TR-248/ATP-248 (IP/MPLS FORUM 23.0.0)

ABSTRACT TEST SUITE FOR TDM SERVICES OVER MPLS

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Revision History

Version	Change	Date
IP/MPLS Forum 23.0.0	Initial version	February 2009
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1 Abstract

This document defines test procedures based on the requirements for encapsulating TDM signals belonging to the PDH hierarchy (T1, E1, T3, E3, Nx64 kbit/s) as pseudo-wires over MPLS networks specified in MFA 8.0.0. In addition to the encapsulation, two modes of emulation of TDM circuits are covered: structure-agnostic or "unstructured" emulation and structure-aware or "structured" emulation. Test procedures are also defined for timing recovery and wander performance over MPLS networks.

2 Terminology

AIS	Alarm Indication Signal
CAS	Channel Associated Signaling
CCS	Common Channel Signaling
CE	Customer Equipment
CES	Circuit Emulation Services
CESoMPLS	Circuit Emulation Service over MPLS
CSRC	Contributing Source
ESF	Extended Super Frame
FCS	Frame Check Sequence
IWF	Inter-Working Function
LOPS	Loss Of Packets State
LOS	Loss Of Signal
MPLS	Multi-Protocol Label Switching
OOF	Out Of Frame
PDH	Plesiochronous Digital Hierarchy
PE	Provider Edge device
PSN	Packet Switched Network
PT	Payload Type
PW	Pseudo-Wire
PWE3	Pseudo-Wire Emulation Edge-to-Edge
RDI	Remote Defect Indication
RTP	Real-time Transport Protocol
SF	Super Frame
SSRC	Synchronization Source
SN	Sequence Number
TDM	Time Division Multiplexing
TDMoMPLS	TDM Services over MPLS

3 Scope

The Abstract Test Suite for TDM Services over MPLS describes test procedures based on the requirements for encapsulating TDM signals and distributing timing using pseudo-wires over a MPLS network. Test cases in this specification are defined for T1, E1, T3 and E3 services. This version of the document addresses mobile backhaul applications. Other applications will be addressed in subsequent versions.

An overview of the different groups of requirements that compose the TDM circuit emulation services over MPLS is provided as follows:

- Packet format and encapsulation layer
- Usage of optional RTP header
- Structure-agnostic emulation
- Structure-aware emulation
- Packetization and depacketization
- TDMoMPLS defects
- Performance monitoring
- Synchronization distribution and performance (Normative Annex)

This document may be updated in the future to reflect new work done in the IP/MPLS Technical Committee.

4 Compliance Levels

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 RFC 2119. All key words **MUST** be use upper case, bold text.

5 Test Status Definitions

MANDATORY status: This means that a test case **MUST** be executed because it verifies an absolute requirement or an absolute requirement dependent on an optional feature. If the requirement is absolute the test must be executed. If the requirement is absolute but dependent on an optional feature and that feature is supported, the test case must be executed. If the optional feature is not supported, the test case is not executed and it is declared as "not applicable".

OPTIONAL status: This word means that a test case **MAY** or **MAY NOT** be executed because it verifies a requirement that is not absolute. The decision to execute such a test case will usually depend on the ability to support a particular feature that is not tied to an absolute requirement. If such a test case is not executed it is declared as "not applicable".

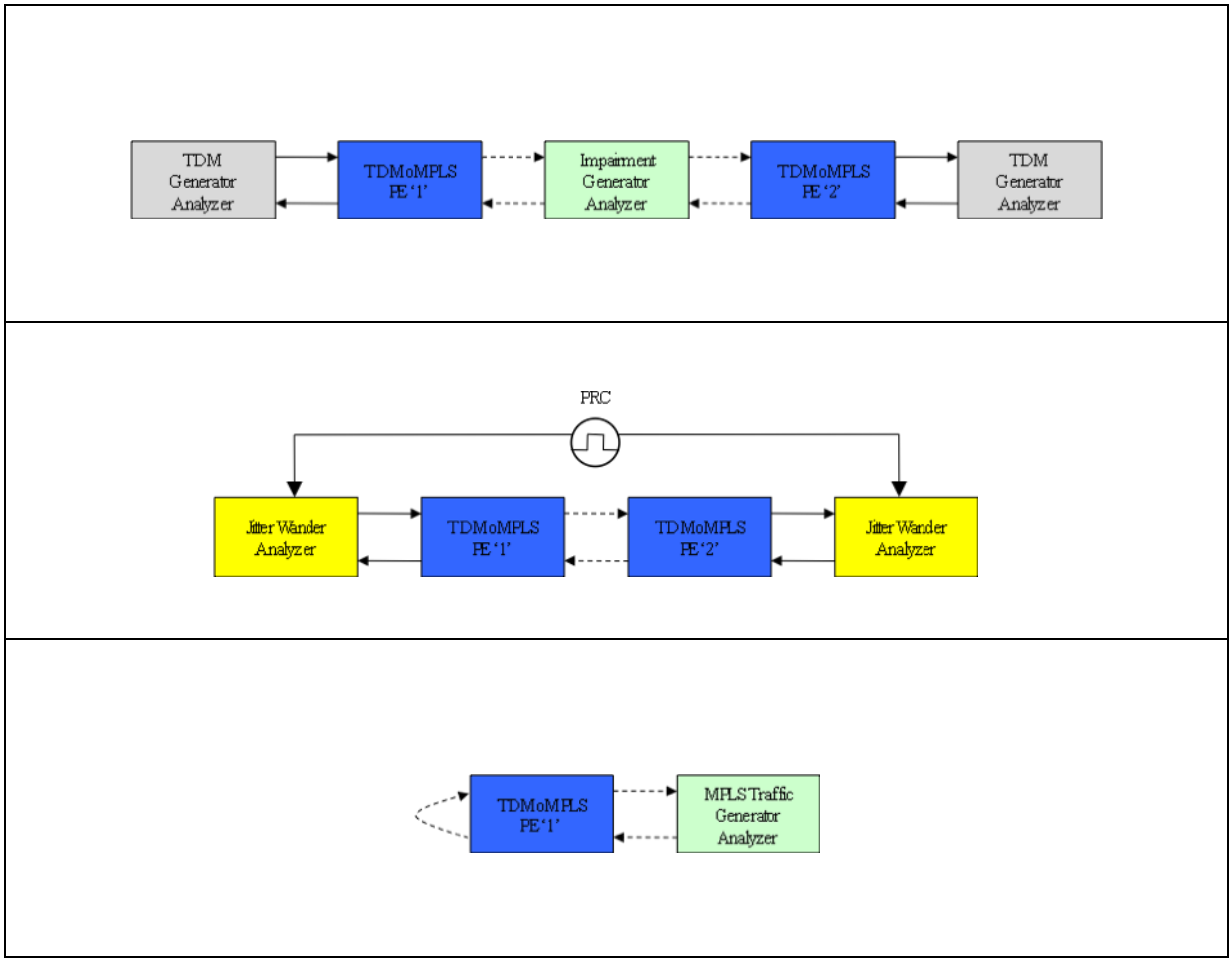
6 Introduction

This document describes the requirements and corresponding test procedures to be used when testing the ability of an MPLS network to deliver TDM Services (e.g. T1, E1, T3 and E3 as part of the IP/MPLS Forum's MPLS in mobile backhaul initiative).

Vendors can refer to the requirements and test procedures defined in this specification in the development and commercial cycles of their products and carriers can use them to ensure that the network elements they deploy or add to their existing network will have the ability to deliver TDM Services over an MPLS network based on the IP/MPLS forum technical specifications.

7 Test Configuration

Although some test cases may require very specific test configurations, most of the TDMoMPLS test cases defined in this document are to be executed using one of the four following test configurations.



8 Emulation and Encapsulation Modes

TDMoMPLS supports two different modes of emulation, Structure-agnostic and Structure-aware.

Structure-agnostic emulation is the transport of structured or unstructured TDM services, when the structure is completely disregarded by the transport mechanism. It maintains the precise bit sequence of data and any structure overhead that may be present.

Structure-aware emulation is the transport of structured TDM services taking some level of the structure into account. Since it is not required to carry all bits of the TDM bit-stream over the PSN, the TDM framing and control information are detected and possibly stripped from the TDM bit-stream at ingress, and are regenerated at egress.

The mandatory mode and optional modes are defined in the following table. In order to be compliant to the IP/MPLS technical specification MFA 8.0.0 an implementation MUST pass all the mandatory test cases for structure agnostic emulation with raw encapsulation.

Structure-agnostic emulation with raw encapsulation	Mandatory mode
Structure-agnostic emulation with octet-aligned encapsulation	Optional mode
Structure-aware emulation	Optional mode

9 End to End Synchronization Distribution

Distribution over TDM PW

In this mode the frequency is distributed using a TDM PW where the attachment circuit is a TDM interface that is running a TDM service (i.e. user data). The TDM PW contains TDM service data as well as synchronization information.

Distribution over Dedicated Synchronization PW

In this mode the frequency is distributed using a dedicated PW where the attachment circuit is a TDM interface that is running synchronization service that complies with MFA 8.0.0 encapsulation format. This dedicated PW may contain standardized synchronization information with no valid TDM service data.

Note: Timing (frequency) information distribution is always unidirectional. Frequency gathered in one direction (e.g. PE slave to PE master) should not be used to discipline the clock in the opposite direction.

10 References

- TDM Circuits over MPLS Using Raw Encapsulation-Implementation Agreement, MFA 8.0.0, November 2004
- H. Schulzrinne et al, RTP: A Transport Protocol for Real-Time Applications, IETF, RFC 3550, 2003
- H. Schulzrinne, S. Petrack, RTP Payload for DTMF Digits, Telephony Tones and Telephony Signals, IETF, RFC 2833, 2000
- The control of jitter and wander within digital networks which are based on the 2048 kbit/s hierarchy", ITU-T recommendation G.823, March 2000
- The control of jitter and wander within digital networks which are based on the 1544 kbit/s hierarchy", ITU-T recommendation G.824, March 2000
- Timing and Synchronisation aspects in Packet Networks", ITU-T recommendation G.8261, April 2008
- RFC 2119, "Key words for use in RFCs to Indicate Requirement Levels", S. Bradner, March 1997

11 Test Cases Summary

Number	Test Case Name	Emulation Mode	Test Status
1	TDMoMPLS packet format	Structure-agnostic	Mandatory
2	TDMoMPLS control word reserved field	Structure-agnostic	Mandatory
3	R Bit – remote loss of packet indication	Structure-agnostic	Mandatory
4	R Bit change reported to the management system	Structure-agnostic	Mandatory
5	L and M bits (0-1-0) RDI of the TDM AC in structure-aware mode	Structure-aware	Mandatory (only if structure-aware mode is supported)
6	L and M bits (1-0-0) outage of the TDM AC in structure-agnostic mode	Structure-agnostic	Mandatory
7	L and M bits (1-0-0) outage of the TDM AC in structure-aware mode	Structure-aware	Mandatory (only if structure-aware mode is supported)
8	FRG bits in structure-agnostic mode	Structure-agnostic	Mandatory
9	LEN field in structure-agnostic mode	Structure-agnostic	Mandatory
10	Control word sequence number	Structure-agnostic	Optional
11	Usage of the fixed RTP header fields	Structure-agnostic	Mandatory (only if a fixed RTP header is used)
12	Minimum tolerable jitter at the TDM interface	Structure-agnostic	Mandatory
13	Structure-agnostic – Packet payload size for raw encapsulation	Structure-agnostic	Mandatory
14	Structure-agnostic – Packet payload size values	Structure-agnostic	Mandatory
15	Structure-agnostic – Packet payload size for octet-aligned T1 encapsulation	Structure-agnostic	Mandatory (only if octet-aligned T1 mode is supported)
16	Structure-aware – Single structure per packet	Structure-aware	Mandatory (only if structure-aware mode is supported)
17	Basic Nx64 kbit/s service packetization latency and payload size	Structure-aware	Mandatory (only if structure-aware emulation of Nx64 kbit/s basic service is supported)
18	Structure-aware emulation with signaling	Structure-aware	Mandatory (only if structure-aware emulation and signaling is supported)
19	Structure-aware emulation with signaling using an RTP header	Structure-aware	Mandatory (only if structure-aware emulation with signaling using an RTP header is supported)
20	Signaling packets encoding	Structure-aware	Mandatory (only if structure-aware emulation and signaling is supported)
21	Signaling packets triggering events	Structure-aware	Optional
22	Signaling packets under normal conditions	Structure-aware	Optional
23	Trunk-specific Nx64 kbit/s – TDM data per packet	Structure-aware	Mandatory (only if structure-aware emulation of trunk-specific Nx64 kbit/s service with CAS is supported)
24	Trunk-specific Nx64 kbit/s – Signaling substructures	Structure-aware	Mandatory (only if structure-aware emulation of trunk-specific Nx64 kbit/s service with CAS is supported)
25	Trunk-specific Nx64 kbit/s with CAS packetization latency and payload size	Structure-aware	Mandatory (only if structure-aware emulation of trunk-specific Nx64 kbit/s service with CAS is supported)

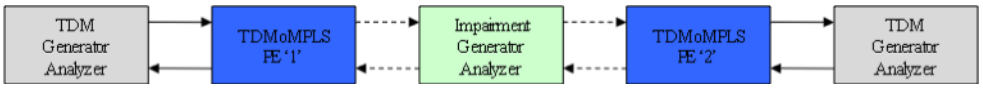
Number	Test Case Name	Emulation Mode	Test Status
26	Trunk-specific Nx64 kbit/s with CAS payload fragmentation	Structure-aware	Mandatory (only if structure-aware emulation of trunk-specific Nx64 kbit/s service with CAS and fragmentation is supported)
27	Trunk-specific Nx64 kbit/s fragmentation – Signaling substructures	Structure-aware	Mandatory (only if structure-aware emulation of trunk-specific Nx64 kbit/s service with CAS and fragmentation is supported)
28	Jitter buffer size	Structure-agnostic	Mandatory
29	Data pattern before set up and after tear down	Structure-agnostic	Mandatory
30	Compensation for lost packets in structure-agnostic mode	Structure-agnostic	Mandatory
31	Compensation for lost packets in structure-aware mode	Structure-aware	Mandatory (only if structure-aware emulation is supported)
32	Detection of misordered packets	Structure-agnostic	Mandatory
33	TDMoMPLS packets carrying invalid TDM data	Structure-agnostic	Optional
34	Loss of packets state (LOPS)	Structure-agnostic	Mandatory
35	Packet loss detection in presence of stray packets	Structure-agnostic	Mandatory (only if stray packets can be detected)
36	Malformed packets detection using RTP PT value	Structure-agnostic	Mandatory (only if malformed packets can be detected)
37	Number of packets transmitted - Counter	Structure-agnostic	Optional
38	Number of payload octets transmitted - Counter	Structure-agnostic	Optional
39	Number of packets received - Counter	Structure-agnostic	Optional
40	Number of payload octets received - Counter	Structure-agnostic	Optional
41	Number of lost packets detected - Counter	Structure-agnostic	Optional
42	Number of OOS packets received and successfully re-ordered - Counter	Structure-agnostic	Optional
43	Number of transitions from normal to loss of packets state - Counter	Structure-agnostic	Optional
44	Number of malformed packets received - Counter	Structure-agnostic	Optional
45	Number of jitter buffer underruns - Counter	Structure-agnostic	Optional
46	Number of jitter buffer overruns - Counter	Structure-agnostic	Optional

12 Test Case Template

Abstract Test Cases for TDMoMPLS	
Test Name	Name derived from reference document
Test Definition ID	A punctuated alphanumeric string assigned to each defined requirement and test procedure couple using the following convention: Up to 8 characters describing the source document followed by up to 10 characters describing the test requirement's section in the source document followed by the test case ID. Example: **MFA8.0.0-2.1-1** where **"MFA8.0.0"** refers to the source document MFA 8.0.0, **"2.1"** refers to the test requirement's section 2.2 and **"1"** refers to the first test case from section 2.1.
Reference document	Reference document name or number
Test Type	Functional, Conformance, Interoperability or Performance test
Test Status	Mandatory or Optional
Requirement Description	Brief description of the service requirement that **MUST, MAY** or **SHOULD** be satisfied
Test Object	Succinct description of the test purpose
Test Configuration	Succinct description of the test bed configuration
Test Procedure	Succinct description of the test procedure
Units	Units can be time units, rates, counts in integers such as milliseconds, packets per second, numbers of valid packets, etc
Variables	Variables such as number of PWs, TDM service (T1, E1, T3, E3), test pattern must be described
Results	Description of the textual, numerical and/or graphical format in which to display the test results. Results can be Pass or Fail
Remarks	Description of any particular observations that might affect the test result

13 Abstract Test Cases for TDMoMPLS

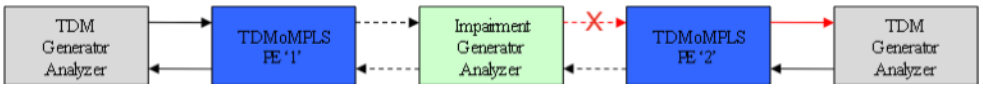
Test Case 1: TDMoMPLS Packet Format

Abstract Test Cases for TDMoMPLS	
Test Name	TDMoMPLS Packet Format
Test Definition ID	MFA8.0.0-2.1-1
Reference document	MFA 8.0.0
Test Type	Conformance
Test Status	Mandatory
Requirement Description	The common format of a TDMoMPLS packet includes the following elements: 1. Zero, one or more transport labels. 2. A single PW label that **MUST** be marked as the bottom of the label stack. 3. The TDMoMPLS control word. 4. An optional fixed RTP header. 5. The TDM payload.
Test Object	Verify that the TDMoMPLS packets include zero, one or more transport labels, a single PW label that is marked as the bottom of the label stack, a TDMoMPLS control word, an optional fixed RTP header and the TDM payload
Test Configuration	
Test Procedure	Set up at least one structure-agnostic flow (PW #1) using raw encapsulation between PE '1' and PE '2'. Use the TDM Generator/Analyzer to generate a TDM circuit with a specific test pattern for emulation by the PEs. Use the Impairment Generator/Analyzer to monitor traffic between PE '1' and PE '2'and to verify that zero, one or more transport labels, a single PW label that is marked as the bottom of the label stack, a TDMoMPLS control word, an optional fixed RTP header and the TDM payload are present in all TDMoMPLS packets
Units	Transport labels, PW label, control word, RTP header and TDM payload values
Variables	Number of PWs (1 or 2), TDM service (T1, E1, T3, E3), test pattern
Results	Pass or fail
Remarks	

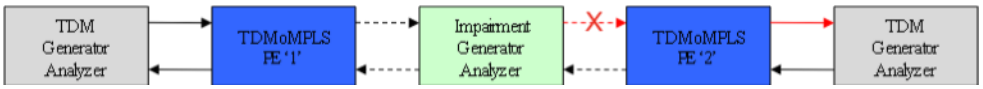
Test Case 2: TDMoMPLS Control Word Reserved Field

Abstract Test Cases for TDMoMPLS	
Test Name	TDMoMPLS Control Word Reserved Field
Test Definition ID	MFA8.0.0-2.2.1-1
Reference document	MFA 8.0.0
Test Type	Conformance
Test Status	Mandatory
Requirement Description	RSVD is a 4-bit reserved field that **MUST** be set to 0 at ingress
Test Object	Verify that the RSVD field is set to 0 at ingress
Test Configuration	
Test Procedure	Set up at least one structure-agnostic flow (PW #1) using raw encapsulation between PE '1' and PE '2'. Use the TDM Generator/Analyzer to generate a TDM circuit with a specific test pattern for emulation by the PEs. Use the Impairment Generator/Analyzer to monitor traffic between PE '1' and PE '2'and to verify that the 4 bits of the RSVD field of the packets associated with the PW #1 are equal to 0
Units	RSVD field value
Variables	Number of PWs (1 or 2), TDM service (T1, E1, T3, E3), test pattern
Results	Pass or fail
Remarks	

Test Case 3: R Bit - Remote Loss of Packets Indication

Abstract Test Cases for TDMoMPLS	
Test Name	R Bit - Remote Loss of Packet Indication
Test Definition ID	MFA8.0.0-2.2.1/3.4.2-1
Reference document	MFA 8.0.0
Test Type	Conformance
Test Status	Mandatory
Requirement Description	The R Bit carries Remote Loss of Packets indication, i.e. it is set in packets transmitted by PE '2' to PE '1' if PE '2' detects loss of packets in the stream received from PE '1'. While in LOPS, the local packetizer **MUST** mark every packet it transmits with the R bit set
Test Object	Verify that when a PE is in LOPS, the local packetizer marks every packet it transmits with the R bit set
Test Configuration	
Test Procedure	Set up at least one structure-agnostic flow (PW #1) using raw encapsulation between PE '1' and PE '2'. Use the TDM Generator/Analyzer to generate a TDM circuit with a specific test pattern for emulation by the PEs. Use the Impairment Generator/Analyzer to stop traffic towards the TDM-bound CES IWF of the PE '2' and use it to verify that the R bit is set to 1 on all packets transmitted into the network by the PE '2'. Re-enable traffic towards the TDM-bound CES IWF of the PE '2' and use the Impairment Generator/Analyzer to verify that the R bit is cleared on all packets transmitted into the network by the PE '2'
Units	R Bit value
Variables	Number of PWs (1 or 2), TDM service (T1, E1, T3, E3), test pattern
Results	Pass or fail
Remarks	

Test Case 4: R Bit Change Reported to the Management System

Abstract Test Cases for TDMoMPLS	
Test Name	R Bit Change Reported to the Management System
Test Definition ID	MFA8.0.0-2.2.1-2
Reference document	MFA 8.0.0
Test Type	Conformance
Test Status	Mandatory
Requirement Description	The R Bit carries Remote Loss of Packets indication, i.e. it is set in packets transmitted by PE '2' to PE '1' if PE '2' detects loss of packets in the stream received from PE '1'. Upon packet reception, a PE **MUST** detect changes in the state of the R Bit, and report these to the management system
Test Object	Verify that upon packet reception the PE detects changes in the state of the R Bit, and reports these to the management system
Test Configuration	
Test Procedure	Set up at least one structure-agnostic flow (PW #1) using raw encapsulation between PE '1' and PE '2'. Use the TDM Generator/Analyzer to generate a TDM circuit with a specific test pattern for emulation by the PEs. Use the Impairment Generator/Analyzer to set the value of the R bit to 1 on all packets transmitted by the PE '1'. Use the management system to verify that the PE '2' reports an R Bit change to the management system. Use the Impairment Generator/Analyzer to set the value of the R bit back to 0 on all packets transmitted by the PE '1'. Use the management system to verify that the PE '2' reports another R Bit change to the management system
Units	R Bit change reported to the management system
Variables	Number of PWs (1 or 2), TDM service (T1, E1, T3, E3), test pattern
Results	Pass or fail
Remarks	

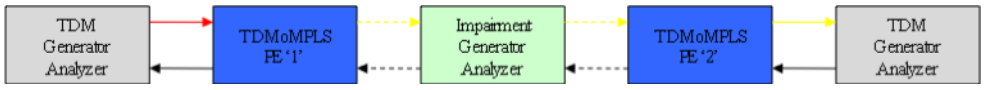
Test Case 5: L and M Bits (0-1-0) RDI of the TDM AC in Structure-Aware Mode

Abstract Test Cases for TDMoMPLS	
Test Name	L and M Bits (0-1-0) RDI of the TDM AC in Structure-Aware Mode
Test Definition ID	MFA8.0.0-2.2.1-3
Reference document	MFA 8.0.0
Test Type	Conformance
Test Status	Mandatory (only if structure-aware emulation mode is supported)
Requirement Description	L = 0 and M = 00 indicates normal conditions. In the case of structure-aware emulation, L = 0 and M = 10 indicates that RDI of the TDM AC has been detected and all implementations **MUST** play out the contents of the payload
Test Object	Verify that under normal conditions L = 0 and M = 00. In the case of structure-aware emulation, verify that when L = 0 and M = 10 due to RDI of the TDM AC, all implementations play out the contents of the payload
Test Configuration	
Test Procedure	Set up at least one structure-aware flow (PW #1) between PE '1' and PE '2'. Use the TDM Generator/Analyzer to generate a TDM circuit with a specific test pattern for emulation by the PEs. Use the Impairment Generator/Analyzer to verify that the TDMoMPLS packets generated by the PE '1' are correctly formed with the L bit and M bits clear. Use the Impairment Generator/Analyzer to set the value of the L and M bits to (0-1-0) on all packets transmitted by the PE '1' and use the TDM Generator/Analyzer to verify that the PE '2' continues to play out the content of the payload
Units	TDM packets payload value
Variables	Number of PWs (1 or 2), TDM service (T1, E1, T3, E3), test pattern
Results	Pass or fail
Remarks	

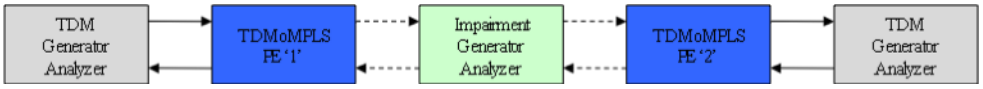
Test Case 6: L and M Bits (1-0-0) Outage of the TDM AC in Structure-Agnostic Mode

Abstract Test Cases for TDMoMPLS	
Test Name	L and M Bits (1-0-0) Outage of the TDM AC in Structure-Agnostic Mode
Test Definition ID	MFA8.0.0-2.2.1-4
Reference document	MFA 8.0.0
Test Type	Conformance
Test Status	Mandatory
Requirement Description	L = 0 and M = 00 indicates normal conditions. In the case of structure-agnostic emulation, L = 1 and M = 00 indicates that there is no valid TDM data in the packet due to an outage of the TDM AC and an equivalent amount of "all-ones" bit pattern **MUST** be played out for a packet
Test Object	Verify that under normal conditions L = 0 and M = 00. In the case of structure-agnostic emulation, verify that when L = 1 and M = 00 due to an outage of the TDM AC, an equivalent amount of "all-ones" bit pattern is played out
Test Configuration	
Test Procedure	Set up at least one structure-agnostic flow (PW #1) using raw encapsulation between PE '1' and PE '2'. Use the TDM Generator/Analyzer to generate a TDM circuit with a specific test pattern for emulation by the PEs. Use the Impairment Generator/Analyzer to verify that the TDMoMPLS packets generated by the PE '1' are correctly formed with the L bit and M bits clear. Use the TDM Generator/Analyzer to stop traffic towards the PE '1' and use the Impairment Generator/Analyzer to verify that the TDMoMPLS packets generated by the PE '1' have the L bit set and the M bits clear and use the TDM Generator/Analyzer to verify that an equivalent amount of "all-ones" bit pattern is played out by the PE '2'. Use the TDM Generator/Analyzer to generate a valid circuit again and use the Impairment Generator/Analyzer to verify that the TDMoMPLS packets generated by the PE '1' have the L bit and the M bits cleared and that the PE '2' plays out the test pattern
Units	L bit and M bits values, TDM data pattern
Variables	Number of PWs (1 or 2), TDM service (T1, E1, T3, E3), test pattern
Results	Pass or fail
Remarks	

Test Case 7: L and M Bits (1-0-0) Outage of the TDM AC in Structure-Aware Mode

Abstract Test Cases for TDMoMPLS	
Test Name	L and M Bits (1-0-0) Outage of the TDM AC in Structure-Aware Mode
Test Definition ID	MFA8.0.0-2.2.1-5
Reference document	MFA 8.0.0
Test Type	Conformance
Test Status	Mandatory (only if structure-aware emulation mode is supported)
Requirement Description	L = 0 and M = 00 indicates normal conditions. In the case of structure-aware emulation, L = 1 and M = 00 indicates that there is no valid TDM data in the packet due to an outage of the TDM AC and an appropriate amount of the locally configured "idle code" **MUST** be played out
Test Object	Verify that under normal conditions L = 0 and M = 00. In the case of structure-aware emulation, verify that when L = 1 and M = 00 due to an outage of the TDM AC, an appropriate amount of the locally configured "idle code" is played out
Test Configuration	
Test Procedure	Set up at least one structure-aware flow (PW #1) between PE '1' and PE '2'. Use the TDM Generator/Analyzer to generate a TDM circuit with a specific test pattern for emulation by the PEs. Use the Impairment Generator/Analyzer to verify that the TDMoMPLS packets generated by the PE '1' are correctly formed with the L bit and M bits clear. Use the TDM Generator/Analyzer to stop traffic towards the PE '1' and use the Impairment Generator/Analyzer to verify that the TDMoMPLS packets generated by the PE '1' have the L bit set and the M bits clear and use the TDM Generator/Analyzer to verify that an appropriate amount of the locally configured "idle code" is played out by the PE '2'. Use the TDM Generator/Analyzer to generate a valid circuit again and use the Impairment Generator/Analyzer to verify that the TDMoMPLS packets generated by the PE '1' have the L bit and the M bits cleared and that the PE '2' plays out the test pattern
Units	L bit and M bits values, TDM data pattern
Variables	Number of PWs (1 or 2), TDM service (T1, E1, T3, E3), test pattern
Results	Pass or fail
Remarks	

Test Case 8: FRG Bits in Structure-Agnostic Mode

Abstract Test Cases for TDMoMPLS	
Test Name	FRG Bits in Structure-Agnostic Mode
Test Definition ID	MFA8.0.0-2.2.1-6
Reference document	MFA 8.0.0
Test Type	Conformance
Test Status	Mandatory
Requirement Description	FRG bits are used to denote fragmentation of the multiframe structure into multiple packets. They are only used for structure-aware emulation of NxDS0 services with CAS. In all other modes they **MUST** be set to 0
Test Object	Verify that in structure-agnostic emulation mode the FRG bits are set to 0
Test Configuration	
Test Procedure	Set up at least one structure-agnostic flow (PW #1) using raw encapsulation between PE '1' and PE '2'. Use the TDM Generator/Analyzer to generate a TDM circuit with a specific test pattern for emulation by the PEs. Use the Impairment Generator/Analyzer to monitor traffic between PE '1' and PE '2'and to verify that the FRG bits of the packets associated with the PW #1 are set to 0
Units	FRG bits value
Variables	Number of PWs (1 or 2), TDM service (T1, E1, T3, E3), test pattern
Results	Pass or fail
Remarks	

Test Case 9: LEN Field in Structure-Agnostic Mode

Abstract Test Cases for TDMoMPLS	
Test Name	LEN Field in Structure-Agnostic Mode
Test Definition ID	MFA8.0.0-2.2.1-7
Reference document	MFA 8.0.0
Test Type	Conformance
Test Status	Mandatory
Requirement Description	LEN is a 6-bit field that optionally can be used to indicate the length of the TDMoMPLS packet. This length is defined as the size of the TDMoMPLS encapsulation header (i.e., control word and, if present, a fixed RTP header) plus the size of the TDM payload. If the length exceeds 63 bytes, the LEN field **MUST** be set to 0
Test Object	Verify that in structure-agnostic emulation mode the LEN field is set to 0
Test Configuration	
Test Procedure	Set up at least one structure-agnostic flow (PW #1) using raw encapsulation between PE '1' and PE '2'. Use the TDM Generator/Analyzer to generate a TDM circuit with a specific test pattern for emulation by the PEs. Use the Impairment Generator/Analyzer to monitor traffic between PE '1' and PE '2'and to verify that the LEN field of the packets associated with the PW #1 is set to 0
Units	LEN field value
Variables	Number of PWs (1 or 2), TDM service (T1, E1, T3, E3), test pattern
Results	Pass or fail
Remarks	

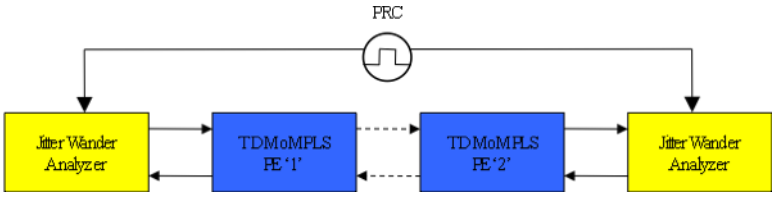
Test Case 10: Control Word Sequence Number

Abstract Test Cases for TDMoMPLS	
Test Name	Control Word Sequence Number
Test Definition ID	MFA8.0.0-2.2.1-8
Reference document	MFA 8.0.0
Test Type	Conformance
Test Status	Optional
Requirement Description	The initial value of the sequence number **SHOULD** be random and increment by one for each packet sent
Test Object	Verify that the initial value of the sequence number is random and increments by one for each packet sent
Test Configuration	
Test Procedure	Set up at least one structure-agnostic flow (PW #1) using raw encapsulation between PE '1' and PE '2'. Use the TDM Generator/Analyzer to generate a TDM circuit with a specific test pattern for emulation by the PEs. Tear down and re-established the emulated PW #1 several times and use the Impairment Generator/Analyzer to monitor traffic between PE '1' and PE '2' and to verify that the initial value of the sequence number is random and that it increments by one for each packet sent
Units	Sequence number value
Variables	Number of PWs (1 or 2), TDM service (T1, E1, T3, E3), test pattern
Results	Pass or fail
Remarks	

Test Case 11: Usage of the Fixed RTP Header Fields

Abstract Test Cases for TDMoMPLS	
Test Name	Usage of the Fixed RTP Header Fields
Test Definition ID	MFA8.0.0-2.2.2-1
Reference document	MFA 8.0.0
Test Type	Conformance
Test Status	Mandatory (only if a fixed RTP header is used)
Requirement Description	If a fixed RTP header is used with TDMoMPLS: The version **MUST** be set to 2, the padding, header extension, CSRC count and marker **MUST** be set to 0, the sequence number **MUST** be equal to that in the TDMoMPLS control word of the same packet and one PT value **MUST** be allocated from the range of dynamic values (96--127) for each direction of the PW. Note: The same PT value may be reused for both directions of the PW and also reused for other PWs
Test Object	If a fixed RTP header is used verify that the version is set to 2, the padding, header extension, CSRC count and marker are set to 0, the sequence number is equal to that in the TDMoMPLS control word of the same packet and one PT value is allocated from the range of dynamic values (96--127) for each direction of the PW
Test Configuration	
Test Procedure	Set up at least one structure-agnostic flow (PW #1) using raw encapsulation and using a fixed RTP header between PE '1' and PE '2'. Use the TDM Generator/Analyzer to generate a TDM circuit with a specific test pattern for emulation by the PEs. Use the Impairment Generator/Analyzer to monitor the packets associated with the PW #1 and to verify that the version is set to 2, the padding, header extension, CSRC count and marker are set to 0, the sequence number is equal to that in the TDMoMPLS control word of the same packet and one valid PT value is allocated for each direction of the PW
Units	Version, padding, header extension, CSRC count, marker, sequence number and PT value
Variables	Number of PWs (1 or 2), TDM service (T1, E1, T3, E3), test pattern
Results	Pass or fail
Remarks	

Test Case 12: Minimum Tolerable Jitter at the TDM Interface

Abstract Test Cases for TDMoMPLS	
Test Name	Minimum Tolerable Jitter at the TDM Interface
Test Definition ID	G.823-7.1 & G.824-7.2
Reference document	G.823, G.824
Test Type	Conformance
Test Status	Mandatory
Requirement Description	The jitter that can be tolerated at the MPLS-bound IWF TDM interface **MUST** meet the traffic interface requirements specified in ITU-T recommendation G.824 for T1 and T3 circuits and G.823 for E1 and E3 circuits
Test Object	Verify that the jitter tolerated at the MPLS-bound IWF TDM interface meets the traffic interface requirements specified in ITU-T recommendation G.824 for T1 and T3 circuits and G.823 for E1 and E3 circuits
Test Configuration	
Test Procedure	Set up at least one structure-agnostic flow (PW #1) using raw encapsulation between PE '1' and PE '2'. Use the Jitter/Wander generator to transmit a specific test pattern with sinusoidal jitter at a defined frequency*. Increase the jitter amplitude of the signal until errors occur. This amplitude is the Maximum Tolerable Jitter (MTJ) result for the defined frequency. Repeat the test for the different frequencies* and use the results to form a MTJ graph and compare it with the requirements specified in ITU-T recommendation G.824 for T1 and T3 circuits and G.823 for E1 and E3 circuits
Units	MTJ
Variables	Number of PWs (1 or 2), TDM service (T1, E1, T3, E3), test pattern
Results	Pass or fail
Remarks	* Frequencies: Specified in ITU-T recommendation G.824 for T1 and T3 circuits and G.823 for E1 and E3 circuits

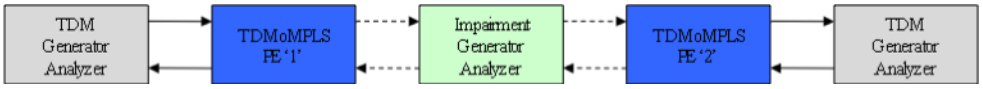
Test Case 13: Structure-Agnostic - Packet Payload Size for Raw Encapsulation

Abstract Test Cases for TDMoMPLS	
Test Name	Structure-Agnostic - Packet Payload Size for Raw Encapsulation
Test Definition ID	MFA8.0.0-2.3.2-1
Reference document	MFA 8.0.0
Test Type	Conformance
Test Status	Mandatory
Requirement Description	For structure-agnostic emulation, the packet payload size **MUST** be defined during the PW setup, **MUST** be the same for both directions of the PW, and **MUST** remain unchanged for the lifespan of the PW
Test Object	Verify that for structure-agnostic emulation, the packet payload size that is defined during the PW setup is the same for both directions of the PW, and remains unchanged for the lifespan of the PW
Test Configuration	
Test Procedure	Set up at least one structure-agnostic flow (PW #1) using raw encapsulation between PE '1' and PE '2'. Use the TDM Generator/Analyzer to generate a TDM circuit with a specific test pattern for emulation by the PEs. Use the Impairment Generator/Analyzer to monitor the packets associated with the PW #1 and to verify that the packet payload size is the same for both directions of the PW, and remains unchanged for the lifespan of the PW
Units	Packet payload size
Variables	Number of PWs (1 or 2), TDM service (T1, E1, T3, E3), test pattern
Results	Pass or fail
Remarks	

Test Case 14: Structure-Agnostic - Packet Payload Size Values

Abstract Test Cases for TDMoMPLS	
Test Name	Structure-Agnostic - Packet Payload Size Values
Test Definition ID	MFA8.0.0-2.3.2-2
Reference document	MFA 8.0.0
Test Type	Conformance
Test Status	Mandatory
Requirement Description	All TDMoMPLS implementations **MUST** support the following packet payload size values: 192 octets for T1, 256 octets for E1 and 1024 octets for T3 and E3
Test Object	Verify that for structure-agnostic emulation, the following packet payload size values: 192 octets for T1, 256 octets for E1 and 1024 octets for T3 and E3 are supported
Test Configuration	
Test Procedure	Set up at least one structure-agnostic flow (PW #1) using raw encapsulation between PE '1' and PE '2'. Use the TDM Generator/Analyzer to generate a TDM circuit with a specific test pattern for emulation by the PEs. Use the Impairment Generator/Analyzer to monitor the packets associated with the PW #1 and to verify that the packet payload size of 192 octets is supported for T1, 256 octets is supported for E1 and 1024 octets is supported for T3 and E3
Units	Packet payload size
Variables	Number of PWs (1 or 2), TDM service (T1, E1, T3, E3), test pattern
Results	Pass or fail
Remarks	

Test Case 15: Structure-Agnostic - Packet Payload Size for Octet-Aligned T1 Encapsulation

Abstract Test Cases for TDMoMPLS	
Test Name	Structure-Agnostic - Packet Payload Size for Octet-Aligned T1 Encapsulation
Test Definition ID	MFA8.0.0-2.3.3-1
Reference document	MFA 8.0.0
Test Type	Conformance
Test Status	Mandatory (only if octet-aligned T1 mode is supported)
Requirement Description	Support of the octet-aligned T1 mode for structure-agnostic emulation of T1 circuits is optional. All implementations supporting this mode **MUST** support a packet payload size of 200 bytes, which corresponds exactly to a 1ms packetization latency.
Test Object	Verify that for octet-aligned T1 mode for structure-agnostic emulation, a packet payload size of 200 bytes is supported
Test Configuration	
Test Procedure	Set up at least one structure-agnostic flow (PW #1) using octet-aligned T1 encapsulation between PE '1' and PE '2'. Use the TDM Generator/Analyzer to generate a TDM circuit with a specific test pattern for emulation by the PEs. Use the Impairment Generator/Analyzer to monitor the packets associated with the PW #1 and to verify that the packet payload size 200 bytes is supported
Units	Packet payload size
Variables	Number of PWs (1 or 2), test pattern
Results	Pass or fail
Remarks	

Test Case 16: Structure-Aware - Single Structure per Packet

Abstract Test Cases for TDMoMPLS	
Test Name	Structure-Aware - Single Structure per Packet
Test Definition ID	MFA8.0.0-2.3.4-1
Reference document	MFA 8.0.0
Test Type	Conformance
Test Status	Mandatory (only if structure-aware emulation mode is supported)
Requirement Description	Multiple multiframe structures **MUST NOT** be packed into a single TDMoMPLS packet
Test Object	Verify that for structure-aware emulation mode, a maximum of one multiframe structure is packed into per TDMoMPLS packet
Test Configuration	
Test Procedure	Set up at least one structure-aware flow (PW #1), Nx64 kbit/s basic service between PE '1' and PE '2'. Use the TDM Generator/Analyzer to generate a TDM circuit with a specific test pattern for emulation by the PEs. Use the Impairment Generator/Analyzer to monitor the packets associated with the PW #1 and to verify that they contain a maximum of one multiframe structure per packet
Units	Number of multiframe structures per TDMoMPLS packet
Variables	Number of PWs (1 or 2), TDM service (T1, E1), multiframe structure, test pattern, Number of DS0 Channels (N)
Results	Pass or fail
Remarks	

Test Case 17: Basic Nx64 kbit/s Service Packetization Latency and Payload Size

Abstract Test Cases for TDMoMPLS	
Test Name	Basic Nx64 kbit/s Service Packetization Latency and Payload Size
Test Definition ID	MFA8.0.0-2.3.5-1
Reference document	MFA 8.0.0
Test Type	Conformance
Test Status	Mandatory (only if structure-aware emulation of Nx64 kbit/s basic service is supported)
Requirement Description	TDMoMPLS implementations supporting Nx64 kbit/s services **MUST** support the following set of configurable packetization latency values: • For $N \geq 5$: 1 ms (with the corresponding packet payload size of 8*N octets) • For $2 \leq N \leq 4$: 4 ms (with the corresponding packet payload size of 32*N octets) • For $N = 1$: 8 ms (with the corresponding packet payload size of 64*N octets)
Test Object	Verify that for Nx64 kbit/s services the packetization latencies and corresponding packet payload sizes mentioned in the "Requirement Description" section above are supported
Test Configuration	
Test Procedure	Set up at least one structure-aware flow (PW #1), Nx64 kbit/s basic service between PE '1' and PE '2'. Use the TDM Generator/Analyzer to generate a TDM circuit with a specific test pattern for emulation by the PEs. For $N \geq 5$, for $2 \leq N \leq 4$ and for $N = 1$, use the Impairment Generator/Analyzer to monitor the packets associated with the PW #1 and to verify that they contain the correct payload size and packetization latency
Units	Packet payload size and packetization latency
Variables	Number of PWs (1 or 2), TDM service (T1, E1), test pattern, Number of DS0 Channels (N)
Results	Pass or fail
Remarks	L = 8 * N * D (Where L: packet payload size in octets, N: number of DS0 channels and D: packetization latency in milliseconds) Ref: RFC 5086

Test Case 18: Structure-Aware Emulation with Signaling

Abstract Test Cases for TDMoMPLS	
Test Name	Structure-Aware Emulation with Signaling
Test Definition ID	MFA8.0.0-2.3.5-2
Reference document	MFA 8.0.0
Test Type	Conformance
Test Status	Mandatory (only if structure-aware emulation and signaling is supported)
Requirement Description	Structure-aware emulation can also be optionally extended to support any form of telephony signaling (CAS or CCS) by carrying the signals in dedicated signaling packets. Signaling packets **SHOULD** be carried in a separate pseudo-wire (different PW label), and **MUST** use a separate numbering scheme for setting the sequence numbers
Test Object	Verify that when structure-aware emulation supports CAS or CCS, signaling packets are carried in a separate pseudo-wire (different PW label), and use a separate numbering scheme for setting the sequence numbers
Test Configuration	
Test Procedure	Set up at least one structure-aware flow (PW #1), Nx64 kbit/s basic service with signaling between PE '1' and PE '2'. Use the TDM Generator/Analyzer to generate a TDM circuit with a specific test pattern for emulation by the PEs. Use the Impairment Generator/Analyzer to monitor the packets associated with the PW #1 and to verify that the signaling packets are carried in a separate pseudo-wire from that used for the TDM data packets, and that signaling packets use a separate numbering scheme for setting the sequence numbers
Units	PW label values and sequence numbers
Variables	Number of PWs (1 or 2), TDM service (T1, E1), test pattern, Number of DS0 Channels (N), Signaling (CAS, CCS)
Results	Pass or fail
Remarks	

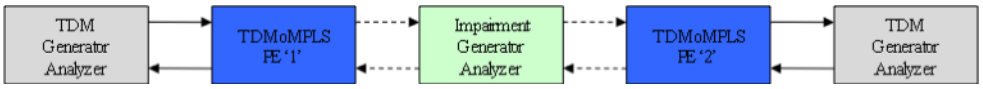
Test Case 19: Structure-Aware Emulation with Signaling Using an RTP Header

Abstract Test Cases for TDMoMPLS	
Test Name	Structure-Aware Emulation with Signaling Using an RTP Header
Test Definition ID	MFA8.0.0-2.3.5-3
Reference document	MFA 8.0.0
Test Type	Conformance
Test Status	Mandatory (only if structure-aware emulation with signaling using an RTP header is supported)
Requirement Description	Structure-aware emulation can also be optionally extended to support any form of telephony signaling (CAS or CCS) by carrying the signals in dedicated signaling packets. If an RTP header is used, an additional RTP payload type **MUST** be allocated from the range of dynamically allocated types, and the SSRC value **MUST** be different from that used for the TDM data packets
Test Object	Verify that when structure-aware emulation supports signaling and an RTP header is used, an additional RTP payload type is allocated from the range of dynamically allocated types, and the SSRC value is different from that used for the TDM data packets
Test Configuration	
Test Procedure	Set up at least one structure-aware flow (PW #1), Nx64 kbit/s basic service with signalling using a RTP header between PE '1' and PE '2'. Use the TDM Generator/Analyzer to generate a TDM circuit with a specific test pattern for emulation by the PEs. Use the Impairment Generator/Analyzer to monitor the packets associated with the PW #1 and to verify that the signaling packets are allocated an additional RTP payload type and their SSRC value is different from that used for the TDM data packets
Units	RTP payload types and SSRC values
Variables	Number of PWs (1 or 2), TDM service (T1, E1), test pattern, Number of DS0 Channels (N), Signaling (CAS, CCS)
Results	Pass or fail
Remarks	

Test Case 20: Signaling Packets Encoding

Abstract Test Cases for TDMoMPLS	
Test Name	Signaling Packets Encoding
Test Definition ID	MFA8.0.0-2.3.5-4
Reference document	MFA 8.0.0
Test Type	Conformance
Test Status	Mandatory (only if structure-aware emulation and signaling is supported)
Requirement Description	The encoded CAS bits in a TDMoMPLS signaling packet **MUST** be encoded in accordance with RFC2833
Test Object	Verify that the encoded CAS bits in a TDMoMPLS signaling packet are encoded in accordance with RFC2833
Test Configuration	
Test Procedure	Set up at least one structure-aware flow (PW #1), Nx64 kbit/s basic service with signaling between PE '1' and PE '2'. Use the TDM Generator/Analyzer to generate a TDM circuit with a specific test pattern for emulation by the PEs. Following the setup of the emulated circuit, use the Impairment Generator/Analyzer to monitor the packets associated with the PW #1 and to verify that signaling packets are encoded in accordance with RFC2833
Units	Signaling packets encoding
Variables	Number of PWs (1 or 2), TDM service (T1, E1), test pattern, Number of DS0 Channels (N)
Results	Pass or fail
Remarks	

Test Case 21: Signaling Packets Triggering Events

Abstract Test Cases for TDMoMPLS	
Test Name	Signaling Packets Triggering Events
Test Definition ID	MFA8.0.0-2.3.5-5
Reference document	MFA 8.0.0
Test Type	Conformance
Test Status	Optional
Requirement Description	Signaling packets **SHOULD** be sent three times at an interval of 5ms on any of the following events: Setup of the emulated circuit, change in the signaling state of the emulated circuit, cleared loss of packets defect and cleared remote loss of packets defect
Test Object	Verify that following each of the events listed in the "Requirement Description" above, signaling packets are sent three times at an interval of 5ms
Test Configuration	
Test Procedure	Set up at least one structure-aware flow (PW #1), Nx64 kbit/s basic service with signaling between PE '1' and PE '2'. Use the TDM Generator/Analyzer to generate a TDM circuit with a specific test pattern for emulation by the PEs. Use the Impairment Generator/Analyzer to monitor the packets associated with the PW #1 and: 1. Following the setup of the emulated circuit, verify that signaling packets are sent three times at an interval of 5ms. 2. Change the signaling state of the emulated circuit and verify that signaling packets are sent three times at an interval of 5ms. 3. Simulate a loss of packet defect and then return to normal conditions and verify that signaling packets are sent three times at an interval of 5ms. 4. Simulate a remote loss of packet defect and then return to normal conditions and verify that signaling packets are sent three times at an interval of 5ms.
Units	Number of signaling packets and time interval
Variables	Number of PWs (1 or 2), TDM service (T1, E1), test pattern, Number of DS0 Channels (N)
Results	Pass or fail
Remarks	

Test Case 22: Signaling Packets Under Normal Conditions

Abstract Test Cases for TDMoMPLS	
Test Name	Signaling Packets Under Normal Conditions
Test Definition ID	MFA8.0.0-2.3.5-6
Reference document	MFA 8.0.0
Test Type	Conformance
Test Status	Optional
Requirement Description	In the absence of any of the following events: Setup of the emulated circuit, change in the signaling state of the emulated circuit, cleared loss of packets defect and cleared remote loss of packets defect, signaling packets **SHOULD** be sent every 5 seconds, except when there is a failure of the local TDM circuit leading to the L flag being set in the associated data frames
Test Object	Verify that in the absence of any of the events mentioned in the "Requirement Description" above, signaling packets are sent every 5 seconds, except when there is a failure of the local TDM circuit leading to the L flag being set in the associated data
Test Configuration	
Test Procedure	Set up at least one structure-aware flow (PW #1), Nx64 kbit/s basic service with signaling between PE '1' and PE '2'. Use the TDM Generator/Analyzer to generate a TDM circuit with a specific test pattern for emulation by the PEs. Use the Impairment Generator/Analyzer to monitor the packets associated with the PW #1 and to verify that under normal conditions, signaling packets are sent every 5 seconds
Units	Number of signaling packets and time interval
Variables	Number of PWs (1 or 2), TDM service (T1, E1), test pattern, Number of DS0 Channels (N)
Results	Pass or fail
Remarks	

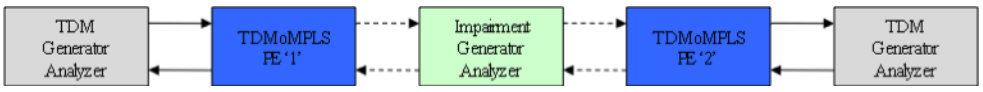
Test Case 23: Trunk-Specific Nx64 kbit/s - TDM Data per Packet

Abstract Test Cases for TDMoMPLS	
Test Name	Trunk-Specific Nx64 kbit/s - TDM Data per Packet
Test Definition ID	MFA8.0.0-2.3.6-1
Reference document	MFA 8.0.0
Test Type	Conformance
Test Status	Mandatory (only if structure-aware emulation of trunk-specific Nx64 kbit/s service with CAS is supported)
Requirement Description	TDMoMPLS implementations supporting trunk-specific Nx64 kbit/s services with CAS **MUST NOT** carry more TDM data per packet than is contained in a single structure
Test Object	Verify that TDMoMPLS implementations supporting trunk-specific Nx64 kbit/s services with CAS do not carry more TDM data per packet than is contained in a single structure
Test Configuration	
Test Procedure	Set up at least one structure-aware flow (PW #1), trunk-specific Nx64 kbit/s service with CAS between PE '1' and PE '2'. Use the TDM Generator/Analyzer to generate a TDM circuit with a specific test pattern for emulation by the PEs. Use the Impairment Generator/Analyzer to monitor the packets associated with the PW #1 and to verify that they do not carry more TDM data per packet than is contained in a single structure
Units	Amount of TDM data per TDMoMPLS packet
Variables	Number of PWs (1 or 2), TDM service (T1, E1), multiframe structure, test pattern, Number of DS0 Channels (N)
Results	Pass or fail
Remarks	

Test Case 24: Trunk-Specific Nx64 kbit/s - Signaling Substructures

Abstract Test Cases for TDMoMPLS	
Test Name	Trunk-Specific Nx64 kbit/s - Signaling Substructures
Test Definition ID	MFA8.0.0-2.3.6-2
Reference document	MFA 8.0.0
Test Type	Conformance
Test Status	Mandatory (only if structure-aware emulation of trunk-specific Nx64 kbit/s service with CAS is supported)
Requirement Description	For TDMoMPLS implementations supporting trunk-specific Nx64 kbit/s services with CAS, the signaling substructures **MUST** be appended to each TDMoMPLS packet which contains the last octet of the payload structure (as marked by the FRG bits in the TDMoMPLS control word)
Test Object	Verify that for TDMoMPLS implementations supporting trunk-specific Nx64 kbit/s services with CAS, the signaling substructures are appended to each TDMoMPLS packet which contains the last octet of the payload structure
Test Configuration	
Test Procedure	Set up at least one structure-aware flow (PW #1), trunk-specific Nx64 kbit/s service with CAS between PE '1' and PE '2'. Use the TDM Generator/Analyzer to generate a TDM circuit with a specific test pattern for emulation by the PEs. Use the Impairment Generator/Analyzer to monitor the packets associated with the PW #1 and to verify that the signaling substructures are appended to each TDMoMPLS packet which contains the last octet of the payload structure
Units	Signaling substructures location
Variables	Number of PWs (1 or 2), TDM service (T1, E1), test pattern, Number of DS0 Channels (N)
Results	Pass or fail
Remarks	

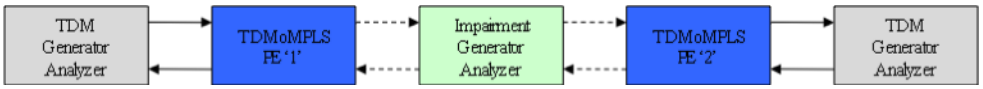
Test Case 25: Trunk-Specific Nx64 kbit/s with CAS Packetization Latency and Payload Size

Abstract Test Cases for TDMoMPLS	
Test Name	Trunk-Specific Nx64 kbit/s with CAS Packetization Latency and Payload Size
Test Definition ID	MFA8.0.0-2.3.6-3
Reference document	MFA 8.0.0
Test Type	Conformance
Test Status	Mandatory (only if structure-aware emulation of trunk-specific Nx64 kbit/s service with CAS is supported)
Requirement Description	All TDMoMPLS implementations supporting trunk-specific Nx64 kbit/s with CAS **MUST** support the default mode where a single TDMoMPLS packet carries exactly one trunk special structure (i.e. the payload and signaling blocks) aligned with the packet payload. In this case: 1. Packetization latency is: a) 2 milliseconds for E1 Nx64 kbit/s b) 3 milliseconds for T1 Nx64 kbit/s (both SF and ESF) 2. The packet payload size is: a) 16*N + floor ((N+1)/2) for E1-Nx64 kbit/s b) 24*N + floor ((N+1)/2) for T1/ESF-Nx64 kbit/s and T1/SF-Nx64 kbit/s
Test Object	Verify that for trunk-specific Nx64 kbit/s services with CAS the packetization latencies and corresponding packet payload sizes mentioned in the “Requirement Description” section above are supported
Test Configuration	
Test Procedure	Set up at least one structure-aware flow (PW #1), trunk-specific Nx64 kbit/s service with CAS between PE ‘1’ and PE ‘2’. Use the TDM Generator/Analyzer to generate a TDM circuit with a specific test pattern for emulation by the PEs. For various values of N, use the Impairment Generator/Analyzer to monitor the packets associated with the PW #1 and to verify that they contain the correct payload size and packetization latency
Units	Packet payload size and packetization latency
Variables	Number of PWs (1 or 2), TDM service (T1, E1), test pattern, Number of DS0 Channels (N)
Results	Pass or fail
Remarks	The payload sub-structure can be considered as a matrix of N columns by M rows, where N is the number of DS0 channels (timeslots), M is the number of frames in the originating trunk multiframe, each row is the structure preserved in emulation of the corresponding basic NxDS0 service described above and his matrix is mapped into the packet payload "row by row"

Test Case 26: Trunk-Specific Nx64 kbit/s with CAS Payload Fragmentation

Abstract Test Cases for TDMoMPLS	
Test Name	Trunk-Specific Nx64 kbit/s with CAS Payload Fragmentation
Test Definition ID	MFA8.0.0-2.3.6-4
Reference document	MFA 8.0.0
Test Type	Conformance
Test Status	Mandatory (only if structure-aware emulation of trunk-specific Nx64 kbit/s service with CAS and fragmentation is supported)
Requirement Description	When TDMoMPLS implementations of trunk-specific Nx64 kbit/s with CAS support fragmentation of the special structures into multiple TDMoMPLS packets, the payload block of the structure **MUST** be fragmented into fragments of equal size so that each fragment comprises an integer number of basic structures of the associated basic NxDS0 service and these structures are aligned with the boundaries of the packet payload
Test Object	Verify that when TDMoMPLS implementations of trunk-specific Nx64 kbit/s with CAS support fragmentation, the payload block of the structure is fragmented into fragments of equal size
Test Configuration	
Test Procedure	Set up at least one structure-aware flow (PW #1), trunk-specific Nx64 kbit/s service with CAS between PE '1' and PE '2'. Use the TDM Generator/Analyzer to generate a TDM circuit with a specific test pattern for emulation by the PEs. Use the Impairment Generator/Analyzer to monitor the packets associated with the PW #1 and to verify that the payload block of the structure is fragmented into fragments of equal size so that each fragment comprises an integer number of basic structures of the associated basic NxDS0
Units	Fragments size
Variables	Number of PWs (1 or 2), TDM service (T1, E1), test pattern, Number of DS0 Channels (N)
Results	Pass or fail
Remarks	

Test Case 27: Trunk-Specific Nx64 kbit/s Fragmentation - Signaling Substructures

Abstract Test Cases for TDMoMPLS	
Test Name	Trunk-Specific Nx64 kbit/s Fragmentation - Signaling Substructures
Test Definition ID	MFA8.0.0-2.3.6-5
Reference document	MFA 8.0.0
Test Type	Conformance
Test Status	Mandatory (only if structure-aware emulation of trunk-specific Nx64 kbit/s service with CAS and fragmentation is supported)
Requirement Description	When TDMoMPLS implementations of trunk-specific Nx64 kbit/s with CAS support fragmentation of the special structures into multiple TDMoMPLS packets, the signaling substructure **MUST** be appended to the last payload fragment
Test Object	Verify that when TDMoMPLS implementations of trunk-specific Nx64 kbit/s with CAS support fragmentation, the signaling substructure is appended to the last payload fragment
Test Configuration	
Test Procedure	Set up at least one structure-aware flow (PW #1), trunk-specific N x 64 kbit/s service with CAS between PE '1' and PE '2'. Use the TDM Generator/Analyzer to generate a TDM circuit with a specific test pattern for emulation by the PEs. Use the Impairment Generator/Analyzer to monitor the packets associated with the PW #1 and to verify that the signaling substructure is appended to the last payload fragment
Units	Signaling substructures location
Variables	Number of PWs (1 or 2), TDM service (T1, E1), test pattern, Number of DS0 Channels (N)
Results	Pass or fail
Remarks	

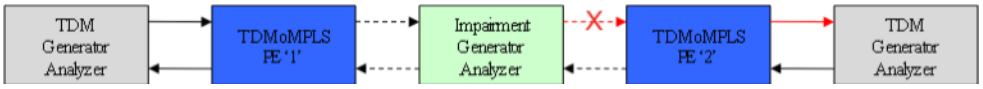
Test Case 28: Jitter Buffer Size

Abstract Test Cases for TDMoMPLS	
Test Name	Jitter Buffer Size
Test Definition ID	MFA8.0.0-3.4.2-1
Reference document	MFA 8.0.0
Test Type	Conformance
Test Status	Mandatory
Requirement Description	The TDMoMPLS CE-bound IWF (depacketizer) includes a "jitter buffer", where the payload of received packets is stored prior to play-out to the local TDM attachment circuit. The size of this buffer **MUST** be locally configurable to allow accommodation of the PSN-specific packet delay variation
Test Object	Verify that the size of the jitter buffer size is locally configurable to allow accommodation of the PSN-specific packet delay variation
Test Configuration	
Test Procedure	Set up at least one structure-agnostic flow (PW #1) using raw encapsulation between PE '1' and PE '2'. Use the management system of the TDMoMPLS PEs under test to verify that the jitter buffer size is locally configurable to allow accommodation of the PSN-specific packet delay variation
Units	Jitter buffer size
Variables	Number of PWs (1 or 2), TDM service (T1, E1, T3, E3), test pattern
Results	Pass or fail
Remarks	

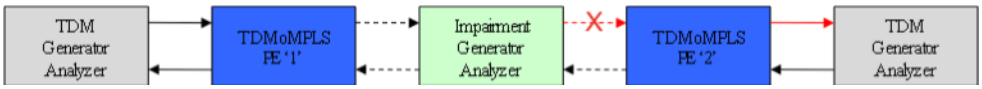
Test Case 29: TDM Data Pattern Before Set Up and After Tear Down

Abstract Test Cases for TDMoMPLS	
Test Name	TDM Data Pattern Before Set Up and After Tear Down
Test Definition ID	MFA8.0.0-3.4.2-2
Reference document	MFA 8.0.0
Test Type	Conformance
Test Status	Mandatory
Requirement Description	Before a PW has been set up and after a PW has been torn down, the depacketizer **MUST** play out the "idle code" pattern to its TDM attachment circuit
Test Object	Verify that before a PW has been set up and after a PW has been torn down, the depacketizer plays out the "idle code" pattern to its TDM attachment circuit
Test Configuration	
Test Procedure	Use the TDM Generator/Analyzer to verify that before a PW has been set up, the PEs play out the "idle code" pattern. Set up at least one structure-agnostic flow (PW #1) using raw encapsulation between PE '1' and PE '2'. Use the TDM Generator/Analyzer to generate a TDM circuit with a specific test pattern for emulation by the PEs and verify that there is "Pattern Sync". Tear down the PW and use the TDM Generator/Analyzer to verify that the PEs resume playing out the "idle code" pattern
Units	TDM data pattern
Variables	Number of PWs (1 or 2), TDM service (T1, E1, T3, E3), test pattern
Results	Pass or fail
Remarks	

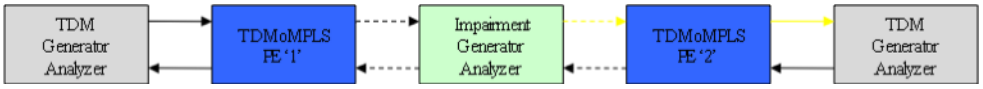
Test Case 30: Compensation for Lost Packets in Structure-Agnostic Mode

Abstract Test Cases for TDMoMPLS	
Test Name	Compensation for Lost Packets in Structure-Agnostic Mode
Test Definition ID	MFA8.0.0-3.4.2-3
Reference document	MFA 8.0.0
Test Type	Conformance
Test Status	Mandatory
Requirement Description	The payload of each lost TDMoMPLS packet **MUST** be replaced with the equivalent amount of replacement data and by default, all TDMoMPLS implementations operating in the structure-agnostic emulation mode **MUST** support generation of the "all ones" pattern as the replacement data
Test Object	Verify that in structure-agnostic mode, the payload of each lost TDMoMPLS packet is replaced with the equivalent amount of replacement data “all ones”
Test Configuration	
Test Procedure	Set up at least one structure-agnostic flow (PW #1) using raw encapsulation between PE ‘1’ and PE ‘2’. Use the TDM Generator/Analyzer to generate a TDM circuit with a specific test pattern for emulation by the PEs. Use the Impairment Generator/Analyzer to discard a specific percentage of TDMoMPLS packets towards the TDM-bound CES IWF of the PE ‘2’ and use the TDM Generator/Analyzer to measure the bit error count over a test period of T seconds and to verify that the bit error count is equal to the number of TDMoMPLS packets lost over the test period times the number of bits included in the TDM payload
Units	Bit error count
Variables	Number of PWs (1 or 2), TDM service (T1, E1, T3, E3), test pattern, percentage of discarded packets, test period T
Results	Pass or fail
Remarks	

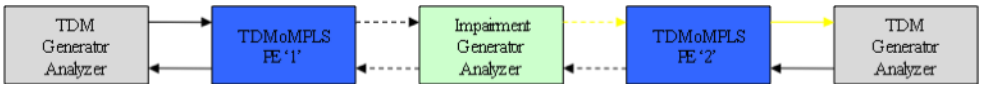
Test Case 31: Compensation for Lost Packets in Structure-Aware Mode

Abstract Test Cases for TDMoMPLS	
Test Name	Compensation for Lost Packets in Structure-Aware Mode
Test Definition ID	MFA8.0.0-3.4.2-4
Reference document	MFA 8.0.0
Test Type	Conformance
Test Status	Mandatory (only if structure-aware emulation mode is supported)
Requirement Description	The payload of each lost TDMoMPLS packet **MUST** be replaced with the equivalent amount of replacement data. All implementations of TDMoMPLS **MUST** support the "all ones" pattern as the idle code. The "idle code" pattern may be locally configurable for structure-aware emulation
Test Object	Verify that in structure-aware mode, the payload of each lost TDMoMPLS packet is replaced with the equivalent amount of replacement data “all ones”
Test Configuration	
Test Procedure	Set up at least one structure-agnostic flow (PW #1) between PE ‘1’ and PE ‘2’. Use the TDM Generator/Analyzer to generate a TDM circuit with a specific test pattern for emulation by the PEs. Use the Impairment Generator/Analyzer to discard a specific percentage of TDMoMPLS packets towards the TDM-bound CES IWF of the PE ‘2’ and use the TDM Generator/Analyzer to measure the bit error count over a test period of T seconds and to verify that the bit error count is equal to the number of TDMoMPLS packets lost over the test period times the number of bits included in the TDM payload.
Units	Bit error count
Variables	Number of PWs (1 or 2), TDM service (T1, E1, T3, E3), test pattern, percentage of discarded packets, test period T
Results	Pass or fail
Remarks	

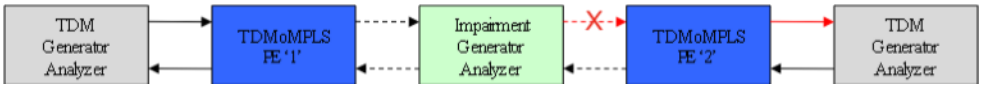
Test Case 32: Detection of Misordered Packets

Abstract Test Cases for TDMoMPLS	
Test Name	Detection of Misordered Packets
Test Definition ID	MFA8.0.0-3.4.2-5
Reference document	MFA 8.0.0
Test Type	Conformance
Test Status	Mandatory
Requirement Description	The depacketizer **MUST** detect misordered packets. The depacketizer **MAY** reorder misordered packets. Misordered packets that cannot be reordered **MUST** be discarded and treated as lost
Test Object	Verify that the depacketizer detects misordered packets and that the ones that cannot be reordered are discarded and treated as lost
Test Configuration	
Test Procedure	Set up at least one structure-agnostic flow (PW #1) using raw encapsulation between PE '1' and PE '2'. Use the TDM Generator/Analyzer to generate a TDM circuit with a specific test pattern for emulation by the PEs. Use the Impairment Generator/Analyzer to delay a specific number of consecutive packets towards the TDM-bound CES IWF of the PE '2' by an offset smaller than the jitter buffer size, forcing them to be re-ordered and use the TDM Generator/Analyzer to verify that no bit errors are detected. Then, use the Impairment Generator/Analyzer delay a specific number of consecutive packets towards the TDM-bound CES IWF of the PE '2' by an offset greater than the jitter buffer size, forcing them to be re-ordered/discarded by the IWF and use the TDM Generator/Analyzer to verify that a burst of bit errors is detected
Units	Bit error count
Variables	Number of PWs (1 or 2), TDM service (T1, E1, T3, E3), test pattern, number of delayed packets
Results	Pass or fail
Remarks	

Test Case 33: TDMoMPLS Packets Carrying Invalid TDM Data

Abstract Test Cases for TDMoMPLS	
Test Name	TDMoMPLS Packets Carrying Invalid TDM Data
Test Definition ID	MFA8.0.0-3.4.2-6
Reference document	MFA 8.0.0
Test Type	Conformance
Test Status	Optional
Requirement Description	The payload of the received TDMoMPLS packets marked as not carrying valid TDM data (L bit = 1, M bits = 00) **SHOULD** be replaced by the equivalent amount of the "idle code" pattern even if this payload has not been omitted
Test Object	Verify that the payload of the received TDMoMPLS packets marked as not carrying valid TDM data (L bit = 1, M bits = 00) is replaced by the equivalent amount of the "idle code" pattern even if this payload has not been omitted
Test Configuration	
Test Procedure	Set up at least one structure-agnostic flow (PW #1) using raw encapsulation between PE '1' and PE '2'. Use the TDM Generator/Analyzer to generate a TDM circuit with a specific test pattern for emulation by the PEs. Use the Impairment Generator/Analyzer to set the L bit of all the TDMoMPLS packets without modifying the payload and use the TDM Generator/Analyzer to verify that the valid TDM data is replaced by the equivalent amount of the "idle code" pattern
Units	Bit error count
Variables	Number of PWs (1 or 2), TDM service (T1, E1, T3, E3), test pattern
Results	Pass or fail
Remarks	

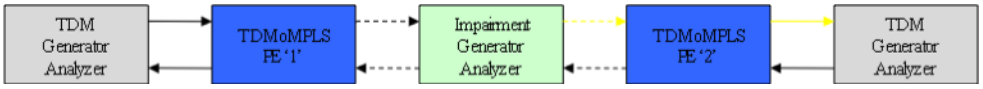
Test Case 34: Loss of Packets State (LOPS)

Abstract Test Cases for TDMoMPLS	
Test Name	Loss of Packets State (LOPS)
Test Definition ID	MFA8.0.0-3.4.2-7
Reference document	MFA 8.0.0
Test Type	Conformance
Test Status	Mandatory
Requirement Description	While in LOPS, the depacketizer **MUST** play out the "idle code" pattern to the local CE
Test Object	Verify that when a PE is in LOPS, the depacketizer plays out the "idle code" pattern to the local CE
Test Configuration	
Test Procedure	Set up at least one structure-agnostic flow (PW #1) using raw encapsulation between PE '1' and PE '2'. Use the TDM Generator/Analyzer to generate a TDM circuit with a specific test pattern for emulation by the PEs. Use the Impairment Generator/Analyzer to stop traffic towards the TDM-bound CES IWF of the PE '2' and use the TDM Generator/Analyzer to verify that the TDM data is replaced by the "idle code" pattern
Units	TDM data pattern
Variables	Number of PWs (1 or 2), TDM service (T1, E1, T3, E3), test pattern
Results	Pass or fail
Remarks	

Test Case 35: Packet Loss Detection in Presence of Stray Packets

Abstract Test Cases for TDMoMPLS	
Test Name	Packet Loss Detection in Presence of Stray Packets
Test Definition ID	MFA8.0.0-3.5-1
Reference document	MFA 8.0.0
Test Type	Conformance
Test Status	Mandatory (only if stray packets can be detected)
Requirement Description	The depacketizer **MAY** detect stray packets. If detected, stray packets **MUST** be discarded and their detection **MUST NOT** affect mechanisms for detection of packet loss
Test Object	Verify that when stray packets are detected, the depacketizer discards them and the mechanisms for detection of packet loss is not affected
Test Configuration	
Test Procedure	Set up at least one structure-agnostic flow (PW #1) using raw encapsulation between PE '1' and PE '2'. Use the TDM Generator/Analyzer to generate a TDM circuit with a specific test pattern for emulation by the PEs. Use the Impairment Generator/Analyzer to duplicate a specific number of consecutive packets creating stray packets towards the TDM-bound CES IWF of the PE '2' and use the TDM Generator/Analyzer to verify that no bit errors are detected (stray packets are discarded). Then, use the Impairment Generator/Analyzer to delete a specific number of consecutive packets from the normal sequence towards the TDM-bound CES IWF of the PE '2' and verify that a burst of bit errors is detected. Then, use the Impairment Generator/Analyzer to duplicate a specific number of consecutive packets and to delete the same number of following packets from the normal sequence towards the TDM-bound CES IWF of the PE '2' and verify that the burst of bit errors is still detected
Units	Bit error count
Variables	Number of PWs (1 or 2), TDM service (T1, E1, T3, E3), test pattern, number of duplicated/deleted packets
Results	Pass or fail
Remarks	

Test Case 36: Malformed Packets Detection Using RTP PT Value

Abstract Test Cases for TDMoMPLS	
Test Name	Malformed Packets Detection Using RTP PT Value
Test Definition ID	MFA8.0.0-3.5-2
Reference document	MFA 8.0.0
Test Type	Conformance
Test Status	Mandatory (only if malformed packets can be detected)
Requirement Description	The depacketizer **MAY** detect malformed packets. When RTP is used, a mismatch between the expected and the actual PT values creates a malformed packet. Malformed in-order packets **MUST** be discarded by the CE-bound IWF and replacement data generated as for lost packets
Test Object	Verify that when malformed packets are detected, the depacketizer discards them and replacement data is generated as for lost packets
Test Configuration	
Test Procedure	Set up at least one structure-agnostic flow (PW #1) using raw encapsulation between PE '1' and PE '2'. Use the TDM Generator/Analyzer to generate a TDM circuit with a specific test pattern for emulation by the PEs. Use the Impairment Generator/Analyzer to modify the PF value of the RTP header of a specific number of TDMoMPLS packets (making them malformed packets) towards the TDM-bound CES IWF of the PE '2' and use the TDM Generator/Analyzer to verify that bit errors are detected. (Bit errors would not be detected if the malformed packets were not discarded by the PE '2')
Units	Bit error count
Variables	Number of PWs (1 or 2), TDM service (T1, E1, T3, E3), test pattern, number of malformed packets
Results	Pass or fail
Remarks	

Test Case 37: Number of Packets Transmitted - Counter

Abstract Test Cases for TDMoMPLS	
Test Name	Number of Packets Transmitted - Counter
Test Definition ID	MFA8.0.0-3.6.2-1
Reference document	MFA 8.0.0
Test Type	Conformance
Test Status	Optional
Requirement Description	An MPLS-bound CES IWF **SHOULD** maintain a counter for the number of packets transmitted
Test Object	Verify that the MPLS-bound CES IWF of the PEs under test maintain a counter for the number of packets transmitted
Test Configuration	
Test Procedure	Set up at least one structure-agnostic flow (PW #1) using raw encapsulation between PE '1' and PE '2' for a period of time T then tear it down. Use the management system associated with the TDMoMPLS PE under test to verify that the number of packets transmitted indicated by the counter is equal to the number of packets monitored by the Impairment Generator/Analyzer
Units	Number of packets transmitted
Variables	Number of PWs (1 or 2), TDM service (T1, E1, T3, E3), test pattern, period of time T
Results	Pass or fail
Remarks	

Test Case 38: Number of Payload Octets Transmitted - Counter

Abstract Test Cases for TDMoMPLS	
Test Name	Number of Payload Octets Transmitted - Counter
Test Definition ID	MFA8.0.0-3.6.2-2
Reference document	MFA 8.0.0
Test Type	Conformance
Test Status	Optional
Requirement Description	An MPLS-bound CES IWF **SHOULD** maintain a counter for the number of payload octets transmitted
Test Object	Verify that the MPLS-bound CES IWF of the PEs under test maintain a counter for the number of payload octets transmitted
Test Configuration	
Test Procedure	Set up at least one structure-agnostic flow (PW #1) using raw encapsulation between PE '1' and PE '2' for a period of time T then tear it down. Use the management system associated with the TDMoMPLS PE under test to verify that the number of payload octets transmitted indicated by the counter is equal to the number of payload octets monitored by the Impairment Generator/Analyzer
Units	Number of payload octets transmitted
Variables	Number of PWs (1 or 2), TDM service (T1, E1, T3, E3), test pattern, period of time T
Results	Pass or fail
Remarks	

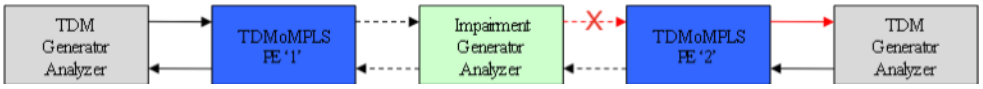
Test Case 39: Number of Packets Received - Counter

Abstract Test Cases for TDMoMPLS	
Test Name	Number of Packets Received - Counter
Test Definition ID	MFA8.0.0-3.6.2-3
Reference document	MFA 8.0.0
Test Type	Conformance
Test Status	Optional
Requirement Description	A TDM-bound CES IWF **SHOULD** maintain a counter for the number of packets received
Test Object	Verify that the TDM-bound CES IWF of the PEs under test maintain a counter for the number of packets received
Test Configuration	
Test Procedure	Set up at least one structure-agnostic flow (PW #1) using raw encapsulation between PE '1' and PE '2' for a period of time T then tear it down. Use the management system associated with the TDMoMPLS PE under test to verify that the number of packets received indicated by the counter is equal to the number of packets monitored by the Impairment Generator/Analyzer
Units	Number of packets received
Variables	Number of PWs (1 or 2), TDM service (T1, E1, T3, E3), test pattern, period of time T
Results	Pass or fail
Remarks	

Test Case 40: Number of Payload Octets Received - Counter

Abstract Test Cases for TDMoMPLS	
Test Name	Number of Payload Octets Received - Counter
Test Definition ID	MFA8.0.0-3.6.2-4
Reference document	MFA 8.0.0
Test Type	Conformance
Test Status	Optional
Requirement Description	A TDM-bound CES IWF **SHOULD** maintain a counter for the number of payload octets received
Test Object	Verify that the TDM-bound CES IWF of the PEs under test maintain a counter for the number of payload octets received
Test Configuration	
Test Procedure	Set up at least one structure-agnostic flow (PW #1) using raw encapsulation between PE '1' and PE '2' for a period of time T then tear it down. Use the management system associated with the TDMoMPLS PE under test to verify that the number of payload octets received indicated by the counter is equal to the number of payload octets monitored by the Impairment Generator/Analyzer
Units	Number of payload octets received
Variables	Number of PWs (1 or 2), TDM service (T1, E1, T3, E3), test pattern, period of time T
Results	Pass or fail
Remarks	

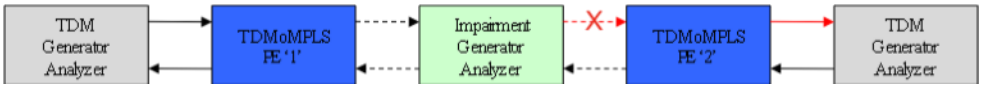
Test Case 41: Number of Lost Packets Detected - Counter

Abstract Test Cases for TDMoMPLS	
Test Name	Number of Lost Packets Detected - Counter
Test Definition ID	MFA8.0.0-3.6.2-5
Reference document	MFA 8.0.0
Test Type	Conformance
Test Status	Optional
Requirement Description	A TDM-bound CES IWF **SHOULD** maintain a counter for the number of lost packets detected
Test Object	Verify that the TDM-bound CES IWF of the PEs under test maintain a counter for the number of lost packets detected
Test Configuration	
Test Procedure	Set up at least one structure-agnostic flow (PW #1) using raw encapsulation between PE '1' and PE '2'. Use the TDM Generator/Analyzer to generate a TDM circuit with a specific test pattern for emulation by the PEs. Use the Impairment Generator/Analyzer to discard a specific number of TDMoMPLS packets towards the TDM-bound CES IWF of the PE '2' and use the management system associated with the TDMoMPLS PE under test to verify that the number of lost packets detected indicated by the counter is equal to the number of TDMoMPLS packets discarded by the Impairment Generator/Analyzer
Units	Number of lost packets
Variables	Number of PWs (1 or 2), TDM service (T1, E1, T3, E3), test pattern, number of discarded packets
Results	Pass or fail
Remarks	

Test Case 42: Number of OOS Packets Received & Successfully Re-Ordered - Counter

Abstract Test Cases for TDMoMPLS	
Test Name	Number of Out-of-Sequence Packets Received & Successfully Re-Ordered - Counter
Test Definition ID	MFA8.0.0-3.6.2-6
Reference document	MFA 8.0.0
Test Type	Conformance
Test Status	Optional
Requirement Description	A TDM-bound CES IWF **SHOULD** maintain a counter for the number of out-of-sequence packets received & successfully re-ordered
Test Object	Verify that the TDM-bound CES IWF of the PEs under test maintain a counter for the number of out-of-sequence packets received & successfully re-ordered
Test Configuration	
Test Procedure	Set up at least one structure-agnostic flow (PW #1) using raw encapsulation between PE '1' and PE '2'. Use the TDM Generator/Analyzer to generate a TDM circuit with a specific test pattern for emulation by the PEs. Use the Impairment Generator/Analyzer to delay a specific number of consecutive packets towards the TDM-bound CES IWF of the PE '2', by an offset smaller than the jitter buffer size, forcing them to be re-ordered and use the management system associated with the TDMoMPLS PE under test to verify that the number of out-of-sequence packets received & successfully re-ordered indicated by the counter is equal to the number of TDMoMPLS packets delayed by the Impairment Generator/Analyzer
Units	Number of out-of-sequence packets received & successfully re-ordered
Variables	Number of PWs (1 or 2), TDM service (T1, E1, T3, E3), test pattern, number of delayed packets
Results	Pass or fail
Remarks	

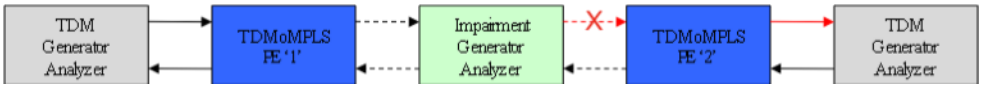
Test Case 43: Number of Transitions from Normal to Loss of Packets State - Counter

Abstract Test Cases for TDMoMPLS	
Test Name	Number of Transitions from Normal to Loss of Packets State - Counter
Test Definition ID	MFA8.0.0-3.6.2-7
Reference document	MFA 8.0.0
Test Type	Conformance
Test Status	Optional
Requirement Description	A TDM-bound CES IWF **SHOULD** maintain a counter for the number of transitions from the normal to the loss of packets state
Test Object	Verify that the TDM-bound CES IWF of the PEs under test maintain a counter for the number of transitions from the normal to the loss of packets state
Test Configuration	
Test Procedure	Set up at least one structure-agnostic flow (PW #1) using raw encapsulation between PE '1' and PE '2'. Use the TDM Generator/Analyzer to generate a TDM circuit with a specific test pattern for emulation by the PEs. Use the Impairment Generator/Analyzer to stop traffic towards the TDM-bound CES IWF of the PE '2' for a period of time T long enough so that the number of lost packets is greater than the preconfigured number of consecutive lost packets required to enter the loss of packet state and then re-enable the traffic. Repeat the test three times and use the management system associated with the TDMoMPLS PE under test to verify that the number of transitions from the normal to the loss of packets state indicated by the counter is equal to the number of times the Impairment Generator/Analyzer was used to stop traffic and re-enable traffic towards the TDM-bound CES IWF of the PE under test
Units	Number of transitions from the normal to the loss of packets state
Variables	Number of PWs (1 or 2), TDM service (T1, E1, T3, E3), test pattern, period of time T
Results	Pass or fail
Remarks	

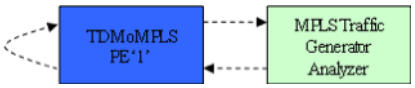
Test Case 44: Number of Malformed Packets Received - Counter

Abstract Test Cases for TDMoMPLS	
Test Name	Number of Malformed Packets Received - Counter
Test Definition ID	MFA8.0.0-3.6.2-8
Reference document	MFA 8.0.0
Test Type	Conformance
Test Status	Optional
Requirement Description	A TDM-bound CES IWF **SHOULD** maintain a counter for the number of malformed packets received
Test Object	Verify that the TDM-bound CES IWF of the PEs under test maintain a counter for the number of malformed packets received
Test Configuration	
Test Procedure	Set up at least one structure-agnostic flow (PW #1) using raw encapsulation between PE '1' and PE '2'. Use the TDM Generator/Analyzer to generate a TDM circuit with a specific test pattern for emulation by the PEs. Use the Impairment Generator/Analyzer to modify the PF value of the RTP header of a specific number of TDMoMPLS packets (making them malformed packets) towards the TDM-bound CES IWF of the PE '2' and use the management system associated with the TDMoMPLS PE under test to verify that the number of malformed packets received indicated by the counter is equal to the number of TDMoMPLS packets modified by the Impairment Generator/Analyzer
Units	Number of malformed packets received
Variables	Number of PWs (1 or 2), TDM service (T1, E1, T3, E3), test pattern, number of modified packets
Results	Pass or fail
Remarks	

Test Case 45: Number of Jitter Buffer Underruns - Counter

Abstract Test Cases for TDMoMPLS	
Test Name	Number of Jitter Buffer Underruns - Counter
Test Definition ID	MFA8.0.0-3.6.2-9
Reference document	MFA 8.0.0
Test Type	Conformance
Test Status	Optional
Requirement Description	A TDM-bound CES IWF **SHOULD** maintain a counter for the number of jitter buffer underruns
Test Object	Verify that the TDM-bound CES IWF of the PEs under test maintain a counter for the jitter buffer underruns
Test Configuration	
Test Procedure	Set up at least one structure-agnostic flow (PW #1) using raw encapsulation between PE '1' and PE '2'. Use the TDM Generator/Analyzer to generate a TDM circuit with a specific test pattern for emulation by the PEs. Use the Impairment Generator/Analyzer to stop traffic towards the TDM-bound CES IWF of the PE '2' for a period of time T long enough so that there is no received TDMoMPLS packets payload ready to be played out on the TDM interface. Repeat the test three times and use the management system associated with the TDMoMPLS PE under test to verify that the number of jitter buffer underruns indicated by the counter is equal to the number of times the Impairment Generator/Analyzer was used to stop traffic and re-enable traffic towards the TDM-bound CES IWF of the PE under test
Units	Number of jitter buffer underruns
Variables	Number of PWs (1 or 2), TDM service (T1, E1, T3, E3), test pattern, period of time T
Results	Pass or fail
Remarks	

Test Case 46: Number of Jitter Buffer Overruns - Counter

Abstract Test Cases for TDMoMPLS	
Test Name	Number of Jitter Buffer Overruns - Counter
Test Definition ID	MFA8.0.0-3.6.2-10
Reference document	MFA 8.0.0
Test Type	Conformance
Test Status	Optional
Requirement Description	A TDM-bound CES IWF **SHOULD** maintain a counter for the number of jitter buffer overruns
Test Object	Verify that the TDM-bound CES IWF of the PEs under test maintain a counter for the jitter buffer overruns
Test Configuration	
Test Procedure	Set up at least one structure-agnostic flow (PW #1) using raw encapsulation between PE '1' and PE '2'. Use the MPLSoEthernet Generator/Analyzer to transmit valid TDMoMPLS packets towards the PE '1' at a rate of 1000 packets/sec. Increase the rate at which the TDMoMPLS packets are sent by a factor of 2 for a period of time T long enough so that the jitter buffer cannot accommodate the newly arrived valid TDMoMPLS packets. Repeat the test three times and use the management system associated with the TDMoMPLS PE under test to verify that the number of jitter buffer overruns indicated by the counter is equal to the number of times the MPLSoEthernet Generator/Analyzer was used to increase the rate at which the TDMoMPLS packets were sent by a factor of 2
Units	Number of jitter buffer overruns
Variables	Number of PWs (1 or 2), TDM service (T1, E1, T3, E3), test pattern, period of time T
Results	Pass or fail
Remarks	

Normative Annex S

Timing Recovery over Packet Switched Network

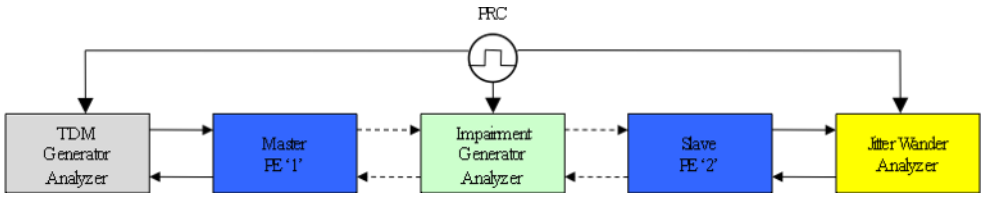
The Test Cases in this normative annex are based on ITU-T recommendation G.8261 that describes a test topology together with a series of network conditions including load variation, network changes and packet loss used to generate a number of packet delay variation profiles reproducing those found in typical production networks as accurately as present knowledge allows. It should be noted that test topology, network conditions and the resulting packet delay variation profiles may be expected to evolve as work in this field progresses. Test Cases that call for the application of packet delay variation profiles will preferably be executed using methods capable of reproducing them in a strictly repeatable manner. These test cases are based on the test topology described in Figure VI.4/G.8261 in which the PRC is connected directly as the source of timing for the CES flow.

S.1 Test Cases Summary

Number	Test Case Name	Emulation Mode	Test Status
S1	Wander performance in presence of low frequency PDV	Structure-agnostic	Mandatory if the slave PE supports timing recovery from the PSN
S2	Wander performance in presence of extremely low frequency PDV	Structure-agnostic	Mandatory if the slave PE supports timing recovery from the PSN
S3	Wander performance in presence of temporary network outages of 10s	Structure-agnostic	Mandatory if the slave PE supports timing recovery from the PSN
S4	Wander performance in presence of temporary network outages of 100s	Structure-agnostic	Mandatory if the slave PE supports timing recovery from the PSN
S5	Wander performance in presence of temporary network congestion of 10s	Structure-agnostic	Mandatory if the slave PE supports timing recovery from the PSN
S6	Wander performance in presence of temporary network congestion of 100s	Structure-agnostic	Mandatory if the slave PE supports timing recovery from the PSN
S7	Wander performance in presence of significant routing changes	Structure-agnostic	Mandatory if the slave PE supports timing recovery from the PSN
S8	Wander performance in presence of very significant routing changes	Structure-agnostic	Mandatory if the slave PE supports timing recovery from the PSN

S9	Wander performance in presence of beating effect	Structure-agnostic	Mandatory if the slave PE supports timing recovery from the PSN
S10	Wander performance in presence of extremely low frequency PDV and blocking effect	Structure-agnostic	Mandatory if the slave PE supports timing recovery from the PSN
S11	Wander performance in presence of low frequency PDV and blocking effect	Structure-agnostic	Mandatory if the slave PE supports timing recovery from the PSN

S.2 Test Configuration

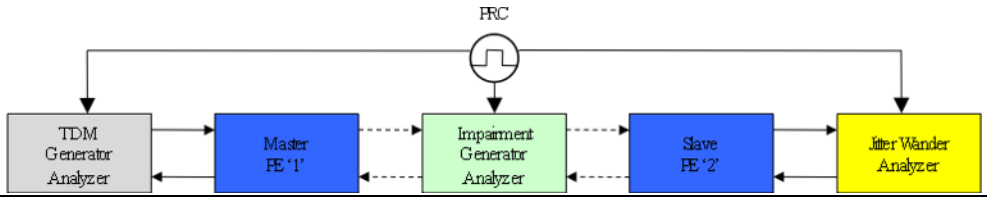


Note 1: PDV impairments are directly affecting the synchronization mechanism under test.

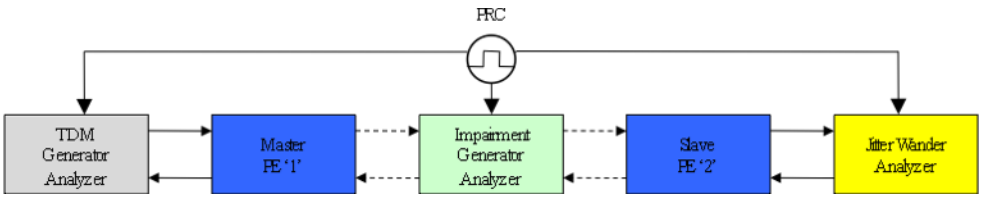
Note 2: The Impairments Generator/Analyzer equipment shall introduce Packet Delay Variation on the packets flowing from the master PE to the slave PE.

S.3 Abstract Test Cases for Synchronization Distribution & Performance

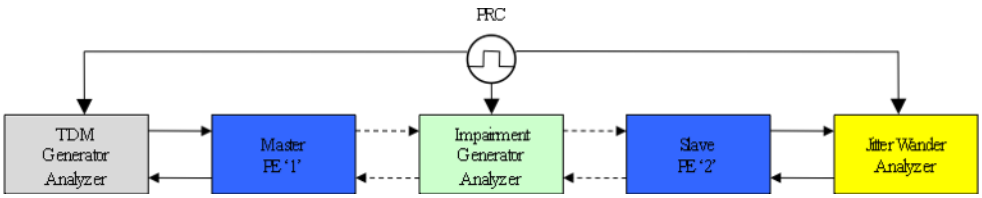
Test Case S1: Wander Performance in Presence of Low Frequency PDV

Abstract Test Cases for TDMoMPLS	
Test Name	Wander Performance in Presence of Low Frequency PDV
Test Definition ID	G.8261-VI.3.2.3-1
Reference documents	G.8261, G.823, G.824
Test Type	Conformance
Test Status	Mandatory if the slave PE supports timing recovery from the PSN
Requirement Description	The method of synchronization used **MUST** be such that the slave TDM-bound IWF meets the traffic interface requirements specified in ITU-T recommendation G.824 for T1 and T3 circuits and G.823 for E1 and E3 circuits while the system under test is in presence of low frequency PDV as described in appendix VI.3.2.3 Test Case 2 of the ITU-T recommendation G.8261
Test Object	Verify that the method of synchronization used is such that the slave TDM-bound IWF meets the traffic interface requirements specified in ITU-T recommendation G.824 for T1 and T3 circuits and G.823 for E1 and E3 circuits while the system under test is in presence of low frequency PDV as described in appendix VI.3.2.3 Test Case 2 of the ITU-T recommendation G.8261
Test Configuration	
Test Procedure	Set up at least one structure-agnostic flow (PW #1) using raw encapsulation between PE '1' and PE '2'. The master PE'1' must be set to recover the clock from the incoming TDM line (traceable to the PRC) and the slave PE'2' must be set to recover the clock from the PSN interface. Use the TDM Generator/Analyzer (locked to the PRC) to generate a TDM circuit with a specific test pattern for emulation by the PEs. Allow a stabilization period of 900 seconds for the clock recovery process to stabilize. Use the Impairment Generator/Analyzer to create a delay variation profile that replaces the MPLS LSRs and the Traffic Generator transmitting the predefined load* and packet size profile** described in G.8261, appendix VI.3.2.3 Test Case 2 and use the Jitter / Wander Analyzer to measure MTIE and to verify that the measurements are within the traffic interface masks specified in ITU-T recommendation G.824 for T1 and T3 circuits and G.823 for E1 and E3 circuits
Units	MTIE (nanoseconds)
Variables	Number of PWs (1 or 2), TDM service (T1, E1, T3, E3), test pattern
Results	Pass or fail
Remarks	*Load: Start with network disturbance load at 80% for 1 hour, drop to 20% for an hour, increase back to 80% for an hour, drop back to 20% for an hour, increase back to 80% for an hour, drop back to 20% for an hour. **Packet size profile is: 60% of 1518-byte, 30% of 64-byte and 10% of 576-byte frames

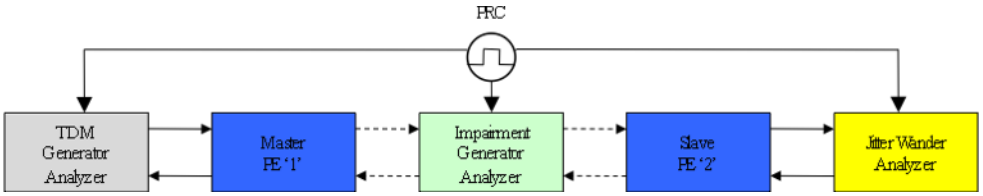
Test Case S2: Wander Performance in Presence of Extremely Low Frequency PDV

Abstract Test Cases for TDMoMPLS	
Test Name	Wander Performance in Presence of Extremely Low Frequency PDV
Test Definition ID	G.8261-VI.3.2.4-1
Reference documents	G.8261, G.823, G.824
Test Type	Conformance
Test Status	Mandatory if the slave PE supports timing recovery from the PSN
Requirement Description	The method of synchronization used **MUST** be such that the slave TDM-bound IWF meets the traffic interface requirements specified in ITU-T recommendation G.824 for T1 and T3 circuits and G.823 for E1 and E3 circuits while the system under test is in presence of extremely low frequency PDV as described in appendix VI.3.2.4 Test Case 3 of the ITU-T recommendation G.8261
Test Object	Verify that the method of synchronization used is such that the slave TDM-bound IWF meets the traffic interface requirements specified in ITU-T recommendation G.824 for T1 and T3 circuits and G.823 for E1 and E3 circuits while the system under test is in presence of extremely low frequency PDV as described in appendix VI.3.2.4 Test Case 3 of the ITU-T recommendation G.8261
Test Configuration	
Test Procedure	Set up at least one structure-agnostic flow (PW #1) using raw encapsulation between PE '1' and PE '2'. The master PE'1' must be set to recover the clock from the incoming TDM line (traceable to the PRC) and the slave PE'2' must be set to recover the clock from the PSN interface. Use the TDM Generator/Analyzer (locked to the PRC) to generate a TDM circuit with a specific test pattern for emulation by the PEs. Allow a stabilization period of 900 seconds for the clock recovery process to stabilize. Use the Impairment Generator/Analyzer to create a delay variation profile that replaces the MPLS LSRs and the Traffic Generator transmitting the predefined load* and packet size profile** described in G.8261, appendix VI.3.2.4 Test Case 3 and use the Jitter / Wander Analyzer to measure MTIE and to verify that the measurements are within the traffic interface masks specified in ITU-T recommendation G.824 for T1 and T3 circuits and G.823 for E1 and E3 circuits
Units	MTIE (nanoseconds)
Variables	Number of PWs (1 or 2), TDM service (T1, E1, T3, E3), test pattern
Results	Pass or fail
Remarks	*Load: Start with network disturbance load at 20% and increment the load using 1% increments (12 minutes per step) up to 80% then decrement the load using 1% decrements (12 minutes per step) down to 20% and repeat it for a 24-hour period. **Packet size profile is: 60% of 1518-byte, 30% of 64-byte and 10% of 576-byte frames

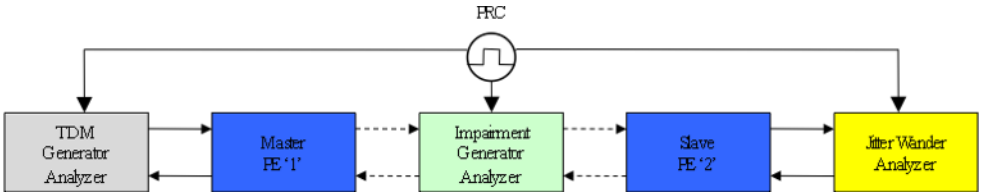
Test Case S3: Wander Performance in Presence of Temporary Network Outages of 10s

Abstract Test Cases for TDMoMPLS	
Test Name	Wander Performance in Presence of Temporary Network Outages of 10s
Test Definition ID	G.8261-VI.3.2.5-1
Reference documents	G.8261, G.823, G.824
Test Type	Conformance
Test Status	Mandatory if the slave PE supports timing recovery from the PSN
Requirement Description	The method of synchronization used **MUST** be such that the slave TDM-bound IWF meets the traffic interface requirements specified in ITU-T recommendation G.824 for T1 and T3 circuits and G.823 for E1 and E3 circuits while the system under test is in presence of temporary network outages of 10s as described in appendix VI.3.2.5 Test Case 4 of the ITU-T recommendation G.8261
Test Object	Verify that the method of synchronization used is such that the slave TDM-bound IWF meets the traffic interface requirements specified in ITU-T recommendation G.824 for T1 and T3 circuits and G.823 for E1 and E3 circuits while the system under test is in presence of temporary network outages of 10s as described in appendix VI.3.2.5 Test Case 4 of the ITU-T recommendation G.8261
Test Configuration	
Test Procedure	Set up at least one structure-agnostic flow (PW #1) using raw encapsulation between PE '1' and PE '2'. The master PE'1' must be set to recover the clock from the incoming TDM line (traceable to the PRC) and the slave PE'2' must be set to recover the clock from the PSN interface. Use the TDM Generator/Analyzer (locked to the PRC) to generate a TDM circuit with a specific test pattern for emulation by the PEs. Allow a stabilization period of 900 seconds for the clock recovery process to stabilize. Use the Impairment Generator/Analyzer to create a delay variation profile that replaces the MPLS LSRs and the Traffic Generator transmitting the predefined load* and packet size profile** described in G.8261, appendix VI.3.2.5 Test Case 4 and use the Jitter / Wander Analyzer to measure MTIE and to verify that the measurements are within the traffic interface masks specified in ITU-T recommendation G.824 for T1 and T3 circuits and G.823 for E1 and E3 circuits
Units	MTIE (nanoseconds)
Variables	Number of PWs (1 or 2), TDM service (T1, E1, T3, E3), test pattern
Results	Pass or fail
Remarks	*Load: Start with network disturbance load at 40% and allow a stabilization period of 900 seconds, then remove the Network connection for 10 seconds and restore. Repeat it 10 times. **Packet size profile is: 60% of 1518-byte, 30% of 64-byte and 10% of 576-byte frames

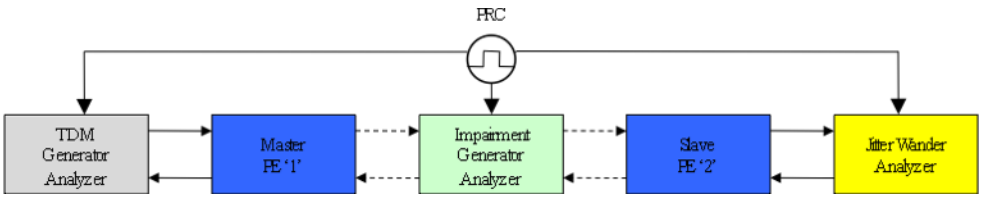
Test Case S4: Wander Performance in Presence of Temporary Network Outages of 100s

Abstract Test Cases for TDMoMPLS	
Test Name	Wander Performance in Presence of Temporary Network Outages of 100s
Test Definition ID	G.8261-VI.3.2.5-2
Reference documents	G.8261, G.823, G.824
Test Type	Conformance
Test Status	Mandatory if the slave PE supports timing recovery from the PSN
Requirement Description	The method of synchronization used **MUST** be such that the slave TDM-bound IWF meets the traffic interface requirements specified in ITU-T recommendation G.824 for T1 and T3 circuits and G.823 for E1 and E3 circuits while the system under test is in presence of temporary network outages of 100s as described in appendix VI.3.2.5 Test Case 4 of the ITU-T recommendation G.8261
Test Object	Verify that the method of synchronization used is such that the slave TDM-bound IWF meets the traffic interface requirements specified in ITU-T recommendation G.824 for T1 and T3 circuits and G.823 for E1 and E3 circuits while the system under test is in presence of temporary network outages of 100s as described in appendix VI.3.2.5 Test Case 4 of the ITU-T recommendation G.8261
Test Configuration	
Test Procedure	Set up at least one structure-agnostic flow (PW #1) using raw encapsulation between PE '1' and PE '2'. The master PE'1' must be set to recover the clock from the incoming TDM line (traceable to the PRC) and the slave PE'2' must be set to recover the clock from the PSN interface. Use the TDM Generator/Analyzer (locked to the PRC) to generate a TDM circuit with a specific test pattern for emulation by the PEs. Allow a stabilization period of 900 seconds for the clock recovery process to stabilize. Use the Impairment Generator/Analyzer to create a delay variation profile that replaces the MPLS LSRs and the Traffic Generator transmitting the predefined load* and packet size profile** described in G.8261, appendix VI.3.2.5 Test Case 4 and use the Jitter / Wander Analyzer to measure MTIE and to verify that the measurements are within the traffic interface masks specified in ITU-T recommendation G.824 for T1 and T3 circuits and G.823 for E1 and E3 circuits
Units	MTIE (nanoseconds)
Variables	Number of PWs (1 or 2), TDM service (T1, E1, T3, E3), test pattern
Results	Pass or fail
Remarks	*Load: Start with network disturbance load at 40% and allow a stabilization period of 900 seconds, then remove the Network connection for 100 seconds and restore. Repeat it 10 times. **Packet size profile is: 60% of 1518-byte, 30% of 64-byte and 10% of 576-byte frames

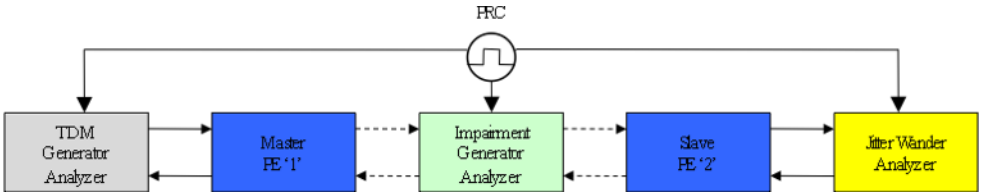
Test Case S5: Wander Performance in Presence of Temporary Network Congestion of 10s

Abstract Test Cases for TDMoMPLS	
Test Name	Wander Performance in Presence of Temporary Network Congestion of 10s
Test Definition ID	G.8261-VI.3.2.6-1
Reference documents	G.8261, G.823, G.824
Test Type	Conformance
Test Status	Mandatory if the slave PE supports timing recovery from the PSN
Requirement Description	The method of synchronization used **MUST** be such that the slave TDM-bound IWF meets the traffic interface requirements specified in ITU-T recommendation G.824 for T1 and T3 circuits and G.823 for E1 and E3 circuits while the system under test is in presence of temporary network congestion of 10s as described in appendix VI.3.2.6 Test Case 5 of the ITU-T recommendation G.8261
Test Object	Verify that the method of synchronization used is such that the slave TDM-bound IWF meets the traffic interface requirements specified in ITU-T recommendation G.824 for T1 and T3 circuits and G.823 for E1 and E3 circuits while the system under test is in presence of temporary network congestion of 10s as described in appendix VI.3.2.6 Test Case 5 of the ITU-T recommendation G.8261
Test Configuration	
Test Procedure	Set up at least one structure-agnostic flow (PW #1) using raw encapsulation between PE '1' and PE '2'. The master PE'1' must be set to recover the clock from the incoming TDM line (traceable to the PRC) and the slave PE'2' must be set to recover the clock from the PSN interface. Use the TDM Generator/Analyzer (locked to the PRC) to generate a TDM circuit with a specific test pattern for emulation by the PEs. Allow a stabilization period of 900 seconds for the clock recovery process to stabilize. Use the Impairment Generator/Analyzer to create a delay variation profile that replaces the MPLS LSRs and the Traffic Generator transmitting the predefined load* and packet size profile** described in G.8261, appendix VI.3.2.6 Test Case 5 and use the Jitter / Wander Analyzer to measure MTIE and to verify that the measurements are within the traffic interface masks specified in ITU-T recommendation G.824 for T1 and T3 circuits and G.823 for E1 and E3 circuits
Units	MTIE (nanoseconds)
Variables	Number of PWs (1 or 2), TDM service (T1, E1, T3, E3), test pattern
Results	Pass or fail
Remarks	*Load: Start with network disturbance load at 40% and allow a stabilization period of 900 seconds, then increase the network disturbance load to 100% (inducing severe delays and packet loss) for 10 seconds and restore. Repeat it 10 times. **Packet size profile is: 60% of 1518-byte, 30% of 64-byte and 10% of 576-byte frames

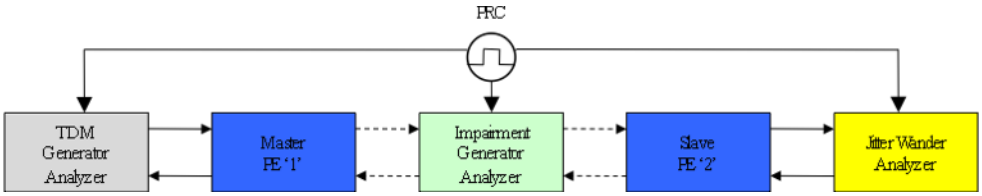
Test Case S6: Wander Performance in Presence of Temporary Network Congestion of 100s

Abstract Test Cases for TDMoMPLS	
Test Name	Wander Performance in Presence of Temporary Network Congestion of 100s
Test Definition ID	G.8261-VI.3.2.6-2
Reference documents	G.8261, G.823, G.824
Test Type	Conformance
Test Status	Mandatory if the slave PE supports timing recovery from the PSN
Requirement Description	The method of synchronization used **MUST** be such that the slave TDM-bound IWF meets the traffic interface requirements specified in ITU-T recommendation G.824 for T1 and T3 circuits and G.823 for E1 and E3 circuits while the system under test is in presence of temporary network congestion of 100s as described in appendix VI.3.2.6 Test Case 5 of the ITU-T recommendation G.8261
Test Object	Verify that the method of synchronization used is such that the slave TDM-bound IWF meets the traffic interface requirements specified in ITU-T recommendation G.824 for T1 and T3 circuits and G.823 for E1 and E3 circuits while the system under test is in presence of temporary network congestion of 100s as described in appendix VI.3.2.6 Test Case 5 of the ITU-T recommendation G.8261
Test Configuration	
Test Procedure	Set up at least one structure-agnostic flow (PW #1) using raw encapsulation between PE '1' and PE '2'. The master PE'1' must be set to recover the clock from the incoming TDM line (traceable to the PRC) and the slave PE'2' must be set to recover the clock from the PSN interface. Use the TDM Generator/Analyzer (locked to the PRC) to generate a TDM circuit with a specific test pattern for emulation by the PEs. Allow a stabilization period of 900 seconds for the clock recovery process to stabilize. Use the Impairment Generator/Analyzer to create a delay variation profile that replaces the MPLS LSRs and the Traffic Generator transmitting the predefined load* and packet size profile** described in G.8261, appendix VI.3.2.6 Test Case 5 and use the Jitter / Wander Analyzer to measure MTIE and to verify that the measurements are within the traffic interface masks specified in ITU-T recommendation G.824 for T1 and T3 circuits and G.823 for E1 and E3 circuits
Units	MTIE (nanoseconds)
Variables	Number of PWs (1 or 2), TDM service (T1, E1, T3, E3), test pattern
Results	Pass or fail
Remarks	*Load: Start with network disturbance load at 40% and allow a stabilization period of 900 seconds, then increase the network disturbance load to 100% (inducing severe delays and packet loss) for 100 seconds and restore. Repeat it 10 times. **Packet size profile is: 60% of 1518-byte, 30% of 64-byte and 10% of 576-byte frames

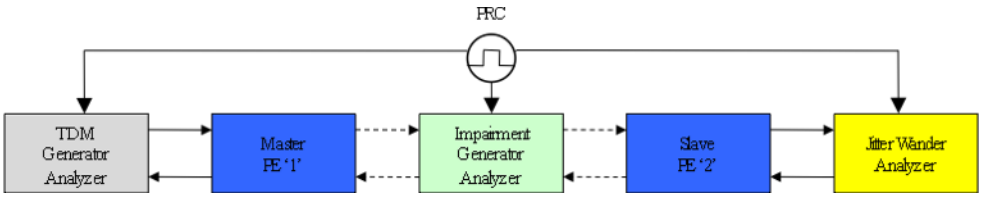
Test Case S7: Wander Performance in Presence of Significant Routing Changes

Abstract Test Cases for TDMoMPLS	
Test Name	Wander Performance in Presence of Significant Routing Changes
Test Definition ID	G.8261-VI.3.2.7-1
Reference documents	G.8261, G.823, G.824
Test Type	Conformance
Test Status	Mandatory if the slave PE supports timing recovery from the PSN
Requirement Description	The method of synchronization used **MUST** be such that the slave TDM-bound IWF meets the traffic interface requirements specified in ITU-T recommendation G.824 for T1 and T3 circuits and G.823 for E1 and E3 circuits while the system under test is in presence of significant routing changes as described in appendix VI.3.2.7 Test Case 6 part 1 (bypass one switch) of the ITU-T recommendation G.8261
Test Object	Verify that the method of synchronization used is such that the slave TDM-bound IWF meets the traffic interface requirements specified in ITU-T recommendation G.824 for T1 and T3 circuits and G.823 for E1 and E3 circuits while the system under test is in presence of significant routing changes as described in appendix VI.3.2.7 Test Case 6 part 1 (bypass one switch) of the ITU-T recommendation G.8261
Test Configuration	
Test Procedure	Set up at least one structure-agnostic flow (PW #1) using raw encapsulation between PE '1' and PE '2'. The master PE'1' must be set to recover the clock from the incoming TDM line (traceable to the PRC) and the slave PE'2' must be set to recover the clock from the PSN interface. Use the TDM Generator/Analyzer (locked to the PRC) to generate a TDM circuit with a specific test pattern for emulation by the PEs. Allow a stabilization period of 900 seconds for the clock recovery process to stabilize. Use the Impairment Generator/Analyzer to create a delay variation profile that replaces the MPLS LSRs and the Traffic Generator transmitting the predefined load* and packet size profile** described in G.8261, appendix VI.3.2.7 Test Case 6 part 1 and use the Jitter / Wander Analyzer to measure MTIE and to verify that the measurements are within the traffic interface masks specified in ITU-T recommendation G.824 for T1 and T3 circuits and G.823 for E1 and E3 circuits
Units	MTIE (nanoseconds)
Variables	Number of PWs (1 or 2), TDM service (T1, E1, T3, E3), test pattern
Results	Pass or fail
Remarks	*Load: Start with network disturbance load at 40% and allow a stabilization period of 900 seconds, then re-route the network to bypass one switch (causing a step change in packet network delay) and allow a stabilization period of 900 seconds and restore the original path. **Packet size profile is: 60% of 1518-byte, 30% of 64-byte and 10% of 576-byte frames

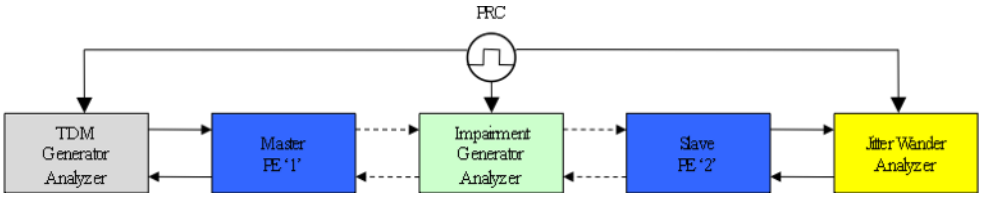
Test Case S8: Wander Performance in Presence of Very Significant Routing Changes

Abstract Test Cases for TDMoMPLS	
Test Name	Wander Performance in Presence of Very Significant Routing Changes
Test Definition ID	G.8261-VI.3.2.7-2
Reference documents	G.8261, G.823, G.824
Test Type	Conformance
Test Status	Mandatory if the slave PE supports timing recovery from the PSN
Requirement Description	The method of synchronization used **MUST** be such that the slave TDM-bound IWF meets the traffic interface requirements specified in ITU-T recommendation G.824 for T1 and T3 circuits and G.823 for E1 and E3 circuits while the system under test is in presence of very significant routing changes as described in appendix VI.3.2.7 Test Case 6 part 2 (bypass three switches) of the ITU-T recommendation G.8261
Test Object	Verify that the method of synchronization used is such that the slave TDM-bound IWF meets the traffic interface requirements specified in ITU-T recommendation G.824 for T1 and T3 circuits and G.823 for E1 and E3 circuits while the system under test is in presence of very significant routing changes as described in appendix VI.3.2.7 Test Case 6 part 2 (bypass three switches) of the ITU-T recommendation G.8261
Test Configuration	
Test Procedure	Set up at least one structure-agnostic flow (PW #1) using raw encapsulation between PE '1' and PE '2'. The master PE'1' must be set to recover the clock from the incoming TDM line (traceable to the PRC) and the slave PE'2' must be set to recover the clock from the PSN interface. Use the TDM Generator/Analyzer (locked to the PRC) to generate a TDM circuit with a specific test pattern for emulation by the PEs. Allow a stabilization period of 900 seconds for the clock recovery process to stabilize. Use the Impairment Generator/Analyzer to create a delay variation profile that replaces the MPLS LSRs and the Traffic Generator transmitting the predefined load* and packet size profile** described in G.8261, appendix VI.3.2.7 Test Case 6 part 2 and use the Jitter / Wander Analyzer to measure MTIE and to verify that the measurements are within the traffic interface masks specified in ITU-T recommendation G.824 for T1 and T3 circuits and G.823 for E1 and E3 circuits
Units	MTIE (nanoseconds)
Variables	Number of PWs (1 or 2), TDM service (T1, E1, T3, E3), test pattern
Results	Pass or fail
Remarks	*Load: Start with network disturbance load at 40% and allow a stabilization period of 900 seconds, then re-route the network to bypass three switches (causing a step change in packet network delay) and allow a stabilization period of 900 seconds and restore the original path. **Packet size profile is: 60% of 1518-byte, 30% of 64-byte and 10% of 576-byte frames

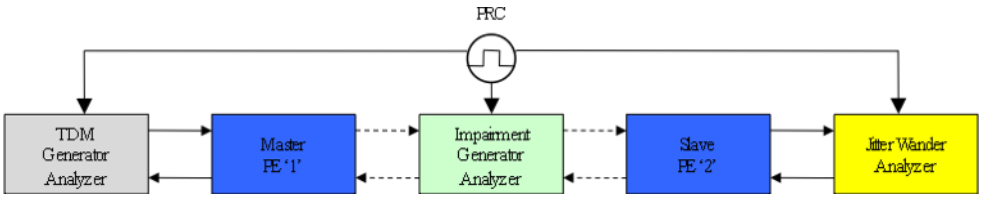
Test Case S9: Wander Performance in Presence of Beating Effect

Abstract Test Cases for TDMoMPLS	
Test Name	Wander Performance in Presence of Beating Effect
Test Definition ID	G.8261-VI.3.2.8-1
Reference documents	G.8261, G.823, G.824
Test Type	Conformance
Test Status	Mandatory if the slave PE supports timing recovery from the PSN
Requirement Description	The method of synchronization used **MUST** be such that the slave TDM-bound IWF meets the traffic interface requirements specified in ITU-T recommendation G.824 for T1 and T3 circuits and G.823 for E1 and E3 circuits while the system under test is in presence of beating effect as described in appendix VI.3.2.8 Test Case 7 part 1 (asynchronous services) of the ITU-T recommendation G.8261
Test Object	Verify that the method of synchronization used is such that the slave TDM-bound IWF meets the traffic interface requirements specified in ITU-T recommendation G.824 for T1 and T3 circuits and G.823 for E1 and E3 circuits while the system under test is in presence of beating effect as described in appendix VI.3.2.8 Test Case 7 part 1 (asynchronous services) of the ITU-T recommendation G.8261
Test Configuration	
Test Procedure	Set up at least one structure-agnostic flow (PW #1) using raw encapsulation between PE '1' and PE '2'. The master PE'1' must be set to recover the clock from the incoming TDM line (traceable to the PRC) and the slave PE'2' must be set to recover the clock from the PSN interface. Use the TDM Generator/Analyzer (locked to the PRC) to generate a TDM circuit with a specific test pattern for emulation by the PEs. Allow a stabilization period of 900 seconds for the clock recovery process to stabilize. Use the Impairment Generator/Analyzer to create a delay variation profile that replaces the MPLS LSRs, the frequency synthesizers and the Traffic Generator transmitting the predefined load* and packet size profile** described in G.8261, appendix VI.3.2.8 Test Case 7 part 1 and use the Jitter / Wander Analyzer to measure MTIE and to verify that the measurements are within the traffic interface masks specified in ITU-T recommendation G.824 for T1 and T3 circuits and G.823 for E1 and E3 circuits
Units	MTIE (nanoseconds)
Variables	Number of PWs (1 or 2), TDM service (T1, E1, T3, E3), test pattern
Results	Pass or fail
Remarks	*Load: Network disturbance load at 60% for the entire test period of 24 hours. **Packet size profile is: 60% of 1518-byte, 30% of 64-byte and 10% of 576-byte frames

Test Case S10: Wander Performance in Presence of Extremely Low Frequency PDV and Blocking Effect

Abstract Test Cases for TDMoMPLS	
Test Name	Wander Performance in Presence of Extremely Low Frequency PDV and Blocking Effect
Test Definition ID	G.8261-VI.3.2.9-1
Reference documents	G.8261, G.823, G.824
Test Type	Conformance
Test Status	Mandatory if the slave PE supports timing recovery from the PSN
Requirement Description	The method of synchronization used **MUST** be such that the slave TDM-bound IWF meets the traffic interface requirements specified in ITU-T recommendation G.824 for T1 and T3 circuits and G.823 for E1 and E3 circuits while the system under test is in presence of beating effect as described in appendix VI.3.2.9 Test Case 8 part A of the ITU-T recommendation G.8261
Test Object	Verify that the method of synchronization used is such that the slave TDM-bound IWF meets the traffic interface requirements specified in ITU-T recommendation G.824 for T1 and T3 circuits and G.823 for E1 and E3 circuits while the system under test is in presence of beating effect as described in appendix VI.3.2.9 Test Case 8 part A of the ITU-T recommendation G.8261
Test Configuration	
Test Procedure	Set up at least one structure-agnostic flow (PW #1) using raw encapsulation between PE '1' and PE '2'. The master PE'1' must be set to recover the clock from the incoming TDM line (traceable to the PRC) and the slave PE'2' must be set to recover the clock from the PSN interface. Use the TDM Generator/Analyzer (locked to the PRC) to generate a TDM circuit with a specific test pattern for emulation by the PEs. Allow a stabilization period of 900 seconds for the clock recovery process to stabilize. Use the Impairment Generator/Analyzer to create a delay variation profile that replaces the MPLS LSRs and the Traffic Generator transmitting the predefined load* and packet size profile** described in G.8261, appendix VI.3.2.9 Test Case 8 part A and use the Jitter / Wander Analyzer to measure MTIE and to verify that the measurements are within the traffic interface masks specified in ITU-T recommendation G.824 for T1 and T3 circuits and G.823 for E1 and E3 circuits
Units	MTIE (nanoseconds)
Variables	Number of PWs (1 or 2), TDM service (T1, E1, T3, E3), test pattern
Results	Pass or fail
Remarks	*Load: Start with network disturbance load at 0% and increment the load using 1% increments (1 minute per step) up to 50% then decrement the load using 1% decrements (1 minute per step) down to 0%. **Packet size profile is: 60% of 1518-byte, 30% of 64-byte and 10% of 576-byte frames

Test Case S11: Wander Performance in Presence of Low Frequency PDV and Blocking Effect

Abstract Test Cases for TDMoMPLS	
Test Name	Wander Performance in Presence of Low Frequency PDV and Blocking Effect
Test Definition ID	G.8261-VI.3.2.9-2
Reference documents	G.8261, G.823, G.824
Test Type	Conformance
Test Status	Mandatory if the slave PE supports timing recovery from the PSN
Requirement Description	The method of synchronization used **MUST** be such that the slave TDM-bound IWF meets the traffic interface requirements specified in ITU-T recommendation G.824 for T1 and T3 circuits and G.823 for E1 and E3 circuits while the system under test is in presence of beating effect as described in appendix VI.3.2.9 Test Case 8 part B of the ITU-T recommendation G.8261
Test Object	Verify that the method of synchronization used is such that the slave TDM-bound IWF meets the traffic interface requirements specified in ITU-T recommendation G.824 for T1 and T3 circuits and G.823 for E1 and E3 circuits while the system under test is in presence of beating effect as described in appendix VI.3.2.9 Test Case 8 part B of the ITU-T recommendation G.8261
Test Configuration	
Test Procedure	Set up at least one structure-agnostic flow (PW #1) using raw encapsulation between PE '1' and PE '2'. The master PE'1' must be set to recover the clock from the incoming TDM line (traceable to the PRC) and the slave PE'2' must be set to recover the clock from the PSN interface. Use the TDM Generator/Analyzer (locked to the PRC) to generate a TDM circuit with a specific test pattern for emulation by the PEs. Allow a stabilization period of 900 seconds for the clock recovery process to stabilize. Use the Impairment Generator/Analyzer to create a delay variation profile that replaces the MPLS LSRs and the Traffic Generator transmitting the predefined load* and packet size profile** described in G.8261, appendix VI.3.2.9 Test Case 8 part B and use the Jitter / Wander Analyzer to measure MTIE and to verify that the measurements are within the traffic interface masks specified in ITU-T recommendation G.824 for T1 and T3 circuits and G.823 for E1 and E3 circuits
Units	MTIE (nanoseconds)
Variables	Number of PWs (1 or 2), TDM service (T1, E1, T3, E3), test pattern
Results	Pass or fail
Remarks	*Load: Start with network disturbance load at 50% for 1 hour, drop to 0% for an hour, increase back to 50% for an hour, drop back to 0% for an hour, increase back to 50% for an hour, drop back to 0% for an hour. **Packet size profile is: 60% of 1518-byte, 30% of 64-byte and 10% of 576-byte frames

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