Siklu

MULTIHAUL™ TG

Wireless 60 GHz L2 SDN Mesh for Multi-Gigabit Ethernet

Installation, Operation and Maintenance Manual

MHTG-I&O-01, vF2

December 2021

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This document was originally written in English. Please refer to the English language version for a full and accurate description of all products and services described herein.

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1 Introduction

1.1 Scope

This document describes how to install, configure, operate and maintain the MultiHaul™ TG, Siklu's Wireless 60 GHz L2 SDN Mesh for Multi-Gigabit Ethernet.

1.2 Applicable Products and Releases

- MultiHaul™ TG Node N366 & N367
- MultiHaul™ TG Terminal Unit (TU) T265
- MultiHaul™ TG Terminal Unit (TU) T260
- MultiHaul™ TG Terminal Unit T280

1.3 Audience

This document assumes a working knowledge of wireless connectivity platforms and their operating environments.

This document is intended for use by persons involved in planning, installing, configuring, and operating the MultiHaul™ TG units.

1.4 Conventions

The following conventions are used in this document in order to make locating, reading, and using information easier.

Note: Informs you of an optional activity that may be performed at this stage.

Caution: Informs you that if you do not proceed as instructed, damage to or destruction of equipment or a loss of functionality may result.

Warning: Warns you that if you do not proceed as instructed, personal injury or loss of life could result.

1.5 List of Abbreviations

Abbreviation	Description
CDRH	Center for Devices and Radiological Health, a branch of the United States Food and Drug Administration (FDA)
FOV	Field Of View
MTU	Maximum Transmission Unit
NVRAM	Non-Volatile Random Access Memory
OTA	Over The Air
PD	Powered Device
PHY	Physical layer
PoE	Power over Ethernet
PoP	Point of Presence
PSE	Power Sourcing Equipment
PtMP	Point to MultiPoint
RAM	Random Access Memory
SaaS	Software as a Service
SDN	Software-Defined Networking
SFF	Small Form Factor
SFP	Small Form-Factor Pluggable
TU	Terminal Unit
UV	Ultraviolet

2 Safety and Regulatory Notices

The following are mandatory notices for installation and operation of MultiHaul™ TG Wireless Backhaul System. Indications appearing here are required by the designated government and regulatory agencies for purposes of safety and compliance.

2.1 General

Do not install or operate the MultiHaul™ TG units in the presence of flammable gases or fumes. Operating any electrical instrument in such an environment is a safety hazard.

2.2 FCC Regulatory Statements

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in any installation scenario. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver isconnected.
- Consult the dealer or an experienced radio/TV technician for help.

Outdoor units and antennas should be installed, serviced or replaced ONLY by trained and qualified professionals who are familiar with local building and safety codes and, wherever applicable, are licensed by the appropriate government regulatory authorities.

The units are sold to service providers or professional network operators. They may not be sold retail to the general public.

Outdoor units may only be installed and operated with their integrated antenna, or with detachable antennas designated by Siklu Communication Ltd. (see section 5.1).

Failure to do so may void the product warranty and may expose the end user or the service provider to legal and financial liabilities. Siklu Communication Ltd. and its resellers or distributors are not liable for injury, damage or violation of regulations associated with the installation of outdoor units or antennas.

Les unités extérieures et les antennes doivent être installées, entretenues ou remplacées UNIQUEMENT par des professionnels formés et qualifiés qui connaissent les codes locaux du bâtiment et de la sécurité et, le cas échéant, sont agréés par les autorités réglementaires gouvernementales appropriées.

Les unités sont vendues à des prestataires de services ou à des opérateurs de réseaux professionnels. Elles ne peuvent être vendues au détail au grand public.

Les unités extérieures ne peuvent être installées et exploitées qu'avec leur antenne intégrée, ou avec des antennes amovibles désignées par Siklu Communication Ltd. (dans la section 5.1).

Le non-respect de ces consignes peut annuler la garantie du produit et exposer l'utilisateur final ou le fournisseur de services à des responsabilités juridiques et financières. Siklu Communication Ltd et ses revendeurs ou distributeurs ne sont pas responsables des blessures, des dommages ou de la violation des réglementations associées à l'installation d'unités extérieures ou d'antennes.

Changes or modifications to this equipment not expressly approved by the party responsible for compliance (Siklu Communication Ltd.) could void the user's authority to operate the equipment.

2.3 Canada Regulatory Statements

This Class B digital apparatus complies with Canadian ICES-003.

Cet appareil numérique de la classe B est conforme à la norme NMB-003 du Canada.

This device complies with Innovation, Science and Economic Development Canada's license-exempt RSS standard (s). Operation is subject to two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference that may be received or that may cause undesired operation.

Le présent appareil est conforme aux CNR d'Innovation, Sciences et Développement économique Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes : (1) l'appareil ne doit pas produire de brouillage, et (2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

T280	This radio transmitter with ISED certification number 12353A-MH60TGA3 has been approved by Innovation, Science and Economic Development Canada to operate with the antenna models and maximum permissible gain listed in section 5.1. Antenna types not included in this list that have a gain greater than the maximum gain indicated for any type listed are strictly prohibited for use with this device.

2.4 EU Regulatory Notes

N366, T265	These products meet the technical requirements of ECC REC 07-03 (7 June 2019), Table 3, bracket C2, with operation between 57 GHz and 66 GHz and radiated transmitted power (EIRP) under 40 dBmi.

T280	This product meets the technical requirements of ECC REC 07-03 (7 June 2019), Table 3, bracket C3, with operation between 57 GHz and 66 GHz, transmit antenna gain ≥ 30 dB, and radiated transmitted power (EIRP) under 55 dBmi.

In some EU countries, outdoor operation of these devices is not permitted. If in doubt, please enquire with your national telecommunications regulator.

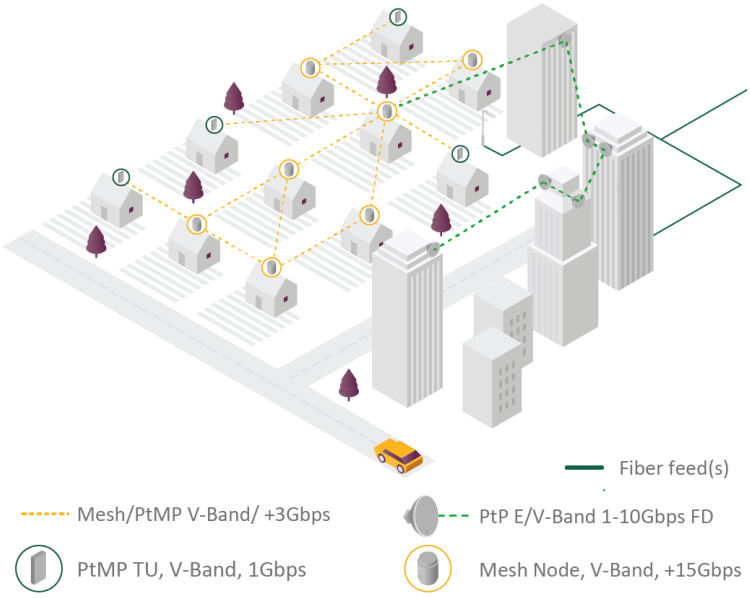
Changes or modifications to this equipment not expressly approved by Siklu Communication Ltd. or the party responsible for compliance could void the user's authority to operate the equipment.

Outdoor units and antennas should be installed ONLY by experienced installation professionals who are familiar with local building and safety codes and, wherever applicable, are licensed by the appropriate government regulatory authorities. Failure to do so may void the product warranty and may expose the end user or the service provider to legal and financial liabilities. Siklu Communication Ltd. and its resellers or distributors are not liable for injury, damage or violation of regulations associated with the installation of outdoor units or antennas.

Les unités extérieures et les antennes doivent être installées par des professionnels expérimentés d'installation qui sont familiers avec les normes locales et les codes de sécurité et, si applicable, sont agréés par les autorités gouvernementales. Ne pas le faire peut annuler la garantie du produit et peut exposer l'utilisateur final ou le fournisseur de services à des d'obligations juridiques et financières. Les revendeurs ou distributeurs de ces équipements ne sont pas responsables des blessures, des dommages ou violations des règlements liés à l'installation des unités extérieures ou des antennes. L'installateur doit configurer le niveau de puissance de sortie des antennes conformément aux réglementations nationales et au type d'antenne.

3 MultiHaul™ TG Overview

The MultiHaul™ TG family is an advanced solution for fixed wireless delivery of multi-Gigabit services to homes, businesses and within smart cities Broadband IoT applications. It is complemented by additional Siklu solutions for network design and operation, the SmartHaul™ suite of SaaS applications and services, together with EtherHaul™, a series of very high capacity PtP wireless links.



MultiHaul™ TG is the culmination of innovation for L2 SDN mesh carrier-class systems operating in the uncongested, unlicensed V-band, delivering very high capacity over small to large neighborhoods for a wide range of applications. The plug and play units are designed for easy installation by a single technician, using a single cable for power and data.

This section provides a brief overview of the MultiHaul™ TG units. The MultiHaul™ TG family consists of the following units:

- MultiHaul™ TG N366 or N367 - a compact multi-sector unit deployed as a L2 SDN mesh node with built-in self-backhaul. Nodes can connect to additional N366 nodes to build a resilient wireless backbone across the served area, or to a network POP via either a fiber connection or a Siklu EtherHaul™ link with up to 10 Gbps FD.
- MultiHaul™ TG T265 - terminal units (TUs) deliver up to 1 GbE wirelessly to served locations. A smart beam-forming antenna provides for easy installation of a high capacity reliable wireless link by a single person, and serves one to three end-units per location.
- MultiHaul™ TG T260 - compact terminal unit (cTU) delivers up to 1 GbE wirelessly to served locations. A smart beam-forming antenna provides for easy installation of a high capacity reliable wireless link by a single person, and serves one end-unit per location.
- MultiHaul™ TG T280 - terminal units (TUs) deliver long-range, point-to-point and point-to-multipoint (future) connectivity, delivering 1 GbE full-duplex traffic (upgradeable to 5.5 Gbps aggregated with licenses and future software upgrade) over ranges of 1 kilometer or more.

3.1 N366 or N367 Node

Featuring 4 independent 90° sectors for a complete 360° coverage, a single node can be installed on a pole or roof to serve multiple locations. The node supports up to 15 TUs in each 90° sector when the sector does not self-backhaul to other nodes, up to a total of 60 TUs per N366. Each sector can also support 1 or 2 self-backhaul links, reducing the number of TUs that can be supported to 13 or 14 respectively (each backhaul link comes at the expense of a TU link).

The main features of the node include:

- 4 x 90° sectors.
- 4600 Mbps aggregate capacity OTA (over the air) per sector.
- > 3800 Mbps L2 traffic per sector, resulting in close to 16 Gbps capacity per node.
- 3 ports:
  - RJ-45 port with PoE-In, and capable of speeds from 1 Gbps to 2.5, 5 and 10 Gbps.
  - RJ-45 port with PoE-Out, and capable of speeds up to 1 Gbps.
  - SFP+ socket for SMF or MMF connections at speeds of up to 1 Gbps or 10 Gbps, depending on the inserted SFP device.
- On-board web GUI or CLI, for local or remote management and operations.
- Centralized management via SmartHaul™.

See the N366 datasheet and product description for more information.

3.2 T265 TU

Featuring 90° scanning for easy installation, long distance and high performance, a TU can be installed on a pole or wall to serve between 1 - 3 connected devices with a copper or fiber interface. Additionally, the PSE/PoE-Out feature simplifies installation of the served devices by removing the need for additional power equipment.

The main features of the TU include:

- 90° horizontal scanning.
- 4600 Mbps aggregate capacity OTA (over the air).
- Up to 1 Gbps traffic.
- Up to 3 Ports, model dependent:
  - RJ-45 ports with PoE-In, and capable of 2.5 and 1Gbps speeds.
  - Optional RJ-45 port with PoE-Out.
  - Optional SFP+ socket for connection of SMF or MMF at speeds of up 10 Gbps.
- On-board Web EMS or CLI, for local or remote management and operations.
- Centralized management via SmartHaul™ EMS.

See the T265 datasheet and product description for more information.

3.3 T260 cTU

Featuring 90° scanning for easy installation, long distance and high performance, a cTU can be installed on a pole or wall to serve between 1 connected device with a copper interface.

The main features of the TU include:

- 90° horizontal scanning.
- 4600 Mbps aggregate capacity OTA (over the air).
- Up to 1 Gbps traffic.
- 1 RJ-45 Port with PoE-In, capable of 1Gbps speeds.
- On-board Web EMS or CLI, for local or remote management and operations.
- Centralized management via SmartHaul™ EMS.

See the T265 datasheet and product description for more information.

3.4 T280 TU

The T280 Terminal Unit delivers long-range (over 1 kilometer), point-to-point connectivity (point-to-multipoint connectivity in the future, following a software upgrade). The T280 mounts easily on a pole, and offers up to 3 ports with both copper and fiber interfaces as well as a PoE out to power a collocated N366 or other 3rd party device.

A choice of 0.5ft, 1ft or 2ft antennas provides an optimal solution for the most challenging long distance links, while allowing installation on roof tops, or on street furniture with the compact streamlined reflector antenna.

The main features of the T280 include:

- 4600 Mbps aggregate capacity OTA (over the air).
- 1 Gbps full duplex traffic, with upgrades up to 5500 Mbps with licenses and future software upgrades.
- 3 Ports:
  - RJ-45 ports with PoE-In, and capable of 1, 2.5, and 5 Gbps speeds.
  - RJ-45 port with PoE-Out.
  - SFP+ socket for connection of SMF or MMF at speeds of 1 or 10 Gbps.
- On-board Web EMS or CLI, for local or remote management and operations.
- Centralized management via SmartHaul™ EMS.

See the T280 datasheet and product description for more information.

3.5 Functional Description

The key features of MultiHaul™ TG systems include:

- PtP and PtMP wireless connectivity in the unlicensed 60 GHz V-band.
- Node units serve as backbone for the wireless network, with built-in self-backhaul and TUs connecting end user devices to the wireless network.
- Node and TUs feature a multiport Ethernet switch and advanced networking features.
- Long range options with the T280 and a choice of antenna gain from 36 dBi to 48 dBi (0.5ft to 2ft respectively).
- Node and TUs can power additional devices via POE-out.

All MultiHaul™ TG units share a common design, for uniformity of features and ease of operations. The following block diagram explains the key building elements:

- The Base Band Section includes the integrated processor and Ethernet switch interconnecting the physical
- Up to four RF Modules, model dependent. The RF module includes all the RF functions, modem, amplifiers and controller of the antenna array, together with the antenna array(s), for a total of up to 256 antenna elements. The modules are designed with specific applications in mind, for example wide horizontal and vertical coverage, or long-distances.

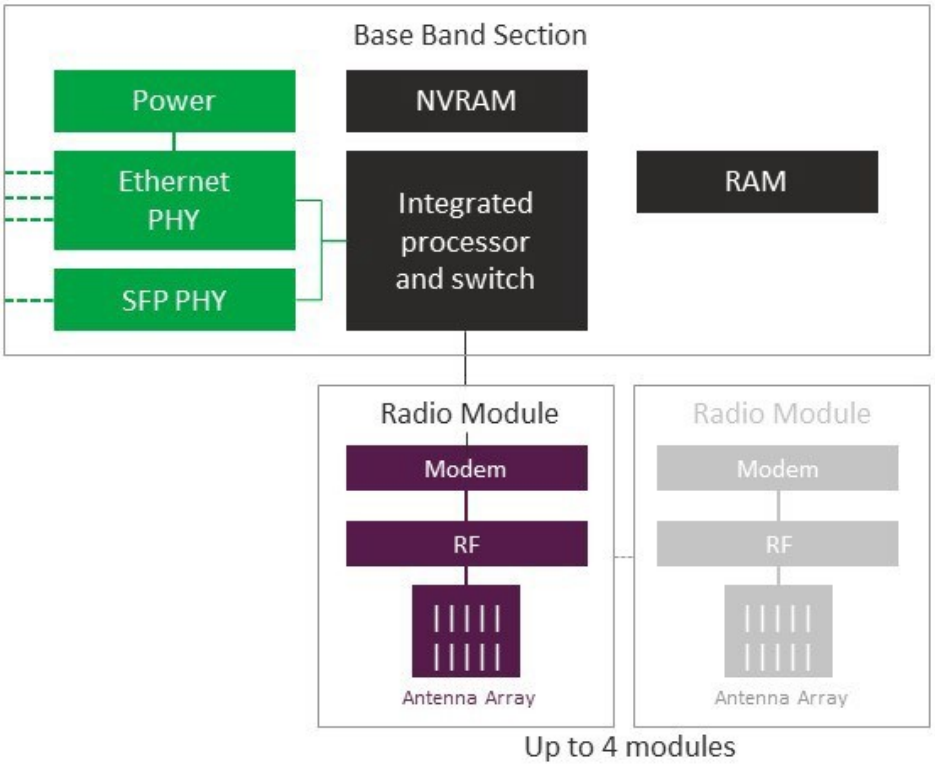


Figure 1: TG unit with Antenna Array

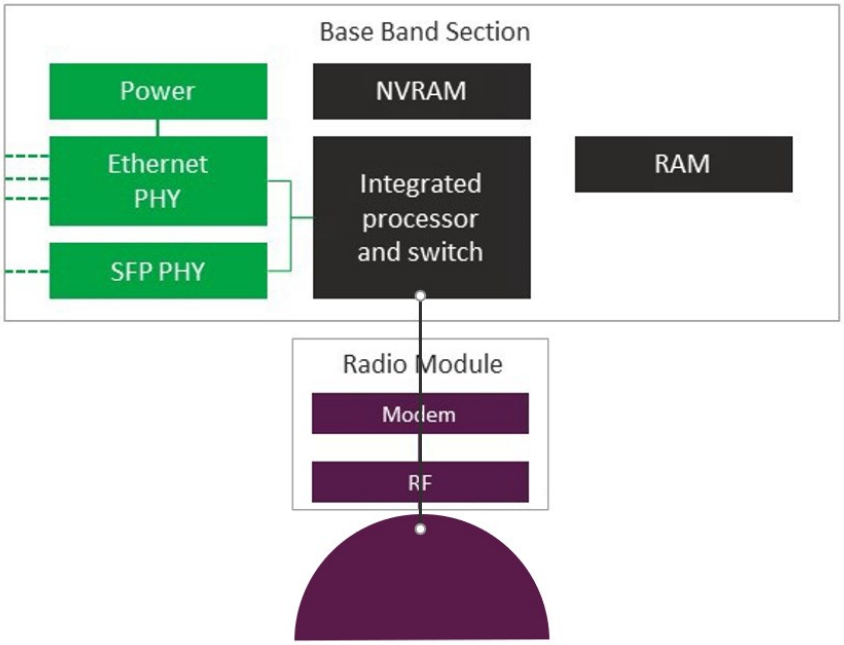


Figure 2: TG unit with External Antenna

3.6 Technical Specifications – N366 / N367, T265 and T260

The main characteristics of the MultiHaul™ TG N366 and T265 units are listed in the following table.

Detailed performance and specifications are available in the datasheets and product descriptions.

Item	Node - N366 or N367	TU - T265	TU - T260
Sector(s)	• Up to 4 x 90° sector, for 360° coverage Each sector: • Horizontal scanning: 90°	• Horizontal scanning: 90° • Vertical scanning: 50°	
Channels & Width	• 4 x non-overlapping channels, each 2160MHz wide • Any sector any of 4 channels, for optimal RF performance	• 4 x non-overlapping channels, each 2160MHz wide for optimal RF performance.	
Typical Reach (Node to Node/TU)	1000 ft. / 300 m For detailed performance calculations, see Siklu's online link budget calculator: lbc.siklu.com		
Interfaces	3 ports: • 1 x RJ-45 10/5/2.5/1GbE with PoE-In • 1 x RJ-45 1GbE with PoE-Out (35W) • 1 x SFP+ 10GbE	T265-CCP - 3 ports: • 1 x RJ-45 2.5/1GbE with PoE-In • 1 x SFP+ 10GbE T265-CNN - 1 port: • 1 x RJ-45 1GbE with PoE-In	• 1 x RJ-45 1GbE with PoE-In
Management & Provisioning	• In-band, Out-of-band management • Web GUI (single -pane configuration of local and remote units) and embedded CLI NETCONF		
Conformance	• Radio: US FCC 47 CFR Part 15.255; EN 303 722 • EMC: US FCC 47 CFR Part 15; EN 301 489 • Safety: UL/IEC 62368-1; UL/IEC 60950-22		
Terragraph	Terragraph certified		

Item	Node - N366 or N367	TU - T265	TU - T260
Power	• PoE, 55 W no POE-Out, 90 W with 35 W POE-Out • PoE-In: IEEE 802.3bt or passive • PoE-Out: IEEE 802.3bt	• T265-CNN: PoE, 25W • T265-CCP: PoE, 25W with no PoE-out, 90W with PoE-Out • PoE-In: IEEE 802.3bt or passive • PoE-Out: IEEE 802.3bt	• PoE, 13W • PoE-In: IEEE 802.3bt or passive
Environmental	• Operating Temperature: -49° ÷ +131°F (-45° ÷ +55°C) • Ingress Protection Rating: IP67		
Dimensions	9.4 x 7.3 in. / 236 x 186 mm (height x diameter)	6.9 x 8.6 x 4.9 in. / 175 x 220 x 125 mm (W x H x D)	4.3 x 7.5 x 2.3 in. / 108 x 190 x 58 mm (W x H x D), mounting kit not included.
Weight	7.9 lbs. / 3.6 kg	4.84 lbs. / 2.2 kg	3.9 lbs. / 1.8 Kg

3.7 Technical Specifications – T280

The main characteristics of the MultiHaul™ TG T280 units are listed in the following table.

Detailed performance and specifications are available in the T280 datasheet and product description.

Item	Value
Sector(s)	One 90° sector: • Horizontal scanning: 90° • Vertical scanning: 40°
Channels & Width	4 channels, 57-66 GHz, TDD/TDMA 2160MHz, BPSK to QAM16, up to 10 levels of hitless adaptive bandwidth, coding and modulation – boost gain by over 29dB.
Typical Reach	PtP, T280 to T280: 1200+ meters PtMP, N366 to T280: 600+ meters For detailed performance calculations, see Siklu's online link budget calculator: lbc.siklu.com
Interfaces	3 ports: • 1 x RJ-45 1/2.5/5 GbE with PoE-In • 1 x RJ-45 1GbE with PoE-Out (55W) • 1 x SFP+ 10GbE
Management & Provisioning	• In-band, Out-of-band management • Web GUI (single -pane configuration of local and remote units) and embedded CLI NETCONF
Conformance	• Radio: US FCC 47 CFR Part 15.255; EN 303 722 • EMC: US FCC 47 CFR Part 15; EN 301 489 • Safety: UL/IEC 62368-1; UL/IEC 60950-22
Terragraph	Terragraph certified
Power	• 35W with no PoE-out, 90W with PoE-Out • PoE-In: IEEE 802.3bt or passive • PoE-Out: IEEE 802.3bt
Environmental	• Operating Temperature: -49°F to +131°F (-45°C to +55°C) • Ingress Protection Rating: IP67
Dimensions	6.9 x 9 x 2.5 in. / 175 x 230 x 65 mm (W x H x D), antenna not included.
Weight	4.4 lbs. / 2 Kg, antenna not included.

3.8 Managing the MultiHaul™ TG Units

You can manage MultiHaul™ TG using the:

- Command Line Interface (CLI)
- Graphical User Interface (GUI)

Remote management systems such as NMS and EMS can interface with the MultiHaul TG units using the NETCONF protocol.

The MultiHaul TG can be completely configured and operated locally or remotely using the GUI or CLI as you prefer. In addition, the GUI and CLI both feature a wide range of built-in indicators and diagnostic tools for advanced OAM functionality. The units are designed to enable quick evaluation, identification, and resolution of operating faults.

4 Installing the MultiHaul™ TG Units

This section describes how to install the MultiHaul™ TG nodes and TUs (T265 & T260). For T280 installation guidelines, see Chapter 5: Installing the MultiHaul™ TG T280 Terminal Unit

4.1 Preparing the Site

Carefully select and prepare each site to make installation and configuration as simple and trouble-free as possible. During site selection and preparation, take into account local safety regulations and consider the long-term needs of both your network and your applications.

Installation and maintenance of the MultiHaul™ TG link should only be done by service personnel who are properly trained and certified to carry out such activities.
L'installation et l'entretien d'une unité MultiHaul™ TG ne doivent être effectués que par du personnel de service qui sont formés et accrédités pour mener à bien ces activités.

Minimum safe distance from antenna while radiating is 33 cm / 13 in (general public) or 15 cm / 6 in (occupational) according to calculation done based on "Environmental evaluation and exposure limit according to FCC CFR 47part 1, 1.1307, 1.1310; RSS-102, Safety Code6.
Distance de sécurité minimum de l'antenne tout en rayonnant est 33 cm selon le calcul fait sur la base de "l'évaluation environnementale et la limite d'exposition selon FCC CFR 47part 1, 1,1307, 1,1310, RSS-102, CODE6 sécurité.

4.1.1 Physical and Environmental Requirements

Each site should meet the following requirements:

- There must be a clear, unobstructed line-of-sight between the units.
- MultiHaul™ TG units should be mounted on a fixed, stable, permanent structure. Units can be mounted using the following methods:
- On reinforced steel mounting poles with the following diameters:
  - Node - 1.5" - 12"
  - TU (T265, T260) - 1.5" - 4"

2" - 4" poles are recommended, in which case you can use the provided self-locking bands.

- Directly on a wall using the AX-MK-WM accessory, ordered separately from Siklu or your reseller.

4.1.2 Cabling Requirements

- Install the MultiHaul™ TG unit where network connections and optional power cabling are ready for operation and easily accessible.

Do not mount a MultiHaul™ TG unit on a structure that is temporary or easily moved.
Doing so may result in poor service or equipment damage.

- All cabling connected to the MultiHaul™ TG unit should be outdoor grade, with UV protection.
- Use the following cables as per your type of connection:
  - 1 GbE - Cat5e (or higher) shielded outdoor cables terminated with metallic RJ45 connectors.
  - 10 GbE - Cat6 (or higher) shielded outdoor cables terminated with metallic RJ45 connectors.
- The MultiHaul™ TG unit is powered through the PoE input (ETH1). Take into account the power requirements of the MultiHaul™ TG unit (see Section 3.6: Technical Specifications – N366 / N367, T265 and T260) and external PD(s) when planning Ethernet cabling and passive POE Midspan/Injectors.
- PSE Output (PoE Out) is available on MultiHaul™ TG units with more than a single Ethernet port.
- PSE port output voltage is nearly the same as PoE port input voltage. The total cable length from the PoE injector or PSE device to the last powered device (PD) should not exceed 100 meters (PSE to first unit + first unit to second unit).

PSE output is available only if the unit is powered directly by a power source such as 48VDC, or a PoE Injector/Midspan.

One MultiHaul™ TG unit will power a 2nd unit, however that 2nd unit cannot power a third unit.

You must also consider proper power-in limitations to avoid damage to the first or second unit in the chain.

- In order to protect indoor equipment, you must install surge protection circuits on all copper cables on their entrance to the building.
- Install the MultiHaul™ TG unit in a location where proper electrical outdoor grounding is readily available. Typically, the grounding connection is attached directly to the mounting pole. If not already present, then suitable structure-to-earth grounding connections must be created before installation. Ground the unit using 16 AWG diameter (minimum) grounding cable or according to local electrical code.

Improper electrical grounding can result in excessive electromagnetic interference or electrical discharge.

Siklu will not be held responsible for any malfunction or damage if the unit is not properly grounded.

4.1.3 Node Orientation

The network has been carefully designed by your or Siklu's Planning Team to achieve the highest standards in availability and reliability, taking into account all potential lines of sight between the large quantity of units in your network. It is critical to implement the orientation of the multi-sector nodes as they are designed by the planners of the network. Sector 1 is the reference sector for node orientation. Make sure you obtain the azimuth for sector 1 from your or Siklu's Planning Team before installing, and align sector 1 along this planned azimuth, as described in Section 4.5 - Mounting and Aligning the MultiHaul™ TG Node on a Pole, Step 7.

4.2 MultiHaul™ TG Package Contents

The MultiHaul™ TG N366 or T265 packages include the following components:

Description	N366	T265 / T260
MultiHaul™ TG unit	1	1
MultiHaul™ TG mounting bracket	1	1 (attached to the TU)
Unit grounding cable (90 cm / 35.4 in)	1	1 (T265 only)
All-weather shells	2	2 (1 shell in case of 1 port)
Self-locking bands	2	2
PoE injector with AC cable	-	1

4.3 Unpacking the MultiHaul™ TG Units

Before installation, the MultiHaul™ TG package content should be examined carefully that all parts listed in the Quick Start Guide are present and there is no visible damage.

Unpack the MultiHaul™ TG components with care to avoid damaging or scratching the antenna radome.

4.4 Required Tools

The following tools are required for MultiHaul™ TG installation:

- Philips screwdriver, medium size head
- 7 and 8 mm hex socket driver
- Standard open-end wrench, 13 mm for the port caps
- Cutter
- Cable ties (for securing network and optional power cables)
- Cable labeling

4.5 Mounting and Aligning the MultiHaul™ TG Node on a Pole

To mount the node on a pole:

1. Insert self-locking bands in the mounting bracket.

The self-locking bands provided with the node are suitable for poles with a diameter of 1.5"-4". Poles with a diameter of 2"-4" are recommended.

2. Align the mounting bracket with the arrow pointing up and mount it on the pole.

Do NOT tighten the self-locking bands yet.

3. If all four sectors have a clear field of view and are not blocked by the pole, tighten the self-locking bands.

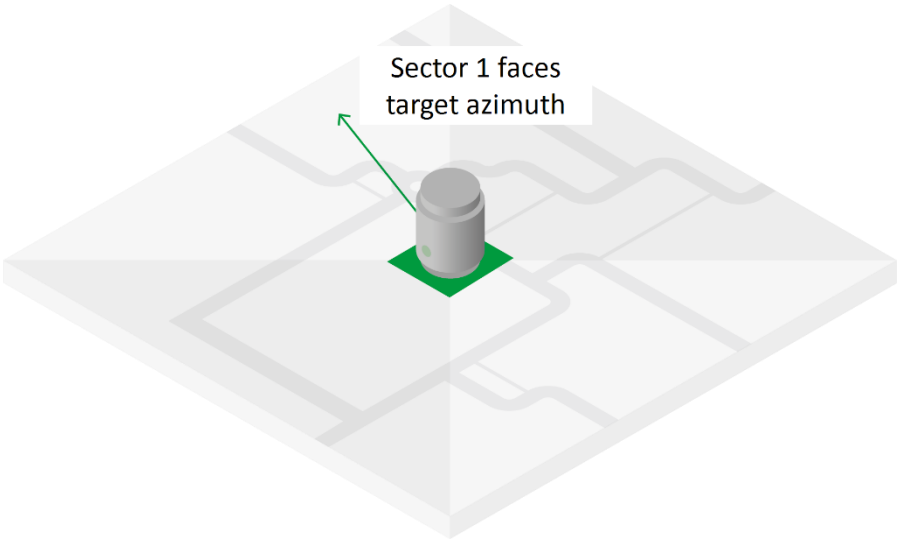
4. Ensure that the 4 mounting bracket screws are open.

5. Slide the node into the mounting bracket.

6. Tighten the four mounting bracket screws so that the node is securely fixed to the mounting bracket.

The node is now mounted on the pole.

7. Visually verify that the node's Sector 1 is aligned in accordance to the network design and instructions you received from your or Siklu's Planning Team (see Section 4.1.3 - Node Orientation). If required, slightly release the self-locking bands and optimize the azimuth alignment by turning the mounting bracket.



Each sector is identified by the number that appears below the sector panel.

8. Once sector 1 faces the target azimuth, tighten the self-locking bands if required to secure the bracket to the mounting pole.

4.6 Mounting the MultiHaul™ TG Node on a Wall

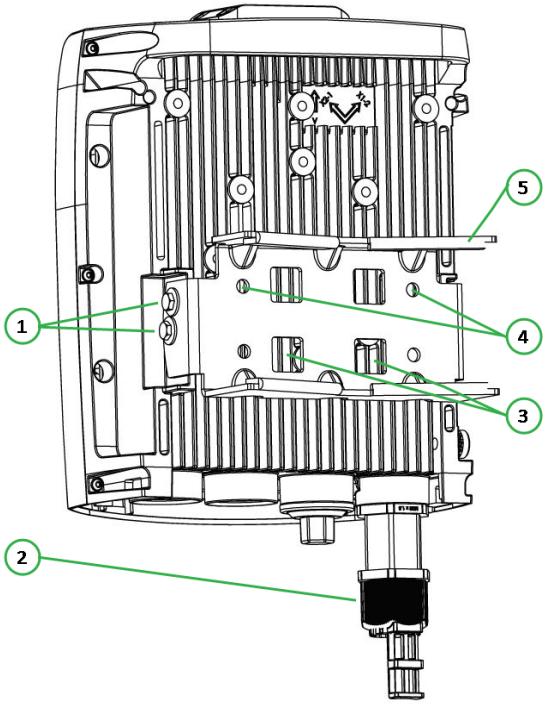
The node can be mounted on a wall using the AX-MK-WM accessory and four wall-mount screws (not provided), as shown in the following figure:

Order the AX-MK-WM accessory separately from Siklu or your reseller.

4.7 Mounting and Aligning the MultiHaul™ TG TU on a Pole or Wall

4.7.1 Mounting the T265

The TU is provided with a pre-attached mounting bracket suitable for mounting on a pole or wall.



1. Elevation lock bolts (2 x 7 mm on each side)
2. All-weather shells (1 or 3, depending on model)
3. Self-locking bands fixing points (for 2 x 130 mm bands provided)
4. Wall-mount fixing holes (4)
5. Mounting bracket

Field of View Considerations while Mounting

TUs should be pointed towards the node.

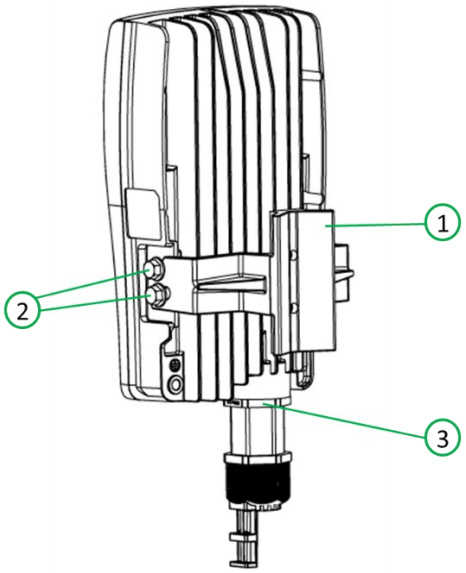
When mounting the TU using the attached mounting bracket, the FOV (field-of-view) of the TU is as follows:

- horizontal: ±45°electronically.
- vertical : ±35° (25° electronically and 10° mechanical adjustment, achieved through the elevation lock bolts).

- When mounting the TU on a pole: if additional vertical adjustment is required, use the EH-MK-SM mounting kit.
- When mounting the TU on a wall using the attached mounting bracket: if additional horizontal adjustment is required, use the AX-MK-WM accessory.
- When mounting the TU on a wall: if both additional horizontal and vertical adjustment are required, use the EH-MK-SM mounting kit and the AX-MK-WM accessory together.

4.7.2 Mounting the T260

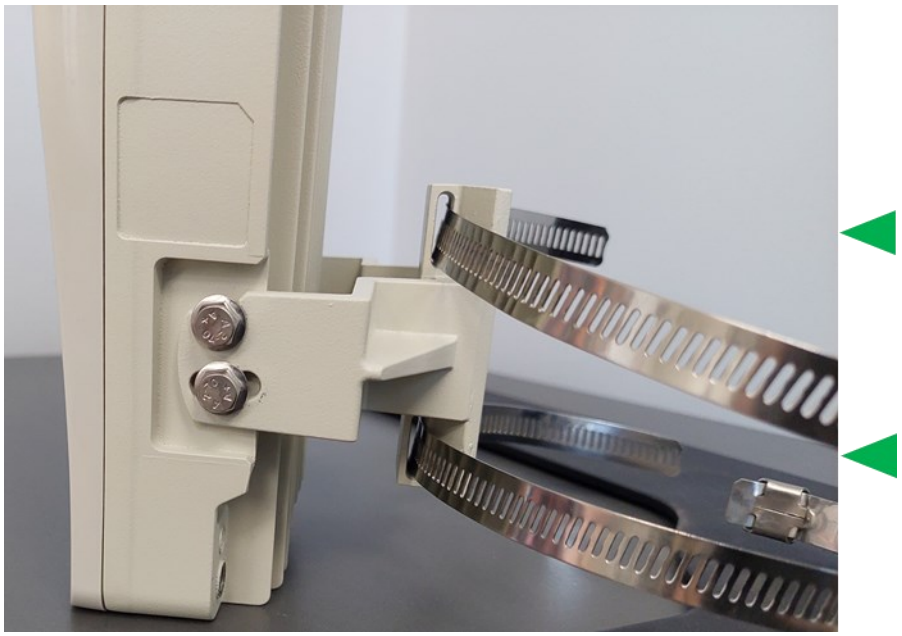
The T260 and its pre-attached mounting bracket are shown in the photo below:



1. Mounting bracket
1. Elevation lock bolts (2 x 8 mm on each side)
2. All-weather shell

To mount the T260 on a pole and perform a coarse alignment:

1. Insert the self-locking bands in the upper and lower slots in mounting bracket, as shown in the photo below.

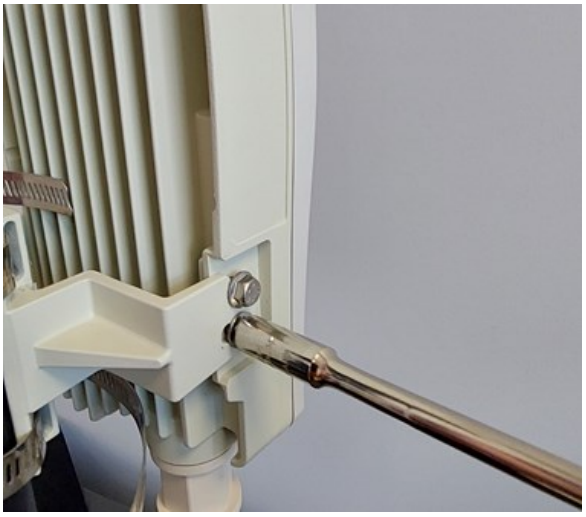


2. Mount the bracket on the pole as shown in the figure below, and secure the bracket to the pole.

The self-locking bands provided with the node are suitable for poles with a diameter of 1.5"-4". Poles with a diameter of 2"-4" are recommended.

Do not completely tighten the bands at this stage in order to allow for antenna alignment.

3. In order to allow free movement when pointing the device, unlock the elevation lock bolts (2 on each side of the bracket) using the 8 mm socket wrench.

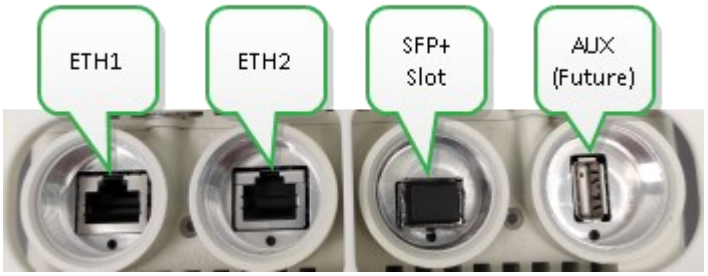


4. Verify visually that the device is pointing to the remote site:
   - Modify the azimuth alignment by turning the radio unit and mounting bracket on the pole.
   - Modify the elevation alignment by tilting the device as facilitated by the open elevation lock bolts.
5. Once optimum alignment is achieved, tighten the self-locking bands to firmly secure the bracket to the mounting pole, and tighten the elevation lock bolts.

4.8 Connecting Cables

4.8.1 Connecting the Cables to the MultiHaul™ TG Node

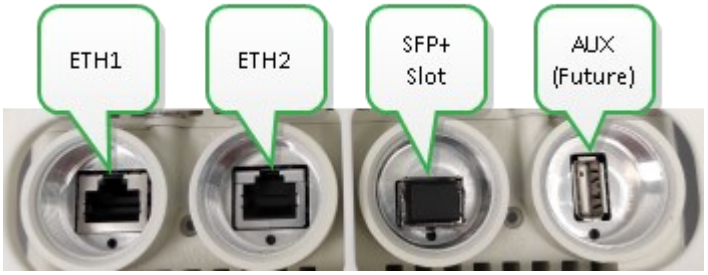
The MultiHaul™ TG node includes the following ports on the connector panel under the node, as shown and described below:



Description	Connector Type	Description
ETH1	RJ45	• 10 GbE (10/5/2.5/1 GbE) • PoE in
ETH2	RJ45	• 1 GbE • PoE out
ETH3	SFP+	• 10 GbE • 1 GbE
⚠	Use only Class 1 Laser SFP/SFP+ devices with rated voltage of 3.3 VDC that are safety-approved in accordance with UL/EN/IEC 62368 / 60950-1. If deploying in the USA, the devices should be registered with the CDRH (Center for Devices and Radiological Health).	
AUX	USB	For future use

4.8.2 Connecting the Cables to the MultiHaul™ TG T265

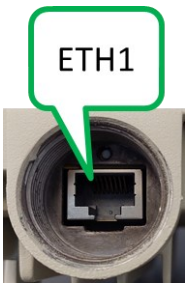
The MultiHaul™ TG TU includes the following ports on the connector panel under the TU, as shown and described below:



Port	Connector Type	Description
ETH1	RJ45	• 2.5/1 GbE • PoE in
ETH2 (T265-CCP only)	RJ45	• 1 GbE • PoE out
ETH3 (T265-CCP only)	SFP+	• 10 GbE • 1 GbE
	⚠ Use only Class 1 Laser SFP with rated voltage of 3.3 Vdc which is safety approved to UL/EN/IEC 60950-1 and which is CDRH registered.	
AUX	USB	For future use

4.8.3 Connecting the Cables to the MultiHaul™ TG T260

The MultiHaul™ TG TU includes the following ports on the connector panel under the TU, as shown and described below:



Port	Connector Type	Description
ETH1	RJ45	• 2.5/1 GbE • PoE in

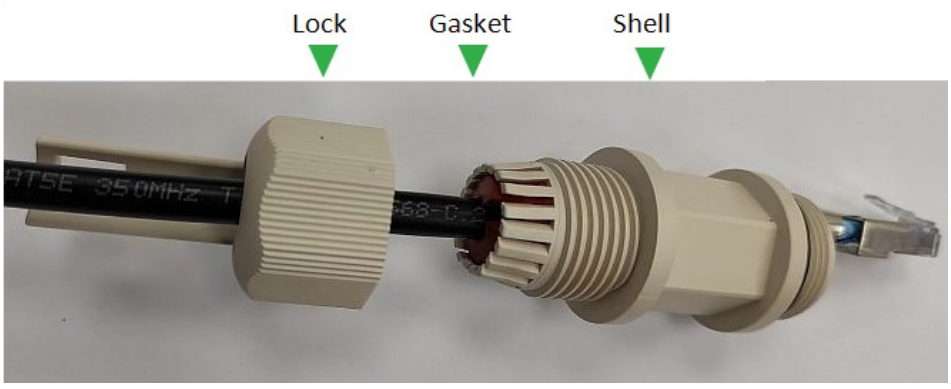
4.8.4 Weatherproofing the Cables

Before connecting a cable to a unit, you must first enclose the cable connector in a protective all-weather shell. Up to two sets of all-weather shells are provided with the unit. Additional all-weather shells can be purchased from Siklu or your reseller (P/N EH-AWS-SHORT).

The provided protective all-weather shells fit cables from 3.5 mm to 9.0 mm in diameter.

In some installations, the cables to the units are protected inside a 3/4" flexible conduit. Siklu provides an adapter to maintain the Ingress Protection (IP) rating of the installation by matching the all-weather shell termination to a Liquid Tight Adaptor (LTA) of your choice. The adapter can be purchased from Siklu or your reseller (P/N EH-AWS-ADAPT-CNDUIT)

To weatherproof the cables:



1. Thread the connectorized cable through the lock and shell, and plug it into the corresponding port.
2. Tighten the shell to the unit firmly by hand (do not use tools).
3. Pick a rubber gasket matching the cable diameter and insert the gasket snugly into the shell.
4. Secure the connector lock manually (do not use tools).

5. Attach the cable to the lock with two cable ties.

To avoid accidental damage to the connector, unlock the lock before removing the shell.

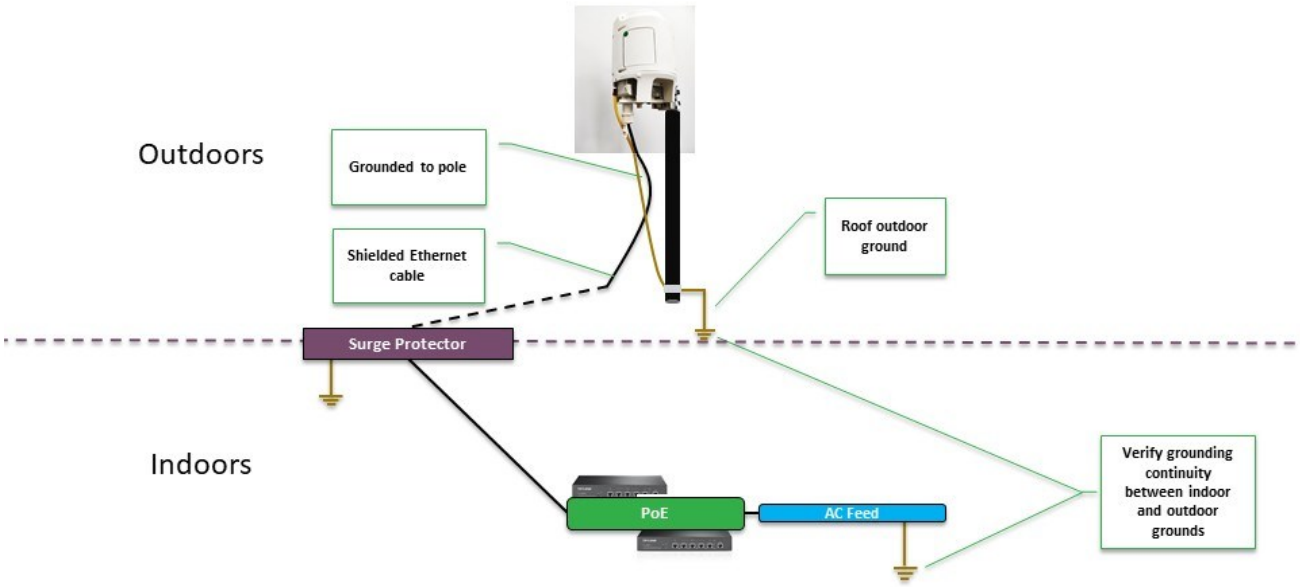
4.8.5 Grounding MultiHaul™ TG Units

1. Connect one end of the grounding cable to the ground lug terminal. Secure the screw.

2. Connect the other end of the grounding cable to the ground connection. If the ground connection is out of reach of the grounding cable, install a longer cable using 16 AWG grounding cable minimum or according to local electrical code.

4.8.6 Installing Lightning Surge Protectors on Cables

A lightning surge protector should be installed on every ethernet cable to protect the indoor networking equipment. The lightning surge arrester should be installed next to the cable point-of-entry and must be properly grounded, as shown in the following figure.



4.8.7 Powering Units

You can power the unit using one of the following methods:

- PoE, active or passive, through the Ethernet cable connected to ETH1.
- Direct DC (input range: 36÷57 Vdc) by using an RJ45-DC adapter that can be purchased from Siklu or your reseller (P/N EH-PoE-DC-adaptor). In this case, port ETH1 will be used for power only.

Use a PoE power supply which is safety approved to UL/EN/IEC 62368 as a limited power source (LPS) with rated voltage of 42-57 Vdc and rated current of 2.5 A max, and approved for the altitude where it is deployed.

To power up the MultiHaul™ TG:

1. Connect the ethernet cable with PoE or direct DC cable to port ETH1.

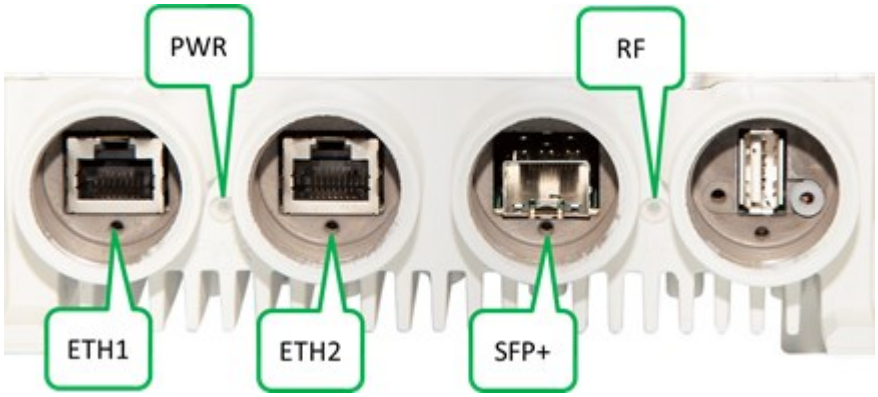
4.8.8 Connecting Other Network Cables

Connect any other network cables (ETH2, ETH3) as required by the deployment plan.

4.9 LED indicators

4.9.1 LED Indicators – N366/T265

The MultiHaul™ TG unit includes the following LEDs on the connector panel under the unit, as shown and described below.

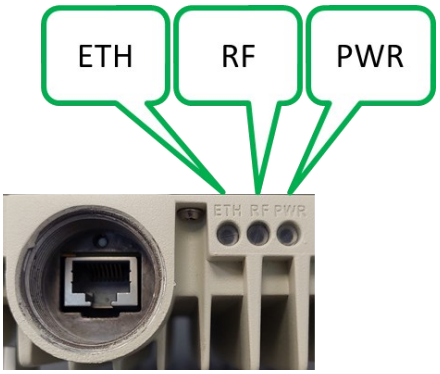


LED	Color	Description
PWR (Power)	Green	• On - power is on. • Blinking - booting up.
	Orange	• On - booting up (boot failure if LED remains on for more than 2 seconds).
	Red	• Blinking - when reset pushbutton is released.
	Off	• No power.

RF	Green	• Node: on - at least one link connected (link can be to another node or a TU on any sector). • TU: on - connected to the node
	Off	• No link.
ETH1	Green	• Node: on - 10 GbE link. • TU: on - 2.5 GbE link.
	Orange	• Node: on - 5/2.5/1 GbE, 10/100 Mbps link. • TU: on - 1 GbE, 10/100 Mbps link.
	Off	• No link (carrier).
ETH2 (Node and T265-CCP only)	Green	• On - 1 GbE link.
	Orange	• On - 10/100 Mbps link.
	Off	• No Link (carrier).
SFP (Node and T265-CCP only)	Green	• On - 10 GbE link.
	Orange	• On - 1 GbE link.
	Off	• No Link (carrier).

4.9.2 LED Indicators – T260

The MultiHaul™ TG unit includes the following LEDs on the connector panel under the unit, as shown and described below.



LED	Color	Description
PWR (Power)	Green	• On - power is on. • Blinking - booting up.
	Orange	• On - booting up (boot failure if LED remains on for more than 2 seconds).
	Red	• Blinking - when reset pushbutton is released.
	Off	• No power.
RF	Green	• Node: on - at least one link connected (link can be to another node or a TU on any sector). • TU: on - connected to the node
	Off	• No link.

ETH	Green	• Node: on - 10 GbE link. • TU: on - 2.5 GbE link.
	Orange	• Node: on - 5/2.5/1 GbE, 10/100 Mbps link. • TU: on - 1 GbE, 10/100 Mbps link.
	Off	• No link (carrier).

4.10 Link Up Verification

4.10.1 Node Checks

Perform the following checks on each node:

1. Verify that node sector 1 is pointing to the azimuth specified for the site.
2. Verify the self-locking bands are tightened.
3. Verify that the unit has been properly grounded.
4. Verify that the PWR LED is green.

4.10.2 TU Checks

Perform the following checks on each TU:

1. Point the TU towards the serving node (see Section 4.7 - Mounting and Aligning the MultiHaul™ TG TU on a Pole or Wall.
2. Verify the self-locking bands and the elevation lock bolts are tightened.

If you mounted the TU using the EH-MK-SM mounting kit, verify the elevation and azimuth lock bolts on the mounting kit are tightened.

3. Verify that the PWR LED is green.
4. Verify that the RF LED is green, indicating correct association with the serving node (Link Up).

4.10.3 Configuring the System

The MultiHaul™ TG units can now pass management and traffic between the units over the radio link, to/from the ethernet ports.

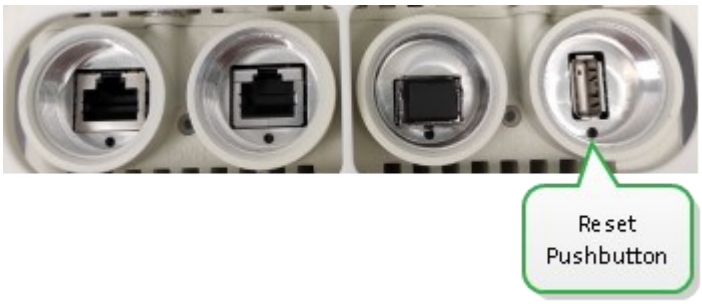
You can use the GUI or CLI for advanced configuration of the units, monitoring their status and troubleshooting.

4.11 Resetting the Unit

Resetting the unit causes all user configurations to be lost.

4.11.1 Resetting the N366/T265

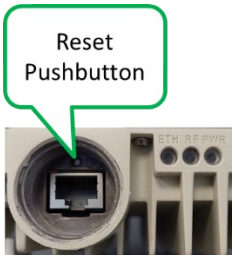
The MultiHaul™ TG N366 and T265 unit have a reset pushbutton next to the USB port on the connector panel under the unit, as shown and described below:



Button	Description
Reset	10 second or more press - reset to factory default. See Section 4.9 - Unit LEDs

4.11.2 Resetting the T260

The MultiHaul™ TG T260 unit has a reset pushbutton next to the Ethernet port on the connector panel under the unit, as shown and described below:



Button	Description
Reset	10 second or more press - reset to factory default. See Section 4.9 - Unit LEDs

5 Installing the MultiHaul™ TG T280 Terminal Unit

This section describes how to install the MultiHaul™ TG T280 terminal unit.

5.1 Preparing the Site

Carefully select and prepare each site to make installation and configuration as simple and trouble-free as possible. During site selection and preparation, take into account local safety regulations and consider the long-term needs of both your network and your applications.

Installation and maintenance of the MultiHaul™ TG link should only be done by service personnel who are properly trained and certified to carry out such activities.
L'installation et l'entretien d'une unité MultiHaul™ TG ne doivent être effectués que par du personnel de service qui sont formés et accrédités pour mener à bien ces activités.

Minimum safe distance from the antenna while radiating varies with the antenna type and is calculated in the table below in accordance with Environmental evaluation and exposure limit according to FCC CFR 47part 1, 1.1307, 1.1310 and ISED RSS-102, Safety Code 6.
La distance de sécurité minimale de l'antenne pendant le rayonnement varie selon le type d'antenne et est calculée dans le tableau ci-dessous conformément à Evaluation environnementale et limite d'exposition selon FCC CFR 47part 1, 1.1307, 1.1310 et ISED RSS-102, Code de sécurité 6.

	16cm / 38dBi	30cm / 43dBi	65cm / 48dBi
General Public / Grand Public	2.1m	0m	0m
Professionals / Professionnels	0m	Om	0m

5.1.1 Physical and Environmental Requirements

Each site should meet the following requirements:

- There must be a clear, unobstructed line-of-sight between the units.
- MultiHaul™ TG units should be mounted on a fixed, stable, permanent structure. Units can be mounted using the following methods:
- On reinforced steel mounting poles with the following diameters:
  - T280: 1.5" - 4"

2" - 4" poles are recommended, in which case you can use the provided self-locking bands.

5.1.2 Cabling Requirements

- Install the MultiHaul™ TG unit where network connections and optional power cabling are ready for operation and easily accessible.

Do not mount a MultiHaul™ TG unit on a structure that is temporary or easily moved.
Doing so may result in poor service or equipment damage.

- All cabling connected to the MultiHaul™ TG unit should be outdoor grade, with UV protection.
- Use the following cables as per your type of connection:
  - 1 GbE - Cat5e (or higher) shielded outdoor cables terminated with metallic RJ45 connectors.
  - 10 GbE - Cat6 (or higher) shielded outdoor cables terminated with metallic RJ45 connectors.
- The MultiHaul™ TG unit is powered through the PoE input (ETH1). Take into account the power requirements of the MultiHaul™ TG unit (see Section 3.7: Technical Specifications – T280) and external PD(s) when planning Ethernet cabling and passive POE Midspan/Injectors.
- PSE Output (PoE Out) is available on MultiHaul™ TG units with more than a single Ethernet port.
- PSE port output voltage is nearly the same as PoE port input voltage. The total cable length from the PoE injector or PSE device to the last powered device (PD) should not exceed 100 meters (PSE to first unit + first unit to second unit).

PSE output is available only if the unit is powered directly by a power source such as 48VDC, or a PoE Injector/Midspan.

One MultiHaul™ TG unit will power a 2nd unit, however that 2nd unit cannot power a third unit.

You must also consider proper power-in limitations to avoid damage to the first or second unit in the chain.

- In order to protect indoor equipment, you must install surge protection circuits on all copper cables on their entrance to the building.
- Install the MultiHaul™ TG unit in a location where proper electrical outdoor grounding is readily available. Typically, the grounding connection is attached directly to the mounting pole. If not already present, then suitable structure-to-earth grounding connections must be created before installation. Ground the unit using 16 AWG diameter (minimum) grounding cable or according to local electrical code.

Improper electrical grounding can result in excessive electromagnetic interference or electrical discharge.

Siklu will not be held responsible for any malfunction or damage if the unit is not properly grounded.

5.1.3 T280 Orientation

The network has been carefully designed by your or Siklu's Planning Team to achieve the highest standards in availability and reliability, taking into account all potential lines of sight between the large quantity of units in your network. Make sure you obtain the azimuth for the T280 from your or Siklu's Planning Team before installing, and align the T280 along this planned azimuth, as described in Section 5.6: Mounting and Aligning the MultiHaul™ TG T280 on a Pole, Step 7.

5.2 MultiHaul™ TG T280 Package Contents

The MultiHaul™ TG T280 package includes the following components:

Description	Quantity
MultiHaul™ TG unit	1
Unit grounding cable (90 cm / 35.4 in)	1
All-weather shells	1

5.3 Optional Items for the T280

The MultiHaul™ TG T280 may require some these optional items, depending on your application:

Description	Required / Optional	Quantity
External antenna	Required	1
Mounting bracket for external antenna	Depends on the antenna size	1
Power, PoE injector	Depends on the use case and source of power	1

5.4 Unpacking the MultiHaul™ TG T280

Before installation, the MultiHaul™ TG package content should be examined carefully that all parts listed in the Quick Start Guide are present and there is no visible damage.

Unpack the MultiHaul™ TG components with care to avoid damaging or scratching the antenna port.

5.5 Required Tools

The following tools are required for MultiHaul™ TG installation:

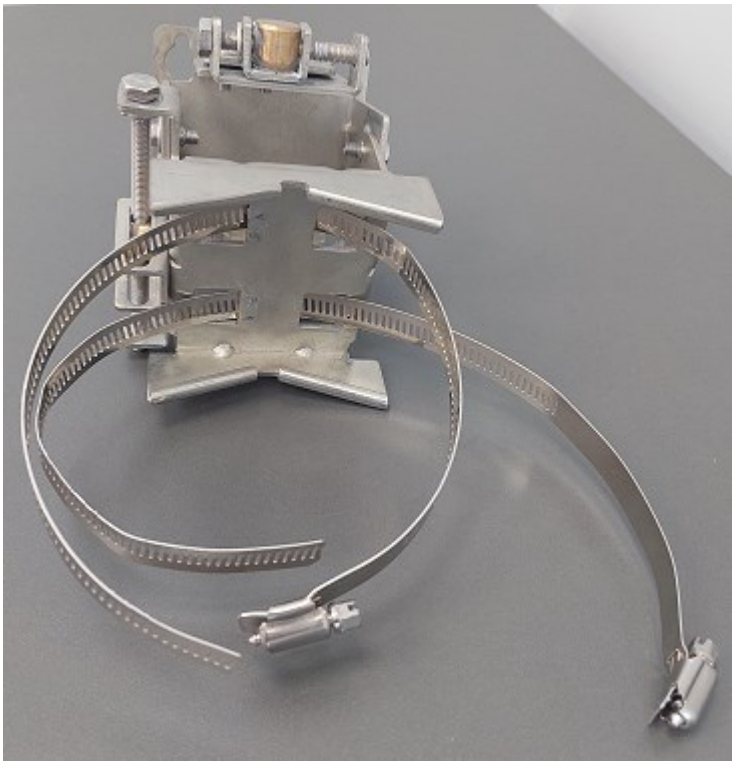
- Standard handheld digital voltage meter (DVM) with probes
- Philips screwdriver, medium size head
- 7 mm hex socket driver
- Standard open-end wrench, 7-millimeter [unless we have moved to 8mm, for tightening the radio on the MK]
- Standard open-end wrench, 13 mm for the port caps
- 8mm Allen key for ODU installation with 2ft antenna
- Standard open-end wrench, 16-millimeter (or equivalent Hex socket) installation with 2ft antenna
- Cutter

- Cable ties (for securing network and optional power cables)
- Cable labeling

5.6 Mounting and Aligning the MultiHaul™ TG T280 on a Pole

To mount the T280 on a pole:

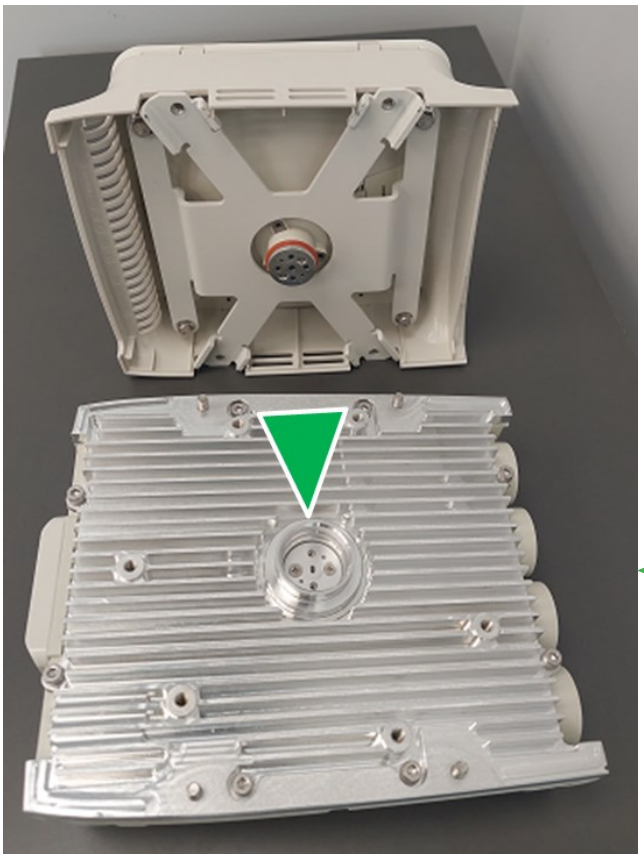
1. Insert self-locking bands in the mounting bracket.



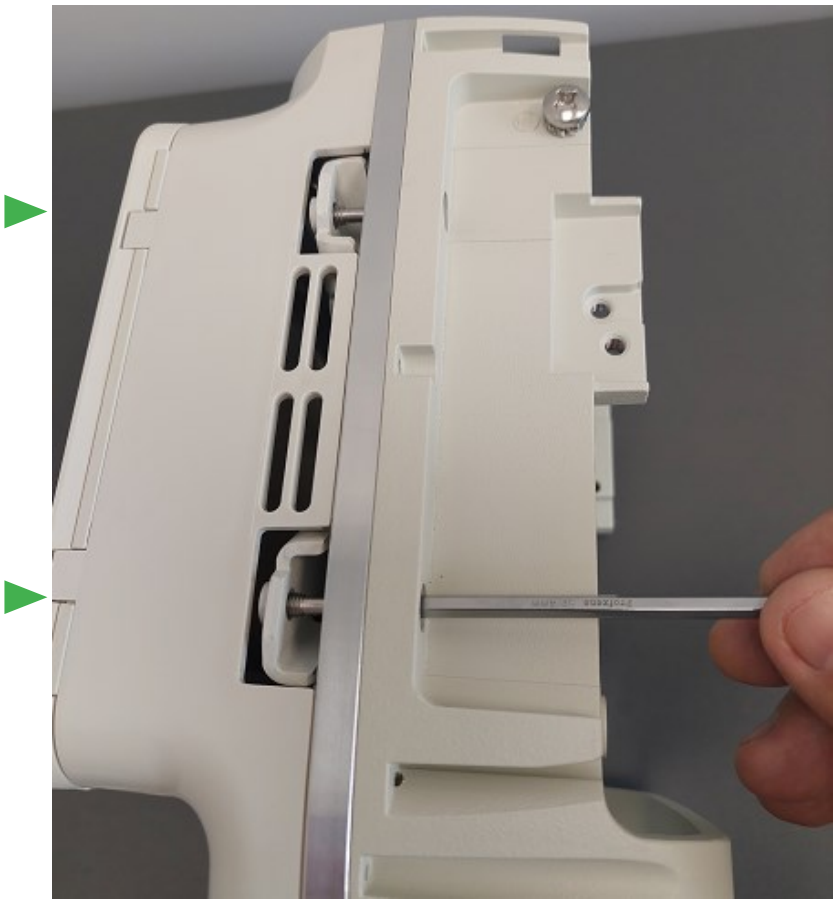
The self-locking bands provided with the node are suitable for poles with a diameter of 1.5"-4". Poles with a diameter of 2"-4" are recommended.

2. Mount the bracket on the pole as shown in the figure below, and tighten the bands.

3. Attach the antenna to the radio unit. They should be aligned so that the interface in the center will overlap when attached.

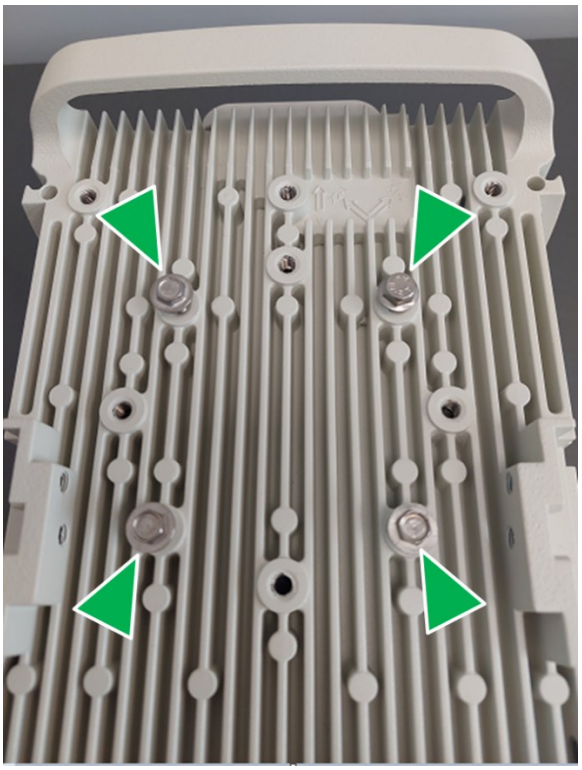


4. Attach the antenna to the radio unit by tightening the 4 pre-attached screws with xxx tool.

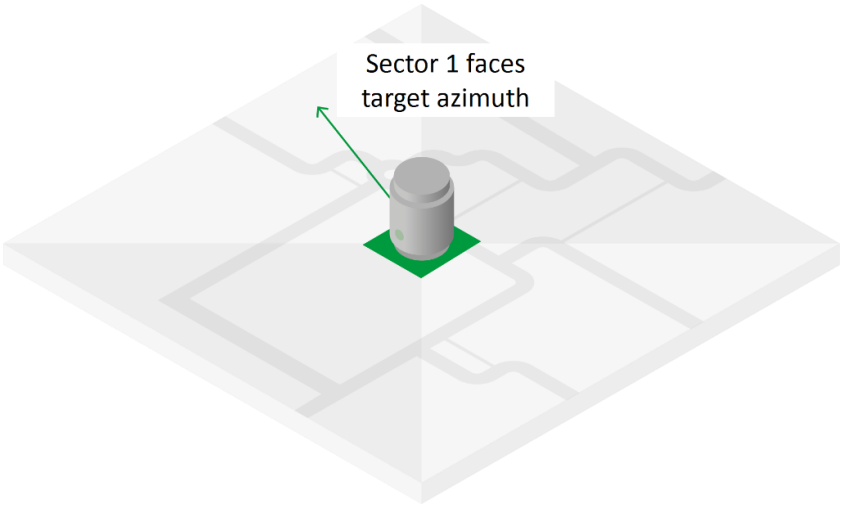


5. Insert the 4 bracket-mounting screws in the rear of the radio unit in accordance with polarity requirements, and screw them in half-way. These screws will be used to mount the radio unit on the bracket.

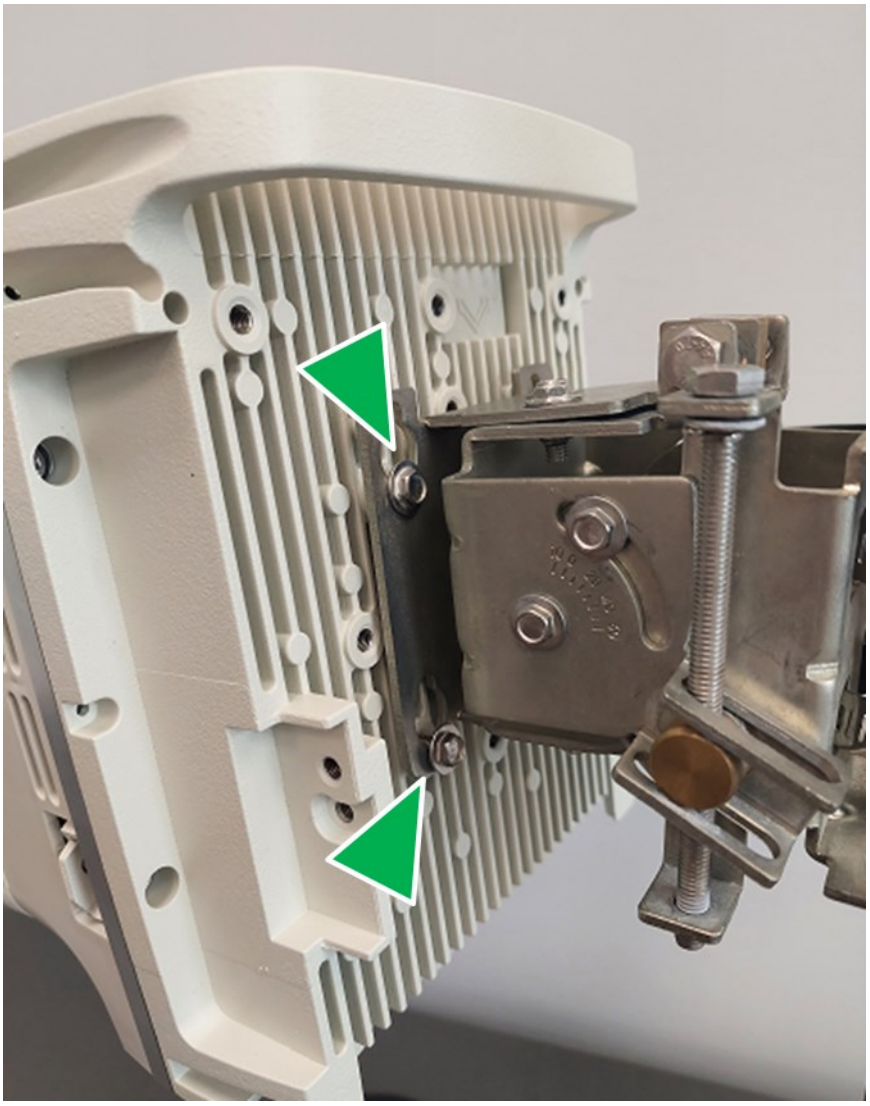
MultiHaul TG radio links are usually configured for either vertical or ±45 degrees polarity. The establishment of multiple links, each with a different polarity, effectively multiplies the bandwidth that is available in a given physical space, using the same frequency.



6. Visually verify that the TU280's Sector 1 is aligned in accordance to the network design and instructions you received from your or Siklu's Planning Team (see Section 5.1.3: Node Orientation).



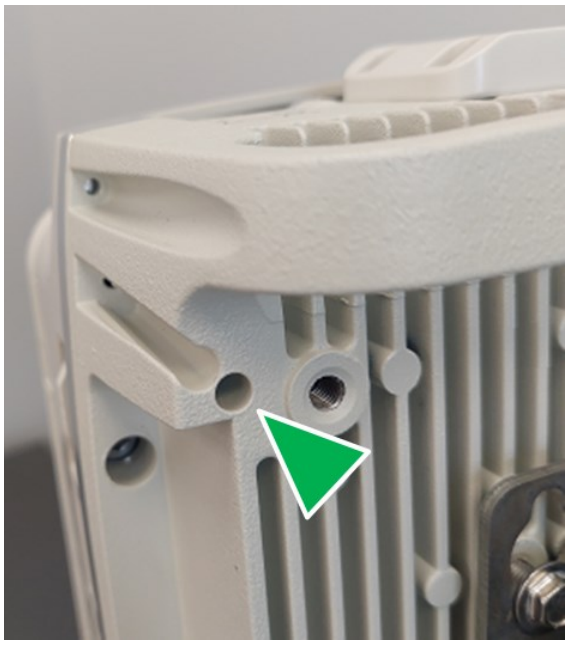
7. Insert the bracket-mounting screws into the corresponding openings in the bracket, and hang the radio unit on the bracket.

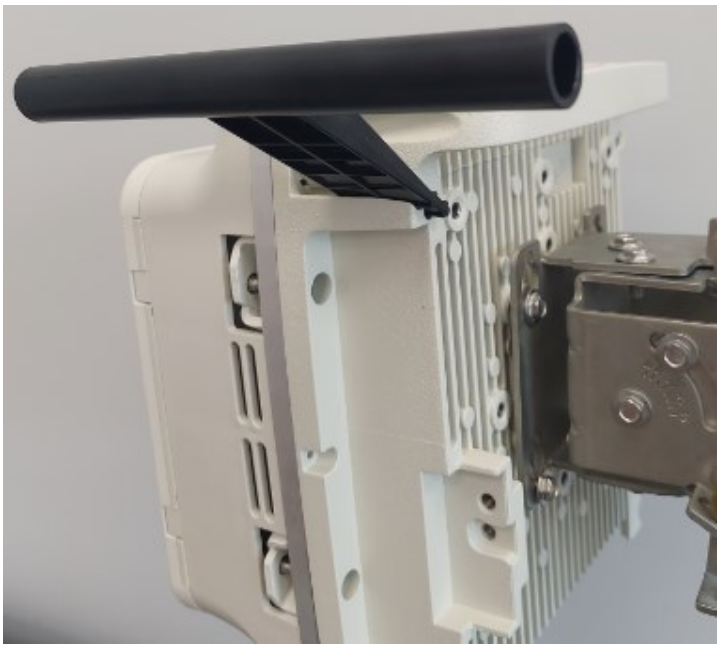


8. Tighten the four mounting bracket screws with a flat xxx so that the radio unitis securely fixed to the mounting bracket.

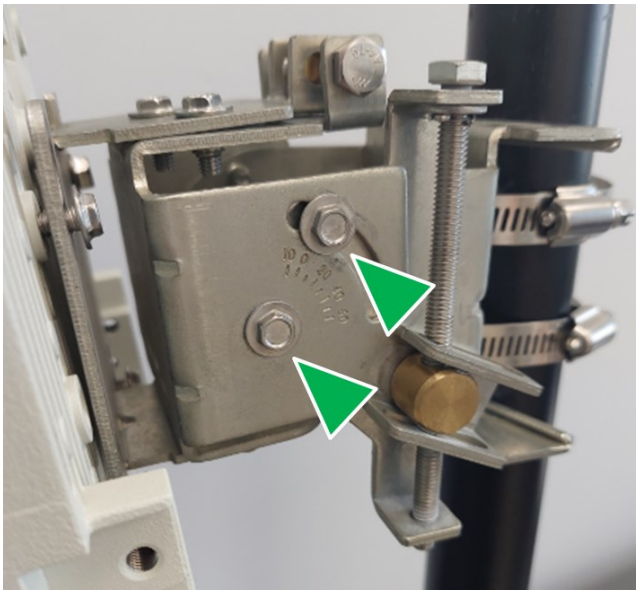
9. To perform a coarse alignment, insert the viewfinder (which can be found in the box containing the antenna) in the T280 as shown in the figure below, and align it with the remote unit by rotating the complete unit and bracket on the pole to achieve the proper azimuth. Following the coarse alignment, tighten the bands.

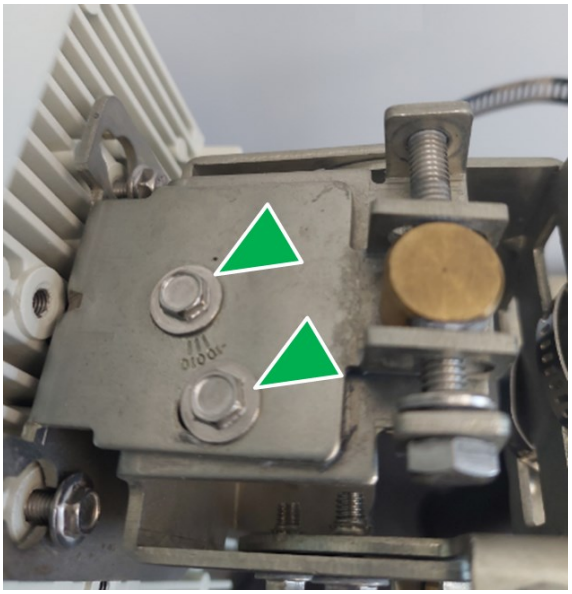
The viewfinder can be mounted on the right side of the radio unit if the left side is not accessible.





10. To optimize the alignment of the T280 with the remote unit, loosen the lock bolts screws on both? sides and the top of the bracket (see the figure below), and adjust the antenna's elevation and azimuth.



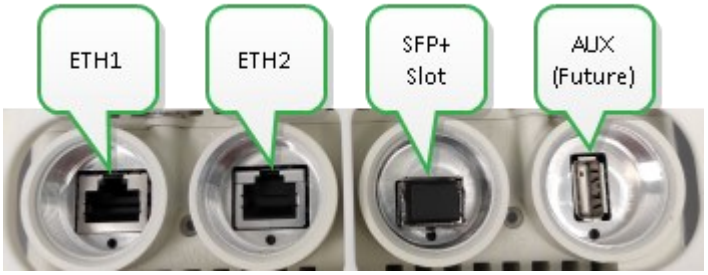


11. If required, tighten the self-locking bands to secure the bracket to the mounting pole.

5.7 Connecting Cables

5.7.1 Connecting the Cables to the MultiHaul™ TG T280

The MultiHaul™ TG T280 includes the following ports on the connector panel under the TU, as shown and described below:



Port	Connector Type	Description
ETH1	RJ45	• 5/2.5/1 GbE / 100MbE • PoE in
ETH2	RJ45	• 1 GbE • PoE out
ETH3	SFP+	• 10 GbE • 1 GbE
	⚠ Use only Class 1 Laser SFP with rated voltage of 3.3 Vdc which is safety approved to UL/EN/IEC 60950-1 and which is CDRH registered.	
DVM Probe Interface	2 prongs	Receive signal level, in dBm
AUX	USB	For future use

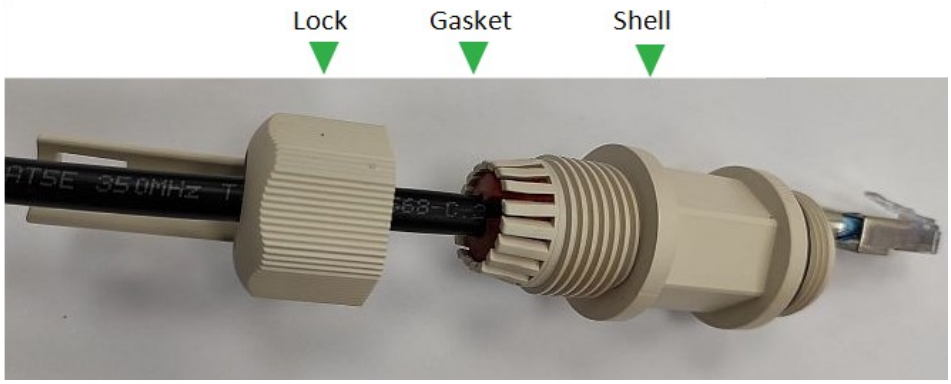
5.7.2 Weatherproofing the Cables

Before connecting a cable to a unit, you must first enclose the cable connector in a protective all-weather shell. Up to two sets of all-weather shells are provided with the unit. Additional all-weather shells can be purchased from Siklu or your reseller (P/N EH-AWS-SHORT).

The provided protective all-weather shells fit cables from 3.5 mm to 9.0 mm in diameter.

In some installations, the cables to the units are protected inside a 3/4" flexible conduit. Siklu provides an adapter to maintain the Ingress Protection (IP) rating of the installation by matching the all-weather shell termination to a Liquid Tight Adaptor (LTA) of your choice. The adapter can be purchased from Siklu or your reseller (P/N EH-AWS-ADAPT-CNDUIT)

To weatherproof the cables:

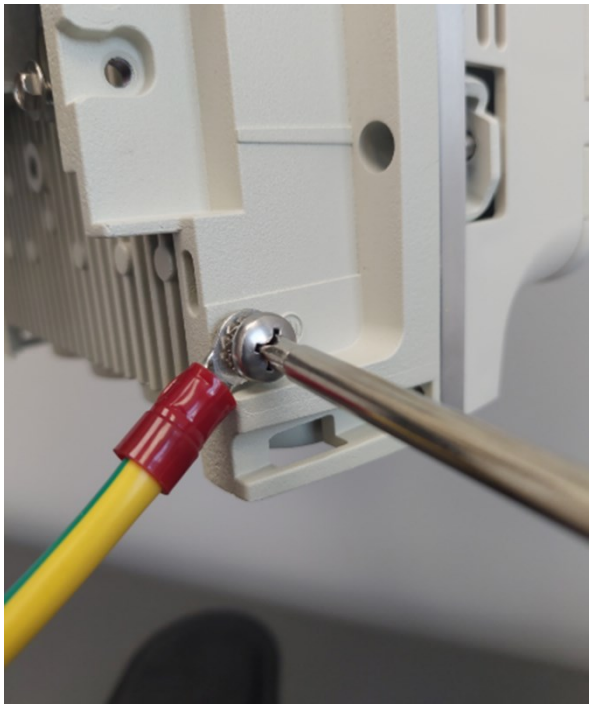


1. Thread the connectorized cable through the lock and shell, and plug it into the corresponding port.
2. Tighten the shell to the unit firmly by hand (do not use tools).
3. Pick a rubber gasket matching the cable diameter and insert the gasket snugly into the shell.
4. Secure the connector lock manually (do not use tools).
5. Attach the cable to the lock with two cable ties.

To avoid accidental damage to the connector, unlock the lock before removing the shell.

5.7.3 Grounding MultiHaul™ TG T280

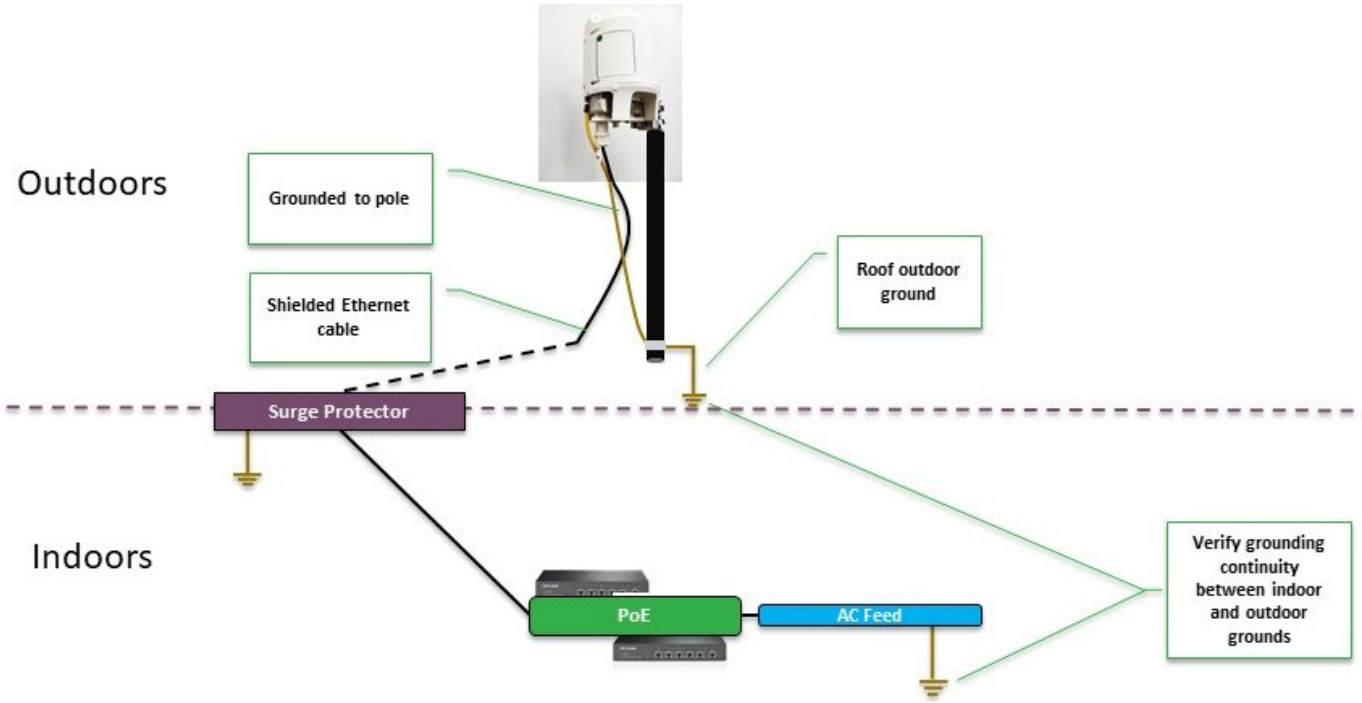
1. Connect one end of the grounding cable to the ground lug terminal. Secure the screw using a Phillips screwdriver.



2. Connect the other end of the grounding cable to the ground connection. If the ground connection is out of reach of the grounding cable, install a longer cable using 16 AWG grounding cable minimum or according to local electrical code.

5.7.4 Installing Lightning Surge Protectors on Cables

A lightning surge protector should be installed on every Ethernet cable to protect the indoor networking equipment. The lightning surge arrester should be installed next to the cable point-of-entry and must be properly grounded, as shown in the following figure.



5.7.5 Powering Units

You can power the unit using one of the following methods:

- PoE, active or passive, through the Ethernet cable connected to ETH1.
- Direct DC (input range: 36÷57 Vdc) by using an RJ45-DC adapter that can be purchased from Siklu or your reseller (P/N EH-PoE-DC-adaptor). In this case, port ETH1 will be used for power only.

Use a PoE power supply which is safety approved to UL/EN/IEC 62368 as a limited power source (LPS) with rated voltage of 42-57 Vdc and rated current of 2.5 A max, and approved for the altitude where it is deployed.

To power up the MultiHaul™ TG:

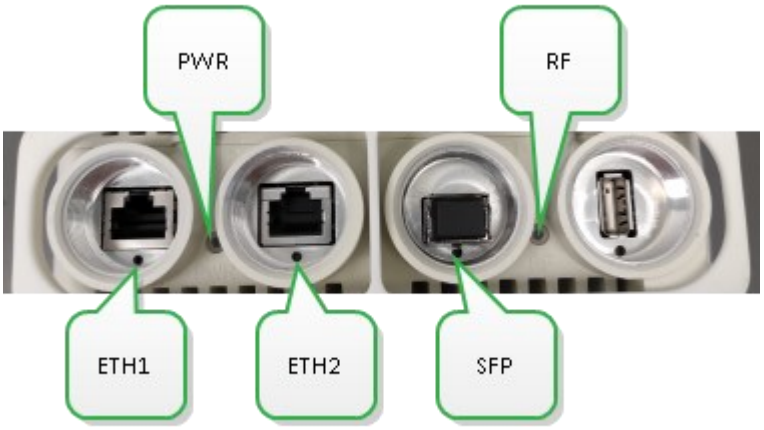
1. Connect the Ethernet cable with PoE or direct DC cable to port ETH1.

5.7.6 Connecting Other Network Cables

Connect any other network cables (ETH2, ETH3) as required by the deployment plan.

5.8 LED indicators

The MultiHaul™ TG T280 includes the following LEDs on the connector panel under the unit, as shown and described below.



LED	Color	Description
PWR (Power)	Green	• On - power is on. • Blinking - booting up.
	Orange	• On - booting up (boot failure if LED remains on for more than 2 seconds).
	Red	• Blinking - when reset pushbutton is released.
	Off	• No power.
RF	Green	• On - connected to the remote unit when in PtP mode; connected to the node when in PtMP mode (future)
	Off	• No link.
ETH1	Green	• Maximum speed achieved
	Orange	• The speed achieved is half of the maximum speed, or less
	Off	• No link (carrier).
ETH2 (Node, T265-CCP, T280)	Green	• On - 1 GbE link.
	Orange	• On - 10/100 Mbps link.
	Off	• No Link (carrier).
SFP (Node, T265-CCP, T280)	Green	• On - 10 GbE link.
	Orange	• On - 1 GbE link.
	Off	• No Link (carrier).

5.9 Link Up Verification

5.9.1 TU Checks

Perform the following checks on each T280 TU:

1. Point the T280 towards the remote unit (see section 5.6: 5.8Mounting and Aligning the MultiHaul™ TG T280 on a Pole).
2. Verify that the self-locking bands and the elevation and azimuth lock bolts are tightened.
3. Verify that the PWR LED is green.
4. Verify that the RF LED is green, indicating correct association with the remote unit (Link Up), and RSSI not different by +/- 2dB from the peak value achieved during alignment.

5.9.2 Configuring the System

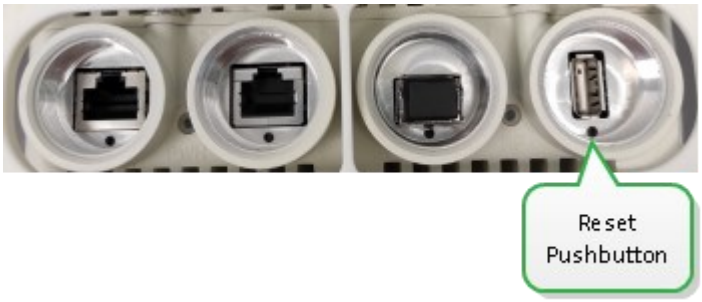
The MultiHaul™ TG units can now pass management and traffic between the units over the radio link, to/from the Ethernet ports.

You can use the GUI or CLI for advanced configuration of the units, monitoring their status and troubleshooting.

5.10 Resetting the Unit

Resetting the unit causes all user configurations to be lost.

The MultiHaul™ TG unit includes a pushbutton next to the USB port on the connector panel under the unit, as shown and described below:



Button	Description
Reset	• 10 second or more press - reset to factory default. See Section 4.9 - Unit LEDs • 2 second press – T280 only, enter alignment mode (in future software release)

6 Management Concepts

You can manage MultiHaul™ TG units using the Command Line Interface (CLI) only with the current SW version. MultiHaul™ TG supports NETCONF and YANG to easily configure the units and extract data.

NETCONF is a protocol defined by the IETF to install, manipulate, and delete the configuration of network devices. NETCONF operations are realized on top of a Remote Procedure Call (RPC) layer using an XML encoding and provides a basic set of operations to edit and query configuration on a network device.

YANG is a data modeling language for the definition of data sent over NETCONF. It can be used to model both configuration data and state data of network elements.

6.1 Unit Databases

Each unit contains the following databases:

- Startup - the database that contains the complete boot configuration.
- Running - the configuration on which the unit is currently running.
- Candidate - a temporary scratchpad for storing pending changes.
- State - a read-only database that contains unit statuses and counters.

When the unit boots up, the Startup database is loaded. When you type commands in the CLI, the changes are pending in the Candidate database and do not immediately go into effect in the Running database. Once you type Commit, all pending commands are then validated and copied to the Running database. In this way, you are able to prepare a set of multiple commands and apply all of them at once.

After you are satisfied with the Running database, you must save it to the Startup database using the copy command. Otherwise, the changes will be lost the next time the unit boots.

6.2 Database Containers and Objects

The information in the databases is arranged in containers such as interfaces, IP addresses, and radios. Each container has different objects and/or parameters as shown in the following table:

Container	Description	Possible Objects or Parameters
interfaces	The interfaces of the unit, such as ports, ethernet or RF links (see Section 0 - Configuring Interfaces).	• **host** - the logical internal interface to the built-in management processor / entity. • **ports** - fixed and SFP interfaces on the unit. • **rf-interface** - RF links to other nodes or to TUs. • **rf** – A dummy **rf-interface** to indicate where to connect all rf-interfaces not specially configured on any bridge.
inventory	The inventory tree for unit components.	-
ip	The unit IP addresses which you use to connect for management, locally or remotely (see Section 7.7 - Configuring Management IP Address).	• **address** - list of static IPv4 addresses for management. • **default gateway** - default IPv4 gateway for the unit.
radio-common	Default radio settings of the unit common to both nodes and TUs (see Section 7.8 - Radio and Links).	• **links** - list of all links. • **node-config** - container that includes all configuration parameters related to the entire unit.
radio-dn	Default radio settings of the node, including links (see Section 7.8 - Radio and Links).	• **links -** list of all RF links defined in this node.

Container	Description	Possible Objects or Parameters
		• **node-**config - container that includes all configuration parameters related to the entire node. • **sectors-config-** container that includes all configuration parameters related to sectors.
system	General hardware and software configuration (see Section 0 - Configuring the System).	• **date -** system date (HH:MM:SS). • **name -** this unit's assigned name. • **state** - state data for the system (use only with the `show` command). • **time -** system time (YYYY-MM-DD).
user-bridge	The ethernet bridges between ports and/or RF links (see Section 6.9 - Ethernet Bridges).	• bridge <bridge-id>
user-management	The user names and associated passwords (see Section. 7.5 - Configuring Users).	• **user** - list of all usernames.

6.3 YANG Files and NETCONF

MultiHaul™ TG units can be managed using the NETCONF protocol. YANG is the definition language for the data sent over NETCONF, and has been standardized in RFC 6020. YANG files contain both configuration data as well as state data for the MultiHaul™ TG units. This description is necessary for EMS systems to understand how to monitor and manage a MultiHaul™ TG unit using the NETCONF protocol.

Siklu provides YANG files with common configurations for your MultiHaul™ TG which you can download from partners.siklu.com under **Software Download**.

6.4 Best Practices

- Siklu recommends not to change the factory default IP management address. Instead, configure your network IP address as an additional (second) IP address. By leaving the default management address unchanged, you have the option to locally connect to the unit using the default IP address in case of misconfiguration. This helps to avoid factory-reset to the unit and wiping your own configuration.
- When more than one user can connect to a unit at the same time using the CLI, it is recommended to use the `lock` command before you start configuring, and `unlock` when you're done configuring the unit. For more information, see Section 6.3.6 - lock / unlock.

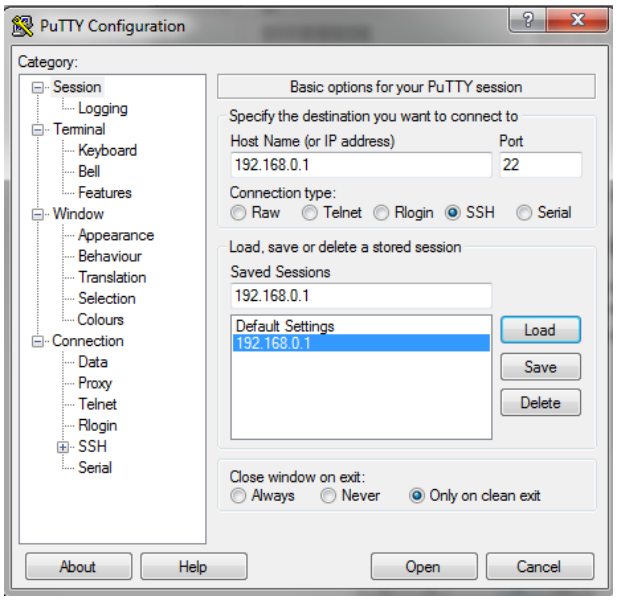
7 Setup Using the Command Line Interface

This section explains how to operate the MultiHaul™ TG units using the Command Line Interface (CLI). The CLI provides a text-based interface for configuring and monitoring the MultiHaul™ TG units.

7.1 Connecting to the CLI

To establish a CLI Session with the MultiHaul™ TG unit:

1. Use any SSH client program, such as PuTTY, available for download from the web.
2. Open an SSH session to the IP address of the unit (default = 192.168.0.1).



3. Configure PuTTY with the following recommended settings:
   a. Under **Terminal** > **Keyboard**:
      - **The function keys and keypad** = Linux
   b. Under Window:
      - **Set Lines of Scrollback** = 10,0000
4. Type a name under **Saved Sessions** and click **Save**. The session will be stored under the Saved Sessions.

Whenever you want to connect, click the saved session name then click Load.

5. After connecting, type the username and password. The default credentials are: username: admin password: admin

6. After you type your username, the prompt changes to [username]@[unit ip address]:

```
login as: admin admin@31.168.34.110's password:
```

If you typed incorrect credentials, **Access denied** appears. If the password was incorrect, you can retype it. If the username was incorrect, disconnect and reconnect.

7.2 CLI Overview

7.2.1 CLI Features

- `set` command configures one parameter at a time in the Candidate database - a temporary scratchpad for stor- ing pending changes. See Section 5.1 - Unit Databases.
- `commit` command stores all the individual changes you made in the Candidate database to the Running data-base.
- Error message with hint in case of improper syntax or failed command.
- Use <Tab> for Auto-complete.
- Use <Up Arrow> and <Down Arrow> to display command history.
- Inline help - see Section 6.2.4 - Inline Help.
- lock/unlock - see Section 6.3.6 - lock / unlock.

7.2.2 Command Prompt

After logging in to the CLI, the command prompt appears:

```
Last login: Thu Nov  5 16:41:18 2020 from 109.160.224.29
MH-N366@popn110>
```

7.2.3 Command Structure

A CLI command typically consists of part or all of the following components:

```
[command] [container] [object] [object-id(s)] [parameter-name] [parameter-value(s)]
```

All objects are arranged in logical groups called containers. When using the CLI, you must first identify the container and then the object inside the container. See Section 5.2 - Database Containers and Objects for a list of containers.

Example:

```
set ip ipv4 address 1.1.1.1
```

7.2.4 Inline Help

To invoke the inline help menu, type `?` at any time. The CLI displays context-related help:

```
Show ?
<cr>
candidate                review candidate configuration or only part of it
compare                  compare two databases to each other
interfaces               all physical and radio interfaces
inventory                the inventory tree of a TG unit
ip                       management of IP connectivity
radio-common             radio information which is available for nodes
                         and/or terminals
radio-dn                 radio information for the nodes only
system                   system HW & SW data
user-bridge              ethernet user bridge information
user-management          management of users
```

7.2.5 List of Commands

The following table briefly describes the CLI commands. Detailed explanations on the commands can be found in Section 6.3 - Commands Detailed Description.

Command	Function
Clear	Clear cumulative running performance counters.
copy	Validates all changes to the Candidate database and then applies them to the Running
commit	Saves the Running database to the Startup database for loading after a reboot.
delete	Delete a configuration object.
discard	Discard all uncommitted changes.
lock / unlock	Lock / unlock the Candidate database.
ping	Pings the device at the specified destination IP address or hostname.
quit	Quit the CLI.
reboot	Reboot the unit or reset its configuration to factory defaults.
rollback	Reboot the unit and load the startup database.
run	Execute a script.
set	Define a configuration object. The command syntax depends on the object you are
show	The show command displays configuration information for the Running or Candidate
software	Download a new software image to the inactive software bank in the unit and activate it.
validate	Validate all pending changes in the Candidate database for validity/integrity.

7.3 Commands Detailed Description

This section details the various structures and relevant parameters for each of the common Commands of the CLI.

7.3.1 clear

Clear cumulative running performance counters.

Syntax

```
clear [object-type]
```

Object	Mandatory	Values
object-type	✓	interfaces - clear the per-port running counters on the internal Ethernet switch
		radio-counters - clear the per-radio-link running counters

Example

```
MH-T265@panks>clear interfaces
```

7.3.2 commit

Validates all changes to the Candidate database and then applies them to the Running database.

Syntax

```
commit
```

7.3.3 copy

Saves the Running database to the Startup database for loading after a reboot.

Syntax

```
copy running startup
```

For more information about the different databases, see Section 6.1 - Unit Databases.

7.3.4 delete

Delete a configuration object

Syntax

```
delete [container] [object-type] [object-id]
```

Object	Mandatory	Values	Remarks
container	✓	`all`	Delete the entire Candidate configuration.
		`interfaces`	For more information see Section 5.2 - Database Containers and Objects
		`ip`	
		`peer-addresses`	
		`radio-common`	
		`radio-dn`	
		`system`	
		`user-bridge`	
		`user-management`	
object-type			The type of object to be deleted.
object-id			The id of the object to be deleted.

```
Example (after showing current configuration)
   MH-N366@popn110>show user-bridge bridge 1
   bridge {
        bridge-id 1;
        bridge-port {
             bridge-port-id 1;
             interface eth1;
             bridge-port-type transparent;
        }
        bridge-port {
             bridge-port-id 2;
             interface host;
             bridge-port-type transparent;
        }
        bridge-port {
             bridge-port-id 3;
             interface eth2;
             bridge-port-type transparent;
        }
        bridge-port {
             bridge-port-id 4;
             interface host;
             bridge-port-type transparent;
        }
   }
   MH-N366@popn110>delete user-bridge bridge 1 bridge-port 2
   MH-N366@popn110>show candidate user-bridge bridge 1
   bridge {
        bridge-id 1;
        bridge-port {
             bridge-port-id 1;
             interface eth1;
             bridge-port-type transparent;
        }
        bridge-port {
             bridge-port-id 3;
             interface eth2;
             bridge-port-type transparent;
        }
        bridge-port {
             bridge-port-id 4;
             interface host;
             bridge-port-type transparent;
        }
   }
   MH-N366@popn110>
```

7.3.5 discard

Discard all uncommitted changes.

Syntax

```
discard
```

Example

```
MH-N366@popn110>set ip ipv4 address 1.1.1.1
MH-N366@popn110>show compare running-candidate
address {
+   ip 1.1.1.1;
}
MH-N366@popn110>discard
MH-N366@popn110>show compare running-candidate
MH-N366@popn110>
```

Changes are indicated by a `+` or `-` character at the beginning of lines returned by the show compare command.

7.3.6 lock / unlock

Lock and unlock the Candidate database.

When more than one user can connect simultaneously to the same unit using the CLI, it is recommended that you type the `lock` command before you start configuring it. This prevents other users from entering commands and making changes while you are configuring the unit.

Once you type the `lock` command, the unit remains locked until you type the `unlock` command, or until you disconnect from the CLI.

There is only a single Candidate database. Therefore, if you do not lock the unit, the Candidate database is potentially shared with other users. In this case, if for example you type `commit` or `discard`, it will apply to the pending changes on the Candidate database for all users, and not only the commands that were entered by you.

Syntax

```
lock
unlock
```

If the database is already locked by another session, and you attempt to lock the database, the following error will appear:

Example

```
MH-N366@popn110>lock
Sep 8 12:15:26: Locking configuration: protocol lock-denied Operation
failed, lock is already held <session- id>3</session-id>
CLI command error
```

If the database is already locked by another session, and you try to modify the Candidate database, the following error will appear:

Example

```
MH-N366@popn110>set ip ipv4 address 1.1.1.1
Sep 8 12:19:03: Editing configuration: protocol lock-denied Operation
failed, lock is already held <session- id>3</session-id>
CLI command error
```

7.3.7 ping

Pings the device at the specified destination IP address.

Syntax

```
ping [IPv4 address] [-l <size>] [-t]
```

Example

```
MH-N366@popn110>ping 8.8.8.8
PING 8.8.8.8 56 bytes of data.
56 bytes from 8.8.8.8: icmp_seq=1 time=65.87 ms
56 bytes from 8.8.8.8: icmp_seq=2 time=60.737 ms
56 bytes from 8.8.8.8: icmp_seq=3 time=60.638 ms
56 bytes from 8.8.8.8: icmp_seq=4 time=60.74 ms
56 bytes from 8.8.8.8: icmp_seq=5 time=60.664 ms
--- 8.8.8.8 ping statistics ---5 packets transmitted, 5 received, 0% packet loss
rtt min/avg/max = 60.638/61.7298/65.87 ms
MH-N366@popn110>
```

Parameter	Mandatory	Values	Remarks
IPv4 address	✓	Valid IPv4 address	Destination IP address.
-l <size>		Payload size (bytes)	Packet payload size option in bytes. Default size is 56 bytes.
-t			Unlimited messages option. Messages are sent until Ctrl+C is keyed or 1000 have been sent. The default behavior is 5 messages.

7.3.8 quit

Quit the CLI.

Syntax

```
quit
```

As a shorthand for this command, you can also type q.

7.3.9 reboot

Reboot the unit or reset its configuration to factory defaults.

Syntax

```
reboot [reset-option]
```

Example

```
MH-N366@popn110>reboot system
```

Parameter	Mandatory	Values	Remarks
reset-option	✓	`restore-factory-defaults`	Reboot the unit and reset the unit to factory defaults.
		`system`	Reboot the unit.

Reboot causes a link down.

7.3.10 rollback

Reboot the unit and load the startup database.

Syntax

```
rollback [rollback-option]
```

Example

```
MH-N366@popn110>rollback start 300
```

Parameter	Mandatory	Values	Remarks
rollback-option	✓	`start` [timeout]	Start the rollback timer, where the timeout is a number between 60 and 7200 (seconds).
		`stop`	Cancel the rollback.

If rollback is active, the suffix rollback is added to the CLI prompt as follows:

`MH-N366-rollback`

7.3.11 run

Execute a script.

Syntax

```
run script [script-filename]
```

Example

```
MH-N366@popn110>run script commit_copy_startup
```

Parameter	Mandatory	Values	Remarks
script	✓	[script-filename]	The list of available scripts may vary from release to release. Currently available scripts are: • commit_copy_startup - script that commits the current candidate database, and copies it to the startup database.

7.3.12 set

Define a configuration object. The command syntax depends on the object you are configuring.

Syntax

```
set [container] [object-type] [object-id] [param1-name] [param1-value] [param2-name] [param2-value]...
```

Example 1

```
MH-N366@popn110>set ip ipv4 address 10.40.1.100 prefix-length 24
```

Object	Mandatory	Values	Remarks
container	✓	`interfaces`	For more information see Section 5.2 - Database Containers and Objects
		`ip`	
		`peer-addresses`	
		`radio-common`	
		`radio-dn`	
		`system`	
		`user-bridge`	
		`user-management`	
object-id			The id of the object you want to delete.

7.3.13 show

The show command displays configuration information for the Running or Candidate databases as follows:

- **show** - shows the current configuration for the Running database.
- **show candidate** - shows the current configuration for the Candidate database.
- **show compare** - shows the current configuration for the Candidate database.

7.3.13.1 show

Display the current configuration for the Running database, and any unit statuses and counters from the State database.

To show the configuration for a specific object type, specify the required container.

Syntax

```
show [container]
```

Example

```
MH-N366@popn110>show interfaces host
host {
    state {
        mac-address 00:24:a4:16:b1:31;
        counters {
            in-octets 21353646;
            in-pkts 142707;
            in-discards 0;
            in-errors 0;
            in-no-rule-discards 184;
            out-octets 21533125;
            out-pkts 190993;
            out-discards 0;
            out-errors 0;
        }
    }
}
MH-N366@popn110>
```

Object	Mandatory	Values	Remarks
container	✓	interfaces	For more information see Section 5.2 - Database Containers and Objects
		inventory	
		ip	
		radio-common	
		radio-dn	
		system	
		user-bridge	
		user-management	
object-id			The id of the object you want to show.

7.3.13.2 show candidate

Display the current configuration for the Candidate database.

To show the configuration for a specific object type, specify the required container.

Syntax

```
show candidate [container]
```

Example

```
MH-N366@popn110>show candidate ip ipv4
ipv4 {
    address {
        ip 1.1.1.1;
        prefix-length 24;
    }
    address {
        ip 192.168.0.1;
        prefix-length 24;
    }
    address {
        ip 31.168.34.110;
        prefix-length 28;
    }
    default-gateway 31.168.34.105;
}
MH-N366@popn110>
```

Object	Mandatory	Values	Remarks
container	✓	database-version	For more information see Section 5.2 - Database Containers and Objects
		interfaces	
		inventory	
		ip	
		peer-addresses	
		radio-common	
		radio-dn	
		system	
		user-bridge	
		user-management	
object-id			The id of the object you want to show.

7.3.13.3 show compare

Display the configuration differences between two databases of a unit.

Syntax

```
show compare [databases to compare]
```

Example

```
(after changing IP address)

MH-N366@popn110>set ip ipv4 address 192.168.1.1
MH-N366@popn110>show compare running-candidate
address {
+   ip 192.168.1.1;
+   prefix-length 24;
+   }
MH-N366@popn110>
```

Parameter	Mandatory	Values
[databases to compare]	✓	`running-candidate` - compare candidate and running databases
		`running-startup` - compare startup and running databases

7.3.14 software

Download a new software file to a passive software bank in the unit and activate it.

Syntax

```
software [action] [url]
```

In the following example, the commands perform the following actions:

1. Download the file multihaulimage-0.1.0-1304-2b64a581-20200924215953.rootfs.ubifs.tar located on server:port 192.168.42.30:2121 using the FTP protocol, with user:pw = anonymous:123.
2. Check the system SW banks.
3. Check the download status
4. Perform immediate activation of the new software, causing the system to reboot.

Example

```
MH-N366@popn110>software download url
ftp://anonymous:123@192.168.42.30:2121/multihaulimage-1.0.0-1304-2b64a581-
20200924215953.rootfs.ubifs.tar
MH-N366@popn110>show system state banks-info
banks-info {
    banks {
        number 0;
        software-version "1.0.0-1304-2b64a581-20200924215953";
        status passive;
        scheduled-to-switch idle;
```

```
        }
        banks {
            number 1;
            software-version "0.1.0-1202-
            2b46a302"; status active;
            scheduled-to-switch idle;
        }
    }
    MH-N366@popn110>show system state sw-upgrade-info
    sw-upgrade-info {
        download-and-burning-state finished-successfully;
        url ftp://anonymous:123@192.168.42.30:2121/multihaul-image-0.1.0-
    1304- 2b64a581-20200924215953.rootfs.ubifs.tar;
    }
    MH-N366@popn110>software activate scheduling immediate
    MH-N366@popn110>
```

Parameter	Mandatory	Values	Remarks

action	✓	`activate`	Activate the flashed upgraded software by switching banks. The following parameters are available:
			• `cancel` - cancels activation of the flashed upgraded software when it is scheduled for the next reset.
			• `scheduling` - must be followed by one of the following mandatory parameters:
			  • **immediate** - resets the unit and activates the flashed upgraded software immediately.
			  • **next-reset** - the unit waits for the next reset to activate the flashed upgraded software.
			  • <scheduling-date> <scheduling-time> - in the format: YYYY-MM-DD HH:MM:SS

		`download url` [url]	Download and flash the software upgrade file from the URL you specify. The URL format should be `file:filename` or `file:///filename`. The following protocols are supported for downloading the software file: HTTP, HTTPS, FTP, SFTP, SCP, TFTP. FTP example: url ftp://anonymous:123@192.168.42.30:2121/multihaul-image-0.1.0-1304-2b64a581-debug-n366-20200924215953.rootfs.ubifs.tar

Use the following show commands as required:

- `show system state banks-info` - show status and SW version of both SW banks.
- `show system state sw-upgrade-info` - show status and progress of the SW upgrade and error messages in case of failure.

7.3.15 validate

Validate all pending changes in the Candidate database for validity/integrity. This operation does not change the Running or Startup databases.

A response is returned only when the validation fails.

Syntax

```
validate
```

Example of Successful Validation

```
MH-N366@popn110>lock
MH-N366@popn110>set ip ipv4 address 192.168.1.0
MH-N366@popn110>validate
MH-N366@popn110>
```

Example of Failed Validation

```
MH-N366@popn110>set ip ipv4 address 255.255.255.255
MH-N366@popn110>validate
Jan 13 09:06:00: Validate failed. Edit and try again or discard changes:
application operation-failed 255.255.255.255: can't be a
loopback/multicast/broadcast address
CLI command error
MH-N366@popn110>
```

7.4 Configuring the System

The unit general hardware and software configuration are managed through the `system` container as follows:

Parameter	Values	Remarks
`name`		The assigned name of the unit that is used by the system. If a name has not been assigned, the unit ID is displayed. If setting the name, use up to 8 characters as follows: a-z0-9.- A reboot of the node is required for this setting to come into effect.
`state`		State data for the system.
	`banks-info`	State of system software banks.
	`date-and-time`	Current system date and time.
	`gps`	Container for GPS state (node only): • `fix-mode` - shows the fix status. • `fix-satellites-number` - the number of satellites from which the unit's GPS reached a fix.
	`product`	Product name.
	`sw-upgrade-info`	Software upgrade progress.
	`uptime`	System uptime.
`date`		Format: YYYY-MM-DD
`time`		Format: HH:MM:SS

To view the system parameters, type the following command:

```
MH-N366@popn110>show system
system {
    name popn110;
    state {
        product MH-N366;
        date-and-time 2021-01-07 19:40:32;
        uptime 0022:03:44:48;
        banks-info {
            banks {
                number 0;
                software-version "1.0.0-1585-70ce9231";
                status active;
                scheduled-to-switch idle;
            }
            banks {
                number 1;
                software-version "1.0.0-1555-915dd2db";
                status passive;
                scheduled-to-switch idle;
            }
        }
        sw-upgrade-info {
            download-and-burning-state not-started;
        }
       gps {
         fix-mode 3D;
```

```
            fix-satellites-number 8;
          }
      }
  }
  MH-N366@popn110>
```

To set the system name, type the following commands:

```
MH-N366@popn110>set system name bondibch
MH-N366@popn110>commit
MH-N366@popn110>copy running startup
MH-N366@popn110>reboot system
MH-N366@popn110>
```

To set the system date:

```
MH-N366@popn110>set system time 19:30:00
MH-N366@popn110>show system state date-and-time
date-and-time 2021-01-07 19:30:29;
MH-N366@popn110>
```

7.5 Configuring Users

System users are managed through the `user-management` container as follows:

Parameter	Values	Remarks
`user`		The username. username can be between 1 to 32 characters, any uppercase or lowercase letters, and the following symbols “.”,”-“ and “_”.
`password`		The user password. Passwords can be between 5 to 40 characters, any printable ASCII character that is not space or question mark (“ “, “?”).

To view a list of current users, type the following command:

```
MH-N366@popn110>show user-management
user-management {
  user {
    username admin;
  }
  user {
    username john;
  }
}
MH-N366@popn110>
```

To create a user and view it in the database, type the following commands:

```
MH-N366@popn110>set user-management user user01 password password01
MH-N366@popn110>commit
MH-N366@popn110>show user-management
user-management {
    user {
        username admin;
    }
    user {
        username user01;
    }
}
MH-N366@popn110>
```

To delete a new user, type the following commands:

```
MH-N366@popn110>delete user-management user user01
MH-N366@popn110>commit
MH-N366@popn110>show user-management
user-management {
    user {
        username admin;
    }
}
MH-N366@popn110>
```

7.6 Configuring Interfaces

Ethernet ports and other interfaces are managed through the `interfaces` container as follows:

Parameter	Values	Remarks
`host`	See section 7.6.1 Showing the Host Interface State	The management host interface of the unit.
`ports`	See section 7.6.2 Configuring Ports	Ethernet and SFP ports on the unit.
`rf-interface`	See section 7.6.3 Configuring RF Interfaces	The radio link to a remote unit is represented by an rf-interface in the local unit.

To view a list of current interfaces, type the following command:

```
MH-N366@popn110>show interfaces
interfaces {
    host {
        state {
            mac-address 00:24:a4:16:b1:31;
            counters {
                in-octets 98586820;
                in-pkts 593187;
                in-discards 0;
                in-errors 0;
                in-no-rule-discards 212;
                out-octets 85617667;
                out-pkts 771370;
                out-discards 0;
                out-errors 0;
            }
        }
    }
    ports {
        name eth1;
        admin-status up;
        copper-specific-config {
            auto-negotiate true;
        }
        state {
            oper-status up;
            actual-duplex-mode full;
            actual-port-speed 10Gbps;
            counters {
                in-octets 232855262;
                in-pkts 2259014;
                in-discards 0;
                in-errors 0;
                in-no-rule-discards 401709;
                out-octets 233038079;
                out-pkts 1567330;
                out-discards 0;
                out-errors 0;
            }
        }
    }
    rf-interface {
        name rf-TU-11067;
        state {
            counters {
                in-octets 111456618;
                in-pkts 816139;
                in-discards 0;
                in-errors 0;
                in-no-rule-discards 0;
                out-octets 98912561;
                out-pkts 1008772;
                out-discards 0;
                out-errors 0;
            }
        }
    }
}
MH-N366@popn110>
```

To view only a specific interface, add the interface name to the command:

```
MH-N366@popn110>show interfaces host
host {
      state {
            mac-address 00:24:a4:16:b1:31;
            counters {
                in-octets 98586820;
                in-pkts 593187;
                in-discards 0;
                in-errors 0;
                in-no-rule-discards 212;
                out-octets 85617667;
                out-pkts 771370;
                out-discards 0;
                out-errors 0;
            }
      }
}
MH-N366@popn110>
```

7.6.1 Showing the Host Interface State

The host interface state is shown through the `interfaces` container `host` parameter.

To view the host interface state and statistics, type the following command:

```
MH-N366@popn110>show interfaces host
host {
      state {
            mac-address 00:24:a4:16:b1:31;
            counters {
                in-octets 98586820;
                in-pkts 593187;
                in-discards 0;
                in-errors 0;
                in-no-rule-discards 212;
                out-octets 85617667;
                out-pkts 771370;
                out-discards 0;
                out-errors 0;
            }
      }
}
MH-N366@popn110>
```

7.6.2 Configuring Ports

The ports are managed through the `interfaces` container `ports` parameter as follows:

Parameter	Values	Remarks
`eth1` or `eth2` or `eth3`	`admin-status`	The interface state: • `down` - disable the port • `up` - enable the port

	`copper-specific-config`	Configurations for a RJ-45 type port:
		• `auto-negotiate` :
		  • `true` - port auto-negotiates transmission parameters with its peer port. Auto-negotiation is on by default for speeds of 1Gbps and higher.
		  • `false` - specify port transmission parameters below manually.
		• `duplex-mode` (optional):
		  • `full` - when auto-negotiate is true, full duplex mode is advertised to the peer.
		  • `half` - when auto-negotiate is true, half duplex mode is advertised to the peer.
		  • `unspecified` - port negotiates the duplex mode directly (typically full-duplex).
		• `speed` (optional):
		  • `10Mbps, 100Mbps, 1Gbps, 2500Mbps, 5G, 10G` - when `auto-negotiate` is `true`, this speed is advertised to the peer.
		  • `unspecified` – port negotiates the speed with the peer.
		• `pse-out`:
		  • `true` – enables PoE PSE function on the port.
		  • `false` – disables PoE PSE function on the port.

To view a list of all ports, type the following command:

```
MH-N366@popn110>show interfaces ports
ports {
    name eth1;
    admin-status up;
    copper-specific-config {
        auto-negotiate true;
        pse-out true;
    }
    state {
        oper-status up;
        actual-duplex-mode full;
        actual-port-speed 1Gbps;
        counters {
            in-octets 235734314;
            in-pkts 2286968;
            in-discards 0;
            in-errors 0;
            in-no-rule-discards 404268;
            out-octets 236290196;
            out-pkts 1588707;
            out-discards 0;
            out-errors 0;
        }
    }
}
ports {
    name eth2;
    admin-status down;
    copper-specific-config {
        auto-negotiate true;
    }
    state {
        oper-status down;
        counters {
            in-octets 0;
            in-pkts 0;
            in-discards 0;
            in-errors 0;
            in-no-rule-discards 0;
            out-octets 0;
            out-pkts 0;
            out-discards 0;
            out-errors 0;
        }
    }
}
MH-N366@popn110>
```

To view only a specific port, add the port name to the command:

```
MH-N366@popn110>show interfaces ports eth3
ports {
    name eth3;
    admin-status down;
    copper-specific-config {
        auto-negotiate true;
    }
    state {
        oper-status down;
        counters {
            in-octets 0;
            in-pkts 0;
            in-discards 0;
            in-errors 0;
            in-no-rule-discards 0;
            out-octets 0;
            out-pkts 0;
            out-discards 0;
            out-errors 0;
        }
    }
}
MH-N366@popn110>
```

To enable a specific port, type the following commands:

```
MH-N366@popn110>set interfaces ports eth2 admin-status up
MH-N366@popn110>commit
MH-N366@popn110>
```

To disable auto-negotiate on a specific port and set the port's duplex-mode and speed:

```
MH-N366@popn110>set interfaces ports eth2 copper-specific-config speed 1Gbps
MH-N366@popn110>set interfaces ports eth2 copper-specific-config duplex-mode
half
MH-N366@popn110>set interfaces ports eth2 copper-specific-config auto-negotiate
false
MH-N366@popn110>commit
```

To reenable auto-negotiate on a specific port, you must also delete existing manual settings for that port:

```
MH-N366@popn110>set interfaces ports eth2 copper-specific-config auto-negotiate
true
MH-N366@popn110>delete interfaces ports eth2 copper-specific-config duplex-mode
full
MH-N366@popn110>delete interfaces ports eth2 copper-specific-config speed 1Gbps
MH-N366@popn110>commit
MH-N366@popn110>
```

To view the actual state and statistics of the port, type the following command:

```
MH-N366@popn110>show interfaces ports eth1 state
state {
    oper-status up;
    actual-duplex-mode full;
    actual-port-speed 1Gbps;
    counters {
        in-octets 236505571;
        in-pkts 2294654;
        in-discards 0;
        in-errors 0;
        in-no-rule-discards 405283;
        out-octets 237176833;
        out-pkts 1594308;
        out-discards 0;
        out-errors 0;
    }
}
MH-N366@popn110>
```

To view the current PoE setting of the port, type the following command:

```
MH-N366@popn110>show interfaces ports eth2 copper-specific-config pse-out
pse-out false;
MH-N366@popn110>
```

To check if a port supports PoE, type the following command:

```
MH-N366@popn110>show inventory component eth2
component {
    name eth2;
    description RJ-45,1G/100M;
    parent Baseband;
    parent-rel-pos 0;
    child {
        name eth2_pse;
    }
    is-fru false;
}
MH-N366@popn110>
```

If the port supports PoE, the child with name [ethX_pse] appears.

To enable PoE for a PoE-equipped port, type the following command:

```
MH-N366@popn110>set interfaces ports eth2 copper-specific-config pse-out true
MH-N366@popn110>
```

7.6.3 Configuring RF Interfaces

The RF links are shown through the `interfaces` container `rf-interface` parameter as follows:

Parameter	Values	Remarks
`name`		Name of a specific link (up to 8 characters as follows: a-z,0-9)

To view the state and statistics of all RF interfaces, type the following command:

```
MH-N366@popn110>show interfaces rf-interface
rf-interface {
    name rf-N10120;
    state {
        counters {
            in-octets 113576090;
            in-pkts 831525;
            in-discards 0;
            in-errors 0;
            in-no-rule-discards 0;
            out-octets 101034434;
            out-pkts 1031923;
            out-discards 0;
            out-errors 0;
        }
    }
}
rf-interface {
    name rf-TU1106;
    state {
        counters {
            in-octets 113576909;
            in-pkts 831252;
            in-discards 0;
            in-errors 0;
            in-no-rule-discards 0;
            out-octets 101034340;
            out-pkts 1031329;
            out-discards 0;
            out-errors 0;
        }
    }
}
MH-N366@popn110>
```

To view the state and statistics of a specific RF link, add the name of the remote device to the command:

```
MH-N366@popn110>show interfaces rf-interface rf-tu1106
rf-interface {
    name rf-TU1106;
    state {
        counters {
            in-octets 113576909;
            in-pkts 831252;
            in-discards 0;
            in-errors 0;
            in-no-rule-discards 0;
            out-octets 101034340;
            out-pkts 1031329;
            out-discards 0;
            out-errors 0;
        }
    }
}
MH-N366@popn110>
```

7.7 Configuring Management IP Address

MultiHaul™ TG supports up to four IP addresses that can be on different subnets. The IP addresses and gateway are managed through the ip container as follows:

Parameter	Mandatory	Values	Remarks
ipv4	✓	address	List of static IPv4 addresses, for management, and optional prefix length
		default-gateway	Unit default IPv4 gateway

To set management IPv4 addresses and a default gateway, type the following commands:

```
MH-N366@popn110>set ip ipv4 address 10.40.1.100 prefix-length 24
MH-N366@popn110>set ip ipv4 default-gateway 10.40.1.1
MH-N366@popn110>commit
MH-N366@popn110>
```

To delete management IPv4 addresses and the default gateway, type the following commands:

```
MH-N366@popn110>delete ip ipv4 address 192.168.0.1
MH-N366@popn110>delete ip ipv4 default-gateway 10.40.1.1
MH-N366@popn110>commit
MH-N366@popn110>
```

To show the management IP configuration, type the following command:

```
MH-N366@popn110>show ip ipv4
ipv4 {
    address {
        ip 192.168.0.1;
        prefix-length 24;
    }
    address {
        ip 31.168.34.110;
        prefix-length 28;
    }
    default-gateway 31.168.34.105;
}
MH-N366@popn110>
```

7.8 Radio and Links

This section describes how to view and configure the radio and link parameters in the MultiHaul™ TG.

7.8.1 Radio and Links Overview

The radio and link parameters are arranged in the following containers:

- `radio-common` - RF settings that are applicable to the nodes or the TUs.
- `radio-dn` - radio settings for the nodes only, including links to other units.

The following table summarizes the distribution of the main parameters between both radio containers and applicability for nodes and/or TUs:

Parameter Groups	Description	Container	Node	TU	Details
`node-config` and **`sectors-config`**	Radio parameters such as channel frequencies.	radio-dn	✓ (node or per sector)	N/A	Section 7.8.2.1 - Radio Parameters
`default-ssid-profile`	Access credentials.	radio-common	✓	✓	Section 7.8.2.2 - Configuring Radio Access Credentials
`links`	Links between units.	radio-dn	✓	N/A	Section 7.8.3 - Configuring Links

7.8.1.1 Radio Overview

The radio parameters define the radio settings such as frequency, polarity, and rx/tx Golay index or radio credentials. You can configure the above radio parameters at 2 levels:

- Node level - the default radio parameters for the unit.
- Sector level - the radio parameters for a specific sector. If undefined, the node level settings are used.

One setting is of particular importance at the Node level, whether the node is the Point of Presence (POP) or not. A node configured as POP will initiate all links unconditionally. A node not configured as POP will wait for 1 incoming link before initiating its own links (links are not torn down in case the incoming link fails, however new or down link will not be initiated). This configuration ensures orderly initiation of all links in the network, no matter the size of the network.

Configuring the POP node per plan will ensure optimal bring up of your network.

Enabling/disabling individual sectors is also possible, as described in the following sections.

7.8.1.2 Link Overview

When establishing an RF link between two units, one unit is considered as the initiator and the second unit as the responder. On the initiator unit, you will need the system name (or unit ID) that was assigned to the responder unit to which you are defining the RF link.

For information on the system names/ID for units in the network, refer to the network design and instructions you received from your or Siklu's Planning Team.

For each link, you must define two sector lists:

- sectors list for the initiating node (1-4)
- sectors list for the responding node (1 to 4 in case of a link to a node, defaults to 1 for TUs)

The initiator node continuously tries to establish a connection from all sectors defined in the local sector list to all sectors defined in the remote sectors list. The initiator node stops initiating the connection on the first combination of local and remote sector that works, which may not be the best one. This feature is therefore useful when the orientation between the units is not clear; however this may also result in a less than optimal link, so you should enter a detailed list of sectors for both sides of the link.

7.8.2 Configuring Radio Settings

7.8.2.1 Radio Parameters

The RF settings unique to the node are managed through the following `radio-dn` parameters:

The network has been carefully designed by your or Siklu's Planning Team to achieve the highest standards in availability and reliability, considering all units in your network. It is critical to implement the radio parameters of the nodes as they are designed by the planners of the network. Make sure you obtain the radio planning from your or Siklu's Planning Team before configuring the radio-profile.

Parameter	Mandatory	Values	Remarks

node-config		default-radio-profile	Default radio configuration (Rx-Tx) for the unit. The following parameters can be managed:
			• frequency - channel center frequency:
			  • 58320, 60480, 62640 or 64800
			  • unspecified - not for use.
			• polarity - the timing of receive and transmit slots relative to those of the node at the PoP:
			  • even - transmit and receive slots synchronized with the PoP node.
			  • hybrid-even - special case to be used as indicated by your network design.
			  • hybrid-odd - special case to be used as indicated by your network design.
			  • odd - transmit and receive slots are opposite to that of the PoP node.
			  • unspecified - not for use.
			• rx-golay-index - index of the Rx interference reduction Golay code sequence:
			  • 1
			  • 2
			  • unspecified - not for use.
			• tx-golay-index - index of the Tx interference reduction Golay code sequence:
			  • 1
			  • 2
			  • unspecified - not for use.

		ignore-gps	Setting for use of the GPS network in the node: • no - the node must use the refence timing from the GPS network to establish links. This is the normal behavior. • yes - the node ignores the GPS network and attempts to establish links without it. This setting is useful for testing indoor links, and should only be used in lab environment. Only 1 hop networks can be established. A reboot of the node is required for this setting to come into effect.
		is-pop-dn	Setting for POP node only: • false - node is not a pop node, will wait for incoming link before initiating own links. • True - node is a pop node, will initiate links unconditionally.

Parameter	Mandatory	Values	Remarks

`sectors-config`		`sector` [index] `radio-profile`	Radio configuration (Rx-Tx) for the sector specified by [index]. The following parameters can be managed:
			• `frequency` - channel center frequency:
			  • `58320`, `60480`, `62640` or `64800` -
			  • `unspecified` - use the value set in the `default-radio- profile`.
			• `polarity`- the timing of receive and transmit slots relative to those of the node at the PoP:
			  • `even` - transmit and receive slots synchronized with the PoP node.
			  • `hybrid-even` - special case to be used as indicated by your network design.
			  • `hybrid-odd` - special case to be used as indicated by your network design.
			  • `odd`- transmit and receive slots are opposite to that of the PoP Node
			  • `unspecified` - use the value set in the `default-radio-profile`.
			• `rx-golay-index` - index of the Rx interference reduction golay code sequence:
			  • `1`
			  • `2`
			  • `unspecified` - use the value set in the `default-radio- profile`.
			• `tx-golay-index` - index of the Tx interference reduction golay code sequence:
			  • `1`
			  • `2`
			`unspecified` - use the value set in the `default-radio-profile`.

To view the current radio-dn configuration, type the following commands:

```
MH-N366@popn110>show radio-dn
radio-dn {
    node-config {
        default-radio-profile {
            polarity even;
            frequency 60480;
            tx-golay-index 1;
            rx-golay-index 1;
        }
        is-pop-dn true;
    }
    sectors-config {
        sector {
            index 1;
            radio-profile {
                polarity unspecified;
                frequency unspecified;
                tx-golay-index unspecified;
                rx-golay-index unspecified;
            }
        }
        sector {
            index 2;
            radio-profile {
                polarity unspecified;
                frequency 64800;
                tx-golay-index unspecified;
                rx-golay-index unspecified;
            }
        }
        <skipping some display lines>
        sector {
            index 4;
            radio-profile {
                polarity unspecified;
                frequency unspecified;
                tx-golay-index unspecified;
                rx-golay-index unspecified;
            }
        }
    }
links {
        configured {
            remote-assigned-name n2-106;
            remote-sector {
                index 1;
            }
            local-sector {
                index 1;
            }
            control-superframe 0;
            responder-node-type dn;
            admin-status up;
        }
    }
}
MH-N366@popn110>
```

To set the node-level radio profile, type the following commands:

```
MH-N366@popn110>set radio-dn node-config default-radio-profile frequency 58320
MH-N366@popn110>set radio-dn node-config default-radio-profile polarity even
MH-N366@popn110>set radio-dn node-config default-radio-profile tx-golay-index 2
MH-N366@popn110>set radio-dn node-config default-radio-profile rx-golay-index 2
MH-N366@popn110>show candidate radio-dn node-config default-radio-profile
default-radio-profile {
    polarity even;
    frequency 58320;
    tx-golay-index 2;
    rx-golay-index 2;
}
MH-N366@popn110>
```

To set the radio profile for a specific sector, type the following command:

```
MH-N366@popn110>set radio-dn sectors-config sector 3 radio-profile frequency 60480
MH-N366@popn110>set radio-dn sectors-config sector 3 radio-profile polarity odd
MH-N366@popn110>set radio-dn sectors-config sector 3 radio-profile rx-golay-index 1
MH-N366@popn110>set radio-dn sectors-config sector 3 radio-profile tx-golay-index 1
MH-N366@popn110>show candidate radio-dn sectors-config sector 3
sector {
    index 3;
    radio-profile {
        polarity odd;
        frequency 60480;
        tx-golay-index 1;
        rx-golay-index 1;
    }
}
MH-N366@popn110>
```

To reset sector level parameters to the node default settings, use the following commands:

```
MH-N366@popn110>set radio-dn sectors-config sector 3 radio-profile frequency unspecified
MH-N366@popn110>set radio-dn sectors-config sector 3 radio-profile polarity unspecified
MH-N366@popn110>show candidate radio-dn sectors-config sector 3
sector {
    index 3;
    radio-profile {
          polarity unspecified;
          frequency unspecified;
          tx-golay-index unspecified;
          rx-golay-index unspecified;
    }
}
MH-N366@popn110>
```

7.8.2.2 Configuring Radio Access Credentials

The wireless access to each node is controlled by its SSID credentials managed through the following `radio-common` parameters:

The ssid-profile credentials must be identical on both sides of the link.

Parameter	Values	Remarks
node-config	default-ssid-profile	Radio access credentials defined by: • ssid - radio network ID. • Password - radio network password.

To configure the SSID credentials for the unit, type the following commands:

```
MH-N366@popn110>set radio-common node-config default-ssid-profile name SMB-007
MH-N366@popn110>set radio-common node-config default-ssid-profile password MH007
MH-N366@popn110>show candidate radio-common node-config default-ssid-profile
default-ssid-profile {
    name SMB-007;
    password MH007;
}
MH-N366@popn110>
```

7.8.2.3 Enabling RF Sectors

Enabling/disabling individual sectors are managed through the following radio-common parameters:

Parameter	Values	Remarks
sectors-config	sector [index]	The parameters for the sector: admin-status: • down - enable the specified sector. • up - disable the specified sector.

To disable sector 2 in the node, type the following commands:

```
MH-N366@popn110>set radio-common sectors-config sector 2 admin-status down
MH-N366@popn110>show candidate radio-common sectors-config
sectors-config {
    sector {
          index 1;
          admin-status up;
    }
    sector {
          index 2;
          admin-status down;
    }
    sector {
          index 3;
          admin-status up;
    }
    sector {
          index 4;
          admin-status up;
    }
}
MH-N366@popn110>
```

7.8.3 Configuring Links

The links between units are managed through the following `radio-dn` parameters:

Parameter	Values	Remarks
`links`	`configured`	List of all links that the node will try to initiate.

	`configured` [remote-assigned-name]	Specific link connected to a TU or to another node (identified by its `remote-assigned-name` - see Section 7.8.1.2 - Link Overview). The parameters for the link:
		• `admin-status`:
		  • `down` - do not initiate this link, and drop it if it is up.
		  • `up` - initiate (and maintain) this link (default).
		• `control-superframe`:
		  • `0` or `1` - set to either 0 or 1 when defining a link to a node. For two remote nodes (maximum permissible) on the same local sector, set each remote node to a different value.
		  • `unspecified` - for links to TUs (can be omitted).
		• `local-sector` - list of sectors (1, 2, 3, or 4) on the local unit from which the link can be setup.
		• `remote-sector` - list of sectors (1, 2, 3, or 4) on the remote unit to which the link can be setup.
		• `responder-node-type`:
		  • `dn` - when connecting to another node.
		  • `cn` - when connecting to a TU.

Configuring a radio link may require connection to the bridge in special cases. For more information on bridge connections, see section 7.9.

To configure a link to a TU with the assigned name nthbondi, type the following commands:

```
MH-N366@popn110>set radio-dn links configured nthbondi local-sector 1
MH-N366@popn110>set radio-dn links configured nthbondi remote-sector 1
MH-N366@popn110>validate
MH-N366@popn110>show candidate radio-dn links
links {
    configured {
          remote-assigned-name nthbondi;
          remote-sector {
                index 1;
          }
          local-sector {
                index 1;
          }
          control-superframe unspecified;
          responder-node-type cn;
          admin-status up;
    }
}
MH-N366@popn110>
```

To configure a link to a node with the assigned name sthmsnbh, type the following commands:

```
MH-N366@popn110>set radio-dn links configured sthmsnbh
MH-N366@popn110>set radio-dn links configured sthmsnbh control-superframe 1
MH-N366@popn110>set radio-dn links configured sthmsnbh responder-node-type dn
MH-N366@popn110>set radio-dn links configured sthmsnbh local-sector 1
MH-N366@popn110>set radio-dn links configured sthmsnbh remote-sector 2
MH-N366@popn110>show candidate radio-dn links
links {
    configured {
          remote-assigned-name sthmsnbh;
          remote-sector {
                index 2;
          }
          local-sector {
                index 1;
          }
          control-superframe 1;
          responder-node-type dn;
          admin-status up;
    }
}
MH-N366@popn110>
```

To disable an RF link, type the following commands:

```
MH-N366@popn110>set radio-dn links configured sthmsnbh admin-status down
MH-N366@popn110>show candidate radio-dn links
links {
    configured {
          remote-assigned-name sthmsnbh;
          remote-sector {
                index 2;
          }
          local-sector {
                      index 1;
          }
          control-superframe 1;
          responder-node-type dn;
          admin-status down;
    }
}
MH-N366@popn110>
```

To permanently delete an RF link, type the following commands:

```
MH-N366@popn110>show radio-dn links
links {
    configured {
          remote-assigned-name nthbondi;
          remote-sector {
                index 1;
          }
          local-sector {
                index 1;
          }
          control-superframe unspecified;
          responder-node-type cn;
          admin-status up;
    }
    configured {
          remote-assigned-name sthbondi;
          remote-sector {
                index 1;
          }
          local-sector {
                index 1;
          }
          control-superframe unspecified;
          responder-node-type cn;
          admin-status up;
    }
}
MH-N366@popn110>delete radio-dn links configured nthbondi
MH-N366@popn110>show candidate radio-dn links
links {
    configured {
          remote-assigned-name sthbondi;
          remote-sector {
                index 1;
          }
          local-sector {
                index 1;
          }
          control-superframe unspecified;
          responder-node-type cn;
          admin-status up;
    }
}
MH-N366@popn110>
```

7.9 Ethernet Bridges

7.9.1 Bridges Overview

This section describes how to configure a bridge in the MultiHaul™ TG.

MultiHaul™ TG radios bridge architecture allows defining 802.1q and 802.1ad services, including adding VLAN, removing VLAN and VLAN translation.

Up to 64 bridges can be defined, and ports may be attached to the bridge as transparent (all traffic passes through), customer port (C-VLAN), provider port (S-VLAN) or provider bridge port (Q-in-Q).

The units include the following types of ports:

- host - for the host.
- eth1, eth2, eth3 - for physical interfaces.
- rf-<assigned name> - for radio links.
- rf - a virtual port used to designate how to connect the radio link to the bridge when no bridge-port has been configured for this radio link.

Following establishment of the radio link, the rf-interface for this link auto-connects to the bridge(s) where “rf” bridge-port(s) are defined (if the rf-interface has not been configured for a different function).

Each bridge has a unique identifier, the bridge-id, ranging from 1 - 64. The bridge-id is a mandatory parameter.

Each port configured to be part of any bridge should be identified by a bridge-port identifier (a number in the range 1 - 64). This identifier should be unique per bridge. You can use any value for the bridge-port-id to identify the bridge-port.

In the default factory settings, one bridge is configured and all physical Ethernet ports, the virtual rf port and the host port are connected to this bridge, as transparent bridge-ports.

You cannot attach the same port with the same port-type and options to more than one bridge.

7.9.2 Configuring Bridges

The bridge settings are managed through the following parameters:

Parameter	Values	Remarks
`user-bridge`		List of all ethernet bridges between ports and/or RF links.
	bridge [bridge-id]	Details of ethernet bridge specified by [bridge-id].

`user-bridge bridge` [bridge-id]	`bridge-port` [bridge-port-id]	• `bridge-port-type`:
		  • c-vlan - traffic with single C-VLAN (customer port).
		  • q-in-q - traffic with C-VLAN and S-VLAN.
		  • s-vlan - traffic with single S-VLAN (provider port).
		  • transparent - all traffic. VLANs are ignored, if present.
		• `c-vlan`[c-vlan-id] - this bridge-port forwards only frames with the specified c-vlan-id.
		• `interface`:
		  • host: Host interface
		  • eth1, eth2, eth3: Physical Ethernet interface
		  • rf-<AN>: For a radio link, where <AN> is the network-assigned name/ID for the radio link.
		  • rf: A virtual port used to designate how to connect radio links when no bridge-port has been configured. For more information, see section 7.9.8 Use of the Default RF Interface.
		• `s-vlan`[s-vlan-id] - this bridge-port forwards only frames with the specified s-vlan-id.

7.9.3 Show Bridge Configuration

To view a list of configured bridges, use the following command:

Syntax

```
show user-bridge
```

Example

```
MH-N366@popn110>show user-bridge
bridge {
    bridge-id 1;
    bridge-port {
          bridge-port-id 1;
          interface eth1;
          bridge-port-type transparent;
    }
    bridge-port {
    bridge-port-id 2;
          interface eth3;
          bridge-port-type transparent;
    }
    bridge-port {
    bridge-port-id 3;
          interface eth2;
          bridge-port-type transparent;
    }
    bridge-port {
          bridge-port-id 4;
          interface host;
       bridge-port-type transparent;
   }
}
MH-N366@popn110>
```

To show the configuration of a specific bridge, enter the following command:

```
Syntax
   show user-bridge bridge <bridge id>
Example
   MH-N366@popn110>show user-bridge bridge 1
   bridge {
       bridge-id 1;
       bridge-port {
             bridge-port-id 1;
             interface eth1;
             bridge-port-type transparent;
       }
       bridge-port {
       bridge-port-id 2;
             interface eth3;
             bridge-port-type transparent;
       }
       bridge-port {
       bridge-port-id 3;
             interface eth2;
             bridge-port-type transparent;
       }
       bridge-port {
             bridge-port-id 4;
             interface host;
          bridge-port-type transparent;
      }
   }
   MH-N366@popn110>
```

7.9.4 Create a Bridge

To create a bridge, use the command `set user-bridge` with a new (unused) bridge ID.

```
Syntax
   set user-bridge bridge <bridge-id> bridge-port <bridge-port-id> interface
   <interface>
Example
   MH-N366@popn110>set user-bridge bridge 2 bridge-port 1 interface eth1
   MH-N366@popn110>set user-bridge bridge 2 bridge-port 1 bridge-port-type
   transparent
   MH-N366@popn110>show candidate user-bridge
   user-bridge {
       bridge {
           bridge-id 1;
           bridge-port {
           bridge-port-id 2;
                 interface eth3;
                 bridge-port-type transparent;
           }
           bridge-port {
           bridge-port-id 3;
                 interface eth2;
                 bridge-port-type transparent;
           }
           bridge-port {
                 bridge-port-id 4;
                 interface host;
                 bridge-port-type transparent;
           }
       }
       bridge {
           bridge-id 2;
           bridge-port {
           bridge-port-id 1;
                 interface eth1;
                 bridge-port-type transparent;
           }
       }
   }
   MH-N366@popn110>
```

7.9.5 Delete a Bridge

To delete a bridge, use the following CLI command:

```
Syntax
   delete user-bridge bridge <bridge-id>
Example
   MH-N366@popn110>show user-bridge user-bridge {
       bridge {
           bridge-id 1;
           bridge-port {
                  bridge-port-id 1;
                  interface eth3;
                  bridge-port-type transparent;
           }
           bridge-port {
                  bridge-port-id 3;
                  interface host;
                  bridge-port-type transparent;
           }
           bridge-port {
                  bridge-port-id 4;
                  interface eth1;
                  bridge-port-type transparent;
           }
       }
       bridge {
           bridge-id 10;
           bridge-port {
                  bridge-port-id 10;
                  interface rf-n111;
                  bridge-port-type q-in-q;
                  s-vlan 10;
                  c-vlan 60;
           }
       }
   }
   MH-N366@popn110>delete user-bridge bridge 10
   MH-N366@popn110>show candidate user-bridge
       bridge {
           bridge-id 1;
           bridge-port {
                  bridge-port-id 1;
                  interface eth3;
                  bridge-port-type transparent;
           }
           bridge-port {
                  bridge-port-id 3;
                  interface host;
                  bridge-port-type transparent;
           }
           bridge-port {
                  bridge-port-id 4;
                  interface eth1;
                  bridge-port-type transparent;
           }
       }
   }
   MH-N366@popn110>
```

7.9.6 Delete a Port from a Bridge

To delete a bridge-port from a bridge, use the following CLI command:

Syntax

```
delete user-bridge bridge <bridge-id> bridge-port <bridge-port-id>
```

Unit management is performed through the host port. If the host port is deleted from the bridge that connected to the external management network, unit management access will be lost.

The following example shows how to delete port 2 on bridge 1:

```
MH-N366@popn110>show user-bridge bridge 1
bridge {
    bridge-id 1;
    bridge-port {
           bridge-port-id 1;
           interface eth1;
           bridge-port-type transparent;
    }
    bridge-port {
           bridge-port-id 2;
           interface host;
           bridge-port-type transparent;
    }
    bridge-port {
           bridge-port-id 3;
           interface eth2;
           bridge-port-type transparent;
    }
    bridge-port {
           bridge-port-id 4;
           interface host;
           bridge-port-type transparent;
    }
}
MH-N366@popn110>delete user-bridge bridge 1 bridge-port 2
MH-N366@popn110>show candidate user-bridge bridge 1
bridge {
    bridge-id 1;
    bridge-port {
           bridge-port-id 1;
           interface eth1;
           bridge-port-type transparent;
    }
    bridge-port {
           bridge-port-id 3;
           interface eth2;
           bridge-port-type transparent;
    }
    bridge-port {
           bridge-port-id 4;
           interface host;
           bridge-port-type transparent;
    }
}
MH-N366@popn110>
```

7.9.7 Add a Port to the Bridge

To add a port to a bridge, use the following command(s):

Syntax

```
set user-bridge bridge <bridge-id> bridge-port <port-id> interface <interface-
id> set user-bridge bridge <bridge-id> bridge-port <port-id> bridge-port-type
<port- type>
```

The following example shows how to add a host port to bridge 10 and set the port type to transparent:

Example

```
MH-N366@popn110>set user-bridge bridge 10 bridge-port 10 interface eth2
MH-N366@popn110>set user-bridge bridge 10 bridge-port 10 bridge-port-type
transparent
MH-N366@popn110>show candidate user-bridge bridge 10
bridge {
    bridge-id 10;
    bridge-port {
          bridge-port-id 10; interface eth2;
          bridge-port-type transparent;
    }
}
MH-N366@popn110>
```

The following example shows how to set a bridge port type to q-in-q in bridge 20:

Example

```
MH-N366@popn110>set user-bridge bridge 20 bridge-port 20 bridge-port-type q-in-q
MH-N366@popn110>set user-bridge bridge 20 bridge-port 20 c-vlan 20
MH-N366@popn110>set user-bridge bridge 20 bridge-port 20 s-vlan 20
MH-N366@popn110>show candidate user-bridge
user-bridge {
     bridge {
          bridge-id 1;
          bridge-port {
                bridge-port-id 1;
                interface eth3;
                bridge-port-type transparent;
          }
          bridge-port {
                bridge-port-id 2;
                interface eth2;
                bridge-port-type transparent;
          }
          bridge-port {
                bridge-port-id 3;
                interface host;
                bridge-port-type transparent;
          }
          bridge-port {
                bridge-port-id 4;
                interface eth1;
                bridge-port-type transparent;
          }
     }
     bridge {
          bridge-id 10;
                bridge-port {
                bridge-port-id 10;
                interface eth2;
                bridge-port-type c-vlan;
                c-vlan 1000;
          }
     }
     bridge {
          bridge-id 20;
                bridge-port {
                bridge-port-id 20;
                bridge-port-type q-in-q;
                s-vlan 20;
                c-vlan 20;
          }
     }
}
MH-N366@popn110>
```

7.9.8 Use of the Default RF Interface

The following example shows how a bridge-port is added automatically to the same bridge where the virtual RF interface exists, after the radio link is connected. First, we show the user-bridge configuration before the radio link is connected, and then we show the configuration again after the radio link is connected.

Note that bridge-port 5 with the “rf-nthbondi” interface is added following the connection.

Example, showing the user-bridge before and after the connection of the radio-link for unit **nthbondi**:

```
MH-N366@popn110>show user-bridge
user-bridge {
    bridge {
        bridge-id 1;
        bridge-port {
            bridge-port-id 1;
            interface eth3;
            bridge-port-type transparent;
        }
        bridge-port {
            bridge-port-id 2;
            interface eth2;
            bridge-port-type transparent;
        }
        bridge-port {
            bridge-port-id 3;
            interface host;
            bridge-port-type transparent;
        }
        bridge-port {
            bridge-port-id 4;
            interface eth1;
            bridge-port-type transparent;
        }
        bridge-port {
            bridge-port-id 100;
            interface rf;
            bridge-port-type transparent;
        }
    }
}

< radio link connects during this interval >

MH-N366@popn110>show user-bridge
user-bridge {
    bridge {
        bridge-id 1;
        bridge-port {
            bridge-port-id 1;
            interface eth3;
            bridge-port-type transparent;
        }
        bridge-port {
            bridge-port-id 2;
            interface eth2;
            bridge-port-type transparent;
```

```
            }
            bridge-port {
                bridge-port-id 3;
                interface host;
                bridge-port-type transparent;
            }
            bridge-port {
                bridge-port-id 4;
                interface eth1;
                bridge-port-type transparent;
            }
            bridge-port {
                bridge-port-id 5;
                interface rf-nthbondi;
                bridge-port-type transparent;
            }
            bridge-port {
                bridge-port-id 100;
                interface rf;
                bridge-port-type transparent;
            }
        }
    }
    MH-N366@popn110>
```

8 Monitoring the System through the CLI

This section describes how to monitor system status and health through the CLI. It is recommended to run the commands in the order of this section for optimal results.

8.1 Show System – Check GPS status (nodes only)

Use this command to check that the node is locked to the GPS network.

This command is relevant for nodes only.

```
MH-N366@popn110>show system
system {
    name popn110;
    state {
          product MH-N366;
          date-and-time 2021-01-21 10:53:03;
          uptime 0001:19:58:11;
          banks-info {
                banks {
                      number 0;
                      software-version "1.0.0-1625-b49477c1-release";
                      status passive;
                      scheduled-to-switch idle;
                }
                banks {
                      number 1;
                      software-version "1.0.1-1639-e52cb79e-release";
                      status active;
                      scheduled-to-switch idle;
                }
          }
       sw-upgrade-info {
           download-and-burning-state not-started;
       }
       gps {
           fix-mode 3D;
           fix-satellites-number 8;
       }
   }
}
MH-N366@popn110>
```

8.2 Check Radio Links

For nodes only, check which links are configured and supposed to be up according to the admin-status parameter:

```
MH-N366@popn110>show radio-dn links configured
configured {
    remote-assigned-name panks;
    remote-sector {
        index 2;
    }
    local-sector {
        index 1;
    }
    control-superframe unspecified;
    responder-node-type cn;
    admin-status up;
}
configured {
    remote-assigned-name tower-205;
    remote-sector {
        index 1;
    }
    local-sector {
        index 1;
    }
    control-superframe 0;
    responder-node-type dn;
    admin-status down;
}
configured {
    remote-assigned-name tower-107;
    remote-sector {
        index 2;
    }
    local-sector {
        index 2;
    }
    control-superframe 0;
    responder-node-type dn;
    admin-status up; }
}
MH-N366@popn110>
```

Validate that all links defined as up in the previous command appear in the active links list. Except for the PoP node, at least one active link from another node should also appear in the list of active links.

```
MH-N366@popn110>show radio-common links
links {
    active {
        remote-assigned-name panks;
        actual-remote-sector-index 2;
        actual-local-sector-index 1;
        remote-mac-addr 02:6e:79:9c:52:9c;
        local-role initiator;
```

```
            rssi -46;
            snr 27;
            mcs-rx 10;
            mcs-tx 10;
            tx-per 0.00;
            rx-per 0.00;
            tx-power-index 6;
            speed-rx 2500;
            speed-tx 2500;
            counters {
                rx-ok 4731468;
                tx-ok 413141;
                tx-fail 647;
                rx-fail 3126;
                rx-hcs-fail 23065;
                tx-drop-lifetime-exp 0;
                rx-drop-buf-size 0;
                rx-drop-encryption-fail 0;
                rx-drop-ra-mismatch 0;
                rx-drop-unexpected 0;
            }
        }
    <some rows omitted>
       active {
            remote-assigned-name tower-107;
            actual-remote-sector-index 2;
            actual-local-sector-index 2;
            remote-mac-addr 02:71:c0:8b:7d:a5;
            local-role initiator;
            rssi -48;
            snr 25;
            mcs-rx 9;
            mcs-tx 10;
            tx-per 0.00;
            rx-per 0.00;
            tx-power-index 6;
            speed-rx 2050;
            speed-tx 2500;
            counters {
                rx-ok 60859;
                tx-ok 58448;
                tx-fail 7;
                rx-fail 0;
                rx-hcs-fail 51;
                tx-drop-lifetime-exp 0;
                rx-drop-buf-size 0;
                rx-drop-encryption-fail 0;
                rx-drop-ra-mismatch 0;
                rx-drop-unexpected 0;
            }
        }
    }
    MH-N366@popn110>
```

If this is a TU, only one link is shown.

```
MH-T265@panks>show radio-common links
links {
    active {
         remote-assigned-name tower-107;
         actual-remote-sector-index 2;
         actual-local-sector-index 2;
         remote-mac-addr 02:71:c0:8b:7d:a5;
         local-role responder;
         rssi -48;
         snr 25;
         mcs-rx 9;
         mcs-tx 9;
         tx-per 0.00;
         rx-per 0.00;
         tx-power-index 6;
         speed-rx 2050;
         speed-tx 2050;
         counters {
             rx-ok 58448;
             tx-ok 60859;
             tx-fail 0;
             rx-fail 0;
             rx-hcs-fail 0;
             tx-drop-lifetime-exp 0;
             rx-drop-buf-size 0;
             rx-drop-encryption-fail 0;
             rx-drop-ra-mismatch 0;
             rx-drop-unexpected 0;
         }
     }
}
MH-T265@panks>
```

8.3 Checking the Radio Beams

The MultiHaul TG antenna array generates 61 beams in the Tx and Rx directions following the establishment of a link with a remote unit. To optimize the accuracy of the beams, you can rotate the Terminal Unit in accordance with the *beam index* that is included in the response to the `debug radio stats` command. The value of the beam index can be translated to an offset from the boresight (the center of the antenna array).

The `debug radio stats` command response contains a wealth of statistics, including the beam index parameters:

- `phyPeriodic.rxBeamIdx`
- `phyPeriodic.txBeamIdx`

The beam index is a number between 0-60 that is used to obtain the vertical and horizontal offset of the TX/RX beam from the center of the antenna array using the following lookup table.

	Horizontal Offset [°]																					
Vertical Offset [°]	**-44**	**-40**	**-36**	**-32**	**-28**	**-24**	**-20**	**-16**	**-12**	**-8**	**-4**	**0**	**+4**	**+8**	**+12**	**+16**	**+20**	**+24**	**+28**	**+32**	**+36**	**+40**	**+44**
-20		0		1		2		3		4		5		6		7		8		9		10	
-10	23		22		21		20		19		18	17	16		15		14		13		12		11
0		24		25		26		27		28	29	30	31	32		33		34		35		36	
+10	49		48		47		46		45		44	43	42		41		40		39		38		37
+20		50		51		52		53		54		55		56		57		58		59		60	

Notes:

- The beam index reading is available when the link is up (active).
- The MultiHaul TG device must be running software release v1.0.2 to support this functionality.
- The beam index is provided per link and is identified by the MAC address of the remote radio unit.
  - In the case of the Terminal Unit, there is only one link - so you will see single `rxBeamIdx` and `txBeamIdx` readings.
  - In case of a Node with multiple links – to other nodes or Terminal Units – you will see readings per link, based on number of active links, identified by the MAC address of the remote. To obtain the MAC address of the remote radio units, use the `show radio-common links active` command.

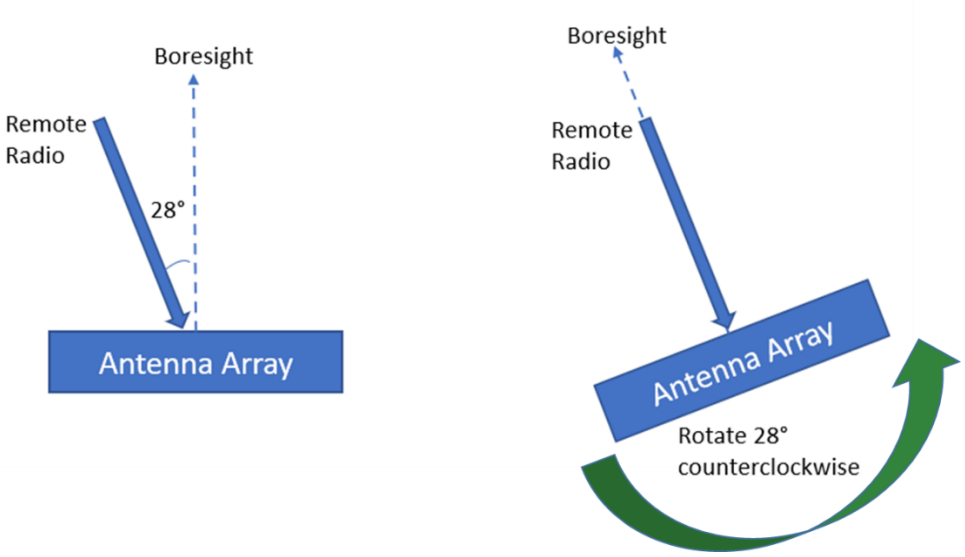
To easily locate the beam index values in the array of statistics that is returned, copy the output to a text file, and search for “xBeamIdx” to find the Tx and Rx beam indices, as shown below.

```
MH-T265@panks> debug radio stats
…
19191998628, tgf.46:54:55:4c:d4:2c.miscLink.txstatusLifetimeExp, 13, 02:75:07:7a:65:e4
18899998621, tgf.46:54:55:4c:d4:2c.phyPeriodic.pktLqm, 119, 02:75:07:7a:65:e4
18899998621, tgf.46:54:55:4c:d4:2c.phyPeriodic.pktRssi, -44, 02:75:07:7a:65:e4
18899998621, tgf.46:54:55:4c:d4:2c.phyPeriodic.rxBeamIdx, 39, 02:75:07:7a:65:e4
18899998621, tgf.46:54:55:4c:d4:2c.phyPeriodic.rxRficBitmap, 0, 02:75:07:7a:65:e4
18899998621, tgf.46:54:55:4c:d4:2c.phyPeriodic.tsf, 18899998621, 02:75:07:7a:65:e4
18899998621, tgf.46:54:55:4c:d4:2c.phyPeriodic.txBeamIdx, 39, 02:75:07:7a:65:e4
18899998621, tgf.46:54:55:4c:d4:2c.phyPeriodic.txRficBitmap, 0, 02:75:07:7a:65:e4
19191998630, tgf.46:54:55:4c:d4:2c.phystatus.dbg16, 0, 02:75:07:7a:65:e4
…
```

In the above example, the beam indices are:

- Rx beam index (rxBeamIdx): 39
- Tx beam index (txBeamIdx): 39

Using the above lookup table, you can see that beam index 39 means that the boresight is +28° horizontally and +10° vertically off-center. To compensate for the offset, the Terminal Unit should be rotated 28° horizontally in the negative (counter-clockwise) direction and 10° downwards.



Following the adjustment, the beam index should be 30, indicating that the Terminal Unit has been optimally oriented – with 0° offset, horizontally and vertically.

General guidelines for proper alignment of MultiHaul TG device:

- If the horizontal offset is positive (+x°) – rotate the unit counterclockwise.
  If the horizontal offset is negative (-x°) – rotate the unit clockwise.
- If the vertical offset is positive (+x°) – tilt the unit down.
  If the vertical offset is negative (-x°) – tilt the unit up.

Beams are optimized when the radio link is first established. Optimization will not reoccur if you rotate the device while radio link is up, and the beam index will *not* change. You should disrupt the link after adjusting the orientation of the TU (for example by blocking line of sight), so that the

device will re-generate the beams – and update the beam index – when the radio link is re-established. You can read the updated beam index at this point.

Multi-Link Example

The following is an example of a node with two active links.

To obtain the MAC address of the remote radio units, use the `show radio-common links active` command.

```
MH-N366@n366-110>show radio-common links active
radio-common {
    links {
        active {
            remote-assigned-name n366-106;
            actual-remote-sector-index 1;
            actual-local-sector-index 1;
            remote-mac-addr 42:d4:86:e0:e4:d0;
            local-role initiator;
            rssi -56;
            snr 17;
            mcs-rx 10;
            mcs-tx 9;
            tx-per 0.00;
            rx-per 0.00;
            tx-power-index 6;
            speed-rx 2500;
            speed-tx 2050;
            counters {
…
…
            }
        }
        active {
            remote-assigned-name n366-107;
            actual-remote-sector-index 2;
            actual-local-sector-index 2;
            remote-mac-addr 46:54:55:4c:d4:2d;
            local-role initiator;
            rssi -40;
            snr 32;
            mcs-rx 9;
            mcs-tx 10;
            tx-per 0.00;
            rx-per 0.00;
            tx-power-index 6;
            speed-rx 2050;
            speed-tx 2500;
            counters {
…
…
            }
        }
    }
}
MH-N366@n366-110>
```

In the above example, there are two active links:

- Link to remote radio with name n366-106 and MAC address 42:d4:86:e0:e4:d0
- Link to remote radio with name n366-107 and MAC address 46:54:55:4c:d4:2d

Now, read the orientation of each radio link:

```
MH-N366@n366-110>debug radio stats
   …
   17999998640, tgf.42:d4:86:e0:e4:d0.phyPeriodic.pktLqm, 123, 42:d4:86:e0:e4:d0
   17999998640, tgf.42:d4:86:e0:e4:d0.phyPeriodic.pktRssi, -43, 42:d4:86:e0:e4:d0
   17999998640, tgf.42:d4:86:e0:e4:d0.phyPeriodic.rxBeamIdx, 28, 42:d4:86:e0:e4:d0
   17999998640, tgf.42:d4:86:e0:e4:d0.phyPeriodic.rxRficBitmap, 0, 42:d4:86:e0:e4:d0
   17999998640, tgf.42:d4:86:e0:e4:d0.phyPeriodic.tsf, 17999998640, 42:d4:86:e0:e4:d0
   17999998640, tgf.42:d4:86:e0:e4:d0.phyPeriodic.txBeamIdx, 28, 42:d4:86:e0:e4:d0
   17999998640, tgf.42:d4:86:e0:e4:d0.phyPeriodic.txRficBitmap, 0, 42:d4:86:e0:e4:d0
   18227998628, tgf.42:d4:86:e0:e4:d0.phystatus.dbg16, 0, 42:d4:86:e0:e4:d0
   18227998628, tgf.42:d4:86:e0:e4:d0.phystatus.gainIndexIf, 26, 42:d4:86:e0:e4:d0
   18227998628, tgf.42:d4:86:e0:e4:d0.phystatus.gainIndexRf, 1, 42:d4:86:e0:e4:d0
   …
   17999998638, tgf.46:54:55:4c:d4:2d.phyPeriodic.pktLqm, 121, 46:54:55:4c:d4:2d
   17999998638, tgf.46:54:55:4c:d4:2d.phyPeriodic.pktRssi, -43, 46:54:55:4c:d4:2d
   17999998638, tgf.46:54:55:4c:d4:2d.phyPeriodic.rxBeamIdx, 12, 46:54:55:4c:d4:2d
   17999998638, tgf.46:54:55:4c:d4:2d.phyPeriodic.rxRficBitmap, 0, 46:54:55:4c:d4:2d
   17999998638, tgf.46:54:55:4c:d4:2d.phyPeriodic.tsf, 17999998638, 46:54:55:4c:d4:2d
   17999998638, tgf.46:54:55:4c:d4:2d.phyPeriodic.txBeamIdx, 12, 46:54:55:4c:d4:2d
   17999998638, tgf.46:54:55:4c:d4:2d.phyPeriodic.txRficBitmap, 0, 46:54:55:4c:d4:2d
   18224998617, tgf.46:54:55:4c:d4:2d.phystatus.dbg16, 0, 46:54:55:4c:d4:2d
   18224998617, tgf.46:54:55:4c:d4:2d.phystatus.gainIndexIf, 10, 46:54:55:4c:d4:2d
   18224998617, tgf.46:54:55:4c:d4:2d.phystatus.gainIndexRf, 1, 46:54:55:4c:d4:2d
…
```

The link to n366-106 (42:d4:86:e0:e4:d0) has the following orientation:

- Rx beam index (rxBeamIdx): 28
- Tx beam index (txBeamIdx): 28

In the lookup table above, beam index 28 indicates that means that the boresight is -8° horizontally and 0° vertically off center.

The link to n366-107 (46:54:55:4c:d4:2d) has the following orientation

- Rx beam index (rxBeamIdx): 12
- Tx beam index (txBeamIdx): 12

In the lookup table above, beam index 12 indicates that means that the boresight is +36° horizontally and -10° vertically off center.

8.4 Check Traffic Through the Unit

Validate that there is traffic passing through the Ethernet bridge. It is easier to confirm traffic after the running counters are zeroed.

```
MH-N366@popn110>clear interfaces
MH-N366@popn110>show interfaces rf-interface rf-panks rf-tower-107
rf-interface {
    name rf-panks;
    state {
          counters {
             rx-ok 4731468;
             tx-ok 413141;
             tx-fail 647;
             rx-fail 3126;
             rx-hcs-fail 23065;
             tx-drop-lifetime-exp 0;
             rx-drop-buf-size 0;
             rx-drop-encryption-fail 0;
             rx-drop-ra-mismatch 0;
             rx-drop-unexpected 0;
          }
    }
    name rf-tower-107;
    state {
          counters {
             rx-ok 58448;
             tx-ok 60859;
             tx-fail 0;
             rx-fail 0;
             rx-hcs-fail 0;
             tx-drop-lifetime-exp 0;
             rx-drop-buf-size 0;
             rx-drop-encryption-fail 0;
             rx-drop-ra-mismatch 0;
             rx-drop-unexpected 0;
          }
    }
}
MH-N366@popn110>
```

8.5 Check Ethernet Ports

The following command shows the operational status (oper-status) and counters for each ethernet port. You should check: oper-status (up), actual-duplex-mode (full), actual-port-speed (10 or 1 Gbps).

```
MH-N366@popn110>show interfaces ports
ports {
    name eth1;
    admin-status up;
    copper-specific-config {
        auto-negotiate true;
    }
    state {
        oper-status up;
        actual-duplex-mode full;
        actual-port-speed 1Gbps;
        counters {
            in-octets 103219046;
            in-pkts 921329;
            in-discards 0;
            in-errors 0;
            in-no-rule-discards 16306;
            out-octets 157664172;
            out-pkts 830753;
            out-discards 0;
            out-errors 0;
        }
    }

<some lines omitted>

ports {
    name eth3;
    admin-status down;
    copper-specific-config {
        auto-negotiate true;
    }
    state {
        oper-status down;
        counters {
            in-octets 0;
            in-pkts 0;
            in-discards 0;
            in-errors 0;
            in-no-rule-discards 0;
            out-octets 0;
            out-pkts 0;
            out-discards 0;
            out-errors 0;
        }
    }
}
MH-N366@popn110>
```

8.6 Check IP Connectivity

The ping command is used to confirm IP connectivity between the node and another entity with an IP address.

```
MH-N366@POPN124>ping 31.168.34.110
PING 31.168.34.110 56 bytes of data.
56 bytes from 31.168.34.110: icmp_seq=1 time=0.38 ms
56 bytes from 31.168.34.110: icmp_seq=2 time=0.34 ms
56 bytes from 31.168.34.110: icmp_seq=3 time=0.622 ms
56 bytes from 31.168.34.110: icmp_seq=4 time=0.779 ms
56 bytes from 31.168.34.110: icmp_seq=5 time=0.749 ms
--- 31.168.34.110 ping statistics ---
5 packets transmitted, 5 received, 0% packet loss
rtt min/avg/max = 0.34/0.574/0.779 ms
```

9 Troubleshooting the System

9.1 Error Conditions

This section provides troubleshooting guidelines for the MultiHaul™ TG system. The potential error conditions are listed in the table below, with the possible causes and solutions. The investigation steps / commands are detailed in the following sections.

Error condition	Possible Cause(s)	Solution(s)
Unit is not working; Power LED is off	No power	Check the power source and the connection from the power source to eth1 port.
	HW fault	Replace the unit.
GPS is not locked to the GPS network Refer to section 9.2.	GPS signal is blocked.	Make sure that GPS at top of node has LOS to the sky.
	Unit fell.	Check that unit is upright.
No RF connection, Link is down	Unit name is misconfigured.	Check the `name` of the remote unit, and confirm it is the same as the `remote-assigned-name` configured for this link in the local unit, as shown in section 9.3.
	Radio credentials do not match.	Confirm the `default-ssid-profile` of the local and remote units do match, as shown in section 9.4.
	Link or sector are admin-down.	Check `admin-status` is `up` for both the sectors and links in the local and the remote units as shown in section 9.5.
	No inbound link is up (N366 does not initiate links when no inbound link is up, except for the POP node).	Check that there is a link with `local-role responder` in the list of `active` links, as shown in section 9.6. If the node is a POP node, check that `is-pop-dn` is `true`, as shown in section 9.7.
	GPS is not locked.	Check the status of the GPS as shown in section 9.2, and proceed to the error condition in this table if GPS is not locked.

9.2 GPS Check

The `fix-mode` of the GPS must be `3D` in the output of the `show system` for a node.

```
MH-N366@popn110>show system
system {
    name popn110;
    state {
        product MH-N366;
        date-and-time 2021-01-07 19:40:32;
        uptime 0022:03:44:48;
        banks-info {
            banks {
                number 0;
                software-version "1.0.0-1585-70ce9231";
                status active;
                scheduled-to-switch idle;
            }
            banks {
                number 1;
                software-version "1.0.0-1555-915dd2db";
                status passive;
                scheduled-to-switch idle;
            }
        }
        sw-upgrade-info {
            download-and-burning-state not-started;
        }
       gps {
         fix-mode 3D;
         fix-satellites-number 8;
        }
    }
}
MH-N366@popn110>
```

9.3 Assigned Name Checks

The own system name of the remote unit can be seen as you log into the remote unit, in the characters to the right of the @ character in the prompt of the CLI, for example `panks` below, and the correction to `panks`, which must be followed by `commit`, saving the configuration and `reboot` of the system to come into effect.

```
MH-T265@panks>set system name panks
MH-T265@panks>commit
MH-T265@panks>copy running startup
MH-T265@panks>reboot system
```

The same name must be used as the `remote-assigned-name` of the radio link in the configuration of the local unit.

```
MH-N366@popn110>show radio-dn links configured
configured {
    remote-assigned-name n366-106;
    remote-sector {
        index 1;
    }
    local-sector {
        index 1;
    }
    control-superframe 0;
    responder-node-type dn;
    admin-status up;
}
configured {
    remote-assigned-name n366-107;
    remote-sector {
        index 2;
    }
    local-sector {
        index 2;
    }
    control-superframe 0;
    responder-node-type dn;
    admin-status up;
MH-N366@popn110>
```

9.4 Radio Credentials Checks

You must check that the `ssid-profile` is configured in the same way on both units.

```
MH-N366@popn110>show radio-common node-config default-ssid-profile
default-ssid-profile {
      name MultiHaul;
      password MultiHaul;
}
MH-N366@popn110>
```

9.5 Admin Status Checks

You must check that the `admin-status` is `up` for the sectors on both sides of the links, and for the link in the node initiating the link.

9.5.1 Check Sectors Admin Status

You must perform this command (`sectors-config` in `radio-common`) on the node and on the TU, or on the 2 nodes, depending on the type of the link.

```
MH-N366@popn110>show radio-common sectors-config
sectors-config {
    sector {
        index 1;
        admin-status up;
        state {
            mac-addr 36:d8:e9:a0:eb:80;
            temperatures {
     <some rows omitted>
}
MH-N366@popn110>
```

9.5.2 Check Link Admin Status

You must perform this command (`links configured` in `radio-dn`) on the node responsible to initiate the link.

```
MH-N366@popn110>show radio-dn links configured
configured {
    remote-assigned-name panks;
    remote-sector {
        index 2;
    }
    local-sector {
        index 1;
    }
    control-superframe unspecified;
    responder-node-type cn;
    admin-status up;
 <some rows omitted>
}
MH-N366@popn110>
```

9.6 Active Links Checks

There must be an active link with `local-role responder` in the list of active links.

```
MH-N366@tower-102>show radio-common links active
links {
    active {
         remote-assigned-name tower-107;
         actual-remote-sector-index 2;
         actual-local-sector-index 2;
         remote-mac-addr 02:71:c0:8b:7d:a5;
         local-role responder;
         rssi -48;
         snr 25;
         mcs-rx 9;
         mcs-tx 9;
         tx-per 0.00;
         rx-per 0.00;
         tx-power-index 6;
         speed-rx 2050;
         speed-tx 2050;
         counters {
             rx-ok 58448;
             tx-ok 60859;
             tx-fail 0;
             rx-fail 0;
             rx-hcs-fail 0;
             tx-drop-lifetime-exp 0;
             rx-drop-buf-size 0;
             rx-drop-encryption-fail 0;
             rx-drop-ra-mismatch 0;
             rx-drop-unexpected 0;
         }
     }
 <some rows omitted>
}
MH-N366@popn110>
```

9.7 POP Node Check

If the node is the POP node in the network, check `node-config` in `radio-dn` and confirm that `is-pop-dn` is `true`. Change to `true` if needed.

```
MH-N366@popn110>show radio-dn node-config
radio-dn {
    node-config {
        default-radio-profile {
            polarity even;
            frequency 60480;
            tx-golay-index 1;
            rx-golay-index 1;
        }
        is-pop-dn true;
    }
}
MH-N366@popn110>
```

-- end –