

EtherHaul™ 8000 Series System Description

June 2018

Release: 1.0



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Document Information

| Revision | Date | Author | Revision notes |
|----------|--------------|--------|---|
| 1 | 25 June 2018 | SH | Initial Release, aligned with System SW R10.0 |

Intended Audience

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

Terminology used in this document assumes audience familiarity with millimeter wave radio communication and networking technologies.

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

1 EtherHaul™ EH-8000 Series Generic Specifications - Introduction

This document describes the generic features of the EtherHaul™ 8000 Series system software and hardware, which are common to all 8000 series products. It complements the product specific information contained in the Production Description document relevant to a particular EtherHaul™ 8000 model. The feature description assumes that the EtherHaul™ units are running Siklu system software R10.0.

2 Radio Features

2.1 E-band spectrum

EtherHaul™ 8000 series operate in the millimeter wave E-band spectrum, from 70GHz to 86GHz, one of the largest band of radio waves, allowing channels up to 2000MHz. The regulation and licensing fees for the use of the spectrum vary from country to country, from a coordinated lightly licensed scheme in the US to a heavily regulated and licensed in other places.

2.1.1 Benefits

There are many benefits to the operation in mmW E-band:

- Abundant spectrum allows the highest wireless capacities up to 10Gbps with large channels and low to medium complexity coding (example: combining channel bandwidth of 2000MHz with QAM128 yields capacity up to 10Gbps).
- Abundant spectrum and high directivity of mmW allows dense deployments, with no practical limits in urban environment.

2.2 Frequency-division duplexing (FDD)

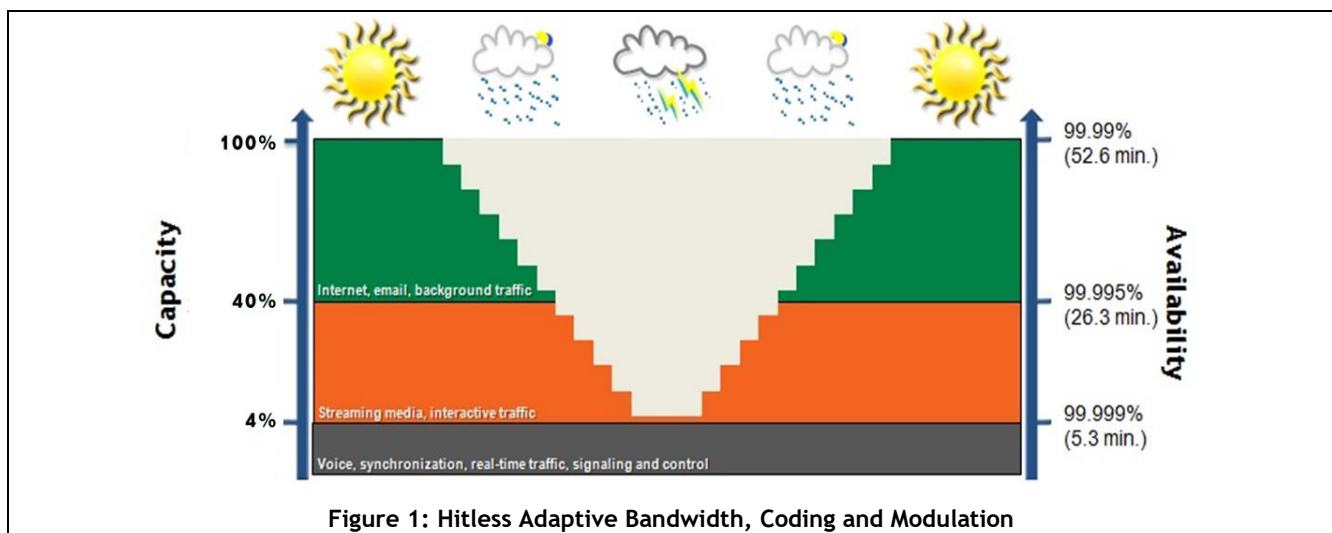
EtherHaul™ 8000 series operate in frequency-division duplexing, one channel per direction of communication, as the abundance of spectrum does not present a practical limitation to the quantity of channels and links that can operate from the same location, or in the same area.

2.2.1 Benefits

- FDD minimizes latency.
- Good match for extending full-duplex Ethernet transmissions.

2.3 Adaptive modulation

EtherHaul™ EH-8000 series implement hitless/errorless adaptive bandwidth, coding and modulation adjustment to optimize the over-the-air transmission and prevent weather-related fading traffic disruption. The EtherHaul™ EH-8000 products can gain up to 29dB (model dependent) in link budget by dynamically adapting the rate, as shown in Figure 1 (capacity and count of minutes for example only, not typical of any specific EH-8000 models or rain climate).



2.3.1 Benefits

- Adaptive bandwidth, coding, and modulation ensure maximum capacity most of the time.
- EtherHaul™ 8000 series hitless algorithm achieves zero down time to enable reliable voice and real-time services, allowing carriers to meet their service level agreements for enhanced user experience.

2.4 Alignment

As any other P2P millimeter wave system, the EtherHaul™ EH-8000 link must be precisely aligned during the installation process.

A standard voltmeter is used for RSSI reading via the (AUX) port, or one of the Ethernet ports and a special adapter (model dependent).

2.4.1 Benefits

- Simple and reliable antenna alignment process (no computer connection needed)
- Alignment is performed using standard single T-bar tool that matches all screws, worm clamps adjustments and locks of the mounting kit(s).

3 Ethernet Switching Specifications

3.1 Standard Ethernet Ports

EtherHaul™ EH-8000 ODUs standard interfaces are standard 1 or 10 Gigabit Ethernet speeds. Some ports are hard-wired 100/1000-BaseT, 100/1000/10G-BaseT while others are an SFP+ MSA compliant cage (model dependent), for communications over multi-mode (MMF) or single-mode optical fiber (SMF).

Each port can be configured to support:

- Auto negotiation enabled/disabled
- Speeds: 100/1000 Mbps or 1000/2.5G/5G/10G (port dependent).
- Full-duplex / half-duplex (not applicable to 10G-BaseT or SFP+ ports)
- Delivery of both payload traffic and/or management traffic
- OAM signaling (SW license required for activation)
- SyncE (model dependent and SW license required for activation)

3.1.1 Benefits

- EtherHaul™ 8000 series interface seamlessly to most common communications equipment.
- Technical staff needs very little training to operate EtherHaul™ 8000 series which act mostly as an extension of existing networks.
- Simple implementation in enterprise or carrier networks, in the LAN or in the WAN, where Ethernet is King.

3.2 Multiple Ports

EtherHaul™ EH-8000 ODUs supports from 2 to 3 Ethernet ports. Ports are 1GbE or 10GbE, model dependent.

3.2.1 Benefits

2 or 3 ports are an ideal number of interfaces at a hub or daisy-chain site, as well as at a drop site delivering multiple services to several devices such as a switch or a router, a hot-spot, or a mobile site with mix of several technologies. This enables:

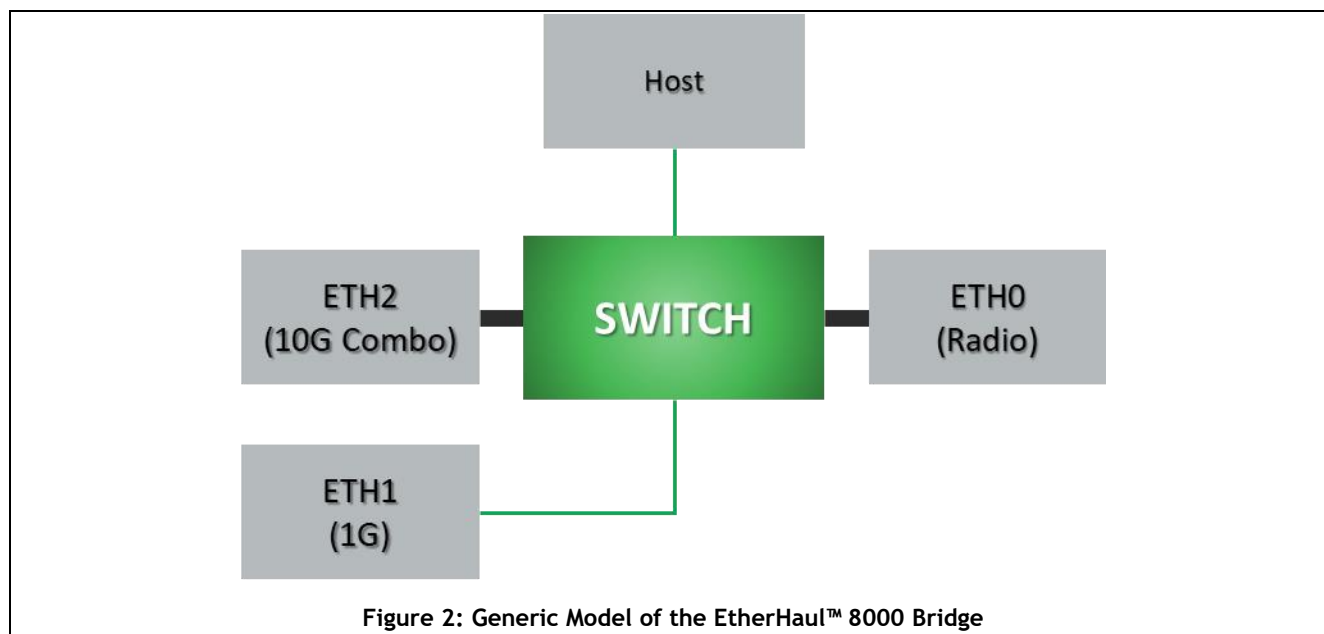
- Advanced network topologies and resiliency: ring, mesh and daisy chain
- Connectivity for more services at each location, avoiding the need for external devices for services grooming/cascading, and thus reducing both CAPEX and OPEX.

3.3 Switching

3.3.1 Managed Ethernet Switch

EtherHaul™ EH-8000 series include an advanced integrated Ethernet switch, connecting the external and the internal interfaces seamlessly, as shown in Figure 2.

- The radio link is identified as ETH0
- The external interfaces are identified ETHx, x = 1, 2, etc...
- The management entity is identified as Host
- All components are managed using either WEB GUI or CLI.



One can change the bridge configuration to suit the networking and management models, using the Web GUI or the CLI.

3.3.2 Transparent Bridge (IEEE 802.1d)

The out-of-the-box configuration of EtherHaul™ EH-8000 is the advanced transparent bridge mode (IEEE 802.1d), a zero-touch judicious match for simple networks. Switching operation is automatic in this mode. Transparent forwarding of both tagged and untagged traffic is performed. It is possible to allocate a dedicated VLAN for in-band management.

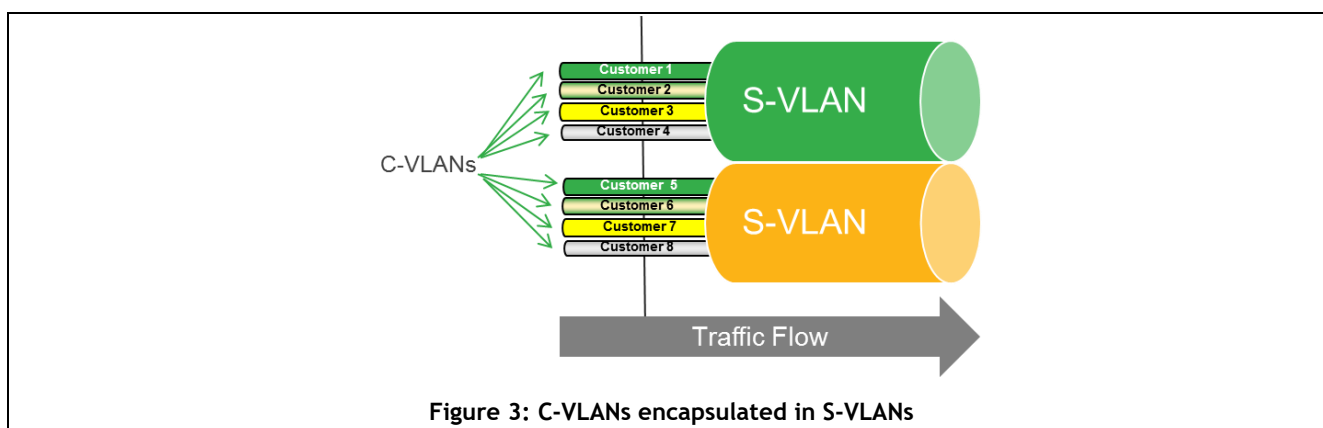
3.3.3 Virtual LAN Bridges (IEEE 802.1Q)

EtherHaul™ EH-8000 series also support IEEE 802.1q for enhanced Ethernet switching or bridging with the support of virtual LAN and or prioritization of traffic. VLAN classification can be added / removed per physical port. It is also possible to allocate a dedicated VLAN for in-band management of the ODU.

3.3.4 Provider Bridge (IEEE 802.1ad)

Alternatively, the EtherHaul™ 8000 series incorporates a full Provider Bridge mode of operation (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.

This enables servicing multiple customers on the same port and forwarding (or tunneling) through the radio link using Service VLAN (S-VLAN). The system is able to deliver multiple S-VLANs, and to manage several customers' VLANs (C-VLAN) in each S-VLAN. Sample VLAN encapsulations are illustrated in Figure 3.



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.

3.3.5 Standards compliance

- IEEE 802.1d - MAC Bridges
- IEEE 802.1Q - Virtual LANs (VLANs)
- IEEE 802.1ad – QinQ

3.3.6 Benefits

- Flexible networking topologies support
- Carrier class services, following leading standards with proven interoperability
- Integrated Gigabit Ethernet switch and advanced networking features allows all outdoor installation
- EtherHaul™ 8000 provider bridge is an easy and fast deployment enabler:
 - It takes any Ethernet based stream, wraps it with service provider tag
 - No practical limits on frame size (the EtherHaul™ 8000 systems supports 9K jumbo frames)

4 EtherHaul™ EH-8000 Series Networking Features

4.1 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 over Ethernet frames. LLDP frames are not forwarded, but are constrained to a single link. The information distributed by the protocol is stored in a topology database. This information can be retrieved by the user or network element using GUI or CLI, 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 EtherHaul™ 8000 to discover other network elements that are connected to it as well as being discovered. This feature enables, amongst other things, to discover third-party network elements connected to the EtherHaul™ 8000 so that they can be managed. In addition, it enables easier integration of EtherHaul™ 8000 links in a LLDP supported network.

4.1.1 Standard compliance

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

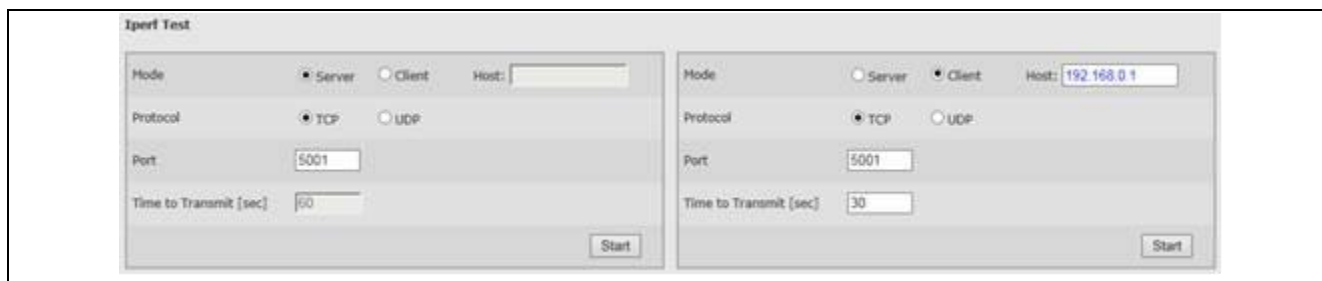
4.1.2 Benefits

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

4.2 Iperf

The built-in Iperf tester implementation includes client/server nodes for over the air TCP/UDP test. Configure one side as Server and run it (click Start) and remote end as Client (and enter the server IP address).

Iperf test run in parallel to traffic over the link.



4.2.1 Benefits

Running Iperf helps the installer to make sure the link is installed properly without the need for external tools. More importantly, Iperf onboard support troubleshooting network and packet losses issues to identify connectivity problems much faster, without the need for on-site visits.

4.3 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.

The EtherHaul™ 8000 management interface acts as a DHCP client by default, and can be configured for static operation when necessary.

4.3.1 Standard compliance

- RFC 2131 - Dynamic Host Configuration Protocol

4.3.2 Benefits

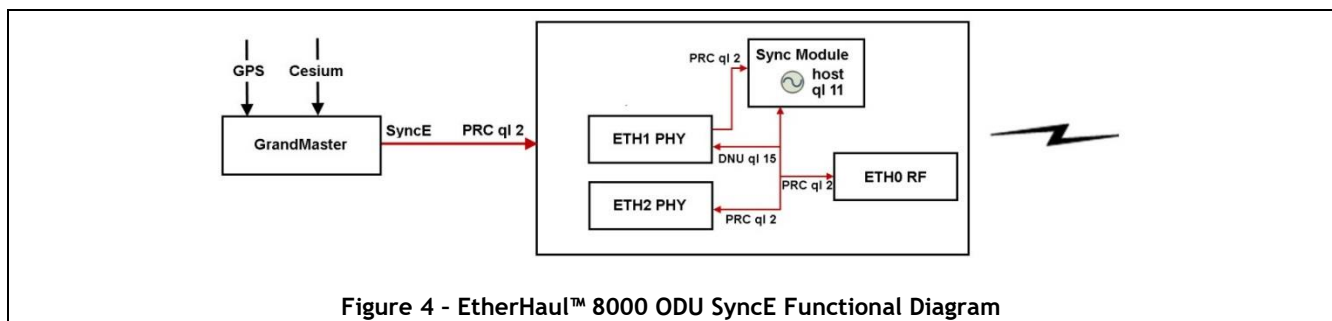
- This protocol reduces system administration workload, allowing networks to add devices with little or no manual intervention.
- Easy and fast discovery of new EtherHaul™ 8000 elements added to any DHCP enabled network

4.4 Synchronous Ethernet (ITU-T G.8261)

Some models in the EtherHaul™ 8000 series support Synchronous Ethernet (SyncE), enabled by a feature license. EtherHaul™ 8000 supports Synchronized Ethernet link input from the network side through one of the physical ports or from the radio side 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 timing distribution scheme that uses the Ethernet physical layer to accurately distribute clock frequency. The ITU-T G.8261 recommendation 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.



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 EtherHaul™ 8000 products to determine which clock source to use, based on performance and the need to avoid loops. Quality Level is based on the clock's holdover performance.

4.4.1 Standard compliance

ITU-T 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.

ITU-T G.8262, Timing characteristics of Synchronous Equipment Slave Clock (EEC), defining the SyncE clock specs

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

4.4.2 Benefits

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

Together with support of IEEE 1588, EtherHaul™ 8000 provide carrier class timing to remote sites and cell-sites, avoiding the need to deploy cumbersome GPS-based timing.

4.5 IEEE 1588 Transparent Clock

Some models in the Siklu's EtherHaul™ 8000 series supports IEEE 1588v2 Transparent Clock (TC), enabled by a feature license. The EtherHaul™ 8000 products comply with the mobile backhaul specifications for packet synchronization distribution.

The EtherHaul™ 8000 products provide optimized transport of the IEEE 1588v2 packets allowing 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).

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. Time stamping and the correction field update are HW based in EtherHaul™ 8000 ODUs.

4.5.1 Standard compliance

- IEEE 1588v2 - Precision Time Protocol (PTP)

4.5.2 Benefits

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

5 EtherHaul™ 8000 Series Management Concepts

EtherHaul™ 8000 is capable of delivering services out of the box (OOB), without any user configuration input, for fast and easy service activation process. In this OOB mode, the system acts as a fully transparent bridge, which matches many network configuration.

For managed operations, EtherHaul™ 8000 includes all fundamentals that enable easy configuration, monitoring, and troubleshooting, 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 user-interface via standard web-browser to manage both ends of the link, 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 SFTP protocols designed to provide file transfer and other manipulations. EtherHaul™ 8000 uses SFTP/FTP/TFTP for software upgrades, configuration uploads and downloads |
| SikluView | EMS – Elements Management System. Siklu solution for high level centralized administration and monitoring of EtherHaul™ 8000 elements and links |

5.1 CLI

All EtherHaul™ series functionality is accessible via secured command line interface (SSH). The user type defines the user's access privileges.

| | |
|-------|---|
| User | Read-only access, but cannot view user names, passwords, and other security settings. |
| Tech | Basic technical operations: can clear statistics, alarms, and log lists, and run diagnostics, but read-only access to configuration settings. |
| Super | Advanced operations and complete access to configuration options, but no access to user names, passwords, and other security settings. |
| Admin | Full access to all management and operations parameters. |

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

EtherHaul™ 8000 units' and link functionality are accessible via secured HTML based Web interface (HTTPS), for monitoring, configuring, SW upgrades and diagnostic.

The GUI enables an easy, realistic view and operation:

- One screen manages both ends of the link
- 'Quick Configuration' wizard to help fast, easy and reliable installation by non-experts staff

- Link status is presented
- Ports highlighted according to actual status
- 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

5.2.1 Web GUI main screen



Figure 5: EtherHaul™ 8000 GUI main screen display

The main screen (Figure 5) displays all essential link status information to enable easy and fast overview:

- Link status (up/down)
- Actual link length, automatically calculated by EtherHaul™ 8000 from the measured wireless delay between both ends of the link
- Used Ethernet ports
- RSSI and CNIR
- Current modulation level
- Available capacity
- Active events or alarms summary

- Shortcuts to both system log and user activity log

Note: the GUI will reflect the exact configuration and physical layout of the ODU (example: PWR port may be present or not; there may be 2 or 3 Ethernet ports).

5.3 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 4 steps:

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

| Step | System | Radio | Eth Ports | Network |
|--------|-----------|-------|-----------|---------|
| step 1 | System | | | |
| step 2 | Radio | | | |
| step 3 | Eth Ports | | | |
| step 4 | Network | | | |

| Product Name | Date | Time |
|--------------|------------|----------|
| ip_0_113 | 2018.06.07 | 18:01:07 |
| ip_0_112 | 2018.06.07 | 21:27:06 |

Copy to Remote >>

Next

Figure 6: Quick Configuration wizard - step 1

2. Configuration of the Radio:
 - Frequency channel selection
 - Tx power
 - Maximum allowed modulation
 - Symmetric / asymmetric mode selection

Figure 7: Quick Configuration wizard - step 2

3. Ethernet Ports

Figure 8: Quick Configuration wizard - step 3

4. Management configuration

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

Quick Config. Main Radio Eth Ports System Network Services Statistics Help Logout

Siklu LOCAL, 192.168.0.113 Name: ip_0_113 Status: Link Up REMOTE Name: ip_0_112

System

Radio

Eth Ports

step 4 Network

IP Address

| # | Type | IP Address | Prefix length | VLAN |
|---|--------|---------------|---------------|------|
| 1 | Static | 192.168.0.113 | 23 | 0 |

Add IPv4 Add IPv6

| # | Type | IP Address | Prefix length | VLAN |
|---|--------|---------------|---------------|------|
| 1 | Static | 192.168.0.112 | 23 | 0 |

Add IPv4 Add IPv6

Default Gateway

IP Address : IPv6 Address :

SNMP Managers

| # | UDP-Port | Security Name | SNMP Version | Engin ID |
|-----|----------|---------------|--------------|----------|
| Add | | | | |

Back Apply

Figure 9: Quick Configuration wizard - step 4

5.3.1 Standard compliance

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

5.3.2 Benefits

- Configuring an EtherHaul™ 8000 link is simple, fast, and secure.
- 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.

5.4 SNMP

The system supports SNMP v2 and SNMP v3 for monitoring and configuration. EtherHaul™ 8000 supports SNMP over both IPv4 and IPv6 addresses.

5.4.1 Standard compliance

- SNMP v2
- SNMP v3

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

5.4.2 Benefits

- Allows simple and standard integration into network management system.
- Enables monitoring, configuring and alarms flows to/from single or multiple northbound 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.

5.5 FTP/SFTP/TFTP

FTP, TFTP and SFTP are network protocols designed to provide file transfer and file manipulation facilities, with optional security services. EtherHaul™ 8000 use SFTP/FTP/TFTP for software upgrades, configuration uploads and downloads.

5.5.1 Standard compliance

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

5.5.2 Benefits

EtherHaul™ 8000 maintenance activities are performed in a secured and standard based method, with standard IT tools.

5.6 Software images

The software images of EtherHaul™ 8000 radios are encrypted and signed with a security certificate. The EtherHaul™ 8000 radios validate a new software image prior to applying the new software, by checking the validity of the signature.

5.6.1 Benefits

EtherHaul™ 8000 radios are protected from mistakes or harmful software updates, an increased protection in the operations of wireless networks built with EtherHaul™ 8000 radios.

5.7 User management

EtherHaul™ 8000 supports both local user management as well as centralized management with industry standard Radius or TACACS server.

5.7.1 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 | Basic technical operations: can clear statistics, alarms, and log lists, and run diagnostics, but read-only access to configuration settings. |
| Super | Advanced operations and complete access to configuration options, but no access to user names, passwords, and other security settings. |
| Admin | Full access to all management and operations parameters. |

5.7.2 Radius and TACACS+ user management

RADIUS (Remote Authentication Dial-In User Service) and TACACS+ (Terminal Access Controller Access-Control System) are 2 industry standard for Authentication, Authorization and Accounting (AAA):

- 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, start and stop times). Note: EH-8000 series does not support the full Accounting standard.

EtherHaul™ 8000 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 EtherHaul™ 8000 as a client. Communication between EtherHaul™ 8000 and the AAA Server is performed by shared secrets which are never sent over the network. In addition, every administrator password is encrypted before it is sent between EtherHaul™ 8000 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.

EtherHaul™ 8000 supports user authentication with TACACS+ or Radius AAA servers, up to five servers.

5.7.3 Benefits

- The hierarchical 4 levels user's access privileges suits all network sizes: 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 support, adds centralized user and rights management for large network operators by enabling access control while minimize IT interactions with end-users without compromising security aspects.

5.8 EtherHaul™ 8000 Series Logging Features

Advanced logging and performance monitoring logs/stats are available and kept in the device. The information can also be exported and collected 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

5.9 System statistics

EtherHaul™ 8000 uses advanced RF and Ethernet counters to provide real-time performance statistics for radio transmission (RF) activities, Ethernet ports, VLAN traffic, and QoS queues.

EtherHaul™ 8000 collects a full day of 15 minutes statistics (96 bins) 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 | <p>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</p> <p>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</p> |
| Ethernet Ports | <p>Displays Ethernet statistics counters per Ethernet port</p> <p>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</p> |

5.9.1 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.

5.9.2 Standard compliance

RFC2819 – RMON Remote Network MONitoring

5.10 System loopbacks

EtherHaul™ 8000 provides 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 Internal Loopback** – Internal loopback is performed on the outgoing Ethernet interface to test the local ODU, the radio link, and the remote ODU. MAC swap of the source address and configurable destination MAC are supported.
- **RF (Radio) Loopback** – Internal loopback is effected on the ODU's RF output to test the local ODU, and the communication up to the ODU.

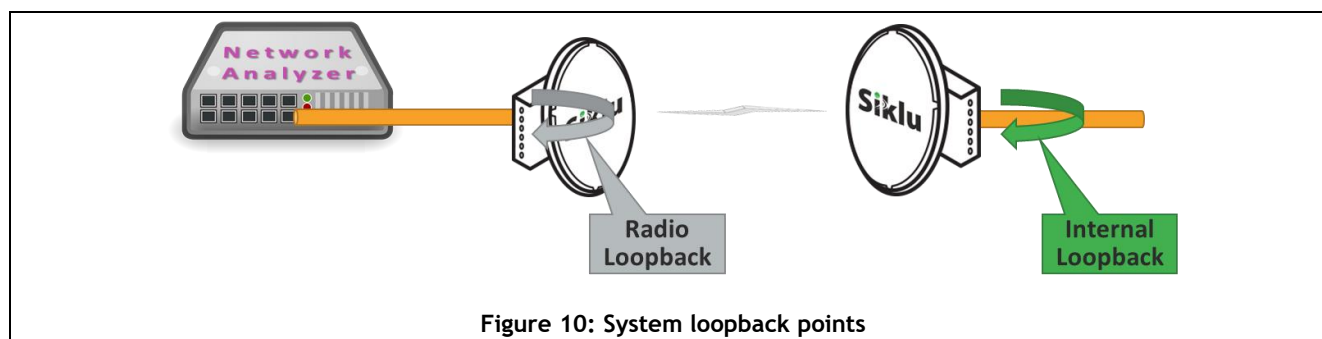


Figure 10: System loopback points

Counters on the network analyzer, system alarms as well as statistic displays are used to determine if loopback testing has passed or failed.

5.10.1 Benefits

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

6 EtherHaul™ 8000 Series Security

6.1 Security features description

- Physical
 - Penciled RF beam: requires a physical location within the antenna transmission path.
 - Minimal reflections: the extremely low transmit power and ultra-high frequencies both contribute to minimal reflections and thus enhances system's resiliency and noticeable footprint.
 - Proprietary DSP (Digital Signal Processor) for RF signals requires Siklu ODU to intercept.
 - Synchronized transmission: only 'man-in-the-middle' interception for eavesdropping.
- Link / data encryption
 - AES with 128/256 bit security (model dependent, licensed based)
- 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
 - Secured communication protocols for management: SSH (Command Line Interface, with SHA-256), HTTPS (Web-GUI, with SHA-256), SFTP (SW download and File Transfer)
- Software images
 - Software images are encrypted and signed
- User access
 - Different user types and privileges categories

6.2 Interface to external access rights management systems

EtherHaul™ 8000 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 EtherHaul™ 8000 Series Power Supply

EtherHaul™ 8000 may have up to 2 power input options working in redundancy.

- Carrier-grade 48VDC (DC input range: 36 ÷ 57 VDC, flexible grounding)
- PoE++ (IEEE 802.3at+)

The power draw of a specific ODU is listed in the product specific Product Description document.

7.1.1 Benefits

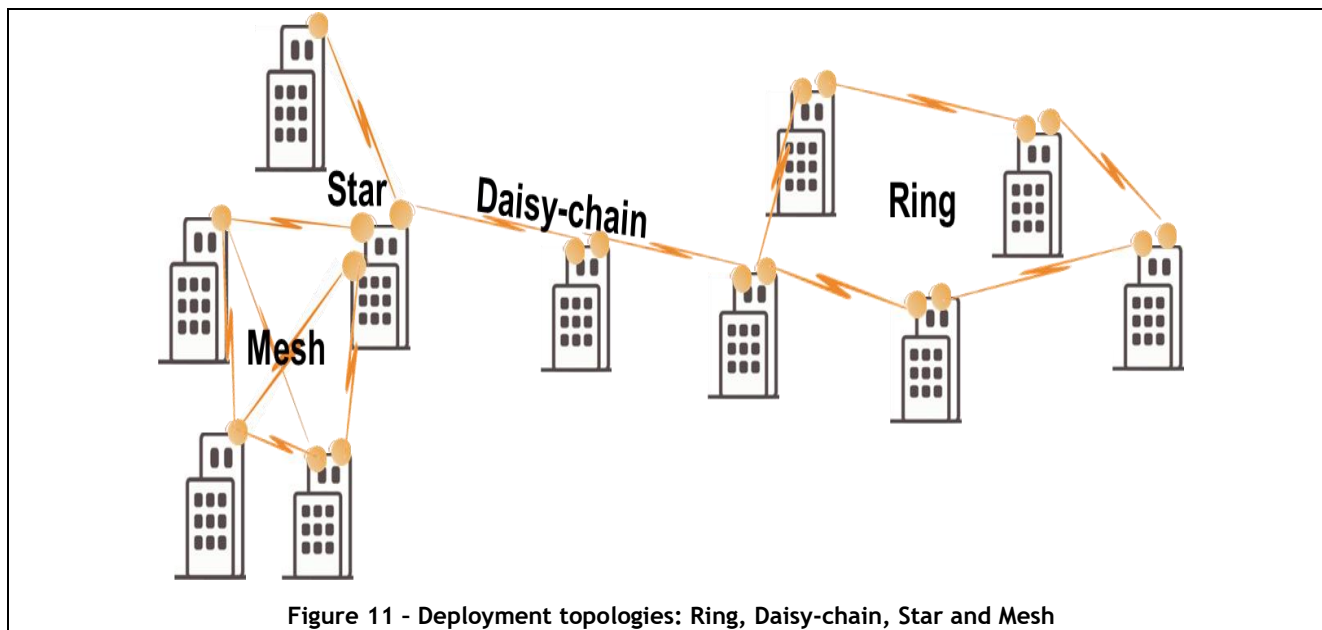
Thanks to the efficient system design and high integration, EtherHaul™ 8000:

- Reduces the power consumption and accordingly the associated energy costs.
- Simplifies the installation scenario, by enabling use of a single cable for both power and management or data.
- Overcomes single point of failure with power redundancy for high availability and carrier grade services.

8 EtherHaul™ 8000 Series Deployment Topologies

EtherHaul™ 8000 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 are deployed in star configuration. The ODUs at the start of the links in the hub site may be chained to each other, or aggregated using an Ethernet switch.
- Daisy-chain - A number of links are used to implement an open series of point-to-point hops, where traffic could be dropped and added at each node in the chain, while extending the reach much beyond that of a single hop. Typically the nodes can be connected without an Ethernet switch.
- Ring - A number of links are 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 also enables a diversity of packet routing options and redundancy.
- Mesh - A number of links are 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.



In all these topologies, EtherHaul™ 8000 performs packet forwarding based on L2. Thus each incoming packet at any port in the entire network can be classified and switched at any other node in the network, typically according to its VLAN tag.

8.1.1 Solution benefits

- Integrated switch with 2 or 3 interfaces, especially designed for daisy chain and still preserve the ability to “drop” customers/services.
- Max installation flexibility - Any combination between the chained links

9 EtherHaul™ 8000 Series Standards Compliance

The list of standards and recommendations supported generically by EtherHaul™ 8000 software and hardware is:

Management (reference also to Security)

- IEEE 802.1AB - Link Layer Discovery Protocol (LLDP)
- RFC 3410/3416 - SNMPv2/3
- RFC 2131 - Dynamic Host Configuration Protocol
- RFC2819 - RMON Remote Network MONitoring

Security

- IETF TACACS+
- RADIUS
- RFC 2246 - Transport Layer Security (TLS) protocol
- RFC 2818 – HTTPS, HTTP over TLS
- RFC 4251 - the IETF extension of the Secure Shell protocol (SSH) version 2.0
- RFC 959/1350 - FTP, SFTP, TFTP
- RFC2616 - Hypertext Transfer Protocol (HTTP)

Networking

- IEEE 802.1ad Provider Bridge – QinQ VLAN/VLAN stacking
- IEEE 802.1d Transparent Bridge
- IEEE 802.3ab / 1000BASE-T
- IEEE 801.1Q – VLAN Bridges
- RFC-2475 - Architecture for differentiated services.

Environmental, Power

- CE: CE Marked (pending)
- EMC: EN 301 489-4 ;FCC 47 CFR part 15
- IEEE 802.3at++ PoE power(ed) device (model dependent)
- Ingress Protection Rating: IP67
- MSA SFP SFF-8431 Specifications for Enhanced Small Form Factor Pluggable Module SFP+
- Operation: EN 300 019-1-4 Class 4.1E
- Safety: UL 60950
- Storage: EN 300 019-1-1 Class 1.2
- Transportation: EN 300 019-1-2 Class 2.2

Additional standards and recommendations supported specifically by an EtherHaul™ 8000 ODU are listed in the product specific Product Description.

10 Acronyms and Abbreviations

| | | | |
|-------|---|-------|--------------------------------------|
| CE | Communauté Européenne (European Community) | MMF | Multi Mode Fiber |
| CLI | Command Line Interface | mmW | millimeter Waves |
| EMC | Electro Magnetic Interference | OOB | Out of the Box |
| ERP | Ethernet Ring Protection | PtP | Point to Point (also P2P) |
| FDD | Frequency Division Duplexing (see also TDD) | P2MP | Point to Multipoint |
| FO | Fiber Optic | RPL | Ring Protection Link |
| GUI | Graphical User Interface | SFP | Small Form-factor Pluggable |
| Iperf | IP Performance (test tool) | SMF | Single Mode Fiber |
| LAN | Local Area Network | SSH | Secure SHell |
| LLDP | Link Layer Discovery Protocol | SyncE | Synchronous Ethernet |
| MSA | Multi-source Agreement | TDD | Time Domain Duplexing (see also FDD) |
| | | WAN | Wide Area Network |

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.

Siklu Communication Ltd.
43, HaSivim St.
Petach Tikva 49517, Israel
Tel: +972 3 921 4015
Fax: +972 3 921 4162
hello@siklu.com