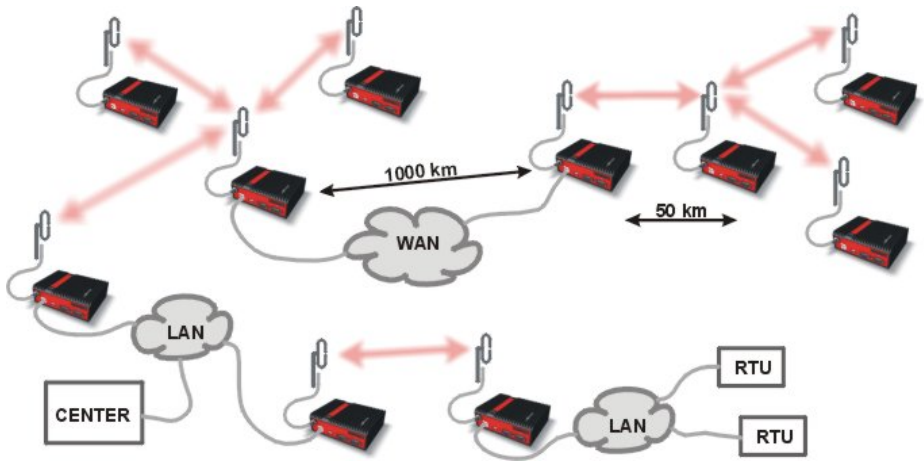
RACOM
RADIO DATA NETWORKS

Application notes



RipEX
Base Driven Protocol

version 1.1
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1. Introduction

Base Driven Protocol,

which is primarily optimized for TCP/IP (IEC104), is also suitable for collision networks when a remote is not be heard by other remotes and/or different Rx and Tx frequencies are used. All packet transmissions are managed by the local base station and distributed uniformly even when a high number of remotes are connected.

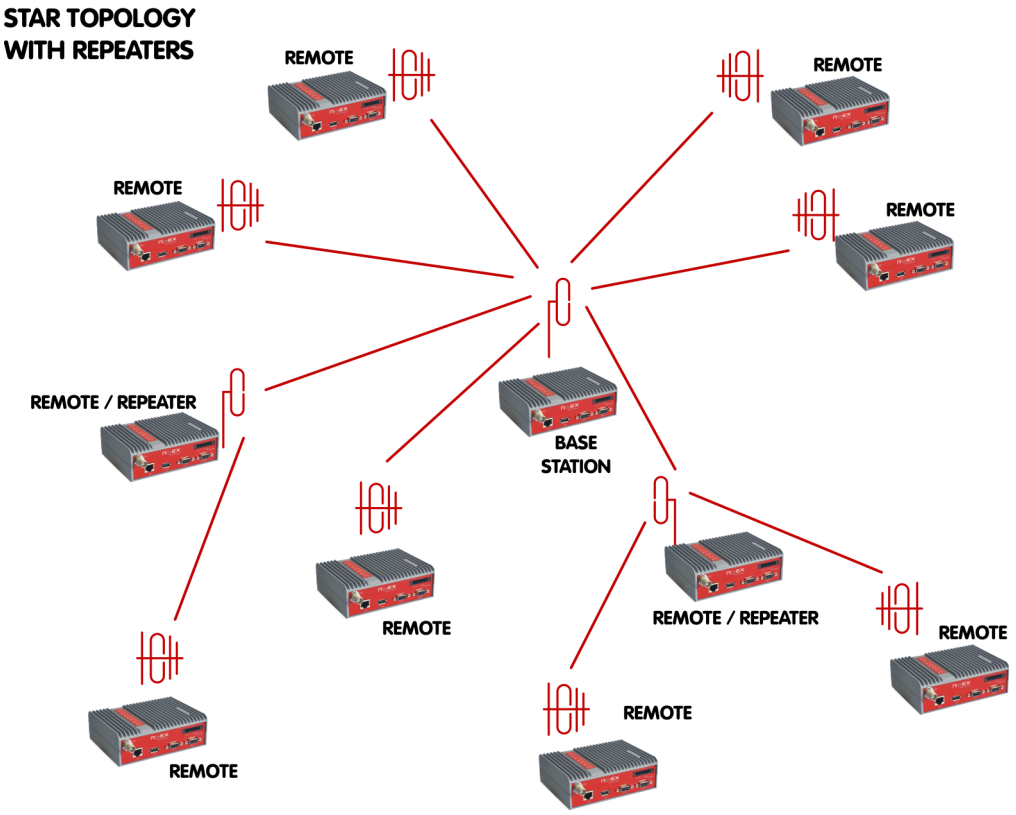

Fig. 1.1: Star topology with repeater

TCP/IP protocols like IEC104, used by modern RTUs, have historically created challenging problems because of limited throughput within narrowband radio data networks. Hence the reason RACOM has developed Base Driven protocol to solve the problem.

- TCP/IP transparent
- Optimized for IEC104
- No TCP errors
- No TCP disconnections

Tests confirm that the new RipEX 'Base Driven' protocol handles 5-10x more remotes under one base station and with higher reliability compared to others.

Hidden remotes

'Hidden remote' is a radio modem that is not heard by his neighbours. Modern SCADA networks are using more and more report-by-exception protocols, so 'hidden remotes' are creating problems, because

common protocols on Radio channel are mostly based on Listen Before Transmit or Carrier Sense Multiple Access principles. Different Rx and Tx frequencies create the same issue in the network. RACOM Base Driven solves these problems.

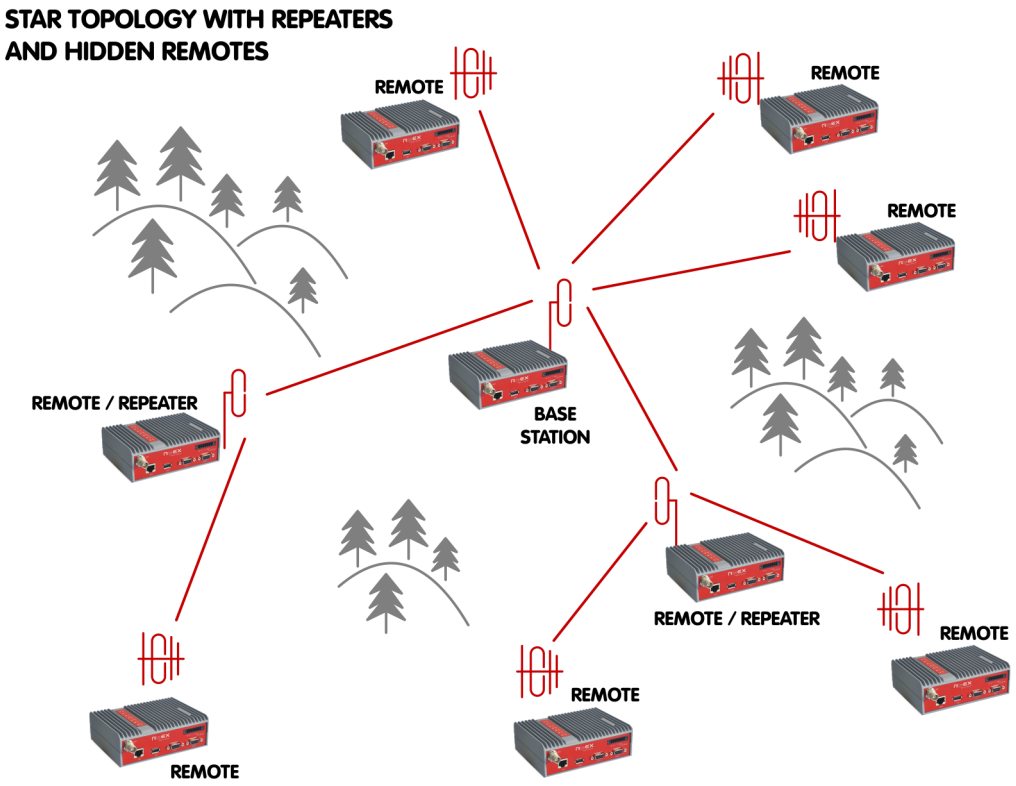

Fig. 1.2: Star topology with repeaters and hidden remotes

- No collisions even in difficult terrain
- Suitable when different Rx and Tx frequencies are used
- Fair access to Radio channel for all remotes
- Channel capacity distributed fairly amongst all remotes

RipEX Base Driven protocol is revolutionising narrowband radio networks! Total user data throughput is significantly higher, creating much improved levels of stability and reliability!

For more details, see:

- *RipEX manual*[1]
- Application note *Address planning*[2]
- The following configuration example

[1] http://www.racom.eu/eng/products/m/ripex/index.html
[2] http://www.racom.eu/eng/products/m/ripex/app/routing.html

2. Configuration Example

In this chapter, we will explain the functionality of Base Driven Protocol. Some aspects were explained in Application notes *Address planning*[1] and *Channel access*[2]. See them before continuing this configuration example.

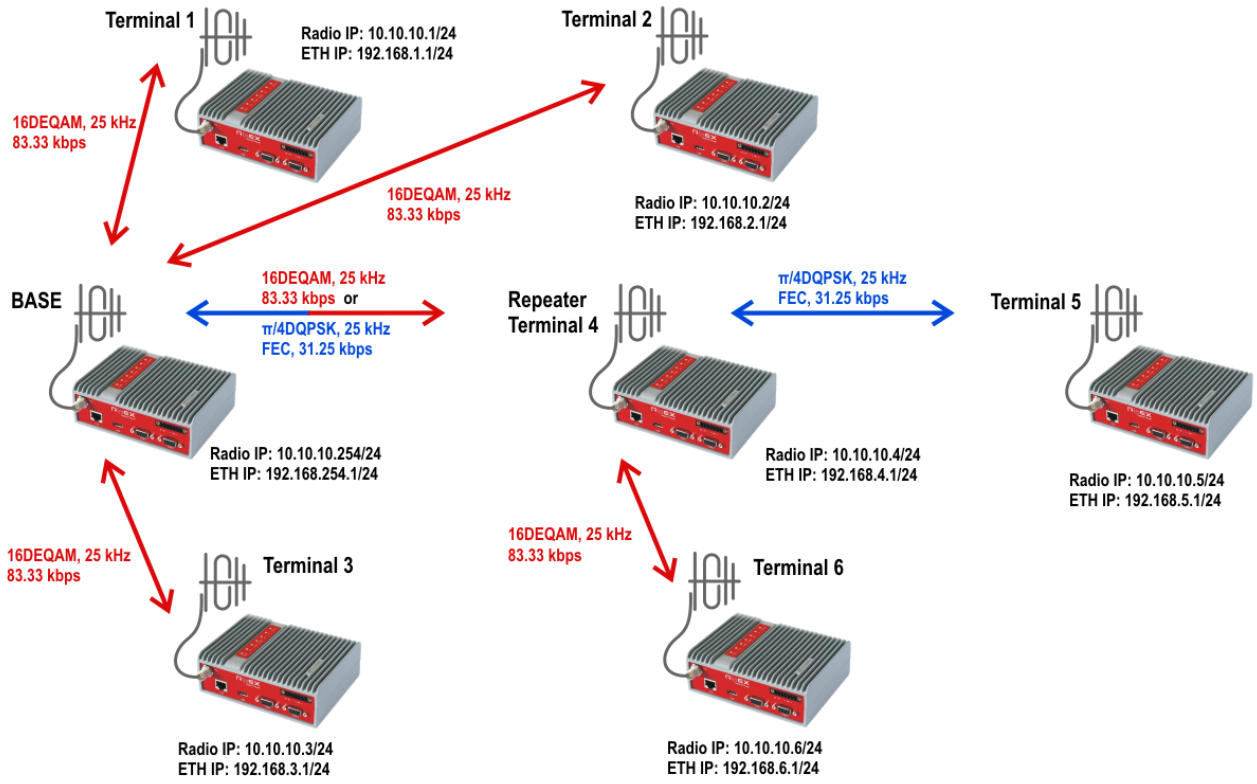

Fig. 2.1: Base driven protocol example topology

The topology consists of one Base station (there can only be one) and 6 terminals (remote RipEX units). One of these terminals serves as a repeater for other two.

From the configuration point of view, we have only two types of units.

- Base
- Remote

There is no “repeater” configuration in Terminal 4. The terminal itself is configured in the exact same way as Terminals 5 and 6. The communication is managed by the Base station which forwards data either directly or via this repeater.

Since the firmware 1.6, RipEX units can also be configured with various modulation rates for individual links. In this example, we configure the highest modulation rate for all links except the link to RipEX terminal 5 (e.g. because there is a bad signal quality). This link is set to use the π/4DQPSK modulation and has FEC enabled.

[1] http://www.racom.eu/eng/products/m/ripex/app/routing.html
[2] http://www.racom.eu/eng/products/m/ripex/app/access.html

Note

If the Base station communicates with Terminal 5, it uses the π/4DQPSK modulation even for the hop between the Base and Repeater, not only for the link between Repeater and Terminal 5.

All units are configured with a Radio IP address within 10.10.10.0/24 subnet. The Ethernet subnets are different for each unit. Each RipEX has the Ethernet address equal to 192.168.x.1/24 where “x” the last digit of its Radio IP address (i.e. Protocol address).

There is no other special functionality configured in this example, such as Modbus TCP, ARP Proxy, TCP Proxy or Protocol server. The Base driven protocol (BDP) is suitable for transparent TCP traffic and thus, only the correct routing is required.

Note

All features are configurable both in the Flexible and Base driven protocols; the Backup routes functionality is only available in the Flexible protocol.

If more than one repeater is required for the remote unit reachability, the Flexible mode should be used or another RipEX unit connected “back-to-back” via switch is necessary creating another BDP network on its own frequency. There cannot be any radio overlap for several BDP networks (i.e. only one Base station can be in the radio coverage).

2.1. BASE Station configuration

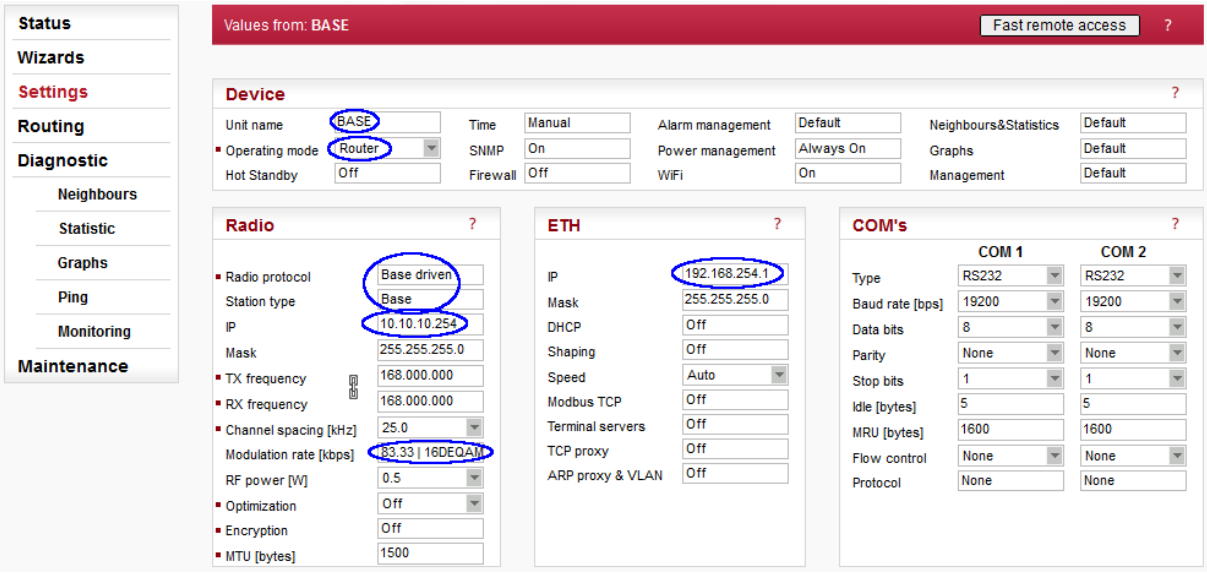

Fig. 2.2: Base station Settings

The Base station must be configured in the following way:

- Name: BASE (no functionality influence)
- Operating mode: Router
- Radio protocol: Base driven
- Station type: Base
- Radio IP: 10.10.10.254/24
- Ethernet IP: 192.168.254./1/24

- Modulation rate: 16DEQAM

Once you open the Station type configuration, a detailed configuration for all remote units is available:

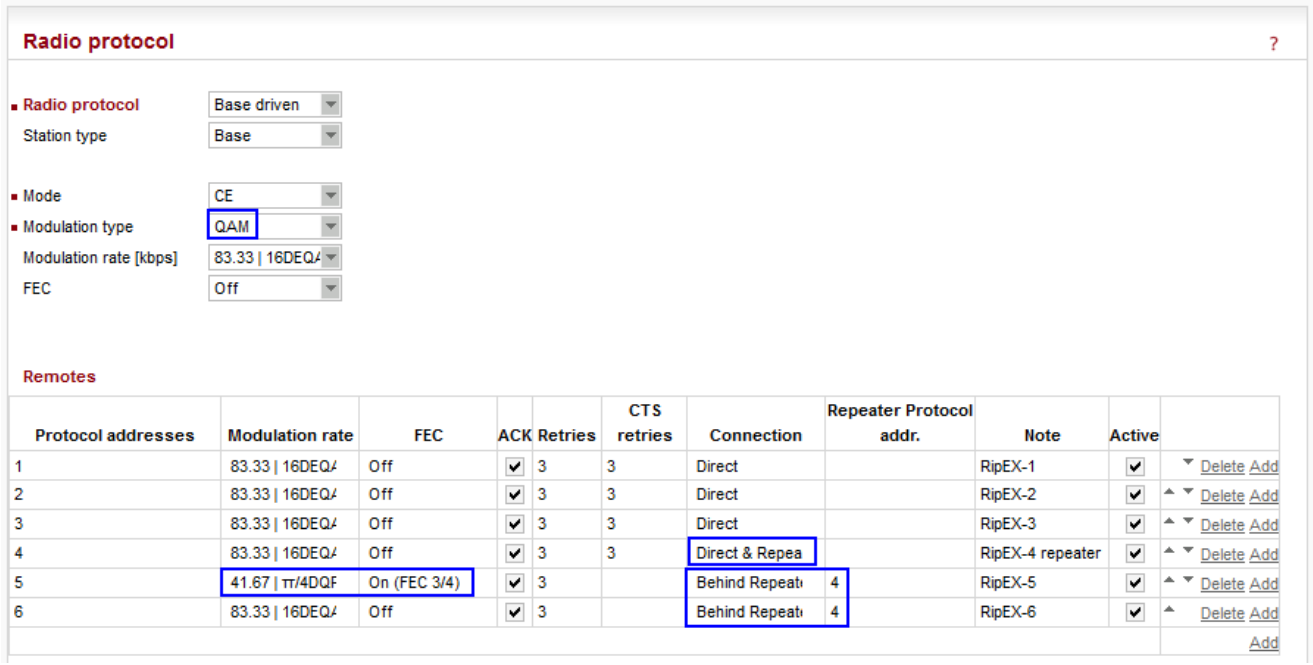

Fig. 2.3: Base station protocol configuration

Modulation type is set to “QAM” which enables communication with terminals using any modulation within this type (16DEQAM, D8PSK, π/4DQPSK or DPSK).

In the “Remotes” table, the individual configuration for each Terminal must be done. Notice the 41.67 kbps modulation rate and enabled FEC used for Terminal 5 (bad condition simulation). Three terminals (1-3) are configured with a “Direct” connection. This means that all of them are reachable directly and not via repeater and are not used for repeating data for other terminals.

On contrary, Terminal 4 is set as “Direct & Repeater” so it forwards data for other terminals. In this example, it forwards data for terminals 5 and 6 (see the particular lines) – both terminals are configured with a “Behind Repeater” connection type and they use the repeater with a protocol address 4. There could be more repeaters so this number is important.

Note

Three “basic” direct terminals (1, 2 and 3) can be configured on a single line – the Protocol addresses column would be set as “1 – 3”. Otherwise the configuration is the same.

While this configuration is fully sufficient for Radio communication and any serial protocol communication (using the Radio IP addresses), we need to configure the Routing rules for all Ethernet subnets. Go to the Routing menu and configure the Base station.

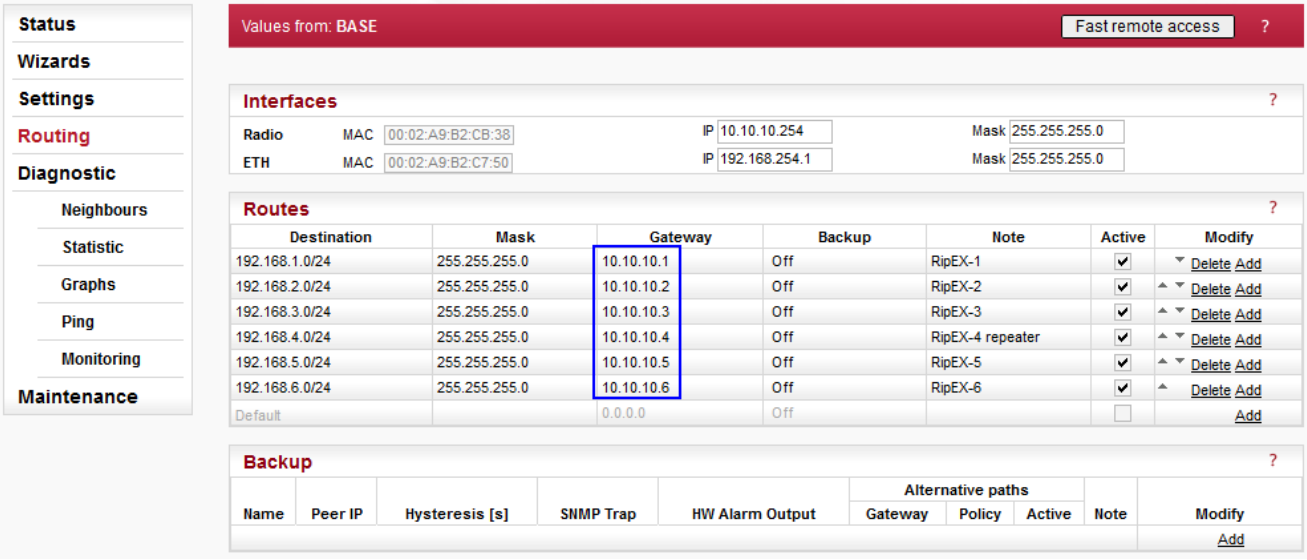

Fig. 2.4: Base station Routing menu

If you are familiar with a regular routing or/and routing in the Flexible mode, these rules might be a bit confusing. First four lines are OK, but in the Flexible mode, the routes for 192.168.5.0/24 and 192.168.6.0/24 would use the 10.10.10.4 Radio IP address as the gateway. This knowledge is already set by the “repeater” functionality within the BDP configuration. This results in a gateway configuration as they were also connected directly (gateways set to 10.10.10.5 and 10.10.10.6). But the BDP mechanism sends data for these networks via the configured repeater (10.10.10.4).

Once you finish this configuration, the Base station starts to communicate rapidly (see the TX LED diode on the unit). This is caused by the BDP mechanism. The Base station controls/manages all the communication within the network and checks the statuses of all remotes in very quick rounds (tens of milliseconds). If any DATA transmission is ready (any RipEX has packet in its queue for the Radio channel), it enables this communication in a very precise time slot minimizing any “waiting” period and utilizing the Radio channel for maximum. Due to this behaviour, there is always communication on the Radio channel even though there is no application data. In the Flexible mode, there is no data traffic in such situations, but collisions happen while in the BDP there is not a single collision on the Radio channel – i.e. the important jitter parameter is minimal (important for many TCP applications).

2.2. Repeater Station Configuration

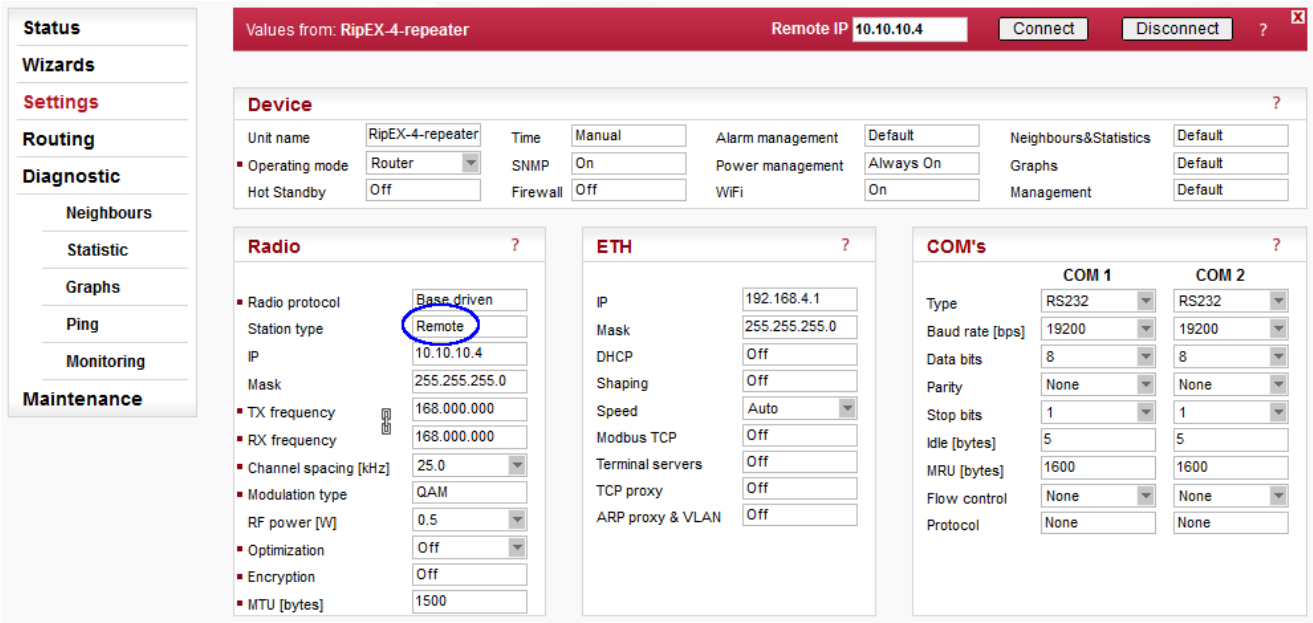

Fig. 2.5: Repeater station Settings

All other RipEX units must be configured following the IP addresses depicted in the topology diagram and the Station type must be “Remote”. Open this menu and configure the details:

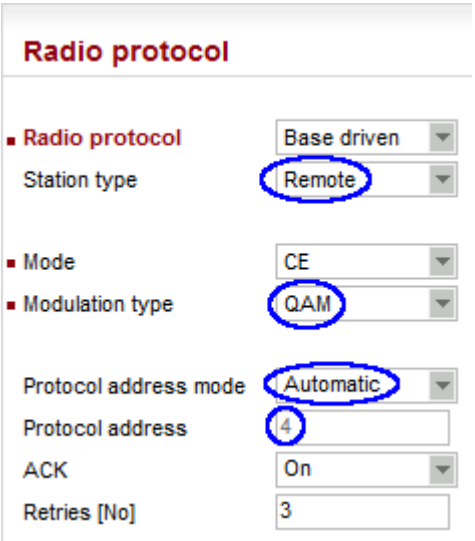

Fig. 2.6: Repeater station Protocol conf iguration

Terminal stations are not set with a particular Modulation, but only with a “type”. The exact modulation is set in the Base station. The Protocol address mode can be either “manual” or “automatic”. If the automatic method is set, the Protocol address is set to the last Radio IP digit (i.e. 10.10.10.4 -> 4).

The last step is to configure the static route back to the Base station’s Ethernet subnet.

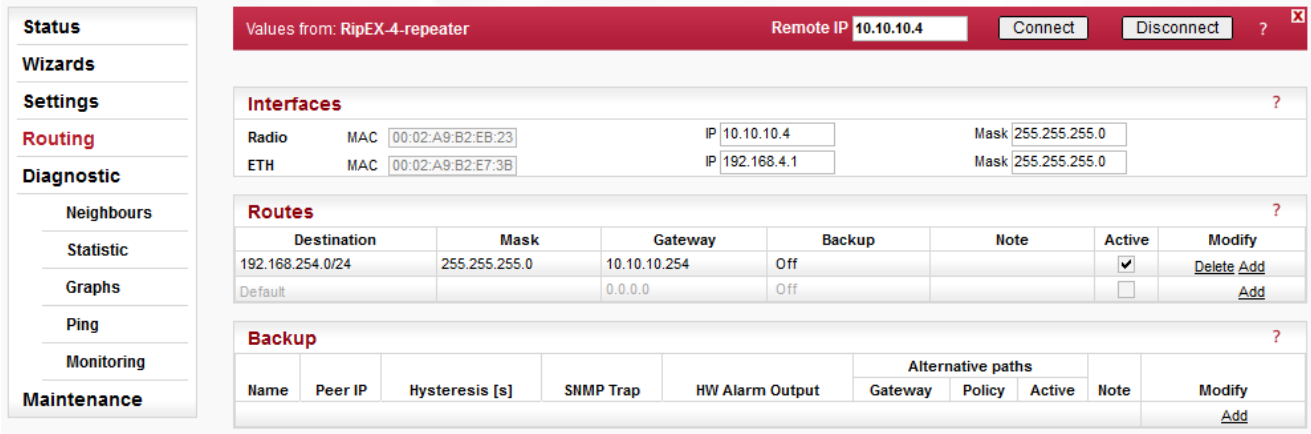

Fig. 2.7: Repeater station Routing rules

The only rule required is to the Base station. If the communication among any Ethernet subnets of any Remote RipEX units is necessary, add other static routes – all rules must use the same gateway 10.10.10.254 (Base), because complete communication goes over the Base station and not directly among individual Remote units.

Remote Stations Configuration

As already mentioned, the configuration is completely the same for all Remote stations, no matter if it is or it is not a repeater. Save the Repeater configuration into the file and upload it to other remote units. Only remember to change the Radio and Ethernet IP addresses! The rest of the configuration parameters are the same.

3. Configuration Verification

To verify the communication, you can do some of the following simple tests:

1. Run the **RSS/ICMP tests** (Diagnostic -> Ping) for a remote RipEX / connected device accessibility. Run this ping from the Base station to any Remote station or vice versa (or end device connected to the Base station to end device connected to any Remote RipEX unit). The explained configuration does not allow Remote to Remote communication (but otherwise, it is configurable).

```
RSS Ping from 10.10.10.254 to 10.10.10.6, size:80+43(+trace)
115 bytes from 10.10.10.6: seq=1 rtt=0.197s
   10.10.10.254-->10.10.10.6 :82/223[RSS/DQ]-->10.10.10.6
   10.10.10.6-->10.10.10.254 :82/207[RSS/DQ]-->10.10.10.254
```

Fig. 3.1: RSS Ping over repeater

Note that the shown RSS ping output does not display all four hops even though data go over the repeater. For the BDP, it seems like two hops. See the diagram below displaying four hops of the RSS ping. In the Fig 14.10, we can see the RSS/DQ link quality information two times, but there are four hops actually. The link quality information is displayed only for the final hop in each direction. In this example, it is a second hop from the Repeater (10.10.10.4) to Terminal 6 (10.10.10.6) and a fourth hop from the Repeater (10.10.10.4) to the Base unit (10.10.10.254).

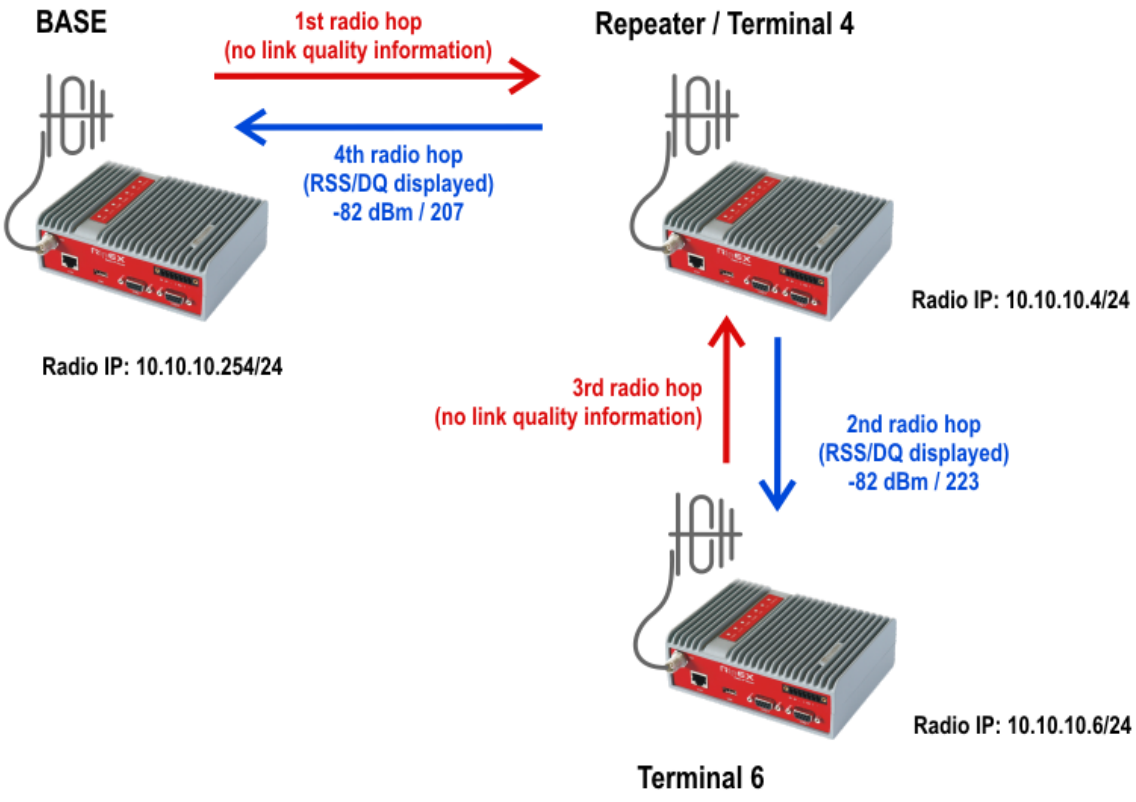

Fig. 3.2: RSS ping in detail

2. **Check the modulation rate** used for a particular link (Diagnostic -> Monitoring). Enable the Monitoring for the Radio link and check the RADIO interface. Choose to capture the Radio link headers and limit the Length of packets to 0 Bytes (it is not useful now to see the data payload). Find the “MC” parameter in the Radio headers.

   TX Modulation and Coding ((MC:00))
   - [7..4] Modulation Select Nibble
     - 0x0 = 2-CPFSK (default)
     - 0x1 = 4-CPFSK
     - 0x8 = DPSK
     - 0x9 = pi/4-DQPSK
     - 0xA = 8DPSK
     - 0xB = 16-DEQAM
   - [3..0] Coding Select Nibble
     - 0x0 = FEC Off (default)
     - 0x1 = FEC On

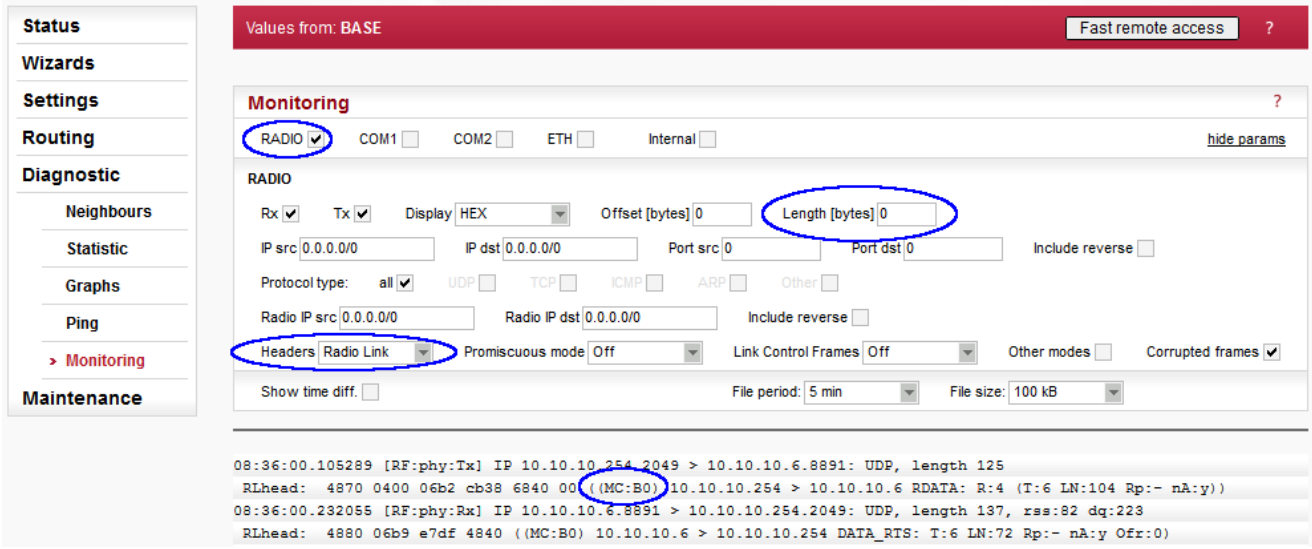

Fig. 3.3: Radio channel Monitoring – Modulation rate (B – 16DEQAM, 0 – no FEC)

3. Run any **TCP application** over the network and check its functionality.

4. Check the Statistics and Neighbours menu for Diagnostic purposes – you should be able to see all Remote stations on the Base station which are within the Radio coverage – with a data statistics and several watched values such as temperature or voltage of these remote stations.

4. Summary

Base driven protocol is suitable and optimized for any RipEX network in a star topology with up to one repeater on each link. The highest benefit is its optimized behaviour for TCP traffic such as IEC104 – minimizing the jitter, utilizing the channel bandwidth much more efficiently and not causing a single collision on the Radio channel.

Do not hesitate to contact us if you have any questions:

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Appendix A. Revision History

Revision 1.0 2017-11-29
First issue

Revision 1.1 2017-12-14
Added *test example*