goRAN™+ LTE Base Station

User Manual

Copyright

Disclaimer

The contents of this document are subject to revision without notice due to ongoing progress in methodology, design and manufacturing. Ubiik Inc. shall not be held liable for any error or damage of any kind resulting from the use of this document.

Table of Contents

1. FCC Statement

1.1. Overview

The goRAN™+ LTE Base Station 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.

This device has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a commercial or industrial installation. This device 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 a particular installation. If this device does cause harmful interference to radio or television reception, which can be determined by turning the device off and on, the user is encouraged to try to correct the interference by one of the following measures.

Table 1.1 Approaches to correcting interference

Method	Action
1	Reorient or relocate the receiving antenna
2	Increase the separation between the device and receiver
3	Connect the equipment into an outlet on a circuit different from that to which the receiver is connected
4	Consult the dealer or an experienced RF technician for help

CAUTION!

Any changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate this device.

1.2. Canada, Industry Canada (IC) notices

This device contains license-exempt transmitter(s) that comply with innovation, Science and Economic Development Canada's Licence-exempt RSS(s). Operation is subject to the following two conditions:

v.1.0 FCC ISED
1. This device may not cause interference.

2. This device must accept any interference, including interference that may cause undesired operation of the device.

1.3. Radio Frequency (RF) Exposure Information

The radiated output power of the Wireless Device is below the Innovation, Science and Economic Development Canada (ISED) radio frequency exposure limits. The Wireless Device should be used in such a manner such that the potential for human contact during normal operation is minimized.

This device has also been evaluated and shown compliant with the IC RF Exposure limits under mobile exposure conditions. (Antennas are greater than 50cm from a person's body).

1.4. Radiation exposure statement

The antenna(s) used for this transmitter must not be co-located or operating in conjunction with any other antenna or transmitter. This device complies with FCC radiation exposure limits set forth for an uncontrolled environment. In order to avoid the possibility of exceeding the FCC radio frequency exposure limits, human proximity to the antenna shall not be less than 19.68 inches (50 cm) during normal operation.

Table 1.2.3 Antenna information (WiFi/SRD)

Technology	Brand	Model	Freq. range	Antenna gain	Antenna Type
SRD 1	Dawn	DB-896-960V-13-75-NV2	896 – 960 MHz	13 dBi	Vertical
SRD 2	M.gear	C1991-690054-A WY	902 – 928 MHz	3.41 dBi	Dipole
SRD 3	M.gear	C1991-690053-A WY	902 – 928 MHz	1.43 dBi	Dipole
SDR 4	Invax	DS0915-0726WNM	902 – 928 MHz	5.72 dBi	Dipole
GNSS	Jinchang	JCA225-N	1561.098 – 1602 MHz	5 dBi	RHCP
LTE	Grand-Tek	OA-LTEWB-035-C0-UB	1850 – 1910 MHz	1.8 dBi	Omni

1.5. Professional installation statement

1. Installation personnel: This device is designed for specific applications and needs to be installed by qualified personnel who have RF and related regulations knowledge. The general user should not attempt to install or change the settings.
2. Installation location: The device should be installed at a location where the radiating antenna can be kept 19.68 inches (50 cm) from any nearby person in normal operating conditions to meet regulatory RF exposure requirements.

3. Installation procedure: Please refer to the procedure for mounting the device to a wall or pole.
4. Warning: Please carefully select the installation position and make sure that the final output power does not exceed the limits set in relevant rules. Violation of rules could lead to serious federal penalties.

1.6. Safety statement

All instructions, warning and caution statements that accompany this device must be strictly followed at all times to ensure its safe use. Observe all warning and caution symbols that are fixed to this device. This device has been designed with the utmost care for the safety of installers and users. However, when using this device, basic safety precautions should always be followed to reduce the risk of injury and electric shock. Do not cover the device or block the airflow to the device with any other objects. This device was qualified under test conditions that included the use of the supplied cables between system components.

To comply with regulations, the user must use the cables supplied with the unit (including power adapter) and follow the installation guide. Place the unit to allow for easy access when disconnecting the power adapter from the main wall outlet. Operate this device only with the type of power source indicated on the marking label. If you are not sure of the type of power supplied to your facility, consult your dealer or local electricity provider.

Do not use this product near water, for example a swimming pool or a bathroom. Keep the device away from excessive heat and humidity and keep the device free from vibration and dust. Wipe the unit with a clean, dry cloth. Never use cleaning fluid or similar chemicals. Do not spray cleaners directly on the unit or use forced air to remove dust.

Avoid installing or using this product during an electrical storm - there may be a remote risk of electric shock from lightning. During electrical storms, for added protection from lightning or power surges we suggest unplugging the unit from the wall outlet and disconnecting all cables. For safety reasons, only authorized service technicians should open the device. If the device is opened the warranty will become void. The device may also affect medical equipment – we recommend checking any potential impact on medical equipment prior to use. This device, like other radio devices, emits radio frequency electromagnetic energy, but operates within the guidelines found in radio frequency safety standards and recommendations. It is recommended that the minimum operating distance from the installed Base Station to person is 19.68 inches (50cm).

1.7. General hazard statement

Safety notes are marked with symbols. Ignoring the safety notes may lead to personal injury, damage to the instrument and malfunctions. Signal Words identify the hazard severity level as the following:

Table 1.5 Safety notes

Word	Meaning
DANGER	Indicates an extremely hazardous situation which, if not avoided, will result in death or serious injury, permanent damage to equipment or large fines and penalties
WARNING	Indicates a hazardous situation which, if not avoided, could result in serious injury or damage to equipment and moderate fines or penalties
CAUTION	Indicates a hazardous situation which, if not avoided, could result in minor injury or minor damage to equipment or minor to moderate penalty fees
NOTICE	Indicates a hazardous situation not related to personal injury or damage to equipment

2. Product overview

2.1. Introduction

The goRAN™+ LTE Base Station is an innovative and cost-effective solution for creating a private LTE (pLTE) IoT network. The solution utilizes LTE Cat-1 and LTE-M technology and provides a standardized and flexible 3GPP-compliant cellular approach to low-power, long-range networks suitable for IoT devices. Supporting both the Anterix B106 900 MHz band and the license-free ISM band (902–928 MHz), it offers dual-band capability with the flexibility to seamlessly switch between bands during operation.

By leveraging the 915 MHz license-free band, users can increase network capacity without additional costs, running less critical applications in the ISM band while preserving the B106 spectrum for higher-priority tasks. This approach optimizes resource allocation, connects more assets, and improves grid visibility, offering a scalable solution for diverse operational needs.

Offering a standardized and flexible cellular approach to low-power, long-range networks, the goRAN™+ LTE Base Station provides a solution-in-a-box for building an LTE network either utilizing a user's specified core network or one built into goRAN™+ directly. Supporting bidirectional wireless communication for both stationary and mobile IoT devices, the goRAN™+ LTE Base Station is the ideal solution for remote data collection, monitoring, and management of IoT devices. With a Linux operating system to allow for easy plug-and-play operation and connection to the cloud via either Power over Ethernet (PoE) or LTE backhaul, the goRAN™+ LTE Base Station combines affordability with the scalability, spectral efficiency, and security brought by LTE technology.

The goRAN™+ LTE Base Station empowers users to deploy private LTE networks that are both cost-efficient and adaptable to future needs. Its dual-band capability provides unmatched flexibility, allowing seamless integration of critical and non-critical applications while ensuring optimal resource allocation. By combining advanced connectivity features with reliable performance, the goRAN™+ LTE Base Station stands as a robust solution for enhancing grid operations and addressing evolving IoT demands.

Figure 2.1 goRAN™+ LTE Base Station

2.2. Modules & interfaces

The items listed in Table 2.2-1 are included as standard options for the goRAN™+ LTE Base Station. An example of the accessories included as part of this standard offering can be seen in Figure 1.2-1. Note that the unit provided is configured to the user's specifications during the ordering process, and the actual accessories may vary from those shown in the diagram.

Table 2.2-1 Items included in a standard goRAN™+ LTE Base Station product offering

Ref	Item	Qty	Ref	Item	Qty
A	goRAN™+ LTE Base Station	1	E	Cable grip for Ethernet	1
B	GPS antenna	1	F	Mounting kit	1
C	RF Antenna	1	G	Backhaul LTE antenna	1
D	Power-Over-Ethernet (PoE) injector	1			

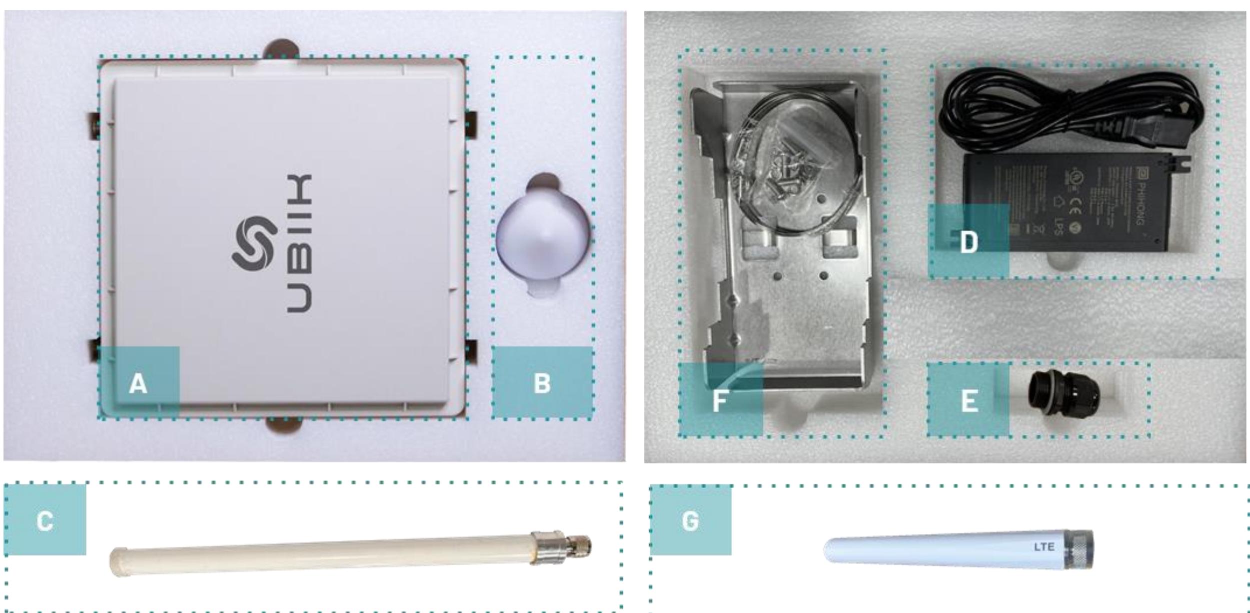


Figure 2.2-1 Items included in a standard goRAN™+ LTE Base Station product offering

Figure 2.2-2 and Table 2.2-2 below depicts the goRAN™+ LTE Base Station, illustrating all the available ports, interfaces, and LEDs. Note that this is the rear view of the unit. RF antenna is employed to establish wireless network coverage for serving end devices. The GPS antenna receives signals from satellites for unit time synchronization. The Backhaul LTE antenna provides a connection through the public network to the customer's enterprise network and application server, with a SIM card from the public network operator used for this purpose. Ethernet backhaul is an alternative for connecting to the application server, with a Power-Over-Ethernet (PoE) injector supplying power to the unit. LEDs indicate the operational status of the unit. A mounting kit is utilized for installing the unit on a pole.

Table 2.2-2 Interfaces & ports

Ref	Item	Ref	Item
A	RF Antenna connector	E	SIM card slot
B	goRAN™+ LTE Base Station	F	White and green LEDs
C	GPS antenna connector	G	Backhaul LTE antenna connector
D	Ethernet port (PoE)		

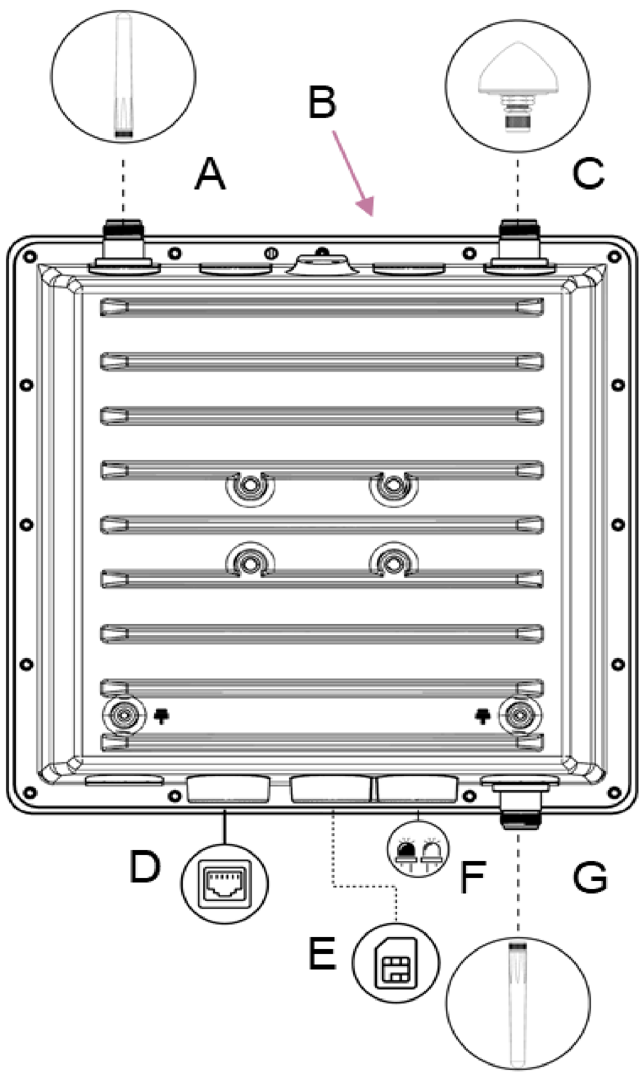


Figure 2.2-2 Interfaces & ports

3. Deployment

3.1. Architecture

The goRAN™+ LTE Base Station can be configured to operate with the eNB (evolved NodeB) and built-in EPC (Evolved Packet Core) or with the eNB and external EPC. The first option allows customers to easily deploy the entire LTE network with just one goRAN™+ unit. Customers need to establish a connection from the goRAN™+ LTE Base Station to the Application Server. Figure 3.1-1 illustrates the architecture of the goRAN™+ LTE Base Station with a built-in EPC.

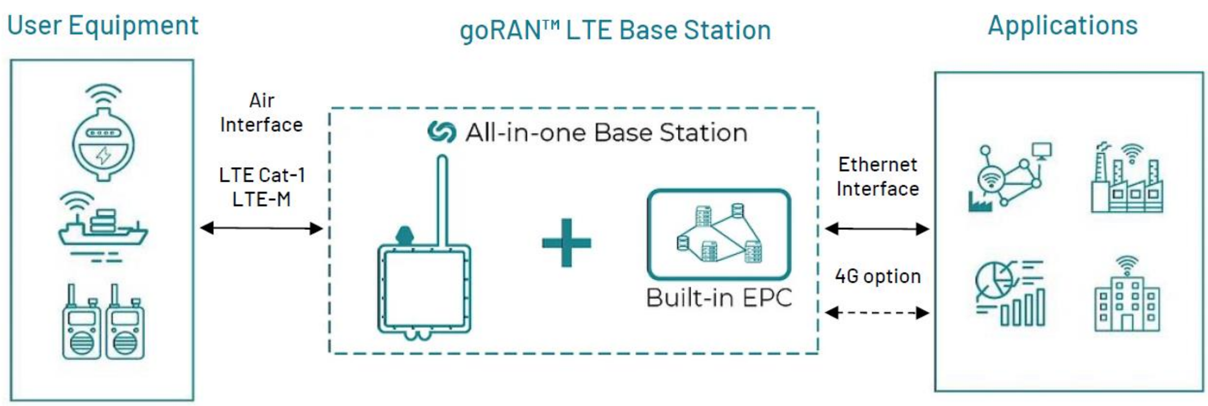


Figure 3.1-1 goRAN™+ LTE Base Station with built-in EPC

Configuration with an external EPC is used to deploy a network with multiple base stations to extend the service area. In this scenario, each goRAN™+ LTE Base Station connects to the EPC using the standard S1 interface, as shown in Figure 3.1-2.

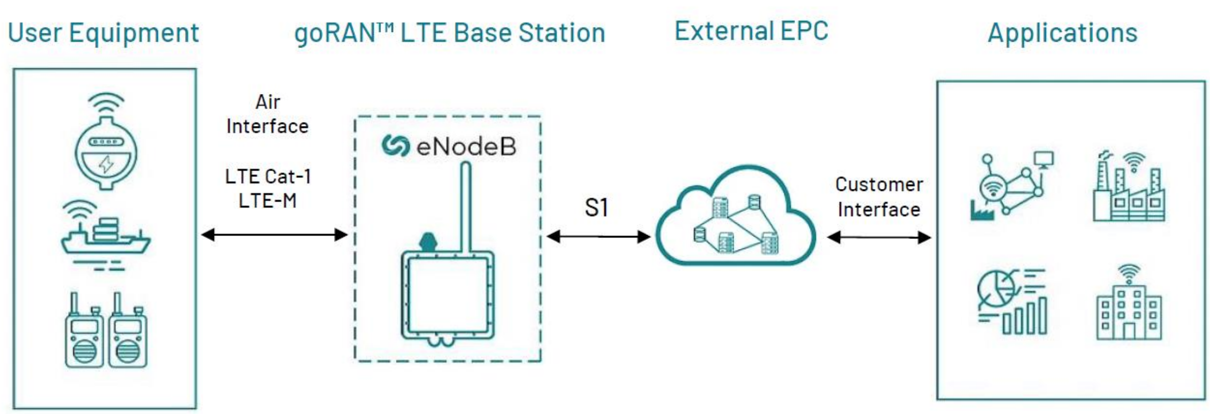


Figure 3.1-2 goRAN™+ LTE Base Station and external EPC

3.2. Deployment scenarios

The goRAN™+ LTE Base Station can be deployed as a private network by a customer, as shown in Figure 3.2-1. In this configuration, the built-in EPC is utilized, and SIMs are provisioned on the goRAN™+ HSS (Home Subscriber Service). The goRAN™+ LTE Base Station performs the function of authenticating the UEs in the network.

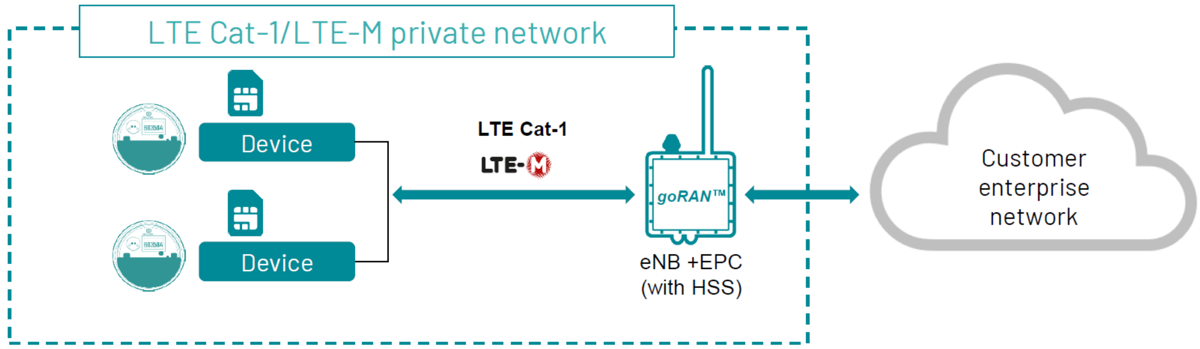


Figure 3.2-1 goRAN™+ LTE Base Station deployed as a private network

In scenarios aimed at extending the range of an existing RAN (Radio Access Network), the goRAN™+ LTE Base Station can be deployed, as shown in Figure 3.2-2. The goRAN™+ LTE Base Station serves as an eNB and interfaces with the EPC within the customer's network. In this configuration, the goRAN™+ LTE Base Station does not handle UEs authentication; instead, the SIMs are provisioned on the HSS of the external EPC.

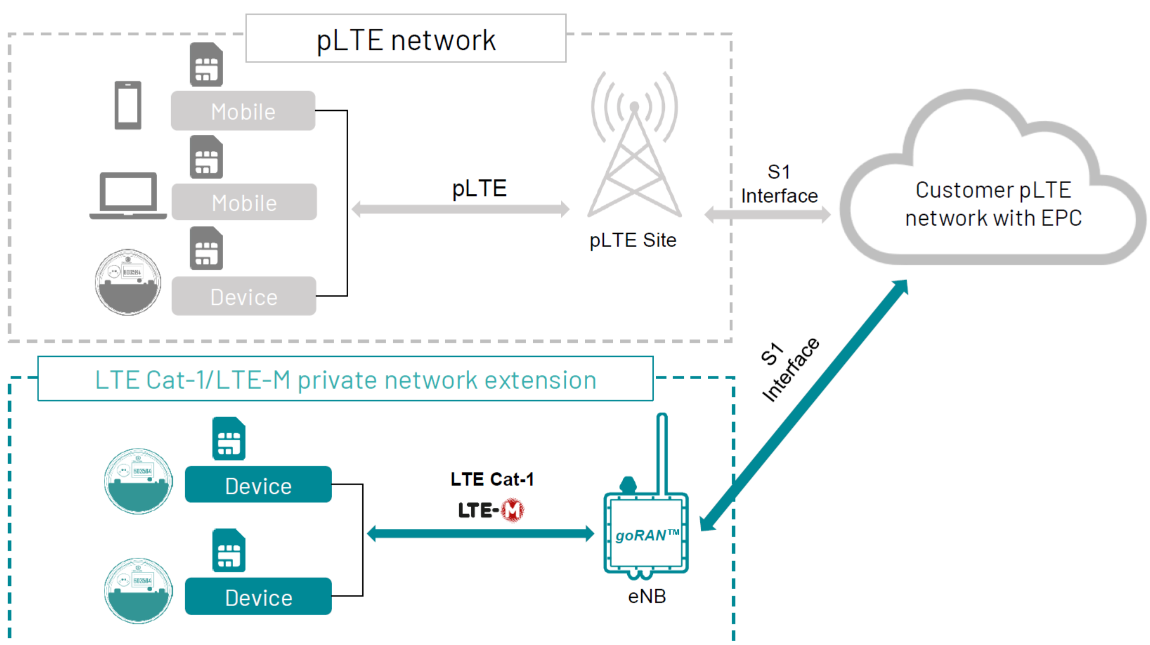


Figure 3.2-2 goRAN™+ LTE Base Station deployed as an eNB to extend a customer's network

Additionally, the goRAN™+ LTE Base Station can be deployed as a private network with a built-in EPC and connected to an external HSS using the S6a interface, as shown in Figure 3.2-3. This setup is suitable for extending the range of an existing pLTE network. It can also be employed when utilizing the HSS of a SIM provider, which might be deployed in the cloud. Additionally, this setup is used as an option for multiple base station deployment, as described in the next section. In this case, the goRAN™+ LTE Base Station doesn't handle UEs authentication, and SIMs are provisioned on the external HSS.

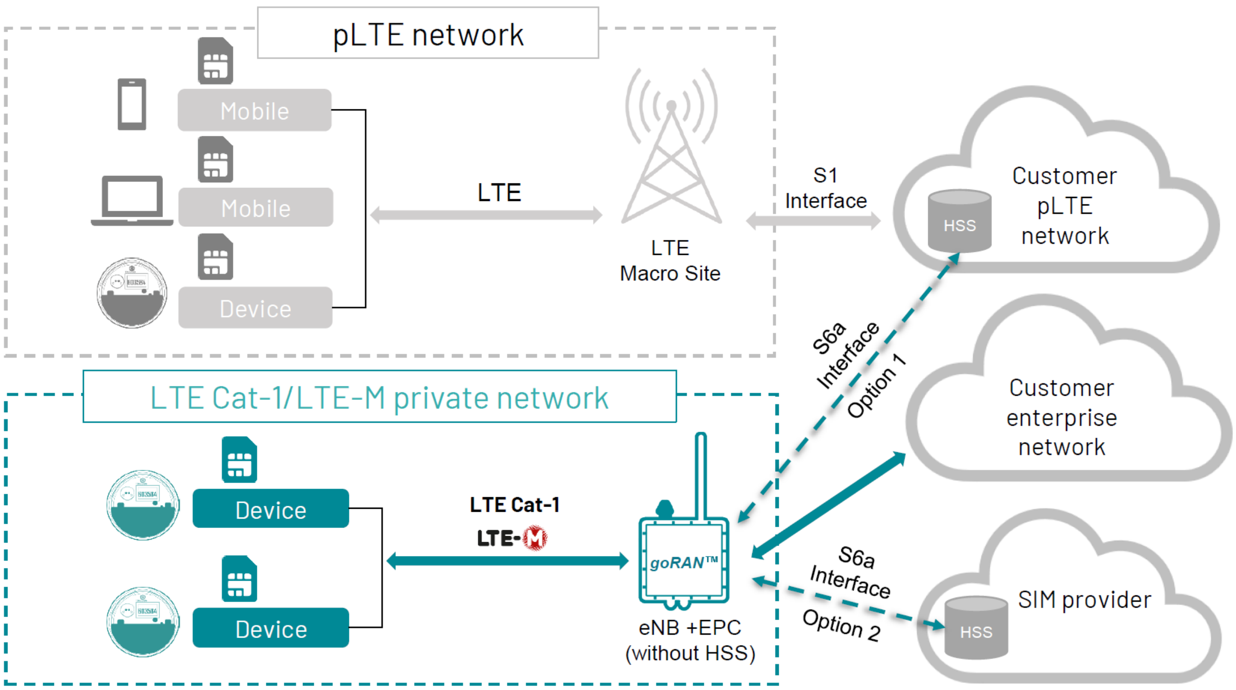


Figure 3.2-3 goRAN™+ LTE Base Station deployed as a private network with a connection to the HSS of the MNO or SIM provider

3.3. Multiple deployments

Depending on the coverage area size and the business requirements, deploying a network of multiple base stations might be essential. Leveraging the scalability offered by the 3GPP standards, the goRAN™+ LTE Base Station can create networks of varying scales. This setup accommodates networks ranging from two to several hundred goRAN™+ units, providing customers with adaptability and scalability. Additional base stations can be seamlessly integrated into the existing network after the initial deployment of the goRAN™+ network.

There are two options for multiple deployments. The first involves each goRAN™+ connecting to a central EPC through a standard S1 interface, similar to how mobile operators establish public networks with numerous base stations and a centralized EPC. In this scenario, the goRAN™+ Base Stations act as eNodeBs, and the internal EPC of the units remains inactive. The second option is an innovative Distributed pLTE solution, where each unit includes a basic built-in EPC function and connects to an external HSS deployed in the customer's network. This solution eliminates the need for a complicated external EPC with many components. It also reduces signaling loading on the backhaul interface compared to the external EPC solution, as most signaling data exchange for the S1 interface occurs inside the goRAN unit. The S6a interface to the external HSS is primarily used during UE attach procedures. It's noteworthy that deploying and maintaining an external HSS is more cost-effective for the customer than an entire dedicated EPC.

There are two network configuration options available for goRAN™+ backhaul interfaces. The first configuration employs Ethernet connectivity, allowing all goRAN™+ units to establish connections and communicate with the EPC/HSS and application server via the local network infrastructure. The second configuration utilizes 4G backhaul interfaces for seamless connectivity between goRAN™+ units and the EPC/HSS and application server. When goRAN™+ is configured to use the 4G backhaul interface, data from goRAN™+ is transmitted to the mobile operator's network. The network then forwards the data to the customer's endpoint, typically employing a dedicated APN (Access Point Name) and secure communication channels. In Figure 3.3, multiple deployments with external EPC and external HSS are shown, illustrating both backhaul interface options.

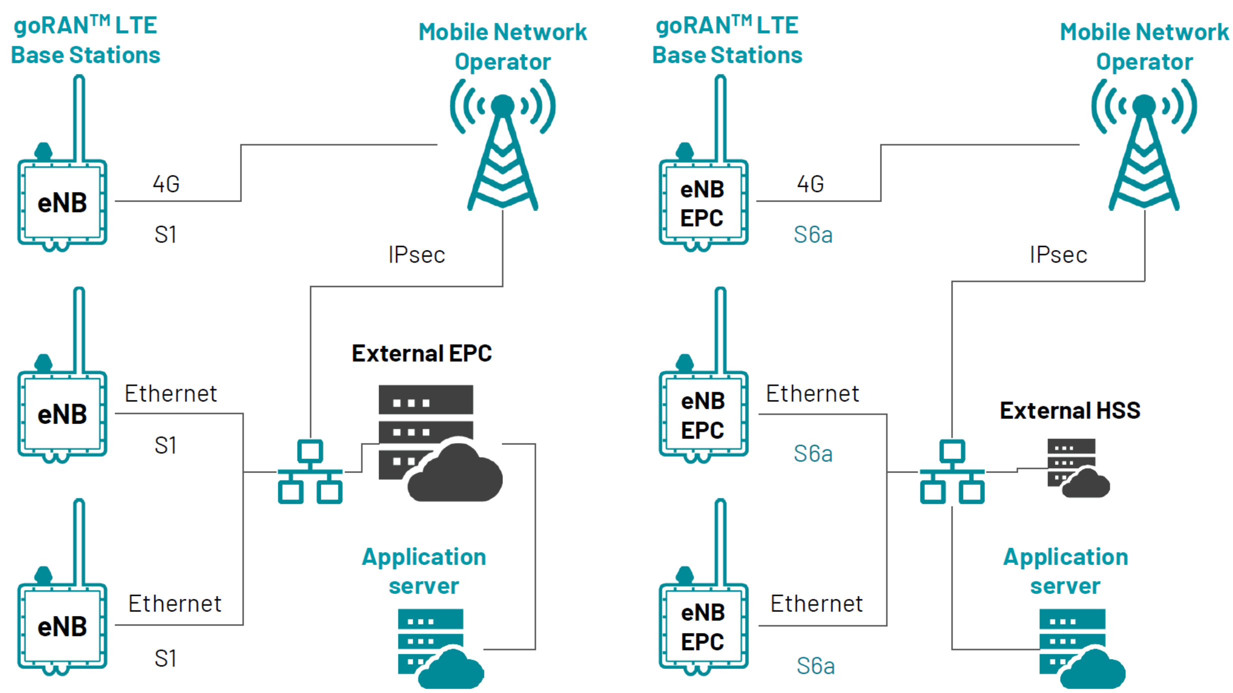


Figure 3.3 External EPC and external HSS options for multiple deployments of goRAN™+ LTE Base Stations

4. Data security

The goRAN™+ LTE Base Station provides a high data security standard that is defined by LTE design. LTE is the only mature wireless technology to enable protection of session set-up and administration signals (control plane) separately from the data payload itself (user plane). Through its Authentication and Key Agreement protocol, LTE secures control plane communications independently from user plane data. LTE includes cryptographic protections for control plane communications between the device and three different network elements to prevent attackers from spoofing devices and/or network elements to compromise the system.

To protect control plane communications between the device and the HSS (Home Subscriber Server), LTE uses an application called USIM that typically runs on the UICC (Universal Integrated Circuit Card). Through USIM, LTE supports the authentication of the user to the device as well as authentication of the device to the HSS, which manages customer information and authorizes the device's access to the network. The MME (Mobile Management Entity) is also a core network element; it manages device mobility on the network. Using a feature called NAS (Non-Access Stratum) security, LTE verifies, encrypts, and protects the integrity of control plane signaling between the device and the MME separately from other interfaces. For protection of the device's control plane communications with the radio network, LTE employs AS (Access Stratum) security, which provides verification and integrity protection as well as encryption for control plane signaling between the device and the base station.

LTE provides enhanced security measures to protect the user data contained in the payload of the communication. For the user plane, LTE utilizes integrity verification and encryption of data sent between the device and the core network. The Figure 4 shows described security levels.

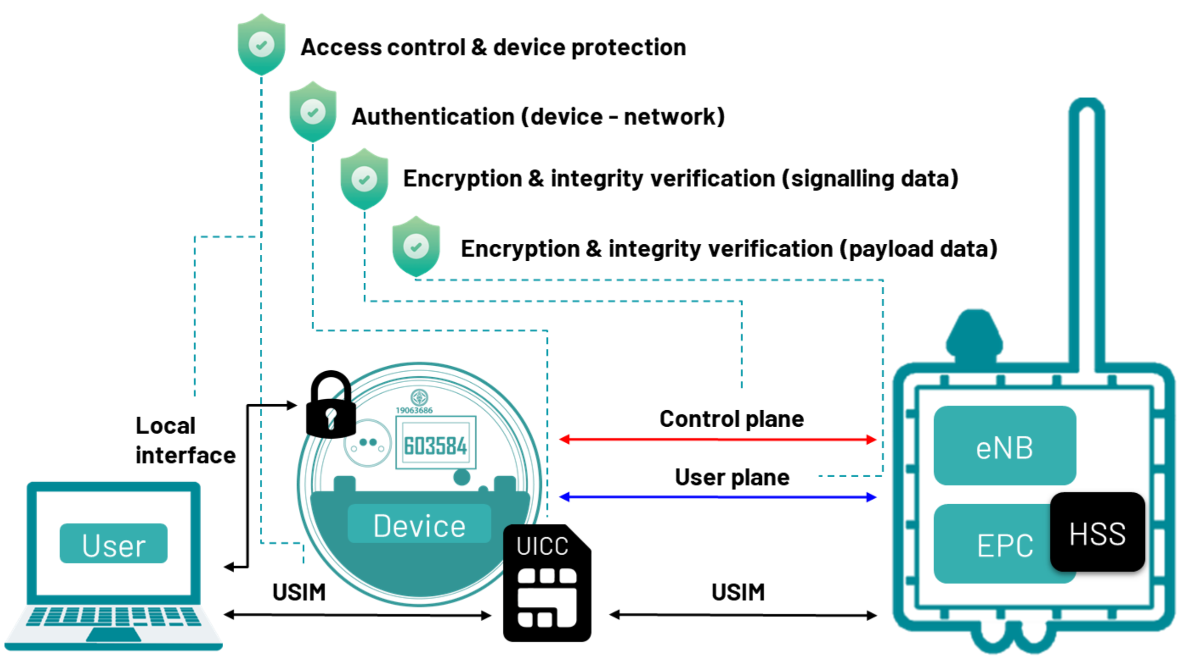


Figure 4 Data security levels

LTE Cat-1 and LTE-M devices provide an additional layer of security, due to their strict adherence to 3GPP specifications, the high security level industry standard, and the highly competitive market they are produced in. Such devices are typically designed with built-in security features, such as secure access, secure boot and firmware updates, to help prevent unauthorized access and tampering. Supported by major mobile equipment, chipset and module manufacturers, private LTE networks benefit from all the security features of 3GPP standards, such as support for user and device authentication, data encryption, data integrity verification and mobile equipment protection.

5. Installation

5.1. Assembly

The pole mounting kit is included as part of the standard offering, providing a mounting system suitable for typical installation environments. Using this kit, the goRAN™+ LTE Base Station can be securely mounted directly onto a pole with a diameter ranging from 4 to 12 inches (100 mm to 300 mm). Note that the wall mounting kit can be chosen during the ordering process. Table 5.1 and Figure 5.1 below shows the mounting items.

Table 5.1 Items of the pole mounting kit

Item	Qty	Item	Qty
goRAN™+ LTE Base Station	1	Washers	4
Mounting Plate	1	Spring Washers	4
Screws	4	Hose Clamps	2

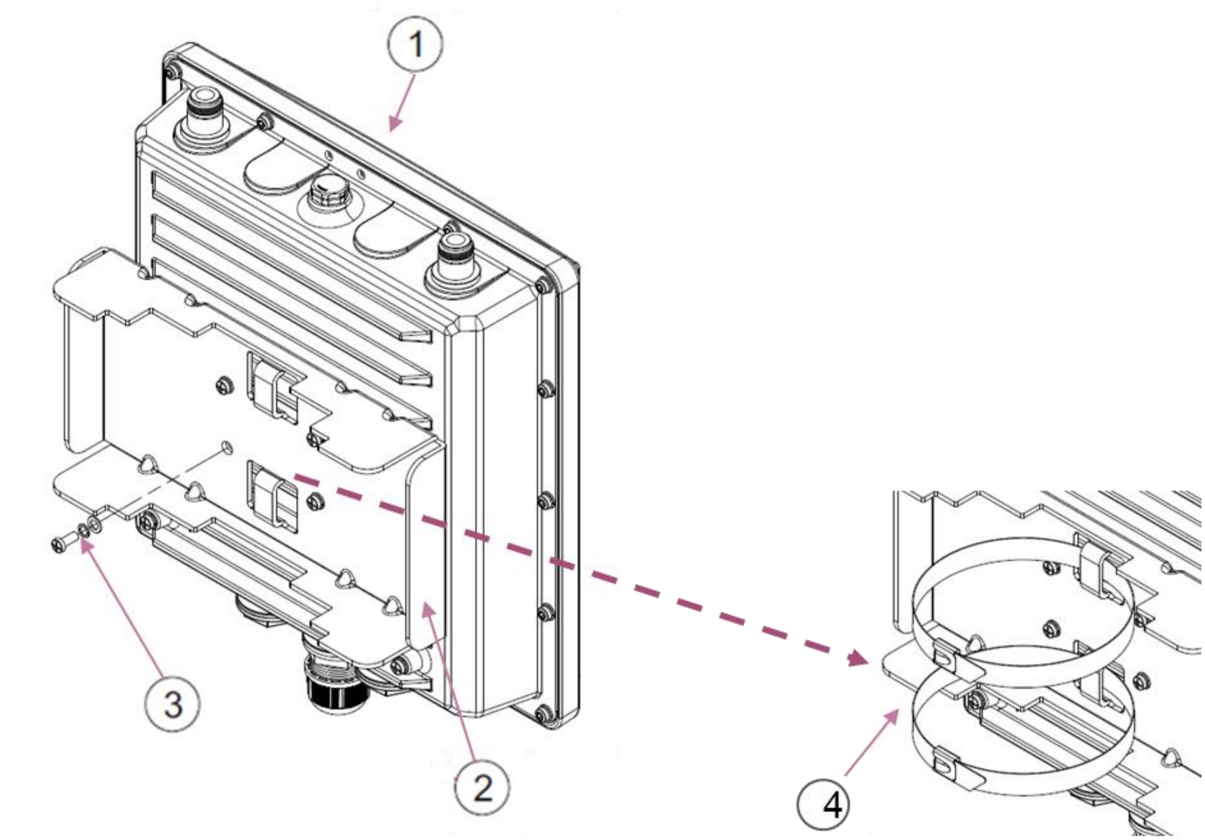


Figure 5.1 Items of the pole mounting kit

Step 1: Use the four screws, spring washers and washers (3) to attach the mounting plate (2) onto the goRAN™+ LTE Base Station (1).

Step 2: Pass the two Hose Clamps (4) through the matching hole in the mounting plate (2) as shown.

Step 3: Loop the open Hose clamps around the pole chosen for the installation and tighten the screw until the unit is secure.

5.2. Grounding

Ensure that the installation of the goRAN™+ LTE Base Station is conducted in accordance with all relevant national and local building and safety codes. Even if grounding is not mandatory according to applicable regulations and national codes, it is highly recommended to ground the unit. This precaution will provide protection against voltage surges and static charges. The two grounding screws M4x12 (marked ⏚) are located on the back of the unit, see Figure 5.2 below). Table 5.2 displays the grounding items included in a standard goRAN™+ LTE Base Station product offering. Note that the grounding cable is not part of the standard offering.

Table 5.2 Items of the grounding

Item	Qty	Item	Qty
Screws	2	Spring Washers	2
Washers	2		

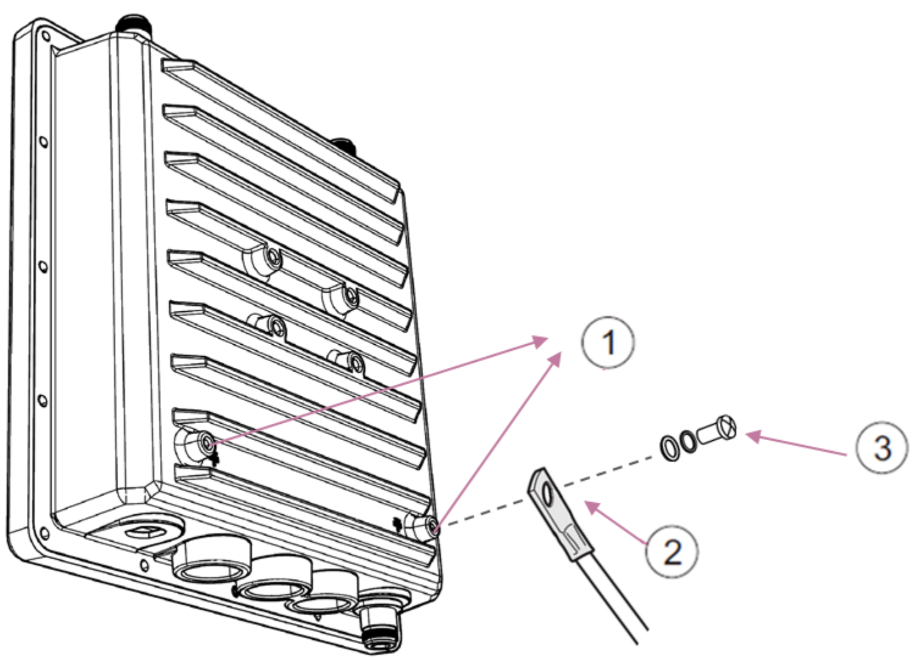


Figure 5.2 Items of the grounding

Step 1: Connect one end of a grounding cable (2) to the grounding screw (3), then connect the grounding screw to the one of two grounding points on the back of the unit (1) and securely tighten it.

Step 2: Connect the opposite end of the grounding cable to a reliable ground (earth) connection.

WARNING!

Always connect the grounding cable before connecting any other cables.

5.3. Mechanical drawings

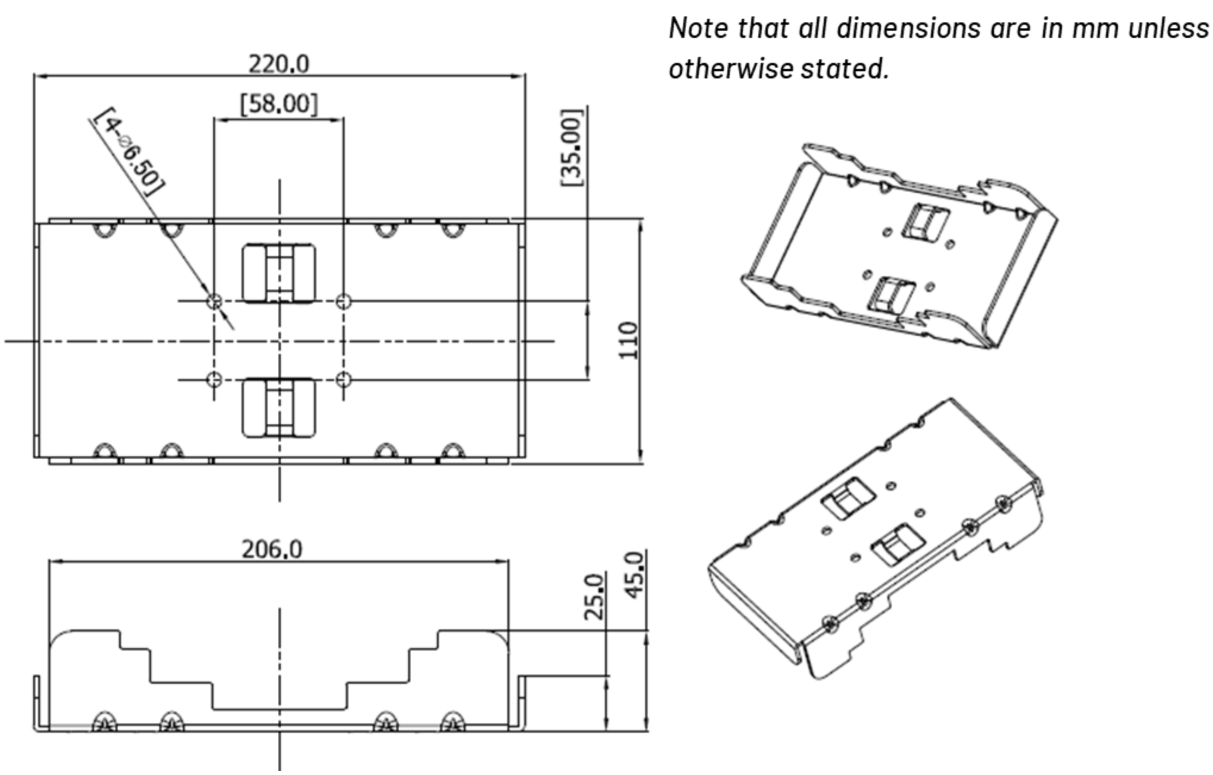


Figure 5.3-1 Mechanical drawings: mounting plate

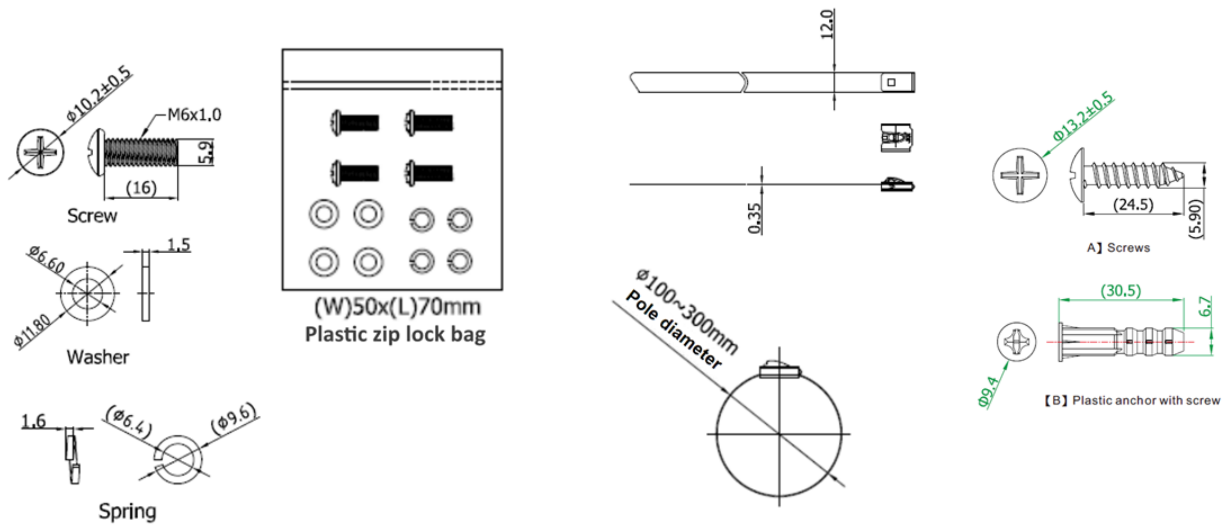


Figure 5.3-2 Mechanical drawings: screw, spring washer, washer, hose clamp, anchor & screw

5.4. Cable & antenna connection

The standard goRAN™+ LTE Base Station requires an RF antenna, backhaul LTE antenna and GPS antenna. The process of attaching these antennas is shown in Figure 5.4-1.

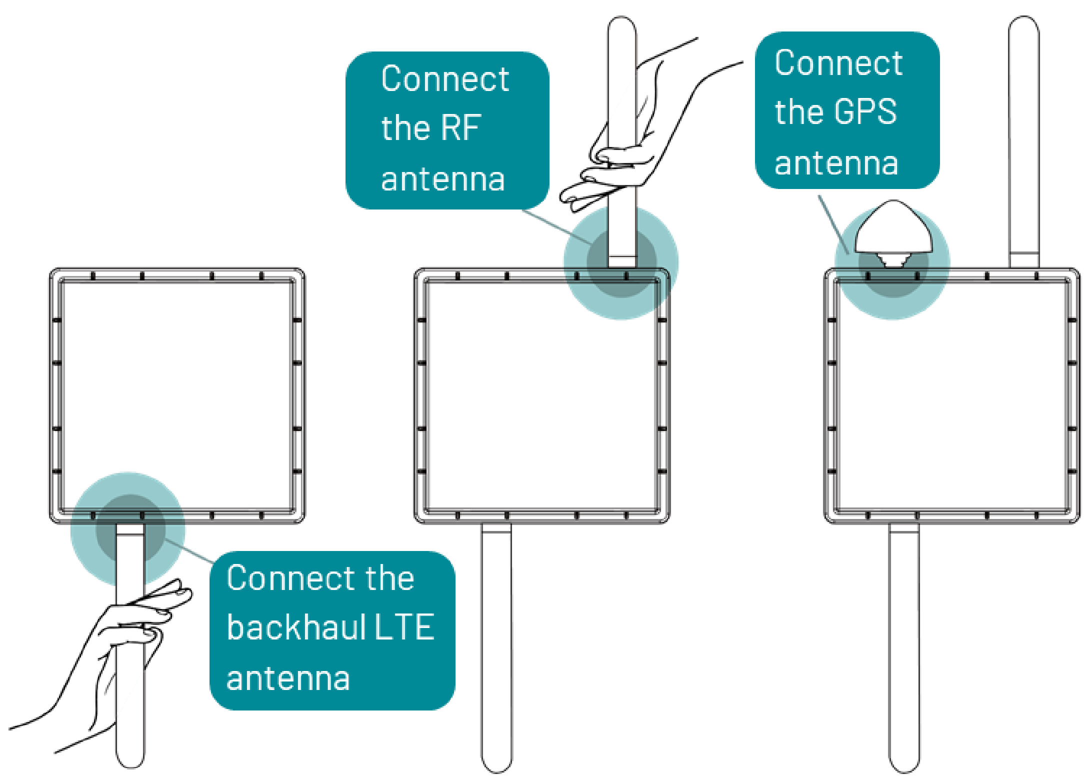


Figure 5.4-1 Attaching the antennas to the goRAN™+ LTE Base Station

The goRAN™+ LTE Base Station is supplied without an Ethernet cable in the standard package, which means that users should utilize their own Cat 5e or Cat 6 Ethernet cable with shielding to meet the IEEE 802.3bt standard requirements for the backhaul connection. The user should attach the cable grip to the Ethernet wire and plug one end into the goRAN™+ LTE Base Station, and the other end into the local network router, as shown in Figure 5.4-2. If using an outdoor version of the goRAN™+ LTE Base Station, screw in the cable grip to ensure a water-tight seal suitable for outdoor use. For an actual outdoor installation, cable grips must be applied to guarantee IP67 ingress protection.

WARNING!

Choose the Cat 5e or Cat 6 Ethernet cable with shielding to meet the IEEE 802.3bt standard requirements to supply POE injector.

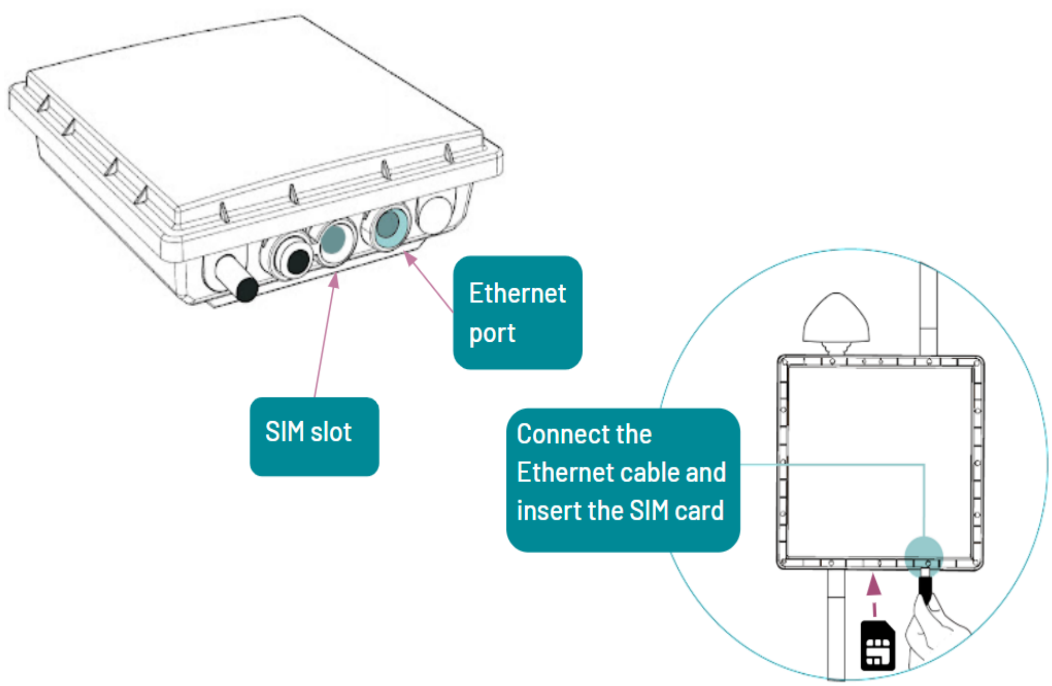


Figure 5.4-2 Connecting the shielded Cat 5e Ethernet cable and inserting the SIM card

The goRAN™+ LTE Base Station comes with a Power-Over-Ethernet (PoE) injector customized to the user specification during the ordering process. Once connected to power, the goRAN™+ LTE Base Station will attempt to connect to a network automatically. The unit can be reset by disconnecting and reconnecting the injector. This may be required should a connection error occur (as indicated by the green and white LEDs). To enable LTE backhaul, the user should insert a SIM card into the unit. Figure 5.4-2 shows the SIM card slot, along with the correct insertion direction.

6. Starting up

6.1. Network connectivity

After completing the installation process of the goRAN™+ LTE Base Station, it's crucial to conduct basic checks to confirm its connectivity to the local network and the internet. The following sections offer guidance on performing these checks.

Before shipment, users can request Ubiik engineers to configure the goRAN™+ LTE Base Station with a static IP address. By default, however, the goRAN™+ LTE Base Station is set up for DHCP. For the DHCP-configured version, the user's local network router should be configured to assign an IP to the goRAN™+ LTE Base Station via DHCP. To verify the IP address assigned to the goRAN™+ LTE Base Station via your router and DHCP, log into your router and check the IP assignment for the MAC address associated with your goRAN™+ LTE Base Station. The goRAN™+ LTE Base Station's MAC address label can be found on a label attached to the unit. If, for any reason, this MAC address is not available, please contact Ubiik Support.

To perform a basic connectivity check, observe the green and white status LEDs. Table 6.1 provides various states for the Status LED. There are two LEDs present, a white and a green. These LEDs, together, will be in one of four states. If the goRAN™+ LTE Base Station is operating correctly and the S1 interface is successfully established, the LEDs should be in a solid state. The LEDs should cycle through all other states to achieve this solid state. If for some reason, the last state is not reached, a problem exists.

Table 6.1 LEDs and system status

Green LED	White LED	System Status
Off	Off	Power off, disconnected
Off	On	Power on, OS running
Flashing	On	Power on, system running
On (Solid)	On	Power on, system running and S1 interface is established

After confirming that the goRAN™+ LTE Base Station is connected to the local network, the next step is to ensure it has Internet access. To do this, the user should establish an SSH connection to the unit from the computer using the following command, as demonstrated in Figure 6.1:

```
ssh -p 45296 guest@XXX.XXX.XXX.XXX
```

Make sure to replace XXX.XXX.XXX.XXX with the goRAN's IP address. When prompted, enter the username `guest` and the password `guest`. Once the SSH connection is established, the user can verify Internet connectivity by performing a ping operation to Google's primary domain using the following command: `ping -c 4 8.8.8.8`

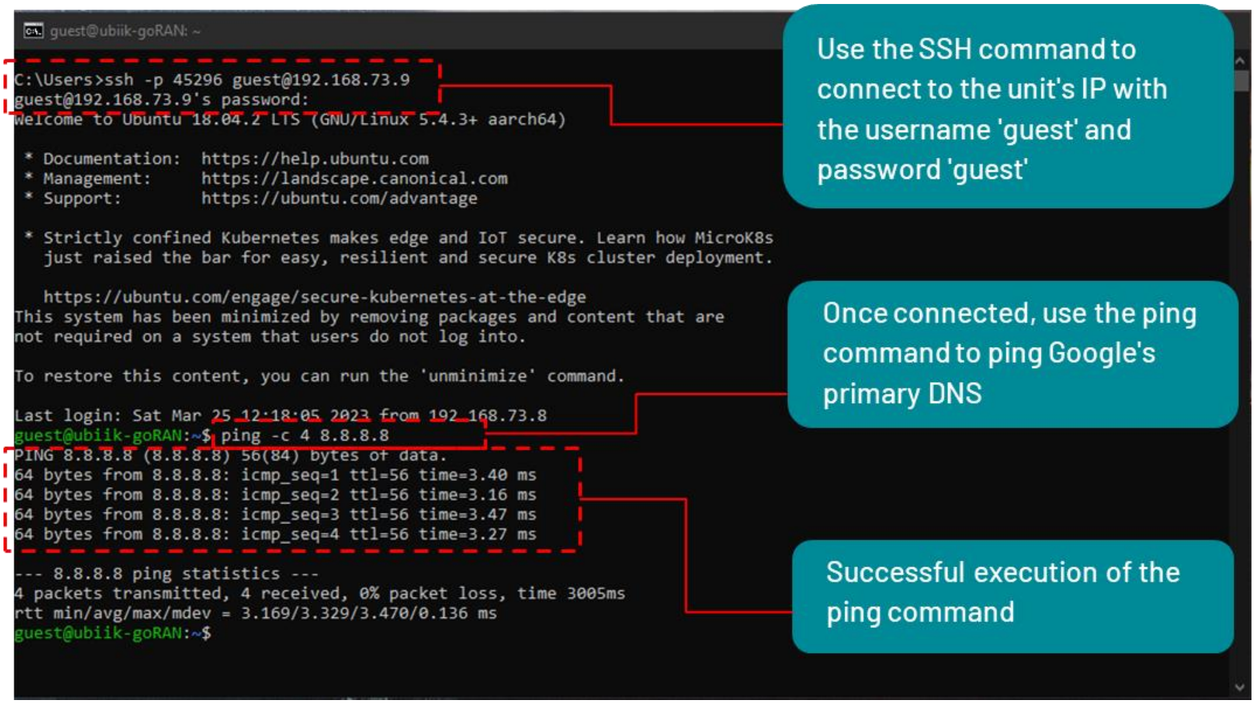


Figure 6.1 Pinging the Internet from the goRAN™+ LTE Base Station

6.2. Options

Table 6.2 showcases the available customizable options that come with the goRAN™+ LTE Base Station. The goRAN™+ LTE Base Station is pre-configured by Ubiik based on user-provided specifications and spectrum licensing requirements prior to delivery.

Table 6.2 Options available for the goRAN™+ LTE Base Station, configured at time of ordering

Options		Description	Sub-options
A	Backhaul	Configured for Ethernet or LTE backhaul	- Ethernet - LTE
B	Installation	Configured for various installation location types	- Mounting types - Cable types - Power supply types
C	PoE	Configured PoE unit for different operating temperatures	- POE60U-BTA5600-R with operating temperature -20℃ to 55℃ - POEO75U-1BT-R with operating temperature -40℃ to 55℃

WARNING!

The user is responsible for setting up the goRAN™+ LTE Base Station in a confined environment to validate spectrum configurations. It is the user's responsibility to ensure that regional spectrum licensing requirements are met during testing and installation.

6.3. UEs connection troubleshooting

It is important to note that the UE & base station need to be properly set up in order for UEs to establish a connection with the goRAN™+ LTE Base Station.

1. Install goRAN antenna correctly. Make sure that the antennas are placed strictly vertically.
2. The minimum distance between the UE and the base station could vary depending on the band and the base station's output power. However, it's not recommended to place the UE closer than 2 meters from the base station.
3. If the UE can receive a signal from the base station, make sure that the RSRP is not higher than -70 dBm. Otherwise, decrease the base station's output power or increase the distance between the UE and the base station.
4. Check if the UE receives a signal from the base station:

   AT+CSQ

   AT+CESQ
5. Make sure the band set on the UE is in accordance with the base station settings. Note that different UEs have different AT commands to retrieve the band information.
6. Make sure the APN is set according to the EPC settings:
   - internet - APN for data service
   - ims - APN for VoLTE service

   Here is an example of AT command (note that different UEs could have different AT commands):

   AT+CGDCONT=1,"IP","internet"
7. Make sure the PLMN on the UE is set to automatic mode or, if it is set to manual selection, the PLMN is set in accordance with the base station settings.

   Here is an example of AT command (note that different UEs could have different AT commands):

   AT+COPS=0 - set to automatic mode

   AT+COPS=1,2,"99970" - set to manual selection, PLMN=99970

   Note that for some UEs, it is needed to power off the transmitter with the AT+CFUN=0 command, then send an AT command to set the PLMN selection mode, and then power on the transmitter again with the AT+CFUN=1 command.

8. In case the UE receives the signal from the base station but cannot attach, analyzing the base station logs could be helpful (see the NMS and ACT sections of the user manual to learn how to collect logs from the base station). Additionally, users could request support from the UE's vendor to collect the DM logs on the UE.

7. Ubiik NMS (Network Management System)

7.1. Ubiik NMS overview

The Ubiik NMS (Network Management System) is a cloud-based management platform accessible to users from anywhere via a web browser. Alternatively, it can be deployed on the customer's infrastructure (on-premises). This system encompasses functions for fault management, configuration management, and accounting management. It empowers users to oversee and configure both individual goRAN™+ LTE Base Stations and entire networks comprising multiple units. The Ubiik NMS supports diverse aspects of goRAN™+ LTE Base Station management, including eNodeB monitoring and configuration, EPC management, alarm monitoring, SIM card provisioning, end-device monitoring, unit firmware upgrades, and more.

CAUTION!

The goRAN™+ LTE Base Station is configured during manufacturing, including parameters such as radio frequency and output power, in compliance with regulations specific to the territory where the base station is deployed. This pre-configured setup eliminates the need for additional configuration. However, this User Manual outlines the possibility of adjusting a wide range of technical parameters based on the hardware and software capabilities. It's important to note that not all parameters may be adjustable by the user, depending on the specific configuration limitations. An exception to this might be the goRAN™+ LTE Base Station provided for testing purposes. In any case, users must adhere to regional regulatory requirements during the configuration process. For further information, please contact Ubiik Support.

A user will have received login details for the Ubiik NMS with their goRAN™+ LTE Base Station package or via email after their purchase. After navigating to https://bsms.ubiik.com/, the user should be presented with a login screen as shown in Figure 7.1.

Figure 7.1 Ubiik NMS login portal

7.2. Dashboard

As shown in Figure 7.2, the first section on the NMS page is the Dashboard. Users can see the list of active alarms in this section. Alarms are divided into several categories: Critical, Major, Minor, and Warning. Users can click on the total number of alarms to retrieve detailed alarm status. By doing this, users go to the Alarm Detail section, which will be described below in the manual.

The next section on the page is the Alarm count, which is a chart displaying the number of alarms over time. The last section on the page is Base station, which shows the number of base stations that have a Connected status over time. Overall, using the Dashboard, users can control and monitor the status of the base stations bound to their user account. For more detailed information on different aspects, users can navigate to other sections of the NMS menu on the left side of the screen.

Figure 7.2 Dashboard

7.3. Base Station

7.3.1. eNodeB

One of the primary features of the goRAN™+ LTE Base Station is its eNodeB functionality, which essentially comprises RAN (Radio Access Network) operations. Ubiik NMS enables the configuration of each specific base station in the network, and provides information about all base stations within the customer's network, as detailed in the following section.

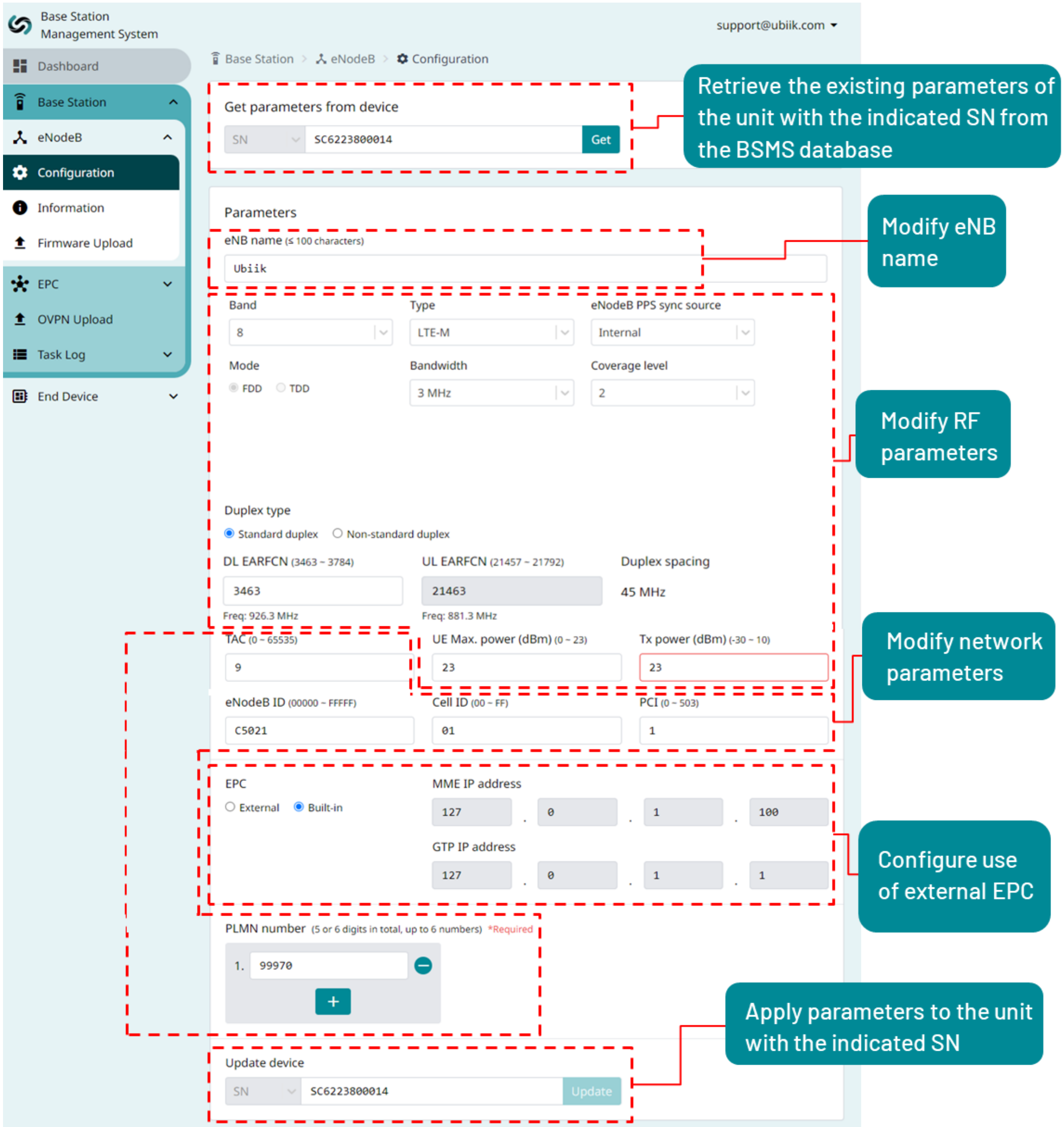


Figure 7.3.1-1: eNodeB Configuration page

Configuration

The Configuration page allows for the simple configuration of parameters related to three main types: RF parameters, network parameters, and basic EPC settings. These parameters can be set by selecting the serial numbers of the goRAN™+ LTE Base Station, retrieving the configuration from the Ubiik NMS database, applying the changes to the database, and subsequently to the goRAN™+ LTE Base Station itself. To change the parameters, the user selects the SN (Serial Number) of the goRAN™+ LTE Base Station and retrieves the parameters to populate the GUI. Then the user can proceed to alter the RF and network parameters, and also choose the EPC mode, setting it to built-in EPC or external EPC. Figure 7.3.1-1 illustrates an example of the Configuration page settings.

The figures below illustrate the Ubiik NMS interface with a brief explanation of the meaning of all the parameters. Note that depending on the specific goRAN™+ LTE Base Station factory hardware configuration, some sub-options within a given parameter may or may not be accessible. The eNB name can be changed to a specific name for user convenience, particularly in scenarios of multiple deployments when numerous goRAN™+ LTE Base Stations are managed under a single Ubiik NMS account.

Figure 7.3.1-2 RF parameters

Figure 7.3.1-2 displays the RF parameters. Users can modify the Band and Bandwidth only for certain factory hardware configurations. The Duplex communication mode (for both uplink and downlink channels) cannot be manually configured for either TDD or FDD, as this parameter is pre-defined for specific bands. Coverage Level can be further used to provide coverage enhancement. To enable both coverage levels (1 and 2) users should choose option 2, and for enabling only one coverage level users should choose option 1.

In case of TDD band there are additional options available as shown in Figure 7.3.1-3 The TDD Frame Configuration and TDD Special Frame Configuration options allow to set up LTE TDD specific operational time periods.

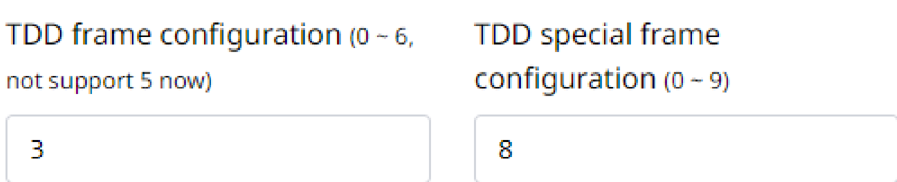


Figure 7.3.1-3 TDD Frame configuration

As shown on Figure 7.3.1-4, users can choose eNodeB PPS Sync Source. There are three sources of synchronization available: Internal, PTP (Indoor) and GPS (Outdoor). For the deployment of a single unit of the goRAN™+ LTE Base Station, the Internal source option could be used. For multiple deployments, there is a need to use PTP (Indoor) or GPS (Outdoor) synchronization source. Note that for using the PTP (Indoor) option, there is needed a PTP Grandmaster Clock deployed in the customer's network. Then goRAN™+ LTE Base Station will synchronize with the Grandmaster Clock through Ethernet. The GPS synchronization source should be chosen only in cases where antenna placement has been properly considered to allow for GPS signal access. Otherwise, proper Base Station operation may not be guaranteed.

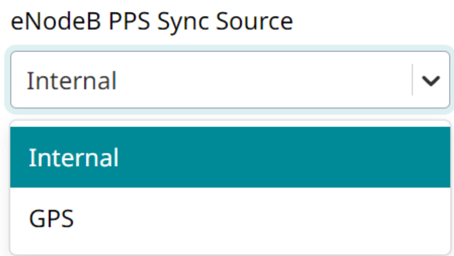


Figure 7.3.1-4 Synchronization source options

The user can also manually set up EARFCN values, for their chosen band, as shown in Figure 7.3.1-5. Depending on the goRAN™+ LTE Base Station's factory hardware capabilities, the user may choose to operate in either Standard Duplex or Non-Standard Duplex mode. Setting up Standard Duplex only requires setup of the DL EARFCN parameter. The second parameter, UL EARFCN, is set automatically to match standard LTE band settings.

In the case of Non-Standard Duplex, users must set up both, DL EARFCN and UL EARFCN, parameters. The frequency values for the user's chosen EARFCN are shown below the text fields to help double check user selections. Note that for the TDD configuration, the duplex settings are not relevant as the same radio channels are used for both uplink and downlink.

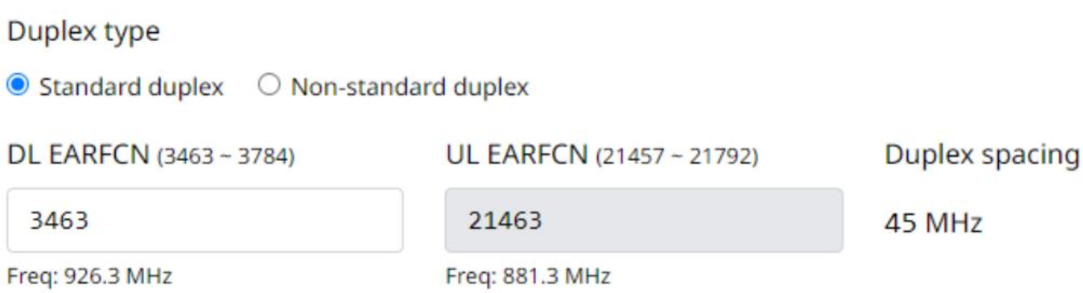


Figure 7.3.1-5 EARFCN configuration for Standard Duplex

The user can set the UE Max. power (dBm), which allows for limiting the maximum power of the devices if needed for specific IoT use cases. By default, the value is set in accordance with UE's power class 3 as specified by 3GPP, which is 23 dBm.

The user can adjust the output power of the base station's transmitter, which is configured in the Tx power (dBm) field. As shown in Figure 7.3.1-6, the value can range from -30 to 30 dBm. It's important to note that the Tx power may be subject to regulatory limits. For detailed information about a specific user base station, please contact Ubiik Support.

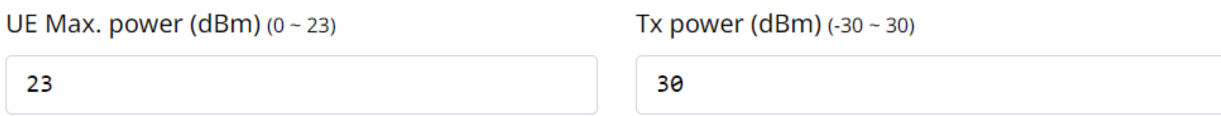


Figure 7.3.1-6 UE Max. power and Tx power

In Figure 7.3.1-7 below, eNodeB parameters are shown. TAC (Tracking Area Code) provides a location code within a given network. eNodeB ID, Cell ID and PCI are identifiers for each eNodeB within the network.

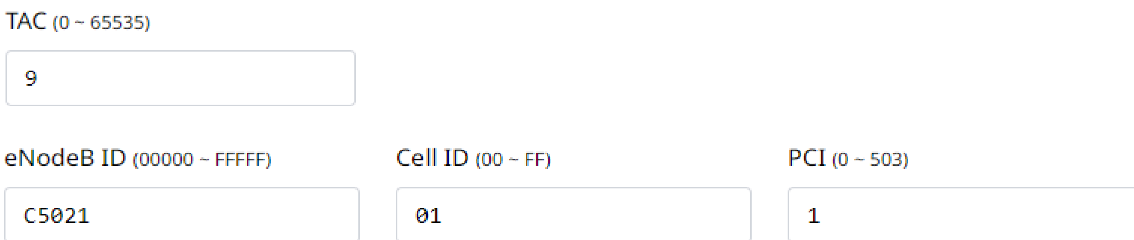


Figure 7.3.1-7 eNodeB parameters

The user can change the PLMN number (Public Land Mobile Network), which consists of the MCC (Mobile Country Code) and MNC (Mobile Network Code). The option to modify this code is shown in Figure 7.3.1-8. Note that the PLMN forms the first digits of the IMSI number.

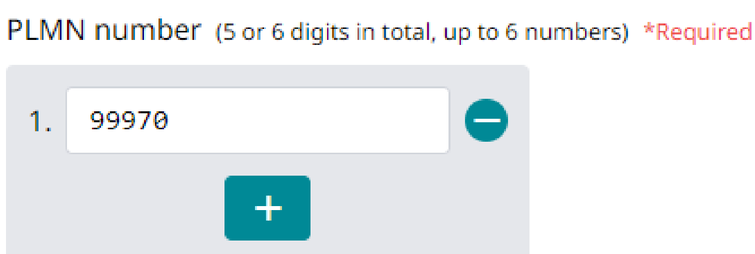


Figure 7.3.1-8 PLMN number

The goRAN™+ LTE Base Station is configured by default to operate with a built-in core. However, there are use cases where the user may prefer to connect the goRAN™+ LTE Base Station to an external EPC instead of using the default internal one. In such cases, the user needs to choose the External option, as shown in Figure 7.3.1-9, and set the EPC option, which includes the MME IP address and GTP IP address. Note that the MME IP address refers to the IP address of the S1 interface on the EPC, while the GTP IP address is the IP address obtained by the goRAN™+ LTE Base Station.

Figure 7.3.1-9 Basic EPC settings

Once the parameters have been modified, the user can apply them by clicking the Update button as shown in Figure 7.3.1-10. Note that it may take up to 60 seconds for the updated configuration to be received by the goRAN™+ LTE Base Station.

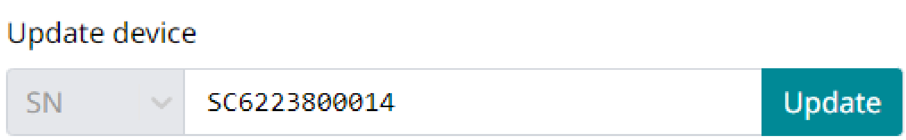


Figure 7.3.1-10 Applying parameters to goRAN™+ LTE Base Station

Information

The Information page provides configuration details for all goRAN™+ LTE Base Stations bound to the customer's account. To locate a specific base station from the list, the user should enter the serial number into the BS SN field and click Search, as shown in Figure 7.3.1-11.

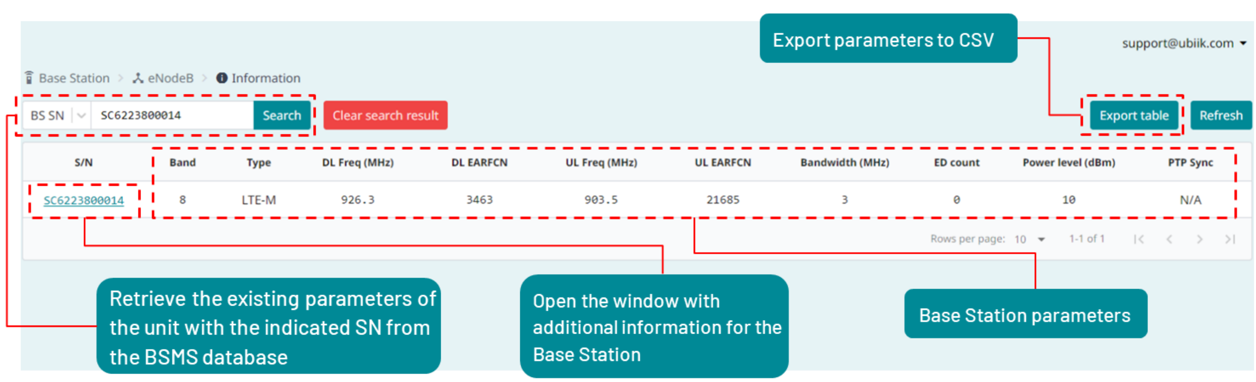


Figure 7.3.1-11 eNodeB Information page

The displayed parameters include Band (frequency range), Type (radio access technology), DL Freq (MHz) for downlink frequency, DL EARFCN for downlink frequency channel, UL Freq (MHz) for uplink frequency, UL EARFCN for uplink frequency channel, Bandwidth, ED count for the number of end devices operating with the base station, Power level (dBm) for the current output power set on the base station, and PTP Sync for the synchronization status (relevant only if enabled). Additional buttons on the page include Clear search result (to cancel the selection of a specific base station and view all base stations linked to the account), Export table (to export data to a CSV file), and Refresh (to update the displayed base station parameters).

It is possible to obtain additional information about the goRAN™+ LTE Base Station by clicking on the unit's serial number, the first field in the row. This action opens a window as depicted in Figure 7.3.1-12. The Basic information section displays the product name and allows users to check for a new software version by clicking Check new version. The Status section provides interface statuses, which can be useful during base station deployment or troubleshooting. BS status pertains to the link between the goRAN™+ LTE Base Station and the cloud, eNB status concerns the link between eNodeB software and managing software inside the goRAN™+ LTE Base Station, S1 status is related to the link between eNodeB and MME, EPC status pertains to EPC software and managing software inside the goRAN™+ LTE Base Station, S6a status is associated with the link between MME and HSS. Last online time indicates the time of connecting the base station to the cloud. ED count represents the number of end devices operating with the goRAN™+ LTE Base Station. The next section displays backhaul interfaces data, where users can find the current IP address obtained by the base station in the local network and the MAC address. If 4G backhaul is enabled, the IP address and MAC could also be shown for 4G backhaul. The last section on the page shows the list of events and provides the ability to search for events by date.

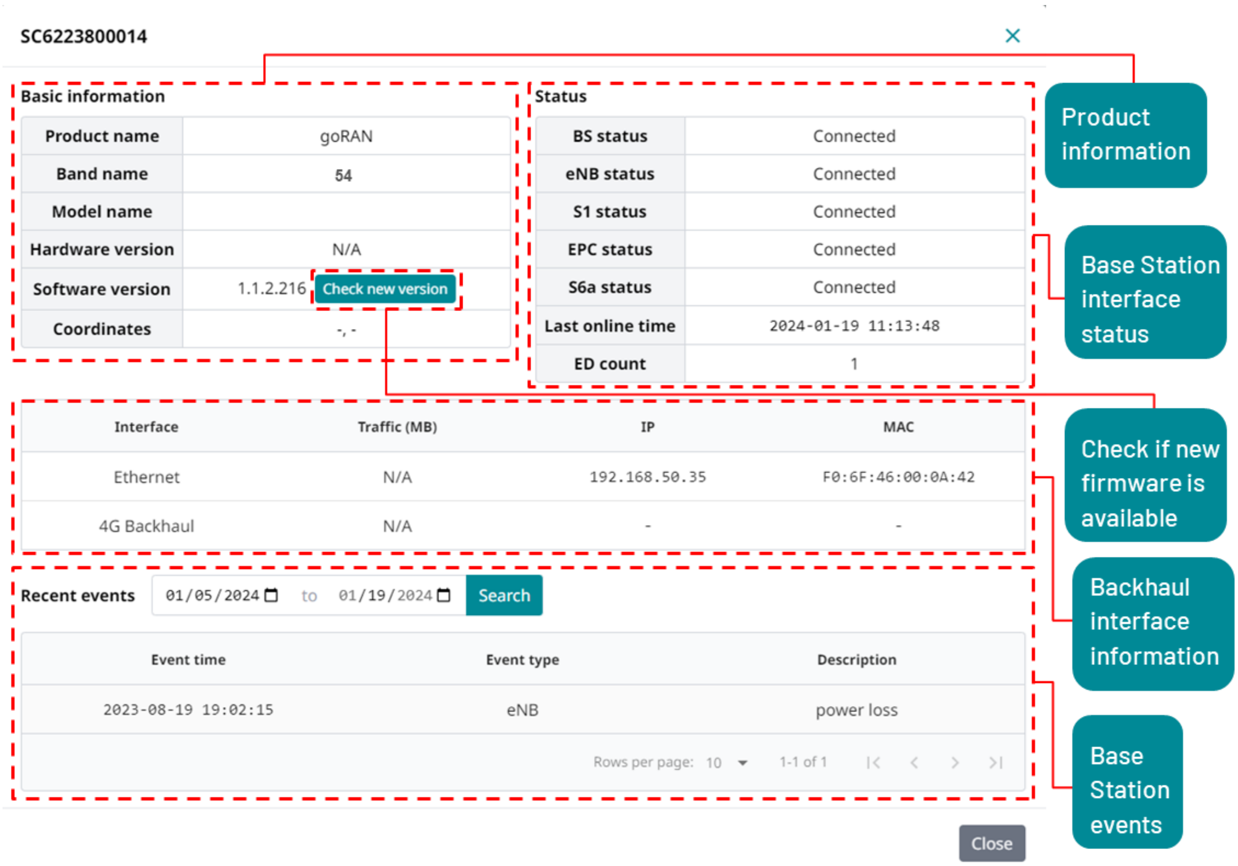


Figure 7.3.1-12 Base Station information

7.3.2. EPC

One more primary feature of the goRAN™+ LTE Base Station is EPC (Evolved Packet Core) functionality. Ubiik NMS allows the user to:

- Set the network name and PLMN.
- Configure power-saving features such as PSM and eDRX for UEs.
- Set up an external HSS (Home Subscriber Server).
- Configure the PDN (Packet Data Network) settings.
- Provision the SIM cards.

Configuration

The example of the Configuration page is shown in Figure 7.3.2-1 below. The following figures illustrate the Ubiik NMS interface with a brief explanation of the meaning of all the parameters.

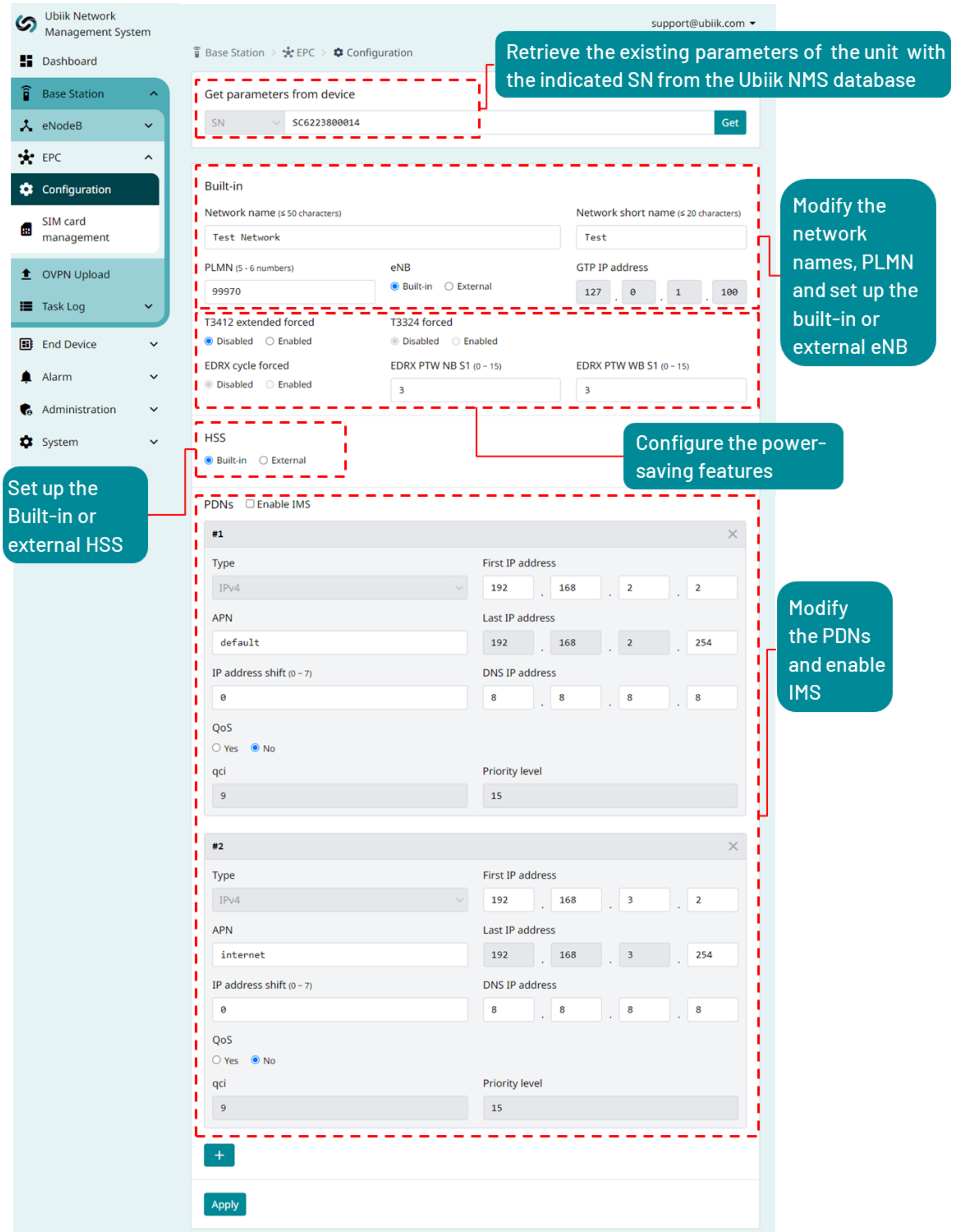


Figure 7.3.2-1 EPC Configuration page

After entering the SN (Serial Number) of the goRAN™+ LTE Base Station and retrieving the EPC configuration, it is possible to modify the EPC parameters using the options displayed in the figures below.

Note that depending on the specific hardware configuration of the goRAN™+ LTE Base Station, certain sub-options within a given parameter may or may not be accessible.

Figure 7.3.2-2 shows the network name settings. The Network name serves as a descriptive name for the network and can include a combination of alphanumeric characters, as well as the network operator's brand name or any other identifier chosen by the user. The Network short name, on the other hand, is a shorter version of the network name. The network names, including the Network name and Network short name, serve as additional identifiers to the PLMN identifier and can be displayed on user equipment.

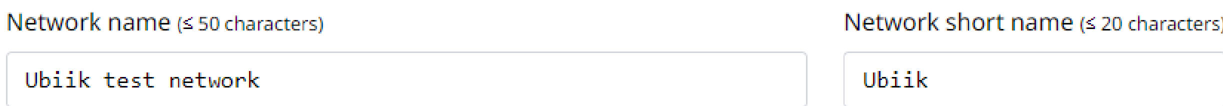


Figure 7.3.2-2 Network name

The user can configure the PLMN number, as depicted in Figure 7.3.2-3. As per the standard, this number should also be set on the EPC and match the number on the eNodeB side. By default, the goRAN™+ LTE Base Station employs the internal eNodeB. However, it's possible to connect an external eNodeB to the built-in goRAN™+ EPC. To do this, the user needs to switch the eNB to External mode and configure the GDP IP address, which corresponds to the IP address of the external eNodeB.

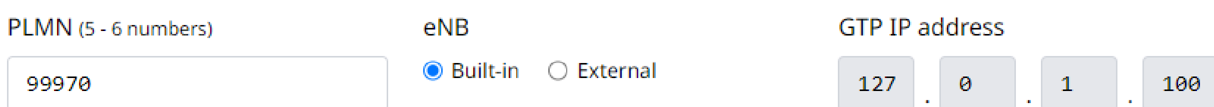


Figure 7.3.2-3 PLMN and Built-in/External eNB settings

The user can configure specific power-saving features: PSM (Power Saving Mode) and eDRX (Extended Discontinuous Reception), as shown in Figure 7.3.2-4. By default, the features T3412 extended forced, T3324 forced, and EDRX cycle forced are Disabled. This signifies that UEs can determine the timers on their own, and these timers will be accepted by the goRAN™+ LTE Base Station. If the user switches these timers to Enabled, the values of the timers will be defined by the goRAN™+ LTE Base Station, and UEs won't be able to change them.

To set the PSM feature, two timers need to be configured. The first one is the T3412 extended forced timer, which determines the duration of the device's sleep mode. The second one is the T3324 forced timer, also known as the active timer, which specifies the duration during which the device remains active and can receive paging and user data from the network. Note that the units to be input in these fields should be in seconds.

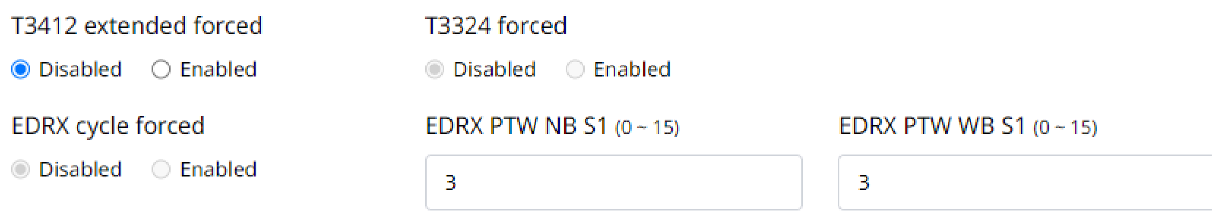


Figure 7.3.2-4 PSM and eDRX settings

To set the eDRX feature, the user needs to configure the EDRX cycle forced timer, which determines the time period after which the device becomes active. Additionally, the user needs to set the eDRX PTW (Packet Transmission Window) timer, which indicates the duration when the device's receiver is enabled and the device is available for paging and incoming data. The eDRX PTW timer has two options: EDRX PTW NB S1, specifically used for NB-IoT radio technology, and EDRX PTW WB S1, specifically used for LTE-M radio technology. The values to be entered in these fields are the numbers of the timers, as specified in 3GPP TS 24.008 Table 10.5.5.32.

The user has the option to configure the setup with an external HSS. In this scenario, the internal goRAN™+ EPC handles the UE authentication procedure with the external HSS. An example of this configuration is illustrated in Figure 7.3.2-5. The HSS IPv4 address represents the IP address of the HSS endpoint. The S6 Bind IPv4 address pertains to the goRAN IP address. The Origin realm and Origin host are additional parameters employed in communications through the S6 interface using the Diameter protocol.

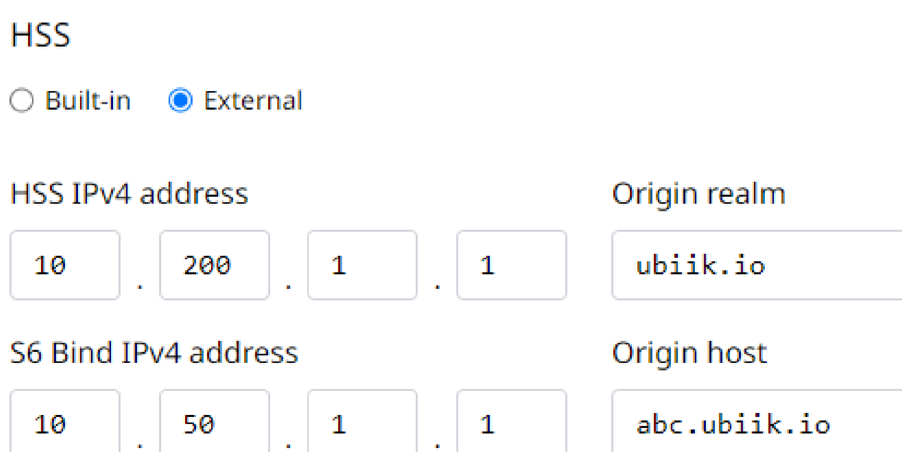


Figure 7.3.2-5 External HSS settings

The user can modify existing PDNs settings or add a new PDN set, as shown in Figure 7.3.2-6. Each PDN includes a group of parameters such as First IP address, Last IP address, DNS IP address and APN. The UE can choose a specific PDN with a corresponding APN in the network request. For each PDN, there is a specific QoS (Quality of Service) functionality available, which can be enabled by selecting Yes on the right side of the settings bar. QoS includes two parameters: qci (QoS Class Identifier) and Priority level. A detailed description of these parameters is beyond the scope of this document, but they allow for flexible and advanced configuration by experienced users. To add a new PDN, the user needs to click on the + button.

For the specific version of the goRAN™+ LTE Base Station, IMS server functionality is enabled, allowing VoLTE calls. The goRAN™+ LTE Base Station uses the built-in IMS server for this purpose. In this case, users can see that the Enable IMS option is enabled in the PDNs section, and additional IMPU parameters should be provisioned for the SIMs, as described in the next section. Note that in the case of multiple base station deployments, an external IMS server should be used.

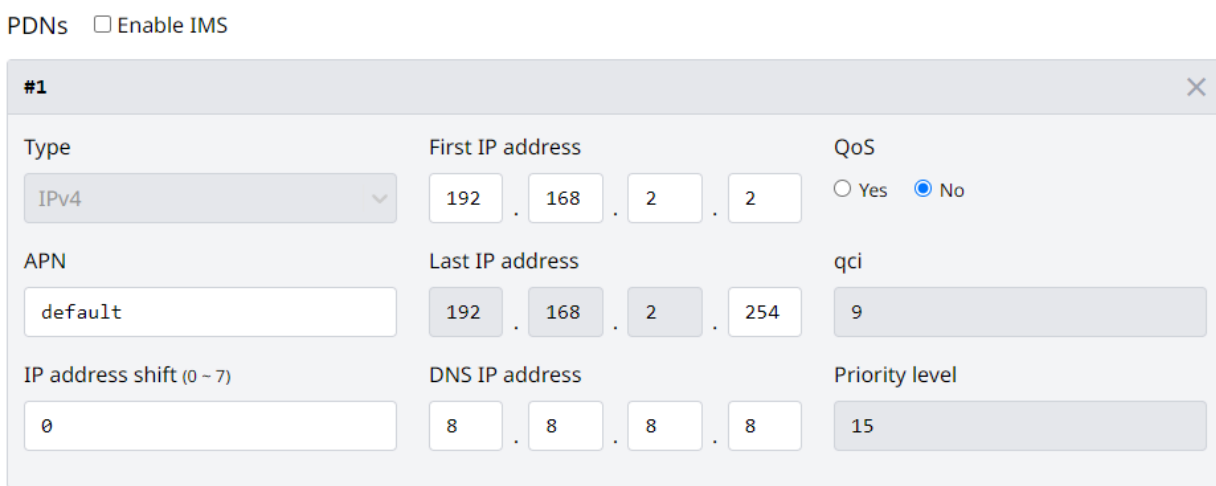


Figure 7.3.2-6 PDNs settings

SIM card management

The goRAN™+ LTE Base Station can be shipped with pre-provisioned SIM cards, in which case all assigned SIM cards are automatically added to the internal HSS. However, if the user needs to add new devices to the network, SIM provisioning actions must be performed.

As depicted in Figure 7.3.2-7, to add a new SIM, several fields for SIM identifiers and secret keys need to be filled in. IMPU parameters should be configured in case of using an IMS server and the VoLTE feature. Note that SIM parameters and secret keys are essential for identification and encryption purposes, and they should not be made available to third parties.

After making all the necessary updates on the Configuration page, the user should click the Apply button located at the bottom left side of the page to save the new configuration in the Ubiik NMS database. Note that it may take up to 60 seconds for the updated configuration to be received by the goRAN™+ LTE Base Station.

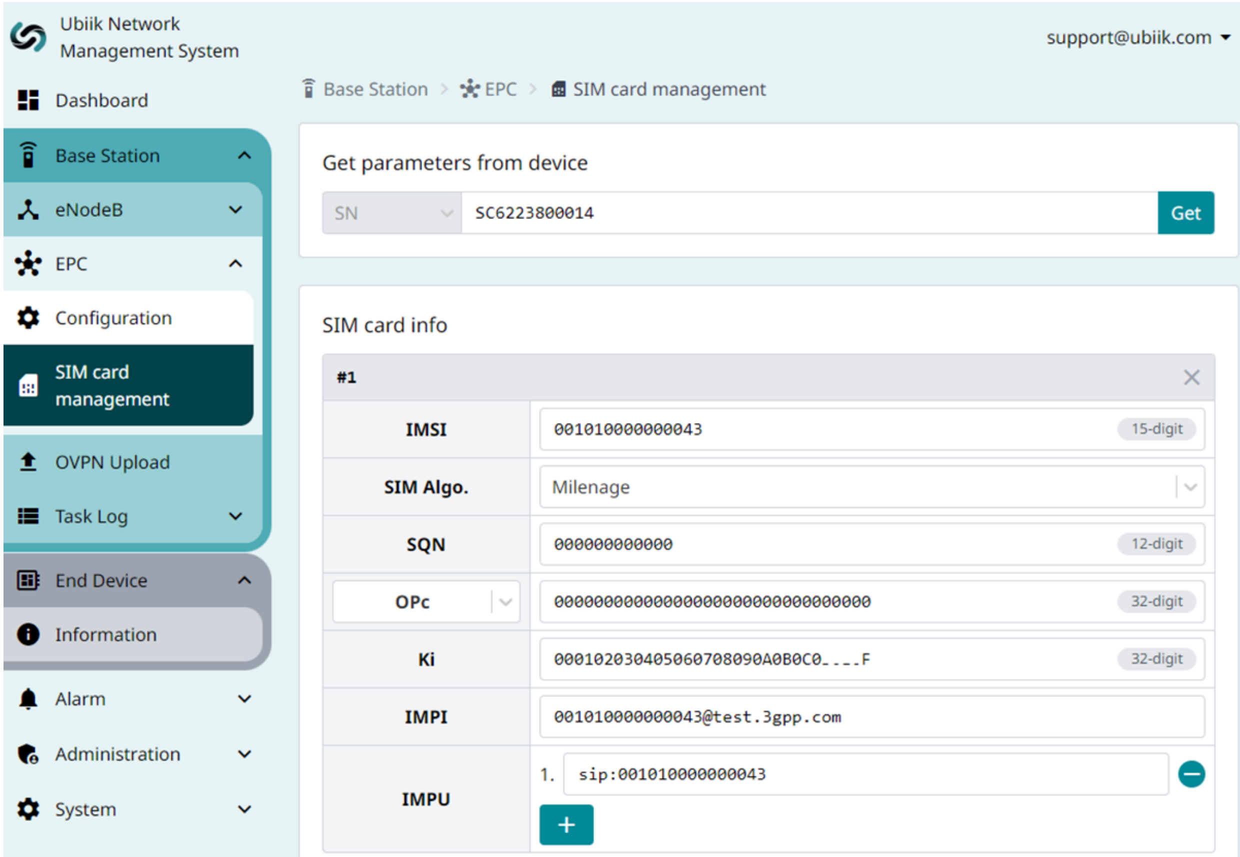


Figure 7.3.2-7 SIM parameters

7.3.3. OVPN Upload

OpenVPN is a virtual private network system that can be employed to establish secure connections through the Internet. Ubiik NMS offers users a convenient method for applying OVPN files to the goRAN™+ LTE Base Station.

Similar to other pages, the initial step on the OVPN Upload page involves entering the SN in the designated field and clicking on Get. After completing this step, the user has the option to upload a new OVPN file or replace the existing one, either by clicking or through drag and drop, as depicted in Figure 7.3.3.

Note that once the upload is completed, the user should wait for 60 seconds for the settings to be applied.

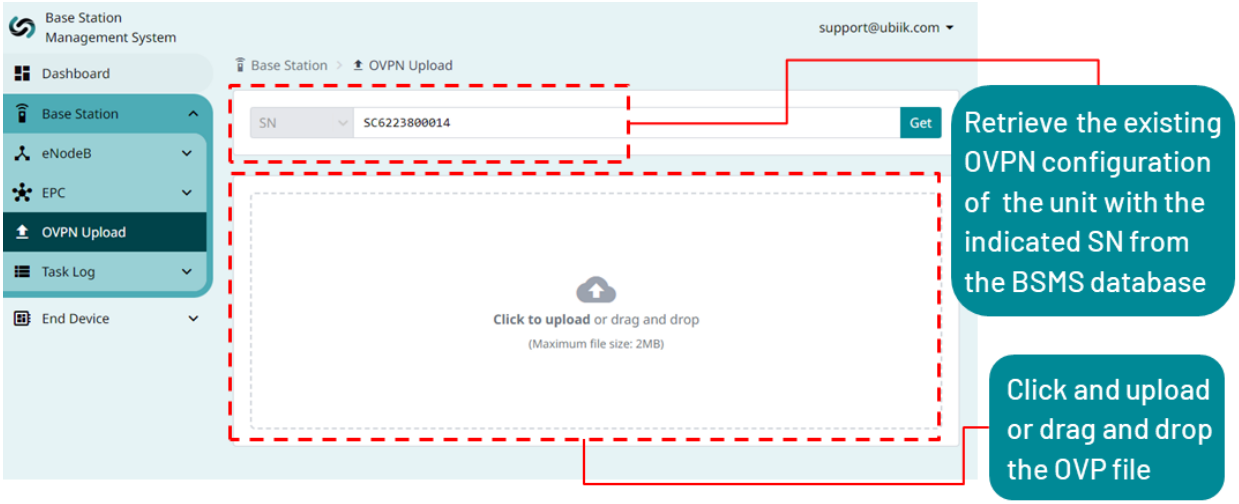


Figure 7.3.3 OVPN file uploading

7.3.4. Task Log

The Ubiik NMS provides three types of logs: Configuration update logs, OVPN Upload logs, and FOTA logs. Configuration update logs capture changes made to the eNodeB and EPC configurations. OVPN Upload logs record activities related to OVPN file uploads. FOTA logs document events associated with unit firmware upgrades.

Configuration

This section contains a log of all configuration updates made by users in the eNodeB Configuration and EPC Configuration sections.

An example of these logs is shown in Figure 7.3.4-1 below. The log includes the event ID, SN (Serial Number), Type of configuration change (eNB or EPC), Start time and Finish time, event State, and User (the user's email address) responsible for the configuration change. The event State can be 'Done' if the configuration is successfully applied or 'Failed' if the update is unsuccessful. In the case of a 'Failed' event, users can contact Ubiik Support for configuration verification.

Note that to access events for a specific unit, users should enter the SN, specify a time period for log retrieval, define the event State, and then click the Search button.

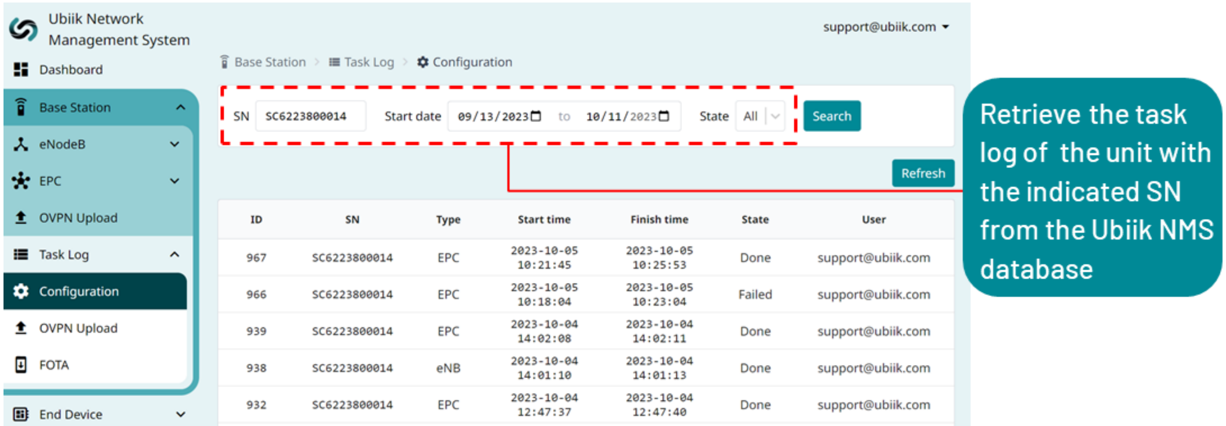


Figure 7.3.4-1 Task Log: Configuration

OVPN Upload

The OVPN Upload page stores records related to updates of the OVPN (OpenVPN) files. The log consists of the same fields as those found in the Configuration section, with the addition of one extra field - Filename, which corresponds to the name of the uploaded OVPN file, as displayed in Figure 7.3.4-2.

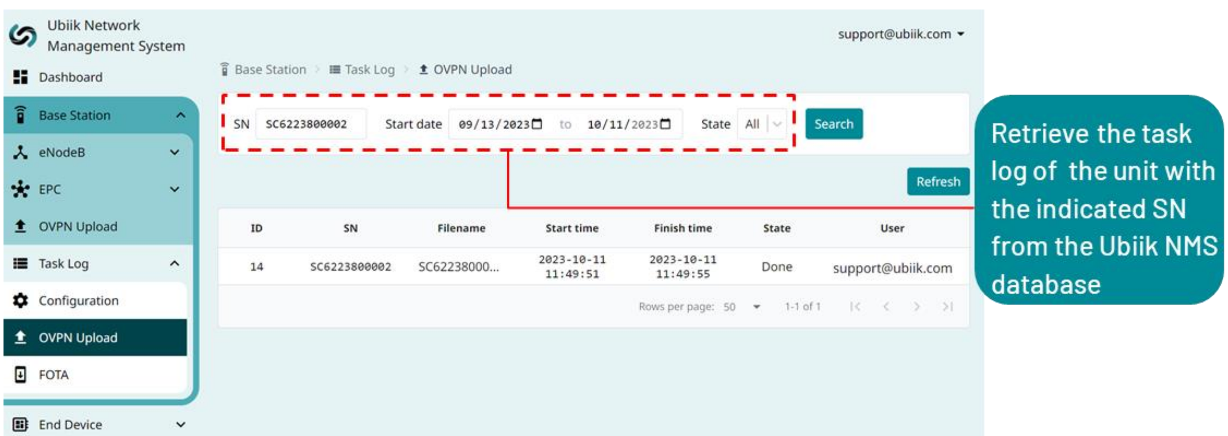


Figure 7.3.4-2 Task Log: OVPN Upload

FOTA

This section comprises logs of events linked to unit firmware upgrades. Similar to the OVPN Upload page, the FOTA (Firmware Over-The-Air) page includes the Filename field, but in this context, the field pertains to the firmware upgrade file name, as depicted in Figure 7.3.4-3.

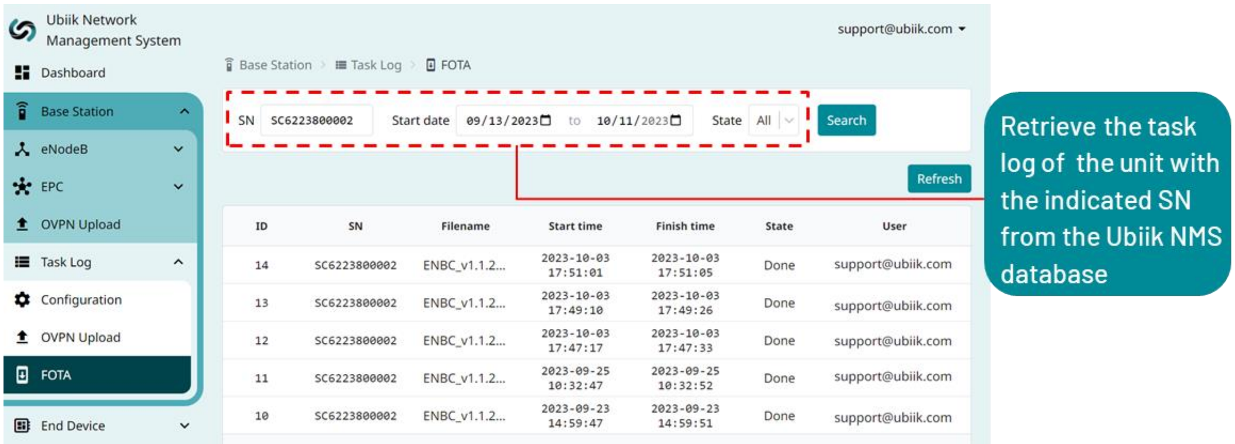


Figure 7.3.4-3 Task Log: FOTA

7.4. End Device

The End Device page is designed for monitoring the status of UEs, which are essentially end devices. This page provides two options for searching as depicted in Figure 7.4. Search by BS SN (Base Station Serial Number). The user can select a specific goRAN™+ LTE Base Station by its serial number to access information about the UEs provisioned on that particular unit. Search by IMSI. The user can choose an IMSI to retrieve detailed information about a specific UE. For each UE, the user can access the following parameters: IMSI number, IMEI number, Status, Last Update Time (indicating the time of the last UE activity), IP address assigned to the UE, and the APN used by the UE.

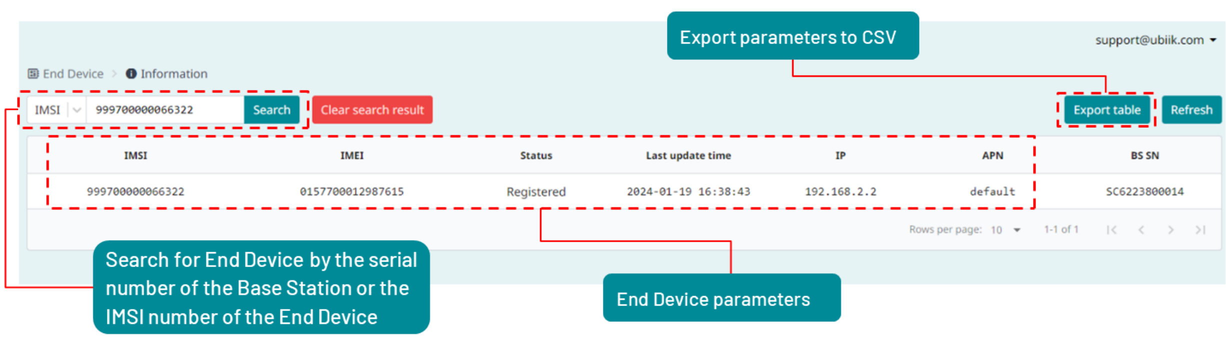


Figure 7.4 End Device

The UE's Status can be one of the following: Unregistered, signifying that the UE is not currently attached to the EPC; Registered, indicating that the UE is currently attached to the goRAN™+ LTE Base Station's EPC; and Connected, indicating that the UE is currently exchanging data with the network. Note that the IP address and APN are displayed only for UEs that have activated the PDN.

7.5. Alarm

7.5.1. Details

A user can check the alarm status using the Alarm page of the Ubiik NMS. On the Details page, all alarms associated with the current user account are displayed, as shown in Figure 7.5.1. At the top of the page, the user can find a filter field to view specific alarms. The Alarm Code refers to the specific code ID of the alarm, and its description can be found on the next page. The Status field displays one of three possible statuses: Active, Inactive, and Solved. Active status indicates that the alarm was triggered by the base station but has not yet been cleared. Inactive status means that the alarm was active but has been cleared by the corresponding unit. Solved status occurs when two conditions are met: the alarm becomes Inactive and the user changes the Progress field to Confirmed.

The Level field indicates the urgency of the alarm and can be Critical, Major, Minor, or Warning, depending on the impact of the alarm on the equipment's functionality and service provided. The Alarm Source field shows which equipment is related to the alarm, either BS (Base Station) or ED (End Device). Alarm Type can have two values: Communications, indicating issues related to interfaces or data sending, and Equipment, indicating issues with the unit's hardware or software.

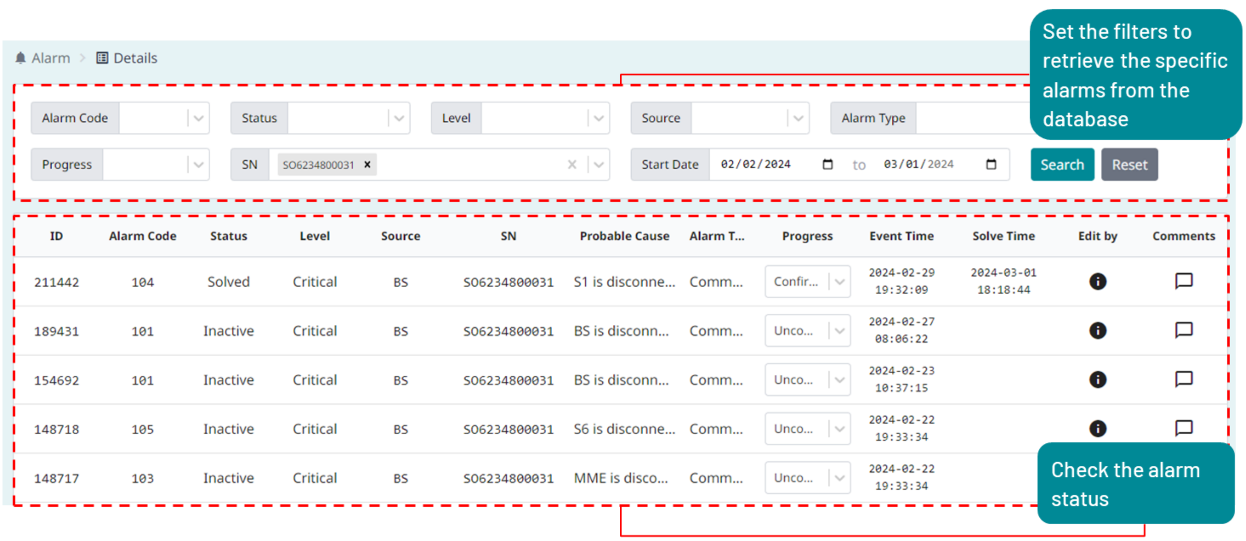


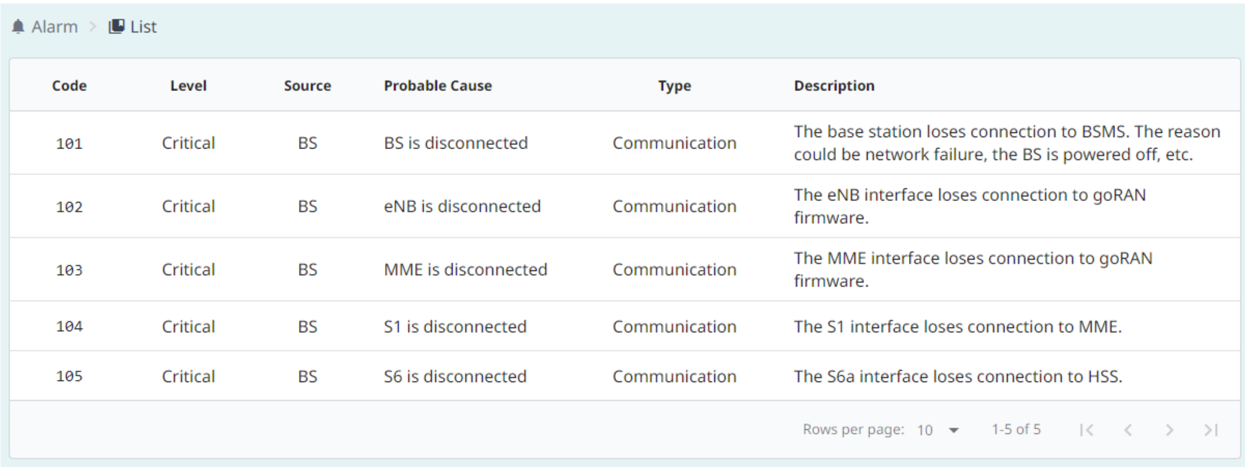
Figure 7.5.1 Alarm details

The Progress field allows the user to track the issue resolution flow. It can be Unconfirmed, which is the default state when the user hasn't taken any actions regarding the alarm, or Confirmed, which means the user is actively working on the issue. The SN field is used to filter alarms for a specific base station. Users can also choose a specific time interval using the Start Date field. After setting the filters, the user needs to press the Search button. To clear all filters, the Reset button should be pressed.

The main section of the Alarm page displays the alarm list with all alarms or alarms filtered using specific criteria as described above. The ID field shows the unique ID number for each alarm. The following fields, such as Alarm Code, Status, Level, Source, and SN, have the same meanings as described earlier. The Probable Cause field corresponds to the specific alarm description and provides a hint to the user about the root cause of the alarm. The Event Time field corresponds to the time when the alarm was reported from the base station to the Ubiik NMS. The Solve Time field indicates the time when the status changed from Inactive to Solved. The Edit By field displays the user ID of the person who edited the Progress and Comments fields. The Comments field can contain useful information regarding the alarm.

7.5.2. List

The List page describes the alarms that can be triggered by the base stations. Note that this section is still under development, and the list will be updated with alarms. Figure 7.5.2 displays the list of alarms, where alarm Code refers to the specific code ID of the alarm, and Level indicates the urgency of the alarm. Alarm Source shows which equipment related to the alarm (BS for Base Station, ED for End Device), and Probable Cause provides a brief description of the alarm. The alarm Type field can have two values: Communications, indicating issues related to interfaces or data sending, and Equipment, indicating issues with the unit's hardware or software. The alarm Description field provides a detailed explanation of the alarm.



Code	Level	Source	Probable Cause	Type	Description
101	Critical	BS	BS is disconnected	Communication	The base station loses connection to BSMS. The reason could be network failure, the BS is powered off, etc.
102	Critical	BS	eNB is disconnected	Communication	The eNB interface loses connection to goRAN firmware.
103	Critical	BS	MME is disconnected	Communication	The MME interface loses connection to goRAN firmware.
104	Critical	BS	S1 is disconnected	Communication	The S1 interface loses connection to MME.
105	Critical	BS	S6 is disconnected	Communication	The S6a interface loses connection to HSS.

Figure 7.5.2 Alarm list

7.6. Administration

The Administration section contains the Login History page, as displayed in Figure 7.6, where users can view the login attempts of the users bound to the account. The fields include Username, which corresponds to the user's email, Login Time, and the Successful field which indicates whether the login attempt was successful or not.

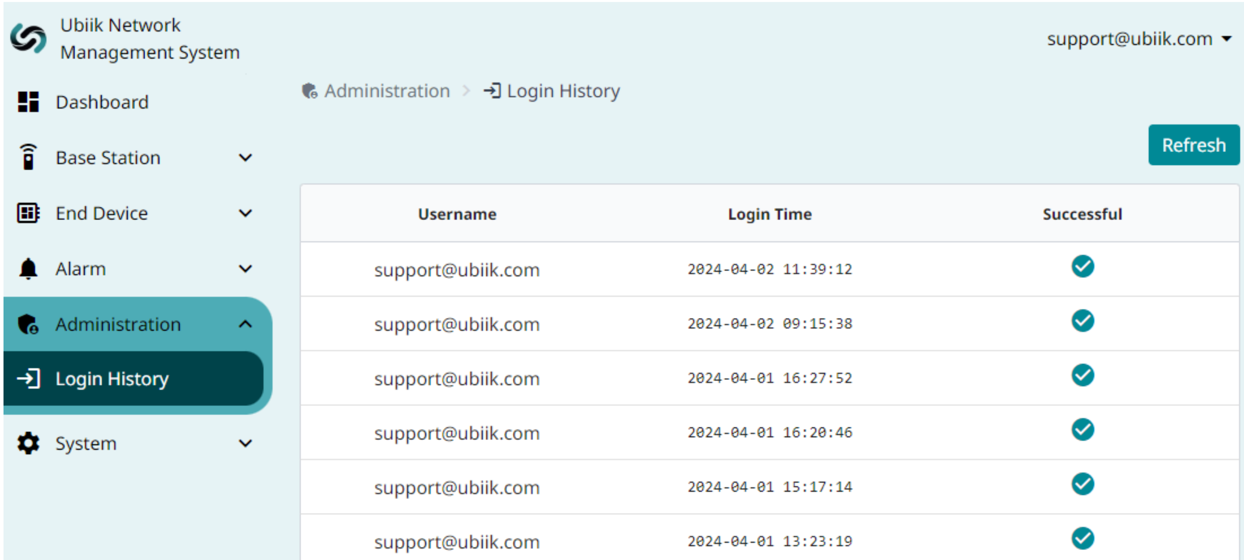


Figure 7.6 Administration page

7.7. System

On the System page, there is the Log section where users can retrieve the logs from the base station. Note that the base station should be online and connected to the Ubiik NMS to allow for log retrieval. The first step is for the user to input the serial number of the base station. The second step is for the user to select the type of logs.

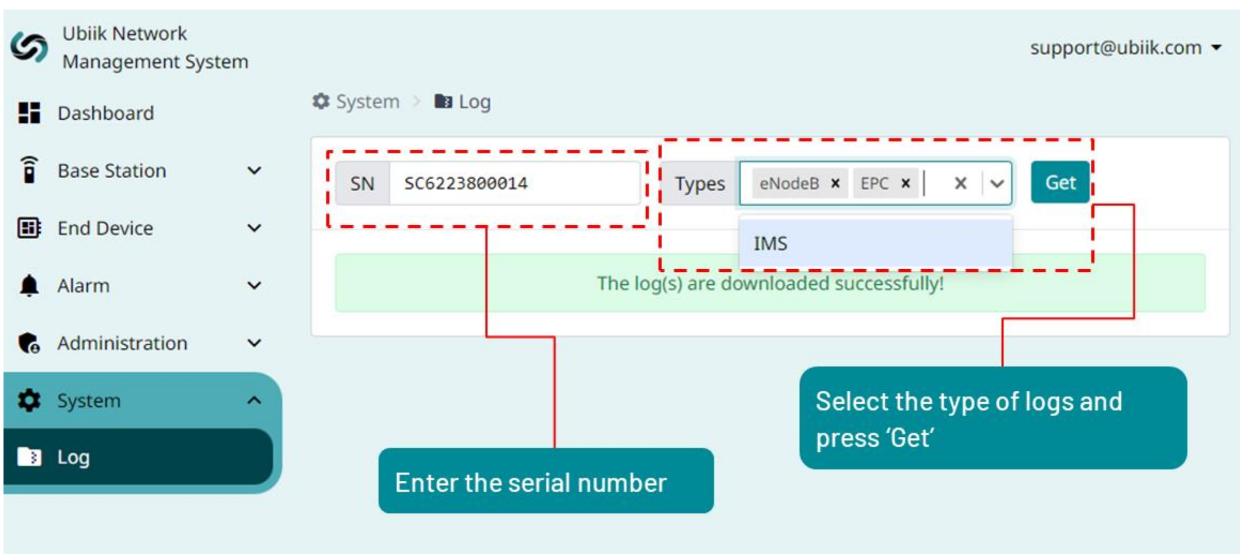


Figure 7.7 System page

- eNodeB logs correspond to the RAN (Radio Access Network) that provide information about the interaction between UE and the base station,
- EPC logs provide information about the interaction between UE and EPC, which includes registration procedure information.
- IMS logs include voice calls information, if this service is used.

After selecting the types of logs to retrieve, the user should press Get, and the logs will be downloaded in ZIP archive format to the PC.

8. Admin Config Tool (ACT) software

The Admin Config Tool (ACT) is a software deployed on the local network where the goRAN™+ LTE Base Station is located. It offers configuration and status information, enabling users to adjust the eNodeB output power, check the status of devices registered with the goRAN™+ LTE Base Station, and download logs. To access the ACT tool, users can visit www.ubiik.com/downloads.

8.1. Installation

The ACT operates using Java with JDK version 17 or higher. Before launching ACT, users should ensure that JDK is present on the operating system. Installation instructions for both Windows and Linux operating systems are provided below.

Windows:

1. Download and extract the ZIP file provided at https://www.ubiik.com/downloads for the Admin Config Tool.
2. Open the folder and execute the run.bat file by double clicking.

Linux:

1. Download and extract the ZIP file provided at https://www.ubiik.com/downloads for the goRAN™+ Admin Config Tool.
2. Open a bash terminal and navigate to the root folder of the extracted ZIP file.
3. Change file permissions for the run.sh shell script for execution: chmod +x run.sh
4. Run the shell script as super user: sudo ./run.sh

8.2. Management

Once installed, the ACT provides a way to connect to the IP of a specific goRAN™+ LTE Base Station unit on a user's local network, as shown in Figure 8.2-1. By default, the goRAN™+ LTE Base Station is configured to obtain the IP address via DHCP. Refer to the Starting Up section of this manual for more details. Note that the IP address in ACT should be changed by the user from the default 127.0.0.1 to the IP address obtained by the goRAN™+ LTE Base Station. The default port, which is 7878, should be kept unchanged. Once ACT is connected, three sections are accessible: EPC UEs, Configuration, and Settings.

The Configuration page is the first one displayed. Here, the goRAN™+ LTE Base Station can be remotely restarted using the Restart button, as seen in Figure 8.2-2. The Base Station field provides the ID number of the goRAN™+ LTE Base Station, and the ENB Controller Version shows the version of the goRAN™+ LTE Base Station's software. Another information field is ENB MODE, which indicates the current mode (LTE/LTE-M/NB-IoT) of the goRAN™+ LTE Base Station.

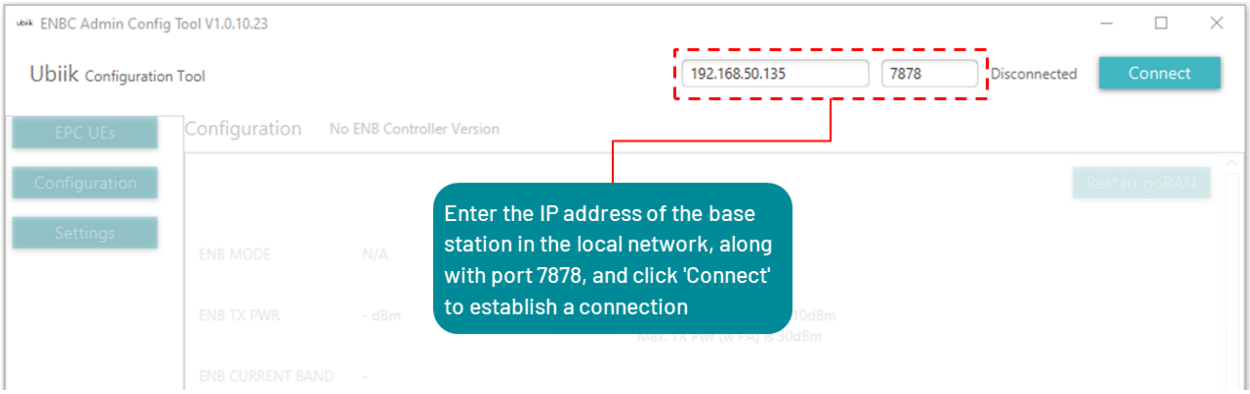


Figure 8.2-1 ACT connection to the goRAN™+ LTE Base Station

The unit's power level can be adjusted via the ENB TX PWR field. Users can input an integer in dBm, ranging from -68 to 10 or from -68 to 30, depending on the unit's configuration. Note that for the ACT, the lower limit of the Tx power range is different from what could be set via Ubiik NMS (refer to the Network Management System (Ubiik NMS) section of this manual). For the Ubiik NMS, the lowest value is -30 dBm.

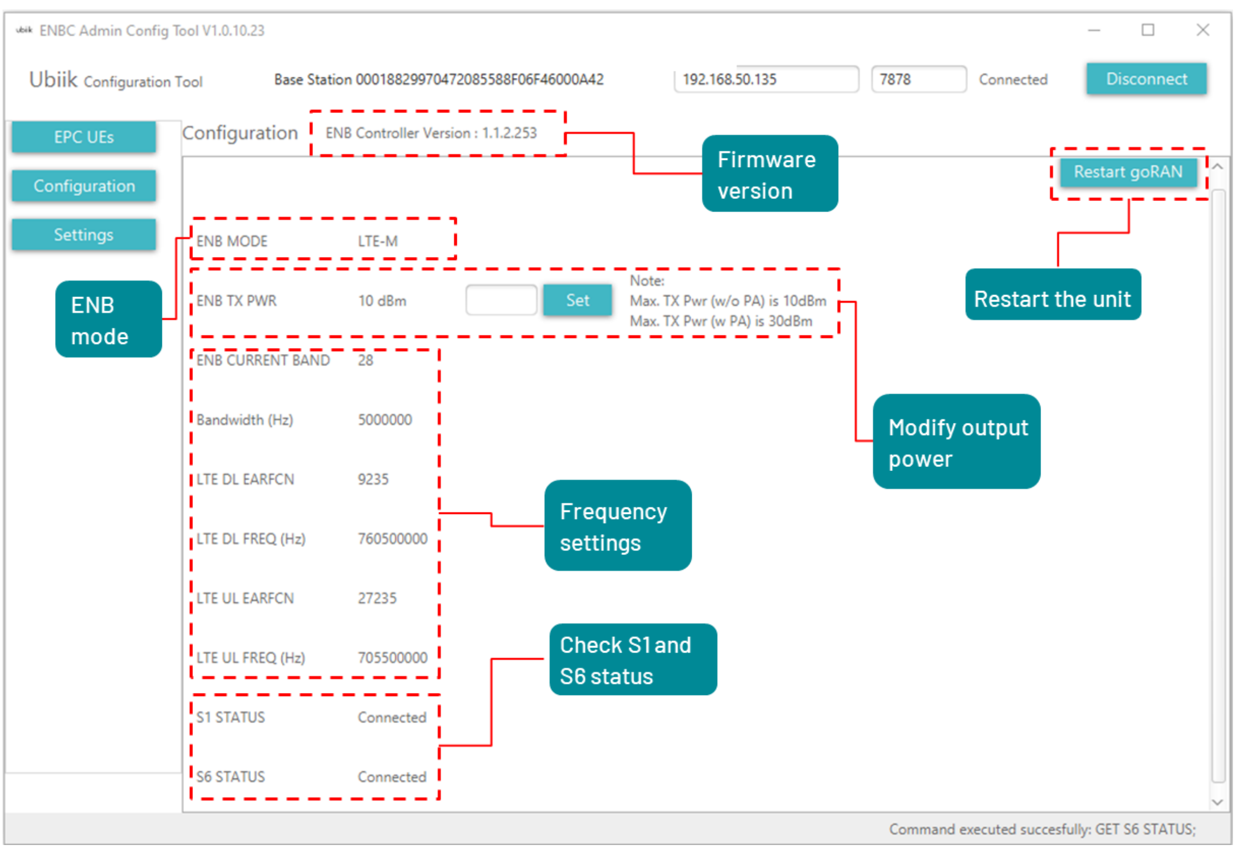


Figure 8.2-2 Configuration page

Users can access various parameters related to the operating frequency of the goRAN™+ LTE Base Station. These parameters include LTE BAND, which corresponds to the frequency number according to the 3GPP standard, Bandwidth, UL EARFCN, and DL EARFCN indicating frequency channel numbers, as well as LTE DL FREQ and LTE UL FREQ, denoting frequencies in Hz. Additionally, users can verify the status of S1 and S6 connections using the S1 STATUS and S6 STATUS fields, respectively. This verification is crucial when using configurations with external EPC or external HSS.

The status of the UEs registered to the goRAN™+ LTE Base Station's EPC can be monitored via the EPC UEs page, as shown in Figure 8.2-3. The EPC UEs page displays the UE IMSI and Status for each UE attached to the EPC. The Status shows Registered if the UE is currently attached to the EPC. The status changes to Unregistered if the UE performs the detach procedure. Note that after powering off the UE without performing the detach procedure, the status will remain as Registered until the next TAU procedure is missed by the UE. The TAU period is defined by the goRAN™+ LTE Base Station's settings, typically 30 minutes. The Connected status is shown when the UE is exchanging data with the network (referring to the RRC connected state). In the fields UL Bytes and DL Bytes, the amount of data traffic for the UE is displayed from the time when the UE was last registered on the EPC.

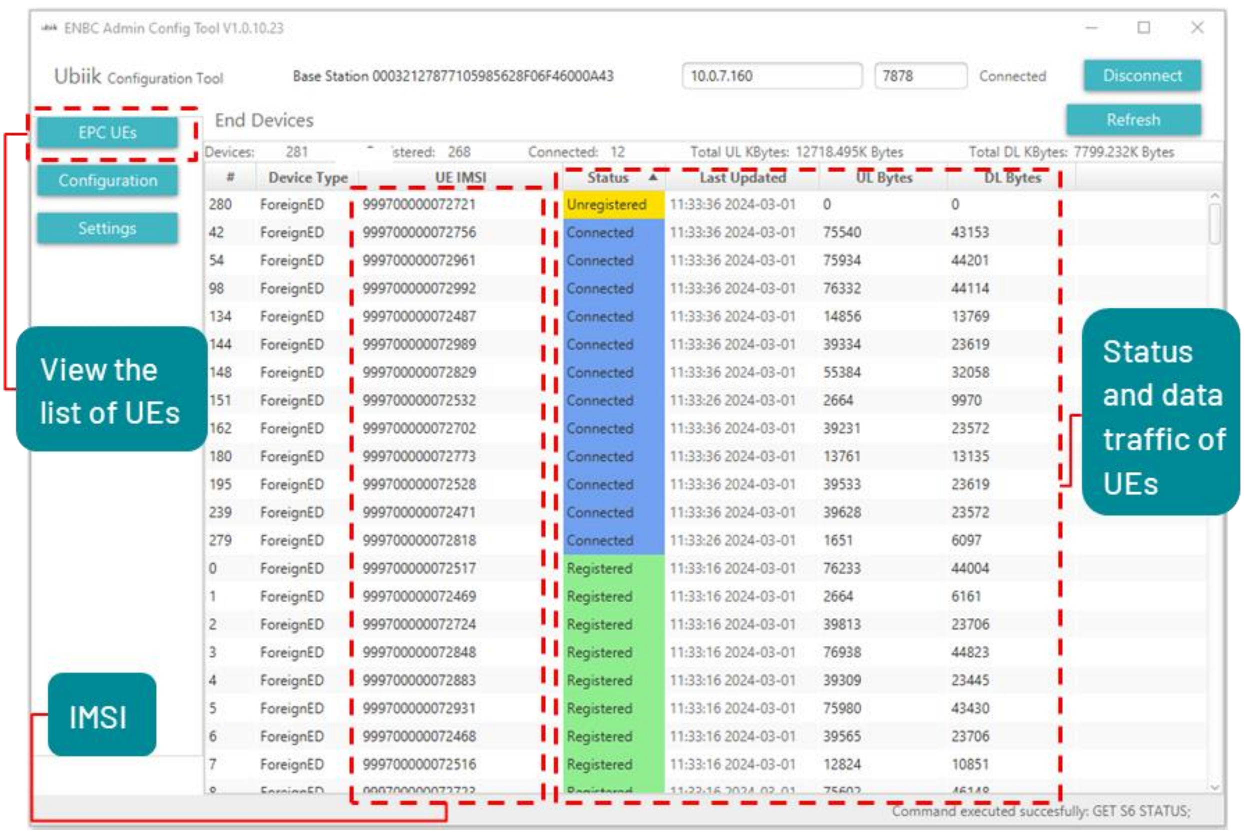


Figure 8.2-3 EPC UEs page

The user can download the logs from eNodeB and EPC. Figure 8.2-4 demonstrates an example of the Settings page. As a first step, it is needed to click the Select Folder button and select the folder on the local PC for logs downloading. In the second step, the user clicks the Download Logs button which initiates the download process from the goRAN™+ LTE Base Station to the local folder. When accessing the folder, the user will encounter two text files. One of these is the ENB log file, which includes service messages generated by the eNodeB and is related to the RAN (Radio Access Network). This log is particularly useful for troubleshooting at the radio access level, addressing issues like RRC connection-related matters. The second file is the MME log file, containing service messages from the EPC. This log is essential for troubleshooting at a higher level, addressing matters such as attach procedure-related issues. Note that users can contact Ubiik Support for log descriptions.

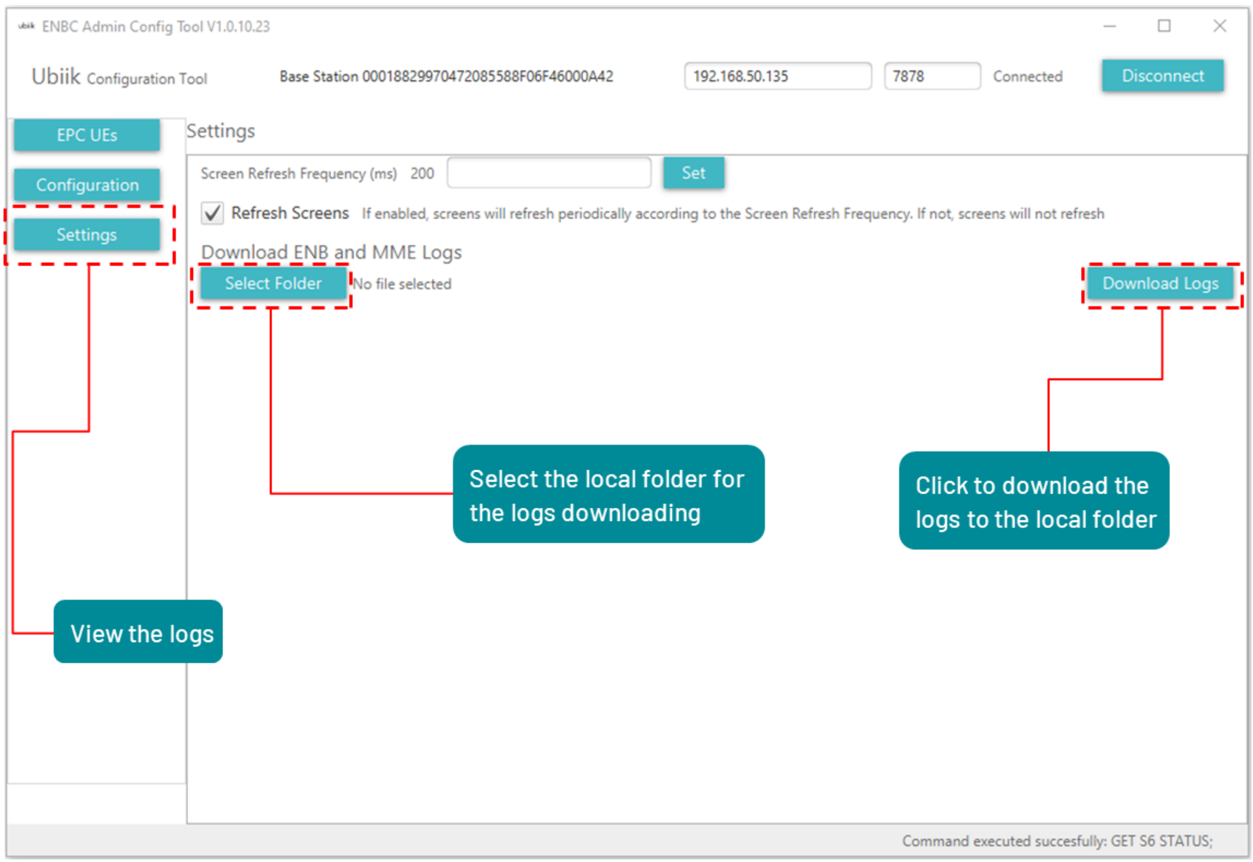


Figure 8.2-4 Settings page

9. Specifications

9.1. System specification

TECHNOLOGY	
Standard	LTE FDD RAN (3GPP Release 15 compliant)
Frequency Bands	ISM-FDD (DL: 925 - 928 MHz, UL: 902 - 915 MHz) B106 (DL: 936.5 - 939.5 MHz, UL: 897.5 - 900.5 MHz)
Channel Bandwidth	ISM-FDD: - LTE-M/Cat-1/1bis: 1.4/3 MHz B106: - LTE/LTE-M 3 MHz
Modulation	LTE: DL: QPSK, 16 QAM, 64 QAM UL: QPSK, 16 QAM LTE-M: DL: QPSK, 16 QAM UL: QPSK, 16 QAM
Multiplexing	SISO
Transmit Power	30 dBm maximum
Receive Sensitivity	-100 dBm
Synchronization	GPS, IEEE 1588v2
Power Consumption	< 40 W
Operation and Maintenance	Fault Management Configuration Management Performance Management Software Upgrade
INTERFACE	
Ethernet Backhaul	1 x RJ-45 Ethernet interface (10/100/1000 Mbps)
Cellular Backhaul	LTE Cat-4
Power Supply	PoE++ (60W) in accordance with IEEE 802.3bt (Type 3 class 6)
I/O Interfaces	1 x reset button, 1 x USIM slot, 1 x Micro SD slot
LED Indicators	2 x status LED for system power and network connection

Antenna Connection	Fronthaul: external high gain antenna with N-Type connector Backhaul: external LTE antenna with N-Type connector
GPS Antenna	External GPS antenna, N-Type connector
PHYSICAL	
Dimensions	10” x 10” x 3.28” (254 mm x 254 mm x 83.4 mm)
Weight with antennas	3.9 kg
Ingress Protection Rating	IP67
Operating Temperature	-4°F to 131°F (-20℃ to 55℃) with PoE unit POE60U-BTA5600-R -40°F to 131°F (-40℃ to 55℃) with PoE unit POEO75U-1BT-R
Storage Temperature	-40°F to 158°F (-40℃ to 70℃)
Humidity	5% to 90% non-condensing
Installation	Pole or wall mount
ANTENNA GAIN	
GPS antenna peak gain	Antenna JCA225-N: 5 dBi
RF antenna peak gain	Antenna DB-896-960V-13-75-NV2: 13 dBi Antenna C1991-690054-A WY: 3.41 dBi Antenna C1991-690053-A WY: 1.43 dBi Antenna DS0915-0726WNM: 5.72 dBi
Backhaul antenna peak gain	Antenna OA-LTEWB-035-C0-UB: 1.8 dBi

9.2. Features

As a release 14/15 3GPP compliant system, the goRAN™+ LTE Base Station’s supported feature list is extensive. However, some key features may be of interest for users. Some of these are presented below.

Table 9.2 The goRAN™+ LTE Base Station features

Ref	Feature
1	Power Saving Mode (PSM)

Ref	Feature
2	Extended Discontinuous Reception (eDRX)
3	Coverage Enhancement (CE)
4	Early Data Transmission (EDT)
5	Release Assistance Indication (RAI)
6	Voice Over LTE (VoLTE)

1. PSM is designed to help UE conserve battery power. If the device's application turns its radio module off to conserve battery power, the device would subsequently have to reattach to the network when the radio module was turned back on. The cumulative energy consumption of reattaches can become significant over the lifetime of a device. PSM allows the devices to go into sleep mode. As a result, the device can save battery current drain and drop power consumption into the micro-Ampere range by disabling parts of the chipset protocol stack and decreasing device-to-network signaling while remaining registered with the network.

2. eDRX is an extension of an existing LTE feature, which can be used by UE to reduce power consumption. eDRX has been designed for downlink-centric applications that usually receive rather than send data. For such applications, the device wakes up from it's momentary slumber and listens to the network at regular intervals for any incoming data. eDRX allows the time interval during which a device is not listening to the network to be greatly extended, thus strongly reducing the power consumption of the device while remaining reachable from the network. Although it does not provide the same level of power reduction as PSM, eDRX provides a good compromise between device reachability and power consumption.

3. Coverage Enhancement (CE). Some IoT applications require devices to be positioned in areas not readily accessible by radio coverage, such as underground parking garages and in ground pits. Coverage Enhancement feature increases the depth and breadth of radio coverage to enable IoT devices to operate in locations that would otherwise not be possible. This feature increases the power levels of signaling channels together with the ability to repeat transmissions. Repeated transmission improves the ability of receivers to correctly resolve the message sent. LTE-M CE Mode A standard supports CE Levels 0 & 1. This CE feature essentially increases maximum coupling loss by approximately up to +5dB.

4. Early Data Transmission (EDT). This 3GPP Release 15 feature allows an idle mode UE/devices to transmit data in Msg3 of the random-access procedure, carrying between 328 and 1000 bits. After successful reception by base station, the random-access procedure terminates, and the UE does not transition to connected mode.

5. Release Assistance Indication (RAI). When UE has no more data to transmit, they wait for the network to release the connection to enter Idle mode. RAI was introduced in order for the network to release the UE to idle mode quickly to save power. The UE may include RAI in non-access stratum (NAS) signaling to indicate that after that uplink data transmission, no further uplink or downlink data transmission is expected or that only a single downlink data transmission is expected, thus helping the network to decide if the connection can be released.

6. This feature introduces the capability of LTE Cat-1 and LTE-M to support voice services. The user equipment (UE) can now initiate and receive voice calls. This enhancement is particularly beneficial for various IoT applications, including devices with emergency call functions such as personal trackers, as well as for phones where voice is the primary function.

Appendix A Terminology abbreviations

Abbreviation	Description
3GPP	The 3rd Generation Partnership Project
ACT	Admin Config. Tool
APN	Access Point Name
BPSK	Binary Phase-Shift Keying
BSMS	Base Station Management System
Cat-M1	Category M1 LTE-M
Cat-NB1/NB2	Category Narrowband1/Narrowband2
CE	Coverage Enhancement
dBi	Decibel Isotropic
dBm	Decibel Milliwatts
DDR4 RAM	Double Data Rate 4 Random-Access Memory
DHCP	Dynamic Host Configuration Protocol
DL	Downlink
DNS	Domain Name System
DoNAS	Data Over NAS (Non-Access Stratum)
EARFCN	E-UTRA Absolute Radio Frequency Channel Number
eDRX	Extended Discontinuous Reception
EDT	Early Data Transmission
eMMC	Embedded MultiMediaCard
eNB	eNodeB (Evolved Node B)
EPC	Evolved Packet Core
E-UTRA	Evolved UMTS Terrestrial Radio Access
EVK	Evaluation Kit
FCC	Federal Communications Commission
FOTA	Firmware Over-The-Air
GPS	Global Positioning System

Abbreviation	Description
GPRS	General Packet Radio Services
GTP	GPRS Tunnelling Protocol
GUI	Graphical User Interface
HARQ	Hybrid Automatic Repeat Request
HSS	Home Subscriber Server
IMEI	International Mobile Equipment Identity
IMS	IP Multimedia Subsystem
IMSI	International Mobile Subscriber Identity
IoT	Internet of Things
IP	Internet Protocol
IP67	International Protection 67
LAN	Local Area Network
JDK	Java Development Kit
LED	Light Emitting Diode
LPWAN	Low-Power, Wide-Area Network
LTE	Long-Term Evolution
LTE Cat 1	LTE Category 1
LTE-M	Long-Term Evolution Machine Type Communication
M2M	Machine-to-Machine
MAC	Media Access Control address
MCC	Mobile Country Code
MME	Mobility Management Entity
MNC	Mobile Network Code
MNO	Mobile Network Operator
mPOS	Mobile Point-Of-Sale
MVNO	Mobile Virtual Network Operator
NB-IoT	Narrowband Internet of Things
NIDD	Non-IP Data Delivery

Abbreviation	Description
OFDMA	Orthogonal Frequency-Division Multiple Access
OS	Operating system
PBX	Private Branch Exchange
PCI	Physical Cell Identity
PDN	Packet Data Network
PHS	Personal Handy Phone
PLMN	Public Land Mobile Network
pLTE	Private Long-Term Evolution network
PSM	Power Saving Mode
PoE	Power over Ethernet
PPS	Pulse Per Second
PTW	Packet Transmission Window
QoS	Quality of Service
QPSK	Quadrature Phase Shift Keying
RAI	Release Assistance Indication
RF	Radio Frequency
RLC	Radio Link Control
SC-FDMA	Single-Carrier Frequency-Division Multiple Access
SDR	Software-Defined Radio
SIM	Subscriber Identity Module
SSH	Secure Socket Shell protocol
sXGP	Shared Extended Global Platform
S/N	Serial Number
T3324	Active Timer
T3412	Periodic Tracking Area Update timer
TAC	Tracking Area Code
TAU	Tracking Area Update
TBS	Transport Block Size

Abbreviation	Description
UDP	User Datagram Protocol
UE	User Equipment
UL	Uplink
UMTS	Universal Mobile Telecommunications Service
VoLTE	Voice over LTE
WAN	Wide Area Network

Revision history

Revision	Date	Description
1.0	December 2024	Initial release

Contact

For further support and contact information, visit us at www.ubiik.com
19F, No. 17, Sec. 1, Chengde Rd., Datong Dist., Taipei City 103, Taiwan
+886-2-7751-5855

support@ubiik.com