Chapter 5

ANTENNA INSTALLATION PROCEDURES

This chapter provides an overview of the installation process. Please familiarize yourself with the installation process in general before proceeding to the next chapter.

Contents

INSTALL THE MAIN AND DIVERSITY ANTENNAS

These procedures describe the general process for installing the main and diversity antennas. Consult your field enginnering package for any site-specific antenna installation requirements.

WARNING: Before proceeding with the installation of the antennas, consult the applicable local code of wiring for requirements, including: clearance from power and lightning conductors, proper mounting methods, and antenna grounding.

Before You Begin

Before you install the antennas:

- Select an installation location away from any objects that might obstruct the RF signals. Although the base station has non-line-of-site RF capability, obstructions may reduce the strength of the transmission or reception signals.
- Ensure that the type and length of cabling used to connect the main and diversity antennas to the radio module meet your attenuation and shielding requirements.

Cabling and Connectors

Figure 5.1 shows the main and diversity antenna cabling and connectors.

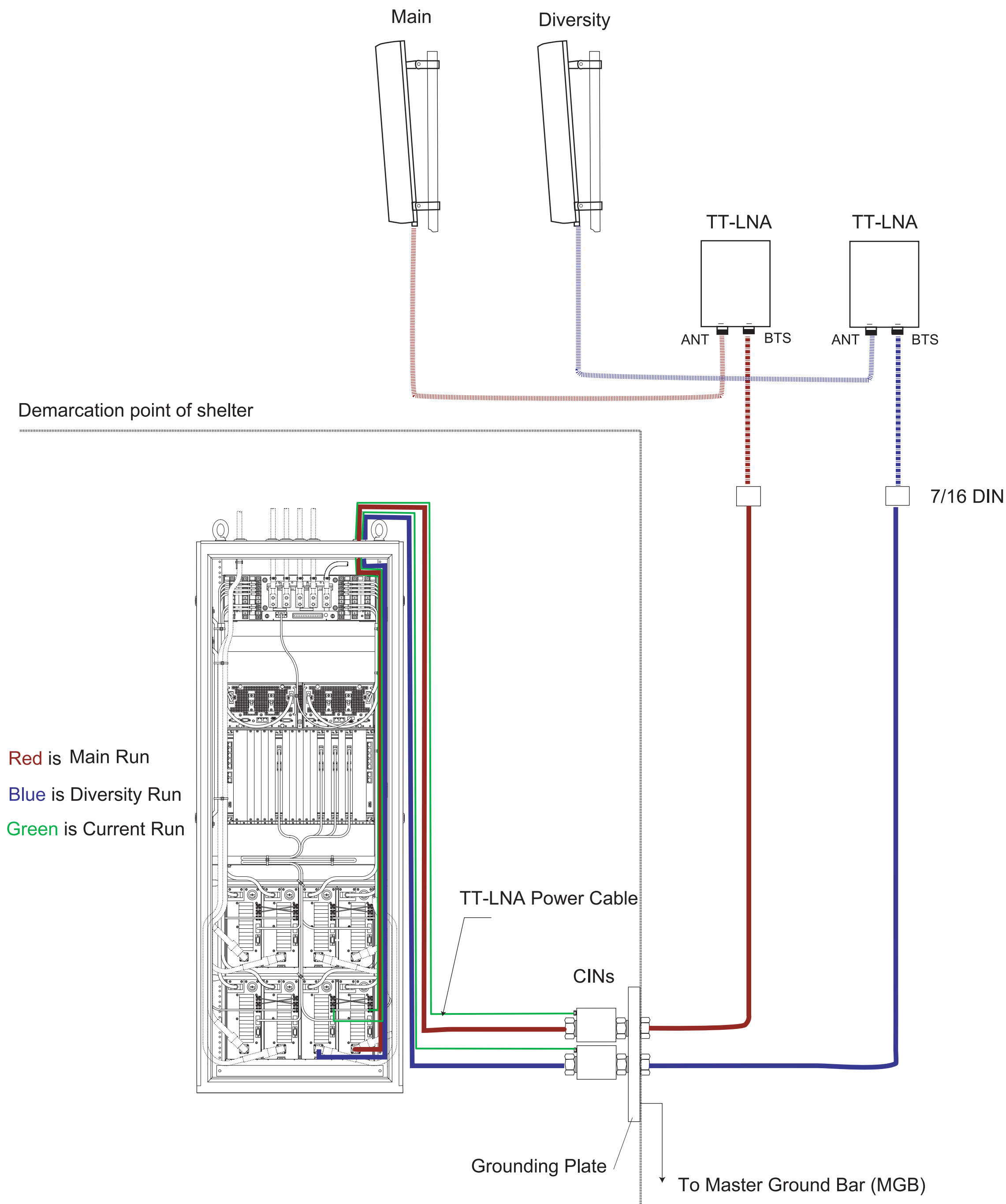

Figure 5.1 Radio Module with TT-LNA Antenna Configuration

To install the main and diversity antennas

1. Verify that you have the right type of antennas, both in terms of frequency and direction.
2. Run the antenna cable from the rack to the intended location of each antenna.

NOTE: Ensure that the cable remains clear of any sources of potential interference, such as transmitting equipment or power lines.

Figure 5.2 shows the radio module antenna connectors on the rack.

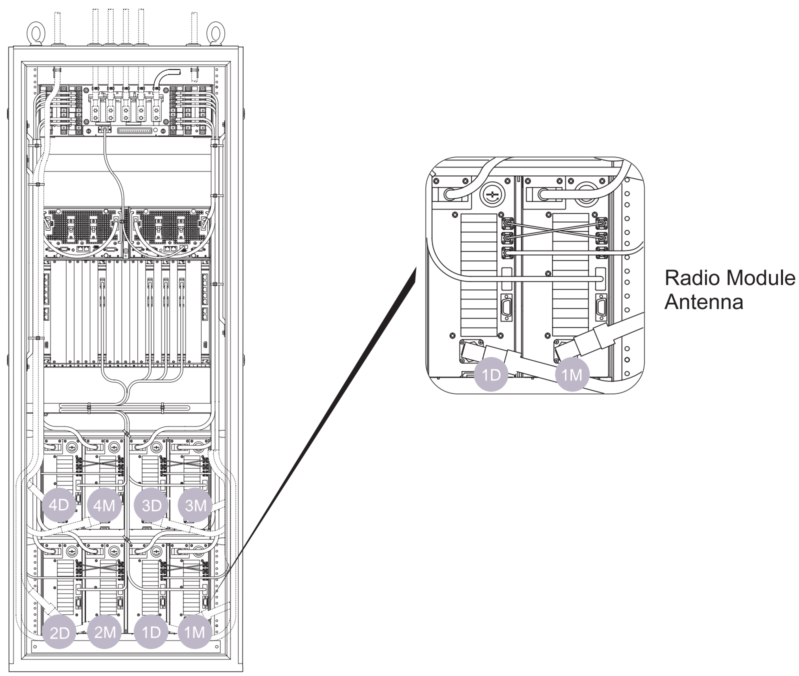

Figure 5.2 Radio Module Antenna Connections

3 Attach each antenna to your tower or building using the required mounting hardware.

4 Orient each antenna to the correct azimuth (direction) and tilt.

CAUTION: Failure to orient the antennas may seriously affect the performance of your wireless network.

5 Tighten and secure each antenna.

6 Connect the antenna to the radio module:

i Install each TT-LNA within 3 m (10 feet) of its antenna. The TT-LNAs should be installed as close to the antennas as possible in order to ensure optimal base station performance. Consult the documentation that ships with the TT-LNAs for the correct mounting procedures.

ii Connect the Antenna (ANT) port on each TT-LNA to its antenna using a suitable coaxial cable. Torque each 7/16 DIN connector to 28.0 N•m (247.8 inch-pounds) and ensure each connector is properly weatherproofed.

CAUTION: Do not over-tighten connectors. Overtightening the connectors may damage the cable and degrade the RF signal.

iii Install each CIN (also called a bias tee) inside or outside the base station building. Connect the ANT port on each CIN to the Base Transfer Station (BTS) port on each TT-LNA. Torque each 7/16 DIN connector to 28.0 N•m (247.8 inch-pounds) and ensure each connector is properly weatherproofed.

NOTE: Ensure that each CIN is installed within 10 m (32 feet) from the base station.

CAUTION: Do not over-tighten connectors. Overtightening the connectors may damage the cable and degrade the RF signal.

iv Connect the BTS on each CIN to the ANT port on each radio module. The ANT port is located on the rear side of the radio module.

v Connect the DC port on each CIN to the EXT/LNA port on each radio module. The EXT/LNA port is located on the rear side of the radio module.

MEASURING VSWR AND RETURN LOSS

Voltage standing wave ratio (VSWR) is a ratio of the maximum to minimum voltage as measured along the length of a mismatched RF transmission line. VSWR indicates the level of impedance matching between RF equipment (such as amplifiers, cabling, and antennas).

When the impedances of the RF equipment are mismatched, some of the RF energy is reflected back along the transmission line.

Reflected energy causes inefficiencies in the transmission power output. A VSWR of 1:1, as measured from antenna cable to the antenna, indicates that 100% of the power output is being radiated by the antenna.

During a cable sweep, RF equipment should show a VSWR of 1.5:1 or less, as measured from 2500-2686 MHz. A VSWR greater than 1.5:1 indicates potential problems with the RF equipment.

A high VSWR may be caused by one or more of the following conditions:

- Moisture in the external cables or connectors
- Faulty equipment
- Poor connections between components
- Damaged cables or connectors
- An open- or short-circuit in RF equipment or cables

Return Loss

Return loss is closely related to VSWR. Return loss is a measure in decibels (dB) of the ratio of forward to reflected power. For example, if a load has a return loss of 10 dB, then 1/10 of the forward power is reflected. The higher the return loss, the less energy is being reflected.

Table 5.1 shows the correlation between VSWR, return loss, and the percentage of reflected power.

VSWR	Return Loss (dB)	Power Being Reflected (%)
1:1	N/A (infinite value)	0
1.25:1	19.1	1.2
1.5:1	14	4.0
1.75:1	11.3	7.4
2:1	9.5	11.1
5:1	3.5	44.7
N/A (infinite value)	0	100.0

Table 5.1 VSWR, Return Loss, and Reflected Power Conversions

To measure the VSWR of RF equipment

1. Power on and calibrate your cable sweep analyzer.
2. Power off the radio module connected to the RF equipment you want to test. See page 93 for a list of circuit breakers.

3 Carefully disconnect the RF equipment and cables you want to test.

WARNING: Extreme care must be taken when connecting or disconnecting the coaxial antenna cable to avoid damage to the center pins. Connectors should be torqued to a maximum of 28.0 N•m (247.8 inch-pounds) and be free of dirt or moisture. Do not over-torque the connectors as this can damage the center pin and cause cable faults and other RF problems.

4 Connect the cable sweep analyzer to the equipment and cables you want to test.

NOTE: Be careful not to damage any cables or connectors when connecting the analyzer to the RF equipment. Due to the use of the tower-top low noise amplifier (TT-LNA), all cable sweeps must measure the total length of the cable run (including all connectors, jumpers, and CIN), using a DIN adapter (female-female) in place of the TT-LNA.

5 Perform the cable sweeps.

See the documentation that comes with your analyzer for information about performing the cable sweep and interpreting the results.

6 Record the results from the cable sweeps. Keeping records of periodic cable sweeps makes trouble-shooting future problems easier.

7 Carefully disconnect the analyzer from the RF equipment.

8 Reconnect the RF equipment and cables back to the radio module.

9 If any of the connectors are outdoors, ensure that they are resealed according to the procedures of your site.

10 Reconnect the RF equipment to the radio module.

11 Power on the radio module. See page 93 for a list of circuit breakers.

MEASURING THE DISTANCE TO A FAULT

Distance to fault (DTF) is a measurement of VSWR or return loss based on distance. A DTF test indicates the distance to a short, open, or load. Perform a DTF test whenever a VSWR test reveals that the antenna system is not operating within specifications.

To accurately interpret the results from a DTF cable sweep, you need to know the lengths of your cables and the location of any devices or connectors attached to those cables. Comparing the results of the test with the layout of your antenna system will help you to determine if problems are caused by faulty devices, connectors, or cables.

To measure the distance to fault

1. Power on and calibrate your cable sweep analyzer.
2. Power off the radio module connected to the RF equipment you want to test. See page 93 for a list of circuit breakers.
3. Carefully disconnect the RF equipment and cables you want to test.
4. Connect the cable sweep analyzer to the equipment and cables you want to test.

> **NOTE:** Be careful not to damage any cables or connectors when connecting the analyzer to the RF equipment.

5. Perform the cable sweeps.

   See the documentation that comes with your analyzer for information about performing the cable sweep and interpreting the results.
6. Document the results from the cable sweeps.

   Keeping records of periodic cable sweeps will make troubleshooting future problems easier.
7. Carefully disconnect the analyzer from the RF equipment.
8. Reconnect the RF equipment and cables back to the radio module.

   If any of the connectors are outdoors, ensure that they are resealed according to the procedures of your site.
9. Power on the radio module. See page 93 for a list of circuit breakers.

Chapter 6

ON-SITE CONFIGURATION PROCEDURES

This chapter describes how to power on the base station and configure the cards.

Contents

Power On the Base Station

The power for the NPM2000 base station is controlled by circuit breakers in the PDP, located at the top of the rack. digital shelf has its own circuit breaker, whereas radio module has its own fuse.

To power on the base station

1 Ensure that your main –48V DC power supply is powered on and is providing a power source that meets the electrical requirements listed on page 23.

2 Ensure that Power-A LED and Power-B LED on the front panel of PDP are lighted.

3 Set all except those for non-installed radio modules and routers to the ON (up) position on the PDP.

4 Power on the power supply in the digital shelf.

Figure 6.1 shows the circuit breakers on the digital shelf.

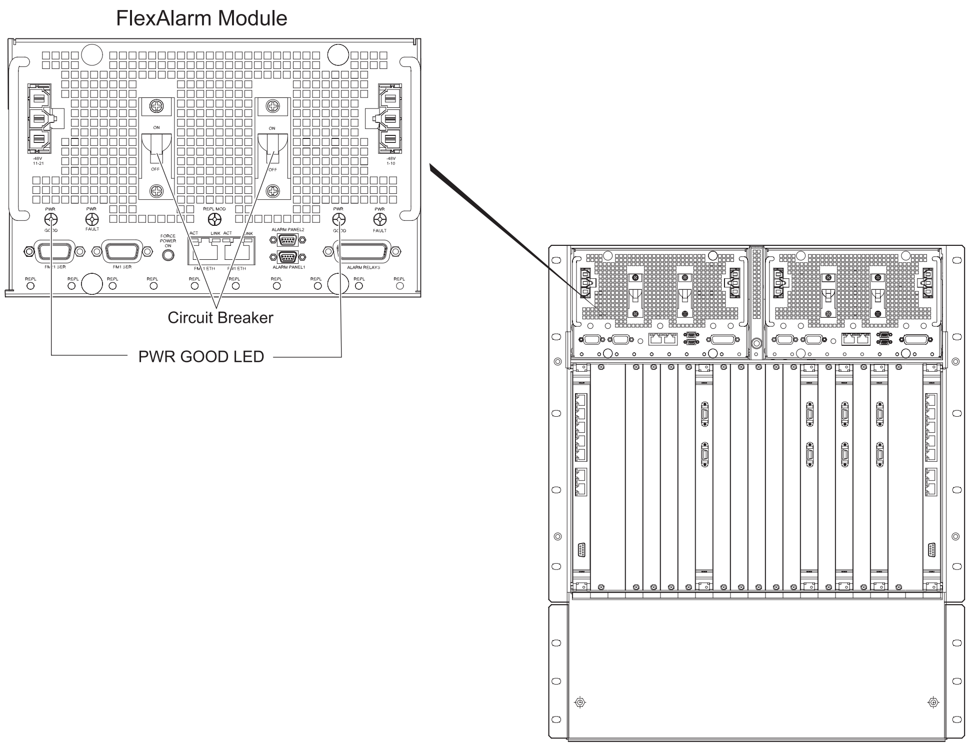

Figure 6.1 Circuit Breakers on the Digital Shelf

i The PWR GOOD LED near each power connector should illuminates. This indicates that the power source is providing voltage on that feed. If one of these LEDs is not illuminated, check the cabling and the power source for that feed.

ii Switch all four circuit breakers to the ON position. It is suggested that you switch on both circuit breakers on one FlexAlarm unit, and then switch on both circuit breakers on the other FlexAlarm unit.

The FlexCool fan units will begin cooling the chassis and the FlexManager cards will boot automatically.

CAUTION: After powering up the system, check the fan status LEDs to make sure that the ventilating fans are operational.

Table 6.1 shows the circuit breakers for each power supply.

Origin	Termination	Origin	Termination
RM 1M (CBA1)	Radio Module Shelf, RM 1-M		
RM 1D (CBB1)	Radio Module Shelf, RM 1-D		
RM 2M (CBA2)	Radio Module Shelf, RM 2-M		
RM 2D (CBB2)	Radio Module Shelf, RM 2-D	CPCI A1 (CBA7)	Digital Shelf FlexAlarm A 1-10
RM 3M (CBA3)	Radio Module Shelf, RM 3-M	CPCI A2 (CBA8)	Digital Shelf FlexAlarm A 11-21
RM 3D (CBB3)	Radio Module Shelf, RM 3-D	CPCI B1 (CBB7)	Digital Shelf FlexAlarm B 1-10
RM 4M (CBA4)	Radio Module Shelf, RM 4-M	CPCI B2 (CBB8)	Digital Shelf FlexAlarm B 11-21
RM 4D (CBB4)	Radio Module Shelf, RM 4-D	RT A	Option
		RT B	Option

Table 6.1 Circuit Breakers

5 Power on each radio module separately. Table 6.1 shows the circuit breakers for the radio module.

Figure 6.2 shows the circuit breakers on the PDP front panel.

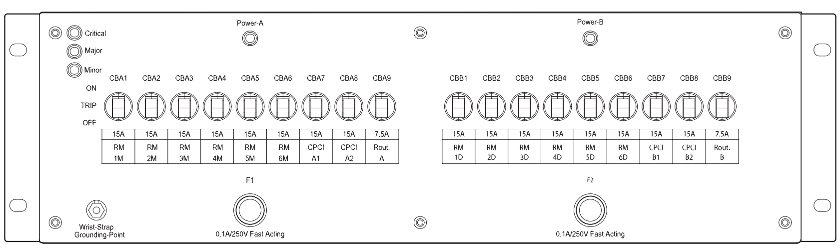

Figure 6.2 Circuit Breakers on the PDP Front Panel

Appendix A

DECOMMISSIONING PROCEDURES

This appendi describes how to safely take an base station out of service.

Contents

Decommission a Base Station

Decommissioning occurs whenever a base station is taken out of service or moved to a new location.

WARNING: Ensure that the necessary requirements and procedures have been reviewed prior to the start of any power-related activity. Refer to your cut-over MOP for procedures specific to your site.

To decommission a base station

1 Shutdown the sector controllers:

- **i** Establish an SSH session with each card, as described in the *System Administration Reference*.
- **ii** Shutdown each card by typing:

  ```
  shutdown now ↲
  ```

2 Shutdown the digital shelf by setting all slots to off.

- **i** Set all slots to off by typing the following command on the active FlexManager:

  ```
  off
  ```

3 Power off the base station by setting all breakers except those for non-installed radio modules and routers to the OFF (down) position.

4 Power off the main power supply for the base station. With most power bays, circuit breakers control the –48V DC feeds to the rack. Ensure that the main power is removed for the rack.

See the documentation that accompanies your main power supply for specific instructions on powering off the –48V DC feeds to the base station.

After the main power supply is powered off, it is safe to prepare the rack for shipment or storage.

5 Package the rack according to the procedures specific to your site. If you remove the cards from the digital shelf, ensure that the cards are stored in antistatic packaging and that the required documentation is included.

Appendix B

ADDING ADDITIONAL SECTORS

This appendix describes how to add additional sectors to an base station to increase capacity.

Contents

Pre-Upgrade Preparation

Before you begin upgrading the base station, ensure that the following preparations are performed. These preparations are intended to minimize the interruption of service.

Site-Specific Documentation

Before upgrading the base station, ensure that the documentation described in Table B.1 is updated, reviewed, and verified.

Document	Description
Field engineering package	Provides site-specific configuration about the base station, such as antenna orientation, cabling requirements, and inventory.
Method of Procedure (MOP) for adding sectors	Describes the sequence and timing of procedures required for the upgrade
Site-specific fall-back plan	Describes any events or triggers that require that the technicians return the base station to its original configuration.

Table B.1 Sector Upgrade Documentation Requirements

RF Planning

RF planners should develop a preliminary RF plot of the new sector configuration that accounts for the location of existing and future users. A change in antenna sector layout may affect the RF planning for the entire network.

After the RF plot is finalized, it shoud be added to the field engineering package.

Install Additional Antennas and Cabling

Install the new antennas and associated cabling. Each new sector requires two antennas (main and diversity). See “Install the Main and Diversity Antennas" on page for information.

After installing the antennas and cabling, perform a cable sweep on each and ensure results are within specifications.

HVAC Requirements

Ensure that the heating, ventilation, and air-conditioning (HVAC) system for the site has the capacity to handle the additional heat produced by the additional sectors. See “Heat Output" on page for information.

Main and Backup Power Supplies

Ensure that the power supplies for the site have the capacity to handle the additional sectors. See "Electrical Requirements" on page for information. Additional rectifier must be installed and tested prior to upgrading.

Backhaul Capacity

Verify that the backhaul connecting the base station to the network core has the capacity to handle the additional traffic.

Edge and Core Router Capacity

If the backhaul is upgraded, the edge and core routers may require changes to their physical interface cards (PIC). Any change must be implemented and tested prior to upgrading.

Adding Sectors to a Base Station

This procedure describes how to add additional sectors to a base station. See your updated field engineering package for site-specific information about the upgrade.

To add sectors to a base station

1. Install any additional radio modules. See "To insert the radio modules in the rack" on page 62.
2. Install any additional CompactPCI power supplies for the radio shelves See "To insert CompactPCI power supplies" on page 67.
3. Install the additional cards. See "To insert the cards into the digital shelf" on page 70.
4. Cover any unused card slots with filler panels. See "To cover the unused slots with filler panels" on page 72.
5. Install the power, Ethernet, signal, and RF cabling for the new sectors. See "Connecting the Cables" on page 73.
6. Perform a quality audit on the base station hardware as described in the field deployment (E1) package.
7. Review the condition of the status lights to ensure correct operation. See the *Macro Base Station Maintenance Procedures* for information.
8. Add the new sectors to the base station network in the CM tool. See the *Base Station Provisioning Procedures (NPM2000)* for information.

Performing the Cutover and Power-On

Switching to the new antenna configuration will result in a service interruption. The cutover should occur during a scheduled maintenance window.

CAUTION: Before performing this procedure, ensure that a quality audit has been performed on the system, as described in "Adding Sectors to a Base Station" on page 101.

This procedure will cause a service interruption. During this procedure, all SOMAports in the affected sectors will be forced to reacquire.

Estimated time of service interruption: 10 min
Estimated time to completion: 30 min

To perform the cutover and power-on

1. Power off the radio modules. See "Power On the Base Station" on page 92 for information about radio module circuit breakers.
2. Disconnect the antenna cables from the old antennas.
3. Connect the new antennas.
4. Power on the radio modules.
5. Peform the acceptance test plan (ATP) to ensure correct operation and functionality. See

Acceptance Test Plan for Base Station Upgrade

After completing the upgrade, review the acceptance test plan (ATP) to verify the functionality and performance of the new configuration.

Site Coverage Verification

Immediately after performing the cutover and quality audit, verify the RF site coverage to identify possible problems with the antenna subsystem, such as antenna radiation patterns, azimuth, tilt, or cabling errors.

Coverage verification includes performing a drive test on non-service-affecting channels, such as the pilot channel (PICH). Service interrput may be required if adjustments to the antenna subsystem are required.

Voice and Data Functionality and Performance

The ATP should include procedures that test the functionality and performance of the voice and data services.

RF Network Coverage Optimization

RF network coverage optimization should be performed after the upgrade is completed for all planned sites within the market area in order to secure high service quality and subscriber satisfaction.

Network optimization typically requires:

- Monitoring network statistics to identify areas or users with service quality degradation
- Drive testing (pilot channel scan) to identify areas with coverage problems

Collected data should be analyzed and, if necessary, appropriate site configuration changes implemented (such as antenna orientation, down tilt, base station power setting, individual channel power allocation, or parameter tuning).

In situations where a configuration change for a large number of sites is planned, sector upgrades should occur in several phases. The entire network should be divided in clusters of sites and sectorization performed for each cluster individually. Coverage optimization should be performed for each cluster after sectorization is completed. Network wide optimization will be performed after entire network is reconfigured.

GLOSSARY

A

air interface

The standards governing radio transmission between two elements of a wireless system, such as a base station and a SOMAport.

The interface typically specifies the frequency band (for example, PCS), multiple-access scheme (for example, CDMA), modulation scheme and coding (for example, QPSK and rate 1/2), power control mechanisms, and protocols for setting up and managing communications.

attenumation

The reduction of signal magnitude over a medium. Attenuation is usually measured in dB per unit of distance, or as a ratio of input to output magnitude in dB. The less the attenuation, the more efficient the medium.

Attenuation is also called signal loss.

AWG (American wire gauge)

A standard for measuring wire thickness. The thicker the wire, the smaller AWG it has and typically, the higher current it can carry.

B

backhaul

The network or service that connects remote devices, such as base stations, to the central office. In the SOMA Networks implementation, backhaul refers to the wireline link between the base station and the network core.

base station

Equipment deployed by service providers at the center of each cell to communicate with wireless devices. In a SOMA network, the base station communicates with wireless subscriber terminals called SOMAports.

BIOS (basic input/output system)

Software, typically stored in nonvolatile memory, that provides a standardized interface between a computer's hardware and the operating system.

bus

An electrical pathway that connects several devices and provides addressing and data-transfer capabilities.

C

CDMA (code-division multiple access)

A cellular technology that divides a frequency into multiple channels by assigning a pseudo-random digital seuence, or code, to each. CDMA does not assign a specific frequency to each user. Instead, every channel uses the full available spectrum.

cellular

A communications system, originally AMPS, that divides a geographic area into cells, each of which has its own radio transmitters and receivers. Competing digital cellular systems include GSM and CDMA.

CompactPCI

An open, industry-standard architecture based on the PCI architecture. Electrically, CompactPCI is superset of PCI. CompactPCI cards use Eurocard form factors and are typically available in 3U and 6U formats.

The CompactPCI standard is controlled the PCI Industrial Computer Manufacturers Group (PICMG).

core network

Generically, the physical infrastructure at the center of a network with a single administrative entity.

See also "network core".

D

dB (decibel)

A logarithmic expression of the ratio of two electrical equalities. To calculate dB, use the formula: S_{db}=10log (P_2/P_1).

E

E1 Package

A SOMA Networks document that provides installation and operation instructions for a specific site.

Ethernet

A LAN protocol that uses CSMA/CD and a bus topology to support data transfer at 10Mbits/s.

A newer version, called Fast Ethernet or 100Base-T, supports data transfer at 100 Mbits/s, and the IEEE has developed a standard for so-called Gigabit Ethernet (IEEE P802.3z).

Ethernet MAC address

A unique, 48-bit number programmed into every LAN card, usually at the time of manufacture.

Destination and source MAC addresses are contained in LAN packets and are used by bridges to filter and forward packets.

G

gateway

A device that connects two networks together. For example, gateways connect the network to the PSTN and the Internet.

H

host

A computer on which operating software resides.

I

IF (intermediate frequency)

A radio signal that will be converted to a new frequency prior to transmission.

IP (Internet Protocol)

The packet-transfer protocol used on the Internet. IP specifies the format of the basic unit of data, the datagram, and defines the addressing scheme used for its transfer.

L

LAN (local area network)

A network of computers, workstations, printers, file servers, and other devices that serves a particular group of users and is usually confined to a small geographical area, such as a building or campus.

latency

The amount of time it takes a packet to travel from source to destination. Network latency refers to the delay introduced when a packet is momentarily stored, analyzed, and then forwarded.

LNA (low-noise amplifier)

A device that increases the amplitude of an RF signal without introducing significant amounts of noise.

M

MAC (medium access control) layer

The network layer protocol that controls access to the physical transmission medium. The MAC layer, defined in IEEE 802, is sometimes called a sublayer because it is equivalent to the lower half of the data link layer in the OSI reference model. It mediates between the physical layer and the logical link control sublayer.

MGB (master ground bar)

The MGB is a bus bar that provides an electrical interface between the building's integrated ground plane and an isolated ground plane.

modem (modulator-demodulator)

A device that performs the conversion between digital data and analog signals.

MOP (methods of procedure)

A SOMA Networks document that describes the work to be done at a customer's site.

N

network core

In a SOMA Networks context, the network core is the switching fabric that interconnects all components and transfers bearer traffic, signaling information, embedded control messages, and network management traffic. The network core could be implemented as a single IP router connecting all components in star topology or could be an arbitrary meshed topology with several routers and routes between systems.

O

OS (Operating system)

The master control program that runs a computer. The OS is the first program loaded when a computer is turned on, controls software access to resources such as the central processing unit, memory, and peripherals, and runs all of the computer's programs.

P

PSTN (public switched telephone network)

The international telephone system for analog voice traffic. The PSTN refers to the original copper wire telephone infrastructure and services.

R

RF (radio frequency)

Any frequency in the electromagnetic spectrum that is used for radio transmission (typically 1 MHz to 300 GHz).

RJ-45 (registered jack-45)

An 8-wire connector used to connect computers to an Ethernet or a token-ring LAN.

router

A device that forwards packets of any type from one LAN or WAN to another. Routers read the information in packet headers and use routing tables an protocols to determine the optimal route between hosts.

S

sector

A wedge of a radio cell used to increase the capacity of the cell. Radio sectors use directional antennas instead of omnidirectional antennas.

The base station supports up to six sectors, each of which is managed by a sector controller.

SOMAport

The SOMA Networks CPE. The SOMAport is the terminal device that connects a subscriber's telephones and personal computers via a wireless link to the base station.

switch

In networks, a device that filters and forwards packets based on the address in the packet header. Switches operate at the data link layer of the OSI Reference Model.

T

TCP (Transmission Control Protocol)

A protocol that enables two hosts to establish a connection and reliably exchange streams of data over IP-controlled networks. TCP operates at the transport layer of the OSI Reference Model.

TCP/IP (Transmission Control Protocol/Internet Protocol)

The suite of communications protocols developed by the United States Department of Defense to connect dissimilar systems. TCP/IP is supported by many operating systems and is the protocol of the Internet. It uses IP addressed to route messages over multiple networks.

U

UPS (uninterruptable power supply)

A battery-powered device that provides power to a system in the event of an interruption to the main power.

W

WAN (wide area network)

A physical or logical data network that spans a relatively large geographical area and that typically connects two or more LANs.

ABBREVIATION

AWG – American wire gauge

BTU – British thermal unit

CFM – cubic feet per minute

CSU – customer service unit

dB – decibel

DIV – diversity

ES – Ethernet switch

HVAC – heating, ventilation, air-conditioning

IP – Internet Protocol

MC – management controller

modem – modulator-demodulator

MOP – methods of procedure

NC – not connected

NEBS – network equipment-building system

NOC – network operations center

OAMP – operations, administration, maintenance, and provisioning

PDP – power distribution panel

PIC – physical interface card

RF – radio frequency

RFSS – radio frequency subsystem

RS – radio shelf

RX – receive

SC – sector controllers

SCP – Secure Copy

SSH – Secure Shell

TX – transmit

UTC – universal time code

VSWR – voltage standing wave ratio

WCS – wireless communications services