Wireless LAN Consortium

802.11 Base STA MAC Conformance Test Suite v3.2 Report

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Report Rev. 1.0

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OFDM, WA 98683

Mr. Smith,

Enclosed are the results from the Wireless Base STA MAC Test Suite testing performed on the:

MDM Tornado 802.11b/g Station

This testing pertains to a set of standard requirements, put forth in the IEEE Std. 802.11-2007 Edition. The tests performed are part of the 802.11 Base STA MAC Conformance Test Suite v3.2, which is available on the UNH-IOL's website:

ftp://ftp.iol.unh.edu/pub/wireless/TestSuites/mac/802.11_Base_STA_MAC_Test_Suite_v3.2.pdf

Issues Observed While Testing
Error! Reference source not found. *- part a*: The DUT was observed to improperly discard a fragmented ICMP Echo Request.

As always, we welcome any comments regarding this Test Suite. If you have any questions about the test procedures or results, please contact me via e-mail at jdf46@iol.unh.edu or by phone at +1-603-862-2263.

Regards,

Jared MacTester

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MD5 Fingerprint: **EEE1 7A82 7806 EB21 AF94 F189 E4BE 361B**
SHA-1 Fingerprint: **ECFB 7FAF AB4A 0832 2408 E965 9F5C E3F2 D784 AAAB**

Table 1 - Result Key - The following table contains possible results and their meanings

Result	Interpretation
PASS	The DUT was observed to exhibit conformant behavior.
FAIL	The DUT was observed to exhibit non-compliant behavior.
PASS with Comments	The DUT was observed to exhibit conformant behavior, however, additional explanation of the situation is included.
Warning	The DUT was observed to exhibit behavior that is not recommended.
Informative	Results are for informative purposes only and are not judged on a pass or fail basis.
Refer to Comments	From the observations, a valid pass or fail could not be determined. An additional explanation of the situation is included.
Not Applicable	The DUT does not support the technology required to perform these tests.
Not Available	Due to testing station or time limitations, the tests could not be performed, or were performed in a limited capacity.
Not Tested	Not tested due to time constraint of the test period.
Borderline	The observed values of the specified parameter are valid at one extreme, and invalid at the other.

Table 2 - Setup and Configuration Information

Product	
Manufacturer	Magic Device Machine
Model	MD-360
Serial Number	3AGE3584
MAC Address	aa:bb:cc:dd:ee
Hardware Version	8.4.2453
Firmware Version	FTH25489FE
IOL Label	VN-DUTT-00000123456
Test System Hardware	
RF Isolated Environment	USC-26 RF/EMI Isolation Chamber 16'x 8' x 8' @ 100dB
Sniffer	Atheros DK4 Sniffer Station
Test Station	Atheros DK4 Testing Station

In many traces, identification frames were used to simplify result collecting. These frames are identified by their source MAC address (00:00:01:ba:bb:1e). Below is an example of an identification frame found in a trace:

No.	Info	Protocol	Source	Destination
1	Beacon frame, BI=100, SSID=MAC""	IEEE 802.11	Xerox_00:00:11	Broadcast
2	Part a: Non-Acknowledged Frames	Babble Frame	0.0.0.0	255.255.255.255
3	MSDU1 => ICMP Echo Request with Protocol Version > 0	Babble Frame	0.0.0.0	255.255.255.255
4	Echo (ping) request	ICMP	192.168.0.102	Vendor (abcd)
5	Acknowledgement	IEEE 802.11		Xerox_00:00:11
6	Clear-to-send	IEEE 802.11		Vendor (abcd)
7	Data	IEEE 802.11	Xerox_00:00:11	Vendor (abcd)

Rows highlighted in green are Management Frames.
Rows highlighted in blue are Control Frames.
Rows highlighted in white are Data Frames.
Rows highlighted in violet are ICMP Echo Requests/Responses

Fields or Frame excerpts highlighted in this reports are important and directly related to the issue being shown in the trace excerpt.

GROUP 1: DEFAULT CONFIGURATION

Test # and Label	Part(s)	Result(s)
1.1.1: Frame Processing	**a**	**PASS**
	b	**PASS**
	c	**PASS**

Comments on Test Procedure

Purpose: To verify that the DUT handles the reception of MAC frames correctly.

This test verifies that the DUT correctly formats MAC layer frames that it receives. This test checks that the DUT properly processes the received frame by continuing the frame exchange sequence. It also verifies that the DUT can handle the reception of an unexpected or incorrectly formatted frame without error. This is to test the robustness of the DUT. It is assumed that the data transmission rate is not a factor in this test other than in the calculation of the duration field.

The DUT should:

a. not transmit an ACK upon reception of MSDU1-4, but should receive the frames without system failure.
b. transmit an ACK upon reception of MSDU5-12, and should receive the frames without system failure.
c. receive the frame without system failure. The DUT may or may not transmit an ACK upon reception of these frames.

Comments on Test Results

a-c. There were no issues uncovered during the testing process.

Test # and Label	Part(s)	Result(s)
1.1.2: Null Data Processing	**a**	**PASS**
	b	**PASS**

Comments on Test Procedure

*Purpose***:** To verify that the DUT operates properly upon reception of Null Data frames, and interprets the frame control field properly.

All STAs must have the ability to operate properly upon reception of null frames with specific bits set in the Frame Control field, which consists of the following subfields: Protocol Version, Type, Subtype, To DS, From DS, More Fragments, Retry, Power Management, More Data, WEP, and Order.

The DUT should:

a. not send an ACK in response to MSDU1 and MSDU2.
b. send an ACK in response to MSDU3-MSDU11.

Comments on Test Results

a-b. There were no issues uncovered during the testing process.

Test # and Label	Part(s)	Result(s)
1.1.3: Deauthentication Processing	**a**	**PASS**
	b	**PASS**
	c	**PASS**

Comments on Test Procedure

Purpose: To verify that the DUT properly handles received deauthentication frames and generates deauthentication frames properly.

Deauthentication nullifies authentication and is a notification rather than a request. It is important that a station properly handle a deauthentication notice as it should terminates network connectivity. Deauthentication frames can also be sent to a group address to deauthenticate from all APs at once or it can also be used in an IBSS using authentication.

a. The DUT should not transmit any class 2 or 3 traffic to the TS upon reception of MSDU1.
b. INFORMATIVE: Upon reception of MSDU2, [1] is unclear whether or not the frame should be processed. If the DUT processes the frame, then all traffic from the DUT to the TS should cease.
c. The DUT should not transmit an ACK upon reception of MSDU3, nor process the frame.

Comments on Test Results

a-c. There were no issues uncovered during the testing process.
b. The DUT was observed to process the Deauthentication frame transmitted to the broadcast address, and correctly ceased all transmissions of class 2 and 3 traffic.

Test # and Label	Part(s)	Result(s)
1.1.4: Authentication Processing	**a**	**PASS**
	b	**PASS**
	c	**PASS**
	d	**PASS**

Comments on Test Procedure

Purpose: To verify that the DUT properly handles received authentication frames and generates authentication frames properly.

Authentication is a distribution system (DS) service that allows an authenticated STA to transmit class 2 frames. Only after a STA has successfully authenticated with an AP, may it associate with that AP. The Authentication response that is transmitted by an AP will have a status code indicating either success or failure. If the Authentication is successful, the status code should be zero. The STA must be able to handle Authentication responses transmitted by the AP that include any Authentication related status code. If the Authentication response indicates a status code other than successful, the STA is not authenticated with the AP.

The DUT should:

a. authenticate successfully and attempt association for status code 0. The DUT should not attempt association upon reception of MSDU1b-e.
b. authenticate unsuccessfully and not attempt to associate.
c. authenticate unsuccessfully and not attempt to associate.
d. not transmit an ACK upon reception of MSDU4, nor process the frame.

Comments on Test Results

a-d. There were no issues uncovered during the testing process.

Test # and Label	Part(s)	Result(s)
1.1.5: Association Processing	**a**	**PASS**
	b	**PASS**
	c	**PASS**
	d	**PASS**
	e	**PASS**
	f	**PASS**

Comments on Test Procedure

Purpose: To verify that the DUT properly handles received association frames and generates association frames properly.

Association is a distribution system (DS) state which allows an associated STA to transmit class 3 frames. Only after a STA has successfully authenticated with an AP, may it associate with that AP. To become associated with an AP that it is currently authenticated with, the STA must transmit an association request to the AP. The association response that is transmitted by an AP will have a status code indicating either success or failure. If the association is successful, the response should include the unique association identifier (AID). The STA must be able to handle association responses transmitted by the AP that include any association related status code. If the association response indicates a status code other than successful, the STA is not associated with the AP and should not attempt to transmit class 3 traffic to the AP.

The DUT should:

a. successfully associate and transmit Class 3 traffic.
b. not associate successfully, nor transmit Class 3 traffic. The DUT should send an ACK for the test frames without any system failure.
c-f. successfully associate and transmit Class 3 traffic without any system failure.

Comments on Test Results

a-f. There were no issues uncovered during the testing process.

Test # and Label	Part(s)	Result(s)
1.1.6: Disassociation Processing	**a**	**PASS**
	b	**Informative**
	c	**PASS**

Comments on Test Procedure

Purpose: To verify that the DUT properly handles received disassociation frames and generates disassociation frames properly.

Disassociation nullifies association and is a notification rather than a request. It is important that a station properly handle a disassociation notice as it partially terminates network connectivity. Disassociation frames can also be sent to a group address to disassociate from all APs at once.

a. The DUT should not transmit class 3 traffic upon reception of MSDU1 for each test frame.
b. INFORMATIVE: Upon reception of MSDU2, [1] is unclear whether or not the frame should be processed. If the DUT processes the frame, then all class 3 traffic from the DUT to the TS should cease.
c. The DUT should not transmit an ACK upon reception of MSDU3, nor process the frame. The DUT should continue transmitting Class 3 traffic.

Comments on Test Results

a. There were no issues uncovered during the testing process.
b. The DUT was observed to process the Disassociation transmitted to the broadcast address, and correctly ceased all transmissions of class 3 traffic.
c. There were no issues uncovered during the testing process.

Test # and Label	Part(s)	Result(s)
1.1.7: Reassociation Processing	**a**	**PASS**
	b	**PASS**
	c	**PASS**
	d	**PASS**
	e	**PASS**
	f	**PASS**

Comments on Test Procedure

Purpose: To verify that

- The DUT can transmit a Reassociation Request frame (if implemented).
- The DUT can handle Reassociation Responses with status codes other than "successful."

For devices to engage in higher-level communication, such as IP layer, they must be part of the same BSS. The first part of becoming part of a BSS is authenticating with the AP. After a device has been successfully authenticated the next step to join the BSS is association. If a device becomes disassociated from a BSS it is possible to re-associate. If A STA attempts reassociation, it should be able to handle all types of reassociation responses, and behave with regards to the reason code within the reassociation response. This test is designed to ensure that a device properly processes re-association responses, and can handle unsuccessful status codes.

The DUT should:

a. successfully associate and respond to ICMP Echo Requests.
b. send an ACK for the test frames without any system failure, but not associate successfully, and also not attempt to transmit class 3 traffic.
c-f. successfully associate and respond to ICMP Echo Requests.

Comments on Test Results

a-f. There were no issues uncovered during the testing process.

Test # and Label	Part(s)	Result(s)
1.1.8: State Variables and Services	**a**	**PASS**
	b	**FAIL**
	c	**FAIL**
	d	**Informative**

Comments on Test Procedure

Purpose: To verify that

- the DUT maintains which stations are authenticated and which stations are associated.
- the DUT does not process class 2 frames from unauthenticated stations, and responds appropriately.
- the DUT does not process class 3 frames from unassociated stations, and responds appropriately.
- the DUT is able to respond to Probe Requests in all states.

For devices to engage in higher-level communication, such as IP layer, they must be part of the same BSS. The first part of becoming part of a BSS is authenticating with the AP. After a device has been successfully authenticated the next step to join the BSS is association. In order for the AP to keep track of what class frames it may transmit to a particular station, each station is given a variable that determines that stations authentication and association state with the AP. The values for this variable are unauthenticated, authenticated but unassociated, and authenticated and associated. Each value of this variable determines a different state that the station is in for communication with the AP, which determines which classes of frames the AP and station may exchange.

The DUT should:

a. respond to MSDU2, and MSDU4-5 with a deauthentication.
b. respond to MSDU6-7, and MSDU9-16 with a deauthentication.
c. respond to MSDU6-7, and MSDU9-16 with a deauthentication or disassociation.
d. respond to MSDU8 with a Probe Response for all transmissions of MSDU8.

Comments on Test Results

a. There were no issues uncovered during the testing process.
b. The DUT was observed to not transmit a Deauthentication frame upon reception of a unicast PS-Poll frame. The DUT should transmit a Deauthentication frame upon reception of class 3 traffic in state 1. See IEEE Std. 802.11-2007 subclause 11.3. Please refer to Table for more information regarding this result.
c. The DUT was observed to not transmit a Deauthentication or Disassociation frame upon reception of unicast PS-Poll frame. The DUT should transmit a Deauthentication or Disassociation frame upon reception of class 3 traffic in state 2. See IEEE Std. 802.11-2007 subclause 11.3. Please refer to Table for more information regarding this result.
d. The DUT was observed to not transmit a Probe Response upon reception of a unicast Probe Request.

Test # and Label	Part(s)	Result(s)
1.1.9: Acknowledgement and Duration Field Validation	**a**	**PASS**
	b	**PASS**
	c	**PASS**
	d	**PASS**
	e	**PASS**

Comments on Test Procedure

Purpose: To verify that

- the DUT will transmit an ACK with all zeros in its duration field in response to a data frame with the More Fragments bit set to zero.
- the DUT will transmit an ACK with a properly calculated duration field (duration of data frame minus time to transmit the ACK and a SIFS, with fractional microseconds rounded up) in response to a data frame with the more fragments bit set.
- the DUT will transmit an ACK in response to a directed frame
- the DUT will only transmit an ACK upon reception of frames with a valid FCS.

Whenever a directed frame is successfully transmitted from one MAC entity to another, an acknowledgement frame must be transmitted. In the event that the acknowledgement frame is lost (e.g. destination receives frame ok and transmit an ACK for it, but source does not receive the ACK), the transmitter should re-transmit the frame, and the receiver must transmit an ACK for the re-transmitted frame. When the last fragment of a MSDU is received, the ACK should have the duration field set to zero to indicate the medium is available. However, when there are more frames in the MSDU, the acknowledging station must take the duration field from the frame it is acknowledging, subtract two SIFS and the time it took to transmit the ACK, and include the result as its duration field.

The DUT should:

a. transmit an ACK, for MSDU1, with a duration field of 0 μs.
b. transmit an ACK, for the first fragment of MSDU2, with an appropriate duration field, transmit an ACK for the second fragment of MSDU2 with a duration field of 0 μs.
c. transmit ACKs for all transmissions by the TS of MSDU3, not transmit ACKs for all transmissions by the TS of MSDU4.
d. transmit an ACK, for the first fragment of MSDU8, with an appropriate duration field.
e. transmit an ACK for MSDU7.

Comments on Test Results

a-e. There were no issues uncovered during the testing process.

Test # and Label	Part(s)	Result(s)
1.1.10: Defragmentation	**a**	**PASS**

Comments on Test Procedure

Purpose: To verify that the DUT is capable of receiving fragments of an arbitrary length, and is able to reassemble them.

Defragmentation is the process of assembling successfully received fragments back into the original MSDU or MMPDU. Each fragment contains information in the header that is used to put a sequence of fragments together after the entire sequence has been received. The information that the defragmenting STA must use includes; the frame type, address of sender, sequence control field, and the More Fragments indicator. All STAs must be capable of defragmentation. Since it is possible for source STAs to transmit fragments of an arbitrary length, destination STAs must also be capable of defragmenting fragments of arbitrary length.

The DUT should:

a. defragment MSDU1 for each of the fragmentation thresholds used by the TS, and send an ICMP Echo Response for each transmission of MSDU1.

Comments on Test Results

a. There were no issues uncovered during the testing process.

Test # and Label	Part(s)	Result(s)
1.1.11: Duplicate Detection and Recovery	**a**	**PASS**
	b	**PASS**

Comments on Test Procedure

Purpose: To verify that the DUT properly detects and filters duplicate frames.

Due to the design of the MAC layer protocol, it is possible for a STA to successfully receive the same frame or fragment of a frame more than once. Accordingly, duplicate detection and recovery is built into the MAC layer. The primary mechanism to detect duplicates is the sequence and fragment numbers. Stations generate sequence numbers as an incrementing sequence of integers. All STAs should maintain a cache of recently received sequence and fragment numbers from each STA. Whenever a STA receives a frame with a matching source address, sequence number, and fragment number, with the retry bit set, it should discard the frame as a duplicate (but still transmit an ACK). Due to the sequence number field being a modulo 4096 counter, it is possible for a frame to be improperly discarded as a duplicate, although it is highly unlikely.

a. The DUT should
- use the same sequence number in the sequence control for all MPDUs that make up the same MSDU.
- use an incrementing sequence number for all transmitted frames.
- acknowledge and forward MSDU1 the ICMP Echo Response to the TS.
- acknowledge but not forward MSDU1r ICMP Echo Response to the TS.
- acknowledge MPDU3a, MPDU3b, MPDU3c and forward the frame composed of MPDU3a and MPDU3b and the ICMP Echo Response to the TS.

b. The DUT should
- use the same sequence number in the sequence control for all MPDUs that make up the same MSDU.
- use an incrementing sequence number for all transmitted frames.
- acknowledge each MSDU and forward the ICMP Echo Response to the TS.

Comments on Test Results

a-b. There were no issues uncovered during the testing process.

GROUP 2: RTS AND FRAGMENTATION

Test # and Label	Part(s)	Result(s)
1.2.1: Recovery Procedure and Retransmit Limits	**a**	**PASS**
	b	**PASS**
	c	**PASS**
	d	**Refer to Comments**

Comments on Test Procedure

Purpose: To verify that

- the DUT properly increments and resets the appropriate retry counters.
- the DUT sets the Retry Bit in all retransmitted MSDUs.

Each MSDU within a frame exchange should have its own short retry counter (SRC) and long retry counter (LRC), and the station must also keep a separate station short retry counter (SSRC) and station long retry counter (SLRC). When the DUT does not successfully transmit a frame (e.g. receives no CTS in response to RTS, or ACK in response to data frame), it should increment the SSRC or SLRC and the SRC or LRC for the MSDU. The counter used is dependent on whether the frame exceeds dot11RTSThreshold. Whenever a directed frame is successfully transmitted, the SSRC or SLRC and either the SRC or LRC is reset to 0. Whenever a group frame is successfully transmitted, both the SSRC and SLRC should be reset to 0. A DUT should stop retrying a frame once the MSDU's SRC has reached dot11ShortRetryLimit, or the MSDU's LRC has reached aLongRetryLimit. [1] recommends that 7 and 4 be used for dot11ShortRetryLimit and aLongRetryLimit respectively.

The DUT should:

a. transmit a RTS in response to MSDU2 exactly dot11ShortRetryLimit times, each RTS with the retry bit set to 0.
b. transmit the ICMP Echo Response in response to MSDU2 exactly aLongRetryLimit times.
c. transmit the ICMP Echo Response to MSDU1 exactly dot11ShortRetryLimit times.
d. transmit the first fragment of the ICMP Echo Response dot11ShortRetryLimit times. The DUT should not attempt to transmit any other fragments of the ICMP Echo Response.

Comments on Test Results

a-c. There were no issues uncovered during the testing process.
d. The DUT was observed to stop responding upon reception of a 1500-byte frame when configured to use an RTSThreshold of 512-bytes and a FragThreshold of 512-bytes. This behavior prevents a valid pass or fail from being determined.

Test # and Label	Part(s)	Result(s)
1.2.2: RTS/CTS and Directed MPDU Transfer	**a**	**PASS**
	b	**PASS**
	c	**PASS**
	d	**PASS**

Comments on Test Procedure

Purpose: To verify that

- The DUT properly receives frames from devices with a different RTS threshold than its own.
- The DUT initiates an RTS/CTS exchange for directed frames when the length of the MPDU is greater than the dot11RTSThreshold.
- The DUT does not initiate an RTS/CTS exchange for all MPDUs if the value of the dot11RTSThreshold is larger than the maximum MPDU length.
- An asynchronous data frame is transmitted using the basic access procedure when a RTS/CTS exchange is not used.

For virtual carrier sense to work properly, RTS and CTS frames must include a properly calculated duration field to indicate to other stations how long the medium will be occupied. The device transmitting an RTS should reserve the medium up until the first ACK of the frame exchange. A CTS frame should be calculated by subtracting (aSIFSTime + aCTSTime) from the RTS frame's duration field. Additionally, both RTS and CTS frames must be transmitted at one of the basic rates so that all stations are aware that the medium will be busy. Consequently, stations must support receiving data frames at a different rate than the rate of the RTS/CTS frames. In order to allow the transmitting station to calculate the duration field for the RTS frame, a receiving station must respond with a CTS at the same rate as the RTS. Since dot11RTSThreshold can be set on a per-station basis, STAs must also be capable of receiving frames larger than their dot11RTSThreshold without a RTS/CTS exchange. A device should process received frames that are longer than its RTS threshold that are not preceded by a RTS/CTS exchange.

a. The DUT should :
   - not use RTS/CTS preceding the ICMP Echo Response to MSDU1.
   - not use RTS/CTS preceding the ICMP Echo Response to MSDU2.
   - use RTS/CTS preceding the ICMP Echo Response to MSDU3.

b. The DUT should:
   - not use RTS/CTS preceding the ICMP Echo Response to MSDU5.
   - not use RTS/CTS preceding the ICMP Echo Response to MSDU6.
   - use RTS/CTS preceding the ICMP Echo Response to MSDU7.

c. The DUT should:
   - use RTS/CTS preceding the first fragment of the ICMP Echo Response to MSDU4.
   - use RTS/CTS only preceding the first fragment.

d. The DUT should:
   - use RTS/CTS preceding the first fragment of the ICMP Echo Response to MSDU8.
   - use RTS/CTS only preceding the first fragment.

Comments on Test Results

a-d. There were no issues uncovered during the testing process.

Test # and Label	Part(s)	Result(s)
1.2.3: Directed MPDU Fragmentation	**a**	**Refer to Comments**
	b	**Refer to Comments**

Comments on Test Procedure

Purpose: To verify that the DUT properly fragments directed MSDUs and MMPDUs when the frame length exceeds the DUT's fragmentation threshold.

A STA's fragmentation threshold is the maximum transmission length that a directed MSDU or MMPDU can be before fragmentation will occur. To determine whether or not a MSDU or MMPDU should be fragmented, a transmitting STA must account for the length and type of frame (unicast, broadcast, or multicast) as well as the type of network that the frame is to be transmitted in (Ad-hoc or Infrastructure).

For either type of network, if the MSDU or MMPDU is unicast and is larger than the transmitting STA's fragmentation threshold, it should be fragmented before transmission. RTS/CTS may be used immediately preceding the first fragment of the sequence dependingon the RTS thresholdof the transmitting STA. An ACK from the receiving STA immediately following every successfully received fragment is required in this case. The receiving STA will reassemble the fragments after receiving the last fragment.

Each fragment has specific information included by the transmitting STA. This includes the frame type, more fragments indicator bit, destination address, retry bit, sequence number, and fragment number. All of these values should be correctly setup by the source STA before the fragment is transmitted. If they are not correctly setup before transmission, they will not be received or assembled correctly.

The DUT should:

a. not use an RTS/CTS exchange throughout the duration of the testing process, correctly set the More Fragments Bit in all fragments (except the last one), correctly sets the Destination Address in all fragments, correctly maintains the same Sequence Number for all fragments belonging to one MSDU or MMPDU, begins the Fragment Number at 0 and increments it by 1 for each successive fragment belonging to one MSDU or MMPDU.
b. not attempt to break MSDU's down into odd sized fragments. The DUT should round down from the configured odd value if it attempts transmission of fragments.

Comments on Test Results

a-b. The DUT was observed to stop responding upon reception of a 1500-byte frame when configured to use an RTSThreshold of 600-bytes and a FragThreshold of 512-bytes. This behavior prevents a valid pass or fail from being determined.

Test # and Label	Part(s)	Result(s)
1.2.4: Multirate Support	**a**	**PASS**
	b	**PASS**
	c	**PASS**
	d	**PASS**
	e	**PASS**
	f	**PASS**

Comments on Test Procedure

Purpose: To verify that the DUT's dynamic rate-switching algorithm will properly interoperate and coexist with all supported physical layer data transmission rates.

One performance enhancer of the 802.11 specification is the dynamic rate-switching mechanism. Rate-switching allows a STA to determine a transmit rate that gives it the optimal throughput based on the number of retries per rate and the throughput per rate. Since dynamic rate-switching may be supported, a STA must also support successful reception and acknowledgement of frames at different transmit rate values. An example of successful reception and acknowledgement is having all frames with multicast and broadcast RA transmitted at one of the rates included in the BSSBasicRateSet, regardless of the underlying physical layer.

The intention for the stringent requirements for rate selection is to allow for multiple STAs in a network to use different rate configurations. In this scenario, it guarantees that an optimal amount of traffic be heard by every STA in the BSS. It also allows for a STA to properly set its NAV value to include any necessary control response frames needed to complete the frame exchange.

a-f. The DUT should

- transmit all control response (CTS and ACK) frames at one of the basic rates in the BSSBasicRateSet that is not only of the same modulation, but at a rate less than or equal to the rate that the previous frame was transmitted at.
- transmit all other control frames at one of the rates in the BSSBasicRateSet.
- transmit directed data and management frames at a rate that is known to be supported by the receiving STA.
- transmit all frames with multicast and broadcast address 1 field are transmitted at one of the rates included in the BSSBasicRateSet, regardless of their PHY type.
- Not initiate transmission of a data or management frame at a data rate higher than the greatest rate in the OperationalRateSet.

Comments on Test Results

a-f. There were no issues uncovered during the testing process.

Test # and Label	Part(s)	Result(s)
1.2.5: Defragmentation using RTS/CTS	**a**	**PASS**

Comments on Test Procedure

Purpose: To verify that the DUT is capable of receiving fragments of an arbitrary length, and is able to reassemble them properly while using RTS/CTS.

Defragmentation is the process of reassembling successfully received fragments back into the original MSDU or MMPDU. Each fragment contains information in the header that is used to put a sequence of fragments together again after the entire sequence has been received. This information that the defragmenting STA must use includes the frame type, address of transmitter, sequence control field, and the More Fragments indicator. All STAs must be capable of defragmentation. Because it is possible for source STAs to transmit fragments of an arbitrary length, destination STAs must be capable of defragmenting fragments of arbitrary length.

The DUT should:

a. defragment MSDU1 for all the fragmentation thresholds used to fragment it, use the RTS/CTS procedure and forward the ICMP Echo Response to the TS.

Comments on Test Results

a. There were no issues uncovered during the testing process.

GROUP 3: WEP AND POWERSAVE

Test # and Label	Part(s)	Result(s)
1.3.1: WEP Decryption Procedure	**a**	**PASS**
	b	**PASS**
	c	**PASS**
	d	**Informative**
	e	**PASS**

Comments on Test Procedure

Purpose: To verify that

- The DUT properly decrypts data as specified by the 802.11 standard.
- The DUT does not process encrypted frames with an invalid ICV.

Due to the inherent nature of the WLAN environment, the opportunity for eavesdropping is greatly increased. Therefore, the Wired Equivalent Privacy (WEP) algorithm was developed. WEP attempts to give 802.11 networks the same amount of security that would be provided on a regular wired network that was using no extra security functions. There are four parts that are essential to the performance of the WEP algorithm:

- The secret key: is the key that is entered into the "WEP key" value.
- The initialization vector (IV): extends the useful lifetime of a secret key and provides the self-synchronous property of the WEP algorithm.
- The pseudorandom number generator (PRNG): transforms a relatively short secret key into an arbitrary length key sequence.
- The integrity check value (ICV): protects against unauthorized data modification.

Given these components, it is imperative that a device have the ability to correctly decrypt received frames.

The DUT should:

a-b. transmit an ACK upon reception of MSDU1, however, not send an ICMP Echo Response.
c. not transmit an ACK upon reception of MSDU3, nor send an ICMP Echo Response.
d. receive the frame without system failure.
e. transmit an ACK for each transmission of MSDU5, and send an ICMP Echo Response.

Comments on Test Results

a-c. There were no issues uncovered during the testing process.
d. The DUT was observed to receive a malformed WEP encrypted frame (pad bits set) without system failure.
e. There were no issues uncovered during the testing process.

Test # and Label	Part(s)	Result(s)
1.3.2: TIM Transmission	**a**	**Not Applicable**
	b	**Not Applicable**
	c	**Not Applicable**
	d	**Not Applicable**

Comments on Test Procedure

Purpose: To verify that

- the DUT processes the TIM element of beacons properly.
- the DUT receives broadcast frames properly when the TIM element indicates there is broadcast traffic.
- the DUT receives directed frames properly when the TIM element indicates there is directed traffic.
- the DUT does not process directed frames when the TIM element indicates there is no directed/broadcast traffic.

Whenever a station enters power save, the AP is supposed to buffer frames for all stations in power save. In order to ensure the AP doesn't need an infinite amount of memory to buffer the frames, all stations are required to at least wake up on DTIMs when their AID is set in the TIM element of beacons. To keep the size of beacons at a reasonable size, part of the TIM element is the bitmap offset. The bitmap offset is the number of bytes that are not being included in the partial virtual bitmap. This allows for the beacons to be kept to a reasonable size and avoid clogging the medium too much.

The DUT should:

a. receive and respond to broadcast traffic sent after DTIMs.
b. request its buffered traffic when the Partial Virtual Bitmap indicates that there is directed buffered traffic for the DUT's AID.
c-d. remain in power save when the Partial Virtual Bitmap indicates that there is no directed traffic being buffered for the DUT's AID.

Comments on Test Results

a-d. The DUT was observed to not support power save, therefore no valid results could be obtained from this section.

Test # and Label	Part(s)	Result(s)
1.3.3: Defragmentation using WEP	**a**	**PASS**
Comments on Test Procedure		

Purpose: To verify that the DUT has the ability to operate properly upon reception of PS-Poll frames.

Defragmentation is the process of reassembling successfully received fragments back into the original MSDU or MMPDU. Defragmentation can be a difficult process for the receiving STA, especially when receiving pieces of different MSDUs or MPDUs at a time. To aid the receiving STA in the assembly process, specific information is included in each fragment by the transmitting STA. Each fragment contains information in the header that is used to put a sequence of fragments together again after the entire sequence has been received. This information that the defragmenting STA must use includes the frame type, address of transmitter, sequence control field, and the More Fragments indicator. All STAs must be capable of defragmentation. Because it is possible for source STAs to transmit fragments of an arbitrary length, destination STAs must be capable of defragmenting fragments of arbitrary length.

The DUT should:

a. defragment MSDU1 for all the fragmentation thresholds used to fragment it and forward the ICMP Echo Response to the TS.

Comments on Test Results

a. There were no issues uncovered during the testing process.

TRACE EVALUATION:

TABLE 3

Test #: 1.1.8: State Variables and Services part b

From: \Base\Traces\Wireshark_Traces\1.1.8.cap

No.	Info	Protocol	Source	Destination
351	Deauthentication	IEEE 802.11	aa:bb:cc:dd:ee	Xerox_00:00:11
352	Acknowledgement	IEEE 802.11		aa:bb:cc:dd:ee (RA)
353-372	Beacon frame, BI=100, SSID=MAC""	IEEE 802.11	Xerox_00:00:11	Broadcast
373	Deauthentication, Unspecified reason	IEEE 802.11	Xerox_00:00:11	aa:bb:cc:dd:ee
374-392	Beacon frame, BI=100, SSID=MAC""	IEEE 802.11	Xerox_00:00:11	Broadcast
393	Authentication, Successful	IEEE 802.11	aa:bb:cc:dd:ee	Xerox_00:00:11
394	Acknowledgement	IEEE 802.11		aa:bb:cc:dd:ee (RA)
395-397	Beacon frames, BI=100, SSID=MAC""	IEEE 802.11	Xerox_00:00:11	Broadcast
398	Power-Save poll	IEEE 802.11	Xerox_00:00:11 (BSSID)	aa:bb:cc:dd:ee (BSSID)
399	Acknowledgement	IEEE 802.11		Xerox_00:00:11 (RA)
400-420	Beacon frames, BI=100, SSID=MAC""	IEEE 802.11	Xerox_00:00:11	Broadcast

TABLE 4

Test #: 1.1.8: State Variables and Services part c

From: \Base\Traces\Wireshark_Traces\1.1.8.cap

No.	Info	Protocol	Source	Destination
972	Authentication, Successful	IEEE 802.11	aa:bb:cc:dd:ee	Xerox_00:00:11
973	Acknowledgement	IEEE 802.11		aa:bb:cc:dd:ee (RA)
974	Authentication, Successful	IEEE 802.11	Xerox_00:00:11	aa:bb:cc:dd:ee
975	Acknowledgement	IEEE 802.11		Xerox_00:00:11 (RA)
976	Association Request, SSID=MAC""	IEEE 802.11	aa:bb:cc:dd:ee	Xerox_00:00:11
977	Acknowledgement	IEEE 802.11		aa:bb:cc:dd:ee (RA)
978	Beacon frame, BI=100, SSID=MAC""	IEEE 802.11	Xerox_00:00:11	Broadcast
1009	Echo (ping) request	ICMP	192.168.1.111	192.168.1.133
1010	Echo (ping) request	ICMP	192.168.1.111	192.168.1.133
1011	Echo (ping) request	ICMP	192.168.1.111	192.168.1.133
1012	Echo (ping) request	ICMP	192.168.1.111	192.168.1.133
1013	Echo (ping) request	ICMP	192.168.1.111	192.168.1.133
1014-1020	Probe Response, BI=100, SSID=MAC""	IEEE 802.11	Xerox_00:00:11	aa:bb:cc:dd:ee

```
Frame 1009
IEEE 802.11 Data
    Type/Subtype: Data (0x20)
    Frame Control: 0x0208 (Normal)
    Duration: 44
    Destination address: aa:bb:cc:dd:ee (aa:bb:cc:dd:ee)
    BSS Id: Xerox_00:00:11 (00:00:01:00:00:11)
    Source address: Xerox_00:00:11 (00:00:01:00:00:11)
    Fragment number: 0
    Sequence number: 420
    Frame check sequence: 0x45e2621a [correct]

0000  08 02 2c 00 02 ba d0 5b b7 6f 00 00 01 00 00 11
0010  00 00 01 00 00 11 40 1a aa aa 03 00 00 00 08 00
0020  45 00 00 3c 00 00 00 00 ff 01 39 7c c0 a8 00 6f
0030  c0 a8 00 85 08 00 5f 51 7e f4 28 b9 00 01 02 03
0040  04 05 06 07 08 09 0a 0b 0c 0d 0e 0f 10 11 12 13
0050  14 15 16 17 18 19 1a 1b 1c 1d 1e 1f 45 e2 62 1a
```