Technical Description

MINI-LINK PT 2010 ETSI

DESCRIPTION

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Contents

1 Introduction

1.1 General

The purpose of this description is to give the reader detailed information on MINI-LINK PT 2010, both from a technical and functional perspective.

MINI-LINK PT 2010 is a complete microwave modem and radio unit with the capability of handling IP and Ethernet traffic using all the required frequencies in the 6–42 GHz range.

MINI-LINK PT 2010 is an all-outdoor Packet Terminal, housed in a radio unit case. It is suitable for repeater and end sites due to the small footprint and the easy mountability.

Some functions described in this document are subject to license handling, that is, a soft key is required to enable a specific function.

1.1.1 Packet Transport in Microwave Networks

Compared to other transmission technologies, a microwave link can be characterized as a limited bandwidth connection. This implies that microwave equipment must be designed to enable maximum packet payload throughput in the available bandwidth over the radio interface. The following features improve the link efficiency:

Congestion Handling/Priority Queues

For connections with limited bandwidth it is important to support a mechanism that prioritizes high priority packets when a connection is congested.

Adaptive Modulation

Adaptive modulation seeks continuously to use the modulation alternatives that will maximize throughput under different conditions.

Low Residual BER

Microwave links operate with large fade margins and forward error correction resulting in low residual BER level, typically 10^{-12}.

Buffering Capabilities

Buffering capacities are 64 MB in the WAN direction. Each TC can use up to 128 blocks, of 64 kB each.

1.2 Scope

The purpose of this description is to support the reader with detailed information on included products and accessories, from technical and functional points of view.

1.3 Revision Information

This release of the document includes an update of the MINI-LINK PT 2010 functions within the scope of release MINI-LINK PT 2010 1.2.

The following changes have been made since the last release:

- Information regarding compatible SFPs has been updated.
- Information regarding capacity has been updated.

2 Network Overview

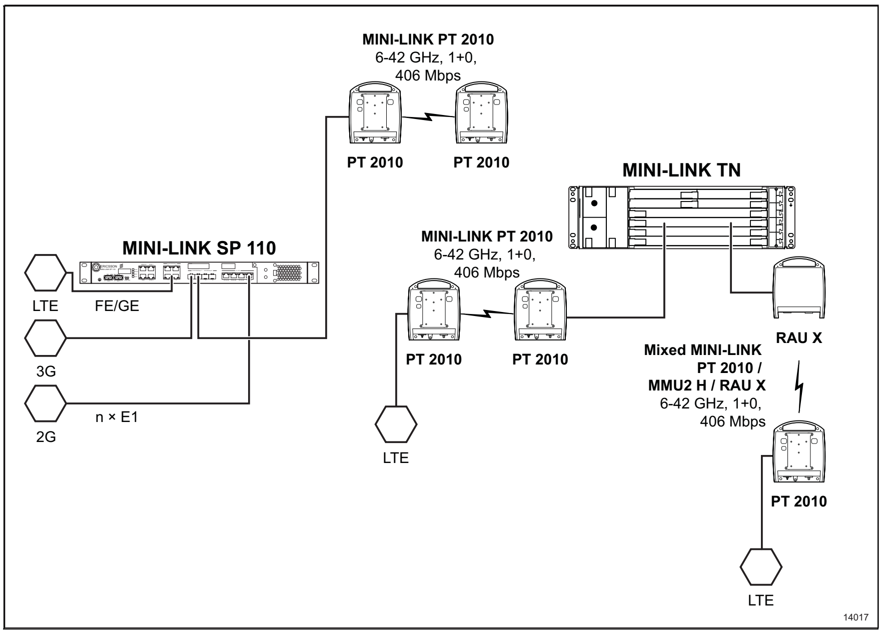

Figure 1 MINI-LINK PT 2010 Network Scenario Overview

Using the MINI-LINK PT 2010 product to build your Ethernet network means that you have a broad range of alternatives to choose from. Within the

MINI-LINK PT 2010 product offering there is support for Ethernet transport with different bandwidth and capacity options over both radio and fixed connections.

MINI-LINK PT 2010 offers the size and capacity to meet the needs of both last mile access and first aggregation point, in a mobile backhaul network.

3 System Overview

This section gives a brief introduction to the system and its components.

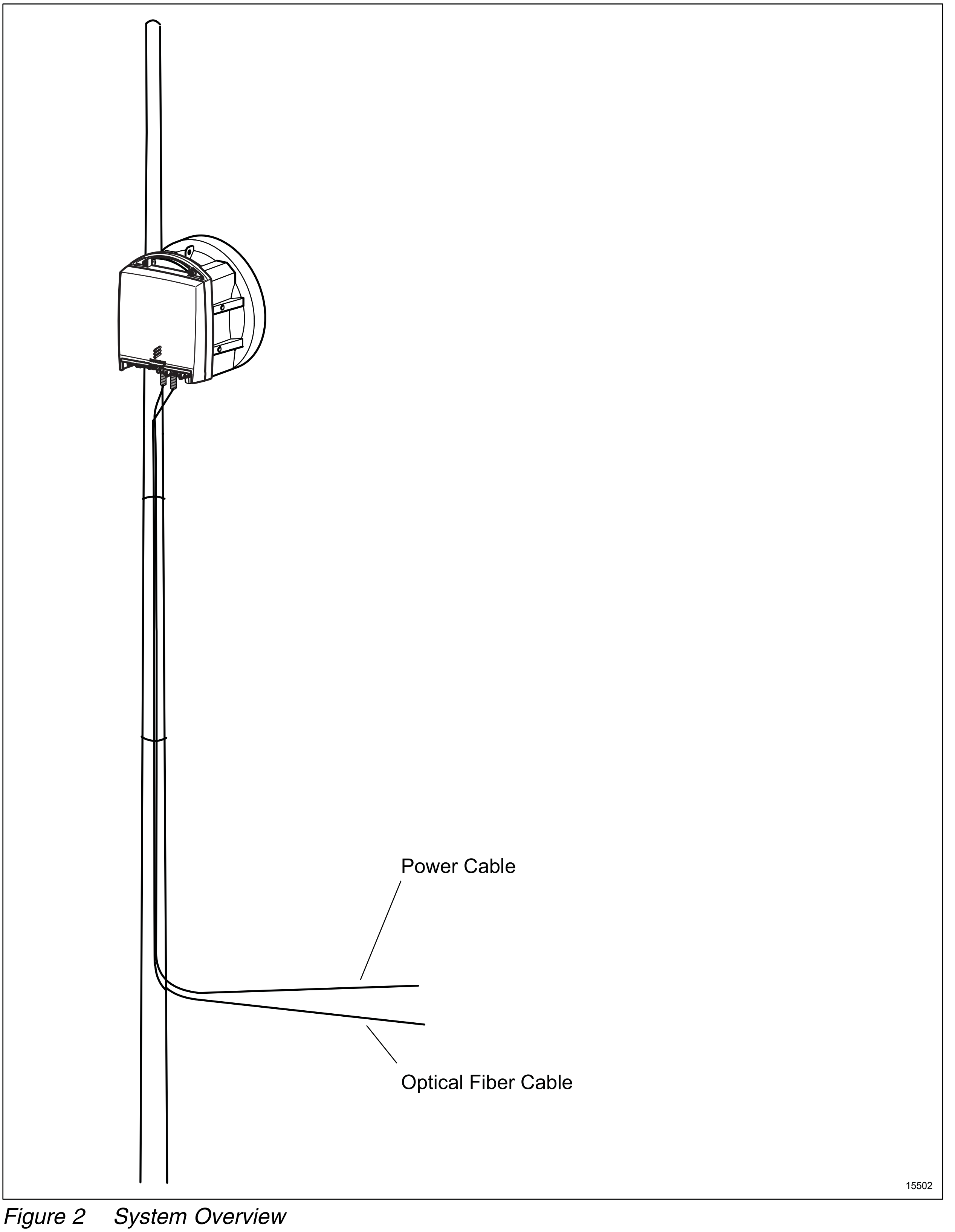

Figure 2 System Overview

MINI-LINK PT 2010 is a stand-alone product integrating the system platform providing traffic and system control, with microwave transmission from 8 to 406 Mbps.

MINI-LINK PT 2010 operates within the 6 to 42 GHz frequency bands, using 4, 16, 32, 64, 128, 256, and 512 QAM modulation schemes, also supporting Hitless Adaptive Modulation.

MINI-LINK PT 2010 is an all-outdoor system. It is connected with a DC supply voltage and an optical fiber cable.

For dual MINI-LINK PT 2010 installation systems, two Packet Terminals and one or two antennas are used. When using one antenna, the two Packet Terminals are connected to the antenna using a power splitter.

The Packet Terminal and the antenna are easily installed on a wide range of support structures. The Packet Terminal is fitted directly to the antenna as standard, integrated installation. The Packet Terminal and the antenna can also be fitted separately and connected by a flexible waveguide. In all cases, the antenna is easily aligned and the Packet Terminal can be disconnected and replaced without affecting the antenna alignment.

The Packet Terminal is described in Section 8.1 on page 32.

The antennas are described in Section 8.2 on page 34.

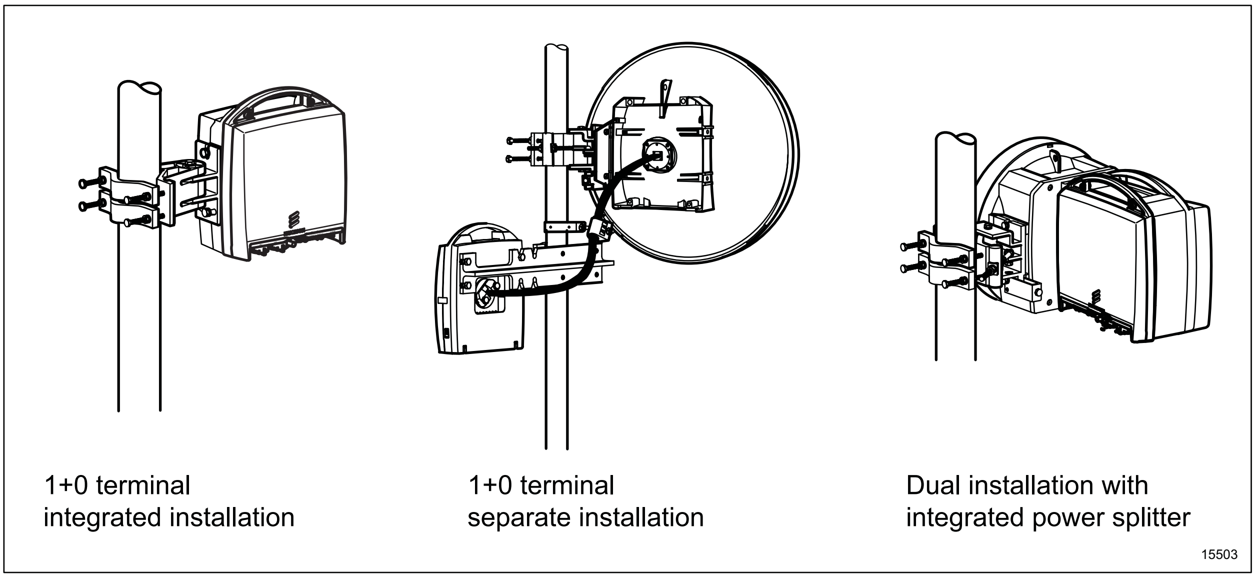

Figure 3 MINI-LINK PT 2010s and Antennas in Different Installation Alternatives

4 Ethernet Traffic Handling in MINI-LINK PT 2010

MINI-LINK PT 2010 supports all-IP and Native Ethernet simultaneously.

Ethernet traffic is sent over a hop as Ethernet over packet link (Native Ethernet).

The Ethernet LAN ports are described in Table 1.

Table 1 Ethernet LAN Port Properties

Ethernet LAN port properties	Description
SFP modules	SFP plug-in module is supported with 1 Gbps optical interface.
Standard frame sizes	Up to 2,000 bytes when used as an external interface (IEEE802.3as-2006). Up to 2,048 bytes when used as an internal interface
Jumbo frames	9,216 byte frame size for data applications
Connectors/cables	Single/multi-mode fiber with LC connector for the optical i/f.

4.1 Ethernet WAN Buffer

The WAN port buffer in MINI-LINK PT 2010 has been designed to handle burst and congestion in order to provide a high link utilization and goodput for high-speed data traffic.

Since extensive buffering has a negative impact on frame delay variation, it is important to have the possibility to configure buffer/queue size for different traffic classes independently.

This means that queues configured to handle delay variation sensitive traffic such as synchronization traffic, shall be configured to be very short.

In contrast, for traffic queues for less delay variation sensitive traffic the Transmission Control Protocol/Internet Protocol (TCP/IP) has a congestion avoidance mechanism that is based on buffer utilization. In order to provide a high link utilization and high TCP goodput, queues configured to handle this type of traffic needs to be in the area of hundreds of milliseconds at the smallest congestion point, equivalent to the network end-to-end Round-Trip time.

For UMTS data traffic, the in-order sequence delivery between the Radio Base Station/nodeB and the Radio Network Controller (RNC) can cause bursts of hundreds of milliseconds.

LAN port buffers are designed to be very small in order to keep delay variation as small as possible, whereas WAN port buffers are larger, to enable handling of congestion at the WAN port. This can be achieved by ensuring that the WAN port link speed is lower than the LAN port link speed (including overhead and so on).

4.2 Native Ethernet

This section describes Native Ethernet in MIN-LINK PT 2010.

The Ethernet traffic is sent over a single hop or through a network. Native Ethernet traffic is sent over a dedicated physical link instead of being transported over PDH or SDH. Native Ethernet enables more efficient use of bandwidth and maximizes Ethernet throughput since no PDH overhead is added.

Overhead Comparison

The overhead for Native Ethernet is only 0.5% for 1,000 byte frames, in comparison to 6.0% for Ethernet over PDH.

Table 2 Native Ethernet WAN Port Properties

Native Ethernet WAN port properties	Description
Interface types	Packet Link radio interface
Frame size	An Ethernet over Packet Link WAN port supports frames with a size up to 9,216 byte (Jumbo Frames)
Throughput	The Packet Terminal supports Ethernet transport over the radio hop. The following maximum bit rate over the radio hop is supported by the Packet Terminal: 406 Mbps in a 56 MHz channel The effective Ethernet payload throughput is less than the maximum bit rate due to a framing overhead. For 2,048 byte frames, 99.5% of the bit rate capacity is used for Ethernet payload (link efficiency).

Native Ethernet WAN port properties	Description
Latency	The end to end latency for an Ethernet over Packet Link connection will differ based on different parameters, for example, link speed. Typical end to end latency contribution between two Ethernet ports on two nodes connected with Ethernet over packet Link with 135 Mbps link capacity is: • 0.15 ms for 64 byte frame size • 0.35 ms for 2,048 byte frame size
Buffer Capacity	All egress WAN ports have a buffer space associated with the port. The available buffer space is shared between the traffic classes (priority queues). A Packet Link WAN port can buffer up to 64 MB of traffic at max link capacity. By default, the buffer space is split in 4 MB for each TC queue for TC0 to TC2, and 128 kB for each TC queue for TC3 to TC7. The individual buffer size per TC queue can be adjusted in 64 kB increments.

5 MINI-LINK PT 2010 Functions – Radio Link

5.1 Hitless Adaptive Modulation

Hitless Adaptive Modulation enables automatic switching between different modulations, depending on radio channel conditions. Hitless Adaptive Modulation makes it possible to increase the available capacity over the same frequency channel during periods of normal propagation conditions.

Modulation, and thereby capacity, is high during normal radio channel conditions and lower during less favorable channel conditions, for example, when affected by rain or snow. Modulation switches are hitless, that is, error free. In situations where traffic interruption normally would occur, it is possible to maintain parts of the traffic by switching to a lower modulation, using Hitless Adaptive Modulation.

The availability for a 56 MHz channel is illustrated in Figure 4.

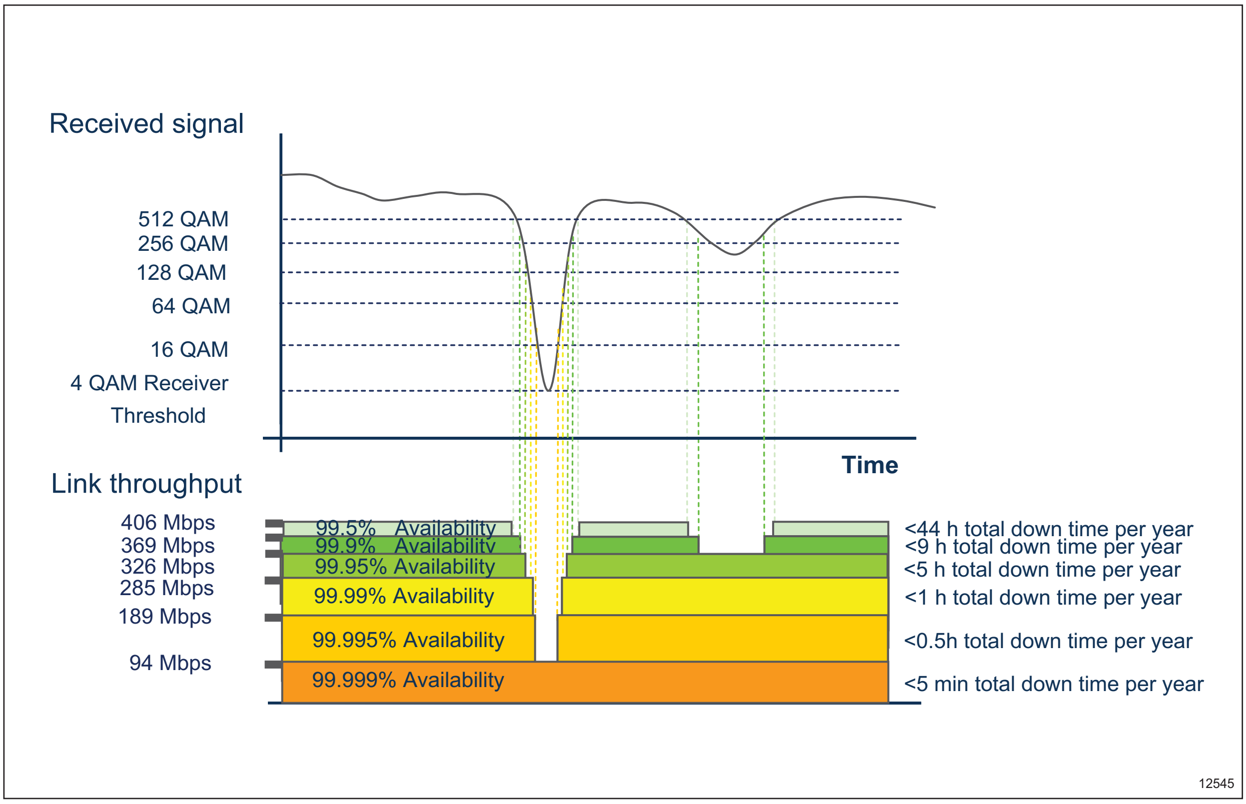

Figure 4 Example of Hitless Adaptive Modulation, 56 MHz

In order to handle channel variations, the channel conditions are continuously monitored on the Rx side by measurement of Signal to Noise and Interference Ratio (SNIR). When the receiver, based on this data, detects that channel conditions imply a change to the next higher or lower modulation, a message is sent to the transmitter on the other side requesting a higher or lower modulation. Upon receipt of such request the transmitter starts transmitting with the new modulation. Each direction is independent. At demodulation the receiver follows the modulation as a slave.

Hitless Adaptive Modulation can be configured to run in automatic or manual mode, where automatic mode is default. In manual mode it is possible to control and set static physical modes and thereby perform advanced fault tracing or advanced performance tests.

Hitless Adaptive Modulation is compatible with Automatic Transmit Power Control (ATPC), which is working in a closed loop only in the highest configured modulation. In lower modulations the output power is set as high as possible.

Note: Hitless Adaptive Modulation requires a license.

Buffering

Adaptive modulation might influence the design of the buffer dimensioning. In case packet aging is not used, the maximum delay variation time will increase due to that the buffer is configured in bytes and that data will travel at a slower speed during lower modulation steps. When packet aging is enabled, the maximum delay variation time will be kept regardless of modulation level. This will also ensure that there is no old data in lower priority queues when modulation is increased after a fading situation.

Adaptive modulation can influence the position of the narrowest congestion point in the network, with too small buffers this might have a strong negative impact on utilization and end user TCP performance. To ensure high link utilization and high TCP performance, buffers for TCP traffic should be dimensioned in the area above average Round Trip Time (RTT), which is typically in the area of 100–200 ms.

RSEC

Reference Spectrum Efficiency Class (RSEC) defines the spectral mask, that is to say, it is which SEC is used as a reference. The maximum output power is dependent on the RSEC used. There is a relation between RSEC and the maximum chosen modulation, which is illustrated in Table 3.

Table 3 RSEC

Modulation	Reference Spectrum Efficiency Class
4 QAM	RSEC=2
16 QAM	RSEC=4L
32 QAM	RSEC=4H
64 QAM / 128 QAM	RSEC=5B
256 QAM / 512 QAM	RSEC=6B

When upgrading an existing path to Adaptive Modulation, it is important to consider if licenses will have an impact on the choice of mask, or spectral class, for a given country.

5.2 Transmit Power Control

The radio transmit power can be controlled in Remote Transmit Power Control (RTPC) mode, selectable from the management system including setting of associated parameters. In Automatic Transmit Power Control (ATPC) mode the transmit power can be increased rapidly during fading conditions and allows the transmitter to operate at less than the maximum power during normal path conditions. The normally low transmit power allows more efficient use of the available spectrum while the high transmit power can be used as input to path reliability calculations, such as fading margin and carrier-to-interference ratio.

The transmitter can be turned on or off from the management system.

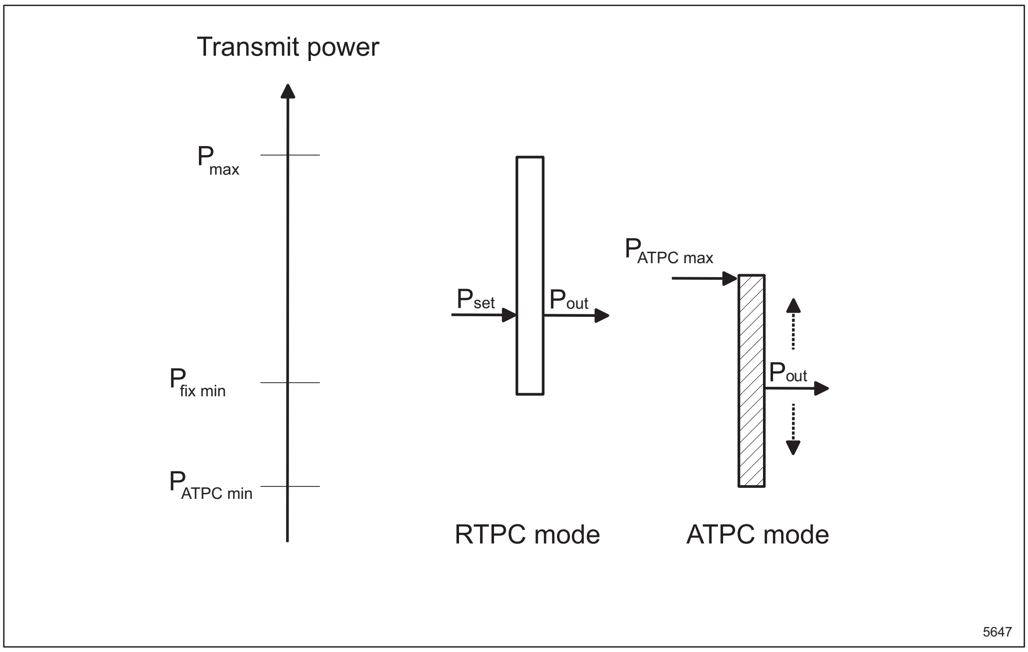

Figure 5 Transmit Power Control

5.2.1 RTPC Mode

In RTPC mode the transmit power (P_{out}) ranges from a minimum level ($P_{fix\ min}$) to a maximum level (P_{max}). The desired value (P_{set}) can be set in 1 dB increments.

5.2.2 ATPC Mode

ATPC is used to automatically adjust the transmit power (P_{out}) in order to maintain the received input level at the far-end terminal at a target value. The received input level is compared with the target value, a deviation is calculated and sent to the near-end terminal to be used as input for possible adjustment of the transmit power. ATPC varies the transmit power, between a selected maximum level ($P_{ATPC\ max}$) and a hardware specific minimum level ($P_{ATPC\ min}$).

6 MINI-LINK PT 2010 Functions – Ethernet

MINI-LINK PT 2010 is targeting multiple applications and network environments with the embedded Ethernet capabilities. MINI-LINK PT 2010 therefore provides flexibility and supports the following Ethernet services and features.

An Ethernet functions overview is presented in the tables below.

Table 4 QoS and Congestion Handling

Quality of Service Support/Congestion Handling	
Number of Traffic Classes (TCs) (priority queues)	The number of TCs is always eight and cannot be changed. It is possible to use any number of queues, from one up to eight.
Class of Service (CoS)/TC/priority queues mapping	The CoS priority information is used to map the Ethernet frames in to the 1–8 TCs. The mapping can be done according to either IEEE802.1D-2004, IEEE802.1Q-2005, or custom. Frames with no CoS information are mapped to the default TC.

Weighted Fair Queuing (WFQ)	The WFQ scheduling mechanism offers a more flexible way to schedule frames on an egress port and prevents starvation of TC queues. WFQ can be used together with the Strict Priority scheme.
CoS classification	The CoS value for a frame is a representation of the end user application, for example, voice, best effort data and so on, and is used to differentiate behavior of frames in a node. The CoS value is set in the priority bits in the Ethernet header, for example, p-bits in Q-tag. The CoS for a frame is typically defined at the network edge. The priority bits are set based on whether the port is trusted/tagged or not. The following options are supported: • DSCP value in IPv4 or IPv6 header (RFC 2474, RFC 2780) • EXP bits in MPLS header • PCP bits in C-tag or S-tag • Default value

Table 5 Network Synchronization

Network Synchronization	
Synchronous Ethernet	Transport of sync information on an Ethernet connection according to ITU-T G.8261, G.8262, and G.8264.

Table 6 Management

Management	
Embedded VLAN based management	The management traffic can be transported in a logically separated VLAN together with the Ethernet traffic on the optical fiber and the Radio Link.
Performance measurements	The following PM counters are available per Ethernet LAN/WAN ports: • **WAN only**: Node delay contribution (due to buffering) • **WAN only**: Link utilization • Number of outbound discarded packets due to, for example, overflow. • Number of outbound discarded packets due to for example, Ethernet CRC-32 errors. • Number of inbound discarded packets due to Ethernet CRC-32 errors and so on. • Total number of discarded packets • Number of received octets • Number of sent octets • Number of received Unicast frames • Number of received Multicast frames • Number of received Broadcast frames • Number of sent Unicast frames • Number of sent Multicast frames • Number of sent Broadcast frames

6.1 Ethernet Functional Flow in MINI-LINK PT 2010

6.1.1 Supported Frame Sizes

In a real network there will often be Ethernet frames of different sizes. The size of a frame is often related to the application. A real time application (for example, voice, video) that requires minimum latency typically uses small Ethernet frames, while a data application with non real-time characteristics uses the maximum frame size. MINI-LINK PT 2010 is well equipped to handle both small and large Ethernet frames as well as a mix.

An Ethernet over Packet Link WAN port supports frames with a size up to 9,216 byte (Jumbo Frames).

6.1.2 Supported Frame Types

MINI-LINK PT 2010 supports multicast, unicast, and broadcast frames.

6.1.3 Priority Classification

The main objective of the priority classification/tagging process is to establish a frames relative priority to offer appropriate propagation in the network and internally in MINI-LINK PT 2010.

Definitions

To set the stage for the coming discussions in this chapter some terms must be clarified.

Trusted Port

In MINI-LINK PT 2010 there are different criteria that come into play when a frame is prioritized. First of all the operator must decide whether the connected user domain is trusted or not. For a trusted domain the operator can reuse the priority information in the frame, set by the client. For an untrusted port the default network priority value is used.

User/customer and Network Domains

A frame’s actual priority in an end to end Ethernet connection can be different based on where in the network you look. A network can be logically split up in a network domain and one or more user/customer domains. All nodes in an area has a similar congestion behavior. In the user/customer domain, an Ethernet frame’s priority settings are based on the individual user/customer definitions and referred to as user/customer priority. In the network domain the network priority settings, defined by the operator, are used.

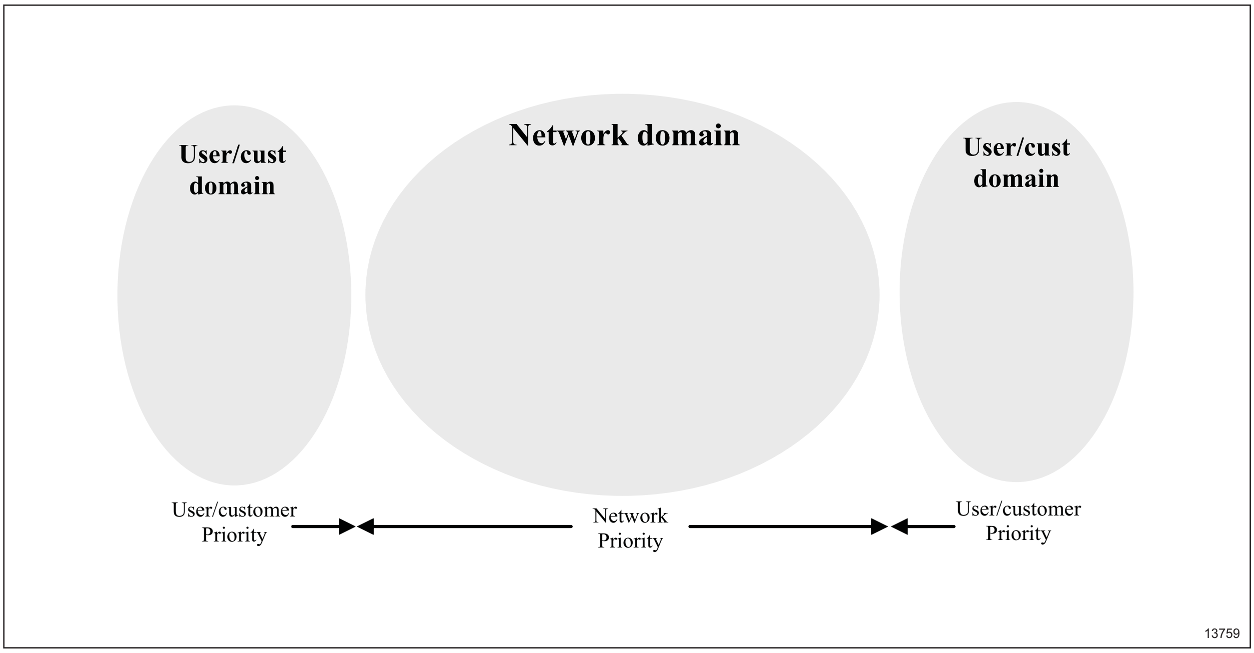

Figure 6 User/Customer and Network Domains

User/Customer Priority

The priority setting used in the user/customer domain and set by the user/customer. The user/customer priority information can be retrieved in one of five different ways from the user domain frames:

1. From the C-VLAN tag PCP bits in Ethernet header
2. From the S-VLAN tag PCP bits in Ethernet header
3. From the IPv4 DSCP bits in IP header
4. From the IPv6 DSCP bits in IP header
5. From the MPLS EXP bits IP header

Network Priority

The network priority is the Ethernet frame's priority setting used in the operator/network domain. The different network priority values are defined by the operator.

An Ethernet frame's network priority is typically a representation of the traffic type and the application generating the Ethernet flow (for example, voice call).

The traffic types and associated priority values are standardized in IEEE802.1Q 2005 and IEEE802.1D 2004. Each traffic type is associated with a priority value to indicate the relative importance of that traffic type. Highest number equals highest priority.

In a network, it is important that only one set of priority definitions is used (for example, IEEE 802.1D-2004). Otherwise, the handling of Ethernet frames and the mapping to egress queues can differ between network elements. The outcome of this scenario is a non predictable behavior for the different traffic types (for example, voice).

Priority Code Point (PCP)

The Priority Code Point is the three bits in the Ethernet header that is used to carry the priority value and coloring information for the Ethernet frame. The priority information is mandatory while coloring information is only applied when the Ethernet flow is policed.

MINI-LINK PT 2010 Priority Handling

MINI-LINK PT 2010 does not currently provide UNI functionality to re-map user/customer priority to network priority, but can be setup to act on quality information, either in the customer or the network domain. This is shown in Figure 7 below and further explained in Section 6.1.4 on page 18.

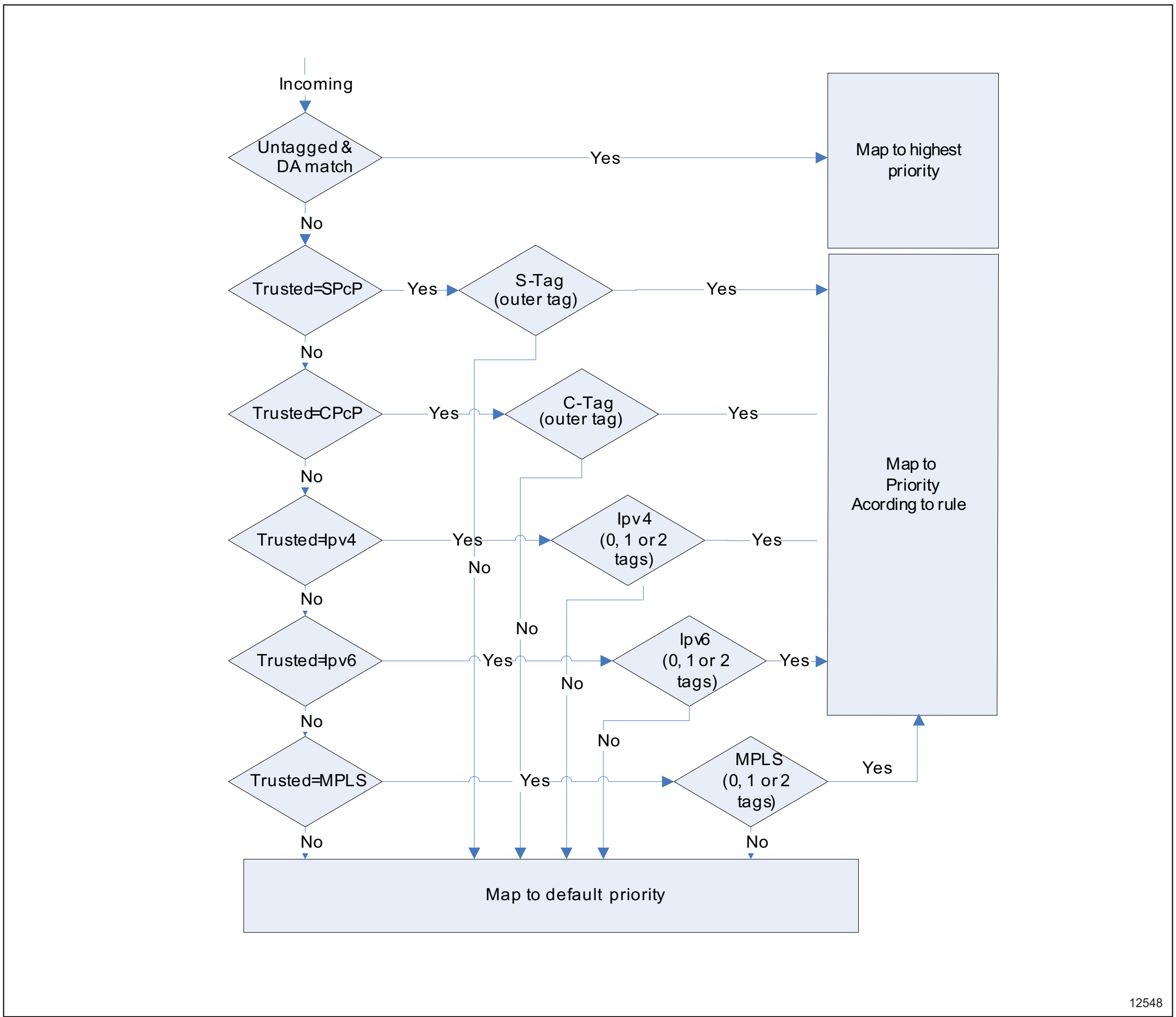

Figure 7 Priority Tagging Flowchart

On a trusted port, the EXP/DSCP priority information in the MPLS/IP header or PCP bits in the Ethernet header is used to establish an internal priority. The internal priority is used for further priority handling but does not alter or add any priority in the frame. The internal priority translation is done according to a mapping table customized by the operator.

6.1.4 Congestion Handling

In a multi service network there is a need to differentiate the processing of the different flows in the congestion points. Typically a voice flow would require low latency/jitter and thus higher priority than a best effort data flow with no latency requirements.

Differentiation of flows is done based on the network priority value in the header part of each Ethernet frame. The network priority value to be used in the network domain is typically set as a part of the tagging process at the network edge.

A frame’s priority value is used to provide different Classes of Service (CoS) and is a representation of the end user application (for example, voice, best effort data and so on). In MINI-LINK PT 2010 the Ethernet frame’s priority value indicates how it shall be prioritized versus the other Ethernet frames in the network element.

An alternative to the mechanisms described in this chapter is to overprovision the network, that is, the capacity is sufficient to guarantee a congestion free network.

Please note that this chapter does not address the QoS (Quality of Service) aspect of a network. QoS is a network level notation for the characteristics supported by an end to end Ethernet connection. QoS involves network dimensioning, protection mechanisms, policing and so on, and is relevant for end to end Ethernet connection provisioning in network management, and is not a notation to be used for a NE.

Traffic Class (TC) mapping

MINI-LINK PT 2010 supports eight Traffic Classes (TC) or priority queues for the egress Ethernet port on the radio side.

The Ethernet frames are mapped to the different TCs based on the internal priority value set in the process described in Figure 7. The mapping can be done according to IEEE 802.1D-2004, see Figure 8, IEEE802.1Q-2005, see Figure 9, or it can be customized.

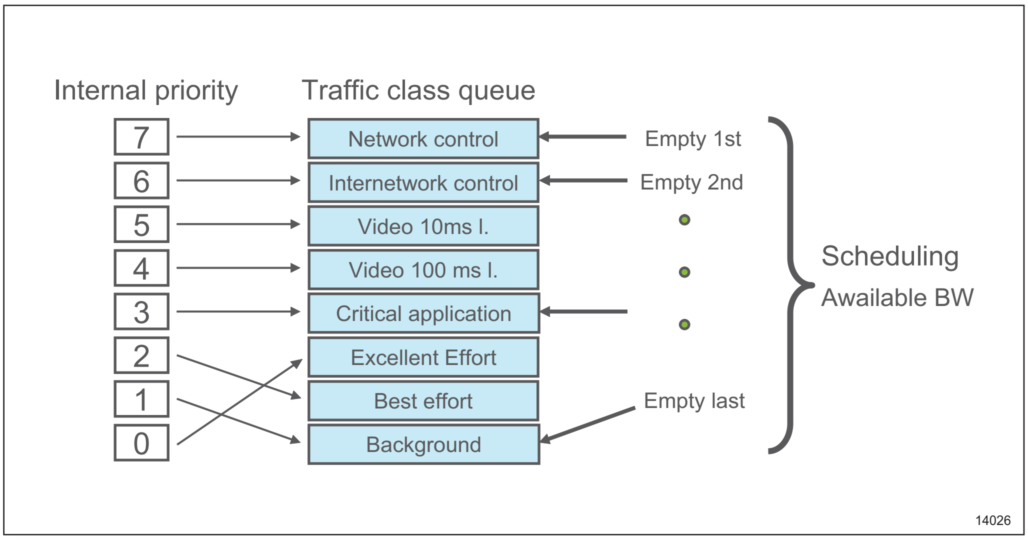

Figure 8 IEEE 802.1D-2004 Mapping

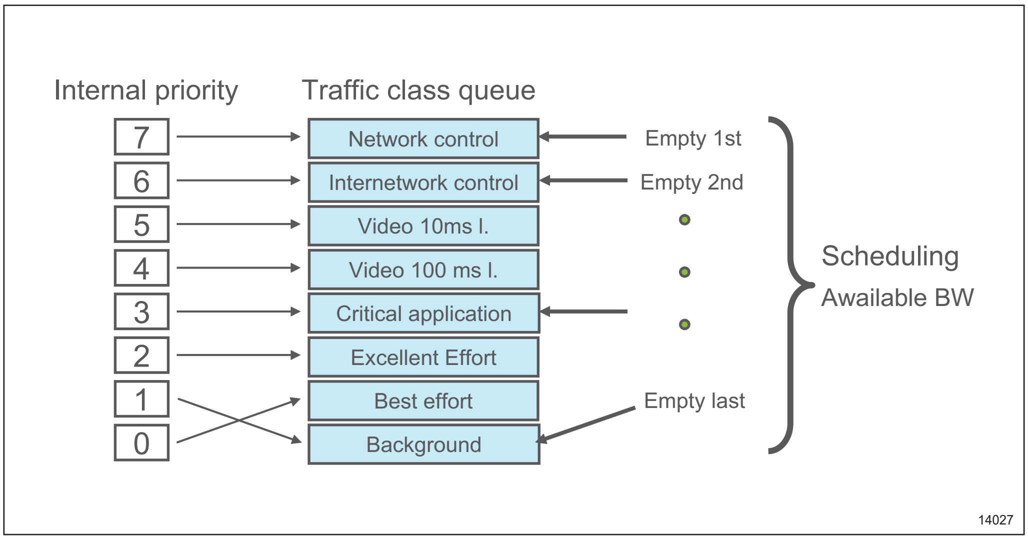

Figure 9 IEEE802.1Q-2005 Mapping

Priority/TC buffers

Each Ethernet interface has a separate egress buffer to handle temporary link congestion. The egress buffers enable MINI-LINK PT 2010 to handle short bursts without packet loss. The buffer is organized in different priority queues or TCs. The buffer capacity is shared between the different egress priority queues for an Ethernet port.

Scheduling

When an Ethernet port is congested the egress priority/TC buffers are filled up with Ethernet frames. To empty the buffers a scheduler must serve the buffers according to a predefined algorithm. MINI-LINK PT 2010 supports both Strict Priority and Weighted Fair Queuing (WFQ) scheduling algorithms to empty the egress priority/TC buffers.

The Strict Priority algorithm is typically used for delay sensitive traffic like voice, video and sync packets. With Strict Priority, Ethernet frames in the buffer with the highest priority are always scheduled first, for example, all Ethernet frames with priority level 7 are scheduled before Ethernet frames with priority level 6.

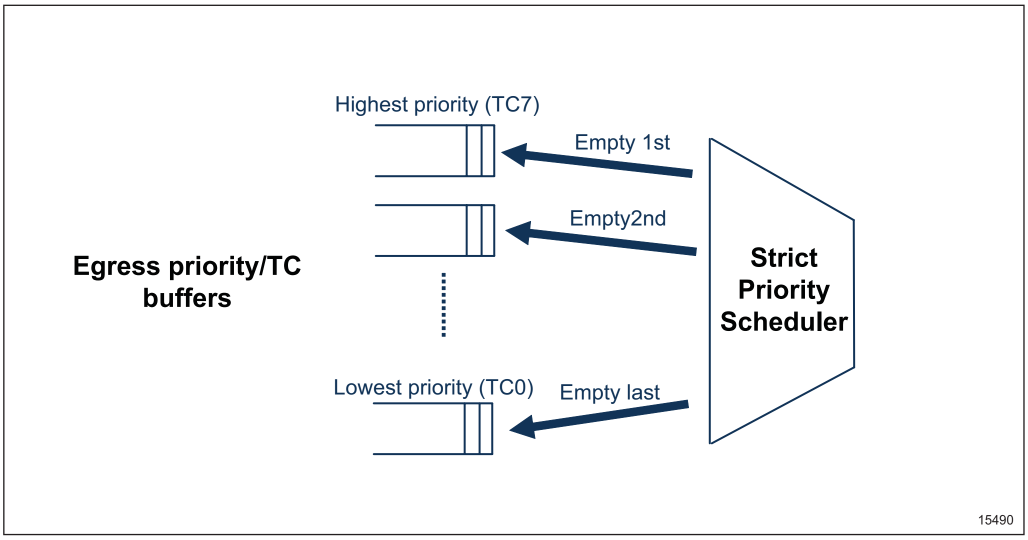

Figure 10 Strict Priority Based Scheduling

With Strict Priority, buffers with lower priority will never get served if high priority queues are constantly being filled up. The scheduler will serve the high priority Strict Priority area first and empty the buffers according to the Strict Priority algorithm. The low priority Strict Priority buffers are emptied when all buffers above are empty.

The WFQ algorithm is used when low latency is not crucial, but it is important to prevent starvation of buffers. With Strict Priority, buffers with lower priority will never get served if high priority queues are constantly being filled up. WFQ however will make sure that all queues are served according to the predefined weight (%). The accuracy of the percentage allocation is roughly 1%, where constant bit rate traffic is more accurate than burst traffic. WFQ is typically used for buffers with non delay sensitive data traffic.

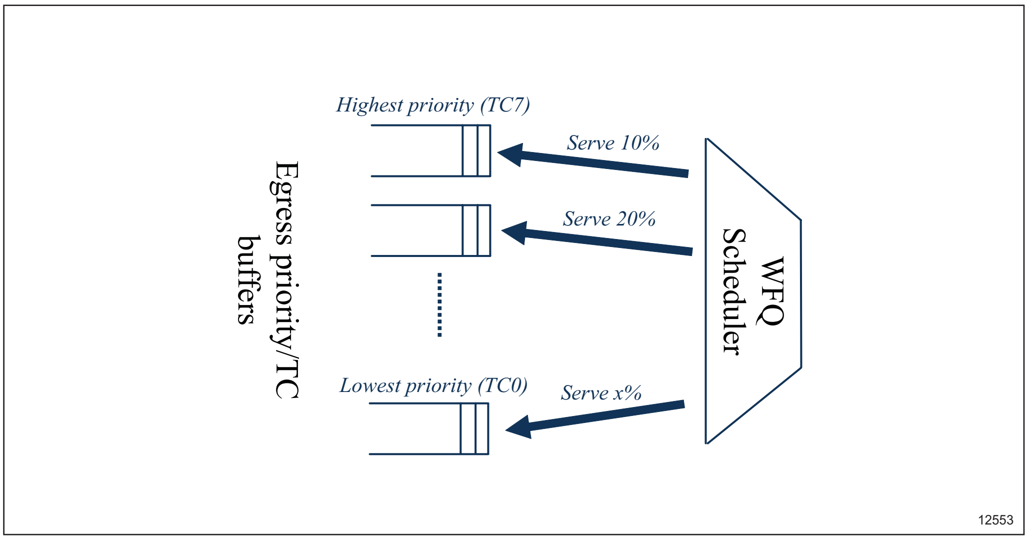

Figure 11 Weighted Fair Queuing Scheduling

In a live network the Strict Priority and WFQ scheduling algorithms are typically combined. In MINI-LINK PT, the Strict Priority and WFQ algorithms can be applied to different buffers as described in the example below. The size of the Strict Priority and WFQ areas (x, y and z values) can differ but the Strict Priority/WFQ/Strict Priority organization is fixed. The scheduler will serve the high priority Strict Priority area first and empty the buffers according to the Strict Priority algorithm. When the high priority Strict Priority area is empty the scheduler starts serving the WFQ buffers according to individual weight. Last, the low priority Strict Priority buffers are emptied when all buffers above are empty.

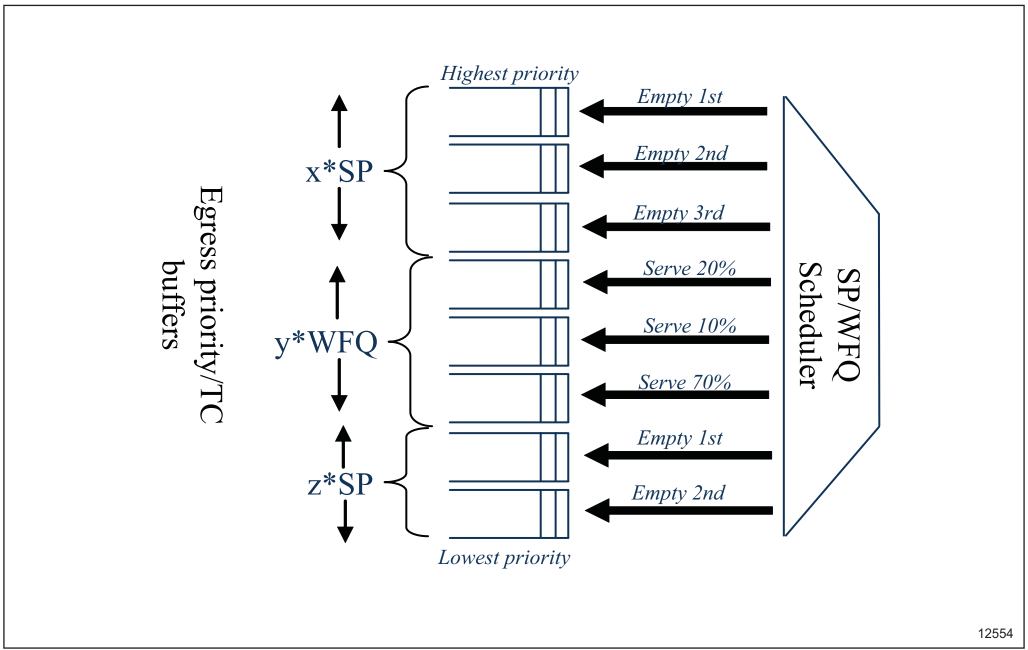

Figure 12 Strict Priority and WFQ Scheduling Combined in the Same Port

The Strict Priority and WFQ schedulers can be configured with the following predefined templates. These templates can be selected from MINI-LINK Craft and SNMP.

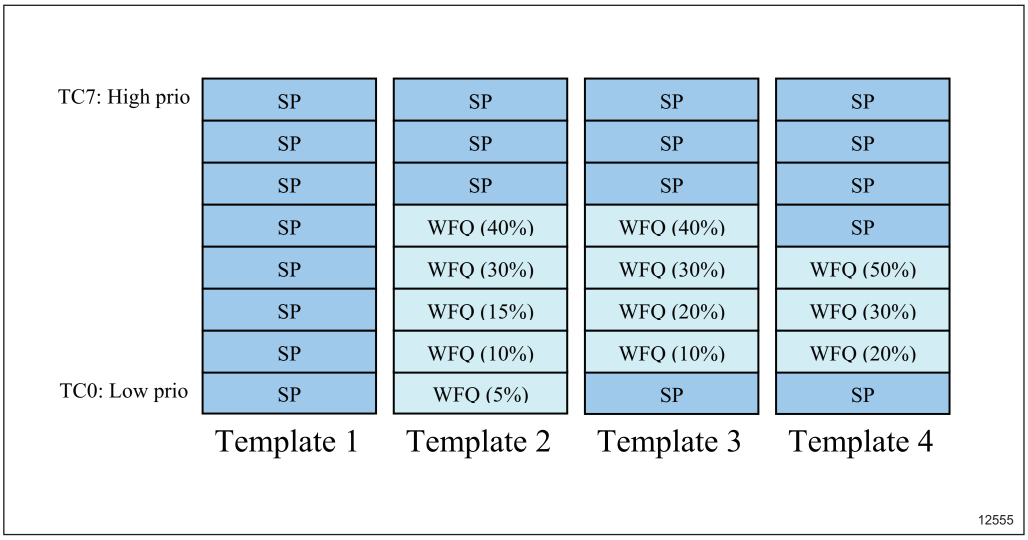

Figure 13 Scheduling Templates

Frame Discard Mechanisms

MINI-LINK PT 2010 supports a number of different frame discard mechanisms for the TC/priority buffers. The different mechanisms are used in different situations and are used for different purposes. In a live network, a combination of different frame drop mechanisms is often used to get the required behavior.

Tail Drop

The tail drop discard mechanism is used when a TC buffer is filled up. When a TC buffer is full, the tail drop feature ensures that new frames are dropped at the entry point of the TC queue.

Tail drop is used to handle discarding of frames during long bursts that completely fills up the available buffer space.

Time Stamp Based Dropping/Aging

A timestamp is applied to the frame when it enters the TC queue buffer. Before exiting the TC buffer (that is, served by the scheduler) the timestamp is checked towards the aging timer. If the timestamp value exceeds the aging timer, the frame is discarded. The aging timer can be adjusted from the management interface.

Aging is useful to discard frames in delay sensitive flows with expired delay values and prevent further propagation of useless frames in the network.

Frame Discard Summary

Figure 14 illustrates how the different discard mechanisms are organized in MINI-LINK PT 2010.

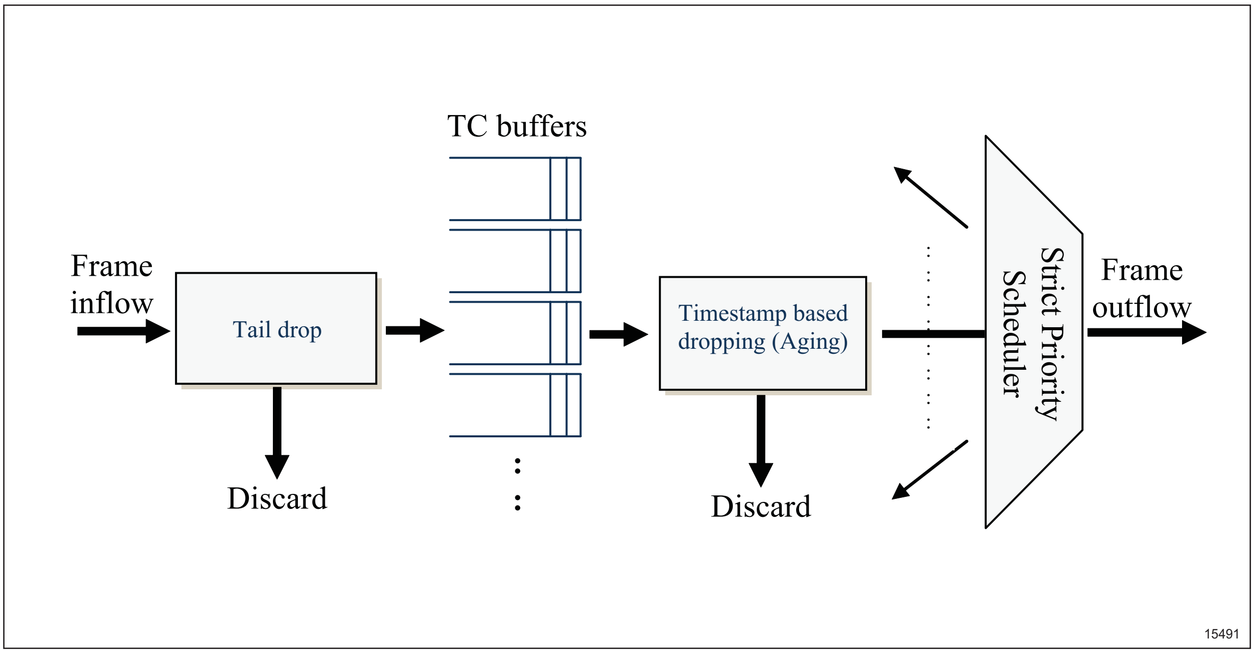

Figure 14 Discard Mechanisms in MINI-LINK PT 2010

Chapter Summary

This is a summary of the congestion handling chapter:

- Defining the LAN port as a trusted port, the Packet Terminal will act on priority information contained in the traffic.
- Ethernet frames are mapped to egress TC buffer according to IEEE802.1D/Q or custom.
- In the egress TC buffer, frames are serviced according to a Strict Priority or Weighted Fair Queuing scheduler, or both.
- Frames are dropped in the egress TC buffer due to tail dropping or aging.

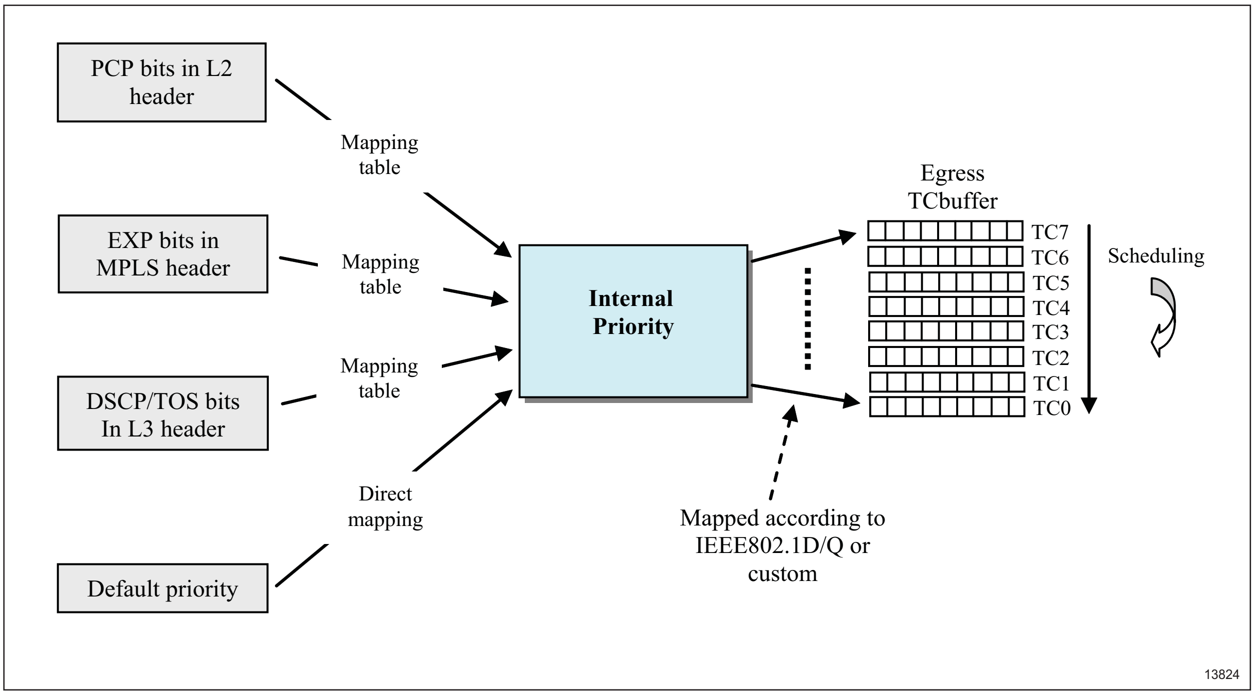

Figure 15 Congestion Handling in MINI-LINK PT 2010

6.1.5 Operation & Maintenance

This chapter describes O&M capabilities related to the Ethernet application in MINI-LINK PT 2010.

PM Counters

MINI-LINK PT 2010 supports the following counters for all LAN/WAN Ethernet ports:

- Number of outbound discarded packets due to overflow and so on.
- Number of outbound discarded packets due to Ethernet CRC-32 errors and so on.
- Number of inbound discarded packets due to Ethernet CRC-32 errors and so on.
- Total number of discarded packets
- Number of received octets
- Number of sent octets
- Number of received Unicast frames
- Number of received Multicast frames

- Number of received Broadcast frames
- Number of sent Unicast frames
- Number of sent Multicast frames
- Number of sent Broadcast frames

Diagnostics Tools

MINI-LINK PT 2010 supports the diagnostic tools described below.

Probes

To detect the usage and congestion level of MINI-LINK PT 2010, two different measurement probes can be activated for all WAN ports.

- Link utilization probe: measures the usage of the available link capacity.
- Buffer filling probe: measures for how long frames are buffered.

6.2 Quality of Service Support

This section describes the Quality of Service (QoS) support in MINI-LINK PT 2010. An overview of the execution order for different QoS functions is illustrated in Figure 16.

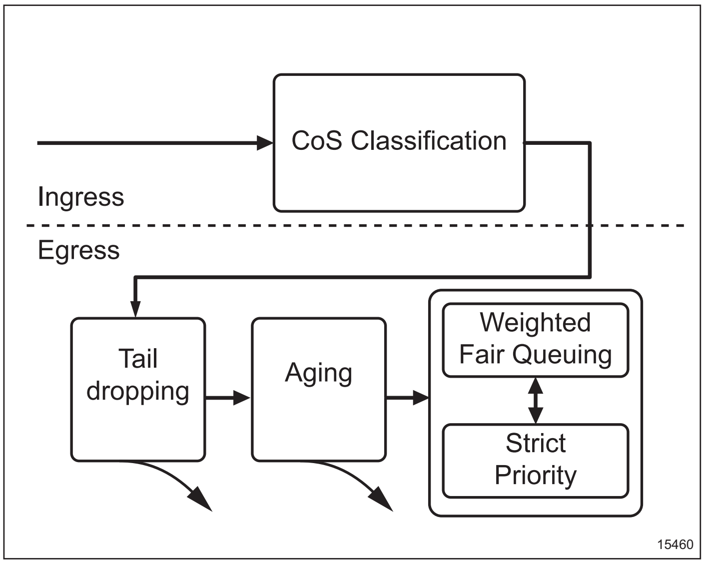

Figure 16 QoS Execution Order

Frames can be dropped at the ingress or egress side by the different QoS functions described in this section.

Note: IEEE 802.3x-based congestion handling mechanism does not take into account the usage of different priority levels. The reception of a PAUSE message triggers a network element to halt all Ethernet frames. This means that IEEE 802.3x-based congestion handling is not suitable for networks configured for different priority levels and transmission of real-time traffic.

6.2.1 Class of Service

The Class of Service (CoS) value for a frame is a representation of the end user services, such as voice and best effort data. The CoS value is set in the priority bits in the Ethernet header and is typically defined at the network edge. The priority bits are set based on whether the port is trusted or not. The following options are supported:

- IP TOS/DSCP for IPv4 or IPv6
- Reuse Priority Code Point (PCP) value in C-tag (Q-tag, VLAN) or S-tag
- User defined value
- EXP bits in MPLS header

The defined CoS value is stored in the PCP value in the Q-tag in the Ethernet header and is used throughout the network.

The WAN (radio side) Ethernet egress port can be configured with 1–8 Traffic Classes (TCs), where 8 TCs are default.

The CoS priority information is used to map the Ethernet frames into the 1–8 TCs. The mapping can be done according to either IEEE802.1D-2004, IEEE802.1Q-2005 or custom. Frames with no CoS information are mapped to the default traffic class (TC0).

There are individual queues for each CoS. The Ethernet frames in the egress queues are either scheduled according to a strict priority scheme.

6.2.2 Tail Dropping

All new packets that are scheduled to a CoS queue that is already full are dropped regardless of priority.

6.2.3 Packet Aging

It is possible to drop packets based on age. When Packet Aging is used, packets that have been stored too long and no longer can be delivered with purpose are dropped. Packet aging is configured per service per TC, where a service is the switch or one of the Ethernet Layer 1 Connection services. The default settings for Ethernet packet aging is shown in Figure 17.

TC0	Disabled
TC1	Disabled
TC2	Disabled
TC3	10 ms
TC4	10 ms
TC5	10 ms
TC6	10 ms
TC7	10 ms

14710

Figure 17 Default Settings for Packet Aging

6.2.4 Strict Priority

With strict priority scheduling, the eight traffic class queues are handled one-by-one with the highest priority queue first. The scheduler always handles the queue with highest priority until it is empty. Once the queue with highest priority is empty the scheduler moves on to the next queue with lower priority. If frames are placed in a queue with higher priority, the scheduler handles these frames before it returns to handle the frames in the queue with lower priority.

6.2.5 Congestion Handling

Congestion Avoidance prevents saturation of queues managed by the classifier, which discards incoming packets according to a specific policy. The following algorithms are supported to realize the Congestion Avoidance:

- Tail dropping

  In case of queue congestion, all incoming packets are dropped. Tail dropping acts on each queue independently.

- Timestamp dropping

  Each incoming packet is tagged with a timestamp. In case of congestion the oldest packets are discarded. Packets will also be discarded if they remain in the queue longer than the set aging time.

Each algorithm has characteristic parameters, such as buffer size and thresholds, that can be configured for the different traffic class queues.

6.3 Performance Monitoring

The following counters are monitored for the whole radio link or for each traffic class:

Bandwidth utilization	Effective use of nominal radio bandwidth allocated to Ethernet traffic.
Delay measurement	Measures the average packet delay.
Packet counters	Counts packets. Reported for LAN and WAN ports on both L2R and R2L direction.

6.4 Delay

Delay performance per link for priority traffic is <0.8 ms for Radio Link capacities below 50 Mbps and <0.5 ms for Radio Link capacities above 50 Mbps. Delay variation for priority traffic is <0.5 ms per link.

7 MINI-LINK PT 2010 Functions – Synchronization

7.1 Overview

MINI-LINK PT 2010 is by default working in Free Running mode. In this mode the node is not a part of the synchronization network, and does not maintain a SEC.

MINI-LINK PT 2010 can also be configured to Network Synchronized mode where the node maintains a SEC and distributes synchronization and synchronization quality level status according to ITU-T G.8261, G.8262, and G.8264.

7.1.1 Network Synchronized Mode

With Network Synchronized mode it is possible to build a synchronized network where all the NEs are synchronized to the same source. Figure 18 shows an example of a network where the synchronization information is carried to all the NEs through an assigned path. In case of link failures the synchronization may be reestablished using the unassigned synchronization paths.

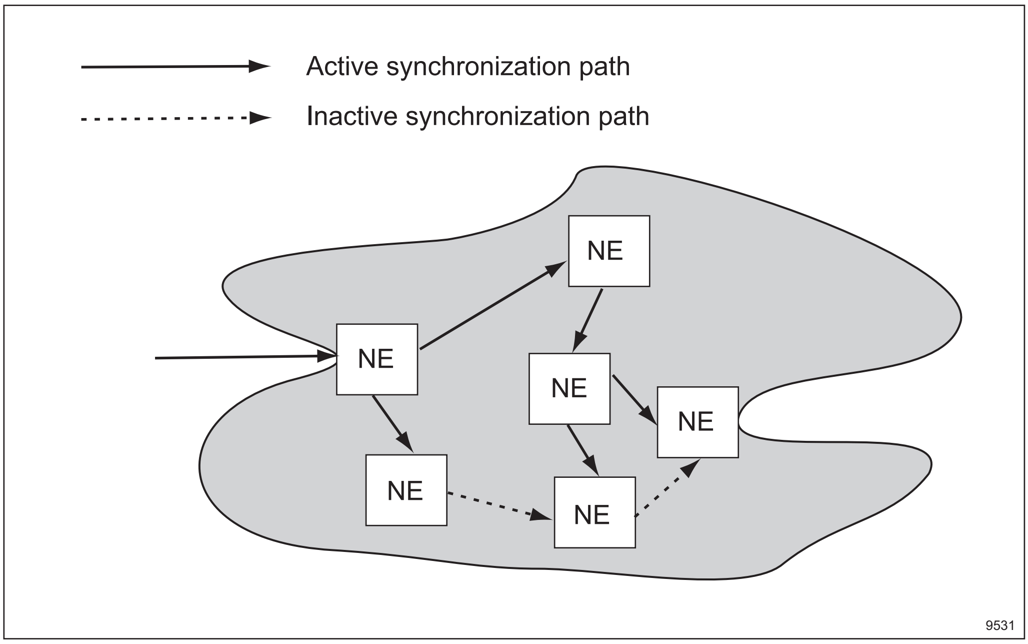

Figure 18 Master-Slave Synchronized Network

In this mode MINI-LINK PT 2010 will use the Node Clock on all the protocol layers generated in the node.

7.2 Synchronization Technologies

Figure 19 shows the different synchronization functions supported by MINI-LINK PT 2010.

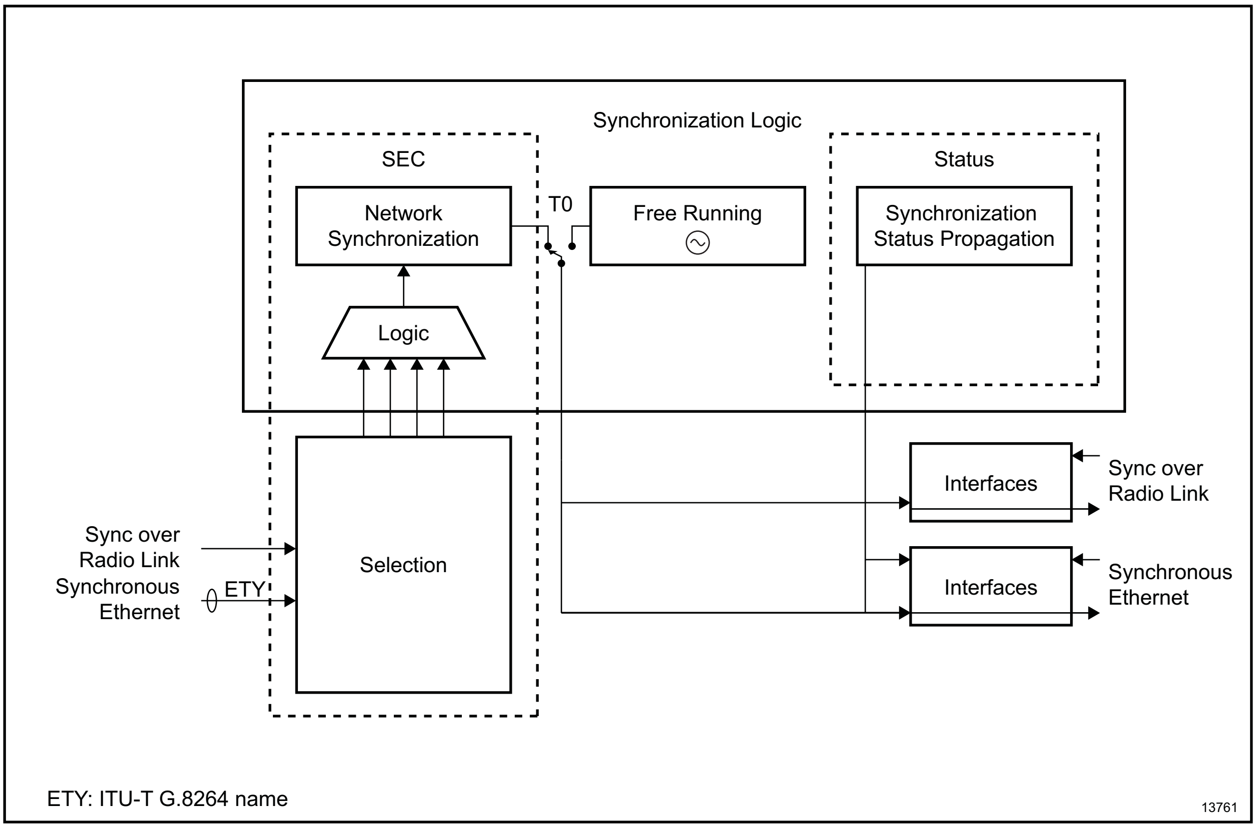

Figure 19 MINI-LINK PT 2010 Synchronization Functions

Synchronous Ethernet enables propagation of frequent synchronization over optical SFPs. The feature provides full SSM handling according to ITU-T G.8264.

The SEC performs automatic synchronization trail restoration based on the priority table and the status of the inputs. In the event of failure of all synchronization source nominees, the SEC enters free running mode using its own internal clock as source.

The SEC clock is distributed throughout the magazine. In network synchronized mode all terminated protocol layers interfaces will follow the SEC.

8 MINI-LINK PT 2010 Hardware

8.1 Packet Terminal

8.1.1 Overview

MINI-LINK PT 2010 is a weatherproof box painted light gray, with a handle for lifting and hoisting. There are also two hooks and catches to guide it for easier handling, when fitting to or removing from an integrated antenna. It comprises a cover and a MINI-LINK PT 2010 terminal.

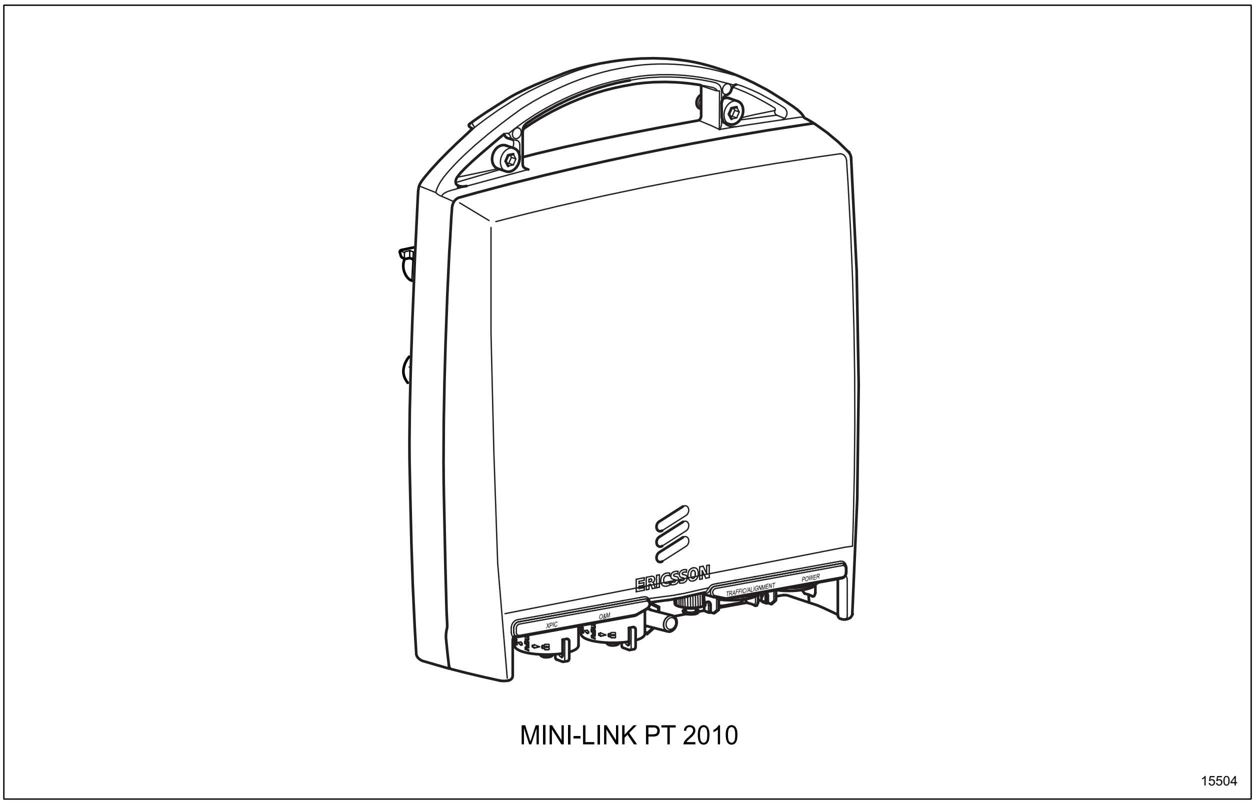

Figure 20 MINI-LINK PT 2010 Mechanical Design

The operating frequency is determined by MINI-LINK PT 2010 and is pre-set at factory and configured on site using MINI-LINK Craft.

8.1.2 External Interfaces

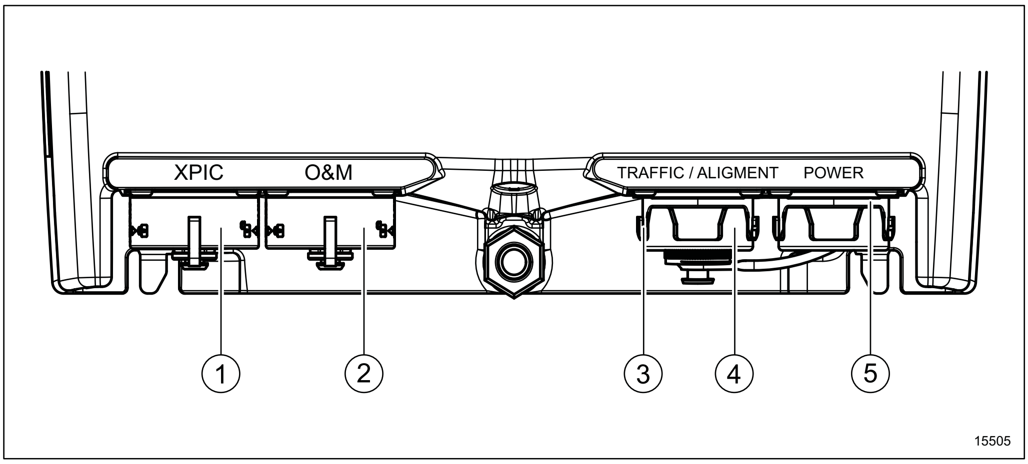

Figure 21 External Interfaces, MINI-LINK PT 2010 Mechanical Design

Item	Description
1	Socket for XPIC cable.(1)
2	Operation & Maintenance socket for local O&M cable, access to RMM port.
3	Optical fiber input socket for traffic cable.
4	Test port for antenna alignment.
5	Power input socket for power cable.

(1) XPIC is not available in this release.

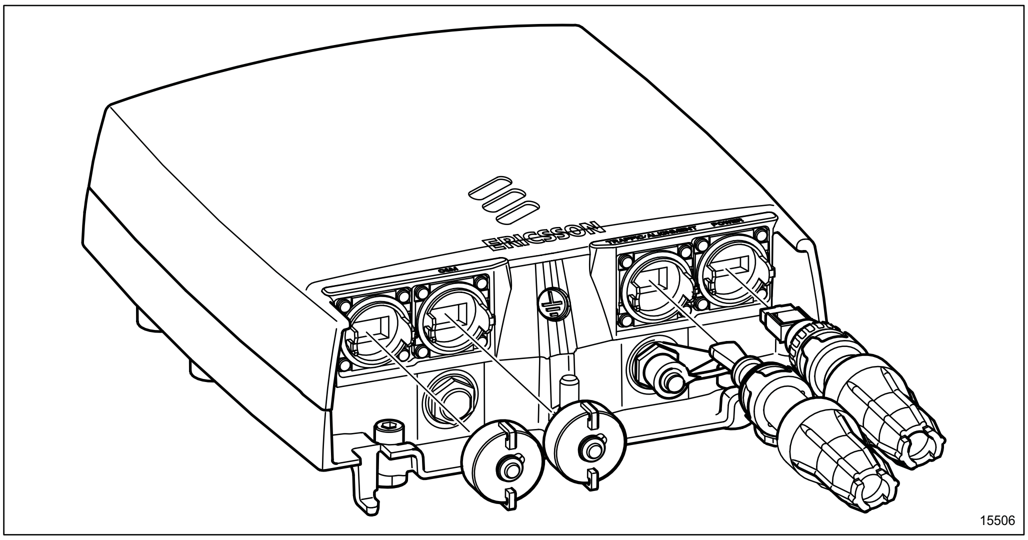

Figure 22 Environmental Seals, MINI-LINK PT 2010 Mechanical Design

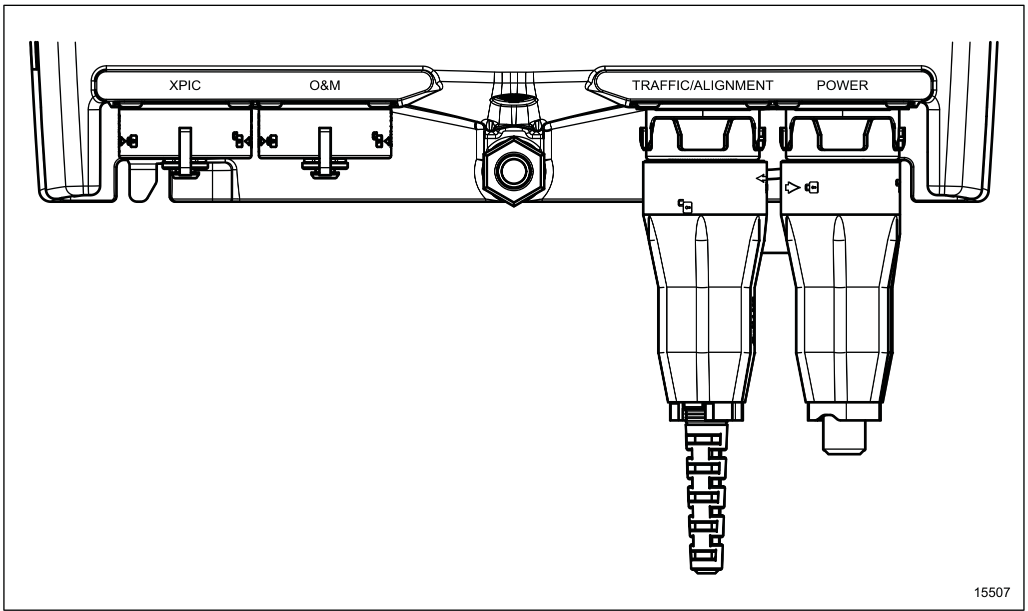

Figure 23 Environmental Seals, MINI-LINK PT 2010 Mechanical Design

MINI-LINK PT 2010 is environmentally sealed, so that it can withstand most conditions. The O&M, power supply and optical fiber cable are sealed, the power supply cable is also shielded as a form of grounding.

8.2 Antennas

8.2.1 Description

The antennas range from 0.2 m up to 1.8 m in diameter, in single and dual polarized version. All antennas are ‘‘compact’’, that is the design is compact with a low profile. The antennas are made of aluminum and painted light gray. All antennas have a standardized waveguide interface. The feed can be adjusted for vertical or horizontal polarization.

All antennas are delivered with a mounting kit.

All high performance antennas have an integrated radome.

8.2.2 Installation

8.2.2.1 Integrated Installation

For a 1+0 configuration, the MINI-LINK PT 2010 is fitted directly to the rear of the antenna in integrated installation. Single polarized antennas up to 1.8 m in diameter are normally fitted integrated with the MINI-LINK PT 2010.

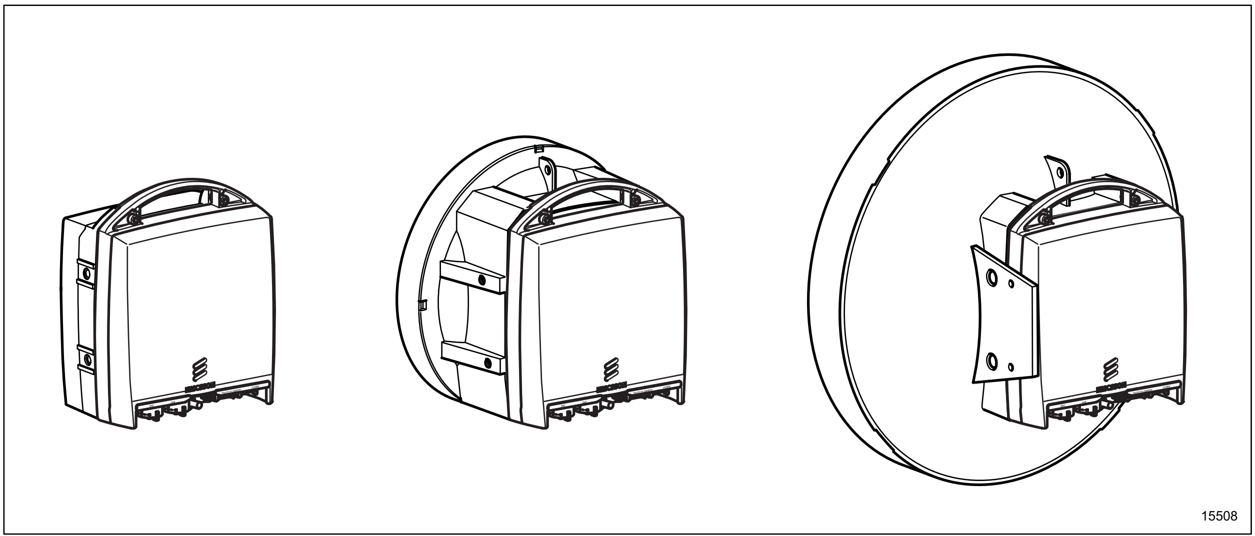

Figure 24 0.2 m, 0.3 m, and 0.6 m Compact Antennas Integrated with MINI-LINK PT 2010s

MINI-LINK PT 2010 can be fitted directly to an Integrated Power Splitter (IPS).

An asymmetrical power splitter is mainly used for hardware protection only. The IPS provides one main channel with low attenuation and one standby channel with higher attenuation.

A symmetrical power splitter is mainly used for frequency diversity. The IPS provides equal attenuation in both channels.

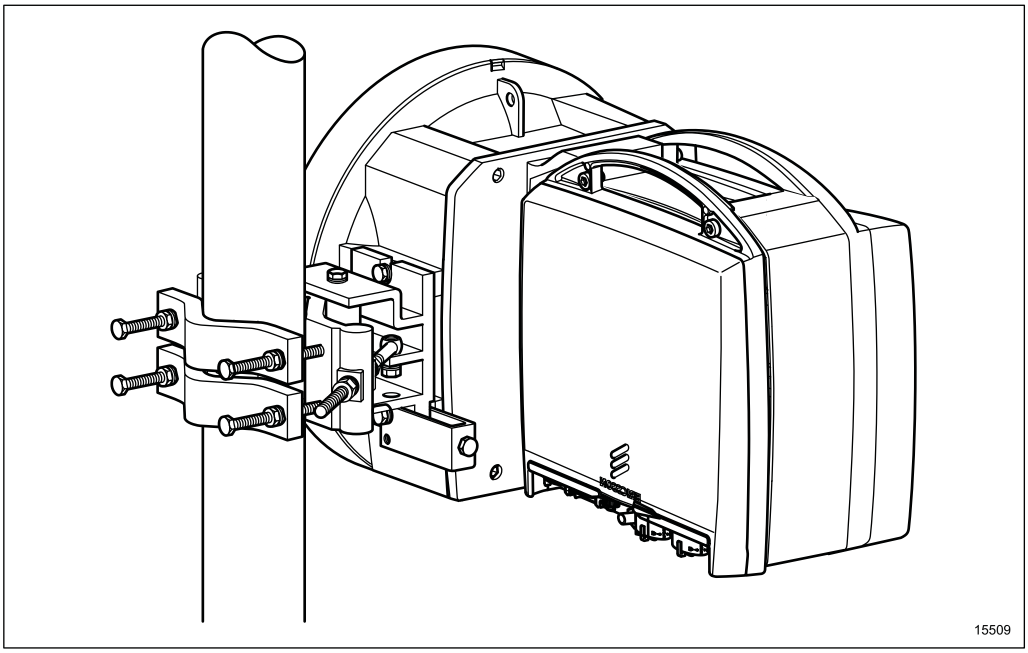

Figure 25 MINI-LINK PT 2010s Fitted to Integrated Power Splitter

The 0.3 m and 0.6 m Integrated dual polarized antennas are used with two MINI-LINK PT 2010s.

8.2.2.2 Separate Installation

All antennas have a standardized waveguide interface and can be installed separately, by using a flexible waveguide to connect to the MINI-LINK PT 2010. The 2.4–3.7 m dual polarized and single polarized antennas are always installed separately.

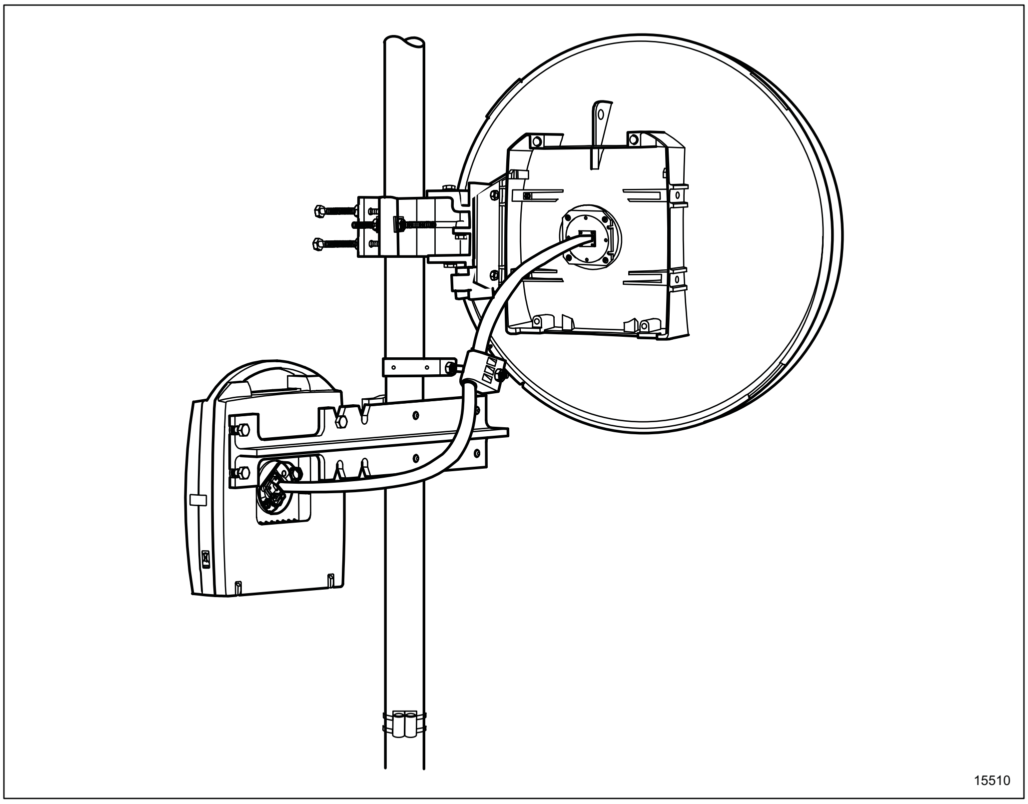

Figure 26 Separate Installation in a 1+0 Configuration

9 Management

9.1 DCN

This section covers the Data Communication Network (DCN) functions provided by MINI-LINK PT 2010.

9.1.1 IP Services

The following standard external IP network services are supported:

- All clocks, used for example, for time stamping alarms and events, can be synchronized with a Network Time Protocol (NTP) server.
- File Transfer Protocol (FTP) is used as a file transfer mechanism for software upgrade, and for backup and restore of system configuration.
- Domain Name System (DNS) enables the use of host names.
- Dynamic Host Configuration Protocol (DHCP) is used by the DHCP relay agent to forward DHCP messages to other equipment connected to the site LAN. MINI-LINK PT 2010 does not, however, support DHCP to allocate IP addresses in the network and DNS.

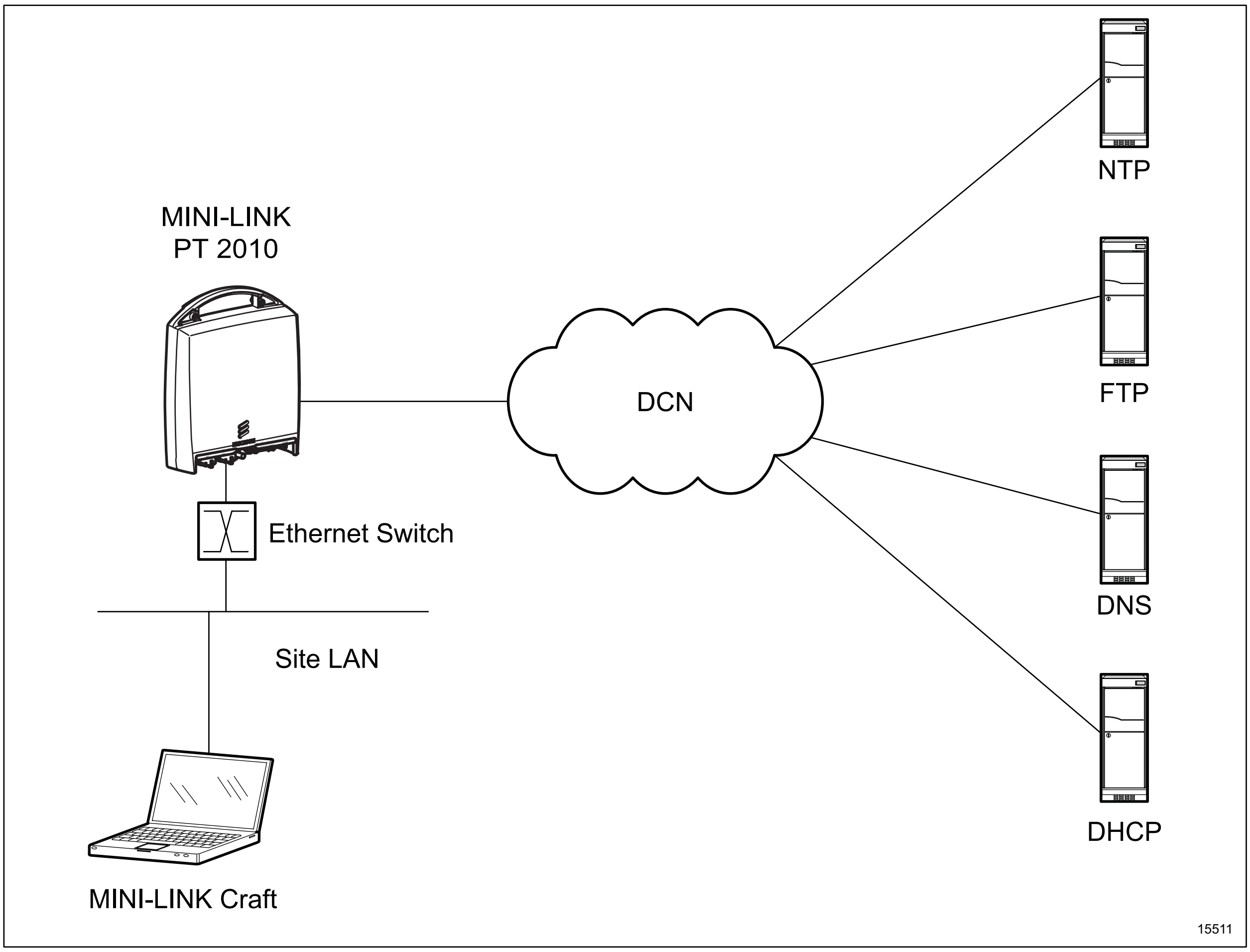

Figure 27 IP Services

9.1.2 DCN Interfaces

MINI-LINK PT 2010 provides an IP based DCN for transport of its O&M data. Each NE has an IP router for handling of the DCN traffic. Figure 28 illustrates the DCN configuration.

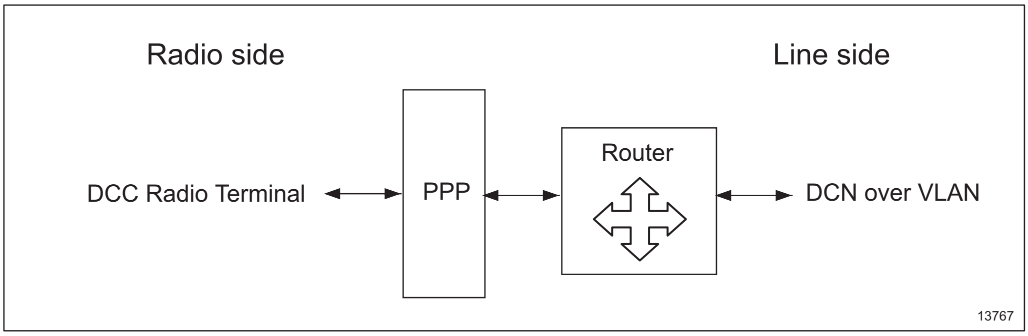

Figure 28 DCN Interfaces

The DCN is carried in-band on the optical fiber or the Radio Link on a separate VLAN. This VLAN is terminated in the MINI-LINK PT 2010.

9.1.2.1 DCC Radio Terminal

Each Radio Terminal provides a DCC of n×64 kbits, where $1 \leq n \leq 6$ depending on traffic capacity and modulation, transported in the radio frame overhead.

9.1.3 IP Addressing

MINI-LINK PT 2010 supports numbered PPP. This means that the line side Ethernet port and radio side PPP port have two different IP addresses.

MINI-LINK PT 2010 supports static routing, where each route is a typed destination, subnet mask, and gateway.

The remote supervision of MINI-LINK PT 2010 can be realized with a connection either over the line side in-band DCN or management VLAN, or the PPP interface over the radio link.

9.2 Management Tools and Interfaces

This section gives a brief overview of the management tools and interfaces used for MINI-LINK PT 2010.

The Ethernet Management Port interface is used for a MINI-LINK Craft connection, locally at the Packet Terminal and for initial set up. It is not connected to the router.

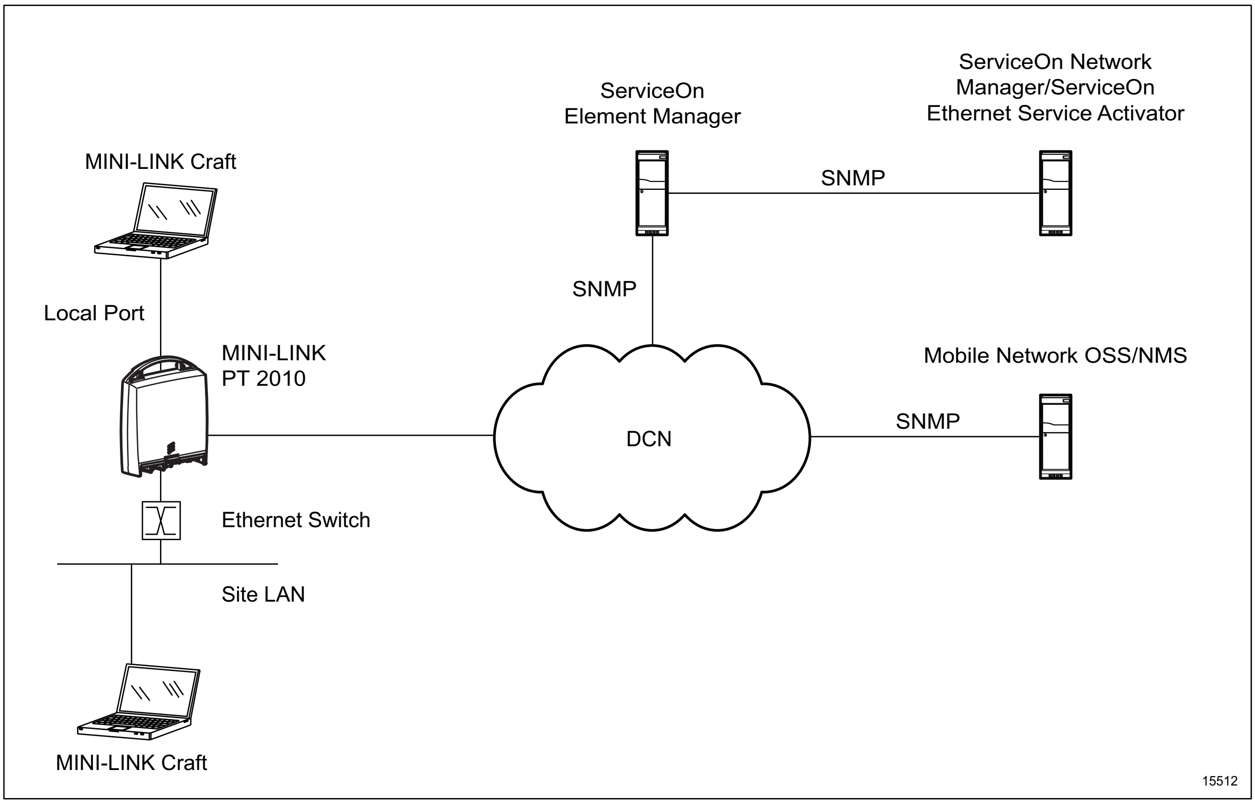

Figure 29 Management Tools and Interfaces

9.2.1 MINI-LINK Craft

MINI-LINK Craft provides tools for on-site installation, configuration management, fault management, performance management and software upgrade. It is also used to configure the traffic routing function, protection and DCN.

MINI-LINK Craft is used for local management, that is the Packet Terminal is accessed locally, on the unit, by connecting a PC to the Ethernet Management Port, with a cable.

The Packet Terminal can also be accessed over the site LAN. In this case, a VLAN capable Ethernet switch has to be used, and the port where Craft is connected should be configured to be on the same VLAN as set up for the in-band DCN.

9.2.2 ServiceOn Element Manager

MINI-LINK PT 2010 is managed remotely using ServiceOn Element Manager. ServiceOn Element Manager provides functions such as FM, CM, AM, PM and SM based on the recommendations from Open Systems Interconnect (OSI) model. The CM functionality is either embedded or provided using dedicated

Local Managers and Element Managers. ServiceOn Element Manager can also be used to mediate FM, PM and Inventory data to other management systems.

The system provides:

- Fault Management
- Configuration Management
- Performance Management
- Security Management
- Remote Software Upgrade

ServiceOn Element Manager provides element management services across a whole network. Network elements can be managed on an individual basis, providing the operator with remote access to several network elements, one by one.

ServiceOn Element Manager supports a real time window reporting alarms and events from the managed network elements. It is possible to filter alarms on the basis of assigned resources and alarm filtering criteria.

9.2.3 ServiceOn Ethernet Service Activator

The ServiceOn Ethernet Service Activator (SO ESA) system is a network management level application providing operators with the ability to support the end to end configuration and management of Ethernet services on packet enabled Ericsson transport products.

The SO ESA management application supports Integration with ServiceOn Element Manager for equipment level management and feature discovery.

9.2.4 SNMP

Each NE provides an SNMP agent enabling easy integration with any SNMP based management system. The SNMP agent can be configured to support SNMP v1/v2c/v3 for get and set operations. SNMP v3 is default. The SNMP agent sends SNMP v1, SNMP v2c and SNMP v3 traps.

The system is built on standard MIBs as well as some private MIBs.

9.3 Configuration Management

All Configuration management operations are performed using MINI-LINK Craft. The following list gives examples of configuration areas:

- Transmission interface parameters

- DCN parameters, such as host name, IP address
- Packet Terminal parameters, such as frequency, output power, ATPC and protection

9.3.1 Configuration File

The configuration file is stored both in the RMM and in a flash memory on the MINI-LINK PT 2010 and both memories must correspond to the same configuration file. The configuration file is identified using the serial number of the MINI-LINK PT 2010 or the fingerprint of the RMM.

If a MINI-LINK PT 2010 needs to be replaced, the RMM from the faulty MINI-LINK PT 2010 can be inserted in the new MINI-LINK PT 2010.

If a MINI-LINK PT 2010 or an RMM is replaced, the configuration file identity of the RMM and flash memory are compared on power up. If the configuration file identity differs between the two locations, it must be restored.

9.4 Fault Management

All software and hardware in operation is monitored by the control system. The control system locates and maps faults down to the correct replaceable hardware unit. Faults that cannot be mapped to one replaceable unit result in a fault indication of all suspect units (this may be the whole NE).

The control system will generally try to repair software faults by performing warm restarts on a given plug-in unit or on the whole NE.

9.4.1 Alarm Handling

MINI-LINK PT 2010 uses SNMP traps to report alarms to ServiceOn Element Manager or any other SNMP based management system. To enable a management system to synchronize alarm status, there is a notification log (alarm history log) where all traps are recorded. There is also a list of current active alarms. Both these can be accessed by the management system using SNMP or from the MINI-LINK Craft. The alarm status of specific managed objects can also be read.

In general, alarms are correlated to prevent alarm flooding. Correlation will cause physical defects to suppress alarms, like AIS, at these higher layers.

Disabling alarm notification means that no new alarms or event notifications are sent to the management systems.

Alarm and event notifications are sent as SNMP v2c/v3 traps with a format according to Ericsson’s Alarm IRP SNMP solution set version 1.2. The following fields are included in such a notification:

- Notification identifier: uniquely identifies each notification.
- Alarm identifier: only applicable for alarms, identifies all alarm notifications that relate to the same alarm.
- Managed object class: identifies the type of the source.
- Managed object instance: identifies the instance of the source like 1/11/1A.
- Event time: time when alarm/event was generated.
- Event type: X.73x compliant alarm/event type like communications alarm and equipment alarm.
- Probable cause: M.3100 and X.733 compliant probable cause, for example, Loss Of Signal (LOS).
- Perceived severity: X.733 compliant severity, for example, critical or warning.
- Specific problem: free text string detailing the probable cause.

The system can also be configured to send SNMP v1 traps. These traps are translated from the IRP format using co-existence rules for v1 and v2/v3 traps (RFC 2576).

For a full description of alarms see user documentation.

9.4.2 Test Functions

Test functions can be used to verify that the transmission system is working properly or they can be used to locate a faulty unit or interface.

9.5 Performance Management

9.5.1 General

The purpose of Performance Management for the Packet Terminal is to monitor the performance of the RF Interface according to G.826.

The following performance counters are used:

- Errored Seconds (ES)
- Severely Errored Seconds (SES)
- Background Block Error (BBE) (only structured interfaces)
- Unavailable Seconds (UAS)

- Elapsed Time

The performance counters above are available for 15 minutes and 24 hours intervals. The start time of a 24 hours interval is configurable.

The following counters are stored in the NE:

- Current 15 minutes and the previous 96×15 minutes
- Current 24 hours and the previous 24 hours

Performance data is stored in a volatile memory, so that a restart will lose all gathered data.

9.5.2 Adaptive Modulation

With the same intervals as mentioned in Section 9.5.1 on page 42, the seconds spent in each modulation as well as the number of changes between modulations are counted.

9.5.3 Ethernet Performance Counters

The following Ethernet performance counters are available:

Bandwidth

- Average, Max, and Min bandwidth
- Bandwidth utilization histogram

Delay

- Average, Max, and Min delay
- Delay histogram

Traffic Performance

- Number of sent/received octets
- Number of sent/received Unicast packets
- Number of sent/received Multicast packets
- Number of sent/received Broadcast packets
- Number of sent/received discarded packets
- Number of Errors, that is, packets that could not be sent due to errors.

9.6 Hardware Management

MINI-LINK PT 2010 is a single unit consisting of both a modem unit and a radio unit.

The replaceable parts of a MINI-LINK PT 2010 system are:

- SFP
- RMM
- MINI-LINK PT 2010 unit.

When replacing an optical SFP, no configuration is needed.

RMMs containing new licenses can be replaced, no new configuration is needed.

When replacing a MINI-LINK PT 2010 unit, the new MINI-LINK PT 2010 must be configured according to the set up requirements. The previous RMM or a new RMM must be inserted as they are not included with the package.

9.7 Software Management

MINI-LINK PT 2010 software and Packet Terminal software is upgraded using load modules. Each load module is downloaded from an FTP server and stored in the flash memory.

The upgrade is manually started by the operator who specifies product and revision number of the load module to be upgraded. When flash programming is completed, a MINI-LINK Craft connected to the MINI-LINK PT 2010 automatically activates the upgraded software, if the activation is not traffic affecting, otherwise the operator is requested to manually perform the activation in the planned maintenance window.

9.8 License Management

MINI-LINK PT 2010 has a smart card reader on the board, and the RMM containing licenses can be accessed through the Ethernet Management Port. Optional features can be expanded by installing license keys that enable additional optional features. Licenses for optional features are distributed in a License Key File (LKF), which can be stored on the RMM.

Features for the MINI-LINK PT 2010 are only enabled if a corresponding license is available on the inserted RMM.

To upgrade the licenses on the MINI-LINK PT 2010, new licenses can be downloaded remotely.

The license key installation can be made both locally and remotely, without disturbing the traffic through the NE. License keys can also be preinstalled at delivery, when a complete and preconfigured NE is purchased.

10 Accessories

The MINI-LINK PT 2010 product program contains a number of accessories for installation and operation. This section gives additional technical information for some accessories.

10.1 Cables and Cable Clamps

The cables in Figure 30 and Figure 31 have fixed lengths with connectors.

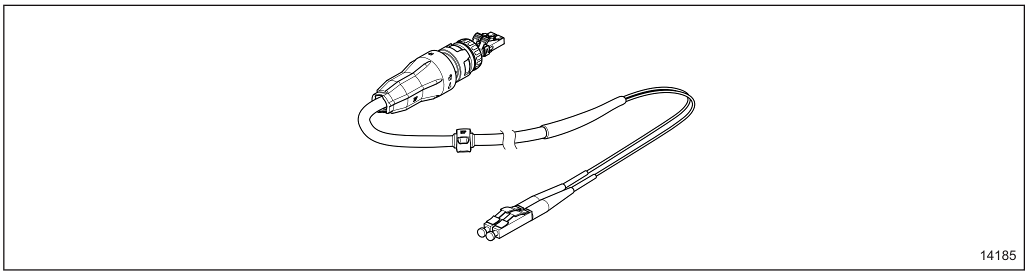

Figure 30 Indoor Optical Cable

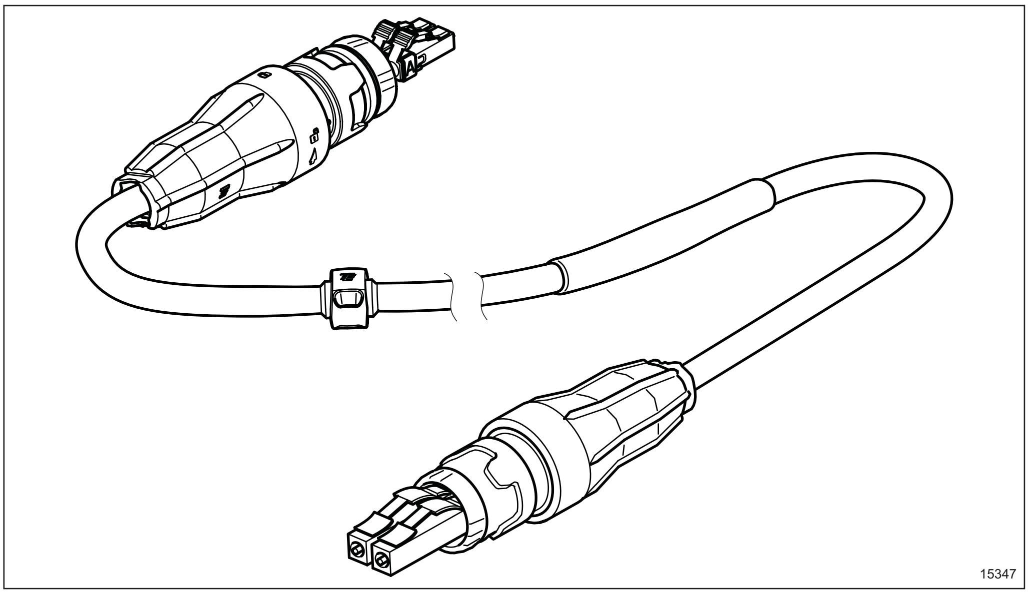

Figure 31 Indoor Extension Cable

The power cable in Figure 32 has one open end.

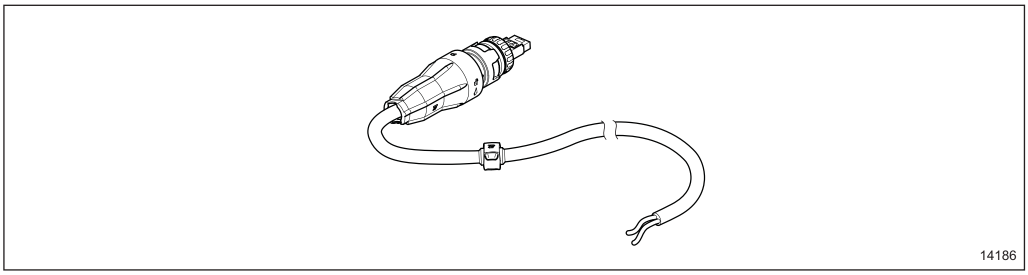

Figure 32 Power Cable

The field installable shielded power cable connector kit in Figure 33 and Table 7 can be used with the power cables in Table 8.

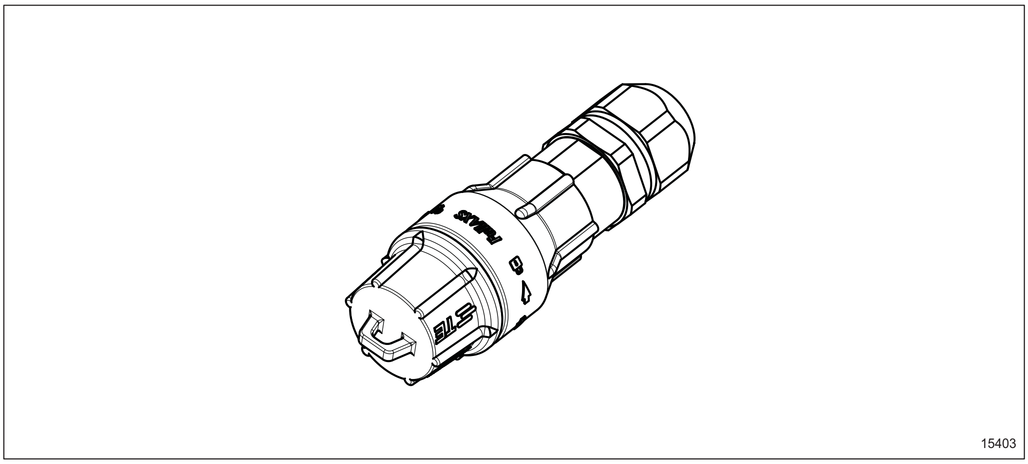

Figure 33 Field Installable Fullax Power Connector Kit

Table 7 Power Cable Connector Kit

Product Name	Product Number
Field installable shielded cover	SDF 107 239/001

The power cables in Table 8 can be used with the power cable connector in Table 7.

Table 8 Fixed Length Cables without Connectors

Product Name	Product Number
Power cable, x m (10 m increments)	NTM 203 72/x

The cable clamps in Table 9 can be used with the cables for MINI-LINK PT 2010.

Table 9 Cable Clamps

Product Name	Product Number
Cable clamp, 10 pcs	NTM 203 73/1
Cable clamp, 50 pcs	NTM 203 73/2

The stacking kit in Table 10 can be used with the cable clamps of MINI-LINK PT 2010.

Table 10 Stacking Kit

Product Number	Description
Stacking Kit, 10 pcs	NTM 203 74/1
Stacking Kit, 50 pcs	NTM 203 74/2

The earthing kit in Figure 34 is used for lightning protection of outdoor cables.

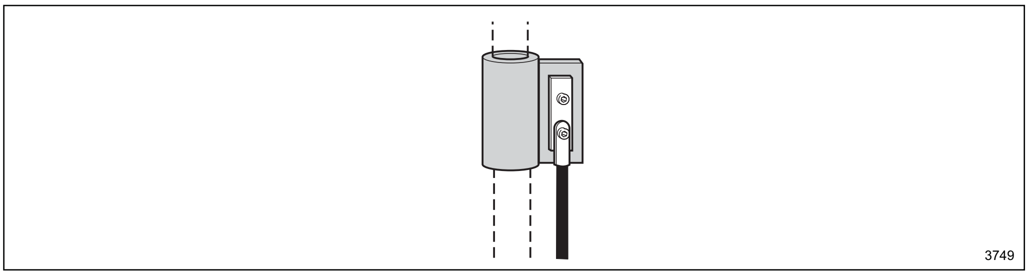

Figure 34 Earthing Kit

10.2 Hybrid Cable

The hybrid cables in Figure 35 contain both optical and power cables.

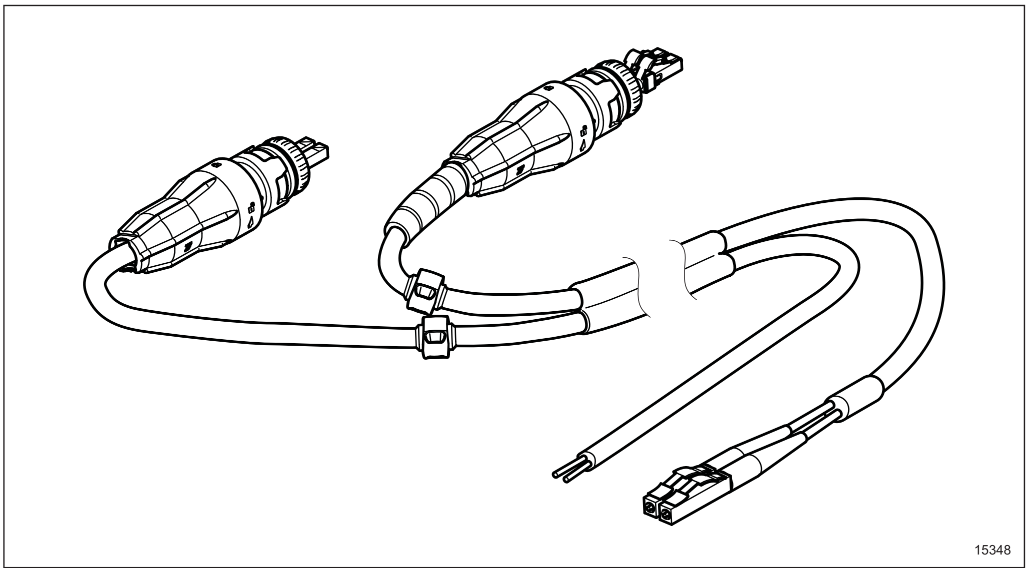

Figure 35 Hybrid Cable

10.3 Optical Cable Distribution System

The cables in Figure 36 and Figure 37 can be used for distributing the optical cables to several MINI-LINK PT 2010s.

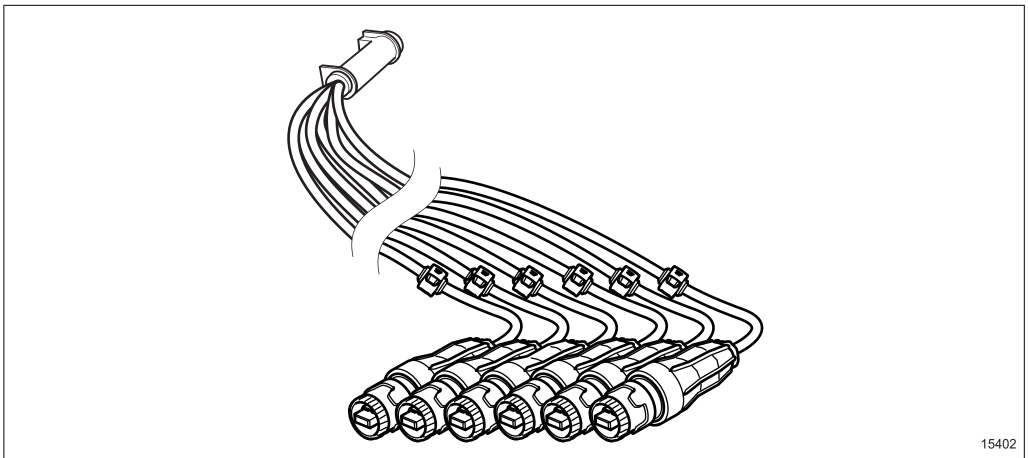

Figure 36 Outdoor Mini FAN Out Box

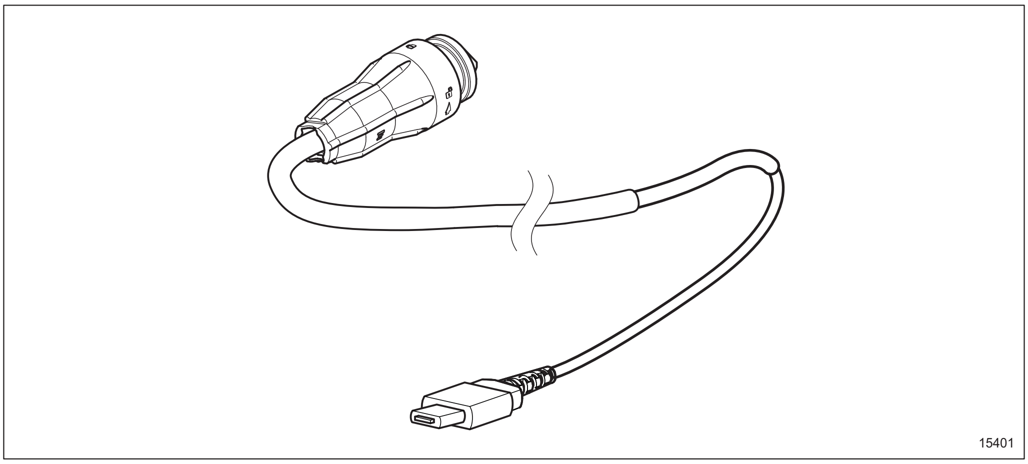

Figure 37 Outdoor Multi Fibre Cable

10.4 SFP

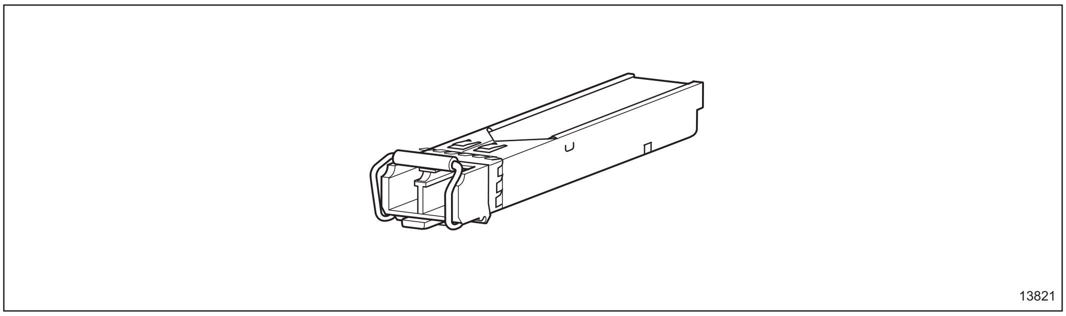

Figure 38 SFP

The Small Form Factor Pluggables (SFPs) in Table 11 can be used in MINI-LINK PT 2010.

Table 11 SFPs

Product Name	Product Number
SFP GB-LX 1310 nm (SFP 1000BASE-LX 1310 nm, 10 dB, 10 km, LC Duplex)	RDH 901 20/D0210
TRX MM 1000Base-SX LC-SFP −40/+85°C	RDH 102 44/11
TRX SM "1000Base-ZX" LC-SFP −40/+85°C	RDH 102 44/41

Product Name	Product Number
TRX SM CPRI dual rate 614/1228 Mbps, 1GBE-LX, 12.5 dB LC-SFP receptacle −40/+85°C	RDH 102 45/1
TRX SM CPRI dual rate 614/1228 Mbps, 1GBE-LX, 12.5 dB LC-SFP receptacle −40/+85°C	RDH 102 47/4

11 Technical Specifications

This section summarizes some technical specifications for MINI-LINK PT 2010.

11.1 Power Supply Requirements

MINI-LINK PT 2010 is power supplied by a fully isolated −48 V input.

11.2 Environmental Conditions

Equipment operates according to the following constraints:

- Continuous Conditions (Full performance)
  - Temperature: −33°C to +45°C (−27°F to +113°F), Solar radiation up to 1120 W/m^2 (104 W/ft^2)
  - Temperature: −33°C to +55°C (−27°F to +131°F), No solar radiation
  - Relative Humidity: 8–100%

  Full function and full performance state is reached within 30 minutes at power up of equipment from −5°C (41°F), and within 10 minutes at power up from 20°C (68°F) and up.

- Extended Continuous Conditions (Safe Function)
  - Temperature: −45°C to +60°C (−49°F to +140°F), No solar radiation

11.3 Dimensions and Weight

The following dimensions and weight apply for the MINI-LINK PT 2010:

- Max Weight: 6.5 kg
- Nominal Dimensions (D×W×H): 117.3×260×321 mm

11.4 Traffic Interfaces

Optical Laser Class 1 SFP: RDH 102 45/1 (or functional identical).

Functional identical to RDH 102 45/1 means:

- Optical laser class 1
- SFP Transceiver MSA, Sep 2000
- SFF-8472
- IEEE802.3z 1000 BASE X
- GbE data handling

ALS is not handled.