Carrier Aggregation & Dual Carrier (Split Mode)

Configuration Guide

BaiBS_QRTB_2.5.4
BaiBS_RTD_3.7.5

March 2021

Version 1.7

About This Document

This document is intended for installers, field technicians, and network administrators responsible for configuring a Baicells two-carrier Nova-436Q or Neutrino-430 eNodeB (eNB) for Carrier Aggregation (CA) or Dual Carrier (DC) / split mode operation or a Baicells two-carrier Nova-246 eNodeB (eNB) for Dual Carrier (DC). In CA mode, the eNB operates as a single cell using all available contiguous or non-contiguous channels in the band to increase capacity. In DC mode, the eNB operates as two independent carriers.

The information in this document is built on the assumption that (a) the user is familiar with and has experience in installing single-carrier Baicells eNBs and (b) the two-carrier eNB to be configured is already installed and in standard single carrier mode. It has basic configuration settings, and is verified as operational per the *Nova-436Q OD 4x1W Two-Carrier TDD eNB Installation Guide* or the *Nova-246 OD 2x20W Two-Carrier TDD eNB Installation Guide*.

This guide pertains only to the setting differences specific to CA and DC configuration. For the full complement of features and configuration settings that are available through the eNB GUI and the Baicells Operations Management Console (OMC), refer to the Baicells *eNodeB Configuration Guide* and *CloudCore Configuration and Network Administration Guide*. To configure HaloB, please refer to the *HaloB User Guide*. For CBRS Spectrum Access System (SAS) operation, refer to the *SAS Deployment Guide*.

This CA & DC configuration guide is based on the following eNB software versions:

- BaiBS_QRTB_2.5.4 (Nova-436Q, Neutrino-430)
- BaiBS_RTD_3.7.5 (Nova-246)

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Revision Record

Date	Version	Description	SMEs/Contributors	Author/Editor
23-Mar-2021	V1.7	Updated for RTD 3.7.5 and QRTB 2.5.4	Jesse Raasch, Nitisha Potti	Kathy Clark
19-Jan-2021	V1.6	• Updated for RTD 3.6.6 and QRTB 2.4.2 • Added information for Nova-246 eNB • Updated company address	Nitisha Potti, Yang Yanan, Chad Murrish	Jocelyn Watson Kathy Clark
19-Feb-2020	V1.5	Further info on DC, SFA	Nitisha Potti, Jesse Raasch	Sharon Redfoot
10-Jan-2020 2-Jan-2020	V1.4 V1.3	SME comments Updated to QRTB 2.0.5	Nitisha Potti	Sharon Redfoot
20-Nov-2019 24-Sep-2019	v1.2 V1.1	Draft-2 Draft-1 (QRTB 2.0.4)	Jesse Raasch, Nitisha Potti, Sonny May, PengYu, Yunfeng Jiang, Chad Murrish, Rick Harnish, WuJunfeng, LiuGuidong	Sharon Redfoot

Support Resources

- **Documentation** - Baicells product data sheets and technical manuals can be found at *Baicells > Support > Documents*.
- **Support** - Open a support ticket, process an RMA, or use the Support Forum at *Baicells > Support*.

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1. Overview

1.1 Description

A two-carrier eNodeB (eNB) such as the Baicells Nova-436Q, Neutrino-430, or Nova-246 gives operators even more flexibility in meeting coverage and capacity requirements. Two key operating modes supported only by two-carrier systems are Carrier Aggregation (CA) - also referred to as two-component carrier aggregation (CCA) - and Dual Carrier (DC) / split mode. Each mode is available for the Nova-436Q and Neutrino-430 via software license. Dual Carrier (DC) / split mode is available for the Nova-246 via software license.

In CA mode, the eNB can aggregate frequencies across the band, in most cases even channels that are not adjacent. Doing so can virtually double the downlink capacity of the eNB when communicating with subscribers who are all using CAT6/7 or higher customer premise equipment (CPE). This operating mode is especially pertinent in a cell area where there is high population density. The CA software supports 2x10 MHz and 2x20 MHz configurations, resulting in a maximum possible bandwidth of 40 MHz. The carriers in a two-carrier eNB are distinguished in the GUI as:

- Primary Cell (Pcell) - Cell 1
- Secondary Cell (Scell) - Cell 2

In DC mode, each carrier is treated as an individual cell, operating independently to support split sectors. Each cell supports 5 MHz, 10 MHz, 15 MHz, or 20 MHz bandwidth, and the two configurations do not have to be parallel, e.g., Cell 1 could be configured as 10 MHz and Cell 2 could be configured as 15 MHz. This gives operators more flexibility in managing the spectrum they are authorized to use. Each cell also has its own physical pair of antenna connectors. The operator can select a single 4-port antenna or two 2-port antennas. Antenna ports ANT0 and ANT1 connect to the Pcell. Antenna ports ANT2 and ANT3 connect to the Scell.

NOTE: If the mode is set to single carrier, only Cell 1 will operate using just antenna ports 0 and 1.

Some of the other differences in planning, installing, configuring, and operating a two-carrier eNB in either mode include the following:

- In the Baicells Operations Management Console (OMC), each carrier will be listed on a separate row.
- In DC mode, if using two 2-port antennas with the antennas pointing in opposite directions, you can keep the same values for the EARFCN and PCI settings for both cells. But, if you are using two 2-port antennas with the antennas *not* pointing in opposite directions, you must manually change one of the cell's EARFCN and PCI settings to keep the two cells from interfering with each other.
- Some parameters are configured for Cell 1 and not for Cell 2, such as Global Positioning System (GPS) settings, WAN interface, and software upgrades. Cell 2 will accept the same configuration as Cell 1 for these settings.

- Rebooting or upgrading one cell will automatically reboot or upgrade the other cell.

1.2 Scope of This Document

The information in this document is built on the assumption that (a) the user is familiar with and has experience installing single-carrier Baicells eNBs; and (b) the two-carrier eNB to be configured is already installed *and,* in standard single carrier mode, already has basic configuration settings for network connectivity and is verified as operational per the *Nova-436Q OD 4x1W Two-Carrier TDD eNB Installation Guide* or the *Nova-246 OD 2x20W Two-Carrier TDD eNB Installation Guide*.

This guide pertains only to the configuration and operational differences specific to CA and DC modes. It does not cover any other operating modes nor all of the eNB features that are available. Following are related document resources that can be found on the Baicells website under Support > *Documents*.

- **Nova-436Q, Neutrino-430, and Nova 246 Data Sheets** -- technical specifications for the eNBs
- **Nova-436Q, Neutrino-430, and Nova 246 Installation Guide** -- provides installation procedures, basic configuration, and how to verify that the newly installed eNB is operational and can connect to the network
- **CloudCore Configuration & Network Administration Guide** -- covers all configuration GUI menus and fields for the CloudCore System, OMC, and BOSS.
- **eNodeB Configuration Guide** -- covers all configuration GUI menus and fields for the eNodeBs.
- **CPE Configuration Guide** -- covers all configuration GUI menus and fields for the CPEs.
- **HaloB User Guide** -- describes the benefits of HaloB, how the eNB operates differently from standard mode, and how to configure/enable/disable HaloB
- **SAS Deployment Guide** -- overviews the process of configuring the Part 96 certified eNBs and OMC for CBRS Spectrum Access System (SAS) operation

Proceed to *section 2 Carrier Aggregation* or *section 3 Dual Carrier (Split Mode)* based on your licensed Nova-436Q, Neutrino-430, or Nova-246 software mode.

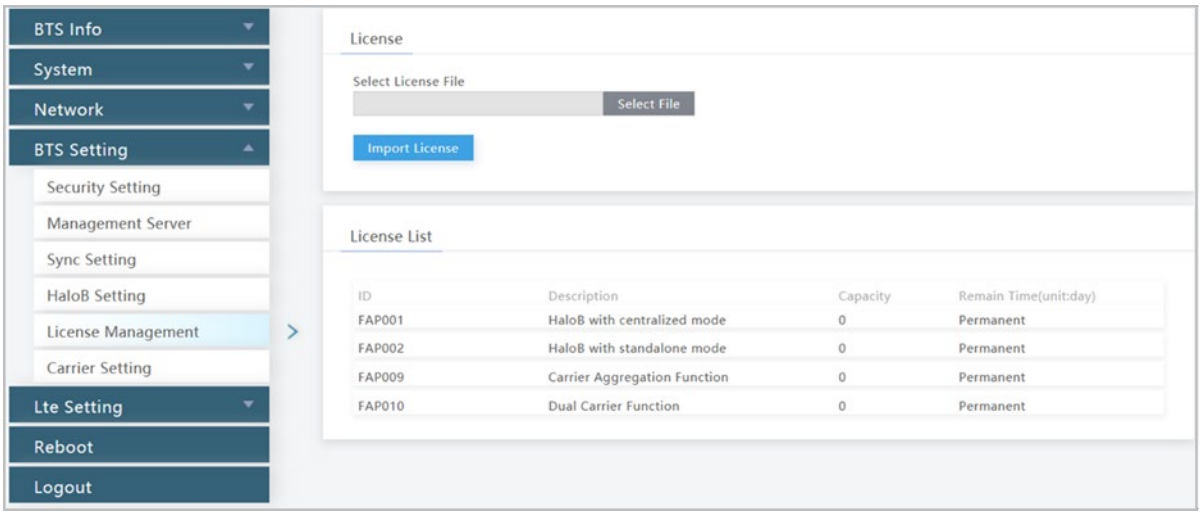
2. Carrier Aggregation

NOTE: This section applies to the Nova-436Q and Neutrino-430 only.

Follow the steps below to transition the Nova-436Q or the Neutrino-430 eNB to CA mode.

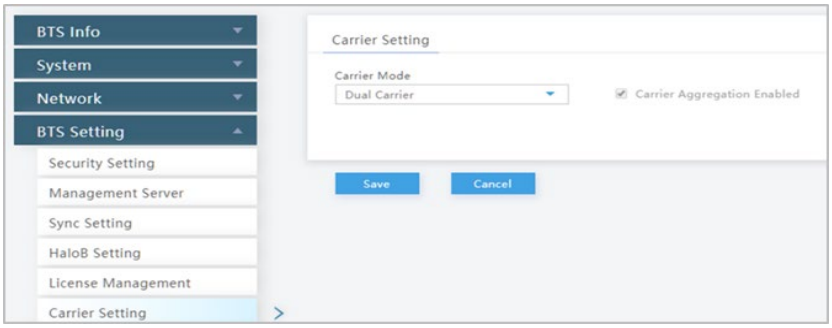
1. **Log in**: Open a Web browser, and enter 192.168.150.1. If you have not changed the eNB's initial *username and password, use the defaults: admin/admin.*
2. **Import carrier aggregation license**: Go to BTS Setting > License Management and perform the following steps (Figure 2-1):
   a. Click on *Select File.*
   b. Find and highlight the Carrier Aggregation Function target file.
   c. Click on *Import License*.

Figure 2-1: Import Licenses to Enable Carrier Aggregation



3. **Configure carrier setting**: Go to BTS Setting > Carrier Setting (Figure 2-2). The *Carrier Mode* field has a pull-down menu where you can select *Single Carrier* or *Dual Carrier*. (The default values should already be configured correctly for CA.) Verify that *Dual Carrier* (meaning two carriers, not split mode) is selected. If it is not already checked, select the *Carrier Aggregation Enabled* check box to enable carrier aggregation.

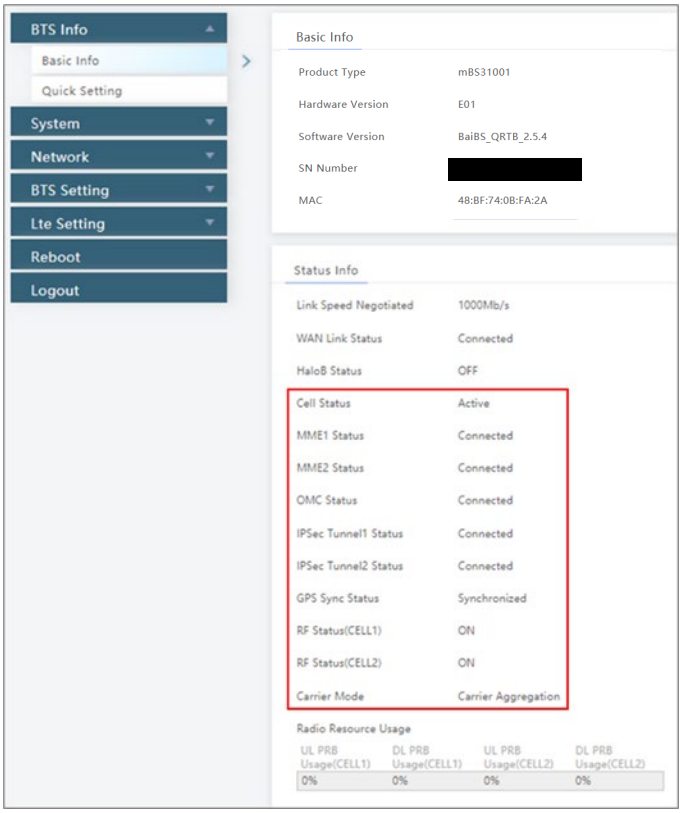
Figure 2-2: Carrier Setting for Carrier Aggregation Mode



4. **Reboot and verify status**: For the settings to take effect, the eNB will reboot; if it does not reboot, manually reboot the eNB. After the eNB completes its boot-up sequence, again check the BTS Info > Basic Info Cell Status (Figure 2-3).

    - *Cell Status* is *Active*
    - *GPS Sync Status* is *Synchronized*
    - *RF Status(CELL1)* and *(CELL2)* are both *ON*

Figure 2-3: Verify Cell Status



Your Nova-436Q is now set up to run in CA mode.

3. Dual Carrier (DC) / Split Mode

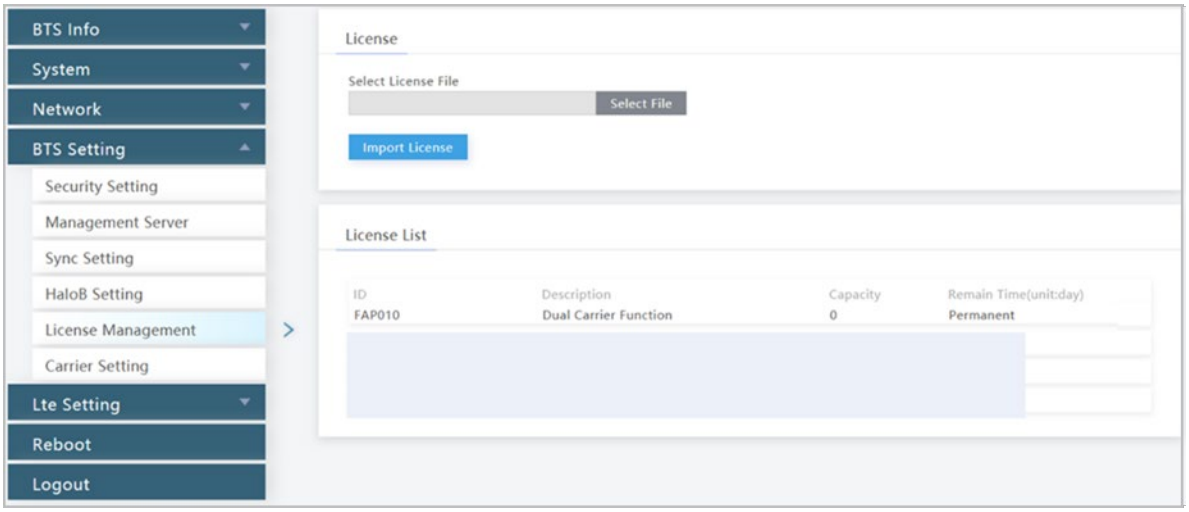
When transitioning the Nova-436Q eNB, the Neutrino-430, or the Nova-246 eNB to DC/split mode, you will first log in to import the license and configure carrier settings. Then, you will reboot the eNB, configure key settings for Cell 1 and Cell 2, reboot the eNB again, and verify the status of both cells. The steps imply the eNB is connecting to the Baicells North America CloudCore EPC.

3.1 Nova-436Q/Neutrino-430 eNB

Follow the steps below to transition the Nova-436Q or the Neutrino-430 eNB to DC/split mode.

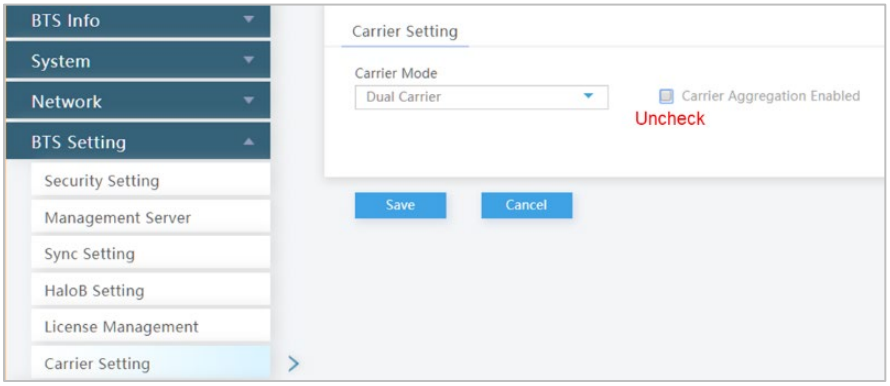
1. **Log in**: Open a Web browser, and enter 192.168.150.1. If you have not changed the eNB's initial username and password, use the defaults: *admin/admin*.
2. **Import dual carrier (split mode) license**: Go to BTS Setting > License Management and perform the following steps (Figure 3-1):
    a. Click on *Select File*.
    b. Find and highlight the Dual Carrier Function target file.
    c. Click on *Import License*.

Figure 3-1: Import License to Enable Dual Carrier (DC) / Split Mode



3. **Configure carrier setting**: Go to BTS Setting > Carrier Setting (Figure 3-2). For the *Carrier Mode* select *Dual Carrier*. Ensure the *Carrier Aggregation Enabled* check box is not checked.

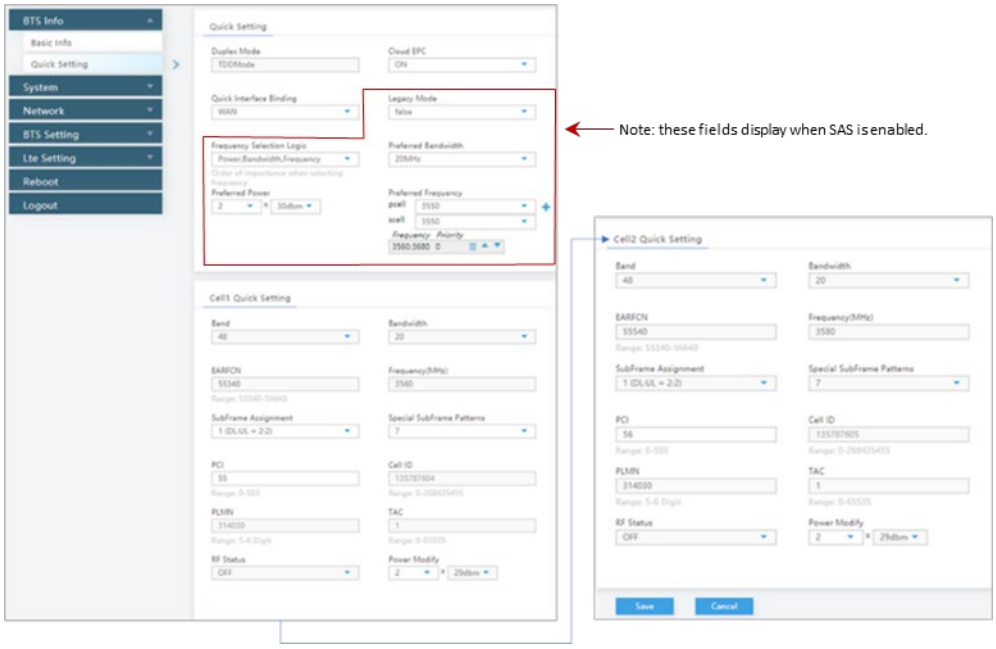
Figure 3-2: Carrier Setting for Dual Carrier (DC) / Split Mode



4. **Reboot and verify status (Cell 1)**: For the settings to take effect, the eNB will reboot; if it does not reboot, manually reboot the eNB. After the eNB completes its boot-up sequence, again check the BTS Info > Basic Info to verify the following settings.
    - *Cell Status = Active*
    - *GPS Sync Status* is *Synchronized*
    - *RF Status(CELL1)* is *ON*
5. **Configure Quick Settings (Cell 1)**: Go to BTS Info > Quick Setting, and configure the following fields (Figure 3-3).
    a. Cloud EPC: Set the *Cloud EPC* field to *ON*.
    b. EARFCN and PCI: If you are using two 2-port antennas and they are not facing in opposite directions, you must manually change one carrier's EARFCN and PCI settings to different values than those used by the other carrier. This is necessary to avoid interference between the two carriers. Verify or enter the values assigned to EARFCN and PCI for Cell 1 per your network design plan.
    c. Verify/Configure all other cell and transmission parameters in the *Quick Setting* menu as you normally would for standard mode.

NOTE: Nova-436Q does not support Subframe Assignment (SFA) = 0.

Figure 3-3: Quick Settings



6. **Configure Network interfaces**:

   a. WAN: Go to Network > WAN/LAN (Figure 3-4).

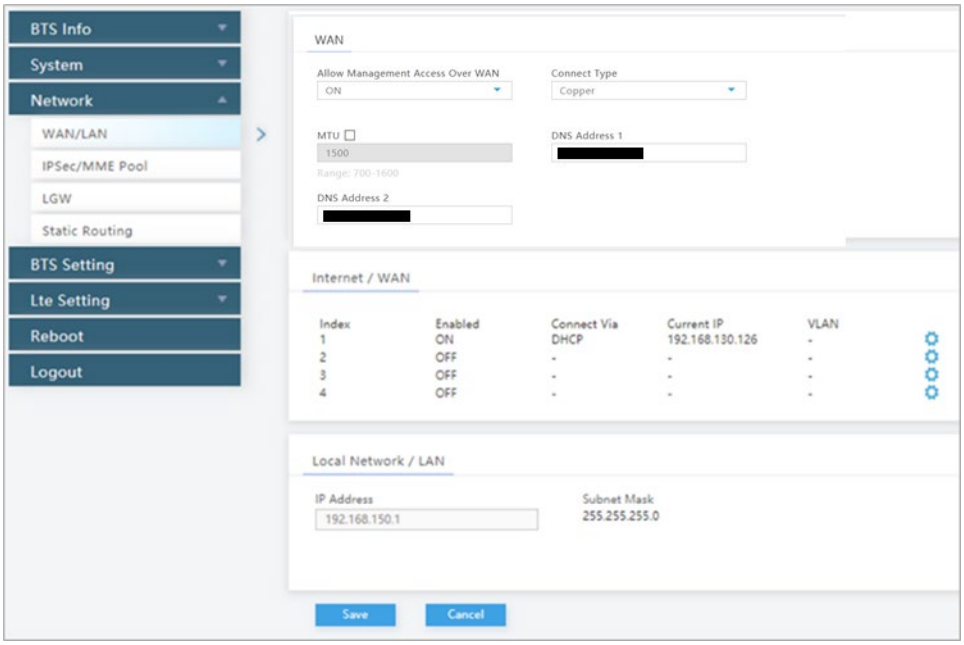
   To allow management access over WAN, select *ON*; otherwise, select *OFF*.

   The *Connect Type* (either copper or fiber) is configured only for Cell 1; Cell 2 will accept the same setting.

   Cell 1 and Cell 2 use the same WAN IP, and they can either be set to acquire DHCP IP or be given a static IP.

   b. LAN: For the LAN address, enter 192.168.150.1.

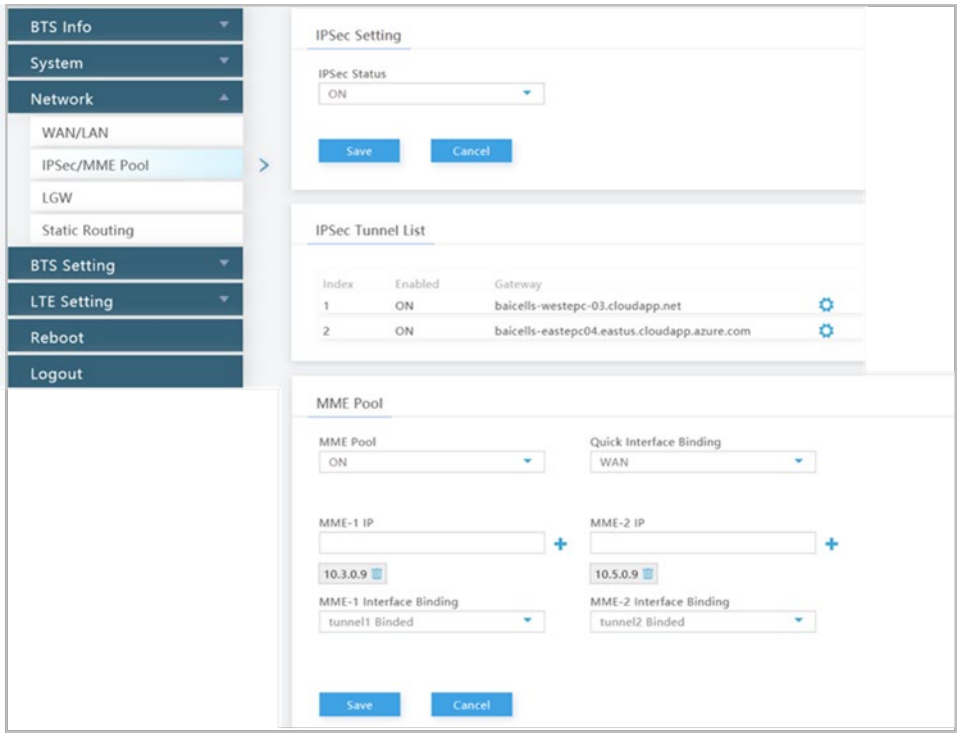
Figure 3-4: WAN/LAN



7. **Configure IPSec/MME Pool**: In step 5a above, when you enabled *Cloud EPC* it automatically established two IPSec tunnels and enabled the MME Pool. Go to Network > IPSec/MME Pool to verify or edit the setup the same as you would when operating the eNB in standard mode (Figure 3-5).

NOTE: This menu is not included in the GUI of an eNB operating in HaloB mode.

Figure 3-5: IPSec/MME Pool

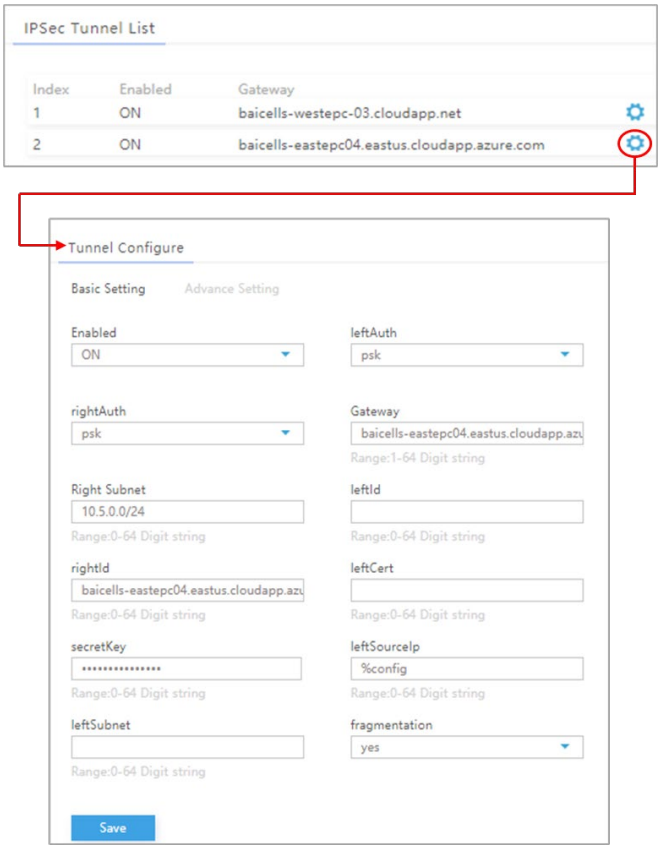


Under *IPSec Tunnel List* use the *Settings* icon to open a new window called *Tunnel Configure*, where you can change some of the tunnel information (Figure 3-6). This window has two tabs, *Basic Setting* and *Advance Setting*. Only the basic settings should be edited if needed.

Caution: It is highly recommended that you use the default values for the *Advance Setting* fields.

Make sure under the *MME Pool* part of the window that *MME Pool* is *ON,* and enter the MME-1 and MME-2 IP addresses if not already auto-configured. When using the Baicells CloudCore, once Cloud EPC is enabled, the MME IP addresses will be 10.3.0.9 and 10.5.0.9. You can also enable interface binding between the MMEs and the IPSec tunnels.

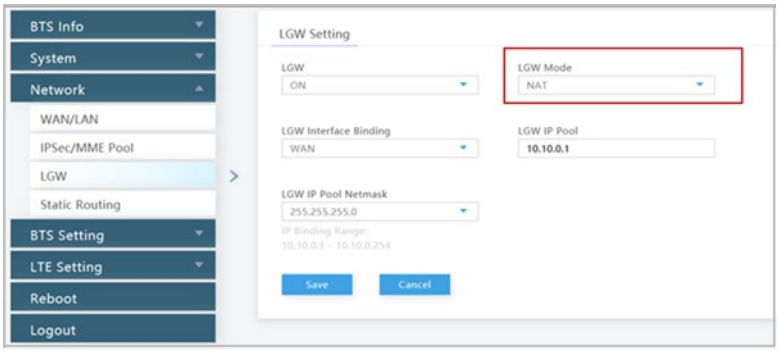
Figure 3-6: IPSec Tunnel List - Basic Setting

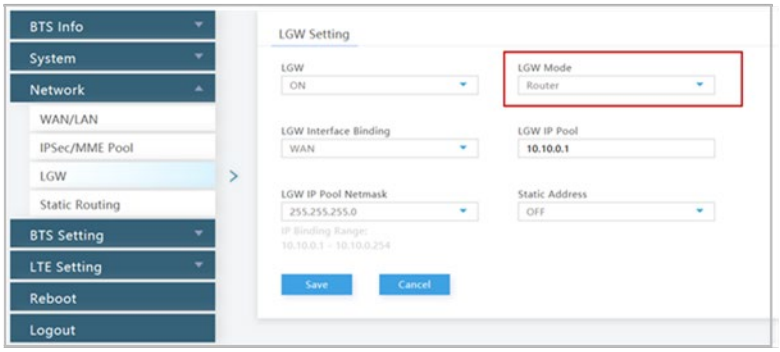


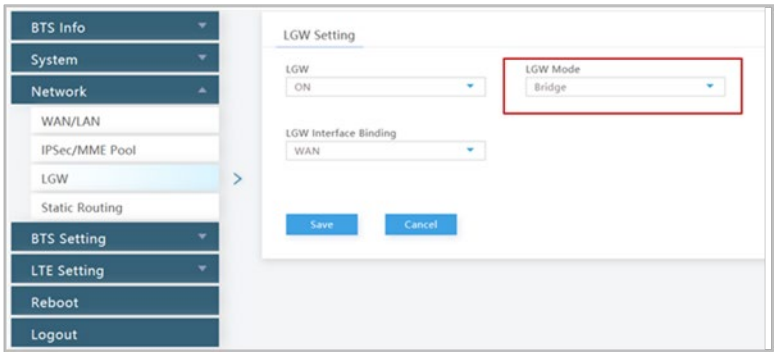
8. **Configure LGW**: The Local Gateway (LGW) is a Baicells feature that enables operators to access equipment remotely. The eNB splits the data plane and control plane, so there are two IP addresses per UE. The data plane carries user traffic and is sent out the local gateway.

   Go to Network > LGW to enable the feature (Figure 3-7). The options for *LGW Mode* are NAT, router, or bridge (most operators use bridge mode). Enter the *LGW IP Pool* address and network information. The IP binding range is 10.10.0.1 to 10.10.0.254. Alternatively, you can enable *Static Address* and enter a static IP address.

Figure 3-7: LGW

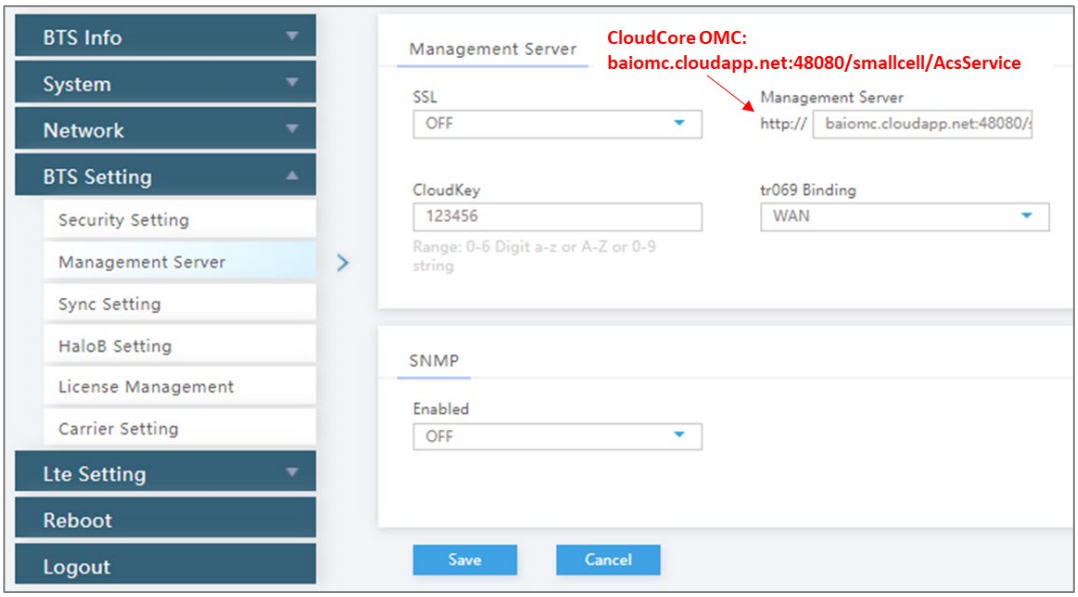






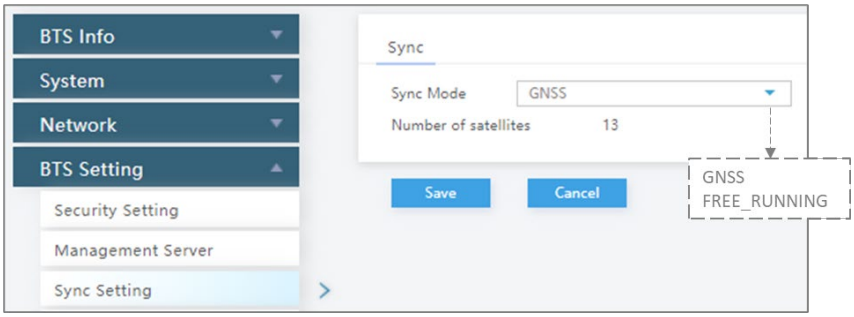
9. **Check/Configure Management Server**: Go to BTS Setting > Management Server, and enter or verify the server address is baiomc.cloudapp.net:48080/smallcell/AcsService. Confirm or add your unique operator CloudKey for the cell to associate to your cloud account (Figure 3-8). Each cell will appear as a separate eNB in the OMC.

Figure 3-8: Management Server



10. **Select Sync Setting**: Cell 1 and Cell 2 use the same GPS, so there is only one GPS setting to configure. Go to BTS Setting > Sync Setting. For *Sync Mode*, select either GNSS or FREE_RUNNING (Figure 3-9).

Figure 3-9: Sync Setting



11. **Reboot and verify status (Cell 1 and Cell 2)**: For the settings to take effect, reboot the eNB. This action will reboot both cells. After the eNB completes its boot-up sequence, check the BTS Info > Basic Info status settings for both Cell 1 and Cell 2:

    - *Cell1 and Cell2 Status* are both *Active*
    - *GPS Sync Status* is *Synchronized*
    - *RF Status(CELL1)* and *(CELL2)* are both *ON*

IMPORTANT: When operating the Nova-436Q or the Neutrino-430 in DC mode and using two 2-port antennas, the antennas must be facing in opposite directions. Otherwise, you will need to change the EARFCN and PCI settings on Cell 2 so the two carriers do not interfere with each other.

Your Nova-436Q or Neutrino-430 is now set up to run in DC mode.

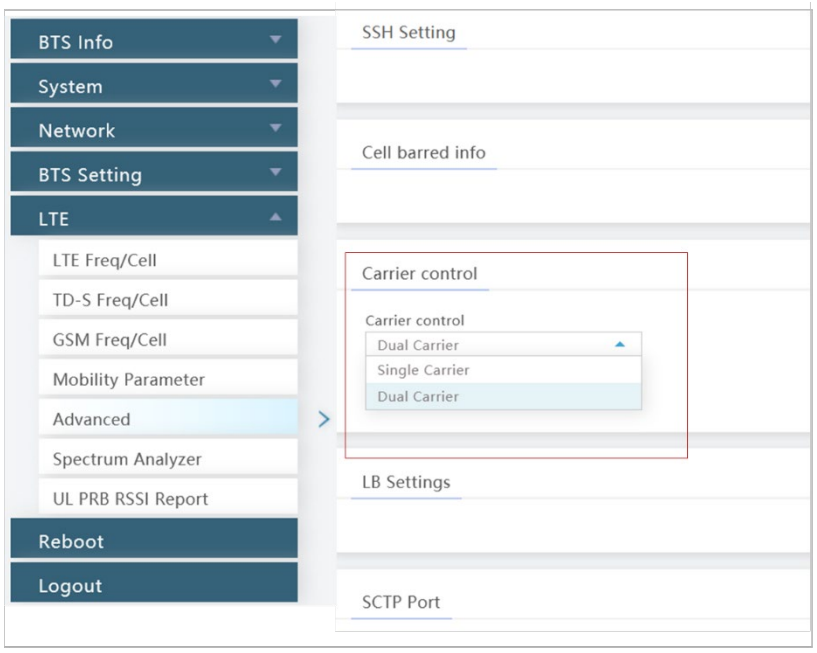
3.2 Nova-246 eNB

For the Nova-246 to operate in Dual Mode, the primary cell (Cell 1) and secondary call (Cell 2) must both be configured. First configure the primary cell, and then click "Access to Cell 2" on the upper right corner of the GUI to enter cell 2 and configure the secondary cell. Some parameters of the secondary cell are limited by the primary cell and the system has set these parameters to non-configurable.

Import License and Select Carrier Control Mode

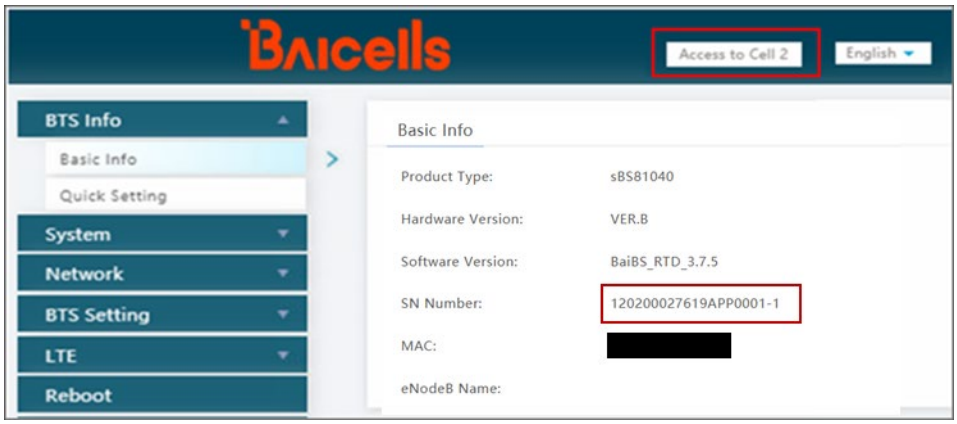
1. **Log in**: Open a Web browser, and enter 192.168.150.1. If you have not changed the eNB's initial username and password, use the defaults: *admin*/*admin*.
2. **Import dual carrier (split mode) license**: Go to BTS Setting > License Management and perform the following steps (Figure 3-10).
    a. Click on *Select File*.
    b. Find and highlight the Dual Carrier Function target file.
    c. Click on *Import License*.
3. **Select Carrier Control Mode**: Go to LTE > Advanced (Figure 3-10). Under *Carrier Control* select *Dual Carrier* and choose the *Save* button at the bottom of the screen.

Figure 3-10: Enable Dual Carrier



4. **Reboot:** Perform a warm reboot to apply the Dual Carrier setting.
5. **Verify Dual Carrier Mode:** After the eNB completes the boot-up sequence, the *Access to Cell 2* button will be visible on the upper right corner of the GUI. On the BTS Info > Basic Info screen, verify the *SN Number* is appended with a *-1,* which indicates this is Cell 1 (Figure 3-11).

Figure 3-11: Verify Dual Carrier Mode



Configure Cell 1

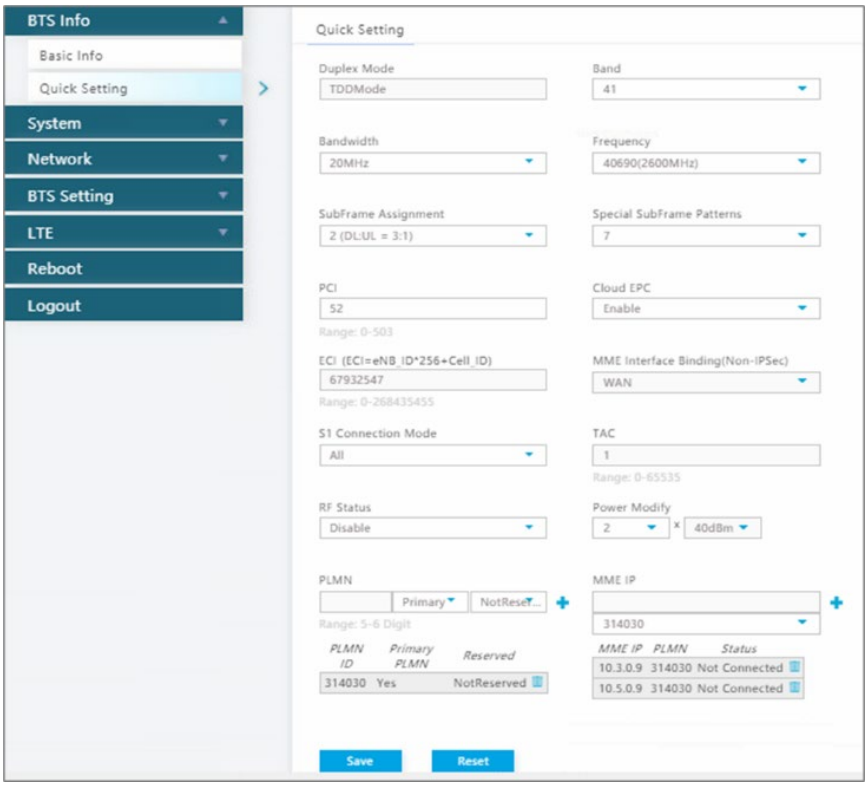
6. **Configure Quick Settings**: Go to BTS Info > Quick Setting, and configure the following fields (Figure 3-12).

   a. Cloud EPC: Set the *Cloud EPC* field to *Enable* if you are using the Baicells CloudCore.

   b. Frequency and PCI: If you are using two 2-port antennas and they are not facing in opposite directions, you must manually change one carrier's Frequency and PCI settings to different values than those used by the other carrier. This is necessary to avoid interference between the two carriers. Verify or enter the values assigned to Frequency and PCI for Cell 1 and Cell 2 per your network design plan.

   c. Verify/Configure all other cell and transmission parameters in the *Quick Setting* menu as you normally would for standard mode.

Figure 3-12: Quick Settings



7. **Configure Network interfaces**:

   a. WAN: Go to Network > WAN/LAN/VLAN (Figure 3-13).

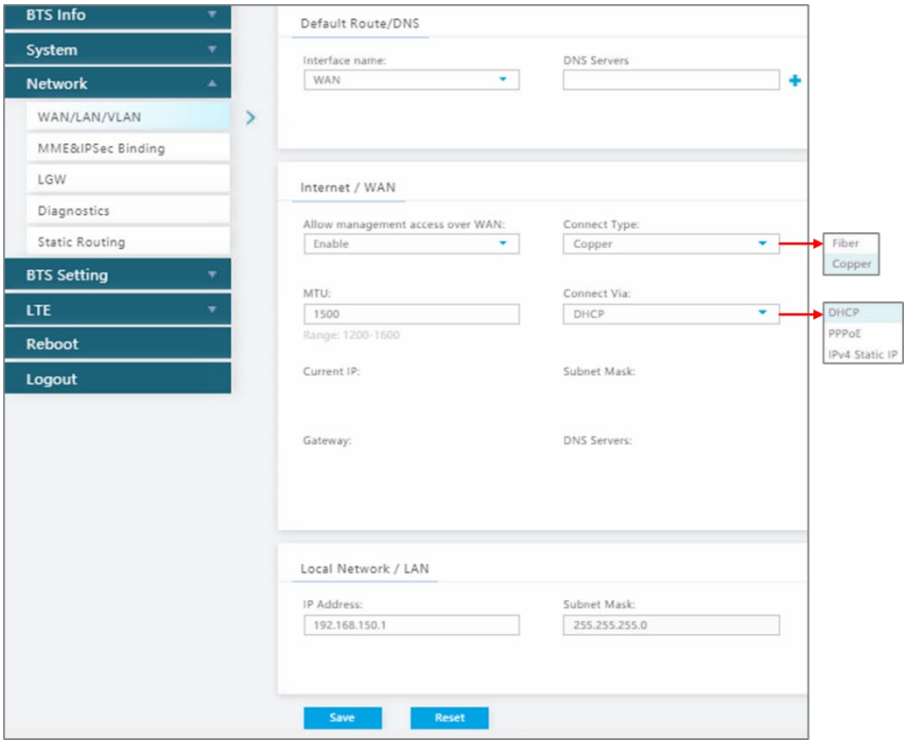
   The *Connect Type* (either copper or fiber) is configured only for Cell 1; Cell 2 will accept the same setting.

   The *Connect Via* field can be configured differently for Cell 1 and Cell 2 depending on what the connect type is. The pull-down menu options are DHCP, PPPoE, and IPv4 Static IP.

   - If the *Connect Type* is copper, the DHCP function can be used for either Cell 1 or Cell 2.
   - If the *Connect Type* is fiber, the DHCP function can be used for either Cell 1 or Cell 2.

   b. LAN: For the LAN address, enter 192.168.150.1.

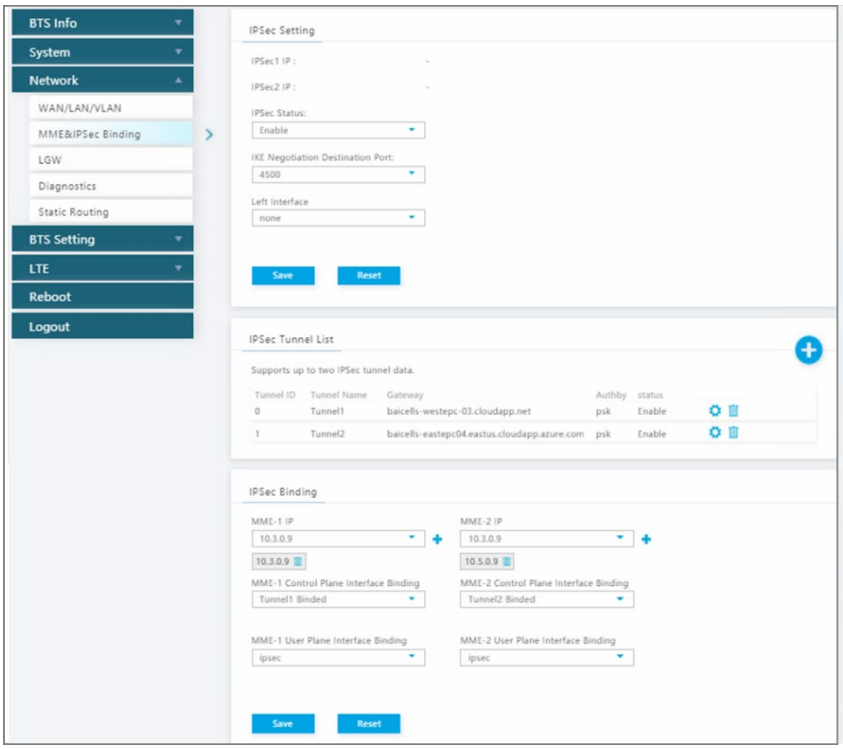
Figure 3-13: WAN/LAN/VLAN



8. **Configure IPSec Binding/MME**: In step 6a above, when you enabled *Cloud EPC* it automatically established two IPSec tunnels. Go to Network > MME&IPSec Binding to verify or edit the setup the same as you would when operating the eNB in standard mode (Figure 3-14).

NOTE: This menu is not included in the GUI of an eNB operating in HaloB mode.

Figure 3-14: IPSec Binding/MME

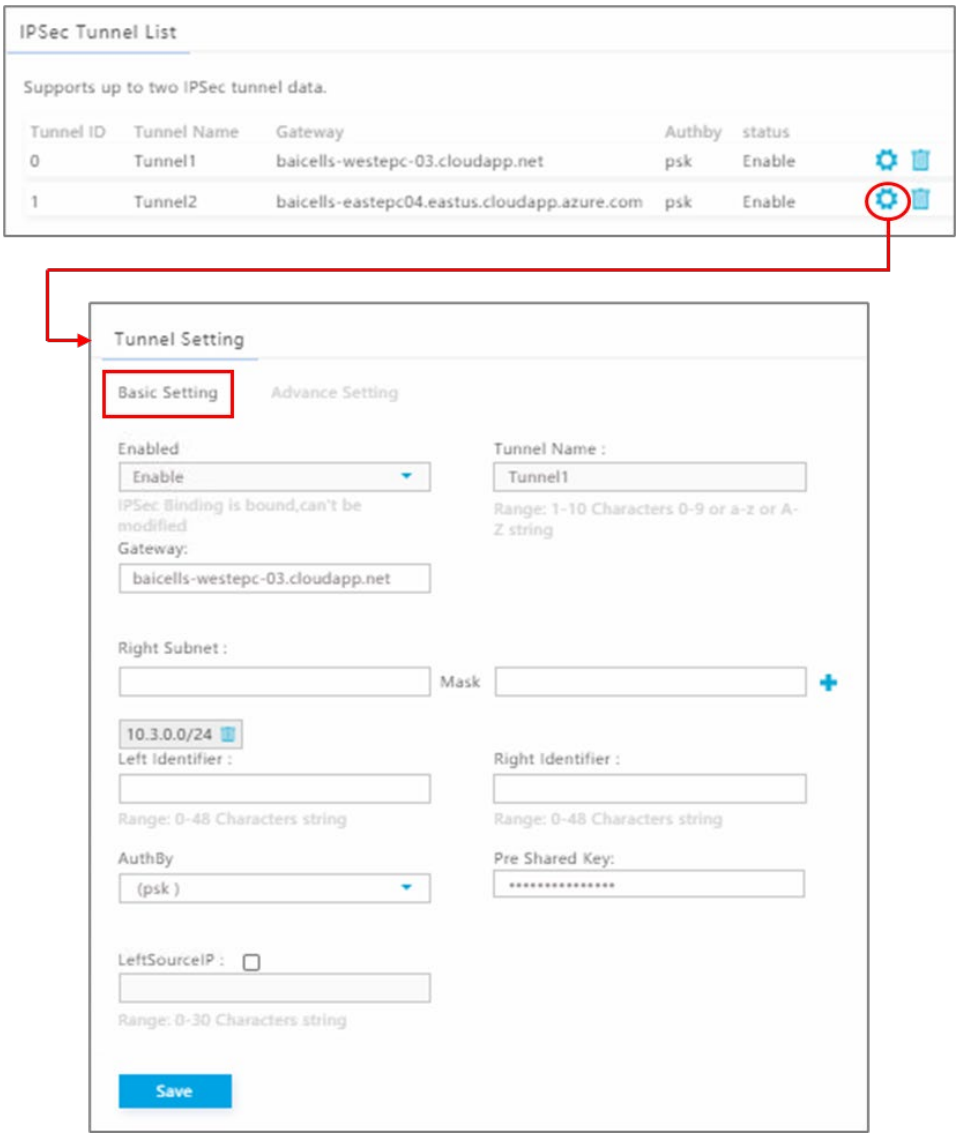


Under *IPSec Tunnel List,* use the *Settings* icon to open a new window called *Tunnel Setting*, where you can change some of the tunnel information (Figure 3-15). This window has two tabs, *Basic Setting* and *Advance Setting*. Only the basic settings should be edited if needed.

Caution: It is highly recommended that you use the default values for the *Advance Setting* fields.

Under *IPSec Binding*, ensure you enter the MME-1 and MME-2 IP addresses if not already auto-configured. When using the Baicells CloudCore, once Cloud EPC is enabled the MME IP addresses will be 10.3.0.9 and 10.5.0.9. You can also enable interface binding between the MMEs and the IPSec tunnels.

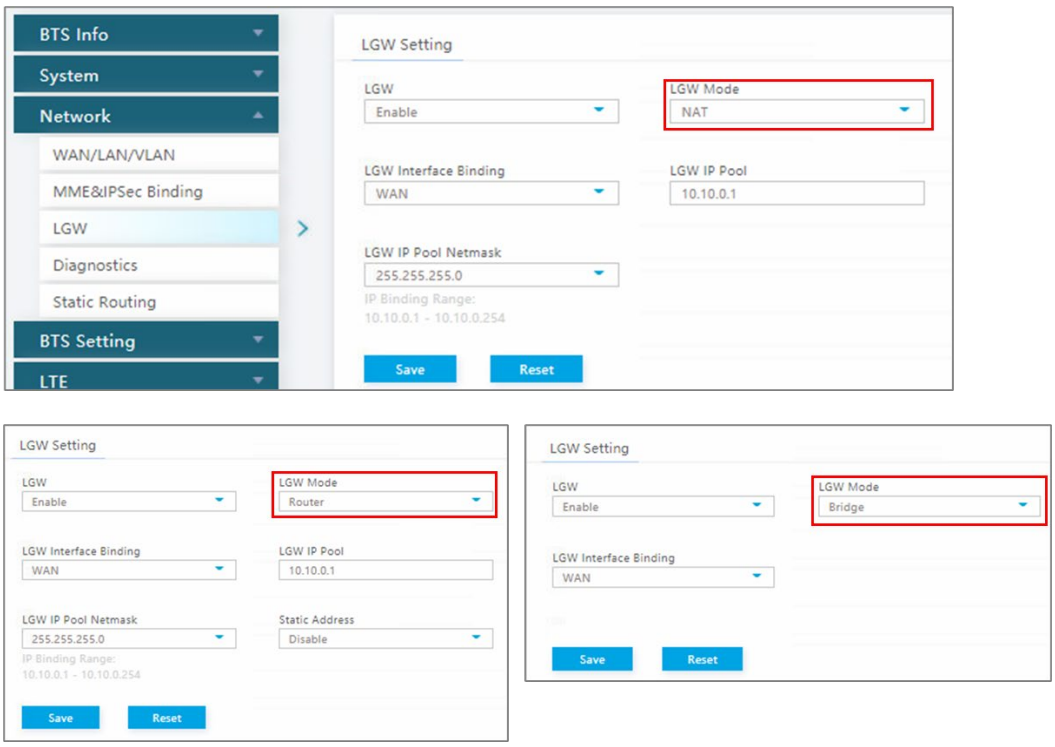
Figure 3-15: IPSec Tunnel List - Basic Setting



9. **Configure LGW**: The Local Gateway (LGW) enables operators to access equipment remotely. The eNB splits the data plane and control plane, so there are two IP addresses per UE. The data plane carries user traffic and is sent out the local gateway.

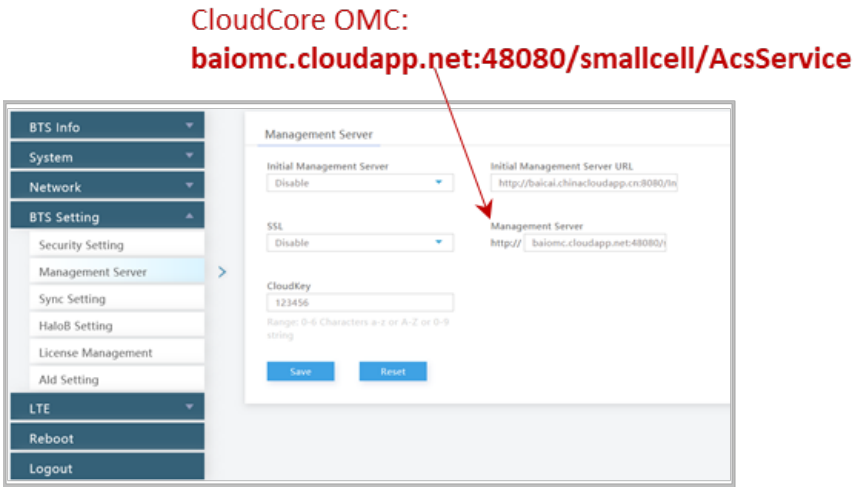
   Go to Network > LGW to enable the feature (Figure 3-16). The options for *LGW Mode* are NAT, router, or bridge (most operators use bridge mode). Enter the *LGW IP Pool* address and network information. The IP binding range is 10.10.0.1 to 10.10.0.254. Alternatively, you can enable *Static Address* and enter a static IP address.

Figure 3-16: LGW



10. **Check/Configure Management Server**: Go to BTS Setting > Management Server, and enter or verify the server address is baiomc.cloudapp.net:48080/smallcell/AcsService. Confirm or add your unique operator CloudKey for the cell to associate to your cloud account (Figure 3-17). Each cell will appear as a separate eNB in the OMC.

Figure 3-17: Management Server



11. **Select Sync Setting**: GPS sync is controlled by Cell 1 and therefore configured in the Cell 1 GUI. Cell 2 will use the same sync settings as Cell 1.

    Go to BTS Setting > Sync Setting (Figure 3-18) :

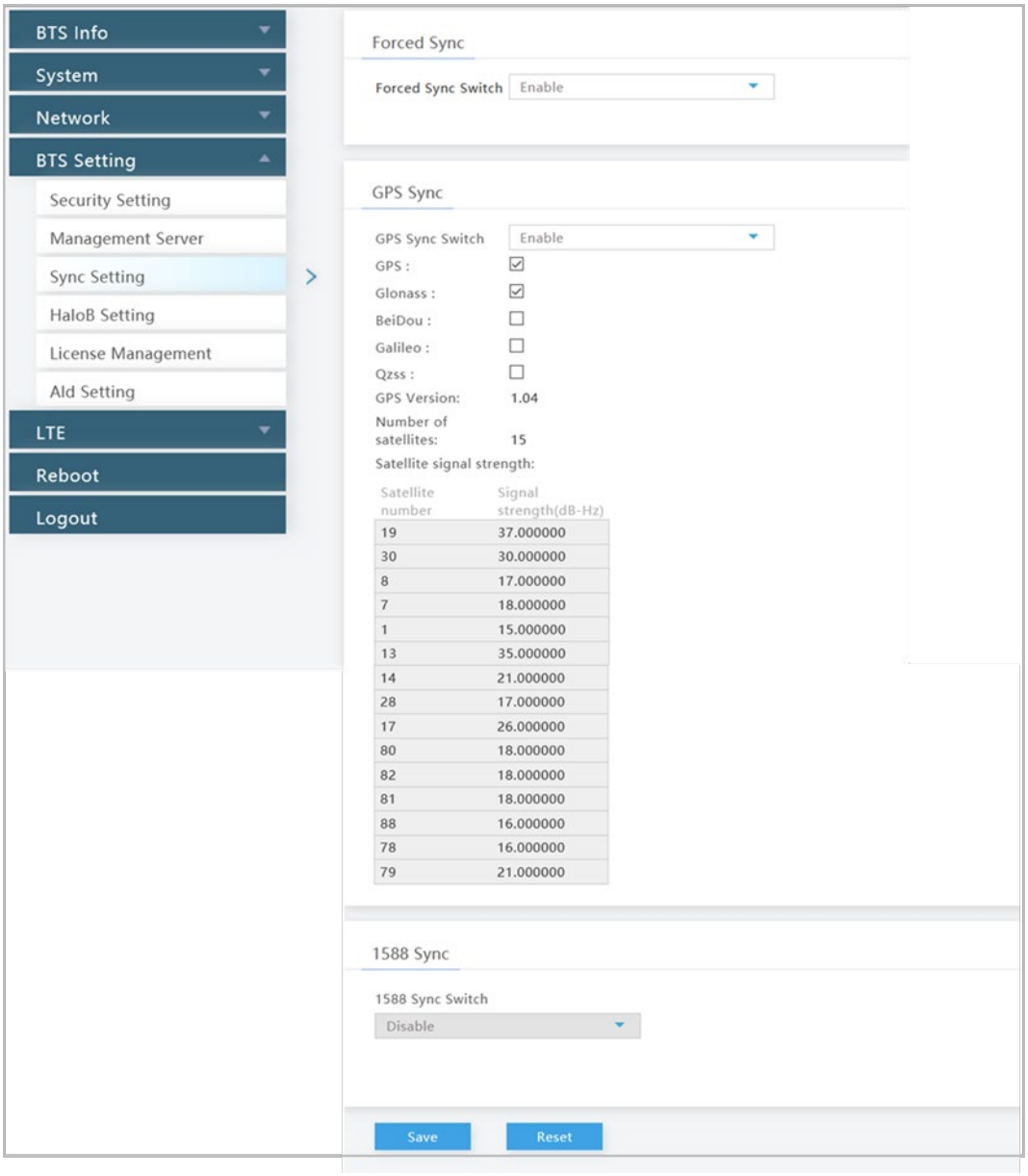
a. Under *Forced Sync*, set *Forced Sync Switch* to *Enable*.

b. Under *GPS Sync*, set *GPS Sync Switch* to *Enable*.

NOTE: The GPS and Glonass boxes are checked as default settings when *GPS Sync Switch* is enabled.

c. Click on *Save* to save the sync options.

Figure 3-18: Sync Setting



The settings for Cell 1 are now configured and Cell 2 can now be configured.

Configure Cell 2:

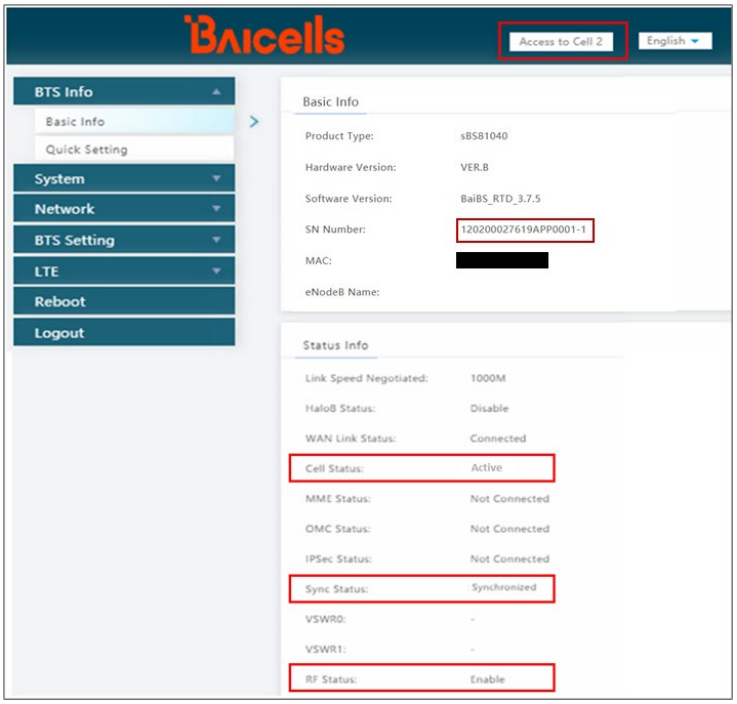
12. **Access Cell 2:** Click the *Access to Cell 2* button. The Cell 2 GUI will render in a separate tab in the web browser.

13. **Log in**: Enter the username and password. Use the default *admin/admin* if you have not changed the password.
14. **Verify you are in Cell 2**: Go to BTS Info > Basic Info to verify the *SN Number* is appended with a *-2.*
15. **Configure Cell 2:** Repeat step 6 through step 10 to configure Cell 2; then, return to step 16 to reboot, which will apply all the settings you configured for Cell 1 and Cell 2.

NOTE: You will not perform Step 11 "Select Sync Setting" again for Cell 2. This setting was configured for Cell 1 and is controlled by Cell 1.

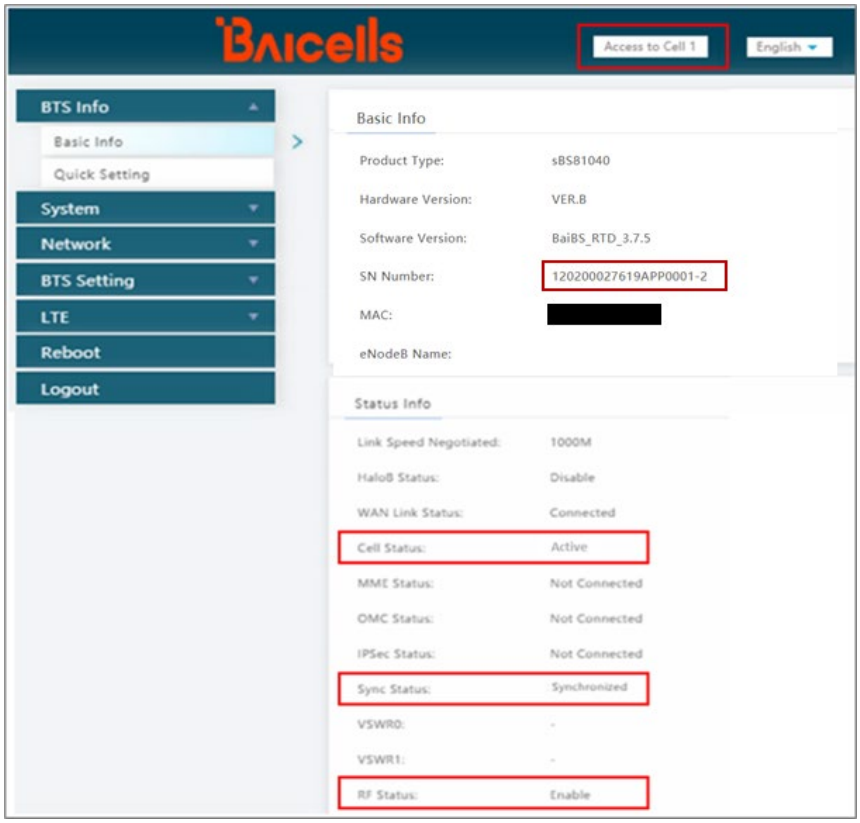
16. **Perform a warm reboot:** Perform a warm reboot to apply all the settings you configured for Cell 1 and Cell 2. After the eNB completes its boot-up sequence, the *Access to Cell 2* button will be visible on the upper right corner of the GUI.
17. **Verify status (Cell 1)**: Verify the BTS Info > Basic Info status settings for Cell 1 (Figure 3-19):
    a. The SN Number is appended with *-1*.
    b. Cell Status is *Active*.
    c. Sync Status is *Synchronized*.
    d. RF Status is *Enable*.

Figure 3-19: Verify Cell 1 Settings



18. **Verify status (Cell 2)**: Verify the BTS Info > Basic Info status settings for Cell 2 (Figure 3-20):
    a. The SN Number is appended with *-2*.
    b. Cell Status is *Active*.
    c. Sync Status is *Synchronized*.
    d. RF Status is *Enable*.

Figure 3-20: Verify Cell 2 Settings



Your Nova-246 is now set up to run in DC mode.