NIO200IAG User Manual

V1.1

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Preface

This manual is for user to set up a network environment using the NIO200 series Product line. It contains step-by-step procedures and graphic examples to guide installer or individuals with slight network system knowledge to complete the installation.

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Acknowledgements

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Safety Information

Before installing and using the device, note the following precautions:

- Read all instructions carefully.
- Do not place the unit on an unstable surface, cart, or stand.
- Follow all warnings and cautions in this manual.
- When replacing parts, ensure that your service technician uses parts specified by the manufacturer.
- Avoid using the system near water, in direct sunlight, or near a heating device.

Installation Recommendations

Ensure you have a stable, clean working environment. Dust and dirt can get into components and cause

a malfunction.

Use containers to keep small components separated.

Adequate lighting and proper tools can prevent you from accidentally damaging the internal components. Most of the procedures that follow require only a few simple tools, including the following:

▪▪ A Philips screwdriver

▪▪ A flat-tipped screwdriver

▪▪ A grounding strap

▪▪ An anti-static pad

Using your fingers can disconnect most of the connections. It is recommended that you do not use needle-nose pliers to disconnect connections as these can damage the soft metal or plastic parts of the connectors.

Safety Precautions

1. Read these safety instructions carefully.
2. Keep this User Manual for later reference.
3. Disconnect this equipment from any AC outlet before cleaning. Use a damp cloth. Do not use liquid or spray detergents for cleaning.
4. For plug-in equipment, the power outlet socket must be located near the equipment and must be easily accessible.
5. Keep this equipment away from humidity.
6. Put this equipment on a stable surface during installation. Dropping it or letting it fall may cause damage.
7. The openings on the enclosure are for air convection to protect the equipment from overheating. DO NOT COVER THE OPENINGS.
8. Make sure the voltage of the power source is correct before connecting the equipment to the power outlet.
9. Place the power cord in a way so that people will not step on it. Do not place anything on top of the power cord. Use a power cord that has been approved for use with the product and that it matches the voltage and current marked on the product's electrical range label. The voltage and current rating of the cord must be greater than the voltage and current rating marked on the product.
10. All cautions and warnings on the equipment should be noted.
11. If the equipment is not used for a long time, disconnect it from the power source to avoid damage by transient overvoltage.
12. Never pour any liquid into an opening. This may cause fire or electrical shock.
13. Never open the equipment. For safety reasons, the equipment should be opened only by qualified service personnel.
14. If one of the following situations arises, get the equipment checked by service personnel:

a. The power cord or plug is damaged.

b. Liquid has penetrated into the equipment.

c. The equipment has been exposed to moisture.

d. The equipment does not work well, or you cannot get it to work according to the user's manual.

e. The equipment has been dropped and damaged.

f. The equipment has obvious signs of breakage.

15. Do not place heavy objects on the equipment.

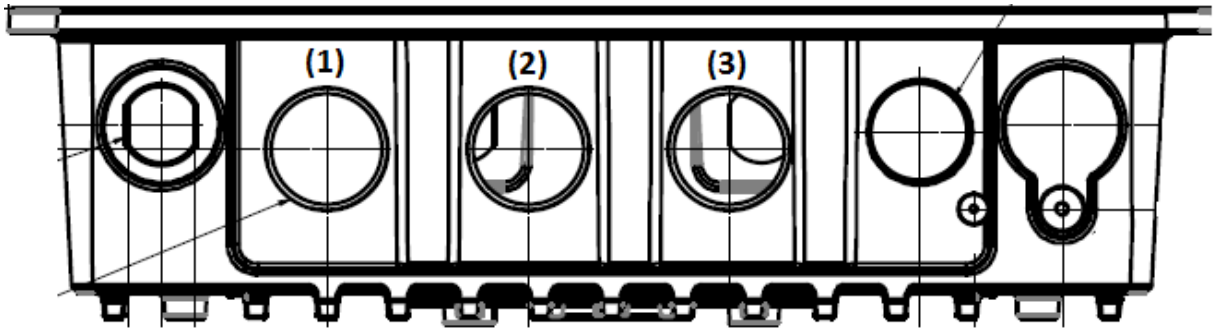
16. **Be sure to ground the 0.75mm2 with an appropriate grounding wire (not included) by attaching it to the grounding screw on the unit and to a good ground connection.**
Earth, Green/Yellow wire, 18AWG, the minimum cross-sectional area of Earthing conductor shall equal to Input wiring cable.

17. The front of the Equipment requires wiring terminals with the following specifications:

- **Wire size: 30-12 AWG** (0.0509-3.3088 mm²)
- **Wire Type: copper wire only**
- **Terminal Blocks Torque: 5 lb. In.** (0.565 N-m).
- For supply connections, use wires suitable for at least 75 degree C ambient environment

- **There must be a disconnect device in front of "NIO200 series" to keep the worker or field side maintainer be cautious and aware to close the general power supply before they start to do maintenance. The disconnect device hereby means a 20A circuit-breaker. Power installation must be performed with qualified electrician and followed with National Electrical Code, ANSI/NFPA 70 and Canadian Electrical Code, Part I, CSA C22.1.**

18.



(1) DC IN: 12-48Vdc, 2.1-0.6A

(2) LAN

(3) WAN(POE):57Vdc, 600mA

19. This equipment is intended to Ex nA IIC T4 Gc.

Note:

This equipment is intended to be mounted on a pole with the mounting bracket, wall mounting or DIN

mounting; the mounting should always let water proof connectors down to bottom position.
Cet équipement est destiné à être monté a la place avec le support de montage, montage mural ou montage DIN; Le montage doit toujours laisser les connecteurs imperméable à la base.

This equipment is suitable for use in Class I, Division 2, Groups A, B, C, and D or non-hazardous locations only.
Cet équipement est adapté à une utilisation en Classe I, Division 2, Groupes A, B, C et D ou des zones non dangereuses uniquement.

- WARNING – EXPLOSION HAZARD. DO NOT CONNECT OR DISCONNECT WHEN ENERGIZED."
  AVERTISSEMENT - RISQUE D'EXPLOSION. NE PAS CONNECTER NI DÉCONNECTER LORSQU'IL EST EN CHARGE.

- Product is UL Listed with UL Listed Fittings for use with liquid-tight flexible metal conduit. This wiring method is suitable for flexible connections in accordance with Article 501.10(B)(2) of the National Electrical Code (ANSI/NFPA 70). Suitability for installation in particular applications is at the discretion of the Authority Having Jurisdiction (AHJ) or similar.

- Le produit est homologué UL avec des accessoires homologués UL
  pour conduit métallique flexible étanche aux liquids. ette méthode de câblage convient aux flexibles connexions conformément à l'article 501.10 (B) (2) du National Code électrique (ANSI / NFPA 70). Pertinenced'installation dans certaines applications à la discrétion de l'Autoritéayant Juridiction (AHJ) Ou similaire.

Technical Support and Assistance

1. For the most updated information of NEXCOM products, visit NEXCOM's website at www.nexcom.com.
2. For technical issues that require contacting our technical support team or sales representative, please have the following information ready before calling:
– Product name and serial number
– Detailed information of the peripheral devices
– Detailed information of the installed software (operating system, version, application software, etc.)
– A complete description of the problem
– The exact wordings of the error messages

Warnings

Read and adhere to all warnings, cautions, and notices in this guide and the documentation supplied with the chassis, power supply, and accessory modules. If the instructions for the chassis and power supply are inconsistent with these instructions or the instructions for accessory modules, contact the supplier to find out how you can ensure that your computer meets safety and regulatory requirements.

1. Handling the unit: carry the unit with both hands and handle it with care.
2. Opening the enclosure: disconnect power before working on the unit to prevent electrical shocks.
3. Maintenance: to keep the unit clean, use only approved cleaning products or cleans with a dry cloth.

Safety Warning: This equipment is intended for installation in a Restricted Access Location only

Avertissement de sécurité: Cet équipement est destiné à être installé uniquement dans un lieu d'accès restreint

Cautions

Electrostatic discharge (ESD) can damage system components. Do the described procedures only at an ESD workstation.

If no such station is available, you can provide some ESD protection by wearing an antistatic wrist strap and attaching it to a metal part of the computer chassis.

Conventions Used in this Manual

Warning: Information about certain situations, which if not observed, can cause personal injury. This will prevent injury to yourself when performing a task.

Caution: Information to avoid damaging components or losing data.

Note: Provides additional information to complete a task easily.

Note: The surface temperature of enclosure may exceed 70℃ under working condition.

Remarque: La température de surface de l'enceinte peut dépasser 70 ℃ dans des conditions de travail.

1. General Information

1.1 Document Purpose

This installation guide is designed to let user quickly get necessary installation information about hardware as well as software so that the field installation can be well done through this first aid.

1.2 Definitions, Acronyms and Abbreviations

The following table lists definitions, acronyms, and abbreviations that are only suitable to this document.

Term	Description
API	Application Programming Interface
Backbone	Any data network (e.g. industrial Ethernet, IEEE 802.11, etc.) within a facility interfacing to the plants network.
Backbone Router	An entity in the ISA100.11a network with routing capability which serves as an interface between the radio network and the backbone network.
BBR	Backbone Router
Blacklisted channel	A channel on which transmission is prohibited.
Broadcast	Transmission intended for all the devices in an ISA100.11a network (used for advertisements with all devices including the BBR, or for receive links for field devices only).
CCA backoffs	The count of transmissions on an RF channel that were aborted due to CCA.

Term	Description
CGI	Common Gateway Interface
Channels	Divisions of radio frequencies supported in a wireless network.
Contract	An agreement between the system manager and a device in the network involving the allocation of network resources by the system manager to support a particular communication need of that device.
Device role	Device capabilities that will be accepted by the Security Manager.
DHCP	Dynamic Host Configuration Protocol – a method to automatically configure the IP settings of a host connected in a LAN.
EUI64, EUI-64	The 64-bit address of a device in the network; it is a unique identifier usually set at the manufacturing of the device.
Field	The geographic space that contains all the nodes of a wireless network.
Field device	A physical device designed to meet the rigors of plant operation that communicates via DPDU's conforming to the ISA100.11a protocol.
Gateway	An entity in the ISA100.11a network that serves as an interface between the ISA100.11a network and a client.
Graph (communication)	A collection of unidirectional interconnected devices, which defines a set of communication paths between a source device and a destination device.
Graph (Topology)	A graphical representation of the network topology.
GW	Gateway
Input/output	A device with minimum characteristics required to participate in an ISA100.11a network and which provides or uses data from other devices.
ISA100.11a	A communication protocol used in wireless networks, set up by the Wireless Compliance Institute.
JSON	JavaScript Object Notation
LAN	Local Area Network
Link	A momentary or persistent interconnecting path between two or more devices for the purpose of transmitting and receiving messaging.
MCS	Monitoring Control System
Network Address	The 128-bit address of a device in the network.

Term	Description
Packet Error Rate	The ratio, in percent, of the number of lost packets (DPDU's) to the total number of packets sent by the selected device to its parent.
Process value	The quantity being controlled or the measurement value.
Provision	To update settings on an entity in order to prepare it for working in the network.
Revision	The device software revision related to vendor/model.
Router	A device that has data routing capability.
Security Manager	An entity in the ISA100.11a network that assigns the security keys that are required for communication between devices.
SM	System Manager
Superframe	A collection of timeslots with a common repetition period and possibly other common attributes.
System Manager	An entity in the ISA100.11a network that supervises the various operational aspects of a network other than security.
TR	Transceiver – the BBR radio
User Application Process	From ISA100.11a standard: An active process within the highest portion of the application layer that is the user of OSI (Open Systems Interconnection) services.
UTC	Coordinated Universal Time – A universal timekeeping standard that is based on the Greenwich Mean Time (GMT). Local time is calculated in UTC and offset by the local time zone.
FD	Field Device
NIO210	NIO 200IAG – NEXCOM ISA100 Wireless All-in-One Gateway

2 Product Overview

2.1 About the NIO200IAG Gateway

NEXCOM NIO 200 is a powerful distributed network topology ISA100.11a / WirelessHART access point integrating 802.11n Mesh technology. With ISA100.11a / WirelessHART technology, NIO 200 can establish fully Mesh network to ensure robust and reliable communication for mission-critical industrial wireless applications. The integration of both 802.11n Mesh & ISA100.11a / WirelessHART technology gives a full Mesh infrastructure from field devices to Wi-Fi backbone, thus a concrete wireless connectivity can be assured. It's designed to meet CID2 and ATEX certified requirement and is perfect solution to critical data monitoring and sensing in oil & gas, chemical plant, etc…

2.2 Logical Interfaces

Interface	Description
Serial Port	The serial port is used as a kernel console and emergency backup.

Interface	Description
TCP	The NIO200IAG Gateway accepts the following TCP connections. ➢ The NIO200IAG Gateway has an http server listening on port 80. ➢ The NIO200IAG Gateway has an http server listening on port 8080. ➢ The NIO200IAG Gateway has an https server listening on port 443. ➢ The MODBUS TCP server is listening on TCP port 502. ➢ The Standard GSAP interface is listening on TCP port 4900. ➢ The GSAP over SSL is listening on TCP port 4901.
UDP	The NIO200IAG Gateway utilizes the NTP protocol to synchronize time with Internet time servers. The UDP port 123 must be open in both directions to allow time synchronization.

NOTE: Not all interfaces are guaranteed to be up in all cases. Some might be disabled for specific applications.

2.3 Package Contents

Each NIO200IAG gateway package contains the following items:

- One NIO200IAG gateway
- Two simple wall mounting kit
- Three liquid-tight conduit (used only for DC power input and Ethernet port)
- Two-pin DC power connector for 12~48 VDC power input
- Grounding screws
- Five outdoor antenna for evaluation purpose (when deployed in field site, the antenna should be changed so that the wireless capability can fit the application requirement)
- One AC power adaptor with 12V output for evaluation purpose (when deployed in field site, DC power source may need to be changed)
- One CID2 warning letter

3 Getting Started

3.1 Installation background

The web-based administration is the preferred method to administer/configure the NIO200IAG Gateway. It requires a web browser and the IP of the NIO200IAG Gateway. The NIO200IAG Gateway is suggested to connect to the local LAN then powered on, and the IP/mask or the router must be accessible from the PC where the browser is running.

3.2 Hardware installation Guide

Hardware connection of NIO200 includes the power, Ethernet interfaces and RF connectors. The installation of NIO200 should be carefully done with standard waterproof connectors accessories in the package (CID2: conduit connector, ATEX: cable gland connector).

Note: the mounting of NIO200 should always let water proof connectors down to bottom position. The following picture illustrates the proper mounting direction of NIO200 in the field.

3.2.1 Water proof connector installation

To install conduit in NIO200 enclosure, please follow the steps below:

- Put conduit through cap nut and gland packing.
- Position the ferrule at the end of the conduit. (Just have the bottom
- Pass DC power cable or Ethernet cable through conduit

of ferrule cover the conduit, over-tighten may enlarge conduit diameter and loosen

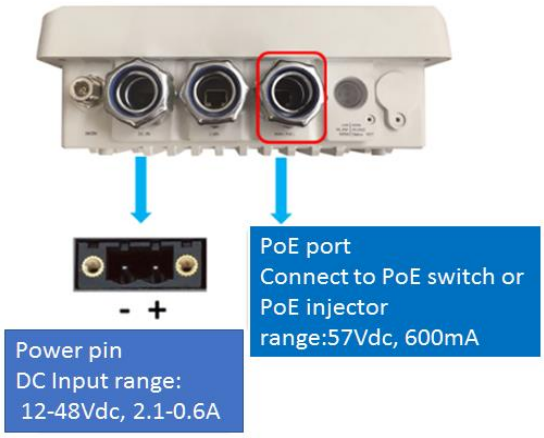
- Connect connector into NIO200 enclosure, tighten locknut with body.
- Insert the conduit with ferrule into connector of NIO200 enclosure.
- Push gland packing and cap nut forwards to NIO200 conduit connector and tighten the cap nut

To install the conduit, user should implement with Flexible Metal Conduit, Liquid-tight which meets UL360 standard. Here is the requirement of the diameter and size information for the selection of Metal Conduit that mate with NIO200 conduit connectors.

Nominal size (inch)	Inner diameter min. (mm)	Inner diameter max. (mm)	Outside diameter min. (mm)	Outside diameter max. (mm)	Min bending radius (mm)	Packing length (m)
3/8"	12.29	12.80	17.50	18.00	50.50	30
1/2"	15.80	16.31	20.80	21.30	82.50	30
3/4"	20.83	21.34	26.20	26.70	108.00	30
1"	26.44	27.08	32.80	33.40	165.00	20
1-1/4"	35.05	35.81	41.40	42.20	203.00	20
1-1/2"	40.01	40.64	47.40	48.30	228.50	20

3.2.2 Power installation

1. Prepare DC power source (12~48 VDC) or standard PoE facility such PoE switch or PoE injector.
2. If use external DC power source, please carefully check if the polarity of power



cord fits the polarity drawing in this diagram.

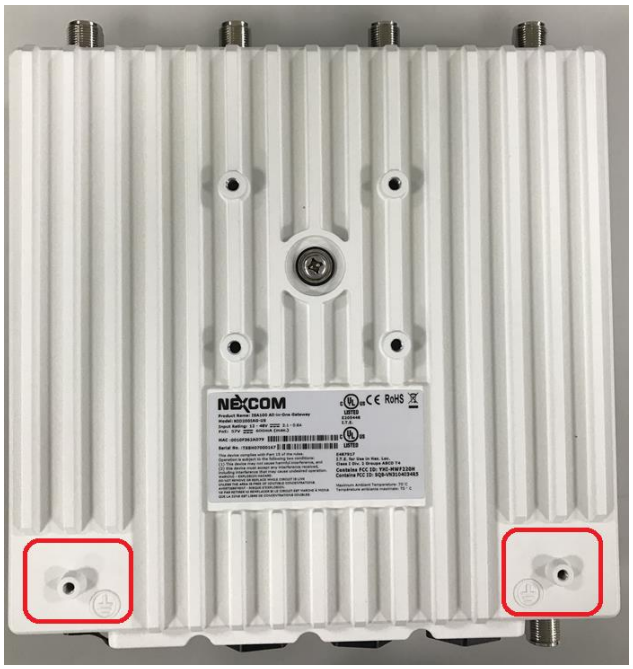
3. When use PoE power source, just plug the Ethernet cable into PoE port.
4. If the power connects correctly, then the "Power LED" will light accordingly.

3.2.3 Antenna installation

Wi-Fi antenna connector for Wi-Fi Mesh connection (WLAN 1 & WLAN 2)

ISA100/WirelessHART antenna connector

3.2.4 Earth grounding



1. Be sure to ground the 0.75mm^2 ground screw with an appropriate grounding wire (Earth, Green/Yellow wire 18AWG, not included) by attaching it to a good earth ground connection.
2. There must be a disconnect device in front of “NIO200 series” to keep the worker or field side maintainer be cautious and aware to close the general power supply before they start to do maintenance.
3. The disconnect device hereby means a 20A circuit-breaker. Power installation must be performed with qualified electrician and followed with National Electrical Code, ANSI/NFPA 70 and Canadian Electrical Code, Part I, CSA C22.1.

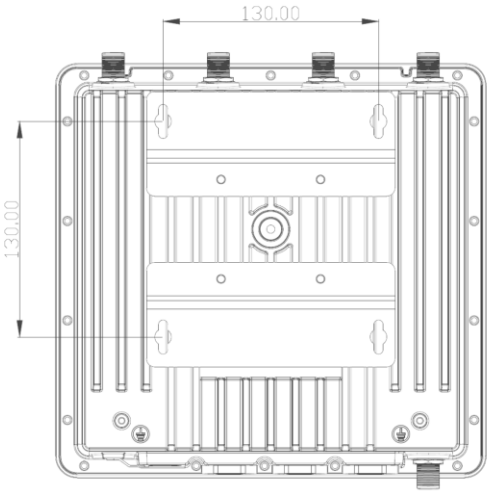
3.2.5 Mounting of NIO200IAG

Mounting method in NIO200IAG is default with simple wall mounting kit. If the installation is with pole mounting method, then user should purchase pole mounting kit for the installation. Here is the guide for both simple wall mounting method and pole mounting method:

A.Simple wall mounting method:

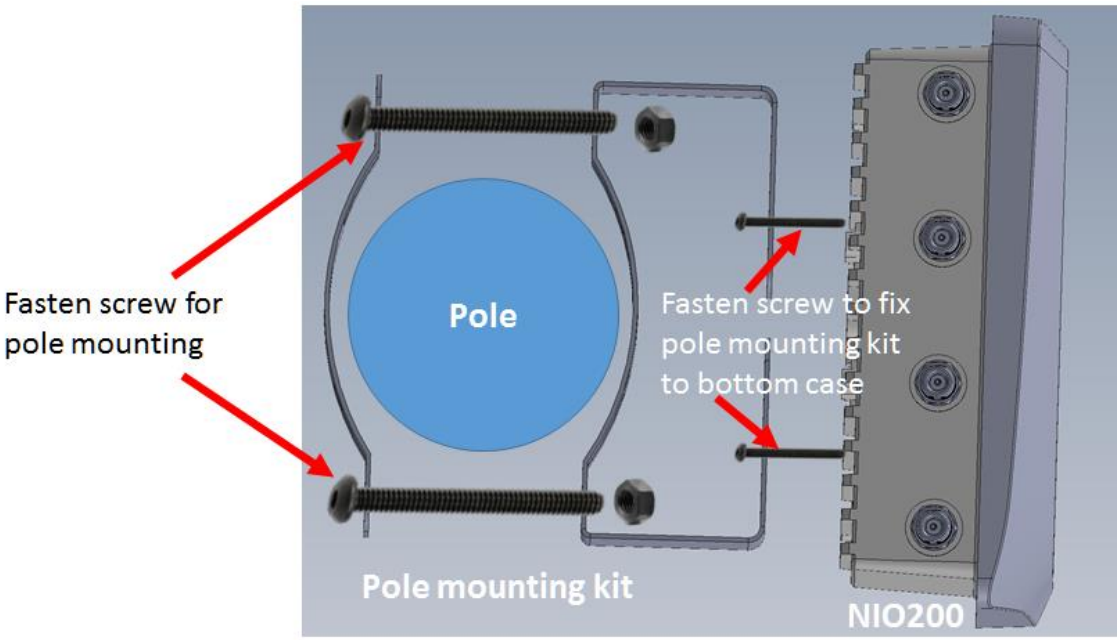
1. Screw the simple wall mounting kit to the bottom of NIO200 enclosure.

2. Be sure to fasten the mounting kit with horizontal position as below:



3. Hang on NIO200 to the wall with water proof connector at the bottom direction. The position of screw holes are 130mm width and height (as specified in right picture above)

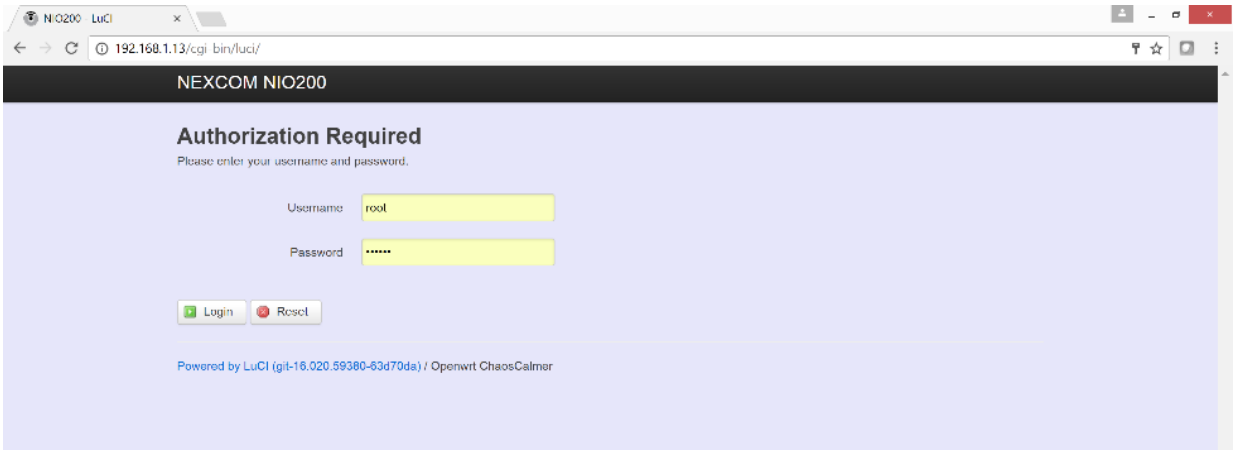
B. Pole mounting method:



3.3 Wi-Fi Mesh Network Configuration

3.3.1 Access to NIO200 Admin website

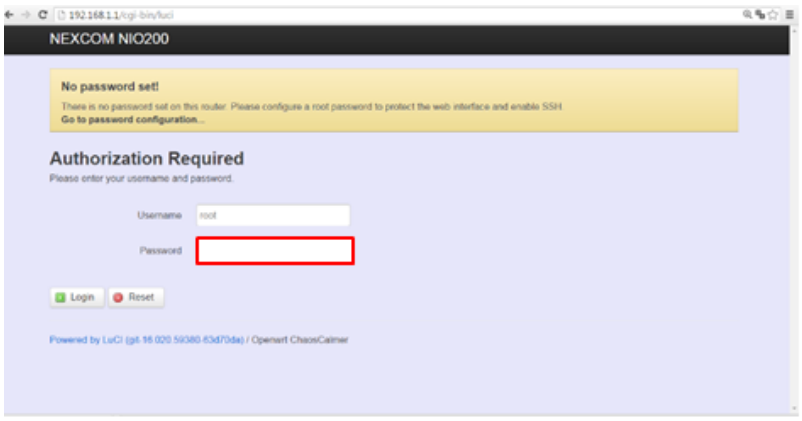
The NIO200IAG is pre-configured a static IP address **192.168.1.1** for connection directly to a computer. In order to communicate with the NIO200IAG, the user must temporarily set the computer IP address to a static address (**192.168.1.100** for example) and may use an Ethernet cross-over cable to connect the NIO200IAG to the computer.



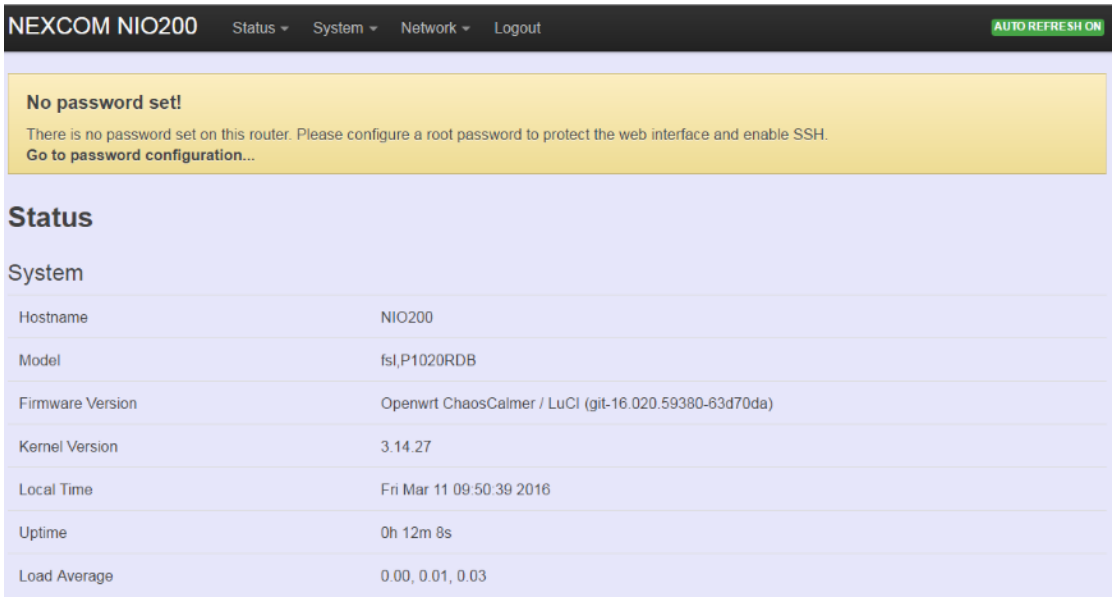
3.3.2 Configure the IP Address

Once the communication has been established with the NIO200IAG, the user can log in the NIO200 Admin website to change the network configuration, including its IP address. To the access this website:

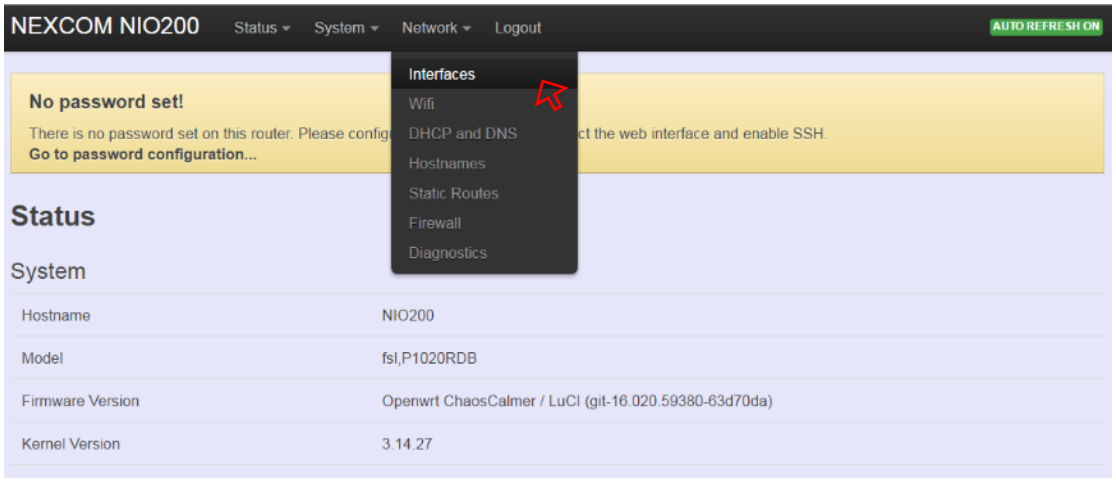
- In browser, open a connection to http://**192.168.1.1/** (or the user defined IP Address)
- Admin website requires authentication, the default *username* and *password* are *root* and *admin*.



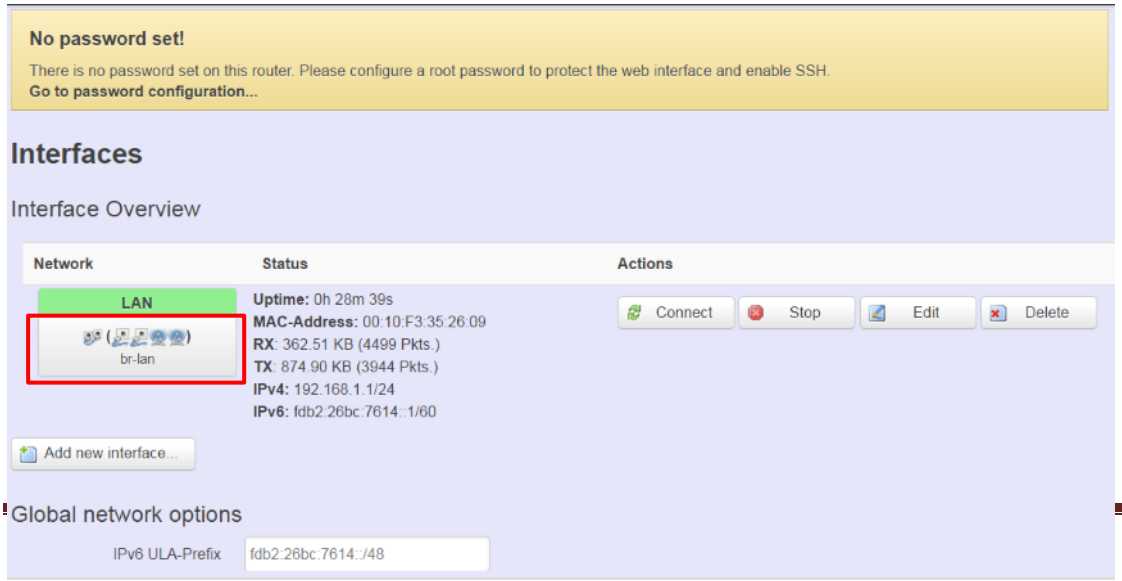
Click “Login” button without password and the following web page will appear:



Select “Network -> Interface”



The following web page will appear.



Interface Name: LAN

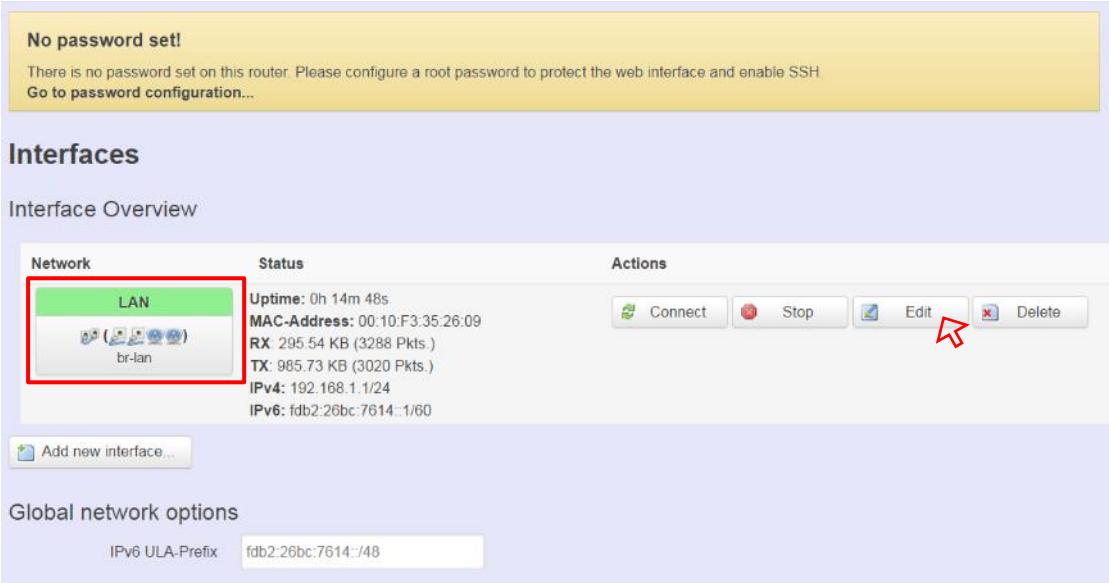
Bridge Interface: br-lan

IP address: 192.168.1. 1

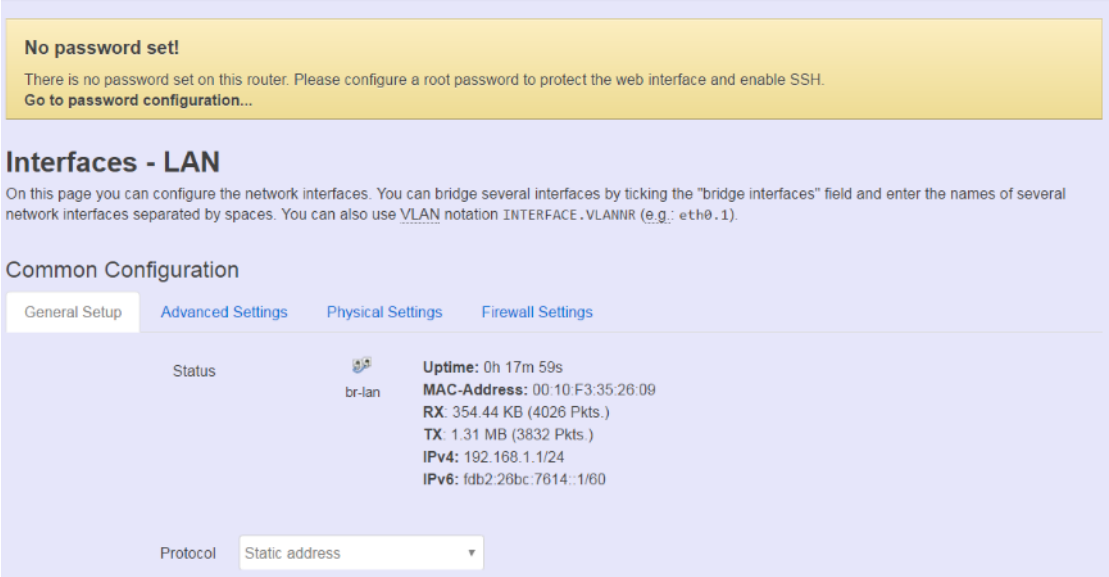
Physical Interfaces: eth1/eth2/wlan0/wlan1

3.3.3 Change IPv4 address

Click the “Edit” button belonging to “br-lan” network interface icon.



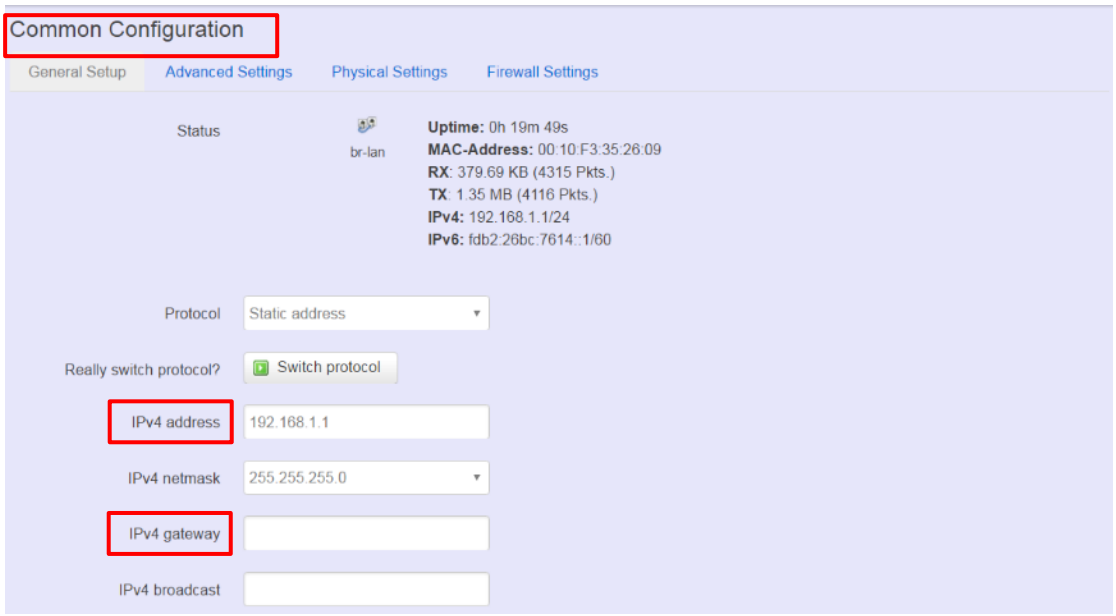
The following web page will appear.

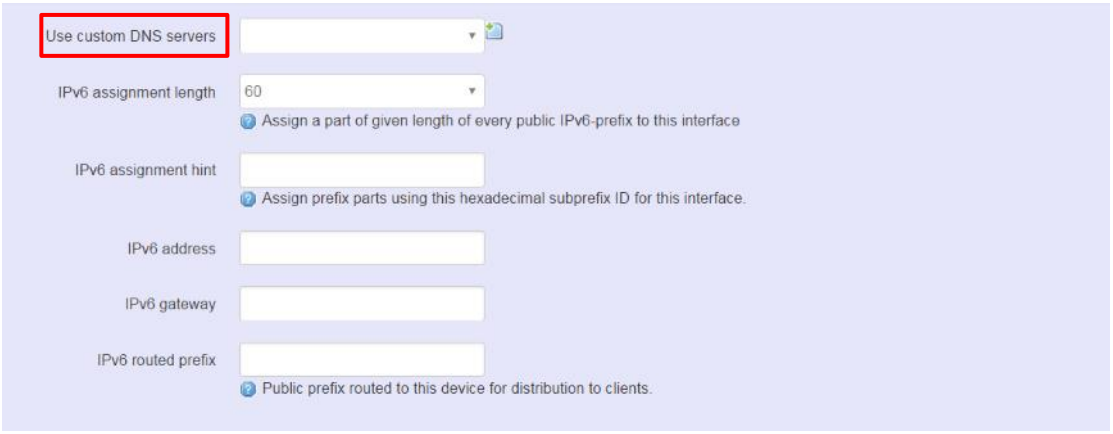


As far as each interface is concerned, there are two configuration sections: “Common Configuration” and “DHCP Server”.

Scroll down to the section “Common Configuration”, and click

“General Setup” tab.





The IP address, default gateway, DNS servers could be changed and added by clicking the text areas of “IPv4 address”, “IPv4 Gateway” and “Use custom DNS servers” and inputting values respectively.

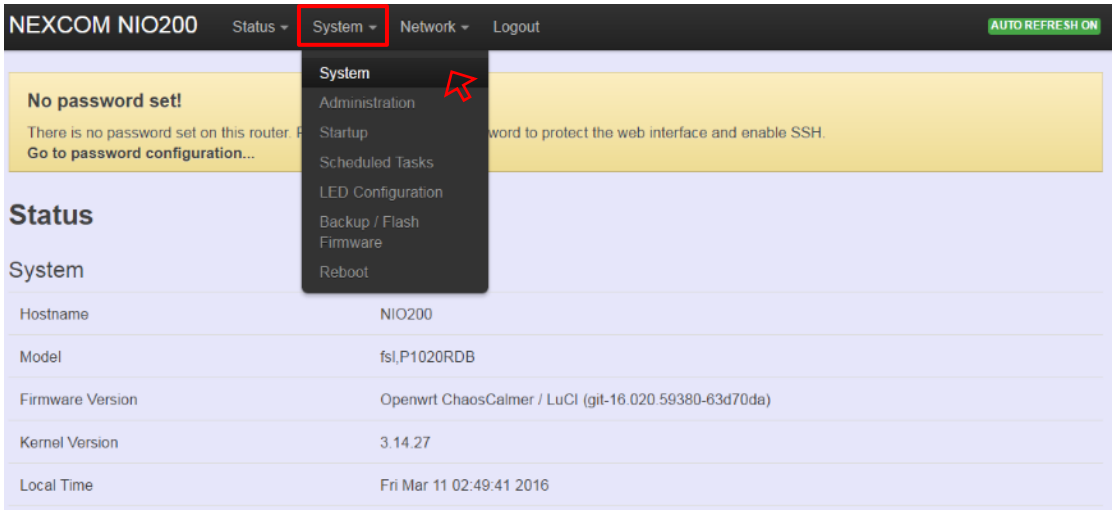
After the configuration is finished, click “Save & Apply” button to save this setting.

Warning:

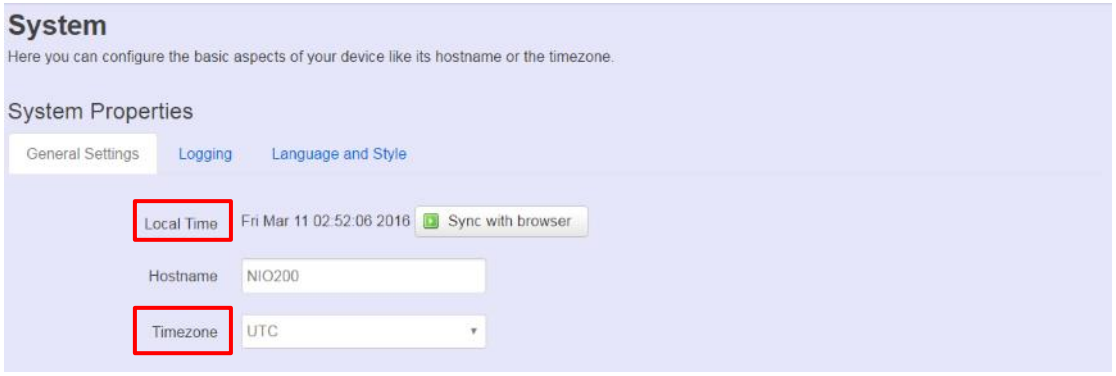
After the IPv4 gateway and DNS servers are configured, user needs to go back to “Network -> Interface” page and click “Connect” button to take effect the setting.

3.3.4 Enable NTP (Network Time Protocol)

Navigate to “System -> System”, and then the web page below will appear.

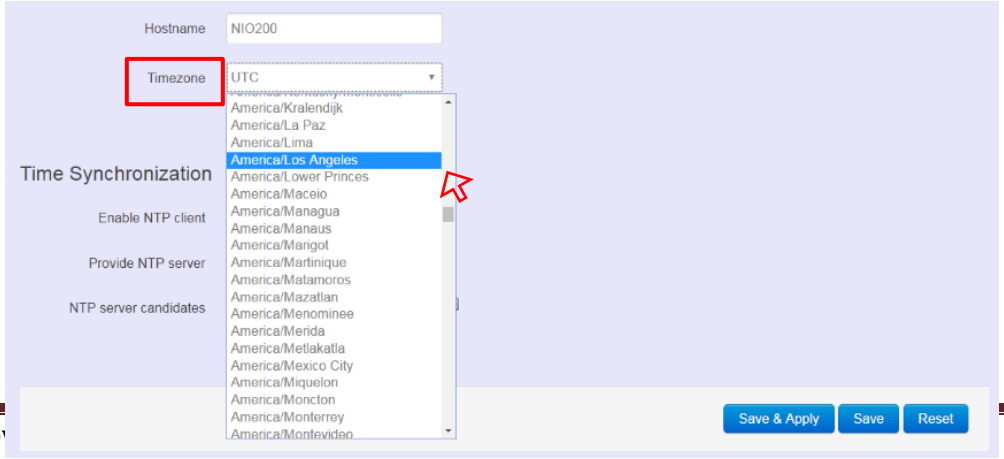


Click “General Settings” tab to configure “Local Time” and “Timezone” as shown below. Configure NTP server in the “Time Synchronization” section when necessary.



Before NTP server is working, NIO200 should have correct date/time by clicking “Sync with browser” and selecting “UTC” as Timezone.

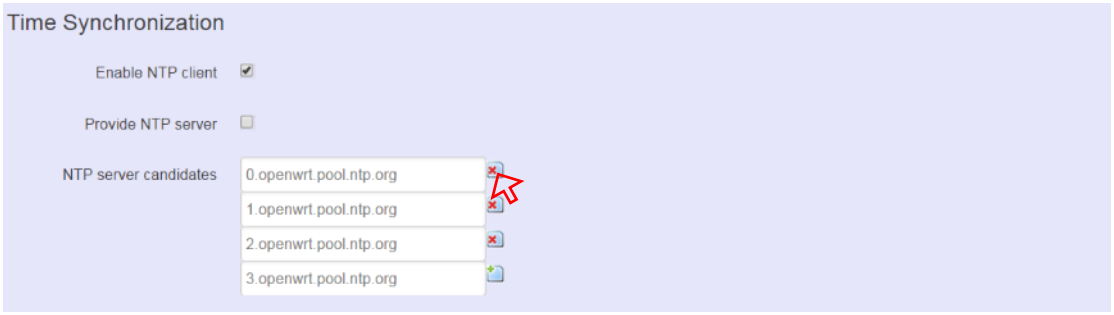
3.3.5 Select Time Zone



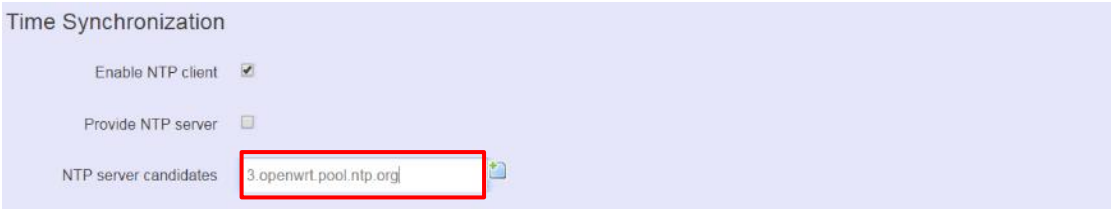
3.3.6 Select/Input Time Server

NTP client is enabled by default.

Click “X” button to delete the incorrect or unwanted time server.



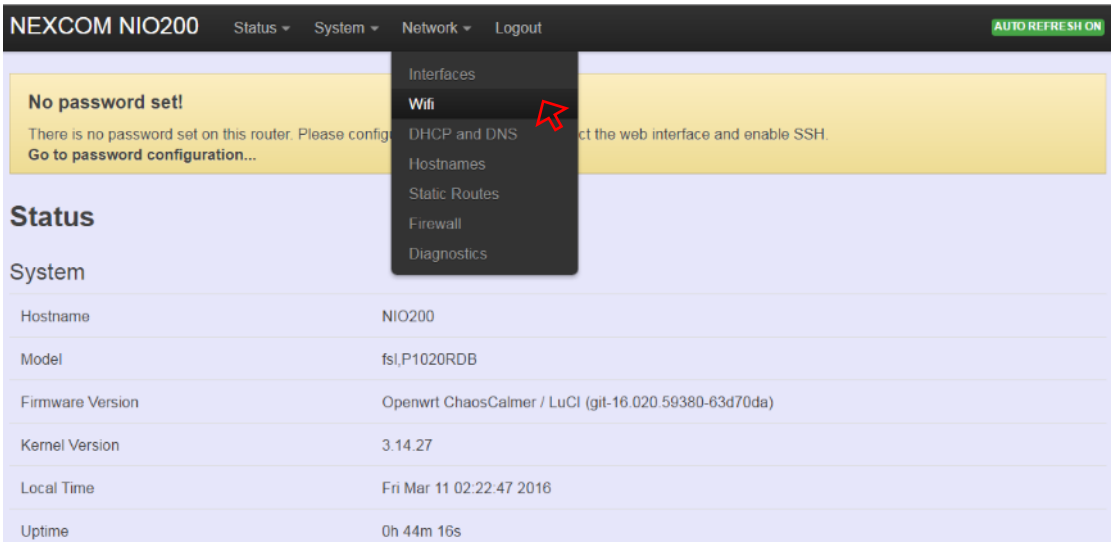
Keep clicking “X” buttons until only one item is left. Point the mouse cursor to text area and input “time.nist.org”.



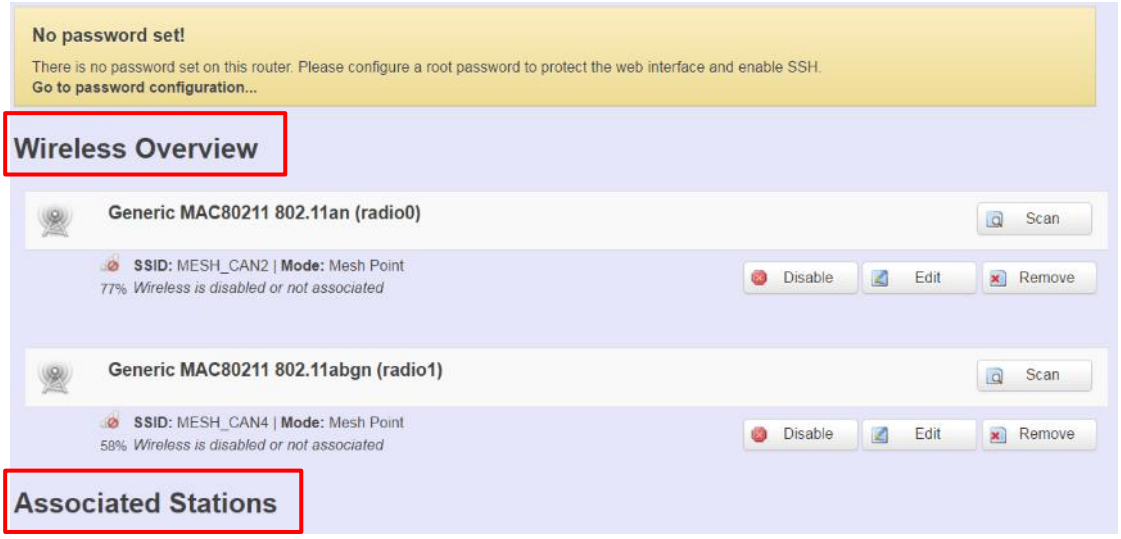
If new time server is required, click “**+**” button.

3.3.7 Configure Wi-Fi Mesh Interface

For Wi-Fi configuration and status reporting, navigate to “Network -> Wi-Fi” and click.



The following web page is shown, and contains two sections: “Wireless Overview” and “Associated Stations”.

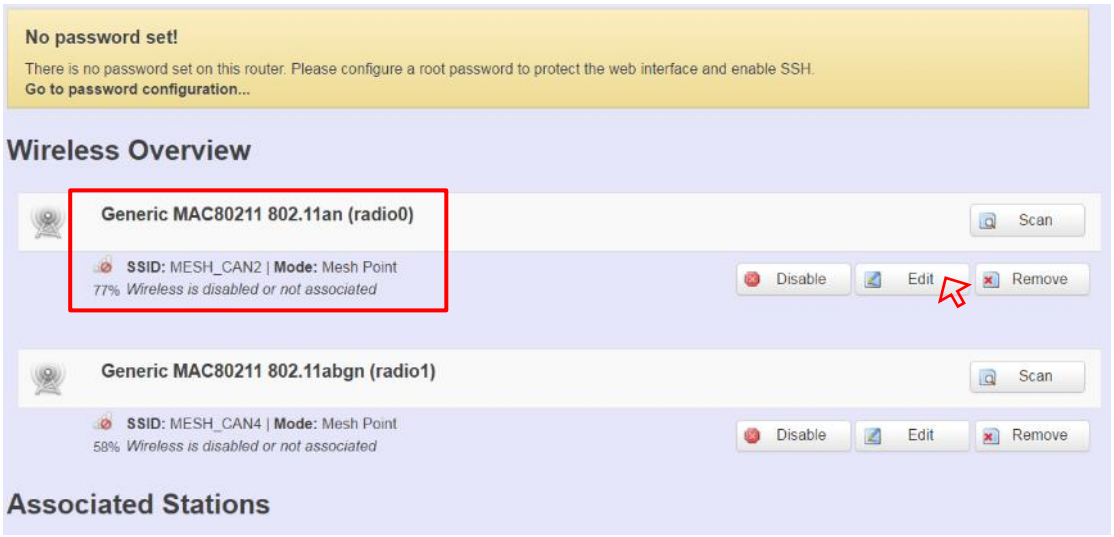


“Wireless Overview” section lists available Wi-Fi interfaces: wlan0 and wlan1.

“Associated Stations” section lists run-time connection information for each Wi-Fi interface (mesh mode).

SSID	MAC-Address	IPv4-Address	Signal	Noise	RX Rate	TX Rate
MESH_CAN2	00:10:F3:35:26:27	?	-49 dBm	-95 dBm	150.0 Mbit/s, MCS 7, 40MHz	52.0 Mbit/s, MCS 5, 20MHz
MESH_CAN2	00:0E:8E:67:62:69	?	-62 dBm	-95 dBm	26.0 Mbit/s, MCS 3, 20MHz	52.0 Mbit/s, MCS 5, 20MHz
MESH_CAN2	00:10:F3:35:26:1E	?	-68 dBm	-95 dBm	15.0 Mbit/s, MCS 0, 40MHz	52.0 Mbit/s, MCS 5, 20MHz
MESH_CAN4	00:10:F3:35:26:29	?	-66 dBm	-94 dBm	6.0 Mbit/s, MCS 0, 20MHz	52.0 Mbit/s, MCS 5, 20MHz
MESH_CAN4	00:0E:8E:67:64:4D	?	-80 dBm	-94 dBm	26.0 Mbit/s, MCS 3, 20MHz	52.0 Mbit/s, MCS 5, 20MHz
MESH_CAN4	00:10:F3:35:26:21	?	-70 dBm	-94 dBm	58.5 Mbit/s, MCS 6, 20MHz	52.0 Mbit/s, MCS 5, 20MHz

Take wlan0/radio0 interface for example.



Edit:

For editing the configuration profile of Wi-Fi interface, click this button

There are 2 configuration sections in the web page: “Device Configuration” and “Interface Configuration”.

The parameters in the “Device Configuration” are related to physical settings of Wi-Fi radio.

The parameters in the “Interface Configuration” are related to network settings of Wi-Fi interface, which is built upon the Wi-Fi radio.

Scan: For displaying the list of all access points around with the same frequency band as this radio has, click this button.

3.3.8 Configure Physical Settings for Radio

The physical settings (radio parameters of Wi-Fi interface) exists in this “Device Configuration” section.

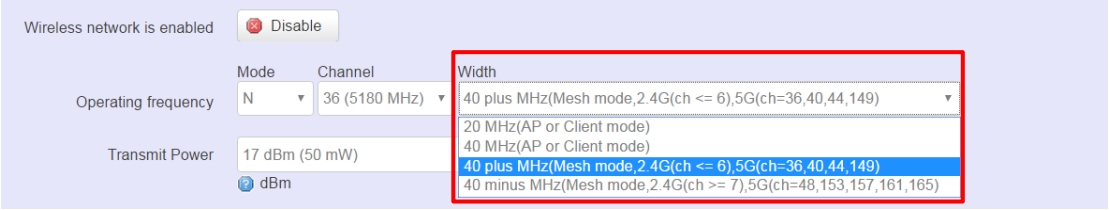
- Clicking “General Setup” tab.

There are 4 basic types of physical settings required for radio: 802.11 protocol, 5GHz Channel, Bandwidth, and Transmit Power.

There are 2 options for “802.11 protocol”: N (802.11n) and Legacy (802.11a).

There are 10 options for channel selection in 5GHz band.

Width: There are 4 options for bandwidth selection. 2 options (“20MHz” and “40MHz”) are used for AP or STA client mode. 2 options (“40 plus” and “40 minus”) are used for mesh mode



Transmit Power: There are 14 options.

3.3.9 Network Settings of Wi-Fi Interface

The network settings (network parameters of Wi-Fi interface) exists in this “Interface Configuration” section.

Clicking “General Setup” tab

ESSID/Mesh ID: (Default: “MESH_CAN2”) Network name.

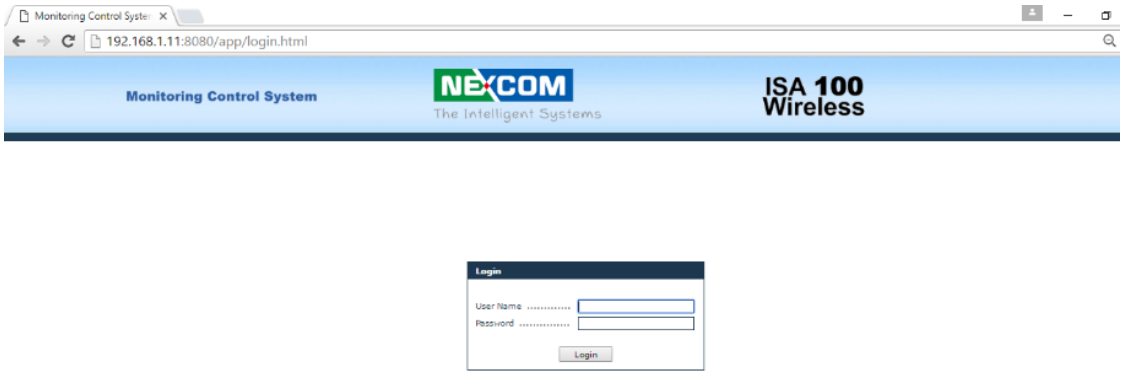
All products with the same ID (or network name) and radio physical settings (802.11 protocol and channel) are connected together automatically.

Mode: (Default: “Mesh, 802.11s”) Wireless network topology. Only mesh is supported.

3.4 ISA100 Gateway Configuration

ISA100 gateway specific network management and configuration takes place into the Monitoring Control System (MCS). Steps to access the MCS:

Step	Action
1.	Open the following URL: **http://192.168.1.1:8080/** (or, replacing <NIO200IAG_IP> with NIO 200IAG Gateway IP if the IP address was changed from default setting.). Once the address is accessed, the login screen appears, as shown in below.
2.	Type the following user name and password in the **Login** fields: ➢ Username: the username provided. (Default: admin) ➢ Password: use the password provided. (Default: adminadmin)
3.	Click the **Login** button to access ISA100 gateway configuration



4 NIO200 Home page

Once the credentials are entered and access is granted, the browser will display the Device List by default.

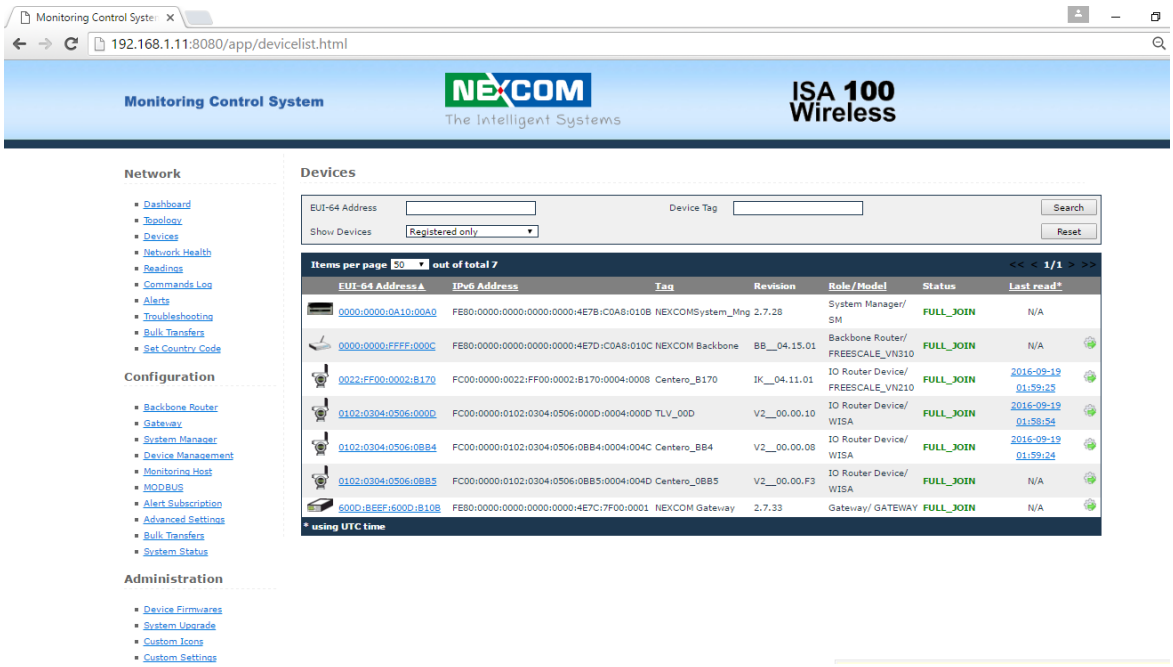


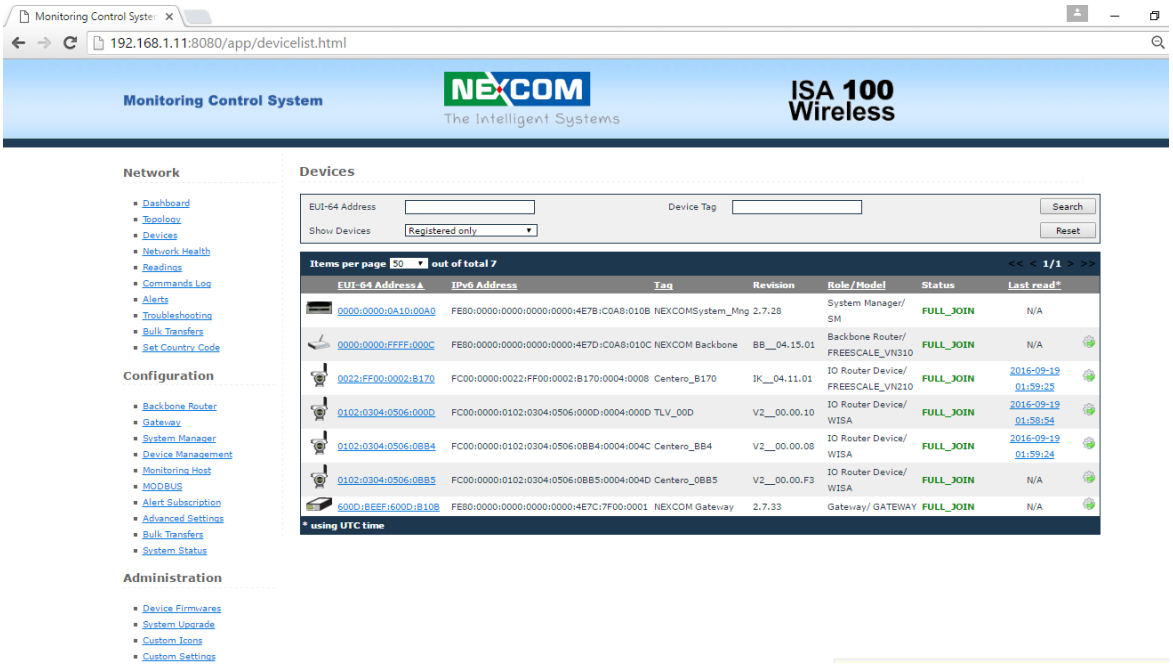
Figure 1

The user interface consists of two sections:

- The menus on the left, which allow you to navigate through the pages of the website
- The main section, which displays the contents of the selected page

5 Administration for the Network Devices

The Network section provides information about various network tasks accessed from the Monitoring Control System Webpage.



5.1 Dashboard

The **Dashboard** page is a report zone that allows you to monitor reading variations for selected devices. The Dashboard consists in a series of panes added by the user, which provide a visual representation of the information published by selected devices on selected channels.

The information is refreshed automatically at regular intervals (10 seconds, 30 seconds, or 1 minute).

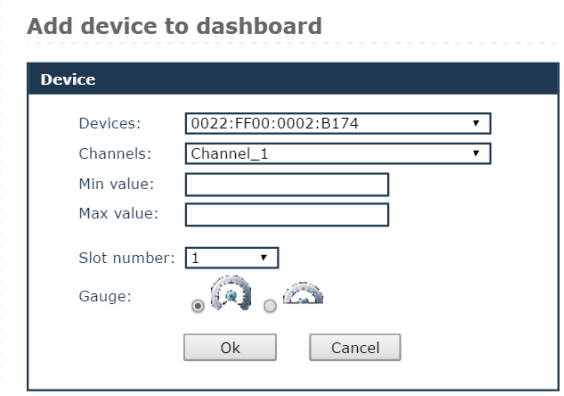
To delete a device from the dashboard, click ☒ in the top right corner of the pane. No confirmation is required for the system to delete the pane.

To add a device to the dashboard, perform the following steps:

Step	Action

1. Click on the **Add Device** button.

2. The **Device** dialog box will open:



Select a **Device** from the drop-down list.

Step	Action

3. Select the **Channel** that you wish to monitor from the drop-down list.

4. Type the desired gauge value range for the readings; if the selected values are out of range, a message on the pane will notify you.

5. Optional, select the **Slot number** (up to the current slot number); if you do not select a slot number, the system automatically assigns the next available slot.

6. Select the desired **Gauge** type.

7. Click **OK** to add the device to the dashboard.

NOTE:

- You can also add a reading to the dashboard from the Device Details page: in the Information pane, click the **Add to dashboard (ATD)** icon next to a reading.
- Up to 9 devices are supported in the dashboard.

5.2 Topology

The **Topology** page displays a graphical representation of the current network topology as well as allows users to view data about contracts and devices.

The system performs regular automatic updates of the topology information. When you load the page, the topology graph is generated based on the latest topology information available. The time of the last topology information update is indicated at the top of the page. To view the latest topology, press **Refresh** – this will generate a Request Topology command and will refresh the page.

In the **SubnetID** drop-down list located at the top of the topology window, select a subnet to view.

The registered devices are displayed on multiple levels represented as grey bands. The levels are numbered from 0 to n. The level number is indicated in the upper left corner of a level. The Gateway, the System Manager, and the Backbone Router are found on level 0. The level is given by the preferred clock source. A device is on level one, if its preferred clock source is a backbone router. A device is on level 2 if its preferred clock source is on level 1 and so on.

Communication-wise, field devices are linked to the backbone router, which is the central device in the network, either directly or via other devices. The backbone router further relays to the Gateway, while the System Manager organizes the entire network. The field devices can have various sensors attached: temperature sensors, humidity sensors, etc.

The devices are identified in the topology by the last four characters of their EUI-64 address. For easier identification, the backbone router, the gateway and the system manager are identified with the abbreviations BBR, GW, and SM. The devices are placed within a level in the order of their EUI64 address. They can be moved freely within the range of their level by *drag-and-drop* to obtain better legibility of the topology.

In addition, they are represented by suggestive icons and against backgrounds of different colors, to distinguish their roles (also shown in the Devices legend at the bottom of the page):

- Gateway – purple background
- Backbone Router – blue
- System Manager – dark green
- IO/Router Devices – blue
- IO Devices – light green
- Routers - red

By positioning the cursor over an icon, you can view the tooltip, which includes the following details for a device:

- EUI-64 address
- device role

- subnet ID
- device tag
- manufacturer
- model

The available Topology page elements and viewing options are described in the following paragraphs.

Adjusting Width and Height

You can adjust the size of the topology representation using the buttons [-] and [+] for height and width.

You can also adjust the height and width to the size of the Topology pane by clicking [Fit], or revert to the original viewing settings by clicking [Normal].

Links

When the page is loaded, the **Links** option located above the topology graph is selected by default. The backbone router is also selected by default in the topology graph and the Preferred ClockSource links to it are displayed as **green** lines.

To view the Preferred ClockSource for a particular device, click on the device in the topology graph, or select the device in the drop-down list located on top of the Topology window. The MCS will display the device's link to its preferred ClockSource.

To view the Secondary ClockSource links for a selected device, check this option in the Links Legend. These links are displayed in **blue** in the topology graph.

To view the transmission links between a selected device and other, check the **Links** option in the Links Legend. The regular links are displayed in **black** in the topology graph.

To view all the other links formed between the network devices, check the **Show all links** option.

This option is unchecked by default.

To view the RSQI signal value for a device's links, check the Show signal quality/PER option. The signal quality value is displayed next to each link and is colored in the color of the respective link.

To view the packet error rate for a device:

- First check the Show signal quality/PER option
- In the Links Legend, select the desired ClockSource links to display (Preferred or Secondary, or both)

- Click the Get PER for selected device button located in the Links Legend. The PER is shown as a percentage next to the respective link

Contracts

To view the contracts for a selected device:

Step	Action
1.	Check the **Contracts** option located at the top of the topology graph.
2.	Choose a device by clicking on it in the topology graph or by selecting it in the **Devices** drop-down list located above the graph.
3.	In the **Contracts** drop-down list you will view the selected device's inbound and outbound contracts with the System Manager and the Gateway. To show a contract on the graph, select it in the list. The contract will be represented by a **green** line if it is periodic or by a **blue** line if it is aperiodic. The Contracts legend located at the bottom of the Topology page also indicates how the types of contracts and links are represented.

NOTE: A device can have both a periodic and an aperiodic contract with the same SM or GW at the same time.

Contract details

In addition, when you select a contract, information about the contract parameters will be shown in the Contract details section at the bottom of the page.

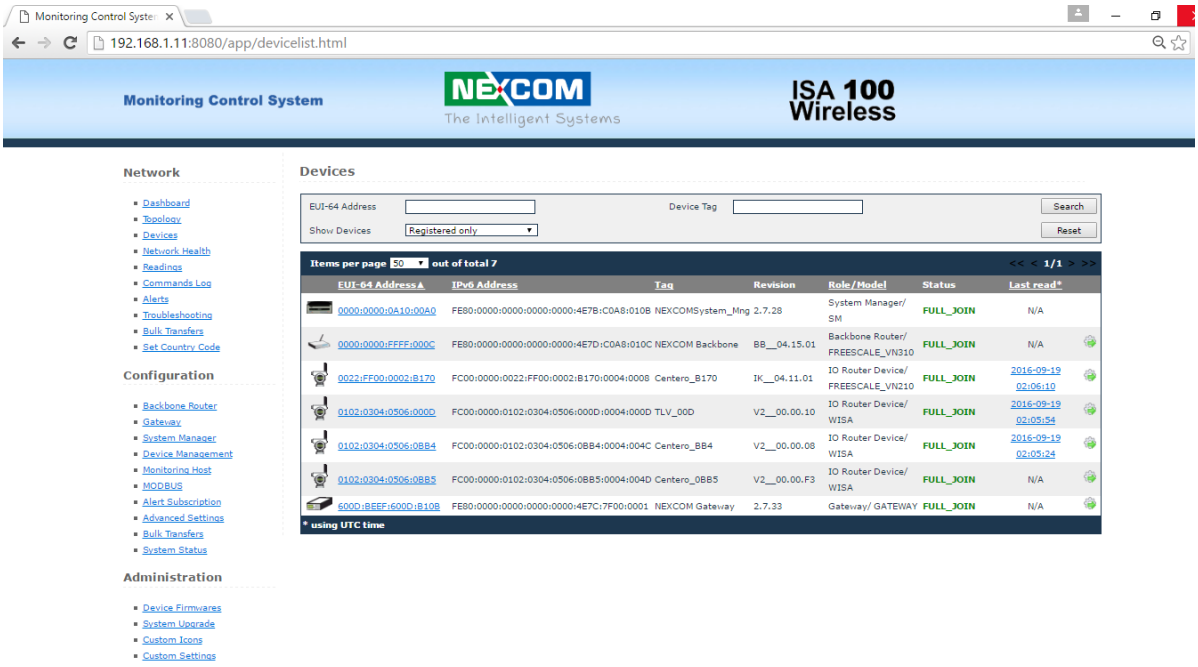
The contract information includes the following parameters:

- Contract ID – the contract identifier based on the contract owner
- Service type – can be periodic or aperiodic
- Source/destination device – the EUI64 address of the requester, and the destination device respectively
- Source / destination SAP –“0” is the default value for the DMAP on a device; “1” is the default value of a SMAP on the System Manager; the other values represent custom SAP’s
- Activation time – the date and time when the contract was established
- Expiration time – the date and time when the contract terminates
- Priority – indicates the base priority for all messages sent using the contract
- NSDU Size – the packet size at network layer
- Reliability – the requested reliability for delivering the transmitted packets to the destination
- Period – identifies the desired publishing period, for periodic contracts

- Phase – identifies the desired phase (within the publishing period) of publications, for periodic contracts
- Deadline – the maximum end-to-end transport delay desired, in periodic communication
- Committed Burst – for long-term aperiodic communication; it specifies the bandwidth:
  - A positive value specifies the packets transmitted per second; e.g. a committed burst of 2 indicates that two packets per second are guaranteed
  - A negative value specifies the number of seconds per packet; e.g. a committed burst of -15 indicates that a packet transmitted every 15 seconds is guaranteed
- Excess Burst – for short-term aperiodic communication; it has the same significance as the committed burst, but is only used in exceptional situations where aggressive communication is needed on a short-term
- MaxSendWindow – the maximum number of client requests that may be simultaneously awaiting a response, in the case of aperiodic communication

5.3 Devices

The devices page features the list of devices that exist in the network and a search form that enables you to search devices based on their EUI-64 address, tag and/or state.



Search devices

When the device page is loaded, the registered devices are displayed by default.

Step	Action
Search by EUI-64 address	
1.	To search a device by its EUI-64 address, type the address in the **EUI-64 Address** input field, or For a partial search: ➢ Type part of the EUI-64 address in the **EUI-64 Address** input field ➢ Select the desired state from the **Show Devices** drop-down list
2.	Click **Search**. The system will retrieve all the devices whose EUI-64 addresses contain the characters provided by the user. **NOTE:** To delete the search parameters, click **Reset**.
Search by device tag	
1.	A tag is a custom description that you can assign to a device in order to facilitate identification of that device in the plant. One tag can be assigned to a single device. To search for devices based on their tag, type the tag in the **Device Tag** input field.
2.	Click **Search**. **NOTE:** ➢ The tag field is case sensitive. ➢ To delete the search parameters, click **Reset**.
Search by device state only	
1.	To display devices based on their state at a given time, select the desired state from the **Show Devices** drop-down list. The device list will update automatically. A device can be in only one of the following states at a given moment in time: ➢ Registered – the device has successfully joined the network and is ready to operate ➢ Joining process – the device has been provisioned and is attempting to join the

Step	Action

network

- Unregistered – the device has lost connection with its neighbors in the network

Device List

The **Device list** shows the network devices in a table, one item per line, with main information about each **logical** device:

- EUI-64 address (the MAC address),
- IPv6 address
- Tag – the device tag
- Revision – the firmware version available on the device
- Role (Gateway, System Manager, Backbone Router, Field Router) and model (manufacturer information)
- Status ("Full Join" for registered devices; "Joining" for joining devices; "Not Joined" for unregistered devices), and
- Last Read (the date and time of the last reading from the device) and a link to the Readings page for the device in question.

In addition, the device list provides a quick link to the Run Commands page for that specific device.

When you load the page, the registered devices are displayed by default. To view unregistered or joining devices, select the corresponding option in the Show Devices drop-down list.

The total number of items in the table is indicated in the top left corner of the table. Here you can set the number of items to be displayed per page in the table. The default number of items displayed in a page is 10. Paging controls in the top right corner of the table also enable you to navigate through the other pages of the table.

The last time the page was refreshed is also indicated at the top of the page. The page does not refresh automatically; therefore you must click **Refresh** to update it.

Delete a device

In the devices page you have the option of deleting an unregistered device. When you delete a device, it will be removed from the network and any related data, including previous readings, will be deleted from the database.

To delete the device, click the icon located next to the device. The system will require confirmation to perform the action. Click **OK** to delete the device or **Cancel** to abort the action.

5.4 Device Details

In this page you can see all the information available for the selected device and perform device-specific commands. The page is accessed by clicking on the device **EUI-64 address** in the device list.

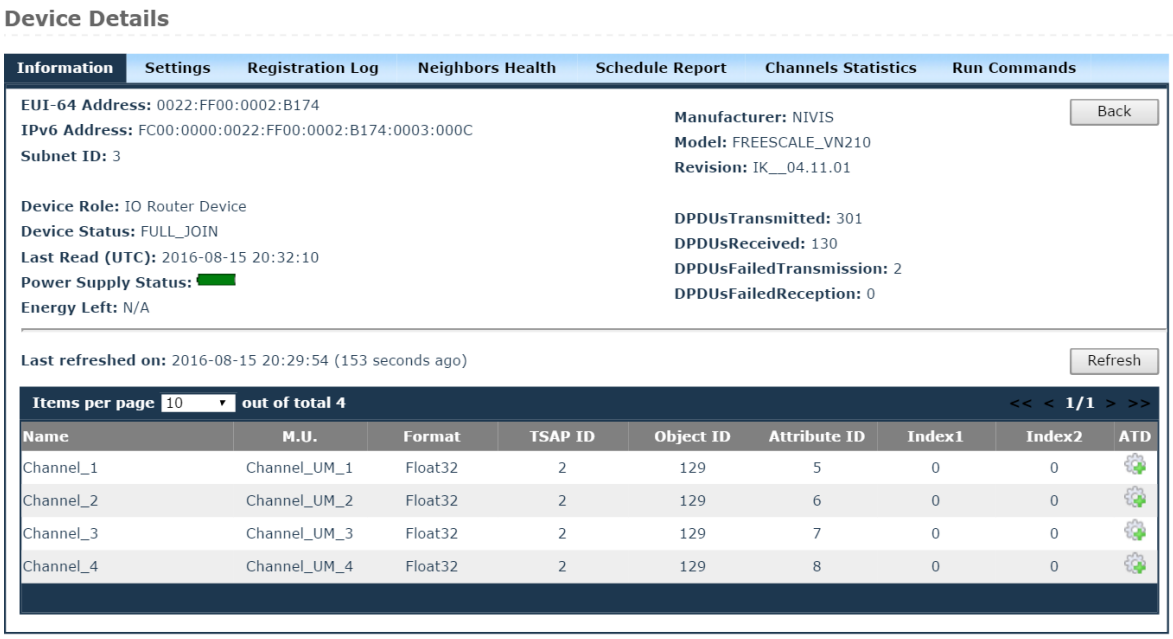
The page is organized into seven tabbed panes by types of information and also features a Back button to allow you to quickly revert to the Devices page, as well as an indication of when the last page was updated and a Refresh button (where applicable) that enables you to retrieve up-to-date information in the specific page.

Information

The Information pane displays general as well as activity specific information about the device. When the page is loaded, it shows the latest information available. To update the information, click **Refresh**.

The following details are shown in addition to those already indicated in the device list:

- Manufacturer – the name of the device manufacturer
- Revision – the radio firmware version
- Subnet ID – the ID of the subnet that includes the device
- Power Supply Status – represented as a battery with the following colors:
  - green, when the device is line powered
  - blue, when the device is battery powered, and the remaining capacity of the battery is greater than 75%
  - yellow, when the device is battery powered, and the remaining capacity of the battery is between 25% and 75%
  - red, when the device is battery powered, and the remaining capacity of the battery is less than 25%
- Data transmission statistics – the number of transmitted/received packages and the number of failed transmissions/receptions
- Process values – the parameters measured by the device.



Process values

The process values are displayed in a table with the following related information:

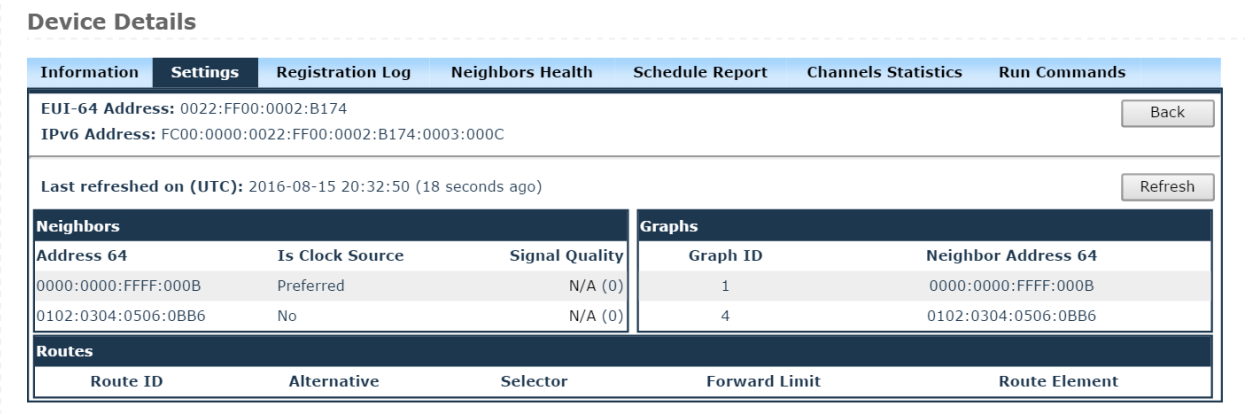
- Name - the process value name
- M.U. - the unit of measurement for the process value
- Format - various formats are possible, defining the value range of the measured parameter: int8, uint8, int16, uint16, int32, uint32, float32
- TSAP ID
- Object ID
- Attribute ID, and
- Two indices.

The total number of items in the table is indicated in the top left corner of the table. Here you can set the number of items to be displayed per page in the table. The default number of items displayed in a page is 10. Paging controls in the top right corner of the table also enable you to navigate through the other pages of the table.

Settings

The settings reflect the current operation of the ISA100.11a stack on a device.

The type of information displayed in this pane includes neighbor details, routes and graphs:



Neighbors

The Neighbors section lists the registered neighbors of the selected device as well as indicates their signal quality and whether they are clock sources for the selected device.

A clock source neighbor can have one of the following roles:

- Preferred clock source – the reference clock source for the selected device.
- Secondary clock source – a backup clock source that becomes preferred, when the reference clock source is not available.

Multiple neighbors may be designated as clock sources for a selected device.

The Signal Quality column displays the received signal quality indicator (RSQI) values and their associated labels, as shown in the following table:

RSQI	Signal Quality
1-63	Poor signal
64-127	Fair signal
128-191	Good signal
192-255	Excellent signal

Graphs

The Graphs section lists all the graphs that include the selected device, with the specific graph ID's and neighbor addresses within each graph.

Graph 1 is the inbound graph, while the other graphs are outbound graphs.

Routes

The Routes section lists the routes of which the source is the selected device.

Routes can be classified into:

- Routes based on graphs, established between two field devices or a field device and the Backbone Router
- Hybrid routes – established between the Backbone Router and a joined device (the destination of the route) for which an outbound graph has not been created yet. Hybrid routes consist of the node's parent's outbound graph and the destination node.

Routes are listed in a table displaying the following information:

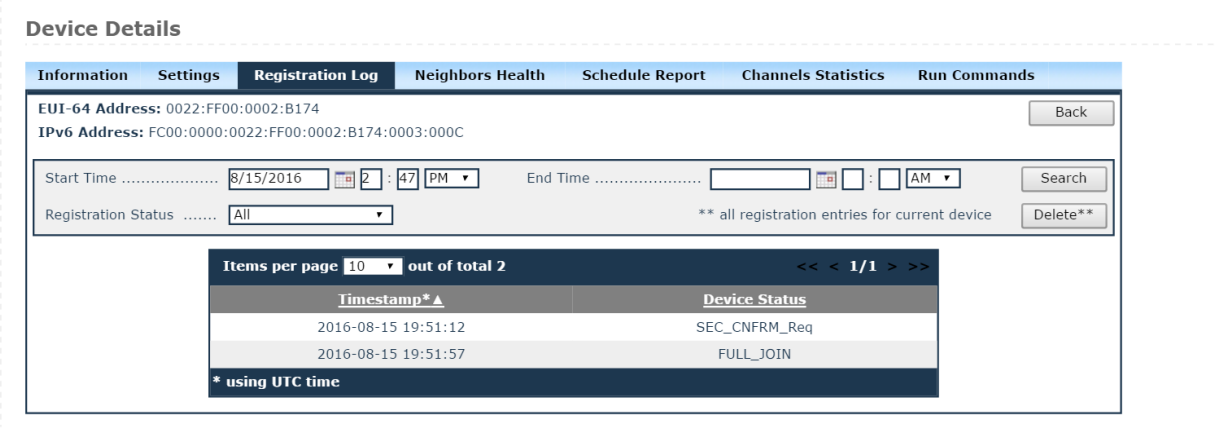
- Route ID – route identification data; ID's are given in the order of creation of the routes. Route 1 is the default route established between field devices and the Backbone Router.
- Alternative – a number ranging from 0 to 3 that enables you to differentiate between routes based on their source and destination:
    - If the alternative is 0, the route is based on a contract requested by the System Manager or the Gateway. This feature will be available in future releases.
    - If the alternative is 1, the route is established between two field devices
    - If the alternative is 2, the Backbone Router is the source of the route and a field device is the destination.
    - If the alternative is 3, this is the device's default route (Route 1) to the Backbone Router.
- Selector – identifies the destination of the route; the selector varies based on the value of the alternative:
    - If the alternative is 0, the selector indicates the contract ID and the address of the source (SM or GW)
    - If the alternative is 1, the selector field indicates the contract ID.
    - If the alternative is 2, the selector field indicates the address of the destination device.
    - If the alternative is 3, the selector is null.
- Forward Limit – the maximum number of nodes that a route can include
- Route Element – indicates the ID of the graph that stands at the basis of the route, or the graph ID and the destination's address, for hybrid routes.

To view the updated device settings, click the **Refresh** button. The **Request Topology** and **Get Contracts and Routes** commands will be sent to the System Manager.

When the command is generated, a message at the bottom of the screen will indicate that the device information is refreshing.

Registration Log

The registration log displays the registration history for the selected device, at different dates and times, commonly known as timestamps.



Use the Search functionality to view the behavior of the device over a specific period time:

- Choose the status you wish to view from the **Registration Status** drop-down list
- Optional, fill in the **Start Time** and the **End Time** fields, and then click **Search**.

The results are displayed in a table that indicates the timestamp and the device status at that specific timestamp. A device can have one of the following statuses at a given moment:

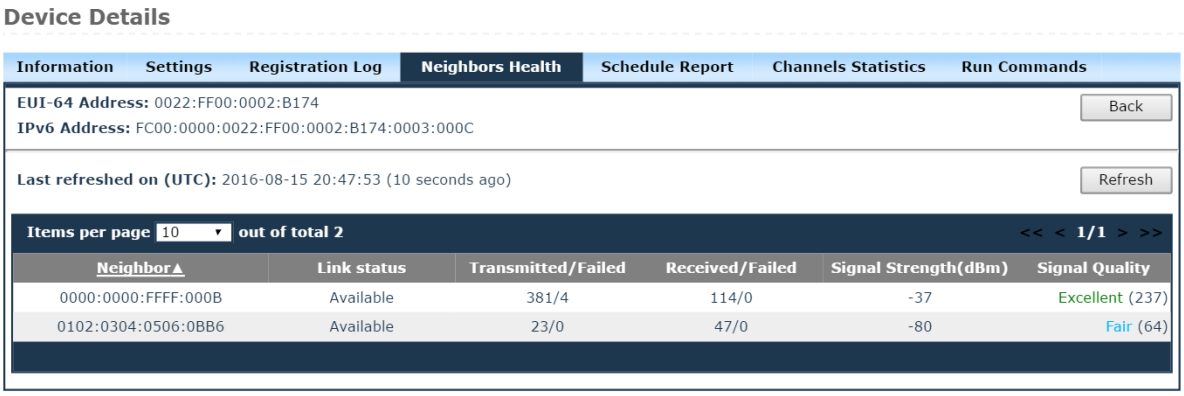
- SEC_JOIN_Req – the security join request was received by the System Manager
- SEC_JOIN_Rsp – a security join response was sent to the device
- NETWORK_Req – the network join request was received by the SM
- NETWORK_Rsp – the network join response was sent to the device
- CONTRACT_Req – the join contract request was received by the SM
- CONTRACT_Rsp – the join contract response was sent to the device
- SEC_CNFRM_Req – the security join confirmation was received by the SM
- SEC_CNFRM_Rsp – the security join confirmation response was sent to the device

- FULL_JOIN – the device is joined and configured and all information about it is available
- NOT_JOINED – the device is not joined

The total number of items in the table is indicated in the top left corner of the table. Here you can set the number of items to be displayed per page in the table. The default number of items displayed in a page is 10. Paging controls in the top right corner of the table also enable you to navigate through the other pages of the table.

Neighbors Health

This pane provides a communication health report about the selected device's neighbors.



The report includes:

- Neighbor identification information - the EUI-64 address
- The timestamp of the report request
- A general link status:
  - Available – if the neighbor is available for communication
  - Unavailable – if the neighbor is unavailable for communication
- Communication health information:
  - The number of DPDU's transmitted to the neighbor and the number of failed transmission attempts
  - the number of DPDU's received from the neighbor and the number of failed receptions from the neighbor
- The neighbor signal strength (measured in dBm) and
- The signal quality (for the RSQI ranges and associated labels

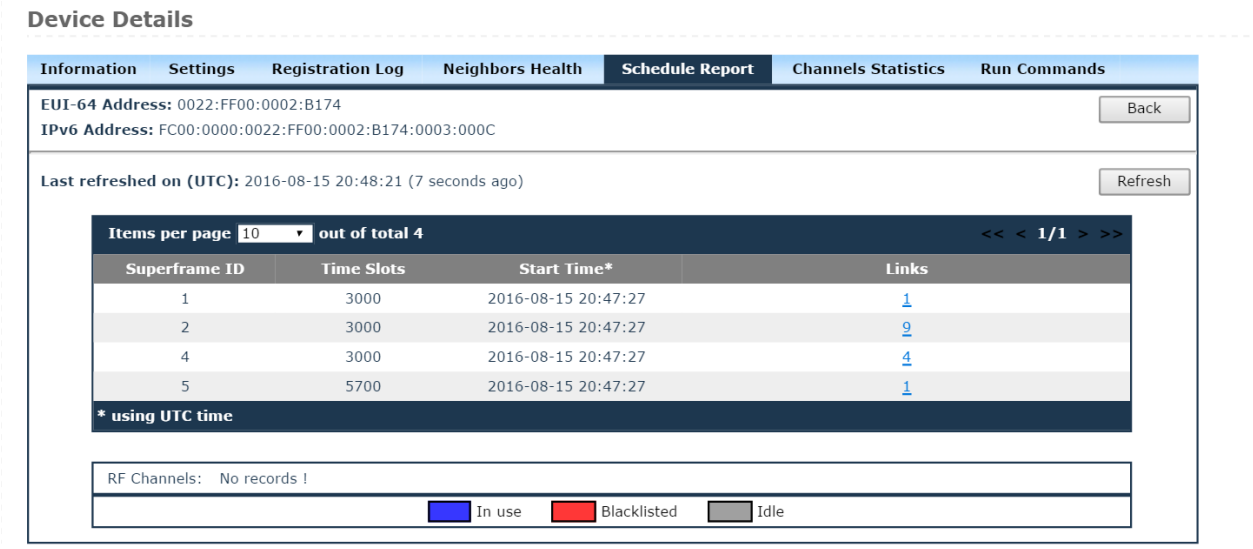
The total number of items in the table is indicated in the top left corner of the table. Here you can set the number of items to be displayed per page in the table. The default number of items displayed in a page is 10. Paging controls in the top right corner of the table also enable you to navigate through the other pages of the table.

Schedule Report

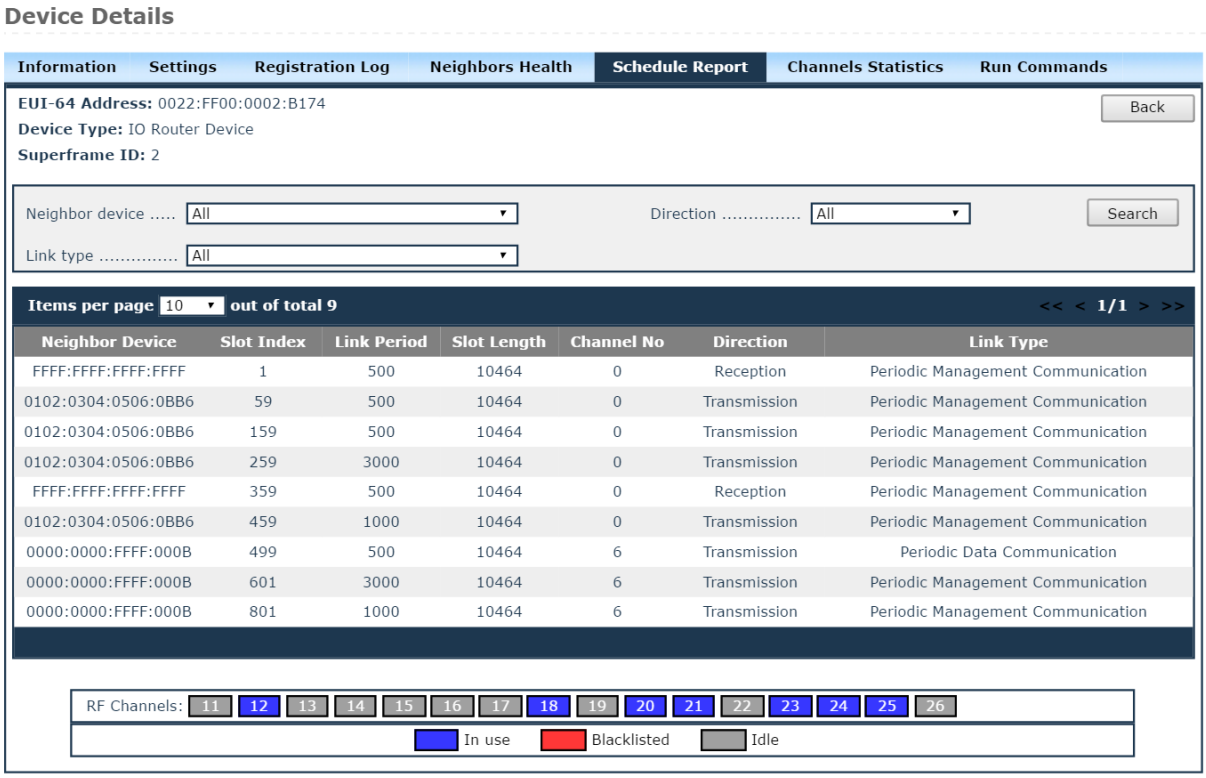
The schedule report pane provides information about time slot and channel allocation for the selected device.

Superframes and links

The active Superframes that the device uses for communication are listed in the page along with information regarding size (the number of time slots), start time, and the number of links allocated on each Superframe.



Clicking on the number of links will display a new page with link related information for each individual link allocated on the selected Superframe, as shown in the following screen:



The following details are shown:

- Neighbor – the EUI-64 address of the neighbor or the broadcast address FFFF:FFFF:FFFF:FFFF (used only for advertisements and receive links)
- Slot index – the ID of the slot within the Superframe
- Link period – the periodicity of a link (measured in No. of slots) within a Superframe cycle
- Slot length – expressed as a multiple of 2^{-20} seconds
- Channel number
- Direction – reception or transmission
- Link type, which can be:
    - aperiodic data communication
    - aperiodic management communication
    - periodic data communication
    - periodic management communication

You can use the search form on the top of the page to sort links based on neighbor device, the link type of the direction of the communication.

In addition, in both the Superframes and Links tables you can sort the information by the number of items listed per page. The default number of records displayed in a page is 10. Paging controls at the bottom of the table enable you to navigate through the pages of the table.

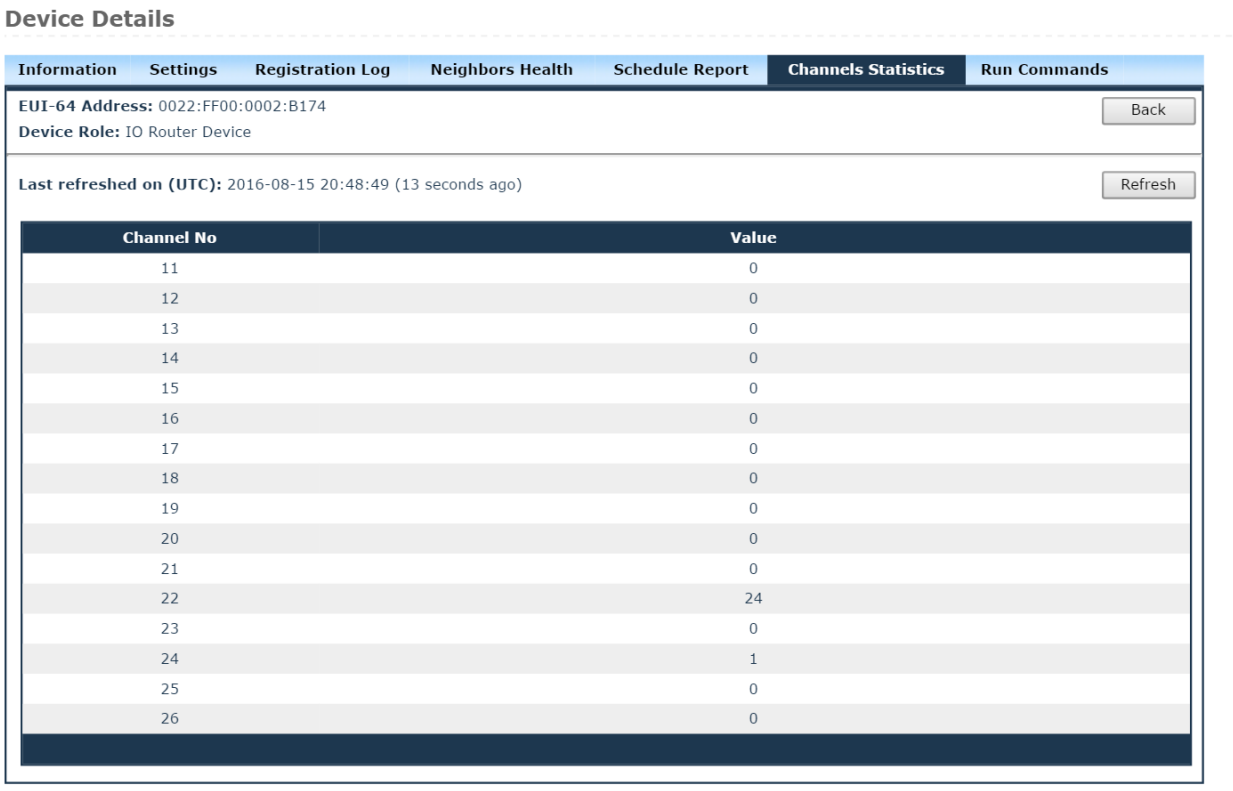
When the pages are loaded, the latest information available is shown. To update the information, click **Refresh**.

RF Channels

The channels of the device are represented at the bottom of the pane. The channels that are clear for communication are highlighted in blue, the unused channels are highlighted in gray, while blacklisted channels are highlighted in red.
Channel 26 has been disabled by default for purposes of compliance in certain countries.

Channel Statistics

This pane displays statistical information about CCA backoffs per channel.

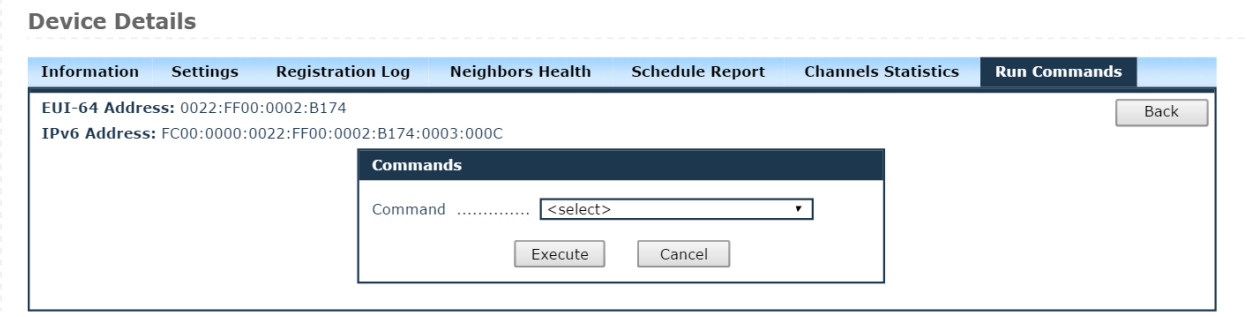


The information is presented in a table, with the value column expressing the percentage (0% to 100%) of aborted transmissions for each channel.

To update the information, click **Refresh**.

Run Commands

This pane enables you to perform device-specific commands.

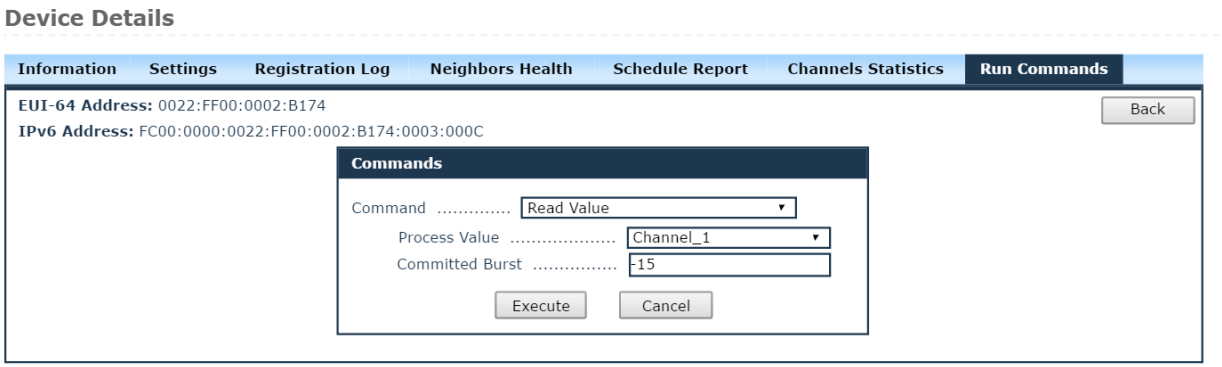


To go to a specific command, select it from the Commands drop-down list. After you generate the command, a message at the bottom of the screen will indicate its status (“Command sent successfully”, “Command sent error”). The tracking number of the command is also indicated, together with a link to the Commands Log, where you can view the results of the command.

The following types of commands are available:

Read Value

This command is available only for field devices and enables you to read a value on a particular channel of the selected device.



To generate the command, select the process value for which to request a reading and click *Execute*. The returned value will be displayed in the Readings page, in engineering units under the Value column as well as in the Command Log, under the Response column.

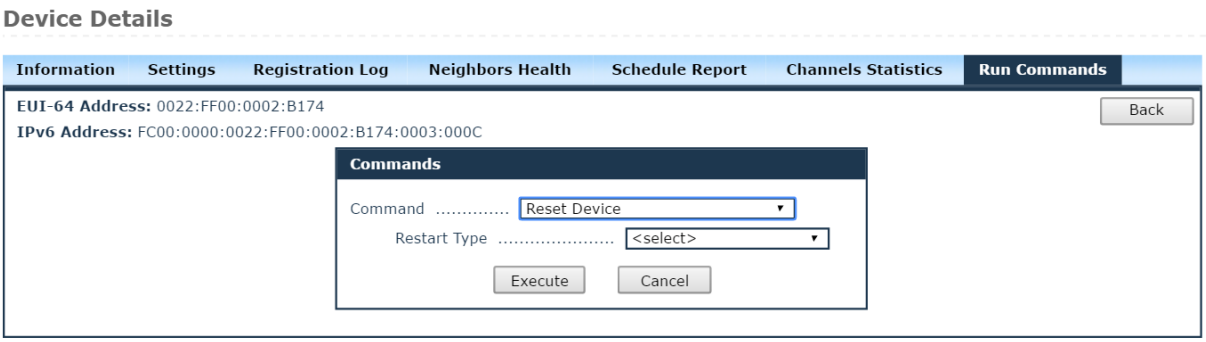
NOTE: When the device is unregistered, the Run Commands tab is unavailable.

Reset Device

This command resets the firmware on the specific device.

Three types of resets can be performed on a device:

- Warm Restart – performs a software reset; as a consequence, the device will unregister and re-register
- Restart as provisioned – resets the device while keeping provisioning information
- Reset to factory defaults – deletes the provisioning information and resets the device to its manufacturing settings; the device must be re-provisioned in order to be able to join the network

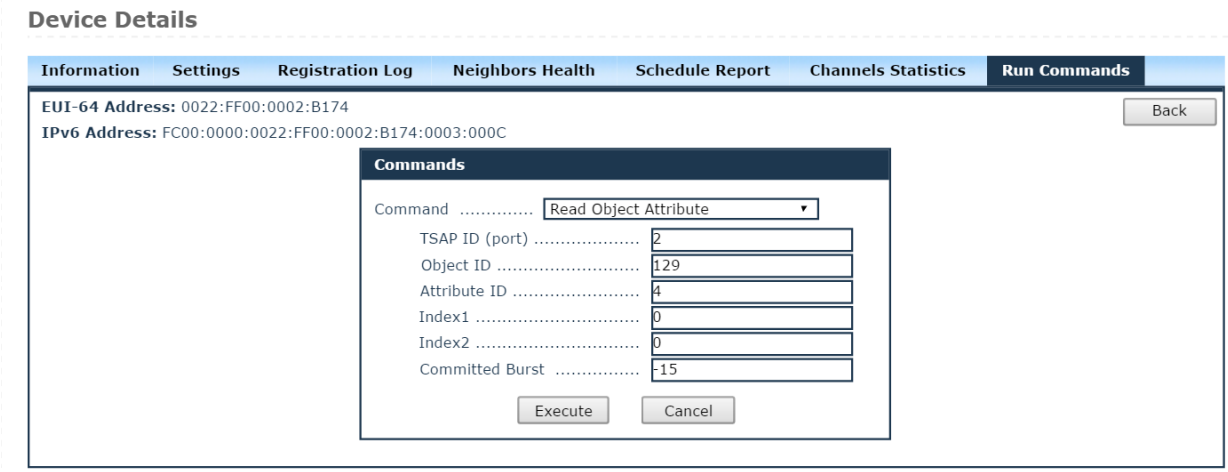


This command is available for all network devices with two exceptions:

- The command cannot be performed on the System Manager
- The **Reset to factory defaults** option is not available on the gateway

Read Object Attribute

Using this command you can read attributes from an object on the selected device.



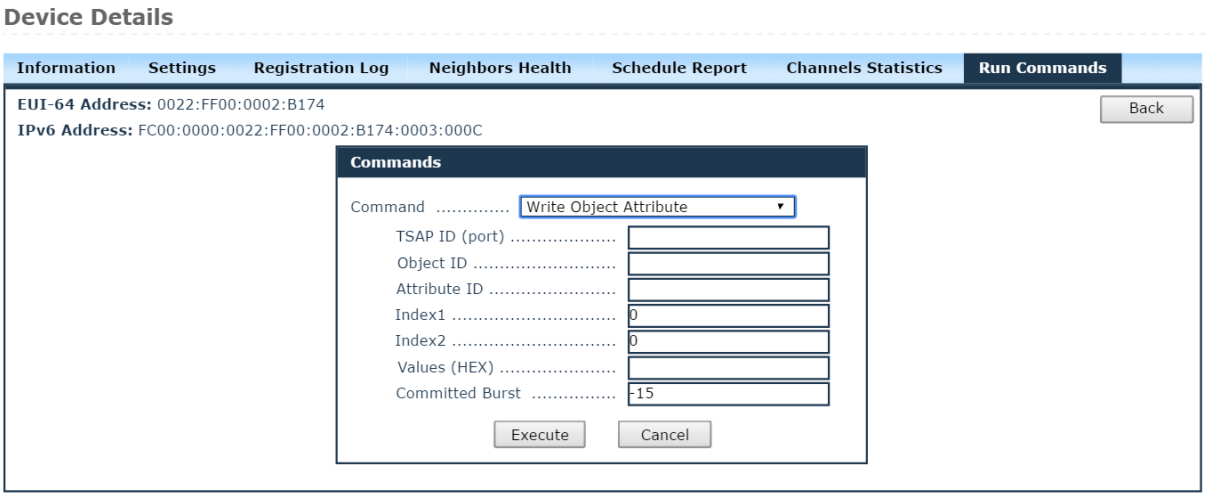
To read an attribute, type in the UAP specific **TSAP ID (port)**, the **Object ID**, and the **Attribute ID** you wish to read. Then click **Execute**.

NOTE: The values of the two indices are 0 by default and the value of the Committed Burst field is -15 by default.

The command returns the content of the attribute, which will be displayed in hex format in the Response column of the Commands Log page.

Write Object Attribute

This command enables you to write/edit a value to an object on the selected device. Only certain attributes are editable.



To write the attribute, type in the **TSAP ID (port)**, the associated **Object ID**, and the **Attribute ID** you wish to write or edit. Then type the desired hex value(s) in the Values input field. And click **Execute**.

NOTE: The values of the two indices are 0 by default and the value of the Committed Burst field is -15 by default.

Execute Object Attribute

The execute service is used to execute a network visible method on an object on the selected device.

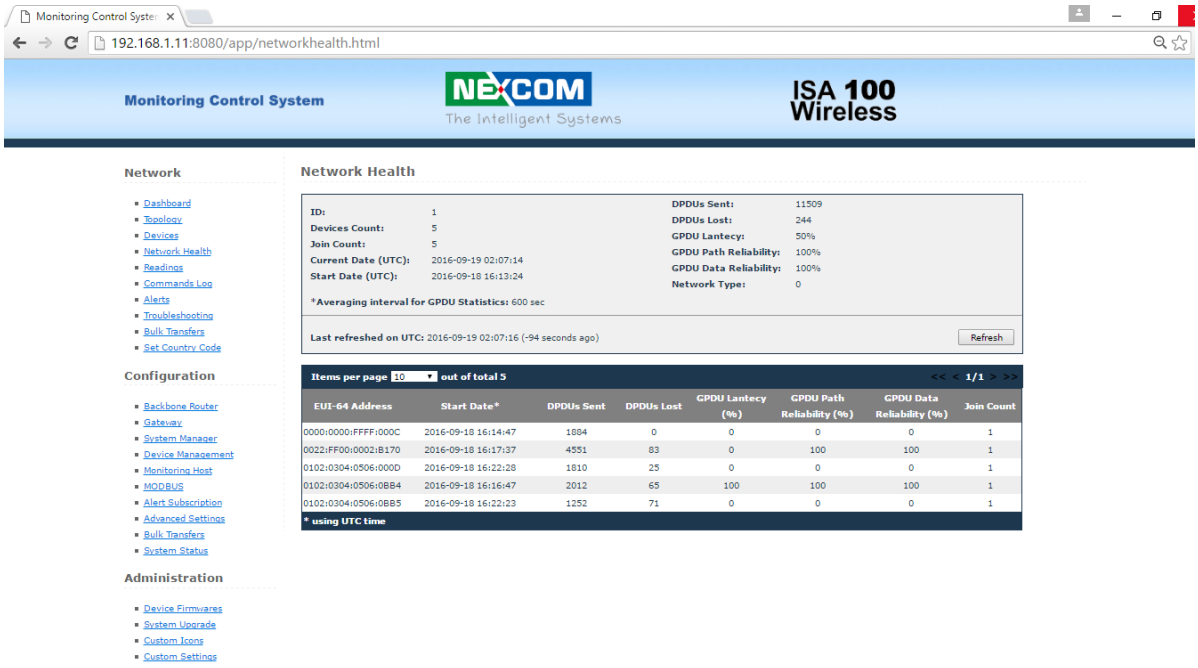
To execute the method, type in the **TSAP ID**, the associated **Object ID**, and the **Method ID** you wish to execute. Provide the method details in hex format in the Details input field. Click **Execute**.

NOTE: The values of the two indices are 0 by default and the value of the Committed Burst field is -15 by default.

5.5 Network Health

The Network Health page provides a communication health report at network level.

The page consists of two sections containing network summary statistics and device-specific communication health information.



In the network summary section the following information is indicated:

- Network ID and Network Type - network identification data(where applicable)
- Devices Count – the total number of registered devices, including the Backbone Router
- Join count – the total number of joins of all the devices in the network
- Current Date – the present time
- Start Date – the date and time the System Manager application was started
- Transmission and reliability statistics, based on the summary report per device
- The averaging interval for GPDU statistics, reported in seconds

The device communication report section consists of a table displaying the following information for each device:

- EUI-64 Address – the network address of the device
- Start Date – the date and time of the device's first join

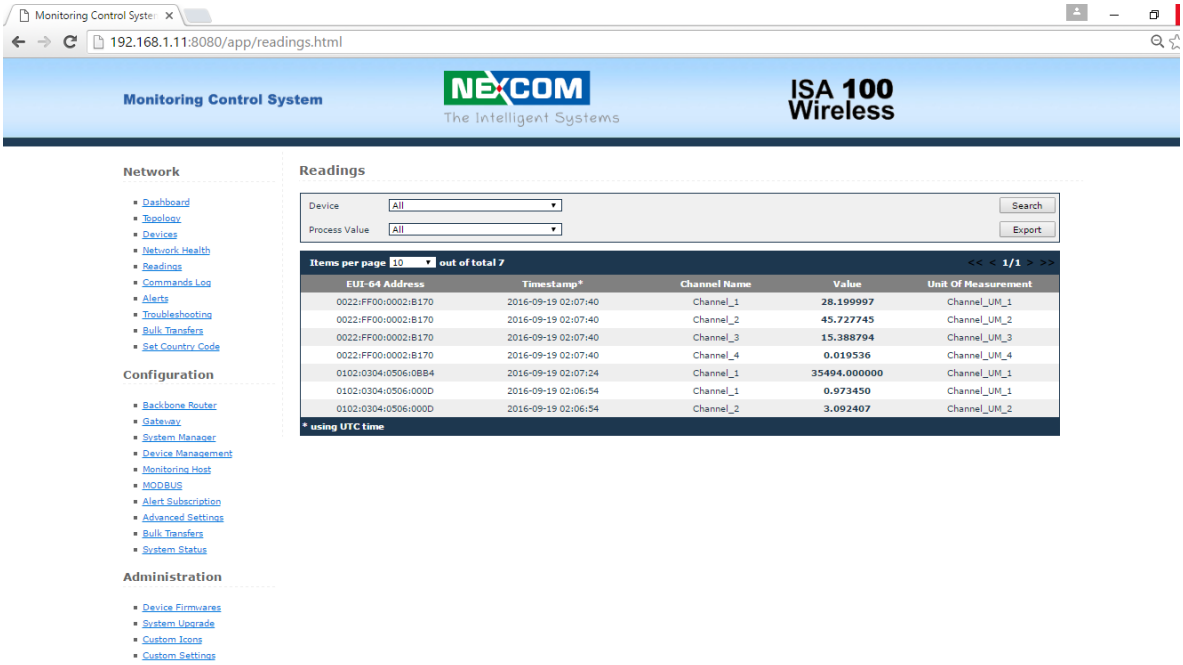
- DPDU's Sent – the total number of packets sent by the device
- DPDU's Lost – the total number of packets sent by the device which failed to reach destination
- GPDU Latency – the percentage of scheduled GPDU's that arrive later than expected
- GPDU Path Reliability – the percentage of GPDU's transmitted successfully on a primary path
- GPDU Data Reliability – the percentage of successful GPDU's (transmit GPDU's that are transferred correctly on the first attempt plus receive GPDU's that pass integrity checks)
- Join Count – the total number of joins per device

The total number of items in the table is indicated in the top left corner of the table. Here you can set the number of items to be displayed per page in the table. The default number of items displayed in a page is 10. Paging controls in the top right corner of the table also enable you to navigate through the other pages of the table.

The last time the page was refreshed is also indicated in the page. To update the information, click **Refresh**.

5.6 Readings

In this page you can view the readings received from devices, which are generated either on demand by Read Value commands or by automatic Publish/Subscribe commands. The readings can be filtered by **Device**, **Process Value**, or **Reading Type** (Publish/Subscribe or On Demand).



To search for readings, select the desired device, process value and reading type as shown in the screen above, and click **Search**. The results are displayed in a table that contains the following information for each reading:

- Device EUI-64 address (MAC address of the device that reported the reading)
- Timestamp (date and time of the reading)
- Channel Name (the process value name)
- Value (the value received on that particular reading) – shown in engineering values
- Unit of Measurement (if applicable)
- Reading Type

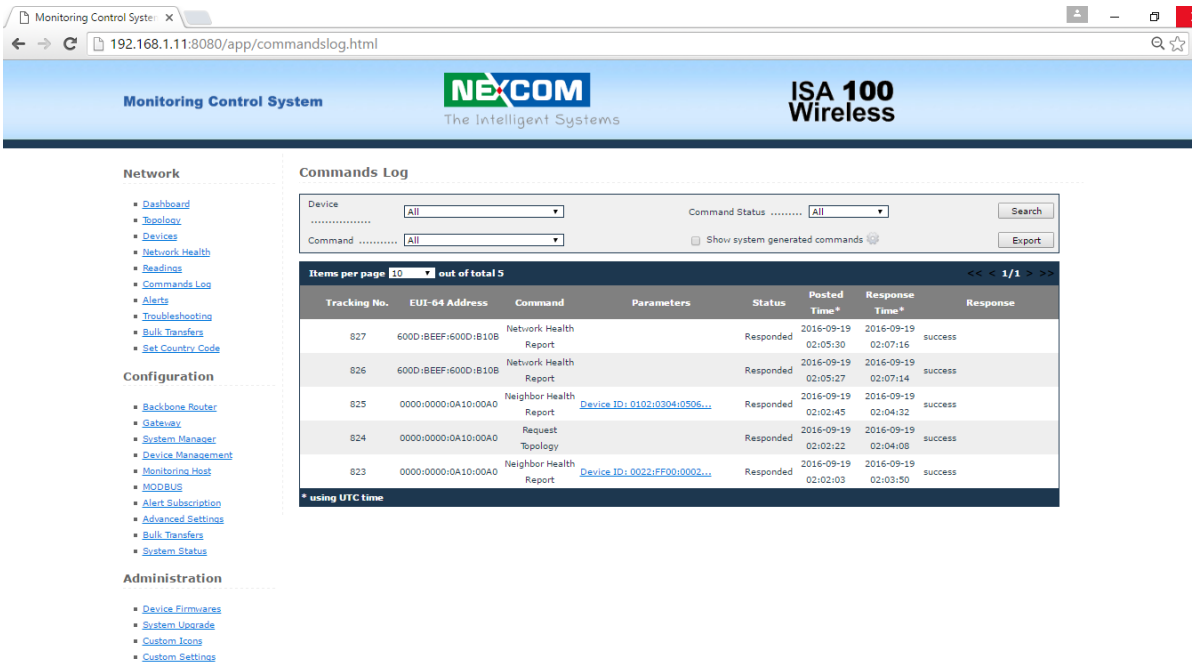
The total number of items in the table is indicated in the top left corner of the table. Here you can set the number of items to be displayed per page in the table. The default number of items displayed in a page is 10. Paging controls in the top right corner of the table also enable you to navigate through the other pages of the table.

From this page you can also save the search results into a Microsoft Excel CSV file, by clicking **Export**.

5.7 Commands Log

In this page you can view all the commands issued on the registered devices in the system. The commands can be filtered by **Device**, **Command** (type), or **Command Status** (New – command

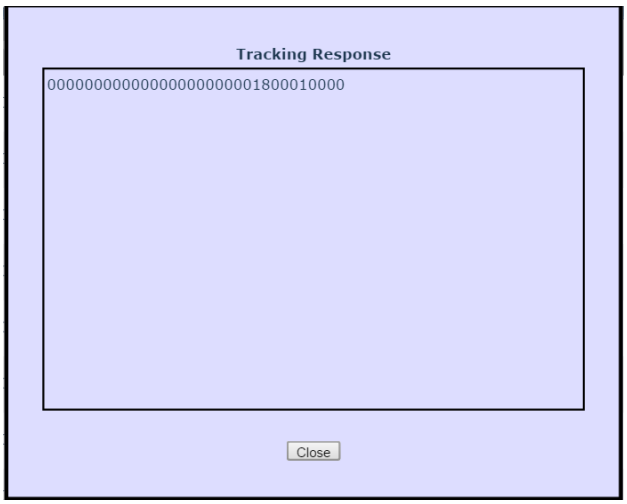
posted in database, Sent – command sent to device, Responded – device responded successfully to the command, Failed – command failed to execute).



To search for commands, select the desired device, command and command status and click **Search**. The results will be displayed in a table, as shown in the screen above, with the following information for each command:

- Tracking Number (internal ID of the command),
- EUI-64 address (MAC address of the command destination device),
- Command (name of the executed command)
- Parameters (description of the parameters chosen for the command, if applicable)
- Status (current status of the command)
- Posted Time (date and time when the command was generated)
- Response Time (date and time when the command was responded successfully or not)
- Response (the response for the issued command if the command was responded successfully or the error reason if the command failed), which can consist of:
    - The measured value expressed in engineering units for the Read Value command
    - The hex value for Read/Execute Object Attribute commands
    - The mention success for all the other types of commands executed on devices

If the length of the response exceeds the size of the Response cell, click on the response link to open the **Tracking Response** form and view the full response:



Given the large number of commands generated automatically by the system at regular intervals, these commands are hidden by default. To view them, check the **Show system generated** commands option in the Search dialog and click **Search**.

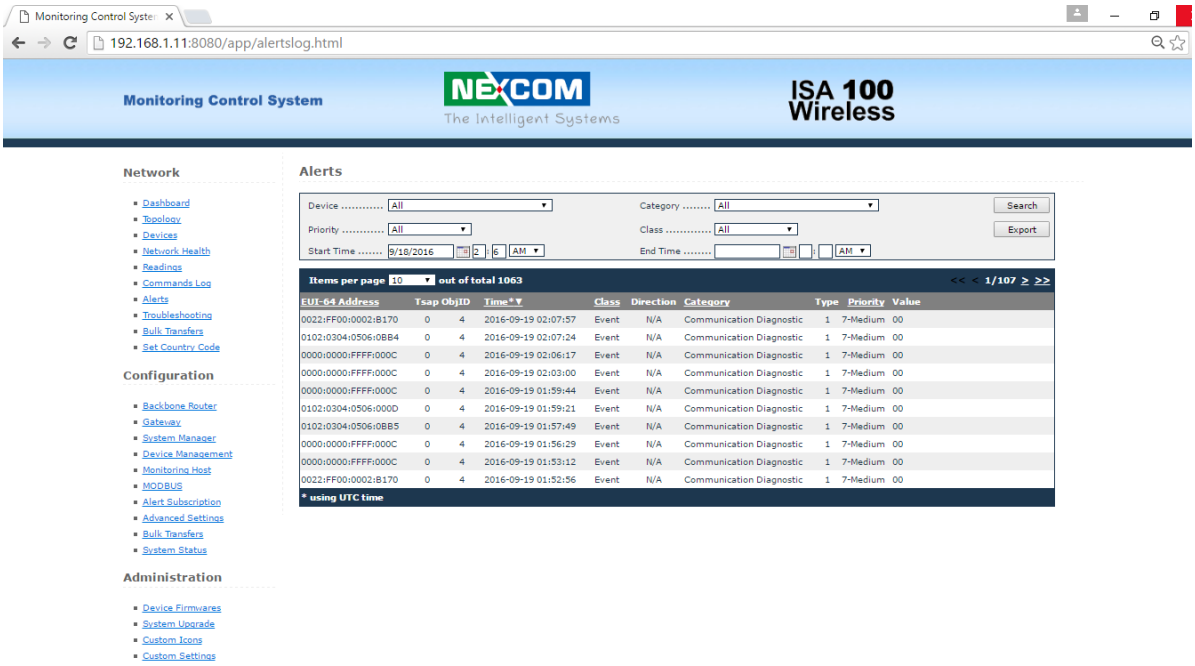
The total number of items in the table is indicated in the top left corner of the table. Here you can set the number of items to be displayed per page in the table. The default number of items displayed in a page is 10. Paging controls in the top right corner of the table also enable you to navigate through the other pages of the table.

From this page you can also save the search results into a Microsoft Excel CSV file, by clicking **Export**.

5.8 Alerts

The Alerts page enables you to view alarms and events generated by devices.

Alerts consist in application messages that advise or warn the recipient of the presence of an impending or existing situation of interest.



Two types (classes) of alerts are supported in accordance with the ISA100.11a specification:

- Events – indicates that something happened with the device
- Alarms – indicates that a device has transitioned to an abnormal state, or has returned to normal from an abnormal state. An alert is sent to describe the change of state

To search for alerts:

- Select the device, the alert category, priority and class of alert
- Optional, fill in the Start Time and the End Time fields, and then click **Search**

The results are displayed in a table that indicates the following information:

- EUI-64 address – the MAC address of the device generating the alert
- TsapID and ObjectID – identification of the application process and the associated object that initiated the alert
- Time – the date and time when the alert condition was detected

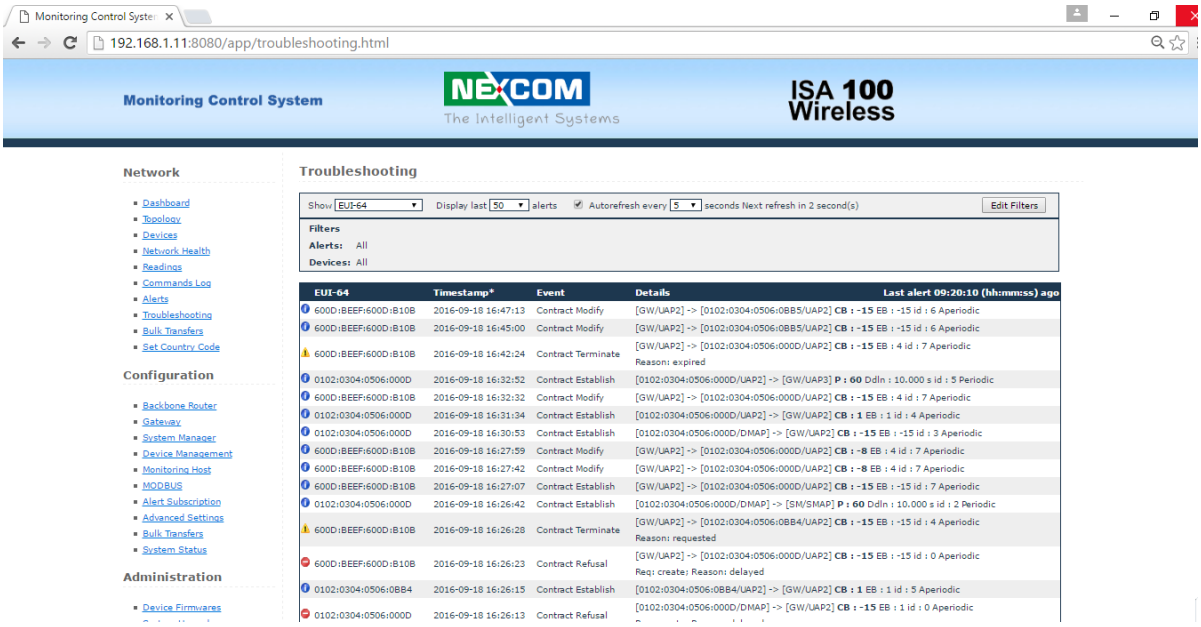
- Class – the type of alert (alarm or event)
- Direction – with the following values:
  - Start/End – only for alarms, it indicates if the report is for an alarm condition, or a return to normal from an alarm condition
  - N/A – if the alert reports an event
- Category – device diagnostic, communication-related, security-related, or process related
- Priority – indicates the importance of the alert, with the following ranges and associated labels, in compliance with the specification:
  - 0 - 2: Journal-only
  - 3 - 5: Low
  - 6 - 8: Medium
  - 9 - 11: High
  - 12 -15: Urgent
- Value – indicates the value associated with the alert condition.

You can set the number of records to be displayed per page in the table. The default number of records displayed in a page is 10. Paging controls at the bottom of the table allow you to navigate through different pages of the search results.

From this page you can also save the search results into a Microsoft Excel CSV file, by clicking **Export**.

5.9 Troubleshooting

The Troubleshooting page displays the latest alerts related to various events in the network.



The alerts are listed in a table, with the following information:

- EUI-64 or IPv6 Address or Device Tag – a drop down list allows you to choose the device identification information that will be displayed in the first column of the table. The drop-down box is set on EUI-64 by default
- Timestamp – the date and time when the alert was generated
- Event – the alert type
- Details – this column displays the following details, depending on the type of alert:

Alert Type	Details	Explanations
Device Join	Device IPv6	IPv6 address of the device
	Device Type	The tags GW, BB, or SM for field devices, the tag is not displayed
Device Join Failed	Parent	The IPv6 address of the parent device

	Phase		
		Join Phase	**Join Phase Description**
		4	SECURITY_JOIN_Req
		5	SECURITY_JOIN_Rsp
		6	NETWORK_JOIN_Req
		7	NETWORK_JOIN_Rsp
		8	JOIN_CONTRACT_Req
		9	JOIN_CONTRACT_Rsp
		10	SECURITY_CONFIRM_Req
		11	SECURITY_CONFIRM_Rsp
	Reason	The reason number and description	
Device Leave	Reason	The reason number and description	

- The time elapsed from the last alert

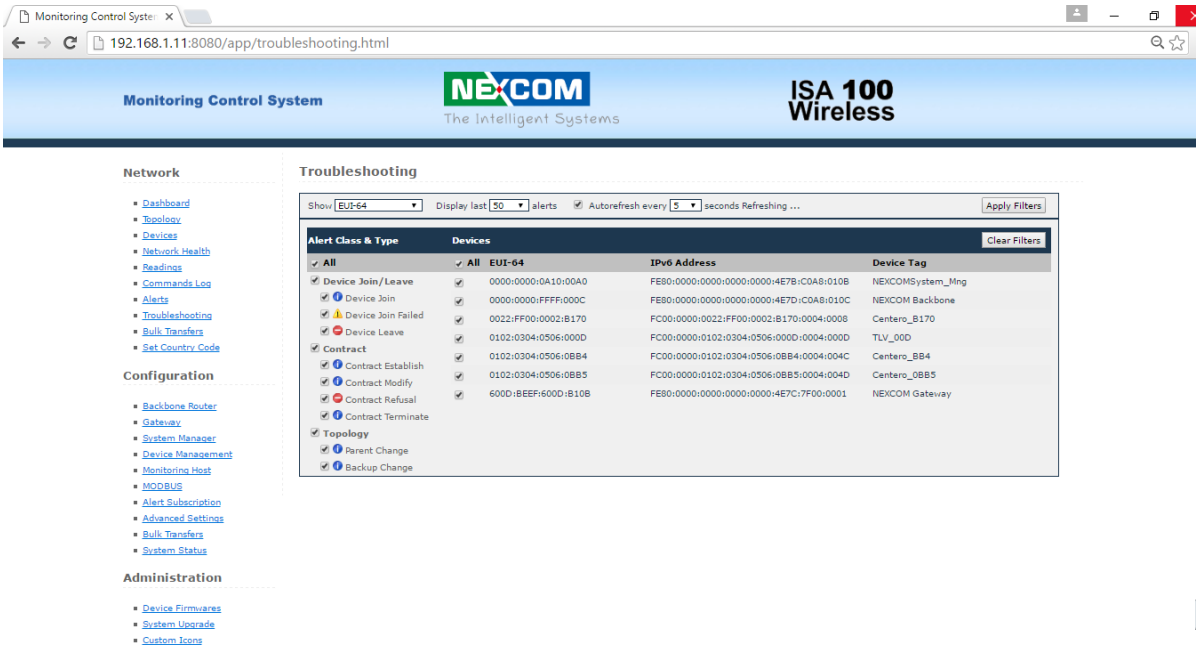
NOTE: Contract Alerts and Topology Alerts will be implemented in a future version of the MCS.

The Display last N alerts drop-down list allows you to select the maximum number of alerts to display in the table. You can choose a value between 50, 100, 150, and 200.

To always view the latest alerts, enable the **Autorefresh every N seconds** checkbox. You can choose a value between 5, 10, 15, 30, and 60 seconds.

Filters

The Edit filters button allows you to define the filters to apply for displaying the alerts. Click the button to expand the upper section of the page:



Under Devices, select the devices for which you want to display alerts. Checking/unchecking the **All** checkbox in the table header will check/uncheck all the devices.

Under Alert Class & Types, you will view a hierarchy of application alerts and you can select the desired alerts combination.

Checking/unchecking an alert class will check/uncheck all the alert types in that class.

Checking/unchecking the All checkbox in the table header will check/uncheck all the alerts.

Pressing Clear Filter will reset the filters to All for both the Devices list and the Alerts list.

Each alert is preceded by an icon indicating the severity of the alert:

- Information

- Warning

- Error

The Severity Icon is displayed for each Alert in the Troubleshooting table based on the following mapping:

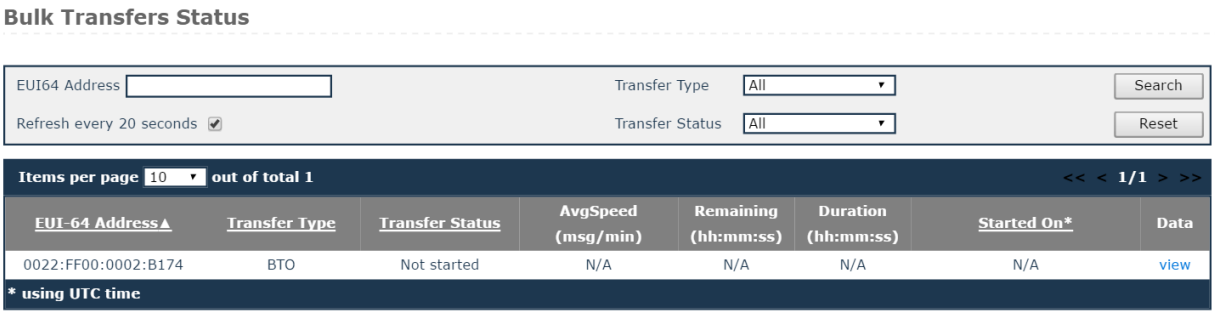
Alert	Reason	Severity
Device join/leave alerts		

Alert	Reason	Severity
Device Join		info
Device Join Failed	1: Timeout (device does not respond to SM queries)	warning
	2: Re-join (new join request while joining)	warning
	3: Parent left the network during device join	warning
	8: Insufficient parent resources - will retry join trough another router	warning
	4: Device removed from SM whitelist	error
	5: Device not found SM whitelist	error
	6: Invalid join key - mismatch with key from SM whitelist	error
	7: Invalid challenge - already used in a Security_Join_Request (possible retry)	error
	9: SubnetID mismatch (device provisioning/SM whitelist mismatch)	Error
Device Leave	1: Timeout - device does not respond to SM queries	error
	2: Re-join (new join request while joined)	error
	3: Parent left the network	error

Alert	Reason	Severity
	4: Device removed from SM whitelist	error
Contract Alerts		
Contract Establish		info
Contract Modify		info
Contract Refusal	1: Insufficient resources	error
	2: Delayed (try again later)	error
	3: Device not found	error
	4: Contract not found (it applies to modification/renewal)	error
	5: Invalid request (requested an operation that cannot be performed or the request contains invalid parameters)	error
	6: timeout (no response to contract request). This reason can only be set by the FD.	Error
Contract Terminate	1: requested	info
	2: expired	
	3: unjoin	
Topology alerts		
Parent Change		info
Backup Change		info

5.10 Bulk Transfers

The bulk transfers page enables you to monitor the status of configured bulk transfers.



Bulk transfers can be filtered by EUI-64 Address, Transfer Type and Transfer Status. To filter them, select the desired filters and/or type the EUI-64 Address for the desired device and click **Search**. To reset all the filters, click **Reset**.

The bulk transfers are displayed in a table with the following information:

- EUI-64 Address - the EUI-64 address of the target device
- Transfer Type:
  - UDO (Upload/Download Object) – the ISA-defined transfer method
  - BTO (Bulk Transfer Object) – an enhanced Nivis-defined transfer method
- Transfer Status - indicates the status of the transfer process at the time of viewing; the possible statuses are: Not Started, In Progress, Failed, and Completed
- Avg. Speed - the average transmission speed, calculated in packets (messages) per minute since the beginning of the transfer
- Remaining - the remaining time to completion
- Duration - the total duration of the transfer
- Started On - the date and time the bulk transfer operation started
- Data – Only for a completed transfer, click the **View** link to see the transferred data in HEX format, as shown in the figure below:

To refresh the information in the table regularly, check the **Refresh every 20 seconds** option in the Search form.

The total number of items in the table is indicated in the top left corner of the table. Here you can set the number of items to be displayed per page in the table. The default number of items displayed in a page is 10. Paging controls in the top right corner of the table also enable you to navigate through the other pages of the table.

5.11 Set Country Code

The page allows setting the Country Code on the field devices and on the transceiver, to follow country-specific RF regulations.

Choose the country in the “Country Code” drop down, select the devices to configure, click Execute.

6 Configuration

The configuration section enables you to view and edit certain settings for the configuration/provisioning of the devices and the network, including connection settings, publishers, alert subscriptions, and Modbus register mapping.

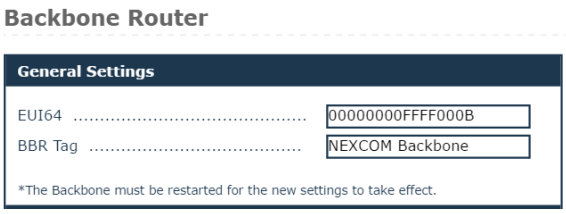
IMPORTANT: **This section is intended for users with thorough technical knowledge, and certain configurations require advanced expertise, therefore they should be carefully planned, as any inconsistencies may render the devices/network inoperative.**

NOTE: The changes you perform in the settings for each separate entity will also be reflected in the Advanced Settings page and vice-versa.

6.1 Backbone Router

The Backbone Router configuration page consists of 5 sections, as shown is the table below.

Step	Action
General Settings	
1.	Specify the **EUI64** and the **BBR Tag**.

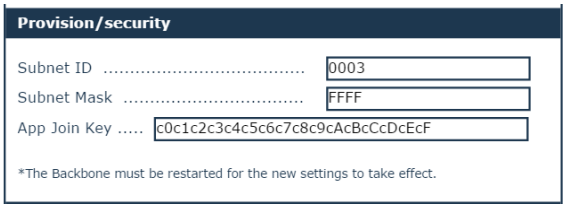


NOTE:

- Hover over an edit box and a tooltip will appear, indicating the allowed format and range for each value.
- If you change any of these settings, you must restart the Backbone Router in order for the new settings to take effect.

Step	Action
Provision/security	

2. Specify the **Subnet ID** – which must be the same for all the devices in a subnet, the **Subnet Mask**, and Specify the **APP Join Key**.



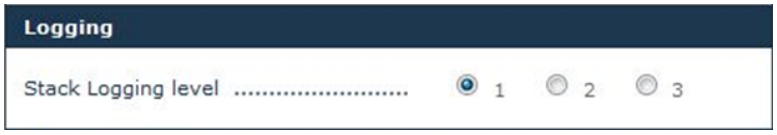
NOTE:

- Hover over an edit box and a tooltip will appear, indicating the allowed format and range for each value.
- If you change any of these settings, you must restart the Backbone Router in order for the new settings to take effect.
- Take care: the subnet ID is **hexadecimal** in this page (while it is **decimal** in the Device management page, as well as in the Gateway Configuration page)

Step	Action
Logging	

3. Select the **Stack Logging level**. The numbers suggest the degree of detail provided in the Backbone Router logs:

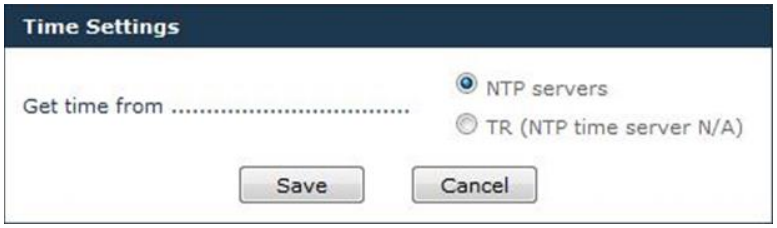
- 1 (ERROR) for error messages only
- 2 (WARN) for error and warning messages
- 3 (DEBUG) for error, warning and debug messages



Time Settings

4. Select **NTP servers** if the NIO 200IAG Gateway has access to internet

In case the NIO 200IAG does not have access to the internet, time synchronization can be performed by using the transceiver clock as the time source

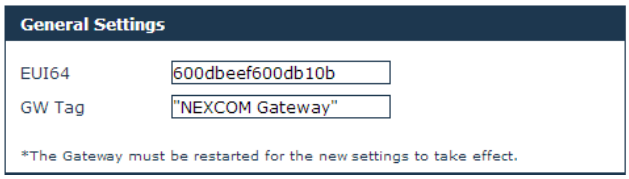


5. When you have finished editing the settings, click **Save**. As mentioned above, depending on the settings that you modify, the backbone router may need to be restarted for the changes to take effect.

6.2 Gateway

The Gateway configuration page consists of 3 sections, as shown is the table below.

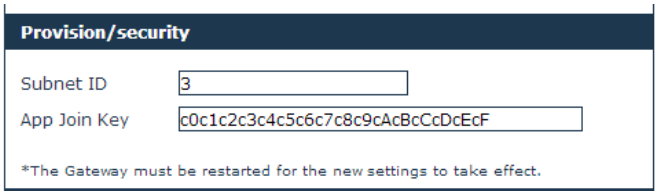
Step	Action
General Settings	
1.	Specify the **EUI64**, **IPv6 Address**, **UDP Port Number**, and the **GW Tag**.



NOTE:

- Hover over an edit box and a tooltip will appear, indicating the allowed format and range for each value.
- If you change any of these settings, you must restart the gateway in order for the new settings to take effect.

Provision/security	
2.	Specify the **Subnet ID** and the **APP Join Key**.



NOTE:

- Hover over an edit box and a tooltip will appear, indicating the allowed format and range for each value.
- If you change any of these settings, you must restart the gateway in order for the new settings to take effect.

Step	Action
Logging	

3. Select the **App Logging level** and the **Stack Logging level**. The numbers suggest the degree of detail provided in the Backbone Router logs:

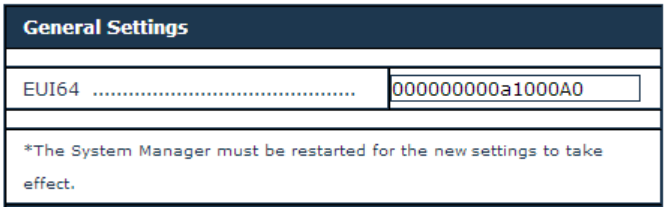
- 1 (ERROR) for error messages only
- 2 (WARN) for error and warning messages
- 3 (DEBUG) for error, warning and debug messages

4. When you have finished editing the settings, click **Save**. As mentioned above, depending on the settings that you modify, the backbone router may need to be restarted for the changes to take effect.

6.3 System Manager

The System Manager configuration page consists of 3 sections, as shown is the table below.

Step	Action
General Settings	
1.	Specify the **EUI64**.



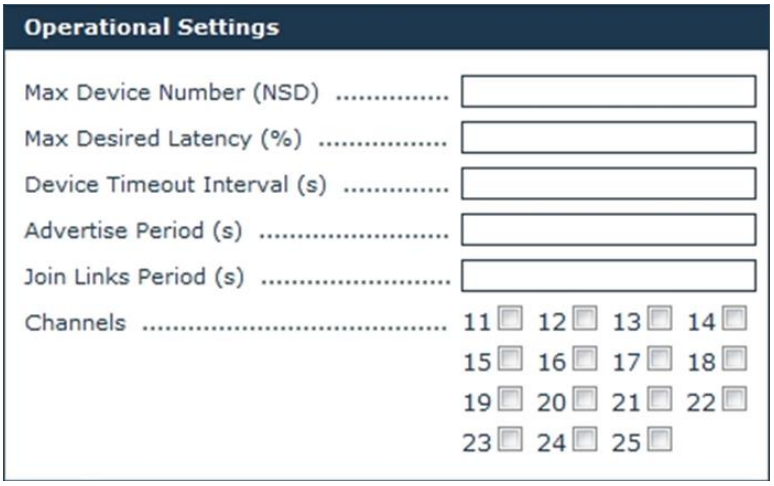
NOTE:

- Hover over an edit box and a tooltip will appear, indicating the allowed format and range for each value.
- If you change any of these settings, you must restart the system manager in order for the new settings to take effect.

Step	Action
Operational Settings	

2. Fill in the input fields with the desired/appropriate values.

Enable the desired frequency channels for communication with the network devices.



NOTE: Hover over an edit box and a tooltip will appear, indicating the allowed format, range and a description (where necessary for disambiguation) for each value.

Step	Action
Logging	

3. Select the **Logging level**, which indicates the degree of detail provided in the logs:

- ERROR for error messages only
- WARN for error and warning messages
- INFO for error, warning, and information messages
- DEBUG for error, warning, information, and debug messages

4. When you have finished editing the settings, click **Save**.

5.	Select the **Logging level**, which indicates the degree of detail provided in the logs: ➢ ERROR for error messages only ➢ WARN for error and warning messages ➢ INFO for error, warning, and information messages ➢ DEBUG for error, warning, information, and debug messages 	
6.	When you have finished editing the settings, click **Save**.	

6.4 Device Management

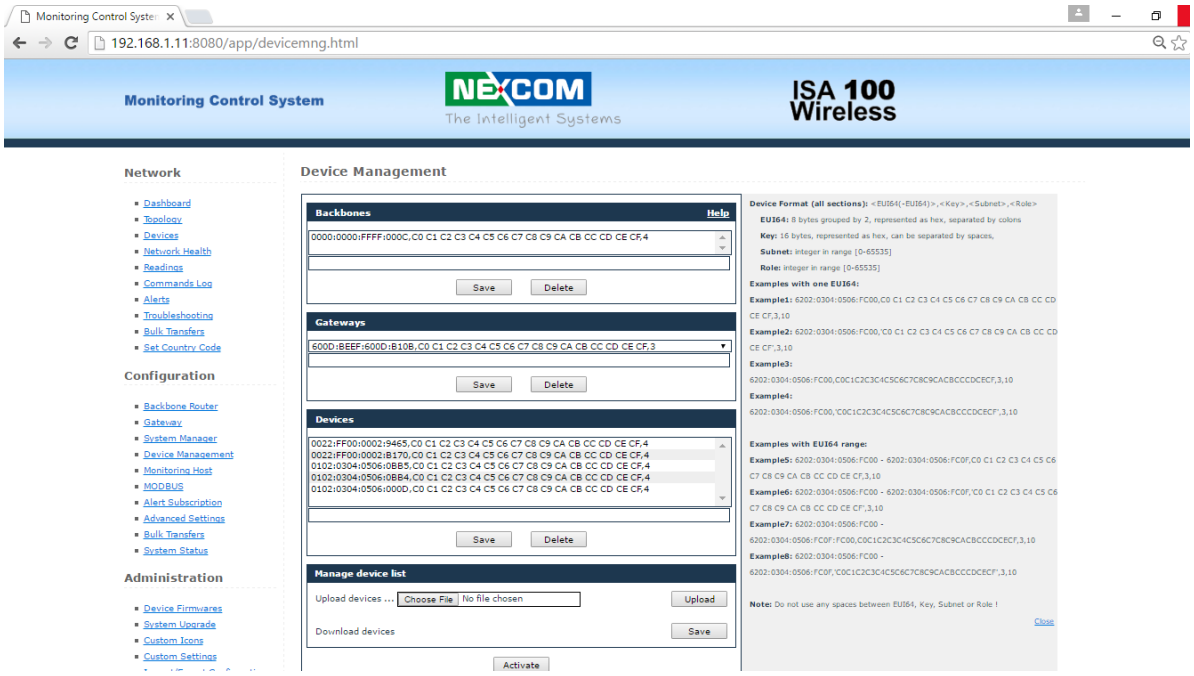
This section enables you to edit the provisioning information (the SM whitelist) in the "system_manager.ini" file for existing devices and to add new devices to the network.

IMPORTANT: **WARNING! Do not change these settings unless you were specifically instructed by a NEXCOM representative! Incorrect values may render the devices dysfunctional, or may cause difficulty to trace malfunctions.**

NOTE: This page is not exposed into the left-hand menu. The user must type its URL in order to access it.

To access the page, Open the following URL: **http://<NIO200IAG_IP>/admin/devicemng.html** replacing <NIO200IAG_IP> with NIO 200IAG Gateway IP. Provide any credentials may be requested if the user is not already logged in

Click **Help** in the upper right corner of the window to view information and examples of the accepted data formats in all the sections.



- The EUI-64 address is unique in a network.

NOTE:

- All the devices in a subnet must have the same security key and the same Subnet ID.

- The number of backbone routers in a network equals the number of subnets in that network.

6.4.1. Configuring Backbones

Step	Action
To add a backbone router in the network	
1.	Type the EUI64, security key, and subnet ID in the empty edit box.
2.	Click the **Save** button.
3.	The new backbone router will be added to the Backbones list.
4.	Click the **Activate** button to load the changes into the System Manager. The changes will be visible in the network topology and where applicable in the device list.
To edit a backbone router	
1.	Click on the entry that you want to edit in the backbones list.
2.	Edit the security key and/or subnet ID, and click **Save** to save the changes in the "system_manager.ini" file. **NOTE:** ➢ If you try to edit the EUI64 address of an existing backbone router, the SM will recognize it as a new entity and will add the new backbone router to the list. ➢ If you edit a BBR, it will be removed from an existing subnet and the devices in that subnet will be unable to join the network, unless you edit the same parameters for all the field devices in that subnet. ➢ Take care: the subnet ID is **decimal** in this page (while it is **hexadecimal** in the BBR Configuration page)
3.	Click the **Activate** button to load the changes into the System Manager. The changes will be visible in the network topology and where applicable in the device list.
To delete a backbone router	

Step	Action
1.	Select the desired backbone router in the list and click **Delete**.
2.	You will be asked for confirmation. Click **Yes** to delete the backbone router or **No** to abort the action. **NOTE:** When you delete a backbone router the devices in its subnet will be unable to join until a new backbone router provisioned with the same security key and subnet ID is added to that subnet.
3.	Click the **Activate** button to load the changes into the System Manager. The changes will be visible in the network topology and where applicable in the device list.

6.4.2. Configuring Gateways

NOTE: By design the NIO 200IAG Gateway supports only one ISA100 Gateway; therefore it is not permitted to add more than one gateway to the system.

Step	Action
To edit the gateway	
1.	Click on the entry that you want to edit in the gateways list.
2.	Edit the security key and/or subnet ID, and click **Save** to save the changes in the“system_manager.ini” file.
3.	Click the **Activate** button to load the changes into the System Manager. The changes will be visible in the network topology and where applicable in the device list.
To delete the gateway	
1.	Select the desired gateway in the list and click **Delete**.
2.	You will be asked for confirmation. Click **Yes** to delete the gateway or **No** to abort the action. **IMPORTANT:** **Caution! If you delete the gateway, you will no longer be able to access the system and retrieve any data, although the network remains functional.**
4.	Click the **Activate** button to load the changes into the System Manager. The changes will be visible in the network topology and where applicable in the device list.

6.4.3. Configuring Devices

Adding devices:

You can add devices either individually, one device at a time, or you can add multiple devices at a time.

- To add a single device in the network, type it's EUI64, security key, and subnet ID in the empty edit box and click Save. The new device will be added to the Devices list.
- To add multiple devices with consecutive EUI-64 addresses type the range of EUI-64 addresses corresponding to the devices that you wish to add; subsequently, type the security key, and the subnet ID and click Save.

The follow example shows how a series of devices with consecutive EUI-64 address can be added to a subnet.

Example:

```
"6302:0304:0506:0B1A - 6302:0304:0506:0B1E,C0 C1 C2 C3 C4 C5 C6 C7 C8 C9 CA CB CC CD CE CF,17, 3"
```

NOTE: When you add a device or a range of devices into the network you can define their role, which is expressed as an integer value and is added after the subnet ID in the device format.

The following table details the role values and associated labels:

Integer Value	Role
1	IO Device
2	Router Device
3	IO Routing Device

The following aspects must be taken into consideration when defining the role for a device or range of devices:

1. Upon join, each device states its capacity.
2. The roles of the backbone router and the gateway cannot be changed, therefore providing a role value in this section is unnecessary.
3. The role selection for a field device is limited to the capacity stated by that device.

Examples:

- If a device has only the IO role, you cannot add the Routing role for that device in the Device Management section.
- If a device has both the IO and the Routing roles, you can limit its role in the network to one of the two, by typing either 1 or 2 after the subnet ID.
- If you do not specify a role in this section, the System Manager will admit the role(s) stated by the device.

4. If you add the role for a range of devices, all the devices in question will have the same role. If any device in the range does not support the assigned role, the device will not join the network.

Step	Action
To edit a device/multiple devices	
1.	In the device list, click on the entry that you want to edit.
2.	Edit the security key and/or subnet ID. **NOTE:** See the previous Note on Device Roles if you wish to edit device roles.
3.	Click **Save** to save the changes in the“system_manager.ini” file.
4.	Click the **Activate** button to load the changes into the System Manager. The changes will be visible in the network topology and where applicable in the device list.
To delete a device/multiple devices	
1.	Select the desired entry in the list and click **Delete**.

Step	Action
2.	You will be asked for confirmation. Click **Yes** to delete the device(s) or **No** to abort the action.
3.	Click the **Activate** button to load the changes into the System Manager. The changes will be visible in the network topology and where applicable in the device list.

Loading a List of Devices

You can add multiple devices at the same time by importing them from a file. The file will contain a list of devices with the <EUI64>, <Key>, and <subnet>) comma separated values.

Step	Action
To load a list	
1.	Click on **Browse** to locate the text file that you wish to load, and click **Upload**.
2.	Click the **Activate** button to load the new device list into the System Manager. The current “system_manager.ini” file will be overwritten and all previous settings will be lost.
Exporting the settings	
1.	This page also enables to export the configuration settings, by clicking **Save** in the “Manage device list” section.

6.5 Monitoring Host

This section enables you to configure the devices publishing settings stored in the “Monitor_Host_Publishers.conf” file. The settings are used by the Monitor Host to subscribe to the data published by the field devices.

NOTE: The settings in this page do not get sent to the field devices. Field devices must be separately provisioned with publish settings (channels to publish, period, phase, endpoint, etc.)

Click **Help** in the upper right corner of the window to view information and examples of the accepted data formats in all the sections.

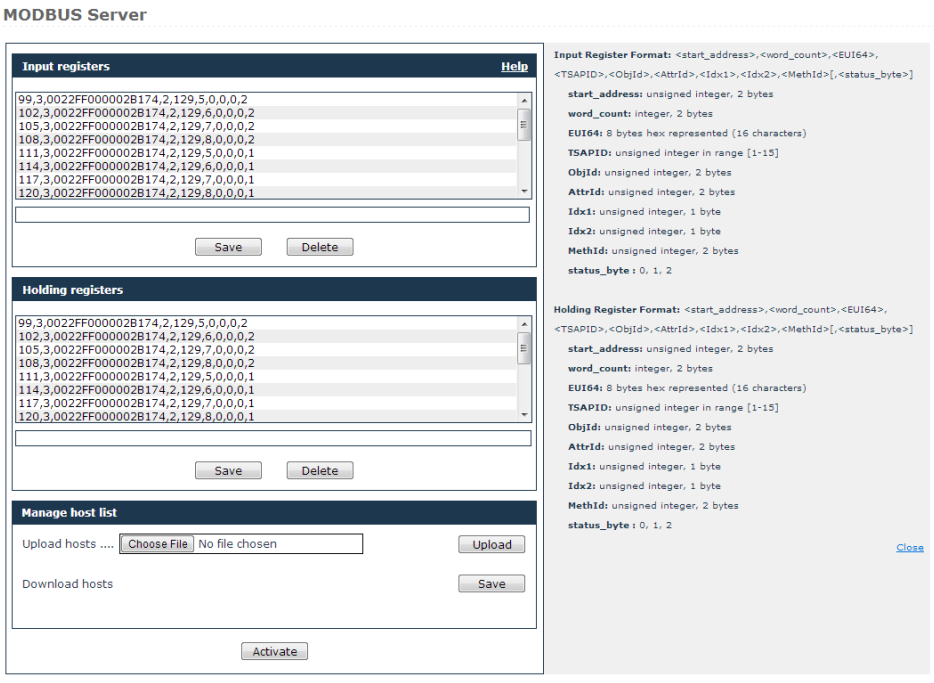
The publishers' configuration can be performed manually, by user adding/editing the lines in the page, or automatically, by interrogating automatically the field devices. The automatic publisher discovery is recommended method.

If the automatic publishers' discovery is enabled: Auto Activate ON means the changes take effect immediately as a device respond to MH interrogations. If Auto Activate is OFF the changes will not take effect until the user press the Activate button, or until the software gets restarted

6.6 MODBUS

This section enables you to map ISA100.11a attributes to Modbus registers.

Click **Help** in the upper right corner of the window to view information and examples of the accepted data formats in all the sections.

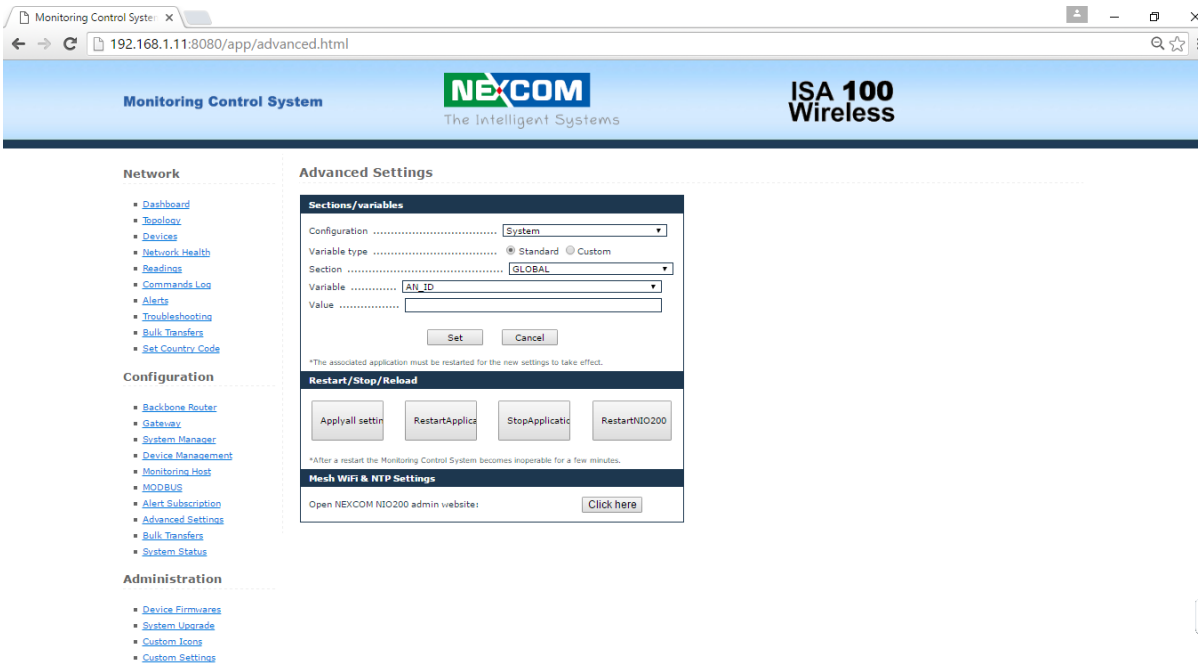


6.7 Alert Subscription

This page enables you to subscribe to alerts generated in the system.

To subscribe to an alert category, enable the checkbox preceding it and click **Save**. When an alert to which you subscribed is generated, it will be listed in the Alerts page.

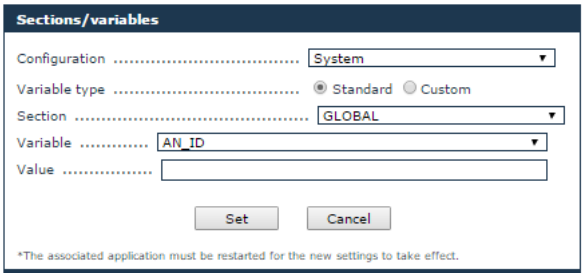
6.8 Advanced Settings

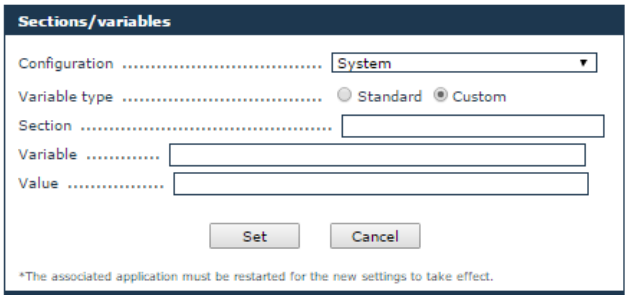


6.8.1. Edit Configuration Variables

This page allows you to view/set less common configuration variables, which cannot be changed using the classic MCS web interface.

IMPORTANT: **This page is for advanced users only – do not use** unless you have been instructed exactly by a NEXCOM representative on what values to change. Incorrect values may render the router dysfunctional, or may cause difficulty to trace malfunctions.

Step	Action
1.	The following form will open to the right of the operation list: 
2.	In the form, select a Section in the drop-down list. The Variable list will change accordingly.
3.	Select a Variable in the drop-down list. **IMPORTANT: Do not change [GLOBAL].AN_ID under any circumstance.**
4.	Set/edit the Value field, then click **Set**.

5.	To add a new variable, select **Custom** under Variable type. The Sections/variables form will be empty. 
6.	Type the desired information in the Section, Variable, and Value fields, then click **Set**.

6.8.2. Restart

This section enables the user to restart the applications running on the NIO 200IAG Gateway.

The "**Apply all settings**" button apply all settings (re-load into all modules the configuration files)

The "**Restart Applications**" restart all applications, without rebooting the board.

The "**Stop Applications**" stops all applications, for powering the board off after an ordered shut down.

The "**Restart NIO200**" reboots the NIO 200IAG Gateway.

NOTE:

After restarting the applications or rebooting the NIO 200IAG Gateway, the Monitoring Control System becomes inoperative for a few minutes.

After Stopping the applications, the Monitoring Control System becomes inoperative until the next power cycle.

6.8.3. Access NEXCOM NIO200 admin website

This section allows the user to navigate to NEXCOM NIO200 admin website, where the NIO200 Network Configuration (Wi-Fi settings, IP Addresses, NTP Server, etc.) can be changed.

6.9 Bulk Transfers

The Bulk Transfers page enables you to create and configure bulk transfers. Bulk data transfers are used to transfer large items between wireless devices (sensor boards) and gateway clients. This can be done via two methods:

- A transfer method described by ISA running on top of UDO
- A Nivis enhanced bulk data transfer protocol

Already configured bulk transfers are displayed in a table, with the following information:

- EUI-64 Address – the EUI-64 Address of the source device
- Transfer Type – the selected transfer protocol (UDO or BTO)

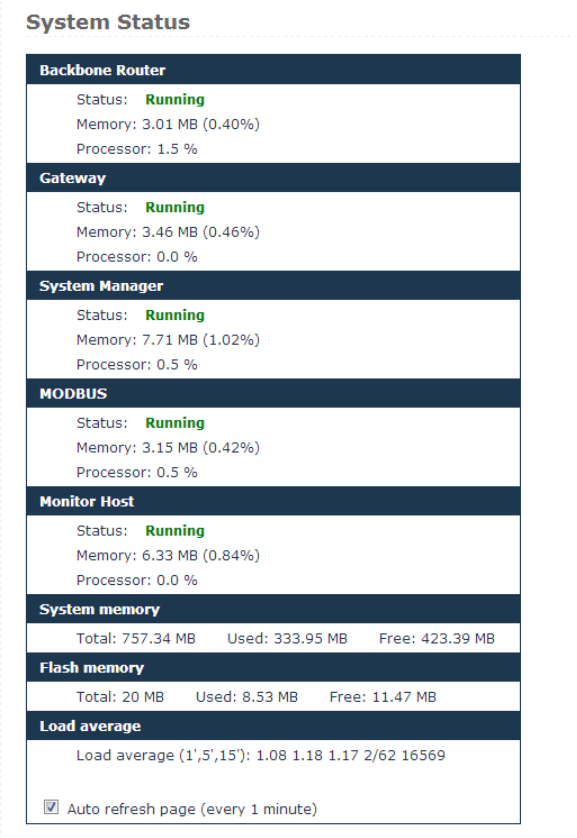
- TsapID –
- Device Tag – the device tag for the source device
- Status – the status of the transfer

The total number of items in the table is indicated in the top left corner of the table. Here you can set the number of items to be displayed per page in the table. The default number of items displayed in a page is 10. Paging controls in the top right corner of the table also enable you to navigate through the other pages of the table.

You can also delete a bulk transfer, by clicking the icon next to it. The system will require confirmation to perform the action. Click **Yes** to delete the bulk transfer or **Cancel** to abort the action.

7. System Status

The Statistics page displays statistical information regarding processor and memory usage, and load average on the NIO 200IAG Gateway.



The first five sections indicate the status (“Running” or “Not Running”), memory usage and processor usage for the backbone router, gateway, system manager, Modbus, and monitor host processes.

The following two sections display system memory and flash memory availability information.

The Load average section indicates:

- The system’s load average over the past one, five and fifteen minutes respectively
- The number of running processes out of the total number of processes
- The ID of the last started process

If you wish to regularly update the system status information, enable the Auto refresh page option at the bottom of the page. The page will auto refresh at one-minute intervals.

8. Administration

The administration section encompasses tools for the management of the ISA100.11a based system.

It allows the users to update device and system firmware and to manage device icons and apply custom settings to their site.

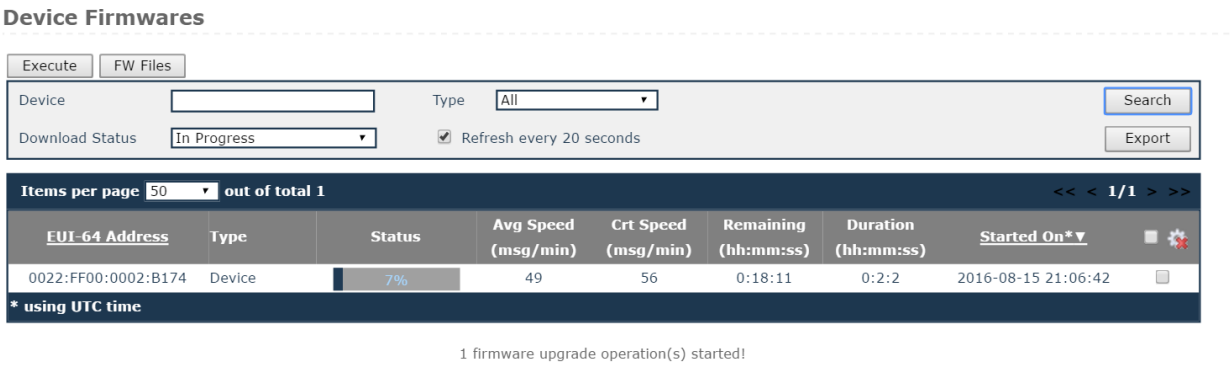
8.1 Device Firmwares

The Device Firmware's section is dedicated to firmware updates for field devices and the backbone router. Firmware updates require technical expertise and must be planned carefully or the devices will be unable to communicate on the ISA100.11a network. We recommend that you contact a Technical Support representative prior to executing such procedure.

This section provides a tool to upload binary firmware files into the system. These files will be used later to upgrade the device firmware.

In the Device Firmware's page you will view all the firmware update operations generated in the system. They can be filtered by Device, Firmware Type, and/or Download Status.

When the main page is loaded, the ongoing update operations (if any) are displayed by default. To search for firmware update operations, select the desired device, type and/or download status and click *Search.* The results will be displayed in a table, as shown in the following figure:



The following information is available:

- EUI-64 address – the EUI-64 address of the target device
- Type – the type of firmware uploaded on a device (for firmware types see 2.5.1.3 Firmware Files)
- Status – indicates the status of the update process at the time of viewing; the possible statuses are Completed, In Progress, Canceled, and Failed
- Completed – indicates the completion percentage at the time of viewing for ongoing operations, or the percentage at which the operation stopped, for canceled or failed updates. For completed updates, the percentage is 100%
- Avg speed – the average transmission speed, calculated in packets (messages) per minute since the beginning of the transfer
- Crt speed – the last recorded transmission speed, calculated based on the smallest of the bandwidths reserved for the two contracts: from and to the device. It varies slightly from the last instantaneous transmission speed
- Remaining – the remaining time to completion
- Duration – the total duration of the update
- Started on – the date and time the update operation started

To refresh the information in the table regularly, check the “Refresh every 1 minute” option in the Search form.

You can also cancel an ongoing firmware update by clicking the icon next to it, or delete a completed/ failed/ canceled/ operation from the records by clicking the icon next to it. The system will require confirmation before performing the requested action.

The total number of items in the table is indicated in the top left corner of the table. Here you can set the number of items to be displayed per page in the table. The default number of items displayed in a page is 10. Paging controls in the top right corner of the table also enable you to navigate through the other pages of the table.

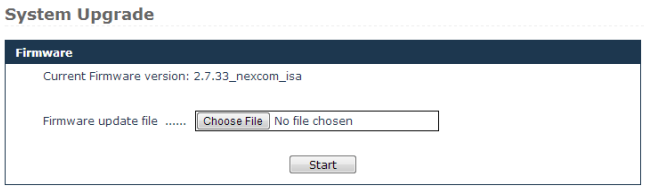
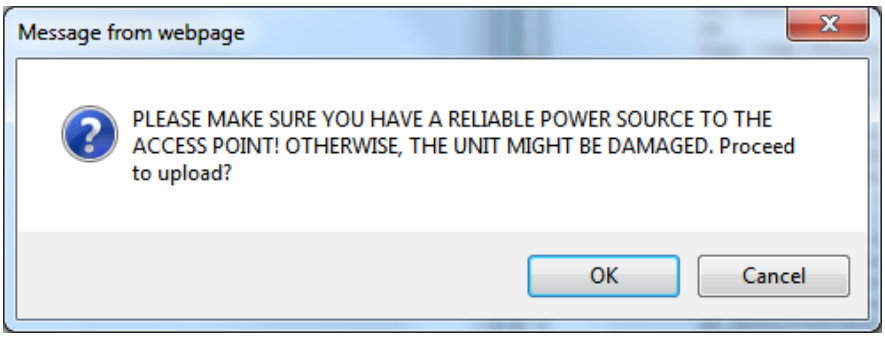
From this page you can export the search results into CSV format, for later use.

8.2 System Upgrade

The System Upgrade page enables you to upgrade the system components hosted on the connected NIO 200IAG Gateway.

The Firmware form indicates the current system version on the NIO 200IAG Gateway.

To initiate the upgrade

Step	Action
1.	Click **Browse** to locate and open the upgrade package that you wish to use: 
2.	Click the **Upload Firmware** button to initiate the process.
3.	Make sure the NIO200 has a reliable power source. When asked click OK 

Step	Action
4.	When the upgrade is complete, the page indicates the result of the upgrade: **System has been upgraded successfully.** System rebooting... Main Page

8.3 Custom Icons

This page enables you to assign custom icons for the devices in a network based on their role, with a view to better distinguishing them.

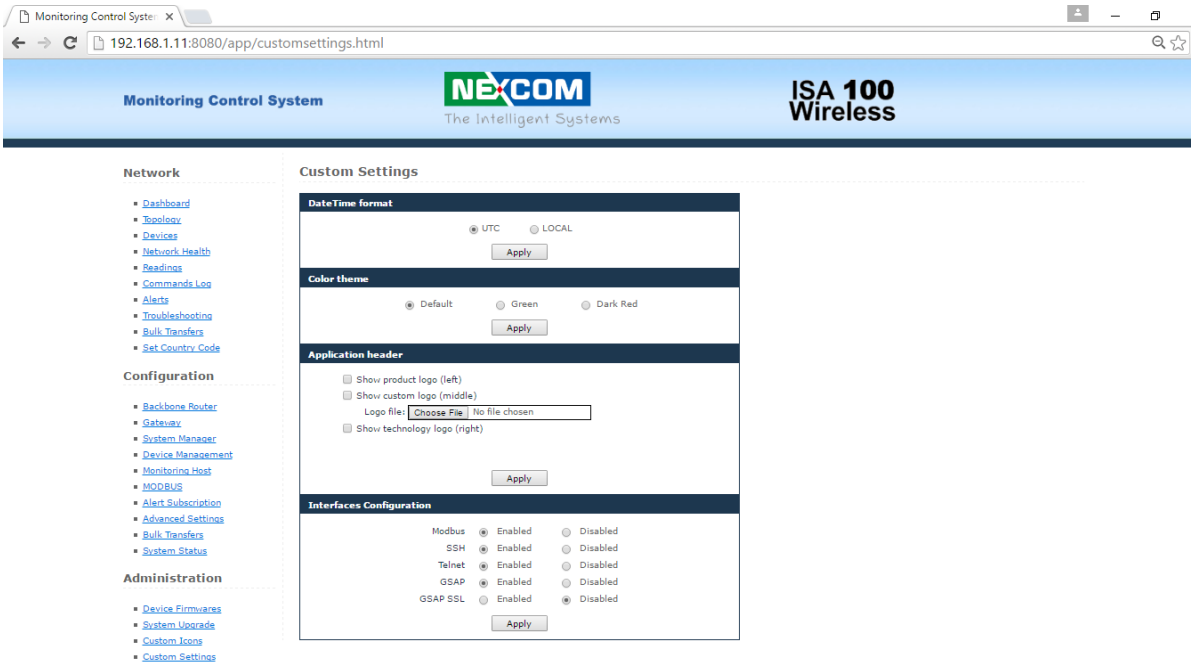
When the page is loaded, the existing custom icons are displayed in a table, with the following information:

- Model – the device model
- Role – the device role
- Icon – shows the existing picture

The default icons are not listed.

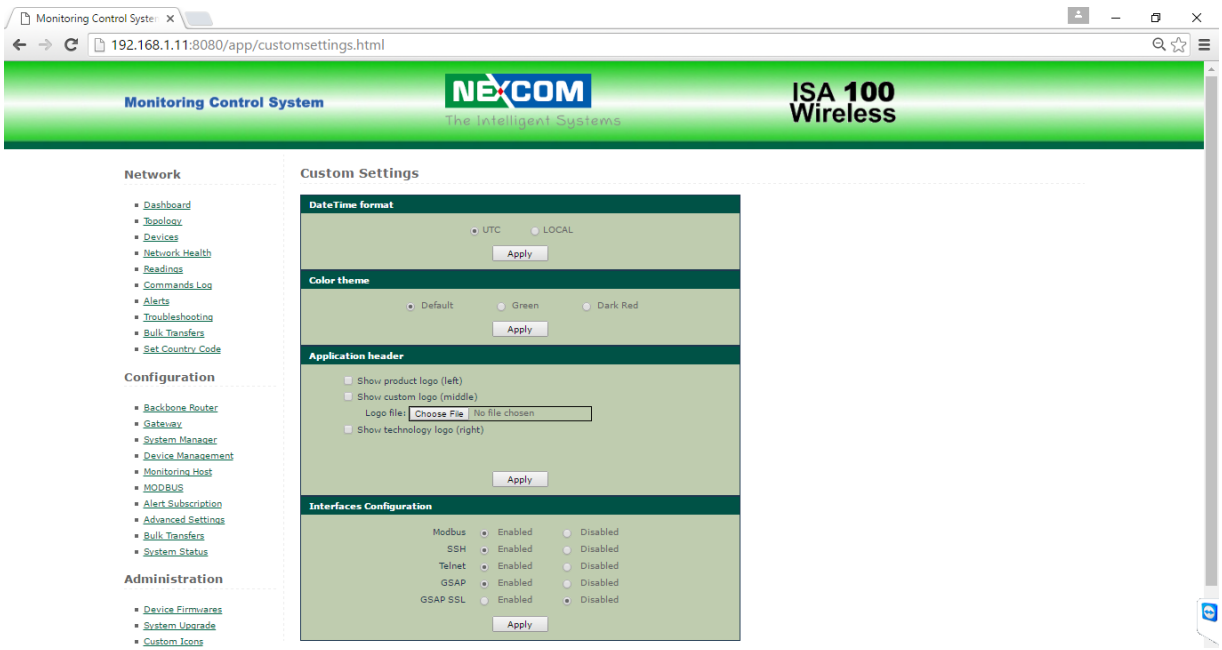
8.4 Custom Settings

This page enables user to define whether the timestamps get shown using browser local time zone or UTC; apply color themes to the website; replace the NEXCOM logo with a logo of preference in the website header, and enable/disable various high-side interfaces.



Date Time Format defines the format to display timestamps: using the browser local time zone settings or using UTC.

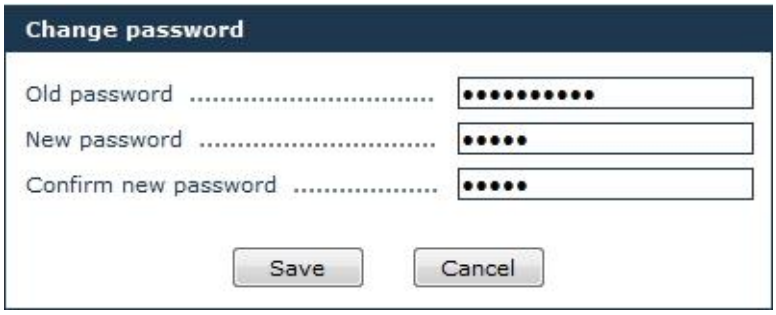
To apply one of the three available themes, select the desired theme and click **Change**. The page will refresh and the new color scheme will be displayed:



The Interfaces configuration allow enabling/disabling the high-side interfaces.Session

8.5 Change Password

This page enables you to change your own password.



Step	Action
1.	In the form, type your current password in the Old Password field.
2.	Type the new password in the New password field.
3.	Retype the new password in the Confirm new password field, for verification. **NOTE:** The passwords are case sensitive.
4.	Click **Save** at the bottom of the page to save the new password, which will become your current password.

Tip: To prevent unauthorized persons to gain access to your account, use a strong password in order to make it difficult for others to determine it and do not disclose your password to anyone.