Vanu Anywave® BSS Operator Guide — DRAFT

February 8, 2008

Contents

Chapter 1

Introducing Vanu Anywave BSS

1.1 Introduction

Welcome to the Vanu Anywave Base Station System Operator Guide. This manual is designed to serve as an information resource for the Vanu system you will be deploying. This guide focuses on hardware preparation and deployment, and prepares you to provide first line technical support for the Anywave BSS.

1.2 Operator Guide Scope and Objectives

This Guide will cover the following topics:

- Anywave Components and Connections
- System Operation

1.3 Operator Guide Assumptions

This Operator Guide assumes that the audience will have working knowledge about the following topics:

- Basic commands and usage of a Linux (or Unix) server, such as: user configuration, logging in, copying files, up- and down-loading files, file permissions, file editing, etc.
- This BSS Operator Guide concentrates primarily on setup of the system; it is not intended to act as an exhaustive guide on how to troubleshoot network issues or specific calls.

1.4 Benefits of the Vanu Anywave BSS

The Vanu Anywave base station provides Radio Access Network (RAN) functionality by implementing a complete GSM Base Station Subsystem (BSS) in software on a single general-purpose server. Signal processing, protocol processing, and other radio access network functionality are implemented as application level software running on top of the Debian GNU/Linux operating system.

Features

The Vanu Base Station System (BSS) has four major software components:

- The Base Transceiver Station (BTS) handles communication over the air interface with individual mobiles. A BTS can handle many radio links simultaneously, and is responsible for any ciphering over the air interface.
- The Base Station Controller (BSC) acts to manage a number of BTSs on functions such as radio resource allocation, mobile handover, and passing messages to the mobile from the core network.
- The Transcoder and Rate Adapter Unit (TRAU) performs transcoding for speech channels and rate adaptation for data channels, as necessary.
- The Packet Control Unit (PCU) is only found in a GPRS (General Packet Radio Service) network. The PCU handles the radio resource aspects of GPRS connections.

Working together, these components integrate into a complete BSS solution that provides the full functionality of a GSM Radio Access Network (RAN).

The Vanu Anywave System seamlessly connects mobiles to the phone network by first making a mobile-to-BTS connection via the radio (or “air”) interface. The BTS is connected to, and exchanges data with, the BSC via the Abis interface. The BSC then communicates to the MSC via the A interface.

In the data domain, there is a similar Gbis interface between the BTS and PCU, and a Gb interface between the PCU and SGSN (Serving GPRS Support Node) for GPRS data.

A full base station is composed of the following major subsystems:

- An RF Front End, supporting the 850, 900, 1800, or 1900 MHz bands, which perform Analog-to-Digital and Digital-to-Analog conversions, as well as up/down mixing and duplex functionality.
- Waveform processing performed by the Anywave BTS software on a standard commercial server.
- A GPS timing reference.
- A typical BTS installation has other important parts that are not considered Vanu Anywave components, such as: antenna(s), amplifier(s), power conditioning, and others.

1.5 Network Operator Role

As Network Operator, you will oversee project planning and deployment of all components for the wireless infrastructure, including the Vanu Anywave BSS. This process will require working with Vanu, Inc. Technical Support to ensure all required settings are appropriately determined, implemented and documented.

The following is an overview of the Network Operator Role and some of the duties you will be expected to perform:

Deployment

- Understand the purpose of all hardware components used in the BSS
- Connect the hardware components of your BSS system
- Install and configure the various software applications used by the system

Operation

- Provide first line customer support in the pursuit of issue resolution, and ensure effective data transfer to Vanu, Inc. Technical Support for all support escalations, as determined by existing service level agreements.
- Manage technical issues regarding hardware and software required to run the Vanu Anywave system.
- Coordinate and confirm system downtime with Vanu, Inc. Technical Support for the deployment of system patches or general updates in accordance with service level agreements.

Chapter 2

Anywave Components & Connections

Your Anywave BSS system includes and interacts with many different hardware components, including:

- The BSS server, which can act as individual or multiple parts of the Anywave System, depending on network resources and requirements (such as BSC/TRAU/BTS, or BTS only).
- A Global Positioning System (GPS) timing reference.
- A Radio Frequency (RF) Front End.
- A Multi-Carrier Power Amplifier (MCPA).
- A circuit breaker.
- A power transformer for the MCPA, generally used for AC to DC conversion.
- A Terminal Server used to remotely access devices' serial interfaces.

This chapter will provide a functional overview of these various components and their functionality.

2.1 BSS Server

A standard commercial rack-mounted server (such as the Dell Poweredge or HP ProLiant series) runs the Vanu BSS software on the Debian GNU/Linux operating system. A typical recommended server has redundant power supplies, fans and hard drives (RAID 1 array) to ensure that the BSS remains functional in the event of most hardware failures.

Figure 2.1: A HP ProLiant DL380 G5 Server, Front View

A Radio Frequency over Ethernet (RFoE) stream over Gigabit Ethernet is used to exchange the RF data between the RF Front End and the server. The BTS application then performs all waveform-specific tasks on this RFoE stream; these waveform-specific tasks include modulation, signalling, and communications with the BSC,TRAU, PCU and mobile station(s).

The BSC controls one or more base stations and directs the BTSs in such functions as channel assignments and handovers. BSCs reduce the processing load on the Mobile Switching Center (MSC) by handling multiple Abis interface connections to all of the BTSs as well as handling the A interface message stream with the MSC.

2.2 GPS Timing Source

The Vanu Anywave System uses a Brandywine GPS4 to provide a precision time source for the BSS system.

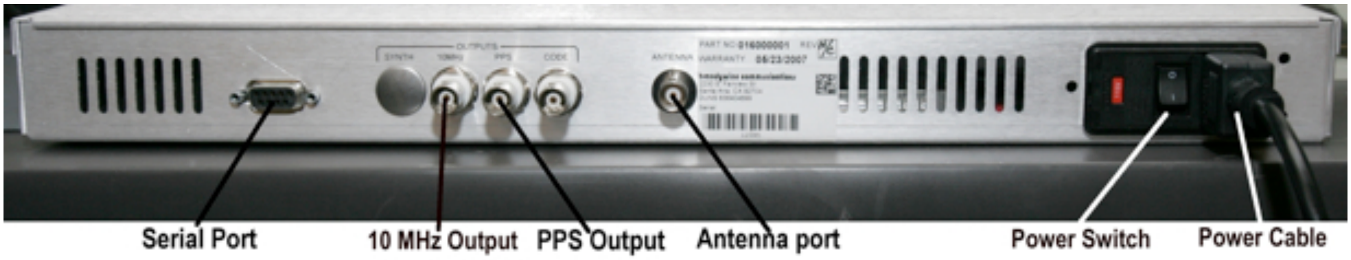

Figure 2.2: GPS4 Timing Source Connections

The GPS unit provides three important sources of data for BSS functionality:

- A 10 MHz signal
- A 1 Hz or Pulse-Per-Second (PPS) signal
- A precise value for time of day

The 10 MHz clock is used as both a frequency reference and a sub-second time reference by the RF Front End.

The 1 Hz signal is used to synchronize the time alignment at BTSs across the network, both for proper hardware alignment and minimization of neighbor BTS interference.

The time of day value is obtained via a serial connection, and is used to ensure that timestamps are valid and consistent throughout the network.

Note:
The GPS unit can also be used to provide location information, but the data is not used by the Anywave System.

2.3 RF Front End

The wideband RF Front End performs transmission and reception over the air interface between the BTS and GSM mobile stations. Using a wideband multi-channel front end allows one BTS unit to transmit and receive multiple carriers over a bandwidth of 26 MHz.

The RF Front End includes both the RF up/down converter and the digital RF subsystem, which perform digital filtering, timestamp injection and other functions. The BTS software communicates with the RF Front End using digital baseband samples sent via Radio Frequency over Ethernet.

The Protium RF Front End Unit is divided into two compartments for noise containment. The lower compartment contains the duplexer and associated filters. The upper compartment contains the RF Up/Down converters, analog-to-digital converters, digital-to-analog converters, and other digital hardware.

The RF signals are piped between the two compartments externally to maintain the noise separation. We will refer to the lower compartment as the Duplexer and the upper compartment as the Up/Down Converter for simplicity. The units will be installed and serviced as one box, but for the sake of clarity we will describe them here as two components.

An RF Front End will provide functionality for a single frequency band, of which four are commonly used: 850 MHz, 900 MHz, 1800 MHz, or 1900 MHz. The chosen band will depend on the project requirements.

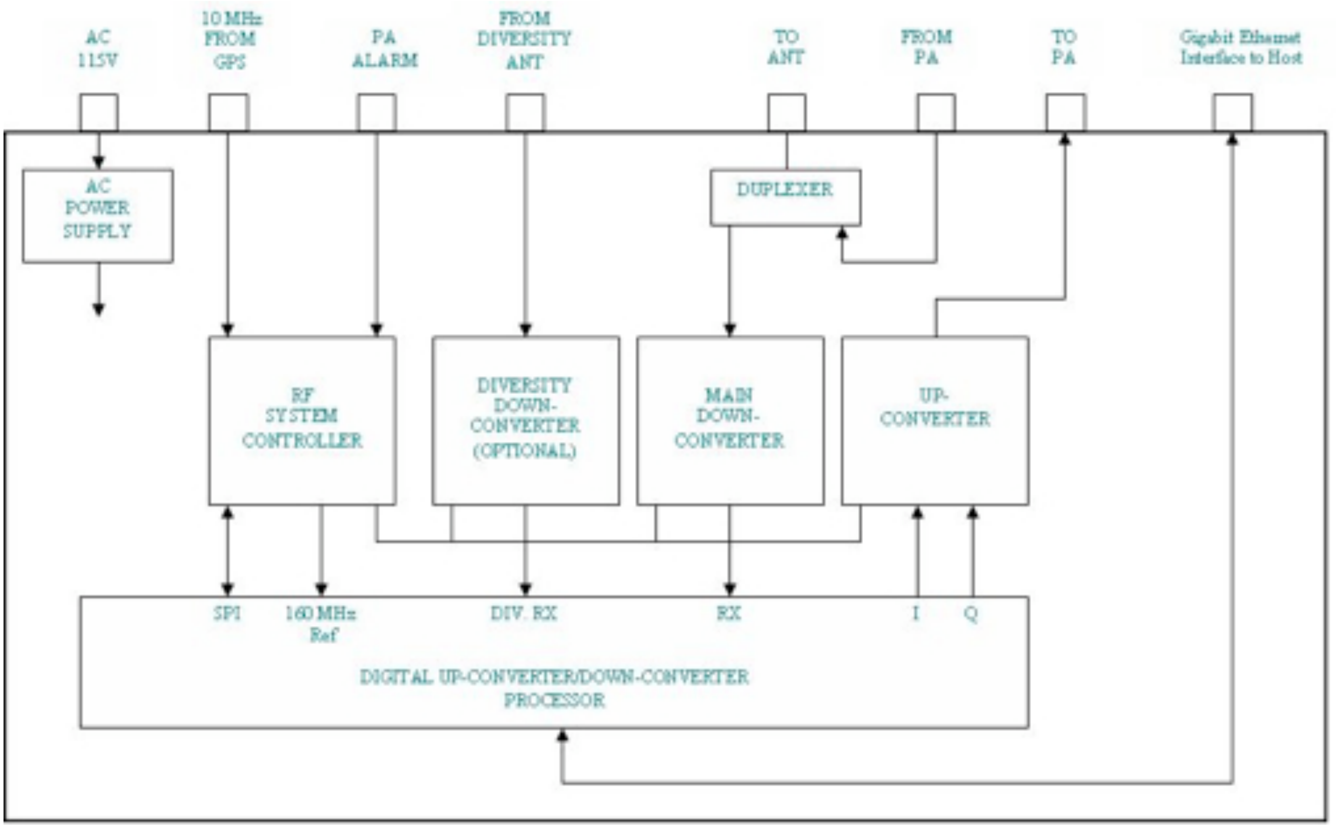

Figure 2.3: Protium RF Front End Block Diagram

The figure above is a block diagram of the internal components that constitute the Protium RF Front End used by the Anywave System.

When the BTS receives a signal from a mobile, an example path that data would follow would be: the RF signal is received through the Main Antenna port (labeled “TO ANT”) which is connected to the duplexer, which is used to separate the transmit and receive sides of the RF data. From there, the signal is sent via RF cable to the main downconverter, which converts the signal to a lower intermediate frequency (IF). That IF signal is then transferred (internally) to the digital downconverter which both digitizes it and downconverts it again to a baseband signal. This digital baseband data is then sent out over the Gigabit Ethernet Interface to the host (server).

For transmission, the BTS will generate and send digitized data over the Gigabit Interface to the RF Front End, which then upconverts the data to an analog signal RF for amplification and broadcast from the antenna to the mobile station.

2.4 Power Chassis and Power Amplifiers

The Powerwave Chassis holds the Multi-Carrier Power Amplifiers (MCPAs) that are connected to each RF Front End in the network. The outputs from the RF Front End are sent to the MCPAs via RF cables, where the signals are amplified by +63 dB for broadcast over the antenna.

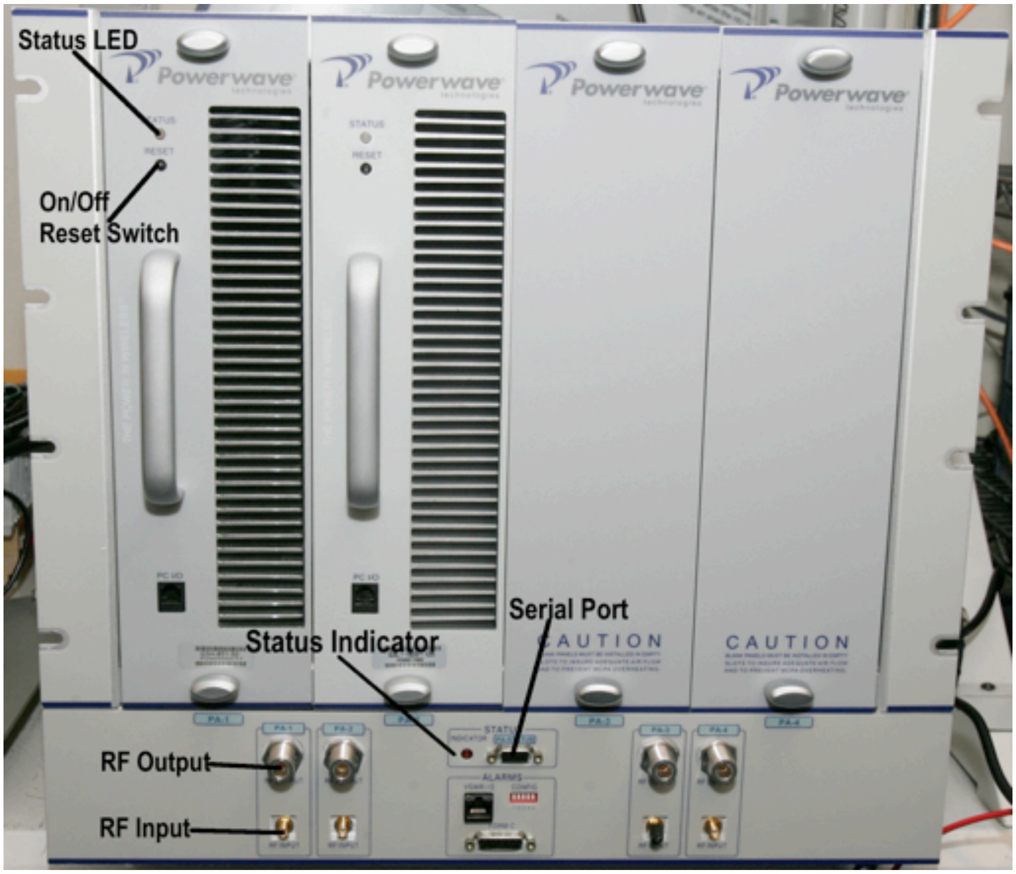

Figure 2.4: Power Chassis and two MCPAs

Please Note: For proper system operation, after the BSS has started, please be sure that the “Status” LED appears green, and that the “Status Indicator” light next to the Serial Port is not lit. Make sure the MCPA is properly seated and secured in the chassis. If problems persist, contact Vanu Technical Support.

2.5 DC Breaker and Bus Bar

The DC Breaker protects the Power Amplifiers from electrical surges and short circuits. Consult the "Equipment Setup Steps" chapter for proper connections from an MCPA to its associated breaker and power source (such as a rectifier).

Figure 2.5: DC Breaker and Bus Bar, Front View

Please Note: For proper surge protection, each MCPA must be connected to its own 50 amp breaker.

2.6 Power Rectifier

The Power Rectifier used in a typical deployment converts 120 Volt AC current to 27 Volt DC current, making it possible for the MCPAs to be powered by an AC power source. The Power Rectifier's ability to hold up to three power modules makes it easy to swap out an existing power module or add a new one as necessary for increased DC power.

The Power Rectifier used in your deployment will have one power module. Each MCPA has two power connections: +27V DC (red) and the Return (black) to the rectifier being used in the system. Each power module in the rectifier requires its own 120 Volt power source.

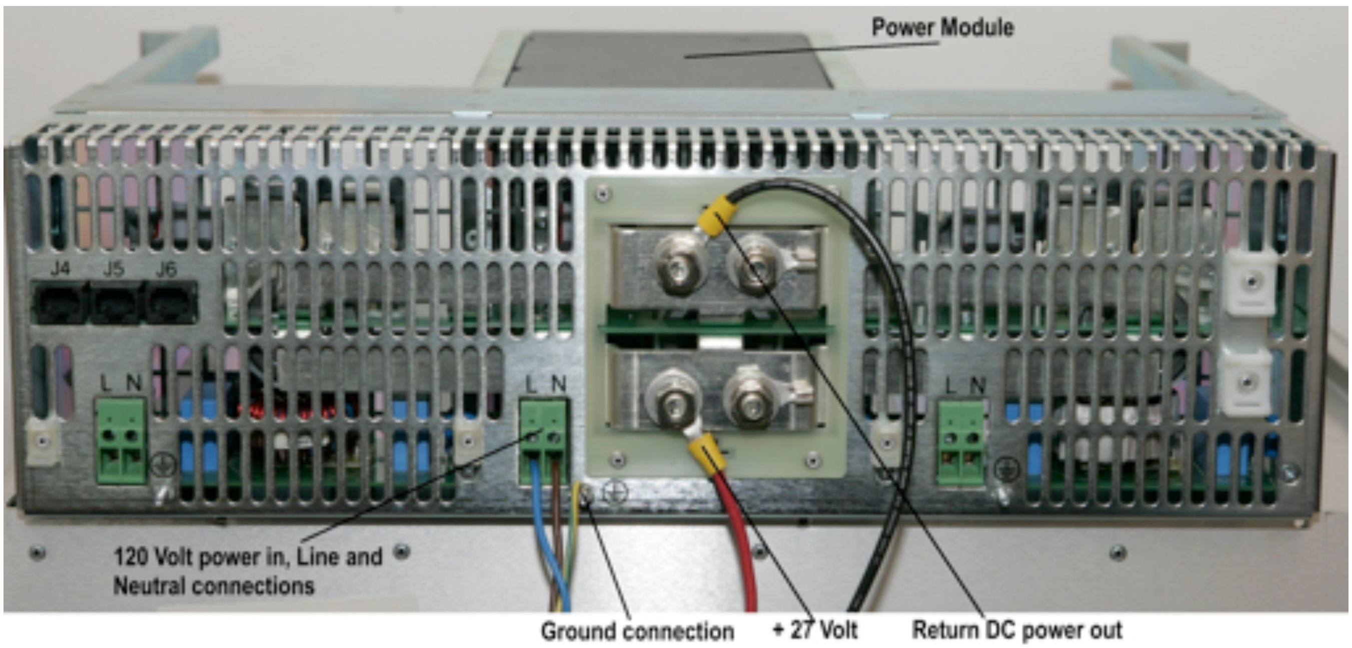

Figure 2.6: Powerwave Power Rectifier

2.7 Terminal Server

The Terminal Server provides serial functionality over the network for both serial consoles and serial data connections. The Terminal Server 16 can provide sixteen independent serial connections from a single IP address to multiple servers, allowing access to network server applications that support TCP/IP. This prevents the need to install serial cards in multiple servers at a location, and enables the use of servers that cannot support a serial card.

Figure 2.7: Digi Terminal Server TS 16

Chapter 3

System operation

3.1 System startup

After all equipment connections have been correctly made, the system will be ready for operation. To start the system:

1. Switch on the Protium RF unit.

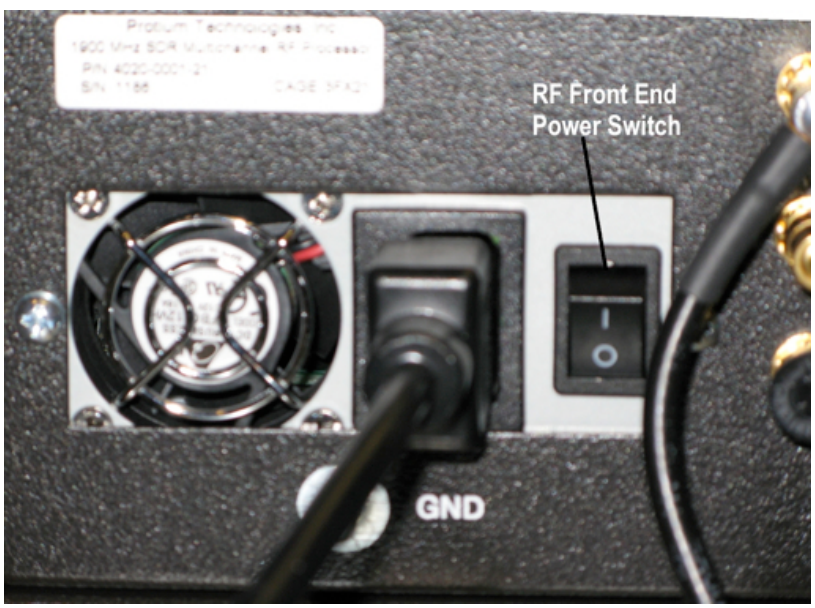

Figure 3.1: RF Front End Power Switch

2. Power on the HP DL380 G5 BSS Server containing the Anywave software.

Figure 3.2: DL380 G5 Control Panel

3.2 System Usage

Once all the Anywave components are installed, configured, and running, the system should be able to register phones after 60 seconds. The phones being used must be properly configured to function correctly. The necessary configuration ‘parameters include:

- provisioning for use at the MSC
- having a SIM card installed
- ensuring that the phone can be used on the network, i.e. not locked to a competing network
- using the correct frequency band for the BTS

3.3 BTS Software Operations

The BTS software is configured to automatically start approximately five minutes after server boot. If there is an operation failure, the BTS software will automatically restart without user input.

3.4 References

- For further information on system installation and correct system component connections, please see the "Vanu Anywave Installation Guide."
- For further information on monitoring and management operations, please see the "Vanu Anywave OA & M System User's Guide" for detailed information on the Vanu, Inc. web-based OA & M system.

Appendix A

Acronym Glossary

Table A.1: Acronym Glossary

ARFCN	Absolute Radio Frequency Control Number
BSC	Base Station Controller
BSS	Base Station Subsystem
BTS	Base Station Transceiver Subsystem
CDMA	Code Division Multiple Access
GSN	Gigabyte System Network
GSM	Global System for Mobile Communications
GPRS	General Packet Radio Service
GPS	Global Positioning System
HLR	Home Location Register
IMEI	International Mobile Equipment Identity
IMSI	International Mobile Subscriber Identity
MCPA	Multi-Carrier Power Amplifier
MSC	Mobile Station Controller
PA	Power Amplifier
PCI	Peripheral Component Interconnect
PCS	Personal Communications Services
PCU	Packet Control Unit
PPS	Port Pulse Per Second port
RF	Radio Frequency
RH	Radio Head
RTP	Realtime Transport Protocol
SDR	Software Defined Radio
SIM	Subscriber Identity Module
SMS	Short Messaging Service
TRAU	Transcoder and Rate Adaptor Unit
VLR	Visitor Location Register
VoIP	Voice over Internet Protocol
VPN	Virtual Private Network
WAP	Wireless Application Protocol
WIC	Wide Area Network Interface Cards

Index