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SS7 MTP2-User Peer-to-Peer Adaptation Layer
Test Specifications
M2PA-TEST
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Status of this Memo

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Abstract

This Internet Draft provides information for the Internet community on test cases for testing the *SS7 MTP2-User Peer-to-Peer Adaptation Layer* [M2PA] based on the conformance test specifications for SS7 MTP Level 2 [Q.781].

This memo describes the test environment and a detailed description of test cases for validation, compatibility and interoperability testing of the M2PA protocol implemented on the foundation of ITU SS7 MTP Signalling Links [Q.703].

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1. Introduction

This draft provides a set of detailed tests of the *SS7 MTP2-User Peer-to-Peer Adaptation Layer* [M2PA] based on the test specifications for SS7 MTP Level 2 [Q.781]. These tests are intended to validate the *SS7 MTP2-User Peer-to-Peer Adaptation Layer* (M2PA) protocol [M2PA].

These tests attempt to completely validate the M2PA protocol without redundancy. Each test is described as simply as possible to check precisely the elementary function of the protocol. The tests are listed in no specific order<1>.

1.1. Scope

Although the SS7 MTP Level 2 Test Specification [Q.781] is largely applicable to SS7 signalling links using the SS7 MTP2-User Peer-to-Peer Adaptation Layer [M2PA], those test cases describe messages and some sequences that are not applicable to M2PA. This document describes a set of Validation and Compatibility tests that are consistent with the SS7 MTP Level 2 Test Specification [Q.781], but which are applicable to M2PA.

The Test Environment used for M2PA testing described in this document is largely compatible with the SS7 Test Specifications [Q.780].

M2PA [M2PA] provides that, unless modified by the M2PA specification [M2PA], that the procedures of the applicable MTP Level 2 standard are to be used. This includes ITU [Q.703], ANSI [T1.111], ETSI [EN 300 008-1], TTC [JT-Q703], and other narrow band specifications as well as broadband specifications for ITU [Q.2140], ANSI [T1.637], and others. This document describes testing of the procedures applicable to ITU signalling links [Q.781], [Q.703] only. Some other testing methodologies applicable to ANSI [T1.111] or ETSI [ETS 300 336], although similar, are outside the scope of this document.

1.2. Terminology

This document extends the terminology of M2PA [M2PA] with the following terms:

Compatibility Test (CPT) — A test where multiple implementations are tested in interaction with each other to test for compatibility between implementations.

Implementation Under Test (IUT) — An implementation being tested (the object of testing) as part of a *Validation Test* or a *Compatibility Test* within the *Test Environment*.

Interoperability Test (IOT) — A test where multiple implementations are tested in interaction with each other to test for interoperability between implementations.

M2PA Monitor — A device or function used to monitor, capture, record and analyze the exchange of M2PA messages across an IP network between implementations or protocol testers. This device or function may be integrated with a *Protocol Tester*.

MTP Level 3 Simulator — A device or function used to simulate the SS7 MTP Level 3 [Q.704] to SS7 MTP Level 2 [Q.703] implementation. This device or function may be integrated within the *Test Environment*. This device or function is normally required for SS7 MTP Level 2 Test Specification [Q.781] Validation as well as Compatibility tests.

Protocol Tester (PT) — A device or function used to generate normal or abnormal messages and test sequences for the purpose of *Validation* testing.

Test Case — A particular sequence of messages and patterns that make up a single Validation or Compatibility test.

Test Environment — The environment that contains testing device and functions necessary and sufficient for executing a *Test Suite*.

Test Suite — A collection of *Test Cases* meant to achieve a specific objective of Validation or Compatibility testing.

Validation Test (VAT) — A test where a single implementation is tested in interaction with a *Protocol Tester* to test for validation of the implementation to a technical specification.

1.3. Abbreviations

ASP — Application Server Process

CPT — Compatibility Test
IOT — Interoperability Test
IPSP — IP Signalling Point
IUT — Implementation Under Test
PT — Protocol Tester
SG — Signalling Gateway
SGP — Signalling Gateway Process
SP — Signalling Point
VAT — Validation Test

1.4. Conventions

The key words "**MUST**", "**MUST NOT**", "**REQUIRED**", "**SHALL**", "**SHALL NOT**", "**SHOULD**", "**SHOULD NOT**", "**RECOMMENDED**", "**MAY**", and "**OPTIONAL**" in this document are to be interpreted as described in [RFC2119].

This test specification is not a replacement for or extension of the *SS7 MTP2-User Peer-to-Peer Adaptation Layer* protocol specification [M2PA]. Where this document and the requirements or recommendations of the *SS7 MTP2-User Peer-to-Peer Adaptation Layer* protocol specification [M2PA] disagree, the requirements and recommendations of the *SS7 MTP2-User Peer-to-Peer Adaptation Layer* protocol specification [M2PA] shall be taken as authoritative.

Notes for §1

<1> **IMPLEMENTATION NOTE:—** An implementation of M2PA which conforms to these test specifications and a test program which executes the validation portion of these tests on that implementation are available from *http://www.openss7.org/downloads.html*

2. Test Environment

The test environment for SS7 MTP Level 2 [Q.781] testing is described in the General Aspects of SS7 Testing [Q.780]. There are three types of testing that are accommodated as follows:

Validation Testing — consists of validating a single Implementation Under Test (IUT). This is performed by connecting the IUT to a Protocol Tester (PT) within the test environment.

Validation testing is more extensive than compatibility testing. This is because it is possible, with the use of the PT, to generate abnormal messages and patterns that cannot normally be generated from an implementation. These tests validate the response of the IUT to abnormal (as well as normal) conditions.

Compatibility Testing — consists of testing the compatibility of one Implementation Under Test (IUT) with another. This is performed by connecting the IUT together within the test environment.

Compatibility testing is less extensive than validation testing. This is because it is not normally possible to generate abnormal test patterns or generate negative test cases with an implementation that conforms to validation testing. However, compatibility tests are better at testing the interoperability of two implementations.

Interoperability Testing — consists of testing the interoperability of one Implementation Under Test (IUT) with another. This is performed by connecting the IUT together within the test environment.

Interoperability testing is more extensive than compatibility testing and less extensive than validation testing. Where compatibility testing assumes that the IUT have passed validation testing, interoperability testing makes no such assumption. In addition, the test environment is expected to have more control over the IUT in interoperability testing than in compatibility testing. It may be possible to generate some message and command or response sequences that would not normally by possible with an IUT during compatibility testing.

The objectives of interoperability testing are often different than compatibility testing. The object of compatibility testing is to assure that an implementation that passes validation testing is, in other respects not tested by validation testing, compatible with other such implementations. The object of interoperability testing is to show that there exist implementations with which each of the IUT being tested can indeed function.

Although they have different objectives, the test environment configuration for interoperability testing is the same as that for compatibility testing.

This document uses the test environment described in the SS7 Test Specification [Q.780].

2.1. Test Configurations

This section details the Validation and Compatibility test configurations used for testing M2PA for SS7 MTP Level 2 [Q.781] conformance.

2.1.1. Validation Test Configuration

```
 ____________________________________________________________________
|                                                                    |
| TEST ENVIRONMENT                                                   |
|                                                   MTP Level 3      |
|                                                    Simulator       |
|                                                        :           |
|         _________                                  ____:____       |
|        |         |            M2PA Link           |         |      |
|        |   PT    |________________________________|   IUT   |      |
|        |         |      |                         |         |      |
|        |_________|      |          SCTP           |_________|      |
|                         |       Association                         |
|            SP B      ____|____                          SP A        |
|                     |         |                                    |
|                     |  M2PA   |                                    |
|                     | Monitor |                                    |
|                     |_________|                                    |
|                                                                    |
|____________________________________________________________________|
```

Figure 2.1.1-1. Validation Test Configuration

Figure 2.1.1-1 illustrates the Validation Test Configuration. The Validation Test environment contains the following essential components:

(1) *Implementation Under Test (IUT)* — An implementation for validation testing acting as “SP A”.

(2) *Protocol Tester (PT)* — A protocol testing device acting as “SP B”.

(3) *MTP Level 3 Simulator* — A simulation device or function used to issue commands and collect response to and from the SS7 MTP2-User Peer-to-Peer Adaptation Layer [M2PA] implementation at position “SP A”.

(4) *M2PA Monitor* — A device or function used to monitor, capture, record and analyze the exchange of M2PA messages between the PT and IUT across the IP network in SCTP associations.

(5) *IP Network* — An intervening IP network used to form SCTP associations between PT and IUT and to exchange messages.

(6) *SCTP Associations* — An single SCTP connection formed between the PT and IUT for the exchange of M2PA messages.

For this configuration, the interface between the Implementation Under Test (IUT) and the *MTP Level 3 Simulator* is that described in the SS7 Test Specification [Q.780]. This is the normal configuration for SS7 MTP Level 2 testing [Q.781] with the exception that an M2PA [M2PA] signalling link has been interposed for an SS7 signalling link [Q.703].

All test cases in this document should be executed when performing Validation testing.

2.1.2. Compatibility Test Configuration

```
 ____________________________________________________________________
|                                                                    |
| TEST ENVIRONMENT                                                   |
|                                                                    |
|       MTP Level 3                             MTP Level 3          |
|        Simulator                               Simulator           |
|            :                                       :               |
|        ____:____                               ____:____           |
|       |         |          M2PA Link          |         |          |
|       |   IUT   |_____________________________|   IUT   |          |
|       |         |      |                      |         |          |
|       |_________|      |         SCTP         |_________|          |
|                        |      Association                          |
|          SP B      ____|____                       SP A            |
|                  |         |                                      |
|                  |  M2PA   |                                      |
|                  | Monitor |                                      |
|                  |_________|                                      |
|                                                                    |
|____________________________________________________________________|
```

Figure 2.1.2-1. Compatibility Test Configuration

Figure 2.1.2-1 illustrates the Compatibility Test Configuration. The Compatibility Test environment contains the following essential components:

(1) *Implementation Under Test (IUT)* — An implementation for compatibility testing acting as “SP A”.

(2) *Implementation Under Test (IUT)* — An implementation for compatibility testing acting as “SP B”.

(3) *MTP Level 3 Simulator* — A simulation device or function used to issue commands and collect responses to and from the SS7 MTP2-User Peer-to-Peer Adaptation Layer [M2PA] implementation at position “SP A”.

(4) *MTP Level 3 Simulator* — A simulation device or function used to issue commands and collect responses to and from the SS7 MTP2-User Peer-to-Peer Adaptation Layer [M2PA] implementation at position “SP B”.

(5) *M2PA Monitor* — A device or function used to monitor, capture, record and analyze the exchange of M2PA messages between the IUT across the IP network in SCTP associations.

(6) *IP Network* — An intervening IP network used to form SCTP associations between IUT and to exchange messages.

(7) *SCTP Associations* — A single SCTP connection formed between IUT for the exchange of M2PA messages.

For this configuration, the interface between each Implementation Under Test (IUT) and the *MTP Level 3 Simulator* is that described in the SS7 Test Specifications [Q.780]. Tihs is the normal configuration to SS7 MTP Level 2 testing [Q.781] with the exception that an M2PA [M2PA] signalling link has been interposed for an SS7 signalling link [Q.703].

Only select test case apply to Compatibility testing in accordance with the SS7 MTP Level 2 Test Specification [Q.781].

2.1.3. Interoperability Test Configuration

The interoperability test configuration closely resembles that for compatibility testing as illustrated in *Figure 2.1.2-1*, above, with the exception that the *MTP Level 3 Simulator* typically has more capabilities for controlling the implementation during testing. For example, the *MTP Level 3 Simulator* can in some instances be capable of closely controlling the sequence of messages generated by the implementation and may even be able to inject or withhold messages during testing.

2.2. Testing Methodology

The normal methodology for testing SS7 MTP Level 2 [Q.781] is to perform Validation testing on an IUT before performing Compatibility testing. The tests presented in this document test functionality the the M2PA MTP Level 2 state machines; however, they do not adequately test the M2PA L2 to L3 interface.

To complete Validation and Compatibility testing of M2PA, the Validation and Compatibility tests present in the SS7 MTP Level 3 Test Specification [Q.782] **SHOULD** be performed with M2PA links in the test environment to assure that the M2PA IUT has properly implemented the L2 to L3 interface.

2.3. Recommended IUT Settings

The following settings are recommended<1> for use with both Validation and Compatibility testing, in the absence of other recommended values to be adopted by the PT and IUT.

2.3.1. Timer Values

It is recommended<1> that the timer values listed in *Table 2.3.1-1* be configured at the IUT for the purposes of performing both validation and compatibility tests.

Table 2.3.1-1. Recommended<1> IUT Timer Values

Timer	Value	Units	Notes
T1	45	seconds	
T2	5	seconds	
T2l	20	seconds	*(not applicable)*
T2h	100	seconds	*(not applicable)*
T3	1	seconds	
T4n	8	seconds	
T4e	0.5	seconds	
T5	0.1	seconds	*(not applicable)*
T6	4	seconds	
T7	1	seconds	
T8	0.1	seconds	*(not applicable)*

2.3.2. Buffer Threshold Values

It is recommended that the buffer threshold values listed in *Table 2.3.2-1* be configured at the IUT for the purpose of performing both validation and compatibility tests.

Table 2.3.2-1. Recommended IUT Buffer Threshold Values

Threshold	Value	Units	Notes
N1	—	Octets	*(not applicable)*
N2	127	Messages	

2.3.3. MSU Length

It is illustrated that all normal User Data messages which are sent have a payload length of 35 bytes. This, however, is not essential to the correct performance of the tests and is an arbitrary choice. Use of different valid MSU lengths should not have an affect on the results.

2.3.4. Labeling of Messages and Primitives

The messages and primitives (requests and indications between M2PA and MTP3) in the test cases that follow are labeled as listed in *Table 2.3.4-1*. All tests are labeled with “VAT:”, “CPT:” or “IOT”, indicating that the test is applicable to Validation, Compatibility or Interoperability forms of testing.

Table 2.3.4-1. Labeling of Messages and Primitives

Label	**Link Status Message**
BUSY	Busy
BUSY-ENDED	Busy Ended
PROCESSOR-OUTAGE	Processor Outage
PROCESSOR-RECOVERED	Processor Recovered
OUT-OF-SERVICE	Out of Service
READY	Ready
PROVING-NORMAL	Proving Normal
PROVING-EMERGENCY	Proving Emergency
ALIGNMENT	Alignment

Label	**User Data Message**
DATA	*(non-zero length)*
DATA-ACK	*(zero-length)*

Label	**Invalid Messages**
{INVALID-STATUS}	*(Link Status Message with an invalid status value or an invalid length.)*
{INVALID-CLASS}	*(M2PA Message with Invalid Message Class.)*
{INVALID-TYPE}	*(M2PA Message with Invalid Message Type.)*

Label	**Request Primitive**
:start	AAL-START-request
:msu	AAL-MESSAGE_FOR_TRANSMISSION-request
:clear buffers	AAL-FLUSH_BUFFERS-request
:stop	AAL-STOP-request
:set emergency	AAL-EMERGENCY-request
:clear emergency	AAL-EMERGENCY-CEASES-request
:set lpo	MAAL-LOCAL_PROCESSOR_OUTAGE-request
:clear lpo	MAAL-LOCAL_PROCESSOR_RECOVERED-request
:power on	*(form SCTP association)*
:tx break	*(abort SCTP association)*
:make cong discard	*(receive discard congestion)*
:clear congestion	*(receive congestion abatement)*

Label	**Indication Primitive**
!in service	AAL-IN_SERVICE-indication
!msu	AAL-RECEIVED_MESSAGE-indication
!out of service	AAL-OUT_OF_SERVICE-indication
!rpo	*(remote processor outage indication)*
!rpr	*(remote processor receovered indication)*

2.3.5. Labeling of Sequence Numbers

Messages containing significant sequence numbers have the sequence numbered labeled in the test diagram. An example is illustrated below.

```
 IOT:             SP B                        SP A
 VAT:               PT                        IUT

                                              :msu
                                              :msu
                        <-FFFFFF, 000000--  DATA [   35 bytes]
                           BSN      FSN

              DATA-ACK  --FFFFFF, 000000->
                           FSN      BSN

                        <-FFFFFF, 000001--  DATA [   35 bytes]
                           BSN      FSN
                                              :set lpo
  [ 35 bytes]     DATA  --000000, 000000->
                           FSN      BSN

                        <----------------  PROCESSOR-OUTAGE
              DATA-ACK  --000000, 000001->
                           FSN      BSN
                                              :clear buffers
                                              :clear lpo
                                              :msu
                        <-FFFFFF, 000001--  PROCESSOR-RECOVERED
                           BSN      FSN

                 READY  --FFFFFF, 000001->
                           FSN      BSN
                                              :msu
                        <-FFFFFF, 000002--  DATA [   35 bytes]
                           BSN      FSN

              DATA-ACK  --FFFFFF, 000002->
                           FSN      BSN
```

Figure 2.3.5-0 illustrates the labeling of sequence numbers. The Forward Sequence Number (FSN) is always labeled closest to the SP originating the message. The Backward Sequence Number (BSN) is always labeled closest to the SP receiving the message.

Notes for §2

<1> **IMPLEMENTATION NOTE:—** The values are recommended to facilitate testing only, and do no represent a recommendation for operational networks. Operational values must be determined considering the needs of the operational network in which M2PA must function.

3. Tests

The M2PA Validation (“VAT”) and Compatibility (“CPT”) tests cases are detailed in the sections that follow. All tests cases that are applicable to M2PA are applicable to Validation testing. Selected test cases (marked as “CPT” in *Table 3-1*) are applicable to M2PA Compatibility testing. Interoperability testing at an IETF interoperability event may include some additional Validation tests in Interoperability testing, depending on the capabilities of the *MTP Level 3 Simulator*. These additional tests have been marked “IOT” in *Table 3-1*.

Table 3-1. Test Case Applicability

No.	Title	VAT	CPT	IOT
3.1.1	Initialization (Power-up)	VAT	CPT	IOT
3.1.2	Timer T2	VAT	CPT	IOT
3.1.3	Timer T3	VAT	–	–
3.1.4	Timer T1 & Timer T4 (Normal)	VAT	–	–
3.1.5	Normal alignment procedure	VAT	CPT	IOT
3.1.6	Normal alignment procedure - correct procedure (Data)	VAT	–	–
3.1.7	Status "Alignment" received during normal proving period	VAT	–	–
3.1.8	Normal alignment with PO set	VAT	–	IOT
3.1.9	Normal alignment with PO set (Data)	VAT	–	IOT
3.1.10	Normal alignment with PO set and cleared	VAT	–	IOT
3.1.11	Set RPO when "Aligned not ready"	VAT	–	–
3.1.12	Status "Out of Service" received when "Aligned not ready"	VAT	–	–
3.1.13	Status "Alignment" received when "Aligned not ready"	VAT	–	–
3.1.14	Set and clear LPO when "Initial alignment"	VAT	–	IOT
3.1.15	Set and clear LPO when "Aligned ready"	VAT	–	–
3.1.16	Timer T1 in "Aligned not ready" state	VAT	–	IOT
3.1.17	No status "Alignment" sent during normal proving period	VAT	–	–
3.1.18	Set and cease emergency prior to "start alignment"	VAT	–	–
3.1.19	Set emergency while in "not aligned" state	VAT	CPT	IOT
3.1.20	Set emergency when "aligned"	VAT	–	IOT
3.1.21	Both ends set emergency.	VAT	–	IOT
3.1.22	Individual end sets emergency	VAT	–	IOT
3.1.23	Set emergency during normal proving	VAT	–	IOT

No.	Title	VAT	CPT	IOT
3.1.24	No status "Alignment" sent during emergency alignment	VAT	–	–
3.1.25	Deactivation during initial alignment	VAT	CPT	IOT
3.1.26	Deactivation during aligned state	VAT	–	–
3.1.27	Deactivation during aligned not ready	VAT	–	IOT
3.1.28	Status "alignment" received during link in service	VAT	–	–
3.1.29	Status "out of service" received during link in service	VAT	CPT	IOT
3.1.30	Deactivation during LPO	VAT	–	IOT
3.1.31	Deactivation during RPO	VAT	–	IOT
3.1.32	Deactivation during the proving period	VAT	CPT	IOT
3.1.33	Status "Alignment" received instead of status "Ready"	VAT	–	–
3.1.34	Status "Out of Service" received instead of status "Ready"	VAT	–	–
3.1.35	Status "Processor Outage" received instead of status "Ready"	VAT	–	IOT
3.2.1	Unexpected signal units/orders in "Out of service" state	VAT	–	–
3.2.2	Unexpected signal units/orders in "Not Aligned" state	VAT	–	–
3.2.3	Unexpected signal units/orders in "Aligned" state	VAT	–	–
3.2.4	Unexpected signal units/orders in "Proving" state	VAT	–	–
3.2.5	Unexpected signal units/orders in "Aligned Ready" state	VAT	–	–
3.2.6	Unexpected signal units/orders in "Aligned Not Ready" state	VAT	–	–
3.2.7	Unexpected signal units/orders in "In Service" state	VAT	–	–
3.2.8	Unexpected signal units/orders in "Processor Outage" state	VAT	–	–
3.3.1	Link aligned ready (Abort)	VAT	–	–
3.3.2	Link aligned ready (Corrupt FIBs)	–	–	–
3.3.3	Link aligned not ready (Abort)	VAT	–	–
3.3.4	Link aligned not ready (Corrupt FIBs)	–	–	–
3.3.5	Link in service (Abort)	VAT	CPT	IOT
3.3.6	Link in service (Corrupt FIBs)	–	–	–
3.3.7	Link in processor outage (Abort)	VAT	–	IOT
3.3.8	Link in processor outage (Corrupt FIBs)	–	–	–
3.4.1	Set and clear LPO while link in service	VAT	–	IOT
3.4.2	RPO during LPO	VAT	–	IOT
3.4.3	Clear LPO when "Both processor outage"	VAT	–	IOT
3.5.1	More than 7 ones between MSU opening and closing flags	–	–	–
3.5.2	Greater than maximum signal unit length	–	–	–
3.5.3	Below minimum signal unit length	VAT	–	–
3.5.4	Reception of single and multiple flags between FISUs	–	–	–

No.	Title	VAT	CPT	IOT
3.5.5	Reception of single and multiple flags between MSUs	–	–	–
3.6.1	Error rate of 1 in 256 - Link remains in service	–	–	–
3.6.2	Error rate of 1 in 254 - Link out of service	–	–	–
3.6.3	Consecutive corrupt SUs	–	–	–
3.6.4	Time controlled break of the link	–	–	–
3.7.1	Error rate below the normal threshold	–	–	–
3.7.2	Error rate at the normal threshold	–	–	–
3.7.3	Error rate above the normal threshold	–	–	–
3.7.4	Error rate at the emergency threshold	–	–	–
3.8.1	Data transmission and reception	VAT	CPT	IOT
3.8.2	Negative acknowledgments of an MSU	–	–	–
3.8.3	Check RTB full	VAT	–	–
3.8.4	Single invalid Ack	VAT	–	–
3.8.5	Duplicated FSN	VAT	–	–
3.8.6	Erroneous retransmission - Single MSU	–	–	–
3.8.7	Erroneous retransmission - Multiple FISUs	–	–	–
3.8.8	Single FISU with corrupt FIB	VAT	–	–
3.8.9	In Service prior to RPO being set	VAT	–	IOT
3.8.10	Abnormal BSN - single Data message	VAT	–	–
3.8.11	Abnormal BSN - two consecutive messages	VAT	–	–
3.8.12	Excessive delay of acknowledgments	VAT	–	–
3.8.13	Level 3 Stop command	VAT	–	IOT
3.9.1	MSU transmission and reception	–	–	–
3.9.2	Priority control	–	–	–
3.9.3	Forced retransmission with the value N1	–	–	–
3.9.4	Forced retransmission with the value N2	–	–	–
3.9.5	Forced retransmission cancel	–	–	–
3.9.6	Reception of forced retransmission	–	–	–
3.9.7	MSU transmission while RPO set	–	–	–
3.9.8	Abnormal BSN - Single MSU	–	–	–
3.9.9	Abnormal BSN - Two MSUs	–	–	–
3.9.10	Unexpected FSN	–	–	–
3.9.11	Excessive delay of acknowledgments	–	–	–
3.9.12	FISU with FSN expected for MSU	–	–	–
3.9.13	Level 3 Stop command	–	–	–
3.10.1	Congestion abatement	VAT	–	IOT
3.10.2	Timer T7	VAT	–	–
3.10.3	Timer T6	VAT	–	–

3.1. Link State Control - Expected signal units/orders

3.1.1. Initialization (Power-up)

These tests check that the IUT enters the correct state upon establishment of the SCTP association. Establishing the association at both peers is the equivalent to the Q.703 "Power On". The correct behavior is for both M2PA peers to send a status "Out of Service" and enter the "Out of Service" state. These test cases are useful both for Validation and Compatibility testing.

3.1.1.1. Forward Direction

The test is performed in the forward direction. The expected sequence of events is illustrated in *Figure 3.1.1-1*.

Reference: Q.781/Test 1.1(a)

```
 ____________________________________________________________________
|                                                                    |
| CPT: IOT:        SP B                       SP A                   |
| VAT:               PT                       IUT                    |
|                                                                    |
|            :power on                                               |
|       OUT-OF-SERVICE  ----------------->                            |
|                                             :power on               |
|                      <-----------------     OUT-OF-SERVICE         |
| (Note) OUT-OF-SERVICE  ----------------->                          |
|                      <-----------------     OUT-OF-SERVICE (Note)  |
|                                                                    |
|____________________________________________________________________|
```

Figure 3.1.1-1. Initialization (Power-up)

Test Description:

(1) The test begins with both SP B and SP A in the "Power Off" state.

(2) The "Power On" command is issued at SP B and then SP A.

(3) Check that SP A sends a status "Out of Service" message enters and remains in the "Out of Service" state. (Note that SP A or B may send additional status "Out of Service" messages.)

(4) Repeat the test in the opposite direction as shown below.

3.1.1.2. Reverse Direction

This is the test repeated in the opposite direction. The expected sequence of events is illustrated in *Figure 3.1.1-2*.

Reference: Q.781/Test 1.1(b)

```
 ____________________________________________________________________
|                                                                    |
| CPT: IOT:        SP B                          SP A                |
| VAT:               PT                          IUT                 |
|                                                                    |
|                                                :power on           |
|                      <------------------      OUT-OF-SERVICE      |
|           :power on                                                |
|       OUT-OF-SERVICE  ------------------>                          |
|                      <------------------      OUT-OF-SERVICE (Note)|
| (Note) OUT-OF-SERVICE ------------------>                          |
|                                                                    |
|____________________________________________________________________|
```

Figure 3.1.1-2. Initialization (Power-up)

Test Description:

(1) The test begins with both SP A and SP B in the "Power Off" state.

(2) The "Power On" command is issued at SP A and then SP B.

(3) Check that SP A sends a status "Out of Service" message enters and remains in the "Out of Service" state. (Note that SP A or B may send additional status "Out of Service" messages.)

3.1.2. Timer T2

This test validates the T2 (Not Aligned) timer and procedure at the IUT. This is the duration of time that the M2PA peer will wait to receive a status "Alignment" message after sending a status "Alignment" message.

Reference: Q.781/Test 1.2

```
 CPT: IOT:        SP B                     SP A
 VAT:               PT                     IUT

                       <-----------------  OUT-OF-SERVICE
        OUT-OF-SERVICE  ----------------->
                                           :start
                       <-----------------  ALIGNMENT
 (Note) OUT-OF-SERVICE  ----------------->
                       <-----------------  ALIGNMENT (Note)
                             !
                             !  T2         5.0 <= T2 <= 150.0
                             !
                       <-----------------  OUT-OF-SERVICE
                                           !out of service(AERM)
```

Figure 3.1.2-1. Timer T2

Test Description:

(1) The test begins with both SP B and SP A in the "Out of Service" state.

(2) The "Start" command is issued at SP A.

(3) Check that SP A sends a status "Alignment" message. (Note that SP A may send additional status "Alignment" messages, and SP B may send additional status "Out of Service" messages.)

(4) Check that SP A sends a status "Out of Service" and issues an "Out of Service" indication to Level 3 with reason "Alignment Not Possible".

(5) Check that T2 is between 5.0 seconds and 150.0 seconds in duration.

(6) SP A should stay in the "Out of Service" state.

3.1.3. Timer T3

This test validates the T3 (Aligned) timer and procedure at the IUT. This is the duration of time that the M2PA peer will wait to receive a status "Proving Normal" or status "Proving Emergency" message from the M2PA peer after sending status "Proving Normal" or status "Proving Emergency". This test case is conditional on the IUT being configured for proving. The expected sequence of events is illustrated in *Figure 3.1.3-1*.

Reference: Q.781/Test 1.3

```
VAT:                PT                        IUT

                       <-----------------  OUT-OF-SERVICE
       OUT-OF-SERVICE  ----------------->
                                           :start
                       <-----------------  ALIGNMENT
               :start
            ALIGNMENT  ----------------->
                       <-----------------  PROVING-NORMAL
                              !
                              !  T3        1.0 <= T3 <= 1.5
                              !
                       <-----------------  OUT-OF-SERVICE
                                           !out of service(AERM)
```

Figure 3.1.3-1. Timer T3

Test Description:

(1) The test begins with both the PT and the IUT in the "Out of Service" state and the IUT set to perform proving.

(2) The Level 3 "Start" command is issued at the IUT.

(3) Check that the IUT sends a status "Alignment" message.

(4) Send a status "Alignment" message to the IUT.

(5) Check that the IUT response with a status "Proving Normal" message. (Note that the IUT may send additional status "Proving Normal" messages.)

(6) Check that the link goes out of service for reason "Alignment Not Possible".

(7) Check that T3 is between 1.0 seconds and 1.5 seconds in duration.

3.1.4. Timer T1 & Timer T4 (Normal)

This test validates the T4(Normal) (Proving) and T1 (Aligned Ready) timers and procedures at the IUT. T4 is the duration of time that the M2PA peer will wait to complete proving. T1 is the duration that the M2PA peer will wait to receive a status "Ready" or a status "Processor Outage" message from the M2PA peer after sending a status "Ready" or status "Processor Outage" message. This test case is condition the IUT being configured to perform proving. The expected sequence of events is illustrated in *Figure 3.1.4-1*.

Reference: Q.781/Test 1.4

```
VAT:               PT                        IUT

                         <-----------------  OUT-OF-SERVICE
       OUT-OF-SERVICE    ----------------->
                                             :start
                         <-----------------  ALIGNMENT
               :start
            ALIGNMENT    ----------------->
                         <-----------------  PROVING-NORMAL
       PROVING-NORMAL    ----------------->
                               !
                               |  T4(Pn)     7.5 <= T4 <= 9.5
                               !
                         <-----------------  READY
                         <-----------------  READY (Note)
                               !
                               !  T1         40.0 <= T1 <- 50.0
                               !
                         <-----------------  OUT-OF-SERVICE
                                             !out of service(T1)
```

Figure 3.1.4-1. Timer T1 & Timer T4 (Normal)

Test Description:

(1) The test begins with both the PT and the IUT in the "Out of Service" state and the IUT set to perform proving.

(2) The Level 3 "Start" command is issued at the IUT.

(3) Check that the IUT sends a status "Alignment" message.

(4) Send a status "Alignment" message to the IUT and exchange status "Proving Normal" messages. (Note that the IUT or PT may send additional status "Alignment" or status "Proving Normal" messages.)

(5) Check that a status "Ready" message is received from the IUT within time T4. (Note that the IUT may send additional status "Ready" messages before sending status "Out of Service".)

(6) Check that T4 is between 7.5 seconds and 9.5 seconds in duration.

(7) Check that a status "Out of Service" message is received from the IUT within time T1 and that an "Out of Service" indication is given to Level 3 at the IUT with reason "T1 Timeout".

(8) Check that T1 is between 40.0 seconds and 50.0 seconds in duration.

3.1.5. Normal alignment procedure

This test case validates the normal alignment procedure at the IUT. This is a normal successful alignment procedure which results in the link going to and staying in the "Ready" state.

3.1.5.1. Forward Direction with Proving

The test is performed in the forward direction with proving enabled at the IUT. The expected sequence of events is illustrated in *Figure 3.1.5-1*.

Reference: Q.781/Test 1.5(a)

```
CPT: IOT:        SP B                          SP A
VAT:               PT                          IUT

                        <-----------------     OUT-OF-SERVICE
       OUT-OF-SERVICE   ----------------->
                                               :start
                        <-----------------     ALIGNMENT
              :start
            ALIGNMENT   ----------------->
                        <-----------------     PROVING-NORMAL
       PROVING-NORMAL   ----------------->
                        <-----------------     READY
                READY   ----------------->
                                               !in service
```

Figure 3.1.5-1. Normal alignment procedure

Test Description:

(1) The test begins with the link "Out of Service" and SP A set to perform proving.

(2) The Level 3 "Start" command is issued at SP A and SP B.

(3) Check that SP A sends the message sequence illustrated in *Figure 3.1.5-1*. (Note that SP A or SP B may send additional status "Proving Normal" messages.)

(4) Check that SP A sends a status "Ready" message and indicates "In Service" to Level 3.

(5) Check that the link maintains the "In Service" state.

3.1.5.2. Reverse Direction with Proving

This test is performed in the reverse direction with proving enabled at the IUT.

The equivalent Q.781 test case is normally repeated with with 2-byte LSSUs instead of 1-byte LSSUs when testing Q.703 links. The effect of sending 2-byte LSSUs is simulated by adding a "filler" to the status message. The expected sequence of events is illustrated in *Figure 3.1.5-2*.

Reference: Q.781/Test 1.5(b)

```
 CPT:               SP B                        SP A
 VAT:                 PT                        IUT

                          <-----------------  OUT-OF-SERVICE
        OUT-OF-SERVICE    ----------------->
                                              :start
                          <-----------------  ALIGNMENT
                :start
             ALIGNMENT    ----------------->
                          <-----------------  PROVING-NORMAL
        PROVING-NORMAL    ----------------->
                          <-----------------  READY
                 READY    ----------------->
                                              !in service
```

Figure 3.1.5-2. Normal alignment procedure

Test Description:

(1) The test begins with the link "Out of Service" and SP A set to perform proving.

(2) The Level 3 "Start" command is issued at SP A and SP B.

(3) Check that SP A sends the message sequence illustrated in *Figure 3.1.5-2*. (Note that SP A or B may send additional status "Alignment" or status "Proving Normal" messages.)

(4) Check that SP A sends a status "Ready" message and indicates "In Service" to Level 3.

(5) Check that the link maintains the "In Service" state.

3.1.5.3. Forward Direction without Proving

This test is performed in the forward direction with proving disabled at the IUT. This test is only applicable if the IUT supports suppression of the proving period. The expected sequence of events is illustrated in *Figure 3.1.5-3*.

Reference: Q.781/Test 1.5(a)

```
 ____________________________________________________________________
|                                                                    |
| CPT:             SP B                      SP A                    |
| VAT:               PT                      IUT                     |
|                                                                    |
|                       <------------------  OUT-OF-SERVICE          |
|       OUT-OF-SERVICE  ------------------>                          |
|                                            :start                  |
|                       <------------------  ALIGNMENT               |
|               :start                                               |
|            ALIGNMENT  ------------------>                          |
|                       <------------------  READY                   |
|                READY  ------------------>                          |
|                                            !in service             |
|                                                                    |
|____________________________________________________________________|
```

Figure 3.1.5-3. Normal alignment procedure (without proving)

Test Description:

(1) The test begins with the link "Out of Service" and SP A set to not perform proving.

(2) The Level 3 "Start" command is issued at SP A and SP B.

(3) Check that SP A sends the message sequence illustrated in *Figure 3.1.5-3*.

(4) Check that SP A sends a status "Ready" message and indicates "In Service" to Level 3.

(5) Check that the link maintains the "In Service" state.

3.1.5.4. Reverse Direction without Proving

This test is performed in the reverse direction with proving disabled at the IUT. This test is only applicable if the IUT supports suppression of the proving period. The expected sequence of events is illustrated in *Figure 3.1.5-4*.

Reference: Q.781/Test 1.5(b)

```
CPT:              SP B                          SP A
VAT:                PT                          IUT

                        <-----------------  OUT-OF-SERVICE
       OUT-OF-SERVICE   ----------------->
                                            :start
                        <-----------------  ALIGNMENT
               :start
            ALIGNMENT   ----------------->
                        <-----------------  READY
                READY   ----------------->
                                            !in service
```

Figure 3.1.5-4. Normal alignment procedure (without proving)

Test Description:

(1) The test begins with the link "Out of Service" and SP A set to not perform proving.

(2) The Level 3 "Start" command is issued at SP A and SP B.

(3) Check that SP A sends the message sequence illustrated in *Figure 3.1.5-4*.

(4) Check that SP A sends a status "Ready" message and indicates "In Service" to Level 3.

(5) Check that the link maintains the "In Service" state.

3.1.6. Normal alignment procedure - correct procedure (Data)

The test case validates the normal alignment procedure at the IUT when a DATA message is used instead of a status "Ready" to complete the alignment procedure.

3.1.6.1. Correct Procedure (Data) with Proving

This test is performed with the IUT set for proving. The expected sequence of events is illustrated in *Figure 3.1.6-1*.

Reference: Q.781/Test 1.6

```
 VAT:                PT                        IUT

                         <-----------------  OUT-OF-SERVICE
        OUT-OF-SERVICE   ----------------->
                                             :start
                         <-----------------  ALIGNMENT
                :start
             ALIGNMENT   ----------------->
                         <-----------------  PROVING-NORMAL
        PROVING-NORMAL   ----------------->
                         <-----------------  READY
  [ 35 bytes]     DATA   --000000, FFFFFF->
                         <-000000, FFFFFF--  DATA-ACK
                                             !in service
                                             !msu
```

Figure 3.1.6-1. Normal alignment procedure (Data) with proving

Test Description:

(1) The test begins with the link "Out of Service" and the IUT set to perform proving.

(2) The Level 3 "Start" command is issued at the IUT and the PT.

(3) Check that the IUT sends the message sequence illustrated in *Figure 3.1.6-1*. (Note that the IUT may send additional status "Out of Service," status "Alignment" or status "Proving Normal" messages.)

(4) Check that the IUT sends a status "Ready" message and indicates "In Service" to Level 3.

(5) Check that the IUT acknowledges the Data message with a "Data Ack" message.

(6) The IUT should maintain the "In Service" state.

3.1.6.2. Correct Procedure (Data) without Proving

This test is performed with the IUT set to disable proving. This test is only applicable if the IUT supports suppression of the proving period. The expected sequence of events is illustrated in *Figure 3.1.6-2*.

Reference: Q.781/Test 1.6

```
 VAT:               PT                        IUT

                         <-----------------  OUT-OF-SERVICE
        OUT-OF-SERVICE   ----------------->
                                             :start
                         <-----------------  ALIGNMENT
                :start
             ALIGNMENT   ----------------->
                         <-----------------  READY
  [ 35 bytes]     DATA   --000000, FFFFFF->
                         <-000000, FFFFFF--  DATA-ACK
                                             !in service
                                             !msu
```

Figure 3.1.6-2. Normal alignment procedure (Data) without proving

Test Description:

(1) The test begins with the link "Out of Service" and the IUT set to not perform proving.

(2) The Level 3 "Start" command is issued at the IUT and the PT.

(3) Check that the IUT sends the message sequence illustrated in *Figure 3.1.6-2*.

(4) Check that the IUT sends a status "Ready" message and indicates "In Service" to Level 3.

(5) Check that the IUT acknowledges the Data message with a "Data Ack" message.

(6) The IUT should maintain the "In Service" state.

3.1.7. Status "Alignment" received during normal proving period

This test case validates that the IUT restarts the alignment and proving procedure when receiving a status "Alignment" message in the "Proving" state. The expected sequence of events is illustrated in *Figure 3.1.7-1*.

Reference: Q.781/Test 1.7

```
 VAT:                PT                       IUT

                          <-----------------  OUT-OF-SERVICE
        OUT-OF-SERVICE    ----------------->
                                              :start
                          <-----------------  ALIGNMENT
                          <-----------------  PROVING-NORMAL
                 :start
             ALIGNMENT    ----------------->
                          <-----------------  PROVING-NORMAL
        PROVING-NORMAL    ----------------->
                                !
                                !
             ALIGNMENT    ----------------->
                          <-----------------  PROVING-NORMAL
        PROVING-NORMAL    ----------------->
                                !
                                !  T4(Pn)     7.5 <= T4 <= 9.5
                                !
                          <-----------------  READY
```

Figure 3.1.7-1. "Alignment" during normal proving

Test Description:

(1) The test begins with the link in the "Out of Service" state and the IUT set to perform proving.

(2) Issue the Level 3 "Start" command at the IUT and the PT.

(3) When normal proving begins, wait for half the duration of T4 and then send the IUT a status "Alignment" message.

(4) Check that the IUT restarts the proving period and sends a status "Ready" message T4 after the last status "Alignment" message was sent to the IUT. (Note that the IUT may send additional status "Out of Service," "Alignment" or "Proving Normal" messages.)

(5) Check that T4(Pn) is between 7.5 seconds and 9.5 seconds in duration.

3.1.8. Normal alignment with PO set

This case tests the normal alignment procedure where one M2PA peer is experiencing a local processor outage before and during alignment. The M2PA peers should still align and the link should go into service at Level 3.

3.1.8.1. Forward Direction with Proving

The test is performed in the forward direction. The expected sequence of events is illustrated in *Figure 3.1.8-1*.

Reference: Q.781/Test 1.8(a)

```
 IOT:             SP B                       SP A
 VAT:               PT                       IUT

                         <-----------------  OUT-OF-SERVICE
        OUT-OF-SERVICE   ----------------->
                                             :set lpo
                                             :start
                         <-----------------  ALIGNMENT
                :start
             ALIGNMENT   ----------------->
                         <-----------------  PROVING-NORMAL
        PROVING-NORMAL   ----------------->
                         <-----------------  PROCESSOR-OUTAGE
                 READY   ----------------->
                  !rpo
```

Figure 3.1.8-1. Normal alignment with PO set

Test Description:

(1) The test begins with the link in the "Out of Service" state and SP A set to perform proving.

(2) Issue the Level 3 "Set Local Processor Outage" and "Start" commands at SP A and the "Start" command at SP B.

(3) Check that SP A sends the message sequence illustrated in *Figure 3.1.8-1*. (Note that SP A or B may send additional status "Out of Service," "Alignment" or "Proving Normal" messages.)

(4) Check that SP A sends status "Processor Outage" message.

(5) Check that the link maintains the "Processor Outage" state at SP A.

3.1.8.2. Reverse Direction with Proving

This case is the same test in the reverse direction. The expected sequence of events is illustrated in *Figure 3.1.8-2*.

Reference: Q.781/Test 1.8(b)

```
 IOT:              SP B                         SP A
 VAT:                PT                         IUT

                         <------------------  OUT-OF-SERVICE
        OUT-OF-SERVICE   ------------------>
               :set lpo
                 :start
                                              :start
                         <------------------  ALIGNMENT
             ALIGNMENT   ------------------>
                         <------------------  PROVING-NORMAL
        PROVING-NORMAL   ------------------>
                         <------------------  READY
      PROCESSOR-OUTAGE   ------------------>
                                              !rpo
```

Figure 3.1.8-2. Normal alignment with PO set

Test Description:

(1) The test begins with the link in the "Out of Service" state and SP A set to perform proving.

(2) Issue the Level 3 "Local Processor Outage" and "Start" command at SP B and the "Start" command at SP A.

(3) Check that SP A sends the message sequence illustrated in *Figure 3.1.8-2*. (Note that SP A or B may send additional status "Out of Service," "Alignment" or "Proving Normal" messages.)

(4) Check that SP A sends status "Ready" message and indicates "Remote Processor Outage" indication to Level 3.

(5) Check that the link maintains the "Processor Outage" state at SP A.

3.1.8.3. Forward Direction without Proving

The test is performed in the forward direction with the IUT set to not perform proving. This test is only applicable if the IUT supports suppression of the proving period. The expected sequence of events is illustrated in *Figure 3.1.8-3*.

Reference: Q.781/Test 1.8(a)

```
 _____________________________________________________________________
|                                                                     |
| IOT:              SP B                      SP A                    |
| VAT:                PT                      IUT                     |
|                                                                     |
|                        <-----------------  OUT-OF-SERVICE           |
|       OUT-OF-SERVICE  ----------------->                            |
|                                             :set lpo                |
|                                             :start                  |
|                        <-----------------  ALIGNMENT                |
|                :start                                               |
|             ALIGNMENT  ----------------->                            |
|                        <-----------------  PROCESSOR-OUTAGE         |
|                 READY  ----------------->                            |
|                  !rpo                                               |
|                                                                     |
|_____________________________________________________________________|
```

Figure 3.1.8-3. Normal alignment with PO set

Test Description:

(1) The test begins with the link in the "Out of Service" state and SP A set to not perform proving.

(2) Issue the Level 3 "Set Local Processor Outage" and "Start" commands at SP A and the "Start" command at SP B.

(3) Check that SP A sends the message sequence illustrated in *Figure 3.1.8-3*.

(4) Check that SP A sends status "Processor Outage" message.

(5) Check that the link maintains the "Processor Outage" state at SP A.

3.1.8.4. Reverse Direction without Proving

This case is the same test in the reverse direction. with the IUT set to not perform proving. This test is only applicable if the IUT supports suppression of the proving period. The expected sequence of events is illustrated in *Figure 3.1.8-4*.

Reference: Q.781/Test 1.8(b)

```
 ____________________________________________________________________
|                                                                    |
| IOT:             SP B                        SP A                  |
| VAT:               PT                        IUT                   |
|                                                                    |
|                       <------------------  OUT-OF-SERVICE          |
|        OUT-OF-SERVICE  ------------------>                         |
|              :set lpo                                              |
|                :start                                              |
|                                            :start                  |
|                       <------------------  ALIGNMENT               |
|             ALIGNMENT  ------------------>                         |
|                       <------------------  READY                   |
|      PROCESSOR-OUTAGE  ------------------>                         |
|                                            !rpo                    |
|                                                                    |
|____________________________________________________________________|
```

Figure 3.1.8-4. Normal alignment with PO set

Test Description:

(1) The test begins with the link in the "Out of Service" state and SP A set to not perform proving.

(2) Issue the Level 3 "Local Processor Outage" and "Start" command at SP B and the "Start" command at SP A.

(3) Check that SP A sends the message sequence illustrated in *Figure 3.1.8-4*.

(4) Check that SP A sends status "Ready" message and indicates "Remote Processor Outage" indication to Level 3.

(5) Check that the link maintains the "Remote Processor Outage" state at SP A.

3.1.9. Normal alignment with PO set (Data)

This test case validates the normal alignment procedure at the IUT in the "Processor Outage" state when a Data message is used instead of an "Ready" message to complete the alignment procedure.

3.1.9.1. Forward Direction with Proving

The test is performed in the forward direction. The expected sequence of events is illustrated in *Figure 3.1.9-1*.

Reference: Q.781/Test 1.9(a)

```
 IOT:             SP B                        SP A
 VAT:               PT                        IUT

                      <------------------  OUT-OF-SERVICE
        OUT-OF-SERVICE  ------------------>
                                           :set lpo
                                           :start
                      <------------------  ALIGNMENT
             ALIGNMENT  ------------------>
                      <------------------  PROVING-NORMAL
        PROVING-NORMAL  ------------------>
                      <------------------  PROCESSOR-OUTAGE
  [ 35 bytes]     DATA  --000000, FFFFFF->
```

Figure 3.1.9-1. Normal alignment with PO set (Data)

Test Description:

(1) The test begins with the link in the "Out of Service" state with SP A set to perform proving.

(2) Issue the Level 3 "Set Local Processor Outage" and "Start" commands at SP A.

(3) Check that SP A sends the message sequence illustrated in *Figure 3.1.9-1*. (Note that SP A or B may send additional status "Out of Service," "Alignment" or "Proving Normal" messages.)

(4) Check that SP A sends status "Processor Outage" message and send a Data message to SP A to complete the alignment procedure.

(5) Check that SP A does not acknowledge the Data message.

(6) Check that SP A maintains the "Processor Outage" state.

3.1.9.2. Reverse Direction with Proving

This is the same test in the reverse direction. The expected sequence of events is illustrated in *Figure 3.1.9-2*.

Reference: Q.781/Test 1.9(b)

```
 IOT:              SP B                        SP A
 VAT:                PT                        IUT

                         <-----------------  OUT-OF-SERVICE
        OUT-OF-SERVICE   ----------------->
              :set lpo
                :start
                                             :start
                         <-----------------  ALIGNMENT
             ALIGNMENT   ----------------->
                         <-----------------  PROVING-NORMAL
                                             :msu
        PROVING-NORMAL   ----------------->
                         <-FFFFFF, 000000--  DATA [   35 bytes]
      PROCESSOR-OUTAGE   ----------------->
                                             !rpo
```

Figure 3.1.9-2. Normal alignment with PO set (Data)

Test Description:

(1) The test begins with the link in the "Out of Service" state with SP A set to perform proving.

(2) Issue the Level 3 "Set Local Processor Outage" and "Start" commands at SP B and the "Start" command at SP A.

(3) Provide an MSU for transmission at SP A before the proving period ends.

(4) Check that SP A sends the message sequence illustrated in *Figure 3.1.9-2*. (Note that SP A or B may send additional status "Out of Service," "Alignment" or "Proving Normal" messages.)

(5) Check that SP A completes the proving process with the MSU and indicates "Remote Processor Outage" to Level 3.

(6) Check that SP A maintains the "Processor Outage" state and does not require acknowledgment of the Data message used to complete alignment.

3.1.9.3. Forward Direction without Proving

The test is performed in the forward direction with the IUT set to not perform proving. This test is only applicable if the IUT supports suppression of the proving period. The expected sequence of events is illustrated in *Figure 3.1.9-3*.

Reference: Q.781/Test 1.9(a)

```
 ____________________________________________________________________
|                                                                    |
| IOT:              SP B                      SP A                   |
| VAT:                PT                      IUT                    |
|                                                                    |
|                        <-----------------  OUT-OF-SERVICE          |
|       OUT-OF-SERVICE  ----------------->                           |
|                                            :set lpo                |
|                                            :start                  |
|                        <-----------------  ALIGNMENT               |
|            ALIGNMENT  ----------------->                           |
|                        <-----------------  PROCESSOR-OUTAGE        |
|  [ 35 bytes]     DATA  --000000, FFFFFF->                          |
|                                                                    |
|____________________________________________________________________|
```

Figure 3.1.9-3. Normal alignment with PO set (Data)

Test Description:

(1) The test begins with the link in the "Out of Service" state with SP A set to not perform proving.

(2) Issue the Level 3 "Set Local Processor Outage" and "Start" commands at SP A.

(3) Check that SP A sends the message sequence illustrated in *Figure 3.1.9-3*.

(4) Check that SP A sends status "Processor Outage" message and send a Data message to SP A to complete the alignment procedure.

(5) Check that SP A does not acknowledge the Data message.

(6) Check that SP A maintains the "Processor Outage" state.

3.1.9.4. Reverse Direction without Proving

This is the same test in the reverse direction with the IUT set to not perform proving. This test is only applicable if the IUT supports suppression of the proving period. The expected sequence of events is illustrated in *Figure 3.1.9-4*.

Reference: Q.781/Test 1.9(b)

```
 IOT:            SP B                      SP A
 VAT:              PT                      IUT

                      <------------------  OUT-OF-SERVICE
       OUT-OF-SERVICE ------------------>
             :set lpo
               :start
                                           :start
                      <------------------  ALIGNMENT
            ALIGNMENT ------------------>
                                           :msu
                      <-FFFFFF, 000000--   DATA [   35 bytes]
     PROCESSOR-OUTAGE ------------------>
                                           !rpo
```

Figure 3.1.9-4. Normal alignment with PO set (Data)

Test Description:

(1) The test begins with the link in the "Out of Service" state with SP A set to not perform proving.

(2) Issue the Level 3 "Set Local Processor Outage" and "Start" commands at SP B and the "Start" command at SP A.

(3) Provide an MSU for transmission at SP A before the proving period ends.

(4) Check that SP A sends the message sequence illustrated in *Figure 3.1.9-4*.

(5) Check that SP A completes the proving process with the MSU and indicates "Remote Processor Outage" to Level 3.

(6) Check that SP A maintains the "Processor Outage" state and does not require acknowledgment of the Data message used to complete alignment.

3.1.10. Normal alignment with PO set and cleared

This case tests that if the local processor outage condition is set and cleared before the alignment procedure starts that normal alignment is performed and no status "Processor Outage" message is sent to the M2PA peer.

3.1.10.1. PO set and cleared with Proving

This test is performed with proving set at the IUT. The expected sequence of events is illustrated in *Figure 3.1.10-1*.

Reference: Q.781/Test 1.10

```
 ____________________________________________________________________
|                                                                    |
| IOT:             SP B                     SP A                     |
| VAT:               PT                     IUT                      |
|                                                                    |
|                      <-----------------  OUT-OF-SERVICE            |
|       OUT-OF-SERVICE  ----------------->                           |
|                                          :set lpo                  |
|                                          :clear lpo                |
|                                          :start                    |
|                      <-----------------  ALIGNMENT                 |
|               :start                                               |
|            ALIGNMENT  ----------------->                           |
|                      <-----------------  PROVING-NORMAL            |
|       PROVING-NORMAL  ----------------->                           |
|                      <-----------------  READY                     |
|                READY  ----------------->                           |
|                                          !in service               |
|                                                                    |
|____________________________________________________________________|
```

Figure 3.1.10-1. Normal alignment with PO set and cleared

Test Description:

(1) The test begins with the link in the "Out of Service" state with SP A set to perform proving.

(2) Issue the Level 3 "Set Local Processor Outage," "Clear Local Processor Outage" and "Start" commands at SP A and "Start" command at SP B.

(3) Check that the sequence of events follows that illustrated in *Figure 3.1.10-1*. (Note that SP A or B may send additional status "Out of Service," "Alignment" or "Proving Normal" messages.)

(4) Check that SP A completes the alignment procedure and sends the status "Ready" message and indicates "In Service" to Level 3.

3.1.10.2. PO set and cleared without Proving

This test is performed with proving disabled at the IUT. This test is only applicable if the IUT supports suppression of the proving period. The expected sequence of events is illustrated in *Figure 3.1.10-2*.

Reference: Q.781/Test 1.10

```
 IOT:              SP B                        SP A
 VAT:                PT                        IUT

                         <------------------  OUT-OF-SERVICE
        OUT-OF-SERVICE   ------------------>
                                               :set lpo
                                               :clear lpo
                                               :start
                         <------------------  ALIGNMENT
                :start
             ALIGNMENT   ------------------>
                         <------------------  READY
                 READY   ------------------>
                                               !in service
```

Figure 3.1.10-2. Normal alignment with PO set and cleared

Test Description:

(1) The test begins with the link in the "Out of Service" state with SP A set to not perform proving.

(2) Issue the Level 3 "Set Local Processor Outage," "Clear Local Processor Outage" and "Start" commands at SP A and "Start" command at SP B.

(3) Check that the sequence of events follows that illustrated in *Figure 3.1.10-2*.

(4) Check that SP A completes the alignment procedure and sends the status "Ready" message and indicates "In Service" to Level 3.

3.1.11. Set RPO when "Aligned not ready"

This test case validates the behavior of the IUT when processor outage condition is set at both the PT and the IUT.

3.1.11.1. Forward Direction with Proving

This test is performed in the forward direction with the IUT set to perform proving. The expected sequence of events is illustrated in *Figure 3.1.11-1*.

Reference: Q.781/Test 1.11

```
 VAT:               PT                        IUT

                          <-----------------  OUT-OF-SERVICE
        OUT-OF-SERVICE    ----------------->
              :set lpo
                                              :set lpo
                                              :start
                          <-----------------  ALIGNMENT
                :start
             ALIGNMENT    ----------------->
                          <-----------------  PROVING-NORMAL
        PROVING-NORMAL    ----------------->
                          <-----------------  PROCESSOR-OUTAGE
      PROCESSOR-OUTAGE    ----------------->
                                              !rpo
```

Figure 3.1.11-1. Set RPO when "Aligned Not Ready"

Test Description:

(1) The test begins with the link in the "Out of Service" state with the IUT set to perform proving.

(2) Issue the Level 3 "Set Local Processor Outage" and "Start" commands at the IUT and PT.

(3) Check that the alignment procedure follows the sequence of events illustrated in *Figure 3.1.11-1*. (Note that the IUT may send additional status "Out of Service," "Alignment" or "Proving Normal" messages.)

(4) Check that the IUT sends status "Processor Outage" and indicates "Remote Processor Outage" to Level 3.

3.1.11.2. Forward Direction without Proving

This test is performed in the forward direction with the IUT set to not perform proving. This test is only applicable if the IUT supports suppression of the proving period. The expected sequence of events is illustrated in *Figure 3.1.11-2*.

Reference: Q.781/Test 1.11

```
VAT:                PT                         IUT

                        <-----------------  OUT-OF-SERVICE
       OUT-OF-SERVICE  ----------------->
             :set lpo
                                            :set lpo
                                            :start
                        <-----------------  ALIGNMENT
               :start
            ALIGNMENT  ----------------->
                        <-----------------  PROVING-NORMAL
       PROVING-NORMAL  ----------------->
                        <-----------------  PROCESSOR-OUTAGE
     PROCESSOR-OUTAGE  ----------------->
                                            !rpo
```

Figure 3.1.11-2. Set RPO when "Aligned Not Ready"

Test Description:

(1) The test begins with the link in the "Out of Service" state with the IUT set to not perform proving.

(2) Issue the Level 3 "Set Local Processor Outage" and "Start" commands at the IUT and PT.

(3) Check that the alignment procedure follows the sequence of events illustrated in *Figure 3.1.11-2*. (Note that the IUT may send additional status "Out of Service," "Alignment" or "Proving Normal" messages.)

(4) Check that the IUT sends status "Processor Outage" and indicates "Remote Processor Outage" to Level 3.

3.1.12. Status "Out of Service" received when "Aligned not ready"

These test cases validate the behavior of the IUT when it receives a status "Out of Service" message in the "Aligned Not Ready" state or sends a Status "Out of Service" message when the M2PA peer is in the "Aligned Not Ready" state.

3.1.12.1. Forward Direction with Proving

The test is performed in the forward direction with the IUT set to perform proving. The expected sequence of events is illustrated in *Figure 3.1.12-1*.

Reference: Q.781/Test 1.12(a)

```
 ____________________________________________________________________
|                                                                    |
| VAT:               PT                       IUT                    |
|                                                                    |
|                       <-----------------  OUT-OF-SERVICE           |
|        OUT-OF-SERVICE  ----------------->                          |
|                                            :set lpo                 |
|                                            :start                   |
|                       <-----------------  ALIGNMENT                |
|                :start                                              |
|             ALIGNMENT  ----------------->                          |
|                       <-----------------  PROVING-NORMAL           |
|        PROVING-NORMAL  ----------------->                          |
|                       <-----------------  PROCESSOR-OUTAGE         |
|                 :stop                                              |
|        OUT-OF-SERVICE  ----------------->                          |
|                       <-----------------  OUT-OF-SERVICE           |
|                                            !out of service(SIOS)    |
|                                                                    |
|____________________________________________________________________|
```

Figure 3.1.12-1. "Out of Service" when "Aligned not ready"

Test Description:

(1) The test begins with the link in the "Out of Service" state with the IUT set to perform proving.

(2) Issue the Level 3 "Set Local Processor Outage" and "Start" commands at the IUT and the "Start" command at the PT.

(3) Check that the IUT follows the sequence of events illustrated in *Figure 3.1.12-1*. (Note that the IUT may send additional status "Out of Service," "Alignment" or "Proving Normal" messages.)

(4) Check that the IUT sends a status "Processor Outage" message when it completes the initial alignment procedure and issue a Level 3 "Stop" command at the PT.

(5) Check that the IUT sends status "Out of Service" and indicates "Out of Service" to Level 3 with the reason "Received SIOS".

3.1.12.2. Reverse Direction with Proving

The test is repeated in the reverse direction with the IUT set to perform proving. The expected sequence of events is illustrated in *Figure 3.1.12-2*.

Reference: Q.781/Test 1.12(b)

```
 ______________________________________________________________________
|                                                                      |
| VAT:              PT                      IUT                        |
|                                                                      |
|                      <-----------------  OUT-OF-SERVICE              |
|       OUT-OF-SERVICE  ----------------->                             |
|             :set lpo                                                 |
|               :start                                                 |
|                                          :start                      |
|                      <-----------------  ALIGNMENT                   |
|               :start                                                 |
|            ALIGNMENT  ----------------->                             |
|                      <-----------------  PROVING-NORMAL              |
|       PROVING-NORMAL  ----------------->                             |
|                      <-----------------  READY                       |
|                                          :stop                       |
|     PROCESSOR-OUTAGE  ----------------->                             |
|                      <-----------------  OUT-OF-SERVICE              |
|                                                                      |
|______________________________________________________________________|
```

Figure 3.1.12-2. "Out of Service" when "Aligned not ready"

Test Description:

(1) The test begins with the link in the "Out of Service" state with the IUT set to perform proving.

(2) Issue the Level 3 "Start" command at the IUT and the PT.

(3) Check that the sequence of events follows those illustrated in *Figure 3.1.12-2*. (Note that the IUT may send additional status "Out of Service," "Alignment" or "Proving Normal" messages.)

(4) When the IUT goes to the "In Service" state, issue the Level 3 "Stop" command at the IUT.

(5) Check that the IUT sends the status "Out of Service" message.

3.1.12.3. Forward Direction without Proving

The test is performed in the forward direction with the IUT set to disable proving. This test is only applicable if the IUT supports suppression of the proving period. The expected sequence of events is illustrated in *Figure 3.1.12-3*.

Reference: Q.781/Test 1.12(a)

```
 ____________________________________________________________________
|                                                                    |
| VAT:               PT                       IUT                    |
|                                                                    |
|                         <-----------------  OUT-OF-SERVICE         |
|        OUT-OF-SERVICE   ----------------->                         |
|                                             :set lpo                |
|                                             :start                  |
|                         <-----------------  ALIGNMENT              |
|                :start                                              |
|             ALIGNMENT   ----------------->                         |
|                         <-----------------  PROCESSOR-OUTAGE       |
|                 :stop                                              |
|        OUT-OF-SERVICE   ----------------->                         |
|                         <-----------------  OUT-OF-SERVICE         |
|                                             !out of service(SIOS)  |
|                                                                    |
|____________________________________________________________________|
```

Figure 3.1.12-3. "Out of Service" when "Aligned not ready"

Test Description:

(1) The test begins with the link in the "Out of Service" state with the IUT set to not perform proving.

(2) Issue the Level 3 "Set Local Processor Outage" and "Start" commands at the IUT and the "Start" command at the PT.

(3) Check that the IUT follows the sequence of events illustrated in *Figure 3.1.12-3*.

(4) Check that the IUT sends a status "Processor Outage" message when it completes the initial alignment procedure and issue a Level 3 "Stop" command at the PT.

(5) Check that the IUT sends status "Out of Service" and indicates "Out of Service" to Level 3 with the reason "Received SIOS".

3.1.12.4. Reverse Direction without Proving

The test is repeated in the reverse direction with the IUT set to disable proving. This test is only applicable if the IUT supports suppression of the proving period. The expected sequence of events is illustrated in *Figure 3.1.12-4*.

Reference: Q.781/Test 1.12(b)

```
 ____________________________________________________________________
|                                                                    |
| VAT:                PT                         IUT                 |
|                                                                    |
|                        <-----------------  OUT-OF-SERVICE          |
|        OUT-OF-SERVICE  ----------------->                          |
|              :set lpo                                              |
|                :start                                              |
|                                            :start                   |
|                        <-----------------  ALIGNMENT               |
|                :start                                              |
|             ALIGNMENT  ----------------->                          |
|                        <-----------------  READY                   |
|                                            :stop                    |
|                 READY  ----------------->                          |
|                        <-----------------  OUT-OF-SERVICE          |
|                                                                    |
|____________________________________________________________________|
```

Figure 3.1.12-4. "Out of Service" when "Aligned not ready"

Test Description:

(1) The test begins with the link in the "Out of Service" state with the IUT set to not perform proving.

(2) Issue the Level 3 "Start" command at the IUT and the PT.

(3) Check that the sequence of events follows those illustrated in *Figure 3.1.12-4*.

(4) When the IUT goes to the "In Service" state, issue the Level 3 "Stop" command at the IUT.

(5) Check that the IUT sends the status "Out of Service" message.

3.1.13. Status "Alignment" received when "Aligned not ready"

This test case validates the behavior of the IUT when it receives a status "Alignment" message in the "Aligned Not Ready" state.

3.1.13.1. Forward Direction with Proving

This test is performed with the IUT set to perform proving. The expected sequence of events is illustrated in *Figure 3.1.13-1*.

Reference: Q.781/Test 1.13

```
 ____________________________________________________________________
|                                                                    |
| VAT:              PT                     IUT                       |
|                                                                    |
|                      <-----------------  OUT-OF-SERVICE            |
|        OUT-OF-SERVICE  ----------------->                          |
|                                          :set lpo                   |
|                                          :start                     |
|                      <-----------------  ALIGNMENT                 |
|                :start                                              |
|             ALIGNMENT  ----------------->                          |
|                      <-----------------  PROVING-NORMAL            |
|        PROVING-NORMAL  ----------------->                          |
|                      <-----------------  PROCESSOR-OUTAGE          |
|             ALIGNMENT  ----------------->                          |
|                      <-----------------  OUT-OF-SERVICE            |
|                                          !out of service(SIO)      |
|        OUT-OF-SERVICE  ----------------->                          |
|                                                                    |
|____________________________________________________________________|
```

Figure 3.1.13-1. "Alignment" when "Aligned not ready"

Test Description:

(1) The test begins with the link in the "Out of Service" state with the IUT set to perform proving.

(2) Issue the Level 3 "Set Local Processor Outage" and "Start" commands at the IUT and "Start" command at the PT.

(3) Check that the sequence of events follows the normal alignment procedure illustrated in *Figure 3.1.13-1*. (Note that the IUT may send additional status "Out of Service," "Alignment" or "Proving Normal" messages.)

(4) When the IUT sends the status "Processor Outage" message, send a status "Alignment" message to the IUT.

(5) Check that the IUT sends the status "Out of Service" message and indicates "Out of Service" to Level 3 with reason "Received SIO".

3.1.13.2. Forward Direction without Proving

This test is performed with the IUT set to disable proving. This test is only applicable if the IUT supports suppression of the proving period. The expected sequence of events is illustrated in *Figure 3.1.13-2*.

Reference: Q.781/Test 1.13

```
 VAT:              PT                       IUT

                        <-----------------  OUT-OF-SERVICE
        OUT-OF-SERVICE  ----------------->
                                            :set lpo
                                            :start
                        <-----------------  ALIGNMENT
                :start
             ALIGNMENT  ----------------->
                        <-----------------  PROCESSOR-OUTAGE
             ALIGNMENT  ----------------->
                        <-----------------  OUT-OF-SERVICE
                                            !out of service(SIO)
        OUT-OF-SERVICE  ----------------->
```

Figure 3.1.13-2. "Alignment" when "Aligned not ready"

Test Description:

(1) The test begins with the link in the "Out of Service" state with the IUT set to not perform proving.

(2) Issue the Level 3 "Set Local Processor Outage" and "Start" commands at the IUT and "Start" command at the PT.

(3) Check that the sequence of events follows the normal alignment procedure illustrated in *Figure 3.1.13-2*.

(4) When the IUT sends the status "Processor Outage" message, send a status "Alignment" message to the IUT.

(5) Check that the IUT sends the status "Out of Service" message and indicates "Out of Service" to Level 3 with reason "Received SIO".

3.1.14. Set and clear LPO when "Initial alignment"

This test case validates the behavior of the IUT when it receives Level 3 "Set Local Processor Outage" and "Clear Local Processor Outage" commands in the "Initial Alignment" state. The expected sequence of events is illustrated in *Figure 3.1.14-1*.

Reference: Q.781/Test 1.14

```
 IOT:              SP B                       SP A
 VAT:                PT                       IUT

                        <------------------  OUT-OF-SERVICE
       OUT-OF-SERVICE  ------------------>
                                              :start
                        <------------------  ALIGNMENT
               :start
           ALIGNMENT   ------------------>
                        <------------------  PROVING-NORMAL
                                              :set lpo
       PROVING-NORMAL  ------------------>
                                              :clear lpo
                        <------------------  READY
                READY  ------------------>
                                              !in service
```

Figure 3.1.14-1. Set and clear LPO when "Initial Alignment"

Test Description:

(1) The test begins with the link in the "Out of Service" state with SP A set to perform proving.

(2) Issue the Level 3 "Start" command at SP A and SP B.

(3) Check that SP A follows the normal alignment procedure and sequence of events illustrated in *Figure 3.1.14-1*. (Note that SP A or B may send additional status "Out of Service," "Alignment" or "Proving Normal" messages.)

(4) Issue the Level 3 "Set Local Processor Outage" command at SP A when SP A begins initial alignment.

(5) Issue the Level 3 "Clear Local Processor Outage" command at SP A before SP A completes initial alignment.

(6) Check that SP A sends the status "Ready" message when it completes initial alignment and that the "In Service" indication is given to Level 3 at SP A.

3.1.15. Set and clear LPO when "Aligned ready"

This test case validates the behavior of the IUT when it receives the Level 3 "Set Local Processor Outage" and "Clear Local Processor Outage" commands in the "Aligned Ready" state.

3.1.15.1. Forward Direction with Proving

This test is performed in the forward direction with the IUT set to perform proving. The expected sequence of events is illustrated in *Figure 3.1.15-1*.

Reference: Q.781/Test 1.15

```
 VAT:              PT                          IUT

                         <------------------  OUT-OF-SERVICE
         OUT-OF-SERVICE  ------------------>
                                              :start
                         <------------------  ALIGNMENT
                 :start
              ALIGNMENT  ------------------>
                         <------------------  PROVING-NORMAL
         PROVING-NORMAL  ------------------>
                         <------------------  READY
                                              :set lpo
                  READY  ------------------>
                         <------------------  PROCESSOR-OUTAGE
                                              :clear lpo
                         <------------------  PROCESSOR-RECOVERED
                  READY  ------------------>
                                              !in service
```

Figure 3.1.15-1. Set and clear LPO when "Aligned ready"

Test Description:

(1) The test begins with the link in the "Out of Service" state with the IUT set to perform proving.

(2) Issue the Level 3 "Start" command at both the IUT and the PT.

(3) Check that the IUT follows the normal alignment procedure and sequence of events illustrated in *Figure 3.1.15-1.* (Note that the IUT may send additional status "Out of Service," "Alignment" or "Proving Normal" messages.)

(4) When the IUT has completed the initial alignment procedure, issues the Level 3 "Set Local Processor Outage" command at the IUT.

(5) Check that the IUT sends a status "Processor Outage" message.

(6) Send a status "Ready" message to the IUT.

(7) Check that the IUT indicates "In Service" to Level 3 at the IUT.

(8) Issue the Level 3 "Clear Local Processor Outage" command at the IUT.

(9) Check that the IUT sends a status "Processor Recovered" message.

(10) Send a status "Ready" message to the IUT on the data stream.

(11) Check that the IUT enters the "In Service" state.

(12) Check that the

3.1.15.2. Forward Direction without Proving

This test is performed in the forward direction with the IUT set to disable proving. This test is only applicable if the IUT supports suppression of the proving period. The expected sequence of events is illustrated in *Figure 3.1.15-2*.

Reference: Q.781/Test 1.15

```
 VAT:                PT                       IUT

                         <-----------------  OUT-OF-SERVICE
        OUT-OF-SERVICE  ----------------->
                                              :start
                         <-----------------  ALIGNMENT
                :start
             ALIGNMENT  ----------------->
                         <-----------------  READY
                                              :set lpo
                 READY  ----------------->
                         <-----------------  PROCESSOR-OUTAGE
                                              :clear lpo
                         <-----------------  PROCESSOR-RECOVERED
                 READY  ----------------->
                                              !in service
```

Figure 3.1.15-2. Set and clear LPO when "Aligned ready"

Test Description:

(1) The test begins with the link in the "Out of Service" state with the IUT set to not perform proving.

(2) Issue the Level 3 "Start" command at both the IUT and the PT.

(3) Check that the IUT follows the normal alignment procedure and sequence of events illustrated in *Figure 3.1.15-2*.

(4) When the IUT has completed the initial alignment procedure, issues the Level 3 "Set Local Processor Outage" command at the IUT.

(5) Check that the IUT sends a status "Processor Outage" message and indicates "In Service" to Level 3 at the IUT.

(6) Issue the Level 3 "Clear Local Processor Outage" command at the IUT.

(7) Check that the IUT sends a status "Processor Recovered" message.

(8) Send a status "Ready" message to the IUT on the data stream.

(9) Check that the IUT indicates "In Service" to Level 3 at the IUT.

3.1.16. Timer T1 in "Aligned not ready" state

This test case validates the T1 timer and procedures at the IUT when the IUT is in the "Aligned Not Ready" state.

3.1.16.1. Forward Direction with Proving

This test is performed in the forward direction with the IUT set to perform proving. The expected sequence of events is illustrated in *Figure 3.1.16-1*.

Reference: Q.781/Test 1.16

```
 ____________________________________________________________________
|                                                                    |
| IOT:             SP B                     SP A                     |
| VAT:               PT                     IUT                      |
|                                                                    |
|                       <-----------------  OUT-OF-SERVICE           |
|       OUT-OF-SERVICE  ----------------->                           |
|                                           :set lpo                 |
|                                           :start                   |
|                       <-----------------  ALIGNMENT                |
|               :start                                               |
|            ALIGNMENT  ----------------->                           |
|                       <-----------------  PROVING-NORMAL           |
|       PROVING-NORMAL  ----------------->                           |
|                       <-----------------  PROCESSOR-OUTAGE         |
|                       <-----------------  PROCESSOR-OUTAGE (Note)  |
|                             !                                      |
|                             !  T1         40.0 <= T1 <= 50.0       |
|                             !                                      |
|                       <-----------------  OUT-OF-SERVICE           |
|                                           !out of service(T1)      |
|                                                                    |
|____________________________________________________________________|
```

Figure 3.1.16-1. Timer T1 in "Aligned not ready" state

Test Description:

(1) The test begins with the link in the "Out of Service" state with SP A set to perform proving.

(2) Issue the Level 3 "Set Local Processor Outage" and "Start" commands at SP A and "Start" command at SP B.

(3) Check that SP A follows the sequence of events illustrated in *Figure 3.1.16-1* while completing the initial alignment procedure. (Note that SP A or B may send additional status "Out of Service," "Alignment" or

"Proving Normal" messages.) (Note that SP A may send additional status "Processor Outage" messages before sending the status "Out of Service" message.)

(4) Check that SP A sends a status "Out of Service" message and indicates "Out of Service" to Level 3 with reason "T1 Timeout".

(5) Check that T1 is between 40.0 seconds and 50.0 seconds in duration.

3.1.16.2. Forward Direction without Proving

This test is performed in the forward direction with the IUT set to disable proving. This test is only applicable if the IUT supports suppression of the proving period. The expected sequence of events is illustrated in *Figure 3.1.16-2*.

Reference: Q.781/Test 1.16

```
 IOT:              SP B                       SP A
 VAT:                PT                       IUT

                         <-----------------   OUT-OF-SERVICE
       OUT-OF-SERVICE    ----------------->
                                              :set lpo
                                              :start
                         <-----------------   ALIGNMENT
               :start
            ALIGNMENT    ----------------->
                         <-----------------   PROCESSOR-OUTAGE
                         <-----------------   PROCESSOR-OUTAGE (Note)
                               !
                               !  T1          40.0 <= T1 <= 50.0
                               !
                         <-----------------   OUT-OF-SERVICE
                                              !out of service(T1)
```

Figure 3.1.16-2. Timer T1 in "Aligned not ready" state

Test Description:

(1) The test begins with the link in the "Out of Service" state with SP A set to not perform proving.

(2) Issue the Level 3 "Set Local Processor Outage" and "Start" commands at SP A and "Start" command at SP B.

(3) Check that SP A follows the sequence of events illustrated in *Figure 3.1.16-2* while completing the initial alignment procedure. <Note that SP A may send additional status "Processor Outage" messages before sending the status "Out of Service" message.)

(4) Check that SP A sends a status "Out of Service" message and indicates "Out of Service" to Level 3 with reason "T1 Timeout".

(5) Check that T1 is between 40.0 seconds and 50.0 seconds in duration.

3.1.17. No status "Alignment" sent during normal proving period

This test validates that the normal alignment procedure completes at the IUT when no status "Alignment" message is sent. The expected sequence of events is illustrated in *Figure 3.1.17-1.*

Reference: Q.781/Test 1.17

```
 VAT:               PT                      IUT

                        <-----------------  OUT-OF-SERVICE
        OUT-OF-SERVICE  ----------------->
                                            :start
                        <-----------------  ALIGNMENT
                :start
        PROVING-NORMAL  ----------------->
                        <-----------------  PROVING-NORMAL
                              !
                              !  T3+T4(Pn)  7.5 <= T3+T4 <= 11.0
                              !
                        <-----------------  READY
```

Figure 3.1.17-1. No "Alignment" during normal proving period

Test Description:

(1) The test begins with the link in the "Out of Service" state with the IUT set to perform proving.

(2) Issue the Level 3 "Start" command at both the IUT and the PT.

(3) Respond to status "Alignment" message sent by the IUT with a status "Proving Normal" message and continue proving. (Note that the IUT may send additional status "Out of Service," "Alignment" or "Proving Normal" messages.)

(4) Check that the IUT sends a status "Ready" message within T4(Pn) plus T3.

(5) Check that the delay from the start of the proving period to the status "Ready" message T4(Pn)+T3 is between 7.5 seconds and 11.0 seconds in duration.

3.1.18. Set and cease emergency prior to "start alignment"

This test case validates the behavior of the IUT when the Level 3 "Set Emergency" and "Clear Emergency" commands are issued prior to the Level 3 "Start" command at the IUT. The expected sequence of events is illustrated in *Figure 3.1.18-1.*

Reference: Q.781/Test 1.18

```
 ________________________________________________________________________
|                                                                        |
| VAT:               PT                       IUT                        |
|                                                                        |
|                       <-----------------  OUT-OF-SERVICE               |
|       OUT-OF-SERVICE  ----------------->                               |
|                                           :set emergency               |
|                                           :clear emergency             |
|                                           :start                       |
|                       <-----------------  ALIGNMENT                    |
|               :start                                                   |
|            ALIGNMENT  ----------------->                               |
|                       <-----------------  PROVING-NORMAL               |
|       PROVING-NORMAL  ----------------->                               |
|                             !                                          |
|                             !  T4(Pn)     7.5 <= T4 <= 10.0            |
|                             !                                          |
|                       <-----------------  READY                        |
|                                                                        |
|________________________________________________________________________|
```

Figure 3.1.18-1. Toggle emergency before "start alignment"

Test Description:

(1) The test begins with the link in the "Out of Service" state with the IUT set to perform proving.

(2) Issue the Level 3 "Set Emergency," "Clear Emergency" then "Start" commands at the IUT and "Start" command at the PT.

(3) Check that the sequence of events are as illustrated in *Figure 3.1.18-1*. Check that the IUT sends a status "Proving Normal" message in response to the "Alignment" message. (Note that the IUT may send additional status "Out of Service," "Alignment" or "Proving Normal" messages.)

(4) Check that the IUT sends a status "Ready" message.

(5) Check that the IUT uses a normal proving period by timing the delay from the status "Proving Normal" message to the status "Ready" message sent by the IUT.

(6) Check that T4 is between 7.5 seconds and 10.0 seconds in duration.

3.1.19. Set emergency while in "not aligned" state

This test case validates the behavior of the IUT when the Level 3 "Set Emergency" command is issued at the IUT immediately after the Level 3 "Start" command (when the IUT is in the "Not Aligned" state). The expected sequence of events is illustrated in *Figure 3.1.19-1*.

Reference: Q.781/Test 1.19

```
CPT: IOT:         SP B                          SP A
VAT:                PT                          IUT

                       <-----------------  OUT-OF-SERVICE
       OUT-OF-SERVICE  ----------------->
                                           :start
                       <-----------------  ALIGNMENT
                                           :set emergency
               :start
            ALIGNMENT  ----------------->
                       <-----------------  PROVING-EMERGENCY
    PROVING-EMERGENCY  ----------------->
                             !
                             !  T4(Pe)     0.4 <= T4 <= 0.6
                             !
                       <-----------------  READY
```

Figure 3.1.19-1. Set emergency in "not aligned" state

Test Description:

(1) The test begins with the link in the "Out of Service" state with SP A set to perform proving.

(2) Issue the Level 3 "Start" and "Set Emergency" commands at SP A and "Start" command at SP B.

(3) Check that the sequence of events are as illustrated in *Figure 3.1.19-1*. Check that SP A sends a status "Proving Emergency" message in response to the "Alignment" message. (Note that SP A or B may send additional status "Out of Service," "Alignment" or "Proving Emergency" messages.)

(4) Check that SP A sends a status "Ready" message.

(5) Check that SP A uses an emergency proving period by timing the delay from the status "Proving Emergency" message to the status "Ready" message sent by SP A.

(6) Check that T4 is between 0.4 seconds and 0.6 seconds in duration.

3.1.20. Set emergency when "aligned"

This test case validates the response of the IUT to the Level 3 "Set Emergency" command when issued in the "Aligned" state at the IUT. The expected sequence of events is illustrated in *Figure 3.1.20-1*.

Reference: Q.781/Test 1.20

```
 ___________________________________________________________________________
|                                                                           |
| IOT:              SP B                        SP A                        |
| VAT:                PT                        IUT                         |
|                                                                           |
|                         <------------------    OUT-OF-SERVICE              |
|        OUT-OF-SERVICE   ------------------>                               |
|                                                :start                      |
|                         <------------------    ALIGNMENT                   |
|                 :start                                                    |
|              ALIGNMENT  ------------------>                               |
|                         <------------------    PROVING-NORMAL              |
|        PROVING-NORMAL   ------------------>                               |
|                                                :set emergency              |
|                         <------------------    PROVING-EMERGENCY           |
|                               !                                           |
|                               !  T4(Pe)        0.4 <= T4 <= 0.6            |
|                               !                                           |
|                         <------------------    READY                       |
|                                                                           |
|___________________________________________________________________________|
```

Figure 3.1.20-1. Set emergency when "aligned"

Test Description:

(1) The test begins with the link in the "Out of Service" state with SP A set to perform proving.

(2) Issue the Level 3 "Start" command at SP A and SP B.

(3) Check that the normal alignment procedure starts as illustrated in *Figure 3.1.20-1*. (Note that SP A or B may send additional status "Out of Service," "Alignment" or "Proving Normal" messages.)

(4) Before the normal proving period completes, issue the Level 3 "Set Emergency" command at SP A.

(5) Check that SP A sends a status "Proving Emergency" message and later follows with a status "Ready" message. (Note that SP A may send additional status "Proving Emergency" messages.)

(6) Check that SP A begins an emergency proving period by timing the delay from the status "Proving Emergency" message to the status "Ready" message.

(7) Check that T4 is between 0.4 seconds and 0.6 seconds in duration.

3.1.21. Both ends set emergency.

This test case validates the IUT behavior when the Level 3 "Set Emergency" command is issued at both ends of the link before the Level 3 "Start" command. The expected sequence of events is illustrated in *Figure 3.1.21-1*.

Reference: Q.781/Test 1.21

```
 IOT:              SP B                          SP A
 VAT:                PT                          IUT

                         <-----------------  OUT-OF-SERVICE
        OUT-OF-SERVICE   ----------------->
                                             :set emergency
                                             :start
                         <-----------------  ALIGNMENT
                :start
             ALIGNMENT   ----------------->
                         <-----------------  PROVING-EMERGENCY
     PROVING-EMERGENCY   ----------------->
                               !
                               !  T4(Pe)     0.4 <= T4 <= 0.6
                               !
                         <-----------------  READY
```

Figure 3.1.21-1. Both ends set emergency

Test Description:

(1) The test begins with the link in the "Out of Service" state with SP A set to perform proving.

(2) Issue the Level 3 "Set Emergency" and "Start" commands at SP A and the "Start" command at SP B.

(3) Check that SP A starts the emergency alignment procedure by sending a status "Proving Emergency" message.

(4) Check that SP A follows the sequence of events as illustrated in *Figure 3.1.21-1*. Check that SP A completes the alignment procedure and sends a status "Ready" message. (Note that SP A or B may send additional status "Out of Service," "Alignment" or "Proving Emergency" messages.)

(5) Check that SP A uses an emergency proving period by timing the delay between sending the status "Proving Normal" message and the status "Ready" message.

(6) Check that T4 is between 0.4 seconds and 0.6 seconds in duration.

3.1.22. Individual end sets emergency

This test case validates the behavior of the IUT when emergency is individually set at the PT before the initial alignment procedure begins. The expected sequence of events is illustrated in *Figure 3.1.22-1*.

Reference: Q.781/Test 1.22

```
IOT:              SP B                          SP A
VAT:                PT                          IUT

                         <------------------  OUT-OF-SERVICE
       OUT-OF-SERVICE   ------------------>
            :set emerg
                :start
             ALIGNMENT  ------------------>
                                              :start
                         <------------------  ALIGNMENT
    PROVING-EMERGENCY   ------------------>
                         <------------------  PROVING-NORMAL
                               !
                               !  T4(Pe)      0.4 <= T4 <= 0.6
                               !
                         <------------------  READY
```

Figure 3.1.22-1. Individual end sets emergency

Test Description:

(1) The test begins with the link in the "Out of Service" state with SP A set to perform proving.

(2) Issue the Level 3 "Set Emergency" and "Start" commands at SP B and the "Start" command at SP A.

(3) Check that the sequence of events follows that illustrated in *Figure 3.1.22-1*.

(4) Check that SP A uses the emergency proving period by timing the delay between the status "Proving Normal" message and the status "Ready" message. (Note that SP B may send additional status "Out of Service," "Alignment" or "Proving Emergency" messages.) (Note that SP A may send additional status "Out of Service," "Alignment" or "Proving Normal" messages.)

(5) Check that T4 is between 0.4 seconds and 0.6 seconds in duration.

3.1.23. Set emergency during normal proving

This test case validates the IUT behavior when it receives a Level 3 "Set Emergency" command after it has already commenced normal proving. The expected sequence of events is illustrated in *Figure 3.1.23-1*.

Reference: Q.781/Test 1.23

```
 IOT:             SP B                        SP A
 VAT:               PT                        IUT

                        <-----------------  OUT-OF-SERVICE
        OUT-OF-SERVICE  ----------------->
                                            :start
                        <-----------------  ALIGNMENT
                :start
             ALIGNMENT  ----------------->
                        <-----------------  PROVING-NORMAL
        PROVING-NORMAL  ----------------->
                                            :set emergency
                        <-----------------  PROVING-EMERGENCY
                              !
                              !  T4(Pe)     0.4 <= T4 <= 0.6
                              !
                        <-----------------  READY
```

Figure 3.1.23-1. Set emergency during normal proving

Test Description:

(1) The test begins with the link in the "Out of Service" state with SP A set to perform proving.

(2) Issue the Level 3 "Start" command at SP A and SP B.

(3) Check that the sequence of events follows that illustrated in *Figure 3.1.23-1*. (Note that SP A or B may send additional status "Out of Service," "Alignment" or "Proving Normal" messages.)

(4) Before the normal proving period completes at SP A, issue the Level 3 "Set Emergency" command at SP A.

(5) Check that SP A sends a status "Proving Emergency" message and continues proving. (Note that SP A may send additional status "Proving Emergency" messages.)

(6) Check that SP A sends a status "Ready" message.

(7) Check that SP A uses an emergency proving period by timing the delay between the status "Proving Emergency" message and the status "Ready" message.

(8) Check that T4 is between 0.4 seconds and 0.6 seconds in duration.

3.1.24. No status "Alignment" sent during emergency alignment

This test case validates the response of the IUT to receiving a status "Proving Normal" without a status "Alignment" during initial alignment using an emergency proving period. The expected sequence of events is illustrated in *Figure 3.1.24-1*.

Reference: Q.781/Test 1.24

```
 VAT:                PT                        IUT

                          <-----------------   OUT-OF-SERVICE
        OUT-OF-SERVICE    ----------------->
                                               :set emergency
                                               :start
                          <-----------------   ALIGNMENT
                :start
     PROVING-EMERGENCY    ----------------->
                          <-----------------   PROVING-EMERGENCY
                                !
                                !  T4(Pe)      0.4 <= T4 <= 0.6
                                !
                          <-----------------   READY
```

Figure 3.1.24-1. No "Alignment" during emergency alignment

Test Description:

(1) The test begins with the link in the "Out of Service" state with the IUT set to perform proving.

(2) Issue the Level 3 "Set Emergency" and "Start" commands at both the IUT and PT.

(3) Check that the IUT sends a status "Proving Emergency" message and starts proving. (Note that the IUT may send additional status "Out of Service," "Alignment" or "Proving Emergency" messages.)

(4) Check that the IUT completes proving and sends a status "Ready" message.

(5) Check that the IUT uses an emergency proving period by timing the delay between the status "Proving Emergency" message and the status "Ready" message.

(6) Check that T4 is between 0.4 seconds and 0.6 seconds in duration.

3.1.25. Deactivation during initial alignment

This test case validates the behavior of the IUT in response to the Level 3 "Stop" command issued during the "Initial Alignment" state at the IUT. The expected sequence of events is illustrated in *Figure 3.1.25-1*.

Reference: Q.781/Test 1.25

```
CPT: IOT:        SP B                     SP A
VAT:               PT                     IUT

                      <-----------------  OUT-OF-SERVICE
       OUT-OF-SERVICE ----------------->
                                          :start
                      <-----------------  ALIGNMENT
                                          :stop
                      <-----------------  OUT-OF-SERVICE
```

Figure 3.1.25-1. Deactivate during initial alignment

Test Description:

(1) The test begins with the link in the "Out of Service" state.

(2) Issue the Level 3 "Start" command at SP A.

(3) Before timer T2 expires, issue the Level 3 "Stop" command at the IUT.

(4) Check that SP A sends a status "Out of Service" message and stays in the "Out of Service" state.

3.1.26. Deactivation during aligned state

This test case validates the behavior of the IUT in response to the Level 3 "Stop" command issued during "Aligned" state at the IUT. The expected sequence of events is illustrated in *Figure 3.1.26-1*.

Reference: Q.781/Test 1.26

```
VAT:               PT                     IUT

                      <-----------------  OUT-OF-SERVICE
       OUT-OF-SERVICE ----------------->
                                          :start
                      <-----------------  ALIGNMENT
               :start
            ALIGNMENT ----------------->
                      <-----------------  PROVING-NORMAL
                                          :stop
                      <-----------------  OUT-OF-SERVICE
```

Figure 3.1.26-1. Deactivate during aligned state

Test Description:

(1) The test begins with the link in the "Out of Service" state with the IUT set to perform proving.

(2) Issue the Level 3 "Start" command at the IUT and the PT.

(3) Check that the IUT follows the sequence of events illustrated in *Figure 3.1.26-1*. (Note that the IUT may send additional status "Out of Service," "Alignment" or "Proving Normal" messages.)

(4) Issue the Level 3 "Stop" command at the IUT.

(5) Check that the IUT sends a status "Out of Service" message and stays in the "Out of Service" state.

3.1.27. Deactivation during aligned not ready

This test case validates the behavior of the IUT in response to the Level 3 "Stop" command issued during the "Aligned Not Ready" state at the IUT.

3.1.27.1. Forward Direction with Proving

This test is performed in the forward direction with the IUT set to perform proving. The expected sequence of events is illustrated in *Figure 3.1.27-1*.

Reference: Q.781/Test 1.27

```
IOT:             SP B                      SP A
VAT:               PT                      IUT

                      <------------------  OUT-OF-SERVICE
       OUT-OF-SERVICE ------------------>
                                           :set lpo
                                           :start
                      <------------------  ALIGNMENT
               :start
            ALIGNMENT ------------------>
                      <------------------  PROVING-NORMAL
       PROVING-NORMAL ------------------>
                      <------------------  PROCESSOR-OUTAGE
                                           :stop
                      <------------------  OUT-OF-SERVICE
```

Figure 3.1.27-1. Deactivate during aligned not ready

Test Description:

(1) The test begins with the link in the "Out of Service" state with SP A set to perform proving.

(2) Issue the Level 3 "Set Local Processor Outage" and "Start" commands at SP A and the "Start" command at the PT.

(3) Check that SP A follows the sequence of events illustrated in *Figure 3.1.27-1* and sends a status "Processor Outage" message. (Note that SP A or B may send additional status "Out of Service," "Alignment" or "Proving Normal" messages.)

(4) Issue the Level 3 "Stop" command at SP A.

(5) Check that SP A sends a status "Out of Service" message and stays in the "Out of Service" state.

3.1.27.2. Forward Direction without Proving

This test is performed in the forward direction with the IUT set to disable proving. This test is only applicable if the IUT supports suppression of the proving period. The expected sequence of events is illustrated in *Figure 3.1.27-2*.

Reference: Q.781/Test 1.27

```
 IOT:              SP B                       SP A
 VAT:                PT                       IUT

                         <-----------------   OUT-OF-SERVICE
        OUT-OF-SERVICE   ----------------->
                                              :set lpo
                                              :start
                         <-----------------   ALIGNMENT
                :start
             ALIGNMENT   ----------------->
                         <-----------------   PROCESSOR-OUTAGE
                                              :stop
                         <-----------------   OUT-OF-SERVICE
```

Figure 3.1.27-2. Deactivate during aligned not ready

Test Description:

(1) The test begins with the link in the "Out of Service" state with SP A set to not perform proving.

(2) Issue the Level 3 "Set Local Processor Outage" and "Start" commands at SP A and the "Start" command at SP B.

(3) Check that SP A follows the sequence of events illustrated in *Figure 3.1.27-2* and sends a status "Processor Outage" message.

(4) Issue the Level 3 "Stop" command at SP A.

(5) Check that SP A sends a status "Out of Service" message and stays in the "Out of Service" state.

3.1.28. Status "alignment" received during link in service

This test case validates the IUT response to receiving a status "Alignment" message in the "In Service" state. The expected sequence of events is illustrated in *Figure 3.1.28-1*.

Reference: Q.781/Test 1.28

```
VAT:                PT                      IUT

            ALIGNMENT  ------------------>
                       <------------------  OUT-OF-SERVICE
                                            !out of service(SIO)
```

Figure 3.1.28-1. "Alignment" during link in service

Test Description:

(1) The test begins with the link in the "In Service" state.

(2) Send a status "Alignment" to the IUT.

(3) Check that the IUT sends a status "Out of Service" message and indicates "Out of Service" to Level 3 with reason "Received SIO".

3.1.29. Status "out of service" received during link in service

This test case validates the response of the IUT to sending or receiving a status "Out of Service" message in the "In Service" state.

3.1.29.1. Forward Direction

The test case is performed in the forward direction. The expected sequence of events is illustrated in *Figure 3.1.29-1*.

Reference: Q.781/Test 1.29(a)

```
CPT: IOT:         SP B                      SP A
VAT:                PT                      IUT

                 :stop
       OUT-OF-SERVICE  ------------------>
                       <------------------  OUT-OF-SERVICE
                                            !out of service(SIOS)
```

Figure 3.1.29-1. "Out of service" during link in service

Test Description:

(1) The test begins with the link in the "In Service" state.

(2) Issue the Level 3 "Stop" command at SP B and send a status "Out of Service" message to SP A.

(3) Check that SP A sends a status "Out of Service" message and indicates "Out of Service" to the Level 3 at SP A with reason "Received SIOS".

3.1.29.2. Reverse Direction

The test case is repeated in the reverse direction. The expected sequence of events is illustrated in *Figure 3.1.29-2*.

Reference: Q.781/Test 1.29(b)

```
 ____________________________________________________________________
|                                                                    |
| CPT: IOT:        SP B                      SP A                    |
| VAT:               PT                      IUT                     |
|                                                                    |
|                                            :stop                   |
|                         <-----------------  OUT-OF-SERVICE          |
|        OUT-OF-SERVICE  ----------------->                          |
|                                                                    |
|____________________________________________________________________|
```

Figure 3.1.29-2. "Out of service" during link in service

Test Description:

(1) The test begins with the link in the "In Service" state.

(2) Issue the Level 3 "Stop" command at SP A.

(3) Check that SP A sends a status "Out of Service" message and stays in the "Out of Service" state.

3.1.30. Deactivation during LPO

These test cases validate the response of the IUT to sending a status "Out of Service" message while in the "Processor Outage" state with LPO set, or receiving an "Out of Service" message from an M2PA peer in the "Processor Outage" state with RPO set.

3.1.30.1. Forward Direction

The test is performed in the forward direction. The expected sequence of events is illustrated in *Figure 3.1.30-1*.

Reference: Q.781/Test 1.30(a)

```
 IOT:              SP B                         SP A
 VAT:                PT                         IUT

                                                :set lpo
                         <------------------    PROCESSOR-OUTAGE
                                                :stop
                         <------------------    OUT-OF-SERVICE
```

Figure 3.1.30-1. Deactivation during LPO

Test Description:

(1) The test begins with the link in the "In Service" state.

(2) Issue the Level 3 "Set Local Processor Outage" command at SP A.

(3) Check that SP A sends a status "Processor Outage" message.

(4) Issue the Level 3 "Stop" command at SP A.

(5) Check that SP A sends a status "Out of Service" message and stays in the "Out of Service" state.

3.1.30.2. Reverse Direction

The test is repeated in the reverse direction. The expected sequence of events is illustrated in *Figure 3.1.30-2*.

Reference: Q.781/Test 1.30(b)

```
 IOT:              SP B                         SP A
 VAT:                PT                         IUT

               :set lpo
       PROCESSOR-OUTAGE  ------------------>
                  :stop
         OUT-OF-SERVICE  ------------------>
                         <------------------    OUT-OF-SERVICE
                                                !rpo
                                                !out of service(SIOS)
```

Figure 3.1.30-2. Deactivation during LPO

Test Description:

(1) The test begins with the link in the "In Service" state.

(2) Issue the Level 3 "Set Local Processor Outage" and "Stop" commands at SP B.

(3) Check that SP A sends a status "Out of Service" message and indicates "Out of Service" to Level 3 at SP A with reason "Received SIOS".

3.1.31. Deactivation during RPO

These test cases validate the response of the IUT to sending a status "Out of Service" message while in the "Processor Outage" state with RPO set, or receiving an "Out of Service" message from an M2PA peer in the "Processor Outage" state with LPO set.

3.1.31.1. Forward Direction

The test is performed in the forward direction. The expected sequence of events is illustrated in *Figure 3.1.31-1*.

Reference: Q.781/Test 1.31(a)

```
 IOT:              SP B                          SP A
 VAT:                PT                          IUT

      PROCESSOR-OUTAGE  ----------------->
                                                 :stop
                        <-----------------       OUT-OF-SERVICE
```

Figure 3.1.31-1. Deactivation during RPO

Test Description:

(1) The test begins with the link in the "In Service" state.

(2) Issue the Level 3 "Set Local Processor Outage" command at SP B and send a status "Processor Outage" message to SP A.

(3) Issue the Level 3 "Stop" command at SP A.

(4) Check that SP A sends the status "Out of Service" message and remains in the "Out of Service" state.

3.1.31.2. Reverse Direction

The test is repeated in the reverse direction. The expected sequence of events is illustrated in *Figure 3.1.31-2*.

Reference: Q.781/Test 1.31(b)

```
 ______________________________________________________________________
|                                                                      |
| IOT:             SP B                     SP A                       |
| VAT:               PT                     IUT                        |
|                                                                      |
|                                           :set lpo                   |
|                       <-----------------  PROCESSOR-OUTAGE           |
|                 :stop                                                |
|       OUT-OF-SERVICE  ----------------->                             |
|                                                                      |
|______________________________________________________________________|
```

Figure 3.1.31-2. Deactivation during RPO

Test Description:

(1) The test begins with the link in the "In Service" state.

(2) Issue the Level 3 "Set Local Processor Outage" command at SP A.

(3) Check that SP A sends a status "Processor Outage" message.

(4) Issue the Level 3 "Stop" command at SP B and send the status "Out of Service" message.

(5) Check that SP A does not indicate "Out of Service" until the local processor outage condition recovers.

3.1.32. Deactivation during the proving period

These test cases validate the response of the IUT to deactivation (sending or receiving a status "Out of Service" message) during the proving period.

3.1.32.1. Forward Direction

The test is performed in the forward direction. The expected sequence of events is illustrated in *Figure 3.1.32-1*.

Reference: Q.781/Test 1.32(a)

```
 ____________________________________________________________________
|                                                                    |
| CPT: IOT:        SP B                      SP A                    |
| VAT:               PT                      IUT                     |
|                                                                    |
|                       <-----------------  OUT-OF-SERVICE           |
|       OUT-OF-SERVICE  ----------------->                           |
|                                           :start                   |
|                       <-----------------  ALIGNMENT                |
|               :start                                               |
|            ALIGNMENT  ----------------->                           |
|                       <-----------------  PROVING-NORMAL           |
|       PROVING-NORMAL  ----------------->                           |
|                :stop                                               |
|       OUT-OF-SERVICE  ----------------->                           |
|                       <-----------------  OUT-OF-SERVICE           |
|                                           !out of service(AERM)    |
|                                                                    |
|____________________________________________________________________|
```

Figure 3.1.32-1. Deactivation during the proving period

Test Description:

(1) The test begins with the link in the "Out of Service" state with SP A set to perform proving.

(2) Issue the Level 3 "Start" command at SP A and SP B.

(3) Check that SP A follows the sequence of events illustrated in *Figure 3.1.32-1*. (Note that SP A or B may send additional status "Out of Service," "Alignment" or "Proving Normal" messages.)

(4) During the proving period, issue the Level 3 "Stop" command at SP B and send status "Out of Service" to SP A.

(5) Check that SP A sends a status "Out of Service" message and indicates "Out of Service" to Level 3 at SP A with reason "Alignment Not Possible".

3.1.32.2. Reverse Direction

The test is repeated in the reverse direction. The expected sequence of events is illustrated in *Figure 3.1.32-2*.

Reference: Q.781/Test 1.32(b)

```
 ____________________________________________________________________
|                                                                    |
| CPT: IOT:        SP B                      SP A                    |
| VAT:               PT                      IUT                     |
|                                                                    |
|       OUT-OF-SERVICE  ------------------>                          |
|               :start                                               |
|                                            :start                  |
|            ALIGNMENT  ------------------>                          |
|                       <------------------  OUT-OF-SERVICE          |
|                       <------------------  ALIGNMENT               |
|       PROVING-NORMAL  ------------------>                          |
|                       <------------------  PROVING-NORMAL          |
|                                            :stop                   |
|                       <------------------  OUT-OF-SERVICE          |
|       OUT-OF-SERVICE  ------------------>                          |
|                                                                    |
|____________________________________________________________________|
```

Figure 3.1.32-2. Deactivation during the proving period

Test Description:

(1) The test begins with the link in the "Out of Service" state with SP A set to perform proving.

(2) Issue the Level 3 "Start" command at SP B and SP A.

(3) Check that the sequence of events follows that illustrated in *Figure 3.1.32-2*. (Note that SP A or B may send additional status "Out of Service," "Alignment" or "Proving Normal" messages.)

(4) During the proving period, issue a Level 3 "Stop" command at SP A.

(5) Check that SP A sends a status "Out of Service" message and remains in the "Out of Service" state.

3.1.33. Status "Alignment" received instead of status "Ready"

This test case validates the response of the IUT to receiving a status "Alignment" message instead of a status "Ready" or "Processor Outage" message at the completion of initial alignment. The expected sequence of events is illustrated in *Figure 3.1.33-1*.

Reference: Q.781/Test 1.33

```
 VAT:               PT                         IUT

                          <-----------------  OUT-OF-SERVICE
       OUT-OF-SERVICE     ----------------->
                                              :start
                          <-----------------  ALIGNMENT
             :start
          ALIGNMENT       ----------------->
                          <-----------------  PROVING-NORMAL
       PROVING-NORMAL     ----------------->
                          <-----------------  READY
          ALIGNMENT       ----------------->
                          <-----------------  OUT-OF-SERVICE
                                              !out of service(SIO)
```

Figure 3.1.33-1. "Alignment" instead of "In Service"

Test Description:

(1) The test begins with the link in the "Out of Service" state with the IUT set to perform proving.

(2) Issue a Level 3 "Start" command at the IUT and the PT.

(3) Check that the sequence of events follows that illustrated in *Figure 3.1.33-1*. (Note that the IUT may send additional status "Out of Service," "Alignment" or "Proving Normal" messages.)

(4) When the IUT sends a status "Ready" message, send a status "Alignment" message to the IUT.

(5) Check that the IUT sends a status "Out of Service" message and indicates "Out of Service" to Level 3 at the IUT with reason "Received SIO".

3.1.34. Status "Out of Service" received instead of status "Ready"

This test case validates the response of the IUT to receiving a status "Out of Service" message instead of a status "Ready" or "Processor Outage" message at the completion of initial alignment. The expected sequence of events is illustrated in *Figure 3.1.34-1*.

Reference: Q.781/Test 1.34

```
 ____________________________________________________________________
|                                                                    |
| VAT:              PT                        IUT                    |
|                                                                    |
|                      <-----------------  OUT-OF-SERVICE            |
|       OUT-OF-SERVICE -----------------> 	                     |
|                                          :start                    |
|                      <-----------------  ALIGNMENT                 |
|               :start                                               |
|            ALIGNMENT ----------------->                            |
|                      <-----------------  PROVING-NORMAL            |
|       PROVING-NORMAL ----------------->                            |
|                      <-----------------  READY                     |
|                :stop                                               |
|       OUT-OF-SERVICE ----------------->                            |
|                      <-----------------  OUT-OF-SERVICE            |
|                                          !out of service(SIOS)     |
|                                                                    |
|____________________________________________________________________|
```

Figure 3.1.34-1. "Out of Service" instead of "In Service"

Test Description:

(1) The test begins with the link in the "Out of Service" state with the IUT set to perform proving.

(2) Issue a Level 3 "Start" command at the IUT and the PT.

(3) Check that the sequence of events follows that illustrated in *Figure 3.1.34-1*. (Note that the IUT may send additional status "Out of Service," "Alignment" or "Proving Normal" messages.)

(4) When the IUT sends a status "Ready" message, send a status "Out of Service" message to the IUT.

(5) Check that the IUT sends a status "Out of Service" message and indicates "Out of Service" to Level 3 at the IUT with reason "Received SIOS".

3.1.35. Status "Processor Outage" received instead of status "Ready"

This test case validates the response of the IUT to receiving a status "Processor Outage" message instead of a status "Ready" message at the completion of initial alignment. The expected sequence of events is illustrated in *Figure 3.1.35-1*.

Reference: Q.781/Test 1.35

```
 IOT:            SP B                       SP A
 VAT:              PT                       IUT

                       <-----------------  OUT-OF-SERVICE
       OUT-OF-SERVICE  ----------------->
                                           :start
                       <-----------------  ALIGNMENT
               :start
            ALIGNMENT  ----------------->
                       <-----------------  PROVING-NORMAL
       PROVING-NORMAL  ----------------->
                       <-----------------  READY
             :set lpo
     PROCESSOR-OUTAGE  ----------------->
                                           !rpo
```

Figure 3.1.35-1. "Processor Outage" instead of "In Service"

Test Description:

(1) The test begins with the link in the "Out of Service" state with SP A set to perform proving.

(2) Issue a Level 3 "Start" command at SP A and SP B.

(3) Check that the sequence of events follows that illustrated in *Figure 3.1.35-1*. (Note that SP A or B may send additional status "Out of Service," "Alignment" or "Proving Normal" messages.)

(4) When SP A sends a status "Ready" message, issue a Level 3 "Set Local Processor Outage" command at SP B and send a status "Processor Outage" message to SP A.

(5) Check that SP A indicates "Remote Processor Outage" to Level 3 at SP A.

3.2. Link State Control - Unexpected signal units/orders

This suite of test cases test the response of the Implementation Under Test to unexpected sequences Level 3 requests and received M2PA messages in various states. These test cases validates the robustness of the implementation in responding to unusual circumstances.

3.2.1. Unexpected signal units/orders in "Out of service" state

This case validates the response of the IUT to the receipt of unexpected Level 3 requests and receipt of unexpected M2PA messages while in the "Out of Service" state. All of the unexpected sequences in this test case MUST be ignored by the IUT. The expected sequence of events is illustrated in *Figure 3.2.1-1*.

Reference: Q.781/Test 2.1

```
 VAT:               PT                        IUT

                         <-----------------  OUT-OF-SERVICE
        OUT-OF-SERVICE   ----------------->
             ALIGNMENT   ----------------->
        PROVING-NORMAL   ----------------->
     PROVING-EMERGENCY   ----------------->
   PROCESSOR-RECOVERED   ----------------->
      PROCESSOR-OUTAGE   ----------------->
            BUSY-ENDED   ----------------->
                  BUSY   ----------------->
      {INVALID-STATUS}   ----------------->
                 READY   ----------------->
              DATA-ACK   --FFFFFF, FFFFFF->
  [ 35 bytes]     DATA   --000000, FFFFFF->
       {INVALID-CLASS}   ----------------->
        {INVALID-TYPE}   ----------------->
                                             :stop
                                             :start
                         <-----------------  ALIGNMENT
             ALIGNMENT   ----------------->
                         <-----------------  PROVING-NORMAL
        PROVING-NORMAL   ----------------->
                         <-----------------  READY
                 READY   ----------------->
                                             !in service
```

Figure 3.2.1-1. Unexpected events in the "Out of Service" State

Test Description:

(1) The test begins with both M2PA peers in the "Out of Service" state with the IUT set to perform proving.

(2) A sequence of unexpected M2PA messages are sent to the IUT. These unexpected messages are:

- Status "Out of Service"
- Status "Alignment"
- Status "Proving Normal"
- Status "Proving Emergency"
- Status "Processor Recovered"
- Status "Processor Outage"
- Status "Busy Ended"
- Status "Busy"
- Status "Ready"
- Status Invalid
- Data Ack
- Data

- M2PA Message with Invalid Message Class
- M2PA Message with Invalid Message Type

(3) A sequence of unexpected Level 3 commands are issued at the IUT. These unexpected Level 3 commands are:

- Level 3 "Stop" command

(4) Check that the IUT ignores the unexpected M2PA messages/Level 3 commands.

(5) The Level 3 "Start" command is then issued.

(6) Check that the link aligns normally.

(7) Check that link alignment uses normal alignment procedures.

(8) Check that the link goes in service and stays in service without local or remote processor outage indications to Level 3.

3.2.2. Unexpected signal units/orders in "Not Aligned" state

This test case validates the response of the IUT to the receipt of unexpected Level 3 requests and receipt of unexpected M2PA messages while in the "Not Aligned" state. All of the unexpected sequences in this test case MUST be ignored by the IUT. The expected sequence of events is illustrated in *Figure 3.2.2-1*.

Reference: Q.781/Test 2.2

```
 ____________________________________________________________________
|                                                                    |
| VAT:              PT                       IUT                     |
|                                                                    |
|                      <-----------------  OUT-OF-SERVICE            |
|       OUT-OF-SERVICE  ----------------->                           |
|                                          :start                     |
|                      <-----------------  ALIGNMENT                 |
|       OUT-OF-SERVICE  ----------------->                           |
|  PROCESSOR-RECOVERED  ----------------->                           |
|     PROCESSOR-OUTAGE  ----------------->                           |
|           BUSY_ENDED  ----------------->                           |
|                 BUSY  ----------------->                           |
|     {INVALID-STATUS}  ----------------->                           |
|                READY  ----------------->                           |
|             DATA-ACK  --FFFFFF, FFFFFF->                           |
| [ 35 bytes]     DATA  --000000, FFFFFF->                           |
|      {INVALID-CLASS}  ----------------->                           |
|       {INVALID-TYPE}  ----------------->                           |
|                                          :clear emergency           |
|                                          :start                     |
|            ALIGNMENT  ----------------->                           |
|                      <-----------------  PROVING-NORMAL            |
|       PROVING-NORMAL  ----------------->                           |
|                      <-----------------  READY                     |
|                READY  ----------------->                           |
|                                          !in service                |
|                                                                    |
|____________________________________________________________________|
```

Figure 3.2.2-1. Unexpected events while "not aligned"

Test Description:

(1) The test begins with both M2PA peers in the "Out of Service" state with the IUT set to perform proving.

(2) The Level 3 "Start" command is issued to IUT to place the IUT in the "Not Aligned" state.

(3) A sequence of unexpected M2PA messages are sent to the IUT. These unexpected messages are:

- Status "Out of Service"
- Status "Processor Recovered"
- Status "Processor Outage"
- Status "Busy Ended"
- Status "Busy"
- Status "Ready"
- Status Invalid
- Data Ack
- Data
- M2PA Message with Invalid Message Class
- M2PA Message with Invalid Message Type

(4) A sequence of unexpected Level 3 commands are issued at the IUT. These unexpected Level 3 commands are:

- Level 3 "Clear Emergency" command
- Level 3 "Start" command

(5) Check that the IUT ignores the unexpected M2PA messages/Level 3 commands.

(6) A status "Alignment" is then sent to the IUT.

(7) Check that the IUT aligns as usual and performs the normal alignment procedures. (Note that the IUT may send additional status "Out of Service," "Alignment" or "Proving Normal" messages.)

(8) Check that the IUT places the link in service and that no local or remote processor outage indications are given to Level 3 at the IUT.

3.2.3. Unexpected signal units/orders in "Aligned" state

This case validates the response of the IUT to the receipt of unexpected Level 3 request and receipt of unexpected M2PA messages while in the "Aligned" state. All of the unexpected sequences in this test case MUST be ignored by the IUT. The expected sequence of events is illustrated in *Figure 3.2.3-1*.

Reference: Q.781/Test 2.3

```
 VAT:               PT                        IUT

                        <-----------------  OUT-OF-SERVICE
        OUT-OF-SERVICE  ----------------->
                                            :start
                        <-----------------  ALIGNMENT
                :start
             ALIGNMENT  ----------------->
                        <-----------------  PROVING-NORMAL
             ALIGNMENT  ----------------->
   PROCESSOR-RECOVERED  ----------------->
      PROCESSOR-OUTAGE  ----------------->
            BUSY-ENDED  ----------------->
                  BUSY  ----------------->
      {INVALID-STATUS}  ----------------->
                 READY  ----------------->
              DATA-ACK  --FFFFFF, FFFFFF->
  [ 35 bytes]     DATA  --000000, FFFFFF->
       {INVALID-CLASS}  ----------------->
        {INVALID-TYPE}  ----------------->
                                            :clear emergency
                                            :start
        PROVING-NORMAL  ----------------->
                        <-----------------  READY
                 READY  ----------------->
                                            !in service
```

Figure 3.2.3-1. Unexpected events while "aligned"

Test Description:

(1) The test begins with both IUT and PT in the "Out of Service" state with the IUT set to perform proving.

(2) The IUT is brought to the "Aligned" state using normal procedures.

(3) A sequence of unexpected M2PA messages are sent to the IUT. These unexpected messages are:

- Status "Alignment"
- Status "Processor Recovered"
- Status "Processor Outage"
- Status "Busy Ended"
- Status "Busy"
- Status "Ready"
- Status Invalid
- Data Ack
- Data
- M2PA Message with Invalid Message Class

- M2PA Message with Invalid Message Type

(4) A sequence of unexpected Level 3 commands are issued at the IUT. These unexpected Level 3 commands are:

- Level 3 "Clear Emergency" command
- Level 3 "Start" command

(5) Check that the IUT ignores the unexpected M2PA messages/Level 3 commands.

(6) Check that the IUT aligns as usual and performs the normal alignment procedure. (Note that the IUT may send additional status "Out of Service," "Alignment" or "Proving Normal" messages.)

(7) Check that the IUT places the link in service and that no local or remote processor outage indications are given to Level 3 at the IUT.

3.2.4. Unexpected signal units/orders in "Proving" state

This case validates the response of the IUT to the receipt of unexpected Level 3 request and receipt of unexpected M2PA messages while in the "Proving" state. All of the unexpected sequences in this test case MUST be ignored by the IUT. The expected sequence of events is illustrated in *Figure 3.2.4-1*.

Reference: Q.781/Test 2.4

```
 VAT:               PT                          IUT

                         <-----------------   OUT-OF-SERVICE
       OUT-OF-SERVICE    ----------------->
                                              :start
                         <-----------------   ALIGNMENT
                :start
            ALIGNMENT    ----------------->
                         <-----------------   PROVING-NORMAL
       PROVING-NORMAL    ----------------->
  PROCESSOR-RECOVERED    ----------------->
     PROCESSOR-OUTAGE    ----------------->
           BUSY-ENDED    ----------------->
                 BUSY    ----------------->
     {INVALID-STATUS}    ----------------->
                READY    ----------------->
             DATA-ACK    --FFFFFF, FFFFFF->
  [ 35 bytes]     DATA   --000000, FFFFFF->
      {INVALID-CLASS}    ----------------->
       {INVALID-TYPE}    ----------------->
                                              :clear emergency
                                              :start
                         <-----------------   READY
                READY    ----------------->
                                              !in service
```

Figure 3.2.4-1. Unexpected events while "proving"

Test Description:

(1) The test begins with both IUT and PT in the "Out of Service" state with the IUT set to perform proving.

(2) The IUT is brought to the "Proving" state using normal procedures.

(3) A sequence of unexpected M2PA messages are sent to the IUT. These unexpected messages are:

- Status "Processor Recovered"
- Status "Processor Outage"
- Status "Busy Ended"
- Status "Busy"
- Status "Ready"
- Status Invalid
- Data Ack
- Data
- M2PA Message with Invalid Message Class
- M2PA Message with Invalid Message Type

(4) A sequence of unexpected Level 3 commands are issued at the IUT. These unexpected Level 3 commands are:

- Level 3 "Clear Emergency" command
- Level 3 "Start" command

(5) Check that the IUT ignores the unexpected M2PA messages/Level 3 commands.

(6) Check that the IUT aligns as usual and performs the normal alignment procedure. (Note that the IUT may send additional status "Out of Service," "Alignment" or "Proving Normal" messages.)

(7) Check that the IUT places the link in service and that no local or remote processor outage indications are given to Level 3 at the IUT.

3.2.5. Unexpected signal units/orders in "Aligned Ready" state

This case validates the response of the IUT to the receipt of unexpected Level 3 request and receipt of unexpected M2PA messages while in the "Aligned Ready" state. All of the unexpected sequences in this test case MUST be ignored by the IUT. The expected sequence of events is illustrated in *Figure 3.2.5-1*.

Reference: Q.781/Test 2.5

```
VAT:                 PT                      IUT

                          <------------------  OUT-OF-SERVICE
       OUT-OF-SERVICE     ------------------>
                                               :start
                          <------------------  ALIGNMENT
               :start
            ALIGNMENT     ------------------>
                          <------------------  PROVING-NORMAL
       PROVING-NORMAL     ------------------>
                          <------------------  READY
  PROCESSOR-RECOVERED     ------------------>
           BUSY-ENDED     ------------------>
                 BUSY     ------------------>
     {INVALID-STATUS}     ------------------>
      {INVALID-CLASS}     ------------------>
       {INVALID-TYPE}     ------------------>
                                               :set emergency
                                               :clear emergency
                                               :clear lpo
                                               :start
                READY     ------------------>
                                               !in service
```

Figure 3.2.5-1. Unexpected events while "aligned ready"

Test Description:

(1) The test begins with both IUT and PT in the "Out of Service" state with the IUT set to perform proving.

(2) The IUT is brought to the "Aligned Ready" state using normal procedures.

(3) A sequence of unexpected M2PA messages are sent to the IUT. These unexpected messages are:

- Status "Processor Recovered"
- Status "Busy Ended"
- Status "Busy"
- Status Invalid
- M2PA Message with Invalid Message Class
- M2PA Message with Invalid Message Type

(4) A sequence of unexpected Level 3 commands are issued at the IUT. These unexpected Level 3 commands are:

- Level 3 "Set Emergency" command
- Level 3 "Clear Emergency" command
- Level 3 "Clear Local Processor Outage" command
- Level 3 "Start" command

(5) Check that the IUT ignores the unexpected M2PA messages/Level 3 commands.

(6) Check that the IUT aligns as usual and performs the normal alignment procedure. (Note that the IUT may send additional status "Out of Service," "Alignment" or "Proving Normal" messages.)

(7) Check that the IUT places the link in service and that no local or remote processor outage indications are given to Level 3 at the IUT.

3.2.6. Unexpected signal units/orders in "Aligned Not Ready" state

This case validates the response of the IUT to the receipt of unexpected Level 3 request and receipt of unexpected M2PA messages while in the "Aligned Not Ready" state. All of the unexpected sequences in this test case MUST be ignored by the IUT. The expected sequence of events is illustrated in *Figure 3.2.6-1*.

Reference: Q.781/Test 2.6

```
 VAT:                PT                        IUT

                          <-----------------  OUT-OF-SERVICE
       OUT-OF-SERVICE     ----------------->
                                              :set lpo
                                              :start
                          <-----------------  ALIGNMENT
                :start
            ALIGNMENT     ----------------->
                          <-----------------  PROVING-NORMAL
       PROVING-NORMAL     ----------------->
                          <-----------------  PROCESSOR-OUTAGE
  PROCESSOR-RECOVERED     ----------------->
           BUSY-ENDED     ----------------->
                 BUSY     ----------------->
     {INVALID-STATUS}     ----------------->
      {INVALID-CLASS}     ----------------->
       {INVALID-TYPE}     ----------------->
                                              :set emergency
                                              :clear emergency
                                              :set lpo
                                              :start
                READY     ----------------->
                                              !in service
```

Figure 3.2.6-1. Unexpected events while "aligned not ready"

Test Description:

(1) The test begins with both IUT and PT in the "Out of Service" state with the IUT set to perform proving.

(2) The IUT is brought to the "Aligned Not Ready" state using normal procedures. (Note that the IUT may send additional status "Out of Service," "Alignment" or "Proving Normal" messages.)

(3) A sequence of unexpected M2PA messages are sent to the IUT. These unexpected messages are:

- Status "Processor Recovered"
- Status "Busy Ended"
- Status "Busy"
- Status Invalid
- M2PA Message with Invalid Message Class
- M2PA Message with Invalid Message Type

(4) A sequence of unexpected Level 3 commands are issued at the IUT. These unexpected Level 3 commands are:

- Level 3 "Set Emergency" command
- Level 3 "Clear Emergency" command
- Level 3 "Set Local Processor Outage" command
- Level 3 "Start" command

(5) Check that the IUT ignores the unexpected M2PA messages/Level 3 commands.

(6) Check that the IUT places the link in service.

3.2.7. Unexpected signal units/orders in "In Service" state

This case validates the response of the IUT to the receipt of unexpected Level 3 request and receipt of unexpected M2PA messages while in the "In Service" state. All of the unexpected sequences in this test case MUST be ignored by the IUT. The expected sequence of events is illustrated in *Figure 3.2.7-1*.

Reference: Q.781/Test 2.7

```
 VAT:                PT                      IUT

   PROCESSOR-RECOVERED  ----------------->
            BUSY-ENDED  ----------------->
       {INVALID-STATUS}  ----------------->
        {INVALID-CLASS}  ----------------->
         {INVALID-TYPE}  ----------------->
                                             :set emergency
                                             :clear emergency
                                             :clear lpo
                                             :start
```

Figure 3.2.7-1. Unexpected events while "in service"

Test Description:

(1) The test begins with both IUT and PT in the "In Service" state.

(2) A sequence of unexpected M2PA messages are sent to the IUT. These unexpected messages are:

- Status "Processor Recovered"
- Status "Busy Ended"
- Status Invalid
- M2PA Message with Invalid Message Class
- M2PA Message with Invalid Message Type

(3) A sequence of unexpected Level 3 commands are issued at the IUT. These unexpected Level 3 commands are:

- Level 3 "Set Emergency" command

- Level 3 "Clear Emergency" command
- Level 3 "Clear Local Processor Outage" command
- Level 3 "Start" command

(4) Check that the IUT ignores the unexpected M2PA messages/Level 3 commands.

(5) Check that the IUT retains the link in the in service state and that no local or remote processor outage indications are given to Level 3 at the IUT.

3.2.8. Unexpected signal units/orders in "Processor Outage" state

This case validates the response of the IUT to the receipt of unexpected Level 3 request and receipt of unexpected M2PA messages while in the "Processor Outage" state. All of the unexpected sequences in this test case MUST be ignored by the IUT. The expected sequence of events is illustrated in *Figure 3.2.8-1*.

Reference: Q.781/Test 2.8

```
VAT:               PT                      IUT

                                           :set lpo
                        <------------------  PROCESSOR-OUTAGE
  PROCESSOR-RECOVERED  ------------------>
           BUSY-ENDED  ------------------>
                 BUSY  ------------------>
     {INVALID-STATUS}  ------------------>
      {INVALID-CLASS}  ------------------>
       {INVALID-TYPE}  ------------------>
                                           :set emergency
                                           :clear emergency
                                           :start
                READY  ------------------>
  PROCESSOR-RECOVERED  ------------------>
           BUSY-ENDED  ------------------>
```

Figure 3.2.8-1. Unexpected events while "processor outage"

Test Description:

(1) The test begins with both IUT and PT in the "In Service" state.

(2) The IUT is brought to the "Processor Outage" state using normal procedures.

(3) A sequence of unexpected M2PA messages are sent to the IUT. These unexpected messages are:

- Status "Processor Recovered"
- Status "Busy Ended"
- Status "Busy"
- Status "Ready"

- Status Invalid
- M2PA Message with Invalid Message Class
- M2PA Message with Invalid Message Type

(4) A sequence of unexpected Level 3 commands are issued at the IUT. These unexpected Level 3 commands are:

- Level 3 "Set Emergency" command
- Level 3 "Clear Emergency" command
- Level 3 "Start" command

(5) Check that the IUT ignores the unexpected M2PA messages/Level 3 commands.

(6) Check that the IUT keeps the link in service and that no local or remote processor outage indications are given to Level 3 at the IUT.

3.3. Transmission Failure

This set of test cases validate specific transmission path failures and anomalies. Specifically transmission path failures, corrupt acknowledgments and invalid sequencing. Because SCTP does not have a transmission path that is separate from a receive path, the Q.781 tests that validate response to breaking the transmission path are simulated by aborting the association. Because M2PA does not have forward indicator bits, the Q.781 tests that validate response to abnormal forward indicator bits are simulated by invalid "Data Ack" messages.

3.3.1. Link aligned ready (Abort)

This case validates the response of the IUT to aborting the SCTP association when the IUT is in the "Aligned Ready" state. The expected sequence of events is illustrated in *Figure 3.3.1-1*.

Reference: Q.781/Test 3.1

```
VAT:                PT                       IUT

                         <-----------------  OUT-OF-SERVICE
      OUT-OF-SERVICE     ----------------->
                                             :start
                         <-----------------  ALIGNMENT
              :start
           ALIGNMENT     ----------------->
                         <-----------------  PROVING-NORMAL
      PROVING-NORMAL     ----------------->
                         <-----------------  READY
           :tx break
                                             !out of service(SUERM)
```

Figure 3.3.1-1. Link aligned ready (Abort)

Test Description:

(1) The test begins with both IUT and PT in the "Out of Service" state with the IUT set to perform proving.

(2) Issue a Level 3 "Start" command at the IUT and the PT.

(3) Check that the IUT follows the sequence of events illustrated in *Figure 3.3.1-1*. (Note that the IUT may send additional status "Out of Service," "Alignment" or "Proving Normal" messages.)

(4) When the IUT sends a status "Ready" message, abort the SCTP association.

(5) Check that the IUT indicates "Out of Service" to Level 3 at the IUT with reason "Excessive error rate SUERM" and stays in the "Out of Service" state.

3.3.2. Link aligned ready (Corrupt FIBs)

This test case is not applicable to M2PA. The expected sequence of events is illustrated in *Figure 3.3.2-1*.

Reference: Q.781/Test 3.2

```
 ___________________________________________________________________
|                                                                   |
| VAT:                PT                         IUT                |
|                                                                   |
|                                                                   |
|                            NOT APPLICABLE                         |
|___________________________________________________________________|
```

Figure 3.3.2-1. Not applicable

Test Description:

(1) Not applicable.

3.3.3. Link aligned not ready (Abort)

This test case validates the response of the IUT to aborting the SCTP association when the IUT is in the "Aligned Not Ready" state. The expected sequence of events is illustrated in *Figure 3.3.3-1*.

Reference: Q.781/Test 3.3

```
 VAT:               PT                        IUT

                        <-----------------  OUT-OF-SERVICE
        OUT-OF-SERVICE  ----------------->
                                            :set lpo
                                            :start
                        <-----------------  ALIGNMENT
                :start
             ALIGNMENT  ----------------->
                        <-----------------  PROVING-NORMAL
        PROVING-NORMAL  ----------------->
                        <-----------------  PROCESSOR-OUTAGE
             :tx break
                                            !out of service(SUERM)
```

Figure 3.3.3-1. Link aligned not ready (Abort)

Test Description:

(1) The test begins with both PT and IUT in the "Out of Service" state with the IUT set to perform proving.

(2) Issue the Level 3 "Set Local Processor Outage" and "Start" commands at the IUT and the "Start" command at the PT.

(3) Check that the IUT follows the sequence of events illustrated in *Figure 3.3.3-1*. (Note that the IUT may send additional status "Out of Service," "Alignment" or "Proving Normal" messages.)

(4) When the IUT sends a status "Processor Outage" message, abort the SCTP association.

(5) Check that the IUT indicates "Out of Service" to Level 3 at the IUT with reason "Excessive Error Rate/SUERM" and stays in the "Out of Service" state.

3.3.4. Link aligned not ready (Corrupt FIBs)

This test case is not applicable to M2PA. The expected sequence of events is illustrated in *Figure 3.3.4-1*.

Reference: Q.781/Test 3.4

```
 VAT:               PT                        IUT


                               NOT APPLICABLE
```

Figure 3.3.4-1. Not applicable

Test Description:

(1) Not applicable.

3.3.5. Link in service (Abort)

The expected sequence of events is illustrated in *Figure 3.3.5-1*.

Reference: Q.781/Test 3.5

```
CPT: IOT:        SP B                         SP A
VAT:               PT                         IUT

            :tx break
                                              !out of service(SUERM)
```

Figure 3.3.5-1. Link in service (Abort)

Test Description:

(1) The test begins with the link in the "In Service" state.

(2) Abort the SCTP association.

(3) Check that SP A indicates "Out of Service" to Level 3 at SP A with reason "Excessive Error Rate/SUERM" and stays in the "Out of Service" state.

3.3.6. Link in service (Corrupt FIBs)

This test case is not applicable to M2PA. The expected sequence of events is illustrated in *Figure 3.3.6-1*.

Reference: Q.781/Test 3.6

```
VAT:               PT                         IUT


                          NOT APPLICABLE
```

Figure 3.3.6-1. Not applicable

Test Description:

(1) Not applicable.

3.3.7. Link in processor outage (Abort)

This test case validates the response of the IUT to aborting the SCTP association when the IUT is in the "Processor Outage" state. The expected sequence of events is illustrated in *Figure 3.3.7-1*.

Reference: Q.781/Test 3.7

```
 IOT:            SP B                     SP A
 VAT:              PT                     IUT

                                          :set lpo
                        <-----------------  PROCESSOR-OUTAGE
            :tx break
                                          !out of service(SUERM)
```

Figure 3.3.7-1. Link in processor outage (Abort)

Test Description:

(1) The test begins with the link in the "In Service" state.

(2) Issues the Level 3 "Set Local Processor Outage" command at SP A.

(3) Check that SP A sends a status "Processor Outage" message.

(4) Abort the SCTP association.

(5) Check that SP A indicates "Out of Service" to Level 3 at SP A with reason "Excessive Error Rate/SUERM" and stays in the "Out of Service" state.

3.3.8. Link in processor outage (Corrupt FIBs)

This test case is not applicable to M2PA. The expected sequence of events is illustrated in *Figure 3.3.8-1*.

Reference: Q.781/Test 3.8

```
 VAT:              PT                     IUT


                          NOT APPLICABLE
```

Figure 3.3.8-1. Not applicable

Test Description:

(1) Not applicable.

3.4. Processor Outage Control

3.4.1. Set and clear LPO while link in service

This test case validates the response of the IUT to a local processor outage condition and recovery with buffer clearing.

3.4.1.1. Forward Direction

This test is in the forward direction, where the IUT suffers local processor outage. The expected sequence of events is illustrated in *Figure 3.4.1-1*.

Reference: Q.781/Test 4.1

```
IOT:              SP B                        SP A
VAT:                PT                        IUT

                                              :msu
 [ 35 bytes]      DATA  --000000, FFFFFF->
                                              :msu
                        <-FFFFFF, 000000--  DATA [   35 bytes]
                                              :set lpo
 [ 35 bytes]      DATA  --000001, FFFFFF->
                        <-000000, 000000--  DATA-ACK
                        <-000000, 000001--  DATA [   35 bytes]
              DATA-ACK  --000001, 000000->
                        <-000000, 000001--  PROCESSOR-OUTAGE
 [ 35 bytes]      DATA  --000002, 000000->
                                              !msu
                                              :clear buffers
                                              :clear lpo
                                              :msu
                        <-000000, 000001--  PROCESSOR-RECOVERED
 [ 35 bytes]      DATA  --000003, 000000->
                 READY  --000000, 000000->
 [ 35 bytes]      DATA  --000001, 000000->
                        <-000000, 000001--  DATA [   35 bytes]
              DATA-ACK  --000001, 000001->
                        <-000001, 000001--  DATA-ACK
                                              !msu
```

Figure 3.4.1-1. Set and clear LPO while link in service

Test Description:

(1) The test begins with the link in the "In Service" state.

(2) Send one data mesage from SP B to SP A.

(3) Send two MSUs from SP A and issue a Level 3 "Set Local Processor Outage" command at SP A.

(4) Send another data message from SP B to SP A and acknowledge the first data message sent from SP A.

(5) Check that SP A sends two Data messages and acknowledges one data message before sending a status "Processor Outage" message.

(6) Check that the second data message sent after "Set Local Processor Outage" was asserted is not acknowledged or indicated.

(7) Upon receiving a status "Processor Outage" message from SP A, send another data message to SP A from SP B.

(8) Check that this last message is neither acknolwedged by nor indicated at SP A.

(9) Issue Level 3 "Clear Buffers" and Level 3 "Clear Local Processor Outage" commands at SP A and send another MSU from SP A.

(10) Check that SP A sends a status "Processor Outage Ended" message.

(11) Send another data message to SP A and send a status "Ready" message from SP B to SP A with the appropriate sequence numbers.

(12) Check that the message sent before status "Ready" is neither acknolwedged by nor indicated at SP A.

(13) Send another data message to SP A.

(14) Check that SP A and SP B exchange this last set of data messages and acknowledgements.

3.4.1.2. Reverse Direction

This test is in the reverse direction, where the IUT suffers remote processor outage. The expected sequence of events is illustrated in *Figure 3.4.1-2*.

Reference: Q.781/Test 4.1

```
IOT:             SP B                       SP A
VAT:               PT                       IUT

                                            :msu
 [ 35 bytes]     DATA  --000000, FFFFFF->
                                            :msu
                       <-FFFFFF, 000000--  DATA [   35 bytes]
                       <-000000, 000000--  DATA-ACK
                       <-000000, 000001--  DATA [   35 bytes]
             DATA-ACK  --000000, 000000->
     PROCESSOR-OUTAGE  --000001, 000000->
 [ 35 bytes]     DATA  --000001, 000000->
                                            :msu
                       <-000001, 000001--  DATA-ACK
                                            !msu
                                            !rpo
                                            !msu
  PROCESSOR-RECOVERED  --000001, 000000->
 [ 35 bytes]     DATA  --000002, 000000->
                       <-000001, 000000--  READY
                       <-000001, 000001--  DATA [   35 bytes]
             DATA-ACK  --000001, 000001->
                       <-000002, 000001--  DATA-ACK
                                            !rpr
                                            !msu
```

Figure 3.4.1-2. Set and clear LPO while link in service

Test Description:

(1) The test begins with the link in the "In Service" state.

(2) Send two data messages from SP A to SP B and one data message from SP B to SP A.

(3) Check that SP A acknowledges the data message sent from SP B to SP A.

(4) Send a "Data Ack" message from SP B to SP A acknolwedging the first data message and send a status "Processor Outage" message.

(5) Send another data message from SP B to SP A and send another MSU from SP A to SP B (during the processor outage period).

(6) Check that SP A acknolwedges the data message sent to it during the processor outage period.

(7) Check that SP A does not issue a data message for the MSU requested at SP A after receipt of status "Processor Outage".

(8) Check that SP A indicates both MSUs and "Remote Processor Outage" to Level 3.

(9) Wait for T7 to ensure that SP A does not require acknowledgement to the data message sent before processor outage was invoked.

(10) Send a status "Processor Recovered" message to SP A.

(11) Check that SP A responds with a status "Ready" message and indicates "Remote Processor Recovered" to Level 3.

(12) Check that SP A sends a data message for the MSU that was requested during processor outage.

(13) Send a "Data Ack" message to SP A to acknowledge the data message.

(14) Send a data message to SP A.

(15) Check that SP A acknolwedges the data message with a "Data Ack" message with the appropriate sequence numbers.

3.4.2. RPO during LPO

This test case validates the response of the IUT to receiving a status "Processor Outage" message and status "Processor Recovered" message while in the "Processor Outage" state with LPO set at the IUT. The expected sequence of events is illustrated in *Figure 3.4.2-1*.

Reference: Q.781/Test 4.2

```
IOT:             SP B                        SP A
VAT:               PT                        IUT

                                             :set lpo
                       <------------------   PROCESSOR-OUTAGE
             set lpo:
     PROCESSOR-OUTAGE  ------------------>
                                             !rpo
           clear lpo:
  PROCESSOR-RECOVERED  ------------------>
                       <------------------   READY
                                             !rpr
```

Figure 3.4.2-1. RPO during LPO

Test Description:

(1) The test begins with the link in the "In Service" state.

(2) Issue a Level 3 "Set Local Processor Outage" command at SP A.

(3) Check that SP A sends a status "Processor Outage" message.

(4) Issue a Level 3 "Set Local Processor Outage" command at SP B and send a status "Processor Outage" message to SP A.

(5) Check that SP A indicates "Remote Processor Outage" to Level 3 at SP A.

(6) Issue a level 3 "Clear Local Processor Outage" command at SP B and send a status "Processor Recovered" message to SP A.

(7) Check that SP A sends a status "Ready" message in the data stream and indicates "Remote Processor Recovered" to Level 3 at SP A.

3.4.3. Clear LPO when "Both processor outage"

This test case validates the response of the IUT to the receipt of a Level 3 "Clear Local Processor Outage" command when the IUT is in the "Processor Outage" state with both processors marked PO. The expected sequence of events is illustrated in *Figure 3.4.3-1*.

Reference: Q.781/Test 4.3

```
 IOT:              SP B                        SP A
 VAT:                PT                        IUT

                                               :set lpo
                        <-----------------     PROCESSOR-OUTAGE
            :set lpo
     PROCESSOR-OUTAGE   ----------------->
                                               !rpo
                                               :clear lpo
                        <-----------------     PROCESSOR-RECOVERED
                READY   ----------------->
                                               !rpo
          :clear lpo
  PROCESSOR-RECOVERED   ----------------->
                        <-----------------     READY
                                               !rpr
```

Figure 3.4.3-1. Clear LPO when "Both processor outage"

Test Description:

(1) The test begins with the link in the "In Service" state.

(2) Issue a Level 3 "Set Local Processor Outage" command at SP A.

(3) Check that SP A sends a status "Processor Outage" message.

(4) Issue a Level 3 "Set Local Processor Outage" command at SP B and send a status "Processor Outage" message to SP A.

(5) Check that SP A indicates "Remote Processor Outage" to Level 3 at SP A.

(6) Issue a Level 3 "Clear Local Processor Outage" command at SP A.

(7) Check that SP A sends a status "Processor Ended" message and SP B sends a status "Ready" message.

(8) Issue a Level 3 "Clear Local Processor Outage" command at SP B and send a status "Processor Recovered" message to SP A.

(9) Check that SP A sends a status "Ready" message, indicates "Remote Processor Recovered" to Level 3 at SP A and remains in the "In Service" state.

3.5. SU delimitation, alignment, error detection and correction

Most of the test cases in this section are not applicable to M2PA operation.

3.5.1. More than 7 ones between MSU opening and closing flags

This test case is not applicable to M2PA. The expected sequence of events is illustrated in *Figure 3.5.1-1*.

Reference: Q.781/Test 5.1

```
 ____________________________________________________________________
|                                                                    |
| VAT:                PT                       IUT                   |
|                                                                    |
|                                                                    |
|                           NOT APPLICABLE                           |
|____________________________________________________________________|
```

Figure 3.5.1-1. Not applicable

Test Description:

(1) Not applicable.

3.5.2. Greater than maximum signal unit length

This test case is not applicable to M2PA. The expected sequence of events is illustrated in *Figure 3.5.2-1*.

Reference: Q.781/Test 5.2

```
 ________________________________________________________________________
|                                                                        |
| VAT:               PT                        IUT                       |
|                                                                        |
|                                                                        |
|                              NOT APPLICABLE                            |
|________________________________________________________________________|
```

Figure 3.5.2-1. Not applicable

Test Description:

(1) Not applicable.

3.5.3. Below minimum signal unit length

This test case validates the IUT response to a Data message with a payload below the minimum MSU length. The expected sequence of events is illustrated in *Figure 3.5.3-1*.

Reference: Q.781/Test 5.3

```
 ________________________________________________________________________
|                                                                        |
| VAT:               PT                        IUT                       |
|                                                                        |
|  [  1 bytes]     DATA  --000000, FFFFFF->                              |
|                                                                        |
|________________________________________________________________________|
```

Figure 3.5.3-1. Below minimum signal unit length

Test Description:

(1) The test begins with the link in the "In Service" state.

(2) Send a Data message with one byte of payload to the IUT.

(3) Check that the IUT does not acknowledge the Data message and remains in the "In Service" state.

3.5.4. Reception of single and multiple flags between FISUs

This test case is not applicable to M2PA. The expected sequence of events is illustrated in *Figure 3.5.4-1*.

Reference: Q.781/Test 5.4(a)

```
 ____________________________________________________________________
|                                                                    |
| VAT:               PT                       IUT                    |
|                                                                    |
|                                                                    |
|                             NOT APPLICABLE                         |
|____________________________________________________________________|
```

Figure 3.5.4-1. Not applicable

Test Description:

(1) Not applicable.

This test case is not applicable to M2PA. The expected sequence of events is illustrated in *Figure 3.5.4-2*.

Reference: Q.781/Test 5.4(b)

```
 ____________________________________________________________________
|                                                                    |
| VAT:               PT                       IUT                    |
|                                                                    |
|                                                                    |
|                             NOT APPLICABLE                         |
|____________________________________________________________________|
```

Figure 3.5.4-2. Not applicable

Test Description:

(1) Not applicable.

3.5.5. Reception of single and multiple flags between MSUs

This test case is not applicable to M2PA. The expected sequence of events is illustrated in *Figure 3.5.5-1*.

Reference: Q.781/Test 5.5(a)

```
 ____________________________________________________________________
|                                                                    |
| VAT:               PT                       IUT                    |
|                                                                    |
|                                                                    |
|                             NOT APPLICABLE                         |
|____________________________________________________________________|
```

Figure 3.5.5-1. Not applicable

Test Description:

(1) Not applicable.

This test case is not applicable to M2PA. The expected sequence of events is illustrated in *Figure 3.5.5-2*.

Reference: Q.781/Test 5.5(b)

```
 ____________________________________________________________________
|                                                                    |
| VAT:               PT                        IUT                   |
|                                                                    |
|                                                                    |
|                          NOT APPLICABLE                            |
|____________________________________________________________________|
```

Figure 3.5.5-2. Not applicable

Test Description:

(1) Not applicable.

3.6. SUERM check

The test cases in this section are not applicable to M2PA. These tests might have corresponding tests at the SCTP layer, however, that is the topic of an SCTP test specification rather than an M2PA test specification.

3.6.1. Error rate of 1 in 256 - Link remains in service

This test case is not applicable to M2PA. The expected sequence of events is illustrated in *Figure 3.6.1-1*.

Reference: Q.781/Test 6.1

```
 ____________________________________________________________________
|                                                                    |
| VAT:               PT                        IUT                   |
|                                                                    |
|                                                                    |
|                          NOT APPLICABLE                            |
|____________________________________________________________________|
```

Figure 3.6.1-1. Not applicable

Test Description:

(1) Not applicable.

3.6.2. Error rate of 1 in 254 - Link out of service

This test case is not applicable to M2PA. The expected sequence of events is illustrated in *Figure 3.6.2-1*.

Reference: Q.781/Test 6.2

```
 ___________________________________________________________________
|                                                                   |
| VAT:              PT                      IUT                     |
|                                                                   |
|                                                                   |
|                          NOT APPLICABLE                           |
|___________________________________________________________________|
```

Figure 3.6.2-1. Not applicable

Test Description:

(1) Not applicable.

3.6.3. Consecutive corrupt SUs

This test case is not applicable to M2PA. The expected sequence of events is illustrated in *Figure 3.6.3-1*.

Reference: Q.781/Test 6.3

```
 ___________________________________________________________________
|                                                                   |
| VAT:              PT                      IUT                     |
|                                                                   |
|                                                                   |
|                          NOT APPLICABLE                           |
|___________________________________________________________________|
```

Figure 3.6.3-1. Not applicable

Test Description:

(1) Not applicable.

3.6.4. Time controlled break of the link

This test case is not applicable to M2PA. The expected sequence of events is illustrated in *Figure 3.6.4-1*.

Reference: Q.781/Test 6.4

```
 ___________________________________________________________________
|                                                                   |
| VAT:              PT                      IUT                     |
|                                                                   |
|                                                                   |
|                          NOT APPLICABLE                           |
|___________________________________________________________________|
```

Figure 3.6.4-1. Not applicable

Test Description:

(1) Not applicable.

3.7. AERM check

The test cases in this section are not applicable to M2PA. These test cases might have a corresponding test at the SCTP layer, however, that is the topic of an SCTP test specification rather than an M2PA test specification.

3.7.1. Error rate below the normal threshold

This test case is not applicable to M2PA. The expected sequence of events is illustrated in *Figure 3.7.1-1*.

Reference: Q.781/Test 7.1

```
 ____________________________________________________________________
|                                                                    |
| VAT:               PT                       IUT                    |
|                                                                    |
|                                                                    |
|                          NOT APPLICABLE                            |
|____________________________________________________________________|
```

Figure 3.7.1-1. Not applicable

Test Description:

(1) Not applicable.

3.7.2. Error rate at the normal threshold

This test case is not applicable to M2PA. The expected sequence of events is illustrated in *Figure 3.7.2-1*.

Reference: Q.781/Test 7.2

```
 ____________________________________________________________________
|                                                                    |
| VAT:               PT                       IUT                    |
|                                                                    |
|                                                                    |
|                          NOT APPLICABLE                            |
|____________________________________________________________________|
```

Figure 3.7.2-1. Not applicable

Test Description:

(1) Not applicable.

3.7.3. Error rate above the normal threshold

This test case is not applicable to M2PA. The expected sequence of events is illustrated in *Figure 3.7.3-1*.

Reference: Q.781/Test 7.3

```
 ____________________________________________________________________
|                                                                    |
| VAT:              PT                       IUT                     |
|                                                                    |
|                                                                    |
|                         NOT APPLICABLE                             |
|____________________________________________________________________|
```

Figure 3.7.3-1. Not applicable

Test Description:

(1) Not applicable.

3.7.4. Error rate at the emergency threshold

This test case is not applicable to M2PA. The expected sequence of events is illustrated in *Figure 3.7.4-1*.

Reference: Q.781/Test 7.4

```
 ____________________________________________________________________
|                                                                    |
| VAT:              PT                       IUT                     |
|                                                                    |
|                                                                    |
|                         NOT APPLICABLE                             |
|____________________________________________________________________|
```

Figure 3.7.4-1. Not applicable

Test Description:

(1) Not applicable.

3.8. Transmission and reception control (Basic)

A number of test cases in this section are not applicable to M2PA. Some may be the topic of a test specification for SCTP but are not applicable to M2PA. Test cases that are applicable in this section validate the basic transmission, reception and acknowledgments of Data messages with status "Data Ack" messages.

3.8.1. Data transmission and reception

This test case validates the IUT response to the sending and receipt of Data and "Data Ack" messages. The expected sequence of events is illustrated in *Figure 3.8.1-1*.

Reference: Q.781/Test 8.1

```
 _____________________________________________________________________
|                                                                     |
| CPT: IOT:        SP B                     SP A                      |
| VAT:               PT                     IUT                       |
|                                                                     |
|  [ 35 bytes]     DATA  --000000, FFFFFF->                           |
|                        <-000000, FFFFFF--  DATA-ACK                 |
|                                            !msu                     |
|                                            :msu                     |
|                        <-000000, 000000--  DATA [   35 bytes]       |
|              DATA-ACK  --000000, 000000->                           |
|                                                                     |
|_____________________________________________________________________|
```

Figure 3.8.1-1. Data transmission and reception

Test Description:

(1) This test begins with the link in the "In Service" state.

(2) Send a Data message to SP A.

(3) Check that SP A sends a "Data Ack" message acknowledging the received Data message and delivers the received MSU to Level 3 at SP A.

(4) Issue a Level 3 MSU to SP A.

(5) Check that SP A sends a Data message.

(6) Send a "Data Ack" message to SP A acknowledging the data message.

(7) Check that SP A receives the acknowledgments by waiting longer than time T7 and ensuring that SP A stays in the "In Service" state.

3.8.2. Negative acknowledgments of an MSU

M2PA does not perform negative acknowledgments at the M2PA layer. Negative acknowledgments are performed as necessary by the underlying SCTP transport. As such, test cases involving negative acknowledgments are not applicable. The expected sequence of events is illustrated in *Figure 3.8.2-1*.

Reference: Q.781/Test 8.2

```
 _____________________________________________________________________
|                                                                     |
| VAT:                PT                        IUT                   |
|                                                                     |
|                                                                     |
|                           NOT APPLICABLE                            |
|_____________________________________________________________________|
```

Figure 3.8.2-1. Not Applicable

Test Description:

(1) Not applicable.

3.8.3. Check RTB full

This test case validates the IUT response to an RTB full condition at the IUT. The expected sequence of events is illustrated in *Figure 3.8.3-1*.

Reference: Q.781/Test 8.3

```
 VAT:                PT                      IUT

                                             :msu
                                             :msu
                                             :msu
                                                     .
                                                     .
                                                     .
                                                     Ct=  254

                         <-FFFFFF, 000000--  DATA [   35 bytes]
                         <-FFFFFF, 000001--  DATA [   35 bytes]
                         <-FFFFFF, 000002--  DATA [   35 bytes]
                                                     .
                                                     .
                                                     .
                                                     Ct=  127
               DATA-ACK  --FFFFFF, 00007F->
                         <-FFFFFF, 000080--  DATA [   35 bytes]
                         <-FFFFFF, 000081--  DATA [   35 bytes]
                         <-FFFFFF, 000082--  DATA [   35 bytes]
                                                     .
                                                     .
                                                     .
                                                     Ct=  127
               DATA-ACK  --FFFFFF, 0000FE->
```

Figure 3.8.3-1. Check RTB full

Test Description:

(1) This test begins with the link in the "In Service" state.

(2) Send 2 x N2 MSUs at the IUT.

(3) Check that the IUT sends N2 Data messages and then stops sending Data messages (RTB Full condition).

(4) Acknowledge the N2 Data messages in a single "Data Ack" message.

(5) Check that the IUT sends another N2 Data messages.

(6) Acknowledge the N2 Data messages in a single "Data Ack" message.

(7) Check that the IUT remains in the "In Service" state longer than time T7.

3.8.4. Single invalid Ack

This test case validates the response of the IUT to a single invalid "Data Ack" message. The expected sequence of events is illustrated in *Figure 3.8.4-1*.

Reference: Q.781/Test 8.4

```
 VAT:                PT                          IUT

              DATA-ACK  --FFFFFF, FFFFFF->
                                                 :msu
                        <-FFFFFF, 000000--  DATA [   35 bytes]
              DATA-ACK  --FFFFFF, 000000->
  [ 35 bytes]     DATA  --000000, 000000->
                        <-000000, 000000--  DATA-ACK
                                                 !msu
```

Figure 3.8.4-1. Single invalid Ack

Test Description:

(1) This test begins with the link in the "In Service" state.

(2) Send an invalid "Data Ack" message to the IUT.

(3) Send an MSU at the IUT.

(4) Check that the IUT sends a Data message.

(5) Acknowledge the Data message with a "Data Ack" message to the IUT

(6) Send an Data message to the IUT.

(7) Check that the IUT acknowledges the Data message with a "Data Ack" message and delivers an MSU to Level 3 at the IUT.

3.8.5. Duplicated FSN

This test validates the response of the IUT to a single Data message which has a repeated Forward Sequence Number. The expected sequence of events is illustrated in *Figure 3.8.5-1*.

Reference: Q.781/Test 8.5

```
 ______________________________________________________________________
|                                                                      |
| VAT:                PT                     IUT                       |
|                                                                      |
|  [ 35 bytes]     DATA  --000000, FFFFFF->                            |
|                        <-000000, FFFFFF--  DATA-ACK                  |
|  [ 35 bytes]     DATA  --000000, FFFFFF->                            |
|                                            !msu                      |
|  [ 35 bytes]     DATA  --000001, FFFFFF->                            |
|                        <-000001, FFFFFF--  DATA-ACK                  |
|                                            !msu                      |
|                                                                      |
|______________________________________________________________________|
```

Figure 3.8.5-1. Duplicated FSN

Test Description:

(1) This test begins with the link in the "In Service" state.

(2) Send an valid Data message to the IUT.

(3) Check that the IUT acknowledges the Data message and delivers an M3U to Level 3 at the IUT.

(4) Send an invalid Data message that contains the same FSN as the previous Data message to the IUT.

(5) Check that the IUT does not deliver an MSU to Level 3 at the IUT.

(6) Send a valid Data message to the IUT.

(7) Check that the IUT acknowledges the Data message and delivers an M3U to Level 3 at the IUT.

(8) Check that the IUT maintains the "In Service" state.

3.8.6. Erroneous retransmission - Single MSU

Retransmission of DATA messages is performed by SCTP for M2PA and as such the related Q.781 tests are not applicable. The expected sequence of events is illustrated in *Figure 3.8.6-1*.

Reference: Q.781/Test 8.6

```
 ______________________________________________________________________
|                                                                      |
| VAT:                PT                     IUT                       |
|                                                                      |
|                                                                      |
|                            NOT APPLICABLE                            |
|______________________________________________________________________|
```

Figure 3.8.6-1. Not Applicable

Test Description:

(1) Not applicable.

3.8.7. Erroneous retransmission - Multiple FISUs

Retransmission of DATA messages is performed by SCTP for M2PA and as such the related Q.781 tests are not applicable. The expected sequence of events is illustrated in *Figure 3.8.7-1*.

Reference: Q.781/Test 8.7

```
 ____________________________________________________________________
|                                                                    |
| VAT:                PT                        IUT                  |
|                                                                    |
|                                                                    |
|                          NOT APPLICABLE                            |
|____________________________________________________________________|
```

Figure 3.8.7-1. Not Applicable

Test Description:

(1) Not applicable.

3.8.8. Single FISU with corrupt FIB

The expected sequence of events is illustrated in *Figure 3.8.8-1*.

Reference: Q.781/Test 8.8

```
 ____________________________________________________________________
|                                                                    |
| VAT:                PT                        IUT                  |
|                                                                    |
|                                                                    |
|                          NOT APPLICABLE                            |
|____________________________________________________________________|
```

Figure 3.8.8-1. Not Applicable

Test Description:

(1) Not applicable.

3.8.9. In Service prior to RPO being set

3.8.9.1. Forward Direction

This test is for the forward direction where the PT suffers local processor outage. The expected sequence of events is illustrated in *Figure 3.8.9-1*.

Reference: Q.781/Test 8.9

```
 IOT:             SP B                     SP A
 VAT:               PT                     IUT

                  :msu
              :set lpo
     PROCESSOR-OUTAGE  ----------------->
                                           !rpo
  [ 35 bytes]     DATA  --000000, FFFFFF->
                        <-000000, FFFFFF--  DATA-ACK
                                           !msu
            :clear lpo
   PROCESSOR-RECOVERED  --000000, FFFFFF->
                        <-000000, FFFFFF--  READY
                                           !rpr
                  :msu
  [ 35 bytes]     DATA  --000001, FFFFFF->
                        <-000001, FFFFFF--  DATA-ACK
                                           !msu
```

Figure 3.8.9-1. In service prior to RPO being set

Test Description:

(1) The test beings with the link in the "In Service" state.

(2) Issue a Level 3 "Set Local Processor Outage" command at SP B and send a status "Processor Outage" message to SP A.

(3) Check that SP A indicates "Remote Processor Outage" to Level 3 at SP A.

(4) Send one User Data message to SP A.

(5) Check that SP A acknowledges the Data message with a "Data Ack" within timer T7 and that the MSU is delivered ot Level 3 at SP A.

(6) Issue a Level 3 "Clear Local Processor Outage" command at SP B and send a status "Processor Recovered" message to SP A.

(7) Check that SP A sends a status "Ready" message in the data stream and indicates "Remote Processor Recovered" to Level 3 at SP A.

(8) Send one User Data message to SP A.

(9) Check that SP A acknowledges the Data message with a "Data Ack" and that the MSU is delivered to Level 3 at SP A.

(10) Check that SP A remains in the "In Service" state.

3.8.9.2. Reverse Direction

This test is for the reverse direction where the IUT suffers local processor outage. The expected sequence of events is illustrated in *Figure 3.8.9-2*.

Reference: Q.781/Test 8.9

```
IOT:              SP B                      SP A
VAT:                PT                      IUT

                                            :msu
                      <-FFFFFF, 000000--    DATA [   35 bytes]
                                            :set lpo
                      <------------------   PROCESSOR-OUTAGE
             DATA-ACK --FFFFFF, 000000->
                                            :clear lpo
                      <-FFFFFF, 000000--    PROCESSOR-RECOVERED
                READY --FFFFFF, 000001->
                                            :msu
                      <-FFFFFF, 000001--    DATA [   35 bytes]
             DATA-ACK --FFFFFF, 000001->
```

Figure 3.8.9-2. In service prior to RPO being set

Test Description:

(1) The test beings with the link in the "In Service" state.

(2) Issue one MSU at SP A and then issue a Level 3 "Set Local Processor Outage" command at SP A.

(3) Check that SP A sends a User Data message followed by a status "Processor Outage" message.

(4) Send a "Data Ack" message from SP B acknowledging the User Data message from SP A and issue a Level 3 "Clear Local Processor Outage" command at SP A.

(5) Check that SP A sends a status "Processor Recovered" message and that the FSN of the status "Processor Recovered" message is the FSN of the acknowledged User Data message.

(6) Send a status "Ready" message to the IUT on the data stream.

(7) Issue one MSU at SP A.

(8) Check that SP A sends a User Data message and that the FSN of the user data message is incremented by one from the FSN of the status "Processor Recovered" message.

(9) Send a "Data Ack" message from SP B acknowledging the User Data message from SP A.

(10) Check that SP A remains in the "In Service" state.

3.8.10. Abnormal BSN - single Data message

This test validates the behavior of the IUT to receiving a single abnormal Backward Sequence Number in a Data message. The expected sequence of events is illustrated in *Figure 3.8.10-1*.

Reference: Q.781/Test 8.10

```
VAT:                PT                      IUT

  [ 35 bytes]     DATA  --000000, 7FFFFF->
                        <-000000, FFFFFF--  DATA-ACK
                                            !msu
  [ 35 bytes]     DATA  --000001, FFFFFF->
                        <-000001, FFFFFF--  DATA-ACK
                                            !msu
```

Figure 3.8.10-1. Abnormal BSN - single Data message

Test Description:

(1) The test begins with the link in the "In Service" state.

(2) Send a Data message to the IUT with an abnormal Backward Sequence Number.

(3) Check that the IUT acknowledges the Data message delivers an MSU to Level 3 at the IUT.

(4) Send a Data message to the IUT with an normal Backward Sequence Number.

(5) Check that the IUT acknowledges the Data message delivers an MSU to Level 3 at the IUT.

(6) Check that the IUT maintains the "In Service" state.

3.8.11. Abnormal BSN - two consecutive messages

This test validates the reponse of the IUT to receiving two consecutive abnormal Backward Sequence Numbers. The expected sequence of events is illustrated in *Figure 3.8.11-1*.

Reference: Q.781/Test 8.11

```
 ____________________________________________________________________
|                                                                    |
| VAT:                PT                      IUT                    |
|                                                                    |
|             DATA-ACK  --FFFFFF, 7FFFFF->                           |
|             DATA-ACK  --FFFFFF, 7FFFFF->                           |
|             DATA-ACK  --FFFFFF, FFFFFF->                           |
|                       <-----------------  OUT-OF-SERVICE           |
|                                           !out of service          |
|                                                                    |
|____________________________________________________________________|
```

Figure 3.8.11-1. Abnormal BSN - two consecutive messages

Test Description:

(1) The test begins with the link in the "In Service" state.

(2) Send two "Data Ack" messages with an abnormal Backward Sequence Number.

(3) Send a "Data Ack" message with an normal Backward Sequence Number.

(4) Check that the IUT responds with a status "Out of Service" message and indicates "Out of Service" to Level 3 at the IUT.

3.8.12. Excessive delay of acknowledgments

This test case validates the IUT response to a excessively delayed acknowledgment.

3.8.12.1. Excessive delay of acknowledgment (single Data)

This test checks excessive delay of acknowledgment where a single User Data message is sent. The expected sequence of events is illustrated in *Figure 3.8.12-1*.

Reference: Q.781/Test 8.12

```
 ____________________________________________________________________
|                                                                    |
| VAT:                PT                      IUT                    |
|                                                                    |
|                                           :msu                     |
|                       <-FFFFFF, 000000--  DATA [   35 bytes]       |
|                             !                                      |
|                             !  T7         0.5 <= T7 <= 2.0         |
|                             !                                      |
|                       <-----------------  OUT-OF-SERVICE           |
|                                           !out of service(T7)      |
|                                                                    |
|____________________________________________________________________|
```

Figure 3.8.12-1. Excessive delay of acknowledgments

Test Description:

(1) This test case begins with the link in the "In Service" state.

(2) Send an MSU from the IUT.

(3) Check that the IUT sends a status "Out of Service" message and indicates "Out of Service" to Level 3 at the IUT with reason "T7 Timeout" and that the link remains in the "Out of Service" state.

(4) Check that the T7 is between 0.5 seconds and 2.0 seconds in duration.

3.8.12.2. Excessive delay of acknowledgment (multiple Data)

This test checks excessive delay of acknowledgment where a multiple User Data messages are sent. Unlike MTP2 [Q.703], [T1.111] requires that the excessive delay of acknowledgment timer T7 expire when the oldest unacknowledged User Data message is over T7 old. This test sends User Data messages while T7 is running to ensure that the IUT does not restart T7 on the receipt of User Data. The expected sequence of events is illustrated in *Figure 3.8.12-2*.

Reference: Q.781/Test 8.12

```
 ___________________________________________________________________
|                                                                   |
| VAT:               PT                      IUT                    |
|                                                                   |
|                                            :msu                   |
|                        <-FFFFFF, 000000--  DATA [   35 bytes]     |
|                              !                                    |
|                              !  T7         0.5 <= T7 <= 2.0       |
|                              !                                    |
|                        <-FFFFFF, 000001--  DATA [   35 bytes]     |
|                              !                                    |
|                        <-----------------  OUT-OF-SERVICE         |
|                                            !out of service(T7)    |
|                                                                   |
|___________________________________________________________________|
```

Figure 3.8.12-2. Excessive delay of acknowledgments

Test Description:

(1) This test case begins with the link in the "In Service" state.

(2) Send an MSU from the IUT.

(3) Wait a short period less than T7 and then send another MSU from the IUT.

(4) Check that the IUT sends a status "Out of Service" message and indicates "Out of Service" to Level 3 at the IUT with reason "T7 Timeout" and that the link remains in the "Out of Service" state.

(5) Check that the T7 is between 0.5 seconds and 2.0 seconds in duration starting from the oldest unacknowledged DATA message.

3.8.13. Level 3 Stop command

This test case validates the response of the IUT to the Level 3 "Stop" command while in the "In Service" state. The expected sequence of events is illustrated in *Figure 3.8.13-1*.

Reference: Q.781/Test 8.13

```
 IOT:             SP B                          SP A
 VAT:               PT                          IUT

                                                :stop
                        <------------------     OUT-OF-SERVICE
        OUT-OF-SERVICE  ------------------>
                        <------------------     OUT-OF-SERVICE (Note)
 (Note) OUT-OF-SERVICE  ------------------>
```

Figure 3.8.13-1. Level 3 Stop command

Test Description:

(1) This test begins with the link in the "In Service" state.

(2) Issue the Level 3 "Stop" command at SP A.

(3) Check that SP A sends a status "Out of Service" message and remains in the "Out of Service" state. (Note that SP A or B may send additional status "Out of Service" messages.)

3.9. Transmission and Reception Control (PCR)

M2PA does not perform Preventative Cyclic Retransmission and, therefore, the test cases in this section are not applicable to M2PA.

3.9.1. MSU transmission and reception

This test case is not applicable to M2PA. The expected sequence of events is illustrated in *Figure 3.9.1-1*.

Reference: Q.781/Test 9.1

```
 CPT:             SP B                          SP A
 VAT:               PT                          IUT

                            NOT APPLICABLE
```

Figure 3.9.1-1. Not Applicable

Test Description:

(1) Not applicable.

3.9.2. Priority control

This test case is not applicable to M2PA. The expected sequence of events is illustrated in *Figure 3.9.2-1*.

Reference: Q.781/Test 9.2

```
 ____________________________________________________________________
|                                                                    |
| VAT:               PT                       IUT                    |
|                                                                    |
|                                                                    |
|                          NOT APPLICABLE                            |
|____________________________________________________________________|
```

Figure 3.9.2-1. Not Applicable

Test Description:

(1) Not applicable.

3.9.3. Forced retransmission with the value N1

This test case is not applicable to M2PA. The expected sequence of events is illustrated in *Figure 3.9.3-1*.

Reference: Q.781/Test 9.3

```
 ____________________________________________________________________
|                                                                    |
| VAT:               PT                       IUT                    |
|                                                                    |
|                                                                    |
|                          NOT APPLICABLE                            |
|____________________________________________________________________|
```

Figure 3.9.3-1. Not Applicable

Test Description:

(1) Not applicable.

3.9.4. Forced retransmission with the value N2

This test case is not applicable to M2PA. The expected sequence of events is illustrated in *Figure 3.9.4-1*.

Reference: Q.781/Test 9.4

```
 ____________________________________________________________
|                                                            |
| VAT:              PT                      IUT              |
|                                                            |
|                                                            |
|                         NOT APPLICABLE                     |
|____________________________________________________________|
```

Figure 3.9.4-1. Not Applicable

Test Description:

(1) Not applicable.

3.9.5. Forced retransmission cancel

This test case is not applicable to M2PA. The expected sequence of events is illustrated in *Figure 3.9.5-1*.

Reference: Q.781/Test 9.5

```
 ____________________________________________________________
|                                                            |
| VAT:              PT                      IUT              |
|                                                            |
|                                                            |
|                         NOT APPLICABLE                     |
|____________________________________________________________|
```

Figure 3.9.5-1. Not Applicable

Test Description:

(1) Not applicable.

3.9.6. Reception of forced retransmission

This test case is not applicable to M2PA. The expected sequence of events is illustrated in *Figure 3.9.6-1*.

Reference: Q.781/Test 9.6

```
 ____________________________________________________________
|                                                            |
| VAT:              PT                      IUT              |
|                                                            |
|                                                            |
|                         NOT APPLICABLE                     |
|____________________________________________________________|
```

Figure 3.9.6-1. Not Applicable

Test Description:

(1) Not applicable.

3.9.7. MSU transmission while RPO set

This test case is not applicable to M2PA. The expected sequence of events is illustrated in *Figure 3.9.7-1*.

Reference: Q.781/Test 9.7

```
 ____________________________________________________________________
|                                                                    |
| VAT:                PT                        IUT                  |
|                                                                    |
|                                                                    |
|                          NOT APPLICABLE                            |
|____________________________________________________________________|
```

Figure 3.9.7-1. Not Applicable

Test Description:

(1) Not applicable.

3.9.8. Abnormal BSN - Single MSU

This test case is not applicable to M2PA. The expected sequence of events is illustrated in *Figure 3.9.8-1*.

Reference: Q.781/Test 9.8

```
 ____________________________________________________________________
|                                                                    |
| VAT:                PT                        IUT                  |
|                                                                    |
|                                                                    |
|                          NOT APPLICABLE                            |
|____________________________________________________________________|
```

Figure 3.9.8-1. Not Applicable

Test Description:

(1) Not applicable.

3.9.9. Abnormal BSN - Two MSUs

This test case is not applicable to M2PA. The expected sequence of events is illustrated in *Figure 3.9.9-1*.

Reference: Q.781/Test 9.9

```
 ______________________________________________________________________
|                                                                      |
| VAT:                PT                       IUT                     |
|                                                                      |
|                                                                      |
|                           NOT APPLICABLE                             |
|______________________________________________________________________|
```

Figure 3.9.9-1. Not Applicable

Test Description:

(1) Not applicable.

3.9.10. Unexpected FSN

This test case is not applicable to M2PA. The expected sequence of events is illustrated in *Figure 3.9.10-1*.

Reference: Q.781/Test 9.10

```
 ______________________________________________________________________
|                                                                      |
| VAT:                PT                       IUT                     |
|                                                                      |
|                                                                      |
|                           NOT APPLICABLE                             |
|______________________________________________________________________|
```

Figure 3.9.10-1. Not Applicable

Test Description:

(1) Not applicable.

3.9.11. Excessive delay of acknowledgments

This test case is not applicable to M2PA. The expected sequence of events is illustrated in *Figure 3.9.11-1*.

Reference: Q.781/Test 9.11

```
 ______________________________________________________________________
|                                                                      |
| VAT:                PT                       IUT                     |
|                                                                      |
|                                                                      |
|                           NOT APPLICABLE                             |
|______________________________________________________________________|
```

Figure 3.9.11-1. Not Applicable

Test Description:

(1) Not applicable.

3.9.12. FISU with FSN expected for MSU

This test case is not applicable to M2PA. The expected sequence of events is illustrated in *Figure 3.9.12-1*.

Reference: Q.781/Test 9.12

```
 ____________________________________________________________________
|                                                                    |
| VAT:              PT                        IUT                    |
|                                                                    |
|                                                                    |
|                         NOT APPLICABLE                             |
|____________________________________________________________________|
```

Figure 3.9.12-1. Not Applicable

Test Description:

(1) Not applicable.

3.9.13. Level 3 Stop command

This test case is not applicable to M2PA. The expected sequence of events is illustrated in *Figure 3.9.13-1*.

Reference: Q.781/Test 9.13

```
 ____________________________________________________________________
|                                                                    |
| VAT:              PT                        IUT                    |
|                                                                    |
|                                                                    |
|                         NOT APPLICABLE                             |
|____________________________________________________________________|
```

Figure 3.9.13-1. Not Applicable

Test Description:

(1) Not applicable.

3.10. Congestion Control

3.10.1. Congestion abatement

This test case validates the response of the IUT to the Level 3 "Congestion" and "Congestion Ceases" conditions. The expected sequence of events is illustrated in *Figure 3.10.1-1*.

Reference: Q.781/Test 10.1

```
 ________________________________________________________________________
|                                                                        |
| VAT:               PT                        IUT                       |
|                                                                        |
|                                              :make cong discard        |
|                        <-----------------   BUSY                       |
|                        <-----------------   BUSY (Note)                |
|                                              :clear congestion         |
|                        <-----------------   BUSY-ENDED                 |
|                                                                        |
|________________________________________________________________________|
```

Figure 3.10.1-1. Congestion abatement

Test Description:

(1) This test begins with the link in the "In Service" state.

(2) Generate a local Level 3 "Congestion" condition at the IUT.

(3) Check that the IUT sends a status "Busy" message. (Note that the IUT may send additional status "Busy" messages before sending a status "Busy Ended" message.)

(4) Generate a local Level 3 "Congestion Ceases" condition at the IUT.

(5) Check that the IUT sends a status "Busy Ended" message.

3.10.2. Timer T7

This test case validates timer T7 and procedures at the IUT.

3.10.2.1. Timer T7 during Receive Congestion

This test case validates that timer T7 will not expire during receive congestion period. The expected sequence of events is illustrated in *Figure 3.10.2-1*.

Reference: Q.781/Test 10.2

```
 IOT:             SP B                        SP A
 VAT:               PT                        IUT

                                              :msu
                       <-FFFFFF, 000000--  DATA [   35 bytes]
                  BUSY  ----------------->
                              !
                              !  T7          0.5 <= T7 <= 2.0
                              !
           BUSY-ENDED  ----------------->
             DATA-ACK  --FFFFFF, 000000->
```

Figure 3.10.2-1. Timer T7

Test Description:

(1) The test begins with the link in the "In Service" state.

(2) Send an MSU at SP A.

(3) Wait for longer than T7 (but less than T6) and then send a Link Status "Busy Ended" message and acknowledge the User Data message with a "Data Ack" message to SP A.

(4) Check that SP A sends no further status messages and remains in the "In Service" state.

3.10.2.2. Timer T7 expiry after Receive Congestion

This test case validates that timer T7 will expire after receive congestion period. The expected sequence of events is illustrated in *Figure 3.10.2-2*.

Reference: Q.781/Test 10.2

```
 ____________________________________________________________________
|                                                                    |
| VAT:               PT                       IUT                    |
|                                                                    |
|                                             :msu                   |
|                        <-FFFFFF, 000000--   DATA [   35 bytes]     |
|                  BUSY  ----------------->                          |
|                              !                                     |
|                              !  T6          3.0 <= T6 <= 6.0       |
|                              !                                     |
|            BUSY-ENDED  ----------------->                          |
|                              !                                     |
|                              !  T7          0.5 <= T7 <= 2.0       |
|                              !                                     |
|                        <-----------------   OUT-OF-SERVICE         |
|                                             !out of service(T7)    |
|                                                                    |
|____________________________________________________________________|
```

Figure 3.10.2-2. Timer T7

Test Description:

(1) The test begins with the link in the "In Service" state.

(2) Send an MSU at the IUT.

(3) Wait for a period less than T6 (but longer than T7) and then send a "Link Status Busy Ended" message not acknowledging the User Data.

(4) Check that the IUT sends a status "Out of Service" message and indicates "Out of Service" to Level 3 at the IUT with reason "T7 Timeout" and that the link remains in the "Out of Service" state.

(5) Check that the T7 is between 0.5 seconds and 2.0 seconds in duration.

3.10.2.3. Timer T7 after Receive Congestion

This test case validates timer T7 after the receive congestion period. The expected sequence of events is illustrated in *Figure 3.10.2-3*.

Reference: Q.781/Test 10.2

```
VAT:                 PT                       IUT

                                              :msu
                        <-FFFFFF, 000000--  DATA [   35 bytes]
                   BUSY  ----------------->
                               !
                               !  T6        3.0 <= T6 <= 6.0
                               !
             BUSY-ENDED  ----------------->
                               !
                               !  T7        0.5 <= T7 <= 2.0
                               !
               DATA-ACK  --FFFFFF, 000000->
```

Figure 3.10.2-3. Timer T7

Test Description:

(1) The test begins with the link in the "In Service" state.

(2) Send an MSU at the IUT.

(3) Wait for a period less than T6 (but longer than T7) and then send a "Link Status Busy Ended" message not acknowledging the User Data.

(4) Wait for less than T7 and then acknowledge the Data message to the IUT with a "Data Ack" message.

(5) Check that the IUT sends no further status messages and remains in the "In Service" state.

3.10.3. Timer T6

This case validates timer T6 and procedures at the IUT. The expected sequence of events is illustrated in *Figure 3.10.3-1*.

Reference: Q.781/Test 10.3

```
VAT:               PT                      IUT

                                           :msu
                       <-FFFFFF, 000000--  DATA [   35 bytes]
                 BUSY  ----------------->
                             !             :msu
                             !
                             !  T6         3.0 <= T6 <= 6.0
                             !
                       <-----------------  OUT-OF-SERVICE
                                           !out of service(T6)
```

Figure 3.10.3-1. Timer T6

Test Description:

(1) The test begins with the link in the "In Service" state.

(2) Send an MSU at the IUT.

(3) Send a status "Busy" messages to the IUT.

(4) Request another MSU at the IUT.

(5) Check that the IUT sends a status "Out of Service" message and indicates "Out of Service" to Level 3 with reason "T6 Timeout" and remains in the "Out of Service" state.

(6) Check that T6 is between 3.0 seconds and 6.0 seconds in duration.

(7) Check that the IUT does not send the second MSU during the busy period.

Security Considerations

Although this document does not introduce new security considerations for M2PA, mention of the role of M2PA security measure during tested is in order.

When the Validation, Compatibility and Interoperability tests in this document are being performed, the test environment and Implementations Under Test (IUT) **MUST** use the security measures required in the Security section of the M2PA specification [M2PA] while the tests are being performed. Test results without the required security measures in place during testing will be of little value for validating the behavior of an implementation for later operation.

IANA Considerations

There are no IANA considerations for this draft.

0. Change History

This section provides historical information on the changes made to this draft. This section will be removed from the document when the document is finalized.

0.8. Changes from Version 0.7 to Version 0.8

(1) Correction to Figure 3.1.12-2 submitted by Andrew Booth.

(2) Correction to Figure 3.1.6-1 submitted by Christine Aubry.

(3) Updates for new boilerplate and idnits-2.00.1.

0.7. Changes from Version 0.6 to Version 0.7

(1) updated version numbers and resubmitted

0.6. Changes from Version 0.5 to Version 0.6

(1) The test specification has been updated to the M2PA RFC [M2PA].

(2) Updated first page and last page IETF boiler plates.

0.5. Changes from Version 0.4 to Version 0.5

(1) The test specification has been updated to M2PA Draft Revision 11 [M2PA11].

(2) Corrected error in test case 3.1.8: SP A should maintain the "Processor Outage" state and not the "In Service" state.

(3) Added status "Ready" response to receipt of state "Processor Recovered".

(4) Added sequence numbers to status "Ready" and status "Processor Recovered" message because these status values are now significant.

(5) Removed test case 3.8.14 because out of order FSNs are just discarded instead of taking the link out of service.

(6) Made test case 3.3.2, 3.3.4, 3.3.6 and 3.3.8 not applicable because out of order FSNs are discarded and invalid acks cannot be generated.

(7) Some corrections to labeling.

(8) Added disclaimer to “Conventions” section.

(9) Minor spelling and typo corrections.

(10) Added description of the labeling of sequence numbers.

(11) Reworked test case 3.4.1(a) and 3.4.1(b) to test new sequence number synchronization, acknowledgement and sending rules for processor outage.

0.4. Changes from Version 0.3 to Version 0.4

(1) The test specification has been updated to M2PA Draft Revision 9 [M2PA09].

(2) Split references into Normative and Informative.

(3) Updated acknowledgments to include those making comments on the draft.

(4) Added section describing labeling of messages and primitives in the diagrams.

(5) Expanded test environment description. Tests have been identified for compatibility and interoperability testing.

(6) Added a test list showing which tests are applicable to Validation, Compatibility and Interoperability testing.

(7) Added a Security section describing that M2PA security measures must be in place during testing.

(8) M2PA Draft Revision 9 [M2PA09] uses normal initial sequence numbers. Sequence numbers on all tests have been updated to match.

(9) M2PA Draft Revision 9 [M2PA09] makes proving configurable. Test cases have been added to 3.1.5, 3.1.6, 3.1.8, 3.1.9, 3.1.10, 3.1.11, 3.1.12, 3.1.13, 3.1.15, 3.1.16 and 3.1.27 to test also the situation where the link is not configured for proving.

(10) M2PA Draft Revision 9 [M2PA09] uses a flexible T7 timer that times the age of the oldest unacknowledged data message in the retransmission buffer. This is slightly different that MTP2 [Q.703], [T1.111] behavior. A test case was added to 3.8.12 (Excessive delay of acknowledgment) to test this variation from MTP2.

(11) M2PA Draft Revision 9 [M2PA09] has some problems with T6 and T7 timer handling. It is anticipated that changes will be made to the T6 and T7 timer handling. Additions to test case 3.10.2 have been made in anticipation of these changes.

(12) PROCESSOR-OUTAGE-ENDED renamed to PROCESSOR-RECOVERED.

(13) M2PA Draft Revision 9 [M2PA09] has some problems with processor outage handing. It is anticipated that changes will be made to the processor outage handling on both sides. Addition or changes to test cases 3.4.1 and 3.8.9 have been made in anticipation of these changes.

(14) Link Status "Out of Service," "Alignment," "Ready," and "Processor Outage" messages can be repeated until the condition that caused them to be sent has cleared. Comments have been added to test cases 3.1.1, 3.1.2, 3.1.4, 3.1.16, 3.8.13 and 3.10.1 to accommodate for this.

(15) Link Status "Proving Normal" and "Proving Emergency" messages are repeated at the proving interval. Notes have been added to test cases performing proving to indicate that these messages may be repeated.

(16) Added Link Status "Busy Ended" and "Processor Recovered" as well as M2PA messages with invalid message class and message type to test cases 3.2.1, 3.2.2, 3.2.3, 3.2.4, 3.2.5, 3.2.6, 3.2.7 and 3.2.8 to fully test unexpected message sequences.

(17) Added new test case 3.8.14 to test the situation where the IUT receives an out of order forward sequence number.

For the most part, however, there have been few changes to the actual test cases.

0.3. Changes from Version 0.2 to Version 0.3

(1) The test specification has been updated to M2PA Draft Revision 7 [M2PA07], with anticipated changes for M2PA Draft Revision 8 [M2PA08].

0.2. Changes from Version 0.1 to Version 0.2

(1) The test specification has been updated to M2PA Draft Revision 6 [M2PA06], with anticipated changes for M2PA Draft Revision 7 [M2PA07].

(2) M2PA Draft Revision 6 [M2PA06] provides for acknowledgment of DATA messages using a special DATA message which contains no data payload. This message has been labeled "DATA-ACK" in the diagrams.

This has resulted in changes to test cases 1.6, 2.1, 2.2, 2.3, 2.4, 3.2, 3.4, 3.6, 3.8, 4.1, 8.1, 8.3, 8.4, 8.5, 8.9, 8.10, 8.11, 10.2

(3) Although M2PA Draft Revision 6 [M2PA06] specifies that the DATA-ACK message should have its Forward Sequence Number (FSN) incremented as with any other normal DATA message, this causes problems in that the DATA-ACK MUST then be acknowledged. This test specification anticipates M2PA Draft Revision 7 by not incrementing FSN for DATA-ACK messages.

(4) M2PA Draft Revision 6 [M2PA06] provides FSN and BSN sequence numbers in STATUS messages as well as DATA messages. It has been proposed that STATUS messages not contain FSN and BSN because they should essentially be ignored because of mis-ordering possibilities. Therefore, FSN and BSN of STATUS messages are ignored in this version of the test specification in anticipation of M2PA Draft Revision 7.

0.1. Changes from Version 0.0 to Version 0.1

(1) The test specification has been updated to M2PA Draft Revision 4 [M2PA04], with anticipated changes for M2PA Draft Revision 5 [M2PA05].

(2) M2PA Draft Revision 4 [M2PA04] no longer contains a special proving message. Status PROVING-NORMAL or PROVING-EMERGENCY messages are padded and sent repeatedly to accomplish proving during the proving period. The occurrence of PROVING messages has been removed from the test cases to update this draft to match the M2PA draft revision 4 [M2PA04].

(3) M2PA Draft Revision 4 [M2PA04] contains both forward and backward sequence numbers (FSN, BSN). The test cases were updated to include the sequence numbers (where other than zero) and test cases were added for abnormal backward sequence numbers.

(4) M2PA Draft Revision 4 [M2PA04] has no formal method for acknowledging the receipt of a DATA message when there are no other messages to send (DATA or STATUS). The Status of "In Service", for which no other use has been specified in the current draft [M2PA04], is used as such an explicit acknowledgment. Another possibility would have been to send a DATA message with no data in it. The old "ACK" message is now labeled "IN-SERVICE".

(5) The status message previously labeled "IN-SERVICE" has been relabeled "READY" to better reflect the name of that status message in the draft and to not conflict with the new [M2PA04] "IN-SERVICE" status message.

Normative References

[**RFC2119**] Bradner, S., *“Key words for use in RFCs to Indicate Requirement Levels,”* **BCP 14/RFC 2119**, The Internet Society (March 1997). **<http://www.ietf.org/rfc/rfc2119.txt>**

[**M2PA**] George, T., Bidulock, B., Dantu, R., Schwarzbauer, H. J. and Morneault, K., *“Signaling System 7 (SS7) Message Transfer Part 2 (MTP2)-User Peer-to-Peer Adaptation Layer (M2PA),”* **RFC 4165**, The Internet Society (September 2005). *(Status: PROPOSED STANDARD)* **<http://www.ietf.org/rfc/rfc4165.txt>**

[**Q.781**] ITU, *“Signalling System No. 7 — MTP Level 2 Test Specification,”* **ITU-T Recommendation Q.781**, ITU-T Telecommunication Standardization Sector of ITU, Geneva (March 1993). *(Previously "CCITT Recommendation")*

[**Q.703**] ITU, *“Signalling System No. 7 — Signalling Link,”* **ITU-T Recommendation Q.703**, ITU-T Telecommunication Standardization Sector of ITU, Geneva (March 1993). *(Previously "CCITT Recommendation")*

[**Q.780**] ITU, *“Signalling System No. 7 Test Specification — General Description,”* **ITU-T Recommendation Q.780**, ITU-T Telecommunication Standardization Sector of ITU, Geneva (October 1995). *(Previously "CCITT Recommendation")*

[**Q.782**] ITU, *“Specifications of Signalling System No. 7 — Test Specification — MTP Level 3 Test Specification,”* **ITU-T Recommendation Q.782**, ITU-T Telecommunication Standardization Sector of ITU, Geneva (July 1996). *(Previously "CCITT Recommendation")*

Informative References

[**T1.111**] ANSI, *“Signalling System No. 7 — Message Transfer Part,”* **ANSI T1.111**, American National Standards Institute (1992).

[**EN 300 008-1**] ETSI, *“Integrated Services Digital Network (ISDN); Signalling System No. 7; Protocol Specification,”* **ETSI EN 300 008-1 V1.3.1** [REN/SPAN-01074-1], European Telecommunications Standards Institute, Cedex (September 2000). *(ITU-T Recommendations Q.701, Q.702, Q.703, Q.704, Q.705, Q.706, Q.707 and Q.708, modified)* **<http://www.etsi.org/>**

[**JT-Q703**] TTC, *“Message Transfer Part — Signalling Link,”* **TTC Standard JT-Q703**, Telecommunication Technology Committee (TTC), Japan (April 28, 1992).

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