PC-400i

User Manual

Release 1.3

March 2025

Revision History

DATE	RELEASE	ISSUE	REASON FOR RELEASE
August 2024	1.0	240823	First release
October 2024	1.1	241024	Minor updates
October 2024	1.2	241025	Updated FCC statement
March 2025	1.3	250310	Additional FCC Notice updates

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1. About This Guide

This manual serves as a guide for configuring and monitoring BLiNQ's PC-400i using NetLiNQ EMS

The sections are laid out according to the navigational menu on EMS User interface (UI).

1.1. Manual Conventions

This document uses the following conventions:

- **Bold** words indicate actual page names, fields or buttons within the software. It may also be words that need to be emphasized.
- **Bold and Underlined items** indicate items that need additional attention.
- References to related documentation or a site location are shown in *italic* text.
- Commands typed at a console are shown in a `blue monospaced` font.
- The following icons are used to indicate the level of attention that are needed:
- This icon indicates crucial information. Failure to observe the information may result in installation failure or error.
- This icon indicates important information that needs to be observed.

1.2. Equipment Compliance

Federal Communications Commission (FCC) Notices

This device is subject to following restrictions:

(1) Operation of this device is restricted to indoor use only

(2) The device is prohibited from being operated on oil platforms, cars, trains, boats, and aircraft

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions:

(1) This device may not cause harmful interference, and

(2) This device must accept any interference received, including interference that may cause undesired operation.

CAUTION: This equipment complies with FCC radiation exposure limits set forth for an uncontrolled environment. This equipment should be installed and operated with a minimum distance of 41cm between the radiator & your body.

CAUTION: Any changes or modifications not expressly approved by BLiNQ Networks could void the user's authority to operate this equipment.

2. Specifications

RADIO SPECIFICATIONS	
3GPP Compliance	3GPP Rel. 16
5G Frequency Bands	3.3-4.2 GHz (n48/n77/n78)
5G RF	4T4R, MU-MIMO
5G Max. Tx Power Per Port	23 dBm
5G Antenna Peak Gain	7 dBi
5G IBW/OBW	200/100 MHz (200/200 MHz Optional)
5G Channel BW	10, 20, 30, 40, 60, 100 MHz
Dual RAT	5G/LTE option
PERFORMANCE AND ATTRIBUTES	
5GNR Radio Standard Support / Quality of Service	5GNR / 3GPP Compliance
5GNR Duplex Mode	TDD
Frame Structure (5ms)	DDDSUUDDDD, DDSSUUDDDD, DDDSUUUUDD
5G Number of Component Carriers (CC)	Up to 4CC
Max. Modulation	DL: 256 QAM / UL:64 QAM
Aggregated Throughput	5GNR: 3 Gbps
Power Consumption	65 W
Synchronization	1588v2 and SyncE
5G Citizens Broadband Radio Service (CBRS)	CBSD Cat. A
Embedded UPF	Optional Hardware SKU

ELECTRICAL AND INTERFACES	
Physical Interfaces	10G Ethernet with PoE & 10G SFP+
Power	PoE (IEEE 802.3bt)
SOFTWARE	
Management Protocols	O-RAN based (NETCONF, WebSocket, REST/HTTPS), TR-069, TR-369
Network	IPv4, IPv6, IPsec, WireGuard, VLANs, MOCN
Core Connectivity	5G Standalone (SA) Optional: 5G Non-Standalone (NSA); 4G LTE
Encryption	AES, CCMP, TKIP
Configuration	Zero-Touch Provisioning (via EMS), CLI
Management Protocols	O-RAN based (NETCONF, WebSocket, REST/HTTPS), TR-069, TR-369
MECHANICAL	
Dimensions (L x W x D)	10.8” x 10.8” x 4.0” (275 x 275 x 101 mm)
Weight	8.27 lbs (3.75 kg)
Operational Temperature	32 °F to 140 °F (0 °C to 50 °C)

3. Getting Started with the PC-400i

3.1. Preparation on NetLiNQ EMS

Prior to gNB installations, it is **crucial** to set up the following items on the EMS:

- Organization Information
  - To onboard the gNBs, you would need to add an **Organization** on the EMS. Input the name, address, SAS information, users to be linked to the organization, networks that will be under this organization and the sites of deployment within this organization.
- Configuration
- Once the organization has been added, go to *Organization* > *Overview* and click onto the newly added organization to see its dashboard. Click on **Configuration** from the left navigation bar.
  - To onbaord a group of gNBs with the same configurations, a **Config Template** needs to be set up. Please add a **Config Template** by going to *Configuration* > *Template*.
- When the desired template has been set up, go to *Configuration* > *Devices* to add the gNBs that are set for deployment. Devices can be added by importing a .csv file with their Name, Serial Number, Model, Software Version, and the desired Template onto the EMS.
- Devices can also be added one at a time.
- When all the information is entered onto the EMS, you can proceed to install the gNBs.

3.2. Pre-Requisites for NetLiNQ EMS Onboarding

These are the pre-requisites for a successful onboarding the gNBs onto NetLiNQ EMS:

- A DHCP server is available and contains EMS host information.
- A DNS server.

3.3. gNB Installation

PC-400i installation should be performed by trained personnel, adhering to the applicable local, regional, and national regulatory requirements.

Instructions for a proper installation of the PC-400i can be found on the *Quick Installation Guide* that came with the device package. Please refer to it for installation process.

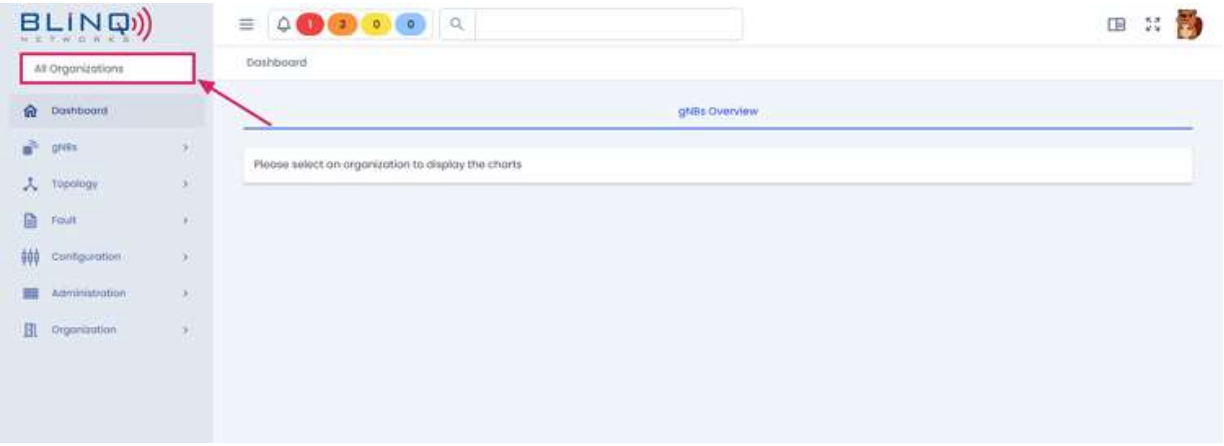
Additional items required:

- A Cat6A or higher RJ45 cable to power up the PC-400i after installation.
- An LED light should come on. It will turn green once the unit is connected and operational.

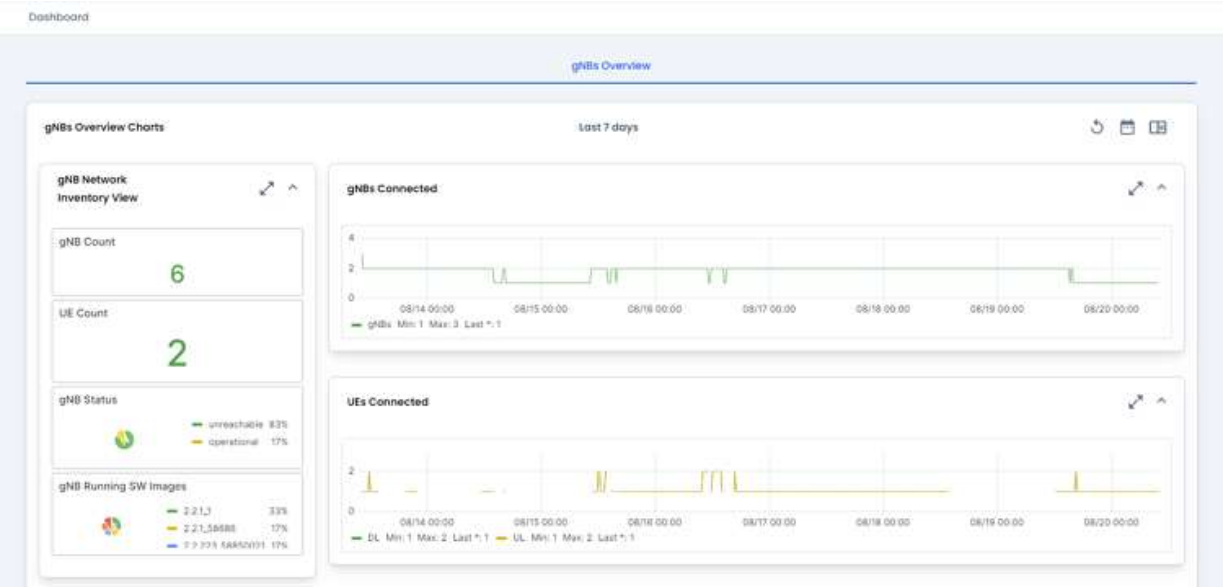
The device should be visible on NetLiNQ EMS within minutes.

4. NetLiNQ EMS Overview

Upon logging in, you will be brought to a dashboard. This dashboard will be empty until an organization has been selected from the left navigational menu.



The charts will start loading with the overview of the gNBs associated with that organization.



This dashboard shows the statistics of the gNBs (gNB count, gNBs Connected) as well as throughput and noise.

One can:

- Expand a chart to full width by clicking on the expand chart button.
- Set a specific date/time range to chart by clicking the calendar button.
- Collapse the chart by clicking on the collapse button.
- Click the help button to get a short help text.
- Sort the avg/current stats, select an individual gNB by system name to show.
- Select an gNB name and search for it in the search bar to get more details

4.1. gNB Overview Charts

There are 9 charts/groups on the main dashboard. Please see below for more information about each chart or groups.

gNB Network Inventory View

Under the gNB Network Inventory View, you can find:

- The current total count of gNBs known to the EMS in this organization.
- The breakdown of gNB counts by status; **operational** or **communication failure**.
- The breakdown of gNB counts by its running software images.

Here are the different charts explained:

gNBs Connected: This chart shows the number of gNBs connected to the EMS vs time.

UEs Connected: This chart shows the number of UEs connected vs time.

gNBs Aggregate Throughput: This chart shows gNBs aggregate throughput vs time.

gNBs with Highest Number of UEs Connected: The gNBs with the highest number of UEs connected over time.

gNBs with Highest Aggregate DL Throughput: This chart shows the gNBs with the highest aggregate downlink throughput vs time.

gNBs with Highest Aggregate UL Throughput: This chart shows the gNBs with the highest aggregate uplink throughput vs time.

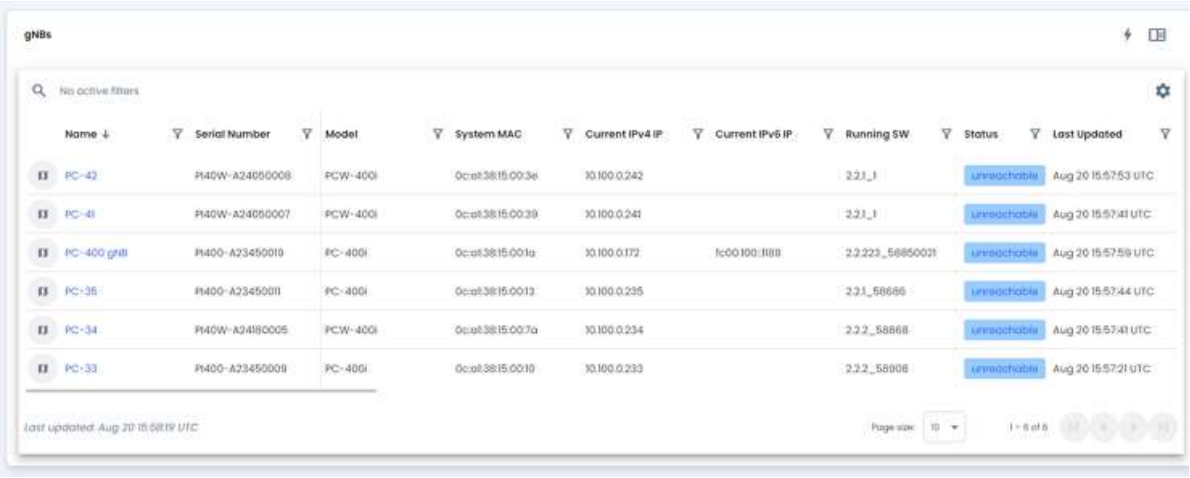
gNBs with Highest DL PRBs Utilization: This chart shows the gNBs with the highest utilization of over the air data usage in the downlink direction, in units called Physical Resource Blocks (PRBs).

gNBs with Highest UL PRBs Utilization: This chart shows the gNBs with the highest utilization of over the air data usage in the uplink direction in PRBs.

5. gNBs

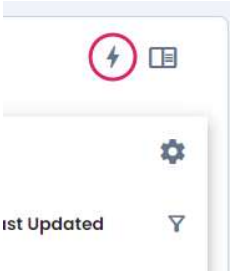
Clicking onto the **Overview** link will show you an overview of all the gNBs connected on the selected organization. Each gNBs along with its **Name**, **Serial Number**, **Model**, when it was **Last Updated**, its current operational **Status**, the IPv4 and IPv6 addresses, and its software version will be shown in a table view.

These columns can be customized according to preferences.

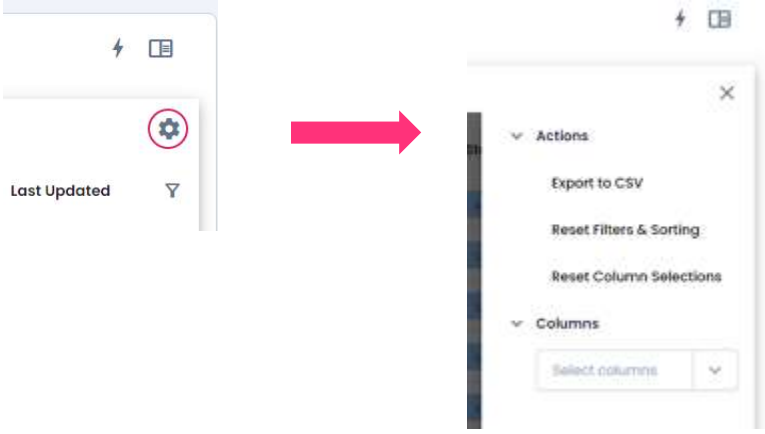


Overview page explained:

- **Lightning Icon** – Click on this icon to refresh the table immediately.



- **Settings Wheel** – Clicking on this icon will open a drop-down menu with the following options.

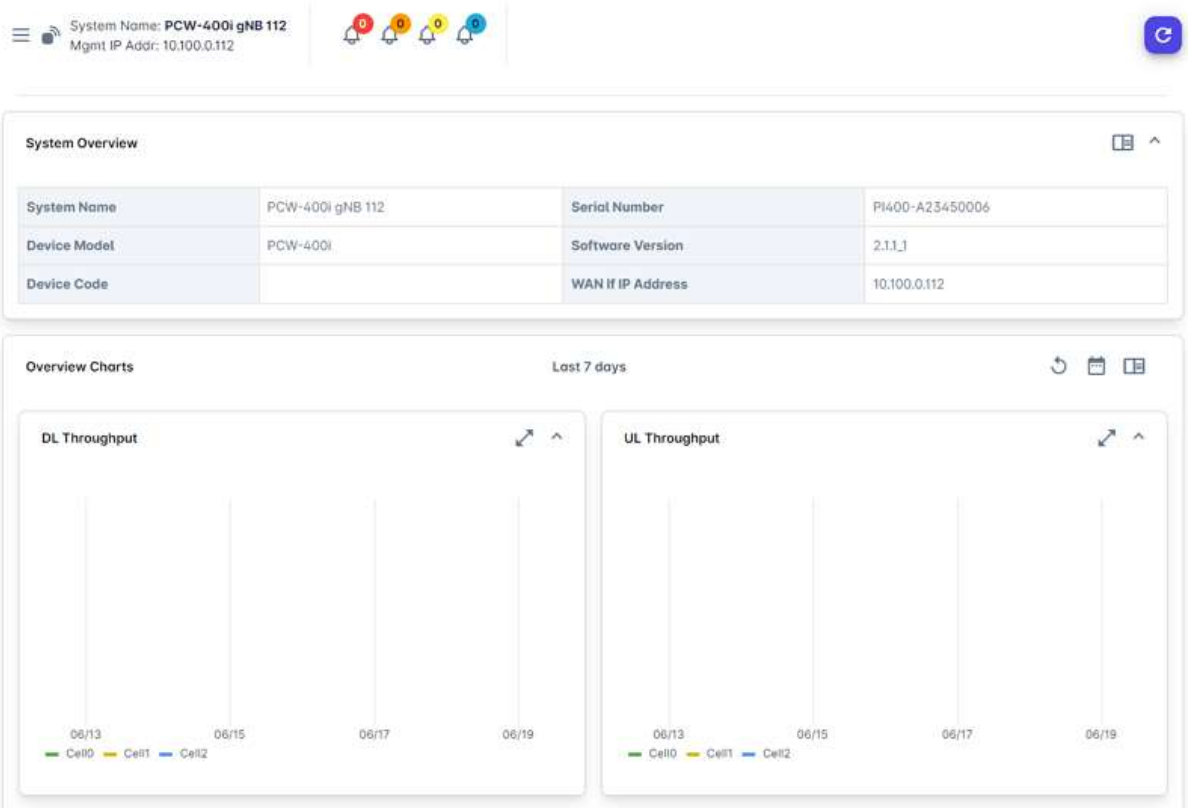


- **Export to CSV**: Export the list of devices with the specific columns into a .csv file.

- **Reset Filters & Sorting**: Filters and Sorting applied to the whole table will reset to their defaults.
- **Reset Column Selections**: Table columns shown will revert back to its defaults.

5.1. gNB Dashboard Overview

Upon clicking on any of the gNBs in the network, you will be brought to an overview page of the selected gNB.



Top Bar

The top bar of this gNB page shows the:

1. Device's System Name and Management IP Address
2. Current active alarms raised by the device

System Overview

A non-editable section that shows the System Name, Device Model, Device Code, Serial Number, Software Version, and WAN Address.

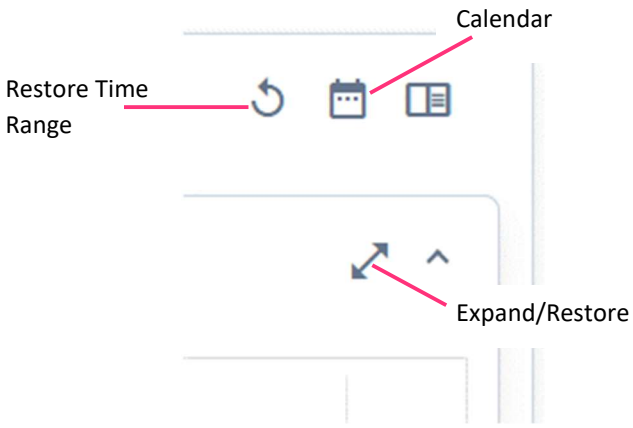
Overview Charts

This section gives a visual overview of the gNB's performance over time.

- **DL Throughput**: A real-time chart of the DL Throughput.
- **UL Throughput**: A real-time chart of the UL Throughput.
- **DL UE Count**: Number of UEs using DL.
- **UL UE Count**: Number of UEs using UL.

Chart Navigation

This section gives a visual overview of the gNB's performance over time. Navigate and adjust the chart view by using these functions below.



- **Calendar**: Specify the desired time range.
- **Restore Time Range**: Sets charts to the global time range (Text in the middle of the charts container). When any chart is zoomed in by selecting a range in the chart with the mouse, use the restore button to go back to the set global time range.
- **Expand/Restore**: Expand the chart to full screen and restore back to its original size.

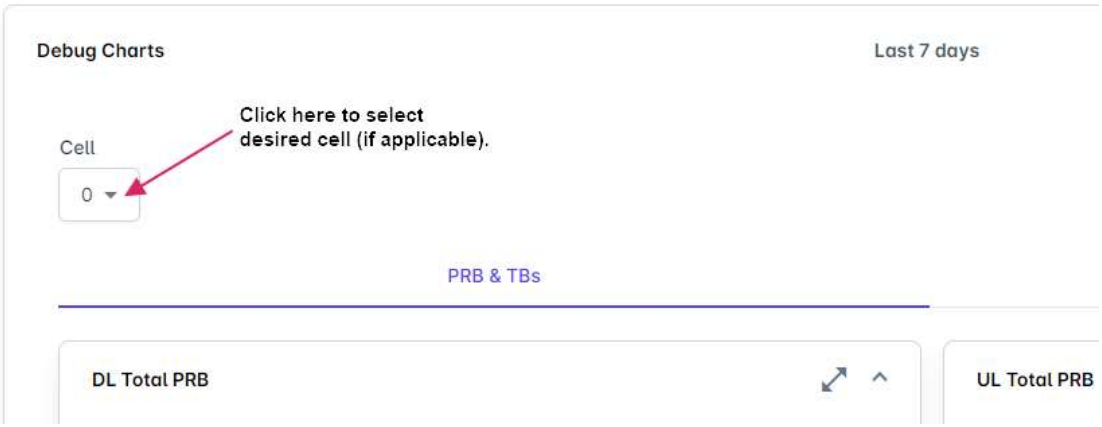
5.2. gNB Debug

There are 2 tabs in the page that can be used to view different KPI charts of the selected device.

The first tab contains downlink and uplink PRB charts as well as downlink and uplink TBs (Transport Blocks) charts.

When TCP throughput fluctuates due to congestion in network, it causes TCP server to pump less traffic. The past congestion in the network affects the current throughput. Therefore, it can be difficult to track down the issue that happened in the past. The data collected from these charts here could prove to be useful in debugging the issue and improve the performance of the device.

5.2.1. PRBs & TBs



After selecting the desired cell (when applicable) from the dropdown menu, you will be able to see the total cell PRB usage for downlink and uplink from the first 2 charts respectively.

The other 2 charts display the total downlink and uplink transport blocks, including the number of TBs with errors attached to the data. The transport block CRC (cyclic redundancy check) attachment in 5G PDSCH channel processing is a step that allows the UE to detect errors in the received transport block, ensuring reliable data transmission over the wireless channel.

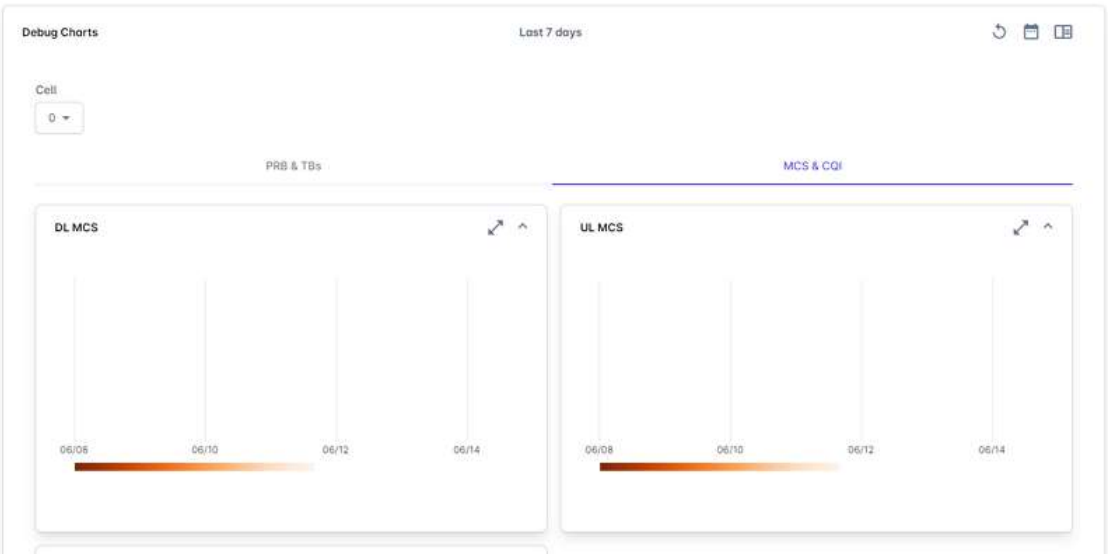
5.2.2. MCS & CQI

MCS (Modulation and Coding Scheme) depends on radio signal quality in wireless link. The better radio signal quality will result in higher MCS and more useful bits can be transmitted within a symbol, while a bad signal quality will result in lower MCS where less useful data can be transmitted within a symbol.

The DL MCS heat map shows UE downlink MCS heat mapped versus time. The heat density indicates how many UEs have an MCS reading for each MCS value in the time interval. Each box represents a one hour increment of time and the color density of the box represents the number of MCS readings across all UEs in the sector that fell into the specific MCS value.

The UL MCS heat map shows UE uplink MCS heat mapped versus time. The heat density indicates how many UEs have an MCS reading for each MCS value in the time interval. Each box represents a one hour increment of time and the color density of the box represents the number of MCS readings across all UEs on the sector that fell into the specific MCS value.

CQI is an indicator of channel quality. The CQI value is a scalar in the range [0, 15]. The CQI value provides information about the highest modulation scheme and the code rate (MCS) suitable for the downlink transmission to achieve the required block error rate (BLER) for given channel conditions.



5.3. System

This read-only page displays the system information for the selected device. To modify the configurations, please modify it under *Organization > Devices* or update the **Configuration Template** associated with this device.

System Settings

- **Name:** A descriptive name for the selected device. This parameter can be configured or edited under Organization > Configuration > Devices.
- **Description:** This is an optional field where you can assign more identifying infor-mation for the device, like "Located on 2nd floor by the North exit".
- **Time Zone**: The time zone where the device is located.
- **Clock Source:** Clock source that will be used for synchronization - PTP SyncE, PTP, Freerun or GPS. Please note that GPS is not applicable for indoor units.

Interfaces

This section displays the different interfaces and their respective information for the device.

- **IPv4 Config:** This column displays the IPv4 configuration of the device - whether it is in Static or DHCP mode, as well as its IPv4 assigned address.
- **IPv6 Config:** If IPv6 is enabled, then this column will display its IPv6 configuration - whether it is in Static or DHCP mode, as well as its IPv6 assigned address. Please do not use Static mode for IPv6 configuration when using any SW 2.1 official releases.
- **Metrics:** This column displays the metrics assigned to each IP route (if applicable).

IPv4 Static Routes

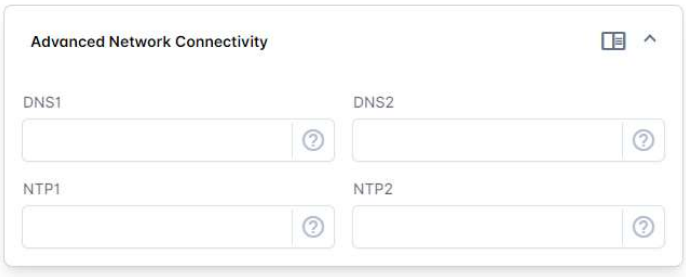
- **Destination:** This column displays the configured IPv4 destination.
- **Next Hop:** The next hop IP address on the route.
- **Interface:** The interface used for this route.
- **Metric:** The cost of this hop.

IPv6 Static Routes

- **Destination:** This column displays the configured IPv6 destination.
- **Next Hop:** The next hop IP address on the route.
- **Interface:** The interface used for this route.
- **Metric:** The cost of this hop.

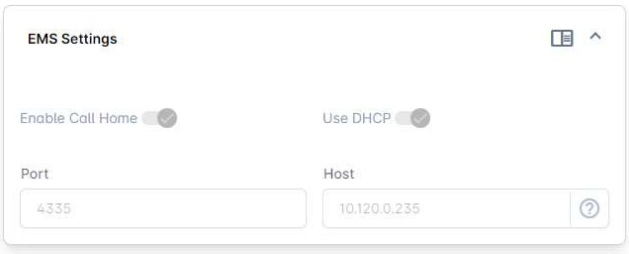
5.3.1. Advanced Options

Advanced Network Connectivity



This section displays the addresses for primary (**DNS1**) and secondary (**DNS2**) DNS servers as well as the NTP (Network Time Protocol) servers. IPv4 addresses should be used for DNS servers while both IPv4 or IPv6 addresses can be used for NTP servers.

EMS Settings



When **Enable Call Home** is toggled On, the gNB to will use NetConf Call Home to connect to NetLiNQ EMS.

Call Home feature can be used via DHCP to obtain EMS address or statically configure EMS host and port by turning **Use DHCP** off. By default, **Use DHCP** is toggled On.

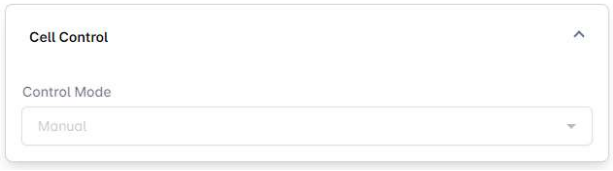
Spectrum Controller

This section displays the Spectrum Controller's **Host** address and its assigned **Port.**

5.4. Carriers

This read-only page displays the carrier(s) information for the selected device. To modify the configurations, please modify it under *Organization > Devices* or update the **Configuration Template** associated with this device.

Cell Control



The Cell Control mode can be modified using a configuration template (*Organization > Configuration > Templates*). There are 3 different modes of operation for the cell:

- **Manual:** Standalone, without the CBSD Agent or Spectrum Controller.
- **Spectrum-Controller:** Operation is controlled by a deployed Spectrum Controller.
- **Standalone-CBSD:** Operation is controlled by a SAS Database using the CBSD Agent.

Cell Parameters

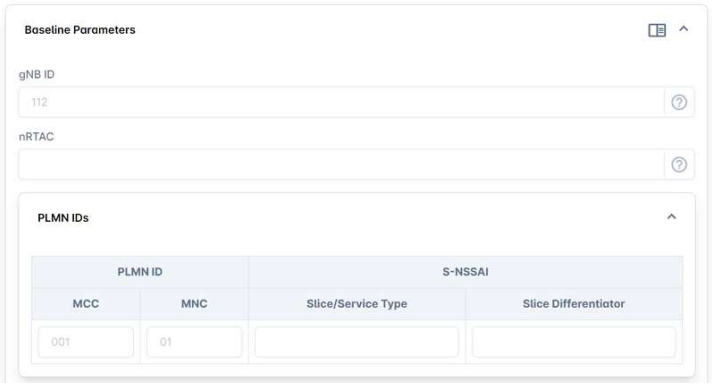
This section displays the current cell values for the selected device. Changes can be made via configuration templates (*Organization > Configuration > Templates*)

- **Channel Size:** PC-400i supports the following bandwidths - 10 MHz, 20 MHz, 40 MHz, 60 MHz and 100 MHz.
- **Frequency:** The configured value should be in kHz and within the range of 3300000 to 4200000.
- **Tx Power:** Transmit power is measured in dBm and can be set within the range of -5dBm to 23dBm.
- **nRPCI:** This is the PCI value of the cell. The PCI in 5G is a 24-bit value (ranging from 0 to 1007) and serves to provide a unique identifier for each cell in the network.

Cell Advanced Parameters

The **P-max Value** is the maximum power in dBm for the UE to transmit. Please set value between -30 to 33 dBm.

5.5. 5G Baseline



This *5G Baseline* read-only page displays the basic attributes of the device.

Once again, most of these parameters can be configured or edited under by using a configuration template (*Organization > Configuration > Templates*).

Here you can view the:

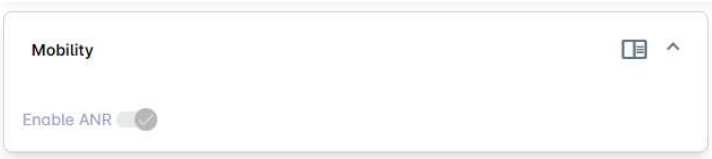
- **gNB ID**: This number is used to identify the gNB within a PLMN (Public Land Mobile Network Identifier). The gNB ID is contained within the NCI (New Radio Cell Identity) of its cells.
- **nRTAC**: The New Radio Tracking Area Code helps to identify the tracking area within the PLMN.
- **PLMN IDs**: In this sub-section, you can view the PLMN ID(s) and S-NSSAI (Single-Network Slice Selection Assistance Information) details.

The PLMN ID defines the network and consists of a 3 digit MCC (mobile country code) and a 2 (or 3)-digit MNC (mobile network code), thus PLMN ID = MCC + MNC. This value must match the PLMN ID configured in the 5G Core (5GC).

The S-NSSAI, used in uniquesly identifying a network slice, contains 2 components: the Slice/Service Type and an optional Slice Differentiator. - **Slice/Service Type**: SST has 8 bit field length implying that it can indicate a total of 255 different slice types. This will define the expected behaviour of the Network Slice in terms of specific features and services. - **Slice Differentiator**: This is an optional information that complements the SST and is used as an additional diffentiator if the multiple Network Slices carry the same SST value.

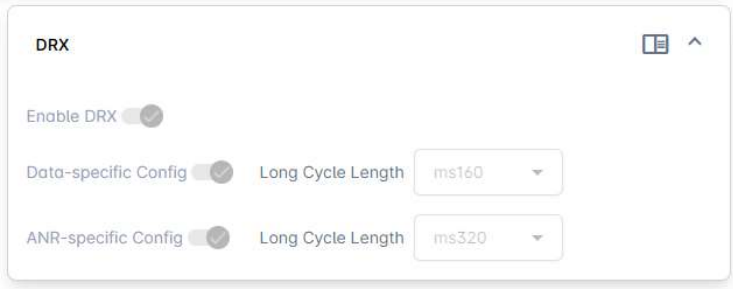
- **NG-C** (NG Control-Plane Interface): This is the interface between an AMF (Access and Mobility Management Function) and the gNodeB. If the NG-C is connected remotely, please ensure that its IPv4/IPv6 address is correct. If it is connected locally, the **VLAN** toggle button should be "**On**".
- **NG-U** (NG User-Plane Interface): This is the interface between a user plane function (the data plane in the 5GC) and gNodeB and can provide a non-guaranteed data transmission service. If the NG-U is connected remotely, please ensure that its IPv4/IPv6 address is correct. If it is connected locally, the **VLAN** toggle button should be "**On**".

Mobility



This section simply shows you if ANR (Automatic Neighbor Relations) is enabled on the device.

DRX



DRX (Discontinuous Reception) is a mechanism in which the UE checks for incoming downlink traffic intermittently. When DRX is enabled, the UE will be "ON" every cycle, according to the value that is configured and check for data. A Long DRX Cycle is consists of an ON period and an OFF period. The ON period is defined in terms of milliseconds (ms). This is the period in which the UE would stay awake and decode PDCCH. If the long cycle is set at 320 ms, then it will repeat itself in cycles of 320 ms.

By default, 10ms is the set time for the UE to communicate with the existing gNB to receive pending data (i.e. the "ON" period).

- **Data-specific Config**: The cycle which the UE has both the ON and OFF period. This is used when ANR is not enabled.
- **ANR-specific Config**: The time allocated for the UE to scan for neighbors. ANR (under *Mobility*) needs to be enabled too for this function to work. Instead of going to "sleep", the UE will scan for neighbors during the "sleep" cycle.

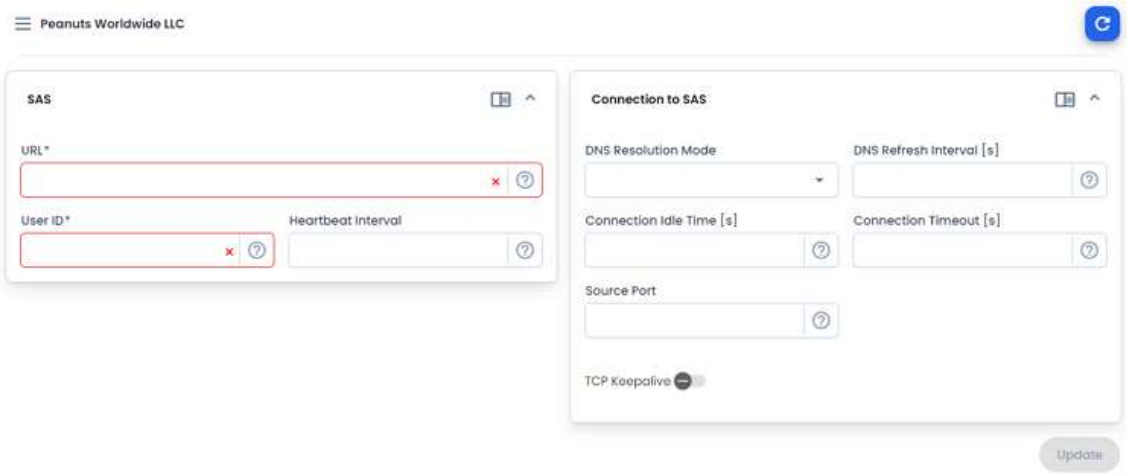
5.5.1. Advanced Options

- **UE Inactivity Timer:** When a UE is inactive for the time period that is stated here, the 5G Small Cell will initiate procedures to place the UE in idle mode.
- **TDD Frame Config:** This defines the uplink and downlink configuration for the network. Right now, BLiNQ's devices supports 3 frame structures: DDDSUUDDDD / DDSSUUDDDD / DDDSUUUUDD.
- **TDD Timing Offset:** TDD frame timing offset with respect to 1pps, in microseconds. Due to the time-sensitive nature in which networks send TDD data, phase (time) synchronization is required to meet tight frame-start specifications and avoid unwanted interference between neighboring small cells and UE.

5.6. CBRS

This CBRS page is only accessible when **Cell Control** mode is set to **standalone-cbsd**.

When SAS (Spectrum Access System) is enabled, this section will display the SAS database server URL and the User ID of the CBSD user.



The **Heartbeat Interval** feature allows users to define the preferred interval value which may be adopted by gNB depending on the reference interval value from SAS. After received the first heartbeat response, the gNB compares the interval from SAS response with the configured interval and selects the shorter interval as the final heartbeat interval. The default interval is set at 100s.

Connection to SAS

The parameters in this section dictates connectivity to SAS server.

- **DNS Resolution Mode:** Set up the desired DNS resolution mode in order to convert a hostname into an IP address.
- **DNS Refresh Interval:** This value (between 300s to 86400s) defines how frequently the DNS server should check for a new update.
- **Connection Idle Time:** The amount of time the connection stays idle before the gNB disconnects from the SAS server.
- **TCP Keepalive:** TCP Keepalive is the message sent from one device to another to prevent the TCP session being broken. In most cases, after TCP session being established, it stays in connected state forever. However, if there is any NAT gateway or firewall in between, due to the limited resources on those intermediate devices, the session may be disconnected after certain amount of time if there is no traffic detected. The TCP keepalive has two timers, idle and interval:
- **TCP Keepalive Idle Time:** The idle timer is to tell TCP state machine after how long time no traffic the session can be deemed as inactive.
- **TCP Keepalive Interval:** The interval timer is to tell TCP state machine how often the keepalive message shall be sent out if session is in an idle state.

5.7. Mobility

5.7.1. Neighbor Cells

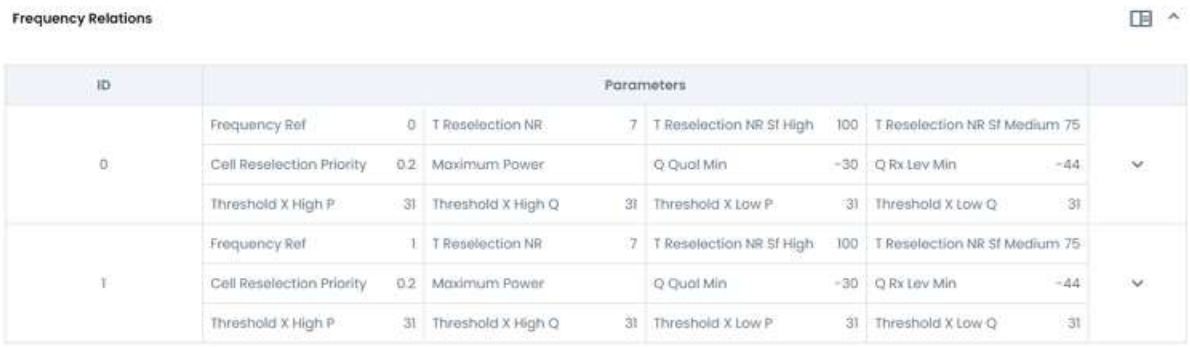
ID	Parameters						
1	Frequency Relation Ref	242	Adjacent Cell Ref	242	nRTCI	1039382085632	
	Q Offset RSRP SSB	0	Q Offset RSRQ SSB	0	Q Offset SINR SSB	0	
	Q Offset RSRP CSI-RS	0	Q Offset RSRQ CSI-RS	0	Q Offset SINR CSI-RS	0	
	HO Allowed	✕	Remove Allowed	✕			
2	Frequency Relation Ref	600	Adjacent Cell Ref	600	nRTCI	2576980377600	
3	Frequency Relation Ref	601	Adjacent Cell Ref	601	nRTCI	2581275344896	

Neighbor cells displayed in this section are advertised in SIB4 (to help with intra-frequency cell reselection), SIB5 (to help with inter-frequency cell reselection), or RRC Connection Reconfiguration (to help with handover). It is not mandatory to advertise them, but they do narrow down the candidates to look for.

You can either use Automatic Neighbor Relation (ANR) to detect neighbor cells automatically or add them manually.

5.7.2. Frequencies

Frequency Relations



This table provides information on cell selection or reselection-related parameters for both the serving cell (ID: 0) and the neighbor cell (ID: 1). Default values are recommended.

Frequencies

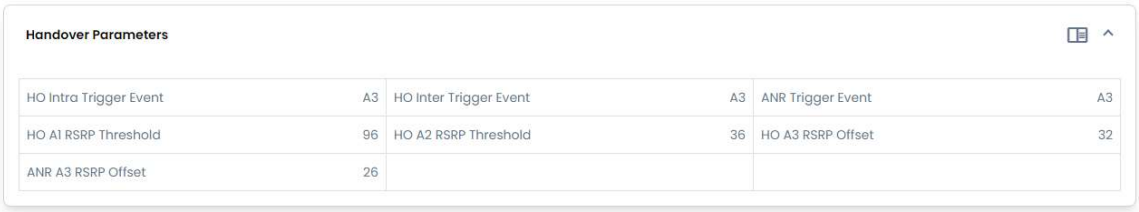
This table shows cell reselection parameters to other frequencies (and then information is advertised in SIB5) and for creating measurement reports (and then it is advertised in RRC Connection Reconfiguration message).

5.7.3. Xn Neighbors

The Xn interface connects one gNodeB to another, with the control plane (Xn-C) handling signaling and the user plane (Xn-U) managing the transfer of application data. Xn is based on the X2 function (in 4G LTE) but with enhanced UE context management function for adopting new QoS flow framework and network slice.

This table shows the Xn Neighbors that are available to the selected gNodeB.

5.7.4. Handover



Handover Parameters

HO Intra Trigger Event	A3	HO Inter Trigger Event	A3	ANR Trigger Event	A3
HO A1 RSRP Threshold	96	HO A2 RSRP Threshold	36	HO A3 RSRP Offset	32
ANR A3 RSRP Offset	26				

Handover is triggered by UE reporting that an event that gNB told UE to look for took place. Hence, this section is primarily about measurement configuration (i.e., what should the gNB tell UE to look for and what to do once an event is detected).

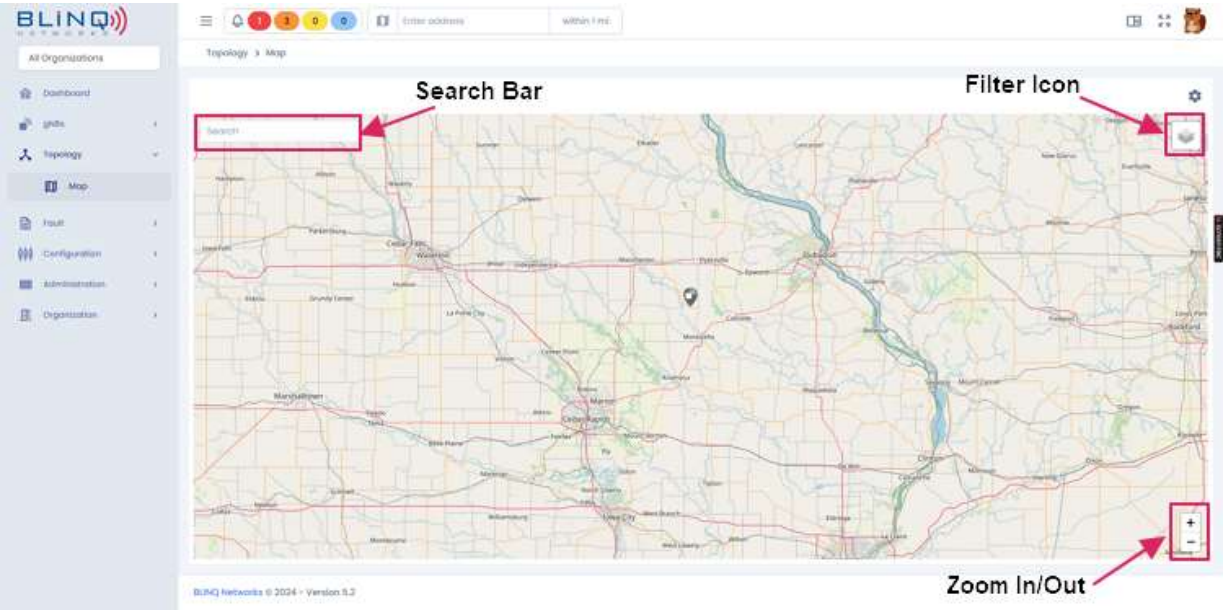
Events are triggered based on thresholds, hysteresis, and offsets:

- **Event A1**: Serving becomes better than the threshold.
- **Event A2**: Serving becomes worse than the threshold.
- **Event A3**: Neighbor becomes offset better than the S cell. Can be used in both intra-frequency and inter-frequency handovers.
- **Event A4**: Neighbor becomes better than the threshold.
- **Event A5**: Serving cell becomes worse than threshold 1 and neighbor becomes better than threshold 2.

It is fundamental to have at least 3 events (A1/A2/A3 or A5) for intra frequency measurements and 1 event (A3/A5) for inter frequency measurements.

6. Topology

Under the **Topology** header, there is a **Map** page. Devices on the EMS network can be searched/viewed on the **Map.**



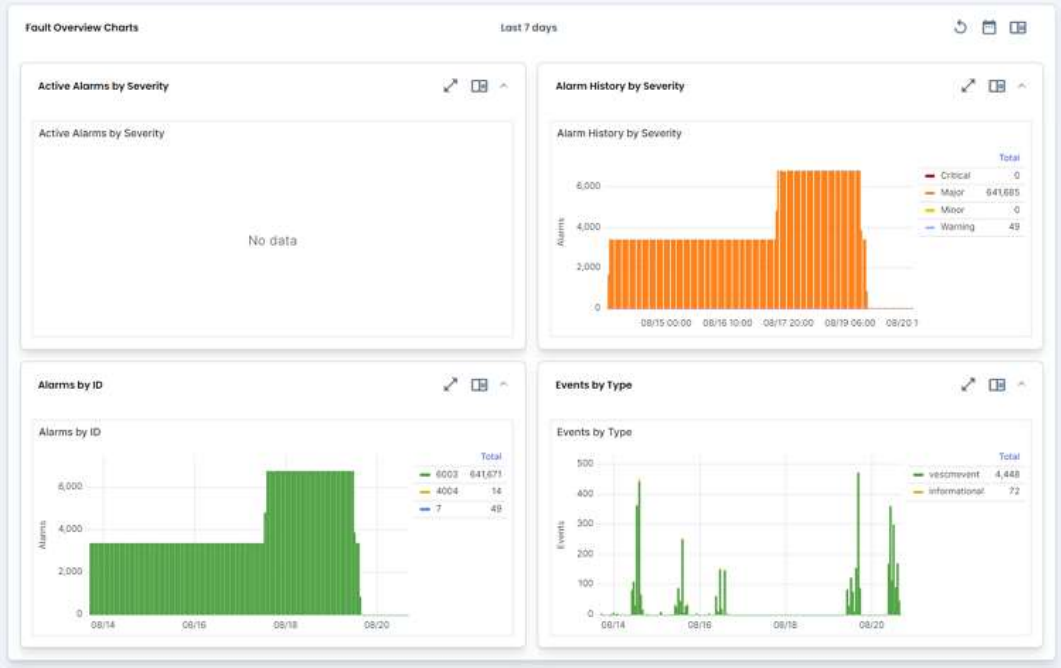
The initial view of the network map is zoomed out to show the overview of the network. Using the map, you can zoom in and out of an area, search for a specific device, or filter to show the gNBs.

Devices that are added onto the EMS network can be viewed on the **Map** if GPS is enabled on it. However, since the PC-400i is an indoor unit, it does not have GPS feature in it and it will not be shown on the map.

7. Fault

There are 4 different pages under **Fault** and their respective information can be found in the following sub sections.

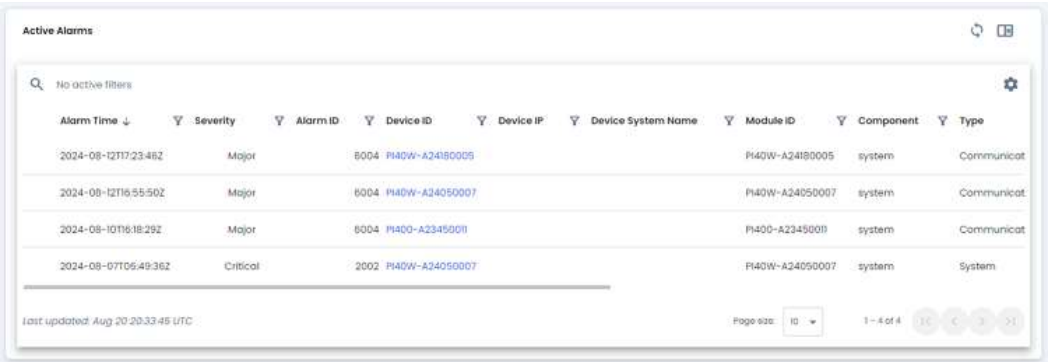
7.1. Overview



The Fault overview charts display current and historical alarm and event information. This includes:

- Current active alarm breakdown by severity.
- Alarm History by Severity versus time.
- Alarms by Alarm ID versus time.
- Events by Type

7.2. Alarms



An overview of all the active alarms that are occurring in the network – the devices on which the alarms are raise, the type of failure and the probable cause of the failure.

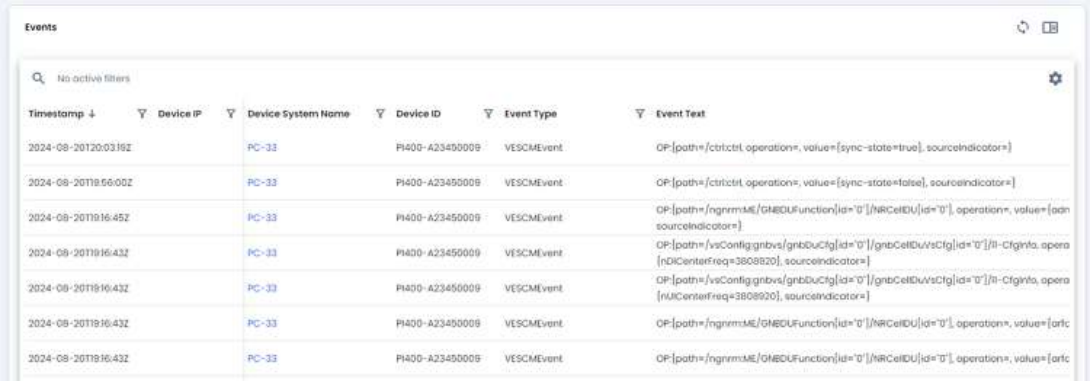
- Click on the icons in the columns to filter alarms, the query conditions will be displayed at the top of the table.
- Click on the gear icon to reset filters and sorting.
- Select a time range for which to show events: **All time**, **Start time** or **Range**.
- Select a set of alarm severities to show in the **Severity** column.
- Click the alarm device IP link to navigate to the device from which the event was sourced.

7.3. Alarm History

The Alarms History page displays the historical alarms that were raised in the managed network.

- Click on the icons in the columns to filter alarms.
- Click on the gear icon to reset filters and sorting.
- Select a time range for which to show events: **All time**, **Start time** or **Range**.
- Select the type of alarms to view on **Active**: **All**, **Raise** or **Clear**.
- Select a set of alarm severities to show in the **Severity** column.
- Click the alarm device IP link to navigate to the device from which the event was sourced.

7.4. Events



A read-only page that lists active alarms and the history of all past alarms and events of the device with further details.

- Click on the icons in the columns to filter alarms, the query conditions will be displayed at the top of the table.
- Click on the gear icon to reset filters and sorting.
- Select a time range for which to show events: **All time**, **Start time** or **Range**.
- Click the event device id link to navigate to the device from which the event was sourced.

8. Configuration

Under **Configuration,** you can find the links for Tag Manager and Bulk Operations.

8.1. Tag Manager

The home page of the Tag Manager shows an overview of all tags that was created. Default tags available for use and they cannot be edited. You can see the **Name**, **Description**, **Device Type**, **Query**, **Updated**, and the **Device Count** (number of devices tagged) of each tag. Click on the gear icon to reset filters and sorting or choose which columns to display.

Tags are required to group devices together to perform a bulk operation.

It is crucial to apply the right tags so that all the applicable devices required for the bulk operation are included.

Search for a Tag

To search for a tag, click on the icons in the columns to apply filters. This will filter the list to show only the tags resulting from the search conditions.

To Add a Tag

Click on the blue "+" button to add a new tag. This will open a new window to enter information.

- Specify a unique tag Name. This is the tag label applied to devices visible in the inventory tables and used to identify which devices to perform a bulk operation on.
  The tag name needs to be between 1 to 16 characters and consists of only letters, numbers, underscore and dash. The first character needs to be either a letter or an underscore.
- Specify a short description capturing the purpose of the tag.
- Specify the device type to which the tag will apply.
- Formulate the query that identifies the devices to tag.
  - Click the + button on the right of the query builder to add a new rule to a rule set. Specify the rule configuration including field name (start typing the device field name and it will show matching fields), operand (contains, is, regexp, match any) and value. Rules in a ruleset can be AND'd, OR'd and NOT'd. A ruleset can contain rules or other rulesets.
    - **contains** - substring that must match a subset of the field value from device
    - **is** - string that must exactly match the field value from device
    - **regexp** - matches regular expression that must match the field from the device Reference
    - **match any** - a list of one or more values for which anyone must match the field value.
    - **equal** - number that must exactly match the field value from device
    - **greater than** - matches any number greater than the input value
    - **greater than or equal to** - matches any number greater than or equal to the input value
    - **less than** - matches any number less than the input value

- **less than or equal to** - matches any number less than or equal to the input value
- **range** - matches any number in between a set of two numbers
- **not empty** - matches any field that has not empty value

- Rules in a ruleset can be AND'd, OR'd and NOT'd. A ruleset can contain rules or other rulesets.
- Once the first rule is set, choose to add another rule or ruleset as needed.
- Click on the red - button to remove a rule or ruleset.
- When the rules/rulesets are done, a list of device hits should show up.

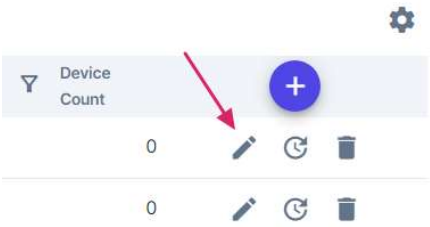
When you are satisfied with the list of devices generated, click on the check mark icon to create the tag.

The newly added tag should appear on the list of the **Tag Manager's** home page with the total number of devices that are contained in the tag.

NOTE: If there is no unifying value between the desired devices, then each value needs be entered individually, using "**OR**" to combine them onto the same tag.

To Edit a Tag

To edit an existing tag, simply click on the **Edit** icon.



A pop-up window will appear, and changes can be made. Simply edit the rule(s) or ruleset(s) and hit the "**Submit**" button. Hit "**Cancel**" if a change is not needed.

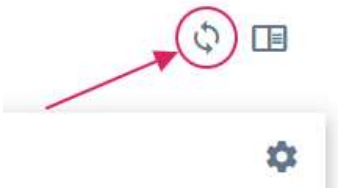
The list on the Tag Manager's home page should be updated with the edited tag.

NOTE: The edited tag might take a few seconds for the Device Count to be updated.

Refresh Tag

All the tags can be refreshed at the same time, or you can select to refresh a single tag. When a tag has been updated or when new devices are added onto the NetLiNQ EMS and the tag or tag list needs to be updated to reflect the change. The count will then be updated to include the new devices or to remove irrelevant devices that no longer fit the edited tag.

- Enable or Disable Auto Refresh Feature:



When **Auto Refresh** is enabled, the Tag List will be refreshed automatically. To enable or disable this function, click on the icon on the top right corner of the section.

- Refresh a single tag:

To refresh only one tag, click on the Reapply Tag icon at the end of the row.

To Delete a Tag

To delete a tag from the Tag Manager list, click on the **trash** icon at the end of the row. A pop-up window will appear to confirm the deletion. Click on "OK" to confirm deletion or hit "**Cancel**" to return to the list.

8.2. Bulk Operations

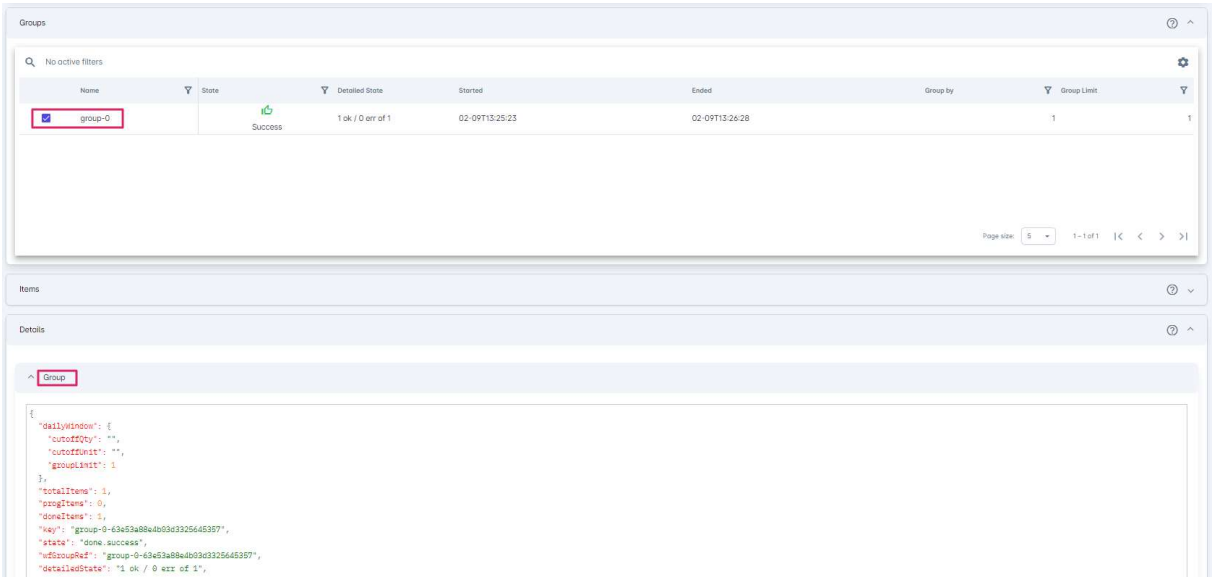
Bulk operations are changes done to the devices on the EMS in bulk (as a whole group)**.** The **Bulk Operation** home page displays all the operations that have been performed, scheduled or running.

Edit the information displayed for each operation by clicking on the settings wheel and unchecking boxes.

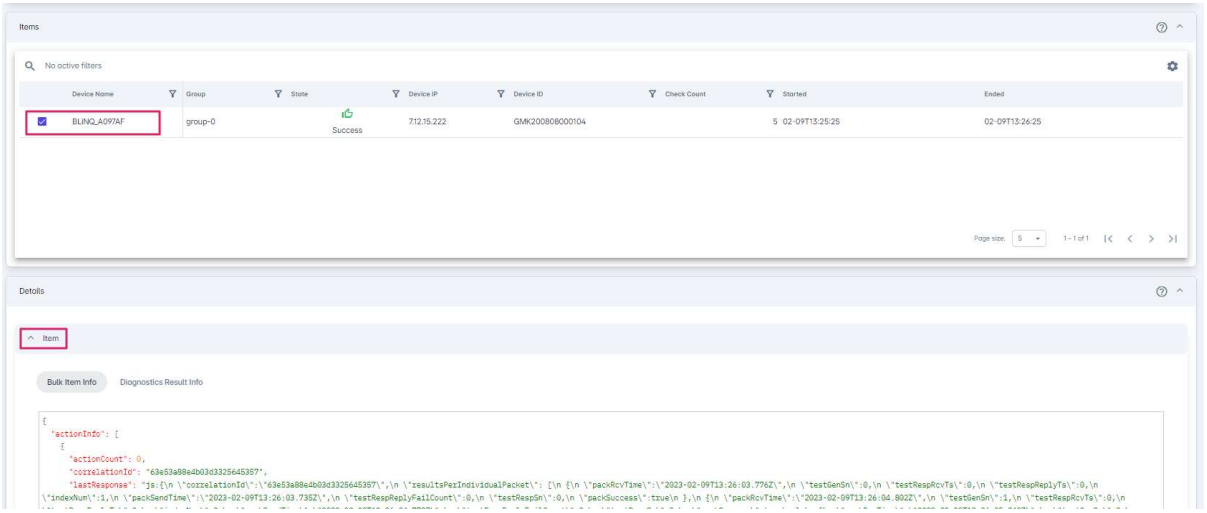
- **Add Operation:** Click the button to add an operation.
- **Groups:** Limiting how many groups a user wants to run for an operation.
- **Items**: an item is a device that has been changed or affected within an execution of a bulk operation.
- **Item details**: Specific details about the selected item.
- Change between multi tables and single table view
  - **Multi tables view mode**: Original operations are displayed in the main table, recurred and reapplied operations are displayed in the sub table.
  - **Single table view mode**: All the operations are displayed in a single table.

8.2.1. Navigating Bulk Operations

When one of the bulk operations from the list is selected, it will bring up 3 new sections on the Bulk Operations page: **Groups**, **Items** and **Details**

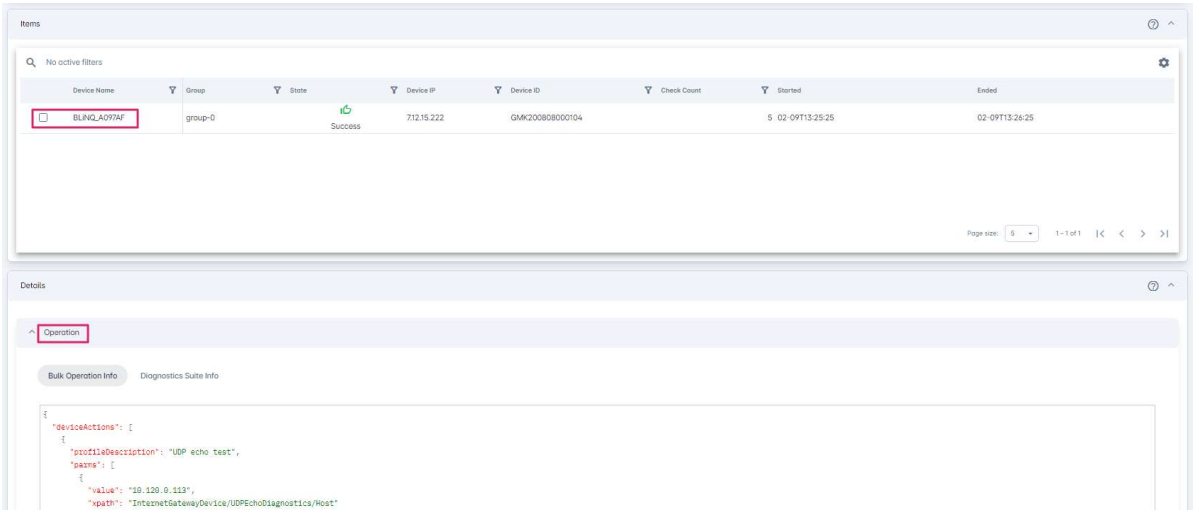


Groups, as the name suggests, will list out the different groups that are part of the bulk operation. It will show the **Detailed State** of the operation and the time of execution. Click on a group to open the details pertaining to the group.



Items on the other hand will list out each device of the bulk operation and whether the operation was a success or not.

Click on the individual device in Items to open **Details** pertaining to the operation done to it. Expanding these subsections will show the detailed codes for the changes or errors that occurred on the specific device during the bulk operation.



Details by default shows more detailed information regarding the Bulk Operation and Diagnostics Suite of the selected operation. If a group is selected in **Groups** or an individual device is selected in **Items**, information pertaining to those selections will be shown in this section.

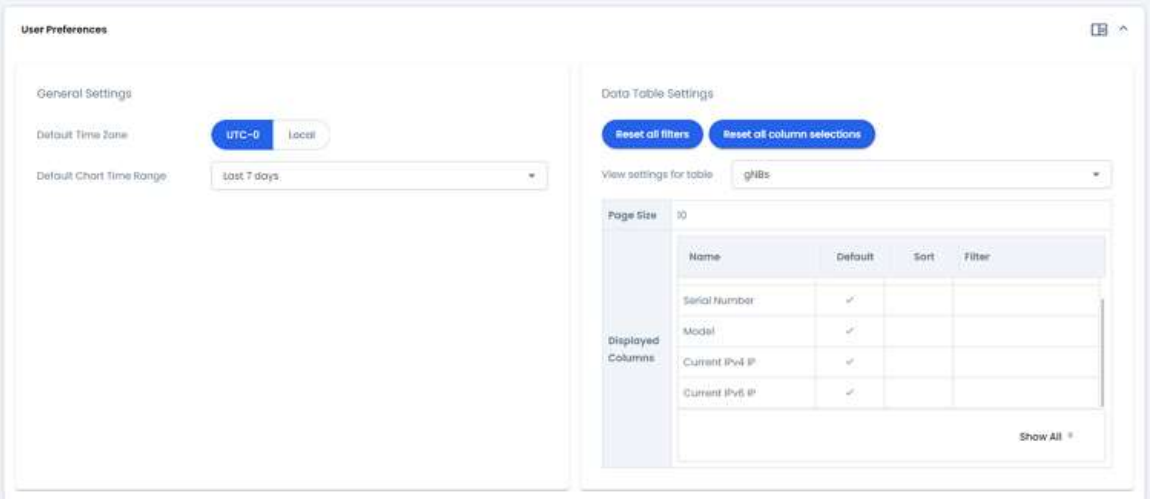
9. Administration

There are 4 pages under Administration: Settings, User Management, File Management and Discovery.

9.1. Settings

This page is divided into 2 sections: User Preferences and SFTP Server.

User Preferences



This is where you can modify the **Default Time Zone** and the **Default Chart Time Range**. The chart time range can be modified within each individual charts if needed.

You can also view the display columns for all the tables within EMS.

- **Reset all filters** and **Reset all column selections** buttons will reset all the items in the EMS UI.
- **View settings for table**: Click and select the desired table from the drop-down menu. Please note that columns for individual tables will need to be updated on their respective pages.

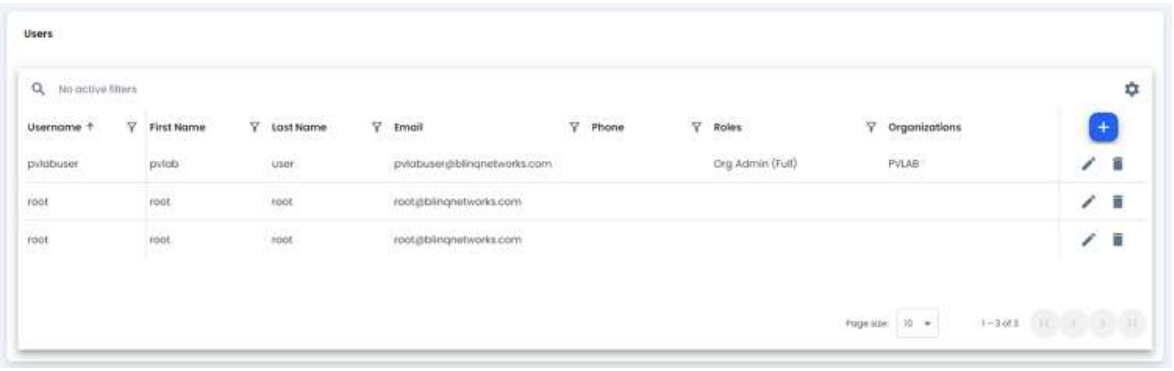
SFTP Server

This section displays local and external sftp server configurations for gNB software upload/download.

9.2. User Management

This page is divided into 2 sections: Users and Roles.

Users



This section displays all the current users registered for the account. You can see the roles and organization that the user is assigned to.

To add a new user, simply click on the blue + button.

Roles

A role has a set level of permissions for working with NetLiNQ EMS. By default, there are 12 pre-defined roles given.

Please note that while new roles can be added, these default roles cannot be deleted.

To add a new role, simply click on the blue + button to set up the desired permissions.

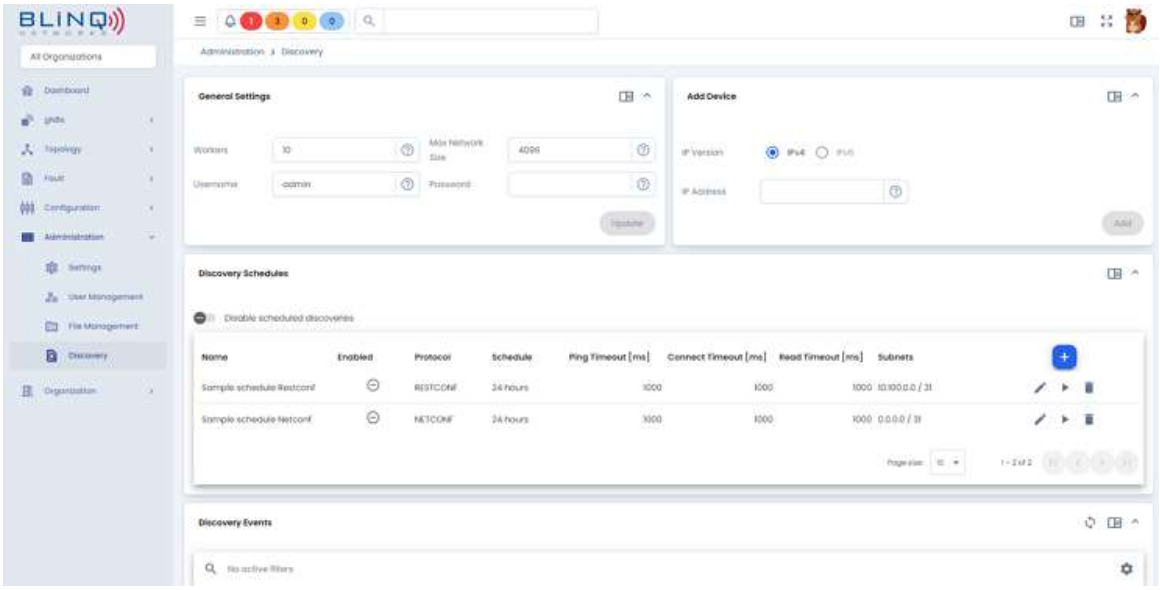
9.3. File Management

This page displays gNB software images, and associated upload and delete functions.

If the local sftp server is enabled: the local sftp server is default (called "host"), and the file path is set by default to "images". If an external server is needed, select from the drop-down, and provide file path information.

- **Display software list**: click "List Files" button to display the software list for the current server and file path.
- **Upload software file**: click the top-left plus button in the table to open the file selection dialog and select a software image file to upload to selected sftp server.
- **Delete software file:** click the left delete button to delete the selected software file.

9.4. Discovery



General Settings

Configure the global parameters for gNB discovery in this section.

- **Workers**: Number of concurrent discovery operations
- **Max Network Size**: The maximum number of IP addresses that will be included in a single discovery operation. Please note that it will take a longer time to scan a large network.
- **Username**: The same login username that is used for all gNBs
- **Password**: The corresponding password for the username above

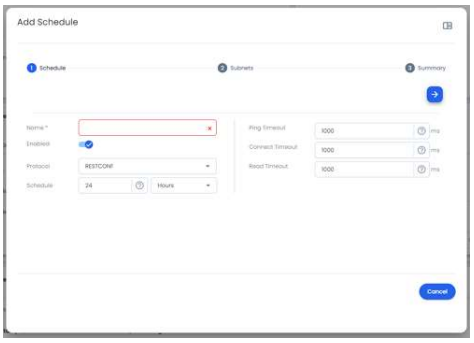
Add Device

Add a gNB to the managed network immediately.

Discovery Schedule

View or setup/update schedules for the EMS to scan the network automatically, with the ability to delete schedules and run schedules immediately.

- **Disable scheduled discoveries**: Disallow all scheduled discoveries from running.
  Note that a schedule that is run immediately by the "**Run Now**" button is an immediate discovery, not a scheduled one.
- **Adding Discovery Schedule**
  Click on the blue + button to add a new discovery schedule. A pop-up window will appear.

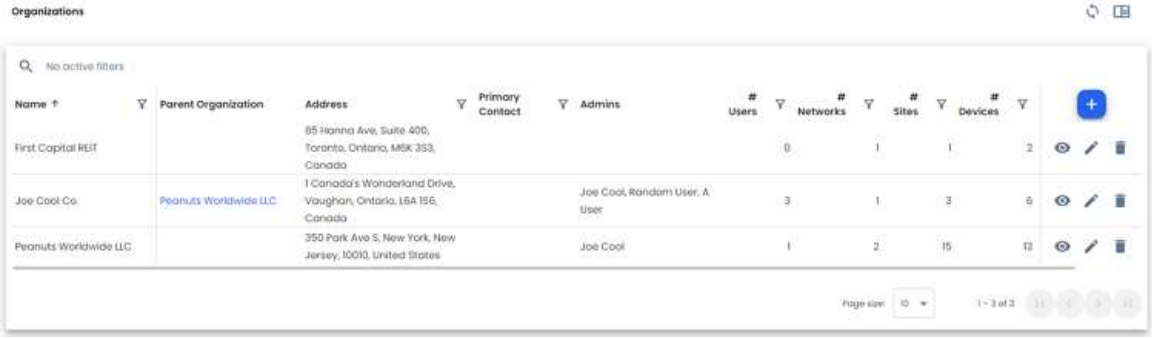


  - **Schedule:** Configure basic settings for this schedule
    - Enter a name for the new schedule.
    - Toggle the button to **Enable** or **Disable** the schedule.
    - Select the desired **Protocol** (RESTCONF or NETCONF) from the drop-down menu.
    - Set up the **Schedule –** the time interval at which this discovery schedule will run.
    - Enter the desired **Ping Timeout**, **Connect Timeout** and **Read Timeout**.
  - **Subnets:** Configure subnets to be discovered for this schedule. If more than one subnet is needed, click on the blue + button to add another line.
  - **Summary:** Review the configurations that have been entered. Click on the **check** button to add the new schedule.

Discovery Events

A read-only section that lists the discoveries of any nodes scanned.

10. Organization



The **Overview** page under Organization displays all the current organizations associated with the account.

You can create, view or edit various organization deployments here.

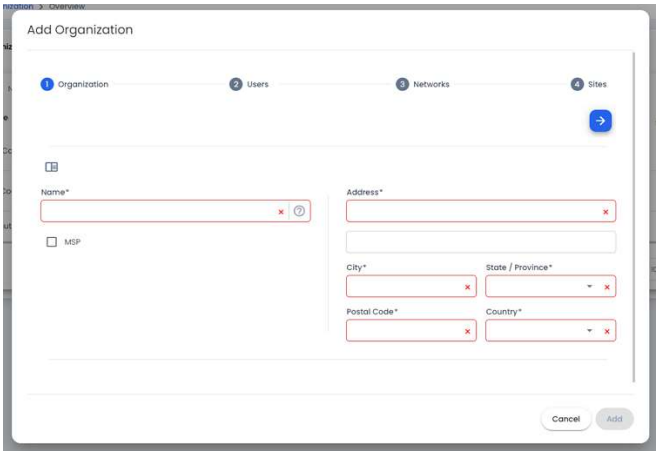
An "Organization" is a grouping of gNBs that are operating together in the network. These gNBs will be accessible by the same group of users.

10.1. Add an Organization

To add a new organization, click on the blue + button.

NOTE: Adding "Users", "Networks", and "Sites" are optional when creating a new Organization.

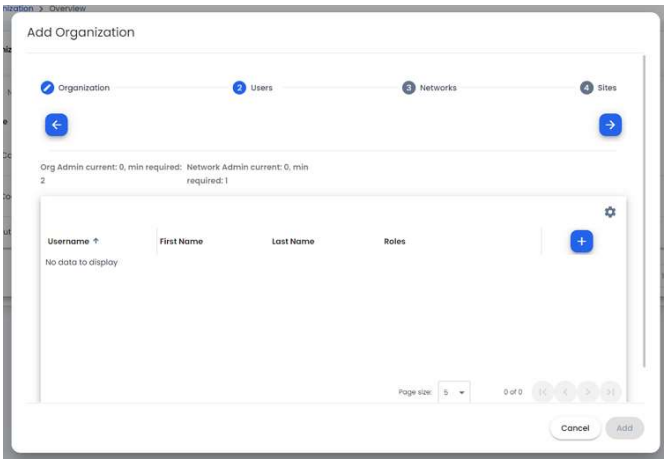
Step 1



- Enter the Name and Address of the new organization that you want to add. Check the box if this is an MSP (Master Service Providers). However, only users with **MSP Org Admin /(Full)** access are able to create or edit MSP organizations. There are 3 levels of organizations:
  - 1st level - MSP Organization
  - 2nd level - MSP Organization or Non-MSP Organization
  - 3rd level - Non-MSP Organization

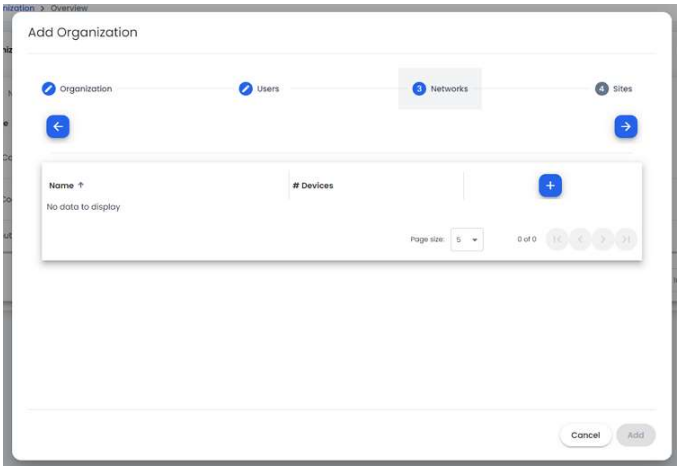
- Please note that a **Country** has to be selected first before the **State/Province** field can be populated/selected.
- Click on the blue right arrow when you are done.

Step 2



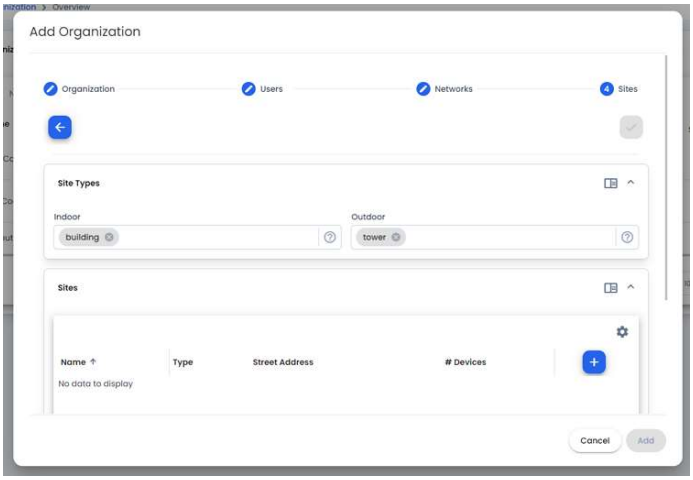
- Add the number of users (new or existing) to be linked to this organization. If no users have been added under "**User Management**", simply click on the blue plus button to create a new user.
- Click on the blue right arrow when all the users have been added.

Step 3



- Add the networks that are grouped in this Organization by clicking on the blue plus button.
- Enter a desired **Name** for this new network and click on **Add**.
- When all the networks are added, click on the blue right arrow again.

Step 4

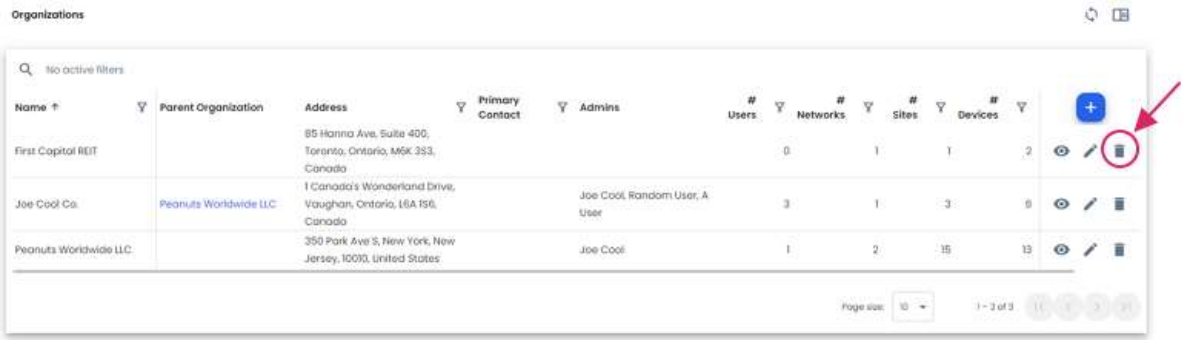


- Add the sites that are to be included in this organization. If there are no sites in the database, click on the blue plus button to add them manually.
- You can filter the sites by using a keyword search that is categorized under either **Indoor** or **Outdoor** sites.
- To add a new site, enter the name of the site. Adding its Type, a short description, its address, location latitude/longtitude/altitude would help to simplify the identification of the site in the future. Click on "**Add**" when the information/values have been added.

When all the desired sites have been added, click on **Add** to add this new organization.

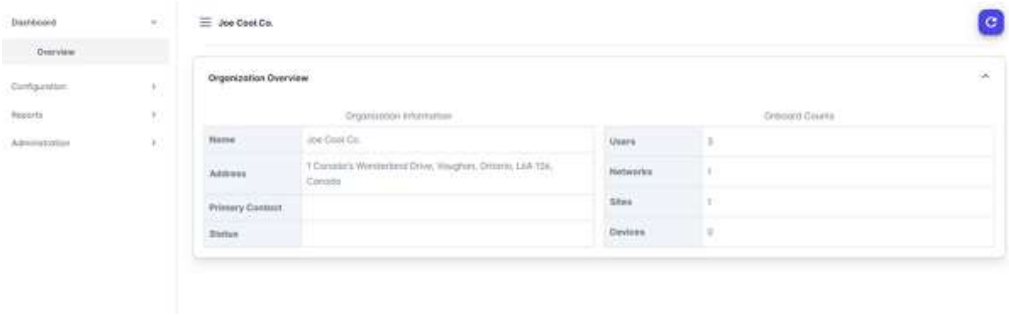
10.2. Delete an Organization

To delete an **Organization**, simple click on the trash can icon located on the last column.



10.3. Organization Dashboard

By clicking onto an organization, you will be brought into its dashboard.



This is a quick overview of the selected organization's information as well as its onboard counts (its users, networks, sites and devices).

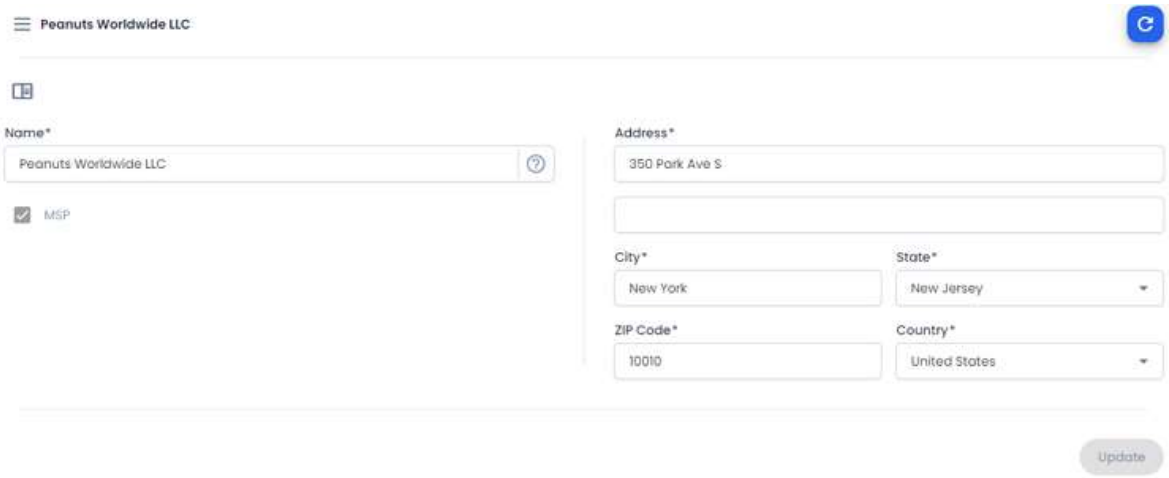
Under **Configuration**, you can edit the Organization information, add/delete Networks, add/delete Sites, and add/delete individual devices. For more details on how to edit or add these items, please refer to section "Add New Organization" above.

NOTE: Please note that when you add a new device here, you could onboard it with the desired configuration template.

10.3.1. Configuration

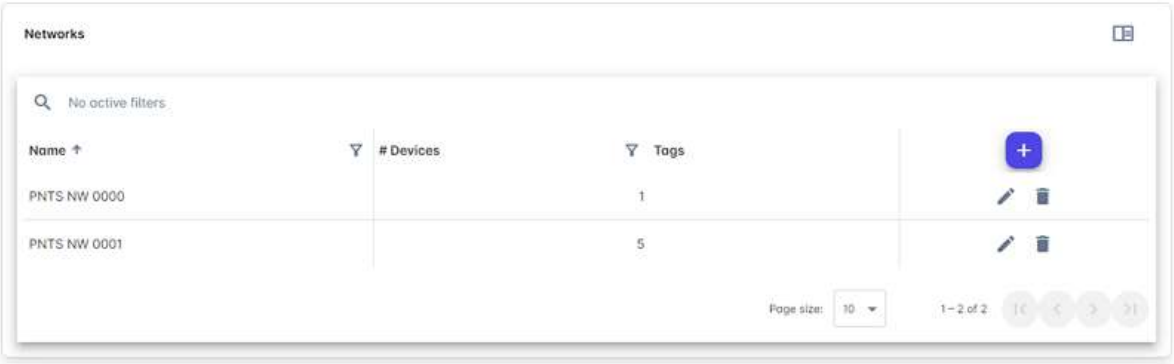
There are 5 subpages under **Configuration**: Organization, Networks, Sites, Templates and Devices.

10.3.1.1. Organization



Update the organization's address and name in this page if needed.

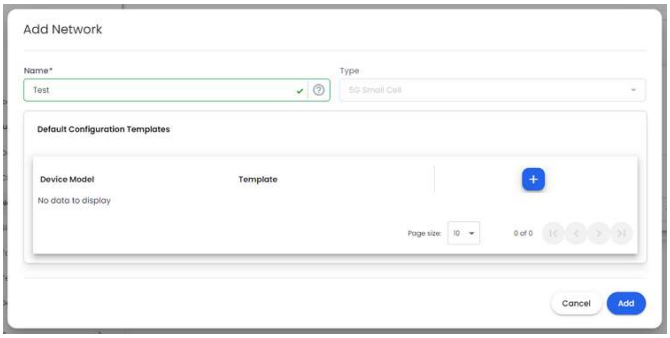
10.3.1.2. Networks



This table displays the existing networks under the selected Organization. You can add, edit or delete a network from the table directly.

Add a Network

Click on the blue plus button to add a new network.

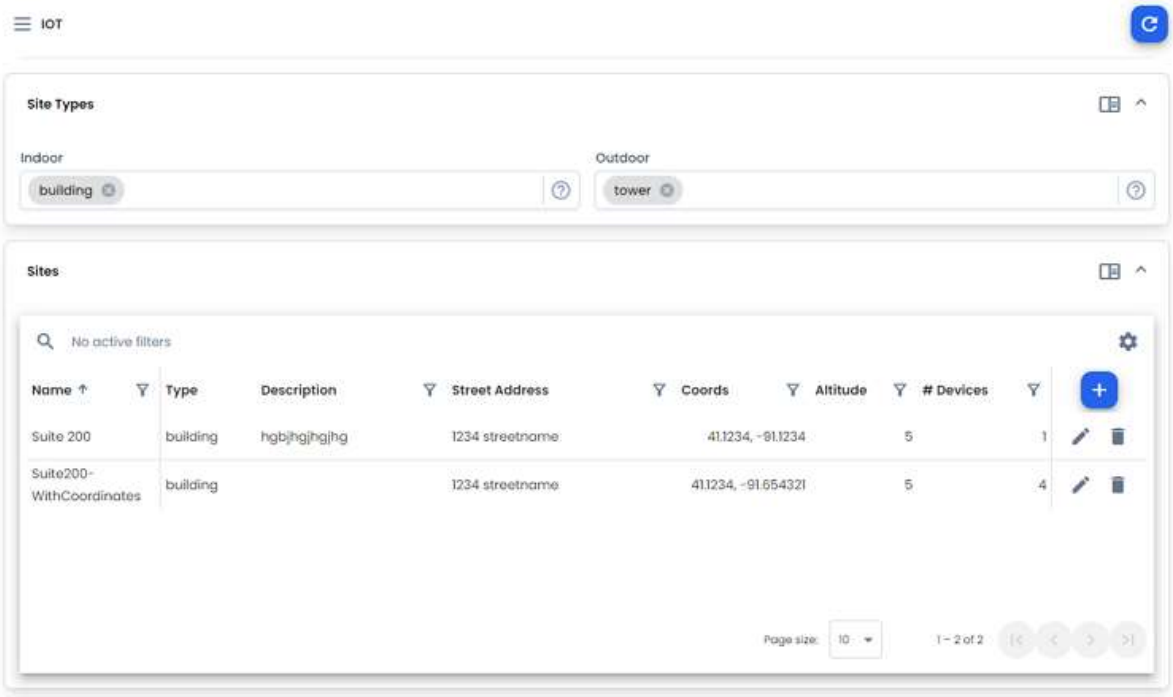


- Enter a descriptive name for the new network and select the template(s) to be associated with the network.
  - Enter a name for the network and select a default configuration template to be associated with this network (optional).
  - When everything has been added, click on "Add" to add the new network.

10.3.1.3. Sites

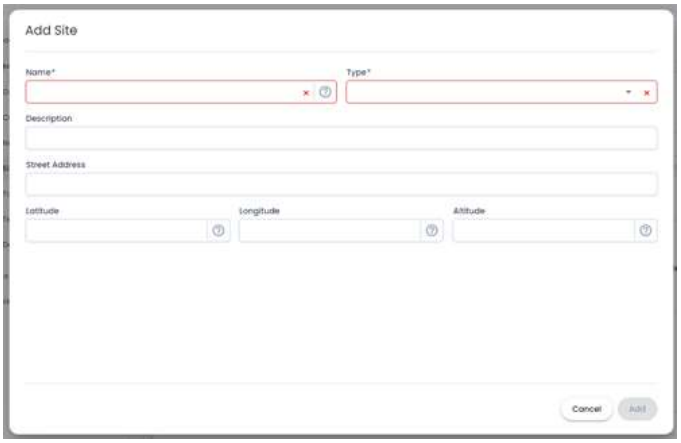
The site types are separated into *Indoor* and *Outdoor* categories. Adding or deleting a site type here can filter the list in the Sites Table as seen in the screenshot below.

This table lists all the sites that are included in the selected organization. The columns of the table can be customized by using the settings wheel icon. The existing sites can be edited or deleted, and new sites can be added to the organization.



Add a New Site

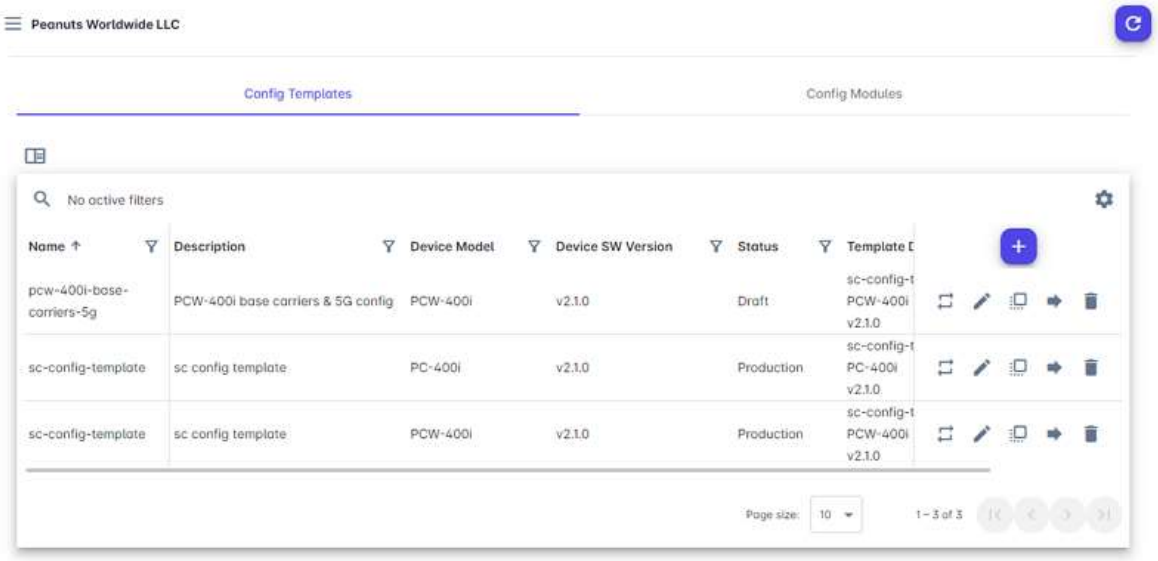
To add a new site to the organization, simply click on the blue + button.



Entering a short descriptive site name is recommended. Adding its Type, a short description, its address, location latitude/longtitude/altitude would also help to simplify the identification of the site in the future. Click on "Add" when the information/values have been added.

The new site should appear on the sites table.

10.3.1.4. Templates



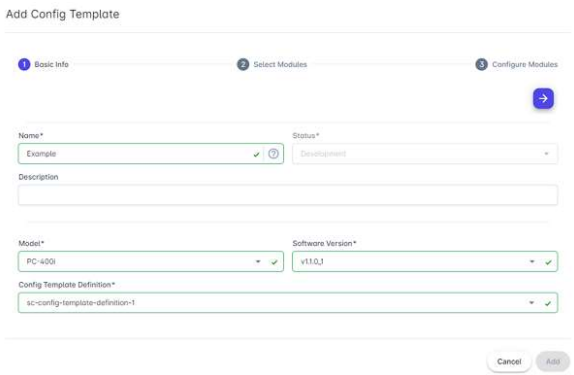
Under "Templates", there are 2 separate tabs: **Config Templates** and **Config Modules**

Config Templates

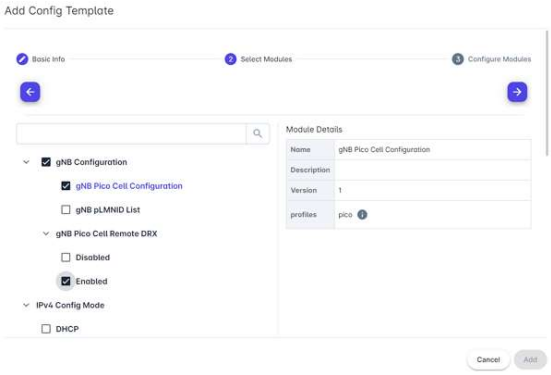
In this tab, you can make changes, delete, clone or migrate an existing template. You can also add new templates to this organization.

To add a new template:

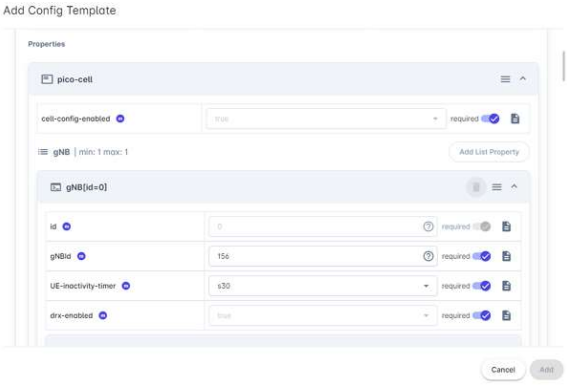
- Click on the blue "+" button to add a new template. A pop-up window will appear.
- Enter/Select the required fields (Name, Model, Software Version, Config Template Definition).



- When the fields are filled, click on the blue right arrow to go to the next step.
- In the modules section, select the desired options and click the blue right arrow to proceed.
  - A **Module** is a set of parameters that is grouped together for a particular feature or functionality.

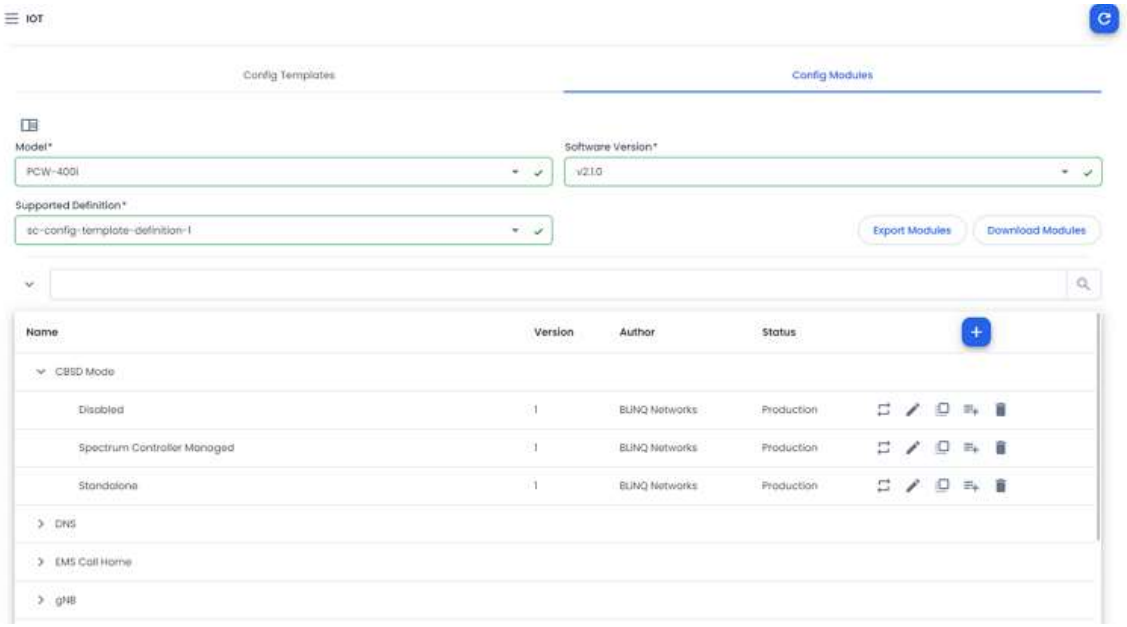


- In this last section, you can dive into the detailed settings of each module. This is where all the desired configuration parameters need to be set up.



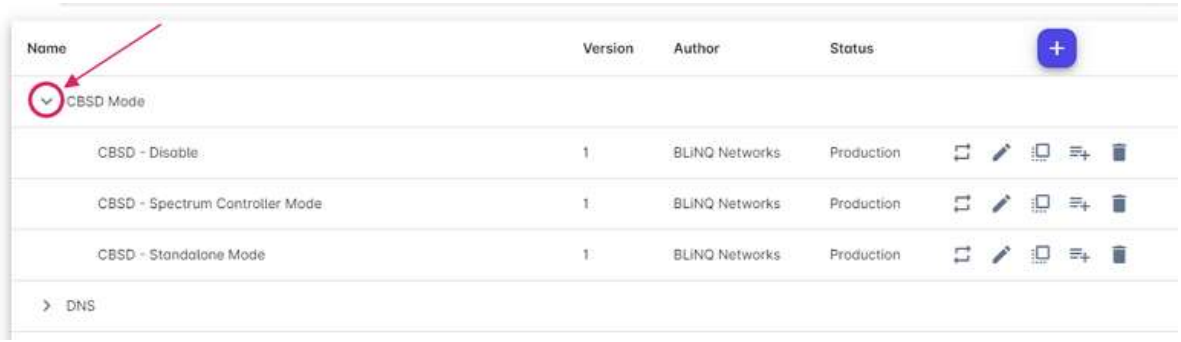
- When all the required fields have been entered, click on the "**Add**" button to add this new template to the organization.

Config Modules



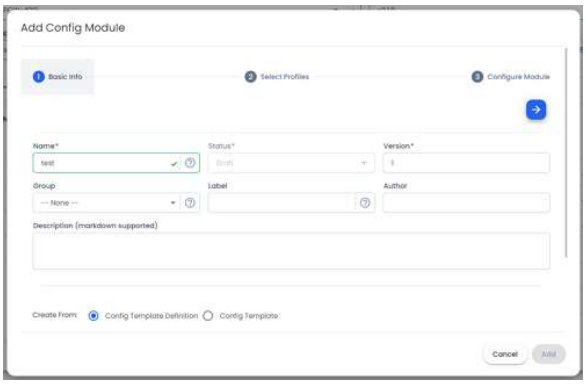
Under this tab, you can view the available configuration modules by selecting the **Model** of the gNodeB, **Software Version** that is desired as well as the **Supported Definition** for the selected software. The list will then be populated.

Clicking on the arrow for a module will reveal a drop-down list of all the sub-modules within it. Modifications, cloning or deletion of the module can be done by selecting the corresponding icons.



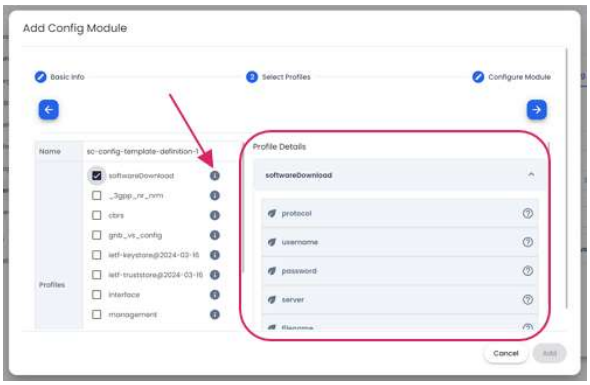
To add a new module:

- Click on the blue plus button.



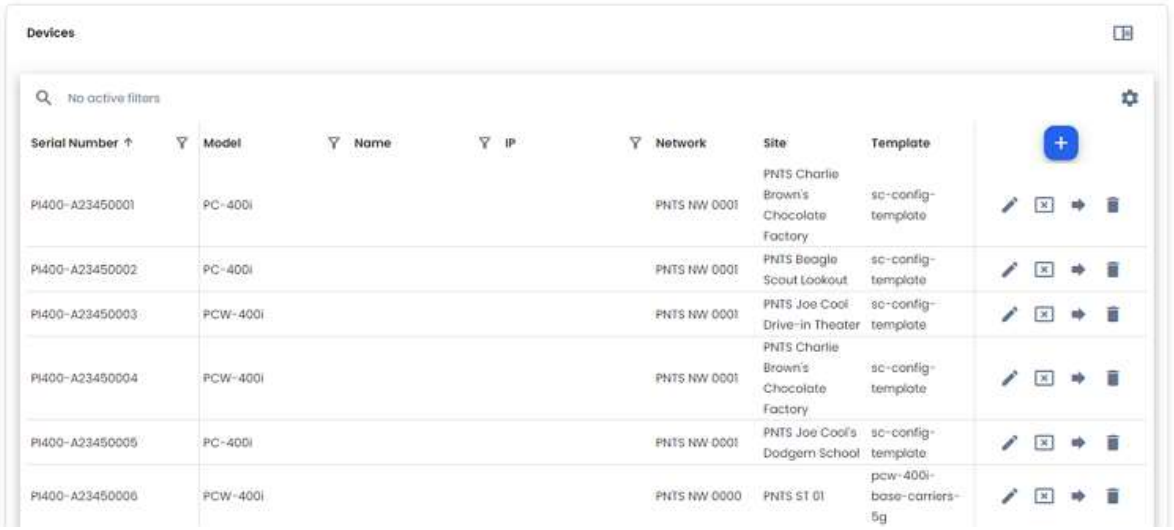
- For the first page, the module **Name** and **Version** are required fields. Adding more descriptive information can help in simple identification of the module in the future.
- Modules need to be created a Config Template Definition. If you are not sure which definition is to be used, you can select a Config Template, and the EMS will pull on its config Template Definition automatically.
- **Base Module** selection will place this new module under the selected module. If you do not what it to be nested in any pre-existing modules, simply leave it blank.
- When the required fields have been filled, click on the blue arrow at the top right of the pop-up window to proceed to the next step.

- On the second page, select the **Profiles** to be included in the module. Details of the profiles can be seen by clicking on the "i" icon (see figure below).



- After checking off the boxes of the desired profiles, move on to the next step by click on the blue arrow button.
- In this last page, different properties can be added or edited from the selected profiles to further customize the module. The red fields are required.
- You can also select "**r/o**" to set a parameter as a "Read Only" field to prevent other users from modifying it.
- Once everything has been configured, click on the "Add" button to add the new module.

10.3.1.5. Devices



Serial Number	Model	Name	IP	Network	Site	Template
PI400-A23450001	PC-400i			PNTS NW 0001	PNTS Charlie Brown's Chocolate Factory	sc-config-template
PI400-A23450002	PC-400i			PNTS NW 0001	PNTS Beagle Scout Lookout	sc-config-template
PI400-A23450003	PCW-400i			PNTS NW 0001	PNTS Joe Cool Drive-in Theater	sc-config-template
PI400-A23450004	PCW-400i			PNTS NW 0001	PNTS Charlie Brown's Chocolate Factory	sc-config-template
PI400-A23450005	PC-400i			PNTS NW 0001	PNTS Joe Cool's Dodgem School	sc-config-template
PI400-A23450006	PCW-400i			PNTS NW 0000	PNTS ST 01	pcw-400i-base-carriers-5g

In the devices table, it lists all the devices that are part of the selected organization. You can use the filter function to search for specific devices.

Devices' parameters, such as the device name, gNB ID, bandwidth, frequency, location coordinates, and config template can be modified here.

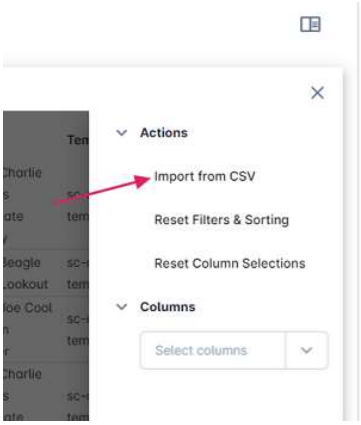
When a network is updated, the config template may also need to be modified.

When the site is updated, other configuration such as location related items may also need to be modified.

Importing Devices

A .csv list of devices can be imported to be added onto the EMS in bulk.

Click on the settings wheel and select "**Import from CSV**" from the menu.



Follow the instructions to select the correct file. Once the devices have been imported into the EMS, they will be listed on the table.

Adding Devices

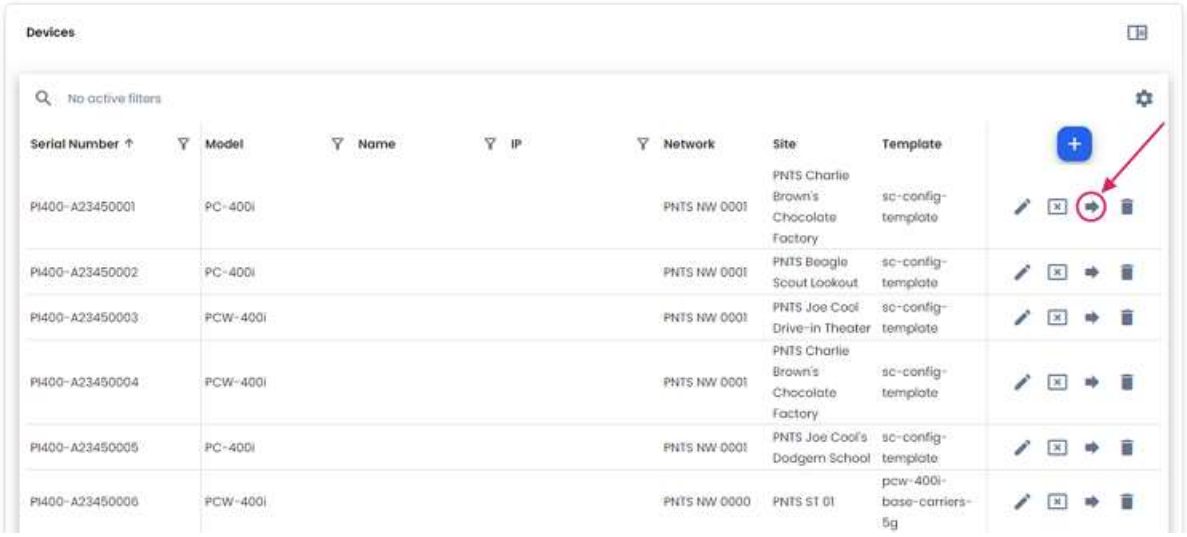
Alternatively, individual devices can also be added by clicking on the blue plus button.

Enter the name and serial number of the device. You will also need to associate the device to an existing Network and Site. Lastly, select the **Model**, **Software Version** and **Template**.

Once it's done, click on the "Add" button to add the device to the organization.

Moving a Device

A device may be moved to another organization if the current user belongs to both the current device's organization and the new organization and has the appropriate permissions.



Select destination organization, and a target network and site within the organization, click "Move" button to move the device to another organization.

After the move completes, the device's configuration would be cleared, and it will need to have its configuration template and/or associated configuration reapplied as appropriate for the new organization.

10.3.2. Reports

There are 3 pages under Reports: Faults, Audit Logs and Security Logs.

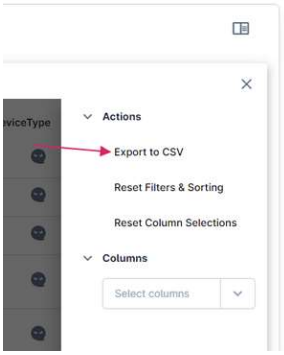
Faults

The **Faults** table display all the alarms under the selected organization. Please use the filter/sort function to locate specific alarms.

Audit Logs

The **Audit Logs** table shows all the activity that has been done for the selected organization.

The whole list can be exported off the EMS by clicking on the settings wheel and select "**Export to CSV**" (see figure below). A report download will start automatically.



Security Logs

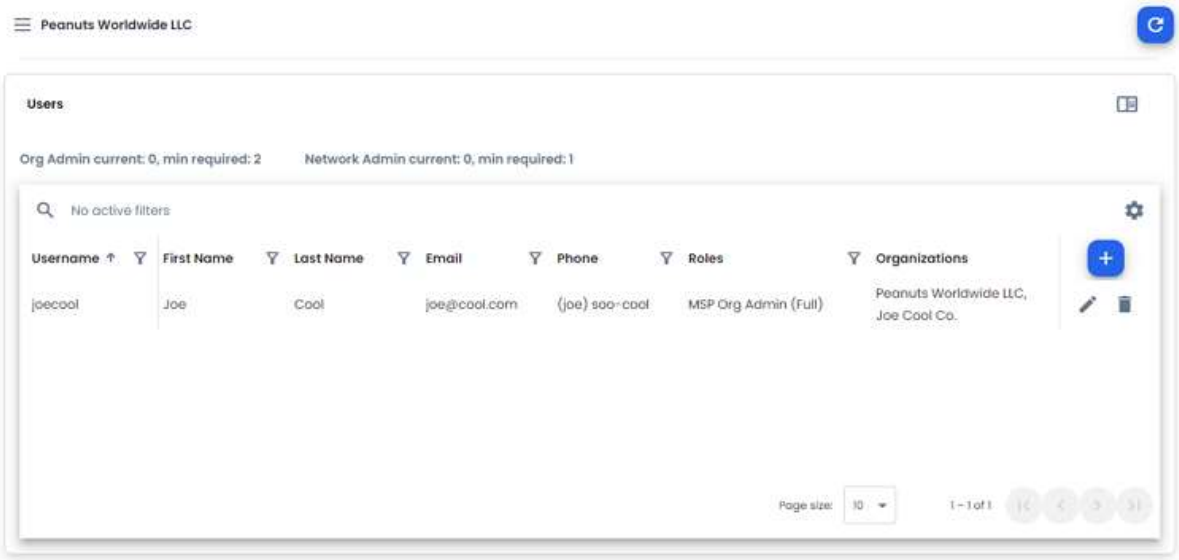
This table displays information on user activities for the organization.

This includes:

- Logged in date and time
- Logged in duration
- Changes made

10.3.3. Administration

View and edit the list of users associated with this organization in this section.



To add new user

- Click on the blue + button to set up a new user.
- Choose to add a new user or select from the list of existing users. When the required fields have been entered, click on the "Add" button to add the user to the organization.