Software Phonepatch for the Asterisk PBX

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Revision History

Revision 0.1 25/05/2006 Introduction

Revision 0.2 31/05/2006 Hardware, Asterisk configuration, Phonepatch configuration, Test

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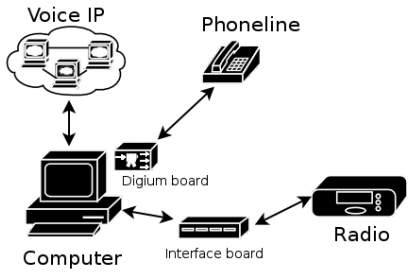
1. Introduction

A *phonepatch* is a device that allows radio stations to make phone calls. On the past, that could only be achieved with a hardware device, connected to the *PSTN* (Public Switched Telephone Network) and with a radio transceiver. Nowadays, with the arise of software PBX, the versatility of a phonepatch is not constrained to hardware, and can be integrated as part of the software. This radio-phonepatch has been designed to work together with the Open-Source Asterisk PBX on a GNU/Linux operating system.

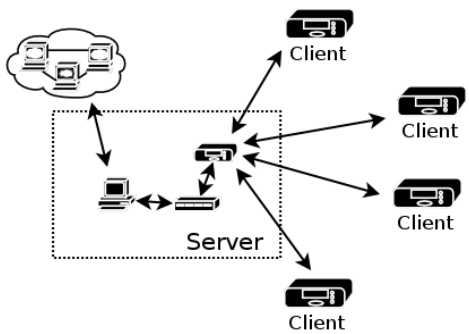
Figure 1. Hardware phonepatch

Figure 2. Software Asterisk-phonepatch



The phonepatch has been designed to work on centralized networks, so the phone link can be used for more than one radio station. The only limitation is, of course, that just one simultaneous talk is possible. In those networks, each radio-user will have its own Asterisk extension and will be able to receive and make (anoymously or not) phone calls

Figure 3. Typical network using an Asterisk phonepatch



1.1. Features

- Incoming calls (from phoneline or VoIP links) to radio users.

- Outgoing calls (from radio to phoneline or VoIP links)
- Multiple phonepatch instances on the same computer (using each one a different sound card, interface board and radio transceiver)
- Audio language configurable, available english and spanish.
- Use festival for text-to-speech.
- Phone, Radio and Festival audio-gain configurable.
- Radio users can control phonepatch with DTMF tones.
- CTCSS authentification
- VOX (Voice Operated Transmitter) processing for automatic PTT keying (*phoneline->radio*)
- Compatible with HF and VHF/UHF transceivers (with carrier detection if available)
- Very tolerant DTMF decoding.
- PTT control configurable: minimum on time, maximum on time, penalty for maximum_on_time reached.
- Uses soundcard to send and receive voice.
- Serial/parallel port (plus extenal apps) to interface PTT and carrier detection.
- Phonepatch audio messages (incoming, outcoming call, errors...) are configurable. All audio formats (WAV, AU, GSM, PCM, ...) can be used.
- Non-anonymous outgoing calls

1.2. Asterisk interface

There are several mechanism to interface an application with Asterisk. Probably the most obvious is to create a new Asterisk channel library (chan_phonepatch.so). This solution garranties full-integration, but needs to patch the Asterisk code directly, which means lots for maintenance work and incompatability issues between versions.

Another option is that the phonepatch replicates a SIP Phone. This option is interesting, but not easy to implement. SIP protocol is not trivial, although there are some SIP frameworks available. For example, for Python we have the (abandoned?) shttom project (http://shtoom.divmod.org/) Interesting for future implementations.

The easiest mechanism to interface Asterisk, and the used in the present version of the Asterisk-Phonepatch, is the AGI (Asterisk Gateway Interface). However, the AGI do not provide directly the bidirectional audio we need: the special EAGI mode (Extended AGI) opens the file descriptor number 3 with the running API, wheren application can read the received audio directly in raw format (8000sps/16 bits/little-endian), but it does not provide a direct way to send audio to the asterisk

link. This issue is solved with a simple trick, using the AGI command *GET DATA* (*STREAM_FILE* works fine also) to play an audio file. This audio file is not a normal one, but a pipe that where the phonepatch writes the audio to send. Asterisk didn't notice the difference and works without any apreciable latency.

2. Hardware

Although the phonepatch is esentially software, the interface between radio transceiver and the computer requires still some hardware, which involves sound, PTT (Pust-to-Talk) activation and carrier detection (used only for VHF and UHF transceivers).

2.1. Audio

The easiest way to interface voice with a computer is undoubtely using the soundcard as cheap D/A & A/D converter. It has no special needings, except for, of course, that must be compatible with GNU/Linux. The 2.6.x kernel series brings drivers from the ALSA project (hyyp://www.alsa-project.org), an excellent software that covers eventually any existing soundcard. Refer to its web for more details.

Check the soundcard you have installed, and its id-number:

```
# cat /proc/asound/cards

0 [ICH            ]: ICH4 - Intel ICH
                     Intel ICH with STAC9752/53 at 0xdfebfe00, irq 16
```

The phonepatch uses the *OSS* (Open Sound System) library to access the soundcard, so make sure you have also the module `snd-pcm-oss` loaded, apart from the ones needed for your soundcard:

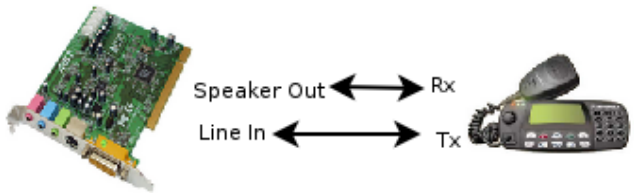
```
modprobe snd-pcm-oss
```

With the OSS library, soundcards are accesed via device files c `/dev/dsp` (device 0), `/dev/dsp1` (device 1), `/dev/dsp2` (device 2), and so on. Before trying to run the phonepatch, make sure that your soundcard is not used by any other process:

```
# lsof /dev/dsp
```

On the radio port (usually at the back) you must be find the transmission (Tx) and received (Rx) audio pins, and connect them to, respectively, soundcard's speaker and line-in (or microphone).

Figure 4. Soundcard to radio connection



Make sure that the mixer values are correctly configured (use the *alsamixer* or *rexima*): *Line In* (or *Mic*) must be selected for recording. Volume recording depends on line *InGain*. Test that the soundcard output and recording work with utilities that use OSS devices, as *rawplay* and *rawrec* (both on *rawrec* debian package)

2.2. Radio control

2.2.1. PTT

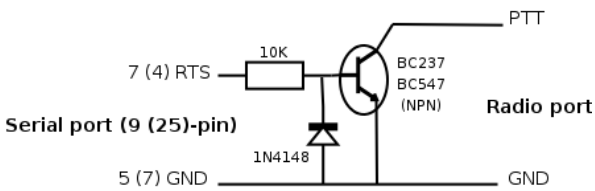
By default, radios are in receiving state, so you have to indicate when to transmit. Note that this is also true for full-duplex radio (which can transmit and receive at the same time). The line responsible for this task is the PTT (Push-to-Talk), usually activated at low-level (Ground) and deactivated at high-impedancy.

There are many ways to interface the PTT, the phonepatch provides applications for the two most common alternatives:

- Serial

  Use a serial port (pin RTS) to set/unset PTT.

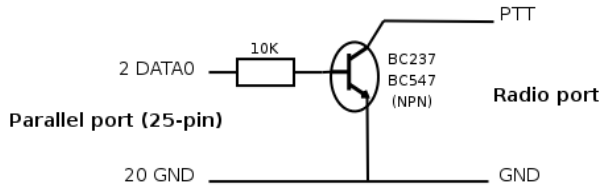
Figure 5. PTT signalling using a serial port



- Parallel

  Use the parallel port (pin DATA0) to set/unset PTT.

Figure 6. PTT signalling using a parallel port



These schemes have been taken from the Soundmodem (http://www.baycom.org/~tom/pcf/ptt_circ/ptt.html) page. Soundmodem is an interesenting project that uses soundcards as modem for digital transmission, so the hardware involved is similar to what we need for building the phonepatch hardware.

You must find the PTT (located usually at the rear part of the radio) and connect it to your serial or parallel port depending on what solution is best for you.

After that, you should test that PTT works well, using the utility *radiocontrol*:

```
radiocontrol -v -m serial -d /dev/ttyS0 -p on
radiocontrol -v -m parallel -d /dev/parport0 -p off
radiocontrol -v -m command -d eboard -o "unset ptt, set ptt„" -p on
```

2.2.2. Carrier detection

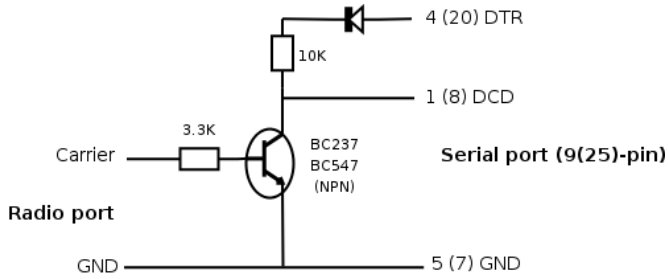
UHF/VHF transceivers work usually with FM modulations, which means that they have a way to determine if a radio is receiving audio or not: that’s called *carrier detection*. When using such transceivers, apart from the PTT signalling the phonepatch must poll the state of that signal, to decide whether the audio received comes from a remote perr or not. If detected, this audio will be sent to the phone link.

As for the PTT, the carrier detection is made with the serial and parallel port:

- Serial

  Use a serial port (pin DCD) to get carrier detection state

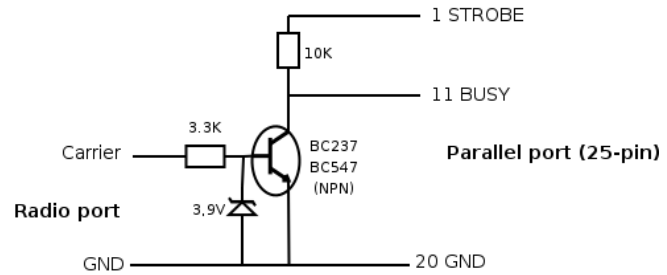
Figure 7. Carrier detection using a serial port



- Parallel

  Use a parallel port (pin Busy) to get carrier detection state

Figure 8. PTT signalling using a parallel port



After that, you should test that carrier detection works well, using as well the utility *radiocontrol*:

```
radiocontrol -v -m serial -d /dev/ttyS0 -c
radiocontrol -v -m parallel -d /dev/parport0 -c
radiocontrol -v -m command -d eboard -o "„get carrier,get carrier: (1|0)" -c
```

2.2.3. Device lines fully configurable

Although lines used by default on these board are pretty common (RTS, DCD, DATA0, ...), your cable may use others for PTT keying and carrier detection (and power needed for carrier detection). For this reason, all lines (both serial and parallel port) are fully configurable with the option *--device-lines pttline,carrierdetectionline,powerline*. In this example we use DTR for PTT, DCD for carrier detection and RTS for power:

```
radiocontrol -v -m serial -d /dev/ttyS0 --device-lines dtr,dcd,rts -p on
radiocontrol -v -m parallel -d /dev/parport0 --device-lines data,paperout,autofeed -c
```

3. Configuration

3.1. Asterisk modules

Make sure that the modules *res_agi.so* and *format_sln.so* are enabled on `/etc/asterisk/modules.conf`:

```
...
; Formats
load => format_sln.so
...
; Channels
load => res_agi.so
...
```

3.2. Groups permissions

Normally, Asterisk is run as asterisk user. Then, the phonepatch must also set its UID to asterisk, in other case it cannot be stopped and continued (using signals) from the asterisk process. As the phonepatch will load as asterisk user, we must assure that it has access to all hardware involved: soundcard, serial/parallel ports:

```
# ls /dev/dsp* /dev/ttyS* /dev/parport*
crw-rw----  1 root audio 14,  3 2006-07-04 09:33 /dev/dsp
crw-rw----  1 root dialout 4, 64 2006-07-04 11:32 /dev/ttyS0
crw-rw----  1 root lp 4, 64 2006-07-04 11:32 /dev/parport0
```

In that case, you should do:

```
usermod -G asterisk,audio,dialout,lp asterisk
```

3.3. Asterisk extensions

On the Asterisk extensions file configuration (`/etc/asterisk/extensions.conf`) we have to add all the radio stations for which we want to enable the phonepatch. Although not really necessary, it's recomendable that yout create a new context (for example: *radio*) for these special users.

On this example, we will asign extensions for *PuertoSaija* (151) and *Munichis* (152).

```
[radio]
```

```
; Phonepatch
exten => 151,1,Answer()
exten => 151,2,EAGI(phonepatch.agi|puertosaija)
exten => 151,3,Hangup

exten => 152,1,Answer()
exten => 152,2,EAGI(phonepatch.agi|munichis)
exten => 152,3,Hangup
```

This extensions are used in both ingoing and outgoing calls. If you plan to use anonymous calls (where the extension is only for ingoing calls), it's not necessary to add another extension. For simplicity, use the same context that you choose for the incoming calls:

```
[radio]

...

; Static outgoing extension
exten => 160,1,Answer()
exten => 160,2,EAGI(phonepatch.agi|outcall)
exten => 160,3,Hangup
```

3.4. Phonepatch configuration

Configuration file is place by default at `/etc/asterisk/phonepatch`. Global parameters and included in [general] section, options regarding a phonepatch (soundcard, PTT/Carrier) must be included in a [*phonepatchname*] section. Numeric sections are reserved to the phonepatch extensions.

When the phonepatch needs to get the value of a parameter, it searchs the configuration file in that order:

- Extension
- Phonepatch definition
- General
- Default values (defined by template: /usr/share/asterisk-phonepatch/phonepatch.conf.template)

If you need to define more than one phonepatch, you have to specify another *soundcard* and PTT/Carrier interface. Example using 2 phonepatchs:

```
; Asterisk Phonepatch configuration

[phonepatch1]

soundcard_device=/dev/dsp
soundcard_samplerate=8000
soundcard_latency=0.01
```

```
ptt=off
carrier_detection=off
radio_control=serial[dtr,dsr,rts]:/dev/ttyUSB0
outcall_daemon=enabled

[phonepatch2]

outcall_daemon=off
soundcard_device=/dev/dsp1
soundcard_samplerate=8000
soundcard_latency=0.05
ptt=off
carrier_detection=off
radio_control=serial[dtr,dsr,rts]:/dev/ttyUSB1

[general]

language="es"
sounds_dir="/usr/share/asterisk-phonepatch/sounds/"
spool_dir="/var/spool/asterisk/outgoing/"

dtmf_noisy_mode_button=
dtmf_sensibility=1.0

festival_audio_gain=5.0
telephony_audio_gain=1.0
radio_audio_gain=1.0

carrier_polling_time=0.5
carrier_threshold_signal=0.1
carrier_tail_time=2
carrier_max_time=20
carrier_wait_time=5
full_duplex=off

ptt_threshold_signal=0.01
ptt_tail_time=2
ptt_max_time=30
ptt_wait_time=5
ptt_txdelay=0.5

ctcss_tx_amplitude=0.001

hangup_button=#
end_audio=php_endcall.ogg
call_limit=600

incall_report_audio=@%d
incall_report_audio_wait=5
incall_report_timeout=60
incall_report_timeout_audio=php_notanswered.ogg

incall_answer_mode=dtmf
incall_answer_button=*

outcall_channel = IAX2/guest:violin@localhost

outcall_context=metadistro
outcall_timeout=10
outcall_priority=1

askfortone_button="*"
tone_audio=php_tone.ogg
tone_audio_time=3
tone_timeout=20
tone_timeout_audio=php_timeoutcall.ogg
outcall_button="*"
clear_button="#"

ring_audio=php_ring.ogg
ring_audio_time=1
ring_audio_wait=3
```

```
ring_timeout_audio=php_ringtimeout.ogg

ctcss_tx=
ctcss_rx=
outcall=on
incall=on
name=default
phonepatch=phonepatch1

outcall_askfortone_mode=dtmf
outcall_dmtf_extension_mode=on

[puertosaija]
name="estacion puertosaija"
ctcss_tx=1Z
ctcss_tx_amplitude=0.02
outcall_dtmf_id=1
outcall_extension=151
incall_answer_mode=ctcss
phonepatch=phonepatch2

[munichis]
name="estacion munichis"
outcall_dtmf_id=2
outcall_extension=152
ctcss_rx=200.0
ctcss_tx_amplitude=0.02
ctcss_tx=150.0
```

As base configuration file, you can also use the example located at `/usr/share/asterisk-phonepatch/phonepatch.conf.example`. Copy it to `/etc/asterisk/phonepatch.conf` and costumize it. Take a look on the manual page (*man phonepatch.conf*) to see a detailed explanation of all the variables. Default values are good for most situations, but take care on the following ones:

- **ptt**

  On most cases you will have to enable this options to turn PTT on when sending audio to the radio.

- **radio_control**

  Use *serial:device*, *parallel:device* or *command:external_command*. Valid values are for example *serial:/dev/ttyS0*, *parallel:/dev/parport0* or *command: /usr/sbin/external-app-to-interface-board*.

  When using parallel port, make sure that the module *ppdev* is loaded.

  The *command* option runs an external command which is supposed to accept commands from the *stdin* and returning its output through *stdout*. When using the *command* option, you have to fill *ptt_on*, *ptt_off* , *get_carrier* and *get_carrier_response* parameters. The first three are the strings that would be sent to process to turn ptt of, turn it off, and get carrier state. The last one, *get_carrier_response*, expects a special regular expression: let's imagine that the external application returns *"get carrier: on"* to say there is carrier and *"get carrier: off"* if there is not. In that case you would have to set *get_carrier_response* parameter to *"get carrier: (on|off)"*.

  If your board don't use the standard lines, you can set the ones you have that way (*device_name[ptt,carrierdetection,power]:device*). Examples:

serial[dtr,dcd,rts]:/dev/ttyS0

parallel[data0,paperout,autofeed]:/dev/parpot0

Use the negative prefix ("-") to logically negate a line.

- **carrier_detection**

  It prevents PTT activation when the carrier is detected. Must be enabled for VHF/UHF transceivers, but of course only if your interface board is able to read the *carrier_detection* state, otherwise the phonepatch won't work. Sometimes enabling *carrier_detection* is optional, but in other cases is compulsory, because the radio outputs noise on the Rx audio signal (noise that the phone user will listen!). Motorola transceivers are known to behave that way.

  If *carrier_detection* is enabled, the *carrier_polling_time* applies. This is the time that the phonepatch waits between succesive looks to carrier state. Use small values carefully as it is likely to load the CPU. *0.5 seconds* should be enough for most cases.

- **full_duplex**

  You should enable this parameter only if you have a full duplex transceiver (notice that it will only work if *carrier_detection* is also enabled). Notice that most transceivers are half-duplex and this options should remain disabled.

- **outcall_extension**

  Here you specify the asterisk extension used for outgoing calls. For anonymous calls set outcall_extension_mode=static and simply give the extension used. For outcall_extension_mode=ctcss, write the specifica asterisk extension inside the station's configuration. For outcall_extension_mode=dtmf, add a outcall_dtmf_id (different for each extension) to allow the phonepatch to identify the radio user. If you want to append this id to the final asterisk extension, enable the outcall_extension_append_id option inside the phonepatch extension's section).

- **ptt_threshold_signal**

  Phones don't have a PTT, so we need to guess when the phone user is talking or not, and activate the PTT automatically (this is called a VOX mechanism). The *ptt_threshold_signal* is the parameter you need to adjust depending on your phoneline and soundcard levels. Maximum received power is the unity (1.0), so *values around 0.05-0.2* should work in most scenarios.

- **dtmf_noisy_mode_button**

  It has been implemented for very noisy links (i.e. HF) where a tone can be decoded accidentally more than once. With this DTMF button you indicate that you are going to push next number. Example (using #): user pressed "1#2#3#4#", but the number was decoded, due to noise, as *1111#2#333333###4444##*; however, this will be correctly interpreted as *1234*. Therefore, you can repeat as many times as you want a number to assure it's decoded, and then press *noisy_mode_button* (also so the times you want).

- **outcall_channel**

  That's the channel used on outgoing calls. Example: *IAX2/user:password@IP*

4. Outcall daemon

Once configured, incoming calls should work without doing anything else, since Asterisk will launch automatically the EAGI script when a call for a phonepatch extension is received. However, to enable outgoing calls we need that the phonepatch listens to the channel, detect DTMF tones from the user and make calls when necessary. To enable the daemon mode, edit the main configuration file `/etc/asterisk/phonepatch.conf` and set *outcall_daemon=on* inside all the phonepatches sections you want to enable.

After a */etc/init.d/asterisk-phonepatch restart*, you sould see the process on a *ps* and the pidfile for them:

```
# init.d/asterisk-phonepatch start
Starting Asterisk Phonepatch daemons: asterisk-phonepatch

# ps awx |grep phonepatch
19119 ?        S      0:00 /usr/bin/python /usr/sbin/asterisk-pho ....
19412 ?        S      0:00 /usr/bin/python /usr/sbin/asterisk-pho ....

# cat /var/run/asterisk/phonepatch.pid
19119

# cat /var/run/asterisk/phonepatch2.pid
19412
```

Daemon info is written to `/var/log/daemon.log`, check this file to see what is its state:

```
# tail -f /var/log/daemon.log
Jun  9 14:41:41 localhost asterisk-phonepatch[6561]: soundcard opened: /dev/dsp1 (8000 sps)
Jun  9 14:41:41 localhost asterisk-phonepatch[6561]: radio control opened: command:eboard -p
Jun  9 14:41:41 localhost asterisk-phonepatch[6564]: creating pidfile: /var/run/asterisk-phonep
Jun  9 14:41:41 localhost asterisk-phonepatch[6564]: waiting for askfortone_button
```

When debugging, you can start phonepatch daemon directly from the console (in this mode only one can be active, select it with the *-p* option).

```
# init.d/asterisk-phonepatch stop
Stopping Asterisk Phonepatch daemons:
 phonepatch: done

# asterisk-phonepatch -p phonepatch1
phonepatch -- daemon -  -- start of state: daemon
phonepatch -- daemon -  -- soundcard opened: /dev/dsp (8000 sps)
phonepatch -- daemon -  -- radio control opened: command:eboard -ep
phonepatch -- daemon -  -- creating pidfile: /var/run/asterisk/phonepatch1.pid
```

5. Testing the phonepatch

Connect to the running Asterisk with with a high-level verbose:

```
asterisk -dr -vvvvvvvvvvvvvvv
```

5.1. Incoming calls

- From a telephone, call a extension defined in the phonepatch.
- On the telephone link and the user radio, a message like *"Radio call for _station_"* (defined on *report_call_audio*) will be heard. Station name is syntetized with Festival. You can create your own audio files to hear a more friendly voice.
- Press *answer_button* on the microphone of the user radio.
- Now it should be possible to talk in both directions

5.2. Outgoing calls

- From the user radio press the button *askfortone_button*, a tone should be heard for *tone_audio_time* seconds.
- When the tone audio finishes, dial the destination number and finally press *call_button, the call should now start.*.
- While asterisk is trying to stablish the call, a ring audio will be listened (*ring_audio*) on the radio.
- If the call is not answered, the (*ring_timeout_audio*) will be listened and the communication will be closed.
- If the call is answered, the phonepatch opens the bridge, and it should be possible to talk in both directions

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