Product Description

EH-1200T, EH-1200F

March 2016

Release: 1.4

sales@pulsesupply.com | www.pulsesupply.com/siklu

Table of Contents

info@siklu.com
www.siklu.com

info@siklu.com
www.siklu.com

Document Information

Revision	Date	Author	Revision notes
1	**30.2.2014**	**Rachel Cohen**	**Created**
1.1	**17.05.2014**	**Rachel Cohen**	**Tables update**
1.2	**31.05.2015**	**Rachel cohen**	**Updating to new format and editing**
1.3	**11.2.2016**	**Rachel Cohen**	**Adding EH-1200T**
1.4	**23.3.2016**	**Rachel Cohen**	**Adding 125MHz channels to EH-1200T**

Intended Audience

- **Solution and network planning staff**
- **Telecom backhaul engineers**
- **Wireless ISP, business connectivity and wireless security networks pre-sale engineers**

Terminology used in this document assumes basic audience familiarity with microwave communication technology.

Comments and suggestions are welcome to: info@siklu.com

1. Introduction

The EtherHaul-1200F and EtherHaul-1200T are Siklu's award winnings next generation, millimeter-wave, all- outdoor, Ethernet backhaul products. The EH-1200F is FDD based operating at the 71-76 GHz and 81-86 GHz, and the EH-1200T is TDD based operating at 71-76 GHz. Both products operate at licensed E-Band and features:

- **Up to 1 Gbps Ethernet capacity**
- **Carrier grade networking capabilities & 4 physical Ethernet ports**
- **Enhanced, hitless Adaptive Bandwidth, Coding & Modulation capabilities for maximum spectral efficiency**
- **Silicon based radio and modem with low power consumption**
- **point-to-point, daisy-chain, ring and mesh configurations**

Designed with strenuous carrier wireless backhaul demands in mind, the EtherHaul products are perfectly suitable for mobile backhaul, enterprise main and backup connectivity or any Ethernet based service provider networks.

Siklu's EtherHaul wireless backhaul products operating in the E-band spectrum has clear technological and economic advantages over the existing lower frequency bands. Taking advantage of the new spectrum, the EtherHaul products enables easy migration to support Gigabit throughput – allowing operators to enhance bandwidth capacity on a "pay as you grow" basis. , With its unique combination of small footprint and reach capabilities, EtherHaul products are offering the most cost effective carrier class availability and services delivery.

Easily integrated into provider or enterprise networks, out-of-the-box up & running capable, the EtherHaul products provides advanced carrier Ethernet features including cutting-edge, integrated Layer 2 switching and Ethernet OA&M capabilities. Highly-scalable, the EtherHaul products are software-upgradable to support future Layer 2.5/3 networking and routing capabilities as networks evolve to flat-IP topologies.

Enhancing the inherent reliability and robustness of the E-Band frequency spectrum, the EtherHaul products features advanced adaptive modulation, bandwidth and coding - allowing operators to maintain, prioritize, and verify QoS in all weather conditions, while achieving maximum (up to 99.999%) link availability.

info@siklu.com
www.siklu.com

Offering easy and low cost all-outdoor installation and a small form factor, the EtherHaul products are also environmentally-friendly - boasting a small system and antenna footprint, and especially low power consumption.

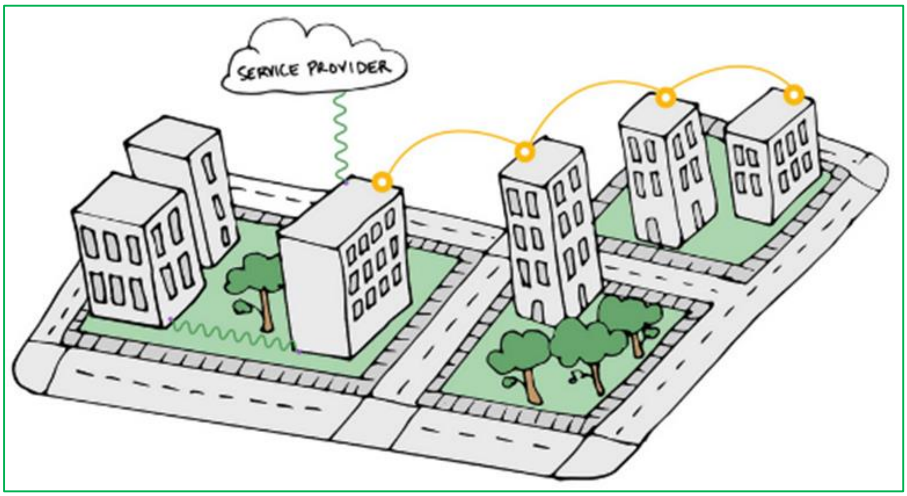
The EtherHaul systems are High-capacity Gigabit Ethernet backhaul, with advanced networking capabilities, at the lowest TCO in the industry. EtherHaul enables mobile operators to profitably and reliably provide data intensive services. Provided by Siklu, the pioneer in silicon based mm-waves backhaul systems, EtherHaul systems are the perfect choice for future proof investment.

info@siklu.com
www.siklu.com

1.1 Typical Applications

- **Mobile backhaul**
- **Business service connectivity**
- **Disaster recovery**
- **Public Wi-Fi backhauling**
- **Campus connectivity**
- **Building to building short-haul interconnections**
- **Smart-cities networks**

Siklu's Etherhaul design took into consideration the requirements to support each of above listed applications, at the most cost-effective available today in the market, without compromising reliability neither rich features set.



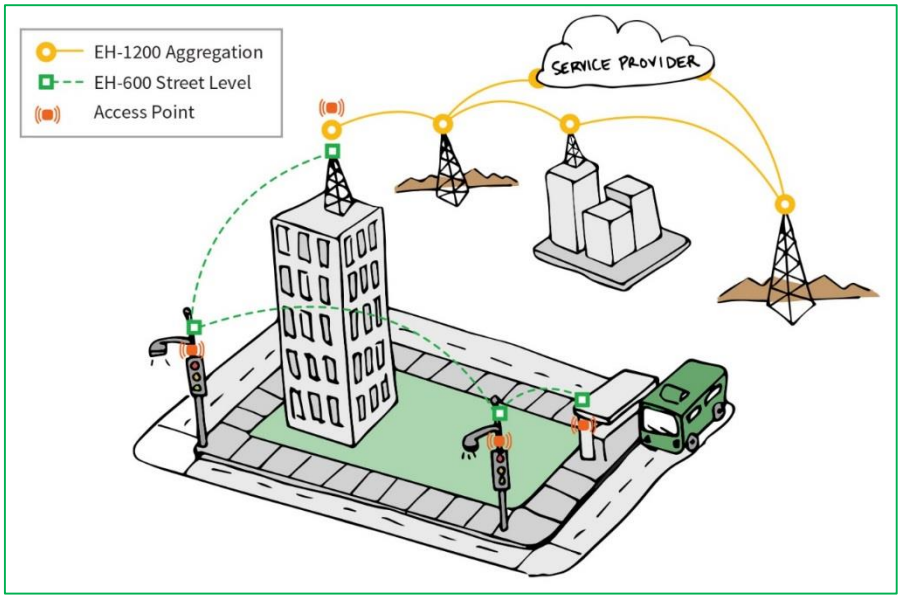


Figure 1 – mobile backhaul and business services connectivity

info@siklu.com
www.siklu.com

Service provider's solutions for services such as mobile backhaul and business connectivity requires high capacity, low latency, high reliability, quick installation and maintenance.

For cellular network expansion, Siklu's EtherHaul also includes advanced synchronization technologies: SyncE and 1588v2 (TC). The synchronization capabilities combined with the metro-Ethernet-forum compliant networking features that includes: 8 levels of strict-priority and weighted-fair-queues QOS, policing and shaping.

Services availability and performance is easily planned with variety of standard based wireless planning tools. Siklu's free, online link-budget-calculator tool, brings enables fast link capacity and availability planning to further ease service deployments. The EtherHaul also features enhanced hitless adaptive bandwidth, coding, and modulations for maximum spectral efficiency, and services availability. It supports advanced OAM & PM tools, network synchronization, and ring protection optimized for both small cell and mobile backhaul applications

Easily integrated into service-provider networks, out-of-the-box up & running capable. Highly-scalable, the EtherHaul is software-upgradable to support future networking and routing capabilities as networks evolve.

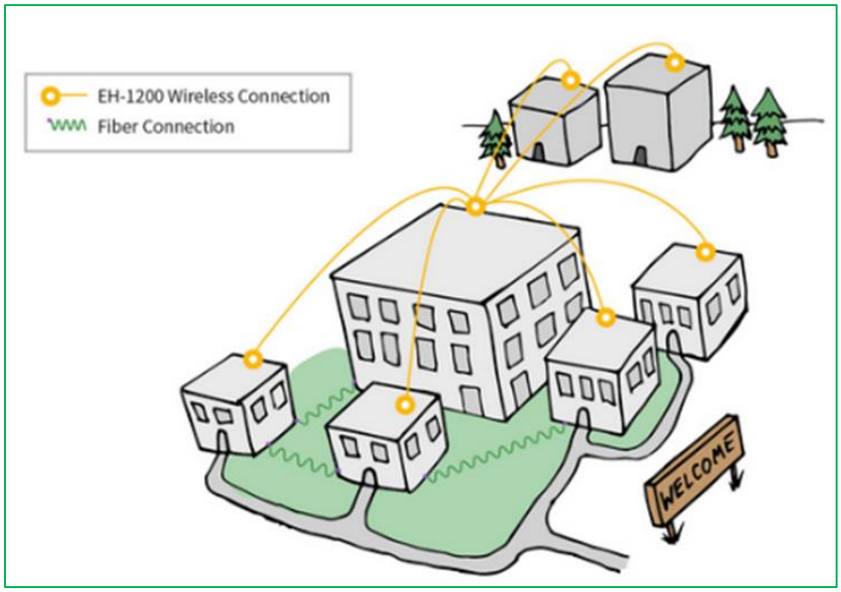


Figure 2 – Campus and building to building connectivity

The Etherhaul products enables the industry's tinyiest volume per-megabit connectivity ensuring high capacity future proof networks. Etherhaul products

info@siklu.com
www.siklu.com

integrated Gigabit switch, eliminates the need for external boxed usually requiered by other solutions for supporting multiple feedings and cascading.

info@siklu.com
www.siklu.com

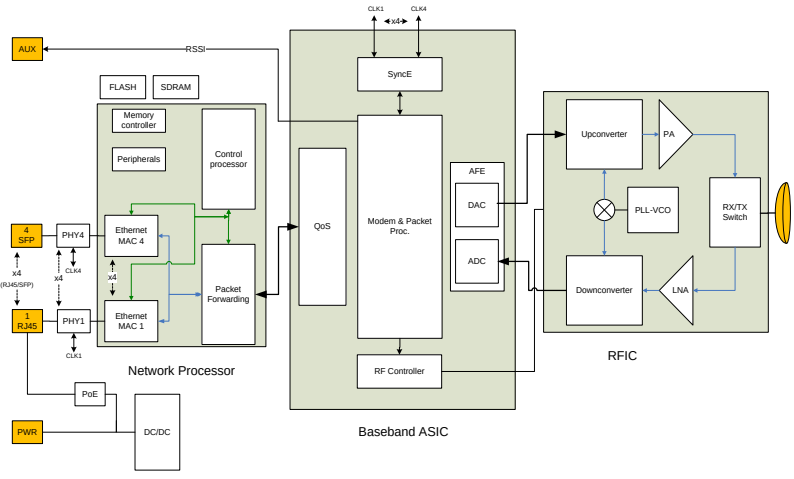
2. EtherHaul-1200 System Overview

2.1 Functional Blocks

The EtherHaul-1200 Family is all-outdoor units comprised of the following functional blocks:

a. **RFIC: Siklu's integrated Silicon Germanium (SiGe) transceiver operating at 71-76/81-86 GHz**
b. **Modem/Baseband ASIC: Siklu's modem/baseband ASIC includes the modem, FEC engines, and Synchronous Ethernet support.**
c. **Network Processor: the networking engine is the heart of the high speed bridge/router function. The engine receives packets from both Ethernet interfaces and from the modem. It is responsible for proper forwarding between these three ports.**
d. **Interfaces: The network interface consists of four integrated 100/1000 Ethernet ports.**
e. **Host processor (integrated with the network processor): the general purpose host processor controls the system, and the antenna alignment system.**
f. **Antenna: Siklu's self-designed, innovative cost effective antenna.**

TDD:



FDD:

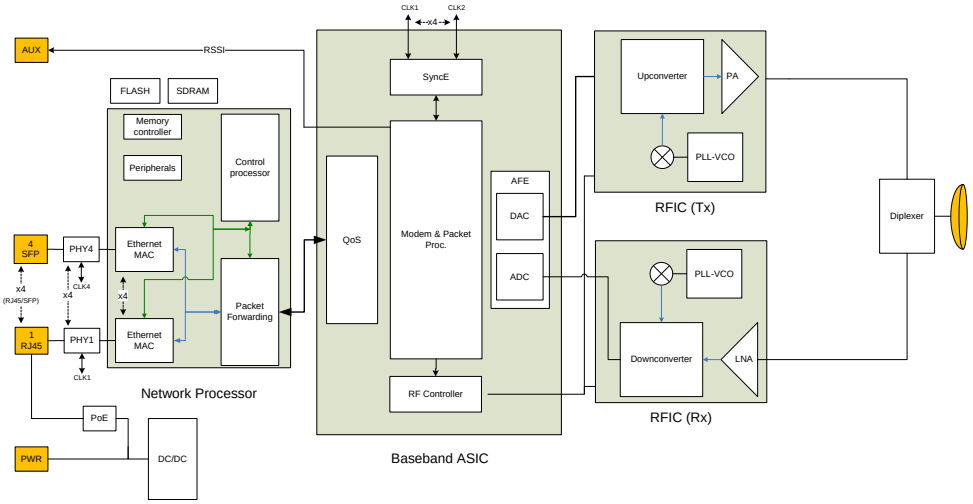


Figure 3 – EtherHaul-1200 Functional Block Diagram

info@siklu.com
www.siklu.com

2.2 EH-1200 Specifications Highlights

Feature		EH-1200F	EH-1200FX	EH-1200T	EH-1200TX
Frequency Duplexing	71-76 GHz, TDD 71-76/81-86GHz FDD	FDD	FDD	TDD	TDD
Modulation	QPSK-1/QPSK-2/QPSK-3/QAM16/QAM64	√	√	√	√
Adaptive rate	Hitless adaptive bandwidth, coding and modulation	√	√	√	√
System throughput	1000 Mbps aggregated 1000Mbps Full Duplex	Up to 1000Mbps FD	Fixed 1000Mbps FD	Up to 1000 Mbps aggregated	Basic 700Mbp Up to 1000 Mbps aggregated
Traffic Interfaces	GE ports	4x GE ports	2x GE copper ports	4x GE ports	4x GE ports
Antenna options	1ft (31cm) 43dBi antenna gain 2ft (65cm) 50dBi antenna gain	1ft, 2ft	1ft, 2ft	1ft, 2ft	1ft, 2ft
Ethernet features	IEEE 802.1d Transparent Bridging MAC learning Link state propagation Jumbo frames	√	√	√	√
	VLAN & VLAN stacking (QinQ- IEEE 802.1ad Provider Bridge) advanced QoS &Traffic management- 802.1p, DSCP & MPLS EXP Scheduling , Shaping, Policing	√	–	√	√
Synchronization	1588 TC Synchronous Ethernet ITU-T G.8261/8262/8264	√	–	√	–
Security	AES 128-bit and 256-bit	√	√	√	√
Advanced L2 features	Eth OAM (IEEE802.1ag/Y.1731/IEEE802.3ah) ITU-T G.8032 ERPS delivering sub 50mSec ring protection	√	–	√	–
Management, provisioning & commissioning	Web GUI (one click management of local & remote units), embedded CLI, SNMPv2/3, in-band, out-of-band Zero touch turn-up, TACACS+, RADIUS	√	√	√	√
ExtendMM		√	√	√	√
Environmental characteristic	Operating Temperature: -45° ÷ +55°C (-49° ÷ +131°F) Ingress Protection Rating - IP67	√	√	√	√
Input Power options specifications	PoE+ (IEEE 802.3at) voltage interface: ±21-57VDC Power supply redundancy (PoE and DC input)	All	PoE+ (IEEE 802.3at)	All	All

Table 1 : EtherHaul Specifications Highlights

info@siklu.com
www.siklu.com

3. EtherHaul-1200 detailed product specifications

3.1 Frequency band, channels and modulation schemes

3.1.1 Frequency band

The EtherHaul products operate at the standards based E-band frequency spectrum and supporting 125,250 MHz, 500MHz channel bandwidths.

Channeling range for EH-1200:

Low Band

- 500 MHz: 71375 + n x 500 MHz, n=0…8
- 250 MHz: 71250 + n x 250 MHz, n=0…18
- 125 MHz: 71187.5 + n x 125 MHz, n=0..37 (TDD only)

High Band

- 500 MHz: 81375 + n x 500 MHz, n=0…8
- 250 MHz: 81250 + n x 250 MHz, n=0…18

500MHz Channels			250MHz Channels			125MHz Channels	
	(MHz)			(MHz)			(MHz)
1	71375		1	71250		1	71187.5
2	71875		2	71500		2	71312.5
3	72375		3	71750		3	71437.5
4	72875		4	72000		4	71562.5
5	73375		5	72250		5	71687.5
6	73875		6	72500		6	71812.5
7	74375		7	72750		7	71937.5
8	74875		8	73000		8	72062.5
9	75375		9	73250		9	72187.5
			10	73500		10	72312.5
			11	73750		11	72437.5
			12	74000		12	72562.5
			13	74250		13	72687.5
			14	74500		14	72812.5
			15	74750		15	72937.5
			16	75000		16	73062.5
			17	75250		17	73187.5
			18	75500		18	73312.5
			19	75750		19	73437.5
						20	73562.5
						21	73687.5
						22	73812.5
						23	73937.5
						24	74062.5

info@siklu.com
www.siklu.com

						25	74187.5
						26	74312.5
						27	74437.5
						28	74562.5
						29	74687.5
						30	74812.5
						31	74937.5
						32	75062.5
						33	75187.5
						34	75312.5
						35	75437.5
						36	75562.5
						37	75687.5
						38	75812.5

The grayed-out channels are currently not supported.

Table 2 : Available Channels (EH-1200T)

500MHz Channels				**250MHz Channels**	
	(MHz)				(MHz)
1	71375/81375			1	71250/81250
2	71875/81875			2	71500/81500
3	72375/82375			3	71750/81750
4	72875/82875			4	72000/82000
5	73375/83375			5	72250/82250
6	73875/83875			6	72500/82500
7	74375/84375			7	72750/82750
8	74875/84875			8	73000/83000
9	75375/85375			9	73250/83250
				10	73500/83500
				11	73750/83750
				12	74000/84000
				13	74250/84250
				14	74500/84500
				15	74750/84750
				16	75000/85000
				17	75250/85250
				18	75500/85500
				19	75750/85750

The grayed-out channels are currently not supported.

Table 3 : Available Channels (EH-1200F)

info@siklu.com
www.siklu.com

3.1.2 Modulation

The system implements an adaptive modulation scheme based on the following:

Mode	Bandwidth (MHz)	Modulation
0	250/ 500	QAM 64
1	250/ 500	QAM 16
2	250/ 500	QPSK
3	250/ 500	QPSK
4	250/ 500	QPSK

Table 4: Modulation table

3.1.3 Standard compliance

The EH-1200 complies with world's major regulations requirements:

- **FCC 47 CFR part 101:2009**
- **ETSI EN 302 217-2-2**

3.1.4 Benefits

The high performance design of radio and modem makes possible using spectral efficient modulations like QAM16 and QAM64 to achieve high capacity on the one hand, and to provide a robust connection using strong error correction codes and increased sensitivity, on the other hand.

3.2 Antennas

The EtherHaul-1200 incorporates option for 1ft 31cm in-house designed antenna and 2ft 50cm antenna.

Type	1ft	2ft
Diameter (cm)	31cm	65cm
Gain (dBi)	43	50

info@siklu.com
www.siklu.com

3 dB Beam width	**1˚**	**0.5˚**
Radiation Pattern Envelope	Class 2, (ETSI EN 302 217-4-2 V1.5.1) FCC 47CFR101.115	Class 2, Class 3 (ETSI EN 302 217-4-2 V1.5.1) FCC 47CFR101.115

Table 5: EH-1200 antenna specifications

3.2.1 Standard compliance

ETSI EN 302 217-4-2 V1.5.1

3.2.2 Benefits

- **Direct-Mount capability and installation kits extend links physical durability for enhanced performance at tough weather conditions.**
- **The parabolic antenna shape is disguised in the box shape of the system, reducing unwanted attention.**

3.3 Integrated Ethernet switch

The Etherhaul products include integrated 2/4 ports 100/1000 base-T Ethernet switch.

Each port can be configured to support:

- **Auto negotiation enabled/disabled**
- **Speeds: 100/1000 Mbps.**
- **Full-duplex / half-duplex**
- **Delivery of both payload traffic and/or management traffic**
- **OAM signaling**
- **SyncE**

3.3.1 Benefits

- **4 Ethernet ports are the ideal number of interfaces at a hub or drain site, as well as edge site serving multiple payload consuming devices such as hot-spots, small-cell, surveillance cameras etc'. It enables:**
  - **Advanced network topologies: ring, mesh and daisy chain**
  - **Connectivity for more services at each location, significantly reducing the need for external devices for services grooming/cascading, and thus reducing both CAPEX and OPEX.**

info@siklu.com
www.siklu.com

3.4 System capacity

The Etherhaul products features up to 1 Gbps, full duplex/aggregated (FDD/TDD) capacity with user configurable option to set symmetric or asymmetric modes.

Mode	Bandwidth (MHz)	Modulation	L1 Rate (Mbps)(1)
0	500	QAM 64	970
1	500	QAM 16	660
2	500	QPSK3	340
3	500	QPSK2	80
4	500	QPSK1	20

Table 6- EtherHaul capacities at each modulation mode

Notes:

(1) Capacity varies according to packet size.

3.4.1 Benefits

High capacity allows operators to:

- **Fulfill current and long term capacity requirements for 3G, LTE and LTE-A small-cell backhaul, including hybrid small cells that supports multiple technologies.**
- **Provide extreme capacities for building to building connectives within a dense urban area as well as closed campuses.**
- **Cascades wireless backhaul links between numerous street-level devices such as small-cell, CCTV cameras, Wi-Fi access points and others.**
- **Deliver multiple services, all with max capacity at same location.**

3.5 Radio Specifications

The system implements a flexible modulation scheme, which includes adaptation of the following system parameters:

EH-1200T:

Channel (MHz)	Modulation	Occupied BW (MHz)	Pout (dBm)	Receiver Threshold (dBm @ BER=10-6)	L1 Capacity - Aggregate (Half Duplex) (Mbps)
500	QAM 64	500	+5	-59	970

info@siklu.com
www.siklu.com

	QAM 16	500	+5	-64	660
	QPSK3	500	+5	-69	340
	QPSK2	250	+5	-75	80
	QPSK1	125	+8	-81	20
250	QAM 64	250	+5	-62	485
	QAM 16	250	+5	-67	330
	QPSK3	250	+5	-72	170
	QPSK2	125	+5	-78	40
	QPSK1	125	+8	-81	20
125	QAM 64	125	+5	-65	240
	QAM 16	125	+5	-70	160
	QPSK3	125	+5	-75	80
	QPSK1	125	+8	-81	20

Table 7: EH-1200T radio parameters

EH-1200F:

Channel (MHz)	Modulation	Occupied BW (MHz)	Pout (dBm)	Receiver Threshold (dBm @ BER=10-6)	L1 Capacity (Mbps)
500	QAM 64	500	+7	-64	970
	QAM 16	500	+7	-69	660
	QPSK3	500	+7	-74	340
	QPSK2	250	+7	-80	80
	QPSK1	125	+10	-86	20
250	QAM 64	250	+7	-67	500
	QAM 16	250	+7	-72	330
	QPSK3	250	+7	-77	170
	QPSK2	125	+7	-83	40
	QPSK1	125	+10	-86	10

Table 8: EH-1200F radio parameters

3.5.1 Benefits

The high performance design of radio and modem enables spectral efficient modulations like QAM16 and QAM64 to achieve high capacity on the one hand, and to provide a robust connectivity using strong error correction codes and increased sensitivity on the other hand.

3.6 Asymmetric uplink/downlink ratio configuration (applicable only to EH-1200T/Tx)

The EtherHaul-1200T/TX operates in Time Division Duplexing (TDD) mode, allowing both symmetric and asymmetric traffic configurations.

The asymmetrical traffic may be configured at downstream-upstream ratio of:

75%-25%

3.6.1 Benefits

Time division multiplexing simplifies system design lowers cost and allows asymmetrical traffic management.

TDD is extremely useful in last mile applications.

Being able to divide the traffic asymmetrically is a more efficient use of the spectrum as the last mile traffic tends to be asymmetric in nature

3.7 ATPC

Automatic Transmit Power Control (ATPC) adjusts transmitter output power of the local ODU based on the varying signal level at the remote receiver.

ATPC allows the transmitter to operate at less than maximum power for most of the time and when fading conditions occur, transmit power will be increased as needed until the maximum configured value is reached.

ATPC is achieved by establishing communication channel between the two ODUs where Tx power change messages are transmitted.

The purpose of ATPC:

- Reduce interference to other radios operation in the same channel/band and to allow better frequency reuse
- Reduce transmitter power consumption and prolong ODU's components life

3.8 Adaptive modulation

The EtherHaul products implements hitless/errorless adaptive bandwidth, coding and modulation adjustment to optimize the over-the-air transmission and prevent

weather-related fading from causing traffic on the link to be disrupted. The EtherHaul™ products can gain up to 21 dB in link budget by dynamically adapting:.

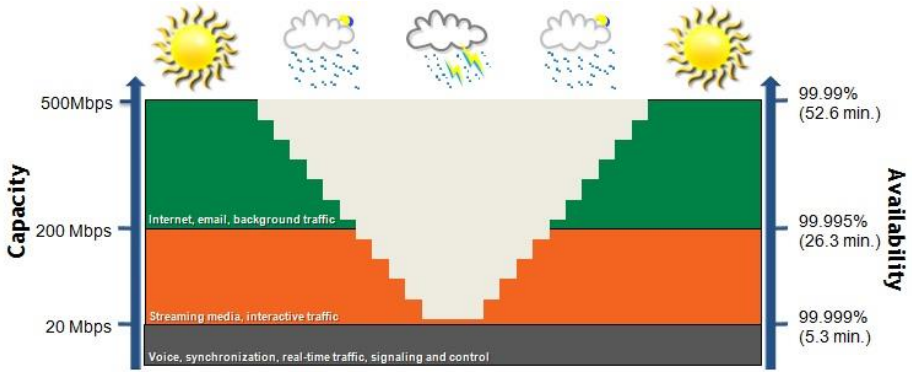


Figure 4 – Hitless Adaptive Bandwidth, Coding and Modulation

3.8.1 Benefits

- **Adaptive bandwidth, coding, and modulation ensure maximum capacity most of the time with guaranteed high priority services all the time.**
- **The solution's hitless algorithm delivers zero down time to enable a constant flow of voice and real-time services allowing carriers to meet their service commitments for enhanced user experience.**

3.9 Physical overview

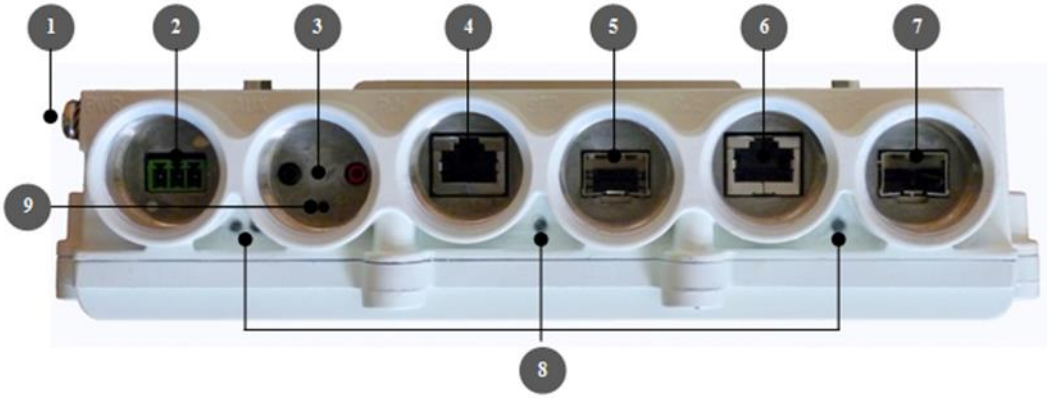


Figure 5 –Interfaces

info@siklu.com
www.siklu.com

1. Electrical Ground Outlet (GND)
2. DC Power Connector Interface (PWR)
3. DVM Probe Interface (AUX)
4. Ethernet Cable RJ45 Interface (1)
5. Fiber Cable SFP Interface (2)
6. Ethernet Cable RJ45 Interface (3)
7. Fiber Cable SFP Interface (4)
8. LED indicators
9, Reset Button

3.10 EtherHual sealed physical connectivity

An EtherHaul™ product use standard GE (RJ-45) connectors and does not require any proprietary sealing solution nor propriety cables needed.
Each EH-1200 unit kit contains sets of cable-glands sealing accessories:

- **Fix connector outlet**
- **Fix rubber gasket**
- **Fix cable inlet with cable securing holes (designed for standard based strips)**

As shown in figure 9, the included EtherHaul™ cables glands were designed to enable in field connectivity of cables already equipped the RJ-45 connectors, and thus eliminate the need to use cable crimp tools.

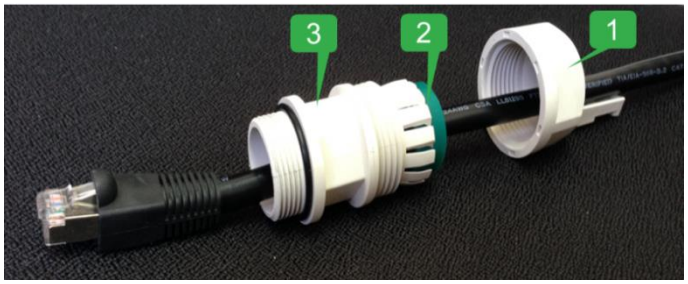


Figure 6 – EtherHaul connector gland assembly

info@siklu.com
www.siklu.com

Figure 7 – EH-1200 installed with cable

3.11 Etherhaul-1200 Mounting bracket

The EH-1200 mounting bracket is a light weight easy to use alignment and physical securing element, specially designed for street level installations.

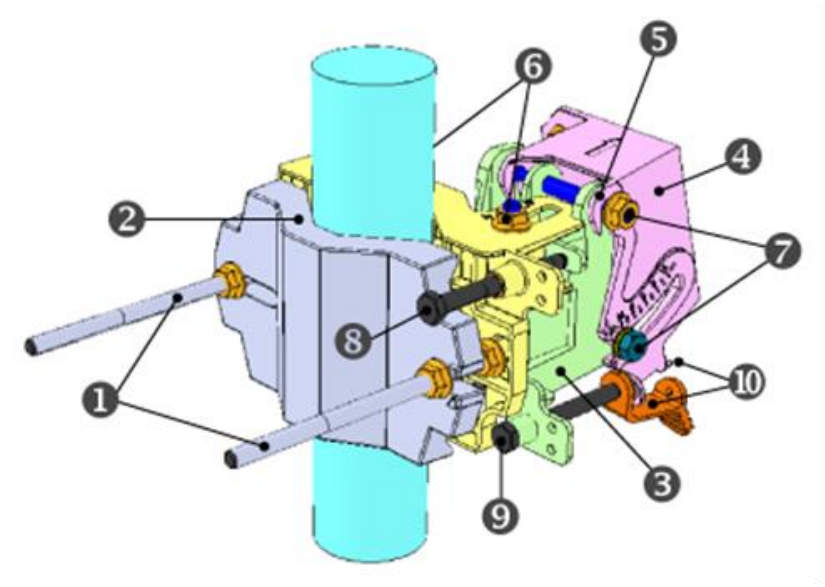


Figure 8 – EH-1200 1ft Mounting Kit

1. Unit mounting screws and bolts
2. Back mounting bracket
3. Front mounting bracket
4. Quick release plate (attached to ODU)
5. Quick release hooks
6. Azimuth adjustment lock bolts
7. Elevation adjustment lock bolts
8. Azimuth fine adjustment screw (± 8°)
9. Elevation fine adjustment screw (± 16°)
10. Elevation screw tension band and pin

info@siklu.com
www.siklu.com

3.11.1 EH-1200 Mounting bracket Benefits

- **Minimized wind resistant and visibility thanks to the central mounted installation design.**
- **No need for re-alignment when replacing an EH-1200 unit under maintenance process.**

3.12 Alignment

As any other P2P wireless system, the EH-1200 should be aligned during the installation process. The course alignment performed on each ODU, followed by fine alignment. Accurate alignment of the ODU is essential for achieving the strongest possible receive signal.

In order to perform antenna alignment, the ODU must be in Alignment Mode, either using CLI/Web or by just plugging the probes of the voltmeter into a dedicated alignment connector.

Dividing the DVM millivolt output by 10 will provide the actual receive signal strength calculation (RSSI). For example, a DVM millivolt reading of 450 mV is equivalent to -45 dBm.

Standard based voltmeter hooks sockets are used for RSSI reading.

3.12.1 Benefits

- **Simple and reliable antenna alignment process (no computer connection is needed)**
- **Simple RSSI indication conversion**
- **Alignment is performed using standard single T-bar tool, that matches all screws and worm clamps adjustments and locking.**

info@siklu.com
www.siklu.com

4. EtherHaul Networking Features

4.1 Switching

4.1.1 QoS-Aware Transparent Bridge (IEEE 802.1d)

In the basic configuration the EH-1200 provides an advanced transparent bridge (IEEE 802.1d) mode relevant for the network scenarios when the networking capabilities of the switch are not required. Quality-of-Service-awareness operation is also possible in this mode.

In this mode of operation transparent forwarding of both tagged and untagged traffic is performed. In addition, for in-band management traffic, it is possible to allocate dedicated VLAN for the management traffic.

4.1.2 Provider Bridge (IEEE 802.1ad)

The EH-1200 and EH-1200F incorporates a fully functional integrated Provider Bridge (IEEE 802.1ad). Provider Bridge, commonly known as Q in Q, extends the IEEE 802.1Q standard by providing for a second stack of VLANs in a bridged network.

The general purpose of Provider Bridge is to enable frames from multiple customers at the UNI (user network interface, i.e. Eth1-4) to be forwarded (or tunneled) through the radio link (acts as NNI – network network interface) using single Service VLAN (S-VLAN). The system is able to deliver multiple S-VLANs, and to allocate in each several customers' VLANs (C-VLAN). Sample VLAN encapsulations are brought in figure 13.

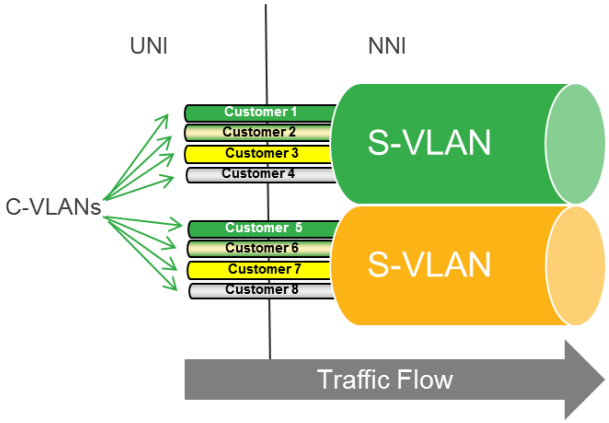


Figure 9: C-VLANs encapsulated in S-VLANs

The provider bridge, which may consist of multiple devices in the service provider domain, looks like a simple bridge port to the customer's traffic and maintains the Customer's VLANs (C-VLAN) with their ID number.

The implementation of Provider Bridge is a network of up to five virtual bridges connected in a "cross-like" fashion as shown in "Figure 14: Provider Bridge Architecture"

info@siklu.com
www.siklu.com

- **Each component acts as a virtual bridge. A component can have both external and internal ports.**
- **An external port name is identical to its interface name.**
- **An internal port name uses the name of its peer component.**
- **The operator can change the default bridge configuration to suit his network by removing or adding the desired bridge components.**
- **All components are created, managed, and removed using both CLI and WEB GUI.**

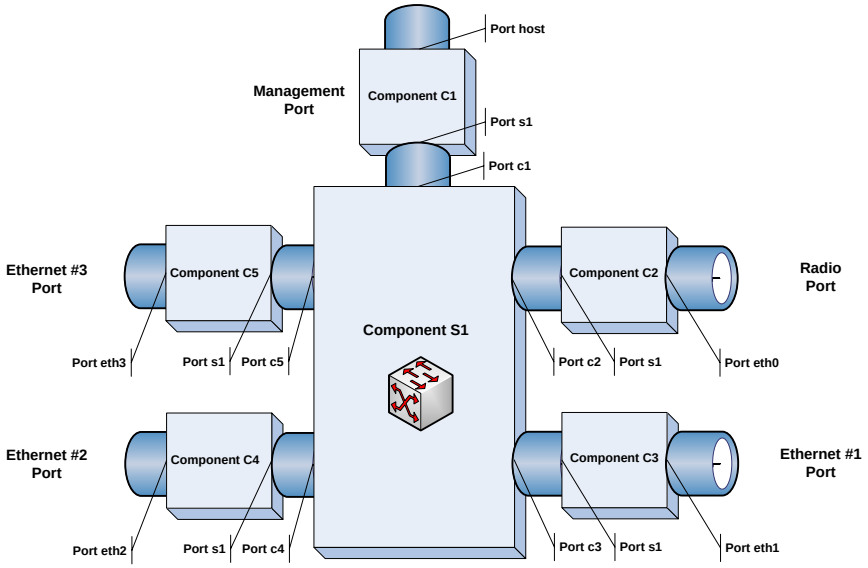


Figure 10– Provider Bridge Architecture*

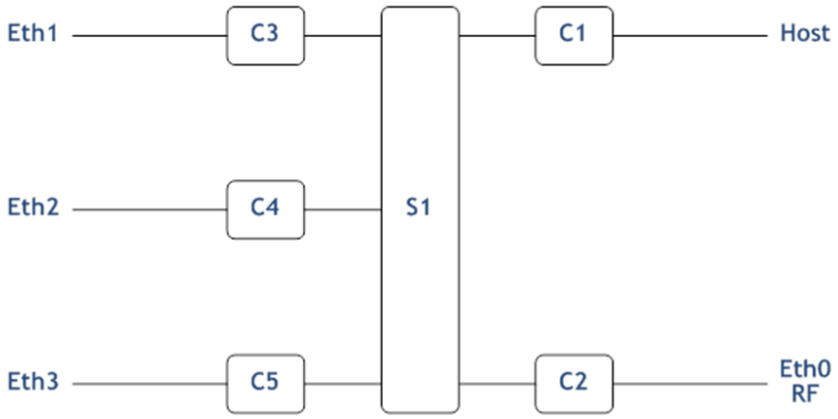


Figure 11– Generic Model of the EtherHaul™ Bridge

Each component acts as a virtual bridge. A component can have both external and internal ports. An external port name is identical to its interface name. An internal port name uses the name of its peer C-component 1 is connected to the S-component, the corresponding internal port in.

info@siklu.com
www.siklu.com

For example, the C-component is called S1 and the corresponding internal port in the S-component is called C1.

You can change the default bridge configuration to suit your network by removing or adding the desired bridge components. All components are created, managed, and removed using the CLI.

4.1.3 Standards compliance

- IEEE 802.1d - MAC Bridges
- IEEE 802.1Q - Virtual LANs (VLANs)
- IEEE 802.1ad – QinQ
- Metro Ethernet Forum (MEF) recommendations and defined services: MEF 9, Ethernet Services Functionality:
    - E-LINE, E-LAN and E-TREE services
        - E-LINE with multiple user defined options:
            - Port based
            - Port with single VLAN
            - Port with double VLAN (QinQ)
        - E-LAN with multiple user defined options:
            - MAC
            - VLAN
            - Double VLAN (QinQ)
        - Multiple isolated E-LAN services – by multiple isolated MAC tables
        - E-Tree with multiple user defined options:
            - Port based
            - Port with single VLAN
            - Port with double VLAN (QinQ)
    - UNI attributes, Service frame delivery, VLAN tag support

4.1.4 Benefits

- Flexible networking topologies support
- Carrier class services, following leading standards with proven interoperability
- Enable
- Integrated Gigabit Ethernet switch and advanced networking features allows all outdoor installation
- The EH-1200's provider bridge is an easy and fast deployment enabler:
    - It takes any Ethernet based stream, wraps it with service provider tag

info@siklu.com
www.siklu.com

- Enhanced, QOS marking based routing of ingress traffic into multiple differentiated queues.
- Keeps its frame size (the EtherHaul™ systems supports 16K jumbo frames)

4.2 Quality of service (QOS)

There are 2 main motives to leverage QOS in a street-level wireless backhaul system:

1. QOS complements hitless adaptive bandwidth, coding, and modulation mechanism, by real time prioritization of parallel data streams and VLAN services. It allows ensuring performance and availability correlated with customer's SLA (service level agreement).
2. QOS enables carriers oversubscribe wireless links will sustaining the SLA agreement of each individual service, and thus leads to enhanced ROI.

The EH-1200, equipped with a powerful network processor and Siklu's proven EtherHaul™ advanced software package, enables any service provider to offer best in class differentiated services.

With 8 queues, the EH-1200 has QoS granularity for the most demanding environment.

4.2.1 Classification and Policing

The EtherHaul™ QoS engine classifies the incoming packets onto streams using any combination of:

1. VLAN number (VID) – prioritizes frames based on their VLAN ID.
2. PCP - 3 priority bits that enables up to 8 differentiated QOS classed of service. PCP bits are part of the L2 VLAN header.
3. DSCP – 8 bits, part of the L3 IP header of incoming packets. The user configurable QOS scheme of EH-1200 enables allocating each of the resulted 64 combinations of the 8 bits DSCP header, into the 8 queues of the system.
4. MPLS EXP - 3 priority bits that enables up to 8 differentiated QOS classed of service. The 3 EXP bits are part of the MPLS frame header.

EH-1200 supports 4 types of bandwidth profile with CIR (committed information rate), CBS (committed burst size), EIR (excess information rate), EBS (excess burst size), can be assigned to each of the above listed (1-4) differentiated streams.

The implemented mechanism supports 3 colors and 2 rates:

info@siklu.com
www.siklu.com

- Frames that fit into CIR/CBS profile marked drop ineligible and colored "green".
- Frames which are within excess profile but exceed committed profile are marked drop eligible ("yellow"), upon congestion at egress interface the yellow packets are dropped first.
- All remaining frames, which are out of profile, are colored "red" and discarded.
    - The "red" frames are dropped using a head drop algorithm and "green" frames take precedence of "yellow" ones.

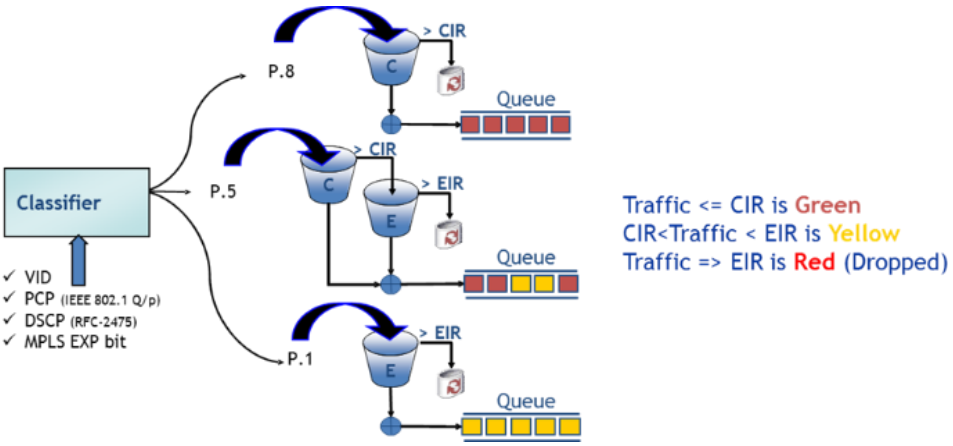


Figure 12 – EH-1200 Calcifications and Policing

These packets are then mapped to 1 of the 8 priority queues (per interface). Each queue may be assigned buffering space (queue depth) manually or automatic by the SW that calculates the adaptive modulation BW changes. These queues are accessed by the scheduling mechanism.

EH-1200 support DSCP identification from both IPv4 and IPv6 L3 packets.

4.2.2 Buffer size

Packets processed in the switch are held in buffers. If the destination queue is congested, the switch holds on to the packet as it waits for capacity to become available on the loaded queue. The ratio between delay and number of dropped frames is a result of the buffer size configuration.

4.2.3 Scheduling Mechanisms

The priority queues of the EtherHaul™ are accessed using the following scheduling mechanisms:

- Strict Priority (SP): Advanced mechanism for assuring both prioritization and minimal delay for mission critical traffic. Higher priority traffic is fully served

info@siklu.com
www.siklu.com

through its differentiated queues, only if all high priority traffic, identified as SP, is fully served the lower priority traffic is delivered to its queues.

- Weighted Fair Queuing (WFQ): A scheduling technique maintaining fairness by applying weights to the queues. Each queue is serviced in the order of its weighted proportion to the available resources. This queueing mechanism is suitable for high capacity statistical applications and it ensures pre-defined serving of multiple services even when the link is fully loaded.
- Shaper: used to control traffic flows in order to optimize or guarantee performance and improve latency by limiting the maximum bandwidth of certain flows to maintain fairness and to assure SLA. Shaper capabilities of internet serving access devices, is crucial for assuring effective and stable delivery of TCP oriented traffic with minimizing re-transmissions and maximizing utilization of the available capacity.
- Best Effort: used for the lowest priority traffic types and simply enable further utilization of statistical multiplexing. Capacity is not guaranteed for this queue, and it enables dynamic utilization of all non-used (by higher queues) available capacity.

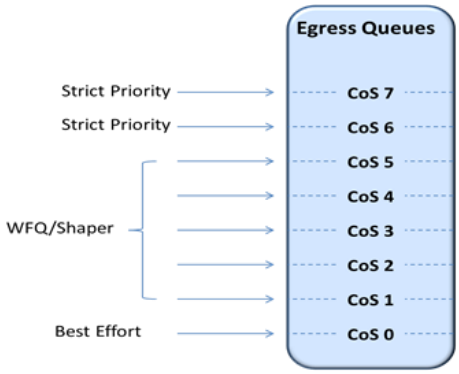


Figure 13 –Scheduling Mechanism

4.2.4 Standard compliance

- IEEE 802.1Q / IEE802.1P - 3 bits identified as priority code point (PCP).
- RFC-2475 - Architecture for differentiated services.
- RFC-5865—A differentiated services code point (DSCP) for capacity-admitted traffic
- Related Metro Ethernet Forum (MEF) recommendations:
    - MEF 14, Ethernet Service Performance
        - Service performance, Bandwidth profiles, BW profile rate enforcement.

info@siklu.com
www.siklu.com

4.2.5 Benefits

- Quality of Service (QoS) mechanism enables service providers to offer different classes of service for different types of traffic or customers.
- QoS mechanism is especially important in wireless links with adaptive capabilities, because changing link conditions may require the system to drop some traffic according to a predetermined priority and scheduling scheme.
- The user defined, wide range of buffer size values, enable fine adjustments for various implementation scenarios, and thus contribute to operators' network capability to optimize traffic flows at heavy load conditions.
- The statistical behavior of today data services enables service providers to oversubscribe their networks while differentiating services based on QoS driven SLA, and thus leads to faster ROI and improved utilization of the network.

4.3 Queue management - WRED

WRED function (Weighted random early detection) adds to the EH-1200 queue management mechanism. WRED enables the EH-1200 to detect the onset of congestion and take corrective action.

EH-1200 has several different queue thresholds. Each queue threshold is associated to a particular traffic class.

Weighted random early detection (WRED) is a queue management algorithm with congestion avoidance capabilities. A single queue may have several different queue thresholds. Each queue threshold is associated to a particular traffic class; a queue may have lower thresholds for lower priority packet.

A queue buildup will cause the lower priority packets to be dropped, hence protecting the higher priority packets in the same queue. In this way quality of service prioritization is made possible for important packets from a pool of packets using the same buffer a standard traffic will be dropped instead of higher prioritized traffic.

4.3.1 WRED Benefits

- WRED assures that the queue does not fill up, so that there will be most of the time room for high-priority packets within the same queue.
- Random drops cause TCP sessions to reduce window sizes and thus extends efficiency.
- Average capacity usage is much closer to actual capacity of the link.

info@siklu.com
www.siklu.com

4.4 Configurable Ethertype

IEEE 802.1ad Provider Bridges (a.k.a Q-in-Q) defines the S-VLAN protocol type as 0x88A8 and list additional Ethertype field values for S-VLAN: 0x8100, 0x9100 and 0x9200 to support backwards compatibility.

4.4.1 Benefits

The configurable Ethertype feature eliminates Ethertype compatibility issues when connecting EtherHaul™ ports/services to 3rd party switches and routers or other network devices such as access points, small-cells etc. Its anther proof for EtherHaul's easy integration into any network.

4.5 LLDP

The Link Layer Discovery Protocol (LLDP) is a unidirectional neighbor discovery protocol.

LLDP performs periodic transmissions of an ODU's capabilities to the adjacent connected stations. LLDP frames are not forwarded, but are constrained to a single link. The information distributed by the protocol is stored in a topology data base. This information can be retrieved by the user or network element using CLI and/or system's web based GUI, in order to easily resolve the network's physical topology and its associated stations.

LLDP enables the discovery of accurate physical network topologies, meaning which devices are neighbors and through which ports they connect. The user can use this information, especially the 'retrieved management IP addresses' option, in order to access these discovered nodes.

LLDP enables the EH-1200 to discover other network elements that are connected to it as well as being discovered. This feature enables, amongst other things, to discovery third-party network elements connected to the EH-1200 so that they can be managed. In addition, it enables easier integration of EH-1200 links in a LLDP supported network.

4.5.1 Standard compliance

- **IEEE 802.1AB - Link Layer Discovery Protocol (LLDP)**

4.5.2 Benefits

- **Enhances trouble shooting process**
- **Standard based topology discovery by 3rd party network monitoring and management systems**

info@siklu.com
www.siklu.com

4.6 DHCP

The Dynamic Host Configuration Protocol (DHCP) is a computer networking protocol used by devices (DHCP clients) to obtain configuration information for operation in an Internet Protocol network.

DHCP is built on a client-server model, where designated DHCP server allocates network addresses and delivers configuration parameters to dynamically configured hosts. "Client" refers to a host requesting initialization parameters from a DHCP server.

While configured at DHCP client mode, the EH-1200's in-band management VLAN Interface can be configured as a DHCP client.

4.6.1 Standard compliance

- **RFC 2131 - Dynamic Host Configuration Protocol**

4.6.2 Benefits

- **This protocol reduces system administration workload, allowing networks to add devices with little or no manual intervention.**
- **Easy and fast discovery of new EH-1200 elements added to any DHCP enabled network**

4.7 Link OAM

Link OAM, as defined in IEEE802.3ah, is an Ethernet layer operation, administration, and management (OAM) protocol designed to ease monitoring and troubleshooting of networks. Link OAM enables to detect, verify, and isolate connectivity failures in point-to-point connections. Link OAM is intended for single point-to-point links, usually used at network edges, between network-termination (NT) device located at customer premises and the directly connected to it, service provider's located access/aggregation network element.

The following IEEE802.3ah functionality is supported by the EH-1200:

- **Discovery:**
    1. **Detect remote element**
    2. **Exchange link state and configuration information:**
    3. **Enable OAM on link**
- **Remote Loopback**

info@siklu.com
www.siklu.com

- Initiated by a loopback control OAMPDU
- The loopback command is acknowledged by responding with an Information OAMPDU with the loopback state indicated in the state field.
- The periodic exchange of OAMPDUs must continue while in the loopback state to maintain the OAM session.

4.7.1 Standard compliance

- IEEE802.3ah: EFM - Ethernet in the first mile

4.7.2 Benefits

- Standardized mechanism to monitor the health of a link and perform diagnostics
- Remote loopback enables standard based test equipment, to be connected at a central location in the network and perform service performance tests all the way to the network edge were the EH1200 unit is usually located.
- Reduces the probability for track-rolls

4.8 Connectivity Fault Management (CFM)

Connectivity Fault Management (CFM) is an Ethernet layer operation, administration, and management (OAM) protocol designed to monitor and troubleshoot networks. CFM enables to detect, verify, and isolate connectivity failures in virtual bridged local area networks.

A Maintenance Domain (MD) is a part of a network that is controlled by a single operator and used to support the connectivity between service access points. There are eight hierarchical Maintenance Domain Levels (MD Level). Each CFM layer supports OAM capabilities independently, with the customer at the highest level, the provider in the middle, and the operator at the lowest level.

CFM is designed to be transparent to the customer data transported by the network and to provide maximum fault coverage. These capabilities enable easier commissioning and troubleshooting at networks operated by multiple independent organizations, each with restricted management access to each other's equipment.

CFM entities support an individual service instance as Maintenance Association End Points (MEPs) are configured to create a Maintenance Association (MA). The MA monitors connectivity provided by that instance through the Maintenance Domain.

Maintenance Association Intermediate Points (MIPs) are the intermediate points in a specific MA or MD.

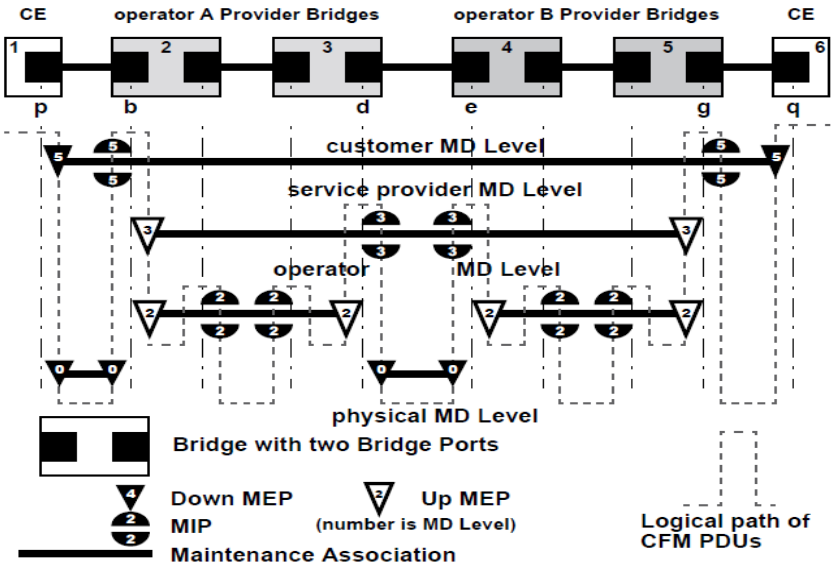
The major features of CFM are fault detection, path discovery, fault verification, fault isolation, and fault recovery.

The system allows to:

- **Define Maintenance Domain (MD)**
- **Define Maintenance Association (MA)**
- **Define Maintenance Association End Points (MEPs) and Maintenance Association Intermediate Points (MIPs)**

The system supports the following monitoring tools:

- **CFM Continuity Check Message (CCM)**
- **CFM Linktrace**
- **CFM Loopback**



- **UP MEP – transmit CFM PDUs into the bridge**
- **Down MEP – transmit CFM PDUs out of the bridge**

Figure 14 – CFM network

CFM allows the operator or service provider perform the following actions:

- **Fault detection**
- **Path discovery**

info@siklu.com
www.siklu.com

- Fault verification
- Fault isolation
- Fault recovery

4.8.1 Standard compliance

- IEEE 802.1ag: CFM - Connectivity Fault Management

4.8.2 Benefits

- Faster faults location isolation
- Enhances SLA assurance
- When used to monitor services across multi-networks, enables hiding internal topologies and network elements.
- Running in parallel to service traffic, in same paths, with no interfering the user traffic.

4.9 Performance monitoring OAM

Performance monitoring provides monitoring functionality according to Y.1731 standard. The following measurements are supported:

- Frame delay measurements
- Frame jitter measurements
- Frame loss measurements

4.9.1 Standard compliance

- ITU-T Y.1731 OAM functions and mechanisms for Ethernet based networks

4.9.2 Benefits

- Allows operators or service providers to monitor network performance and commit to SLA to the customer.
- Useful both for in-service monitoring and during faults troubleshootings

EH-1200 OAM functionality also complies with MEF 21, UNI Type 2 – Link OAM:

- OAM Discovery process.
- OAM PDU tests.
- OAM TLV tests

info@siklu.com
www.siklu.com

4.10 ITU-T G.8032 Ethernet Ring Protection (Resiliency)

Ethernet Ring Protection (ERP) is a network resiliency protocol defined by ITU-T G.8032. The EH-1200 supports ERP G.8032v2, with backwards compatibility to previous versions. ERP functionality enables ultra-fast protection for any point of failure in the network. This means that network connectivity is maintained in the event that the Ethernet link, the radio link, or even the entire EH-1200link fails. This provides resiliency for both Ethernet-phisical rings that typically protect single site connectivity and Ethernet-RF rings that typically protect against RF network failure.

ERP is a relatively simple protocol that operates at the network level on the set of nodes that constitute the ring or set of rings. ERP monitors the Ethernet layer to discover and identify Signal Failure (SF) conditions, and prevents loops within the ring by blocking one of the links (either a pre-determined link or a failed link). ERP verifies at all times the ring is closed that frames will not be looped. This is accomplished by taking down a Ring protection Link (RPL) whenever there is no failure in the ring.

Using ERP, the EH-1200 provides protection and recovery switching within 50 ms for typical rings. The ERP mechanism occupies extremely low portion from the available bandwidth.

Figure 13 illustrates the basic ERP protection mechanism. In normal ring operation, the RPL is blocked. In a failure condition, the failed link is blocked, R-APS messages are sent from the nodes adjacent to the failed links in order to unblock the RPL, and an FDB flush is performed on all ring nodes as necessary.

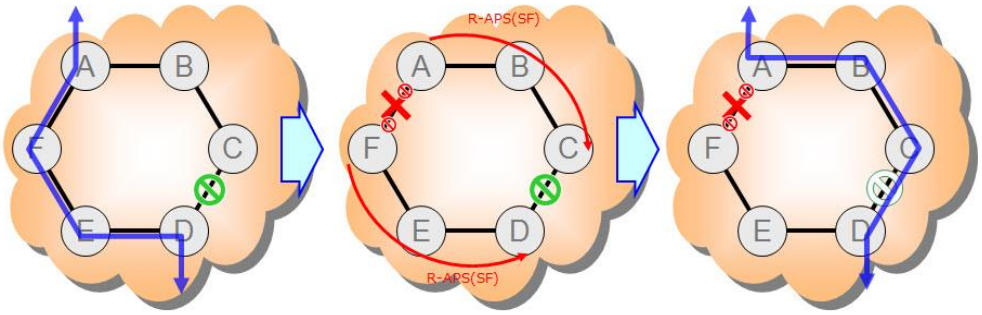


Figure 15 – Basic ERP Protection Mechanism

Among the ERP features supported by the EH-1200 are:

- **Backwards compatibility to previous versions**
- **Revertive and non-revertive behavior**
- **Flush logic with the Node-ID and BPR (Blocked Port Reference) mechanism**
- **Administrative commands (manual and forced switch, clear)**

info@siklu.com
www.siklu.com

- **Ability to block RPL at both ends of the link (RPL owner and RPL neighbor)**
- **Multiple logical ERP instances over a given physical ring**

4.10.1 Standard compliance

- **IEEE G.8032v2 Ethernet Ring Protection Switching**

4.10.2 Benefits

- **Non-proprietary protection resiliency standard that allows mixed-vendor deployments,**
- **Higher reliability, with sub50mSec performance**
- **Can be deployed in both all wireless backhaul environment as well as in mixed wireless / optical**
- **Overcomes old spanning-tree protocols issues while adding the shorter restoration performance**

info@siklu.com
www.siklu.com

4.11 Ethernet Synchronization

4.11.1 Synchronous Ethernet (ITU-T G.8261)

The EH-1200 supports Synchronous Ethernet (SyncE). The EH-1200 supports Synchronized Ethernet link input from the network through on of the physical ports or the radio port and providing a synchronized Ethernet link over the air to the other end of the wireless link within the required masks.

SyncE is a link-by-link distribution scheme that uses the Ethernet physical layer to accurately distribute clock frequency. ITU-T standard G.8261 defines various aspects of SyncE, such as the acceptable limits of jitter and wander as well as the minimum requirements for synchronization of network elements.

With SyncE, the receive clock is extracted from the Ethernet Rx by the clock unit and used for transmission on all interfaces, propagating the clock in the path. Every SyncE Network Element contains an internal clock called the Ethernet Equipment Clock (EEC). The EEC locks on the Rx clock and distributes it for transmission on all interfaces, attenuating jitter and wander, and maintaining clock-in holdover. If the Rx clock fails, the local unit switches to holdover and regenerates the clock accurately until the failure is corrected.

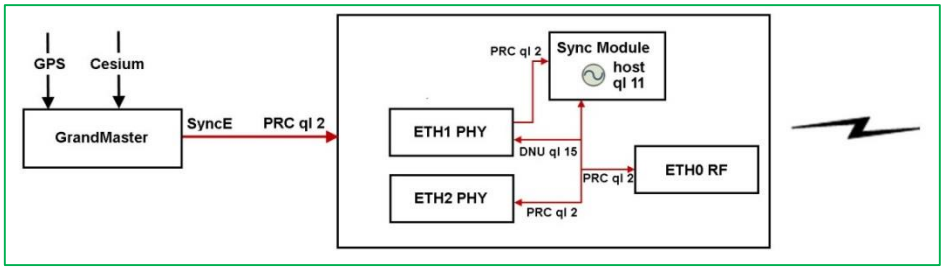


Figure 16 – EtherHaul™ ODU SyncE Functional Diagram

Synchronization messages are transported between the SyncE elements using Ethernet Synchronization Message Channel (ESMC). ESMC is similar to SSM (Synchronization Status Message), used in Sonnet/SDH systems. ESMC carries information about the Quality Level (ql) and sync status of the source clock, enabling the EtherHaul™ products to determine which clock source of use-based on performance and the need to avoid loops. Quality Level is based on the clock's holdover performance.

4.11.1.1 Standard compliance

G.8261 defines various aspects of Synchronous Ethernet such as the acceptable limits of jitter and wander for packet networks as well as the minimum requirements for the synchronization function of network elements.

info@siklu.com
www.siklu.com

G.8262, Timing characteristics of Synchronous Equipment Slave Clock (EEC), defining the SyncE clock specs, such as Jitter, Wander, Holdover…

G.8264, Distribution of timing through packet networks, defining the Ethernet Synchronization Messaging Channel (ESMC) protocol

4.11.1.2 Benefits

SyncE allows operators and service providers a faster and reliable migration from old SDH/PDH/SONET networks, to packet switched networks and thus significantly reduce OPEX.

4.11.2 1588 Transparent Clock (EH-1200F only)

Siklu's EH-1200F supports IEEE 1588v2 Transparent Clock (TC). The EH1200 products comply with the mobile backhaul specifications for packet synchronization distribution.

1588v2 Transparent Clocks (TCs) used to overcome the 1588 synchronization performance issue due to packet delay variation over the network. In a wireless links, the compensation of the PDV needs to be done for the entire link including the air interface, and not only per node. 1588TC functionality in EH-1200 i.e. the time stamping and the correction field update is HW based.

4.11.2.1 Standard compliance

- IEEE 1588v.2 - Precision Time Protocol (PTP)

4.11.2.2 Benefits

- Allows accurate "Wall time" synchronization in the packet switched network.
- Enables stamping updates

4.11.3 1588 optimization

The EtherHaul™ products provide optimized transport of the IEEE 1588v.2 packets allowing to the slave to regenerate the clock within the required masks.

The IEEE standard 1588-2008, also known as 1588v2, defines a packet-based, timestamp distribution between a master clock and a slave, whereby the timing information originates from a Grandmaster clock function that is usually traceable to a Primary Reference Clock (PRC) or Coordinated Universal Time (UTC).

4.11.3.1 Standard compliance

- IEEE 1588v.2

4.11.3.2 Benefits

Allow accurate "Wall time" synchronization in the packet switched network.

5. Management concept

The EH-1200 is capable of delivering services out of the box, without any user configuration input. At this mode, the system acts as a fully transparent bridge and it is intended for fast and easy service activation process.

For managed mode, the EH-1200 includes all fundamentals that enable easy configuration, monitoring, and trouble shooting, by variety of all leading Telco-grade systems, as well as direct local and remote management directly from operator's desktop.
The supported management options are:

CLI	**Professional Command Line Interface for full configuration and maintenance activities, with multiple privileges levels as required by service providers.**
WEB GUI	**Easy to interact, secured HTML browsing for monitoring, configuring, and diagnostic that controls both link's ends from one graphical screen.**
RADIUS and TACACS+	**RADIUS (Remote Authentication Dial-In User Service) and TACACS+ (Terminal Access Controller Access-Control System) are advanced authentication and report standards for large scale networks.**
SNMP	**Both versions 2 and 3 of the Simple Network Management Protocol are supported for north-bound connectivity to central configuration and monitoring systems.**
FTP SFTP TFTP	**FTP, TFTP and SSH File Transfer Protocol, network protocols designed to provide secure file transfer and manipulation facilities over SSH. The EH-1200 uses SFTP/FTP/TFTP for software upgrades, configuration uploads and downloads**
SikluView	**EMS – Elements Management System. Siklu solution for high level administration and monitoring of EtherHaul™ elements and links**

5.1 CLI

All EH-1200's functionality is accessible via secured command line interface (SSH). The user type defines the user's access privileges.

info@siklu.com
www.siklu.com

User	Read-only access, but cannot view user names, passwords, and other security settings.
Tech	Read-only access to configuration settings. Can clear statistics, alarms, and log lists, and run diagnostics
Super	Read-write access, but no access to user names, passwords, and other security settings.
Admin	Full access except for access to debugging tools.

5.1.1 Benefits

- Well know professional configuration and troubleshooting tool.
- Enables efficient, large scale projects rollouts with an easy loading of configurations scripts.
- Systems logs are easily reviewed and uploaded.
- Intuitive events' investigations and troubleshooting.

5.2 Web GUI

EH-1200 Units' and link functionality are accessible via HTML based Web interface.

The GUI enables an easy, realistic view and operation:

- Link status is presented
- Ports highlighted according to actual status
- One screen manages both ends
- Real reflection of systems LED indicators
- When mouse pointer touches each topic in the menu, it automatically show list of available functions with no need to enter the other screen
- Link configuration and settings
- 'Quick Configuration' wizard to help fast, easy and reliable installation by non-experts staff

5.2.1 GUI main screen

info@siklu.com
www.siklu.com

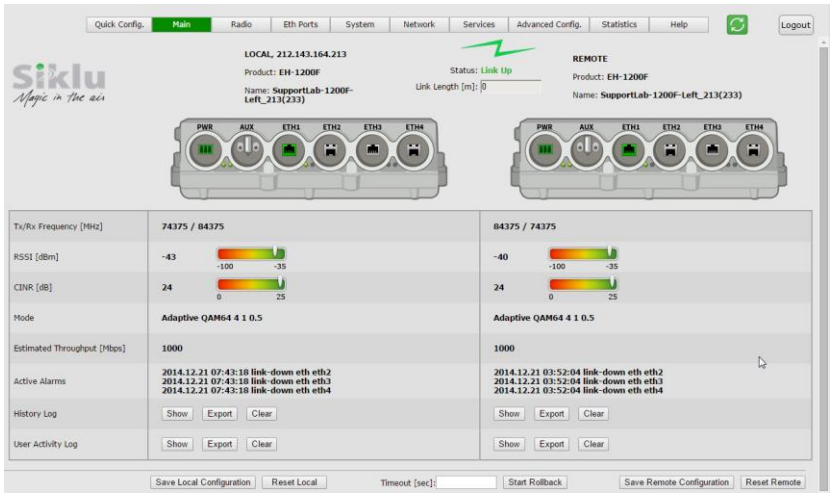


Figure 17: EH-1200 GUI main screen display

At the WEB GUI launce the main screen (figure 22) displays all essential link status information to enable easy and fast overview:

- **Link status (up/down)**
- **Current modulation level**
- **RSSI and CNIR**
- **Available capacity**
- **Active alarms summary**
- **Shortcuts to both system log and user activity log**
- **Actual link length. This value is automatic calculated by the EtherHaul™ software based on the measured air delay between both ends of the link**

5.2.2 Quick configuration wizard

Easy, fast, and minimal configuration process enables one quick flow, for the user to set up a link with all mandatory parameters that leads to a fully managed mode of operation.

The quick configuration wizard includes:

- **Specific system identification for the related location/service.**
- **Date and time (there is also an option for redundant central NTP connection).**

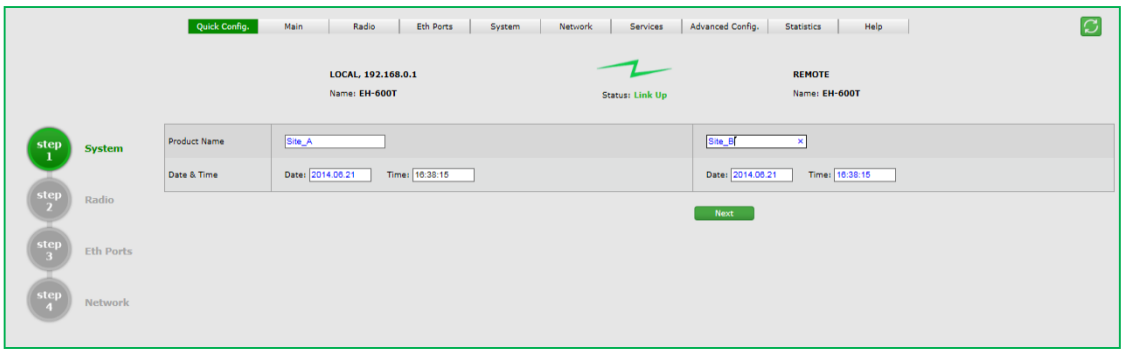
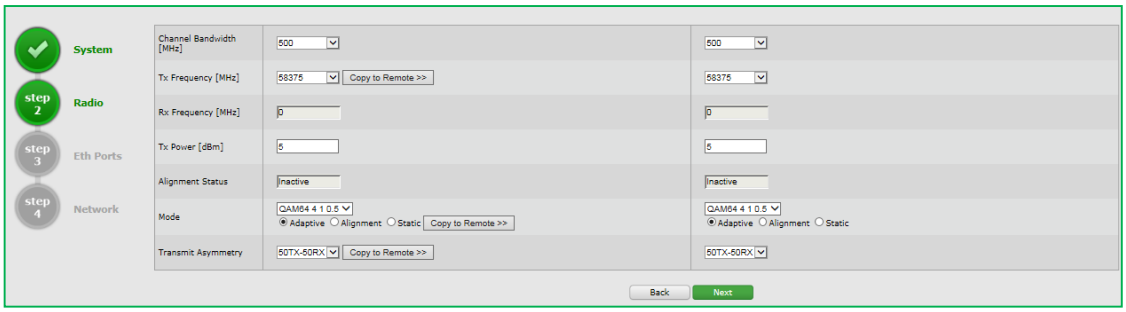


Figure 18: EH-1200 GUI managed mode wizard step 1

- Frequency channel selection
- Tx power
- Maximum allowed modulation
- Symmetric / asymmetric mode selection



- Management IP address
  - Up to 4 concurrent addresses are supported
  - Both IPv4 and IPv6 addresses are supported.
- SNMP connectivity parameters

5.2.3 Standard compliance

- RFC2616 - Hypertext Transfer Protocol (HTTP)
- RFC2246 - Transport Layer Security (TLS) protocol
- RFC2818 - HTTP Over TLS

5.2.4 Benefits

- Configuration to an EH-1200 link is made in a simple, fast, and in a secured manner.
- No need for dedicated client or plugins in user's terminal.
- Multiple supported management addresses enable multiple network domains connections, eliminating the need for dedicated router/VPN for multi domains connectivity.

5.3 SNMP

The system supports SNMP v.2 and SNMP v.3 – for configuration, monitoring and northbound. EH-1200 support SNMP over both IPv4 and IPv6 L3 addresses schemes.

info@siklu.com
www.siklu.com

5.3.1 Standard compliance

- SNMP v.2
- SNMP v.3

SNMP is defined by the Internet Engineering Task Force (IETF).

5.3.2 Benefits

- Allows simple and standard integration into operator's networking management system.
- Enables monitoring, configuring and alarms flows to/from single or multiple north-bound systems.
- Most of the SNMP objects (sub element for control / monitor) are well defined by the IETF standard, thus time to market with most of systems' parameters can be within hours.

5.4 FTP/SFTP/TFTP

FTP, TFTP and SSH File Transfer Protocol, a network protocol designed to provide secure file transfer and manipulation facilities over SSH. The EH-1200 uses SFTP/FTP/TFTP for software upgrades, configuration uploads and downloads.

5.4.1 Standard compliance

RFC4251- The IETF extension, of the Secure Shell protocol (SSH) version 2.0.

5.4.2 Benefits

Enable EH-1200 maintenance activities are performed in a secured and standard based method.

5.5 User management

The EH-1200 supports both internal user management and with external Radius or TACACS server.

5.5.1 Local/Remote user management

The user type defines the user's access privileges.

- User – Read-only access, but cannot view user names, passwords, and other security settings.

- **Tech – Read-only access to configuration settings. Can clear statistics, alarms, and log lists, and run diagnostics.**
- **Super – Read-write access, but no access to user names, passwords, and other security settings.**
- **Admin – Full access except for access to debugging tools.**

5.5.2 Radius and TACACS+ user management

RADIUS (Remote Authentication Dial-In User Service) and TACACS+ (Terminal Access Controller Access-Control System) are AAA mechanisms.

- **Authentication: Identification of requester profile (username, password, and privilege level) on a per-request basis.**
- **Authorization: Permission/denial of access to a subset of commands subject to authentication success/failure. (The mechanisms of Authorization and authentication are independent of each other.)**
- **Accounting: Reporting of information on requesters (identities, number of access attempts per requester, start, and stop times, executed commands, etc.)**

The EH-1200 is a Network Access Server (NAS) for requesters and functions as AAA client passing requester information (e.g. username, password, etc.). The AAA Server is responsible for receiving connection requests, authenticating or disqualifying the requester, and sending the permit or denies response to the client EH-1200. Communication between the EH-1200 and the AAA Server performed by shared secrets which are never sent over the network. In addition, every administrator password is encrypted before it is sent between the EH-1200 and the AAA Server in order to prevent deciphering.

The AAA Server can also provide accounting of requester commands and of changes in authorization level. This information is recorded in a special log file that enables a supervisor to view the activities of all the administrators. Accounting can include logging of commands or logging of transitions from one mode to another.

The EH-1200 supports user authentication with TACACS+ or Radius AAA servers, up to five servers.

5.5.3 Benefits

- **The hierarchical 4 levels user's access privileges, suits all: large network operators, carrier-of-carrier providers as well as smaller local operators and WISPs. It enables clear separation between multiple classes of users.**
- **The RADIUS and TACACS supports, adds effective aspect for large network operators, carrier-of-carrier providers by enabling connectivity control and accounting to minimize IT interactions with end-users without compromising security aspects.**

6. Security

6.1 Security features description

- **Physical**
  - **Proprietary DSP (Digital Signal Processor) for RF signals requires Siklu ODU to intercept.**
  - **Pencil beam – requires a physical location within antenna transmission path.**
  - **Synchronized transmission – only 'man-in-the-middle' interception for eavesdropping.**
  - **Minimal reflections. The extremely low power and ultra-high frequencies both contribute to minimal reflections effects and thus further enhances system's both resiliency and noticeable footprint.**
- **Link / data encryption**
  - **Link ID – link layer password**
  - **AES with 128/256 bit security**
- **Management aspects**
  - **SNMPv3 - Supporting both HMAC (Hash-based message authentication code) and MD5 (message-digest algorithm)**
  - **Access list for Host (management access) - ACL based on IP and Mask for security and Denial of Service**
  - **Management Vlan for isolated control of the device**

info@siklu.com
www.siklu.com

- Secured communication protocols for management: SSH (Command Line Interface), HTTPS (Web-GUI), SFTP (SW download and File Transfer)

- User access
  - Different user types and privileges categories
- TACACS+/ Radius AAA

6.2 Interface to external OSS systems

The EH-1200 includes full Radius/TACACS+ AAA support:

- Authentication: Identification of requester profile [username, password, and privilege level] on a per-request basis.
- Authorization: Permission/denial of access to a subset of commands subject to authentication success/failure. (The mechanisms of Authorization and authentication are independent of each other.)
- Accounting: Reporting of information on requesters (identities, number of access attempts per requester, start and stop times, executed commands, etc.)

7. Logging and auditing features

Advanced logging and performance monitoring logs/stats are available and kept in the device.

All logs and performance monitoring statistics are available for export and collection by external tools using File Transfer (both FTP, SFTP are supported).

Logs:

1. Current alarms
2. Alarm & event log file (history)
3. User activity log (stores all actions and configuration commands)

Performance statistics:

1. RF link statistics: RSSI, CINR, Modulation changes, RF statistics (errors and frame loss counters)
2. Ethernet ports statistics

info@siklu.com
www.siklu.com

3. VLAN statistics
4. Queues statistics

7.1 System statistics

The EH-1200 uses advanced RF and Ethernet counters to provide real-time performance statistics for radio transmission (RF) activities, Ethernet ports, VLAN traffic, and QoS queues.

The EH-1200 collects 96 periods of 15 minutes statistics and 30 days of 24 hours history summary, the counters are available for RF, per ETH port and per VLAN (service).

The following statistics enable quick analysis of system and component performance in support of troubleshooting and diagnostics:

RF	Displays RF statistic counters to identify radio errors and check the radio status history. The RF statistics consist of real time statistic counters since the last time the counters were cleared Detailed collected statistics: in-octets, in-idle-octets, in-good-octets, in-errored-octets, out-octets, out-idle-octets, in-pkts, in-good-pkts, in-errored-pkts, in-lost-pkts, out-pkts, min-cinr, max-cinr, min-rssi, max-rssi, min-modulation, max-modulation
VLAN	Displays statistic counters of each EtherHaul™ link component per VLAN Detailed collected statistics: in-octets, in-ucast-pkts, in-discards, in-errors, out-octets, out-ucast-pkts, out-errors, in-mcast-pkts, in-bcast-pkts, out-mcast-pkts, out-bcast-pkts, out-discards, in-no-rule-discards
Ethernet Ports	Displays Ethernet statistics counters per Ethernet port Detailed collected statistics: in-pkts, out-pkts, drop-pkts

7.1.1 Benefits

Real time and historical data, including RF, Ethernet ports, and VLANs values enable simple and reliable way to identify operating faults and monitor link's performance by both operators and automatic statistics collection systems.

7.1.2 Standard compliance

RFC2819 – RMON Remote Network MONitoring

info@siklu.com
www.siklu.com

7.2 System loopbacks

The EH-1200 uses Ethernet and RF loopbacks designed to enable fault isolation and Ethernet service performance testing. Loopbacks functions are user configurable and support timeout in seconds.

- **Ethernet Loopback – Internal and external loopbacks are performed on the interface, testing the local ODU, the radio link, and the remote ODU.**
- **RF (Radio) Loopback – Internal loopback is performed on the ODU's RF output.**

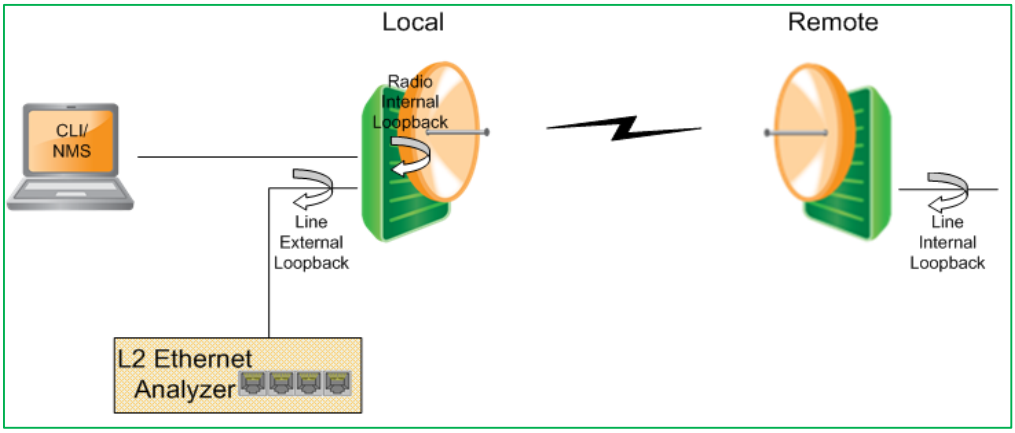


Figure 19 –System loopback points

System alarms as well as statistic displays should be used to determine if Loopback testing has passed or failed.

7.2.1 Benefits

- **Enables end-to-end link tests or single unit self-test for fault detection and isolation.**
- **Significantly reduces operation costs by saving track-rolls as well as number of test equipment needed for network maintenance.**

8. Power supply

8.1 Power options DC power supply and PoE

The EH-1200 has 2 power input options

- **Carrier-grade ±48VDC (DC input range: ± 36 ÷ ± 57 VDC)**
- **PoE+ (IEEE 802.3at) over port #1**

info@siklu.com
www.siklu.com

8.1.1 Benefits

Thanks to the efficient system design and high integration into silicon, the EH-1200:

- **Reduces the power consumption and accordingly the associated energy costs.**
- **PoE power input simplify the installation scenario and enables the customer to use only one cable for both power and data.**
- **Power redundancy for high availability and carrier grade service**

9. EH-1200 Deployment topologies

The EH-1200 is easy to integrate in various topologies such as:

- **Point-to-Point - Two units are used to implement a point-to-point single hop**
- **Point-to-Multipoint – A number of links is used to implement a number of parallel point-to-point hops, using a star topology. The ends of the link in the center point may be chained to each other, or be multiplexed using a simple Ethernet switch.**
- **Daisy-chain – A number of links is used to implement an open series of point-to-point hops, where traffic could be dropped and added at each node in the chain. Typically the nodes can be connected without an additional Ethernet switch.**
- **Ring – A number of links is used to implement a closed series of point-to-point hops, where traffic could be dropped and added at each node in the ring. This topology enables a diversity of packet routing options.**
- **Mesh - A number of links is used to implement a series of point-to-point hops which enable interconnection between the nodes, where traffic could be dropped and added at each node in the mesh. This topology enables redundant interconnections between the nodes.**

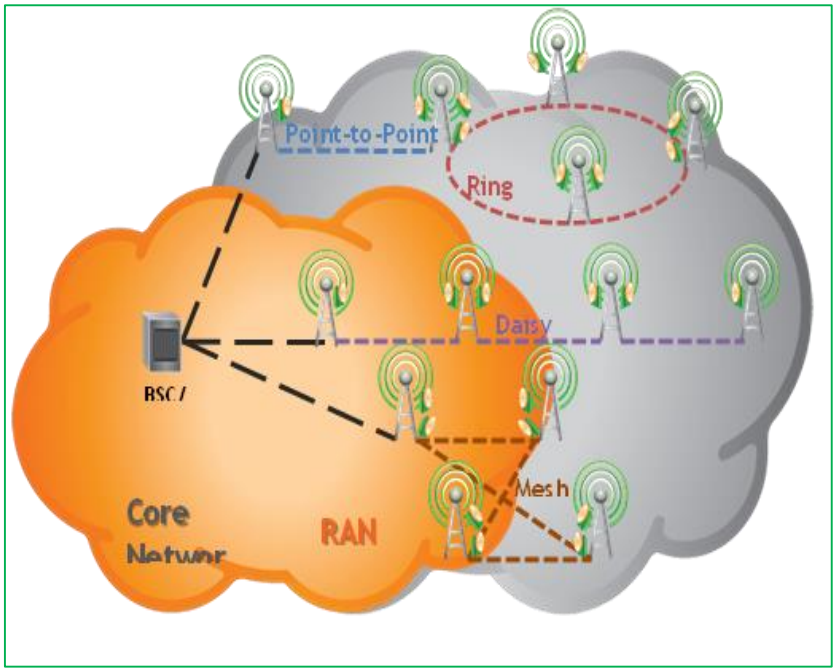


Figure 20 – Deployment topologies

In all the topologies the product performs packet forwarding based on L2, and QoS based on either L2 or L3 information. Thus each packet incoming from any port in the entire network can be identified at any other node in the network, typically according to its VLAN tag and CoS bits. Based on this identification, a node can assign the packet to the proper priority queue, and thus force it to share the BW in a controlled manner with packets coming from other sources. The bandwidth allocation policy (QoS) at each node is fully controlled based on operator's QoS scheme configured into the system.

9.1.1 Solution benefits

- **Integrated, MEF complaint, switch with 4 GE interfaces, especially designed for daisy chain and still preserve the ability to connect "drop" more customers/services (Technology/ costumers co-location)**
- **Max installation flexibility - Any combination between the chained links**

info@siklu.com
www.siklu.com

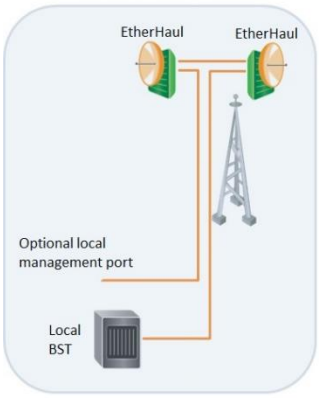


Figure 21 – Daisy chain, Ring and Mesh connection

info@siklu.com
www.siklu.com

10. Standards compliance

Comply with both ETSI spectrum channel arrangement and FCC recommendation.

The list of supported standards by EtherHaul-1200 is:

- **IEEE 1588v2 TC**
- **Synchronous Ethernet ITU-T G.8261/8262/8264**
- **Synchronization Messaging Channel - ESMC**
- **AES 128-bit and 256-bit**
- **MEF 9,14 and 21 complaint**
- **Eth OAM –**
  - **CFM-IEEE802.1ag, Y.1731**
  - **EFM- IEEE802.3ah**
- **G.8032 ERPS**
- **IEEE 802.1d Transparent Bridging**
- **IEEE 802.1ad Provider Bridge – QinQ VLAN/VLAN stacking**
- **Traffic management: 802.1p (L2), DSCP (L3) & MPLS EXP (L2.5)**
- **Antenna: ETSI EN 302 217-4 Class2, class3**
- **Ingress Protection Rating: IP67**
- **PoE+ (IEEE 802.3at)**
- **SNMP: v2/3**
- **Frequency Regulations:**
  - **ETSI EN 302 217-2-2**
  - **USA FCC Part 15.255**
- **Transportation: EN 300 019-1-2 Class 2.2**
- **Storage: EN 300 019-1-1 Class 1.2**
- **Operation: EN 300 019-1-4 Class 4.1E**
- **Safety: UL 60950**
- **EMC: EN 301 489-4 ;FCC 47 CFR part 15**
- **CE: CE Marked**

info@siklu.com
www.siklu.com

About Siklu

Siklu delivers Gigabit capacity millimeter wave wireless backhaul solutions operating in the 60, 70 and 80 GHz bands. Ideal for dense, capacity-hungry urban security networks, the ultra-high capacity wireless links can be easily and discreetly installed on the very same street fixtures as the security cameras. The most deployed mmW radios in the world, thousands of units are delivering carrier grade performance in varying weather conditions around the world.