TITLE: The Asterisk with app_rpt Server Installation Process

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PURPOSE

Our goal is to enable Push-To-Talk radio users to interconnect radio systems via IP networks and incorporate the power of the Asterisk IP-PBX. This document explains an installation process recommended by the developers.

DESCRIPTION

This process installs a complete Asterisk IP-PBX system with app_rpt radio interface features. Because the full power of Asterisk enables linked radios to do much more than just communicate among themselves, we chose the EasyVoxBox package as a basis for the app_rpt installation. It provides the popular FreePBX Asterisk web based configuration tool and other amazing utilities. Unlike most Asterisk packages, EasyVoxBox includes the complete source code and development environment for Asterisk. Because app_rpt is developing rapidly, including the source code allows us to provide a simple app_rpt update utility.

AUDIENCE

Persons who attempt to use this document to construct an Asterisk app_rpt server should be well versed in private radio communications technology, Linux software, programs, tools and utilities.

These include but are not limited to:
- using the Linux command line,
- public and private IP Networking,
- the Webmin Linux server configuration tool,
- a programmer's text editor,
- Private or Amateur Mobile Radio terms, practices and methods.

COMPUTER HARDWARE REQUIREMENTS

PC, Intel Pentium III 800 MHz CPU or better.
256 MB RAM, 4.5 GB Hard Drive
Ethernet Network Interface Card (NIC)
During the installation only:
- CDROM Drive
- Attached Monitor and Keyboard

IP NETWORK REQUIREMENTS

This application requires an Ethernet connection to an IP network with DHCP and broadband Internet access. Incoming packets to the computer's FQDN on port number 4569 must be routed to the computer through any intervening routers or firewalls.

RADIO TRANSCEIVER REQUIREMENTS

Asterisk with app_rpt can be connected to almost any radio transceiver and network if you have the skills and patience to make the necessary interface and configurations.

Several different radio makes and models are well supported by vendors who provide ready made interfaces and cables.

For example, several Motorola commercial radios use a common 16 or 20 pin rear panel accessory connector. These include the GM300 and M1225 mobile radios and the R1225 repeaters.

Also for the commercial private mobile radio bands there are many radio repeaters with a community repeater or trunking radio controller port available such as the Ritron Patriot series (http://www.ritron.com).

For frequency agile remote applications, app_rpt can control a multi-band, frequency programmable radio transceiver such as the Icom IC-706.

Even consumer grade GMRS and FRS radios are supported using the DingoTel USB adapter. Though originally sold for use on the DingoTel network, the hardware device is compatible with Asterisk app_rpt. Note that these connections use a Voice Operated Transmit (VOX) method to detect when the remote radios are transmitting and this impairs several features and the general operating quality of connections.

RADIO TRANSCEIVER TO ASTERISK INTERFACES

We will now describe two well supported hardware solutions for interfacing PTT radios to Asterisk.

QUAD RADIO PCI - This was the second interface that was devised. This card is installed in a computer's PCI slot. It supports up to four (4) simplex or full duplex radios. It has CTCSS/DCS encoder/decoders on-board. Audio level adjustments are accomplished via a group of internal, multi-turn potentiometers for each channel. One advantage of the Quad Radio PCI card is that it supports the serial control of frequency agile amateur radio transceivers.

USB RADIO ADAPTER (URA) - The third and most recently developed radio interface is the USB Radio Adapter. The principle advantage of this device is that it has a low cost. For example you can build your own radio cable by attaching it to a $7.00 off-the-shelf commercial USB Sound Adapter. With the USB Radio Adapter, CTCSS and other signaling encoding and decoding is done in the software. And, signal level setting is done in software so there are no physical adjustments to make that require access to the computer and taking the covers off to reach the potentiometers. Additionally, the URA can determine the received signal level in software and use it for squelch and other features.

With all of these interfaces, the best and preferred radio connection is directly to a radio's unsquelched and unfiltered receiver audio signal and its flat transmitter audio modulation point. Of course a transmitter activate or PTT connection is required. Connection to a carrier or signaling tone detection point is required for use with the ARIB and QUAD RADIO interfaces and optional for the URA interface.

GENERAL INFORMATION

These instructions and the installation scripts apply to the the use of EasyVoxBox (EVB) 0.011 (http://www.easyvoxbox.org or http://sourceforge.net/projects/easyvoxbox/) as a base Linux and Asterisk installation. This process also works with the older EVB 0.010 but the use of EVB 0.011 is strongly recommended.

This installation will completely erase the computer's hard drive. Any information that existed on it before the installation will be irretrievably lost.

In our tests, an 800MHz Pentium III computer required a bit more than an hour to execute the complete installation process.

INSTALLATION PROCEDURE

If you are an amateur radio operator you really should put at least one node on the AllStar Link Network. So go to "http://allstarlink.org/" and complete the form to request a node number. The node information that you receive can then be entered during the installation process and automatically used to build the Asterisk and app_rpt configuration files.

We recommend that you assign your computer a Fully Qualified Domain Name (FQDN). If your Internet connection has a dynamically assigned IP address, you should register for a free Dynamic DNS service at "http://www.dyndns.com" or use an equivalent service. The app_rpt installation process installs the 'inadyn' dynamic DNS client and places your DNS FQDN in the '/etc/inadyn.conf' file. The line that starts the client is normally commented out in the '/etc/rc.local' file. If you use this service, when the automated portion of the installation is complete, edit '/etc/inadyn.conf' to add your DynDNS account username and password and then uncomment the inadyn start line in '/etc/rc.local'.

Because of the large number of potential IP network configurations, we cannot describe them all in this document. Therefore we will cover a common case. This is where the node is attached to a network with a router that provides a DHCP service that assigns local NAT addresses to client computers.

In that case you must set the router so that incoming packets to the system's Internet address on port number 4569 must be routed to the node computer's local address through any intervening routers or firewalls.

For example: 1) determine your node computers Ethernet MAC address, 2) set your router's DHCP server to always assign a fixed internal IP address to that MAC address, 3) set your router to forward traffic on that port the fixed internal address of the node computer.

If you have a single Internet IP Address available and several computers running on a NAT and you have a main high availability Asterisk server for telephone call processing and a separate Asterisk Wireless Server for connection to your wireless communications equipment, you should consider using a non-standard port number for IAX2 on your Asterisk Wireless Server. The app_rpt suite easily accommodates IAX2 on non-standard port numbers. Some telephony applications do not. So the wireless server gets to be the one with

the non-standard port number (e.g. 4568). Configure your NAT Router to send incoming traffic on the standard IAX port number (4569) to the main Asterisk server and traffic to the non-standard IAX port number to the Asterisk Wireless server.

Now let's start the installation.

Connect your node computer to a network with DHCP and broadband Internet access.

You need an attached local video monitor and keyboard during the installation. If the computer BIOS permits it, you can remove these after the installation is complete.

Create a CDROM with an EasyVoxBox (EVB) 0.011 image. The CDROM image is available at "http://www.easyvoxbox.org/" or or "http://sourceforge.net/projects/easyvoxbox/"

Start the computer and press the keys necessary to enter its BIOS utility.

In the BIOS, enter the correct date and time. We recommend using UTC (a.k.a. GMT or Zulu) time. Setting the proper time is important to make sure that the software builds and operates properly.

Also in the computer BIOS, select the boot or start device to first boot from the CDROM and then the Hard Drive.

Save the BIOS settings and exit the BIOS.

Insert the EVB CDROM into the computer CDROM drive.

Reboot the computer by pressing Ctl-Alt-Delete or power cycling.

The computer should boot from the CDROM and begin the installation of the Centos Linux operating system. Follow the prompts and instructions. If you set the computer BIOS clock to UTC, when prompted for system time information, select "Computer Uses UTC" and then your timezone.

When prompted to enter the root password of your choice, enter it and then write it down. If you forget it, you will have to start all over.

The installation of the operating system will continue. After the operating system is installed, the CDROM will eject. If you are watching the screen when the "Performing Post Install Scripts" message appears on the screen, push the CDROM back in. This will allow the post install script to find the CDROM and complete the EVB install. If you miss it, don't worry because this is detected by a later process and you will be prompted to put the CDROM back in the drive.

The computer will reboot a few times and finally come to rest with a login prompt. Now you need to login as 'root' and issue the following commands:

```
cd /root
wget http://xelatec.com/asterisk/evbphase2
chmod 700 evbphase2
./evbphase2
```

The installation now continues. Follow the instructions and prompts on the screen.

When the installation completes, your system is almost ready to use.

You may enter the computer BIOS and change the Boot Order to only boot from the Hard Drive.

If you have a dynamic Internet IP connection, set up the dynamic DNS client as described above.

Edit the '/etc/asterisk/' configuration files 'rpt.conf', and if you are using a USB Radio Adapter, edit 'usbradio.conf' to match your radio hardware and enable the desired operating features.

IMPORTANT: Almost any file without the keyword 'custom' in its filename is overwritten when you make changes using the FreePBX web interface. The file 'iax.conf' and the non-FreePBX supported app_rpt files of 'rpt.conf' and the 'usbradio.conf' files are exceptions to this guideline and we do modify them directly.

In all other cases, we create files using the naming convention 'zzz_rpt_custom.conf' where 'zzz' is a specific parent Asterisk .conf file name. We then add an '#include 'zzz_rpt_custom.conf' in the parent '.conf' file to reference our information.

OBTAINING USB RADIO ADAPTER'S

Refer to http://www.usbradio.org/

INSTALLING USB RADIO ADAPTERS (URA's) AND ADJUSTING SIGNAL AMPLITUDES

Though other methods are possible, this installation process requires a direct connection to the radio's unfiltered, unsquelched receive audio signal and the radio's transmitter microphone input and its sub-audible tone modulation input. It also assumes that this is a narrow band FM radio with a peak modulation level of +/-5 KHz.

The best adjustment of these settings is accomplished using a properly calibrated Radio Communications Test Set or a separate radio frequency signal generator and modulation analyzer.

The '/etc/asterisk/usbradio.conf' file must contain valid information for your specific radio connection. Refer to the file 'usbradio.conf.sample' for details.

Each USB Radio Adapter is named by the expression [URANAME] in the '/etc/asterisk/usbradio.conf' file where URANAME is the user assigned name of the interface. The installation process automatically uses the name 'usb' for the first device. A good practice would be to name additional devices 'usb1', 'usb2' and so forth. Each interface name is logically linked to a specific USB bus address and its radio signal amplitudes are set by the information in its associated 'usbradio_tune_URANAME.conf' file.

After they are installed, USB Radio Adapters cannot be casually moved from one physical USB port to another whether those ports are on the node computer or on an attached USB hub. If you need to move one or more URA's, unplug them from their originally installed positions and then one at a time, plug them into the

new port and as you plug in each moved URA, use the CLI 'radio active xxx' command where 'xxx' is the device name that you moved. Use a 'radio tune' CLI command to verify that the device is found at its new location. Then use 'radio tune save' to save the configuration information for that device with the new USB port number. Now you can plug in the next USB to its new port and use 'radio active xxx' to select the device configuration for it. Do this one at a time for each URA you move.

We now describe the command line process to set the radio transceiver signal amplitudes.

Using either an attached keyboard and monitor or a remote ssh session, login to the node computer as root.

Make sure Asterisk is not running with the command 'amportal kill'.

Start Asterisk with the Command Line Interface (CLI) using 'asterisk -c'.

Each URA must be attached in sequence during the installation process in order for it to be properly identified and match a specific radio. Attach the first URA to the computer and radio now.

Enter the CLI command 'radio tune'. The information that returns indicates the currently selected radio interface, its settings and a list of 'radio tune' command options. There is a later section in this document that describes these options in detail.

To set the URA receiver input level adjustment the radio must be running with no signal applied on the receive frequency. Because the URA is connected to the radio's unfiltered and unsquelched receive signal point it is now subject to a maximum amplitude white noise signal from the radio.

Enter on the CLI 'radio tune rxnoise'. The software will now automatically adjust the URA's input sensitivity to match the radio output signal.

To set the URA receiver carrier detect squelch level, enter the CLI command 'radio tune rxsquelch'. The display will show the current no-signal strength and the current squelch setting. Enter the CLI command 'radio tune rxsquelch xxx' where xxx is the Current Signal Strength reading plus 150. You test the squelch setting and make a final adjustment later.

To set the URA receiver voice level adjustment, apply an on-channel, strong, full-quieting RF signal modulated by a 1 KHz tone at 3 KHz deviation. Enter the CLI command 'radio tune rxvoice'. The software will now automatically adjust level for voice modulation.

To set the URA receiver sub-audible tone level adjustment, apply a strong, on-channel, full-quieting RF signal modulated by a 100 Hz tone at 650 Hz deviation. Enter the CLI command 'radio tune rxtone'. The software will now automatically adjust the level to decode the sub-audible tone modulation.

Configure the equipment used to measure the radio transmitter modulation.

If the attached radio sub-audible tone modulation is not supplied by the URA enter the CLI command 'radio tune txtone 0'. The transmitter will activate for a few seconds to enable you to observe the modulation.

If the radio sub-audible tone modulation is supplied by the URA, enter the CLI command 'radio tune txtone 100'. The transmitter will momentarily activate. Using the modulation measurement equipment note the sub-audible tone modulation level. Repeatedly issue the 'radio tune txtone xxx' command with xxx as a new relative level adjustment as necessary to properly set the sub-audible tone modulation.

Issue the CLI command 'radio tune txvoice'. The transmitter will momentarily activate. The URA applies both the sub-audible tone modulation signal and a 1 KHz tone. Repeatedly issue the 'radio tune txvoice xxx' command with xxx as a new relative level adjustment as necessary to properly set the combined voice and tone modulation to +/- 3.65 KHz of deviation.

Save the URA settings for this device using the CLI command 'radio tune save'.

You will have to enter the information for additional URA's and radios in the 'rpt.conf' and 'usbradio.conf' files using the first device's information and the '.sample' files as a guide.

If desired, attach an additional URA and issue the command 'radio active xxx' where 'xxx' is the assigned name for the device in the 'usbradio.conf' file. Then repeat the procedure above. Repeat this again to install each additional URA.

The URA installation and tuning process is now complete.

Enter 'stop now' on the CLI then 'amportal start' to start Asterisk and FreePBX as a secure and reliable service.

ABOUT USB RADIO ADAPTER CONNECTIONS IN GENERAL

The simplest transceiver connection is just 4 (four) points consisting of ground, tx composite modulation, rx detector output, ptt input.

The radio transceiver can be either simplex (PTT) or duplex (repeater).

Connection directly to a repeater transceiver offers the best performance and allows the radio users to remain in control of the link and answer and originate telephone calls and connect to remote base nodes such as HF transceivers that usually operate in open squelch mode.

General Receiver Connection Options

1) Baseband Demodulated Signal - Unsquelched - Unfiltered
2) Filtered Rx Audio with separate CTCSS Decode signal.
3) Speaker or Earphone Audio - Voice Operated Transmit (VOX)

General Transmitter Connection Options

1) Microphone Audio
2) Separate Microphone Audio and Tone Modulation Inputs
3) Composite Modulation Post Limiter Baseband Input

The preferred method of connection is directly to the radio transceiver's baseband signals. For the receiver this is known as the discriminator, quadrature or detector output. It is unsquelched and has a flat frequency response and in some cases is DC coupled.

For the transmitter this is called the flat transmit modulation or post-limiter input.

The chan_usbradio module can be set to provide either flat unprocessed audio ready for application to the transmitter's microphone input or for FM pre-emphasized, amplitude limited and low pass filtered voice suitable for direct connection to a post-limiter modulation point. The chan_usbradio module also encodes CTCSS tones and can be configured to output them either mixed with the processed voice in a composite modulation signal or on an output separate from the voice band modulation.

All transmit amplitudes are software adjustable via an interactive tuning process.

The chan_usbradio module performs transmit and receive radio signal processing using the host PC's CPU much like a high compression factor VoIP speech transcoder. For this reason PC CPU's offering less than 800 MHz of processor speed are not recommended. You should use the Linux 'top' command or an equivalent tool to determine how a mix of simultaneous radio and telephony calls are loading your processor to ensure that your users' call quality expectations are met.

One PC can support several USB Radio Adapters and telephone connections. In our tests a 2.66 GHz Pentium 4 functioned well with simultaneous communications taking place on 4 USB radio adapters and 4 TDM-400/ZAP based telephone calls. The developers can provide special assistance in constructing nodes with 20 or more transceivers connected to a single host computer.

USB RADIO ADAPTER (URA) ASTERISK COMMAND LINE INTERFACE (CLI) OPTIONS:

radio active - selects by name a specific USB radio adapter for display or tuning.

radio tune - displays information about the current active radio device.

radio tune rxnoise - Automatically adjusts the USB Radio Adapter input sensitivity to match the maximum signal output from the connected radio. This is the signal from the radio when no signal is present on the receive frequency. If the receive signal connection point is not the unsquelched and unfiltered receive signal point, this maximum signal can be obtained by using the user controls to unmute the receiver and open the squelch.

If the USB Adapter is connected directly to an unmuted and unfiltered demodulated signal point in the radio receiver and no signal is present on the radio channel then this is the open channel reference signal.

radio tune rxsquelch - This sets the receiver noise squelch sensitivity. It provides a measurement of the current signal strength as a reference value.

radio tune txtone - This adjustment sets the modulation amplitude of the sub-audible tone or data that is transmitted simultaneously with the voice signal.

radio tune txvoice - This adjustment sets the modulation amplitude of the voice signal. The device generates a reference signal of 1000 Hz at the 60% modulation level.

radio tune save - This save the adjustments to a configuration file for a specific channel that will be automatically loaded when the server restarts.

ADDITIONAL SOFTWARE PACKAGES

FreePBX - This is a browser based Asterisk configuration and operation program. You can see the FreePBX interface on your Asterisk app_rpt server by using a web browser to view "http://(your computer ip address or FQDN)".

Webmin - The 'Webmin' Linux server administration utility is a wonderful interface to control the many complex features and services available on a Linux server. It is included in this installation. See "http://www.webmin.com" for full documentation. You can see the Webmin interface on your Asterisk app_rpt server by using a web browser to view "http://(your computer ip address or FQDN):10000".

Screen - The Linux 'screen' utility is installed to help a system operator and developer share a terminal window and configure the system or resolve issues. The screen manual is available from the command line as 'man screen'. Typically you will temporarily change the root password, make it available to the assisting developer and open a port through your router for them to make an ssh connection. They can issue a 'screen' command after they login and then you can login as root and issue a 'screen -x' command and your screen will then be shared with the developer's.

svn_rpt_update - This command line utility updates your Asterisk w/app_rpt server's local copy of the app_rpt sources and rebuilds and reinstalls Asterisk (and Zaptel if necessary). Your existing configuration files are not replaced by this utility.

RECOMMENDED REFERENCES

Asterisk - The Future of Telephony - Second Edition
http://www.usbradio.org
http://www.zapatatelephony.org/app_rpt.html
http://www.qrvc.com
http://www.xelatec.com/asterisk

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The developers provide generous assistance to Amateur Radio Operators and request that commercial users be prepared to retain their professional services as necessary.

NOTICES

"Asterisk" as referred to herein is a trademark of Digium.

Asterisk, app_rpt and other items referenced by this document contain GPL software contributed by several organizations including but not limited to Digium, Inc., ZapataTelephony, QRVC Communications and Xelatec, LLC.

CONCLUSION

Thank you for considering this project as something useful and perhaps even enjoyable.

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