9.4.9 Obtaining Valid IP Addresses for the End-user's PC

To obtain IP addresses for the end-user's PC, including the PC IP address, Gateway IP address, and DNS server address, the PC must request an update from the DHCP server. This procedure varies depending on which operating system is running on the end-user's PC, but a general method is outlined as follows.

> **NOTE:** The subscriber PC may obtain a dynamic IP through DHCP, or it may use a static IP and DNS server.

To Obtain a Valid IP Address for the End-user's PC (Windows XP)

1. Open a command prompt window.
2. At the prompt, type **`ipconfig/release`** and press **Enter**.
3. Type **`ipconfig/renew`** and press **Enter**.
4. If no error messages are returned, the WISP network has successfully provided an IP address to the end-user's PC.

9.4.10 Testing the Data Link

The fact that the IP address was successfully obtained indicates that the data link from the PC to the WISP's network is functioning properly. WaveRider recommends more thorough testing of the EUM-to-CCU data link, as outlined below. These tests can also be used to troubleshoot simple problems if DHCP access is not available.

There are several tools available for testing the quality of the link between the end-user PC and the WISP network. The most important tool is the "file get" test, which tests the quality of the data link. You can also use the ping command to progressively test presence of the data link. The procedures for running the "file get" throughput tests and "ping" data link tests are described below.

To Run a "File Get" Throughput Test From the EUM

1. Open the EUM console, as described in *Access Interface* on page 221.
2. At the prompt, type **`file get <ccu_ip_address>`**, and press **Enter**.

```
WaveRider Communications, Inc. LMS3000
Password:

60:ff:fe> file get 192.168.1.21
Enter password:
file transfer started (press 'qqq' to abort)...
bytes processed:     2097152 at   829 kbps
file transfer complete
Transfered "/tffs0/null" Okay.
60:ff:fe>
```

To Run a "File Get" Throughput Test From the CCU

1. Establish a Telnet connection to the CCU.
2. At the prompt, type **`file get <eum_ip_address>`**, and press **Enter**.

```
WaveRider Communications, Inc. LMS3000
Password:

60:03:3a> file get 192.168.10.250
Enter password:
file transfer started (press 'qqq' to abort)...
by   2097152 at   183 kbps24 at   201 kbps
file transfer complete
Transfered "/tffs0/null" Okay.
60:03:3a>
```

The following three tests use the “ping” command to progressively test the data link.

To Test the Data Link from the End-user’s PC to the EUM

1. Ping the EUM’s IP address from the end-user’s PC, as follows:
   - Open a DOS window in the end-user’s PC.
   - At the command prompt, type **`ping <aaa.bbb.ccc.ddd>`**, where <aaa.bbb.ccc.ddd> is the IP address of the EUM and press **Enter**.
2. If there is no response, check the following:
   - PC IP address settings.
   - Ethernet crossover cable between the EUM and the end-user’s PC, to ensure that the pins have not been damaged.
3. If there is a response, but with errors, check the Ethernet crossover cable.

To illustrate data link testing between the PC and the EUM, consider the sample configuration shown in Figure 60.

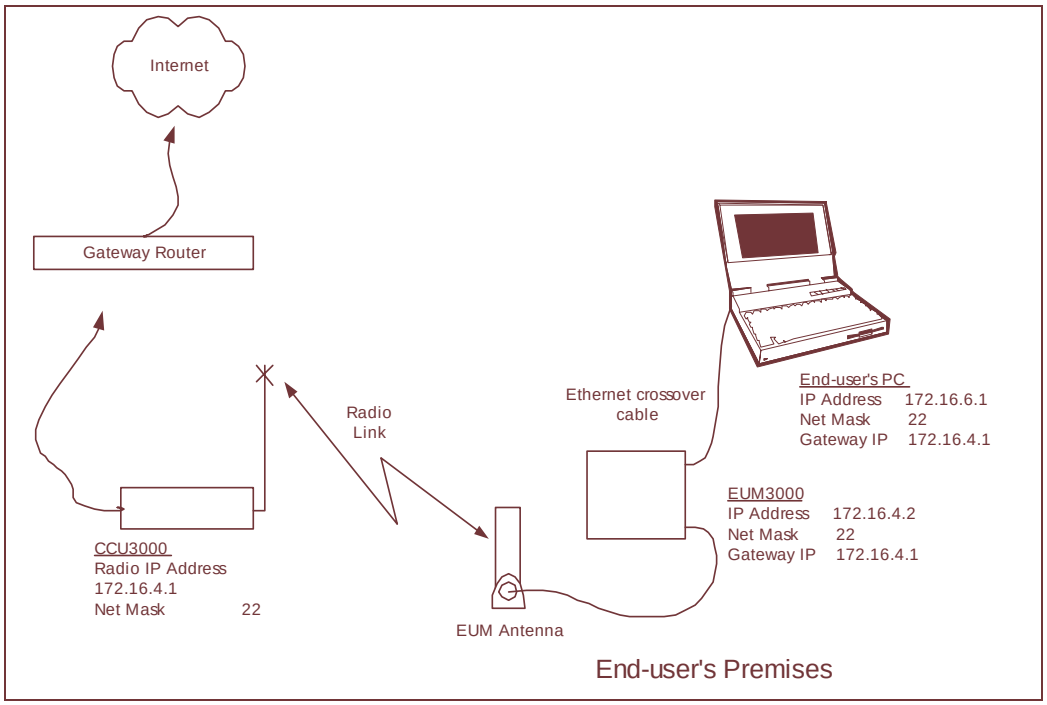

Figure 60 Sample Configuration — Testing the Data Link

Using the sample configuration shown in Figure 60, confirm the connection between the end-user's PC and the EUM as demonstrated below:

This is what successful ping from the end-user's PC to the EUM looks like:

```
C:\>ping 172.16.6.1

Pinging 172.16.6.1 with 32 bytes of data:

Reply from 172.16.6.1: bytes=32 time<10ms TTL=64
Reply from 172.16.6.1: bytes=32 time<10ms TTL=64
Reply from 172.16.6.1: bytes=32 time<10ms TTL=64
Reply from 172.16.6.1: bytes=32 time<10ms TTL=64

Ping statistics for 172.16.6.1:
 Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
 Minimum = 0ms, Maximum =  0ms, Average =  0ms

C:\>
```

This is what an unsuccessful ping from the end-user's PC to the EUM looks like:

```
C:\>ping 172.16.10.1

Pinging 172.16.10.1 with 32 bytes of data:

Request timed out.
Request timed out.
Request timed out.
Request timed out.

Ping statistics for 172.16.10.1:
 Packets: Sent = 4, Received = 0, Lost = 4 (100% loss),
Approximate round trip times in milli-seconds:
 Minimum = 0ms, Maximum =  0ms, Average =  0ms

C:\>
```

Testing the Data Link from the End-user's PC to the Network

Once the connection from the PC to the EUM is confirmed, ping the EUM gateway address from a PC DOS window. Ping with short packets first to confirm function, and then with long packets (1472 byte packets) to confirm performance. Errors observed on pings with long packets indicate a high error rate on the channel, caused by low signal levels or interference.

To Ping a CCU with the Maximum Packet Size

1. Open a DOS window.
2. At the command prompt, type **`ping <aaa.bbb.ccc.ddd> -t -L 1472`**, where <aaa.bbb.ccc.ddd> is the CCU radio IP address and press **Enter**.
3. Press **Ctrl**+**c** to end the test.

NOTE: If this test fails, but pinging the CCU with the default packet size succeeds, then the connection is working but is not operating at maximum capacity, possibly due to poor antenna placement or orientation.

This following example uses the sample configuration shown in Figure 60:

Pinging the CCU from the end-user's PC (with maximum packet size):

```
C:\>ping 172.16.4.1 -t -l 1472

Pinging 172.16.4.1 with 1472 bytes of data:

Reply from 172.16.4.1: bytes=1472 time=40ms TTL=64
Reply from 172.16.4.1: bytes=1472 time=81ms TTL=64
Reply from 172.16.4.1: bytes=1472 time=80ms TTL=64
Reply from 172.16.4.1: bytes=1472 time=40ms TTL=64
Reply from 172.16.4.1: bytes=1472 time=60ms TTL=64
Reply from 172.16.4.1: bytes=1472 time=80ms TTL=64
Reply from 172.16.4.1: bytes=1472 time=40ms TTL=64
Reply from 172.16.4.1: bytes=1472 time=110ms TTL=64

Ping statistics for 172.16.4.1:
 Packets: Sent = 8, Received = 8, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
 Minimum = 40ms, Maximum =  110ms, Average =  66ms
Control-C
^C
C:\>
```

Testing the Data Link from the End-user's PC to the Internet

Use the following test to determine whether the end-user's PC can communicate with the Internet.

Pinging an Internet site from the PC using the site's IP address:

```
C:\>ping 207.23.175.75

Pinging 207.23.175.75 with 32 bytes of data:

Reply from 207.23.175.75: bytes=32 time=90ms TTL=113
Reply from 207.23.175.75: bytes=32 time=80ms TTL=113
Reply from 207.23.175.75: bytes=32 time=80ms TTL=113
Reply from 207.23.175.75: bytes=32 time=70ms TTL=113

Ping statistics for 207.23.175.75:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 70ms, Maximum =  90ms, Average =  80ms

C:\>
```

Use the following test to verify that the DNS server IP address is correctly configured in the end-user's PC and is operating properly:

Pinging an Internet site from the PC, using the site's domain name:

```
C:\>ping www.waverider.com

Pinging waverider.com [207.23.175.75] with 32 bytes of data:

Reply from 207.23.175.75: bytes=32 time=70ms TTL=113
Reply from 207.23.175.75: bytes=32 time=90ms TTL=113
Reply from 207.23.175.75: bytes=32 time=60ms TTL=113
```

```
Reply from 207.23.175.75: bytes=32 time=50ms TTL=113

Ping statistics for 207.23.175.75:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 50ms, Maximum =  90ms, Average =  67ms

C:\>
```

9.4.11 Configuring the Browser Application

Follow the manufacturer's instructions for configuring the end-user's browser, so that it correctly uses the PC Ethernet interface. Once you have done this:

1. Launch the browser
2. Confirm access to sites of interest.

9.4.12 Completing the Installation

1. Configure the remaining PC applications, as required.
2. Re-activate the end-user's cordless phones, and any other 900 MHz ISM-band equipment that was turned off at the beginning of the installation. Note the following points:
    - Cordless phones operating in the 900 MHz ISM band can disrupt service to the EUM if precautions are not taken.
    - Run an FTP throughput test, and turn on the cordless phones in sequence, while monitoring the downlink throughput. Since there is naturally a wide variation in the downlink speed, for reasons more associated with the network than with the performance of the LMS4000 wireless service, repeat the tests several times to confirm whether or not the end user's cordless phones are going to affect the EUM performance.
    - If the cordless phones do affect the performance of the EUM, move the cordless phone base station to a location as far from the antenna as possible. Instruct the end user to avoid using the cordless handset in the proximity of the antenna, particularly when the EUM is being used.

9.4.13 Baselining the Installation

Once you have completed the installation, WaveRider recommends recording the following information:

- EUM IP addresses
- EUM radio settings
- RSSI readings
- Tx retry rate readings (displayed with the RSSI readings)
- SQ, RNA, and RNB (displayed with the RSSI readings)

If you have problems with the EUM at a later date, you can compare the latest site settings and RSSI readings with the original settings in the site installation record.

You can record and save this information in several ways:

- using the EUM Configuration Utility. Through the EUM Configuration Utility, you can also upload and store the EUM's complete configuration file.
- through the EUM command-line interface locally, using a Telnet session, through the EUM Ethernet connection.
- through a Telnet session over the wireless link between the network and the EUM.

Record the information from the following session, and store it to a file.

```
60:02:04>
60:02:04> ip
IP Address: 172.16.4.2 / 22
IP Subnet : 10.5.0.0 ( 255.255.0.0 )
Gateway IP Address: 172.16.4.1
60:02:04>
60:02:04> radio
RF Power: HIGH
Radio Frequency: 9170
60:02:04>
60:02:04> rad rssi
Press any key to stop

RSSI[dBm]   RX;  TX;  R1;  R2;  R3;   F;Retry%;  SQ; RNA; RNB
RSSI: -36     0;   0;   0;   0;   0;   0;     0;   7;  71;  71
RSSI: -36   887;   2;   0;   0;   0;   0;     0;   5;  72;  71
RSSI: -36   899;   2;   0;   0;   0;   0;     0;   8;  73;  72
RSSI: -36   899;   3;   0;   0;   0;   0;     0;   6;  73;  72
RSSI: -37   898;   2;   0;   0;   0;   0;     0;   5;  72;  72
RSSI: -37   898;   2;   0;   0;   0;   0;     0;   6;  71;  71
RSSI: -36   899;   2;   0;   0;   0;   0;     0;   5;  72;  72
```

You should also run the "file get" command from both the CCU and EUM to baseline the installation.

To Run a "File Get" Throughput Test From the EUM

1. Open the EUM console, as described in *Access Interface* on page 221.
2. At the prompt, type **`file get <ccu_ip_address>`**, and press **Enter**.

```
WaveRider Communications, Inc. LMS3000
Password:

60:ff:fe> file get 192.168.1.21
Enter password:
file transfer started (press 'qqq' to abort)...
bytes processed:     2097152 at   829 kbps
file transfer complete
Transfered "/tffs0/null" Okay.
60:ff:fe>
```

To Run a "File Get" Throughput Test From the CCU

1. Establish a Telnet connection to the CCU.
2. At the prompt, type **`file get <eum_ip_address>`**, and press **Enter**.

```
WaveRider Communications, Inc. LMS3000
Password:
```

```
60:03:3a> file get 192.168.10.250
Enter password:
file transfer started (press 'qqq' to abort)...
by   2097152 at   183 kbps24 at   201 kbps
file transfer complete
Transfered "/tffs0/null" Okay.
60:03:3a>
```

10 Maintaining the Network

The LMS4000 900 MHz radio network requires virtually no maintenance. This chapter describes what you need to do to maintain the CCU and EUM operating environments.

The CCU and EUM must be kept in a temperature-controlled and dust-free environment, as described under the following headings:

- *Maintaining Temperature and Humidity* on page 163
- *Cleaning the Equipment* on page 164
- *Checking the CCU Shelf Cooling Fans* on page 164

Maintaining Temperature and Humidity

Make sure the CCU and EUM sites meet the environmental requirements outlined in Table 27.

Table 27 Temperature and Humidity Requirements

Equipment	Operating Temperature	Non-condensing Relative Humidity	Storage Temperature
CCU3000	0° to +50°C	5% to 95%	-40° to +70°C
EUM3000	10° to +40°C	5% to 95%	-40° to +70°C
EUM3003	0° to +40°C	5% to 95%	-40° to +70°C

Cleaning the Equipment

WARNING!

Make sure you follow ESD precautions when you touch and clean CCU and EUM components.

When cleaning CCU and EUM components:

- Use dry, static-free cloths to wipe dust from the devices.
- Make sure you do not disconnect any cables or wires when cleaning.

Checking the CCU Shelf Cooling Fans

WARNING!

Exercise caution when you are in close proximity to the CCU Shelf cooling fans. Disconnect AC power to the fans prior to handling.

Verify that the cooling fans in the CCU Shelf are rotating freely and at a high speed when connected to the power supply to ensure proper cooling of the CCUs.

11 Monitoring the Network

Although there are a large number of detailed statistics available for the various data handling applications in the CCU (refer to Appendix J on page 277 for a complete list), there are only a few that are key for monitoring system performance on an on-going basis. These statistics are described in detail on the following pages.

- *CCU Transmit Statistics* on page 165
- *CCU Receive Statistics* on page 169
- *EUM Transmit Statistics* on page 171
- *EUM Receive Statistics* on page 172
- *User Data* on page 173
- *Logging CCU or EUM Statistics* on page 173
- *CCU Air Table Statistics* on page 174
- *CCU Radio Meter* on page 175

11.1 CCU Transmit Statistics

As described in *CCU–EUM Interface MAC Layer (Polling MAC)* on page 40, the MAC continuously transmits polls to the EUMs. These polls can contain specific user payloads directed to the EUM or the PC connected to the EUM, control payloads directed to the EUM, broadcast payloads directed to all EUMs, or empty polls, which contain no payload.

In an ideal system, all data transmitted would be received error free by the EUMs, and no re-transmissions would be required. In the real world, unfortunately, RF noise, low signal conditions, interferers, system engineering problems, and equipment malfunction can result in the need to retransmit data over the radio link. These retransmissions, which are key to maintaining data integrity for the end user, come with the trade-off of reduced network capacity.

Statistics reported by the CCU can assist in identifying when retransmissions are occurring and at what rate they are occurring. They can also be used to troubleshoot the cause of retransmissions.

The statistic *txPayloads* gives the total number of transmitted payloads, consisting of

- user data received by the CCU Ethernet port, and transmitted over the radio network,
- user data received from an EUM, that is “switched” to the CCU radio port for transmission to another EUM,
- MAC control data,
- broadcast data, and
- data retransmitted because it was not acknowledged by an EUM and is assumed lost.

Examining this statistic in more detail, *txPayloads* includes

- Tx Data Payloads which, in turn, includes
    - data originated by the CCU application and sent to the radio port,
    - data coming from the Ethernet port of the CCU (either end-user data or operator monitoring [SNMP] data),
    - data coming from EUM-originated data payloads that have been “switched” to the CCU radio port (for transmission to other EUMs), and
    - broadcast data to all EUMs(*TxPayloadsBCast*).
- Tx Ctrl Payloads — Control data generated in the CCU, and used to configure, or request status from, the EUMs. Tx Ctrl Payloads are transmitted during specific EUM poll periods.
- Retransmitted data — Data that is not acknowledged after a transmission and is assumed to be lost or corrupted.

Understanding the relationship between these values helps you monitor the integrity of a CCU radio environment.

All non-broadcast payloads (hence, “directed” payloads) are explicitly acknowledged by the EUMs. For these payloads, the result of a transmission during an EUM poll cycle will be one of the following:

Table 28 Possible Transmission Outcomes

Result of Transmission	Reported Statistic
Payload is delivered to an EUM and acknowledged on the first poll.	*txPayloads10k*
Payload is transmitted twice, after which an acknowledgement is received.	*txPayloads20k*
Payload is transmitted three times, after which an acknowledgement is received.	*txPayloads30k*
Payload is transmitted four times, after which an acknowledgement is received.	*txPayloads40k*

Result of Transmission	Reported Statistic
No acknowledgement received after four transmissions, and the payload is discarded.	*txPayloadsFailRetry*
Payload is not transmitted at all.	*txPayloadsFailAssocDeleted*
Total number of payloads returned to host because they are malformed.	*txPayloadsFailBadParam*
Total number of payloads returned to host because the virtual net was not active.	*txPayloadsFailVnetInactive*
Total number of empty payloads received and returned to host.	*txPayloadsEmpty*
Total number of payloads returned to the host because an association could not be created.	*txPayloadsFailAssocFail*
Total number of payloads returned to the host because of timeout.	*txPayloadsFailTimeout*
	txPayloadsFailQueueTooLong

To put these values in perspective, the following samples have been taken from a live CCU, using the `<stats mac>` CLI command:

Table 29 Typical CCU Transmit Statistics

	Statistic	Sample
A	*txPayloadsBCast*	445
B	*txPayloads10k*	66,001
C	*txPayloads20k*	1,761
D	*txPayloads30k*	281
E	*txPayloads40k*	91
F	*txPayloadsFailRetry*	102
G	*txPayloadsFailAssocDeleted*	11
H	*txPayloadsFailBadParam*	0
I	*txPayloadsFailVnetInactive*	0
J	*txPayloadsEmpty*	0
K	*txPayloadsFailAssocFail*	0
L	*txPayloadsFailTimeout*	0
M	*txPayloadsFailQueueTooLong*	0

The objective of the first level analysis of this data is to determine the relative amount of radio traffic resulting from retransmissions. Ideally, the percentage would be 0. In practice, local engineering limitations result in a certain normal level. Once this normal level is established, the statistics can be used to monitor changes.

Since not all of these CCU transmit statistics are independent, you have to be careful when interpreting and using results which are based on these statistics. For example, since broadcast payloads are not acknowledged, the retry data is not relevant to these payloads, and they have to be subtracted from the total. In addition, the *txPayloadsFailAssocDeleted* and the following payloads are never transmitted and should be subtracted from the total. The calculations to do this are shown below:

Net Payloads sent through directed polls (see note) = B + C + D + E + F = 68,236

NOTE: Due to real-time issues (at any given time, some packets are being processed or queued), the numbers often differ by the small number of packets that are in queues.

The percentage of directed payloads that are delivered on the first transmission

= 66,001 / 68,236 = 97%

Similarly, the percentage of directed payloads not delivered on the first transmission, but delivered on the second transmission

= 1,761 / (68,236 - 66,001) = 79%

It is generally a good indication if most payloads that fail on the first try are then successful with only one retry.

The percentage of directed payloads that are not able to be delivered

= 102 / 68,681 = 0.15%

A very low undeliverable payload rate implies that user service has a high level of integrity, and that the radio link is not significantly impacting higher-level TCP/IP applications.

The impact of the retransmission can be calculated by looking at the total number of transmissions requiring acknowledgments:

= 1xB + 2xC + 3xD + 4xE + 4xF = 71,138.

Adding to this value the non-acknowledged broadcast payloads (*txPayloadsBCast* = 445) results in total txPayloads - 71,583.

A simple metric of overall sector link quality is the effective utilization of the channel, which can be readily calculated as desired payloads transmitted/actual payloads transmitted, or:

(*B + C + D + E +F*) / (*71,138 - G + H + I + J + K + L)*

= 68,236 / 71,127 = 96%

which suggests that 4% of the radio traffic is used to retransmit packets, which is referred to in this document as the Retransmission Rate.

From an operational point of view, it is important to keep the number of retransmissions to a minimum since they reduce the total air time available and the total network throughput.

These calculations may appear tedious, but since all of the referenced statistics are available through MIBs, SNMP management tools, such as SNMPc, can directly collect the statistics, calculate the above metric, and track and report its value over time.

NOTE: The “stats summary” command displays similar calculations.

You can also monitor the MAC statistic “txPayloadsFailQueueTooLong” at the CCU to give an indication of packet discards due to queue overrun. The MAC statistic “lastQueueTooLongEUM” at the CCU indicates for which EUM the last packet was discarded. That EUM can then be “watched” to determine how often discards occur and whether it is a problem. Some discards may occur simply due to multiple concurrent downloads combined with heavy system loading. If more than one EUM is having problems, the “lastQueueTooLongEUM” statistic will change as discards occur.

11.2 CCU Receive Statistics

Similar to the case for CCU transmit statistics, there are several key CCU receive statistics that you can use to monitor on-going performance of the CCU radio network. When the CCU sends a directed poll to an EUM, it expects to get an acknowledgement. The following results have been taken from a live CCU using the `<stats mac>` command:

Table 30 Typical CCU Receive Statistic

	Statistic	Description	Sample
A	*rxPktsDirected*	The number of packets received correctly from all EUMs. These may contain an ack.	409,730

	Statistic	Description	Sample
B	*rxPktsHCRCFail*	Packet received with a corrupted header.	2,464
C	*rxPktsFCS Fail*	Packet received from an EUM, with a corrupted payload.	192
D	*replyOrRssiTimeouts*	No reply or EUM HCRC errors and missed packets. Does not include FCS (frame check sequence) errors. Note: This statistic also includes EUM receive errors, by virtue of the fact that if an EUM does not receive a poll from the CCU, for any reason, then it will not reply to the CCU.	22,688

From these statistics:

Total number of replies expected = A + B + D = 434,882

and the receive packet error rate which, as noted in Table 30, includes EUM receive errors and errors associated with random access attempts, is given by

RxPER = (B + C + D) / (A + B + D) = (2,464 + 192 + 22,688) / 434,882 = 5.8%

One other receive statistic that is important in multi-CAP environments where frequency re-use is implemented is *rxPktsNoMatch*. A high value of *rxPktsNoMatch* indicates that the two CCU radio environments are interfering with each other.

The statistic *rxPktsDuplicate* measures the number of times the EUM sends the same packet of information more than once. A high value of *rxPktsDuplicate* indicates that the acknowledgements from the CCU are not being properly received at the EUM.

11.3 Watch Statistics

CCU statistics monitor the aggregate traffic to all EUMs connected to that CCU. The CCU “watch” command is available for monitoring a single EUM, which is a very useful tool for troubleshooting individual links. These statistics have the same meaning as the “stats mac” statistics of the same name, but apply to a single EUM, rather than all EUMs. This command is described in detail in *CCU Watch Statistics* on page 298.

11.4 EUM Transmit Statistics

In general, the statistics collected at the EUM are the same as those collected at the CCU; however, there are some differences in meaning (see Appendix H). More significantly, of course, is that the EUM statistics are unique to the EUM, as opposed to the CCU statistics, which are a collective of the CCU and all EUM interactions.

The relationships of the key EUM statistics are the same as those for the CCU. In the case of the EUM, however, no broadcast packets are transmitted, and the value of *txPayloadsFailAssocDeleted* will always be 0. The key EUM transmit statistics, with sample values, are shown below.

Table 31 EUM Transmit Statistics

	Statistic	Description	Sample	Total Payload		Total Packets
A	*txPayloads*	Number of payloads transmitted.	49,101	-		-
B	*Tx Data Payloads*	Number of data payloads to be transmitted (user data)	45,879	-		-
C	*Tx Control Payloads*	Number of control payloads to be transmitted.	2	-		-
D	*txPayloads10k*	Payload is delivered to the EUM and acknowledged on the first poll.	43,153	43,153	x1	43,153
E	*txPayloads20k*	Payload is transmitted twice, then acknowledge received.	2,306	2,306	x2	44,612
F	*txPayloads30k*	Payload is transmitted three times, then acknowledge received.	344	344	x3	1,032
G	*txPayloads40k*	Payload is transmitted four times, then acknowledge received.	47	47	x4	188
H	*txPayloadsFailRetry*	No acknowledge received after four transmissions, packet discarded.	29	29	x4	116
I	*txPayloadsFailTime out*	Total number of payloads returned to host because of timeout.	0	-	-	-
			Sum	45,879		49,101

The same combinations used for the CCU case are also included in the table for clarity.

As with the CCU transmit statistics, the following sample calculations can be made using the sample data from Table 31:

Total number of desired payloads = B + C = 45,879 + 2 = 45,881

This is also equal to:

(D + E + F + G + H + I) = (43,153 + 2,306 + 344 + 47 + 29 + 0) = 45,879

NOTE: Due to real-time issues (the fact that at any given time, some packets are being processed or queued), the numbers frequently differ by the number of packets that are in queues.

NOTE: In the case of the EUM, most payloads are sent in response to directed polls; however, a small number of payloads are sent in response to random access polls.

The percentage of payloads that are delivered on the first transmission

= *txPayloads10k* / (B + C) = 43,153 / 45,879 = 94.1%

Similarly, the percentage of payloads that are not delivered on the first transmission but are delivered on the second transmission

= *txPayloads20k* / (45,879 - 43,153) = 2,306 / 2,726 = 84.6%

The percentage of payloads that are not able to be delivered

= 29 /45,879 = 0.06%

Since there are no broadcast or control payloads, the calculation of the Retransmission Rate is fairly straightforward:

Retransmission Rate = (1 - desired payloads/actual payloads) x 100
= (1 - *tx Data Payloads* / *txPayloads*) x 100
= (1 - 44,153 / 49,101) x 100
= 10.1%

These calculations are displayed by the “stats summary” command.

11.5 EUM Receive Statistics

Perhaps the most important receive statistic is the Receive Signal Strength Indicator (RSSI), which provides an indication of the receive signal strength in dBm.

NOTE: Since the EUM can receive packets that are destined for other EUMs, the EUM receive statistics are not as useful as the CCU receive statistics. They are useful when the EUM is the only EUM

that is active, which is seldom the case after more than one EUM have been activated.

The statistic *rxPktsDuplicate* measures the number of times the CCU sends the same packet of information more than one time. A high value of *rxPktsDuplicate* indicates that the acknowledgements from the EUM are not being properly received at the CCU.

11.6 User Data

The total user data is recorded by the statistics *Rx Data Payloads*, *Tx Data Payloads*, *Rx Data Octets*, and *Tx Data Octets*. These statistics could be viewed as billable data and allow you to monitor total usage at the EUM level.

11.7 Logging CCU or EUM Statistics

The system log is an extremely powerful tool since it has accurate absolute time stamps and can be downloaded very quickly using FTP. The system log has two roles:

- To assist in troubleshooting unit and network problems. The MAC statistics for the CCU and EUM are recorded hourly and are very useful, especially when an absolute time reference is entered to coordinate the logs.
- To monitor individual unit traffic after the fact, which is useful if any unit is in trouble. It can also be helpful with billing information. By recording information to the log, events of interest are less likely to be missed, as can happen with real-time monitoring.

The system log records every command you enter, either through the serial console port or through a Telnet session, which can be useful when troubleshooting problems. The system log also saves the statistics defined below at each recording period. Each statistic line is preceded by the date/time stamp and the “statN” label, where “N” is the line number. If the statistics are recorded every 15 minutes, then the system log can hold at least 36 hours worth of data. Since not all counters are large numbers, the log can typically contain information for the last 2-3 days. The system logs can be downloaded during quiet hours to avoid affecting system performance during peak periods. Downloading the logs every 2 days should ensure that all statistics are retrieved for each unit.

To control system logging, connect to the device with Telnet and use the following commands:

- **`stats log <interval>`**. <interval> is the time interval in minutes between each data sample to log. You may set the interval to any number of minutes between 1 and 65535. After entering this command, the CCU or EUM will begin logging statistics at the specified interval. The default interval is 15 minutes.
- **`stats log off`** stops logging statistics.
- **`stats log now`** records the current statistics in the log without affecting the statistics period or whether it is on or off.
- **`stats log`** shows the logging interval.

- **sys log <number of characters to display> [<offset in log (default=0)>]** displays a portion of the system log file.

  NOTE: If statistics logging is enabled and you use the “statistics clear” command, the current values are logged before the statistics are cleared.

To Retrieve the System Log File

1. Connect to the unit with FTP.
2. Use the **bin** command to switch to binary image mode.
3. Use the **get log <log_filename>** command to transfer the file.

   NOTE: The <log_filename> is a filename you assign to identify the file on your computer. WaveRider recommends including the date and time in the filename. If you do not specify any filename, the received file will be named “log”.

4. Use the **quit** command to close the FTP session.

```
C:\TEMP>ftp 10.0.2.253
Connected to 10.0.2.253.
220 FTP server ready
User (10.0.2.253:(none)):
331 Password required
Password:
230 User logged in
ftp> bin
200 Type set to I, binary mode
ftp> get log 020808
200 Port set okay
150 Opening BINARY mode data connection
226 Transfer complete
ftp: 169939 bytes received in 0.28Seconds 606.92Kbytes/sec.
ftp> quit
221 Bye...see you later

C:\TEMP>
```

For more information about CCU and EUM statistics logging, refer to *CCU and EUM System Log Statistics* on page 302.

11.8 CCU Air Table Statistics

The air table statistics are a useful tool for monitoring Tx/Rx data transfer rates on a particular EUM. You can use it to isolate EUMs that may be using an unreasonably large portion of the network. You can also use the air table statistics to generate usage billing reports for each EUM.

The air table statistics:

- provide accumulated octet/packet counts for each registered EUM. The Rx- and Tx-directions are from the perspective of the CCU. In other words, Rx-Octets and Rx-Packets refers to data received by the CCU from the EUM; Tx-Octets and Tx-Packets refers to data transmitted from the CCU to the EUM,
- may be cleared by CCU reset or using the **`air flush`** command,
- sorts entries by EUM IDs, and
- if RADIUS accounting is enabled, the CCU RADIUS client—periodically and on special events—sends RADIUS accounting packets to a RADIUS server for each EUM authorized through RADIUS. (For example, this event occurs when an EUM is removed from the registration table.)

11.9 CCU Radio Meter

The CCU radio meter is a very useful CLI tool for determining the system load. In addition, it assists in monitoring grade of service violations. The radio meter displays the running average of per second traffic and polling statistics for each grade of service.

The CCU radio meter

- displays only the active grade of service levels since last CCU reset (for example, if the CCU has Silver and BE grades of service, the radio meter displays entries only for Silver Active/Inactive and BE Active/Inactive),
- can specify the interval (in seconds) over which the average is made,
- can generate graphs of Rx/Tx packets for the CCU channel,
- provides broadcast rates for both forward traffic (such as CCU to EUM Tx traffic) and reverse traffic.

Keep the following points in mind when using the CCU radio meter:

- The Tx broadcasts should not exceed 10% of the total Tx traffic.
- The reverse packet rate should be less than 15% of the total poll rate for the broadcast traffic.
- The Max IPS Violation monitoring indicates the number of “missed polls” within the inter-poll space defined by the EUM's grade of service.
- The Ideal IPS Violation indicates “below GOS” EUMs (in other words, the number of times a particular grade of service has not been achieved).

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12 Specialized Applications

The advanced capabilities of the LMS4000 900 MHz radio network modems can support a variety of special applications.

12.1 EUM Thin Route

The EUM Thin Route configuration, in Figure 61, shows how to use an EUM as a thin route to extend the reach of the LMS4000 900 MHz radio network to a small number of outlying EUMs.

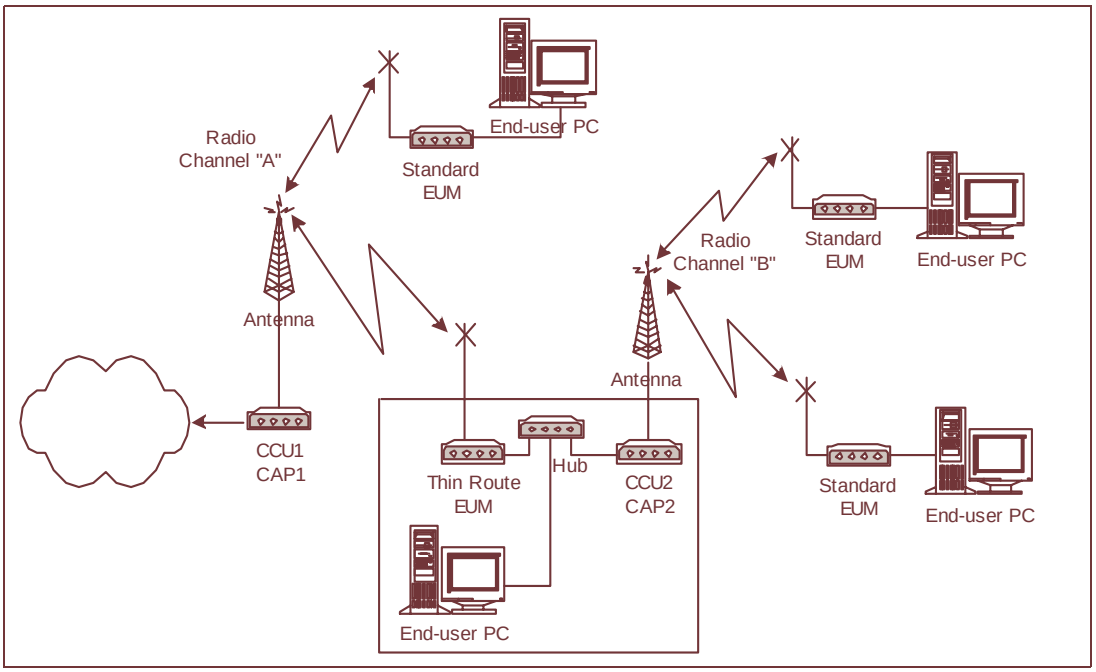

Figure 61 Using an EUM for Thin Route

NOTE: This EUM Thin Route example uses Routed mode. You can also use Switched Ethernet mode.

In the above configuration, a backhaul is created between the local CCU1 (CAP1) and the remote CCU2 (CAP2) by deploying an EUM (Thin Route EUM) from CAP1 in CAP2. The Thin Route EUM will operate at the frequency of CCU1 and have CCU1 as its gateway.

CCU2 may be connected to the Ethernet port of the EUM either directly or through a switch. Additional subscriber EUMs may then be deployed off CCU2.

To correctly route the traffic between CAP1 and CAP2, routes need to be added to the CAP1 router and CAP1 CCU1. The latter route is required to route the traffic to CCU2.

Traffic traversing from the CAP2 subscribers' radio network will place additional load on CAP1 CCU1, reducing its available throughput. In order to improve the overall backhaul performance, a special grade of service (Thin Route GOS) should be provisioned in CAP1 CCU1 and assigned to the Thin Route EUM.

12.2 EUM Backhaul

In some cases, it may be cost-effective to use an EUM as the backhaul link as an alternative to a separate wired or wireless link to the CCU, as is illustrated in Figure 62.

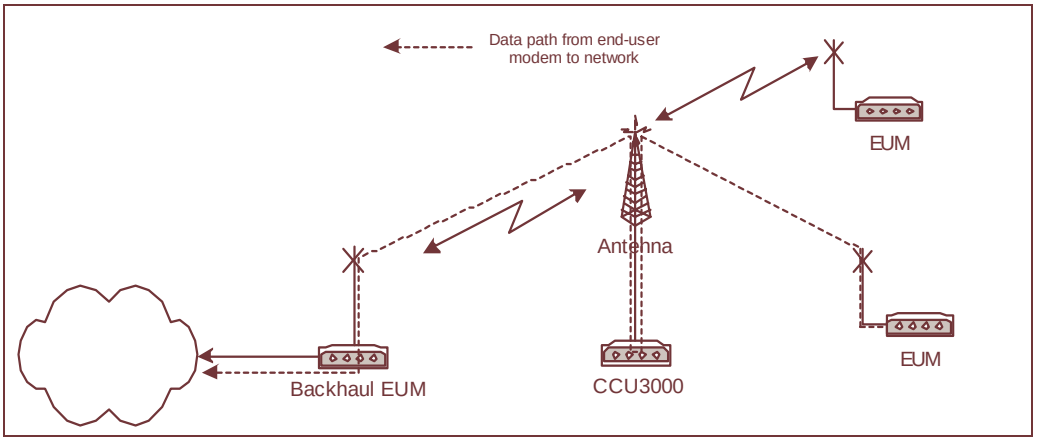

Figure 62 Using an EUM for Backhaul

The above configuration has one CCU located at a remote location and one EUM (Backhaul) installed at a NAP or CAP. The CCU's Ethernet port is unused and may be left unconnected, or with appropriate routing it may be used for a co-located user PC. The Backhaul EUM's Ethernet would typically be connected to a router, switch, or a hub. The subscriber EUMs are setup as normal.

The Backhaul EUM scenario creates an extended bridged network with Backhaul EUM, CCU, and subscribers EUMs following the same IP scheme as the rest of the existing network.

The Max Customers setting in the Backhaul EUM applies to the number of hosts on the Ethernet side of the Backhaul EUM, not to the number of customers served by the CCU. WaveRider recommends setting Max Customers to 50.

To have a good backhaul performance it is important that the Backhaul EUM is positioned for optimum RF reception (for example, on a tower).

Traffic traversing from subscriber computers to the Backhaul EUM will use the radio link twice, placing additional load on the Backhaul EUM. To alleviate potential performance bottlenecks, a special grade of service (EUM Backhaul GOS) should be provisioned in the CCU used for the backhaul configuration and assigned to the Backhaul EUM.

Traffic load considerations in the EUM Backhaul configuration imply that the CCU should support approximately half the usual number of subscribers, with approximately the same throughput as usual.

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Appendix A Specifications

This appendix lists the following specifications for the LMS4000 900 MHz Radio Network, specifically the technical specifications for the CCU and EUM, configured for operation in the FCC/IC RF regulatory domain:

- *Radio Specifications* on page 181
- *Ethernet Interface Specifications* on page 182
- *Power Supply Specifications* on page 182
- *Environmental Specifications* on page 182

Table 32 Radio Specifications

Maximum Number of Operational CCUs and Orthogonal Channels	4
Maximum Number of EUMs per CCU	300
Maximum Address Table Size (CCU)	1051
Maximum Bridge Table Size	256
Minimum Channel Center Frequency	905 MHz
Maximum Channel Center Frequency	925 MHz
Channel Bandwidth	5.5 MHz
Center Frequency Spacing Increment	0.2 MHz (101 channels possible)
Minimum Separation Between Co-located Channels	6.6 MHz
Maximum Co-located Channels	4

Co-located Channel Set Center Frequencies (standard)	905 MHz, 911.6 MHz, 918.4 MHz, and 925 MHz Note: Other frequencies can be used, depending on site-specific considerations. Contact WaveRider for more information.
Modulation Scheme	Based on DSSS (Direct-Sequence Spread Spectrum) signals, modulated with CCK (Complementary Code Keying), and Barker-coded BPSK (Binary Phase Shift Keying) and QPSK (Quaternary Phase Shift Keying)
Receiver Sensitivity for BER < 10^{-5}	Better than -86 dBm
Maximum Over-the-Air, Raw Data Rate	2.75 Mbps
Maximum Output Power	+26 dBm

Table 33 Ethernet Interface Specifications

CCU Physical Interface	10BaseT (Ethernet)
EUM Physical Interface	10BaseT (Ethernet)

Table 34 Power Supply Specifications

AC Input	110/230 ± 15% VAC, single phase
AC Input Frequency	50/60 ± 3 Hz
Maximum Input Current	0.2 A

Table 35 Environmental Specifications

Operating Temperature	0°C to +50°C, CCU 10°C to +40°C, EUM3000 0°C to +40°C, EUM3003 (10%-80% RH non-condensing)
Storage Temperature	-40°C to +70°C

Appendix B Factory Configuration

This appendix identifies the factory configuration settings for the CCU and EUM.

Table 36 CCU Factory Configuration

Parameter	Default Configuration
Console Prompt	The default console prompt is the station (CCU) ID.
Deregistration Count	8
DHCP Relay	Disabled
Ethernet IP Address	192.168.10.250
Ethernet Netmask	24 255.255.255.0 ffffff00
Gateway IP Address	192.168.10.1
GOS Definitions	BE (0 - 384 kbps) Bronze (0 - 1024 kbps) Silver (128 - 256 kbps) Gold (256 - 512 kbps) Denied (0 kbps) Note: The above data rates are based on FTP transfers from a single EUM, using maximum-sized packets.
GOS Default (Authorization Table)	BE (Best Effort)
Maximum Associations	75
Maximum Registered EUMs	300
Password	By default, the CCU has no password. Press **Enter** at the password prompt to enter a null password.

Table 36 CCU Factory Configuration

Parameter	Default Configuration
Port Filters	137 (both) 138 (both) 139 (both) 445 (both) 1512 (both)
Protocol	Switched Ethernet Mode (“Switched”)
Radio	Enabled
Radio Frequency	9050 (905.0 MHz)
Radio Power	+26 dBm (High)
RADIUS Period	60 (minutes)
SNMP Contact	WaveRider Communications Inc.
SNMP Location	www.waverider.com
SNMP Read Communities	public
SNMP Write Communities	private
SNMP Traps	None entered
SNTP Client Enabled	No
SNTP Client Resynchronization Period	3600 seconds
SNTP Client Retry Period	30 seconds
SNTP Relay Enabled	Yes
SNTP Relay Send Time on Boot	Yes
SNTP Relay Send Time on EUM Registration	Yes
SNTP Servers	132.246.168.148 (time.nrc.ca) 140.162.8.3 (ntp.cmr.gov) 136.159.2.1 (ntp.cpsc.ucalgary.ca) 192.5.5.250 (clock.isc.org)
Statistics Log Interval	15 minutes

To reset the CCU to factory default

```
60:03:3a> fi dir
Directory listing:
  SA1110.EXE     475764
  BASIC.CFG        1992
  PORT.CFG         6240
  SNTP.CFG          156
  ROUTE.CFG        2896
  AUTHDB.CFG       3496
  DHCP.CFG          896
  SA1110.BAK     475764

60:03:3a> fil del basic.cfg
file deleted
60:03:3a> fil del port.cfg
file deleted
60:03:3a> fil del sntp.cfg
file deleted
60:03:3a> fil del route.cfg
file deleted
60:03:3a> fil del authdb.cfg
file deleted
60:03:3a> fil del dhcp.cfg
file deleted
60:03:3a> reset

rebooting CCU ...

(... Power On Self Test ...)

WaveRider Communications, Inc. LMS3000
Password:
60:03:3a> port add 137 both
60:03:3a> port add 138 both
60:03:3a> port add 139 both
60:03:3a> port add 445 both
60:03:3a> port add 1512 both
60:03:3a>
60:03:3a> save
Basic Config saved
Port Filter Config saved
sntp cfg file saved
Route Config saved
Authorization Database saved
DHCP Server Config saved
60:03:3a>
60:03:3a> port
PORT FILTERS
    Port                   Filter
--------------------------------
      445                   both
      137                   both
      138                   both
      139                   both
     1512                   both
----------------------------------
60:03:3a>
```

Table 37 EUM Factory Configuration

Parameter	Default Configuration
Console Prompt	The default console prompt is the station (EUM) ID.
Ethernet IP Address	192.168.10.250
Ethernet Netmask	24 255.255.255.0 ffffff00
Gateway IP Address	192.168.10.1
Maximum Number of Customers	1
Password	By default, the EUM has no password. Press **Enter** at the password prompt to enter a null password.
Port Filters	137 (both) 138 (both) 139 (both) 445 (both) 1512 (both)
Radio	Enabled
Radio Frequency	9050 (905.0 MHz)
Radio Power	+26 dBm (High)
SNMP Contact	WaveRider Communications Ltd.
SNMP Location	www.waverider.com
SNMP Read Communities	public
SNMP Write Communities	private
SNMP Traps	None entered
SNTP Client (listen only) Enabled	Yes

To reset the EUM to factory default

```
60:ff:fe> fil dir
Directory listing:
  BASIC.CFG        1992
  SNTP.CFG          156
  SA1110.EXE     475764
  PORT.CFG         6240
  SA1110.BAK     475764

60:ff:fe> fil del basic.cfg
file deleted
60:ff:fe> fil del sntp.cfg
file deleted
60:ff:fe> fil del port.cfg
file deleted
60:ff:fe> reset
rebooting EUM ...

(... Power On Self Test ...)

WaveRider Communications, Inc. LMS3000
Password:
60:ff:fe> port add 137 both
60:ff:fe> port add 138 both
60:ff:fe> port add 139 both
60:ff:fe> port add 445 both
60:ff:fe> port add 1512 both
60:ff:fe>
60:ff:fe> save
Basic Config saved
Port Filter Config saved
sntp cfg file saved
60:ff:fe>
60:ff:fe> port
PORT FILTERS
    Port                   Filter
--------------------------------
      445                   both
      137                   both
      138                   both
      139                   both
     1512                   both
---------------------------------
60:03:3a>
```

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Appendix C Command-Line Syntax

This appendix describes the various LMS4000 commands and syntax, and consists of the following sections:

- *Command-line Syntax Conventions and Shortcuts* on page 189
- *CCU Command-line Syntax* on page 191
- *EUM Command-line Syntax* on page 204

NOTE: The **help** command on the CCU or EUM may display additional commands that are not listed in the following tables. WaveRider recommends that you use only commands listed in this Appendix.

All commands typed at the command-line interface are recorded verbatim in the system log.

For instructions on accessing the command-line interface, refer to *Access Interface* on page 221.

Command-line Syntax Conventions and Shortcuts

Table 38 shows the typographical conventions used to represent command-line syntax. Table 39 provides a list of shortcuts and methods to get help on commands. To execute a command, type the command and press **Enter**.

Table 38 Command-Line Syntax Conventions

Convention	Use	Examples
`monospaced font`	Indicates that you must type the text.	`ip route`

Convention	Use	Examples
Enter	Bold face type indicates a keyboard key press. A plus sign (+) indicates key combinations. For example, for **Ctrl**+**U**, press and hold down the **Ctrl** key, then press the **U** key.	**Enter** **Esc** **Ctrl**+**U**
<variable>	Specifies a variable name or other information that you must replace with a real name or value.	`ip address ethernet <ip_address>`
bold **ch**aracters	Indicates the shortcut characters for a command.	**i**p **e**thernet can also be typed as **i e**
|	Separates two mutually exclusive choices in a command. Type one choice and do not type the vertical bar.	**e**xit|**q**uit
( )	Encloses a range of values from which you can choose a value.	**i**p **e**thernet <aaa.bbb.ccc.ddd> (0-32)

Table 39 Command-Line Shortcuts and Getting Help

Type	To do this...
↑↓	Scroll up and down through last 10 commands.
?	To display the names of the root commands.
<command_name> ?	To display the syntax for a command.
help	To display all the commands, their subcommands and the parameters and options for each command.
help <command_name>	To display the parameters and options for the command.
ESC	To cancel the command you are typing.

CCU Command-line Syntax

Table 40 CCU Command-Line Syntax

NOTE: In Table 40, commands that are noted with a √ in the right-hand column will not take effect until you have rebooted the CCU.

Command Syntax (CCU)	Command Description	
`address`	Displays the Address Table.	
`address delete|remove <eum_id>`	Removes an EUM ID from the Address Table. • `<eum_id>` is the EUM ID, in the form XX:XX:XX.	
`address flush`	Removes all entries from the Address Table.	
`air`	Displays the EUM Registration Table.	
`air associations`	Displays the maximum association count.	
`air associations <value>`	Changes the maximum number of associations. • <value> must be between 1 and 75.	
`air delete <eum_id>`	Deletes an EUM from the Registration Table. • `<eum_id>` is the EUM ID, formatted in hexadecimal XX:XX:XX.	
`air dereg`	Displays the deregistration count.	
`air dereg <value>`	Changes the deregistration count. • `<value>` is the deregistration count, from 1 to 254.	
`air fdereg <eum_id>`	Forces deregistration of an EUM. • `<eum_id>` is the EUM ID, in the form XX:XX:XX.	
`air flush`	Removes all entries from the EUM Registration Table.	
`arp`	Displays the ARP Table.	

Command Syntax (CCU)	Command Description
arp add <aaa.bbb.ccc.ddd> <XX.XX.XX.XX.XX.XX> [flags]	Adds an entry to the ARP Table. • <aaa.bbb.ccc.ddd> is the IP address of the new entry. • <XX:XX:XX:XX:XX:XX> is the MAC address, in hexadecimal format. • [flags] is always set to 4, meaning the entry is *permanent* and does not time out, as long as the CCU or EUM is ON.
arp delete <aaa.bbb.ccc.ddd>	Deletes an entry from the ARP Table: • <aaa.bbb.ccc.ddd> is the IP address of the entry being deleted.
arp flush	Removes all entries from the ARP Table.
arp map	Displays the ARP Map Table.
arp map <aaa.bbb.ccc.ddd>|<eum_id>	Maps an IP address <aaa.bbb.ccc.ddd> to a MAC address, EUM ID, grade of service, etc. • <aaa.bbb.ccc.ddd> is the IP address of the host to display. • <eum_id> is the EUMID of the EUM to display.
auth	Displays the EUM Authorization Table.
auth add | **edit** <eum_id> <gos>	Adds an EUM to the Authorization Table. • <eum_id> is the EUM ID, in the form XX:XX:XX. • <gos> is the EUM grade of service. Available GOSs are gold, silver, bronze, be (best effort), and denied.
auth default <gos>	Sets the default GOS, which is the GOS assigned to an EUM upon registration. • <gos> is the default grade of service. Available GOSs are gold, silver, bronze, be (best effort), and denied. **NOTE:** After changing the default GOS, execute the “air flush” and “arp flush” commands for the default GOS to apply to EUMs that are already registered.
auth delete <eum_id>	The EUM will receive the default grade of service. • <eum_id> is the EUM ID, in the form XX:XX:XX.

Command Syntax (CCU)	Command Description
auth gos <gos>	Displays the GOS definitions. • <gos> is the default grade of service. Available GOSs are gold, silver, bronze, be (best effort), and broadcast.
auth radius	Displays the RADIUS client configuration.
auth radius accounting enable	Enable RADIUS accounting. NOTE: RADIUS authorization must be enabled before you can enable RADIUS accounting.
auth radius accounting disable	Disable RADIUS accounting.
auth radius disable	Disables RADIUS authorization and accounting.
auth radius enable	Enables RADIUS authorization.
auth radius period <period>	Sets the period between RADIUS requests for each EUM. • <period> is the number of minutes between RADIUS requests. The period must be between 5 and 20000 minutes.
auth radius primary <aaa.bbb.ccc.ddd>|none	Sets the primary RADIUS server IP address and password. The CCU prompts for password entry. • <aaa.bbb.ccc.ddd> is the primary RADIUS server IP address.
auth radius secondary <eee.fff.ggg.hhh>|none	Sets the secondary RADIUS server IP address and password. The CCU prompts for password entry. • <eee.fff.ggg.hhh> is the secondary RADIUS server IP address.
bcf	Displays the basic configuration file (BCF).
bridge | customer	Displays the bridge table.
bridge | customer flush	Removes all entries from the bridge table.
bridge | customer maximum <max>	Sets the maximum number of customers. • <max> is the maximum, which must be from 1 to 50.
dhcp	Displays status of CCU DHCP Relay, either *enabled* or *disable*.
dhcp disable	Disables DHCP relay.
dhcp enable	Enables DHCP relay.

Command Syntax (CCU)	Command Description
dhcp **r**elay	Displays the CCU DHCP relay status and contents of the DHCP Server Table.
dhcp **r**elay **a**dd <aaa.bbb.ccc.ddd> <netmask>	Adds the DHCP server IP address. • <aaa.bbb.ccc.ddd> is the IP address of the DHCP server. • <netmask> is the subnet mask of the DHCP server (0-32).
dhcp **r**elay **d**elete <aaa.bbb.ccc.ddd> <netmask>	Deletes the DHCP server IP address. • <aaa.bbb.ccc.ddd> is the IP address of the DHCP server. • <netmask> is the subnet mask of the DHCP server (0-32).
dhcp **r**elay **f**lush	Removes all DHCP server IP addresses.
exit|**q**uit	Exits the current console session and returns to the password prompt.
file **co**py | **cp** <source> <destination>	Copies a file. • <source> is the name of the source file. • <destination> is the name of the destination file.
file **de**lete <filename>	Deletes a file. • <filename> is the name of the file you want to delete.
file **di**r | **l**s	Lists the name, size, and cyclic redundancy check (CRC) for each file.

Command Syntax (CCU)	Command Description
file get <aaa.bbb.ccc.ddd>|<EUM_ID> <username> [<password>|_] <source> <destination>	**NOTE:** If you enter only the IP address or EUM ID, then <username> defaults to “buywavc”, <source> defaults to “null”, and <destination> defaults to “null”—the link speed test. Retrieves a file from a remote location. • <aaa.bbb.ccc.ddd> is the IP address of the computer from which you are retrieving the file. **NOTE:** You can use <EUM_ID> in place of the IP address for EUMs or CCUs. • <username> is the user name required to log on to the remote computer. Defaults to “buywavc” if left blank. • <password> is the password to log on to the remote computer. If you omit the password argument, you will be prompted for the password, which will be asterisked out and not recorded in the system log. Use _ when the password is blank. • <source> is the path and filename of the file that is being retrieved from the remote computer. Defaults to “null” if left blank. • <destination> is the path and filename to which the file will be copied. Defaults to “null” if left blank.
file mkboot | **makeboot** <filename>	Makes a new boot file. Use this command with caution. • <filename> is the name of the new boot file.
file rename | **rn** <from> <to>	Renames a file. • <from> is the old file name. • <to> is the new file name.
help	Displays the console command structure.
ip	Displays the CCU IP address assignments.
ip ethernet	Displays the Ethernet IP address of the CCU. **NOTE:** If the CCU is in Switched Ethernet mode or Through Only mode, this command displays the CCU IP address.

Command Syntax (CCU)	Command Description	
ip ethernet <aaa.bbb.ccc.ddd> <netmask>	Changes the Ethernet IP address of the CCU. • <aaa.bbb.ccc.ddd> is the new Ethernet IP address of the CCU. • <netmask> is the subnet mask of the CCU Ethernet address (0-32). **NOTE:** If the CCU is in Switched Ethernet mode or Through Only mode, this command sets the CCU IP address.	√
ip gateway	Displays the IP address of the router through which the CCU connects to the Internet.	
ip gateway <aaa.bbb.ccc.ddd>	Defines the router through which the CCU connects to the Internet. • <aaa.bbb.ccc.ddd> is the new Ethernet IP address of the router.	√
ip radio	Displays the radio IP address of the CCU. **NOTE:** If the CCU is in Switched Ethernet mode or Through Only mode, this command displays the CCU IP address.	
ip radio <aaa.bbb.ccc.ddd> <netmask>	Changes the radio IP address of the CCU. • <aaa.bbb.ccc.ddd> is the new IP address of the CCU radio. • <netmask> is the subnet mask of the CCU radio address (0-32). **NOTE:** If the CCU is in Switched Ethernet mode or Through Only mode, this command sets the CCU IP address.	√
password	Initiates the process for changing the system password.	
pcf	Displays the permanent configuration file (PCF).	

Command Syntax (CCU)	Command Description	
ping <aaa.bbb.ccc.ddd>|<eum_id> <length> <interval>	Sends ICMP echo requests to a remote host. • <aaa.bbb.ccc.ddd> is the IP address of the remote host. • <eum_id> is the EUMID (in the form XX:XX:XX) of an EUM or CCU to ping. • <length> is an optional parameter defining the ping packet size in bytes. The default length is 64 bytes, and the maximum length is 1460 bytes. • <interval> is an optional parameter defining the number of milliseconds between pings. The interval may be from 100 to 4000 milliseconds, and the default is 490 milliseconds. Press any key to halt.	
port	Displays the TCP/UDP port filters.	
port add <port number> tcp|udp|both	Adds or modifies a port filter. • <port number> is the number of the port to be filtered. • One of tcp, udp, or both is selected to filter TCP or UDP messages, or both.	
port delete <port number>	Deletes a port filter. • <port number> is the port to be deleted.	
port flush	Deletes all port filters.	
protocol	Displays the protocol mode.	
protocol routed|switched|through	Changes the protocol mode.	√
radio	Displays the radio attributes of the CCU.	

Command Syntax (CCU)	Command Description	
radio **a**nalyse <samples> <interval> <start> <stop>	Starts a spectral analysis. • <samples> is the number of RSSI and noise floor samples taken at each frequency. The default value is *200*. • <interval> is the step size between sample points. The default is *2* (200 kHz), which is also the minimum step size allowed. The maximum interval is *200* (20 MHz). • <start> is the lowest frequency sampled, in 100's of kHz. The default is *9000* (900.0 MHz), which is also the minimum allowed. • <stop> is the upper boundary on frequencies sampled, in 100's of kHz. The default is *9300* (930.0 MHz), which is also the maximum allowed.	
radio **a**nalyse **l**ast	This command will redisplay the results of the last spectral analysis that was performed.	
radio **c**omment <comment>	Adds a comment to both the tabular and the graphical versions of the spectral analysis output. The character string that you enter in <comment> will be displayed below the date and time line. Up to 50 characters are allowed.	
radio **d**isable	Disables the radio transmitter/receiver. The radio is re-enabled automatically after rebooting the unit. NOTE: When using this command, ensure that an Ethernet or serial port connection to the CCU is available; otherwise, you will be unable to re-enable the radio.	
radio **e**nable	Enables the radio transmitter/receiver.	
radio **f**requency	Displays the CCU radio frequency in tenths of a MHz; for example, 905.0 MHz is displayed as 9050.	√
radio **f**requency <frequency>	Changes the CCU radio frequency. • <frequency> is the new radio frequency, in tenths of a MHz. (For example, 905.0 MHz is entered as 9050.) The radio frequency must be within the range of 9050 to 9250. The frequency may use only 0.2 MHz increments and may use even values only.	

Command Syntax (CCU)	Command Description
radio meter	Displays traffic statistics and polling statistics totals for each grade of service.
radio meter <interval>	Displays running average per second traffic and polling statistics for each grade of service. • <interval> in seconds is the time over which the average is made. Press any key to halt.
radio rf high|low|<value>	Displays or sets the power of the CCU radio, where programming the value to: • high will set the transmit power output to +26 dBm, • low will set the transmit power to +15 dBm, and • <value>, where <value>, an integer between 15 and 26 inclusive, will set the transmit power to +<value> dBm. **NOTE:** The CCU RF level should normally be set to high.
radio rssi	Displays continuous RSSI readings. Press any key to halt.
rcf	Displays the contents of the route configuration file (RCF).
reset|reboot	Reboots the CCU.
route	Displays the routing table of the CCU.
route add <aaa.bbb.ccc.ddd> <eee.fff.ggg.hhh> <netmask>	Adds a static route to the routing table. • <aaa.bbb.ccc.ddd> is the Ethernet IP address of the network being added to the routing table. • <eee.fff.ggg.hhh> is the Ethernet IP address of the gateway through which the destination is reached. • <netmask> is the subnet mask of the destination network (0-32).

Command Syntax (CCU)	Command Description	
route **d**elete <aaa.bbb.ccc.ddd> <eee.fff.ggg.hhh> <netmask>	Deletes a route from the routing table. • <aaa.bbb.ccc.ddd> is the Ethernet IP address of the network being removed from the routing table. • <eee.fff.ggg.hhh> is the Ethernet IP address of the gateway through which the destination device can be reached. • <netmask> is the subnet mask for the destination network (0-32).	
route **s**tats	Displays the routing statistics.	
save | **com**mit	Saves configuration changes.	
snmp	Displays the CCU SNMP information.	
snmp **com**munity	Displays the SNMP communities.	
snmp **com**munity **a**dd <community> <**r**ead|**w**rite>	Adds an SNMP community. • <community> is the name of the SNMP community being added, from 1-31 characters in length. • Enter <read> or <write> to indicate the type of the community being added.	
snmp **com**munity **d**elete <community>	Deletes an SNMP community. • <community> is the name of the SNMP community being deleted.	
snmp **con**tact	Displays the SNMP system contact.	
snmp **con**tact <contact>	Changes the SNMP system contact. • <contact> is the name of the contact (WISP, for example), from 1-80 characters in length.	√
snmp **i**nterface	Displays the SNMP interface MIBs.	
snmp **l**ocation	Displays the SNMP system location.	√
snmp **l**ocation <location>	Changes the SNMP system location. • <location> is the location of the CCU, from 1-80 characters in length.	
snmp **t**rap	Displays the SNMP Trap Server Table.	
snmp **t**rap **a**dd <aaa.bbb.ccc.ddd> <community>	Adds a trap server community. • <aaa.bbb.ccc.ddd> is the Ethernet IP address of the trap server. • <community> is the community name for the trap server, from 1-63 characters in length.	

Command Syntax (CCU)	Command Description
snmp **t**rap **d**elete <aaa.bbb.ccc.ddd> <community>	Deletes a trap server community. • <aaa.bbb.ccc.ddd> is the Ethernet IP address of the trap server. • <community> is the community name for the trap server being deleted, from 1-63 characters in length.
stats	Displays the statistics for all drivers and network protocols.
stats **a**uth	Displays authorization/RADIUS statistics.
stats **c**lear	Clears the statistics for all drivers.
stats **e**thernet	Displays Ethernet statistics.
stats **l**og <interval>|OFF|NOW	Displays or sets statistics logging interval in minutes. • <interval> is the time interval in minutes of statistics logging, from 1 to 65535 minutes; setting the interval also turns logging on. • OFF turns statistics logging off. • NOW prints the current statistics to the log without affecting the period or turning logging on or off.
stats **m**ac	Displays MAC driver statistics.
stats **n**et	Displays network protocol statistics.
stats **n**et **ic**mp	Displays ICMP statistics.
stats **n**et **ip**	Displays IP statistics.
stats **n**et **t**cp	Displays TCP statistics.
stats **n**et **u**dp	Displays UDP statistics.
stats **rad**io	Displays radio driver statistics.
stats **rp** | **ro**uting	Displays routing protocol statistics.
stats **s**ummary	Displays a summary of the Atmel MAC statistics.
sys **l**og <number> <offset>	Displays the modem log file. • <number> is the number of characters to print from the log file. • <offset> is the character offset; default is 0.
sys **ma**c	Displays the Atmel MAC log.
sys **mem**ory	Displays memory allocation information.

Command Syntax (CCU)	Command Description
sys prompt <new prompt>	Changes the system prompt. • <new prompt> is the new prompt, from 1-20 characters in length. You cannot use the “>” character. It will be appended to the prompt automatically.
sys ss	Displays the system status file, which includes POST results, file status, I/O connections, and system statistics.
sys tasks	Displays the task list.
sys uptime	Displays the length of time the system has been running. **NOTE:** It rolls over to zero after about 8 days.
sys version	Displays software version information.
sys wlog <text>	Writes text to the log file. This command is useful for adding information to the log for subsequent analysis: • <text> may be from 1-246 characters in length.
telnet <aaa.bbb.ccc.ddd>|<eum_id>	Begins a telnet session to a destination address. • <aaa.bbb.ccc.ddd> is the IP address of a host, such as an EUM, accessible from this CCU, in the format aaa.bbb.ccc.ddd. • <eum_id> is the EUMID (in the form XX:XX:XX) of an EUM or CCU to connect to.
time	Displays the system calendar clock time.
time client	Manages the SNTP client and displays a list of NTP servers.
time client disable	Disables the SNTP client.
time client enable	Enables the SNTP client.
time print	Prints the SNTP configuration and NTP server list.
time relay destination [**broadcast**|<aaa.bbb.ccc.ddd>]	Relays NTP messages to an EUM network or to an individual EUM. • <aaa.bbb.ccc.ddd> is the multicast address, SNTP client network address, EUM IP address.

Command Syntax (CCU)	Command Description
`time relay disable`	Disables SNTP relay over the radio interface.
`time relay disable boot`	Disables CCU time updates when the CCU boots.
`time relay disable registration`	Disables EUM time updates when an EUM registers with a CCU.
`time relay enable`	Enables SNTP relay over the radio interface.
`time relay period <seconds>`	Sets the time relay resynchronization period, in seconds. • Time period may be from 0 to 100000 seconds. • Enter 0 to force immediate resynchronization. The default time relay period is 3600 seconds.
`time server`	Manages NTP servers.
`time server add <aaa.bbb.ccc.ddd>`	Adds or modifies an NTP server.
`time server default`	Restores default NTP servers.
`time server delete <aaa.bbb.ccc.ddd>`	Deletes an NTP server.
`time server flush`	Deletes all NTP servers.
`time set <time>`	Sets the system time (Greenwich Mean Time). • `<time>` is formatted [dy-mon-year hh:mm:ss] or [mm-dd-yy hh:mm:ss}. This command overwrites the local time obtained from the NTP server. The local time will be updated on the next refresh from the NTP server, unless the time client is disabled.
`time stats`	Displays time statistics.
`watch <eum_id>`	Gathers link statistics for a specified EUM. The watch command zeros the statistics before executing.
`watch`	Displays link statistics previously gathered for a specific EUM. Note that the watch command displays only the link statistics for the EUM connected to this CCU for which statistics were most recently gathered.

EUM Command-line Syntax

Table 41 EUM Command-Line Syntax

NOTE: In Table 41, commands that are noted with a √ in the right-hand column will not take effect until you have rebooted the EUM.

Command Syntax (EUM)	Command Description	
`arp`	Displays the ARP Table.	
`arp add <aaa.bbb.ccc.ddd> <XX.XX.XX.XX.XX.XX> [flags]`	Adds an entry to the ARP Table. • `<aaa.bbb.ccc.ddd>` is the IP address of the new entry. • `<XX:XX:XX:XX:XX:XX>` is the MAC address, in hexadecimal format. • `[flags]` is always set to 4, meaning the entry is *permanent* and does not time out, as long as the CCU or EUM is ON.	
`arp delete <aaa.bbb.ccc.ddd>`	Deletes an entry from the ARP table. • `<aaa.bbb.ccc.ddd>` is the IP address of the entry.	
`arp flush`	Removes all entries from the ARP Table.	
`bcf`	Displays the basic configuration file (BCF).	
`bridge | customer`	Displays the bridge table.	
`bridge | customer flush`	Removes all entries from the bridge table.	
`bridge | customer maximum <max>`	Sets the maximum number of customers. • <max> is the maximum, which must be from 1 to 50.	
`exit|quit`	Exits the current console session and returns to the password prompt.	
`file copy|cp <source> <destination>`	Copies a file. • `<source>` is the name of the source file. • `<destination>` is the name of the destination file.	
`file delete <filename>`	Deletes a file. • `<filename>` is the name of the file you want to delete.	
`file dir|ls`	Lists the file directory.	

Command Syntax (EUM)	Command Description
file get <aaa.bbb.ccc.ddd>|<EUM_ID> <username> [<password>|_] <source> <destination>	**NOTE:** If you enter only the IP address or EUM ID, then <username> defaults to “buywavc”, <source> defaults to “null”, and <destination> defaults to “null”—the link speed test. Retrieves a file from a remote location. • <aaa.bbb.ccc.ddd> is the IP address of the computer from which you are retrieving the file. **NOTE:** You can use <EUM_ID> in place of the IP address for EUMs or CCUs. • <username> is the user name required to log on to the remote computer. Defaults to “buywavc” if left blank. • <password> is the password to log on to the remote computer. If you omit the password argument, you will be prompted for the password, which will be asterisked out and not recorded in the system log. Use _ when the password is blank. • <source> is the path and filename of the file that is being retrieved from the remote computer. Defaults to “null” if left blank. • <destination> is the path and filename to which the file will be copied. Defaults to “null” if left blank.
file mkboot|makeboot <filename>	Makes a new boot file. • <filename> is the name of the new boot file.
file rename|**rn** <from> <to>	Renames a file. • <from> is the old file name. • <to> is the new file name.
help	Displays the console command structure.
ip	Displays the EUM IP address assignments.
ip ethernet	Displays the EUM IP address and netmask, the same for both the radio and Ethernet port.

Command Syntax (EUM)	Command Description	
ip ethernet <aaa.bbb.ccc.ddd> <netmask>	Changes the IP address of the EUM. • <aaa.bbb.ccc.ddd> is the new IP address of the EUM. • <netmask> is the subnet mask of the EUM IP address (0-32).	√
ip gateway	Displays the IP address of the router through which the EUM connects to the Internet. In routed mode networks, this is the IP address of the router.	
ip gateway <aaa.bbb.ccc.ddd>	Changes the router through which the EUM connects to the Internet. • <aaa.bbb.ccc.ddd> is the radio IP address of the router through which the EUM connects to the Internet. In routed mode networks, this is the CCU radio IP address.	√
password	Initiates the process for changing the system password.	
pcf	Displays the permanent configuration file (PCF).	
ping <aaa.bbb.ccc.ddd>|<eum_id> <length> <interval>	Sends ICMP echo requests to a remote host. • <aaa.bbb.ccc.ddd> is the IP address of the remote host. • <eum_id> is the EUMID (in the form XX:XX:XX) of an EUM or CCU to ping. • <length> is an optional parameter defining the ping packet size in bytes. The default length is 64 bytes, and the maximum length is 1460 bytes. • <interval> is an optional parameter defining the number of milliseconds between pings. The interval may be from 100 to 4000 milliseconds, and the default is 490 milliseconds. Press any key to halt.	
port	Displays the TCP/UDP port filters.	
port add <port number> tcp|udp|both	Adds or modifies a port filter. • <port number> is the number of the port to be filtered. • One of tcp, udp, or both is selected to filter TCP or UDP messages, or both.	

Command Syntax (EUM)	Command Description
port delete <port number>	Deletes a port filter. • <port number> is the port to be deleted.
port flush	Deletes all port filters.
radio	Displays the radio attributes of the EUM.
radio analyse <samples> <interval> <start> <stop>	Starts a spectral analysis. • <samples> is the number of RSSI and noise floor samples taken at each frequency. The default value is *200*. • <interval> is the step size between sample points. The default is *2* (200 kHz), which is also the minimum step size allowed. The maximum interval is *200* (20 MHz). • <start> is the lowest frequency sampled, in 100's of kHz. The default is *9000* (900.0 MHz), which is also the minimum allowed. • <stop> is the upper boundary on frequencies sampled, in 100's of kHz. The default is *9300* (930.0 MHz), which is also the maximum allowed.
radio analyse last	This command will redisplay the results of the last spectral analysis that was performed.
radio comment	Adds a comment to both the tabular and the graphical versions of the spectral analysis output.
radio disable	Disables the radio transmitter/receiver. The radio is re-enabled automatically after rebooting the unit. NOTE: When using this command, ensure that an Ethernet connection to the EUM is available; otherwise, you will be unable to re-enable the radio.
radio enable	Enables the radio transmitter/receiver.
radio frequency	Displays the EUM radio frequency in tenths of a MHz; for example, 905.0 MHz is displayed as 9050.

Command Syntax (EUM)	Command Description	
radio **f**requency <frequency>	Changes the EUM radio frequency. • <frequency> is the new radio frequency, in tenths of a MHz. (For example, 905.0 MHz is entered as 9050.) The radio frequency must be within the range of 9050 to 9250. The frequency may use only 0.2 MHz increments and may use even values only.	√
radio **rc**	Clears the RSSI, SQ, RNA, and RNB histograms.	
radio **rf** high|low|<value>	Displays or sets the power of the EUM radio, where programming the value to: • high will set the transmit power output to +26 dBm, • low will set the transmit power to +15 dBm, and • <value>, where <value>, an integer between 15 and 26 inclusive, will set the transmit power to +<value> dBm. **NOTE:** The EUM RF level should normally be set to high.	
radio **rh**	Displays the RSSI, SQ, RNA, and RNB histograms.	
radio **rs**si	Displays continuous RSSI readings. Press any key to halt.	
reset|**reb**oot	Reboots the EUM.	
route	Displays the routing table for the EUM.	
route **s**tats	Displays the routing statistics.	
save|**com**mit	Saves configuration changes.	
snmp	Displays the EUM SNMP information.	
snmp **co**mmunity	Displays the SNMP communities.	
snmp **com**munity **a**dd <community> <**r**ead|**w**rite>	Adds an SNMP community. • <community> is the name of the SNMP community being added, from 1-31 characters in length. • Enter <read> or <write> to indicate the type of the community being added.	

Command Syntax (EUM)	Command Description	
snmp community delete <community>	Deletes an SNMP community. • <community> is the name of the SNMP community being deleted.	
snmp contact	Displays the SNMP system contact.	
snmp contact <contact>	Changes the SNMP system contact. • <contact> is name of the EUM SNMP system contact (subscriber, for example), from 1-80 characters in length.	√
snmp interface	Displays the interface MIBs.	
snmp location	Displays the SNMP system location.	
snmp location <location>	Changes the SNMP system location. • <location> is the location of the EUM, from 1-80 characters in length.	√
snmp trap	Displays the SNMP Trap Server Table.	
snmp trap add <aaa.bbb.ccc.ddd> <community>	Adds a trap server community. • <aaa.bbb.ccc.ddd> is the Ethernet IP address of the trap server. • <community> is the community name for the trap server, from 1-63 characters in length.	
snmp trap delete <aaa.bbb.ccc.ddd> <community>	Deletes a trap server community. • <aaa.bbb.ccc.ddd> is the Ethernet IP address of the trap server. • <community> is the community name for the trap server being deleted, from 1-63 characters in length.	
stats	Displays the statistics for all drivers and network protocols.	
stats clear	Clears the statistics for all drivers.	
stats ethernet	Displays Ethernet statistics.	
stats log <interval>|OFF|NOW	Displays or sets statistics logging interval in minutes. • <interval> is the time interval in minutes of statistics logging, from 1 to 65535 minutes; setting the interval also turns logging on. • OFF turns statistics logging off. • NOW prints the current statistics to the log without affecting the period or turning logging on or off.	

Command Syntax (EUM)	Command Description
stats **m**ac	Displays MAC driver statistics.
stats **n**et	Displays network protocol statistics.
stats **n**et **ic**mp	Displays ICMP statistics.
stats **n**et **ip**	Displays IP statistics.
stats **n**et **t**cp	Displays TCP statistics.
stats **n**et **u**dp	Displays UDP statistics.
stats **rad**io	Displays radio driver statistics.
stats **rp**|**ro**uting	Displays routing protocol statistics.
stats **s**ummary	Displays a summary of the Atmel MAC statistics.
sys **l**og <number> <offset>	Displays the modem log file. • <number> is the number of characters to print from the log file. • <offset> is the character offset, default is 0.
sys **ma**c	Displays the Atmel MAC log.
sys **me**mory	Displays memory allocation information.
sys **p**rompt <new prompt>	Changes the system prompt. • <new prompt> is the new prompt, from 1-20 characters in length. You cannot use the “>” character. It will be appended to the prompt automatically.
sys **s**s	Displays the system status file, which includes POST results, file status, I/O connections, and system statistics.
sys **t**ask	Displays the task list.
sys **u**ptime	Displays system uptime.
sys **v**ersion	Displays software version information.
sys **w**log <text>	Writes text to the log file. This feature is useful for adding information to the log for subsequent analysis. • <text> may be from 1-246 characters in length.
time	Displays the system calendar clock time.
time **c**lient	Manages the SNTP client and displays a list of NTP servers.
time **c**lient **d**isable	Disables the SNTP client.

Command Syntax (EUM)	Command Description
`time client enable`	Enables the SNTP client.
`time print`	Prints the SNTP configuration and NTP server list.
`time set <time>`	Sets the system time (Greenwich Mean Time). • `<time>` is formatted [dy-mon-year hh:mm:ss] or [mm-dd-yy hh:mm:ss}. This command overwrites the local time obtained from the NTP server. The local time will be updated on the next refresh from the NTP server, unless the time client is disabled.
`time stats`	Displays time statistics.

Appendix D INOP Commands

If CCU or EUM software becomes inaccessible or corrupted, the unit will start in inoperative mode (INOP). You can also force an EUM3003 to start in INOP mode to recover an EUM if the IP address is not known. While in INOP mode, CCUs and EUMs use a subset of the regular CLI commands. For instructions on putting an EUM3003 into INOP mode, refer to *EUM3003 INOP Button* on page 224. These INOP commands are described in the following tables.

NOTE: The radio is not functional while in INOP mode.

Table 42 CCU INOP

NOTE: In Table 42, commands that are noted with a √ in the right-hand column will not take effect until you have rebooted the CCU.

Command Syntax (CCU)	Command Description	
bcf	Displays the basic configuration file (BCF).	
exit|**quit**	Exits the current console session and returns to the password prompt.	
file copy | **cp** <source> <destination>	Copies a file. • <source> is the name of the source file. • <destination> is the name of the destination file.	
file delete <filename>	Deletes a file. • <filename> is the name of the file you want to delete.	
file dir | **ls**	Lists the name, size, and cyclic redundancy check (CRC) for each file.	

Command Syntax (CCU)	Command Description
file get <aaa.bbb.ccc.ddd>|<EUM_ID> <username> [<password>|_] <source> <destination>	**NOTE:** If you enter only the IP address or EUM ID, then <username> defaults to “buywavc”, <source> defaults to “null”, and <destination> defaults to “null”—the link speed test. Retrieves a file from a remote location. • <aaa.bbb.ccc.ddd> is the IP address of the computer from which you are retrieving the file. **NOTE:** You can use <EUM_ID> in place of the IP address for EUMs or CCUs. • <username> is the user name required to log on to the remote computer. Defaults to “buywavc” if left blank. • <password> is the password to log on to the remote computer. If you omit the password argument, you will be prompted for the password, which will be asterisked out and not recorded in the system log. Use _ when the password is blank. • <source> is the path and filename of the file that is being retrieved from the remote computer. Defaults to “null” if left blank. • <destination> is the path and filename to which the file will be copied. Defaults to “null” if left blank.
file mkboot | **makeboot** <filename>	Makes a new boot file. Use this command with caution. • <filename> is the name of the new boot file.
file rename | **rn** <from> <to>	Renames a file. • <from> is the old file name. • <to> is the new file name.
help	Displays the console command structure.
ip	Displays the CCU IP address assignments.
ip ethernet	Displays the Ethernet IP address of the CCU.

Command Syntax (CCU)	Command Description	
ip ethernet <aaa.bbb.ccc.ddd> <netmask>	Changes the Ethernet IP address of the CCU. • <aaa.bbb.ccc.ddd> is the new Ethernet IP address of the CCU. • <netmask> is the subnet mask of the CCU Ethernet address (0-32).	√
ip gateway	Displays the IP address of the router through which the CCU connects to the Internet.	
ip gateway <aaa.bbb.ccc.ddd>	Defines the router through which the CCU connects to the Internet. • <aaa.bbb.ccc.ddd> is the new Ethernet IP address of the router.	√
ip radio	Displays the radio IP address of the CCU.	
ip radio <aaa.bbb.ccc.ddd> <netmask>	Changes the radio IP address of the CCU. • <aaa.bbb.ccc.ddd> is the new IP address of the CCU radio. • <netmask> is the subnet mask of the CCU radio address (0-32).	√
password	Initiates the process for changing the system password.	
pcf	Displays the permanent configuration file (PCF).	
ping <aaa.bbb.ccc.ddd>|<eum_id> <length> <interval>	Sends ICMP echo requests to a remote host. • <aaa.bbb.ccc.ddd> is the IP address of the remote host. • <eum_id> is the EUMID (in the form XX:XX:XX) of an EUM or CCU to ping. • <length> is an optional parameter defining the ping packet size in bytes. The default length is 64 bytes, and the maximum length is 1460 bytes. • <interval> is an optional parameter defining the number of milliseconds between pings. The interval may be from 100 to 4000 milliseconds, and the default is 490 milliseconds. Press any key to halt.	
radio	Displays the radio attributes of the CCU.	
radio frequency	Displays the CCU radio frequency in tenths of a MHz; for example, 905.0 MHz is displayed as 9050.	

Command Syntax (CCU)	Command Description	
radio **f**requency <frequency>	Changes the CCU radio frequency. • <frequency> is the new radio frequency, in tenths of a MHz. (For example, 905.0 MHz is entered as 9050.) The radio frequency must be within the range of 9050 to 9250. The frequency may use only 0.2 MHz increments and may use even values only.	√
radio **rf** high|low|<value>	Displays or sets the power of the CCU radio, where programming the value to: • high will set the transmit power output to +26 dBm, • low will set the transmit power to +15 dBm, and • <value>, where <value>, an integer between 15 and 26 inclusive, will set the transmit power to +<value> dBm. **NOTE:** The CCU RF level should normally be set to high.	
reset|**re**boot	Reboots the CCU.	
save | **com**mit	Saves configuration changes.	

Table 43 EUM INOP CLI

In Table 43, commands that are noted with a √ in the right-hand column will not take effect until you have rebooted the EUM.

Command Syntax (EUM)	Command Description	
bcf	Displays the basic configuration file (BCF).	
exit|**q**uit	Exits the current console session and returns to the password prompt.	
file **co**py|**cp** <source> <destination>	Copies a file. • <source> is the name of the source file. • <destination> is the name of the destination file.	
file **del**ete <filename>	Deletes a file. • <filename> is the name of the file you want to delete.	

Command Syntax (EUM)	Command Description
`file dir|ls`	Lists the file directory.
`file get <aaa.bbb.ccc.ddd>|<EUM_ID> <username> [<password>|_] <source> <destination>`	**NOTE:** If you enter only the IP address or EUM ID, then <username> defaults to “buywavc”, <source> defaults to “null”, and <destination> defaults to “null”—the link speed test. Retrieves a file from a remote location. • `<aaa.bbb.ccc.ddd>` is the IP address of the computer from which you are retrieving the file. **NOTE:** You can use <EUM_ID> in place of the IP address for EUMs or CCUs. • `<username>` is the user name required to log on to the remote computer. Defaults to “buywavc” if left blank. • `<password>` is the password to log on to the remote computer. If you omit the password argument, you will be prompted for the password, which will be asterisked out and not recorded in the system log. Use _ when the password is blank. • `<source>` is the path and filename of the file that is being retrieved from the remote computer. Defaults to “null” if left blank. • `<destination>` is the path and filename to which the file will be copied. Defaults to “null” if left blank.
`file mkboot|makeboot <filename>`	Makes a new boot file. • `<filename>` is the name of the new boot file.
`file rename|rn <from> <to>`	Renames a file. • `<from>` is the old file name. • `<to>` is the new file name.
`help`	Displays the console command structure.
`ip`	Displays the EUM IP address assignments.
`ip ethernet`	Displays the EUM IP address and netmask, the same for both the radio and Ethernet port.

Command Syntax (EUM)	Command Description	
ip ethernet <aaa.bbb.ccc.ddd> <netmask>	Changes the IP address of the EUM. • <aaa.bbb.ccc.ddd> is the new IP address of the EUM. • <netmask> is the subnet mask of the EUM IP address (0-32).	√
ip gateway	Displays the IP address of the router through which the EUM connects to the Internet. In routed mode networks, this is the IP address of the router.	
ip gateway <aaa.bbb.ccc.ddd>	Changes the router through which the EUM connects to the Internet. • <aaa.bbb.ccc.ddd> is the radio IP address of the router through which the EUM connects to the Internet. In routed mode networks, this is the CCU radio IP address.	√
password	Initiates the process for changing the system password.	
pcf	Displays the permanent configuration file (PCF).	
ping <aaa.bbb.ccc.ddd>|<eum_id> <length> <interval>	Sends ICMP echo requests to a remote host. • <aaa.bbb.ccc.ddd> is the IP address of the remote host. • <eum_id> is the EUMID (in the form XX:XX:XX) of an EUM or CCU to ping. • <length> is an optional parameter defining the ping packet size in bytes. The default length is 64 bytes, and the maximum length is 1460 bytes. • <interval> is an optional parameter defining the number of milliseconds between pings. The interval may be from 100 to 4000 milliseconds, and the default is 490 milliseconds. Press any key to halt.	
radio	Displays the radio attributes of the EUM.	
radio frequency	Displays the EUM radio frequency in tenths of a MHz; for example, 905.0 MHz is displayed as 9050.	

Command Syntax (EUM)	Command Description	
radio **f**requency <frequency>	Changes the EUM radio frequency. • <frequency> is the new radio frequency, in tenths of a MHz. (For example, 905.0 MHz is entered as 9050.) The radio frequency must be within the range of 9050 to 9250. The frequency may use only 0.2 MHz increments and may use even values only.	√
radio **rf** high|low|<value>	Displays or sets the power of the EUM radio, where programming the value to: • high will set the transmit power output to +26 dBm, • low will set the transmit power to +15 dBm, and • <value>, where <value>, an integer between 15 and 26 inclusive, will set the transmit power to +<value> dBm. **NOTE:** The EUM RF level should normally be set to high.	
reset|**reb**oot	Reboots the EUM.	
save|**com**mit	Saves configuration changes.	

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Appendix E Access Interface

There are up to three different access interfaces available on CCUs and EUMs. Table 44 below identifies which access interfaces are available on each device type.

Table 44 CCU and EUM Access Interfaces

Access Interface	CCU3000	EUM3000	EUM3003
Local Telnet Session	Available	Available	Available
Remote Telnet Session	Available	Available	Available
Serial Port Session	Available	Available	Not Available

Telnet Connection

You can use Telnet to connect to a CCU or an EUM from a PC. Two different types of Telnet connections are possible:

- Local Telnet Session—The PC and the target CCU or EUM are on the same Ethernet segment and IP subnet. For example, you may connect an Ethernet cable directly between them.

  NOTE: In Switched Ethernet mode, with multiple subnets, the end-user PC and EUM may not be on the same IP subnet, so the session would be remote even though they are on the same Ethernet segment.

- Remote Telnet Session—The PC and the target CCU or EUM are connected by an IP network. For example, you may be connecting from the PC to the CCU or EUM over the radio link.

Procedures for both types of Telnet sessions are explained below.

To Connect to a Local CCU or EUM with Telnet

1. Open a Command Prompt window. (For instructions on opening a command prompt window, please refer to your operating system documentation.)
2. Connect a crossover Ethernet cable with ferrite bead between the PC and CCU or EUM.
3. Change the IP address of the PC, so the PC and CCU or EUM are on the same subnet. For more information about configuring PC IP settings, refer to *To Configure PC Network Settings (Windows XP Operating System)* on page 226.

TIP: If you do not know the IP address and netmask of the CCU or EUM, connect to the unit through a serial port and use the “ip ethernet” command (for CCUs and EUM3000s), or use the INOP button (for EUM3003s). The default IP address for an EUM is 192.168.10.250 /24.

4. At the prompt, type **`telnet aaa.bbb.ccc.ddd`** and press **Enter**. (aaa.bbb.ccc.ddd is the IP Ethernet address of the CCU or EUM.)

```
WaveRider Communications, Inc. LMS3000
Password:
```

5. At the password prompt, type the device password and press **Enter**.

NOTE: The default password for CCUs and EUMs is blank, so press **Enter**.

```
60:ff:fe>
```

You are now connected to the CCU or EUM with a Telnet session, and you may issue CLI commands to the device at the command prompt.

To Connect to a Remote CCU or EUM with Telnet

1. Open a Command Prompt window. (For instructions on opening a command prompt window, please refer to your operating system documentation.)
2. If you are using Routed mode, ensure there is a route between the PC and the target CCU or EUM. If the PC is connected by Ethernet to the CCU, and you are connecting to a remote EUM, you must add a route to the radio subnet. For instructions on adding a route, refer to *To Add a Route on a PC* on page 227.

TIP: If you do not know the IP address of an EUM, but you know the EUM ID and can access the CCU, you can Telnet to the CCU and check the ARP MAP table.

3. At the prompt, type **`telnet aaa.bbb.ccc.ddd`** and press **Enter**. (aaa.bbb.ccc.ddd is the IP Ethernet address of the CCU or EUM.)

```
WaveRider Communications, Inc. LMS3000
Password:
```

4. At the password prompt, type the device password and press **Enter**.

   NOTE: The default password for CCUs and EUMs is carriage return.

```
60:ff:fe>
```

   You are now connected to the CCU or EUM with a Telnet session, and you may issue CLI commands to the device at the command prompt.

Serial Port Connection

To Connect to a CCU3000 or EUM3000 Through a Serial Port

1. Connect and RS-232, DB9 male to DB9 female, straight-through cable between the console ports on the CCU3000 or EUM3000 and the PC.
2. Open a terminal emulation program, such as Tera Term Pro or HyperTerminal.

   NOTE: You can download Tera Term Pro from WaveRider Technical Support.

3. Connect to the device using the port settings shown in Table 45.

Table 45 Serial Port Settings

Bits per second	9600
Data bits	8
Parity	None
Stop bits	1
Flow Control	None

4. At the password prompt, type the device password and press **Enter**.

   NOTE: The default password for CCUs and EUMs is carriage return.

   You are now connected to the CCU or EUM with a Serial Port session, and you may issue CLI commands to the device at the command prompt.

EUM3003 INOP Button

NOTE: If you are trying to determine an EUM's IP address, the gratuitous ARP feature provides an alternative to using the INOP button. The EUM transmits a "gratuitous" ARP (an ARP for its own IP address) two seconds after power up. This gratuitous ARP can be used to determine the IP address of an EUM if it is not already known. The operator can either sniff the ARP packet on the Ethernet interface, or look in the ARP table of a connected host.

The EUM3003 includes an Inoperative Mode (INOP) button. It is a recessed push button on the connector end of the EUM. Use a paperclip or a small flat screw driver to push the button gently. You will hear a soft click noise.

The INOP button provides the following functionality:

- Enables you to temporarily reset the IP address to 192.168.10.250 / 24 (Gateway 192.168.10.251).
- Allows for error recovery if the EUM3003 fails during the startup sequence (including a corrupt boot line).

NOTE: The INOP button is NOT a RESET button. Pushing the INOP button during normal operation will not reboot the unit.

CAUTION: The radio interface is not functional in INOP mode.

Using the INOP Button to Recover the IP Address

The EUM3003 may be reset to a default IP address by pressing the INOP button.

To Recover the EUM3003 IP Address

1. During the EUM30003 power up cycle, press the INOP button, hold it until the front three LEDs flash, and then release the INOP button.

   The unit starts in INOP Mode, with the IP Address set to 192.168.10.250 /24.

2. Ensure that the PC connected to the EUM3003 is on Ethernet subnet 192.168.10.0 / 24. If not, change the PC network settings. For instructions on changing the PC network settings, refer to *To Configure PC Network Settings (Windows XP Operating System)* on page 226.

   NOTE: Restarting an EUM3003 in INOP Mode will not change the IP address displayed in the BCF.

3. Open a Telnet session to the EUM3003. For instructions, refer to *Telnet Connection* on page 221.

4. At the prompt, type **bcf** and press **Enter**.

```
WaveRider Communications, Inc. LMS3000
Password:
InOp> bcf
Basic Cfg File:
File ID : basic.cfg
File Time Stamp:
File Version : 5
File Notes : Operator updated
File CRC : 0xE1
IP Address: 192.168.10.250 / 24
IP Subnet : 192.168.10.0 ( 255.255.255.0 )
Gateway IP Address: 192.168.10.1
Contact: WaveRider Communications Inc.
Location: www.waverider.com
Name: LMS3000
SNMP Read Communities:
public
SNMP Write Communities:
private
SNMP Traps:
Statistics Log Interval: 15 minutes
Radio Frequency: 9050
RF Power: LOW
Maximum Number of Customers: 1
InOp>
```

5. Note the IP settings in the BCF.
6. Type **reset** and press **Enter**.

   The EUM3003 is now functioning with its previous IP configuration.

Using the INOP Button When You Cannot Connect to an EUM3003

The EUM3003 may come up in the INOP Mode if the startup fails due to a corrupt boot sequence or other problem. INOP Mode resets the IP address to the default setting of 192.168.10.250 /24.

To Use the INOP Button

1. From a PC on the 192.168.10.0 /24 subnet, attempt to connect to the EUM3003 through a local Telnet connection.
2. If the connection is successful

   a. At the prompt, type **ip** and press **Enter**.

```
60:ff:fe> ip
Ethernet IP Address: 192.168.10.100
Ethernet Net Mask  : ffffff00
Gateway IP Address: 192.168.10.1

60:ff:fe>
```

   b. At the prompt, type **file dir** and press **Enter**.

```
60:ff:fe> file dir
  Filename       Size     CRC
```

```
 SA1110.BAK         0  1d6523d1
  BASIC.CFG      1992  1fd3b0ba
   PORT.CFG      6240  c7148a64
 SA1110.EXE    477617  9af8566b
BOOTROM.BIN    447864  b4fb30fe
   SNTP.CFG       156  c771acf9
```

c. Look for problems, such as an executable file with a size of 0, which indicates a corrupted file.

3. If the connection is unsuccessful, restart the EUM30003 in INOP mode, as described in *To Recover the EUM3003 IP Address* on page 224.
4. If you still cannot connect to the EUM3003, contact WaveRider Technical Support.

PC Configuration

The following two procedures explain how to configure network settings on a PC running the Windows XP operating system, and how to add a static route to a PC.

To Configure PC Network Settings (Windows XP Operating System)

1. Click the Windows **Start** button and open **Control Panel** > **Network Connections** > **Local Area Connection**.
2. Click the **Properties** button.
3. Select **Internet Protocol (TCP/IP)** and click the **Properties** button.
4. Select **Use the following IP address**.
5. Fill in the IP address, Subnet mask, and Default gateway fields, so the PC is on the same subnet as the EUM, and click **OK**.

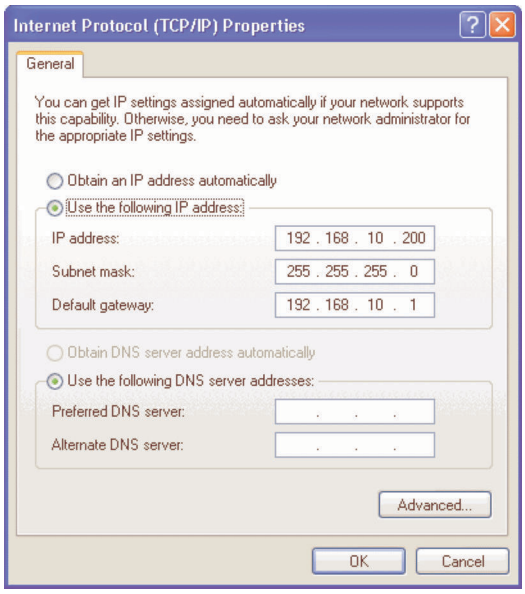

Figure 63 Windows XP TCP/IP Properties

To Add a Route on a PC

1. On the PC, open a command prompt window.
2. At the prompt, type **`route add aaa.bbb.ccc.ddd mask eee.fff.ggg.hhh iii.jjj.kkk.lll`** and press **Enter**.
    - aaa.bbb.ccc.ddd is the radio subnet
    - eee.fff.ggg.hhh is the radio subnet mask
    - iii.jjj.kkk.lll is the gateway to the radio subnet (Ethernet IP address of the CCU)

Appendix F Antenna Guidelines

WARNING!

Antennas and associated transmission cable must be installed by qualified personnel, and external antennas must be properly grounded. WaveRider assumes no liability for failure to adhere to this recommendation or to recognized general safety precautions.

The CCU and EUM have been certified for use with Omni, Patch, Yagi, and Dipole Reflector antenna types, in addition to the WaveRider Diversity Antenna. Table 46 includes examples of each of the recommended antenna types, as well as their associated maximum antenna gains.

Table 46 CCU, EUM Supported Antennas

Antenna Type	Maximum Antenna Gain
Omni	5.1dBi
Patch	8.5dBi
Yagi	13.0dBi
Panel	12.0dBi

Antenna system gain is the net gain of the system. In other words, it is the antenna gain minus the insertion loss due to cabling, connectors, filters, surge protectors, and other hardware components. During installation, you must verify that the antenna system does not exceed the maximum allowable certified antenna system gain, which is 8.8 dBi.

Calculate the antenna system gain by adding the value of the insertion loss for each component of the antenna system, excluding the antenna, and subtracting the total of that sum from the antenna gain. You can measure the insertion loss of the components, and the

antenna gain, at the frequency of interest, or obtain it by referencing the manufacturer's supplied literature.

WaveRider Guidelines for outdoor installation are:

- select a cable of type and length so that cable loss is 3.5dB, including connectors.
- use a surge protector, which has about 0.1 db loss,
- use a WaveRider jumper cable to connect the modem to the exterior cable or surge protector. The jumper cable has a loss of 1 dB.

For example, with a Yagi antenna system, 15m of cable, a surge protector, and a jumper cable (from modem to surge protector), you would calculate the following antenna system gain:

- Antenna Gain: 13.0dBi
- Insertion loss:
    - External Cable: - 3.5dB
    - Surge Protector: - 0.1dB
    - Jumper Cable: - 1.0dB

    _____

- - 4.6dBi

The antenna gain (13.0dBi) minus the total insertion loss (4.6dBi), yields an antenna system gain of 8.4dBi, which is a valid antenna configuration, because the antenna system gain is lower than the maximum permissible value of 8.8 dBi.

WARNING!

To prevent equipment damage, you must use the WaveRider proprietary WCM connector to connect transmission line and antennas to the EUM3000.

WARNING!

Use of an outdoor antenna with the EUM requires professional installation, in accordance with FCC guidelines.

WARNING!

Antennas used with the EUM must not present a short to ground at the EUM antenna port. Contact the WaveRider Customer Support Centre for more information.

Appendix G CCU/EUM Data Tables

The CCU and EUM firmware is structured around a set of tables and files, which are discussed in the following sections in the logical order that they are actively involved in the transmission of packets from the Internet to the end-user's PC:

- *Port Filter Table (CCU and EUM)* on page 231
- *Routing Table (CCU and EUM)* on page 232
- *ARP Table (CCU and EUM)* on page 236
- *Address Translation Table (CCU only)* on page 238
- *Authorization Table (CCU only)* on page 239
- *Registration Table (CCU only)* on page 240
- *ARP Map Table (CCU only)* on page 241
- *Bridge Table (EUM or CCU in Switched Ethernet or Through Only Mode)* on page 242
- *Basic Configuration File (CCU and EUM)* on page 243
- *Permanent Configuration File (CCU and EUM)* on page 245
- *System Status File (CCU and EUM)* on page 246

Port Filter Table (CCU and EUM)

The Port Filter Table provides a list of all port filters that have been enabled. Any IP packet with one of these port numbers will be discarded.

The contents of the Port Filter Table are:

Table 47 Port Filter Table Entries

Table Entry	Description
Port	The number of the port which is to be filtered.
Filter	For each port listed, the CCU or EUM can be set to filter UDP, TCP, or both UDP and TCP packets.

To access the Port Filter Table:

```
60:03:3a> port
PORT FILTERS
    Port                    Filter
--------------------------------
      445                    both
      137                    both
      138                    both
      139                    both
     1512                    both
---------------------------------
60:03:3a>
```

Routing Table (CCU and EUM)

The Routing Table is used by the CCU to determine the routing of IP packets. The routes in the Routing Table are either entered by the system operator as static routes, or automatically generated by the CCU. The CCU does not support dynamic routing.

NOTE: With a CCU in Switched Ethernet mode or Through Only mode, or with an EUM, these routes apply only to packets originated by the EUM or CCU application. Additional routes can only be added to a CCU in Routed mode.

The Routing Table contains the following three routes:

Table 48 Basic Routes

Default Route	Any packet with a destination not listed in the Routing Table is forwarded to the gateway address defined in the default route. Normally, this is be the IP address of the NAP router. The CCU or EUM generates the default route automatically when you enter the gateway IP address.
Radio Subnet Route	Any packet with a destination in the radio subnet (EUMs, end-user PCs) is forwarded to the CCU radio port. The CCU or EUM generates this route automatically, using the CCU radio subnet IP address.
Loopback Route	The loopback interface exists (among other reasons) so the CCU operating system can talk to itself without handing the packet to a hardware driver. This route keeps unneeded traffic off the network. The CCU or EUM generates this loopback route automatically.

In addition to these standard routes, the system operator may add other routes; for example, routes to support direct CCU-to-CCU communications, without going back to the NAP router.

Each route in the Routing Table has the following entries:

Table 49 Routing Table Entries

Entry	Description
Destination	The IP address for the destination network.
Mask	The subnet mask for the destination network.
TOS	Type of service, for example: • 0000 Default • 0001 Minimize monetary cost • 0010 Maximize reliability • 0100 Maximize throughput • 1000 Minimize delay RFC1700 and RFC1349 recommend TOS settings for various protocols, including Telnet, FTP, TFTP, ICMP and SNMP.
Gateway	The IP address of the gateway through which to access the destination network.
Flags	Refer to Table 50.
RefCnt	Number of processes currently referencing the route. If a process requires a route, it looks it up in the Routing Table. When the route is being referenced by a process, *refcnt* will be incremented by one. When the process is done with the route, *refcnt* will be decremented by one.

Entry	Description
Use	Initialized to 0 and incremented every time an IP datagram uses this route.
Interface	The CCU interface through which to send packets to the gateway and destination, one of: • esmc0: CCU Ethernet interface • rdr1: CCU radio interface • lo0: Loopback
Proto	This entry is an operating system parameter that has no meaning for CCU configuration and operation.

To view the Routing Table:

```
WaveRider Communications, Inc. LMS3000
Password:

60:03:3a> route
Destination     Mask      TOS  Gateway         Flags RefCnt Use          Interface
Proto

0.0.0.0         0         0    192.168.1.1     3     0      67           esmc0       1
127.0.0.1       0         0    127.0.0.1       5     1      30           lo0         0
192.168.10.0    ffffff00  0    192.168.10.1    101   0      0            rdr1        0
60:03:3a>

60:03:3a>
```

In the above example, the default route is defined by:

```
Destination     Mask     TOS   Gateway        Flags RefCnt  Use    Interface Proto
0.0.0.0         0         0    10.0.0.1        803   0      196587  esmc0     1
```

Any IP packet with a destination which is not listed in the Routing Table will be forwarded through the Ethernet port and on to the NAP router (IP address 10.0.0.1).

The radio subnet route is defined by:

```
Destination     Mask     TOS   Gateway        Flags RefCnt  Use    Interface Proto
10.5.0.0        ffff0000  0    10.5.0.1        101   0      0       rdr1      0
```

Any IP packet destined for the radio subnet (any IP address starting with 10.5.xx.xx) will be forwarded through the CCU radio port (IP address 10.5.0.1) and over the radio link to the EUMs and end-user's computers.

The loopback route is defined by:

```
Destination     Mask     TOS   Gateway        Flags RefCnt  Use    Interface Proto
127.0.0.1       0         0    127.0.0.1       5     0      24      lo0       0
```

Any IP packet destined for 127.0.0.1, which is an IP address reserved for loopback, will be looped back to the CCU operating system.

The Routing Table flags are summarized in Table 50.

Table 50 Routing Table Flags.

Flag Mask	Description
0x1	Route usable
0x2	Destination is a gateway
0x4	Host entry (net otherwise)
0x8	Host or net unreachable
0x10	Created dynamically (by redirect)
0x20	Modified dynamically (by redirect)
0x40	Message confirmed
0x80	Subnet mask present
0x100	Generate new routes on use
0x200	External daemon resolves name
0x400	Generated by ARP or ESIS
0x800	Manually added
0x1000	Just discard packets (during updates)
0x2000	Protocol specific routing flag
0x4000	Protocol specific routing flag
0x8000	Modified by management protocol

To use Table 50, consider the flag associated with the default route, 803, which is equal to (800 + 2 +1). Referring to Table 50, this route was manually added, the destination is a gateway, and the route is usable.

With the CCU in *routed* mode, you can display the routing configuration file by entering `rcf` in the CCU command line:

```
60:02:xx> rcf
File ID        : route.cfg
File Time Stamp:
File Version   :
File Notes     : Default File - Auto Created
File CRC       : 0xDE

Routing Table:

  Destination Address: 172.24.8.0
  Gateway Address    : 192.168.10.1
  Destination Mask   : ffffffff
  TOS                : 0
  Flags              : 0

  Destination Address: 172.24.11.255
  Gateway Address    : 192.168.10.1
  Destination Mask   : ffffffff
  TOS                : 0
  Flags              : 0
```

The above example shows a routing table to which two routes have been manually added.

ARP Table (CCU and EUM)

For each host (EUM, PC, or router) in the system, the ARP (Address Resolution Protocol) Table displays the following information:

Table 51 ARP Table Entries

Table Entry	Description
destination	Host IP Address
gateway	Host Ethernet MAC Address
flags	The only valid flag is 4.
Refcnt	Number of processes currently referencing this ARP entry. If a process requires a MAC address, it looks it up in the ARP Table. When the ARP entry is referenced by a process, *refcnt* will be incremented by one. When the process is done with the ARP entry, *refcnt* will be decremented by one.
Use	Number of times the ARP Table has been accessed for this network element.
Interface	The type of interface, one of the following: • esmc0: Ethernet • rdr1: Radio • lo0: Loopback

The ARP Table is automatically built by the CCU or EUM based on traffic passing between the Ethernet and Radio ports. This table displays the host IP and MAC addresses. After the CCU or EUM recovers the destination IP address from an IP packet sent to the router layer, it looks in the ARP Table to find the destination Ethernet MAC address. If the IP address does not appear in the ARP Table, the CCU or EUM obtains the MAC address through an ARP request/reply and adds it to the ARP Table. The only time a host IP address appears in the ARP Table, is if the host has recently (in the past ten minutes or so) sent or received data. This can be forced using a ping, Telnet, SNMP request, or by entering **`arp map <aaa.bbb.ccc.ddd>`**, where `<aaa.bbb.ccc.ddd>` is the host IP address.

To View the CCU ARP MAP table:

```
60:03:3a> arp map 192.168.10.250
IP Address       Ethernet           EUMID    GOS        Last Rx
192.168.10.250   00:90:c8:60:ff:fe  60:ff:fe bronze-61         1
60:03:3a>
```

OR:

```
60:03:3a> arp map
ARP MAP TABLE
IP Address       Ethernet           EUMID    GOS        RSSI[dBm] Last Rx
5.11.1.101       00:10:a4:c2:10:bb  60:00:6b be         -48       100
```

```
5.11.1.102       ee:ee:ee:37:02:03  60:00:04 be         -53       0
5.11.1.103       ee:ee:ee:37:02:04  60:02:08 be         -54       0
5.11.1.104       ee:ee:ee:37:01:01  60:06:b6 be         -47       0
5.11.1.105       ee:ee:ee:37:01:02  60:06:9d be         -47       0
5.11.1.106       ee:ee:ee:37:01:03  60:06:a4 be         -47       0
5.11.1.107       ee:ee:ee:37:01:04  60:0a:99 be         -48       0
60:03:3a>
```

To view the CCU ARP table:

```
60:03:3a> arp

LINK LEVEL ARP TABLE
destination      gateway            flags  Refcnt  Use           Interface
-------------------------------------------------------------------------
10.0.0.1         00:30:80:4a:08:a1    405    1       5             esmc0
10.0.0.2         00:10:4b:6c:fa:54    405    0       4610          esmc0
10.0.0.3         00:90:27:33:c7:e8    405    0       507           esmc0
10.0.0.10        00:a0:98:00:9b:26    405    0       1             esmc0
10.0.0.15        00:10:83:fd:61:a     405    0       781           esmc0
10.0.0.16        00:10:83:fd:e1:4e    405    0       1839          esmc0
10.0.0.17        00:b0:d0:e1:04:c0    405    0       155           esmc0
10.0.1.68        00:00:e8:4d:62:3     405    1       19054         esmc0
10.5.1.17        00:50:da:bb:d1:de    405    0       135           rdr1
10.5.2.50        00:50:ba:b3:97:cd    405    0       12            rdr1
10.5.2.54        00:50:da:b7:25:2f    405    0       8823          rdr1
-------------------------------------------------------------------------
60:03:3a>
```

Address Translation Table (CCU only)

The Address Translation Table lists the MAC addresses for:

- End-user PC's that have been granted air access, if the CCU has sent traffic to, or received traffic from, the PC
- EUMs, if the CCU has sent traffic to, or received traffic from, the network element.

If no traffic has been sent traffic to, or received traffic from, an end-user PC or EUM host for a 12-hour period, they will be removed from the Address Translation Table.

The CCU uses the Address Translation Table, which is built automatically by the CCU, to look up the EUM ID for a particular MAC address. The MAC addresses associated with the EUM, are:

- EUM Ethernet MAC Address
- End-user PC MAC Address (one or more)

To view the Address Translation Table:

```
60:03:3a> add

EUM ID      MAC Address       Time[s]
-------------------------------------
60:00:83    00:90:c8:60:00:83    106
60:00:83    00:d0:b7:69:94:b1   40
Total of 2 entries
60:03:3a>
```

In the above view, the following MAC addresses are associated with EUM ID 60:00:83:

- `00:90:c8:60:00:83` EUM Ethernet MAC Address

- `00:d0:b7:69:94:b1` End-user PC MAC Address

Authorization Table (CCU only)

The Authorization Table controls the EUMs' access to the LMS4000 900 MHz Radio Network. The Authorization Table contains the grade of service class for each EUM in the system, whether the EUM is *registered* or not.

The contents of the Authorization Table are used by the Polling MAC algorithm, and also by the CCU, to automatically build the Registration Table.

The entries in the Authorization Table can be entered directly by you, or the complete table can be modified remotely and downloaded to the CCU using FTP. The GOS class entry will either be a grade of service class, or "denied" (service).

The Default entry in the Authorization Table is assigned on registration to any EUM that has not been assigned a grade of service class. The Default entry can be a grade of service class, or *denied*, meaning any EUM that has not been assigned a grade of service class will be denied service. This rule applies only to newly registered EUMs, and not to EUMs that have been previously registered. Once you have changed the default, if you want the default changed for all EUMs, regardless of when they registered, then you must flush the Registration Table. The new default then takes effect as the EUMs re-register.

There are two approaches to managing the Authorization Table:

- Approach 1: If the default is set to *denied*, then EUMs will be denied service unless they are explicitly entered in the Authorization Table, with a grade of service.
- Approach 2: If the default is set to a grade of service, such as *best effort*, then EUMs will be authorized and given a *best effort* grade of service unless they are explicitly denied service in the Authorization Table.

NOTE: If the CCU RADIUS Client is enabled, any EUM authorized through RADIUS is marked as a "radius" entry. An authorization entry made through the CLI is marked as "static" and is be updated by RADIUS.

To view the Authorization Table:

```
60:03:3a> auth

EUM ID    GOS   CLASS TYPE
-----------------------------------
60:05:13  gold  radius
60:08:60  be    radius
Default denied
Total of 2 entries
60:03:3a>
```

Registration Table (CCU only)

The Registration Table contains a list of all *registered* EUMs. The CCU automatically builds and adds to this table as EUMs communicate with the CCU. Every EUM that registers with the CCU appears in this table. The EUM will be removed from the Registration Table if the:

- EUM has not communicated with the CCU for more than 12 hours because:
  - the EUM has been turned off for more than 12 hr., or
  - the EUM has had no traffic to send for more than 12 hr., or
  - the EUM has lost its RF connection to the CCU for more than 12 hr.
- EUM does not respond to traffic from the CCU. In this case, the EUM will be removed immediately from the Registration Table.

The Registration Table contains the following entries:

Table 52 Registration Table Entries

Table Entry	Description
EUM ID	EUM ID
GOS Class	Grade of Service Class
RSSI (dBm)	Radio received signal strength (RSSI) in dBm of the EUM.
SQ	Signal quality, measured at the same time as the RSSI is recorded.
RNA (dB)	Difference between the RSSI and the measured noise floor.
Time (s)	Time since the last payload was received from the EUM.
Rx-Octets	Number of octets received from this EUM in data payloads, including Ethernet header but not radio MAC header.
Rx-Packets	Number of Ethernet packets received from this EUM in data payloads.
Tx-Octets	Number of octets sent to this EUM in data payloads, including Ethernet header but not radio MAC header.
Tx-Packets	Number of Ethernet packets sent to this EUM in data payloads.
Maximum Associations	The maximum number of EUMs that can be *associated* at any one instant in time.
Deregistration Count	An EUM will be de-registered if it does not respond after the CCU has sent it this many consecutive polls.

NOTE: The Rx-Octets, Rx-Packets, Tx-Octets, and Tx-Packets statistics are identical to the RADIUS accounting statistics and may be considered the appropriate usage statistics for billing purposes.

The end of the air table also prints the total number of EUMs registered.

To view the Registration Table:

```
60:03:3a> air
Maximum Associations: 75
Deregistration Count: 8

REGISTERED EUMs
  EUM ID     GOS RSSI  SQ RNA  Time  Rx-Octets Rx-Packets  Tx-Octets Tx-Packets
           Class  dBm      dB     s
-------------------------------------------------------------------------------
60:05:13    gold  -50   7  59     6     721564       6610     435914       6236
60:08:60      be  -47   7  62    32     360842       3318     226746       3224

 2 EUMs registered of 300 allowed
60:03:3a>
```

NOTE: The `air` command has been used to view the Registration Table, because `reg` is too close to `reb` (reboot).

ARP Map Table (CCU only)

For each host (EUM or PC) in the system, the ARP Map Table displays the following entries:

Table 53 ARP MAP Table Entries

Table Entry	Description
IP Address	Host IP address
Ethernet	Host Ethernet MAC address
EUMID	EUM ID
GOS	EUM Grade of Service
RSSI	RSSI in dBm of the last payload received from the EUM.
SQ	Signal quality, measured at the same time as the RSSI is recorded.
RNA (dB)	Difference between the RSSI and the measured noise floor.
Last Rx	Number of seconds since the last payload was received from the EUM.

The ARP MAP Table is built automatically by the CCU, from information contained in the Address, ARP and Registration Tables. Its primary use is to summarize the information in these tables in a user-friendly format, for presentation to the system operator.

To view the ARP MAP Table:

```
60:03:3a> arp map 192.168.10.250
IP Address       Ethernet           EUMID    GOS        Last Rx
192.168.10.250   00:90:c8:60:ff:fe  60:ff:fe bronze-61         1
60:03:3a>
```

OR:

```
60:03:3a> arp map
ARP MAP TABLE
IP Address       Ethernet           EUMID    GOS        RSSI[dBm] Last Rx
5.11.1.101       00:10:a4:c2:10:bb  60:00:6b be         -48       100
5.11.1.102       ee:ee:ee:37:02:03  60:00:04 be         -53       0
5.11.1.103       ee:ee:ee:37:02:04  60:02:08 be         -54       0
5.11.1.104       ee:ee:ee:37:01:01  60:06:b6 be         -47       0
5.11.1.105       ee:ee:ee:37:01:02  60:06:9d be         -47       0
5.11.1.106       ee:ee:ee:37:01:03  60:06:a4 be         -47       0
5.11.1.107       ee:ee:ee:37:01:04  60:0a:99 be         -48       0
60:03:3a>
```

Bridge Table (EUM or CCU in Switched Ethernet or Through Only Mode)

The primary purpose of the Bridge Table is to determine which Ethernet destination addresses are on the Ethernet side, ensuring local traffic is kept local.

The following points apply to the Bridge Table on an EUM only:

- The Bridge Table also gives you control over the number of PCs that can access the Internet through the EUM. The Bridge Table is optimized for the case where multiple hosts are connected to the EUM, but only one accesses the Internet at any given time.
- The Bridge Table presents a list of the end-user computers that are connected to the EUM. If *customer_max* is set to “1”, only one of the computers in the table will have air access. If *customer_max* is set to “n”, up to “n” computers in the Bridge Table will have air access.
- Air access is assigned on a “first come, first served” basis. If n=1, the first computer to transmit packets will be granted air access. All other computers will be denied air access. If the computer that has been granted air access, does not transmit traffic for 10 minutes, then his air access will be removed and the next computer that transmits a packet will be granted air access.
- More generally, for any “n”, up to *customer_max*, the first n computers transmitting packets will be granted air access and, if any of them fails to transmit traffic for 10 minutes, their air access will be removed, allowing the next computer without air access to be granted air access as soon as they transmit data.

  NOTE: The Bridge Table may contain a maximum of 256 entries.

Table 54 Bridge Table Entries

Table Entry	Description
MAC Address	Computer's MAC address
Air Access (EUM Only)	Y - computer has been granted air access. N - computer has not been granted air access
Time (s)	Time, in seconds, since the last packet was received from a particular end-user computer or device.

NOTE: If *customer max* is set to 1, and you want to connect a different PC to the EUM, for maintenance purposes, for example, you must clear the Bridge Table, reset the EUM, and wait 10 minutes.

To display the Bridge Table:

```
60:03:3a> cust

  MAC Address          Air Access   Time[s]
-------------------------------------------
    00:50:da:b7:34:f3    Y            100
    00:50:da:bb:d1:de    N            100

Total of: 2 entries
```

Basic Configuration File (CCU and EUM)

The Basic Configuration File (BCF) presents a summary of CCU and EUM configurable parameters, which are either the factory default settings, or those entered by the system operator. The BCFs for the CCU and EUM are slightly different, as shown in the examples below.

EUM BCF

```
60:ff:fe> bcf

Basic Cfg File:
File ID        : basic.cfg
File Time Stamp:
File Version   : 5
File Notes     : Operator updated
File CRC       : 0xE1

IP Address: 192.168.10.250 / 24
IP Subnet : 192.168.10.0 ( 255.255.255.0 )
Gateway IP Address: 192.168.10.1

Contact: WaveRider Communications Inc.
Location: www.waverider.com
Name: LMS3000
```

```
SNMP Read Communities:
        public

SNMP Write Communities:
        private
SNMP Traps:

Statistics Log Interval: 15 minutes

Radio Frequency: 9050
RF Power: LOW
Maximum Number of Customers: 1

60:ff:fe>
```

CCU BCF

```
60:06:4e> bcf

Basic Cfg File:
File ID        : basic.cfg
File Time Stamp:
File Version   : 5
File Notes     : Operator updated
File CRC       : 0x7B

CCU in Switched Ethernet Mode
IP Address: 172.16.6.1 / 22
IP Subnet : 172.16.4.0 ( 255.255.252.0 )
Gateway IP Address: 172.16.6.10

Contact: WaveRider
Location: test
Name: LMS3000

SNMP Read Communities:
        readtest

SNMP Write Communities:
        writetest
SNMP Traps:
    192.168.60.7   traptest

Radius Authentication Enabled, Period: 60
Radius Accounting is Enabled
Radius Primary Server  : 192.168.60.96
Radius Secondary Server:
Statistics Log Interval: 15 minutes

Radio Frequency: 9184
RF Power: HIGH
Max EUMs allowed to be Registered: 300
Deregistration Count: 8
Maximum Associations: 75
DHCP Disabled
```

Permanent Configuration File (CCU and EUM)

The Permanent Configuration File (PCF) is a record of device parameters that are permanently programmed during manufacturing.

CCU PCF

```
60:03:3a> pcf


Permanent Cfg File:

File ID        : perm.cfg
File Time Stamp: 14May2001
File Version   : 002
File Notes     : Based on TN040

Hardware ID: 4B

Ethernet MAC Address: 00:90:c8:e0:03:3a
Airlink MAC Address: 00:90:c8:60:03:3a

Serial Number: E0033A

Modem Type: CCU

RF level             +27 dbm       +15 dbm
Lo   - 905.0 Mhz       -10        28
Med  - 915.0 Mhz       -26        20
High - 925.0 Mhz       -22        20

RSSI level            -76 dbm      -70 dbm      -46 dbm
Lo   - 905.0 Mhz          44           50           74
Med  - 915.0 Mhz          44           50           74
High - 925.0 Mhz          44           50           74

POT Settings: Wiper1: 121 Wiper2: 127


60:03:3a>
```

EUM PCF

```
60:ff:fe> pcf


Permanent Cfg File:

File ID        : perm.cfg
File Time Stamp: 8Oct2002
File Version   : 003
File Notes     : Default File - Auto Created
File CRC       : 0xBE

Ethernet MAC Address: 00:90:c8:e0:ff:fe

Hardware ID: 4B

Airlink MAC Address: 00:90:c8:60:ff:fe

Serial Number: E0301F
```

```
Modem Type: EUM

RF level              +27 dbm       +15 dbm
Lo   - 905.0 Mhz         -2         28
Med  - 915.0 Mhz         -2         20
High - 925.0 Mhz         -2         20

RSSI level             -76 dbm      -70 dbm      -46 dbm
Lo   - 905.0 Mhz          44           50           74
Med  - 915.0 Mhz          44           50           74
High - 925.0 Mhz          44           50           74

POT Settings: Wiper1: 50 Wiper2: 100


60:ff:fe>
```

System Status File (CCU and EUM)

The System Status File is a record of the results of the CCU and EUM POST (Power On Self Test).

To view the System Status File, type **`sys ss`** at the command prompt, and press **Enter**.

CCU SYS SS

```
60:03:3a> sys ss
POST Results:
-----------------------
Registers......Passed
Timers.........Passed
SDRAM..........Passed
Watchdog.......Passed
TFFS...........Passed
Ethernet.......Passed
MAC............Passed
USB............Not run
RS232_1........Not run
RS232_2........Not run

File Status:
-----------------------
perm.cfg........Opened-OK
basic.cfg.......Opened-OK
route.cfg.......Opened-OK
sa1110.exe......Opened-OK
authdb.cfg......Opened-OK

IO Connections:
-----------------------
USB Detected...........True
Ethernet Detected......True
RS232_1 Detected.......True
RS232_2 Detected.......False

System State:
-----------------------
```

```
System.........Operational
Hardware Rev...A

60:03:3a>
```

EUM3003 SYS SS

```
60:ff:fe> sys ss
POST Results:
-----------------------
Registers......Passed
Timers.........Passed
SDRAM..........Passed
Watchdog.......Passed
TFFS...........Passed
Ethernet.......Passed
MAC............Passed
USB............Not run
RS232_1........Not run
RS232_2........Not run

File Status:
-----------------------
perm.cfg........Opened-OK
basic.cfg.......Opened-OK
route.cfg.......Test Not Run
sa1110.exe......Opened-OK
authdb.cfg......Test Not Run

IO Connections:
-----------------------
USB Detected...........False
Ethernet Detected......True
RS232_1 Detected.......False
RS232_2 Detected.......False

System State:
-----------------------
System.........Operational
Hardware Rev...B

60:ff:fe>
```

Appendix H Windows Ping Commands

The following table lists the options available for use with a Windows Ping test. This information was obtained from *Microsoft Windows 2000 TCP/IP Protocols and Services Technical Reference, pp. 184-185.*

Table 55 Windows Ping Test Command Options

Option	Use	Default
-t	Sends Echoes until interrupted.	Not set
-a	Performs a Domain Name System (DNS) reverse query to resolve the DNS hose name of the specified IP address	Not set
-n *count*	The number of Echoes to send	4
-l *size*	The size of the Optional Data field up to a maximum of 65,500	32
-f	Sets the Don't Fragment (DF) flag to 1	Not set
-l *TTL*	Sets the value of the TTL field in the IP header	32
-v *TOS*	Sets the value of the Type of Service field in the IP header. The TOS value is in decimal	0
-r *count*	Sends the ICMP Echoes using the IP Record Route option and sets the value of the number of slots. Count has a maximum value of 9.	Not set
-s *count*	Sends the ICMP Echoes using the IP Internet Timestamp option and sets the value of the number of slots. Count has a maximum value of 4. Windows 2000 PING uses the Internet Timestamp FLAG set to 1 (records both the IP addresses of each hop and the timestamp.	Not set

Option	Use	Default
-j *host-list*	Sends the ICMP Echoes using the Loose Source Route option and sets the next hop addresses to the IP addresses in the host list. The host list is made up of IP addresses separated by spaces corresponding to the loose source route. There can be up to nine IP addresses in the lost list.	Not set
-k *host-list*	Sends the ICMP Echoes using the Strict Source Route option and sets the next hop addresses to the IP addresses in the host list. The host list is made of IP addresses in the host list. The host list is made of IP addresses separated by spaces corresponding to the loose source route. There can be up to 9 IP addresses in the host list.	Not set
-w *timeout*	Waits the specified amount of time, in milliseconds, for the corresponding Echo Reply before displaying a Request Timed Out message.	1000

Appendix I SNMP MIB Definitions

This appendix defines the MIBs used in the CCU and EUM. These MIBs are organized under the following headings:

- *MIB-II Elements Supported from RFC-1213* on page 251
- *WaveRider CCU Enterprise MIBs* on page 255
- *CCU RFC MIB-II Traps* on page 266
- *WaveRider EUM Enterprise MIBs* on page 267
- *EUM RFC MIB-II Traps* on page 276

MIB-II Elements Supported from RFC-1213

The CCU and EUM support the following MIB-II groups, which are defined in detail in RFC1213.

Groups in MIB-II

MIB-II is divided into the following MIBs. All values in Table 56 are prefixed by 1.3.6.1.2.1.

Table 56 Groups in MIB-II

MIB Name	OID	Type	Status	Description
system	1	MIB	R	This group provides information on the general system, such as system description, contact, system up time.
interfaces	2	MIB	R	This group has one set of values for each interface on the modem. The CCU/EUM has 3 interfaces: 1= loopback, 2 = esmc0 (ethernet) and 2 = mdr1 (radio).

MIB Name	OID	Type	Status	Description
at	3	MIB	R	This group shows the address translation table, mapping Ethernet addresses to IP addresses. This group is only for MIB-I compatibility.
ip	4	MIB	R	This group provides all of the statistics on IP traffic that is routed through the modem. For EUMs, all traffic from the end-user to the CCU bypass the IP stack in the EUM so these numbers are only for the EUM applications. For the CCU, all IP traffic through the CCU router application, including CCU application traffic.
icmp	5	MIB	R	This groups provides statistics on all ICMP packets processed by the IP stack.
tcp	6	MIB	R	This provides counters for all TCP packets processed by the modem. Only TCP packets sent or received by the modem applications are counted (e.g. FTP or Telnet sessions directly to the modem) since any packets for other hosts are routed by the IP protocol and never reach the TCP protocol.
udp	7	MIB	R	Counters for all UDP packets processed by the modem's applications. Only UDP packets sent or received by the modem applications are counted (e.g. FTP or Telnet sessions directly to the modem) since any packets for other hosts are routed by the IP protocol and never reach the UDP protocol.
snmp	11	MIB	R	Counters for all SNMP packets process by the modem's applications.

Interfaces Group MIB

Table 57 provides the details of the Interfaces group MIB mentioned above. All values in the following table are prefixed with 1. 3. 6.1. 2.1. 2.

Table 57 MIB-II Interface List Header MIB

MIB Name	OID	Type	Status	Description
ifIndex	1	Integer	R	The number of entries in ifTable.
ifTable	2	MIB		The list of interfaces.

All values in Table 58 are prefixed with 1.3.6.1.2.1.2.2.1, as defined in RFC1213, and are read only.

Table 58 MIB-II Interface List Table MIB

MIB Name	OID	Value Type	Accepted Values	Description
ifIndex	1	Integer		A unique value for each interface. Its value ranges between 1 and the value of ifNumber. The value for each interface must remain constant at least from one re-initialization of the entity's network management system to the next re-initialization.
ifDescr	2	String	lo0: loopback esmc0: ethernet mdr1: radio	A textual string containing information about the interface. This string should include the name of the manufacturer, the product name and the version of the hardware interface.
ifType	3	Integer	6:ethernet-csmacd 6: radio interface 24: softwareLoopback	The type of interface, distinguished according to the physical/link protocol(s) immediately `below' the network layer in the protocol stack. The radio interface and ethernet-csmacd return the same value since they are both viewed as Ethernet ports by the CCU routing application.
ifMtu	4	Integer		The size of the largest datagram which can be sent/received on the interface, specified in octets. For interfaces that are used for transmitting network datagrams, this is the size of the largest network datagram that can be sent on the interface.
ifSpeed	5	Gauge		An estimate of the interface's current bandwidth in bits per second. For interfaces which do not vary in bandwidth or for those where no accurate estimation can be made, this object should contain the nominal bandwidth.

MIB Name	OID	Value Type	Accepted Values	Description
ifPhysAddress	6	Phys Address		The interface's address at the protocol layer immediately `below' the network layer in the protocol stack. For interfaces which do not have such an address (e.g., a serial line), this object should contain an octet string of zero length.
ifAdminStatus	7	Integer	1: up 2: down 3: testing	The desired state of the interface. The testing(3) state indicates that no operational packets can be passed.
ifOperStatus	8	Integer	1: up 2: down 3: testing	The current operational state of the interface. The testing(3) state indicates that no operational packets can be passed.
ifLastChange	9	TimeTicks		The value of sysUpTime at the time the interface entered its current operational state. If the current state was entered prior to the last re-initialization of the local network management subsystem, then this object contains a zero value.
ifInOctets	10	Counter		The total number of octets received on the interface, including framing characters.
ifInUcastPkts	11	Counter		The number of subnetwork-unicast packets delivered to a higher-layer protocol.
ifInNUcastPkts	12	Counter		The number of non-unicast (i.e., subnetwork-broadcast or subnetwork-multicast) packets delivered to a higher-layer protocol.
ifInDiscards	13	Counter		The number of inbound packets which were chosen to be discarded even though no errors had been detected to prevent their being deliverable to a higher-layer protocol. One possible reason for discarding such a packet could be to free up buffer space.
ifInErrors	14	Counter		The number of inbound packets that contained errors preventing them from being deliverable to a higher-layer protocol.
ifInUnknownProtos	15	Counter		The number of packets received through the interface which were discarded because of an unknown or unsupported protocol.
ifOutOctets	16	Counter		The total number of octets transmitted out of the interface, including framing characters.
ifOutUcastPkts	17	Counter		The total number of packets that higher-level protocols requested be transmitted to a subnetwork-unicast address, including those that were discarded or not sent.

MIB Name	OID	Value Type	Accepted Values	Description
ifOutNUcastPkts	18	Counter		The total number of packets that higher-level protocols requested be transmitted to a non-unicast (i.e., a subnetwork-broadcast or subnetwork-multicast) address, including those that were discarded or not sent.
ifOutDiscards	19	Counter		The number of outbound packets which were chosen to be discarded even though no errors had been detected to prevent their being transmitted. One possible reason for discarding such a packet could be to free up buffer space.
ifOutErrors	20	Counter		The number of outbound packets that could not be transmitted because of errors.
ifOutQLen	21	Gauge		The length of the output packet queue (in packets).
ifSpecific	22	object		Not used

WaveRider CCU Enterprise MIBs

The structure of the CCU MIBs is illustrated in Figure 64.

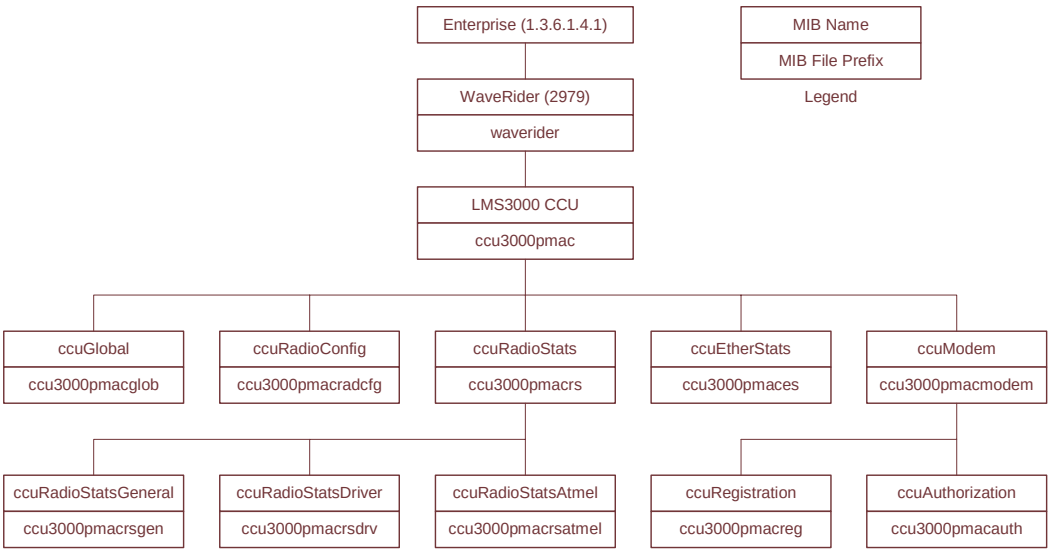

Figure 64 CCU MIBs

Each of the MIBs in Figure 64 is discussed in the following sections.

CCU Base MIB

All values in Table 59, which are read only, are prefixed with 1. 3. 6.1.4.1. 2979.11.

Table 59 WaveRider CCU Base MIB

MIB Name	OID	Value Type	Description
ccuGlobal	1	MIB	CCU general data.
ccuRadioConfig	2	MIB	CCU configuration and setup data.
ccuRadioStats	3	MIB	CCU radio statistics.
ccuEtherStats	4	MIB	CCU Ethernet statistics
ccuModem	5	MIB	CCU registration and authorization information.

CCU General Information Group

All values in Table 60 are prefixed with 1.3.6.1.4.1.2979.11.1.

Table 60 WaveRider CCU General Information Enterprise MIBs

MIB Name	OID	Value Type	Status	Accepted Values	Description
ccuGlobalSerialNumber	1	String	R		CCU hardware serial number
ccuGlobalSoftwareVersion	2	String	R		CCU firmware version.
ccuGlobalHardwareVersion	3	String	R		CCU hardware version.
ccuGlobalCapacity	4	Integer	R	0	A special option identification mask.
ccuGlobalStatus	5	Integer	R	1: startup 2: dead 3: ok 4: suspect	Current status of the radio interface. For now, this field returns ‘ok’.
ccuGlobalSaveCounter	6	Counter	R		A count of the number of times the configuration is saved. Initially, this field always returns ‘0’.
ccuGlobalConfigFiles	7	String	R		A list of configuration files for the CCU. The list is delimited with a semicolon; i.e., “basic.cfg;route.cfg, ...”
ccuGlobalReset	8	Integer	W	1: reset	Not functional at this time.
ccuGlobalReload	9	Integer	W	1: reload	Not functional at this time.

CCU Radio Configuration Group

All CCU Radio Configuration Group MIB values are read only. All values in Table 61 are prefixed with 1.3.6.1.4.1.2979.11.2.

Table 61 WaveRider CCU Radio Configuration Enterprise MIBs

MIB Name	OID	Value Type	Accepted Values	Description
ccuRadioConfigVersion	1	String		Radio firmware version.
ccuRadioUnitMacAddress	2	Physical Address	MAC address	Radio MAC address.
ccuRadioConfigFrequency	3	Integer		Radio frequency in use (in 1/10ths of a MHz)
ccuRadioConfigDomain	4	Integer	0: IEEE 1: FCC or IC/Canada	Current regulatory domain for which the radio is configured.
ccuRadioHardwareRevision	5	String		Radio hardware revision.

CCU Radio Statistics Group

All CCU Radio Statistics Group MIB values are read only. All values in Table 62 are prefixed with 1.3.6.1.4.1.2979.11.3.

Table 62 WaveRider CCU Radio Statistics MIB

MIB Name	OID	Value Type	Description
ccuRadioStatsGeneral	1	MIB	General radio statistics.
ccuRadioStatsDriver	2	MIB	Radio driver statistics
ccuRadioStatsAtmel	3	MIB	Radio MAC statistics.

CCU Radio General Statistics Group

All CCU Radio General Statistics Group MIB values are read only. All values in Table 63 are prefixed with 1.3.6.1.4.1.2979.11.3.1.

Table 63 WaveRider CCU Radio General Statistics Group MIB

MIB Name	OID	Value Type	Description
ccuRadioGenRSSI	1	Integer	Not used.
ccuRadioGenTPI	2	Integer	Radio transmit power indicator.

CCU Radio Driver Statistics Group

All CCU Radio Driver Statistics Group MIB values are read only. All values in Table 64 are prefixed with 1.3.6.1.4.1.2979.11.3.2.

Table 64 WaveRider CCU Radio Driver Statistics Group MIB

MIB Name	OID	Value Type	Description
ccuRadioDrvEvents	1	Counter	Number of interrupts received (any interrupt) in the radio driver ISR (Interrupt Service Routine)
ccuRadioDrvRxComplete	2	Counter	Number of *receive complete* interrupts received by the radio driver ISR.
ccuRadioDrvTxComplete	3	Counter	Number of *transmit complete* interrupts received by the radio driver ISR.
ccuRadioDrvCmdComplete	4	Counter	Number of *command complete* interrupts received by the radio driver ISR.
ccuRadioDrvFatalEvent	5	Counter	Number of *fatal error* interrupts received by the radio driver ISR.
ccuRadioDrvTxPowerRailEvent	6	Counter	Number of *Tx Power alarm* interrupts received by the radio driver ISR.

MIB Name	OID	Value Type	Description
ccuRadioDrvUnknownEvent	7	Counter	Number of *received an unknown/no event* interrupts received by the radio driver ISR.
ccuRadioDrvSend	8	Counter	Number of packets sent successfully by the radio driver transmit queue.
ccuRadioDrvSendQFull	9	Counter	Number of packets not sent because the radio driver transmit queue was full.
ccuRadioDrvSendUnavailable	10	Counter	Number of times invalid (null) mblks were sent to the radio driver for transmission.
ccuRadioDrvSendNotEnabled	11	Counter	Number of times tried to send packets before the radio driver was started; i.e., before the device was up and working.
ccuRadioDrvAMMPut	12	Counter	Number of times a packet was successfully sent to the MAC-layer shared memory for transmission over the air.
ccuRadioDrvAMMQFull	13	Counter	Number of times a packet could not be sent to the MAC-layer shared memory because there were no transmit descriptors left. Radio driver tries 5 more times to send the packet.
ccuRadioDrvAMMQFullDiscard	14	Counter	Number of times, after 5 attempts, a packet could not be sent to the MAC-layer shared memory because there were no transmit descriptors left. Packet is discarded.
ccuRadioDrvGet	15	Counter	Number of packets received from the MAC-layer shared memory.
ccuRadioDrvQEmpty	16	Counter	Number of times there was a receive interrupt, but nothing available to read out of the MAC-layer shared memory.
ccuRadioDrvRx	17	Counter	Number of successfully received packets.
ccuRadioDrvRxNotAvailable	18	Counter	Number of times the radio driver could not allocate an mblk (memory block) for storing a packet retrieved from the MAC-layer shared memory.
ccuRadioDrvNotEnabled	19	Counter	Number of times the radio driver received a receive interrupt, but the radio driver was not yet up and running. The received packet is ignored in this case.

CCU Radio MAC Statistics Group

All CCU Radio MAC Statistics Group MIB values are read only. All values in Table 65 are prefixed with 1.3.6.1.4.1.2979.11.3.3.

Table 65 WaveRider CCU Radio MAC Statistics Group MIB

MIB Name	OID	Value Type	Description
ccuRadioMACRxDataPayloads	1	Counter	Number of Ethernet frames received correctly from the air interface.

MIB Name	OID	Value Type	Description
ccuRadioMACRxDataOctets	2	Counter	Number of data octets received correctly from the air interface.
ccuRadioMACRxCtrlPayloads	3	Counter	Number of control payloads received correctly from the air interface.
ccuRadioMACRxPayloadFailInvalidType	4	Counter	Number of times an unknown type of payload was received from the air interface.
ccuRadioMACRxPayloadFailGiant	5	Counter	Number of times a payload that was too long was received from the air interface, and therefore discarded.
CCURadioMACNullRxDesc	6	Counter	Number of times the internal MAC receive interface was corrupted.
ccuRadioMACTxDataPayloads	7	Counter	Number of Ethernet frames transmitted to the air interface.
ccuRadioMACTxDataOctets	8	Counter	Number of data octets transmitted to the air interface.
ccuRadioMACTxCtrlPayloads	9	Counter	Number of control payloads transmitted to the air interface.
ccuRadioMACTxPayloadFailInvalidType	10	Counter	Number of times a payload of an unknown type was discarded.
ccuRadioMACTxPayloadFailGiant	11	Counter	Number of times a payload that was too long was discarded.
ccRadioMACTxPayloadFailInvalidDesc	12	Counter	Number of times the internal MAC transmit interface was corrupted.
ccuRadioMACTxBufferFullOnArrival	13	Counter	Number of transmit packets that were queued for delivery.
ccuRadioMACCmdTimeOuts	14	Counter	Number of times the MAC-layer management message was incomplete.
ccuRadioMACCmdMissedIRQs	15	Counter	Number of times there was no response to the MAC-layer management message.
ccuRadioMACFalseCmdIRQs	16	Counter	Number of times a hardware IRQ was detected with no message associated. This MIB parameter is used primarily by software development.
ccuRadioMACCmdStatusErrors	17	Counter	Number of times the MAC-layer management message was rejected.
ccuRadioMACFatalError	18	Counter	Number of nonrecoverable MAC-layer errors, each causing a CCU reboot.
ccuRadioMACTxRailError	19	Counter	Transmit power alarm interrupt.
ccuRadioMACRxPacketsDirected	20	Counter	Number of times a reply from the EUM is received with the correct HCRC (header cyclic redundancy check).
ccuRadioMACRxPktsBroadcast	21	Counter	Number of times an EUM succeeds in a random access.
ccuRadioMACRxPktsNoMatch	22	Counter	Number of packets correctly received, but not directed to, this station.

MIB Name	OID	Value Type	Description
ccuRadioMACRxPktsDuplicate	23	Counter	Number of duplicate payloads (see note 1) received and discarded. Indicates that a MAC layer acknowledgement was lost.
ccuRadioMACRxPktsRuntFail	24	Counter	Number of packets received that were shorter than the minimum size.
ccuRadioMACRxPktsLongFail	25	Counter	Number of packets received that were longer than the maximum size.
ccuRadioMACRxPktsHCRCFail	26	Counter	Number of packets received with a MAC header CRC failure (header corrupted).
ccuRadioMACRxPktsICVFail	27	Counter	Number of packets received with an encryption (WEP, wireless equivalent privacy) key mismatch (see note 3).
ccuRadioMACRxPktsFCSFail	28	Counter	Number of packets received with a Frame Check Sequence failure (payload corrupted).
ccuRadioMACRxPktsAssocFail	29	Counter	Number of times a received packet had to be discarded because too many EUMs were already *associated*.
ccuRadioMACRxPktsIncomplete	30	Counter	Number of times the receive DMA for a payload does not complete (internal error).
ccuRadioMACRxPayloadsFailFull	31	Counter	Number of times a received payload has to be discarded because either no receive descriptor was available, or there was not enough buffer space.
ccuRadioMACRxPayloadsDelivered	32	Counter	Number of payloads that this station received correctly.
ccuRadioMACRxPktsEmpty	33	Counter	Number of packets received with no payload.
ccuRadioMACTxPkts	34	Counter	Number of packets transmitted.
ccuRadioMACTxPktsEmpty	35	Counter	Number of packets transmitted with no payload.
ccuRadioMACTxPayloads	36	Counter	Number of payloads transmitted.
ccuRadioMACTxPayloadsBCast	37	Counter	Number of broadcast payloads transmitted.
ccuRadioMACTxPayloads10k	38	Counter	Number of payloads acknowledged after the first transmission.
ccuRadioMACTxPayloads20k	39	Counter	Number of payloads acknowledged after the second transmission.
ccuRadioMACTxPayloads30k	40	Counter	Number of payloads acknowledged after the third transmission.
ccuRadioMACTxPayloads40k	41	Counter	Number of payloads acknowledged after the fourth transmission.
ccuRadioMACTxPayloadsFailRetry	42	Counter	Number of payloads that failed to transmit due to the retry limit.

MIB Name	OID	Value Type	Description
ccuRadioMACTxPayloadsFailDeleted	43	Counter	Number of payloads discarded from a queue that was emptied when an EUM was deregistered due to non-response or deauthorization.
ccuRadioMACTxPayloadsBadParam	44	Counter	Number of payloads returned to the host because they are improperly formed (internal error).
ccuRadioMACTxPayloadsVnetInactive	45	Counter	Number of payloads returned to the host because the virtual net was not active (internal error).
ccuRadioMACTxPayloadsAssocFail	46	Counter	Number of payloads returned to the host because too many other EUMs were already *associated*.
ccuRadioMACTxPayloadsTimeout	47	Counter	Number of payloads returned to the host because of timeout.
ccuRadioMACTxPayloadQueueTooLong	48	Counter	Number of payloads returned to the host because the transmit queue for the EUM was too long (see note 4).
ccuRadioMACTxPayloadEmpty	49	Counter	Total number of empty payloads received and returned to host (GOS directives).
ccuRadioMACReplyOrRssiTimeout	50	Counter	Number of times that no response was received to a directed poll.
ccuRadioMACRestarts	51	Counter	Number of times that the MAC layer recovered from an internal error or unexpected event.
ccuRadioMACRegRequests	52	Counter	Number of registration requests received (see note 5).
ccuRadioMACRegResponse	53	Counter	Number of registration responses transmitted (see note 5).
ccuRadioMACDeregRequests	54	Counter	Number of deregistration requests transmitted (see note 5).
ccuRadioMACDeregInits	55	Counter	Number of times no response was received from an EUM, after multiple polls (see note 5). This statistic indicates a poor radio link to one or more EUMs.
ccuRadioMACDisassociationRequests	56	Counter	Number of disassociation requests transmitted (see note 6).
ccuRadioMACDisassociationInits	57	Counter	Number of times the CCU has determined than an EUM should be *disassociated* (see note 6).

Notes:

- A *packet* is the basic unit of transmission. A *packet* may or may not contain a *payload*. A *payload* is user data, which may be an Ethernet frame or a logical link layer control message.
- WEP is not supported in this release.

- The CCU maintains a transmit queue for each EUM. The length of this queue is limited, to prevent one EUM from consuming all the resources and impacting service to other EUMs. Discards indicate excessive load by one EUM, possibly due to large TCP windows.
- Registration occurs once per EUM and/or CCU boot time. Deregistration may occur if an EUM is not authorized (a registration/deregistration request pair occurs periodically while that EUM is powered ON) or if the EUM does not respond to multiple consecutive polls, such as when it is powered OFF.
- Association occurs when there is traffic to send to or from an EUM. Disassociation occurs if there is no traffic to or from an EUM for a short period of time.

CCU Ethernet Statistics Group

All CCU Ethernet Statistics Group MIB values are read only. All values in Table 66 are prefixed with 1.3.6.1.4.1.2979.11.4.

Table 66 WaveRider CCU Ethernet Statistics Group MIB

MIB Name	OID	Value Type	Description
ccuEtherInterrupts	1	Counter	Total number of interrupts received by the Ethernet driver ISR, interrupt service routine.
ccuEtherRxInterrupt	2	Counter	Number of *receive complete* interrupts received by the Ethernet driver ISR.
ccuEtherRxOverrunInterrupt	3	Counter	Number of *overrun* interrupts received by the Ethernet driver ISR. An overrun occurs when a received packet has exceeded the packet size, or the processor has missed one or more packets.
ccuEtherRxInProgressInterrupt	4	Counter	Number of times a *receive complete* interrupt was received by the Ethernet driver ISR before the current packet was finished.
ccuEtherTxCompleteInterrupt	5	Counter	Number of normal transmit interrupts received by the Ethernet driver ISR.
ccuEtherTxErrorInterrupt	6	Counter	Number of *transmit error* interrupts received by the Ethernet driver ISR.
ccuEtherTxCarrierLostInterrupt	7	Counter	Number of *transmit carrier lost* interrupts received by the Ethernet driver ISR.
ccuEtherTxAllocInterrupt	8	Counter	Number of *transmit allocation complete* interrupts received by the Ethernet driver ISR.
ccuEtherTxEPHInterrupt	9	Counter	Number of *transmit EPH* interrupts (Ethernet protocol handler interrupts) received by the Ethernet driver ISR.
ccuEtherTxERCVInterrupts	10	Counter	Number of *transmit ERCV* interrupts (early receive interrupts) received by the Ethernet driver ISR..
ccuEtherRxData	11	Counter	Number of packets received and accepted by the IP stack.
ccuEtherRxDataError	12	Counter	Number of packets received and rejected by the IP stack because of errors.

MIB Name	OID	Value Type	Description
ccuEtherRxDataMblkAllocError	13	Counter	Number of packets lost due to insufficient memory resources.
ccuEtherRxDataLenghtError	14	Counter	Number of packets received that violate Ethernet packet length rules.
ccuEtherRxDiscards	15	Counter	Number of packets discarded because the unit was not ready to receive data.
ccuEtherTxData	16	Counter	Number of packets received and placed on the transmit queue.
ccuEtherTxDataQFull	17	Counter	Number of packets discarded because the transmit queue was full.
ccuEtherTxOk	18	Counter	Number of packets sent correctly.
ccuEtherTxTimeout	19	Counter	Number of times the packet transmit has timed out.
ccuEtherTxSemWait	20	Counter	Number of times a transmit semaphore could not be taken in the timeout period.

CCU Modem Information MIB

All values in Table 67 are prefixed with 1.3.6.1.4.1.2979.11.5.

Table 67 WaveRider CCU Modem Information MIB

MIB Name	OID	Value Type	Description
ccuRegistration	1	MIB	Registration Table.
ccuAuthorization	2	MIB	Authorization Table.

CCU Registration Information MIB

All CCU Registration MIB values are read only. All values in Table 68 are prefixed with 1.3.6.1.4.1.2979.11.5.1

Table 68 WaveRider CCU Registration Information MIB

MIB Name	OID	Value Type	Description
ccuRegistrationCount	1	Integer	Number of connections in the Registration Table.
ccuRegistrationTable	2	MIB	

CCU Registration Table

All CCU Registration Table Group MIB values are read only. All values in Table 69 are prefixed with 1.3.6.1.4.1.2979.11.5.1.2.

Table 69 WaveRider CCU Registration Table MIB

MIB Name	OID	Value Type	Accepted Values	Description
ccuRegistrationIndex	1	Integer		Index of entry in Registration Table.
ccuRegistrationId	2	Integer	000000-FFFFFF	Integer representation of the EUM ID, normally displayed in hexadecimal.

CCU Authorization Information MIB

All CCU Authorization MIB values are read only. All values in Table 70 are prefixed with 1.3.6.1.4.1.2979.11.5.2.

Table 70 WaveRider CCU Authorization Table MIB

MIB Name	OID	Value Type	Description
ccuAuthorizationCount	1	Integer	Number of authorized EUMs.
ccuAuthorizationTable	2	MIB	

CCU Authorization Table

All CCU Authorization Table Group MIB values are read only. All values in Table 71 are prefixed with 1.3.6.1.4.1.2979.11.5.2.2.

Table 71 WaveRider CCU Authorization Table MIB

MIB Name	OID	Type	Accepted Values	Description
ccuAuthorizationIndex	1	Integer		Index of entry in Authorization Table.
ccuAuthorizationId	2	Integer	000000-FFFFFF	Integer representation of the EUM ID, normally displayed in hexadecimal.
ccuAuthorizationGosClass	3	Integer	1: Best Effort 2: Bronze 3: Silver 4: Gold 5: Denied	The grade of service associated with the EUM.

CCU RFC MIB-II Traps

RFC MIB-II Traps

Table 72 CCU RFC MIB-II Traps

MIB Name	OID	Description
coldStart	1.3.6.1.2.1.11.0.0	Power Cycle or Power On.
authenticationFailure	1.3.6.1.2.1.11.0.4	An SNMP request has failed due to improper authentication.

WaveRider EUM Enterprise MIBs

The structure of the EUM MIBs is illustrated in Figure 65.

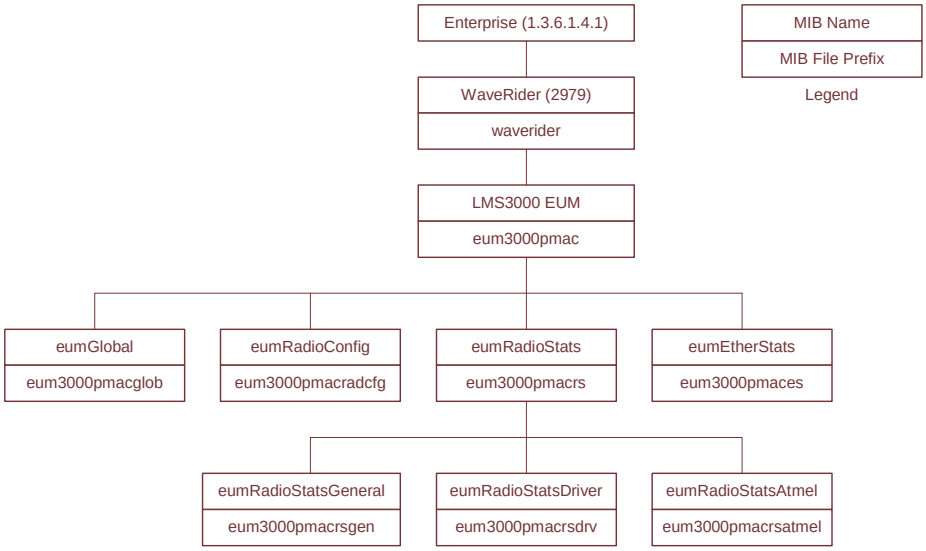

Figure 65 EUM MIBs

Each of the MIBs in Figure 65 is discussed in the following sections.

EUM Base MIB

All values in Table 73, which are read only, are prefixed with 1. 3. 6.1.4.1. 2979.12.

Table 73 WaveRider EUM Base MIB

MIB Name	OID	Value Type	Description
eumGlobal	1	MIB	EUM general data.
eumRadioConfig	2	MIB	EUM configuration and setup data.
eumRadioStats	3	MIB	EUM radio statistics.
eumEtherStats	4	MIB	EUM Ethernet statistics
eumUSBStats	5	MIB	EUM USB statistics.

EUM General Information Group

All values in Table 74 are prefixed with 1.3.6.1.4.1.2979.12.1.

Table 74 WaveRider EUM General Information Enterprise MIBs

MIB Name	OID	Value Type	Status	Accepted Values	Description
eumGlobalSerialNumber	1	String	R		EUM hardware serial number
eumGlobalSoftwareVersion	2	String	R		EUM firmware version.
eumGlobalHardwareVersion	3	String	R		EUM hardware version.
eumGlobalCapability	4	Integer	R		Special option identification mask.
eumGlobalStatus	5	Integer	R	1: startup 2: dead 3: ok 4: suspect	Current status of the radio interface. For now, this field returns ‘ok’.
eumGlobalSaveCounter	6	Counter	R		A count of the number of times the configuration is saved. Initially, this field always returns ‘0’.
eumGlobalConfigFiles	7	String	R		A list of configuration files for the EUM. The list is delimited with a semicolon; i.e., “basic.cfg;route.cfg, ...”
eumGlobalReset	8	Integer	W	1: reset	Not functional at this time.
eumGlobalReload	9	Integer	W	1: reload	Not functional at this time.
eumGlobalConnectionType	10	Integer	R	1: ethernet 2: usb	The type of customer connection.

EUM Radio Configuration Group

All EUM Radio Configuration Group MIB values are read only. All values in Table 75 are prefixed with 1.3.6.1.4.1.2979.12.2.

Table 75 WaveRider EUM Radio Configuration Enterprise MIBs

MIB Name	OID	Value Type	Accepted Values	Description
eumRadioConfigVersion	1	String		Radio firmware version.
eumRadioUnitMacAddress	2	Physical Address	MAC address	Radio MAC address.
eumRadioConfigFrequency	3	Integer		Radio frequency in use (in 1/10ths of a MHz)
eumRadioConfigDomain	4	Integer	0: IEEE 1: FCC or IC/Canada	Current regulatory domain for which the radio is configured.
eumRadioHardwareRevision	5	String		Radio hardware revision.

EUM Radio Statistics Group

All EUM Radio Statistics Group MIB values are read only. All values in Table 76 are prefixed with 1.3.6.1.4.1.2979.12.3.

Table 76 WaveRider EUM Radio Statistics MIB

MIB Name	OID	Value Type	Description
eumRadioStatsGeneral	1	MIB	General radio statistics.
eumRadioStatsDriver	2	MIB	Radio driver statistics
eumRadioStatsAtmel	3	MIB	Radio MAC statistics.

EUM Radio General Statistics Group

All EUM Radio General Statistics Group MIB values are read only. All values in Table 77 are prefixed with 1.3.6.1.4.1.2979.12.3.1.

Table 77 WaveRider EUM Radio General Statistics Group MIB

MIB Name	OID	Value Type	Description
eumRadioGenRSSI	1	Integer	Radio receive signal strength indicator, in dBm. '0' indicates no signal present.
eumRadioGenTPI	2	Counter	The radio transmit power indicator.

EUM Radio Driver Statistics Group

All EUM Radio Driver Statistics Group MIB values are read only. All values in Table 78 are prefixed with 1.3.6.1.4.1.2979.12.3.2.

Table 78 WaveRider EUM Radio Driver Statistics Group MIB

MIB Name	OID	Value Type	Description
eumRadioDrvEvents	1	Counter	Number of interrupts received (any interrupt) in the radio driver ISR (Interrupt Service Routine)
eumRadioDrvRxComplete	2	Counter	Number of *receive complete* interrupts received by the radio driver ISR.
eumRadioDrvTxComplete	3	Counter	Number of *transmit complete* interrupts received by the radio driver ISR.
eumRadioDrvCmdComplete	4	Counter	Number of *command complete* interrupts received by the radio driver ISR.
eumRadioDrvFatalEvent	5	Counter	Number of *fatal error* interrupts received by the radio driver ISR.
eumRadioDrvTxPowerRailEvent	6	Counter	Number of *Tx Power alarm* interrupts received by the radio driver ISR.
eumRadioDrvUnknownEvent	7	Counter	Number of *received an unknown/no event* interrupts received by the radio driver ISR.
eumRadioDrvSend	8	Counter	Number of packets sent successfully by the radio driver transmit queue.
eumRadioDrvSendQFull	9	Counter	Number of packets not sent because the radio driver transmit queue was full.
eumRadioDrvSendUnavailable	10	Counter	Number of times invalid (null) mblks were sent to the radio driver for transmission.
eumRadioDrvSendNotEnabled	11	Counter	Number of times tried to send packets before the radio driver was started; i.e., before the device was up and working.
eumRadioDrvAMMPut	12	Counter	Number of times a packet was successfully sent to the MAC-layer shared memory for transmission over the air.

MIB Name	OID	Value Type	Description
eumRadioDrvAMMQFull	13	Counter	Number of times a packet could not be sent to the MAC-layer shared memory because there were no transmit descriptors left. Radio driver tries 5 more times to send the packet.
eumRadioDrvAMMQFullDiscard	14	Counter	Number of times, after 5 attempts, a packet could not be sent to the MAC-layer shared memory because there were no transmit descriptors left. Packet is discarded.
eumRadioDrvGet	15	Counter	Number of packets received from the MAC-layer shared memory.
eumRadioDrvQEmpty	16	Counter	Number of times there was a receive interrupt, but nothing available to read out of the MAC-layer shared memory.
eumRadioDrvRx	17	Counter	Number of successfully received packets.
eumRadioDrvRxNotAvailable	18	Counter	Number of times the radio driver could not allocate an mblk (memory block) for storing a packet retrieved from the MAC-layer shared memory.
eumRadioDrvNotEnabled	19	Counter	Number of times the radio driver received a receive interrupt, but the radio driver was not yet up and running. The received packet is ignored in this case.

EUM Radio MAC Statistics Group

All EUM Radio MAC Statistics Group MIB values are read only. All values in Table 79 are prefixed with 1.3.6.1.4.1.2979.12.3.3.

Table 79 WaveRider EUM Radio MAC Statistics Group MIB

MIB Name	OID	Value Type	Description
eumRadioMACRxDataPayloads	1	Counter	Number of Ethernet frames received correctly from the air interface.
eumRadioMACRxDataOctets	2	Counter	Number of data octets received correctly from the air interface.
eumRadioMACRxCtrlPayloads	3	Counter	Number of control payloads received correctly from the air interface.
eumRadioMACRxPayloadFailInvalidType	4	Counter	Number of times an unknown type of payload was received from the air interface.
eumRadioMACRxPayloadFailGiant	5	Counter	Number of times a payload that was too long was received from the air interface, and therefore discarded.
eumRadioMACNullRxDesc	6	Counter	Number of times the internal MAC receive interface was corrupted.
eumRadioMACTxDataPayloads	7	Counter	Number of Ethernet frames transmitted to the air interface.

MIB Name	OID	Value Type	Description
eumRadioMACTxDataOctets	8	Counter	Number of data octets transmitted to the air interface.
eumRadioMACTxCtrlPayloads	9	Counter	Number of control payloads transmitted to the air interface.
eumRadioMACTxPayloadFailInvalidType	10	Counter	Number of times a payload of an unknown type was discarded.
eumRadioMACTxPayloadFailGiant	11	Counter	Number of times a payload that was too long was discarded.
ccRadioMACTxPayloadFailInvalidDesc	12	Counter	Number of times the internal MAC transmit interface was corrupted.
eumRadioMACTxBufferFullOnArrival	13	Counter	Number of transmit packets that were queued for delivery.
eumRadioMACCmdTimeOuts	14	Counter	Number of times the MAC-layer management message was incomplete.
eumRadioMACCmdMissedIRQs	15	Counter	Number of times there was no response to the MAC-layer management message.
eumRadioMACFalseCmdIRQs	16	Counter	Number of times a hardware IRQ was detected with no message associated. This MIB parameter is used primarily by software development.
eumRadioMACCmdStatusErrors	17	Counter	Number of times the MAC-layer management message was rejected.
eumRadioMACFatalError	18	Counter	Number of nonrecoverable MAC-layer errors, each requiring an EUM reboot.
eumRadioMACTxRailError	19	Counter	Transmit power alarm interrupt.
eumRadioMACRxPacketsDirected	20	Counter	Number of times a poll for the EUM is received from the CCU with the correct HCRC.
eumRadioMACRxPktsBroadcast	21	Counter	Number of broadcast packets (see note 1) received with the correct HCRC.
eumRadioMACRxPktsNoMatch	22	Counter	Number of packets correctly received, but not directed to, this station.
eumRadioMACRxPktsDuplicate	23	Counter	Number of duplicate payloads (see note 1) received and discarded. Indicates that a MAC layer acknowledgement was lost.
eumRadioMACRxPktsRuntFail	24	Counter	Number of packets received that were shorter than the minimum size.
eumRadioMACRxPktsLongFail	25	Counter	Number of packets received that were longer than the maximum size.
eumRadioMACRxPktsHCRCFail	26	Counter	Number of packets received with a MAC header CRC failure (header corrupted).
eumRadioMACRxPktsICVFail	27	Counter	Number of packets received with an encryption (WEP, wireless equivalent privacy) key mismatch (see note 3).

MIB Name	OID	Value Type	Description
eumRadioMACRxPktsFCSFail	28	Counter	Number of packets received with a Frame Check Sequence failure (payload corrupted).
eumRadioMACRxPktsAssocFail	29	Counter	Total number of times a received packet is discarded because no association can be made.
eumRadioMACRxPktsIncomplete	30	Counter	Number of times the receive DMA for a payload does not complete (internal error).
eumRadioMACRxPayloadsFailFull	31	Counter	Number of times a received payload has to be discarded because either no receive descriptor was available, or there was not enough buffer space.
eumRadioMACRxPayloadsDelivered	32	Counter	Number of payloads that this station received correctly.
eumRadioMACRxPktsEmpty	33	Counter	Number of packets received with no payload.
eumRadioMACTxPkts	34	Counter	Number of packets transmitted.
eumRadioMACTxPktsEmpty	35	Counter	Number of packets transmitted with no payload.
eumRadioMACTxPayloads	36	Counter	Number of payloads transmitted.
eumRadioMACTxPayloadsBCast	37	Counter	Total number of broadcast payloads transmitted.
eumRadioMACTxPayloads10k	38	Counter	Number of payloads acknowledged after the first transmission.
eumRadioMACTxPayloads20k	39	Counter	Number of payloads acknowledged after the second transmission.
eumRadioMACTxPayloads30k	40	Counter	Number of payloads acknowledged after the third transmission.
eumRadioMACTxPayloads40k	41	Counter	Number of payloads acknowledged after the fourth transmission.
eumRadioMACTxPayloadsFailRetry	42	Counter	Number of payloads that failed to transmit due to the retry limit.
eumRadioMACTxPayloadFailDeleted	43	Counter	Total number of payloads returned to the host because an association could not be created.
eumRadioMACTxPayloadsBadParam	44	Counter	Number of payloads returned to the host because they are improperly formed (internal error).
eumRadioMACTxPayloadsVnetInactive	45	Counter	Total number of payloads returned to host because the virtual net was not active.
emRadioMACTxPayloadAssocFailed	46	Counter	Total number of payloads returned to the host because an association could not be created.
eumRadioMACTxPayloadsTimeout	47	Counter	Number of payloads returned to the host because of timeout.

MIB Name	OID	Value Type	Description
eumRadioMACTxPayloadQueueTooLong	48	Counter	Total number of payloads returned to the host because the EUM's transmit queue was too long.
eumRadioMACTxPayloadEmpty	49	Counter	Total number of empty payloads received and returned to host (GOS directives).
eumRadioMACReplyOrRssiTimeout	50	Counter	Number of times the RSSI timer expired because the EUM had not received anything from the CCU for more than 0.5s.
eumRadioMACRestarts	51	Counter	Number of times that the MAC layer recovered from an internal error or unexpected event.
eumRadioMACRegRequests	52	Counter	Number of registration requests transmitted (see note 4).
eumRadioMACRegResponse	53	Counter	Number of registration responses received (see note 4).
eumRadioMACDeregRequests	54	Counter	Number of deregistration requests received (see note 4).
eumRadioMACDeregInits	55	Counter	Number of deregistration initialization messages to the host.
eumRadioMACDisassociationRequests	56	Counter	Number of disassociation requests received (see note 5).
eumRadioMACDisassociationInits	57	Counter	Number of disassociation initialization messages to the host.

Notes:

- A *packet* is the basic unit of transmission. A *packet* may or may not contain a *payload*. A *payload* is user data, which may be an Ethernet frame or a logical link layer control message.
- WEP is not supported in this release.
- Registration occurs once per EUM and/or CCU boot time. Deregistration may occur if an EUM is not authorized (a registration/deregistration request pair occurs periodically while that EUM is powered ON) or if the EUM does not respond to multiple consecutive polls, such as when it is powered OFF.
- Association occurs when there is traffic to send to or from an EUM. Disassociation occurs if there is no traffic to or from an EUM for a short period of time.

EUM Ethernet Statistics Group

All EUM Ethernet Statistics Group MIB values are read only. All values in Table 80 are prefixed with 1.3.6.1.4.1.2979.12.4.

Table 80 WaveRider CCU Ethernet Statistics Group MIB

MIB Name	OID	Value Type	Description
eumEtherInterrupts	1	Counter	Total number of interrupts received by the Ethernet driver ISR, interrupt service routine.
eumEtherRxInterrupt	2	Counter	Number of *receive complete* interrupts received by the Ethernet driver ISR.
eumEtherRxOverrunInterrupt	3	Counter	Number of *overrun* interrupts received by the Ethernet driver ISR. An overrun occurs when a received packet has exceeded the packet size, or the processor has missed one or more packets.
eumEtherRxInProgressInterrupt	4	Counter	Number of times a *receive complete* interrupt was received by the Ethernet driver ISR before the current packet was finished.
eumEtherTxCompleteInterrupt	5	Counter	Number of normal transmit interrupts received by the Ethernet driver ISR.
eumEtherTxErrorInterrupt	6	Counter	Number of *transmit error* interrupts received by the Ethernet driver ISR.
eumEtherTxCarrierLostInterrupt	7	Counter	Number of *transmit carrier lost* interrupts received by the Ethernet driver ISR.
eumEtherTxAllocInterrupt	8	Counter	Number of *transmit allocation complete* interrupts received by the Ethernet driver ISR.
eumEtherTxEPHInterrupt	9	Counter	Number of *transmit EPH* interrupts (Ethernet protocol handler interrupts) received by the Ethernet driver ISR.
eumEtherTxERCVInterrupts	10	Counter	Number of *transmit ERCV* interrupts (early receive interrupts) received by the Ethernet driver ISR..
eumEtherRxData	11	Counter	Number of packets received and accepted by the IP stack.
eumEtherRxDataError	12	Counter	Number of packets received and rejected by the IP stack because of errors.
eumEtherRxDataMblkAllocError	13	Counter	Number of packets lost due to insufficient memory resources.
eumEtherRxDataLenghtError	14	Counter	Number of packets received that violate Ethernet packet length rules.
eumEtherRxDatasDiscards	15	Counter	Number of packets discarded because the unit was not ready to receive data.
eumEtherTxData	16	Counter	Number of packets received and placed on the transmit queue.
eumEtherTxDataQFull	17	Counter	Number of packets discarded because the transmit queue was full.
eumEtherTxOk	18	Counter	Number of packets sent correctly.
eumEtherTxTimeout	19	Counter	Number of times the packet transmit has timed out.
eumEtherTxSemWait	20	Counter	Number of times a transmit semaphore could not be taken in the timeout period.

EUM RFC MIB-II Traps

RFC MIB-II Traps

Table 81 EUM RFC MIB-II Traps

MIB Name	OID	Description
coldStart	1.3.6.1.2.1.11.0.0	Power Cycle or Power On
authenticationFailure	1.3.6.1.2.1.11.0.4	An SNMP request has failed due to improper authentication

Appendix J Operating Statistics

The CCU and EUM provide a comprehensive set of operating statistics for each of the following:

- *Ethernet Statistics* on page 278
- *Radio Driver Statistics* on page 280
- *MAC Interface Statistics* on page 282
- *Routing/Bridging Protocol Statistics* on page 287
- *RADIUS Client Statistics* on page 291
- *Network Interface Statistics* on page 293
- *System Load Statistics (Radio Meter)* on page 295
- *CCU Watch Statistics* on page 298
- *Registration Table (CCU only)* on page 301
- *CCU and EUM System Log Statistics* on page 302

These statistics can be used as a diagnostic and troubleshooting tool when system performance is being impaired by interference, radio link degradation, network problems, atypical end-user applications, capacity issues, and so on.

All of these statistics are available through the command-line interface. Most of the statistics are also available in the CCU and EUM MIBs, if you want to monitor the LMS4000 900 MHz radio network from an SNMP manager.

CAUTION: Each CCU and EUM statistic is a maximum 32-bit number (maximum 4,294,967,296). If a statistics counter exceeds its maximum value, the counter resets to zero and begins again. When this occurs, you must either take the rollover into account, or reset the statistics to re-synchronize the counters. To reset statistics, type **`stats clear`** at the command prompt and press **Enter**.

To Display (all) Statistics from the CLI

- At the command prompt, type **`stats`** and press **Enter**.

The following sections describe each of the statistics in detail and the procedure for obtaining specific sets of statistics (Ethernet, Radio, and so on).

Ethernet Statistics

Ethernet Statistics present operational information about data passing through the CCU and EUM Ethernet ports. These statistics are described in Table 82.

As indicated in Table 82, all of the Ethernet statistics are available in a WaveRider MIB.

Table 82 Ethernet Statistics

Statistic	Description
Interrupts	Total number of interrupts received by the Ethernet driver ISR, interrupt service routine.
RX Interrupts	Number of *receive complete* interrupts received by the Ethernet driver ISR.
RX Overrun Interrupts	Number of *overrun* interrupts received by the Ethernet driver ISR. An overrun occurs when a received packet has exceeded the packet size, or the processor has missed one or more packets.
RX In Progress Interrupts	Number of times a *receive complete* interrupt was received by the Ethernet driver ISR before the current packet was finished.
TX Complete Interrupts	Number of normal transmit interrupts received by the Ethernet driver ISR.
TX Error Interrupts	Number of *transmit error* interrupts received by the Ethernet driver ISR.
TX Carrier Lost Interrupts	Number of *transmit carrier lost* interrupts received by the Ethernet driver ISR.
TX Alloc Interrupts	Number of *transmit allocation complete* interrupts received by the Ethernet driver ISR.
TX EPH Interrupts	Number of *transmit EPH* interrupts (Ethernet protocol handler interrupts) received by the Ethernet driver ISR.
TX ERCV Interrupts	Number of *transmit ERCV* interrupts (early receive interrupts) received by the Ethernet driver ISR.

Statistic	Description
RX Data	Number of packets received and accepted by the IP stack.
RX Data Error	Number of packets received and rejected by the IP stack because of errors.
RX Data Mblk Alloc Error	Number of packets lost due to insufficient memory resources.
RX Data Length Error	Number of packets received that violate Ethernet packet length rules.
RX Discards	Number of packets discarded because the unit was not ready to receive data.
TX Data	Number of packets received and placed on the transmit queue.
TX Data Q Full	Number of packets discarded because the transmit queue was full.
TX'D OK	Number of packets sent correctly.
TX Timeout	Number of times the packet transmit has timed out.
TX Sem Wait	Number of times a transmit semaphore could not be taken in the timeout period.

To view the Ethernet statistics:

```
60:03:3a> stats ethernet
-------------------- Ethernet Statistics -----------------------
Interrupts                        : 4066
RX Interrupts                     : 3988
RX Overrun Interrupts             : 0
RX In Progress Interrupts         : 0
TX Complete Interrupts            : 78
TX Error Interrupts               : 0
TX Carrier Lost Interrupts        : 0
TX Alloc Interrupts               : 0
TX EPH Interrupts                 : 0
TX ERCV Interrupts                : 0

RX Data                           : 5935
RX Data Error                     : 0
RX Data Mblk Alloc Error          : 0
RX Data Length Error              : 0
RX Discards (No Space Available)  : 0

TX Data                           : 78
TX Data Q Full                    : 0
TX'D OK                           : 78
TX Timeout                        : 0
TX Sem Wait                       : 0

60:03:3a>
```

Radio Driver Statistics

Radio Driver Statistics present operational information about data passing through the CCU and EUM radio driver and ports. These statistics are described in Table 83.

As indicated in Table 83, all of the Radio Driver statistics are available in a WaveRider MIB.

Table 83 Radio Driver Statistics

Statistic	Description
Events	Number of interrupts received (any interrupt) in the radio driver ISR (Interrupt Service Routine)
Rx Complete Event	Number of *receive complete* interrupts received by the radio driver ISR.
Tx Complete Event	Number of *transmit complete* interrupts received by the radio driver ISR.
Cmd Complete Event	Number of *command complete* interrupts received by the radio driver ISR.
Fatal Error Event	Number of *fatal error* interrupts received by the radio driver ISR.
Tx Power Rail Event	Number of *Tx Power alarm* interrupts received by the radio driver ISR.
Unknown Event	Number of received an unknown/no event interrupts received by the radio driver ISR.
Send	Number of packets sent successfully by the radio driver transmit queue.
Send Q Full	Number of packets not sent because the radio driver transmit queue was full.
Send MBlk Unavailable	Number of times invalid (null) mblks (memory blocks) were sent to the radio driver for transmission.
Send Not Enabled	Number of times tried to send packets before the radio driver was started; i.e., before the device was up and working.
AMM Put	Number of times a packet was successfully sent to the MAC-layer shared memory for transmission over the air.
AMM Q Full	Number of times a packet was delayed before being placed in the MAC-layer shared memory due to a full transmit queue.
AMM Q Full Discard	Number of times a packet was discarded due to the MAC-layer shared memory transmit queue not draining.

Statistic	Description
AMM Get	Number of packets received from the MAC-layer shared memory.
AMM Q Empty	Number of times there was a receive interrupt, but nothing available to read out of the MAC-layer shared memory.
Receive	Number of successfully received packets.
Receive MBlk Unavailable	Number of times the radio driver could not allocate an mblk (memory block) for storing a packet retrieved from the MAC-layer shared memory.
Receive Not Enabled	Number of times the radio driver received a receive interrupt, but the radio driver was not yet up and running. The received packet is ignored in this case.

To view the radio driver statistics:

```
60:03:3a> stats rad
------------------- Radio Driver Statistics ---------------------

Events                          : 634
Rx Complete Event               : 300
Tx Complete Event               : 329
Cmd Complete Event              : 3
FATAL ERROR Event               : 0
Tx Power Rail Event             : 0
Unknown Event                   : 2
Send                            : 329
Send Q Full                     : 0
Send MBlk Unavailable           : 0
Send Not Enabled                : 1
AMM Put                         : 329
AMM Q Full                      : 0
AMM Q Full Discard              : 0
AMM get                         : 300
AMM Q Empty                     : 1
Receive                         : 300
Receive MBlk Unavailable        : 0
Receive Not Enabled             : 0

60:03:3a>
```

MAC Interface Statistics

MAC Interface Statistics present operational information about data which is processed by the CCU and EUM MAC layer. These statistics are described in Table 84.

As noted in Table 84, most of the MAC interface statistics are available in a WaveRider MIB.

Table 84 MAC Interface Statistics

Statistic	Description
Rx Data Payloads	Number of data payloads received correctly from the air interface.
Rx Data Octets	Number of data octets received correctly from the air interface.
Rx Ctrl Payloads	Number of control payloads received correctly from the air interface.
Rx Payload Fail Invalid Type	Number of times an unknown type of payload was received from the air interface.
Rx Payload Fail Giant	Number of times a payload that was too long was received from the air interface, and therefore discarded.
Null Rx Descriptors	Number of times the internal MAC receive interface was corrupted.
Tx Data Payloads	Number of data payloads transmitted to the air interface.
Tx Data Octets	Number of data octets transmitted to the air interface.
Tx Ctrl Payloads	Number of control payloads transmitted to the air interface.
Tx Payload Fail Invalid Type	Number of times a payload of an unknown type was discarded.
Tx Payload Fail Giant	Number of times a payload that was too long was discarded.
Tx Payload Fail Invalid Desc	Number of times the internal MAC transmit interface was corrupted.
Atmel Tx Buffer full on arrival	Number of transmit packets that were queued for delivery.
Command Time Outs	Number of times the MAC-layer management message was incomplete.
Command Missed IRQs	Number of times there was no response to the MAC-layer management message.

Statistic	Description
False Command IRQs	Number of times a command failed because the previous command was still being processed.
Command Status Errors	Number of times the MAC-layer management message was rejected.
Atmel Fatal Error	Not used.
Unused Statistic	Not used.
rxPktsDirected	At the CCU, the number of times a reply from the EUM is received with the correct HCRC (header cyclic redundancy check). In the EUM, the number of times a poll for the EUM is received from the CCU with the correct HCRC.
rxPktsBroadcast	At the CCU, the number of times an EUM succeeds in a random access. Note that all EUM packets are directed to the CCU, not broadcast. At the EUM, the number of broadcast packets (see note 1) received with the correct HCRC. These are also random access opportunities.
rxPktsNoMatch	Number of packets correctly received, but not directed to, this station.
rxPktsDuplicate	Number of duplicate payloads (see note 1) received and discarded. Indicates that a MAC layer acknowledgement was lost.
rxPktsRuntFail	Number of packets received that were shorter than the minimum size.
rxPktsLongFail	Number of packets received that were longer than the maximum size.
rxPktsHCRCFail	Number of packets received with a MAC header CRC failure (header corrupted).
rxPktsICVFail	Number of packets received with an encryption (WEP, wireless equivalent privacy) key mismatch (see note 3).
rxPktsFCSFail	Number of packets received with a Frame Check Sequence failure (payload corrupted).
rxPktsAssocFail	Number of times a received packet had to be discarded because too many EUMs were already *associated*. [CCU only]
rxPktsIncomplete	Number of times the receive DMA for a payload does not complete (internal error).
rxPayloadsFailFull	Number of times a received payload has to be discarded because either no receive descriptor was available, or there was not enough buffer space.

Statistic	Description
rxPayloadsDelivered	Number of payloads that this station received correctly.
rxPktsEmpty	Number of packets received that are directed to this station, but that did not contain a payload.
txPkts	Number of packets transmitted.
txPktsEmpty	Number of packets transmitted with no payload.
txPayloads	Number of payloads transmitted.
txPayloadsBCast	Number of broadcast payloads transmitted. [CCU only]
txPayloads10k	Number of payloads acknowledged after the first transmission.
txPayloads20k	Number of payloads acknowledged after the second transmission.
txPayloads30k	Number of payloads acknowledged after the third transmission.
txPayloads40k	Number of payloads acknowledged after the fourth transmission.
txPayloadsFailRetry	Number of payloads that failed to transmit due to the retry limit.
txPayloadsFailAssocDeleted	Number of payloads that were discarded because the EUM was unreachable or deauthorized. [CCU only]
txPayloadsFailBadParam	Number of payloads returned to the host because they are improperly formed (internal error).
txPayloadsFailVnetInactive	Number of payloads returned to the host because the virtual net was not active (internal error). [CCU only]
txPayloadsFailAssocFail	Number of payloads returned to the host because too many other EUMs were already *associated*. [CCU only]
txPayloadsFailTimeout	Number of payloads returned to the host because of timeout.
txPayloadsFailQueueTooLong	Number of payloads returned to the host because the transmit queue for the EUM was too long (see note 4). [CCU only]
txPayloadsEmpty	Not used.
replyOrRssiTimeouts	At the CCU, the number of times that no response was received to a directed poll. At the EUM, the number of times the RSSI timer expired because the EUM had not received anything from the CCU for more than 0.5s.

Statistic	Description
restarts	Number of times that a PAI (physical attachment interface) state machine restart occurred (internal error).
registrationRequests	At the CCU, the number of registration requests received (see note 5). At the EUM, the number of registration requests transmitted (see note 5).
registrationResponses	At the CCU, the number of registration responses transmitted (see note 5). At the EUM, the number of registration responses received (see note 5).
deregistrationRequests	At the CCU, the number of deregistration requests transmitted (see note 5). At the EUM, the number of deregistration requests received (see note 5).
deregistrationInits	Number of times no response was received from an EUM, after multiple polls (see note 5). [CCU only]
disassociationRequests	At the CCU, the number of disassociation requests transmitted (see note 6). At the EUM, the number of disassociation requests received (see note 6).
disassociationInits	Number of times the CCU has determined than an EUM should be *disassociated* (see note 6). [CCU only]
newAssociations	At the CCU, the number of times a new association is created (see note 6). At the EUM, the number of transitions to *associated* state (see note 6).
currentAssociations	Number of EUMs currently associated + 1 (see note 6). The one additional association is for “broadcast”. [CCU only]
unexpectedEvents	Number of internal unexpected events.
txDescAvail	Indicates the instantaneous number of transmit buffers that are not in use.
lastQueueTooLongEUM	Indicates for which EUM the last packet was discarded.

Notes:

- A *packet* is the basic unit of transmission. A *packet* may or may not contain a *payload*. A *payload* is user data, which may be an Ethernet frame or a logical link layer control message.
- WEP is not supported in this release.
- The CCU maintains a transmit queue for each EUM. The length of this queue is limited, to keep one EUM from consuming all the resources and impacting other EUMs. Discards indicate excessive load by one EUM, possibly due to large TCP windows.
- Registration occurs once per EUM and/or CCU boot time. Deregistration may occur if an EUM is not authorized (a registration/deregistration request pair occurs periodically

while that EUM is powered ON) or if the EUM does not respond to multiple consecutive polls, such as when it is powered OFF.

- Association occurs when there is traffic to send to or from an EUM. Disassociation occurs if there is no traffic to or from an EUM for a short period of time.

To view the MAC Interface Statistics:

```
60:03:3a> stats mac
---------------- MAC Interface Statistics --------------------

Rx Data Payloads                : 225
Rx Data Octets                  : 29169
Rx Ctrl Payloads                : 68
Rx Payload Fail Invalid Type    : 0
Rx Payload Fail Giant           : 0
Null Rx Descriptors             : 0
Tx Data Payloads                : 252
Tx Data Octets                  : 30919
Tx Ctrl Payloads                : 70
Tx Payload Fail Invalid Type    : 0
Tx Payload Fail Giant           : 0
Tx Payload Fail Invalid Desc    : 0
Atmel Tx Buffer full on arrival : 0
Command time outs               : 0
Command missed IRQs             : 0
False Command IRQs              : 2
Command Status Errors           : 0
Atmel Fatal Errors              : 0
Unused statistic                : 0
                rxPktsDirected:  86419
               rxPktsBroadcast:  73
                 rxPktsNoMatch:  0
               rxPktsDuplicate:  0
                rxPktsRuntFail:  0
                rxPktsLongFail:  0
                rxPktsHCRCFail:  111
                 rxPktsICVFail:  0
                 rxPktsFCSFail:  0
               rxPktsAssocFail:  0
              rxPktsIncomplete:  0
            rxPayloadsFailFull:  0
           rxPayloadsDelivered:  293
                   rxPktsEmpty:  86263
                        txPkts:  96286237
                   txPktsEmpty:  96285907
                    txPayloads:  330
               txPayloadsBCast:  167
                 txPayloads1Ok:  151
                 txPayloads2Ok:  2
                 txPayloads3Ok:  0
                 txPayloads4Ok:  1
           txPayloadsFailRetry:  1
    txPayloadsFailAssocDeleted:  0
        txPayloadsFailBadParam:  0
    txPayloadsFailVnetInactive:  0
       txPayloadsFailAssocFail:  0
         txPayloadsFailTimeout:  0
    txPayloadsFailQueueTooLong:  0
               txPayloadsEmpty:  0
           replyOrRssiTimeouts:  968
                      restarts:  1
          registrationRequests:  4
         registrationResponses:  4
```

```
          deregistrationRequests:  2
             deregistrationInits:  0
          disassociationRequests:  64
             disassociationInits:  64
                 newAssociations:  71
             currentAssociations:  1
                unexpectedEvents:  0
                      txDescAvail:  74
             lastQueueTooLongEUM:  00:00:00
60:03:3a>
```

Routing/Bridging Protocol Statistics

Routing/Bridging Protocol Statistics present operational information about data which is processed by the bridging, switching, and routing layers. These statistics are described in Table 85.

The Routing/Bridging Protocol Statistics are not available in the WaveRider MIBs.

Table 85 Routing/Bridging Protocol Statistics

Statistic	Description
Rx Eth Dst - App	Number of received Ethernet frames transferred from the Ethernet port to the EUM application. [EUM only]
Rx Eth Dst - Radio	Number of received Ethernet frames bridged from the Ethernet port to the radio port. [EUM only]
Rx Eth Dst - To Router	(CCU Only) Number of Ethernet frames received on the Ethernet port sent to the internal router.
Rx Eth Err - Rx Discard	Number of Ethernet frames received on the Ethernet port discarded because the destination is known to be on the Ethernet side or the source address is itself or is invalid.
Rx Eth Err - Mblk	Number of Ethernet frames from the Ethernet port that were discarded because of a specific type of memory allocation error.
Rx Eth Err - Msg Buffer	Number of Ethernet frames from the Ethernet port that were discarded because of a specific type of memory allocation error.
Rx Eth Err - Pkt Size	Number of Ethernet frames from the Ethernet port that were discarded because the frame was too large or too small to decode.

Statistic	Description
Rx Eth Err - Unknown Ether Type	Number of Ethernet frames from the Ethernet port that were discarded because they were not IP, ARP, RARP, or PPPoE frames (example, IPX frame).
Rx Eth Err - Bridge Table Full	(CCU Only) Number of Ethernet frames received on the Ethernet port discarded because the bridge table was full.
Rx Eth Err - Customer Table Error	(EUM Only) Number of Ethernet frames from the Ethernet port that were discarded because the host was not allowed air access or because the bridge table was full.
Rx Eth Err - Invalid NetPool	Number of Ethernet frames from the Ethernet port that were discarded because of a specific type of memory allocation error.
Rx Eth Err - Could not Duplicate	Number of Ethernet frames received on the Ethernet port discarded because of a specific type of memory allocation error.
Rx Eth Err - IP Filter	Number of Ethernet frames received on the Ethernet port discarded because they matched an installed port filter.
Rx Radio Dst - App	Number of Ethernet frames received from the radio and sent to the host application.
Rx Radio Dst - Radio	(CCU Only) Number of Ethernet frames received from the radio and transmitted back out through the radio (i.e., “switched”).
Rx Radio Dst - To Router	(CCU Only) Number of Ethernet frames received from the radio and sent to the internal router.
Rx Radio Dst - Eth	Number of Ethernet frames received from the radio and bridged to the Ethernet port.
Rx Radio Err - Reflection	Number of Ethernet frames received from the radio and discarded because the source address was itself, known to be on the Ethernet port, or invalid.
Rx Radio Err - Mblk	Number of Ethernet frames from the radio port that were discarded because of a specific type of memory allocation error.
Rx Radio Err - Msg Buffer	Number of Ethernet frames from the radio port that were discarded because of a specific type of memory allocation error.

Statistic	Description
Rx Radio Err - Pkt Size	Number of Ethernet frames from the radio port that were discarded because the frame was too large or too small to decode.
Rx Radio Err - Unknown Ether Type	Number of Ethernet frames from the radio port that were discarded because they were not IP, ARP, RARP, or PPPoE frames (example, IPX frame).
Rx Radio Err - Unknown Msg Type	Number of Ethernet frames received from the radio port and discarded because of an internal routing error.
Rx Radio Err - Invalid NetPool	Number of Ethernet frames received from the radio and discarded because of a specific type of memory allocation error.
Rx Radio Err - Could not Duplicate	Number of Ethernet frames received from the radio discarded because of a specific type of memory allocation error.
Rx Radio Err - IP Filter	Number of Ethernet frames received from the radio and discarded because they matched an installed port filter.
Rx Radio Err - Unreg Request	(CCU Only) Number of Ethernet frames received from the radio port and discarded because they came from an *unregistered* EUM.
Rx Radio Err - Address Table Full	(CCU Only) Number of Ethernet frames received from the radio and discarded because the address table was full.
Rx Radio Err - Duplicate IP address	(CCU Only) Number of ARP packets received from the radio and discarded because the source IP address was the same as the CCU radio IP address.
Last Duplicate IP from EUMID:	ID of the EUM from which the last duplicate IP address was received.
Tx Dst - Eth	Number of Ethernet frames that were transmitted through the Ethernet port.
Tx Dst - Radio	Number of Ethernet frames that were transmitted through the radio port.
Tx Dst - Unknown	(CCU Only) Number of transmit Ethernet frames discarded because the destination address was not in the bridging or address tables.

Statistic	Description
Tx Dst - Unregistered	(CCU Only) Number of transmit Ethernet frames discarded because the destination EUM was unregistered.
Tx Err - Mblk	Number of transmit Ethernet frames that had to be discarded because of a specific type of memory allocation error.
Tx Err - Msg Buffer	Number of transmit Ethernet frames that had to be discarded because of a specific type of memory allocation error.
Tx Err - Pkt Size	Number of transmit Ethernet frames that had to be discarded because the frame was too large or too small to decode.
Tx Err - Could not Duplicate	Number of transmit Ethernet frames that had to be discarded because of a specific type of memory allocation error.

To view the Routing Protocol Statistics:

```
60:03:3a> stats rp

----------------Routing Protocol Statistics -------------------

Rx Eth Dst - App                            : 337
Rx Eth Dst - Radio                          : 338
Rx Eth Dst - To Router                      : 0
Rx Eth Err - Rx Discard            (Discard) : 0
Rx Eth Err - Mblk                  (Discard) : 0
Rx Eth Err - Msg Buffer            (Discard) : 0
Rx Eth Err - Pkt Size              (Discard) : 0
Rx Eth Err - Unknown Ether Type    (Discard) : 0
Rx Eth Err - Bridge Table Full     (Discard) : 0
Rx Eth Err - Invalid NetPool       (Discard) : 0
Rx Eth Err - Could not Duplicate   (Discard) : 0
Rx Eth Err - IP Filter             (Discard) : 0

Rx Radio Dst - App                          : 2667
Rx Radio Dst - Radio                        : 0
Rx Radio Dst - To Router                    : 0
Rx Radio Dst - Eth                          : 1931
Rx Radio Err - Reflection          (Discard) : 0
Rx Radio Err - Mblk                (Discard) : 0
Rx Radio Err - Msg Buffer          (Discard) : 0
Rx Radio Err - Pkt Size            (Discard) : 0
Rx Radio Err - Unknown Ether Type  (Discard) : 0
Rx Radio Err - Unknown Msg Type    (Discard) : 0
Rx Radio Err - Invalid NetPool     (Discard) : 0
Rx Radio Err - Could not Duplicate (Discard) : 0
Rx Radio Err - IP Filter           (Discard) : 0
Rx Radio Err - Unreg Request       (Discard) : 0
Rx Radio Err - Address Table Full  (Discard) : 0
Rx Radio Err - Duplicate IP address(Discard) : 0
   Last Duplicate IP from EUMID 00:00:00

Tx Dst - Eth                                : 1938
Tx Dst - Radio                              : 1097
```

```
Tx Err - Unknown                    (Discard) : 0
Tx Err - Unregistered               (Discard) : 0
Tx Err - Mblk                       (Discard) : 0
Tx Err - Msg Buffer                 (Discard) : 0
Tx Err - Pkt Size                   (Discard) : 0
Tx Err - Could not Duplicate        (Discard) : 0

60:03:3a>
```

RADIUS Client Statistics

RADIUS Client Statistics, described in Table 86, are generated by the RADIUS client resident on the CCU.

RADIUS Client Statistics are not available in the WaveRider MIBs.

Table 86 RADIUS Client Statistics

Statistic	Description
Tx Access Requests	Number of distinct access request messages transmitted (not including retries).
Tx Accounting Starts	Number of distinct accounting start messages transmitted (not including retries).
Tx Accounting Updates	Number of distinct accounting update messages transmitted (not including retries).
Tx Accounting Stops	Number of distinct accounting stop messages transmitted (not including retries).
Tx Messages (including retries)	Number of RADIUS packets transmitted, including retries.
Rx Errors	Number of received RADIUS messages discarded because they were too large.
Rx Runts	Number of received RADIUS messages discarded because they were too small.
Rx Invalid Server Address	Number of received RADIUS messages discarded because they were not from the expected RADIUS server.
Rx Unmatched Id	Number of received RADIUS messages discarded because they did not have the expected message ID.
Rx Unmatched Length	Number of received RADIUS messages discarded because the internal structure did not match the packet length.
Rx Authenticator Fail	Number of received RADIUS messages discarded because the authenticator was incorrect (e.g., wrong shared secret)

Statistic	Description
Rx Timeouts	Number of times an expected response did not arrive within 3 seconds.
Rx Okay	Number of RADIUS messages received with the correct authenticator.
Rx Wrong Code	Number of received RADIUS messages of an unsupported type.
Rx Accept, No GOS	Number of received RADIUS access accept responses not containing a WaveRider vendor-specific attribute.
Rx Accept, Misformed GOS	Number of received RADIUS access accept responses with a poorly formed WaveRider vendor-specific attribute.
Rx Accept, Unknown GOS	Number of received RADIUS access accept responses specifying an unknown grade of service.
Rx Access Reject Okay	Number of received RADIUS access reject responses (these cause an EUM to be denied).
Rx Access Accept Okay	Number of received RADIUS access accept messages with valid grade of service (these cause an EUM to be assigned that grade of service).
Rx Accounting Response Okay	Number of received RADIUS accounting responses.
No Access Response (4 attempts)	No response is received to a RADIUS access request message after trying the primary and secondary servers twice each.
No Accounting Response (4 attempts)	No response is received to a RADIUS accounting request message after trying the primary and secondary servers twice each.

To view RADIUS Client statistics:

```
60:06:4e> stats auth
RADIUS Client
Tx Access Requests                  71
Tx Accounting Starts                2
Tx Accounting Updates               67
Tx Accounting Stops                 0
Tx Messages (including retries)     140

Rx Errors                 (discard) 0
Rx Runts                  (discard) 0
Rx Invalid Server Address (discard) 0
Rx Unmatched Id           (discard) 0
Rx Unmatched Length       (discard) 0
Rx Authenticator Fail     (discard) 0
Rx Timeouts                         0
Rx Okay                             140

Rx Wrong Code             (discard) 0
Rx Accept, No GOS         (discard) 0
Rx Accept, Misformed GOS  (discard) 0
```

```
Rx Accept, Unknown GOS    (discard) 0
Rx Access Reject Okay               0
Rx Access Accept Okay               71
Rx Accounting Response Okay         69

No Access Response (4 attempts)     0
No Accounting Response (4 attempts) 0
```

Network Interface Statistics

Network Interface Statistics, described in Table 85, are generated by the IP-protocol suite resident on the CCU and EUM.

Network Interface Statistics are not available in the WaveRider MIBs.

Table 87 Network Interface Statistics

Statistic	Description
ICMP	For information on ICMP, and ICMP-related statistics, refer to RFC729.
IP	For information on IP, and IP-related statistics, refer to RFC791.
TCP	For information on TCP, and TCP-related statistics, refer to RFC793.
UDP	For information on UDP, and UDP-related statistics, refer to RFC768.

To view all network interface statistics:

```
60:03:3a> stats net
---------------- Network Interface Statistics ----------------

ICMP:
        20 calls to icmp_error
        0 error not generated because old message was icmp
        Output histogram:
                echo reply: 36
                destination unreachable: 20
        0 message with bad code fields
        0 message < minimum length
        0 bad checksum
        0 message with bad length
        Input histogram:
                echo reply: 15
                destination unreachable: 15
                echo: 36
        36 message responses generated

               total 3883
              badsum    0
            tooshort    0
            toosmall    0
             badhlen    0
```

```
              badlen    0
         infragments    0
         fragdropped    0
         fragtimeout    0
             forward   69
         cantforward 1046
        redirectsent    0
     unknownprotocol   15
           nobuffers    0
         reassembled    0
        outfragments    0
             noroute    0


Active Internet connections (including servers)
PCB      Proto Recv-Q Send-Q  Local Address      Foreign Address    (state)
-------- ----- ------ ------  ------------------ ------------------ -------
5cc6b4   TCP        0      0  0.0.0.0.23         0.0.0.0.0          LISTEN
5cc4ac   TCP        0      0  0.0.0.0.21         0.0.0.0.0          LISTEN
5cc8bc   UDP        0      0  0.0.0.0.123        0.0.0.0.0
5cc9c0   UDP        0      0  0.0.0.0.20001      0.0.0.0.0
5cbb88   UDP        0      0  0.0.0.0.161        0.0.0.0.0

TCP:
        0 packet sent
                0 data packet (0 byte)
                0 data packet (0 byte) retransmitted
                0 ack-only packet (0 delayed)
                0 URG only packet
                0 window probe packet
                0 window update packet
                0 control packet
        0 packet received
                0 ack (for 0 byte)
                0 duplicate ack
                0 ack for unsent data
                0 packet (0 byte) received in-sequence
                0 completely duplicate packet (0 byte)
                0 packet with some dup. data (0 byte duped)
                0 out-of-order packet (0 byte)
                0 packet (0 byte) of data after window
                0 window probe
                0 window update packet
                0 packet received after close
                0 discarded for bad checksum
                0 discarded for bad header offset field
                0 discarded because packet too short
        0 connection request
        0 connection accept
        0 connection established (including accepts)
        0 connection closed (including 0 drop)
        0 embryonic connection dropped
        0 segment updated rtt (of 0 attempt)
        0 retransmit timeout
                0 connection dropped by rexmit timeout
        0 persist timeout
        0 keepalive timeout
                0 keepalive probe sent
                0 connection dropped by keepalive
        0 pcb cache lookup failed

UDP:
        2786 total packets
        2702 input packets
        84 output packets
```

```
        0 incomplete header
        0 bad data length field
        0 bad checksum
        2651 broadcasts received with no ports
        0 full socket
        51 pcb cache lookups failed
        20 pcb hash lookups failed
60:03:3a>
```

System Load Statistics (Radio Meter)

These statistics are only available at the CCU. The load statistics are summarized in Table 88. System Load Statistics are not available through the WaveRider MIBs.

- The **`radio meter`** command—without an argument—prints current totals.
- The **`radio meter`** command—with an argument—prints averages at the given interval.

Table 88 Load Statistics (Radio Meter)

Statistic	Description
Time	Value of the CCU's internal 32-bit microsecond timer at the instant the messages were taken. `Time` rolls over to "0" about every hour and eleven minutes.
Fw Pyls	Number of payloads transmitted from the CCU to EUMs in this class/level, including retries.
Fw Bytes	Number of bytes of payload transmitted from the CCU to EUMs in this class/level, including retries.
Rev Pyls	Number of payloads transmitted from EUMs in this class/level that are correctly received by the CCU.
Rev Bytes	Number of bytes of payload transmitted from EUMs in this class/level that are correctly received by the CCU.
Max Vio	MaxIPS Violations - Number of times the CCU has not polled an EUM in this class/level within the inter-poll space defined by the EUM's grade of service.
Ideal Vio	IdealIPS Violations - Number of times the average inter-poll space for EUMs in this class/level has been more than 25% higher than the ideal inter-poll space defined by the grade of service.
#EUMs	Number of EUMs in the class/level at the instant in time the load statistics were collected. The broadcast channel counts as one.

Statistic	Description
Avg IPS	Current low-pass average inter-poll space, in microseconds, for the class/level at that instant in time, which corresponds to the current polling rate for EUMs in that class. If no EUMs are currently in the class, it is the average taken at the time the last EUM exited the class.
Total Polls	Number of times the CCU has polled an EUM in the class/level.
Empty Polls	Number of times the CCU has polled an EUM in the class/level and did not either transmit or receive a payload.

Notes:

- All counters are continuous; that is, they are never zeroed, except if the unit is reset or power cycled.
- Payload and poll counters can roll over after a minimum of 50 days.
- Byte counters can roll over after a minimum of 4 hours.
- Violation counters could roll over after 70 seconds if the corresponding parameter was set too small. A steeply climbing violation counter indicates serious problems with either the settings or the system load.

To view the load statistics:

```
60:03:3a> radio meter
CCU Load Meter    Time (us): 1201172156
                   Fw Pyls   Fw Bytes   Rev Pyls  Rev Bytes Max Vio Ideal Vio
    Gold Active          0          0          0          0       0         0
  Gold Inactive          0          0          0          0       0         0
  Silver Active          0          0          0          0       0         0
Silver Inactive          0          0          0          0       0         0
  Bronze Active          0          0          0          0       0         0
Bronze Inactive          0          0          0          0       0         0
      BE Active         99       8904        117      13047       0         0
    BE Inactive         67       2144         57       5154       0         0
      Broadcast        173      24127         61      12342       0         0
        Overall        339      35175        235      30543       0         0

                  #EUMs     Avg IPS  Total Polls  Empty Polls
    Gold Active       0           0            0            0
  Gold Inactive       0           0            0            0
  Silver Active       0           0            0            0
Silver Inactive       0           0            0            0
  Bronze Active       0           0            0            0
Bronze Inactive       0           0            0            0
      BE Active       0        1108        87426        87213
    BE Inactive       0       49492         2389         2265
      Broadcast       1        1071     97274096     97273862
        Overall       1        1071     97363911     97363340
60:03:3a>
```

Each row on the above table, except for `Overall`, corresponds to a grade of service/activity level combination. The last row is the overall totals, which in all cases except IPS, are the sum of the entries in the column. *Active* refers to EUMs that have had traffic within the last *activePollTimeout*, and *Inactive* refers to EUMs that have not had traffic within the last

activePollTimeout and have not timed out on *disassociationTime*. Therefore payload counts for *inactive* EUMs indicate transitions from *inactive* to *active*.

NOTE: Broadcast traffic is carried with random access polls. Therefore, forward traffic (CCU-to-EUM) in the broadcast row is broadcast traffic, while reverse traffic is random access traffic. The reverse packet rate should be less than 15% of the total poll rate for the broadcast traffic, since random access attempts can collide. Assuming uncorrelated arrivals, this should ensure that 99.7% of random access attempts succeed (in four retries or less).

CCU Watch Statistics

The CCU includes the <watch> command, which enables you to monitor link statistics for a single specified EUM.

- **`watch xx:xx:xx`** clears the watch statistics memory and starts watching the specified EUM.
- **`watch`** displays the results of the watch statistics gathering.

While an EUM is being watched, the statistics are incremented only for packets transmitted to or from the specified EUM.

As part of installing or troubleshooting an EUM, you should “watch” the EUM from the CCU. If the TxPayloadsFailQueueTooLong statistic increments, then the TCP receive window in the user’s PC is probably set too high, causing packet discards at the CCU, retransmission on the network link, and reduced throughput.

> **NOTE:** Long queues at the CCU can also occur due to multiple concurrent transfers in the process.

You can monitor the MAC statistic “txPayloadsFailQueueTooLong” at the CCU to give an indication of packet discards due to queue overrun. The MAC statistic “lastQueueTooLongEUM” at the CCU indicates for which EUM the last packet was discarded. That EUM can then be “watched” to determine how often discards occur and whether it is a problem. Some discards may occur simply due to multiple concurrent downloads combined with heavy system loading. If more than one EUM is having problems, the “lastQueueTooLongEUM” statistic changes as discards occur.

```
60:03:3a> watch 60:00:83
Watching 60:00:83
60:03:3a> watch
      The EUMID under watch is:  60:30:01
              Grade of service:  be
                    RSSI [dBm]:  -50
                            SQ:  6
                      RNA [dB]:  63
       Time since last payload:  0
                  Input Octets:  1386814542
                Input Packets:  20956103
                Output Octets:  3395296420
               Output Packets:  39582379
Transmitted Packets
          No payload :     14192  99.7%
               Total :     14229
Transmitted Payloads
                 1Ok :        34  97.1%
                 2Ok :         1   2.8%
                 3Ok :         0   0.0%
                 4Ok :         0   0.0%
          Fail Retry :         0   0.0%
     Fail Q Too Long :         0
        Fail Timeout :         0

Received and Expected Responses
          HCRC Error :         1   0.0%
            Directed :     14227  99.9%
       Random Access :         0   0.0%
```

```
   No Reply Received :          0   0.0%
          No Payload :      14194  99.7%

Received Payloads
           FCS Error :          0   0.0%
           Duplicate :          0   0.0%
           Delivered :         33 100.0%
60:03:3a>
```

NOTE: `Input Octets`, `Input Packets`, `Output Octets`, and `Output Packets` are measured from the point of EUM registration. All statistics below `Output Packets` are measured from the point at which the `watch xx:xx:xx` command was entered.

Table 89 CCU Watch Statistics

Statistic	Description
The EUMID under watch is	EUM ID of the EUM being watched.
Grade of service	Grade of service (GOS) assigned to the EUM under watch.
RSSI [dBm]	Received radio signal strength from the EUM, measured in dBm. **NOTE:** This is the received level measured at the CCU.
SQ	Service Quality, measured at the same time as the RSSI measurement was made.
RNA (dB)	Difference, in dB, between the RSSI and the noise floor.
Time since last payload	Number of seconds passed since the CCU received the last payload from the EUM.
Input Octets	Number of octets received since registration.
Input Packets	Number of packets received since registration.
Output Octets	Number of octets transmitted since registration.
Output Packets	Number of packets transmitted since registration.
Transmitted Packets	
No payload	Number of packets received that did not contain a payload.
Total	Number of packets transmitted.
Transmitted Payloads	
10k	Number of payloads acknowledged after the first transmission.

Statistic	Description
20k	Number of payloads acknowledged after the second transmission.
30k	Number of payloads acknowledged after the third transmission.
40k	Number of payloads acknowledged after the fourth transmission.
Fail Retry	Number of payloads that failed to transmit due to the retry limit.
Fail Q Too Long	Number of payloads returned to the host because the transmit queue for the EUM was too long.
Fail Timeout	Number of payloads returned to the host because of timeout.
Received and Expected Responses	
HCRC Error	Number of packets received with corrupted headers, in response to polling the EUM.
Directed	Number of packets received with correct headers, in response to polling the EUM.
Random Access	Number of packets received with correct headers, in response to a random access polling. These are considered successful random accesses.
No Reply Received	Number of times the EUM did not respond to a directed poll.
No Payload	Number of packets received that are directed to this station, from the EUM, but that did not contain a payload.
Received Payloads	
FCS Error	Number of packets received with a Frame Check Sequence failure (payload corrupted).
Duplicate	Number of duplicate payloads (see note 1) received and discarded. Indicates that a MAC layer acknowledgement was lost.
Delivered	Number of payloads received correctly.
txPayloads	Number of payloads transmitted.

Notes:

- A *packet* is the basic unit of transmission. A *packet* may or may not contain a *payload*. A *payload* is user data, which may be an Ethernet frame or a logical link layer control message.

Registration Table (CCU only)

The Registration Table contains a list of all *registered* EUMs. The CCU automatically builds and adds to this table as EUMs communicate with the CCU. Every EUM that registers with the CCU appears in this table. The EUM will be removed from the Registration Table if the:

- EUM has not communicated with the CCU for more than 12 hours because:
  - the EUM has been turned off for more than 12 hr., or
  - the EUM has had no traffic to send for more than 12 hr., or
  - the EUM has lost its RF connection to the CCU for more than 12 hr.
- EUM does not respond to traffic from the CCU. In this case, the EUM will be removed immediately from the Registration Table.

The Registration Table contains the following entries:

Table 90 Registration Table Entries

Table Entry	Description
EUM ID	EUM ID
GOS Class	Grade of Service Class
RSSI (dBm)	Radio received signal strength (RSSI) in dBm of the EUM.
Time(s)	Time since the last payload was received from the EUM.
Rx-Octets	Number of octets received from this EUM in data payloads, including Ethernet header but not radio MAC header.
Rx-Packets	Number of Ethernet packets received from this EUM in data payloads.
Tx-Octets	Number of octets sent to this EUM in data payloads, including Ethernet header but not radio MAC header.
Tx-Packets	Number of Ethernet packets sent to this EUM in data payloads.
Maximum Associations	The maximum number of EUMs that can be *associated* at any one instant in time.
Deregistration Count	An EUM will be de-registered if it does not respond after the CCU has sent it this many consecutive polls.

NOTE: The Rx-Octets, Rx-Packets, Tx-Octets, and Tx-Packets statistics are identical to the RADIUS accounting statistics and may be considered the appropriate usage statistics for billing purposes.

The end of the air table also prints the total number of EUMs registered.

To view the Registration Table:

```
60:03:3a> air
```

```
Maximum Associations: 75
Deregistration Count: 8

REGISTERED EUMs
  EUM ID GOS Class RSSI[dBm] Time[s] Rx-Octets Rx-Packets  Tx-Octets Tx-Packets
--------------------------------------------------------------------------------
60:05:13      gold      -50       1     721564       6610     435914       6236
60:08:60        be      -55      78     232140       1983     125470       1794

2 EUMs registered of 300 allowed
60:03:3a>
```

NOTE: The `air` command has been used to view the Registration Table, because `reg` is too close to `reb` (reboot).

CCU and EUM System Log Statistics

The System Log Statistics are logged using a subset of the SNMP MIB counters in a comma-delimited decimal format. Each line in the system log file has eight fields:

- **Date/Time Stamp**, which is automatically added to the system log. (e.g., 18-DEC-2001 21:24:39,)
- **Line Label**, which identifies the statistics line number, so the numbers can be extracted correctly. (e.g., stat2,) If the system log requires more than nine lines of statistics, lines following “stat9” are numbered in hexadecimal format. (e.g., stata,)
- **Counters**. Each line contains up to six counters, with leading commas. Each counter contains between 2 and 11 characters, including the commas. All counters reset when the device reboots or when you issue the `stats clear` command.

Sample system log file:

```
60:03:3a> sys log 1600
08,time set to 22-JUL-2002 21:57:08 from 132.246.168.148
22-JUL-2002 21:57:38,time set to 22-JUL-2002 21:57:38 from 132.246.168.148
22-JUL-2002 21:58:08,time set to 22-JUL-2002 21:58:08 from 132.246.168.148
22-JUL-2002 21:58:38,time set to 22-JUL-2002 21:58:38 from 132.246.168.148
22-JUL-2002 21:59:08,time set to 22-JUL-2002 21:59:08 from 132.246.168.148
22-JUL-2002 21:59:38,time set to 22-JUL-2002 21:59:38 from 132.246.168.148
22-JUL-2002 22:00:09,time set to 22-JUL-2002 22:00:09 from 132.246.168.148
22-JUL-2002 22:00:39,time set to 22-JUL-2002 22:00:39 from 132.246.168.148
22-JUL-2002 22:01:09,time set to 22-JUL-2002 22:01:09 from 132.246.168.148
22-JUL-2002 22:01:39,time set to 22-JUL-2002 22:01:39 from 132.246.168.148
22-JUL-2002 22:02:09,time set to 22-JUL-2002 22:02:09 from 132.246.168.148
22-JUL-2002 22:02:39,time set to 22-JUL-2002 22:02:39 from 132.246.168.148
22-JUL-2002 22:02:45,stats log now
22-JUL-2002 22:02:45,stat1,446034,1192148,750227,443347,32644966,32704692
22-JUL-2002 22:02:45,stat2,11980819,7,0,0,0,0
22-JUL-2002 22:02:45,stat3,14,0,0,0,0,0
22-JUL-2002 22:02:45,stat4,441485,11539357,415920420,415477917,442503,1422
22-JUL-2002 22:02:45,stat5,440414,332,1,0,0,0
22-JUL-2002 22:02:45,stat6,0,0,0,0,0,0
22-JUL-2002 22:02:45,stat7,9823,1,2,2,2,0
22-JUL-2002 22:02:45,stat8,16,16,18
22-JUL-2002 22:02:45,stat9,0,0,0,0,0,0
22-JUL-2002 22:02:46,stata,0,0,0,26683,0,0
22-JUL-2002 22:02:57,sys log 1600
```

```
60:03:3a>
```

The system log records every command you enter, either through the serial console port or through a Telnet session, which can be useful when troubleshooting problems.

The system log also saves the following statistics at each recording period. Each line is preceded by the date/time stamp and the “statN” label, where “N” is the line number.

Table 91 CCU and EUM System Log Statistics — Line 1

Field	Name	Description
1	SYSUPTIME	Time counter in 1/100 of a second. This counter allows a parser to determine time difference between successive statistics, as well as noting if the unit has rebooted recently. Note that the current SYSUPTIME counter rolls over every 715,827 seconds (8 days, 6 hours, 50 minutes, 27 seconds).
2	Ethernet Interrupts	Total interrupts caused by the Ethernet device, including completed RX, TX and errors.
3	Ethernet RX Data	Number of packets received on Ethernet Interface. For EUMs which operate in promiscuous mode, the receiver will record all packets seen on the Ethernet, including local Ethernet traffic.
4	Ethernet TX Data	Number of packets transmitted over the Ethernet Interface. Only packets from the EUM or from the radio network should be transmitted.
5	RX Data Octets	Total number of octets received in good packets from the radio. This includes all Ethernet, IP and TCP/UP headers and checksums as well as user information. Does not include MAC header or LLC packets.
6	TX Data Octets	Total number of octets transmitted by radio interface. This includes all Ethernet, IP and TCP/UP headers and checksums as well as user information. Does not include MAC header packets, LLC packets, or retries.

Table 92 CCU and EUM System Log Statistics — Line 2

Field	Name	Description
1	rxPktsDirected	CCU: Total responses to directed polls (with HCRC okay) EUM: Total directed polls received to this station (with HCRC okay).
2	rxPktsBroadcast	CCU: Total responses to random access polls (with HCRC okay) EUM: Total broadcast packets received to this station (with HCRC okay).
3	rxPktsNoMatch	Total packets received not to this station.
4	rxPktsDuplicate	Total duplicate packets received and discarded.
5	rxPktsRuntFail	Total packets received shorter than MAC header size
6	rxPktsLongFail	Total packets received longer than max receive length

Table 93 CCU and EUM System Log Statistics — Line 3

Field	Name	Description
1	rxPktsHCRCFail	Total packets received with HCRC failure.
2	rxPktsICVFail	Total packets received with ICV failure (WEP key mismatch).
3	rxPktsFCSFail	Total packets received with FCS failure.
4	rxPktsAssocFail	Total times received packet is discarded because no association can be made.
5	rxPktsIncomplete	Total times rx DMA for payload does not complete.
6	rxPayloadsFailFull	Total times received payload is discarded because no receive descriptor is available or not enough buffer space is available.

Table 94 CCU and EUM System Log Statistics — Line 4

Field	Name	Description
1	rxPayloadsDelivered	Total receive descriptors sent to host.
2	rxPktsEmpty	Total number of directed packets received to this station with no payload.
3	txPkts	Total number of packets transmitted.

Field	Name	Description
4	txPktsEmpty	Total number of packets transmitted with no payload.
5	txPayloads	Total number of payloads transmitted .
6	txPayloadsBCast	Total number of payloads broadcasted. No ACKs are expected.

Table 95 CCU and EUM System Log Statistics — Line 5

Field	Name	Description
1	txPayloads10k	Total number of payloads acknowledged after the first transmission.
2	txPayloads20k	Total number of payloads acknowledged after the second transmission.
3	txPayloads30k	Total number of payloads acknowledged after the third transmission.
4	txPayloads40k	Total number of payloads acknowledged after the fourth transmission.
5	txPayloadsFailRetry	Total number of payloads that fail to transmit due to retry limit.
6	txPayloadsFailAssocDeleted	Total number of payloads returned to the host because the association was deleted.

Table 96 CCU and EUM System Log Statistics — Line 6

Field	Name	Description
1	txPayloadsFailBadParam	Total number of payloads returned to host because they are malformed.
2	txPayloadsFailVnetInactive	Total number of payloads returned to host because the virtual net was not active.
3	txPayloadsFailAssocFail	Total number of payloads returned to the host because an association could not be created.
4	txPayloadsFailTimeout	Total number of payloads returned to the host because of timeout.
5	txPayloadsFailQueueTooLon g	Total number of payloads returned to the host because the EUM's tx queue was too long.
6	txPayloadsEmpty	Total number of empty payloads received and returned to host (gos directives).

Table 97 CCU and EUM System Log Statistics — Line 7

Field	Name	Description
1	replyOrRssiTimeouts	CCU: number of times the reply timer expires. EUM: number of times the RSSI timer expires.
2	restarts	Number of times PAI state machine restart occurs.
3	registrationRequests	CCU: Number of registration requests received. EUM: Number of registration requests transmitted.
4	registrationResponses	CCU: Number of registration responses transmitted. EUM: Number of registration responses received.
5	deregistrationRequests	CCU: Number of deregistration requests transmitted. EUM: Number of deregistration requests received.
6	deregistrationInits	CCU: Number of deregistration initialization messages to the host.

Table 98 CCU and EUM System Log Statistics — Line 8

Field	Name	Description
1	disassociationRequests	CCU: Number of disassociation requests transmitted. EUM: Number of disassociation requests received.
2	disassociationInits	CCU: Number of disassociation initialization messages to the host.
3	newAssociations	CCU: Number of times a new association is created. EUM: Number of times transition to associated state.

The statistics in Table 99 and Table 100 are recorded for the CCU only.

Table 99 CCU ONLY System Log Statistics — Line 9

Field	Name	Description
1	Gold Average IPS	Interpacket Spacing (IPS) for Gold Active Users
2	Gold MAX Violations	Violations of MAX IPS for Gold Active Users
3	Gold Ideal Violations	Violations of the ideal IPS for Gold Active Users

Field	Name	Description
4	Silver Average IPS	Interpacket Spacing (IPS) for Silver Active Users
5	Silver MAX Violations	Violations of MAX IPS for Silver Active Users
6	Silver Ideal Violations	Violations of the ideal IPS for Silver Active Users

Table 100 CCU ONLY System Log Statistics — Line a

Field	Name	Description
1	Bronze Average IPS	Interpacket Spacing (IPS) for Bronze Active Users
2	Bronze MAX Violations	Violations of MAX IPS for Bronze Active Users
3	Bronze Ideal Violations	Violations of the ideal IPS for Bronze Active Users
4	Best Effort Average IPS	Interpacket Spacing (IPS) for Best Effort Active Users
5	Best Effort MAX Violations	Violations of MAX IPS for Best Effort Active Users
6	Best Effort Ideal Violations	Violations of the ideal IPS for Best Effort Active Users

Appendix K Sample IP Plan

This section includes sample IP plans for an LMS4000 system. There is a sample IP plan for each of the following network configurations:

- *Routed Mode* on page 309
- *Switched Ethernet and Through-Only Modes* on page 322

TIP: For a large system, the CCU radio subnets should lie in different Ethernet domains to reduce broadcast traffic. This is automatically the case in Routed Mode, but requires careful planning of upstream networking equipment in Switched Ethernet mode. Contact WaveRider Technical Support for details.

Routed Mode

The following tables provide an example of an IP plan for an LMS4000 system equipped with fifteen 900 MHz CAPs, using Routed mode:

- *CAP IP Addressing Plan* on page 310
- *CCU Ethernet IP Addressing Plan* on page 310
- *CCU Radio IP Addressing Plan* on page 311
- *EUM IP Addressing Plan* on page 314
- *Subscriber IP Addressing Plan* on page 318

CAP IP Addressing Plan

Table 101 Example – CAP IP Addressing Plan

CAP Element	IP Address
Gateway Router	192.168.10.1 /24
CAP Switch	192.168.10.5 /24
CAP UPS	192.168.10.6 /24
SNMP Manager	192.168.10.7 /24

CCU Ethernet IP Addressing Plan

Table 102 Example – CCU Ethernet IP Addressing Plan

Site	CCU	CCU Ethernet Address	Site	CCU	CCU Ethernet Address
CAP01	CCU01	192.168.10.11	CAP09	CCU01	192.168.10.43
	CCU02	192.168.10.12		CCU02	192.168.10.44
	CCU03	192.168.10.13		CCU03	192.168.10.45
	CCU04	192.168.10.14		CCU04	192.168.10.46
CAP02	CCU01	192.168.10.15	CAP10	CCU01	192.168.10.47
	CCU02	192.168.10.16		CCU02	192.168.10.48
	CCU03	192.168.10.17		CCU03	192.168.10.49
	CCU04	192.168.10.18		CCU04	192.168.10.50
CAP03	CCU01	192.168.10.19	CAP11	CCU01	192.168.10.51
	CCU02	192.168.10.20		CCU02	192.168.10.52
	CCU03	192.168.10.21		CCU03	192.168.10.53
	CCU04	192.168.10.22		CCU04	192.168.10.54
CAP04	CCU01	192.168.10.23	CAP12	CCU01	192.168.10.55
	CCU02	192.168.10.24		CCU02	192.168.10.56
	CCU03	192.168.10.25		CCU03	192.168.10.57
	CCU04	192.168.10.26		CCU04	192.168.10.58
CAP05	CCU01	192.168.10.27	CAP13	CCU01	192.168.10.59
	CCU02	192.168.10.28		CCU02	192.168.10.60
	CCU03	192.168.10.29		CCU03	192.168.10.61
	CCU04	192.168.10.30		CCU04	192.168.10.62

Site	CCU	CCU Ethernet Address	Site	CCU	CCU Ethernet Address
CAP06	CCU01	192.168.10.31	CAP14	CCU01	192.168.10.63
	CCU02	192.168.10.32		CCU02	192.168.10.64
	CCU03	192.168.10.33		CCU03	192.168.140.65
	CCU04	192.168.10.34		CCU04	192.168.140.66
CAP07	CCU01	192.168.10.35	CAP15	CCU01	192.168.10.67
	CCU02	192.168.10.36		CCU02	192.168.10.68
	CCU03	192.168.10.37		CCU03	192.168.10.69
	CCU04	192.168.10.38		CCU04	192.168.10.70
CAP08	CCU01	192.168.10.39			
	CCU02	192.168.10.40			
	CCU03	192.168.10.41			
	CCU04	192.168.10.42			

CCU Radio IP Addressing Plan

Table 103 Example – CCUs, EUMs, and Subscriber Subnet Data

NOTE: EUMs and PCs are on the same subnet.

Subnet	172.16.0.0
Subnet Mask Bits	22
Subnet Mask	255.255.252.0 (ff.ff.fc.00)

Table 104 Example – CCU Radio IP Addressing Plan

Site	CCU	Subnet	CCU Radio IP Address	CCU Radio Subnet Range	Broadcast
CAP01	CCU01	172.16.4.0	172.16.4.1	172.16.4.1 - 172.16.7.254	172.16.7.255
	CCU02	172.16.8.0	172.16.8.1	172.16.8.1 - 172.16.11.254	172.16.11.255
	CCU03	172.16.12.0	172.16.12.1	172.16.12.1 - 172.16.15.254	172.16.15.255
	CCU04	172.16.16.0	172.16.16.1	172.16.16.1 - 172.16.19.254	172.16.19.255

Site	CCU	Subnet	CCU Radio IP Address	CCU Radio Subnet Range	Broadcast
CAP02	**CCU01**	**172.16.20.0**	**172.16.20.1**	**172.16.20.1 - 172.16.23.254**	**172.16.23.255**
	CCU02	**172.16.24.0**	**172.16.24.1**	**172.16.24.1 - 172.16.27.254**	**172.16.27.255**
	CCU03	**172.16.28.0**	**172.16.28.1**	**172.16.28.1 - 172.16.31.254**	**172.16.31.255**
	CCU04	172.16.32.0	172.16.32.1	172.16.32.1 - 172.16.35.254	172.16.35.255
CAP03	CCU01	172.16.36.0	172.16.36.1	172.16.36.1 - 172.16.39.254	172.16.39.255
	CCU02	172.16.40.0	172.16.40.1	172.16.40.1 - 172.16.43.254	172.16.43.255
	CCU03	172.16.44.0	172.16.44.1	172.16.44.1 - 172.16.47.254	172.16.47.255
	CCU04	172.16.48.0	172.16.48.1	172.16.48.1 - 172.16.51.254	172.16.51.255
CAP04	CCU01	172.16.52.0	172.16.52.1	172.16.52.1 - 172.16.55.254	172.16.55.255
	CCU02	172.16.56.0	172.16.56.1	172.16.56.1 - 172.16.59.254	172.16.59.255
	CCU03	172.16.60.0	172.16.60.1	172.16.60.1 - 172.16.63.254	172.16.63.255
	CCU04	172.16.64.0	172.16.64.1	172.16.64.1 - 172.16.67.254	172.16.67.255
CAP05	CCU01	172.16.68.0	172.16.68.1	172.16.68.1 - 172.16.71.254	172.16.71.255
	CCU02	172.16.72.0	172.16.72.1	172.16.72.1 - 172.16.75.254	172.16.75.255
	CCU03	172.16.76.0	172.16.76.1	172.16.76.1 - 172.16.79.254	172.16.79.255
	CCU04	172.16.80.0	172.16.80.1	172.16.80.1 - 172.16.83.254	172.16.83.255
CAP06	CCU01	172.16.84.0	172.16.84.1	172.16.84.1 - 172.16.87.254	172.16.87.255
	CCU02	172.16.88.0	172.16.88.1	172.16.88.1 - 172.16.91.254	172.16.91.255
	CCU03	172.16.92.0	172.16.92.1	172.16.92.1 - 172.16.95.254	172.16.95.255
	CCU04	172.16.96.0	172.16.96.1	172.16.96.1 - 172.16.99.254	172.16.99.255
CAP07	CCU01	172.16.100.0	172.16.100.1	172.16.100.1 - 172.16.103.254	172.16.103.255
	CCU02	172.16.104.0	172.16.104.1	172.16.104.1 - 172.16.107.254	172.16.107.255
	CCU03	172.16.108.0	172.16.108.1	172.16.108.1 - 172.16.111.254	172.16.111.255
	CCU04	172.16.112.0	172.16.112.1	172.16.112.1 - 172.16.115.254	172.16.115.255
CAP08	CCU01	172.16.116.0	172.16.116.1	172.16.116.1 - 172.16.119.254	172.16.119.255
	CCU02	172.16.120.0	172.16.120.1	172.16.120.1 - 172.16.123.254	172.16.123.255
	CCU03	172.16.124.0	172.16.124.1	172.16.124.1 - 172.16.127.254	172.16.127.255
	CCU04	172.16.128.0	172.16.128.1	172.16.128.1 - 172.16.131.254	172.16.131.255
CAP09	CCU01	172.16.132.0	172.16.132.1	172.16.132.1 - 172.16.135.254	172.16.135.255
	CCU02	172.16.136.0	172.16.136.1	172.16.136.1 - 172.16.139.254	172.16.139.255
	CCU03	172.16.140.0	172.16.140.1	172.16.140.1 - 172.16.143.254	172.16.143.255
	CCU04	172.16.144.0	172.16.144.1	172.16.144.1 - 172.16.147.254	172.16.147.255

Site	CCU	Subnet	CCU Radio IP Address	CCU Radio Subnet Range	Broadcast
CAP10	CCU01	172.16.148.0	172.16.148.1	172.16.148.1 - 172.16.151.254	172.16.151.255
	CCU02	172.16.152.0	172.16.152.1	172.16.152.1 - 172.16.155.254	172.16.155.255
	CCU03	172.16.156.0	172.16.156.1	172.16.156.1 - 172.16.159.254	172.16.159.255
	CCU04	172.16.160.0	172.16.160.1	172.16.160.1 - 172.16.163.254	172.16.163.255
CAP11	CCU01	172.16.164.0	172.16.164.1	172.16.164.1 - 172.16.167.254	172.16.167.255
	CCU02	172.16.168.0	172.16.168.1	172.16.168.1 - 172.16.171.254	172.16.171.255
	CCU03	172.16.172.0	172.16.172.1	172.16.172.1 - 172.16.175.254	172.16.175.255
	CCU04	172.16.176.0	172.16.76.1	172.16.176.1 - 172.16.179.254	172.16.179.255
CAP12	CCU01	172.16.180.0	172.16.180.1	172.16.180.1 - 172.16.183.254	172.16.183.255
	CCU02	172.16.184.0	172.16.184.1	172.16.184.1 - 172.16.187.254	172.16.187.255
	CCU03	172.16.188.0	172.16.188.1	172.16.188.1 - 172.16.191.254	172.16.191.255
	CCU04	172.16.192.0	172.16.192.1	172.16.192.1 - 172.16.195.254	172.16.195.255
CAP13	CCU01	172.16.196.0	172.16.196.1	172.16.196.1 - 172.16.199.254	172.16.199.255
	CCU02	172.16.200.0	172.16.200.1	172.16.200.1 - 172.16.203.254	172.16.203.255
	CCU03	172.16.204.0	172.16.204.1	172.16.204.1 - 172.16.207.254	172.16.207.255
	CCU04	172.16.208.0	172.16.208.1	172.16.208.1 - 172.16.211.254	172.16.211.255
CAP14	CCU01	172.16.212.0	172.16.212.1	172.16.212.1 - 172.16.215.254	172.16.215.255
	CCU02	172.16.216.0	172.16.216.1	172.16.216.1 - 172.16.219.254	172.16.219.255
	CCU03	172.16.220.0	172.16.220.1	172.16.220.1 - 172.16.223.254	172.16.223.255
	CCU04	172.16.224.0	172.16.224.1	172.16.224.1 - 172.16.227.254	172.16.227.255
CAP15	CCU01	172.16.228.0	172.16.228.1	172.16.228.1 - 172.16.231.254	172.16.231.255
	CCU02	172.16.232.0	172.16.232.1	172.16.232.1 - 172.16.235.254	172.16.235.255
	CCU03	172.16.236.0	172.16.236.1	172.16.236.1 - 172.16.239.254	172.16.239.255
	CCU04	172.16.240.0	172.16.240.1	172.16.240.1 - 172.16.243.254	172.16.243.255

EUM IP Addressing Plan

Table 105 Example – EUM IP Addressing Plan

Site	CCU	Subnet ID	EUM IP Address Range
CAP01	CCU01	EUM001-253	172.16.4.2 - 172.16.4.254
		EUM254-300	172.16.5.1 - 172.16.5.47
	CCU02	EUM001-253	172.16.8.2 - 172.16.8.254
		EUM254-300	172.16.9.1 - 172.16.9.47
	CCU03	EUM001-253	172.16.12.2 - 172.16.12.254
		EUM254-300	172.16.13.1 - 172.16.13.47
	CCU04	EUM001-253	172.16.16.2 - 172.16.16.254
		EUM254-300	172.16.17.1 - 172.16.17.47
CAP02	CCU01	EUM001-253	172.16.20.2- 172.16.20.254
		EUM254-300	172.16.21.1 - 172.16.21.47
	CCU02	EUM001-253	172.16.24.2 - 172.16.24.254
		EUM254-300	172.16.25.1 - 172.16.25.47
	CCU03	EUM001-253	172.16.28.2 - 172.16.28.254
		EUM254-300	172.16.29.1 - 172.16.29.47
	CCU04	EUM001-253	172.16.32.2 - 172.16.32.254
		EUM254-300	172.16.33.1 - 172.16.33.47
CAP03	CCU01	EUM001-253	172.16.36.2 - 172.16.36.254
		EUM254-300	172.16.37.1 - 172.16.37.47
	CCU02	EUM001-253	172.16.40.2 - 172.16.40.254
		EUM254-300	172.16.41.1 - 172.16.41.47
	CCU03	EUM001-253	172.16.44.2 - 172.16.44.254
		EUM254-300	172.16.45.1 - 172.16.45.47
	CCU04	EUM001-253	172.16.48.2 - 172.16.48.254
		EUM254-300	172.16.49.1 - 172.16.49.47

Site	CCU	Subnet ID	EUM IP Address Range
CAP04	CCU01	EUM001-253	172.16.52.2 - 172.16.52.254
		EUM254-300	172.16.53.1 - 172.16.53.47
	CCU02	EUM001-253	172.16.56.2 - 172.16.56.254
		EUM254-300	172.16.57.1 - 172.16.57.47
	CCU03	EUM001-253	172.16.60.2 - 172.16.60.254
		EUM254-300	172.16.61.1 - 172.16.61.47
	CCU04	EUM001-253	172.16.64.2 - 172.16.64.254
		EUM254-300	172.16.65.1 - 172.16.65.47
CAP05	CCU01	EUM001-253	172.16.68.2 - 172.16.68.254
		EUM254-300	172.16.69.1 - 172.16.69.47
	CCU02	EUM001-253	172.16.72.2 - 172.16.72.254
		EUM254-300	172.16.73.1 - 172.16.73.47
	CCU03	EUM001-253	172.16.76.2 - 172.16.76.254
		EUM254-300	172.16.77.1 - 172.16.77.47
	CCU04	EUM001-253	172.16.80.2 - 172.16.80.254
		EUM254-300	172.16.81.1 - 172.16.81.47
CAP06	CCU01	EUM001-253	172.16.84.2 - 172.16.84.254
		EUM254-300	172.16.85.1 - 172.16.85.47
	CCU02	EUM001-253	172.16.88.2 - 172.16.88.254
		EUM254-300	172.16.89.1 - 172.16.89.47
	CCU03	EUM001-253	172.16.92.2 - 172.16.92.254
		EUM254-300	172.16.93.1 - 172.16.93.47
	CCU04	EUM001-253	172.16.96.2 - 172.16.96.254
		EUM254-300	172.16.97.1 - 172.16.97.47
CAP07	CCU01	EUM001-253	172.16.100.2 - 172.16.100.254
		EUM254-300	172.16.101.1 - 172.16.101.47
	CCU02	EUM001-253	172.16.104.2 - 172.16.104.254
		EUM254-300	172.16.105.1 - 172.16.105.47
	CCU03	EUM001-253	172.16.108.2 - 172.16.108.254
		EUM254-300	172.16.109.1 - 172.16.109.47
	CCU04	EUM001-253	172.16.112.2 - 172.16.112.254
		EUM254-300	172.16.113.1 - 172.16.113.47

Site	CCU	Subnet ID	EUM IP Address Range
CAP08	CCU01	EUM001-253	172.16.116.2 - 172.16.116.254
		EUM254-300	172.16.117.1 - 172.16.117.47
	CCU02	EUM001-253	172.16.120.2 - 172.16.120.254
		EUM254-300	172.16.121.1 - 172.16.121.47
	CCU03	EUM001-253	172.16.124.2 - 172.16.124.254
		EUM254-300	172.16.125.1 - 172.16.125.47
	CCU04	EUM001-253	172.16.128.2 - 172.16.128.254
		EUM254-300	172.16.129.1 - 172.16.129.47
CAP09	CCU01	EUM001-253	172.16.132.2 - 172.16.132.254
		EUM254-300	172.16.133.1 - 172.16.133.47
	CCU02	EUM001-253	172.16.136.2 - 172.16.136.254
		EUM254-300	172.16.137.1 - 172.16.137.47
	CCU03	EUM001-253	172.16.140.2 - 172.16.140.254
		EUM254-300	172.16.141.1 - 172.16.141.47
	CCU04	EUM001-253	172.16.144.2 - 172.16.144.254
		EUM254-300	172.16.145.1 - 172.16.145.47
CAP10	CCU01	EUM001-253	172.16.148.2 - 172.16.148.254
		EUM254-300	172.16.149.1 - 172.16.149.47
	CCU02	EUM001-253	172.16.152.2 - 172.16.152.254
		EUM254-300	172.16.153.1 - 172.16.153.47
	CCU03	EUM001-253	172.16.156.2 - 172.16.156.254
		EUM254-300	172.16.157.1 - 172.16.157.47
	CCU04	EUM001-253	172.16.160.2 - 172.16.160.254
		EUM254-300	172.16.161.1 - 172.16.161.47
CAP11	CCU01	EUM001-253	172.16.164.2 - 172.16.164.254
		EUM254-300	172.16.165.1 - 172.16.165.47
	CCU02	EUM001-253	172.16.168.2 - 172.16.168.254
		EUM254-300	172.16.169.1 - 172.16.169.47
	CCU03	EUM001-253	172.16.172.2 - 172.16.172.254
		EUM254-300	172.16.173.1 - 172.16.173.47
	CCU04	EUM001-253	172.16.176.2 - 172.16.176.254
		EUM254-300	172.16.177.1 - 172.16.177.47

Site	CCU	Subnet ID	EUM IP Address Range
CAP12	CCU01	EUM001-253	172.16.180.2 - 172.16.180.254
		EUM254-300	172.16.181.1 - 172.16.181.47
	CCU02	EUM001-253	172.16.184.2 - 172.16.184.254
		EUM254-300	172.16.185.1 - 172.16.185.47
	CCU03	EUM001-253	172.16.188.2 - 172.16.188.254
		EUM254-300	172.16.189.1 - 172.16.189.47
	CCU04	EUM001-253	172.16.192.2 - 172.16.192.254
		EUM254-300	172.16.193.1 - 172.16.193.47
CAP13	CCU01	EUM001-253	172.16.196.2 - 172.16.196.254
		EUM254-300	172.16.197.1 - 172.16.197.47
	CCU02	EUM001-253	172.16.200.2 - 172.16.200.254
		EUM254-300	172.16.201.1 - 172.16.201.47
	CCU03	EUM001-253	172.16.204.2 - 172.16.204.254
		EUM254-300	172.16.205.1 - 172.16.205.47
	CCU04	EUM001-253	172.16.208.2 - 172.16.208.254
		EUM254-300	172.16.209.1 - 172.16.209.47
CAP14	CCU01	EUM001-253	172.16.212.2 - 172.16.212.254
		EUM254-300	172.16.213.1 - 172.16.213.47
	CCU02	EUM001-253	172.16.216.2 - 172.16.216.254
		EUM254-300	172.16.217.1 - 172.16.217.47
	CCU03	EUM001-253	172.16.220.2 - 172.16.220.254
		EUM254-300	172.16.221.1 - 172.16.221.47
	CCU04	EUM001-253	172.16.224.2 - 172.16.224.254
		EUM254-300	172.16.225.1 - 172.16.225.47
CAP15	CCU01	EUM001-253	172.16.228.2 - 172.16.228.254
		EUM254-300	172.16.229.1 - 172.16.229.47
	CCU02	EUM001-253	172.16.232.2 - 172.16.232.254
		EUM254-300	172.16.233.1 - 172.16.233.47
	CCU03	EUM001-253	172.16.236.2 - 172.16.236.254
		EUM254-300	172.16.237.1 - 172.16.23747
	CCU04	EUM001-253	172.16.240.2 - 172.16.240.254
		EUM254-300	172.16.241.1 - 172.16.241.47

Subscriber IP Addressing Plan

Table 106 Example – Subscriber IP Addressing Plan

Site	CCU	Subnet ID	Subscriber IP Address Range
CAP01	CCU01	SUB001-253	172.16.6.1 - 172.16.6.254
		SUB254-300	172.16.7.1 - 172.16.7.46
	CCU02	SUB001-253	172.16.10.1 - 172.16.10.254
		SUB254-300	172.16.11.1 - 172.16.11.46
	CCU03	SUB001-253	172.16.14.1 - 172.16.14.254
		SUB254-300	172.16.15.1 - 172.16.15.46
	CCU04	SUB001-253	172.16.18.1 - 172.16.18.254
		SUB254-300	172.16.19.1 - 172.16.19.46
CAP02	CCU01	SUB001-253	172.16.22.1 - 172.16.22.254
		SUB254-300	172.16.23.1 - 172.16.23.46
	CCU02	SUB001-253	172.16.26.1 - 172.16.26.254
		SUB254-300	172.16.27.1 - 172.16.27.46
	CCU02	SUB001-253	172.16.30.1 - 172.16.30.254
		SUB254-300	172.16.31.1 - 172.16.31.46
	CCU04	SUB001-253	172.16.34.1 - 172.16.34.254
		SUB254-300	172.16.35.1 - 172.16.35.46
CAP03	CCU01	SUB001-253	172.16.38.1 - 172.16.38.254
		SUB254-300	172.16.39.1 - 172.16.39.46
	CCU02	SUB001-253	172.16.42.1 - 172.16.42.254
		SUB254-300	172.16.43.1 - 172.16.43.46
	CCU03	SUB001-253	172.16.46.1 - 172.16.46.254
		SUB254-300	172.16.47.1 - 172.16.47.46
	CCU04	SUB001-253	172.16.50.1 - 172.16.50.254
		SUB254-300	172.16.51.1 - 172.16.51.46

Site	CCU	Subnet ID	Subscriber IP Address Range
CAP04	CCU01	SUB001-253	172.16.54.1 - 172.16.54.254
		SUB254-300	172.16.55.1 - 172.16.55.46
	CCU02	SUB001-253	172.16.58.1 - 172.16.58.254
		SUB254-300	172.16.59.1 - 172.16.59.46
	CCU03	SUB001-253	172.16.62.1 - 172.16.62.254
		SUB254-300	172.16.63.1 - 172.16.63.46
	CCU04	SUB001-253	172.16.66.1 - 172.16.66.254
		SUB254-300	172.16.67.1 - 172.16.67.46
CAP05	CCU01	SUB001-253	172.16.70.1 - 172.16.70.254
		SUB254-300	172.16.71.1 - 172.16.71.46
	CCU02	SUB001-253	172.16.74.1 - 172.16.74.254
		SUB254-300	172.16.75.1 - 172.16.75.46
	CCU03	SUB001-253	172.16.78.1 - x172.16.78.254
		SUB254-300	172.16.79.1 - 172.16.79.46
	CCU04	SUB001-253	172.16.82.1 - 172.16.82.254
		SUB254-300	172.16.83.1 - 172.16.83.46
CAP06	CCU01	SUB001-253	172.16.86.1 - 172.16.86.254
		SUB254-300	172.16.87.1 - 172.16.87.46
	CCU02	SUB001-253	172.16.90.1 - 172.16.90.254
		SUB254-300	172.16.91.1 - 172.16.91.46
	CCU03	SUB001-253	172.16.94.1 - 172.16.94.254
		SUB254-300	172.16.95.1 - 172.16.95.46
	CCU04	SUB001-253	172.16.98.1 - 172.16.98.254
		SUB254-300	172.16.99.1 - 172.16.99.97
CAP07	CCU01	SUB001-253	172.16.102.1 - 172.16.102.254
		SUB254-300	172.16.103.1 - 172.16.103.46
	CCU02	SUB001-253	172.16.106.1 - 172.16.106.254
		SUB254-300	172.16.107.1 - 172.16.107.46
	CCU03	SUB001-253	172.16.110.1 - 172.16.110.254
		SUB254-300	172.16.111.1 - 172.16.111.46
	CCU04	SUB001-253	172.16.114.1 - 172.16.114.254
		SUB254-300	172.16.115.1 - 172.16.115.46

Site	CCU	Subnet ID	Subscriber IP Address Range
CAP08	CCU01	SUB001-253	172.16.118.1 - 172.16.118.254
		SUB254-300	172.16.119.1 - 172.16.119.46
	CCU02	SUB001-253	172.16.122.1 - 172.16.122.254
		SUB254-300	172.16.123.1 - 172.16.123.46
	CCU03	SUB001-253	172.16.126.1 - 172.16.126.254
		SUB254-300	172.16.127.1 - 172.16.127.46
	CCU04	SUB001-253	172.16.130.1 - 172.16.130.254
		SUB254-300	172.16.131.1 - 172.16.131.46
CAP09	CCU01	SUB001-253	172.16.134.1 - 172.16.134.254
		SUB254-300	172.16.135.1 - 172.16.135.46
	CCU02	SUB001-253	172.16.138.1 - 172.16.138.254
		SUB254-300	172.16.139.1 - 172.16.139.46
	CCU03	SUB001-253	172.16.142.1 - 172.16.142.254
		SUB254-300	172.16.143.1 - 172.16.143.46
	CCU04	SUB001-253	172.16.146.1 - 172.16.146.254
		SUB254-300	172.16.147.1 - 172.16.147.46
CAP10	CCU01	SUB001-253	172.16.150.1 - 172.16.150.254
		SUB254-300	172.16.151.1 - 172.16.151.46
	CCU02	SUB001-253	172.16.154.1 - 172.16.154.254
		SUB254-300	172.16.155.1 - 172.16.155.46
	CCU03	SUB001-253	172.16.158.1 - 172.16.158.254
		SUB254-300	172.16.159.1 - 172.16.159.46
	CCU04	SUB001-253	172.16.162.1 - 172.16.162.254
		SUB254-300	172.16.163.1 - 172.16.163.46
CAP11	CCU01	SUB001-253	172.16.166.1 - 172.16.166.254
		SUB254-300	172.16.167.1 - 172.16.167.46
	CCU02	SUB001-253	172.16.170.1 - 172.16.170.254
		SUB254-300	172.16.171.1 - 172.16.170.46
	CCU03	SUB001-253	172.16.174.1 - 172.16.174.254
		SUB254-300	172.16.175.1 - 172.16.175.46
	CCU04	SUB001-253	172.16.178.1 - 172.16.178.254
		SUB254-300	172.16.179.1 - 172.16.179.46

Site	CCU	Subnet ID	Subscriber IP Address Range
CAP12	CCU01	SUB001-253	172.16.182.1 - 172.16.182.254
		SUB254-300	172.16.183.1 - 172.16.183.46
	CCU02	SUB001-253	172.16.186.1 - 172.16.186.254
		SUB254-300	172.16.187.1 - 172.16.187.46
	CCU03	SUB001-253	172.16.190.1 - 172.16.190.254
		SUB254-300	172.16.191.1 - 172.16.191.46
	CCU04	SUB001-253	172.16.194.1 - 172.16.194.254
		SUB254-300	172.16.195.1 - 172.16.195.46
CAP13	CCU01	SUB001-253	172.16.198.1 - 172.16.198.254
		SUB254-300	172.16.199.1 - 172.16.199.46
	CCU02	SUB001-253	172.16.202.1 - 172.16.202.254
		SUB254-300	172.16.203.1 - 172.16.203.46
	CCU03	SUB001-253	172.16.206.1 - 172.16.206.254
		SUB254-300	172.16.207.1 - 172.16.207.46
	CCU04	SUB001-253	172.16.210.1 - 172.16.210.254
		SUB254-300	172.16.211.1 - 172.16.211.46
CAP14	CCU01	SUB001-253	172.16.214.1 - 172.16.214.254
		SUB254-300	172.16.215.1 - 172.16.215.46
	CCU02	SUB001-253	172.16.218.1 - 172.16.218.254
		SUB254-300	172.16.219.1 - 172.16.219-.46
	CCU03	SUB001-253	172.16.222.1 - 172.16.222.254
		SUB254-300	172.16.223.1 - 172.16.223.46
	CCU04	SUB001-253	172.16.226.1 - 172.16.226.254
		SUB254-300	172.16.227.1 - 172.16.227.46
CAP15	CCU01	SUB001-253	172.16.230.1 - 172.16.230.254
		SUB254-300	172.16.231.1 - 172.16.231.46
	CCU02	SUB001-253	172.16.234.1 - 172.16.234.254
		SUB254-300	172.16.235.1 - 172.16.235.46
	CCU03	SUB001-253	172.16.238.1 - 172.16.238.254
		SUB254-300	172.16.239.1 - 172.16.239.46
	CCU04	SUB001-253	172.16.242.1 - 172.16.242.254
		SUB254-300	172.16.243.1 - 172.16.243.46

Switched Ethernet and Through-Only Modes

The following tables provide an example of an IP plan for a small LMS4000 system equipped with a single 900 MHz CAP and up to 4 CCUs:

- *CAP IP Addressing Plan* on page 322
- *CCU Radio IP Addressing Plan* on page 323
- *EUM IP Addressing Plan* on page 323
- *Subscriber IP Addressing Plan* on page 324

A maximum of 200 nodes (CCUs, EUMs, routers, and other backend equipment) will be supported in a small network. The example given here is for a network with up to 200 hosts and uses the following configuration:

- multiple radio subnets
- multi-homing on router
- private IP addresses for EUMs
- public IP addresses for subscribers (example uses the RFC recommended IP address block for documentation)
- DHCP Relay at the CCU is disabled
- SNTP Relay is enabled at the CCU
- SNTP clients are enabled on the CCU and EUMs

CAP IP Addressing Plan

Table 107 Example – CAP IP Addressing Plan

CAP Element	IP Address
Gateway Router	192.168.10.1 /24 192.0.2.1 /24 172.16.4.1/22 172.16.8.1/22 172.16.12.1/22 172.16.16.1/22
CAP Switch	192.168.10.5 /24
CAP UPS	192.168.10.6 /24
SNMP Manager	192.168.10.7 /24

CCU Radio IP Addressing Plan

Table 108 Example – CCU Radio Subnet Data

Subnet	172.16.0.0
Subnet Mask Bits	22
Subnet Mask	255.255.252.0 (ff.ff.fc.00)

Table 109 Example – CCU Radio IP Addressing Plan

Site	CCU	Subnet	CCU Radio IP Address	CCU Radio Subnet Range	Broadcast
CAP01	CCU01	172.16.4.0	172.16.4.2	172.16.4.1 - 172.16.7.254	172.16.7.255
	CCU02	172.16.8.0	172.16.8.2	172.16.8.1 - 172.16.11.254	172.16.11.255
	CCU03	172.16.12.0	172.16.12.2	172.16.12.1 - 172.16.15.254	172.16.15.255
	CCU04	172.16.16.0	172.16.16.2	172.16.16.1 - 172.16.19.254	172.16.19.255

EUM IP Addressing Plan

Table 110 Example – EUM Subnet Data

Subnet	172.16.0.0
Subnet Mask Bits	22
Subnet Mask	255.255.252.0 (ff.ff.fc.00)

Table 111 Example – EUM IP Addressing Plan

Site	CCU	Subnet ID	EUM IP Address Range
CAP01	CCU01	EUM001-253	172.16.4.3 - 172.16.4.254
		EUM254-300	172.16.5.1 - 172.16.5.47
	CCU02	EUM001-253	172.16.8.3 - 172.16.8.254
		EUM254-300	172.16.9.1 - 172.16.9.47
	CCU03	EUM001-253	172.16.12.3 - 172.16.12.254
		EUM254-300	172.16.13.1 - 172.16.13.47
	CCU04	EUM001-253	172.16.16.3 - 172.16.16.254
		EUM254-300	172.16.17.1 - 172.16.17.47

Subscriber IP Addressing Plan

Table 112 Example – Subscriber Subnet Data

Subnet	192.0.2.0 (RFC-3330 TEST-NET)
Subnet Mask Bits	24
Subnet Mask	255.255.255.0 (ff.ff.ff.00)

Assign IP addresses sequentially from the 192.0.2.0 subnet.

Table 113 Example – Subscriber IP Addressing Plan

Site	CCU	Subnet ID	EUM IP Address Range
CAP01	CCU01	SUB002-051	192.0.2.2 - 192.0.2.51
	CCU02	SUB052-101	192.0.2.52 - 192.0.2.101
	CCU03	SUB102-151	192.0.2.102 - 192.0.2.151
	CCU04	SUB152-201	192.0.2.152 - 192.0.2.201

NOTE: 192.0.2.1 is reserved for the gateway router interface.

Appendix L WaveRider Attribute Definition

```
WaveRider-Grade-of-Service
Description:

This attribute contains the grade of service assigned to the user. If
it is not present, the default grade of service will be used. This
attribute is only included in Access-Accept packets.

A summary of the WaveRider-Grade-of-Service attribute format is shown
below. The fields are transmitted from left to right.

 0                   1                   2                   3
 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|  Vendor-Type  | Vendor-Length |               Value
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
           Value (cont)         |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+

Vendor-Type
    1 for WaveRider-Grade-of-Service
Vendor-Length
    6
Value
    The Value field is four octets.
      1   best effort
      2   bronze
      3   silver
      4   gold
```

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Appendix M Acronyms and Glossary

Table 114 Acronyms and Abbreviations

Acronym or Abbreviation	Definition
AC	Alternating Current
API	Application Programming Interface
ARP	Address Resolution Protocol
ARQ	Automatic Retry Request
ASCII	American Standard Code for Information Interchange
BCF	Basic Configuration File
CAP	Communications Access Point
CCU	CAP Channel Unit
C/I	Carrier to interference ratio
CLI	Command Line Interface
CPU	Central Processing Unit
CRC	Cyclic Redundancy Check
CSA	Canadian Standards Association
CTS	Clear To Send
dB	decibel
dBi	decibel—with respect to an isotropic radiator
dBm	decibel—with respect to milliwatts
DCE	Data Communication Equipment
DES	Data Encryption Standard
DHCP	Dynamic Host Configuration Protocol
DNS	Domain Name Server, Domain Network Server

Acronym or Abbreviation	Definition
DRAM	Dynamic Random-access Memory
DSR	Data Set Ready
DSSS	Direct-sequence Spread Spectrum
DTE	Data Terminal Equipment
ESD	Electrostatic Discharge
ESN	Electronic Serial Number
ETSI	European Telecommunications Standards for Industry
EUM	End-user Modem
FCC	Federal Communications Commission (U.S.A.)
FRU	Field Replaceable Unit
FTP	File Transfer Protocol
GHz	Gigahertz
GMT	Greenwich Mean Time
GOS	Grade of Service
HTTP	HyperText Transfer Protocol
IC	Industry Canada
ICMP	Internet Control Message Protocol
ID	Identifier, Identification
IP	Internet Protocol
ISM	Industrial, Scientific, and Medical (Unlicensed Radio Band)
ISP	Internet Service Provider
LAN	Local Area Network
LED	Light-Emitting Diode
LMDS	Local Multipoint Distribution System
LMS	Last Mile Solution®
LOS	Line Of Sight
MAC	Media Access Control, Medium Access Controller
Mbps	Megabits per second
MBR	Maximum Burst Rate
MCF	MAC Configuration File
MHz	Megahertz
MIB	Management Information Base
MTU	Maximum Transmission Unit
n/a	not applicable

Acronym or Abbreviation	Definition
NAP	Network Access Point
NAT	Network Address Translation
NCL	Network Communication Link
NTP	Network Time Protocol
OAM	Operations, Administration and Maintenance
OID	Object Identifier
OS	Operating System
PAT	Port Address Translation
PC	Personal Computer
PCF	Permanent Configuration File
PDF	Portable Document Format
PHY	Physical Layer
PPPoE	Point-to-Point Protocol over Ethernet
RADIUS	Remote Access Dial-in User Service
RCF	Route Configuration File
RF	Radio Frequency
RFC	Request For Comment
RIP	Routing Information Protocol
RMA	Returned Merchandise Authorization
RSSI	Receive Signal Strength Indicator
RTS	Request To Send
Rx	Receive
SLA	Service Level Agreement
SNMP	Simple Network Management Protocol
SNTP	Simple Network Time Protocol
SOHO	Small Office/Home Office
SRAM	Static Random Access Memory
TCP	Transmission Control Protocol
TCP/IP	Transmission Control Protocol/Internet Protocol
TDD	Time-Division Duplex (Modulation)
TDMA	Time-Division Multiple Access
Tx	Transmit
UDP	User Datagram Protocol
UL	Underwriters Laboratories

Acronym or Abbreviation	Definition
UPS	Uninterruptable Power Supply
UTC	Coordinated Universal Time
VLAN	Virtual Local Area Network

Table 115 LMS4000 Network Glossary

Term	Definition
LMS4000 RF Subsystem	The RF Equipment associated with an LMS4000, including CCUs, antennas, and transmission lines.
Broadcast (Message)	A message sent by one network device to all other devices connected to the network.
Cell Size	The nominal radius of the geographic area served by a single CAP, within which EUMs can reliably receive service.
Channel	Generally, the medium though which information is communicated. In wireless communications, the channel is usually defined by the center frequency, modulation type, and occupied bandwidth.
CLI (Command Line Interface)	In contrast to a graphical user interface, a CLI is a configuration and control interface based on keyboard-entry commands and responses.
Console Port	Typically, the 9–pin RS-232 serial port on an LMS device to which a terminal or laptop computer is connected, for the purpose of configuring or controlling the device.
Configuration Terminal	The configuration terminal is provided for the purpose of configuring or controlling a device directly through its console port.
dBm	A measure of power in decibels with reference to 1 milliwatt. A power of *n* milliwatts equals 10 log *n* dBm.
DNS (Domain Name System)	A database system that translates domain names into IP addresses. For example, waverider.com is converted into 207.23.187.242.
DSSS (Direct-Sequence Spread Spectrum)	A form of spread-spectrum communications that uses a high-speed code sequence, along with the information being sent, to modulate the RF carrier.
Ethernet Switch	In the context of LMS, the devices that provide data link layer Ethernet connection between the router, NMS, UPS, and back haul equipment at the LMS4000, and the CCUs, back haul equipment and UPS at the CAP.

Term	Definition
Host Name	The common name given to network devices to make them more easily identifiable by network operators and maintenance personnel.
Gateway	A device connecting two networks that use different communications technologies or protocols; for example, an IP/ Telephony Gateway provides a connection between an IP network and a telephone network.
GOS (Grade of Service)	A level of service associated with an EUM, which determines how often, and when, an EUM will be polled. Since an EUM can only send one packet each time it is polled, the data rate is related to the polling rate.
IP (Internet Protocol)	The network-layer protocol in the TCP/IP stack (defined by RFC 791).
Line of Sight	The radio link between a transmitter and receiver is said to be line of sight if the direct path between the two is relatively free from physical obstruction.
MAC (Medium Access Control)	The mechanism of managing access, by multiple users, to a common transmission medium.
Multicast (Message)	A message sent by a network device to a limited set of network devices.
Orthogonal Channels	Communications channels that can operate over a common transmission medium without significantly interfering with each other. In the context of LMS, radio frequencies on appropriately spaced frequencies are considered to be orthogonal.
OSPF (Open Shortest Path First)	A link-state, hierarchical interior gateway routing protocol that can provide least-cost routing, multipath routing, and load balancing.
NAT (Network Address Translation)	An Internet standard that enables a local area network to use one set of IP addresses for internal traffic and another set of addresses for external traffic.
PAT (Port Address Translation)	A feature that lets you number a LAN with inside local addresses and filter them through one globally routable IP address.
Point-to-Multipoint	A communications architecture in which a central station (CAP, for example) communicates with multiple remote stations (EUMs).
POTS (Plain Old Telephone Service)	The basic telephone service provided by the public switched telephone network (PSTN).

Term	Definition
Radio Module	The device in the EUM (or CCU) that provides the wireless interface to the LMS network. The radio module performs signal spreading and modulation, channelization, up-conversion and amplification in the transmit direction, and signal amplification, down-conversion, channel selection, demodulation, de-spreading and data recovery in the receive direction.
Range	The maximum distance that a signal can be reliably transmitted between a CCU and EUM.
RIP (Routing Information Protocol)	A routing protocol in which network routers periodically broadcast their entire current routing database.
Router	A network device that routes IP messages from one physical port to another based on a table of routes that are manually entered by a crafts person (static routes) or generated by the router using a routing protocol such as RIP or OSPF.
Routing	The process of finding a path to a destination host through an IP network.
Sectorization	An RF engineering technique whereby co-located transceivers are connected to separate antennas with different but geometrically arranged azimuths, for the purpose of optimizing radio frequency reuse, extending range, and reducing interference. 120° sectorization is commonly applied in LMS systems.
SNMP (Simple Network Management Protocol)	A protocol used to manage nodes in an IP network.
SNMP Agent	An agent resides on an SNMP-managed device, and performs operations when requested to do so by an SNMP manager.
SNMP Community	A grouping of SNMP agents that can be managed by an SNMP manager. An SNMP manager can manage more than one SNMP community. The community name is used to authenticate the SNMP manager before allowing it access to the agent.
SNMP MIB (Management Information Base)	The information that an SNMP manager, such as the NMS, can request from an SNMP agent.
SNMP Trap	A message sent by an SNMP agent to an NMS, console, or terminal to indicate the occurrence of a significant event, such as a specified condition, or a defined threshold that was reached.
SNMP Trap Server	The server to which SNMP trap messages are forwarded.
SNTP (Simple Network Time Protocol)	A feature that provides LMS4000 devices with an accurate time clock for time stamping events in a log file.

Term	Definition
Spread Spectrum	A communication technology in which the transmitted signal occupies a much greater bandwidth than the information bandwidth. The benefits of spread spectrum are generally lower spectral power density, and immunity to noise, interference and jamming.
Static Route	A route that is manually entered into a routing table by a crafts person or network operator.
Subscriber	In the context of LMS, it is the individual or entity associated with an EUM.
TCP (Transmission Control Protocol)	The connection-oriented transport layer protocol that provides reliable, full-duplex data transmission in TCP/IP networks.
Telnet	A terminal emulation program for TCP/IP networks.
UDP (User Datagram Protocol)	Part of the TCP/IP protocol suite, which provides a way for applications to access the connectionless features of IP. It provides for exchange of datagrams without acknowledgements or guaranteed delivery.
Unicast	A message sent by one network device to another network device.
User Authentication	In LMS, the secure mechanism through which a user identification is verified.
User Authorization	The secure mechanism by which a user is approved to use LMS services. To illustrate, an EUM may be authenticated but denied service because of the delinquent payment of a bill.
VoIP (Voice over IP)	The ability to carry normal telephony-style voice over an IP-based internet, with POTS-like functionality, reliability and voice quality.

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