

InfiNet Wireless Router

Quick start guide

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I. Getting Started

This document is designed to help engineers/technicians in rapid configuring of InfiNet Wireless Routers. The document includes detailed instructions for first configuration steps and configuration scenarios for typical network topologies.

1. Scope of document

This document consists of the following chapters:

Getting started

This chapter includes the information about this document purpose and structure.

Getting access to the router

The chapter describes how to get access to the router via Console Port and to configure Ethernet port.

Point-to-point configuration

This chapter includes a comprehensive list of instructions for point-to-point link configuration including providing LAN connectivity.

Point-to-multipoint configuration

The chapter briefly describes the difference between PTM and PTP topology when building a network based on InfiNet Wireless Routers. Due to similarity of PTM and PTP configuration it mostly references a previous chapter.

Performing outdoor testing

The chapter contains a list of requirements for outdoor testing. Also a basic steps for link improvement and antenna alignment is presented.

2. Abbreviations

The following abbreviations are used in this document:

- BS – Base Station
- CPE – Customer Premises Equipment (also called **subscriber** or **subscriber unit**)
- ODU – Outdoor Unit (relevant for 5000-O and 5000-M modifications)
- IDU – Indoor power supply Unit (relevant for 5000-O and 5000-M modifications)
- RF cable – Radio Frequency cable to connect ODU and antenna/Router and antenna for 5000-O and 5000-I modifications correspondingly
- LOS – Line-of-Sight
- STP cable – Shielded Twisted Pair cable to connect ODU and IDU (relevant for 5000-O and 5000-M modifications)
- PTP – Point-to-Point topology
- PTM – Point-to-Multipoint topology
- RMA – Routed Multiple Access Protocol

3. Document marks



All warnings are marked with a special warning sign. One should pay a great deal of attention to what is written in the Warning sections.



All notes are marked with a special note sign. Notes usually contain useful comments or hints to the described section of the document.

4. Additional information

Additional information which is not included in this Manual can be found in the following sources:

- Device passport located in the box with the device
- InfiNet Wireless Router. Technical User Manual
- WANFlex OS User Guide
- Our web-site: www.infinetwireless.com

II. Getting access to the router

1. PC/Laptop/LAN connection

Cabling (lab)

The sequence of actions to be performed in order to connect the router to the PC/Laptop is the following:

1. Unpack the equipment
2. If you do not have a service cable soldered, please do it using special connectors included into the package according to the soldering scheme located in the "Supplementary information" section. STP cable cat 5 or cat 5E should be used.
3. Locate IDU (blue case) and ODU (white case). Using STP Service cable connect ODU and IDU. Service cable sockets are marked on the diagrams below



Figure 1. IDU Front

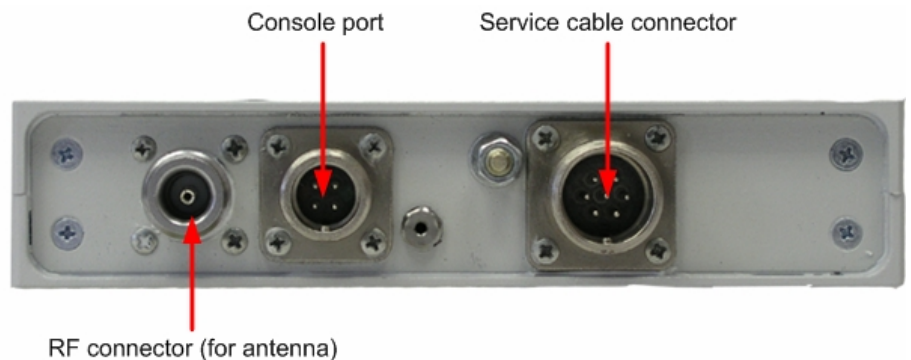


Figure 2. 5000-O ODU Front

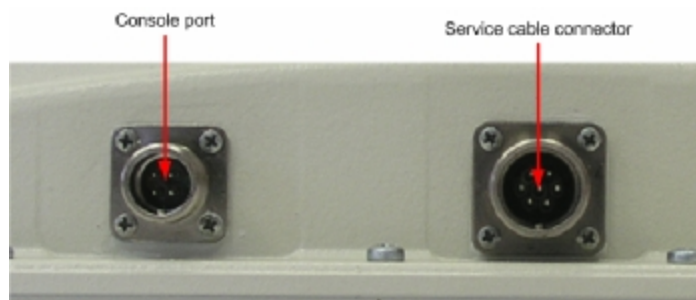


Figure 3. 5000-M ODU Front (fragment)

Accessing the router via Console

If you cannot get access to the router using procedure described in “Accessing the router via Ethernet” section please follow the steps described in this section.

1. Using InfiNet Console Cable please connect the router’s console port (see Fig. 2) to the COM-port of your PC/Laptop



In order to accomplish the steps described in this section your PC/Laptop must be equipped with a COM-port

2. Locate the power cord in the package
3. Plug the power cord into the IDU power supply connector and to the power supply socket (220V 50 Hz or 110V 60 Hz depending on the country of residence)
4. Green power indicator on the IDU must light up
5. Power your PC/Laptop on



Following step's screenshots are taken from Microsoft Windows XP. You can also perform this procedure in Microsoft Windows 98/NT/2003

6. Run Hyperterminal. See Figure 4

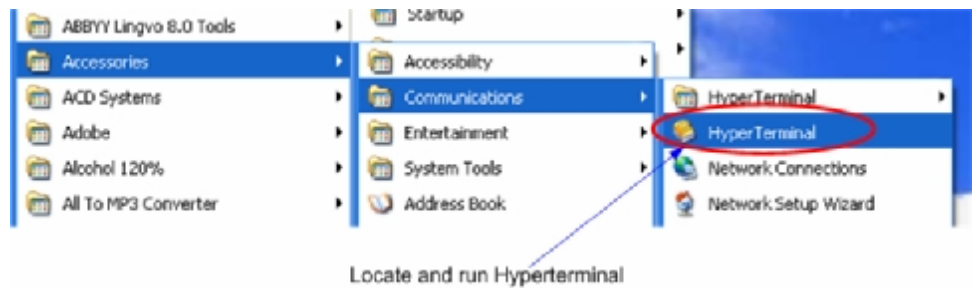


Figure 4. Locate Hyperterminal

7. Indicate connection name (e.g. “IWR Lab Test”) and specify the COM-port name to which the router is connected. See Figure 5

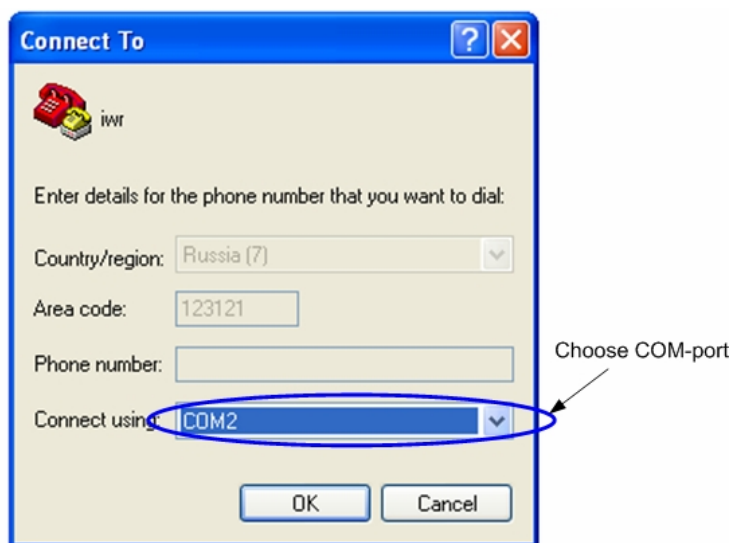
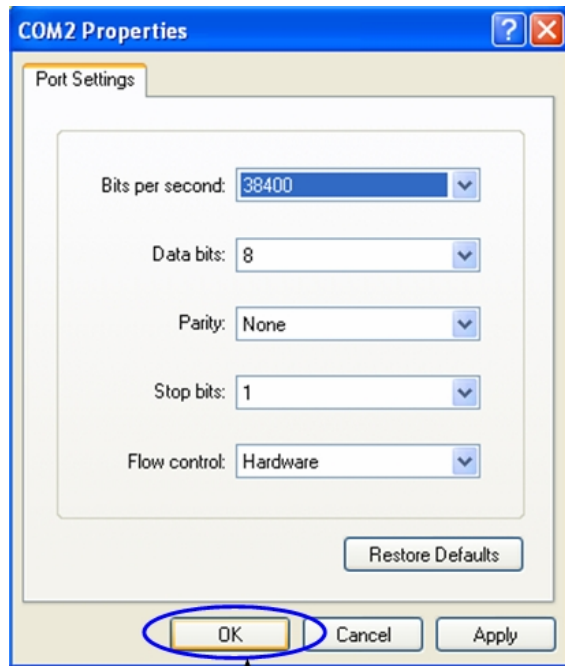


Figure 5. Select the port

- Specify port parameters exactly as shown on Figure 6



After configuring, press OK

Figure 6. Port parameters

- If you connected everything properly, selected the right port and made its configuration right, after pressing enter on the white blank screen (after step 8) you should see WANFlex OS prompt as shown on Figure 7

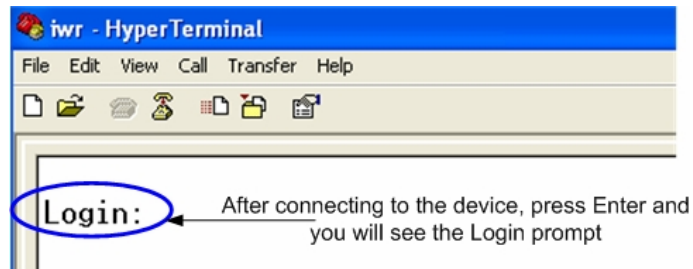


Figure 7. WANFlex OS prompt

- Your device has a factory configuration. That means that you can enter ANY non-zero length login and password. Once this is done, you will see WANFlex CLI (Command Line Interface). See Figure 8

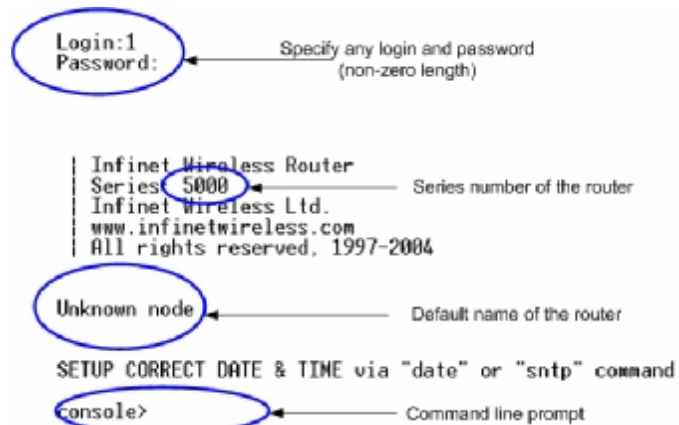


Figure 8. "After login" screen

11. In order for your Router to be accessible from your LAN/PC/Laptop via Ethernet, you should configure **eth0** interface IP-address so the router would allocate in the desired LAN (or accessible from your PC/Laptop Ethernet adapter). You can change this IP-address via "**ifc eth0**" command as shown on figure 9. After changing the IP-address, save the configuration using "**co sa**" command. In the example given the IP-address being assigned to **eth0** interface is **9.1.8.1** with mask length 24 (255.255.255.0). In order to check whether your changes were correct, use "**co sh ifc**" command which shows configuration for all interfaces of the router. Do not forget to save your configuration using "**co sa**" (config save) command.

Changing IP-address on Ethernet interface

```

console> ifc eth0 9.1.8.1/24
console> co sh ifc
#Interfaces parameters
ifc lo0 127.0.0.1/8
ifc eth0 9.1.8.1/24
ifc eth0 media auto mtu 1500 up
ifc rf4.0 mtu 1500 up

console> co sa
Ok!
console> _

```

Figure 9. Changing IP-address on **eth0** interface

12. If all your settings are correct you can connect the router to your LAN using UTP cable with RJ-45 connectors (Ethernet port of the router is located on IDU).

Accessing the router via Ethernet

If your PC/Laptop does not have a COM-port or you want to plug the router to the LAN switch you can configure it using Telnet protocol.

The default IP-address assigned to the **eth0** interface of the router is **10.10.10.1** with 255.255.255.0 mask.

If you connect the router directly to the LAN/PC/Laptop you should either change the IP-address on the Ethernet adaptor or create an alias IP-address which would be located in **10.10.10.0/24** network.

Connect the router to LAN/PC/Laptop using UTP cable with RJ-45 connectors.

The procedure is the following:

1. Open the Control Panel in Windows. See Figure 10

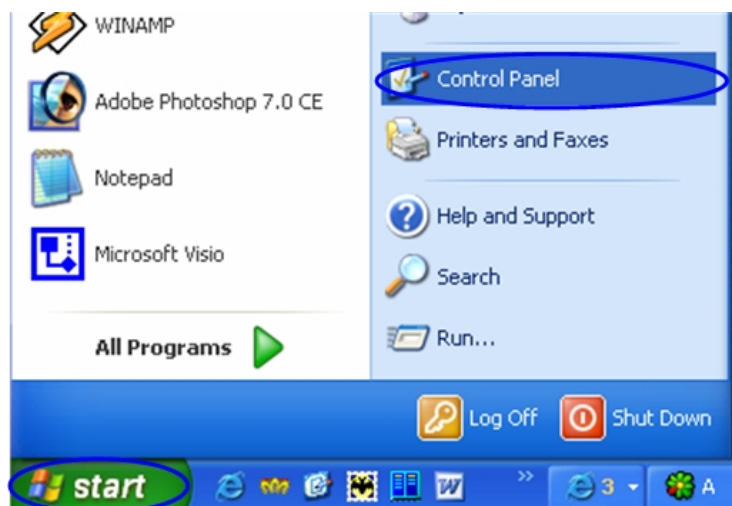


Figure 10. Open Control Panel

2. Open "Network connections" icon. See Figure 11



Figure 11. "Network connections"

3. In "Network connections" folder right mouse button click on the LAN connection and click "Properties". See Figure 12

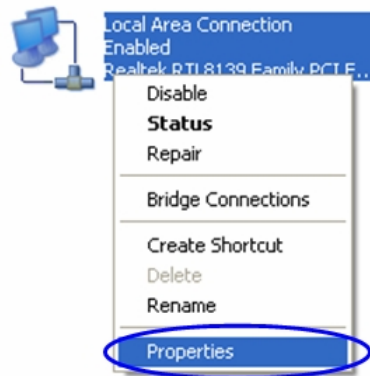


Figure 12. LAN Connection properties

4. Choose "Internet protocol (TCP/IP)" and click "Properties". See Figure 13.

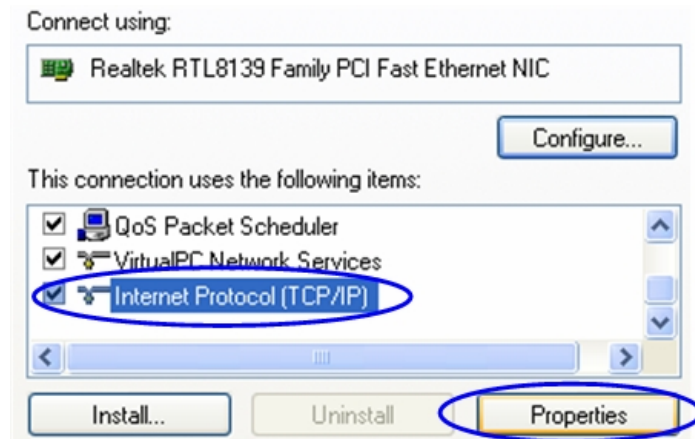


Figure 13. Internet Protocol Properties

5. If you want to connect to the router using PC/Laptop you can just change an IP-address on the Ethernet adaptor to some address from 10.10.10.0/24 network (e.g. change "IP-address" field to "10.10.10.2" and "Subnet mask" to "255.255.255.0"). After that click OK and move to step 7. See Figure 14

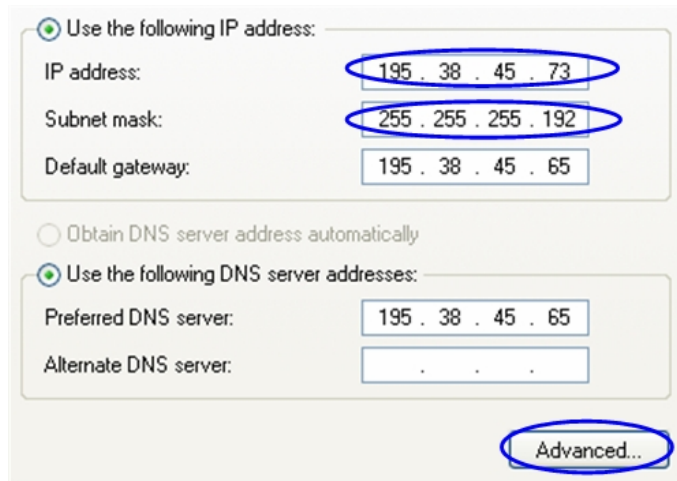


Figure 14. Change IP-address

- If you are in a LAN and you do not want to change your primary IP-address so you could keep LAN connectivity, you can assign an alias. In order to do that, press "Advanced..." button (Figure 14). In "Advanced TCP/IP Settings" click "Add" and put alias IP-address and mask (e.g. "10.10.10.2" and "255.255.255.0" correspondingly). See Figure 15. Click OK in all windows opened in the described procedure.

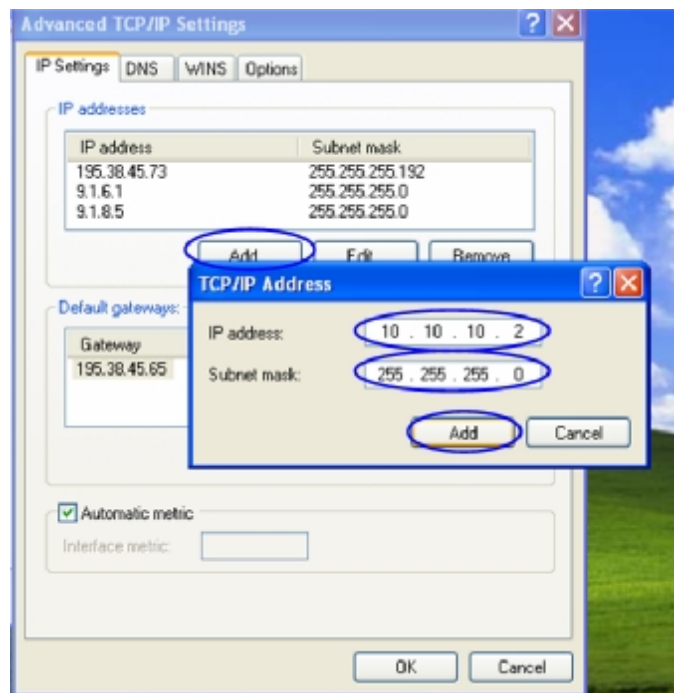


Figure 15. Create alias

- Run "Telnet" utility using "Start->Run" and typing "telnet IP-address" where IP-address is either the IP-address configured at Step 5 or alias configured at Step 6.
- Follow Steps 9 to 11 of "Accessing the router via Console" section in order to change the IP-address on the eth0 interface on the router to the desired one.

2. Initial setup

Once you have got the access to the router via Telnet, you can perform initial router setup. Run telnet application (Start->Run) using IP-address that was assigned on the eth0 interface of the router (for example, 9.1.8.1)

First of all, let us list some useful commands that should be remembered.

- “help” – lists all available commands in the router
- “config show” (or “co sh” for short) – shows router’s current configuration
- “config save” (or “co sa” for short) – saves router’s current configuration
- “restart y” – immediate router reboot. Reboot lasts for 15 seconds (approximately) and during this time you will not be able to control it over Telnet
- “quit” – finishes current configuration session



The maximum number of concurrent Telnet sessions per one router is five.

System parameters

Once you’ve got access to the router, the most common thing to be done in the first turn is to set up some basic system parameters:

- System name. System name is specified by the following command:
system name [system_name]
- System user. This parameter will be used as a login:
system user [user_name]
- System password. System password is used as a password while login:
system password [password]
- System prompt. This command will change current command line interface prompt:
system prompt [any_word]

Also, it may be useful to know firmware version that is currently available in the router and router’s serial number. “Sys ver” command can be used for this purpose (Figure 16):

Firmware version	Firmware compilation time	Device Serial Number
↓	↓	↓
<pre>iwr_test#1> sys ver RS000 WANFlex 3.33-MINI <type 0> * Oct 11 2004 10:33:48 * SN:4593 iwr_test#1></pre>		

Figure 16. System version

Learning router’s capabilities

1. In order to learn current interfaces configuration, execute “co sh ifc” command
2. In order to learn all configured interfaces, their states and statistics, execute “ifc -a” command. See Figure 17.

```

Loopback interface
ifconfig test#1> ifconfig -a
(lo0: flags=8009<UP,LOOPBACK,MULTICAST> mtu 1500
  inet 127.0.0.1 netmask 0xff000000
Ethernet interface
eth0: flags=8003<UP,BROADCAST,MULTICAST> mtu 1500
  inet 9.1.8.1 netmask 0xffffffff broadcast
  ether 00:04:35:00:11:f1
eth0 is up, line protocol is up
  full-duplex, 100Mb/s
  Received 2161 packets, 273824 bytes
  0 pause packets, 0 bad packets, 0 overrun
  0 short packets, 0 alignment errors, 0 CR
  0 long packets, 0 out of range errors, 0
  Transmitted 103 packets, 6538 bytes
  64 CRC errors, 0 carrier loss, 0 excessiv
  0 excessive collisions, 0 late collisions
  0 multiple collisions, 0 single collision
  0 underruns, 0 SQE tests failed
Radio interface
rf4.0: flags=8003<UP,BROADCAST,MULTICAST> mtu 150
  inet 0.0.0.0 netmask 0x0
  ether 00:02:8a:e1:dd:13
Logical interface
null0: flags=8802<BROADCAST, NULL, MULTICAST> mtu 1
MAC-address for rf4.0 radio

```

Figure 17. Interfaces information

Note that radio interface name may differ from "rf4.0" depending on the model's frequency range (2.4GHz or 5GHz) and number of radio modules in the device (one or two). Anyway, radio interface name always starts with "rf".

Information on the specific interface can be obtained using "ifconfig <IF-NAME>" command. For example, "ifconfig rf4.0" will give you information on "rf4.0" interface.

3. In order to get router's capabilities including available frequency list, transmit power levels, bitrates for the specific radio interface, "rf <IF-NAME> cap" command is used. For example, "rf rf4.0 cap". See Figure 18.

```

Atheros AR5212 radio capabilities:
MAC silicon revision:      5.6
PHY silicon revision:     4.1
5GHz analog silicon revision: 1.7
Power levels (mW):        6, 8, 16, 32, 63
MAC address:              00028ae1daa8
Frequency list:           5260, 5280, 5300, 5320, 5340,
                          6000, 9000, 12000, 18000,
Bitrate list:             24000, 36000, 48000, 54000

```

Figure 18. Router's capabilities

Radio module parameters configuration

1. Power level changing is accomplished using "rf <IF-NAME> pwr <power-level>" command. For example, "rf rf4.0 pwr 32" sets transmitting power level to 32 mW. Power level specified in the command should be the one from the list of available power levels.
2. Frequency changing is accomplished using "rf <IF-NAME> freq <frequency>" command. For example, "rf rf4.0 freq 5340" sets current working frequency to 5340 MHz. At the same time one radio module can work only on ONE frequency.
3. Bitrate can be changed using "rf rf4.0 bitr <bitrate>" command. For example, "rf rf4.0 bitr 24000" sets current bitrate to 24 Mbps.

III.Point-to-Point configuration

In our point-to-point configuration example we will built a simple network as shown in Figure 19.

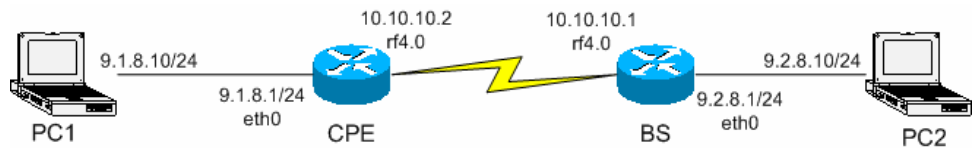


Figure 19. Sample network (PtP connection)

Here we will set up a connection between two PC/Laptops.



All configuration samples and notes will use IP-addresses and names as specified in Figure 19.

1. Routers configuration

1. Choose one of the routers to be CPE and the other one to be BS.
2. Provide connectivity from PC1 to CPE and PC2 to BS following the procedure described in "Getting access to the router". As a result you should make sure that you can ping/telnet CPE from PC1 and ping/telnet from PC2
3. Now we will proceed to routers configuration. From PC1 enter CPE router using Telnet (Start->Run: "telnet 9.1.8.1") and from PC2 enter BS router ("telnet 9.2.8.1")
4. On BS: configure desired frequency (e.g. "rf rf4.0 freq 5300"). Configure SID (system identifier) - system identifier of the router, a hexadecimal number in the range of 1H to FFFFFH. All routers that are supposed to see each other on the same radio link must have the same identifier – for example:

rf rf4.0 sid 20202020

5. On CPE: obtain its MAC-address for radio interface. In order to do that type: "ifc <IF-NAME>". IF-NAME – name of the radio interface. For example, "ifc rf4.0". See Figure 20.

```
CPE#1> ifc rf4.0
rf4.0: flags=8003<UP,BROADCAST,MULTICAST> mtu 1500
       inet 10.10.10.2 netmask 0xffffffc broadcast 10.10.10.3
       ether 00:02:8a:e1:dd:13
```

Write down this MAC-address

Figure 20. Obtaining CPE MAC-address

6. On BS: using rma command configure the CPE. The command looks as follows:

rma ab <IF-NAME> <MAC> ip=<IP> name=<NAME>

- IF-NAME – name of the radio interface (e.g. rf4.0)
- MAC – MAC-address of the configured CPE (see step 5)
- ip – IP-address for the radio interface with THIS CPE as viewed from the Base Station. For example, you set up 10.10.10.1 IP-address for the CPE. Once CPE is registered at the Base Station, the BS will **automatically** assign IP-address to CPE radio interface with the BS. In our example, it will be 10.10.10.2 address – a connection of BS with EACH CPE is described as a sub-network with mask length 30 – that means that 10.10.10.3 would become a broadcast address.

- **NAME** – CPE's mnemonic name.

In our sample network this configuration string will look as follows:

```
rma ab rf4.0 00028ae1dd13 ip=10.10.10.1 name=CPE
```



VERY IMPORTANT! ETHERNET IP-ADDRESS AND IP-ADDRESS FOR RADIO INTERFACE MUST BE IN DIFFERENT NETWORKS

This warning is very important. That means that if you have 10.10.10.1/24 address on the Ethernet interface you **cannot** have any of 10.10.10.0/24 addresses on your radio interface.

7. On BS: type "rma start". This will run Routed Multiple Access Protocol. From this moment BS will wait for the configured CPEs (in our case it's only one CPE) for the registration request.

8. On CPE: we need to configure our BS for this CPE. "rma bs" command is used for this purpose. Generally, each CPE can be configured for several BS. But in our example we have only one BS to establish a PTP link. The syntax for BS configuring is the following:

```
rma bs <IF-NAME> SID/[MINSPEED/]SPEED <FREQ-LIST>
```

- **<IF-NAME>** - radio interface name (e.g. rf4.0)
- **SID** – System identifier of the BS you want to connect to. In our case it will be 20202020 (see step 4)
- **MINSPEED** – if **autobitrade** mechanism is used (see below) this value will set the minimal value for the bitrate. This parameter is optional. If skipped, the lowest available bitrate will be used
- **SPEED** – BS requested connection speed. This speed should not be higher than maximal available bitrate for the CPE (see capabilities of the router). If **autobitrade** is not set, BS will work with CPE on this speed. If **autobitrade** is set, BS will transmit on the highest reachable (and available) bitrate and CPE will transmit on highest reachable speed but not higher than **SPEED** value
- **FREQ-LIST** – list of frequencies on which the BS should be searched. It can be one or several frequencies.

In our example the most evident thing that we must write is:

```
rma rf4.0 20202020/24000 5300
```

9. On CPE: type "rma start". This will start Routed Multiple Access Protocol for the CPE and it will immediately start "searching" for the configured BS by sending registration requests.

10. On BS: turn on polling mode on. Polling mode (Wireless Marker Access) is **STRONGLY RECOMMENDED** to be used in ALL cases as well as RMA protocol.

In order to turn polling on, please type:

```
rma <IF-NAME> poll
```

In our case, **rma rf4.0 poll**



Polling mode is turned on ONLY for the Base Station. This will include ALL Base Station's CPEs into the polling circle!

12. Do not forget to save the configuration using "co sa" command on both CPE and BS

2. Learning BS/CPE connection status

Once all configuration steps are correctly performed you should make sure that the connection is established.

Actually, it makes no sense to connect antennas to the devices while lab testing but still you need to make them “hear” each other. In order to do that, locate their RF connector as close to each other as possible. Also you may try inserting some kind of steel paper-clip in the connector – this might help in signal improvement.

Base Station table

Base Station has a table of all configured CPEs no matter whether they are registered or not. In our case, the table looks as shown on Figure 21 if CPE is registered and as shown on Figure 22 if CPE is not registered. The command to view BS table is “rma ab”.

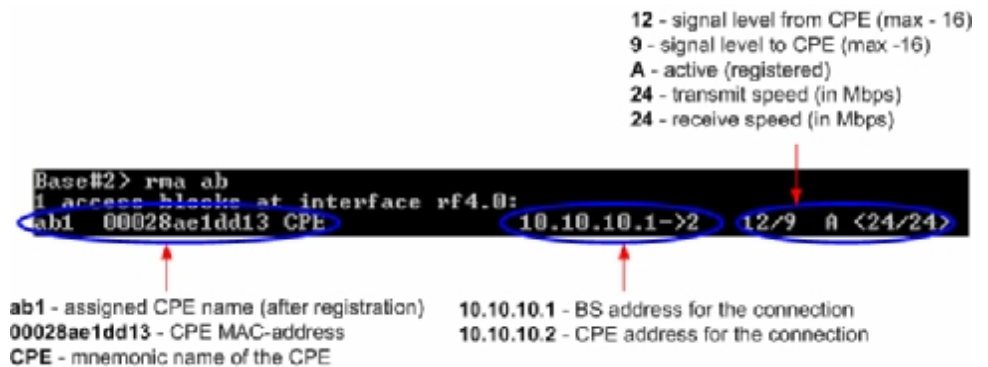


Figure 21. BS table with registered CPE



Figure 22. BS table with not-registered CPE

CPE registration status

In order to know whether CPE is registered at the BS, one should type “rma bs”. If CPE is **not** registered at the BS, the command will not output anything, otherwise it will show BS information at which the CPE is registered. See Figure 23.

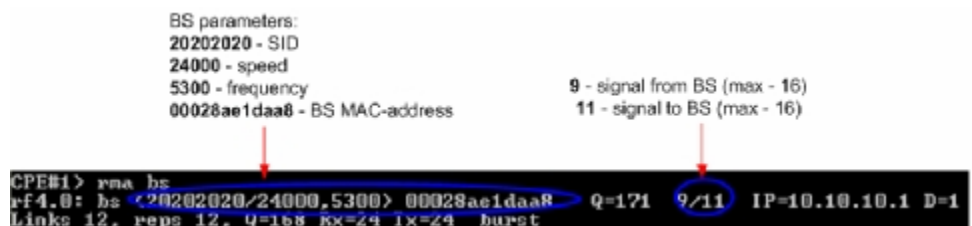


Figure 23. CPE registration status

If CPE is not registered on the BS, the command “rma bs” will have an empty output.

Checking radio connectivity

As soon as you see corresponding records at CPE side (rma bs command) confirming BS registration, and CPE is in BS’s table (rma ab command), you can check their connectivity also using ping command.

1. Pinging from BS to CPE via radio

When CPE registers at the BS it is automatically assigned an IP-address next to that from the BS side. In our case BS has 10.10.10.1 IP-address for RF interface with the CPE and CPE in its turn has 10.10.10.2 for the RF connection. See Figure 21: it says "10.10.10.1->2". Figure 24 shows ping result from BS to CPE.

```
Base#1> ping 10.10.10.2
ping <10.10.10.2>: 56 data bytes
64 bytes from 10.10.10.2: icmp_seq=0 ttl=255 time=1 ms
64 bytes from 10.10.10.2: icmp_seq=1 ttl=255 time=1 ms
64 bytes from 10.10.10.2: icmp_seq=2 ttl=255 time=<1 ms
64 bytes from 10.10.10.2: icmp_seq=3 ttl=255 time=1 ms
64 bytes from 10.10.10.2: icmp_seq=4 ttl=255 time=<1 ms
--- 10.10.10.2 ping statistics ---
5 packets transmitted, 5 packets received, 0% packet loss
```

Figure 24. Ping from BS to CPE

2. Pinging from CPE to BS via radio

The idea stays the same. From CPE we should use BS's IP-address for the RF connection. See Figure 25.

```
CPE#1> ping 10.10.10.1
ping <10.10.10.1>: 56 data bytes
64 bytes from 10.10.10.1: icmp_seq=0 ttl=255 time=1 ms
64 bytes from 10.10.10.1: icmp_seq=1 ttl=255 time=1 ms
64 bytes from 10.10.10.1: icmp_seq=2 ttl=255 time=1 ms
64 bytes from 10.10.10.1: icmp_seq=3 ttl=255 time=1 ms
64 bytes from 10.10.10.1: icmp_seq=4 ttl=255 time=1 ms
--- 10.10.10.1 ping statistics ---
5 packets transmitted, 5 packets received, 0% packet loss
```

Figure 25. Ping from CPE to BS

3. Providing PC/LAN connectivity

Once radios "see" each other we need to make our LAN/PC/Laptop "see" each other also. The best thing that should be done in the first turn is to turn on dynamic routing on both of the devices. InfiNet Wireless Router supports two types of routing: static routing (using `route add` command) and dynamic routing using RIP v1 and v2 (command `rip` – Routing Information Protocol).

In order to turn RIP on, on both BS and CPE, type: `rip start`. This will start dynamic routing and will force the routers with RIP turned on to exchange their routing tables with each other. The exchange is performed approximately every 30 seconds.

On the Figure 26 Routing tables are shown (use `net -r` command) to make sure that RIP protocol has already exchanged the routing tables with the remote.

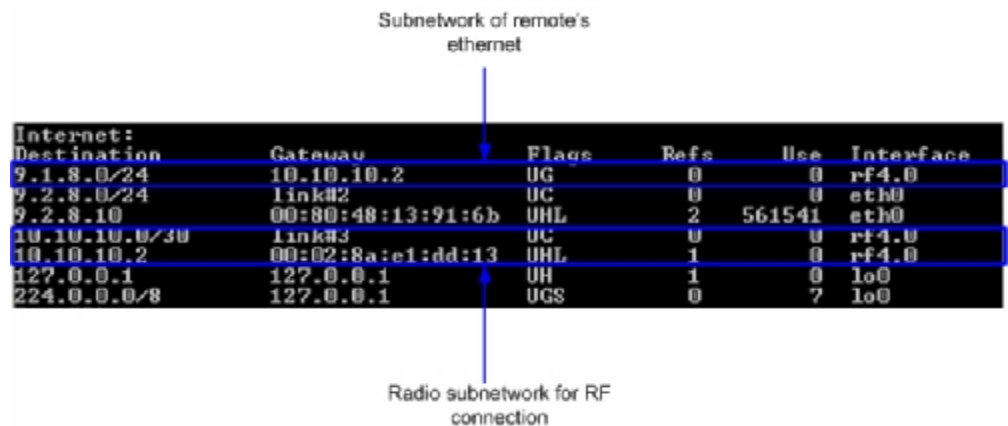


Figure 26. Routing tables

At this point, you can reach (e.g. ping) remote's eth0 interface both from BS to CPE and from CPE to BS. For example, from Base Station you can ping CPE's Ethernet interface (IP-address is 9.1.8.1). See Figure 27.

```
Base#3> ping 9.1.8.1
ping (9.1.8.1): 56 data bytes
64 bytes from 9.1.8.1: icmp_seq=0 ttl=255 time=1 ms
64 bytes from 9.1.8.1: icmp_seq=1 ttl=255 time=<1 ms
64 bytes from 9.1.8.1: icmp_seq=2 ttl=255 time=1 ms
64 bytes from 9.1.8.1: icmp_seq=3 ttl=255 time=<1 ms
64 bytes from 9.1.8.1: icmp_seq=4 ttl=255 time=1 ms
--- 9.1.8.1 ping statistics ---
5 packets transmitted, 5 packets received, 0% packet loss
```

Figure 27. Pinging remote's Ethernet

The next step is to make you Laptops/PC/LAN "see" each other.

If you connect two PC/Laptops (with MS Windows installed) two options are available in this case:

1. Write a route to the corresponding Ethernet network at the opposite side of the link. In order to do this, go "Start->Run" and run "cmd" – Command Line. At the BS computer you should write the following:


```
route add 9.1.8.0 mask 255.255.255.0 9.2.8.1
```

This means that when an IP-packet goes from the computer connected to your BS device to the computer at the CPE side, it will go to the BS Ethernet interface. In the router, according to the routing tables formed using RIP protocol, the packet will be sent via radio to the CPE router. After that, CPE router will look up in its routing tables and send the packet through its Ethernet interface to the remote computer.

At the CPE computer you should perform similar actions. Go "Start->Run" and run "cmd" command. Type the following:

```
route add 9.2.8.0 mask 255.255.255.0 9.1.8.1
```

Now we provided connectivity between two computers.

 *All routes in Windows that are specified using **route** command have power until next reboot of the computer.*

2. The second option is to specify a **default gateway** for the PC/Laptop which is going to be an Ethernet interface of the connected router. You can specify default gateway parameter in the window shown on Figure 14. Please refer. For the BS side it will be 9.2.8.1, for CPE – 9.1.8.1

In order to make sure that your PC/Laptops are connected, you can ping one side from the other one. For example, from BS connected computer we are pinging remote computer at the CPE side (Figure 28)

```
Pinging 9.1.8.1 with 32 bytes of data:
Reply from 9.1.8.1: bytes=32 time<1ms TTL=255
Reply from 9.1.8.1: bytes=32 time<1ms TTL=255
Reply from 9.1.8.1: bytes=32 time<1ms TTL=255
Reply from 9.1.8.1: bytes=32 time<1ms TTL=255
Ping statistics for 9.1.8.1:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 0ms, Maximum = 0ms, Average = 0ms
```

Figure 28. Pinging remote computer

Once attainability is obtained from both sides, you can try to carry out some performance tests.

4. Link throughput test

The most evident way to test link throughput is to install FTP server on either first or second computer. For example, we set it up on the CPE computer.

During link throughput test using PC or Laptop with MS Windows please note the following:

1. Hard disk drive speed or Ethernet adaptor speed may become a bottleneck of the system at either side.
2. In MS Windows you need to run several (3 or more) TCP or UDP streams to load up the radio link. In this case you will obtain a correct result.

Log on to FTP server on the remote computer. To do that go "Start->Run" and execute "ftp 9.1.8.10". IP-address 9.1.8.10 is the address of the remote computer. Enter login and password for the FTP-server.

Run several FTP streams from the remote computer. In order to do that create several FTP sessions according to the procedure described in the previous paragraph and start downloading files from the remote computer (files should be relatively big).

Once the streams are run you can check the throughput using Load Meter utility built into the router. You can run it on either side. Run it for the eth0 interface. The command is the following:

loadm -l eth0

"-l" parameter means line-by-line output.

The example is shown on the Figure 29.

```
Base#3> loadm -l eth0
```

Load Meter 1.2										
All results in Kbits per second										
Name	I N P U T				O U T P U T				SUM	PACKETS
	cur	avg	max	packets	cur	avg	max	packets		
eth0	339	339	339	689	15245	15231	15245	1291	15584	1980
eth0	329	334	339	668	14859	15045	15245	1261	15188	1929
eth0	332	333	339	674	14974	15021	15245	1268	15306	1942
eth0	327	332	339	666	14878	14985	15245	1262	15205	1928
eth0	336	333	339	681	15186	15025	15245	1288	15522	1969
eth0	338	333	339	672	14802	14988	15245	1255	15140	1927
eth0	334	333	339	669	14838	14967	15245	1257	15172	1926
eth0	334	334	339	677	14991	14970	15245	1271	15325	1948
eth0	331	333	339	670	14902	14962	15245	1263	15233	1933
eth0	328	333	339	667	14886	14955	15245	1261	15214	1928
eth0	331	332	339	670	14873	14947	15245	1262	15204	1932

Figure 29. Load meter utility

In the second column from the right you can see the total throughput in both sides. In our example it is approximately 15.2 Mbps.

Also, you can review statistics using **net -i** command. It shows number of successfully received/sent packets and faulted packets through each interface. See Figure 30.

```
Base#3> net -i
```

Name	Mtu	Network	Address	Ipkts	Ierrs	Opkts	Oerrs
lo0	1500	Link:		10	0	10	0
lo0	1500	127.0.0.0/8	127.0.0.1	10	0	10	0
eth0	1500	Link:	00:04:35:00:12:d3	2069684	0	1548704	0
eth0	1500	9.2.8.0/24	9.2.8.1	2069684	0	1548704	0
rf4.0	1500	Link:	00:02:8a:e1:da:a8	1885622	22541	1791128	0
rf4.0	1500	10.10.10.0/30	10.10.10.1	1885622	22541	1791128	0
null0	1500	Link:		0	0	0	0

Figure 30. Network statistics

IV. Point-to-Multipoint configuration

Generally, point-to-multipoint configuration is NO different from point-to-point configuration in terms of devices configuration. This flexibility is obtained due to common hardware/software platform used in InfiNet Wireless routers. Thus, before reading this section of the Guide one MUST read carefully Point-to-Point Configuration section in order to set up connection between the Base Station and one CPE. In our next example we will add one MORE CPE to the network. If you want to add more CPEs please follow the procedure described a desired number of times.

Let us look at the Figure 31 that shows our network design.

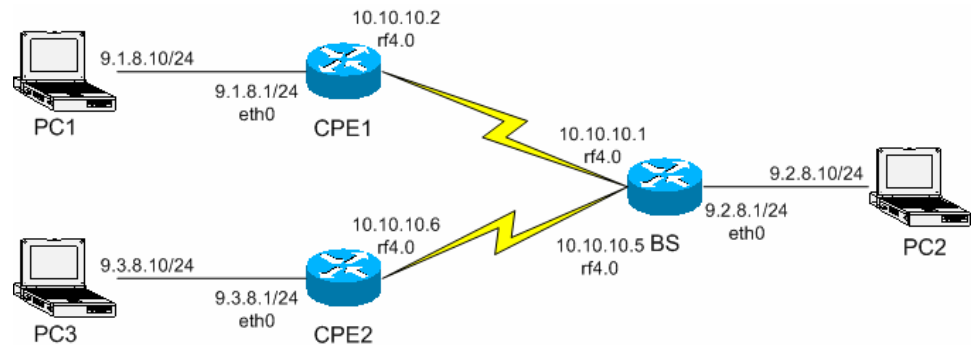


Figure 31. PTM network design

Here we have added another CPE (CPE2) from a different network. No need to have a detailed description of each step to be taken as all of them were discussed in the previous chapter. The steps to be taken are the following:

1. Get access to the router (CPE2) from PC3.
2. Configure BS router's CPE table for the CPE2. In order to do that learn CPE2 MAC-address for the radio (ifc -a command). On the BS execute the following command: `rma ab rf4.0 <MAC> ip=10.10.10.5 name=CPE2`
 <MAC> - is a MAC-address of CPE2 radio interface.
 10.10.10.5 – IP-address of the BS connection with CPE2 from the side of BS. CPE will be automatically assigned next IP-address for its connection with BS after its registration.
3. Configure BS at the CPE side. It should be done in the same way as we did for the first CPE: `rma rf4.0 20202020/24000 5300`
 Requested speed (here 24000) may differ according to the CPE capabilities and your network design.
4. Run RMA at the CPE: `rma start`
5. After some time (several seconds) the CPE will register at BS (if the configuration was accomplished correctly). To learn that, type `rma bs` at the CPE side (you will see BS parameters) and `rma ab` at the BS side (you will see whether this CPE is registered or not).
6. Run RIP protocol on CPE (`rip start`)
7. Provide PC3 connectivity from all nodes of the network. Write corresponding routes on all PCs. For PC1 and PC2 it will be a route to 9.3.8.0/24 network. On PC3 it will be routes to 9.2.8.0/24 and 9.1.8.0/24 network. If you use eth0 address of the router as a default gateway for the PC you do not have to write routes.

Note that BS throughput will be redistributed between CPEs according to different criteria, including their connection speed with BS and QoS rules (if any).

V. Performing outdoor testing

Before carrying out outdoor testing make sure that the equipment is properly configured and tested in the lab. If you use outdoor equipment please prepare service cables to connect IDU and ODU and check them in the lab. Also the following accessories may be very useful while outdoor testing:

1. InfiNet Console cable to perform configuration of the rooftops/masts etc
2. Binoculars to locate the opposite side
3. Mobile phones at either side to coordinate each others actions
4. Screwdrivers set
5. Soldering iron in case if you have to fix some problems with connectors.
6. Voltage analyzer to reveal cable problems if any

When planning your outdoor testing it is **strongly recommended** to perform calculations using:

- Speed/Range Calculator
- Fade Margin Calculator

Both of this calculators are located on InfiNet Wireless web-site www.infinetwireless.com in the "Support" section.

How-to-use instructions are located in the Technical User Manual on the CD delivered with the equipment.

1. Distance setting

For outdoor testing/deployment it is vitally important to set up distance parameter correctly. The recommended procedure is the following:

1. If the you have a PTP topology, on the BS you set up the distance to the CPE in kilometers. **It is required to set up a bit bigger distance. Setting up a smaller distance may cause errors on the link.** At the CPE set up distance as **auto**
2. In case of PTM topology on BS set up the distance to the remotest CPE. On every CPE set up distance as **auto**

Distance parameter is set up using **rf** command:

```
rf rf4.0 distance <VALUE>
```

2. Learning link status/antenna alignment procedure

In order to install the equipment, please do the following:

1. Install ODU and antenna at the roof top/mast etc. Connect ODU and antenna using RF cable. If the link is just for testing usage make sure that it is not going to rain or snow (because in this case you do not have to seal the connectors).
2. Even in test link it is highly recommended to provide all grounding. Ground the ODU to the mast/building grounding contour
3. Usually when installing ODU at the top, the ODU-IDU service cable is already connected to the ODU.
4. Connect ODU-IDU cable to IDU indoors
5. Provide IDU grounding to the LAN grounding contour
6. Connect power cable to IDU and plug this cable into the power socket

Once the power is switched on, you can access the router via Telnet (all necessary configuration steps were already taken in the lab).

It takes approximately 10-15 seconds for RMA to perform registration procedure. After this period of time you can check the following:

- On BS: type "rma ab" to learn whether CPEs are registered
- On CPE: type "rma bs" to learn whether CPE has a BS registration

If it turns out that during some significant period of time (1 minute) there is no CPE registration at BS, it can generally imply two options:

- Link fade margin is not sufficient to handle the connection
- Antenna alignment procedure is required in order to establish the connection

Even if registration has occurred but signal levels are not enough (signal levels according to InfiNet scale are meant in the case, antenna alignment procedure is strongly recommended).

In both cases (whether there is a registration or not) the following procedure for antenna alignment is recommended:

1. Either on BS device or CPE run rma test. Run it only from ONE side. The command looks as follows:

```
rma rf4.0 test <MAC> 1400
```

Here, <MAC> - is a MAC-address of the CPE radio.

1400 – the length of the testing packet.

From CPE side it is possible to run rma test only if CPE has a registration on BS.

2. Antenna alignment should be done only from one side at one time. Align one side, than other side. Use mobile phones to check current signal levels. The output of rma test command is demonstrated on the Figure 32.

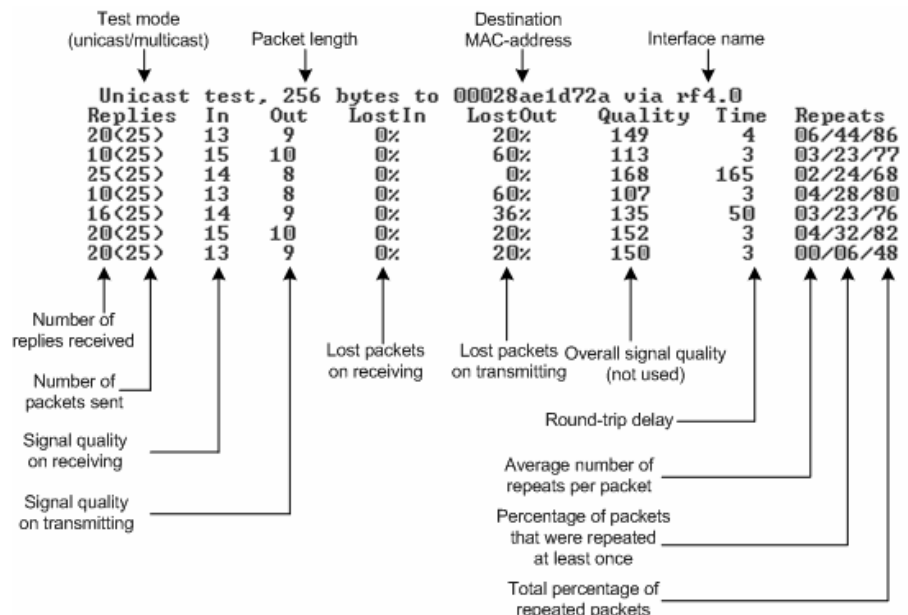


Figure 32. Rma test output

3. The link can be claimed to be working when the following requirements are met:

- Percentage of LostIn and LostOut packets is equal to 0
- Quality parameter is 120 and higher
- No repeats (00/00/00 value must be obtained)

- Achievement of required signal levels (In and Out parameters). The appropriate minimal signal level parameters for different speeds are presented at the table below

Speed, Mbps	Receiver Sensitivity, dBm	Minimal InfiNet scale level, required for maximal speed
6	-90	2
9	-89	3
12	-87	4
18	-84	5
24	-81	6
36	-78	7
48	-73	8
54	-69	9

Keep in mind that the antenna alignment should be performed slowly and with pauses. After each alignment step it is required to wait for at least 3 seconds to see the alignment result in rma test table.

4. Interference can be a possible reason for the link quality degradation (number of repeats increases, CPE does not register at the BS etc). Muffer utility is used to monitor electromagnetic environment. In order to run muffer one should turn RMA off using `rma stop` command. Review mode is recommended to see the activity on all available for your radio frequencies:

`muffer rf4.0 review`

Figure 33 shows a sample output for this command.

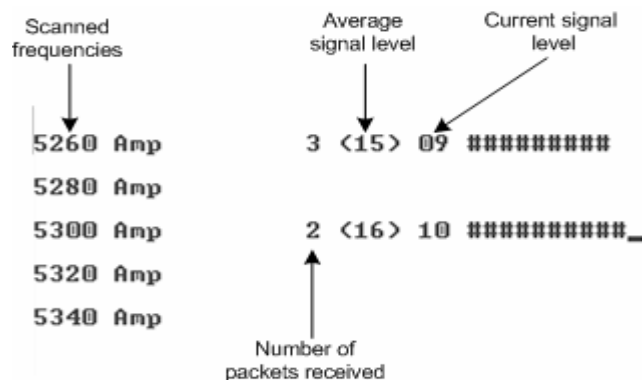


Figure 33. Muffer review mode

On the figure we can see the activity on frequencies 5260 and 5300 MHz. If a strong and permanent activity is located on the frequency that is used by your link, it is strongly recommended to switch to another frequency which is free from any activity.

5. If you fail to establish a link on a desired bitrate you can either change the requested speed from CPE or turn on `autobitrate` mechanism. This mechanism automatically varies the speed (from both sides) according to changing link conditions. If the mechanism is turned on on CPE, the BS will also work with this

mechanism. If it is turned on on BS, the whole cell will switch to this mode. The syntax for the command is the following:

```
rma rf4.0 autobitrate
```