

TITLE: The XIPAR Asterisk Radio Over IP Server Installation Process  
DATE: May 18, 2010 14:48 EST  
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VERSION: 00.10

#### 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. Additionally, organizations need far more than basic PTT radio communications and this package incorporates several related applications that complement Radio Over IP connectivity. This document explains an installation process for these applications recommended by the Xelatec developers. This package is named the XIPAR for Xelatec Internet Protocol Amateur Radio.

#### DESCRIPTION

This process installs a complete Asterisk IP-PBX system with radio interface modules and VoIP linking features. Because the full power of Asterisk enables linked radios to do much more than just communicate among themselves, we included several popular telecommunications packages and server administration tools. Most recognizable are the FreePBX web based Asterisk configuration tool and Webmin for system administration. Unlike most Asterisk packages, this package includes the complete source code and development environment for Asterisk and the radio linking software. Because the Radio Over IP modules for Asterisk are continuously evolving, including the source code allows us to provide a simple update and bug fix process.

#### AUDIENCE

Persons who attempt to use this document to construct a XIPAR Radio Over IP 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 866 MHz CPU or better.  
512 MB RAM, 5.5 GB Hard Drive or larger  
Ethernet Network Interface Card (NIC)

During the installation only:

- CDROM Drive or USB 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 (or an alternate port number defined during installation) must be routed to the computer through any intervening routers or firewalls.

## RADIO TRANSCEIVER REQUIREMENTS

The XIPAR system's Radio Over IP modules enable it to 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 Motorola R1225 and 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 type GMRS and FRS radios are supported.

## RADIO TRANSCEIVER TO ASTERISK INTERFACES

USB RADIO ADAPTER (URA) - This low cost device provides the largest feature set of all interfaces. To get started, you can build your own radio cable by attaching it to a \$7.00 (or less) commercial off-the-shelf 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 uses it for squelch and other features. Commercial software modules are available that enable this interface to encode and decode several professional digital coded squelch and trunking radio formats.

Refer to <http://www.dmkeng.com/> or <http://www.xelatec.com/> for specific and ready-made USB Radio Adapters.

## GENERAL INFORMATION

These instructions and the installation scripts apply to a CDROM based installation using the ISO image from the Xelatec website and then the subsequent install of the Fedora Linux Operating System (OS) and applications via the Internet.

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 866MHz Pentium III computer connected to a 6 Mb/s ADSL Internet service required about 2 hours 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://www.allstarlink.org/>" and complete the form to request a node number and network registration password. The node information that you receive can then be entered during the installation process and automatically used to build the XIPAR 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 XIPAR 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 (or another port number specified in the configuration files) must be routed to the node computer's local area network 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 XIPAR Server for connection to your wireless communications equipment, you should consider using a non-standard port number for IAX2 on your XIPAR Server. The software easily accommodates IAX2 (the VoIP protocol developed for Asterisk) 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 XIPAR server.

Now let's start the installation.

Install the PCI card or connect the USB interface to your computer. The interfaces do not need to be connected to radios but they must be present during the installation process so that they are recognized and the software is properly configured.

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.

Using another computer with a CDROM burner, you must download the CDROM ISO image from "<http://www.xelatec.com/pub/iso/xosipt.iso>" and burn it to a blank CDROM. Alternatively see the section below about using a USB flash drive.

Start the computer that is to host the XIPAR software 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, set the boot or start device to first boot from to be the CDROM and then the Hard Drive.

Finally, disable the BIOS Automatic Power Management (APM) options. It might be possible to re-enable these later but if the computer goes into standby or turns off during the installation process, it will fail.

Save the BIOS settings and exit the BIOS setting menu.

Insert the installation 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 present you with a menu and option prompt. Select the XIPAR version and operating system that you want to use and then press Enter.

The the OS and the applications will be downloaded over the Internet and installed on your computer. Follow the prompts and instructions. If you set the computer BIOS clock to UTC and if prompted for system time information, select "Computer Uses UTC" and then your timezone.

If 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 default root password is "madminx63". You should change this to something unique and secure as soon as the install completes.

The installation of the operating system will continue. After the Operating System is installed, the CDROM may eject. When the "Reboot" prompt appears, remove the CDROM from the drive and press the enter key.

The computer will reboot and later in the installation process it will prompt you for more information and then reboot again and display a login prompt.

After the installation is complete and confirmed to be operating properly, you may reboot the computer and enter the BIOS setup utility 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.

The installation process will prompt you for the information necessary to configure a single primary radio interface. If you connect additional radios edit the '/etc/asterisk/' configuration files 'rpt.conf', and if you are using USB Radio Adapters, edit 'urd.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 non-FreePBX supported files of 'rpt.conf' and the 'urd.conf' files are exceptions to this guideline and the installation process modifies 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.

#### 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, unscelched 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/urd.conf' file must contain valid information for your specific radio connection. Refer to the file 'urd.conf.sample' for details.

Each USB Radio Adapter is named by the expression [URANAME] in the '/etc/asterisk/urd.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 'urd\_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 'ampportal 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 rxsqlch'. The display will show the current no-signal strength and the current squelch setting. Enter the CLI command 'radio tune rxsqlch 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 'urd.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 'urd.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

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

#### 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)

## 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 unscelched 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_urd` driver 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_urd` 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_urd` 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 7 USB radio adapters and 4 TDM-400/ZAP based telephone calls. Xelatec can provide special assistance in constructing nodes with 20 or more radio 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 unscelched 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 rxsqlch - 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.

#### THE NEW USB RADIO DEVICE CHANNEL DRIVER (chan\_urd)

This distribution features the Xelatec chan\_urd USB Radio Device channel driver module. This module replaces the original chan\_usbradio module and provides additional features. The configuration file for chan\_urd is "/etc/asterisk/urd.conf". At the time of this document, an existing usbradio.conf file may be renamed urd.conf to update a system. For details, review the comments in the urd.conf file that is generated by the installation process.

#### OTHER INCLUDED 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" or using the tabbed menu.

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.

Upgrade - This utility should be run after updating any of the server software including FreePBX or Webmin. It is available through the web based interface at "http://(your computer ip address or FQDN)" underneath the System menu tab.

xipar\_update - This command line utility updates your XIPAR server's local copy of the Radio Over IP software sources and rebuilds and reinstalls them. Your existing configuration files are not replaced by this utility.

#### INSTALLING FROM A USB FLASH DRIVE INSTEAD OF A CDROM

You can use a tool such as "liveusb-creator" to write the install ISO image to a USB flash drive. Of course you must configure the computer BIOS to boot from the USB flash drive. Be advised that when it boots the computer may enumerate the USB flash drive as a hard drive and make it a candidate for the installation. This could result in the USB flash drive being erased and an unusable installation. Therefore, after entering your install selection watch for either the "Waiting for NetworkManager to configure eth0" or "Running pre-Installation scripts" banner to display. Unplug the USB flash drive when these banners appear so that it is not formatted. The installation will proceed normally.

#### SPECIAL PURPOSE INSTALLATION OPTIONS

Contact Xelatec for assistance with these options including:

- Fedora 64 bit O/S
- Centos 32 and 64 bit O/S
- OpenVZ O/S
- Custom disk partitions
- Additional over the air signaling protocols

#### RECOMMENDED REFERENCES

<http://www.xelatec.com/xipar>, which includes additional information and links including the text "Asterisk - The Future of Telephony - Second Edition".

#### DEVELOPER AND CONSULTANT RESOURCES FOR ASTERISK WITH APP\_RPT

Contact Steven Henke, W9SH, XELATEC LLC, sph@xelatec.com. The developers provide generous assistance to Amateur Radio Operators and request that commercial users be prepared to retain their professional services as necessary.

#### NOTICES

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

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#### CONCLUSION

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