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ETSI Secretariat

Postal address
F-06921 Sophia Antipolis Cedex - FRANCE

Office address
650 Route des Lucioles - Sophia Antipolis
Valbonne - FRANCE
Tel.: +33 4 92 94 42 00 Fax: +33 4 93 65 47 16
Siret N° 348 623 562 00017 - NAF 742 C
Association à but non lucratif enregistrée à la
Sous-Préfecture de Grasse (06) N° 7803/88

Internet
secretariat@etsi.fr
http://www.etsi.fr
http://www.etsi.org

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Foreword

This European Standard (Telecommunications series) has been produced by ETSI Technical Committee Transmission and Multiplexing (TM), and is now submitted for the Public Enquiry phase of the ETSI standards Two-step Approval Procedure.

Proposed national transposition dates	
Date of latest announcement of this EN (doa):	3 months after ETSI publication
Date of latest publication of new National Standard or endorsement of this EN (dop/e):	6 months after doa
Date of withdrawal of any conflicting National Standard (dow):	6 months after doa

1 Scope

The present document specifies the technical requirements and test principles for bi-directional and symmetrical leased line connections of SDH virtual containers, i.e. VC-4, VC-3, VC-2 and VC-12. Signals transmitted across the leased line connections are subject to restrictions (e.g. to the payload independent path overhead) and impairments (e.g. transfer delay, jitter, wander, errors, etc.).

A connection is presented via interfaces at Network Termination Points (NTPs) and includes any equipment that may provide the NTP. Together with the companion standard, EN 301 165 [4] defining the network and terminal interface presentation, the present document describes the technical characteristics of the leased line service offered to the user.

The present document is applicable for leased lines, including part time leased lines, for which the establishment or release does not require any protocol exchange or other intervention at the NTP.

The present document specifies compliance tests for the connection requirements. The present document does not include details concerning the implementation of tests, nor does it include information of any relevant regulations.

2 Normative references

References may be made to:

a) specific versions of publications (identified by date of publication, edition number, version number, etc.), in which case, subsequent revisions to the referenced document do not apply; or

b) all versions up to and including the identified version (identified by "up to and including" before the version identity); or

c) all versions subsequent to and including the identified version (identified by "onwards" following the version identity); or

d) publications without mention of a specific version, in which case the latest version applies.

A non-specific reference to an ETS shall also be taken to refer to later versions published as an EN with the same number.

[1] ETS 300 417-2-1 (1997): "Transmission and Multiplexing (TM); Generic requirements of transport functionality of equipment; Part 2-1: Synchronous Digital Hierarchy (SDH) and Plesiochronous Digital Hierarchy (PDH) physical section layer functions".

[2] ETS 300 417-3-1 (1997): "Transmission and Multiplexing (TM); Generic requirements of transport functionality of equipment; Part 3-1: Synchronous Transport Module-N (STM-N) regenerator and multiplex section layer functions".

[3] ETS 300 417-4-1 (1997): "Transmission and Multiplexing (TM); Generic requirements of transport functionality of equipment; Part 4-1: Synchronous Digital Hierarchy (SDH) path layer functions".

[4] prEN 301 165: "Transmission and Multiplexing (TM); Synchronous Digital Hierarchy (SDH) leased lines; Network and terminal interface presentation".

[5] ITU-T Recommendation G.826 (1996): "Error performance parameters and objectives for international, constant bit rate digital paths at or above the primary rate".

[6] ETS 300 417-1-1 (1996): "Transmission and Multiplexing (TM); Generic functional requirements for Synchronous Digital Hierarchy (SDH) equipment; Part 1-1: Generic processes and performance".

3 Definitions, symbols and abbreviations

3.1 Definitions

For the purposes of the present document, the following definitions apply:

Layer: A concept used to allow the transport network functionality to be described hierarchically as successive levels; each layer being solely concerned with the generation and transfer of its "characteristic information".

Client/server layer: Any two adjacent network layers are associated in a client/server relationship. Each transport network layer provides transport to the layer above and uses transport from the layers below. The layer providing transport is termed a "server", the layer using transport is termed "client".

Remote Defect Indication (RDI): A signal which conveys the defect status of the characteristic information received by the Trail Termination sink function back to the network element which contains the characteristic information originating trail termination source function.

Remote Error Indication (REI): A signal which conveys either the exact or truncated number of error detection code violations within the characteristic information (as detected by the trail termination sink function) back to the network element which contains the characteristic information originating trail termination source function.

AU-4-AIS: An STM-N signal in which the entire capacity of an Administrative Unit 4 (AU-4) is set to logic "1".

TU-m-AIS: An STM-N signal in which the entire capacity of a TU-m is set to logic "1".

Characteristic Information (CI): A signal of specific rate and format which is transferred within and between "sub-networks", and presented to an "adaptation" function for "transport" by the server layer network.

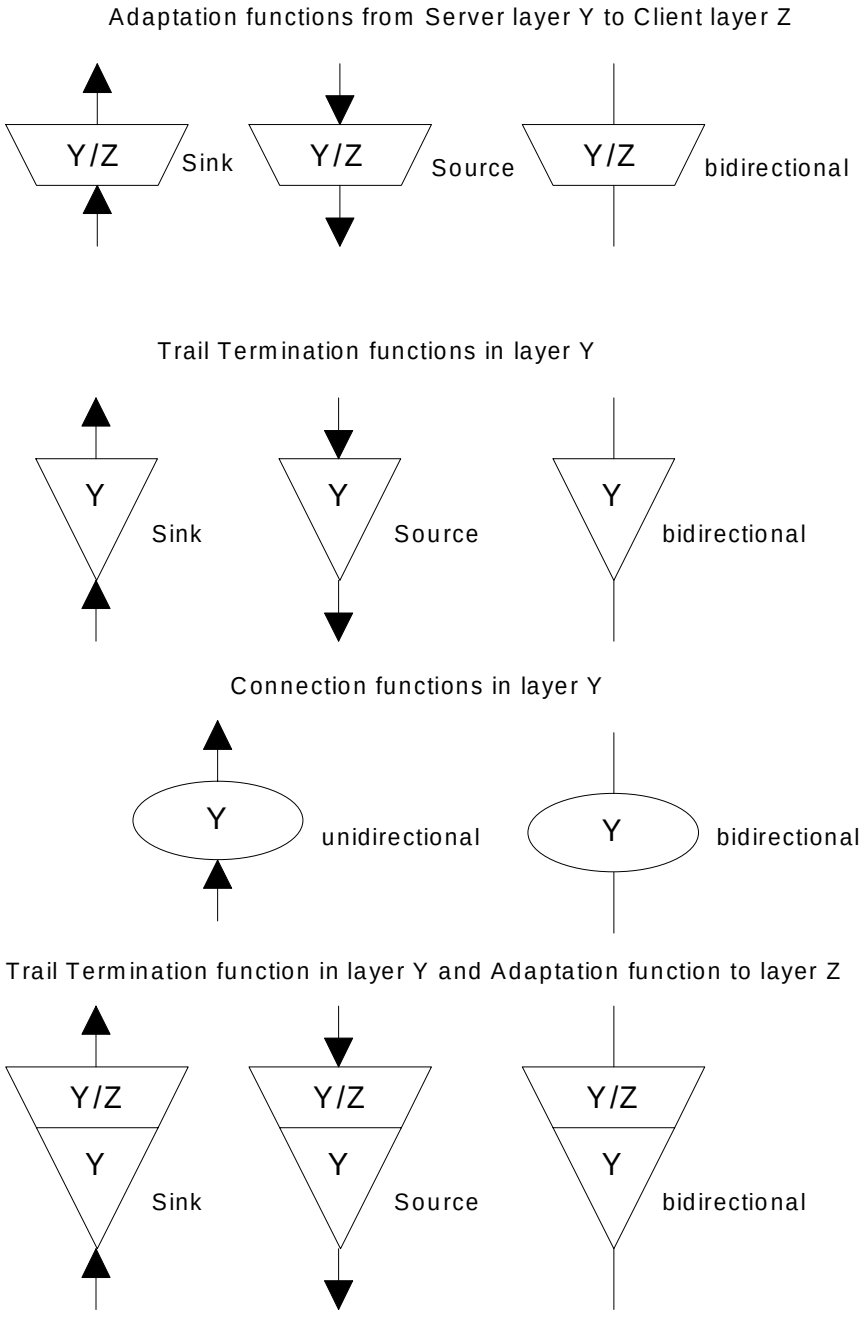
Connection Point (CP): A "reference point" where the output of a "trail termination source" or a "connection" is bound to the input of another "connection", or where the output of a "connection" is bound to the input of a "trail termination sink" . The "connection point" is characterized by the information which passes across it. A bi-directional "connection point" is formed by the association of a contra-directional pair.

Termination Connection Point (TCP): A special case of a "connection point" where a "trail termination" function is bound to an "adaptation" function or a "connection" function.

Defect: The density of anomalies has reached a level where the ability to perform a required function has been interrupted. Defects are used as input for PM, the control of consequent actions, and the determination of fault cause.

3.2 Symbols

The diagrammatic conventions and nomenclature used in the present document for adaptation, termination and connection functions (used to describe the atomic functions) are taken from ETS 300 417-1-1 [6] and are shown in figure 1.



NOTE: If the above symbols are used for generic figures, i.e. not for specific layers, the layer references Y and Z may be omitted. Alternatively, the references may be to the type of function or layer, e.g. supervision, protection.

Figure 1: Symbols and diagrammatic conventions

3.3 Abbreviations

For the purposes of the present document, the following abbreviations apply:

A	Adaptation function
AI	Adapted Information

AIS	Alarm Indication Signal
AU	Administrative Unit
AU-n	Administrative Unit, level n
BBE	Background Block Error
BBER	Background Block Error Ratio
BIP	Bit Interleaved Parity
BIP-N	Bit Interleaved Parity, width N
C	Connection function
CI	Characteristic Information
CP	Connection Point
ES	Errored Second
ES1	STM-1 Electrical Section
LOF	Loss Of Frame
LOM	Loss Of Multiframe
LOP	Loss Of Pointer
LOS	Loss Of Signal
MS	Multiplex Section
MS1	STM-1 Multiplex Section
MS4	STM-4 Multiplex Section
NE	Network Element
NNI	Network Node Interface
NT	Network Termination
NTP	Network Termination Point
OS	Optical Section
OS1	STM-1 Optical Section
OS4	STM-4 Optical Section
PDH	Plesiochronous Digital Hierarchy
PLM	PayLoad Mismatch
RDI	Remote Defect Indication
REI	Remote Error Indication
RI	Remote Information
RX	Receive
S12	VC-12 path layer
S2	VC-2 path layer
S3	VC-3 path layer
S4	VC-4 path layer
SDH	Synchronous Digital Hierarchy
SES	Severely Errored Second
SF	Signal Fail
Sk	Sink
So	Source
SSF	Server Signal Fail
STM	Synchronous Transport Module
STM-N	Synchronous Transport Module, level N
TCP	Terminal Connection Point
TE	Terminal Equipment
TIM	Trace Identifier Mismatch
TSF	Trail Signal Fail
TSS	Test Signal Structure
TSSx	Test Signal Structure 1,3 or 4
TT	Trail Termination function
TTP	Trail Termination Point
TU	Tributary Unit
TU-m	Tributary Unit, level m
TX	Transmit
UNEQ	UNEQuipped
UTC	Universal Time Co-ordinated
VC	Virtual Container
VC-n	Virtual Container, level n

4 Characteristics of VC-4, VC-3, VC-2 and VC-12 leased line connections

4.1 Tolerance of Virtual Container (VC) timing

Requirement: The leased line connection shall carry user timing with a tolerance of ±4,6 ppm

NOTE: For optimum jitter and wander performance of Plesiochronous Digital Hierarchy (PDH) signal carried over a end to end Virtual Container (VC), it is recommended to generate VC timing at the nominal frequency. The recommended method of Synchronous Digital Hierarchy (SDH) synchronization is specified in ETS 300 462-2. It should be noted that a systematic offset of the VC timing from the nominal VC frequency will result in periodic pointer adjustments at the output of the VC leased line connection. The SDH section signal which is transmitted from the Network Termination (NT) is carrying, under normal condition, the timing of the leased line network and may be used to generate the VC timing at the terminal interface.

4.2 Transfer delay

Requirement: The requirement depends upon whether satellite connection is involved in the connection or not:

- for connection where satellite transmission is not involved, the one way end-to-end delay shall be less than (10 + 0,01 G) ms, where G is the geographical distance in kilometres; or
- for connection where satellite transmission is involved, the one way end-to-end delay shall be less than 350 ms.

4.3 Jitter

The leased line connection shall operate as specified when the jitter at the leased line input is within the limits given in the companion standard EN 301 165 [4].

NOTE 1: The jitter and wander requirements of the Synchronous Transport Module, level N (STM-N) section layers are given at the associated Physical Section Layer to Regenerator Section Layer adaptation functions as specified in ETS 300 417-2-1 [1].

NOTE 2: Jitter requirements of the VC-4 path are specified by the requirements for AU-4 pointer justification events of the Multiplex Section Layer to VC-4 path Layer adaptation function which is specified in ETS 300 417-3-1 [2].

NOTE 3: Jitter requirements of the lower order VC paths are specified by the requirements for TU-3/2/12 pointer justification events of the "VC-4 Layer to VC-3, VC-2 and VC-12 Layer Adaptation functions, S4/Sx_A" which are specified ETS 300 417-4-1 [3].

NOTE 4: Wander at the section layer may create pointer justification at VC path layers. Existing ETSs for leased line connection characteristics consider wander is irrelevant for a single leased line connection. That approach might be unacceptable for SDH leased lines.

4.4 Error performance

ITU-T Recommendation G.826 [5] is used as a basis for deriving the error performance objectives specified in the present document. The performance parameters referred to in the present document are as those defined in ITU-T Recommendation G.826 [5]. The performance objective tables in the present document apply for a 24 hour test period. They are derived using ITU-T Recommendation G.826 [5] as a basis. Detailed derivation of the performance objectives is described in annex B of the present document.

5 Characteristics of VC-4 leased line connections

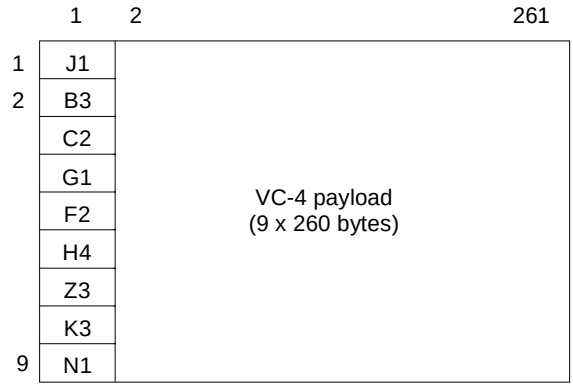
5.1 Information transfer susceptance

Requirement: The connection shall be capable of transferring transparently a complete and bi-directional VC-4 except the N1 byte when the VC-4 is generated according to EN 301 165 [4], subclause 4.3.1. The structure of a VC-4 is shown in figure 2. The bytes of a VC-4 are transmitted with a frequency of 8 kHz, i.e. the frame length is 125 µs.

When a defect occurs:

- along the leased line connection; or
- at the leased line input (refer to EN 301 165 [4]);

AU4-AIS shall occur at the far end output.



NOTE: The contents of B3 may change at the tandem connection monitoring processes. The integrity of parity information of B3 is maintained through the leased line.

Figure 2: Structure of a VC-4

5.2 Error performance

5.2.1 Bringing into service limits

There are no requirements under the present document.

5.2.2 Performance objectives

Requirement: The performance of a VC-4 leased line either in service or taken out of service in order to perform an error measurement shall meet the requirements of table 1.

Table 1: Performance objectives over a 24 hour test period for a block length of 18 792 bits (VC-4)

Performance parameter	Terrestrial		Satellite	
	Ratio (mean)	S1 (note)	Ratio (mean)	S1 (note)
ES	0,08	≤ 6 746 s	0,12	≤ 10 575 s
SES	0,001	≤ 68 s	$1{,}56 \times 10^{-3}$	≤ 112 s
BBE	$1{,}0 \times 10^{-4}$	≤ 68 594 blocks	$1{,}56 \times 10^{-4}$	≤ 107 170 blocks
NOTE: The threshold S1 is defined in clause B.4.				

5.2.3 Availability

There are no requirements under the present document.

6 Characteristics of VC-3 leased line connections

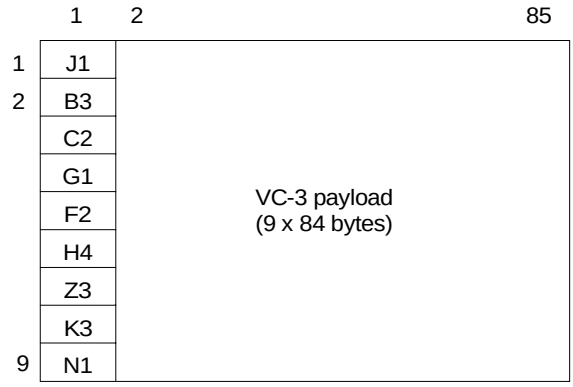
6.1 Information transfer susceptance

Requirement: The connection shall be capable of transferring transparently a complete and bi-directional VC-3 except the N1 byte. The structure of a VC-3 is shown in figure 3. The bytes of a VC-3 are transmitted with a frequency of 8 kHz, i.e. the frame length is 125 μs.

When a defect occurs:

- along the leased line connection; or
- at the leased line input (refer to EN 301 165 [4]);

TU3-AIS shall occur at the far end output.



NOTE: The contents of B3 may change at the tandem connection monitoring processes. The integrity of parity information of B3 is maintained through the leased line.

Figure 3: Structure of a VC-3

6.2 Error performance

6.2.1 Bringing into service limits

There are no requirements under the present document.

6.2.2 Performance objectives

Requirement: The performance of a VC-3 leased line either in service or taken out of service in order to perform an error measurement shall meet the requirements of table 2.

Table 2: Performance objectives over a 24 hour test period for a block length of 6 120 bits (VC-3)

Performance parameter	Terrestrial		Satellite	
	Ratio (mean)	S1 (note)	Ratio (mean)	(note)S1
ES	0,0375	≤ 3 126 s	0,059	≤ 4 912 s
SES	0,001	≤ 68 s	$1{,}56 \times 10^{-3}$	≤ 112 s
BBE	$1{,}0 \times 10^{-4}$	≤ 68 594 blocks	$1{,}56 \times 10^{-4}$	≤ 107 170 blocks
NOTE: The threshold S1 is defined in clause B.4.				

6.2.3 Availability

There are no requirements under the present document.

7 Characteristics of VC-2 leased line connections

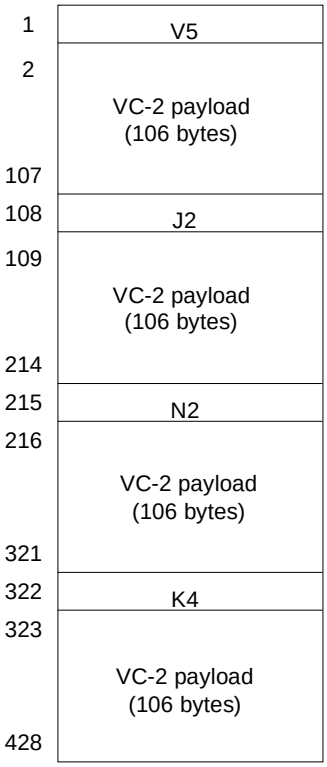
7.1 Information transfer susceptance

Requirement: The connection shall be capable of transferring transparently a complete and bi-directional VC-2 except the N2 byte. The structure of a VC-2 is shown in figure 4. The bytes of a VC-2 are transmitted with a frequency of 2 kHz, i.e. the frame length is 500 μs.

When a defect occurs:

- along the leased line connection; or
- at the leased line input (refer to EN 301 165 [4]);

TU2-AIS shall occur at the far end output.



NOTE: The contents of V5[1,2] may change at the tandem connection monitoring processes. The parity information of the BIP-2 is maintained through the leased line.

Figure 4: Structure of a VC-2

7.2 Error performance

7.2.1 Bringing into service limits

There are no requirements under the present document.

7.2.2 Performance objectives

Requirement: The performance of a VC-2 leased line either in service or taken out of service in order to perform an error measurement shall meet the requirements of table 3.

Table 3: Performance objectives over a 24 hour test period for a block length of 3 424 bits (VC-2)

Performance parameter	Terrestrial		Satellite	
	Ratio (mean)	S1 (note)	Ratio (mean)	S1 (note)
ES	0,025	≤ 2 067 s	0,039	≤ 3 254 s
SES	0,001	≤ 68 s	$1{,}56 \times 10^{-3}$	≤ 112 s
BBE	$1{,}0 \times 10^{-4}$	≤ 17 017 blocks	$1{,}56 \times 10^{-4}$	≤ 26 628 blocks
NOTE: The threshold S1 is defined in clause B.4.				

7.2.3 Availability

There are no requirements under the present document.

8 Characteristics of VC-12 leased line connections

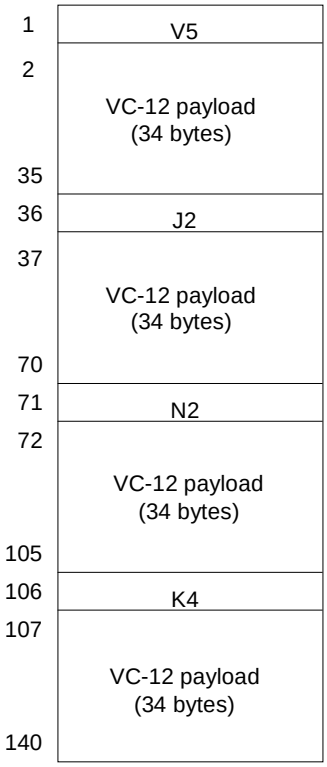
8.1 Information transfer susceptance

Requirement: The connection shall be capable of transferring transparently a complete and bi-directional VC-12 except the N2 byte. The structure of a VC-12 is shown in figure 5. The bytes of a VC-12 are transmitted with a frequency of 2 kHz, i.e. the frame length is 500 μs.

When a defect occurs:

- along the leased line connection; or
- at the leased line input (refer to EN 301 165 [4]);

TU12-AIS shall occur at the far end output.



NOTE: The contents of V5[1,2] may change at the tandem connection monitoring processes. The integrity of parity information BIP-2 is maintained through the leased line.

Figure 5: Structure of a VC-12

8.2 Error performance

8.2.1 Bringing into service limits

There are no requirements under the present document.

8.2.2 Performance objectives

Requirement: The performance of a VC-12 leased line either in service or taken out of service in order to perform an error measurement shall meet the requirements of table 4.

Table 4: Performance objectives over a 24 hour test period for a block length of 1 120 bits (VC-12)

Performance parameter	Terrestrial		Satellite	
	Ratio (mean)	S1 (note)	Ratio (mean)	S1 (note)
ES	0,02	≤1 645 s	0,031	≤ 2 592 s
SES	0,001	≤ 68 s	$1{,}56 \times 10^{-3}$	≤ 112 s
BBE (note 2)	$1{,}0 \times 10^{-4}$	≤ 17 017 blocks	$2{,}34 \times 10^{-4}$	≤ 26 628 blocks
NOTE 1: The threshold S1 is defined in clause B.4.				
NOTE 2: ITU-T Recommendation G.826 [5], version 1996 changed the BBER from 3×10^{-4} to 2×10^{-4}.				

8.2.3 Availability

There are no requirements under the present document.

Annex A (normative): Test methods

A.1 General

This annex describes the test principles to determine the compliance of a connection against the requirements of the present document. The present document does not specify the circumstances in which these tests are to be performed.

It is outside the scope of this annex to identify the specific details of the implementation of the tests.

Details of test equipment accuracy and the specification tolerance of the test devices are not included in all cases. Where such details are provided they shall be complied with, but the way they are expressed shall not constrain the method of implementing the test.

NOTE: Attention is drawn to the issue of measurement uncertainty which may be addressed in future documents. Not all the required test results make allowance for spurious events during testing (e.g. errors due to EMC effects), which may make it necessary to repeat a test.

The test configurations given do not imply a specific realization of the test equipment or test arrangement, or the use of specific test devices. However any test configuration used shall provide those test conditions specified under "connection state", "stimulus" and "monitor" for each individual test.

The test equipment shall be a device, or a group of devices that is capable of generating a stimulus signal and capable of monitoring the signal received from the network interface.

A.1.1 Equipment connection

Testing shall be performed at the defined Network Termination Point (NTP) as this is the point at which compliance with the present document is required.

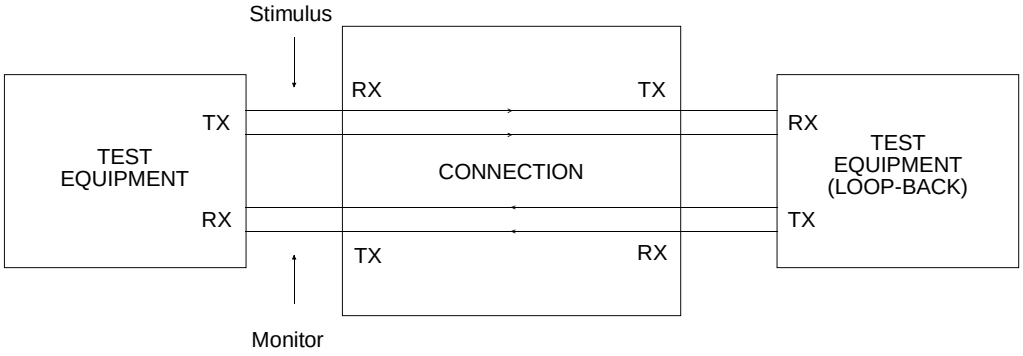
A.2 Test methods

One test may cover more than one requirement. The scope of each test is defined under the heading "purpose".

A.2.1 Leased line timing tolerance, susceptance and symmetry

Purpose: To verify compliance with the requirements for VC leased line timing (subclause 4.1), jitter (subclause 4.3), susceptance and symmetry (subclauses 5.1, 6.1, 7.1 and 8.1).

Test configuration: Test equipment shall be connected to the leased line as shown in figure A.1. The leased line shall be looped back at the far end by a test equipment.



NOTE: A physical loopback could be applied in cases where the leased line uses the same time slot for the Receive (RX) and Transmit (TX) side.

Figure A.1: Leased line timing, jitter, susceptance and symmetry

Connection State: Available.

Stimulus: The test equipment shall generate a VC with the Test Signal Structure 1,3 or 4 (TSSx) payload as defined in ETS 300 417-4-1 [3] at the given time slot. The server layers shall comply to the requirements given in EN 301 165 [4]. The test signal (section layers and the path layers) shall have the:

- nominal frequency and maximum tolerable input jitter;
- nominal frequency +4,6 ppm and maximum tolerable input jitter; and
- nominal frequency -4,6 ppm and maximum tolerable input jitter.
  (Nominal frequency is referred to UTC frequency.)

Monitor: The VC at the output of the leased line.

Results: For a continuous period of at least one second no alterations to the binary content of the VC shall occur except for the BIP-8/BIP-2 and the bytes N1/N2. No block error shall be indicated by the Bit Interleaved Parity (BIP).

A.2.2 Delay

Purpose: To verify compliance with the requirements for one way transmission delay as specified in subclause 4.2.

Test configuration: Test equipment shall be connected to the leased line as shown in figure A.2. The leased line shall be looped back at the far end by a test equipment.

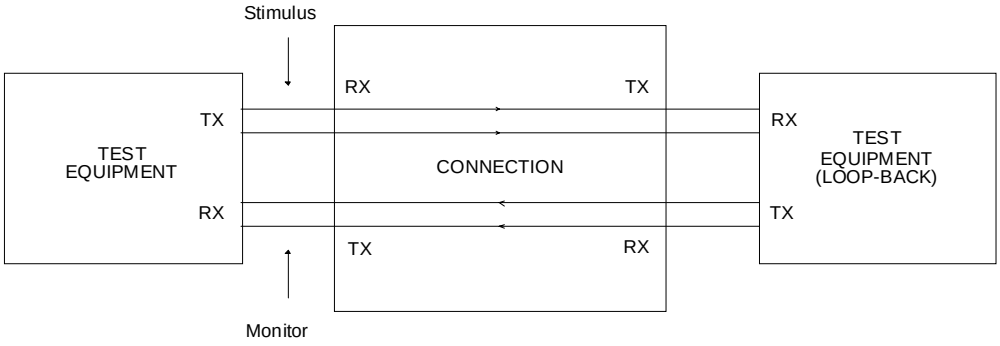


Figure A.2: Delay

Connection State: Available.

Stimulus: The test equipment shall generate a VC with a distinctive bit pattern whose repetition period is greater than the round trip delay at the given time slot. The server layers shall comply to the requirements given in EN 301 165 [4].

Monitor: The round trip delay between transmission and reception of the distinctive bit pattern.

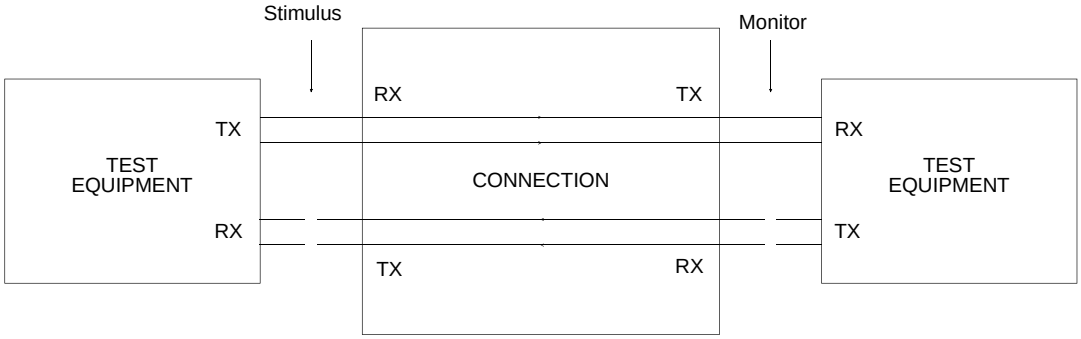
Results: The round trip delay after deduction of the delay introduced by the loop-back test equipment, shall be less than or equal to twice the delay specified in the requirement of subclause 4.2.

NOTE: This test assumes that the same transmission path is used in both directions. It is not practicable to provide a test of the transmission delay in each individual direction.

A.2.3 Alarm Indication Signal (AIS) generation

Purpose: To verify compliance with the requirements for AIS generation as specified in subclauses 5.1, 6.1, 7.1 and 8.1.

Test configuration: Test equipment shall be connected to both ends of the leased line (see figure A.3). Each direction shall be tested separately.



NOTE: Alternatively a test configuration according to figure A.1 could be used.

Figure A.3: AIS generation and error

Connection State: Available.

Stimulus: The test equipment shall generate a VC with the TSSx payload as defined in ETS 300 417-4-1 [3] at the given time slot. The server layers comply to the requirements given in EN 301 165 [4]. The test equipment shall generate in sequence the following defects: Loss Of Signal (LOS), Loss Of Frame (LOF) AU4-AIS and AU4-Loss Of Pointer (LOP). For lower order VC connection the following defects shall be generated in addition: VC-4-Trace Identifier Mismatch (TIM), VC-4-PayLoad Mismatch (PLM) and Loss Of Multiframe (LOM) (VC-2 and VC-12 only) also in sequence.

Monitor: The Administrative Unit (AU)/Tributary Unit (TU) of the VC.

Results: For VC-4 connection AU4-AIS shall occur on application of a defect. On clearance of the defect AU4-AIS shall be replaced by the normal signal.

For a lower order VC connection TU-AIS shall occur on application of a defect. On clearance of the defect TU-AIS shall be replaced by the normal signal.

A.2.4 Error performance

Purpose: To verify compliance with the requirements for error performance as specified in subclauses 5.2.2, 6.2.2, 7.2.2 and 8.2.2.

Test configuration: Test equipment shall be connected to both ends of the leased line (see figure A.4). Each direction shall be tested separately.

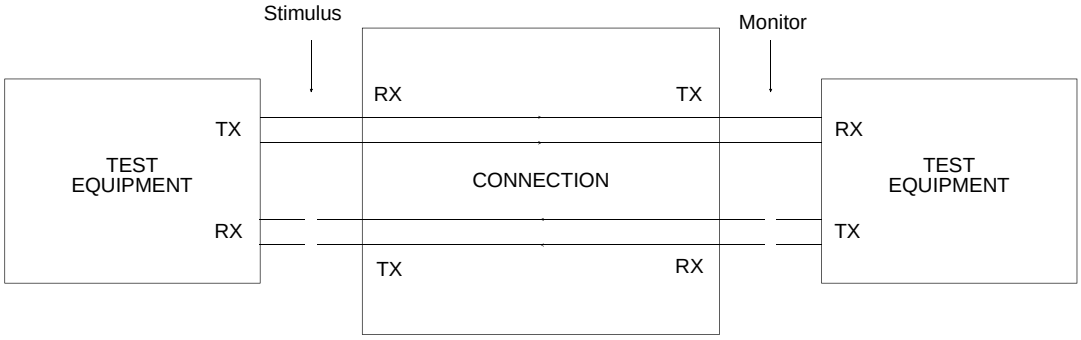


Figure A.4: Error performance measurement

Connection State: Available.

Stimulus: The test equipment shall generate a VC with the TSSx payload as defined in ETS 300 417-4-1 [3] at the given time slot. The server layers shall comply to the requirements given in EN 301 165 [4].

The test signal (section and path layers) shall have a timing within the range of nominal frequency ±4,6 ppm.
(Nominal frequency is referred to UTC frequency.)

Monitor:
a) the number of errored seconds;
b) the number of severely errored seconds;
c) the number of background block errors.

Results: When monitoring a line that has been taken out of service to perform a measurement, the number or errors, severely errored seconds and background block errors shall be less than the performance levels given in subclauses 5.2.2, 6.2.2, 7.2.2 and 8.2.2.

NOTE: If the requirements are met during the first continuous period of 24 hours, the test need not be continued for the second period of 24 hours.

Annex B (informative): Derivation of error performance limits

B.1 Introduction

Errors are caused by various influences such as:

- human intervention;
- thermal noise;
- induced voltages in equipment and cables due to lightning, radio transmissions and other electromagnetic effects;
- loss of synchronization following uncontrolled slips;
- joints and connections.

The main cause of errors is induced voltages and such errors frequently occur in dense bursts due to particular phenomena. Due to improvements in technology resulting in part from a greater understanding of electromagnetic effects, there is a long term trend for error rates to reduce.

Studies in ITU-T Recommendations have concluded that error rates for lines have a low dependence on distance.

B.2 Reference connections

ITU-T Recommendation G.826 [5] contains error performance limits for a hypothetical reference connection of 27 500 km. In order to apply these figures to a leased line, it is necessary to define reference connections to represent the leased lines covered by the present document. A terrestrial reference connection and a satellite reference connection are defined in subclauses B.2.1 and B.2.2 based on ITU-T Recommendation G.826 [5].

B.2.1 Terrestrial connection

Figure B.1 shows the reference connection for a terrestrial connection used in the derivation of error performance limits specified in the present document.

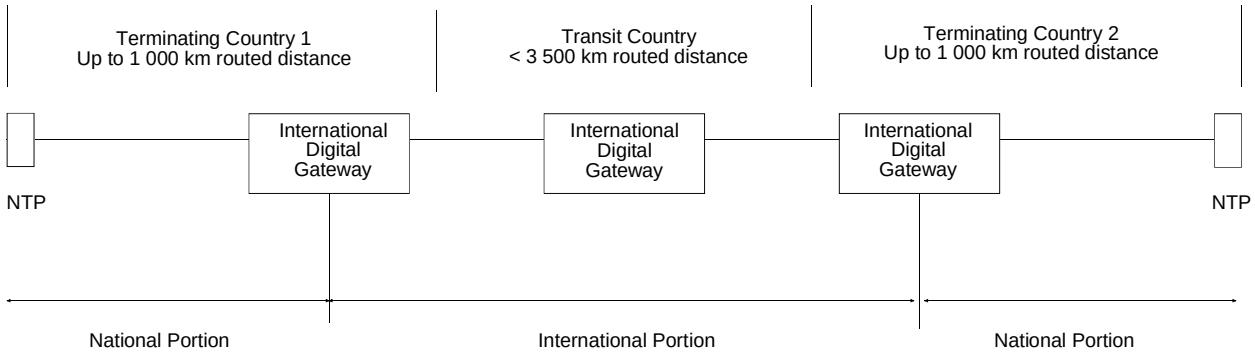


Figure B.1: Reference connection for terrestrial VC leased line

The reference connection given in figure B.1 comprises two terminating countries and a single transit country. For each terminating country, there is a routed distance of up to 1 000 km between the NTP and the international digital gateway. For the transit country there is a single international gateway and a routed distance up to 3 500 km. The routed distance is given by 1,5 × straight line distance, except that for undersea cable the actual routed length should be used.

NOTE: This model allows for a total routed distance of up to 5 500 km. Although this reference connection shows separate national portions, the present document does not apportion errors between different countries and the errors may be apportioned differently.

B.2.2 Satellite connection

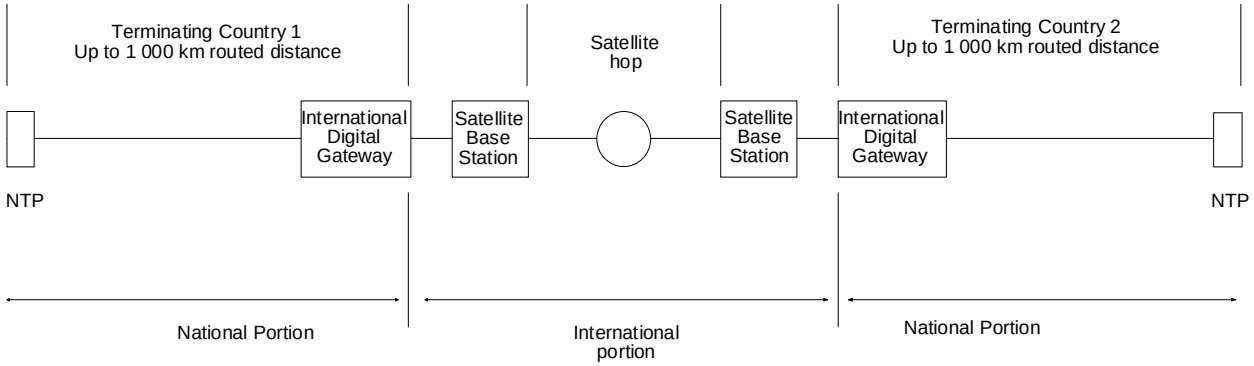


Figure B.2: Reference connection for satellite VC leased line

The reference connection in figure B.2 contains a satellite link connecting the two terminating countries. For each terminating country a routed distance of 1 000 km is assumed.

B.3 Error performance objectives

Tables B.1 and B.2 show the percentage allocation of the overall error performance objectives specified in ITU-T Recommendation G.826 [5] to the various portions of the leased lines specified in the reference connections (terrestrial and satellite) defined in subclause B.2. The tables include both fixed allocations and distance dependent allocations of 1 % per 500 km routed distance.

Table B.1: Allocation of error performance objectives derived from G.826 [5] - terrestrial connection

Path portion (terrestrial link)	Allocation
Terminating country 1 (fixed allocation)	17,5 %
Terminating country 1 (routed 1 000 km)	2,0 %
International transit termination	1,0 %
International transit (fixed allocation)	2,0 %
International transit (routed 3 500 km)	7,0 %
International transit termination	1,0 %
Terminating country 2 (routed 1 000 km)	2,0 %
Terminating country 2 (fixed allocation)	17,5 %
TOTAL	50,0 %

Table B.2: Allocation of error performance objectives derived from G.826 [5] - satellite connection

Path portion (satellite link)	Allocation
Terminating country 1 (fixed allocation)	17,5 %
Terminating country 1 (routed 1 000 km)	2,0 %
International termination	2,0 %
Satellite connection	35,0 %
International termination	2,0 %
Terminating country 2 (routed 1 000 km)	2,0 %
Terminating country 2 (fixed allocation)	17,5 %
TOTAL	78,0 %

NOTE: The inclusion of additional transit countries to the terrestrial connection would require an additional fixed allocation (2 %), transit termination (1 %) and a routed portion (1 % per 500 km). Further information is given in ITU-T Recommendation G.826 [5].

ITU-T Recommendation G.826 [5] defines error performance objectives in terms of errored seconds, severely errored seconds and background block errors for a hypothetical reference path of 27 500 km and is taken as the basis of 100 %.

The application of the percentage figures given in tables B.1 and B.2 to the error performance objectives given in ITU-T Recommendation G.826 [5] gives error rates for VC leased lines and shown in row 1 of table 1 to table 4 of the present document.

B.4 Long term error performance

The error performance ratio derived in subclause B.3 for the specific reference connections can be used to calculate the long term error performance requirements, expressed as an absolute figure over a 24 hour period; these are given in table 1 to table 4 for the terrestrial and satellite connections.

The error performance requirements specified are, however, statistical figures based on long term measurements (greater than one month) which are not statistically valid over a 24 hour measurement period. Therefore ITU-T Recommendation M.2100 presents a method of reducing these limits to 24 hour test limits S1 and S2. S1 is the limit below which there is confidence that the leased line meets the requirement, S2 is the limit above which there is confidence that the leased line fails to meet the requirement. Between S1 and S2 the results are inconclusive. Therefore, in order to have confidence that the leased line meets the long term requirement, the 24 hour test result should be better than the limit S1. In the event that the limit S1 is not met, the test should be repeated a second time.

S1 and S2 are derived from:

$$S1 = (requirement) - 2 \times \sqrt{requirement}$$

$$S2 = (requirement) + 2 \times \sqrt{requirement}$$

B.5 Error performance figures

Table B.3 shows error performance value according to G.826 [5] compared with the mean values of the reference leased line connection and the S1 and S2 values.

Table B.3: Error performance values according to G.826 [5] compared with leased line values

VC-4									
55 Mbit/s to 160 Mbit/s		**Terrestrial**				**Satellite**			
Parameter	G.826	Ratio (mean)	Absolute	S1	S2	Ratio (mean)	Absolute	S1	S2
ES	16.0%	8.00%	6912	6746	7076	12.48%	10783	10575	10988
SES	0.20%	0.10%	86	68	103	0.16%	135	112	156
BBE	0.02%	0.010%	69120	68594	69644	0.016%	107827	107170	108482
VC-3									
15 Mbit/s to 55 Mbit/s		**Terrestrial**				**Satellite**			
Parameter	G.826	Ratio (mean)	Absolute	S1	S2	Ratio (mean)	Absolute	S1	S2
ES	7.50%	3.75%	3240	3126	3352	5.85%	5054	4912	5195
SES	0.20%	0.10%	86	68	103	0.16%	135	112	156
BBE	0.02%	0.010%	69120	68594	69644	0.016%	107827	107170	108482
VC-2									
5 Mbit/s to 15 Mbit/s		**Terrestrial**				**Satellite**			
Parameter	G.826	Ratio (mean)	Absolute	S1	S2	Ratio (mean)	Absolute	S1	S2
ES	5.00%	2.50%	2160	2067	2251	3.90%	3370	3254	3484
SES	0.20%	0.10%	86	68	103	0.16%	135	112	156
BBE	0.02%	0.010%	17280	17017	17541	0.016%	26957	26628	27283
VC-12									
1,5 Mbit/s to 5 Mbit/s		**Terrestrial**				**Satellite**			
Parameter	G.826	Ratio (mean)	Absolute	S1	S2	Ratio (mean)	Absolute	S1	S2
ES	4.00%	2.00%	1728	1645	1809	3.12%	2696	2592	2798
SES	0.20%	0.10%	86	68	103	0.16%	135	112	156
BBE	0.02%	0.010%	17280	17017	17541	0.016%	26957	26628	27283

Annex C (informative): Defects and consequent actions at leased line connections

C.1 Explanation of defect detection and consequent actions of atomic function

Figure C.1 illustrates the defect detection and consequent actions by means of a functional model. This model shows only the functions which are relevant lower order VC connections. At the lower order path layer to client layer adaptation function only the non-specific defects are given.

A terminology according to the equipment specification in ETS 300 417-x-1 is used:

- Defects begin with a lower case "d" followed by the abbreviation of the defect, e.g. dLOS = Loss of Signal defect.
- Consequent actions begin with a lower case "a" followed by the abbreviation of the consequent action, e.g. aAIS = action AIS.
- Primitives indicate that a server layer (SSF) or a trail (TSF) is not working. Issuing SSF by an adaptation function is called aSSF and issuing TSF by a trail termination function is called aTSF. The information is called AI_TSF or CI_SSF respectively.

C.2 Handling of defects along a leased line connection or at the leased line interface

Figure C.2 shows a unidirectional interruption of the physical layer.

NE2:	ES1/RS1_TT_Sk aAIS ← dLOS aTSF ← dLOS
MS1_TT_Sk	aAIS ← dAIS aRDI ← dAIS aTSF ← dAIS
MS_TT_So	inserts RDI pattern "110" in K2[6-8]
S4_TT_Sk	aRDI ← CI_SSF aTSF ← CI_SSF
S4_TT_So	inserts RDI pattern "1" in G1[5]
TE2:	S3_TT_Sk aRDI ← CI_SSF aTSF ← CI_SSF
S4_TT_So	inserts RDI pattern "1" in G1[5]
TE1:	S3_TT_Sk dRDI

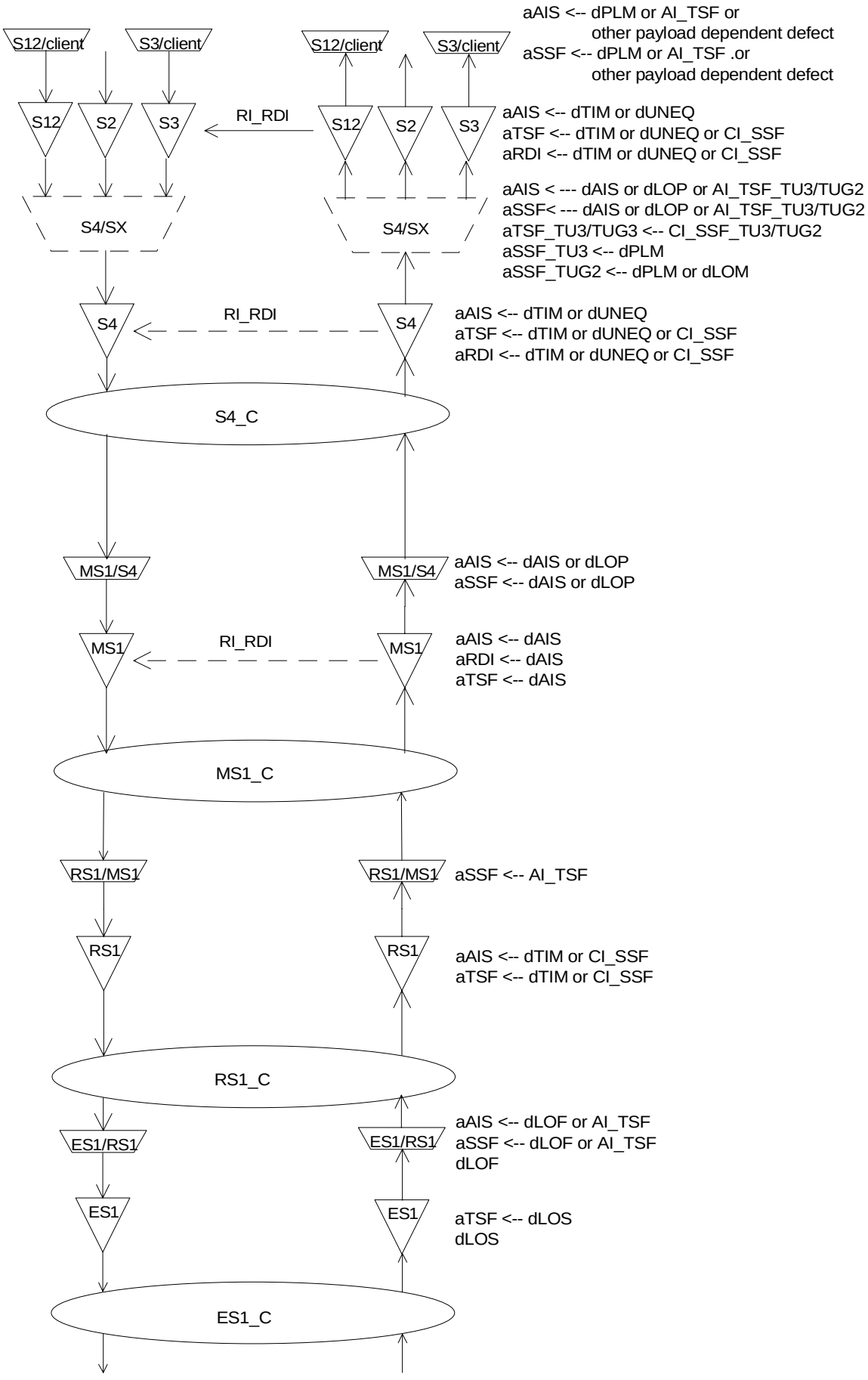


Figure C.1: Overview of defect detection and consequent actions of atomic functions

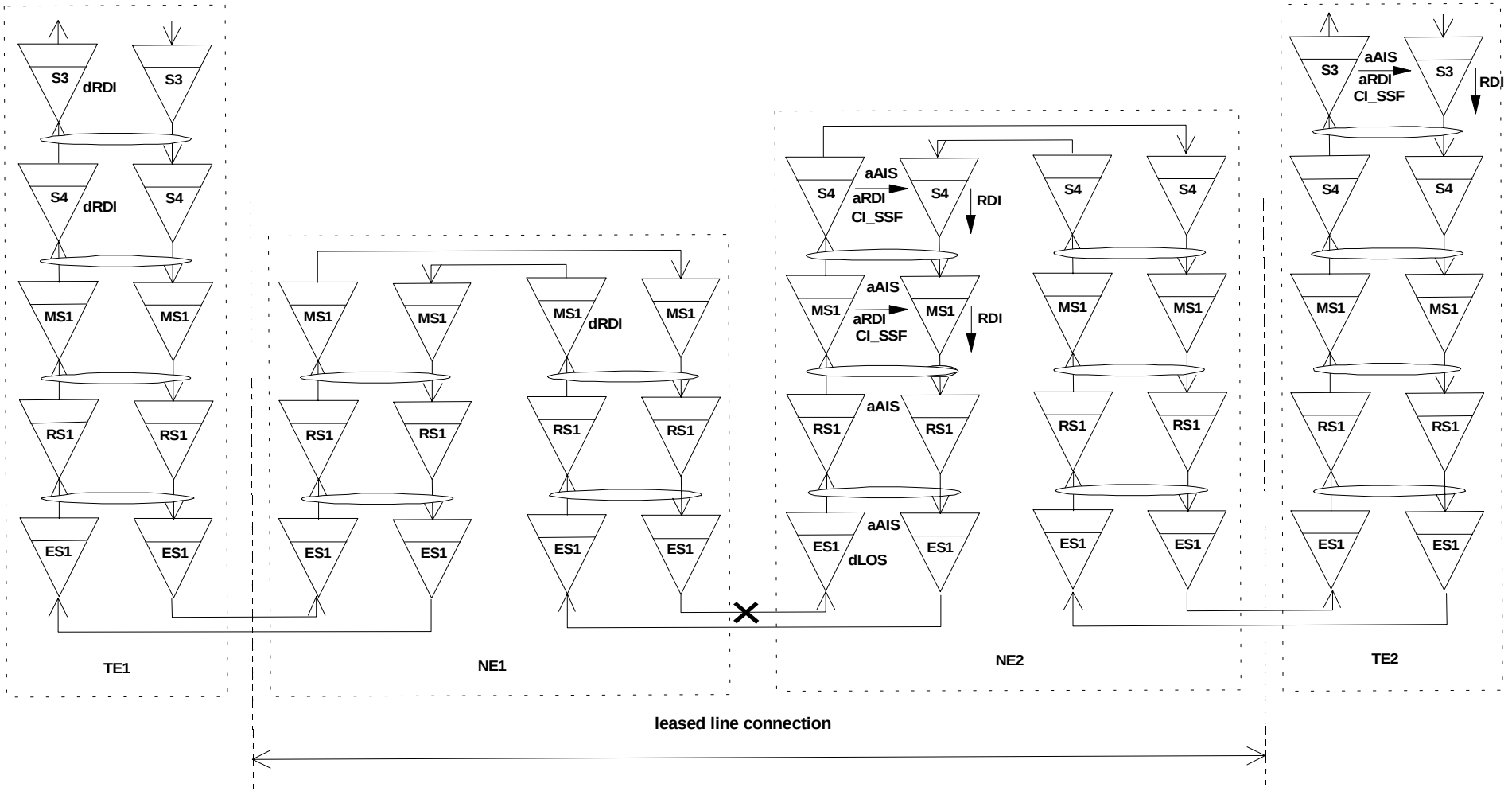


Figure C.2: Example of an unidirectional LOS defect within a VC-3 leased line

Annex D (informative): Configuration of a lower order VC leased line connection

Figure D.1 shows an example of lower order VC connections. It shows that path and section could be terminated at different equipment as it is assumed for VC leased line connection. For that reason the requirements for each layer are identical for the leased line network and the TEs.

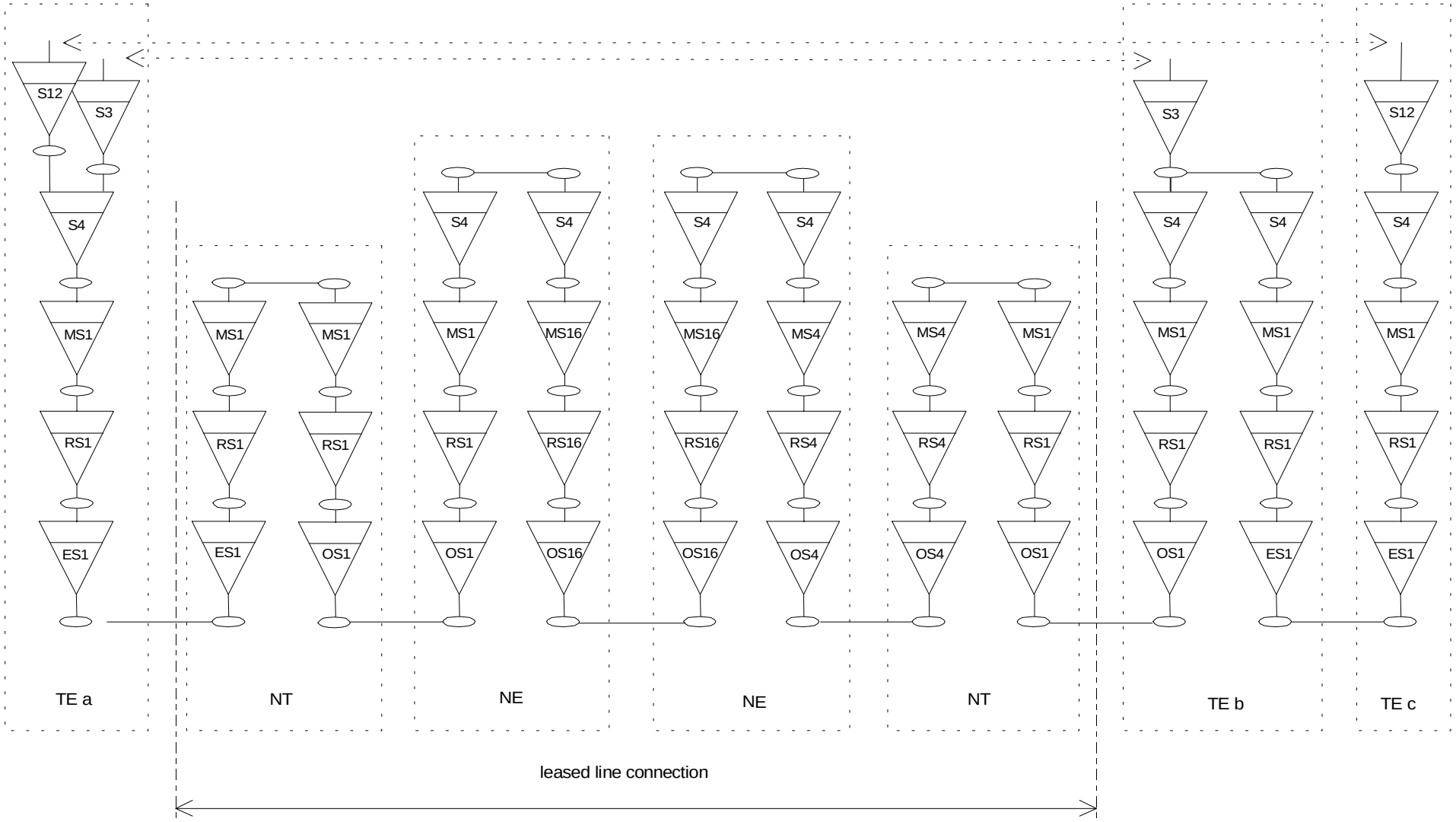


Figure D.1: Example of lower order VC connection generated in one TE and terminated in different TEs

Annex E (informative): Bibliography

- CCITT Recommendation I.140 (1993): "Attribute techniques for the characterization of telecommunication services supported by an ISDN and network capabilities of an ISDN".
- CCITT Recommendation M.1016 (1988): "Assessment of the service availability performance of international leased circuits".
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- ITU-T Recommendation G.114 (1993): "Mean one-way propagation time".
- ITU-T Recommendation M.2100 (1995): "Performance limits for bringing-into-service and maintenance of international digital paths, sections and transmission systems".
- ITU-T Recommendation M.2101 (1996): "Performance limits for bringing-into-service and maintenance of international SDH paths and multiplex sections".
- ITU-T Recommendation G.704 (1995): "Synchronous frame structures used at 1544, 6312, 2048, 8488 and 44 736 kbit/s hierarchical levels".
- I-ETS 300 416: "Transmission and Multiplexing (TM); Availability performance of path elements of international digital paths".
- ETS 300 462-2: "Transmission and Multiplexing (TM); Generic requirements for synchronization networks; Part 2: Synchronization network architecture".

History

Document history				
V1.1.1	March 1998	Public Enquiry	PE 9829:	1998-03-20 to 1998-07-17