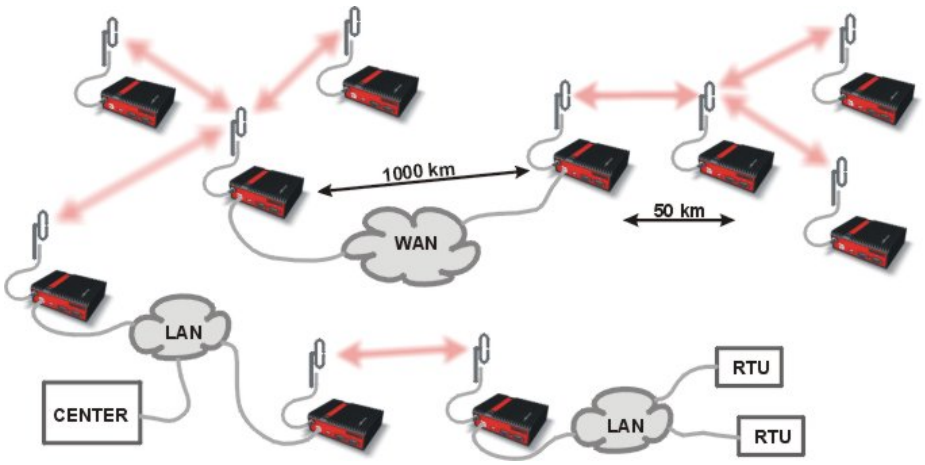
RACOM
RADIO DATA NETWORKS

Application notes



RipEX
Address Planning

version 1.0
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RACOM s.r.o. • Mirova 1283 • 592 31 Nove Mesto na Morave • Czech Republic
Tel.: +420 565 659 511 • Fax: +420 565 659 512 • E-mail: racom@racom.eu

www.racom.eu

Table of Contents

Address planning

Since the firmware 1.6, the Router mode consists two different protocols. The original one is now called "Flexible protocol"; the new protocol is called "Base driven protocol".

In the Flexible Router mode standard IP routing is used between individual RipEX radio modems and their interfaces. The only non-standard feature is that even if you assign all RipEX's radio interface IP addresses to a single network, the RipEX's may not "hear" each other over the radio channel; therefore, routing tables should include even routes within the same network (over repeaters).

In the Base driven Router mode (BDP), all traffic over the Radio channel is managed by the Base station. All frames inside the radio network have to be routed through the Base station. Appropriate routing has to be set. Any Remote can work as a Repeater for another Remote. Only one Repeater is possible between Base station and Remote, however a number of Remotes can use the same Repeater.

BDP is optimized for TCP/IP, especially for IEC104 - stable response times with minimum jitter.

This Application Note draws attention to certain situations in which routing tables can be simplified significantly.

1. End devices connected via serial interface

1.1. Flexible Protocol

Every RipEX radio modem has two network interfaces, and hence two IP addresses. First is the Ethernet interface, second the radio interface. Serial interfaces are defined by their UDP port and are shared for the entire RipEX modem; as a result both RipEX IP addresses can be used to access them (both IP addresses work equally well).

The destination IP address of a packet received via the serial interface is determined inside the radio modem from the "SCADA address" depending on the protocol used, either using a mask or table (see RipEX manual, Adv. config., Protocols[1]). The source IP is generated similarly.

If all devices are connected to RipEX's via serial interface, it is helpful to only use the radio IP addresses for translation and routing of data. Ethernet IP addresses may be assigned randomly (you could keep their defaults, however we recommend setting Ethernet addresses similar to radio IP addresses to keep things organised). Remote service access over the radio channel is also possible via the IP addresses of the radio interface.

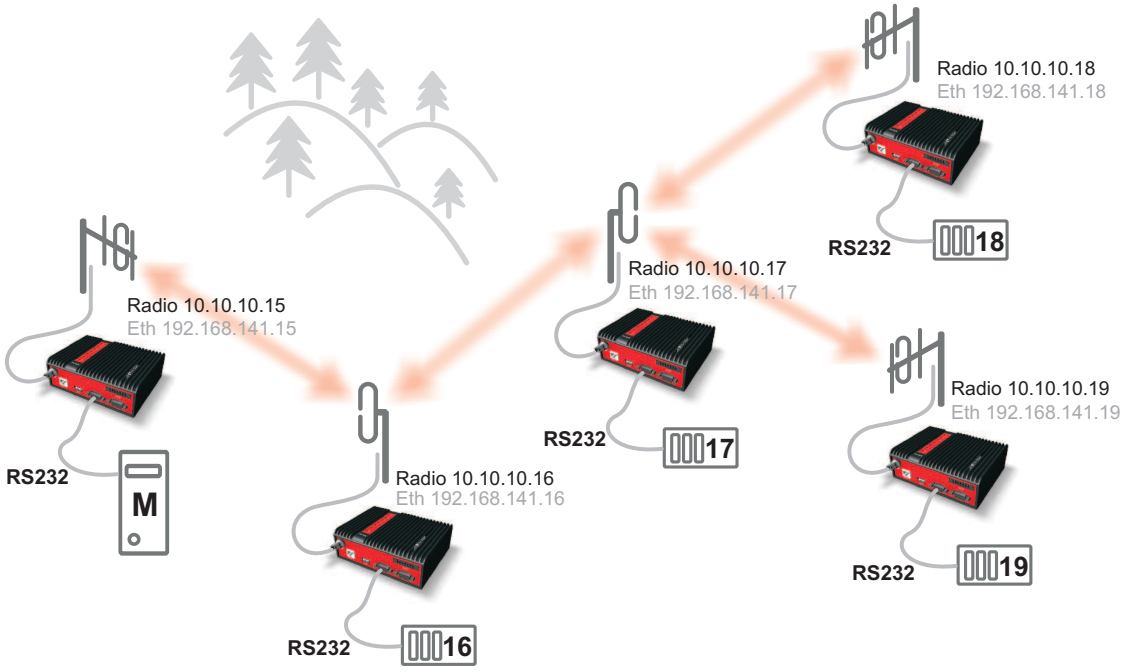


Fig. 1.1: Network 1

The following paragraph shows routing tables for individual radio modems which enable mutual communication between all devices. All destinations share the mask 255.255.255.255, i.e. 10.10.10.xx/32, interface Auto or Radio:

- For 10.10.10.15

```
Destination via Gateway
10.10.10.17 via 10.10.10.16
```

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

```
10.10.10.18 via 10.10.10.16
10.10.10.19 via 10.10.10.16
```

- For 10.10.10.16

```
10.10.10.18 via 10.10.10.17
10.10.10.19 via 10.10.10.17
```

- For 10.10.10.17

```
10.10.10.15 via 10.10.10.16
```

- For 10.10.10.18

```
10.10.10.15 via 10.10.10.17
10.10.10.16 via 10.10.10.17
10.10.10.19 via 10.10.10.17 (this record is only necessary if you require
                             communication between end devices 19 and 18)
```

- For 10.10.10.19

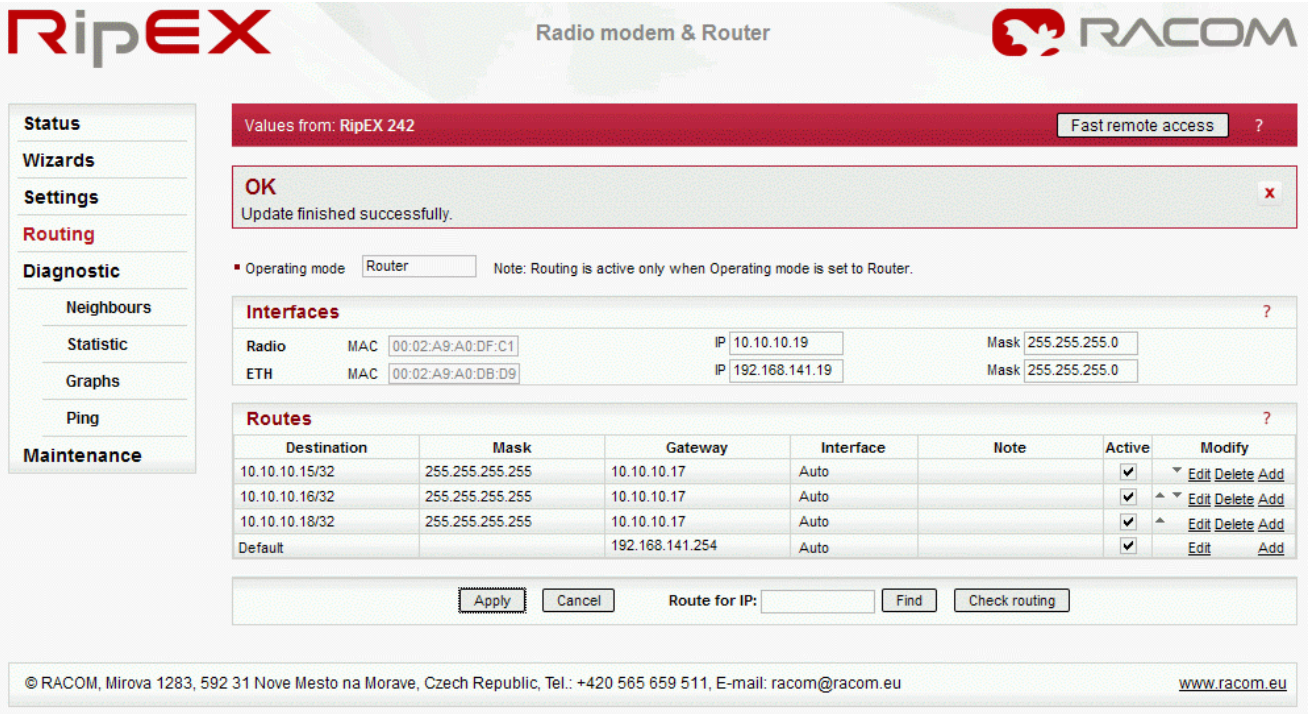
```
10.10.10.15 via 10.10.10.17
10.10.10.16 via 10.10.10.17
10.10.10.18 via 10.10.10.17 (this record is only necessary if you require
                             communication between end devices 19 and 18)
```

To display the full routing table type "ip route show table normal" in CLI interface

- For 10.10.10.19

```
10.10.10.15 via 10.10.10.17 dev radio  proto static
broadcast 10.10.10.0 dev radio  proto static  scope link  src 10.10.10.19
broadcast 10.10.10.255 dev radio  proto static  scope link  src 10.10.10.19
10.10.10.16 via 10.10.10.17 dev radio  proto static
10.10.10.18 via 10.10.10.17 dev radio  proto static
10.10.10.0/24 dev radio  proto static  scope link
192.168.141.0/24 dev eth0  proto static  scope link
default via 192.168.141.254 dev eth0  proto static
```

An example of a routing table on page Routing for 10.10.10.19



If SCADA device addresses can be chosen arbitrarily, routing can be significantly simplified when radio IP addresses can be grouped to subnets according to radio network layout.

One example of simplification is shown with repeaters connecting to separate subnets. The routing table can then contain a single record for all devices on the subnet.

In this example the first repeater connects to subnet 10.10.10.0/29, i.e. devices may have addresses from 10.10.10.1 to 10.10.10.6 (10.10.10.0 is reserved for the subnet, address 10.10.10.7 for broadcasting).

See e.g. http://www.subnet-calculator.com/subnet.php?net_class=A

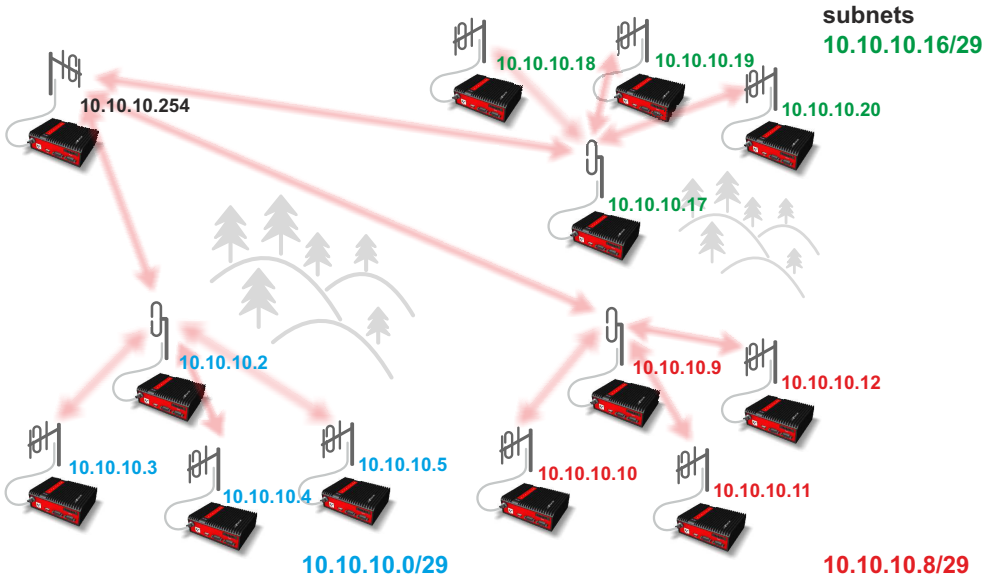


Fig. 1.2: Network with subnets

- For 10.10.10.254

```
Destination subnet via Gateway
10.10.10.0/29  via 10.10.10.2
10.10.10.8/29  via 10.10.10.9
10.10.10.16/29 via 10.10.10.17
```

- For 10.10.10.2 (subnet 10.10.10.0/29)

```
10.10.10.8/29  via 10.10.10.254
10.10.10.16/29 via 10.10.10.254
```

- For 10.10.10.3 and 10.10.10.4 and 10.10.10.5

```
10.10.10.248/29 via 10.10.10.2
10.10.10.8/29   via 10.10.10.2
10.10.10.16/29  via 10.10.10.2
```

- For 10.10.10.9 (subnet 10.10.10.8/29)

```
10.10.10.0/29 via 10.10.10.254
10.10.10.16/29 via 10.10.10.17
```

- For 10.10.10.10 and 10.10.10.11 and 10.10.10.12

```
10.10.10.248/29 via 10.10.10.9
10.10.10.0/29   via 10.10.10.9
10.10.10.16/29  via 10.10.10.9
```

- For 10.10.10.17 (subnet 10.10.10.16/29)

```
10.10.10.0/29  via 10.10.10.254
10.10.10.8/29 via 10.10.10.9
```

- For 10.10.10.18 and 10.10.10.19 and 10.10.10.20

```
10.10.10.248/29 via 10.10.10.17
10.10.10.0/29   via 10.10.10.17
10.10.10.8/29   via 10.10.10.17
```

1.2. Base Driven Protocol

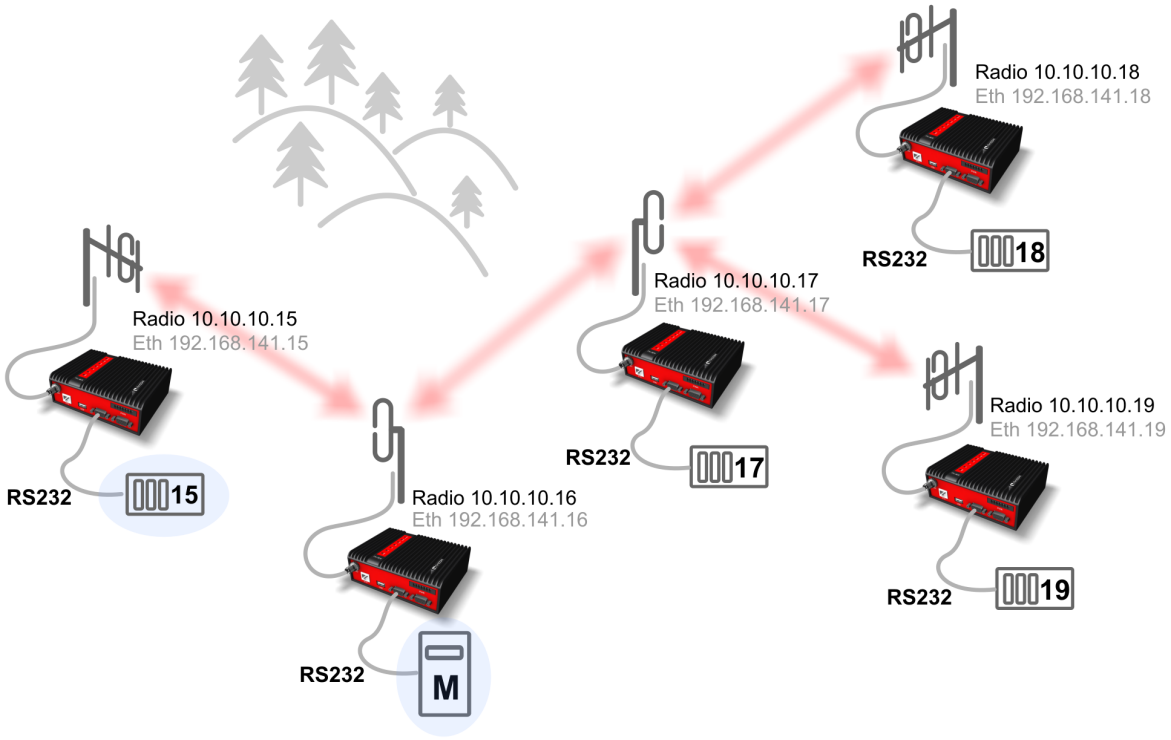


Fig. 1.3: Network 1

The BDP must be configured as a STAR topology with up to 1 repeater for any remote. I.e. It is not possible to configure RipEX 10.10.10.15 as a Base station, because remote RipEX units 10.10.10.18 and .19 would go over two repeaters (3 hops). For this topology, RipEX 10.10.10.16 or .17 could be used as a Base station (up to 2 hops to any remote unit). The example uses RipEX 10.10.10.16 as a Base station.

While using BDP, there is no need to configure any Routing in the Base or Terminal RipEX modem. Everything is set in the Base Settings menu. See the Base station Protocol configuration below:

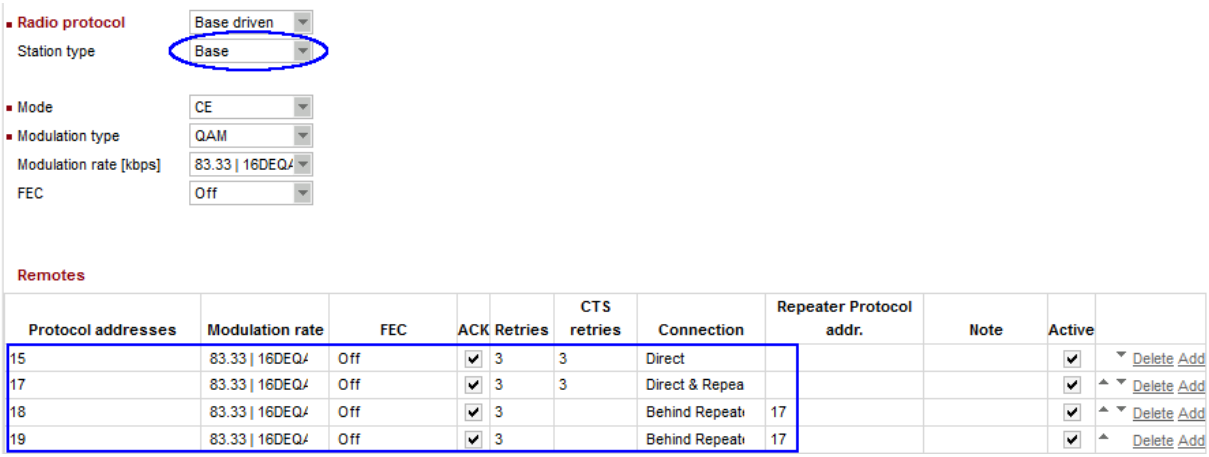


Fig. 1.4: Protocol configuration - Base station

Remote unit 15 - this unit is reachable directly (one hop)

Remote unit 17 - this unit is reachable directly (one hop) AND is used as a repeater for other remote units
Remote units 18 and 19 - both units are reachable via the Repeater unit (17)

All remote units have the same configuration except the Radio/ETH IP address. The Protocol address equals the last digit of the Radio IP address and thus, "automatic" protocol address can be used. There is no need to configure any routing, everything is managed by the rules in the Base station (no matter if the remote unit is the repeater or simple terminal).

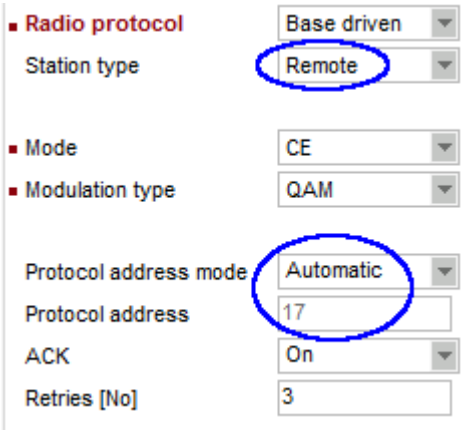


Fig. 1.5: Protocol configuration - Remote station

Important

This configuration enables the communication between the Base station and all Remote units (terminals). If the communication among individual remote units is required, the Routing rules must be added in the Routing menu of all Remote units. All the static routes will use the Base Radio IP as a gateway, because all data must go through this Base station (not directly Remote to Remote as in the Flexible mode!). E.g. See the RipEX 10.10.10.19 Routing table:

Routes

Destination	Mask	Gateway	Backup	Note	Active	Modify
10.10.10.15/32	255.255.255.255	10.10.10.16	Off		☑	Delete Add
10.10.10.17/32	255.255.255.255	10.10.10.16	Off		☑	Delete Add
10.10.10.18/32	255.255.255.255	10.10.10.16	Off		☑	Delete Add
Default		0.0.0.0	Off		☐	Add

Fig. 1.6: Advanced Routing rules - Remote station

Note

For example the communication between RipEX 10.10.10.19 and 10.10.10.18 would not only go via Repeater 10.10.10.17, but also via the Base station. Prefer the Flexible mode in case that a lot of remote to remote communication is required and higher jitter or lower payload bitrate is not an issue for your application.

The following example explains the second scenario from the 1.1.1 Chapter, but configured using BDP.

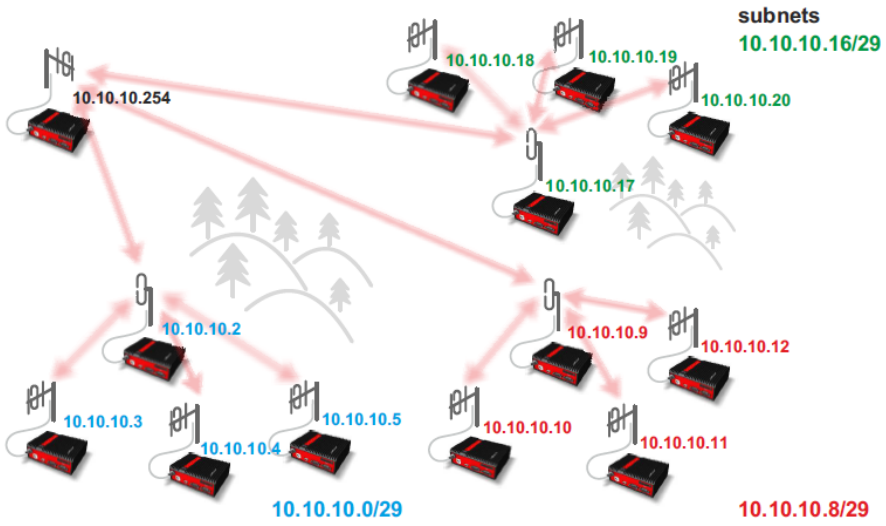


Fig. 1.7: Network 2

In this topology, the Base station can have just one rule to a group of remote units behind a particular repeater instead of configuring them separately. See the Base station configuration:

Remotes

Protocol addresses	Modulation rate	FEC	ACK	Retries	CTS retries	Connection	Repeater Protocol addr.
2	83.33 | 16DEQA	Off	✔	3	3	Direct & Repea	
3 - 5	83.33 | 16DEQA	Off	✔	3		Behind Repeat	2
9	83.33 | 16DEQA	Off	✔	3	3	Direct & Repea	
10 - 12	83.33 | 16DEQA	Off	✔	3		Behind Repeat	9
17	83.33 | 16DEQA	Off	✔	3	3	Direct & Repea	
18 - 20	83.33 | 16DEQA	Off	✔	3		Behind Repeat	17

Fig. 1.8: Protocol configuration - Base station

For each /29 subnet, we have two rules. One rule for the repeater itself and then a group of remote units reachable via this repeater.

All the remotes have the same configuration as in the previous example, just automatic Protocol address based on the last digit of the Radio IP. No routing required.

2. End devices connected over Ethernet

2.1. Flexible Protocol

Both radio modem's network interfaces must be used for routing. Radio modem routing works the same as standard IP routing – for more information refer to http://www.comptechdoc.org/independent/networking/guide/netguide.pdf chapter Network Routing.

Limitations:

A. **If you can set the IP address, network mask, gateway and routing table in the IP device connected to RipEX**
There are no limitations to setting up routing in this case. The only rule is that the range of radio and Ethernet IP addresses must not overlap.

B. **If you can only set the IP address, network mask and gateway, not the routing table in the IP device connected to RipEX**
In this case destination addresses must not be on the same network (i.e. the destination address must always be outside of the network mask). A destination address is the IP address of one of the devices connected to RipEX's which mutually communicate over the radio channel.

C. **If the connected device allows neither network mask, nor gateway to be set up**
Router mode cannot be used at all; use Bridge mode instead.

Important

In both B and C options, the functionality called "ARP Proxy" can be used so even the devices within the same subnet with no routing options, can be interconnected via the RipEX network utilizing the Router mode (Flexible or/and Base driven).

2.2. Base Driven Protocol

There is one significant routing difference using the Base driven protocol compared to the Flexible one:

All communication is managed by the Base station

- Any routing from the Remote station back to the Base station or to any other Remote station MUST use the Radio IP of the Base station itself - no matter if it is or it is not behind a repeater.
- Example: RipEX1 is a base station and communicates with RipEX3 (terminal) over RipEX2 (repeater). RipEX3 configures the route back to the Base station's ETH subnet not via the Radio IP of RipEX2 (repeater), but via the Radio IP of RipEX1 (base). The communication is managed by the Base station which actually forwards the data over the RipEX2 repeater, but RipEX3 (terminal) does not need to "know" about this. RipEX3 "considers" itself to be in a direct reachability with RipEX1 (Base). See the simple example below:

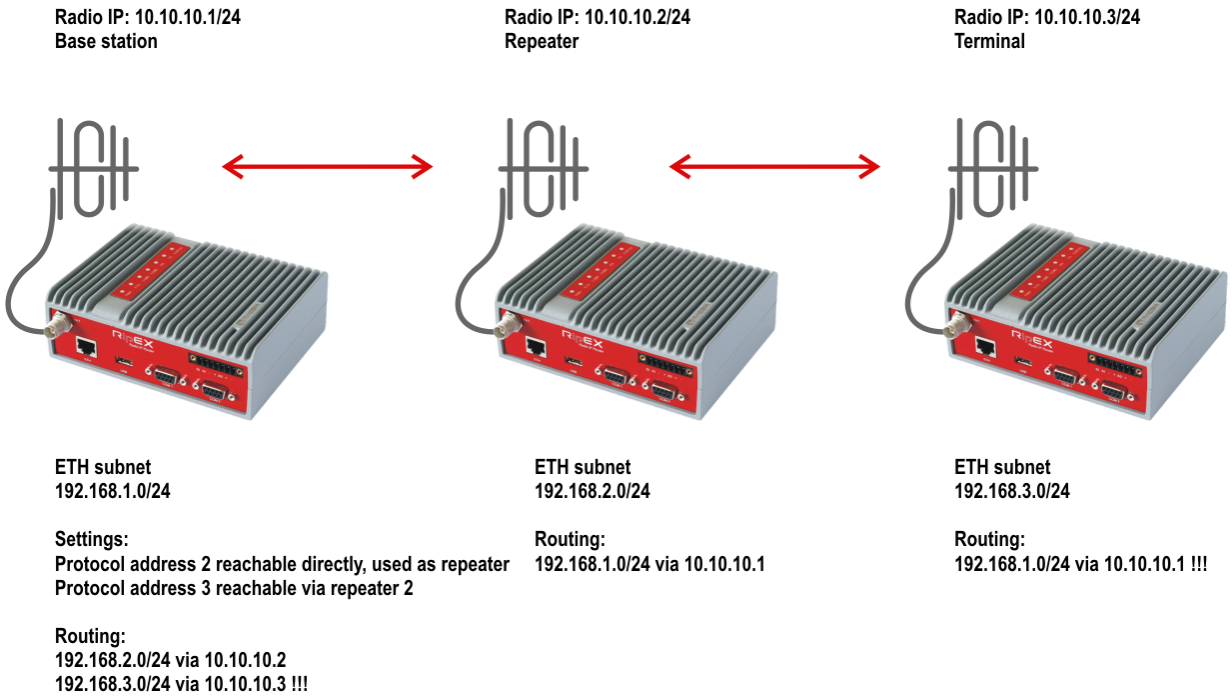


Fig. 2.1: Simple network - Base driven protocol routing

Otherwise, BDP has the same limitations as the Flexible protocol regarding the Routing options.

3. Ethernet addressing

3.1. Flexible Protocol

If you can set up IP addresses of the end devices connected over Ethernet, you can simplify routing by hierarchic division into subnets, either complete or for routing purposes only. An example of such network layout follows.

The centre and main repeater form distinct networks with mask 255.255.255.0 (/24), the sub-networks narrow down towards the end devices 255.255.255.192 (/26) and then 255.255.255.248 (/29). Routing tables are only given for a single branch of the network for clarity. They will be similar for other RipEX's. Only Master – Slave type applications are presumed – without any direct communication between Slave devices.

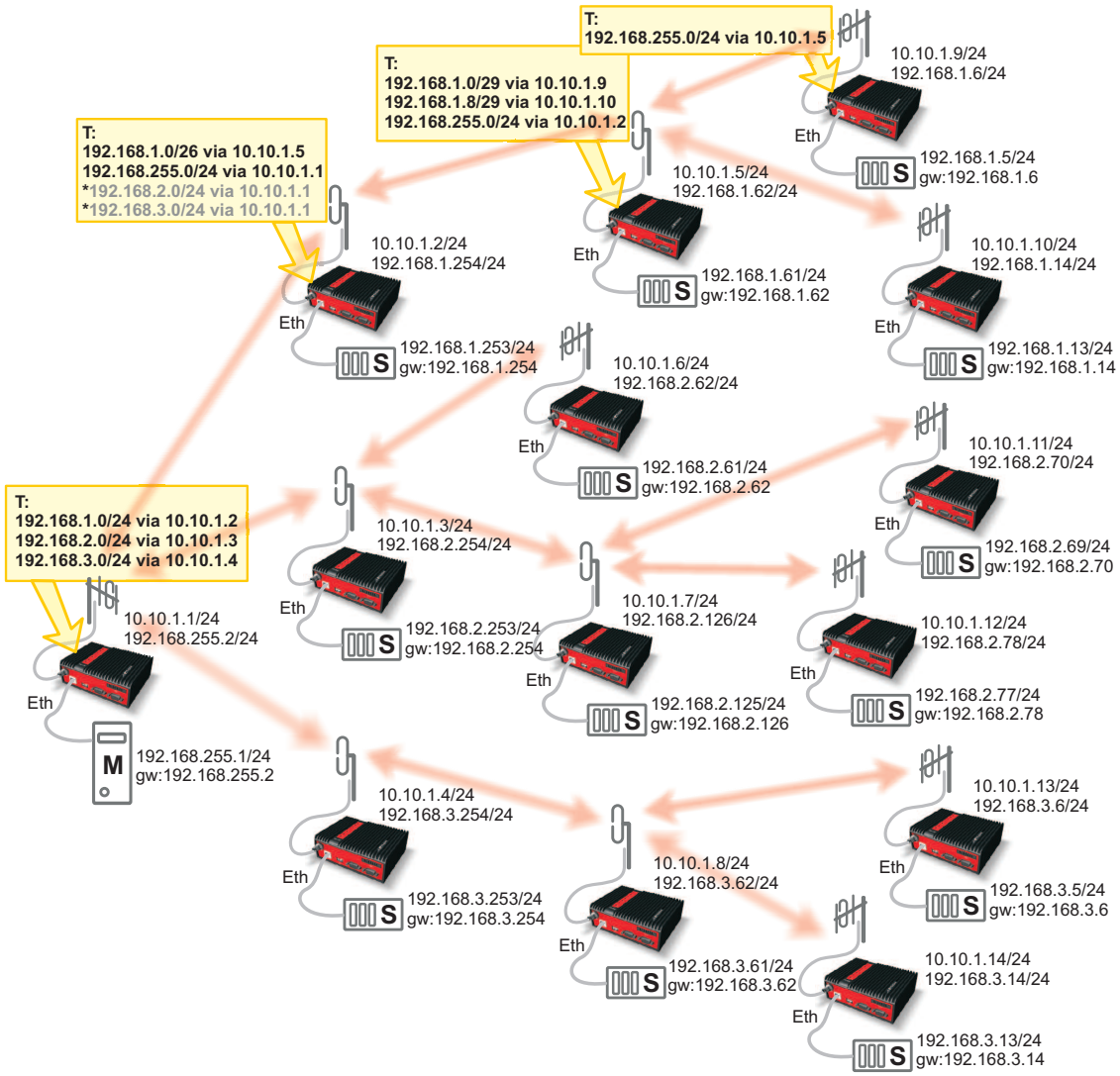


Fig. 3.1: Network with standard masks

Virtual network narrowing may also be used, while in reality narrower masks will be only used for routing purposes. This would allow you to use even the addresses reserved for network and broadcasting, though we do not recommend doing so.

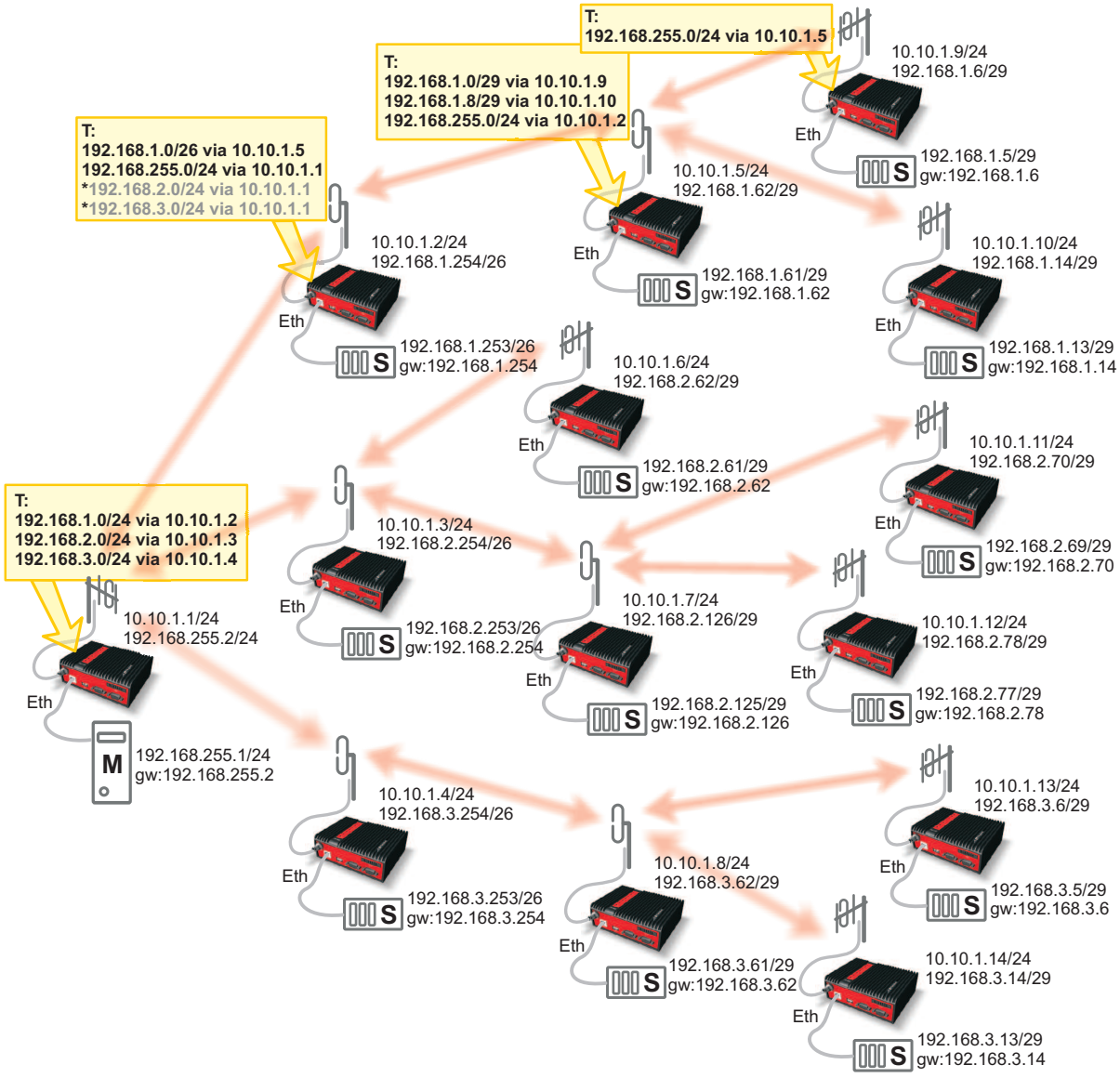


Fig. 3.2: Network with narrowed masks

3.2. Base Driven Protocol

Both topology diagrams are too wide for the Base driven protocol. I.e. there are two repeaters on one path to the terminals on the right. This is not supported by the BDP. One solution would be adding an additional RipEX unit to each RipEX two hops from the Base station (e.g. 10.10.1.5) connected via Ethernet (switch), so called "back-to-back". Then another part of this network will utilize its own BDP with a new Base station (this added RipEX) and original remote units. Note that there cannot be any radio coverage overlap, otherwise the communication will not work (two BDP networks within one radio coverage); in such a case, use different frequencies.

Another difference would be Routing rules, which were explained in previous chapters. Keep in mind that Remote to Remote communication can be very complex and can use too many hops compared to the Flexible mode in this example.

Appendix A. Revision History

Revision 1.0 2017-11-15

First issue