LMS4000 Wireless Internet Access

Application Note

Issue 1.0

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CAP3000 (CSMA) Installation Guide

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1.0 Introduction

This Application Note is intended to be a simple installation guide for establishing basic connectivity to the Internet using WaveRider's LMS4000 900-MHz system. Although there are many configuration possibilities that are not included here, these procedures have proven to be most useful to our existing field population. The appendices include examples of network configurations that have been used by customers using the LMS product.

This guideline covers the following material:

- Description of basic system components
- Data Flow for basic Internet connectivity
- Developing an IP plan
- Initial System set-up and testing

Please review all of the material carefully before attempting to install the LMS system. This is the time to bring any questions to your WaveRider representative. It will save you time and frustration.

Please note that the LMS4000 is a system for transmitting IP traffic. Other protocols, such as PPPoE, are not supported.

2.0 LMS4000 Component Descriptions – 900 MHz

2.1 CCU3000

- The CCU3000 serves as a static router, connecting the IP as seen at its radio port to the IP network as seen at its Ethernet port
- The CCU3000 requires the entry of the following parameters
  - Radio frequency
  - Ethernet IP address with subnet
  - Radio IP address with subnet
  - Gateway IP address with subnet
- These parameters can be entered from the serial port, or by using the Configuration Utility
- Once these parameters are entered, the CCU automatically builds the required routes. Additional static routes can be entered, but are not required for basic system operation.
- Settings are not stored in non-volatile memory until saved, don't forget to **SAVE**.
- IP and radio settings do not take effect until the unit is reset, after you save, **RESET.**
- If these settings are being programmed through the serial port (using the Command Line Interface – CLI), at the console prompt of the CCU the essential settings required for operation would appear as:

```
Console> ip

Ethernet IP Address: 192.168.10.10
Ethernet Net Mask  : ffffff00

Radio IP Address: 10.0.0.1
Radio Net Mask  : fffffc00

Customer IP Address: 0.0.0.0
Customer Net Mask  : ffff0000

CCU Gateway IP Address: 192.168.10.1
CCU Gateway Net Mask  : ffffff00

Registration Server IP Address: 0.0.0.0
Registration Server Net Mask  : ffff0000


Console> mac frequency
Radio Frequency: 9150
Console> exit
```

- The commands to configure the CCU using the CLI for the above are:

```
Console> ip ethernet 192.168.10.10 24
Console> ip radio 10.0.0.1 22
Console> ip gateway 192.168.10.1 24
Console> mac frequency 9150
Console>
Console> save
Basic configuration file saved
MAC configuration file saved
Console>
Console> reset

Rebooting now
```

- The CCU incorporates a health monitor that looks at a number of operational factors to detect any abnormal conditions and will reset the unit if any suspect conditions are detected. Suspect conditions include corrupted data or no EUMs present in the registration table. During setup not all conditions may be met. For example, if an EUM does not receive a confirmation of registration from the CCU, the health monitor will flag this as an error and initiate a reset. The constant reset of a unit during initial setup is an impediment to a smooth setup and installation. **Disable the health monitor during initial setup**. The health monitor cannot be permanently disabled, if turned "off", it will default to "on" after a unit reset.
- An Address Resolution Protocol (arp) table is built in the CCU based on IP traffic passing between the Ethernet port and the Radio port. This table displays the IP and MAC address for active EUMs. The only time the EUM IP address will appear is if the EUM has sent or received data, which can be made to happen through a ping, Telnet or SNMP request.
- The Registration (reg) table contains a list of all active EUMs. The CCU automatically builds this table as EUMs communicate with the CCU. The table displays the IP address of the EUM3000 Ethernet port and the IP address of the customer PC, but will display only the mac address of the EUM for both of these IP addresses. Every EUM connected will appear in this table. If the EUM is turned off, or loses its rf connection to the CCU, the table entry will be removed after 3 minutes.

2.2 EUM3000

- The EUM3000 serves as a bridge, connecting the PC Ethernet port to t he airlink.
- The EUM3000 requires the entry of the following parameters:
  - Radio frequency
  - Ethernet IP address with subnet
  - Customer IP address with subnet
  - Gateway IP address (CCU radio IP) with subnet

- The Radio and Ethernet interfaces must be set to be elements on the same network as the Radio interface of the CCU.
- These parameters can be entered from the serial port, or by using the Configuration Utility
- At the console prompt of the EUM the essential settings required for operation would appear as:

```
Console> ip
Ethernet IP Address: 10.0.0.2
Ethernet Net Mask  : ffffffc00

Radio IP Address: 10.0.0.2
Radio Net Mask  : fffffc00

Customer IP Address: 10.0.1.2
Customer Net Mask  : fffffc00

CCU Gateway IP Address: 10.0.0.1
CCU Gateway Net Mask  : fffffc00

Registration Server IP Address: 0.0.0.0
Registration Server Net Mask  : ffff0000

Console> mac frequency
Radio Frequency: 9150
Console> exit
```

- The commands to configure the EUM using the CLI (command line interface) for the above are:

```
Console> ip ethernet 10.0.0.2 22
Console> ip radio 10.0.0.2 22
Console> ip customer 10.0.1.2 22
Console> ip gateway 10.0.0.1 22
Console>
Console> mac frequency 9150
Console>
Console> save
Basic configuration file saved
MAC configuration file saved
Console>
Console> reset

Rebooting now
```

- The EUM3000 will only recognize one mac address connected to its Ethernet port. That mac address must have the same IP address as assigned as the Customer IP address in the EUM.

- The Receive Signal Strength Indicator (RSSI) feature allows the installer to determine if a useable airlink has been established. The RSSI value is only valid if a valid data packet is received and demodulated by the EUM, implying that the signal level is above the receive threshold of the EUM, and there is no significant interferer present . The RSSI can be read through the config utility or through the command line interface (CLI), or a relative indication of RSSI can be seen via the center LED on the EUM. The value should be greater than 35. Typically it is in the upper 30's to as high as the 70's. This value can be approximately (+/- 3 dB tolerance) translated to a dBm level by the relationship (dBm = RSSI – 120). For example, an RSSI value of 40 represents a signal level of – 80 dBm.

- WaveRider provides a phase diversity switched antenna for indoor applications. This antenna uses a 6 VDC injected at the antenna port to switch between two beams based on signal quality as determined by the EUM baseband processor. It has proven quite effective for multipath (NLOS) installations and interference nulling. If other antennas are used, care must be taken to ensure the antenna does not short out this dc voltage.

2.3 Subscriber PC or IP Sharing Device

- This equipment connects to the EUM. This typically requires the use of a CAT5 crossover cable. This cable is supplied as part of the EUM kit.
- The customer IP network also appears as a member of the EUM subnet, as such, the Customer IP address is set to be on the same network subnet.
- The device must be configured with the following parameters:
    - Static IP address
    - Subnet
    - Gateway (CCU radio IP)
    - DNS IP address (primary & secondary)
- The procedure to program these parameters will depend on the Operating System.

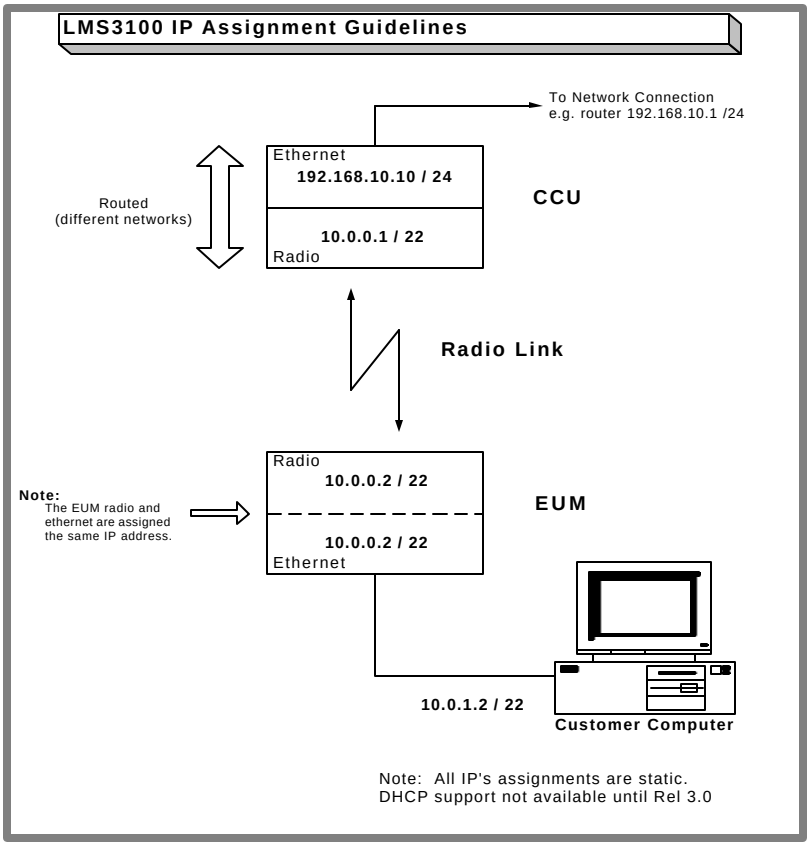
2.4 Summary of CCU/EUM/PC set-up Requirements

The basics for setting up a link are:

1. The CCU requires the following settings in order to talk to the Internet network and over the air to the EUMs.
    - Radio address and Ethernet address and subnet mask
    - subnet mask
    - Gateway address (e.g. the address of the upstream router)
    - Radio frequency setting (to communicate with the EUMs)

2. The EUM requires the following in order to communicate to the CCU and the customer network (e.g. PC):
    - Ethernet address and subnet mask
    - Radio address and subnet mask (the radio side of the EUM and CCU must be on the same subnet)
    - Customer network (PC) address
    - Radio frequency setting (to communicate with the CCU)

3. The Customer PC requires the following settings in order to talk to the EUM, and on to the Internet:
    - IP address
    - Subnet
    - Gateway (set as CCU radio IP address)
    - DNS IP addresses



3.0 Data Flow in the CAP3000

The objective of the basic system is to pass data traffic to/from the Subscriber device to the Internet. The LMS system uses a combination of 900 MHz wireless and Ethernet 10BaseT HDX as the medium to transport the data. The data must also know where to go. This is accomplished using IP routes.

The subscriber's PC has been configured with the static IP address, the subnet, the gateway IP address (CCU radio IP) and the DNS server IP address. It is connected via a CAT5 crossover cable to the EUM. Ethernet LED's on the RJ45 ports indicate a connection. If these lights are not on, the most likely problem is a bad crossover cable.

To initiate an Internet activity, the subscriber opens their browser and the browser requests to go to its home page. The data flows from the PC to the Ethernet port of the EUM, and since the EUM is a bridge, it directly passes the data to the radio port, and across the airlink to the CCU. The CCU will have the EUM with its two associated IP addresses, and the EUM mac address, in its registration table. The data will be routed (this route is created automatically at the time of CCU IP address entry) from the CCU radio port to the CCU Ethernet port. The subscriber's PC IP address and mac address will be entered into the CCU ARP table. Since the CCU is an IP router, it will forward the data to its default route (route "0.0.0.0" is also created automatically when the CCU gateway IP address is entered).

The data thus flows from the CCU Ethernet port to the gateway router. There may be also be one or more switches or hubs to travel through before reaching this gateway router.

The router receives the packet and determines where to send it. To get to the WAN (Internet) side, the route for the specific CCU radio network must be in it's route table. If NAT is being used, the private IP address of the subscriber must be in its NAT table as either a dynamic or static entry. For Cisco routers, the access lists must include the permit and deny entries. The subscriber's PC IP address is translated to the registered IP address and forwarded to the Internet.

The reverse occurs to get the response back to the subscriber's PC.

4.0 IP Plan for Your Network

To achieve the full capacity of a single CAP Channel Unit, you need to plan your IP scheme based on the requirements outlined below. The numbers given take into account future expansions of CCU3000 user capacity, expected to grow up to 300 EUMs per CCU.

- The CCU Ethernet and CCU Gateway must be on the same subnet, (as shown above, CCU Ethernet address = 192.168.10.10 / 24 and the CCU Gateway = 192.168.10.1 /24).
- The CCU acts as a router, as such, the CCU Radio interface must be on a different network than the CCU Ethernet interface. (As a convention, the use of the private addressing "10 dot series" for the radio interface makes the distinction readily identifiable, but other private addresses are equally valid.)
- The IP plan for the radio side of the CCU3000 should allow for growth up to at least 601 Registered or Unregistered IP addresses for the subscribers. (One for the each EUM3000, one for each subscriber PC. The CCU Radio Interface requires a single IP.)
- From a network perspective the EUM is a bridge, as such, the Radio and Ethernet interfaces must be set to be elements on the same network as the Radio interface of the CCU. Additionally, as can be seen above, both the Radio and Ethernet interfaces are set to the same IP address (truly transparent).
- The customer IP network also appears as a member of the EUM subnet, as such, the Customer IP address is set to be on the same network subnet.
- To provide 601 IP addresses (or hosts) on the same subnet requires a subnet with a 22 bit mask (255.255.252.0).
- Currently, each subscriber PC must be statically assigned an IP address. (DHCP (Dynamic Host Configuration Protocol) is not supported at this time.)
- Use of IP addresses from a contiguous pool will facilitate the use of DHCP assignment when it is available.
- If unregistered IP addresses are used for EUM & Subscriber IP addressing, the subscriber IP addresses must be translated to a globally unique Internet Registered address before they leave the private domain.
- The CCU is a router, but does not provide this address translation of the EUM/Customer network addresses. As such, if a private IP addressing scheme is used for the implementation, then NAT (Network Address Translation) and the appropriate routing entries must be provided upstream, at say the gateway router, in order to access the Internet.

4.1 Network Address Translation

The following NAT (Network Address Translation) possibilities are listed for reference but you need to carefully plan the best configuration applicable to you. This depends on the Registered IP addresses available to you and the nature of your subscriber base. For example Business Users may require Static NAT while Dynamic NAT should be adequate for average home user.

- **Static Inside Source Address Translation**
  This is a one-to-one translation and requires a registered IP addresses for each unregistered IP address. This is recommended if customers inside the Private Network are required to host Mail/FTP Servers etc. that need to be accessed from outside addresses.

- **Dynamic Inside Source Address Translation**
  This type of translation is based on dynamic translation, which establishes a mapping between a group of inside local addresses and a pool of global addresses. This translation is useful when you have a large group of unregistered users who wish to access the net services. For example, depending on the traffic pattern, 10 registered IP addresses could service 40 subscribers.

- **Overloading an Inside Global Address**
  This technique will greatly reduce the number of registered IP addresses needed. When overloading is configured, the router maintains enough information from high-level protocols to translate the global address back to the correct private address.

5.0 How to Connect to the Internet – Basic

In order for a subscriber to connect to the Internet, two conditions must be present. The first is the subscriber must obtain a registered IP address. The second is that there must be a path to connect the subscriber PC to the Internet destination.

Registered IP Address

There are three considerations with respect to assigning a registered or public IP address to the subscriber's host device (PC or IP sharing).

1. Static assignment. This method requires the use of two IP addresses for each subscriber (one for the EUM and one for the host PC). In addition, one will be required for the Radio interface of the CCU. (As mentioned earlier, to be able to take advantage of future CCU3000 capabilities supporting up to 300 users, this translates into 601 IP addresses required.) If public IP Addresses are used directly, 601 such addresses are thus required. If private IP addresses are used, then NAT must be used to translate these private addresses to public one's.

2. Network Address Translation (NAT). This is the preferred way to assign public addresses. Two methods have proven successful, dynamic (one-to-many) and static (one-to-one). The subscriber host id is translated at the router. All addressing behind the router can be unregistered (private) IP's.

3. Dynamic Host Configuration Protocol (DHCP) is not available in either EUM or CCU at this time. However, future releases of the CCU3000 will have the DHCP relay feature. This should be kept in mind when planning the IP address scheme. When this is available, static assignment of the IP addresses in the subscriber PC will not be required.

6.0 Bandwidth Management

It is highly recommended to use a form of bandwidth shaping or limiting. For the CCU3000 radio link, the bandwidth management achieves two key objectives. First, the nature of the CSMA MAC layer used in the CCU3000 dictates that as the traffic level increases (during busy times of day, typically the period between 7:00 to 9:00 am and 6:00 to 10:00 pm), unmanaged traffic will be subject to collisions and lost packets. This results in variable delays in completing transactions, and a lower level of customer satisfaction. Implementing bandwidth management lowers the peak throughput for all users, but ensures consistent levels of service for all classes of users. LMS4000 operators implementing bandwidth management are achieving effective and reliable service levels for up to 100 EUMs per CCU.

A second useful function of the bandwidth manager is the ability it provides to monitor and control individual usage. Some Internet services result in a sustained traffic flow as opposed to a bursty traffic flow. This type of service will dominate the airlink and impact its overall capacity. These types of users should be closely managed and perhaps treated as a business user – resulting in a higher monthly tariff.

7.0 Initial Set-up

The methodology presented here has been proven effective in many of the LMS systems installed to date. Deviating from this process is not recommended at this time.

The first subscriber site should be set up as a reference site, with a line-of-sight radio link between the CCU3000 and EUM antennas. This serves as a baseline for measuring network performance, facilitates troubleshooting and provides a means for validating CCU functionality. The first goal is to determine that the CCU antenna sub-system is performing as designed. The EUM has the RSSI feature, which can be used to measure the received signal level, and confirm the calculated levels for the LOS (free space) conditions. The antenna placement must be in the boresight (within the half-power beamwidth) of the CCU antenna. The WaveRider Design Guide spreadsheet can be used for this calculation. The measured versus calculated difference should be within 3 dB.

From this LOS site, constant traffic can be provided over the airlink by using a continuous ping. This is required until the network builds up and traffic naturally occurs. Recall that the RSSI function will only work when there is traffic on the CCU radio link. Also recall that if the health monitor function is not turned off, without this airlink traffic the CCU will reset when it sees no EUMs in its registration table. This can be very frustrating when attempting to install the second EUM.

Basic requirements for initial system install:

- (1) CCU3000
- (1) CCU antenna sub-system
- (1) Connection to Internet via router
- (2) EUM3000
- (2) EUM antenna sub-system (WAVC antenna or patch/yagi antenna with jumper)
- (2) PC's with Ethernet NIC and crossover cable
- (1) CAT5 straight cable from CCU to router (or intervening switch/hub)
- (2) Straight serial cable DB9-M to DB9-F
- (1) LMS3000 Config Utility with manual (Can download at www.waverider.com technical support. **Username** wavc, **Password** support)
- (1) LMS3100 Users Guide (Can download at www.waverider.com technical support. **Username** wavc, **Password** support)
- (1) LMS3000 Design Guide Spreadsheet (Can download at www.waverider.com technical support. **Username** wavc, **Password** support)

Plan your IP address scheme. WaveRider provides a guideline for this (www.waverider.com). Test the configuration of CCU, EUM and PC prior to going outdoors. WaveRider supplies a set-up antenna with the CCU3000 kit for this purpose.

8.0 Configuration Validation Procedure

1. Install the LMS3000 Config Utility (provides GUI-menu or terminal interface) on PC-1. A terminal emulation program for CLI (such as Hyperterm) can be used as well. Set to 9600 B, 8 bits, No parity, 1 stop bit with No flow control.
2. Remove the CCU from the box. Connect the set-up antenna, then the power supply and then the serial cable to the console port.
3. Connect PC-1 to the CCU and configure:
    a. The radio frequency (if using the config utility, the standard 905, 915 and 925 are the first three in the drop down list). Suggest 915 MHz as starting point.
    b. The Ethernet IP address with subnet
    c. The Radio IP address with subnet
    d. The gateway IP address with subnet
    e. Save
    f. Reset
    g. The SSID, Registration Server and RF power settings should not be altered.
4. Remove EUM-1 from box. Set up about 10-ft from CCU. Connect antenna (Wavc or patch/yagi with jumper), then power supply and then the serial cable to the console port.
5. Connect PC-1 to EUM-1 and configure:
    a. The radio frequency (if using the config utility, the standard 905, 915 and 925 are the first three in the drop down list)
    b. The Ethernet IP address with subnet
    c. The Customer IP address with subnet
    d. The Gateway (CCU radio) IP address with subnet
    e. Save
    f. Reset
    g. The SSID, Radio IP address and RF power settings should not be altered.
6. After the reset of the EUM, the EUM center LED should be on solid.
7. Configure PC-1 with:
    a. IP address
    b. Subnet
    c. Gateway
    d. DNS servers
8. Connect PC-1 to EUM-1 with CAT5 crossover cable. Ethernet link indicators should be lit on both devices.
9. From PC-1, ping the EUM Ethernet address. There should be a response. (For more information re ping tests, see Appendix E.)
10. From PC-1, ping the CCU Radio address. There should be a response.
11. From PC-1, ping the CCU Ethernet address. There should be a response.
12. You have now established the airlink and confirmed connectivity.
13. Now it is time to connect the CCU Ethernet port to the existing network. Plug a CAT5 straight cable from the CCU Ethernet port to the switch or hub, or directly to the gateway router.
    a. Configure the Gateway router for new CCU radio network
    b. Configure the Gateway router for access lists – permit and deny
    c. Configure the Gateway router for NAT of new subscribers (might as well add both PCs)
    d. Save changes
14. From PC-1, ping the CCU Ethernet address. There should be a response.
15. From PC-1, ping the Router LAN address. There should be a response.
16. From PC-1, ping the Router WAN address. There should be a response.
17. From PC-1, open the WEB browser. Should be able to surf.

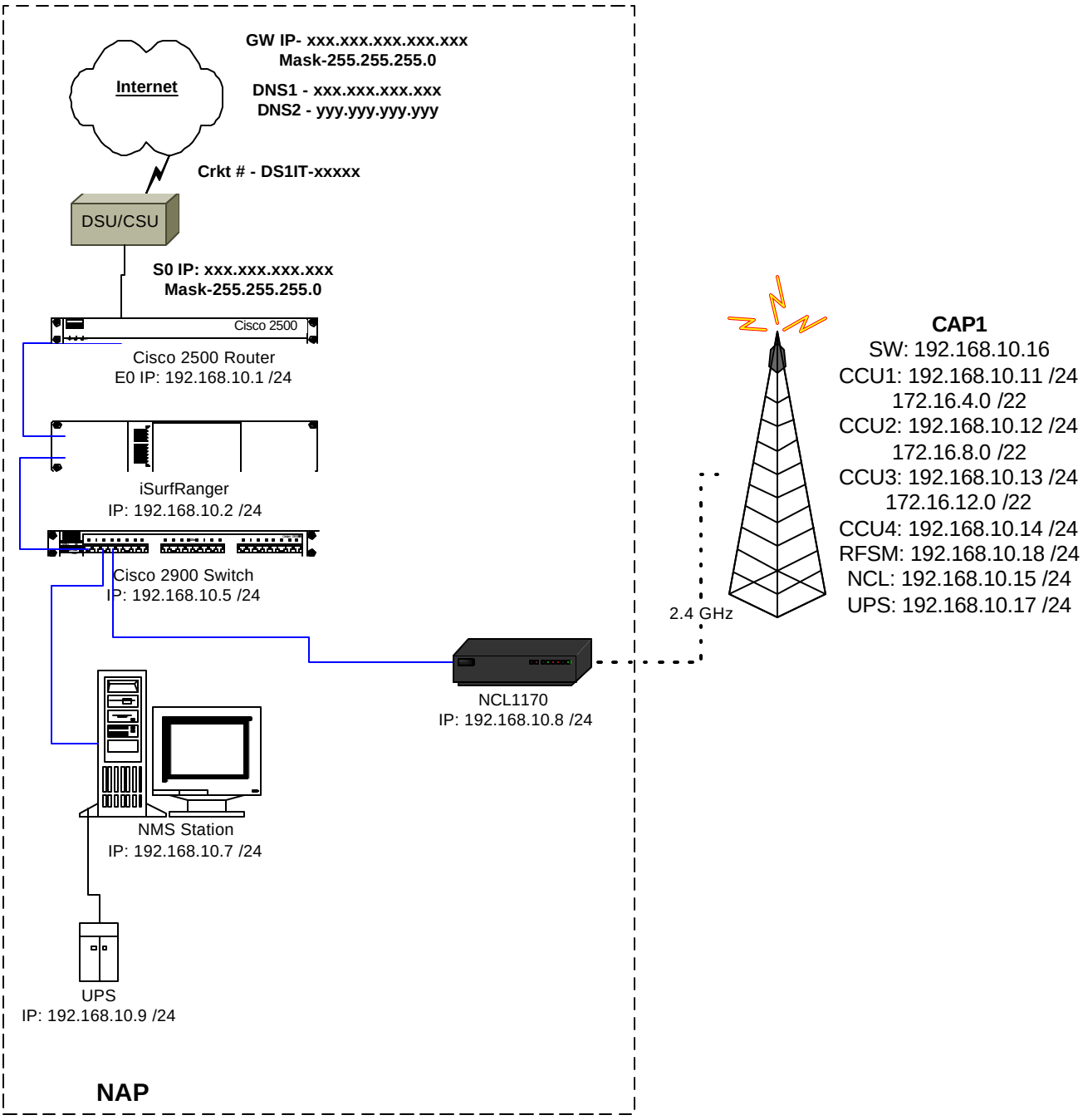
Repeat 4-17 for EUM-2 and PC-2.

9.0 Setting Up the Network

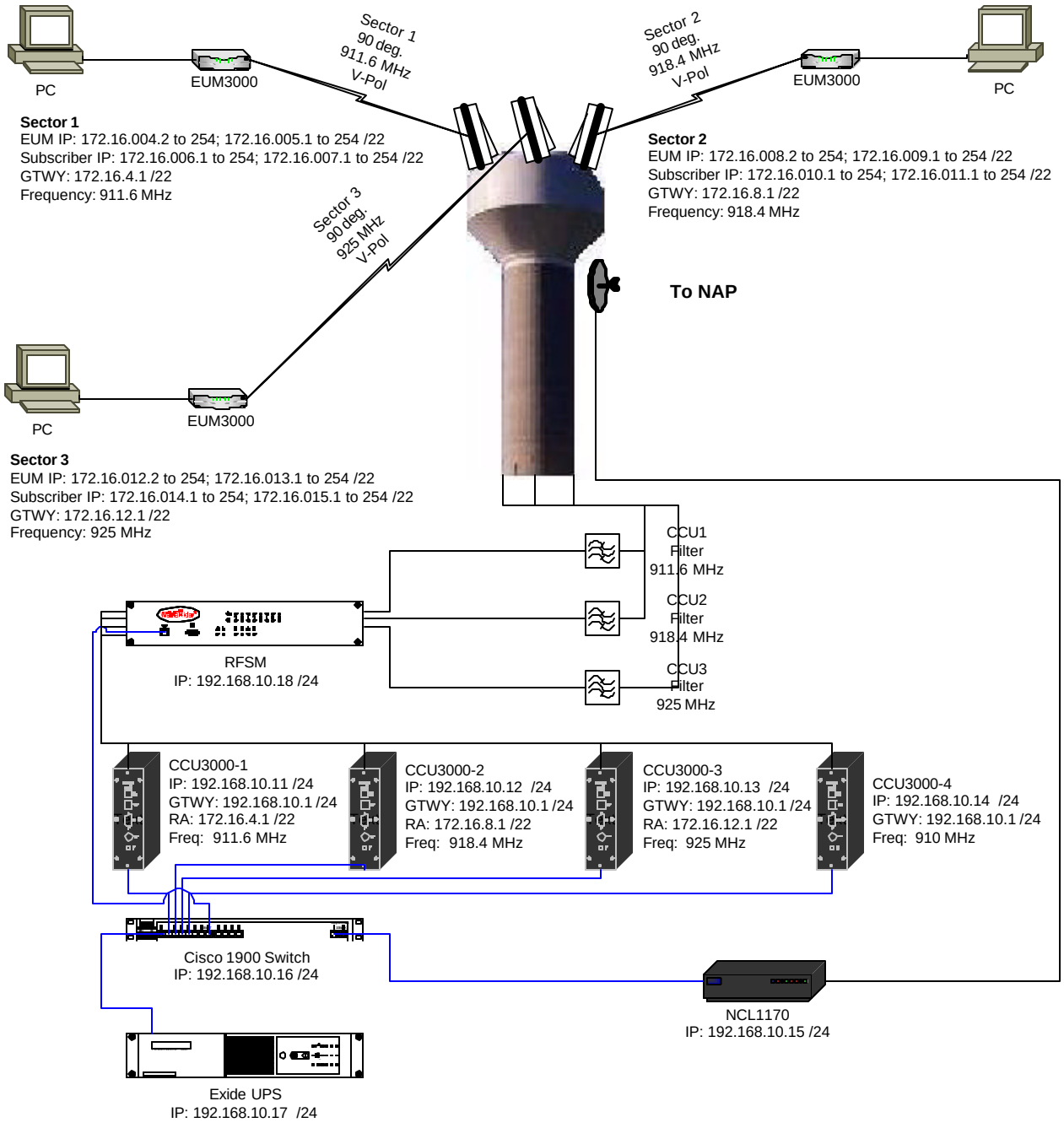
Now it is time to connect the CCU to its permanent antenna sub-system and establish the reference EUM site.

1. Connect CCU3000 to a bandpass filter, or if not used, connect to lightning arrestor feed. Connect Ethernet port.
2. It is best to have a local PC (use PC-2) connected to the CCU's console port for the initial tests. This allows access to the CLI.
3. Through the CLI, disable the health monitor - <h off>. This prevents the CCU from resetting when the reg table is emptied. The health monitor will be enabled after a reset or using the command <h on>. The disabled state cannot be saved and is not recommended in normal operation.
4. Again, through the CLI, ping the router interface to confirm connectivity.
5. Install EUM-1 LOS antenna. Be sure the antenna polarization is the same as the CCU antenna. Attach antenna feed to EUM-1 and power on EUM-1. Connect PC-1 to EUM-1 using the serial cable and CAT5 cable. Now begin a ping test from PC-1 to EUM-1 and then to the CCU. There should be a response. Once the connection is confirmed, begin a continuous ping from PC-1 to the CCU Ethernet address <ping xxx.xxx.xxx.xxx –t>. This establishes airlink traffic.
6. From PC-1, enter into the console port CLI and run <m rssi> this will display a continuous rssi value. The value should correspond to what is expected from this line-of-sight location.
7. At the CCU, enable the health monitor. The PC at the CCU can be removed. Before leaving the CCU site, be sure to access CCU remotely to confirm remote access.
8. EUM-1 is now ready for performance testing as desired.
9. EUM-2 is now ready to be installed.

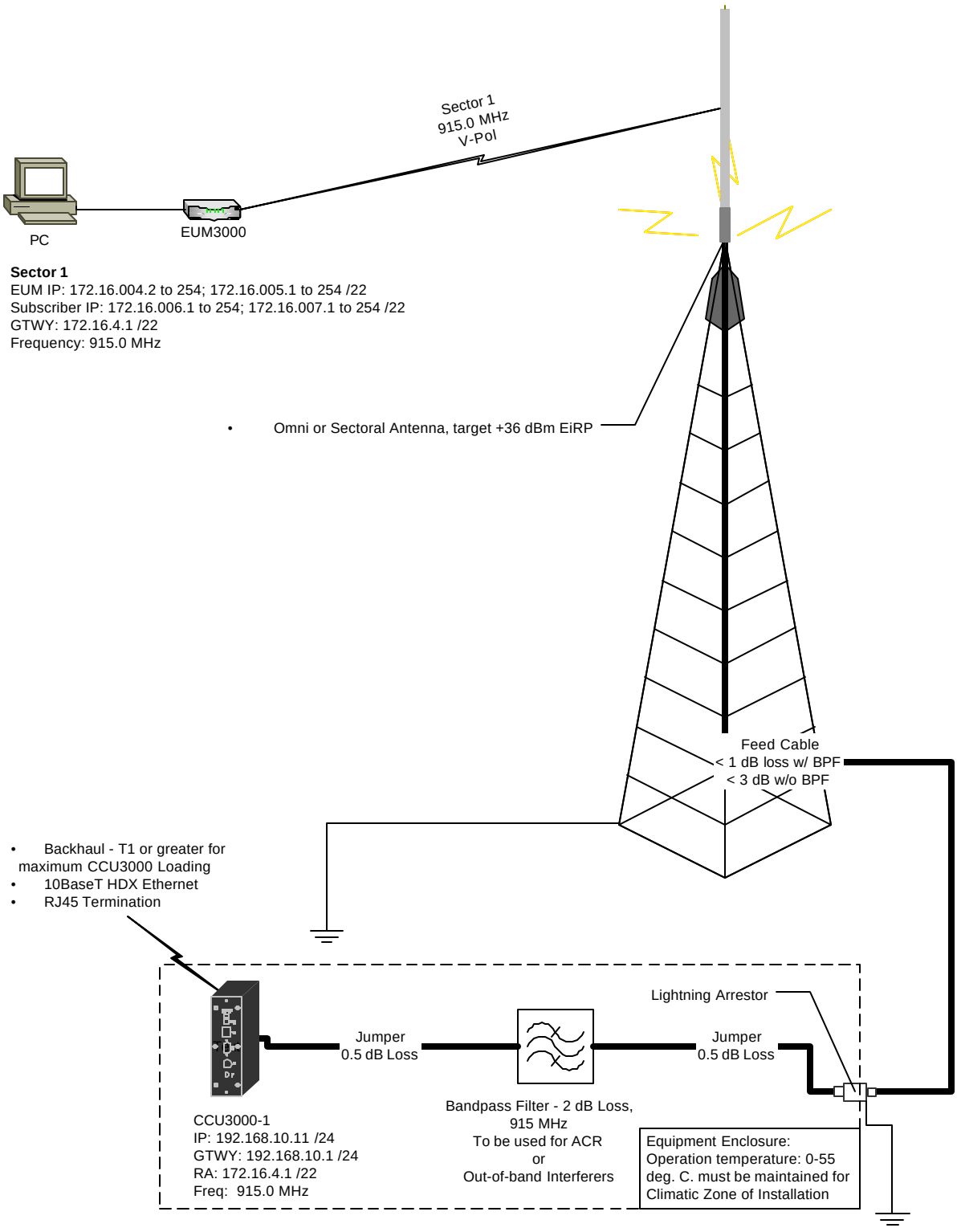
APPENDIX A – Typical Network



LMS4000 CAP1

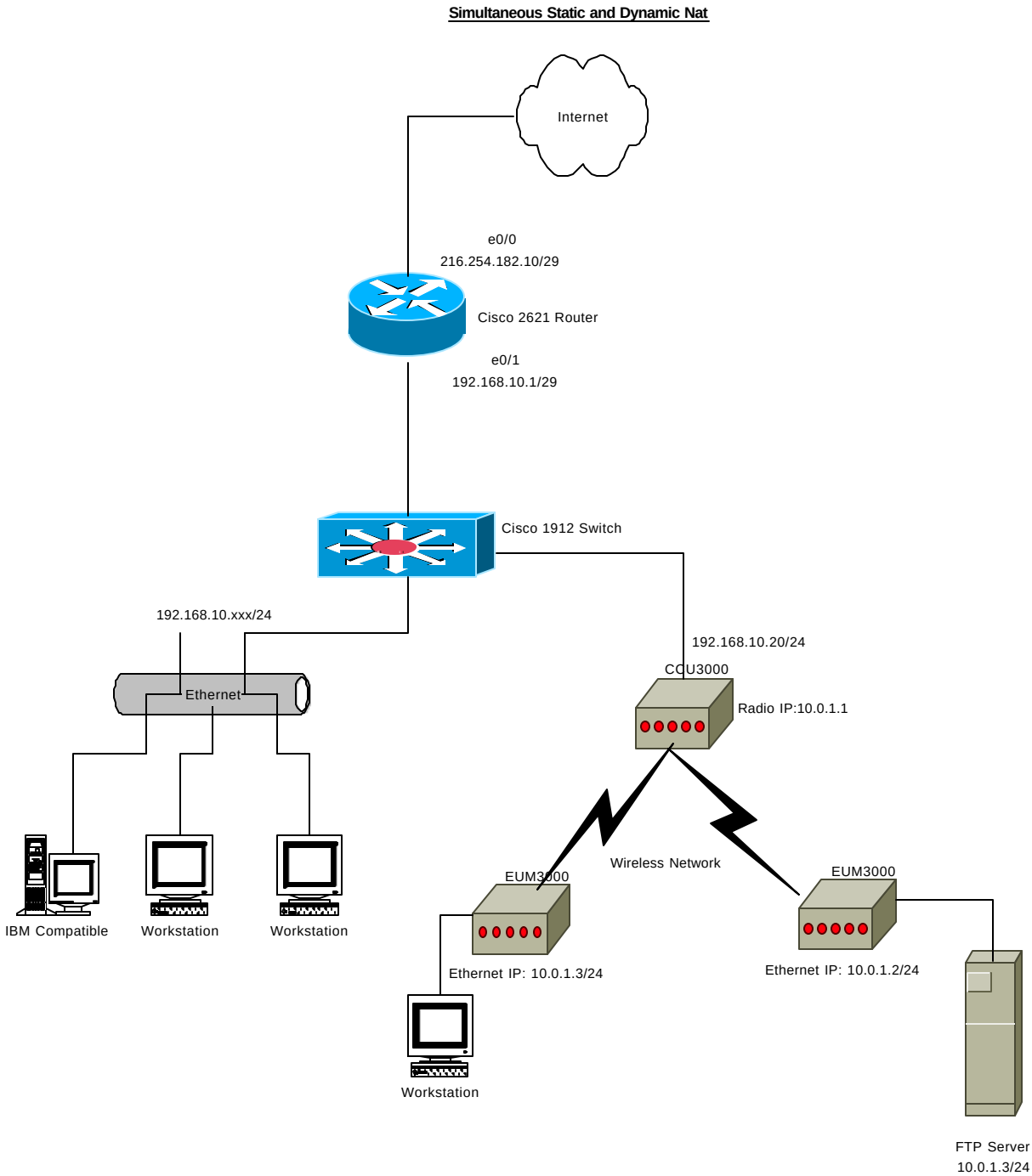


LMS4000 CAP1



APPENDIX B – NAT Configurations

The network scenario described below is a small private network that needs web access, with limited Global IP addresses. Also, Server (FTP/Mail etc.) inside the Private Network required to be accessed from Outside.



Configuration

IP NAT POOL WAVERIDER 216.254.182.013 216.254.182.014 NETMASK 255.255.255.248
(Define the name of the pool and the address of the pool. Waverider is the name of the pool)

IP NAT INSIDE SOURCE LIST 7 POOL WAVERIDER OVERLOAD
(Defines what global addresses to use and allow multiple inside local addresses to be translated to one address)

IP NAT INSIDE SOURCE STATIC 10.0.1.3 216.254.182.12
(Statically configure NAT to translate the source address 10.0.1.3 to e0/0. Since this is static it will apply in the other direction as well)

INTERFACE E0/0
IP NAT OUTSIDE
(Define the outside interface)

INTERFACE E0/1
IP NAT INSIDE
(Define the inside interface)

ACCESS-LIST 7 PERMIT 192.168.010.000 0.0.0.255
ACCESS-LIST 7 PERMIT 10.0.0.0 0.255.255.255
ACCESS-LIST 7 DENY 10.0.1.3

APPENDIX C – Sample Configurations

Cisco 2600 Router

Router# config t
Router (config) #
access-list 1 permit 192.168.10.0 0.0.0.255
access-list 1 permit 172.16.0.0 0.0.255.255
ip nat inside source list 1 pool no-overload
ip nat inside source static 172.16.6.1 aa.bb.cc.17
ip nat inside source static 172.16.6.2 aa.bb.cc.18
ip route 172.16.4.0 255.255.252.0 192.168.10.11
access-list 1 deny 172.16.6.1
access-list 1 deny 172.16.6.2
Router (config-if)# <control+Z>
Router#
Router# wr mem
Router# exit

CCU3000 from CLI

ip ethernet 192.168.10.11 24
ip radio 172.16.4.1 22
ip gateway 192.168.10.1 24
mac freq 9150
save
reset

EUM3000-1 from CLI

ip ethernet 172.16.4.2 22
ip customer 172.16. 6.1 22
ip gateway 172.16.4.1 22
mac freq 9150
save
reset

Subscriber PC-1

IP: 172.16.6.1
Subnet: 255.255.252.0
Gateway: 172.16.4.1
DNS1: aaa.bbb.ccc.ddd
DNS2: eee.fff.ggg.hhh
reset

EUM3000-2 from CLI

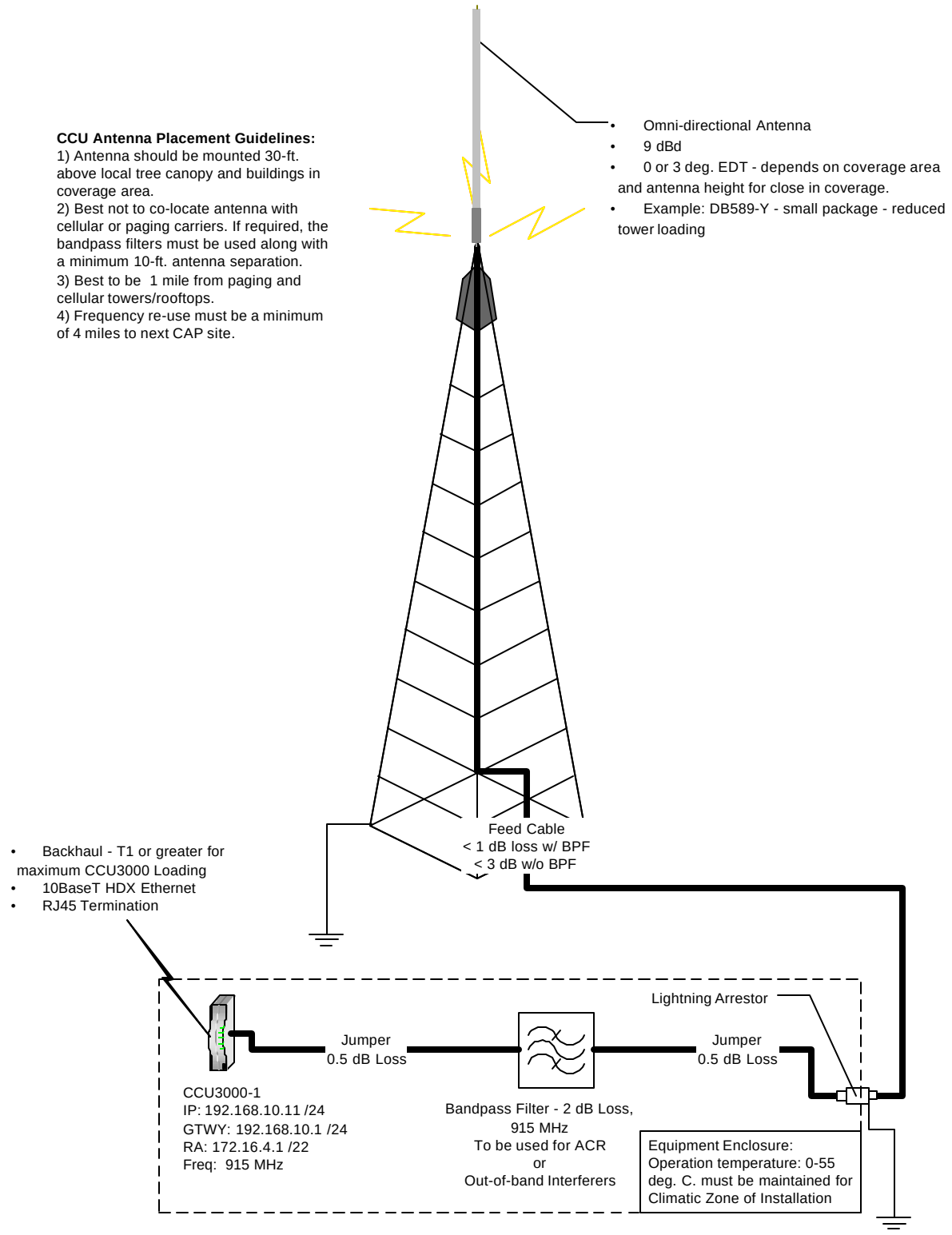
ip ethernet 172.16.4.3 22
ip customer 172.16.6.2 22
ip gateway 172.16.4.1 22
mac freq 9150
save
reset

Subscriber PC-1

IP: 172.16.6.2
Subnet: 255.255.252.0
Gateway: 172.16.4.1
DNS1: aaa.bbb.ccc.ddd
DNS2: eee.fff.ggg.hhh
reset

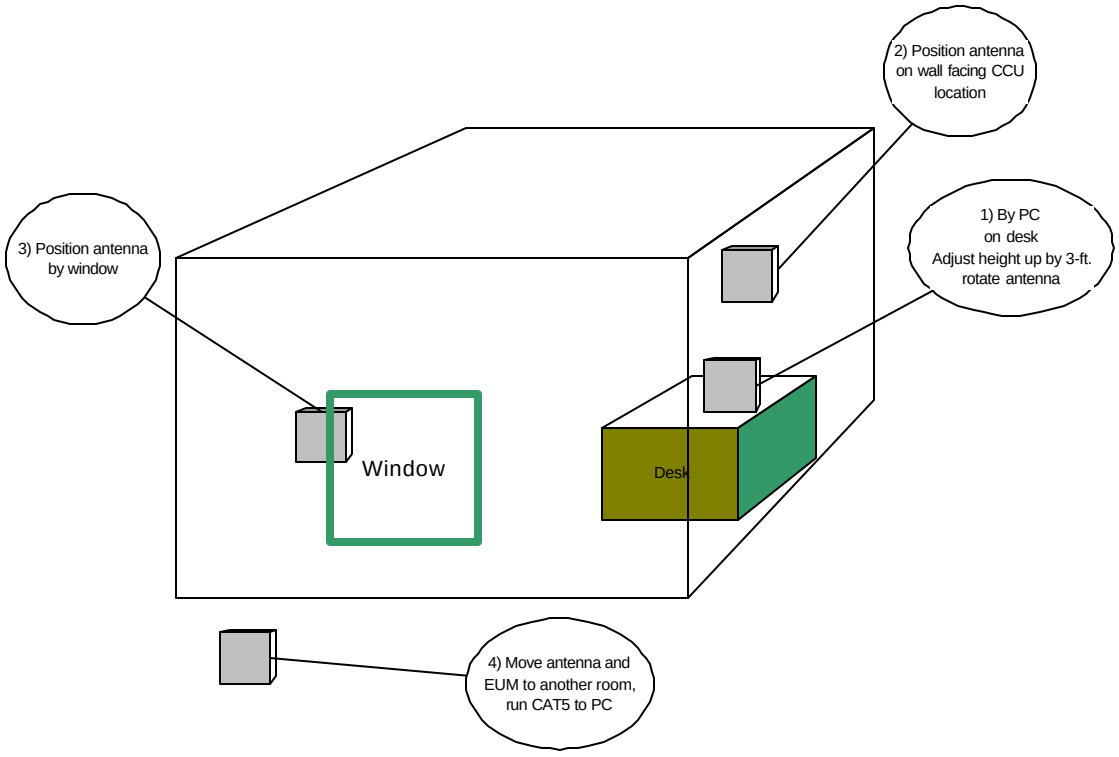
APPENDIX D – CCU Site Selection

This is a guideline only. A detailed site survey should be carried out prior to site lockdown.



APPENDIX E – EUM3000 Installation Guide

1. Setup NAT parameters (if applicable)
   - ip nat inside source static xxx.xxx.xxx.xxx xxx.xxx.xxx.xxx
   - access-list xx deny xxx.xxx.xxx.xxx
2. Configure EUM from data sheet
   - terminate with antenna
   - set channel, IP addresses, SNMP (if used), password, save
3. Subscriber site outdoor coverage benchmark tests - this is required to build up a database of signal levels in specific areas. As more subscribers are added, this will not be necessary.
   - Use an omni antenna, mounted on a vehicle, and drive around the proposed coverage area recording RSSI values.
   - Look for an RSSI > 45; if less, an indoor installation is most likely not feasible (depends on type of structure) unless the antenna is placed higher up (2nd floor, attic)
4. Indoor or Outdoor Antenna Location
   - Consult with subscriber where they would like antenna to be installed, indoor or outdoor
   - Start antenna alignment from preferred location
   - Whenever possible, mount the EUM antenna in a room that does not contain other wireless devices.
5. Antenna Alignment
   - Connect the antenna to the EUM
   - Remember to terminate the EUM with an antenna before powering up the EUM!!!
   - Power on the EUM
   - Observe RSSI LED
   - No light - no signal
   - Slow blink - good
   - Fast blink - better
   - Solid light - best
   - When positioning antenna allow approximately 25 s dwell time for that position. As experience is gained, positioning of the antenna becomes much quicker.



6) Ping test

- once a flashing RSSI LED is established, a PC can be connected to the EUM Ethernet port
- be sure PC is configured to talk to the EUM, verify with DOS ping
- Open an MS DOS window on PC
- Continuously Ping the CCU using a standard 32-byte IP ping
- Command is “ping CCU radio IP address –t”
- CCU should respond to IP pings with no timeouts, adjust antenna accordingly, if there are sequential timeouts, try another location
- If there are problems with Link Continuity Test, eg if CCU does not respond to IP ping or there are numerous timeouts:
    - Re-locate antenna towards the window/wall facing the CAP
    - Try elevating antenna near the ceiling towards window/wall facing the CAP, second floor of building
    - Change EUM antenna to outdoor 9dBi Yagi
    - Test in attic or garage
    - Repeat test outside from balcony or roof

7) Link Quality Test

- Continuously ping the CCU using a 1472-byte ping
- Command is “ ping CCU Radio IP address –l 1472 –t”
- CCU response should be consistent with a response time of < 30 msec.
- Slightly pivot antenna in both directions to optimize position.
- Stop the continuous ping with ‘Ctrl C’ command

Problems with Link Quality Test

- Link quality is poor if ping responses vary in length or timeout
- The antenna may need to be re-aligned or re-located
- Change EUM antenna to a higher gain antenna

8) Test Link Throughput

- WaveRider recommends use of FTP server
- Connect FTP server just after the CCU
- FTP Server has a variety of file sizes: 6 Mbytes, 10 Mbytes, 20 Mbytes
- Usually test with a 6Meg byte file
- Set up an FTP session from the Laptop to FTP Server
- Do a binary file transfer to the Laptop using the GET command
- Record the ‘data file transfer rate’ at the end of the FTP transfer
- Can be expresses as bytes per second or bits per second
- If expressed in bytes per second, multiply number by 8 to get bits per second, should see transfer rates in excess of 1 Mbps

9) Subscriber PC to Internet

- Configure Subscriber PC Communication Settings
- Set DNS, IP Address and Subnet Mask of subscriber’s computer according to IP addressing scheme.
- For instructions on setting IP addresses, refer to Microsoft Windows documentation.
- Ping CCU Ethernet address
- Using DOS command, ftp (bin, hash, get) ftptest.dat file from CCU, the download should be > 150 Kbytes/sec
- Browse favorite WEB sites

10) Document Installation

APPENDIX F – EUM3000 Installation Datafill

Date of Install:

Address:

Latitude: Longitude:

Ground Elevation:

Distance to CAP site (km):

Line Of Sight: ☐
Near Line Of Sight: ☐
Non Line Of Sight: ☐

Dwelling Building Material:

Outside Wall		Roof	
Brick	☐	Tar Shingles	☐
Aluminum Siding	☐	Clay Shingles	☐
Wood Siding	☐	Metal	☐
Stucco	☐	Gravel	☐
Cement	☐		

Dwelling Building Types: House ☐ Townhouse ☐ Apartment ☐ Office Building ☐

Dwelling Building Height: 1 Storey ☐ 2 Storey ☐ __Storey ☐

Insert Horizon Photograph In Direction Of CAP Here:

Exterior Install: ☐ Antenna Height:

Antenna Type: 7dBd Yagi ☐ ___Yagi ☐

RSSI:

Insert EUM Install Photograph Here:

Interior Install: ☐ Antenna Height:

Antenna Type: 4.4 dBd WaveRider ☐ ___Yagi ☐

RSSI:

FTP Transfer Results: Bytes Sent Seconds Kbytes/sec

100 Ping Test: Packet Size (bytes)
Min. Resp. (msec)
Max. Resp. (msec)
Packet Loss (%)
Average Resp (msec)

Insert EUM Install Photograph Here:
Insert bcf capture here: