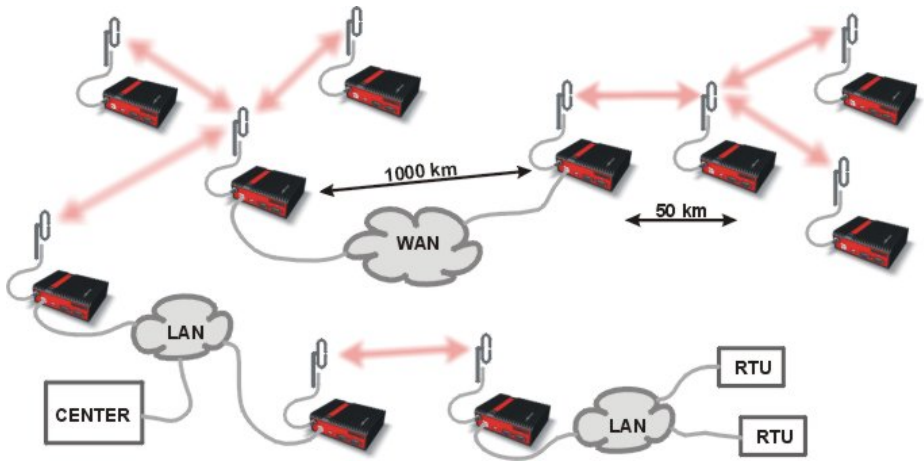
RACOM
RADIO DATA NETWORKS

Application notes



RipEX - Nomadic Mode

Backup Routes

Nomadic Mode

Base Driven Protocol

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Table of Contents

Introduction

Nomadic mode is a method of building a network that offers easy addition of a new 'nomadic remote' station to the radio network or easy transfer of 'nomadic remote' stations between different 'nomadic base' stations. Switching between 'nomadic base' stations will not be a rapid process; in order of minutes and longer.

Nomadic mode is only available in Router mode operating in Flexible radio protocol.

Please see more details in *RipEX Manual*[1].

[1] http://www.racom.eu/eng/products/m/ripex/h-menu.html#nomad

1. Typical Use Cases

Temporary RipEX operation at a given location

There may be requirements to install a RipEX unit, temporarily, somewhere and after a given time period, transfer it to another location. With Nomadic mode and RipEX set as Remote unit, it is not required to change this RipEX's configuration. It automatically registers with the static RipEX backbone and starts to operate correctly.

Measurement units – Site survey

Nomadic mode can be utilized for site survey job. A technician can install a Remote unit in a given location and the mechanism itself finds out the best connection point (the best RipEX Base unit). After this step, the unit can be changed to a static unit and re-configured to given IP addresses to suit the network architecture.
It is recommended to re-configure the unit from the Nomadic mode to a static solution due to Nomadic mode overhead and thus optimizing the channel utilization. If the unit will not be moved to a new location, do not leave it in Nomadic mode.

"Mobile application"

The Nomadic mode is NOT a mobile mode. It is NOT intended to be used as a mobile network, but with some limitations, it can be operated in this manner.
Static backbone of RipEX units with one central unit and number of Base stations will build a core of the network. Any number of static remote units can operate in the network as well.
Mobile nodes can change their position in time and in given time periods, it will operate via the best Base station, no matter its current location. The transitions are NOT immediate, but it is possible to configure the radio network for transition times in tens of seconds. If this limitation is OK, Nomadic mode can be utilized.

2. Configuration Example

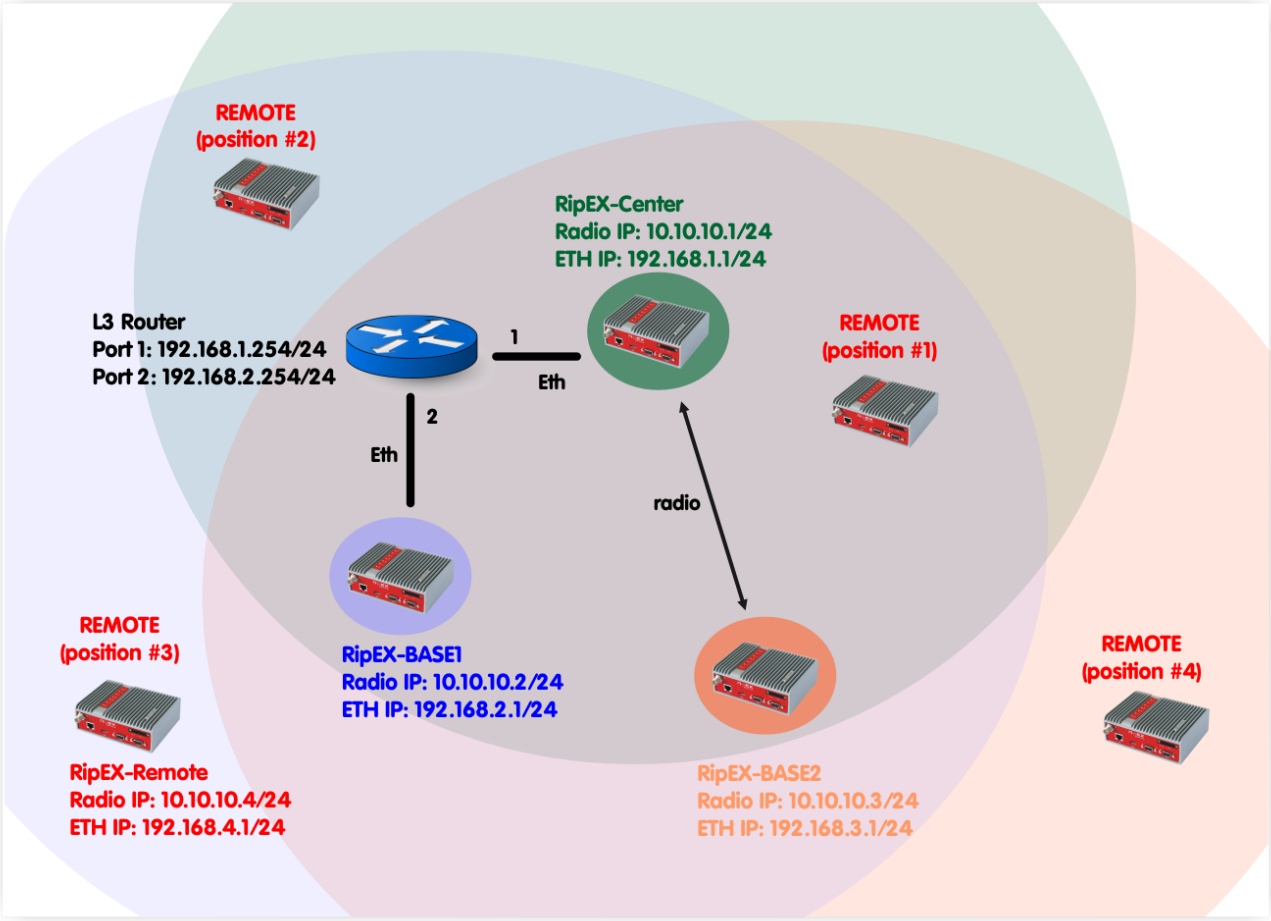

Fig. 2.1: Nomadic Mode example topology

In this example, 4 RipEX units are used. RipEX-Center serves as a Center for the Nomadic mode functionality. Two units serve as Bases (RipEX-Base1 and RipEX-Base2). The fourth unit is called RipEX-Remote and serves as a Remote unit. This unit can be placed anywhere within the radio range of at least one RipEX Base (Center is also operating as a Base) and it dynamically creates connection with the best Base. There is no need to re-configure the Remote unit, the Nomadic mode handles the connectivity on its own.

NOTE:
The topology diagram depicts different Remote unit positions, but it is actually one unit.

In the following chapter, individual RipEX units' configuration will be explained and showed together with actual dynamic routing so no matter where the Remote RipEX is placed, it can always communicate with other units within the network.

2.1. RipEX-Center Configuration

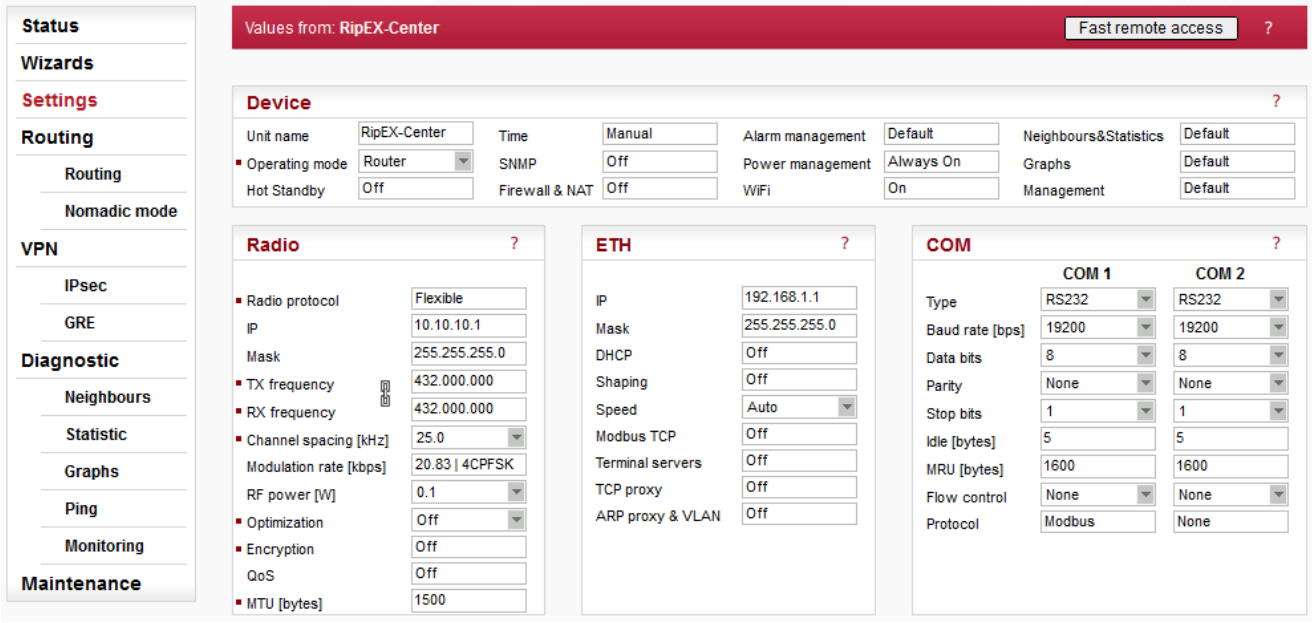

Fig. 2.2: RipEX-Center Settings

Parameters:

Unit name	RipEX-Center
Operating mode	Router
Radio protocol	Flexible (Nomadic mode is supported only in the Flexible protocol)
Radio IP/Mask	10.10.10.1/255.255.255.0
Frequency	432.000.000 MHz (configure any frequency, but the same among all RipEX units – simplex or duplex scenarios are both possible)
Channel spacing	25 kHz (configure any spacing, but this must be the same for all units)
Modulation rate	20.83 | 4CPFSK (use the same “type” for all units, but otherwise, configure as preferred)
RF power	0.1 W (set the minimum possible RF power for tests using dummy loads on your desk – laboratory tests)
ETH IP/Mask	192.168.1.1/255.255.255.0

There is no special configuration within the Flexible Router mode required.

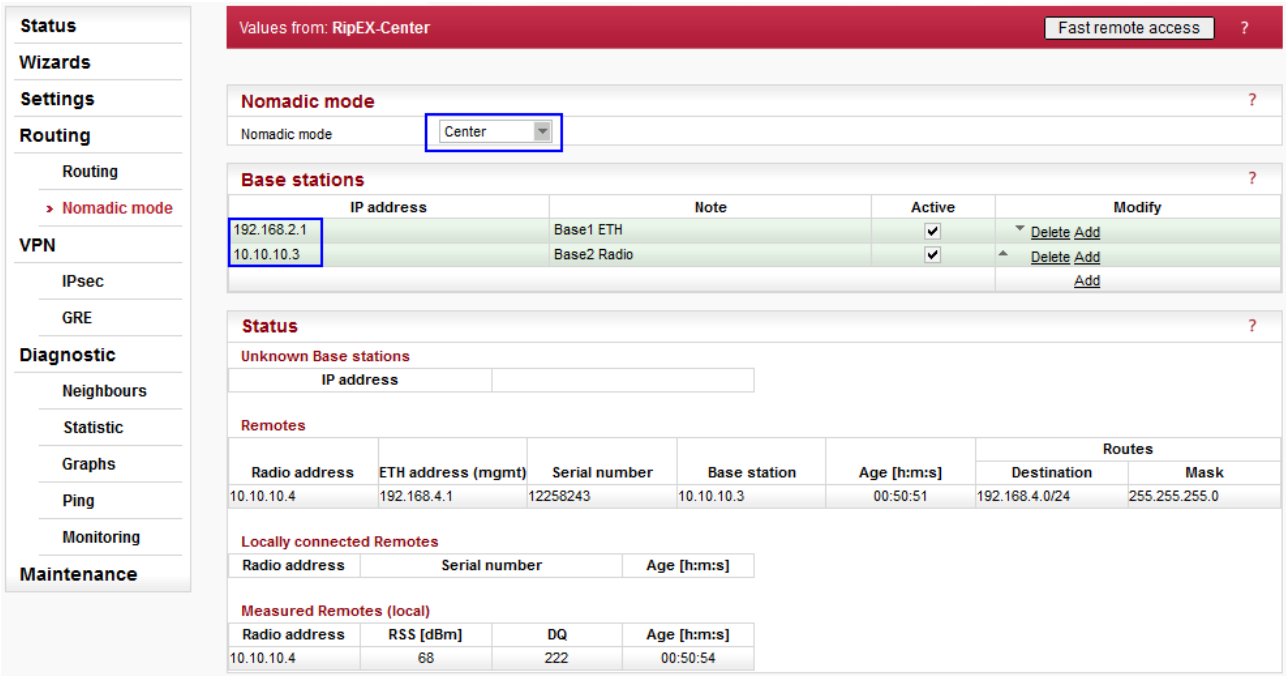

Fig. 2.3: RipEX-Center Nomadic mode

Parameters:

Nomadic mode Center

Base stations 192.168.2.1, Base1 ETH, Active
10.10.10.3, Base2 Radio, Active

In this RipEX network, there must be only one central unit. The central unit communicates and controls the Nomadic functionality together with the two Base units. One Base is connected via Ethernet and one is connected over the Radio channel. The central unit also acts as a Base.

Once the central unit synchronizes with Base units and the Remote unit, the Status is displayed i.e. information about the connected Base and Remote units. See the details in *Chapter 2.5.1*.

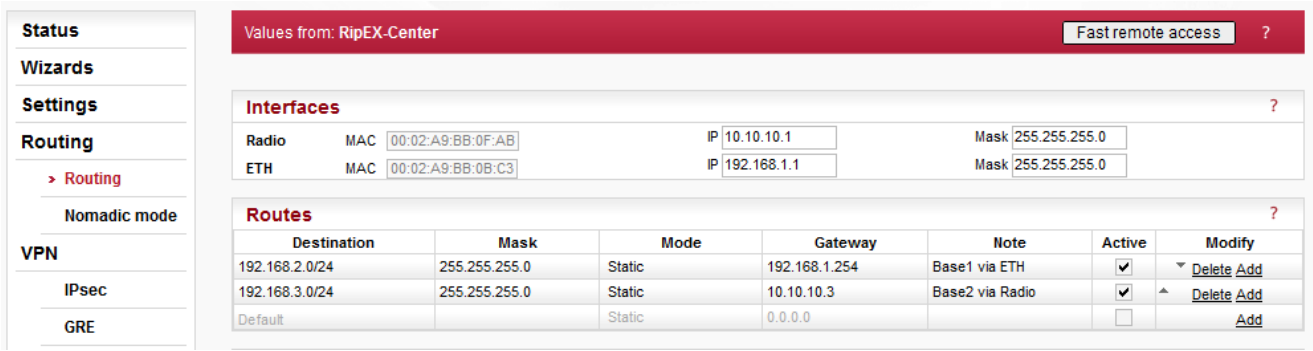

Fig. 2.4: RipEX-Center Routing

Within this example, two routes are set.

- 192.168.2.0/24 via 192.168.1.254, Mode: static
- 192.168.3.0/24 via 10.10.10.3, Mode: static

Both routes are required due to Base stations' networks accessibility. The network of the Remote unit is not configured, because it is created dynamically upon the Remote unit current location. This route is displayed in the Nomadic mode menu.

2.2. RipEX-Base1 Configuration

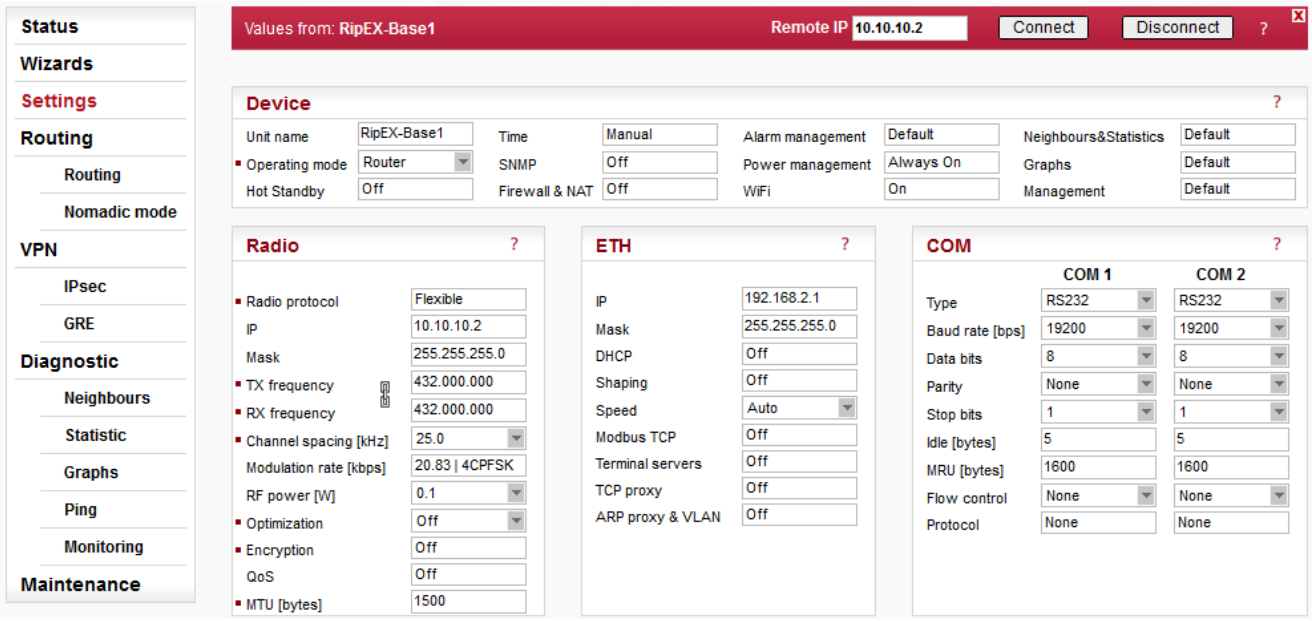

Fig. 2.5: RipEX-Base1 Settings

Only the different parameters compared to the central unit are explained below.

Parameters:

Unit name	RipEX-Base1
Radio IP/Mask	10.10.10.2/255.255.255.0
ETH IP/Mask	192.168.2.1/255.255.255.0

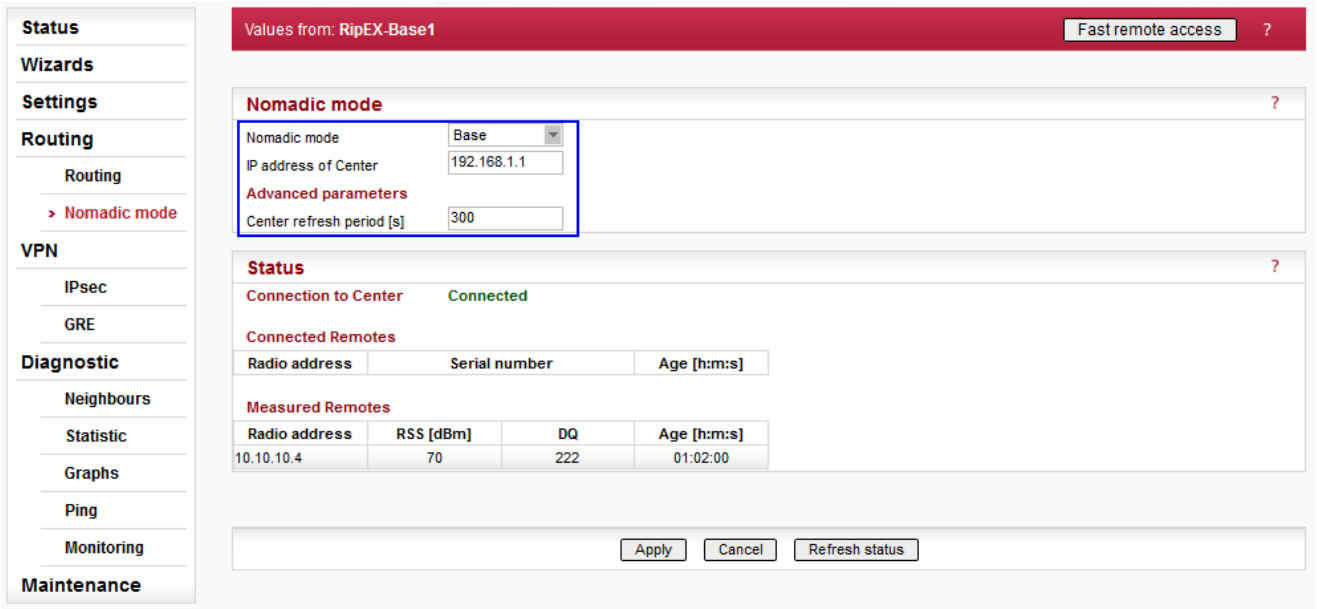

Fig. 2.6: RipEX-Base1 Nomadic mode

Parameters:

Nomadic mode Base

IP address of Center 192.168.1.1 (RipEX-Center Ethernet IP address – the communication is operated via Ethernet)

Advanced parameters:

Center refresh period [s] 300

The Status menu is described in *Chapter 2.5.1* once the complete network is configured.

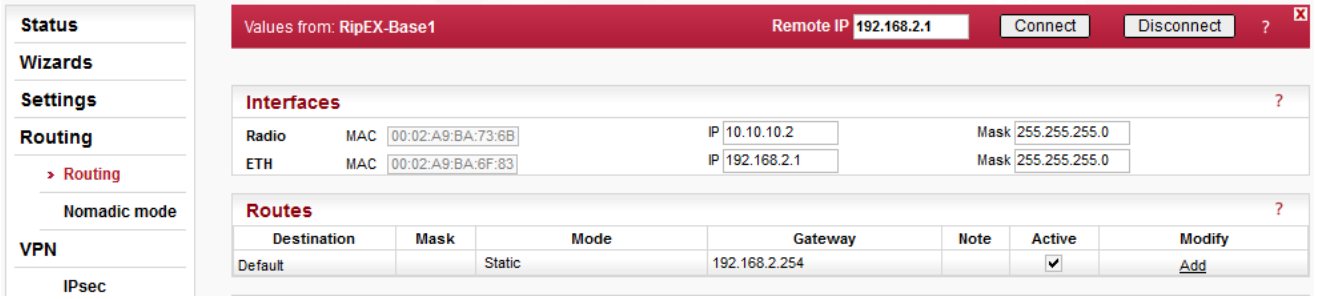

Fig. 2.7: RipEX-Base1 Routing

2.3. RipEX-Base2 Configuration

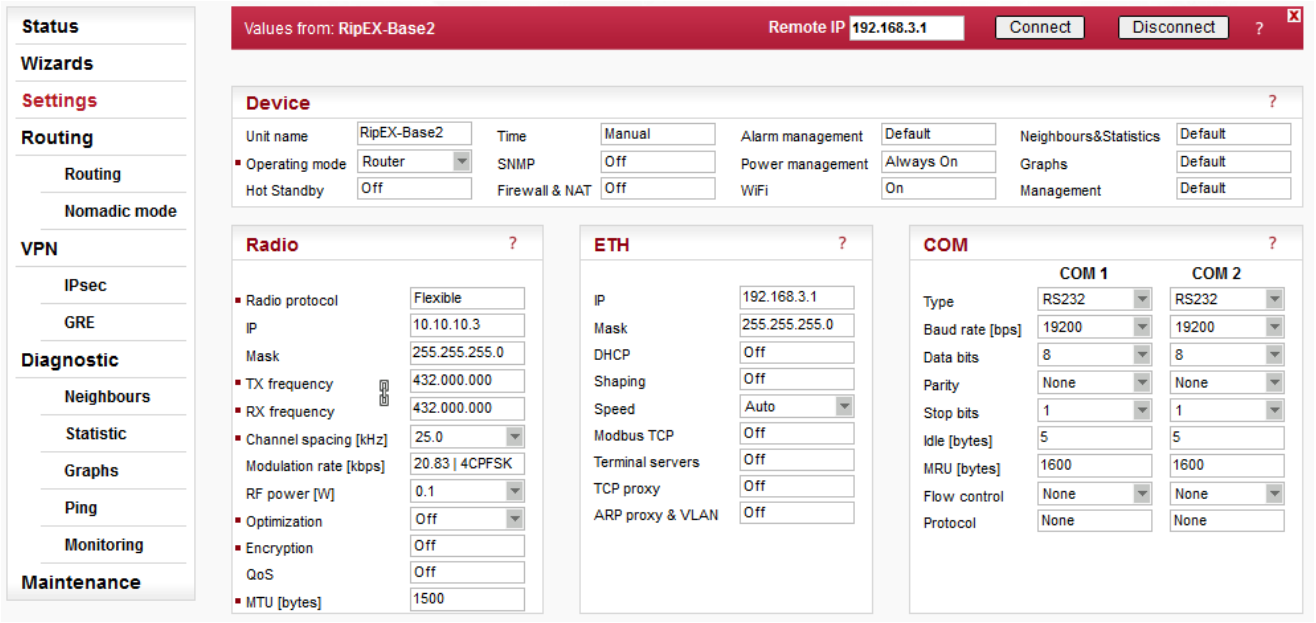

Fig. 2.8: RipEX-Base2 Settings

Only the different parameters compared to the central unit are explained below.

Parameters:

Unit name	RipEX-Base2
Radio IP/Mask	10.10.10.3/255.255.255.0
ETH IP/Mask	192.168.3.1/255.255.255.0

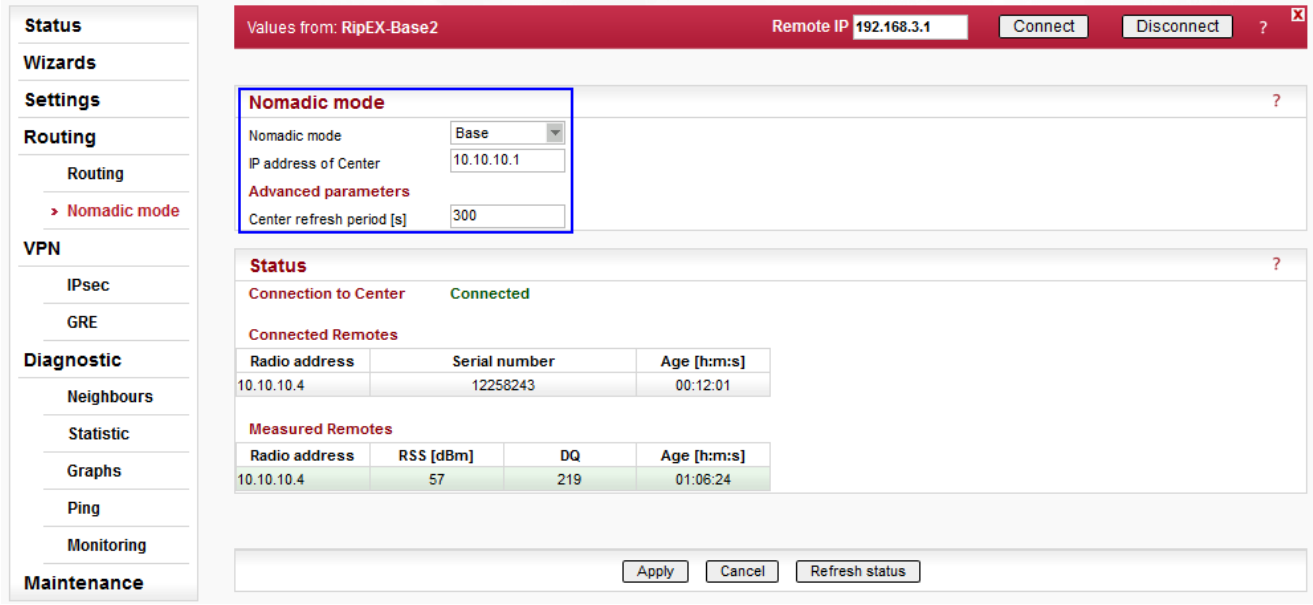

Fig. 2.9: RipEX-Base2 Nomadic mode

Parameters:

Nomadic mode Base

IP address of Center 10.10.10.1 (RipEX-Center Radio IP address – the communication is operated via Radio channel)

Advanced parameters:

Center refresh period [s] 300

The Status menu is described in *Chapter 2.5.1* once the complete network is configured.

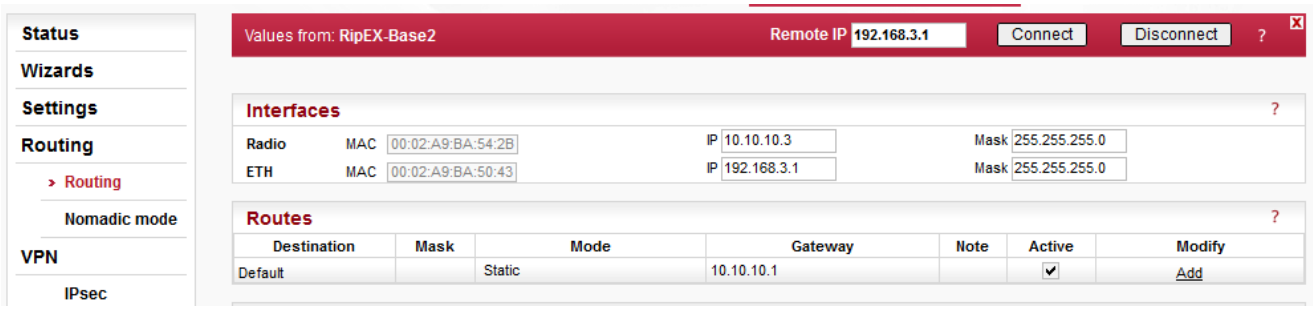

Fig. 2.10: RipEX-Base2 Routing

The only required route in this example is a default route, because the unit communicates only with the central unit (e.g. even with the Remote connected directly to this Base, the packets are transmitted via the central unit).

2.4. RipEX-Remote Configuration

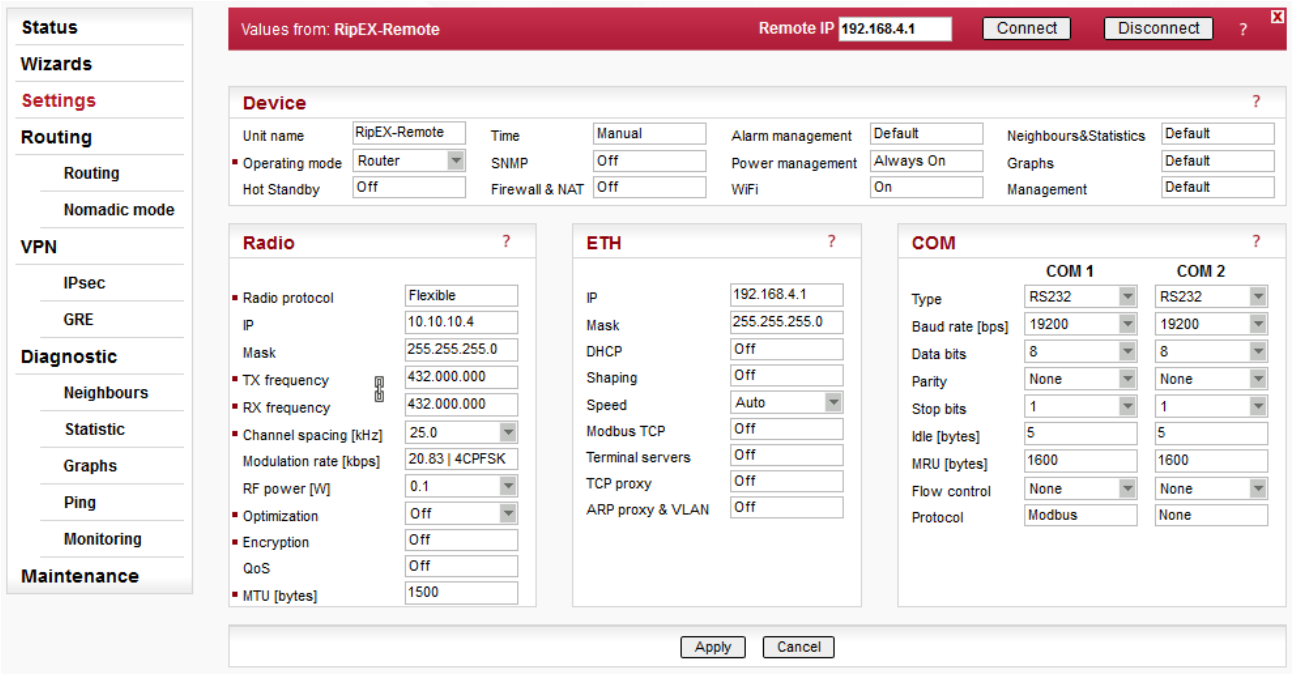

Fig. 2.11: RipEX-Remote Settings

Only the different parameters compared to the central unit are explained below.

Parameters:

Unit name	RipEX-Remote
Radio IP/Mask	10.10.10.4/255.255.255.0
ETH IP/Mask	192.168.4.1/255.255.255.0

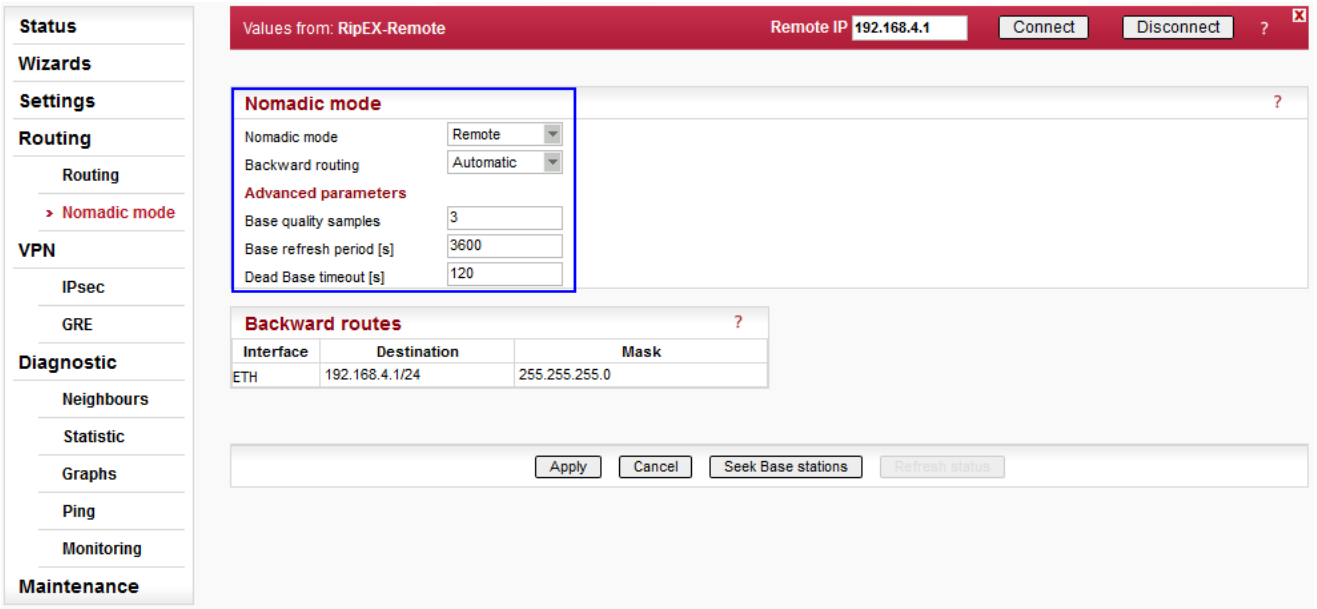

Fig. 2.12: RipEX-Remote Nomadic mode

Parameters:

Nomadic mode remote

Backward routing Automatic

Advanced parameters:

Base quality samples 3

Base refresh period [s] 3600

Dead base timeout [s] 120

The backward routing could also be set to Manual option, but in our example, it is much easier to choose the Automatic option, because it automatically uses the Ethernet subnet configured in this unit. This subnet is the only one required in our example.

The Status menu is described in *Chapter 2.5.1* once the complete network is configured.

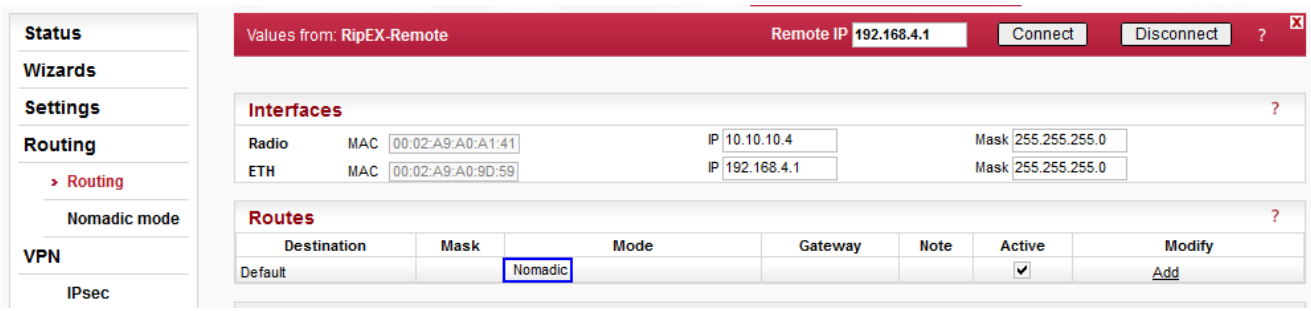

Fig. 2.13: RipEX-Remote Routing

The routing table is different compared to other units within this example. All routes must be configured in the “Nomadic” mode. The only required route is the “Nomadic” default route which results in dynamic routing based on current conditions (location, RSS/DQ values, etc.).

Each Remote can be configured in the same way, they just require to have different Radio IP addresses and Ethernet subnets. The Routing menu is the same.

2.5. Testing and Functionality Verification

Status tables and information for different roles in Nomadic mode are described in this chapter. Examples of possible Remote unit locations are provided as well.

2.5.1. Nomadic Mode menu

Central Unit

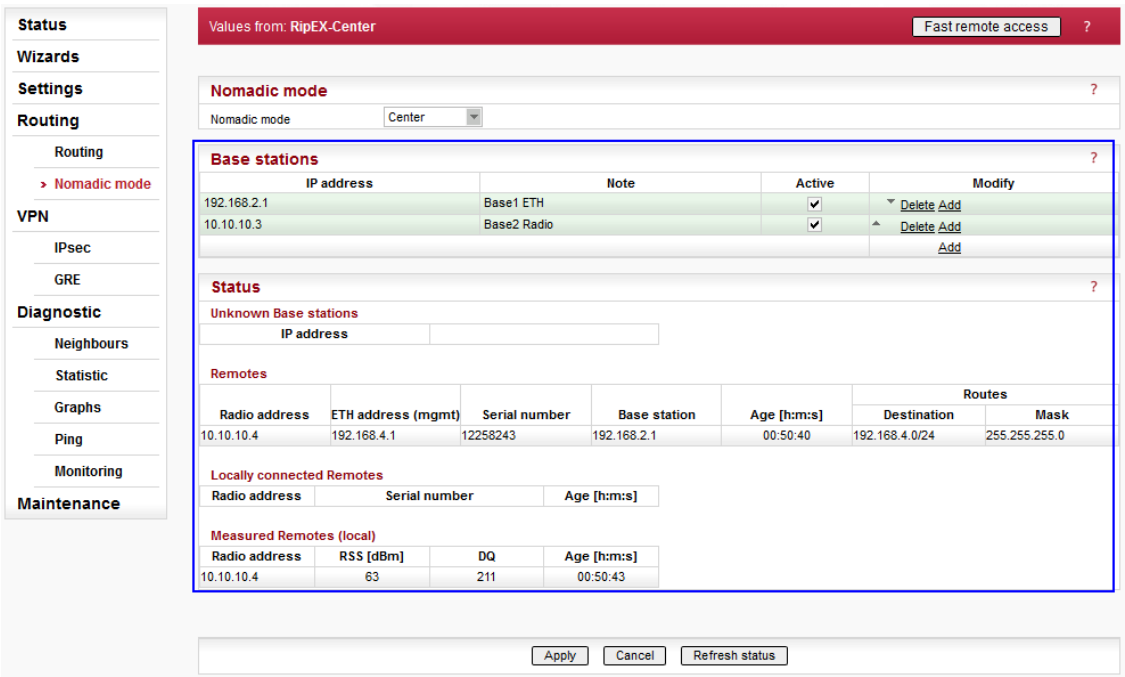

Fig. 2.14: RipEX-Central Nomadic mode

The menu displays the status of configured Base stations. The example utilizes two **Base stations** and both are accessible – i.e. both are highlighted in green. If any Base station is not accessible, it is highlighted in red.

Below the configured Base stations table, **Unknown Base stations** are displayed. These are Base stations that tried to connect with this Central station, but are not configured yet. A button “Add” can be pressed to add the unknown Base station to the list of configured/active Base stations. Entries older than 1 day, are automatically discarded.

Another table displays all the **Remote** units within the network. Each one of them is listed with:

- Radio address
- ETH address (mgmt) – use this address for the Fast Remote Access feature. The Radio address might not work in all cases.
- Serial number
- Base station – the IP address of the Base station to which the Remote unit is connected currently.
- Age – the time of its last enrollment
- Routes – the list of its backward routes

Each Remote unit (row) can be colored red if it is considered to be a “duplicated” remote. The pop-up notification “Suspected duplicated Remote” disappears once this unit is refreshed 8 times in a row without the serial number change.

The list of backward routes is colored:

- “ok” (gray) – the rule does not collide and it’s successfully used.
- “ok_coll” (light green) – the rule collides with another rule, but it is used.
- “ok_backup” (light green) – the rule collides with a Backup routing rule. It is correct only if a backup path is “built” over nomadic route, otherwise it is a configuration error.
- “coll_rmt” (red) – The rule collides with a routing rule from another remote. This rule is rejected.
- “collision” (red) – The rule collides with local static routing rules or local interface subnets. It is rejected.
- “loop” (red) – The rule would create a routing loop. It collides either with a base station or with the address range or radio interface. It is rejected.

Another table “**Locally connected Remotes**” displays the list of Remotes which are connected directly to this central unit. Each line consists of remote Radio address, Serial number and Age (time since the last refresh).

The last table “**Measured Remotes**” displays RSS/DQ values of Remote units which tried to communicate with this central unit directly. Entries older than 1 day are deleted.

Base Unit

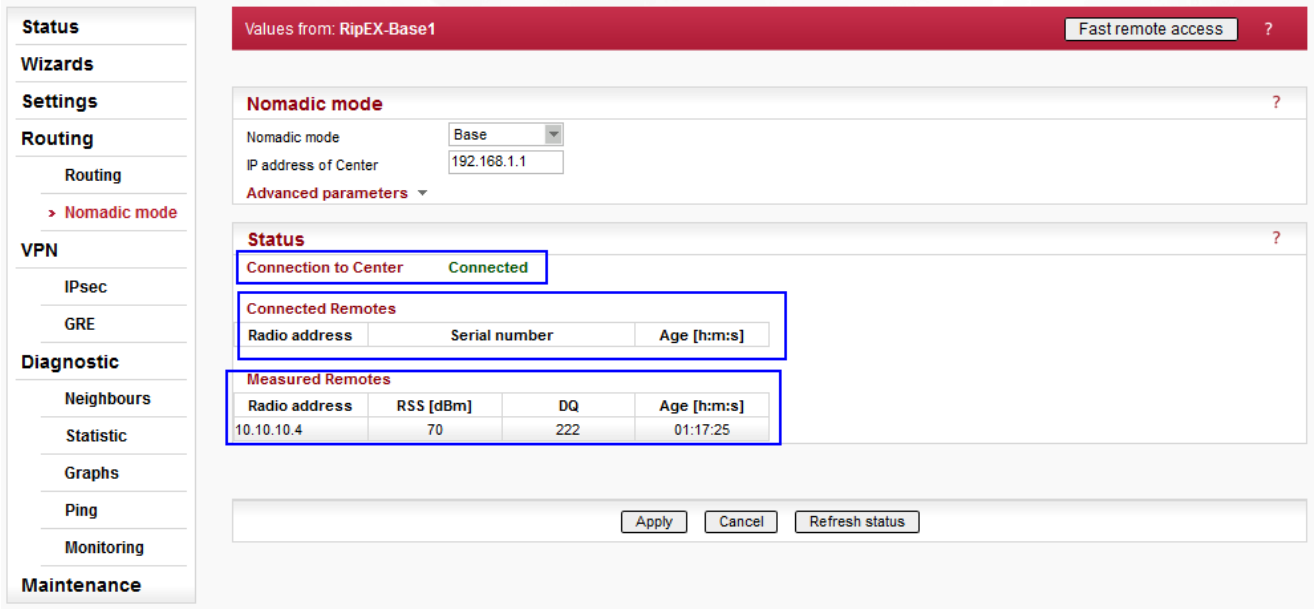

Fig. 2.15: RipEX Base – Nomadic menu

Within the Base Nomadic mode menu there are three parts. The first one displays whether this Base unit is connected to the central unit or not.

The “Connected Remotes” and “Measured Remotes” tables display the same information as explained in the central unit, because any central unit can also serve as a Base unit.

Remote Unit

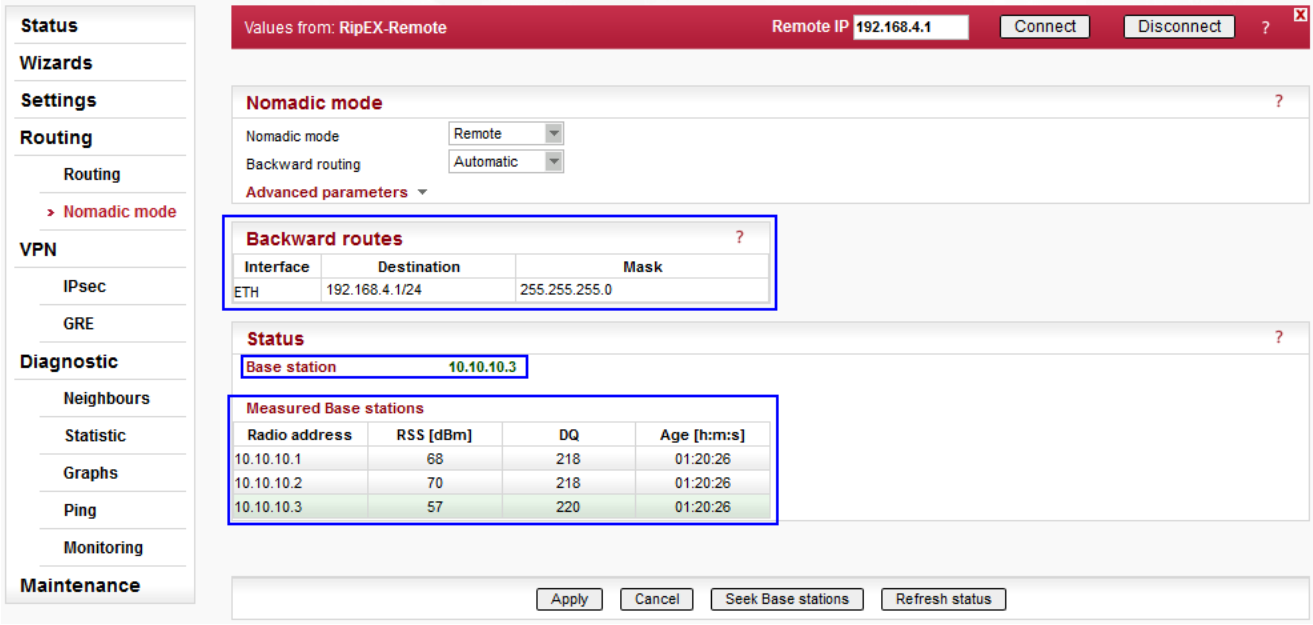

Fig. 2.16: RipEX Remote – Nomadic menu

The first table “Backward routes” can be filled in manually or automatically. In this example, automatic option was configured and thus 192.168.4.1/24 backward route was set automatically (because this IP/mask is the local unit’s Ethernet configuration).

In the Status, the Radio IP of the currently used Base station is displayed.

Each Remote unit displays the list of all measured Base stations with their Radio address, RSS/DQ values and Age (time of the last measurement). If any Base station is not displayed, click on the “Seek Base stations” button to restart the process of selecting the best Base unit, or just refresh the page to reload the displayed information.

The selected Base is colored green. Others are gray. If the Base unit rejected this Remote’s connection, this Base unit is colored red.

2.5.2. Monitoring

The nomadic traffic uses the UDP port 8905. The nomadic mode does not have its own monitoring interface, but it can be captured on the Radio interface after specifying the UDP port equal to mentioned number 8905.

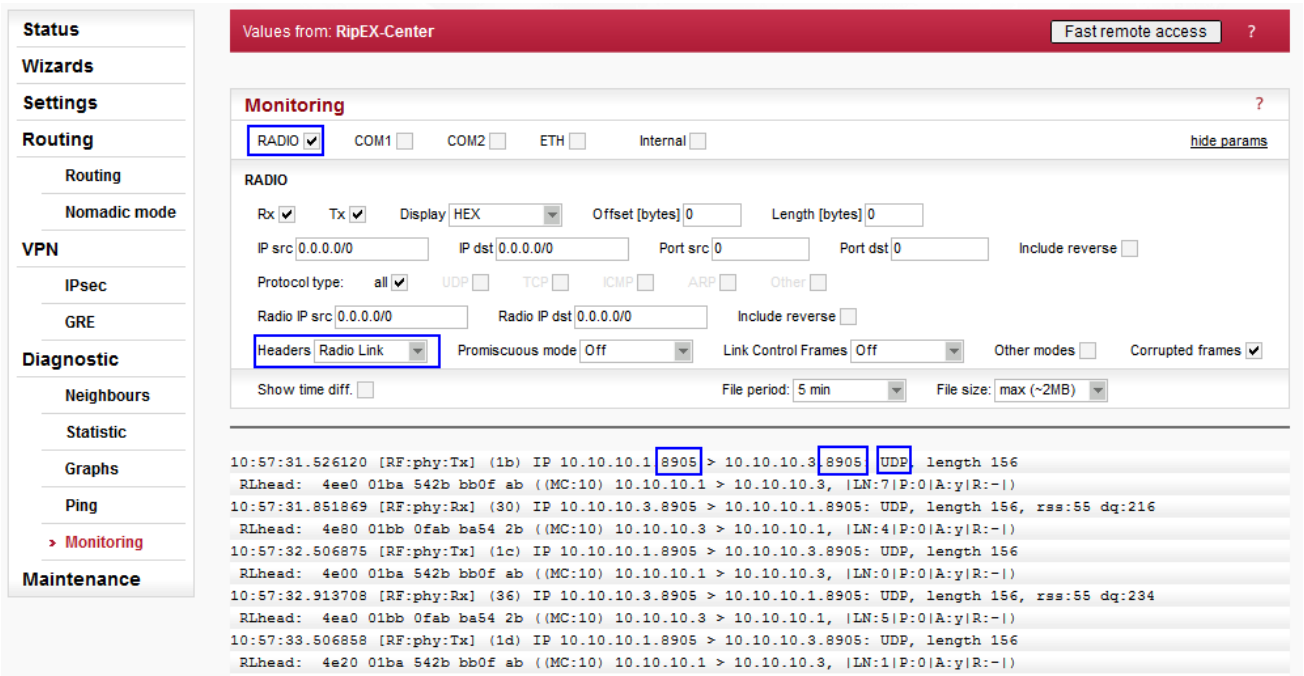

Fig. 2.17: Radio protocol monitoring in central location

In the central and remote units, the ETH interface can be used to check the nomadic traffic as well. Put the advanced filter “-i nomad” as a User rule and start the traffic capture.

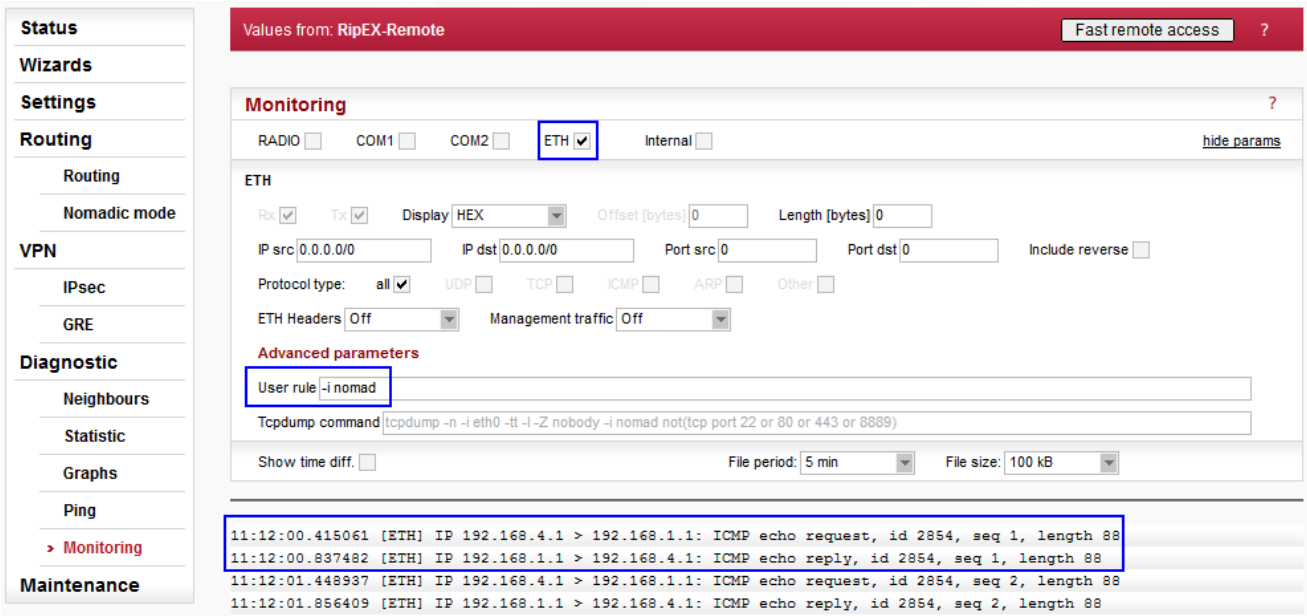

Fig. 2.18: Remote unit – Monitoring of the nomadic interface (via ETH)

2.6. Various Remote Locations

The Remote can be connected to the Central unit or one of the Base units. If the Remote is within the radio coverage of at least one of these Base units, it will work correctly. Based on measured RSS/DQ values, Remote unit dynamically chooses the best Base.

For our tests, all three possible Base stations will be selected by the Remote unit. One of the easiest way is to turn off and on particular units. You can simulate the same via changing the RSS/DQ values if you are using attenuators and coaxial cables for radio coverage. Or you can remove Ethernet cable between the central unit and Base1 unit. Decreasing configuration parameters' timeouts should also speed up re-selecting the Base unit.

For any following scenarios, actual path of data can be verified in the Monitoring menu as well. Check the UDP port 8905 on the Radio interface or use the parameter '-i nomad' for the Ethernet interface.

2.6.1. Central unit

Turn off all RipEX units except the central unit and then, turn on the Remote unit immediately. Check that the Remote selected the central unit and turn on both Base units.

In this scenario, the Remote will be communicating with the central unit directly, via one radio hop.

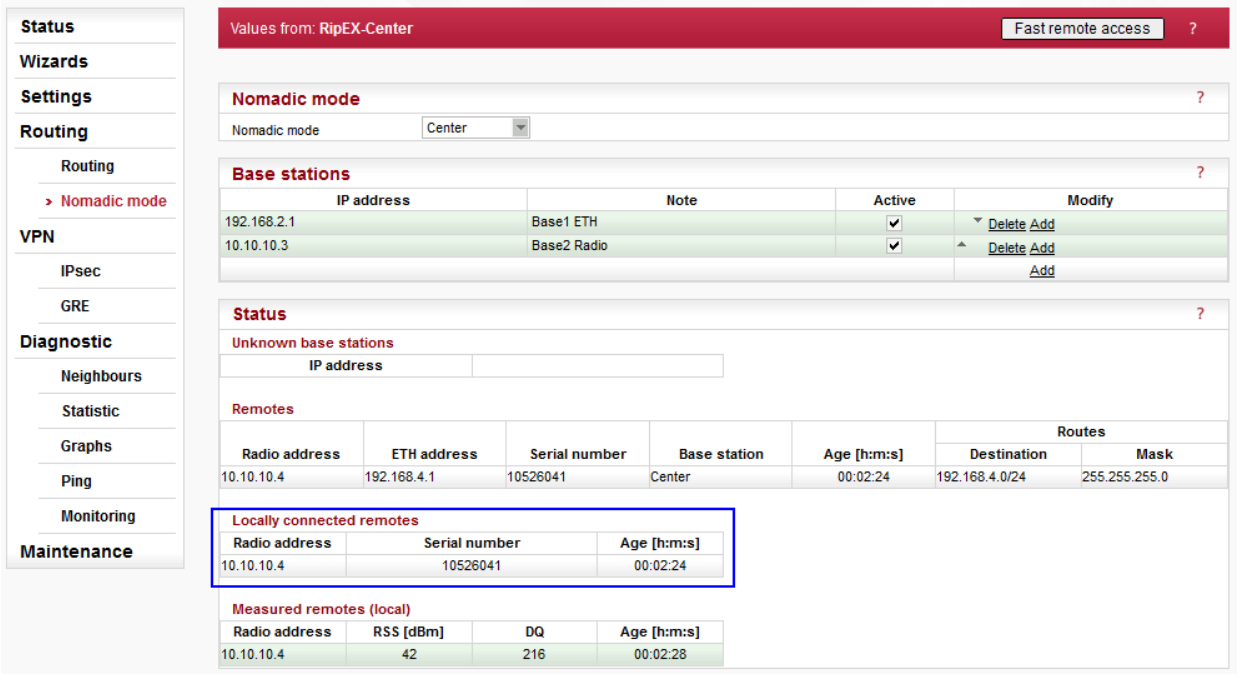

Fig. 2.19: RipEX-Center – Directly connected Remote unit

In the central unit, the Remote 10.10.10.4 is displayed as locally connected Remote.

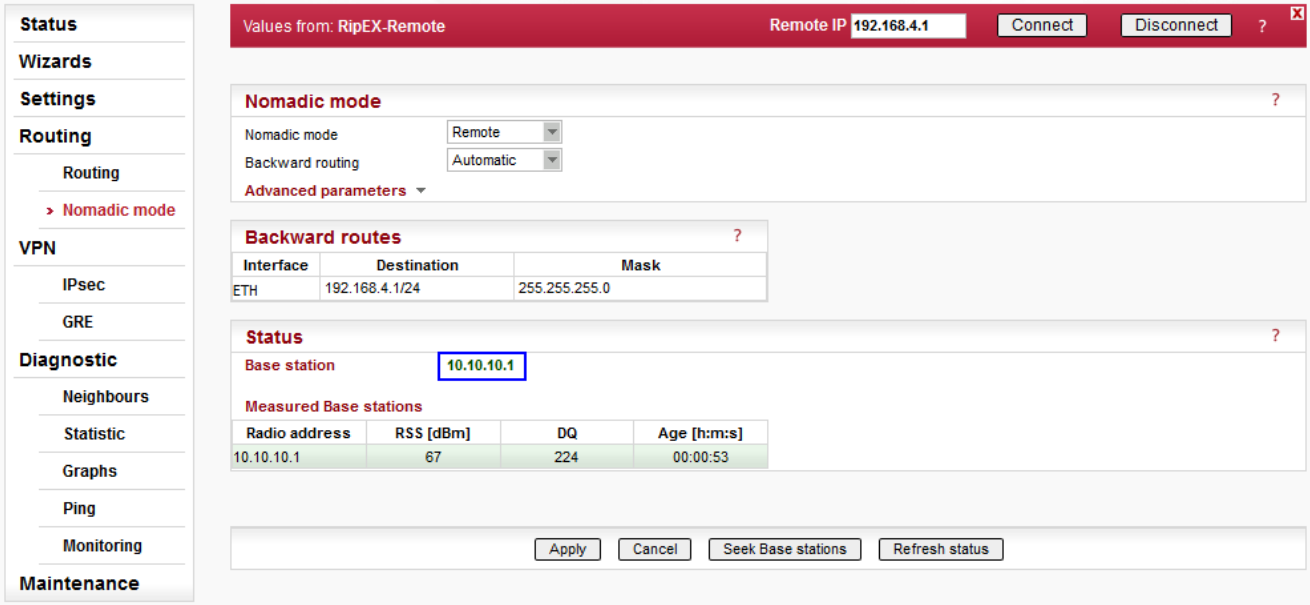

Fig. 2.20: Remote unit – Central unit selected as the best Base unit

The menu displays the central radio's IP for the selected Base unit. In the "Measured Base stations" table, there is only one entry. Currently, the Remote unit does not know about other Base units.

If the current Base station is not accessible for more than 120 seconds (there are no replies for data sent from Remote to this Base station), the "Base refresh period" is started to verify the Base accessibility. If the current Base is not accessible, a new "Seek" is started and a new Base is selected.

Click on the "Seek Base stations" button to start the process of selecting the best Base unit. The results might vary on your current signal values. Refresh the status and check the menu.

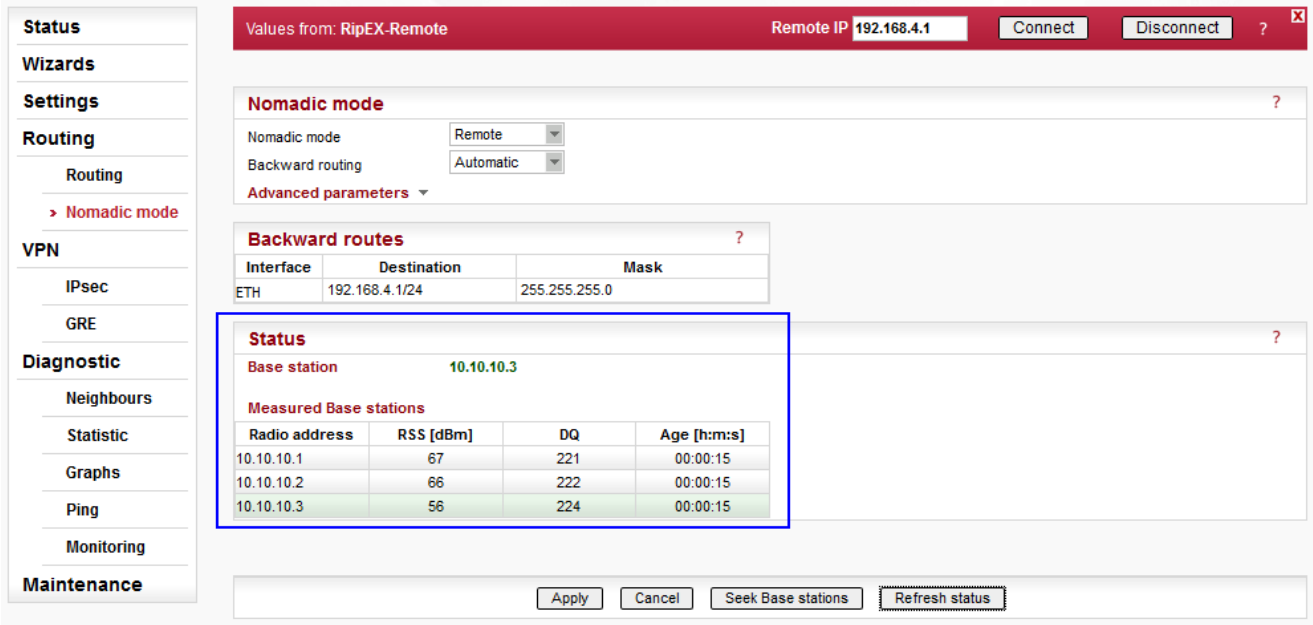

Fig. 2.21: Nomadic mode menu after seeking Base stations

The current Base station is the Base2 unit (10.10.10.3).

NOTE:
The algorithm changes the current Base unit only if the signal is more than 5 dBm better, otherwise it prefers the current one.

2.6.2. Base1 unit

A similar approach can be taken for Base1 unit. Turn off the RipEX-Center and RipEX-Base2 units. Press the “Seek Base stations” button in the Remote unit and check the status. The “Disconnected” status should be displayed.

In this scenario, the Remote will be communicating with the central unit directly, via one radio hop.

Fig. 2.22: Remote unit – Disconnected status

The reason is simple – at this time, there is no central unit, only one Base unit. Turn on the central unit and refresh the Remote’s status.

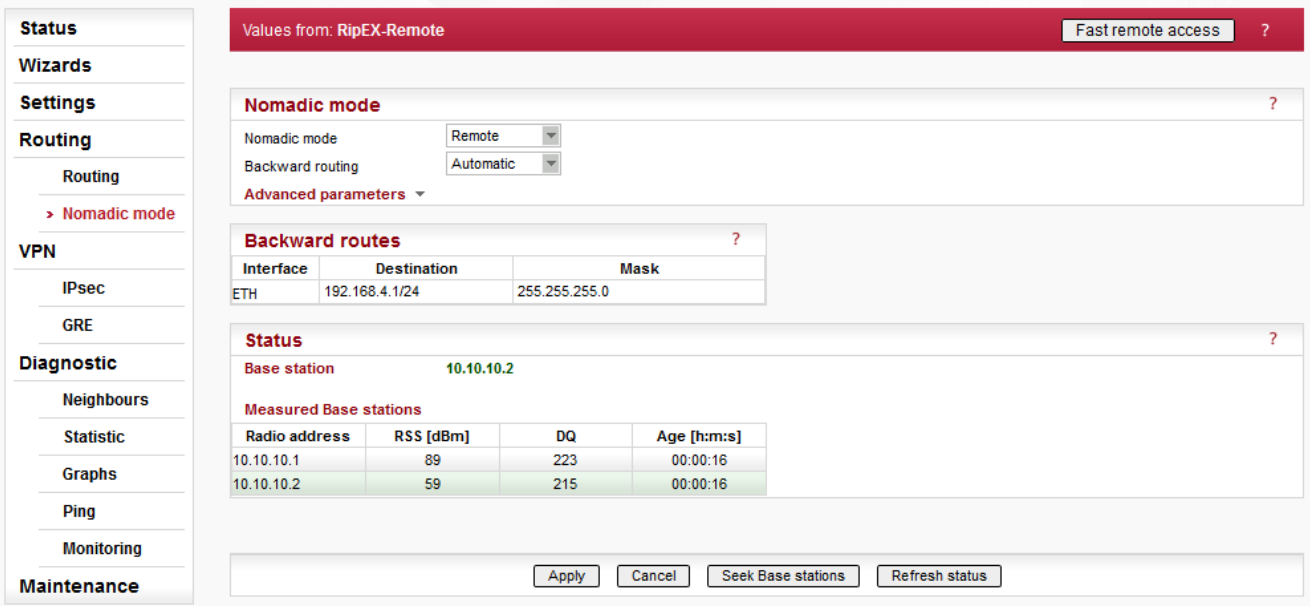

Fig. 2.23: Remote unit – Connected status

Verify the central unit accessibility via the Ping diagnostic tool.

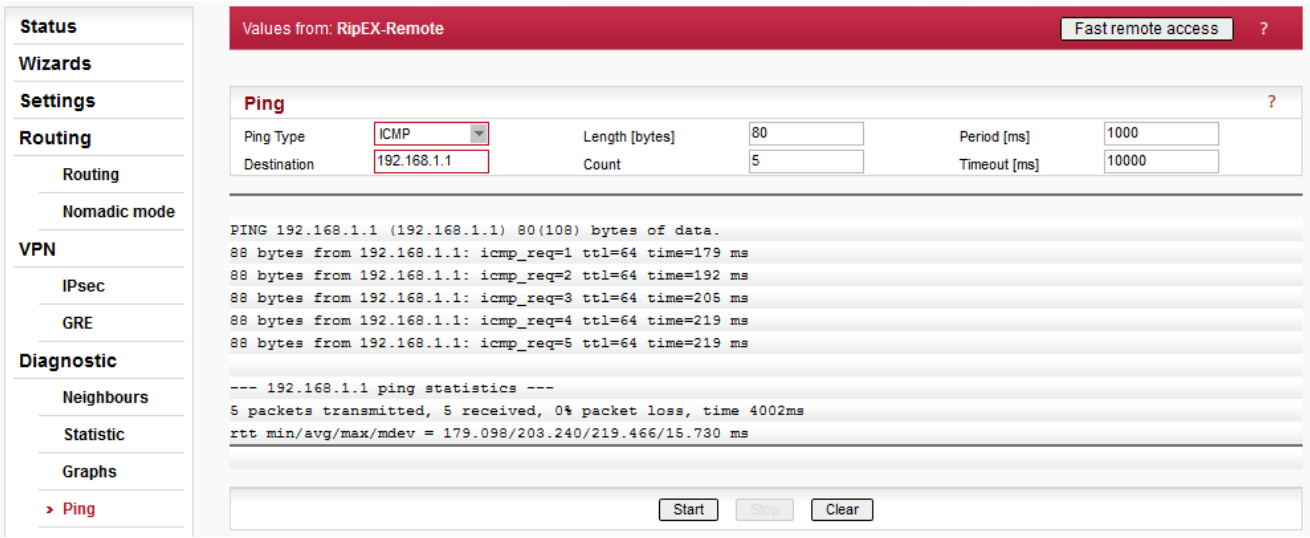

Fig. 2.24: Remote unit – Accessibility check

NOTE:
Follow the same principles and simulate the RipEX-Base2 selected as the best Base.

3. Nomadic Mode Overhead and Recommendations

The Nomadic mode edits the MTU, comparing it to the configured one on the Radio channel and decreasing this configured value by its 46B overhead. E.g. for the configured 1500B MTU, the actual MTU drops to 1454 Bytes.

The **RSS ping** works even in the Nomadic mode but does not display the measured RSS/DQ values. It does not display the current path because each packet is encapsulated into the tunnel.

Nomadic mode in relation to other RipEX services is described in *RipEX Manual*[1].

[1] http://www.racom.eu/eng/products/m/ripex/h-menu.html#nomad

4. Troubleshooting

- I have configured Router mode in RipEX unit, but I cannot configure Nomadic mode.

  Only the “Flexible” protocol supports the Nomadic functionality. You probably set up the Base Driven Protocol.

- I see three Base stations in the Remote unit, but the selected one does not have the best RSS/DQ values. Why is that?

  If the Remote is already connected to some Base unit, it reconnects to another Base unit only if the signal quality is at least 5 dBm better. Otherwise, it prefers the current Base. What is the RSS level difference? Have you tried to trigger a new “Seek” manually?

- I moved Remote unit to a different location and it cannot communicate with central unit any more.

  If the Remote is already connected to some Base unit, it reconnects to another Base unit only if the signal quality is at least 5 dBm better. Otherwise, it prefers the current Base. What is the RSS level difference? Have you tried to trigger a new “Seek” manually?

  Trigger the “Seek Base stations” manually so a new Base station can be selected, or

  wait until “Dead base timeout” is reached so the automatic seek is triggered.

  If there is no communication request, “Base refresh period” must time out before a new seek is triggered automatically.

  Is it in the radio coverage of at least one Base station?

- The Remote can only communicate with the central unit if it is connected directly. In case of connection over another Base unit, it does not communicate.

  Is this Base unit configured in the central unit? Each Base unit must be added manually.

  Does the Remote use “nomadic” routing rules? I.e. it dynamically changes its routes based on current connectivity conditions. Aren’t routes set statically to the central unit?

  Is the Remote really connected to the required Base? Trigger a manual “Seek” of Base units and verify the functionality.

5. CLI Commands

CLI interface (Command Line Interface) is an alternative to web access. You can work with the CLI interface in text mode using an appropriate client, either SSH (putty) or Telnet.

Please see more details in *RipEX Manual*[1].

See the Nomadic CLI commands:

- cli_status_nomad_show
  Display status of Nomadic mode

```
CLI(admin):~cli_status_nomad_show
Status of Nomadic mode:
Mode: remote
State: connected
Base: 10.10.10.2
Measured Base stations:
  Radio address: 10.10.10.1  RSS: 89dBm  DQ: 223  Age: 293s  Flag:
  Radio address: 10.10.10.2  RSS: 59dBm  DQ: 215  Age: 293s  Flag: selected
```

- cli_cnf_show_nomad
  Display configuration of Nomadic mode

```
CLI(admin):~$ cli_cnf_show_nomad
Nomadic mode: Remote (r)
Protocol message repeats: 2
Remote - Base quality samples: 3
Remote - Base seek slots: 8
Remote - Base refresh period: 3600 s
Remote - Base re-seek ratio: 24
Remote - Dead Base detection timeout: 120 s
Remote - Backward routing mode: Automatic (a)
```

- cli_cnf_show_nomad_backrts
  Display backward routes of Nomadic mode

```
CLI(admin):~$ cli_cnf_show_nomad_backrts
Backward routes:
1. Destination IP: 192.168.4.1    Destination mask: 24    Note:     Rule active: On (n)
```

- cli_cnf_show_nomad_bases
  Display list of Base stations of Nomadic mode

```
CLI(admin):~$ cli_cnf_show_nomad_bases
Base stations:
1. IP address: 192.168.2.1    Note: Base1 ETH    Item is active: On (n)
2. IP address: 10.10.10.3    Note: Base2 Radio    Item is active: On (n)
```

[1] http://www.racom.eu/eng/products/m/ripex/cli-conf.html

- cli_cnf_set_nomad_backrts
  Change backward routes of Nomadic mode

- cli_cnf_set_nomad_bases
  Change list of Base stations of Nomadic mode

- cli_nomad_force_seek
  Force Base station Seek in Nomadic mode (Remote)

- cli_nomad_reject_remotes
  Disconnect all locally connected Remotes in Nomadic mode (Base or Center)

- cli_cnf_set_nomad
  Change configuration of Nomadic mode

Run the CLI command with -h parameter for particular command options.

5.1. CLI-Only Configuration Parameters

Several advanced parameters can be configured via CLI only.

Center

Protocol message timeout

- Default = 5 s [0.1 - 25.5]
- Timeout for messages sent to Base
- Command example: “cli_cnf_set_nomad -msg-tout 10”

Base

Protocol message timeout

- Default = 5 s [0.1 - 25.5]
- Timeout for messages sent to Center. Service packet keeping the connection is sent after this timeout if there is no other communication running.
- Command example: “cli_cnf_set_nomad -msg-tout 10”

Reconnection speedup

- Default = 1 [1 no speedup - 15 max. speedup]
- The “Center refresh period” value is divided by this parameter to speedup reconnection.
- Command example: “cli_cnf_set_nomad -bs-speedup 2”

Remote

Base seek slots

- Default = 8 [3 - 32]
- Defines time period (measured in slots) to wait for Base response while searching for Base with the best signal. Higher number equals lower collision probability.
- Command example: “cli_cnf_set_nomad -seek-slots 12”

Base re-seek ratio

- Default = 24 [4 - 2047]
- Used to set time period between searches to establish Base station with the best signal strength instead of just current Base station verification.
- By default, one “Base refresh period” is 3600 seconds and this “base re-seek ratio” is 24, i.e. Seek Base stations once a day.
- Command example: “cli_cnf_set_nomad -rsk-ratio 48”

Appendix A. Revision History

Revision 1.0 2018-03-22

First issue