

# *Agility White Space Radio (AWR)*

## *Operator Manual*



*Model Number AWR-US-U-100*

*June 2012*

*Revision A.12*



## ***Quick Start Procedure***

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The KTS AWR White Space radio must be professionally installed by an authorized installer. The installer must be authorized by KTS Wireless. The installation must be in accordance with 47 CFR Part 15, Subpart H. Only the following components are approved for use with the radio.

- Power Supply: **APX Technologies SP63P924R**
- Antenna: **Telex ALP-450**

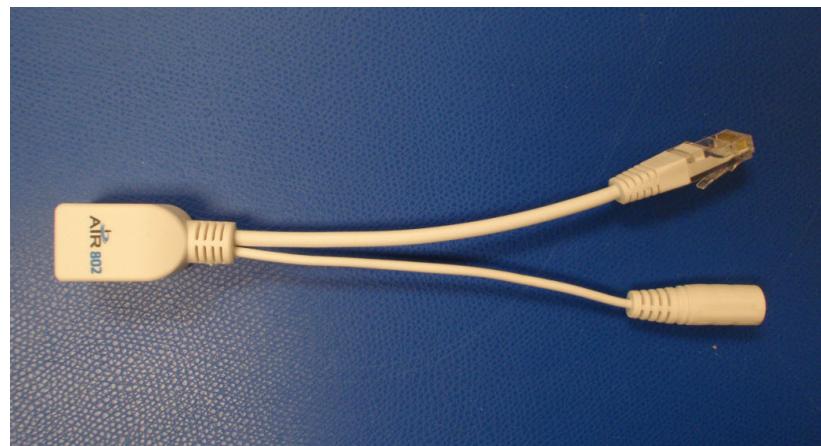
Install and configure Agility White Space Radio (AWR) as follows:

1. The AWR requires a 12-24 VDC input and consumes 6 Watts (RX) and 20 Watts (TX). Power is supplied via Power over Ethernet (PoE).



External Interfaces –Ethernet (PoE) and Antenna Port

2. The AC power supply and PoE injector should be co-located in a weatherproof enclosure or environmentally controlled building.

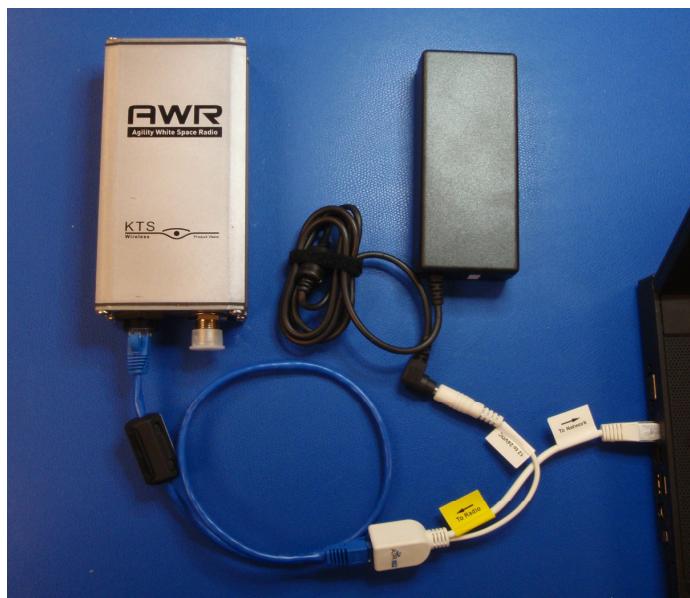


PoE Injector

3. Install the clamp on ferrite bead provided in the kit (Fair-rite part number 0446164281 or equivalent) 2.5 cm from the molded end of the Ethernet cable that plugs into the radio's Ethernet port.
4. Connect a laptop and power supply to the AWR as shown. **Failure to connect the PoE injector and power supply correctly can damage a connected device. Do not use a crossover terminated Ethernet cable.** The AWR requires approximately 10 seconds to initialize.

Set the computers IP Address to a static IP address on the same subnet as the AWR (e.g., 192.168.1.100). The default IP Address for new AWR radios is **192.168.1.4** with an IP Gateway address of **192.168.1.1**. When the laptop and AWR are connected together and powered on, use the default IP Address to access and configure each new device prior to deployment using the EMS application.

Each new AWR is preconfigured as a Spoke radio as shown on the Element Manager's Device Info tab. All AWR's destined to be network Hubs must have its Node Type changed to a Hub using the Node Type dropdown box. Select the desire node type and "save" the configuration to the radio using the EMS tool. The latitude and longitude where each radio is to be installed must be entered using the White Space tab. This information is provided to the White Space database so that the correct list of available channels can be sent to the radio.



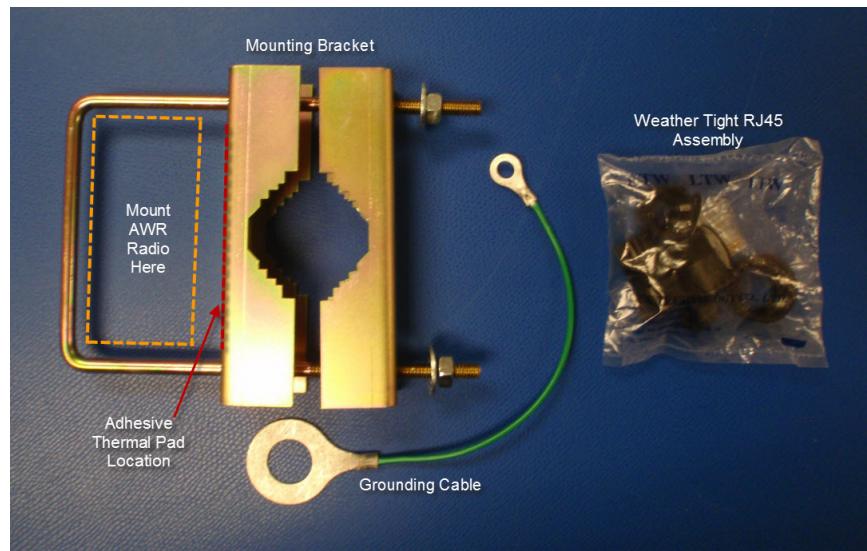
**Note: The AWR should not be powered on without an antenna connected to the RF connector.**

5. Installation of the EMS software provided with the AWR is required in order to manage the AWR devices. Insert the included CD into a computer and double click on the installation file: **TVBD\_Installer.exe**. Follow the prompts to complete the EMS software installation process. The software installation process is described in detail in **Section 4.0 TVBD Element Management System**.

6. The mounting bracket, grounding cable and weather resistant RJ45 cap assembly is shown below. A thermal pad with adhesive is also included. Installing this thermal pad will reduce the operating temperature of the AWR, while maximizing performance and reliability. The bracket with thermal pad should be centered between the two screws located on the back of the radio.

To connect the grounding cable, remove the nut and lock-washer from the AWR radio's N-female RF connector and install the large ring-lug on the grounding cable over the N-female connector. Reinstall the lock-washer and nut. Tighten the nut securely.

Remove one locknut from the mounting bracket U-bolt. Install the small ring-lug on the U-bolt and reinstall the locknut.



Mounting Bracket Assembly and Weather Tight RJ45 cap



Weather Tight Connector Assembly Sequence

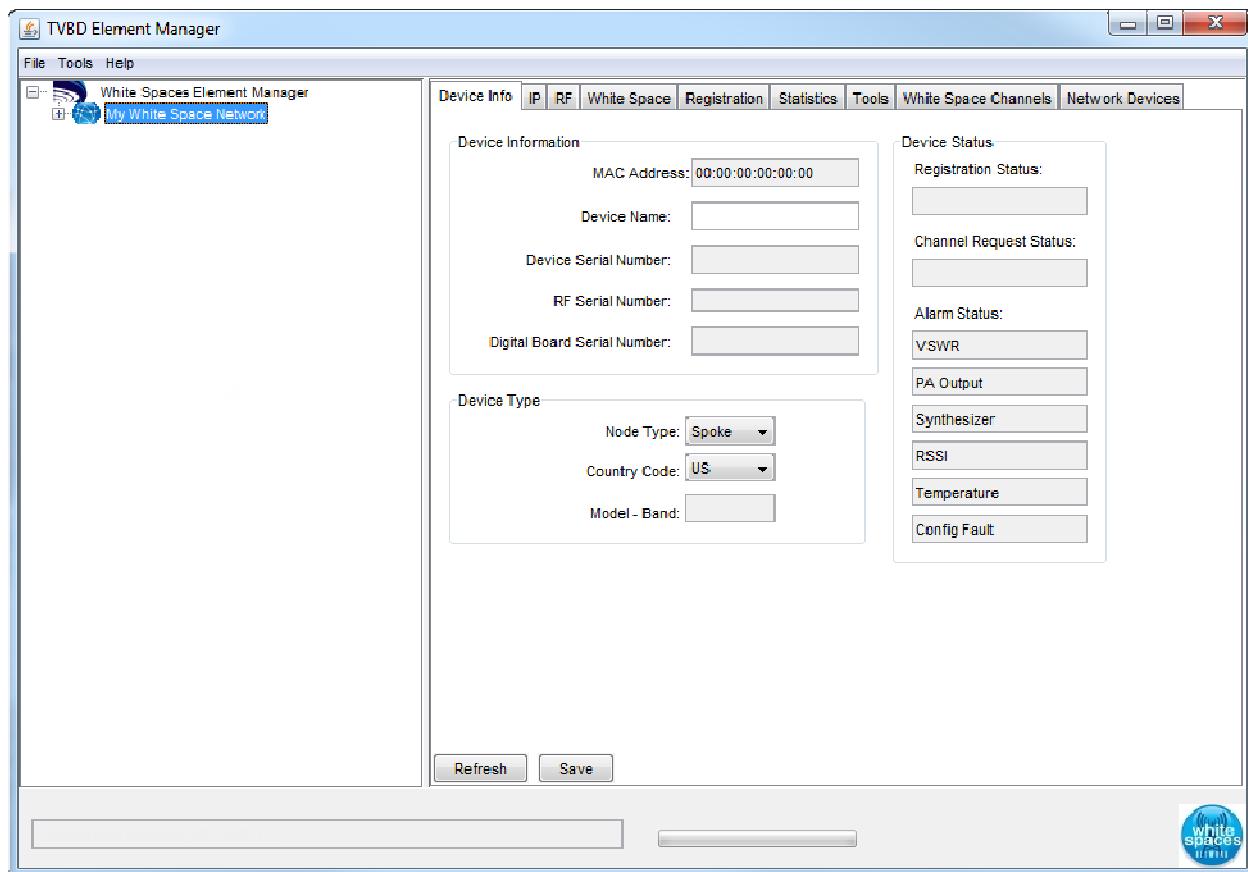
Weather Tight Connector Assembly



Pole Mounted Configuration

7. Locate the coaxial cable used to connect the antenna. Each AWR is supplied with a three foot LMR-400 coaxial cable with N-male connectors. If a longer cable is required, it should be a high quality, low-loss cable that is as short as possible. An in-line surge arrestor is recommended to prevent lightning strike damage to the radio.

- After the installation process is complete and the EMS application is started, the Device Info screen will appear. Section 4.0 of this manual contains information regarding the use of the TVBD Element Management System (EMS). Reference Section 4.0 for details on configuring the AWR IP addresses.  
Note: The default IP address of the AWR is **192.168.1.4**.



**TVBD EMS Main Screen**

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## Copyright Notice

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## Operational and Safety Notices



### RF Exposure

The radio described in this manual transmits RF energy. The concentrated energy from the antenna may pose a health hazard. All antennas used with this radio must be installed to provide a minimum separation from all persons of 40 cm (15.7 inches). The above separation distance must be maintained at all times. More information can be obtained from the FCC at the following website:

[http://www.fcc.gov/Bureaus/Engineering\\_Technology/Documents/bulletins/oet65/oet65.pdf](http://www.fcc.gov/Bureaus/Engineering_Technology/Documents/bulletins/oet65/oet65.pdf)



### FCC Part 15 Notice

Equipment operation currently conforms to the rules for TV band devices, pursuant to Part 15 of the FCC Rules. These rules are designed to provide reasonable protection against harmful interference. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the operator is encouraged to try to correct the interference by adopting one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the manufacturer, dealer or an experienced radio/ TV technician for help.

The KTS AWR White Space radio must be professionally installed by an authorized installer. Only the following components are approved for use with the radio.

- Power Supply: **APX Technologies SP63P924R**
- Antenna: **Telex ALP-450**

## Safety

It is advisable to use the device only in the normal operating position as described in this guide.

- WARNING:** This device transmits radio frequency (RF) energy. To comply with FCC RF exposure requirements, antennas must be installed and operated with a minimum separation distance of 40 cm (15.7 inches) from all persons.
- WARNING:** When the system is operational, avoid standing directly in front of the antenna. Strong RF fields are present when the transmitter is on. The antenna must not be deployed in a location where it is possible for people to stand or walk inadvertently in front of the antenna.
- WARNING:** The electrical installation must be accomplished in accordance with the National Electrical Code (NEC), and with any local codes effective at the time of installation
- WARNING:** To eliminate risk of electric shock, DO NOT connect/disconnect cables while units are energized.
- WARNING:** Safety will be compromised if external quality cables are not used for connections that will be exposed to the weather.
- WARNING:** Installation of antennas near power lines is dangerous, and contacting power lines can be lethal. Select the installation site with safety, as well as performance, in mind. Make sure there are no power lines anywhere where possible contact can be made. Carefully check the distance to any power lines before starting installation. The distance from the mast or antenna to the nearest power line should be at least twice the total length of the mast/antenna combination.

## 1.0 Product Description

The Agility White Space Radio (AWR) shown below is designed to provide a reliable wireless connection for digital communication in UHF TV bands in the 470 – 698 MHz frequency range.



**Agility White Space Radio (AWR)**

The AWR is operated under the control of a FCC-approved TVBD database such as the one provided by Spectrum Bridge, Inc. Its frequency, power level and many other transmit parameters cannot be set by the operator. This is done to ensure the AWR does not interfere with incumbent users in the TV bands.

## 2.0 Applications

The most common application for the AWR is a “star” network, in which a single hub site communicates with a collection of remote or “spoke” sites.

The Hub AWR is connected to a directional antenna via a length of coaxial cable. The signal transmitted by the Hub AWR is then transmitted to all remote sites within a range supported by the configured transmitted power. Each remote site AWR is typically connected to a directional antenna via a length of coaxial cable. These antennas are “pointed” toward the hub to achieve maximum gain.

User devices are connected to the Ethernet RJ45 connector of the AWR. The point-to-multipoint network shown in Figure 2.1 interconnects the Hub AWR with all remote AWRs over the air. Media Access Control (MAC) software within the AWR allows all the radios to share the wireless spectrum on a non-interfering basis.

It is assumed that the user traffic is IP. The Hub AWR performs the polling of all remote AWRs. This happens automatically and transparently to the user devices connected to the Ethernet ports. This MAC is referred to as Poll/Select. When a remote AWR receives an IP message over the Ethernet port, it is routed through a Learning Bridge in the AWR. If this bridge determines it should be transmitted over the air, the AWR buffers the message until the next poll is received from the Hub AWR and transmits the message.

## **3.0 Specifications**

### **Electrical**

- UHF 470 – 698 MHz (TV Channels 14-51)
- Maximum RF Transmit Power: +21 dBm with ATPC
- Noise Figure 4 dB
- Spurious & Harmonic Emissions FCC Part 15 compliant
- Data Rates 3.125 MB/s
- Modulation SOQPSK
- Channel Bandwidth 6 MHz
- Selectivity >60 dB
- Operating mode Half-duplex or simplex
- User Port Ethernet (10/100 BT)

### **Mechanical**

- Dimensions 3.25" x 5.5" x 1.6"
- Enclosure material AL Anodized
- Weight (w/o mount) 1.2 lb

### **Environmental**

- Operating Temperature Range: -30 to +60 C
- Operating Humidity: Up to 95%, non-condensing

### **Power**

- Input Voltage: +12 to 24 VDC
- Power Consumption: 6 Watts (RX), 20 Watts (TX)

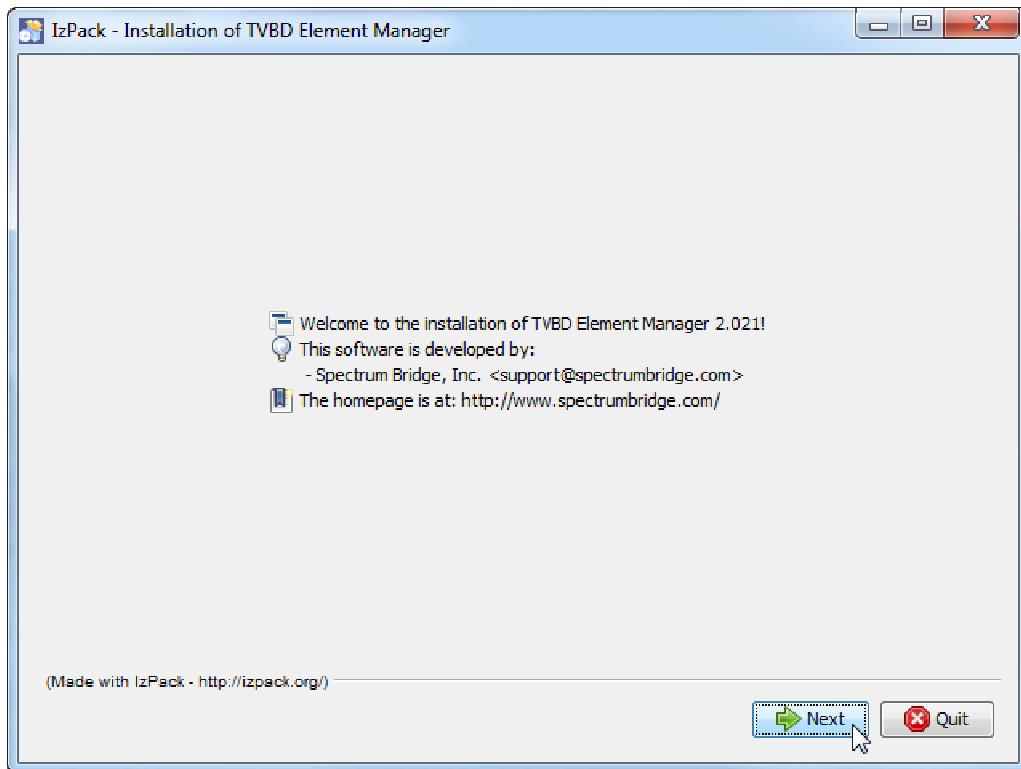
## 4.0 TVBD Element Management System

Most networks require some level of network management and a White Space Network is no exception. This document will describe the use of the KTS Wireless TVBD White Space Element Management System (EMS). This tool is used by an authorized professional installer (or network operator) during radio deployment and to manage the network.

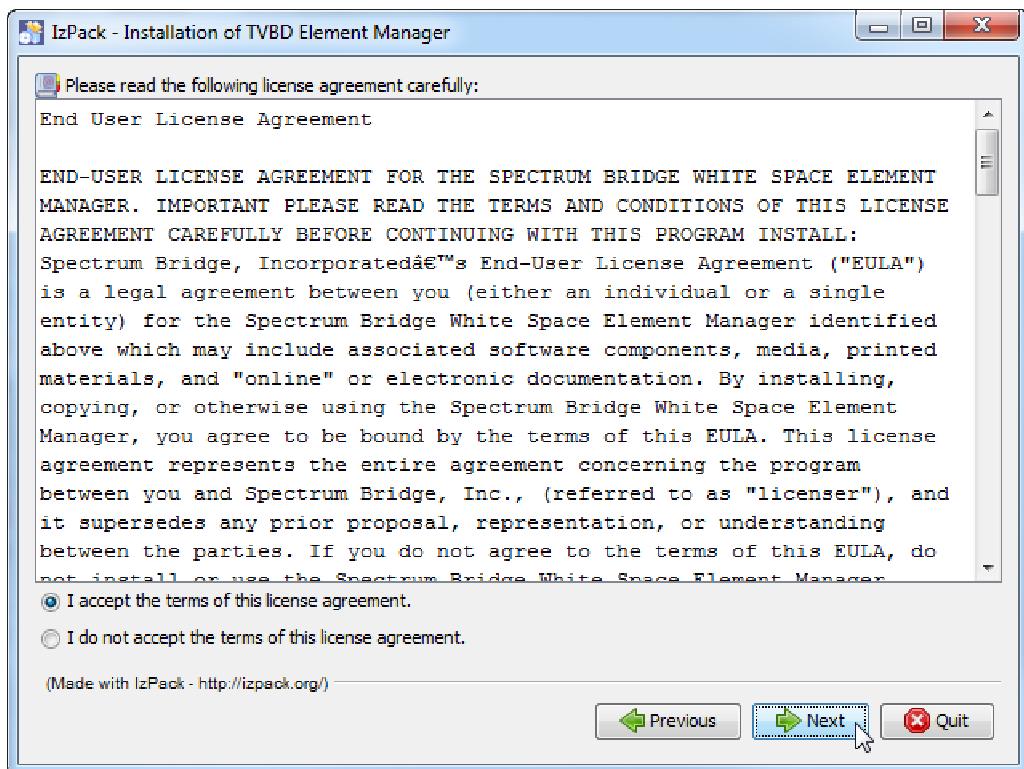
### EMS Application Installation

The EMS Application is a Java based application. The application requires a Windows XP (32-bit) or newer operating system, but it will also run in Linux. The minimum [Java Runtime Environment](#) is 5.0.

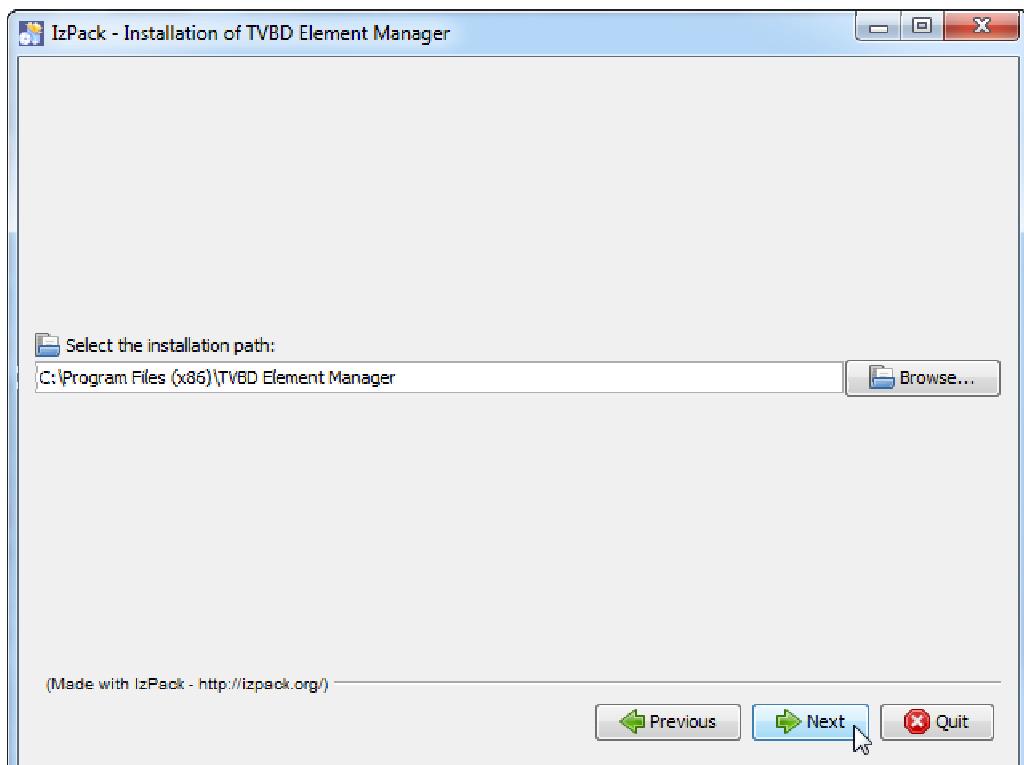
The included CD contains a software directory with a file called TVBD\_Installer.exe. Double-click on the file to launch the installer. The following installation program will be displayed.



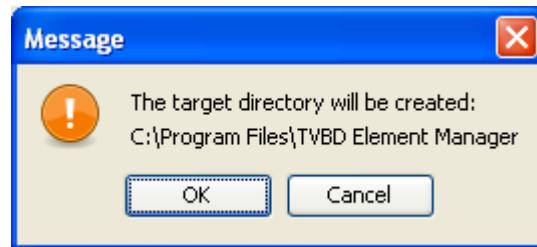
Select “Next” to continue installation of the Element Manager Program.



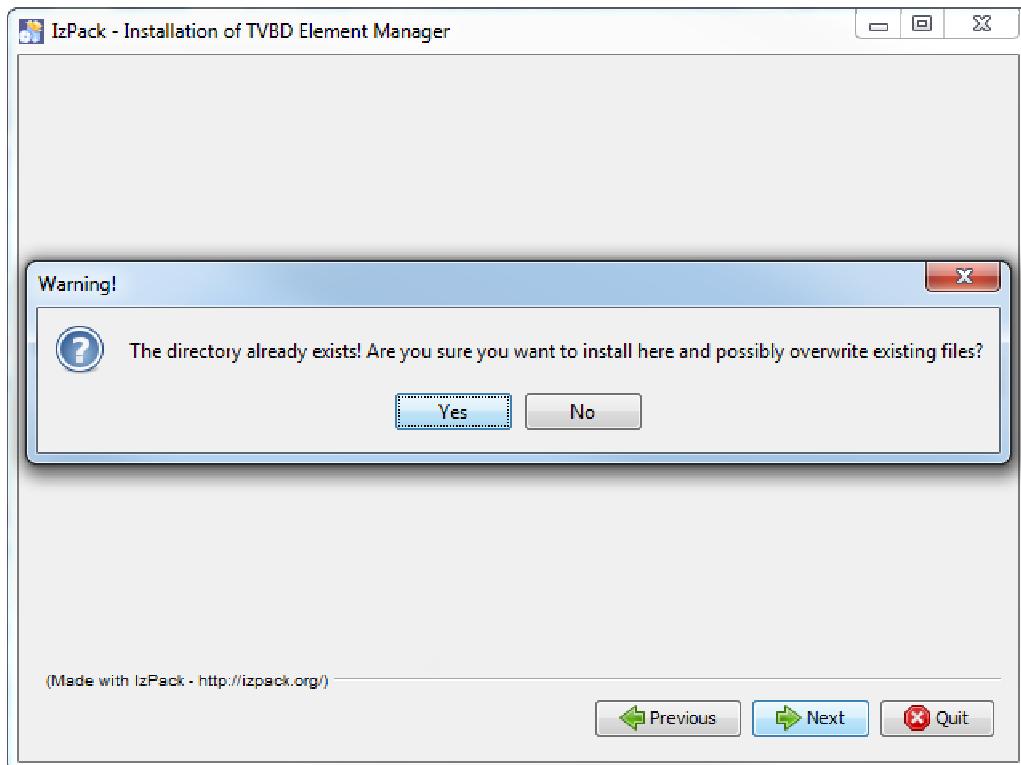
To continue the installation, select the “I accept...” radio button and then “Next.”



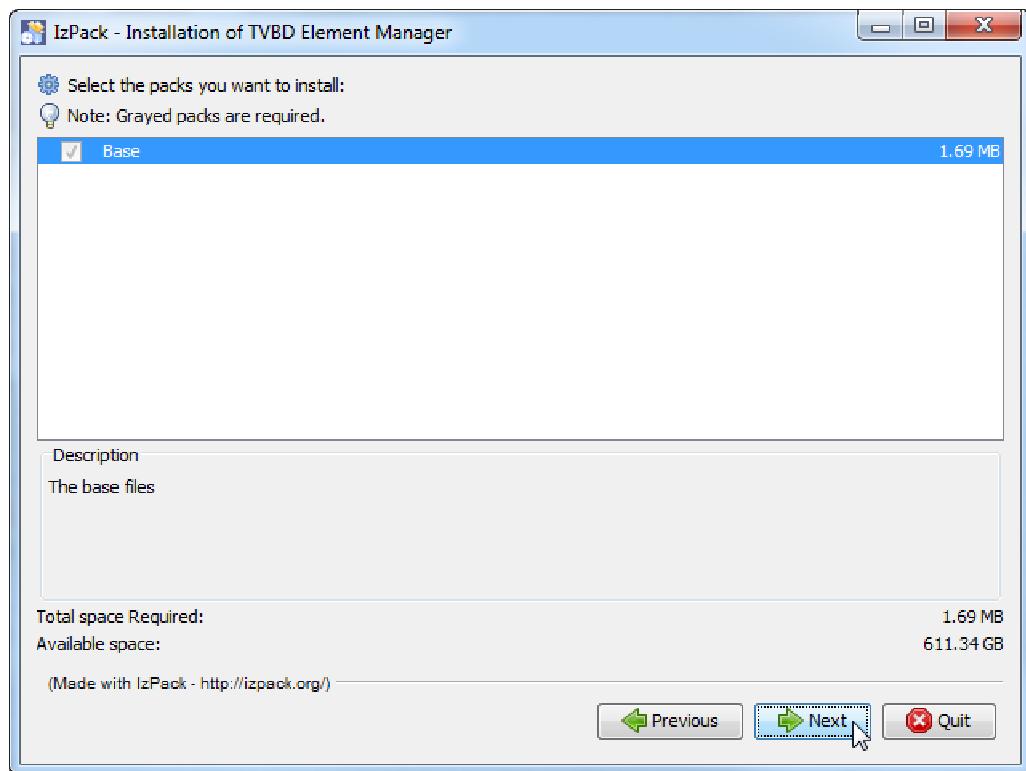
The file installation path is displayed. Click “Next” to continue.



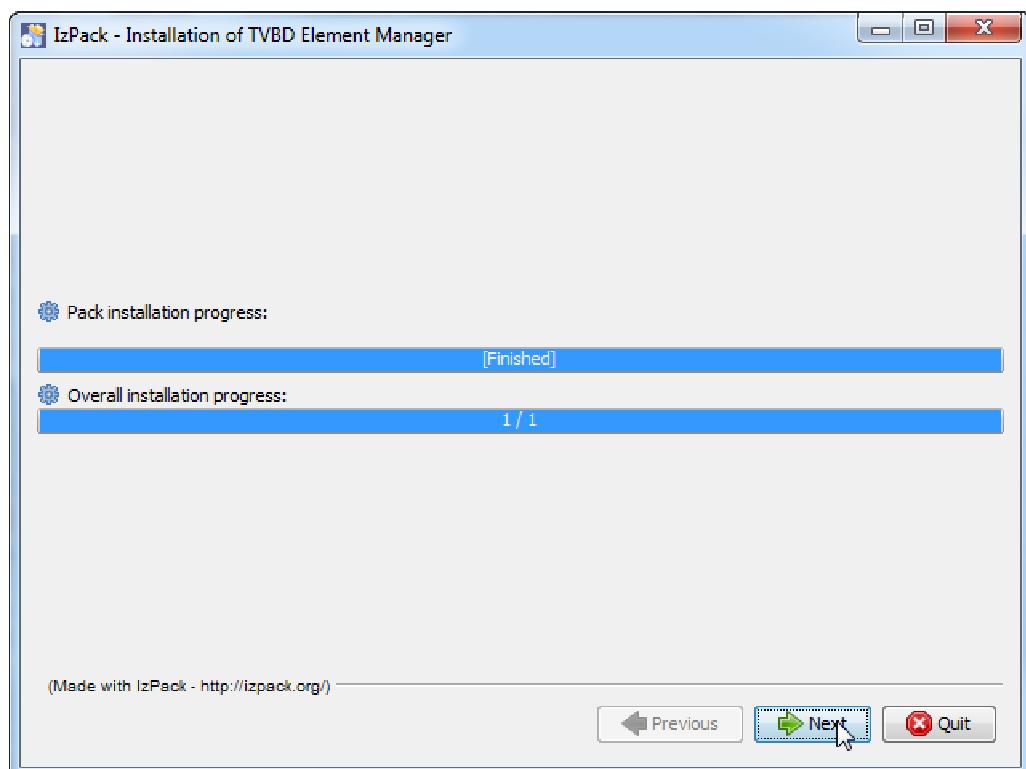
“The target directory will be created” message is displayed if this is the first installation of the EMS application. Select “OK” to continue the installation.



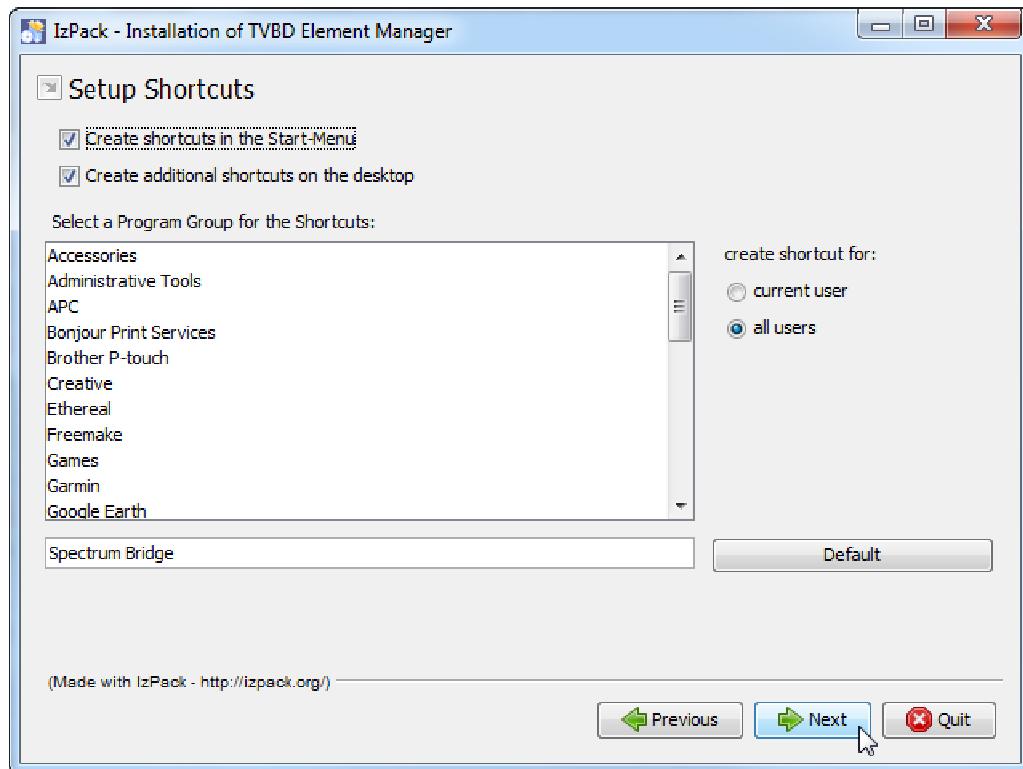
“The directory already exists” message is displayed when the EMS application is being reinstalled or updated. Select “Yes”, and then select “Next” to continue the installation.



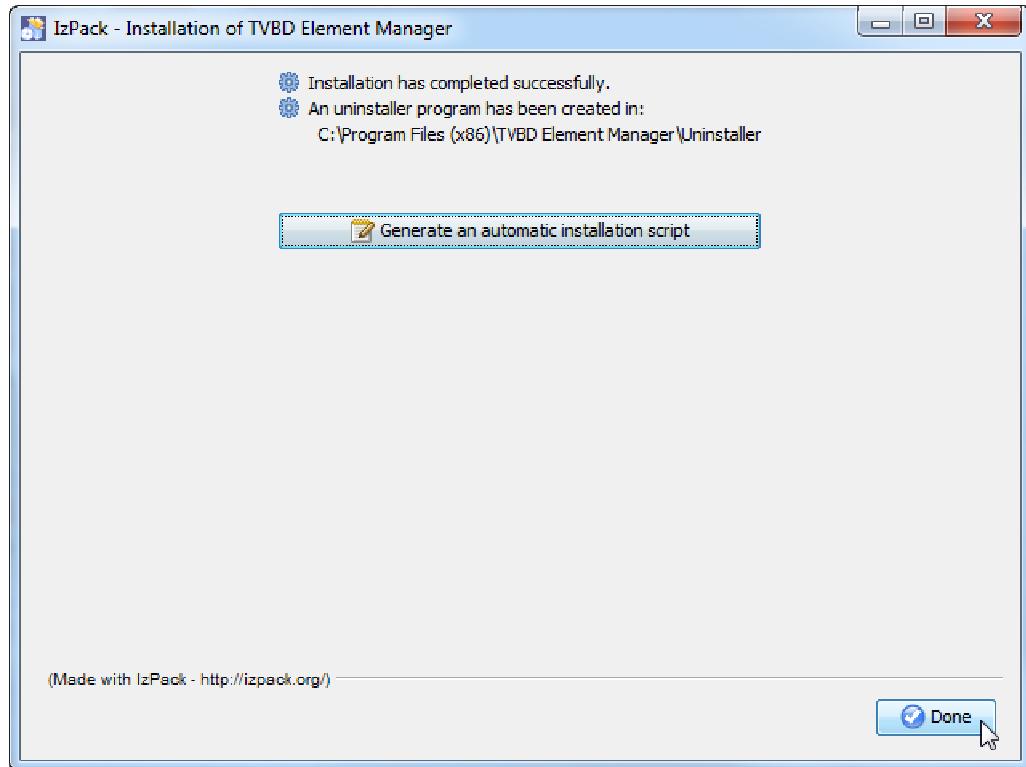
Select “Next” to continue the installation.



Select “Next” to continue the installation.

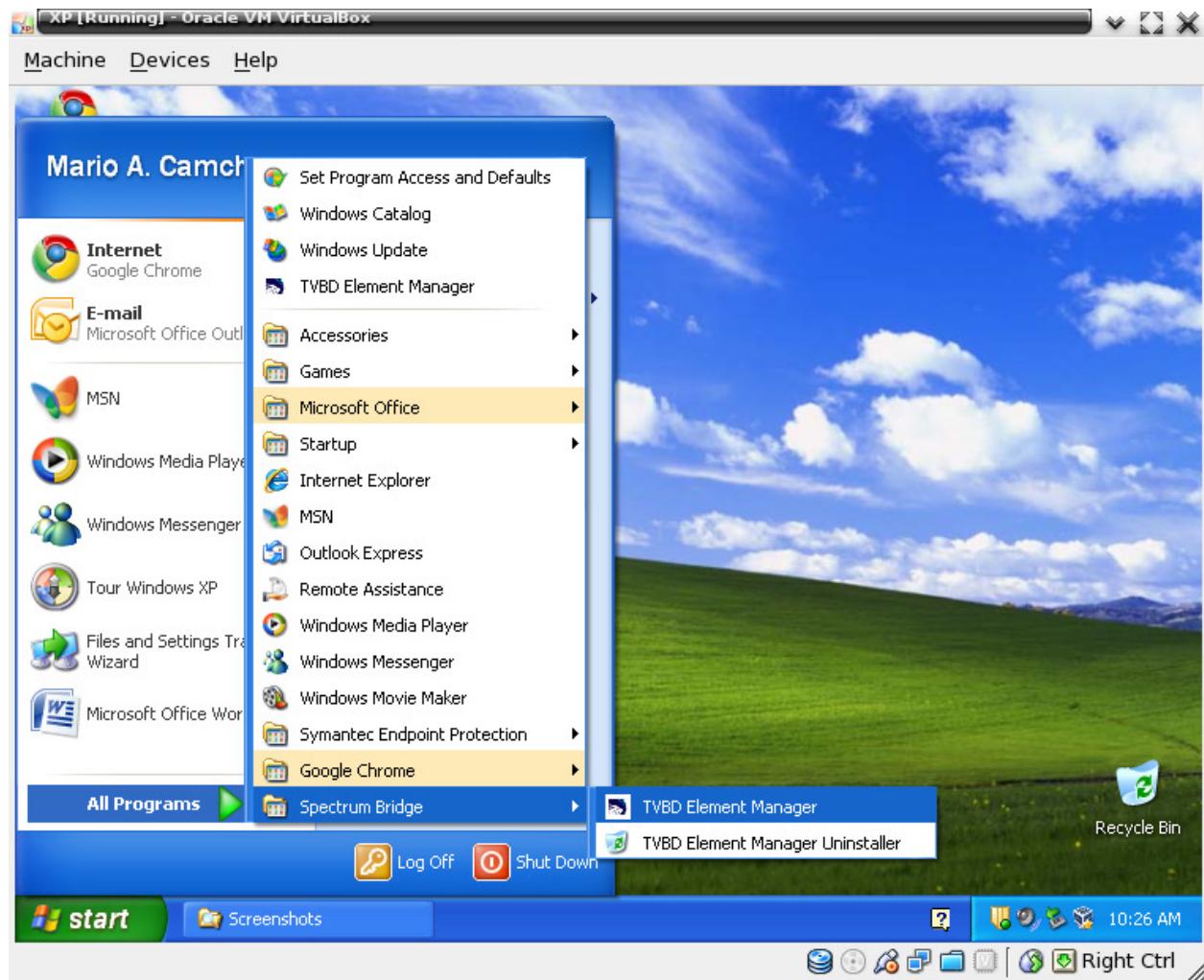


Modify the Shortcut preferences as desired and select “Next” to continue.



Select “Done” to complete the installation process.

Once the EMS application has been installed, it can be launched by clicking on the TVBD Element Manager entry in the Start Menu, or from the icon installed on the desktop.



## EMS Application User Guide

The TVBD White Space Element Manager is designed to show one or more networks and their associated nodes on the left panel and specific details about a selected node on the right panel. Clicking on the circle next to the network's name expands the tree view to show associated hubs. Clicking the circle to the left of the hub expands the branch to show the spokes associated with that hub. When the operator clicks on a node name, the application displays information about that node on the right panel. To change the name or IP of a node, click on the node, and then select "Tools" -> "Edit Node."

Note: You cannot remove the words Network, Hub, or Spoke.

Each tab on the right panel groups specific features of the radio. Clicking the "Refresh" button on the bottom refreshes the information about the node and clicking the "Save" button pushes changes (any change done to a field) to the node. Unless they are grayed out, most fields in the application can be edited and saved by clicking the "Save" button at the bottom of the window.

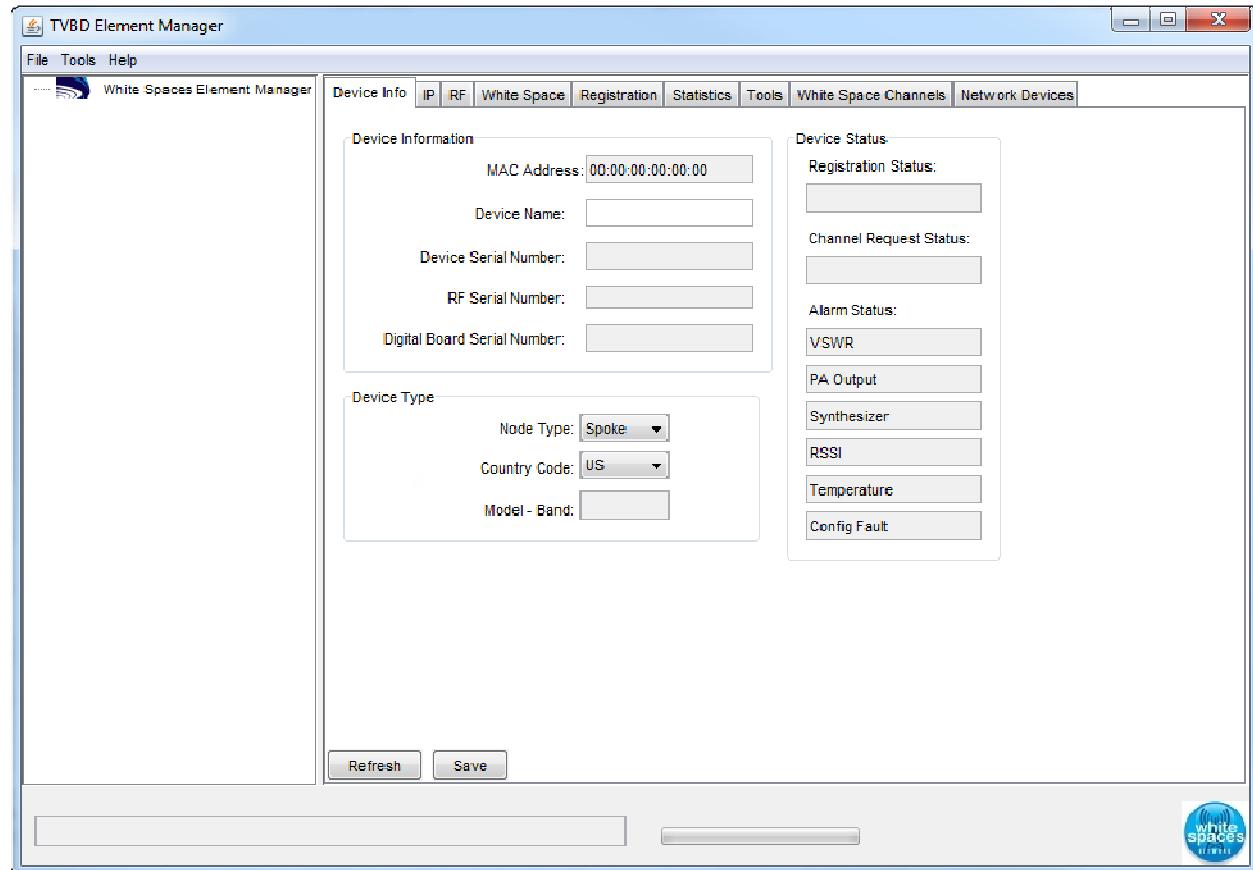


Figure 1 - Main EMS Window

A screenshot of each TV Band Devices Element Manager window is provided in order to make the descriptions of the manager more meaningful.

## Adding a Network

When the EMS application is started for the first time, the application will not have any network elements in the left panel and the installer must “build” a network tree by first adding a Network name. To add a Network, first select the White Spaces Element Manager element, and then click on “Tools” -> “Add Network.”

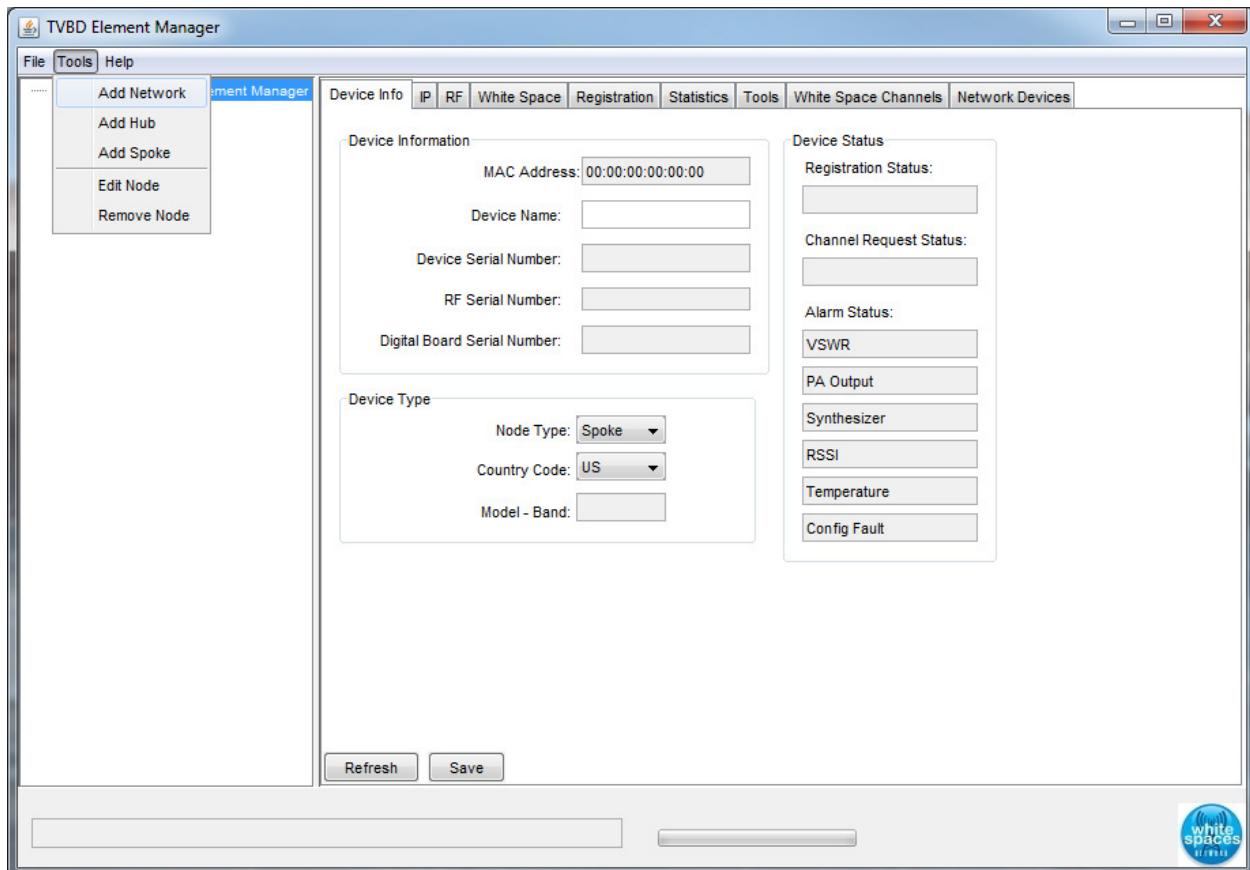
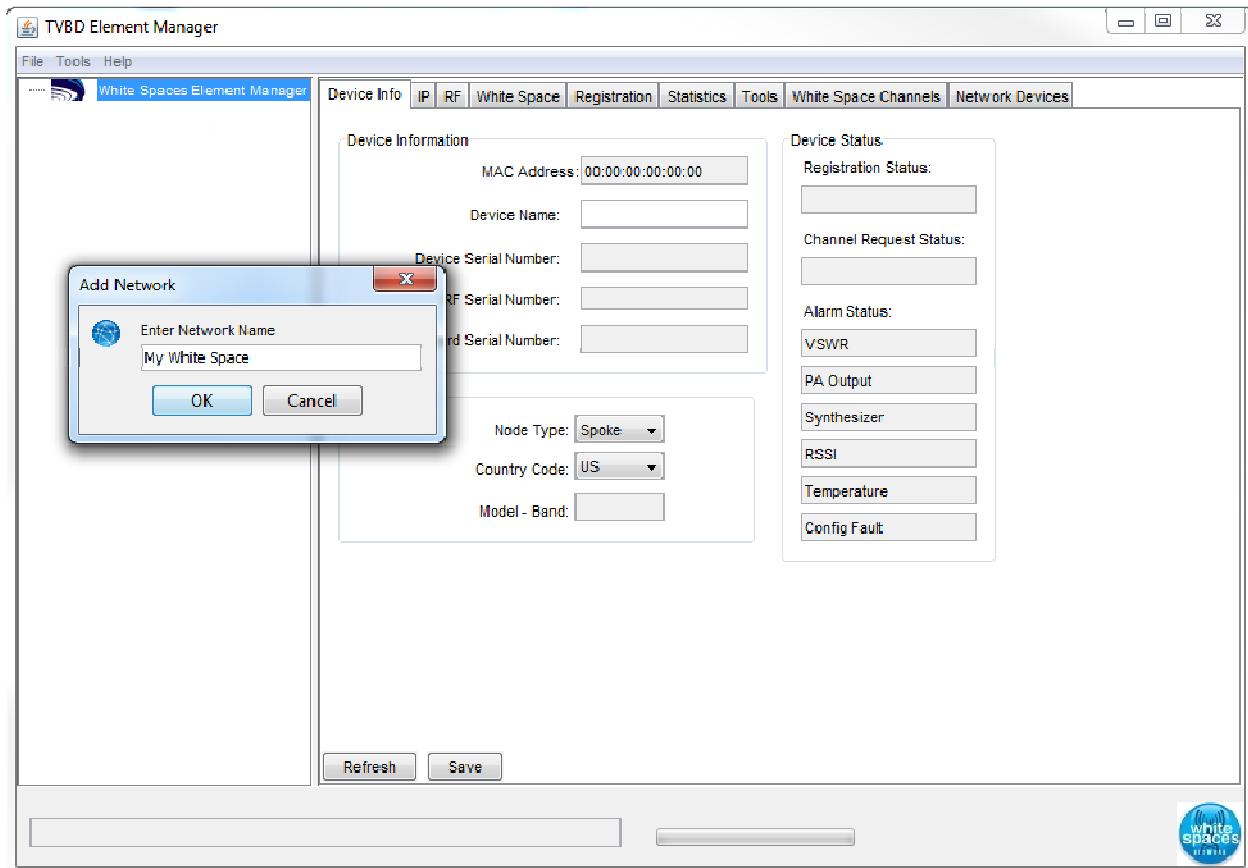


Figure 2 - Adding a Network

A window will be displayed to enter a network name as shown below. You do not need to add the word “Network” to the name as the application will add this automatically. Multiple networks can be added to the Element Manager. Once the name has been entered, click the “OK” button.



**Figure 3 - Entering the Network Name**

The newly created network will show up as a new branch under the White Spaces Element Manager (the root of the tree).

## Adding Hub to the Network

A hub can be added to the network by first selecting the appropriate network name and then by clicking on “Tools” -> “Add Hub” as shown below:

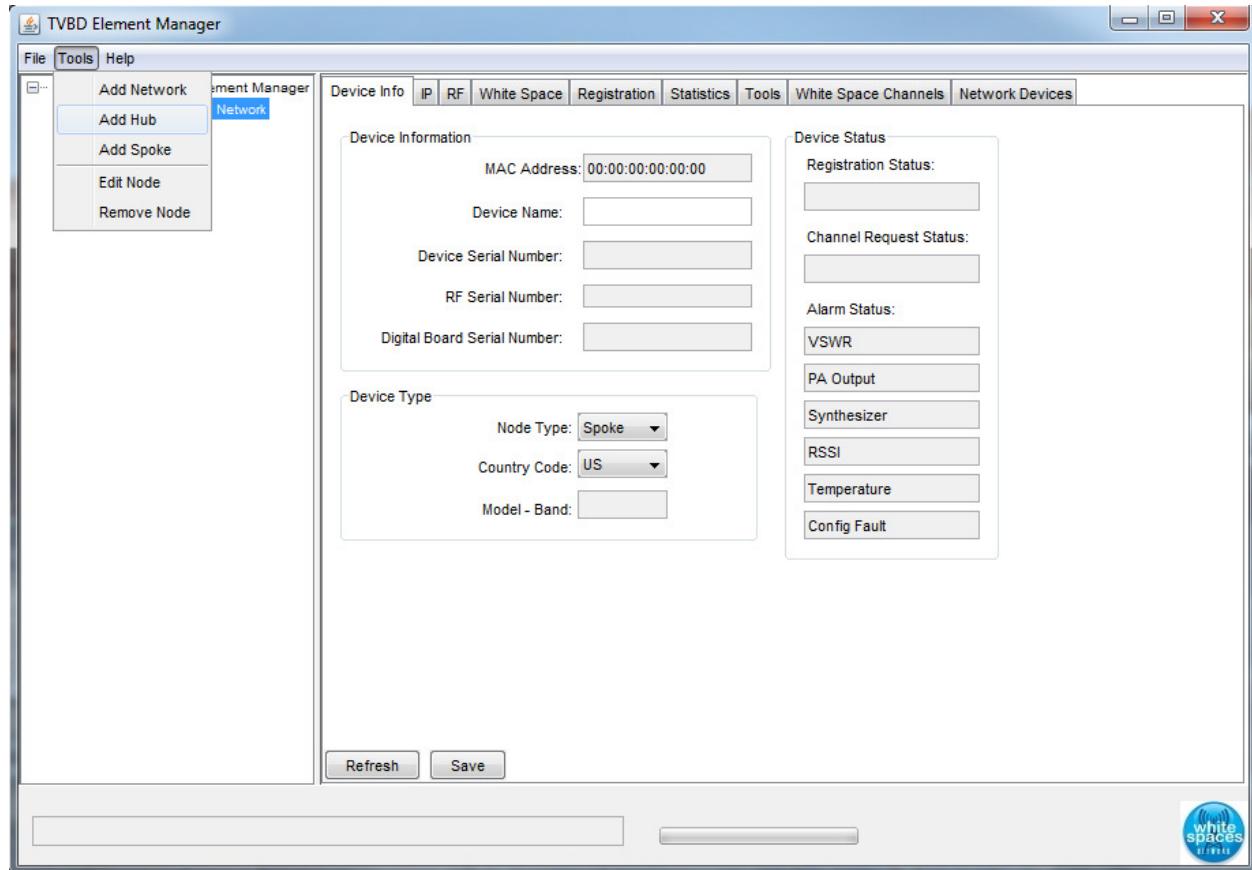


Figure 4 - Adding a Hub

A window will be displayed to enter a name for the new hub. Enter name in the text box and select “OK.” Note: You do not need to add the word “hub” to the name as the application will add this automatically.

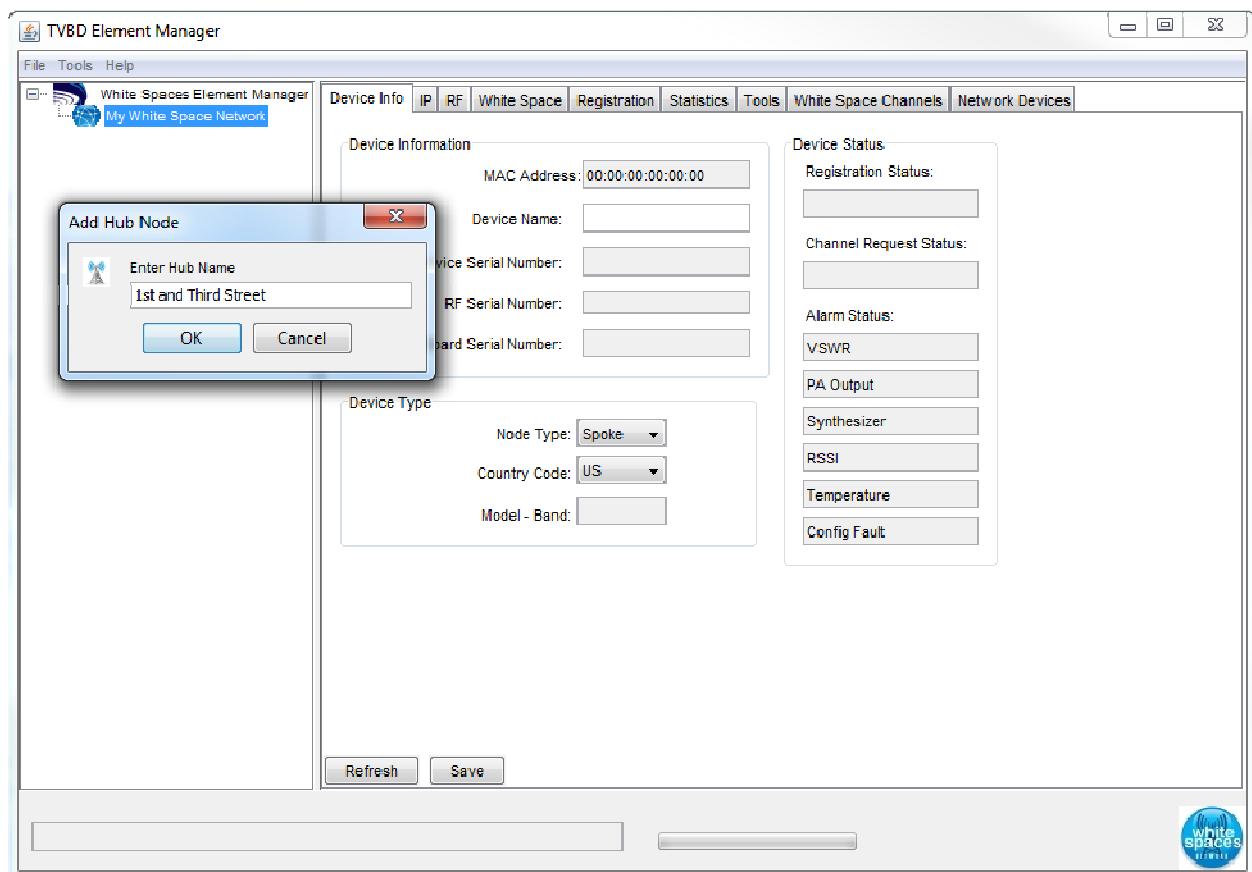


Figure 5 - Entering the Hub Name

When the hub name has been entered, select the “OK” button. Another popup window will be displayed to enter the IP address for the hub. Select “OK” to finish adding the new hub.

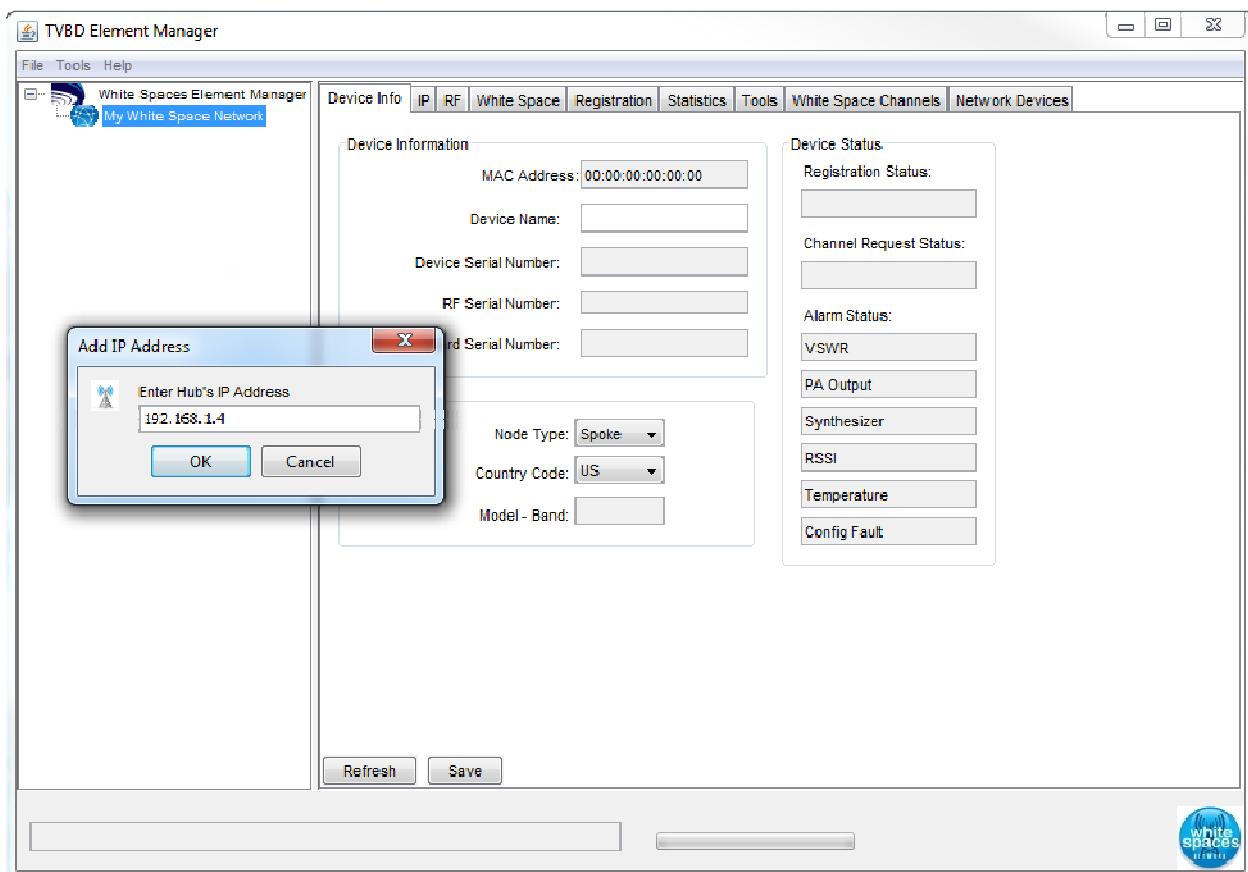


Figure 6 - Entering the Hub IP Address

Once the hub has been added, it will appear under the selected network as a new branch.

Note: The network IP address scheme will be defined by the Network Manager or Installer. The IP addresses displayed in the screen examples are for reference only. The default IP Address for new AWR radios is **192.168.1.4** with an IP Gateway address of **192.168.1.1**. Use this IP Address to access and configure each new device prior to deployment through the IP tab.

Each new AWR is preconfigured as a Spoke radio as shown on the Element Manager’s Device Info tab. All AWR’s destined to be network Hubs must have its Node Type changed to a Hub using the Node Type dropdown box. Then, save the configuration change to the radio using the EMS tool.

## Adding a Spoke to a Hub

A spoke can be added by first selecting the appropriate hub and then by clicking on “Tools” -> “Add Spoke.” Complete the process by following the screens just like when adding a hub.

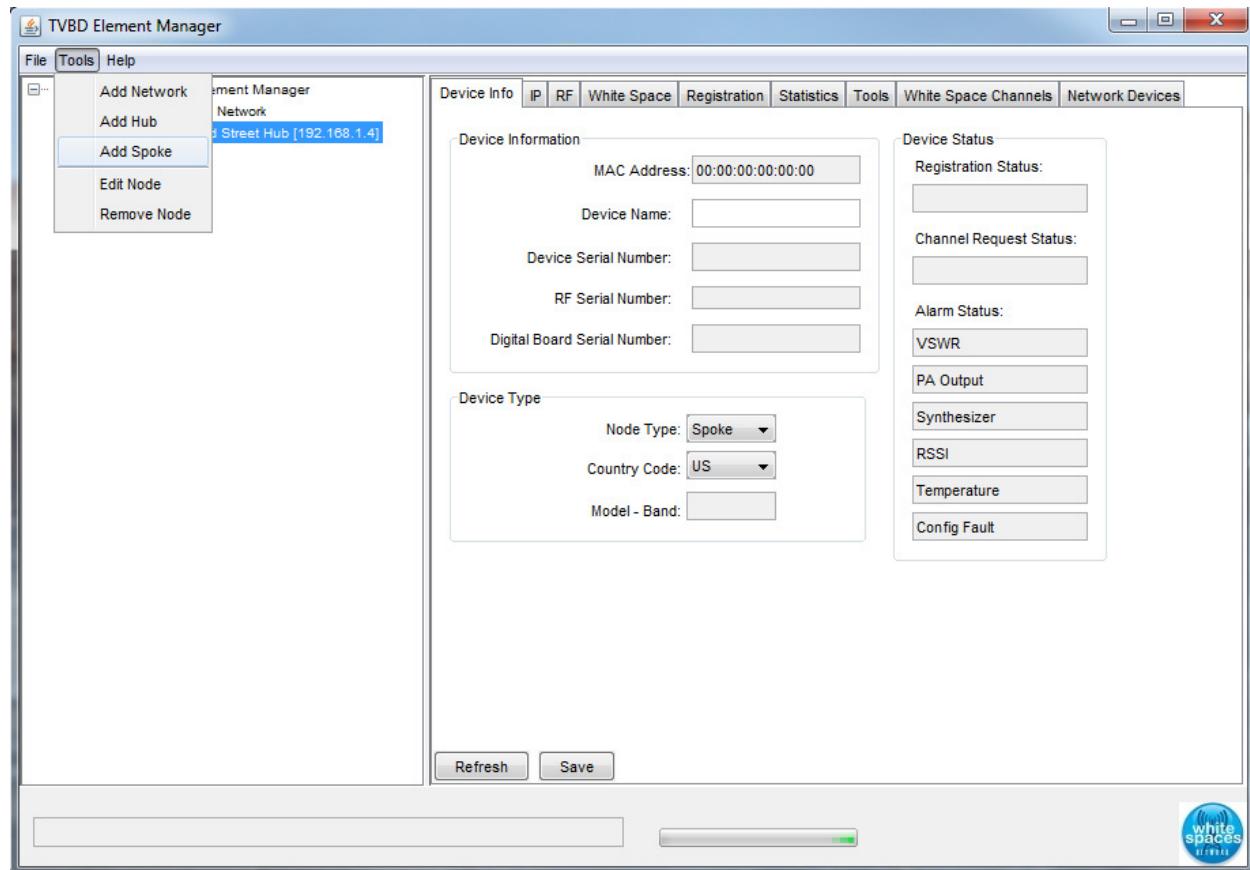


Figure 7 - Adding a Spoke

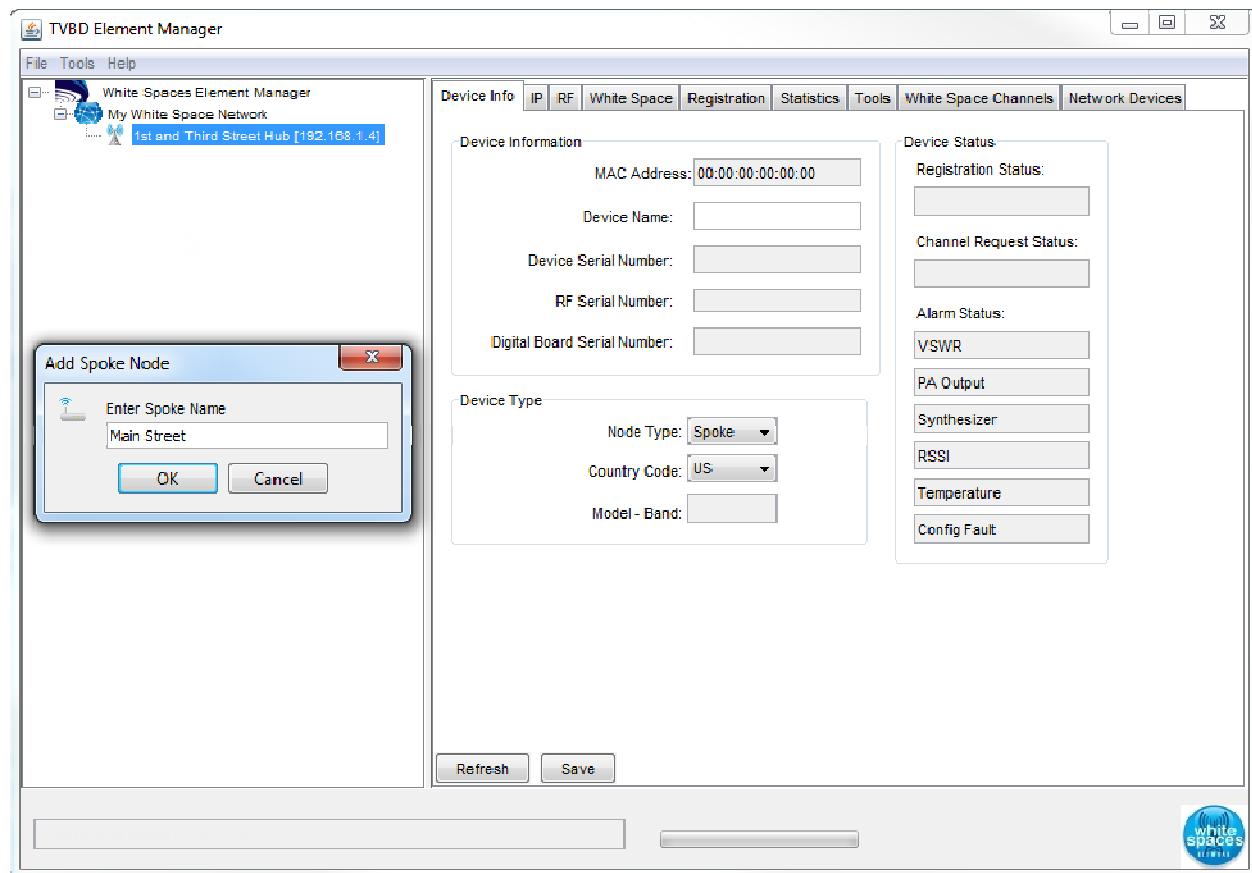


Figure 8 - Entering the Spoke Name

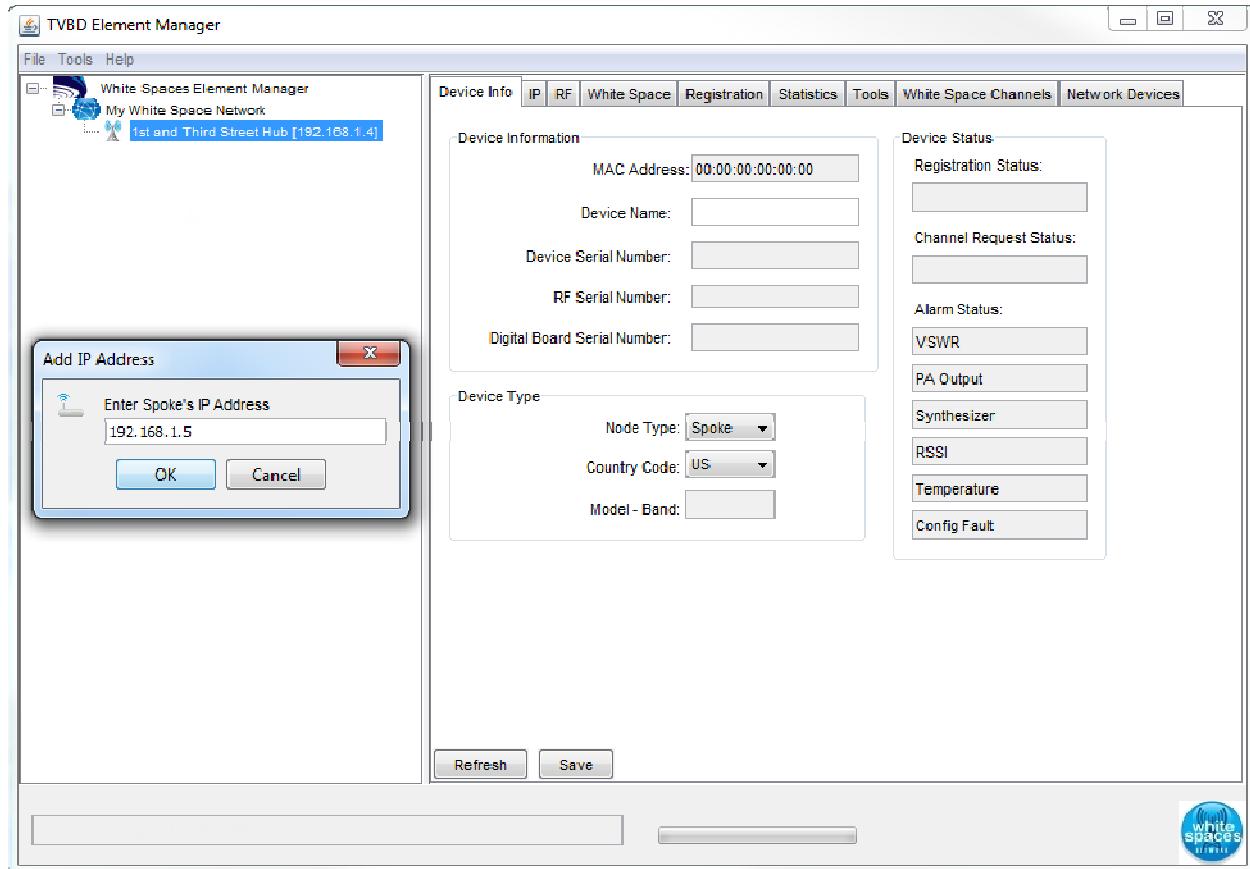


Figure 9 - Entering the Spoke IP Address

## Deleting a Node

A node can be deleted at any time by selecting it and then clicking “Tools” -> “Remove Node.” Please note that this feature can remove a complete network including branches within this network. The same applies to deleting a hub node, which will remove all spokes that talk to, or are linked to that node.

## Editing a Node

A node can be edited at any time by selecting it and then by clicking “Tools” -> “Edit Node.” The name box will be displayed first. If required, enter the change to the node name and select “OK” to continue. The IP Address box will then be displayed. If required, enter the revised address and select “OK” to complete the editing process.

## Saving the Network Configuration

To preserve the network tree, the entire network layout must be saved by clicking “File” -> “Save Network.” Once the network is saved, every time the application is launched, it will remember the network configuration. The only way to reset this is to delete all network nodes and click “File” -> “Save Network.” A message in the status bar will indicate a successful action.

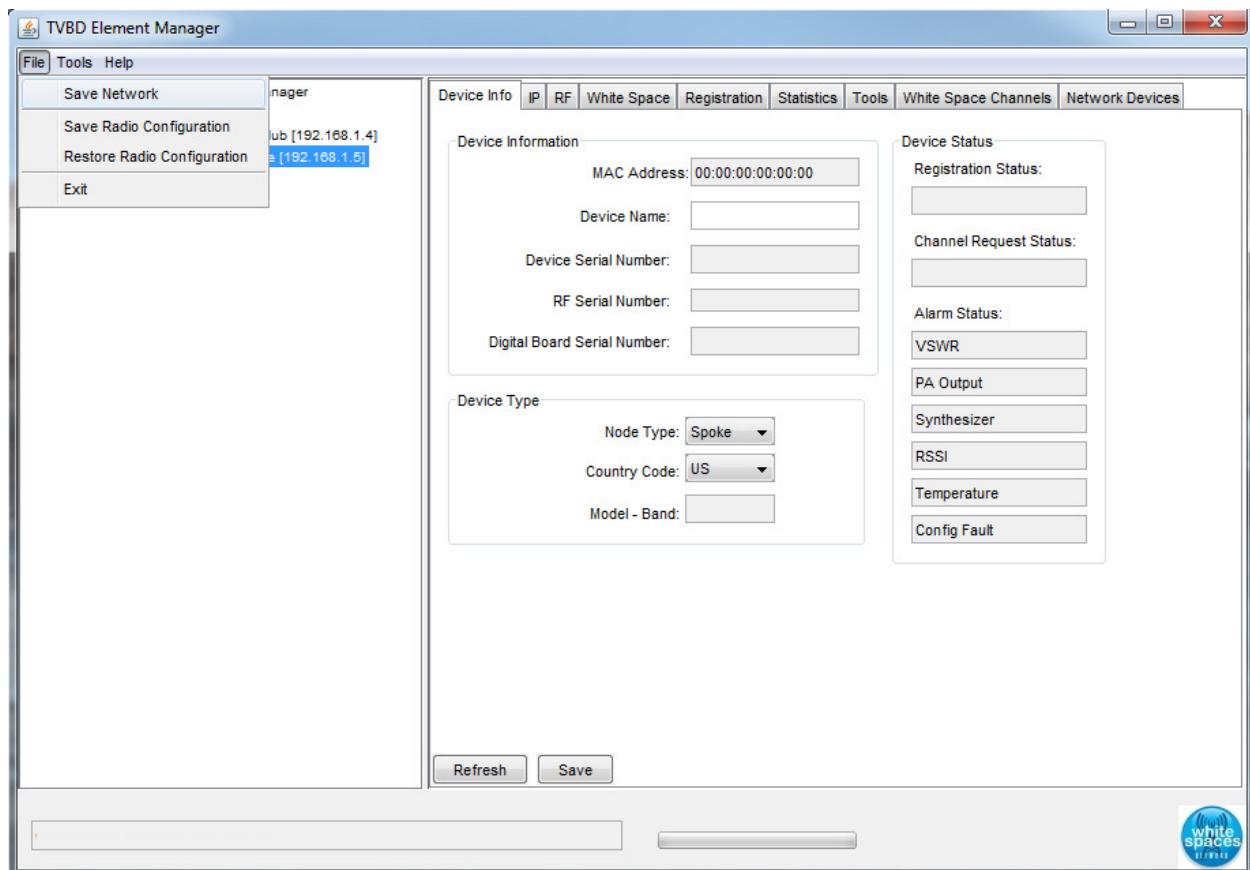


Figure 10 - Saving the Network Configuration

## Save Radio Configuration

Saving a device configuration acts as a backup for a single device. This feature is particularly useful when doing firmware upgrades to the devices. To save a radio configuration, select the device to be backed up and click “File” -> “Save Radio Configuration.” Note that this is only possible when selecting a hub or a spoke. A message in the status bar will indicate if the backup has been successful.

## Restore Radio Configuration

To restore a backed up radio configuration, select the device to be restored and click “File” -> “Restore Radio Configuration.” A message in the status bar will indicate if the restore has been successful.

## Device Info Tab

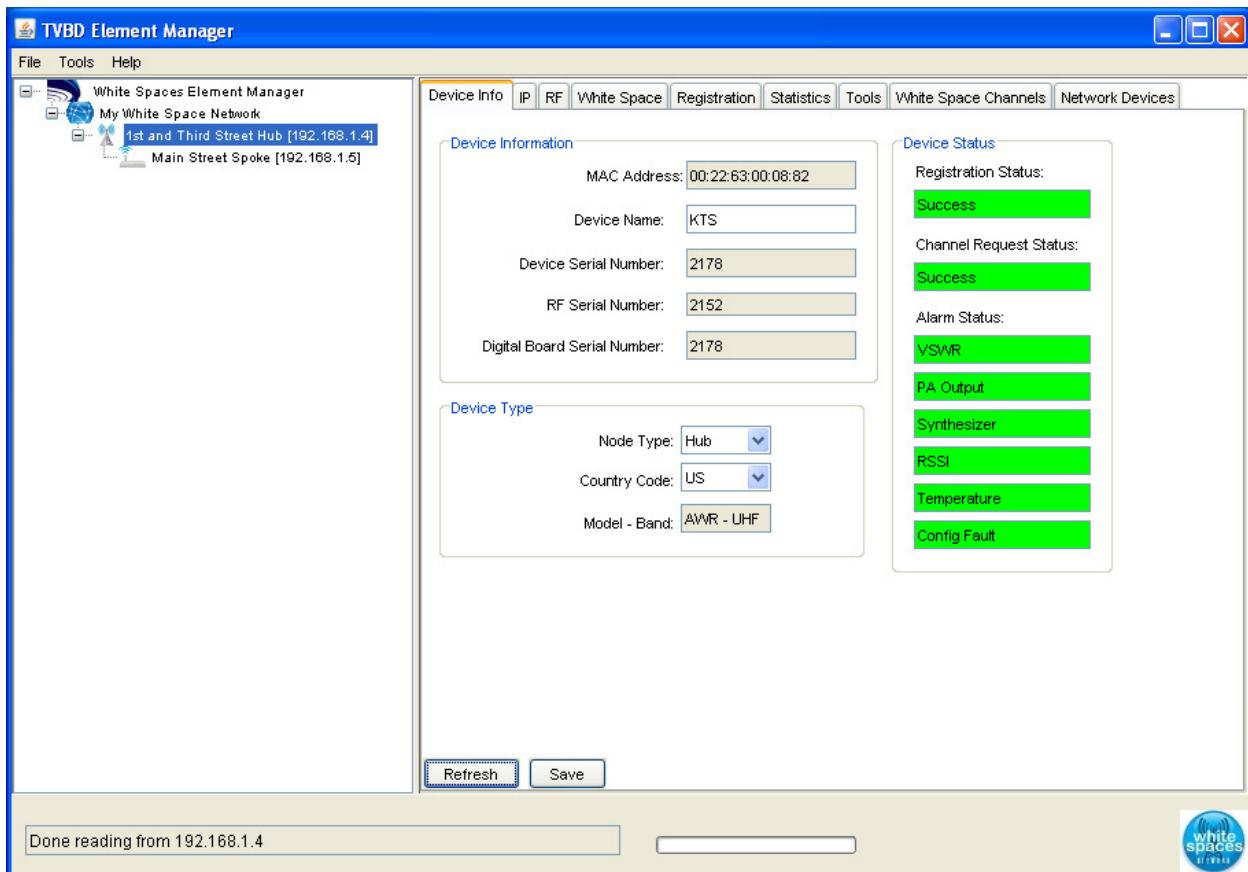


Figure 11 - Device Info Tab

The Device Info tab shows information about the radio that makes it unique.

- The MAC Address is a non-editable field populated with its MAC address.
- The Device Name is the radio name (up to 15 characters). This could match the name selected on the left pane of the EMS tool.
- The Device, RF, and Digital Board Serial Number are non-editable fields populated with the serial numbers of the radio.
- Device Status – Registration Status and Channel Request Status indicate “Success” and are green in color when the device has successfully connected with the White Space Database and successfully received a channel list for the location programmed into the radio.
- The Alarm Status displays six possible alarms which could indicate a radio system failure. VSWR, PA Output, Synthesizer, RSSI, Temperature, and Config Fault are all non-editable fields that indicate if there is an operational problem on the radio by changing their colors to colors other than green.
- The Node Type specifies if the radio is a Hub or a Spoke (Remote).

- Country Code is a drop-down list of Countries. “US” should be selected when the device is deployed in United States of America.
- Model – Brand displays the White Space Radio type.

Only the Device Name, Node Type and Country Code fields can be edited and saved to the radio by clicking the “Save” button at the bottom of the window.

## IP Tab

The TVBD Radios have two network stacks: one for the Ethernet interface and one for the wireless interface. The IP tab is used by the installer to enter a specific IP Address and a Gateway IP Address,

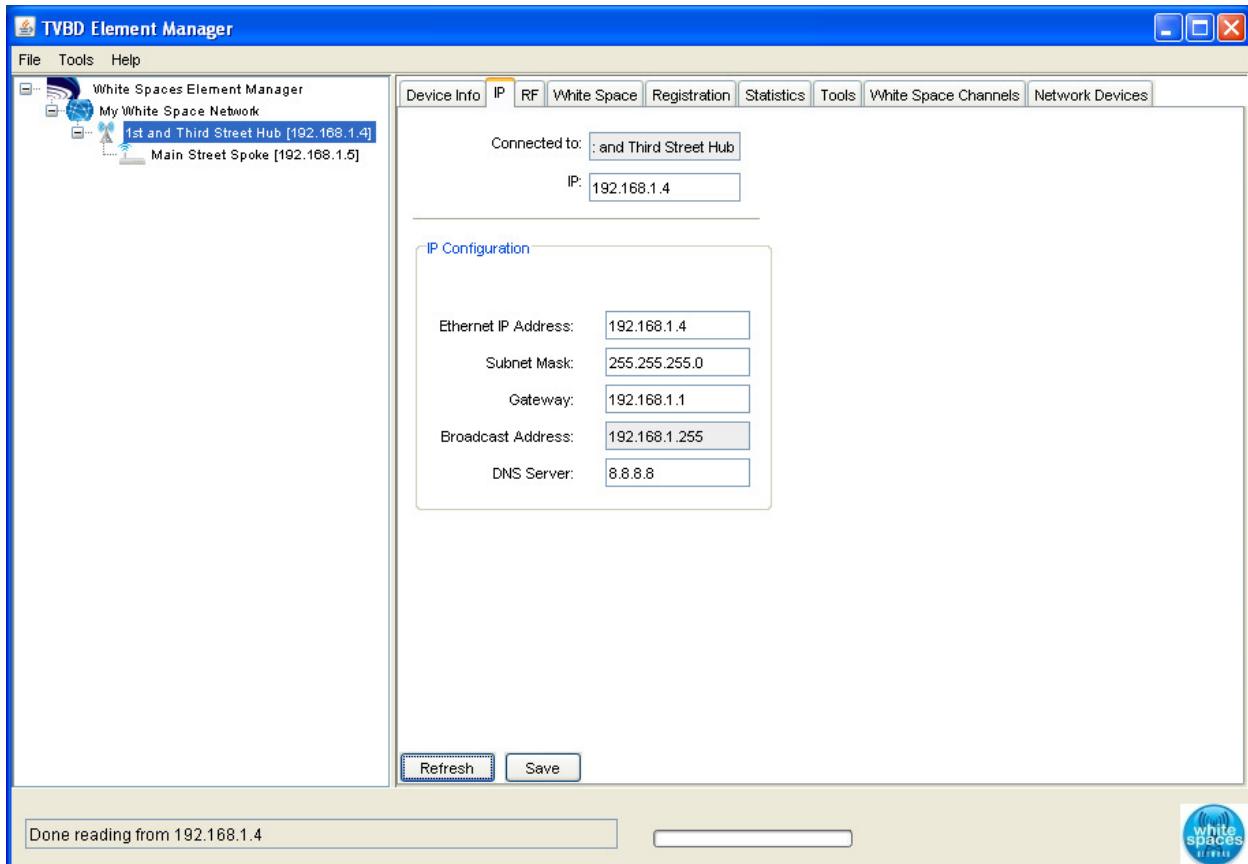


Figure 12 - IP Tab

### The Static IP Configuration

- Ethernet IP address displays the IP address used to communicate to the device.
- The Subnet Mask, Gateway, Broadcast Address and DNS Server address fields are also displayed and are part of the Static IP Ethernet network configuration when DHCP mode is not enabled.

All fields on this tab can be saved by clicking the “Save” button. Changing the Ethernet Address will prompt the operator to reboot the device.

## RF Tab

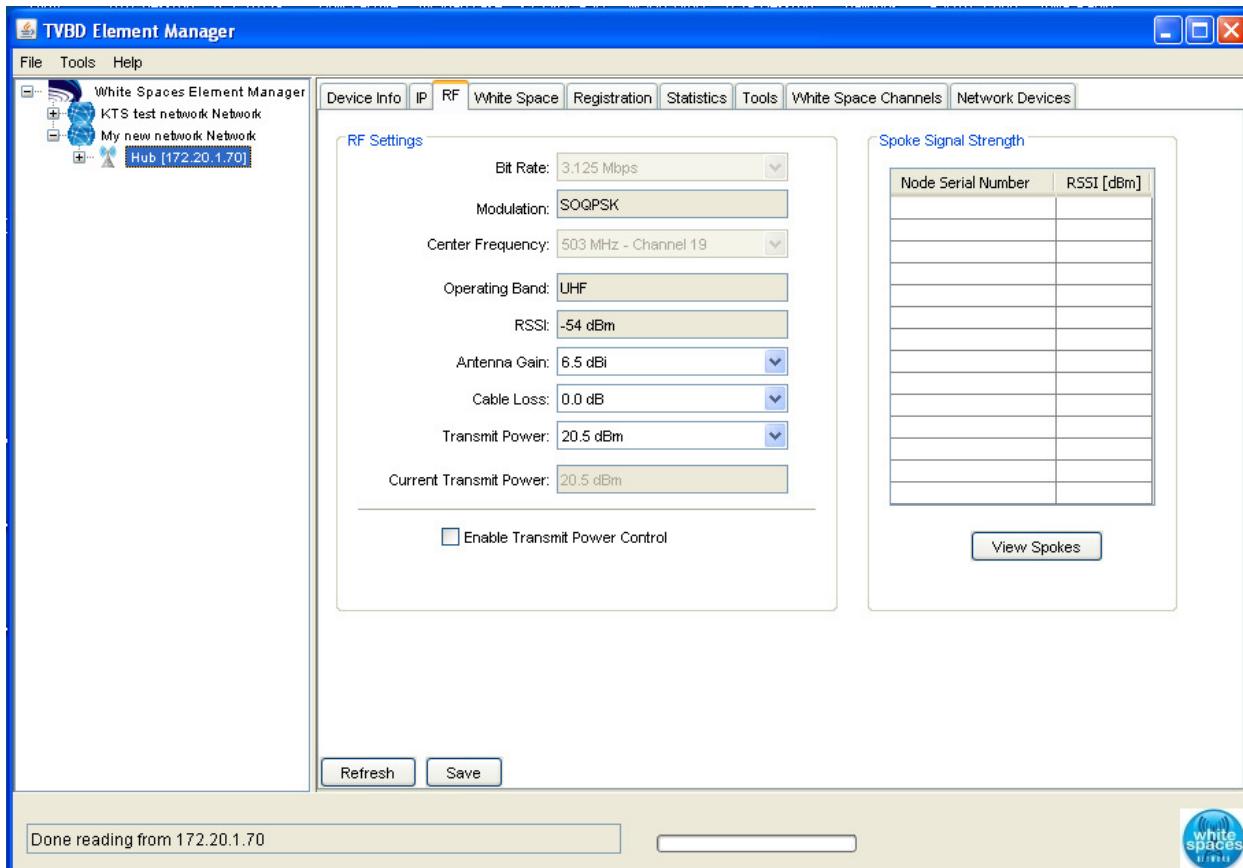


Figure 13 – RF Tab

The RF tab allows for configuration of the radio.

- The Bit Rate is fixed at 3.125 Mbps.
- The Modulation is a non-editable field populated with the modulation used by the radio.
- The Center Frequency is the operating frequency of the radio. The corresponding TV channel is associated with the frequency.
- The Operating Band is a non-editable field populated with the RF board type.
- The RSSI is a non-editable field populated with the RSSI as a relative value.
- Antenna gain is adjustable from 0 to 6.5 dbi.
- Cable Loss is a dropdown box that inputs the cable loss in  $\frac{1}{2}$  dB increments and is limited to a 2 dB maximum.
- The Transmit Power is the conducted power level set in dBm and displays the power level in increments of  $\frac{1}{2}$  dB from 10.0 dBm to 23 dBm based on the antenna gain and cable losses. Invalid inputs that exceed the authorized transmit power limits are not allowed by the application.
- Enable Transmit Power Control checkbox allows dynamic power control.

- Spoke Signal Strength – when a hub is selected in the tree and read, clicking on “View Spokes” will display all the spokes associated with that hub and their associated RSSI values.

## White Space Tab

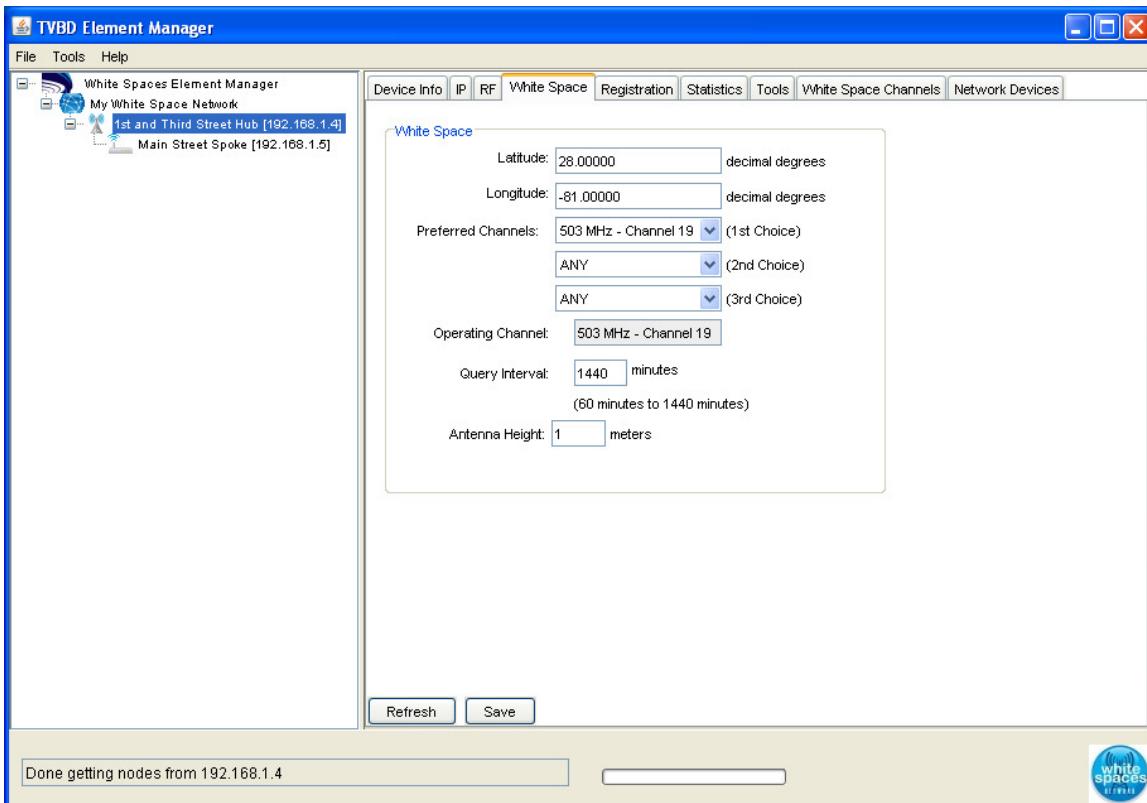


Figure 14 - White Space Tab

The White Space tab allows for configuration of the White Space specific radio parameters.

- The coordinates (Latitude and Longitude) are NAD83 decimal coordinates with a maximum of 5 decimal places. The entered location of the radio is used by the White Space database to determine an authorized channel map. The installed location must be determined with +/- 50 m accuracy.
- Preferred Channels: The operator can select 3 preferred channels for the radio to operate. If the 1st choice is not available from the channel map provided by the authorized TV Bands Database, the radio will attempt to use the 2nd choice, if authorized. If the 2nd channel isn't authorized, the device will attempt to use the 3<sup>rd</sup> channel, if authorized. If the 3<sup>rd</sup> channel is not available or authorized the radio will select another authorized channel from the list. Note that the radio is designed to select channels authorized by the database, and unauthorized channels (if selected) will be disregarded.
- The Operating Channel is a non-editable field which displays the operating frequency and TV channel of the radio.

- The Query Interval field is used to specify the interval, in minutes, in which the radio will request a new channel authorization list from the database. Note that authorized channel maps expire at midnight the following day if not renewed.
- Antenna Height is used to enter the height of the antenna in meters. Antenna height cannot exceed 30 m.

## Registration Tab

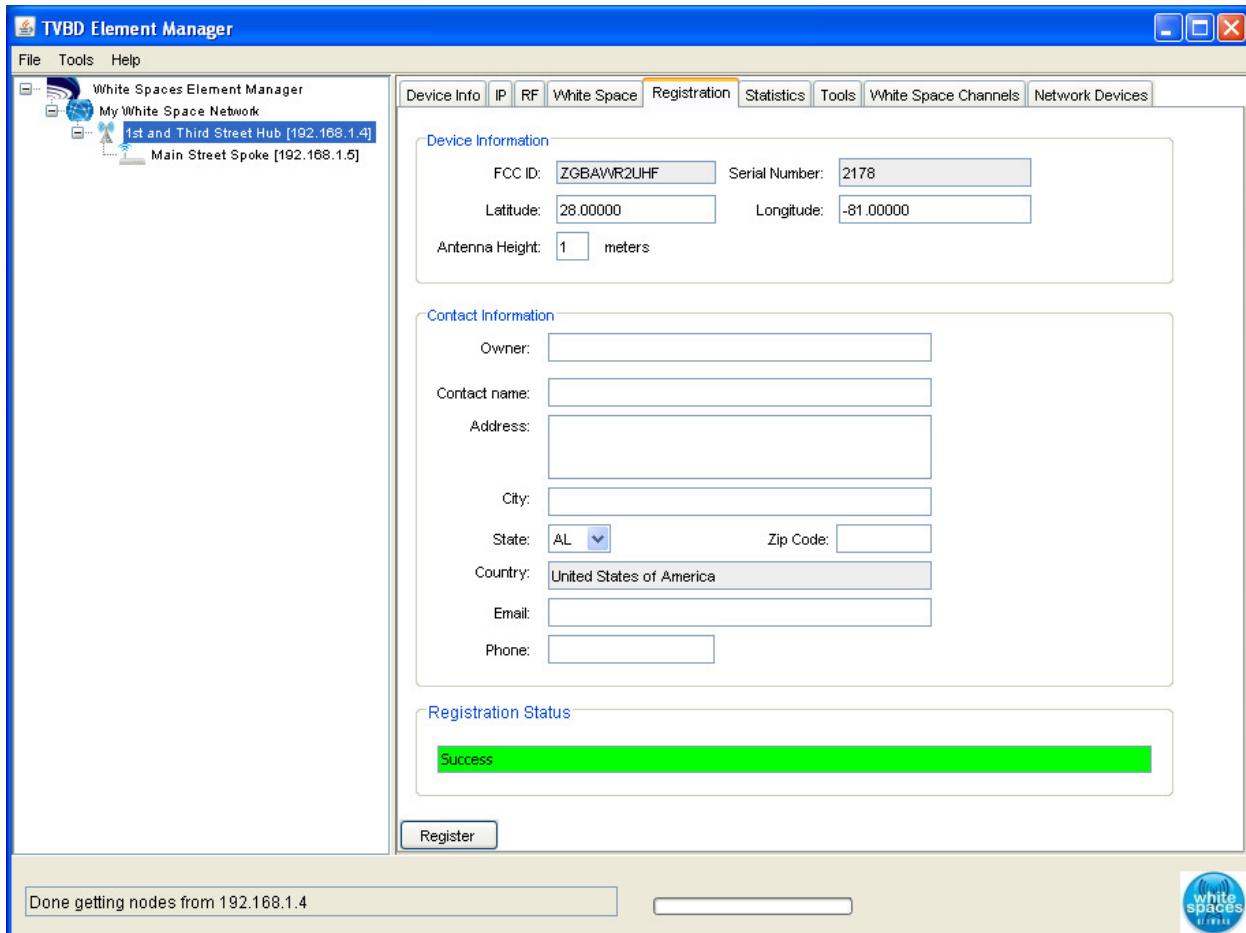


Figure 15 - Registration Tab

The registration tab contains a tool to register the device with the White Space TV Bands Database Service.

**Note:** Each TVBD must be registered before it can access the White Space Database. During the device registration process, the Operator must provide the Manufacturer Name, location information, contact information, the FCC ID, Model and Serial Number for each device to be registered.

- FCC ID: This field is automatically populated by the radio.
- Serial Number: This field is automatically populated by the radio.
- Latitude: This field is automatically populated with the configuration from the White Space tab.
- Longitude: This field is automatically populated with the configuration from the White Space tab.
- Antenna Height: Enter the actual height of the antenna.

- Owner: The name of the individual or business that owns the device.
- Contact name: Name of the contact person responsible for the device's operation.
- Address: The City, State, and Zip Code components of the contact person's address.
- Email: Email address of the contact person.
- Phone: Phone number of the contact person.

To register the device, click on the “Register” button.

Registration Status indicates whether the device is successfully registered.

## Statistics Tab

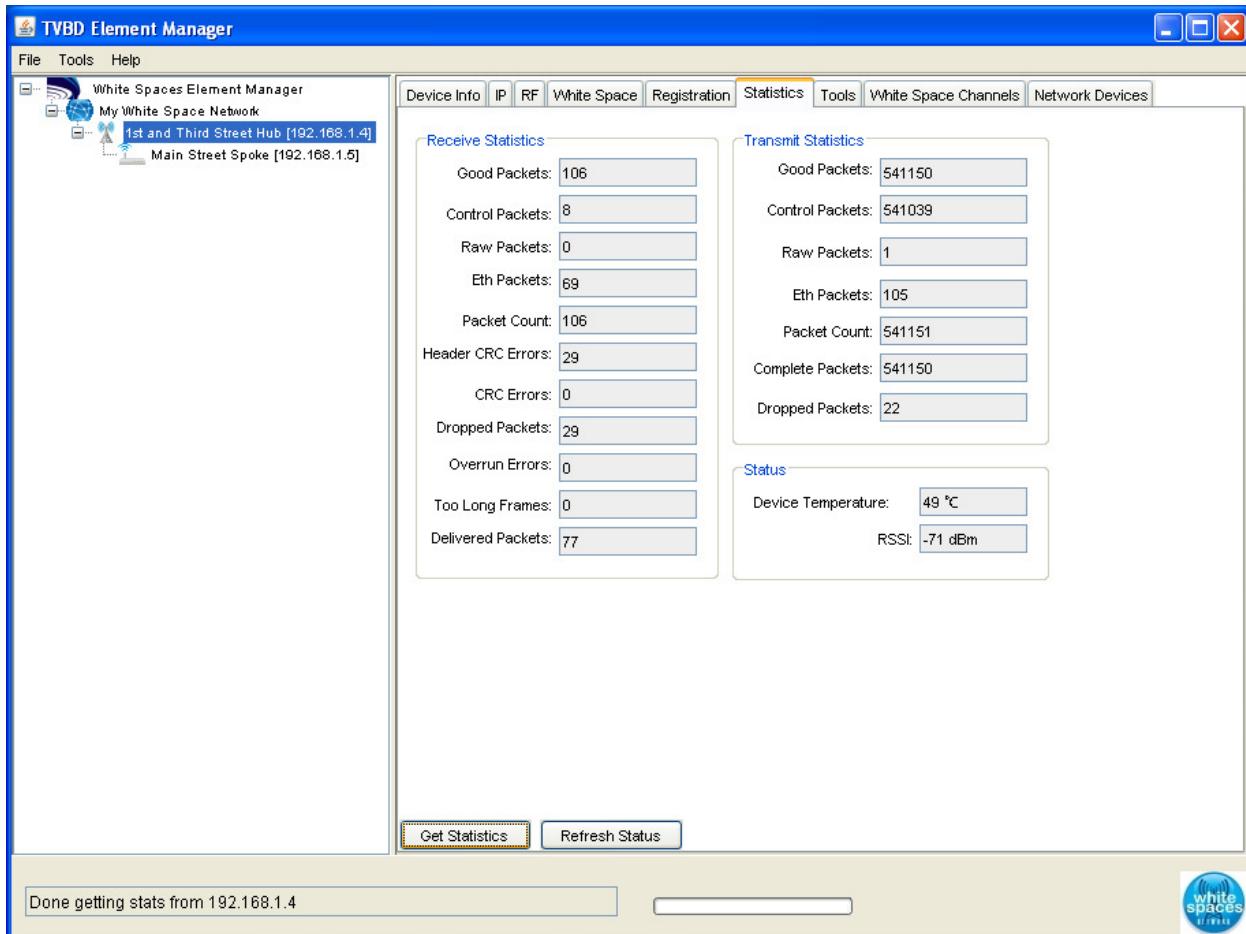


Figure 16 - Statistics Tab

Receive Statistics displays receive packet information handled by the MAC. None of the fields in this tab are editable, but can be polled by clicking the “Get Statics” button.

- The Good Packets field displays the count of good received packets.
- The Control Packets field displays the count of received control packets.
- The Raw Packets field displays the count of received Raw packets.
- The Eth Packets field displays the count of received Ethernet packets.
- The Packet Count field displays the total packets received.
- The Header CRC Errors field displays the count of received header CRC errors.
- The CRC Errors field displays the count of received CRC errors.
- The Dropped Packets field displays the count of received packets that were dropped.
- The Overrun Errors field displays the count of received overrun errors.
- The Too Long Frames field displays the count of received too long frames.

- The Delivered Packets field displays the count of successfully delivered packets.

Transmit Statistics displays transmit packet information handled by the MAC. None of the fields in this tab are editable, but can be polled by clicking the “Get Statistics” button.

- The Good Packets field displays the count of good transmitted packets.
- The Control Packets field displays the count of transmitted control packets.
- The Raw Packets field displays the count of transmitted Raw packets.
- The Eth Packets field displays the count of transmitted Ethernet packets.
- The Packet Count field displays the total amount of data packets transmitted.
- The Complete Packets field displays the total transmitted packet count including control packets and data packets (without dropped packets).
- The Dropped Packets field displays the count of transmitted packets that were dropped.

Status displays the Device Temperature and RSSI from the radio. None of the fields in the Status are editable, but can be polled by clicking the “Get Statistics” button.

## Tools Tab

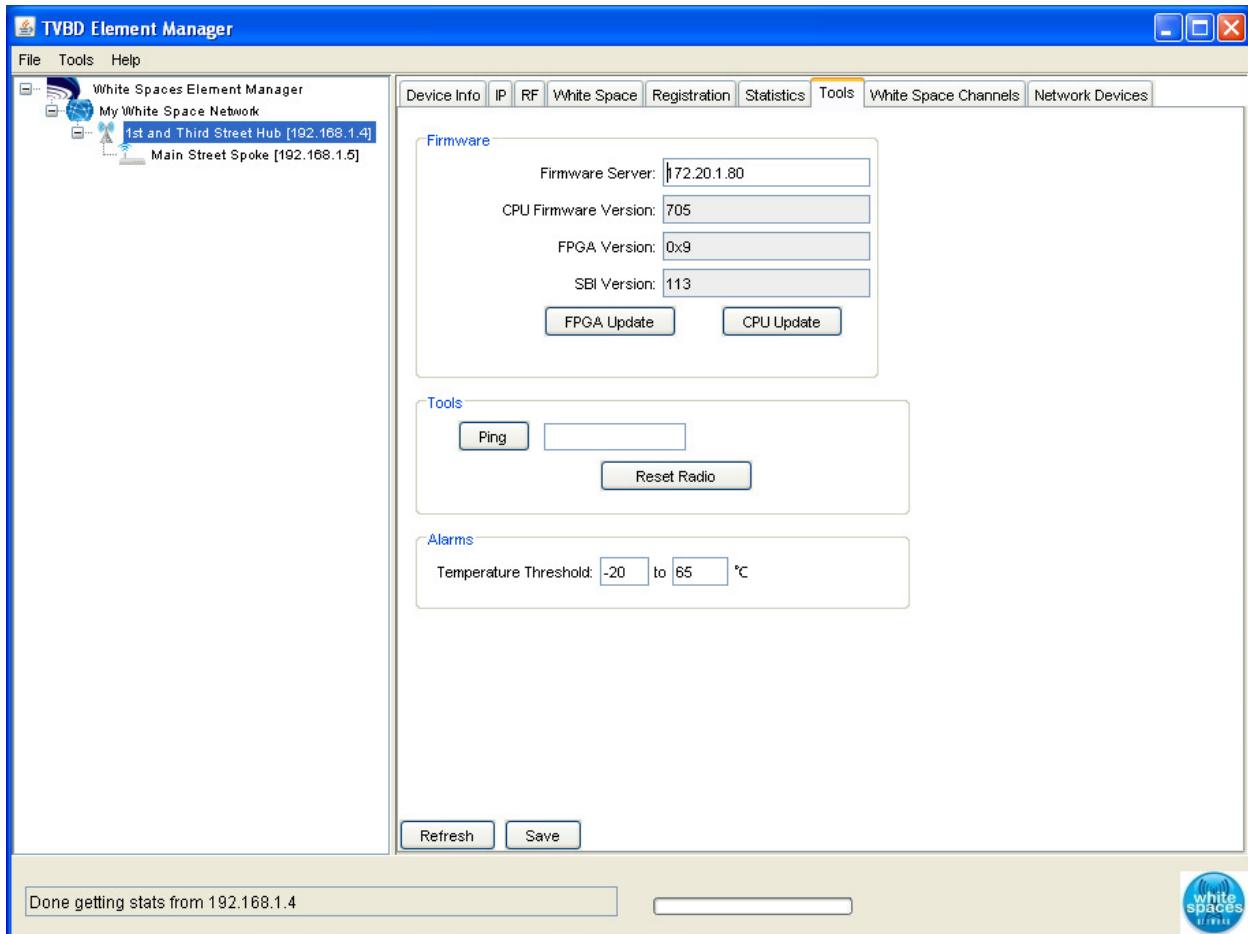


Figure 17 - Tools Tab

The Tools tab contains actions for the radio.

- Firmware Server is the IP address of the device used as the firmware server. To change the Firmware Server IP address, replace the address in the text box with the new address and select “Save.”
- The CPU Firmware version is a non-editable field populated with the current version of the radio firmware.
- The FPGA Version is a non-editable field populated with the current version of the FPGA firmware.
- SBI Firmware displays the current version of firmware running on the digital board.
- The CPU Update button will update the CPU firmware using the Firmware server address.
- The FPGA Update button will update the FPGA firmware using the Firmware Server address.
- Tools: If pressed, will ping the IP address in the text field if reachable.

- The Reset Radio button will reboot the device (digital and radio board).
- Alarms: Temperature Threshold fields allow for a minimum and maximum operating temperature to be set in degrees Celsius. If the radio operates beyond these thresholds, an alarm will be triggered.

Note: The buttons will take action immediately once pressed.

## White Space Channels Tab

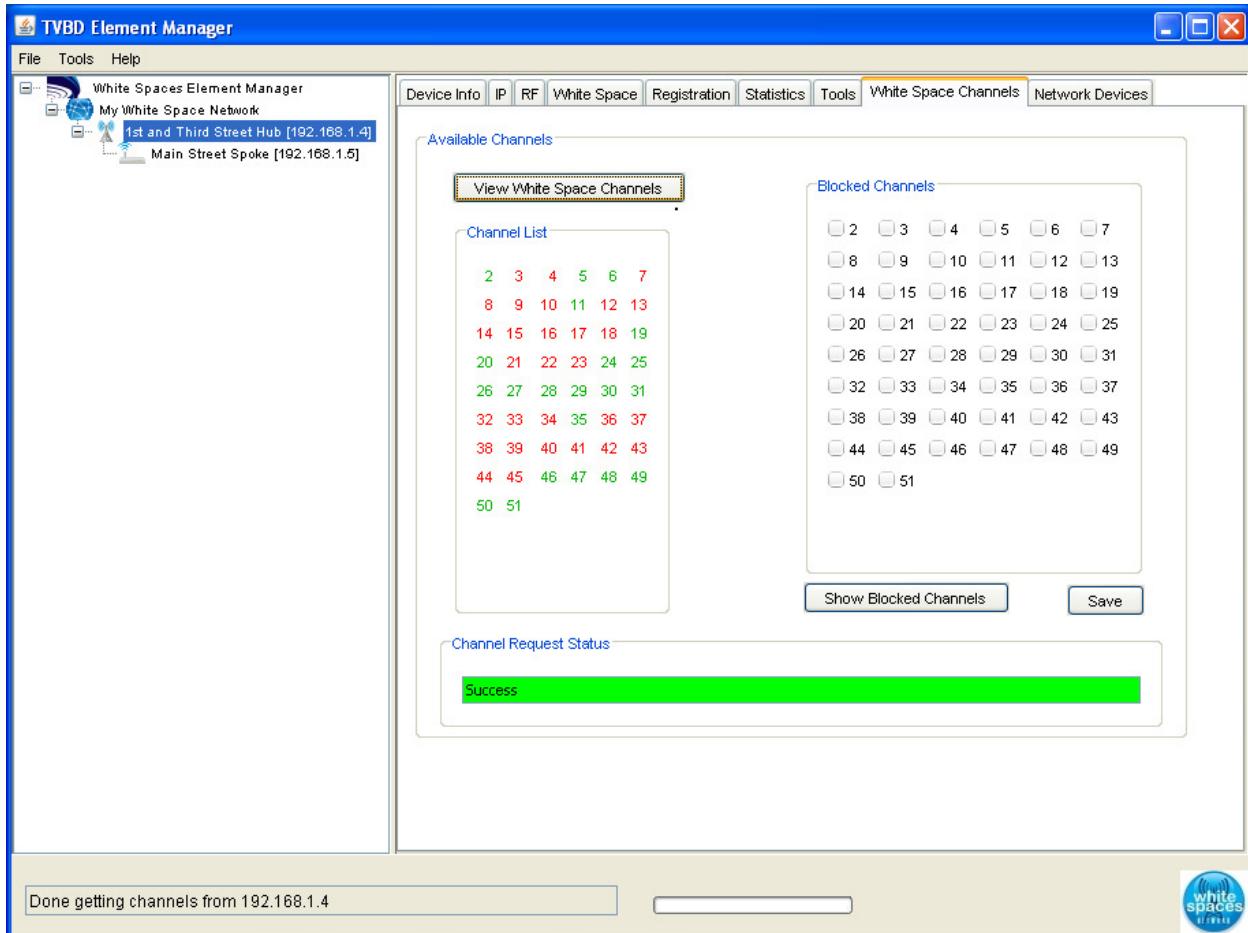


Figure 18 - White Space Channels Tab

The White Space Channels tab is used to display the channel list returned by the TV Bands Database for the specific geographic coordinates entered and saved within the device through the White Space tab. To display a channel list as shown above, select “View White Space Channels” button.

To minimize the time a spoke radio will scan or search for a hub to join with, specific channels can be blocked within a device by using the Blocked Channels feature. Click on “Show Blocked Channels” to display the currently blocked channels stored on a device. Select the channels to be blocked and select the “Save” button.

The TV Bands Database is the server with which the radio communicates to register and get a list of available channels for operation.

## **5.0 Upgrading Software**

The software in the AWR can be upgraded in the field. This can be done either locally through the Ethernet port and or remotely over the air. The radio has two types of software which can be field-upgraded (CPU and FPGA). The CPU code controls the radio's higher-level functionality, including the MAC, networking layers, network management and operator interfaces. The FPGA code supports the Physical layer.

Software upgrades for both the CPU and FPGA codes are provided periodically by KTS wireless. Operators are notified when these become available. Some upgrades may be mandatory to resolve problems while others may be optional if they include new features. Release notes will be available for each new version outlining the changes. Some new releases may require additional fees and/or licensing agreements.

The tools tab is used to change the software within the AWR.