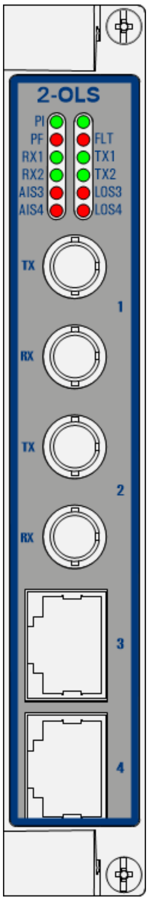
User Manual

Installation
Dragon PTN
Interface Module PTN-2-OLS with E1
PTN-2-OLS with T1



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1. INTRODUCTION

1.1 General

This document is valid as of Dragon PTN Release 4.3DR.

The 2-OLS interface module (=IFM) is an Optical Low Speed Serial interface module which can be used to transport low speed serial data and E1 data. This IFM has four ports: two Optical Serial ports (=port1, port2) and two E1 ports (=port3, port4). Each optical port has two ST connectors: one Rx (=Receive) and one Tx (=Transmit) ST. Each E1 port is an RJ-45 connector. This IFM can be used in 3 different service types (a mix in one IFM is possible):

- Local Mode (Figure 1): The IFM converts serial data into E1 and vice versa. This mode does not use any backplane access (or Dragon PTN network) in a point-to-point connection. It converts the incoming serial signal on port1 into E1 on port3 and vice versa. The same counts for port2 and port4. The E1 links provide synchronous TDM links between two end points that can be used to transport over an external network e.g. SDH. The optical ports are the access ports whereas the E1 ports are the SDH interconnection ports. At the destination side, the 2-OLS receives the E1 traffic and converts it back to an optical low speed serial signal towards the end application. Service in HiProvision = 'Local Mode - Optical Low Speed Serial';
- Circuit Emulation Optical Serial Data (Figure 2): The IFM uses backplane access and transports the received optical serial data over the Dragon PTN network to a destination optical serial port. Service in HiProvision = 'Circuit Emulation - Optical Low Speed Serial';
- Circuit Emulation E1 Data (Figure 3): The IFM uses backplane access and transports the received E1 data over the Dragon PTN network to a destination E1 port. The E1 port could be any E1 port from any type of IFM, see §4. Service in HiProvision = 'Circuit Emulation - E1';

Verify the 'Dragon PTN Bandwidth Overview' manual (Ref.[100] in Table 1) to see in which node and IFM slot this IFM can be used. This IFM requires an interface adapter kit in core nodes which is not needed in aggregation nodes (see §2.12.1, Nodes: see Ref. [3], [3b] in Table 1).

The main supported features are:

- (Local Mode) Converting optical serial into E1 and vice versa;
- (Circuit Emulation) Packetizing of Optical Low Speed Serial data;
- (Circuit Emulation) Packetizing of E1 Framing;
- LAN function;
- Services (See Ref. [2Leg] in Table 1 for the creation of services in HiProvision)
  - Local Mode - Optical Low Speed Serial:
  - Circuit Emulation - Optical Low Speed Serial/E1:
    - SAToP (=Structured Agnostic TDM over Packet) → all channels transparently;
    - CESoPSN (=CES over Packet Switched Network) → customized channel transport;
    - Hitless Switching / Single Path;
- Synchronization
  - SyncE for E1 ports;

- E1 port on 2-OLS IFM can slave to E1 clock from external network;

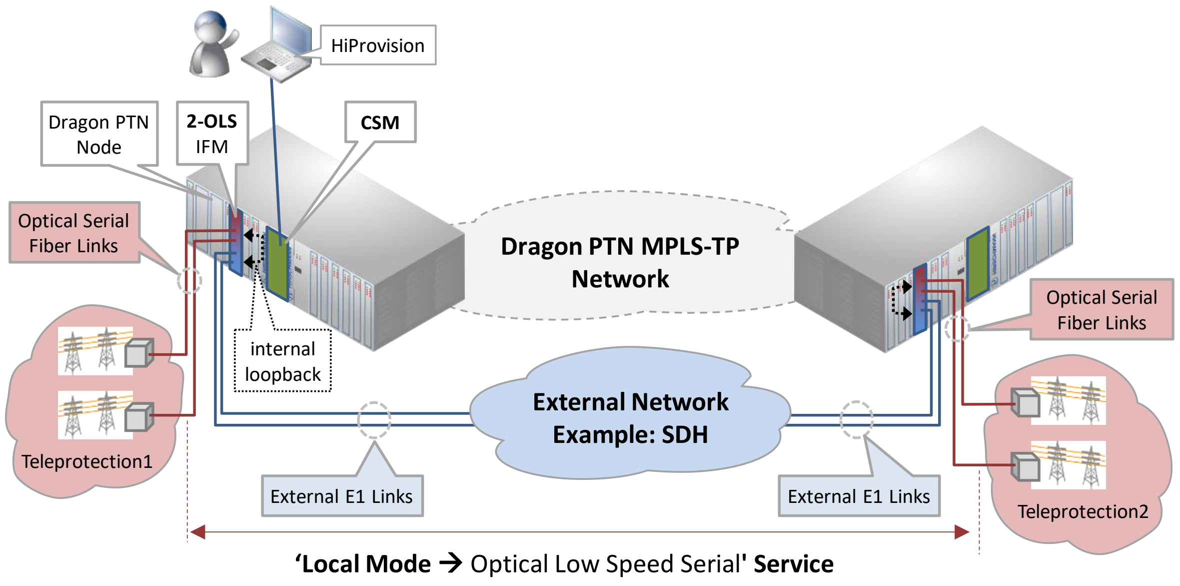

Figure 1 Local Mode: Optical Low Speed Serial - SDH Example

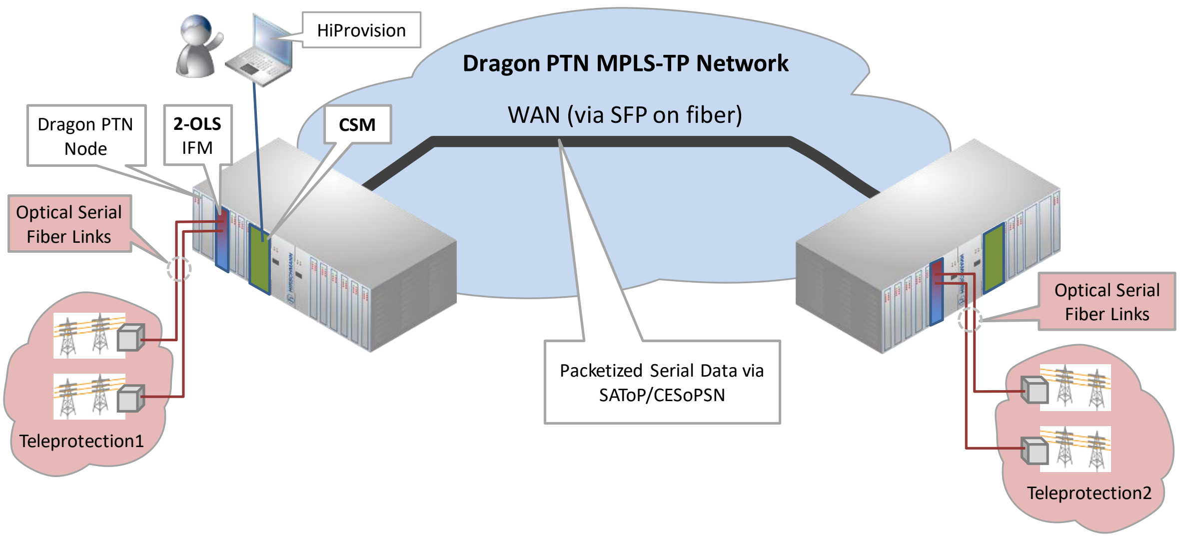

Figure 2 Circuit Emulation: Transport Optical Serial Data via Dragon PTN

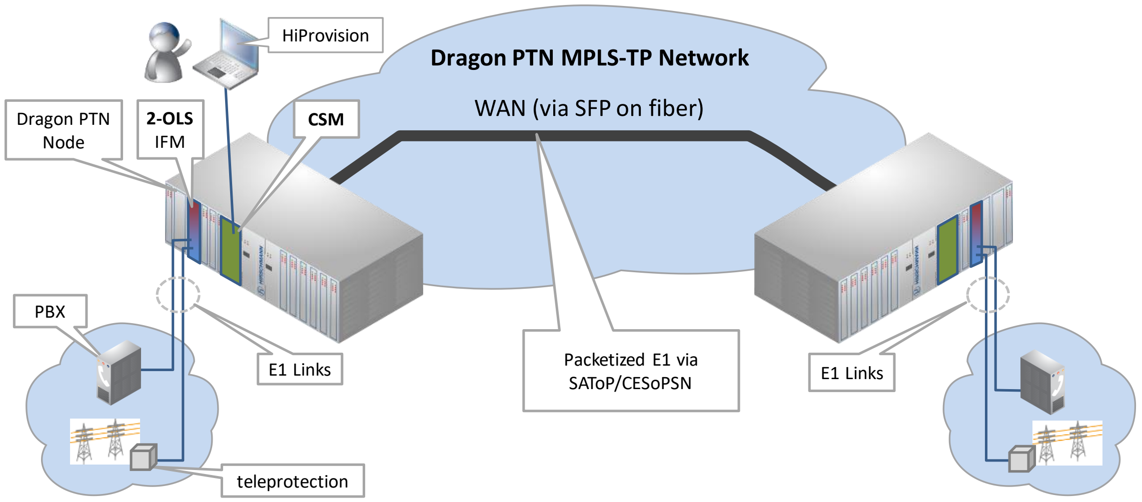

Figure 3 Circuit Emulation: Transport E1 Data via Dragon PTN

1.2 Manual References

Table 1 is an overview of the manuals referred to in this manual. '&' refers to the language code, '*' refers to the manual issue. All these manuals can be found in the HiProvision (=Dragon PTN Management System) Help function.

Table 1 Manual References

Ref.	Number	Title
[1]	DRA-DRM801-&-*	Dragon PTN Installation and Operation
[2Mgt]	DRA-DRM830-&-*	HiProvision Management Operation
[2Leg]	DRA-DRM832-&-*	Dragon PTN Legacy Services
[2Net]	DRA-DRM833-&-*	Dragon PTN Network Operation
[3]	DRB-DRM802-&-*	Dragon PTN Aggregation Nodes: PTN2210, PTN2206, PTN1104, PTN2209
[3b]	DRB-DRM840-&-*	Dragon PTN Core Nodes: PTN2215
[4]	DRB-DRM803-&-*	Dragon PTN Switching Module: PTN-CSM310-A/ PTN-CSM540-A
[5]	DRA-DRM810-&-*	Dragon PTN General Specifications
[6]	DRE-DRM805-&-*	Dragon PTN Interface Module: PTN-4-E1-L/ PTN-4-T1-L
[7]	DRE-DRM818-&-*	Dragon PTN Interface Module: PTN-16-E1-L/ PTN-16-T1-L
[8]	DRE-DRM809-&-*	Dragon PTN Interface Module: PTN-2-C37.94
[100]	DRA-DRM828-&-*	Dragon PTN Bandwidth Overview

2. MODULE DESCRIPTION

2.1 Front Panel

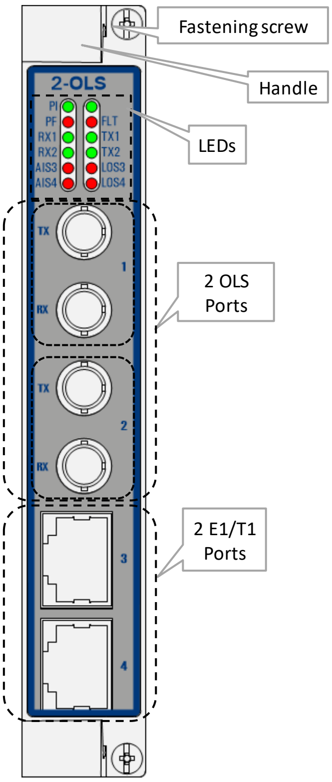

Figure 4 IFM in Aggregation Nodes

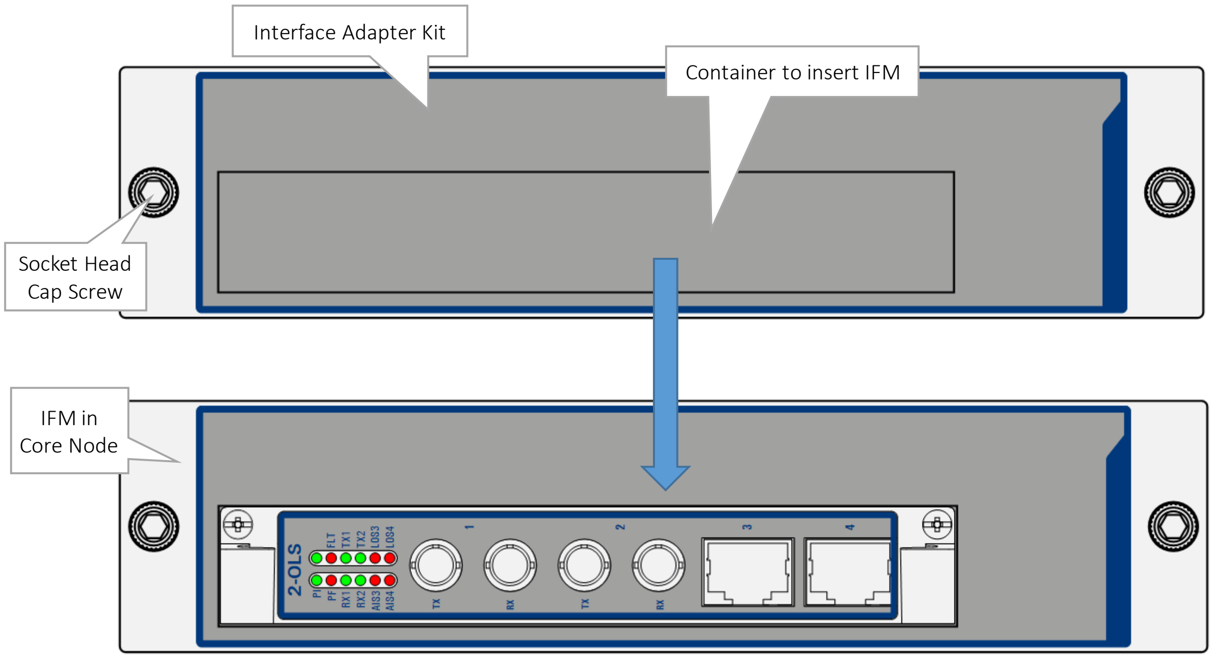

Figure 5 IFM in Core Nodes

2.1.1 Insert/Remove Module into/from Node

See 'Dragon PTN Installation and Operation Manual' Ref.[1] in Table 1.

2.1.2 LEDs

The meaning of the LEDs depends on the mode of operation (= boot or normal) in which the 2-OLS module currently is running. After plugging in the module or rebooting it, the module turns into the boot operation, see Table 2. After the module has gone through all the cycles in the table below (=rebooted successfully), the module turns into the normal operation, see LEDs in Table 3.

Table 2 LED Indications In Boot Operation

Cycle	PI	PF	FLT	Spare LED	RX[1,2]	TX[1,2]	AIS[3,4]	LOS[3,4]
1	✓	---	Slow blinking	---	---	---	---	---
2	✓	---	Fast blinking	---	---	---	---	---
3	✓	---	---	---	---	---	---	---
4	✓	---	Fast blinking	---	✓	✓	✓	✓
✓ : LED is lit; --- : LED is not lit; The sub cycle times may vary. The entire boot cycle time [1→4] takes approximately 2 minutes.								

Table 3 LED Indications In Normal Operation

LED	Color	Status
PI (=Power Input)	Not lit, dark	+12V power input to the board not OK
	Green	+12V power input to the board OK
PF (=Power Failure)	Not lit, dark	power generation on the board itself is OK
	Red	power generation on the board itself is erroneous
FLT (=FauLT)	Not lit, dark	no other fault or error situation, different from PF, is active on the module
	Red	a fault or error situation, different from PF, is active on the module
RX<port n°>	Not lit, dark	no service programmed on this optical serial port
	Green, blinking	Service programmed, no optical serial port activity detected
	Green, lit	Service programmed, optical serial port activity detected
TX<port n°>	Not lit, dark	No service programmed on this optical serial port
	Green, blinking	Service programmed, optical serial port not sending out data
	Green, lit	Service programmed, optical serial port sending out data, no errors
AIS<port n°> (=Alarm Indication Signal)	Not lit, dark	- no service on this port - service on this port: no alarms detected on backplane (=network) side, everything fine
	Red, lit	service on this port: no network traffic or TX AIS detected on backplane (=network) side
	Red, blinking	other errors different from TX AIS detected on backplane (=network) side
LOS<port 1-2> (OLS ports) (Loss of Signal)	Not lit, dark	- no service on this port - service on this port: local OLS traffic on this front port is OK
	Red, lit	service on this port: LOF on this front port
	Red, blinking	other errors different from LOF received on this front port
LOS<port 3-4> (E1/T1 ports) (Loss of Signal)	Not lit, dark	- no service on this port - service on this port: local E1 traffic on this front port is OK
	Red, lit	service on this port: local E1 signal is lost on this front port
	Red, blinking	AIS, LOF or RAI received on this front port

2.1.3 Optical Serial Port (Fiber)

The 2-OLS module provides two optical serial ports with each port having two ST (=Straight Tip) connectors: TX and RX. These ports can be used for communication over optical fiber.

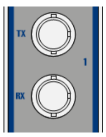

Figure 6 Optical Serial ST Connector

2.1.4 E1 RJ-45 Ports (Copper) and Cables

The 2-OLS module provides two E1 ports and each port connector has eight pins. Each port provides one tip/ring pair. See the table and figure below for an overview and description. The cables below can be ordered to connect these ports.

- E1 cable (120 Ω): ordering number S30827-C40-Axx-y;

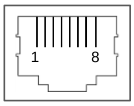

Figure 7 E1 RJ-45 Connector

Table 4 E1 RJ-45 Connector: Pin Assignments

Pin Number	Description	Cable Wire Colors
1	Rx (Receive) RING	OG
2	Rx (Receive) TIP	WH/OG
3	Not connected	-
4	Tx (Transmit) RING	BU
5	Tx (Transmit) TIP	WH/BU
6, 7 ,8	Not connected	-

2.2 Functional Operation

2.2.1 General

See §1.1.

2.2.2 Serial: FM0 Coding (Biphase Space Encoding)

FM0 Coding is a biphase 'space' encoding ('space' = 0-bit; 'mark': 1-bit) that can be used in serial data communication. FM0 encoding guarantees to have a transition (from high to low or vice versa) in every data bit. This encoded data contains sufficient transitions to recover a clock from the data. Further advantages are the DC balancing resulting in enhanced signal reliability.

With FM0 Coding enabled, a 0-bit (='space') will always have an extra transition halfway its bit time (=2 phases = biphase) whereas a 1-bit will have no transition within its bit time.

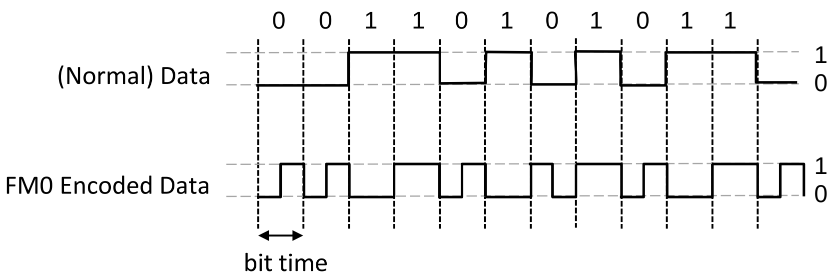

Figure 8 FM0 Coding

FM0 Coding:

- disabled (=default): Normal data (without encoding) is expected at the optical serial RX ports. Normal data (without encoding) is generated at the optical serial TX ports;
- enabled: FM0 encoded data is expected at the optical serial RX ports. FM0 encoded data is generated at the optical serial TX ports;

2.2.3 E1 Framing

E1 is a 2.048 Mbps bi-directional (full duplex) link through which the data is transported in a digital way in frames. One frame consists of 32 time slots (Figure 9). Timeslot 0 is used for framing and synchronization, and time slot 16 for signaling. The bandwidth of one time slot is 64 kbps (=8 bits/125 µs). One frame thus consists of 32*8 = 256 bits and lasts 125 µs. Typically 16 frames are packed together in one multiframe.

NOTE: Multiframe = future support;

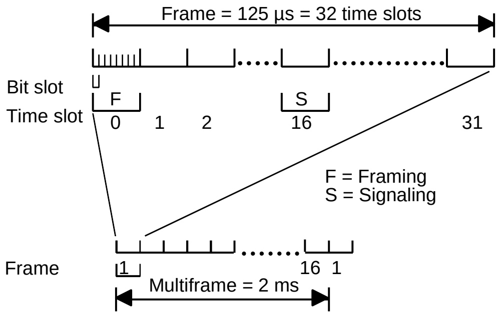

Figure 9 E1 Framing

2.2.4 E1 Coding: AMI, HDB3

AMI, HDB3 are different types of line coding. HDB3 is used in E1. The 2-OLS module supports HDB3 for E1. HDB3 is an enhancement of AMI. For this reason, AMI is mentioned here as well.

As the E1 link has no separate clock transmission, the receiver will derive the clock from the incoming data stream. A minimum density of logical ones is required in order to guarantee a faultless clock recovery. This is achieved basically by AMI which encodes the data stream with bipolar violations. A more enhanced and better encoding is HDB3 which enhances the AMI stream by replacing successive zeros:

- E1→ HDB3: replace four successive zeros with a fixed bit pattern ‘000V’ or ‘B00V’;

A ‘B’ and ‘V’ can either be ‘-‘ or ‘+’. Which pattern is used depends on the amount of ‘+’ and ‘-‘ already received from send on the link.

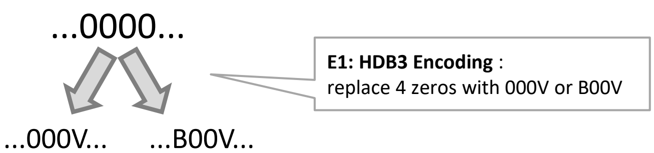

Figure 10 HDB3 Encoding

2.2.5 E1 Short Haul/Long Haul on E1 Ports

Long E1 links (>200m, Long Haul) have more signal attenuation than shorter links (<200m, Short Haul). As a result, the signal levels or sensitivity ('0' or '1') on the receiver side must be configured according the used link: Long Haul or Short Haul.

In HiProvision, a Short Haul parameter can be checked for Short Haul links and unchecked (=default) for Long Haul links. This parameter can be set on port level in the IFM or at service creation.

2.2.6 Service Type Overview

With the 2-OLS IFMs, following service types are possible:

- Local Mode - Optical Low Speed Serial - via external network, no Dragon PTN;
- Circuit Emulation - Optical Low Speed Serial:
  - SAToP;
  - CESoPSN;
- Circuit Emulation - E1:
  - SAToP;
  - CESoPSN;

NOTE: See Ref. [2Leg] in Table 1 for the creation of services in HiProvision.

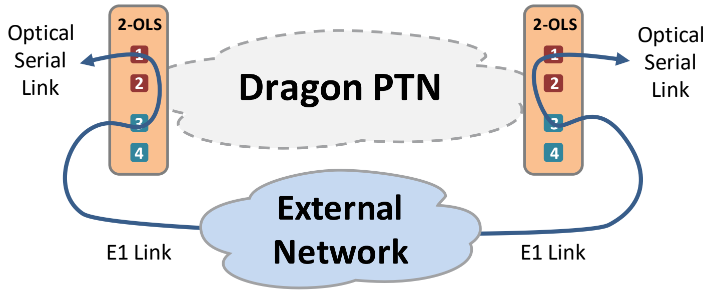

Figure 11 Local Mode - Optical Low Speed Serial - via External Network

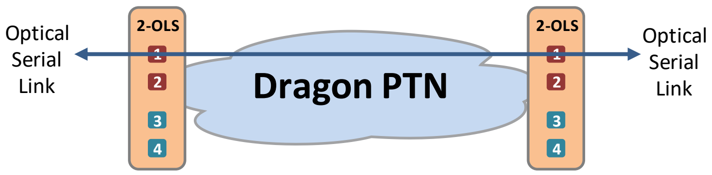

Figure 12 Circuit Emulation - Optical Low Speed Serial

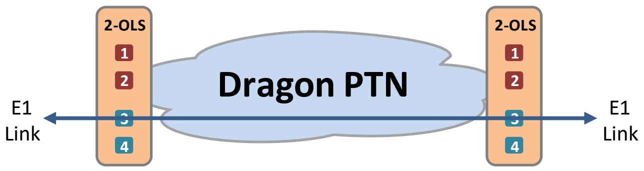

Figure 13 Circuit Emulation - E1

2.2.7 Service: Local Mode - Optical Low Speed Serial - via External Network

The 'Local Mode - Optical Low Speed Serial service' is a point-to-point service between two optical serial ports (via a fixed loopback on the E1 ports on the own IFM), each serial port located in a different node, see §1.1. The E1 link will go over an external network, not via Dragon PTN. This service can be configured in HiProvision (=Dragon PTN management system). It converts the incoming serial signal into E1 and vice versa.

Within one 2-OLS IFM, [port 1 <-> port3] and [port 2 <-> port4] are always linked via a fixed local loopback including the conversion. See figure below:

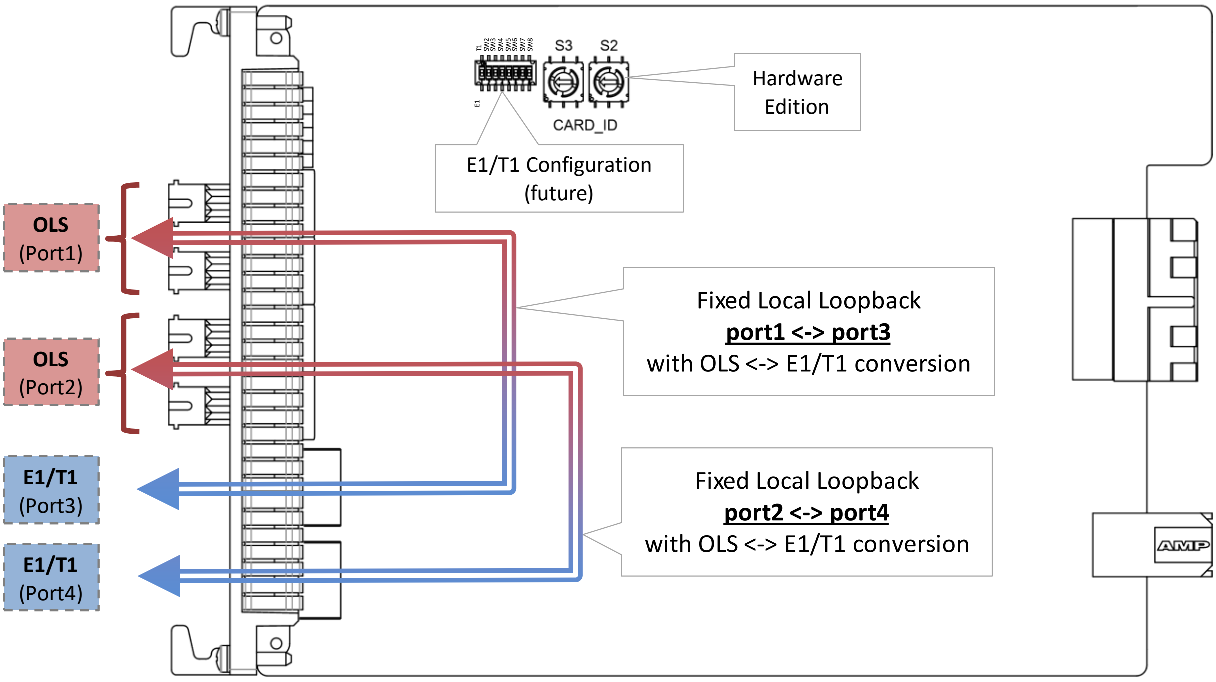

Figure 14 2-OLS IFM Side View: Local Loopbacks

Following can be configured during service creation:

- Optical Serial Ports:
  - Synchronisation: synchronous or asynchronous;
  - Synchronous:
    - Bitrates: see §2.2.12;
    - FM0 Coding (see §2.2.2): disabled/enabled;
  - Asynchronous:
    - Bitrates: see §2.2.12;
- E1 Ports:
  - Short Haul (see §2.2.5): unchecked (=default) /checked;

2.2.8 Service: Circuit Emulation - Optical Low Speed Serial - SAToP

Similar to §2.2.10 but using OLS ports instead.

SAToP (=Structure Agnostic TDM over Packet) is a point-to-point service between two OLS ports. The OLS data will be packetized in an E1 frame, using all 32 timeslots, over the Dragon PTN network. As a result, maximum one SAToP service can be configured per port.

This way of transportation consumes more bandwidth over the Dragon PTN network than CESoPSN (see next paragraph), but has less differential delay than CESoPSN. If delay must be as low as possible, use SAToP instead of CESoPSN to transport your OLS data.

NOTE: Each end-point or OLS port must be located in a different node.

- Synchronous:

- Bitrates: see §2.2.12;
- FM0 Coding (see §2.2.2): disabled/enabled;

- Asynchronous:
  - Bitrates: see §2.2.12. When a bit rate is selected, an incoming serial signal with a lower bitrate will operate as well, because 2-OLS samples at 6.6 times the selected bitrate;

2.2.9 Service: Circuit Emulation - Optical Low Speed Serial - CESoPSN

Similar to §2.2.11 but using OLS ports instead.

CESoPSN (=Circuit Emulation Service over Packet Switched Network) is a point-to-point service between two OLS ports. One such service can be configured per port. This service converts the incoming OLS data into an amount of timeslots, to transport it over the MPLS-TP Dragon PTN network. The amount of timeslots over the network just depends on the selected bit rate.

The destination module will receive the transported timeslots from the Dragon PTN network and regenerate the OLS data from it. As a result, the destination sends out the regenerated OLS data on its OLS port.

Each end-point or port must be located in a different node.

- Synchronous:
  - Bitrates: see §2.2.12;
  - FM0 Coding (see §2.2.2): disabled/enabled;

- Asynchronous:
  - Bitrates: see §2.2.12. When a bit rate is selected, an incoming serial signal with a lower bitrate will operate as well, because 2-OLS samples at 6.6 times the selected bitrate;

2.2.10 Service: Circuit Emulation - E1 - SAToP

SAToP is a point-to-point CES which sends transparently the entire E1 frame from the source to the destination E1 port over the MPLS-TP network. The entire frame = all data + synchronization + alignment timeslots = 32 timeslots for E1. As a result, maximum one SAToP service can be configured per port.

NOTE: Each end-point or E1 port must be located in a different node.

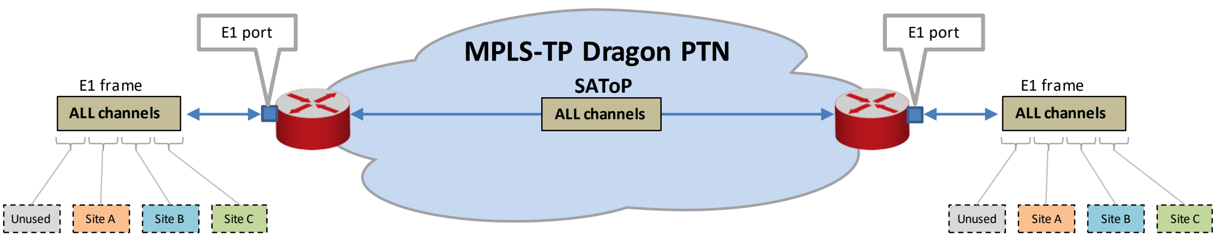

Figure 15 General SAToP Example With E1

In the figure below, a more detailed example has been worked out.

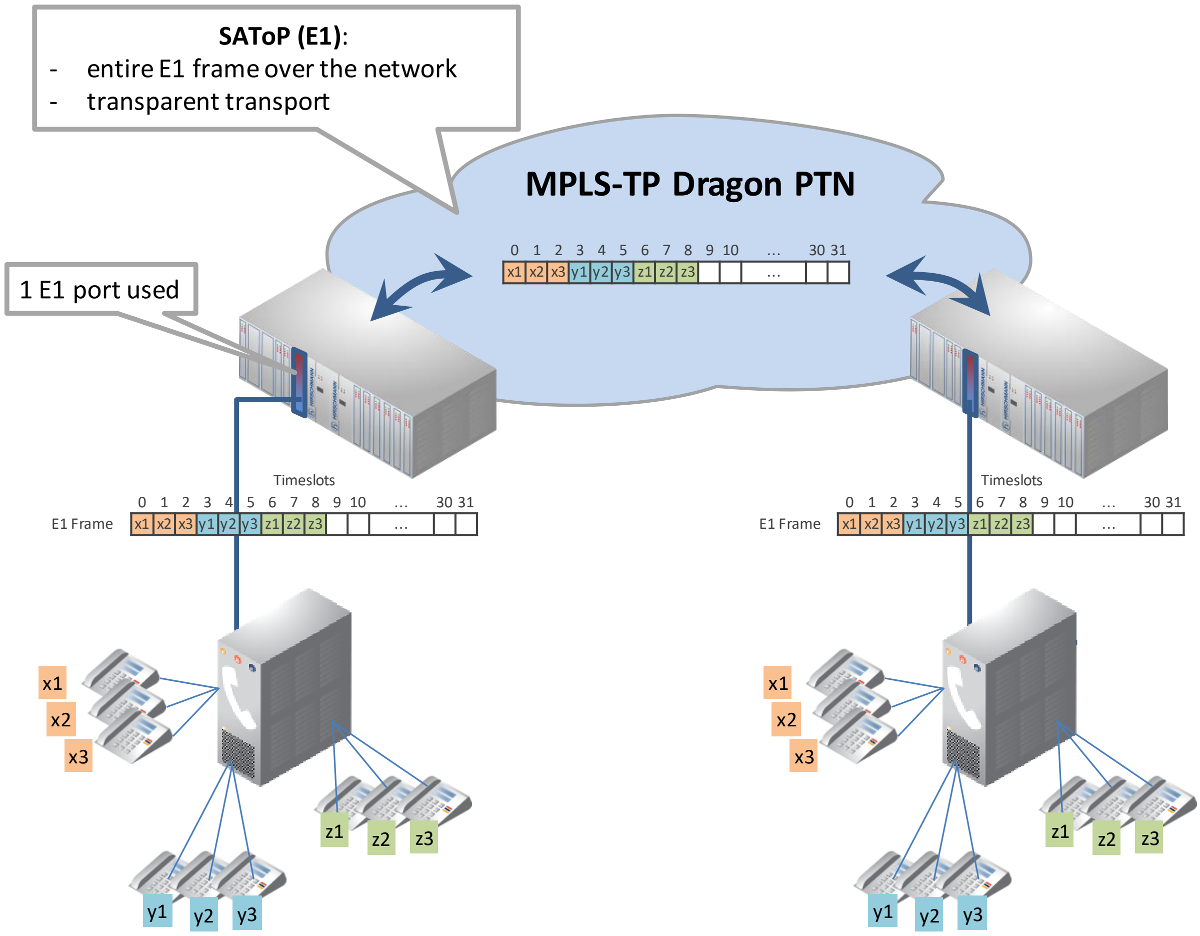

Figure 16 Detailed E1 SAToP Example

2.2.11 Service: Circuit Emulation - E1 - CESoPSN

CESoPSN is a point-to-point CES which only sends a selection of channels or timeslots over the MPLS-TP Dragon PTN network. In HiProvision (=Dragon PTN Management System), the operator selects which timeslots of the input E1 frame must be transported. This customized transportation of timeslots through the network results in a more efficient bandwidth use.

The destination module will receive the transported channels from the Dragon PTN network, and regenerate all the other missing timeslots itself (empty or dummy timeslots, synchronization). As a result, the destination sends out the entire regenerated E1 frame on its port.

Each end-point or E1 port must be located in a different node.

CESoPSN services can be configured:

- Between two or more E1 ports, see below;
- Between a C37.94 and an E1 port, see below;

a. Between Two or More E1 Ports

Multiple CESs per port can be configured to transport an amount of timeslots between two or more E1 ports. In HiProvision, the operator selects the timeslots individually to be transported per CES. On both the source and destination side, the same amount of timeslots must be selected. The selected timeslots from the source side can be mapped onto the timeslots from the destination side.

The timeslot order does not change during the mapping. The first selected source timeslot will be mapped automatically onto the first selected destination timeslot etc....

See some examples in the figures below.

NOTE: In E1, timeslot 0 cannot be transported;

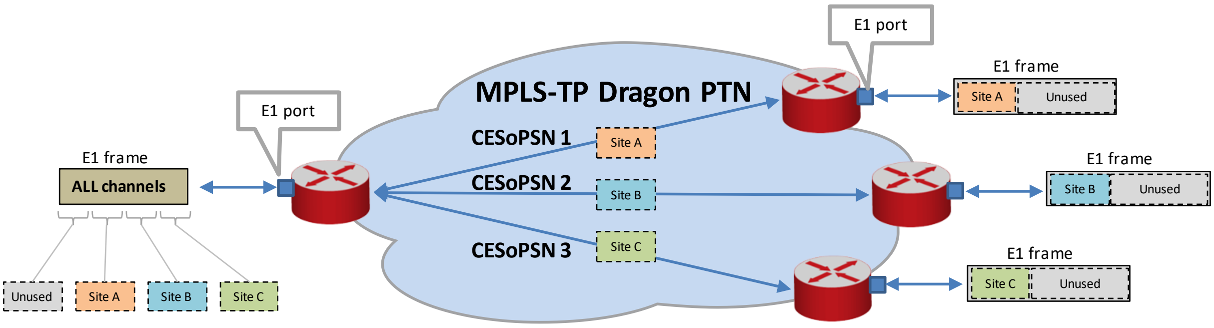

Figure 17 General CESoPSN Example

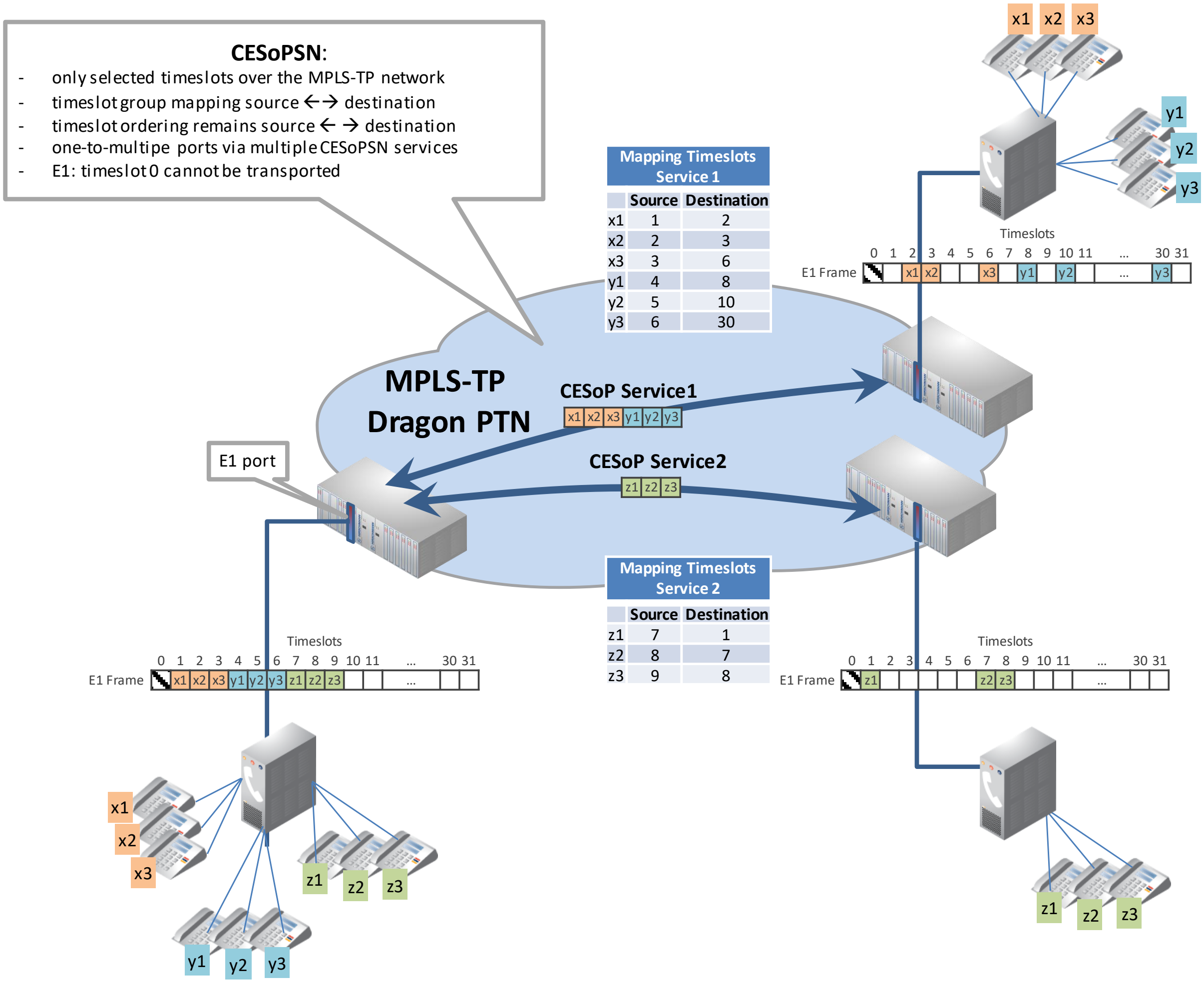

Figure 18 Detailed E1 CESoPSN Example

b. Between a C37.94 and an E1 Port

See Ref.[8] in Table 1;

2.2.12 Optical Low Speed Serial Bitrates

See paragraph 'Optical Low Speed Serial Bitrates' in the Ref. [2Leg] in Table 1.

2.2.13 Start Sending Data

When an OLS/E1 port has been configured in a SAToP service, it can be configured when the port starts sending data. See ‘send data’ in the Ref. [2Leg] in Table 1 for more information.

2.2.14 SAToP Compared With CESoPSN

Table 5 Comparison: SAToP ←→ CESoPSN

	SAToP	CESoPSN
Optical Low Speed Serial		
amount of services/port	1	1;
amount of used timeslots or channels/service	always 32 for E1, including synchronization and alignment data.	depends on the selected bitrate;
E1		
amount of services/port	1	31 (=E1);
amount of used timeslots or channels/service	always 32 for E1, including synchronization and alignment data.	must be configured, amount on input = amount on output; timeslot 0 is never transported;
timeslot mapping	just port to port configuration, ‘timeslot x’ on the input side will always be ‘timeslot x’ on the output side.	time slot mapping between input side and output side must be configured, ‘timeslot x’ on the input side could be mapped to ‘timeslot y’ on the output side; Per CESoPSN service, the timeslots on the input side must be part of the same port, the timeslots on the output side must be part of the same port. All the data channels on an input port can be mapped on different CESoPSN services, which can have different destination ports.

2.2.15 Circuit Emulation: Hitless Switching

Hitless Switching is a feature within SAToP/CESoPSN that provides a safe serial or E1 redundant connection where no data or synchronization is lost when switching from the active to the backup path or vice versa, e.g. because of cable break. The total delay over the network remains nearly constant during switch-over. Redundancy via Hitless Switching is obtained via completing the list below:

- creating two independent point-to-point tunnels without protection;
- setting the Hitless Switching on at service creation time in HiProvision.

NOTE: See Ref. [2Net]/[2Leg] in Table 1 for the creation of tunnels/services;;

On the source side, with Hitless Switching enabled, the 2-OLS IFM duplicates each packet on a second tunnel (e.g. Tunnel y, see figure below). Each packet also contains a 16 bit sequence number. Different tunnels mean different paths through the network, with each path its own delay. Different delays result in a slow and a fast path.

On the destination side, with Hitless Switching enabled, the 2-OLS IFM buffers the fastest path and forwards packets from the slowest path on the serial or E1 link. Packets will be processed according a packet sequence number.

Hitless Switching is a redundant mechanism but differs from Protection Switching, see the table below for an overview. So if redundancy is needed in the service, either choose Hitless Switching or Protection Switching, mixing up both mechanisms is not allowed. Depending on the choice, settings must be done at tunnel creation time and/or service creation time.

When Hitless Switching has been enabled, the CES can only start up with two links up, coming out of a two-links-down situation (except when Single Path has been enabled, see §2.2.16).

See §2.2.17 for a delay comparison within CES depending on the enabled sub features, see also further on.

Table 6 Difference Between Hitless and Protection Switching

	Serial/E1 Protection Switching	Serial/E1 Hitless Switching
required tunnel type	1 point-to-point tunnel	2 point-to-point tunnels
tunnel protection type	1:1;	none; the redundancy is created via two independent point-to-point tunnels.
service parameter	Hitless Switching = disabled	Hitless Switching = enabled
at switch-over	possible data loss	no data or synchronization loss
total delay	less than hitless switching	more than protection switching

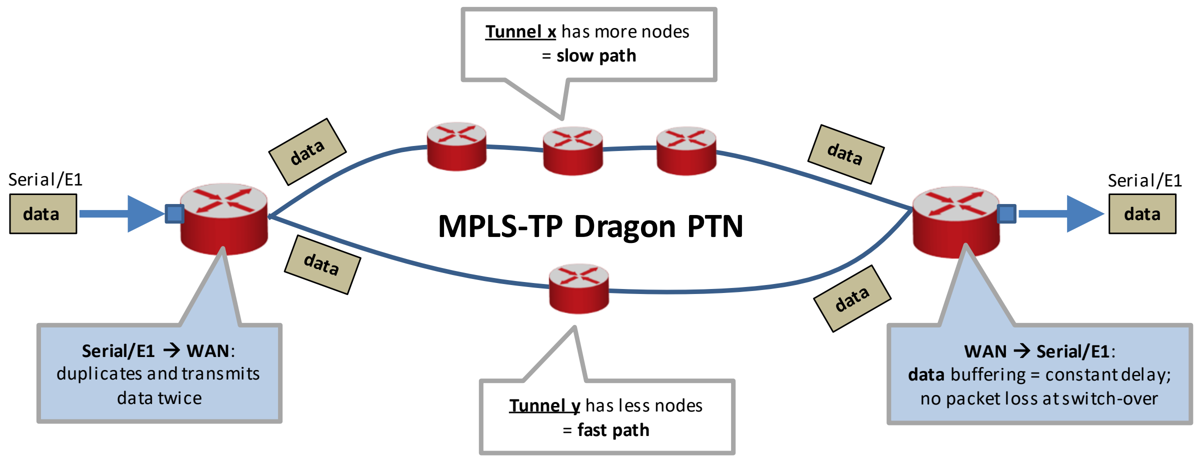

Figure 19 Hitless Switching

2.2.16 Circuit Emulation: Single Path

The Single Path feature is a sub feature of Hitless Switching (see §2.2.15). It influences the start-up behavior of the Hitless Switching mechanism:

- enabled: The CES can already start up with only one link up, coming out of a two-links-down situation.
  - if the fastest path came up first:
    - the CES starts up according to the fastest path;
    - possible CES interrupt or minor packet loss when the slowest path comes up later on;
  - if the slowest path came up first:
    - the CES starts up according to the slowest path;
    - no CES interrupt or packet loss when the fastest path comes up later on;

See §2.2.17 for a delay comparison within CES depending on the enabled sub features, see also further on.

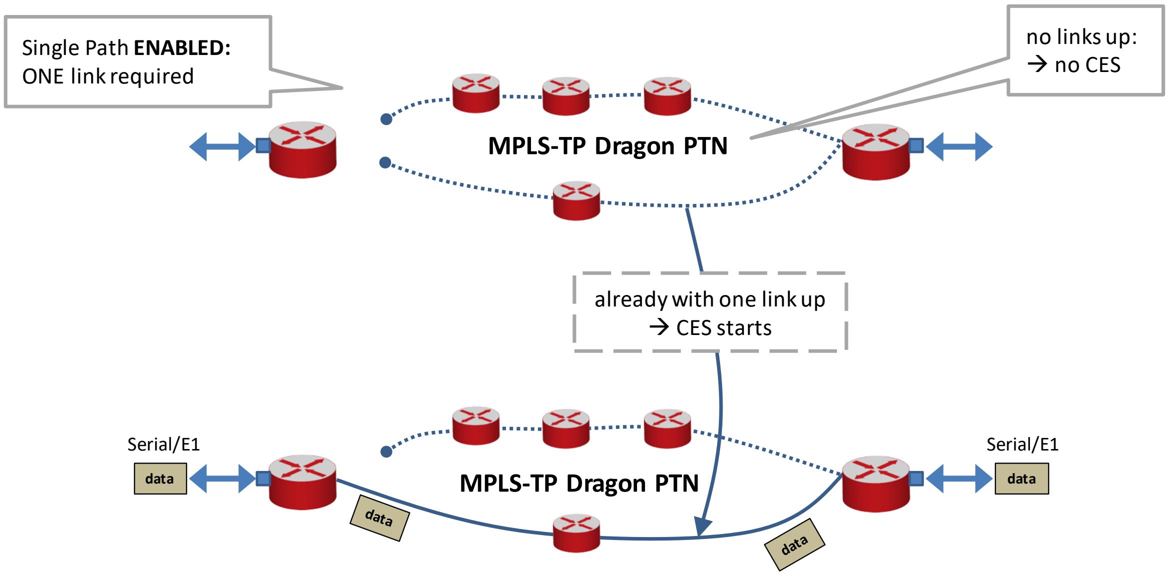

Figure 20 Single Path Enabled

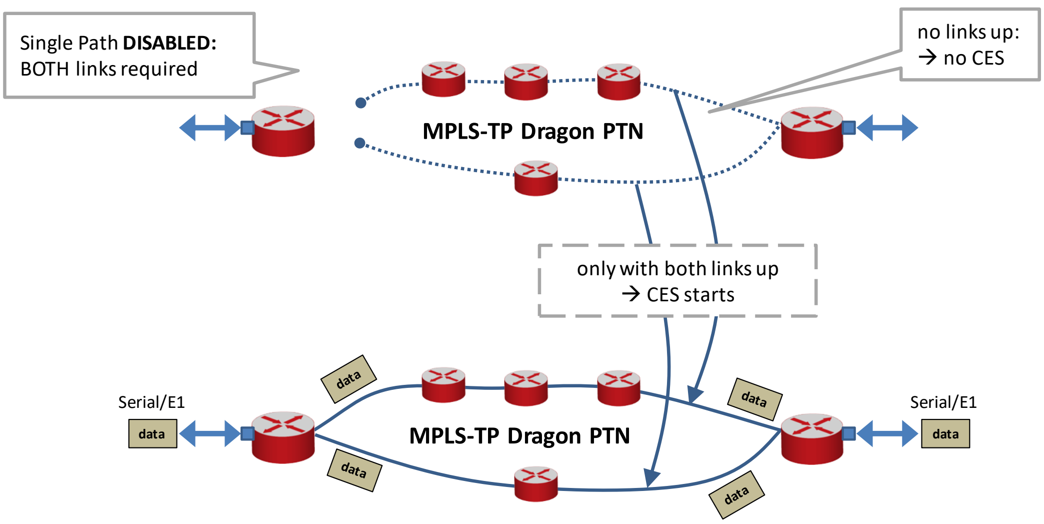

Figure 21 Single Path Disabled

2.2.17 Delay Comparison in CES (Features)

A CES with Hitless Switching has a higher delay than a CES without Hitless Switching.

2.2.18 I/O with the Central Switching Module (=CSM)

a. Service Type1

(see §2.2.6) The CSM is only needed to program the 2-OLS IFM via HiProvision. Once the 2-OLS IFM has been configured, it does not need the CSM anymore.

b. Service Type2, Service Type3

(see §2.2.6) The 2-OLS module receives Serial/E1 traffic via its front panel ports and converts this into Ethernet traffic which is forwarded to the CSM via the backplane. The CSM does all the processing on this data (synchronization, CRC checks, conversions, switching…).

The CSM converts this data into MPLS-TP packets and transmits it via an Ethernet IFM (e.g. 4-GC-LW) onto the WAN. On the destination side, the same processing occurs in reverse order. See the manuals Ref.[4] in Table 1 for more detailed CSM information.

2.2.19 Synchronization / Clock Distribution / Network Timing

CAUTION: Make sure to configure/verify the clocking parameters below.

The Dragon PTN network provides a number of mechanisms to perform synchronization / clock distribution / network timing per CES. The CSM synchronizes all the included IFMs in the node.

The application endpoints in a 'Circuit Emulation: E1' service can communicate in a synchronized way. Which synchronization method can be used depends on:

- the ‘Clock source’ port setting of the two endpoints;
- the 'Differential Clocking' setting in the E1 service;
- the Clock Source bundle ID in case of CESopSN;
- SyncE availability in the endpoint nodes;

The figures below show relevant end-to-end clocking configurations for this IFM. The PRC (=Primary Reference Clock) is a very stable high quality clock that can be used as a reference clock delivered via SyncE to the node:

- A, D = Application ports;
- B, C = IFM front ports;

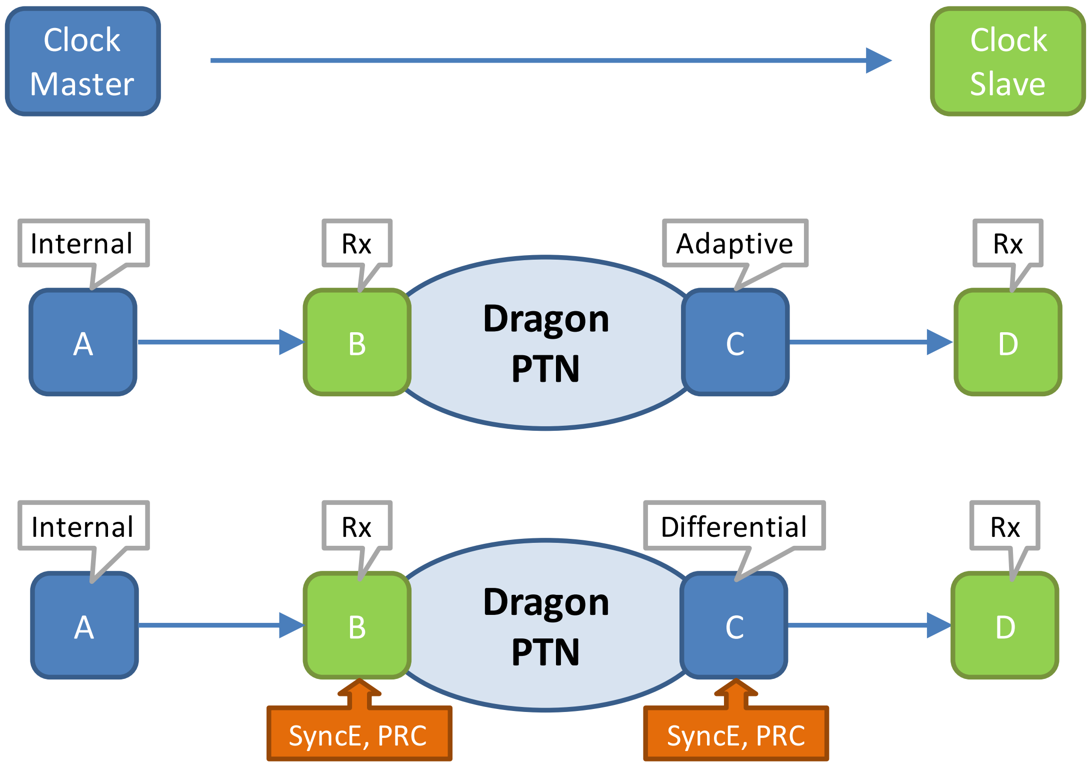

Figure 22 Clocking: Application D Slaves to Application A via Dragon PTN

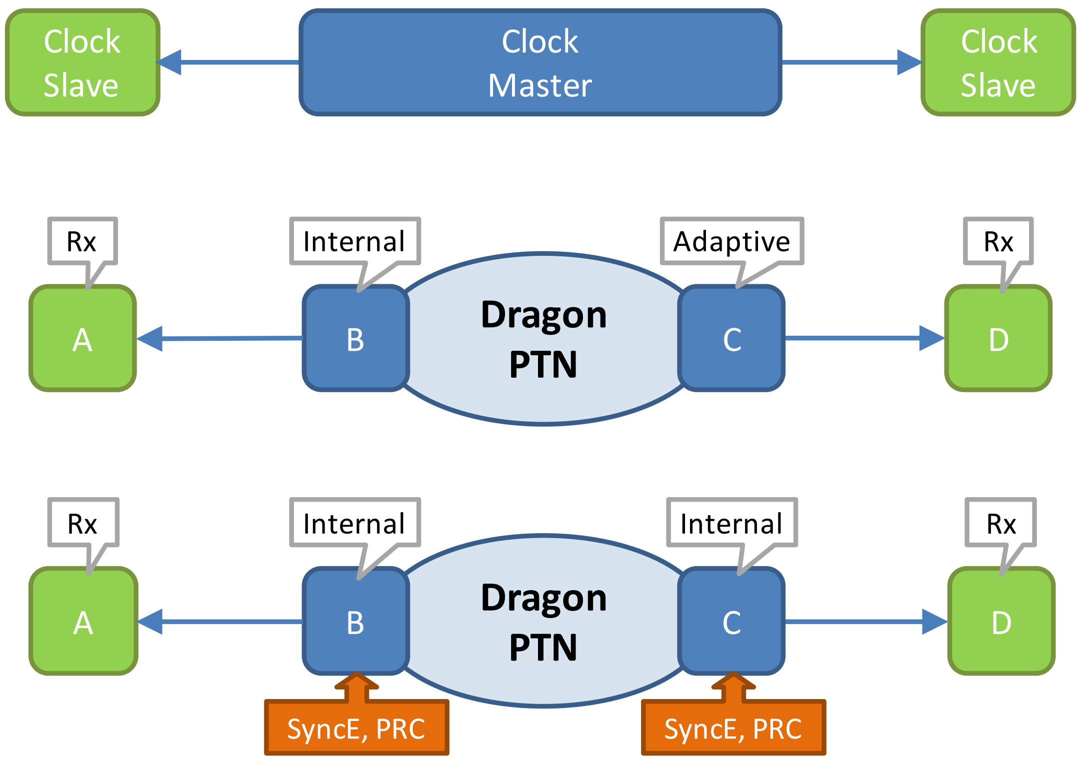

Figure 23 Clocking: Both Applications A and D Slave to Dragon PTN Clock Master

Table 7 Clocking Parameters on Port & Service Level

Port A: Clock Source	Port B: Clock Source	Service: Differential Clocking	Port C: Clock Source	Port D: Clock Source	Description
Application D slaves to application A via Dragon PTN					
'Internal Clock'	'Rx Clock'	Unchecked	'Adaptive/ Differential'	'Rx Clock'	Node (B) recovers the clock from the incoming data stream from Application (A) and uses it to decode/encode the packet stream. Node (C) recovers the clock from the incoming packet stream from the network and uses it to encode/decode the data stream. Application (D) slaves its clock to this stream.
'Internal Clock'	'Rx Clock' + SyncE	Checked	'Adaptive/ Differential' + SyncE	'Rx Clock'	Node (B) recovers the clock from the incoming data stream from Application (A) and uses it to decode/encode the packet stream. Node (B) embeds extra RTP timing information in that packet stream when forwarding it on the Dragon PTN network. Node (C) generates the clock based on the PRC and the embedded RTP timing information in the incoming packet stream. The generated clock is used to encode/decode the data stream. Application (D) slaves its clock to this stream.
Both Applications A and D slave to Dragon PTN Clock Master					
'Rx Clock'	'Internal Clock'	Unchecked	'Adaptive/ Differential'	'Rx Clock'	Node (B) transmits packets to node (C) based on an Internal Clock. This clock is delivered by the local oscillator on the IFM. Node (C) recovers the clock from the incoming packet stream from the network and uses it to encode/decode data streams. Both applications (A) and (D) slave their clock to the data streams delivered by node (B) and (C).
'Rx Clock'	'Internal Clock' + SyncE	Unchecked	'Internal Clock' + SyncE	'Rx Clock'	Both nodes (B) and (C) encode/decode the data stream to/from the end applications based on the 'Internal Clock' on the IFM. This clock is delivered by the CSM and is based on a PRC delivered via SyncE. Both applications (A) and (D) slave their clock to the data streams delivered by node (B) and (C).
E1 port: CESoPSN Clock Source Bundle Id					
Fill out the 'Clock Source Bundle id': Each E1 CESoPSN service that is created in HiProvision will automatically get a 'bundle ID' assigned. The value of this 'Bundle ID' can be found in HiProvision → Network → Services → Monitoring Properties → Circuit Emulation. This value must be filled out in the 'CESoPSN Clock Source Bundle ID' port property to indicate to which CESoPSN service this port must slave its clock (=adaptive).					

NOTE: SyncE: See the manuals in Ref. [2Net] in Table 1 and Ref.[4] for more detailed information;

2.2.20 Short Haul/Long Haul

Long E1 links (>200m, Long Haul) have more signal attenuation than shorter links (<200m, Short Haul). As a result, the signal levels or sensitivity ('0' or '1') on the receiver side must be configured according the used link: Long Haul or Short Haul.

In HiProvision, a Short Haul parameter can be checked for Short Haul links and unchecked (=default) for Long Haul links. This parameter can be set on port level in the IFM or at service creation.

2.2.21 Test and Loopback Selftests

Test and Loopback selftests can be performed (via HiProvision) in CESs, e.g when configuring or troubleshooting a CES. Following two functions can be used in a programmed CES:

- Loopbacks: on backplane or front port, direction towards line (=application) or network can be configured;
- BERT: test traffic generation and verification via Bit Error Ratio Tester.

CAUTION: enabling self tests disables or disturbs normal service traffic on a port!

For more information and configuration settings, see 'Test and Loopback' in Ref. [2Leg] in Table 1.

2.2.22 Forced Power Mode

The powering of the 2-OLS IFM can be configured by the 'Forced Power Mode' parameter on the 2-OLS IFM in HiProvision. The setting of this parameter determines whether a CSM is required in the node for powering the 2-OLS IFM.

See 'Forced Power Mode' in Ref. [2Leg] in Table 1 for more information.

2.3 Onboard Interfaces

See Figure 14 for a side view of the IFM module.

2.3.1 Straps

No user relevant straps.

2.3.2 DIP Switches

a. Hardware Edition

The Hardware Edition is set in decimal code using rotary switches S2 to S3 (=most significant). It can be read out as well via HiProvision. This edition has been factory set and MUST NOT BE CHANGED!

Example: Setting S3='0' and S2='5' indicates Hardware Edition '5' (dec).

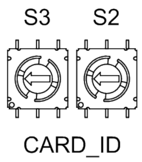

Figure 24 Hardware Edition

b. E1/T1 Configuration

The E1/T1 configuration of the 2-OLS module is factory set by the S1 DIP switch and must not be changed. The configuration depends on the ordered IFM (see §5.3). The configuration can be read out via HiProvision.

- Switch = E1: both E1/T1 ports operate as E1 ports, use the '2-OLS-E1-L' IFM in HiProvision;
- Switch = T1 (=future): both E1/T1 ports operate as T1 ports, use the '2-OLS-T1-L' IFM in HiProvision.

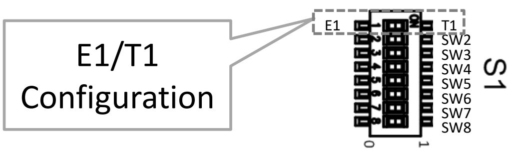

Figure 25 E1/T1 Configuration

3. TDM FRAMES/PACKET FOR CES

3.1 General

In a CES service, the amount of TDM Frames per Ethernet packet is an important setting because it influences the amount of consumed bandwidth and delay through the network. The more TDM Frames/Packet, the less bandwidth is used but the bigger the total delay through the network.

NOTE: In HiProvision, it can be configured how many TDM Frames/Packet can be encoded. Default TDM Frames/Packet = 4;

3.1.1 CES: Optical Low Speed Serial

- For CESoPSN: Minimum TDM Frames/Packet: 1, 2 or 3 depending on the configured settings:
  - Asynchronous:
    - bitrate < 19200 → value = 3;
    - bitrate = 19200 → value = 2;
    - bitrate >= 38400 → value = 1;
  - Synchronous:
    - bitrate = 64k → value = 3;
    - bitrate = 128k → value = 2;
    - bitrate >= 256k → value = 1;
- Maximum TDM Frames/Packet, no Hitless Switching: 24;
- Maximum TDM Frames/Packet, Hitless Switching: 10;

3.1.2 CES: E1

In the table below, find the minimum and maximum TDM Frames/Packet according the configured CES and the amount of used timeslots. Also find the maximum number of allowed bundles in the other table.

Table 8 TDM Frames/Packet For CES - E1 Services

CES	Amount of Timeslots		Min. TDM Frames/Packet		Max. TDM Frames/Packet (no hitless/hitless switching)	
	E1	T1 (*)	E1	T1(*)	E1	T1(*)
SAToP	always 32	always 24	1	1	24/10	24/10
CESoPSN	1	1	3	3	24/10	24/10
CESoPSN	2	2	2	2	24/10	24/10
CESoPSN	3 or 4	3 or 4	1	1	24/10	24/10
CESoPSN	5..31	5..24	1	1	24/10	24/10
(*) T1 = Future Support.						

Table 9 Maximum Number Of Bundles

TDM Frames/Packet	Maximum Number of Bundles
1	24 (with hitless switching configured or without)
2 or more	32 + 32 with hitless switching configured

3.2 Bandwidth

If only one TDM frame per packet is encoded, it generates a lot of header information on the network resulting in a lot of consumed bandwidth. Encoding more frames into one packet will decrease the amount of header information and as a result the consumed bandwidth as well. As of 8 frames per packet and higher, the bandwidth consumption stabilizes towards the minimum bandwidth consumption. See the graph below.

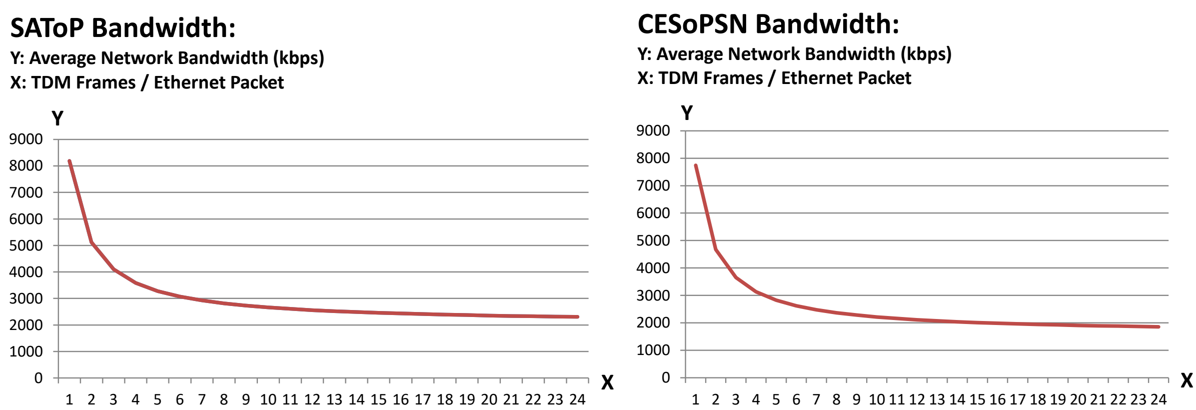

Figure 26 SAToP, CESoPSN Bandwidth

3.3 Delay

3.3.1 General

The total delay between two end points over the Dragon PTN network depends on:

- **P** (=Packetization Delay): Delay to encode Serial/E1 input into MPLS-TP packets;
- **DP** (=Depacketization Delay): Delay to decode MPLS-TP packets into Serial/E1 output;
- **DPh**: Extra Depacketizing Delay due to hitless switching;
- **Path Delay**: Delay from source to destination over the MPLS-TP network path; can be measured by HiProvision via OAM delay measurement for the specific service; Path Delay = Delay external network (if any) + 5µs/km + 10µs/node;
- **Total Delay** = Total Network delay between two Serial/E1 applications;
- **Total Delay** = (Packetization + Path + Depacketization + Hitless Switching) Delay;

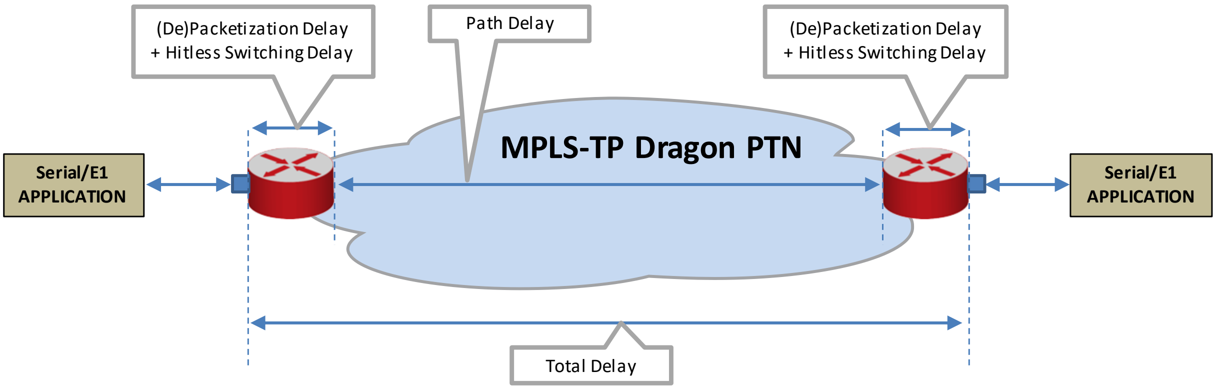

Figure 27 Delays

3.3.2 Delay Parameters

These delays in §3.3.1 depend on the selected service in HiProvision and its configured delay parameters. HiProvision offers the delay parameters listed below to tune the delay.

CAUTION: If you are not familiar with these parameters, keep the default values.

- **TDM Frames per Packet**: The lower the value, the lower the delay.
- **Jitter Buffer Size (µs)**: advice: Set this value to 'Packetizing Delay + expected peak-to-peak jitter (µs)'; the default peak-to-peak jitter could be 250 µs; the expected peak-to-peak jitter (µs) must be measured in the network. If the packetizing delay 'P' <2000 µs, set the buffer size to at least 2000 µs. If the packetizing delay 'P' > 2000 µs (e.g. 2500 µs), set the buffer size to at least e.g. 2500 µs.

CAUTION: By default, the jitter buffer will reset once for optimal processing 15 seconds after a change in the service occurs. This reset will cause a minimal loss of data. See 'jitter buffer' in the Ref. [2Leg] in Table 1 for more information.

- **Maximum Network Path Delay Difference (µs)** (only for Hitless Switching): advise: Set this value to '(Two Paths nodes difference)*10 + expected peak-to-peak jitter (µs)'. If path1 has 17 nodes and path2 has 8 nodes, this is a difference of 9 nodes. You could set MaxNetwPathDelayDiff = 9*10 + 250 = 340 µs;

3.3.3 Estimated Delay Calculation and Formulas

Table 10 shows formulas to calculate an estimated delay. Once you have the desired estimated delay, fill out the parameter values in HiProvision, which shows the calculated 'P+DP+DPh'.

Table 10 Estimated Delay Formulas

Delay	No Hitless Switching	Hitless Switching (SATOP)	Hitless Switching (CESOP)
P	TDMFramesPerPacket * 125		
DP	(JitterBufferSize) / 2		
DPh	0	2P + MaxNetwPathDelayDiff + 766	2P + MaxNetwPathDelayDiff + 1087
Path Delay	measured by HiProvision		
Total	P + DP + DPh + Path Delay		

3.3.4 Estimated Delay Examples

Below, fill out the example values in the formulas to find out the estimated total delay:

- TDMFramesPerPacket = 10
- JitterBufferSize = 4000 µs
- MaxNetwPathDelayDiff = 340 µs
- Pathdelay (measured by HiProvision) = 500 µs

Table 11 Estimated Delay (µs) Examples

Delay	No Hitless Switching	Hitless Switching (SATOP)	Hitless Switching (CESOP)
P	**10** * 125 = 1250		
DP	(**4000**) / 2 = 2000		
DPh	0	2*1250 + **340** + 766 = 3606	2*1250 + **340** + 1087 = 3927
Path Delay	**500**		
Total	1250 + 2000 + 0 + 500 = **3750 µs**	1250 + 2000 + 3606 + 500 = **7356 µs**	1250 + 2000 + 3927 + 500 = **7677 µs**

3.3.5 Differential Delay

Differential Delay is the difference in Path Delays between two end-points, measured in two opposite directions over the same path.

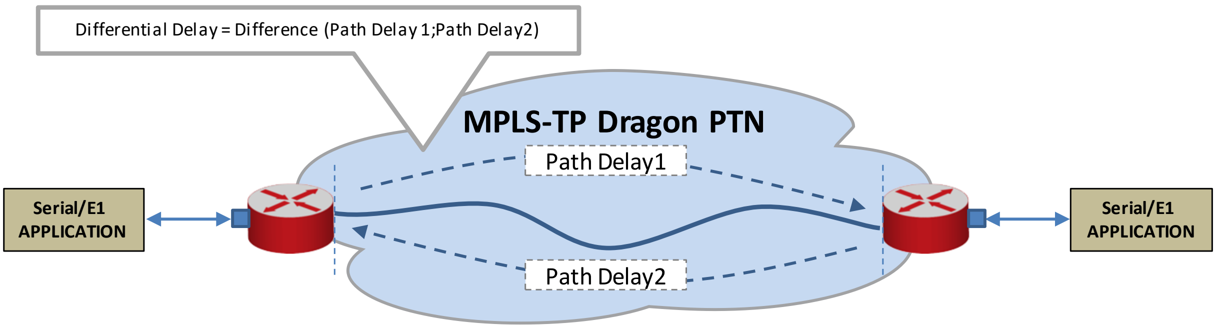

Figure 28 Differential Delay

- When Differential Delay is very important for your application, we strongly advise not to use Hitless Switching with Single Path (§2.2.16), all the other modes are OK;
- Maximum Differential Delay for both SAToP and CESoPSN is 400 µs;
- When programming a service in HiProvision between a 16-E1-L/16-T1-L and a 4-E1-L/4-T1-L
  /2-C37.94/2-OLS IFM, we strongly advise to configure SAToP and a low amount (preferably 1) of TDM Frames per Ethernet Packet for the best Differential Delay.

3.4 Tuning CES = Tuning TDM Frames/Packet

Tuning the CES is mainly done by tuning the TDM Frames/Packet parameter. Tuning this parameter is a trade-off between bandwidth and delay. The more bandwidth is consumed the less the resulting network delay and vice versa. This tuning is application dependent. Check out whether bandwidth or delay is critical for an application or network. Based on these findings, bandwidth and delay parameters can be tuned.

Some examples according the information in §3.2 and §3.3:

- if bandwidth is not a problem, and a small delay is wanted → 1-3 TDM frames/packet;
- if less bandwidth is required and delay is not important → at least 4 TDM frames/packet;
- if less bandwidth and a small delay are wanted → 5 .. 10 TDM frames/packet.

4. COMPATIBILITY

For the E1 ports, the 2-OLS IFM is compatible with the IFMs listed below:

- 16-E1-L IFM;
- 4-E1-L IFM;
- 2-C37.94 IFM.

It means that E1 ports of all these IFMs can be programmed in the same service.

5. MODULE SPECIFICATIONS

5.1 General Specifications

For general specifications like temperature, humidity, EMI... see Ref.[5] in Table 1.

5.2 Other Specifications

Table 12 Other Specifications

Description	Value
Weight	0.23 kg / 0.5 lb
MTBF	87 years at 25°C/77°F
Power Consumption	8.4 W (measured at 25°C/77°F)
Module Size	width: 20.32 mm / 0.8 inches height: 126 mm / 4.96 inches depth: 195 mm / 7.68 inches

5.3 Ordering Information

- 2-OLS with E1: 942 236-022;
- 2-OLS with T1: 942 236-023;
- Interface Adapter Kit for Core Nodes: 942 237-007.

6. ABBREVIATIONS

AIS	Alarm Indication Signal
AMI	Alternate Mark Inversion
CES	Circuit Emulation Service
CESoPSN	CES over Packet Switched Network
CSM	Central Switching Module
DC	Direct Current
DP	Depacketization Delay
DPh	Depacketization Delay due to Hitless Switching
EMI	Electromagnetic Interference
ERR	Error
ETH	Ethernet
FLT	Fault
HDB3	High Density Bipolar of Order 3
IEEE	Institute of Electrical and Electronics Engineers
IFM	InterFace Module
kbps	Kilobit per Second
LAN	Local Area Network
LOF	Loss Of Framing
LOS	Loss Of Signal
LVD	Low Voltage Directive
Mbps	Megabit per Second
MPLS-TP	MultiProtocol Label Switching – Transport Profile
MSB	Most Significant Bit
MTBF	Mean Time Between Failures
OLS	Optical Low Speed
PF	Power Failure
P	Packetization Delay
PI	Power Input

PTN	Packet Transport Network
PTP	Point to Point
RAI	Remote Alarm Indicator
SAToP	Structured Agnostic TDM over Packet
SDH	Synchronous Digital Hierarchy
SF	Super Frame
ST	Straight Tip
SyncE	Synchronous Ethernet
TDM	Time Division Multiplex
WAN	Wide Area Network