n*' varied from 1 to 8.

Observable results:

a. The testing station should capture a collision fragment. This fragment should consist of complete preamble, SFD, a 32-bit jam pattern and an EPD. The jam pattern should be in agreement with IEEE 802.3 subclause 4.2.3.2.4.
b. The testing station should capture a complete, valid reply indicating successful retransmission.

Possible Problems: If the jam pattern generated is not a fixed and readily identifiable pattern, it is difficult to determine how many bits of jam were transmitted.

Test 4.1.2 - Collisions in data within slotTime

Purpose: To test collision detection and enforcement when collisions occur during data transmission and it is within slotTime (4096 bits).

References:
- IEEE Std 802.3, 1998 Edition- subclauses 4.1.2.2, 4.2.3.2.3, 4.2.3.2.4, 4.2.3.2.5, 4.2.3.4, 4.2.4.2.2, 4.4.2.4, 35.2.2.10, Figure 4-4 (a): Transmit Frame State Diagram, and Figure 35-13
- Annex A - Table of Acronym Definitions

Resource Requirements:
- A testing station capable of encoding (decoding) 8 bit octets to (from) 10-bit code groups as specified in clause 36 and sending (receiving) these code groups using the signaling method described in clause 38 or clause 39.

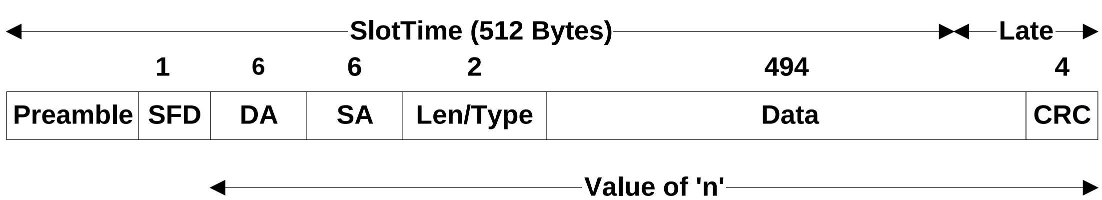
Last Modification: 3 January, 2000

Discussion: While a station is transmitting and the PCS sublayer asserts the COL signal, then a collision event has occurred. The MAC monitors the medium for collisions and it will treat any collision which occurs after the threshold (slotTime - headerSize) as a late collision. When a collision occurs during transmission of data, the station should cease transmission of data and transmit a 32-bit "jam" signal to enforce the collision.

When a collision occurs during transmission of data, the content of the jam is unspecified. It may be any fixed or variable pattern convenient to the media access implementation. However, the pattern shall not be intentionally designed to be the 32-bit CRC value corresponding to the (partial) frame transmitted prior to the jam. Upon completing transmission of the jam signal, the DUT transmits an EPD and then returns to transmitting an idle stream.

Test Setup: Connect the device under test (DUT) to the testing station (transmit to receive, receive to transmit) with the appropriate medium (i.e. balanced copper, multi-mode fiber, etc.).

Procedure:



1. The testing station is instructed to transmit a properly encapsulated, valid, 512-byte frame. This will cause the DUT to generate a response.
2. The testing station is instructed to create a collision at the DUT '*n*' octets after the DUT transmits the SPD. The initial value of '*n*' should be 9.

3. The activity captured by the testing station and the statistics gathered by the DUT are observed.
4. Steps 1 through 3 are repeated with the value of ‘*n*’ varied from 9 to 520 to include frames of slotTime (512 bytes).

Observable results:

a. When the value of ‘n’ is between 9 and 512, the testing station should capture a collision fragment. This fragment should consist of complete preamble, SFD, any terminated data transmission, a 32-bit jam pattern, and an EPD. The jam pattern should be in agreement with IEEE 802.3 subclause 4.2.3.2.4. The testing station should capture a complete, valid reply indicating successful retransmission.
b. When the value of ‘n’ is between 513 and 520, the DUT should detect a late collision and should report an excessiveCollisionError to the LLC sublayer. The frame should not be retransmitted.

Possible Problems: If the jam pattern generated is not a fixed and readily identifiable pattern, it is difficult to determine how many bits of jam were transmitted.

Test 4.1.3 - Collisions during extension within slotTime

Purpose: To test collision detection and enforcement when collisions occur during extension and it is within slotTime (4096 bits).

References:

- IEEE Std 802.3, 1998 Edition- subclauses 4.1.2.2, 4.2.3.2.3, 4.2.3.2.4, 4.2.3.2.5, 4.2.3.4, 4.2.4.2.2, 4.4.2.4, 35.2.2.11, Figure 4-4 (a): Transmit Frame State Diagram and Figure 35-14
- Annex A - Table of Acronym Definitions

Resource Requirements:

- A testing station capable of encoding (decoding) 8 bit octets to (from) 10-bit code groups as specified in clause 36 and sending (receiving) these code groups using the signaling method described in clause 38 or clause 39.

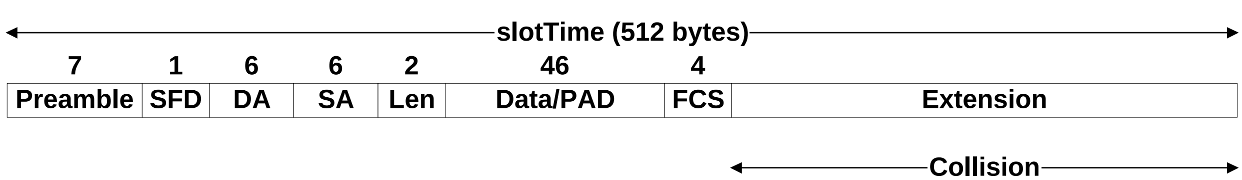
Last Modification: 3 January, 2000

Discussion: In half-duplex mode at operating speeds above 100 Mb/s, the slotTime employed at slower speeds is inadequate to accommodate network topologies of the desired physical extent. Carrier extension provides a means by which the slotTime can be increased to a sufficient value for the desired topologies, without increasing the minFrameSize parameter. Non-data bits, referred to as extension bits, are appended to frames which are less than slotTime bits in length so that the resulting transmission is at least one slotTime in duration. The maximum length of the extension is equal to the quantity (slotTime – minFrameSize).

While a station is transmitting and the COL signal is asserted by the PCS sublayer, then a collision event has occurred. The MAC continues to monitor the medium for collisions while it is transmitting extension bits, and it will treat any collision, which occurs after the threshold (slotTime - headerSize) as a late collision. When a collision occurs during transmission of extension, the station should cease transmission of extension and transmit a 32-bit "jam" signal to enforce the collision. The content of the jam must be extension error code groups.

Test Setup: Connect the device under test (DUT) to the testing station (transmit to receive, receive to transmit) with the appropriate medium (i.e. balanced copper, multi-mode fiber, etc.).

Procedure:



1. The testing station is instructed to transmit a properly encapsulated, valid, 64-byte echo request frame padded with extension to meet slotTime requirements. This will cause the DUT to transmit an echo reply.
2. The testing station is instructed to create a collision at the DUT ‘*n*’ octets after the DUT transmits the SPD. The initial value of ‘*n*’ should be 73. This should cause a collision to occur when the DUT is transmitting extension.
3. The activity captured by the testing station and the statistics gathered by the DUT are observed.
4. Steps 2 through 3 are repeated with the value of ‘*n*’ incremented from 74 to 512.

Observable results:

a. The testing station should capture a collision fragment. This fragment should consist of complete preamble, SFD, any data transmitted, a 32-bit jam of extension error bits and an EPD.
b. The testing station should capture a complete, valid reply indicating successful retransmission.

Possible Problems: None.

Test 4.1.4 - Collisions during preamble and SFD outside of slotTime (Burst Mode).

Purpose: To test collision detection and enforcement when collisions occur in preamble or SFD and the device under test (DUT) is in **burst mode**.

References:

- IEEE Std 802.3, 1998 Edition- subclauses 4.1.2.2, 4.2.3.2.3, 4.2.3.2.4, 4.2.3.2.5, 4.2.3.2.7, 4.2.3.4, 4.2.4.2.2, 4.2.8, 4.2.9, 4.4.2.4, Figure 4.3: Relationship among CSMA/CD procedures and Figure 4-4 (a): Transmit Frame State Diagram.
- Annex A - Table of Acronym Definitions

Resource Requirements:

- A testing station capable of encoding (decoding) 8 bit octets to (from) 10-bit code groups as specified in clause 36 and sending (receiving) these code groups using the signaling method described in clause 38 or clause 39.

Last Modification: 3 January, 2000

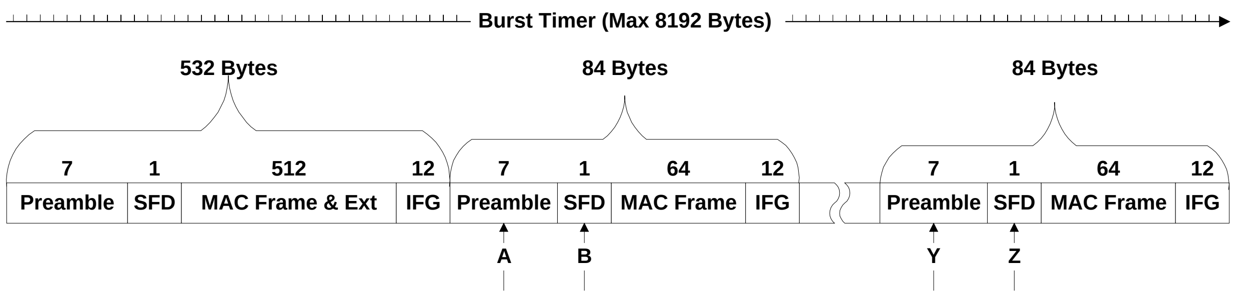
Discussion: In half-duplex mode at operating speeds above 100 Mb/s, the slotTime employed at slower speeds is inadequate to accommodate network topologies of the desired physical extent. Carrier Extension provides a means by which the slotTime can be increased to a sufficient value for the desired topologies, without increasing the minFrameSize parameter. Non-data bits, referred to as extension bits, are appended to frames which are less than slotTime bits in length so that the resulting transmission is at least one slotTime in duration. In Gigabit Ethernet the value for slotTime is 4096 bits. The maximum length of the extension is equal to the quantity (slotTime – minFrameSize).

In half-duplex mode at operating speeds above 100 Mb/s, an implementation may optionally transmit a series of frames without relinquishing control of the transmission medium. This mode of operation is referred to as burst mode. The first frame of a burst must always be at least 4096 bits long which may be accomplished through the addition of extension bits. Once this first frame has been successfully transmitted, the transmitting station can begin transmission of another frame without contending for the medium. Other stations on the network will continue to defer to its transmission, provided that the transmitting station does not allow the medium to assume an idle condition between frames. The transmitting station fills the interFrame spacing interval with extension bits in order to maintain control of the medium. The transmitting station is allowed to initiate frame transmission until a specified limit, referred to as burstLimit, is reached. The value of burstLimit is specified in 4.4.2.4.

In a properly configured network, and in the absence of errors, collisions cannot occur during a burst at any time after the first frame of a burst has been transmitted. Therefore, the MAC will treat all collisions which occur after the first frame of a burst as a late collision. Within a burst of frames, the first frame of a burst must be at least slotTime bits in length in order to be accepted by the receiver, while subsequent frames within a burst must be at least minFrameSize in length. Anything less is presumed to be a fragment resulting from a collision, and is discarded by the receiver. The discarding of such a fragment by a MAC is not reported as an error.

Test Setup: Connect the device under test (DUT) to the testing station (transmit to receive, receive to transmit) with the appropriate medium (i.e. balanced copper, multi-mode fiber, etc.).

Procedure:



Collision Tests during preamble and SFD while in Burst mode

1. The DUT is instructed to transmit ten properly encapsulated, valid, 64 byte request frames. The requests should have incremented sequence numbers to facilitate the observation phase. The first frame will have extension added to it to make a valid 512 byte (4096 bit) frame. The remaining 9 frames must be sent in burst mode with a 12 byte IPG between each frame. The IPG should be filled with extension in order to maintain control of the medium. This will yield a carrier event of 1288 bytes (532 + (9 * 84)).
2. The testing station is instructed to create a collision at the DUT (532 + n + [m * 84]) octets after the DUT transmits the SPD. Initially 'n' and 'm' are set to zero. This will cause a collision to occur during the preamble of the second frame. The position is indicated by the arrow "A".
3. The activity captured by the testing station and the statistics gathered by the DUT are observed.
4. Steps 1 through 3 are repeated with the value of '*n*' incremented from 1 to 8 and 'm' set to zero which tests collisions throughout preamble and SFD of the second frame. When n is set to 8, the collision will occur in SFD which is indicated by the arrow "B".
5. Finally steps 1 through 4 are repeated with the value of 'm' incremented from 1 to 9. This will test collisions in preamble and SFD in all the frames sent during the Burst. The final testing positions are indicated by the arrows "Y" and "Z".

Observable results:

a. The testing station should capture a complete valid frame indicating successful transmission of the first frame with extension. The sequence number should be the first of the series.
b. The testing station should capture a complete valid frame for all complete frames transmitted during the burst, prior to the collision. The number of these additional valid frames should equal the value of 'm'. The sequence numbers of the frames should be checked to verify that the correct frames were received.
c. Finally the testing station should capture a collision fragment which indicates the collision occurring during preamble or SFD. This fragment should consist of complete preamble, SFD, a 32-bit jam pattern and an EPD. The jam pattern should be in agreement with IEEE 802.3 subclause 4.2.3.2.4.
d. After the collision, the DUT should cease transmitting in burst mode and the DUT should not retransmit the frame.

Possible Problems:

- If the jam pattern generated is not a fixed and readily identifiable pattern, it is difficult to determine how many bits of jam were transmitted.
- It may be difficult to force the DUT to transmit in burst mode.

Test 4.1.5 - Collisions during data outside of slotTime (Burst Mode)

Purpose: To test collision detection and enforcement when a collision occurs in the data portion of a frame and the device under test (DUT) is in burst mode.

References:

- IEEE Std 802.3, 1998 Edition- subclauses 4.1.2.2, 4.2.3.2.3, 4.2.3.2.4 and 4.2.3.2.5, 4.2.3.2.7, 4.2.3.4, 4.2.4.2.2, 4.2.8, 4.2.9, 4.4.2.4, Figure 4.3: Relationship among CSMA/CD procedures and Figure 4-4 (a): Transmit Frame State Diagram.
- Annex A - Table of Acronym Definitions

Resource Requirements:

- A testing station capable of encoding (decoding) 8 bit octets to (from) 10-bit code groups as specified in clause 36 and sending (receiving) these code groups using the signaling method described in clause 38 or clause 39.

Last Modification: 3 January, 2000

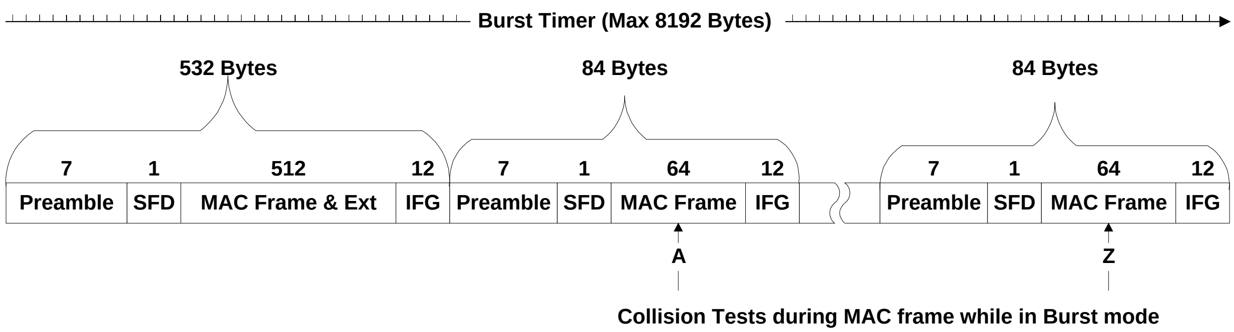
Discussion: In half-duplex mode at operating speeds above 100 Mb/s, the slotTime employed at slower speeds is inadequate to accommodate network topologies of the desired physical extent. Carrier Extension provides a means by which the slotTime can be increased to a sufficient value for the desired topologies, without increasing the minFrameSize parameter. Non-data bits, referred to as extension bits, are appended to frames which are less than slotTime bits in length so that the resulting transmission is at least one slotTime in duration. In Gigabit Ethernet the value for slotTime is 4096 bits. The maximum length of the extension is equal to the quantity (slotTime – minFrameSize).

In half-duplex mode at operating speeds above 100 Mb/s, an implementation may optionally transmit a series of frames without relinquishing control of the transmission medium. This mode of operation is referred to as burst mode. The first frame of a burst must always be at least 4096 bits long which may be accomplished through the addition of extension bits. Once this first frame has been successfully transmitted, the transmitting station can begin transmission of another frame without contending for the medium. Other stations on the network will continue to defer to its transmission, provided that the transmitting station does not allow the medium to assume an idle condition between frames. The transmitting station fills the interFrame spacing interval with extension bits in order to maintain control of the medium. The transmitting station is allowed to initiate frame transmission until a specified limit, referred to as burstLimit, is reached. The value of burstLimit is specified in 4.4.2.4.

In a properly configured network, and in the absence of errors, collisions cannot occur during a burst at any time after the first frame of a burst has been transmitted. Therefore, the MAC will treat all collisions which occur after the first frame of a burst as a late collision. Within a burst of frames, the first frame of a burst must be at least slotTime bits in length in order to be accepted by the receiver, while subsequent frames within a burst must be at least minFrameSize in length. Anything less is presumed to be a fragment resulting from a collision, and is discarded by the receiver. The discarding of such a fragment by a MAC is not reported as an error.

Test Setup: Connect the device under test (DUT) to the testing station (transmit to receive, receive to transmit) with the appropriate medium (i.e. balanced copper, multi-mode fiber, etc.).

Procedure:



1. The DUT is instructed to transmit 10 properly encapsulated, valid, 64 byte request frames. The requests should have incremented sequence numbers to facilitate in the observation phase. The first frame will have extension added to it to make a valid 512 byte (4096 bit) frame. The remaining 9 frames must be sent in burst mode with a 12 byte IPG between each frame. The IPG should be filled with extension in order to maintain control of the medium. This will yield a carrier event of 1288 bytes (532 + (9 * 84)).
2. The testing station is instructed to create a collision at the DUT (532 + n + [m * 84]) octets after the DUT transmits the SPD. Initially ‘n’ is set to 9 and ‘m’ is set to zero. This will cause a collision to occur during the data portion of the next frame. The arrow “A” indicates the position.
3. The activity captured by the testing station and the statistics gathered by the DUT are observed.
4. Steps 1 through 3 are repeated with the value of ‘*n*’ incremented from 9 to 64 and ‘m’ set to zero which tests collisions throughout the data portion of the frame.
5. Finally steps 1 through 4 are repeated with the value of ‘m’ incremented from 1 to 9. This will test collisions in data portion in all the frames sent during the Burst. The arrow “Z” indicates the final testing position.

Observable results:

a. The testing station should capture a complete valid frame indicating successful transmission of the first frame with extension. The sequence number should be the first of the series.
b. The testing station should capture a complete valid frame for all frames transmitted during the burst, but prior to the collision. The final number of these additional valid frames should equal ‘m’. The sequence numbers of the frames should be checked to verify that the correct frames were received.
c. Finally the testing station should capture a collision fragment which indicates a collision occurring during the transmission of data. This fragment should consist of complete preamble, SFD, any data transmitted prior to the collision, a 32-bit jam pattern and an EPD. The jam pattern should be in agreement with IEEE 802.3 subclause 4.2.3.2.4.
d. After the collision, the DUT should cease transmitting in burst mode and not attempt retransmission of the frame.

Possible Problems:

- If the jam pattern generated is not a fixed and readily identifiable pattern, it is difficult to determine how many bits of jam were transmitted.
- It may be difficult to force the DUT to transmit in burst mode.

Test 4.1.6 - Collisions during IFG outside of slot time (Burst Mode)

Purpose: To test collision detection and enforcement when collisions occur in the inter frame gap (IFG) and the device under test is in **burst mode**.

References:

- IEEE Std 802.3, 1998 Edition - subclauses 4.1.2.2, 4.2.3.2.3, 4.2.3.2.4, 4.2.3.2.5, 4.2.3.2.7, 4.2.3.4, 4.2.4.2.2, 4.2.8, 4.2.9, 4.4.2.4, Figure 4.3: Relationship among CSMA/CD procedures and Figure 4-4 (a): Transmit Frame State Diagram.
- Annex A - Table of Acronym Definitions

Resource Requirements:

- A testing station capable of encoding (decoding) 8 bit octets to (from) 10-bit code groups as specified in clause 36 and sending (receiving) these code groups using the signaling method described in clause 38 or clause 39.

Last Modification: 3 January, 2000

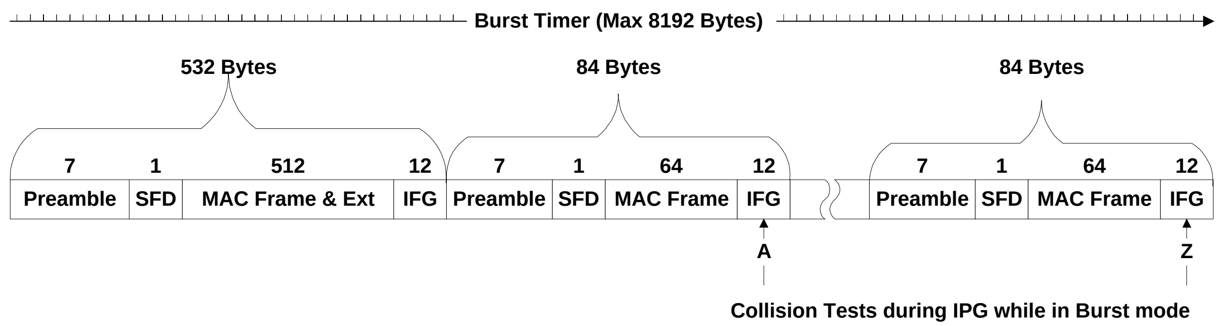
Discussion: In half-duplex mode at operating speeds above 100 Mb/s, the slotTime employed at slower speeds is inadequate to accommodate network topologies of the desired physical extent. Carrier Extension provides a means by which the slotTime can be increased to a sufficient value for the desired topologies, without increasing the minFrameSize parameter. Non-data bits, referred to as extension bits, are appended to frames which are less than slotTime bits in length so that the resulting transmission is at least one slotTime in duration. In Gigabit Ethernet the value for slotTime is 4096 bits. The maximum length of the extension is equal to the quantity (slotTime – minFrameSize).

In half-duplex mode at operating speeds above 100 Mb/s, an implementation may optionally transmit a series of frames without relinquishing control of the transmission medium. This mode of operation is referred to as burst mode. The first frame of a burst must always be at least 4096 bits long which may be accomplished through the addition of extension bits. Once this first frame has been successfully transmitted, the transmitting station can begin transmission of another frame without contending for the medium. Other stations on the network will continue to defer to its transmission, provided that the transmitting station does not allow the medium to assume an idle condition between frames. The transmitting station fills the interFrame spacing interval with extension bits in order to maintain control of the medium. The transmitting station is allowed to initiate frame transmission until a specified limit, referred to as burstLimit, is reached. The value of burstLimit is specified in 4.4.2.4.

In a properly configured network, and in the absence of errors, collisions cannot occur during a burst at any time after the first frame of a burst has been transmitted. Therefore, the MAC will treat all collisions, which occur after the first frame of a burst as a late collision. Within a burst of frames, the first frame of a burst must be at least slotTime bits in length in order to be accepted by the receiver, while subsequent frames within a burst must be at least minFrameSize in length. Anything less is presumed to be a fragment resulting from a collision, and is discarded by the receiver. The discarding of such a fragment by a MAC is not reported as an error. The receiving station accepts each complete frame in a burst individually. If a collision occurs in the IFG, then the frame transmitted prior to it should be accepted. If there was a frame waiting to be sent, it should not be transmitted. Also burst mode should be discontinued.

Test Setup: Connect the device under test (DUT) to the testing station (transmit to receive, receive to transmit) with the appropriate medium (i.e. balanced copper, multi-mode fiber, etc.).

Procedure:



1. The DUT is instructed to transmit 10 properly encapsulated, valid, 64 byte request frames. The requests should have incremented sequence numbers to facilitate in the observation phase. The first frame will have extension added to it to make a valid 512-byte (4096 bit) frame. The remaining 9 frames must be sent in burst mode with a 12 byte IFG between each frame. The IFG should be filled with extension in order to maintain control of the medium. This will yield a carrier event of 1288 bytes (532 + (9 * 84)).
2. The testing station is instructed to create a collision at the DUT (532 + n + [m * 84]) octets after the DUT transmits the SPD. Initially ‘n’ is set to 72 and ‘m’ is set to zero. This will cause a collision to occur during the IFG after the most recent frame. The position is indicated by the arrow “A”.
3. The activity captured by the testing station and the statistics gathered by the DUT are observed.
4. Steps 1 through 3 are repeated with the value of ‘*n*’ incremented from 73 to 84 and ‘m’ set to zero which tests collisions throughout the IFG after the most recent frame.
5. Finally steps 1 through 4 are repeated with the value of ‘m’ incremented from 1 to 9. This will test collisions in the IFG, in all the frames sent during the Burst. The arrow “Z” indicates the final testing position.

Observable results:

a. The testing station should capture a complete, valid frame indicating successful transmission of the first frame with extension. The sequence number should be the first of the series.
b. The testing station should capture a complete, valid frame for all complete frames transmitted during the burst, including the frame transmitted just prior to the collision. The number of these **additional** valid frames should equal ‘m + 1’. The sequence numbers of the frames should be checked to verify that the correct frames were received.
c. Finally the testing station should capture a collision fragment which contains extension transmitted in the IFG prior to the collision and 32 bits of jam which should contain extensionErrorBits.
d. The DUT should cease transmitting in burst mode . If there was a frame waiting to be sent after IFG, the DUT should follow the deference process and transmit the frame when the medium is available again.

Possible Problems:

- It may be difficult to force the DUT to transmit in burst mode.
- If the number of additional replies is greater than ‘m + 1’, it could indicate that the DUT did not go into Burst mode.

Test 4.1.7 - Collisions during frames of maximum size outside of slot time

Purpose: To test collision detection and enforcement when collisions occur outside of slot time, in a frame of maximum size (1518 bytes).

References:

- IEEE Std 802.3, 1998 Edition - subclauses 4.1.2.2, 4.2.3.2.3, 4.2.3.2.4, 4.2.3.2.5, 4.2.3.2.7, 4.2.3.4, 4.2.4.2.2, 4.2.8, 4.2.9, 4.4.2.4, Figure 4-3: Relationship among CSMA/CD procedures and Figure 4-4 (a): Transmit Frame State Diagram.
- Annex A - Table of Acronym Definitions

Resource Requirements:

- A testing station capable of encoding (decoding) 8 bit octets to (from) 10-bit code groups as specified in clause 36 and sending (receiving) these code groups using the signaling method described in clause 38 or clause 39.

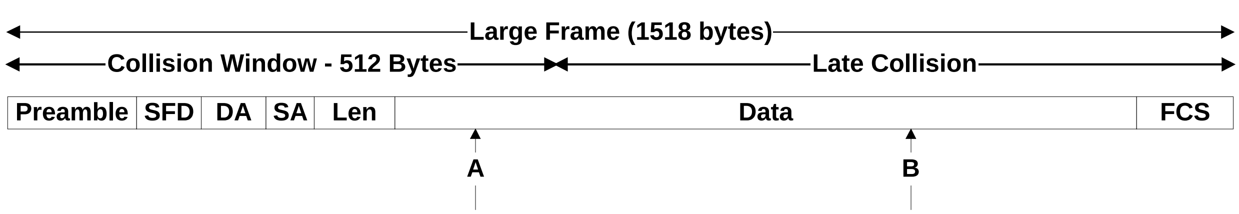
Last Modification: 3 January, 2000

Discussion: A large frame is defined as a frame containing 1518 bytes**.** In Gigabit Ethernet, slot time is 512 bytes (4096 bits) and therefore a station does not acquire the medium until slot time has expired. Consequently any collision occurring in the collision window of 512 bytes, will cause the station to attempt to retransmit and follow the Truncated Binary Exponential Backoff Algorithm. This specifies that the station should defer to any passing traffic and when the medium is available, the station can attempt to retransmit a maximum of 15 times.

If a collision occurs after the collision window, a late collision has occurred and the MAC should not attempt to retransmit.

Test Setup: Connect the device under test (DUT) to the testing station (transmit to receive, receive to transmit) with the appropriate medium (i.e. balanced copper, multi-mode fiber, etc.).

Procedure:



Collision Tests during a large MAC frame

1. The testing station is instructed to transmit a properly encapsulated, valid 1518-byte echo request frame. This will cause the DUT to transmit a 1518 echo reply.
2. The testing station is instructed to transmit a properly encapsulated, valid 1518-byte echo request frame, which will cause the DUT to transmit a 1518 echo reply. The testing station is then instructed to create a collision at the DUT '*n*' octets after the DUT transmits the SPD. The initial value of '*n*' should be less than 512.

3. The activity captured by the testing station and the statistics gathered by the DUT are observed.
4. Steps 2 and 3 are repeated with the value of '*n*' greater than 512 but less than or equal to 1518.

Observable results:

a. The testing station should capture a valid 1518 byte reply.
b. Then the testing station should capture a collision fragment. This fragment should consist of complete preamble, SFD, any terminated data transmission, a 32-bit jam pattern, and an EPD. The jam pattern should be in agreement with IEEE 802.3 subclause 4.2.3.2.4.
c. The testing station should capture a complete, valid reply indicating successful retransmission.
d. Finally any frames that are involved in a late collision should be detected by the DUT and should not be retransmitted.

Possible Problems: If the jam pattern generated is not a fixed and readily identifiable pattern, it is difficult to determine how many bits of jam were transmitted.

Group 2 – Errors during Reception

Test 4.2.1 - Frames with FCS errors.

Purpose: To verify that the device under test (DUT) detects frames with frame check sequence (FCS) errors and reports a frameCheckError.

References:

- IEEE Std 802.3, 1998 Edition - subclauses 3.2.8, 4.2.3.1.2, 4.2.4.1.2 and 35.2.1.5
- Annex A - Table of Acronym Definitions

Resource Requirements:

- A testing station capable of encoding (decoding) 8 bit octets to (from) 10-bit code groups as specified in clause 36 and sending (receiving) these code groups using the signaling method described in clause 38 or clause 39.

Last Modification: 3 January, 2000

Discussion: A CRC is used by the transmit and receive algorithms to generate a CRC value for the FCS field. The FCS field contains a 4-octet (32-bit) CRC value. This value is computed as a function of the contents of the source address, destination address, length, LLC data and pad (that is, all fields except the preamble, SFD, and FCS). The receiving MAC sublayer collects bits from the reconciliation layer. One of its functions is to check for invalid MAC frames by checking the Frame Check Sequence (FCS) field. It does so by computing the 32-bit CRC of the received frame and comparing it to the received 32-bit CRC in the FCS field. In case of a mismatch, it should reject the frame.

Test Setup: Connect the device under test (DUT) to the testing station (transmit to receive, receive to transmit) with the appropriate medium (i.e. balanced copper, multi-mode fiber, etc.).

Procedure:

1. The testing station is instructed to transmit a properly encapsulated, valid 512 byte request frame. This will cause the DUT to transmit a reply, indicating that the DUT is functioning properly.
2. The testing station is instructed to retransmit the frame with an incorrect 32-bit CRC value in the FCS field. The output and statistics of the DUT are observed.
3. The testing station is instructed to transmit the valid 512 byte request frame. After a minimum inter-frame gap (96 bit-times), the testing station transmits the invalid request frame. Finally, after a minimum inter-frame gap, the valid 512 byte request frame is retransmitted. The output and statistics of the DUT is observed.

Observable results:

a. The DUT should detect the frames with invalid FCS fields, and log an FCS error for each invalid frame in the statistics of the DUT. The reception of the valid request frames should not be affected.

Possible Problems: None.

Test 4.2.2 - Fragments and Runts.

Purpose: To verify that the device under test discards collision fragments. In half-duplex and **non-burst mode**, a frame less than 512 bytes is considered to be a fragment. In **burst mode**, the first frame must be 512 bytes and following frames must be at least 64 bytes.

References:

- IEEE Std 802.3, 1998 Edition, subclauses 4.2.3.3 and 4.2.4.2.2, 4.2.9: *process* BitReceiver, *process* SetExtending, and *procedure* ReceiveLinkMgmt.
- Annex A - Table of Acronym Definitions

Resource Requirements:

- A testing station capable of encoding (decoding) 8 bit octets to (from) 10-bit code groups as specified in clause 36 and sending (receiving) these code groups using the signaling method described in clause 38 or clause 39.

Last Modification: 3 January, 2000

Discussion:

Half duplex mode and <u>not</u> bursting:
Any frame containing less than 512 bytes is presumed to be a fragment resulting from a collision.

Half duplex mode and bursting:
The first frame of a burst must be 512 bytes. Any frame other than the first frame of a burst which is less than 64 bytes is presumed to be a fragment resulting from a late collision or a line malfunction.

Full duplex mode:
Any frame containing less than 64 bytes is presumed to be a fragment resulting from a malfunctioning station.

The MAC should discard these collision fragments. Since occasional collisions are a normal part of Media Access management procedure in half duplex mode, the discarding of such a fragment is not reported as an error. In addition to fragments, a runt request is sent to the DUT. A "runt" refers to a frame with no data pad, but has valid checksums and 32-bit CRC values. The IEEE 802.3 standard does not define a runt, but various implementations have commonly logged this type of packet as a runt frame.

Test Setup: Connect the device under test (DUT) to the testing station (transmit to receive, receive to transmit) with the appropriate medium (i.e. balanced copper, multi-mode fiber, etc.).

Procedure:

Test Frame Descriptions:

Test Frame 1: SPD, 6 octets of preamble, EPD
Test Frame 2: SPD, 6 octets of preamble and SFD, EPD
Test Frame 3: SPD, 6 octets of preamble, SFD and the MAC destination address of the DUT, EPD.

Test Frame 4: SPD, 6 octets of preamble, SFD, the MAC destination address of the DUT, and an arbitrary source address, EPD.

Test Frame 5: A runt frame, consisting of a properly encapsulated, 42-byte request with valid checksums and 32-bit CRC fields.

Test Frame 6: A runt frame, consisting of a properly encapsulated, 42-byte request with valid checksums, 32-bit CRC fields and 470 bytes of extension to make the frame slotTime in length.

Test Frame 7: A frame, consisting of a properly encapsulated, 511 byte request frame with valid checksums and 32-bit CRC fields.

Test Frame 8: A burst frame, consisting of Test Frame 5, 12 bytes of extension (IPG) and Test Frame 7. This combination satisfies slotTime.

Test Frame 9: A burst frame, consisting of a properly encapsulated valid 512 byte request frame, 12 bytes of extension (IPG), Test Frame 5, 12 bytes of extension (IPG), and a valid 64 byte request frame.

Test Frame 10: A frame, consisting of a properly encapsulated, 64 byte request frame with valid checksums and 32-bit CRC fields.

Test Frame 11: A frame, consisting of a properly encapsulated, 64 byte request frame with valid checksums and 32-bit CRC fields and extension not to exceed a total carrier event of 4095 bit times.

1. The testing station is instructed to transmit a properly encapsulated, valid, request frame. This will cause the DUT to transmit a reply, indicating that the DUT is functioning properly.
2. The testing station is instructed to transmit Test Frame 1 to the DUT. The output and statistics of the DUT are observed.
3. The testing station retransmits Test Frame 1 preceded and followed by valid request frames and minimum inter-frame gaps (96 bit-times). The output and statistics of the DUT is observed.
4. Steps 1 through 3 are repeated for Test Frames 2 through 11.

Observable Results:

a. The fragments should not affect the reception of the valid request frames.
b. Runt frames should be discarded and the reception of the valid request frames should not be affected. The statistics of the DUT may indicate the reception of a runt.
c. See the Observable Results Table below for each of the Test Frames described above.

Observable Results Table

	Half Duplex Mode	**Full Duplex Mode**
Test Frame 1	Discarded	Discarded
Test Frame 2	Discarded	Discarded
Test Frame 3	Discarded	Discarded
Test Frame 4	Discarded	Discarded
Test Frame 5	Discarded	Discarded
Test Frame 6	Discarded	Discarded
Test Frame 7	Discarded	Accepted
Test Frame 8	Test Frame 5 discarded. Test Frame 7 discarded.	Test Frame 5 discarded. Test Frame 7 accepted.

Test Frame 9	Test Frame 5 discarded. All other frames accepted.	Test Frame 5 discarded. All other frames accepted.
Test Frame 10	Discarded	Accepted
Test Frame 11	Discarded	Accepted

Possible Problems: None.

Test 4.2.3 - Frames greater than maxFrameSize

Purpose: To verify that the device under test (DUT) is insensitive to frames greater than maxFrameSize. The test covers frames from 1519 bytes up to the repeater jabber limit of 18750 bytes (150,000 bits). The device under test (DUT) should detect frames greater than maxFrameSize and should report a frameTooLong error to the LLC sublayer.

References:

- IEEE Std 802.3, 1998 Edition - subclauses 4.2.9, 4.2.4.2.1, 4.4.2.4, 41.2.1.7, and 41.2.2.1.4
- Annex A - Table of Acronym Definitions

Resource Requirements:

- A testing station capable of encoding (decoding) 8 bit octets to (from) 10-bit code groups as specified in clause 36 and sending (receiving) these code groups using the signaling method described in clause 38 or clause 39.

Last Modification: 10 January, 2000

Discussion: Any frame containing more than maxFrameSize bits is presumed to be sourced from a malfunctioning station or the result of a line fault. As specified in 4.2.4.2.1, enforcement of the frame size limit by the receiving device is not required. The receiving device is allowed to truncate frames longer than maxFrameSize and report this event as an error.
The maximum possible, properly encapsulated frame is a jabber frame, consisting of 150,000 bits. This size is the maximum transmit size allowed until a repeater's Receive Jabber function terminates transmission.

Reception of frames greater than maxFrameSize should not affect the reception of valid frames occurring a minimum inter-frame gap before and after the large frame. As specified in 4.4.2.4, at no time should a device transmit a frame exceeding maxFrameSize.

Test Setup: Connect the device under test (DUT) to the testing station (transmit to receive, receive to transmit) with the appropriate medium (i.e. balanced copper, multi-mode fiber, etc.).

Procedure:

Test Frame Descriptions:

Test Frame 1: A properly encapsulated 1519 byte request frame, with valid checksums and 32-bit CRC. Bytes 1514 - 1518 should not correspond to the proper 32-bit CRC for the preceding 1514 bytes of data. Bytes 1515 - 1519 should correspond to the proper 32-bit CRC for the preceding 1515 bytes of data.

Test Frame 2: A properly encapsulated 1534 byte request frame, with valid checksums and 32-bit CRC. Bytes 1514 - 1518 should not correspond to the proper 32-bit CRC for the preceding 1514 bytes of data.

Test Frame 3: A properly encapsulated frame 1534 bytes long. The first 1518 bytes correspond to a maximum length request frame with valid checksums and 32-bit CRC. The remaining 16 bytes (1519-1534) consist of 12 bytes of 00h, followed by the valid

32-bit CRC for the entire 1534 byte frame. Thus, if the frame is truncated at 1518 bytes, it would appear as a valid frame.

Test Frame 4: A jabber frame consisting of a valid SPD, preamble, SFD, 18742 bytes of data and an EPD producing a 150,000 bit-time frame.

1. The testing station is instructed to transmit a properly encapsulated, valid, 1518 byte request frame. This will cause the DUT to transmit a reply, indicating that the DUT is functioning properly.
2. The testing station is instructed to transmit Test Frame 1 to the DUT. The output and statistics of the DUT are observed.
3. The testing station retransmits Test Frame 1 preceded and followed by valid request frames and minimum inter-frame gaps (96 bit-times). The output and statistics of the DUT is observed.
4. Steps 1 through 3 are repeated for Test Frames 2 through 4.

Observable Results:

a. The maximum length valid request frame should be replied to.
b. The DUT should detect Test Frame 1 and should report a frameTooLong error message. The DUT should not transmit a 1519 byte reply in response to the 1519 byte request.
c. The DUT should detect Test Frame 2 and should report a frameTooLong error message. The DUT should not transmit a 1534 byte reply in response to the 1534 byte request.
d. The DUT should detect Test Frame 3 as in (c). In the event that the DUT truncates Test Frame 3 at 1518 bytes, the DUT should not accept the truncated frame and should report a frameTooLong error message.
e. The DUT should detect Test Frame 4 and report a frameTooLong error.
f. All valid frames preceding and following the test frames should be replied to.

Possible Problems: None.

Test 4.2.4 - Frames with length errors.

Purpose: To verify that the device under test (DUT) detects frames with length errors and reports a lengthError to the LLC sublayer.

References:

- IEEE Std 802.3, 1998 edition- subclauses 3.2.6, 4.2.9
- Annex A - Table of Acronym Definitions

Resource Requirements:

- A testing station capable of encoding (decoding) 8 bit octets to (from) 10-bit code groups as specified in clause 36 and sending (receiving) these code groups using the signaling method described in clause 38 or clause 39.

Last Modification: 10 January, 2000

Discussion: The Length field is a 2-octet field whose value indicates the number of data octets in the data field. If the value is less than the minimum required for proper operation of the protocol, a PAD field (a sequence of octets) will be added at the end of the data field but prior to the FCS field. The procedure that determines the size of the pad field is specified in 4.2.8. The length field is transmitted and received with the high order octet first.
When a frame is received by MAC sublayer the *function* ReceiveDataDecap verifies that the length field matches the length of the LLC data field received. If the two are mismatched then ReceiveDataDecap returns a lengthError to the LLC sublayer.

Test Setup: Connect the device under test (DUT) to the testing station (transmit to receive, receive to transmit) with the appropriate medium (i.e. balanced copper, multi-mode fiber, etc.).

Procedure:

Test Frame Descriptions:

Test Frame 1: A properly encapsulated 64-byte frame with pad and an invalid length/type field.

Preamble	SFD	DA	SA	Length	Data	Pad	FCS	Extension

Test Frame 2: A properly encapsulated 64 byte frame without pad and an invalid length/type field.

Preamble	SFD	DA	SA	Length	Data	FCS	Extension

1. The testing station is instructed to transmit a properly encapsulated, valid 64 byte request frame. This will cause the DUT to transmit a reply, indicating that the DUT is functioning properly.
2. The testing station is instructed to transmit Test Frame 1. The output and statistics of the DUT are observed.

3. The testing station transmits Test Frame 1 preceded and followed by valid request frames and minimum inter-frame gaps (96 bit-times). The output and statistics of the DUT is observed.
4. Steps 1 through 3 are repeated for Test Frame 2.

Observable results:

a. The DUT should detect the frames with invalid length fields, and should log a lengthError for each invalid frame in the statistics of the DUT. The reception of the valid frames should not be affected.

Possible Problems: None.

Group 3 - Bursting

Test 4.3.1 - Burst limit

Purpose: To verify that the device under test (DUT) enforces the burst timer of 64Kb (65536).

References:

- IEEE Std 802.3, 1998 Edition - subclauses 4.2.3.2.7, 4.2.3.4, 4.2.8, 4.2.9, 4.4.2.4, and Figure 4-5 (b): BurstTimer Process
- Annex A - Table of Acronym Definitions

Resource Requirements:

- A testing station capable of encoding (decoding) 8 bit octets to (from) 10-bit code groups as specified in clause 36 and sending (receiving) these code groups using the signaling method described in clause 38 or clause 39.

Last Modification: March 19, 1998

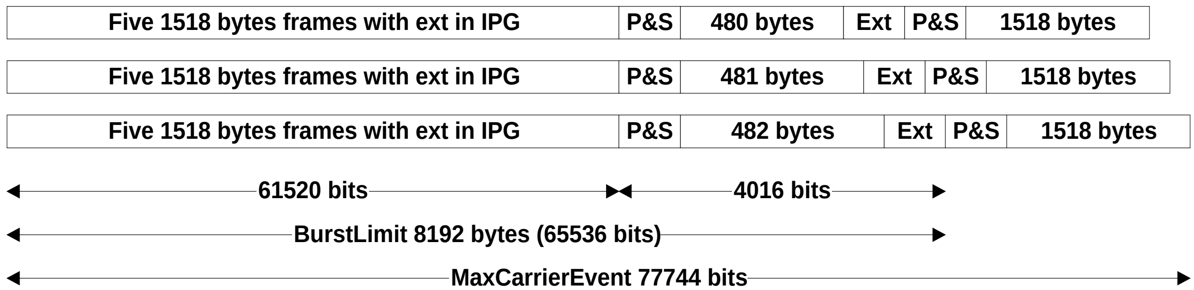
Discussion: Once a frame has been successfully transmitted (with extension if necessary), the transmitting station can begin transmission of another frame without contending for the medium because all of the other stations on the network will continue to defer to its transmission, provided that it does not allow the medium to assume an idle condition between frames. The transmitting station fills the interframe spacing interval with extension bits, which are readily distinguished from data bits at the receiving stations, and which maintain the detection of carrier in the receiving stations. The MAC continues to monitor the medium for collisions while it is transmitting extension bits, and it will treat any collision which occurs after the threshold (slotTime - headerSize) as a late collision.

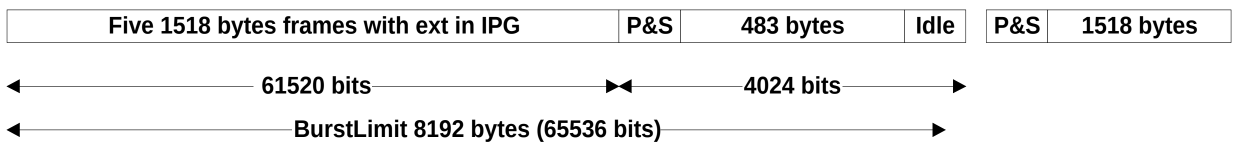
The burstLimit is 64Kbps (65536 bits). Once the burstLimit has been reached, the transmitting station is no longer in burst mode. After the current frame is successfully transmitted, the IPG is filled with idle instead of extension thus relinquishing control of the medium. This establishes the maximum CarrierEvent as the burst limit (65536) plus maximum frame size (12144) plus the header size (64).

Test Setup: Connect the device under test (DUT) to the testing station (transmit to receive, receive to transmit) with the appropriate medium (i.e. balanced copper, multi-mode fiber, etc.).

Procedure:

1. The testing station is instructed to transmit five 1518 byte frames, then a 480 byte frame and finally a 1518 byte frame. This should cause the DUT to reply in burst mode.
2. The size of the 480 byte frame is incremented by 1 byte at a time until the burstLimit is exceeded.





Observable Results:

a. The testing station should capture 5 properly encapsulated 1518 byte reply frames followed by the IPG. Then it should receive the frame that is being incremented and finally it should receive the 1518 byte frame.
b. As the size of the frame is incremented, the test results should remain the same until the burst limit is reached.
c. When the size of the incremented frame reaches 483 bytes, the burst timer should expire which will cause the final frame to be transmitted in non-burst mode. This will be verified by observing an idle code group in the IPG between the incremented frame and the final frame.
d. Since burstLimit has been found, the maximum CarrierEvent has also been found to be a combination of burstLimit and maxFrameSize which was established in test 4.2.4.

Possible Problems: None.

Test 4.3.2 Interframe Fill

Purpose: To verify that the device under test (DUT) transmits extension in the inter frame space when in burst mode.

References:

- IEEE Std 802.3, 1998 Edition - subclauses 4.2.3.2.7, 4.2.3.4, 4.2.8, 4.2.9 and 4.4.2.4.
- Annex A - Table of Acronym Definitions

Resource Requirements:

- A testing station capable of encoding (decoding) 8 bit octets to (from) 10-bit code groups as specified in clause 36 and sending (receiving) these code groups using the signaling method described in clause 38 or clause 39.

Last Modification: 10 January, 2000

Discussion: Once a frame has been successfully transmitted (with extension if necessary), the transmitting station can begin transmission of another frame without contending for the medium because all of the other stations on the network will continue to defer to its transmission, provided that it does not allow the medium to assume an idle condition between frames. The transmitting station fills the interframe spacing interval with extension bits, which are readily distinguished from data bits at the receiving stations, and which maintain the detection of carrier in the receiving stations. The MAC continues to monitor the medium for collisions while it is transmitting extension bits, and it will treat any collision which occurs after the threshold (slotTime - headerSize) as a late collision.

Test Setup: Connect the device under test (DUT) to the testing station (transmit to receive, receive to transmit) with the appropriate medium (i.e. balanced copper, multi-mode fiber, etc.).

Procedure: The testing station is instructed to transmit five properly encapsulated, valid 1518 byte echo request frames which should cause the DUT to reply in burst mode .

Observable Results: The testing station should capture five replies consisting of the 1518 byte reply frames with an IPG following each frame. The IPG should contain at least 12 bytes of extension.

Possible Problems: None.

Group 4 - Deference

Test 4.4.1 Defer to carrier sense while frame waiting

Purpose: To verify that the device under test (DUT) defers to the carrier sense signal when it has a frame waiting to be sent.

References:

- IEEE Std 802.3, 1998 Edition - subclauses 4.1.2.1.1, 4.2.3.2.1, Figure 4-5 (b) and 4.2.8 *process* Deference
- Annex A - Table of Acronym Definitions

Resource Requirements:

- A testing station capable of encoding (decoding) 8 bit octets to (from) 10-bit code groups as specified in clause 36 and sending (receiving) these code groups using the signaling method described in clause 38 or clause 39.

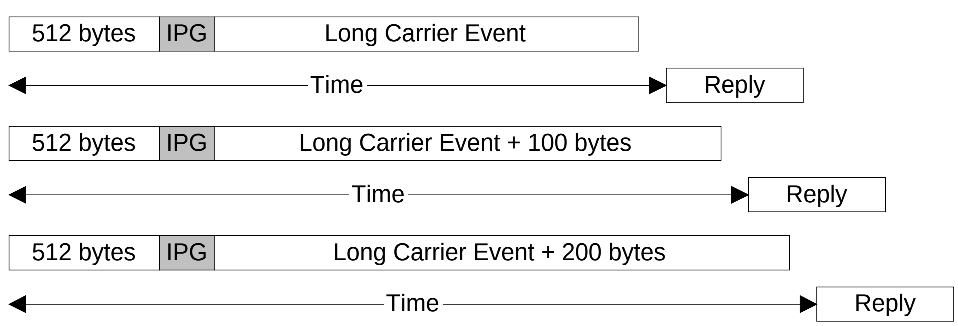
Last Modification: 10 January, 2000

Discussion: In half duplex mode, the MAC must defer to carrier sense when there is a frame waiting to be sent. Carrier sense is a physical signal provided by the physical layer to the MAC and it is asserted by any device on the network that is currently transmitting. When carrier sense is de-asserted (that is the medium is free of traffic) the MAC must continue to defer for at least a minimum IPG (interPacketGap) which is defined as 96 bitTimes. This is done in order to allow recovery time for other devices on the network.. The MAC sublayer may then transmit the frame waiting to be sent.

Test Setup: Connect the device under test (DUT) to the testing station (transmit to receive, receive to transmit) with the appropriate medium (i.e. balanced copper, multi-mode fiber, etc.).

Procedure:

1. The testing station is instructed to transmit a 512 byte request frame, minimum IPG and then a long carrier event of ‘n’ bytes. The initial value of ‘n’ should be at least 8192 bytes (burstLimit).
2. Step 1 is repeated and the value of ‘n’ is incremented by 100 (n = n + 100).
3. Step 2 should be repeated until a consistent response pattern has been established.



Observable Results:

a. The testing station should receive a 512 byte reply frame.
b. The time difference between the transmission of the 512 byte request and the reception of the reply from the DUT is measured and recorded as Δt. If Δt is greater than the length of the long carrier event plus 512 bytes, then the DUT deferred to carrier sense.
c. Each time the value of 'n' is incremented by 100 bytes, there should be a consistent increase in Δt. This verifies that the delay is due to deference and not to delays in the medium.

Possible Problems: None.

Test 4.4.2 Deference after collision

Purpose: To verify that the device under test (DUT) continues to observe the deference process when it attempts to retransmit after a collision which occurs within slotTime.

References:

- IEEE Std 802.3, 1998 Edition - subclauses 4.1.2.1.1, 4.2.3.2.1, 4.2.3.2.3, 4.2.3.2.4, 4.2.8 *process* Deference and fig. 4.5(b)-Deference process.
- Annex A - Table of Acronym Definitions

Resource Requirements:

- A testing station capable of encoding (decoding) 8 bit octets to (from) 10-bit code groups as specified in clause 36 and sending (receiving) these code groups using the signaling method described in clause 38 or clause 39.

Last Modification: 10 January, 2000

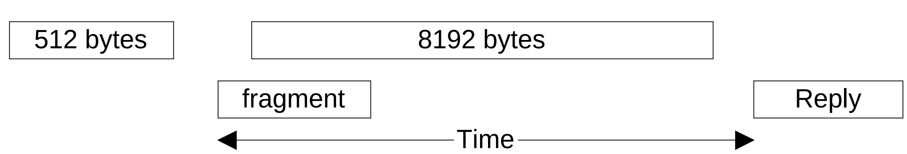
Discussion: In half duplex mode, the MAC must defer to carrier sense when there is a frame waiting to be sent. Carrier sense is a physical signal provided by the physical layer to the MAC and it is asserted by any device on the network that is currently transmitting. When carrier sense is de-asserted (that is the medium is free of traffic) the MAC must continue to defer for at least a minimum IPG (interPacketGap) which is defined as 96 bitTimes. This is done in order to allow recovery time for other devices on the network.. The MAC sublayer may then transmit the frame waiting to be sent.

The physical layer also monitors the medium and in the case of a collision it provides a collision detect signal. In the event of a collision detect signal the DUT should cease transmitting and backoff on its attempt to transmit the waiting frame. It should follow the Truncated Binary Exponential BackOff algorithm discussed in Test 4.6.2. If the medium is then idle the DUT may attempt to transmit the frame. However if carrier is detected on the media the station must defer to the station that has control of the media.

Test Setup: Connect the device under test (DUT) to the testing station (transmit to receive, receive to transmit) with the appropriate medium (i.e. balanced copper, multi-mode fiber, etc.).

Procedure:

1. The testing station is instructed to transmit a 512 byte request frame.
2. When the testing station detects the SPD on its receiver the testing station is instructed to transmit a long carrier event of ‘n’ bytes. The initial value of ‘n’ should be at least 8192 bytes (burstLimit).



Observable Results:

a. The testing station should capture a collision fragment and one reply from the DUT. The DUT should retransmit its reply after deferring to the long carrier event.
b. The time difference (Δt) between the reception of the collision fragment and the retransmission of the DUT reply can also be observed. If Δt is greater than the length of the long carrier event, then the DUT deferred to carrier after the collision.

Possible Problems: None.

Test 4.4.3 - ISFP1

Purpose: To verify that the device under test observes the 2/3 rule for interFrameSpacing.

References:

- IEEE Std 802.3, 1998 Edition - subclauses 4.1.2.1.1, 4.2.3.2.1, 4.2.3.2.2, Figure 4-5 (b) and 4.2.8 *process* Deference
- Annex A - Table of Acronym Definitions

Resource Requirements:

- A testing station capable of encoding (decoding) 8 bit octets to (from) 10-bit code groups as specified in clause 36 and sending (receiving) these code groups using the signaling method described in clause 38 or clause 39.

Last Modification: 10 January, 2000

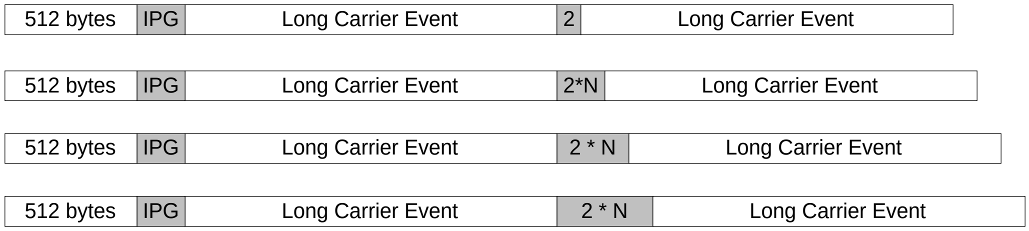
Discussion: In half duplex mode, the MAC must defer to carrier sense when there is a frame waiting to be sent. Carrier sense is a physical signal provided by the physical layer to the MAC and it is asserted by any device on the network that is currently transmitting. When carrier sense is de-asserted (that is the medium is free of traffic) the MAC must continue to defer for at least a minimum IPG (interPacketGap) which is defined as 96 bitTimes. This is done in order to allow recovery time for other devices on the network.. The MAC sublayer may then transmit the frame waiting to be sent.

The value for interFrameSpacingPart1 is determined by the vendor. An initial period shorter than 2/3 of the interval is permissible including zero. If this value is greater than zero the following measures should be implemented. The variable to track the time expired for interFrameSpacing should be initially set to zero. When transmitting and carrierSense are both false the timer should start. The interFrameSpacing timer should be reset to zero if carrierSense becomes true during interFrameSpacingPart1 of the IPG. If carrierSense becomes true during interFrameSpacingPart2 of the IPG, the timer should not be reset. This is done to ensure that all stations have fair access to the medium.

Test Setup: Connect the device under test (DUT) to the testing station (transmit to receive, receive to transmit) with the appropriate medium (i.e. balanced copper, multi-mode fiber, etc.).

Procedure:

1. The testing station is instructed to send a 512 byte echo request frame, and then a long carrier event and finally another long carrier event which is separated by an IPG consisting of idle code groups. The length of the IPG is 2 * ‘n’ bytes long and ‘n’ is initially set to 1.
2. The value of ‘n’ is incremented by 1 and step one is repeated until a collision occurs.



Observable Results:

a. If the testing station receives a reply without collision after the long carrier events, it indicates that ISFP1 did not expire. This means that ISFP1 is greater than or equal to (2 * n) bytes. If a collision occurs before the reception of the reply, then ISFP1 is between 0 and 16 bit times.
b. If the testing station captures a collision fragment and then a reply after completing step 2, IFSP1 is less than or equal to the IPG (2 * n). For example if idle time between the frames was 64 bit times then IFSP1 is less than or equal to 2/3 minimum IPG. IFSP2 = (minimum IPG - IFSP1).

Possible Problems: None.

Group 5 – Encapsulation and De-capsulation

Test 4.5.1 Transmit proper SFD and Preamble

Purpose: To verify that the device under test (DUT) properly encapsulates a frame with preamble and SFD and that they form 8 octets.

References:
- IEEE Std 802.3, 1998 Edition- subclause 3.2.1, 3.2.2, 4.2.5, 4.2.6, 4.2.8, 4.2.9, function TransmitLinkMgmt, procedures PhysicalSignalEncap and PhysicalSignalDecap.
- Annex A - Table of Acronym Definitions

Resource Requirements:
- A testing station capable of encoding (decoding) 8 bit octets to (from) 10-bit code groups as specified in clause 36 and sending (receiving) these code groups using the signaling method described in clause 38 or clause 39.

Last Modification: 10 January, 2000

Discussion: When the MAC is requested to send a new frame, it calls the procedure PhysicalSignalEncap. This procedure transmits 7 bytes of preamble and then 1 byte of SFD. The preamble pattern has historically been used to stabilize and synchronize the physical medium. In Gigabit Ethernet, the MAC is required to transmit preamble and SFD but it is not necessary for stabilization and synchronization. The preamble pattern is:

10101010 10101010 10101010 10101010 10101010 10101010 10101010

If the collision detect signal is asserted while preamble is being transmitted, any remaining preamble bits must be transmitted. In the absence of the collision detect signal and the successful transmission of preamble, the MAC shall transmit SFD which consist of the pattern 10101011.
Any successive bits following the transmission of SFD are recognized by the receiving MAC as data bits and are passed onto the LLC sublayer.

Test Setup: Connect the device under test (DUT) to the testing station (transmit to receive, receive to transmit) with the appropriate medium (i.e. balanced copper, multi-mode fiber, etc.).

Procedure:

1. The testing station is instructed to transmit a 512 byte request frame.
2. The activity captured by the testing station and the statistics gathered by the DUT are observed.

Observable Results:

a. The testing station should capture one reply from the DUT.
b. The preamble and SFD should form the following bit pattern.

10101010 10101010 10101010 10101010 10101010 10101010 10101010 10101011

Note: The first octet of preamble is replaced by /S/ by the DUT and should be interpreted as preamble by the testing station.

Possible Problems: None.

Test 4.5.2 Transmit proper Length/Type

Purpose: To verify that the device under test (DUT) correctly calculates the length of the data field.

References:
- IEEE Std 802.3, 1998 Edition - subclauses 3.2.6, 4.2.8
- Annex A - Table of Acronym Definitions

Resource Requirements:
- A testing station capable of encoding (decoding) 8 bit octets to (from) 10-bit code groups as specified in clause 36 and sending (receiving) these code groups using the signaling method described in clause 38 or clause 39.

Last Modification: 10 January, 2000

Discussion: There are 3 major frame types: Ethernet II, 802.2 and 802.3. Each of these three types has a length field of two bytes. However the value differs according to the type of frame. In Ethernet II the length/type field is used exclusively to convey a type and does not indicate data length. In 802.2 and 802.3, numbers up to 1500 indicate the length of the data field. Values greater than 1500 specify types rather than lengths and therefore should be accepted as valid frames. In order to verify that the DUT is transmitting the length field correctly, it may be necessary to configure the device to transmit using Ethernet 802.3 framing. The length field is transmitted and received with the high order octet first.

If the size of the data field is less than the minimum required for proper operation of the protocol, a PAD field (a sequence of octets) will be added at the end of the data. The procedure that determines the size of the pad field is specified in 4.2.8.

Test Setup: Connect the device under test (DUT) to the testing station (transmit to receive, receive to transmit) with the appropriate medium (i.e. balanced copper, multi-mode fiber, etc.).

Procedure:

1. If necessary, configure the device to transmit using Ethernet 802.3 framing.
2. The testing station is instructed to transmit request frames varying in length from 512 bytes to 1518 bytes. The output from the DUT is observed.
3. The value in the length field is compared to the number of data octets transmitted by the DUT.

Observable Results:

a. The test testing station should capture one reply for each request frame transmitted by the testing station.
b. The value in the length field should be equal to the number of data octets transmitted by the DUT.

Possible Problems: None.

Test 4.5.3 Compute and transmit proper CRC

Purpose: To verify that the device under test (DUT) correctly calculates the CRC-32 value for the frame being transmitted and assigns it to the frame check sequence (FCS) field.

References:

- IEEE Std 802.3, 1998 Edition - subclause 3.2.8, 3.4 and 4.2.8..
- Annex A - Table of Acronym Definitions

Resource Requirements:

- A testing station capable of encoding (decoding) 8 bit octets to (from) 10-bit code groups as specified in clause 36 and sending (receiving) these code groups using the signaling method described in clause 38 or clause 39.

Last Modification: 10 January, 2000

Discussion: In order to prevent errors during transmission, a 32-bit Cyclic Redundancy Check (CRC) value is computed and added to the end of each packet. This value is inserted in the FCS field and it is computed using the contents of the source address, destination address, length, data and pad (that is, all fields except the preamble, SFD, and FCS). The contents are divided by the polynomial listed below:

$$G(x) = x^{32} + x^{26} + x^{23} + x^{22} + x^{16} + x^{12} + x^{11} + x^{10} + x^{8} + x^{7} + x^{5} + x^{4} + x^{2} + x + 1$$

The 32-bit remainder of this division is added to the end of the frame as the FCS value. On the receiving end the same calculation is performed on the incoming data and this is compared to the value in the FCS field. If they do not match an error is reported to the LLC sublayer.

Test Setup: Connect the device under test (DUT) to the testing station (transmit to receive, receive to transmit) with the appropriate medium (i.e. balanced copper, multi-mode fiber, etc.).

Procedure:

1. The testing station is instructed to transmit a 512 byte request frame. The output from the DUT is observed.
2. The CRC value of the reply is computed by the testing station and compared to the CRC transmitted by the DUT.

Observable Results:

a. The testing station should capture 1 reply from the DUT.
b. The value of the CRC transmitted by the DUT must match the value calculated by the testing station.

Possible Problems: None.

Test 4.5.4 Compute and transmit proper extension

Purpose: To verify that the device under test (DUT) correctly calculates the need for extension in a frame that is less than slotTime.

References:

- IEEE Std 802.3, 1998 Edition - subclauses 3.2.9, 4.2.3.4 and 4.4.2. 4
- Annex A - Table of Acronym Definitions

Resource Requirements:

- A testing station capable of encoding (decoding) 8 bit octets to (from) 10-bit code groups as specified in clause 36 and sending (receiving) these code groups using the signaling method described in clause 38 or clause 39.

Last Modification: 10 January, 2000

Discussion: In half-duplex mode and at speeds greater than 100 Mb/s, the slotTime value employed in Fast Ethernet is not sufficient to allow networks topologies of adequate size. In order to maintain backwards compatibility, the minimum frame size was not modified. Rather extension bits are added to the frame when necessary in order to achieve a slotTime of 4096 bit-times. This insures that all transmissions are at least slotTime in length. The extension field follows the FCS field, and is made up of a sequence of extension bits, which are readily distinguished from data bits. When transmitting extension the GMII signals should be TX_EN de-asserted, TX_ER asserted and TXD<7:0> = 0Fh. The necessary number of extension bits is determined by the process BitTransmitter and the procedure NextBit. The length of the field may be from zero to (slotTime – minFrameSize). The contents of the Extension field are not included in the FCS computation.

Test Setup: Connect the device under test (DUT) to the testing station (transmit to receive, receive to transmit) with the appropriate medium (i.e. balanced copper, multi-mode fiber, etc.).

Procedure:

1. The testing station is instructed to transmit a 64 byte request frame and 448 bytes of extension. The output from the DUT is observed.
2. Step 1 is repeated with the size of the frame incremented by one octet and the length of the extension decremented by one octet until the frame size is equal to slotTime.

Observable Results:

a. The testing station should capture 448 replies.
b. The carrier event of each reply should be at least slotTime in length.
c. The length of each reply, after extension is removed, should increment from 64 to 512 bytes.

Possible Problems: None.

Test 4.5.5 Receive variable preamble

Purpose: To verify that the device under test (DUT) is insensitive to the length of received preamble.

References:

- IEEE Std 802.3, 1998 Edition- subclauses 4.2.9, 35.2.3.2.1, 35.2.3.2.2, process BitReceiver and procedure PhysicalSignalDecap.
- Annex A - Table of Acronym Definitions

Resource Requirements:

- A testing station capable of encoding (decoding) 8 bit octets to (from) 10-bit code groups as specified in clause 36 and sending (receiving) these code groups using the signaling method described in clause 38 or clause 39.

Last Modification: 10 January, 2000

Discussion: Preamble is not required for clock synchronization in a 1000BASE-X frame. Therefore the DUT should not be sensitive to its size. When the MAC is receiving a frame, the process BitReceiver first calls the procedure PhysicalSignalDecap. This procedure receives one bit a time from the physical medium and discards all bits until a valid SFD is detected. At this point the BitReceiver process accepts bits while the receiveDataValid signal is asserted and the frame is not finished. This test verifies that no preamble is necessary in a 1000BASE-X frame. It should also be noted that there is no upper limit to the amount of preamble that can be received. In this test we are only testing up to a reasonably large value.

Test Setup: Connect the device under test (DUT) to the testing station (transmit to receive, receive to transmit) with the appropriate medium (i.e. balanced copper, multi-mode fiber, etc.).

Procedure:

1. The testing station is instructed to transmit a request frame with only a SPD and SFD present. The output from the DUT is observed.
2. Step 1 is repeated inserting additional preamble between the SPD and SFD until the preamble is 30 octets long.

Observable Results:

a. The DUT should reply to all frames.

Possible Problems: None.

Group 6 – BackOff

Test 4.6.1 - Retransmission attempt limit

Purpose: To verify that the device under test (DUT) allows a maximum of 15 attempts for retransmission after a collision.

References:

- IEEE Std 802.3, 1998 Edition - subclauses 4.1.2.2, 4.2.3.2.3, 4.2.3.2.4, 4.2.3.2.5, 4.4.2.4, 35.2.2.10, 36.2.5.2.1, Figure 4-4 (a): Transmit Frame State Diagram and Figure 35-13: Transmission with collision.
- Annex A - Table of Acronym Definitions

Resource Requirements:

- A testing station capable of encoding (decoding) 8 bit octets to (from) 10-bit code groups as specified in clause 36 and sending (receiving) these code groups using the signaling method described in clause 38 or clause 39.

Last Modification: 10 January, 2000

Discussion: If a station is transmitting and it detects the SFD on its receiver, a collision is generated. When a station detects a collision, it should stop transmission of data and transmit a 32-bit "jam" signal to enforce the collision. The content of the jam is unspecified. It may be any fixed or variable pattern convenient to the Media Access implementation. However, the pattern shall not be intentionally designed to be the 32-bit CRC value corresponding to the (partial) frame transmitted prior to the jam. Upon completing transmission of the jam signal, the DUT transmits an EPD and then returns to transmitting an idle stream. The DUT then backs off and attempts retransmission of its frame.
The scheduling of the retransmissions is determined by a controlled randomization process called **T**runcated **B**inary **E**xponential **B**ack**O**ff. At the end of enforcing a collision (jamming), the CSMA/CD sublayer delays before attempting to retransmit the frame. The delay is an integer multiple of slotTime. The number of slotTimes to delay before the nth retransmission attempt is chosen as a uniformly distributed random integer 'r' in the range:

$$[0, 2^k - 1] \quad \text{where} \quad k = \min(n, 10)$$

In the event of repeated consecutive collisions, the DUT should attempt a total of only 15 retransmissions of the frame and then drop the frame and report an error.

Test Setup: Connect the device under test (DUT) to the testing station (transmit to receive, receive to transmit) with the appropriate medium (i.e. balanced copper, multi-mode fiber, etc.).

Procedure:

1. The testing station is instructed to transmit a properly encapsulated, valid, 512-byte request frame. This will cause the DUT to transmit a reply.
2. The testing station is then instructed to send a properly encapsulated colliding fragment when the testing station detects the SPD from the reply sent by the DUT.
3. Step 2 is repeated until transmission attempts from the DUT cease.

4. The activity captured by the testing station and the statistics gathered by the DUT are observed.

Observable results:

a. The testing station should capture 16 collision fragments. Each fragment should consist of complete preamble, any terminated data transmission, a 32-bit jam pattern, and an EPD. The jam pattern should be in agreement with IEEE 802.3 subclause 4.2.3.2.4.
b. The testing station should **not** capture a complete, valid, reply indicating successful retransmission.

Possible Problems: If the jam pattern generated is not a fixed and readily identifiable pattern, it is difficult to determine how many bits of jam were transmitted.

Test 4.6.2 Truncated Binary Exponential BackOff test

Purpose: To verify that the device under test (DUT), correctly calculates the time to wait before attempting retransmission.

References:

- IEEE Std 802.3, 1998 Edition - subclauses 4.1.2.2, 4.2.3.2.3, 4.2.3.2.4, 4.2.3.2.5, 4.4.2.4, 35.2.2.10, 36.2.5.2.1, Figure 4-4 (a): Transmit Frame State Diagram and Figure 35-13: Transmission with collision.
- Annex A - Table of Acronym Definitions

Resource Requirements:

- A testing station capable of encoding (decoding) 8 bit octets to (from) 10-bit code groups as specified in clause 36 and sending (receiving) these code groups using the signaling method described in clause 38 or clause 39.

Last Modification: 10 January, 2000

Discussion: If a station is transmitting and it detects the SFD on its receiver, a collision is generated. When a station detects a collision, it should stop transmission of data and transmit a 32-bit "jam" signal to enforce the collision. The content of the jam is unspecified. It may be any fixed or variable pattern convenient to the Media Access implementation. However, the pattern shall not be intentionally designed to be the 32-bit CRC value corresponding to the (partial) frame transmitted prior to the jam. Upon completing transmission of the jam signal, the DUT transmits an EPD and then returns to transmitting an idle stream. The DUT then backs off and attempts retransmission of its frame.
The scheduling of the retransmissions is determined by a controlled randomization process called **T**runcated **B**inary **E**xponential **B**ack**O**ff. At the end of enforcing a collision (jamming), the CSMA/CD sublayer delays before attempting to retransmit the frame. The delay is an integer multiple of slotTime. The number of slotTimes to delay before the nth retransmission attempt is chosen as a uniformly distributed random integer r in the range:

$$[0, 2^k - 1] \quad \text{where } k = \min(n, 10)$$

The value for 'k' should always be the lesser of the value of 'n' and the number 10. The value of 'k' is then used to determine the range for 'r'. Because 'r' is chosen as a uniformly distributed random integer in this range, we can use the value of 'r' to determine compliance of the DUT. Repeated samples are acquired for each value of 'k' to determine the distribution of 'r'.

Test Setup: Connect the device under test (DUT) to the testing station (transmit to receive, receive to transmit) with the appropriate medium (i.e. balanced copper, multi-mode fiber, etc.).

Procedure:

1. The testing station is instructed to transmit a properly encapsulated, valid, 512-byte request frame. This will cause the DUT to transmit a reply.

2. The testing station is then instructed to send a properly encapsulated colliding fragment when the testing station detects the SPD from the reply sent by the DUT.
3. Step 2 is repeated 15 times and the time difference between retransmission attempts is recorded.
4. The activity captured by the testing station and the statistics gathered by the DUT are observed.
5. This test should be repeated until the testing station has acquired a sufficient number of samples to judge the underlying distribution of the random variable ‘r’.

Observable results:

a. The testing station should capture 16 collision fragments each time the procedure is executed. Each fragment should consist of complete preamble, any terminated data transmission, a 32-bit jam pattern, and an EPD. The jam pattern should be in agreement with IEEE 802.3 subclause 4.2.3.2.4.

b. Each time the procedure is executed, the time difference between transmissions should always fall within a range of $0 \rightarrow 2^k - 1$ (1023) bit times.

c. Given enough samples, the distribution of the values for ‘r’ should be uniform.

Possible Problems:

- If the jam pattern generated is not a fixed and readily identifiable pattern, it is difficult to determine how many bits of jam were transmitted.
- Because ‘r’ is randomly selected, it will be difficult to verify that the DUT always chooses ‘k’ as the minimum(n,10).
- If a limited number of tests are performed it may be it difficult to be verify that the uniform distribution is statistically valid.
- It is also unclear how to verify that the value of ‘r’ is both random and uniformly distributed.

Group 7 – Full Duplex

Test 4.7.1 Does not defer

Purpose: To verify that the device under test (DUT) does not defer to carrier sense.

References:

- IEEE Std 802.3, 1998 Edition - subclause 4.1.2.1.1, 4.2.4.2.2, 4.2.8 function TransmitLinkMgmt, process deference and Figure 4.3 - Relationship among CSMA/CD procedures
- Annex A - Table of Acronym Definitions

Resource Requirements:

- A testing station capable of encoding (decoding) 8 bit octets to (from) 10-bit code groups as specified in clause 36 and sending (receiving) these code groups using the signaling method described in clause 38 or clause 39.

Last Modification: 10 January, 2000

Discussion: Full duplex mode requires that two stations have separate, dedicated transmit and receive channels. Each station has dedicated use of one channel to transmit and another to receive. There is no need to share the medium and therefore arbitration is unnecessary. Extension is not needed while in full-duplex mode since extension is only used to insure adequate propagation time delay in a half duplex Gigabit Ethernet network.. There is also no frame bursting in full duplex since a MAC has full access to the transmit channel and frame transmission is always permitted after the MAC has observed the minimum interframe delay. Although collisions do not occur in full duplex, frames containing less than minFrameSize bits are discarded by the MAC. The discarding of such a frame by a MAC is not reported as an error. Since collisions do not occur in full duplex there is no need for the MAC to defer to any traffic on its receive channel.

Test Setup: Connect the device under test (DUT) to the testing station (transmit to receive, receive to transmit) with the appropriate medium (i.e. balanced copper, multi-mode fiber, etc.).

Procedure:

1. The testing station is instructed to transmit a 512 byte request frame followed by minimum IPG consisting of idle code groups and finally a continuous stream of data.

Observable Results:

a. The testing station should receive a reply frame from the DUT indicating that it received the 512 byte request and that the DUT did not defer to the stream of data.

Possible Problems: None.

Test 4.7.2 No collisions

Purpose: To verify that no collisions occur when the DUT is in full duplex mode.

References:

- IEEE Std 802.3, 1998 Edition - subclauses 4.1.2.1.1, 4.2.4.2.2, 4.3.3, function TransmitLinkMgmt and Figure 4.3 - Relationship among CSMA/CD procedures.
- Annex A - Table of Acronym Definitions

Resource Requirements:

- A testing station capable of encoding (decoding) 8 bit octets to (from) 10-bit code groups as specified in clause 36 and sending (receiving) these code groups using the signaling method described in clause 38 or clause 39.

Last Modification: 10 January, 2000

Discussion: Full duplex mode requires that two stations have separate, dedicated transmit and receive channels. Each station has dedicated use of one channel to transmit and another to receive. There is no need to share the medium and therefore arbitration is unnecessary. Extension is not needed while in full-duplex mode since extension is only used to insure adequate propagation time delay in a half duplex Gigabit Ethernet network.. There is also no frame bursting in full duplex since a MAC has full access to the transmit channel and frame transmission is always permitted after the MAC has observed the minimum interframe delay. Although collisions do not occur in full duplex, frames containing less than minFrameSize bits are discarded by the MAC. The discarding of such a frame by a MAC is not reported as an error. Since collisions do not occur in full duplex there is no need for the MAC to defer to any traffic on its receive channel.

Test Setup: Connect the device under test (DUT) to the testing station (transmit to receive, receive to transmit) with the appropriate medium (i.e. balanced copper, multi-mode fiber, etc.).

Procedure:

1. The testing station is instructed to transmit a 512 byte request frame.
2. When the testing station receives the SPD from the DUT reply, the testing station is instructed to transmit another 512 byte request frame.

Observable Results:

a. The testing station should receive two reply frames from the DUT and no collision fragment.

Possible Problems: None.

Test 4.7.3 No extension

Purpose: To verify that the device under test (DUT) does not add extension to valid frames that are less than slotTime when in full duplex mode.

References:

- IEEE Std 802.3, 1998 Edition - subclauses 4.2.7.5 *procedure* Initialize, and 4.2.8 *procedure* NextBit.
- Annex A - Table of Acronym Definitions

Resource Requirements:

- A testing station capable of encoding (decoding) 8 bit octets to (from) 10-bit code groups as specified in clause 36 and sending (receiving) these code groups using the signaling method described in clause 38 or clause 39.

Last Modification: 10 January, 2000

Discussion: Full duplex mode requires that two stations have separate, dedicated transmit and receive channels. Each station has dedicated use of one channel to transmit and another to receive. There is no need to share the medium and therefore arbitration is unnecessary. Although collisions do not occur in full duplex, frames containing less than minFrameSize bits are discarded by the MAC. The discarding of such a frame by a MAC is not reported as an error. Since collisions do not occur in full duplex there is no need for the MAC to defer to any traffic on its receive channel. There is also no frame bursting in full duplex since a MAC has full access to the transmit channel and frame transmission is always permitted after the MAC has observed the minimum interframe delay. Extension is not needed while in full-duplex mode since extension is only used to insure adequate propagation time delay in a half duplex Gigabit Ethernet network..

In full-duplex mode at operating speeds above 100 Mb/s, transmitted frames only have to meet minFrameSize in length. Since full-duplex mode only needs to meet minFrameSize and not slotTime for transmitted frames, Carrier Extension is not necessary to provide a means by which the slotTime can be increased. Therefore it is unnecessary to transmit extension while in full-duplex mode. This can be confirmed by monitoring the signal on the wire and verifying that there are no 10 bit /R/ code groups added to the end of the reply frames.

Test Setup: Connect the device under test (DUT) to the testing station (transmit to receive, receive to transmit) with the appropriate medium (i.e. balanced copper, multi-mode fiber, etc.).

Procedure:

1. The testing station is instructed to send a series of valid request frames between 64 and 512 bytes long.

Observable Results:

a. All of these frames should be accepted and should generate a valid reply of a length equal to the original request. There should be no extension added to any of the frames.

Possible Problems: None.

Test 4.7.4 No bursting

Purpose: To verify that if the device under test (DUT) is in full duplex mode, it does not go into burst mode when it has acquired the medium and there are still frames to send.

References:

- IEEE Std 802.3, 1998 Edition - subclause 4.2.8 *function* TransmitLinkMgmt.
- Annex A - Table of Acronym Definitions

Resource Requirements:

- A testing station capable of encoding (decoding) 8 bit octets to (from) 10-bit code groups as specified in clause 36 and sending (receiving) these code groups using the signaling method described in clause 38 or clause 39.

Last Modification: 10 January, 2000

Discussion: Full duplex mode requires that two stations have separate, dedicated transmit and receive channels. Each station has dedicated use of one channel to transmit and another to receive. There is no need to share the medium and therefore arbitration is unnecessary. Although collisions do not occur in full duplex, frames containing less than minFrameSize bits are discarded by the MAC. The discarding of such a frame by a MAC is not reported as an error. Since collisions do not occur in full duplex there is no need for the MAC to defer to any traffic on its receive channel. Extension is not needed while in full-duplex mode since extension is only used to insure adequate propagation time delay in a half duplex Gigabit Ethernet network.. There is also no frame bursting in full duplex since a MAC has full access to the transmit channel and frame transmission is always permitted after the MAC has observed the minimum interframe delay.

Burst mode is only applicable to half-duplex mode of operation. In full-duplex mode at operating speeds above 100 Mb/s, a station may transmit a series of frames separated by minimum interframe gaps. Once a frame has been successfully transmitted, the station can begin transmission of another frame without contending for the medium because the station only needs to defer to its own transmission to enforce minimum interframe gap.

Test Setup: Connect the device under test (DUT) to the testing station (transmit to receive, receive to transmit) with the appropriate medium (i.e. balanced copper, multi-mode fiber, etc.).

Procedure:

1. The testing station is instructed to transmit five 1518 byte request frames.

Observable Results:

a. The testing station should receive 5 replies separated by IPG consisting of idle code groups. It should not receive extension in the IPG, which would indicate that the DUT had transmitted in burst mode.

Possible Problems:

- It may be difficult to ensure that the DUT will not go into burst mode. Detecting a burst mode transmission can be verified by observing the /R/ code group in the IPG. However if the DUT is observed to transmit a series of frames with IPG containing /I/ code groups, we can't ensure that the DUT will never go into burst mode. This could be due to timing issues which were not conducive to burst mode.

Test 4.7.5 Transmission of minimum interframe gap

Purpose: To verify that the device under test (DUT) enforces minimum interframe spacing of 96BT.

References:

- IEEE Std 802.3, 1998 Edition - subclauses 4.1.2.1.1, 4.2.8 function TransmitLinkMgmt, process deference and Figure 4.3 - Relationship among CSMA/CD procedures
- Annex A - Table of Acronym Definitions

Resource Requirements:

- A testing station capable of encoding (decoding) 8 bit octets to (from) 10-bit code groups as specified in clause 36 and sending (receiving) these code groups using the signaling method described in clause 38 or clause 39.

Last Modification: 10 January, 2000

Discussion: Full duplex mode requires that two stations have separate, dedicated transmit and receive channels. Each station has dedicated use of one channel to transmit and another to receive. There is no need to share the medium and therefore arbitration is unnecessary. Although collisions do not occur in full duplex, frames containing less than minFrameSize bits are discarded by the MAC. The discarding of such a frame by a MAC is not reported as an error. Since collisions do not occur in full duplex there is no need for the MAC to defer to any traffic on its receive channel. Extension is not needed while in full-duplex mode since extension is only used to insure adequate propagation time delay in a half duplex Gigabit Ethernet network.. There is also no frame bursting in full duplex since a MAC has full access to the transmit channel and frame transmission is always permitted provided the station is not paused and after the MAC has observed the minimum interframe delay. If the station has been paused and there are a series of frames waiting, the DUT must still observe minimum IPG between the frames.

Regardless of the duplex transmission mode, the MAC must always observe a minimum IPG between transmission of a series of frames.

Test Setup: Connect the device under test (DUT) to the testing station (transmit to receive, receive to transmit) with the appropriate medium (i.e. balanced copper, multi-mode fiber, etc.).

Procedure:

1. The testing station is instructed to transmit a stream of request frames, which should cause the DUT to transmit a series of replies.
2. The testing station is then instructed to send a pause frame to temporarily halt the transmission of reply frames. The testing station is again instructed to transmit a stream of request frames, which should cause the DUT to transmit a series of replies.

Observable Results:

a. All frames captured should have a minimum IPG between each frame. IPG should be a minimum of 96 BT.
b. The pause frame should not affect the minimum IPG after the DUT resumes transmission.

Possible Problems: None