

Quick guide for configuring a system with multiple IP-LINKs

Version 1.00 October 4th 2005, KK.

This guide will show an example configurations for a system with multiple IP-LINKs.

Example 1, three devices connected together, different networks

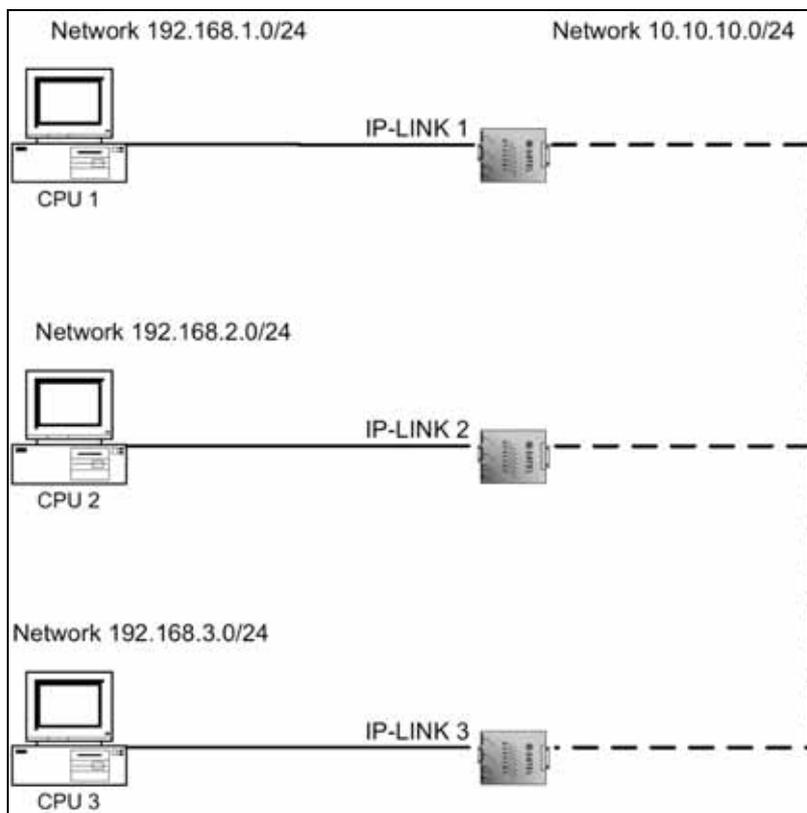
In the first example is a system with three customer devices (CPU) and IP-LINKs (and radio modems). Radio modems are left out of the pictures to make them simpler.

The system has four networks. Each CPU is in a separate network. The fourth network is the network between the radio interfaces (satelo) of IP-LINKs. It is easier to keep different networks if more devices are added to the same network.

To keep the network IP addresses and radio interface IP addresses easier to understand, the CPU network addresses start from 192.168.1.0 and radio interface addresses start from 10.10.10.1.

So, first we have three CPUs and three IP-LINKs. Networks are 24-bit, in other words they have network mask of 255.255.255.0. To keep the picture more simple the 24-bit network mask is markes as "/24" after the network address.

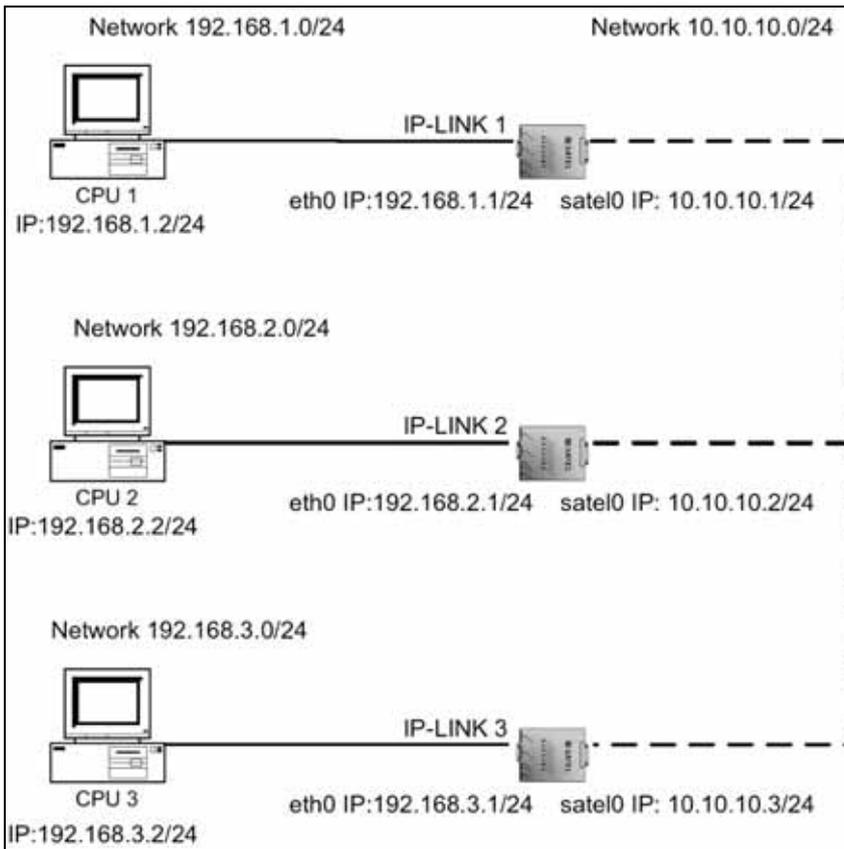
Lets add the networks.



Network plan with network addresses.

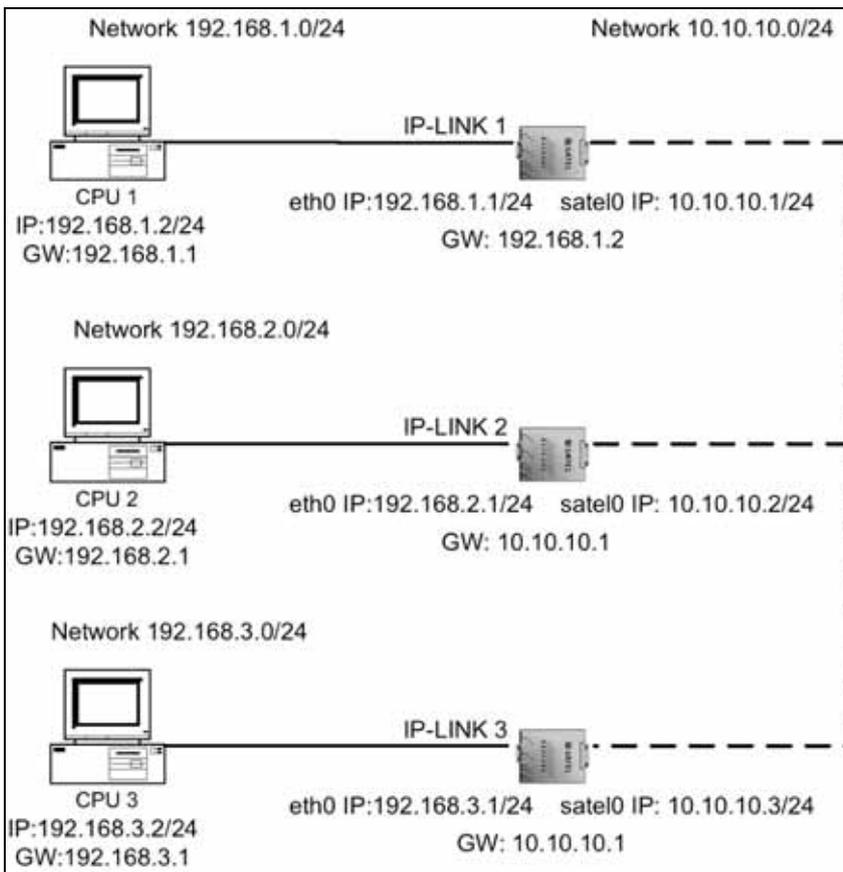
The IP-LINK has only one physical Ethernet connector but the radio interface has an IP address. The radio network is shared with all the radio interfaces. So IP-LINK is connected to two different networks and therefore is a router.

Now we need to add interface IP addresses and masks. Routers are usually numbered from one, and user devices accordingly. Now we know the mask was 255.255.255.0 for every network so we can use that as a interface IP mask. Remember that the IP addresses must be unique.



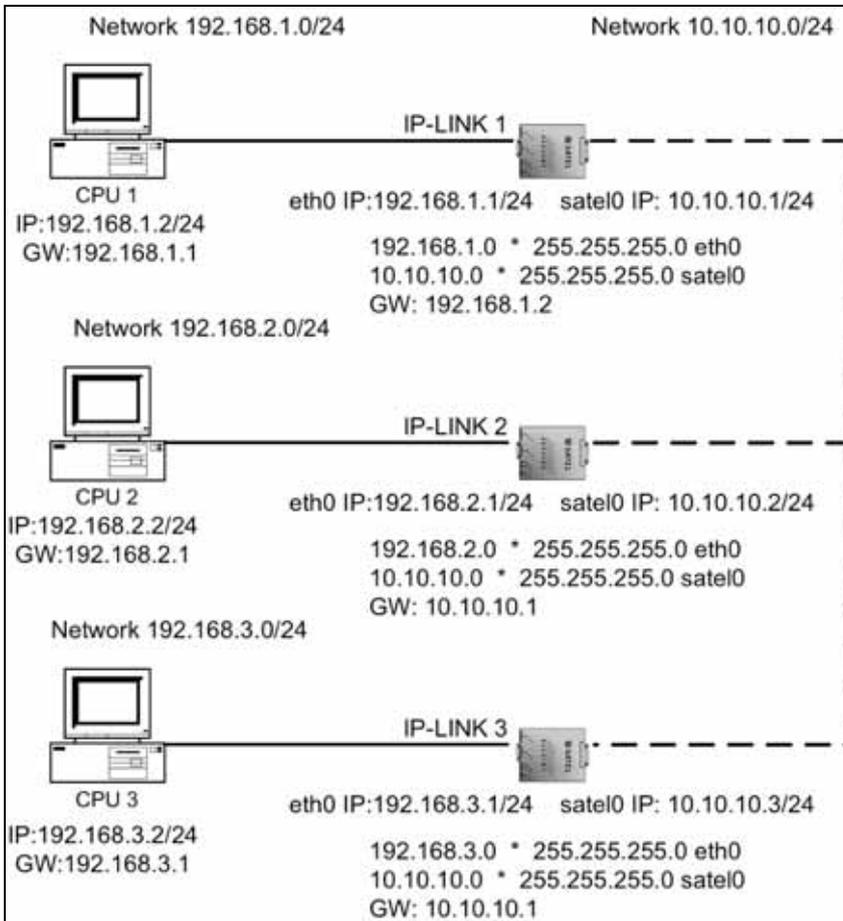
Network plan with IP addresses added.

Every device needs also a default gateway setting. The default gateway is used when the customer device wants to send a packet to a foreign network (a network where itself does not belong based in the IP address and mask). In IP-LINK the default gateway is used when there is no specific route to a destination network. The default gateway should be the next point where the traffic is routed onwards. The default gateways for CPUs in this case are naturally IP-LINKs. For IP-LINKs we set the gateway to be another IP-LINK. There is only one default gateway setting, so they do not look the same in all IP-LINKs. In this example we consider the CPU 1 to be more important than CPU 2 and CPU 3, therefore the default gateway in IP-LINK 1 is set to be CPU 1. By more important we mean that it may for example have the control software to control CPU 2 and CPU 3 or it may be the connection to the Internet.



Network plan with gateways added.

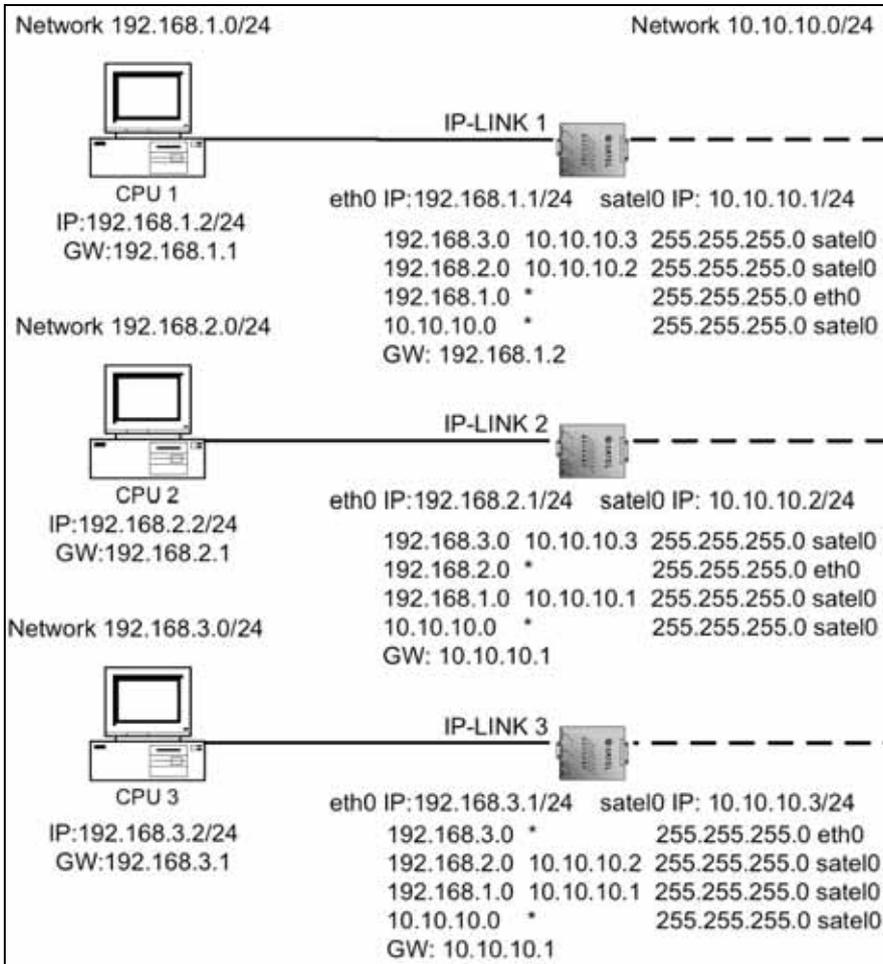
IP-LINK has a routing table where it looks the information where to send packets. By default the IP-LINK routing table has the routes from the interface IP addresses. So with these interface IP settings the routing tables would look like this. The routing tables are simplified for the picture. In a routing table, the first column is the destination network or host, then a possible gateway for the route and last the interface where *to* send the packet. The "*" means no gateway. (CPUs have routing tables too but there is no need to change them).



Network plan with the default routes from the IP-LINK interface addresses.

Notice that in this example the last zero is the *network* IP address (for example 192.168.1.0). The networks can end to any number, it is the combination of IP address and mask that make the network address. The eth0 and satel0 are the interfaces where *to* a packet is sent. With the default routes the packets would not get very far. We need to add some routes to the IP-LINKs. In routing design it is important to remember that both (or all) routers must have routes to both (or all) directions, after all TCP/IP is two-way communication. The IP-LINKs need to know where the other networks are. They all have the *radio interface* in the same network but they do not know what other networks there are in the *Ethernet interfaces behind the other radio interfaces*. So, the IP-LINK 1 needs to have routes to 192.168.2.0/24 and 192.168.3.0/24 networks. IP-LINK 2 needs the routes to 192.168.1.0/24 and 192.168.3.0/24 networks. IP-LINK 3 needs the routes to 192.168.1.0/24 and 192.168.2.0/24 networks.

(Technical detail: The routes are defined here with the route specific gateway. They could be without the route specific gateway, since IP-LINK radio interface has Proxy ARP. It is generally better to define the route with specific gateway to avoid unnecessary ARP traffic.)



Network plan with the added routes.

Lets take a closer look for the routing table of IP-LINK 2.
In the IP-LINK 2 it will look as this:

Kernel IP routing table							
Destination	Gateway	Genmask	Flags	Metric	Ref	Use	Iface
192.168.3.0	10.10.10.3	255.255.255.0	U	0	0	0	satel0
192.168.2.0	*	255.255.255.0	U	0	0	0	eth0
192.168.1.0	10.10.10.1	255.255.255.0	U	0	0	0	satel0
10.10.10.0	*	255.255.255.0	U	0	0	0	satel0
127.0.0.0	*	255.0.0.0	U	0	0	0	lo
default	10.10.10.1	0.0.0.0	UG	0	0	0	satel0

IP-LINK 2 routing table.

This has some additional information to the network plan picture.

The "Destination" column this is where the packet is going. The last line "default" has an exception.

The "Gateway" column is the *route specific gateway* NOT the *default gateway* (GW in pictures).

The "Genmask" column is the network mask for the destination address. Remember, destination (IP address) and mask (Genmask) together form the network address.

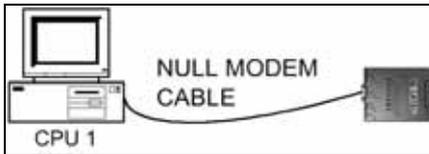
Columns "Flags", "Metric", "Ref" and "Use" can be omitted.

The column "Iface" is important. It is the interface where the packet is *sent to*. It does not matter for the routing table where the packet came, it got the packet and needs to know to which interface to send it.

The line "127.0.0.00" is the local loopback. If the Linux kernel wants to send a packet to itself it would use address 127.0.01. Based on the route, the packet is sent to "lo" (local) interface, which is a software interface, not physical interface.

The last "default" line is the *default gateway*. If the packet is going to a network, which is not in the routing table it is sent to the default gateway (which IP address is in the "Gateway" column). Notice the mask at the "Genmask" column, "0.0.0.0". This means that everything is accepted. On the last column is the interface satel0.

Now lets make the changes to the IP-LINKs. Start with the IP-LINK 1. Power it up and log in to the menu. The booting takes about 45 seconds, There is two ways to get to the menu. The first option is to use a null-modem cable and a terminal program in PC. This is preferred if we need to change the radio modem settings later.



PC connected to IP-LINK for configuration. PC should have a terminal program (for example SaTerm or HyperTerminal).

(If you do not have null modem cable, you can use crossover Ethernet cable. These are marked usually with red ends. Open a Telnet connection to the IP-LINK, "telnet 192.168.0.1".)

And the default login is *root*.

The menu will look like this:

```
IP-LINK login: root

-----
Satel IP-LINK Configuration
-----
1) Ethernet Interface Settings
2) Radio Modem Serial Settings
3) Radio Interface Settings
4) Show All Current Interfaces
5) Routes
6) ARP Cache
7) Firewall
8) Other Settings
N) Domain Names
T) Tests
A) System information

D) Load Default Configuration
L) Stored Configurations
R) Apply Changes without Saving
E) Save Changes
X) Logout
B) Boot

IP-LINK>
```

Select "1)Ethernet Interface Settings" and we will see the following:

```
-----  
Ethernet Interface Settings  
1)   Ethernet IP Address           192.168.0.1  
2)   Ethernet Network Mask        255.255.255.0  
3)   Ethernet Broadcast Address    192.168.0.255  
4)   Maximum Packet Size (MTU)    1500  
5)   MAC Address                   00:06:70:01:03:8A  
6)   Ethernet Proxy ARP           ON  
7)   Show Statistics
```

These are the default settings. We need to change the IP address AND broadcast address. Make the changes as in the following picture:

```
-----  
Ethernet Interface Settings  
1)   Ethernet IP Address           192.168.1.1  
2)   Ethernet Network Mask        255.255.255.0  
3)   Ethernet Broadcast Address    192.168.1.255  
4)   Maximum Packet Size (MTU)    1500  
5)   MAC Address                   00:06:70:01:03:8A  
6)   Ethernet Proxy ARP           ON  
7)   Show Statistics
```

Now go back to the main menu and select "3)Radio Interface Settings"

```
-----  
Radio Interface Settings  
1)   Radio IP Address              10.10.10.1  
2)   Radio Network Mask            255.255.255.0  
3)   Radio Broadcast Address        10.10.10.255  
4)   Maximum Packet Size (MTU)    1500  
5)   Radio Proxy ARP               ON  
6)   Min Time Between Packets      10  
7)   Max Random Factor for Time    4  
8)   Packet Retry Limit            500  
A)   Use CD Signal for TX Control  ON  
B)   Radio Network Compression     ON/500/1.1  
C)   Radio Network Encryption      ON  
D)   Show Statistics
```

The default Radio IP Address is correct for IP-LINK 1 so there is no need to change it.

Go back to the main menu and select "5) Routes".

```
-----  
Routes  
  
1) Show All Routes  
2) Show User Defined Routes  
3) Edit or Delete User Defined Routes  
4) Define a Route  
5) Default Gateway
```

Select "1)Show All Routes"

Kernel IP routing table						
Destination	Gateway	Genmask	Flags	Metric	Ref	Use Iface
192.168.0.0	*	255.255.255.0	U	0	0	0 eth0
10.10.10.0	*	255.255.255.0	U	0	0	0 satel0
127.0.0.0	*	255.0.0.0	U	0	0	0 lo
default	192.168.0.254	0.0.0.0	UG	0	0	0 eth0

These are the default settings.

We have changed the IP address settings but *we did not yet apply them so they are not shown (and not in use).*

Go back to the route menu and select "4)Define a Route".

First we add the route to the 192.168.2.1/24 network through the route specific gateway 10.10.10.2 (as in the picture).

```
Route Type:
1)  Route to a Single Host
2)  Route to a Network

ESC)  Back

IP-LINK>2

Route Destination IP Address:192.168.2.0

Route Netmask (usually 255.255.255.0):255.255.255.0

Rejecting Route? (usually No):
1)  No, this route is a normal route
2)  Yes, this route is a rejecting route

ESC)  Back

IP-LINK>1

Route Packets to Interface:
1)  Ethernet (eth0)
2)  Radio (satel0)

ESC)  Back

IP-LINK>2

Route Specific Gateway. This is NOT the default gateway (press ENTER for
none):10.10.10.2

-----
Edit Route

1)  Route Number          3
2)  IP Address            192.168.2.0
3)  Type                  Route to a Network
4)  Netmask               255.255.255.0
5)  Reject?               No, this route is a normal route
6)  Route to Interface    Radio (satel0)
7)  Route Specific Gateway 10.10.10.2

C)  Check Route
N)  Next Route
B)  Previous Route
R)  Go to Route
A)  Create a New Route
D)  Delete Route
```

So now we have a route to the 192.168.2.0/24 network.

We need to add also the route to 192.168.3.0.

Select "A)Create a New Route" . The adding is similar to the previous route.

```
Route Type:
1) Route to a Single Host
2) Route to a Network

ESC) Back

IP-LINK>2

Route Destination IP Address:192.168.3.0

Route Netmask (usually 255.255.255.0):255.255.255.0

Rejecting Route? (usually No):
1) No, this route is a normal route
2) Yes, this route is a rejecting route

ESC) Back

IP-LINK>1

Route Packets to Interface:
1) Ethernet (eth0)
2) Radio (satel0)

ESC) Back

IP-LINK>2

Route Specific Gateway. This is NOT the default gateway (press ENTER for
none):10.10.10.3

-----
Edit Route

1) Route Number          4
2) IP Address            192.168.3.0
3) Type                  Route to a Network
4) Netmask                255.255.255.0
5) Reject?               No, this route is a normal route
6) Route to Interface    Radio (satel0)
7) Route Specific Gateway 10.10.10.3

C) Check Route
N) Next Route
B) Previous Route
R) Go to Route
A) Create a New Route
D) Delete Route
```

Now we are almost ready.

We need only to change the default gateway. Go back to the route menu and select "5) Default Gateway"

```
-----  
Default Gateway  
1)   Default Gateway           192.168.0.254  
2)   Interface                 Ethernet
```

These are the default settings.

Select 1 and change the default gateway address to 10.10.10.2.

The interface needs not to be changed in this IP-LINK 1. The result must look as follows.

```
-----  
Default Gateway  
1)   Default Gateway           192.168.1.2  
2)   Interface                 Ethernet
```

Now we need to apply the changes. Go back to the main menu and select "R) Apply Changes without Saving".

The following text will come and the main menu comes back.

```
IP-LINK>r  
Resetting system..OK  
Initializing new settings..  
Satel interface unregistered  
Starting Satel interface  
Starting Satel interface  
Satel interface registered  
Startup completed.  
OK
```

Now the changes have been applied but they are not saved yet. Select "E) Save Changes" from the main menu and save the settings.

Now we can take a look at the settings. Select "4)Show All Current Interfaces" from the main menu.

```
-----
Interface Statistics:
eth0      Link encap:Ethernet  HWaddr 00:06:70:01:03:8A
          inet addr:192.168.1.1  Bcast:192.168.1.255  Mask:255.255.255.0
          UP BROADCAST RUNNING MULTICAST  MTU:1500  Metric:1
          RX packets:0 errors:0 dropped:0 overruns:0 frame:0
          TX packets:0 errors:0 dropped:0 overruns:0 carrier:0
          collisions:0 txqueuelen:100
          Base address:0x840

lo        Link encap:Local Loopback
          inet addr:127.0.0.1  Mask:255.0.0.0
          UP LOOPBACK RUNNING  MTU:16436  Metric:1
          RX packets:0 errors:0 dropped:0 overruns:0 frame:0
          TX packets:0 errors:0 dropped:0 overruns:0 carrier:0
          collisions:0 txqueuelen:0

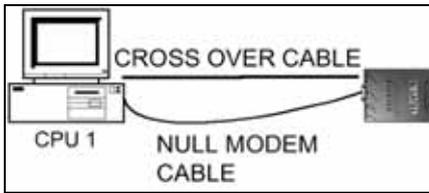
satel0    Link encap:Ethernet  HWaddr 00:06:70:01:03:8A
          inet addr:10.10.10.1  Bcast:10.10.10.255  Mask:255.255.255.0
          UP BROADCAST RUNNING MULTICAST  MTU:1500  Metric:1
          RX packets:0 errors:0 dropped:0 overruns:0 frame:0
          TX packets:0 errors:0 dropped:0 overruns:0 carrier:0
          collisions:0 txqueuelen:3
```

IP addresses look all right. Go back to the main menu and select "5)Routes" and " 1)Show All Routes"

Kernel IP routing table						
Destination	Gateway	Genmask	Flags	Metric	Ref	Use Iface
192.168.3.0	10.10.10.3	255.255.255.0	UG	0	0	0 satel0
192.168.2.0	10.10.10.2	255.255.255.0	UG	0	0	0 satel0
192.168.1.0	*	255.255.255.0	U	0	0	0 eth0
10.10.10.0	*	255.255.255.0	U	0	0	0 satel0
127.0.0.0	*	255.0.0.0	U	0	0	0 lo
default	192.168.1.2	0.0.0.0	UG	0	0	0 eth0

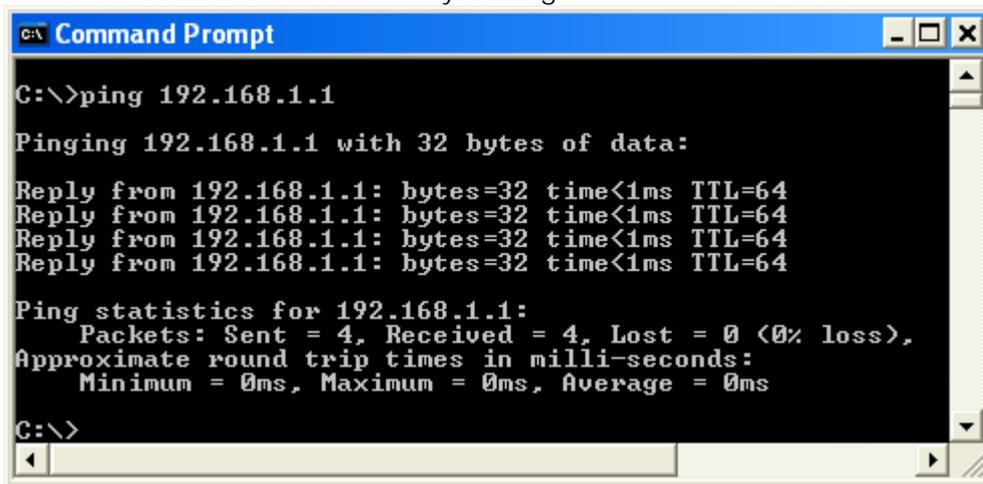
The routes are as we wanted them to be. Now go back to the main menu.

Set the IP settings to the CPU 1 as in the network plan.



PC connected to IP-LINK with Ethernet crossover cable for data transfer.

Now we can test the connection between CPU 1 and IP-LINK 1. Connect a crossover Ethernet cable between the devices and try to Ping IP-LINK 1 from CPU 1.



Pinging IP-LINK 1 from CPU 1.

The communication between CPU 1 and IP-LINK 1 works.
Now we have to change the settings to the IP-LINK 2 and CPU 2.

The settings for IP-LINK 2 must look like this.

```
Interface Statistics:
eth0      Link encap:Ethernet  HWaddr 00:06:70:01:03:8A
          inet addr:192.168.2.1  Bcast:192.168.2.255  Mask:255.255.255.0
          UP BROADCAST RUNNING MULTICAST  MTU:1500  Metric:1
          RX packets:0 errors:0 dropped:0 overruns:0 frame:0
          TX packets:0 errors:0 dropped:0 overruns:0 carrier:0
          collisions:0 txqueuelen:100
          Base address:0x840

lo        Link encap:Local Loopback
          inet addr:127.0.0.1  Mask:255.0.0.0
          UP LOOPBACK RUNNING  MTU:16436  Metric:1
          RX packets:0 errors:0 dropped:0 overruns:0 frame:0
          TX packets:0 errors:0 dropped:0 overruns:0 carrier:0
          collisions:0 txqueuelen:0

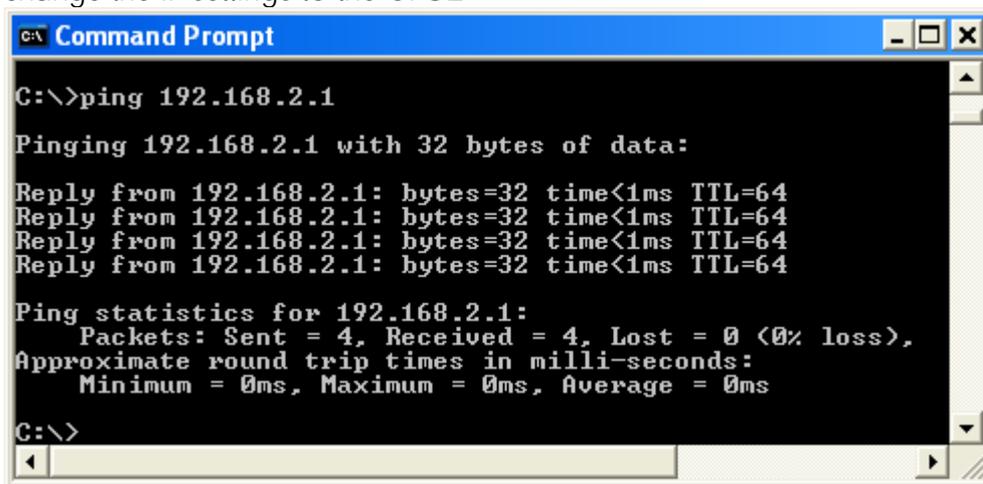
satel0    Link encap:Ethernet  HWaddr 00:06:70:01:03:8A
          inet addr:10.10.10.2  Bcast:10.10.10.255  Mask:255.255.255.0
          UP BROADCAST RUNNING MULTICAST  MTU:1500  Metric:1
          RX packets:0 errors:0 dropped:0 overruns:0 frame:0
          TX packets:0 errors:0 dropped:0 overruns:0 carrier:0
          collisions:0 txqueuelen:3
```

IP-LINK 2 IP settings, local loopback left out.

Kernel IP routing table							
Destination	Gateway	Genmask	Flags	Metric	Ref	Use	Iface
192.168.3.0	10.10.10.3	255.255.255.0	UG	0	0	0	satel0
192.168.2.0	*	255.255.255.0	U	0	0	0	eth0
192.168.1.0	10.10.10.1	255.255.255.0	UG	0	0	0	satel0
10.10.10.0	*	255.255.255.0	U	0	0	0	satel0
127.0.0.0	*	255.0.0.0	U	0	0	0	lo
default	10.10.10.1	0.0.0.0	UG	0	0	0	satel0

IP-LINK 2 routing table.

Test the connection between CPU2 and IP-LINK 2 with Ping (from the CPU 2). Remember to change the IP settings to the CPU2



Pinging IP-LINK 2 from CPU 2.

Looks good again.

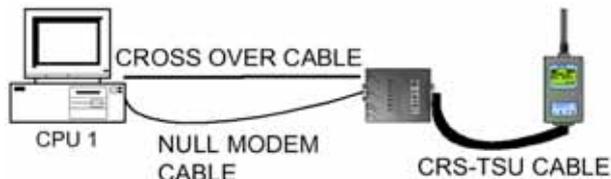
Now we can test the routing between IP-LINK 1 and IP-LINK 2.

If you have a IP-LINK test cable CRS-IPT, you can connect the IP-LINKs with it. **CONNECT THE CABLE WITHOUT POWER.**

If you do not have the test cable CRS-IPT connect the radio modems.

POWER OFF THE IP-LINKs and then connect the radio modems. You can connect the radio modems with 0,5m or 2m CRS-TSU cable.

POWER ON the IP-LINKs. It takes 45 seconds to boot and the radio modem is not powered until the IP-LINK booting has finished.



Radio modem connected to IP-LINK. DO NOT CONNECT THE RADIO MODEM WHEN THE IP-LINK IS POWERED.

To get to the radio modem menu you have to have a null-modem cable between the IP-LINK and the computer and switch the IP-LINK "Radio Modem Prog" switch. When this switch is in the "Prog" mode, the LEDs STATUS1 and STATUS2 are lit.

It is not possible to use Telnet for radio modem menu.

```

-----
                ***** SATELLINE-3AS 3069 *****
                SW version 3.15 / HW TC4m
-----

Current settings
-----
1) Radio frequency  468.90000 MHz ( CF 468.20000 MHz, spacing 25 kHz )
2) Radio settings  TX power 10 mW / Signal threshold -112 dBm / FCS OFF /
                   TX start delay 0ms / Diversity RX OFF / EPIC PWRSave OFF
3) Addressing      RX address OFF / TX address OFF /
                   RX address to RS port OFF / TX address autoswitch OFF
4) Serial port 1   ON / 19200 bit/s / 8 bit data / None parity /
                   1 stop bit
5) Serial port 2   OFF / 9600 bit/s / 8 bit data / Even parity /
                   1 stop bit ( RS-232 )
6) Handshaking    CTS Clear to send / CD RSSI-threshold /
                   RTS Ignored
7) Additional setup Error correction OFF / Error check OFF / Repeater OFF /
                   SL-commands OFF / Priority RX
8) Routing        OFF
9) Tests          OFF
A) Restore factory settings
E) EXIT and save settings
Q) QUIT without saving

```

Here are an example settings for a radio modem. Following settings are important.

The frequency (in this case 468.9 MHz) must be the same in every radio modem.

The TX power is set to minimum for testing with short distances.

In the addressing no addresses are used. The system is based only on the MAC and IP addresses in IP-LINKs.

Serial port settings must be the same in the IP-LINK and in the radio modem. In this case 19200, 8 bits, no parity, 1 stop bit. In IP-LINK these settings are in "2)Radio Modem Serial Settings".

The handshaking should be as in the picture.

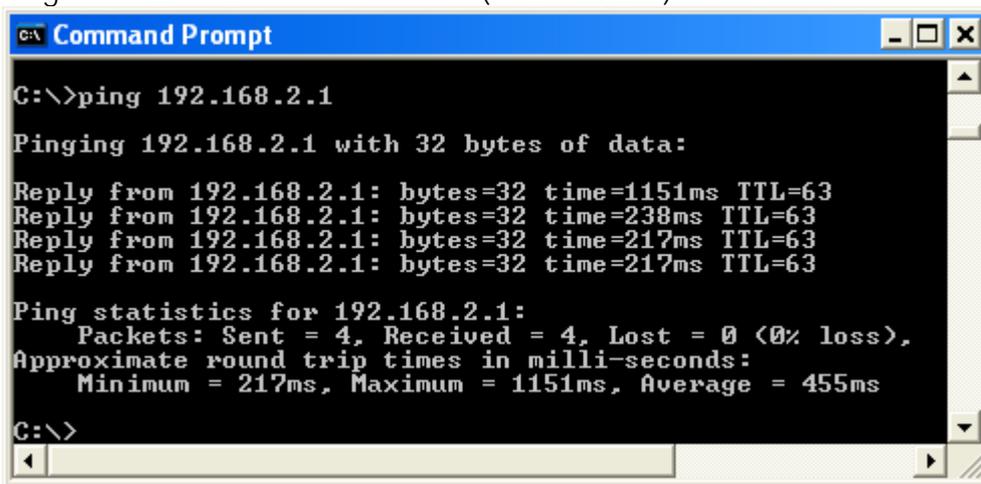
In additional setup the "Priority RX" should be set.

Switch the IP-LINK "Radio Modem Prog" switch to "OFF" position.

Check the settings on the other radio modem too.

Now we can Ping over the radio modems.

Ping the IP-LINK 2 network interface(192.168.2.1) from the CPU 1.



```
C:\>ping 192.168.2.1

Pinging 192.168.2.1 with 32 bytes of data:

Reply from 192.168.2.1: bytes=32 time=1151ms TTL=63
Reply from 192.168.2.1: bytes=32 time=238ms TTL=63
Reply from 192.168.2.1: bytes=32 time=217ms TTL=63
Reply from 192.168.2.1: bytes=32 time=217ms TTL=63

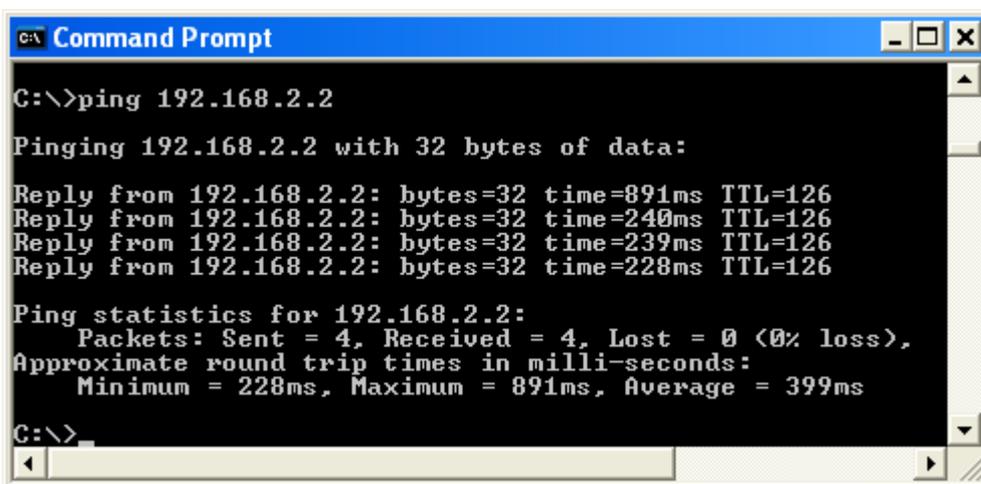
Ping statistics for 192.168.2.1:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 217ms, Maximum = 1151ms, Average = 455ms

C:\>
```

Pinging IP-LINK 2 Ethernet interface from CPU 1.

The Ping works. Notice the delays. The first delay is longer due to the ARP query. The three last responses have a variable delay. This is due the random radio transmission protocol in IP-LINK.

Ping the CPU 2 network interface from the CPU 1.



```
C:\>ping 192.168.2.2

Pinging 192.168.2.2 with 32 bytes of data:

Reply from 192.168.2.2: bytes=32 time=891ms TTL=126
Reply from 192.168.2.2: bytes=32 time=240ms TTL=126
Reply from 192.168.2.2: bytes=32 time=239ms TTL=126
Reply from 192.168.2.2: bytes=32 time=228ms TTL=126

Ping statistics for 192.168.2.2:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 228ms, Maximum = 891ms, Average = 399ms

C:\>
```

Pinging CPU 2 from CPU 1.

This works great, too.

Now we have a two device system up and running. Now we need to add the third device to the system.

The settings for the IP-LINK 3 should look like this:

```
Interface Statistics:
eth0      Link encap:Ethernet  HWaddr 00:06:70:01:03:8A
          inet addr:192.168.3.1  Bcast:192.168.3.255  Mask:255.255.255.0
          UP BROADCAST RUNNING MULTICAST  MTU:1500  Metric:1
          RX packets:0 errors:0 dropped:0 overruns:0 frame:0
          TX packets:0 errors:0 dropped:0 overruns:0 carrier:0
          collisions:0 txqueuelen:100
          Base address:0x840

lo        Link encap:Local Loopback
          inet addr:127.0.0.1  Mask:255.0.0.0
          UP LOOPBACK RUNNING  MTU:16436  Metric:1
          RX packets:0 errors:0 dropped:0 overruns:0 frame:0
          TX packets:0 errors:0 dropped:0 overruns:0 carrier:0
          collisions:0 txqueuelen:0

satel0    Link encap:Ethernet  HWaddr 00:06:70:01:03:8A
          inet addr:10.10.10.3  Bcast:10.10.10.255  Mask:255.255.255.0
          UP BROADCAST RUNNING MULTICAST  MTU:1500  Metric:1
          RX packets:0 errors:0 dropped:0 overruns:0 frame:0
          TX packets:0 errors:0 dropped:0 overruns:0 carrier:0
          collisions:0 txqueuelen:3
```

IP-LINK 3 IP settings, local loopback left out.

Kernel IP routing table						
Destination	Gateway	Genmask	Flags	Metric	Ref	Use Iface
192.168.3.0	*	255.255.255.0	UG	0	0	0 eth0
192.168.2.0	10.10.10.2	255.255.255.0	U	0	0	0 satel0
192.168.1.0	10.10.10.1	255.255.255.0	UG	0	0	0 satel0
10.10.10.0	*	255.255.255.0	U	0	0	0 satel0
127.0.0.0	*	255.0.0.0	U	0	0	0 lo
default	10.10.10.1	0.0.0.0	UG	0	0	0 satel0

IP-LINK 3 IP routing table.

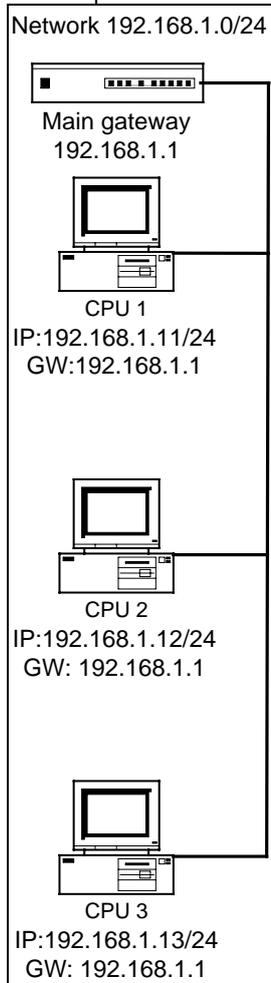
Test the communication with Ping as with the previous devices.

If you Ping multiple devices at the same time there will be some packet loss due to the packet collisions in the air (radio transfer). Ping uses ICMP protocol, which does not have retransmissions. TCP protocol has retransmissions so the collisions are not a problem with TCP.

Example 2 Three devices connected together in the same network

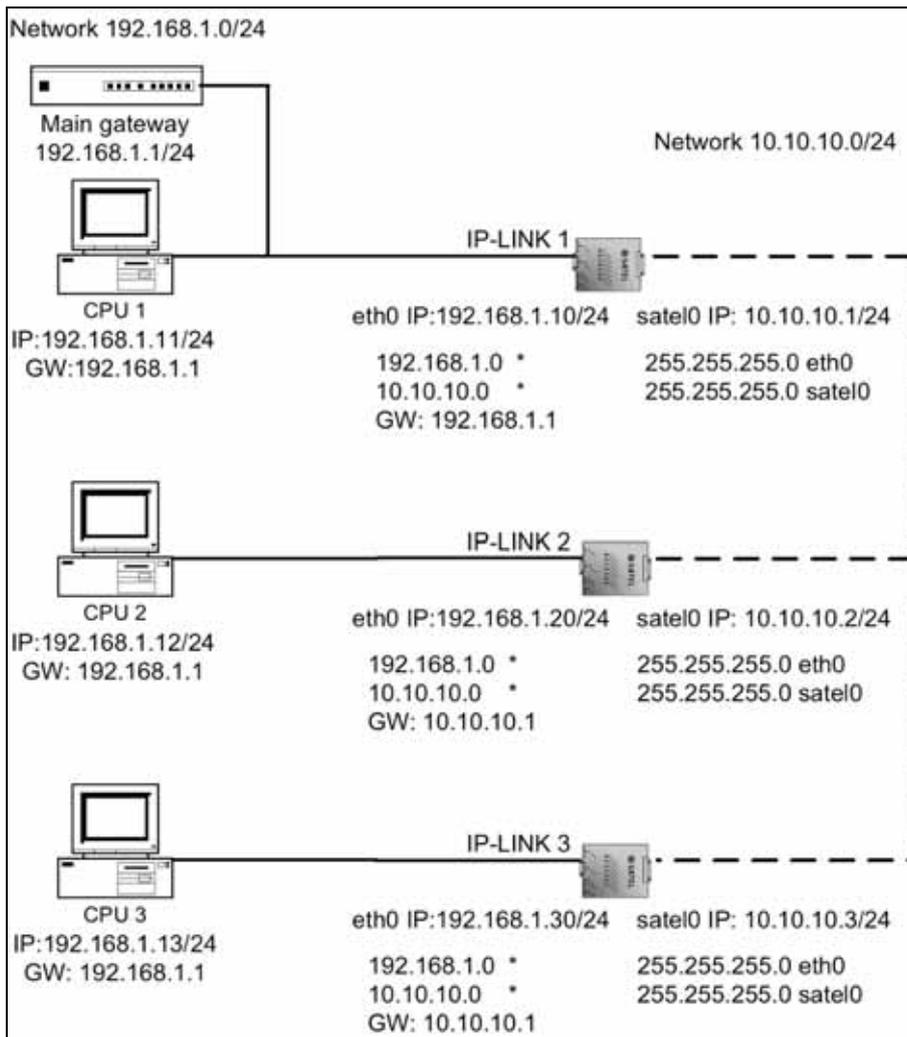
If we have an existing network and cannot change the settings we must design n the routes little bit differently than in the example one. .

In this picture we have the original setup.



The existing network.

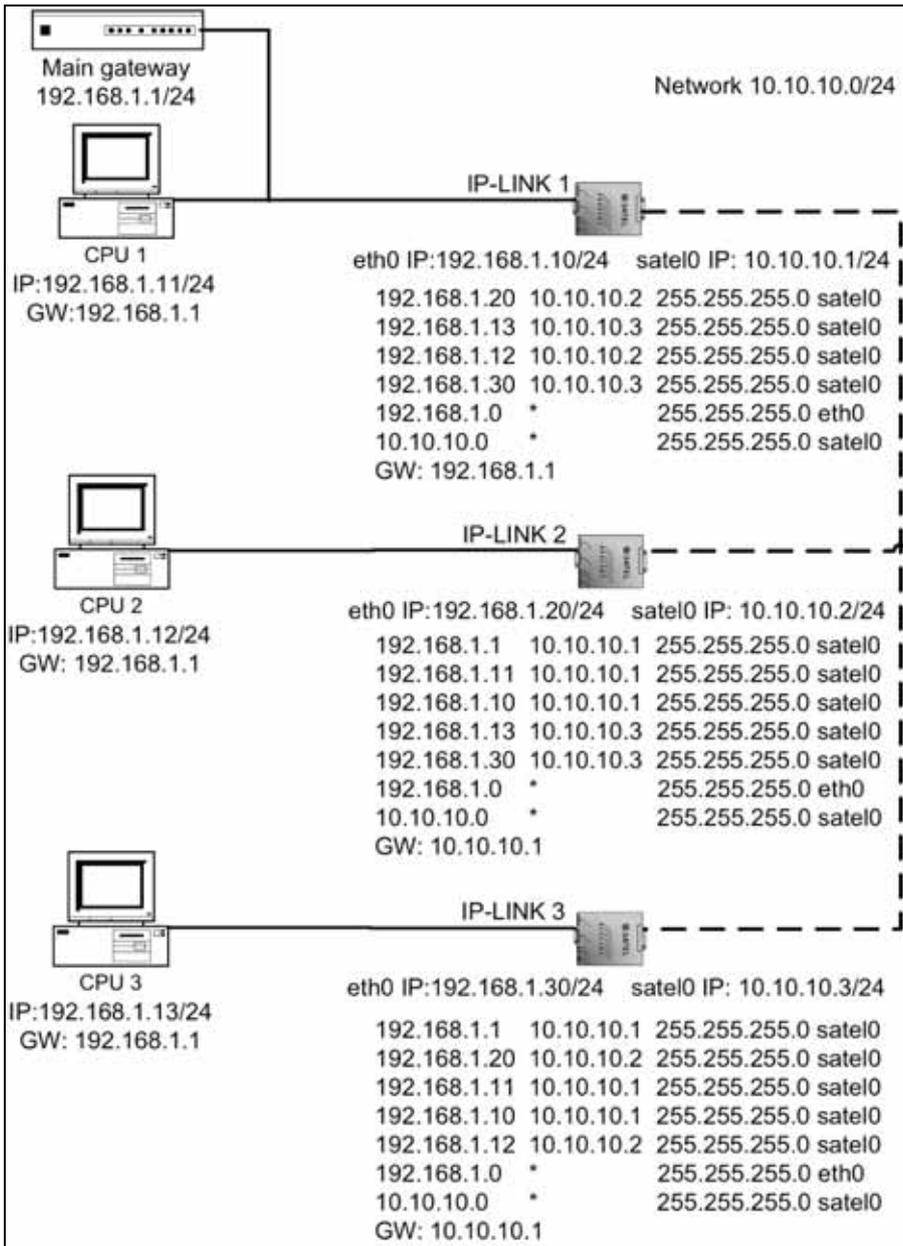
Now we need to add the IP-LINKs. We will add two wireless stations to the system.



IP-LINKs added to the system with IP addresses and default routes.

In this picture the IP-LINK IP addresses have been applied and the default gateway has been set. No routes have been added, only the routes from the interface IP addresses are shown..

As we can now see every IP-LINK thinks that the 192.168.1.0/24 network is in the IP-LINK Ethernet interface. Therefore the packets from CPU 2 and CPU3 would not get very far. We need to add separate routes to other destinations.



The network with routes added.

In this picture all the routes have been added.

Note that the IP-LINK 2 and IP-LINK 3 have a specific routes to 192.168.1.1 and 192.168.1.11. They do not need separate routes since they are in the Ethernet interface of IP-LINK 1.

If the CPU 2 and CPU 3 need not to communicate, then the routes between them can be discarded.

This is how the settings look like in the IP-LINKs.

```
-----
Interface Statistics:
eth0      Link encap:Ethernet  HWaddr 00:06:70:01:03:97
          inet addr:192.168.1.10  Bcast:192.168.1.255  Mask:255.255.255.0
          UP BROADCAST RUNNING MULTICAST  MTU:1500  Metric:1
          RX packets:5165 errors:0 dropped:0 overruns:0 frame:0
          TX packets:4760 errors:0 dropped:0 overruns:0 carrier:0
          collisions:0 txqueuelen:100
          Base address:0x840

satel0    Link encap:Ethernet  HWaddr 00:06:70:01:03:97
          inet addr:10.10.10.1   Bcast:10.10.10.255  Mask:255.255.255.0
          UP BROADCAST RUNNING MULTICAST  MTU:1500  Metric:1
          RX packets:3751 errors:39 dropped:2113 overruns:0 frame:39
          TX packets:4048 errors:0 dropped:0 overruns:0 carrier:0
          collisions:0 txqueuelen:3
```

IP-LINK 1 IP settings, local loopback left out.

```
Kernel IP routing table
Destination      Gateway          Genmask         Flags Metric Ref    Use Iface
192.168.1.20    10.10.10.2      255.255.255.255 UGH    0      0      0 satel0
192.168.1.13    10.10.10.3      255.255.255.255 UGH    0      0      0 satel0
192.168.1.12    10.10.10.2      255.255.255.255 UGH    0      0      0 satel0
192.168.1.30    10.10.10.3      255.255.255.255 UGH    0      0      0 satel0
192.168.1.0     *                255.255.255.0   U      0      0      0 eth0
10.10.10.0      *                255.255.255.0   U      0      0      0 satel0
127.0.0.0       *                255.0.0.0       U      0      0      0 lo
default         192.168.1.1     0.0.0.0          UG     0      0      0 eth0
```

IP-LINK 1 routing table.

```

Interface Statistics:
eth0      Link encap:Ethernet  HWaddr 00:06:70:01:03:8A
          inet addr:192.168.1.20  Bcast:192.168.1.255  Mask:255.255.255.0
          UP BROADCAST RUNNING MULTICAST  MTU:1500  Metric:1
          RX packets:5055 errors:0 dropped:0 overruns:0 frame:0
          TX packets:4820 errors:0 dropped:0 overruns:0 carrier:0
          collisions:0 txqueuelen:100
          Base address:0x840

satel0    Link encap:Ethernet  HWaddr 00:06:70:01:03:8A
          inet addr:10.10.10.2   Bcast:10.10.10.255  Mask:255.255.255.0
          UP BROADCAST RUNNING MULTICAST  MTU:1500  Metric:1
          RX packets:3914 errors:64 dropped:3165 overruns:0 frame:64
          TX packets:3891 errors:0 dropped:0 overruns:0 carrier:0
          collisions:0 txqueuelen:3

```

IP-LINK 2 IP settings, local loopback left out.

Kernel IP routing table							
Destination	Gateway	Genmask	Flags	Metric	Ref	Use	Iface
192.168.1.1	10.10.10.1	255.255.255.255	UGH	0	0	0	satel0
192.168.1.11	10.10.10.1	255.255.255.255	UGH	0	0	0	satel0
192.168.1.10	10.10.10.1	255.255.255.255	UGH	0	0	0	satel0
192.168.1.13	10.10.10.3	255.255.255.255	UGH	0	0	0	satel0
192.168.1.30	10.10.10.3	255.255.255.255	UGH	0	0	0	satel0
192.168.1.0	*	255.255.255.0	U	0	0	0	eth0
10.10.10.0	*	255.255.255.0	U	0	0	0	satel0
127.0.0.0	*	255.0.0.0	U	0	0	0	lo
default	10.10.10.1	0.0.0.0	UG	0	0	0	satel0

IP-LINK 2 routing table.

```

Interface Statistics:
eth0      Link encap:Ethernet  HWaddr 00:06:70:01:03:7F
          inet addr:192.168.1.30  Bcast:192.168.1.255  Mask:255.255.255.0
          UP BROADCAST RUNNING MULTICAST  MTU:1500  Metric:1
          RX packets:3485 errors:0 dropped:0 overruns:0 frame:0
          TX packets:2470 errors:0 dropped:0 overruns:0 carrier:0
          collisions:0 txqueuelen:100
          Base address:0x840

satel0    Link encap:Ethernet  HWaddr 00:06:70:01:03:7F
          inet addr:10.10.10.3  Bcast:10.10.10.255  Mask:255.255.255.0
          UP BROADCAST RUNNING MULTICAST  MTU:1500  Metric:1
          RX packets:3260 errors:11 dropped:5057 overruns:0 frame:11
          TX packets:3251 errors:0 dropped:0 overruns:0 carrier:0
          collisions:0 txqueuelen:3
  
```

IP-LINK 3 IP settings, local loopback left out.

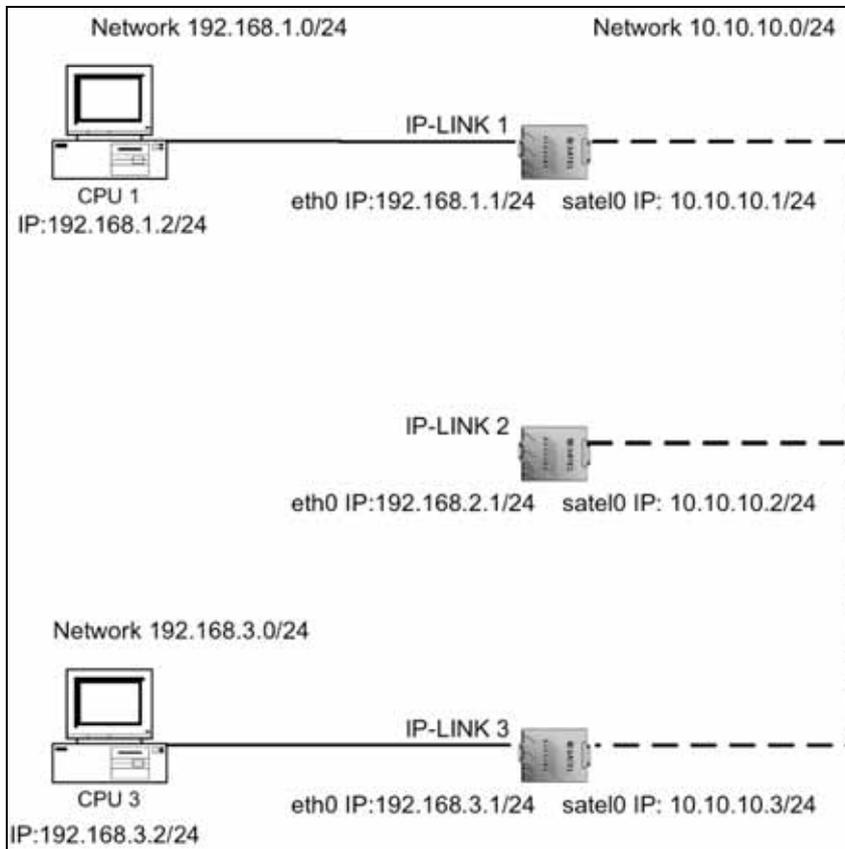
```

Kernel IP routing table
Destination      Gateway         Genmask         Flags Metric Ref    Use Iface
192.168.1.1     10.10.10.1     255.255.255.255 UGH    0      0      0 satel0
192.168.1.20    10.10.10.2     255.255.255.255 UGH    0      0      0 satel0
192.168.1.11    10.10.10.1     255.255.255.255 UGH    0      0      0 satel0
192.168.1.10    10.10.10.1     255.255.255.255 UGH    0      0      0 satel0
192.168.1.12    10.10.10.2     255.255.255.255 UGH    0      0      0 satel0
192.168.1.0     *               255.255.255.0   U      0      0      0 eth0
10.10.10.0      *               255.255.255.0   U      0      0      0 satel0
127.0.0.0       *               255.0.0.0       U      0      0      0 lo
default         10.10.10.1     0.0.0.0         UG     0      0      0 satel0
  
```

IP-LINK 3 routing table.

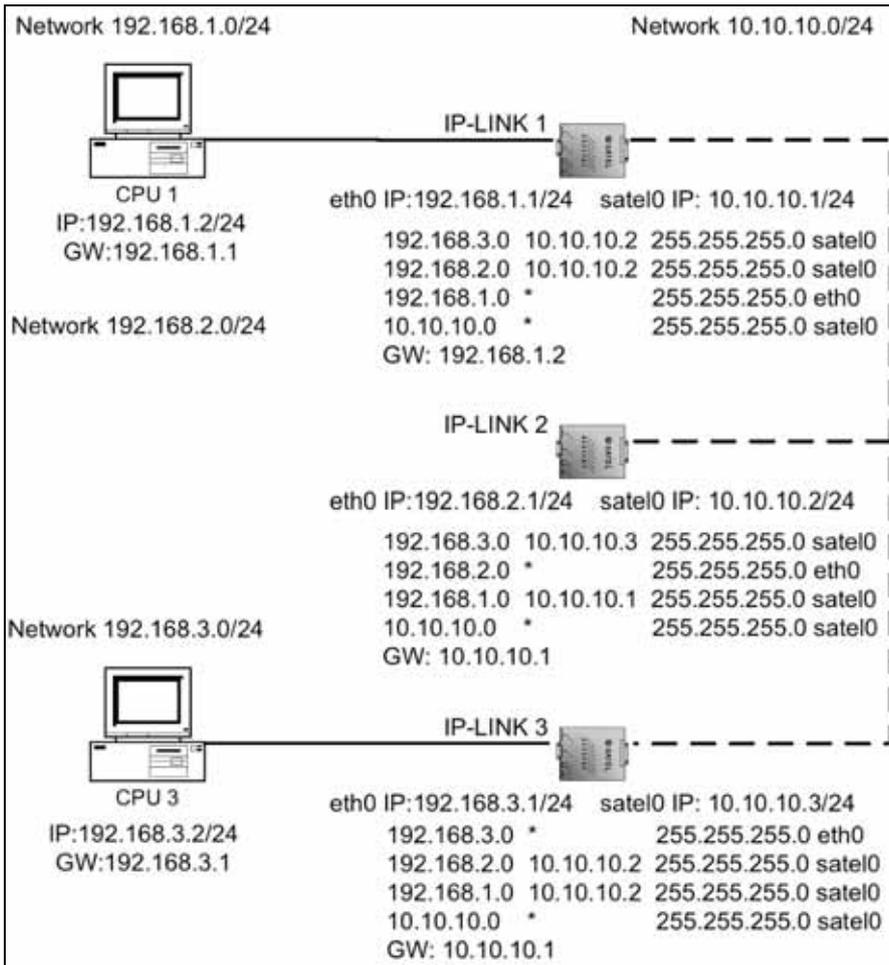
Example 3 Using a Repeater

With IP-LINK it is not possible to use radio modem alone as a repeater but IP-LINK is always needed. As an example the network from the first example.



Network where IP-LINK 1 and IP-LINK 3 do NOT have a direct radio connection. IP-LINK 2 is used as a repeating station. Radio modems not shown in the picture.

The setting is similar to example 1 with the IP addresses but routes must be different. IP-LINK 1 needs to use IP-LINK 2 to send data to IP-LINK 3 and vice versa. So the routes for networks 192.168.1.0/24 and 192.168.3.0/24 must be defined through IP-LINK 2. IP-LINK 2 has same routes as in the example 1.



Network with routes. The routes between IP-LINK 1 and IP-LINK 3 go through IP-LINK 2 (10.10.10.2).

Naturally it is possible to add CPU 2 to the network, as in the example 1. Note that the transmission speed between CPU 1 and CPU 3 is now half compared to the example 1.

NAT

NAT (Network Address Translation) hides the other IP addresses behind the device where the NAT is ON.

As an example look at the network in the example 1. If there would be only one IP address available to be used, but we needed many devices with IP-LINKs we can use NAT. This happens for example with Internet connections, you only get one IP address to use.

We need to set the NAT ON in IP-LINK 1 AND set Ethernet Proxy ARP OFF. The reason for disabling Proxy ARP is that when the Proxy ARP is ON the IP-LINK 1 will answer to ARP queries for packets to the networks it has in the routing table. As we assume in this case we can only use one IP address and that is in the IP-LINK 1 Ethernet interface. So now it is possible (but not recommended) to have duplicate IP addresses (same IP addresses as are behind the IP-LINK 1) since the NAT hides away the rest of the network.

Proxy ARP setting OFF does not affect normal ARP queries.

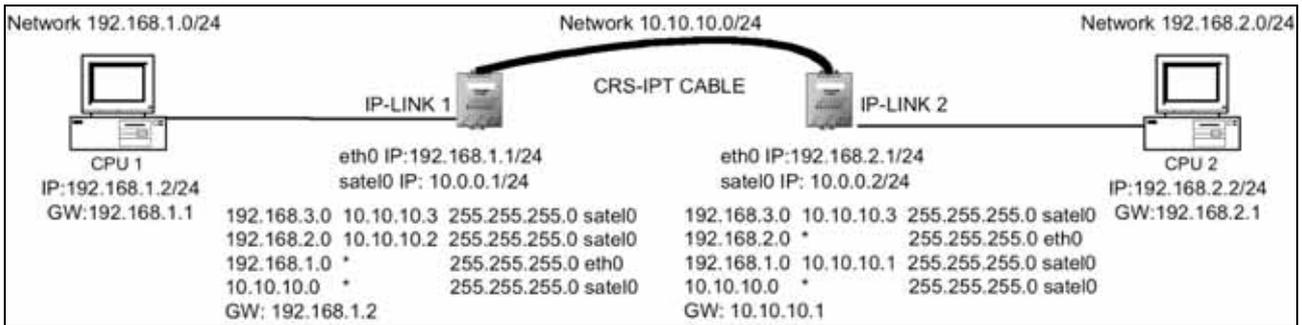
The only limitation with NAT is that you have to open the connection from inside the NATted network. It is not possible to open the connection from the outside (and especially since we set the Proxy ARP OFF).

The IP-LINK 1 NAT table will keep track of the connections opened from the NATted network. This is automatic and needs no settings.

For example when CPU 2 sends a packet to CPU 1, IP-LINK 1 will change the source address in the packet from 192.168.2.2 (CPU2) to 192.168.1.1 (IP-LINK 1 eth0).

When CPU 1 responds to that packet, it will send it to address 192.168.1.1 (IP-LINK 1 eth0) and IP-LINK 1 NAT knows that this packet must be send to 192.168.2.2 (CPU2) and changes the destination address of the packet. NAT will keep track of the individual sequence numbers on the packets so it will know which packets belong to which connection.

When you set NAT ON the Firewall must also be set ON. By default no firewall rules are defined, so only the NAT is ON.



IP-LINKs connected with test cable CRS-IPT.

Does it work now? If it does, check the settings in the radio modems. If it does not, there is something wrong in the IP or routing settings.

Does the system work at all ?

Connect the CPU 1 and CPU 2 together, but you have to change the settings to a same network.

When testing a system on a table with radio modems set the TX power to the minimum.

If the (in SATELLINE-3AS) CD led is YELLOW, when there is not a transmission decrease the threshold level in 3dBm steps, from -112dBm to -109dBm. Is the CD still yellow ? Decrease from -109dBm to -106dBm. Repeat if necessary. It is recommended to use cable CRS-TSU between IP-LINK and radio modem.

“Ping 192.168.2.2 “works poorly over the radio modems, from CPU 1 to CPU 2.

How poorly ? Run “ping -n 100 192.168.2.2” from CPU 1. This sends 100 ping packets.

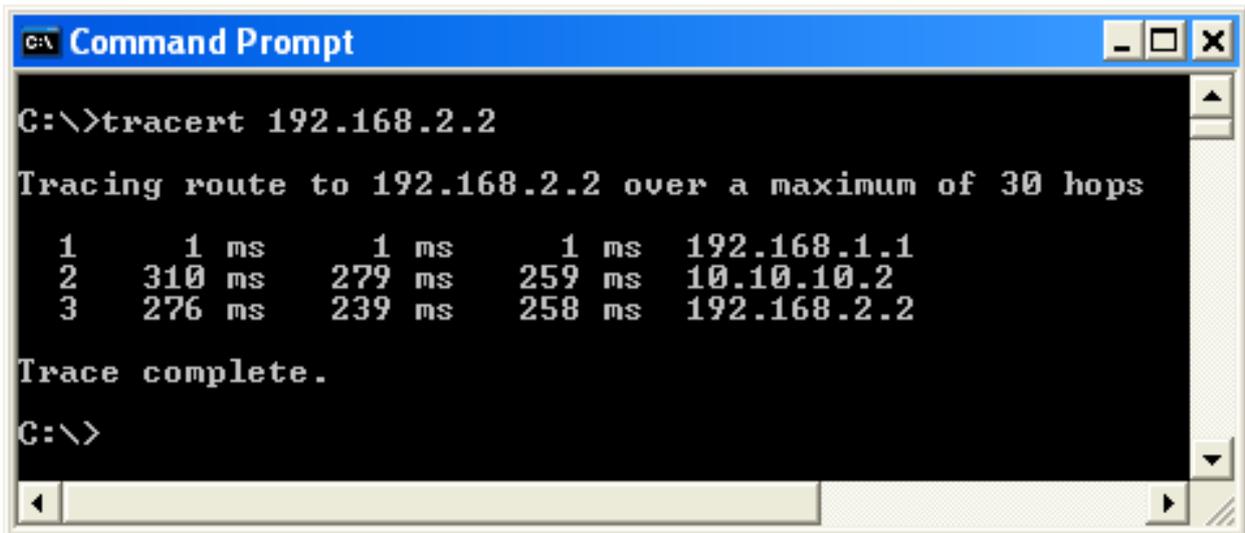
What is the packet loss ratio? If it is a few percent it is acceptable.

If the packet loss is greater, check the radio modems.

In a system with multiple devices (like in example 1) if you ping all the devices you will get a higher packet loss ratio. Ping uses ICMP protocol which does not have retransmissions. TCP protocol has retransmissions. IP-LINK has the random collision *avoidance* protocol for the radio interface but it is not completely collision *free*. In a case with multiple devices IP-LINK radio protocol settings may need to be changed. This increases the delay but the probability for collisions is smaller. The IP-LINK radio protocol settings are in “3)Radio Interface Settings”. If needed it is possible to change the “7)Max Random Factor for Time” to a higher value, try increasing it one step at a time.

If the radio channel is very noisy (noticeable from the CD led) it may be needed to change the handshaking setting from the radio modem from “RSSI-threshold” to “Data on channel”. In the worst cases the CD-line monitoring can be set off from the IP-LINK “Use CD Signal for TX Control”

Run Traceroute from CPU 1 command line as follows: “tracert 192.168.2.2”. Traceroute will show all the IP-addresses where the Ping packet has gone. If there are too many addresses check the routing settings.



```
C:\>tracert 192.168.2.2

Tracing route to 192.168.2.2 over a maximum of 30 hops

  1     1 ms     1 ms     1 ms    192.168.1.1
  2    310 ms    279 ms    259 ms    10.10.10.2
  3    276 ms    239 ms    258 ms    192.168.2.2

Trace complete.

C:\>
```

Traceroute to 192.168.2.2 (CPU 2) from 192.168.1.2 (CPU1). The Ping request has first gone through IP-LINK 1 ethernet interface, then through IP-LINK 2 radio interface and then to the destination (192.168.2.2).

The system does not work well.

The transfer speed may just be too slow for the application. The radio modem bandwidth is shared among all devices and TCP is two way communication. So, with 3 IP-LINKs individual customer device gets 1/6 of the nominal radio modem transfer speed 19200 bauds. This applies to situations when every device is communicating at the same time and at the both directions. If the devices do not operate at the same time (for example polling system) the transfer speed is better. Communication to one direction is usually 80% TCP data and 20% of TCP acknowledgements.

If three or more devices are used depending on the application the random factor for transmission may need to be increased. As a rule of thumb, the random factor should be twice the amount of devices. So for 3 devices it can be 6, for 4 devices it should be 8. This depends on the application so in most cases the default value of 4 is good. Increasing the value minimises the collision probability but increases the delay.