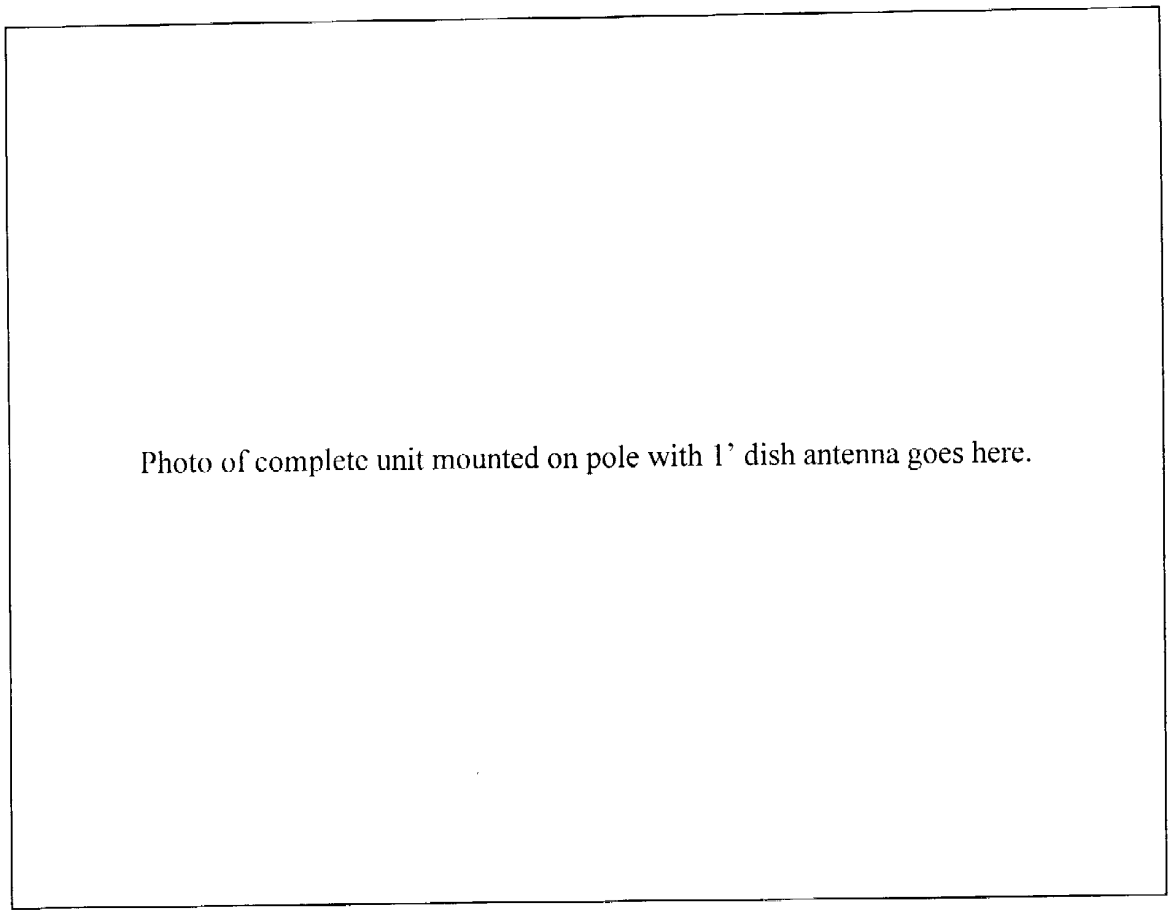
WIRELESS, INC.



WaveNet IP 2458
Operations Manual

Version 0.6 DRAFT

Notice

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

Caution: Any user changes or modifications not expressly approved by Wireless, Inc. could void the user's authority to operate this equipment.

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1 Preface

WaveNet® IP 2458 is a wireless access router, that can be used to link up to hundreds of remote Ethernet LAN's to a single central site location. WaveNet IP 2458 has voice prioritization and user selectable bandwidth reserved for voice, which allows WaveNet IP2458 to integrate seamlessly with your VoIP network. Along with providing full duplex operation, special care has been taken in the design of this product to minimize latency, the number one concern when deploying VoIP networks

Purpose of Document

This document contains the information and procedures necessary to plan, install, operate, test, and maintain *WaveNet IP 2458* systems.

Intended Audience

This document is intended for personnel who install, operate, and support *WaveNet IP 2458* equipment. This includes network administrators, as well as those who plan and install the radio links. Network administrators should have experience planning, installing, and operating internetwork equipment and networks.

How Document is Organized

The information in this document is ordered to match the chronological flow of tasks needed to plan and deploy a network:

- Specifications
- Network and Site Planning
- Pre-Installation Configuration
- Installation
- Operation
- Troubleshooting/Maintenance

2 Specifications

WaveNet IP 2458, a point-to-multipoint wireless access router, offers a low-cost alternative to ISDN, leased lines and Frame Relay for Internet and intranet connectivity. *WaveNet IP 2458* is capable of supporting hundreds of remote networks from a single central location. Radio link margins exceeding 15 dB are consistently achievable for remote routers located within 20-30 km of a central router site.

The system is composed of central and remote routers. The entire wireless router unit is contained within a single outdoor enclosure. The remote routers are typically mounted on the roof or side of a building and connect into the remote site Ethernet with a standard 10Base-T connection. Central site routers are typically mounted on top of tall buildings or hilltops. Up to ten central units can be co-located at each central site, allowing incremental deployment of network capacity at the central site.

Operation in the 2.4 GHz and 5.8 GHz ISM frequency bands eliminates the wait for frequency licenses, allowing rapid deployment of networks. Adding a new remote site to an existing network can be accomplished within hours.

The central router physically transmits to all remotes that it serves, in a point-to-multipoint manner. The router functionality at the remote routers insures that data is only delivered to the correct remote site Ethernet. The remote router physically transmits only to the central router, in a point-to-point manner. The router functionality at the central router determines if the data should be routed over its Ethernet link or to another remote router that it serves.

Configuration

Figure 1 shows how a single central site network might be constructed as part of an Internet Service Provider network, or corporate intranet.

The network configuration limits are:

- Up to 10 central units per central site location
- Up to 60 remote units per central unit (600 per central site)
- Central to remote line of site distances:
  ⇒ up to 32 km

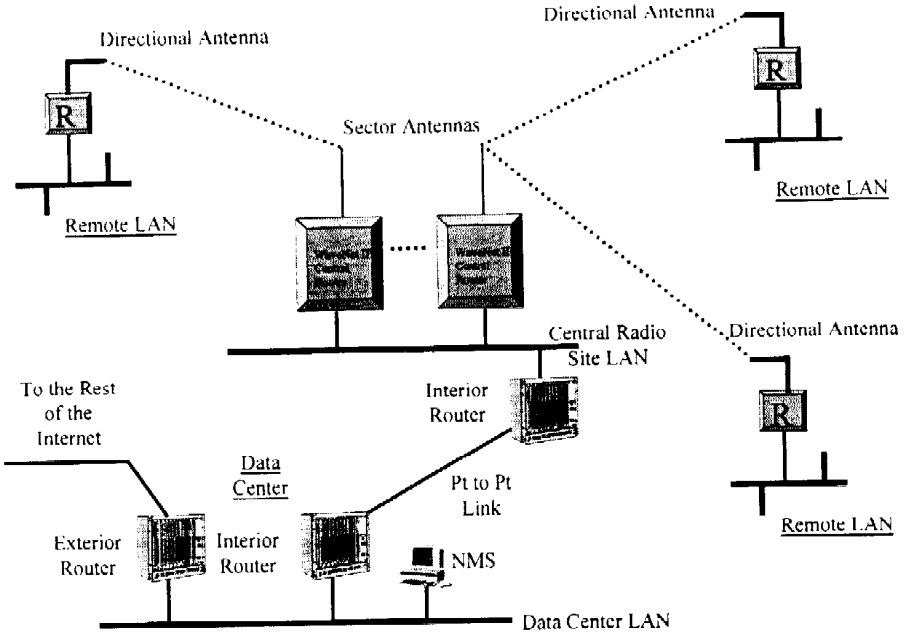

Figure 1 Radio Network Example

Theory of Operation

Radio Network

The radio network utilizes three separate communications channels: outbound, inbound, and inbound contention.

Packets flow from the central router to the remote routers in the outbound channel. Packets destined for all remotes share this channel. Each remote router examines each packet, and accepts those that have the correct radio network address (RF Net ID) and are addressed to its radio interface station address. Normally these packets will be either received locally by the remote router (for router management functions), or forwarded to the remote router's Ethernet network based on the packet's destination IP address and the contents of the remote router's Route Table. If there is no Route Table entry matching the packet's IP network address, the packet will be discarded. Packets are transmitted on the outbound channel based on the order that the central router receives them.

Packets flow from the remote routers to the central router in the inbound channel. Packets destined for the central router from all remote routers share this channel. The central router acts on these packets in the same manner that the remote routers act on packets from the outbound channel. When one remote router addresses a packet through another remote router, the packet is first transmitted to the central router, which in turn transmits it to the destination remote router.

When a remote router initially has one or more packets to transmit to the central, it signals its need to transmit by placing a *reservation* request in the inbound contention channel. This channel is divided into slots, which are shared by all remote routers. It is possible that more than one remote will attempt to transmit in the same slot (a *collision*), and as a result either one or the other remote will succeed in transmitting its request, or else neither will succeed. If the remote does not receive an acknowledgment that it can transmit its packet(s), it will retry the reservation request. The number of slots available is sufficient to ensure that no remote router will be consistently blocked from making reservation requests due to collisions.

When the central router receives a reservation request from a remote router, it adds the remote router to its *polling* list. The central router polls each remote router on its polling list in a round-robin manner. When a remote router receives a *poll request* from the central router in the outbound channel, it responds by transmitting one data packet in the inbound channel.

Security

Security provisions exist at several levels, allowing a highly secure network to be deployed. Specific security features include:

- Frequency hopping spread spectrum protects reception of raw radio transmission
- Proprietary physical layer protocol protects the decoding of data from raw radio transmission
- Authentication feature (when enabled) prevents unauthorized remote units from accessing radio network
- Static route tables ensure that remote sites only receive packets destined for their local networks
- Passwords and community names restrict management operations to authorized users

Due to these features, the radio network is usually more secure than the wireline networks that link to it (Ethernet, PPP links, etc.). To insure user application security, either all network links must be physically and logically secured (usually difficult), or else end-to-end application-level encryption should be used.

Performance

The radio link operates at a raw rate of 850 kbps full-duplex. Inbound and outbound channels each operate at a raw data rate of 850 kbps, approximately 20% of which goes to the contention channel and other overhead. IP packets are transmitted in variable length segments resulting in a maximum capacity for the combined inbound and outbound channels of over 100 IP packets per second of size 1500 bytes.

Management

There are three basic management facilities included with each router:

- HTTP/HTML server providing embedded management Web pages
- SNMP MIB-II and *WaveNet IP 2458* enterprise MIB support
- FTP upload and download of configuration data files and system software

Configuration and monitoring of individual routers can be accomplished using the Web pages served from within the router itself. Overall network monitoring can be accomplished using an SNMP network management station (NMS), using both the standard MIB-II variables as well as device-specific variables included in the supplied *WaveNet IP 2458* enterprise MIB. The router contains a flash file system, and configuration data and system software are stored in various files that can be accessed using FTP. No special management applications are required to use these facilities.

Network administrators can enable or disable access to these facilities, and can limit access by use of passwords or SNMP community names.

Internal Interfaces

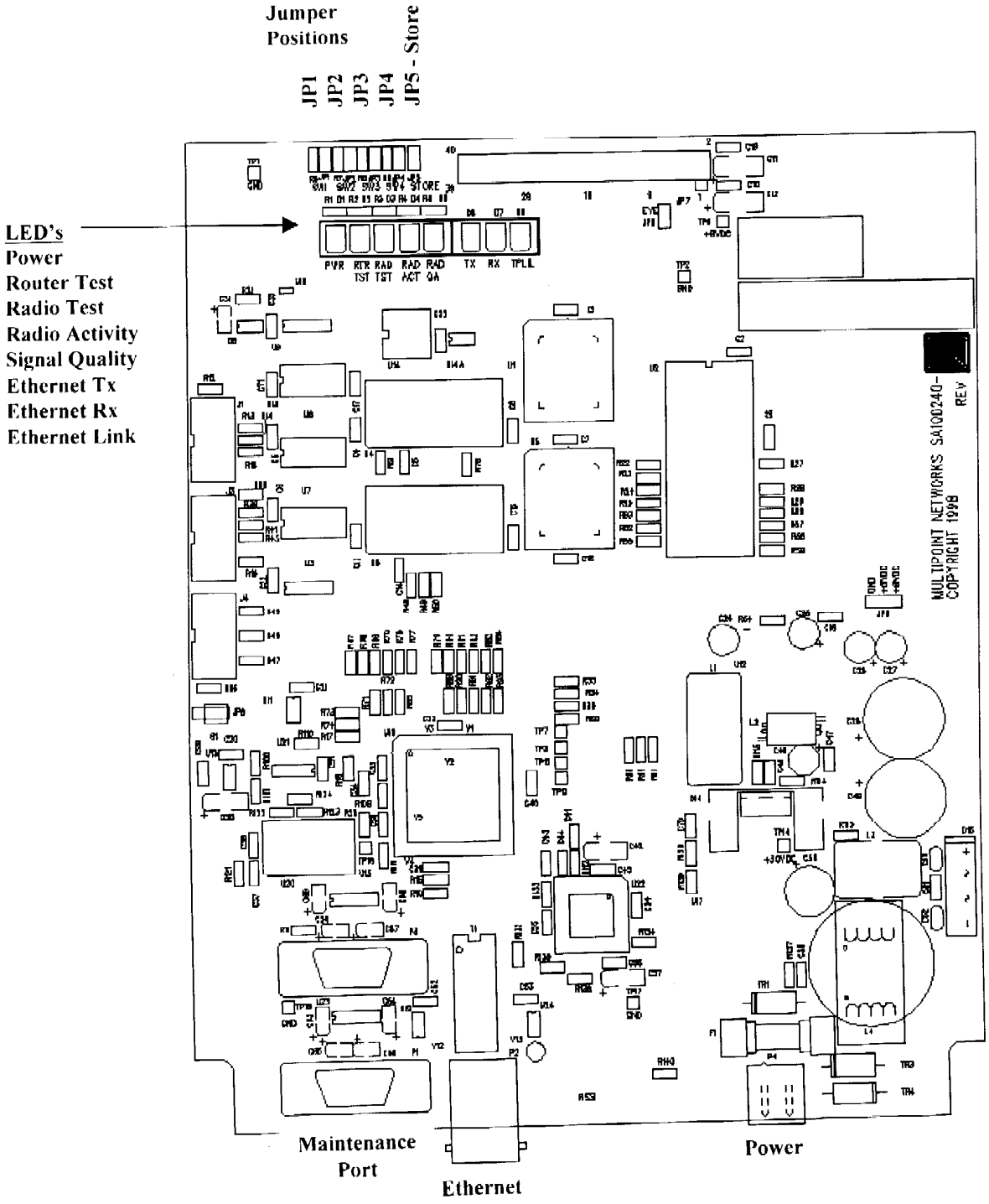

Figure 2 Internal Interfaces

The following interfaces are located inside of the enclosure (see Figure 2):

- LED's: See Chapter 7 for descriptions
- Jumper: Jumper should normally be in the *store* position. Moving the jumper to *J4* modifies the Set-up switch behavior. (The jumper positions are located below the LED's towards the top of the board.)
- Set-up switch: When jumper is in the *store* position, this switch restarts the router. When the jumper is moved to *J4*, the switch sets various router parameters to a known state to allow pre-installation configuration to be performed. (The switch is located in the middle of the left edge of the board.)
- Ethernet: 10Base-T with RJ-45 connector supporting Type II framing
- Antenna ports: Internal RF connections are made using SMA connectors, located on the bottom of the shield plate beneath the router board. The antenna cables connect directly to female N connectors located on the bottom of the enclosure (See Figure 3).
- Power: Plug-able male terminal block, with two conductors, drawing 25 watts maximum. Power options include:
  - ⇒ ± 20 to 41 VDC (at router input terminals)
  - ⇒ 14 to 29 VAC (at router input terminals)
  - ⇒ ± 42 to 60 VDC (with external voltage limiter)
  - ⇒ 103 to 136 VAC (with external transformer)
  - ⇒ 206 to 265 VAC (with external transformer)
- Signal Quality: Signal strength voltage test point (plated through hole) for aiming antenna. Used with digital volt meter with alligator clip leads (remote routers only)
- Maintenance Port: RS-232 DB-9 (use only under direction of Multipoint technical staff)

Protocols

- Network: IP Version 4.0 (with CIDR support), ICMP
- Transport: TCP, UDP
- Application: FTP, Telnet, HTTP, SNMP

Radio

- Frequency-Hopping Spread Spectrum Transmit and Receive Frequencies
  - Central - Transmit 2.403-2.481 GHz, Receive 5.770-5.848 GHz
  - Remote - Transmit 5.770-5.848 GHz, Receive 2.403-2.481 GHz
- 79 channels
- 26 unique hopping sequences
- GMSK modulation with 850 kbps raw data rate
- Tx power: +15 to +24 dBm (adjustable)
- Rx sensitivity: -88 dBm minimum (-90 dBm typical) at 10^{-6} BER