



INTERNATIONAL TELECOMMUNICATION UNION

ITU-T

TELECOMMUNICATION
STANDARDIZATION SECTOR
OF ITU

G.798

Amendment 1
(08/2018)

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

Amendment 1

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Amendment 1 to Recommendation ITU-T G.798

Characteristics of optical transport network hierarchy equipment functional blocks

Amendment 1

Summary

Amendment 1 to Recommendation ITU-T G.798 (2017) contains text modifications and additions:

- moving the ODUkP to Ethernet MAC layer and Ethernet Reconciliation sublayer adaptation functions from ITU-T G.8021 to ITU-T G.798.
- to support adaptation of ODUkP to Ethernet Coding sublayer for 25 Gb/s, 200 Gb/s and 400 Gb/s Ethernet signals.
- to align with ITU-T G.8023.
- replacing Appendix VIII to align with ITU-T G.872 and G.873.1.

Amendment 1 to Recommendation ITU-T G.798

Characteristics of optical transport network hierarchy equipment functional blocks

Amendment 1

1) Scope

This amendment contains text modifications and additions:

- moving the ODUkP to Ethernet MAC layer and Ethernet Reconciliation sublayer adaptation functions from ITU-T G.8021 to ITU-T G.798.
- to support adaptation of ODUkP to Ethernet Coding sublayer for 25 Gb/s, 200 Gb/s and 400 Gb/s Ethernet signals.
- to align with ITU-T G.8023.
- replacing Appendix VIII to align with ITU-T G.872 and G.873.1.

2) Modifications to Clause 1 – Scope

Replace EthPP-OS with ERS10G in figure 1-5 as follows:

3) Modifications to Clause 2 – References

Add the following references:

[ITU-T G.8023]	Recommendation ITU-T G.8023 (2018), <i>Characteristics of equipment functional blocks supporting Ethernet physical layer and Flex Ethernet interfaces.</i>
[IEEE 802.3by]	IEEE Std. 802.3by–2016), <i>IEEE Standard for Ethernet – Amendment 2: Media Access Control Parameters, Physical Layers, and Management Parameters for 25 Gb/s Operation.</i>
[IEEE 802.3bs]	IEEE Std. 802.3bs–2017, <i>IEEE Standard for Ethernet – Amendment 10: Media Access Control Parameters, Physical Layers, and Management Parameters for 200 Gb/s and 400 Gb/s Operation.</i>

4) Modifications to Clause 4 – Abbreviations and acronyms

Delete the following acronyms:

~~ETC~~	~~Ethernet Coding~~
~~ETC3~~	~~Ethernet Coding 1000BASE-X~~
~~ETC5~~	~~Ethernet Coding 40GBASE-R~~
~~ETC6~~	~~Ethernet Coding 100GBASE-R~~
~~EthPP-OS~~	~~Ethernet Preamble and Ordered Set~~

Add the following acronyms:

<u>CDI</u>	<u>Client Defect Indication</u>
<u>ERSy</u>	<u>Ethernet Reconciliation sublayer for PHY y</u>
<u>ETCy</u>	<u>Ethernet Coding sublayer for PHY y</u>

5) Modifications to Clause 6 – Conventions

Add the y, ERSy and ETCy conventions:

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.

y is used as a variable for the client layer in the adaptation functions, specifically:

ERSy indicates a reconciliation sublayer of an Ethernet PHY, and ETCy indicates a coding sublayer of an Ethernet PHY, with 'y' describing the PHY using IEEE nomenclature, minus the word BASE. For example, the coding sublayer for 1000BASE-X PHY would be ETC1000X.

[1..n]: Suffix indicating the signal consists of an array of n elements indexed from 1 to n.

6) Modifications to Clause 13 – OTU (layer) functions

6.1) Subclause 13.2.1 – OTU trail termination function

Add *MI_Mode* to the *OTU_TT* functions:

13.2.1.1 OTU trail termination source function (OTU_TT_So)

The OTU_TT_So function computes the BIP-8[1..n] and adds section monitoring overhead (SMOH) – including the TTI, BIP-8[1..n], BDI, BEI[1..n] and IAE signals – in the SM overhead fields to the OTU signal at its OTU_AP. The OTUCn signal has n SM overhead fields; the OTUk signal has one (n=1) SM overhead field.

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

Symbol

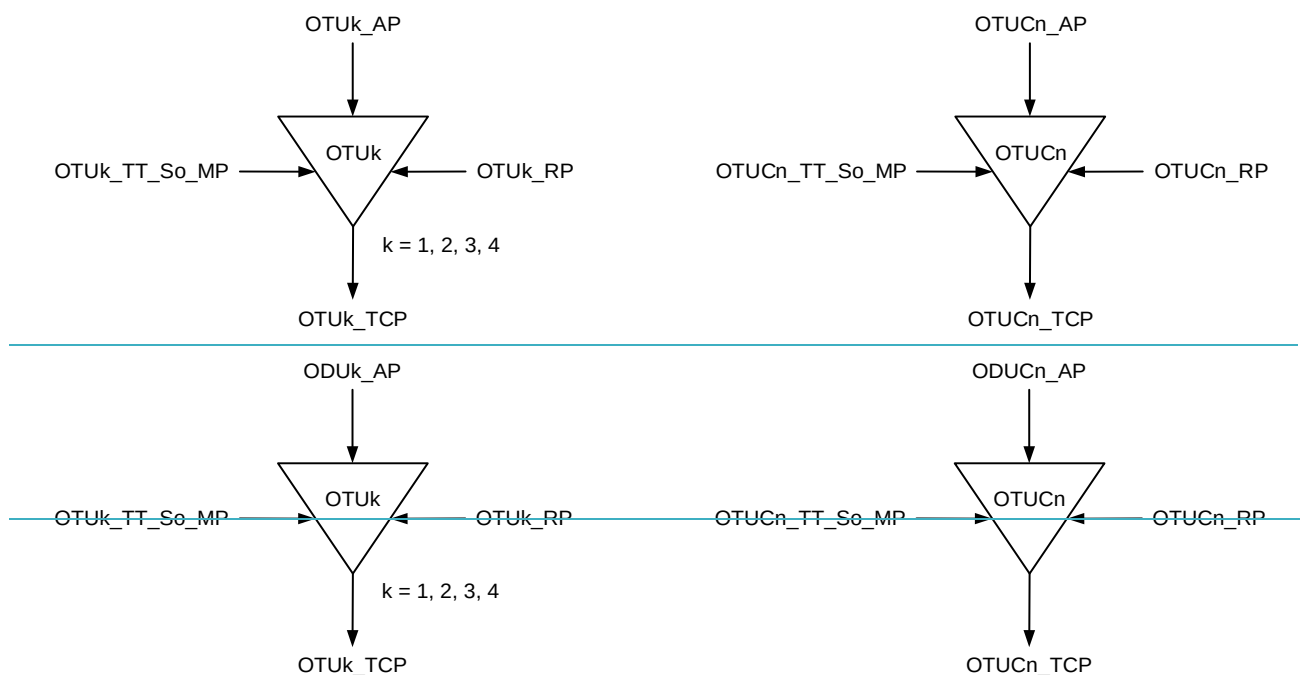


Figure 13-4 – OTU_TT_So function

Interfaces

Table 13-1 – OTU_TT_So inputs and outputs

Input(s)	Output(s)
OTU_AP: OTU_AI_CK OTU_AI_D OTU_AI_FS OTU_AI_MFS OTU_AI_IAE OTU_RP: OTU_RI_BDI OTU_RI_BEI[1..n] OTU_RI_BIAE OTU_TT_So_MP: OTU_TT_So_MI_TxTI <u>OTU TT So MI Mode</u>	OTU_TCP: OTU_CI_CK OTU_CI_D OTU_CI_FS OTU_CI_MFS

Processes

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

Mode: If the MI Mode has the value OPERATIONAL, the following processes shall be performed. If the MI Mode has the value TRANSPARENT, all information shall be passed through transparently and the following processes shall not be performed.

SMOH-TTI: If the MI Mode is OPERATIONAL, the ~~The~~ trail trace identifier is inserted in the TTI byte position of the SM field in the first OTU overhead instance. Its value is derived from reference point OTU_TT_So_MP. The trail trace format is described in clause 15.2 of [ITU-T G.709].

SMOH-BDI: If the MI Mode is OPERATIONAL, the ~~The~~ backward defect indication is inserted in the BDI bit position of the SM field in the first OTU overhead instance. Its value is derived from reference point OTU_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 the MI Mode is OPERATIONAL, if ~~RI_BIAE~~ is true, the value "1011" is inserted into the BEI/BIAE bits of the SM field in all OTU overhead instances. If RI_BIAE is false, the number of errors indicated in RI_BEI[i] is encoded in the BEI/BIAE bits of the SM field in OTU overhead instance #i. 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-BIP-8: See clause 8.3.4.1. If the MI Mode is OPERATIONAL, the ~~The~~ calculated BIP-8[i] is inserted into the BIP-8 byte of the SM field in OTU overhead instance #i. For the BIP-8 calculation, see clause 8.3.4.1.

SMOH-IAE: If the MI Mode is OPERATIONAL, the ~~The~~ incoming alignment error information AI_IAE is inserted into the IAE bit position of the SM field in the first OTU overhead instance. 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. If the MI Mode is OPERATIONAL, the ~~The~~ value shall be fixed to 00.

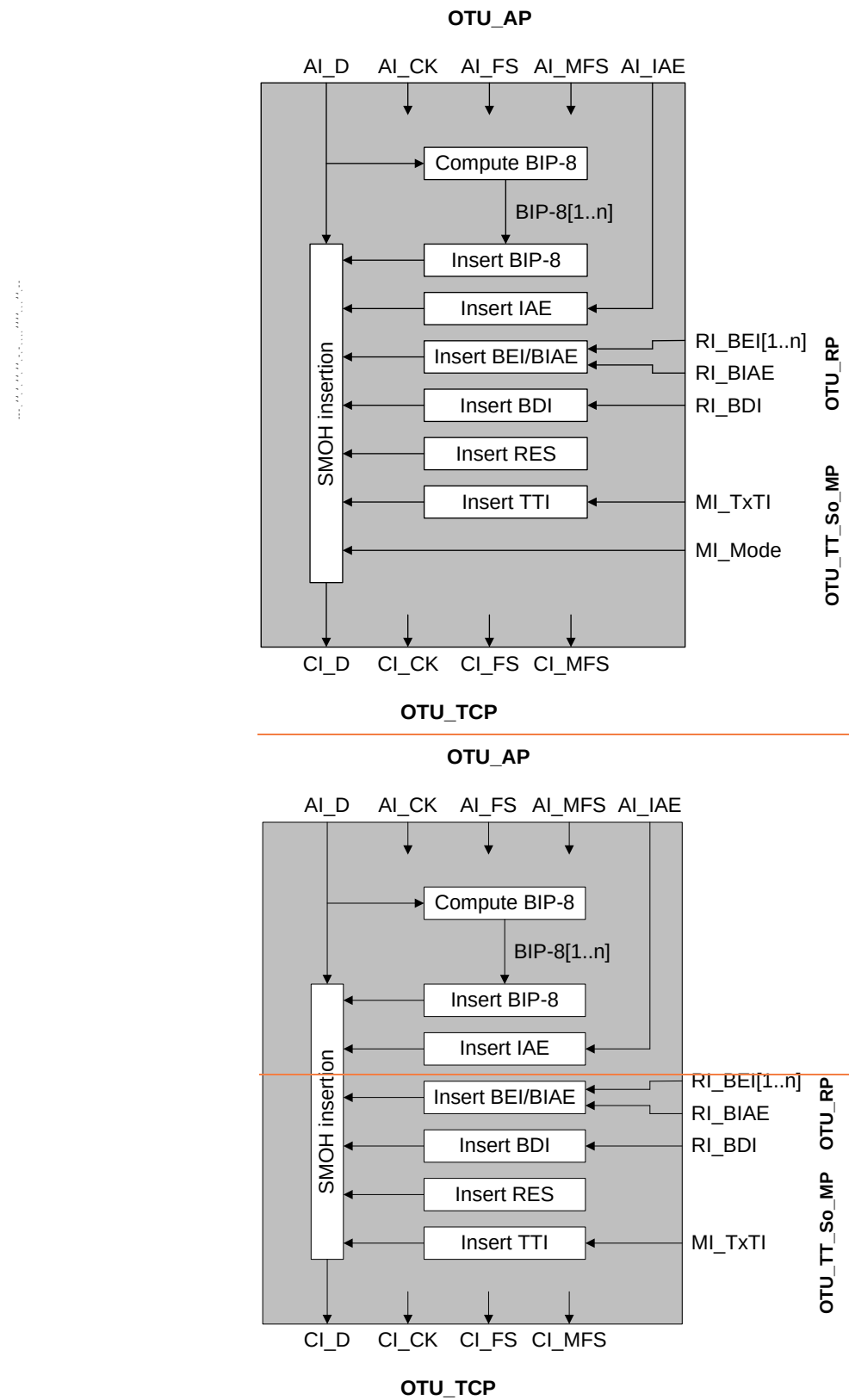


Figure 13-5 – OTU_TT_So processes

Defects: None.

Consequent actions: None.

Defect correlations: None.

Performance monitoring: None.

13.2.1.2 OTU trail termination sink function (OTU_TT_Sk)

The OTU_TT_Sk function reports the state of the OTU trail. It computes the BIP-8[1..n], extracts section monitoring overhead (SMOH) – including the TTI, BIP-8[1..n], IAE, BDI and BEI[1..n] signals and for OTUCn the STAT field – in the SM overhead fields from the OTU signal at its OTU_TCP, detects for TIM, DEG and BDI defects, counts during one-second periods errors (detected via the BIP-8) 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 OTU_TT_So function. The OTUCn signal has n SM overhead fields; the OTUk signal has one (n=1) SM overhead field.

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

Symbol

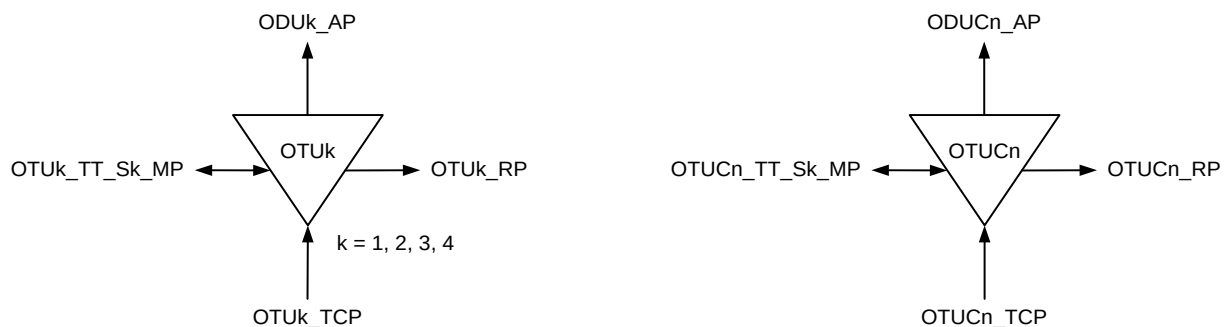


Figure 13-6 – OTU_TT_Sk function

Interfaces

Table 13-2 – OTU_TT_Sk inputs and outputs

Input(s)	Output(s)
OTU_TCP: OTU_CI_CK OTU_CI_D OTU_CI_FS OTU_CI_MFS OTU_CI_SSF OTU_TT_Sk_MP: OTU_TT_Sk_MI_ExSAPI OTU_TT_Sk_MI_ExDAPI OTU_TT_Sk_MI_GetAcTI OTU_TT_Sk_MI_TIMDetMo OTU_TT_Sk_MI_TIMActDis OTU_TT_Sk_MI_DEGThr OTU_TT_Sk_MI_DEGM OTU_TT_Sk_MI_1second <u>OTU TT Sk MI Mode</u>	OTU_AP: OTU_AI_CK OTU_AI_D OTU_AI_FS OTU_AI_MFS OTU_AI_TSF OTU_AI_TSD OTU_RP: OTU_RI_BDI OTU_RI_BEI[1..n] OTU_RI_BIAE OTU_TT_Sk_MP: OTU_TT_Sk_MI_AcTI OTU_TT_Sk_MI_cTIM OTU_TT_Sk_MI_cDEG OTU_TT_Sk_MI_cBDI OTU_TT_Sk_MI_cSSF OTU_TT_Sk_MI_pN_EBC OTU_TT_Sk_MI_pN_DS OTU_TT_Sk_MI_pF_EBC OTU_TT_Sk_MI_pF_DS OTU_TT_Sk_MI_pBIAE OTU_TT_Sk_MI_pIAE

Processes

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

Mode: If the MI Mode has the value OPERATIONAL, the following processes shall be performed. MI Mode OPERATIONAL initiates the consequent actions aAIS, aTSF and aTSD, in case of defects. If the MI Mode has the value TRANSPARENT, all information shall be passed through transparently and the following processes shall not be performed.

SMOH-BIP-8: If the MI Mode has the value OPERATIONAL, the BIP-8[1..n] shall be processed as defined in See-clause 8.3.4.2. The BIP-8[1..n] is extracted from the BIP-8[1..n] bytes of the SM fields in the n SM overhead instances of the OTU signal at the OTU_TCP.

SMOH-TTI: If MI Mode is OPERATIONAL, theThe trail trace identifier shall be recovered from the TTI byte position of the SM field in the first OTU overhead instance of the OTU signal at the OTU_TCP and processed as specified as defined in clause 8.6. The accepted value of the TTI is available at the MP (MI_AcTI).

SMOH-BDI: If MI Mode is OPERATIONAL, theThe backward defect indication shall be recovered from the BDI bit position of the SM field in the first OTU overhead instance of the OTU signal at the OTU_TCP. It shall be used for BDI defect detection.

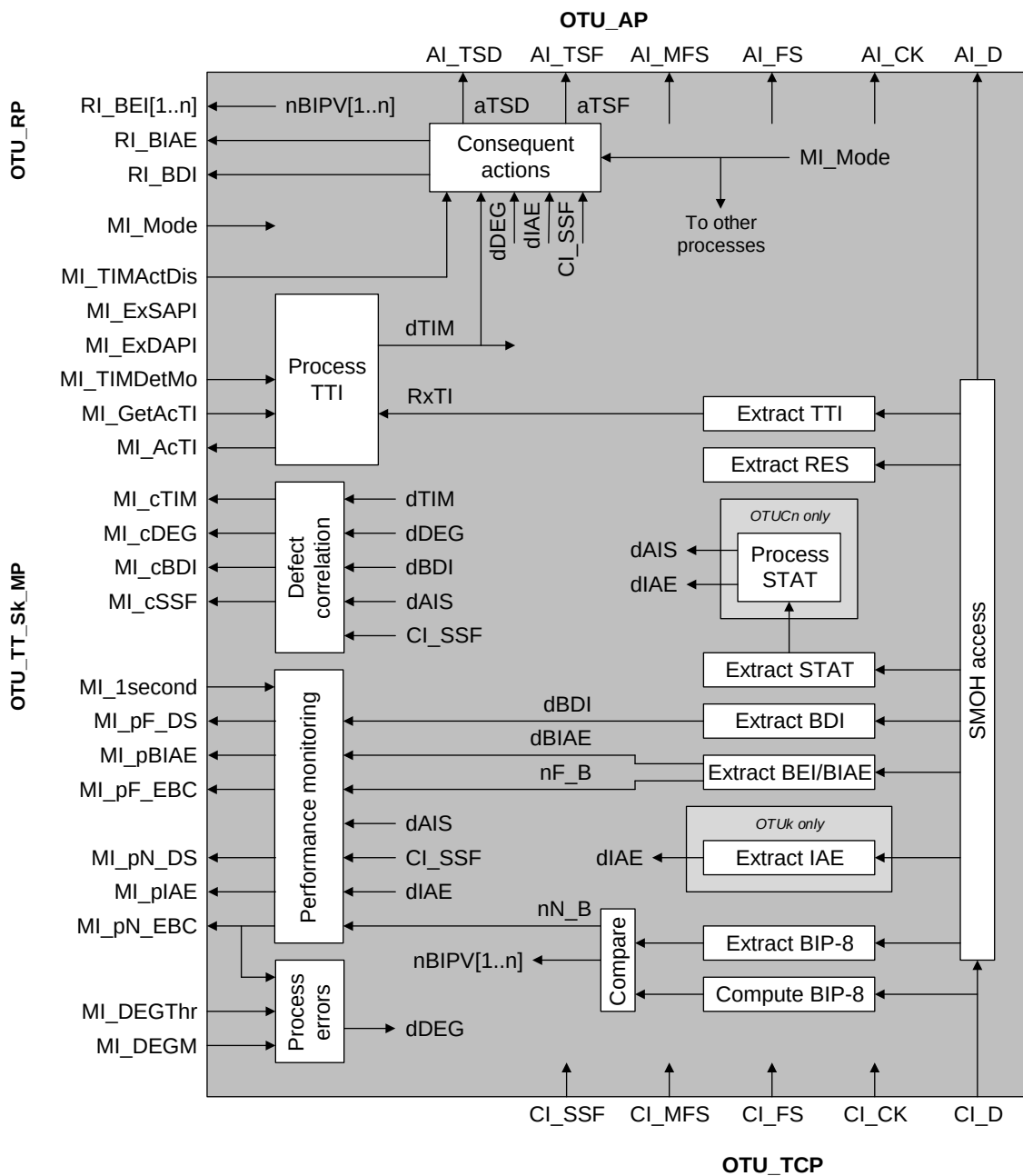
SMOH-BEI/BIAE: If MI Mode is OPERATIONAL, theThe BEI[1..n] shall be recovered from the BEI/BIAE bits in the SM fields of the n SM overhead instances in the OTU signal at the OTU_TCP. They shall be used to determine if far-end errored blocks (nF_B) have occurred. One

nF_B has occurred per BEI/BIAE[i] value between 1 [0001] and 8 [1000]; otherwise, no nF_B has occurred.

SMOH-IAE: For the case of OTU_k and if MI Mode is OPERATIONAL, the incoming alignment error information shall be recovered from IAE bit position of the SM field in the first OTU overhead instance of the OTU signal at the OTU_TCP. It shall be used for IAE defect detection.

SMOH-RES: RES in the SM field in the OTU signal at the OTU_TCP is reserved for future international standardization. For this version of this Recommendation, its value shall be ignored.

SMOH-STAT: For OTU_{Cn} and if MI Mode is OPERATIONAL, the status information shall be recovered from the STAT bits in the SM field of the first OTU overhead instance in the OTU_{Cn} signal at the OTU_{Cn}_TCP as defined in clause 8.8. It shall be used for AIS and IAE defect detection.



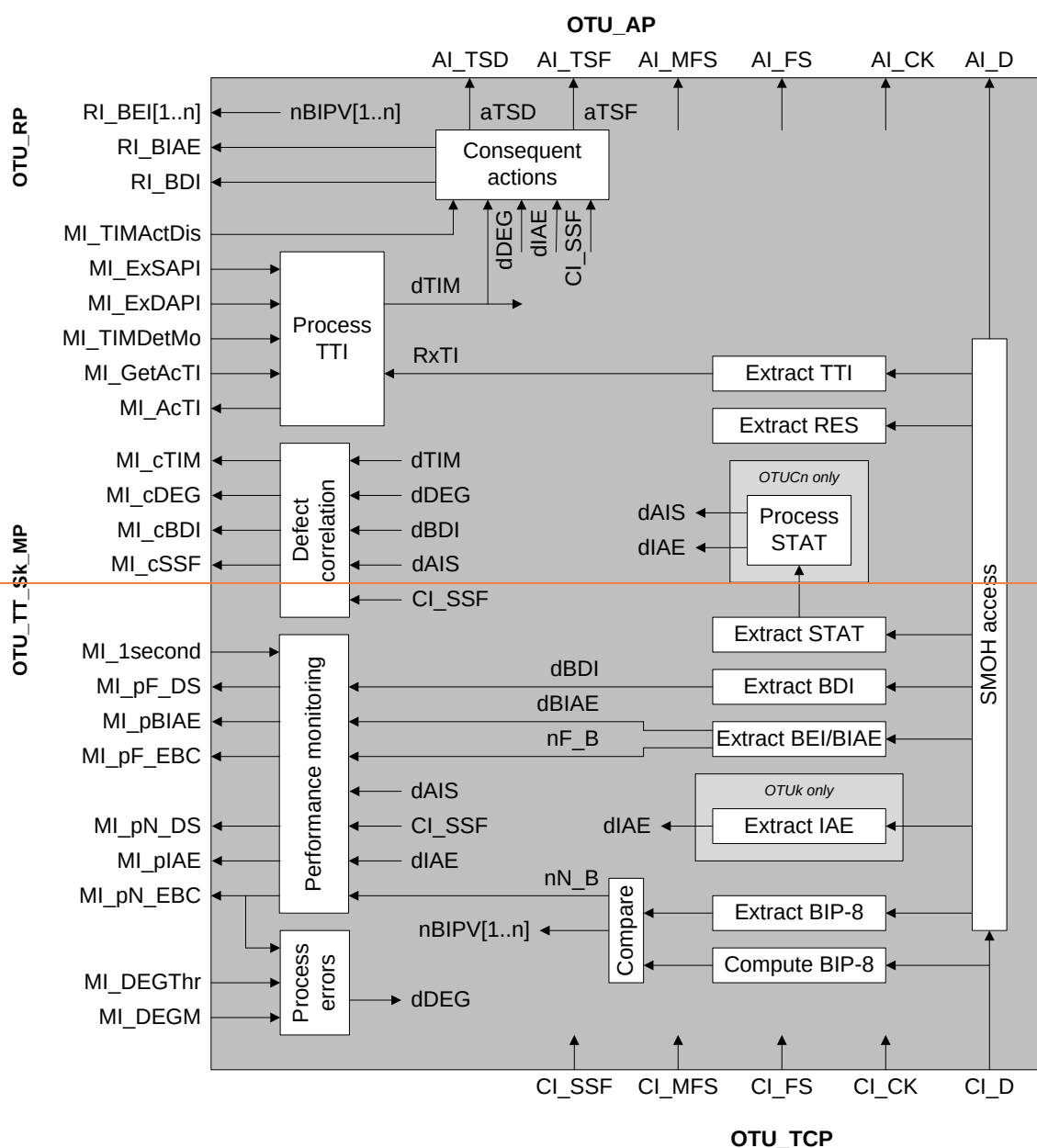


Figure 13-7 – OTU_TT_Sk processes

Defects

If the MI Mode has the value OPERATIONAL, the The-function shall detect dAIS, dTIM, dDEG, dBDI, dBIAE and dIAE defects. If the MI Mode is TRANSPARENT, all defects are cleared.

dAIS: See clause 6.2.6.3.2 for OTUCn; for OTUK[V] dAIS shall be assumed false.

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

dDEG: See clause 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.

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

dIAE: See clause 6.2.6.10.1 for OTUk and 6.2.6.10.2 for OTUCn; dIAE shall be set to false during CI_SSF and dTIM.

dBIAE: See clause 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 dAIS or dTIM) and MI_Mode == OPERATIONAL
aBIAE ← dIAE and MI_Mode == OPERATIONAL
aTSF ← (CI_SSF or dAIS or (dTIM and (not TIMActDis))) and MI_Mode == OPERATIONAL
aTSD ← dDEG and MI_Mode == OPERATIONAL

For each OTU overhead instance #i:

aBEI[i] ← nBIPV[i] and MI_Mode == OPERATIONAL

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) and (not dAIS)
cDEG ← dDEG and (not CI_SSF) and (not dAIS) and (not (dTIM and (not TIMActDis)))
cBDI ← dBDI and (not CI_SSF) and (not dAIS) and (not (dTIM and (not TIMActDis)))
cSSF ← CI_SSF or dAIS

Performance monitoring

If the MI_Mode has the value OPERATIONAL, the 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 dAIS or dTIM

pF_DS ← dBDI

pN_EBC ← $\sum nN_B$

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

pF_EBC ← $\sum nF_B$

NOTE 3 – During CI_SSF and dAIS, 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 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 $DS = \text{false}$). 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 $DS = \text{false}$). The previous second has to be included due to the delay of the IAE information coming from the remote source.

6.2) Subclause 13.3.1 – OTU to ODU adaptation function

Add MI_Mode to the OTU/ODU_A functions:

13.3.1.1 OTU to ODU adaptation source function (OTU/ODU_A_So)

The OTU/ODU_A_So function creates the OTU signal and maps the ODU signal frame synchronous into this OTU signal as defined in [ITU-T G.709]. Additionally, the OTUk/ODUk_A_So function provides access to the ODUk SM APS overhead if it is OPERATIONAL.

The information flow and processing of the OTU/ODU_A_So functions is defined with reference to Figures 13-13 and 13-14.

Symbol

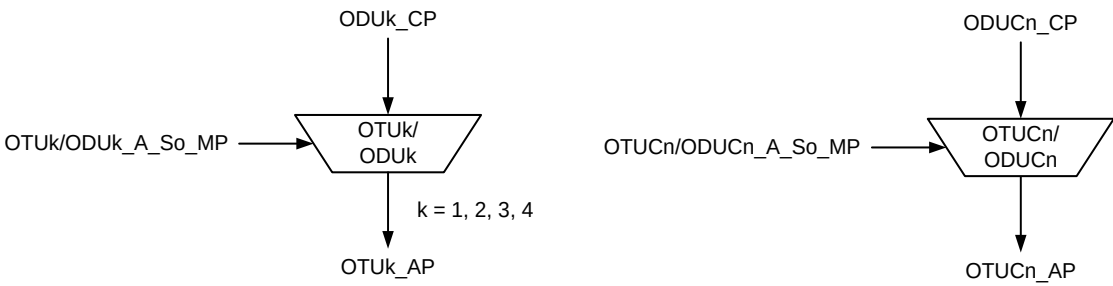


Figure 13-13 – OTU/ODU_A_So function

Interfaces

Table 13-5 – OTU/ODU_A_So inputs and outputs

Input(s)	Output(s)
ODU_CP: ODU_CI_CK ODU_CI_D ODU_CI_FS ODU_CI_MFS ODU_CI_APS OTU/ODU_A_So_MP: OTU/ODU_A_So_MI_AdminState <u>OTU/ODU_A_So_MI_Mode</u> OTU/ODU_A_So_MI_APS_EN (Note 1) OTU/ODU_A_So_MI_APS_LVL (Note 1)	OTU_AP: OTU_AI_CK OTU_AI_D OTU_AI_FS OTU_AI_MFS OTU_AI_IAE
NOTE 1 – For OTUk/ODUk_A_So only.	

Processes

The processes associated with the OTU/ODU_A_So function are as depicted in Figure 13-14.

ODU-LCK: The function shall generate the ODU-LCK signal as defined in clause 16.5 of [ITU-T G.709]. The clock, frame start and multiframe start are defined by the incoming ODUk signal.

Mode: If the MI Mode has the value OPERATIONAL, the following processes shall be performed. If the MI Mode has the value TRANSPARENT, all information shall be passed through transparently and the following processes shall not be performed.

Selector: If MI Mode is OPERATIONAL, the The normal signal may be replaced by the ODU-LCK signal. ODU-LCK signal is selected if the MI_AdminState is LOCKED.

ODUk server layer APS: If MI Mode is OPERATIONAL and When APS is enabled (MI_APS_EN is true), the OTUk/ODUk_A_So function shall insert the CI_APS value into the ODUk APS/PCC[MI_APS_LVL] field, which is available once per eight ODUk frames when MFAS bits 6, 7, 8 is equal to MI_APS_LVL.

NOTE – The ODUk SM APS information may be present in the case where the ODUk signal contains an ODU-AIS, ODU-LCK or ODU-OCI maintenance signal. The ODU-LCK maintenance signal may be inserted in this adaptation source function. ODUk SNC/I protection is unable to detect the insertion of such ODU-LCK and will not perform a protection switch.

OTU clock generation: The function shall generate the OTUk clock (AI_CK) by multiplying the incoming ODUk clock (CI_CK) by 255/239 to the OTUk frequency as listed in Table 7-1 of [ITU-T G.709]. The OTUCn clock (AI_CK) shall be the ODUCn clock (CI_CK).

For the case that an ODU signal is not terminated in the network element (e.g., it is through connected from an OTU input to an OTU output), the clock parameters and jitter and wander requirements, as defined in Annex A of [ITU-T G.8251] (ODCr clock), apply. Otherwise, the clock requirements are defined in the ODUP/client adaptation functions.

NOTE – The OTU/ODU_A_Sk and So clocks are concentrated in a single ODCr clock in [ITU-T G.8251].

The function shall generate the OTU frame start reference signals (AI_FS), which is derived from the incoming ODU frame start (CI_FS).

The function shall generate the OTU multiframe start reference signals (AI_MFS), which is derived from the incoming ODU multiframe start (CI_MFS).

Incoming alignment error (IAE): If the incoming ODU frame start (CI_FS) position is not at the expected frame start position, the incoming alignment error IAE shall be activated. IAE shall be deactivated if the incoming ODU frame start (CI_FS) position is at the expected frame start position. The expected frame start position is based on the previous incoming ODU frame start.

Mapping: The function shall map the incoming ODU frame (CI_D) into the OTU frame (AI_D) as defined in clause 11.1 of [ITU-T G.709].

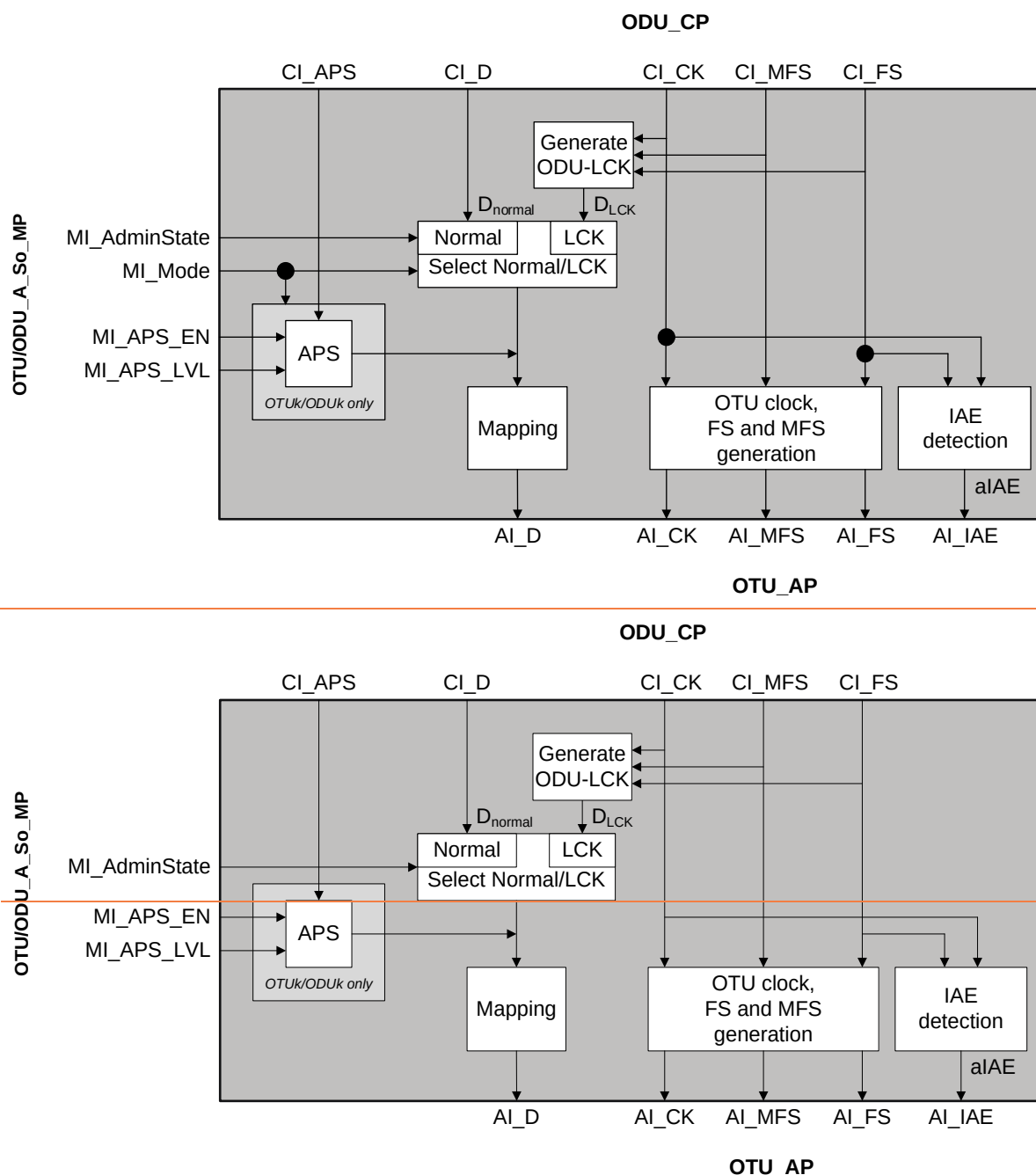


Figure 13-14 – OTU/ODU_A_So processes

Defects: None.

Consequent actions

The function shall perform the following consequent actions:

aIAE ← IAE

Defect Correlations: None.

Performance monitoring: None.

13.3.1.2 OTU to ODU adaptation sink function (OTU/ODU_A_Sk)

The OTU/ODU_A_Sk extracts the ODU signal from the OTU. It may insert ODU-AIS under signal fail conditions. Additionally, the OTUk/ODUk_A_So function provides access to the ODUk SM APS overhead if it is OPERATIONAL.

The information flow and processing of the OTU/ODU_A_Sk functions is defined with reference to Figures 13-15 and 13-16.

Symbol

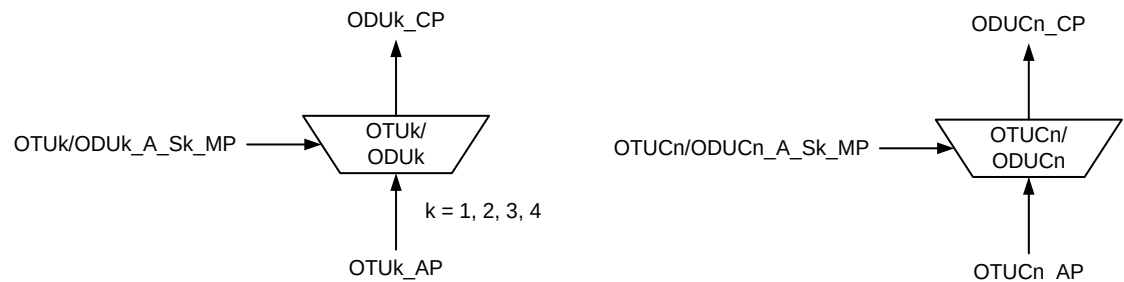


Figure 13-15 – OTUk/ODUk_A_Sk function

Interfaces

Table 13-7 – OTU/ODU_A_Sk inputs and outputs

Input(s)	Output(s)
OTU_AP: OTU_AI_CK OTU_AI_D OTU_AI_FS OTU_AI_MFS OTU_AI_TSF OTU_AI_TSD OTU/ODUk_A_Sk_MP: OTU/ODU_A_Sk_MI_AdminState <u>OTU/ODU_A_Sk_MI_Mode</u> OTU/ODU_A_Sk_MI_APS_EN (Note 1) OTU/ODU_A_Sk_MI_APS_LVL (Note 1)	ODU_CP: ODU_CI_CK ODU_CI_D ODU_CI_FS ODU_CI_MFS ODU_CI_SSF ODU_CI_SSD ODU_CI_APS
NOTE 1 – For OTUk/ODUk_A_So only.	

Processes

The processes associated with the OTUk/ODUk_A_Sk function are as depicted in Figure 13-16.

ODU clock, FS and MFS signal generation: The function shall generate the ODUk clock (CI_CK) by dividing the incoming OTUk clock (AI_CK) down by a factor of 239/255 to the particular ODUk clock as listed in Table 7-2 of [ITU-T G.709]. The ODUCn clock (AI_CK) shall be the OTUCn clock (CI_CK).

For the case that an ODU signal is not terminated in the network element (e.g., it is through connected from an OTU input to an OTU output), the clock parameters and jitter and wander requirements, as defined in Annex A of [ITU-T G.8251] (ODCr clock), apply. Otherwise, the clock requirements are defined in the ODUP/client adaptation functions.