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SERIES G: TRANSMISSION SYSTEMS AND MEDIA, DIGITAL SYSTEMS AND NETWORKS

Digital terminal equipments – Other terminal equipment

Characteristics of optical transport network hierarchy equipment functional blocks

ITU-T Recommendation G.798

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ITU-T Recommendation G.798

Characteristics of optical transport network hierarchy equipment functional blocks

Summary

This Recommendation specifies both the components and the methodology that should be used in order to specify optical transport network functionality of network elements; it does not specify individual optical transport network equipment as such.

Source

ITU-T Recommendation G.798 was approved on 13 June 2004 by ITU-T Study Group 15 (2001-2004) under the ITU-T Recommendation A.8 procedure.

Keywords

Atomic functions, equipment functional blocks, optical transport network.

FOREWORD

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Introduction

This Recommendation forms part of a suite of Recommendations covering the full functionality of network equipment (e.g., G.783, G.705, G.781, and G.784) and follows the principals defined in ITU-T Rec. G.806.

This Recommendation specifies a library of basic building blocks and a set of rules by which they may be combined in order to describe equipment used in an optical transport network. The library comprises the functional building blocks needed to specify completely the generic functional structure of the optical transport network. In order to be compliant with this Recommendation, the OTN functionality of any equipment which processes at least one of the OTN layers needs to be describable as an interconnection of a subset of these functional blocks contained within this Recommendation. The interconnections of these blocks should obey the combination rules given.

The specification method is based on functional decomposition of the equipment into atomic and compound functions. The equipment is then described by its Equipment Functional Specification (EFS) which lists the constituent atomic and compound functions, their interconnection, and any overall performance objectives (e.g., transfer delay, availability, etc.).

ITU-T Recommendation G.798

Characteristics of optical transport network hierarchy equipment functional blocks

1 Scope

This Recommendation covers the functional requirements of Optical Transport Network functionality within equipment. Some examples of the functionality are:

– Optical Transmission Section Termination and line amplification functionality;
– Optical Multiplex Section Termination functionality;
– Optical Channel Termination functionality;
– Optical Channel Cross-Connect functionality.

This Recommendation uses the specification methodology defined in ITU-T Rec. G.806 in general for transport network equipment and is based on the architecture of optical transport networks defined in ITU-T Rec. G.872 and the interfaces for optical transport networks defined in ITU-T Rec. G.709/Y.1331. The description is generic and no particular physical partitioning of functions is implied. The input/output information flows associated with the functional blocks serve for defining the functions of the blocks and are considered to be conceptual, not physical.

The OCh layer as defined in ITU-T Rec. G.872 is divided into an OCh layer, an OTU layer and an ODU layer with tandem connection sub-layers as defined in ITU-T Rec. G.709/Y.1331.

The functionality defined in this Recommendation can be applied at User to Network Interfaces (UNI) and Network Node Interfaces (NNI) of the Optical Transport Network. It is recognized for interfaces used within optical subnetworks, aspects of the interface are optical technology dependent and subject to change as technology progresses. Therefore, optical technology dependent aspects (for transverse compatibility) are not defined for functional blocks used for these interfaces to allow for technology changes. The overhead processing functionality necessary for operations and management of optical subnetworks is defined.

Not every functional block defined in this Recommendation is required for every application. Different subsets of functional blocks from this Recommendation and others (e.g., ITU-T Rec. G.783) may be assembled in different ways according to the combination rules given in these Recommendations to provide a variety of different capabilities. Network operators and equipment suppliers may choose which functions must be implemented for each application.

The internal structure of the implementation of this functionality (equipment design) need not be identical to the structure of the functional model, as long as all the details of the externally observable behaviour comply with the EFS.

Equipment developed prior to the production of this Recommendation may not comply in all details with this Recommendation.

Equipment which is normally stated to be compliant with this Recommendation may not fulfil all the requirements in the case that it is interworking with old equipment that is not compliant with this Recommendation.

Figures 1-1, 1-2 and 1-3 present the set of atomic functions associated with the traffic signal transport. The functions for the processing of communication channels (COMMS) are not shown in these figures in order to reduce the complexity of the figures. For the COMMS functions, refer to the specific layer network descriptions.

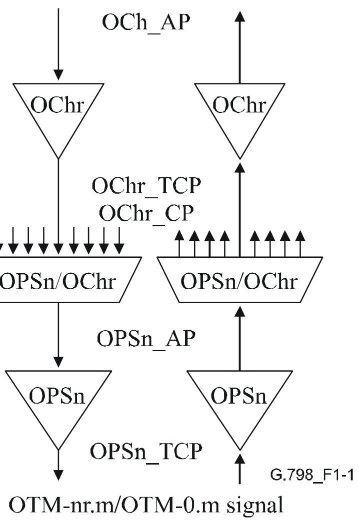
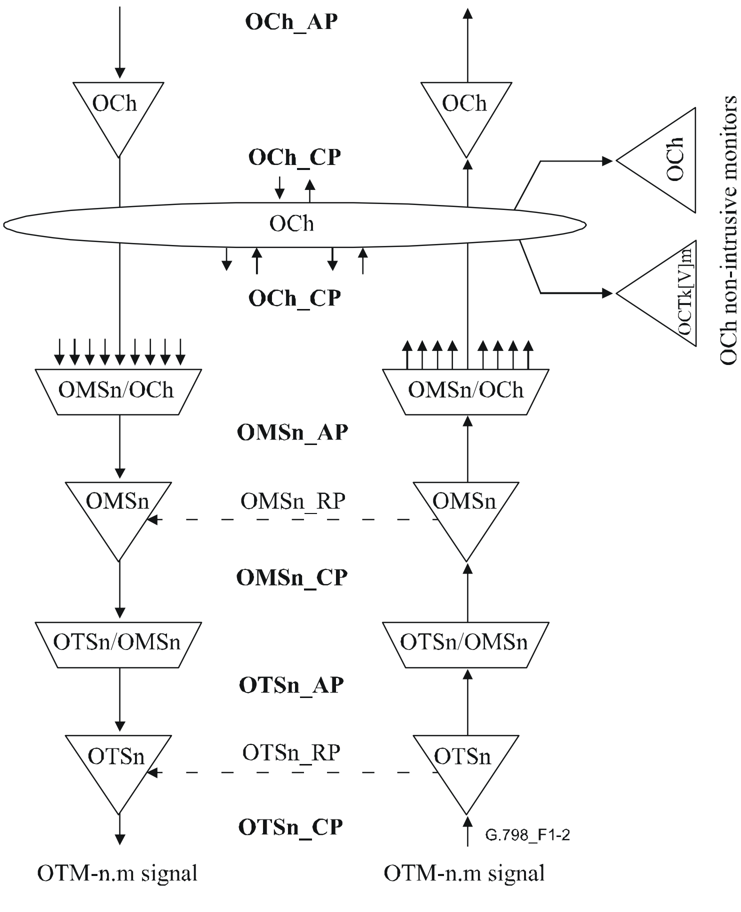


Figure 1-1/G.798 – OTN atomic functions specific for the reduced functionality OTM-nr.m/OTM-0.m interface



NOTE – OMS trail protection sub-layer functions not shown.

Figure 1-2/G.798 – OTN atomic functions specific for the full functionality OTM-n.m interface

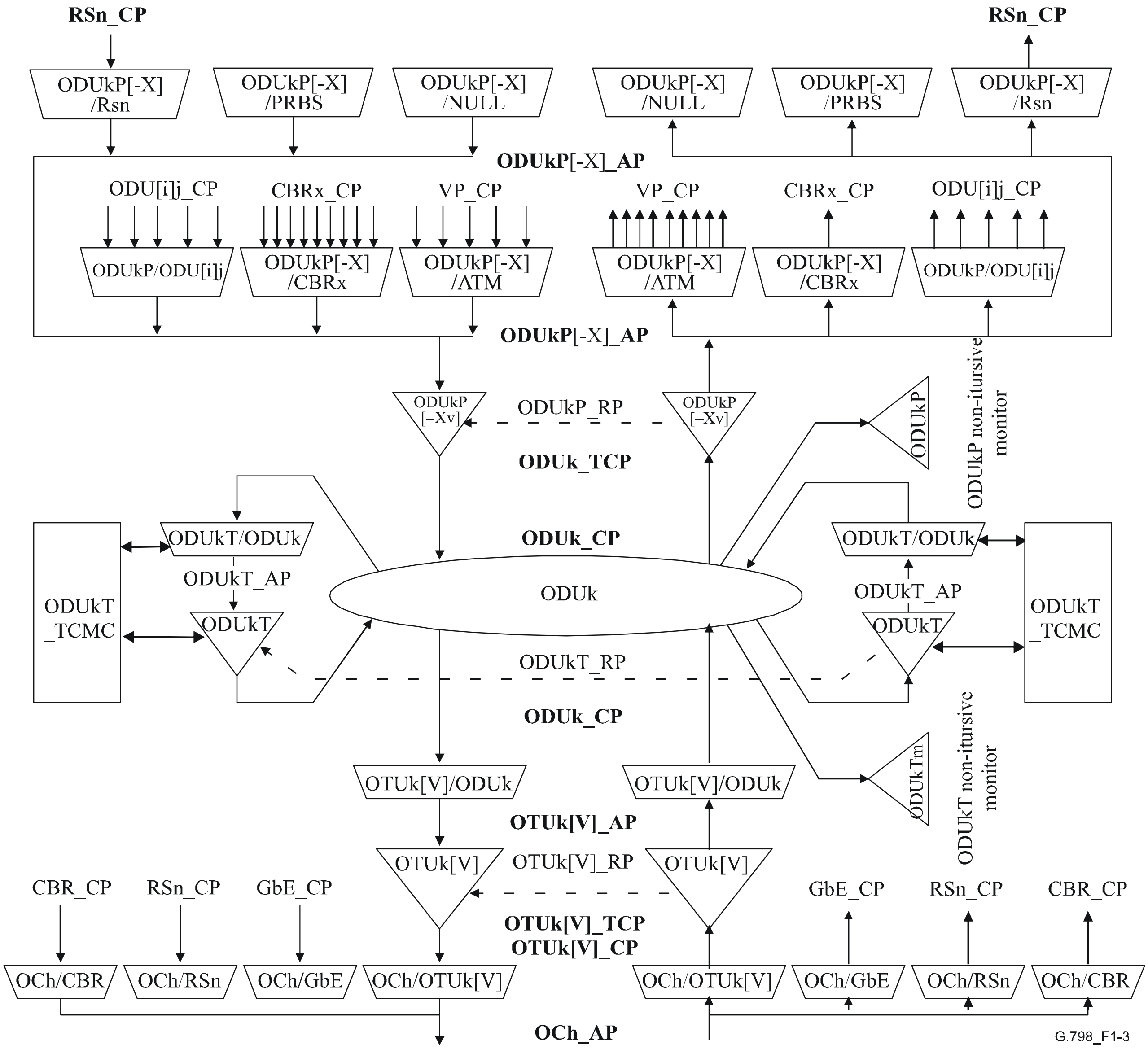


Figure 1-3/G.798 – OTN common atomic functions

2 References

The following ITU-T Recommendations and other references contain provisions which, through reference in this text, constitute provisions of this Recommendation. At the time of publication, the editions indicated were valid. All Recommendations and other references are subject to revision; users of this Recommendation are therefore encouraged to investigate the possibility of applying the most recent edition of the Recommendations and other references listed below. A list of the currently valid ITU-T Recommendations is regularly published. The reference to a document within this Recommendation does not give it, as a stand-alone document, the status of a Recommendation.

– ITU-T Recommendation G.664 (2003), *Optical safety procedures and requirements for optical transport systems*.

– ITU-T Recommendation G.691 (2003), *Optical interfaces for single channel STM-64 and other SDH systems with optical amplifiers*.

– ITU-T Recommendation G.707/Y.1322 (2003), *Network node interface for the synchronous digital hierarchy (SDH)*.

– ITU-T Recommendation G.709/Y.1331 (2003), *Interfaces for the optical transport network (OTN)*.

– ITU-T Recommendation G.783 (2004), *Characteristics of synchronous digital hierarchy (SDH) equipment functional blocks*.

– ITU-T Recommendation G.805 (2000), *Generic functional architecture of transport networks*.

– ITU-T Recommendation G.806 (2004), *Characteristics of transport equipment – Description methodology and generic functionality*.

– ITU-T Recommendation G.808.1 (2003), *Generic protection switching – Linear trail and subnetwork protection*.

– ITU-T Recommendation G.825 (2000), *The control of jitter and wander within digital networks which are based on the synchronous digital hierarchy (SDH)*.

– ITU-T Recommendation G.831 (2000), *Management capabilities of transport networks based on the synchronous digital hierarchy (SDH)*.

– ITU-T Recommendation G.841 (1998), *Types and characteristics of SDH network protection architectures*.

– ITU-T Recommendation G.873.1 (2003), *Optical Transport Network (OTN) – Linear protection*.

– ITU-T Recommendation G.874 (2001), *Management aspects of the optical transport network element*.

– ITU-T Recommendation G.957 (1999), *Optical interfaces for equipments and systems relating to the synchronous digital hierarchy*.

– ITU-T Recommendation G.959.1 (2003), *Optical transport network physical layer interfaces*.

– ITU-T Recommendation G.7042/Y.1305 (2004), *Link capacity adjustment scheme (LCAS) for virtual concatenated signals*.

– ITU-T Recommendation G.8251 (2001), *The control of jitter and wander within the optical transport network (OTN)*.

– ITU-T Recommendation I.150 (1999), *B-ISDN asynchronous transfer mode functional characteristics*.

– ITU-T Recommendation I.321 (1991), *B-ISDN protocol reference model and its application*.

– ITU-T Recommendation I.361 (1999), *B-ISDN ATM layer specification*.

– ITU-T Recommendation I.371.1 (2000), *Guaranteed frame rate ATM transfer capability*.

– ITU-T Recommendation I.432.1 (1999), *B-ISDN user-network interface – Physical layer specification: General characteristics*.

– ITU-T Recommendation I.610 (1999), *B-ISDN operation and maintenance principles and functions*.

– ITU-T Recommendation I.732 (2000), *Functional characteristics of ATM equipment; Annex D, Library of atomic functions*.

– IEC 60825-1 (2001-08), *Safety of laser products – Part 1: Equipment classification, requirements and user's guide*.

– IEC 60825-2 (2004-08), *Safety of laser products – Part 2: Safety of optical fibre communication systems*.

3 Terms and definitions

3.1 This Recommendation uses terms defined in ITU-T Rec. G.707/Y.1322:

a) BIP-X

3.2 This Recommendation uses terms defined in ITU-T Rec. G.805:

a) Adapted Information (AI)

b) Access Point (AP)

c) Characteristic Information (CI)

d) Connection Point (CP)

e) Network

f) Subnetwork

3.3 This Recommendation uses terms defined in ITU-T Rec. G.872:

a) Optical Transport Network (OTN)

b) Optical Multiplex Section (OMS)

c) Optical Transmission Section (OTS)

3.4 This Recommendation uses terms defined in ITU-T Rec. G.709/Y.1331:

a) Optical Transport Module (OTM-n[r].m)

b) OTM with full functionality (OTM-n.m)

c) OTM with reduced functionality (OTM-0.m, OTM-nr.m)

d) Optical Channel (OCh[r])

e) Optical Channel with full functionality (OCh)

f) Optical Channel with reduced functionality (OChr)

g) Optical channel Transport Unit (OTUk[V])

h) Completely standardized OTUk (OTUk)

i) Functionally standardized OTUk (OTUkV)

j) Optical channel Data Unit (ODUk)

k) ODUk Path (ODUkP)

l) ODUk TCM (ODUkT)

m) Optical channel Payload Unit (OPUk)

n) Optical Physical Section of order n (OPSn)

o) OTM Overhead Signal (OOS)

p) Optical Supervisory Channel (OSC)

q) Optical Transport Hierarchy (OTH)

r) CBR2G5

s) CBR10G

t) CBR40G

3.5 This Recommendation uses terms defined in ITU-T Rec. G.806:

a) Adaptation function (A)
b) Connection function (C)
c) Connection Matrix (CM)
d) Compound function
e) Defect
f) Fault cause
g) Function
h) Management Information (MI)
i) Management Point (MP)
j) MST_Range
k) Process
l) Remote Information (RI)
m) Remote Point (RP)
n) Server Signal Degrade (SSD)
o) Server Signal Fail (SSF)
p) Sub-Network Connection (SNC)
q) Termination Connection Point (TCP)
r) Trail Signal Degraded (TSD)
s) Trail Signal Fail (TSF)
t) Trail Termination function (TT)

3.6 This Recommendation uses the following term defined in ITU-T Rec. G.664:

a) Automatic Power Reduction (APR)

3.7 This Recommendation uses the following term defined in ITU-T Rec. G.831:

a) Access Point Identifier (API)

3.8 This Recommendation uses the following term defined in ITU-T Rec. G.7042/Y.1305:

a) Member

3.9 This Recommendation uses terms defined in ITU-T Rec. G.808.1:

a) APS protocol
b) Protection Class:
   - b.1) Sub-network connection protection
     - b.1.1) Sublayer monitored (/S)
     - b.1.2) Non-intrusive monitored (/N)
     - b.1.3) Inherent monitored (/I)
c) Component
   - c.1) Bridge
     - c.1.1) Permanent bridge
     - c.1.2) Broadcast bridge

c.2) Selector

c.2.1) Selective selector

d) Architecture

d.1) 1+1 (protection) architecture

d.2) 1:n (protection) architecture

e) Operation

e.1) Revertive (protection) operation

e.2) Non-revertive (protection) operation

f) Signal

f.1) Traffic signal

f.2) Normal traffic signal

f.3) Extra traffic signal

f.4) Null signal

g) Switching

g.1) Bidirectional (protection) switching

g.2) Unidirectional (protection) switching

h) Protection

3.10 This Recommendation uses terms defined in ITU-T Rec. G.873.1:

a) APS channel

b) Protection group

3.11 This Recommendation defines the following terms:

3.11.1 Access Function (AC): An access function provides access (add, drop, drop and continue) at CPs to communication channels transported in the overhead.

3.11.2 CBRx: Is a CBR signal with the approximate bit rate x.

3.11.3 TCM Control function (TCMC): A TCM control function is responsible for the activation/deactivation of a TCM trail.

3.11.4 TCM Control Information (TCMCI): The TCMCI is the information that passes over a TCMCP for activation/deactivation of a TCM trail.

3.11.5 TCM Control Point (TCMCP): A reference point where the output of an atomic function is bound to the input of the TCM control function, or where the output of the TCM control function is bound to the input of an atomic function.

3.11.6 x: Gives the approximate bit rate for a CBR signal. It is used in the form "unit value, unit, [fractional unit value]". The currently defined unit value is "G" for gigabit/s. Examples for x are "40G" for 40 Gbit/s and "2G5" for 2.5 Gbit/s.

4 Abbreviations

This Recommendation uses the following abbreviations:

1second	1 second pulse
1+1u	1+1 unidirectional protection
A	Adaptation function
AcMSI	Accepted MSI
AcPT	Accepted PT
AcPTI	Accepted PTI
AcSTAT	Accepted STAT
AcTI	Accepted TTI
AcVcPT	Accepted vcPT
AC	Access function
ACT	Activation (for ODUk TCM trail)
ACTEn	ACT enabled
ACTRx	Received ACT
ACTTx	Transmitted ACT
AdminState	Administrative State
AI	Adapted Information
AIS	Alarm Indication Signal
AP	Access Point
API	Access Point Identifier
APR	Automatic Power Reduction
APRCntrl	APR Control
APS	Automatic Protection Switching
ARC	Alarm Reporting Control
ATM	Asynchronous Transfer Mode
AUX	Auxiliary channels
BEI	Backward Error Indicator
BDI	Backward Defect Indicator
BDI-O	BDI Overhead
BDI-P	BDI Payload
BIAE	Backward Incoming Alignment Error
BIP	Bit Interleaved Parity
C	Connection function
CBR	Constant Bit Rate signal
CBRx	Constant bit rate signal of bit rate [range] x

CI	Characteristic Information
CK	Clock
COMMS	Communications channel
CP	Connection Point
CPn	Connection Point normal
CPp	Connection Point protection
CPw	Connection Point working
CRC	Cyclic Redundancy Check
D	Data
d	Defect
DAa	Amplifier-aided dispersion accommodation
DAc	Channel dispersion accommodation
DAPI	Destination Access Point Identifier
dB	Decibel
DCC	Data Communications Channel
DEG	Degraded defect
DEGM	DEG consecutive 1 second monitoring intervals
DEGThr	DEG 1 second EBC threshold
DMod	Demodulation
DS	Defect Second
DS-O	DS Overhead
DS-P	DS Payload
EBC	Errored Block Count
ExDAPI	Expected DAPI
ExMSI	Expected MSI
ExSAPI	Expected SAPI
ExtCMD	External command
F	Far-end
FDI	Forward Defect Indicator
FDI-O	FDI Overhead
FDI-P	FDI Payload
FEC	Forward Error Correction
FECCorrErr	FEC Corrected Errors
FECEn	FEC Enabled
FM	Fault Management
FOP	Failure of Protocol
FOP-PM	Failure of Protocol; Provisioning Mismatch

FOP-NR	Failure of Protocol; No Response
FS	Frame Start
F_DS	Far-end Defect Second
F_EBC	Far-end Errored Block Count
GFC	Generic Flow Control
GCC	Generic Communications Channel
GCCAccess	GCC Access
GCCCont	GCC Continue
HEC	Header Error Control
HoTime	Hold-off Time
IAE	Incoming Alignment Error
IF	In-Frame
IM	In multiframe
LCAS	Link Capacity Adjustment Scheme
LCK	Locked defect
LOA	Loss of Alignment
LOF	Loss of Frame
LOFLOM	Loss of Frame and Multiframe
LOM	Loss of Multiframe
LOS	Loss of Signal
LOS-O	LOS Overhead
LOS-P	LOS Payload
LSS	Loss of PRBS lock
LTC	Loss of Tandem Connection
m	Non-intrusive monitor
MFI	Multiframe Indicator
MFS	Multiframe Start
MI	Management Information
Mod	Modulation
MP	Management Point
MSI	Multiplex Structure Identifier
MSIM	Multiplex Structure Identifier Mismatch
MST	Member Status (signal)
n	Normal
N	Near-end
N/A	Not Applicable
NC	Network Connection

NNI	Network Node Interface
N_DS	Near-end Defect Second
N_EBC	Near-end Errored Block Count
OA	Optical Amplification
OAM	Operation, Administration, Maintenance
OCh	Optical Channel
OCI	Open Connection Indication
OChr	Optical Channel with reduced functionality
ODM	Optical Demultiplexing
ODU	Optical Data Unit
ODUi	Optical Data Unit of level i
ODU[i]j	Optical Data Unit of level j and i (i is optional; i < j)
ODUj	Optical Data Unit of level j
ODUj[/i]	Optical Data Unit of level j or i (i is optional; i < j)
ODUk	Optical Data Unit of level k
ODUkP	Optical Data Unit of level k, Path
ODUkT	Optical Data Unit of level k, Tandem connection sub-layer
OH	OverHead
OHDM	OverHead DeMultiplexing
OHM	OverHead Multiplexing
OM	Optical Multiplexing
OMS	Optical Multiplex Section
OMSn	Optical Multiplex Section of level n
OMSnP	Optical Multiplex Section Protection sub-layer of level n
OOF	Out of Frame
OOM	Out of Multiframe
OOS	OTM Overhead Signal
OperType	Operation Type
OPS	Optical Physical Section
OPSn	Optical Physical Section of level n
OPU	Optical Payload Unit
OPUk	Optical Payload Unit of level k
OPUk-Xv	Virtually concatenated Optical Payload Unit of level k
OS	Optical Section
OSC	Optical Supervisory Channel
OSn	Optical Section of order n
OSx	Optical Section of bit rate [range] x

OTM	Optical Transmission Module
OTN	Optical Transport Network
OTS	Optical Transmission Section
OTSn	Optical Transmission Section of level n
OTU	Optical Transmission Unit
OTUk	Optical Transmission Unit of level k
OTUkV	Optical Transmission Unit of level k, functional standardized
p	Protection
p	Performance data
PLD	Payload
PLM	PayLoad Mismatch
PM	Performance Management
PMDC	Polarization Mode Dispersion Compensation
PMI	Payload Missing Indication
PMOH	Path Monitoring OverHead
ppm	parts per million
ProtType	Protection Type
PRBS	Pseudo-Random Bit Sequence
PSI	Payload Structure Indication
PT	Payload Type
PTI	Payload Type Identifier
RES	Reserved overhead
RI	Remote Information
RP	Remote Point
RS	Regenerator Section
RSn	Regenerator Section of level n
SAPI	Source Access Point Identifier
SDH	Synchronous Digital Hierarchy
SF	Signal Fail
Sk	Sink
SMOH	Section Monitoring OverHead
SNC	Sub-Network Connection
SNC/I	SNC with Inherent monitoring
SNC/N	SNC with Non-intrusive monitoring
SNC/S	SNC with Sub-layer monitoring
So	Source
SQM	Sequence indicator Mismatch

SSD	Server Signal Degraded
SSF	Server Signal Fail
SSF-O	SSF Overhead
SSF-P	SSF Payload
STAT	Status field
STM	Synchronous Transport Module
TCM	Tandem Connection Monitoring
TCMC	TCM Control function
TCMCI	TCM Control Information
TCMCP	TCM Control Point
TCMOH	Tandem Connection Monitoring Overhead
TCP	Termination Connection Point
TIM	Trail trace Identifier Mismatch
TIMActDis	TIM consequent Actions Disabled
TIMDetMo	TIM Detection Mode
TSD	Trail Signal Degraded
TSE	Test Sequence Error
TSF	Trail Signal Fail
TSF-O	TSF Overhead
TSF-P	TSF Payload
TT	Trail Termination function
TTI	Trail Trace Identifier
TxMSI	Transmitted MSI
TxTI	Transmitted TTI
UNI	User Network Interface
VCLOM	Virtual Concatenation Loss of Multiframe
VCMF	Virtual Concatenation MultiFrame
VCOH	Virtual Concatenation OverHead
vcPT	virtual concatenation Payload Type
VcPLM	Virtual concatenation Payload Mismatch
VLI	VCAT/LCAS Information
VP	Virtual Path
VPI	Virtual Path Identifier
w	working
WA	Wavelength Assignment
WS	Wavelength Selection
WTR	Wait to Restore

5 Methodology

For the basic methodology to describe transport network functionality of network elements, refer to clause 5/G.806.

6 Supervision

The generic supervision functions are defined in clause 6/G.806. Specific supervision functions for the OTN are defined in this clause.

6.1 Alarm Reporting Control

Trail termination Point Mode and Port Modes are not supported by OTN equipment, instead Alarm Reporting Control (ARC) is used. Refer to ITU-T Rec. G.874 for the OTN ARC functionality.

6.2 Defects

6.2.1 Continuity supervision (loss of continuity defect)

Continuity supervision refers to the set of processes for monitoring the integrity of the continuity of a trail. Generic continuity supervision defects are described in 6.2.1/G.806. OTN specific continuity supervision defects are described here. The continuity supervision requirements for the OTN are defined in ITU-T Rec. G.872.

6.2.1.1 Loss of Signal Payload defect (dLOS-P)

Loss of Signal Payload (LOS-P) defect is monitored at the OTS, OMS, and OCh layers of an OTM-n.m and at OPS and OChr layer of an OTM-nr.m/OTM-0.m signal.

At the OTS layer LOS-P shall correspond to loss of the OTS payload in the OTM-n.m signal. At the OMS layer, LOS-P shall correspond to loss of the OMS payload in the OTM-n.m signal. At the OCh layer, LOS-P shall correspond to loss of an OCh payload in the OTM-n.m signal. See Figure 6-2/G.709/Y.1331 for an illustration of OTS, OMS, and OCh payload information within an OTM-n.m signal.

At the OPS layer, LOS shall correspond to the loss of the OTM-nr.m/OTM-0.m signal. At the OChr layer, LOS shall correspond to loss of an OCh payload of the OTM-nr.m/OTM-0.m signal. See Figure 6-3/G.709/Y.1331 for an illustration of OPS and OChr information within an OTM-0.m signal. See Figure 6-4/G.709/Y.1331 for an illustration of OPS and OChr information within an OTM-nr.m signal.

dLOS-P should take on the value "incoming payload signal absent" when the incoming power level of the payload signal at the receiver has dropped to a level that corresponds to a high error condition. The purpose of monitoring this parameter is to indicate either:

i) transmitter failure at the OCh or OChr layer;

ii) optical path break at the OCh, OMS, OTS or OPS layer.

The specific detection process, including the detection time, is for further study.

An additional hold-off time is defined for the dLOS-P activation at the OTSn_TT_Sk and OMSn_TT_Sk. This time is introduced in order to avoid false dLOS-P activation in case the payload signal is already missing at the related trail termination source. The PMI signal is used to signal this information from the trail termination source to the sink (see 6.2.6.7 and 8.10). The hold-off time has to cover the propagation, processing and detection delay of the PMI signal between the source and sink. The hold-off time is not configurable, it depends on the specific implementation of the PMI signalling and LOS-P detection. Its value is for further study.

6.2.1.2 Loss of Signal Overhead defect (dLOS-O)

Loss of Signal Overhead defect is monitored at the OTS layer. LOS-O shall correspond to loss of the Optical Supervisory Channel (OSC) signal. dLOS-P should take on the value "incoming overhead signal absent" when the incoming power level of the OSC at the receiver has dropped to a level that corresponds to a high error condition. The purpose of monitoring this parameter is to indicate either:

i) OSC transmitter failure at the OTS layer;

ii) OSC optical path break at the OTS layer.

The specific detection process, including the detection time, is for further study.

6.2.1.3 Open Connection Indication defect (dOCI)

See 6.2.6.8.

6.2.1.4 Loss of Tandem Connection (dLTC)

6.2.1.4.1 dLTC at the ODUkT layer

dLTC shall be declared if the accepted STAT information (AcSTAT) is "000". dLTC shall be cleared if the accepted STAT information is not equal to "000". For the STAT information acceptance process, see 8.8.

During signal fail conditions of the data signal, dLTC shall be set to false. For details on the signal fail conditions, see the specific atomic functions.

6.2.2 Connectivity supervision/Trace Identifier Mismatch defect (dTIM)

For the generic connectivity supervision requirements of the OTN, refer to ITU-T Rec. G.872.

6.2.2.1 dTIM at the OTS, OTUk, ODUkT and ODUkP layer

The TTI Mismatch process reports the Trace Identifier Mismatch defect (dTIM). The process is based on the comparison of expected APIs (i.e., SAPI and DAPI) with the APIs in the incoming signal. The APIs are part of the 64 byte TTI as defined in ITU-T Rec. G.709/Y.1331.

Depending on the topology, only the SAPI, only the DAPI or both SAPI and DAPI are taken into account for the mismatch detection. These topologies are:

– **Point-to-point**

  In a point-to-point topology, either unidirectional or bidirectional, only the SAPI is taken into account for the comparison at the trail termination sink as shown in Figure 6-1.

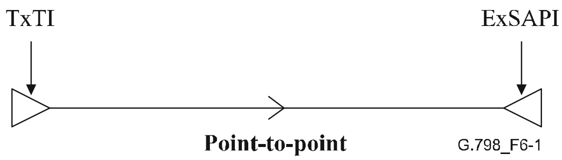


Figure 6-1/G.798 – Point-to-point configuration

– **Point-to-multipoint**

  In a point-to-multipoint topology, only the SAPI is taken into account for the comparison at the trail termination sink as shown in Figure 6-2.

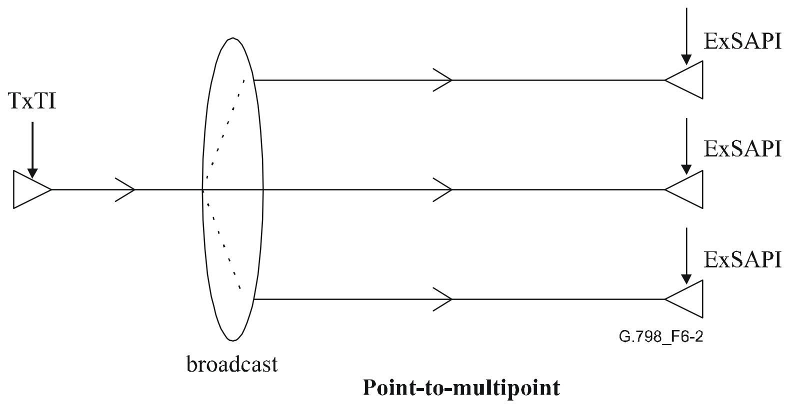


Figure 6-2/G.798 – Point-to-multipoint configuration

– **Multipoint-to-point**

In a multipoint-to-point topology, only the DAPI is taken into account for the comparison at the trail termination sink as shown in Figure 6-3.

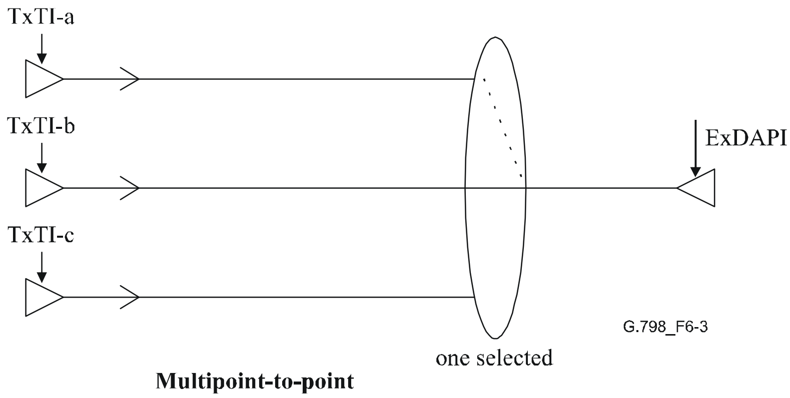


Figure 6-3/G.798 – Multipoint-to-point configuration

In addition, the mismatch detection can be disabled.

A functional decomposition of the TTI Mismatch Detection process is given in Figure 6-4.

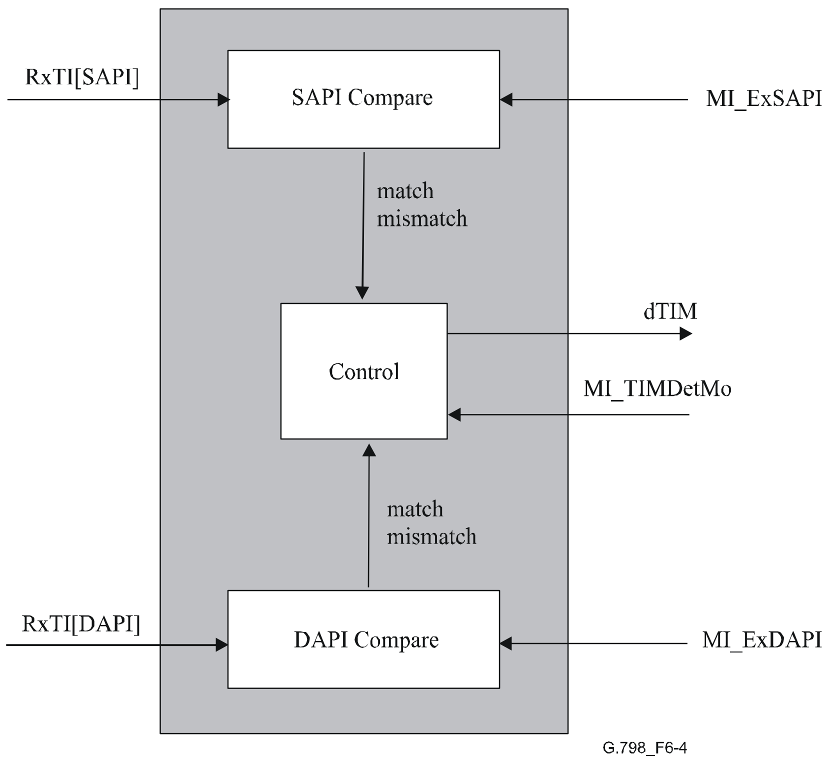


Figure 6-4/G.798 – TTI Mismatch Detection Process

The SAPI/DAPI compare process compares the SAPI/DAPI part of the TTI in the incoming signal (RxTI) (see 15.2/G.709/Y.1331) with the equivalent expected SAPI/DAPI values set via the MP (MI_ExSAPI/DAPI). The comparison result is "match" if all 16 bytes were equal, and "mismatch" if one or more bytes were unequal. "match/mismatch" conditions shall be detected within 100 ms of changes to the RxTI, ExSAPI or ExDAPI in the absence of bit errors. A persistence check shall be used in order to prevent wrong/toggling dTIM information during bit errors.

Based on the TIM detection mode set via the MP (MI_TIMDetMo) the defect dTIM is generated as listed in Table 6-1 in the control process.

During signal fail conditions of the data/overhead signal, dTIM shall be set to false. For details on the signal fail conditions, see the specific atomic functions.

Table 6-1/G.798 – dTIM generation

MI_TIMDetMo	SAPI compare	DAPI compare	dTIM
off	don't care	don't care	clear
SAPI	match	don't care	clear
SAPI	mismatch	don't care	raise
DAPI	don't care	match	clear
DAPI	don't care	mismatch	raise
SAPI+DAPI	match	match	clear
SAPI+DAPI	match	mismatch	raise
SAPI+DAPI	mismatch	match	raise
SAPI+DAPI	mismatch	mismatch	raise

6.2.3 Signal quality supervision

6.2.3.1 OTS signal quality supervision

Specific requirements for OTS signal quality supervision are for further study. The specific implementation for signal quality supervision is outside the scope of this Recommendation.

6.2.3.2 OMS signal quality supervision

For further study.

6.2.3.3 OCh signal quality supervision

For further study.

6.2.3.4 OTUk, ODUkT Signal Degrade Defect (dDEG) detection

The algorithm for the OTUk and ODUkT dDEG detection is defined in 6.2.3.1.2/G.806 with the addition that the current and previous errored second count is discarded (assumed as 0 errored blocks) if the defect dIAE was active once during the second.

Bursty distribution of errors is assumed and only the degraded signal defect (dDEG) is supported.

For the errored block definition and the number of blocks per 1-second interval, see Table 6-2.

6.2.3.5 ODUkP Signal Degrade Defect (dDEG) detection

The algorithm for the ODUkP dDEG detection is defined in 6.2.3.1.2/G.806. Bursty distribution of errors is assumed and only the degraded signal defect (dDEG) is supported.

For the errored block definition and the number of blocks per 1-second interval, see Table 6-2.

6.2.4 Payload Mismatch supervision (dPLM)

6.2.4.1 dPLM at the ODUkP layer

dPLM shall be declared if the accepted payload type (AcPT) is not equal to the expected payload type(s) as defined by the specific adaptation function. dPLM shall be cleared if the accepted payload type is equal to the expected payload type(s) as defined by the specific adaptation function.

NOTE – An adaptation function may support more than one payload type.

For the payload type acceptance process, see 8.7.1.

6.2.4.2 dVcPLM at the ODUkP layer

dVcPLM shall be declared if the accepted virtual concatenation payload type (AcVcPT) is not equal to the expected payload type(s) as defined by the specific adaptation function. dVcPLM shall be cleared if the accepted virtual concatenation payload type is equal to the expected payload type(s) as defined by the specific adaptation function.

NOTE – An adaptation function may support more than one payload type.

For the virtual concatenation payload type acceptance process, see 8.7.3.

6.2.5 Alignment supervision

6.2.5.1 OTUk Loss of Frame defect (dLOF)

OTUk dLOF is generated based on the state of the frame alignment process defined in 8.2.1.

If the frame alignment process is in the out-of-frame (OOF) state for 3 ms, dLOF shall be declared. To provide for the case of intermittent OOFs, the integrating timer shall not be reset to zero until an in-frame (IF) condition persists continuously for 3 ms. dLOF shall be cleared when the IF state persists continuously for 3 ms.

6.2.5.2 OTUk Loss of Multiframe defect (dLOM)

OTUk dLOM is generated based on the state of the multiframe alignment process defined in 8.2.2.

If the multiframe alignment process is persistently in the out-of-multiframe (OOM) state for 3 ms, dLOM shall be declared. dLOM shall be cleared immediately when the multiframe alignment process is in the in-multiframe (IM) state.

6.2.5.3 ODUj[/i] Loss of Frame and Multiframe defect (dLOFLOM)

ODUj[/i] dLOFLOM is generated based on the state of the frame and multiframe alignment process defined in 8.2.3.

If the process is in the out-of-frame (OOF) state for 3 ms, dLOFLOM shall be declared. To provide for the case of intermittent OOFs, the integrating timer shall not be reset to zero until an in-frame (IF) condition persists continuously for 3 ms. dLOFLOM shall be cleared when the IF state persists continuously for 3 ms.

6.2.5.4 ODUk Virtual Concatenation Loss of Multiframe defect (dVCLOM)

ODUkd VCLOM is generated based on the state of the virtual concatenation multiframe alignment process defined in 8.2.4.

If the multiframe alignment process is persistently in the out-of-multiframe (OOM) state for 500 ms, dLOM shall be declared. dLOM shall be cleared immediately when the multiframe alignment process is in the in-multiframe (IM) state.

6.2.6 Maintenance signal supervision

6.2.6.1 Forward Defect Indication Payload defect (dFDI-P)

6.2.6.1.1 dFDI-P at the OMS and OCh layer

Forward Defect Indication Payload (FDI-P) defect is monitored at the OMS and OCh layers. The purpose of monitoring this parameter is to suppress downstream alarms at the client layer caused by upstream defects detected by the server layer, which interrupt the client payload signal.

FDI-P defect (dFDI-P) shall be declared at the trail termination sink function within X ms of detecting the upstream defect causing the insertion of FDI-P into the OOS.

FDI-P defect (dFDI-P) shall be cleared at the trail termination sink function within Y ms of detecting that the upstream defect, which caused the insertion of FDI-P into the OOS, has cleared.

X and Y are for further study.

6.2.6.2 Forward Defect Indication Overhead defect (dFDI-O)

6.2.6.2.1 dFDI-O at the OMS and OCh layer

Forward Defect Indication Overhead (FDI-O) defect is monitored at the OMS and OCh layers. The purpose of monitoring this parameter is to suppress downstream alarms at the client layer caused by upstream defects detected by the server layer which interrupt the OTM Overhead Signal (OOS).

FDI-O defect (dFDI-O) shall be declared at the trail termination sink function within X ms of detecting the upstream defect causing the insertion of FDI-O into the OOS.

FDI-O defect (dFDI-O) shall be cleared at the trail termination sink function within Y ms of detecting that the upstream defect, which caused the insertion of FDI-O into the OOS, has cleared.

X and Y are for further study.

6.2.6.3 Alarm Indication Signal defect (dAIS)

6.2.6.3.1 dAIS at OTUk layer (Generic AIS)

The OTUk dAIS defect detection is identical to the CBR client signal dAIS detection defined in 6.2.6.3.3.

6.2.6.3.2 dAIS at ODUkT and ODUkP layer

dAIS shall be declared if the accepted STAT information (AcSTAT) is "111". dAIS shall be cleared if the accepted STAT information is not equal to "111". For the STAT information acceptance process, see 8.8.

6.2.6.3.3 dAIS for CBR client signals (Generic AIS)

For the CBR dAIS detection the reverse PN-11 process is applied to the data signal as shown in Figure 6-5. At the output of this process (OUT) an all-ZEROs pattern will occur if the input data (IN) is the PN-11 Generic AIS sequence. Note that an all-ZEROs output pattern will also occur in case of an all-ZEROs input pattern. Both the output (OUT) and input (IN) signals are constantly checked over an 8192-bit interval for the number of none ZERO bits (= ONE bits). If the number of ONE bits per interval at OUT is less than 256 and the number of ONE bits per interval at IN is above or equal to 256 in 3 consecutive intervals, dAIS is raised. If the number of ONE bits at OUT is above or equal to 256 or the number of ONE bits at IN is below 256 in 3 consecutive intervals, dAIS is cleared.

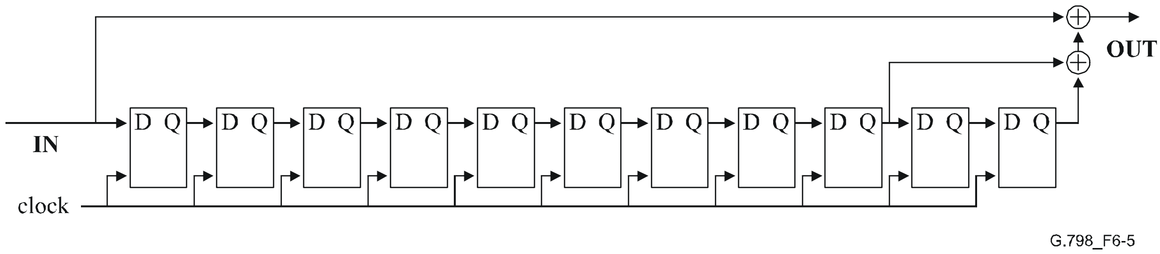


Figure 6-5/G.798 – Inverse PN-11 process for Generic AIS detection

6.2.6.4 Backward Defect Indication Payload defect (dBDI-P)

6.2.6.4.1 dBDI-P at OTS and OMS layer

Backward Defect Indication Payload defect (dBDI-P) is monitored at the OTS and OMS layers. The purpose of monitoring this parameter is to allow for single ended supervision of the trail.

BDI-P (dBDI-P) defect shall be declared at the trail termination sink function within X ms of detecting the far-end defect causing the insertion of BDI-P into the OOS.

BDI-P (dBDI-P) defect shall be cleared at the trail termination sink function within Y ms of detecting that the far-end defect, which caused the insertion of BDI-P into the OOS, has cleared.

X and Y are for further study.

During signal fail conditions of the overhead signal, dBDI-P shall be set to false. For details on the signal fail conditions, see the specific atomic functions.

6.2.6.5 Backward Defect Indication Overhead defect (dBDI-O)

6.2.6.5.1 dBDI-O at OTS and OMS layer

Backward Defect Indication Overhead defect (dBDI-O) is monitored at the OTS and OMS layers. The purpose of monitoring this parameter is to allow for single ended supervision of the trail.

BDI-O (dBDI-O) defect shall be declared at the trail termination sink function within X ms of detecting the far-end defect causing the insertion of BDI-O into the OOS.

BDI-O (dBDI-O) defect shall be cleared at the trail termination sink function within Y ms of detecting that the far-end defect, which caused the insertion of BDI-O into the OOS, has cleared.

X and Y are for further study.

During signal fail conditions of the overhead signal, dBDI-O shall be set to false. For details on the signal fail conditions, see the specific atomic functions.

6.2.6.6 Backward Defect Indication defect (dBDI)

6.2.6.6.1 dBDI at OTUk, ODUkT and ODUkP layer

dBDI shall be declared if the BDI bit in the SM/TCMi/PM overhead field (byte 3, bit 5) is "1" for X consecutive frames. dBDI shall be cleared if the BDI bit in the SM/TCMi/PM overhead field is "0" for X consecutive frames. X shall be 5.

During signal fail conditions of the data signal, dBDI shall be set to false. For details on the signal fail conditions, see the specific atomic functions.

6.2.6.7 Payload Missing Indication defect (dPMI)

6.2.6.7.1 dPMI at the OTS and OMS layer

Payload Missing Indication (PMI) defect is monitored at the OTS and OMS layers. The purpose of monitoring this parameter is to suppress downstream loss of signal alarms at the trail termination sink due to upstream defects causing missing payload at the start of the trail.

PMI defect (dPMI) shall be declared at the trail termination sink function within X ms of detecting the missing payload condition causing the insertion of PMI into the OOS.

PMI defect (dPMI) shall be cleared at the trail termination sink function within Y ms of detecting that the missing payload condition, which caused the insertion of PMI into the OOS, has cleared.

X and Y are for further study. Values in the range of a few milliseconds are proposed, as PMI has to suppress the payload defect at the sink immediately.

During signal fail conditions of the overhead signal, dPMI shall be set to false. For details on the signal fail conditions, see the specific atomic functions.

NOTE – The defect PMI will not result in a fault cause. It is used to suppress LOS-P defects related consequent actions, defect correlations and performance monitoring data at the OTS and OMS trail termination sink in case of an already missing payload at the trail termination source (see 6.2.1.1 and 8.10).

6.2.6.8 Open Connection Indication defect (dOCI)

Open Connection Indication (OCI) defect (dOCI) is monitored at the OCh and ODUk layers. The purpose of monitoring this parameter is to qualify a downstream loss of signal defect by indicating that the loss of signal defect is due to an output connection point not connected to an input connection point.

6.2.6.8.1 dOCI at the OCh layer

OCI defect (dOCI) shall be declared at the OCh trail termination sink function within X ms of the OCh connection function having received the command via the MP to disconnect the output OCh_CP from an input OCh_CP.

OCI defect (dOCI) shall be cleared at the OCh trail termination sink function within Y ms of the OCh connection function detecting that the output OCh_CP, which the OCI corresponded to, is connected to an input OCh_CP.

X and Y are for further study.

During signal fail conditions of the overhead signal, dOCI shall be set to false. For details on the signal fail conditions, see the specific atomic functions.

6.2.6.8.2 dOCI at the ODUkP and ODUkT layer

dOCI shall be declared if the accepted STAT information (AcSTAT) is "110". dOCI shall be cleared if the accepted STAT information is not equal to "110". For the STAT information acceptance process, see 8.8.

During signal fail conditions of the data signal, dOCI shall be set to false. For details on the signal fail conditions, see the specific atomic functions.

6.2.6.9 Locked defect (dLCK)

6.2.6.9.1 dLCK at the ODUkP and ODUkT layer

dLCK shall be declared if the accepted STAT information (AcSTAT) is "101". dLCK shall be cleared if the accepted STAT information is not equal to "101". For the STAT information acceptance process, see 8.8.

During signal fail conditions of the data signal, dLCK shall be set to false. For details on the signal fail conditions, see the specific atomic functions.

6.2.6.10 Incoming Alignment Error defect (dIAE)

NOTE – The defect IAE will not result in a fault cause. It is used to suppress wrong PM data (EBC and DS) at the OTUk and ODUkT trail termination sink in case of an incoming frame slip to the trail (see 8.10).

6.2.6.10.1 dIAE at the OTUk layer

dIAE shall be declared if the IAE bit in the SM overhead field (byte 3, bit 6) is "1" for X consecutive frames. dIAE shall be cleared if the IAE bit in the SM overhead field is "0" for X consecutive frames. X shall be 5.

During signal fail conditions of the data signal, dIAE shall be set to false. For details on the signal fail conditions, see the specific atomic functions.

6.2.6.10.2 dIAE at the ODUkT layer

dIAE shall be declared if the accepted STAT information (AcSTAT) is "010". dIAE shall be cleared if the accepted STAT information is not equal to "010". For the STAT information acceptance process, see 8.8.

During signal fail conditions of the data signal, dIAE shall be set to false. For details on the signal fail conditions, see the specific atomic functions.

6.2.6.11 Backward Incoming Alignment Error defect (dBIAE)

NOTE – The defect BIAE will not result in a fault cause. It is used to suppress wrong far-end PM data (EBC and DS) at the OTUk and ODUkT trail termination sink in case of an incoming frame slip to the trail (see 8.10).

6.2.6.11.1 dBIAE at the OTUk and ODUkT layer

dBIAE shall be declared if the BEI/BIAE bits in the SM/TCM overhead field (byte 3, bits 1 to 4) are "1011" for X consecutive frames. dBIAE shall be cleared if the BEI/BIAE bits in the SM/TCM overhead field are not equal to "1011" for X consecutive frames. X shall be 3.

During signal fail conditions of the data signal, dBIAE shall be set to false. For details on the signal fail conditions, see the specific atomic functions.

6.2.7 Protocol supervision

6.2.7.1 Protection protocol supervision

6.2.7.1.1 ODU Linear protection Failure of Protocol Provisioning Mismatch (dFOP-PM)

ODUk dFOP-PM shall be declared when the B bit of the transmitted and accepted APS protocol do not match.

ODUk dFOP-PM shall be cleared when the B bit of the transmitted and accepted APS protocols do match.

For a description of the APS protocol, see ITU-T Rec. G.873.1.

6.2.7.1.2 ODU Linear protection Failure of Protocol No Response (dFOP-NR)

ODUk dFOP-NR shall be declared when the requested signal and the bridge signal in the APS protocol do not match within 1 s.

NOTE – The time after which a response on a bridge request is received depends on the transmission delay between the protection switching nodes (and the processing delay in the nodes).

ODUk dFOP-NR shall be cleared when the requested signal and the bridge signal in the APS protocol match.

For a description of the APS protocol, see ITU-T Rec. G.873.1.

6.2.8 OTM Overhead Signal (OOS) related defects

As the specific format of the OOS is outside the scope of ITU-T Rec. G.709/Y.1331, no specific defects except for dLOS-P (see 6.2.1.2) are defined in this Recommendation either. However, depending on the specific OOS format additional defect detection (e.g., loss of alignment) is required. These defects will contribute to the TSF-P, SSF-P, FDI-P and BDI-P consequent actions.

6.2.9 Multiplex Structure Identifier Mismatch supervision defect (dMSIM)

6.2.9.1 dMSIM at the ODUkP layer

If automatic configuration of the multiplex structure is supported and activated (AutoMS = true), dMSIM shall be declared if the accepted Multiplex Structure Identifier (AcMSI) has an invalid value that is not supported by the specific adaptation function (e.g., wrong tributary port, wrong ODU type). dMSIM shall be cleared if the AcMSI has a valid value.

If automatic configuration of the multiplex structure is not supported or not activated (AutoMS = false), dMSIM shall be declared if the AcMSI is not equal to the expected multiplex structure identifier (ExMSI). dMSIM shall be cleared if the AcMSI is equal to the ExMSI. ExMSI is either a fixed value or configured via the management interface. For details, see 14.3.7.2 (ODUkP/ODU[i]j_A_Sk function).

For the AcMSI acceptance process, see 8.7.2.

6.3 Consequent actions

For consequent actions, see ITU-T Rec. G.806 and the specific atomic functions.

6.4 Defect correlations

For the defect correlations, see the specific atomic functions.

6.5 Performance filters

6.5.1 One-second performance monitoring filters associated with counts

6.5.1.1 Errored Block Count (EBC)

The one-second performance monitoring filters pN_EBC and pF_EBC are defined in 6.5/G.806. For the application of these filters, see the specific atomic functions.

The OTN errored block definitions are given in Tables 6-2 and 6-3.

During signal fail conditions of the data signal, no errored blocks shall be counted. For details on the signal fail conditions, see the specific atomic functions.

Table 6-2/G.798 – OTN near-end errored blocks definition

Layer	Errored block definition	Number of blocks per second (Note 4)
OTUk (Notes 1 and 3)	One or more errors detected by the OTUk BIP8	OTU1: 20421 OTU2: 82026 OTU3: 329492
ODUkT/P (Notes 2 and 3)	One or more errors detected by the ODUkT/P BIP8	ODU1: 20421 ODU2: 82026 ODU3: 329492
NOTE 1 – The block size for OTUk, k = 1, 2, 3, is equal to the OTUk frame size, which is 4 × 4080 × 8 = 130 560 bits. NOTE 2 – The block size for ODUk, k = 1, 2, 3, is equal to the ODUk frame size, which is 4 × 3824 × 8 = 122 368 bits. NOTE 3 – The EDC is BIP8, and is computed over the OPUk payload (4 × 3808 × 8 bits) plus OPUk overhead (4 × 2 × 8 bits), for a total of 4 × 3810 × 8 = 121 920 bits. The EDC usage is 1 × BIP8. NOTE 4 – These values are rounded to the next larger integer value.		

Table 6-3/G.798 – OTN far-end errored blocks definition

Layer	Errored block definition	Number of blocks per second (Note)
OTUk	One or more errors indicated by BEI in the OTUk frame	ODU1: 20421 ODU2: 82026 ODU3: 329492
ODUkT/P	One or more errors indicated by BEI in the ODUkT/P frame	ODU1: 20421 ODU2: 82026 ODU3: 329492
NOTE – These values are rounded to the next larger integer value.		

6.5.1.2 Defect second (DS)

The one-second performance monitoring filters pN_DS and pF_DS are defined in 6.5/G.806. For the application of these filters, see the specific atomic functions.

6.5.1.3 FEC corrected errors (FECcorrErr)

The number of bits corrected by the FEC (see 8.5) are counted over one second and reported to the MI at the end of the second. For the application of this filter, see the specific atomic functions.

During signal fail conditions of the data signal, no corrected bits shall be counted. For details on the signal fail conditions, see the specific atomic functions.

6.5.2 Performance monitoring filters associated with gauges

For further study.

7 Information flow across reference points

See clause 7/G.806 for generic description of information flow. For OTN specific information flow see the description of the functions in clause 9.

8 Generic processes

Generic processes are defined in clause 8/G.806. This clause defines the specific process for the OTN.

8.1 Scrambling processes

Scrambling is required for the OTUk signal. The OTUk scrambler is defined in 11.2/G.709/Y.1331.

8.2 Alignment processes

8.2.1 OTUk frame alignment

The OTUk frame alignment shall be found by searching for the OA1, OA2 FAS bytes (see ITU-T Rec. G.709/Y.1331) contained in the OTUk frame.

The process has two states, out-of-frame (OOF) and in-frame (IF).

In the OOF state, the framing pattern searched for shall be a 4-byte subset of the OA1 and OA2 bytes. The IF shall be entered if this subset is found and confirmed one frame period later.

In the IF state, the frame signal shall be continuously checked with the presumed frame start position for correct alignment. The framing pattern checked for shall be the OA1OA2OA2 pattern (bytes 3, 4 and 5 of the first row of the OTUk frame). The OOF state shall be entered if this subset is not found at the correct position in 5 consecutive frames.

The frame start shall be maintained during the OOF state.

8.2.2 OTUk multiframe alignment

The OTUk multiframe alignment shall be found based on the MFAS byte (see ITU-T Rec. G.709/Y.1331) contained in the OTUk frame.

The process has two states, out-of-multiframe (OOM) and in-multiframe (IM).

In the IM state, OOM shall be assumed when the received MFAS does not match with the expected multiframe number in 5 consecutive OTUk frames.

In the OOM state, multiframe alignment shall be assumed to be recovered, the multiframe counter shall be set to the new MFAS, and the IM state shall be entered, when in two consecutive OTUk frames a valid MFAS sequence is found. The MFAS sequence is valid if the MFAS of the second frame is the increment of the MFAS of the first frame.

The multiframe start shall be maintained during the OOM state.

8.2.3 ODUj[/i] frame and multiframe alignment

The ODUj[/i] frame and multiframe alignment shall be found by searching for the framing pattern (OA1, OA2 FAS bytes) and checking the multiframe sequence (MFAS byte) (see ITU-T Rec. G.709/Y.1331) contained in the ODUj[/i] frame.

The process has two states, out-of-frame (OOF) and in-frame (IF).

In the OOF state, the framing pattern searched for shall be the full set of the OA1 and OA2 bytes. The IF state shall be entered if this set is found and confirmed one frame period later and an error free multiframe sequence is found in the MFAS bytes of the two frames.

In the IF state, the frame alignment signal shall be continuously checked with the presumed frame start position and the expected multiframe sequence. The framing pattern checked for shall be the OA1OA2 pattern (bytes 3 and 4 of the first row of the ODUj[/i] frame). The OOF state shall be entered if this subset is not found at the correct position in 5 consecutive frames or the received MFAS does not match with the expected multiframe number in 5 consecutive frames.

The frame and multiframe start shall be maintained during the OOF state.

8.2.4 ODUk virtual concatenation multiframe alignment

The ODUk virtual concatenation multiframe (VCMF) is used on top of the ODUk MFAS multiframe. It uses the MFI1 and MFI2 bytes of the VCOH overhead as defined in 18.1.2.2.2.1/G.709/Y.1331.

The process has two states, out-of-multiframe (OOM) and in-multiframe (IM).

In the IM state, OOM shall be assumed when the received VCMF number in the MFI1 and MFI2 bytes of the VCOH does not match with the expected multiframe number in 3 consecutive ODUk MFAS multiframes.

In the OOM state, multiframe alignment shall be assumed to be recovered, the multiframe counter shall be set to the received VCMF number, and the IM state shall be entered, when in two consecutive ODUk MFAS multiframes a valid VCMF sequence is found. The VCMF sequence is valid if the received VCMF number of the second MFAS multiframe is the increment of the received VCMF number of the first frame.

NOTE – The MFI1 and MFI2 bytes are transmitted eight times per MFAS multiframe containing the same VCMF number. For the VCMF alignment process only the first occurrence of the MFI1 and MFI2 bytes in the MFAS multiframe (MFAS multiframe number 0 and 1) shall be used.

The multiframe start shall be maintained during the OOM state.

8.3 Signal quality supervision

8.3.1 OTS signal quality supervision

For further study.

8.3.2 OMS signal quality supervision

For further study.

8.3.3 OCh signal quality supervision

For further study.

8.3.4 OTUk, ODUkT and ODUkP signal quality supervision

A BIP8 is used for each of these layers as defined in clause 15/G.709/Y.1331.

8.3.4.1 BIP8 source processing

The BIP8 shall be computed over the OPUk frame (columns 15 to 3824). The computed BIP8 is inserted in the BIP8 byte position of the relevant overhead field of the 2nd following frame as shown in Figure 8-1.

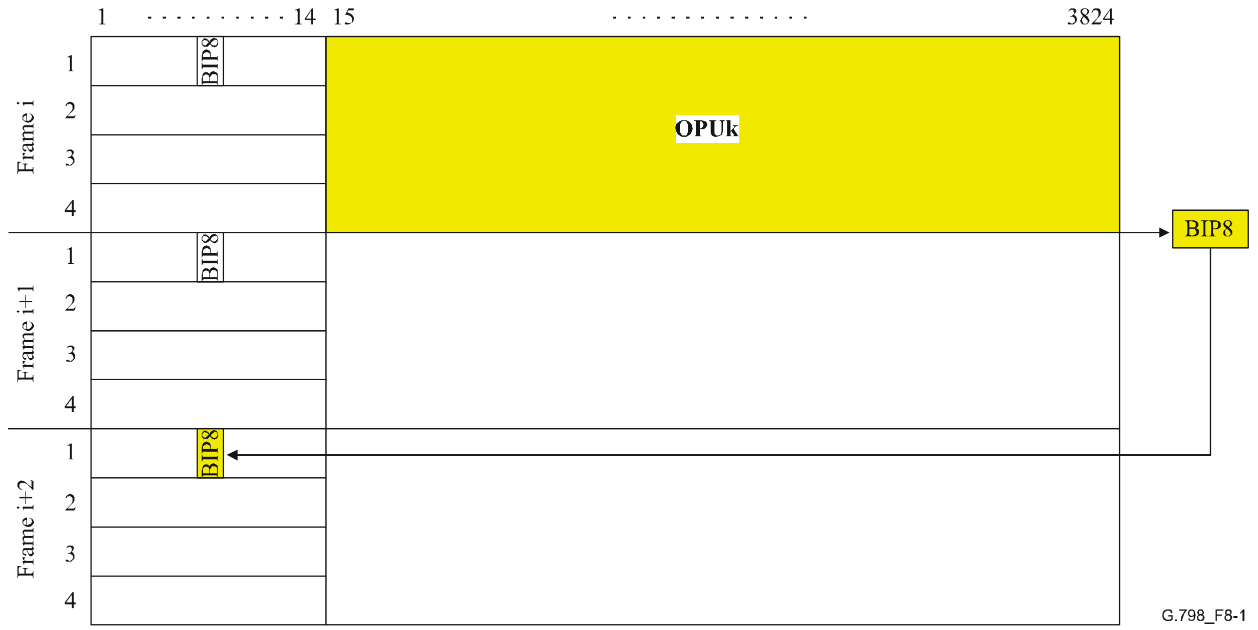


Figure 8-1/G.798 – BIP8 source processing (SMOH used as example)

8.3.4.2 BIP8 sink processing

The BIP8 is computed over the OPUk (columns 15 to 3824 of the frame). The BIP8 value generated by the TT_So shall be extracted from the BIP8 byte position of the relevant overhead field. The computed BIP8 value of the 2nd preceding frame is compared with the BIP8 value extracted from the current frame as shown in Figure 8-2. If there is a mismatch between the two values, a near-end errored block (nN_B) is detected and the number of BIP Violations (nBIPV) is forwarded to the companion TT_So function.

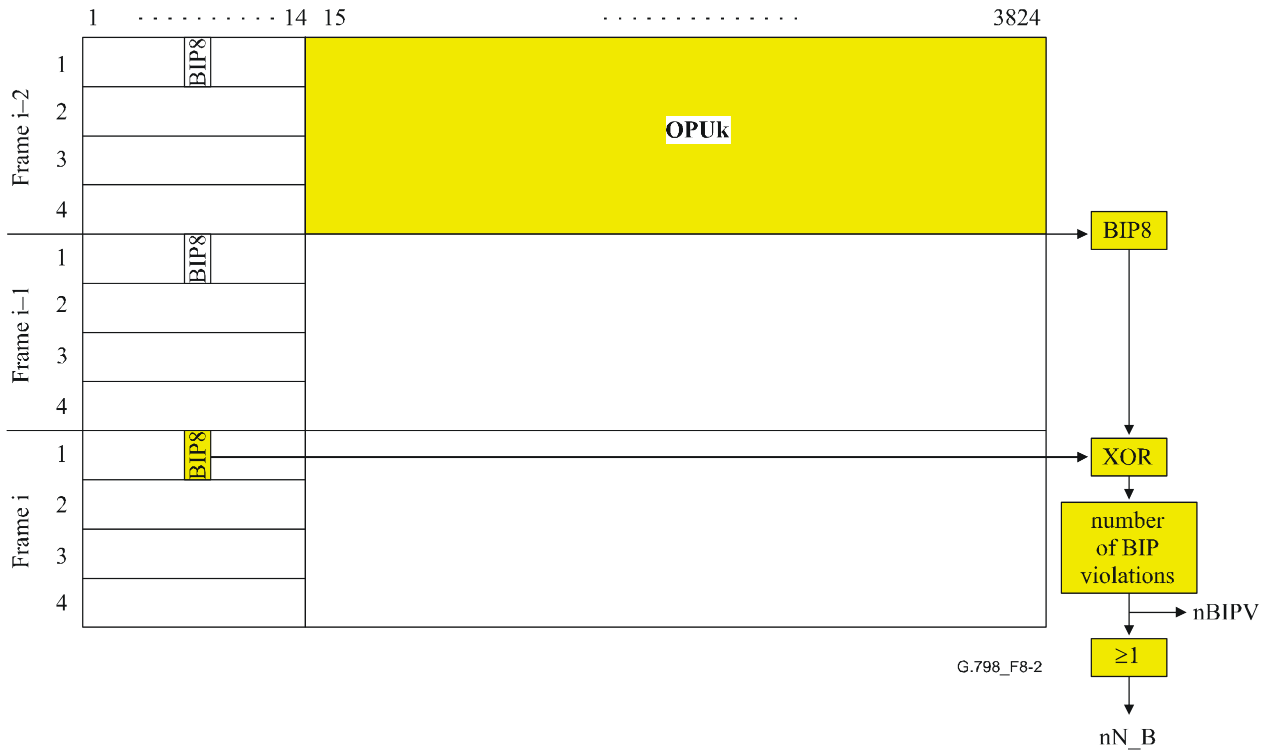


Figure 8-2/G.798 – BIP8 sink processing (SMOH used as example)

8.4 BIP correction

BIP correction is not required as the OTUk, ODUkT and ODUkP BIP8 is only calculated over the OPU and the relevant overhead is excluded. Modifications within the OTUk, ODUkT and ODUkP overhead have therefore no influence on the BIP8.

8.5 OTUk Forward Error Correction (FEC) processing

For the FEC algorithm see, Annex A/G.709/Y.1331.

The FEC decoder shall report the number of corrected bits (nFECcorrErr). For further processing, see 6.5.1.3.

8.6 Trail Trace Identifier (TTI) processing

On request via the management interface (MI_GetAcTI) the TTI shall be reported within 100 ms. It shall be an accepted TTI (AcTI) instead of the received TTI (RxTI). The acceptance process shall include a persistency check in order to avoid wrong/toggling TTI values during bit error conditions.

For the TIM defect detection process, see 6.2.2.1.

8.7 Payload Structure Indication (PSI) acceptance processes

8.7.1 Payload Type (PT) acceptance process

A new payload type PT (AcPT) is accepted if a new consistent value is received in the PSI[0] byte in X consecutive multiframes. X shall be 3.

8.7.2 Multiplex Structure Identifier (MSI) acceptance process

A new multiplex structure identifier MSI (AcMSI) is accepted if a new consistent value is received in the MSI bytes of the PSI overhead (PSI[2..5] for ODU2, PSI[2..17] for ODU3) in X consecutive multiframes. X shall be 3.

8.7.3 Virtual Concatenation Payload Type (vcPT) acceptance process

The virtual concatenation payload type (vcPT) is always extracted from the first OPUk of the virtual concatenated OPUk-Xv. The vcPT information in the other OPUks is ignored.

A new vcPT (AcVcPT) is accepted if a new consistent value is received in the PSI[1] byte in X consecutive multiframes. X shall be 3.

8.8 Status information (STAT) acceptance process

A new STAT value (AcSTAT) is accepted if a new consistent value is received in the PM/TCM overhead, byte 3, bits 6 to 8 in X consecutive frames. X shall be 3.

8.9 Generic AIS generation and detection

Generic AIS including OTUk AIS is a PN-11 pseudo-random pattern as defined in ITU-T Rec. G.709/Y.1331. The pattern is generated by a pseudo-random generator. For the detection of Generic AIS, the reverse process as shown in Figure 8-3 is used. As the flip-flops of the detector circuit are feed with the same data as the flip-flops of the generator circuit, data at point D1 is the same as data at G1 with a delay of 11 clock cycles. As the G1 data appears at the output of the generator (G_{out}) and as such also at the input of the detector (D_{in}) with a delay of 11 clock cycles, D1 and D_{in} data is the same for each clock cycle. A PN-11 Generic AIS pattern at the input of the detector (D_{in}) should therefore result in an all ZEROs pattern at point D2. The only other input pattern that will result in an all ZEROs pattern at D2 is an all ZEROs input pattern.

The detection of an all ZEROs pattern at D2 and a non-all ZEROs pattern at D_{in} is a criteria for the Generic AIS defect. For the specific detection process, see 6.2.6.3.3.

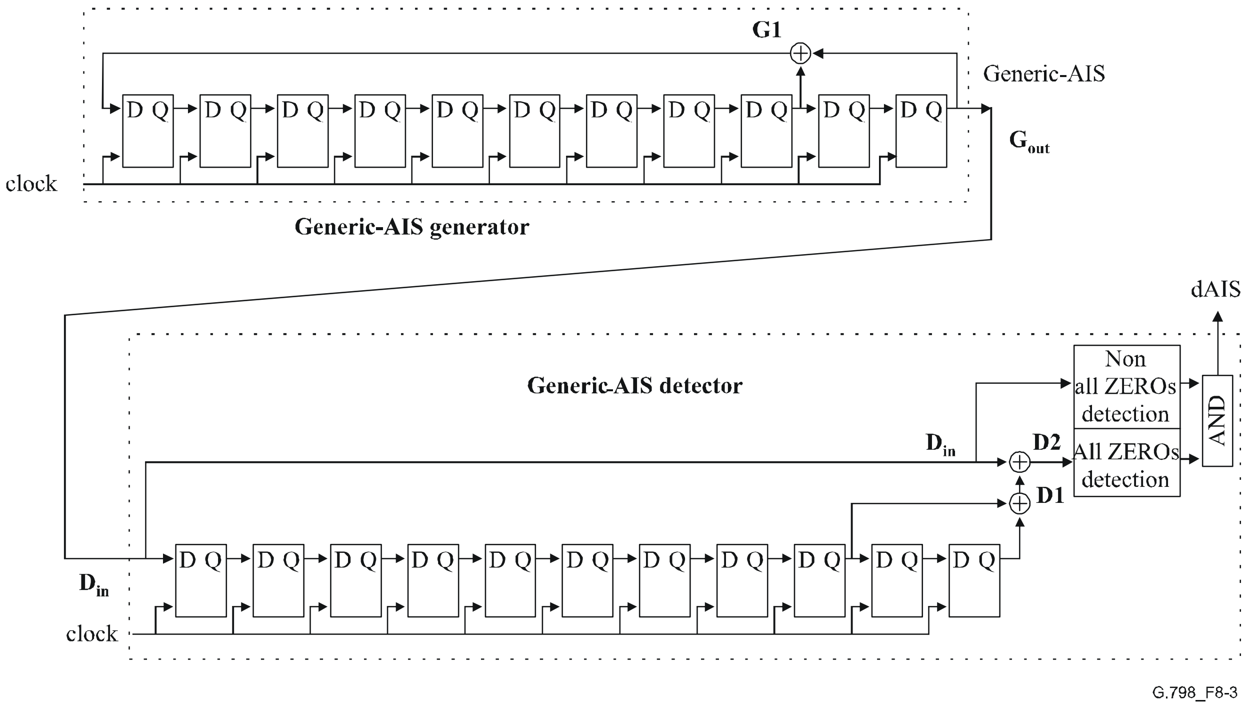


Figure 8-3/G.798 – Generic AIS generation and detection

8.10 Generic layer fault processing

Layer fault processing is concerned with the detection of failures within a layer network, the generation of consequent actions (for suppression of unwanted downstream alarms and remote information for upstream single ended maintenance) and the report of probable fault causes to the management system.

Figure 8-4 illustrates in general the atomic functions connection, trail termination and adaptation of a layer which perform their specific fault processing tasks. The connection function, if present, can interconnect the adaptation and trail termination functions according to the signal flow shown. Note that not all features are supported by all layers. For the specific fault processing, see the layer specific functions.

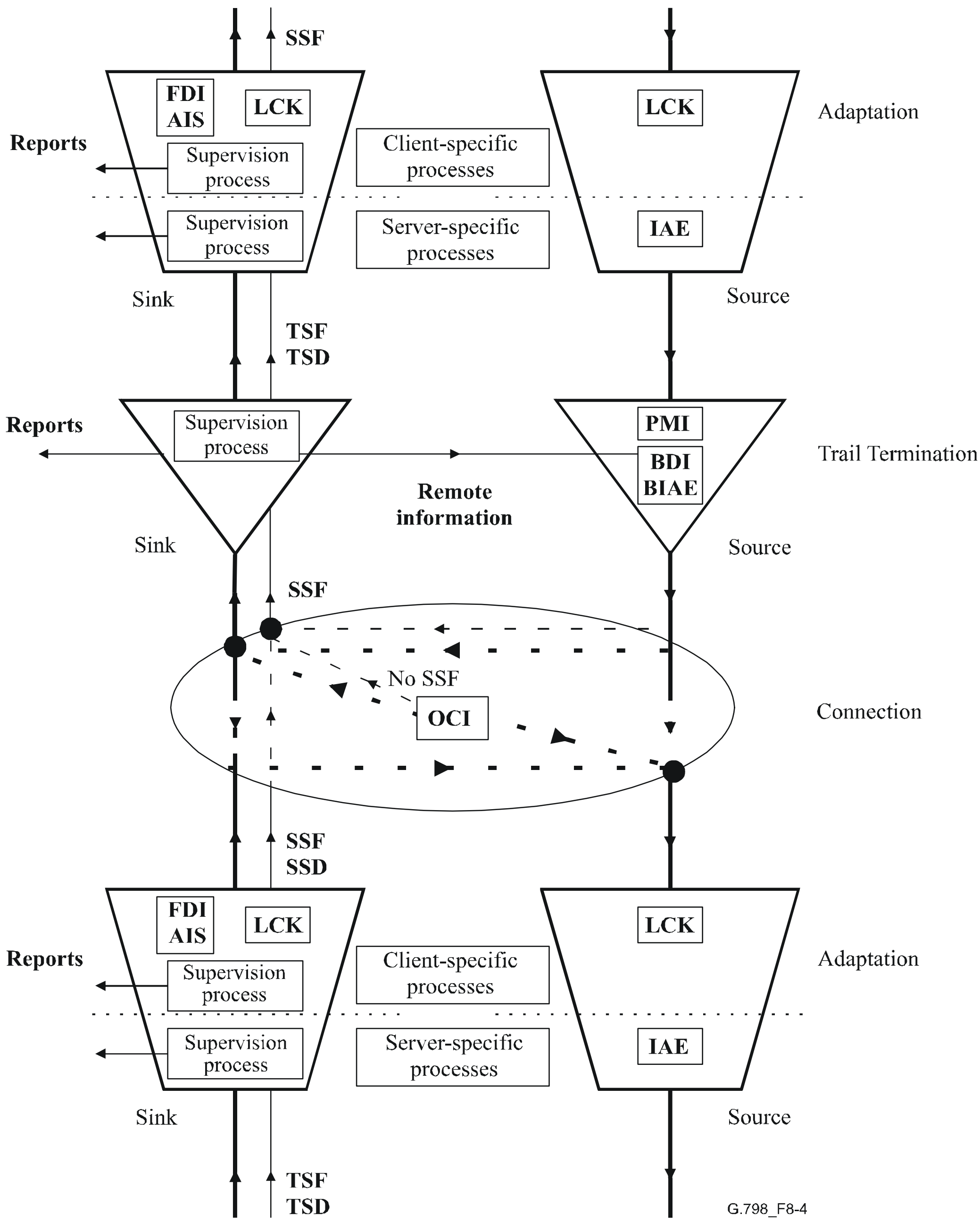


Figure 8-4/G.798 – Generic layer fault processing

In the sink direction, every layer receives a server signal fail indication (SSF) from its server layer, performs supervision of parameters pertaining to the layer, and generates a server signal fail indication to its client layer. Reports of probable fault causes are made to the management system. The signal fail state of the layer is forwarded/indicated via a forward defect indication (FDI) or an alarm indication signal (AIS). AIS is used as the term when the signal is in the digital domain (ODU and OTU layer). FDI is used as the term when the signal is in the optical domain; FDI is transported as non-associated overhead in the OOS.

The LCK maintenance signal is generated on operator request in order to lock the signal from user access while the operator is for example performing set-up tests. In this case, the client signal is replaced by fixed data indicated as locked (LCK). It can be generated by the server layer adaptation sink and source functions.

An open connection of a connection function generates the OCI maintenance signal in conjunction with a no SSF indication.

The trail termination source function of the OTS and OMS layer monitors the optical payload signal to determine when the incoming signal is absent. Upon detecting that the incoming payload signal is absent (see Figure 8-5), the function inserts the payload missing indication (PMI) into the OOS. At the trail termination sink, it is used to suppress the loss of payload signal defect related actions (consequent actions, fault cause, PM data).

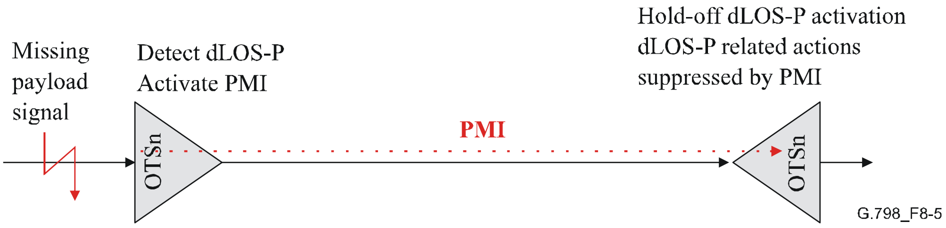


Figure 8-5/G.798 – PMI processing

NOTE 1 – A hold-off time has to be used at the trail termination sink functions for the activation of the payload missing indication. The hold-off time has to cover the propagation, processing and detection delay of the PMI signal between the source and sink.

In digital layers (ODUk, OTUk) the maintenance signals (AIS, LCK, and OCI) provide a replacement of the layer characteristic information except some OH as defined in ITU-T Rec. G.709/Y.1331. As for the optical layers (OCh, OMS, OTS) it is too expensive to generate a replacement for the optical payload, the maintenance signals FDI and OCI consist only of overhead transported as non-associated overhead in the OOS.

The trail termination sink function detects trail specific defects (continuity, connectivity and maintenance signals). It correlates the defects and incoming SSF in order to determine the probable cause in failure reports. It activates trail signal fail (TSF) and trail signal degraded (TSD) indication towards the layer adaptation sink function on these defects and triggers the insertion of backward defect indications (BDI) at the trail termination source of upstream direction. Similarly, the adaptation sink function combines the result of its measurements with the TSF indication to generate the SSF indication, forwards TSD as SSD and presents appropriate failure reports to the layer manager. These processes aim to present only probable causes pertaining to maintenance actions required at that layer, i.e., to perform suitable alarm suppression.

The adaptation function is split into server (common) and client-specific supervision processes. The common supervision applies to the compound signal and checks for the correct payload structure on ODUkP. The client-specific supervision performs alignment supervision. Note that several client signals may be transported by the same server signal.

The adaptation source function of the OTU layer and ODU TCM sublayers generates an incoming alignment error (IAE), if it detects a frame slip (see Figure 8-6). At the trail termination sink function, the IAE information is detected and is used to suppress near-end and far-end performance monitoring data (DS and EBC) and DEG defect data. Furthermore, the co-located trail termination source will insert in upstream the BIAE in order to suppress the far-end performance monitoring data (DS and EBC) at the remote end.

NOTE 2 – Suppression of the performance monitoring data is performed in the equipment management function.

Within the OTS, OMS and OCh layers the data (optical payload) and overhead streams are processed independently. This independence results in the need for separate SSF, TSF, FDI and BDI signals for each such stream.

NOTE 3 – If a SSF input is not connected to any output, it is considered as a no SSF.

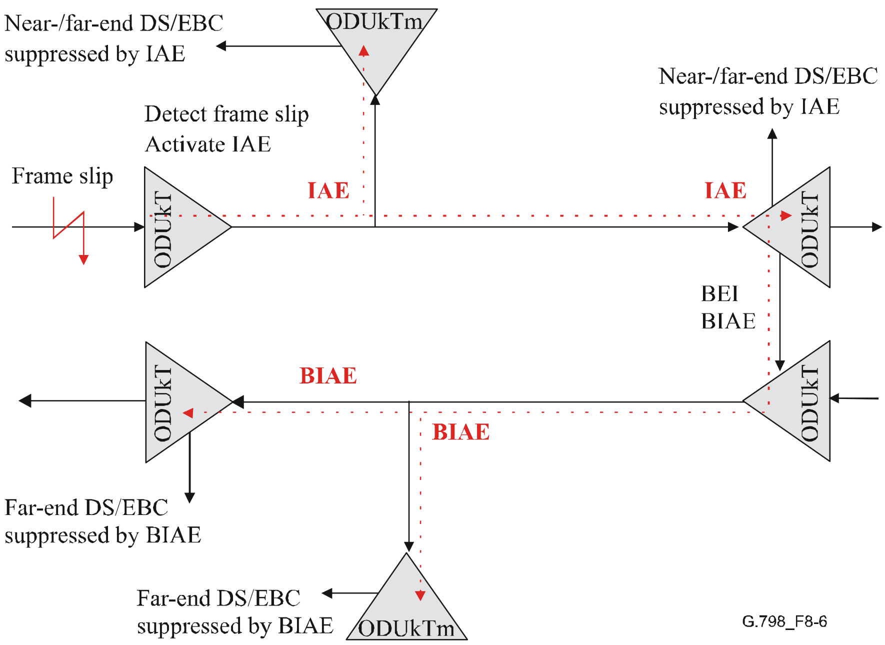


Figure 8-6/G.798 – IAE processing

8.11 Optical signal processing

This clause defines generic processes for the processing of the optical signal. These processes refer to the generation and termination of optical signals, wavelength division multiplexing, pre-conditioning of the optical signal before transmission over an optical media (e.g., fibre) and post-conditioning of the optical signal after transmission over an optical media. Some of these processes are mandatory for certain atomic functions while others depend on the specific optical interface. With the advance of optical technology, additional processes might be introduced.

8.11.1 Optical modulation and wavelength multiplexing processes

The processes listed below are mandatory when they are listed in atomic functions. Specific parameters of these processes depend on the interface type. Refer to ITU-T Rec. G.959.1 for the currently standardized OTN interfaces.

Mod (Optical Carrier Modulation): This process performs modulation of an optical carrier with the payload signal (PLD) by means of a defined modulation scheme. The modulation scheme and optical parameters (e.g., operating wavelength) depend on the specific interface type. This process is used for the generation of a non-coloured optical signal.

Mod/WA (Optical Carrier Modulation and Wavelength Assignment): This process performs modulation of an optical carrier of a specific wavelength with the payload (PLD) signal by means of a defined modulation scheme. The modulation scheme and optical parameters for the individual channels (e.g., central frequency) depend on the specific interface type. This process is used for the generation of a coloured optical signal.

DMod (Optical Carrier Demodulation): This process demodulates the payload signal (PLD) from the Optical Carrier. The modulation scheme depends on the specific interface type. This process is used for the termination of coloured and non-coloured optical signal.

OM (Optical Multiplexing): This process performs optical channel multiplexing to form an optical multiplex signal.

ODM/WS (Optical Demultiplexing and Wavelength Selection): This process performs the optical channel demultiplexing and provides access to the individual wavelength signals. The physical parameters (e.g., channel spacing) depend on the specific interface type.

8.11.2 Optical signal pre- and post-conditioning processes

The processes defined below are optional when they are listed in atomic functions. Their use and specific parameters depend on the interface type. Refer to ITU-T Rec. G.959.1 for the currently standardized OTN interfaces.

OA (Optical Amplification): This process performs optical amplification of the signal. It can be performed on multi- and single wavelength signals. It can be used as pre- and post-conditioning process.

DAc (Channel Dispersion Accommodation): This process performs the active chromatic fibre dispersion accommodation of a single wavelength signal. It can be used as pre- and post-conditioning process.

DAa (Amplifier-aided Dispersion Accommodation): This process performs the passive chromatic fibre dispersion accommodation multi- or single wavelength signals. It can be used as pre- and post-conditioning process.

DAa and DAc processes are independent and can be operated together.

PMDC (Polarization Mode Dispersion Compensation): This process performs the polarization mode dispersion compensation of multi- or single wavelength signals. Details are for further study.

9 Optical Transmission Section (OTS) layer functions

Figure 9-1 illustrates the OTS layer network and client layer adaptation functions. The information crossing the OTSn termination connection point (OTSn_TCP) is referred to as the OTSn characteristic information (OTSn_CI). The information crossing the OTSn access point (OTSn_AP) is referred to as the OTSn adapted information (OTSn_AI).

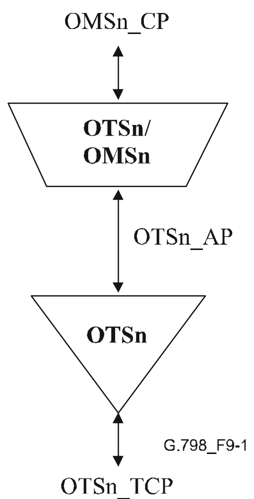


Figure 9-1/G.798 – OTS layer network and client layer adaptation functions

The OTSn Characteristic Information (OTSn_CI) is a physical optical signal consisting of the n multiplexed traffic wavelengths and the Optical Supervisory Channel (OSC). The physical characteristics of the OTSn_CI signal are outside the scope of this Recommendation. The OSC wavelength transports the OTM Overhead Signal (OOS), which is a logical signal that contains the OTS, OMS, and OCh overhead logical information elements. The OOS may also contain general management communications. Figure 9-2 illustrates the overhead information elements that shall be supported by the OOS across the OTSn_CP.

The specific OOS format is outside the scope of this Recommendation. In addition, vendor specific overhead might be supported via the OOS. This is outside the scope of this Recommendation.

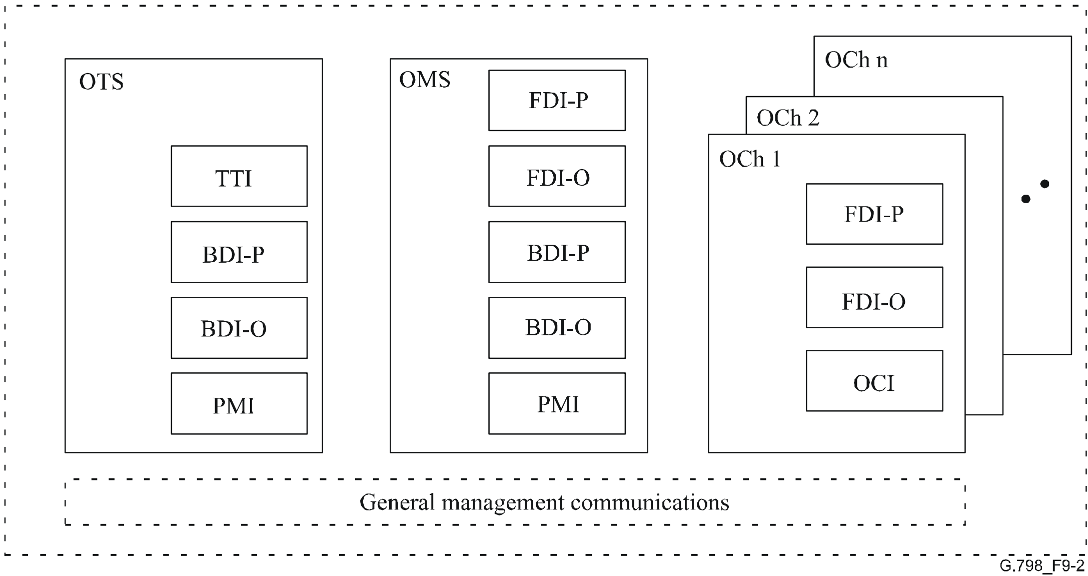


Figure 9-2/G.798 – OOS information elements at OTSn_TCP

The OTSn Adapted Information (OTSn_AI) consists of the OTSn adapted information payload (OTSn_AI_PLD), which is the multiplexed traffic wavelengths, and OTSn adapted information overhead (OTSn_AI_OH), which is the OMS, and OCh overhead information supported across the OTSn_AP. The OOS may also contain general management communications. Figure 9-3 illustrates the overhead information elements that shall be supported by the OOS across the OTSn_AP.

The specific OOS format is outside the scope of this Recommendation. In addition vendor specific overhead might be supported via the OOS. This is outside the scope of this Recommendation.

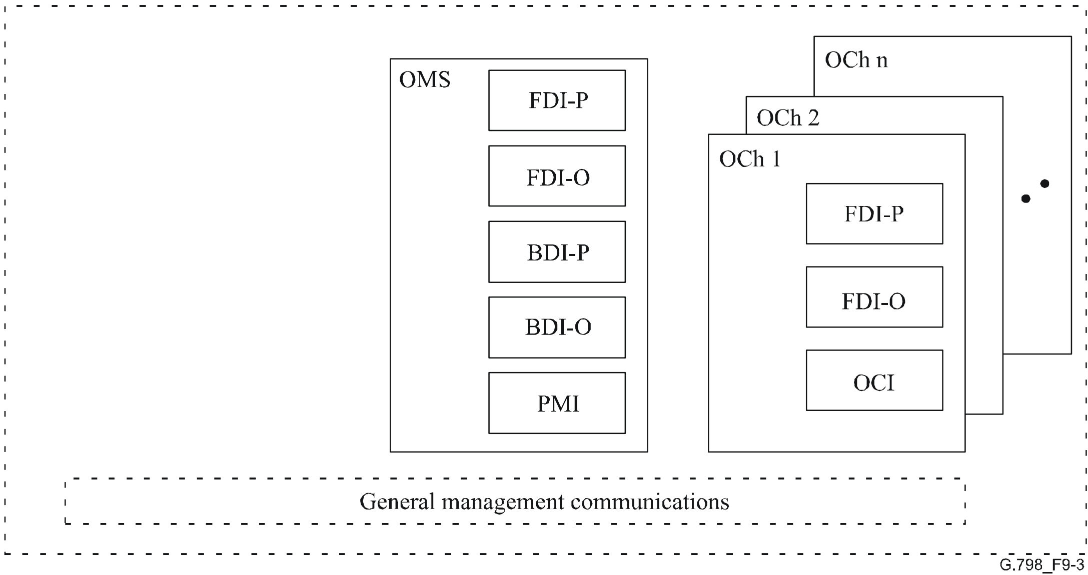


Figure 9-3/G.798 – OOS information elements at OTSn_AP

9.1 Connection functions (N/A)

Not applicable.

9.2 Termination functions

9.2.1 OTS Trail Termination function (OTSn_TT)

The OTSn_TT functions are responsible for the end-to-end supervision of the OTSn trail. Figure 9-4 shows the combination of the unidirectional sink and source functions to form a bidirectional function.

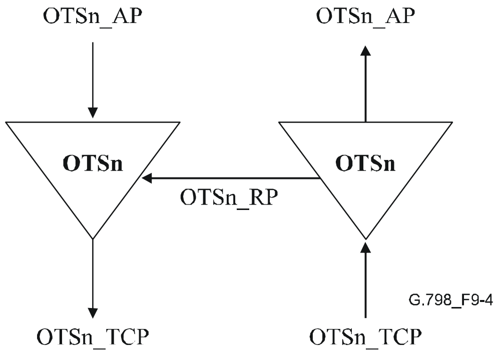


Figure 9-4/G.798 – OTSn_TT

9.2.1.1 OTS trail termination source function (OTSn_TT_So)

The OTSn_TT_So function adds OTS layer overhead into the OTM Overhead Signal (OOS) – including OTS TTI, PMI and BDI-P/O. The OTSn_TT_So function also maps the logical OOS into the OSC, and combines the OSC and the OTS payload signal to form the OTSn Characteristic Information (OTSn_CI).

The information flow and processing of the OTSn_TT_So functions is defined with reference to Figures 9-5 and 9-6.

Symbol

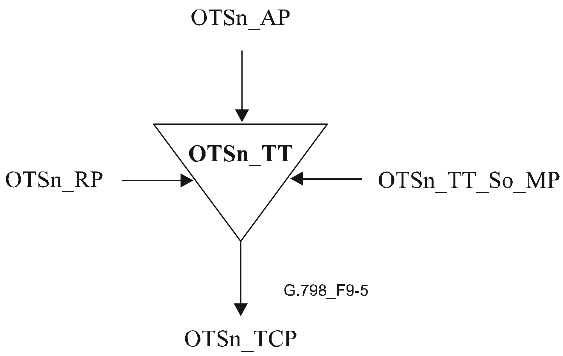


Figure 9-5/G.798 – OTSn_TT_So function

Interfaces

Table 9-1/G.798 – OTSn_TT_So inputs and outputs

Input(s)	Output(s)
OTSn_AP: OTSn_AI_PLD OTSn_AI_OH **OTSn_RP**: OTSn_RI_BDI-P OTSn_RI_BDI-O OTSn_RI_APR (Note 1) **OTSn_TT_So_MP**: OTSn_TT_So_MI_TxTI OTSn_TT_So_MI_APRCntrl (Notes 1 and 2)	**OTSn_TCP**: OTSn_CI
NOTE 1 – If APR is required. NOTE 2 – The APRCntrl commands depend on the specific APR process.	

Processes

The processes associated with the OTSn_TT_So function are as depicted in Figure 9-6.

TTI: The trail trace identifier information (OTS-TTI) is inserted into the OTS overhead of the OOS. Its value is derived from reference point OTSn_TT_So_MP. The trail trace format is described in 15.2/G.709/Y.1331. The specific TTI information structure within the OOS is outside the scope of this Recommendation.

BDI-P: The BDI-P information (OTS-BDI-P) is inserted into the OTS overhead of the OOS. Its value is derived from reference point OTSn_RP. Upon the declaration/clearing of aBDI-P at the termination sink function, the trail termination source function shall have inserted/removed the BDI-P indication within 50 ms. The specific BDI-P information structure within the OOS is outside the scope of this Recommendation.

BDI-O: The BDI-O information (OTS-BDI-O) is inserted into the OTS overhead of the OOS. Its value is derived from reference point OTSn_RP. Upon the declaration/clearing of aBDI-O at the termination sink function the trail termination source function shall have inserted/removed the BDI-O indication within 50 ms. The specific BDI-O information structure within the OOS is outside the scope of this Recommendation.

OSC and PLD: The OTSn_TT_So function maps the logical OOS into the OSC information structure, and combines the OSC with the OTS payload signal to form the OTSn Characteristic Information (OTSn_CI). The specific OSC implementation is outside the scope of this Recommendation.

PMI: The PMI information is inserted into the OTS overhead of the OOS. Upon the declaration/clearing of aPMI, the function shall have inserted/removed the PMI indication. The specific PMI information structure within the OOS is outside the scope of this Recommendation.

Automatic Power Reduction (APR): For eye safety considerations, according to IEC 60825-1 and IEC 60825-2, it may be necessary to provide for a capability for Automatic (optical) Power Reduction (APR) in case of loss of the optical input signal at the sink function. The OTSn_TT_So performs in this case the power reduction for the outgoing OTM-n signal based on the trigger criteria from the sink (RI_APR) and control information (MI_APRCntrl). The specific APR procedures and trigger criteria are outside the scope of this Recommendation. Clause 6.2/G.664 provides basic requirements for APR.

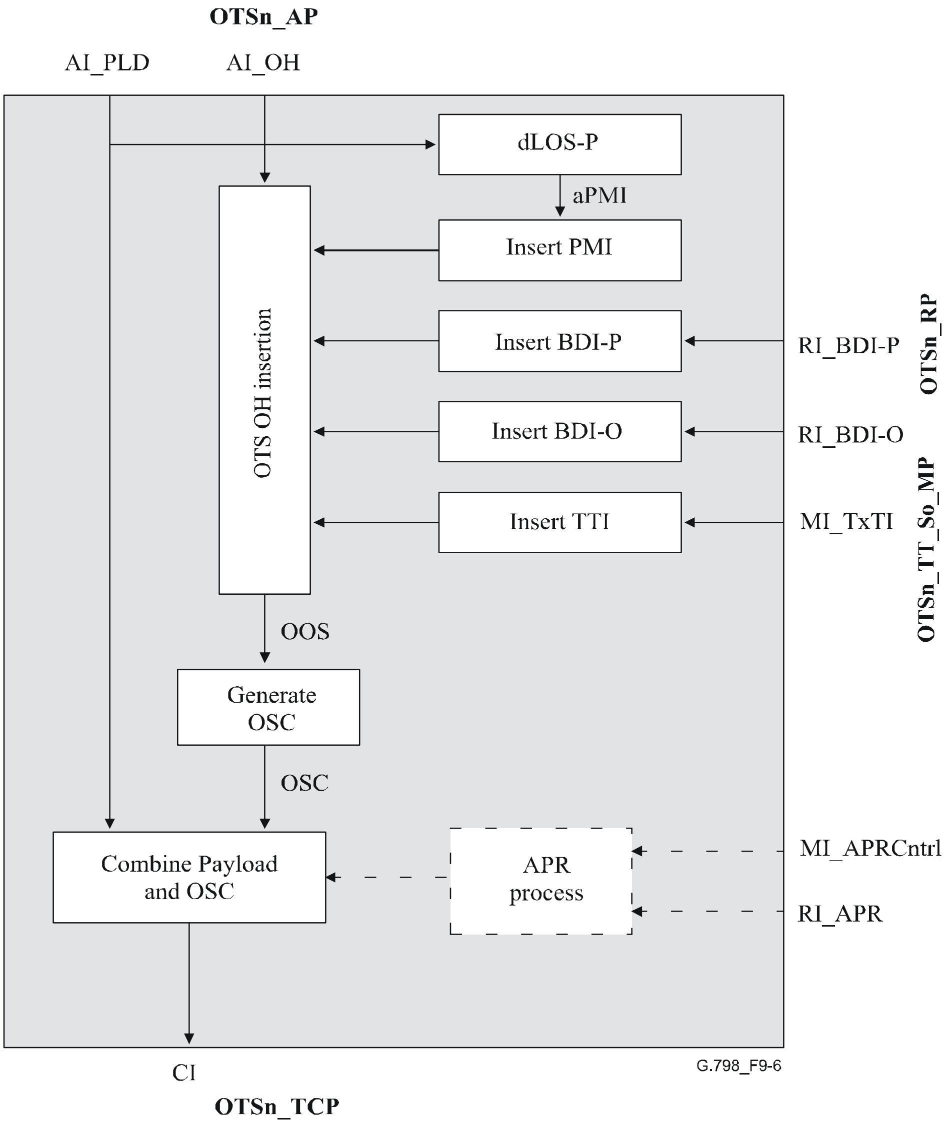


Figure 9-6/G.798 – OTSn_TT_So processes

Defects

dLOS-P: See 6.2.1.1.

Consequent actions

aPMI ← dLOS-P

Defect correlations: None.

NOTE – dLOS-P is not reported as fault cause, as it is not a failure condition of the trail itself. It is an incoming failure condition to the trail. It is used to generate PMI to the trail termination sink function (see 8.10).

Performance monitoring: None.

9.2.1.2 OTS trail termination sink function (OTSn_TT_Sk)

The OTSn_TT_Sk reports the state of the OTSn trail. The OTSn_TT_Sk function filters out the OSC from the incoming optical signal on the OTM-n.m interface and recovers the OOS from the OSC. It extracts OTSn monitoring overhead – including TTI, BDI and PMI. It detects dLOS-P, dLOS-O, dTIM, dPMI, dBDI-P and dBDI-O defects, counts during 1-second periods defects to feed performance monitoring when connected, makes the TTI available to network management and forwards the defect information as backward defect indications to the companion OTSn_TT_So function.

The information flow and processing of the OTSn_TT_Sk function is defined with reference to Figures 9-7 and 9-8.

Symbol

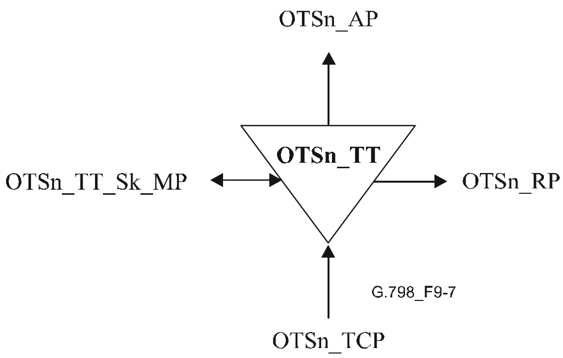


Figure 9-7/G.798 – OTSn_TT_Sk function

Interfaces

Table 9-2/G.798 – OTSn_TT_Sk inputs and outputs

Input(s)	Output(s)
OTSn_TCP: OTSn_CI **OTSn_TT_Sk_MP**: OTSn_TT_Sk_MI_ExSAPI OTSn_TT_Sk_MI_ExDAPI OTSn_TT_Sk_MI_GetAcTI OTSn_TT_Sk_MI_TIMDetMo OTSn_TT_Sk_MI_TIMActDis OTSn_TT_Sk_MI_1second	**OTSn_AP**: OTSn_AI_PLD OTSn_AI_OH OTSn_AI_TSF-P OTSn_AI_TSF-O **OTSn_RP**: OTSn_RI_BDI-P OTSn_RI_BDI-O OTSn_RI_APR (Note) **OTSn_TT_Sk_MP**: OTSn_TT_Sk_MI_AcTI OTSn_TT_Sk_MI_cTIM OTSn_TT_Sk_MI_cBDI OTSn_TT_Sk_MI_cBDI-P OTSn_TT_Sk_MI_cBDI-O OTSn_TT_Sk_MI_cLOS-P OTSn_TT_Sk_MI_cLOS-O OTSn_TT_Sk_MI_cLOS OTSn_TT_Sk_MI_pN_DS-P OTSn_TT_Sk_MI_pN_DS-O OTSn_TT_Sk_MI_pF_DS-P OTSn_TT_Sk_MI_pF_DS-O
NOTE – If APR is required.	

Processes

The processes associated with the OTSn_TT_So function are as depicted in Figure 9-8.

OSC and PLD: The OTSn_TT_Sk function separates the OSC and the OTS payload signal which form the OTSn Characteristic Information (OTSn_CI). The logical OOS is extracted from the OSC information structure. The specific OSC implementation is outside the scope of this Recommendation.

TTI: The trail trace identifier information (OTS-TTI) shall be recovered from the OTS overhead of the OOS and processed as specified in 8.6. The accepted value of the TTI is available at the MP. The trail trace format is described in 15.2/G.709/Y.1331. The specific TTI information structure within the OOS is outside the scope of this Recommendation.

BDI-P: The BDI-P information (OTS-BDI-P) shall be extracted from the OTS overhead of the OOS. It shall be used for BDI-P defect detection. The specific implementation for extracting BDI-P from the OOS and detecting its value is outside the scope of this Recommendation.

BDI-O: The BDI-O information (OTS-BDI-O) shall be extracted from the OTS overhead of the OOS. It shall be used for BDI-O defect detection. The specific implementation for extracting BDI-O from the OOS and detecting its value is outside the scope of this Recommendation.

PMI: The PMI information (OTS-PMI) shall be extracted from the OTS overhead of the OOS. It shall be used for PMI defect detection. The specific implementation for extracting PMI from the OOS and detecting its value is outside the scope of this Recommendation.

Signal quality supervision: For further study.

Automatic Power Reduction (APR): For eye safety considerations, according to IEC 60825-1 and IEC 60825-2, it may be necessary to provide for a capability for Automatic (optical) Power Reduction (APR) in case of loss of the optical input signal at the sink function. The OTSn_TT_Sk generates in this case the APR trigger criteria based on the incoming OTM-n signal (OTSn_CI) and forwards it to the OTSn_TT_So (RI_APR). The specific APR procedures and trigger criteria are outside the scope of this Recommendation. Clause 6.2/G.664 provides basic requirements for APR.

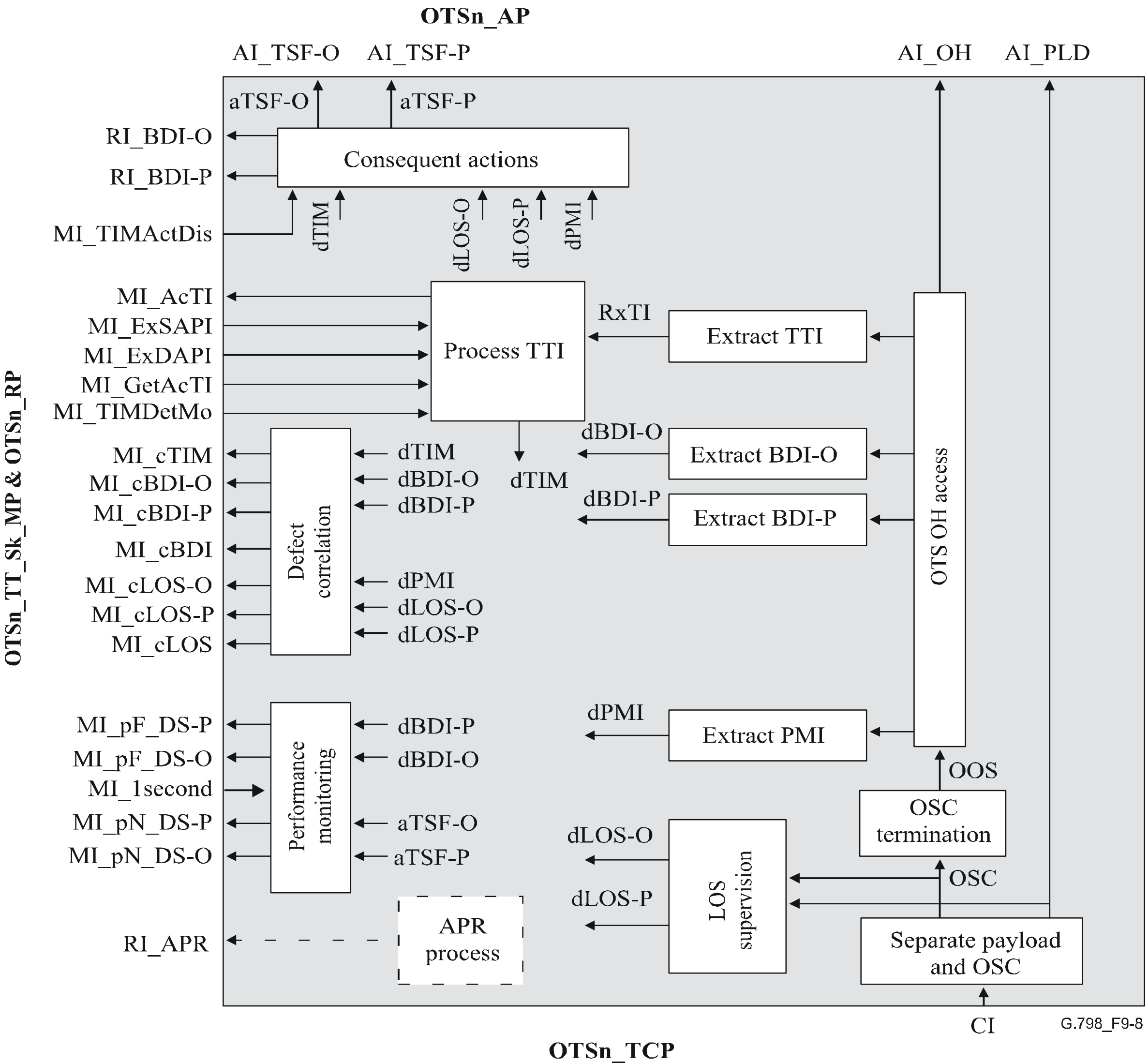


Figure 9-8/G.798 – OTSn_TT_Sk processes

Defects

The OTSn_TT_Sk function shall detect for dLOS-P, dLOS-O, dTIM, dBDI-P, dBDI-O and dPMI defects.

NOTE 1 – Detection of additional OOS related defects might be required (see 6.2.8). This depends on the specific OOS format and is outside the scope of this Recommendation.

dLOS-P: See 6.2.1.1.

NOTE 2 – A hold-off time has to be used for the activation of LOS-P. The hold-off time has to cover the propagation, processing and detection delay of the PMI signal between the source and sink.

dLOS-O: See 6.2.1.2.

dTIM: See 6.2.2.1; dTIM shall be set to false during dLOS-O.

dBDI-P: See 6.2.6.4.1; dBDI-P shall be set to false during dLOS-O.

dBDI-O: See 6.2.6.5.1; dBDI-O shall be set to false during dLOS-O.

dPMI: See 6.2.6.7.1; dPMI shall be set to false during dLOS-O.

NOTE 3 – Other additional OOS related defects will also set the above defects to false (dTIM, dBDI-P, dBDI-O, dPMI). This depends on the specific defects (e.g., loss of alignment).

Consequent actions

The OTSn_TT_Sk function shall perform the following consequent actions.

aTSF-P ← (dLOS-P and (not dPMI)) or (dTIM and (not TIMActDis))

aTSF-O ← dLOS-O or (dTIM and (not TIMActDis))

aBDI-P ← (dLOS-P and (not dPMI)) or dTIM

aBDI-O ← dLOS-O or dTIM

Defect correlations

The OTSn_TT_Sk function shall perform the following defect correlations.

cBDI ← dBDI-P and dBDI-P and (not dLOS-O) and (not dTIM)

cBDI-P ← dBDI-P and (not dLOS-O) and (not (dTIM and (not TIMActDis))) and (not dBDI-O)

cBDI-O ← dBDI-O and (not dLOS-O) and (not (dTIM and (not TIMActDis))) and (not dBDI-P)

cTIM ← dTIM and (not dLOS-O)

cLOS-P ← dLOS-P and (not dPMI) and (not cLOS)

cLOS-O ← dLOS-O and (not cLOS)

cLOS ← (dLOS-P and (not dPMI)) and dLOS-O

Performance monitoring

The OTSn_TT_Sk function shall perform the following performance monitoring primitives. The performance monitoring primitives shall be reported to the EMF.

pN_DS-P ← (dLOS-P and (not dPMI)) or dTIM

pN_DS-O ← dLOS-O or dTIM

pF_DS-P ← dBDI-P

pF_DS-O ← dBDI-O

NOTE 4 – Performance monitoring primitives based on signal quality monitoring are for further study. Specific implementations are outside the scope of this Recommendation.

9.3 Adaptation functions

The OTS is server for the following clients:

– Optical multiplex section (OMS);

– General Management Communications (COMMS).

9.3.1 OTS to OMS adaptation function (OTSn/OMSn_A)

The OTS to OMS adaptation functions performs the adaptation between the OTS layer adapted information and the OMS layer characteristic information.

9.3.1.1 OTS to OMS adaptation source function (OTSn/OMSn_A_So)

The information flow and processing of the OTSn/OMSn_A_So function is defined with reference to Figures 9-9 and 9-10. The OTSn/OMSn_A_So function monitors the OMSn_CI_PLD signal received at its OMSn_CP for missing payload.

Symbol

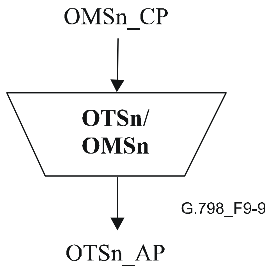


Figure 9-9/G.798 – OTSn/OMSn_A_So function

Interfaces

Table 9-3/G.798 – OTSn/OMSn_A_So inputs and outputs

Input(s)	Output(s)
OMSn_CP: OMSn_CI_PLD OMSn_CI_OH	**OTSn_AP**: OTSn_AI_PLD OTSn_AI_OH

Processes

The processes associated with the OTSn/OMSn_A_So function are as depicted in Figure 9-10.

Optical signal pre-conditioning: Pre-conditioning of the optical signal might be required. The specific conditioning processes depend on the OTM-n interface type and are outside the scope of this Recommendation. The processes OA and DAa as defined in 8.11.2 are possible.

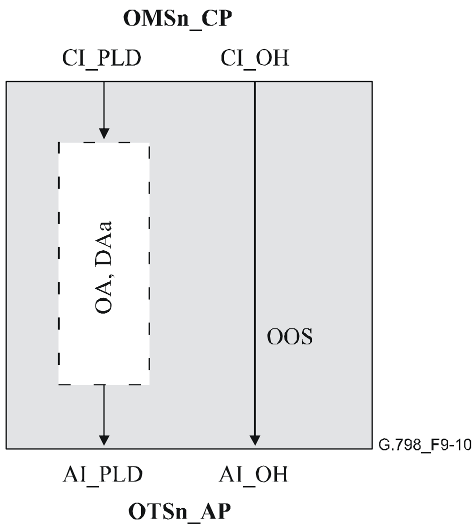


Figure 9-10/G.798 – OTSn/OMSn_A_So processes

Defects: None.

Consequent actions: None.

Defect correlations: None.

Performance monitoring: None.

9.3.1.2 OTS to OMS adaptation sink function (OTSn/OMSn_A_Sk)

The information flow and processing of the OTSn/OMSn_A_Sk function is defined with reference to Figures 9-11 and 9-12.

Symbol

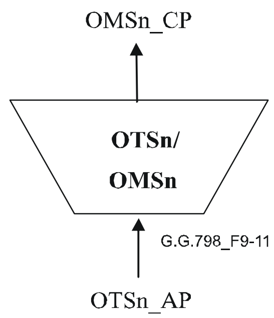


Figure 9-11/G.798 – OTSn/OMSn_A_Sk function

Interfaces

Table 9-4/G.798 – OTSn/OMSn_A_Sk inputs and outputs

Input(s)	Output(s)
OTSn_AP: OTSn_AI_PLD OTSn_AI_OH OTSn_AI_TSF-P OTSn_AI_TSF-O	**OMSn_CP**: OMSn_CI_PLD OMSn_CI_OH OMSn_CI_SSF-P OMSn_CI_SSF-O

Processes

The processes associated with the OTSn/OMSn_A_Sk function are as depicted in Figure 9-12.

FDI-O: On declaration of aFDI-O the function shall insert the FDI-O information (OMS-FDI-O) into the OMS overhead of the OOS. Otherwise the incoming OMS-FDI-O information is passed through. The specific FDI-O information structure within the OOS is outside the scope of this Recommendation.

FDI-P: On declaration of aFDI-P the function shall insert the FDI-P information (OMS-FDI-P) into the OMS overhead of the OOS. Otherwise the incoming OMS-FDI-P information is passed through. The specific FDI_P information structure within the OOS is outside the scope of this Recommendation.

Optical signal post-conditioning: Post-conditioning of the optical signal might be required. The specific conditioning processes depend on the OTM-n interface type and are outside the scope of this Recommendation. The processes OA, DAa and PMDC as defined in 8.11.2 are possible.

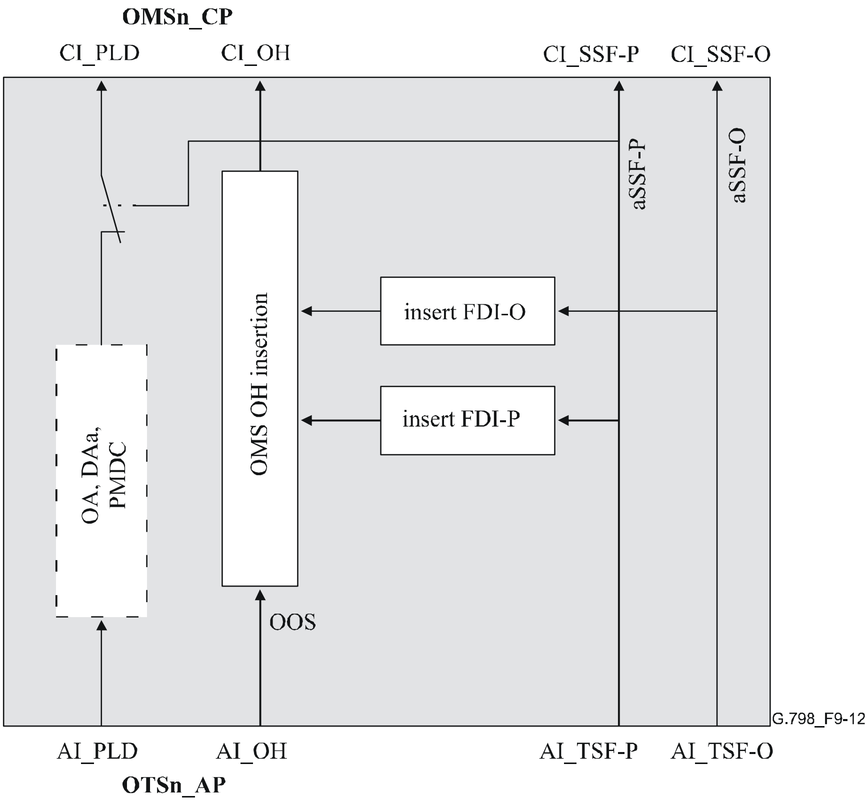


Figure 9-12/G.798 – OTSn/OMSn_A_Sk processes

Defects: None.

NOTE 1 – Detection of OOS related defects might be required (see 6.2.8). This depends on the specific OOS format and is outside the scope of this Recommendation.

Consequent actions

The OTSn/OMSn_A_Sk function performs the following consequent actions.

aSSF-P ← AI_TSF-P

aFDI-P ← AI_TSF-P

NOTE 2 – If a FDI-P is active forwarding of the downstream payload information (PLD) is discontinued (the payload signal is switched off).

aSSF-O ← AI_TSF-O

aFDI-O ← AI_TSF-O

Defect correlations: None.

Performance monitoring: None.

9.3.2 OTS to COMMS adaptation function (OTS/COMMS_A)

For further study.

10 Optical Multiplex Section (OMS) layer functions

Figure 10-1 illustrates the OMS layer network and client layer adaptation functions. For the trail protection sub-layer functions, see Figure 10-13. The information crossing the OMSn (termination) connection point (OMSn_CP/TCP) is referred to as the OMSn characteristic information

(OMSn_CI). The information crossing the OMSn access point (OMSn_AP) is referred to as the OMSn adapted information (OMSn_AI).

For trail protection sub-layer functions, see Figure 10-13.

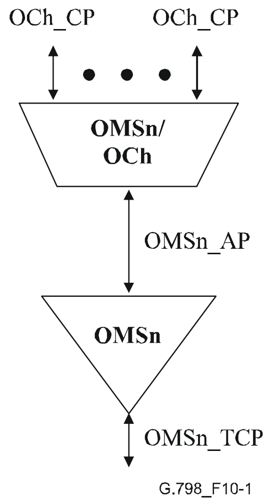


Figure 10-1/G.798 – OMS layer network and client layer adaptation functions

The OMSn Characteristic Information (OMSn_CI) consists of the OMSn characteristic information payload (OMSn_CI_PLD), which are the n multiplexed traffic wavelengths, and OMSn characteristic information overhead (OMSn_CI_OH), which is the OMS and OCh overhead information supported across the OMSn_CP. The OOS may also contain general management communications. Figure 10-2 illustrates the overhead information elements that shall be supported by the OOS across the OMSn_CP.

The specific OOS format is outside the scope of this Recommendation. In addition vendor specific overhead might be supported via the OOS. This is outside the scope of this Recommendation.

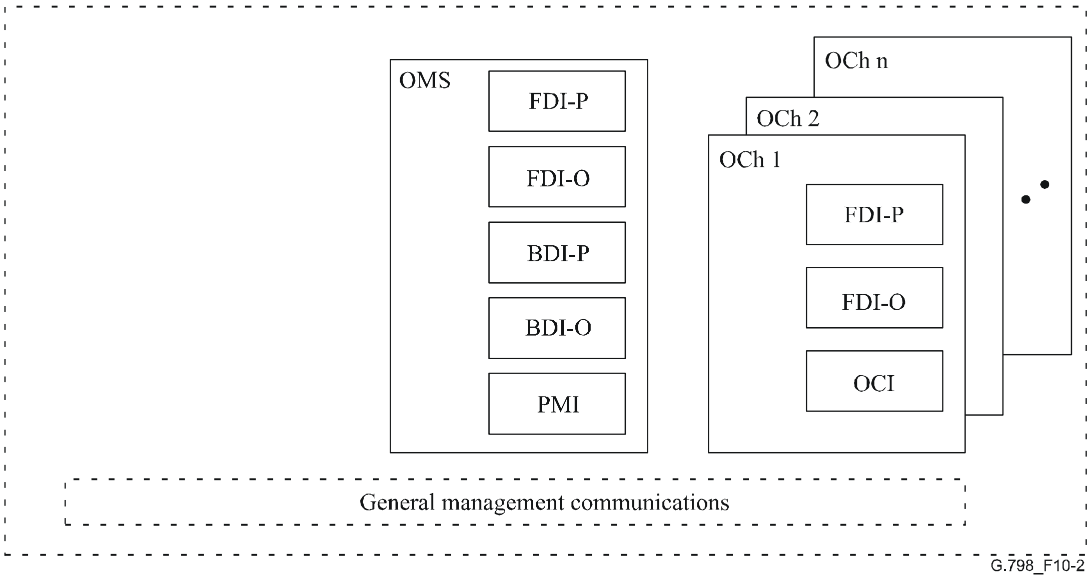


Figure 10-2/G.798 – OOS information elements at OMSn_CP/TCP

The OMSn Adapted Information (OMSn_AI) consists of the OMSn adapted information payload (OMSn_AI_PLD), which are the n multiplexed traffic wavelengths, and OMSn adapted information overhead (OMSn_AI_OH), which is the OCh overhead information supported across the OMSn_AP. The OOS may also contain general management communications. Figure 10-3 illustrates the overhead information elements that shall be supported by the OOS across OMSn_AP.

The specific OOS format is outside the scope of this Recommendation. In addition, vendor specific overhead might be supported via the OOS. This is outside the scope of this Recommendation.

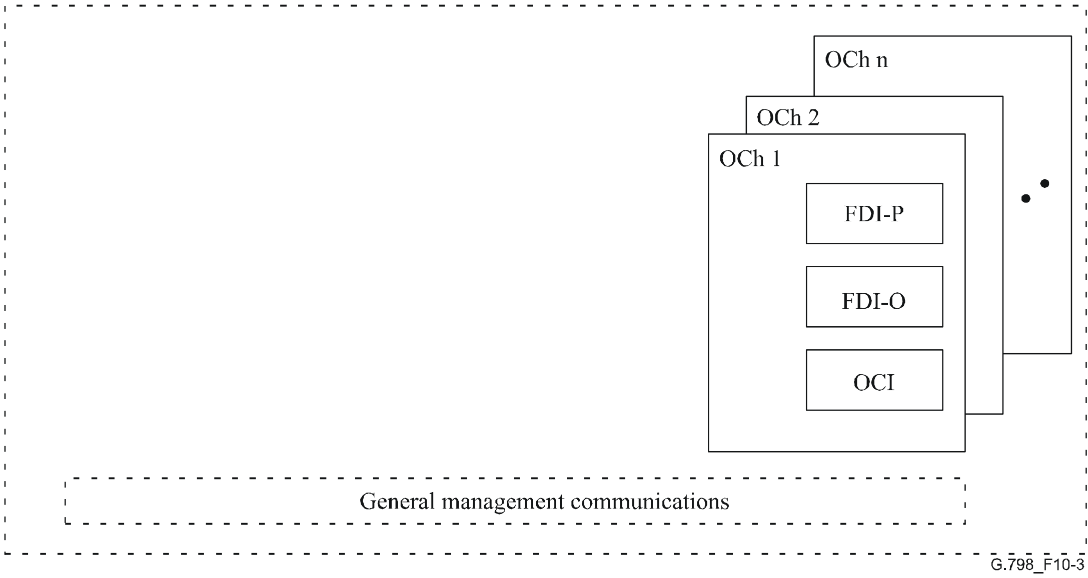


Figure 10-3/G.798 – OOS information elements at OMSn_AP

10.1 Connection functions (N/A)

Not applicable.

10.2 Termination functions

10.2.1 OMS Trail Termination function (OMSn_TT)

The OMSn_TT functions are responsible for the end-to-end supervision of the OMSn trail. Figure 10-4 shows the combination of the unidirectional sink and source functions to form a bidirectional function.

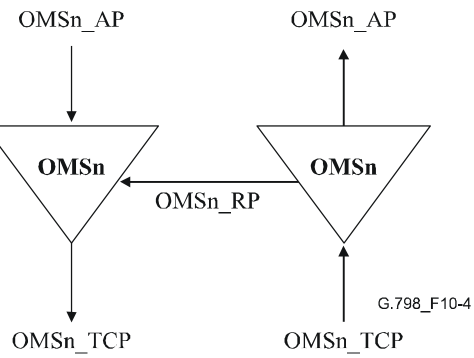


Figure 10-4/G.798 – OMSn_TT

10.2.1.1 OMS trail termination source function (OMSn_TT_So)

The OMSn_TT_So function adds OMS layer overhead into the OTM Overhead Signal (OOS) – including OMS BDI-P/O and PMI.

The information flow and processing of the OMSn_TT_So function is defined with reference to Figures 10-5 and 10-6.

Symbol

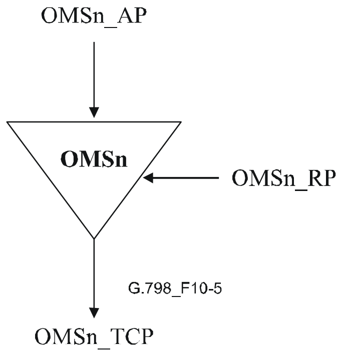


Figure 10-5/G.798 – OMSn_TT_So function

Interfaces

Table 10-1/G.798 – OMSn_TT_So inputs and outputs

Input(s)	Output(s)
OMSn_AP: OMSn_AI_PLD OMSn_AI_OH **OMSn_RP**: OMSn_RI_BDI-P OMSn_RI_BDI-O	**OMSn_TCP**: OMSn_CI_PLD OMSn_CI_OH

Processes

The processes associated with the OMSn_TT_So function are as depicted in Figure 10-6.

BDI-P: The BDI-P information is inserted into the OMS overhead of the OOS. Its value is derived from reference point OMSn_RP. Upon the declaration/clearing of aBDI-P at the termination sink function, the trail termination source function shall have inserted/removed the BDI-P indication within 50 ms. The specific BDI-P information structure within the OOS is outside the scope of this Recommendation.

BDI-O: The BDI-O information is inserted into the OMS overhead of the OOS. Its value is derived from reference point OMSn_RP. Upon the declaration/clearing of aBDI-O at the termination sink function, the trail termination source function shall have inserted/removed the BDI-O indication within 50 ms. The specific BDI-O information structure within the OOS is outside the scope of this Recommendation.

PMI: The PMI information is inserted into the OTS overhead of the OOS. Upon the declaration/clearing of aPMI the function shall have inserted/removed the PMI indication. The specific PMI information structure within the OOS is outside the scope of this Recommendation.

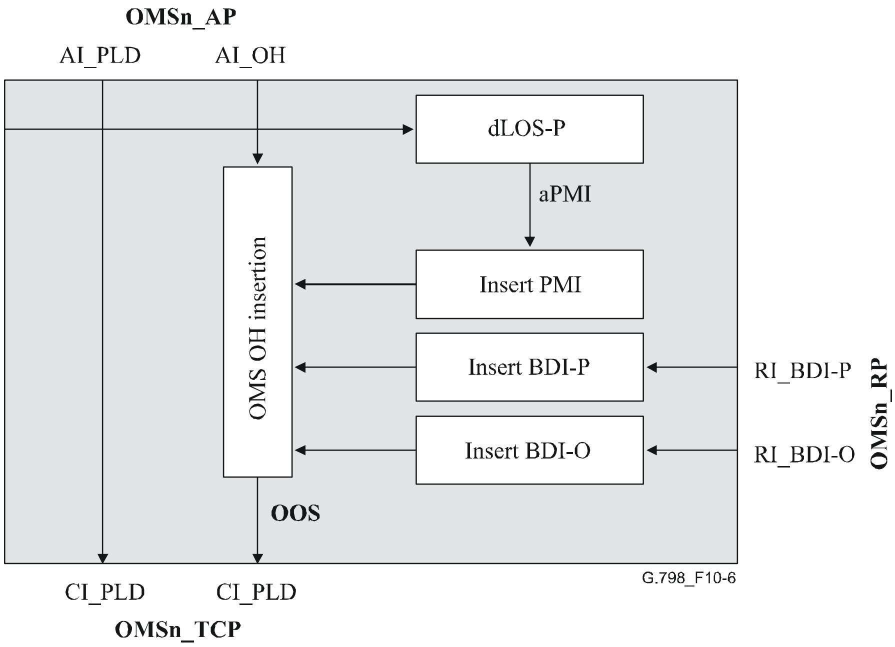


Figure 10-6/G.798 – OMSn_TT_So processes

Defects

dLOS-P: See 6.2.1.1.

Consequent actions

aPMI ← dLOS-P

Defect correlations: None.

NOTE – dLOS-P is not reported as fault cause, as it is not a failure condition of the trail itself. It is an incoming failure condition to the trail. It is used to generate PMI to the trail termination sink function (see 8.10).

Performance monitoring: None.

10.2.1.2 OMS trail termination sink function (OMSn_TT_Sk)

The OMSn_TT_Sk reports the state of the OMSn trail. The OMSn_TT_Sk function extracts OMSn monitoring overhead – including BDI, FDI-P, FDI-O and PMI. It detects dLOS-P, dPMI, dFDI-P, dFDI-O, dBDI-P and dBDI-O defects, counts during 1-second periods defects to feed performance monitoring when connected and forwards the defect information as backward defect indications to the companion OMSn_TT_So function.

The information flow and processing of the OMSn_TT_Sk function is defined with reference to Figures 10-7 and 10-8.

Symbol

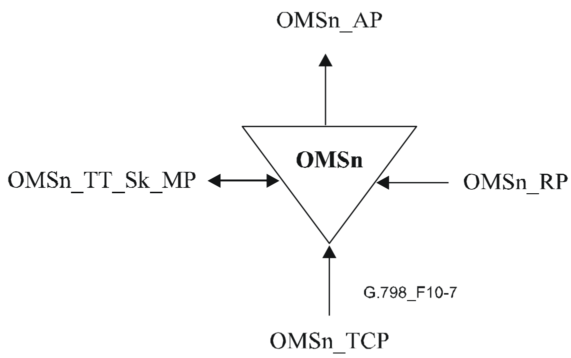


Figure 10-7/G.798 – OMSn_TT_Sk function

Interfaces

Table 10-2/G.798 – OMSn_TT_Sk inputs and outputs

Input(s)	Output(s)
OMSn_TCP: OMSn_CI_PLD OMSn_CI_OH OMSn_CI_SSF-P OMSn_CI_SSF-O **OMSn_TT_Sk_MP**: OMSn_TT_Sk_MI_1second	**OMSn_AP**: OMSn_AI_PLD OMSn_AI_OH OMSn_AI_TSF-P OMSn_AI_TSF-O **OMSn_RP**: OMSn_RI_BDI-P OMSn_RI_BDI-O **OMSn_TT_Sk_MP**: OMSn_TT_Sk_MI_cSSF-P OMSn_TT_Sk_MI_cSSF-O OMSn_TT_Sk_MI_cSSF OMSn_TT_Sk_MI_cBDI OMSn_TT_Sk_MI_cBDI-P OMSn_TT_Sk_MI_cBDI-O OMSn_TT_Sk_MI_cLOS-P OMSn_TT_Sk_MI_pN_DS-P OMSn_TT_Sk_MI_pN_DS-O OMSn_TT_Sk_MI_pF_DS-P OMSn_TT_Sk_MI_pF_DS-O

Processes

The processes associated with the OMSn_TT_Sk function are depicted in Figure 10-8.

FDI-P: The FDI-P information (OMS-FDI-P) shall be extracted from the OMS overhead of the OOS. It shall be used for FDI-P defect detection. The specific implementation for extracting FDI-P from the OOS and detecting its value is outside the scope of this Recommendation.

FDI-P: The FDI-O information (OMS-FDI-O) shall be extracted from the OMS overhead of the OOS. It shall be used for FDI-O defect detection. The specific implementation for extracting FDI-O from the OOS and detecting its value is outside the scope of this Recommendation.

BDI-P: The BDI-P information (OMS-BDI-P) shall be extracted from the OMS overhead of the OOS. It shall be used for BDI-P defect detection. The specific implementation for extracting BDI-P from the OOS and detecting its value is outside the scope of this Recommendation.

BDI-O: The BDI-O information (OMS-BDI-O) shall be extracted from the OMS overhead of the OOS. It shall be used for BDI-O defect detection. The specific implementation for extracting BDI-O from the OOS and detecting its value is outside the scope of this Recommendation.

PMI: The PMI information (OMS-PMI) shall be extracted from the OMS overhead of the OOS. It shall be used for PMI defect detection. The specific implementation for extracting PMI from the OOS and detecting its value is outside the scope of this Recommendation.

Signal quality supervision: For further study.

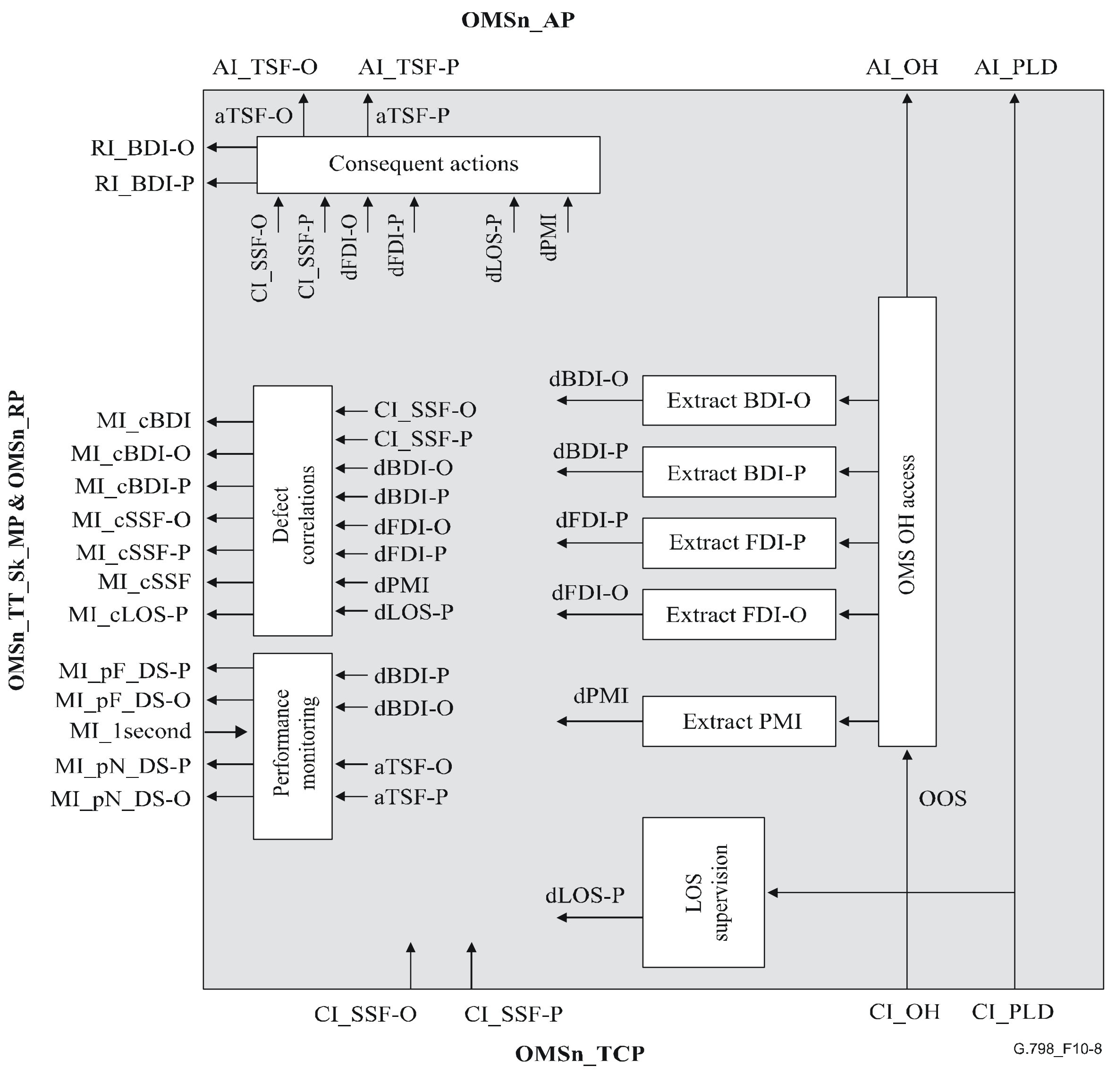


Figure 10-8/G.798 – OMSn_TT_Sk processes

Defects

The OMSn_TT_Sk function shall detect for dLOS-P, dFDI-P, dFDI-O, dBDI-P, dBDI-O and dPMI defects.

NOTE 1 – Detection of additional OOS related defects might be required (see 6.2.8). This depends on the specific OOS format and is outside the scope of this Recommendation.

dLOS-P: See 6.2.1.1.

NOTE 2 – A hold-off time has to be used for the activation of LOS-P. The hold-off time has to cover the propagation, processing and detection delay of the PMI signal between the source and sink.

dFDI-P: See 6.2.6.1.1.

dFDI-O: See 6.2.6.2.1.

dBDI-P: See 6.2.6.4.1; dBDI-P shall be set to false during CI_SSF-O and dFDI-O.

dBDI-O: See 6.2.6.5.1; dBDI-O shall be set to false during CI_SSF-O and dFDI-O.

dPMI: See 6.2.6.7.1; dPMI shall be set to false during CI_SSF-O and dFDI-O.

Consequent actions

The OMSn_TT_Sk function shall perform the following consequent actions.

aTSF-P ← (dLOS-P and (not dPMI)) or dFDI-P or CI_SSF-P

aTSF-O ← dFDI-O or CI_SSF-O

aBDI-P ← (dLOS-P and (not dPMI)) or dFDI-P or CI_SSF-P

aBDI-O ← dFDI-O or CI_SSF-O

Defect correlations

The OMSn_TT_Sk function shall perform the following defect correlations.

cSSF ← (CI_SSF-P or dFDI-P) and (CI_SSF-O or dFDI-O)

cSSF-P ← (CI_SSF-P or dFDI-P) and (not cSSF)

cSSF-O ← (CI_SSF-O or dFDI-O) and (not cSSF)

cBDI ← (dBDI-P and (not dFDI-O)) and (dBDI-O and (not dFDI-O))

cBDI-P ← (dBDI-P and (not dFDI-O)) and (not cBDI)

cBDI-O ← (dBDI-O and (not dFDI-O)) and (not cBDI)

cLOS-P ← dLOS-P and (not dPMI) and (not dFDI-P) and (not CI_SSF-P)

Performance monitoring

The OMSn_TT_Sk function shall perform the following performance monitoring primitives. The performance monitoring primitives shall be reported to the EMF.

pN_DS-P ← aTSF-P

pN_DS-O ← aTSF-O

pF_DS-P ← dBDI-P

pF_DS-O ← dBDI-O

NOTE 3 – Performance monitoring primitives based on signal quality monitoring are for further study.

10.2.2 OMS Non-intrusive Monitoring function (N/A)

Not Applicable.

10.3 Adaptation functions

The OMS is server for the following clients:

– Optical channel (OCh).

10.3.1 OMS to OCh adaptation function (OMSn/OCh_A)

The OMS to OCh adaptation functions perform the adaptation between the OMS layer adapted information and the characteristic information of n OCh layer signals. This includes the optical payload and the overhead.

10.3.1.1 OMS to OCh adaptation source function (OMSn/OCh_A_So)

The OMSn/OCh_A_So function multiplexes the individual OCh_CIs to the OMSn_AI. The information flow and processing of the OMSn/OCh_A_So function is defined with reference to Figures 10-9 and 10-10.

Symbol

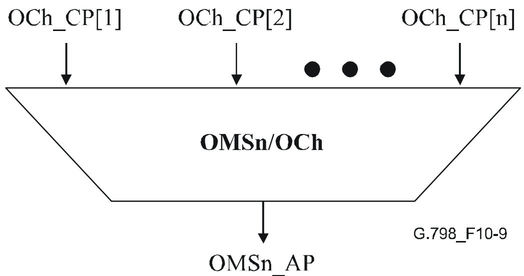


Figure 10-9/G.798 – OMSn/OCh_A_So function

Interfaces

Table 10-3/G.798 – OMSn/OCh_A_So inputs and outputs

Input(s)	Output(s)
per OCh_CP: OCh_CI_PLD OCh_CI_OH	**OMSn_AP**: OMSn_AI_PLD OMSn_AI_OH

Processes

The processes associated with the OMSn/OCh_A_So function are specific processes for each OChr_CI and common processes for the compound (multiplexed) signal as depicted in Figure 10-10.

Specific processes

Mod/WA (Optical Carrier Modulation and Wavelength Assignment): See 8.11.1.

Optical signal pre-conditioning: Pre-conditioning of the single wavelength optical signal might be required. The specific conditioning processes depend on the OTM-n interface type and are outside the scope of this Recommendation. The processes OA, DAc, DAa and PMDC as defined in 8.11.2 are possible.

Common processes

OM (Optical Multiplexing): See 8.11.1. The parameters are outside the scope of this Recommendation.

Optical signal pre-conditioning: Pre-conditioning of the multi-wavelength optical signal might be required. The specific conditioning processes depend on the OTM-n interface type and are outside the scope of this Recommendation. The processes OA and DAa as defined in 8.11.2 are possible.

OHM (Overhead Multiplexing): This process performs overhead multiplexing of the OH of the individual OCh signals. The specific multiplex function is outside the scope of this Recommendation.

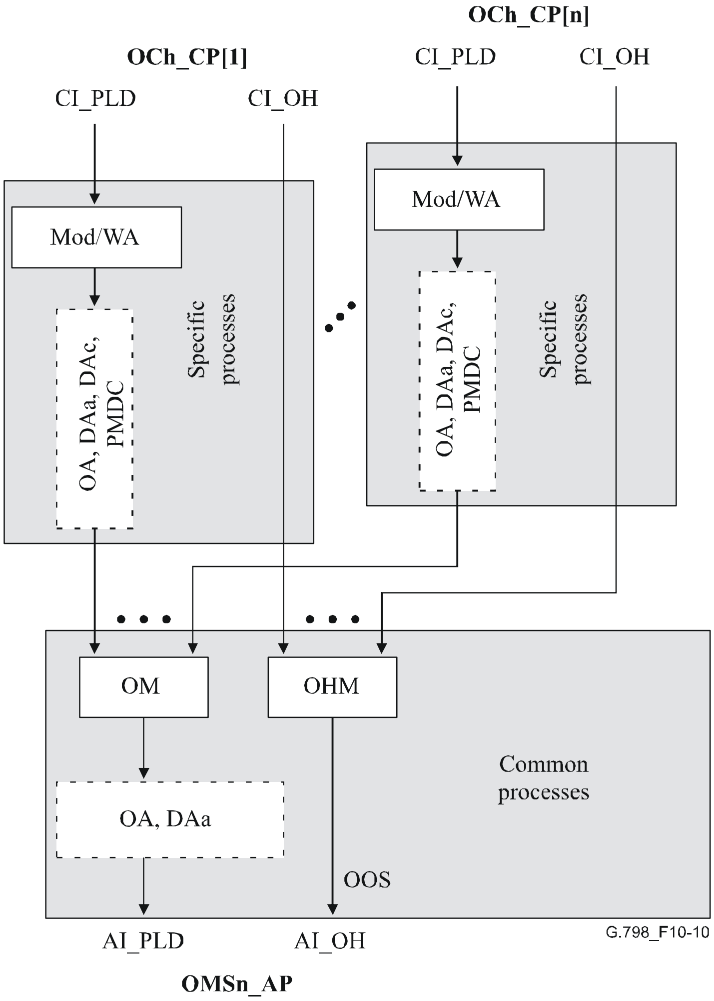


Figure 10-10/G.798 – OMSn/OCh_A_So processes

Defects: None.

Consequent actions: None.

Defect correlations: None.

Performance monitoring: None.

10.3.1.2 OMS to OCh adaptation sink function (OMSn/OCh_A_Sk)

The OMSn/OCh_A_Sk function demultiplexes the OMSn_AI into the individual OCh_CIs. Upon signal fail conditions, it generates FDI for the individual channels.

The information flow and processing of the OMSn/OCh_A_Sk function is defined with reference to Figures 10-11 and 10-12.

Symbol

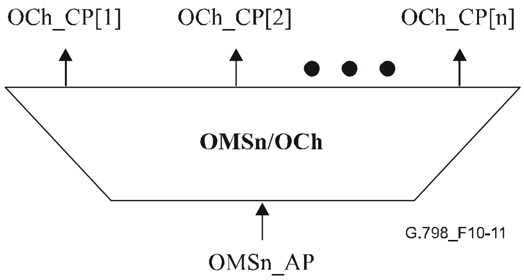


Figure 10-11/G.798 – OMSn/OCh_A_Sk function

Interfaces

Table 10-4/G.798 – OMSn/OCh_A_Sk inputs and outputs

Input(s)	Output(s)
OMSn_AP: OMSn_AI_PLD OMSn_AI_OH OMSn_AI_TSF-P OMSn_AI_TSF-O	**per OCh_CP**: OCh_CI_PLD OCh_CI_OH OCh_CI_SSF-P OCh_CI_SSF-O

Processes

The processes associated with the OMSn/OCh_A_Sk function are specific processes for each OCh signal and common processes for the compound (multiplexed) signal as depicted in Figure 10-12.

Common processes

ODM/WS (Optical Demultiplexing and Wavelength Selection): See 8.11.1. The parameters are outside the scope of this Recommendation.

Optical signal post-conditioning: Post-conditioning of the multi-wavelength signal might be required. The specific conditioning processes depend on the OTM-n interface type and are outside the scope of this Recommendation. The processes OA, DAa and PMDC as defined in 8.11.2 are possible.

OHDM (Overhead Demultiplexing): This process performs the overhead demultiplexing and provides access to the OH of the individual OCh signals. The specific multiplex function is outside the scope of this Recommendation.

Specific processes

DMod (Optical Carrier Demodulation): See 8.11.1.

Optical signal post-conditioning: Post-conditioning of the single wavelength signal might be required. The specific conditioning processes depend on the OTM-n interface type and are outside the scope of this Recommendation. The processes OA, DAc, DAa and PMDC as defined in 8.11.2 are possible.

FDI-O: On declaration of aFDI-O the function shall insert the FDI-O information (OCh-FDI-O) into the OCh overhead of the OOS of each OCh. Otherwise the incoming OCh-FDI-O information is passed through. The specific FDI-O information structure within the OOS is outside the scope of this Recommendation.

FDI-P: On declaration of aFDI-P the function shall insert the FDI-P information (OCh-FDI-P) into the OCh overhead of the OOS of each OCh. Otherwise the incoming OCh-FDI-P information is passed through. The specific FDI_P information structure within the OOS is outside the scope of this Recommendation.

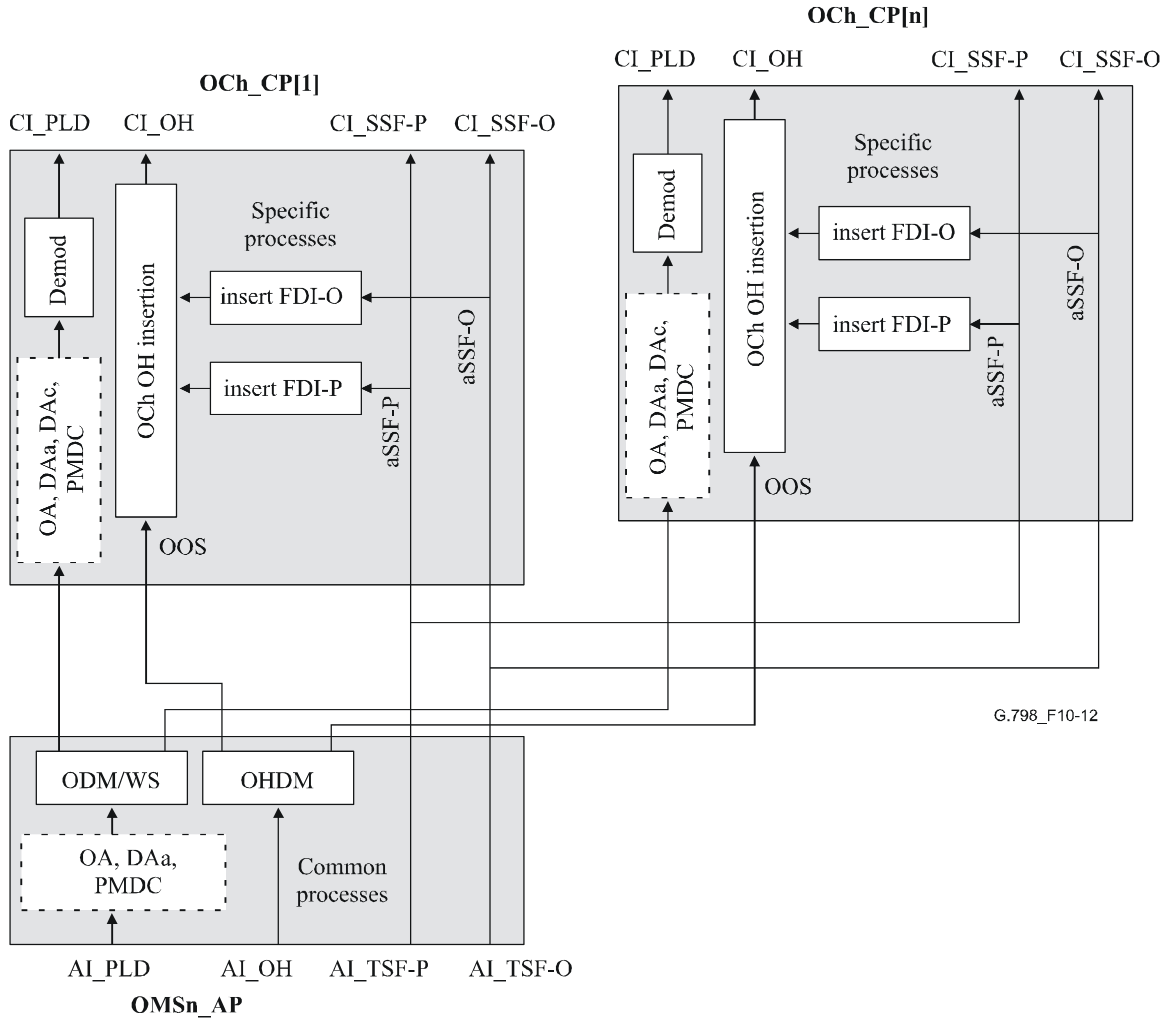


Figure 10-12/G.798 – OMSn/OCh_A_Sk processes

Defects: None.

NOTE – Detection of OOS related defects might be required (see 6.2.8). This depends on the specific OOS format and is outside the scope of this Recommendation.

Consequent actions

The OMSn/OCh_A_Sk function performs the following consequent actions.

aSSF-P ← AI_TSF-P

aFDI-P ← AI_TSF-P

aSSF-O ← AI_TSF-O

aFDI-O ← AI_TSF-O

Defect correlations: None.

Performance monitoring: None.

10.3.2 OMS to COMMS adaptation function (OMS/COMMS_A)

For further study.

10.4 Sub-layer functions

10.4.1 OMS trail protection sub-layer functions

The OMS trail protection sub-layer (OMSnP) is generated by expanding the OMS trail termination. Figure 10-13 shows the OMS trail protection functions and the location between the OMS_TT and the OMS to client layer adaptation.

The following trail protection schemes are supported:

– 1+1 unidirectional.

Other protection schemes are for further study.

The basic trail protection mechanism is identical to the SDH trail connection process described in ITU-T Rec. G.841.

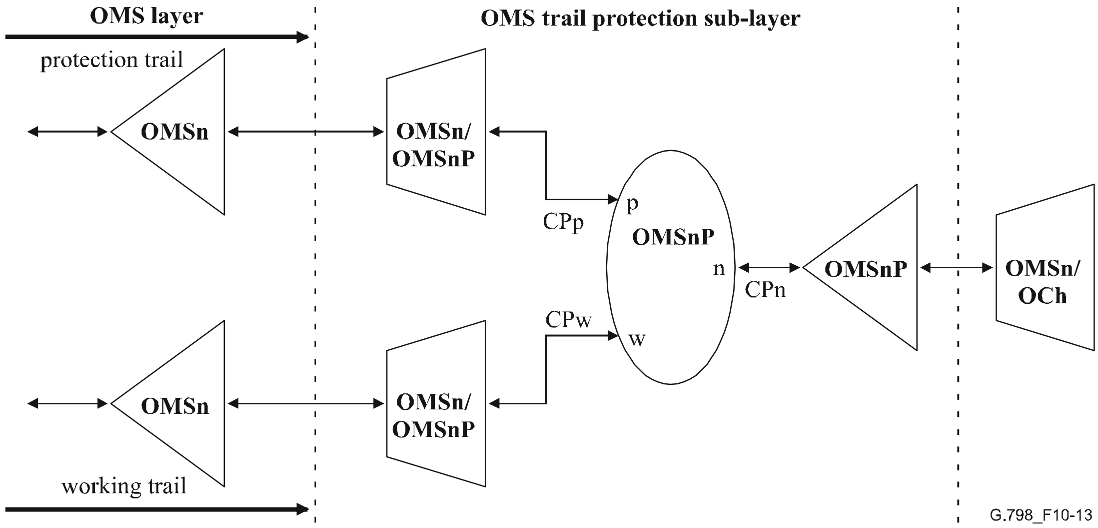


Figure 10-13/G.798 – OMS trail protection sub-layer functions

10.4.1.1 OMSP 1+1 unidirectional trail protection connection function (OMSnP1+1u_C)

The OMSnP1+1u_C provides 1+1 unidirectional trail protection at the OMS layer.

10.4.1.1.1 OMSP 1+1 unidirectional trail protection connection source function (OMSnP1+1u_C_So)

The information flow and processing of the OMSnP1+1u_C_So function is defined with reference to Figure 10-14.

Symbol

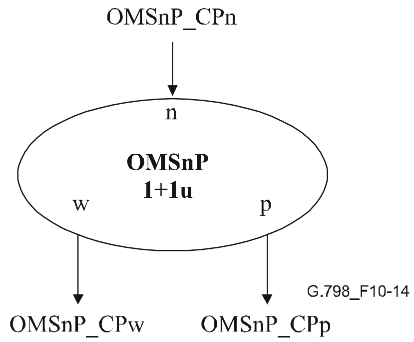


Figure 10-14/G.798 – OMSnP1+1u_C_So function

Interfaces

Table 10-5/G.798 – OMSnP1+1u_C_So inputs and outputs

Input(s)	Output(s)
OMSnP_CPn: OMSnP_CI_PLD OMSnP_CI_OH	**OMSnP_CPw and OMSnP_CPp**: OMSnP_CI_PLD OMSnP_CI_OH

Processes

The function performs the bridge for the 1+1 unidirectional trail protection.

For 1+1 architecture, the CI coming from the normal (protected) OMSnP_CP is bridged permanently to both the working and protection OMSnP_CP.

Defects: None.

Consequent actions: None.

Defect correlations: None.

Performance monitoring: None.

10.4.1.1.2 OMSP 1+1 unidirectional trail protection connection sink function (OMSnP1+1u_C_Sk)

The information flow and processing of the OMSnP1+1u_C_Sk function is defined with reference to Figure 10-15.

Symbol

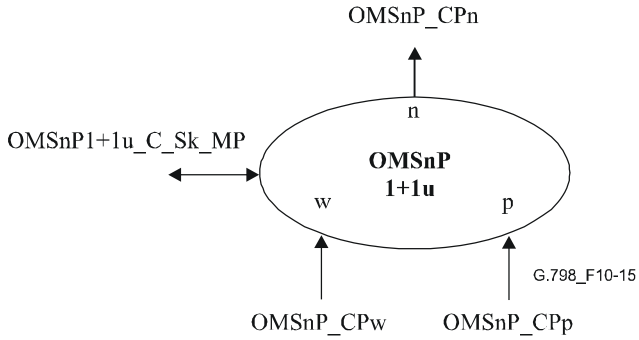


Figure 10-15/G.798 – OMSnP1+1u_C_Sk function

Interfaces

Table 10-6/G.798 – OMSnP1+1u_C_Sk inputs and outputs

Input(s)	Output(s)
OMSnP_CPw and OMSnP_CPp: OMSnP_CI_PLD OMSnP_CI_OH OMSnP_CI_SSF-P OMSnP_CI_SSF-O **OMSnP1+1u_C_Sk_MP**: OMSnP_C_MI_OperType OMSnP_C_MI_WTR OMSnP_C_MI_HoTime OMSnP_C_MI_ExtCMD OMSnP_C_MI_TSF-ODis	**OMSnP_CPn**: OMSnP_CI_PLD OMSnP_CI_OH OMSnP_CI_SSF-P OMSnP_CI_SSF-O **OMSnP1+1u_C_Sk_MP**: For further study

Processes

For a 1+1 architecture, the CI from either the working or protection OMSnP_CP is switched to the normal (protected) OMSnP_CP. A switchover from working to protection OMSnP_CP or vice versa is initiated by the switch initiation criteria defined below.

Switch initiation criteria

Automatic protection switching is based on the defect conditions of the working and protection trail. These condition(s) are server signal fail payload (TSF-P) and server signal fail overhead (TSF-O). The use of TSF-O as protection switching criteria can be disabled (MI_TSF-ODis). The priority of TSF-P shall be equal to Signal Fail as defined in ITU-T Rec. G.841. The priority of TSF-O shall be equal to Signal Degrade as defined in ITU-T Rec. G.841.

In order to allow interworking between nested protection schemes a hold-off timer is provided. The hold-off timer delays switch initiation in case of signal fail in order to allow a nested protection to react and clear the fault condition. The hold-off timer is started by the activation of signal fail and runs for the hold-off time. Protection switching is only initiated if signal fail is still present at the end of the hold-off time. The hold-off time shall be provisionable between 0 and 10 s in steps of 100 ms.

Protection switching can also be initiated by external switch commands received via the MP.

Depending on the mode of operation internal states (e.g., wait to restore) may also initiate a switch over.

See the switch initiation criteria described in ITU-T Rec. G.841.

Switching time

Refer to ITU-T Rec. G.841.

Switch restoration

In the revertive mode of operation, the protected signal shall be switched back from the protection trail to the working trail when the working trail has recovered from the fault.

To prevent frequent operation of the protection switch due to an intermittent fault, a failed working trail must become fault-free for a certain period of time before it is used again. This period, called wait-to-restore (WTR) period should be of the order of 5-12 minutes and should be capable of being set.

In the non-revertive mode of operation, no switch back to the working trail is performed when it has recovered from the fault.

Protection switching notifications to the MP are for further study.

Defects: None.

Consequent actions: None.

Defect correlations: None.

Performance monitoring: None.

10.4.1.2 OMSP trail termination function (OMSnP_TT)

10.4.1.2.1 OMSP trail termination source function (OMSnP_TT_So)

The information flow and processing of the OMSnP_TT_So function is defined with reference to Figure 10-16.

Symbol

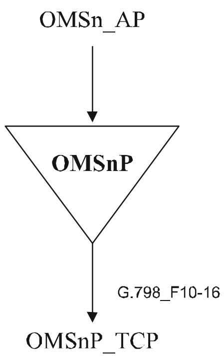


Figure 10-16/G.798 – OMSnP_TT_So function

Interfaces

Table 10-7/G.798 – OMSnP_TT_So inputs and outputs

Input(s)	Output(s)
OMSn_AP: OMSn_AI_PLD OMSn_AI_OH	**OMSnP_TCP**: OMSnP_CI_PLD OMSnP_CI_OH

Processes

No information processing is required in the OMSnP_TT_So, the OMSnP_CI at its output being identical to the OMSn_AI at its input.

Defects: None.

Consequent actions: None.

Defect correlations: None.

Performance monitoring: None.

10.4.1.2.2 OMSP trail termination sink function (OMSnP_TT_Sk)

The information flow and processing of the OMSnP_TT_Sk function is defined with reference to Figure 10-17.

Symbol

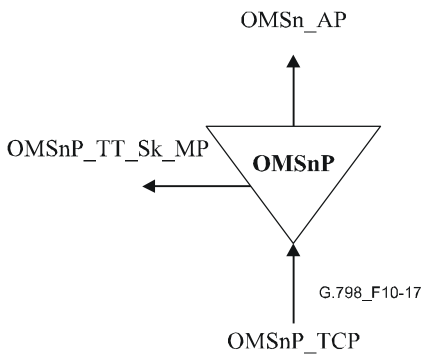


Figure 10-17/G.798 – OMSnP_TT_Sk function

Interfaces

Table 10-8/G.798 – OMSnP_TT_Sk inputs and outputs

Input(s)	Output(s)
OMSnP_TCP: OMSnP_CI_PLD OMSnP_CI_OH OMSnP_CI_SSF-P OMSnP_CI_SSF-O	**OMSn_AP**: OMSn_AI_PLD OMSn_AI_OH OMSn_AI_TSF-P OMSn_AI_TSF-O **OMSnP_TT_Sk_MP**: OMSnP_TT_Sk_MI_cSSF-P OMSnP_TT_Sk_MI_cSSF-O OMSnP_TT_Sk_MI_cSSF

Processes

The OMSnP_TT_Sk function reports the state of the protected OMSn trail.

No additional information processing is required in the OMSnP_TT_Sk, the OMSn_AI at its output being identical to the OMSnP_CI at its input.

Defects: None.

Consequent actions

The OMSnP_TT_Sk function performs the following consequent actions.

aTSF-P ← CI_SSF-P

aTSF-O ← CI_SSF-O

Defect correlations

The OMSnP_TT_Sk function shall perform the following defect correlations.

cSSF ← CI_SSF-P and CI_SSF-O

cSSF-P ← CI_SSF-P and (not CI_SSF-O)

cSSF-O ← CI_SSF-O and (not CI_SSF_P)

Performance monitoring: None.

10.4.1.3 OMS to OMSP adaptation function (OMSn/OMSnP_A)

10.4.1.3.1 OMS to OMSP adaptation source function (OMSn/OMSnP_A_So)

The information flow and processing of the OMSn/OMSnP_A_So functions is defined with reference to Figure 10-18.

Symbol

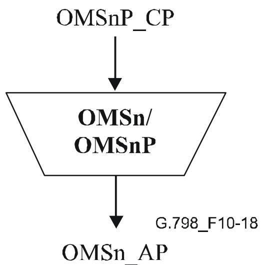


Figure 10-18/G.798 – OMSn/OMSnP_A_So function

Interfaces

Table 10-9/G.798 – OMSn/OMSnP_A_So inputs and outputs

Input(s)	Output(s)
OMSnP_CP: OMSnP_CI_PLD OMSnP_CI_OH	**OMSn_AP**: OMSn_AI_PLD OMSn_AI_OH

Processes

No information processing is required in the OMSn/OMSnP_A_So, the OMSn_AI at its output being identical to the OMSnP_CI at its input.

Defects: None.

Consequent actions: None.

Defect correlations: None.

Performance monitoring: None.

10.4.1.3.2 OMS to OMSP adaptation sink function (OMSn/OMSnP_A_Sk)

The information flow and processing of the OMSn/OMSnP_A_Sk function is defined with reference to Figure 10-19.

Symbol

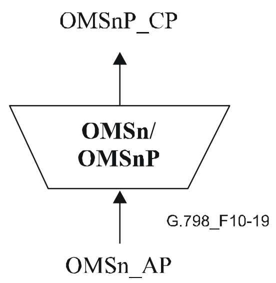


Figure 10-19/G.798 – OMSn/OMSnP_A_Sk function

Interfaces

Table 10-10/G.798 – OMSn/OMSnP_A_Sk inputs and outputs

Input(s)	Output(s)
OMSn_AP: OMSn_AI_PLD OMSn_AI_OH OMSn_AI_TSF-P OMSn_AI_TSF-O	**OMSnP_CP**: OMSnP_CI_PLD OMSnP_CI_OH OMSnP_CI_SSF-P OMSnP_CI_SSF-O

Processes

No information processing is required in the OMSn/OMSnP_A_Sk, the OMSnP_CI at its output being identical to the OMSn_AI at its input.

Defects: None.

Consequent actions

aSSF-P ← AI_TSF-P

aSSF-O ← AI_TSF-O

Defect correlations: None.

Performance monitoring: None.

11 Optical Physical Section (OPS) layer functions

Figure 11-1 illustrates the OPS layer network and client layer adaptation functions. The information crossing the OPSn termination connection point (OPSn_TCP) is referred to as the OPSn characteristic information (OPSn_CI). The information crossing the OPSn access point (OPSn_AP) is referred to as the OPSn adapted information (OPSn_AI).

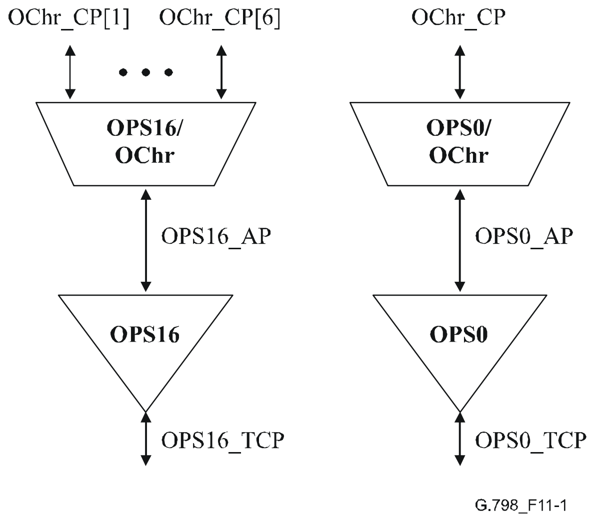


Figure 11-1/G.798 – OPSn layer network and client layer adaptation functions

The OPSn Characteristic Information (OPSn_CI) is a physical optical signal consisting of the n multiplexed traffic wavelengths for n ≥ 1 and a single optical signal for n = 0.

The OPSn Adapted Information (OPSn_AI) consists of the OPSn adapted information payload (OTSn_AI_PLD), which are the n multiplexed traffic wavelengths for n ≥ 1 and a single optical signal for n = 0.

11.1 Connection functions (N/A)

Not applicable.

11.2 Termination functions

11.2.1 OPSn Trail Termination function (OPSn_TT), n = 0, 16

The OPSn_TT functions are responsible for the end-to-end supervision of the OPSn trail. Figure 11-2 shows the combination of the unidirectional sink and source functions to form a bidirectional function.

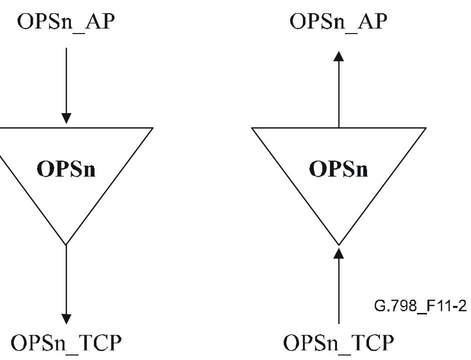


Figure 11-2/G.798 – OPSn_TT

11.2.1.1 OPS Trail Termination source function (OPSn_TT_So), n = 0, 16

The information flow and processing of the OPSn_TT_So function is defined with reference to Figure 11-3. The OPSn_TT_So generates the OTM-nr.m signal within the physical specifications of ITU-T Rec. G.959.1.

Symbol

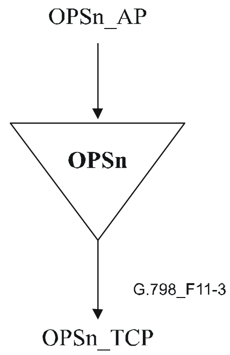


Figure 11-3/G.798 – OPSn_TT_So function

Interfaces

Table 11-1/G.798 – OPSn_TT_So inputs and outputs

Input(s)	Output(s)
OPSn_AP: OPSn_AI_PLD	**OPSn_TCP**: OPSn_CI

Processes

NOTE – For the optical power levels of the OTN interface specified in the current version of ITU-T Rec. G.959.1 Automatic Power Reduction (APR) is not necessary according to ITU-T Rec. G.664 and IEC 60825-1 and IEC 60825-2. Future versions of ITU-T Rec. G.959.1 may, however, contain power levels exceeding the safe levels. In this case, APR procedures have to be defined.

Defects: None.

Consequent actions: None.

Defect correlations: None.

Performance monitoring: None.

11.2.1.2 OPSn trail termination sink function (OPSn_TT_Sk), n = 0, 16

The information flow and processing of the OPSn_TT_Sk function is defined with reference to Figures 11-4 and 11-5. The OPSn_TT_Sk reports the state of the OPSn trail. The OPSn_TT_Sk accepts an OTM-nr.m signal with physical parameters according to clause 7/G.959.1 after transport over an optical path as defined in ITU-T Rec. G.959.1.

Symbol

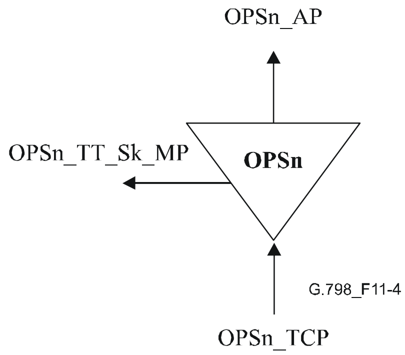


Figure 11-4/G.798 – OPSn_TT_Sk function

Interfaces

Table 11-2/G.798 – OPSn_TT_Sk inputs and outputs

Input(s)	Output(s)
OPSn_TCP: OPSn_CI	**OPSn_AP**: OPSn_AI_PLD OPSn_AI_TSF-P **OPSn_TT_Sk_MP**: OPSn_TT_Sk_MI_cLOS-P OPSn_TT_Sk_MI_pN_DS-P

Processes

The processes associated with the OPSn_TT_Sk function are depicted in Figure 11-5.

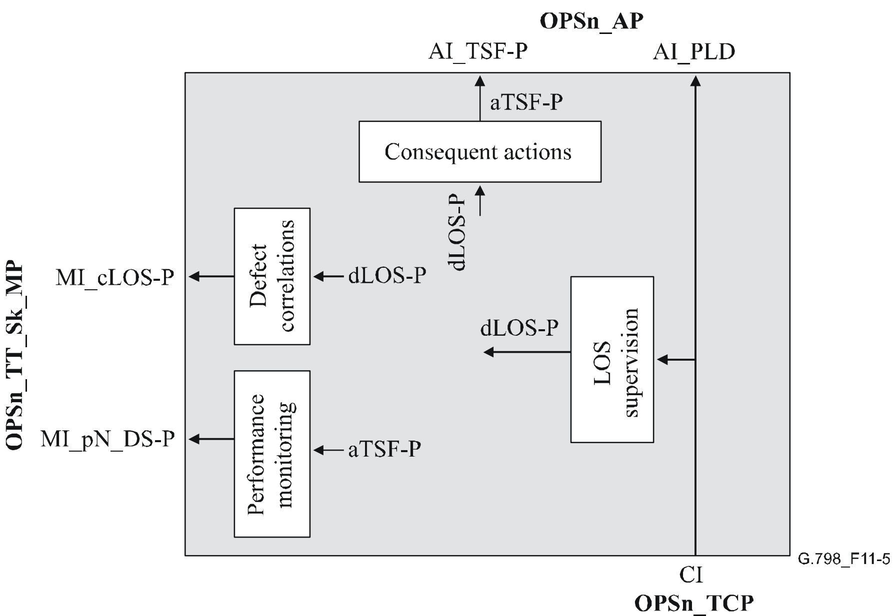


Figure 11-5/G.798 – OPSn_TT_Sk processes

Defects

The OPSn_TT_Sk function shall detect for dLOS-P defect.

dLOS-P: See 6.2.1.1.

Consequent actions

The OPSn_TT_Sk function shall perform the following consequent actions.

aTSF-P ← dLOS-P

Defect correlations

The OPSn_TT_Sk function shall perform the following defect correlations.

cLOS-P ← dLOS-P

Performance monitoring

The OPSn_TT_Sk function shall perform the following performance monitoring primitives. The performance monitoring primitives shall be reported to the EMF.

pN_DS-P ← aTSF-P

11.3 Adaptation functions

The OPS is server for the following clients:

– OChr Optical Channel with reduced functionality (e.g., without non-associated overhead).

11.3.1 OPS0 to OChr adaptation function (OPS0/OChr_A)

The OPS0 to OChr adaptation functions perform the adaptation between the OPS0 layer adapted information and the characteristic information of an OChr layer signal.

11.3.1.1 OPS0 to OChr adaptation source function (OPS0/OChr_A_So)

The information flow and processing of the OPS0/OChr_A_So function is defined with reference to Figures 11-6 and 11.7.

Symbol

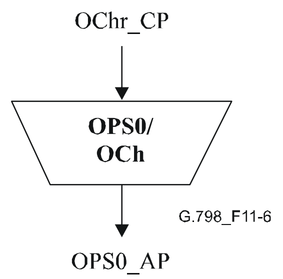


Figure 11-6/G.798 – OPS0/OChr_A_So function

Interfaces

Table 11-3/G.798 – OPS0/OChr_A_So inputs and outputs

Input(s)	Output(s)
OChr_CP: OChr_CI_PLD	**OPS0_AP**: OPS0_AI_PLD

Processes

The processes associated with the OPS0/OChr_A_So function are depicted in Figure 11-7.

Mod (Optical Carrier Modulation): See 8.11.1. For the parameters, see ITU-T Rec. G.959.1.

Optical signal pre-conditioning: Pre-conditioning of the single wavelength optical signal might be required. The specific conditioning processes depend on the OTM-0 interface type (see ITU-T Rec. G.959.1). The processes OA, DAc, DAa and PMDC as defined in 8.11.2 are possible.

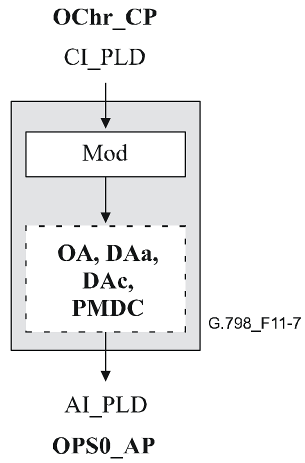


Figure 11-7/G.798 – OPS0/OChr_A_So processes

Defects: None.

Consequent actions: None.

Defect correlations: None.

Performance monitoring: None.

11.3.1.2 OPS0 to OChr adaptation sink function (OPS0/OChr_A_Sk)

The information flow and processing of the OPS0/OChr_A_Sk function is defined with reference to Figures 11-8 and 11-9.

Symbol

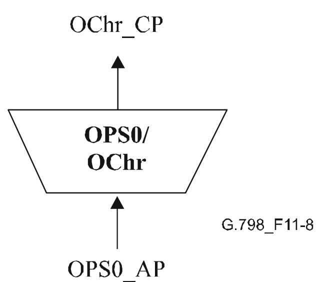


Figure 11-8/G.798 – OPS0/OChr_A_Sk function

Interfaces

Table 11-4/G.798 – OPS0/OChr_A_Sk inputs and outputs

Input(s)	Output(s)
OPS0_AP: OPS0_AI_PLD OPS0_AI_TSF-P	**OChr_CP**: OChr_CI_PLD OChr_CI_SSF-P

Processes

The processes associated with the OPS0/OChr_A_Sk function are depicted in Figure 11-9.

Optical signal post-conditioning: Post-conditioning of the single wavelength signal might be required. The specific conditioning processes depend on the OTM-0 interface type (see ITU-T Rec. G.959.1). The processes OA, DAc, DAa and PMDC as defined in 8.11.2 are possible.

DMod (Optical Carrier Demodulation): See 8.11.1. For the parameters see ITU-T Rec. G.959.1.

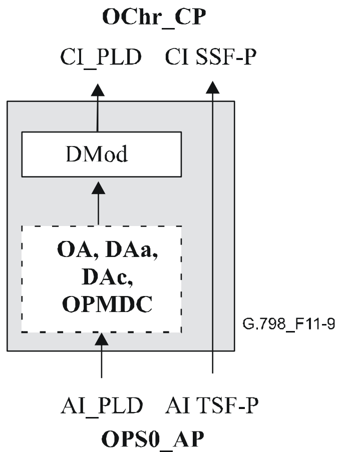


Figure 11-9/G.798 – OPS0/OChr_A_Sk processes

Defects: None.

Consequent actions

The OPS0/OChr_A_Sk function performs the following consequent actions.

aSSF-P ← AI_TSF-P

Defect correlations: None.

Performance monitoring: None.

11.3.2 OPS16 to OChr adaptation function (OPS16/OChr_A)

The OPS16 to OChr adaptation functions perform the adaptation between the OPS16 layer adapted information and the characteristic information of 16 OChr layer signals.

11.3.2.1 OPS16 to OChr adaptation source function (OPS16/OChr_A_So)

The information flow and processing of the OPS16/OChr_A_So function is defined with reference to Figures 11-10 and 11-11.

Symbol

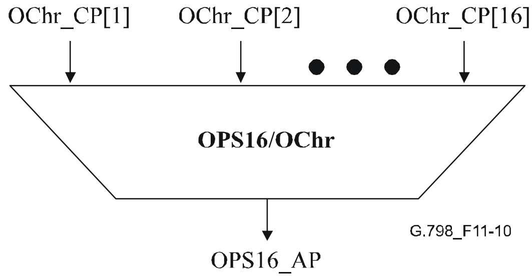


Figure 11-10/G.798 – OPS16/OChr_A_So function

Interfaces

Table 11-5/G.798 – OPS16/OChr_A_So inputs and outputs

Input(s)	Output(s)
per OChr_CP: OChr_CI_PLD	**OPS16_AP**: OPS16_AI_PLD

Processes

The processes associated with the OPSn/OChr_A_So function are specific processes for each OChr_CI and common processes for the compound signal as depicted in Figure 11-11.

Specific processes

Mod/WA (Optical Carrier Modulation and Wavelength Assignment): See 8.11.1. For the parameters, see ITU-T Rec. G.959.1.

Optical signal pre-conditioning: Pre-conditioning of the single wavelength optical signal might be required. The specific conditioning processes depend on the OTM-nr interface type (see ITU-T Rec. G.959.1). The processes OA, DAc, DAa and PMDC as defined in 8.11.2 are possible.

Common processes

OM (Optical Multiplexing): See 8.11.1.

Optical signal pre-conditioning: Pre-conditioning of the multi-wavelength optical signal might be required. The specific conditioning processes depend on the OTM-nr interface type (see ITU-T Rec. G.959.1). The processes OA and DAa as defined in 8.11.2 are possible.

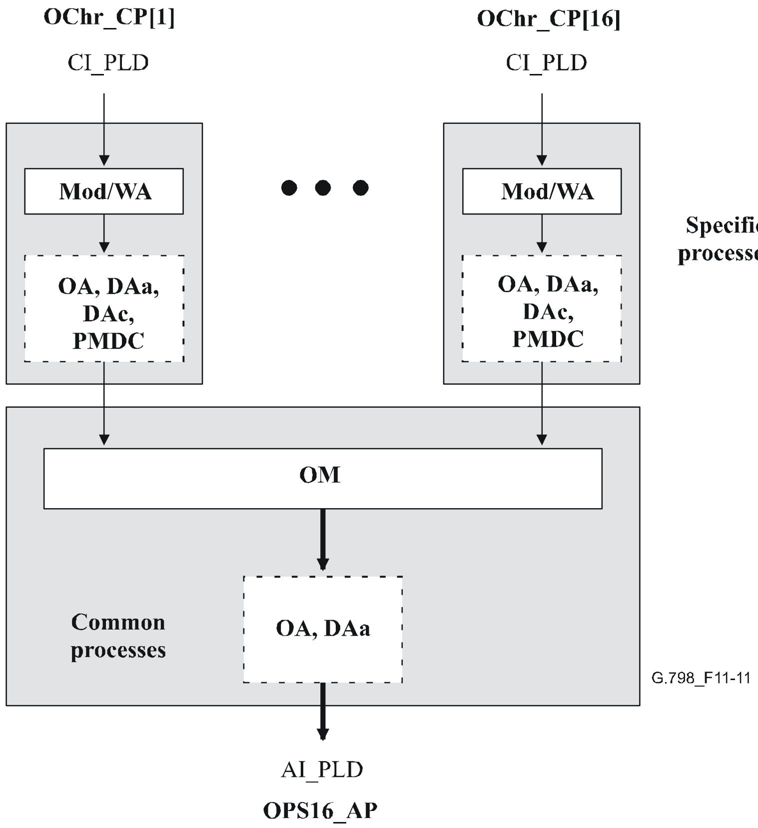


Figure 11-11/G.798 – OPS16/OChr_A_So processes

Defects: None.

Consequent actions: None.

Defect correlations: None.

Performance monitoring: None.

11.3.3 OPS16 to OChr adaptation sink function (OPS16/OChr_A_Sk)

The information flow and processing of the OPS16/OChr_A_Sk function is defined with reference to Figures 11-12 and 11-13.

Symbol

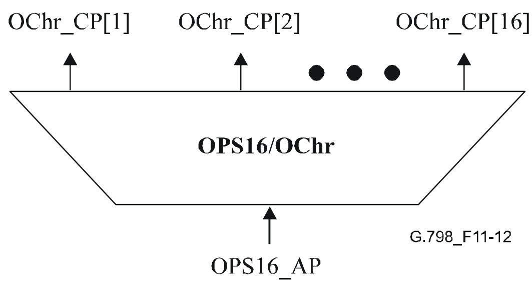


Figure 11-12/G.798 – OPS16/OChr_A_Sk function

Interfaces

Table 11-6/G.798 – OPS16/OChr_A_Sk inputs and outputs

Input(s)	Output(s)
OPS16_AP: OPS16_AI_PLD OPS16_AI_TSF-P	**per OChr_CP**: OChr_CI_PLD OChr_CI_SSF-P

Processes

The processes associated with the OPS16/OChr_A_Sk function are specific processes for each OChr signal and common processes for the compound signal as depicted in Figure 11-13.

Common processes

ODM/WS (Optical Demultiplexing and Wavelength Selection): See 8.11.1. For the parameters, see ITU-T Rec. G.959.1.

Optical signal post-conditioning: Post-conditioning of the multi-wavelength signal might be required. The specific conditioning processes depend on the OTM-nr interface type (see ITU-T Rec. G.959.1). The processes OA, DAa and PMDC as defined in 8.11.2 are possible.

Specific processes

DMod (Optical Carrier Demodulation): See 8.11.1.

Optical signal post-conditioning: Post-conditioning of the single wavelength signal might be required. The specific conditioning processes depend on the OTM-nr interface type (see ITU-T Rec. G.959.1). The processes OA, DAc, DAa and PMDC as defined in 8.11.2 are possible.

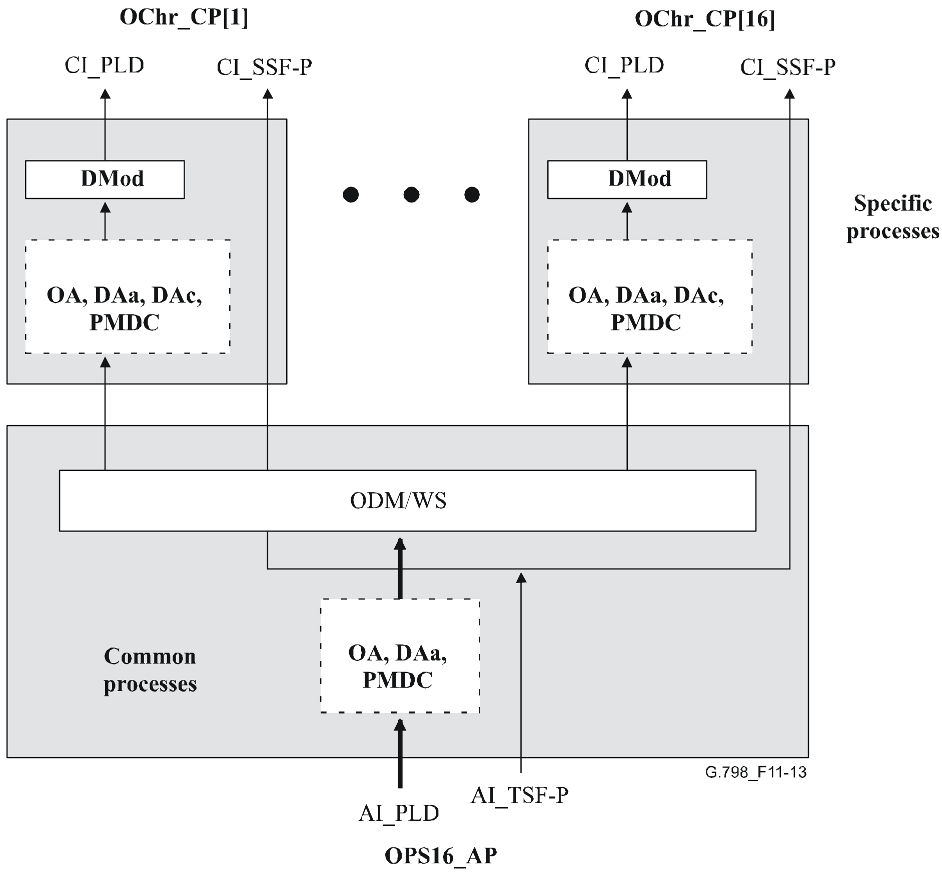


Figure 11-13/G.798 – OPS16/OChr_A_Sk processes

Defects: None.

Consequent actions

The OPS16/OChr_A_Sk function performs the following consequent actions.

aSSF-P[1..16] ← AI_TSF-P

Defect correlations: None.

Performance monitoring: None.

12 OCh (Layer) functions

Two distinct flavours of the OCh layer and related functionality exist as shown in Figure 12-1. The OCh layer with full functionality using non-associated overhead and the OChr layer with reduced functionality and without non-associated overhead. Each layer has its distinct trail termination functions, while the adaptation functions are used by both. The connection function is only defined for the OCh layer and not for the OChr layer.

The information crossing the OCh (trail) connection point (OCh_CP/TCP) is referred to as the OCh characteristic information (OCh_CI). The information crossing the OChr connection point (OChr_CP) is referred to as the OChr characteristic information (OChr_CI). The information crossing the OCh access point (OCh_AP) is referred to as the OCh adapted information (OCh_AI).

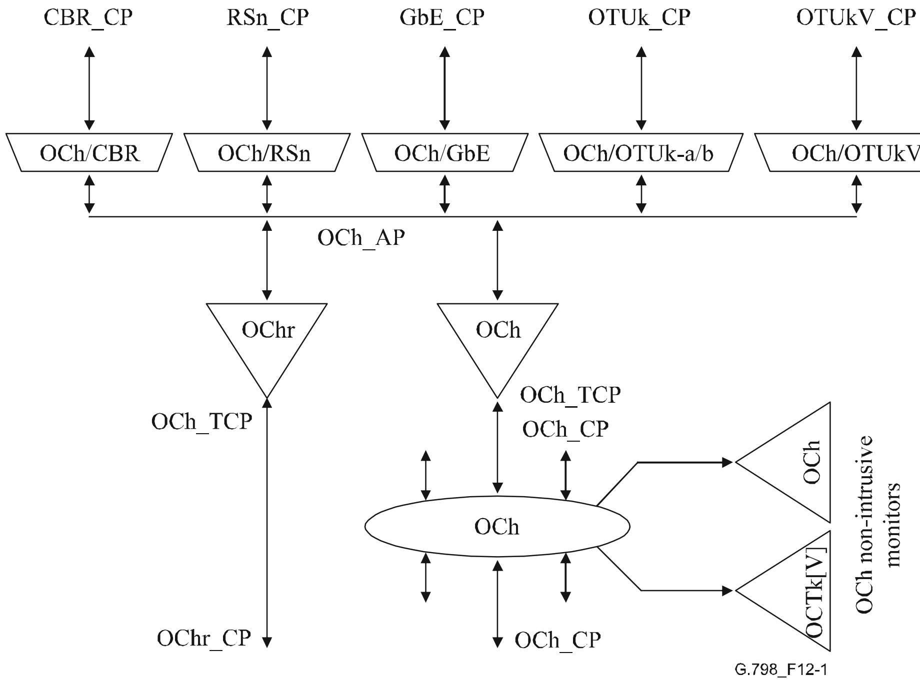


Figure 12-1/G.798 – OCh/OChr layer network and client layer adaptation functions

The OCh Characteristic Information (OCh_CI) consists of the OCh characteristic information payload (OCh_CI_PLD), which is a single traffic signal, and OCh characteristic information overhead (OCh_CI_OH), which is the OCh overhead information supported across the OCh_CP. The OOS may also contain general management communications. Figure 12-2 illustrates the overhead information elements that shall be supported by the OOS across the OCh_CP.

The specific OOS format is outside the scope of this Recommendation. In addition, vendor specific overhead might be supported via the OOS. This is outside the scope of this Recommendation.

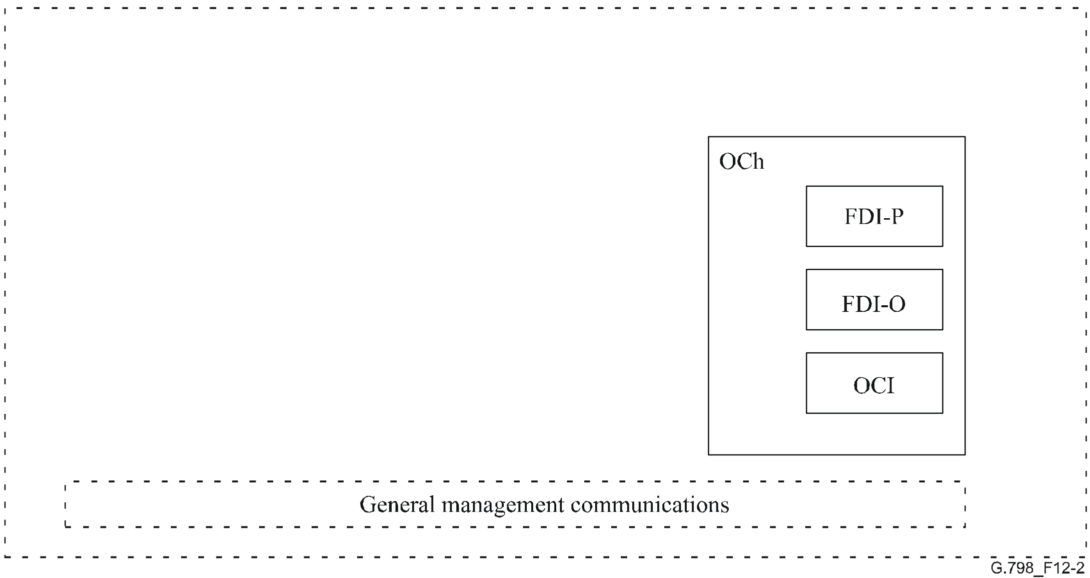


Figure 12-2/G.798 – OOS information elements at OCh_CP/TCP

The OChr Characteristic Information (OChr_CI) consists of the OChr characteristic information payload (OChr_CI_PLD), which is a single traffic signal.

The OCh Adapted Information (OCh_AI) consists of the single OCh data signal (OCh_AI_D). In case of an OTUk client signal, it is the OTUk signal as defined in ITU-T Rec. G.709/Y.1331.

12.1 Connection functions

12.1.1 OCh connection function (OCh_C)

The information flow and processing of the OCh_C function is defined with reference to Figures 12-3 and 12-4. The OCh_C function connects OCh characteristic information from its input ports to its output ports. As the process does not affect the nature of characteristic information, the reference points on either side of the OCh_C function are the same as illustrated in Figure 12-3.

The connection process is unidirectional and as such no differentiation in sink and source is required.

In addition the OCh_C function supports the following subnetwork connection protection scheme:

– 1+1 unidirectional SNC/N.

Other protection schemes are for further study.

NOTE 1 – The protection processes have a dedicated sink and source behaviour.

Symbol

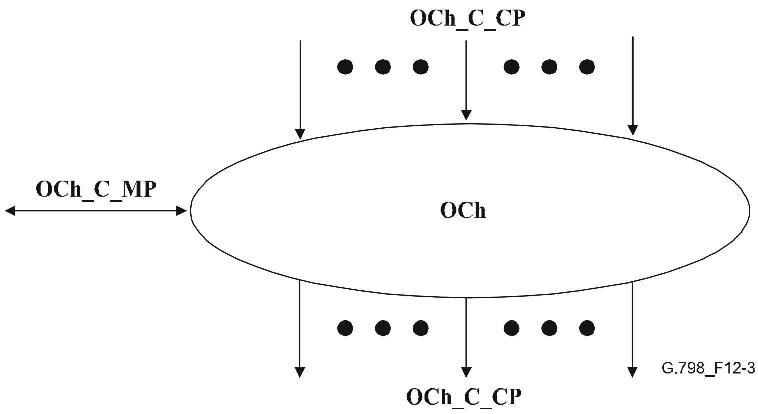


Figure 12-3/G.798 – OCh_C function

Interfaces

Table 12-1/G.798 – OCh_C function inputs and outputs

Input(s)	Output(s)
Per OCh_CP: OCh_CI_PLD OCh_CI_OH OCh_CI_SSF-P OCh_CI_SSF-O OCh_CI_TSF-P (Note) **OCh_C_MP**: MI_MatrixControl **Per protection group**: OCh_C_MI_OperType OCh_C_MI_WTR OCh_C_MI_HoTime OCh_C_MI_ExtCMD OCh_C_ MI_TSF-ODis	**Per OCh_CP**: OCh_CI_PLD OCh_CI_OH OCh_CI_SSF-P OCh_CI_SSF-O **OCh_C_MP**: For further study
NOTE – In case of SNC/N protection.	

Processes

The processes associated with the OCh_C function are as depicted in Figure 12-4.

OCh_CI is routed between input and output connection points by means of a matrix connection. Connection points may be allocated within a protection group.

NOTE 2 – Neither the number of input/output signals to the connection function, nor the connectivity is specified in this Recommendation. That is a property of individual network elements.

Routing: The function shall be able to connect a specific input with a specific output by means of establishing a matrix connection between the specified input and output and it shall be able to remove an established matrix connection as defined by MI_MatrixControl.

Each (matrix) connection in the OCh_C function should be characterized by the:

- Type of connection: unprotected, 1+1 unidirectional protected;
- Traffic direction: unidirectional, bidirectional;
- Input and Output connection points: set of connection points.

NOTE 3 – Broadcast connections are handled as separate connections to the same CP.

NOTE 4 – For the case a network element supports 1+1 protected matrix connections in its OCh_C function, this function may contain at any moment in time either all unprotected matrix connections, or all 1+1 protected matrix connections, or a mixture of unprotected and 1+1 protected matrix connections. The actual set of matrix connections and associated connection types and directions are operational parameters controlled by network management.

Provided no protection switching action is activated/required, the following changes to (the configuration of) a connection shall be possible without disturbing the CI passing the connection:

– addition and removal of protection;

– addition and removal of connections to/from a broadcast connection;

– change of WTR time;

– change of operation type;

– change of Hold-off time.

Open Connection Indication (OCI): If an output of the connection function is not connected to an input, the OCI maintenance signal is generated for the overhead of the outgoing signal (CI_OH). No optical payload CI_PLD is available. CI_SSF-P and CI_SSF-O are false.

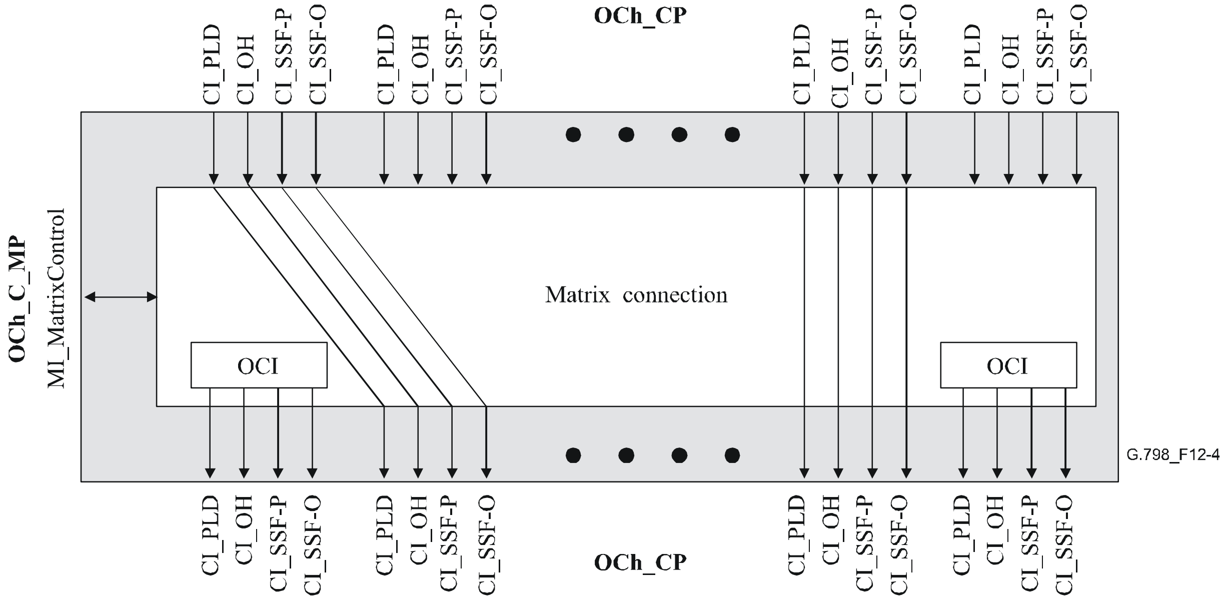


Figure 12-4/G.798 – OCh_C function processes

Defects: None.

Consequent actions: None.

Defect correlations: None.

Performance monitoring: None.

12.1.1.1 Sub-Network connection protection process

NOTE – This process is active in the OCh_C function as many times as there are 1+1 protected matrix connections.

The basic subnetwork connection protection mechanism is identical to the SDH subnetwork connection process described in ITU-T Rec. G.841.

SNC protection with non-intrusive monitoring (SNC/N) is supported.

Figure 12-5 gives the atomic functions involved in SNC/N protection. The working and protection OCh_CI coming from an OMSn/OCh_A function are monitored by an OCh non-intrusive monitor, which provides the TSF-P protection switching criteria.

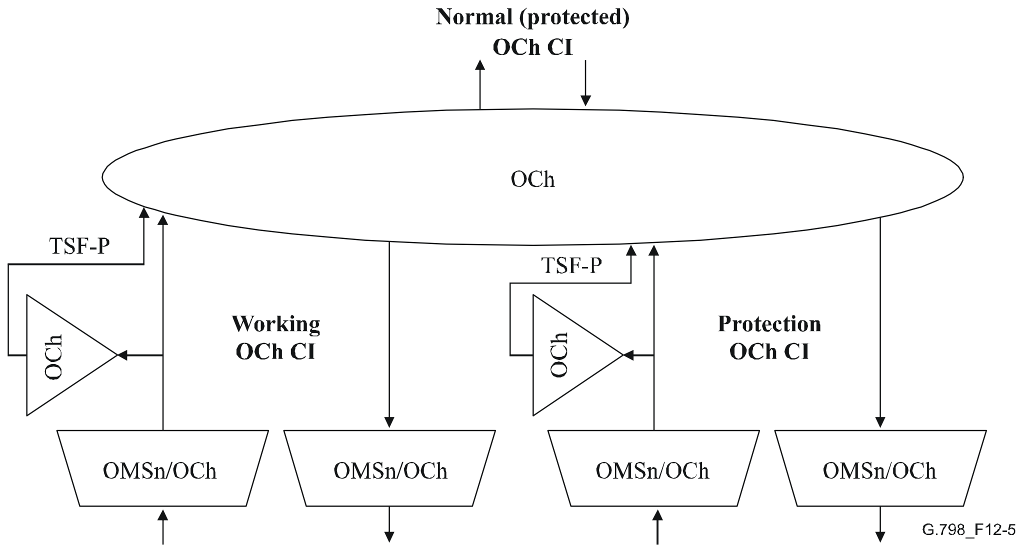


Figure 12-5/G.798 – SNC/N protection atomic functions

The protection functions at both ends operate the same way, by monitoring working and protection subnetwork connections for defects, evaluating the system status taking into consideration the priorities of defect conditions and of external switch requests, and switching the appropriate channel to the protected (sub)network connection.

The signal flow associated with the OCh_C SNC protection process is described with reference to Figure 12-6. The protection process receives control parameters and external switch requests at the MP reference point. The report of status information at the MP reference point is for further study.

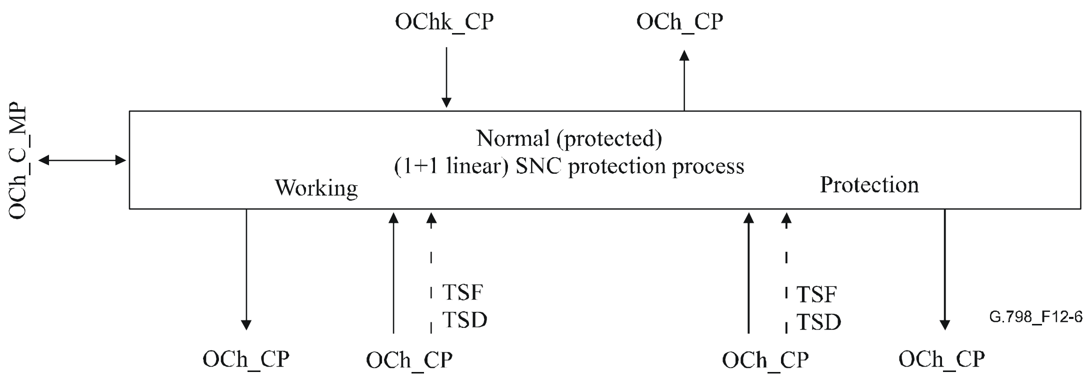


Figure 12-6/G.798 – SNC/N protection process

Source direction

For 1+1 architecture, the CI coming from either the normal (protected) OCh_CP is bridged permanently to both the working and protection OCh_CP.

Sink direction

For a 1+1 architecture, the CI coming either from the working or protection OCh_CP is switched to the normal (protected) OCh_CP. A switchover from working to protection OCh_CP or vice versa is initiated by the switch initiation criteria defined below.

Switch initiation criteria

Automatic protection switching is based on the defect conditions of the working and protection (sub)network connections. These condition(s) are for SNC/N trail signal fail payload (TSF-P) and trail signal fail overhead (TSF-O). The use of TSF-O as protection switching criteria can be disabled (MI_TSF-ODis). The priority of TSF-P shall be equal to Signal Fail as defined in ITU-T Rec. G.841. The priority of TSF-O shall be equal to Signal Degrade as defined in ITU-T Rec. G.841.

In order to allow interworking between nested protection schemes a hold-off timer is provided. The hold-off timer delays switch initiation in case of signal fail in order to allow a nested protection to react and clear the fault condition. The hold-off timer is started by the activation of signal fail and runs for the hold-off time. Protection switching is only initiated if signal fail is still present at the end of the hold-off time. The hold-off time shall be provisionable between 0 and 10 s in steps of 100 ms.

Protection switching can also be initiated by external switch commands received via the MP.

Depending on the mode of operation, internal states (e.g., wait to restore) may also initiate a switch over.

See the switch initiation criteria described in ITU-T Rec. G.841.

Switching time

Refer to ITU-T Rec. G.841.

Switch restoration

In the revertive mode of operation, the protected signal shall be switched back from the protection (sub)network connection to the working (sub)network connection when the working (sub)network connection has recovered from the fault.

To prevent frequent operation of the protection switch due to an intermittent fault, a failed working (sub)network connection must become fault-free for a certain period of time before it is used again. This period, called wait-to-restore (WTR) period should be of the order of 5-12 minutes and should be capable of being set.

In the non-revertive mode of operation, no switch back to the working (sub)network connection is performed when it has recovered from the fault.

Protection switching notifications to the MP are for further study.

12.2 Termination functions

12.2.1 OCh trail termination function (OCh_TT)

The OCh_TT functions are responsible for the end-to-end supervision of the OCh trail. They provide full functionality based on the non-associated overhead information. Figure 12-7 shows the combination of the unidirectional sink and source functions to form a bidirectional function.

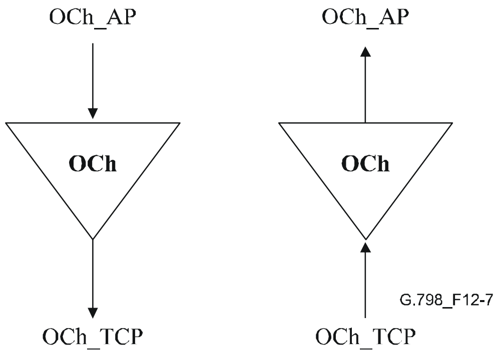


Figure 12-7/G.798 – OCh_TT

12.2.1.1 OCh trail termination source function (OCh _TT_So)

The OCh_TT_So function conditions the data for transmission over the optical medium and presents it at the OCh_TCP. The information flow and processing of the OCh_TT_So function is defined with reference to Figures 12-8 and 12-9.

Symbol

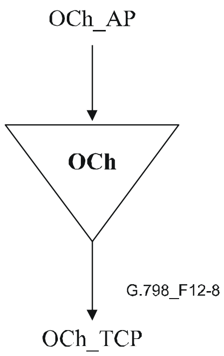


Figure 12-8/G.798 – OCh_TT_So function

Interfaces

Table 12-2/G.798 – OCh_TT_So inputs and outputs

Input(s)	Output(s)
OCh_AP: OCh_AI_D	**OCh_TCP**: OCh_CI_PLD

Processes

The processes associated with the OCh_TT_So function are as depicted in Figure 12-9.

Payload generation: The function shall generate the OCh payload signal (baseband signal). The physical specifications of the signal are outside the scope of this Recommendation.

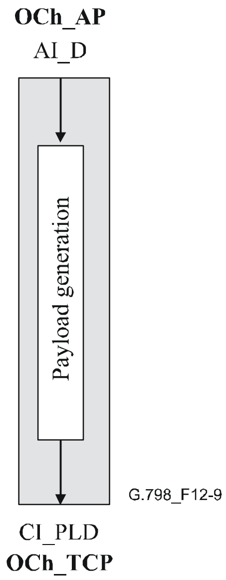


Figure 12-9/G.798 – OCh_TT_So processes

Defects: None.

Consequent actions: None.

Defect correlations: None.

Performance monitoring: None.

12.2.1.2 OCh trail termination sink function (OCh_TT_Sk)

The OCh_TT_Sk function recovers the OCh payload signal and reports the state of the OCh trail. It extracts the OCh overhead – including the FDI-P, FDI-O, and OCI signals – from the OCh signal at its OCh_TCP, detects for LOS, OCI, FDI-P and FDI-O defects.

Symbol

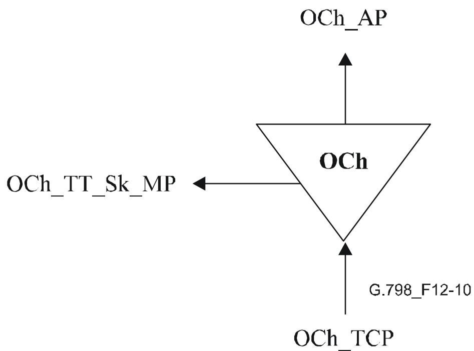


Figure 12-10/G.798 – OCh_TT_Sk function

Interfaces

Table 12-3/G.798 – OCh_TT_Sk inputs and outputs

Input(s)	Output(s)
OCh_TCP: OCh_CI_PLD OCh_CI_OH OCh_CI_SSF-P OCh_CI_SSF-O	**OCh_AP**: OCh_AI_D OCh_AI_TSF-P OCh_AI_TSF-O **OCh_TT_Sk_MP**: OCh_TT_Sk_MI_cLOS-P OCh_TT_Sk_MI_cOCI OCh_TT_Sk_MI_cSSF OCh_TT_Sk_MI_cSSF-P OCh_TT_Sk_MI_cSSF-O

Processes

The processes associated with the OCh_TT_So function are as depicted in Figure 12-11.

Payload recovery: This function shall recover the OCh payload signal. The physical specifications of the signal are outside the scope of this Recommendation.

FDI-P: The FDI-P information (OCh-FDI-P) shall be extracted from the OCh overhead of the OOS. It shall be used for FDI-P defect detection. The specific implementation for extracting FDI-P from the OOS and detecting its value is outside the scope of this Recommendation.

FDI-O: The FDI-O information (OCh-FDI-O) shall be extracted from the OCh overhead of the OOS. It shall be used for FDI-O defect detection. The specific implementation for extracting FDI-O from the OOS and detecting its value is outside the scope of this Recommendation.

OCI: The OCI information (OCh-OCI) shall be extracted from the OCh overhead of the OOS. It shall be used for OCI defect detection. The specific implementation for extracting OCI from the OOS and detecting its value is outside the scope of this Recommendation.

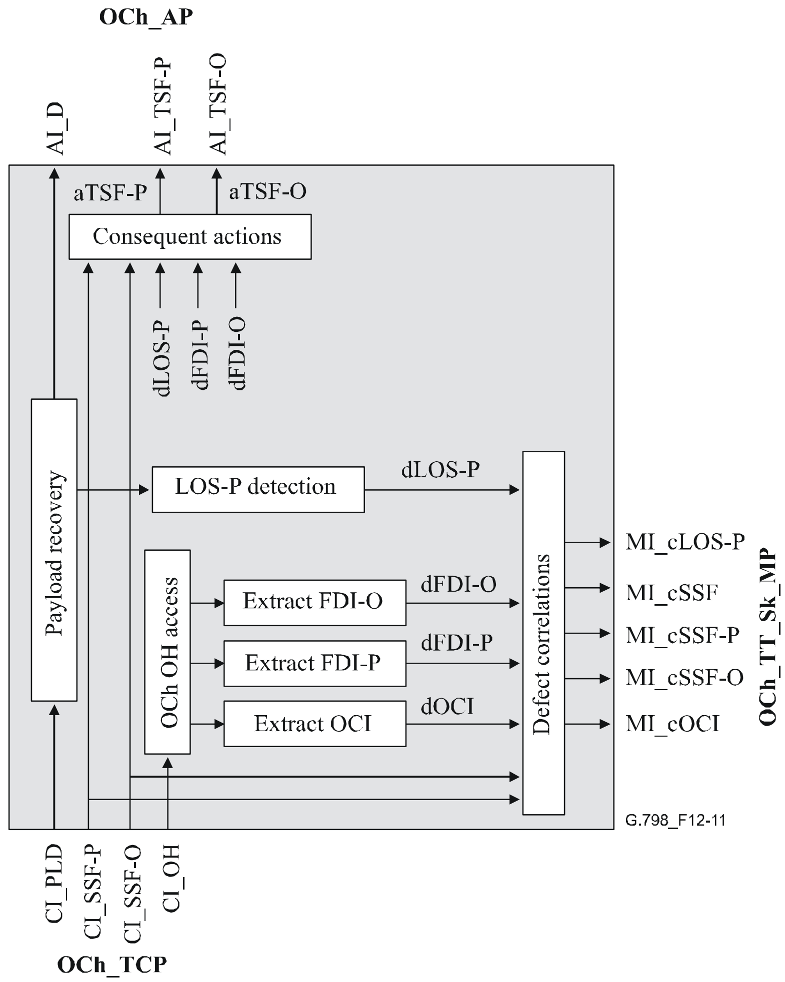


Figure 12-11/G.798 – OCh_TT_Sk processes

Defects

The function shall detect for dLOS-P, dFDI-P, dFDI-O and dOCI.

NOTE – Detection of additional OOS related defects might be required (see 6.2.8). This depends on the specific OOS format and is outside the scope of this Recommendation.

dLOS-P: See 6.2.1.1.

dFDI-P: See 6.2.6.1.1.

dFDI-O: See 6.2.6.2.1.

dOCI: See 6.2.6.8.1; dOCI shall be set to false during CI_SSF-O and dFDI-O.

Consequent actions

The function shall perform the following consequent actions:

aTSF-P ← CI_SSF-P or dLOS-P or dOCI or dFDI-P

aTSF-O ← CI_SSF-O or dFDI-O

Defect correlations

The function shall perform the following defect correlations to determine the most probable fault cause. This fault cause shall be reported to the EMF.

cLOS-P ← dLOS-P and (not dOCI) and (not FDI-P) and (not CI_SSF-P) cOCI ← dOCI and (not CI_SSF-P) and (not CI_SSF-O) and (not FDI-O) and (not FDI-P)

cSSF ← (CI_SSF-P or dFDI-P) and (CI_SSF-O or dFDI-O)

cSSF-P ← (CI_SSF-P or dFDI-P) and (not cSSF)

cSSF-O ← (CI_SSF-O or dFDI-O) and (not cSSF)

Performance monitoring

For further study.

12.2.2 OChr trail termination function (OChr_TT)

The OChr_TT functions are responsible for the end-to-end supervision of the OChr trail. They provide only reduced functionality as no non-associated overhead information is available. Figure 12-12 shows the combination of the unidirectional sink and source functions to form a bidirectional function.

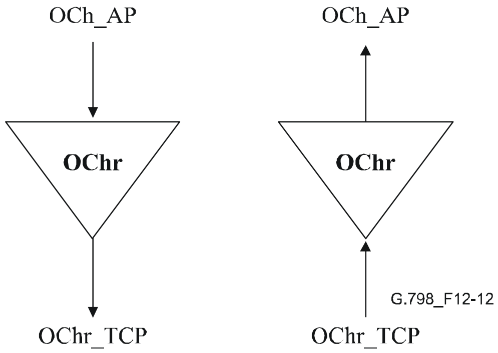


Figure 12-12/G.798 – OChr_TT

12.2.2.1 OChr trail termination source function (OChr _TT_So)

The OChr_TT_So function conditions the data for transmission over the optical medium and presents it at the OChr_TCP.

The information flow and processing of the OChr_TT_So function is defined with reference to Figures 12-13 and 12-14.

Symbol

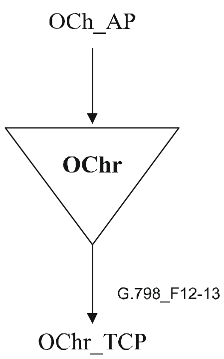


Figure 12-13/G.798 – OChr_TT_So function

Interfaces

Table 12-4/G.798 – OChr_TT_So inputs and outputs

Input(s)	Output(s)
OCh_AP: OCh_AI_D	**OChr_TCP**: OChr_CI_PLD

Processes

The processes associated with the OChr_TT_So function are as depicted in Figure 12-14.

Payload generation: The function shall generate the OChr payload signal (baseband signal). The physical specifications of the signal are defined in ITU-T Rec. G.959.1.

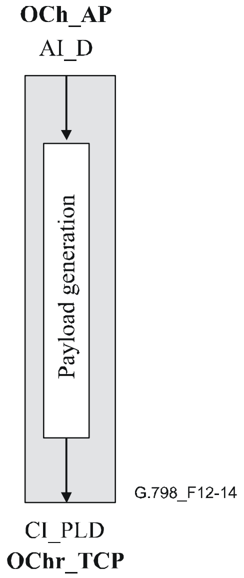


Figure 12-14/G.798 – OChr_TT_So processes

Defects: None.

Consequent actions: None.

Defect correlations: None.

Performance monitoring: None.

12.2.2.2 OChr trail termination sink function (OChr_TT_Sk)

The OChr_TT_Sk function recovers the OCh payload signal and reports the state of the OChr trail. It detects for LOS of the payload signal.

The information flow and processing of the OChr_TT_Sk function is defined with reference to Figures 12-15 and 12-16.

Symbol

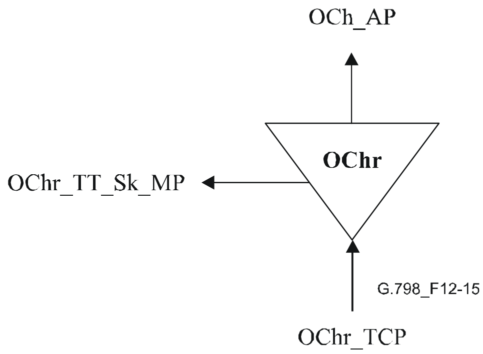


Figure 12-15/G.798 – OChr_TT_Sk function

Interfaces

Table 12-5/G.798 – OChr_TT_Sk inputs and outputs

Input(s)	Output(s)
OChr_TCP: OChr_CI_PLD OChr_CI_SSF-P	**OCh_AP**: OCh_AI_D OCh_AI_TSF-P **OChr_TT_Sk_MP**: OChr_TT_Sk_MI_cLOS OChr_TT_Sk_MI_cSSF-P

Processes

The processes associated with the OChr_TT_Sk function are as depicted in Figure 12-16.

Payload recovery: This function shall recover the OChr payload signal. The physical characteristics of the signal are defined in ITU-T Rec. G.959.1.

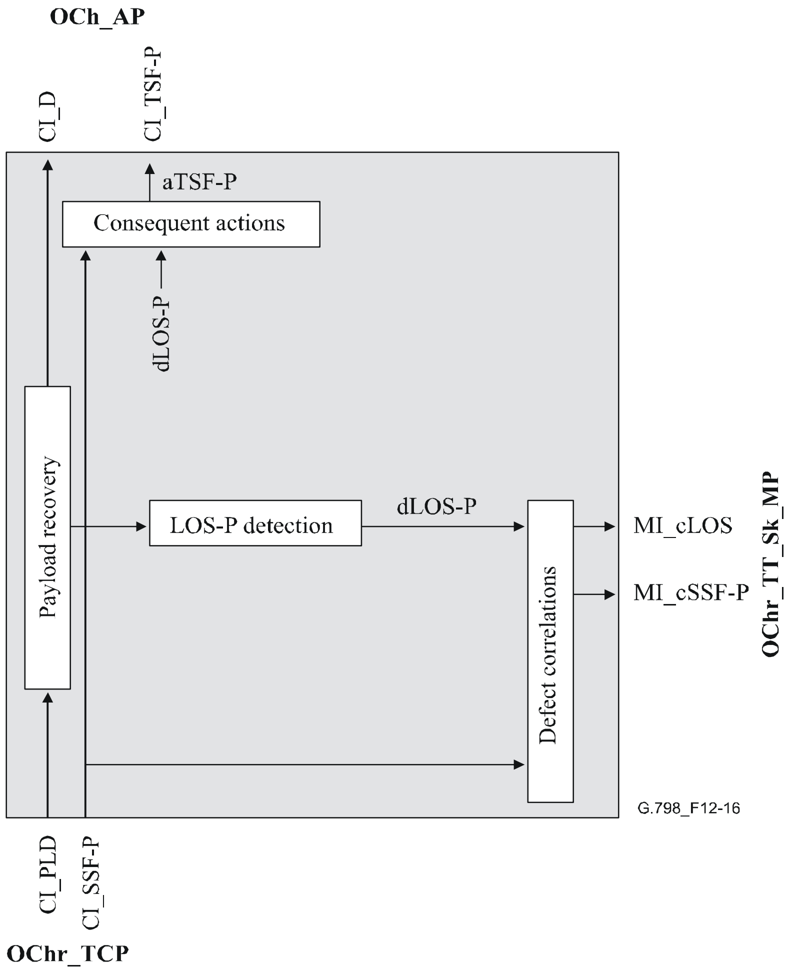


Figure 12-16/G.798 – OChr_TT_Sk processes

Defects

The function shall detect for dLOS-P.

dLOS-P: See 6.2.1.1.

Consequent actions

The function shall perform the following consequent actions:

aTSF-P ← CI_SSF-P or dLOS-P

Defect correlations

The function shall perform the following defect correlations to determine the most probable fault cause.

cLOS ← dLOS and (not CI_SSF-P)

cSSF-P ← CI_SSF-P

Performance monitoring

For further study.

12.2.3 OCh non-intrusive monitor function

As the functionality of the OCh non-intrusive monitor function is identical to the OCh_TT_Sk function (see 12.2.1.2), no dedicated OCh non-intrusive monitoring function OChm_TT_Sk is defined. For OCh non-intrusive monitoring, the OCh_TT_Sk function can be connected to the OCh_CP as shown in Figure 12-17. The OCh_TT_Sk function can be connected to any OCh_CP in this manner.

The unused outputs (e.g., OCh_AI_D) are left open. The TSF and TSD outputs can be connected to an OCh_C connection function and used as protection switching trigger criteria for SNC/N protection.

The unused outputs (e.g., OCh_AI_D) are left open.

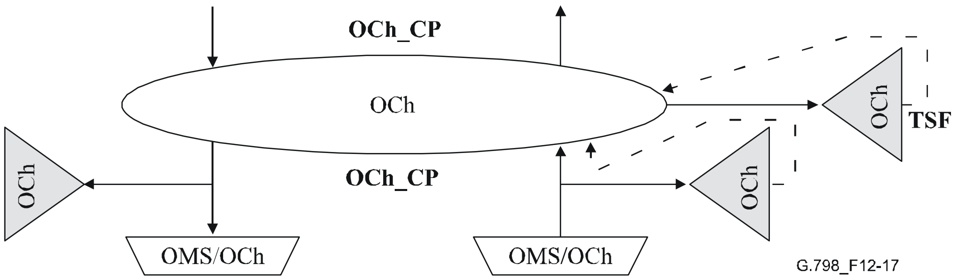


Figure 12-17/G.798 – Connection of OCh_TT_Sk function as non-intrusive monitor

12.2.4 Combined OCh and OTUk[V] non-intrusive monitor function (OCTk[V]m)

As the OCh and OTUk[V] termination are always co-located in an OTN network, a combined OCh and OTUk[V] non-intrusive monitor is defined as a compound function OCTk[V]m. The OCTk[V]m compound functions is the combination of a OCh_TT_Sk (see 12.2.1.2), OCh/OTUk[V]_A_Sk (see 12.3.1 and 12.3.2.2) and OTUk[V]_TT_Sk (see 13.2.1.2 and 13.2.2.2) as shown in Figure 12-18. For the OCh/OTUk_A, either an OCh/OTUk-a_A_Sk with FEC (see 12.3.1.3) or an OCh/OTUk-b_A_Sk without FEC (see 12.3.1.4) can be used. This depends on the specific application and OTUk signal.

For non-intrusive monitoring, the OCTk[V]m function can be connected to the OCh_CP as shown in Figure 12-19. The OCTk[V]m function can be connected to any OCh_CP in this manner.

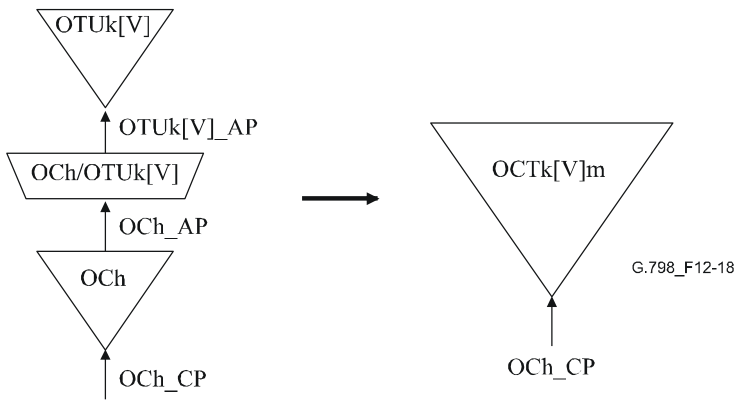


Figure 12-18/G.798 – OCTk[V]m compound function

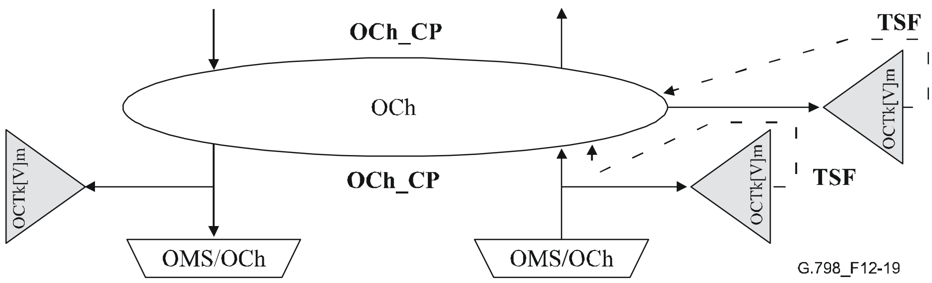


Figure 12-19/G.798 – Connection OCTk[V]m compound function (non-intrusive monitor)

12.3 Adaptation functions

12.3.1 OCh to OTUk adaptation function (OCh/OTUk_A)

The OCh to OTUk adaptation functions perform the adaptation between the OCh layer adapted information and the characteristic information of completely standardized OTUk layer signal. Two types of functions are defined. One that supports forward error correction (FEC) and one that does not support FEC.

12.3.1.1 OCh to OTUk adaptation source function with FEC (OCh/OTUk-a_A_So)

The information flow and processing of the OCh/OTUk-a_A_So function is defined with reference to Figures 12-20 and 12-21.

Symbol

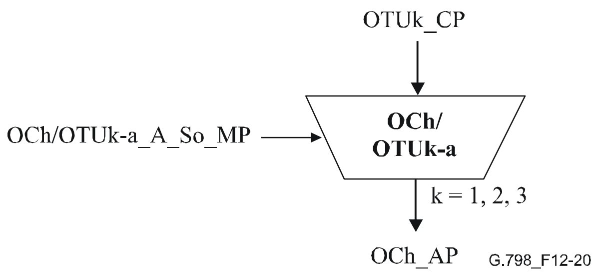


Figure 12-20/G.798 – OCh/OTUk-a_A_So function

Interfaces

Table 12-6/G.798 – OCh/OTUk-a_A_So inputs and outputs

Input(s)	Output(s)
OTUk_CP: OTUk_CI_CK OTUk_CI_D OTUk_CI_FS OTUk_CI_MFS **OCh/OTUk-a_A_So_MP**: OCh/OTUk-a_A_So_MI_Active	**OCh_AP**: OCh_AI_D

Processes

The processes associated with the OCh/OTUk-a_A_So function are as depicted in Figure 12-21.

Activation

– The OCh/OTUk-a_A_So function shall access the access point when it is activated (MI_Active is true). Otherwise, it shall not access the access point.

FAS/MFAS insertion: The function shall insert the FAS and MFAS into the OTUk OH area as described in ITU-T Rec. G.709/Y.1331.

FEC encoder: The function shall generate the RS(255,239) FEC code as defined in Annex A/G.709/Y.1331 and insert it into the OTUk FEC area.

Scrambler: The function shall scramble the signal as defined in 11.2/G.709/Y.1331.

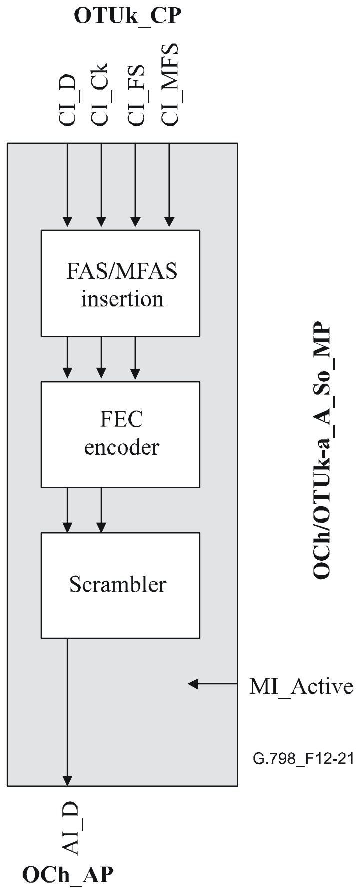


Figure 12-21/G.798 – OCh/OTUk-a_A_So processes

Defects: None.

Consequent actions: None.

Defect correlations: None.

Performance monitoring: None.

12.3.1.2 OCh to OTUk adaptation source function without FEC (OCh/OTUk-b_A_So)

The information flow and processing of the OCh/OTUk-b_A_So function is defined with reference to Figures 12-22 and 12-23.

Symbol

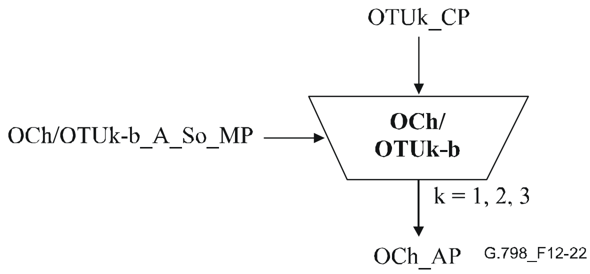


Figure 12-22/G.798 – OCh/OTUk-b_A_So function

Interfaces

Table 12-7/G.798 – OCh/OTUk-b_A_So inputs and outputs

Input(s)	Output(s)
OTUk_CP: OTUk_CI_CK OTUk_CI_D OTUk_CI_FS OTUk_CI_MFS **OCh/OTUk-b_A_So_MP**: OCh/OTUk-b_A_So_MI_Active	**OCh_AP**: OCh_AI_D

Processes

The processes associated with the OCh/OTUk-b_A_So function are as depicted in Figure 12-23.

Activation

– The OCh/OTUk-b_A_So function shall access the access point when it is activated (MI_Active is true). Otherwise, it shall not access the access point.

FAS/MFAS insertion: The function shall insert the FAS and MFAS into the OTUk OH area as described in ITU-T Rec. G.709/Y.1331.

Scrambler: The function shall scramble the signal as defined in 11.2/G.709/Y.1331.

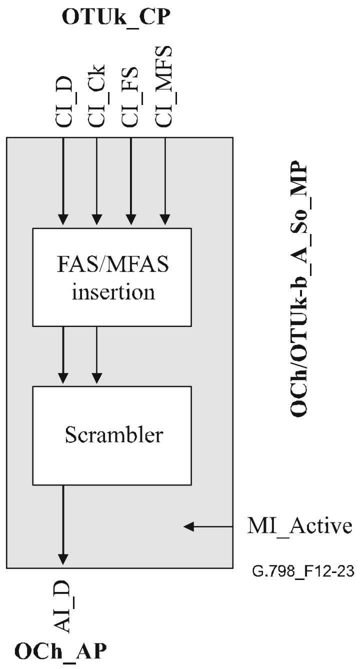


Figure 12-23/G.798 – OCh/OTUk-b_A_So processes

Defects: None.

Consequent actions: None.

Defect correlations: None.

Performance monitoring: None.

12.3.1.3 OCh to OTUk adaptation sink function with FEC (OCh/OTUk-a_A_Sk)

The information flow and processing of the OCh/OTUk-a_A_Sk function is defined with reference to Figures 12-24 and 12-25.

Symbol

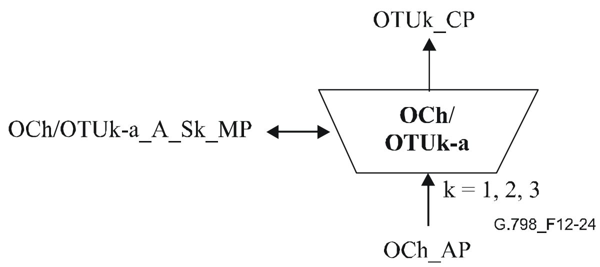


Figure 12-24/G.798 – OCh/OTUk-a_A_Sk function

Interfaces

Table 12-8/G.798 – OCh/OTUk-a_A_Sk inputs and outputs

Input(s)	Output(s)
OCh_AP: OCh_AI_D OCh_AI_TSF **OCh/OTUk-a_A_Sk_MP**: OCh/OTUk-a_A_Sk_MI_FECEn OCh/OTUk-a_A_Sk_MI_Active OCh/OTUk-a_A_Sk_MI_1second	**OTUk_CP**: OTUk_CI_CK OTUk_CI_D OTUk_CI_FS OTUk_CI_MFS OTUk_CI_SSF **OCh/OTUk-a_A_Sk_MP**: OCh/OTUk-a_A_Sk_MI_cLOF OCh/OTUk-a_A_Sk_MI_cLOM OCh/OTUk-a_A_Sk_MI_pFECcorrErr

Processes

The processes associated with the OCh/OTUk-a_A_Sk function are as depicted in Figure 12-25.

Activation

– The OCh/OTUk-a_A_Sk function shall access the access point and perform the Common and Specific Processes operation specified below when it is activated (MI_Active is true). Otherwise, it shall activate the SSF signals at its output (CP) and not report its status via the management point.

Clock recovery: The function shall recover the OTUk clock signal from the incoming data. The function shall introduce no errors in case of jitter and wander as defined in clause 6/G.8251.

Frame alignment: The function shall recover the OTUk frame start as described in 8.2.1.

Descrambler: The function shall perform descrambling as defined in 11.2/G.709/Y.1331.

FEC decoder: If FEC processing is enabled (MI_FECEn = true), the function shall extract the RS(255,239) FEC data from the OTUk FEC area and perform error correction as defined in Annex A/G.709/Y.1331. The number of corrected bits shall be reported (nFECcorrErr). Otherwise, the FEC data is ignored and no error correction is performed.

Multiframe alignment: The function shall recover the OTUk multiframe start as described in 8.2.2.

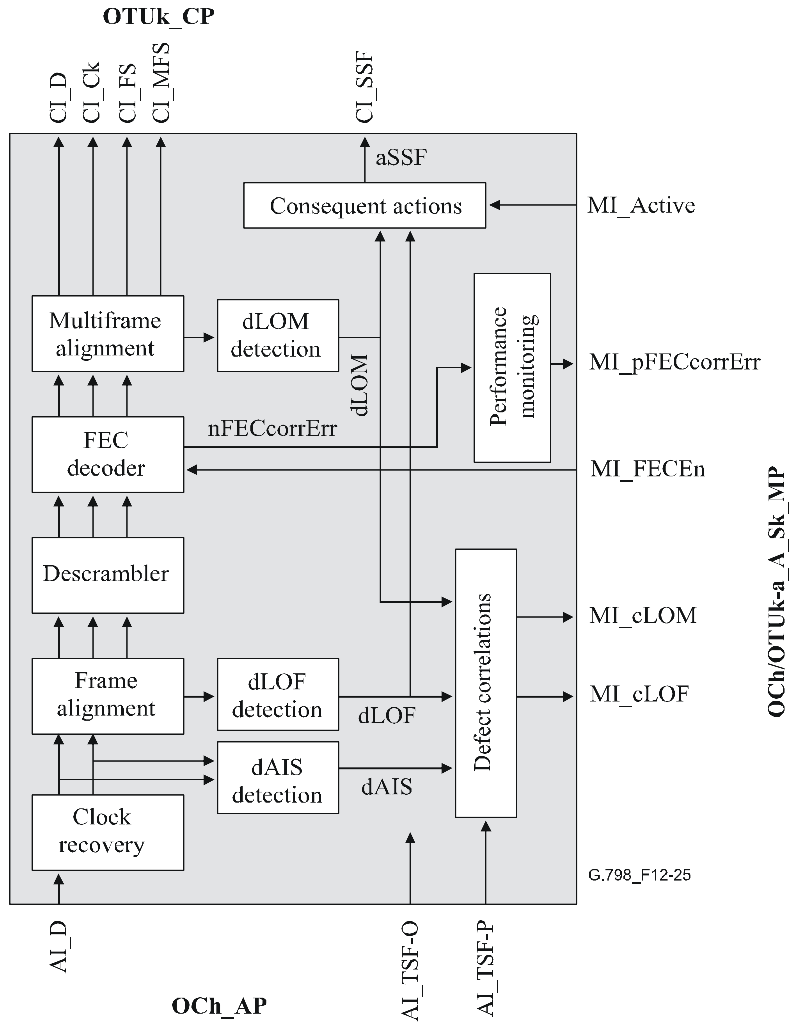


Figure 12-25/G.798 – OCh/OTUk-a_A_Sk processes

Defects

The function shall detect for dAIS, dLOF and dLOM.

dAIS: See 6.2.6.3.1.

dLOF: See 6.2.5.1.

dLOM: See 6.2.5.2.

Consequent actions

aSSF ← dAIS or dLOF or dLOM or AI_TSF-P or (not MI_Active)

Defect correlations

cLOF ← dLOF and (not dAIS) and (not AI_TSF-P)

cLOM ← dLOM and (not dLOF) and (not dAIS) and (not AI_TSF-P)

NOTE 1 – dAIS is not reported as fault cause as it is a secondary alarm and will result in aSSF, which is reported as cSSF fault cause in the OTUk_TT_Sk that directly follows this function.

Performance monitoring

The function shall perform the following performance monitoring primitives processing. The performance monitoring primitives shall be reported to the EMF.

pFECcorrErr ← $\sum$ nFECcorrErr

NOTE 2 – During AI_TSF-P, dAIS, dLOF and dLOM no corrected bits shall be counted.

12.3.1.4 OCh to OTUk adaptation sink function without FEC (OCh/OTUk-b_A_Sk)

The information flow and processing of the OCh/OTUk-b_A_Sk function is defined with reference to Figures 12-26 and 12-27.

Symbol

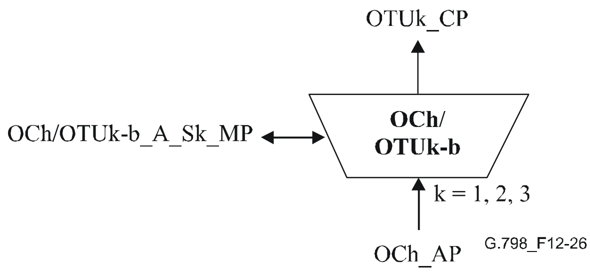


Figure 12-26/G.798 – OCh/OTUk-b_A_Sk function

Interfaces

Table 12-9/G.798 – OCh/OTUk-b_A_Sk inputs and outputs

Input(s)	Output(s)
OCh_AP: OCh_AI_D OCh_AI_TSF **OCh/OTUk-b_A_Sk_MP**: OCh/OTUk-b_A_Sk_MI_Active	**OTUk_CP**: OTUk_CI_CK OTUk_CI_D OTUk_CI_FS OTUk_CI_MFS OTUk_CI_SSF **OCh/OTUk-b_A_Sk_MP**: OCh/OTUk-b_A_Sk_MI_cLOF OCh/OTUk-b_A_Sk_MI_cLOM

Processes

The processes associated with the OCh/OTUk-b_A_Sk function are as depicted in Figure 12-27.

Activation

– The OCh/OTUk-b_A_Sk function shall access the access point and perform the Common and Specific Processes operation specified below when it is activated (MI_Active is true). Otherwise, it shall activate the SSF signals at its output (CP) and not report its status via the management point.

Clock recovery: The function shall recover the OTUk clock signal from the incoming data. The function shall introduce no errors in case of jitter and wander as defined in clause 6/G.8251.

Frame alignment: The function shall recover the OTUk frame start as described in 8.2.1.

Descrambler: The function shall perform descrambling as defined in 11.2/G.709/Y.1331.

Multiframe alignment: The function shall recover the OTUk multiframe start as described in 8.2.2.

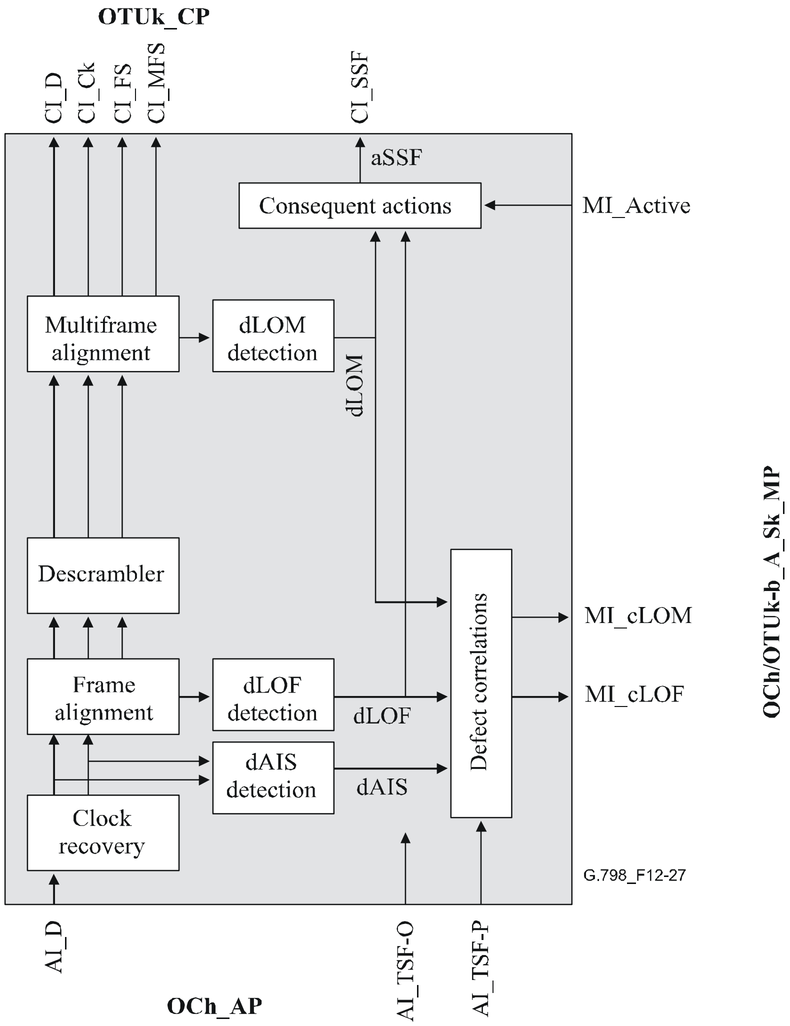


Figure 12-27/G.798 – OCh/OTUk-b_A_Sk processes

Defects

The function shall detect for dAIS, dLOF and dLOM.

dAIS: See 6.2.6.3.1.

dLOF: See 6.2.5.1.

dLOM: See 6.2.5.2.

Consequent actions

aSSF ← dAIS or dLOF or dLOM or AI_TSF-P or (not MI_Active)

NOTE – dAIS is not reported as fault cause as it is a secondary alarm and will result in aSSF, which is reported as cSSF fault cause in the OTUk_TT_Sk that directly follows this function.

Defect correlations

cLOF ← dLOF and (not dAIS) and (not AI_TSF-P)

cLOM ← dLOM and (not dLOF) and (not dAIS) and (not AI_TSF-P)

Performance monitoring: None.

12.3.2 OCh to OTUkV adaptation function (OCh/OTUkV_A)

The OCh to OTUkV adaptation functions perform the adaptation between the OCh layer adapted information and the characteristic information of functional standardized OTUkV layer signal.

12.3.2.1 OCh to OTUkV adaptation source function (OCh/OTUkV_A_So)

The information flow and processing of the OCh/OTUkV_A_So function is defined with reference to Figure 12-28.

Symbol

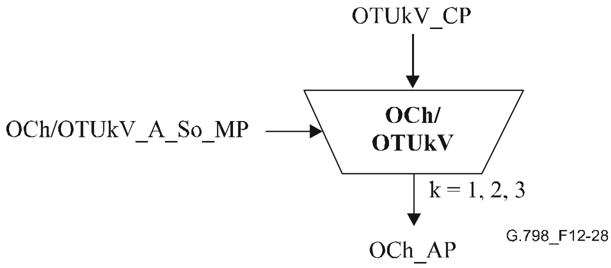


Figure 12-28/G.798 – OCh/OTUkV_A_So function

Interfaces

Table 12-10/G.798 – OCh/OTUkV_A_So inputs and outputs

Input(s)	Output(s)
OTUkV_CP: OTUkV_CI_CK OTUkV_CI_D OTUkV_CI_FS OTUkV_VI_MFS (Note) **OCh/OTUkV_A_So_MP**: OCh/OTUkV_A_So_MI_Active	**OCh_AP**: OCh_AI_D
NOTE – If the OTUkV has a multiframe.	

Processes

Activation

– The OCh/OTUkV_A_So function shall access the access point when it is activated (MI_Active is true). Otherwise, it shall not access the access point.

The OCh/OTUkV_A_So function provides all processes necessary for the adaptation to the OCh layer, which includes processes that ensure clock and frame recovery at the adaptation sink and optional forward error correction coding.

The specific processes are outside the scope of this Recommendation.

Defects: None.

Consequent actions: None.

Defect correlations: None.

Performance monitoring: None.

12.3.2.2 OCh to OTUkV adaptation sink function (OCh/OTUkV_A_Sk)

The information flow and processing of the OCh/OTUkV_A_Sk function is defined with reference to Figure 12-29.

Symbol

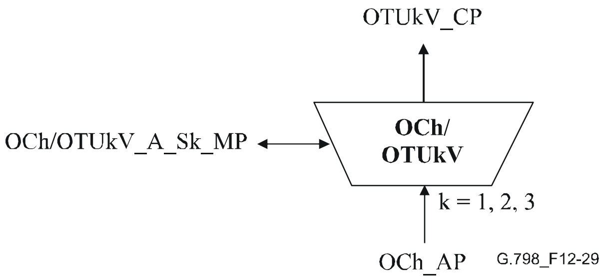


Figure 12-29/G.798 – OCh/OTUkV_A_Sk function

Interfaces

Table 12-11/G.798 – OCh/OTUkV_A_Sk inputs and outputs

Input(s)	Output(s)
OCh_AP: OCh_AI_D OCh_AI_TSF **OCh/OTUkV_A_Sk_MP**: OCh/OTUkV_A_Sk_MI_Active OCh/OTUkV_A_Sk_MI_1second (Note 2)	**OTUkV_CP**: OTUkV_CI_CK OTUkV_CI_D OTUkV_CI_FS OTUkV_CI_MFS (Note 1) OTUk_CI_SSF **OCh/OTUkV_A_Sk_MP**: OCh/OTUkV_A_Sk_MI_cLOF OCh/OTUkV_A_Sk_MI_cLOM (Note 1) OCh/OTUkV_A_Sk_MI_pFECcorrErr (Note 2)
NOTE 1 – If the OTUkV has a multiframe. NOTE 2 – If the function performs FEC.	

Processes

Activation

– The OCh/OTUkV_A_Sk function shall access the access point and perform the Common and Specific Processes operation specified below when it is activated (MI_Active is true). Otherwise, it shall activate the SSF signals at its output (CP) and not report its status via the management point.

The OCh/OTUkV_A_Sk function provides all processes necessary for the adaptation from the OCh layer, which includes processes for clock and frame start recovery and optional forward error correction decoding.

The specific processes are outside the scope of this Recommendation.

Defects

The function shall detect for dAIS and dLOF. If the OTUkV includes a multiframe, it shall in addition detect dLOM.

dAIS: See 6.2.6.3.1.

dLOF: The dLOF detection depends on the specific frame structure and is outside the scope of this Recommendation.

dLOM: The dLOM detection is only required if the OTUkV has a multiframe, the detection depends on the specific multiframe structure and is outside the scope of this Recommendation.

Consequent actions:

aSSF ← dAIS or dLOF or AI_TSF-P or dLOM or (not MI_Active)

NOTE 1 – dLOM is only included if the OTUkV has a multiframe.

Defect correlations

cLOF ← dLOF and (not dAIS) and (not AI_TSF-P)

cLOM ← dLOM and (not dLOF) and (not dAIS) and (not AI_TSF-P)

NOTE 2 – cLOM is only defined if the OTUkV has a multiframe.

NOTE 3 – dAIS is not reported as fault cause as it is a secondary alarm and will result in aSSF, which is reported as cSSF fault cause in the ODUk_TT_Sk that directly follows this function.

Performance monitoring

The function shall perform the following performance monitoring primitives processing if it includes FEC processing. The performance monitoring primitives shall be reported to the EMF.

pFECcorrErr ← $\sum$ nFECcorrErr

NOTE 4 – During AI_TSF-P, dAIS, dLOF and dLOM no corrected bits shall be counted.

12.3.3 OCh to CBRx adaptation (OCh/CBRx_A)

The OCh to CBRx adaptation functions perform the adaptation between the OCh layer adapted information and the characteristic information of a CBRx layer signal.

The parameter x defines the supported bit rate or bit rate range. The values x = 2G5, 10G and 40G are defined for client signals that comply to the SDH bit rates as defined in Table 12-12. Support for other bit rates and bit rate ranges is for further study.

Table 12-12/G.798 – Defined values for x

x	Bit rate	Clock range
2G5	2 488 320 kbits ± 20 ppm	2 488 320 kHz ± 20 ppm
10G	9 953 280 kbits ± 20 ppm	9 953 280 kHz ± 20 ppm
40G	39 813 120 kbits ± 20 ppm	39 813 120 kHz ± 20 ppm

12.3.3.1 OCh to CBRx adaptation source function (OCh/CBRx_A_So), x = 2G5, 10G, 40G

The information flow and processing of the OCh/CBRx_A_So function is defined with reference to Figure 12-30.

Symbol

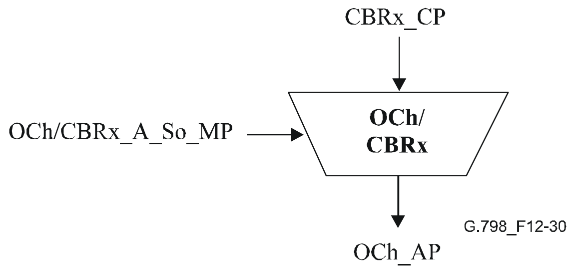


Figure 12-30/G.798 – OCh/CBRx_A_So function

Interfaces

Table 12-13/G.798 – OCh/CBRx_A_So inputs and outputs

Input(s)	Output(s)
CBRx_CP: CBRx_CI_D CBRx_CI_CK **OCh/CBRx_A_So_MP**: OCh/CBRx_A_So_MI_Active	**OCh_AP**: OCh_AI_D

Processes

The function generates the OCh_AI signal from the CBRx_CI.

Activation

– The OCh/CBRx_A_So function shall access the access point when it is activated (MI_Active is true). Otherwise, it shall not access the access point.

For the defined values of x, the jitter and wander requirements as defined in 9.3.1.1/G.783, apply.

Defects: None.

Consequent actions: None.

Defect correlations: None.

Performance monitoring: None.

12.3.3.2 OCh to CBRx adaptation sink function (OCh/CBRx_A_Sk), x = 2G5, 10G, 40G

The information flow and processing of the OCh/CBRx_A_Sk function is defined with reference to Figures 12-31 and 12-32.

Symbol

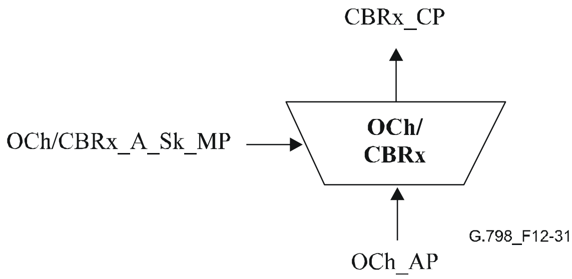


Figure 12-31/G.798 – OCh/CBRx_A_Sk function

Interfaces

Table 12-14/G.798 – OCh/CBRx_A_Sk inputs and outputs

Input(s)	Output(s)
OCh_AP: OCh_AI_D OCh_AI_TSF **OCh/CBRx_A_Sk_MP**: OCh/CBRx_A_Sk_MI_Active	**CBRx_CP**: CBRx_CI_D CBRx_CI_CK CBRx_CI_SSF

Processes

The processes associated with the OCh/CBRx_A_Sk function are depicted in Figure 12-32.

Activation

– The OCh/CBRx_A_Sk function shall access the access point and perform the Common and Specific Processes operation specified below when it is activated (MI_Active is true). Otherwise, it shall activate the SSF signals and generate Generic AIS at its output (CP).

Clock recovery: The function shall recover the clock signal from the incoming data. For the defined values of x the input clock ranges are defined in Table 12-12, and the jitter and wander requirements as defined in 9.3.1.2/G.783 apply.

To ensure adequate immunity against the presence of Consecutive Identical Digits (CID) in the signal, the function shall comply with the specification in 15.1.4/G.783.

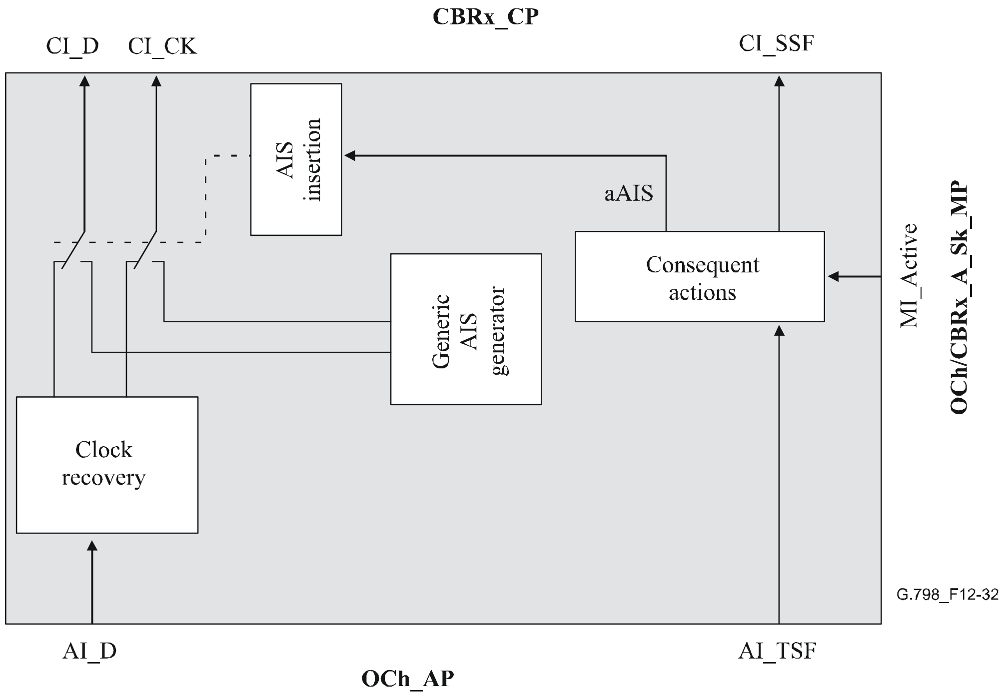


Figure 12.32/G.798 – OCh/CBRx_A_Sk processes

Defects: None.

Consequent actions

The OCh/CBRx_A_Sk function performs the following consequent actions.

aSSF ← AI_TSF or (not MI_Active)

aAIS ← AI_TSF or (not MI_Active)

On declaration of aAIS the function shall output a GenericAIS pattern/signal as defined in 16.6/G.709/Y.1331 within X ms. On clearing of aAIS, the GenericAIS pattern/signal shall be removed within Y ms and normal data being output. The values for X and Y are for further study.

The GenericAIS clock start shall be independent from the incoming clock. The GenericAIS clock has to be within the range defined in Table 12-12.

Defect correlations: None.

Performance monitoring: None.

12.3.4 OCh to GbE adaptation function (OCh/GbE_A)

For further study.

12.3.5 OCh to RSn adaptation (OCh/RSn_A)

The OCh to RSn adaptation functions perform the adaptation between the OCh layer adapted information and the characteristic information of a RSn layer signal.

NOTE – The source function is identical with the OCh/CBRx adaptation source functions, except for the different CI at the CP (CBRx_CI replaced by RSn_CI). In the sink direction, the function provides framing on the SDH signal and GenericAIS supervision. In the OCh/CBR_A_Sk function no such functionality is available.

12.3.5.1 OCh to RSn adaptation source function (OCh/RSn_A_So)

The information flow and processing of the OCh/RSn_A_So function is defined with reference to Figure 12-33.

Symbol

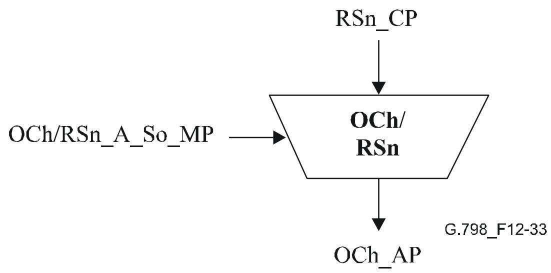


Figure 12-33/G.798 – OCh/RSn_A_So function

Interfaces

Table 12-15/G.798 – OCh/RSn_A_So inputs and outputs

Input(s)	Output(s)
RSn_CP: RSn_CI_D RSn_CI_CK **OCh/RSn_A_So_MP**: OCh/RSn_A_So_MI_Active	**OCh_AP**: OCh_AI_D

Processes

The function generates the OCh_AI signal from the RSn_CI.

Activation

– The OCh/RSn_A_So function shall access the access point when it is activated (MI_Active is true). Otherwise, it shall not access the access point.

The jitter and wander requirements as defined in 9.3.1.1/G.783 apply.

Defects: None.

Consequent actions: None.

Defect correlations: None.

Performance monitoring: None.

12.3.5.2 OCh to RSn adaptation sink function (OCh/RSn_A_Sk)

The information flow and processing of the OCh/RSn_A_Sk function is defined with reference to Figures 12-34 and 12-35.

Symbol

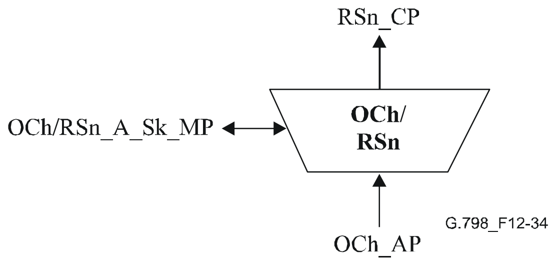


Figure 12-34/G.798 – OCh/RSn_A_Sk function

Interfaces

Table 12-16/G.798 – OCh/RSn_A_Sk inputs and outputs

Input(s)	Output(s)
OCh_AP: OCh_AI_D OCh_AI_TSF **OCh/RSn_A_Sk_MP**: OCh/RSn_A_Sk_MI_Active	**RSn_CP**: RSn_CI_D RSn_CI_CK RSn_CI_FS RSn_CI_SSF **OCh/RSn_A_Sk_MP**: OCh/RSn_A_Sk_MI_cLOF

Processes

The processes associated with the OCh/RSn_A_Sk function are depicted in Figure 12-35.

Activation

– The OCh/RSn_A_Sk function shall access the access point and perform the Common and Specific Processes operation specified below when it is activated (MI_Active is true). Otherwise, it shall activate the SSF signals and generate AIS at its output (CP) and not report its status via the management point.

Clock recovery: The function shall recover the RSn clock signal from the incoming data. The supported input clock range is N × 155 520 kbit/s ± 20 ppm.

To ensure adequate immunity against the presence of Consecutive Identical Digits (CID) in the STM-N signal, the function shall comply with the specification in 15.1.4/G.783.

The function shall process the signal such that in the absence of input jitter, the intrinsic jitter at the STM-N output interface shall not exceed the values specified in 15.1.2/G.783.

The function shall process the signal such that the jitter transfer shall be as specified in 15.1.3/G.783.

Frame alignment: The function shall perform frame alignment on the STM-N frame as described in 8.2.1/G.783.

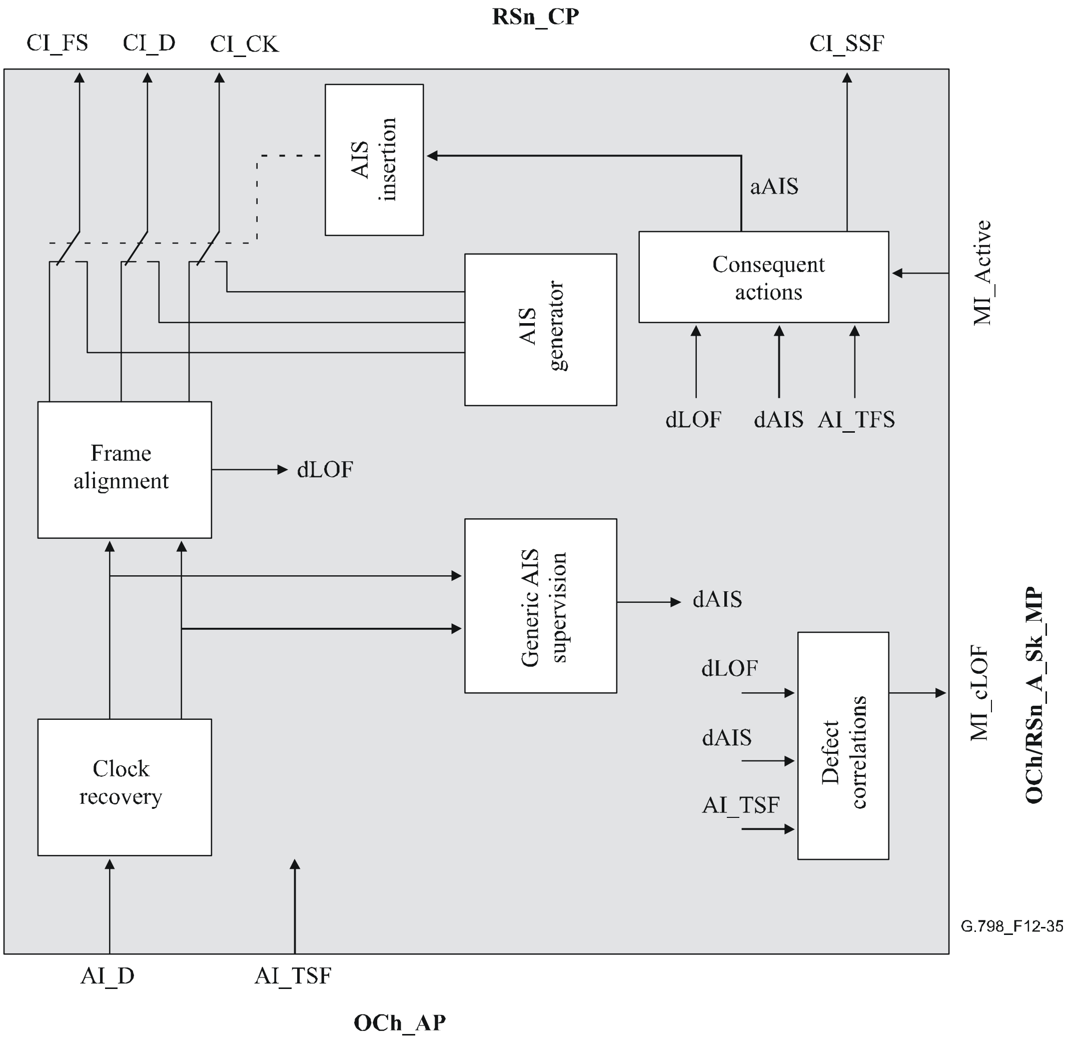


Figure 12-35/G.798 – OCh/RSn_A_Sk processes

Defects

The function shall detect for the dAIS and dLOF.

dAIS: See 6.2.6.3.3.

dLOF: See 6.2.5.1/G.783.

Consequent actions

aSSF ← AI_TSF or dAIS or dLOF or (not MI_Active)

aAIS ← AI_TSF or dAIS or dLOF or (not MI_Active)

On declaration of aAIS, the function shall output a logical all-ones (AIS) signal within 2 STM-N frames. On clearing of aAIS, the logical all-ones (AIS) signal shall be removed within 2 STM-N frames and normal data being output. The AIS clock start shall be independent from the incoming clock. The AIS clock has to be within N × 155 520 kbit/s ± 20 ppm. Jitter and wander requirements are for further study.

Defect correlations

cLOF ← LOF and (not dAIS) and (not AI_TSF)

NOTE – dAIS is not reported as fault cause as it is a secondary alarm and will result in aSSF, which is reported as cSSF fault cause in the RSn_TT_Sk that directly follows this function.

Performance monitoring: None.

12.3.6 OMMS adaptation function (OCh/COMMS_A)

For further study.

12.4 Layer functions (N/A)

Not applicable.

13 OTU (Layer) functions

A completely standardized OTUk and functional standardized OTUkV are defined. Figure 13-1 illustrates the OTUk[V] layer network and client layer adaptation functions. The information crossing the OTUk[V] (trail) connection point (OTUk[V]_CP/TCP) is referred to as the OTUk[V] characteristic information (OTUk[V]_CI). The information crossing the OTUk[V] access point (OTUk[V]_AP) is referred to as the OTUk[V] adapted information (OTUk[V]_AI).

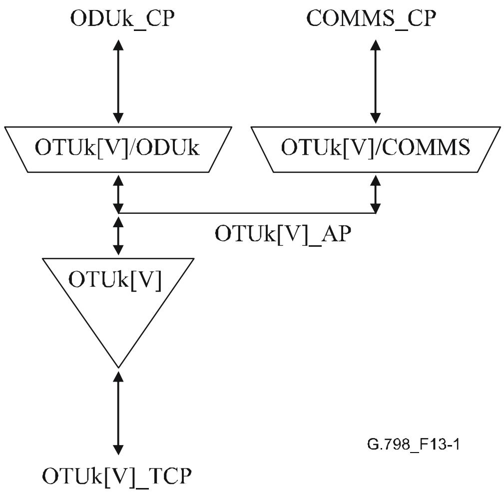


Figure 13-1/G.798 – OTUk[V] layer network and client layer adaptation functions

The OTUk Characteristic Information (OTUk_CI) is the unscrambled OTUk frame without FEC code and defined SM, GCC0 and RES overhead as shown in Figure 13-2, together with a frame and multiframe start. The GCC0 overhead is optional and set to all ZEROs if not used. The RES overhead is set to all ZEROs.

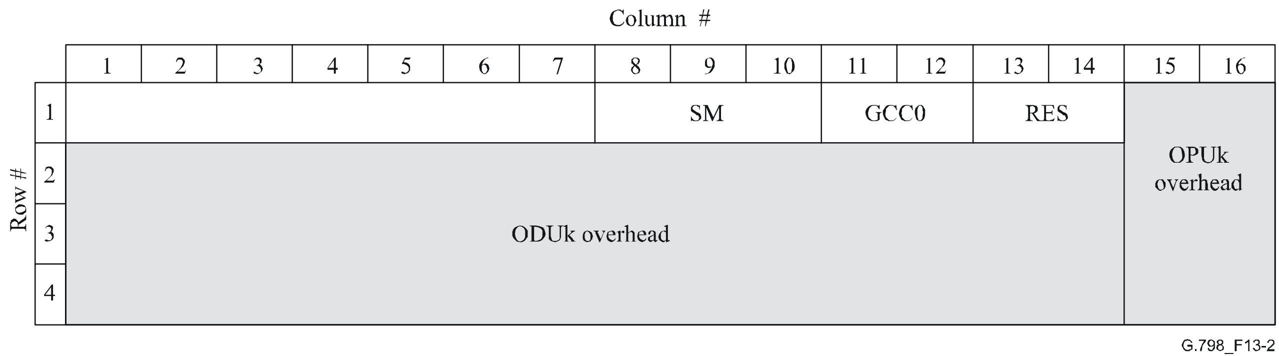


Figure 13-2/G.798 – OTUk overhead at the OTUk_CP/TCP

The OTUkV Characteristic Information (OTUkV_CI) is the OTUkV frame with valid SM and GCC0 overhead. The OTUkV frame format is outside the scope of this Recommendation.

The OTUk Adapted Information (OTUk_AI) consists of the ODUk_CI adapted to the OTUk frame, together with a frame and multiframe start. In case of COMMS access at the OTUk_AP, it includes also the OTUk GCC overhead (GCC0).

The OTUkV Adapted Information (OTUkV_AI) consists of the ODUk CI adapted to the OTUkV frame. The OTUkV frame format and the ODUk_CI mapping are outside the scope of this Recommendation. In case of COMMS access at the OTUkV_AP, it includes also the OTUkV GCC overhead.

13.1 Connection functions (N/A)

Not applicable.

13.2 Termination functions

13.2.1 OTUk trail termination function (OTUk_TT)

The OTUk_TT function terminates the Section Monitoring (SM) overhead of the OTUk overhead to determine the status of the OTUk trail. Figure 13-3 shows the combination of the unidirectional sink and source functions to form a bidirectional function.

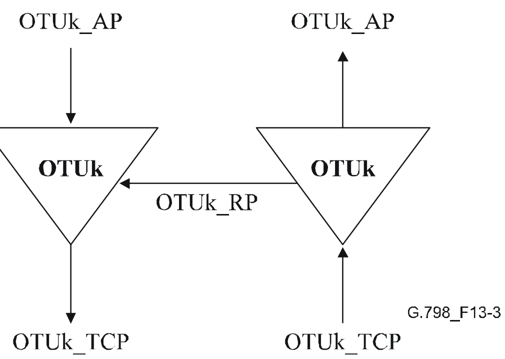


Figure 13-3/G.798 – OTUk_TT

13.2.1.1 OTUk trail termination source function (OTUk_TT_So)

The OTUk_TT_So function computes the BIP8 and adds Section Monitoring Overhead (SMOH) – including the TTI, BIP8, BDI, BEI and IAE signals – in the SM overhead field to the OTUk signal at its OTUk_AP.

The information flow and processing of the OTUk_TT_So function is defined with reference to Figures 13-4 and 13-5.

Symbol

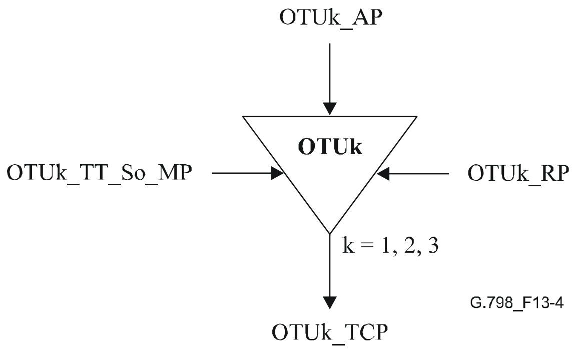


Figure 13-4/G.798 – OTUk_TT_So function

Interfaces

Table 13-1/G.798 – OTUk_TT_So inputs and outputs

Input(s)	Output(s)
OTUk_AP: OTUk_AI_CK OTUk_AI_D OTUk_AI_FS OTUk_AI_MFS OTUk_AI_IAE **OTUk_RP**: OTUk_RI_BDI OTUk_RI_BEI OTUk_RI_BIAE **OTUk_TT_So_MP**: OTUk_TT_So_MI_TxTI	**OTUk_TCP**: OTUk_CI_CK OTUk_CI_D OTUk_CI_FS OTUk_CI_MFS

Processes

The processes associated with the OTUk_TT_So function are as depicted in Figure 13-5.

SMOH-TTI: The trail trace identifier is inserted in the TTI byte position of the SM field. Its value is derived from reference point OTUk_TT_So_MP. The trail trace format is described in 15.2/G.709/Y.1331.

SMOH-BDI: The backward defect indication is inserted in the BDI bit position of the SM field. Its value is derived from reference point OTUk_RP. Upon the declaration/clearing of aBDI at the termination sink function, the trail termination source function shall have inserted/removed the BDI indication within 50 ms.

SMOH-BEI/BIAE: If RI_IBAE is true, the value "1011" is inserted into the BEI/BIAE bits of the SM field. If RI_BIAE is false, the number of errors indicated in RI_BEI is encoded in the BEI/BIAE bits of the SM field. Upon the detection of incoming alignment error or a number of errors at the termination sink function, the trail termination source function shall have inserted the value in the BEI/BIAE bits within 50 ms.

SMOH-BIP8: See 8.3.4.1. The calculated BIP8 is inserted into the BIP8 byte of the SM field.

SMOH-IAE: The incoming alignment error information AI_IAE is inserted into the IAE bit position of the SM field. Upon the declaration of AI_IAE, the function shall insert the IAE indication for the next 16 multiframes (16 × 256 frames). Each new declaration of AI_IAE restarts the 16 multiframe insertion time.

SMOH-RES: The RES field is reserved for future international standardization. The value shall be fixed to 00.

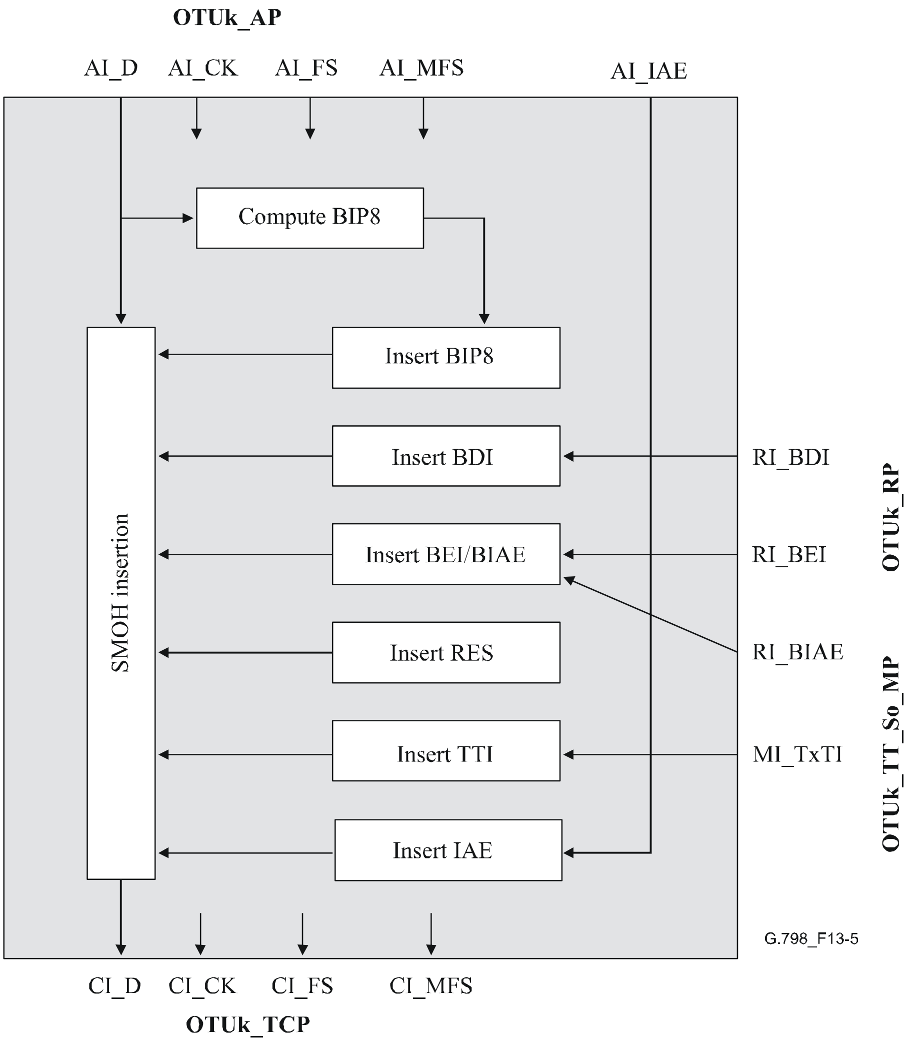


Figure 13-5/G.798 – OTUk_TT_So processes

Defects: None.

Consequent actions: None.

Defect correlations: None.

Performance monitoring: None.

13.2.1.2 OTUk trail termination sink function (OTUk_TT_Sk)

The OTUk_TT_Sk function reports the state of the OTUk trail. It computes the BIP8, extracts Section Monitoring Overhead (SMOH) – including the TTI, BIP8, IAE, BDI and BEI signals – in the SM overhead field from the OTUk signal at its OTUk_TCP, detects for TIM, DEG and BDI defects, counts during 1-second periods errors (detected via the BIP8) and defects to feed PM when connected, makes the TTI available to network management and forwards the error and defect information as backward indications to the companion OTUk_TT_So function.

The information flow and processing of the OTUk_TT_Sk function is defined with reference to Figures 13-6 and 13-7.

Symbol

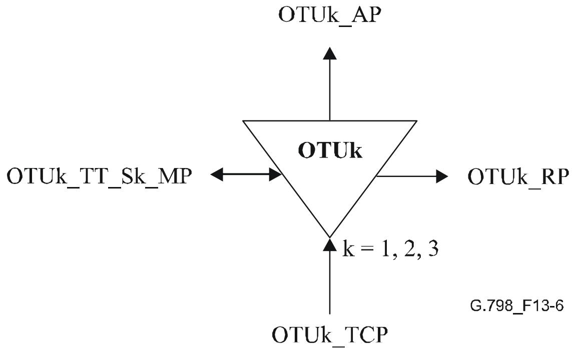


Figure 13-6/G.798 – OTUk_TT_Sk function

Interfaces

Table 13-2/G.798 – OTUk_TT_Sk inputs and outputs

Input(s)	Output(s)
OTUk_TCP: OTUk_CI_CK OTUk_CI_D OTUk_CI_FS OTUk_CI_MFS OTUk_CI_SSF **OTUk_TT_Sk_MP**: OTUk_TT_Sk_MI_ExSAPI OTUk_TT_Sk_MI_ExDAPI OTUk_TT_Sk_MI_GetAcTI OTUk_TT_Sk_MI_TIMDetMo OTUk_TT_Sk_MI_TIMActDis OTUk_TT_Sk_MI_DEGThr OTUk_TT_Sk_MI_DEGM OTUk_TT_Sk_MI_1second	**OTUk_AP**: OTUk_AI_CK OTUk_AI_D OTUk_AI_FS OTUk_AI_MFS OTUk_AI_TSF OTUk_AI_TSD **OTUk_RP**: OTUk_RI_BDI OTUk_RI_BEI OTUk_RI_BIAE **OTUk_TT_Sk_MP**: OTUk_TT_Sk_MI_AcTI OTUk_TT_Sk_MI_cTIM OTUk_TT_Sk_MI_cDEG OTUk_TT_Sk_MI_cBDI OTUk_TT_Sk_MI_cSSF OTUk_TT_Sk_MI_pN_EBC OTUk_TT_Sk_MI_pN_DS OTUk_TT_Sk_MI_pF_EBC OTUk_TT_Sk_MI_pF_DS OTUk_TT_Sk_MI_pBIAE OTUk_TT_Sk_MI_pIAE

Processes

The processes associated with the OTUk_TT_Sk function are as depicted in Figure 13-7.

SMOH-BIP8: See 8.3.4.2. The BIP8 is extracted from the BIP8 byte of the SM field.

SMOH-TTI: The trail trace identifier shall be recovered from TTI byte position of the SM field as defined in 8.6. The accepted value of the TTI is available at the MP (MI_AcTI).

SMOH-BDI: The backward defect indication shall be recovered from BDI bit position of the SM field. It shall be used for BDI defect detection.

SMOH-BEI/BIAE: The BEI shall be recovered from the BEI/BIAE bits in the SM field. It shall be used to determine if a far-end errored block (nF_B) has occurred. A nF_B has occurred if the BEI/BIAE value is between 1 [0001] and 8 [1000]; otherwise, no nF_B has occurred.

SMOH-IAE: The incoming alignment error information shall be recovered from IAE bit position of the SM field. It shall be used for IAE defect detection.

SMOH-RES: RES in the SM field in the OTUk signal at the OTUk_TCP are reserved for future international standardization. For the moment, their value shall be ignored.

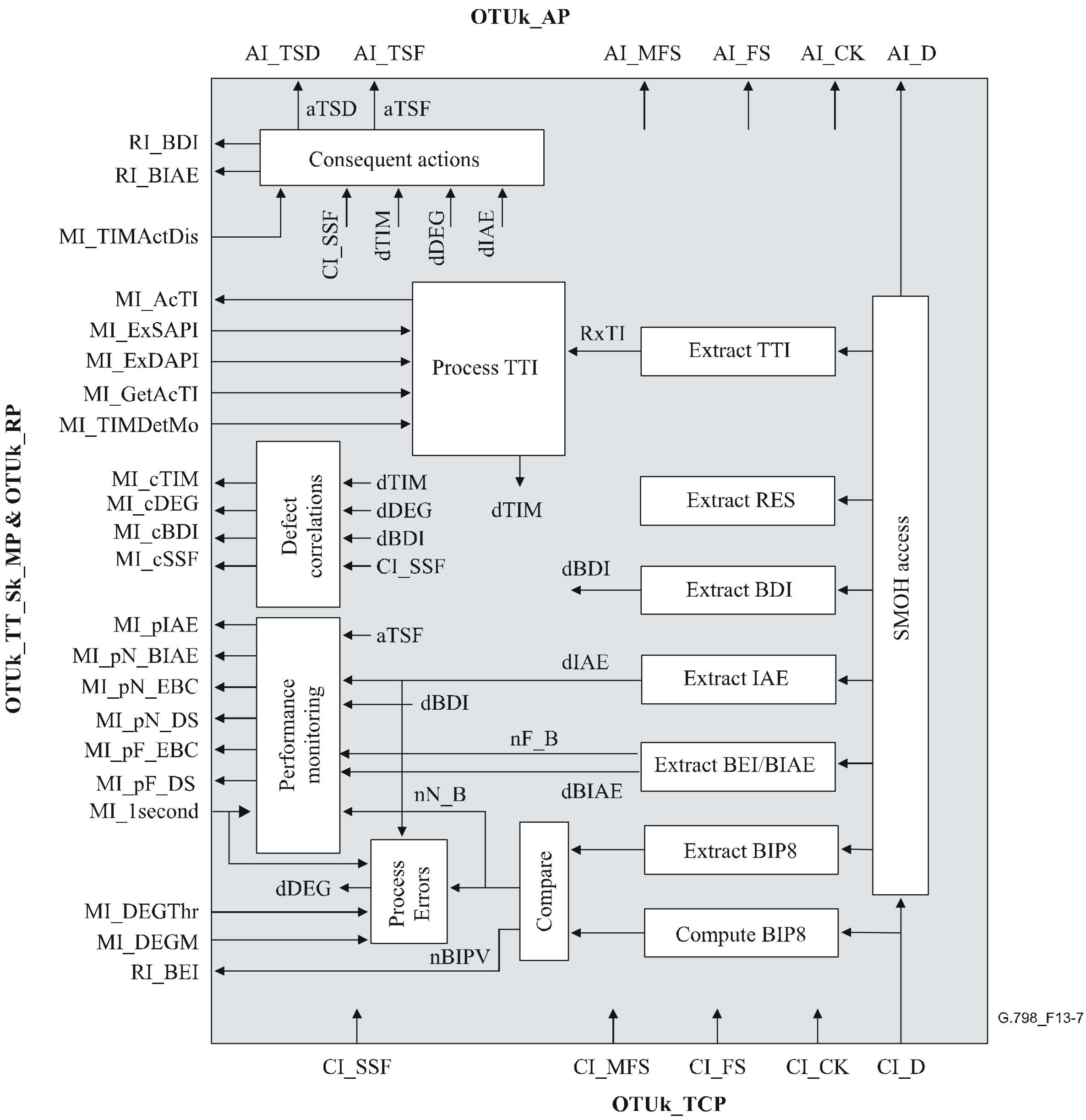


Figure 13-7/G.798 – OTUk_TT_Sk processes

Defects

The function shall detect for dTIM, dDEG, dBDI, dBIAE and dIAE defects.

dTIM: See 6.2.2.1; dTIM shall be set to false during CI_SSF.

dDEG: See 6.2.3.4.

NOTE 1 – IAE suppresses the one-second near end errored block count, which is the input for the dDEG detection. This avoids wrong dDEG declaration due to alignment errors already incoming in an OTUk trail.

dBDI: See 6.2.6.6.1; dBDI shall be set to false during CI_SSF.

dIAE: See 6.2.6.10.1; dIAE shall be set to false during CI_SSF and dTIM.

dBIAE: See 6.2.6.11.1; dBIAE shall be set to false during CI_SSF and dTIM.

Consequent actions

The function shall perform the following consequent actions:

aBDI ← CI_SSF or dTIM

aBEI ← nBIPV

aBIAE ← dIAE

aTSF ← CI_SSF or (dTIM and (not TIMActDis))

aTSD ← dDEG

Defect correlations

The function shall perform the following defect correlations to determine the most probable fault cause. This fault cause shall be reported to the EMF.

cTIM ← dTIM and (not CI_SSF)

cDEG ← dDEG and (not CI_SSF) and (not (dTIM and (not TIMActDis)))

cBDI ← dBDI and (not CI_SSF) and (not (dTIM and (not TIMActDis)))

cSSF ← CI_SSF

Performance monitoring

The function shall perform the following performance monitoring primitives processing. The performance monitoring primitives shall be reported to the EMF.

pN_DS ← CI_SSF or dTIM

pF_DS ← dBDI

pN_EBC ← ∑ nN_B

NOTE 2 – During CI_SSF no errored blocks shall be counted.

pF_EBC ← ∑ nF_B

NOTE 3 – During CI_SSF no errored blocks shall be counted.

pBIAE ← dBIAE

NOTE 4 – pBIAE is activated at the end of a second if dBIAE was active once during the second.

pIAE ← dIAE

NOTE 5 – pIAE is activated at the end of a second if dIAE was active once during the second.

NOTE 6 – pIAE and pBIAE are used for the suppression of the PM data in the equipment management functions (see ITU-T Rec. G.874). If pBIAE is active, the F_DS and F_EBC values of the previous and current second have to be discarded (EBC = 0 and DS = false). If pIAE is active, the N/F_DS and N/F_EBC values of the previous and current second have to be discarded (EBC = 0 and DS = false). The previous second has to be included due to the delay of the IAE information coming from the remote source.

13.2.2 OTUkV trail termination function (OTUkV_TT)

The OTUkV_TT function terminates the Section Monitoring (SM) overhead of the OTUkV overhead to determine the status of the OTUkV trail. Figure 13-8 shows the combination of the unidirectional sink and source functions to form a bidirectional function.

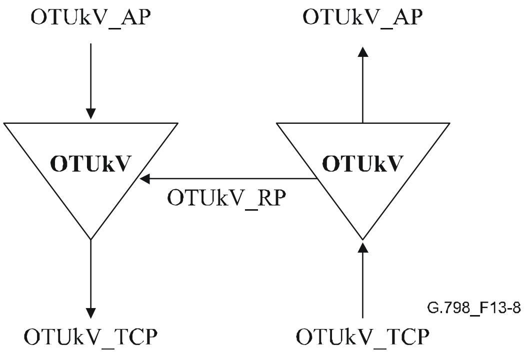


Figure 13-8/G.798 – OTUkV_TT

13.2.2.1 OTUkV trail termination source function (OTUkV_TT_So)

The OTUkV_TT_So function computes the signal quality supervision code and adds Section Monitoring Overhead (SMOH) – including the TTI, signal quality supervision code, BDI, BEI signals – in the SM overhead to the OTUkV signal at its OTUk_AP. In case of frame synchronous mapping of the ODUk client signal, an IAE signal has to be added to the SM overhead.

The information flow and processing of the OTUkV_TT_So function is defined with reference to Figures 13-9 and 13-10.

Symbol

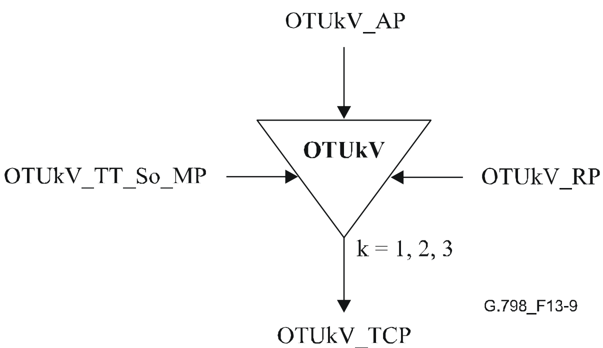


Figure 13-9/G.798 – OTUkV_TT_So function

Interfaces

Table 13-3/G.798 – OTUkV_TT_So inputs and outputs

Input(s)	Output(s)
OTUkV_AP: OTUkV_AI_CK OTUkV_AI_D OTUkV_AI_FS OTUkV_AI_MFS (Note 1) OTUkV_AI_IAE (Note 2) **OTUkV_RP**: OTUkV_RI_BDI OTUkV_RI_BEI OTUkV_RI_BIAE (Note 2) **OTUkV_TT_So_MP**: OTUkV_TT_So_MI_TxTI	**OTUkV_TCP**: OTUkV_CI_CK OTUkV_CI_D OTUkV_CI_FS OTUkV_CI_MFS (Note 1)
NOTE 1 – If OTUkV has a multiframe. NOTE 2 – In case of frame synchronous mapping of ODUk client signal.	

Processes

The processes associated with the OTUkV_TT_So function are as depicted in Figure 13-10.

SMOH-TTI: The trail trace identifier is inserted in the TTI byte position of the SM field. Its value is derived from reference point OTUk_TT_So_MP. The trail trace format is described in 15.2/G.709/Y.1331.

SMOH-BDI: The backward defect indication is inserted in the BDI field of the SMOH. Its value is derived from reference point OTUk_RP. Upon the declaration/clearing of aBDI at the termination sink function the trail termination source function shall have inserted/removed the BDI indication within 50 ms. The BDI coding is outside the scope of this Recommendation.

SMOH-BEI: The number of errors indicated in RI_BEI is encoded in the BEI field of the SMOH. Upon the detection of a number of errors at the termination sink function, the trail termination source function shall have inserted that value in the BEI bits within 50 ms. The BEI coding is outside the scope of this Recommendation.

SMOH-Signal Quality Supervision: The calculated signal quality supervision code is inserted into the signal quality supervision field of the SMOH. The signal supervision code is outside the scope of this Recommendation.

SMOH-IAE: If a frame synchronous mapping for the ODUk is used, the incoming alignment error information AI_IAE is inserted into the IAE field of the SMOH. Upon the declaration of AI_IAE, the function shall insert the IAE indication for the next 16 multiframes. Each new declaration of AI_IAE restarts the 16 multiframe insertion time. The IAE coding is outside the scope of this Recommendation.

SMOH-BIAE: If a frame synchronous mapping for the ODUk is used, the backward incoming error information RI_BIAE is inserted into the BIAE field of the SMOH. Upon the detection of incoming alignment error at the termination sink function, the trail termination source function shall have inserted that value in the BIAE fields within 50 ms. The BIAE coding is outside the scope of this Recommendation.

The format of the OTUkV frame and overhead is outside the scope of this Recommendation.

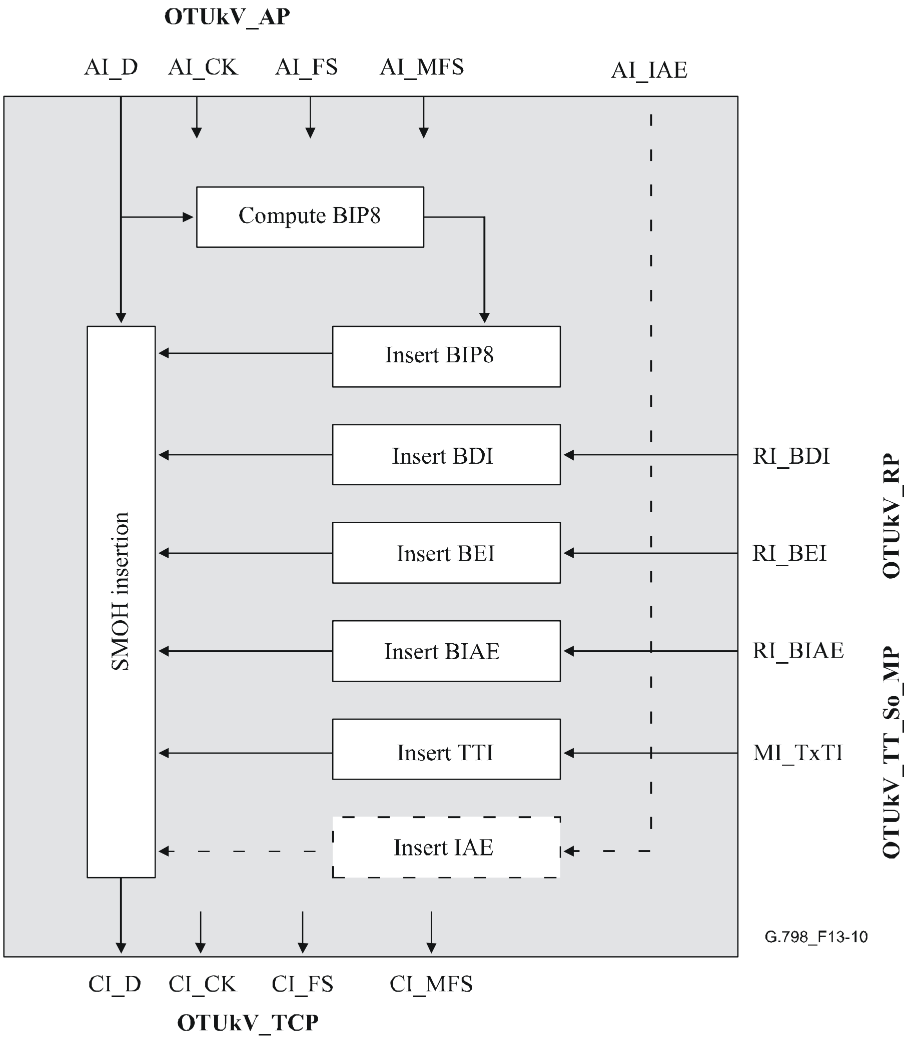


Figure 13-10/G.798 – OTUkV_TT_So processes

Defects: None.

Consequent actions: None.

Defect correlations: None.

Performance monitoring: None.

13.2.2.2 OTUkV trail termination sink function (OTUkV_TT_Sk)

The OTUkV_TT_Sk function reports the state of the OTUk trail. It computes the signal quality supervision code, extracts Section Monitoring Overhead (SMOH) – including the TTI, signal quality supervision, BDI and BEI signals – in the SM overhead field from the OTUkV signal at its OTUkV_TCP, detects for TIM, DEG and BDI defects, counts during 1-second periods errors (detected via the signal quality supervision) and defects to feed PM when connected, makes the TTI available to network management and forwards the error and defect information as backward indications to the companion OTUkV_TT_So function. In case of frame synchronous mapping of the ODUk client signal, an IAE signal has to be extracted from the SM overhead.

The information flow and processing of the OTUkV_TT_Sk function is defined with reference to Figures 13-11 and 13-12.

Symbol

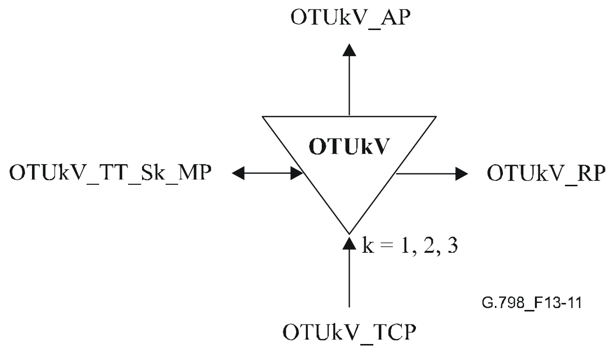


Figure 13-11/G.798 – OTUkV_TT_Sk function

Interfaces

Table 13-4/G.798 – OTUkV_TT_Sk inputs and outputs

Input(s)	Output(s)
OTUkV_TCP: OTUkV_CI_CK OTUkV_CI_D OTUkV_CI_FS OTUkV_CI_MFS (Note 1) OTUkV_CI_SSF **OTUkV_TT_Sk_MP**: OTUkV_TT_Sk_MI_ExSAPI OTUkV_TT_Sk_MI_ExDAPI OTUkV_TT_Sk_MI_GetAcTI OTUkV_TT_Sk_MI_TIMDetMo OTUkV_TT_Sk_MI_TIMActDis OTUkV_TT_Sk_MI_DEGThr OTUkV_TT_Sk_MI_DEGM OTUkV_TT_Sk_MI_1second	**OTUkV_AP**: OTUkV_AI_CK OTUkV_AI_D OTUkV_AI_FS OTUkV_AI_MFS (Note 1) OTUkV_AI_TSF OTUkV_AI_TSD **OTUkV_RP**: OTUkV_RI_BDI OTUkV_RI_BEI OTUkV_RI_BIAE (Note 2) **OTUkV_TT_Sk_MP**: OTUkV_TT_Sk_MI_AcTI OTUkV_TT_Sk_MI_cTIM OTUkV_TT_Sk_MI_cDEG OTUkV_TT_Sk_MI_cBDI OTUkV_TT_Sk_MI_cSSF OTUkV_TT_Sk_MI_pN_EBC OTUkV_TT_Sk_MI_pN_DS OTUkV_TT_Sk_MI_pF_EBC OTUkV_TT_Sk_MI_pF_DS OTUkV_TT_Sk_MI_pBIAE (Note 2) OTUkV_TT_Sk_MI_pIAE (Note 2)
NOTE 1 – If OTUkV has a multiframe. NOTE 2 – In case of frame synchronous mapping of ODUk client signal.	

Processes

The processes associated with the OTUkV_TT_Sk function are as depicted in Figure 13-12.

SMOH-Signal Quality Supervision: The signal quality supervision code is extracted from the signal quality field of the SMOH. The signal supervision code is outside the scope of this Recommendation.

SMOH-TTI: The trail trace identifier shall be recovered from TTI field of the SMOH as defined in 8.6. The accepted value of the TTI is available at the MP (MI_AcTI).

SMOH-BDI: The backward defect indication shall be recovered from BDI field of the SMOH. It shall be used for BDI defect detection. The BDI code is outside the scope of this Recommendation.

SMOH-BEI: The BEI shall be recovered from the BEI field in the SMOH. It shall be used to determine if a far-end errored block (nF_B) has occurred. The BEI code is outside the scope of this Recommendation.

SMOH-IAE: If a frame synchronous mapping for the ODUk client layer is used, the incoming alignment error information shall be recovered from IAE field of the SMOH. It shall be used for IAE defect detection. The IAE code is outside the scope of this Recommendation.

The format of the OTUkV frame and overhead is outside the scope of this Recommendation.

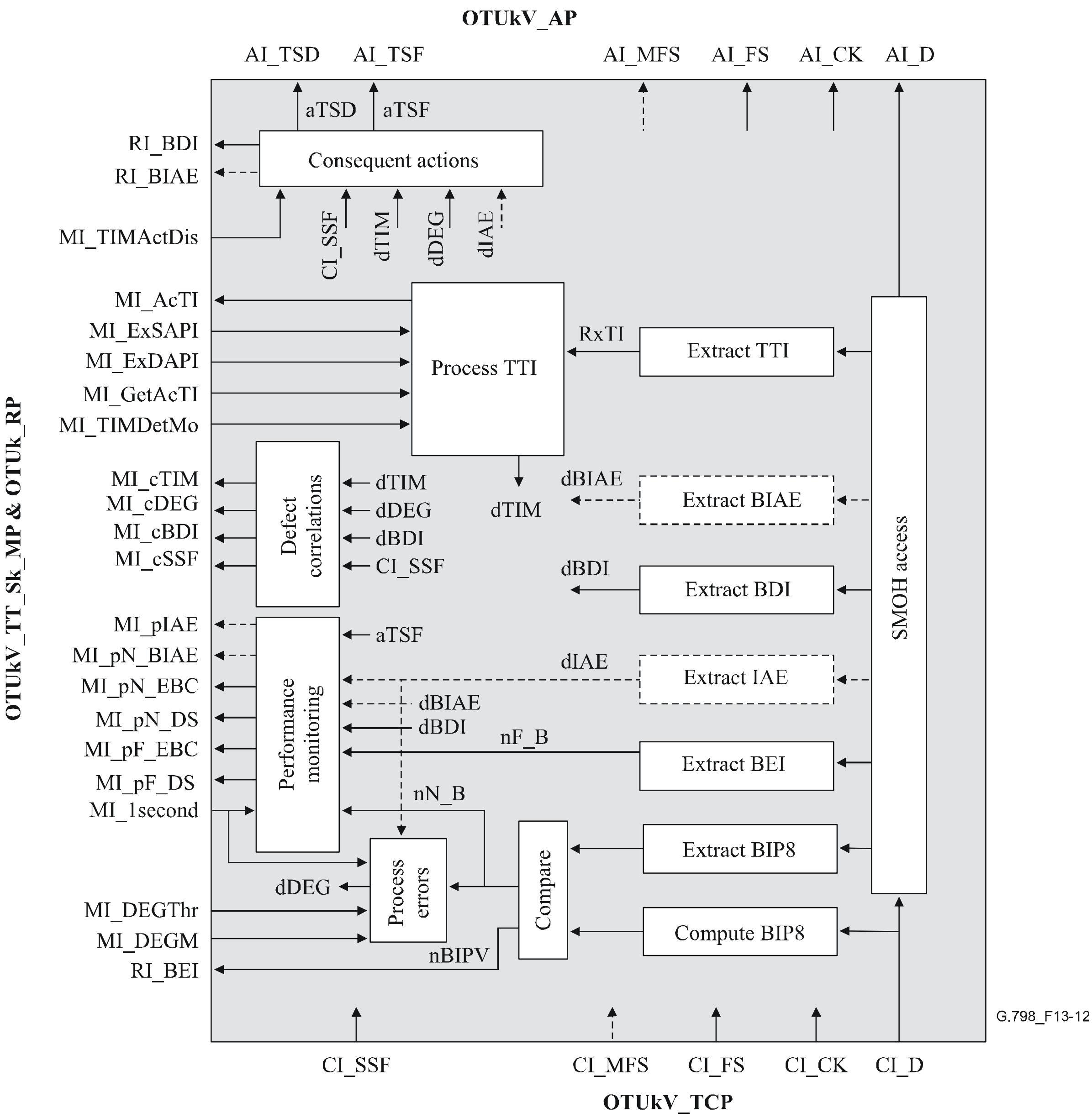


Figure 13-12/G.798 – OTUkV_TT_Sk processes

Defects

The function shall detect for dTIM, dDEG, dBDI and if a frame synchronous mapping for the ODUk client layer is used, it shall detect for dIAE defects.

dTIM: See 6.2.2.1; dTIM shall be set to false during CI_SSF.

dDEG: See 6.2.3.4.

NOTE 1 – IAE (if supported) suppresses the one-second near end errored block count, which is the input for the dDEG detection. This avoids wrong dDEG declaration due to alignment errors already incoming in an OTUk trail.

dBDI: The dBDI detection depends on the specific frame structure and is outside the scope of this Recommendation; dBDI shall be set to false during CI_SSF.

dIAE: The dIAE detection depends on the specific frame structure and is outside the scope of this Recommendation; dIAE shall be set to false during CI_SSF and dTIM.

dBIAE: The dBIAE detection depends on the specific frame structure and is outside the scope of this Recommendation; dTIM shall be set to false during CI_SSF and dTIM.

NOTE 2 – IAE and BIAE are only required in case of frame synchronous mapping of the ODUk into the OTUkV.

Consequent actions

The function shall perform the following consequent actions:

aBDI ← CI_SSF or dTIM

aBEI ← nBIPV

aBIAE ← dIAE

aTSF ← CI_SSF or (dTIM and (not TIMActDis))

aTSD ← dDEG

Defect correlations

The function shall perform the following defect correlations to determine the most probable fault cause. This fault cause shall be reported to the EMF.

cTIM ← dTIM and (not CI_SSF)

cDEG ← dDEG and (not CI_SSF) and (not (dTIM and (not TIMActDis)))

cBDI ← dBDI and (not CI_SSF) and (not (dTIM and (not TIMActDis)))

cSSF ← CI_SSF

Performance monitoring

The function shall perform the following performance monitoring primitives processing. The performance monitoring primitives shall be reported to the EMF.

pN_DS ← CI_SSF or dTI

pF_DS ← dBDI

pN_EBC ← ∑ nN_B

NOTE 3 – During CI_SSF no errored blocks shall be counted.

pF_EBC ← ∑ nF_B

NOTE 4 – During CI_SSF no errored blocks shall be counted.

pBIAE ← dBIAE

NOTE 5 – pBIAE is activated at the end of a second if dBIAE was active once during the second.

pIAE ← dIAE

NOTE 6 – pIAE is activated at the end of a second if dIAE was active once during the second.

NOTE 7 – pBIAE and pIAE are only defined in case of frame synchronous mapping of the ODUk into the OTUkV.

NOTE 8 – pIAE and pBIAE are used for the suppression of the PM data in the equipment management functions (see ITU-T Rec. G.874). If pBIAE is active, the F_DS and F_EBC values of the previous and current second have to be discarded (EBC = 0 and DS = false). If pIAE is active, the N/F_DS and N/F_EBC values of the previous and current second have to be discarded (EBC = 0 and DS = false). The previous second has to be included due to the delay of the IAE information coming from the remote source.

13.3 Adaptation functions

13.3.1 OTUk to ODUk adaptation function (OTUk/ODUk_A)

The OTUk to ODUk adaptation functions perform the adaptation between the OTUk layer adapted information and the characteristic information of an ODUk layer signal.

13.3.1.1 OTUk to ODUk adaptation source function (OTUk/ODUk_A_So)

The OTUk/ODUk_A_So function creates the OTUk signal and maps the ODUk signal frame synchronous into this OTUk signal as defined in ITU-T Rec. G.709/Y.1331.

The information flow and processing of the OTUk/ODUk_A_So functions is defined with reference to Figures 13-13 and 13-14.

Symbol

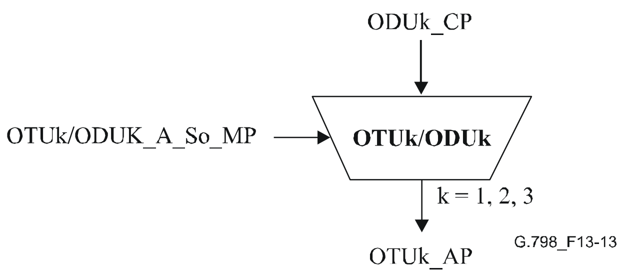


Figure 13-13/G.798 – OTUk/ODUk_A_So function

Interfaces

Table 13-5/G.798 – OTUk/ODUk_A_So inputs and outputs

Input(s)	Output(s)
ODUk_CP: ODUk_CI_CK ODUk_CI_D ODUk_CI_FS ODUk_CI_MFS **OTUk/ODUk_A_So_MP**: OTUk/ODUk_A_So_MI_AdminState	**OTUk_AP**: OTUk_AI_CK OTUk_AI_D OTUk_AI_FS OTUk_AI_MFS OTUk_AI_IAE

Processes

The processes associated with the OTUk/ODUk_A_So function are as depicted in Figure 13-14.

ODUk-LCK: The function shall generate the ODUk-LCK signal as defined in 16.5/G.709/Y.1331. The clock, frame start and multiframe start are defined by the incoming ODUk signal.

Selector: The normal signal may be replaced by the ODUk-LCK signal. ODUk-LCK signal is selected if the MI_AdminState is LOCKED.

OTUk signal generation: The function shall generate the OTUk clock (AI_CK) by multiplying the incoming ODUk clock (CI_CK) by a factor of 255/239.

NOTE 1 – The OTUk clock is "255/(239 – k) * $4^{(k-1)}$ * 2 488 320 kHz ± 20 ppm".

For the case that an ODU signal is not terminated in the network element (e.g., it is through connected from an OTM input to an OTM output), the clock parameters and jitter and wander requirements as defined in Annex A/G.8251 (ODCr clock) apply. Otherwise, the clock requirements are defined in the ODUkP/Client adaptation functions.

NOTE 2 – The OTUk/ODUk_A_Sk and So clocks are concentrated in a single ODCr clock in ITU-T Rec. G.8251.

The function shall generate the OTUk frame start reference signals (AI_FS), which is derived from the incoming ODUk frame start (CI_FS).

The function shall generate the OTUk multiframe start reference signals (AI_MFS), which is derived from the incoming ODUk multiframe start (CI_MFS).

Incoming Alignment Error (IAE): If the incoming ODUk frame start (CI_FS) position is not at the expected frame, start position incoming alignment error IAE shall be activated. IAE shall be deactivated if the incoming ODUk frame start (CI_FS) position is at the expected frame start position. The expected frame start position is based on the previous incoming ODUk frame start.

Mapping: The function shall map the incoming ODUk frame (CI_D) into the OTUk frame (AI_D) as defined in 11.1/G.709/Y.1331.

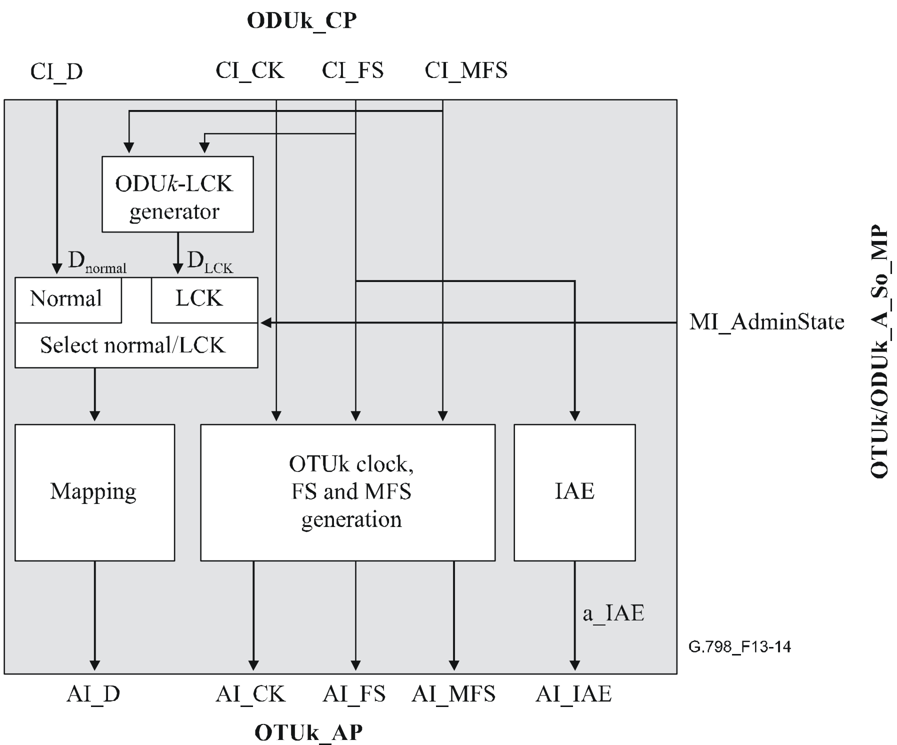


Figure 13-14/G.798 – OTUk/ODUk_A_So processes

Defects: None.

Consequent actions

The function shall perform the following consequent actions:

aIAE ← IAE

Defect Correlations: None.

Performance monitoring: None.

13.3.1.2 OTUk to ODUk adaptation sink function (OTUk/ODUk_A_Sk)

The ODUk/ODUk_A_Sk extracts the ODUk signal from the OTUk. It may insert ODUk-AIS under signal fail conditions.

The information flow and processing of the OTUk/ODUk_A_Sk functions is defined with reference to Figures 13-15 and 13-16.

Symbol

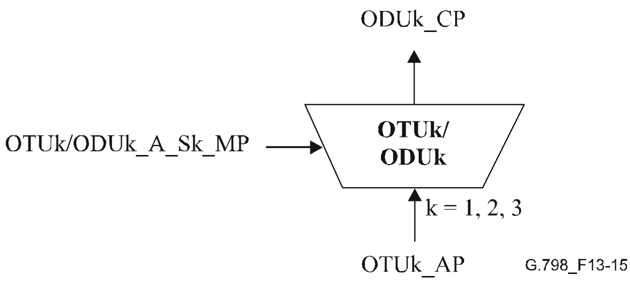


Figure 13-15/G.798 – OTUk/ODUk_A_Sk function

Interfaces

Table 13-6/G.798 – OTUk/ODUk_A_Sk inputs and outputs

Input(s)	Output(s)
OTUk_AP: OTUk_AI_CK OTUk_AI_D OTUk_AI_FS OTUk_AI_MFS OTUk_AI_TSF OTUk_AI_TSD **OTUk/ODUk_A_Sk_MP**: OTUk/ODUk_A_Sk_MI_AdminState	**ODUk_CP**: ODUk_CI_CK ODUk_CI_D ODUk_CI_FS ODUk_CI_MFS ODUk_CI_SSF ODUk_CI_SSD

Processes

The processes associated with the OTUk/ODUk_A_Sk function are as depicted in Figure 13-16.

ODUk Clock, FS and MFS signal generation: The function shall generate the ODUk clock (CI_CK) by dividing the incoming OTUk clock (AI_CK) by a factor of 255/239.

NOTE 1 – The ODUk clock is "239/(239 – k) * $4^{(k-1)}$ * 2 488 320 kHz ± 20 ppm".

For the case that an ODU signal is not terminated in the network element (e.g., it is through connected from an OTM input to an OTM output), the clock parameters and jitter and wander requirements as defined in Annex A/G.8251 (ODCr clock) apply. Otherwise the clock requirements are defined in the ODUkP/Client adaptation functions.

NOTE 2 – The OTUk/ODUk_A_Sk and So clocks are concentrated in a single ODCr clock in ITU-T Rec. G.8251.

The function shall generate the ODUk frame start reference signals (AI_FS), which is derived from the incoming OTUk frame start (CI_FS).

The function shall generate the ODUk multiframe start reference signals (AI_MFS), which is derived from the incoming OTUk multiframe start (CI_MFS).

Extract ODUk from OTUk: The function shall extract the ODUk frame (AI_D) from the incoming OTUk frame (CI_D) as defined in 11.1/G.709/Y.1331.

ODUk-LCK, ODUk-AIS: The function shall generate the ODUk-LCK and ODUk-AIS signals as defined in ITU-T Rec. G.709/Y.1331. The clock, frame start and multiframes start shall be independent from the incoming clock. The clock has to be within $239/(239 - k) * 4^{(k-1)} *$ 2 488 320 kHz ± 20 ppm. Jitter and wander requirements as defined in Annex A/G.8251 (ODCa clock) apply.

Selector: The normal signal may be replaced by either the ODUk-AIS or the ODUk-LCK signal. ODUk-LCK signal is selected if the MI_AdminState is LOCKED. ODUk-AIS is selected if MI_AdminState is not LOCKED and aAIS is true.

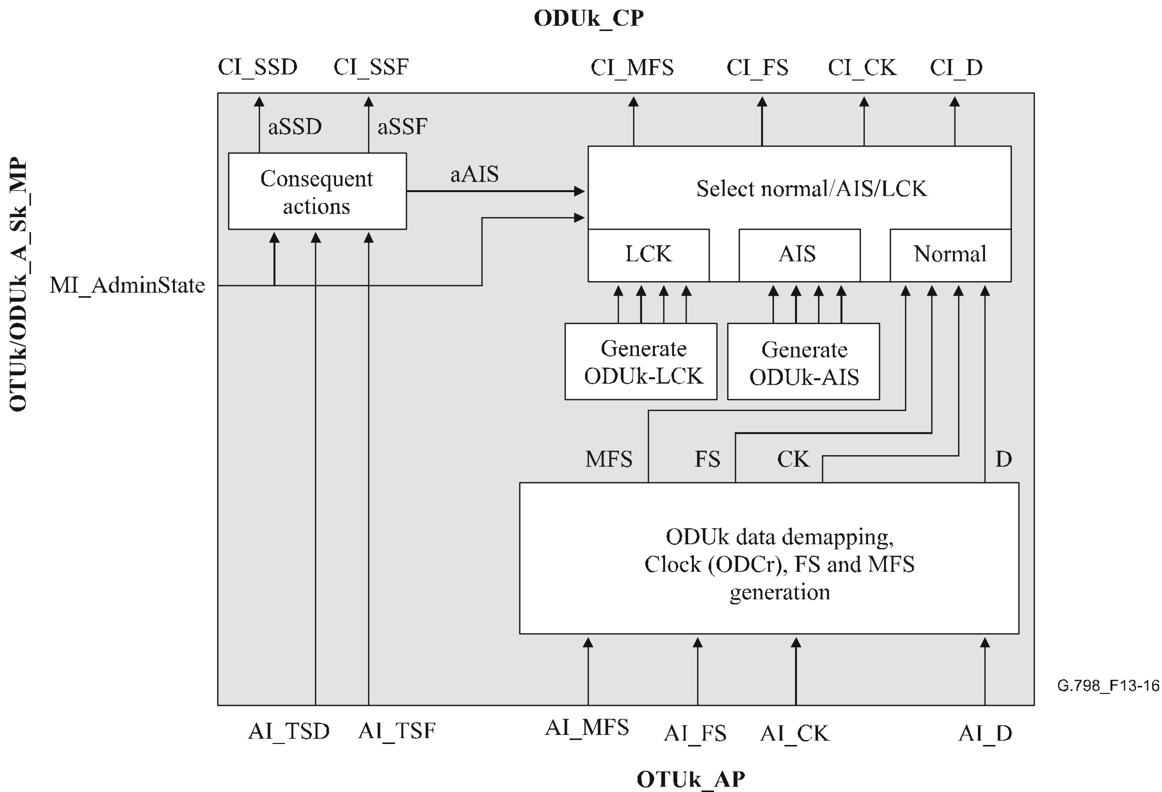


Figure 13-16/G.798 – OTUk/ODUk_A_Sk processes

Defects: None.

Consequent actions

The function shall perform the following consequent actions:

aSSF ← AI_TSF and (not MI_AdminState = LOCKED) aAIS ← AI_TSF and (not MI_AdminState = LOCKED)

aSSD ← AI_TSD and (not MI_AdminState = LOCKED)

On declaration of aAIS the function shall output an All-ONEs pattern/signal within 2 frames. On clearing of aAIS the All-ONEs pattern/signal shall be removed within 2 frames and normal data being output. The AIS clock, frame start and multiframe start shall be independent from the incoming clock, frame start and multiframe start. The AIS clock has to be within 239/(239 – k) * $4^{(k-1)}$ * 2 488 320 kHz ± 20 ppm. Jitter and wander requirements as defined in Annex A/G.8251 (ODCa clock) apply.

Defect correlations: None.

Performance monitoring: None.

13.3.2 OTUkV to ODUk adaptation function (OTUkV/ODUk_A)

The OTUkV to ODUk adaptation functions perform the adaptation between the OTUkV layer adapted information and the characteristic information of an ODUk layer signal.

13.3.2.1 OTUkV to ODUk adaptation source function (OTUkV/ODUk_A_So)

The OTUkV/ODUk_A_So function creates the OTUkV signal and maps the ODUk signal into this OTUkV.

The information flow and processing of the OTUkV/ODUk_A_So functions is defined with reference to Figures 13-17 and 13-18.

Symbol

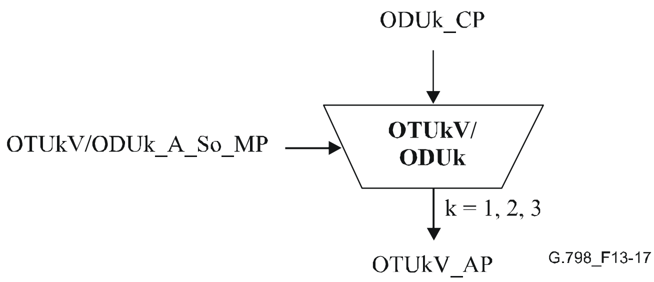


Figure 13-17/G.798 – OTUkV/ODUk_A_So function

Interfaces

Table 13-7/G.798 – OTUkV/ODUk_A_So inputs and outputs

Input(s)	Output(s)
ODUk_CP: ODUk_CI_CK ODUk_CI_D ODUk_CI_FS ODUk_CI_MFS **OTUkV/ODUk_A_So_MP**: OTUkV/ODUk_A_So_MI_AdminState	**OTUkV_AP**: OTUkV_AI_CK OTUkV_AI_D OTUkV_AI_FS OTUkV_AI_MFS (Note 1) OTUkV_AI_IAE (Note 2)
NOTE 1 – If the OTUkV has a multiframe. NOTE 2 – In case of frame synchronous mapping of ODUk client signal.	

Processes

The processes associated with the OTUkV/ODUk_A_So function are as depicted in Figure 13-18.

ODUk-LCK: The function shall generate the ODUk-LCK signal as defined in 16.5/G.709/Y.1331. The clock, frame start and multiframe start are defined by the incoming ODUk signal.

Selector: The normal signal may be replaced by the ODUk-LCK signal. ODUk-LCK signal is selected if the MI_AdminState is LOCKED.

OTUkV signal generation: The function shall generate the OTUkV clock and frame start. The specific generation processes are outside the scope of this Recommendation.

Incoming Alignment Error: In case of a frame synchronous mapping of the ODUk in the OTUkV, IAE has to be generated. If the incoming ODUk frame start (CI_FS) position is not at the expected frame start position incoming alignment error, IAE shall be activated. IAE shall be deactivated if the incoming ODUk frame start (CI_FS) position is at the expected frame start position. The expected frame start position is based on the previous incoming ODUk frame start.

Mapping: The function shall map the incoming ODUk frame (CI_D) into the OTUkV frame (AI_D). The specific mapping process is outside the scope of this Recommendation.

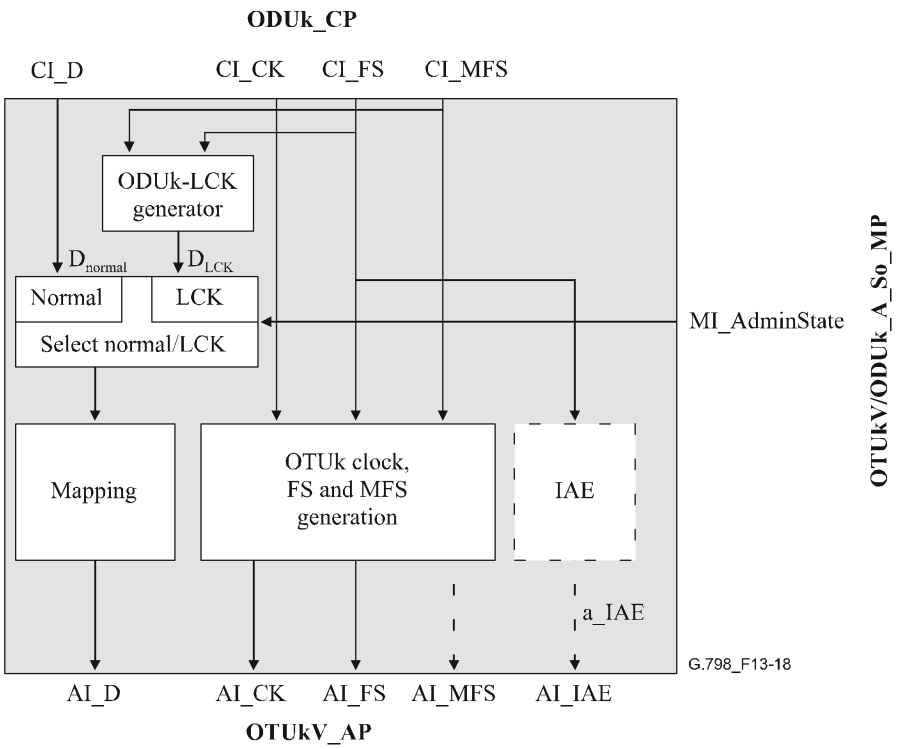


Figure 13-18/G.798 – OTUkV/ODUk_A_So processes

Defects: None.

Consequent actions

The function shall perform the following consequent actions:

aIAE ← IAE

NOTE – aIAE is only required in case of frame synchronous mapping of the ODUk client signal.

Defect correlations: None.

Performance monitoring: None.

13.3.2.2 OTUkV to ODUk adaptation sink function (OTUkV/ODUk_A_Sk)

The OTUkV/ODUk_A_Sk extracts the ODUk signal from the OTUkV. It may insert ODUk-AIS under signal fail conditions.

The information flow and processing of the OTUkV/ODUk_A_Sk functions is defined with reference to Figures 13-19 and 13-20.

Symbol

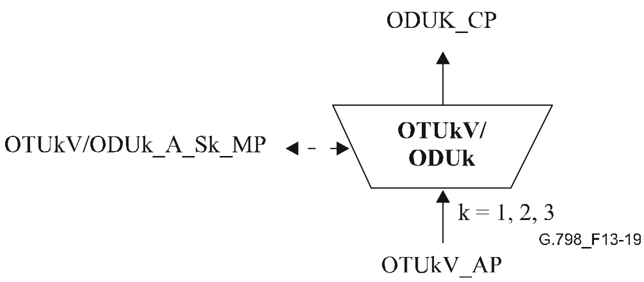


Figure 13-19/G.798 – OTUkV/ODUk_A_Sk function

Interfaces

Table 13-8/G.798 – OTUkV/ODUk_A_Sk inputs and outputs

Input(s)	Output(s)
OTUkV_AP: OTUkV_AI_CK OTUkV_AI_D OTUkV_AI_FS OTUkV_AI_MFS (Note 1) OTUkV_AI_TSF OTUkV_AI_TSD	**ODUk_CP**: ODUk_CI_CK ODUk_CI_D ODUk_CI_FS ODUk_CI_MFS ODUk_CI_SSF ODUk_CI_SSD
OTUkV/ODUk_A_Sk_MP: OTUkV/ODUk_A_Sk_MI_AdminState	**OTUkV/ODUk_A_Sk_MP**: OTUkV/ODUk_A_Sk_MI_cLOA (Note 2)
NOTE 1 – If the OTUkV has a multiframe. NOTE 2 – If loss of alignment supervision is performed.	

Processes

The processes associated with the OTUkV/ODUk_A_Sk function are as depicted in Figure 13-20.

Demapping: The function shall extract the ODUk signal, including clock, frame start, multiframe start and data from the OTUkV. The specific demapping processes are outside the scope of this Recommendation.

ODUk-LCK, ODUk-AIS: The function shall generate the ODUk-LCK and ODUk-AIS signals as defined in ITU-T Rec. G.709/Y.1331. The clock, frame start and multiframes start shall be independent from the incoming clock. The clock has to be within $239/(239 - k) * 4^{(k-1)} *$ 2 488 320 kHz ± 20 ppm. Jitter and wander requirements as defined in Annex A/G.8251 (ODCa clock) apply.

Selector: The normal signal may be replaced by either the ODUk-AIS or the ODUk-LCK signal. ODUk-LCK signal is selected if the MI_AdminState is LOCKED. ODUk-AIS is selected if MI_AdminState is not LOCKED and aAIS is true.

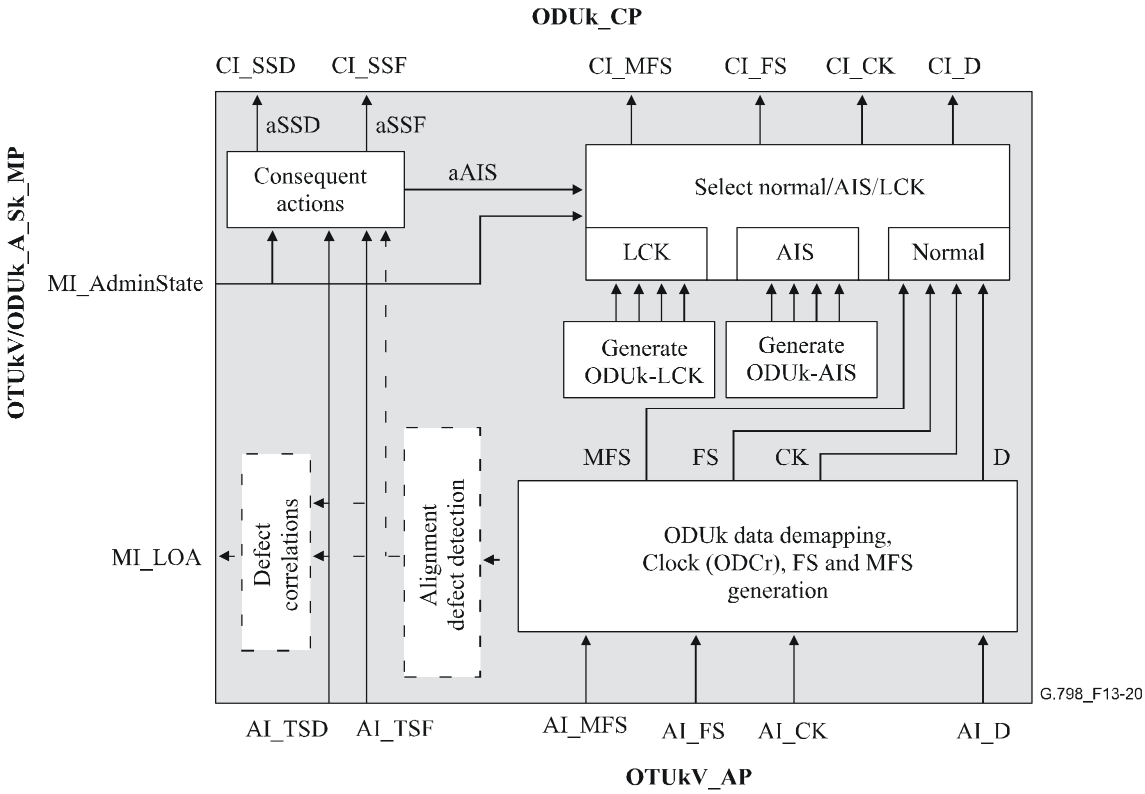


Figure 13-20/G.798 – OTUkV/ODUk_A_Sk processes

Defects

Depending on the ODUk mapping defect detection might be necessary (e.g., loss of alignment LOA).

Consequent actions

The function shall perform the following consequent actions:

aSSF ← AI_TSF and (not MI_AdminState = LOCKED)

aAIS ← AI_TSF and (not MI_AdminState = LOCKED)

aSSD ← AI_TSD and (not MI_AdminState = LOCKED)

Depending on the ODUk mapping, additional defects might contribute to aSSF and aAIS (e.g., loss of alignment LOA).

On declaration of aAIS, the function shall output an All-ONEs pattern/signal within 2 frames. On clearing of aAIS the All-ONEs pattern/signal shall be removed within 2 frames and normal data being output. The AIS clock, frame start and multiframe start shall be independent from the incoming clock, frame start and multiframe start. The AIS clock has to be within $239/(239 - k) * 4^{(k-1)} * 2\,488\,320$ kHz ± 20 ppm. Jitter and wander requirements as defined in Annex A/G.8251 (ODCa clock) apply.

Defect correlations

Depending on the ODUk mapping, defect correlations might be necessary (e.g., loss of alignment).

Performance monitoring: None.

13.3.3 OTUk to COMMS adaptation function (OTUk/COMMS_A)

The OTUk to COMMS adaptation functions provide access to the GCC0 overhead in the OTUk for generic data communication.

13.3.3.1 OTUk to COMMS adaptation source function (OTUk/COMMS_A_So)

The OTUk/COMMS_A_So function maps the generic communication channel data into the OTUk GCC0 overhead.

The information flow and processing of the OTUk/COMMS_A_So functions is defined with reference to Figures 13-21 and 13-22.

Symbol

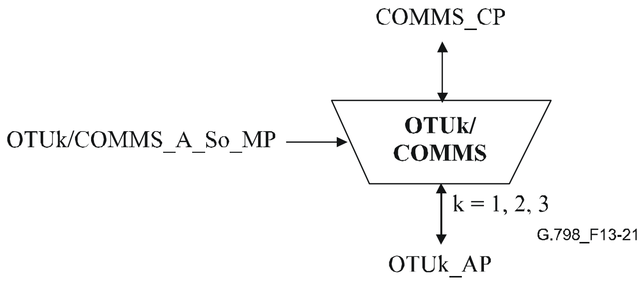


Figure 13-21/G.798 – OTUk/COMMS_A_So function

Interfaces

Table 13-9/G.798 – OTUk/COMMS_A_So inputs and outputs

Input(s)	Output(s)
COMMS_CP: COMMS_CI_D **OTUk_AP**: OTUk_AI_CK OTUk_AI_FS **OTUk/COMMS_A_So_MP**: OTUk/COMMS_A_So_MI_Active	**COMMS_CP**: COMMS_CI_CK **OTUk_AP**: OTUk_AI_D

Processes

Activation

– The OTUk/COMMS_A_So function shall access the access point when it is activated (MI_Active is true). Otherwise, it shall not access the access point.

The processes associated with the OTUk/COMMS_A_So function are as depicted in Figure 13-22.

COMMS clock generation: The function shall generate the COMMS clock (CI_CK) by dividing the incoming OTUk clock (AI_CK) by a factor of 8160.

Mapping: The function shall map the incoming COMMS data (CI_D) into the GCC0 overhead of the OTUk frame (AI_D). The bit rate of the COMMS data is defined by the outgoing COMMS clock (CI_CK) and is in the range of $(255/(239 - k) * 4^{(k-1)})/8160 * 2\,488\,320$ kHz ± 20 ppm.

The insertion of the COMMS data follows the transmission order of the GCC bits and bytes.

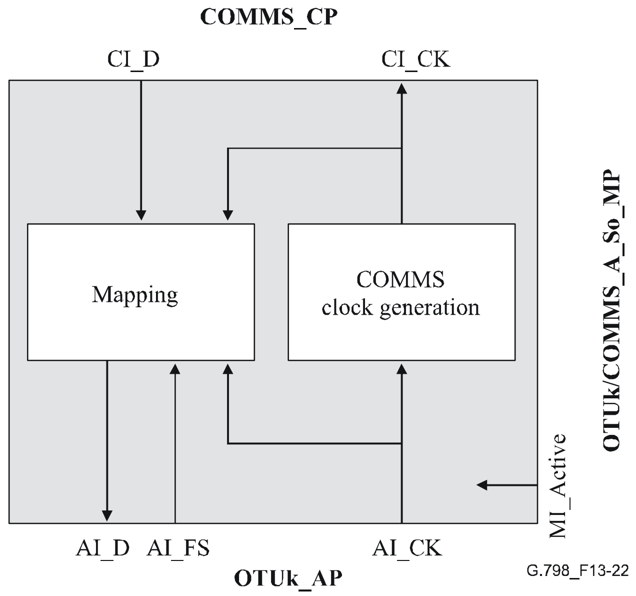


Figure 13-22/G.798 – OTUk/COMMS_A_So processes

Defects: None.

Consequent actions: None.

Defect correlations: None.

Performance Monitoring: None.

13.3.3.2 OTUk to COMMS adaptation sink function (OTUk/COMMS_A_Sk)

The OTUk/COMMS_A_Sk extracts the COMMS data from the OTUk GCC0 overhead.

The information flow and processing of the OTUk/COMMS_A_Sk functions is defined with reference to Figures 13-23 and 13-24.

Symbol

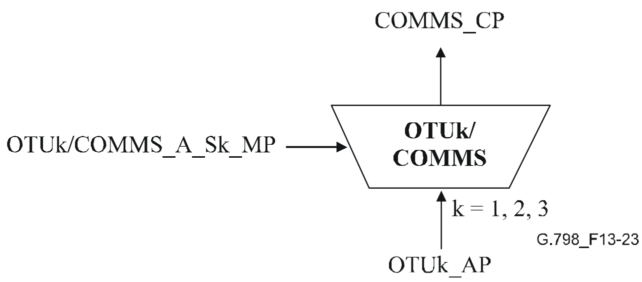


Figure 13-23/G.798 – OTUk/COMMS_A_Sk function

Interfaces

Table 13-10/G.798 – OTUk/COMMS_A_Sk inputs and outputs

Input(s)	Output(s)
OTUk_AP: OTUk_AI_CK OTUk_AI_D OTUk_AI_FS OTUk_AI_TSF **OTUk/COMMS_A_Sk_MP**: OTUk/COMMS_A_Sk_MI_Active	**COMMS_CP**: COMMS_CI_CK COMMS_CI_D COMMS_CI_SSF

Processes

Activation

– The OTUk/COMMS_A_Sk function shall access the access point and perform the Common and Specific Processes operation specified below when it is activated (MI_Active is true). Otherwise, it shall activate the SSF signals at its output (CI_SSF).

The processes associated with the OTUk/COMMS_A_Sk function are as depicted in Figure 13-24.

COMMS clock generation: The function shall generate the COMMS clock (CI_CK) by dividing the incoming OTUk clock (AI_CK) by a factor of 8160.

Demapping: The function shall extract the COMMS data (CI_D) from the GCC0 overhead of the OTUk frame (AI_D). The bit rate of the COMMS data is defined by the outgoing COMMS clock (CI_CK) and is in the range of $(255/(239 – k) * 4^{(k–1)})/8160 * 2\ 488\ 320$ kHz ± 20 ppm.

The extraction of the COMMS data follows the transmission order of the GCC bits and bytes.

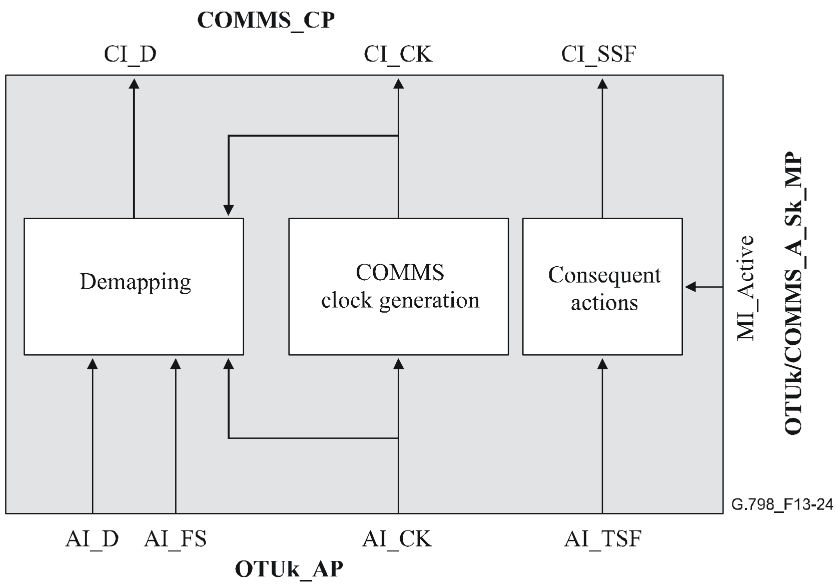


Figure 13-24/G.798 – OTUk/COMMS_A_Sk processes

Defects: None.

Consequent actions

The function shall perform the following consequent actions:

aSSF ← AI_TSF or (not MI_Active)

Defect correlations: None.

Performance monitoring: None.

13.3.4 OTUkV to COMMS adaptation function (OTUkV/COMMS_A)

The OTUkV to COMMS adaptation functions provide access to the GCC overhead in the OTUkV for generic data communication. The format of the OTUkV GCC overhead is outside the scope of this Recommendation.

13.3.4.1 OTUkV to COMMS adaptation source function (OTUkV/COMMS_A_So)

The OTUkV/COMMS_A_So function maps the generic communication channel data into the OTUkV GCC overhead.

The information flow and processing of the OTUkV/COMMS_A_So functions is defined with reference to Figure 13-25.

Symbol

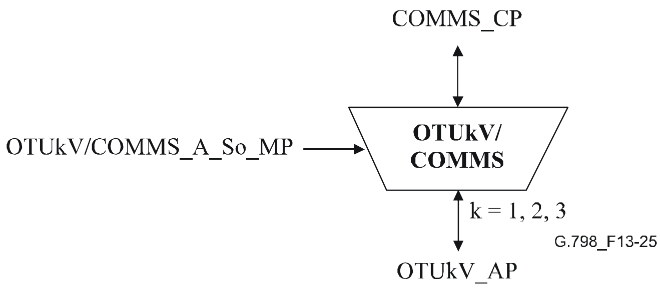


Figure 13-25/G.798 – OTUkV/COMMS_A_So function

Interfaces

Table 13-11/G.798 – OTUkV/COMMS_A_So inputs and outputs

Input(s)	Output(s)
COMMS_CP: COMMS_CI_D **OTUkV_AP**: OTUkV_AI_CK OTUkV_AI_FS **OTUkV/COMMS_A_So_MP**: OTUkV/COMMS_A_So_MI_Active	**COMMS_CP**: COMMS_CI_CK **OTUkV_AP**: OTUkV_AI_D

Processes

Activation

– The OTUkV/COMMS_A_So function shall access the access point when it is activated (MI_Active is true). Otherwise, it shall not access the access point.

The function shall insert the COMMS data into the OTUkV GCC overhead. The specific processes are outside the scope of this Recommendation.

Defects: None.

Consequent actions: None.

Defect correlations: None.

Performance monitoring: None.

13.3.4.2 OTUkV to COMMS adaptation sink function (OTUkV/COMMS_A_Sk)

The OTUkV/COMMS_A_Sk extracts the COMMS data from the OTUkV GCC overhead.

The information flow and processing of the OTUkV/COMMS_A_Sk functions is defined with reference to Figure 13-26.

Symbol

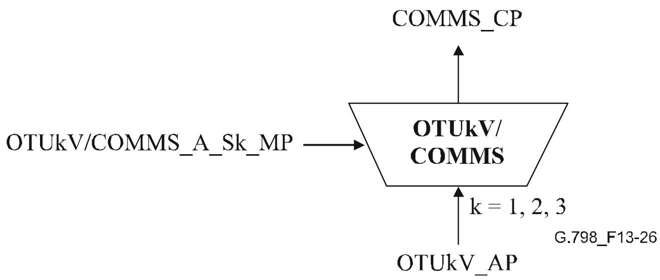


Figure 13-26/G.798 – OTUkV/COMMS_A_Sk function

Interfaces

Table 13-12/G.798 – OTUkV/COMMS_A_Sk inputs and outputs

Input(s)	Output(s)
OTUkV_AP: OTUkV_AI_CK OTUkV_AI_D OTUkV_AI_FS OTUkV_AI_TSF **OTUkV/COMMS_A_Sk_MP**: OTUkV/COMMS_A_Sk_MI_Active	**COMMS_CP**: COMMS_CI_CK COMMS_CI_D COMMS_CI_SSF

Processes

Activation

– The OTUkV/COMMS_A_Sk function shall access the access point and perform the Common and Specific Processes operation specified below when it is activated (MI_Active is true). Otherwise, it shall activate the SSF signals at its output (CI_SSF).

The function shall extract the COMMS data from the OTUkV GCC overhead. The specific processes are outside the scope of this Recommendation.

Defects: None.

Consequent actions

The function shall perform the following consequent actions:

aSSF ← AI_TSF or (not MI_Active)

Defect correlations: None.

Performance monitoring: None.

13.4 Sub-layer functions (N/A)

Not applicable.

14 ODU (Layer) functions

Figure 14-1 illustrates the ODUk layer network and client layer adaptation functions. The information crossing the ODUk connection point (ODUk_CP) is referred to as the ODUk characteristic information (ODUk_CI). The information crossing the ODUkP access point (ODUkP_AP) is referred to as the ODUkP adapted information (ODUkP_AI).

The tandem connection monitoring (TCM) sublayer ODUkT and the related functions (ODUkT_TT, ODUkT/ODUk_A, and ODUkTm) are optional. Up to 6 TCM sub-layers can be terminated within one NE. The figure shows a generic example for the connection of the ODUkT functions. They can be connected to any ODUk CP. It is not required to connect them via an ODUk_C function, they can be directly inserted without a connection function.

The COMMS access functions (ODUk/COMMS_AC and ODUkP/COMMS_A) are optional. The figure shows a generic example for the connection of the ODUk/COMMS_AC functions. They can be inserted into any ODUk CP (including TCPs) independent of sink or source processing. It is not required to connect them via an ODUk_C function, they can be directly inserted without a connection function.

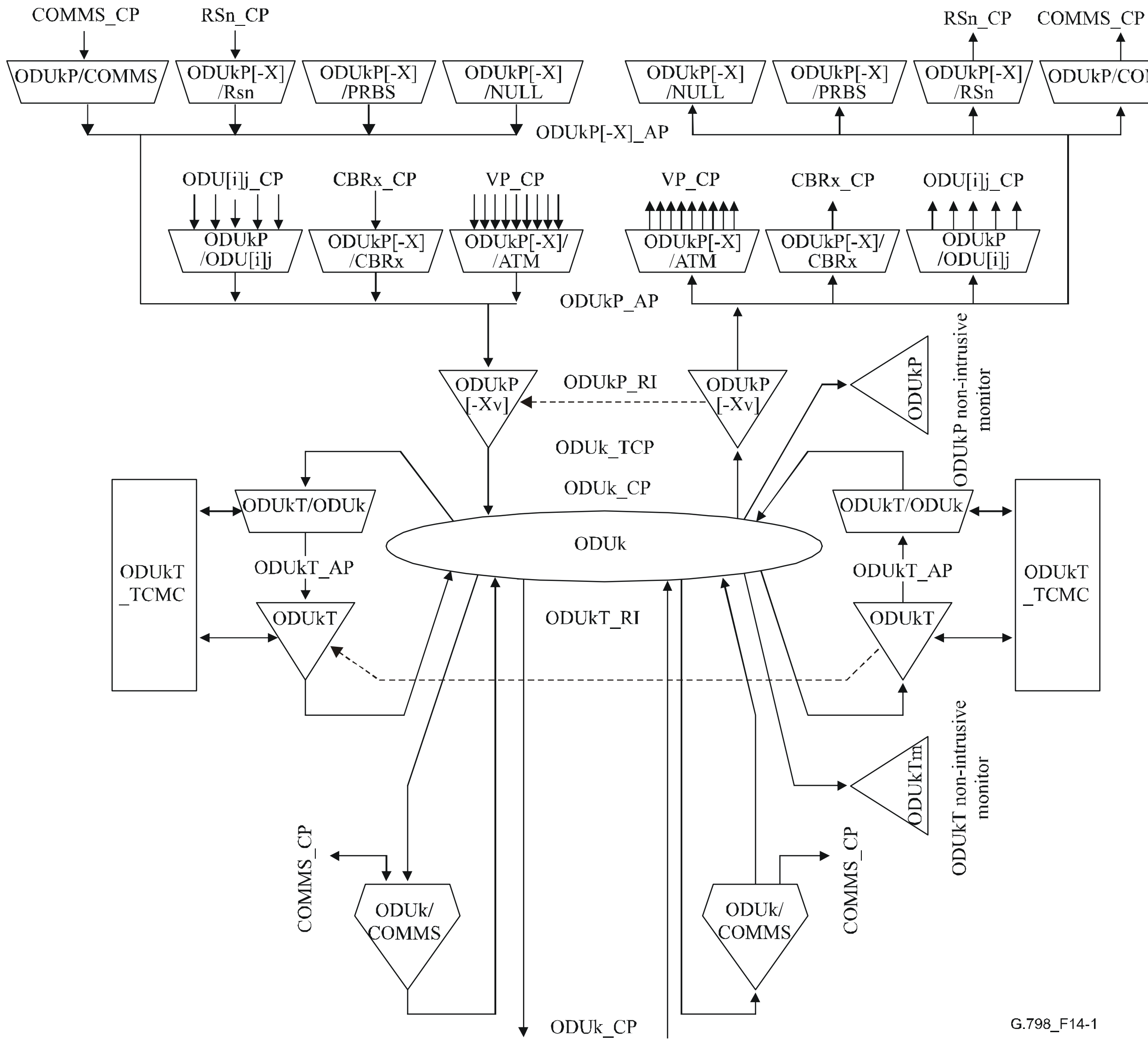


Figure 14-1/G.798 – ODUk layer network and client layer adaptation functions

The ODUk Characteristic Information (ODUk_CI) is the ODUk frame as defined in ITU-T Rec. G.709/Y.1331 with valid ODUk overhead as shown in Figure 14-2, together with a frame and multiframe start. TCM1..6 overhead is only used if one or more ODUkT trails cross the CP, otherwise, it is set to all ZEROs. APS/PCC overhead is only used in case of an ODUk protection scheme with APS support, otherwise, it is set to all ZEROs. GCC1, GCC2 and EXP overhead are optional. If they are not used, they are set to all ZEROs. FTFL and TCM ACT overhead are for further study, they are set to all ZEROs. The RES overhead is set to all ZEROs.

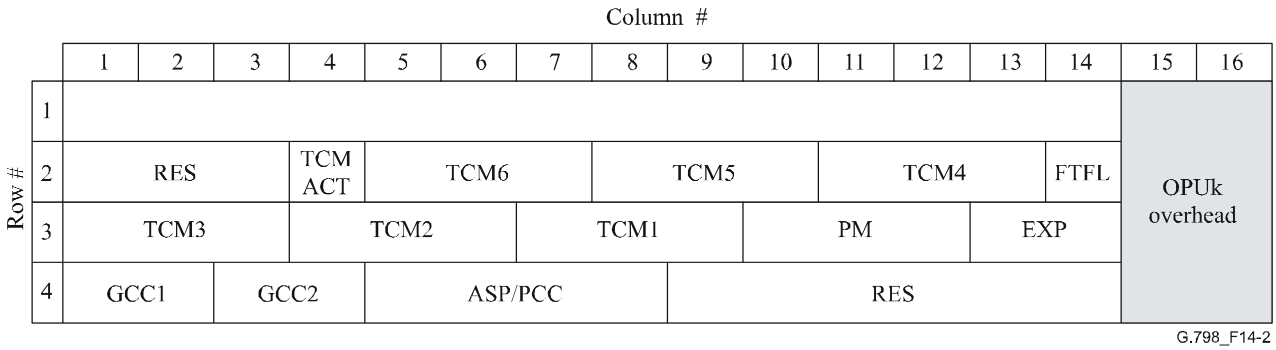


Figure 14-2/G.798 – ODUk overhead at ODUk_CP

The ODUkP Adapted Information (ODUkP_AI) consists of the client layer CI adapted to the OPUk frame as defined in ITU-T Rec. G.709/Y.1331 and the OPUk overhead as shown in Figure 14-3, together with a frame and multiframe start. The mapping specific overhead depends on the client mapping scheme. In case of COMMS access at the ODUkP_AP, it includes also ODUk GCC overhead (GCC1/2).

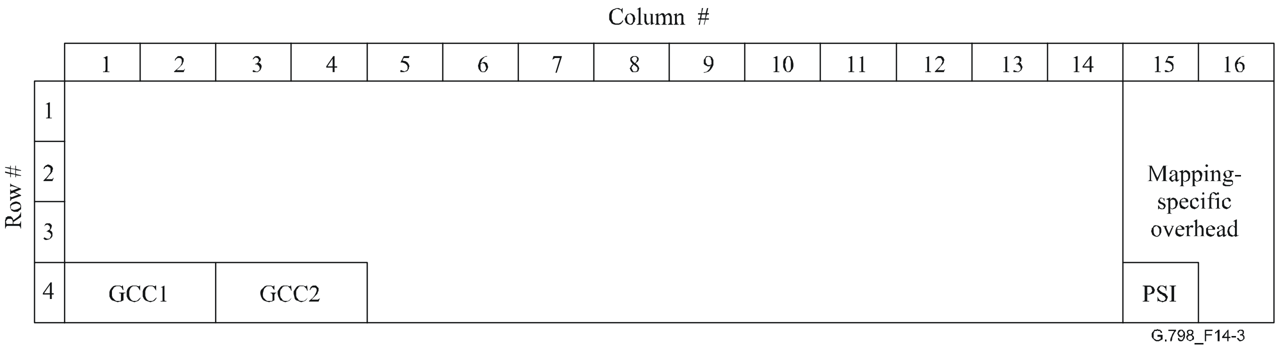


Figure 14-3/G.798 – OPUk overhead at ODUk_AP

14.1 Connection functions

14.1.1 ODUk connection function (ODUk_C)

The information flow and processing of the ODUk_C function is defined with reference to Figures 14-4 and 14-5. The ODUk_C function connects ODUk characteristic information from its input ports to its output ports. As the process does not affect the nature of characteristic information, the reference points on either side of the ODUk_C function are the same as illustrated in Figure 14-4.

The connection process is unidirectional and as such no differentiation in sink and source is required.

In addition, the ODUk_C function supports the following sub-network connection protection schemes:

– 1+1 unidirectional SNC/N, SNC/I and SNC/S protection without an APS protocol.

– 1+1 unidirectional SNC/N, SNC/I and SNC/S protection with an APS protocol.

– 1+1 bidirectional SNC/N, SNC/I and SNC/S protection with an APS protocol.

– 1:n unidirectional SNC/I and SNC/S protection with an APS protocol.

– 1:n bidirectional SNC/I and SNC/S protection with an APS protocol.

The protection functionality is described in 14.1.1.1.

NOTE 1 – The protection processes have a dedicated sink and source behaviour.

Symbol

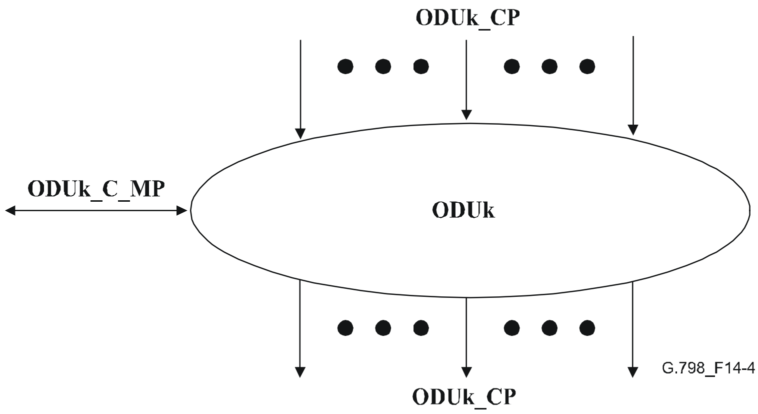


Figure 14-4/G.798 – ODUk_C function

Interfaces

Table 14-1/G.798 – ODUk_C function inputs and outputs

Input(s)	Output(s)
per ODUk_CP: ODUk_CI_D ODUk_CI_CK ODUk_CI_FS ODUk_CI_MFS ODUk_CI_SSF ODUk_CI_SSD (for SNC/S and SNC/I protection) ODUk_CI_TSF (for SNC/N protection) ODUk_CI_TSD (for SNC/N protection) **ODUk_C_MP**: ODUk_C_MI_MatrixControl **per protection group (for SNC protection)**: ODUk_C_MI_ProtType ODUk_C_MI_OperType ODUk_C_MI_WTR ODUk_C_MI_HoTime ODUk_C_MI_ExtCMD ODUk_C_MI_APSChannel (for SNC protection with APS protocol) ODUk_C_MI_SDEnable	**per ODUk_CP**: ODUk_CI_D ODUk_CI_CK ODUk_CI_FS ODUk_CI_MFS ODUk_CI_SSF **ODUk_C_MP**: **per protection group (for SNC protection with APS protocol)**: ODUk_C_MI_cFOP-PM ODUk_C_MI_cFOP-NR

Processes

The processes associated with the ODUk_C function are as depicted in Figure 14-5.

ODUk_CI is routed between input and output connection points by means of a matrix connection. Connection points may be allocated within a protection group.

NOTE 2 – Neither the number of input/output signals to the connection function, nor the connectivity is specified in this Recommendation. That is a property of individual network elements.

Routing: The function shall be able to connect a specific input with a specific output by means of establishing a matrix connection between the specified input and output. It shall be able to remove an established matrix connection.

Each (matrix) connection in the ODUk_C function should be characterized by the:

- Type of connection: unprotected.
- Traffic direction: unidirectional, bidirectional.
- Input and Output connection points: set of connection points.

NOTE 3 – Broadcast connections are handled as separate connections to the same CP.

The following changes to (the configuration of) a connection shall be possible without disturbing the CI passing the connection:

– addition and removal of protection;
– addition and removal of connections to/from a broadcast connection;
– change of WTR time;
– change of operation type;
– change of Hold-off time;
– change of APS channel.

Open Connection Indication (OCI): If an output of the connection function is not connected to an input, an ODUk-OCI signal as defined in 16.5/G.709/Y.1331 is generated for this output. The clock of the OCI signal has to be within $239/(239 - k) * 4^{(k-1)} * 2\ 488\ 320$ kHz ± 20 ppm. The jitter and wander requirements as defined in Annex A/G.8251 (ODCa clock) apply. CI_SSF is false.

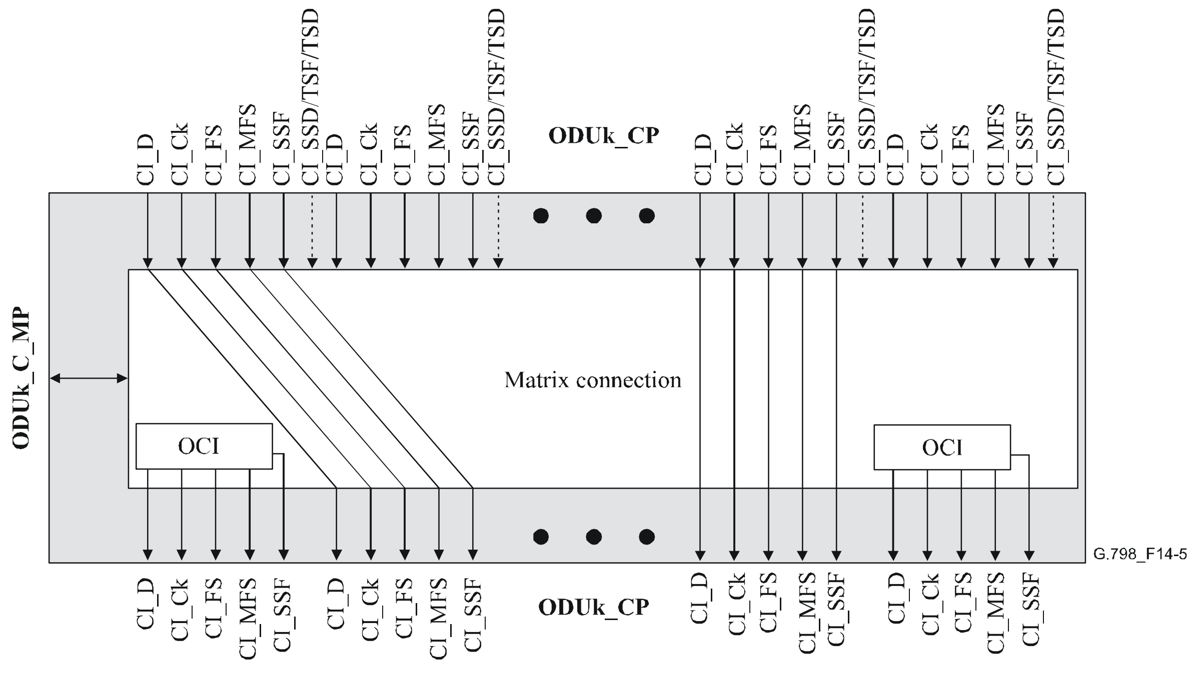


Figure 14-5/G.798 – ODUk_C function processes

Defects: See 14.1.1.1 for protection specific defects.

Consequent actions: None.

Defect correlations: See 14.1.1.1 for protection specific defect correlations.

Performance monitoring: None.

14.1.1.1 Subnetwork connection protection process

NOTE 1 – This process is active in the ODUk_C function as many times as there are 1+1 protected matrix connections.

The generic sub-network connection protection mechanism is defined in ITU-T Rec. G.808.1 with OTN specific extensions in ITU-T Rec. G.873.1.

SNC protection with non-intrusive monitoring (SNC/N), with inherent monitoring (SNC/I) and with sub-layer monitoring based on TCM (SNC/S) are supported. SNC/I is limited to a single OTUk[V] server layer trail for the working and protection sub-network connection between the source and sink protection switch (e.g., no intermediate OTUk termination/3R regeneration is allowed).

NOTE 2 – The limitation to a single server layer trail for SNC/I protection is given by the use of signal degrade (SD) as protection switching criteria. SD is only available from the OTUk[V] trail that is locally terminated and not from further upstream OTUk[V] trails. Furthermore FDI, which provides information about defects in upstream OTUk[V] trails, is not detected in the OTUk[V]/ODUk_A_Sk.

Figure 14-6 gives the atomic functions involved in SNC/N protection. The working and protection ODUk_CI coming from either a OTUk[V]/ODUk_A or ODUkT/ODUk_A function are monitored by a ODUkP or ODUkT non-intrusive monitor, which provide the TSF and TSD protection switching criteria.

Figure 14-7 gives the atomic functions involved in SNC/I protection. The trail termination sink of an OTUk[V] or ODUkP server layer provides the TSF and TSD protection switching criteria via the OTUk[V]/ODUk_A or ODUkP/ODU[I]j_A functions (SSF and SSD).

Figure 14-8 gives the atomic functions involved in SNC/S protection. The trail termination sink of an ODUkT TCM sub-layer provides the TSF and TSD protection switching criteria via the ODUkT/ODUk_A function (SSF and SSD).

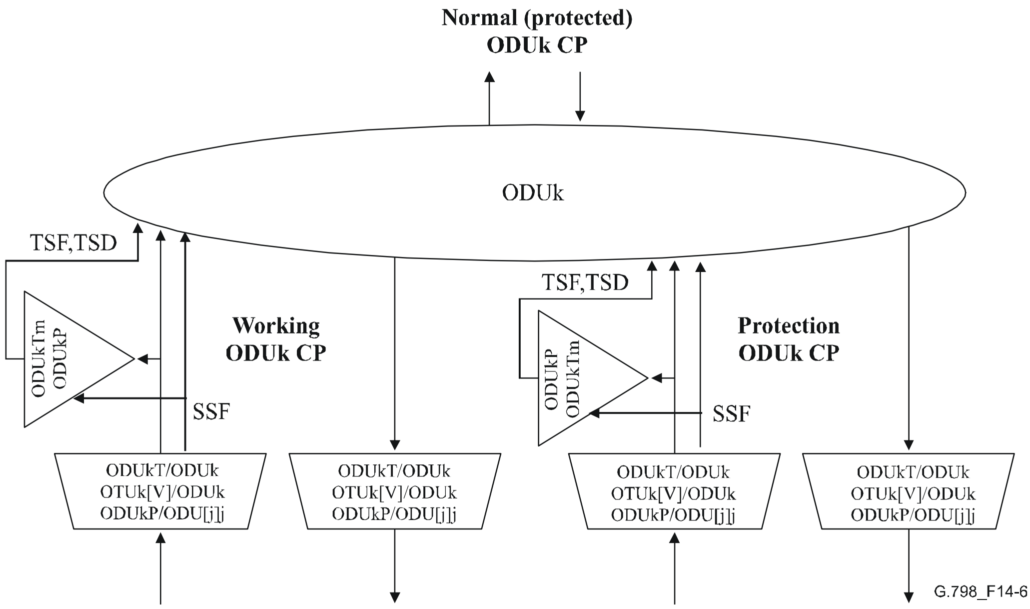


Figure 14-6/G.798 – SNC/N protection atomic functions

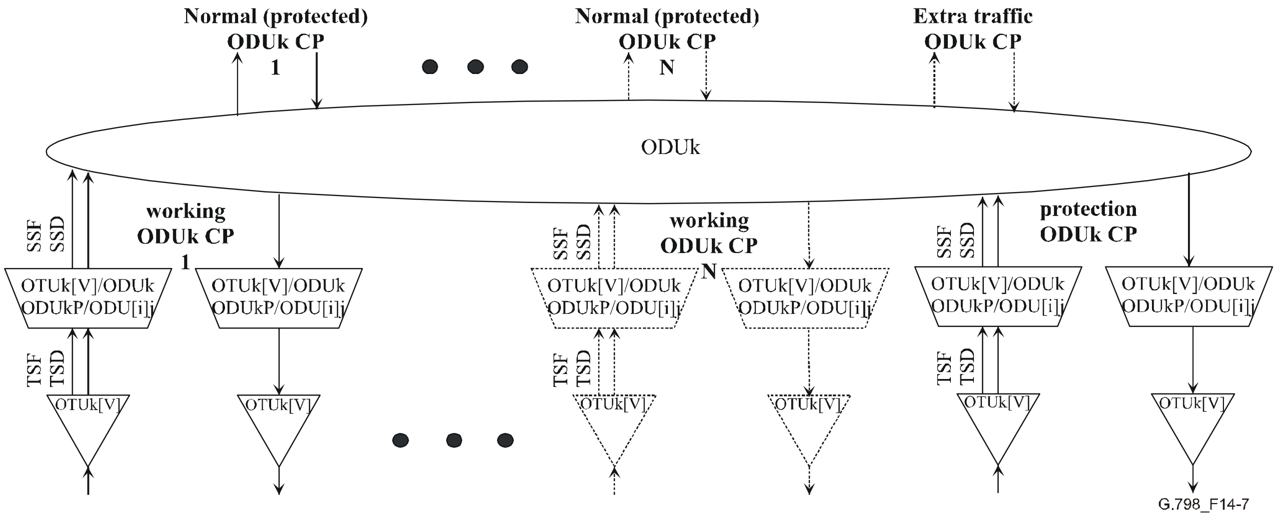


Figure 14-7/G.798 – SNC/I protection atomic functions

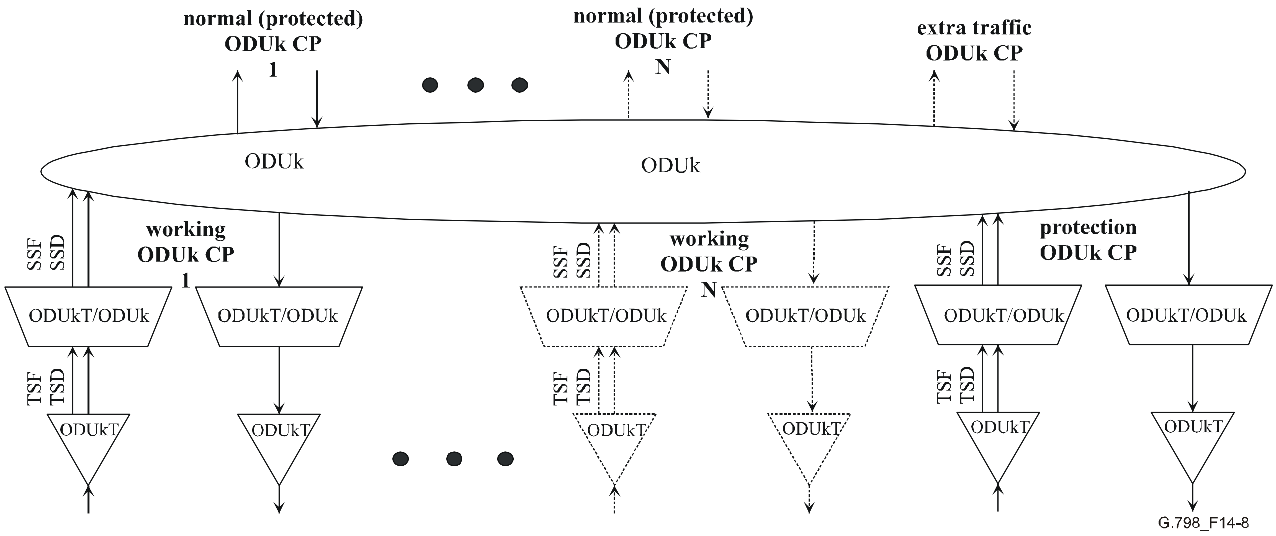


Figure 14-8/G.798 – SNC/S protection atomic functions

The signal flow associated with the ODUk_C SNC protection process is described with reference to Figures 14-9 to 14-13. The protection process receives control parameters and external switch requests at the MP reference point. The report of status information at the MP reference point is for further study.

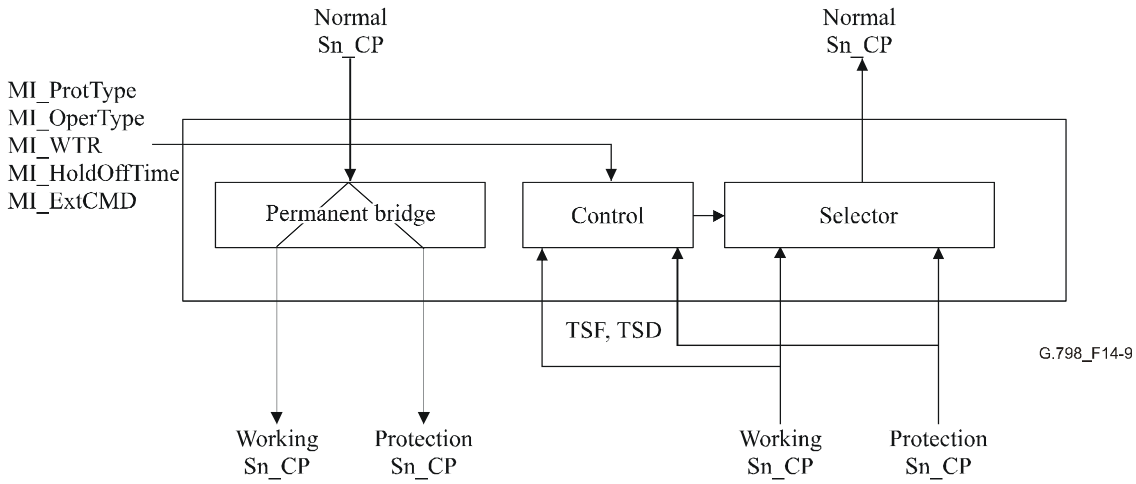


Figure 14-9/G.798 – 1+1 unidirectional SNC/N protection process without APS protocol

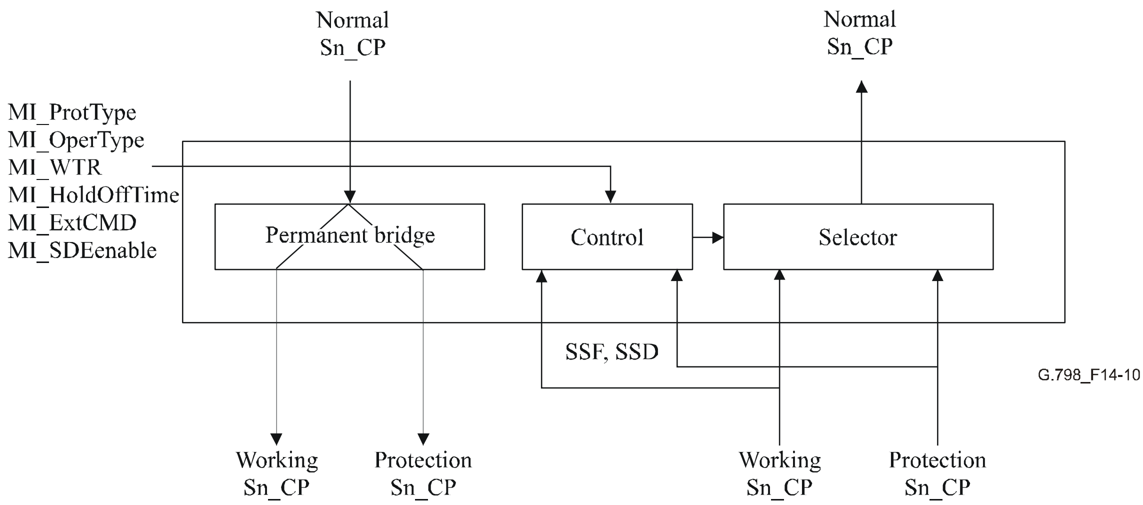


Figure 14-10/G.798 – 1+1 unidirectional SNC/S and SNC/I protection process without APS protocol

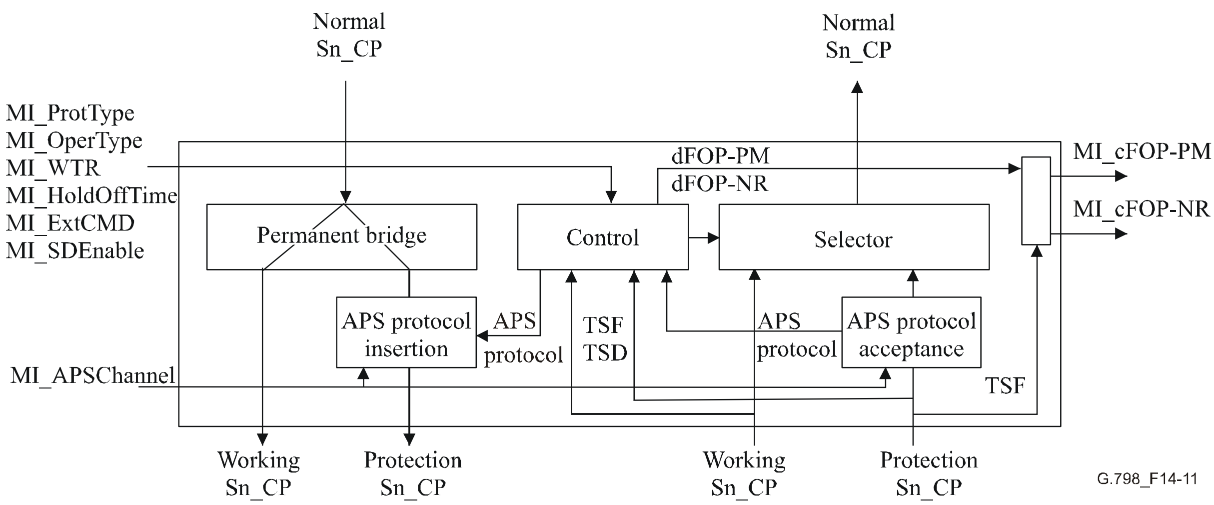


Figure 14-11/G.798 – 1+1 SNC/N protection process with APS protocol

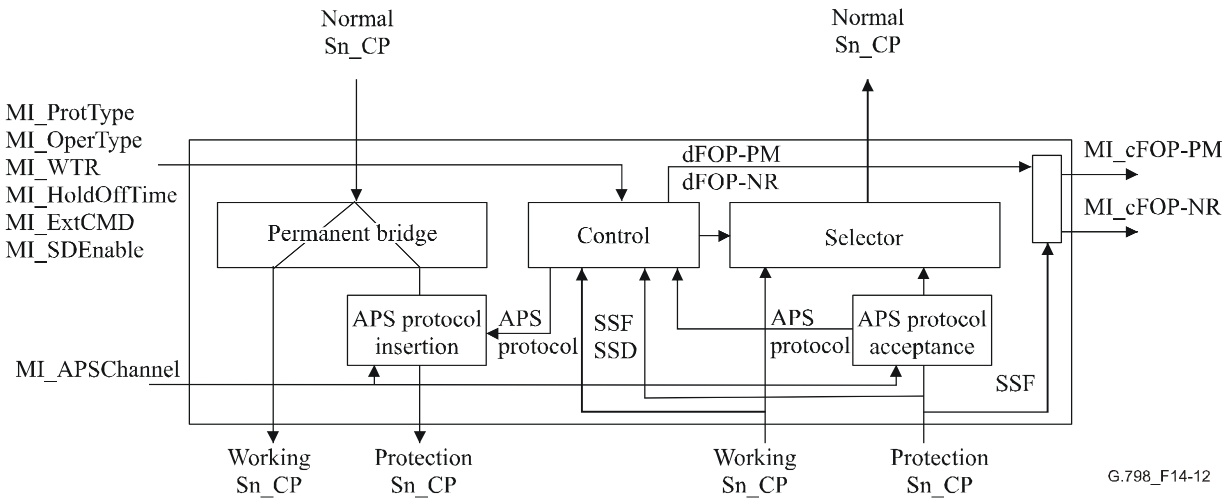


Figure 14-12/G.798 – 1+1 SNC/S and SNC/I protection process with APS protocol

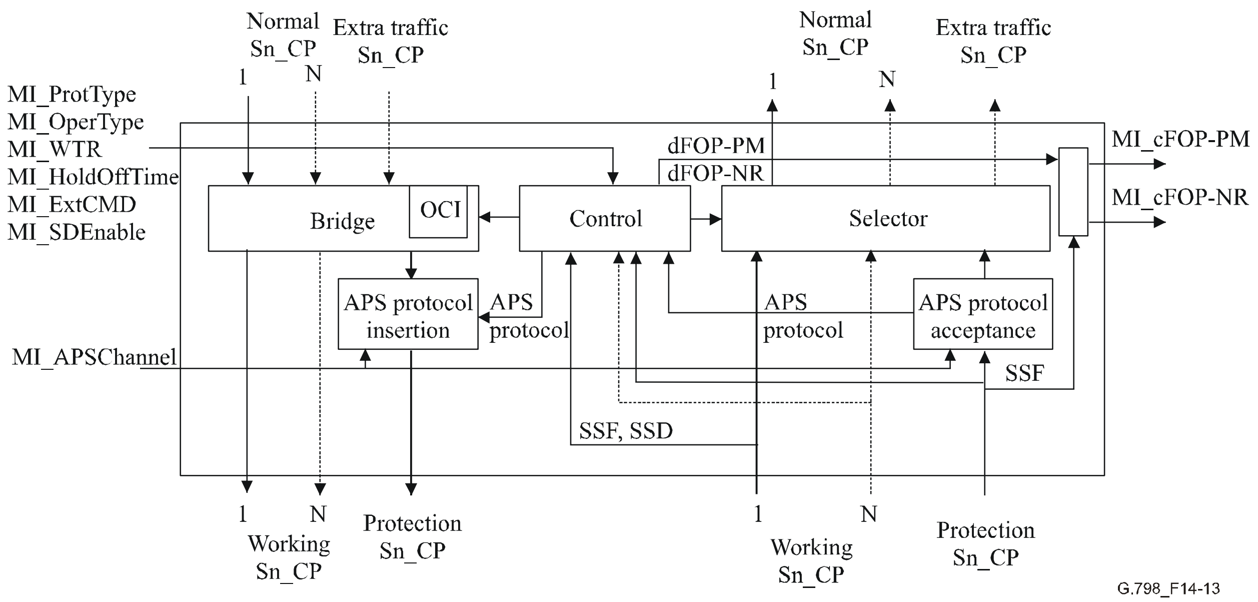


Figure 14-13/G.798 – 1:N SNC/S and SNC/I protection process with APS protocol

For the description of the protection processes including bridge and selector control, APS acceptance and transmission, see ITU-T Rec. G.873.1.

A permanent bridge as defined in ITU-T Rec. G.808.1 shall be used for the 1+1 protection. A broadcast bridge as defined in ITU-T Rec. G.808.1 shall be used for the 1:N protection. It permanently connects the normal traffic signal to the working transport entity. In case no normal or extra traffic signal is connected to the protection transport entity, an ODUk-OCI signal as defined in 16.5/G.709/Y.1331 is generated for the protection transport entity. The clock of the OCI signal has to be within $239/(239 - k) * 4^{(k-1)} * 2\ 488\ 320$ kHz ± 20 ppm. The jitter and wander requirements as defined in Annex A/G.8251 (ODCa clock) apply. CI_SSF is false.

A merging selector as defined in ITU-T Rec. G.808.1 shall be used.

MI_ProtType configures the protection type as defined in 8.4/G.873.1.

NOTE 3 – Only a subset or a single protection type can be supported. In the latter case, the configuration is not needed.

MI_OperType configures between revertive and non-revertive operation as defined in 7.3/G.873.1.

NOTE 4 – Only a single operation type can be supported. In this case the configuration is not needed.

MI_HoTime configures the hold-off time as defined in 8.12/G.873.1.

MI_WTR configures the Wait-to-restore (WTR) time as defined in clause 15/G.808.1.

MI_ExtCMD configures the protection group command as defined in clause 6/G.873.1.

MI_APSChannel configures the APS channel (see 15.8.2.4/G.709/Y.1331) in case an APS protocol is used.

If MI_SDEnable is true the SSD/TSD signal is used as trigger for the protection. If it is false SSD/TSD is not used as trigger for the protection. It applies to all working and the protection signal in common.

Protection switching performance

The transfer Time T_t as defined in clause 13/G.808.1 shall not exceed 50 ms for a protection span length that does not exceed 1200 km.

Defects

The function shall detect for dFOP-PM and dFOP-NR defects in case the APS protocol is used.

dFOP-PM: See 6.2.7.1.1.

dFOP-NR: See 6.2.7.1.2.

Consequent actions: None.

Defect correlations

cFOP-PM ← dFOP-PM and (not CI_SSF/TSF)

cFOP-NR ← dFOP-NR and (not CI_SSF/TSF)

In case of SNC/S and SNC/I CI_SSF of the protection signal is used. In case of SNC/N CI_TSF of the protection signal is used.

Performance monitoring: None.

14.2 Termination functions

14.2.1 ODUkP trail termination function (ODUkP_TT)

The ODUkP_TT function terminates the Path Monitoring (PM) overhead of the ODUk overhead to determine the status of the ODUk trail. Figure 14-14 shows the combination of the unidirectional sink and source functions to form a bidirectional function.

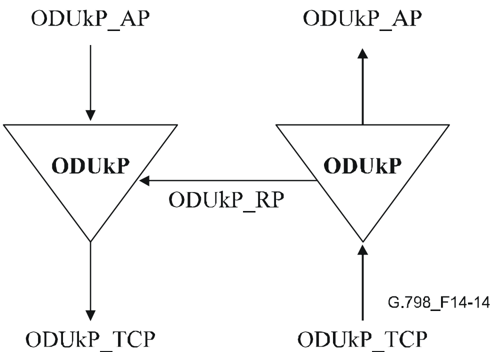


Figure 14-14/G.798 – ODUkP_TT

14.2.1.1 ODUkP trail termination source function (ODUkP_TT_So)

The ODUkP_TT_So function computes the BIP8 and adds Path Monitoring Overhead (PMOH) – including the TTI, BIP8, BDI and BEI signals – in the PM overhead field to the ODUk signal at its ODUkP_AP.

The information flow and processing of the ODUkP_TT_So function is defined with reference to Figures 14-15 and 14-16.

Symbol

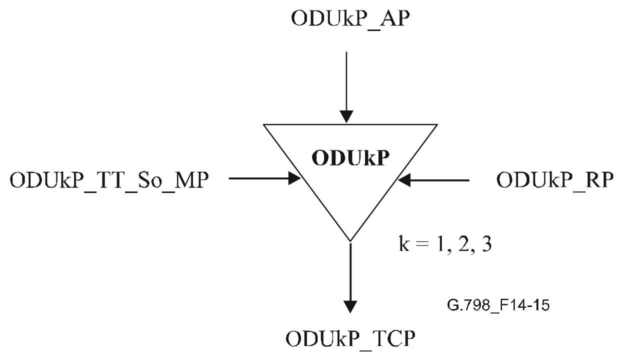


Figure 14-15/G.798 – ODUkP_TT_So function

Interfaces

Table 14-2/G.798 – ODUkP_TT_So inputs and outputs

Input(s)	Output(s)
ODUkP_AP: ODUkP_AI_CK ODUkP_AI_D ODUkP_AI_FS ODUkP_AI_MFS **ODUkP_RP**: ODUkP_RI_BDI ODUkP_RI_BEI **ODUkP_TT_So_MP**: ODUkP_TT_So_MI_TxTI	**ODUk_TCP**: ODUk_CI_CK ODUk_CI_D ODUk_CI_FS ODUk_CI_MFS

Processes

The processes associated with the ODUkP_TT_So function are as depicted in Figure 14-16.

PMOH-TTI: The trail trace identifier is inserted in the TTI byte position of the PM field. Its value is derived from reference point ODUkP_TT_So_MP. The trail trace format is described in 15.2/G.709/Y.1331.

PMOH-BDI: The backward defect indication is inserted in the BDI bit position of the PM field. Its value is derived from reference point ODUkP_RP. Upon the declaration/clearing of aBDI at the termination sink function, the trail termination source function shall have inserted/removed the BDI indication within 50 ms.

PMOH-BEI: The number of errors indicated in RI_BEI is encoded in the BEI bits of the PM field. Upon the detection of a number of errors at the termination sink function, the trail termination source function shall have inserted that value in the BEI bits within 50 ms.

PMOH-BIP8: See 8.3.4.1. The calculated BIP8 is inserted into the BIP8 byte of the PM field.

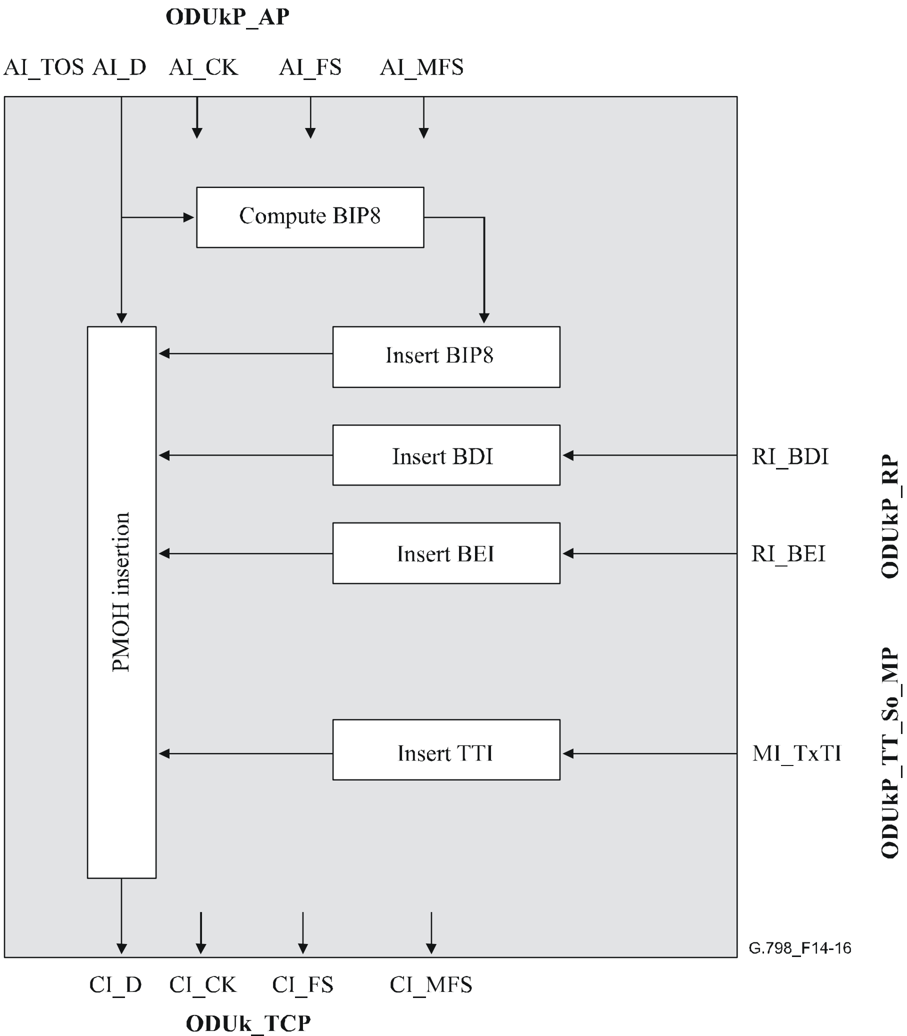


Figure 14-16/G.798 – ODUkP_TT_So processes

Defects: None.

Consequent actions: None.

Defect correlations: None.

Performance monitoring: None.

14.2.1.2 ODUkP trail termination sink function (ODUkP_TT_Sk)

The ODUkP_TT_Sk function reports the state of the ODUk Trail (Path). It computes the BIP8, extracts Path Monitoring Overhead (PMOH) – including the TTI, BIP8, BDI, BEI and STAT signals – in the PM overhead field from the ODUk signal at its ODUk_TCP, detects for AIS, OCI, LCK, TIM, DEG and BDI defects, counts during 1-second periods errors (detected via the BIP8) and defects to feed Performance Monitoring when connected, makes the TTI available to network management and forwards the error and defect information as backward indications to the companion ODUkP_TT_So function.

NOTE 1 – The ODUkP_TT_Sk function extracts and processes the PM Overhead irrespective of the presence of one or more levels of tandem connection overhead in the TCM fields.

The information flow and processing of the ODUkP_TT_Sk function is defined with reference to Figures 14-17 and 14-18.

Symbol

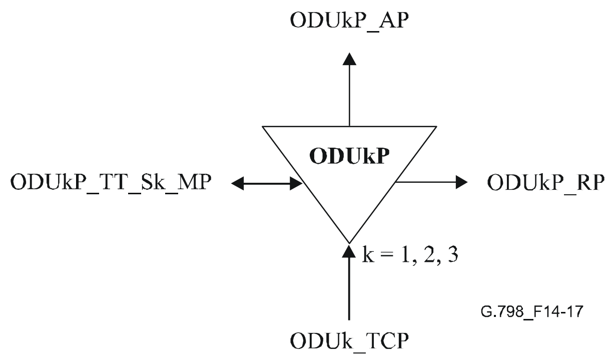


Figure 14-17/G.798 – ODUkP_TT_Sk function

Interfaces

Table 14-3/G.798 – ODUkP_TT_Sk inputs and outputs

Input(s)	Output(s)
ODUk_TCP: ODUk_CI_CK ODUk_CI_D ODUk_CI_FS ODUk_CI_MFS ODUk_CI_SSF **ODUkP_TT_Sk_MP**: ODUkP_TT_Sk_MI_ExSAPI ODUkP_TT_Sk_MI_ExDAPI ODUkP_TT_Sk_MI_GetAcTI ODUkP_TT_Sk_MI_TIMDetMo ODUkP_TT_Sk_MI_ TIMActDis OTUk_TT_Sk_MI_DEGThr OTUk_TT_Sk_MI_DEGM OTUk_TT_Sk_MI_1second	**ODUkP_AP**: ODUkP_AI_CK ODUkP_AI_D ODUkP_AI_FS ODUkP_AI_MFS ODUkP_AI_TSF ODUkP_AI_TSD **ODUkP_RP**: ODUkP_RI_BDI ODUkP_RI_BEI **ODUkP_TT_Sk_MP**: ODUkP_TT_Sk_MI_AcTI ODUkP_TT_Sk_MI_cOCI ODUkP_TT_Sk_MI_cLCK ODUkP_TT_Sk_MI_cTIM ODUkP_TT_Sk_MI_cDEG ODUkP_TT_Sk_MI_cBDI ODUkP_TT_Sk_MI_cSSF ODUkP_TT_Sk_MI_pN_EBC ODUkP_TT_Sk_MI_pN_DS ODUkP_TT_Sk_MI_pF_EBC ODUkP_TT_Sk_MI_pF_DS

Processes

The processes associated with the ODUkP_TT_Sk function are as depicted in Figure 14-18.

PMOH-BIP8: See 8.3.4.2. The BIP8 is extracted from the BIP8 byte of the PM field.

PMOH-TTI: The trail trace identifier shall be recovered from TTI byte position of the PM field in the ODUk signal at the ODUk_TCP and processed as specified in 8.6. The accepted value of the TTI is available at the MP (MI_AcTI).

PMOH-BDI: The backward defect indication shall be recovered from BDI bit position of the PM field in the ODUk signal at the ODUk_TCP. It shall be used for BDI defect detection.

PMOH-BEI: The BEI shall be recovered from the BEI bits in the PM field in the ODUk signal at the ODUk_TCP. It shall be used to determine if a far-end errored block (nF_B) has occurred. A nF_B has occurred if the BEI value is between 1 [0001] and 8 [1000]; otherwise, no nF_B has occurred.

PMOH-STAT: The status information shall be recovered from the STAT bits in the PM field in the ODUk signal at the ODUk_TCP as defined in 8.8. It shall be used for AIS, OCI and LCK defect detection.

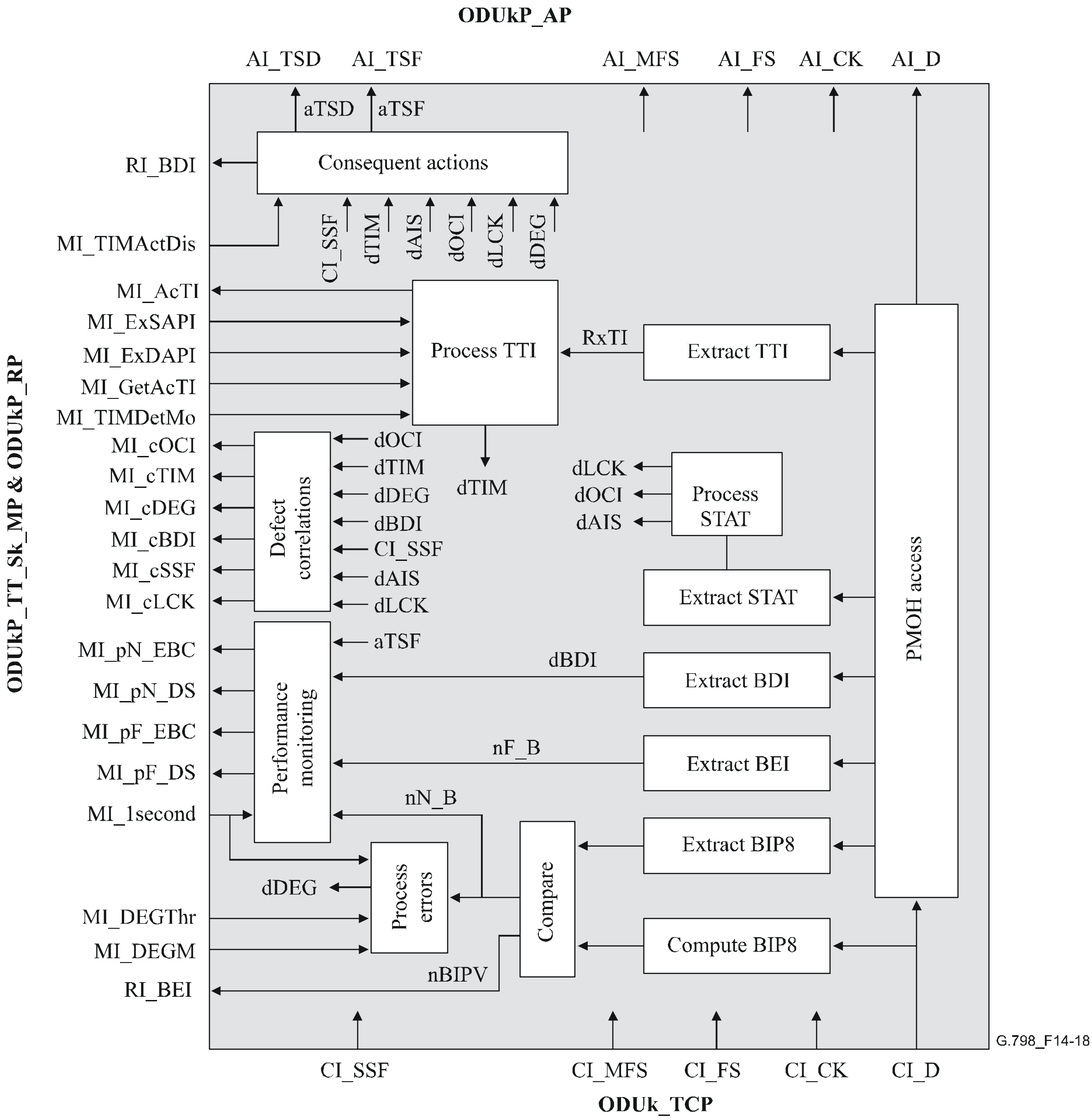


Figure 14-18/G.798 – ODUkP_TT_Sk processes

Defects

The function shall detect for dAIS, dOCI, dLCK, dTIM, dDEG and dBDI defects.

dAIS: See 6.2.6.3.2.

dOCI: See 6.2.6.8.2; dOCI shall be set to false during CI_SSF.

dLCK: See 6.2.6.9.1; dLCK shall be set to false during CI_SSF.

dTIM: See 6.2.2.1; dTIM shall be set to false during CI_SSF.

dDEG: See 6.2.3.5.

dBDI: See 6.2.6.6.1; dBDI shall be set to false during CI_SSF.

Consequent actions

The function shall perform the following consequent actions:

aBDI ← CI_SSF or dAIS or dOCI or dLCK or dTIM

aBEI ← NBIPV

aTSF ← CI_SSF or dAIS or dOCI or dLCK or (dTIM and (not TIMActDis))

aTSD ← dDEG

Defect correlations

The function shall perform the following defect correlations to determine the most probable fault cause (see 6.4/G.806). This fault cause shall be reported to the EMF.

cOCI ← dOCI and (not CI_SSF)

cLCK ← dLCK and (not CI_SSF)

cTIM ← dTIM and (not CI_SSF) and (not dAIS) and (not dOCI) and (not dLCK)

cDEG ← dDEG and (not CI_SSF) and (not dAIS) and (not dOCI) and (not dLCK) and (not (dTIM and (not TIMActDis)))

cBDI ← dBDI and (not CI_SSF) and (not dAIS) and (not dOCI) and (not dLCK) and (not (dTIM and (not TIMActDis)))

cSSF ← CI_SSF or dAIS

Performance monitoring

The function shall perform the following performance monitoring primitives processing (see 6.5/G.806). The performance monitoring primitives shall be reported to the EMF.

pN_DS ← CI_SSF or dAIS or dOCI or dLCK or dTIM

pF_DS ← dBDI

pN_EBC ← ∑ nN_B

NOTE 2 – During CI_SSF, dAIS, dLCK and dOCI no errored blocks shall be counted.

pF_EBC ← ∑ nF_B

NOTE 3 – During CI_SSF, dAIS, dLCK and dOCI no errored blocks shall be counted.

14.2.2 ODUkP non-intrusive monitor function

As the functionality of the ODUkP non-intrusive monitor function is identical to the ODUkP_TT_Sk function (see 14.2.1.2), no dedicated ODUkP non-intrusive monitoring function ODUkPm_TT_Sk is defined. For ODUkP non-intrusive monitoring, the ODUkP_TT_Sk function is connected to the ODUk_CP as shown in Figure 14-19. The ODUkP_TT_Sk function can be connected to any ODUk_CP in this manner.

The unused outputs (e.g., ODUk_RI, ODUk_AI_CK/D/FS/MFS) are left open. The TSF and TSD outputs can be connected to an ODUk_C connection function and used as protection switching trigger criteria for SNC/N protection.

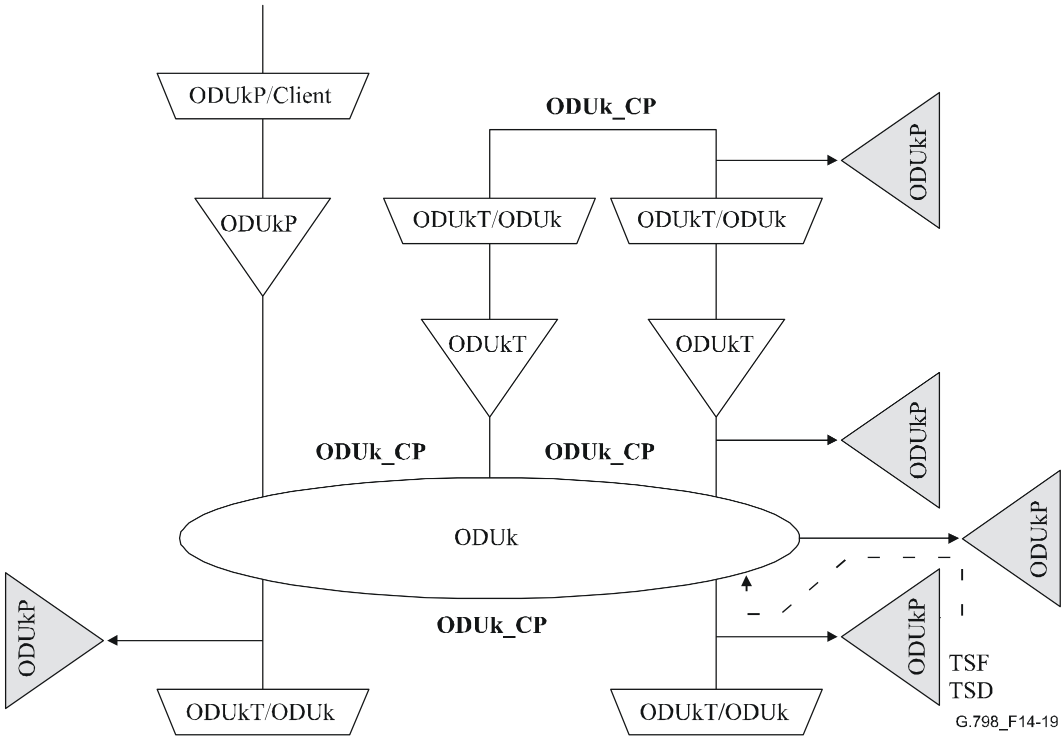


Figure 14-19/G.798 – Connection of ODUkP_TT_Sk function as non-intrusive monitor (examples)

14.3 Adaptation functions

14.3.1 ODUkP to CBRx adaptation function (ODUkP/CBRx_A) (x = 2G5, 10G, 40G)

The ODUkP to CBRx adaptation functions perform the adaptation between the ODUkP (k = 1, 2, 3) layer adapted information and the characteristic information of a CBRx signal.

The parameter x defines the bit rate or bit rate range of the CBR signal. The values x = 2G5, 10G and 40G are defined for client signals that comply to the SDH bit rates as defined in Table 14-4. Support for other bit rates and bit rate ranges is for further study.

Table 14-4/G.798 – Defined values for x

x	Bit rate	Clock range
2G5	2 488 320 kbits ± 20 ppm	2 488 320 kHz ± 20 ppm
10G	9 953 280 kbits ± 20 ppm	9 953 280 kHz ± 20 ppm
40G	39 813 120 kbits ± 20 ppm	39 813 120 kHz ± 20 ppm

Two different source functions are defined. The ODUkP/CBRx-a_A_So provides asynchronous mapping, while the ODUkP/CBRx-b_A_So provides bit synchronous mapping. In the sink direction, the ODUkP/CBRx_A_Sk can handle both (bit synchronous and asynchronous) mappings.

14.3.1.1 ODUkP to CBRx asynchronous mapping adaptation source function (ODUkP/CBRx-a_A_So) (x = 2G5, 10G, 40G)

The ODUkP/CBRx-a_A_So function creates the ODUk signal from a free running clock. It asynchronously maps the $4^{(k-1)}$ * 2 488 320 kbit/s constant bit rate client signal from the CBRx_CP into the payload of the OPUk (k = 1, 2, 3), adds OPUk Overhead (RES, PT, JC) and default ODUk Overhead.

The information flow and processing of the ODUkP/CBRx-a_A_So function is defined with reference to Figures 14-20 and 14-21.

Symbol

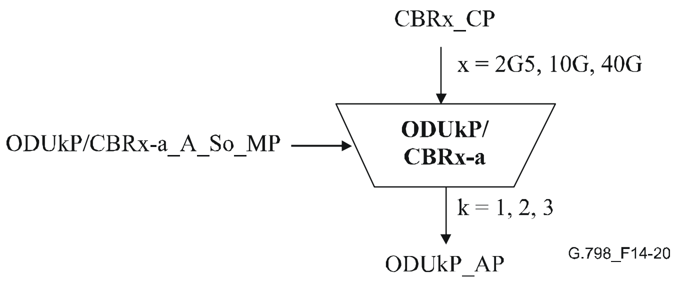


Figure 14-20/G.798 – ODUkP/CBRx-a_A_So function

Interfaces

Table 14-5/G.798 – ODUkP/CBRx-a_A_So inputs and outputs

Input(s)	Output(s)
CBRx_CP: CBRx_CI_CK CBRx_CI_D **ODUkP/CBRx-a_A_So_MP**: ODUkP/CBRx-a_A_So_MI_Active	**ODUkP_AP**: ODUkP_AI_CK ODUkP_AI_D ODUkP_AI_FS ODUkP_AI_MFS

Processes

Activation

– The ODUkP/CBRx-a_A_So function shall access the access point when it is activated (MI_Active is true). Otherwise, it shall not access the access point.

Clock and (Multi)Frame Start signal generation: The function shall generate a local ODUk clock (ODUkP_AI_CK) of "239/(239 – k) * $4^{(k-1)}$ * 2 488 320 kHz ± 20 ppm" from a free running oscillator. The clock parameters, including jitter and wander requirements, as defined in Annex A/G.8251 (ODCa clock) apply.

The function shall generate the (multi)frame start reference signals AI_FS and AI_MFS for the ODUk signal. The AI_FS signal shall be active once per 122368 clock cycles. AI_MFS shall be active once every 256 frames.

Mapping, frequency justification and bit rate adaptation: The function shall provide an elastic store (buffer) process. The data signal CBRx_CI shall be written into the buffer under control of the associated input clock. The data shall be read out of the buffer and written onto the D and N/PJO bytes in the OPUk frame under control of the ODUk clock and justification decisions as defined in 17.1/G.709/Y.1331.

A justification decision shall be performed each frame. Each justification decision results in a corresponding positive, negative or no justification action. Upon a positive justification action, the reading of 1 data byte out of the buffer shall be cancelled once. No CBRx data shall be written onto the PJO and NJO byte. Upon a negative justification action, 1 extra data byte shall be read once out of the buffer. CBRx data shall be written onto the PJO and NJO byte. If neither a positive nor a negative justification action is to be performed, CBRx data shall be written onto the PJO byte and no CBRx data shall be written onto the NJO byte.

The justification decisions determine the phase error introduced by the function.

Buffer size: In the presence of jitter as specified by ITU-T Rec. G.825 and a frequency within the range $4^{(k-1)}$ * 2 488 320 kHz ± 20 ppm, this mapping process shall not introduce any errors. The maximum buffer hysteresis, and therefore the maximum phase error introduced, shall be as listed in Table 14-6.

Table 14-6/G.798 – Maximum buffer hysteresis

Mapping	Maximum buffer hysteresis
2G5 → ODU1	2 bytes
10G → ODU2	8 bytes
40G → ODU3	32 bytes

JC bits: The function shall generate the justification control (JC) bits based on the justification decision performed in the current frame according to the specification in 17.1/G.709/Y.1331. It shall insert the justification control bits in the appropriate JC bit positions in the JC bytes of the current frame.

PT: The function shall insert code "0000 0010" into the PT byte position of the PSI overhead as defined in 15.9.2.1/G.709/Y.1331.

RES: The function shall insert all-0's into the RES bytes and Reserved bits within the JC bytes.

All other bits of the ODUk overhead should be sourced as "0"s, except the ODUk-PM STAT field which should be set to the value "normal path signal" (001).

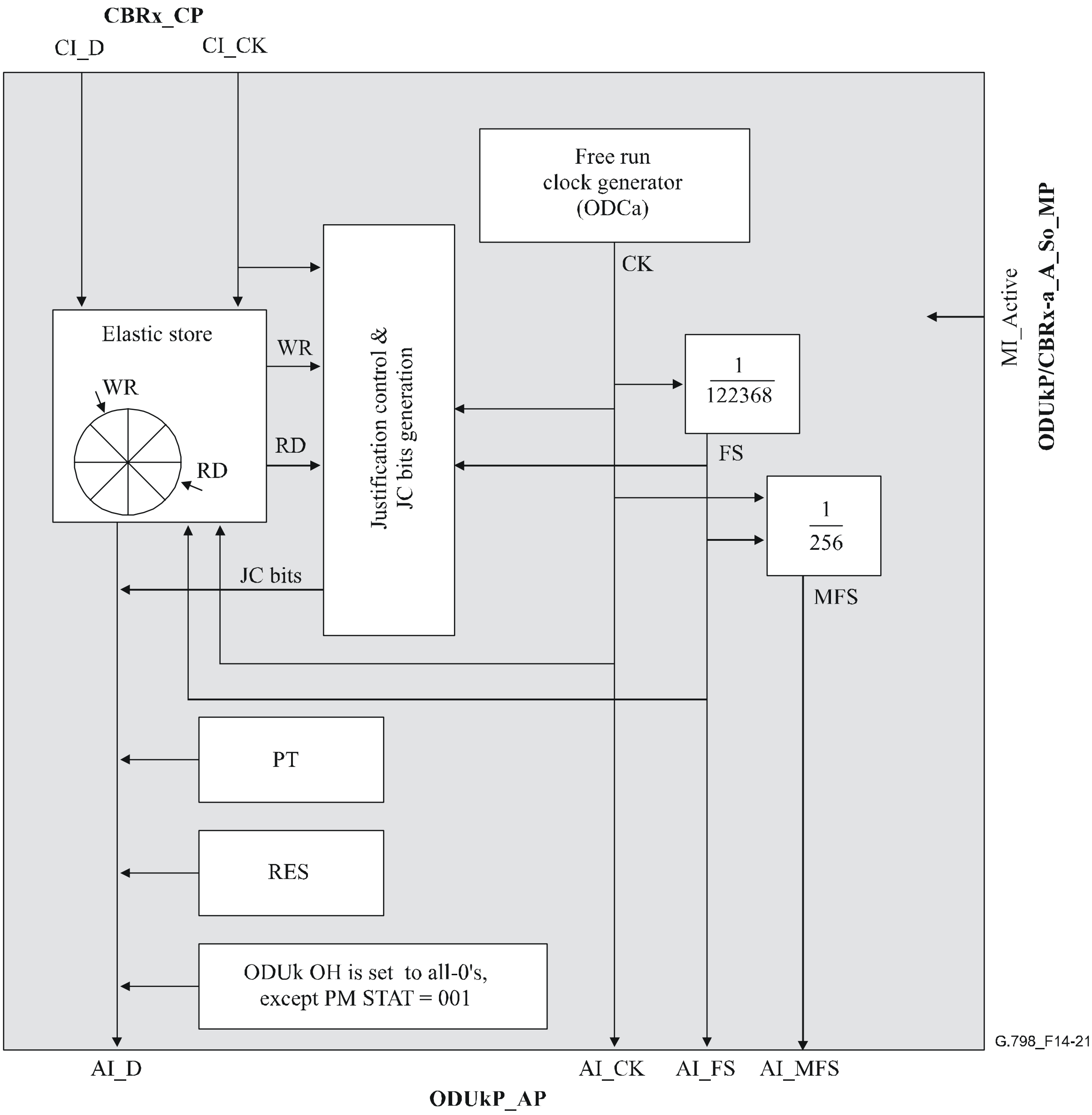


Figure 14-21/G.798 – ODUkP/CBRx-a_A_So processes

Defects: None.

Consequent actions: None.

Defect correlations: None.

Performance monitoring: None.

14.3.1.2 ODUkP to CBRx bit synchronous mapping adaptation source function (ODUkP/CBRx-b_A_So) (x = 2G5, 10G, 40G)

The ODUkP/CBRx-b_A_So function creates the ODUk signal from a clock, derived from the incoming CBRx_CI clock. It bit synchronously maps the $4^{(k-1)}$ * 2 488 320 kbit/s ± 20 ppm constant bit rate client signal from the CBRx_CP into the payload of the OPUk, adds OPUk Overhead (PT, JC, RES) and default ODUk Overhead.

The information flow and processing of the ODUkP/CBRx-b_A_So function is defined with reference to Figures 14-22 and 14-23.

Symbol

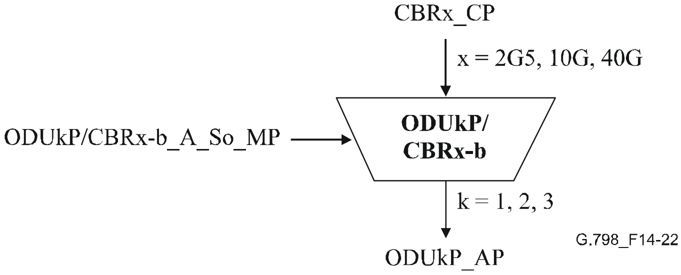


Figure 14-22/G.798 – ODUkP/CBRx-b_A_So function

Interfaces

Table 14-7/G.798 – ODUkP/CBRx-b_A_So inputs and outputs

Input(s)	Output(s)
CBRx_CP: CBRx_CI_CK CBRx_CI_D **ODUkP/CBRx-b_A_So_MP**: ODUkP/CBRx-b_A_So_MI_Active	**ODUkP_AP**: ODUkP_AI_CK ODUkP_AI_D ODUkP_AI_FS ODUkP_AI_MFS

Processes

Activation

– The ODUkP/CBRx-b_A_So function shall access the access point when it is activated (MI_Active is true). Otherwise, it shall not access the access point.

Clock and (Multi)Frame Start signal generation: The function shall generate the ODUk (AI_CK) clock by multiplying the incoming CBRx clock (CI_CK) by factor of 239/(239 – k). The clock parameters, including jitter and wander requirements, as defined in Annex A/G.8251 (ODCb clock) apply.

NOTE 1 – The ODUk clock is "239/(239 – k) * $4^{(k-1)}$ * 2 488 320 kHz ± 20 ppm".

NOTE 2 – The incoming CBRx CK (CI_CK) signal has to be within the range of $4^{(k-1)}$ * 2 488 320 kHz ± 20 ppm.

During failure conditions of the incoming CBR clock signal (CI_CK), the ODUk clock shall stay within its limits as defined in ITU-T Rec. G.8251 and no frame phase discontinuity shall be introduced.

The function shall generate the (multi)frame start reference signals AI_FS and AI_MFS for the ODUk signal. The AI_FS signal shall be active once per 122368 clock cycles. AI_MFS shall be active once every 256 frames.

Mapping, frequency justification and bit rate adaptation: The function shall provide an elastic store (buffer) process. The data signal CBRx_CI shall be written into the buffer under control of the associated input clock. The data shall be read out of the buffer and written onto the D and PJO bytes in the OPUk frame under control of the ODUk clock as defined in 17.1/G.709/Y.1331.

Neither negative nor positive justification is to be performed. No data shall be written onto the NJO byte and data shall always be written onto the PJO byte.

Buffer size: In the presence of jitter as specified by ITU-T Rec. G.825 and a frequency within the range $4^{(k-1)}$ * 2 488 320 kHz ± 20 ppm, this mapping process shall not introduce any errors.

Following a step in frequency of the $4^{(k-1)}$ * 2 488 320 kbit/s CI_CK signal (for example due removal of AIS (generic AIS)) there will be a maximum recovery time of X seconds after which this process shall not generate any bit errors. The value of X is for further study; a value of 1 second has been proposed.

JC bits: The function shall generate the fixed justification control (JC) bits "00" according to 17.1/G.709/Y.1331. It shall insert the justification control bits in the appropriate JC bit positions in the JC bytes.

RES: The function shall insert all-0's into the RES bytes and Reserved bits within the JC bytes.

PT: The function shall insert code "0000 0011" into the PT byte position of the PSI overhead as defined in 15.9.2.1/G.709/Y.1331.

All other bits of the ODUk overhead should be sourced as "0"s, except the ODUk-PM STAT field which should be set to the value "normal path signal" (001).

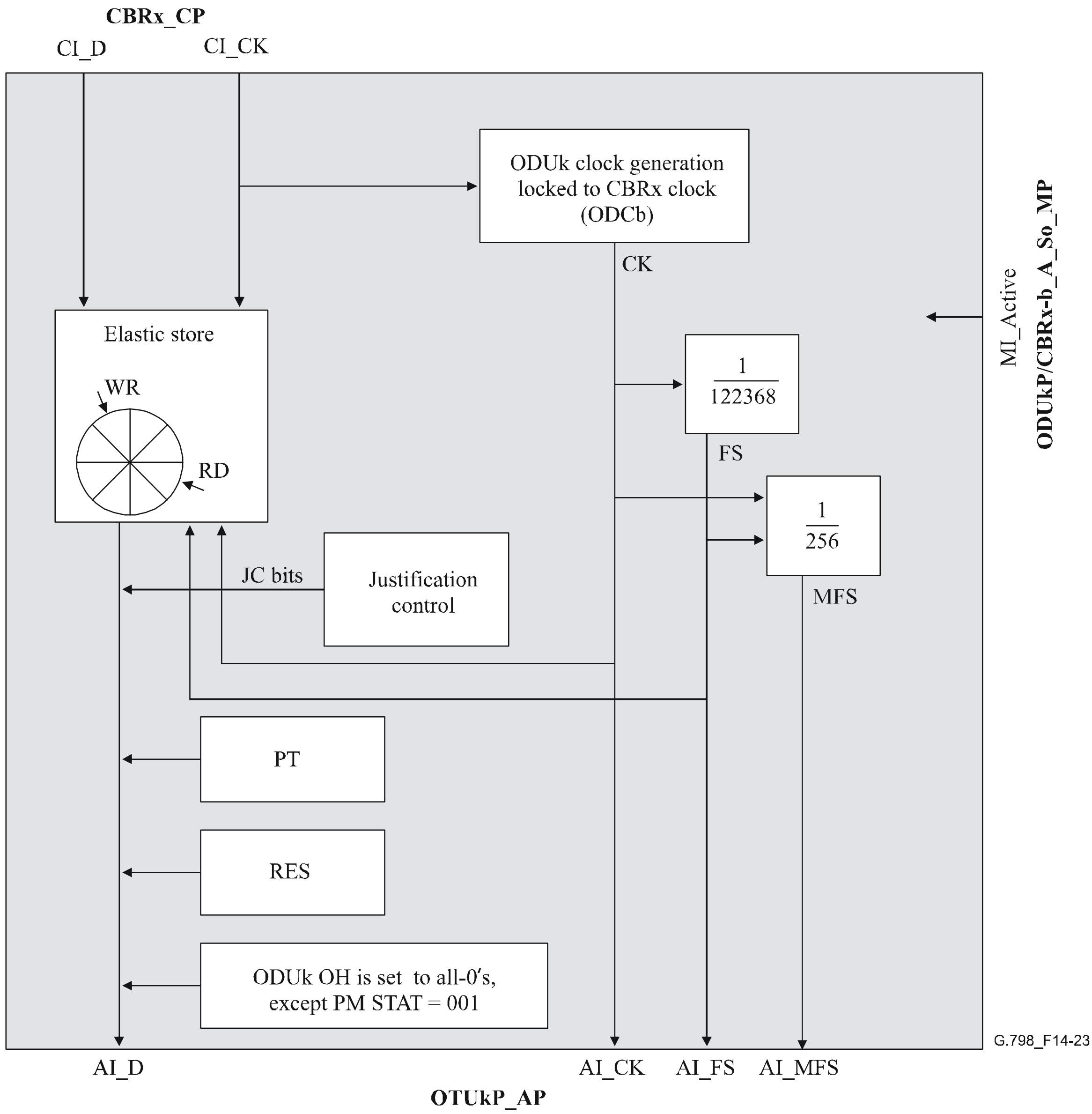


Figure 14-23/G.798 – ODUkP/CBRx-b_A _So processes

Defects: None.

Consequent actions: None.

Defect correlations: None.

Performance monitoring: None.

14.3.1.3 ODUkP to CBRx adaptation sink function (ODUkP/CBRx_A_Sk) (x = 2G5, 10G, 40G)

The ODUkP/CBRx_A_Sk recovers the $4^{(k-1)}$ * 2 488 320 kbit/s ± 20 ppm constant bit rate client signal from the OPUk payload using the justification control information (JC overhead) to determine if a data or stuff byte is present within the NJO and PJO bytes. It extracts the OPUk Overhead (PT, JC, and RES) and monitors the reception of the correct payload type. Under signal fail condition generic-AIS shall be generated.

The information flow and processing of the ODUkP/CBRx_A_Sk function is defined with reference to Figures 14-24 and 14-25.

Symbol

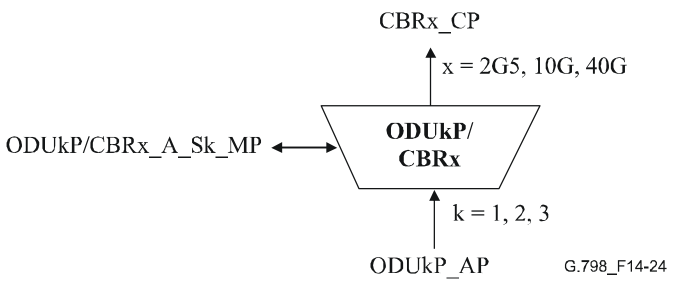


Figure 14-24/G.798 – ODUkP/CBRx_A_Sk function

Interfaces

Table 14-8/G.798 – ODUkP/CBRx_A_Sk inputs and outputs

Input(s)	Output(s)
ODUkP_AP: ODUkP_AI_CK ODUkP_AI_D ODUkP_AI_FS ODUkP_AI_TSF **ODUkP/CBRx_A_Sk_MP**: ODUkP/CBRx_A_Sk_MI_Active	**CBRx_CP**: CBRx_CI_CK CBRx_CI_D CBRx_CI_SSF **ODUkP/CBRx_A_Sk_MP**: ODUkP/CBRx_A_Sk_MI_cPLM ODUkP/CBRx_A_Sk_MI_AcPT

Processes

Activation

– The ODUkP/CBRx_A_Sk function shall access the access point and perform the Common and Specific Processes operation specified below when it is activated (MI_Active is true). Otherwise, it shall activate the SSF signals and generate Generic AIS at its output (CP) and not report its status via the management point.

PT: The function shall extract the PT byte from the PSI overhead as defined in 8.7.1. The accepted PT value is available at the MP (MI_AcPT) and is used for PLM defect detection.

RES: The value in the RES bytes shall be ignored.

JC: The function shall interpret the justification control information in the JC byte as defined in 17.1/G.709/Y.1331 in order to determine the justification action (positive, negative, none) for the current frame. RES bits in the JC shall be ignored.

Demapping, CBR clock generation: The function shall provide an elastic store (buffer) process. The CBR data shall be written into the buffer from the D, PJO and NJO byte in the OPUk frame. The information extraction of the PJO and NJO bytes shall be under control of the justification control information. The CBRx data (CI_D) shall be read out of the buffer under control of the CBRx clock (CI_CK).

Upon a positive justification action, the writing of 1 data byte into the buffer shall be cancelled once. No CBRx data shall be read from the PJO and NJO byte. Upon a negative justification action, 1 extra data byte shall be written into the buffer once. CBRx data shall be read from the PJO and NJO byte. If neither a positive nor a negative justification action is to be performed, CBRx data shall be read from the PJO byte and no CBRx data shall be read from the NJO byte.

Smoothing & jitter limiting process: The function shall provide for a clock smoothing and elastic store (buffer) process. The $4^{(k-1)}$ * 2 488 320 kbit/s (k = 1, 2, 3) data signal shall be written into the buffer under control of the associated (gapped) input clock (with a frequency accuracy within ± 20 ppm). The data signal shall be read out of the buffer under control of a smoothed (equally spaced) $4^{(k-1)}$ * 2 488 320 kbit/s ± 20 ppm clock (the rate is determined by the 2.5 Gbit/s, 10 Gbit/s, 40 Gbit/s signal at the input of the remote ODUkP/CBRx_A_So).

The clock parameters, including jitter and wander requirements, as defined in Annex A/G.8251 (ODCp clock), apply.

Buffer size: In the presence of jitter as specified by ITU-T Rec. G.825 and a frequency within the range $4^{(k-1)}$ * 2 488 320 kbit/s ± 20 ppm, this justification process shall not introduce any errors.

Following a step in frequency of the $4^{(k-1)}$ * 2 488 320 kbit/s signal transported by the ODUkP_AI (for example due to reception of CBRx_CI from a new RSn_TT_So at the far end or removal of generic-AIS signal with a frequency offset), there will be a maximum recovery time of X seconds after which this process shall not generate any bit errors. The value of X is for further study; a value of 1 second has been proposed.

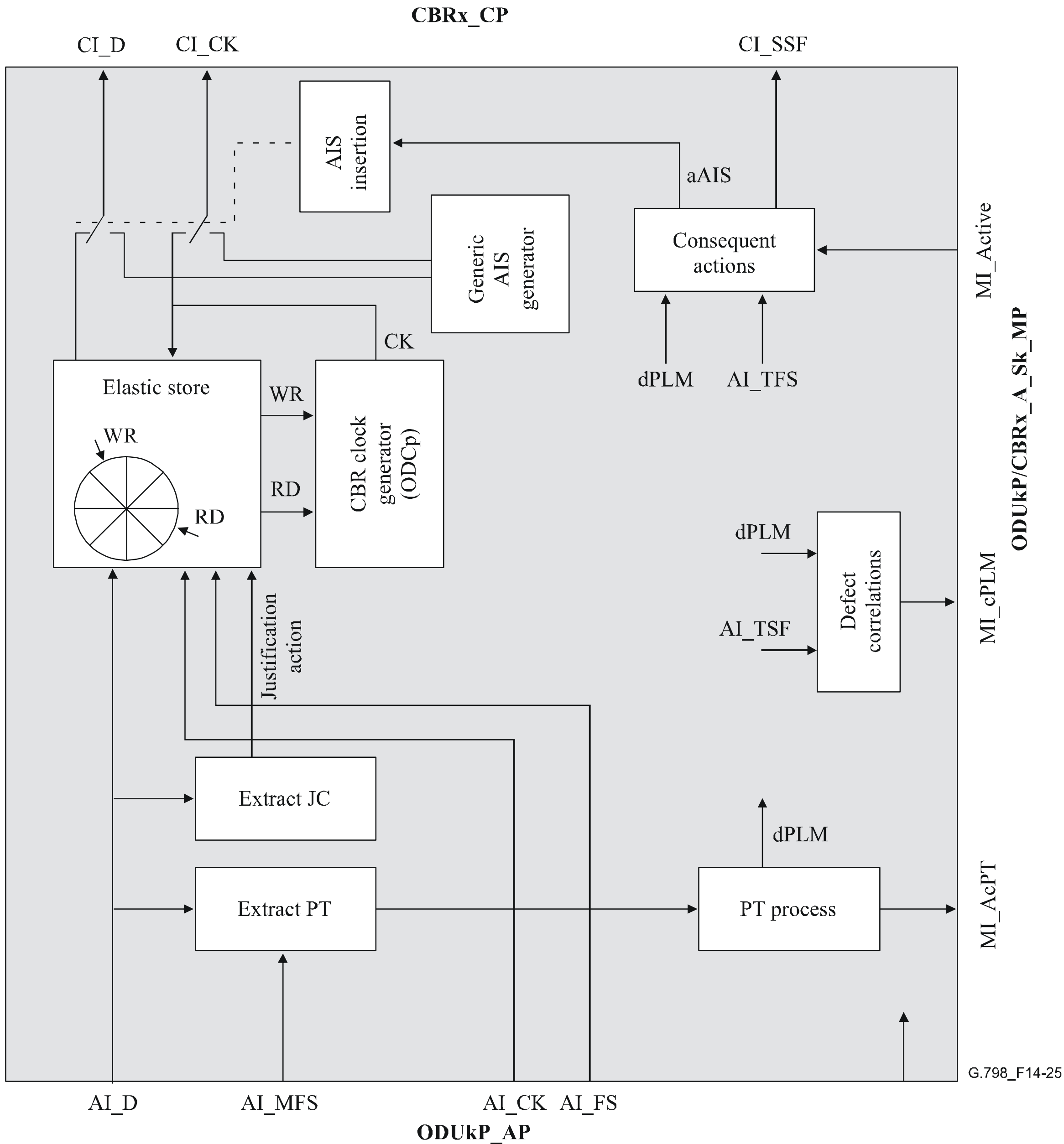


Figure 14-25/G.798 – ODUkP/CBRx_A_Sk processes

Defects

The function shall detect for dPLM.

dPLM: See 6.2.4.1. The expected payload types are "0000 0010" (asynchronous CBRx mapping) and "0000 0011" (bit synchronous CBRx mapping) as defined in ITU-T Rec. G.709/Y.1331.

Consequent actions

aSSF ← AI_TSF or dPLM or (not MI_Active)

aAIS ← AI_TSF or dPLM or (not MI_Active)

On declaration of aAIS the function shall output a GenericAIS pattern/signal as defined in 16.6/G.709/Y.1331 within 2 frames. On clearing of aAIS the GenericAIS pattern/signal shall be removed within 2 frames and normal data being output. The GenericAIS clock start shall be independent from the incoming clock. The GenericAIS clock has to be within $4^{(k-1)}$ *

2 488 320 kHz ± 20 ppm. Jitter and wander requirements as defined in Annex A/G.8251 (ODCp clock) apply.

Defect correlations

cPLM ← dPLM and (not AI_TSF)

Performance monitoring: None.

14.3.2 ODUkP to ATM VP adaptation function (ODUkP/VP_A)

NOTE – The specification of this adaptation function is derived from equivalent adaptation functions defined in Annex D/I.732.

14.3.2.1 ODUkP to ATM VP adaptation source function (ODUkP/VP_A_So)

Symbol

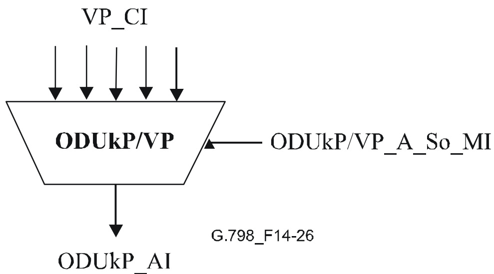


Figure 14-26/G.798 – ODUkP/VP_A_So symbol

Interfaces

Table 14-9/G.798 – ODUkP/VP_A_So input and output signals

Input(s)	Output(s)
per VP_CP, for each VP configured: VP_CI_D VP_CI_ACS VP_CI_SSF **ODUkP/VP_A_So_MP**: ODUkP/VP_A_So_MI_Active ODUkP/VP_A_So_MI_CellDiscardActive ODUkP/VP_A_So_MI_TPusgActive ODUkP/VP_A_So_MI_GFCActive ODUkP/VP_A_So_MI_VPI-KActive	**ODUkP_AP**: ODUkP_AI_CK ODUkP_AI_D ODUkP_AI_FS ODUkP_AI_MFS

Processes

The ODUkP/VP_A_So function provides adaptation from the ATM Virtual Path layer to the ODUk path. This is performed by a grouping of Specific Processes and Common Processes as shown in Figure 14-27.

Activation

– The ODUkP/VP_A_So function shall access the access point when it is activated (MI_Active is true). Otherwise, it shall not access the access point.

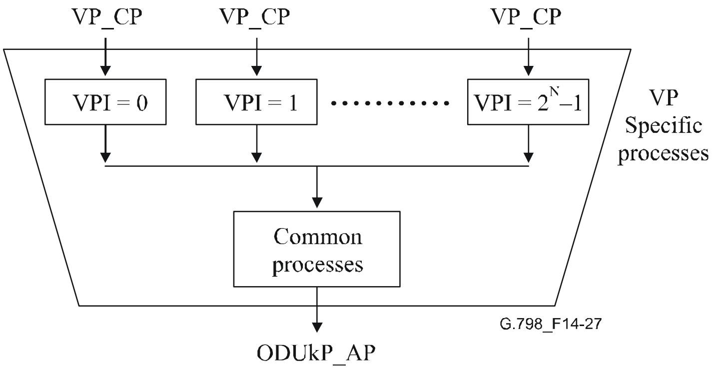


Figure 14-27/G.798 – ODUkP/VP_A_So atomic function decomposed into specific and common processes parts

NOTE 1 – The sequential order of the processes within the atomic functions is important. For the correct order, refer to the ordering of the processes given below.

Clock and (Multi)Frame Start signal generation: The function shall generate a local ODUk (k = 1, 2, 3) clock (ODUkP_AI_CK) of "239/(239 – k) * $4^{(k-1)}$ * 2 488 320 kHz ± 20 ppm". The jitter and wander requirements as defined in Annex A/G.8251 (ODCa clock) apply.

The function shall generate the (multi)frame start reference signals ODUkP_AI_FS and ODUkP_AI_MFS for the ODUk signal. The ODUkP_AI_FS signal shall be active once per 122 368 clock cycles. ODUkP_AI_MFS shall be active once every 256 frames.

VP specific processes

These Processes include VPI setting as well as VP asynchronous multiplexing. Each of these Specific Processes is characterized by the Virtual Path Identifier number K, where $0 \leq K \leq 2^N - 1$.

NOTE 2 – The value of N represents the number of bits in the VPI field and is an integer number. Its maximum value is equal to 12 for the ATM NNI. Its maximum value is equal to 8 for the ATM UNI.

VPI-K activation

– Layer Management function: The Specific Processes perform the operation specified below when it is activated (MI_VPI-KActive is true).

The format of the Characteristic Information (VP_CI) is given in Figure 14-28.

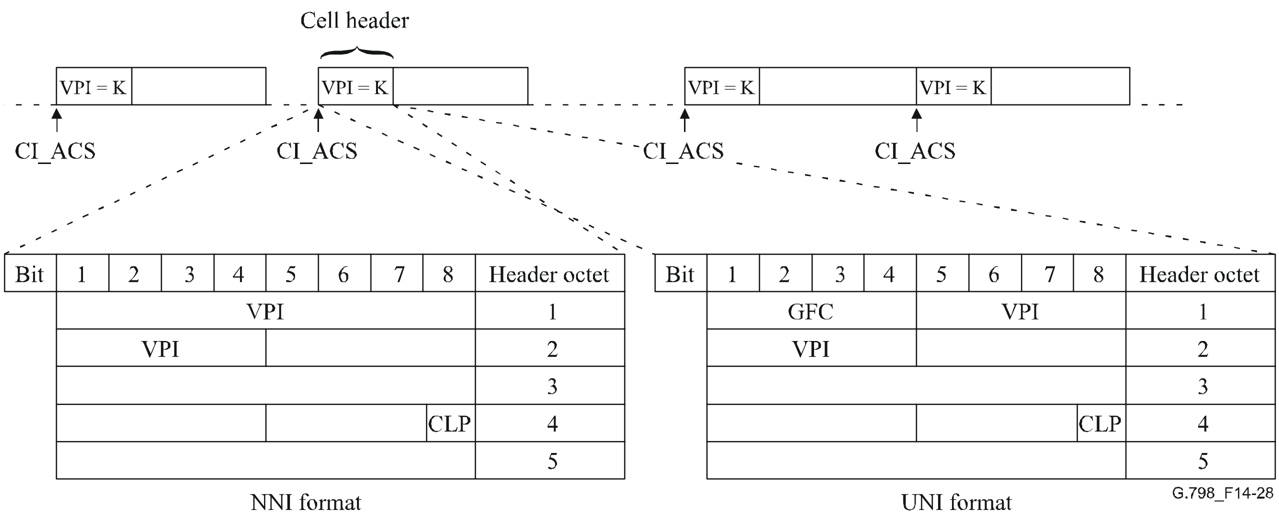


Figure 14-28/G.798 – VP_CI (NNI format)

VPI setting

– Transfer function: VPI setting inserts the value of "K" as VPI for each active Specific Function.

– Layer Management function: VPI setting is based on the activation of the Specific function by MI_VPI-KActive.

VP multiplexing

– Transfer function: Asynchronous multiplexing is performed for each active Specific function.

Common processes

The Common Processes include: Congestion control (selective cell discard (CLP based)), GFC processing, TP usage measurement, cell rate decoupling, HEC processing, cell information field scrambling, cell stream mapping and processing of the payload specific bytes PT and RES, to the OPUk OH. The logical ordering of the processes from input to output must be maintained.

Bit	1	2	3	4	5	6	7	8	Header octet
	GFC				VPI				1
	VPI								2
									3
									4
	HEC								5

UNI format

Bit	1	2	3	4	5	6	7	8	Header octet
	VPI								1
	VPI								2
									3
									4
	HEC								5

NNI format

G.798_F14-29

Figure 14-29/G.798 – Cell header information processed in ODUkP/VP_A_So

Congestion control

– Transfer function: If enabled by MI_CellDiscard = Active, this process shall perform selective cell discard according to CLP value. In the event of congestion, cells with CLP = 1 are subject to be discarded prior to cells with CLP = 0. See ITU-T Rec. I.371.1 for further details about the use of the CLP. In the event of congestion, the EFCI marking in the PTI field is set according to ITU-T Rec. I.361.

GFC processing

– Transfer function: The support of the GFC protocol applies to the UNI and in point-to-point configuration only and is an option. This process sets the GFC filed. The GFC field processing is defined in ITU-T Recs I.150 and I.361.

– Layer Management function: The GFC function uses assigned and unassigned cells. Two modes of operation are available: Uncontrolled Transmission (MI_GFCActive = false) and Controlled Transmission (MI_GFCActive = true). In Uncontrolled Transmission mode, neither the controlling nor the controlled NE performs the GFC procedure. If enabled by MI_GFCActive = true, this process shall insert the GFC protocol in the GFC field. If the GFC function is not supported or the GFC function disabled by MI_GFCActive = false, the binary contents of the GFC field shall be set to "0000".

TP usage measurement

– Transfer function: Cell transmission is indicated to layer management.

– Layer Management function: The process shall count the transmitted cells for cell measurement purposes. This cell counting shall be activated/deactivated by MI_TPusgActive.

Cell rate decoupling

– Transfer function: This process takes the ATM cell stream present at its input and inserts it into the OPUk payload having a capacity of 4*3808 bytes adding fixed stuff idle cells. The idle cells format is specified in ITU-T Rec. I.361. The cell rate decoupling process makes use of the ODUk local timing clock, frame position, and idle cell generator.

HEC processing

– Transfer function: The HEC value for each cell is calculated and inserted into the HEC field. The method of HEC value calculation shall be according to ITU-T Rec. I.432.1.

Cell information field scrambling

– Transfer function: The self-synchronizing scrambler polynomial $x^{43} + 1$ has been identified for the SDH-based transmission paths and minimizes the error multiplication introduced by the self-synchronizing scrambling process. It is also used here for the mapping into ODUks. It scrambles the information field bits only. The operation of the scrambler shall be according to 7.3.4.1/I.432.1.

Cell stream mapping

– Transfer function: The octet structure of ATM cells shall be aligned with the octet structure of the OPUk payload area as defined in 17.2/G.709/Y.1331.

Processing of the payload specific bytes

RES: This payload dependent set of bytes is not used for the mapping of ATM cells into OPUk. The contents of this byte shall be 00Hex.

PT: In this byte the process shall insert code "0000 0100" (ATM mapping) as defined in ITU-T Rec. G.709/Y.1331.

All other bits of the ODUk overhead should be sourced as "0"s, except the ODUk-PM STAT field which should be set to the value "normal path signal" (001).

Defects: None.

Consequent actions: None.

Defect correlations: None.

Performance monitoring

The use of the Performance Monitoring parameters is for further study. The parameters for the following processes need to be defined:

- TP usage measurement;
- Count of discarded cells from congestion control.

14.3.2.2 ODUkP to ATM VP adaptation sink function (ODUkP/VP_A_Sk)

Symbol

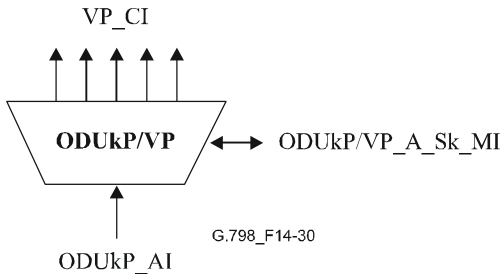


Figure 14-30/G.798 – ODUkP/VP_A_Sk symbol

Interfaces

Table 14-10/G.798 – ODUkP/VP_A_Sk input and output signals

Input(s)	Output(s)
ODUkP_AP: ODUkP_AI_CK ODUkP_AI_D ODUkP_AI_FS ODUkP_AI_TSF ODUkP_AI_TSD **ODUkP/VP_A_Sk_MP**: ODUkP/VP_A_Sk_MI_Active ODUkP/VP_A_Sk_MI_CellDiscardActive ODUkP/VP_A_Sk_MI_TPusgActive ODUkP/VP_A_Sk_MI_VPIrange ODUkP/VP_A_Sk_MI_HECactive ODUkP/VP_A_Sk_MI_GFCactive ODUkP/VP_A_Sk_MI_DTDLuseEnabled ODUkP/VP_A_Sk_MI_VPI-KActive ODUkP/VP_A_Sk_MI_VPI-K_SAISActive	**per VP_CP, for each VP configured**: VP_CI_D VP_CI_ACS VP_CI_SSF VP_CI_CNGI **ODUkP/VP_A_Sk_MP**: ODUkP/VP_A_Sk_MI_cPLM ODUkP/VP_A_Sk_MI_cLCD ODUkP/VP_A_Sk_MI_AcPT

Processes

The ODUkP/VP_A_Sk function provides adaptation from the ODUk to the ATM Virtual Path. This is performed by a grouping of Specific Processes and Common Processes as shown in Figure 14-31.

Activation

– The ODUkP/VP_A_Sk function shall access the access point and perform the Common and Specific Processes operation specified below when it is activated (MI_Active is true). Otherwise, it shall activate the SSF signals and generate AIS at its output (CP) and not report its status via the management point.

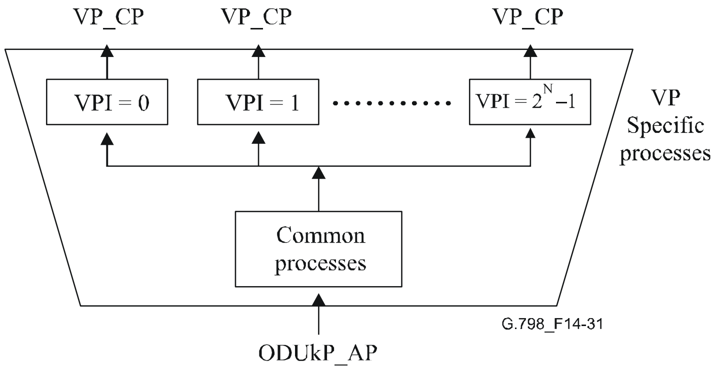


Figure 14-31/G.798 – ODUkP/VP_A_Sk atomic function decomposed into Specific and Common Processes parts

NOTE 1 – The sequential order of the processes within the atomic functions is important. For the correct order, refer to the ordering of the processes given below.

Common processes

These Common Processes include: Handling of the payload specific bytes (PT, PSI and RES), demapping, cell delineation, cell information field descrambling, HEC processing, cell rate decoupling, TP usage measurement, header verification, GFC processing, VPI verification and congestion control (selective cell discard (CLP based)). The logical ordering of these processes from input to output must be maintained.

Handling of payload specific bytes

PT: The process shall extract the payload type as defined in 8.7.1. The accepted PT value is available at the MP (MI_AcPT) and is used for PLM defect detection.

RES: This payload dependent byte is not used for this mapping and the receiver shall ignore its contents.

Demapping

– Transfer function: The cell stream shall be extracted from OPUk payload in the ODUkP_AI in accordance with ITU-T Rec. G.709/Y.1331.

Cell delineation

– Transfer function: Cell delineation is performed on the continuos cell stream. The cell delineation algorithm should be in accordance with ITU-T Rec. I.432.1. The OCD events are indicated to the Layer Management function.

– Layer Management function: Loss of Cell Delineation defect (dLCD) shall be declared as in the defect section below.

Cell information field descrambling

– Transfer function: The self-synchronizing descrambler polynomial $x^{43} + 1$ has been identified for the SDH-based transmission paths and minimizes the error multiplication introduced by the self-synchronizing scrambling process (factor 2). It is also used here for the mapping into ODUks. It descrambles the information field bits only. The operation of the descrambler in relation to the HEC cell delineation state diagram shall be according to 7.3.4.1/I.432.1.

HEC processing

– Transfer function: HEC verification and correction shall be according to ITU-T Rec. I.432.1. Cells determined to have an invalid and incorrectible HEC pattern shall be discarded.

– Layer Management function: A count of invalid HEC events and a count of invalid HEC cell discard events are maintained with threshold crossings checked. HEC correction mode may be activated/deactivated by MI_HECactive. The HEC correction mode should be activated by default.

Cell rate decoupling

– Transfer function: The process shall extract the idle cells used as fixed stuff in the far-end ODUkP/VP adaptation source function.

TP usage measurement

– Transfer function: The cell reception is indicated to the Layer Management function.

– Layer Management function: The process shall count the received cells for cell measurement purposes. This cell counting shall be activated/deactivated by MI_TPusgActive.

Header verification

– Transfer function: The receiving function shall verify that the first four octets of the ATM cell header are recognizable as being a valid header pattern. Cells with unrecognized header patterns shall be discarded. An indication of an invalid header cell discard event is provided to layer management.

– Invalid header patterns from paths based on OTN transmission systems are as follows (except idle cell) (x=any value):

	GFC	VPI	VCI	PTI	CLP
UNI	xxxx	all 0's	all 0's	xxx	1

	VPI		VCI	PTI	CLP
NNI	all 0's		all 0's	xxx	1

– Layer Management function: The process shall count the invalid header cell discard event.

GFC processing

– Transfer function: The support of the GFC protocol applies to the UNI and in point-to-point configuration only and is an option. This process extracts the GFC field. The GFC field processing is defined in ITU-T Recs I.150 and I.361.

– Layer Management function: The GFC function uses assigned and unassigned cells. Two modes of operation are available: Uncontrolled Transmission (MI_GFCActive = false) and Controlled Transmission (MI_GFCActive = true). In Uncontrolled Transmission mode, neither the controlling nor the controlled NE performs the GFC procedure. If enabled by MI_GFCActive = true, this process shall extract the GFC protocol from the GFC field.

NOTE 2 – According to the Protocol Reference Model (ITU-T Rec. I.321), the unassigned cells should be processed in the ATM layer. Some of the ATM layer processes are adaptation processes belonging to the adaptation function between the TP and the VP layer network. The unassigned cells as well as idle cells are per physical connection (VPI = 0, VCI = 0). For this reason, the idle and unassigned cells processing is allocated to the same atomic function.

VPI verification

– Transfer function: The process shall verify that the received cell VPI is valid. If the VPI is determined to be invalid (i.e., out-of-range VPI or not assigned), the cell shall be discarded. An indication of the invalid VPI cell discard events is provided to the Layer Management function.

– Layer Management function: The range of valid VPIs is given by MI_VPIrange. The invalid VPI cell discard events are counted.

Congestion control

– Transfer function: In the event of congestion, cells with CLP = 1 are subject to be discarded prior to cells with CLP = 0. See ITU-T Rec. I.371.1 for further details about the use of the CLP. In the event of congestion, the indication VP_CI_CNGI is set for the traffic management function VPTM_TT_So to insert EFCI on all VPs.

– Layer Management function: If enabled by MI_CellDiscardActive, this process shall perform selective cell discard according to CLP value.

VP specific processes

The function performs end-to-end VP-AIS insertion, segment VP-AIS insertion and demultiplexing on a per VP basis.

VPI-K activation

– Layer Management function: The Specific Processes perform the operation specified below when it is activated (MI_VPI-KActive is true). Otherwise, it shall send no cells and SSF = false.

End-to-end VP-AIS insertion

– Transfer function: This process inserts end-to-end VP-AIS cells from the Layer Management function for each active Specific Function.

– Layer Management function: End-to-end VP-AIS cells (Figure 14-32) shall be generated according to the Consequent Actions section of the Coordination Function below for each active Specific Function.

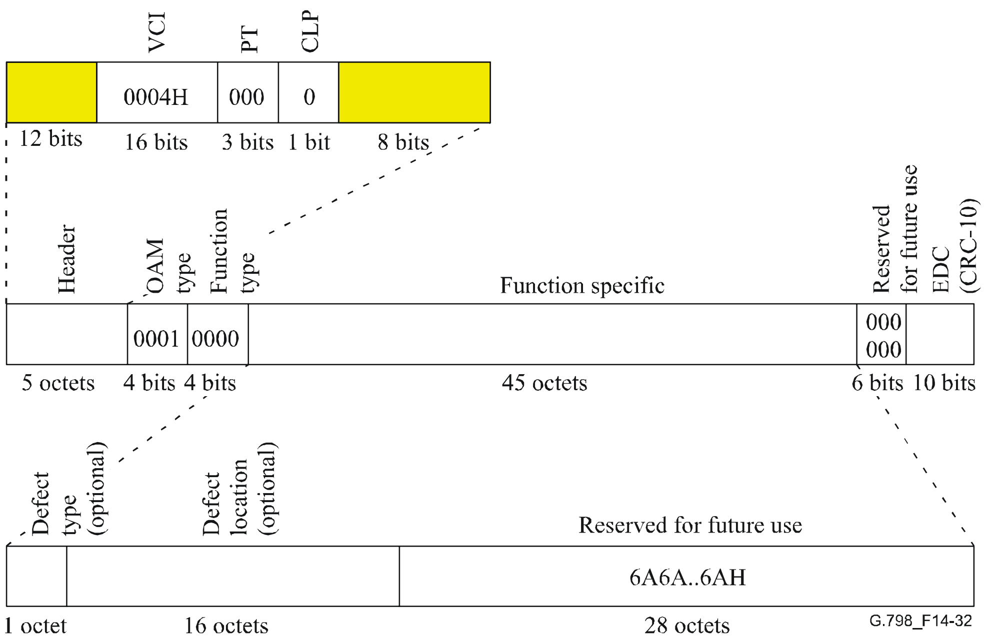


Figure 14-32/G.798 – End-to-end VP-AIS OAM cell as part of the VP_CI

Segment VP-AIS insertion

– Transfer function: This process inserts segment VP-AIS cells from the Layer Management function for each active Specific Function.

– Layer Management function: Segment VP-AIS cells (Figure 14-33) shall be generated according to the Consequent Actions section of the Coordination Function below for each active Specific Function and the segment VP-AIS cells insertion is also activated (MI_VPI-K_SAISactive is true).

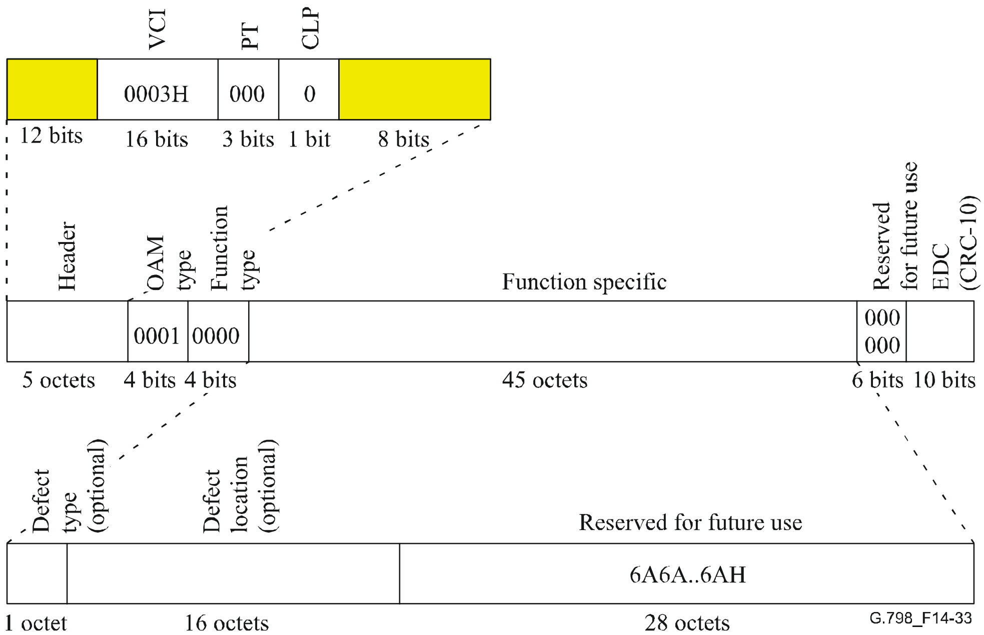


Figure 14-33/G.798 – Segment VP-AIS OAM cell as part of the VP_CI

VP demultiplexing

– Transfer function: The adaptation sink function has access to a specific VP identified by the number K ($0 \le K \le 2^N - 1$). For each active Specific Function, only the cells of that specific VPI-K are passed in client direction.

NOTE 3 – The value of N represents the number of bits in the VPI field and is an integer number. Its maximum value is equal to 12 for the ATM NNI. Its maximum value is equal to 8 for the ATM UNI.

Defects

The function shall detect for the dPLM and dLCD defects.

dPLM: See 6.2.4.1. The expected payload type is "000 0100" (ATM mapping).

dLCD: See ITU-T Rec. I.432.1.

Consequent actions

aCNGI ← "Event of Congestion" and CellDiscardActive

aSSF ← dPLM or dLCD or AI_TSF or (not MI_Active)

aAIS ← dPLM or dLCD or AI_TSF or (not MI_Active)

On declaration of aAIS, the function shall output end-to-end VP-AIS cells (Figure 14-32) on all active VPCs and segment VP-AIS cells (Figure 14-33) on all active VPCs for which MI_SAISactive is true, according to 9.2.1.1.1.1/I.610. On clearing of aAIS, the generation of end-to-end and segment VP-AIS cells shall be stopped. If either the function does not support the Defect Type and Defect Location (DTDL) option, or the function supports the DTDL option and the MI_DTDLuseEnabled is false, the binary contents of the Defect Type and Defect Location fields of the end-to-end and segment VP-AIS cell shall be coded as 6AH. If the function supports the DTDL option and if the MI_DTDLuseEnabled is true, the Defect Type and Defect Location values shall be inserted in the information field of the end-to-end and segment VP-AIS cells.

NOTE 4 – As long as the coding scheme of Defect Type and Defect Location fields is not defined, the fields shall be encoded as 6AH.

The consequent action aSSF is conveyed by CI_SSF through the VP_CI.

Defect correlations

cPLM ← dPLM and (not AI_TSF)

cLCD ← dLCD and (not dPLM) and (not AI_TSF)

Performance monitoring

The use of the Performance Monitoring parameters is for further study. The parameters for the following functions need to be defined:

- TP usage measurement;
- Count of discarded cells from congestion control;
- Count of invalid HEC events;
- Count of invalid HEC discard events;
- Count of invalid header discard events (one common counter for invalid header/invalid VPI/invalid VCI is maintained);
- OCD event.

14.3.3 ODUkP to GFP adaptation function (ODUkP/GFP_A)

Not applicable.

An ODUkP/GFP adaptation is not applicable as GFP is not a client signal but a mapping method for various client signals (e.g., Ethernet). The GFP processing therefore will be part of such ODUkP/client adaptations (see 8.5/G.806).

14.3.4 ODUkP to NULL adaptation function (ODUkP/NULL_A)

The ODUkP to NULL adaptation functions perform the adaptation of a NULL test signal as defined in 17.4.1/G.709/Y.1331 into the ODUkP (k = 1, 2, 3). The NULL signal is an all-0's pattern.

14.3.4.1 ODUkP to NULL adaptation source function (ODUkP/NULL_A_So)

The ODUkP/NULL_A_So function creates the ODUk signal from a free running clock. It maps the NULL signal into the payload of the OPUk (k = 1, 2, 3), adds OPUk Overhead (RES, PT) and default ODUk Overhead.

The information flow and processing of the ODUkP/NULL_A_So function is defined with reference to Figures 14-34 and 14-35.

Symbol

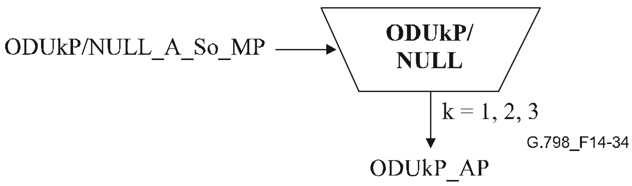


Figure 14-34/G.798 – ODUkP/NULL_A_So function

Interfaces

Table 14-11/G.798 – ODUkP/NULL_A_So inputs and outputs

Input(s)	Output(s)
ODUkP/NULL_A_So_MP: ODUkP/NULL_A_So_MI_Active	**ODUkP_AP**: ODUkP_AI_CK ODUkP_AI_D ODUkP_AI_FS ODUkP_AI_MFS

Processes

Activation

– The ODUkP/NULL_A_So function shall access the access point when it is activated (MI_Active is true). Otherwise, it shall not access the access point.

Clock and (Multi)Frame Start signal generation: The function shall generate a local ODUk clock (ODUkP_AI_CK) of "239/(239 – k) * $4^{(k-1)}$ * 2 488 320 kHz ± 20 ppm" from a free running oscillator. The jitter and wander requirements as defined in Annex A/G.8251 (ODCa clock) apply.

The function shall generate the (multi)frame start reference signals AI_FS and AI_MFS for the ODUk signal. The AI_FS signal shall be active once per 122368 clock cycles. AI_MFS shall be active once every 256 frames.

Insert NULL signal: The function shall insert an all-0'pattern into the OPUk payload area as defined in 17.4.1/G.709/Y.1331.

PT: The function shall insert code "1111 1101" into the PT byte position of the PSI overhead as defined in 15.9.2.1/G.709/Y.1331.

RES: The function shall insert all-0's into the RES bytes.

All other bits of the ODUk overhead should be sourced as "0"s, except the ODUk-PM STAT field which should be set to the value "normal path signal" (001).

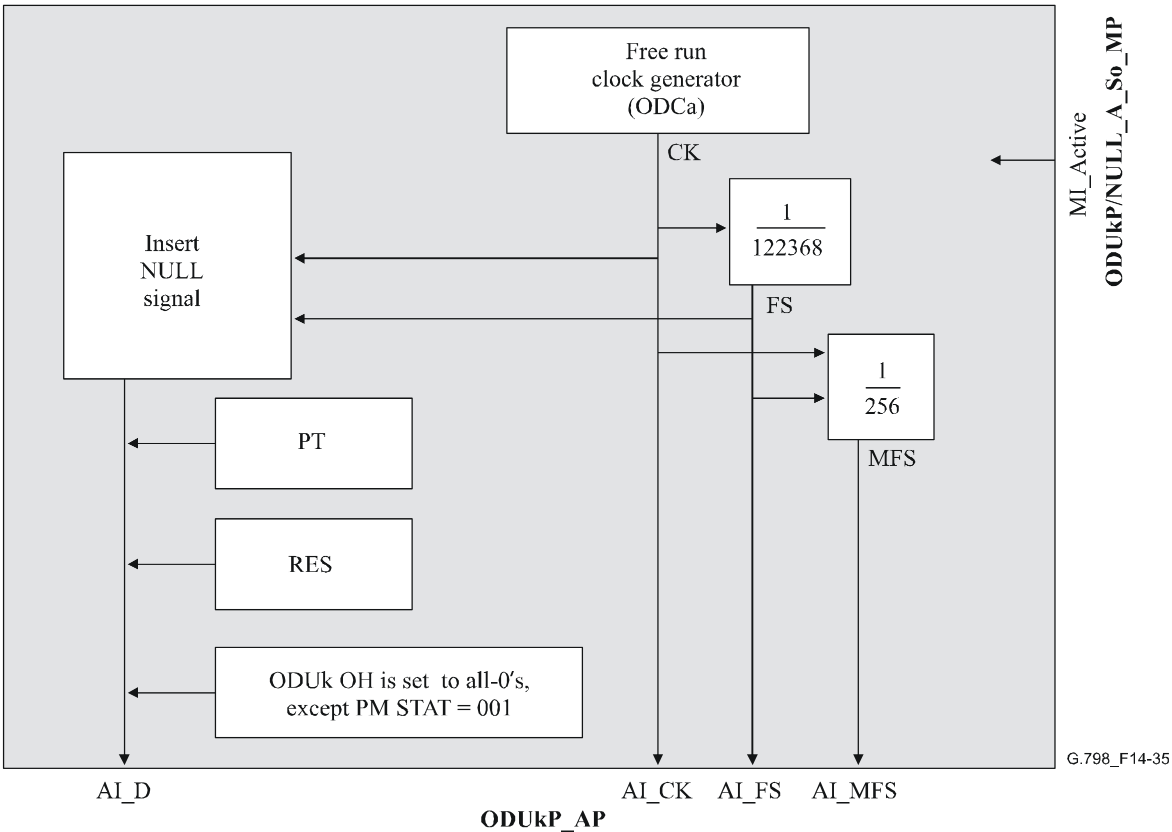


Figure 14-35/G.798 – ODUkP/NULL_A_So processes

Defects: None.

Consequent actions: None.

Defect correlations: None.

Performance monitoring: None.

14.3.4.2 ODUkP to NULL adaptation sink function (ODUkP/NULL_A_Sk)

The ODUkP/NULL_A_Sk extracts the OPUk Overhead (PT and RES) and monitors the reception of the correct payload type.

The information flow and processing of the ODUkP/NULL_A_Sk function is defined with reference to Figures 14-36 and 14-37.

Symbol

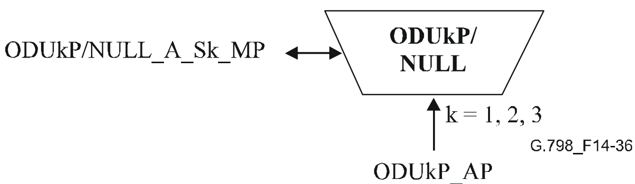


Figure 14-36/G.798 – ODUkP/NULL_A_Sk function

Interfaces

Table 14-12/G.798 – ODUkP/NULL_A_Sk inputs and outputs

Input(s)	Output(s)
ODUkP_AP: ODUkP_AI_CK ODUkP_AI_D ODUkP_AI_FS ODUkP_AI_TSF **ODUkP/NULL_A_Sk_MP**: ODUkP/NULL_A_Sk_MI_Active	**ODUkP/NULL_A_Sk_MP**: ODUkP/NULL_A_Sk_MI_cPLM ODUkP/NULL_A_Sk_MI_AcPT

Processes

Activation

– The ODUkP/NULL_A_Sk function shall access the access point and perform the Common and Specific Processes operation specified below when it is activated (MI_Active is true). Otherwise, it shall not report its status via the management point.

PT: The function shall extract the PT byte from the PSI overhead as defined in 8.7.1. The accepted PT value is available at the MP (MI_AcPT) and is used for PLM defect detection.

RES: The value in the RES bytes shall be ignored.

Payload: The value in the OPUk payload area shall be ignored.

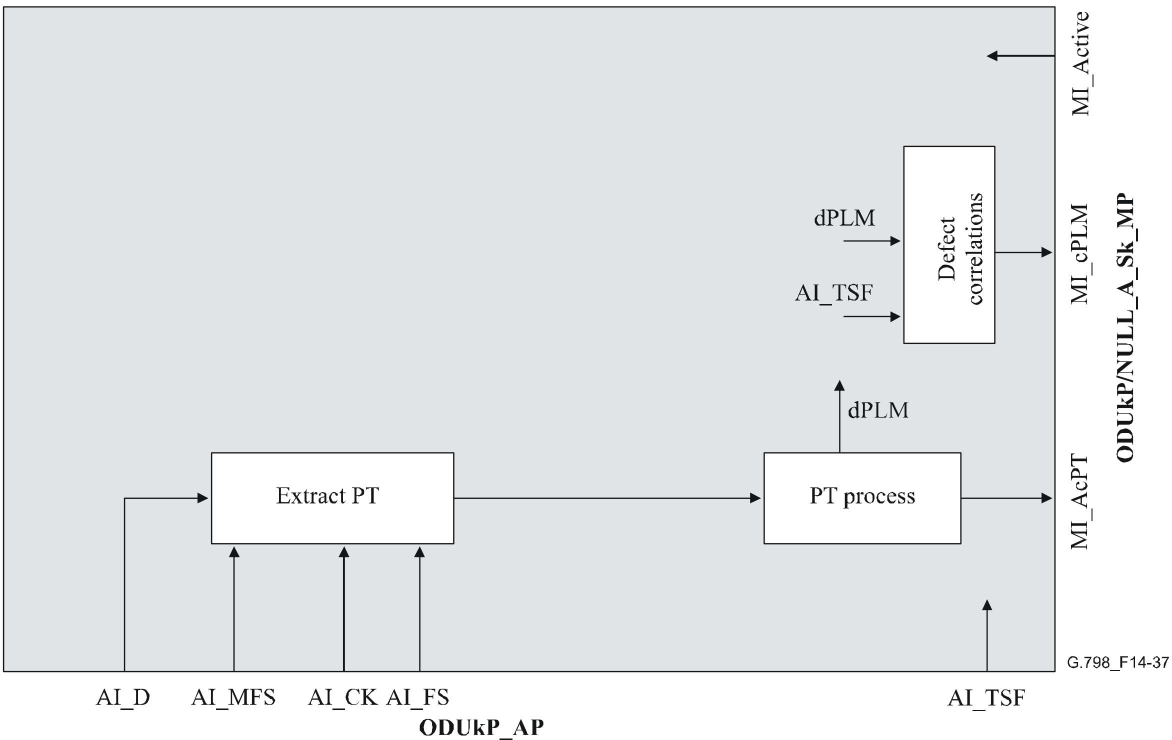


Figure 14-37/G.798 – ODUkP/NULL_A_Sk processes

Defects

The function shall detect for dPLM.

dPLM: See 6.2.4.1. The expected payload type is "1111 1101" (NULL test signal mapping) as defined in ITU-T Rec. G.709/Y.1331.

Consequent actions: None.

Defect correlations

cPLM ← dPLM and (not AI_TSF)

Performance monitoring: None.

14.3.5 ODUkP to PRBS adaptation function (ODUkP/PRBS_A)

The ODUkP to PRBS adaptation functions perform the adaptation of a PRBS test signal as defined in 17.4.2/G.709/Y.1331 into the ODUkP (k = 1, 2, 3). The PRBS signal is a 2 147 483 647-bit pseudo-random test sequence ($2^{31} - 1$) as specified in 5.8/O.150.

14.3.5.1 ODUkP to PRBS adaptation source function (ODUkP/PRBS_A_So)

The ODUkP/PRBS_A_So function creates the ODUk signal from a free running clock. It maps the PRBS signal into the payload of the OPUk (k = 1, 2, 3), adds OPUk Overhead (RES, PT) and default ODUk Overhead.

The information flow and processing of the ODUkP/PRBS_A_So function is defined with reference to Figures 14-38 and 14-39.

Symbol

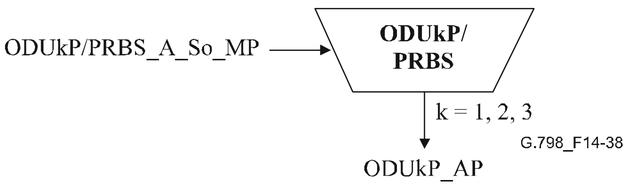


Figure 14-38/G.798 – ODUkP/PRBS_A_So function

Interfaces

Table 14-13/G.798 – ODUkP/PRBS_A_So inputs and outputs

Input(s)	Output(s)
ODUkP/PRBS_A_So_MP: ODUkP/PRBS_A_So_MI_Active	**ODUkP_AP**: ODUkP_AI_CK ODUkP_AI_D ODUkP_AI_FS ODUkP_AI_MFS

Processes

Activation

– The ODUkP/PRBS_A_So function shall access the access point when it is activated (MI_Active is true). Otherwise, it shall not access the access point.

Clock and (Multi)Frame Start signal generation: The function shall generate a local ODUk clock (ODUkP_AI_CK) of "$239/(239 - k) * 4^{(k-1)} * 2\ 488\ 320$ kHz ± 20 ppm" from a free running oscillator. The jitter and wander requirements as defined in Annex A/G.8251 (ODCa clock) apply.

The function shall generate the (multi)frame start reference signals AI_FS and AI_MFS for the ODUk signal. The AI_FS signal shall be active once per 122 368 clock cycles. AI_MFS shall be active once every 256 frames.

Generate and insert PRBS signal: The function shall generate the PRBS signal and insert it into the OPUk payload area as defined in 17.4.2/G.709/Y.1331.

PT: The function shall insert code "1111 1110" into the PT byte position of the PSI overhead as defined in 15.9.2.1/G.709/Y.1331.

RES: The function shall insert all-0's into the RES bytes.

All other bits of the ODUk overhead should be sourced as "0"s, except the ODUk-PM STAT field which should be set to the value "normal path signal" (001).

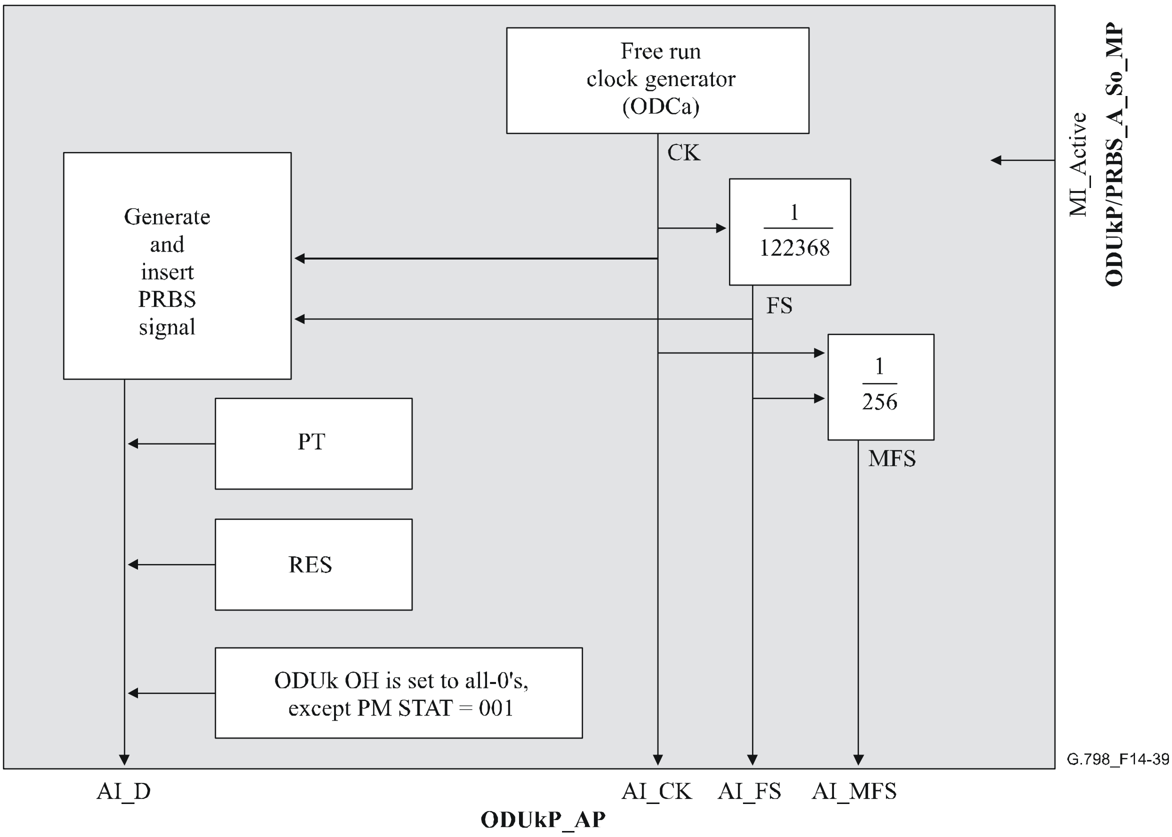


Figure 14-39/G.798 – ODUkP/PRBS_A_So processes

Defects: None.

Consequent actions: None.

Defect correlations: None.

Performance monitoring: None.

14.3.5.2 ODUkP to PRBS adaptation sink function (ODUkP/PRBS_A_Sk)

The ODUkP/PRBS_A_Sk recovers the PRBS test signal from the OPUk payload area and monitors test sequence errors (TSE) in the PRBS sequence. It extracts the OPUk Overhead (PT and RES) and monitors the reception of the correct payload type.

The information flow and processing of the ODUkP/PRBS_A_Sk function is defined with reference to Figures 14-40 and 14-41.

Symbol

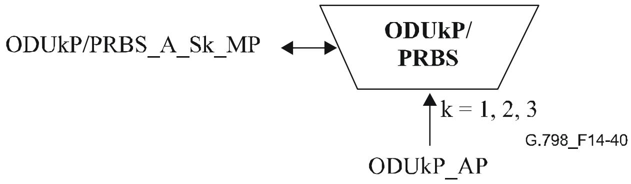


Figure 14-40/G.798 – ODUkP/PRBS_A_Sk function

Interfaces

Table 14-14/G.798 – ODUkP/PRBS_A_Sk inputs and outputs

Input(s)	Output(s)
ODUkP_AP: ODUkP_AI_CK ODUkP_AI_D ODUkP_AI_FS ODUkP_AI_TSF **ODUkP/PRBS_A_Sk_MP**: ODUkP/PRBS_A_Sk_MI_Active	**ODUkP/PRBS_A_Sk_MP**: ODUkP/PRBS_A_Sk_MI_cPLM ODUkP/PRBS_A_Sk_MI_AcPT ODUkP/PRBS_A_Sk_MI_cLSS ODUkP/PRBS_A_Sk_MI_pN_TSE

Processes

Activation

– The ODUkP/PRBS_A_Sk function shall access the access point and perform the Common and Specific Processes operation specified below when it is activated (MI_Active is true). Otherwise, it shall not report its status via the management point.

PT: The function shall extract the PT byte from the PSI overhead as defined in 8.7.1. The accepted PT value is available at the MP (MI_AcPT) and is used for PLM defect detection.

RES: The value in the RES bytes shall be ignored.

TSE check: Test sequence errors (TSE) are bit errors in the PRBS data stream extracted from the OPUk payload area and shall be detected whenever the PRBS detector is in lock and the received data bit does not match the expected value.

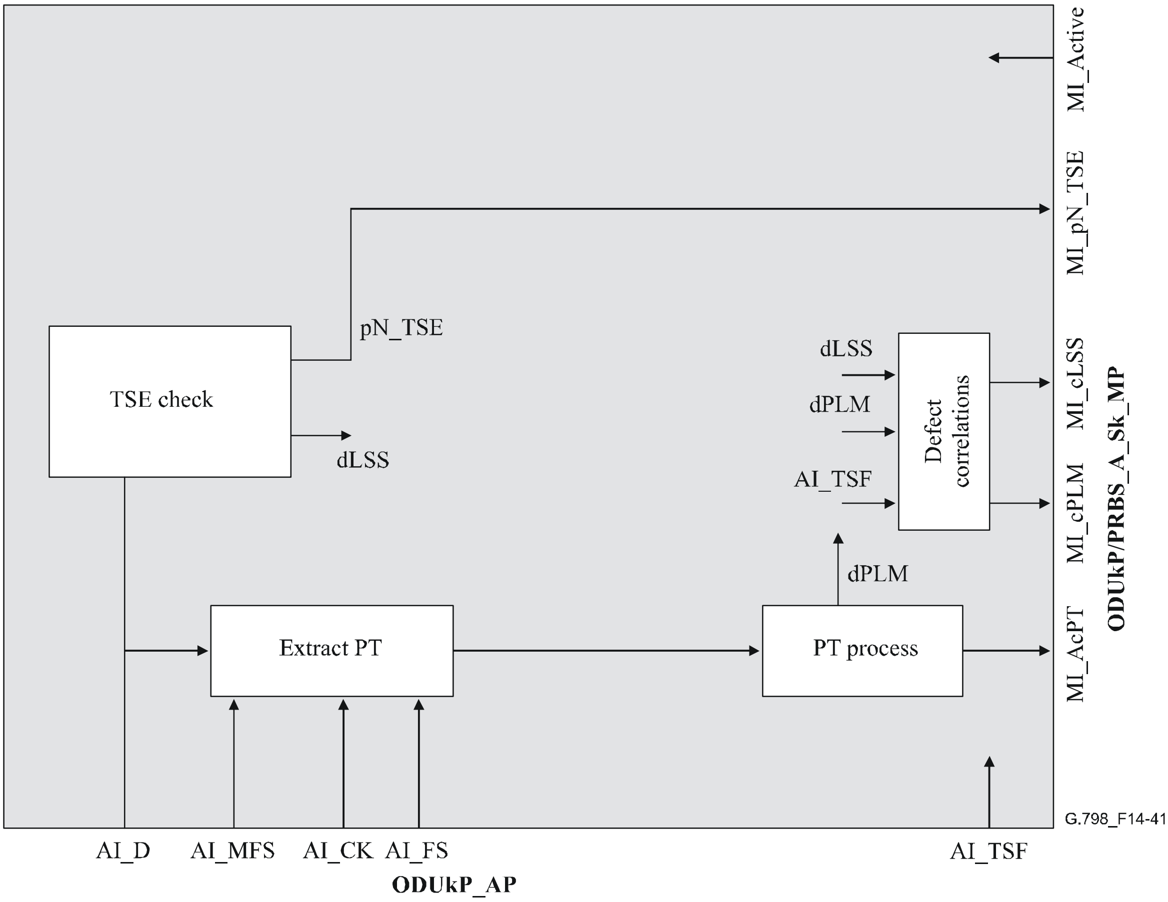


Figure 14-41/G.798 – ODUkP/PRBS_A_Sk processes

Defects

The function shall detect for dPLM and dLSS.

dPLM: See 6.2.4.1. The expected payload type is "1111 1110" (PRBS test signal mapping) as defined in ITU-T Rec. G.709/Y.1331.

dLSS: The function shall detect for loss of PRBS lock (dLSS) according to the criteria defined in 2.6/O.151.

Consequent actions: None.

Defect correlations

cPLM ← dPLM and (not AI_TSF)

cLSS ← dLSS and (not AI_TSF) and (not dPLM)

Performance monitoring

pN_TSE ← Sum of Test Sequence Errors (TSE) within one second period.

14.3.6 ODUkP to RSn adaptation function (ODUkP/RSn_A)

The ODUkP to RSn adaptation functions perform the adaptation between the ODUkP (k = 1, 2, 3) layer adapted information and the characteristic information of a RSn signal (n = 16, 64, 256).

Two different source functions are defined. The ODUkP/RSn-a_A_So provides asynchronous mapping, while the ODUkP/RSn-b_A_So provides bit synchronous mapping. In the sink direction, the ODUkP/RSn_A_Sk can handle both (bit synchronous and asynchronous) mappings.

NOTE 1 – The source functions are identical with the ODUkP/CBRx adaptation source functions, except for the different CI at the CP (CBRx_CI replaced by RSn_CI). In the sink direction, the function provides framing on the SDH signal and GenericAIS supervision. In the ODUkP/CBR_A_Sk function no such functionality is available.

NOTE 2 – The ODUkP/RSn_A functions are only intended to be used together with RSn_TT functions (see ITU-T Rec. G.783). The direct interconnection of ODUkP/RSn_A functions with any other (server layer)/RS_A functions at the RSn_CP is not intended. The ODUkP/RSn functions are only used if further SDH processing is performed (e.g., RS termination). For example Figure I.1 shows the ODUkP/RSn_A_Sk together with a RS_TT_Sk for non-intrusive monitoring, and Figure I.4 shows the use of the ODUkP/RSn_A functions at OTN interfaces on SDH equipment. For transparent mapping of constant bit rate signals, the ODUkP/CBRx_A functions shall be used as shown in Figure I.1.

14.3.6.1 ODUkP to RSn asynchronous mapping adaptation source function (ODUkP/RSn-a_A_So)

The ODUkP/RSn-a_A_So function creates the ODUk signal from a free running clock. It asynchronously maps the STM-N ($N = 4^{(k+1)}$) client signal from the RSn_CP into the payload of the OPUk (k = 1, 2, 3), adds OPUk Overhead (RES, PT, JC) and default ODUk Overhead.

The information flow and processing of the ODUkP/RSn-a_A_So function is defined with reference to Figures 14-42 and 14-43.

Symbol

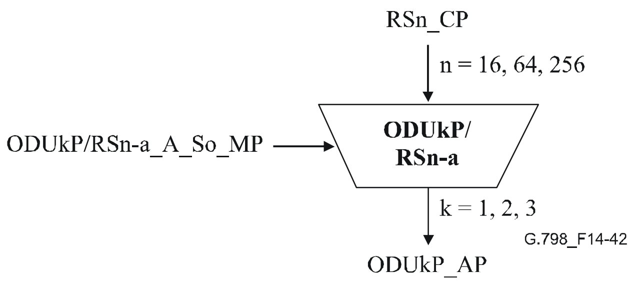


Figure 14-42/G.798 – ODUkP/RSn-a_A_So function

Interfaces

Table 14-15/G.798 – ODUkP/RSn-a_A_So inputs and outputs

Input(s)	Output(s)
RSn_CP: RSn_CI_CK RSn_CI_D **ODUkP/RSn-a_A_So_MP**: ODUkP/RSn-a_A_So_MI_Active	**ODUkP_AP**: ODUkP_AI_CK ODUkP_AI_D ODUkP_AI_FS ODUkP_AI_MFS

Processes

Activation

– The ODUkP/RSn-a_A_So function shall access the access point when it is activated (MI_Active is true). Otherwise, it shall not access the access point.

Clock and (Multi)Frame Start signal generation: The function shall generate a local ODUk clock (ODUkP_AI_CK) of "239/(239 – k) * $4^{(k-1)}$ * 2 488 320 kHz ± 20 ppm" from a free running oscillator. The clock parameters, including jitter and wander requirements, as defined in Annex A/G.8251 (ODCa clock) apply.

The function shall generate the (multi)frame start reference signals AI_FS and AI_MFS for the ODUk signal. The AI_FS signal shall be active once per 122 368 clock cycles. AI_MFS shall be active once every 256 frames.

Mapping, frequency justification and bit rate adaptation: The function shall provide an elastic store (buffer) process. The data signal RSn_CI shall be written into the buffer under control of the associated input clock. The data shall be read out of the buffer and written onto the D and N/PJO bytes in the OPUk frame under control of the ODUk clock and justification decisions as defined in 17.1/G.709/Y.1331.

A justification decision shall be performed each frame. Each justification decision results in a corresponding positive, negative or no justification action. Upon a positive justification action, the reading of 1 data byte out of the buffer shall be cancelled once. No RSn data shall be written onto the PJO and NJO byte. Upon a negative justification action, 1 extra data byte shall be read once out of the buffer. RSn data shall be written onto the PJO and NJO byte. If neither a positive nor a negative justification action is to be performed, RSn data shall be written onto the PJO byte and no RSn data shall be written onto the NJO byte.

The justification decisions determine the phase error introduced by the function.

Buffer size: In the presence of jitter as specified by ITU-T Rec. G.825 and a frequency within the range $4^{(k-1)}$ * 2 488 320 kHz ± 20 ppm, this mapping process shall not introduce any errors. The maximum buffer hysteresis, and therefore the maximum phase error introduced, shall be as listed in Table 14-6.

JC bits: The function shall generate the justification control (JC) bits based on the justification decision performed in the current frame according to the specification in 17.1/G.709/Y.1331. It shall insert the justification control bits in the appropriate JC bit positions in the JC bytes of the current frame.

PT: The function shall insert code "0000 0010" into the PT byte position of the PSI overhead as defined in 15.9.2.1/G.709/Y.1331.

RES: The function shall insert all-0's into the RES bytes and Reserved bits within the JC bytes.

All other bits of the ODUk overhead should be sourced as "0"s, except the ODUk-PM STAT field which should be set to the value "normal path signal" (001).

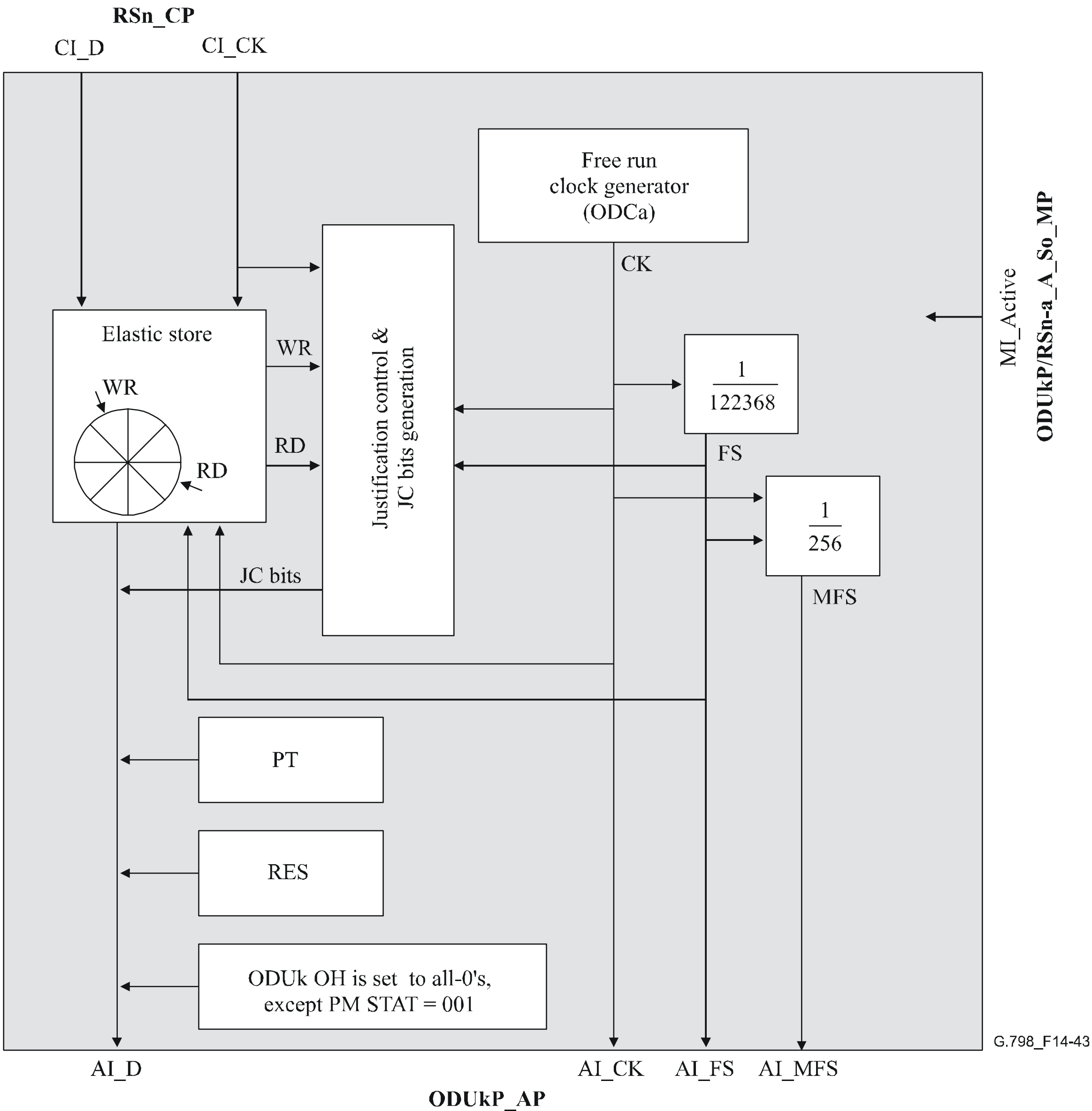


Figure 14-43/G.798 – ODUkP/RSn-a_A_So processes

Defects: None.

Consequent actions: None.

Defect correlations: None.

Performance monitoring: None.

14.3.6.2 ODUkP to RSn bit synchronous mapping adaptation source function (ODUkP/RSn-b_A_So)

The ODUkP/RSn-b_A_So function creates the ODUk signal from a clock, derived from the incoming RSn_CI clock. It bit synchronously maps the STM-N ($N = 4^{(k+1)}$) client signal from the RSn_CP into the payload of the OPUk, adds OPUk Overhead (PT, JC, RES) and default ODUk Overhead.

The information flow and processing of the ODUkP/RSn-b_A_So function is defined with reference to Figures 14-44 and 14-45.

Symbol

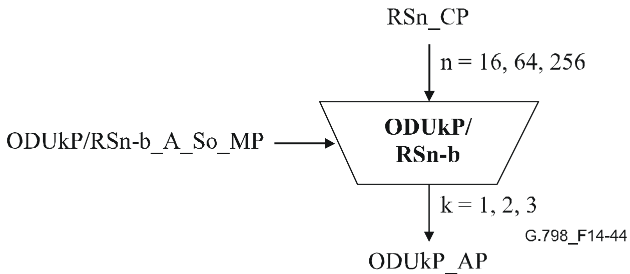


Figure 14-44/G.798 – ODUkP/RSn-b_A_So function

Interfaces

Table 14-16/G.798 – ODUkP/RSn-b_A_So inputs and outputs

Input(s)	Output(s)
RSn_CP: RSn_CI_CK RSn_CI_D **ODUkP/RSn-b_A_So_MP**: ODUkP/RSn-b_A_So_MI_Active	**ODUkP_AP**: ODUkP_AI_CK ODUkP_AI_D ODUkP_AI_FS ODUkP_AI_MFS

Processes

Activation

– The ODUkP/RSn-b_A_So function shall access the access point when it is activated (MI_Active is true). Otherwise, it shall not access the access point.

Clock and (Multi) Frame Start signal generation: The function shall generate the ODUk (AI_CK) clock by multiplying the incoming RSn clock (CI_CK) by factor of 239/(239 – k). The clock parameters, including jitter and wander requirements, as defined in Annex A/G.8251 (ODCb clock) apply.

NOTE 1 – The ODUk clock is "$239/(239 - k) * 4^{(k-1)} * 2\,488\,320$ kHz ± 20 ppm".

NOTE 2 – The incoming RSn CK (CI_CK) signal has to be within the range of $4^{(k-1)} * 2\,488\,320$ kHz ± 20 ppm.

During failure conditions of the incoming RS clock signal (CI_CK), the ODUk clock shall stay within its limits as defined in ITU-T Rec. G.8251 and no frame phase discontinuity shall be introduced.

The function shall generate the (multi) frame start reference signals AI_FS and AI_MFS for the ODUk signal. The AI_FS signal shall be active once per 122 368 clock cycles. AI_MFS shall be active once every 256 frames.

Mapping, frequency justification and bit rate adaptation: The function shall provide an elastic store (buffer) process. The data signal RSn_CI shall be written into the buffer under control of the associated input clock. The data shall be read out of the buffer and written onto the D and PJO bytes in the OPUk frame under control of the ODUk clock as defined in 17.1/G.709/Y.1331.

Neither negative nor positive justification is to be performed. No data shall be written onto the NJO byte and data shall always be written onto the PJO byte.

Buffer size: In the presence of jitter as specified by ITU-T Rec. G.825 and a frequency within the range $4^{(k-1)}$ * 2 488 320 kHz ± 20 ppm, this mapping process shall not introduce any errors.

Following a step in frequency of the $4^{(k-1)}$ * 2 488 320 kbit/s CI_CK signal (for example due removal of AIS (RS-AIS)) there will be a maximum recovery time of X seconds after which this process shall not generate any bit errors. The value of X is for further study; a value of 1 second has been proposed.

JC bits: The function shall generate the fixed justification control (JC) bits "00" according to 17.1/G.709/Y.1331. It shall insert the justification control bits in the appropriate JC bit positions in the JC bytes.

RES: The function shall insert all-0's into the RES bytes and Reserved bits within the JC bytes.

PT: The function shall insert code "0000 0011" into the PT byte position of the PSI overhead as defined in 15.9.2.1/G.709/Y.1331.

All other bits of the ODUk overhead should be sourced as "0"s, except the ODUk-PM STAT field which should be set to the value "normal path signal" (001).

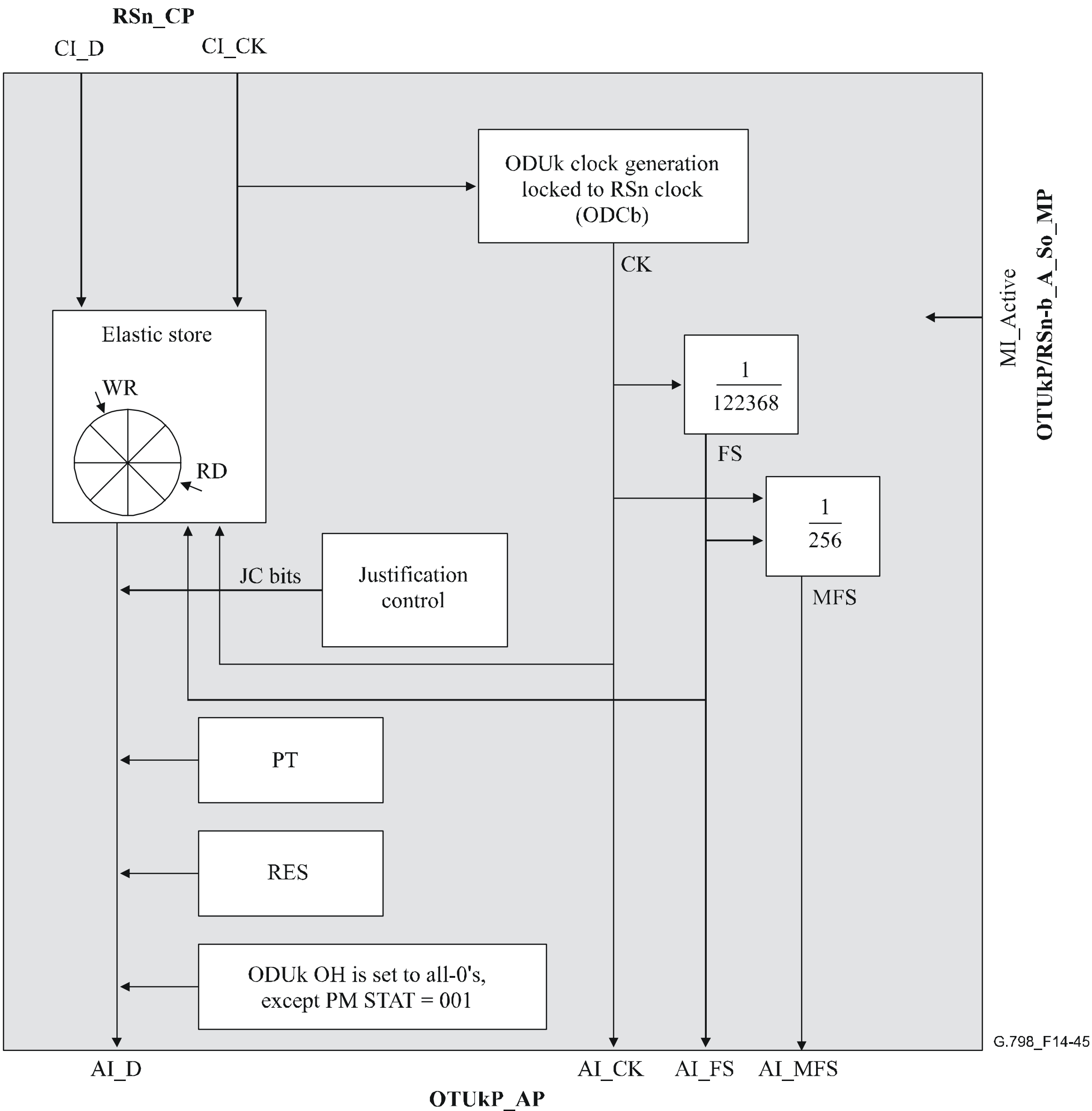


Figure 14-45/G.798 – ODUkP/RSn-b_A _So processes

Defects: None.

Consequent actions: None.

Defect correlations: None.

Performance monitoring: None.

14.3.6.3 ODUkP to RSn adaptation sink function (ODUkP/RSn_A_Sk)

The ODUkP/RSn_A_Sk recovers the STM-N ($N = 4^{(k+1)}$) client signal from the OPUk payload using the justification control information (JC overhead) to determine if a data or stuff byte is present within the NJO and PJO bytes. It extracts the OPUk Overhead (PT, JC, and RES) and monitors the reception of the correct payload type. It detects GenericAIS and recovers the frame start of the STM-N signal. Under signal fail condition, a logical all-ones (AIS) signal shall be generated.

The information flow and processing of the ODUkP/RSn_A_Sk function is defined with reference to Figures 14-46 and 14-47.

Symbol

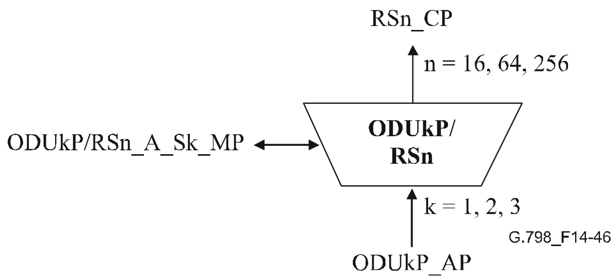


Figure 14-46/G.798 – ODUkP/RSn_A_Sk function

Interfaces

Table 14-17/G.798 – ODUkP/RSn_A_Sk inputs and outputs

Input(s)	Output(s)
ODUkP_AP: ODUkP_AI_CK ODUkP_AI_D ODUkP_AI_FS ODUkP_AI_TSF	**RSn_CP**: RSn_CI_CK RSn_CI_D RSn_CI_FS RSn_CI_SSF
ODUkP/RSn_A_Sk_MP: ODUkP/RSn_A_Sk_MI_Active	**ODUkP/RSn_A_Sk_MP**: ODUkP/RSn_A_Sk_MI_cPLM ODUkP/RSn_A_Sk_MI_AcPT ODUkP/RSn_A_Sk_MI_cLOF

Processes

Activation

– The ODUkP/RSn_A_Sk function shall access the access point and perform the Common and Specific Processes operation specified below when it is activated (MI_Active is true). Otherwise, it shall activate the SSF signals and generate AIS at its output (CP) and not report its status via the management point.

PT: The function shall extract the PT byte from the PSI overhead as defined in 8.7.1. The accepted PT value is available at the MP (MI_AcPT) and is used for PLM defect detection.

RES: The value in the RES bytes shall be ignored.

JC: The function shall interpret the justification control information in the JC byte as defined in 17.1/G.709/Y.1331 in order to determine the justification action (positive, negative, none) for the current frame. RES bits in the JC shall be ignored.

Demapping, CBR clock generation: The function shall provide an elastic store (buffer) process. The CBR data shall be written into the buffer from the D, PJO and NJO byte in the OPUk frame. The information extraction of the PJO and NJO bytes shall be under control of the justification control information. The RSn data (CI_D) shall be read out of the buffer under control of the RSn clock (CI_CK).

Upon a positive justification action, the writing of 1 data byte into the buffer shall be cancelled once. No RSn data shall be read from the PJO and NJO byte. Upon a negative justification action, 1 extra data byte shall be written into the buffer once. RSn data shall be read from the PJO and NJO byte. If neither a positive nor a negative justification action is to be performed, RSn data shall be read from the PJO byte and no RSn data shall be read from the NJO byte.

Smoothing & jitter limiting process: The function shall provide for a clock smoothing and elastic store (buffer) process. The $4^{(k-1)}$ * 2 488 320 kbit/s (k = 1, 2, 3) data signal shall be written into the buffer under control of the associated (gapped) input clock (with a frequency accuracy within ± 20 ppm). The data signal shall be read out of the buffer under control of a smoothed (equally spaced) $4^{(k-1)}$ * 2 488 320 kbit/s ± 20 ppm clock (the rate is determined by the 2.5 Gbit/s, 10 Gbit/s, 40 Gbit/s signal at the input of the remote ODUkP/RSn_A_So).

The clock parameters, including jitter and wander requirements, as defined in Annex A/G.8251 (ODCp clock), apply.

Buffer size: In the presence of jitter as specified by ITU-T Rec. G.825 and a frequency within the range $4^{(k-1)}$ * 2 488 320 kbit/s ± 20 ppm, this justification process shall not introduce any errors.

Following a step in frequency of the $4^{(k-1)}$ * 2 488 320 kbit/s signal transported by the ODUkP_AI (for example due to reception of RSn_CI from a new RSn_TT_So at the far end or removal of generic-AIS signal with a frequency offset), there will be a maximum recovery time of X seconds after which this process shall not generate any bit errors. The value of X is for further study; a value of 1 second has been proposed.

Frame alignment: The function shall perform frame alignment on the STM-N frame as described in 8.2.1/G.783.

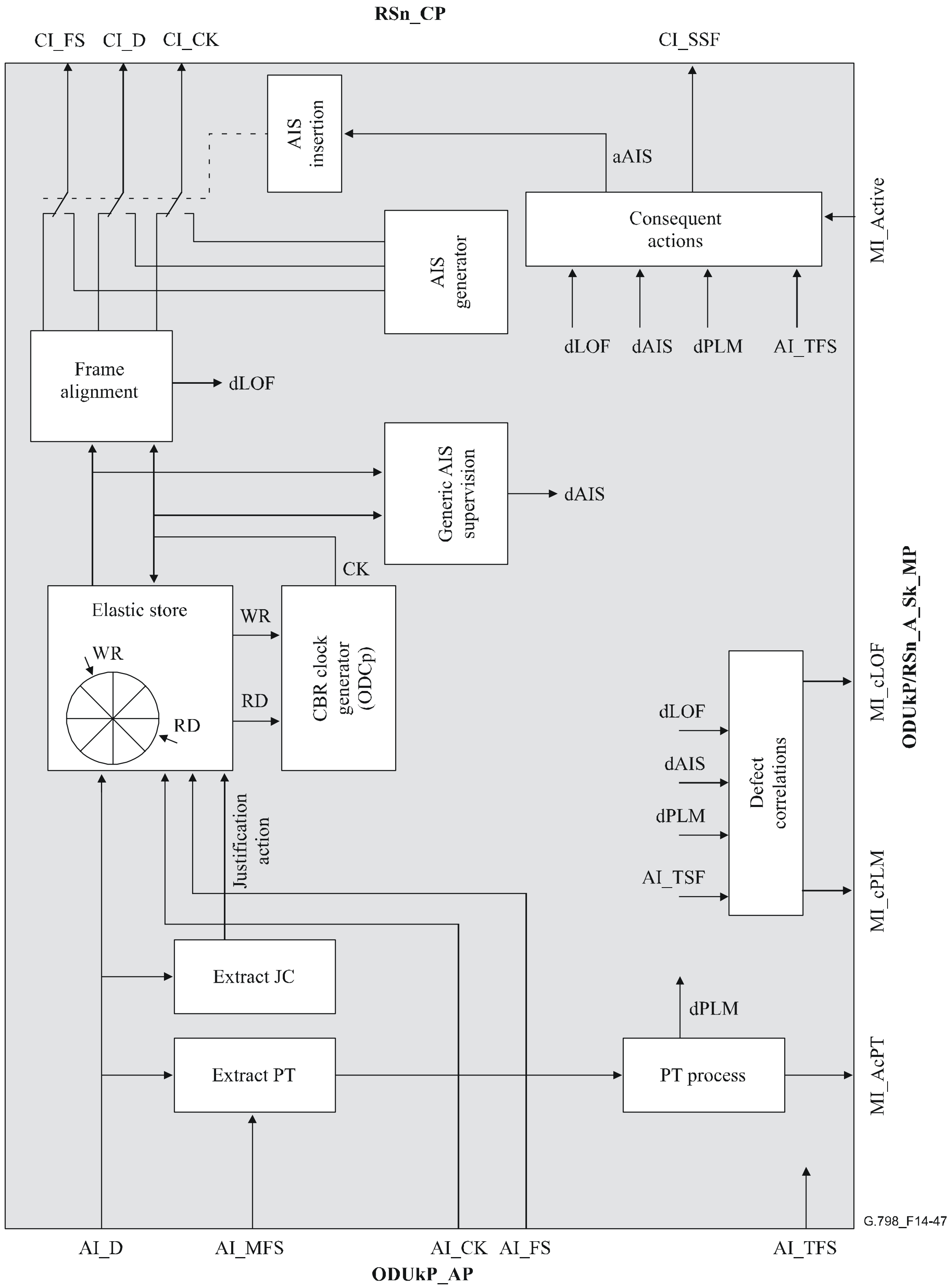


Figure 14-47/G.798 – ODUkP/RSn_A_Sk processes

Defects

The function shall detect for dPLM, dAIS and dLOF.

dPLM: See 6.2.4.1. The expected payload types are "0000 0010" (asynchronous CBRx mapping) and "0000 0011" (bit synchronous CBRx mapping) as defined in ITU-T Rec. G.709/Y.1331.

dAIS: See 6.2.6.3.3.

dLOF: See 6.2.5.1/G.783.

Consequent actions

aSSF ← AI_TSF or dPLM or dAIS or dLOF or (not MI_Active)

aAIS ← AI_TSF or dPLM or dAIS or dLOF or (not MI_Active)

On declaration of aAIS, the function shall output a logical all-ones (AIS) signal within 2 STM-N frames. On clearing of aAIS, the logical all-ones (AIS) signal shall be removed within 2 STM-N frames and normal data being output. The AIS clock start shall be independent from the incoming clock. The AIS clock has to be within $4^{(k-1)}$ * 2 488 320 kHz ± 20 ppm. The jitter and wander requirements as defined in Annex A/G.8251 (ODCp clock) apply.

Defect correlations

cPLM ← dPLM and (not AI_TSF)

cLOF ← dLOF and (not dAIS) and (not dPLM) and (not AI_TSF)

NOTE – dAIS is not reported as fault cause as it is a secondary alarm and will result in aSSF, which is reported as cSSF fault cause in the RSn_TT_Sk that directly follows this function.

Performance monitoring: None.

14.3.7 ODUkP to ODU[i]j adaptation function (ODUkP/ODU[i]j_A)

The ODUkP to ODU[i]j adaptation functions perform the adaptation between the ODUkP (k = 2, 3) layer adapted information and the characteristic information of ODUj (j = 1, 2; j < k) [and ODUi (i = 1; i < j)] signals.

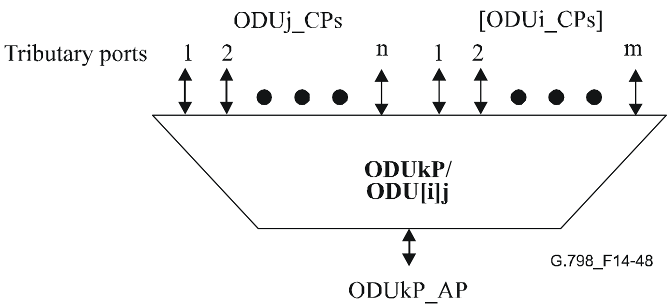


Figure 14-48/G.798 – ODUkP/ODU[i]j_A function

Four different types of functions are possible:

– the ODU2P/ODU1_A performs multiplexing/demultiplexing of 4 ODU1 into an ODU2;

– the ODU3P/ODU1_A performs multiplexing/demultiplexing of 16 ODU1 into an ODU3;

– the ODU3P/ODU2_A performs multiplexing/demultiplexing of 4 ODU2 into an ODU3;

– the ODU3P/ODU12_A performs multiplexing/demultiplexing of ODU1 and ODU2 into an ODU3.

The maximum number of tributary ports depends on the specific function type as listed in Table 14-18. Note that for the ODU3P/ODU12_A function only a subset of the tributary signals can be active and transported via the ODU3 at a time. The number of active ODU1 ports plus four times the number of active ODU2 ports is limited to 16. The multiplex structure identifier (MSI) defines the configuration in this case.

Note that the ODU3P/ODU12_A function can interwork with the ODU2P/ODU1_A, ODU3P/ODU1_A and ODU3P/ODU2_A functions as it supports all related multiplex structures.

Table 14-18/G.798 – ODUkP/ODU[i]j_A tributary ports

Function type	n ports	m ports
ODU2P/ODU1_A	4 ODU1	–
ODU3P/ODU1_A	16 ODU1	–
ODU3P/ODU2_A	4 ODU2	–
ODU3P/ODU12_A	16 ODU1	4 ODU2

14.3.7.1 ODUkP to ODU[i]j adaptation source function (ODUkP/ODU[i]j_A_So)

The ODUkP/ODU[i]j_A_So function creates the ODUk signal from a free running clock. It asynchronously maps the ODUj [and ODUi] client signal from the ODUj_[and ODUi] CPs into ODTUjk[/ik] including justification control (JC) information. The ODTUjk[/ik] are multiplexed into the payload area of the OPUk. It adds OPUk Overhead (RES, PT, MSI) and default ODUk Overhead.

The information flow and processing of the ODUkP/ODU[i]j_A_So function is defined with reference to Figures 14-49 and 14-50.

Symbol

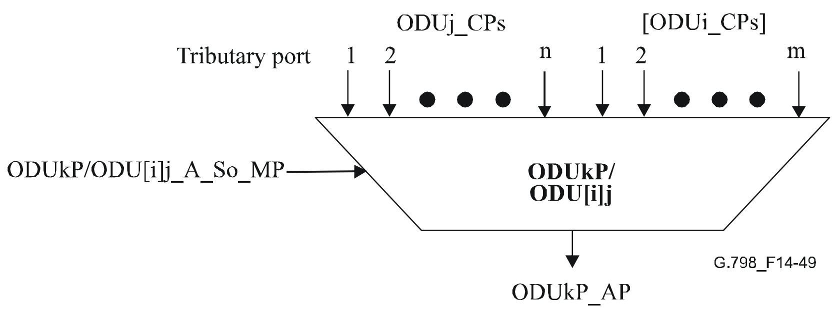


Figure 14-49/G.798 – ODUkP/ODU[i]j_A_So function

Interfaces

Table 14-19/G.798 – ODUkP/ODU[i]j_A_So inputs and outputs

Input(s)	Output(s)
n x ODUj_CP: ODUj_CI_CK ODUj_CI_D ODUj_CI_FS ODUj_CI_MFS **m x ODUi_CP**: (Note) ODUi_CI_CK ODUi_CI_D ODUi_CI_FS ODUi_CI_MFS **ODUkP/ODU[i]j_A_So_MP**: ODUkP/ODU[i]j_A_So_MI_Active ODU3P/ODU12_A_So_MI_TxMSI (Note)	**ODUkP_AP**: ODUkP_AI_CK ODUkP_AI_D ODUkP_AI_FS ODUkP_AI_MFS
NOTE – For ODU3P/ODU12_A_So only.	

Processes

Activation

The ODUkP/ODU[i]j_A_So function shall access the access point when it is activated (MI_Active is true). Otherwise, it shall not access the access point.

The processes associated with the ODUkP/ODU[i]j_A_So function are specific processes for each ODUj[i/]_CP and common processes for the compound (multiplexed) signal as depicted in Figure 14-50.

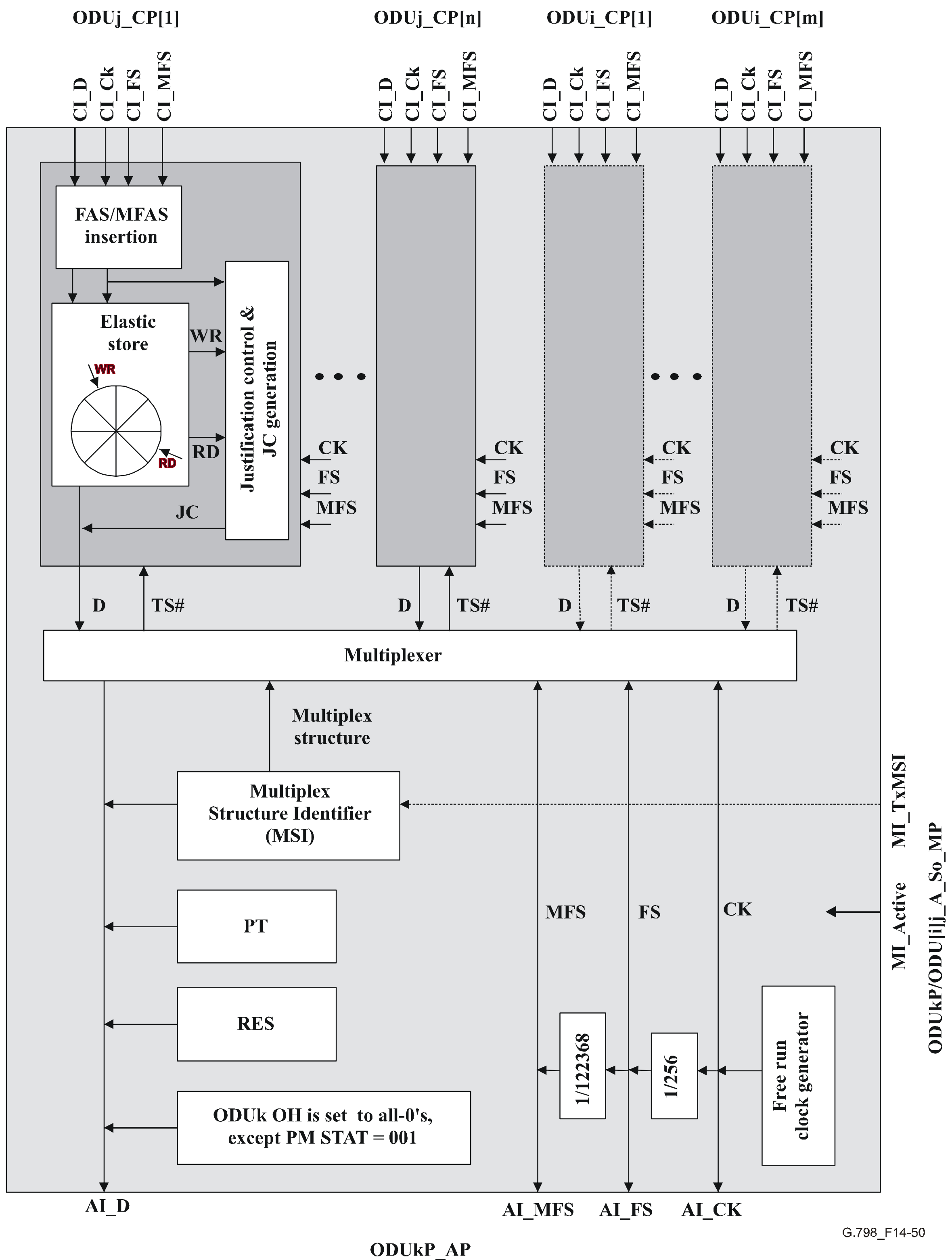


Figure 14-50/G.798 – ODUkP/ODU[i]j_A_So processes

Specific processes

The specific processes are performed independently for each ODUj [and ODUi] client signal that is multiplexed into the ODUk. The specific processes perform the mapping of the ODUj[/i] into an ODTUjk[/ik].

FAS/MFAS insertion: The function shall extend the ODUj[/i] with the frame alignment overhead (FAS and MFAS) in row 1 bytes 1 to 7 as described in 15.6.2/G.709/Y.1331. Byte 8 to14 of row 1 are set to all-0's.

Mapping, frequency justification and bit rate adaptation: The function shall provide an elastic store (buffer) process for the ODUj[/i] client signal. The data signal ODUj[/i]_CI shall be written into the buffer under control of the associated input clock. The data shall be read out of the buffer and written onto the D, NJO, PJO1 and PJO2 bytes of the selected ODTUjk[/ik] frame under control of the ODUk clock and justification decisions as defined in 19.5/G.709/Y.1331.

A justification decision shall be performed every fourth frame for the ODTU12, every sixteenth frame for the ODTU13 and four times every sixteen frames for the ODTU23. Each justification decision results in a corresponding double positive, positive, negative or no justification action. Upon a double positive justification action, the reading of 2 data bytes out of the buffer shall be cancelled once. No ODUj[/i] data shall be written onto the PJO2, PJO1 and NJO byte. Upon a positive justification action, the reading of 1 data byte out of the buffer shall be cancelled once. No ODUj[/i] data shall be written onto the PJO1 and NJO byte and data shall be written onto the PJO2 byte. Upon a negative justification action, 1 extra data byte shall be read once out of the buffer. ODUj[/i] data shall be written onto the PJO2, PJO1 and NJO byte. If no justification action is to be performed, ODUj[/i] data shall be written onto the PJO2 and PJO1 byte and no ODUj[/i] data shall be written onto the NJO byte. The ODUk frame that contains the PJO2, PJO1 and NJO bytes depends on the time slot[s] of the ODTUjk[/ik].

The justification decisions determine the phase error introduced by the function.

Buffer size: In the presence of jitter as specified by ITU-T Rec. G.8251 and a frequency within the range 239/(239 – j[/i]) * $4^{(j[/i]-1)}$ * 2 488 320 kHz ± 20 ppm, this mapping process shall not introduce any errors. The maximum buffer hysteresis, and therefore the maximum phase error introduced, shall be as listed in Table 14-20.

Table 14-20/G.798 – Maximum buffer hysteresis

Mapping	Maximum buffer hysteresis
ODU1 → ODU2 or ODU3	2 bytes
ODU2 → ODU3	8 bytes

JC: The function shall generate the justification control bits based on the justification decision (double positive, positive, negative, none) according to the specification in 19.5/G.709/Y.1331. It shall insert the justification control bits in bit 7 and 8 of all three JC bytes of the frame in which the justification is performed. The remaining (RES) bits of the JC byte shall be set to all-0's. The ODUk frame that contains the JC bytes depends on the time slot[s] of the ODTUjk[/ik].

Common processes

Clock and (Multi) Frame Start signal generation: The function shall generate a local ODUk clock (ODUkP_AI_CK) of "239/(239 – k) * $4^{(k-1)}$ * 2 488 320 kHz ± 20 ppm" from a free running oscillator. The clock parameters, including jitter and wander requirements, as defined in Annex A/G.8251 (ODCa clock) apply.

The function shall generate the (multi) frame start reference signals AI_FS and AI_MFS for the ODUk signal. The AI_FS signal shall be active once per 122368 clock cycles. AI_MFS shall be active once every 256 frames.

Multiplexing: The function assigns the individual ODTUjk[/ik] to specific times slots of the OPUk payload area as defined by the multiplex structure (see 19.3 and 19.4.1 in ITU-T Rec. G.709/Y.1331).

MSI: The function shall insert the TxMSI into the MSI byte positions of the PSI overhead as defined in 19.4/G.709/Y.1331. The TxMSI value and as such the multiplex structure is either fixed or configurable via MI_TxMSI as shown in Table 14-21.

PT: The function shall insert code "0010 0000" (ODU multiplex structure) into the PT byte position of the PSI overhead as defined in 15.9.2.1/G.709/Y.1331.

RES: The function shall insert all-0's into the RES bytes.

All other bits of the ODUk overhead should be sourced as "0"s, except the ODUk-PM STAT field which should be set to the value "normal path signal" (001).

Table 14-21/G.798 – Multiplex structure configuration and TxMSI values

Function	Multiplex structure	TxMSI value for fixed multiplex structure
ODU2P/ODU1_A	Fixed 4 ODU1 → ODU2	00 000000 00 000001 00 000010 00 000011
ODU3P/ODU1_A	Fixed 16 ODU1 → ODU3	00 000000 00 000001 00 000010 00 000011 00 000100 00 000101 00 000110 00 000111 00 001000 00 001001 00 001010 00 001011 00 001100 00 001101 00 001110 00 001111
ODU3P/ODU2_A	Fixed 4 ODU2 → ODU3	01 000000 01 000001 01 000010 01 000011 01 000000 01 000001 01 000010 01 000011 01 000000 01 000001 01 000010 01 000011 01 000000 01 000001 01 000010 01 000011
ODU3P/ODU12_A	Configured via MI_TxMSI	–

Defects: None.

Consequent actions: None.

Defect correlations: None.

Performance monitoring: None.

14.3.7.2 ODUkP to ODU[i]j adaptation sink function (ODUkP/ODU[i]j_A_Sk)

The ODUkP/ODU[i]j_A_Sk function extracts the OPUk Overhead (PT, MSI, and RES) and monitors the reception of the correct payload type. It demultiplexes the individual ODTUjk[/ik] from the payload area of the OPUk and recovers the ODUj[/i] signals using the justification control information (JC overhead). It determines the frame and multiframe structure of the ODUj[/i].

The information flow and processing of the ODUkP/ODU[i]j_A_Sk function is defined with reference to Figures 14-51 and 14-52.

Symbol

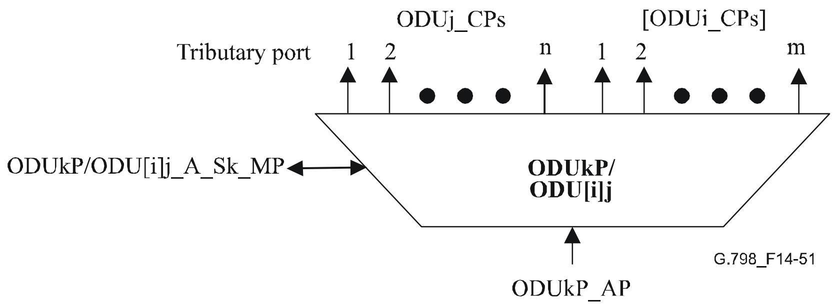


Figure 14-51/G.798 – ODUkP/ODU[i]j_A_Sk function

Interfaces

Table 14-22/G.798 – ODUkP/ODU[i]j_A_Sk inputs and outputs

<table>
<tr><th>Input(s)</th><th>Output(s)</th></tr>
<tr><td>ODUkP_AP:
ODUkP_AI_CK
ODUkP_AI_D
ODUkP_AI_FS
ODUkP_AI_MFS
ODUkP_AI_TSF
ODUkP_AI_TSD
ODUkP/ODU[i]j_A_Sk_MP:
ODUkP/ODU[i]j_A_Sk_MI_Active
ODU3P/ODU12_A_Sk_MI_AutoMS (Note)
ODU3P/ODU12_A_Sk_MI_ExMSI (Note)</td><td>n × ODUj_CP:
ODUj_CI_CK
ODUj_CI_D
ODUj_CI_FS
ODUj_CI_MFS
ODUj_CI_SSF
ODUj_CI_SSD
m × ODUi_CP: (Note)
ODUi_CI_CK
ODUi_CI_D
ODUi_CI_FS
ODUi_CI_MFS
ODUi_CI_SSF
ODUj_CI_SSD
ODUkP/ODU[i]j_A_Sk_MP:
ODUkP/ODU[i]j _A_Sk_MI_cPLM
ODUkP/ODU[i]j _A_Sk_MI_cMSIM
ODUkP/ODU[i]j _A_Sk_MI_AcPT
n × ODUkP/ODUj_A_Sk_MI_cLOFLOM
m × ODUkP/ODUi_A_Sk_MI_cLOFLOM (Note)</td></tr>
<tr><td colspan="2">NOTE – For ODU3P/ODU12_A_Sk only.</td></tr>
</table>

Processes

Activation

The ODUkP/ODU[i]j_A_Sk function shall access the access point when it is activated (MI_Active is true). Otherwise, it shall not access the access point.

The processes associated with the ODUkP/ODU[i]j_A_Sk function are specific processes for each ODUj[i/]_CP and common processes for the compound (multiplexed) signal as depicted in Figure 14-52.

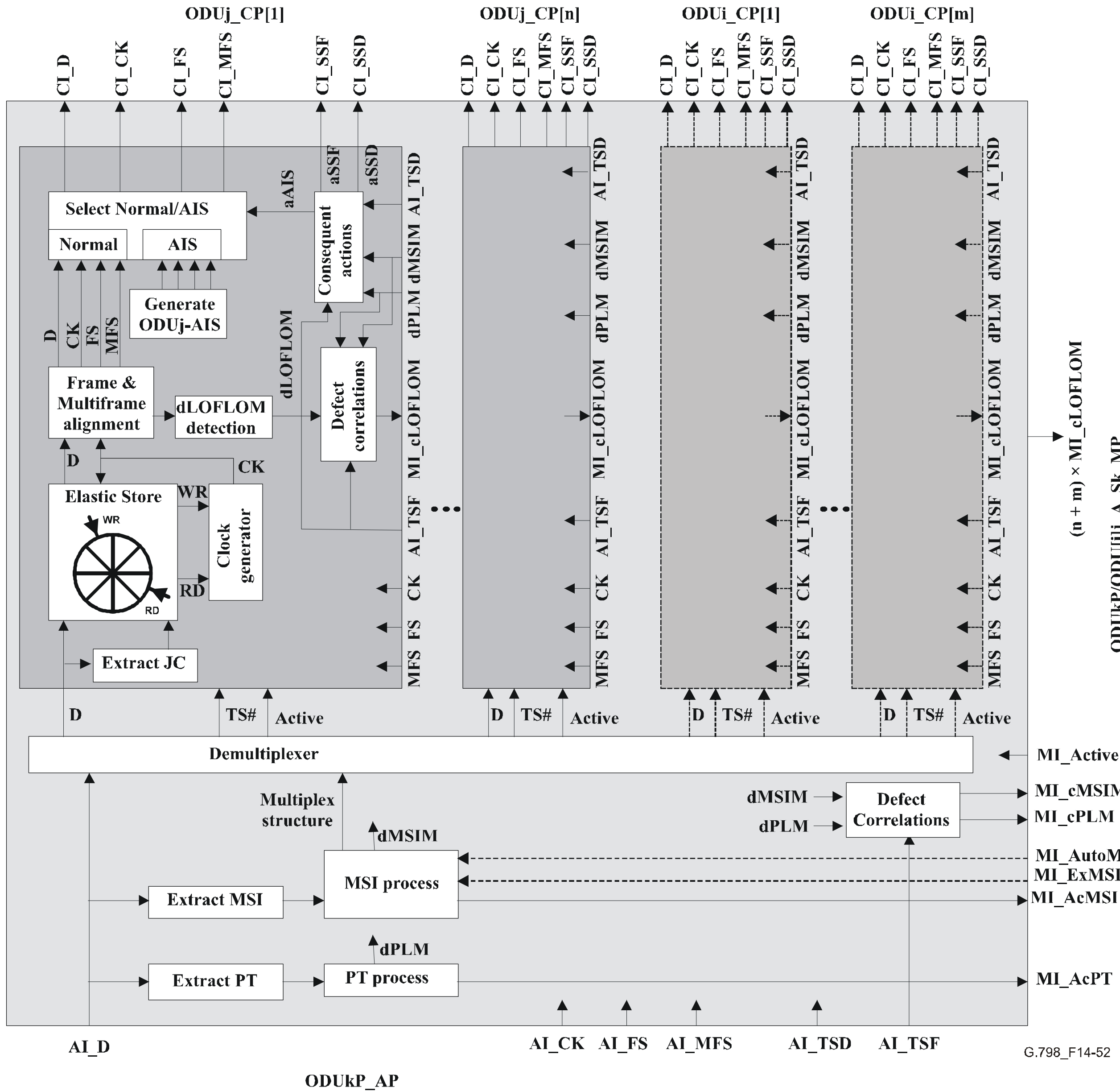


Figure 14-52/G.798 – ODUkP/ODU[i]j_A_Sk processes

Common processes

PT: The function shall extract the PT byte from the PSI overhead as defined in 8.7.1. The accepted PT value is available at the MP (MI_AcPT) and is used for PLM defect detection.

MSI: The function shall extract the MSI from the PSI overhead as defined in 8.7.2. The accepted MSI (AcMSI) is available at the MP (MI_AcMSI). If MI_AutoMSI is supported and true, the AcMSI defines the multiplex structure. Otherwise, the multiplex structure is defined by ExMSI, which is either fixed or configurable via MI_ExMSI as shown in Table 14-23.

RES: The value in the RES bytes shall be ignored.

Demultiplexing: The function activates the ODTUjk[/ik] and assigns the times slots of the ODUk payload area to the individual ODTUjk[/ik] as defined by the multiplex structure (see 19.3 and 19.4.1 in ITU-T Rec. G.709/Y.1331).

Table 14-23/G.798 – Multiplex structure configuration and ExMSI values

Function	Multiplex structure	ExMSI value for fixed multiplex structure
ODU2P/ODU1_A	Fixed 4 ODU1 → ODU2 AutoMS not supported	00 000000 00 000001 00 000010 00 000011
ODU3P/ODU1_A	Fixed 16 ODU1 → ODU3 AutoMS not supported	00 000000 00 000001 00 000010 00 000011 00 000100 00 000101 00 000110 00 000111 00 001000 00 001001 00 001010 00 001011 00 001100 00 001101 00 001110 00 001111
ODU3P/ODU2_A	Fixed 4 ODU2 → ODU3 AutoMS not supported	01 000000 01 000001 01 000010 01 000011 01 000000 01 000001 01 000010 01 000011 01 000000 01 000001 01 000010 01 000011 01 000000 01 000001 01 000010 01 000011
ODU3P/ODU12_A	Configured via MI_ExMSI or AcMSI if MI_AutoMS = true	–

Specific processes

The specific processes are performed independently for each ODUj [and ODUi] client signal that is multiplexed into the ODUk. The specific processes recover the ODUj[/i] from the ODTUjk[/ik].

JC: The function shall interpret the justification control information in bit 7 and 8 of the JC bytes as defined in 19.5/G.709/Y.1331 in order to determine the justification action (double positive, positive, negative, none) for the current frame. A 2 out of 3 majority decision is used. RES bits in the JC bytes shall be ignored. The ODUk frame that contains the JC bytes depends on the time slot[s] of the ODTUjk[/ik].

Demapping, CBR clock generation: The function shall provide an elastic store (buffer) process. The ODUj[/i] data shall be written into the buffer from the D, NJO, PJO1 and PJO2 bytes in the

ODTUjk[/ik] frame. The information extraction of the PJO2, PJO1 and NJO bytes shall be under control of the justification control information. The ODUj[/i] data (CI_D) shall be read out of the buffer under control of the ODUj[/i] clock (CI_CK).

Upon a double positive justification action, the writing of 2 data byte into the buffer shall be cancelled once. No ODUj[/i] data shall be read from the PJO2, PJO1 and NJO byte. Upon a positive justification action, the writing of 1 data byte into the buffer shall be cancelled once. No ODUj[/i] data shall be read from the PJO1 and NJO byte and data shall be read from the PJO2 byte. Upon a negative justification action, 1 extra data byte shall be written into the buffer once. ODUj[/i] data shall be read from the PJO2, PJO1 and NJO byte. If no justification action is to be performed, ODUj[/i] data shall be read from the PJO2 and PJO1 byte and no ODUj[/i] data shall be read from the NJO byte. The ODUk frame that contains the PJO2, PJO1 and NJO bytes depends on the time slot[s] of the ODTUjk[/ik].

Smoothing & jitter limiting process: The function shall provide for a clock smoothing and elastic store (buffer) process. The 239/(239 – j[/i]) * $4^{(j[/i]-1)}$ * 2 488 320 kbit/s (k = 1, 2, 3) data signal shall be written into the buffer under control of the associated (gapped) input clock (with a frequency accuracy within ± 20 ppm). The data signal shall be read out of the buffer under control of a smoothed (equally spaced) 239/(239 – j[/i]) * $4^{(j[/i]-1)}$ * 2 488 320 kbit/s ± 20 ppm clock (the rate is determined by the ODUj[/i] signal at the input of the remote ODUkP/ODU[i]j_A_So).

The clock parameters, including jitter and wander requirements, as defined in Annex A/G.8251 (ODCp clock) apply.

Buffer size: In the presence of jitter as specified by ITU-T Rec. G.8251 and a frequency within the range 239/(239 – j[/i]) * $4^{(j[/i]-1)}$ * 2 488 320 kbit/s ± 20 ppm, this justification process shall not introduce any errors.

Following a step in frequency of the 239/(239 – j[/i]) * $4^{(j[/i]-1)}$ * 2 488 320 kbit/s signal transported (for example due to reception of ODUj[/i]_CI from a new ODUj[/i]_TT_So at the far end or removal of a ODU AIS signal with a frequency offset), there will be a maximum recovery time of X seconds after which this process shall not generate any bit errors. The value of X is for further study; a value of 1 second has been proposed.

Frame & Multiframe alignment: The function shall perform frame and multiframe alignment as described in 8.2.3.

ODUj[/i]-AIS: The function shall generate the ODUj[/i]-AIS signals as defined in ITU-T Rec. G.709/Y.1331. The clock, frame start and multiframes start shall be independent from the incoming clock. The clock has to be within 239/(239 – j[/i]) * $4^{(j[/i]-1)}$ * 2 488 320 kHz ± 20 ppm. Jitter and wander requirements as defined in Annex A/G.8251 (ODCa clock) apply.

Selector: The normal signal may be replaced by the ODUj[/i]-AIS. ODUj[/i]-AIS is selected if aAIS is true.

Defects

The function shall detect for dPLM, dMSIM and dLOFLOM.

dPLM: See 6.2.4.1. The expected payload type is "0010 0000" (ODU multiplex structure) as defined in ITU-T Rec. G.709/Y.1331.

dMSIM: See 6.2.9.1.

dLOFLOM: See 6.2.5.3. dLOFLOM is detected per active ODUj[/i].

Consequent actions

For each ODUj[/i]:

aSSF ← AI_TSF or dPLM or dMSIM or dLOFLOM or (not Active)

For each ODUj[/i]:

aSSD ← AI_TSD

For each ODUj[/i]:

aAIS ← AI_TSF or dPLM or dMSIM or dLOFLOM or (not Active)

On declaration of aAIS the function shall output an All-ONEs pattern/signal within 2 frames. On clearing of aAIS the All-ONEs pattern/signal shall be removed within 2 frames and normal data being output. The AIS clock, frame start and multiframe start shall be independent from the incoming clock, frame start and multiframe start. The AIS clock has to be within 239/(239 – j[/i]) * $4^{(j[/i]-1)}$ * 2 488 320 kHz ± 20 ppm. Jitter and wander requirements as defined in Annex A/G.8251 (ODCa clock) apply.

Defect correlations

cPLM ← dPLM and (not AI_TSF)

cMSIM ← dMSIM and (not dPLM) and (not AI_TSF)

For each ODUj[/i]:

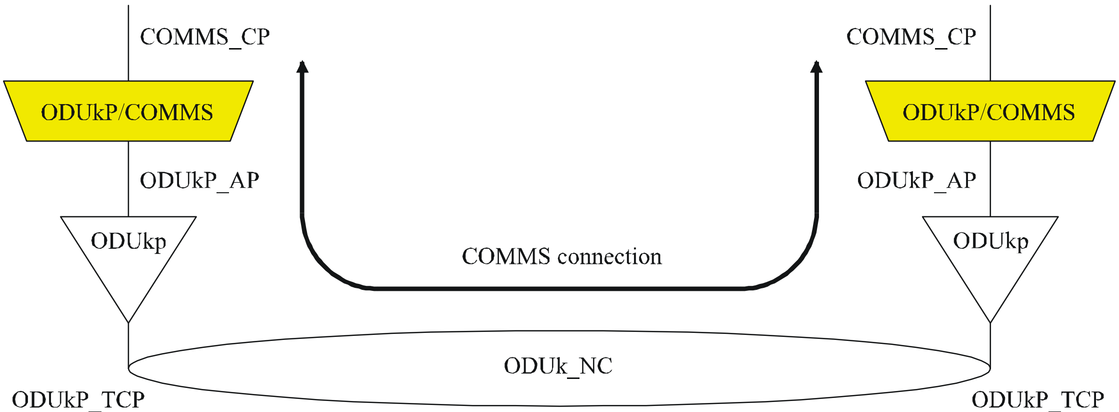
cLOFLOM ← dLOFLOM and (not MSIM) and (not dPLM) and (not AI_TSF) and (Active)

Performance monitoring: None.

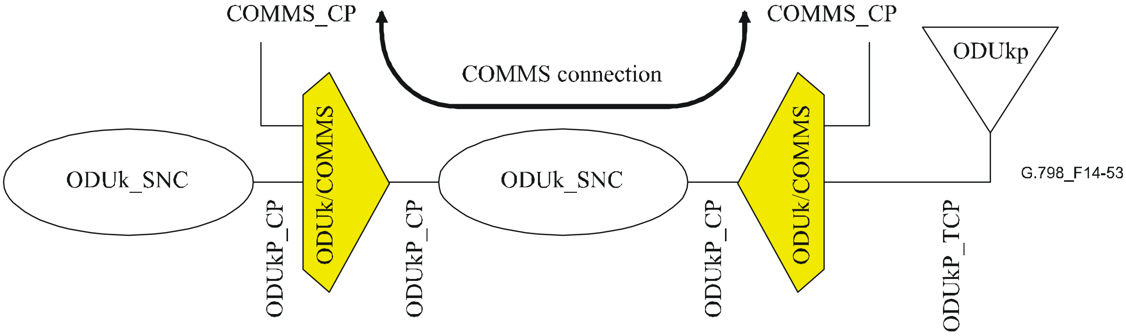
14.4 COMMS functions

Two types of COMMS functions are defined for the ODUk, the ODUkP/COMMS adaptation function (ODUkP/COMMS_A) that provides access to the ODUk GCC1/2 overhead at the ODUkP access point (ODUkP_AP) and the ODUk/COMMS access function (ODUk/COMMS_AC) that provides access to the ODUk GCC1/2 at ODUk (termination) connection points (ODUk_CP/TCPs) as shown in Figure 14-53. The ODUkP/COMMS_A function supports transport of the COMMS data over an ODUkP trail including the trail supervision, while the ODUk/COMMS_AC function supports transport of COMMS data over a ODUk sub-network connection.

NOTE – COMMS sub-network connections are independent of TCM sub-network connections.



a) COMMS (GCC) access at ODUkP access points



b) COMMS (GCC) access at ODUk connection points

Figure 14-53/G.798 – ODUk GCC access

14.4.1 ODUkP to COMMS adaptation function (ODUkP/COMMS_A)

The ODUkP to COMMS adaptation functions provide access to the GCC1/2 overhead in the ODUk for generic data communication.

14.4.1.1 ODUkP to COMMS adaptation source function (ODUkP/COMMS_A_So)

The ODUkP/COMMS_A_So function maps the generic communication channel data into the ODUk GCC1/2 overhead.

The information flow and processing of the ODUkP/COMMS_A_So functions is defined with reference to Figures 14-54 and 14-55.

Symbol

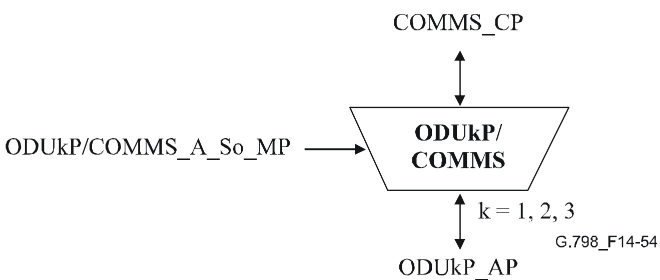


Figure 14-54/G.798 – ODUkP/COMMS_A_So function

Interfaces

Table 14-24/G.798 – ODUkP/COMMS_A_So inputs and outputs

Input(s)	Output(s)
COMMS_CP: COMMS_CI_D **ODUkP_AP**: ODUkP_AI_CK ODUkP_AI_FS **ODUkP/COMMS_A_So_MP**: ODUkP/COMMS_A_So_MI_Active ODUkP/COMMS_A_So_MI_GCCAccess	**COMMS_CP**: COMMS_CI_CK **ODUkP_AP**: ODUkP_AI_D

Processes

Activation

– The ODUkP/COMMS_A_So function shall access the access point when it is activated (MI_Active is true). Otherwise, it shall not access the access point.

The processes associated with the ODUkP/COMMS_A_So function are as depicted in Figure 14-55.

COMMS clock generation: The function shall generate the COMMS clock (CI_CK) by dividing the incoming ODUkP clock (AI_CK) by a factor of 7648 if one GCC overhead is accessed or by a factor of 3824 if both GCC overheads are accessed.

Mapping: Depending on the MI_GCCAccess configuration, the function shall map the incoming COMMS (CI_D) data only into GCC1 (MI_GCCAccess="GCC1") or only into GCC2 (MI_GCCAccess="GCC2") or into both GCC1 and GCC2 overhead (MI_GCCAccess="GCC1+GCC2") of the ODUk frame. The bit rate of the COMMS data is defined by the outgoing COMMS clock (CI_CK) and is in the range of $(239/(239 - k) * 4^{(k-1)})/7648 *$ 2 488 320 kHz ± 20 ppm if one GCC overhead is accessed or in the range of $(239/(239 - k) * 4^{(k-1)})/3824 *$ 2 488 320 kHz ± 20 ppm if both GCC overheads are accessed.

The insertion of the COMMS data follows the transmission order of the GCC bits and bytes.

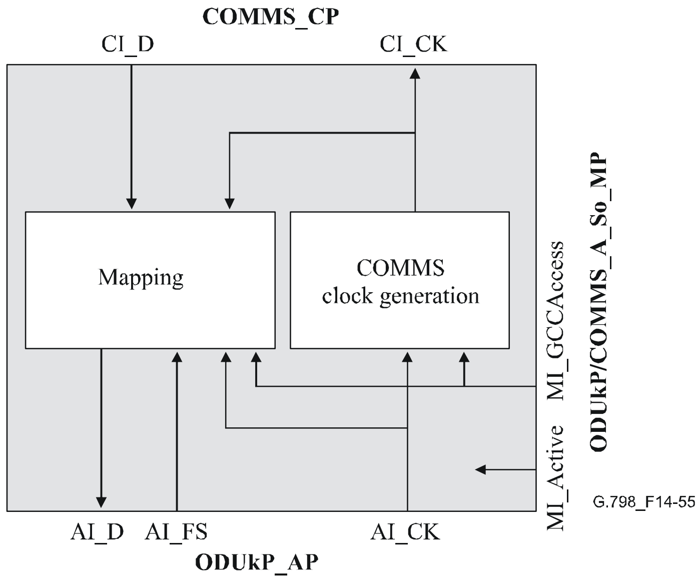


Figure 14-55/G.798 – ODUkP/COMMS_A_So processes

Defects: None.

Consequent actions: None.

Defect correlations: None.

Performance monitoring: None.

14.4.1.2 ODUkP to COMMS adaptation sink function (ODUkP/COMMS_A_Sk)

The ODUkP/COMMS_A_Sk extracts the COMMS data from the ODUk GCC overhead.

The information flow and processing of the ODUkP/COMMS_A_Sk functions is defined with reference to Figures 14-56 and 14-57.

Symbol

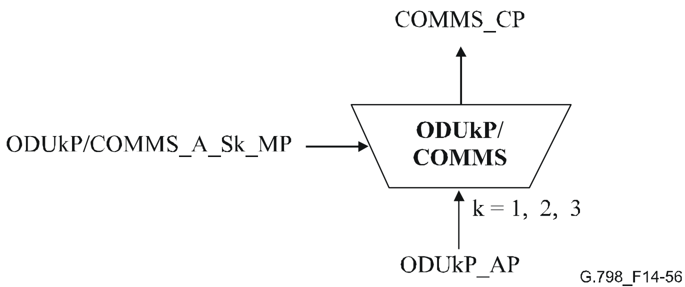


Figure 14-56/G.798 – ODUkP/COMMS_A_Sk function

Interfaces

Table 14-25/G.798 – ODUkP/COMMS_A_Sk inputs and outputs

Input(s)	Output(s)
ODUkP_AP: ODUkP_AI_CK ODUkP_AI_D ODUkP_AI_FS ODUkP_AI_TSF **ODUkP/COMMS_A_Sk_MP**: ODUkP/COMMS_A_Sk_MI_Active ODUkP/COMMS_A_Sk_MI_GCCAccess	**COMMS_CP**: COMMS_CI_CK COMMS_CI_D COMMS_CI_SSF

Processes

Activation

– The ODUkP/COMMS_A_Sk function shall access the access point and perform the Common and Specific Processes operation specified below when it is activated (MI_Active is true). Otherwise, it shall activate the SSF signals at its output (CP).

The processes associated with the ODUkP/COMMS_A_Sk function are as depicted in Figure 14-57.

COMMS clock generation: The function shall generate the COMMS clock (CI_CK) by dividing the incoming ODUkP clock (AI_CK) by a factor of 7648 if one GCC overhead is accessed or by a factor of 3824 if both GCC overheads are accessed.

Demapping: Depending on the MI_GCCAccess configuration the function shall extract the COMMS (CI_D) data only from GCC1 (MI_GCCAccess="GCC1") or only from GCC2 (MI_GCCAccess="GCC2") or from both GCC1 and GCC2 overhead (MI_GCCAccess="GCC1+GCC2") of the ODUk frame. The bit rate of the COMMS data is defined by the outgoing COMMS clock (CI_CK) and is in the range of $(239/(239 - k) * 4^{(k-1)})/7648 * 2\,488\,320$ kHz ± 20 ppm if one GCC overhead is accessed or in the range of $(239/(239 - k) * 4^{(k-1)})/3824 * 2\,488\,320$ kHz ± 20 ppm if both GCC overheads are accessed.

The extraction of the COMMS data follows the transmission order of the GCC bits and bytes.

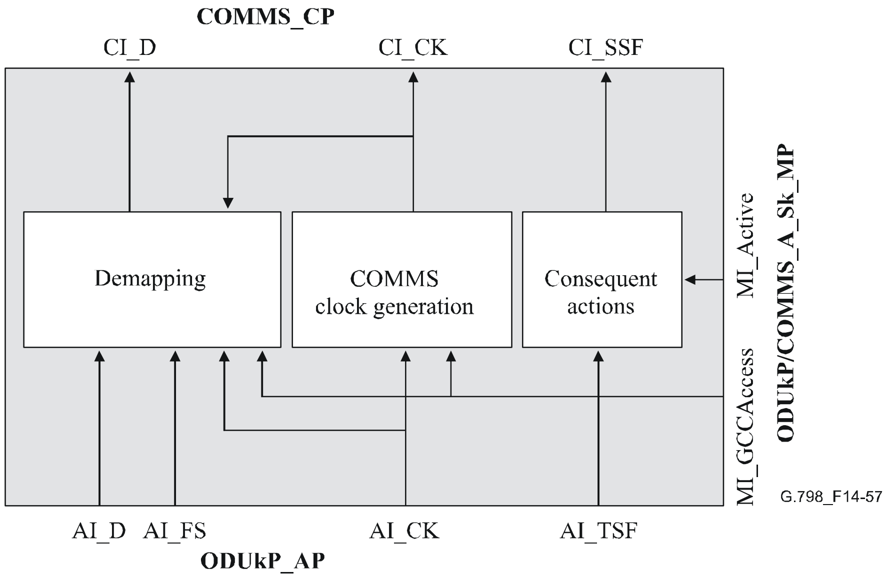


Figure 14-57/G.798 – ODUkP/COMMS_A_Sk processes

Defects: None.

Consequent actions

The function shall perform the following consequent actions:

aSSF ← AI_TSF or (not MI_Active)

Defect correlations: None.

Performance monitoring: None.

14.4.2 ODUk to COMMS access function (ODUk/COMMS_AC)

The ODUk to COMMS access functions provide access to the GCC1/2 overhead in the ODUk for generic data communication at ODUk CPs (including TCPs). As the functions act on the ODUk signal that passes through the CP, they are inserted into an expanded ODUk CP as shown in Figure 14-58. They can be inserted into any ODUk_CP independent of sink or source processing. A ODUk/COMMS_AC_Sk and So function can be used at the same CP for extraction of the COMMS data from the GCC and insertion of new COMMS data.

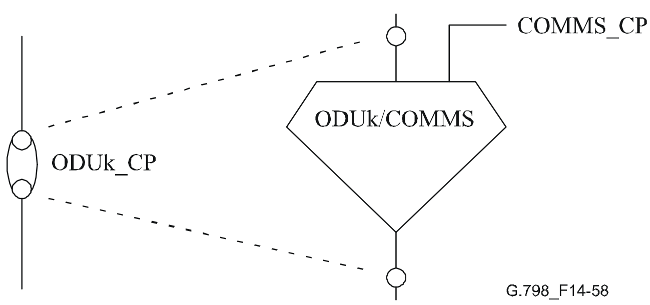


Figure 14-58/G.798 – ODUk CP expansion for COMMS access

14.4.2.1 ODUk to COMMS access source function (ODUk/COMMS_AC_So)

The ODUk/COMMS_AC_So function maps the generic communication channel data into the GCC1/2 overhead of the ODUk signal that passes through the function.

The information flow and processing of the ODUk/COMMS_AC_So functions is defined with reference to Figures 14-59 and 14-60.

Symbol

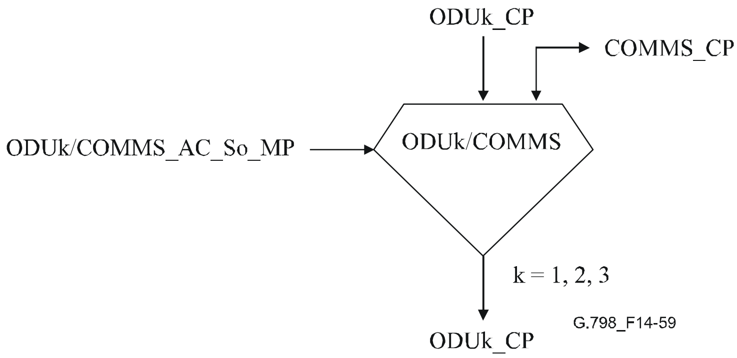


Figure 14-59/G.798 – ODUk/COMMS_AC_So function

Interfaces

Table 14-26/G.798 – ODUk/COMMS_AC_So inputs and outputs

Input(s)	Output(s)
COMMS_CP: COMMS_CI_D **ODUk_CP**: ODUk_CI_D ODUk_CI_CK ODUk_CI_FS ODUk_CI_MFS ODUk_CI_SSF **ODUk/COMMS_AC_So_MP**: ODUk/COMMS_AC_So_MI_Active ODUk/COMMS_AC_So_MI_GCCAccess	**COMMS_CP**: COMMS_CI_CK **ODUk_CP**: ODUk_CI_D ODUk_CI_CK ODUk_CI_FS ODUk_CI_MFS ODUk_CI_SSF

Processes

Activation

– The ODUk/COMMS_AC_So function shall perform the processes defined below when it is activated (MI_Active is true). Otherwise, it shall pass trough the ODUk CI between the input and output ODUk CP unmodified.

The processes associated with the ODUk/COMMS_AC_So function are as depicted in Figure 14-60.

COMMS clock generation: The function shall generate the COMMS clock (COMMS_CI_CK) by dividing the incoming ODUk clock (ODUk_CI_CK) by a factor of 7648 if one GCC overhead is accessed or by a factor of 3824 if both GCC overheads are accessed.

Mapping: Depending on the MI_GCCAccess configuration, the function shall map the incoming COMMS (COMMS_CI_D) data only into GCC1 (MI_GCCAccess="GCC1") or only into GCC2 (MI_GCCAccess="GCC2") or into both GCC1 and GCC2 overhead (MI_GCCAccess="GCC1+GCC2") of the ODUk frame that passes through the function (ODUk_CI_D). The bit rate of the COMMS data is defined by the outgoing COMMS clock

(COMMS_CI_CK) and is in the range of $(239/(239 - k) * 4^{(k-1)})/7648 * 2\,488\,320$ kHz ± 20 ppm if one GCC overhead is accessed or in the range of $(239/(239 - k) * 4^{(k-1)})/3824 * 2\,488\,320$ kHz ± 20 ppm if both GCC overheads are accessed.

The insertion of the COMMS data follows the transmission order of the GCC bits and bytes.

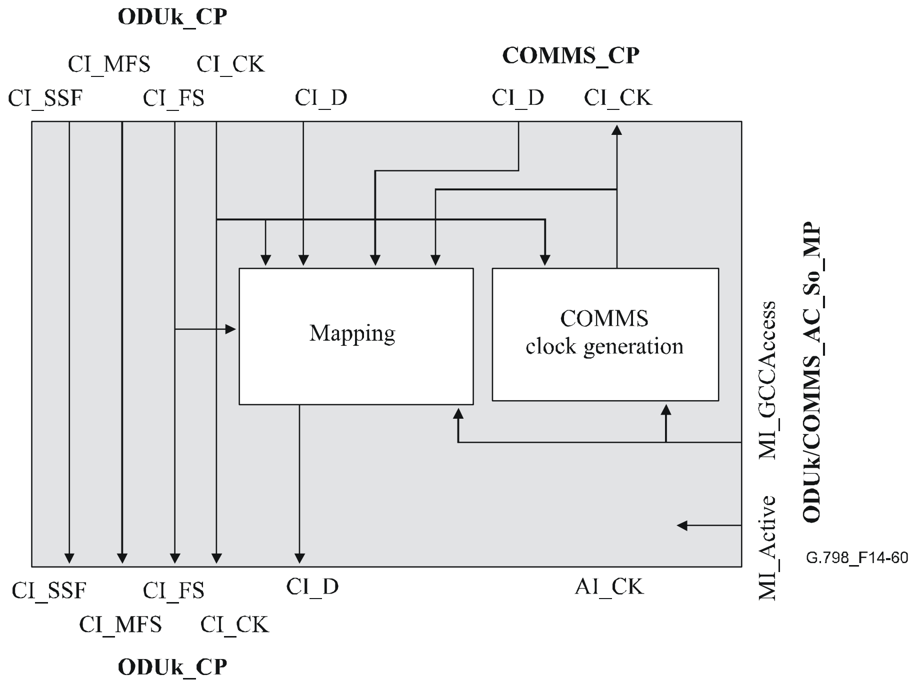


Figure 14-60/G.798 – ODUk/COMMS_AC_So processes

Defects: None.

Consequent actions: None.

Defect correlations: None.

Performance monitoring: None.

14.4.2.2 ODUk to COMMS access sink function (ODUk/COMMS_AC_Sk)

The ODUk/COMMS_AC_Sk extracts the COMMS data from the ODUk GCC overhead.

The information flow and processing of the ODUk/COMMS_AC_Sk functions is defined with reference to Figures 14-61 and 14-62.

Symbol

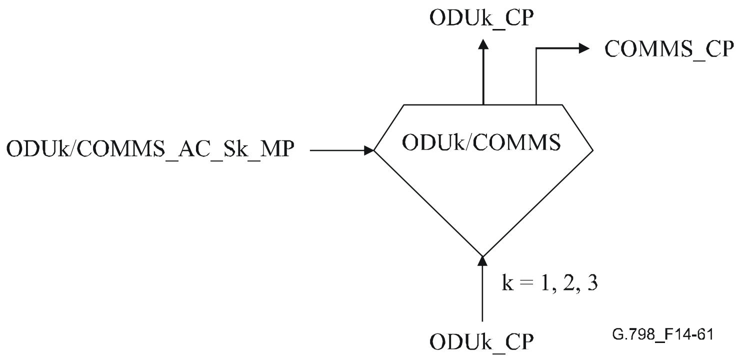


Figure 14-61/G.798 – ODUk/COMMS_AC_Sk function

Interfaces

Table 14-27/G.798 – ODUk/COMMS_AC_Sk inputs and outputs

Input(s)	Output(s)
ODUk_CP: ODUk_CI_CK ODUk_CI_D ODUk_CI_FS ODUk_CI_MFS ODUk_CI_SSF **ODUk/COMMS_AC_Sk_MP**: ODUk/COMMS_AC_Sk_MI_Active ODUk/COMMS_AC_Sk_MI_GCCAccess ODUk/COMMS_AC_Sk_MI_GCCCont	**COMMS_CP**: COMMS_CI_CK COMMS_CI_D COMMS_CI_SSF **ODUk_CP**: ODUk_CI_CK ODUk_CI_D ODUk_CI_FS ODUk_CI_MFS ODUk_CI_SSF

Processes

Activation

– The ODUk/COMMS_AC_Sk function shall perform the processes defined below when it is activated (MI_Active is true). Otherwise, it shall pass trough the ODUk CI between the input and output ODUk CP unmodified and it shall activate the SSF signals at its COMMS output (COMMS CP).

The processes associated with the ODUk/COMMS_AC_Sk function are as depicted in Figure 14-62.

COMMS clock generation: The function shall generate the COMMS clock (COMMS_CI_CK) by dividing the incoming ODUk clock (ODUk_CI_CK) by a factor of 7648 if one GCC overhead is accessed or by a factor of 3824 if both GCC overheads are accessed.

Demapping: Depending on the MI_GCCAccess configuration, the function shall extract the COMMS (COMMS_CI_D) data only from GCC1 (MI_GCCAccess="GCC1") or only from GCC2 (MI_GCCAccess="GCC2") or from both GCC1 and GCC2 overhead (MI_GCCAccess="GCC1+GCC2") of the ODUk frame that passes through the function (ODUk_CI_D). If MI_GCCCont is true, the selected GCC overhead shall pass trough unmodified from the ODUk CP input to the ODUk_CP output. Otherwise, it shall be set to all 0s at the ODUk CP output after the extraction of the COMMS data. The bit rate of the COMMS data is defined by the outgoing COMMS clock (COMMS_CI_CK) and is in the range of $(239/(239 - k) * 4^{(k-1)})/7648$

* 2 488 320 kHz ± 20 ppm if one GCC overhead is accessed or in the range of (239/(239 – k) * $4^{(k-1)}$)/3824 * 2 488 320 kHz ± 20 ppm if both GCC overheads are accessed.

The extraction of the COMMS data follows the transmission order of the GCC bits and bytes.

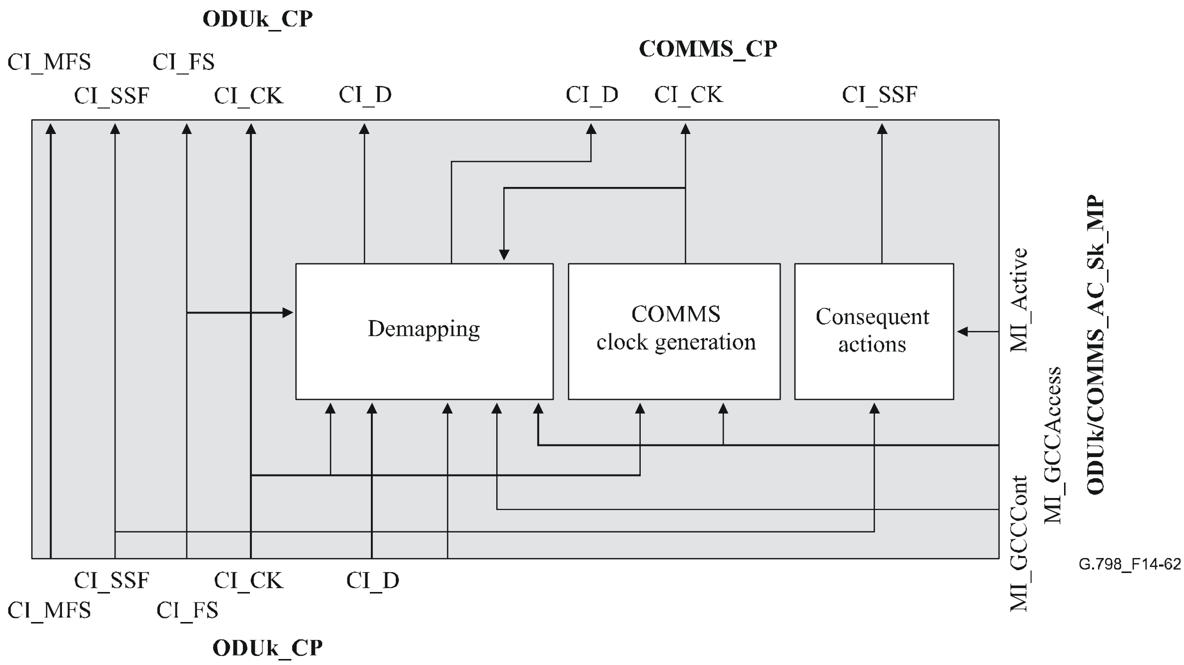


Figure 14-62/G.798 – ODUk/COMMS_AC_Sk processes

Defects: None.

Consequent actions

The function shall perform the following consequent actions:

COMMSaSSF ← ODUk_CI_SSF or (not MI_Active)

Defect correlations: None.

Performance monitoring: None.

14.5 Sub-Layer functions

14.5.1 ODU Tandem Connection Sub-Layer (ODUkT) functions

Up to 6 independent ODUkT sub-layers can pass-through or can be terminated at an ODUk_CP as defined in ITU-T Rec. G.709/Y.1331. For an ODUkT sub-layer termination, the ODUk-CP is expanded as defined in ITU-T Rec. G.805.

The ODUkT_TT, ODUkT/ODUk_A and ODUkT_TCMC functions are always combined together and can be located at any ODUk_CP as shown in Figure 14-63. For the location of the OTUkTm_TT function, see Figure 14-69.

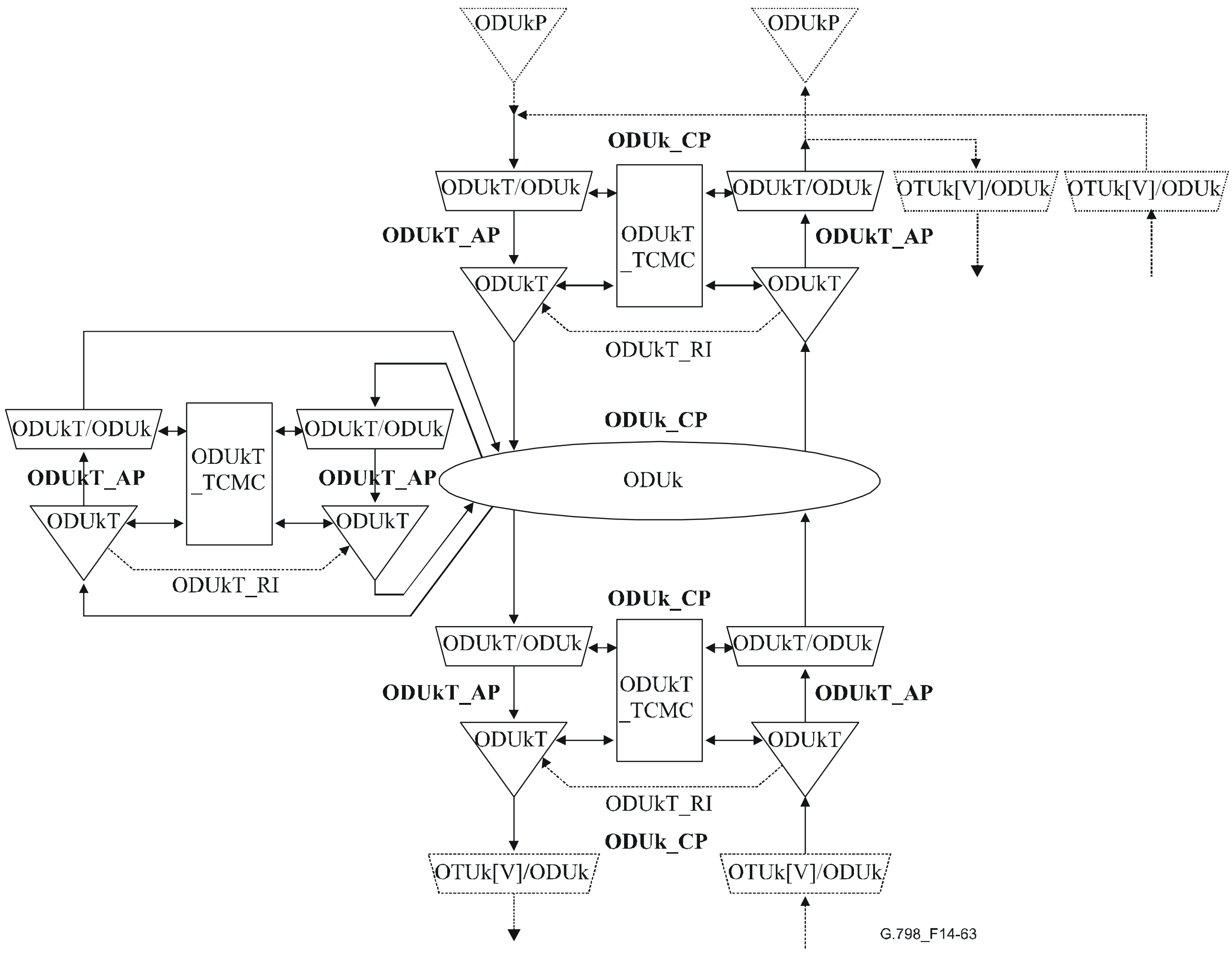


Figure 14-63/G.798 – Location of ODUkT_TT, ODUkT/ODUk_A and ODUkT_TCMC functions

14.5.1.1 ODUkT trail termination function (ODUkT_TT)

The ODUkP_TT function terminates a level of Tandem Connection Monitoring (TCM) overhead of the ODUk overhead to determine the status of an ODUk TCM sub-layer trail.

Furthermore, the ODUkT_TT function provides read/write access to the TCM ACT signal in the ODUk overhead over the TCM control point (TCMCP) for the Tandem Connection Monitor Control (TCMC) function that can be connected to an ODUkT_TT.

Figure 14-64 shows the combination of the unidirectional sink and source functions to form a bidirectional function.

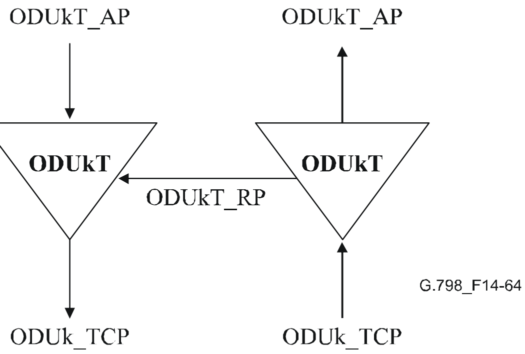


Figure 14-64/G.798 – ODUkT_TT

14.5.1.1.1 ODUkT trail termination source function (ODUkT_TT_So)

The ODUkT_TT_So function computes the BIP8 and adds Tandem Connection Monitoring Overhead (TCMOH) – including the TTI, BIP8, BDI and BEI signals – in a selected TCMOH field to the ODUk signal at its ODUkT_AP if it is OPERATIONAL; otherwise, in TRANSPARENT mode, the TCMOH field signal is passed through transparently.

The information flow and processing of the ODUkT_TT_So function is defined with reference to Figures 14-65 and 14-66.

Symbol

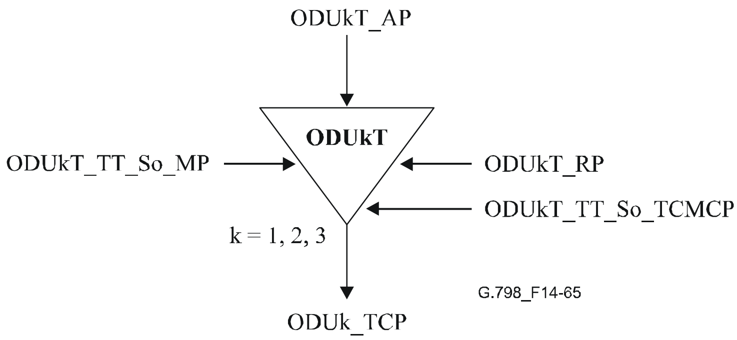


Figure 14-65/G.798 – ODUkT_TT_So function

Interfaces

Table 14-28/G.798 – ODUkT_TT_So inputs and outputs

Input(s)	Output(s)
ODUkT_AP: ODUkT_AI_CK ODUkT_AI_D ODUkT_AI_FS ODUkT_AI_MFS **ODUkT_RP**: ODUkT_RI_BDI ODUkT_RI_BEI ODUkT_RI_BIAE **ODUkT_TT_So_MP**: ODUkT_TT_So_MI_TxTI **ODUkT_TT_So_TCMCP**: ODUkT_TT_So_TCMCI_Mode ODUkT_TT_So_TCMCI_Level	**ODUk_TCP**: ODUk_CI_CK ODUk_CI_D ODUk_CI_FS ODUk_CI_MFS

Processes

The processes associated with the ODUkT_TT_So function are as depicted in Figure 14-66.

Mode: If the TCMCI_Mode has the value OPERATIONAL, the following processes shall be performed. If the TCMCI_Mode has the value TRANSPARENT, all information shall be passed through transparently and the following processes shall not be performed.

TCMOH-TTI: If TCMCI_Mode is OPERATIONAL, the trail trace identifier is inserted in the TTI byte position of the TCM[TCMCI_Level] field. Its value is derived from reference point ODUkT_TT_So_MP. The trail trace format is described in 15.2/G.709/Y.1331.

TCMOH-BDI: If TCMCI_Mode is OPERATIONAL, the backward defect indication is inserted in the BDI bit position of the TCM[TCMCI_Level] field. Its value is derived from reference point ODUkT_RP. Upon the declaration/clearing of aBDI at the termination sink function, the trail termination source function shall have inserted/removed the BDI indication within 50 ms.

TCMOH-BEI/BIAE: If TCMCI_Mode is OPERATIONAL, if RI_BIAE is true the value "1011" is inserted into the BEI/BIAE bits of the TCM[TCMCI_Level] field. If RI_BIAE is false, the number of errors indicated in RI_BEI is encoded in the BEI/IBAE bits of the TCM[TCMCI_Level] field. Upon the detection of incoming alignment error or a number of errors at the termination sink function, the trail termination source function shall have inserted the values in the BEI/BIAE bits within 50 ms.

TCMOH-BIP8: If TCMCI_Mode is OPERATIONAL, the calculated BIP8 is inserted into the BIP8 byte of the TCM[TCMCI_Level] field. For the BIP8 calculation, see 8.3.4.1.

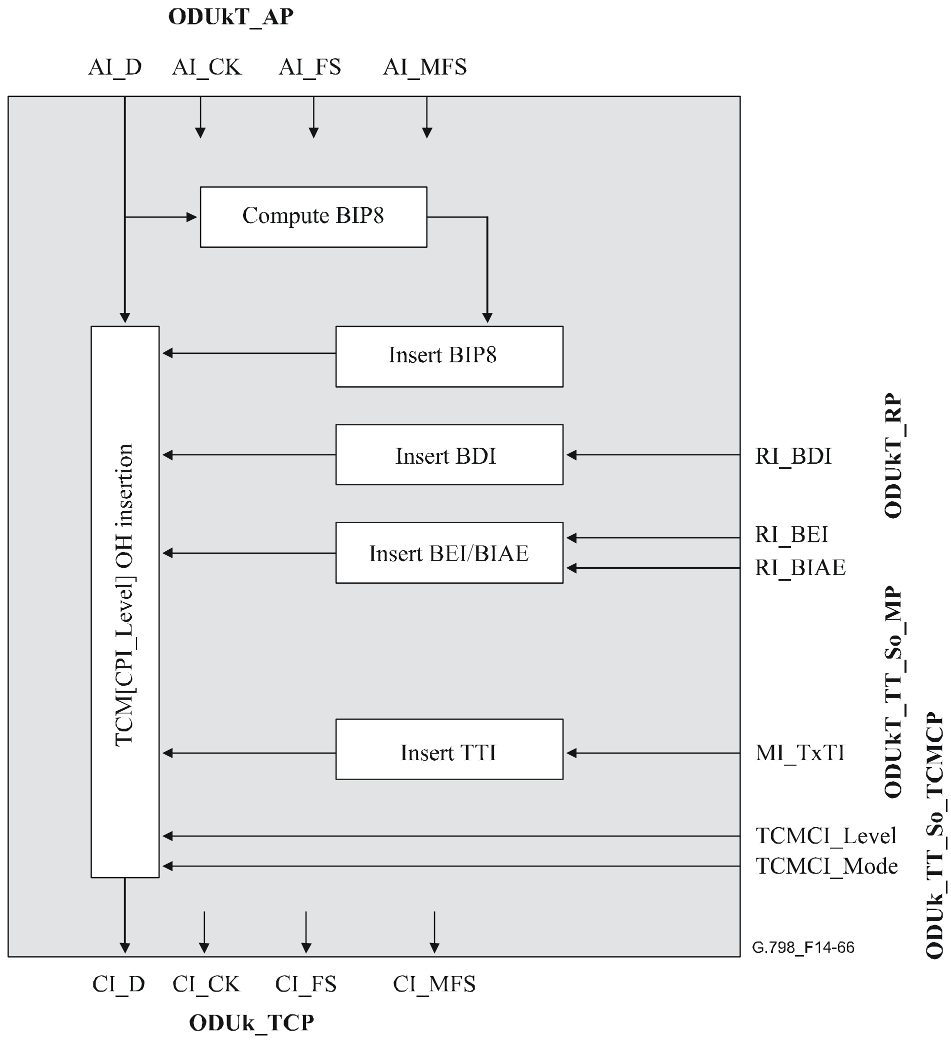


Figure 14-66/G.798 – ODUkT_TT_So processes

Defects: None.

Consequent actions: None.

Defect correlations: None.

Performance monitoring: None.

14.5.1.1.2 ODUkT trail termination sink function (ODUkT_TT_Sk)

The ODUkT_TT_Sk function reports the state of the ODUk Monitored Tandem Connection. It computes the BIP8, extracts Tandem Connection Monitoring Overhead (TCMOH) – including the TTI, BIP8, BDI and BEI signals – in a selected TCMOH field from the ODUk signal at its ODUk_TCP, detects for AIS, OCI, LCK, TIM, DEG and BDI defects, counts during 1-second periods errors (detected via the BIP8) and defects to feed PM when it is OPERATIONAL or MONITOR.

The information flow and processing of the ODUkT_TT_Sk function is defined with reference to Figures 14-67 and 14-68.

Symbol

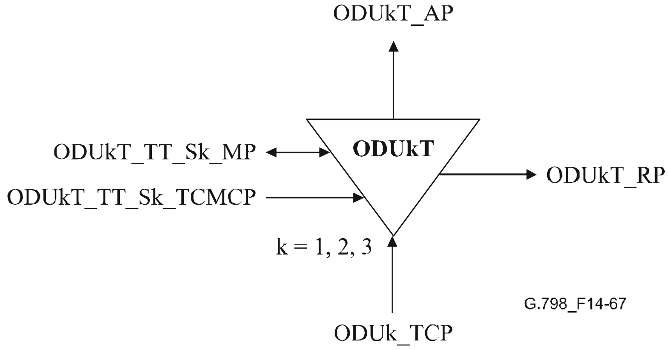


Figure 14-67/G.798 – ODUkT_TT_Sk function

Interfaces

Table 14-29/G.798 – ODUkT_TT_Sk inputs and outputs

Input(s)	Output(s)
ODUk_TCP: ODUk_CI_CK ODUk_CI_D ODUk_CI_FS ODUk_CI_MFS **ODUkT_TT_Sk_MP**: ODUkT_TT_Sk_MI_ExSAPI ODUkT_TT_Sk_MI_ExDAPI ODUkT_TT_Sk_MI_GetAcTI ODUkT_TT_Sk_MI_TIMDectMo ODUkT_TT_Sk_MI_TIMActDis ODUkT_TT_Sk_MI_DEGThr ODUkT_TT_Sk_MI_DEGM ODUkT_TT_Sk_MI_1second **ODUkT_TT_Sk_TCMCP**: ODUkT_TT_Sk_TCMCI_Mode ODUkT_TT_Sk_TCMCI_Level	**ODUkT_AP**: ODUkT_AI_CK ODUkT_AI_D ODUkT_AI_FS ODUkT_AI_MFS ODUkT_AI_TSF ODUkT_AI_TSD ODUkT_AI_AIS **ODUkT_RP**: ODUkT_RI_BDI ODUkT_RI_BEI ODUkT_RI_BIAE **ODUkT_TT_Sk_MP**: ODUkT_TT_Sk_MI_AcTI ODUkT_TT_Sk_MI_cOCI ODUkT_TT_Sk_MI_cLCK ODUkT_TT_Sk_MI_cLTC ODUkT_TT_Sk_MI_cTIM ODUkT_TT_Sk_MI_cDEG ODUkT_TT_Sk_MI_cBDI ODUkT_TT_Sk_MI_cSSF ODUkT_TT_Sk_MI_pN_EBC ODUkT_TT_Sk_MI_pN_DS ODUkT_TT_Sk_MI_pF_EBC ODUkT_TT_Sk_MI_pF_DS ODUkT_TT_Sk_MI_pBIAE ODUkT_TT_Sk_MI_pIAE

Processes

The processes associated with the ODUkT_TT_Sk function are as depicted in Figure 14-68.

Mode: If the TCMCI_Mode has the value OPERATIONAL or MONITOR, the following processes shall be performed. TCMCI_Mode OPERATIONAL initiates the consequent actions aAIS, aTSF and aTSD in case of defects. TCMCI_Mode MONITOR does not initiate the consequent actions aAIS, aTSF and aTSD in case of defects. If the TCMCI_Mode has the value TRANSPARENT, all information shall be passed through transparently and the following processes shall not be performed.

TCMOH-BIP8: If the TCMCI_Mode has the value OPERATIONAL or MONITOR, the BIP8 shall be processed as defined in 8.3.4.2. The BIP8 is extracted from the BIP8 byte of the TCM[TCMCI_Level] field.

TCMOH-TTI: If the TCMCI_Mode has the value OPERATIONAL or MONITOR, the trail trace identifier shall be recovered from TTI byte position of the TCM[TCMCI_Level] field in the ODUk signal at the ODUk_TCP as specified in 8.6. The accepted value of the TTI is available at the MP (MI_AcTI).

TCMOH-BDI: If the TCMCI_Mode has the value OPERATIONAL or MONITOR, the backward defect indication shall be recovered from BDI bit position of the TCM[TCMCI_Level] field in the ODUk signal at the ODUk_TCP. It shall be used for BDI defect detection.

TCMOH-BEI/BIAE: If the TCMCI_Mode has the value OPERATIONAL or MONITOR, the BEI shall be recovered from the BEI/BIAE bits in the TCM[TCMCI_Level] field in the ODUk signal at the ODUk_TCP. It shall be used to determine if a far-end errored block (nF_B) has occurred. A nF_B has occurred if the BEI/BIAE value is between 1 [0001] and 8 [1000]; otherwise no nF_B has occurred.

TCMOH-STAT: If the TCMCI_Mode has the value OPERATIONAL or MONITOR, the status information shall be recovered from the STAT bits in the TCM[TCMCI_Level] field in the ODUk signal at the ODUk_TCP as defined in 8.8 (→ AcSTAT). It shall be used for AIS, OCI, LCK, LTC and IAE defect detection.

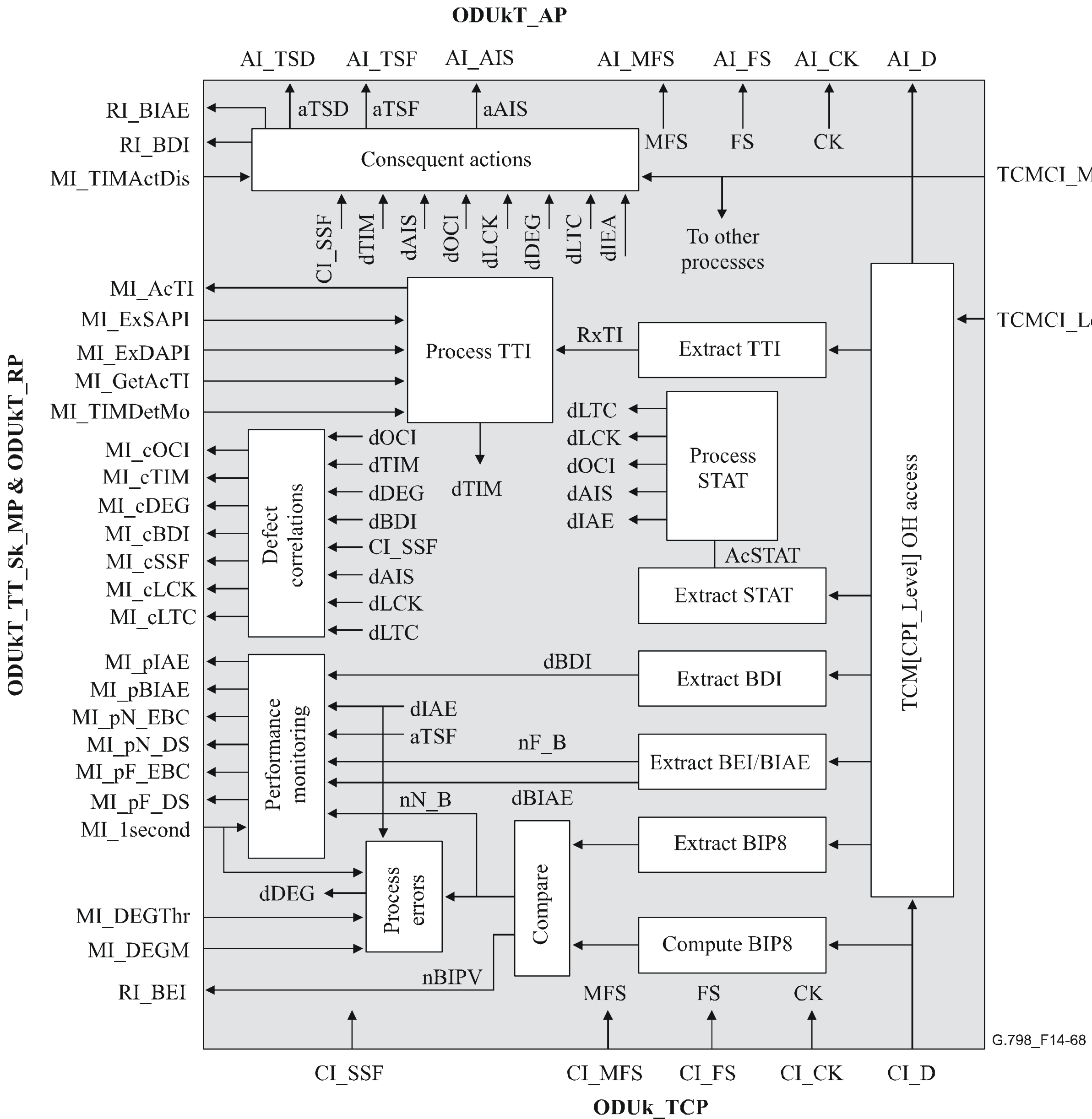


Figure 14-68/G.798 – ODUkT_TT_Sk processes

Defects

If the TCMCI_Mode has the value OPERATIONAL or MONITOR, the function shall detect for dLTC, dAIS, dOCI, dLCK, dTIM, dDEG, dIAE, dBIAE and dBDI defects. If the TCMCI_Mode is TRANSPARENT, all defects are cleared.

dLTC: See 6.2.1.4; dLTC shall be set to false during CI_SSF and dAIS.

dAIS: See 6.2.6.3.2.

dOCI: See 6.2.6.8.2; dOCI shall be set to false during CI_SSF and dAIS.

dLCK: See 6.2.6.9.1; dLCK shall be set to false during CI_SSF and dAIS.

dTIM: See 6.2.2.1; dTIM shall be set to false during CI_SSF and dAIS.

dDEG: See 6.2.3.4.

NOTE 1 – IAE suppresses the one-second near end errored block count, which is the input for the dDEG detection. This avoids wrong dDEG declaration due to alignment errors already incoming in an OTUk trail.

dBDI: See 6.2.6.6.1; dBDI shall be set to false during CI_SSF and dAIS.

dIAE: See 6.2.6.10.2; dIAE shall be set to false during CI_SSF, dAIS and dTIM.

dBIAE: See 6.2.6.11.1; dBIAE shall be set to false during CI_SSF, dAIS and dTIM.

Consequent actions

The function shall perform the following consequent actions (see 6.3/G.806):

aBDI ← (CI_SSF or dAIS or dLTC or dOCI or dLCK or dTIM) and TCMCI_Mode≠TRANSPARENT

aBEI ← "nBIPV" and TCMCI_Mode≠TRANSPARENT

aBIAE ← dIAE and TCMCI_Mode≠TRANSPARENT

aTSF ← CI_SSF or ((dAIS or dLTC or dOCI or dLCK or (dTIM and (not TIMActDis))) and TCMCI_Mode==OPERATIONAL)

aTSD ← dDEG and TCMCI_Mode==OPERATIONAL

aAIS ← (dOCI or dLCK or (dTIM and (not TIMActDis))) and TCMCI_Mode==OPERATIONAL

Defect correlations

The function shall perform the following defect correlations to determine the most probable fault cause (see 6.4/G.806). This fault cause shall be reported to the EMF.

cSSF ← CI_SSF or dAIS

cLTC ← dLTC and (not CI_SSF)

cOCI ← dOCI and (not CI_SSF)

cLCK ← dLCK and (not CI_SSF)

cTIM ← dTIM and (not CI_SSF) and (not dAIS) and (not dLTC) and (not dOCI) and (not dLCK)

cDEG ← dDEG and (not CI_SSF) and (not dAIS) and (not dLTC) and (not dOCI) and (not dLCK) and (not (dTIM and (not TIMActDis)))

cBDI ← dBDI and (not CI_SSF) and (not dAIS) and (not dLTC) and (not dOCI) and (not dLCK) and (not (dTIM and (not TIMActDis)))

Performance monitoring

If the TCMCI_Mode has the value OPERATIONAL or MONITOR, the function shall perform the following performance monitoring primitives processing (see 6.5/G.806). The performance monitoring primitives shall be reported to the EMF.

pN_DS ← CI_SSF or dAIS or dLTC or dOCI or dLCK or dTIM

pF_DS ← dBDI

pN_EBC ← ∑ nN_B

NOTE 2 – During CI_SSF, dAIS, dLTC, dLCK and dOCI, no errored blocks shall be counted.

pF_EBC ← ∑ nF_B

NOTE 3 – During CI_SSF, dAIS, dLTC, dLCK and dOCI, no errored blocks shall be counted.

pBIAE ← dBIAE

NOTE 4 – pBIAE is activated at the end of a second if dBIAE was active once during the second.

pIAE ← dIAE

NOTE 5 – pIAE is activated at the end of a second if dIAE was active once during the second.

NOTE 6 – pIAE and pBIAE are used for the suppression of the PM data in the equipment management functions (see ITU-T Rec. G.874). If pBIAE is active, the F_DS and F_EBC values of the previous and current second have to be discarded (EBC=0 and DS=false). If pIAE is active, the N/F_DS and N/F_EBC values of the previous and current second have to be discarded (EBC=0 and DS=false). The previous second has to be included due to the delay of the IAE information coming from the remote source.

14.5.1.1.3 ODUkT non-intrusive monitoring function (ODUkTm_TT_Sk)

The ODUkTm_TT_Sk function reports the state of the ODUk Monitored Tandem Connection. It computes the BIP8, extracts Tandem Connection Monitoring Overhead (TCMOH) – including the TTI, BIP8, BDI and BEI signals – in a selected TCMOH field from the ODUk signal at its ODUk_TCP, detects for AIS, OCI, LCK, TIM, DEG and BDI defects, counts during 1-second periods errors (detected via the BIP8) and defects to feed PM.

For ODUkT non-intrusive monitoring, the ODUkTm_TT_Sk function can be connected to the ODUk_CPs as shown in Figure 14-69. The ODUkTm_TT_Sk function can be connected to any ODUk_CP in this manner, either directly or via a connection function.

The TSF and TSD outputs can be connected to an ODUk_C connection function and used as protection switching trigger criteria for SNC/N protection.

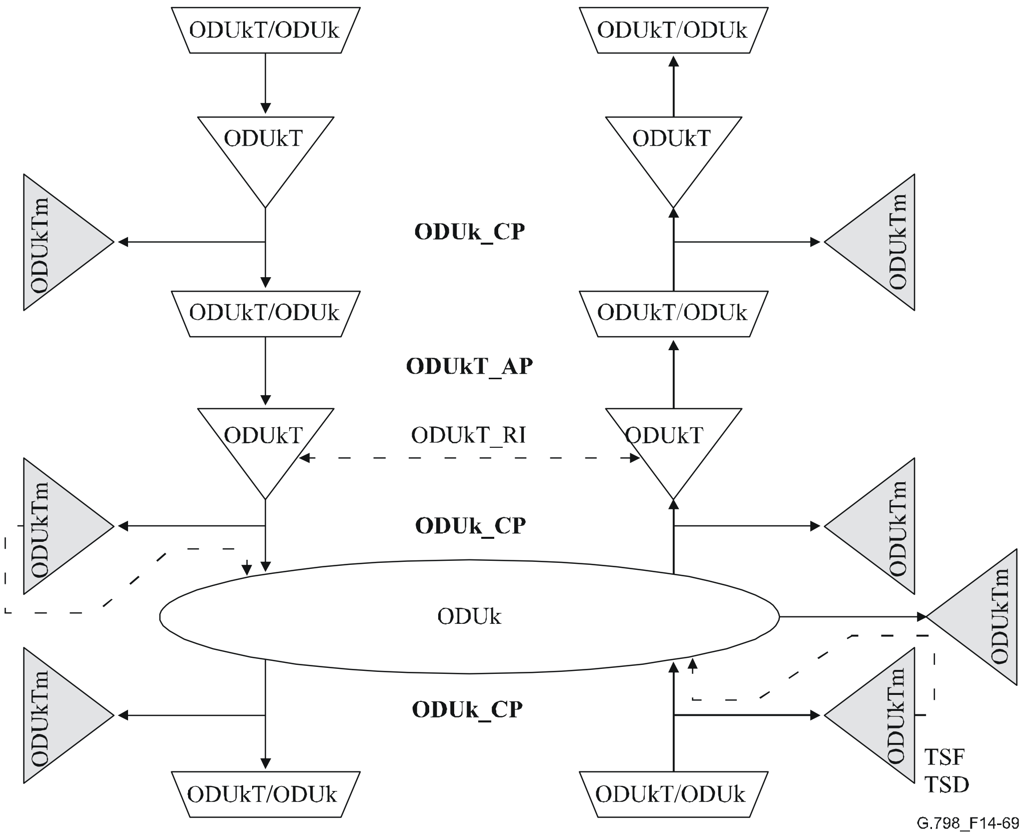


Figure 14-69/G.798 – Connection of ODUkTm_TT_Sk function (non-intrusive monitor)

The information flow and processing of the ODUkTm_TT_Sk function is defined with reference to Figures 14-70 and 14-71.

Symbol

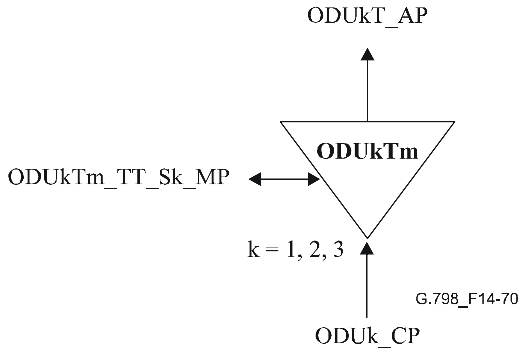


Figure 14-70/G.798 – ODUkTm_TT_Sk function

Interfaces

Table 14-30/G.798 – ODUkTm_TT_Sk inputs and outputs

Input(s)	Output(s)
ODUk_CP: ODUk_CI_CK ODUk_CI_D ODUk_CI_FS ODUk_CI_MFS **ODUkTm_TT_Sk_MP**: ODUkTm_TT_Sk_MI_Level ODUkTm_TT_Sk_MI_ExSAPI ODUkTm_TT_Sk_MI_ExDAPI ODUkTm_TT_Sk_MI_GetAcTI ODUkTm_TT_Sk_MI_TIMDectMo ODUkTm_TT_Sk_MI_TIMActDis ODUkTm_TT_Sk_MI_DEGThr ODUkTm_TT_Sk_MI_DEGM ODUkTm_TT_Sk_MI_1second	**ODUkT_AP**: ODUkT_AI_TSF ODUkT_AI_TSD **ODUkTm_TT_Sk_MP**: ODUkTm_TT_Sk_MI_AcTI ODUkTm_TT_Sk_MI_cOCI ODUkTm_TT_Sk_MI_cLCK ODUkTm_TT_Sk_MI_cLTC ODUkTm_TT_Sk_MI_cTIM ODUkTm_TT_Sk_MI_cDEG ODUkTm_TT_Sk_MI_cBDI ODUkTm_TT_Sk_MI_cSSF ODUkTm_TT_Sk_MI_pN_EBC ODUkTm_TT_Sk_MI_pN_DS ODUkTm_TT_Sk_MI_pF_EBC ODUkTm_TT_Sk_MI_pF_DS ODUkTm_TT_Sk_MI_pBIAE ODUkTm_TT_Sk_MI_pIAE

Processes

The processes associated with the ODUkTm_TT_Sk function are as depicted in Figure 14-71.

TCMOH-BIP8: The BIP8 shall be processed as defined in 8.3.4. The BIP8 is extracted from the BIP8 byte of the TCM[MI_Level] field.

TCMOH-TTI: The trail trace identifier shall be recovered from TTI byte position of the TCM[MI_Level] field in the ODUk signal at the ODUk_TCP as specified in 8.6. The accepted value of the TTI is available at the MP (MI_AcTI).

TCMOH-BDI: The backward defect indication shall be recovered from BDI bit position of the TCM[MI_Level] field in the ODUk signal at the ODUk_TCP. It shall be used for BDI defect detection.

TCMOH-BEI/BIAE: The BEI shall be recovered from the BEI/BIAE bits in the TCM[MI_Level] field in the ODUk signal at the ODUk_TCP. It shall be used to determine if a far-end errored block (nF_B) has occurred. A nF_B has occurred if the BEI/BIAE value is between 1 [0001] and 8 [1000]; otherwise, no nF_B has occurred. The BEI/BIAE information is also used for BIAE defect detection.

TCMOH-STAT: The status information shall be recovered from the STAT bits in the TCM[MI_Level] field in the ODUk signal at the ODUk_TCP as defined in 8.8 (→ AcSTAT). It shall be used for AIS, OCI, LCK, LTC and IAE defect detection.

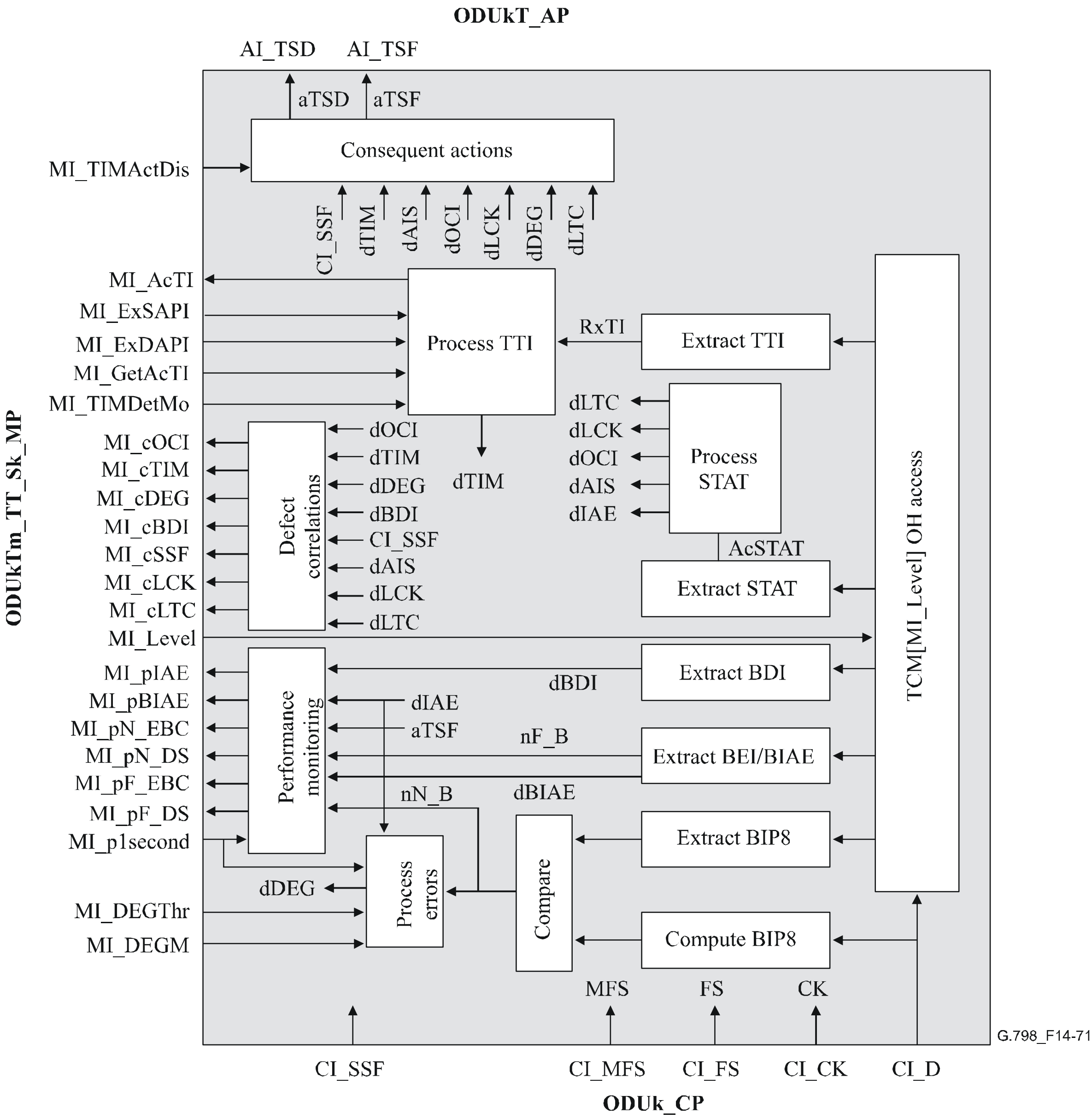


Figure 14-71/G.798 – ODUkTm_TT_Sk processes

Defects

The function shall detect for dLTC, dAIS, dOCI, dLCK, dTIM, dDEG, dIAE, dBIAE and dBDI defects.

dLTC: See 6.2.1.4.1; dLTC shall be set to false during CI_SSF and dAIS.

dAIS: See 6.2.6.3.2.

dOCI: See 6.2.6.8.2; dOCI shall be set to false during CI_SSF and dAIS.

dLCK: See 6.2.6.9.1; dLCK shall be set to false during CI_SSF and dAIS.

dTIM: See 6.2.2.1; dTIM shall be set to false during CI_SSF and dAIS.

dDEG: See 6.2.3.4.

NOTE 1 – IAE suppresses the one-second near end errored block count, which is the input for the dDEG detection. This avoids wrong dDEG declaration due to alignment errors already incoming in an OTUk trail.

dBDI: See 6.2.6.6.1; dBDI shall be set to false during CI_SSF and dAIS.

dIAE: See 6.2.6.10.2; dIAE shall be set to false during CI_SSF, dAIS and dTIM.

dBIAE: See 6.2.6.11.1; dBIAE shall be set to false during CI_SSF, dAIS and dTIM.

Consequent actions

The function shall perform the following consequent actions (see 6.3/G.806):

aTSF ← CI_SSF or (dAIS or dLTC or dOCI or dLCK or (dTIM and (not TIMActDis)))

aTSD ← dDEG

Defect correlations

The function shall perform the following defect correlations to determine the most probable fault cause (see 6.4/G.806). This fault cause shall be reported to the EMF.

cSSF ← CI_SSF or dAIS

cLTC ← dLTC and (not CI_SSF)

cOCI ← dOCI and (not CI_SSF)

cLCK ← dLCK and (not CI_SSF)

cTIM ← dTIM and (not CI_SSF) and (not dAIS) and (not dLTC) and (not dOCI) and (not dLCK)

cDEG ← dDEG and (not CI_SSF) and (not dAIS) and (not dLTC) and (not dOCI) and (not dLCK) and (not (dTIM and (not TIMActDis)))

cBDI ← dBDI and (not CI_SSF) and (not dAIS) and (not dLTC) and (not dOCI) and (not dLCK) and (not (dTIM and (not TIMActDis)))

Performance monitoring

The function shall perform the following performance monitoring primitives processing (see 6.5/G.806). The performance monitoring primitives shall be reported to the EMF.

pN_DS ← CI_SSF or (dAIS or dLTC or dOCI or dLCK or dTIM

pF_DS ← dBDI

pN_EBC ← ∑ nN_B

NOTE 2 – During CI_SSF, dAIS, dLTC, dLCK and dOCI no errored blocks shall be counted.

pF_EBC ← ∑ nF_B

NOTE 3 – During CI_SSF, dAIS, dLTC, dLCK and dOCI no errored blocks shall be counted.

pBIAE ← dBIAE

NOTE 4 – pBIAE is activated at the end of the second if dBIAE was active once during the second.

pIAE ← dIAE

NOTE 5 – pIAE is activated at the end of the second if dIAE was active once during the second.

NOTE 6 – pIAE and pBIAE are used for the suppression of the PM data in the equipment management functions (see ITU-T Rec. G.874). If pBIAE is active, the F_DS and F_EBC values of the previous and current second have to be discarded (EBC=0 and DS=false). If pIAE is active, the N/F_DS and N/F_EBC values of the previous and current second have to be discarded (EBC=0 and DS=false). The previous second has to be included due to the delay of the IAE information coming from the remote source.

14.5.1.2 ODUkT to ODUk adaptation function (ODUkT/ODUk_A)

The ODUkT/ODUk_A function starts and ends a selected TCM level if it is OPERATIONAL.

Furthermore, the ODUkT/ODUk_A function provides access to the TCM ACT signal and the TCM status information in the ODUk overhead over the TCM control point (TCMCP) for the Tandem Connection Monitor Control (TCMC) function that can be connected to an ODUkT/ODUk_A.

14.5.1.2.1 ODUkT to ODUk adaptation source function (ODUkT/ODUk_A_So)

The ODUkT/ODUk_A_So function starts a selected TCM level and can initiate maintenance signals (LCK) if it is OPERATIONAL.

Furthermore, the ODUkT/ODUk_A_So function provides access to the TCM ACT signal and the TCM status information in the ODUk overhead over the TCMCP for the TCMC function that can be connected to an ODUkT/ODUk_A.

The information flow and processing of the ODUkT/ODUk_A_So function is defined with reference to Figures 14-72 and 14-73.

Symbol

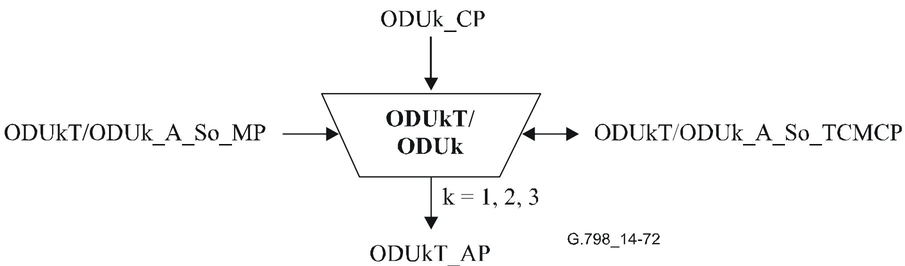


Figure 14-72/G.798 – ODUkT/ODUk_A_So function

Interfaces

Table 14-31/G.798 – ODUkT/ODUk_A_So inputs and outputs

Input(s)	Output(s)
ODUk_CP: ODUk_CI_CK ODUk_CI_D ODUk_CI_FS ODUk_CI_MFS **ODUkT/ODUk_A_So_MP**: ODUkT/ODUk_A_So_MI_AdminState **ODUkT/ODUk_A_So_TCMCP**: ODUkT/ODUk_A_So_TCMCI_Mode ODUkT/ODUk_A_So_TCMCI_Level ODUkT/ODUk_A_So_TCMCI_ACTTx ODUkT/ODUk_A_So_TCMCI_ACTEn	**ODUkT_AP**: ODUkT_AI_CK ODUkT_AI_D ODUkT_AI_FS ODUkT_AI_MFS **ODUkT/ODUk_A_So_TCMCP**: ODUkT/ODUk_A_So_TCMCI_AcSTAT[1..6] ODUkT/ODUk_A_So_TCMCI_ACTRx

Processes

The processes associated with the ODUkT/ODUk_A_So function are as depicted in Figure 14-73.

TCMOH-STAT RX: The status of all 6 TCM levels is recovered from the TCM OH [1..6] STAT field and provided to the TCM control function via TCMCI_STAT[1..6]. for the STAT acceptance process, see 8.8.

TCM ACT: The TCM ACT overhead byte is made available to the control plane via TCMCI_ACTRx. The byte is taken directly from the overhead without any acceptance process. If TCMCI_ACTEn is true the ACT value received via TCMCI_ACTRx from the TCM control function is inserted into the TCM ACT byte. Otherwise the byte is passed through transparently.

NOTE – An acceptance process might be performed for the received ACT information in the control plane.

ODUk-LCK: The function shall generate the ODUk-LCK signal as defined in 16.5/G.709/Y.1331. The clock, frame start and multiframe start are defined by the incoming ODUk signal.

Mode: If the CPI_Mode has the value OPERATIONAL, the following processes shall be performed. If the TCMCI_Mode has the value TRANSPARENT, all information shall be passed through transparently and the following processes shall not be performed.

IAE: If the incoming ODUk frame start (CI_FS) position is not at the expected frame start position, incoming alignment error (IAE) shall be activated. IAE shall be deactivated if the incoming ODUk frame start (CI_FS) position is at the expected frame start position. The expected frame start position is based on the previous incoming ODUk frame start.

Selector: If TCMCI_Mode is OPERATIONAL, the normal signal may be replaced by the ODUk-LCK signal. ODUk-LCK signal is selected if the MI_AdminState is LOCKED.

TCMOH-STAT TX: If TCMCI_Mode is OPERATIONAL the TC status is inserted into the STAT bit positions of TCM OH[TCMCI_Level] based on the incoming alignment error (IAE) information. Normally, the code "in use without IAE" (001) is inserted. Upon the declaration of aIAE at the adaptation source function, the function shall insert the code "in use with IAE" (010) in the STAT field for the next 16 multiframes. Each new declaration of aIAE restarts the 16 multiframe insertion time.

TCMOH-Others: If TCMCI_Mode is OPERATIONAL, all other TCM OH[TCMCI_Level] bits are set to "0".

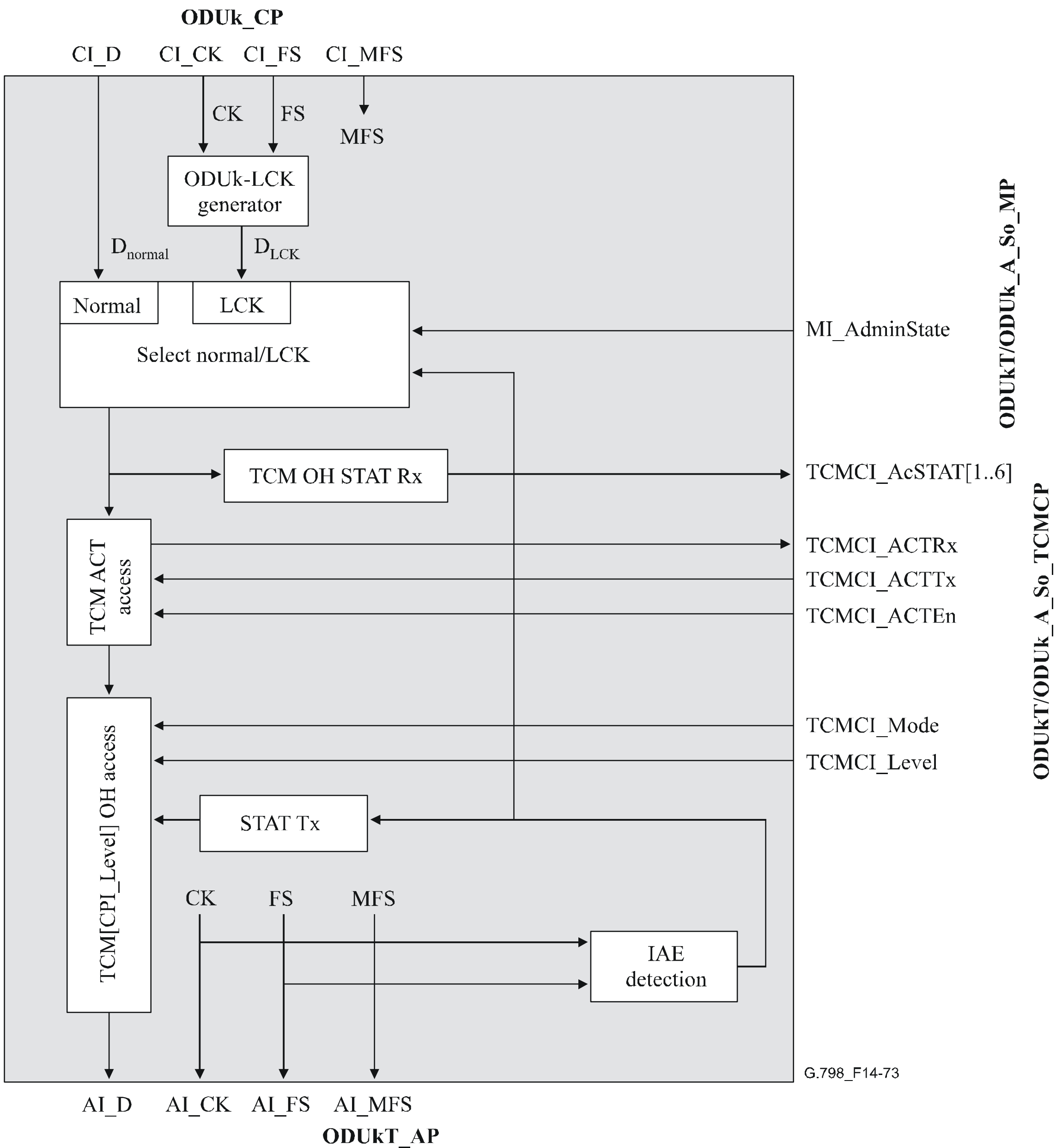


Figure 14-73/G.798 – ODUkT/ODUk_A_So processes

Defects: None.

Consequent actions: None.

Defect correlations: None.

Performance monitoring: None.

14.5.1.2.2 ODUkT to ODUk adaptation sink function (ODUkT/ODUk_A_Sk)

The ODUkT/ODUk_A_Sk function ends a selected TCM level and can initiate maintenance signals (ODUk AIS, LCK) if it is OPERATIONAL.

Furthermore, the ODUkT/ODUk_A_Sk function provides access to the TCM ACT signal and the TCM status information in the ODUk overhead over the TCMCP for the TCMC function that can be connected to an ODUkT/ODUk_A.

The information flow and processing of the ODUkT/ODUk_A_Sk function is defined with reference to Figures 14-74 and 14-75.

Symbol

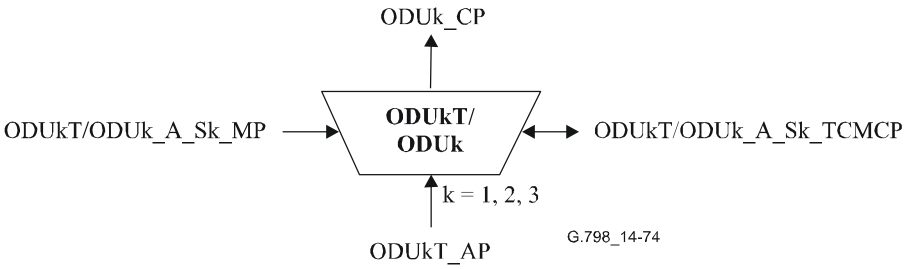


Figure 14-74/G.798 – ODUkT/ODUk_A_Sk function

Interfaces

Table 14-32/G.798 – ODUkT/ODUk_A_Sk inputs and outputs

Input(s)	Output(s)
ODUkT_AP: ODUkT_AI_CK ODUkT_AI_D ODUkT_AI_FS ODUkT_AI_MFS ODUkT_AI_TSF ODUkT_AI_TSD ODUkT_AI_AIS **ODUkT/ODUk_A_Sk_MP**: ODUkT/ODUk_A_Sk_MI_AdminState **ODUkT/ODUk_A_Sk_TCMCP**: ODUkT/ODUk_A_Sk_TCMCI_Mode ODUkT/ODUk_A_Sk_TCMCI_Level ODUkT/ODUk_A_Sk_TCMCI_ACTTx ODUkT/ODUk_A_Sk_TCMCI_ACTEn	**ODUk_CP**: ODUk_CI_CK ODUk_CI_D ODUk_CI_FS ODUk_CI_MFS ODUk_CI_SSF ODUk_CI_SSD **ODUkT/ODUk_A_Sk_TCMCP**: ODUkT/ODUk_A_Sk_TCMCI_AcSTAT[1..6] ODUkT/ODUk_A_Sk_TCMCI_ACTRx

Processes

The processes associated with the ODUkT/ODUk_A_Sk function are as depicted in Figure 14-75.

TCMOH-STAT RX: The status of all 6 TCM levels is recovered from the TCM OH [1..6] STAT field and provided to the control function via TCMCI_AcSTAT[1..6]. For the STAT acceptance process, see 8.8.

TCM ACT: The TCM ACT overhead byte is made available to the control function via TCMCI_ACTRx. The byte is taken directly from the overhead without any acceptance process. If TCMCI_ACTEn is true, the ACT value received via TCMCI_ACTRx from the control plane is inserted into the TCM ACT byte. Otherwise, the byte is passed through transparently.

NOTE – An acceptance process might be performed for the received ACT information in the control function.

ODUk-LCK, ODUk-AIS: The function shall generate the ODUk-LCK and ODUk-AIS signals as defined in ITU-T Rec. G.709/Y.1331. The clock, frame start and multiframe start are defined by the incoming ODUk signal.

Mode: If the TCMCI_Mode has the value OPERATIONAL, the following processes shall be performed. If the TCMCI_Mode has the values MONITOR or TRANSPARENT, all information shall be passed through transparently and the following processes shall not be performed.

Selector: If TCMCI_Mode is OPERATIONAL, the normal signal may be replaced by either the ODUk-AIS or the ODUk-LCK signal. ODUk-LCK signal is selected if the MI_AdminState is LOCKED. ODUk-AIS is selected if MI_AdminState is not LOCKED and aAIS is true. If TCMCI_Mode has the values MONITOR or TRANSPARENT, the normal signal is always selected.

Remove TCMOH: If the TCMCI_Mode has the value OPERATIONAL, an all-0's pattern shall be inserted in the TCMOH at location TCM[CPI_Level]. If the TCMCI_Mode has the values TRANSPARENT or MONITOR, the information shall be passed through transparently.

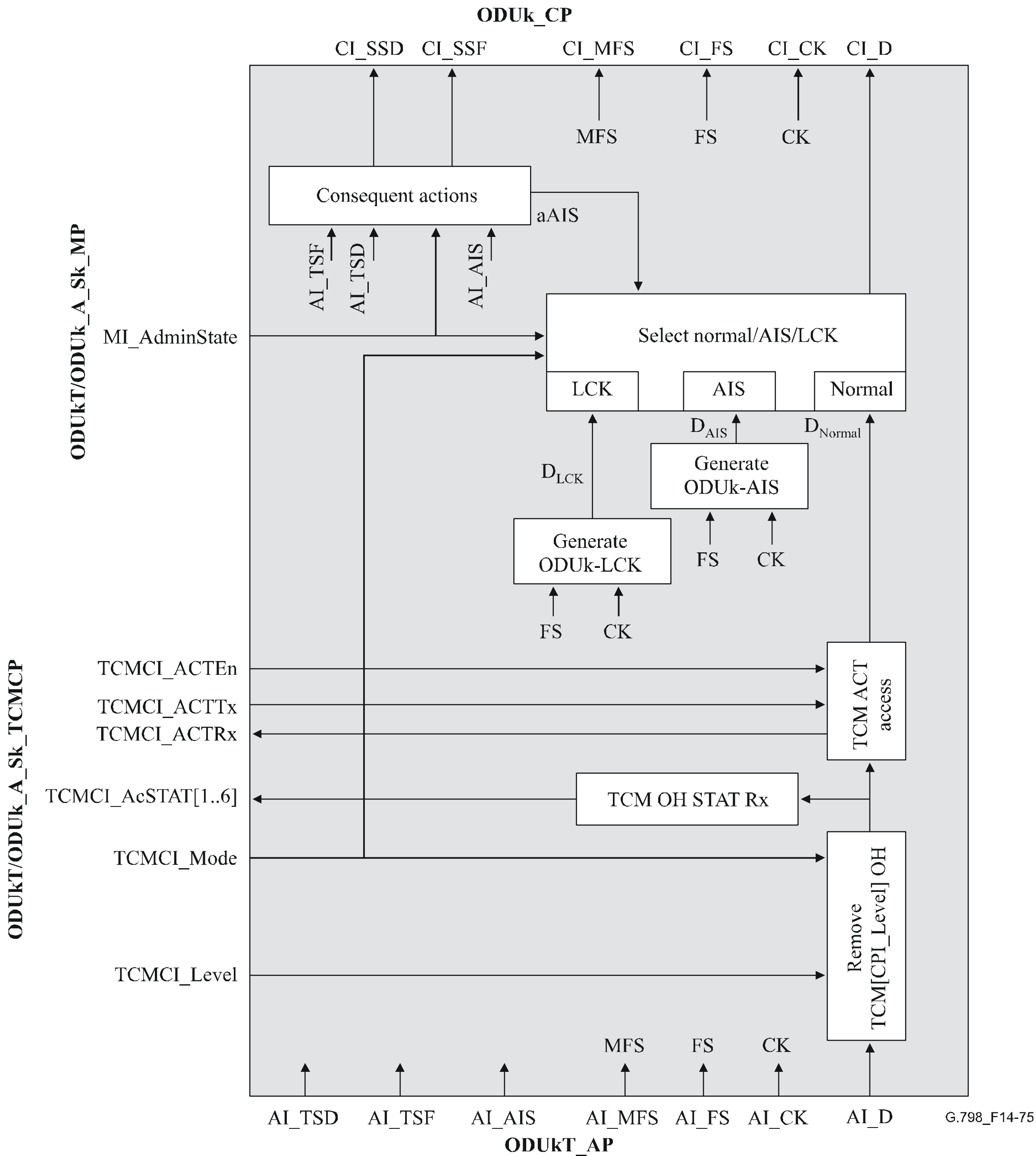


Figure 14-75/G.798 – ODUkT/ODUk_A_Sk processes

Defects: None.

Consequent actions

aAIS	←	AI_AIS and (TCMCI_Mode=OPERATIONAL) and (not MI_AdminState=LOCKED)
aSSF	←	AI_TSF and (not MI_AdminState=LOCKED)
aSSD	←	AI_TSD and (not MI_AdminState=LOCKED)

On declaration of aAIS the function shall output an ODUk-AIS signal within 2 frames. On clearing of aAIS, the ODUk-AIS signal shall be removed within 2 frames and normal data being output.

Defect correlations: None.

Performance monitoring: None.

14.5.1.3 ODUkT TCM control functions (ODUkT_TCMC)

The ODUkT_TCMC functions are responsible for the activation/deactivation of a TCM trail. An ODUkT_TCMC function is connected to the ODUkT_TT and ODUkT/ODUk_A functions at the TCM Control Points (TCMCP) as shown in Figure 14-76.

Currently only an ODUkT_TCMC function for manual activation/deactivation via the management is defined. ODUkT_TCMC functions for automatic activation are for further study.

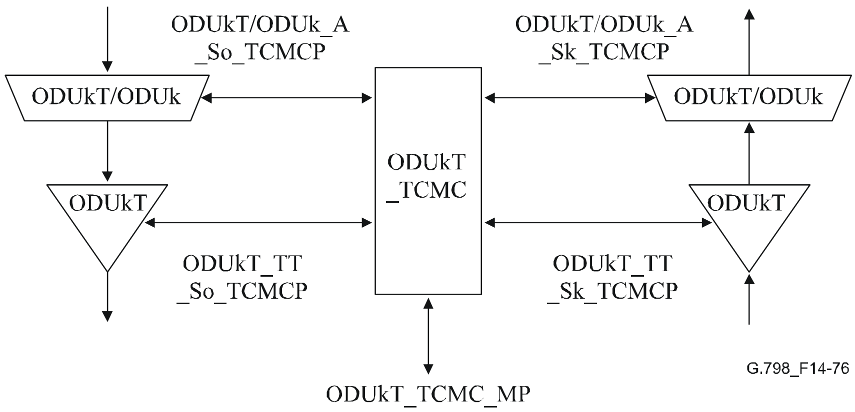


Figure 14-76/G.798 – ODUkT_TCMC connections

14.5.1.3.1 ODUkT control function for manual activation (ODUkT_TCMCm)

The ODUkT_TCMCm function performs manual activation/deactivation of a TCM trail via the management interface.

The TCM ACT channel is not used. The TCM status of sink and source is provided to the management. The TCM level and the mode of the sink and source functions is selected by the management.

The information flow and processing of the ODUkT_TCMCm function is defined with reference to Figures 14-77 and 14-78.

Symbol

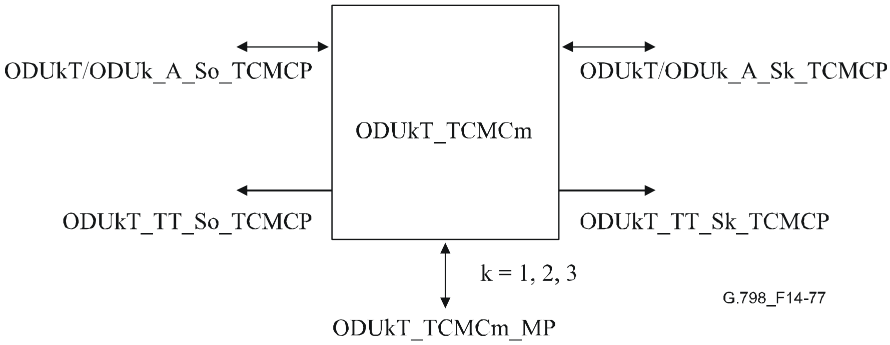


Figure 14-77/G.798 – ODUkT_TCMCm function

Interfaces

Table 14-33/G.798 – ODUkT_TCMCm inputs and outputs

Input(s)	Output(s)
ODUkT_TCMCm_MP: ODUkT_TCMCm_MI_Level ODUkT_TCMCm_MI_ModeSo ODUkT_TCMCm_MI_ModeSk **ODUkT/ODUk_A_So_TCMCP**: ODUkT/ODUk_A_So_TCMCI_AcSTAT[1..6] **ODUkT/ODUk_A_Sk_TCMCP**: ODUkT/ODUk_A_Sk_TCMCI_AcSTAT[1..6]	**ODUkT_TCMCm_MP**: ODUkT_TCMCm_MI_AcSTATSo[1..6] ODUkT_TCMCm_MI_AcSTATSk[1..6] **ODUkT/ODUk_A_So_TCMCP**: ODUkT/ODUk_A_So_TCMCI_Mode ODUkT/ODUk_A_So_TCMCI_Level ODUkT/ODUk_A_So_TCMCI_ACTEn **ODUkT/ODUk_A_Sk_TCMCP**: ODUkT/ODUk_A_Sk_TCMCI_Mode ODUkT/ODUk_A_Sk_TCMCI_Level ODUkT/ODUk_A_Sk_TCMCI_ACTEn **ODUkT_TT_So_TCMCP**: ODUkT_TT_So_TCMCI_Mode ODUkT_TT_So_TCMCI_Level **ODUkT_TT_Sk_TCMCP**: ODUkT_TT_Sk_TCMCI_Mode ODUkT_TT_Sk_TCMCI_Level

Processes

The processes associated with the ODUkT_TCMCm function are as depicted in Figure 14-78.

As the TCM ACT bytes are not used, TCMCI_ACTEn for sink and source is fixed set to "false".

The TCM level is provided by the management via MI_Level and distributed to sink and source termination and adaptation functions.

The mode is provided independently for sink and source by the management (MI_ModeSo and MI_ModeSk).

The sink and source TCM status of all 6 levels is provided to the management (MI_AcSTATSo[1..6] and MI_AcSTATSk[1..6]).

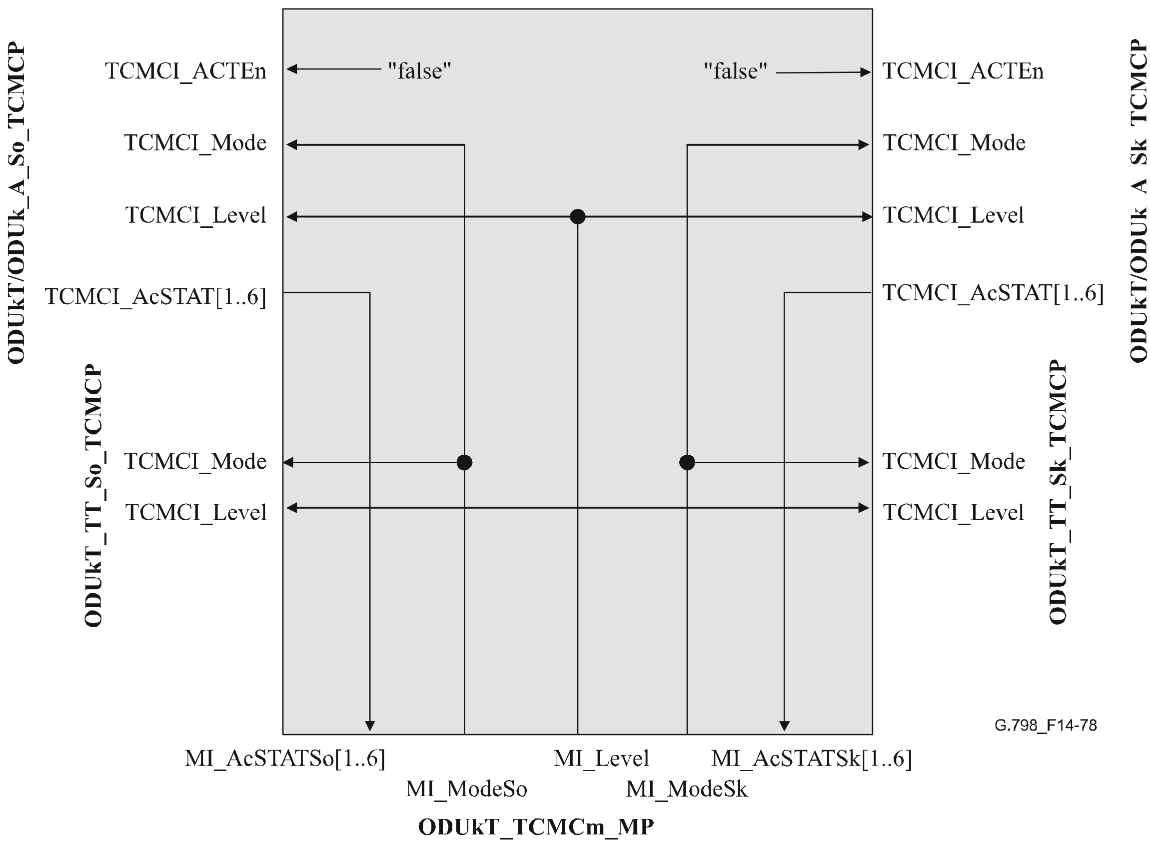


Figure 14-78/G.798 – ODUkT_TCMCm processes

Defects: None.

Consequent actions: None.

Defect correlations: None.

Performance monitoring: None.

14.6 Virtual concatenation functions

NOTE – Only LCAS-capable virtual concatenation functions are defined. In case the LCAS functionality is not needed (e.g., support of a CBR client) it can be disabled. If only a fixed-bandwidth ODUkP-Xv-L-to-Client (e.g., ODUkP-Xv-L/CBRx_A) adaptation function is supported by the ODUkP-Xv-L termination, only the functionality for the LCAS-disabled mode is required to be implemented.

14.6.1 LCAS-capable virtual concatenated ODUkP layer functions ODUkP-Xv-L (k = 1, 2, 3; X ≥ 1)

The LCAS-capable virtual concatenated ODUkP layer functions (ODUkP-Xv-L, k = 1, 2, 3) are instantiations of the generic functions defined in 10.1/G.806 (P-Xv-L), particularized with some technology-specific aspects.

The definitions in this clause provide references to the appropriate generic function definitions in 10.1/G.806 and specify the technology-specific particularizations where necessary.

14.6.1.1 ODUkP-Xv-L Layer Trail Termination Function (ODUkP-Xv-L_TT)

The ODUkP-Xv-L_TT function is further decomposed as defined in 10.1.1/G.806 and shown in Figure 14-79.

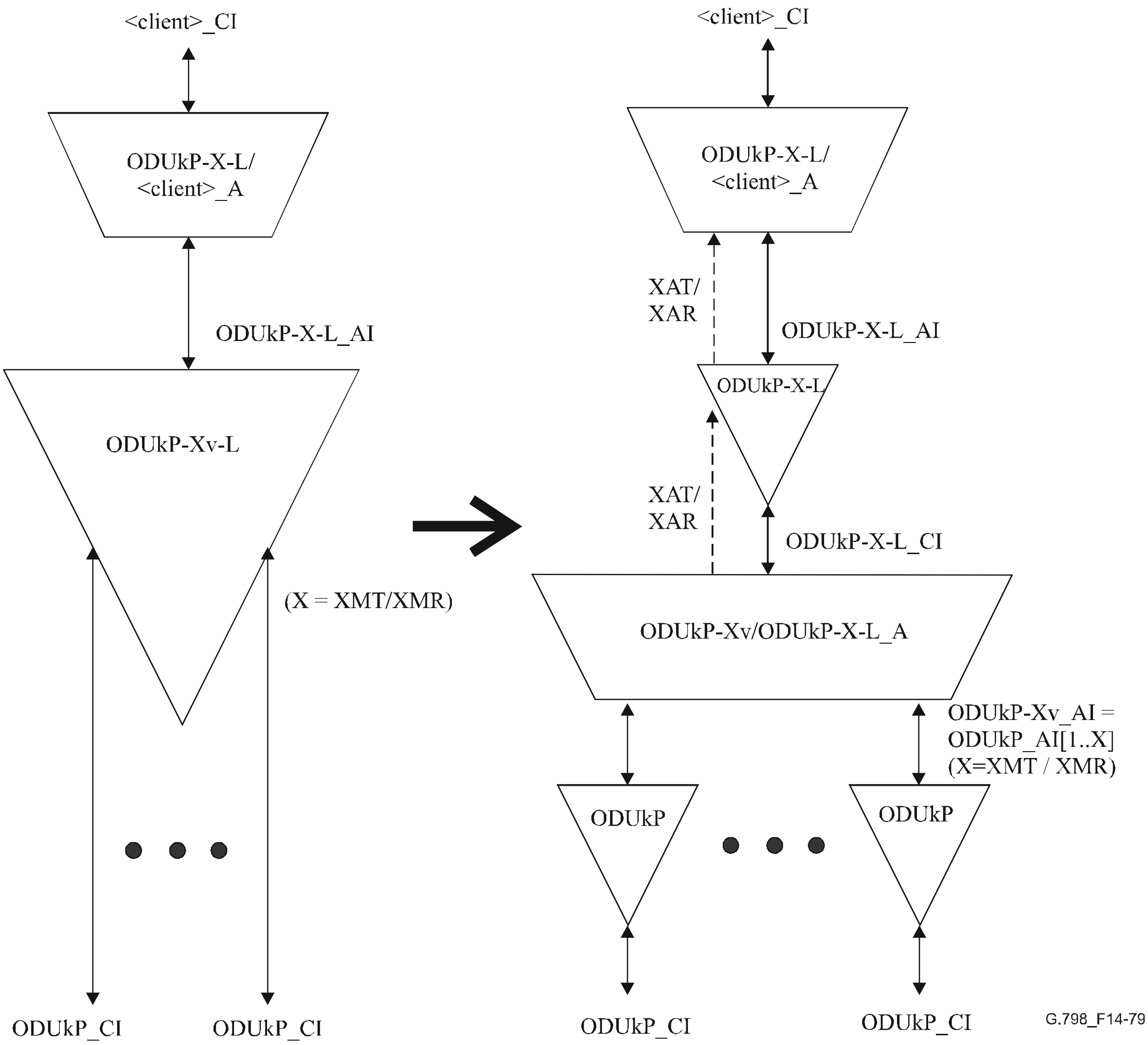


Figure 14-79/G.798 – Decomposition of ODUkP-Xv-L_TT function

The decomposition for this function is the same as for the corresponding generic function P-Xv-L_TT as defined in 10.1.1/G.806, with the following technology-specific particularizations:

– The path-layer "P-" is the ODUkP-layer.

– The ODUkP_TT functions are the normal ODUkP trail termination functions as defined in 14.2.1.

– X_{MT}, $X_{MR} \leq 256$, according to the definitions in 18.1/G.709/Y.1331.

14.6.1.2 ODUkP-Xv/ODUkP-X-L Adaptation Source Function (ODUkP-Xv/ODUkP-X-L_A_So)

Symbol

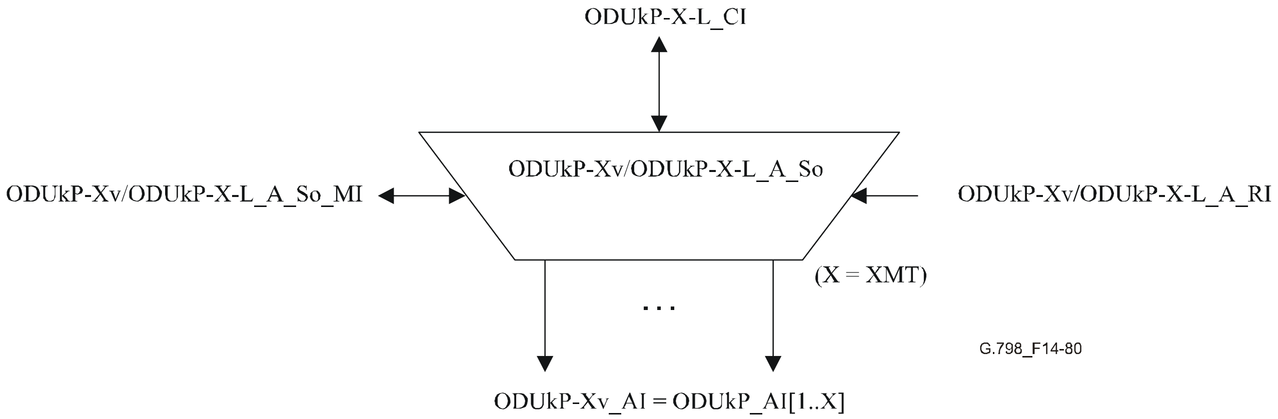


Figure 14-80/G.798 – ODUkP-Xv/ODUkP-X-L_A_So symbol

Interfaces

The interfaces for this function are the same as for the corresponding generic function P-Xv/P-X-L_A_So as defined in 10.1.1.1/G.806, with the following technology-specific particularizations:

- The path-layer "P-" is the ODUkP-layer.
- MST_Range = 255 (corresponding to the range as defined in 18.1/G.709/Y.1331).

In addition to those in 10.1.1.1/G.806, this function shall have the following interfaces (see Table 14-34):

Table 14-34/G.798 – ODUkP-Xv/ODUkP-X-L_A_So additional inputs and outputs

Input(s)	Output(s)
ODUkP-X-L_CP: ODUkP-X-L_CI_MFS **ODUkP-Xv/ODUkP-X-L_A_So_MP**: ODUkP-Xv/ODUkP-X-L_A_So_MI_Active	**ODUkP_AP**: ODUkP_AI_MFS

Processes

The process definitions for this function are the same as for the corresponding generic function P-Xv/P-X-L_A_So as defined in 10.1.1.1/G.806, with the following technology-specific particularizations:

Clock, frame start and multiframe start: The clock for each of the ODUkP signals (ODUkP_AI_Ck) is generated by dividing the ODUkP-X-L clock (ODUkP-X-L_CI_CK) by X_{AT}.

The multiframe start signal (MFS) is transported from the ODUkP-X-L_CP to each of the ODUkP_AP points through the processes along with the frame start (FS) signal.

The virtual concatenation multiframe is generated by the function.

OH Extract: The extracted overhead information _CI_OH consists of the null signal (i.e., this process does not perform any function for the ODUkP virtual concatenation case).

Deinterleave (distribution process): The distribution process shall be as follows:

Starting from column 14X+1, the ODUkP-X-L_CI_D signal shall be distributed to the X_{AT} ODUkP as defined in Table 14-35 below.

Table 14-35/G.798 – ODUkP-X distribution mapping

ODUkP-X-L_CI_D column	Deinterleave output number	Deinterleave output column
14X + 1	1	15
…	…	…
$15X_{AT}$	X_{AT}	15
$15X_{AT} + 1$	1	16
...	...	...
$16 \times X_{AT}$	X_{AT}	16
$16 \times X_{AT} + 1$	1	17
...	...	...
$3824 \times X_{AT}$	X_{AT}	3824

NOTE – This mapping is uniform throughout the OPUk overhead and payload columns. This mapping is illustrated in Figure 18-1/G.709/Y.1331.

For the outputs X_{AT}+1, X_{AT}+2, … , X_{MT}, this block inserts an all-zeros signal with the rate and format of an ODUkP signal.

"Switch 1" (assignment of sequence numbers): For all non-payload-carrying outputs (_PC[s]=0) this process inserts an all-zeros signal with the rate and format of an ODUkP signal.

VLI Insertion: The VLI information consists of the value of the VCOH bytes, and has the coding defined in 18.1/G.709/Y.1331 for those overhead bytes.

VLI Assemble and CRC: The VLI information consists of the value of the VCOH bytes, and has the coding defined in 18.1/G.709/Y.1331 for those overhead bytes. The CRC code used is the CRC-8 defined in 18.1/G.709/Y.1331.

Irrespective of the value of MI_LCASEnable, all unused fields in the VCOH multiframe structure shall be sourced as zeros.

OH Insert: The function shall insert code "0000 0110" into the PT byte position of the PSI overhead as defined in 15.9.2/G.709/Y.1331.

All bits of the X times ODUk overhead should be sourced as "0"s, except the ODUk-PM STAT field which should be set to the value "normal path signal" (001).

Defects: See 10.1.1.1/G.806.

Consequent actions: See 10.1.1.1/G.806.

Defect correlations: See 10.1.1.1/G.806.

Performance monitoring: See 10.1.1.1/G.806.

14.6.1.3 LCAS-capable ODUkP-Xv/ODUkP-X-L Adaptation Sink Function (ODUkP-Xv/ODUkP-X-L_A_Sk)

Symbol

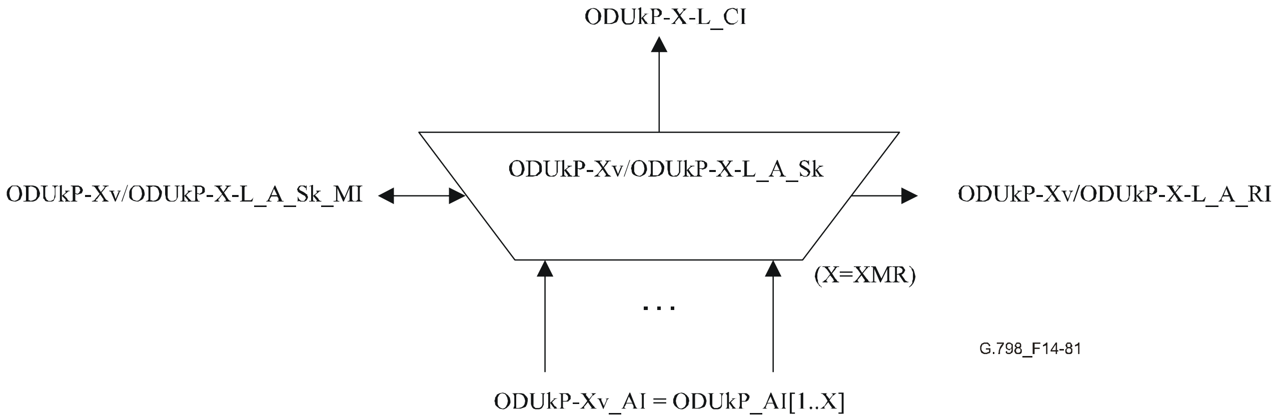


Figure 14-81/G.798 – ODUkP-Xv/ODUkP-X-L_A_Sk symbol

Interfaces

The interfaces for this function are the same as for the corresponding generic function P-Xv/P-X-L_A_Sk as defined in 10.1.1.2/G.806, with the following technology-specific particularizations:

- The path-layer "P-" is the ODUkP-layer.
- MST_Range = 255 (corresponding to the range as defined in 18.1/G.709/Y.1331).

In addition to those in 10.1.1.2/G.806, this function shall have the following interfaces (see Table 14-36):

Table 14-36/G.798 – ODUkP-Xv/ODUkP-X-L_A_Sk additional inputs and outputs

Input(s)	Output(s)
ODUkP_AP: ODUkP_AI_MFS	**ODUkP-X-L_CP**: ODUkP-X-L_CI_MFS **ODUkP-Xv/ODUkP-X-L_A_Sk_MP**: ODUkP-Xv/ODUkP-X-L_A_Sk_MI_cPLM[1..XMR] ODUkP-Xv/ODUkP-X-L_A_Sk_MI_AcPT[1..XMR] ODUkP-Xv/ODUkP-X-L_A_Sk_MI_Active

Processes

The process definitions for this function are the same as for the corresponding generic function P-Xv/P-X-L_A_Sk as defined in 10.1.1.2/G.806, with the following technology-specific particularizations:

The function shall extract the PT byte from the PSI overhead as defined in 8.7.1. The accepted PT value is available at the MP (MI_AcPT[1..X_{MR}]) and is used for PLM defect detection. This processing is done individually for each of the ODUkP_AI input signals.

MI_AcPT acceptance and PLM defect detection are performed at each ODUkP_AI input of the function before any further processing. A dPLM[i] detected for a member is treated equivalently to an active ODUkP_AI_TSF[i] indication by all subsequent processes.

Clock, frame start and multiframe start: The clock for the ODUkP-X-L signal (ODUkP-X-L_CI_CK) is generated by selecting the ODUkP clock (ODUkP_AI_CK) of one of the active members and multiply it by X_{AR}. The clock parameters, including jitter and wander requirements, as defined in Annex A/G.8251 (ODCr clock) apply.

The frame start and multiframe start signals for the ODUkP-X-L signal (ODUkP-X-L_FS/MFS) are generated based on the frame and multiframe at the output of the delay process.

MFI Extract: The multiframe alignment process shall be according to 8.2.4. The _MFI[i] output consists of a 24-bit word with the value of the MFI contained in the MFI-1, MFI-2 and MFAS positions (from MSB to LSB) in AI_D[i]. If AI_TSF[i]=true, then the _MFI[i] output of this process shall be an all-ones 24-bit word. The dLOM[i] detection for each member shall be as described in Defects below.

VLI, TSx Extract: The VLI information consists of the value of the VCOH bytes, and has the coding defined in 18.1/G.709/Y.1331 for those overhead bytes. If _TSF[i] is false and dMND[i] is false, then the _VLI[i] output of this process is the value of the VCOH byte positions at the input of this process. If _TSF[i] is true or dMND[i] is true, then the _VLI[i] output of this process shall be an all-ones signal.

VLI Disassemble and CRC: The VLI information consists of the value of the VCOH bytes, and has the coding defined in 18.1/G.709/Y.1331 for those overhead bytes. The CRC code used is the CRC-8 defined in 18.1/G.709/Y.1331.

"Interleave process": The recovery process shall be as follows:

Starting from column 15 the ODUkP-Xc signal shall be recovered from the X_{AR} ODUkP as defined in Table 14-37 below.

Table 14-37/G.798 – ODUkP-X-L recovery mapping

Interleave input number	Interleave input column	ODUkP-X-L_CI column
1	15	14 X_{AR} + 1
…	…	…
X_{AR}	15	15 X_{AR}
1	16	15 X_{AR} + 1
...	...	...
X_{AR}	16	16 × X_{AR}
1	17	16 × X_{AR} + 1
...	...	...
X_{AR}	3824	3824 × X_{AR}

NOTE – This mapping is uniform throughout the OPUk overhead and payload columns.

Defects

Payload Mismatch (dPLM): The function shall detect payload mismatch (dPLM[i]) for each of its ODUkP_AI[i] input signals. The processing is as per 6.2.4.1. The expected payload type is "0000 0110" (virtual concatenated signal) as defined in ITU-T Rec. G.709/Y.1331.

Loss of Multiframe defect (dLOM): See 6.2.5.2.

Loss of Sequence defect (dSQM): See 10.1.1.2/G.806.

Member Not Deskewable (dMND): See 10.1.1.2/G.806.

Loss of Alignment (dLOA): See 10.1.1.2/G.806.

Consequent actions

See 10.1.1.2/G.806, taking the following definitions of mMSU and mMSU_L:

mMSU[i] ← MI_ProvM[i] and (AI_TSF[i] or dPLM[i] or dLOM[i] or dLOA or dSQM[i])

mMSU_L[i] ← MI_ProvM[i] and (AI_TSF[i] or dPLM[i] or dMND[i] or AI_TSD[n] or dLOM[i])

On declaration of aAIS, the function shall output a generic AIS signal within two frames; on clearing of aAIS, the function shall output normal data within two frames. The bit rate of this generic AIS signal shall be consistent with the value of $\_X_{AR}$ as calculated by the processes involved.

Defect correlations

cPLM[i] ← dPLM[i] and (not AI_TSF[i])

cLOM[i] ← MI_ProvM[i] and dLOM[i] and (not dPLM[i]) and (not AI_TSF[i])

cMND[i] ← MI_ProvM[i] and dMND[i] and (not dPLM[i]) and (not dLOM[i]) and (not AI_TSF[i])

cSQM[i] ← MI_ProvM[i] and dSQM[i] and (not dPLM[i]) and (not dLOM[i]) and (not dLOA) and (not AI_TSF[i])

cLOA: As per 10.1.1.2/G.806.

cPLCR: As per 10.1.1.2/G.806.

cTLCR: As per 10.1.1.2/G.806.

Performance monitoring: See 10.1.1.2/G.806.

14.6.1.4 LCAS-capable ODUkP-X-L Trail Termination Source Function (ODUkP-X-L_TT_So)

Symbol

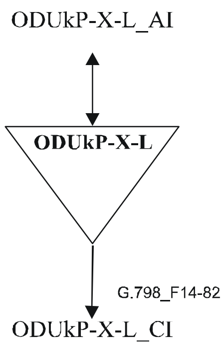


Figure 14-82/G.798 – ODUkP-X-L_TT_So symbol

Interfaces

The interfaces for this function are the same as for the corresponding generic function P-Xv/P-X-L_TT_So as defined in 10.1.1.3/G.806, with the following technology-specific particularization:

- The path-layer "P-" is the ODUkP-layer.

In addition to those in 10.1.1.3/G.806, this function shall have the following interfaces (see Table 14-38):

Table 14-38/G.798 – ODUkP-X-L_TT_So additional inputs and outputs

Input(s)	Output(s)
ODUkP-X-L_AP: ODUkP-X-L_AI_MFS	**ODUkP-X-L_CP**: ODUkP-X-L_CI_MFS

Processes: See 10.1.1.3/G.806.

In addition, the multiframe start signal (MFS) is transported from the ODUkP-X-L_AP to the ODUkP-X-L_CP point along with the frame start (FS) signal.

Defects: See 10.1.1.3/G.806.

Consequent actions: See 10.1.1.3/G.806.

Defect correlations: See 10.1.1.3/G.806.

Performance monitoring: See 10.1.1.3/G.806.

14.6.1.5 LCAS-capable ODUkP-X-L Layer Trail Termination Sink Function (ODUkP-X-L_TT_Sk)

Symbol

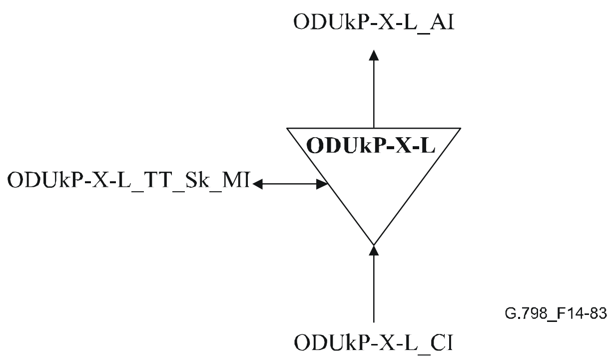


Figure 14-83/G.798 – ODUkP-X-L_TT_Sk symbol

Interfaces

The interfaces for this function are the same as for the corresponding generic function P-Xv/P-X-L_TT_Sk as defined in 10.1.1.4/G.806, with the following technology-specific particularization:

- The path-layer "P-" is the ODUkP-layer.

In addition to those in 10.1.1.4/G.806, this function shall have the following interfaces (see Table 14-39) :

Table 14-39/G.798 – ODUkP-X-L_TT_Sk additional inputs and outputs

Input(s)	Output(s)
ODUkP-X-L_CP: ODUkP-X-L_CI_MFS	**ODUkP-X-L_AP**: ODUkP-X-L_AI_MFS

Processes: See 10.1.1.4/G.806.

In addition, the multiframe start signal (MFS) is transported from the ODUkP-X-L_CP to the ODUkP-X-L_AP point along with the frame start (FS) signal.

Defects: See 10.1.1.4/G.806.

Consequent actions: See 10.1.1.4/G.806.

Defect correlations: See 10.1.1.4/G.806.

Performance monitoring: See 10.1.1.4/G.806.

14.6.2 Virtual concatenated ODUkP to Client adaptation functions

14.6.2.1 ODUkP-X-L to CBRx adaptation function (ODUkP-X-L/CBRx_A) (x = 10G, 40G)

The ODUkP-X-L to CBRx adaptation functions perform the adaptation between the ODUkP-X-L (k = 1, 2; X = 4, 16) layer adapted information and the characteristic information of a CBRx signal.

The parameter x defines the bit rate or bit rate range of the CBR signal. The values x = 10G and 40G are defined for client signals that comply to the SDH bit rates as defined in Table 14-40. Support for other bit rates and bit rate ranges is for further study.

Table 14-40/G.798 – Defined values for x

x	Bit rate	Clock range	Supporting ODUkP-X-L
10G	9 953 280 kbits ± 20 ppm	9 953 280 kHz ± 20 ppm	ODU1P-4-L
40G	39 813 120 kbits ± 20 ppm	39 813 120 kHz ± 20 ppm	ODU1P-16-L ODU2P-4-L

Two different source functions are defined. The ODUkP-X-L/CBRx-a_A_So provides asynchronous mapping, while the ODUkP-X-L/CBRx-b_A_So provides bit synchronous mapping. In the sink direction the ODUkP-X-L/CBRx_A_Sk can handle both (bit synchronous and asynchronous) mappings.

NOTE – The ODUkP-X-L/CBRx_A functions require that the LCAS functionality is disabled, as a fixed number of virtual concatenated ODUks are required for the transport of the client signal.

14.6.2.1.1 ODUkP-X-L to CBRx asynchronous mapping adaptation source function (ODUkP-X-L/CBRx-a_A_So) (x = 10G, 40G)

The ODUkP-X-L/CBRx-a_A_So function creates the ODUk signal from a free running clock. It asynchronously maps the $X * 4^{(k-1)} * 2\ 488\ 320$ kbit/s constant bit rate client signal from the CBRx_CP into the payload of the OPUk-Xv (k = 1, 2; X = 4, 16) and adds OPUk-Xv Overhead (RES, vcPT, JC).

The information flow and processing of the ODUkP-X-L/CBRx-a_A_So function is defined with reference to Figures 14-84 and 14-85.

Symbol

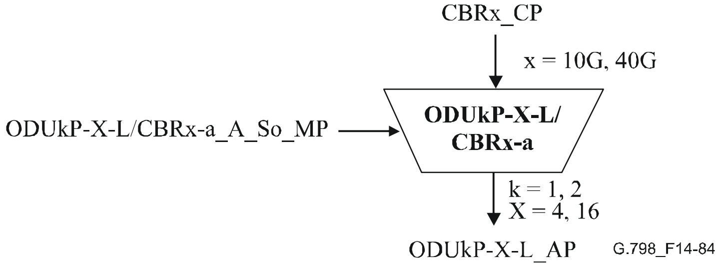


Figure 14-84/G.798 – ODUkP-X-L/CBRx-a_A_So function

Interfaces

Table 14-41/G.798 – ODUkP-X-L/CBRx-a_A_So inputs and outputs

Input(s)	Output(s)
CBRx_CP: CBRx_CI_CK CBRx_CI_D **ODUkP-X-L/CBRx-a_A_So_MP**: ODUkP-X-L/CBRx-a_A_So_MI_Active	**ODUkP-X-L_AP**: ODUkP-X-L_AI_CK ODUkP-X-L_AI_D ODUkP-X-L_AI_FS ODUkP-X-L_AI_MFS

Processes

Activation

– The ODUkP-X-L/CBRx-a_A_So function shall access the access point when it is activated (MI_Active is true). Otherwise, it shall not access the access point.

Clock and (Multi)Frame Start signal generation: The function shall generate a local ODUk-X-L clock (ODUkP-X-L_AI_CK) of "X * 239/(239 – k) * $4^{(k-1)}$ * 2 488 320 kHz ± 20 ppm" from a free running oscillator. The clock parameters, including jitter and wander requirements, as defined in Annex A/G.8251 (ODCa clock) apply.

The function shall generate the (multi)frame start reference signals AI_FS and AI_MFS for the ODUk-X-L signal. The AI_FS signal shall be active once per X*122368 clock cycles. AI_MFS shall be active once every 256 frames.

Mapping, frequency justification and bit rate adaptation: The function shall provide an elastic store (buffer) process. The data signal CBRx_CI shall be written into the buffer under control of the associated input clock. The data shall be read out of the buffer and written onto the D and N/PJO bytes in the OPUk-Xv frame under control of the ODUk-X-L clock and justification decisions as defined in 18.2.1/G.709/Y.1331 for OPUk-4v and in 18.2.2/G.709/Y.1331 for OPUk-16v.

A justification decision shall be performed each row for OPUk-4v and 4 times per row for OPUk-16v. Each justification decision results in a corresponding positive, negative or no justification action. Upon a positive justification action, the reading of 1 data byte out of the buffer shall be cancelled once. No CBRx data shall be written onto the PJO and NJO byte. Upon a negative justification action, 1 extra data byte shall be read once out of the buffer. CBRx data shall be written onto the PJO and NJO byte. If neither a positive nor a negative justification action is to be performed, CBRx data shall be written onto the PJO byte and no CBRx data shall be written onto the NJO byte.

The justification decisions determine the phase error introduced by the function.

Buffer size: In the presence of jitter as specified by ITU-T Rec. G.825 and a frequency within the range $4^{(k-1)}$ * 2 488 320 kHz ± 20 ppm, this mapping process shall not introduce any errors. The maximum buffer hysteresis, and therefore the maximum phase error introduced, shall be as listed in Table 14-42.

Table 14-42/G.798 – Maximum buffer hysteresis

Mapping	Maximum buffer hysteresis
10G → ODU1-4v	8 bytes
40G → ODU2-4v, ODU1-16v	32 bytes

JC bits: The function shall generate the justification control (JC) bits based on the justification decision performed in the current frame according to the specification in 18.2.1/G.709/Y.1331 for OPUk-4v and in 18.2.2/G.709/Y.1331 for OPUk-16v. It shall insert the justification control bits in the appropriate JC bit positions in the JC bytes of the current frame.

vcPT: The function shall insert code "0000 0010" into the vcPT byte position of the PSI overhead as defined in 18.1.2.2/G.709/Y.1331.

RES: The function shall insert all-0's into the RES bytes and Reserved bits within the JC bytes.

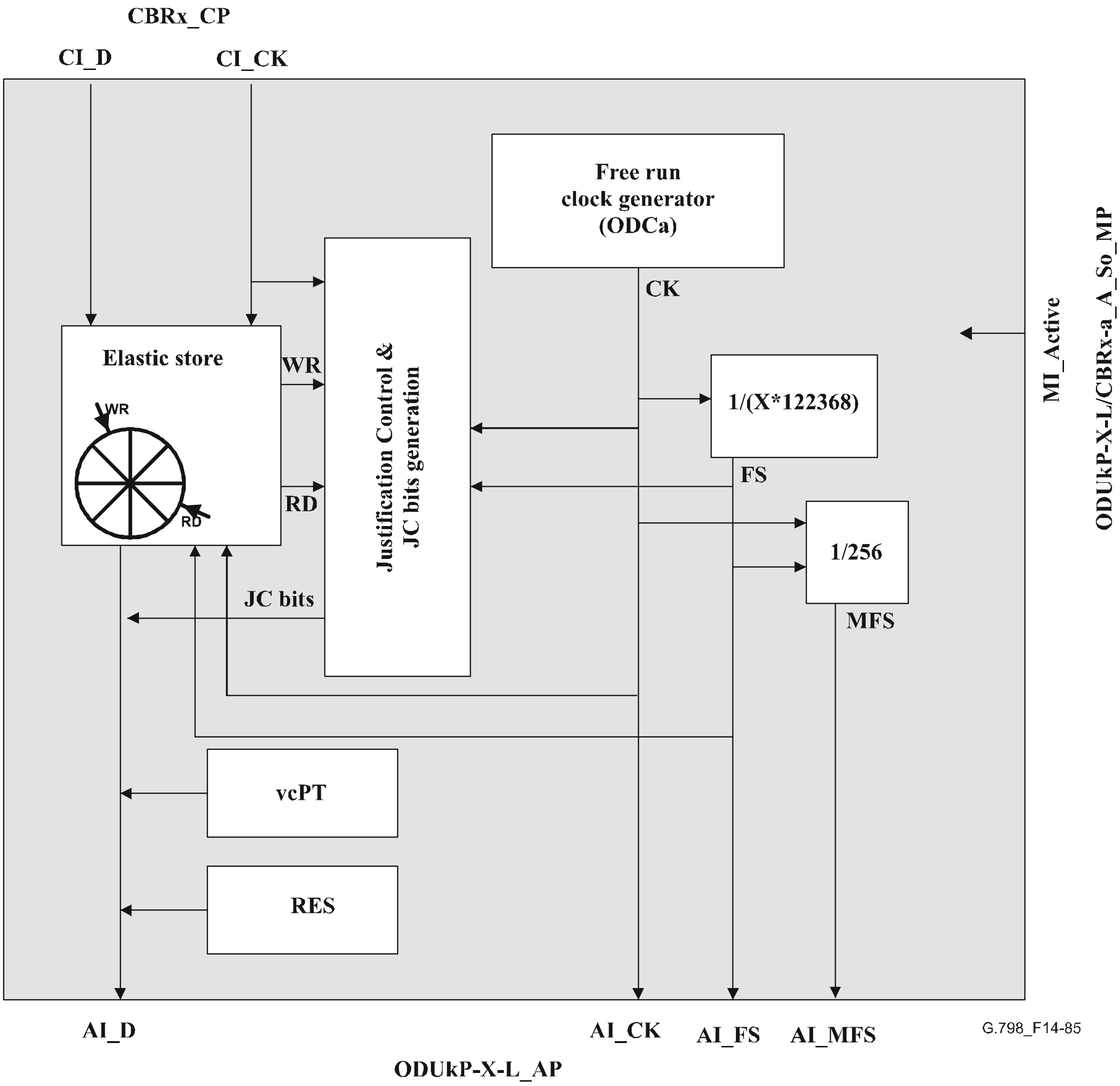


Figure 14-85/G.798 – ODUkP-X-L/CBRx-a_A_So processes

Defects: None.

Consequent actions: None.

Defect correlations: None.

Performance monitoring: None.

14.6.2.1.2 ODUkP-X-L to CBRx bit synchronous mapping adaptation source function (ODUkP-X-L/CBRx-b_A_So) (x = 10G, 40G)

The ODUkP-X-L/CBRx-b_A_So function creates the ODUk signal from a clock, derived from the incoming CBRx_CI clock. It bit synchronously maps the X * $4^{(k-1)}$ * 2 488 320 kbit/s ± 20 ppm constant bit rate client signal from the CBRx_CP into the payload of the OPUk-Xv (k = 1, 2; X = 4, 16) and adds OPUk-Xv Overhead (vcPT, JC, RES).

The information flow and processing of the ODUkP-X-L/CBRx-b_A_So function is defined with reference to Figures 14-86 and 14-87.

Symbol

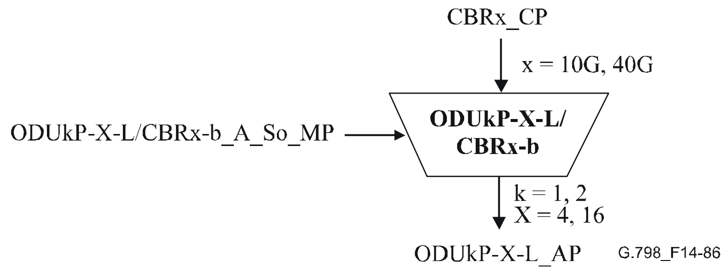


Figure 14-86/G.798 – ODUkP-X-L/CBRx-b_A_So function

Interfaces

Table 14-43/G.798 – ODUkP-X-L/CBRx-b_A_So inputs and outputs

Input(s)	Output(s)
CBRx_CP: CBRx_CI_CK CBRx_CI_D **ODUkP-X-L/CBRx-b_A_So_MP**: ODUkP-X-L/CBRx-b_A_So_MI_Active	**ODUkP-X-L_AP**: ODUkP-X-L_AI_CK ODUkP-X-L_AI_D ODUkP-X-L_AI_FS ODUkP-X-L_AI_MFS

Processes

Activation

– The ODUkP-X-L/CBRx-b_A_So function shall access the access point when it is activated (MI_Active is true). Otherwise, it shall not access the access point.

Clock and (Multi)Frame Start signal generation: The function shall generate the ODUk-X-L (AI_CK) clock by multiplying the incoming CBRx clock (CI_CK) by factor of 239/(239 – k). The clock parameters, including jitter and wander requirements, as defined in Annex A/G.8251 (ODCb clock) apply.

NOTE 1 – The ODUkP-X-L clock is "X * 239/(239 – k) * $4^{(k-1)}$ * 2 488 320 kHz ± 20 ppm".

NOTE 2 – The incoming CBRx CK (CI_CK) signal has to be within the range of X * $4^{(k-1)}$ * 2 488 320 kHz ± 20 ppm.

During failure conditions of the incoming CBR clock signal (CI_CK), the ODUk-X-L clock shall stay within its limits as defined in ITU-T Rec. G.8251 and no frame phase discontinuity shall be introduced.

The function shall generate the (multi)frame start reference signals AI_FS and AI_MFS for the ODUk-X-L signal. The AI_FS signal shall be active once per X*122368 clock cycles. AI_MFS shall be active once every 256 frames.

Mapping, frequency justification and bit rate adaptation: The function shall provide an elastic store (buffer) process. The data signal CBRx_CI shall be written into the buffer under control of the associated input clock. The data shall be read out of the buffer and written onto the D and PJO bytes in the OPUk-Xv frame under control of the ODUk-X-L clock as defined in 18.2.1/G.709/Y.1331 for OPUk-4v and in 18.2.2/G.709/Y.1331 for OPUk-16v.

Neither negative nor positive justification is to be performed. No data shall be written onto the NJO byte and data shall always be written onto the PJO byte.

Buffer size: In the presence of jitter as specified by ITU-T Rec. G.825 and a frequency within the range X * $4^{(k-1)}$ * 2 488 320 kHz ± 20 ppm, this mapping process shall not introduce any errors.

Following a step in frequency of the X * $4^{(k-1)}$ * 2 488 320 kbit/s CI_CK signal (for example due removal of AIS (generic AIS)) there will be a maximum recovery time of Y seconds after which this process shall not generate any bit errors. The value of Y is for further study; a value of 1 second has been proposed.

JC bits: The function shall generate the fixed justification control (JC) bits "00" according to 18.2.1/G.709/Y.1331 for OPUk-4v and 18.2.2/G.709/Y.1331 for OPUk-16v. It shall insert the justification control bits in the appropriate JC bit positions in the JC bytes.

RES: The function shall insert all-0's into the RES bytes and Reserved bits within the JC bytes.

vcPT: The function shall insert code "0000 0010" into the vcPT byte position of the PSI overhead as defined in 18.1.2.2/G.709/Y.1331.

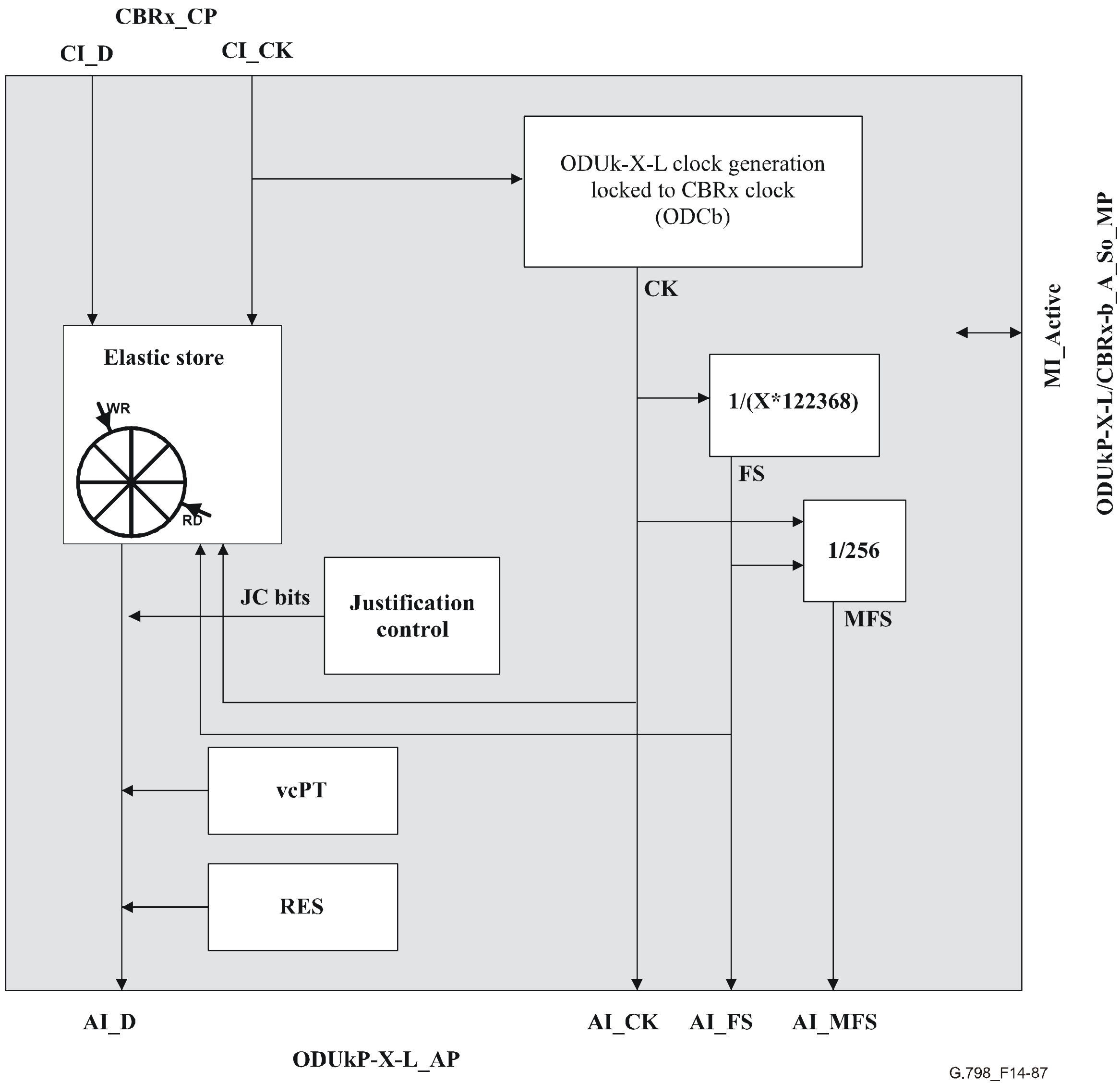


Figure 14-87/G.798 – ODUkP-X-L/CBRx-b_A _So processes

Defects: None.

Consequent actions: None.

Defect correlations: None.

Performance monitoring: None.

14.6.2.1.3 ODUkP-X-L to CBRx adaptation sink function (ODUkP-X-L/CBRx_A_Sk) (x = 10G, 40G)

The ODUkP-X-L/CBRx_A_Sk recovers the X * $4^{(k-1)}$ * 2 488 320 kbit/s ± 20 ppm constant bit rate client signal from the OPUk-Xv payload using the justification control information (JC overhead) to determine if a data or stuff byte is present within the NJO and PJO bytes. It extracts the OPUk-Xv Overhead (vcPT, JC, and RES) and monitors the reception of the correct virtual concatenation payload type. Under signal fail condition generic-AIS shall be generated.

The information flow and processing of the ODUkP-X-L/CBRx_A_Sk function is defined with reference to Figures 14-88 and 14-89.

Symbol

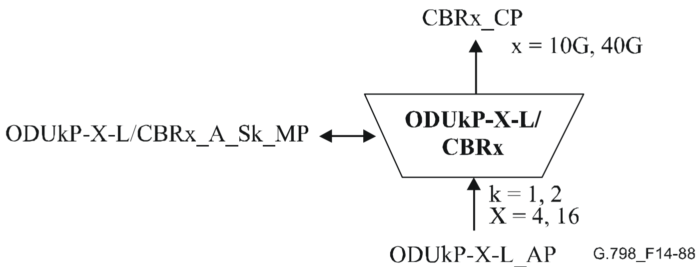


Figure 14-88/G.798 – ODUkP-X-L/CBRx_A_Sk function

Interfaces

Table 14-44/G.798 – ODUkP-X-L/CBRx_A_Sk inputs and outputs

Input(s)	Output(s)
ODUkP-X-L_AP: ODUkP-X-L_AI_CK ODUkP-X-L_AI_D ODUkP-X-L_AI_FS ODUkP-X-L_AI_TSF **ODUkP-X-L/CBRx_A_Sk_MP**: ODUkP-X-L/CBRx_A_Sk_MI_Active	**CBRx_CP**: CBRx_CI_CK CBRx_CI_D CBRx_CI_SSF **ODUkP-X-L/CBRx_A_Sk_MP**: ODUkP-X-L/CBRx_A_Sk_MI_cVcPLM ODUkP-X-L/CBRx_A_Sk_MI_AcVcPT

Processes

Activation

– The ODUkP-X-L/CBRx_A_Sk function shall access the access point and perform the Common and Specific Processes operation specified below when it is activated (MI_Active is true). Otherwise, it shall activate the SSF signals and generate Generic AIS at its output (CP) and not report its status via the management point.

vcPT: The function shall extract the vcPT byte from the PSI overhead as defined in 8.7.3. The accepted vcPT value is available at the MP (MI_AcVcPT) and is used for VcPLM defect detection.

RES: The value in the RES bytes shall be ignored.

JC: The function shall interpret the justification control information in the JC byte as defined in 18.2.1/G.709/Y.1331 for OPUk-4v and in 18.2.2/G.709/Y.1331 for OPUk-16v in order to determine the justification action (positive, negative, none) for the current frame. RES bits in the JC shall be ignored.

Demapping, CBR clock generation: The function shall provide an elastic store (buffer) process. The CBR data shall be written into the buffer from the D, PJO and NJO byte in the OPUk-X-L frame. The information extraction of the PJO and NJO bytes shall be under control of the justification control information. The CBRx data (CI_D) shall be read out of the buffer under control of the CBRx clock (CI_CK).

Upon a positive justification action, the writing of 1 data byte into the buffer shall be cancelled once. No CBRx data shall be read from the PJO and NJO byte. Upon a negative justification action, 1 extra data byte shall be written into the buffer once. CBRx data shall be read from the PJO and NJO byte. If neither a positive nor a negative justification action is to be performed, CBRx data shall be read from the PJO byte and no CBRx data shall be read from the NJO byte.

Smoothing & jitter limiting process: The function shall provide for a clock smoothing and elastic store (buffer) process. The $X * 4^{(k-1)} * 2\,488\,320$ kbit/s (k = 1, 2) data signal shall be written into the buffer under control of the associated (gapped) input clock (with a frequency accuracy within ± 20 ppm). The data signal shall be read out of the buffer under control of a smoothed (equally spaced) $X * 4^{(k-1)} * 2\,488\,320$ kbit/s ± 20 ppm clock (the rate is determined by the 10 Gbit/s, 40 Gbit/s signal at the input of the remote ODUkP-X-L/CBRx_A_So).

The clock parameters, including jitter and wander requirements, as defined in Annex A/G.8251 (ODCp clock) apply.

Buffer size: In the presence of jitter as specified by ITU-T Rec. G.825 and a frequency within the range $X * 4^{(k-1)} * 2\,488\,320$ kbit/s ± 20 ppm, this justification process shall not introduce any errors.

Following a step in frequency of the $X * 4^{(k-1)} * 2\,488\,320$ kbit/s signal transported by the ODUkP-X-L_AI (for example due to reception of CBRx_CI from a new RSn_TT_So at the far end or removal of generic-AIS signal with a frequency offset), there will be a maximum recovery time of Y seconds after which this process shall not generate any bit errors. The value of Y is for further study; a value of 1 second has been proposed.

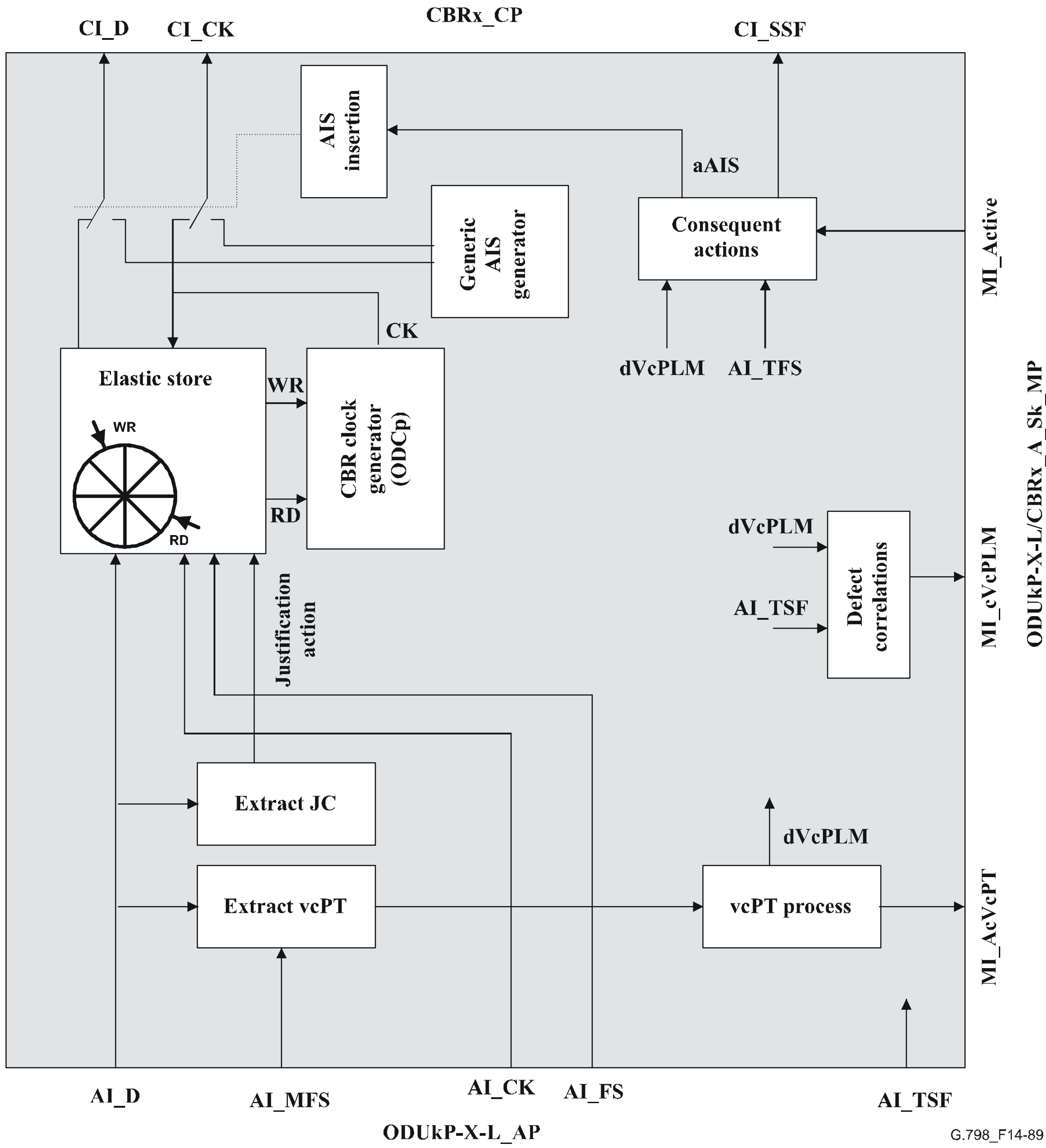


Figure 14-89/G.798 – ODUkP-X-L/CBRx_A_Sk processes

Defects

The function shall detect for dVcPLM.

dVcPLM: See 6.2.4.2. The expected payload types are "0000 0010" (asynchronous CBRx mapping) and "0000 0011" (bit synchronous CBRx mapping) as defined in ITU-T Rec. G.709/Y.1331.

Consequent actions

aSSF ← AI_TSF or dVcPLM or (not MI_Active)

aAIS ← AI_TSF or dVcPLM or (not MI_Active)

On declaration of aAIS the function shall output a GenericAIS pattern/signal as defined in 16.6/G.709/Y.1331 within 2 frames. On clearing of aAIS the GenericAIS pattern/signal shall be removed within 2 frames and normal data being output. The GenericAIS clock start shall be independent from the incoming clock. The GenericAIS clock has to be within $X * 4^{(k-1)} *$ 2 488 320 kHz ± 20 ppm. Jitter and wander requirements as defined in Annex A/G.8251 (ODCp clock) apply.

Defect correlations

cVcPLM ← dVcPLM and (not AI_TSF)

Performance monitoring: None.

14.6.2.2 ODUkP-X-L to RSn adaptation function (ODUkP-X-L/RSn_A)

The ODUkP-X-L to RSn adaptation functions perform the adaptation between the ODUkP-X-L (k = 1, 2; L = 4, 16) layer adapted information and the characteristic information of a RSn signal (n = 64, 256). Table 14-45 shows by which ODUkP-X-L signals the RSn signals are supported.

Table 14-45/G.798 – Defined values for x

RSn	STM-N signal	Bit rate	Supporting ODUkP-X-L
RS64	STM-64	9 953 280 kbits ± 20 ppm	ODU1P-4-L
RS256	STM-256	39 813 120 kbits ± 20 ppm	ODU1P-16-L ODU2P-4-L

Two different source functions are defined. The ODUkP-X-L/RSn-a_A_So provides asynchronous mapping, while the ODUkP-X-L/RSn-b_A_So provides bit synchronous mapping. In the sink direction, the ODUkP-X-L/RSn_A_Sk can handle both (bit synchronous and asynchronous) mappings.

NOTE 1 – The source functions are identical with the ODUkP-X-L/CBRx adaptation source functions, except for the different CI at the CP (CBRx_CI replaced by RSn_CI). In the sink direction, the function provides framing on the SDH signal and GenericAIS supervision. In the ODUkP/CBR_A_Sk function, no such functionality is available.

NOTE 2 – The ODUkP-X-L/RSn_A functions are only intended to be used together with RSn_TT functions (see ITU-T Rec. G.783). The direct interconnection of ODUkP-X-L/RSn_A functions with any other (server layer)/RS_A functions at the RSn_CP is not intended. The ODUkP-X-L/RSn functions are only used if further SDH processing is performed (e.g., RS termination). For example Figure I.1 shows the ODUk/RSn_A_Sk together with a RS_TT_Sk for non-intrusive monitoring and Figure I.4 shows the use of the ODUkP/RSn_A functions at OTN interfaces on SDH equipment. For transparent mapping of constant bit rate signals, the ODUkP[X-L]/CBRx_A functions shall be used as shown in Figure I.1.

14.6.2.2.1 ODUkP-X-L to RSn asynchronous mapping adaptation source function (ODUkP-X-L/RSn-a_A_So)

The ODUkP-X-L/RSn-a_A_So function creates the ODUk-X-L signal from a free running clock. It asynchronously maps the STM-N ($N = 4^{(k+1)}$) client signal from the RSn_CP into the payload of the OPUk-Xv (k = 1, 2; X = 4, 16) and adds OPUk-Xv Overhead (RES, vcPT, JC).

The information flow and processing of the ODUkP-X-L/RSn-a_A_So function is defined with reference to Figures 14-90 and 14-91.

Symbol

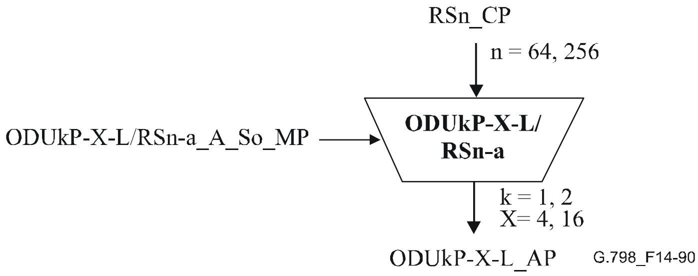


Figure 14-90/G.798 – ODUkP-X-L/RSn-a_A_So function

Interfaces

Table 14-46/G.798 – ODUkP-X-L/RSn-a_A_So inputs and outputs

Input(s)	Output(s)
RSn_CP: RSn_CI_CK RSn_CI_D **ODUkP-X-L/RSn-a_A_So_MP**: ODUkP-X-L/RSn-a_A_So_MI_Active	**ODUkP-X-L_AP**: ODUkP-X-L_AI_CK ODUkP-X-L_AI_D ODUkP-X-L_AI_FS ODUkP-X-L_AI_MFS

Processes

Activation:

– The ODUkP-X-L/RSn-a_A_So function shall access the access point when it is activated (MI_Active is true). Otherwise, it shall not access the access point.

Clock and (Multi) Frame Start signal generation: The function shall generate a local ODUk-X-L clock (ODUkP-X-L_AI_CK) of "X * 239/(239 – k) * $4^{(k-1)}$ * 2 488 320 kHz ± 20 ppm" from a free running oscillator. The clock parameters, including jitter and wander requirements as defined in Annex A/G.8251 (ODCa clock) apply.

The function shall generate the (multi) frame start reference signals AI_FS and AI_MFS for the ODUk-X-L signal. The AI_FS signal shall be active once per X*122368 clock cycles. AI_MFS shall be active once every 256 frames.

Mapping, frequency justification and bit rate adaptation: The function shall provide an elastic store (buffer) process. The data signal RSn_CI shall be written into the buffer under control of the associated input clock. The data shall be read out of the buffer and written onto the D and N/PJO bytes in the OPUk-Xv frame under control of the ODUk-X-L clock and justification decisions as defined in 18.2.1/G.709/Y.1331 for OPUk-4v and in 18.2.2/G.709/Y.1331 for OPUk-16v.

A justification decision shall be performed each frame. Each justification decision results in a corresponding positive, negative or no justification action. Upon a positive justification action, the reading of 1 data byte out of the buffer shall be cancelled once. No RSn data shall be written onto the PJO and NJO byte. Upon a negative justification action, 1 extra data byte shall be read once out of the buffer. RSn data shall be written onto the PJO and NJO byte. If neither a positive nor a negative justification action is to be performed, RSn data shall be written onto the PJO byte and no RSn data shall be written onto the NJO byte.

The justification decisions determine the phase error introduced by the function.

Buffer size: In the presence of jitter as specified by ITU-T Rec. G.825 and a frequency within the range X * $4^{(k-1)}$ * 2 488 320 kHz ± 20 ppm, this mapping process shall not introduce any errors. The maximum buffer hysteresis, and therefore the maximum phase error introduced, shall be as listed in Table 14-42.

JC bits: The function shall generate the justification control (JC) bits based on the justification decision performed in the current frame according to the specification in 18.2.1/G.709/Y.1331 for OPUk-4v and in 18.2.2/G.709/Y.1331 for OPUk-16v. It shall insert the justification control bits in the appropriate JC bit positions in the JC bytes of the current frame.

vcPT: The function shall insert code "0000 0010" into the vcPT byte position of the PSI overhead as defined in 18.1.2.2/G.709/Y.1331.

RES: The function shall insert all-0's into the RES bytes and Reserved bits within the JC bytes.

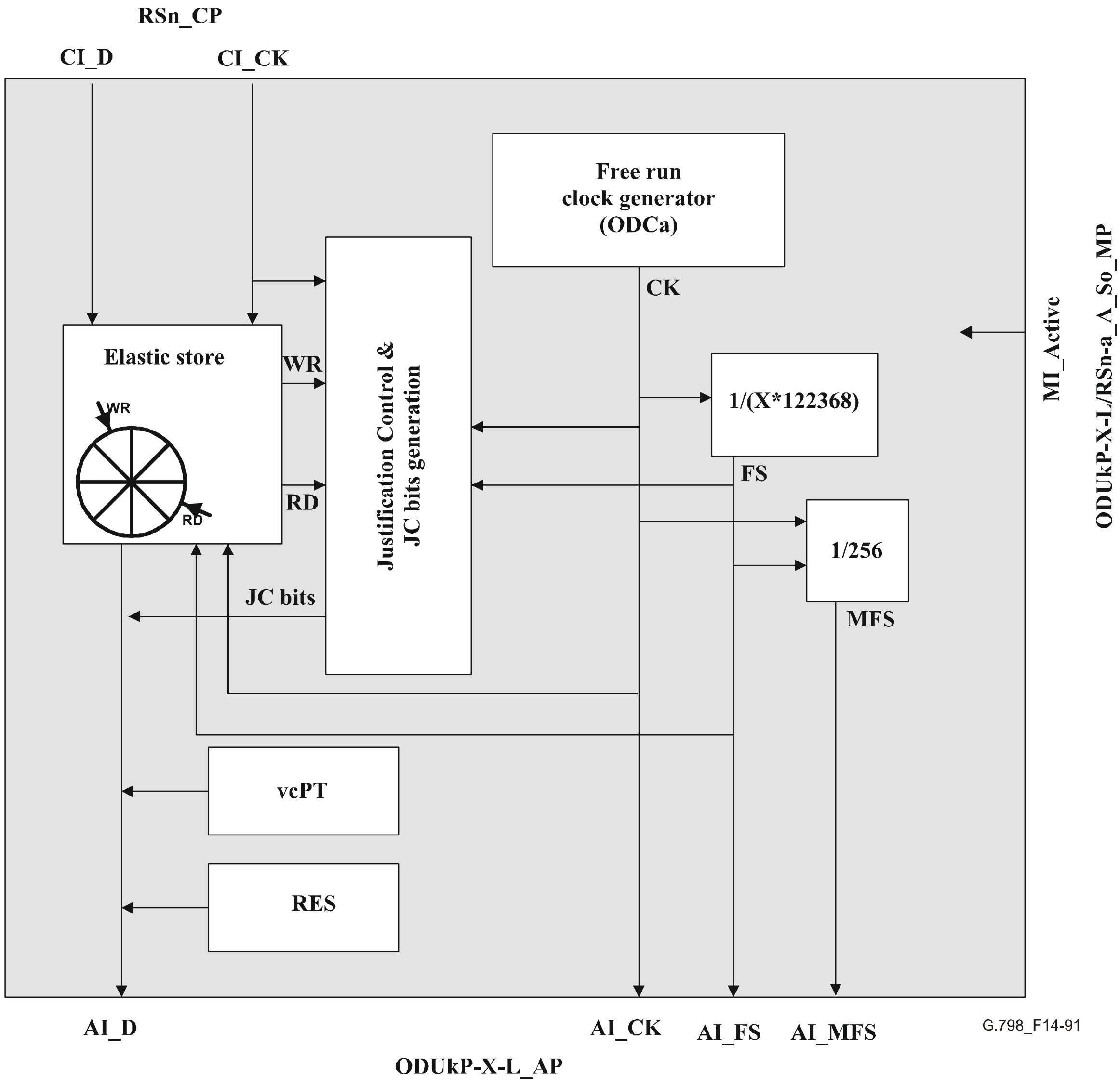


Figure 14-91/G.798 – ODUkP-X-L/RSn-a_A_So processes

Defects: None.

Consequent actions: None.

Defect correlations: None.

Performance monitoring: None.

14.6.2.2.2 ODUkP-X-L to RSn bit synchronous mapping adaptation source function (ODUkP-X-L/RSn-b_A_So)

The ODUkP-X-L/RSn-b_A_So function creates the ODUk-X-L signal from a clock, derived from the incoming RSn_CI clock. It bit synchronously maps the STM-N ($N = 4^{(k+1)}$) client signal from the RSn_CP into the payload of the OPUk-Xv and adds OPUk-Xv Overhead (vcPT, JC, RES).

The information flow and processing of the ODUkP-X-L/RSn-b_A_So function is defined with reference to Figures 14-92 and 14-93.

Symbol

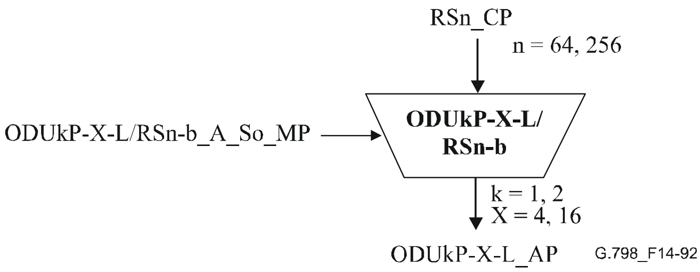


Figure 14-92/G.798 – ODUkP-X-L/RSn-b_A_So function

Interfaces

Table 14-47/G.798 – ODUkP-X-L/RSn-b_A_So inputs and outputs

Input(s)	Output(s)
RSn_CP: RSn_CI_CK RSn_CI_D **ODUkP-X-L/RSn-b_A_So_MP**: ODUkP-X-L/RSn-b_A_So_MI_Active	**ODUkP-X-L_AP**: ODUkP-X-L_AI_CK ODUkP-X-L_AI_D ODUkP-X-L_AI_FS ODUkP-X-L_AI_MFS

Processes

Activation

– The ODUkP-X-L/RSn-b_A_So function shall access the access point when it is activated (MI_Active is true). Otherwise, it shall not access the access point.

Clock and (Multi) Frame Start signal generation: The function shall generate the ODUk-X-L (AI_CK) clock by multiplying the incoming RSn clock (CI_CK) by factor of 239/(239 – k). The clock parameters, including jitter and wander requirements, as defined in Annex A/G.8251 (ODCb clock) apply.

NOTE 1 – The ODUk-X-L clock is "$X * 239/(239 - k) * 4^{(k-1)} * 2\,488\,320$ kHz ± 20 ppm".

NOTE 2 – The incoming RSn CK (CI_CK) signal has to be within the range of $X * 4^{(k-1)} * 2\,488\,320$ kHz ± 20 ppm.

During failure conditions of the incoming RS clock signal (CI_CK), the ODUk-X-L clock shall stay within its limits as defined in ITU-T Rec. G.8251 and no frame phase discontinuity shall be introduced.

The function shall generate the (multi) frame start reference signals AI_FS and AI_MFS for the ODUk-X-L signal. The AI_FS signal shall be active once per X*122368 clock cycles. AI_MFS shall be active once every 256 frames.

Mapping, frequency justification and bit rate adaptation: The function shall provide an elastic store (buffer) process. The data signal RSn_CI shall be written into the buffer under control of the associated input clock. The data shall be read out of the buffer and written onto the D and PJO bytes in the OPUk-Xv frame under control of the ODUk-X-L clock as defined in 18.2.1/G.709/Y.1331 for OPUk-4v and in 18.2.2/G.709/Y.1331 for OPUk-16v.

Neither negative nor positive justification is to be performed. No data shall be written onto the NJO byte and data shall always be written onto the PJO byte.

Buffer size: In the presence of jitter as specified by ITU-T Rec. G.825 and a frequency within the range $X * 4^{(k-1)} * 2\,488\,320$ kHz ± 20 ppm, this mapping process shall not introduce any errors.

Following a step in frequency of the $X * 4^{(k-1)} * 2\,488\,320$ kbit/s CI_CK signal (for example due removal of AIS (RS-AIS)), there will be a maximum recovery time of Y seconds after which this process shall not generate any bit errors. The value of Y is for further study; a value of 1 second has been proposed.

JC bits: The function shall generate the fixed justification control (JC) bits "00" according to 18.2.1/G.709/Y.1331 for OPUk-4v and 18.2.2/G.709/Y.1331 for OPUk-16v. It shall insert the justification control bits in the appropriate JC bit positions in the JC bytes.

RES: The function shall insert all-0's into the RES bytes and Reserved bits within the JC bytes.

vcPT: The function shall insert code "0000 0010" into the vcPT byte position of the PSI overhead as defined in 18.1.2.2/G.709/Y.1331.

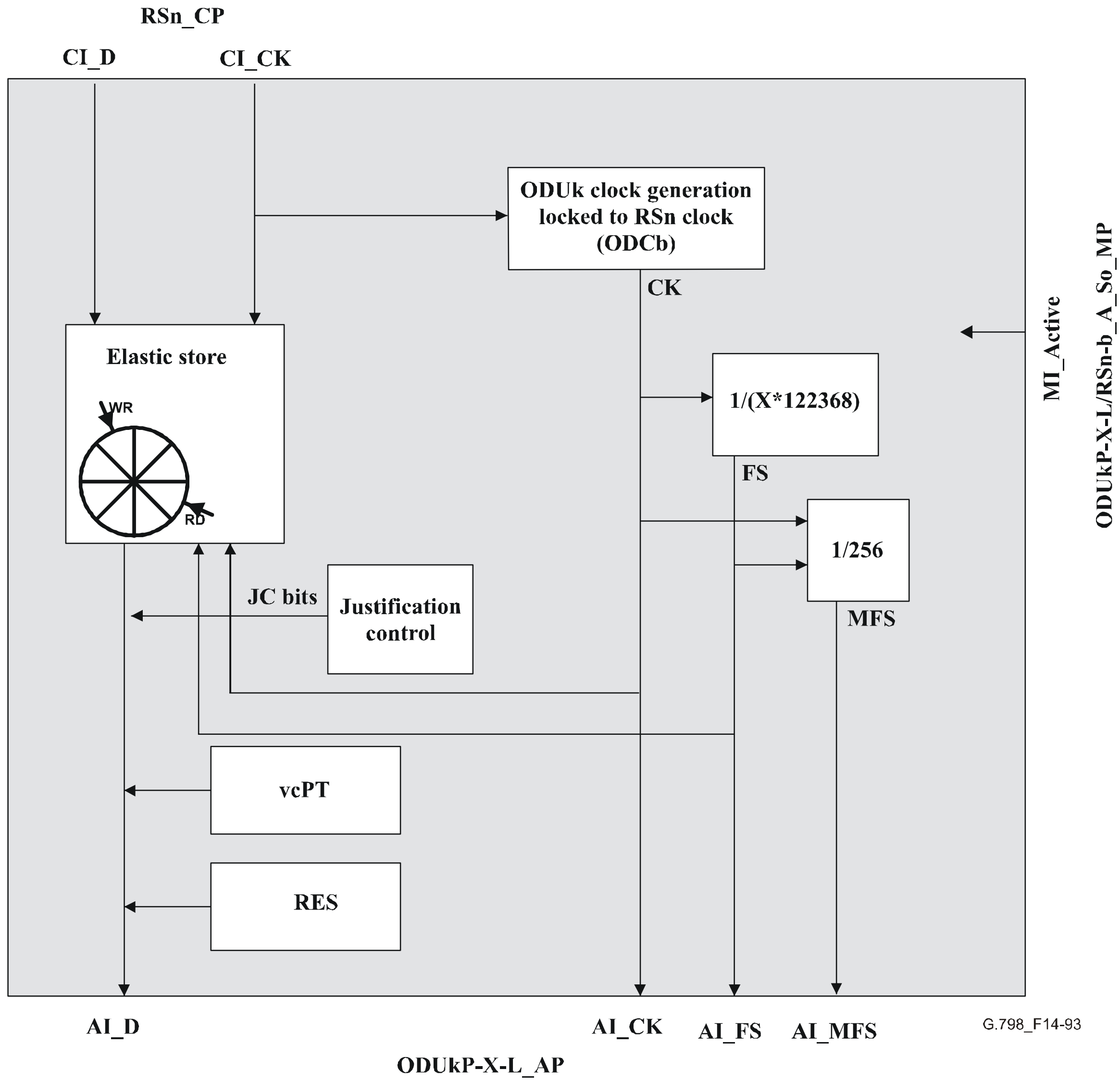


Figure 14-93/G.798 – ODUkP-X-L/RSn-b_A _So processes

Defects: None.

Consequent actions: None.

Defect correlations: None.

Performance monitoring: None.

14.6.2.2.3 ODUkP-X-L to RSn adaptation sink function (ODUkP-X-L/RSn_A_Sk)

The ODUkP-X-L/RSn_A_Sk recovers the STM-N ($N = 4^{(k+1)}$) client signal from the OPUk-Xv payload using the justification control information (JC overhead) to determine if a data or stuff byte is present within the NJO and PJO bytes. It extracts the OPUk-Xv Overhead (vcPT, JC, and RES) and monitors the reception of the correct payload type. It detects GenericAIS and recovers the frame start of the STM-N signal. Under signal fail condition a logical all-ones (AIS) signal shall be generated.

The information flow and processing of the ODUkP-X-L/RSn_A_Sk function is defined with reference to Figures 14-94 and 14-95.

Symbol

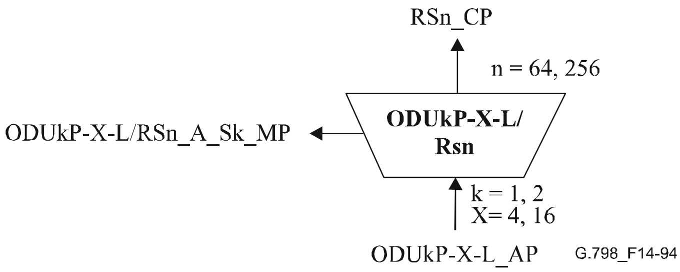


Figure 14-94/G.798 – ODUkP-X-L/RSn_A_Sk function

Interfaces

Table 14-48/G.798 – ODUkP-X-L/RSn_A_Sk inputs and outputs

Input(s)	Output(s)
ODUkP-X-L_AP: ODUkP-X-L_AI_CK ODUkP-X-L_AI_D ODUkP-X-L_AI_FS ODUkP-X-L_AI_TSF **ODUkP-X-L/RSn_A_Sk_MP**: ODUkP-X-L/RSn_A_Sk_MI_Active	**RSn_CP**: RSn_CI_CK RSn_CI_D RSn_CI_FS RSn_CI_SSF **ODUkP-X-L/RSn_A_Sk_MP**: ODUkP-X-L/RSn_A_Sk_MI_cVcPLM ODUkP-X-L/RSn_A_Sk_MI_AcVcPT ODUkP-X-L/RSn_A_Sk_MI_cLOF

Processes

Activation

– The ODUkP-X-L/RSn_A_Sk function shall access the access point and perform the Common and Specific Processes operation specified below when it is activated (MI_Active is true). Otherwise, it shall activate the SSF signals and generate AIS at its output (CP) and not report its status via the management point.

vcPT: The function shall extract the vcPT byte from the PSI overhead as defined in 8.7.3. The accepted vcPT value is available at the MP (MI_AcVcPT) and is used for VcPLM defect detection.

RES: The value in the RES bytes shall be ignored.

JC: The function shall interpret the justification control information in the JC byte as defined in 18.2.1/G.709/Y.1331 for OPUk-4v and in 18.2.2/G.709/Y.1331 for OPUk-16v in order to determine the justification action (positive, negative, none) for the current frame. RES bits in the JC shall be ignored.

Demapping, CBR clock generation: The function shall provide an elastic store (buffer) process. The CBR data shall be written into the buffer from the D, PJO and NJO byte in the OPUk frame. The information extraction of the PJO and NJO bytes shall be under control of the justification control information. The RSn data (CI_D) shall be read out of the buffer under control of the RSn clock (CI_CK).

Upon a positive justification action, the writing of 1 data byte into the buffer shall be cancelled once. No RSn data shall be read from the PJO and NJO bytes. Upon a negative justification action, 1 extra data byte shall be written into the buffer once. RSn data shall be read from the PJO and NJO bytes. If neither a positive nor a negative justification action is to be performed, RSn data shall be read from the PJO byte and no RSn data shall be read from the NJO byte.

Smoothing & jitter limiting process: The function shall provide for a clock smoothing and elastic store (buffer) process. The $X * 4^{(k-1)} * 2\ 488\ 320$ kbit/s ($k = 1, 2$) data signal shall be written into the buffer under control of the associated (gapped) input clock (with a frequency accuracy within ± 20 ppm). The data signal shall be read out of the buffer under control of a smoothed (equally spaced) $X * 4^{(k-1)} * 2\ 488\ 320$ kbit/s ± 20 ppm clock (the rate is determined by the 10 Gbit/s, 40 Gbit/s signal at the input of the remote ODUkP-X-L/RSn_A_So).

The clock parameters, including jitter and wander requirements, as defined in Annex A/G.8251 (ODCp clock) apply.

Buffer size: In the presence of jitter as specified by G.825 and a frequency within the range $X * 4^{(k-1)} * 2\ 488\ 320$ kbit/s ± 20 ppm, this justification process shall not introduce any errors.

Following a step in frequency of the $X * 4^{(k-1)} * 2\ 488\ 320$ kbit/s signal transported by the ODUkP-X-L_AI (for example due to reception of RSn_CI from a new RSn_TT_So at the far end or removal of generic-AIS signal with a frequency offset), there will be a maximum recovery time of Y seconds after which this process shall not generate any bit errors. The value of Y is for further study; a value of 1 second has been proposed.

Frame alignment: The function shall perform frame alignment on the STM-N frame as described in 8.2.1/G.783.

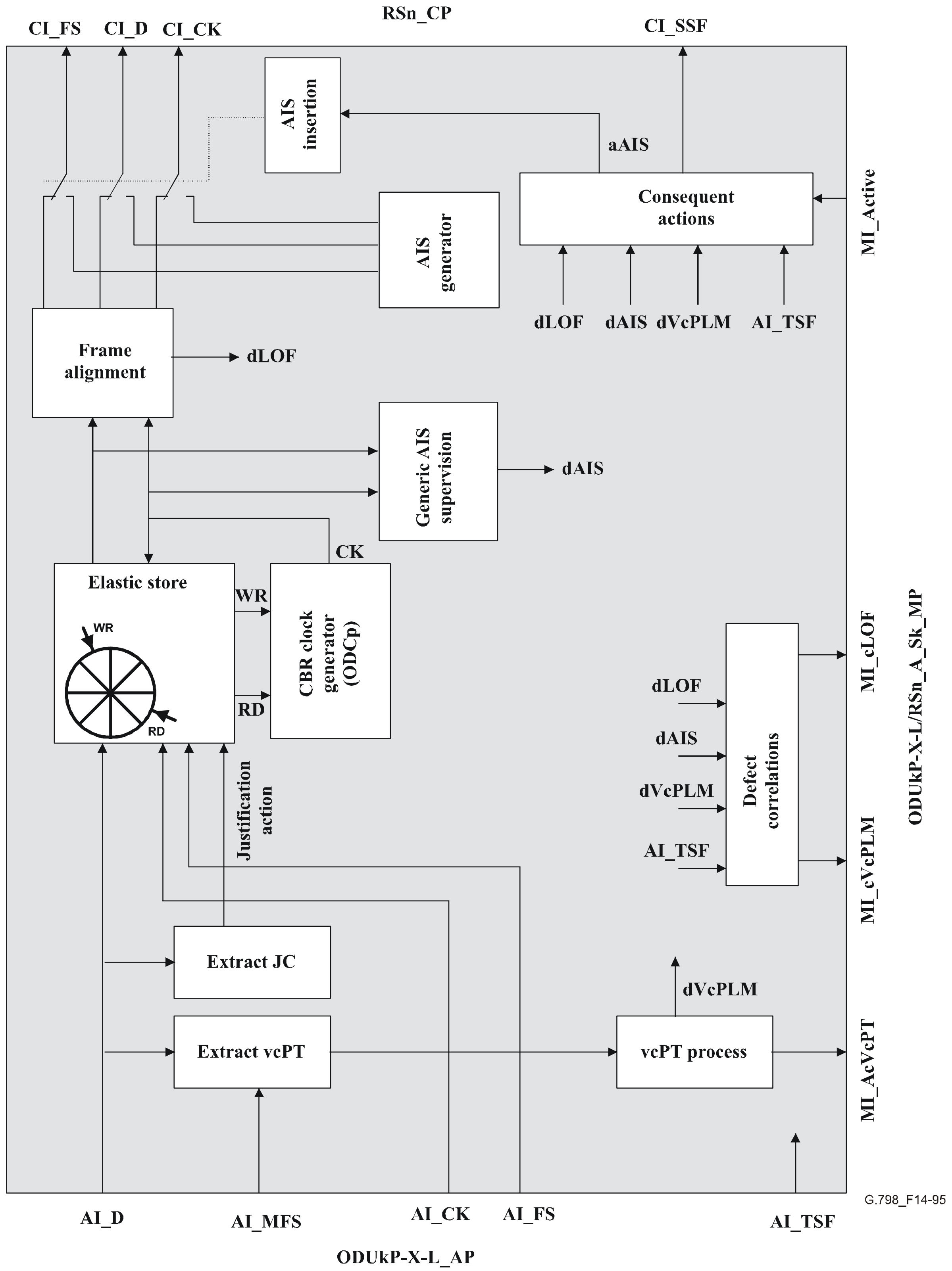


Figure 14-95/G.798 – ODUkP-X-L/RSn_A_Sk processes

Defects

The function shall detect for dVcPLM, dAIS and dLOF.

dVcPLM: See 6.2.4.2. The expected payload types are "0000 0010" (asynchronous CBRx mapping) and "0000 0011" (bit synchronous CBRx mapping) as defined in ITU-T Rec. G.709/Y.1331.

dAIS: See 6.2.6.3.3.

dLOF: See 6.2.5.1/G.783.

Consequent actions

aSSF ← AI_TSF or dVcPLM or dAIS or dLOF or (not MI_Active)

aAIS ← AI_TSF or dVcPLM or dAIS or dLOF or (not MI_Active)

On declaration of aAIS, the function shall output a logical all-ones (AIS) signal within 2 STM-N frames. On clearing of aAIS, the logical all-ones (AIS) signal shall be removed within 2 STM-N frames and normal data being output. The AIS clock start shall be independent from the incoming clock. The AIS clock has to be within $X * 4^{(k-1)} * 2\,488\,320$ kHz ± 20 ppm. The jitter and wander requirements as defined in Annex A/G.8251 (ODCp clock) apply.

Defect correlations

cVcPLM ← dVcPLM and (not AI_TSF)

cLOF ← dLOF and (not dAIS) and (not dVcPLM) and (not AI_TSF)

NOTE – dAIS is not reported as fault cause as it is a secondary alarm and will result in aSSF, which is reported as cSSF fault cause in the RSn_TT_Sk that directly follows this function.

Performance monitoring: None.

14.6.2.3 ODUkP-X-L to ATM VP adaptation function (ODUkP-X-L/VP_A)

NOTE – The specification of this adaptation function is derived from equivalent adaptation functions defined in Annex D/I.732.

14.6.2.3.1 ODUkP-X-L to ATM VP adaptation source function (ODUkP-X-L/VP_A_So)

Symbol

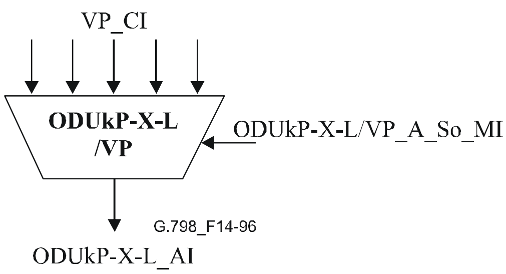


Figure 14-96/G.798 – ODUkP-X-L/VP_A_So symbol

Interfaces

Table 14-49/G.798 – ODUkP-X-L/VP_A_So input and output signals

Input(s)	Output(s)
per VP_CP, for each VP configured: VP_CI_D VP_CI_ACS VP_CI_SSF **ODUkP-X-L_AP**: ODUkP-X-L_AI_X_{AT} **ODUkP-X-L/VP_A_So_MP**: ODUkP-X-L/VP_A_So_MI_Active ODUkP-X-L/VP_A_So_MI_CellDiscardActive ODUkP-X-L/VP_A_So_MI_TPusgActive ODUkP-X-L/VP_A_So_MI_GFCActive ODUkP-X-L/VP_A_So_MI_VPI-KActive	**ODUkP-X-L_AP**: ODUkP-X-L_AI_CK ODUkP-X-L_AI_D ODUkP-X-L_AI_FS ODUkP-X-L_AI_MFS

Processes

The ODUkP-X-L/VP_A_So function provides adaptation from the ATM Virtual Path layer to the ODUk-X-L path. This is performed by a grouping of Specific Processes and Common Processes as shown in Figure 14-97.

Activation

– The ODUkP-X-L/VP_A_So function shall access the access point when it is activated (MI_Active is true). Otherwise, it shall not access the access point.

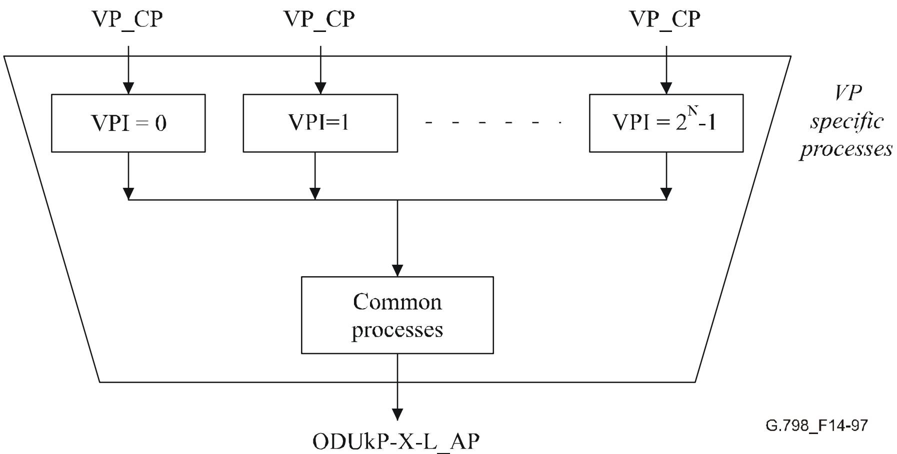


Figure 14-97/G.798 – ODUkP-X-L/VP_A_So atomic function decomposed into Specific and Common Processes parts

NOTE 1 – The sequential order of the processes within the atomic functions is important. For the correct order, refer to the ordering of the processes given below.

Clock and (Multi)Frame Start signal generation: The function shall generate a local ODUk-X-L clock (ODUkP-X-L_AI_CK) of "X_{AT} * 239/(239 – k) * $4^{(k-1)}$ * 2 488 320 kHz ± 20 ppm". The jitter and wander requirements as defined in Annex A/G.8251 (ODCa clock) apply.

The function shall generate the (multi)frame start reference signals ODUkP-X-L_AI_FS and ODUkP-X-L_AI_MFS for the ODUk-X-L signal. The ODUkP-X-L_AI_FS signal shall be active once per X_{AT} * 122 368 clock cycles. ODUkP-X-L_AI_MFS shall be active once every 256 frames.

NOTE 2 – The size and clock rate of the OPUk-Xv is defined by AI_X_{AT}. In case of a change of X_{AT} the clock rate shall be adjusted immediately. This shall not introduce any loss or errors to the mapped ATM cells except for the case where the incoming ATM cell rate exceeds the available ODUk-Xv payload capacity.

VP specific processes

These Processes include VPI setting as well as VP asynchronous multiplexing. Each of these Specific Processes is characterized by the Virtual Path Identifier number K, where $0 \leq K \leq 2^N - 1$.

NOTE 3 – The value of N represents the number of bits in the VPI field and is an integer number. Its maximum value is equal to 12 for the ATM NNI. Its maximum value is equal to 8 for the ATM UNI.

VPI-K activation

– Layer Management function: The Specific Processes perform the operation specified below when it is activated (MI_VPI-KActive is true).

The format of the Characteristic Information (VP_CI) is given in Figure 14-98.

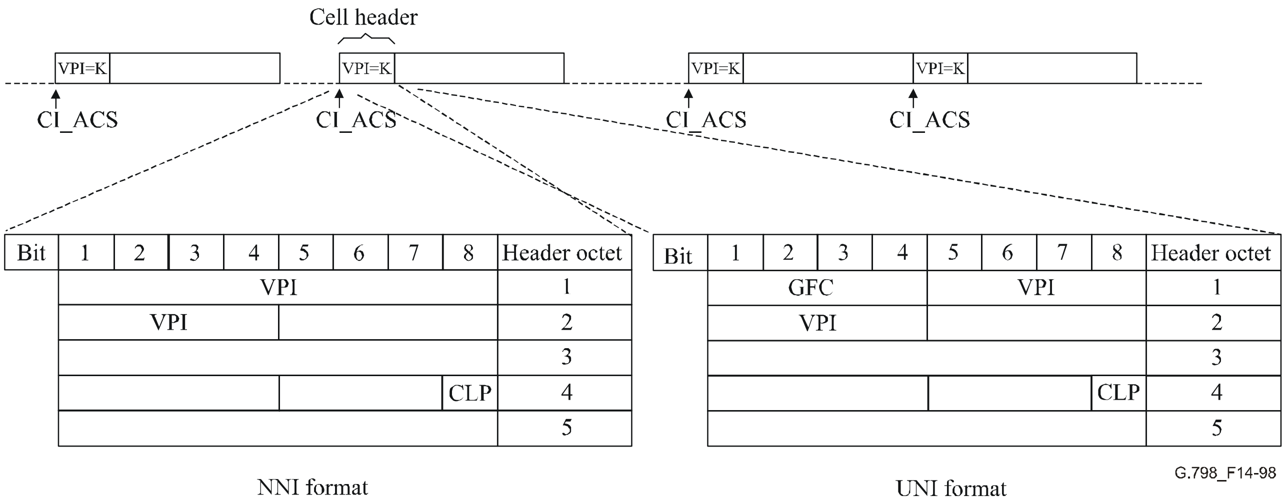


Figure 14-98/G.798 – VP_CI (NNI format)

VPI setting

– Transfer function: VPI setting inserts the value of "K" as VPI for each active Specific Function.

– Layer Management function: VPI setting is based on the activation of the Specific function by MI_VPI-KActive.

VP *multiplexing*

– Transfer function: Asynchronous multiplexing is performed for each active Specific function.

Common processes

The Common Processes include: Congestion control (selective cell discard (CLP based)), GFC processing, TP usage measurement, cell rate decoupling, HEC processing, cell information field scrambling, cell stream mapping and processing of the payload specific bytes vcPT and RES, to the OPUk OH. The logical ordering of the processes from input to output must be maintained.

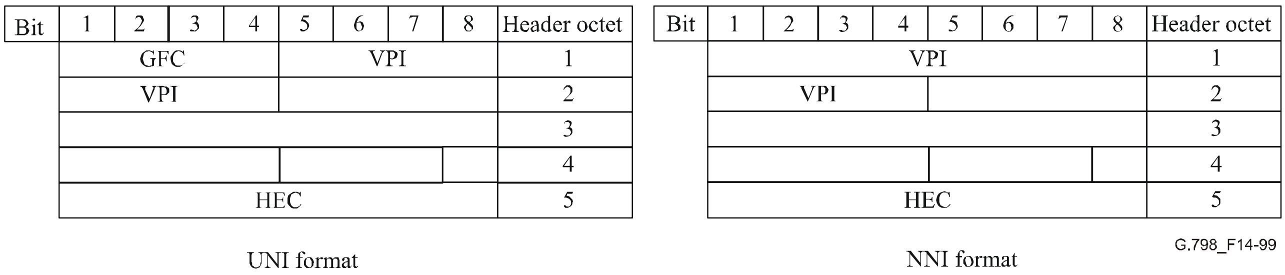


Figure 14-99/G.798 – Cell header information processed in ODUkP-X-L/VP_A_So

Congestion control

– Transfer function: If enabled by MI_CellDiscard = Active, this process shall perform selective cell discard according to CLP value. In the event of congestion, cells with CLP = 1 are subject to be discarded prior to cells with CLP = 0. See ITU-T Rec. I.371.1 for further details about the use of the CLP. In the event of congestion, the EFCI marking in the PTI field is set according to ITU-T Rec. I.361.

GFC processing

– Transfer function: The support of the GFC protocol applies to the UNI and in point-to-point configuration only and is an option. This process sets the GFC field. The GFC field processing is defined in ITU-T Recs I.150 and I.361.

– Layer Management function: The GFC function uses assigned and unassigned cells. Two modes of operation are available: Uncontrolled Transmission (MI_GFCActive = false) and Controlled Transmission (MI_GFCActive = true). In Uncontrolled Transmission mode, neither the controlling nor the controlled NE performs the GFC procedure. If enabled by MI_GFCActive = true, this process shall insert the GFC protocol in the GFC field. If the GFC function is not supported or the GFC function disabled by MI_GFCActive = false, the binary contents of the GFC field shall be set to "0000".

TP usage measurement

– Transfer function: Cell transmission is indicated to layer management.

– Layer Management function: The process shall count the transmitted cells for cell measurement purposes. This cell counting shall be activated/deactivated by MI_TPusgActive.

Cell rate decoupling

– Transfer function: This process takes the ATM cell stream present at its input and inserts it into the OPUk-Xv payload having a capacity of X_{AT} * 4 * 3808 bytes adding fixed stuff idle cells. The idle cells format is specified in ITU-T Rec. I.361. The cell rate decoupling process makes use of the ODUk-X-L local timing clock, frame position, and idle cell generator.

NOTE 4 – The clock rate and size of the OPUk-Xv is defined by AI_X_{AT}. In case of a change of X_{AT} the size shall be adjusted immediately. This shall not introduce any loss or errors to the mapped ATM cells except for the case where the incoming ATM cell rate exceeds the available ODUk-Xv payload capacity.

HEC Processing

– Transfer function: The HEC value for each cell is calculated and inserted into the HEC field. The method of HEC value calculation shall be according to ITU-T Rec. I.432.1.

Cell information field scrambling

– Transfer function: The self-synchronizing scrambler polynomial $x^{43} + 1$ has been identified for the SDH-based transmission paths and minimizes the error multiplication introduced by the self-synchronizing scrambling process. It is also used here for the mapping into ODUks. It scrambles the information field bits only. The operation of the scrambler shall be according to 7.3.4.1/I.432.1.

Cell stream mapping

– Transfer function: The octet structure of ATM cells shall be aligned with the octet structure of the OPUk-Xv and mapped into the OPUk-Xv payload area as defined in 18.2.3/G.709/Y.1331.

NOTE 5 – The clock rate and size of the OPUk-Xv is defined by AI_X_{AT}. In case of a change of X_{AT} the size shall be adjusted immediately. This shall not introduce any loss or errors to the mapped ATM cells except for the case where the incoming ATM cell rate exceeds the available ODUk-Xv payload capacity.

Processing of the payload specific bytes

RES: This payload dependent set of bytes is not used for the mapping of ATM cells into OPUk-Xv. The contents of this byte shall be 00Hex.

vcPT: The function shall insert code "0000 0100" (ATM mapping) into the vcPT byte position of the PSI overhead as defined in 18.1.2.2/G.709/Y.1331.

Defects: None.

Consequent actions: None.

Defect correlations: None.

Performance monitoring

The use of the Performance Monitoring parameters is for further study. The parameters for the following processes need to be defined:

- TP usage measurement;
- Count of discarded cells from congestion control.

14.6.2.3.2 ODUkP-X-L to ATM VP adaptation sink function (ODUkP-X-L/VP_A_Sk)

Symbol

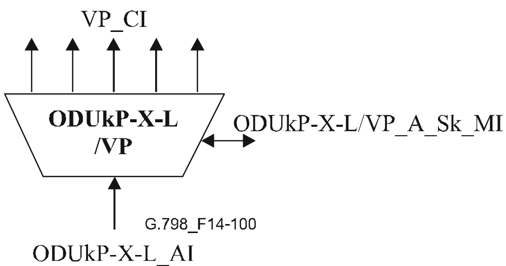


Figure 14-100/G.798 – ODUkP-X-L/VP_A_Sk symbol

Interfaces

Table 14-50/G.798 – ODUkP-X-L/VP_A_Sk input and output signals

Input(s)	Output(s)
ODUkP-X-L_AP: ODUkP-X-L_AI_CK ODUkP-X-L_AI_D ODUkP-X-L_AI_FS ODUkP-X-L_AI_TSF ODUkP-X-L_AI_TSD ODUkP-X-L_AI_X_{AR} **ODUkP-X-L/VP_A_Sk_MP**: ODUkP-X-L/VP_A_Sk_MI_Active ODUkP-X-L/VP_A_Sk_MI_CellDiscardActive ODUkP-X-L/VP_A_Sk_MI_TPusgActive ODUkP-X-L/VP_A_Sk_MI_VPIrange ODUkP-X-L/VP_A_Sk_MI_HECactive ODUkP-X-L/VP_A_Sk_MI_GFCactive ODUkP-X-L/VP_A_Sk_MI_DTDLuseEnabled ODUkP-X-L/VP_A_Sk_MI_VPI-KActive ODUkP-X-L/VP_A_Sk_MI_VPI-K_SAISActive	**per VP_CP, for each VP configured**: VP_CI_D VP_CI_ACS VP_CI_SSF VP_CI_CNGI **ODUkP-X-L/VP_A_Sk_MP**: ODUkP-X-L/VP_A_Sk_MI_cVcPLM ODUkP-X-L/VP_A_Sk_MI_cLCD ODUkP-X-L/VP_A_Sk_MI_AcVcPT

Processes

The ODUkP-X-L/VP_A_Sk function provides adaptation from the ODUk-X-L to the ATM Virtual Path. This is performed by a grouping of Specific Processes and Common Processes as shown in Figure 14-101.

Activation

– The ODUkP-X-L/VP_A_Sk function shall access the access point and perform the Common and Specific Processes operation specified below when it is activated (MI_Active is true). Otherwise, it shall activate the SSF signals and generate AIS at its output (CP) and not report its status via the management point.

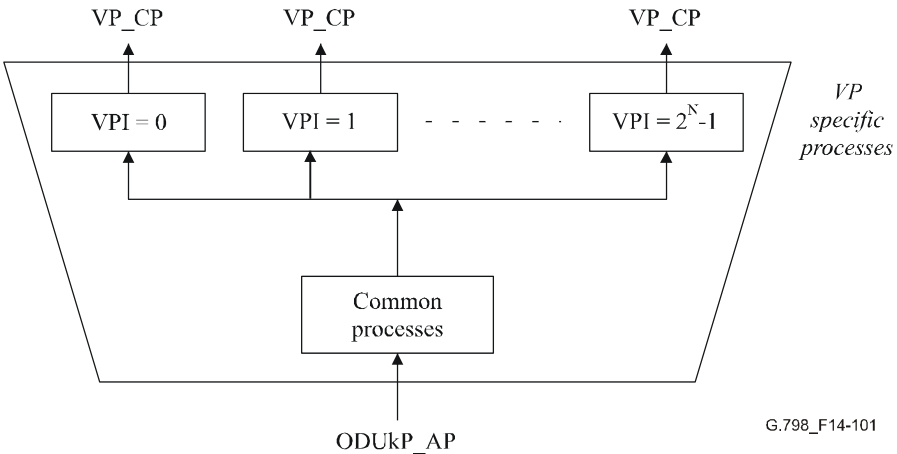


Figure 14-101/G.798 – ODUkP-X-L/VP_A_Sk atomic function decomposed into specific and common processes parts

NOTE 1 – The sequential order of the processes within the atomic functions is important. For the correct order, refer to the ordering of the processes given below.

Common processes

These Common Processes include: Handling of the payload specific bytes (vcPT, PSI and RES), demapping, cell delineation, cell information field descrambling, HEC processing, cell rate decoupling, TP usage measurement, header verification, GFC processing, VPI verification and congestion control (selective cell discard (CLP based)). The logical ordering of these processes from input to output must be maintained.

Handling of payload specific bytes

vcPT: The function shall extract the vcPT byte from the PSI overhead as defined in 8.7.3. The accepted vcPT value is available at the MP (MI_AcVcPT) and is used for VcPLM defect detection.

RES: This payload dependent byte is not used for this mapping and the receiver shall ignore its contents.

Demapping

– Transfer function: The cell stream shall be extracted from OPUk-XV payload in the ODUkP-X-L_AI as defined in 18.2.3/G.709/Y.1331.

NOTE 2 – The clock rate and size of the OPUk-Xv is defined by AI_X_{AR}. In case of a change of X_{AR} the size shall be adjusted immediately. This shall not introduce any loss or errors to the demapped ATM cells.

Cell delineation

– Transfer function: Cell delineation is performed on the continuos cell stream. The cell delineation algorithm should be in accordance with ITU-T Rec. I.432.1. The OCD events are indicated to the Layer Management function.

– Layer Management function: Loss of Cell Delineation defect (dLCD) shall be declared as in the defect clause below.

Cell information field descrambling

– Transfer function: The self-synchronizing descrambler polynomial $x^{43} + 1$ has been identified for the SDH-based transmission paths and minimizes the error multiplication introduced by the self-synchronizing scrambling process (factor 2). It is also used here for the mapping into ODUks. It descrambles the information field bits only. The operation of the descrambler in relation to the HEC cell delineation state diagram shall be according to 7.3.4.1/I.432.1.

HEC processing

– Transfer function: HEC verification and correction shall be according to ITU-T Rec. I.432.1. Cells determined to have an invalid and incorrectible HEC pattern shall be discarded.

– Layer Management function: A count of invalid HEC events and a count of invalid HEC cell discard events are maintained with threshold crossings checked. HEC correction mode may be activated/deactivated by MI_HECactive. The HEC correction mode should be activated by default.

Cell rate decoupling

– Transfer function: The process shall extract the idle cells used as fixed stuff in the far-end ODUkP-X-L/VP adaptation source function.

TP usage measurement

– Transfer function: The cell reception is indicated to the Layer Management function.

– Layer Management function: The process shall count the received cells for cell measurement purposes. This cell counting shall be activated/deactivated by MI_TPusgActive.

Header verification

– Transfer function: The receiving function shall verify that the first four octets of the ATM cell header are recognizable as being a valid header pattern. Cells with unrecognized header patterns shall be discarded. An indication of an invalid header cell discard event is provided to layer management.

Invalid header patterns from paths based on OTN transmission systems are as follows (except idle cell) (x=any value):

	GFC	VPI	VCI	PTI	CLP
UNI	xxxx	all 0's	all 0's	xxx	1

	VPI	VCI	PTI	CLP
NNI	all 0's	all 0's	xxx	1

– Layer Management function: The process shall count the invalid header cell discard event.

GFC processing

– Transfer function: The support of the GFC protocol applies to the UNI and in point-to-point configuration only and is an option. This process extracts the GFC field. The GFC field processing is defined in ITU-T Recs I.150 and I.361.

– Layer Management function: The GFC function uses assigned and unassigned cells. Two modes of operation are available: Uncontrolled Transmission (MI_GFCActive = false) and Controlled Transmission (MI_GFCActive = true). In Uncontrolled Transmission mode, neither the controlling nor the controlled NE performs the GFC procedure. If enabled by MI_GFCActive = true, this process shall extract the GFC protocol from the GFC field.

NOTE 3 – According to the Protocol Reference Model (ITU-T Rec. I.321), the unassigned cells should be processed in the ATM layer. Some of the ATM layer processes are adaptation processes belonging to the adaptation function between the TP and the VP layer network. The unassigned cells as well as idle cells are per physical connection (VPI = 0, VCI = 0). For this reason, the idle and unassigned cells processing is allocated to the same atomic function.

VPI verification

– Transfer function: The process shall verify that the received cell VPI is valid. If the VPI is determined to be invalid (i.e., out-of-range VPI or not assigned), the cell shall be discarded. An indication of the invalid VPI cell discard events is provided to the Layer Management function.

– Layer Management function: The range of valid VPIs is given by MI_VPIrange. The invalid VPI cell discard events are counted.

Congestion control

– Transfer function: In the event of congestion, cells with CLP = 1 are subject to be discarded prior to cells with CLP = 0. See ITU-T Rec. I.371.1 for further details about the use of the CLP. In the event of congestion, the indication VP_CI_CNGI is set for the traffic management function VPTM_TT_So to insert EFCI on all VPs.

– Layer Management function: If enabled by MI_CellDiscardActive, this process shall perform selective cell discard according to CLP value.

VP specific processes

The function performs end-to-end VP-AIS insertion, segment VP-AIS insertion and demultiplexing on a per VP basis.

VPI-K activation

– Layer Management function: The Specific Processes perform the operation specified below when it is activated (MI_VPI-KActive is true). Otherwise, it shall send no cells and SSF = false.

End-to-end VP-AIS insertion

– Transfer function: This process inserts end-to-end VP-AIS cells from the Layer Management function for each active Specific Function.

– Layer Management function: End-to-end VP-AIS cells (Figure 14-102) shall be generated according to the Consequent Actions section of the Coordination Function below for each active Specific Function.

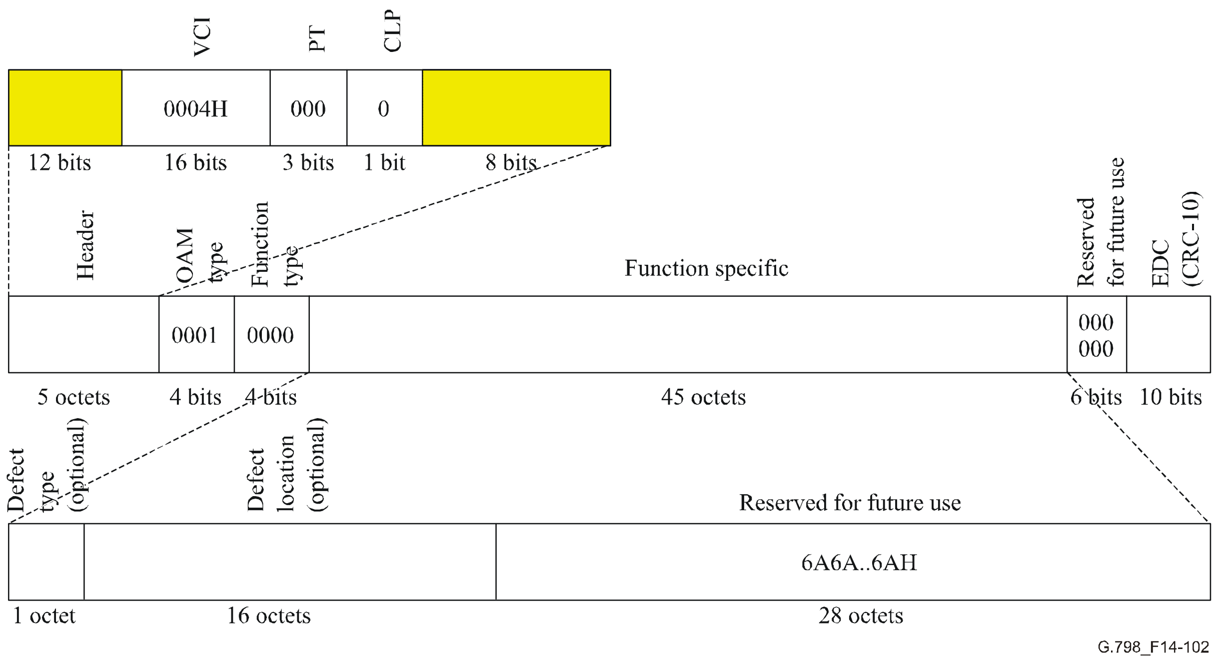


Figure 14-102/G.798 – End-to-end VP-AIS OAM cell as part of the VP_CI

Segment VP-AIS insertion

– Transfer function: This process inserts segment VP-AIS cells from the Layer Management function for each active Specific Function.

– Layer Management function: Segment VP-AIS cells (Figure 14-103) shall be generated according to the Consequent Actions section of the Coordination Function below for each active Specific Function and the segment VP-AIS cells insertion is also activated (MI_VPI-K_SAISactive is true).

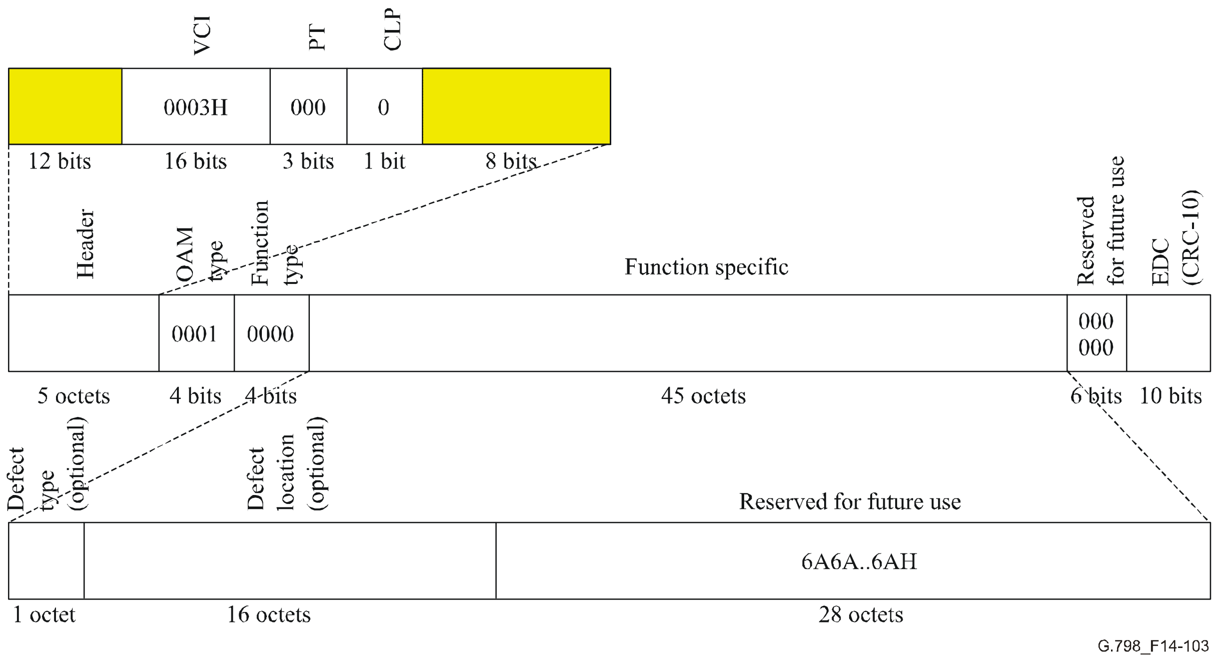


Figure 14-103/G.798 – Segment VP-AIS OAM cell as part of the VP_CI

VP demultiplexing

– Transfer function: The adaptation sink function has access to a specific VP identified by the number K ($0 \le K \le 2^N - 1$). For each active Specific Function, only the cells of that specific VPI-K are passed in client direction.

NOTE 4 – The value of N represents the number of bits in the VPI field and is an integer number. Its maximum value is equal to 12 for the ATM NNI. Its maximum value is equal to 8 for the ATM UNI.

Defects

The function shall detect for the dVcPLM and dLCD defects.

dVcPLM: See 6.2.4.2. The expected payload type is "000 0100" (ATM mapping).

dLCD: See ITU-T Rec. I.432.1.

Consequent actions

aCNGI ← "Event of Congestion" and CellDiscardActive

aSSF ← dVcPLM or dLCD or AI_TSF or (not MI_Active)

aAIS ← dVcPLM or dLCD or AI_TSF or (not MI_Active)

On declaration of aAIS, the function shall output end-to-end VP-AIS cells (Figure 14-102) on all active VPCs and segment VP-AIS cells (Figure 14-103) on all active VPCs for which MI_SAISactive is true, according to 9.2.1.1.1.1/I.610. On clearing of aAIS, the generation of end-to-end and segment VP-AIS cells shall be stopped. If either the function does not support the Defect Type and Defect Location (DTDL) option, or the function supports the DTDL option and the MI_DTDLuseEnabled is false, the binary contents of the Defect Type and Defect Location fields of the end-to-end and segment VP-AIS cell shall be coded as 6AH. If the function supports the DTDL option and if the MI_DTDLuseEnabled is true, the Defect Type and Defect Location values shall be inserted in the information field of the end-to-end and segment VP-AIS cells.

NOTE 5 – As long as the coding scheme of Defect Type and Defect Location fields is not defined, the fields shall be encoded as 6AH.

The consequent action aSSF is conveyed by CI_SSF through the VP_CI.

Defect correlations

cVcPLM ← dVcPLM and (not AI_TSF)

cLCD ← dLCD and (not dVcPLM) and (not AI_TSF)

Performance monitoring

The use of the Performance Monitoring parameters is for further study. The parameters for the following functions need to be defined:

- TP usage measurement;
- Count of discarded cells from congestion control;
- Count of invalid HEC events;
- Count of invalid HEC discard events;
- Count of invalid header discard events (one common counter for invalid header/invalid VPI/invalid VCI is maintained);
- OCD event.

14.6.2.4 ODUkP-X-L to NULL adaptation function (ODUkP-X-L/NULL_A)

The ODUkP-X-L to NULL adaptation functions perform the adaptation of a NULL test signal as defined in 18.2.5.1/G.709/Y.1331 into the ODUkP-X-L. The NULL signal is an all-0's pattern.

14.6.2.4.1 ODUkP-X-L to NULL adaptation source function (ODUkP-X-L/NULL_A_So)

The ODUkP-X-L/NULL_A_So function creates the ODUk-X-L signal from a free running clock. It maps the NULL signal into the payload of the OPUk-Xv and adds OPUk-Xv Overhead (RES, vcPT).

The information flow and processing of the ODUkP-X-L/NULL_A_So function is defined with reference to Figures 14-104 and 14-105.

Symbol

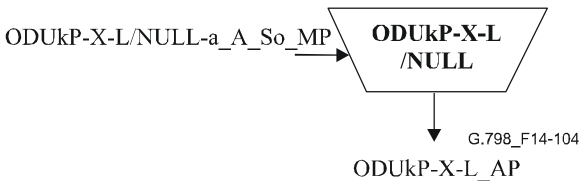


Figure 14-104/G.798 – ODUkP-X-L/NULL_A_So function

Interfaces

Table 14-51/G.798 – ODUkP-X-L/NULL_A_So inputs and outputs

Input(s)	Output(s)
ODUkP-X-L_AP: ODUkP-X-L_AI_X_{AT} **ODUkP-X-L/NULL-a_A_So_MP**: ODUkP-X-L/NULL-a_A_So_MI_Active	**ODUkP-X-L_AP**: ODUkP-X-L_AI_CK ODUkP-X-L_AI_D ODUkP-X-L_AI_FS ODUkP-X-L_AI_MFS

Processes

Activation

– The ODUkP-X-L/NULL_A_So function shall access the access point when it is activated (MI_Active is true). Otherwise, it shall not access the access point.

Clock and (Multi)Frame Start signal generation: The function shall generate a local ODUk-X-L clock (ODUkP-X-L_AI_CK) of "X_{AT} * 239/(239 – k) * $4^{(k-1)}$ * 2 488 320 kHz ± 20 ppm". The jitter and wander requirements as defined in Annex A/G.8251 (ODCa clock) apply.

The function shall generate the (multi)frame start reference signals ODUkP-X-L_AI_FS and ODUkP-X-L_AI_MFS for the ODUk-X-L signal. The ODUkP-X-L_AI_FS signal shall be active once per X_{AT} * 122 368 clock cycles. ODUkP-X-L_AI_MFS shall be active once every 256 frames.

NOTE 1 – The size and clock rate of the OPUk-Xv is defined by AI_X_{AT}. In case of a change of X_{AT} the clock rate shall be adjusted immediately. This shall not introduce any loss or errors to the mapped NULL signal.

Insert NULL signal: The function shall insert an all-0'pattern into the OPUk-Xv payload area as defined in 18.2.5.1/G.709/Y.1331.

NOTE 2 – The clock rate and size of the OPUk-Xv is defined by AI_X_{AT}. In case of a change of X_{AT} the size shall be adjusted immediately. This shall not introduce any loss or errors to the mapped NULL signal.

vcPT: The function shall insert code "1111 1101" into the vcPT byte position of the PSI overhead as defined in 18.1.2.2/G.709/Y.1331.

RES: The function shall insert all-0's into the RES bytes.

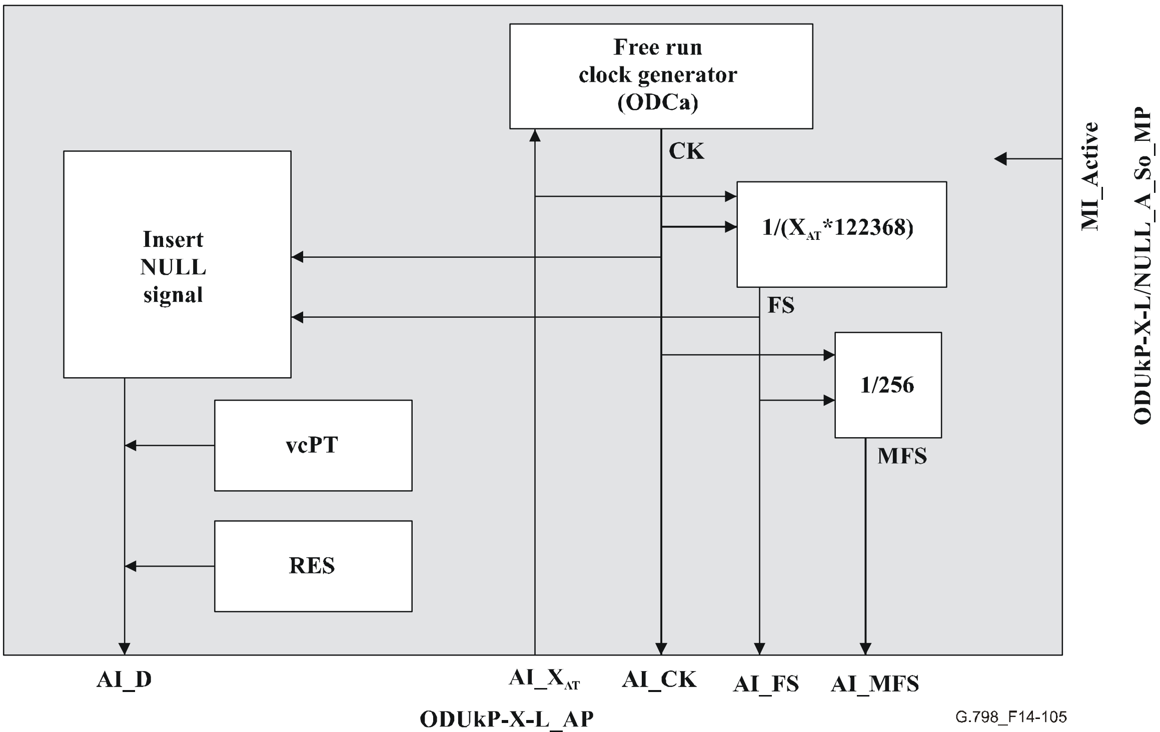


Figure 14-105/G.798 – ODUkP-X-L/NULL_A_So processes

Defects: None.

Consequent actions: None.

Defect correlations: None.

Performance monitoring: None.

14.6.2.4.2 ODUkP-X-L to NULL adaptation sink function (ODUkP-X-L/NULL_A_Sk)

The ODUkP-X-L/NULL_A_Sk extracts the OPUk-Xv Overhead (vcPT and RES) and monitors the reception of the correct payload type.

The information flow and processing of the ODUkP-X-L/NULL_A_Sk function is defined with reference to Figures 14-106 and 14-107.

Symbol

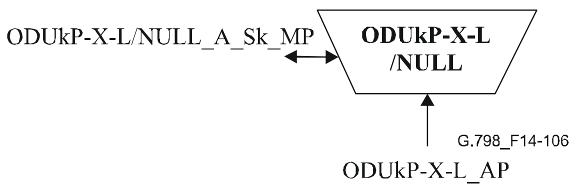


Figure 14-106/G.798 – ODUkP-X-L/NULL_A_Sk function

Interfaces

Table 14-52/G.798 – ODUkP-X-L/NULL_A_Sk inputs and outputs

Input(s)	Output(s)
ODUkP-X-L_AP: ODUkP-X-L_AI_CK ODUkP-X-L_AI_D ODUkP-X-L_AI_FS ODUkP-X-L_AI_TSF ODUkP-X-L_AI_X_{AR} **ODUkP-X-L/NULL_A_Sk_MP**: ODUkP-X-L/NULL_A_Sk_MI_Active	**ODUkP-X-L/NULL_A_Sk_MP**: ODUkP-X-L/NULL_A_Sk_MI_cPLM ODUkP-X-L/NULL_A_Sk_MI_AcPT

Processes

Activation

– The ODUkP-X-L/NULL_A_Sk function shall access the access point and perform the Common and Specific Processes operation specified below when it is activated (MI_Active is true). Otherwise, it shall not report its status via the management point.

vcPT: The function shall extract the vcPT byte from the PSI overhead as defined in 8.7.3. The accepted vcPT value is available at the MP (MI_AcVcPT) and is used for VcPLM defect detection.

RES: The value in the RES bytes shall be ignored.

Payload: The value in the OPUk-Xv payload area shall be ignored.

NOTE – The clock rate and size of the OPUk-Xv is defined by AI_X_{AR}. In case of a change of X_{AR}, the size shall be adjusted immediately. This shall not introduce any error.

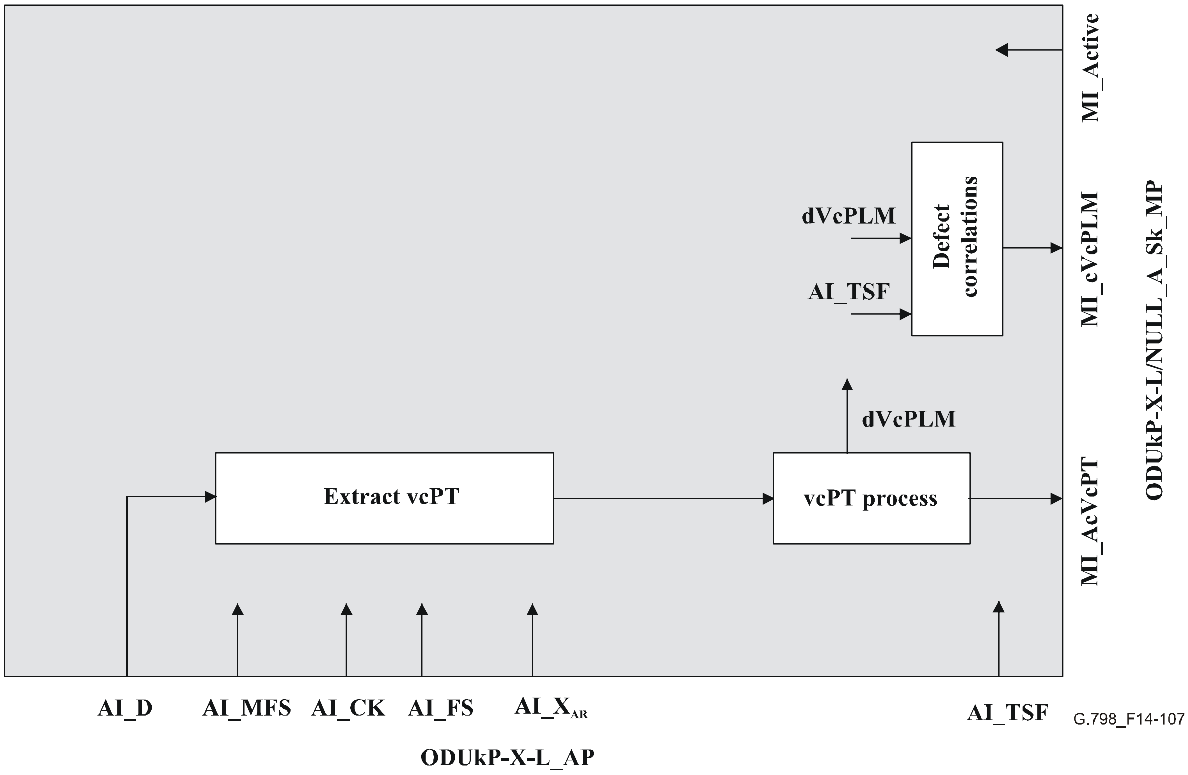


Figure 14-107/G.798 – ODUkP-X-L/NULL_A_Sk processes

Defects

The function shall detect for dVcPLM.

dVcPLM: See 6.2.4.2. The expected payload type is "1111 1101" (NULL test signal mapping) as defined in ITU-T Rec. G.709/Y.1331.

Consequent actions: None.

Defect correlations

cVcPLM ← dVcPLM and (not AI_TSF)

Performance monitoring: None.

14.6.2.5 ODUkP-X-L to PRBS adaptation function (ODUkP-X-L/PRBS_A)

The ODUkP-X-L to PRBS adaptation functions perform the adaptation of a PRBS test signal as defined in 18.2.5.2/G.709/Y.1331 into the ODUkP-X-L. The PRBS signal is a 2 147 483 647-bit pseudo-random test sequence (2^{31} – 1) as specified in 5.8/O.150.

14.6.2.5.1 ODUkP-X-L to PRBS adaptation source function (ODUkP-X-L/PRBS_A_So)

The ODUkP-X-L/PRBS_A_So function creates the ODUk-X-L signal from a free running clock. It maps the PRBS signal into the payload of the OPUk-Xv and adds OPUk Overhead (RES, vcPT).

The information flow and processing of the ODUkP-X-L/PRBS_A_So function is defined with reference to Figures 14-108 and 14-109.

Symbol

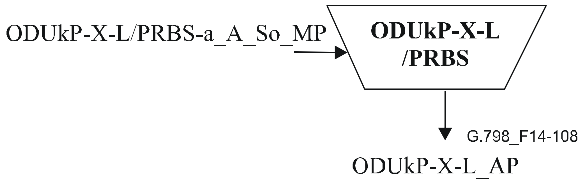


Figure 14-108/G.798 – ODUkP-X-L/PRBS_A_So function

Interfaces

Table 14-53/G.798 – ODUkP-X-L/PRBS_A_So inputs and outputs

Input(s)	Output(s)
ODUkP-X-L_AP: ODUkP-X-L_AI_X_{AT} **ODUkP-X-L/PRBS-a_A_So_MP**: ODUkP-X-L/PRBS-a_A_So_MI_Active	**ODUkP-X-L_AP**: ODUkP-X-L_AI_CK ODUkP-X-L_AI_D ODUkP-X-L_AI_FS ODUkP-X-L_AI_MFS

Processes

Activation

– The ODUkP-X-L/PRBS_A_So function shall access the access point when it is activated (MI_Active is true). Otherwise, it shall not access the access point.

Clock and (Multi)Frame Start signal generation: The function shall generate a local ODUk-X-L clock (ODUkP-X-L_AI_CK) of "X_{AT} * 239/(239 – k) * $4^{(k-1)}$ * 2 488 320 kHz ± 20 ppm". The jitter and wander requirements as defined in Annex A/G.8251 (ODCa clock) apply.

The function shall generate the (multi)frame start reference signals ODUkP-X-L_AI_FS and ODUkP-X-L_AI_MFS for the ODUk-X-L signal. The ODUkP-X-L_AI_FS signal shall be active once per X_{AT} * 122 368 clock cycles. ODUkP-X-L_AI_MFS shall be active once every 256 frames.

NOTE 1 – The size and clock rate of the OPUk-Xv is defined by AI_X_{AT}. In case of a change of X_{AT} the clock rate shall be adjusted immediately. This shall not introduce any loss or errors to the mapped NULL signal.

Generate and insert PRBS signal: The function shall generate the PRBS signal and insert it into the OPUk-Xv payload area as defined in 18.2.5.2/G.709/Y.1331.

NOTE 2 – The clock rate and size of the OPUk-Xv is defined by AI_X_{AT}. In case of a change of X_{AT} the size shall be adjusted immediately. This shall not introduce any loss or errors to the mapped PRBS signal.

vcPT: The function shall insert code "1111 1110" into the vcPT byte position of the PSI overhead as defined in 18.1.2.2/G.709/Y.1331.

RES: The function shall insert all-0's into the RES bytes.

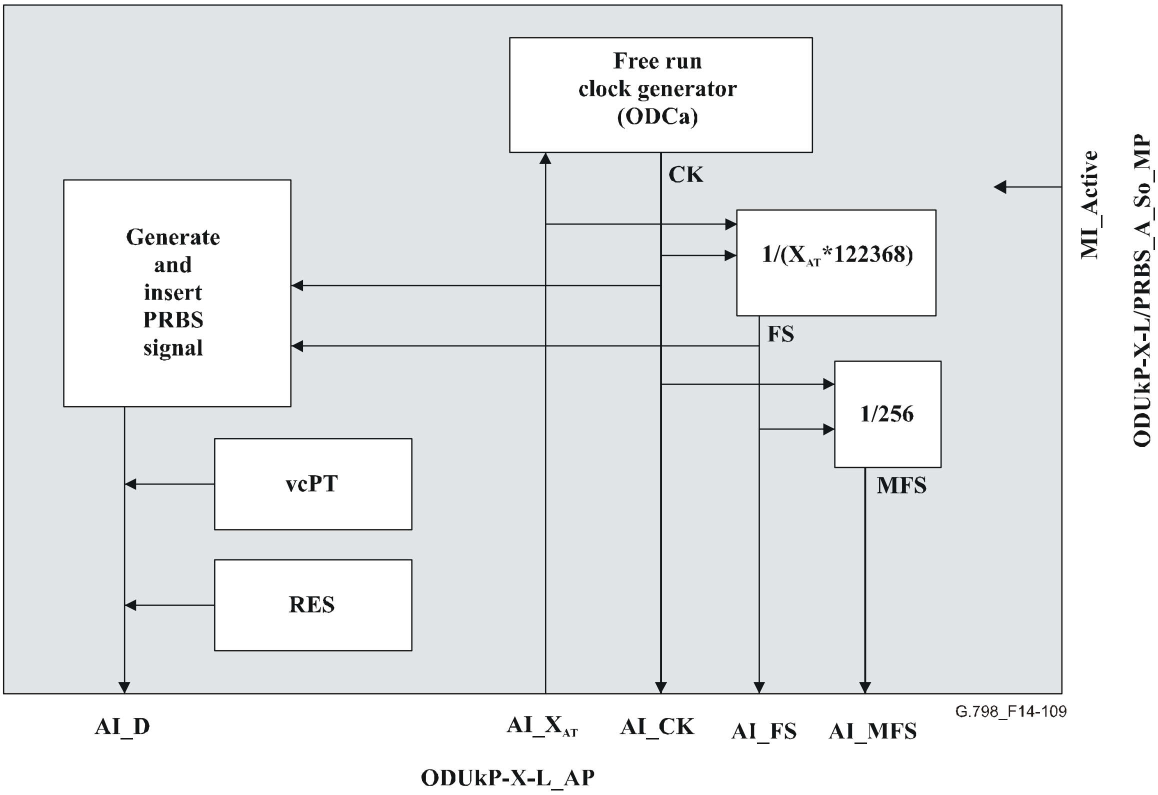


Figure 14-109/G.798 – ODUkP-X-L/PRBS_A_So processes

Defects: None.

Consequent actions: None.

Defect correlations: None.

Performance monitoring: None.

14.6.2.5.2 ODUkP-X-L to PRBS adaptation sink function (ODUkP-X-L/PRBS_A_Sk)

The ODUkP-X-L/PRBS_A_Sk recovers the PRBS test signal from the OPUk-Xv payload area and monitors test sequence errors (TSE) in the PRBS sequence. It extracts the OPUk-Xv Overhead (vcPT and RES) and monitors the reception of the correct payload type.

The information flow and processing of the ODUkP-X-L/PRBS_A_Sk function is defined with reference to Figures 14-110 and 14-111.

Symbol

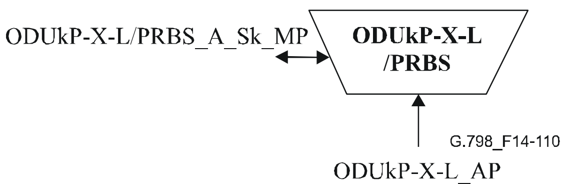


Figure 14-110/G.798 – ODUkP-X-L/PRBS_A_Sk function

Interfaces

Table 14-54/G.798 – ODUkP-X-L/PRBS_A_Sk inputs and outputs

Input(s)	Output(s)
ODUkP-X-L_AP: ODUkP-X-L_AI_CK ODUkP-X-L_AI_D ODUkP-X-L_AI_FS ODUkP-X-L_AI_TSF ODUkP-X-L_AI_X_{AR} **ODUkP-X-L/PRBS_A_Sk_MP**: ODUkP-X-L/PRBS_A_Sk_MI_Active	**ODUkP-X-L/PRBS_A_Sk_MP**: ODUkP-X-L/PRBS_A_Sk_MI_cPLM ODUkP-X-L/PRBS_A_Sk_MI_AcPT ODUkP-X-L/PRBS_A_Sk_MI_cLSS ODUkP-X-L/PRBS_A_Sk_MI_pN_TSE

Processes

Activation

– The ODUkP-X-L/PRBS_A_Sk function shall access the access point and perform the Common and Specific Processes operation specified below when it is activated (MI_Active is true). Otherwise, it shall not report its status via the management point.

vcPT: The function shall extract the vcPT byte from the PSI overhead as defined in 8.7.3. The accepted vcPT value is available at the MP (MI_AcVcPT) and is used for VcPLM defect detection.

RES: The value in the RES bytes shall be ignored.

TSE check: Test sequence errors (TSE) are bit errors in the PRBS data stream extracted from the OPUk-Xv payload area and shall be detected whenever the PRBS detector is in lock and the received data bit does not match the expected value.

NOTE – The clock rate and size of the OPUk-Xv is defined by AI_X_{AR}. In case of a change of X_{AR} the size shall be adjusted immediately. This shall not introduce any error.

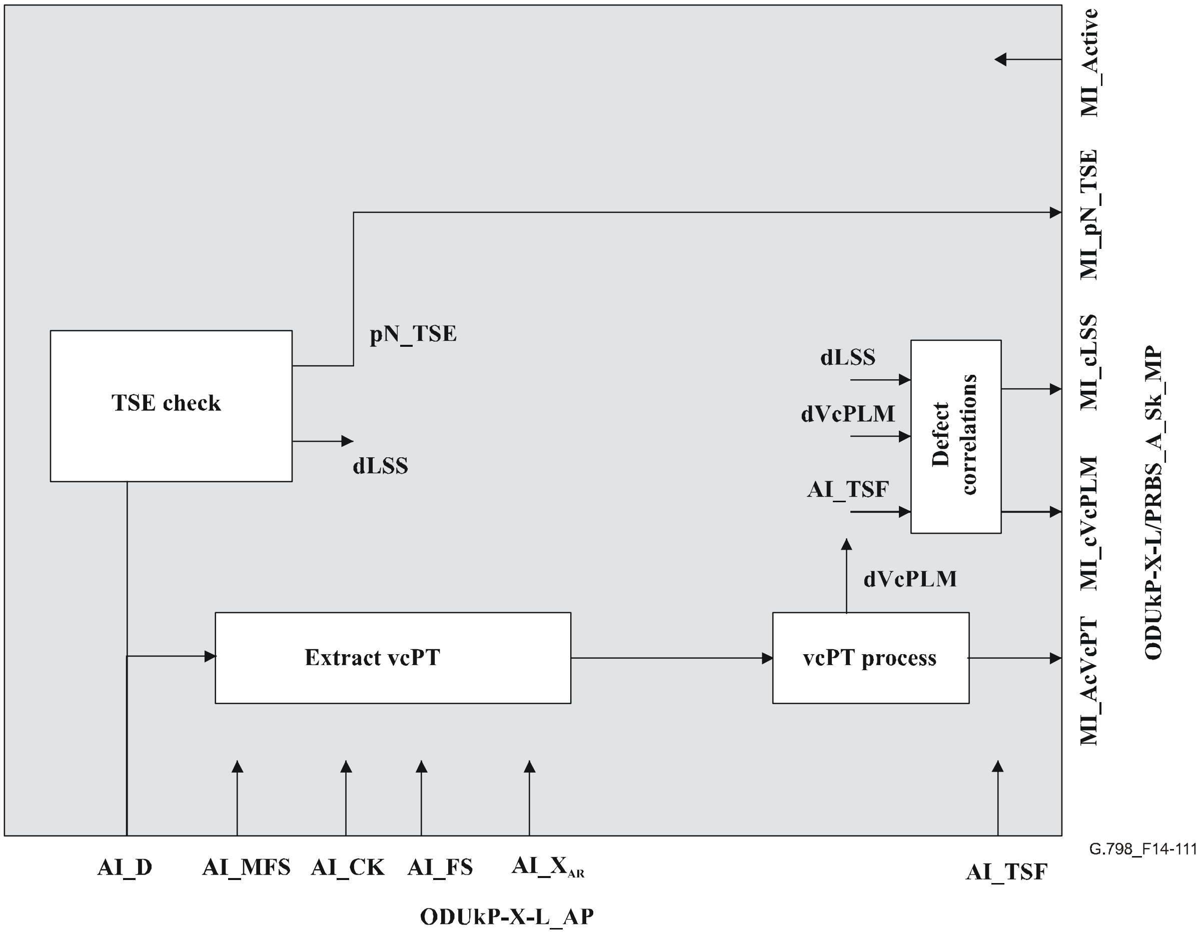


Figure 14-111/G.798 – ODUkP-X-L/PRBS_A_Sk processes

Defects

The function shall detect for dVcPLM and dLSS.

dVcPLM: See 6.2.4.2. The expected payload type is "1111 1110" (PRBS test signal mapping) as defined in ITU-T Rec. G.709/Y.1331.

dLSS: The function shall detect for loss of PRBS lock (dLSS) according to the criteria defined in 2.6/O.151.

Consequent actions: None.

Defect correlations

cVcPLM ← dVcPLM and (not AI_TSF)

cLSS ← dLSS and (not AI_TSF) and (not dVcPLM)

Performance monitoring

pN_TSE ← Sum of Test Sequence Errors (TSE) within one second period.

Annex A

Optical Section (OSx) and Constant Bit Rate (CBRx) layer functions

The OSx and CBRx layer functions are not part of the OTN. They are defined in this Recommendation in order to provide transparent transport of constant bit rate (CBR) signals over the OTN. The CBR signal is either mapped into the ODU (see 14.3.1) or directly into the OCh (see 12.3.3).

The parameter x defines the supported bit rate or bit rate range. The values x = 2G5, 10G and 40G are defined for client signals that comply to the SDH bit rates as defined in Table A.1. Support for other bit rates and bit rate ranges is for further study.

Table A.1/G.798 – Defined values for x

x	Bit rate	Clock range
2G5	2 488 320 kbits ± 20 ppm	2 488 320 kHz ± 20 ppm
10G	9 953 280 kbits ± 20 ppm	9 953 280 kHz ± 20 ppm
40G	39 813 120 kbits ± 20 ppm	39 813 120 kHz ± 20 ppm

Figure A.1 illustrates the OSx layer network and CBRx layer adaptation functions. The OSx layer network represents physical optical interface for constant bit rate signals. The information crossing the OSx termination connection point (OSx_TCP) is referred to as the OSx characteristic information (OSx_CI). The information crossing the OSx access point (OSx_AP) is referred to as the OSx adapted information (OSx_AI).

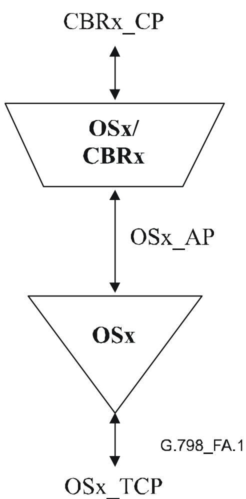


Figure A.1/G.798 – OSx layer network and client layer adaptation functions

A.1 Connection functions (N/A)

Not applicable.

A.2 Termination functions

A.2.1 OSx Trail Termination function (OSx_TT) (x = 2G5, 10G, 40G)

The OSx_TT functions are responsible for the end-to-end supervision of the OSx trail. Figure A.2 shows the combination of the unidirectional sink and source functions to form a bidirectional function.

NOTE – For the case an STM-N signal is to be transported as a CBR signal, the OSx_TT functions are equivalent to the OSn_TT functions specified in ITU-T Rec. G.783.

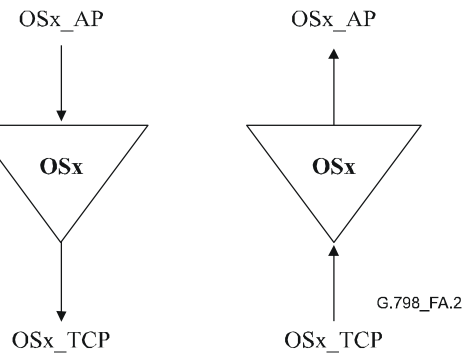


Figure A.2/G.798 – OSx_TT

A.2.1.1 OS trail termination source function (OSx_TT_So) (x = 2G5, 10G, 40G)

The information flow and processing of the OSx_TT_So function is defined with reference to Figures A.3 and A.4. The OSx_TT_So generates an optical signal. The physical parameters of the signal depend on the application. For SDH type interfaces the specifications in ITU-T Rec. G.957 or G.691 apply.

Symbol

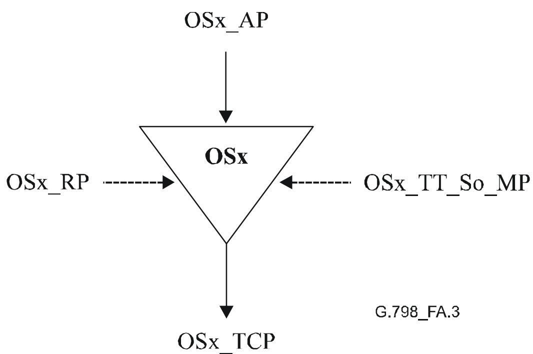


Figure A.3/G.798 – OSx_TT_So function

Interfaces

Table A.2/G.798 – OSx_TT_So inputs and outputs

Input(s)	Output(s)
OSx_AP: OSx_AI_D **OSx_RP**: OSx_RI_APR (Note 1) **OSx_TT_So_MP**: OSx_TT_So_MI_APRCntrl (Notes 1 and 2)	**OSx_TCP**: OSx_CI
NOTE 1 – If APR is required. NOTE 2 – The APRCntrl commands depend on the specific APR process.	

Processes

The processes associated with the OSx_TT_So function are depicted in Figure A.4.

Automatic Power Reduction (APR): For eye safety considerations, according to IEC 60825-1 and IEC 60825-2, it may be necessary to provide for a capability for Automatic (optical) Power Reduction (APR) in case of loss of the optical input signal at the sink function. The OSx_TT_So performs in this case the power reduction for the outgoing OSx signal based on the trigger criteria from the sink (RI_APR) and control information (MI_APRCntrl). The specific APR procedures and trigger criteria are outside the scope of this Recommendation. Clause 6.2/G.664 provides basic requirements for APR.

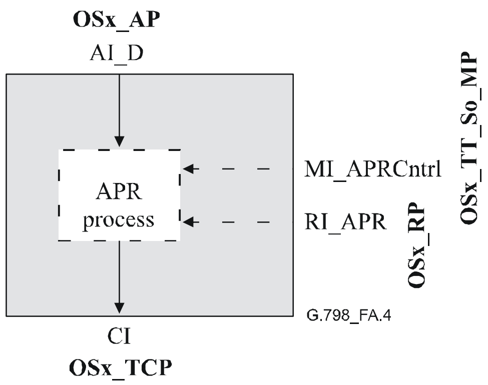


Figure A.4/G.798 – OSx_TT_So processes

Defects: None.

Consequent actions: None.

Defect correlations: None.

Performance monitoring: None.

A.2.1.2 OSx trail termination sink function (OSx_TT_Sk) (x = 2G5, 10G, 40G)

The information flow and processing of the OSx_TT_Sk function is defined with reference to Figures A.5 and A.6. The OSx_TT_Sk reports the state of the OSx trail. The OSx_TT_Sk accepts an optical signal. The physical parameters of the signal depend on the application. For SDH type interfaces the specifications in ITU-T Rec. G.957 or G.691 apply.

Symbol

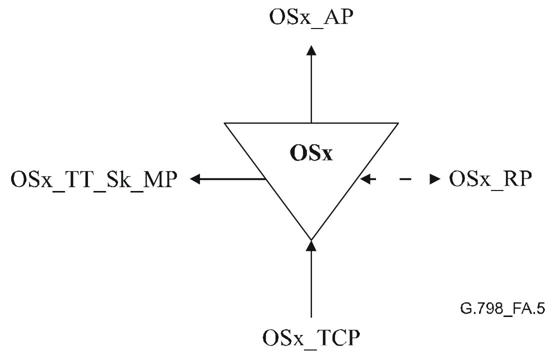


Figure A.5/G.798 – OSx_TT_Sk function

Interfaces

Table A.3/G.798 – OSx_TT_Sk inputs and outputs

Input(s)	Output(s)
OSx_TCP: OSx_CI	**OSx_AP**: OSx_AI_D OSx_AI_TSF **OTSn_RP**: OTSn_RI_APR (Note) **OSx_TT_Sk_MP**: OSx_TT_Sk_MI_cLOS OSx_TT_Sk_MI_pN_DS
NOTE – If APR is required.	

Processes

The processes associated with the OSx_TT_Sk function are depicted in Figure A.6.

Automatic Power Reduction (APR): For eye safety considerations, according to IEC 60825-1 and IEC 60825-2, it may be necessary to provide for a capability for Automatic (optical) Power Reduction (APR) in case of loss of the optical input signal at the sink function. The OSx_TT_Sk generates in this case the APR trigger criteria based on the incoming OSx signal (OTSn_CI) and forwards it to the OSx_TT_So (RI_APR). The specific APR procedures and trigger criteria are outside the scope of this Recommendation. Clause 6.2/G.664 provides basic requirements for APR.

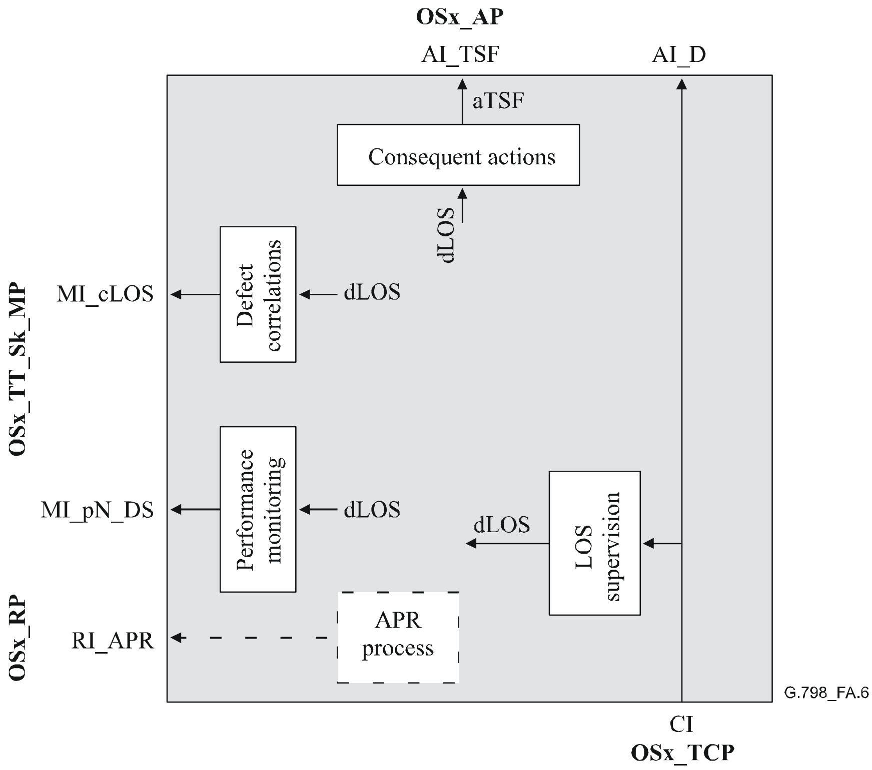


Figure A.6/G.798 – OSx_TT_Sk processes

Defects

The OSx_TT_Sk function shall detect for dLOS defect.

dLOS: See 6.2.1.1/G.783.

Consequent actions

The OSx_TT_Sk function shall perform the following consequent actions.

aTSF ← dLOS

Defect correlations

The OSx_TT_Sk function shall perform the following defect correlations.

cLOS ← dLOS

Performance monitoring

The OSx_TT_Sk function shall perform the following performance monitoring primitives. The performance monitoring primitives shall be reported to the EMF.

pN_DS ← dLOS

A.3 Adaptation functions

A.3.1 OSx to CBRx adaptation (OSx/CBRx_A) (x = 2G5, 10G, 40G)

The OSx to CBRx adaptation functions perform the adaptation between the OSx layer adapted information and the characteristic information of a CBRx layer signal.

A.3.1.1 OSx to CBRx adaptation source function (OSx/CBRx_A_So) (x = 2G5, 10G, 40G)

The information flow and processing of the OSx/CBRx_A_So function is defined with reference to Figures A.7 and A.8.

Symbol

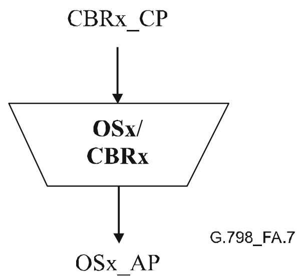


Figure A.7/G.798 – OSx/CBRx_A_So function

Interfaces

Table A.4/G.798 – OSx/CBRx_A_So inputs and outputs

Input(s)	Output(s)
CBRx_CP: CBRx_CI_D CBRx_CI_CK	**OSx_AP**: OSx_AI_D

Processes

The processes associated with the OSx/CBRx_A_So function are depicted in Figure A.8.

Mod (Optical Carrier Modulation): See 8.11.1. For parameters of SDH type interfaces, ITU-T Recs G.957 and G.691 apply.

Optical signal pre-conditioning: Pre-conditioning of the single wavelength optical signal might be required. The specific conditioning processes depend on the OSx interface type (see ITU-T Recs G.957 and G.691 for SDH type interfaces). For optical pre-conditioning processes, see 8.11.2.

For the defined values of x, the jitter and wander requirements as defined in 9.3.1.1/G.783 apply.

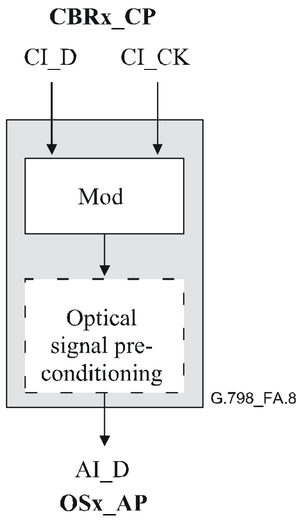


Figure A.8/G.798 – OSx/CBRx_A_So processes

Defects: None.

Consequent actions: None.

Defect correlations: None.

Performance monitoring: None.

A.3.1.2 OSx to CBRx adaptation sink function (OSx/CBRx_A_Sk) (x = 2G5, 10G, 40G)

The information flow and processing of the OSx/CBRx_A_Sk function is defined with reference to Figures A.9 and A.10.

Symbol

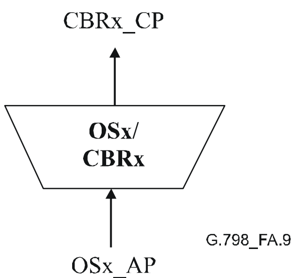


Figure A.9/G.798 – OSx/CBRx_A_Sk function

Interfaces

Table A.5/G.798 – OSx/CBRx_A_Sk inputs and outputs

Input(s)	Output(s)
OSx_AP: OSx_AI_D OSx_AI_TSF	**CBRx_CP**: CBRx_CI_D CBRx_CI_CK CBRx_CI_SSF

Processes

The processes associated with the OSx/CBRx_A_Sk function are depicted in Figure A.10.

Optical signal post-conditioning: Post-conditioning of the single wavelength signal might be required. The specific conditioning processes depend on the OSx interface type (see ITU-T Recs G.957 and G.691 for SDH type interfaces). For optical post-conditioning processes, see 8.11.2.

DMod (Optical Carrier Demodulation): See 8.11.1. For parameters of SDH type interfaces, ITU-T Recs G.957 and G.691 apply.

Clock recovery: The function shall recover the clock signal from the incoming data. For the defined values of x, the input clock ranges are defined in Table A.1 and the jitter and wander requirements as defined in 9.3.1.2/G.783 apply.

To ensure adequate immunity against the presence of Consecutive Identical Digits (CID) in the signal, the function shall comply with the specification in 15.1.4/G.783.

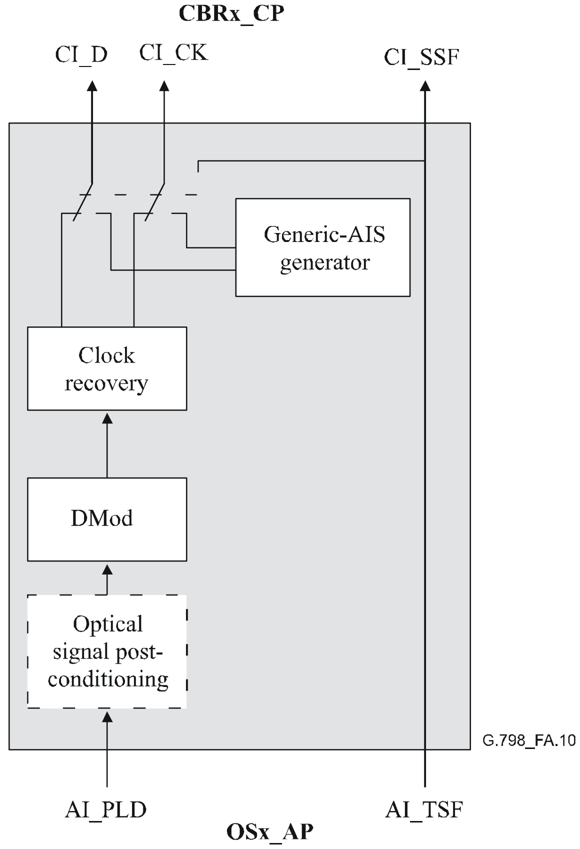


Figure A.10/G.798 – OSx/CBRx_A_Sk processes

Defects: None.

Consequent actions

The OSx/CBRx_A_Sk function performs the following consequent actions.

aSSF ← AI_TSF

aAIS ← AI_TSF

On declaration of aAIS the function shall output a GenericAIS pattern/signal as defined in 16.6/G.709/Y.1331 within X ms. On clearing of aAIS, the GenericAIS pattern/signal shall be removed within Y ms and normal data being output. The values for X and Y are for further study.

The GenericAIS clock start shall be independent from the incoming clock. For the defined values of x, the GenericAIS clock has to be within the range defined in Table A.1.

Defect correlations: None.

Performance monitoring: None.

Appendix I

Applications and functional diagrams

This appendix shows example functional diagrams for a number of OTN and non-OTN interface ports on OTN equipment and a number of OTN interface ports on non-OTN equipment.

NOTE – The following functional diagrams are for illustrative purposes only.

I.1 Transparent CBRx tributary interface port with optional SDH RS non-intrusive monitor on OTN equipment

NOTE – A generic, bit rate non-specific model is presented. Actual interface ports will be bit rate specific; e.g., 10 Gbit/s (n = 64, x = 10G).

Figures I.1 shows the equipment functions for this application. The processing down to the ODUk layer in direction to the line interface is shown.

The following operations are performed:

– termination of the G.957/G.691 optical signal;
– optional RSn non-intrusive monitoring in ingress and egress directions;
– mapping of CBR signal into the ODUk;
– termination of ODUk path overhead;
– termination of up to 3 levels of ODUk TCM overhead in line port direction (for TCM applications, see Appendix II).

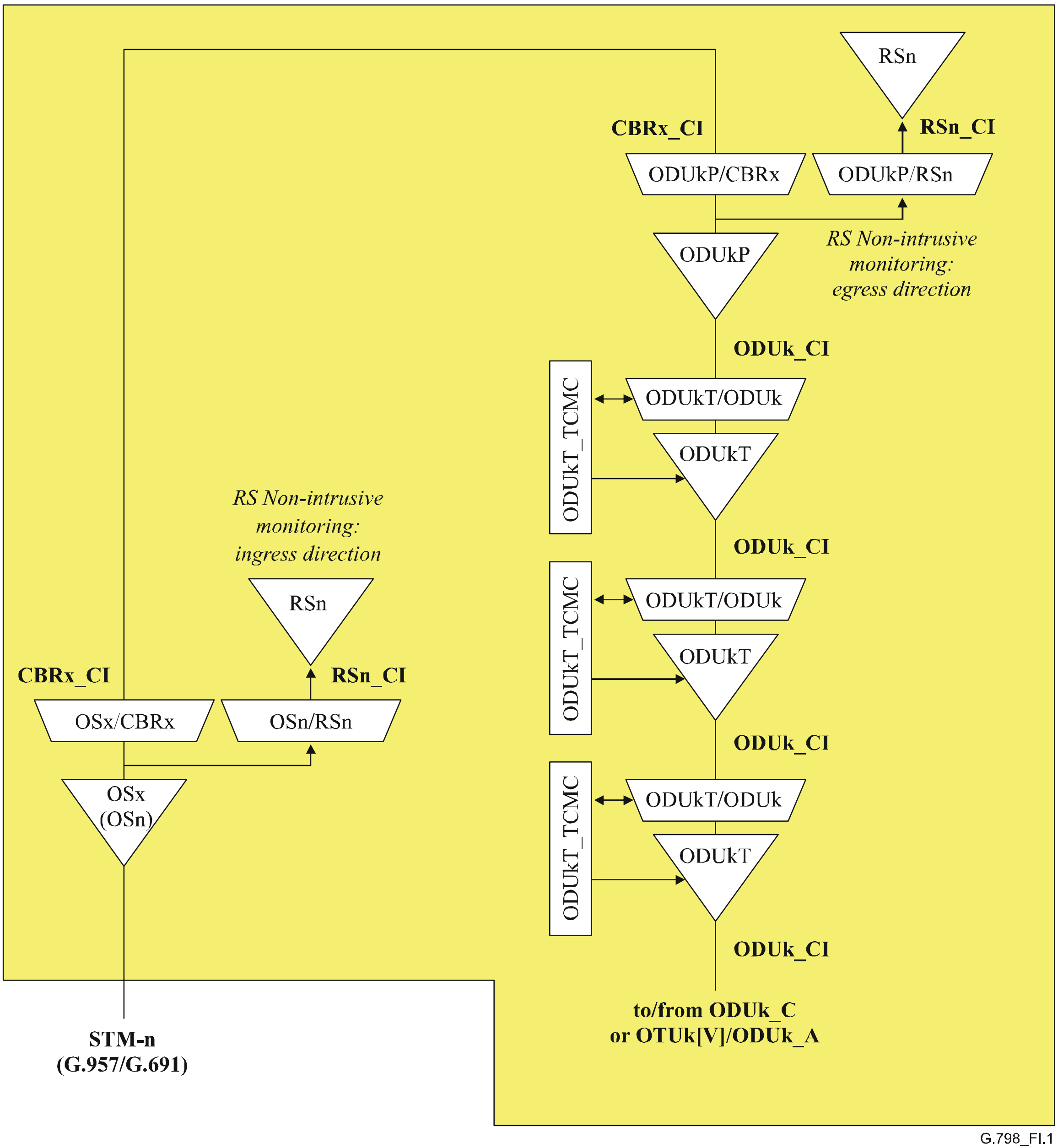


Figure I.1/G.798 – Transparent CBRx tributary interface port with optional SDH RS non-intrusive monitor on OTN equipment

I.2 OTM-0.m tributary interface port on OTN equipment

NOTE – A generic, bit rate non-specific model is presented. Actual interface ports will be bit rate specific; e.g., 10 Gbit/s (m = 2).

Figure I.2 shows the equipment functions for this application. The processing down to the ODUk layer in direction to the line interface is shown.

The following operations are performed:

– termination of the G.959.1 optical signal;

– termination of OTUk section overhead;

– termination of up to 3 levels of ODUk TCM overhead in tributary port direction (for TCM applications, see Appendix II);

– ODUkP non-intrusive monitoring in ingress and egress directions;

– termination of up to 3 levels of ODUk TCM overhead in the line port direction (for TCM applications, see Appendix II).

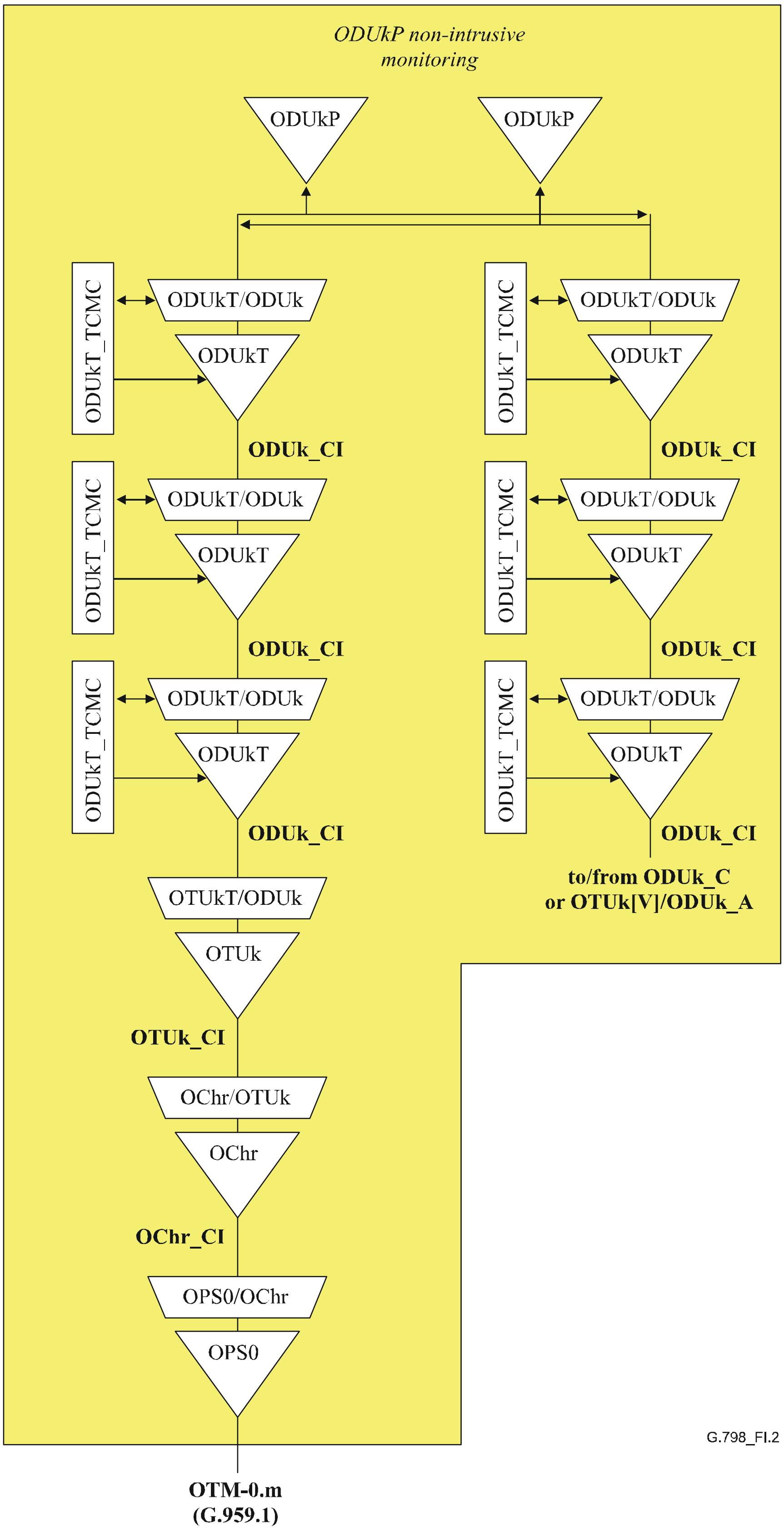


Figure I.2/G.798 – OTM-0.m tributary interface port on OTN equipment

I.3 Selectable CBRx/OTM-0.m tributary interface port on OTN equipment

NOTE – A generic, bit rate non-specific model is presented. Actual interface ports will be bit rate specific; e.g., 10 Gbit/s (n = 64, x = 10G, m = 2).

As the optical interfaces for CBRx (STM-n) and OTM-0.m are similar, it is possible to build equipment that can switch the processing between the two signals at the same tributary port. This is a combination of the two applications defined above. Depending on the selected interface mode one of two function sets is active.

Figure I.3 shows the equipment functions for this application. The processing down to the ODUk layer in direction to the line interface is shown.

The following operations independent of the interface mode are performed:

– termination of up to 3 levels of ODUk TCM overhead in the line port direction (for TCM applications, see Appendix II);

– termination of OTUk section overhead.

The following operations specific to the OTM-0.n mode are performed:

– termination of up to 3 levels of ODUk TCM overhead in tributary port direction (for TCM applications, see Appendix II);

– ODUkP non-intrusive monitoring in ingress and egress directions.

The following operations specific to the CBRx mode are performed:

– optional RSn non-intrusive monitoring in ingress and egress directions;

– mapping of CBR signal into the ODUk;

– termination of ODUk path overhead.

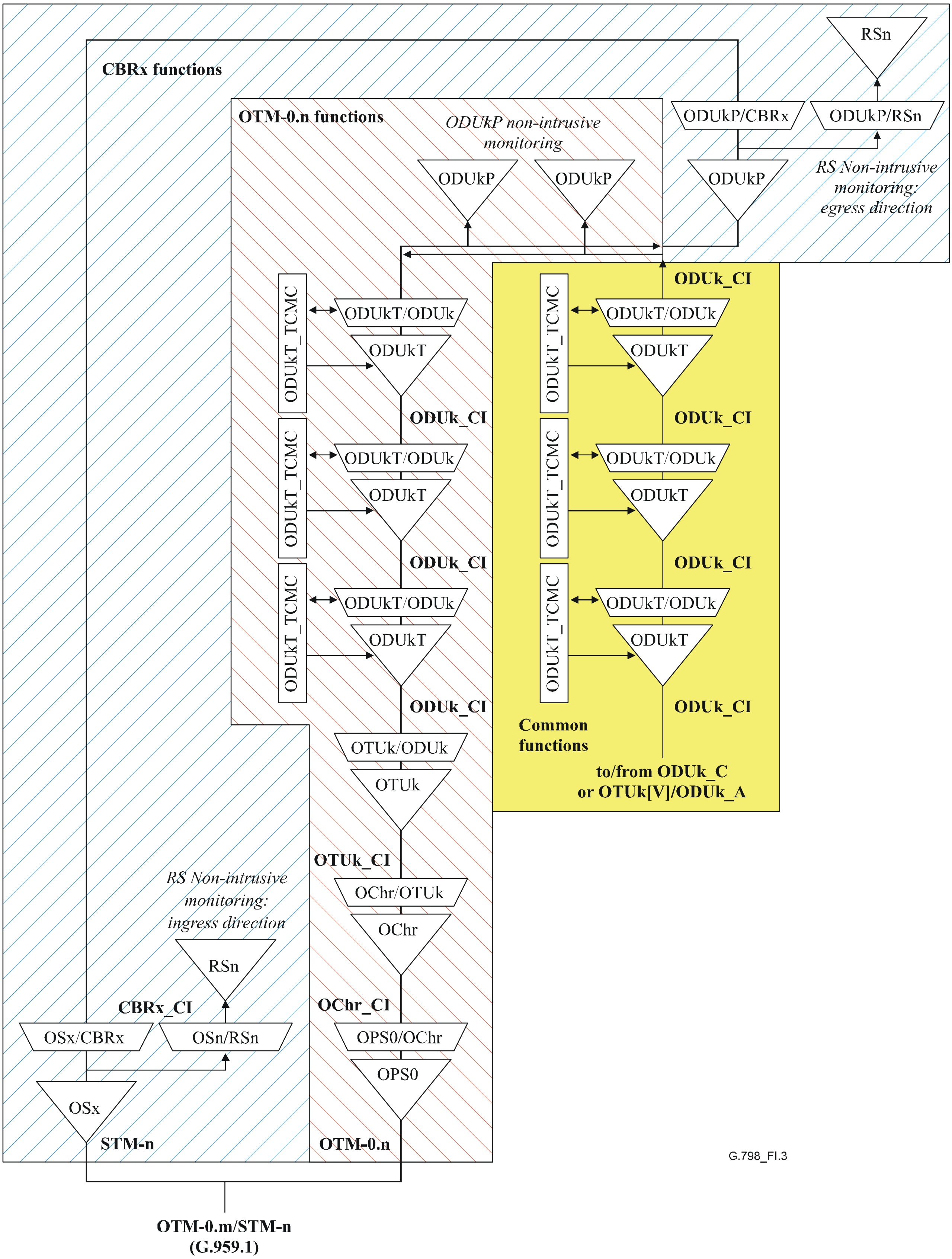


Figure I.3/G.798 – Selectable CBRx/OTM-0.m tributary interface port on OTN equipment

I.4 OTM-0.m interface ports on non-OTN equipment

OTN interfaces can be used in non-OTN equipment in the same way as SDH interfaces in non-SDH equipment (e.g., STM-n interfaces for IP routers and IP switches). Figure I.4 shows three examples, an OTM-0.1 interface port on an ATM Network Element, an OTM-0.2 interface port on an IP/Ethernet network element and an OTM-0.3 interface port on an SDH network element:

The OTM-0.1 interface port on ATM equipment supports:

– mapping and multiplexing of ATM VP signals into the ODU2;
– termination of ODU1 path overhead;
– termination of OTU1 section overhead;
– termination of the G.959.1 optical signal.

The OTM-0.2 interface port on IP/Ethernet equipment supports:

– mapping and multiplexing of IP [or Ethernet] packet signals into the ODU3 using GFP;
– termination of ODU2 path overhead;
– termination of OTU2 section overhead;
– termination of the G.959.1 optical signal.

The OTM-0.3 interface port on SDH equipment supports:

– mapping and multiplexing of the STM-256 signal (RS256 layer) into the ODU3;
– termination of ODU2 Path Overhead;
– termination of up to 1 level of ODU2 TCM overhead (for TCM applications, see Appendix II);
– termination of OTU2 section overhead;
– termination of the G.959.1 optical signal.

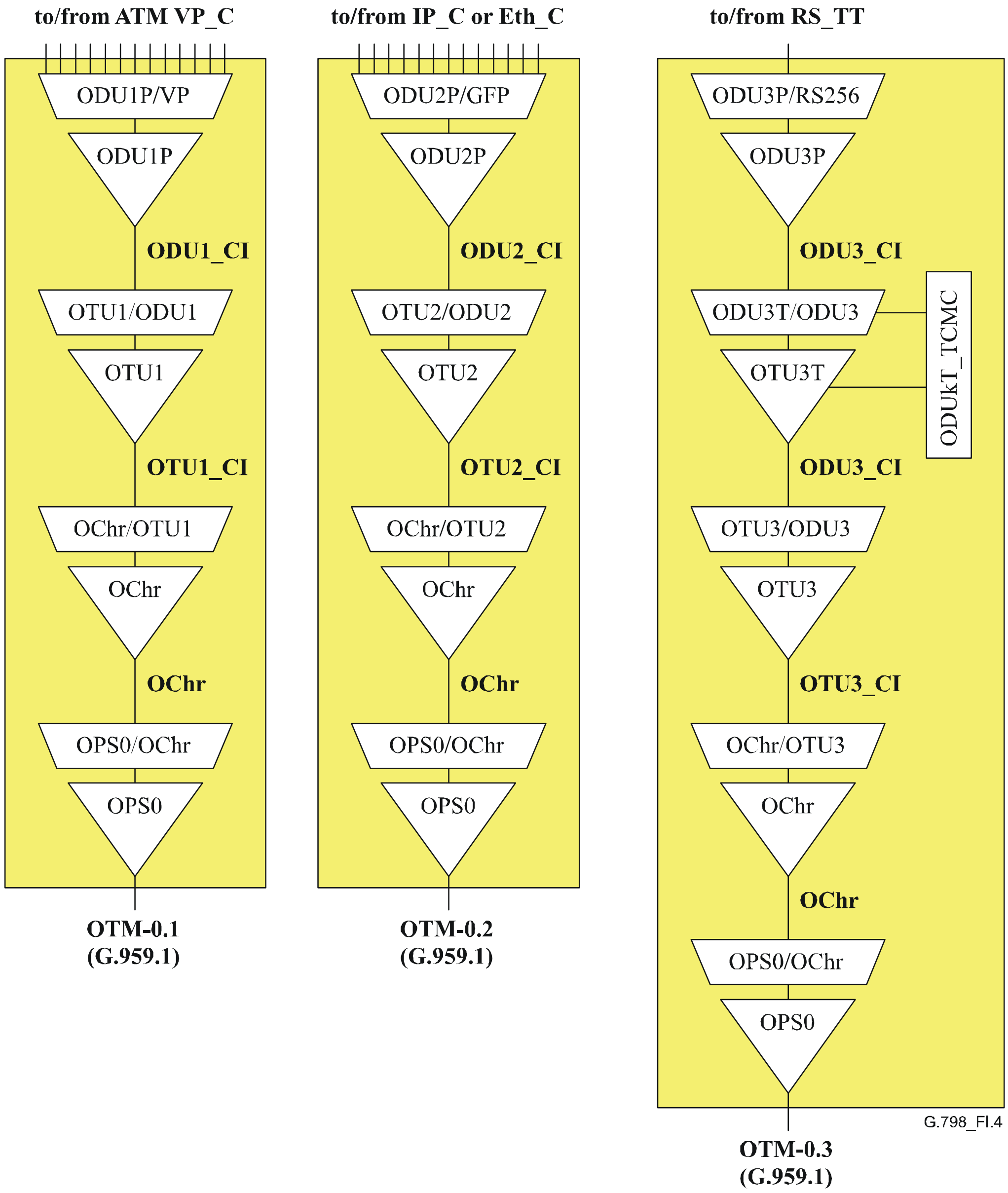


Figure I.4/G.798 – OTM-0.m interface ports on non-OTN equipment

For the above applications without ODUk TCM processing, the OTUk/ODUk overhead in the OTM-n.m signal has the following fields in use as a minimum (see Figure I.5):

– Client specific overhead if applicable;
– OPUk Payload Type in the Payload Structure Identifier (PSI);
– ODUk Path Monitoring (PM) overhead;
– OTUk Section Monitoring (SM) overhead;
– Frame Alignment (FAS, MFAS).

The other overhead fields are set to all-0's.

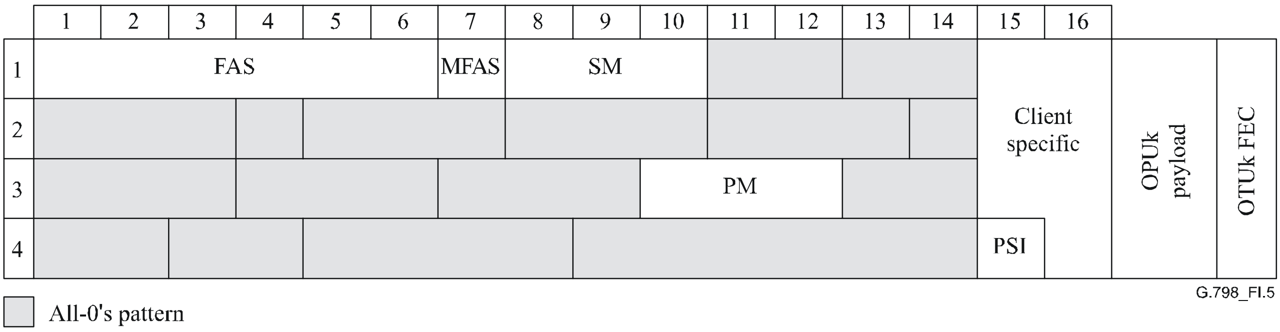


Figure I.5/G.798 – Minimum OTUk/ODUk overhead

I.5 OTM-n.m interface port with 3-R regeneration functionality for an ODUk connection function

Figure I.6 shows the equipment functions for this application. The processing up to the ODUk layer is shown. A vendor specific OTUkV signal is used in the example.

The OTM-n.m interface port supports:

– termination of the optical DWDM signal;

– termination of the OTSn and OMSn overhead;

– wavelength multiplexing and demultiplexing;

– termination of the OCh overhead;

– termination of OTUkV section overhead;

– termination of up to 3 levels of ODUk TCM overhead (for TCM applications, see Appendix II);

– ODUkP non-intrusive monitoring in ingress and egress directions;

– ODUk cross-connection.

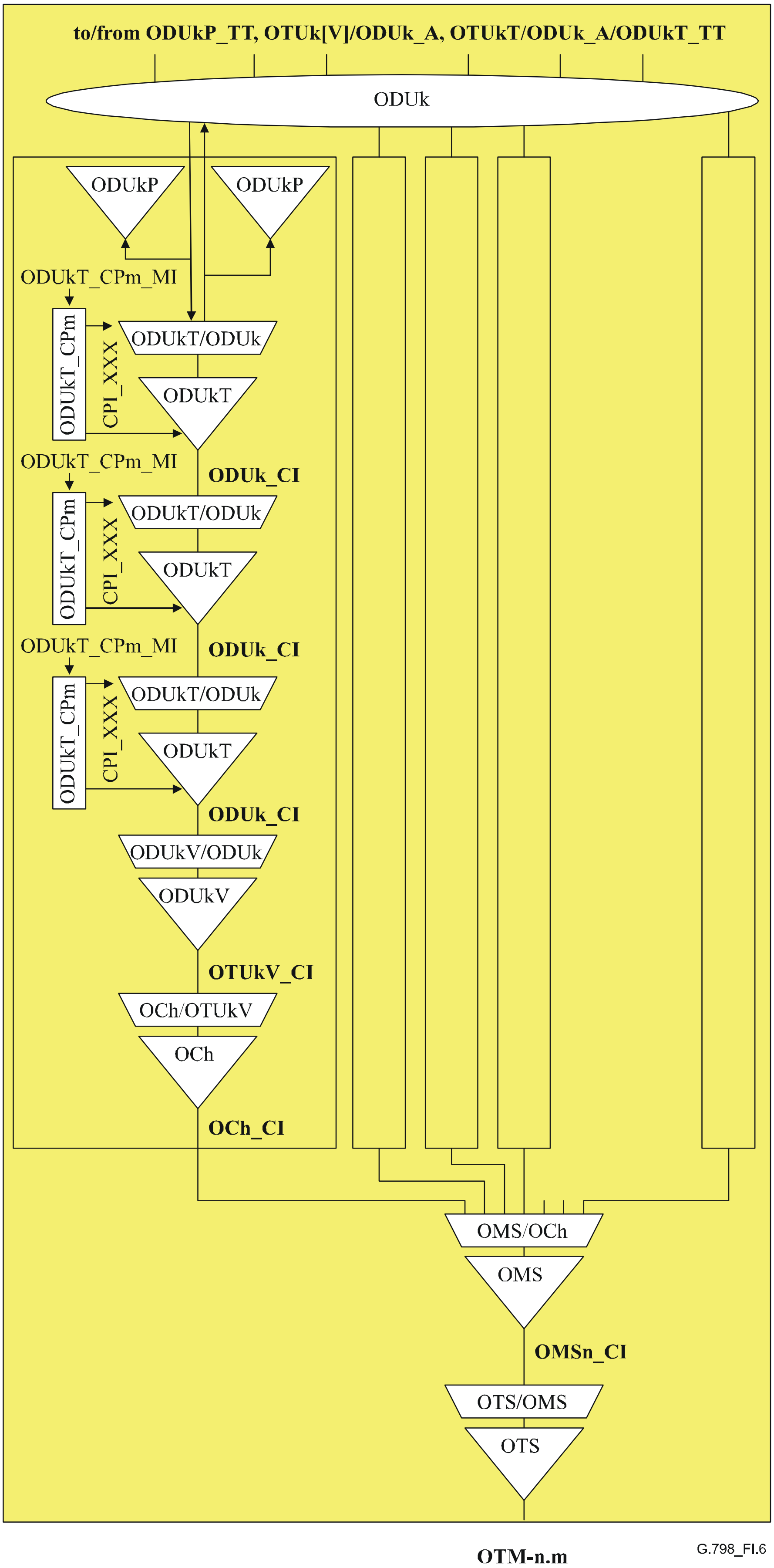


Figure I.6/G.798 – OTM-n.m interface port with 3-R regeneration functionality for an ODUk connection function

Appendix II

TCM applications

In several of the examples in Appendix I, ODUk TCM functions (ODUkT_TT + ODUkT/ODUk_A) are shown.

The activation of TCM functions is dependent on the location/role of the interface port in the network:

- Verification of provided Quality of Service to the user (Provider TCM):
  - For the case of STM UNI interfaces (Figure II.1), the UNI-UNI connection is monitored on the network side using ODUk Path Monitoring (PM).
  - For the case of mixed STM/OTM and pure OTM UNI interfaces (Figures II.2, II.3 and II.4), the UNI-UNI connection is monitored on the network side using one level of ODUk Tandem Connection Monitoring (TCM).
  - In case of a multi-operator environment as shown in the figures, each operator monitors the Quality of Service in its own network using an additional level of ODUk Tandem Connection Monitoring (TCM) to monitor the NNI-NNI connection.
- Verification of received Quality of Service from the provider (User TCM):
  - In case of OTM UNI interfaces the UNI-UNI connection is monitored on the user side:
    - either by using ODUk Path Monitoring (PM) if the ODUk and as such the OTN is terminated on the user sides of both UNIs (Figure II.3);
    - or using ODUk Tandem Connection Monitoring (TCM) if the ODUk and as such the OTN continues into one or both user networks (Figure II.4).
  - In case of a multi-operator environment as shown in the figures, the service provided by an operator can be monitored by the other operators using an additional level of ODUk Tandem Connection Monitoring (TCM) to monitor the NNI-NNI connection.

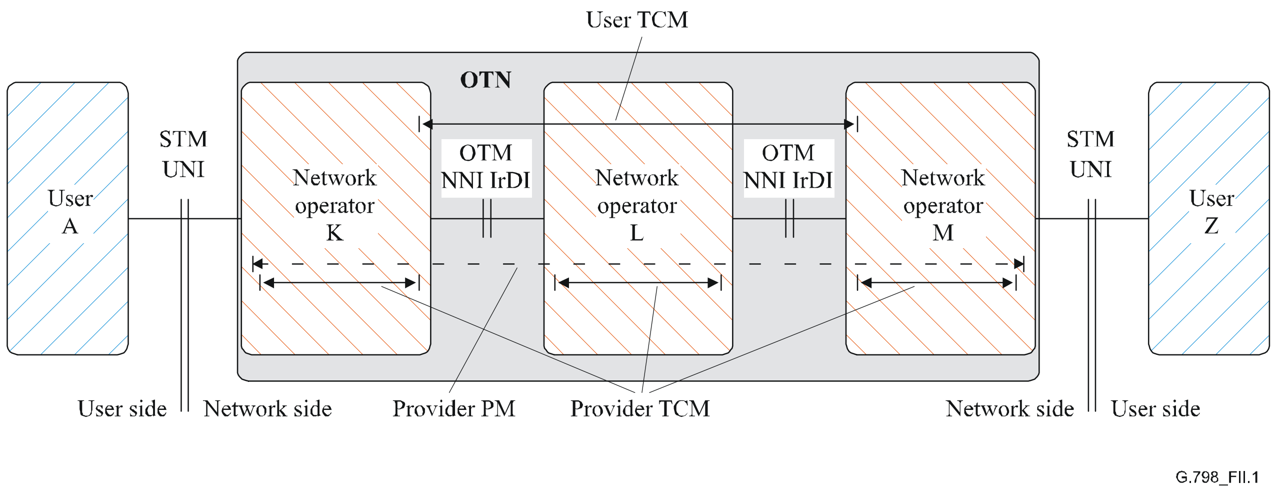


Figure II.1/G.798 – Provider and user tandem connections for case of STM-N UNI interface

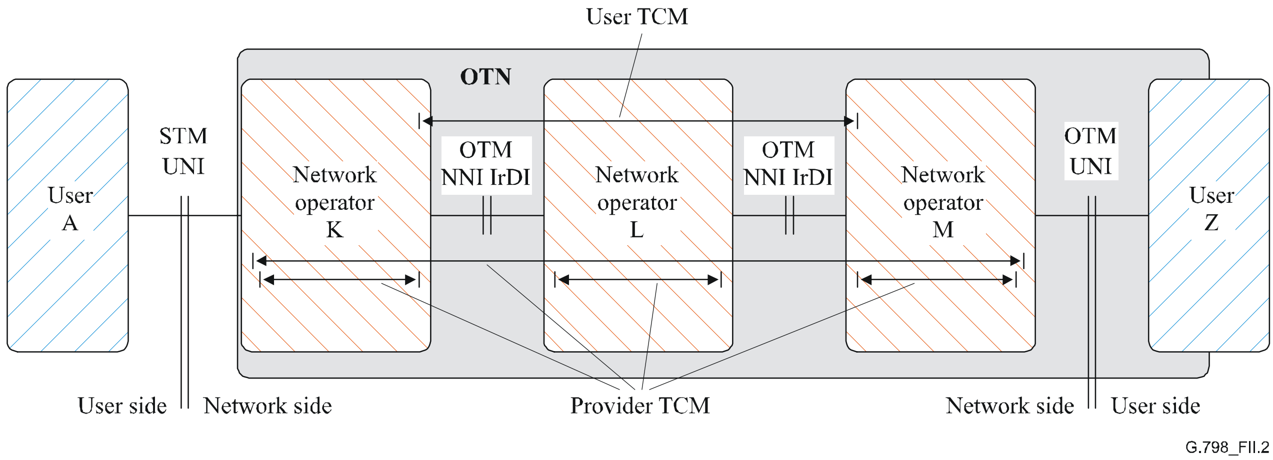


Figure II.2/G.798 – Provider and user tandem connections for case of mixed STM and OTM UNI interfaces

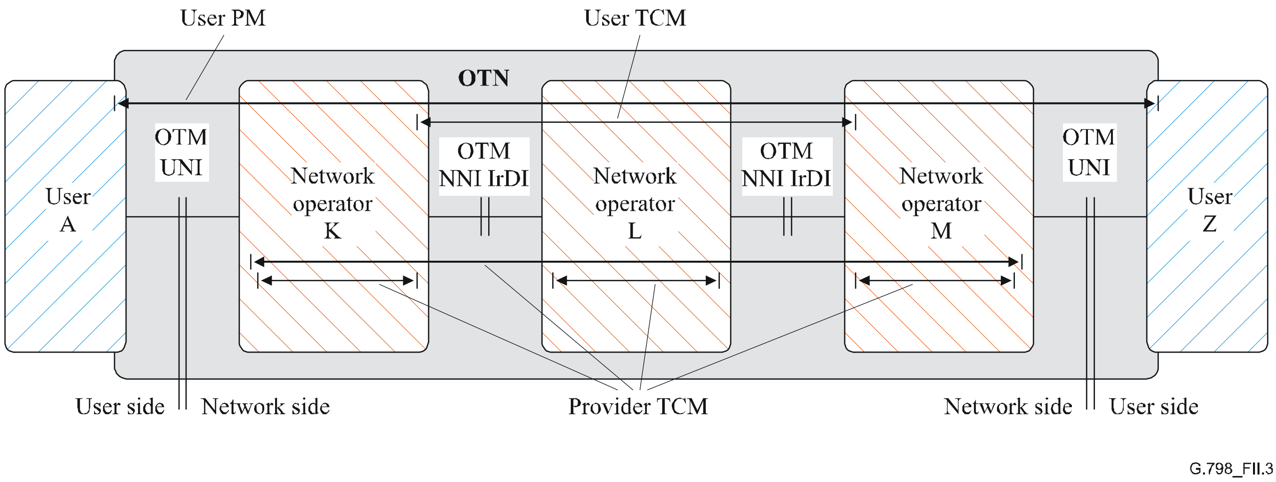


Figure II.3/G.798 – Provider and user tandem connections for case of OTM UNI interfaces and termination of the OTN on the user side of the UNI

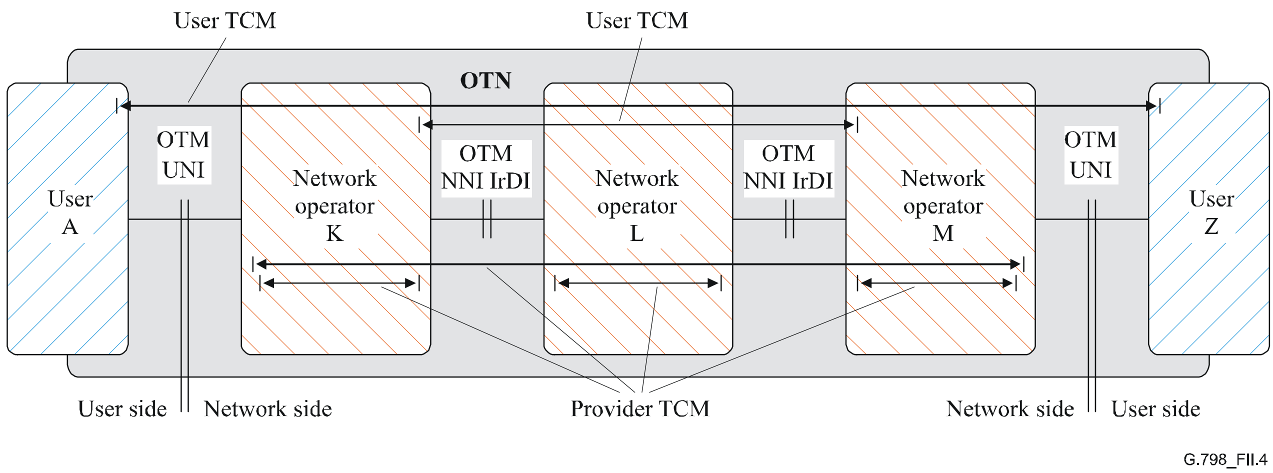


Figure II.4/G.798 – Provider and user tandem connections for case of OTM UNI interfaces and no termination of the OTN on the user side of the UNI

The TCM functions may furthermore be used to e.g.:

– test a subnetwork connection consisting of multiple cascaded OTUk[V] trails for e.g., fault localization;
– monitor working and protection connections for the case of ODUk SNC/S protection.

Appendix III

Performance of processes

This appendix provides information on the performance of some processes like defect detection processes and frame alignment process.

III.1 Bibliography

The results given in this appendix are based on equations given in [CHOI] "Frame Alignment in a Digital Carrier System – A Tutorial", DooWhan Choi, IEEE Communications Magazine, February 1990.

III.2 OTUk frame alignment process

III.2.1 False out-of-frame events

False out-of-frame event will occur whenever the in-frame state is lost due to line bit error rate. This event is related to the probability $\boldsymbol{P_{wFAS}}$ of receiving a corrupted FAS, which is equal to:

$$P_{wFAS} = 1 - (1 - \varepsilon)^{FASL} \cong \varepsilon * FASL$$

Where ε is the line bit error rate, with Poisson distribution, and FASL is the number of bits of the FAS to be checked. The probability $\boldsymbol{P_{fOOF}}$ that the system will detect an OOF state coincides with the probability that α consecutive FAS are received. It means that:

$$P_{fOOF} = P_{wFAS}^{\alpha} \cong (\varepsilon * FASL)^{\alpha}$$

It shall be noted that such a probability of occurrence is directly proportional to the FAS length and inversely proportional to the number of pre-alarms states (i.e., α – 1) defined in the alignment process.

The average time between two false out-of-frame events is defined as follows:

$$T_{fOOF} = \frac{T_{frame}}{P_{fOOF}}$$

III.2.2 Minimum average time between false out-of-frame events

It is not possible to give the exact expression for the minimum average time between two out-of-frame events, being it a stochastic process. It is instead possible to give an approximate value for that. Given that the distribution of the OOF events is a Poisson like, it is possible to evaluate the minimum interval between two events with given probability of occurrence. In other words, assuming that the probability of occurrence of an out-of-frame event in an interval shorter than T_{min} is $P[t \le T_{\min}] = p$, it can be demonstrated that:

$$T_{\min} = -T_{OOF} * \ln(1 - p)$$

With $p = 10^{-3}$ the minimum average time between false OOF events results: $T_{\min} \cong T_{OOF} * 10^{-3}$.

Figure III.1 shows the numerical results.

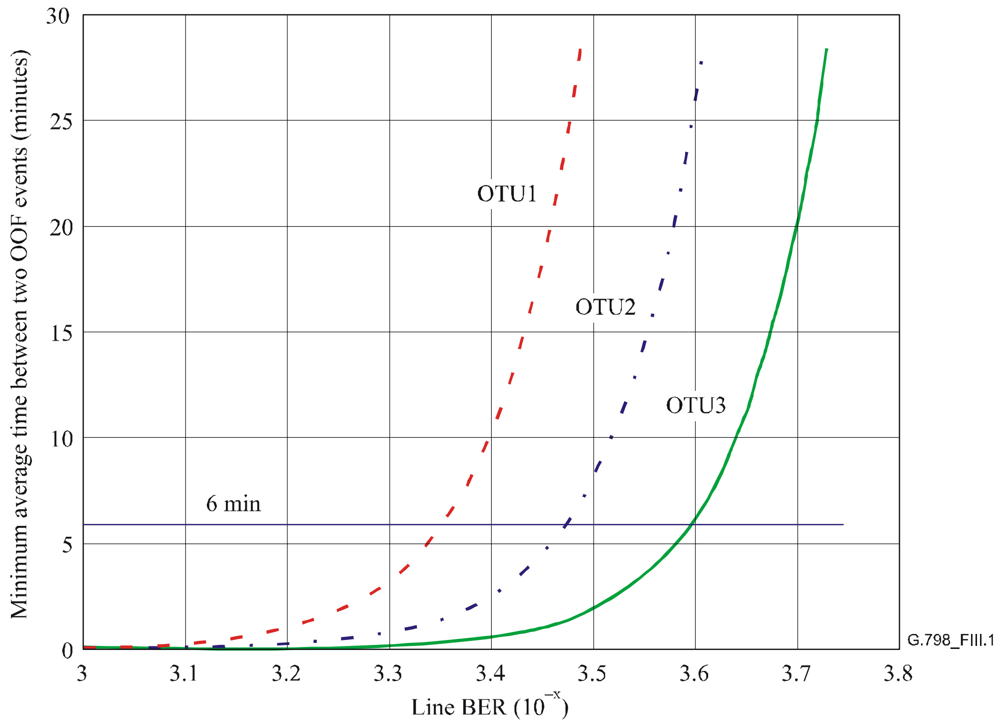


Figure III.1/G.798 – Minimum average time between false out-of-frame events

II.2.3 False in-frame events

The probability for false in-frame alignment can be obtained noting that the FAS is searched for up to 1 frame (FL bit long) with FL-1 possibilities for a false (simulated) FAS and confirmed the following δ frames. Given the equi-probability of receiving the symbol '0' or symbol '1', it is clear that the simulation of FAS only depends on FAS length. In fact, it results:

$$P_{fFAS} = \left(\frac{1}{2}\right)^{FASL}$$

False frame recovery probability can be defined as:

$$P_{ff} = 1 - \left(1 - P_{fFAS}\right)^{FL-1}$$

The resulting probability for the false in-frame event thus results:

$$P_{fIF} = p_{ff} * p_{fFAS}{}^{\delta}$$

The resulting rate of false frame recovery occurrence depends on frame length and is equal to:

$$T_{fIF} = \frac{T_{frame}}{P_{fIF}}$$

III.2.4 Frame alignment time

The frame alignment time is the time needed to reach the in-frame state starting from out-of-frame state.

In case of no FAS simulation it is clear that this time is $T_{frame} * (1+\delta)$. Otherwise, the detection of a false FAS will start an alignment process that will lead inevitably to OOF state. This time is taken into account in the just defined relation with an aleatory variable, *H*, depending on false frame alignment probability; that means:

$$T_{IF} = T_{frame} * (1 + \delta + H)$$

The value of the variable *H* is approximated by:

$$H = P_{fFAS} * FASL$$

It shall be noted that in practice the frame alignment time is not affected by the false alignment occurrence. It means that the in-frame state will be reached in two periods of the OTUk frame, anyhow.

III.3 STAT acceptance process and related defect detection (ODUkP/TdAIS, ODUkP/TdOCI, ODUkP/TdLCK, ODUkTdLTC, ODUkTdIAE)

III.3.1 Average acceptance, raising and clearing time

The average acceptance time for the STAT field can be calculated using Equation 33 of [CHOI, see III.1] as the STAT acceptance procedure is analogous to the misframe declaration procedure in Figure 7 of [CHOI see III.1] by reading p_d as probability for a disturbed STAT value.

Table III.1/G.798 – Average STAT acceptance time

BER	ODU frames	Time		
		ODU1	ODU2	ODU3
1.000E-03	3.02	147.8 µs	36.8 µs	9.1 µs
1.000E-04	3.00	147.0 µs	36.6 µs	9.1 µs
1.000E-05	3.00	146.9 µs	36.6 µs	9.1 µs
1.000E-06	3.00	146.9 µs	36.6 µs	9.1 µs

The average dAIS, dOCI, dLTC, dLCK and dIAE raising/clearing time is equal to the average acceptance time.

III.3.2 Mean time between false ODUkP/TdAIS and ODUkTdIAE defects due to bit errors assuming a transmitted STAT value of "001" (normal path signal)

$$p_d(\text{false dAIS}) = (BER^2 \cdot (1 - BER))^X$$

X number of consecutive STAT fields for acceptance (X = 3)

The mean number of frame between false defects is approximately the reciprocal of p_d: $t_{dm} = 1/p_d$.

Table III.2/G.798 – Mean time between false ODUkP/TdAIS and ODUkTdIAE defects

BER	ODU frames	Time		
		ODU1	ODU2	ODU3
1.000E-03	1.00E+18	1.5E+06 years	3.9E+05 years	9.6E+04 years
1.000E-04	1.00E+24	1.5E+12 years	3.9E+11 years	9.6E+10 years
1.000E-05	1.00E+30	1.5E+18 years	3.9E+17 years	9.6E+16 years
1.000E-06	1.00E+36	1.5E+22 years	3.9E+23 years	9.6E+22 years

III.3.3 Mean time between false ODUkP/TdOCI defects due to bit errors assuming a transmitted STAT value of "001" (normal path signal)

$$p_d(\text{false dOCI}) = (BER^3)^N$$

The mean number of frames between false defects is approximately the reciprocal of p_d: $t_{dm} = 1/p_d$.

Table III.3/G.798 – Mean time between false ODUkP/TdOCI defects

BER	ODU frames	Time		
		ODU1	ODU2	ODU3
1.000E-03	1.00E+27	1.5E+15 years	3.9E+14 years	9.6E+13 years
1.000E-04	1.00E+36	1.5E+24 years	3.9E+23 years	9.6E+22 years
1.000E-05	1.00E+45	1.5E+33 years	3.9E+32 years	9.6E+31 years
1.000E-06	1.00E+54	1.5E+42 years	3.9E+41 years	9.6E+40 years

III.3.4 Mean time between false ODUkTdLTC and ODUkP/TdLCK defects due to bit errors assuming a transmitted STAT value of "001" (normal path signal)

$$p_d(\text{false dLTC, dLCK}) = (BER\cdot(1 - BER)^2)^X$$

X number of consecutive STAT fields for acceptance (X = 3)

The mean number of frames between false defects is approximately the reciprocal of p_d: $t_{dm} = 1/p_d$.

Table III.4/G.798 – Mean time between false ODUkTdLTC and ODUkP/TdLCK defects

BER	ODU frames	Time		
		ODU1	ODU2	ODU3
1.000E-03	1.01E+09	13.6 h	3.4 h	0.8 h
1.000E-04	1.00E+12	1.5 years	3.9E-01 years	842.2 h
1.000E-05	1.00E+15	1.5E+03 years	3.9E+02 years	9.6E+01 years
1.000E-06	1.00E+18	1.5E+6 years	3.9E+05 years	9.6E+04 years

III.4 OTUkdIAE, OTUkdBDI, ODUkP/TdBDI detection

III.4.1 Average raising and clearing time

The average raising/clearing delay can be calculated using Equation 33 of [CHOI] as the detection procedure is analogous to the misframe declaration procedure in Figure 7 of [CHOI] by reading p_d as probability for a disturbed value.

Table III.5/G.798 – Average OTUkdIAE, ODUkdBDI, ODUkP/dBDI raising/clearing time

BER	ODU frames	Time		
		ODU1	ODU2	ODU3
1.000E-03	5.02	245.8 µs	61.1 µs	15.2 µs
1.000E-04	5.00	244.8 µs	61.0 µs	15.2 µs
1.000E-05	5.00	244.8 µs	61.0 µs	15.2 µs
1.000E-06	5.00	244.8 µs	61.0 µs	15.2 µs

III.4.2 Mean time between false defects due to bit errors

$$p_d(\text{false dBDI}) = BER^X$$

X number of consecutive fields for acceptance (X = 5)

The mean number of frames between false defects is approximately the reciprocal of p_d: $t_{dm} = 1/p_d$.

Table III.6/G.798 – Mean time between false OTUkdIAE, OTUkdBDI, ODUkP/TdBDI defects

BER	ODU frames	Time		
		ODU1	ODU2	ODU3
1.000E-03	1.00E+15	1.5E+03 years	3.9E+02 years	9.6E+01 years
1.000E-04	1.00E+20	1.5E+08 years	3.9E+07 years	9.6E+06 years
1.000E-05	1.00E+25	1.5E+13 years	3.9E+12 years	9.6E+11 years
1.000E-06	1.00E+30	1.5E+18 years	3.9E+17 years	9.6E+16 years

III.5 PT acceptance process and ODUkPdPLM detection

III.5.1 Average acceptance, raising and clearing time

The average acceptance time for the PT field can be calculated using Equation 33 of [CHOI] as the PT acceptance procedure is analogous to the misframe declaration procedure in Figure 7 of [CHOI] by reading p_d as probability for a disturbed PT value.

Table III.7/G.798 – Average PT acceptance time

BER	ODU multiframes	Time		
		ODU1	ODU2	ODU3
1.000E-03	3.05	38.2 ms	9.5 ms	2.4 ms
1.000E-04	3.00	37.6 ms	9.4 ms	2.3 ms
1.000E-05	3.00	37.6 ms	9.4 ms	2.3 ms
1.000E-06	3.00	37.6 ms	9.4 ms	2.3 ms

The average dPLM raising/clearing time is equal to the average acceptance time.

III.5.2 Mean time between false PLM defects due to bit errors

A false PLM defect is declared if the same i bits (out of n = 8) are disturbed in X = 3 consecutive multiframes. According to Equation 33 of [CHOI], the mean number of multiframes between the acceptance of a false PT byte with i certain false bits is:

$$t_{mf,i} = \frac{1}{p_i^X} \frac{1 - p_i^X}{1 - p_i}$$

with the probability p_i of i certain bits being disturbed within one multiframe.

$$p_i = BER^i \cdot (1 - BER)^{n-i}$$

The mean number of multiframes between any false acceptance resulting in a false dPLM is:

$$t_{mf} = \frac{1}{\sum_i \binom{n}{i} \cdot \frac{1}{t_{mf,i}}}$$

Table III.8/G.798 – Mean time between false ODUkP PLM defects

BER	ODU frames	Time		
		ODU1	ODU2	ODU3
1.000E-03	1.25E+08	434.4 h	108.2 h	26.9 h
1.000E-04	1.25E+11	49.6 years	12.4 years	3.1 years
1.000E-05	1.25E+14	4.97E+04 years	1.24E+04 years	3077 years
1.000E-06	1.25E+17	4.97E+07 years	1.24E+07 years	3.08E+06 years

III.6 Generic AIS and OTUk AIS detection

III.6.1 Average dAIS detection time

The probability of detecting the generic AIS pattern within one counting interval is:

$$p_d = \sum_{k=0}^{255} \binom{Nb}{k} \cdot (3 \cdot BER)^k \cdot (1 - 3 \cdot BER)^{(Nb-k)}$$

with Nb = 8192 being the number of bits per counting interval. Inserting p_d and the number of counting intervals in which the generic AIS signal must be detected before raising the defect, c = 3, into Equation 33 of [CHOI] leads to the average dAIS detection time. The factors of 3 found in the above equation are due to the error multiplication that occurs within the Generic AIS detection circuit (see 6.2.6.3.3).

Table III.9/G.798 – Average dAIS detection time

BER	intervals (8192 bits)	Time		
		ODU1	ODU2	ODU3
2.00E-02	5.0E+98	5.2E+85 years	1.3E+85 years	3.2E+84 years
1.00E-02	5.7	18.6 µs	4.6 µs	1.2 µs
1.00E-03	3	9.8 µs	2.4 µs	0.61 µs
1.00E-04	3	9.8 µs	2.4 µs	0.61 µs
1.00E-05	3	9.8 µs	2.4 µs	0.61 µs
1.00E-06	3	9.8 µs	2.4 µs	0.61 µs

III.7 OTUkdBIAE and ODUkTdBIAE detection process

III.7.1 Average dBIAE detection time

The average dBIAE detection/clearing time can be calculated using Equation 33 of [CHOI] as the procedure is analogous to the misframe declaration procedure in Figure 7 of [CHOI] by reading q_d as probability for an undisturbed BIAE value.

$$q_d = (1 - BER)^n$$

$$t_d = \frac{1}{q_d^X} \frac{1 - q_d^X}{1 - q_d}$$

n number of BEI/BIAE bits (n = 4)

X number of consecutive BIAE values for dBIAE (X = 3)

Table III.10/G.798 – Average dBIAE detection/clearing time

BER	OTU/ODU frames	Time		
		ODU1	ODU2	ODU3
1.000E-03	3.02	148.1 μs	36.9 μs	9.2 μs
1.000E-04	3.00	147.0 μs	36.6 μs	9.1 μs
1.000E-05	3.00	146.9 μs	36.6 μs	9.1 μs
1.000E-06	3.00	146.9 μs	36.6 μs	9.1 μs

III.7.2 Mean time between false BIAE defects due to bit errors

A false BIAE defect is declared if the received BEI value is disturbed in such a way that the BIAE value (i.e., '1011') is falsely detected in X = 3 consecutive frames. Since the BEI value changes each frame due to received far end bit errors, the probability of a false BIAE value occurring depends on the specific value of BEI generated each frame. Therefore, the probability of detecting a false BIAE value is the product of the conditional probability of a false BIAE value occurring given a particular BEI value and the probability of the occurrence of the particular BEI value. Summing over all possible BEI values gives the total probability of a false BIAE being detected in any single frame.

$$p = \sum_{k=0}^{8} p_{BEI,k} \cdot p_{BIAE|BEI,k}$$

where:

$$p_{BEI,k} = \binom{8}{k} (p_{BIP1})^k \cdot (1 - p_{BIP1})^{8-k}, \ 0 \le k \le 8$$

and:

$$p_{BIAE|BEI,k} = (BER)^n \cdot (1 - BER)^{4-n}, \ 0 \le k \le 8$$

where n represents the number of BEI bit errors required to convert the BEI value to a false BIAE value (n = 3, 2, 2, 1, 4, 3, 3, 2, 2, for k = 0, 1, 2, 3, 4, 5, 6, 7 and 8, respectively). Additionally, Equation C.3 of ANSI T1.231-1997 provides a closed form expression for the probability of an error in a single BIP thread as follows:

$$p_{BIP1} = \frac{1 - (1 - 2 \cdot BER)^m}{2}, \ m = 15240$$

The value 15240 represents the number of bits per thread of the BIP8 of the ODU tandem connection and path monitors.

According to Equation 33 of [CHOI] the mean number of frames between false BIAE defects because of bit errors within the BEI/BIAE field is:

$$t_{mf} = \frac{1}{p^X} \frac{1-p^X}{1-p}$$

with the probability p of a false BIAE.

In Table III.11 the same BER for both directions of a bidirectional connection is assumed.

Table III.11/G.798 – Mean time between false BIAE defects

BER	OTU/ODU frames	Time		
		ODU1	ODU2	ODU3
1.000E-03	9.6E+10	1310 h	326 h	81.1 h
1.000E-04	7.4E+13	115 years	28.6 years	7.1 years
1.000E-05	4.0E+18	6.3E+06 years	1.6E+06 years	3.9E+05 years
1.000E-06	1.8E+29	2.9E+17 years	7.1E+16 years	1.8E+16 years

Appendix IV

TTI processing examples

This appendix gives implementation examples for TTI processing that fulfil the definitions given in the main body of this Recommendation. Other implementations that fulfil the definitions are possible.

IV.1 Example 1

IV.1.1 Trail Trace Identifier (TTI) acceptance and reporting process

A new TTI is accepted if a new consistent value is received in the 64 TTI bytes in X consecutive multiframes. X shall be 3.

The accepted TTI shall be reported to the management system (MI_AcTI) if requested (MI_GetAcTI). The SAPI and DAPI part of the accepted TTI shall be compared with the expected SAPI and DAPI for TTI mismatch detection (see IV.I.2).

IV.I.2 SAPI/DAPI compare process

The SAPI/DAPI compare process compares the SAPI/DAPI part of the accepted TTI (AcTI, see IV.1.1) with the equivalent expected SAPI/DAPI values set via the MP (MI_ExSAPI/DAPI). The comparison result is "match" if all 16 bytes were equal, and "mismatch" if one or more bytes were unequal.

For the dTIM generation based on the results of the SAPI/DAPI compare process, see 6.2.2.1.

IV.1.3 Performance of Example 1

IV.1.3.1 Average TTI acceptance time

The average TTI acceptance time can be calculated using Equation 33 of [CHOI] as the procedure is analogous to the misframe declaration procedure in Figure 7 of [CHOI] by reading q_d as probability for the received TTI value being equal to the last one.

$$q_d = (1 - BER)^n$$

$$t_d = \frac{1}{q_d^X} \frac{1 - q_d^X}{1 - q_d}$$

n number of TTI bits (n = 512)

X number of consecutive equal comparison results for TTI acceptance (X = 3)

Table IV.1/G.798 – Average TTI acceptance time

BER	TTI periods	Time		
		ODU1	ODU2	ODU3
1.000E-03	9.10	28.5 ms	7.1 ms	1.8 ms
1.000E-04	3.33	10.4 ms	2.6 ms	0.6 ms
1.000E-05	3.03	9.5 ms	2.4 ms	0.6 ms
1.000E-06	3.00	9.4 ms	2.3 ms	0.6 ms

IV.1.3.2 Average dTIM detection and clearing time

The average dTIM detection and clearing times are equal to the TTI acceptance time.

IV.1.3.3 Mean time between false TIM defects due to bit errors

A false TTI defect is declared if a TTI with bit errors is accepted and an errored bit is within the compared SAPI, respectively DAPI, field of the TTI. The same i bits (out of n = 512) have to be disturbed in X = 3 consecutive TTIs. According to Equation 33 of [CHOI], the mean number of TTIs between the acceptance of a false TTI with i certain false bits is:

$$t_{mf,i} = \frac{1}{p_i^X} \cdot \frac{1 - p_i^X}{1 - p_i}$$

with the probability p_i of i certain bits being disturbed within one TTI

$$p_i = BER^i \cdot (1 - BER)^{n-i}$$

The mean number of TTIs between any false dTIM is:

$$t_{mf} = \frac{1}{\sum_i \frac{p_{API,i}}{t_{mf,i}}}$$

with the probability $p_{API,i}$ that the API field contains an errored bit of the false accepted TTI with i bit errors.

n number of TTI bits

X number of consecutive equal comparison results for TTI acceptance (X = 3)

Table IV.2/G.798 – Mean time between false TIM defects

BER	TTI periods	Time		
		ODU1	ODU2	ODU3
1.000E-03	3.62E+07	31.5 h	7.9 h	2.0 h
1.000E-04	9.11E+09	0.9 years	0.2 years	0.06 years
1.000E-05	7.93E+12	788 years	196 years	49 years
1.000E-06	7.82E+15	777093 years	193457 years	48160 years

IV.2 Example 2

IV.2.1 TTI reporting

TTI Reporting consists of a Control, Compare & Store and Persistency process as shown in Figure IV.1. When a request for TTI reporting is received via MI_GetAcTI by the Control process, it starts the Compare & Store and Persistency process.

The Compare & Store process contains a 64-byte store, holding the latest stored TTI. Once started, this process compares the received TTI byte with the equivalent byte in the store. After the comparison the byte is copied into the store. After all 64 bytes have been compared and stored, the total comparison result is sent to the Persistency process. This total comparison result is "equal" if all 64 bytes were equal, and "unequal" if one or more bytes were unequal. Now processing is continued for the next TTI sample.

When the Persistency process is started, it outputs "unstable" to the control process. When it receives three consecutive "equal" comparison results from the Compare & Store process, it outputs "stable" to the Control process.

When the Control process receives "stable" from the Persistency process, it stops the Compare & Store and Persistency process. The Compare & Store process makes the stored TTI available at MI_AcTI.

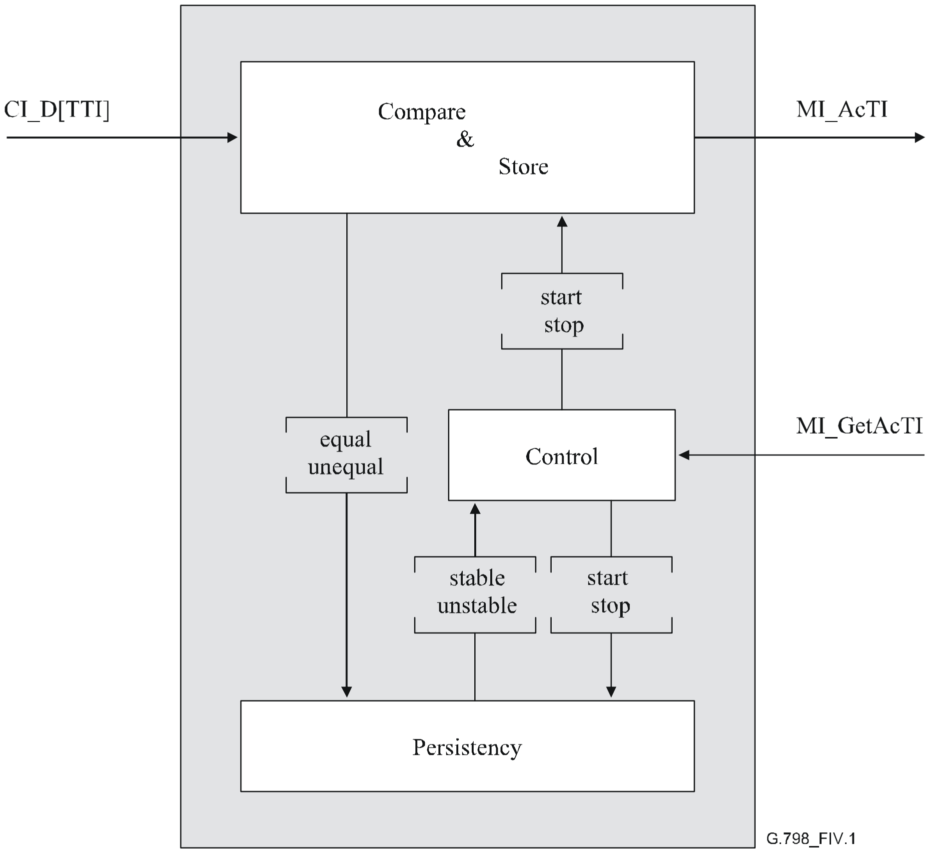


Figure IV.1/G.798 – TTI reporting process

IV.2.2 SAPI/DAPI compare process

The SAPI/DAPI compare process compares the received SAPI/DAPI byte (RxTI) with the equivalent expected SAPI/DAPI byte set via the MP (MI_ExSAPI/DAPI). After all 16 bytes have been compared, the total comparison result is sent to the SAPI/DAPI persistency process. This total comparison result is "equal" if all 16 bytes were equal, and "unequal" if one or more bytes were unequal. Now processing is continued for the next SAPI/DAPI, consecutive with the previous one.

The SAPI/DAPI persistency process outputs its state, either "match" or "mismatch" to the control process. The process enters the "match" state after having received three consecutive "equal" comparison results. The process enters the "mismatch" state when seven consecutive "unequal" comparison results are received.

For the dTIM generation based on the results of the SAPI/DAPI compare process, see 6.2.2.1.

IV.2.3 Performance of Example 2

IV.2.3.1 Average TTI acceptance time

The average TTI acceptance time can be calculated using Equation 33 of [CHOI] as the procedure is analogous to the misframe declaration procedure in Figure 7 of [CHOI] by reading q_d as probability for the received TTI value being equal to the last one. For the calculation it is assumed that the Compare & Store process hold the current TTI when the TTI Reporting process is started.

$$q_d = (1 - BER)^n$$

$$t_d = \frac{1}{q_d^X} \frac{1 - q_d^X}{1 - q_d}$$

n number of TTI bits (n = 512)

X number of consecutive equal comparison results for a stable TTI (X = 3)

Table IV.3/G.798 – Average TTI acceptance time

BER	TTI periods	Time		
		ODU1	ODU2	ODU3
1.000E-03	9.10	28.5 ms	7.1 ms	1.8 ms
1.000E-04	3.33	10.4 ms	2.6 ms	0.6 ms
1.000E-05	3.03	9.5 ms	2.4 ms	0.6 ms
1.000E-06	3.00	9.4 ms	2.3 ms	0.6 ms

IV.2.3.2 Average dTIM detection time

The average dTIM detection time can be calculated using Equation 33 of [CHOI] as the procedure is analogous to the misframe declaration procedure in Figure 7 of [CHOI] by reading q_d as probability for an unequal SAPI respectively DAPI value. Here the worst case is calculated where ExSAPI and RxSAPI respectively ExDAPI and RxDAPI differ in only 1 bit.

$$q_d = 1 - BER$$

$$t_d = \frac{1}{q_d^X} \frac{1 - q_d^X}{1 - q_d}$$

X number of consecutive unequal comparison results for dTIM (X = 7)

Table IV.4/G.798 – Average dTIM detection time

BER	TTI periods	Time		
		ODU1	ODU2	ODU3
1.000E-03	7.03	22.0 ms	5.5 ms	1.4 ms
1.000E-04	7.00	21.9 ms	5.5 ms	1.4 ms
1.000E-05	7.00	21.9 ms	5.5 ms	1.4 ms
1.000E-06	7.00	21.9 ms	5.5 ms	1.4 ms

IV.2.3.3 Average dTIM clearing time

The average dTIM clearing time can be calculated using Equation 33 of [CHOI] as the procedure is analogous to the misframe declaration procedure in Figure 7 of [CHOI] by reading q_d as probability for an equal SAPI respectively DAPI value.

$$q_d = (1 - BER)^n$$

$$t_d = \frac{1}{q_d^X} \frac{1 - q_d^X}{1 - q_d}$$

n number of SAPI respectively DAPI bits (n = 128)

X number of consecutive equal comparison results for dTIM clearance (X = 3)

Table IV.5/G.798 – Average dTIM clearance time for point-to-multipoint and multipoint-to-point configurations

BER	TTI periods	Time		
		ODU1	ODU2	ODU3
1.000E-03	3.90	12.2 ms	3.0 ms	0.8 ms
1.000E-04	3.08	9.6 ms	2.4 ms	0.6 ms
1.000E-05	3.01	9.4 ms	2.3 ms	0.6 ms
1.000E-06	3.00	9.4 ms	2.3 ms	0.6 ms

IV.2.3.4 Mean time between false TIM defects due to bit errors

The mean time between false TIM defects can be calculated using Equation 33 of [CHOI] as the procedure is analogous to the misframe declaration procedure in Figure 7 of [CHOI] by reading q_d as probability for an unequal SAPI respectively DAPI value due to bit errors.

$$q_d = 1 - (1 - BER)^n$$

$$t_d = \frac{1}{q_d^X} \frac{1 - q_d^X}{1 - q_d}$$

n number of SAPI, respectively DAPI bits (n = 128)

X number of consecutive unequal comparison results for dTIM (X = 7)

Table IV.6/G.798 – Mean time between false TIM defects for point-to-multipoint and multipoint-to-point configurations

BER	TTI periods	Time		
		ODU1	ODU2	ODU3
1.000E-03	3.13E+06	2.7 h	0.7 h	0.2 h
1.000E-04	1.88E+13	1868 years	465 years	116 years
1.000E-05	1.79E+20	1.8E+10 years	4.4E+09 years	1.8E+10 years
1.000E-06	1.78E+27	1.8E+17 years	4.4E+16 years	1.8E+17 years

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