User Manual

Basic Configuration
Dragon PTN Legacy Services
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1. INTRODUCTION

1.1 General

This document is valid as of Dragon PTN Release 4.3DR. This manual describes the OAM for so-called “legacy services” that can be used to transport “legacy applications” over the Dragon PTN network. Legacy services are all the services that are not pure Ethernet services (see Ref. [2Eth] in Table 2). The following legacy service (types) are described further on:

- Local Mode
- Optical Low Speed Serial / C37.94
- Serial Ethernet
- Circuit Emulation (SAToP/CESoPSN)
  - E1 / T1 / C37.94 / Serial / 2W/4W Voice (only CESoPSN) / CODIR / Optical Low Speed Serial
- Voice
- Smart SFP (uses service type ‘Ethernet’ over Dragon PTN but transports STM/OC frames from an SDH/Sonet network)

Prerequisites:

- The HiProvision PC must have been configured/installed as described in Ref. [2Mgt] in Table 2;
- The Dragon PTN core network has been configured as described in Ref. [2Net] in Table 2. At least one tunnel must have been created (except for the Local Mode services);
- Before creating the service, it is always interesting to verify the bandwidth already configured through the WAN links and tunnels of your network, see §12.4.

<table>
<thead>
<tr>
<th>Legacy Application</th>
<th>Required IFM (Refs. in Table 2)</th>
<th>Service Type</th>
<th>Chapter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Serial (RS232, RS422, RS485, X.21, V.35)</td>
<td>7-SERIAL</td>
<td>Circuit Emulation: Serial</td>
<td>§5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Serial Ethernet</td>
<td>§4</td>
</tr>
<tr>
<td>64 kbps (ITU G.703)</td>
<td>4-CODIR</td>
<td>Circuit Emulation: CODIR</td>
<td>§5</td>
</tr>
<tr>
<td>2-Wire Voice, 4-Wire Voice, E&amp;M Signaling</td>
<td>4-2/4WEM</td>
<td>Circuit Emulation: 2W/4W Voice</td>
<td>§5</td>
</tr>
<tr>
<td>E1</td>
<td>4-E1-L / 16-E1-L</td>
<td>Circuit Emulation: E1</td>
<td>§5</td>
</tr>
<tr>
<td>T1</td>
<td>4-T1-L / 16-T1-L</td>
<td>Circuit Emulation: T1</td>
<td>§5</td>
</tr>
<tr>
<td>Voice (FXO, SIP)</td>
<td>8-FXS, all Ethernet IFMs</td>
<td>Voice</td>
<td>§7</td>
</tr>
<tr>
<td>Optical Low Speed Serial</td>
<td>2-OLS</td>
<td>Local Mode: Optical Low Speed Serial</td>
<td>§2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Circuit Emulation: Optical Low Speed Serial</td>
<td>§5</td>
</tr>
<tr>
<td>C37.94</td>
<td>2-C37.94</td>
<td>Local Mode: C37.94</td>
<td>§3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Circuit Emulation: C37.94</td>
<td>§5</td>
</tr>
<tr>
<td>SHDSL</td>
<td>4-DSL-LW</td>
<td>Ethernet</td>
<td>§8</td>
</tr>
<tr>
<td>SDH/SONET (STM/OC)</td>
<td>Via smart SFPs on 4-GO-LW, 4-GC-LW/4-GCB-LW port 1</td>
<td>Ethernet</td>
<td>§9</td>
</tr>
</tbody>
</table>
1.2 Manual References

Table 2 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 via the HiProvision Help Tile.

<table>
<thead>
<tr>
<th>Ref.</th>
<th>Number</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>[1]</td>
<td>DRA-DRM801-&amp;-*</td>
<td>Dragon PTN Installation and Operation</td>
</tr>
<tr>
<td>[2Mgt]</td>
<td>DRA-DRM830-&amp;-*</td>
<td>HiProvision Management Operation</td>
</tr>
<tr>
<td>[2Eth]</td>
<td>DRA-DRM831-&amp;-*</td>
<td>Dragon PTN Ethernet Services</td>
</tr>
<tr>
<td>[2Net]</td>
<td>DRA-DRM833-&amp;-*</td>
<td>Dragon PTN Network Operation</td>
</tr>
<tr>
<td>[4]</td>
<td>DRE-DRM817-&amp;-*</td>
<td>Dragon PTN Interface Module: PTN-4-GO-LW</td>
</tr>
<tr>
<td>[5]</td>
<td>DRE-DRM805-&amp;-*</td>
<td>Dragon PTN Interface Module: PTN-4-E1-L/PTN-4-T1-L</td>
</tr>
<tr>
<td>[8]</td>
<td>DRE-DRM813-&amp;-*</td>
<td>Dragon PTN Interface Module: PTN-7-serial</td>
</tr>
<tr>
<td>[10]</td>
<td>DRE-DRM814-&amp;-*</td>
<td>Dragon PTN Interface Module: PTN-4-2/4WEM</td>
</tr>
<tr>
<td>[14]</td>
<td>DRF-DRM811-&amp;-*</td>
<td>Dragon PTN TRMs (Transmit Receive Modules: SFP, XFP, QSFP+)</td>
</tr>
<tr>
<td>[22]</td>
<td>DRE-DRM818-&amp;-*</td>
<td>Dragon PTN Interface Module: PTN-16-E1-L/PTN-16-T1-L</td>
</tr>
</tbody>
</table>

2. LOCAL MODE: OPTICAL LOW SPEED SERIAL

2.1 General

Supported IFMs: 2-OLS: More information on this IFM in Ref. [13] in Table 2;

Local Mode at the source side means the conversion of incoming Serial signals into E1 signals, both at the front panel of the IFM. No IFM backplane or Dragon PTN network or Dragon PTN bandwidth is involved. The IFM just acts as a local Serial to E1 converter via an internal loopback. At the destination side, the conversion is just vice versa.

Prerequisite: make sure that you created links of type ‘External E1 Link’ (see figure below) between the two 2-OLS IFMs. These links can be created as via Dashboard → Network Hardware → Links → (Link type) ‘External E1 Link’. More info in Ref. [2Net] in Table 2.

![Create External E1 Link](image-url)
2.2 Configure Service

2.2.1 Service Wizard

Click Dashboard → Configuration → Connections → Services → + to open the services wizard. See figure below.

![Figure 3 Create Services]

The services wizard opens. The list below summarizes every page in the wizard:

- Page: Information: Click Next>>;
- Page: Service Name and Type Selection:
  - Service Name: enter a name for your service.
  - Service Type: Local Mode;
Figure 4 Service Type: Local Mode: Optical Low Speed Serial

- Protocol: Optical Low Speed Serial:
- Synchronisation:
  - Asynchronous (=default): When a bitrate 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;
  - Synchronous: offers additional option to use FM0 Coding;
- Bitrate: depends on the selected Synchronisation method, see overview in §8.
- FM0 Coding (in Synchronous mode)
  - 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. 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 5 FM0 Coding

Page: Service Endpoint Selection: It is point-to-point, so only select two end-points. The end-points are the optical serial ports of the 2-OLS IFMs connected to that External E1 link. Note: Within one 2-OLS IFM, [port 1 <-> port3] and [port 2 <-> port4] are always linked via a fixed local loopback including the conversion. E.g. It means that if port3 is used in the External E1 Link, port1 must be selected (and not port2) as end-point. Selecting ports can be done in two ways:

- Via the table. The tree view can be expanded/collapsed via clicking the expand/collapse buttons. Just click the Selected checkbox to select the desired port;
- Via clicking the node icons in the network drawing, see general example in §13;
NOTE: Per port, an extra Info field can be filled out later on via Network Hardware → Devices → Select Node/IFM/Port → Generic → Info.

Page: (Tunnel Selection: No tunnel must be selected in this service setup. The Dragon PTN network will not be used. After this service setup, a special tunnel with tunnel type ‘External’ has been created automatically.)

Page: Port Settings:

- Short Haul Link: (refers to E1 ports on the 2-OLS IFM): Long E1 links (>200m, Long Haul) have more E1 signal attenuation than shorter E1 links (<200m, Short Haul). As a result, the E1 signal levels or sensitivity (‘0’ or ‘1’) on the receiver side depend on the usage of Long Haul/Short Haul links. Check this parameter for Short Haul links and uncheck it (=default) for Long Haul links. This parameter can be set on port level in the IFM or at service creation.

![Figure 6 Port Settings: Short Haul](image)

Page: Review: The selected service ports will be shown: if ok, click Finish, the configuration load manager will be invoked.

Page: Load: The configuration load manager is a tool that starts and monitors the load process of a HiProvision configuration. Click the Load button to load the new HiProvision configuration into the live network. See Ref. [2Mgt] in Table 2 for more info;

**CAUTION:** While the loading to the Dragon PTN network is in progress, do not turn off, shut down or restart the HiProvision Server or Agent, since this may cause database corruption and network problems!

Page: After this step, your customer applications connected to the front ports of the IFMs should be able to communicate.

2.2.2 Network Hardware → IFM Settings

After configuring the service via the service wizard, all IFM settings will be set according to the service configuration. Some individual IFM settings might need extra tuning or must be overruled. Find IFM settings via Network Hardware → Devices → 2-OLS.

a. Forced Power Mode

The powering of the 2-OLS IFM can be configured by the ‘Forced Power Mode’. The setting of this parameter determines whether a CSM is required in the node for powering the 2-OLS IFM. Go to Network Hardware → Devices → 2-OLS → Specific → Forced Power Mode.
Forced Power Mode:
- On (=default): Once the 2-OLS IFM has been configured by the CSM, the CSM can be removed from the node if desired. After removing the CSM, the 2-OLS IFM remains powered and a configured Local Mode service on this IFM remains operational;
- Off: the 2-OLS IFM always needs an operational CSM in the node for powering and for normal operation. After removing the CSM from the node, the 2-OLS IFM will be powered off automatically and goes out of service.

Best Practice:
- If a Local Mode service has been configured on the 2-OLS IFM and you want to remove the CSM from the node later on, set Forced Power Mode = ‘On’. In any other case, set it to ‘Off’.

2.2.3 Network Hardware → IFM-Port Settings

After configuring the service via the service wizard, all port settings of the endpoints in this service will be set according to the service configuration. Some individual port settings might need extra tuning or must be overruled. Go to Network Hardware → Devices → 2-OLS → (optical/E1) port.

a. Clock Source Settings

The ports of the 2-OLS IFM have by default the settings below which are OK if the IFM can slave to the external E1 network.

Within one 2-OLS IFM, the E1 ports will slave to the external network e.g. SDH (=Rx Clock). The optical serial ports use the same clock as the clock on their associated E1 ports (=Through Timing). Port 1 is linked to Port3 and Port2 is linked to Port4;

Clock Source:
- Optical Serial Port1: Through Timing;
- E1 Port3: Rx Clock;
- Optical Serial Port2: Through Timing;
- E1 Port4: Rx Clock;

Apply your changes and load these changes into the Dragon PTN network.
2.3 Modify Service

After service creation, this service can be modified if needed via:

- Wizard: Dashboard → Configuration → Connections → Services → select service → ;
- Port settings, see §2.2.3;

2.4 Delete Service

After service creation, this service can be deleted if needed via:

- Dashboard → Configuration → Connections → Services → select service → ;

2.5 Troubleshooting: Test and Loopback

This service can be tested via loopback settings on IFM level and port level in the Network Hardware tab. See §14 for setting up loopbacks.

You also could use OLS testers, two 2-OLS IFMs and a direct E1 link between the 2 E1 ports (= exclude the external SDH network) to test your Local Mode. Configure the ‘Clock Source’ port settings as indicated in the figure. You could also play with the ‘Link Enabled’ port setting to enable/disable a link.

![Figure 8 Local Mode: Troubleshooting and Testing](image)

2.6 Monitoring

2.6.1 (Configuration) Network Hardware Tile

It can be verified if a local loopback or local mode is active on the IFM. Go to Dashboard → (Configuration) Network Hardware → Devices → IFM → Specific → Internal Connection. If this parameter is ‘True’, a local loopback is active on your IFM.
2.6.2  (Configuration) Connections Tile

What has been configured via the service wizard can also be viewed via Dashboard → Connections → Services → select service in the list. Some extra tabs (Service, Local Mode) with service configuration data will be shown.

CAUTION: The configuration that you see here is the service configuration done via the service wizard. Port settings could be tuned manually via §2.2.3 and as a result could be different from these service settings. Always verify these port settings, to know the exact port setting in the live network.

2.6.3  (Monitoring) Network Tile

None.

2.6.4  Performance Counters

None. There are only counters available via Test and Loopback.
2.6.5 HiProvision Add-on: Generic Reporting Engine

Service and port reporting information is available via the Reporting Engine Add-on, see Ref.[24] in Table 2.

3. LOCAL MODE: C37.94

3.1 General

Supported IFMs: 2-C37.94: More information on this IFM in Ref. [6] in Table 2;

Local Mode at the source side means the conversion of incoming C37.94 signals into E1 signals, both at the front panel of the IFM. No IFM backplane or Dragon PTN network or Dragon PTN bandwidth is involved. The IFM just acts as a local C37.94 to E1 converter via an internal loopback. At the destination side, the conversion is just vice versa.

Prerequisite: make sure that you created links of type ‘External E1 Link’ (see figure below) between the two 2-C37.94 IFMs. These links can be created as via Dashboard → Network Hardware → Links → (Link type) ‘External E1 Link’. More info in Ref. [2Net] in Table 2.

![Figure 11 Create External E1 Link](image11.png)

![Figure 12 Local Mode: C37.94 via 2-C37.94 IFMs](image12.png)
3.2 Configure Service

3.2.1 Service Wizard

Click Dashboard → Configuration → Connections → Services → + to open the services wizard. See figure below.

![Services Wizard](image)

**Figure 13 Create Services**

The services wizard opens. The list below summarizes every page in the wizard:

- **Page: Information**: Click Next>>;
- **Page: Service Name and Type Selection**:
  - **Service Name**: enter a name for your service.
  - **Service Type**: Local Mode;
- **Protocol**: C37.94;
- **Number of Timeslots**: (=default, read-only). Not relevant.
- **Page: Service Endpoint Selection**: It is point-to-point, so only select two end-points. The end-points are the C37.94 ports of the 2-C37.94 IFMs connected to that External E1 link. Note: Within one 2-C37.94 IFM, [port 1 <-> port3] and [port 2 <-> port4] are always linked via a fixed local loopback including the conversion. E.g. It means that if port3 is used in the External E1 Link, port1 must be selected (and not port2) as end-point. Selecting ports can be done in two ways:
  - Via the table. The tree view can be expanded/collapsed via clicking the expand/collapse buttons. Just click the Selected checkbox to select the desired port;
  - Via clicking the node icons in the network drawing, see general example in §13;
NOTE: Per port, an extra Info field can be filled out later on via Network Hardware → Devices → Select Node/IFM/Port → Generic → Info.

Page: (Tunnel Selection: No tunnel must be selected in this service setup. The Dragon PTN network will not be used. After this service setup, a special tunnel with tunnel type ‘External’ has been created automatically.)

Page: Port Settings:

- Short Haul Link: (refers to E1 ports on the 2-C37.94 IFM): Long E1 links (>200m, Long Haul) have more E1 signal attenuation than shorter E1 links (<200m, Short Haul). As a result, the E1 signal levels or sensitivity ('0' or '1') on the receiver side depend on the usage of Long Haul/Short Haul links. Check this parameter for Short Haul links and uncheck it (=default) for Long Haul links. This parameter can be set on port level in the IFM or at service creation.

![Figure 15 Port Settings: Short Haul](image)

Page: Review: The selected service ports will be shown: if ok, click Finish, the configuration load manager will be invoked.

Page: Load: The configuration load manager is a tool that starts and monitors the load process of a HiProvision configuration. Click the Load button to load the new HiProvision configuration into the live network. See Ref. [2Mgt] in Table 2 for more info.

**CAUTION:** While the loading to the Dragon PTN network is in progress, do not turn off, shut down or restart the HiProvision Server or Agent, since this may cause database corruption and network problems!

After this step, your customer applications connected to the front ports of the IFMs should be able to communicate.

3.2.2 Network Hardware → IFM Settings

None.

3.2.3 Network Hardware → IFM-Port Settings

After configuring the service via the service wizard, all port settings of the endpoints in this service will be set according to the service configuration. Some individual port settings might need extra tuning or must be overruled. Go to Network Hardware → Devices → 2-C37.94 → (C37.94/E1) port.

a. Clock Source Settings

The ports of the C37.94 IFM in Local Mode have by default the settings below which are OK if the IFM can slave to the external E1 network.
Within one 2-C37.94 IFM, the E1 ports will slave to the external network e.g. SDH (=Rx Clock). The C37.94 ports uses the same clock as their associated E1 ports (=Through Timing). Port 1 is linked to Port3 and Port2 is linked to Port4;

- Clock Source:
  - C37.94 Port1: Through Timing;
  - E1 Port3: Rx Clock;
  - C37.94 Port2: Through Timing;
  - E1 Port4: Rx Clock;

- Apply your changes and load these changes into the Dragon PTN network.

### 3.3 Modify Service

After service creation, this service can be modified if needed via:

- Wizard: Dashboard → Configuration → Connections → Services → select service → ;
- Port settings, see §3.2.3;

### 3.4 Delete Service

After service creation, this service can be deleted if needed via:

- Dashboard → Configuration → Connections → Services → select service → ;

### 3.5 Troubleshooting: Test and Loopback

This service can be tested via loopback settings on IFM level and port level in the Network Hardware tab. See §14 for setting up loopbacks. You could also use C37.94 testers, two 2-C37.94 IFMs and a direct E1 link between the 2 E1 ports (= exclude the external SDH network) to test your Local Mode. Configure the ‘Clock Source’ port settings as indicated in the figure. You could also play with the ‘Link Enabled’ port setting to enable/disable a link.

![Figure 16 Local Mode: Troubleshooting and Testing](image-url)
3.6 Monitoring

3.6.1 (Configuration) Network Hardware Tile

It can be verified if a local loopback or local mode is active on the IFM. Go to Dashboard → (Configuration) Network Hardware → Devices → IFM → Specific → Internal Connection. If this parameter is ‘True’, a local loopback is active on your IFM.

![Figure 17 Local Mode Indication: Internal Connection](image)

3.6.2 (Configuration) Connections Tile

What has been configured via the service wizard can also be viewed via Dashboard → Connections → Services → select service in the list. Some extra tabs (Service, Local Mode) with service configuration data will be shown.

**CAUTION:** The configuration that you see here is the service configuration done via the service wizard. Port settings could be tuned manually via §3.2.3 and as a result could be different from these service settings. Always verify these port settings, to know the exact port setting in the live network.

![Figure 18 (Configuration) Connections Tile: Local Mode Service](image)
3.6.3 (Monitoring) Network Tile

None.

3.6.4 Performance Counters

None. There are only counters available via Test and Loopback.

3.6.5 HiProvision Add-on: Generic Reporting Engine

Service and port reporting information is available via the Reporting Engine Add-on, see Ref.[24] in Table 2.

4. SERIAL ETHERNET

4.1 General

Supported IFMs: 7-SERIAL. More information on this IFM in Ref. [8] in Table 2.

7-SERIAL IFMs can use either ‘Serial Ethernet’ or ‘Circuit Emulation → Serial’ services. Depending on your needs and application, you can choose either one or the other. The table below compares both types. This chapter describes the Serial Ethernet, for a description of the Circuit Emulation → Serial service, see §5.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Serial Ethernet</th>
<th>Circuit Emulation → Serial</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interface Types</td>
<td>RS232, RS422, RS485</td>
<td>RS232, RS422, RS485, X.21, V.35</td>
</tr>
<tr>
<td>Front ports</td>
<td>All 7 ports supported</td>
<td>Port support depends on the used interface type, see Figure 20</td>
</tr>
<tr>
<td>Hitless Switching</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Data bits, parity, speed, ...</td>
<td>Must be configured exactly</td>
<td>Easier configuration</td>
</tr>
<tr>
<td>Synchronization</td>
<td>Asynchronous only</td>
<td>Both Synchronous and Asynchronous</td>
</tr>
<tr>
<td>Clocking</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Point-to-Point</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Multidrop or Point-to-MultiPoint (master/slave)</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Bandwidth Usage</td>
<td>Less</td>
<td>More</td>
</tr>
<tr>
<td>Control signals (RTS, CTS, ...)</td>
<td>Only transmitted if data is transmitted</td>
<td>Always transmitted</td>
</tr>
</tbody>
</table>

Best Practice: Try to use Circuit Emulation for Point-to-Point and Serial Ethernet for Multi-drop services.
4.2 Configure Service

4.2.1 Service Wizard

a. Wizard Steps

Click Dashboard → Configuration → Connections → Services → + to open the services wizard. See figure below.
The services wizard opens. The list below summarizes every page in the wizard:

- **Page: Information**: Click Next>>;
- **Page: Service Name and Type Selection**:
  - Service Name: enter a name for your service.
  - Service Type: Serial Ethernet;

- **Figure 21 Create Services**

- **Figure 22 Service Type: Serial Ethernet**

- Interface Type: RS232 (=default) /RS422/RS485;
- Bitrate: see overview in §8;
- Data Bits: Amount of data bits: 6,7,8 (=default);
- Parity: None (=default), Odd, Even, Mark, Space;
- Stop Bits: Amount of stop bits: 1 (=default), 2;
- Multidrop Consistency: is a polling mechanism between the master(s) port(s) and the slave ports to check whether the slaves are still alive (more info in §b).
  - Unchecked: polling disabled;
  - Checked (=default): polling enabled.
Advanced Mode (see §c): Fixed Block Size; Fixed Transmit Timer; Delimiter Line Termination Character; Delimiter Timeout;

Page: Service Endpoint Selection: Select the front ports on the involved IFMs that must be part of this service. Make sure to select the ports in nodes that are linked to a same tunnel. Selecting ports can be done in two ways:

- Via the table. The tree view can be expanded/collapsed via clicking the expand/collapse buttons. Just click the Selected checkbox to select the desired port;
- Via clicking the node icons in the network drawing, see general example in §13;

**NOTE:** Per port, an extra Info field can be filled out later on via Network Hardware → Devices → Select Node/IFM/Port → Generic → Info.

A node can have a maximum of 32767 MAC addresses. By default, per new Serial Ethernet service, 256 MAC addresses will be added to each LER node of the tunnel in which the service resides (not for point-to-point tunnels). If the maximum number of MAC addresses on a node has been reached, an error warning will pop up. After this warning, you will have to decrease the number of MAC addresses in this node from the other services first via clicking the MAC limit button (see Ref. [2Eth] in Table 2 for more info). See the figure below:

![Serial Ethernet: MAC Limit, Master/Slave](image)

**Figure 23 Serial Ethernet: MAC Limit, Master/Slave**

**Master/Slave:**

- In this service, at least one master (maximum two masters) and one or more slaves (maximum 156 slaves) must be selected. By default, the end-point is set as Slave but can be changed to Master by clicking the Master/Slave cell of the desired end-point and selecting Master, see figure above. In some network drawings the Master will be indicated by the icon.

- When two masters are selected, one of them will be the active one and the other one will be the backup master. Which one is the active/backup master will be decided by the serial protocol itself.

- The (active) master will initiate commands or requests to their slaves. The backup master and all the slaves will see this request. Only the addressed slave will process the request and send a response back to the (active) master. The backup master and all the other slaves will see the slave response.
Only the (active) master will process the slave response. The backup master (if any) will be synchronized with the active master and will take over when the active master gets out of service.

Page: Tunnel Selection: Allowed tunnels for this service type: point-to-multipoint, logical ring. See §11 to select the desired tunnel;

Page: Quality of Service Parameters: QoS (=Quality of Service) is a service traffic handling process in order to provide sufficient service delivery and bandwidth for critical applications. HiProvision provides a few QoS mechanisms, based on the parameters below.

Priority (range [0..5], default = 4): priority that will be assigned internally in the Dragon PTN node. 0 indicates the lowest priority (=least important). In the Dragon PTN network, higher priority traffic will be processed before lower priority traffic so that high priority traffic will not be compromised.

Frame Size: The 7-SERIAL IFMs convert their incoming signals from the LAN side into Ethernet packets towards the CSM. The Frame Size is the size of these Ethernet packets. The better you know the traffic (and its frame sizes) in your network, the better you can tune the consumed bandwidth on the WAN side. The Frame Size indicates the Ethernet frame size = payload + Ethernet overhead.

Frame Size is read-only;
Frame Size depends on settings in Page: Service Name and Type Selection;

![Figure 24 Wizard: Serial Ethernet: Quality of Service Parameters](image)

Page: Quality of Service Parameters Detail: see §12. Leave this page as it is, defaults are OK;

Page: Pseudo Wire Label Selection: leave this page as it is, defaults are OK;

Page: Review: The selected service ports will be shown: if ok, click Finish, the configuration load manager will be invoked.

Page: Load: The configuration load manager is a tool that starts and monitors the load process of a HiProvision configuration. Click the Load button to load the new HiProvision configuration into the live network. See Ref. [2Mgt] in Table 2 for more info.
CAUTION: While the loading to the Dragon PTN network is in progress, do not turn off, shut down or restart the HiProvision Server or Agent, since this may cause database corruption and network problems!

After this step, your customer applications connected to the front ports of the IFMs should be able to communicate over the Dragon PTN network.

b. Multidrop Consistency

Multidrop Consistency is a polling mechanism, within a Serial Ethernet service, between the master(s) port(s) and the slave ports to check whether the slaves are still alive. The master IFM is the IFM connected to the master application, the slave IFM is the IFM connected to the slave application. Each slave will see the poll requests to other slaves as well, but only answers the poll request addressed to itself.

- Checked (=default): the polling occurs every 500 ms. If a polling error occurs, the necessary alarms will be raised. If there are two masters, both masters poll independently of each other;
- Unchecked: no polling occurs at all. No alarm will be raised or nothing will be reported in HiProvision when a slave is missing.

Polling results can be monitored, see §4.6.5.

c. Advanced Mode – Bandwidth/Delay Optimization

At service creation, fine-tuning the bandwidth and delay through the network is done via the Advanced Mode parameter. It allows to group payload data into bigger packets, allowing more bandwidth efficiency (= resulting in less bandwidth). But grouping the payload into bigger packets costs more time, resulting in more delay.

Serial data is collected at the front ports and the payload data bits are buffered until one of the Advanced Mode events below is triggered. After the trigger, the payload data is packetized and sent over the Dragon PTN network.

- Advanced Mode:
  - Number of payload data bytes (=block) received at the front (Fixed Block size);
  - Periodic transmit timer expires (Fixed Transmit Timer);
  - Detection of a line termination character (Delimiter Line Termination Character);
  - Timeout occurs after the last received byte (Delimiter Timeout).

Each mode is explained more in detail below:

- Fixed Block Size (=default): Whenever ‘N’ payload data bytes are received at the front port, a packet including ‘N’ bytes will be sent through the Dragon PTN network. Configure ‘N’ in the Block Size field (default=8 bytes, range[1..1000] bytes). If ‘N’ is never received, the packet will be sent anyway after a specific timeout based on ‘N’ and the bitrate. A small ‘N’ results in an inefficient bandwidth but a low delay and vice versa.

- Fixed Transmit Timer: Configure the Transmit Timer (default = 10 ms, range [0-10000] ms). This timer is started whenever a serial data message enters a front port of the
7-SERIAL IFM. When the timer expires, a packet is transmitted through the Dragon PTN network and the timer is started again. This periodical process is repeated until the entire serial data message has been transmitted. The timer will only be started again when a new serial data message enters the 7-SERIAL IFM.

- **Delimiter Line Termination (=LT) Character:** Whenever an LT character is received at the front port, a packet will be sent through the Dragon PTN network. Configure the decimal ASCII value in the ‘Line Termination Character (decimal)’ field. The LT character will be sent as well. E.g. two common LT characters are Line Feed (‘\n’ = ASCII decimal 10) and Carriage Return (‘\r’ = ASCII decimal 13). Also fill out the Minimum Message Size (default=8 bytes, range[1..1000] bytes), needed to calculate the required bandwidth. Attention: filling out a higher (incorrect) minimal value than the real minimum could cause data loss.

- **Delimiter Timeout:** Whenever a Timeout occurs after the last received byte at the front port, a packet will be sent through the Dragon PTN network. Configure the Timeout (default = 100000 µs, range [0-100000] µs). Also fill out the Minimum Message Size (default= 8 bytes, range[1..1000] bytes), needed to calculate the required bandwidth. Attention: filling out a higher (incorrect) minimal value than the real minimum could cause data loss.

![Figure 25 Serial Ethernet: Advanced Mode - Bandwidth Optimization](image)

### 4.2.2 Network Hardware → IFM Settings

No extra settings must be done.

### 4.2.3 Network Hardware → IFM-Port Settings

After configuring the service via the service wizard, all port settings of the endpoints in this service will be set according to the service configuration. Some individual port settings might need extra tuning or must be overruled (e.g. DCE or DTE behaviour, or other settings...) via:

- **Network Hardware → Devices → 7-SERIAL → 7-SERIAL Port:**
  - **Serial Ethernet Port Settings:** values configured via the Serial Ethernet service wizard are visible, and can be overwritten manually if desired;
  - **Generic Port Properties:** Fill out these properties depending the use case you have. More information on these properties can be found in Ref. [8] in Table 2.

- Apply your changes and load these changes into the Dragon PTN network.
4.3 Modify Service

After service creation, this service can be modified if needed via:

- Wizard: Dashboard → Configuration → Connections → Services → select service;
- Port settings, see §4.2.3;

4.4 Delete Service

After service creation, this service can be deleted if needed via Dashboard → Configuration → Connections → Services → select service;

4.5 Troubleshooting: Test and Loopback

This service can be tested via loopback settings on IFM level and port level in the Network Hardware tab. See §14 for setting up loopbacks.

4.6 Monitoring

4.6.1 (Configuration) Network Hardware Tile

None.

4.6.2 (Configuration) Connections Tile

What has been configured via the service wizard can also be viewed via Dashboard → Connections → Services → select service in the list. Some extra tabs (Service, Serial Ethernet) with service configuration data will be shown.
**CAUTION:** The configuration that you see here is the service configuration done via the service wizard. Port settings could be tuned manually via §4.2.3 and as a result could be different from these service settings. Always verify the port settings in §4.2.3 as well, to know the exact port setting in the live network.

**Figure 27 (Configuration) Connections Tile: Serial Ethernet**

### 4.6.3 (Monitoring) Network Tile

Live service data can be monitored via the Dashboard → Network → Services → select service in the list. The service will be shown in the network drawing. Click 🔄 to show extra monitoring properties for this service. Click 🟠 to show the used nodes/links/tunnels.

**Figure 28 (Monitoring) Network Tile: Serial Ethernet**
4.6.4 Performance Counters

Go to Dashboard → (Monitoring) Performance → Counter Control → Service Performance → Serial Ethernet Monitoring. See figure below.

A detailed and similar monitoring set-up description (adding counters to graphs etc…) can be found in ‘Port Performance’ → ‘CSM Ethernet Port Monitoring’ in Ref. [2Net] in Table 2.

![Figure 29 Performance Counters: Serial Ethernet Monitoring](image)

### Table 4 Services: Serial Ethernet Monitoring 'Module' Fields

<table>
<thead>
<tr>
<th>Field</th>
<th>Values</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Module</td>
<td>value</td>
<td>Monitored module</td>
</tr>
<tr>
<td>Data Rx Packet (ingress)</td>
<td>packets</td>
<td>The number of received data packets.</td>
</tr>
<tr>
<td>Data Tx Packet (egress)</td>
<td>packets</td>
<td>The number of transmitted data packets.</td>
</tr>
<tr>
<td>Data Rx Packet Error (ingress)</td>
<td>packets</td>
<td>The number of received erroneous data packets. The packets had for example a CRC error.</td>
</tr>
</tbody>
</table>

**Note:** Click the Refresh button for the latest results; 'C' value in cell = current value; 'P' value in cell = previous value;

### Table 5 Services: Serial Ethernet Monitoring 'Port' Fields

<table>
<thead>
<tr>
<th>Field</th>
<th>Values</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Port</td>
<td>value</td>
<td>Monitored port</td>
</tr>
<tr>
<td>Seconds With Parity Errors (ingress)</td>
<td>seconds</td>
<td>increasing = NOT OK: The total amount in seconds that frames with parity errors were received</td>
</tr>
<tr>
<td>Seconds With Framing Errors (ingress)</td>
<td>seconds</td>
<td>increasing = NOT OK: The total amount in seconds that frames with framing errors were received</td>
</tr>
<tr>
<td>Seconds With Overrun Errors (ingress)</td>
<td>seconds</td>
<td>increasing = NOT OK: The total amount in seconds that buffer overrun errors occurred</td>
</tr>
<tr>
<td>Rx Good Characters (ingress)</td>
<td>characters</td>
<td>The number of valid or good received characters. A good character contains 8 bits and has no errors in it. Character validation is based on start/stop/parity bits.</td>
</tr>
<tr>
<td>Tx Good Characters (egress)</td>
<td>characters</td>
<td>The number of valid or good transmitted characters. A good character contains 8 bits and has no errors in it. Character validation is based on start/stop/parity bits.</td>
</tr>
</tbody>
</table>

**Note:** Click the Refresh button for the latest results;
**Note:** Clear the counter values by disabling and enabling the BERT via the IFM/port settings in the network hardware tile;
**Note:** 'C' value in cell = current value; 'P' value in cell = previous value;
4.6.5 Multidrop Consistency

The following poll results are reported per master and per slave in HiProvision and visible via the Dashboard → Network → Services → Click Service in the list → Click Serial Ethernet tab. The polling results can be updated via the refresh button.

- **Poll Error Seen by Master:**
  - False: Everything OK, slave IFM has answered the poll request of the master IFM;
  - True: Failure, slave IFM has not answered the poll request of the master IFM;

- **Poll Error Seen by Slave:**
  - False: Everything OK, the slave IFM receives all the poll requests to other slaves as well;
  - True: Failure, the slave IFM does not receive at least one of the poll requests addressed to other slaves;

- **Specific Poll Error Seen by Slave:**
  - False: Everything OK, slave IFM has received a poll request of the master IFM;
  - True: Failure, slave IFM has not received the poll request of the master IFM;

![Figure 30 Monitoring: Multidrop Consistency: Polling Results](image)

![Figure 31 Multidrop Consistency Alarm](image)
4.6.6 HiProvision Add-on: Generic Reporting Engine

Service and port reporting information is available via the Reporting Engine Add-on, see Ref.[24] in Table 2.

4.6.7 MAC Monitor

The MAC Monitor will show the MAC address table of the selected Node (=CSM). This table includes all MAC addresses used on this device except for the MAC addresses that are used in a point-to-point tunnel. More information can be found in Ref. [2Eth] in Table 2.

MAC Monitor via: Dashboard → (Monitoring) Network → Services →

5. CIRCUIT EMULATION

5.1 General

A Circuit Emulation service (=CES) is a point-to-point packetized TDM service. The following CES types are available:

- SAToP (=Structured Agnostic TDM over Packet) → transport all channels transparently;
- CESoPSN (=CES over Packet Switched Network) → customized channel transport;
- Differential Clocking / Hitless Switching / Single Path;

The following protocols are supported:

- E1 / T1 / C37.94 / Serial / 2W/4W Voice / CODIR / Optical Low Speed Serial.

The involved IFMs convert the legacy data from the legacy links into MPLS-TP packets over the Dragon PTN network, and vice versa. The destination IFM must also compensate for possible jitter and network delays to keep everything synchronized, e.g. via SyncE. The example figure below shows a E1/T1 example but is similar for other protocols.

Figure 32 1 General Circuit Emulation Example with E1/T1
5.2 Configure Service

5.2.1 Service Wizard

Click Dashboard → Configuration → Connections → Services → + to open the services wizard. See figure below.

![Services wizard](image)

**Figure 33 Create Services**

The services wizard opens. The list below summarizes every page in the wizard:

**Note**: The referred IFM manuals in Table 2 often show a lot more info and pictures on the mentioned parameters and settings below. Read the manual of involved IFMs as well!

- **Page**: Information: Click Next>>;
- **Page**: Service Name and Type Selection: Example screen below with E1. An overview of all screens of this page per protocol, can be found in the table below.

![Service wizard](image)

**Figure 34 Service Type: Circuit Emulation Example Screen with E1 – SAToP**

- Service Name: enter a name for your service.
- Service Type: Circuit Emulation;
- Protocol: E1 / T1 / C37.94 / Serial / 2W/4W Voice / CODIR / Optical Low Speed Serial. The table below shows each protocol screen. The second table shows a summarized overview and needed parameters in this page per protocol.
Table 6 Service Name and Type Selection: Protocol Screens Overview

<table>
<thead>
<tr>
<th>Service Name and Type Selection Screen</th>
<th>Service Name and Type Selection Screen</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Protocol</strong></td>
<td><strong>Protocol</strong></td>
</tr>
<tr>
<td>E1</td>
<td>T1</td>
</tr>
<tr>
<td>Usage: SAToP</td>
<td>Usage: SAToP</td>
</tr>
</tbody>
</table>

Make sure you adjust the Clock Source of the ports used by this service.

| **Protocol**                          | **Protocol**                          |
| C37.84                                | Serial                                |
| Usage: CESoPSN                        | Usage: SAToP                          |

Make sure you adjust the Clock Source of the ports used by this service.

| **Protocol**                          | **Protocol**                          |
| 2W/4W Voice                           | CO3S                                  |
| Usage: CESoPSN                        | Usage: SAToP                          |

Make sure you adjust the Clock Source of the ports used by this service.

| **Protocol**                          | **Protocol**                          |
| Optical Low Speed Serial              | CO3S                                  |
| Usage: SAToP                          | Usage: SAToP                          |

Make sure you adjust the Clock Source of the ports used by this service.

- CESoPSN
- Asynchronous
- RS232
- 1,200 bps
- 4 Wire
- Multidrop
- Optical Low Speed Serial
- Asynchronous
- 207,200 kbps
- No Framing
## Table 7 Service Name and Type Selection: Protocol Overview

<table>
<thead>
<tr>
<th>Protocol</th>
<th>Supported IFMs (Refs. in Table 2)</th>
<th>Supported Ports</th>
<th>Usage: SAToP</th>
<th>Usage: CESoPSN</th>
<th>Mux/ Demux (SAToP)</th>
<th>Diff. Clocking</th>
<th>Hitless Switching (+Single Path)</th>
<th>Specific Parameters</th>
</tr>
</thead>
<tbody>
<tr>
<td>E1</td>
<td>2-OLS, 2-C37.94, 4-E1-L/4-T1-L, 16-E1-L/16-T1-L</td>
<td>E1</td>
<td>✓</td>
<td>✓</td>
<td>---</td>
<td>✓</td>
<td>✓</td>
<td>Page: Circuit Emulation Parameters: Short Haul on E1 Ports</td>
</tr>
<tr>
<td>T1</td>
<td>2-OLS, 2-C37.94, 4-E1-L/4-T1-L, 16-E1-L/16-T1-L</td>
<td>T1</td>
<td>✓</td>
<td>✓</td>
<td>---</td>
<td>✓</td>
<td>✓</td>
<td>Page: Circuit Emulation Parameters: Short Haul on T1 Ports</td>
</tr>
<tr>
<td>C37.94</td>
<td>2-OLS, 2-C37.94, 4-E1-L/4-T1-L, 16-E1-L/16-T1-L</td>
<td>C37.94, E1, T1</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>Number of Timeslots: for CESoPSN, the number of timeslots that must be transported can be selected. Circuit Emulation Parameters: Short Haul on E1/T1 Ports</td>
</tr>
<tr>
<td>Serial</td>
<td>7-SERIAL</td>
<td>7-SERIAL</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>---</td>
<td>✓</td>
<td>- Synchronisation: Synchronous / Asynchronous - Interface Type: RS232, RS422, RS485 (Async.), X.21(Sync.), V.35 (Sync.) - Bitrate: see §8 - Pin Layout (for X.21, V.35): Full, Optimized. Full means that all signals are used, Optimized means that a reduced set of the signals is used ( \rightarrow ) See Ref.[8] for more info.</td>
</tr>
<tr>
<td>2W/4W Voice (See also §6)</td>
<td>4-2/4WEM</td>
<td>4-2/4WEM</td>
<td>---</td>
<td>✓</td>
<td>---</td>
<td>---</td>
<td>✓</td>
<td>- 2W/4W Mode: transportation mode 2W or 4W mode selector. - Multidrop: check if you want to use multidrop (=combining several PTP services with the same master), unchecked means one PTP service. Page: Service EndPoint Selection (See also §6): - Master/Slave: if multidrop is used, one port must be indicated as master.</td>
</tr>
<tr>
<td>Protocol</td>
<td>Supported IFMs (Refs. in Table 2)</td>
<td>Supported Ports</td>
<td>Usage: SAToP</td>
<td>Usage: CESoPSN</td>
<td>Mux/ Demux (SAToP)</td>
<td>Diff. Clocking</td>
<td>Hitless Switching (+Single Path)</td>
<td>Specific Parameters</td>
</tr>
<tr>
<td>------------------------</td>
<td>-----------------------------------</td>
<td>-----------------</td>
<td>--------------</td>
<td>----------------</td>
<td>------------------</td>
<td>---------------</td>
<td>-------------------------------</td>
<td>-------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>CODIR</td>
<td>CODIR</td>
<td>CODIR</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>- Echo On Master: allows inter-slave communication when using multidrop.</td>
</tr>
<tr>
<td>Optical Low Speed Serial</td>
<td>2-OLS</td>
<td>2-OLS</td>
<td>✓</td>
<td>✓</td>
<td>---</td>
<td>✓</td>
<td>✓</td>
<td>- Send Condition: condition when to send Voice data, E&amp;M is always sent.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>- Synchronisation: Synchronous / Asynchronous</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>- Bitrate: see §8</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>- FM0 Coding (in Sync. mode): Disabled (=default): Normal data (without encoding) is used;</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Enabled: FM0 encoded data is used. 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.</td>
</tr>
</tbody>
</table>

![Diagram](image.png)

- (Normal) Data
- FM0 Encoded Data
- bit time

(0 0 1 1 0 1 0 1 0)
Usage:

- SAToP (=default): one-to-one mapping of timeslots, protocol data is transported transparently. Use this type when a constant ‘Differential Delay’ is important for your application;
- CESoPSN: customized mapping of timeslots, only transmit used timeslots with real payload;
- Mux/Demux (only for SAToP): mux/demux multiple services to/from a single E1 port.
  - unchecked (=default): Not possible to mux this service with other services to one E1 port.
  - checked: Possible to mux/demux this service with other services to/from an E1 port. These muxed/demuxed services can either have the same or a different protocol. E.g. Codir, Serial and C37.94 frames can be muxed together to that E1 port1.
- The muxing/demuxing port will always be **port1** of a 4-E1-L IFM.
- V.110 (for Serial protocol only):
  - Asynchronous: V.110 is always used to transport serial streams over Dragon PTN;
  - Synchronous: V.110 usage depends on the selected bitrate (see §10);
- A maximum of 4 point-to-point SAToP services that have checked Mux/Demux, can be muxed/demuxed to/from that same E1 port1.
- Per extra muxed service to that E1 port1, an extra available E1 port on that 4-E1-L IFM is required and will be disabled for other service connections. E.g., a second muxed service disables the next available port (starting with the lowest port number first) on that 4-E1-L IFM.

**NOTE:** After having programmed a muxed service to port1 on the 4-E1-L IFM, this port 1 can only become available again after removing all the muxed services that were programmed to that port1.

- Differential Clocking (when the Clock Source field = adaptive/differential):
  - unchecked (=default): adaptive clocking
  - checked: differential clocking;

**Note:** The referred IFM manuals in Table 2 often show a lot more info on Differential Clocking, Clock Source settings etc. (Synchronization / Clock Distribution / Network Timing). So make sure to read the required IFM manual as well.

- Hitless Switching:
  - unchecked (=default): possible data and/or synchronisation loss when switching from active to backup path or vice versa, e.g. because of cable break;
  - checked: no data and/or synchronisation loss when switching from active to backup path or vice versa, e.g. because of cable break;
- Single Path (Hitless Switching): The service can already start up with only one link up, coming out of a two-links-down situation with single path enabled. Do not use this option when ‘Differential Delay’ is important for your application.
Specific Parameters per protocol: see previous table.

Page: Service Endpoint Selection:
- Select the front ports on the involved IFMs that must be part of this service. Make sure to select the ports in nodes that are linked to a same tunnel. Selecting ports can be done in two ways.
  - Via the table. The tree view can be expanded/collapsed via clicking the expand/collapse buttons. Just click the Selected checkbox to select the desired port;
  - Via clicking the node icons in the network drawing, see general example in §13;
- (for 2W/4W Voice only:) For a 2W/4W Voice service in multidrop, master(s)/slave(s) must be selected. By default, the end-point is set as slave but can be changed to master by clicking the cell, see figure below. In some network drawings the master will be indicated by master/Slave setting for Multidrop in '2W/4W Voice' service.

![Figure 35 Master/Slave Setting for 2W/4W Voice](image)

**Note:** Per port, an extra Info field can be filled out later on via Network Hardware → Devices → Select Node/IFM/Port → Generic → Info.

Page: Tunnel Selection: Select the desired tunnels for your service. More info on tunnels, tunnel selection and allowed tunnels can be found in §11;

Page: Hitless Tunnel Selection (only visible with ‘hitless switching’ enabled): if no tunnel is listed, it means that no point-to-point tunnel without protection is available anymore. This type of tunnel is needed to create the protection path for hitless switching. Create a new point-to-point tunnel without protection first.

Page: Circuit Emulation Parameters:
- Port Parameters (only on E1/T1 ports → in E1, T1, C37.94 protocol):
  - Short Haul Link: Long E1/T1 links (>200m, Long Haul) have more E1/T1 signal attenuation than shorter E1/T1 links (<200m, Short Haul). As a result, the E1/T1 signal levels or sensitivity (‘0’ or ‘1’) on the receiver side depends on the usage of Long Haul/Short Haul links. Check this parameter for Short Haul links and uncheck
it (=default) for Long Haul links. This parameter can be set now at service creation or later on at port level in the IFM → port settings.

- **Bundle Parameters**: fine-tuning of parameters, defaults are OK. More info on these parameters can be found in the referred manuals above.
- **TDM Frames per Packet**
- **Jitter Buffer Size**
- **Maximum Network Path Delay Difference** (only with ‘Hitless Switching’)
- **Calculated Packetization and Depacketization Delay**

**Figure 36 Circuit Emulation Parameters**

- **Page: Quality of Service Parameters**: QoS (=Quality of Service) is a service traffic handling process in order to provide sufficient service delivery and bandwidth for critical applications. HiProvision provides a few QoS mechanisms, based on the parameters below.
- **Priority** (range [0..5], default = 4): priority that will be assigned internally in the Dragon PTN node. 0 indicates the lowest priority (=least important). In the Dragon PTN network, higher priority traffic will be processed before lower priority traffic so that high priority traffic will not be compromised.
- **Frame Size**: The CES IFMs convert their incoming signals from the LAN side into Ethernet packets towards the CSM. The Frame Size is the size of these Ethernet packets. The better you know the traffic (and its frame sizes) in your network, the better you can tune the consumed bandwidth on the WAN side. The Frame Size indicates the Ethernet frame size = payload + Ethernet overhead.
  - **Frame Size is read-only**;
  - **Frame Size depends on**:
    - **Page: Service Name and Type Selection** → Differential Clocking on or off;
    - **Page: Circuit Emulation Parameters** → TDM Frames per Ethernet Packet.
Page: Quality of Service Parameters Detail: see §12. Leave this page as it is, defaults are OK;

Page: Pseudo Wire Label Selection: leave this page as it is, defaults are OK;

Page: Review: The selected service ports will be shown: if ok, click Finish, the configuration load manager will be invoked.

Page: Load: The configuration load manager is a tool that starts and monitors the load process of a HiProvision configuration. Click the Load button to load the new HiProvision configuration into the live network. See Ref. [2Mgt] in Table 2 for more info.

CAUTION: While the loading to the Dragon PTN network is in progress, do not turn off, shut down or restart the HiProvision Server or Agent, since this may cause database corruption and network problems!

After this step, your customer applications connected to the front ports of the IFMs should be able to communicate over the Dragon PTN network;

5.2.2 Network Hardware → IFM Settings
No extra settings must be done.

5.2.3 Network Hardware → IFM-Port Settings
Go to Dashboard → Network Hardware → Device → IFM → used ports → Circuit Emulation

Optimise Jitter Buffer (default = True): The default is OK for most applications. In some special cases, tuning this parameter might be necessary.

CAUTION: If differential delay is important and must be as low as possible then make sure to leave Optimise Jitter Buffer = True
**CAUTION:** If Optimise Jitter Buffer = True, the jitter buffer will be reset for optimal processing 15 or 120 (*) seconds after one of the events below occur. This reset will cause a minimal loss of data:
- CES service creation/modification;
- CES service recovery after a possible service failure;
- Modifying clocking port parameters (clock source, bundle id for E1/T1) in HiProvision;

(*) 120 seconds for 16-E1-L/16-T1-L IFMs and 15 seconds for the other IFMs.

Send Data: It can be configured when an adaptive (*) SAToP service starts sending data.
- Immediately (=default): Start sending immediately;
- After Clock PreLocked: after 120 seconds for 16-E1-L/16-T1-L IFMs, after 15 seconds for the other IFMs;
- After Clock Locked: after the 'Clock Recovery State' field on port level is in the 'Locked' state;

**NOTE:** (*): One of the both service ports has property Clock Source set to 'Adaptive/Differential'

**NOTE:** Make sure that both ports of the service are configured the same.

Clock Source: RX Clock, Adaptive/Differential, Internal Clock. This parameter needs to be tuned according to the description in the IFM manual, depending on the desired clocking and timing scenarios.

CESoPSN Clock Source Bundle Id: Each CESoPSN service that is created in HiProvision will automatically get a 'bundle ID' assigned. The value of this 'Bundle ID' can be found in Dashboard → Network → Services → Monitoring Properties → Circuit Emulation (see figure below). 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).

**Figure 38 Find and Fill out the CESoPSN Bundle ID**
5.3 Modify Service

After service creation, this service can be modified if needed via:

- Wizard: Dashboard → Configuration → Connections → Services → select service → ;
- Port settings, see §5.2.3;

5.4 Delete Service

After service creation, this service can be deleted if needed via Dashboard → Configuration → Connections → Services → select service → ;

5.5 Troubleshooting: Test and Loopback

This service can be tested via loopback settings on IFM level and port level in the Network Hardware tab. See §14 for setting up loopbacks.

5.6 Monitoring

5.6.1 (Configuration) Network Hardware Tile

None

5.6.2 (Configuration) Connections Tile

What has been configured via the service wizard can also be viewed via Dashboard → Connections → Services → select service in the list. Some extra tabs (Service, Pseudo-Wires, Circuit Emulation) with service configuration data will be shown.

Figure 39 (Configuration) Connections Tile: Circuit Emulation Service
5.6.3 (Monitoring) Network Tile

Live service data can be monitored via the Dashboard → Network → Services → select service in the list. The service will be shown in the network drawing. Click to show extra monitoring properties for this service. Click to show the used nodes/links/tunnels.

![Figure 40 (Monitoring) Network Tile: Circuit Emulation]

5.6.4 Performance Counters

Go to Dashboard → (Monitoring) Performance → Counter Control → Service Performance → Circuit Emulation Monitoring. See figure below.

A detailed and similar monitoring set-up description (adding counters to graphs etc…) can be found in ‘Port Performance’ → ‘CSM Ethernet Port Monitoring’ in Ref. [2Net] in Table 2.

![Figure 41 Services: Circuit Emulation Monitoring]
### Table 8 Services: Circuit Emulation Monitoring 'Module' Fields

<table>
<thead>
<tr>
<th>Field</th>
<th>Values</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Module</td>
<td>value</td>
<td>Monitored module</td>
</tr>
<tr>
<td>Data Rx Packet</td>
<td>packets</td>
<td>The number of received data packets.</td>
</tr>
<tr>
<td>Data Rx Packet Error</td>
<td>packets</td>
<td>The number of received erroneous data packets. The packets had for example a CRC error.</td>
</tr>
<tr>
<td>Data Rx Information Bandwidth</td>
<td>kbps</td>
<td>The reserved module bandwidth for only the payload data on the ingress side. This value remains the same until the HiProvision bandwidth configuration changes.</td>
</tr>
<tr>
<td>Data Tx Packet</td>
<td>packets</td>
<td>The number of transmitted data packets.</td>
</tr>
<tr>
<td>Data Tx Information Bandwidth</td>
<td>kbps</td>
<td>The reserved module bandwidth for only the payload data on the egress side. This value remains the same until the HiProvision bandwidth configuration changes.</td>
</tr>
<tr>
<td>Data Reserved Full Bandwidth</td>
<td>kbps</td>
<td>The reserved full module bandwidth including both overhead and payload data. This value remains the same until the HiProvision bandwidth configuration changes.</td>
</tr>
</tbody>
</table>

*Note:* Click the Refresh button for the latest results; *Note:* Clear the counter values by clicking ; *Note:* 'C' value in cell = current value; 'P' value in cell = previous value;

### Table 9 Services: Circuit Emulation Monitoring 'Bundle' Fields

<table>
<thead>
<tr>
<th>Field</th>
<th>Values</th>
<th>Description</th>
<th>Curative Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bundle</td>
<td>value</td>
<td>The monitored bundle or stream</td>
<td></td>
</tr>
<tr>
<td>Total Buffer Initial Fill Level</td>
<td>µs</td>
<td>The start level of the buffer right after resetting/rebooting the IFM</td>
<td>verify the Service wizard → Circuit emulation parameters / QoS configuration in HiProvision</td>
</tr>
<tr>
<td>Total Buffer Size</td>
<td>µs</td>
<td>This is the reserved jitter buffer size. It is the absolute maximum that a buffer level can reach. The size is based on the configuration parameters. If the current buffer level would increase above the buffer size (which is not possible), a buffer overrun occurs and packets are lost.</td>
<td>no drifting, and close to minimum size (0) due to network jitter or hitless path interruption, verify buffers configuration, buffer too small?</td>
</tr>
<tr>
<td>Total Buffer Minimum Level</td>
<td>µs</td>
<td>The minimum (current) level that has been reached so far</td>
<td>if this level is drifting, verify clocking settings master/slave</td>
</tr>
<tr>
<td>Total Buffer Current Level</td>
<td>µs</td>
<td>The current fill level of the buffer</td>
<td>no drifting, and close to maxsize (=size buffer) due to network jitter, verify buffers configuration, buffer too small?</td>
</tr>
<tr>
<td>Total Buffer Maximum Level</td>
<td>µs</td>
<td>The maximum (current) level that has been reached so far</td>
<td>verify clock settings master/slave, jitter buffer might be too small.... verify the Service wizard → Circuit emulation parameters in HiProvision</td>
</tr>
<tr>
<td>Total Buffer Underrun</td>
<td>count</td>
<td>The number of times that a buffer has underrun. A buffer underrun occurs when the buffer is filled slower than packets in the buffer are processed. As a result, the buffer will finally run empty which results in an underrun. If an underrun occurs, the buffer will be reset to the initial level.</td>
<td>verify the Service wizard → Circuit emulation parameters in HiProvision</td>
</tr>
</tbody>
</table>
### Field

<table>
<thead>
<tr>
<th>Field</th>
<th>Values</th>
<th>Description</th>
<th>Curative Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Buffer Overrun</td>
<td>count</td>
<td>The number of times that a buffer has overrun. A buffer overrun occurs when</td>
<td>verify clock settings master/slave, jitter buffer might be too small. verify the Service wizard Circuit emulation parameters in HiProvision.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>the buffer is filled faster than packets in the buffer are processed. As a</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>result, the buffer fill level will grow up to the maximum or buffer size,</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>and finally will overflow or overrun. After an overrun, the buffer will be</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>reset to the initial level.</td>
<td></td>
</tr>
<tr>
<td>Ethernet Rx Frames</td>
<td>frames</td>
<td>The number of received Ethernet frames.</td>
<td></td>
</tr>
<tr>
<td>Ethernet Rx Sequence Number</td>
<td>frames</td>
<td>The number of received Ethernet frames that were dropped due to an invalid</td>
<td></td>
</tr>
<tr>
<td>Drop Errors</td>
<td></td>
<td>sequence number.</td>
<td></td>
</tr>
<tr>
<td>Hitless Sequence Error</td>
<td>count</td>
<td>The number of times that a sequence number error occurred</td>
<td>verify the Service wizard Circuit emulation parameters / QoS configuration in HiProvision</td>
</tr>
<tr>
<td>Hitless Overflow</td>
<td>count</td>
<td>The number of times that the hitless buffer (in FPGA) overflow occurred</td>
<td></td>
</tr>
<tr>
<td>Hitless Timeout</td>
<td>count</td>
<td>The number of times that a timeout occurred on one of the hitless paths.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>E.g. pulling out the WAN link of the hitless path will increase the counter</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>by one.</td>
<td></td>
</tr>
<tr>
<td>Reserved Information Bandwidth</td>
<td>kbps</td>
<td>The reserved bundle bandwidth for only the payload data. This value remains</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>the same until the HiProvision bandwidth configuration changes.</td>
<td></td>
</tr>
<tr>
<td>Reserved Full Bandwidth</td>
<td>kbps</td>
<td>The reserved full bundle bandwidth including both overhead and payload data.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>This value remains the same until the HiProvision bandwidth configuration</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>changes.</td>
<td></td>
</tr>
</tbody>
</table>

**Note:** Click the Refresh button for the latest results; Clear the counter values by clicking ; 'C' value in cell = current value; 'P' value in cell = previous value;

### 5.6.5 HiProvision Add-on: Generic Reporting Engine

Service and port reporting information is available via the Reporting Engine Add-on, see Ref.[24] in Table 2.

### 6. CIRCUIT EMULATION: EXTRA INFO ON 2W/4W-VOICE

#### 6.1 General

A point-to-point '2W/4W Voice' service can be configured via creating a Circuit Emulation Service (=CES) with protocol type '2W/4W Voice' and Multidrop unchecked. Check the multidrop checkbox if you want a multidrop service. The multidrop behavior is accomplished via combining individual PTP services with the same master, see further. The E-Signal (E&M signaling) will be transmitted together with the voice data in the '2W/4W Voice service. A maximum of 4 CESs can be configured per 4-2/4WEM IFM if only PTP services are configured. A multidrop service can configure up to 15 PTP services on the same master voice port with a total maximum of 16 CESs per IFM. The table below shows more settings that influence the 2W/4W Voice and E&M signaling behavior.
### Table 10 2W/4W Voice E&M Settings

<table>
<thead>
<tr>
<th>Type</th>
<th>Parameter</th>
<th>Values</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>General</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Service</td>
<td>Usage</td>
<td>CESoPSN</td>
<td>Feature within CESoPSN that provides a safe redundant connection. Yes: switching between active and protection path stays synchronized.</td>
</tr>
<tr>
<td>Service</td>
<td>Hitless Switching</td>
<td>No (=default) / Yes</td>
<td>Subfeature of Hitless Switching: Yes: The service can already start up with only one link up, coming out of a two-links-down situation with single path enabled. Do not use this option when ‘Differential Delay’ is important for your application.</td>
</tr>
<tr>
<td>Service</td>
<td>Single Path</td>
<td>No (=default) / Yes</td>
<td></td>
</tr>
<tr>
<td>Service</td>
<td>Mode</td>
<td>4 Wire (=default) / 2 Wire</td>
<td>Mode of voice transportation, via 4 wires or 2 wires.</td>
</tr>
<tr>
<td>Service</td>
<td>Multidrop</td>
<td>No (=default=PTP) / Yes</td>
<td>No = PTP = Point-to-Point. Yes = Multidrop: Accomplished by creating different PTP services that share the same master.</td>
</tr>
<tr>
<td>Service → Port</td>
<td>Master/Slave</td>
<td>Slave = default</td>
<td>If multidrop = Yes, at least one port must be configured as master whereas maximum 15 ports can be configured as slave.</td>
</tr>
<tr>
<td>Hardware → Port Property</td>
<td>Clock Source</td>
<td>See Ref. [10] in Table 2</td>
<td>See Ref. [10] in Table 2</td>
</tr>
<tr>
<td><strong>Voice</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Service → Port</td>
<td>Echo On Master</td>
<td>Off (=default) / On</td>
<td>If Multidrop = Yes, Echo on Master will be configurable. This feature allows slaves to communicate with each other. If Echo on Master = On, slaves can communicate with each other.</td>
</tr>
<tr>
<td>Service → Port</td>
<td>Send Condition (only for Voice, not for E&amp;M)</td>
<td>Active E Signal: Rx signal &gt; 50 mV; Rx signal &gt; 10 mV (=default); Never send</td>
<td>If Multidrop = Yes, the condition for sending or transmitting voice signals over the Dragon PTN network can be configured to one of the indicated values. NOTE: the Send Condition does not influence E&amp;M, E&amp;M will always be transmitted. For 2-Wire Voice, it is advised to use ‘Rx signal &gt; 50 mV’.</td>
</tr>
<tr>
<td>Hardware → Port Property</td>
<td>Tx Signal Level</td>
<td>-15 dB → +18 dB</td>
<td>0 dB = Default. Tx Signal can be amplified in the indicated range in steps of 3 dB.</td>
</tr>
<tr>
<td>Hardware → Port Property</td>
<td>Rx Signal Level</td>
<td>-15 dB → +18 dB</td>
<td>0 dB = Default. Rx Signal can be amplified in the indicated range in steps of 3 dB.</td>
</tr>
<tr>
<td><strong>E&amp;M Signaling</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Service → Port</td>
<td>Echo On Master</td>
<td>Off (=default) / On</td>
<td>If Multidrop = Yes, Echo on Master will be configurable. This feature allows slaves to communicate with each other. If Echo on Master = On, slaves can communicate with each other.</td>
</tr>
<tr>
<td>Hardware → Port Property</td>
<td>E&amp;M Signaling</td>
<td>Type 2, 3, 4, 5</td>
<td>Select the E&amp;M signaling type.</td>
</tr>
<tr>
<td>Hardware → Port Property</td>
<td>M Signal Mode</td>
<td>Transparent / Fixed</td>
<td><strong>Transparent:</strong> The E-signal on the other side is transmitted transparently to the M output. What comes in on the E side of the other side, goes out transparently on the M side. If M = transparent on the slave, the E-signal on the master comes out transparently on the M of the slave. If M = transparent on the master, the E-signal of any of the slaves goes out transparently on the M of the master. <strong>Fixed:</strong> The M output will be fixed Off or On depending the ‘M Signal Output’ setting.</td>
</tr>
<tr>
<td>Hardware → Port Property</td>
<td>M Signal Output</td>
<td>Off/On</td>
<td>The M output will be fixed Off or On.</td>
</tr>
</tbody>
</table>

**NOTE:** the Send Condition has only impact on the Voice/Data. E&M will always be transmitted.
6.2 CES: CESoPSN (Point-to-Point)

CESoPSN (=Circuit Emulation Service over Packet Switched Network) is a point-to-point service between two voice ports that uses the timeslots of an E1 frame to transport the data over the MPLS-TP Dragon PTN network. Such a PTP service can be configured per port. This service transports the voice data into the first timeslot and the E&M signaling in the second timeslot of an E1 frame.

The destination module will receive the transported timeslots from the Dragon PTN network and regenerate the voice data and the E&M signaling from it to finally output it on its voice port. Indicate in the service creation if you want to use 4 or 2wire. Make sure that the Multidrop setting disabled. Each end-point or port must be located in a different node.

6.3 CES: CESoPSN (Multidrop)

A multidrop behavior between one master and ‘n’ (maximum 15) slaves is accomplished by creating ‘n’ individual CESoPSN Point-to-Point services in HiProvision, between each slave port and the same master port. All these point-to-point (=PTP) services within that multidrop:

- must be configured with the multidrop setting enabled;
- must have the same wire type usage, either 2 or 4wire;
- have exact one (shared) master and one slave. The first created PTP service within that multidrop, defines the master. The 2nd, 3rd... PTP service that select the same master at service creation, will be part of that resulting multidrop service;
- Must have the master in a different node than the slave nodes.
CAUTION: Unused ports in a 2-Wire Voice multidrop service must be terminated with a 600Ω impedance.

The figure below shows a multidrop example between one master and three slaves.

![Multidrop example between one master and three slaves]

**Figure 43 Multiple PTP Services with Same Master result in Multidrop Behavior**

6.4 Tone Generation/Level Metering

It is possible to generate test tone signals, see §14.4

7. VOICE

7.1 General

Supported IFMs: 8-FXS (for analog voice), all IFMs with Ethernet ports (for voice over IP). More information on these IFMs can be found in Ref. [8] in Table 2.

A Voice service requires at least one analog (8-FXS) and one Ethernet (4-GC-LW, ...) port.

The Voice service can set up connections between both analog phones (via 8-FXS) and SIP elements (client, server, trunk) over the Dragon PTN network. SIP elements can be connected to the Dragon PTN network via Ethernet IFMs (e.g. 4-GC-LW, ..., 9-L3A-L). This service operates VLAN based and is routable (with Gateway IP address). Depending on where the call handling must be done, two different modes can be selected:

- Remote extension (FXO Gateway): call handling via FXO gateway to analog public or private telephone networks;
- SIP-server: call handling done in dedicated external SIP server;

A general analog Voice service example can be found in the figure below:
7.2 Configure Service

7.2.1 Service Wizard

Click Dashboard → Configuration → Connections → Services → + to open the services wizard. See figure below.
The services wizard opens. The list below summarizes every page in the wizard:

- **Page: Information:** Click Next>>;
- **Page: Service Name and Type Selection:**
  - Service Name: enter a name for your service.
  - Service Type: Voice;
- **VLAN ID:** Set the default VLAN ID in the range [3-3699, 3802-4000] for the Ethernet ports in this service. Ethernet packets with this VLAN ID will be forwarded in this service, other VLAN IDs and untagged packets will be dropped. This behavior can be overruled by a more advanced VLAN processing in the ‘VLAN Tagging/Untagging’ feature further on this wizard;
- **Mode:** Remote Extension (FXO Gateway), SIP-Server, see §7.3 for more information;
- **Routable (including Gateway IP address):** Enable this when your 8-FXS IFMs, FXO Gateway or SIP Server are spread over multiple VLAN IP subnets. When enabling it, also fill out the Gateway IP address via which the FXO Gateway or SIP Server can be reached. One routed voice service is allowed per 8-FXS IFM.
Page: Service Endpoint Selection: Select the front ports on the involved IFMs that must be part of this service. A Voice service requires at least one analog (8-FXS) and one Ethernet (4-GC-LW, ...) port. Make sure to select the ports in nodes that are linked to a same tunnel. Selecting ports can be done in two ways:

- Via the table. The tree view can be expanded/collapsed via clicking the expand/collapse buttons. Just click the Selected checkbox to select the desired port;
- Via clicking the node icons in the network drawing, see general example in §13;

**NOTE:** Per port, an extra Info field can be filled out later on via Network Hardware → Devices → Select Node/IFM/Port → Generic → Info.

A node can have a maximum of 32767 MAC addresses. By default, per new Voice service, 256 MAC addresses will be added to each LER node of the tunnel in which the service resides (not for point-to-point tunnels). If the maximum number of MAC addresses on a node has been reached, an error warning will pop up. After this warning, you will have to decrease the number of MAC addresses in this node from the other services first via clicking the MAC limit button (see Ref. [2Eth] in Table 2 for more info). See the figure below:

**Figure 48 Voice: MAC Limit**

Page: VLAN Tagging/Untagging: Hi Provision supports VLAN processing for voice services. The Voice service is always VLAN based.

**ATTENTION:** By default, the VLAN processing behavior in this wizard page is as described previously in the ‘Service Name and Type Selection’ page in this wizard: Only forward packets (ingress and egress) with the configured VLAN ID and drop all the other packets. When changing the settings in the ‘VLAN Tagging/Untagging’ page, it will overrule the default behavior.

The possible VLAN processing actions are described in the table below. Each port in the service can be configured with its own VLAN processing. For applying the same VLAN
processing to multiple ports at once, use the button. Configure the VLAN settings and click the apply button.

### Table 11 VLAN Tagging/Untagging

<table>
<thead>
<tr>
<th>Ingress/Egress</th>
<th>Possible Actions</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ingress</td>
<td>Untagged: Drop</td>
<td>Incoming untagged Ethernet packets will be dropped.</td>
</tr>
<tr>
<td></td>
<td>Untagged: Tag and forward (&lt;configured VLAN ID&gt;)</td>
<td>Incoming untagged Ethernet packets will be tagged with the configured VLAN ID in the range [2-3699, 3802-4000] and forwarded.</td>
</tr>
<tr>
<td></td>
<td>Priority Tagged: Drop</td>
<td>Incoming priority tagged Ethernet packets will be dropped.</td>
</tr>
<tr>
<td></td>
<td>Priority Tagged: Tag and forward (&lt;configured VLAN ID&gt;)</td>
<td>Replace the priority tag (=VLAN ID 0) in the incoming Ethernet packet with the configured VLAN ID in the range [2-3699, 3802-4000] and forward it.</td>
</tr>
<tr>
<td>Egress</td>
<td>Keep Tag</td>
<td>The VLAN or Prio tag is kept when sending out the Ethernet packet (transparent transport of packets).</td>
</tr>
<tr>
<td></td>
<td>Untag</td>
<td>The VLAN or Prio tag is removed from the Ethernet packet when sending out the packet.</td>
</tr>
<tr>
<td></td>
<td>PrioTag</td>
<td>Replace the VLAN tag with a Priority tag.</td>
</tr>
</tbody>
</table>

Note: A Prio Tag is a VLAN tag with VLAN ID = 0
Note: the actions are only valid for the configured endpoints in the configured service
Note: Ingress and Egress VLAN ID: the configured VLAN ID is the same for both INGRESS and EGRESS

Figure 49 VLAN Based: VLAN Tagging/Untagging

- Page: Tunnel Selection: Allowed tunnels for this service type: point-to-multipoint, logical ring. See §11 to select the desired tunnel;
- Page: IP Configuration: Each 8-FXS module in a Voice service must be assigned an IP address to allow registration to the FXO gateway or the SIP Server later on. Fill out the IP Range Start and click the Auto Assign button. As a result, the 8-FXS modules will get an IP address assigned from this IP range. So all the phones connected to the ports within the

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same 8-FXS module have the same IP address. The phones can be differentiated based on the SIP account on application level. These automatically assigned IP addresses can be overruled or manually changed/edited.

Page: Quality of Service Parameters: QoS (=Quality of Service) is a service traffic handling process in order to provide sufficient service delivery and bandwidth for critical applications. HiProvision provides a few QoS mechanisms, based on the parameters below.

- **Priority**: configures the priority that will be assigned internally in the Dragon PTN node. 0 indicates the lowest priority (=least important). In the Dragon PTN network, higher priority traffic will be processed before lower priority traffic so that high priority traffic will not be compromised.
  - Normal (=Non-HQoS) tunnel used: priority range [0..4], default = 3.
  - HQoS tunnel used: priority is inherited from the Tunnel Application Priority [0..6], read-only.

- **Average Frame Size**: The 8-FXS IFMs convert their incoming signals from the LAN side into Ethernet packets towards the CSM. The Average Frame Size is the size of these Ethernet packets. The better you know the traffic (and its frame sizes) in your network, the better you can tune the consumed bandwidth on the WAN side. The Average Frame Size indicates the Ethernet frame size = payload + Ethernet overhead.
  - Priority >1: Average Frame Size = 64 bytes, read-only.
  - Priority <=1: Average Frame Size is configurable.

- **Additional Ethernet Port Bandwidth**: The Ethernet ports in a voice service consume a bandwidth which consists of voice channels and some additional bandwidth.
  - **Number of Voice Channels**: (default=1, maximum depends on the available bandwidth on the links) The number of voice channels that go via this port. HiProvision will reserve 100 kbps per voice channel;
  - **Additional Bandwidth (kbps)**: (default=0, maximum depends on the available bandwidth on the links) The additional or extra bandwidth that this port requires in this service to serve non-voice or different applications if any e.g. FTP server, ...
Burst Size (bytes): (default=0, maximum depends on the available bandwidth on the links) The maximum burst size in bytes that can be sent on the service via this port.

Figure 51 Voice: Quality of Service Parameters

Page: Quality of Service Parameters Detail: see §12. Leave this page as it is, defaults are OK;

Page: Service Back End Port Selection (only if Ethernet L2/L3 IFMs have been selected in the service): This page shows which Back Back End ports are used towards the CSM, in the participating L2/L3 IFMs in the Voice service. The line towards the CSM shows the bandwidth usage, 0% means all bandwidth still available on that port. Another Back End port can be selected if desired. More info on back end ports in Ref. [2Eth] in Table 2.

Figure 52 Voice: L2/L3 IFM Service Back End Port Selection

Page: Pseudo Wire Label Selection: leave this page as it is, defaults are OK;

MSTP Region Selection (only when modifying the Voice service involved in Regions/MSTP (see MSTP in Ref. [2Eth] in Table 2) and adding a L2/L3 IFM which is still part of the default MSTP Region): A configured Voice service can overlap different MSTP regions. When adding a L2/L3 IFM to this service, the IFM will run with default MSTP settings available on the IFM itself (not visible in HiProvision) and indicated by 'Default Region'. Loop protection is guaranteed via this 'Default Region'. If you want to assign this IFM immediately to an existing MSTP Region, select one from the Region drop-down list. If not, leave 'Default
Region’ selected. Later on in the MSTP wizard, you can still assign this IFM to a new or existing Region.

![Service Wizard - MSTP Region Selection](image)

**Figure 53 Voice (Modify): MSTP Region Selection**

- Page: Review: The selected service ports will be shown: if ok, click Finish, the configuration load manager will be invoked.
- Page: Load: The configuration load manager is a tool that starts and monitors the load process of a HiProvision configuration. Click the Load button to load the new HiProvision configuration into the live network. See Ref. [2Mgt] in Table 2 for more info.

**CAUTION:** While the loading to the Dragon PTN network is in progress, do not turn off, shut down or restart the HiProvision Server or Agent, since this may cause database corruption and network problems!

After this step, your customer applications connected to the front ports of the IFMs should be able to communicate over the Dragon PTN network.

### 7.2.2 Network Hardware → IFM Settings

No extra settings must be done.

### 7.2.3 Network Hardware → IFM-Port Settings

No extra settings must be done.

### 7.3 Configure Voice Protocol

#### 7.3.1 General

The Voice Protocol must be configured to configure extra service properties. An overview can be found below:
7.3.2 Prerequisite

A Voice service must have been created.

7.3.3 Configuration


Depending on the configured voice type in the service, the settings will differ:

- Remote Extension Mode: see §7.3.4;
- SIP-Server Mode: see §7.3.5;

7.3.4 Remote Extension (FXO Gateway) Mode

a. General

- See Figure 54: connections between FXS ↔ VoIP Gateway (=FXO Gateway);
- Analog phones in the Dragon PTN network are a remote extension of the public (PSTN) and/or private (PBX) telephone network. The extension is possible via a third party VoIP Gateway (e.g. Patton), in this case an FXO Gateway;
- Analog phones are connected to an FXS interface (8-FXS module);
- FXO Gateways are connected to an Ethernet interface (e.g. 4-GC-LW module);
- Voice switching and telephony feature handling between all phones are performed in the PSTN or PBX;
- DTMF (=Dual Tone Multi-Frequency) must be used for number dialing;
- Analog speech and signaling are converted and packetized by the FXS interface and the FXO Gateway towards the Dragon PTN network;

Figure 54 Voice Service Elements Overview

Analog Voice

Analog Phone

Analog Phones

FXS

11

14

FXS

12

15

VoIP Gateway

Public (PSTN, ISDN, ...)
or
Private (PBX)

VoIP Gateway

SIP Trunk

Internet

SIP Client

SIP Server / IP PBX

SIP Phone

Analog Phones

Analog Phone

Analog Phones

SIP Phone

Internet

FXS

10

11

14

ETH

ETH

ETH

VoIP Gateway

Public (PSTN, ISDN, ...)
or
Private (PBX)

VoIP Gateway

SIP Trunk

Internet

SIP Client

SIP Server / IP PBX

SIP Phone

Analog Phones

Analog Phone

Analog Phones

SIP Phone

Internet

SIP Server / IP PBX

SIP Phone
b. Configuration

- Information: Click Next>>;
- Service Selection: select the Voice service in the list for which you want extra configuration and registration settings. Only the voice services without Voice Protocol configuration yet will be listed. Click Next>>;

![Figure 55 Voice Protocol FXO: Service Selection](image)

- Service Properties:
  - DTMF Transmit Mode: DTMF is a voice-frequency signaling system that generates tones when the caller presses numbers on its phone. This field has only impact when the call has already been set up. During a call, when the caller is requested to enter some extra numbers for selecting a menu (e.g. press ‘1’ for sales, ’2’ for services etc...), the selected DTMF Transmit Mode below configures how these entered numbers are transmitted on the line. Make sure that this setting matches the setting in the FXO Gateway. Click Next>>;
  - Audio Passthrough: Transports the DTMF tones transparently inband between the two SIP endpoints, the caller and callee. The tones are encoded within the voice. When using this method, it is strongly advised to use a G711 Audio Codec (G729 could compress the tones too much resulting in unrecognized tones at the receiving side);
  - Rtp (=advised for Remote Extension (FXO Gateway)): Inband method that sends DTMF tones separately in dedicated RTP packets, distinct from audio packets.
  - Sip (=default, advised for SIP server): Inband method that sends DTMF tones separately in dedicated SIP packets, distinct from audio packets.

![Figure 56 Voice Protocol FXO: Service Properties](image)

- 8-FXS Port Properties: Each phone connected to an 8-FXS port has some properties that can be configured in this page. Click the arrow in the Device Name column to expand/collapse the node to show/hide the 8-FXS ports in this service. Configure the port property via clicking a cell in the port row and start typing to enter or select a value;
Table 12 8-FXS Port Properties (Remote Extension)

<table>
<thead>
<tr>
<th>Field</th>
<th>Values</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Device Name</td>
<td>&lt;ports&gt;</td>
<td>Shows the selected 8-FXS ports in the voice service that must be configured.</td>
</tr>
<tr>
<td>Display Name (=future support)</td>
<td>&lt;text&gt;</td>
<td>Name that must be displayed on the telephone display on the receiver side (=callee) when a call is set up.</td>
</tr>
<tr>
<td>Telephone Number</td>
<td>&lt;number&gt;</td>
<td>Telephone number that is assigned to the telephone connected to this 8-FXS port (=caller).</td>
</tr>
<tr>
<td>Auth User Name</td>
<td>&lt;text&gt;</td>
<td>User name assigned to this FXS port. This user name will be used in the SIP messages to authenticate this FXS port to the VoIP Gateway when it requests some client authentication.</td>
</tr>
<tr>
<td>Auth Password</td>
<td>&lt;text&gt;</td>
<td>Password assigned to this FXS port. This password will be used in the SIP messages to authenticate this FXS port to the VoIP Gateway when it requests some client authentication.</td>
</tr>
<tr>
<td>Audio Codec</td>
<td>G711a (=default)</td>
<td>Encoding/Decoding standards that encodes/decodes analog voice into digital data or vice versa. G711a is the preferred Codec. Fallback to one of the other Codecs is possible if the SIP-server or remote side does not support this preferred Codec.</td>
</tr>
<tr>
<td></td>
<td>G711u</td>
<td></td>
</tr>
<tr>
<td>VoIP Gateway</td>
<td>&lt;ip address&gt;</td>
<td>Default = 0.0.0.0. IP address of the VoIP Gateway (or SIP server port).</td>
</tr>
<tr>
<td>Remote SIP Port</td>
<td>&lt;number&gt;</td>
<td>Default = 5060. Indicates the remote SIP port that the VOIP Gateway is listening to for SIP traffic. The local SIP port on the 8-FXS IFM is not configurable and is by default 5060.</td>
</tr>
</tbody>
</table>

Review: if ok, click Finish. The configuration load manager will be invoked.

Load: The configuration load manager is a tool that starts and monitors the load process of a HiProvision configuration. Click the Load button to load the new HiProvision configuration into the live network. See Ref. [2Mgt] in Table 2 for more info.

CAUTION: While the loading to the Dragon PTN network is in progress, do not turn off, shut down or restart the HiProvision Server or Agent, since this may cause database corruption and network problems!

NOTE: Monitoring info available via Dashboard → (Monitoring) Protocols → Other → Voice or via Dashboard → (Monitoring) Performance → Port Performance → CSM Ethernet Port Monitoring or CSM, L2 and L3 IFM Ethernet Port Monitoring.
### 7.3.5 SIP-Server Mode

#### a. General
- See Figure 54: SIP elements like a SIP Phone and VoIP gateways can be registered on and handled by the SIP Server;
- Analog phones are connected to an FXS interface (8-FXS module) which are registered on a SIP Server;
- Voice switching and telephony feature handling for all calls are performed in the SIP Server;
- Possible SIP telephony features depend on the used SIP devices and their interoperability.

#### b. Configuration
- Information: Click Next>>;
- Service Selection: select the Voice service in the list for which you want extra configuration and registration settings. Only the voice services without Voice Protocol configuration yet will be listed. Click Next>>;

![Voice Protocol SIP: Service Selection](image)

Service Properties:
- DTMF Transmit Mode: See §7.3.4;
- Dial Plan - Translation Pattern (default = e#r*~, use Reset button to set back to default): The Dial Plan specifies how a 8-FXS IFM must interpret digit sequences dialed by the caller, and how to convert the digit input into an outgoing dial string. The rules will be applied to all the 8-FXS IFMs in the service. Optional, click the Configure button to configure a more advanced Dial Plan - Translation Pattern. NOTE: it is also possible to overwrite this field manually without using the Dial Plan wizard (for advanced users!).

![Voice Protocol SIP: Dial Plan - Translation Pattern](image)
- Internal Calls - Allowed First Digit(s): (default = no allowed first digits = no internal calls allowed) Click the numbers that are allowed as first digit when dialing a number for an internal call.
- Internal Calls - Number Length: (default = 4, range [1..10]) Fill out the allowed dialed number length for internal calls e.g. internal number 4831 has length 4.
- External Calls - Supported:
  - Checked (=default): external calls supported;
  - Unchecked: external calls not supported.
- External Calls - First Digit: (default = 0, range [0..9]) If external calls are supported, fill out the number that must be used as first digit to set up external calls.
- Activate Features via */ #:
  - Checked (=default): telephone features are activated and can be accessed via dialing first the '* or '#' key. See your SIP-server documentation to find the allowed feature codes;
  - Unchecked: telephone features are disabled.
- Example Resulting Translated Pattern: 4r*x|*r*~|*r*~|[0136]xxxs
  - 4r*x = Indicates that external calls (with first digit = 4) are supported;
  - r*~ = indicates allow any digit (0-9, a-d, *, #) until the timeout or the terminating character is found;
  - #r*~ = allows the digit string to start with '#';
  - *r*~ = allows the digit string to start with '*';
  - [0136]xxxs = Internal calls with a length of 4 characters and starting with 0, 1, 3 or 6 are allowed;

### Table 13 Translated Pattern Parameters

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>separates different possible patterns</td>
</tr>
<tr>
<td>r</td>
<td>repeat by following a number (1-9), letter (a-z for 10 to 35 times) or &quot;**, &quot;+&quot; or &quot;.&quot; to mean any number of times (255 times)</td>
</tr>
<tr>
<td>.</td>
<td>repeat previous digit any number of times (0 to 255)</td>
</tr>
<tr>
<td>+</td>
<td>repeat previous digit any number of times (0 to 255)</td>
</tr>
<tr>
<td>x</td>
<td>match any numerical digit (0-9)</td>
</tr>
<tr>
<td>~</td>
<td>match any digit (0-9, A-D, *, #) excluding any specified terminators</td>
</tr>
<tr>
<td>!</td>
<td>disallows pattern</td>
</tr>
<tr>
<td>$</td>
<td>indicates secondary dialing to follow - used only by fixed dial strings</td>
</tr>
<tr>
<td>&lt;:&gt;</td>
<td>replace group to replace left digit(s) with right digit(s)</td>
</tr>
<tr>
<td></td>
<td>selection group of candidate digits</td>
</tr>
<tr>
<td>[^]</td>
<td>exclusion group of digits</td>
</tr>
<tr>
<td>[0-9]</td>
<td>selection range of candidate numerical digits</td>
</tr>
<tr>
<td>[a-d]</td>
<td>selection range of candidate letter digits</td>
</tr>
<tr>
<td>s</td>
<td>seize on string as only candidate if match to this point</td>
</tr>
<tr>
<td>e</td>
<td>specify ending termination digit which follows (usually * or #)</td>
</tr>
<tr>
<td>f</td>
<td>pause timeout causes failure instead of dial</td>
</tr>
<tr>
<td>Parameters</td>
<td>Description</td>
</tr>
<tr>
<td>------------</td>
<td>-------------</td>
</tr>
<tr>
<td>p</td>
<td>set digit pause to number of seconds which follow (1-9) for current pattern</td>
</tr>
<tr>
<td>t</td>
<td>set digit timeout to default for current pattern</td>
</tr>
<tr>
<td>&lt;space&gt;</td>
<td>human readable spacing which is ignored</td>
</tr>
</tbody>
</table>

8-FXS Port Properties: Each phone connected to an 8-FXS port has some properties that can be configured in this page. Click the arrow in the Device Name column to expand/collapse the node to show/hide the 8-FXS ports in this service. Configure the port property via clicking a cell in the port row and start typing to enter or select a value;

![Figure 60 Voice Protocol SIP: 8-FXS Port Properties](image)

<table>
<thead>
<tr>
<th>Field</th>
<th>Values</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Device Name</td>
<td>&lt;ports&gt;</td>
<td>Shows the selected 8-FXS ports in the voice service that must be configured.</td>
</tr>
<tr>
<td>Display Name (=future support)</td>
<td>&lt;text&gt;</td>
<td>Name that must be displayed on the telephone display on the receiver side (=callee) when a call is set up.</td>
</tr>
<tr>
<td>Telephone Number</td>
<td>&lt;number&gt;</td>
<td>Telephone number that is assigned to the telephone connected to this 8-FXS port (=caller).</td>
</tr>
<tr>
<td>Auth User Name</td>
<td>&lt;text&gt;</td>
<td>User name assigned to this FXS port. This user name will be used in the SIP messages to authenticate this FXS port to the SIP Server when it requests some client authentication.</td>
</tr>
<tr>
<td>Auth Password</td>
<td>&lt;text&gt;</td>
<td>Password assigned to this FXS port. This password will be used in the SIP messages to authenticate this FXS port to the SIP Server when it requests some client authentication.</td>
</tr>
<tr>
<td>Audio Codec</td>
<td>G711a (=default) G711u, G729</td>
<td>See Table 12.</td>
</tr>
<tr>
<td>Use Hot Line Dialing</td>
<td>Yes/No</td>
<td>Hotline means that if you pick up a phone or initiate a call, an immediate direct connection will be set up with the configured ‘Hot Line Dialing Number’ without the need of manual dialing a number yourself. A client that has a hotline configured will not be able to call any other number besides the hot line number.</td>
</tr>
<tr>
<td>Hot Line Dialing Number</td>
<td>&lt;number&gt;</td>
<td>Default = empty. Indicates the number that must be dialed when a client with 'Use Hot Line Dialing=Yes' picks up a phone to initiate a call.</td>
</tr>
</tbody>
</table>
Use Call Waiting
(future use)
Yes/No
No (=default): The call waiting feature is disabled on this client. This client cannot accept a second call when a first call is already in progress.
Yes: The call waiting feature is enabled on this client. This client can temporarily suspend or set on hold the first call to accept a second incoming call. This client can switch between the two calls.

SIP Server
<ip address>
Default = 0.0.0.0. IP address of the SIP Server.

SIP Server (R)
<ip address>
Default = 0.0.0.0. IP address of the Redundant SIP Server.

Registration Server
(future use)
<ip address>
Default = 0.0.0.0. IP address of the Registration Server. Current behavior: Registration will be done on the SIP Server.

Registration Server (R)
(future use)
<ip address>
Default = 0.0.0.0. IP address of the Redundant Registration Server. Current behavior: Registration will be done on the SIP Server.

Remote SIP Port
<number>
default = 5060. Indicates the remote SIP port that the SIP server is listening to for SIP traffic. The local SIP port on the 8-FXS IFM is not configurable and is by default 5060.

Review: if ok, click Finish. The configuration load manager will be invoked.

Load: The configuration load manager is a tool that starts and monitors the load process of a HiProvision configuration. Click the Load button to load the new HiProvision configuration into the live network. See Ref. [2Mgt] in Table 2 for more info.

CAUTION: While the loading to the Dragon PTN network is in progress, do not turn off, shut down or restart the HiProvision Server or Agent, since this may cause database corruption and network problems!


7.4 Modify Service/Protocol

After service/protocol creation, this service/protocol can be modified if needed via:

Service: Dashboard → Configuration → Connections → Services → select service → ;
Protocol: Dashboard → Configuration → Protocols → Protocol Categories → Other → Voice Protocol → select protocol in the protocols list ;

7.5 Delete Service/Protocol

After service/protocol creation, this service/protocol can be deleted if needed via:

Service: Dashboard → Configuration → Connections → Services → select service → ;
Protocol: Dashboard → Configuration → Protocols → Protocol Categories → Other → Voice Protocol → select protocol in the protocols list ;

NOTE: A service can only be deleted if its linked protocol has been deleted first.

7.6 Troubleshooting

The protocols monitor can help in troubleshooting. See §7.7.5.
7.7 Monitoring

7.7.1 (Configuration) Network Hardware Tile

None.

7.7.2 (Configuration) Connections Tile

What has been configured via the service wizard can also be viewed via Dashboard → Connections → Services → select service in the list. Some extra tabs (Service, Voice, VLAN Tagging/Untagging/Address Assignments) with service configuration data will be shown.

Figure 61 (Configuration) Connections Tile: Voice

7.7.3 (Configuration) Protocols Tile

Below, you can find the voice protocols monitor via Dashboard → (Configuration) Protocols → Protocol Category → Other → Voice Protocol → Select Protocol....
7.7.4  (Monitoring) Network Tile

Live service data can be monitored via the Dashboard → Network → Services → select service in the list. The service will be shown in the network drawing. Click to show extra monitoring properties for this service. Click to show the used nodes/links/tunnels.

NOTE:  No extra monitoring info in the Dashboard → Network → Protocols available.

7.7.5  (Monitoring) Protocols Tile

Below, you can find the voice protocols monitor via Dashboard → (Monitoring) Protocols → Protocol Category → Other → Voice Protocol → Select Protocol....
7.7.6 Performance Counters

The used Ethernet ports (either 4-GC-LW ... via CSM, or L2/L3) in this service can be monitored. Go to Dashboard → (Monitoring) Performance → Counter Control → Service Performance → ‘CSM Ethernet Port Monitoring’ or ‘L2 and L3 IFM Ethernet Port Monitoring’. See figure below.

A detailed and similar monitoring set-up description (adding counters to graphs etc...) can be found in ‘Port Performance’ → ‘CSM Ethernet Port Monitoring’ in Ref. [2Net] in Table 2.

7.7.7 HiProvision Add-on: Generic Reporting Engine

Service and port reporting information is available via the Reporting Engine Add-on, see Ref.[24] in Table 2.
7.7.8 MAC Monitor

The MAC Monitor will show the MAC address table of the selected Node (=CSM). This table includes all MAC addresses used on this device except for the MAC addresses that are used in a point-to-point tunnel. More information can be found in Ref. [2Eth] in Table 2.

MAC Monitor via: Dashboard → (Monitoring) Network → Services → ;

8. SHDSL (VIA ETHERNET)

8.1 General

Supported IFMs: 4-DSL-LW, more information on this IFM can be found in Ref. [8] in Table 2.

In a general SHDSL link setup between a customer and network side, one link partner must act as the CO (=Central Office) and the other link partner must act as the CPE (=Customer Premises Equipment). Within the Dragon PTN solution, the 4-DSL-LW module is by default configured as CO. If both SHDSL link partners are configured in the same device mode, the SHDSL link will not synchronize and as a result will not come up. A general SHDSL example can be found in the figure below.

![Figure 66 General SHDSL Example](image)

8.2 Configure Service

8.2.1 Service Wizard

To transport SHDSL, an Ethernet service must be configured. Configuring this service in the service wizard is exactly the same as described in the ‘Ethernet Services manual’, see Ref.[2Eth] in Table 2.
8.2.2 Network Hardware → IFM Settings

After configuring the service via the service wizard, all IFM settings will be set according to the service configuration. Some individual IFM settings might need extra tuning or must be overruled. Find IFM settings via Network Hardware → Devices → 4-DSL-LW. Following two parameters can be configured (description further below):

- Unit Type.
- PAF Mode;

![Image of IFM settings configuration]

Figure 67 4-DSL-LW IFM: Unit Type/PAF Mode

a. Unit Type (=Device Mode)

In a general SHDSL link setup between a customer and network side, one link partner must act as the CO (=Central Office) and the other link partner must act as the CPE (=Customer Premises Equipment). Within the Dragon PTN solution, the 4-DSL-LW module is by default configured as CO. If both SHDSL link partners are configured in the same device mode, the SHDSL link will not synchronize and as a result will not come up.

The powering of the 2-OLS IFM can be configured by the ‘Forced Power Mode’. The setting of this parameter determines whether a CSM is required in the node for powering the 2-OLS IFM. Go to Network Hardware → Devices → 4-DSL-LW → Specific → Unit Type.

The ‘Device Mode’ (CO or CPE) of the 4-DSL-LW module depends on the configuration in HiProvision and some DIP switch settings in on the IFM (see Ref. [3] in Table 2).

The ‘Device Mode’ configuration in HiProvision will always be the master setting. In HiProvision, configure the ‘Unit Type’ parameter on IFM level as follows:

- CO: Unit Type = ‘LT Unit’; (LT = Line Termination);
- CPE: Unit Type = ‘NT Unit’; (NT = Network Termination);

Only when there is nothing configured in HiProvision for this IFM, the DIP switch settings on the IFM board itself come into play.
b. PAF Mode

- PAF: PME Aggregation Function;
- PME: Physical Medium Entities.

PAF or Bonding is a technique where multiple SHDSL links, connected to the 4-DSL-LW module, are combined into one logical link. This results in redundancy and a higher bandwidth for the resulting combined link. Within the SHDSL link, bonding must be configured on either the CO or the CPE, see Table 15. The link partner without bonding configured will slave and negotiate with the link partner that has bonding configured. After the bonding has been negotiated between the CO and CPE, the bonded SHDSL links come up. Different line rates are possible within the bonded links, but the difference between the fastest and slowest link must be less than 4 Mbps. SHDSL ports can be combined or bonded in HiProvision as indicated in Table 15.

**NOTE:** When using the SHDSL link as LAN, make sure to configure the local and the remote LAN SHDSL links with the same bonding or PAF mode;

### Table 15 Bonding Combinations

<table>
<thead>
<tr>
<th>Bonding Mode</th>
<th>PAF Mode in HiProvision</th>
<th>Must be Configured on</th>
<th>Port1</th>
<th>Port2</th>
<th>Port3</th>
<th>Port4</th>
</tr>
</thead>
<tbody>
<tr>
<td>No Bonding</td>
<td>NotInService (=default)</td>
<td>---</td>
<td>Single</td>
<td>Single</td>
<td>Single</td>
<td>Single</td>
</tr>
<tr>
<td>2 links</td>
<td>34</td>
<td>CO (or LT)</td>
<td>Single</td>
<td>Single</td>
<td></td>
<td>Bonding (P4)</td>
</tr>
<tr>
<td>3 links</td>
<td>234</td>
<td>CO (or LT)</td>
<td>Single</td>
<td></td>
<td></td>
<td>Bonding (P4)</td>
</tr>
<tr>
<td>4 links</td>
<td>1234</td>
<td>CO (or LT)</td>
<td></td>
<td></td>
<td>Bonding (P4)</td>
<td></td>
</tr>
<tr>
<td>2 + 2 links</td>
<td>12 and 34</td>
<td>CPE (or NT)</td>
<td>Bonding (P2)</td>
<td></td>
<td>Bonding (P4)</td>
<td></td>
</tr>
</tbody>
</table>

Single: No bonding is active on this port;
Bonding (Px): The bonding aggregation is internally mapped on ‘Port x’; Only ‘Port x’ must be used when configuring the service in HiProvision;

When changing the bonding or PAF mode, in some cases the bonded SHDSL links will go down until the new mode has been negotiated again between the CO and CPE.

- Changing the bonding from ‘2 + 2 links’ to another mode;
- Changing the bonding from ‘4 links’ to ‘3 links’ or ‘2 links’;
- Changing the bonding from ‘3 links’ to ‘2 links’;

### 8.2.3 Network Hardware \(\rightarrow\) IFM-Port Settings

After configuring the service via the service wizard, all port settings of the endpoints in this service will be set according to the service configuration. Some individual port settings might need extra tuning or must be overruled. Go to Network Hardware \(\rightarrow\) Devices \(\rightarrow\) 4-DSL-LW \(\rightarrow\) 4-DSL-LW port.
a. **Line Probing**

Enable the parameter ‘Line Probing’. As a result, the port will automatically check the quality of the SHDSL link. The port will automatically decide which is the best possible bandwidth or Line rate for the available SHDSL link.

![Image](Figure 68 4-DSL-LW IFM: Line Probing)

b. **ShdslMinLineRate**

Configure the SHDSL Minimum Line Rate (range [192...5696] kbps). The default value is 192 kbps. It can be configured in steps of 64 kbps.

c. **ShdslMaxLineRate**

Configure the SHDSL Maximum Line Rate (range [192...5696] kbps). The default value is 5696 kbps. It can be configured in steps of 64 kbps.

d. **PAM Mode**

The line coding or PAM (Pulse Amplitude Modulation) can be configured. When the value is changed, the link has to be disabled and enabled again.

- **PAM Mode:**
  - Auto Select (=default);
  - 16 Pam: uses 3 bits (16 codes) for encoding, possible between 192-3840kbps;
  - 32 Pam: uses 4 bits (32 codes) for encoding, possible between 768-5696kbps;

e. **Region**

The Region can be configured. When the value is changed, the link has to be disabled and enabled again.
f. Forced Power Back Off Mode (No/Yes) / Power Back Off Value (0..31) (Future)
(Future support) The power back off algorithm enables 4-DSL-LW IFMs to adjust transmit power according to conditions on the line. Operators can use this feature to manage and reduce crosstalk noise on the network. When the value is changed, the link has to be disabled and enabled again.

- Yes: Lower the transmitter power level of the modem with the ‘Power Back Off Value’. This reduces interference to other transmission systems operating on adjacent pairs bundled in the same cable. The transmit power will be reduced adaptively in function of the estimated cable attenuation.
- No: do not lower the transmitter power;

g. Estimated Power Loss (Enable/Disable) (Future)
Future support.

8.3 Troubleshooting: Test and Loopback
This service can be tested via loopback settings on port level in the Network Hardware tab. See §14 for setting up loopbacks on the 4-DSL-LW IFM ports.

8.4 Monitoring

8.4.1 (Configuration) Network Hardware Tile
The SHDSL link status can be verified via the port settings. Go to Dashboard → (Configuration) Network Hardware → Devices → select IFM → select port → Specific:

- Link State: The link should come up. As a result, the link status should indicate ‘up’.
- SNR: as a result of the line probing, the signal-to-noise ratio (=SNR) will be filled out automatically in dB. SNR is an indication of the quality of the signal on the SHDSL link. If the quality or the SNR is too poor, the SHDSL link will not come up. The longer the SHDSL link, and the higher the automatically selected line rate due to line probing, the lower the SNR will be. Make sure that the SNR is at least 6dB or higher. If the measured SNR is lower than 6dB, disable ‘Line Probing’ and set the Maximum Line Rate lower, until SNR is higher than 6dB.
8.4.2 Other

Other monitoring info ethernet service related and is similar to the monitoring info in the manual Ref.[2Eth] in Table 2.

9. SMART SFP

9.1 General

Smart SFP is a hot-pluggable optical transceiver that converts incoming STM/OC frames from a fiber-optic SDH/SONET network into Ethernet frames or vice versa for outgoing frames. This conversion occurs at ports or IFMs that support smart SFP, see Ref.[14] in Table 2.

Smart SFPs must be used in a point-to-point (1st/2nd Smart SFP, see figure below) port based Ethernet service over Dragon PTN.

As a result, Dragon PTN allows to transparently transport synchronous digital bit streams from an SDH/SONET network via the IFMs that support smart SFP. The available Smart SFPs can be found in Ref. [14] in Table 2.

For clocking/synchronization, SyncE (see Ref. [2Net] in Table 2) must be configured in the nodes that have Smart SFPs plugged in.
9.2 Configure Service and Monitor

Prerequisite: Make sure to have two Smart SFPs (with the right speed, see Ref. [14] in Table 2) plugged in somewhere in the Dragon PTN network in an IFM that supports smart SFP. These ports must have been configured as LAN port.

1. Configure SyncE (see Ref. [2Net] in Table 2) in the nodes that have plugged in the Smart SFPs;
2. In HiProvision, configure a point-to-point port based Ethernet service with these two Smart SFP ports.

   ▶ Click Dashboard → Configuration → Connections → Services → + to open the services wizard. See figure below. The services wizard opens. The list below summarizes every page in the wizard.

   ![Figure 2 Create Services](image)

   ▶ Page: Information: Click Next>>;
   ▶ Page: Service Name and Type Selection:
     ▶ Service Name: enter a name for your service.
     ▶ Service Type: Ethernet;

   ![Figure 3 Smart SFP: Ethernet Service Type / Port Based](image)
Page: Service Endpoint Selection: Select the front ports on the involved IFMs that must be part of this service. Make sure to select the ports in nodes that are linked to a same tunnel. Selecting ports can be done in two ways:
- Via the table. The tree view can be expanded/collapsed via clicking the expand/collapse buttons. Just click the Selected checkbox to select the desired port;
- Via clicking the node icons in the network drawing, see general example in §13;

**NOTE:** Per port, an extra Info field can be filled out later on via Network Hardware → Devices → Select Node/IFM/Port → Generic → Info

Page: VLAN Tagging/Untagging: leave this page as it is, defaults are OK.

Page: Tunnel Selection: Allowed tunnels for this service type: a normal point-to-point tunnel without HQoS. See §11 to select the desired tunnel;

Page: Quality of Service Parameters: Configure the exact values below:
- Priority = 1
- Maximum Frame Size = 1522 bytes (=default)
- Frame Size Mode = custom frames;
- Small Frame = 1% : 64 bytes;
- Custom Frame = 99%: 848 bytes;
- Large Frame = 0%;
- Bandwidth & Burst Size Mode: Endpoint Based;

Page: Quality of Service Parameters Detail: see §12. Leave this page as it is, defaults are OK;

Page: Pseudo Wire Label Selection: leave this page as it is, defaults are OK;

Page: Review: The selected service ports will be shown: if ok, click Finish, the configuration load manager will be invoked.

Page: Load: The configuration load manager is a tool that starts and monitors the load process of a HiProvision configuration. Click the Load button to load the new HiProvision configuration into the live network. See Ref. [2Mgt] in Table 2 for more info;

**CAUTION:** While the loading to the Dragon PTN network is in progress, do not turn off, shut down or restart the HiProvision Server or Agent, since this may cause database corruption and network problems!

After this step, your customer applications connected to the front ports of the IFMs should be able to communicate over the Dragon PTN network.

3. If your Smart SFPs are plugged in and the port is up, HiProvision must show both basic SFP and Smart SFP info after selecting the ports, see figure below. Also the Link Active (LA) LED of the IFM will blink immediately after plugging in the Smart SFPs.

4. Each Smart SFP has its own MAC address. It is possible to add extra security to the point-to-point connection. You can configure that the 1st Smart SFP only communicates with the 2nd one and vice versa. This can be done by filling out the **Destination MAC Address** of the...
other Smart SFP and setting the **Destination MAC Check** to **true**. This must be done on both Smart SFPs. As a result, if you plug in another Smart SFP with another MAC address, the point-to-point connection will not work anymore.

5. Connect your two fiber-optic SDH/SONET points to the Smart SFPs;

6. If your link is up and running, the 'TSoP Tx/Rx' counters increase (refresh rate takes a few seconds). Counters can be cleared via the 'Clear Counters' drop down.

7. If you think the link is not up and running, you could reboot the smart SFP by selecting a warm (=no traffic loss) or a cold (=traffic loss) reboot in the 'Reboot' dropdown.

![Figure 4 Example: Smart SFPs in Hi Provision](image)

### 9.3 Alarms

Some alarms are provided which can be found in the table below.

<table>
<thead>
<tr>
<th>Condition</th>
<th>Alarm 1st Smart SFP</th>
<th>Alarm 2nd Smart SFP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pull out Rx at 1st Smart SFP</td>
<td>Loss Of Signal, Rx Loss Of Frame</td>
<td>Tx Loss Of Frame, No TDM Payload</td>
</tr>
<tr>
<td>Pull out Tx at 1st Smart SFP</td>
<td>no alarms</td>
<td>no alarms</td>
</tr>
<tr>
<td>Pull out Rx &amp; Tx at 1st Smart SFP</td>
<td>Loss Of Signal, Rx Loss Of Frame</td>
<td>Tx Loss Of Frame, No TDM Payload</td>
</tr>
<tr>
<td>Stop Ethernet traffic going to 1st Smart SFP</td>
<td>Local Packet Loss, Tx Loss Of Frame</td>
<td>Remote Packet Loss</td>
</tr>
<tr>
<td>Pull out WAN link between two Dragon PTN nodes</td>
<td>Local Packet Loss, TX Loss Of Frame</td>
<td>Local Packet Loss, TX Loss Of Frame</td>
</tr>
<tr>
<td>Pull out 1st Smart SFP</td>
<td>no alarms</td>
<td>Tx Loss Of Frame, No TDM Payload, Local Packet Loss</td>
</tr>
</tbody>
</table>
## 10. SERIAL BITRATES

<table>
<thead>
<tr>
<th>Service Type</th>
<th>Local Mode</th>
<th>Serial Ethernet</th>
<th>Circuit Emulation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Protocol</td>
<td>Optical Low Speed Serial</td>
<td>---</td>
<td>Serial</td>
</tr>
<tr>
<td>Usage</td>
<td>---</td>
<td>---</td>
<td>SAToP/CESoPSN</td>
</tr>
<tr>
<td>Mux/Demux</td>
<td>---</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Bitrate (bps)</td>
<td>1200</td>
<td>2400</td>
<td>4800</td>
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<tr>
<td></td>
<td>2400</td>
<td>4800</td>
<td>9600</td>
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<td></td>
<td>76800</td>
<td>115200</td>
<td>297600</td>
</tr>
</tbody>
</table>

(*) With these selected bitrates, the V.110 standard will be used to transport the serial streams over the Dragon PTN network. Note: The BERT generator on the 4-E1-L IFM port1 does not support these V.110 speeds.
11. WIZARD PAGE: TUNNEL SELECTION

11.1 General

> Prerequisite: tunnels must have been created. See Ref. [2Net] in Table 2 for more info.
Different tunnel types are possible:
> Point-to-Point; MultiPoint; Logical Ring; Subring;

A service connects front ports on one side of the tunnel to the front ports on the other side of the tunnel. The service can be programmed within one tunnel or within multiple combined tunnels with each tunnel already configured before. See figures below:

**Figure 5 Service Creation in Tunnels**

**NOTE:** A maximum of eight services can be programmed per tunnel;

**NOTE:** If one tunnel cannot cover the required service path, multipoint, logical ring and subring tunnels can be combined into one big tunnel to provide the path. Tunnels must be combined in a Tunnel Combination Point, which is a node in which one tunnel ends and the other tunnel starts, see figure below.

**Figure 6 Service Via Combined Tunnels**
11.2 Tunnel Selection

Select the required tunnel(s) from the available tunnels list, via checking the ‘Selected’ checkbox, to transport your configured service. See figure below.

Tunnels list: The allowed or shown tunnels in the tunnel list depend on your service type.

Table 3 Allowed Tunnel Types per Service Type

<table>
<thead>
<tr>
<th>Service Type</th>
<th>Point-to-Point</th>
<th>MultiPoint</th>
<th>Logical Ring</th>
<th>Subring</th>
</tr>
</thead>
<tbody>
<tr>
<td>Smart SFP (Ethernet)</td>
<td>✓</td>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>Voice</td>
<td>---</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Serial Ethernet</td>
<td>---</td>
<td>✓</td>
<td>---</td>
<td>✓</td>
</tr>
<tr>
<td>Circuit Emulation</td>
<td>✓</td>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>Local Mode (no tunnel needed)</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
</tbody>
</table>

✓ = allowed; --- = not allowed/not possible

Note: A service can only use either a normal (=Non-HQoS) or HQoS tunnel, but not a mix of both.

Match (x/y):
- x: number of reachable service ports (or termination points) via this tunnel;
- y: number of selected service ports (or termination points);
- Perfect match: e.g. 2/2: all the selected service ports belong to nodes that are all linked to this tunnel. This tunnel can transport the service;
Mismatch: e.g. 1/2: at least one of the selected service ports belongs to a node that is not linked to this tunnel. A single selected tunnel with a mismatch cannot transport the required service;

Selected: checkbox to select the tunnel.

One tunnel: If only one tunnel is selected, this tunnel has to have a perfect match to transport the required service;

Combined tunnels: multiple tunnels can be selected or combined (by just selecting them in the tunnel list) into one big tunnel to transport the required service. It is possible to combine single tunnels with a mismatch into one big combined tunnel that has a perfect match for the entire service. Point-to-point tunnels cannot be combined, see Figure 6;

NOTE: If no more tunnel with a perfect match is available in the tunnels list, it is also possible to create a new tunnel via clicking +. In doing so, the tunnel wizard will automatically select the needed devices for this service. After closing the tunnel wizard, the new tunnel will automatically appear in the tunnel list;

![Diagram of tunnel selection](image)

**Figure 8 Selected Highlighted Tunnel**

### 12. WIZARD PAGE: QUALITY OF SERVICE PARAMETERS DETAIL (READ-ONLY)

**CAUTION:**
When the real or measured average frame size is reasonably lower than the configured average frame size, extra delay and/or frame loss can occur! Frame loss can be detected and verified via the 'Disc In Packets'/ 'Disc Out Packets' counters, see 'Port Performance' → 'CSM Ethernet Port Monitoring' in Ref. [2Net] in Table 2.
When the real or measured average frame size is reasonably higher than the configured average frame size, a lower BWE will be obtained but traffic will not be influenced.

12.1 General

After configuring the ‘Quality of Service Parameters’ page in the service wizard and clicking Next>>, the page with ‘Quality of Service Parameters Detail’ shows up. See figure below. This
page by default shows a nice overview of the bandwidth and burst size usage of your configured service through the network.

Some values are configured, others are calculated by HiProvision based on the configured values. E.g. if the service values are configured, the according service port values will be calculated automatically. Both configured and calculated values are visible in both the network drawing and tables in the Ports and LSPs tabs.

**CAUTION:** For legacy services, this ‘Quality of Service Parameters Detail’ must not be adapted. The Ports and LSPs values should remain as calculated by HiProvision. Changing these values could result in packet loss.

12.2 Filtering Tables

When a lot of nodes and/or links are in the network or in the tables, scrolling through the table records and comparing values of some records can sometimes be hard. Therefore to

**Figure 9 Bandwidth/Burst Size Parameters in Detail**

**Figure 10 Graphic View Option Buttons**

- Filter button \(\checkmark\): see §12.2.
- Clear Selection button \(\square\): clears selected rows in the Ports/LSPs tab.
- Advanced button \(\square\): not relevant for legacy services, do not use.
- BandwidthMatch button \(\square\): not relevant for legacy services, do not use.
avoid too much scroll work, you can easily filtering out your needed Ports/LSPs to show less records.

12.2.1 Filtering Nodes/Ports

- Via network drawing: Just click one node or one port in the network drawing. The Ports tab becomes active, with the clicked node or port filtered out. Note: Multiple select is not possible via the network drawing.
- Via table: Just click/select the port (device name column) in the Ports tab and click \( \checkmark \). Multiple records can be selected via holding the CTRL or SHIFT key and clicking/selecting ports followed by clicking \( \checkmark \).
- If you made a wrong selection, just click the \( \square \) button to clear the selection.
- Disable the filtering (and show all records) by just clicking the highlighted \( \checkmark \) again.

12.2.2 Filtering Links (or LSPs)

- Via network drawing: Just click the link in the network drawing. The LSPs tab becomes active, with the clicked link filtered out. Note: Multiple select is not possible via the network drawing.
- Via table: Just click/select the LSP (direction column) in the LSPs tab and click \( \checkmark \). Multiple records can be selected via holding the CTRL or SHIFT key and clicking/selecting LSPs followed by clicking \( \checkmark \).
- If you made a wrong selection, just click the \( \square \) button to clear the selection.
- Disable the filtering (and show all records) by just clicking the highlighted \( \checkmark \) again.

12.3 Values on the Network Drawing

![Figure 11 Bandwidth/Burst Size on WAN Side](image)

- [1] = Node input: for this service, a useful bandwidth of 1274 kbps is available from link \( \rightarrow \) node;
- [2] = Node input: for this service, a gross bandwidth of 1712 kbps and gross burst size of 172 bytes is available from link \( \rightarrow \) node;
- [3] = Node output: for this service, a useful bandwidth of 1274 kbps is available from node \( \rightarrow \) link;
- [4] = Node output: for this service, a gross bandwidth of 1712 kbps and gross burst size of 172 bytes is available from node \( \rightarrow \) link;
Figure 12 Bandwidth/Burst Size on LAN Side

[1] = Node input: for this service, a useful bandwidth of 1360 kbps and a useful burst size of 128 bytes is available from application → node;

12.4 (Service) Bandwidth Already Configured on WAN Links

CAUTION: ‘Bandwidth’ in this paragraph always refers to the configured bandwidth!

12.4.1 General

If you want to configure new services, it is always nice to know how much bandwidth has been reserved (or configured) already on the link or how much is still available. This paragraph shows all the info you need to about bandwidth usage within Dragon PTN, in order to configure it as efficiently as possible.

WAN links in the Dragon PTN network are Ethernet 1G, 10G or 40G links. They can carry 1, 10 or 40 Gbps in both directions on the link.

Max. Service Bandwidth = Max. WAN link bandwidth – Reserved bandwidth

Max. Service Bandwidth = Maximum available bandwidth on a link that a Dragon PTN user can configure in HiProvision when programming an Ethernet service. It also means that no other services are configured yet on this link.

Max. WAN Link Bandwidth = Link Capacity:

The Link Capacity is by default the same as the original bandwidth of the selected link type (1 Gbps, 10 Gbps or 40 Gbps links). However, the Link Capacity can be downscaled to a lower bandwidth if desired, see Link Capacity in Ref. [2Net] in Table 2.

Reserved Bandwidth depends on:

DCN Channel Bandwidth: The DCN channel bandwidth is by default 40 Mbps but can be downscaled to 1.5 Mbps if desired. It is advised to keep 40 Mbps. See DCN Channel in Ref. [2Net] in Table 2.

Configured Average Frame Size: Small Frames (64 bytes) is more overhead than Large Frames (1522 bytes).

MACsec (1-10G-LW): A link with MACsec on has more overhead than a link with MACsec off;

PHY Mode setting (LAN/WAN) (1-10G-LW): WAN setting has more overhead;

The less reserved bandwidth, the more service bandwidth can be configured for applications.
Point-to-point service: a service bandwidth of ‘x’ Mbps on the link automatically results in a possible endpoint bandwidth of ‘y’ Mbps on the access port and vice versa.

- ‘x’ = service bandwidth including ‘L2 Ethernet Frame’ data and MPLS-TP overhead;
- ‘y’ = endpoint bandwidth including only ‘L2 Ethernet Frame’ data;
- ‘y’ is always less than ‘x’ with the maximum of ‘x’ depending on all the existing overhead described above;

By default, the service bandwidth is configured the same in both directions, but can be tuned individually if desired.

The maximum bandwidth on the link is in both directions.

### 12.4.2 Connections Tab

#### a. Overview

Via the Connections tab, the bandwidth occupation (% color) can be shown per link. Click a link in the Links table (see figure) to show the network drawing. The link is encircled in the network drawing and a cross-section of that link with all its details is split out at the bottom section. The link colors indicate the bandwidth occupation severity, which can be adapted via the color slider.

![Figure 13 Connection Tab: Bandwidth Information](image)

### b. Link Bandwidth Occupation: Percentage, Status Color

- Percentage label:
  - x%: used bandwidth, x percent of the available link bandwidth;
In the network drawing: If a percentage label hides another percentage label of an underlying link, the top label can be dragged aside after having it clicked first;

In the network drawing: clicking the button relayouts the percentage labels on the link;

Status color = color indication of the bandwidth occupation percentage. The list below shows the colors for the default occupation ranges. The ranges can be modified via the color sliders:
- green (0-30%): low;
- orange (30-60%): medium;
- red (60-80%): high;
- dark red (80-100%): critical;

In the figure below, the selected link shows all its tunnels including all its configured services. Each service also shows its bandwidth. The total bandwidth for the link in one direction from Node x → Node y, is the sum of the DCN bandwidth and all individual service bandwidths in that link in that direction, see figures below.

The ‘Min. Total Link Bandwidth’ including DCN: Indicates the minimum bandwidth that the configured services can address when consuming the bandwidth in the least efficient way (small packets, frame size = 64 bytes). As a result, when programming an additional service in a more efficient way (e.g. frame size = 500 bytes), this value will increase. The more efficient you use the bandwidth, the more total bandwidth can be consumed.

The bandwidth occupation for this link in this direction is 65% (= 543.6/841.937). This results in a red status color for the link according to the color slider settings. The used DCN bandwidth is also shown and depends on the link type, see Ref. [2Net] in Table 2.

**Figure 14 Bandwidth Percentage Label and Status Colors**

c. **Link Details**

In the figure below, the selected link shows all its tunnels including all its configured services. Each service also shows its bandwidth. The total bandwidth for the link in one direction from Node x → Node y, is the sum of the DCN bandwidth and all individual service bandwidths in that link in that direction, see figures below.

The ‘Min. Total Link Bandwidth’ including DCN: Indicates the minimum bandwidth that the configured services can address when consuming the bandwidth in the least efficient way (small packets, frame size = 64 bytes). As a result, when programming an additional service in a more efficient way (e.g. frame size = 500 bytes), this value will increase. The more efficient you use the bandwidth, the more total bandwidth can be consumed.

The bandwidth occupation for this link in this direction is 65% (= 543.6/841.937). This results in a red status color for the link according to the color slider settings. The used DCN bandwidth is also shown and depends on the link type, see Ref. [2Net] in Table 2.
NOTE: The grey (=zoom in) ‘eye icon’ becomes visible when hovering over the tunnel or the service pipes. Click this icon to zoom in. It also shows more detailed information in the right-hand side of the Connections Tab. After zooming in, the black (=zoom out) ‘eye icon’ becomes visible. Click this icon to zoom out again. Hovering over the labels in the figure below will zoom in the labels for a better view.

**Figure 15 Link Details**

d. **Two Bandwidth Directions in one Link**

The bandwidths for a service is by default the same in both directions, but can be tuned differently if desired at service creation time. In the figure below, the thicker a pipe (link, tunnel or service), the more bandwidth it reflects. If the pipe of ‘service x’ is thicker in one direction than the other, it means that both directions have different bandwidths. The resulting link color is the severest status color of both directions (e.g. red is more severe than green). Also the highest percentage value of both directions will be taken.
13. WIZARD PAGE: SERVICE ENDPOINT SELECTION VIA NETWORK DRAWING

This general example shows how to select service endpoints or ports on a 9-L3A-L IFM (= L3 IFM) via clicking the node icons in the network drawing. This way of working is similar for all services (Serial Ethernet, Circuit Emulation...) and IFM types (4-GC-LW, 7-SERIAL, 4-E1-L/4-T1-L, ...). Below this figure, all possible port icons and colors are explained. Not all port icons are available for all IFM types, but this list just shows a total overview.

Figure 16 Highest Value and Severest Color

Figure 17 Example: Service EndPoint Selection via Network Drawing
A port icon overview can be found below:

- **brown LAN port** = available for this service, the port number is shown in the port icon when hovering over it;
- **brown bold LAN port** = selected for this service;
- **white LAN port** = unavailable for this service, cannot be selected (correct port type but already taken by another service or wrong port type);
- **white filled WAN port** = Cannot be selected. In most of the cases, available means not taken at all by any service. In case of an Ethernet IFM (see Ethernet service in Ref. [2Eth] in Table 2) it could mean a VLAN port as well which has already one or more VLAN based Ethernet services configured;

- **Only on L2/L3 IFMs (see also Ref. [2Eth] in Table 2 for more info):**
  - **brown LAG port** = available for this service;
  - **brown LAG port** = selected for this service;
  - **white LAG port** = unavailable for this service, cannot be selected (correct port type but already taken by another service or wrong port type);

- **Only on L3 IFMs (see also Ref. [2Eth] in Table 2 for more info):**
  - **brown router**: available VRF (=Virtual Routing and Forwarding) port which can be included in the service. Click this icon if this service must only reach possible virtual router and not the front ports in this IFM. If you click this icon, the front ports on this IFM will become unavailable for this service and vice versa.
  - **white router**: 1) unavailable VRF port for this service because already included in another service... or 2) automatic included VRF port because normal L3 IFM LAN ports are selected for this service in this IFM.

#### 14. TEST & LOOPBACK CONFIGURATION

##### 14.1 General

Test and Loopback self-tests can be performed in all Circuit Emulation services (=CES) or in the 4-DSL-LW Ethernet service or in the Serial Ethernet service, e.g. when configuring or troubleshooting a service. The available self-test functions are listed below. Where these functions are supported is listed in Table 4.

- **Loopbacks**: on backplane or front port both supporting two directions: towards line (=application) or network;
- **BERT**: test traffic generation and verification = Bit Error Ratio Tester;
- **Tone Generation/Level Metering**: test tone signal generation.

The table below shows which IFMs support the functionalities:
### Table 4 Test & Loopback Support

<table>
<thead>
<tr>
<th>IFM</th>
<th>Loopbacks</th>
<th>BERT</th>
<th>Tone Generation /Level Metering</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Backplane</td>
<td>Front Port</td>
<td>One Port per IFM</td>
</tr>
<tr>
<td>4-E1-L/4-T1-L</td>
<td>✓</td>
<td>✓</td>
<td>---</td>
</tr>
<tr>
<td>16-E1-L/16-T1-L</td>
<td>✓</td>
<td>✓</td>
<td>---</td>
</tr>
<tr>
<td>4-DSL-LW</td>
<td>---</td>
<td>✓</td>
<td>---</td>
</tr>
<tr>
<td>2-C37.94</td>
<td>✓</td>
<td>✓</td>
<td>✓ (for C37.94 ports)</td>
</tr>
<tr>
<td>7-SERIAL</td>
<td>✓</td>
<td>✓</td>
<td>✓ (for CES)</td>
</tr>
<tr>
<td>4-CODIR</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>4-2/4WEM</td>
<td>✓</td>
<td>✓</td>
<td>---</td>
</tr>
<tr>
<td>2-OLS</td>
<td>✓</td>
<td>✓</td>
<td>✓ (for OLS ports)</td>
</tr>
</tbody>
</table>

✓ = supported; --- = not supported

---

14.2 Loopbacks

14.2.1 General

A loopback can be configured on the backplane (=IFM settings) or front port (=port settings). It just loops back the received traffic on an Rx pin towards its associated Tx pin on a specific port. If a backplane loopback has been configured enabled, all the ports on the IFM will be in loopback. Each loopback can be enabled towards the line interface (=application side) or network side. An overview can be found in the figure below.

![Figure 18 Loopback Functionality](image-url)
14.2.2 Configuration

Go to Dashboard → Network Hardware and select a supported IFM or port (from Table 4) in the device list. The settings are shown in the 'Test and Loopback' section on the right-hand side. Always load the configuration into the network to activate it. Activating loopbacks will also generate a 'Test and Loopback active' alarm in HiProvision.

CAUTION: enabling/disabling loopbacks disables/resumes normal service traffic on a port. Verify alarms!

### Table 5 Loopback Settings

<table>
<thead>
<tr>
<th>Settings</th>
<th>Field</th>
<th>Values</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>IFM(1)</td>
<td>Loopback</td>
<td>On/Off</td>
<td>Enable/Disable the backplane loopback towards the network. As a result, all/no ports in service will be looped back on the backplane!</td>
</tr>
<tr>
<td></td>
<td>Network Data</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Loopback Line Data</td>
<td>On/Off</td>
<td>Enable/Disable the backplane loopback towards the line or application. As a result, all/no ports in service will be looped back on the backplane!</td>
</tr>
<tr>
<td>Port</td>
<td>Loopback(2)</td>
<td>Off</td>
<td>Off: Disable the front port loopback</td>
</tr>
<tr>
<td></td>
<td>Line</td>
<td>Line</td>
<td>Line: Enable the front port loopback towards the line or application</td>
</tr>
<tr>
<td></td>
<td>Network</td>
<td>Network</td>
<td>Network: Enable the front port loopback towards the network</td>
</tr>
</tbody>
</table>

Note: by default, all the loopbacks have been disabled
(1): Supported on IFMs: 4-E1-L/4-T1-L, 16-E1-L/16-T1-L, 2-C37.94, 7-SERIAL, 4-2/4WEM, 4-CODIR, 2-OLS.
(2): Supported on ports on IFMs listed in (1), including the ports on the 4-DSL-LW IFM. For 7-SERIAL, this setting will only become visible after this port has been configured in a service.

14.3 BERT (=Bit Error Ratio Tester)

14.3.1 General

The BERT module allows the IFM to send test traffic on a selected service port towards the line interface (=application side) or network side. This module also allows to listen on a port for incoming test traffic and verify it.

The test results of the test traffic can be easily monitored via the 'Test & Loopback Performance' in the Dashboard → Monitoring → Performance tile, see also §14.6.
CAUTION:
- Enabling BERT to send test traffic on a service port will disable the normal service traffic on that port!
- Sending BERT traffic from a 4-E1-L IFM (port 1) using V.110 speeds is not supported, see §10.

14.3.2 Configuration

To configure BERT, go to Dashboard → Network Hardware and select a supported IFM or port (from Table 4) in the device list. The BERT settings are shown in the 'Test and Loopback' section on the right-hand side. Always load the configuration into the network to activate them. Activating BERT will also generate a 'Test and Loopback active' alarm in HiProvision.

CAUTION: enabling/disabling BERT disables/resumes normal service traffic on a port. Verify alarms!

Table 6 BERT Settings

<table>
<thead>
<tr>
<th>Settings</th>
<th>Field</th>
<th>Values</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>2-C37.94 IFM</td>
<td>BERT Tx Direction</td>
<td>Port 1 Line&lt;br&gt;Port 1 Network&lt;br&gt;Port 2 Line&lt;br&gt;Port 2 Network</td>
<td>Port n Line: If BERT is enabled, BERT module transmits test traffic towards the line or application side via port n&lt;br&gt;Port n Network: If BERT is enabled, BERT module transmits test traffic towards the network side via backplane port n</td>
</tr>
<tr>
<td></td>
<td>BERT Rx Direction</td>
<td>Port 1 Line&lt;br&gt;Port 1 Network&lt;br&gt;Port 2 Line&lt;br&gt;Port 2 Network</td>
<td>Port n Line: If BERT is enabled, BERT module listens to the line or application side to receive and verify test traffic via port n&lt;br&gt;Port n Network: If BERT is enabled, BERT module listens to the network side to receive and verify test traffic via backplane port n</td>
</tr>
<tr>
<td></td>
<td>BERT Tx/Rx Enable</td>
<td>True/False</td>
<td>Enable/Disable both the transmit and receive functionality on the BERT module, only for the C37.94 ports, not for the E1 and T1 ports.</td>
</tr>
<tr>
<td>7-SERIAL IFM 4-CODIR IFM 2-OLS IFM</td>
<td>BERT Tx Direction</td>
<td>Line&lt;br&gt;Network</td>
<td>Line: If BERT is enabled, BERT module transmits test traffic towards the line or application side via the BERT Tx Port (=front port)&lt;br&gt;Network: If BERT is enabled, BERT module transmits test traffic towards the network side via the BERT Tx Port (=backplane port)</td>
</tr>
<tr>
<td></td>
<td>BERT Tx Port</td>
<td>Port 1..4 (4-CODIR)&lt;br&gt;Port 1,2,4,6 (7-SERIAL)&lt;br&gt;Port 1,2 (2-OLS)</td>
<td>The port on which the BERT module will transmit test traffic either on the front or backplane port, based on the selected direction.</td>
</tr>
<tr>
<td></td>
<td>BERT Rx Direction</td>
<td>Line&lt;br&gt;Network</td>
<td>Line: If BERT is enabled, BERT module listens to the line or application side to receive and verify test traffic via the BERT Rx Port (=front port).&lt;br&gt;Network: If BERT is enabled, BERT module listens to the network side to receive and verify test traffic via the BERT Rx Port (=backplane port).</td>
</tr>
<tr>
<td></td>
<td>BERT Rx Port</td>
<td>Same ports as BERT Tx Ports</td>
<td>The port on which the BERT module will listen to receive test traffic and verify it. Either on the front or backplane port, based on the selected direction.</td>
</tr>
<tr>
<td></td>
<td>BERT Tx/Rx Enable</td>
<td>True/False</td>
<td>True: BERT module will transmit test traffic on the Tx port and listen on the Rx port to verify incoming test traffic.</td>
</tr>
<tr>
<td>Settings</td>
<td>Field</td>
<td>Values</td>
<td>Description</td>
</tr>
<tr>
<td>----------</td>
<td>-------</td>
<td>--------</td>
<td>-------------</td>
</tr>
<tr>
<td>BERT Bitrate (only CES on 7-SERIAL and 2-OLS IFM)</td>
<td>&lt;value 1…n&gt;</td>
<td>7-SERIAL: n=24 2-OLS: n=64</td>
<td>Set the bitrate for asynchronous CES. The resulting bitrate = n * 4800 bps. 4800 bps (with n=1) is ok if 1200 bps or 2400 bps are required. For synchronous CES, always the service bitrate is taken.</td>
</tr>
<tr>
<td><strong>E1/T1 Port (3)</strong></td>
<td>BERT Pattern Select</td>
<td>PRBS 2e9-1 PRBS 2e11-1 PRBS 2e15-1 QRSS</td>
<td>PRBS = Pseudo Random Bit Sequence; Select which bit test pattern must be generated by BERT: PRBS 2e9-1: Maximum of 8 consecutive zeros and 9 consecutive ones. Bit pattern length = 511 bits. PRBS 2e11-1: Maximum of 10 consecutive zeros and 11 consecutive ones. Bit pattern length = 2047 bits. PRBS 2e15-1: Maximum of 14 consecutive zeros and 13 consecutive ones. Bit pattern length = 32767 bits. QRSS (= Quasi Random Signal Source): Modified version of PBRS that allows 20 consecutive ones. Bit pattern length = 1048575 bits.</td>
</tr>
<tr>
<td>****</td>
<td>BERT Tx/Rx Direction</td>
<td>Line Network</td>
<td>Line: If BERT enabled, BERT module transmits test traffic towards the line or application side and listens to the same side to receive test traffic and verify it. Network: If BERT enabled, BERT module transmits test traffic towards the network side and listens to the same side to receive test traffic and verify it.</td>
</tr>
<tr>
<td>****</td>
<td>BERT Tx/Rx Timeslot</td>
<td>&lt;number&gt;</td>
<td>The number is a decimal representation of the timeslots that have BERT enabled. Each timeslot represents a bit of the 32/24 timeslots in E1/T1, with E1: timeslot 0, 1, ...,31 = 1st, 2nd,...,32nd bit T1: timeslot 1, 2, ...,24 = 1st, 2nd,...,24th bit Example1: Enable BERT module on all E1 timeslots: Binary (32 bits): 1111 1111 1111 1111 1111 1111 1111 1111 Decimal = &lt;number&gt; = 4294967295 Example2: Enable BERT module on E1 timeslots 1, 5, 6: Binary (32bits): 0000 0000 0000 0000 0000 0000 0110 00010 0010 Decimal = &lt;number&gt; = 98</td>
</tr>
<tr>
<td>****</td>
<td>BERT Tx Enable</td>
<td>True/False</td>
<td>BERT module will transmit/not transmit test traffic on the Tx port</td>
</tr>
<tr>
<td>****</td>
<td>BERT Rx Enable</td>
<td>True/False</td>
<td>True: BERT module will listen on the Rx port and verify the incoming test traffic False: BERT module will not listen on the Rx port for incoming test traffic</td>
</tr>
</tbody>
</table>

Note: by default, all the test traffic generation has been disabled

(2): Only ports that are not configured yet in a Serial Ethernet service will show up

(3): E1/T1 port on either 4-E1-L/4-T1-L, 16-E1-L/16-T1-L, 2-C37.94 IFM or 2-OLS

### 14.4 Tone Generator/Level Meter

#### 14.4.1 General

Each port on the 4-2/4WEM IFM has a test tone generator that can generate two tones: 1000 or 1500 Hz. Each 4-2/4WEM IFM can measure an incoming voice signal on one selected port. The received voice signal level can be easily monitored via the 'Test & Loopback Performance' in the Dashboard → Monitoring → Performance tile, see also §14.6.4.
14.4.2 Configuration

Go to Dashboard → Network Hardware and select a 4-2/4WEM IFM or port in the device list. The settings are shown in the 'Test and Loopback' section on the right-hand side. Always load the configuration into the network to activate them. Activating it will also generate a 'Test and Loopback active' alarm in HiProvision.

### Table 7 Tone Generator/Level Meter Settings

<table>
<thead>
<tr>
<th>Settings</th>
<th>Field</th>
<th>Values</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>4-2/4WEM IFM</td>
<td>Level Meter Enabled</td>
<td>True/False</td>
<td>The signal level meter on the 4-2/4WEM IFM will listen/not listen to an incoming voice signal on the selected port (Level Meter Port Selection).</td>
</tr>
</tbody>
</table>
|                 | Level Meter Port Selection     | Port1..4 | Select the port which incoming voice signal must be measured. Example: test tones will be have approximately following levels: Test tone 1000Hz: 1V ptp @ 600 ohm results in -6.81dbm
| 4-2/4WEM Port   | Tone Generator                 | No Tone Generator 1000 Hz /1500 Hz | No Tone Generator: Disable the test tone generation n Hz: The test tone generator will generate an n Hz test signal on this port |

Note: by default, all the test tone generation has been disabled

14.5 Combined BERT / Loopback Example

In the example below, activating BERT on one side and activating port loopback on the other side sets up a test traffic flow through a configured CES in the Dragon PTN network. The results can be easily monitored in §14.6.5.

![Figure 20 Combined BERT / Loopback](image)
14.6 Monitoring: Test & Loopback Performance

Test and Loopback traffic can be monitored as well via the performance counters. Go to Dashboard → (Monitoring) Performance → Counter Control → Test and Loopback Performance → Select your desired protocol to monitor. Each protocol monitoring is described in more detail in the paragraphs below.

14.6.1 E1/T1 Monitoring

E1/T1 monitoring can be found in the figure below. A detailed and similar monitoring set-up description (adding counters to graphs etc...) can be found in ‘Port Performance’ → ‘CSM Ethernet Port Monitoring’ in Ref. [2Net] in Table 2.

![Figure 21 Test and Loopback: E1/T1 Monitoring](image)

Table 8 Test and Loopback: E1/T1 Monitoring Fields

<table>
<thead>
<tr>
<th>Field</th>
<th>Values</th>
<th>Description</th>
<th>Curative Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Port</td>
<td>value</td>
<td>Monitored port</td>
<td></td>
</tr>
<tr>
<td>BERT Bit Error Counter</td>
<td>bit errors</td>
<td>increasing = NOT OK: The number of bit errors received by the BERT receiver, this should be zero for a successful test.</td>
<td></td>
</tr>
<tr>
<td>BERT Sync Loss</td>
<td>True/False</td>
<td>True: the BERT receiver is not synchronized with the BERT transmitter, the measurement is failing. False: the BERT receiver is synchronized with the BERT transmitter.</td>
<td>True: Verify the clocking settings, BERT settings, broken paths, ....</td>
</tr>
<tr>
<td>BERT Good Seconds</td>
<td>seconds</td>
<td>increasing = OK: The total amount in seconds that the test traffic received by the BERT receiver was OK, meaning synchronized and no errors</td>
<td></td>
</tr>
<tr>
<td>BERT All Zeros Seconds</td>
<td>seconds</td>
<td>increasing = NOT OK: The total amount in seconds that the BERT receiver was receiving all zeros</td>
<td></td>
</tr>
<tr>
<td>BERT All Ones Seconds</td>
<td>seconds</td>
<td>increasing = NOT OK: The total amount in seconds that the BERT receiver was receiving all ones</td>
<td></td>
</tr>
<tr>
<td>BERT Error Seconds</td>
<td>seconds</td>
<td>increasing = NOT OK: The total amount in seconds that the BERT receiver was receiving bit errors, an increasing value does not result in synchronization loss</td>
<td></td>
</tr>
<tr>
<td>Measure Time (seconds)</td>
<td>seconds</td>
<td>The total amount in seconds that the BERT receiver has been measuring</td>
<td></td>
</tr>
</tbody>
</table>

**Note:** Click the Refresh button for the latest results;
**Note:** Clear the counter values by disabling and enabling the BERT via the IFM/port settings in the network hardware tile;
**Note:** 'C' value in cell = current value; 'P' value in cell = previous value;

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14.6.2 C37.94 Monitoring

C37.94 monitoring can be found in the figure below. A detailed and similar monitoring set-up description (adding counters to graphs etc...) can be found in ‘Port Performance’ → ‘CSM Ethernet Port Monitoring’ in Ref. [2Net] in Table 2.

Figure 22 Test and Loopback Performance: C37.94 Monitoring

Figure 23 Analysing Counter Values
Table 9 Test and Loopback Performance: C37.94 Monitoring Fields

<table>
<thead>
<tr>
<th>Field</th>
<th>Values</th>
<th>Description</th>
<th>Curative Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Module value</td>
<td></td>
<td>Monitored module</td>
<td></td>
</tr>
<tr>
<td>BERT Sync Loss</td>
<td>True/False</td>
<td><strong>True</strong>: the BERT receiver is not synchronized with the BERT transmitter, the measurement is failing. <strong>False</strong>: the BERT receiver is synchronized with the BERT transmitter.</td>
<td>True: Verify the clocking settings, BERT settings, broken paths, ...</td>
</tr>
<tr>
<td>BERT Sync Loss Seconds</td>
<td>seconds</td>
<td>increasing = NOT OK: The total amount in seconds that the BERT receiver is not synchronized with the BERT transmitter</td>
<td>True: Verify the clocking settings, BERT settings, broken paths, ...</td>
</tr>
<tr>
<td>BERT Bit Error Counter</td>
<td>number</td>
<td>increasing = NOT OK: The number of bit errors received by the BERT receiver, this should be zero for a successful test.</td>
<td></td>
</tr>
<tr>
<td>BERT Good Seconds</td>
<td>seconds</td>
<td>increasing = OK: The total amount in seconds that the test traffic received by the BERT receiver was OK, meaning synchronized and no errors</td>
<td></td>
</tr>
</tbody>
</table>

Note: Click the Refresh button for the latest results;  
Note: Clear the counter values by disabling and enabling the BERT via the IFM/port settings in the network hardware tile;  
Note: 'C' value in cell = current value; 'P' value in cell = previous value;

14.6.3 Serial Monitoring

Exactly the same description as in §14.6.2.

14.6.4 2W/4W Voice Monitoring

2W/4W Voice monitoring can be found in the figure below. A detailed and similar monitoring set-up description (adding counters to graphs etc...) can be found in ‘Port Performance’ → ‘CSM Ethernet Port Monitoring’ in Ref. [2Net] in Table 2.

![Figure 24 Test and Loopback Performance: 2W/4W Voice Monitoring](image)
Table 10 Test and Loopback Performance: 2W/4W Voice Monitoring Fields

<table>
<thead>
<tr>
<th>Field</th>
<th>Values</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Module value</td>
<td></td>
<td>Monitored module</td>
</tr>
<tr>
<td>Signal Level (dBm)</td>
<td>dBm</td>
<td>The 'Signal Level (dBm)' of an incoming voice signal can be measured if 'Level Meter' has been enabled on a specific port; see also §14.4 for more information and to know which port is being measured. The accuracy of the measurement is +/- 0.5 dBm.</td>
</tr>
</tbody>
</table>

Note: Click the Refresh button for the latest results;
Note: 'C' value in cell = current value; 'P' value in cell = previous value;

14.6.5 CODIR Monitoring

Exactly the same description as in §14.6.2.

14.6.6 Optical Low Speed Serial Monitoring

Exactly the same description as in §14.6.2.

15. ABBREVIATIONS

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>BWE</td>
<td>Bandwidth Efficiency</td>
</tr>
<tr>
<td>CAR IP</td>
<td>Central Alarm Reporter Internet Protocol</td>
</tr>
<tr>
<td>CES</td>
<td>Circuit Emulation Service</td>
</tr>
<tr>
<td>CESoPSN</td>
<td>Circuit Emulation Service over Packet Switched Network</td>
</tr>
<tr>
<td>CRMI</td>
<td>Committed Rate Measurement Interval</td>
</tr>
<tr>
<td>CSM</td>
<td>Central Switching Module</td>
</tr>
<tr>
<td>CSV</td>
<td>Comma Separated Values</td>
</tr>
<tr>
<td>DCN</td>
<td>Data Communication Network</td>
</tr>
<tr>
<td>HQoS</td>
<td>Hierarchical Quality of Service</td>
</tr>
<tr>
<td>IFM</td>
<td>InterFace Module</td>
</tr>
<tr>
<td>IP</td>
<td>Internet Protocol</td>
</tr>
<tr>
<td>L2</td>
<td>Layer2</td>
</tr>
<tr>
<td>LAN</td>
<td>Local Area Network</td>
</tr>
<tr>
<td>LER</td>
<td>Label Edge Router</td>
</tr>
<tr>
<td>LPS</td>
<td>Linear Protection Switching</td>
</tr>
<tr>
<td>LSP</td>
<td>Label Switched Path</td>
</tr>
<tr>
<td>LSR</td>
<td>Label Switching Router</td>
</tr>
<tr>
<td>MAC</td>
<td>Media Access Control</td>
</tr>
<tr>
<td>Abbreviation</td>
<td>Description</td>
</tr>
<tr>
<td>--------------</td>
<td>-------------</td>
</tr>
<tr>
<td>MPLS-TP</td>
<td>Multiprotocol Label Switching – Transport Profile</td>
</tr>
<tr>
<td>MSTP</td>
<td>Multiple Spanning Tree Protocol</td>
</tr>
<tr>
<td>MTU</td>
<td>Maximum Transmission Unit</td>
</tr>
<tr>
<td>NIC</td>
<td>Network Interface Card</td>
</tr>
<tr>
<td>NSM</td>
<td>Node Support Module</td>
</tr>
<tr>
<td>NTP</td>
<td>Network Timing Protocol</td>
</tr>
<tr>
<td>OAM</td>
<td>Operation and Maintenance</td>
</tr>
<tr>
<td>PAF</td>
<td>PME Aggregation Function</td>
</tr>
<tr>
<td>PAM</td>
<td>Pulse Amplitude Modulation</td>
</tr>
<tr>
<td>PME</td>
<td>Physical Medium Entities</td>
</tr>
<tr>
<td>PSU</td>
<td>Power Supply Unit</td>
</tr>
<tr>
<td>PTP</td>
<td>Precision Time Protocol</td>
</tr>
<tr>
<td>QoS</td>
<td>Quality of Service</td>
</tr>
<tr>
<td>QSFP</td>
<td>Quad SFP</td>
</tr>
<tr>
<td>SAToP</td>
<td>Structured Agnostic TDM over Packet</td>
</tr>
<tr>
<td>SDH</td>
<td>Synchronous Digital Hierarchy</td>
</tr>
<tr>
<td>SFP</td>
<td>Small Form Factor Pluggable</td>
</tr>
<tr>
<td>SONET</td>
<td>Synchronous Optical Network</td>
</tr>
<tr>
<td>TRM</td>
<td>Transmit Receive Module</td>
</tr>
<tr>
<td>TSoP</td>
<td>Transparent Sonet/SDH over Packet</td>
</tr>
<tr>
<td>TTL</td>
<td>Time to Live</td>
</tr>
<tr>
<td>HiProvision</td>
<td>Dragon PTN Management System</td>
</tr>
<tr>
<td>WAN</td>
<td>Wide Area Network</td>
</tr>
<tr>
<td>XFP</td>
<td>10 Gigabit Small Form Factor Pluggable</td>
</tr>
</tbody>
</table>