Ham Radio Applications of Linux Single Board Computers

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This talk is available online at

http://www.prinmath.com/ham/talks/

Single Board Computers

- Full Linux boxes *(today's topic)*
  - Raspberry Pi
  - Beaglebone
- Microcontrollers *(not covered)*
  - Arduino
  - PICAXE
  - BASIC Stamp

Linux SBCs

- Runs a full Linux OS
- Usable stand alone computer or server
- Built in connectivity
  - Ethernet networking
  - USB and serial
  - General purpose IO
- Expandable using daughter boards
- Inexpensive ($50 for a working system)

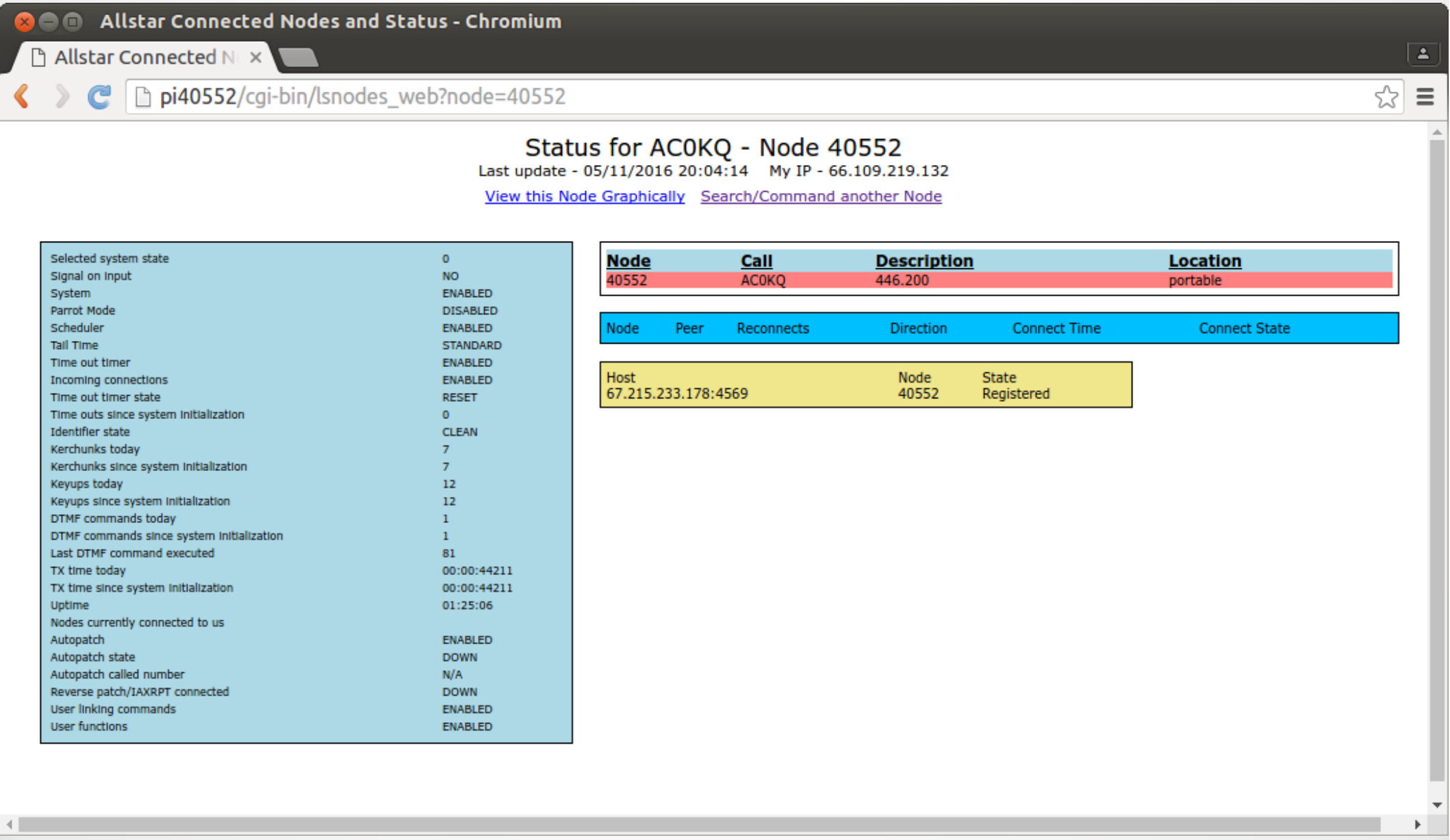
Potential Applications

- This talk:
  - AllStarLink repeater
  - ADSB receiver
  - Software Defined Receiver (SDR)
- Other talks
  - BPQ BBS, RMS and iGate
  - Site monitoring

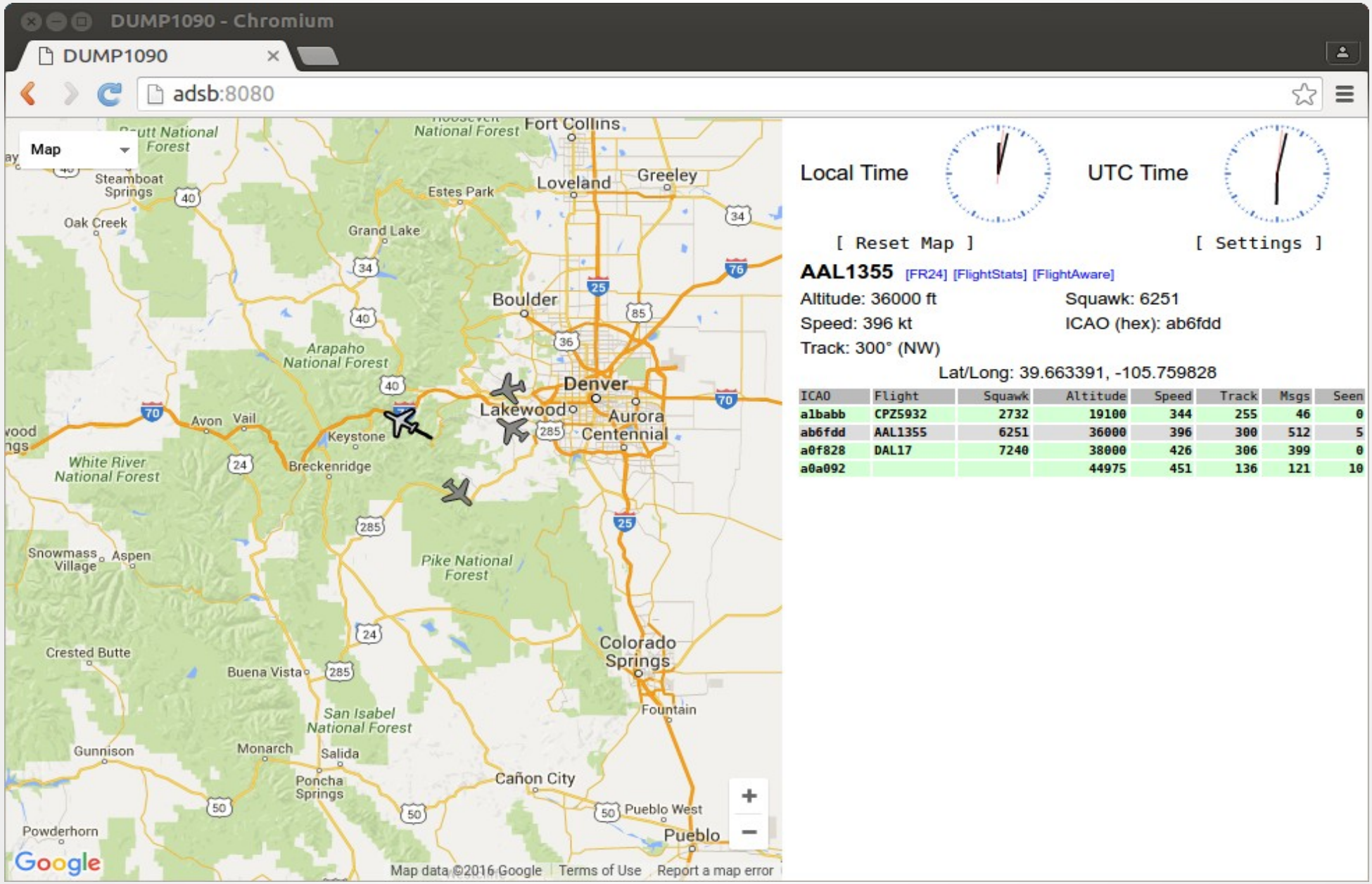
Pros and Cons

- Pros
  - Inexpensive
  - No moving parts
  - 5V power
  - Expandable
- Cons
  - SD cards corrupted by bad power

AllStarLink Repeater



ADSB SDR Receiver



ICAO	Flight	Squawk	Altitude	Speed	Track	Msgs	Seen
a1babb	CPZ5932	2732	19100	344	255	46	0
ab6fdd	AAL1355	6251	36000	396	300	512	5
a0f828	DAL17	7240	38000	426	306	399	0
a0a092			44975	451	136	121	10

Raspberry Pi

- Most Popular
- Best supported
- rPi2 most powerful
- Lots of USB ports
- Lots of daughterboards
- No analog inputs
- $35 plus SD card

BeagleBone

- Less well supported
- Onboard eMMC
- Power & Reset buttons
- More GPIO pins
- 8 analog inputs
- $50 street price

Power and Storage

- Runs on 5V DC
  - Needs clean power
- Micro SD card storage
  - Finite life
  - Bad power kills SD

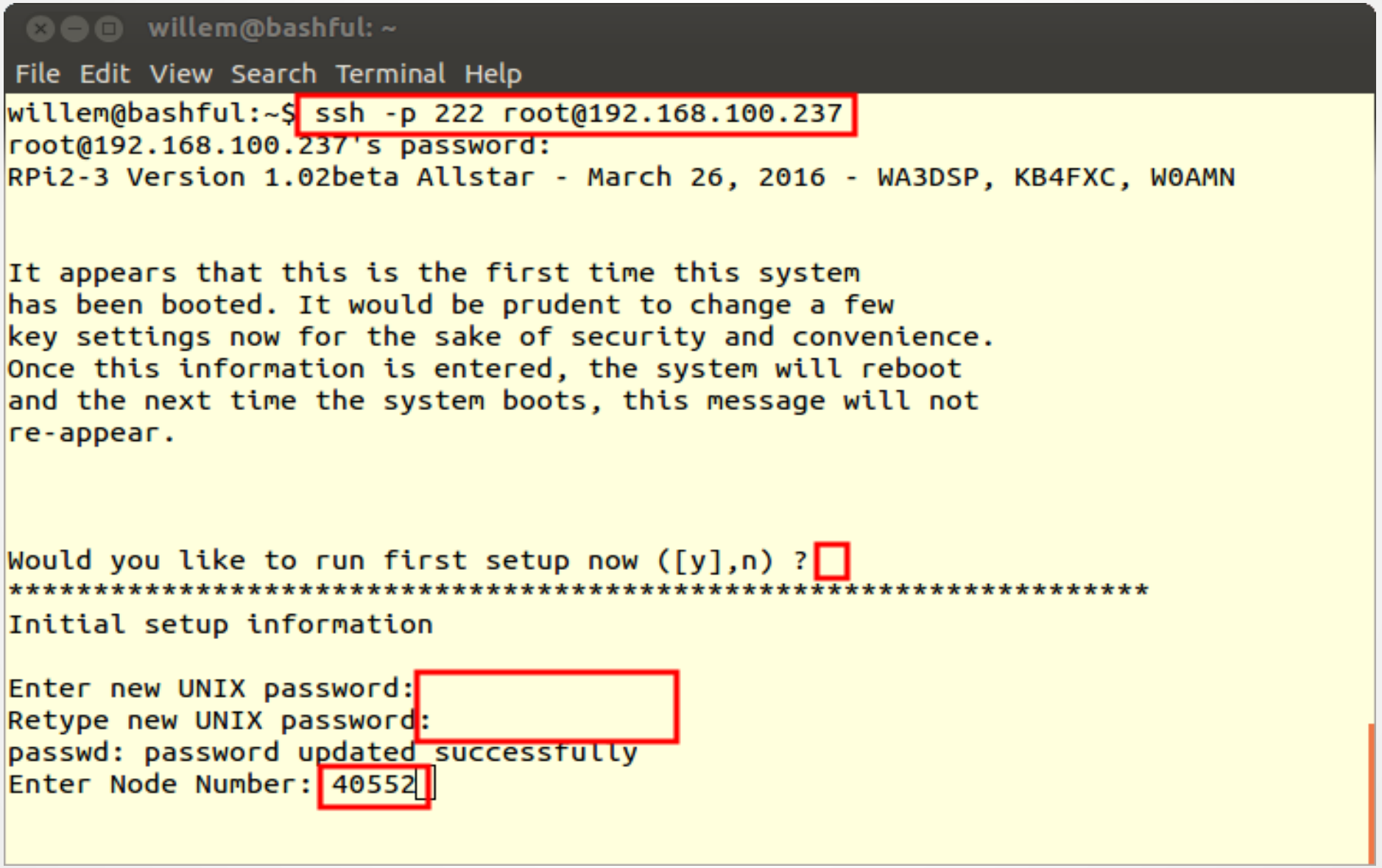
What is AllStarLink?

- Asterisk VOIP software for radio
- Interfaces with radio via URIx
  - CM119 USB audio chip
  - DB25 connector
- Can roll your own with equivalent fob

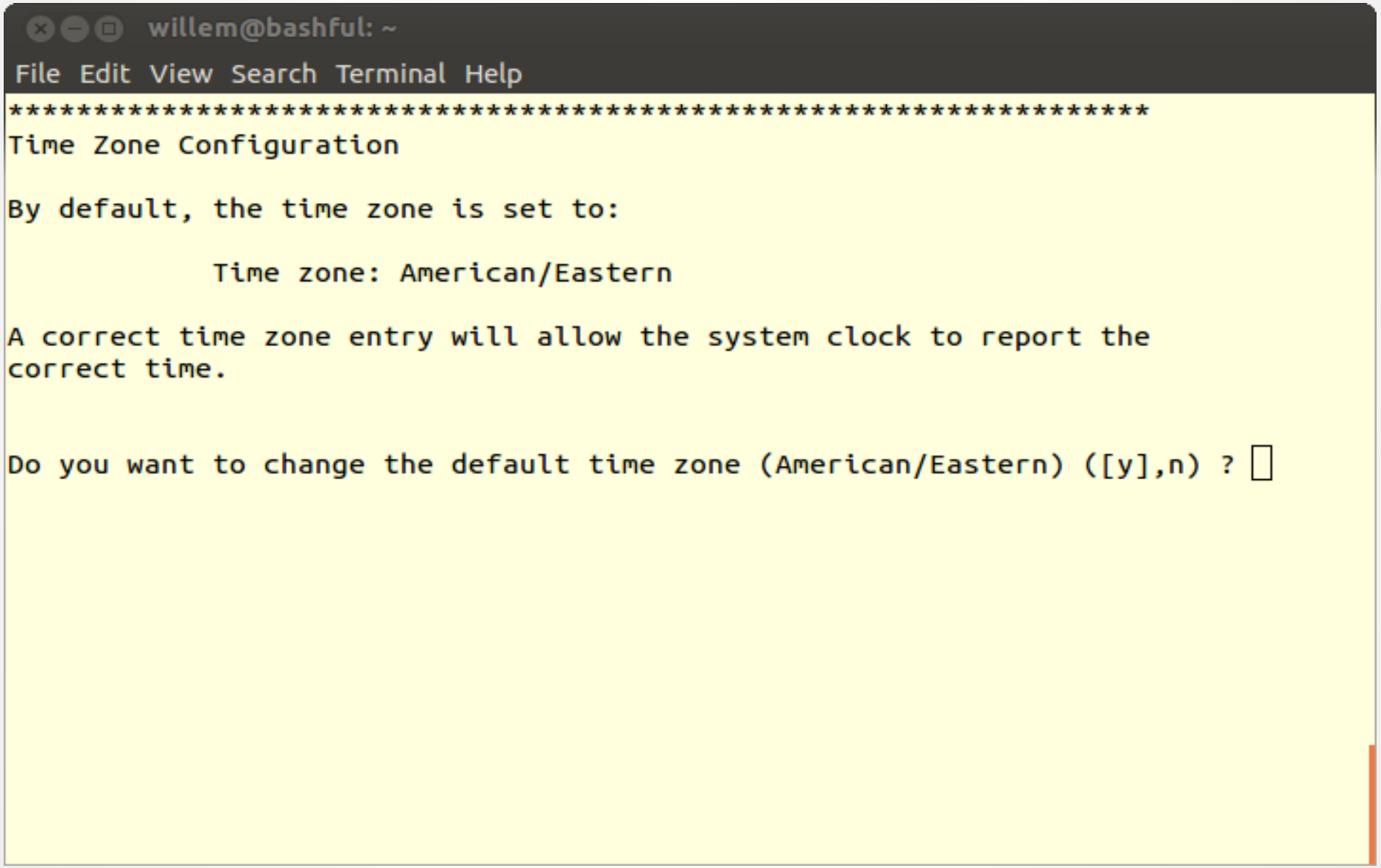
Installing AllStarLink

- Download from *www.hamviop.com*
  - Burn image to SD card
- Program your radio/repeater
  - Set radio to encode/decode CTCSS
  - On Motorola set accessories to output COS & PL on pin 8

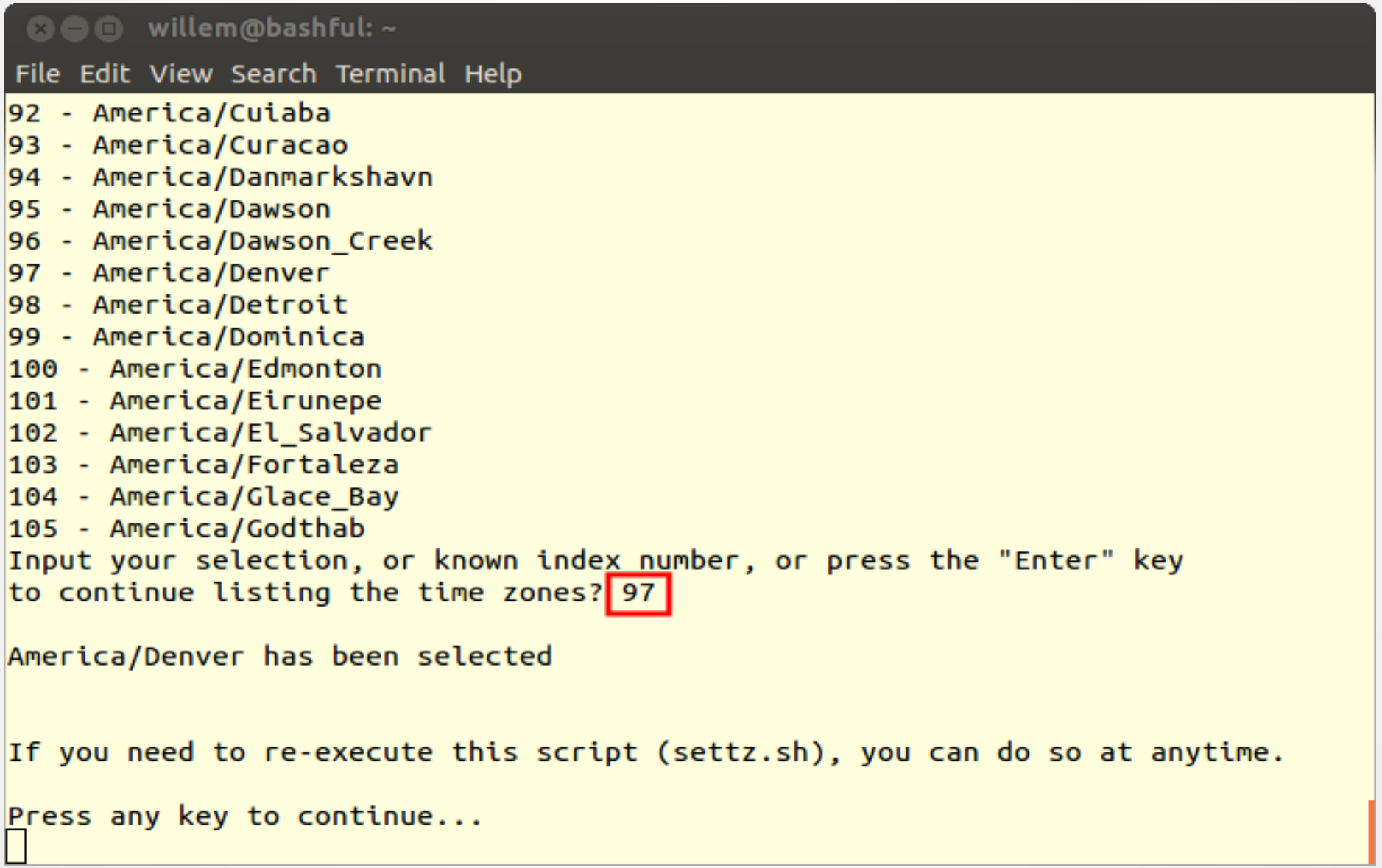
Initial Login



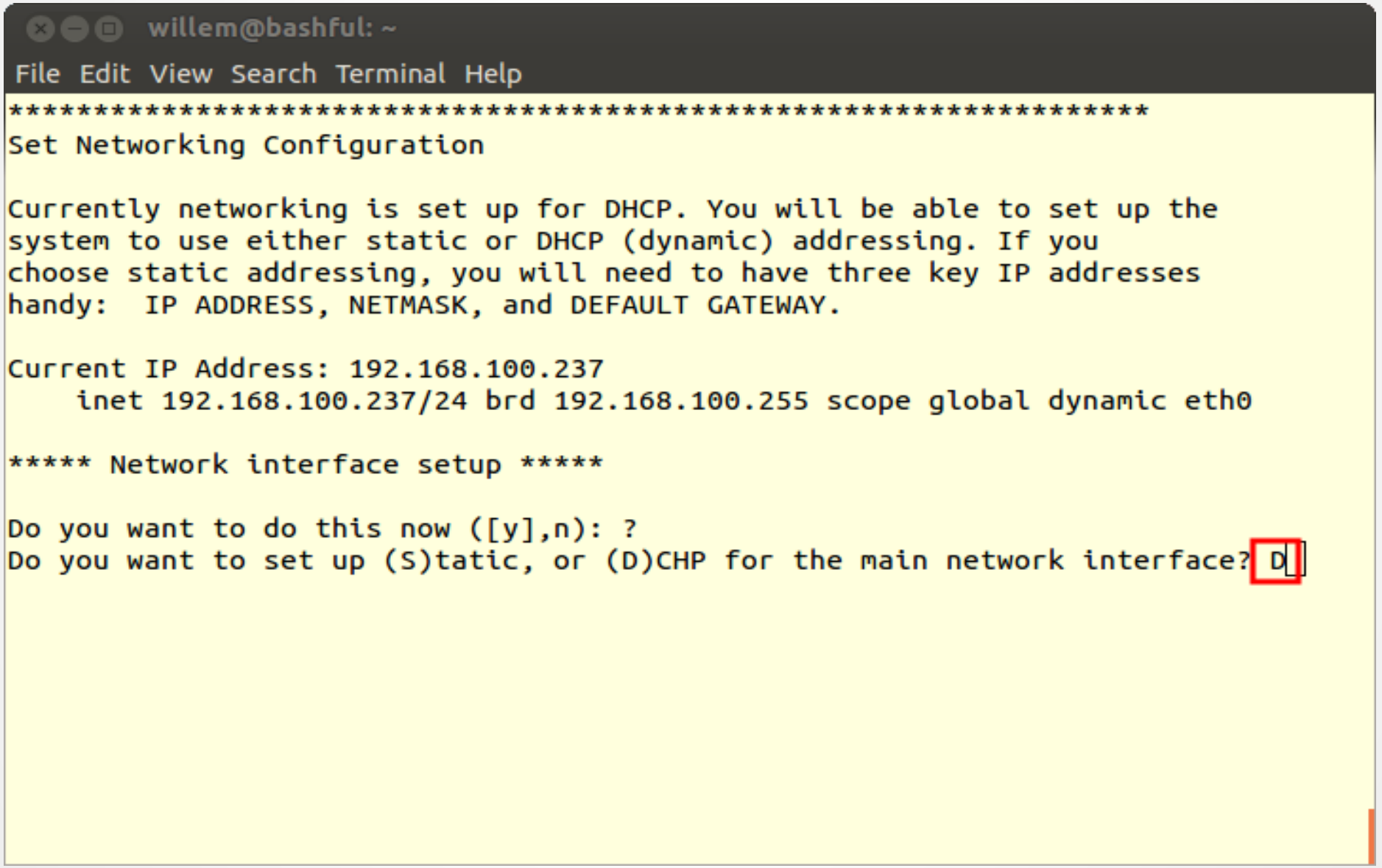
Set Time Zone 1



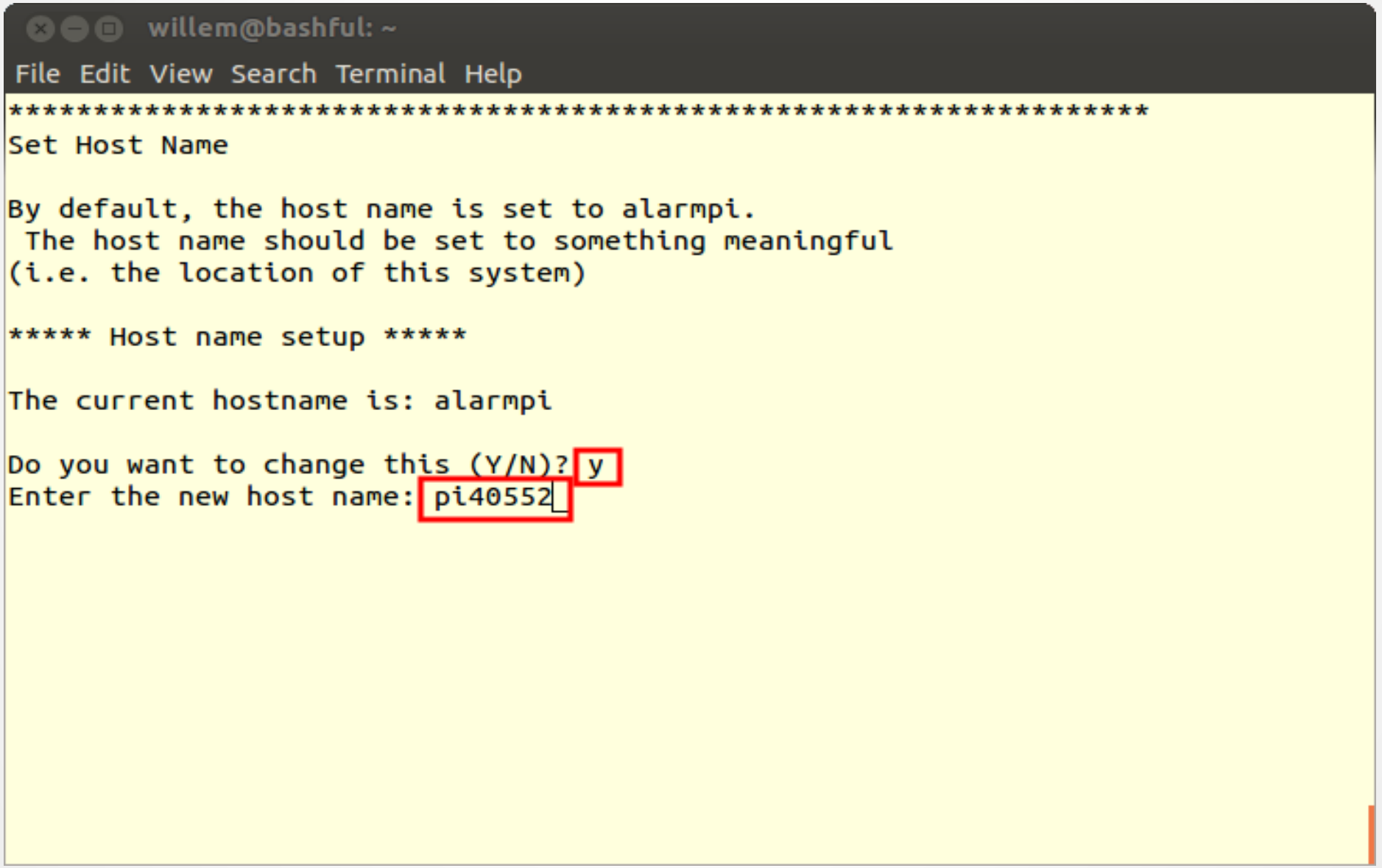
Set Time Zone 2



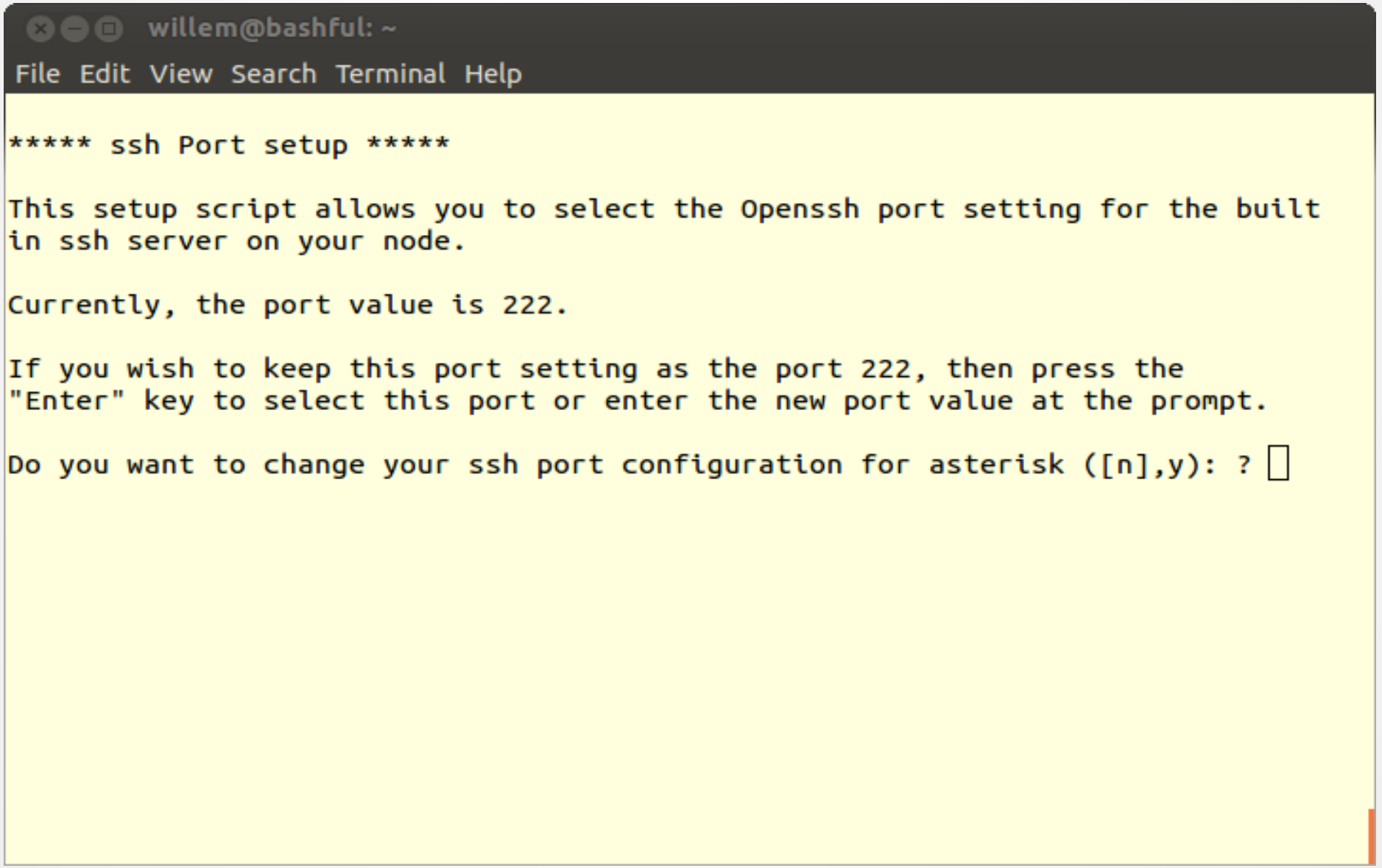
Network Configuration



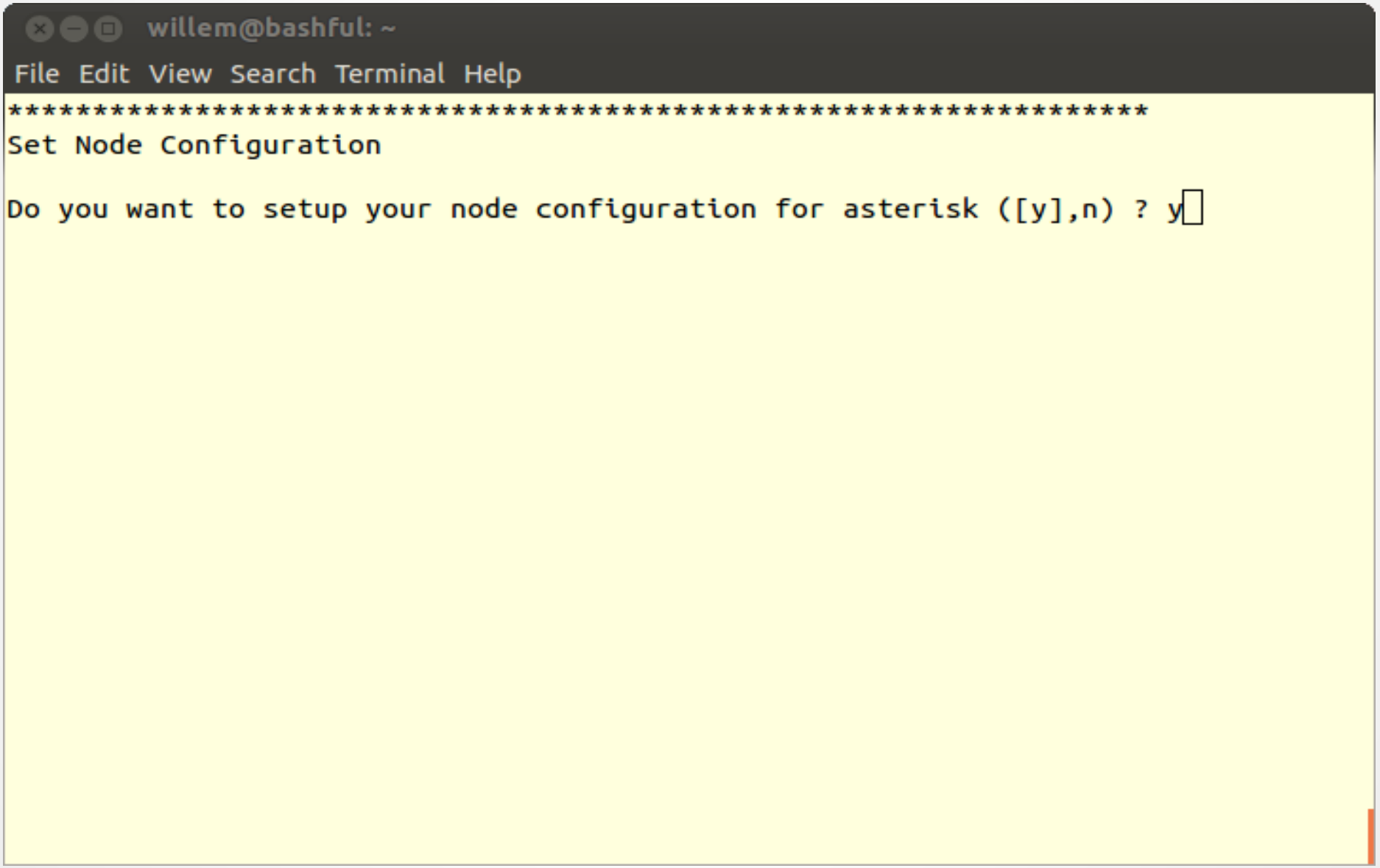
Set Hostname



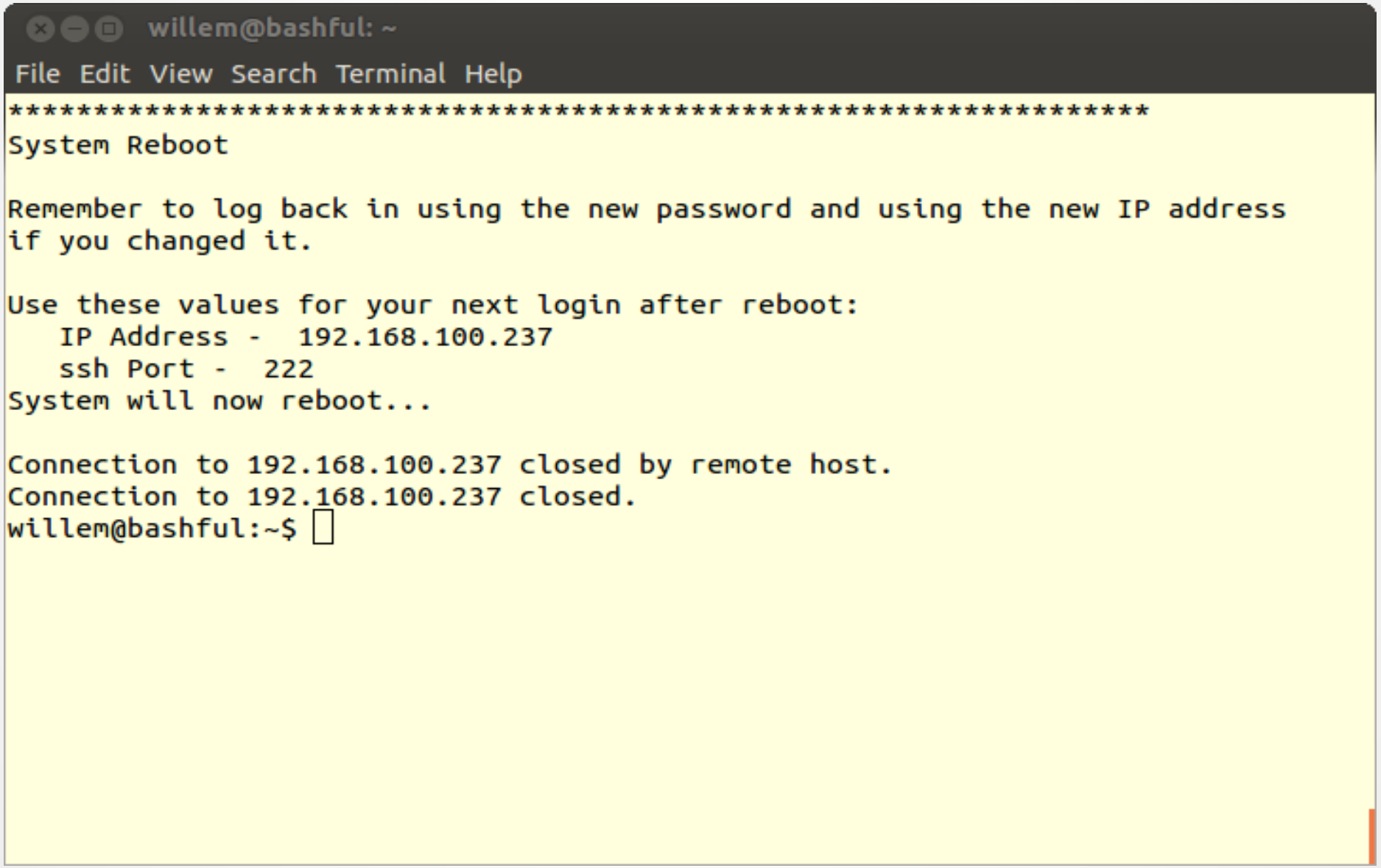
Configure ssh



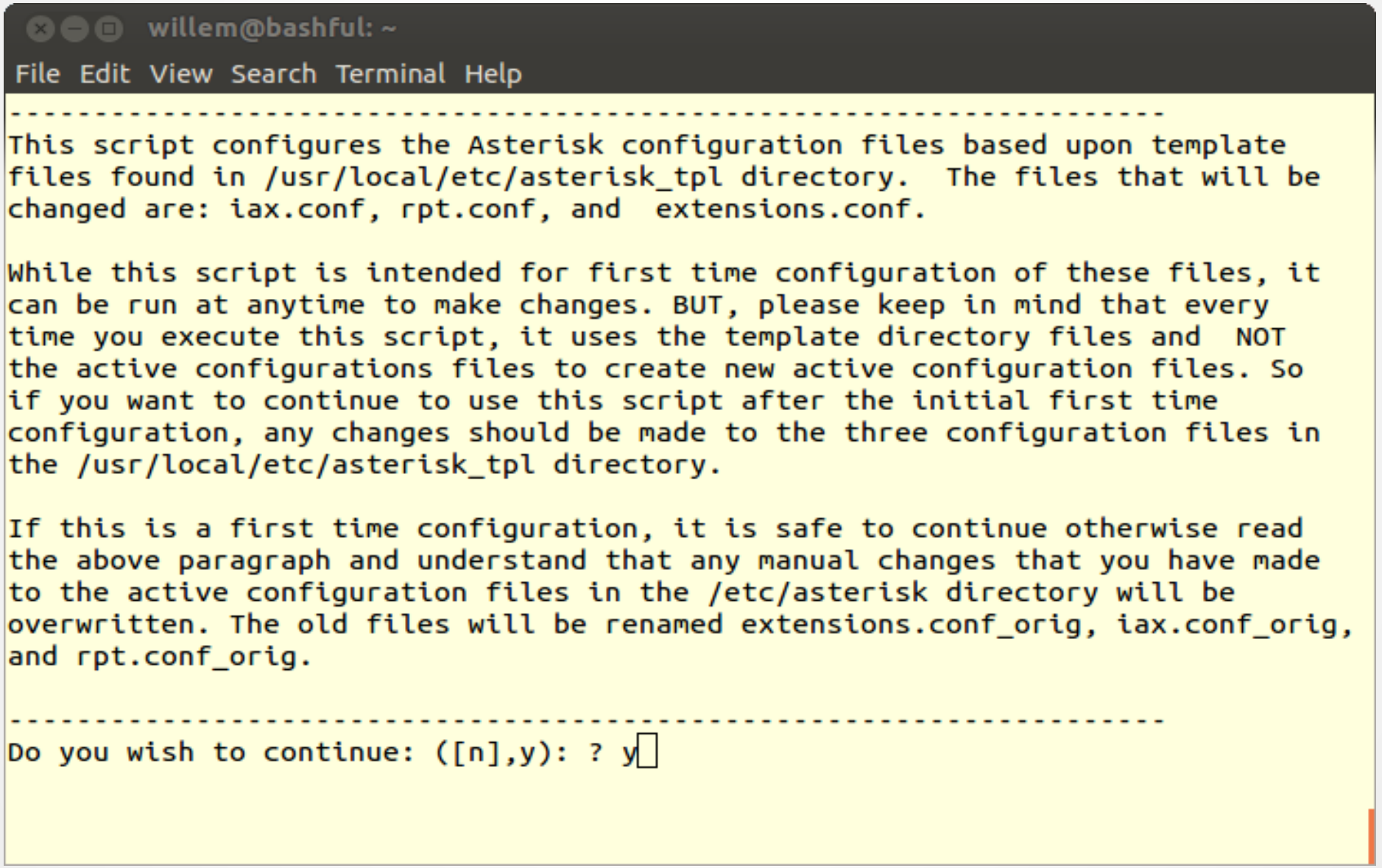
Node Setup 1


willem@bashful: ~
File Edit View Search Terminal Help
****
Set Node Configuration
Do you want to setup your node configuration for asterisk ([y],n) ? y

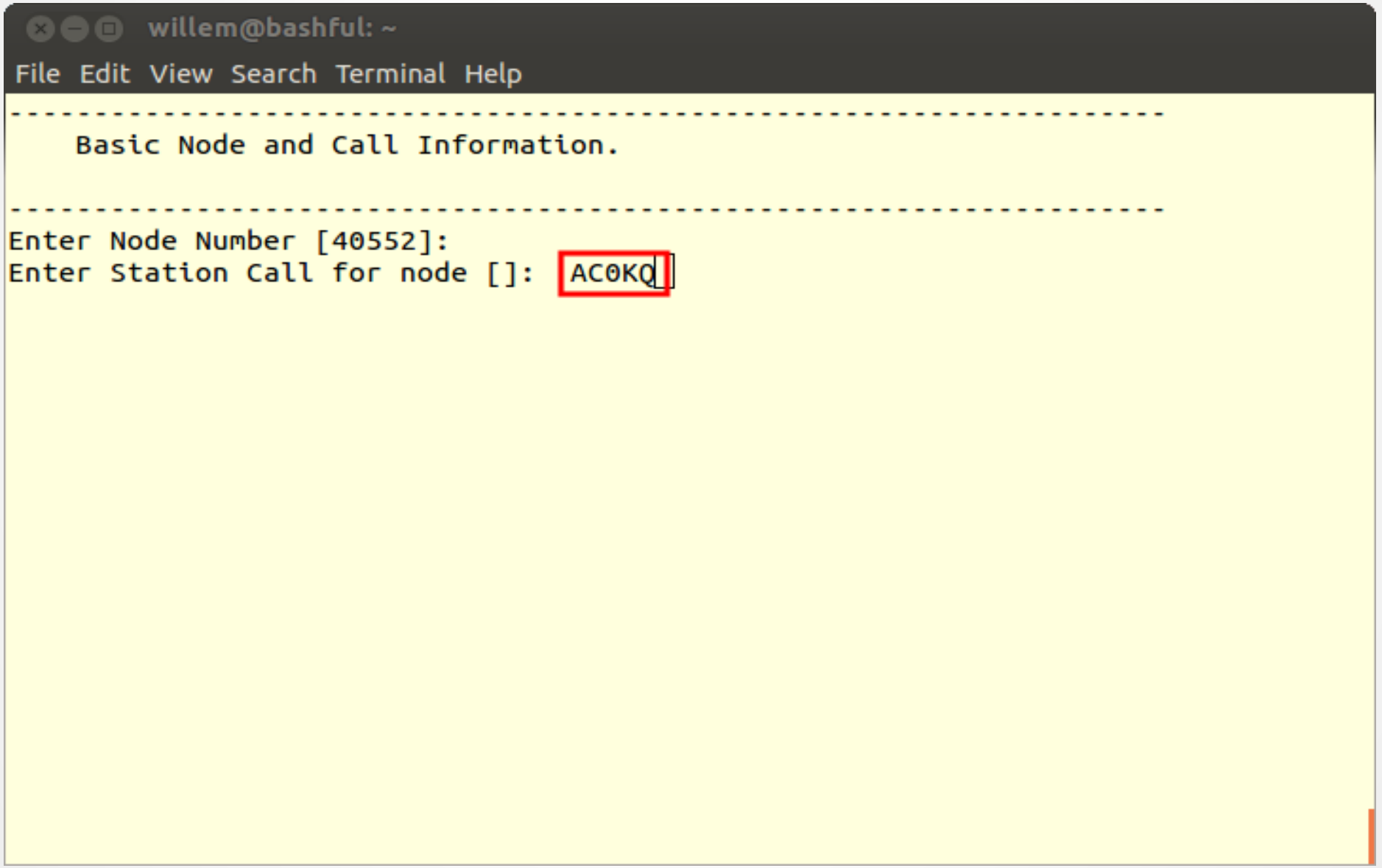
Node Setup 2


willem@bashful: ~
File Edit View Search Terminal Help
****
System Reboot
Remember to log back in using the new password and using the new IP address
if you changed it.
Use these values for your next login after reboot:
IP Address - 192.168.100.237
ssh Port - 222
System will now reboot...
Connection to 192.168.100.237 closed by remote host.
Connection to 192.168.100.237 closed.
willem@bashful:~$

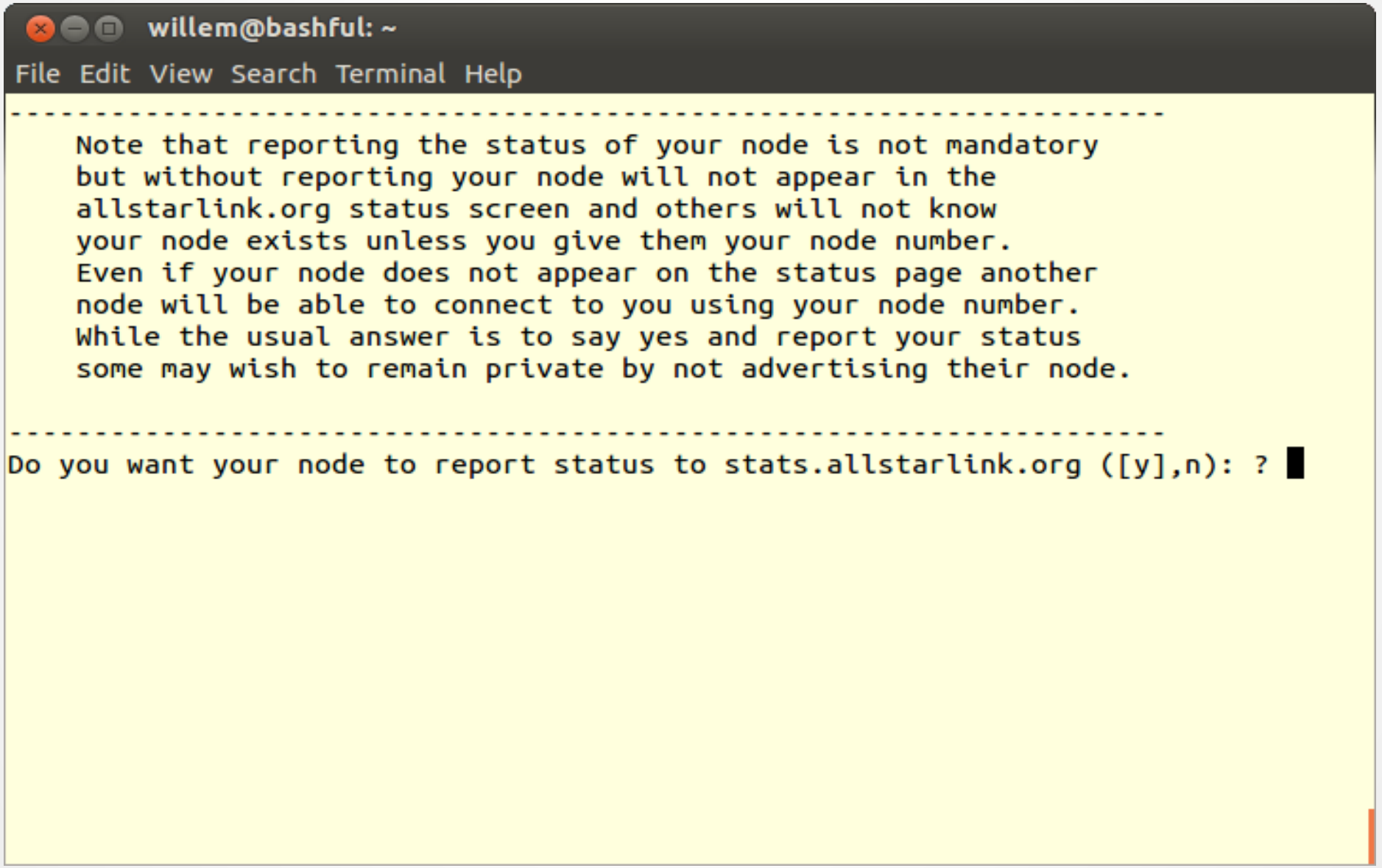
Node Setup 3


willem@bashful: ~
File Edit View Search Terminal Help
This script configures the Asterisk configuration files based upon template files found in /usr/local/etc/asterisk_tpl directory. The files that will be changed are: iax.conf, rpt.conf, and extensions.conf.
While this script is intended for first time configuration of these files, it can be run at anytime to make changes. BUT, please keep in mind that every time you execute this script, it uses the template directory files and NOT the active configurations files to create new active configuration files. So if you want to continue to use this script after the initial first time configuration, any changes should be made to the three configuration files in the /usr/local/etc/asterisk_tpl directory.
If this is a first time configuration, it is safe to continue otherwise read the above paragraph and understand that any manual changes that you have made to the active configuration files in the /etc/asterisk directory will be overwritten. The old files will be renamed extensions.conf_orig, iax.conf_orig, and rpt.conf_orig.
Do you wish to continue: ([n],y): ? y

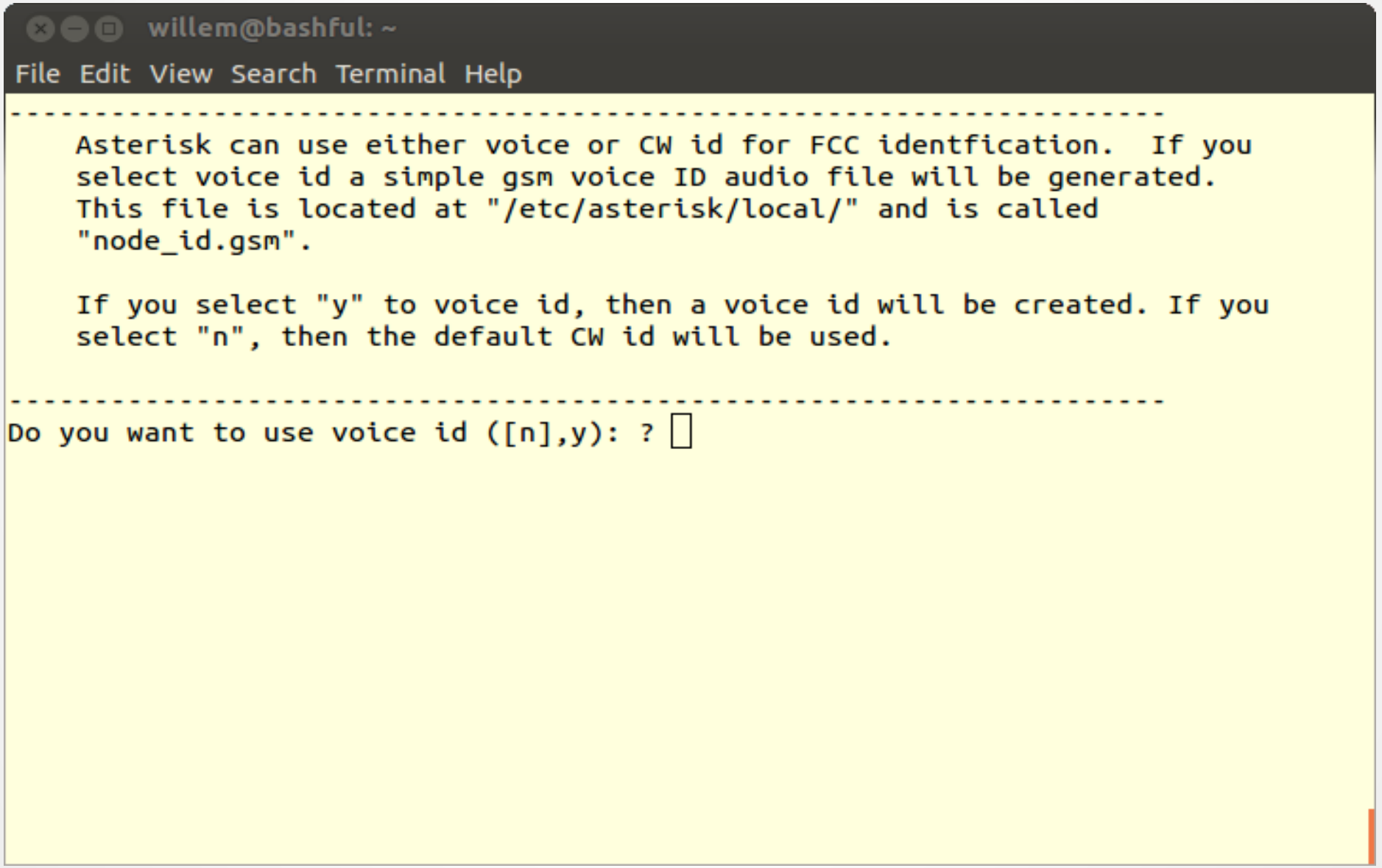
Node Callsign



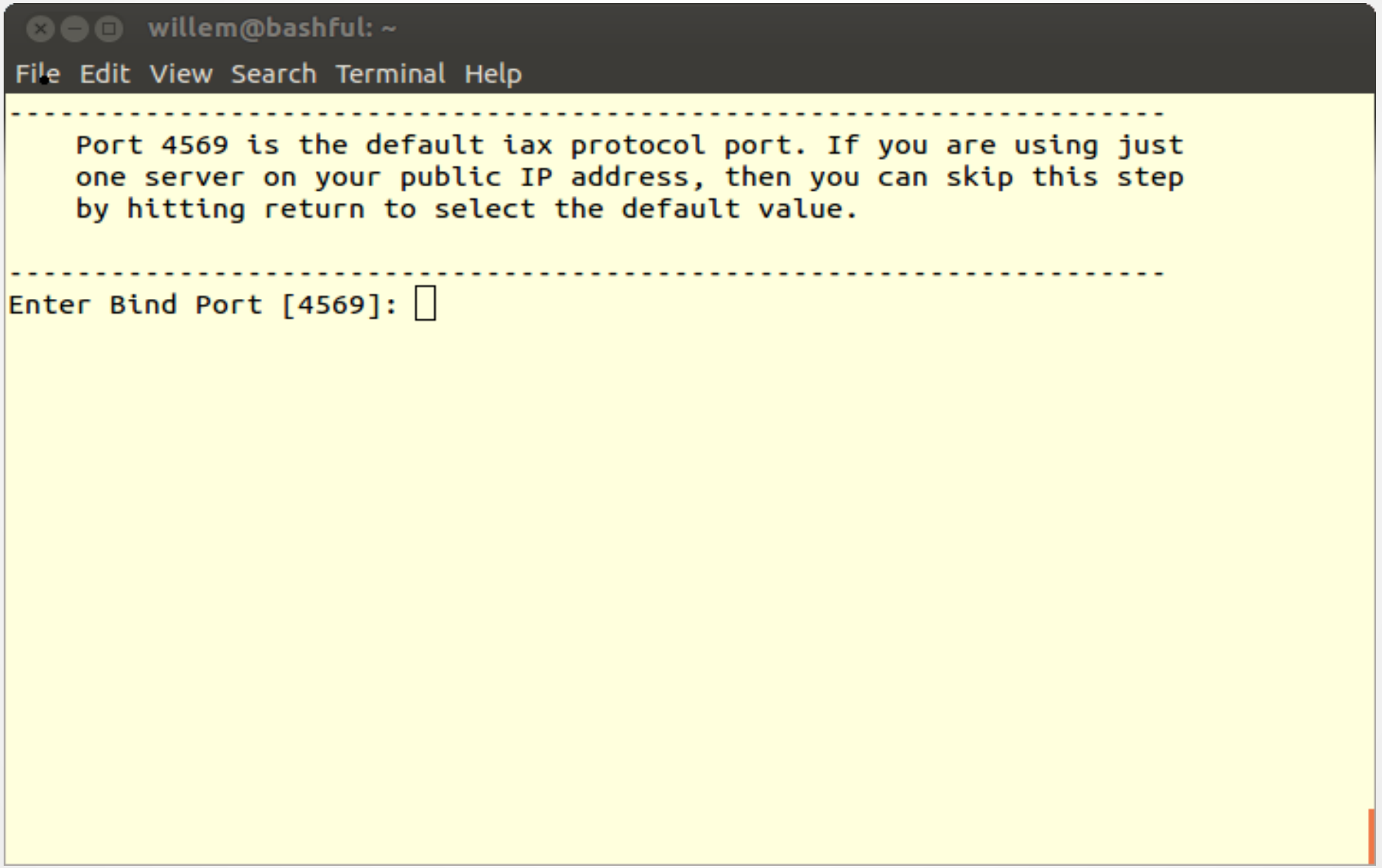
Stats


willem@bashful: ~
File Edit View Search Terminal Help
Note that reporting the status of your node is not mandatory
but without reporting your node will not appear in the
allstarlink.org status screen and others will not know
your node exists unless you give them your node number.
Even if your node does not appear on the status page another
node will be able to connect to you using your node number.
While the usual answer is to say yes and report your status
some may wish to remain private by not advertising their node.
Do you want your node to report status to stats.allstarlink.org ([y],n): ?

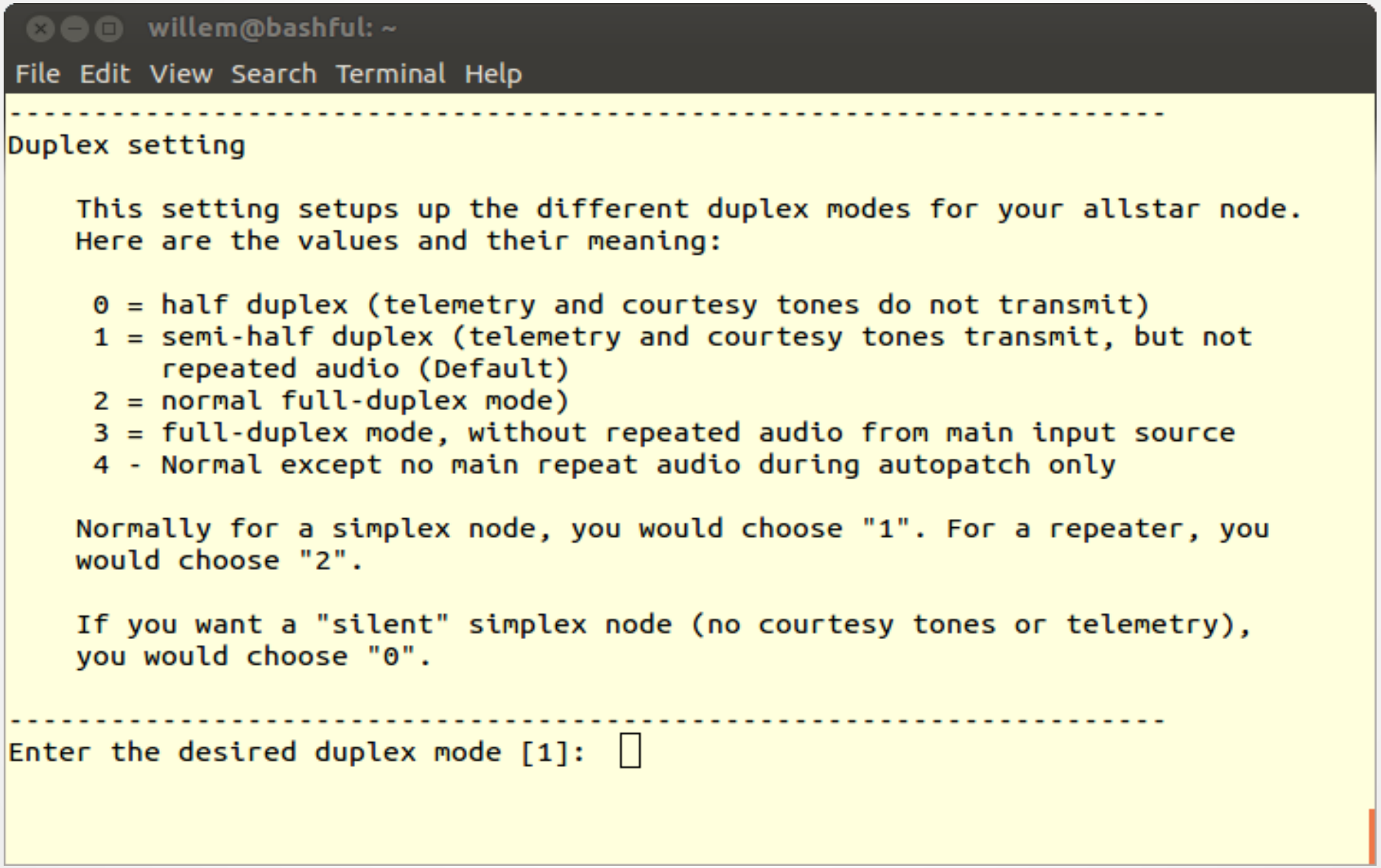
CW or Voice ID



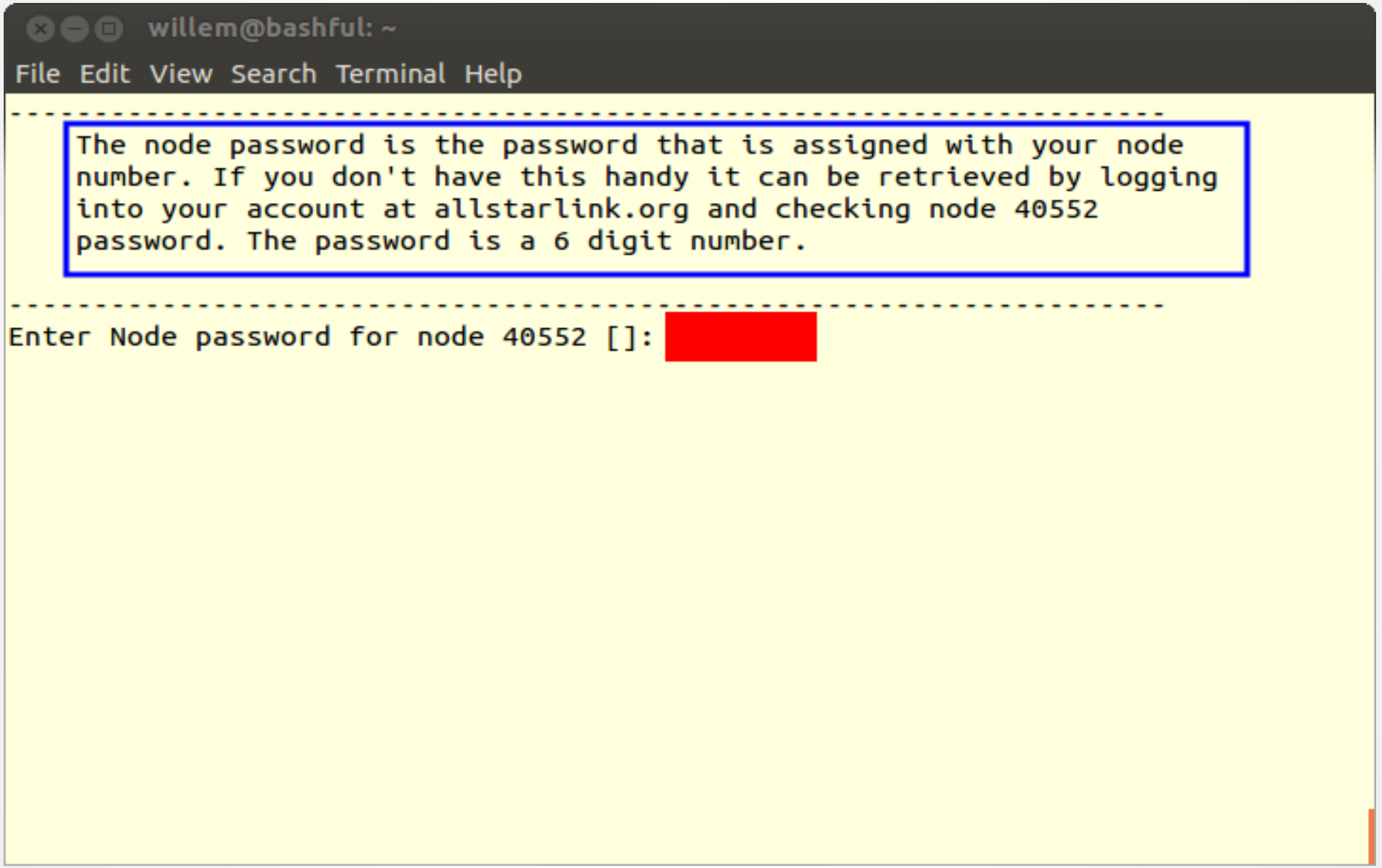
Network Port



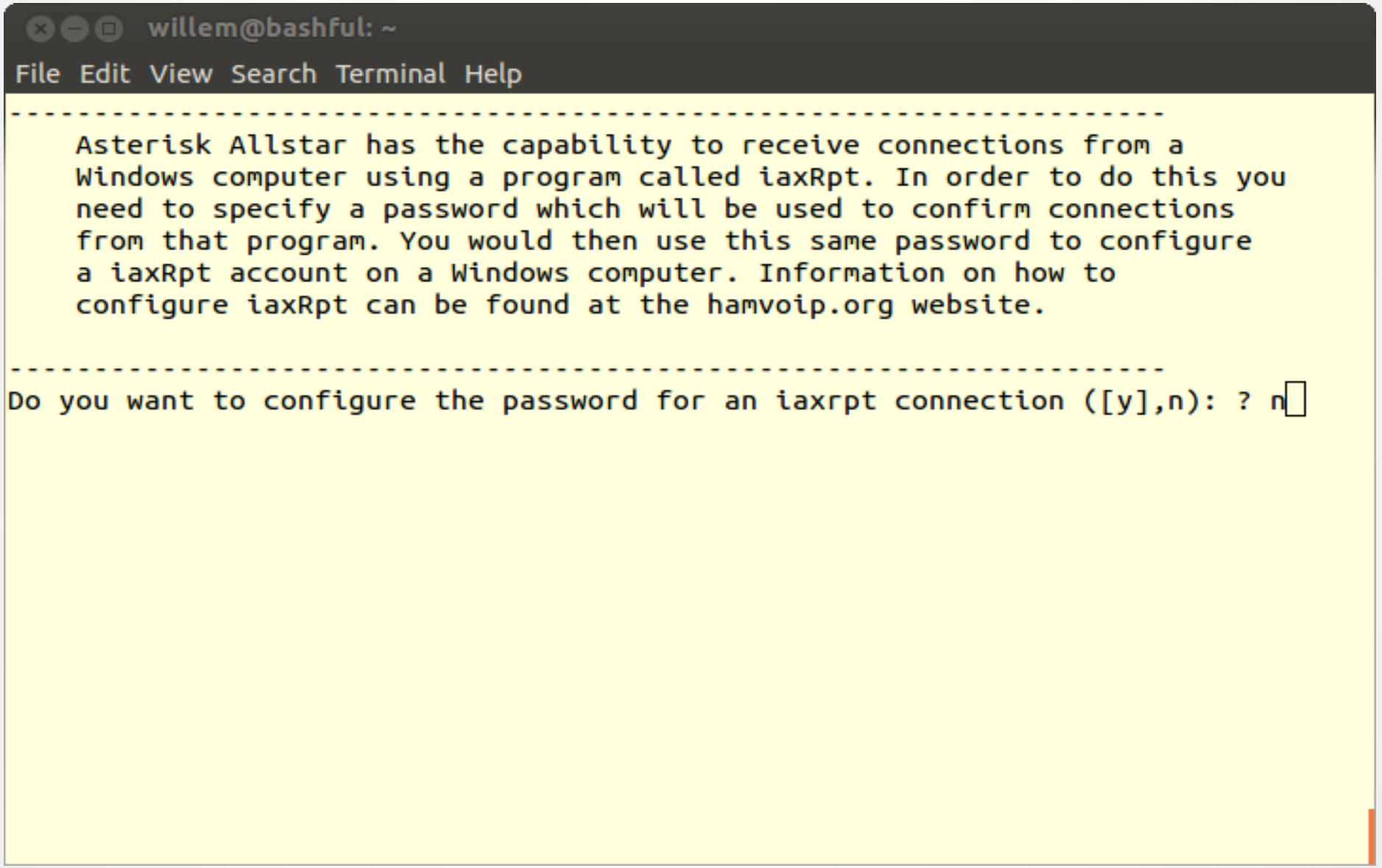
Duplex


willem@bashful: ~
File Edit View Search Terminal Help
Duplex setting
This setting setups up the different duplex modes for your allstar node.
Here are the values and their meaning:
0 = half duplex (telemetry and courtesy tones do not transmit)
1 = semi-half duplex (telemetry and courtesy tones transmit, but not repeated audio (Default)
2 = normal full-duplex mode)
3 = full-duplex mode, without repeated audio from main input source
4 - Normal except no main repeat audio during autopatch only
Normally for a simplex node, you would choose "1". For a repeater, you would choose "2".
If you want a "silent" simplex node (no courtesy tones or telemetry), you would choose "0".
Enter the desired duplex mode [1]:

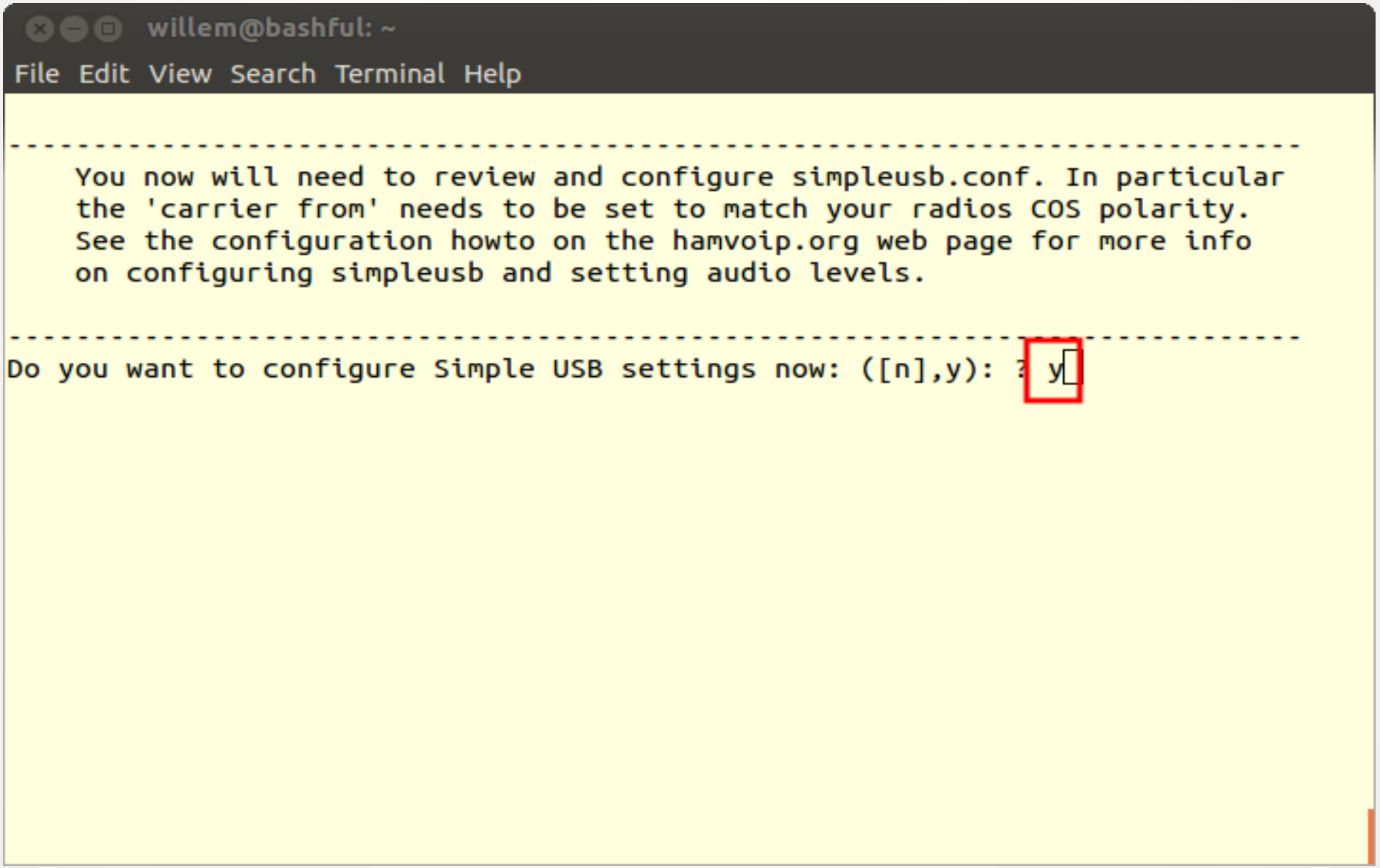
Node Password



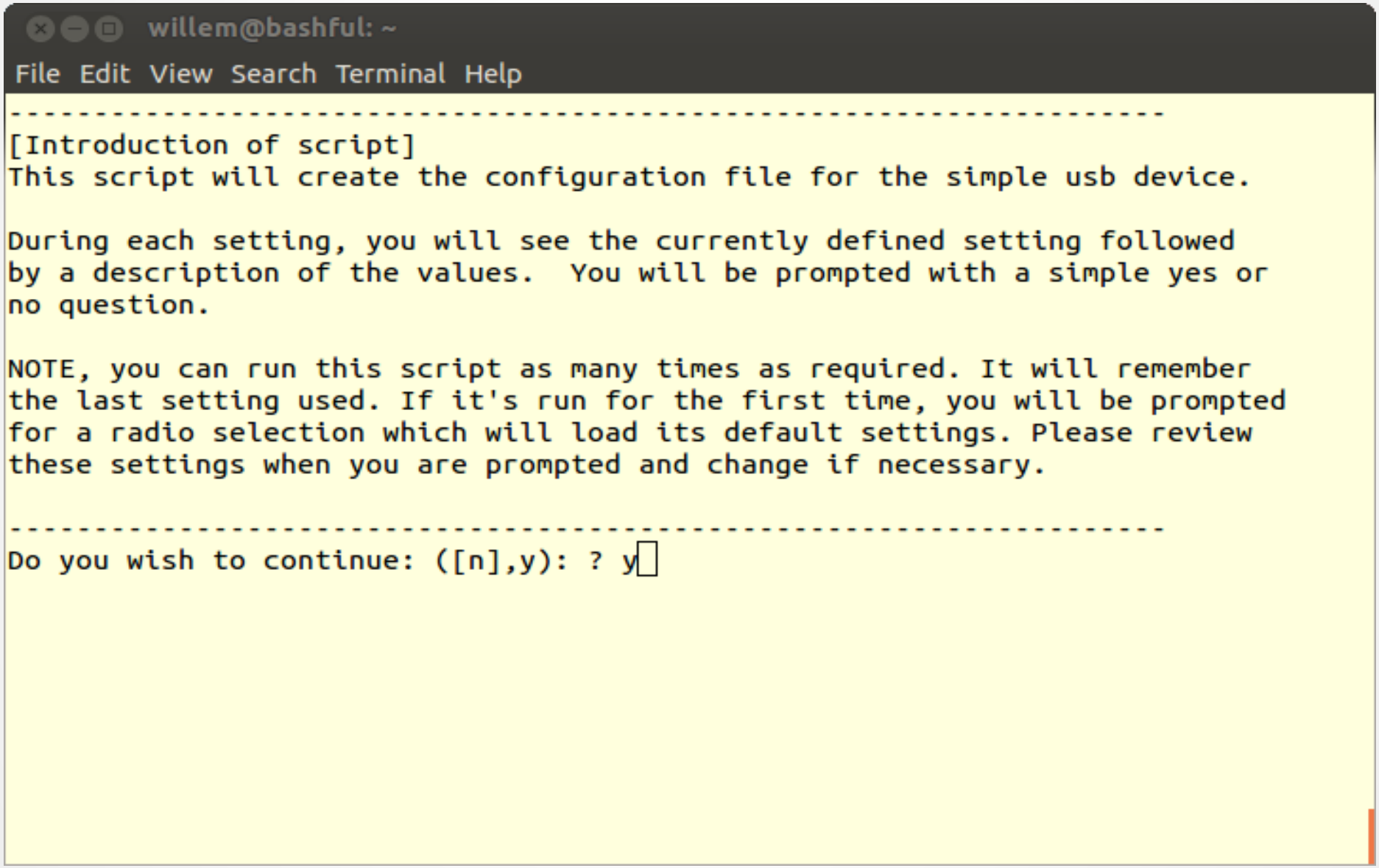
IAX Password



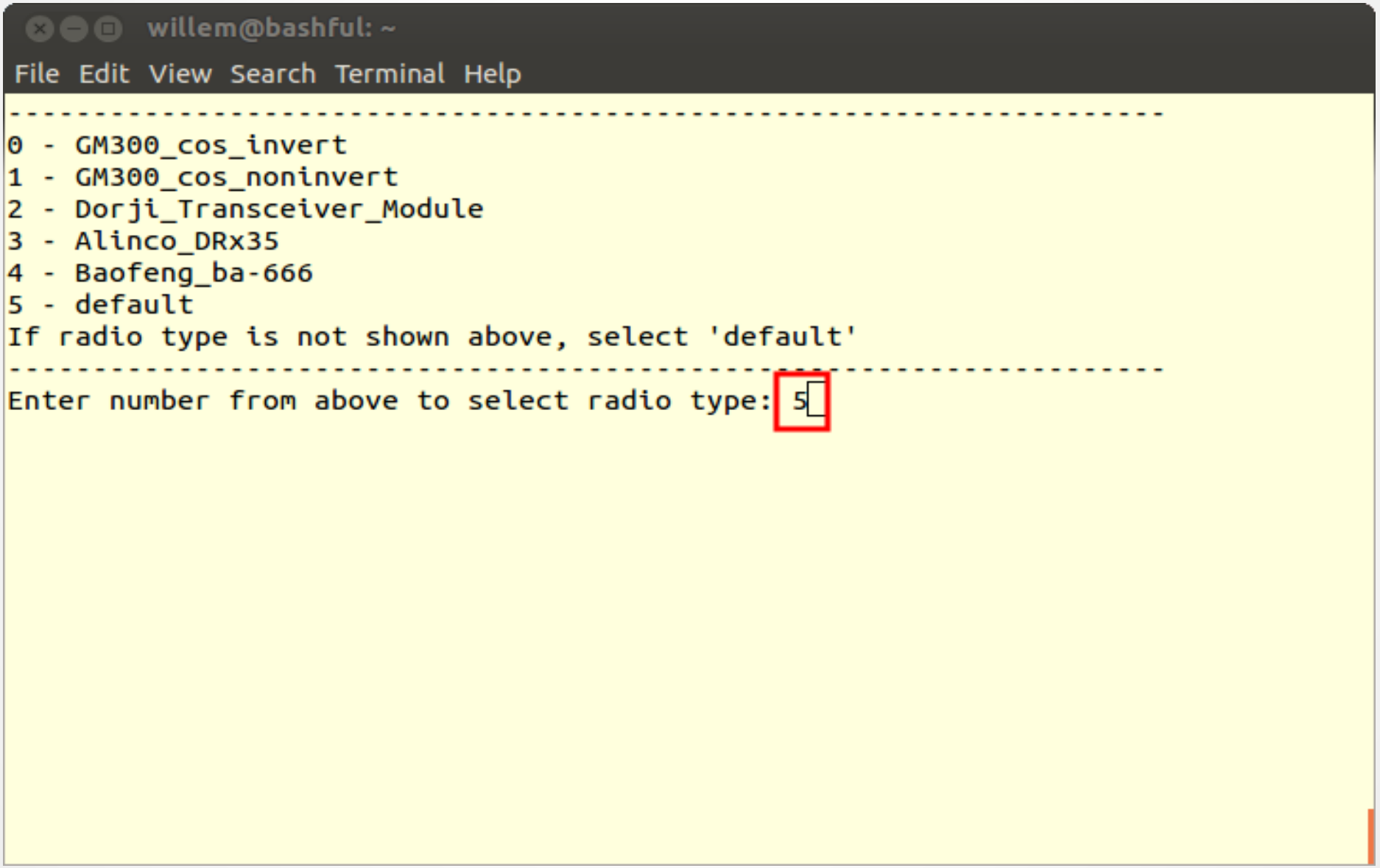
Simple USB Configuration 1



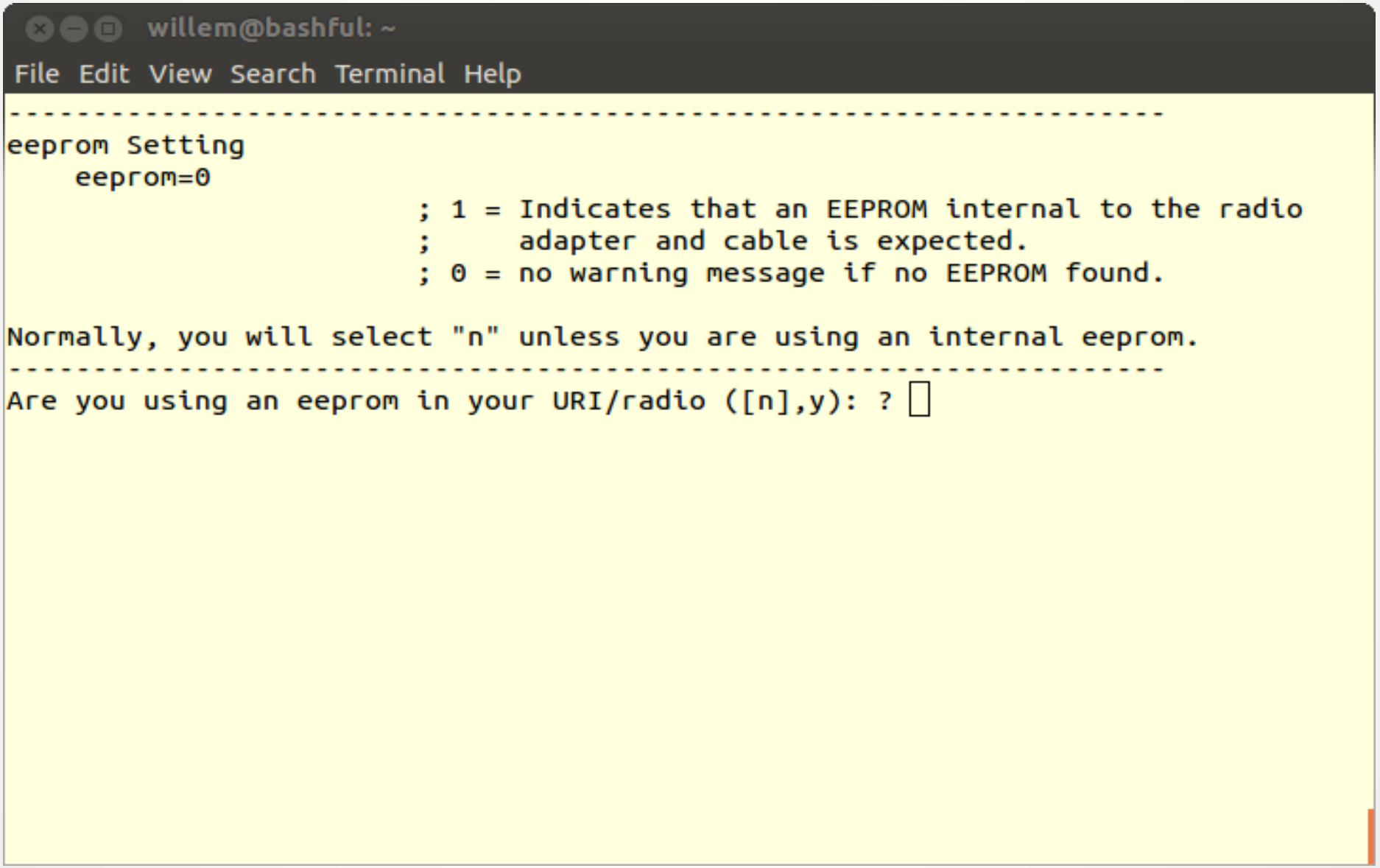
Simple USB Configuration 2



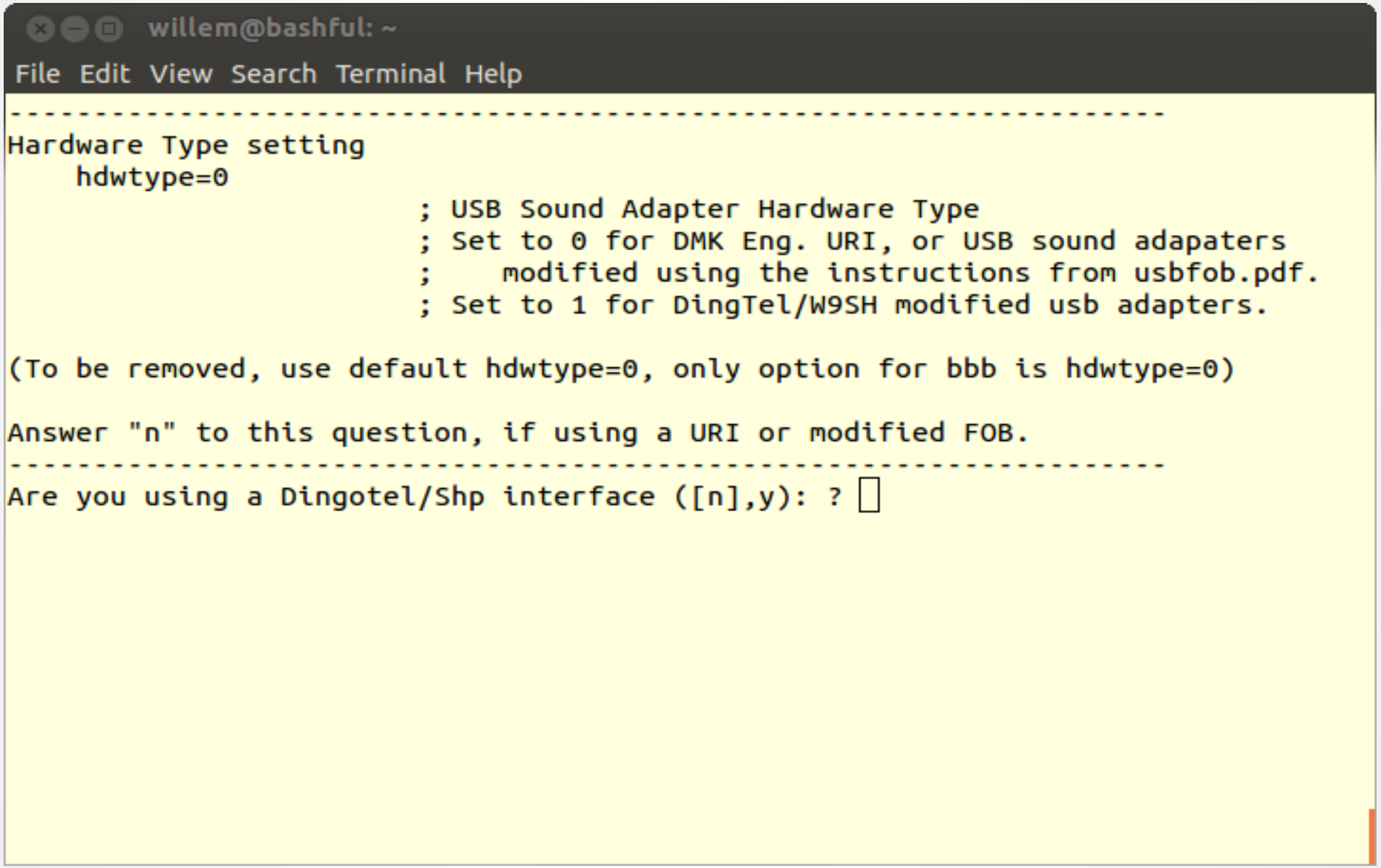
Select Radio



EEPROM on URI



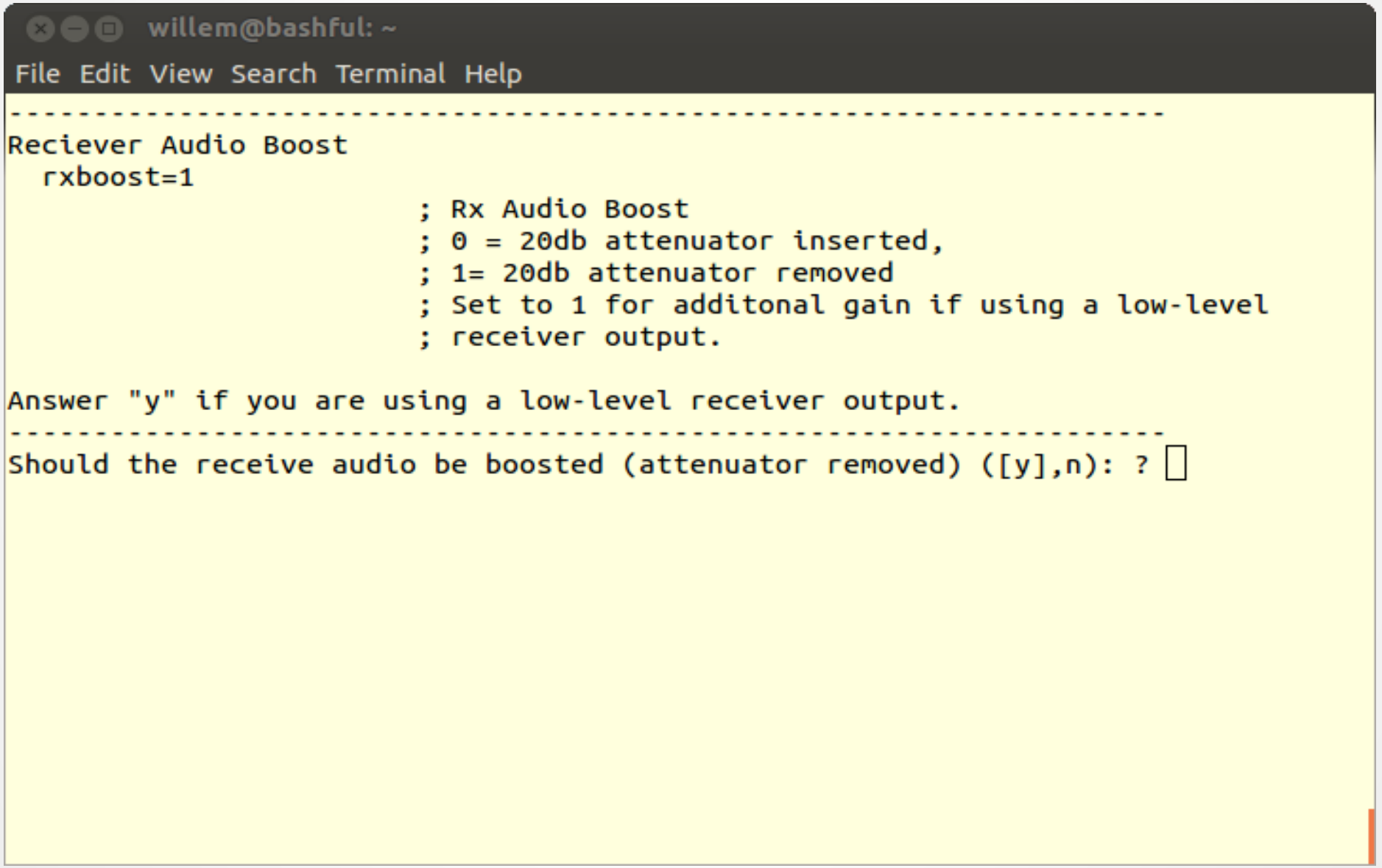
URI Type


willem@bashful: ~
File Edit View Search Terminal Help

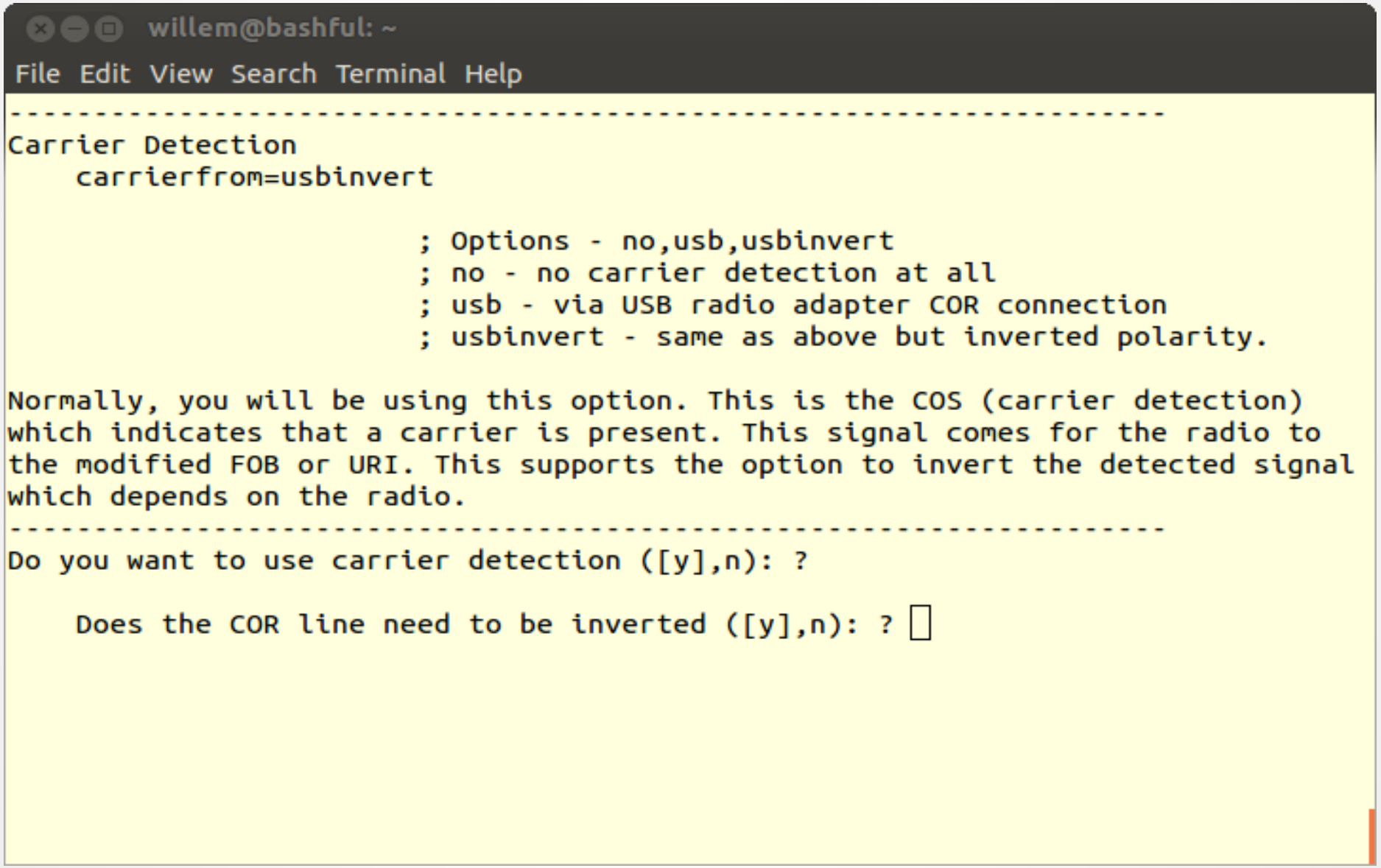
Hardware Type setting
hdwtype=0
; USB Sound Adapter Hardware Type
; Set to 0 for DMK Eng. URI, or USB sound adapaters
; modified using the instructions from usbfob.pdf.
; Set to 1 for DingTel/W9SH modified usb adapters.
(To be removed, use default hdwtype=0, only option for bbb is hdwtype=0)
Answer "n" to this question, if using a URI or modified FOB.

Are you using a Dingotel/Shp interface ([n],y): ?

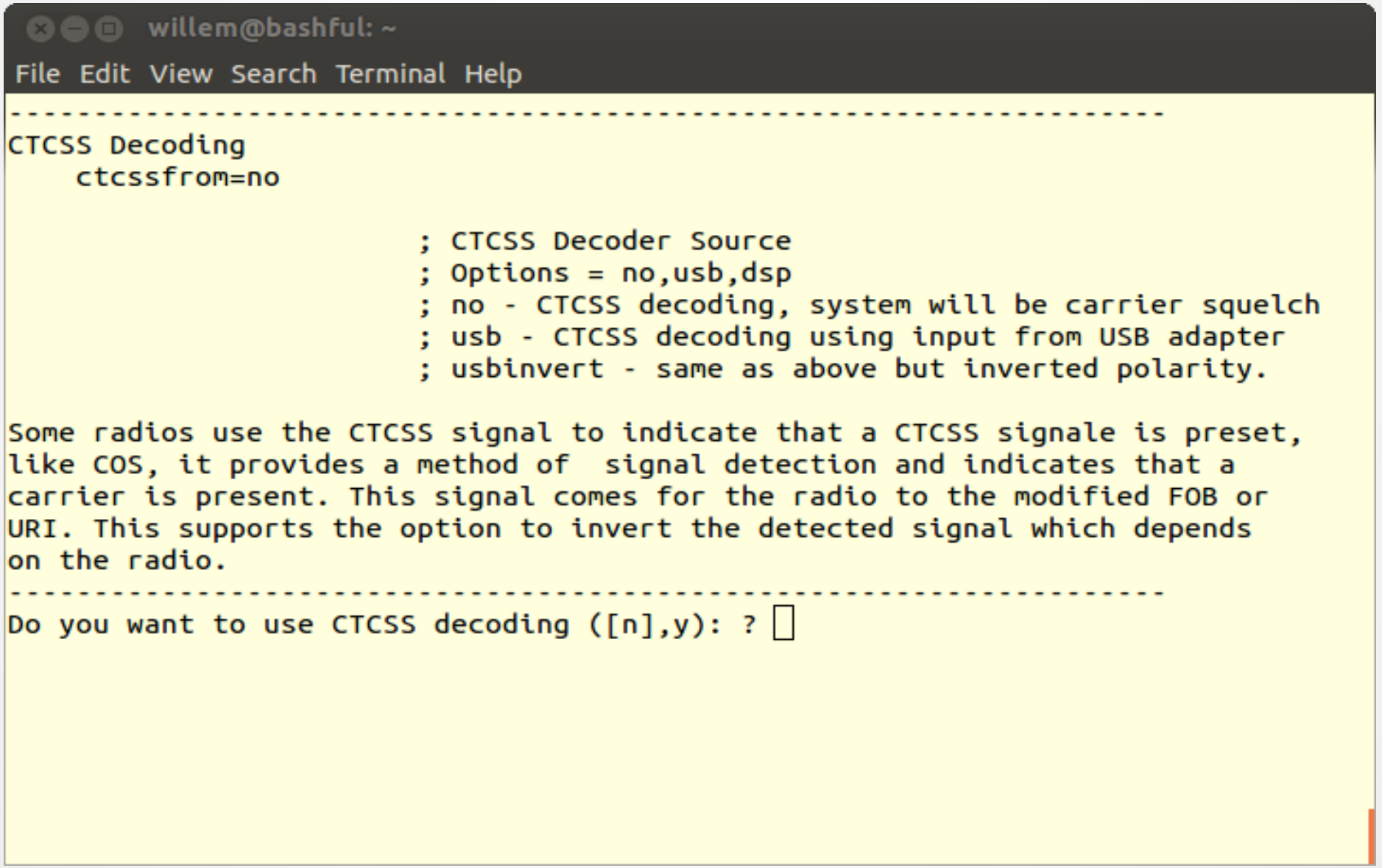
Audio Boost


willem@bashful: ~
File Edit View Search Terminal Help
Reciever Audio Boost
rxboost=1
; Rx Audio Boost
; 0 = 20db attenuator inserted,
; 1= 20db attenuator removed
; Set to 1 for additonal gain if using a low-level
; receiver output.
Answer "y" if you are using a low-level receiver output.
Should the receive audio be boosted (attenuator removed) ([y],n): ?

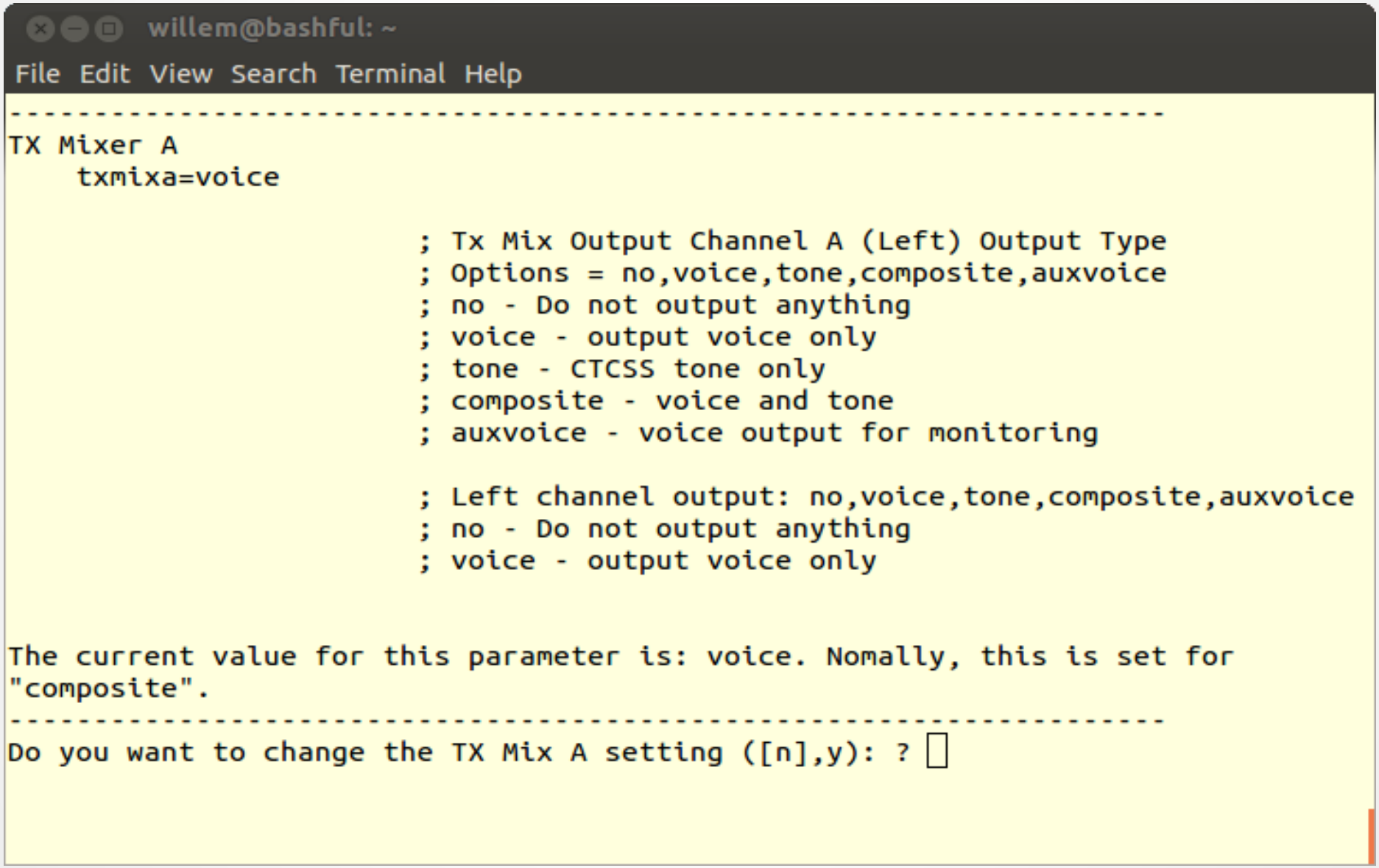
Carrier Detect (COR or COS)



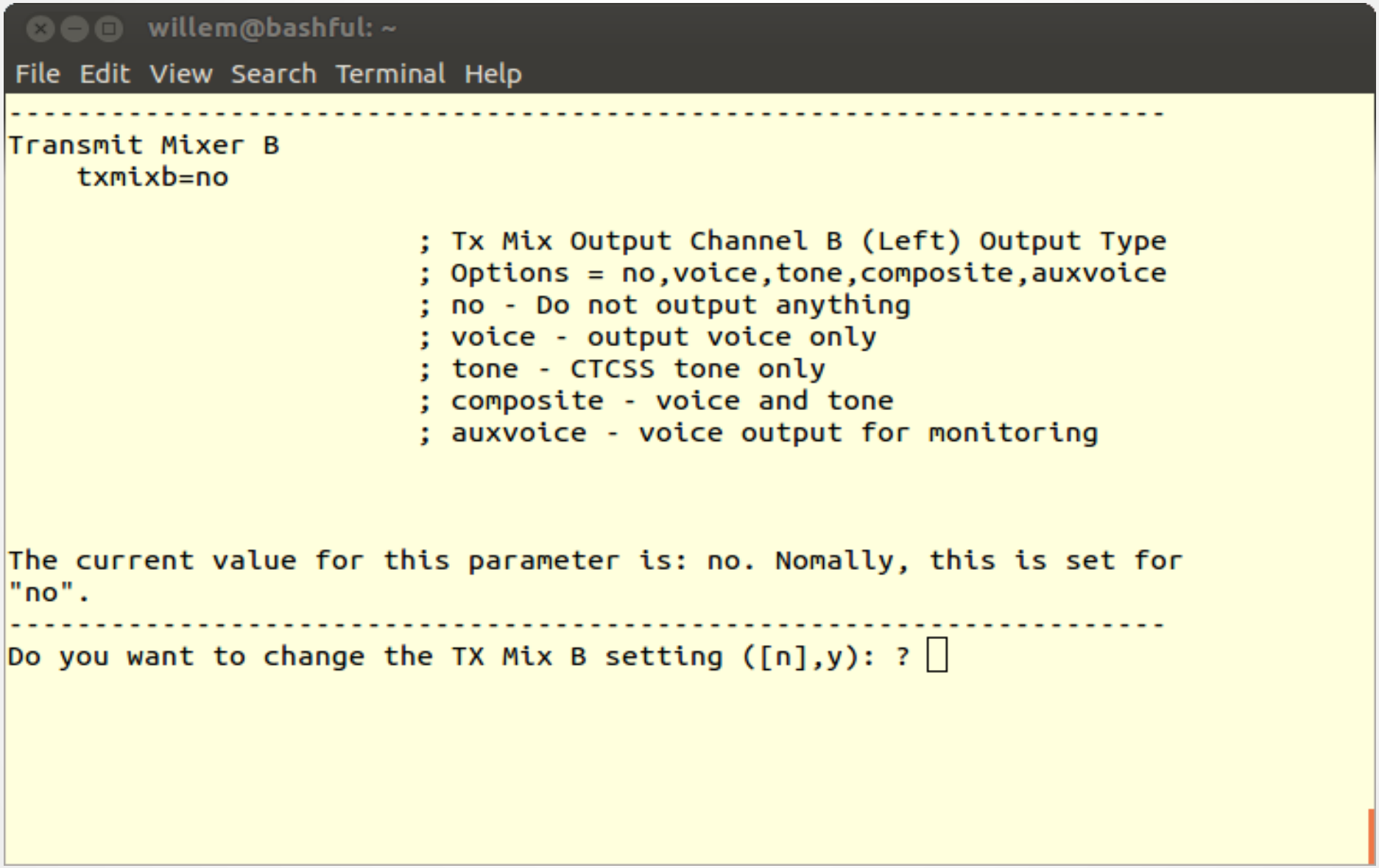
CTCSS Decode



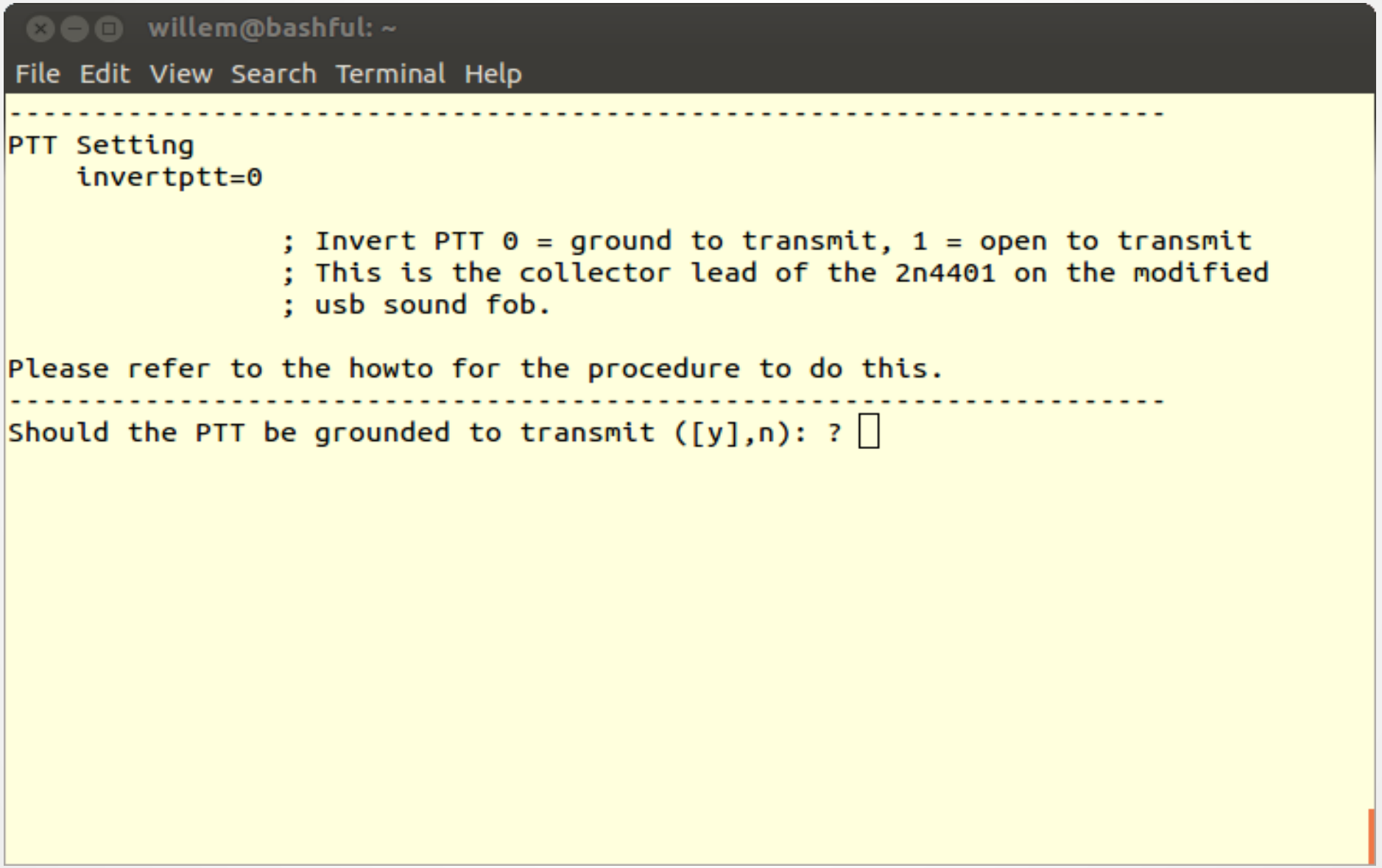
Transmit Left Channel



Transmit Right Channel



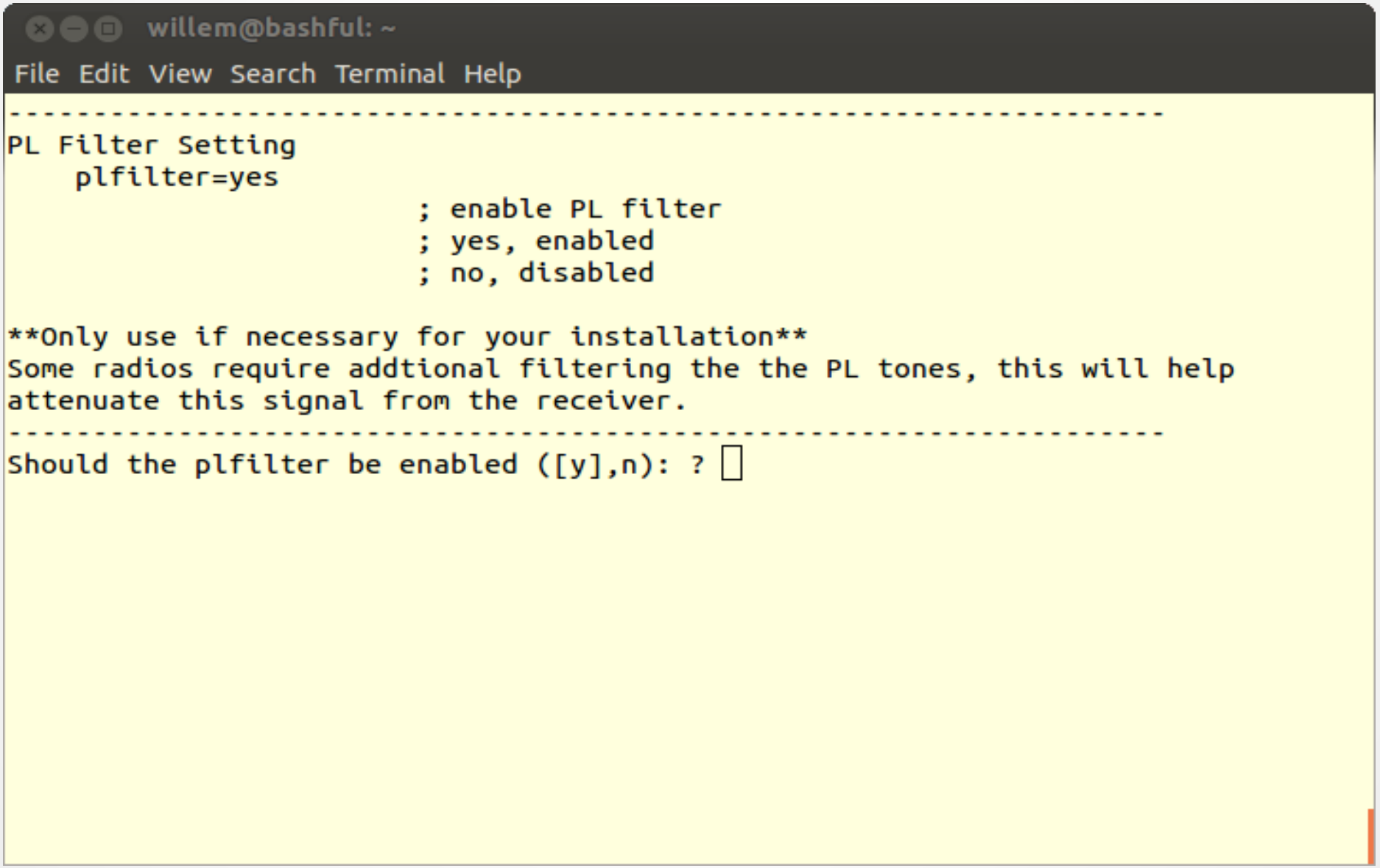
PTT


willem@bashful: ~
File Edit View Search Terminal Help

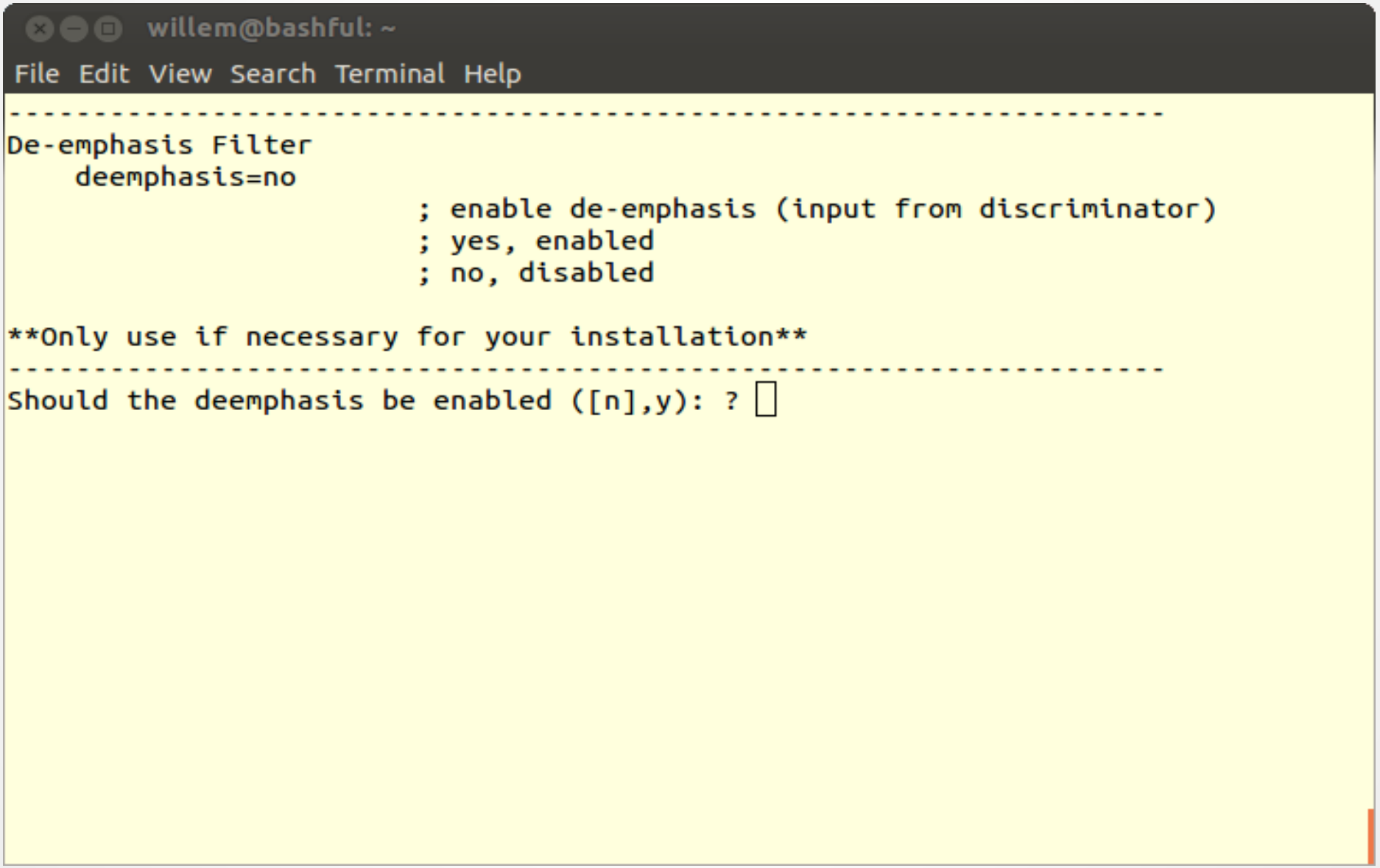
PTT Setting
invertptt=0
; Invert PTT 0 = ground to transmit, 1 = open to transmit
; This is the collector lead of the 2n4401 on the modified
; usb sound fob.
Please refer to the howto for the procedure to do this.

Should the PTT be grounded to transmit ([y],n): ?

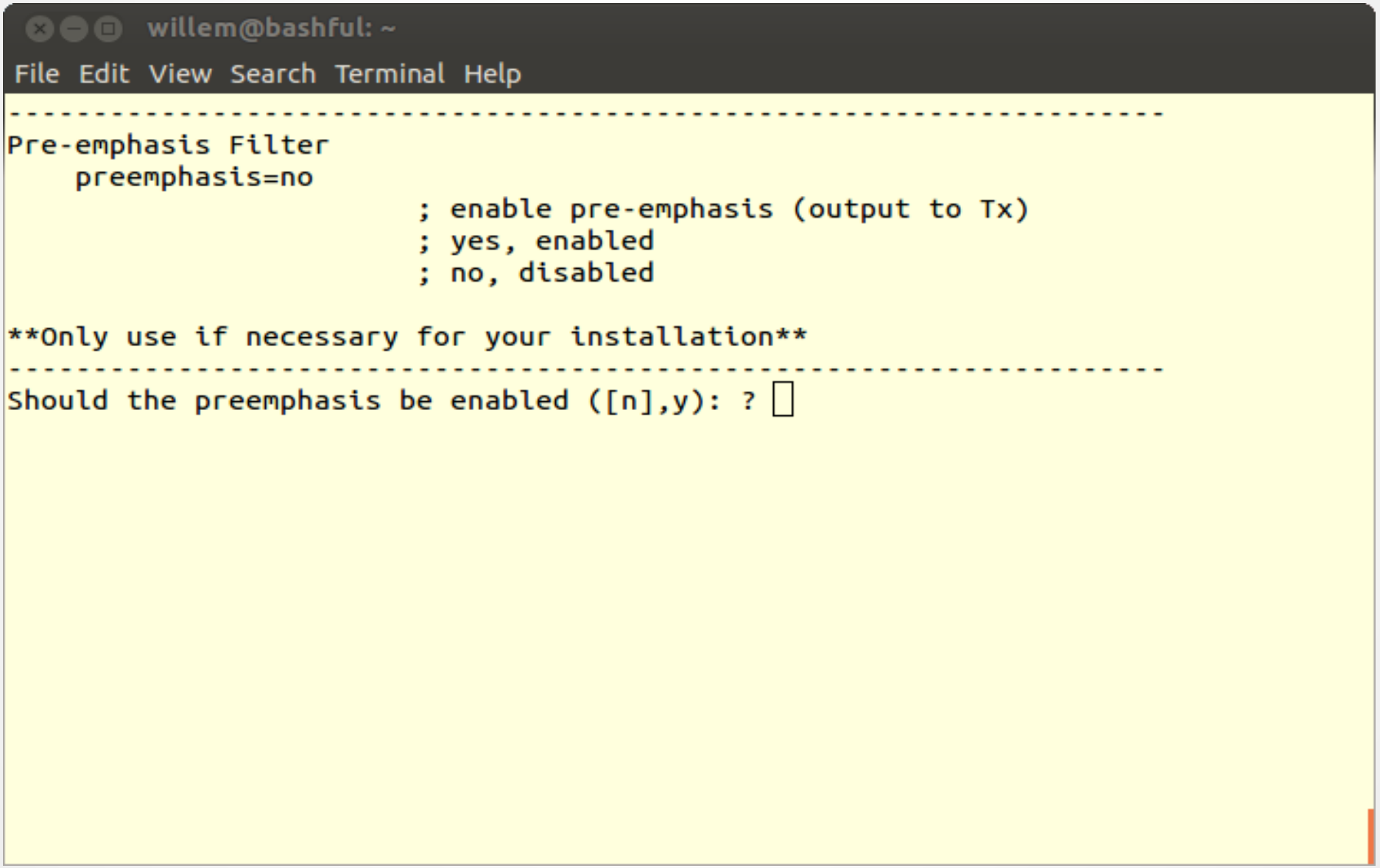
Filter CTCSS



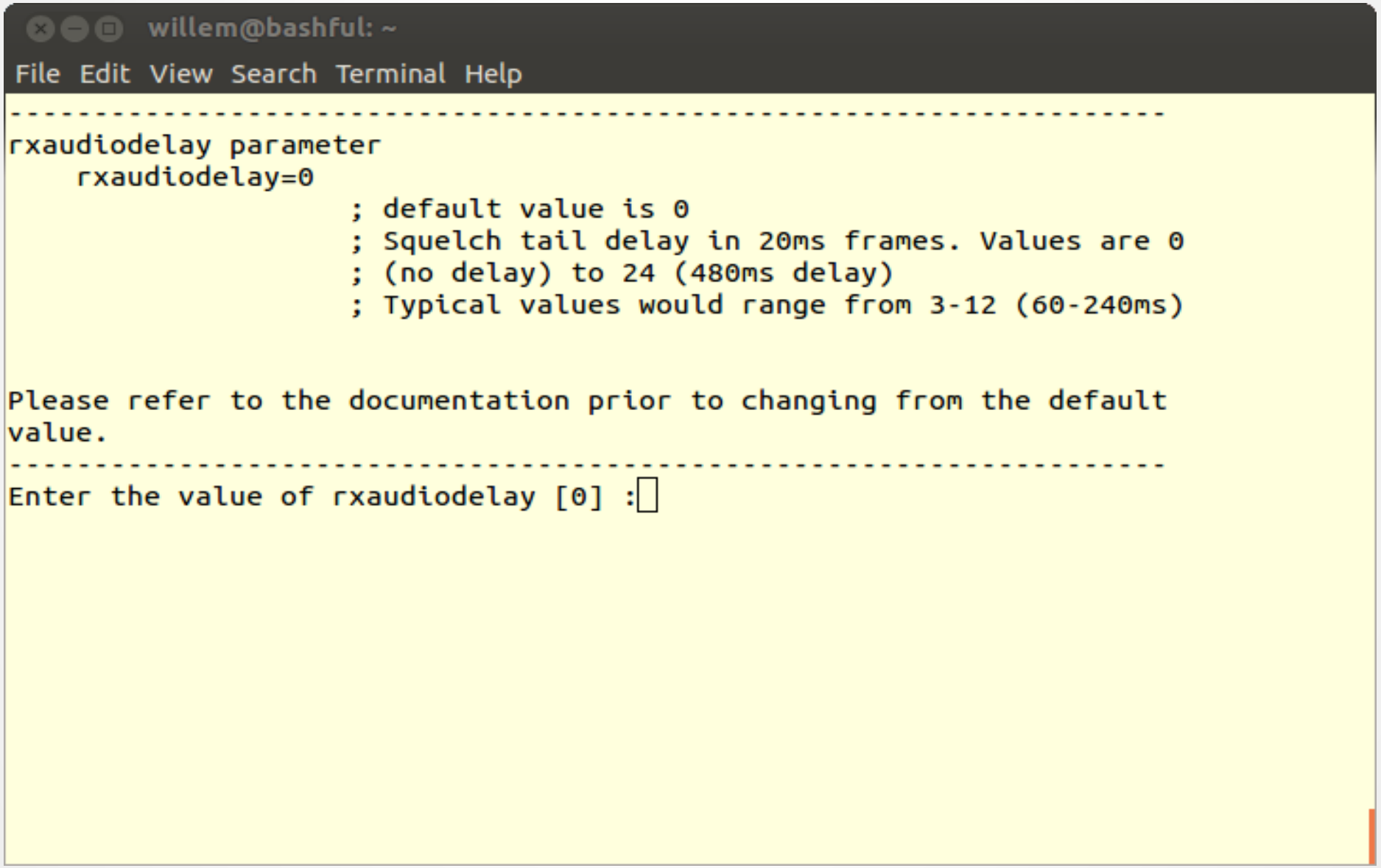
Flat or Speaker Audio



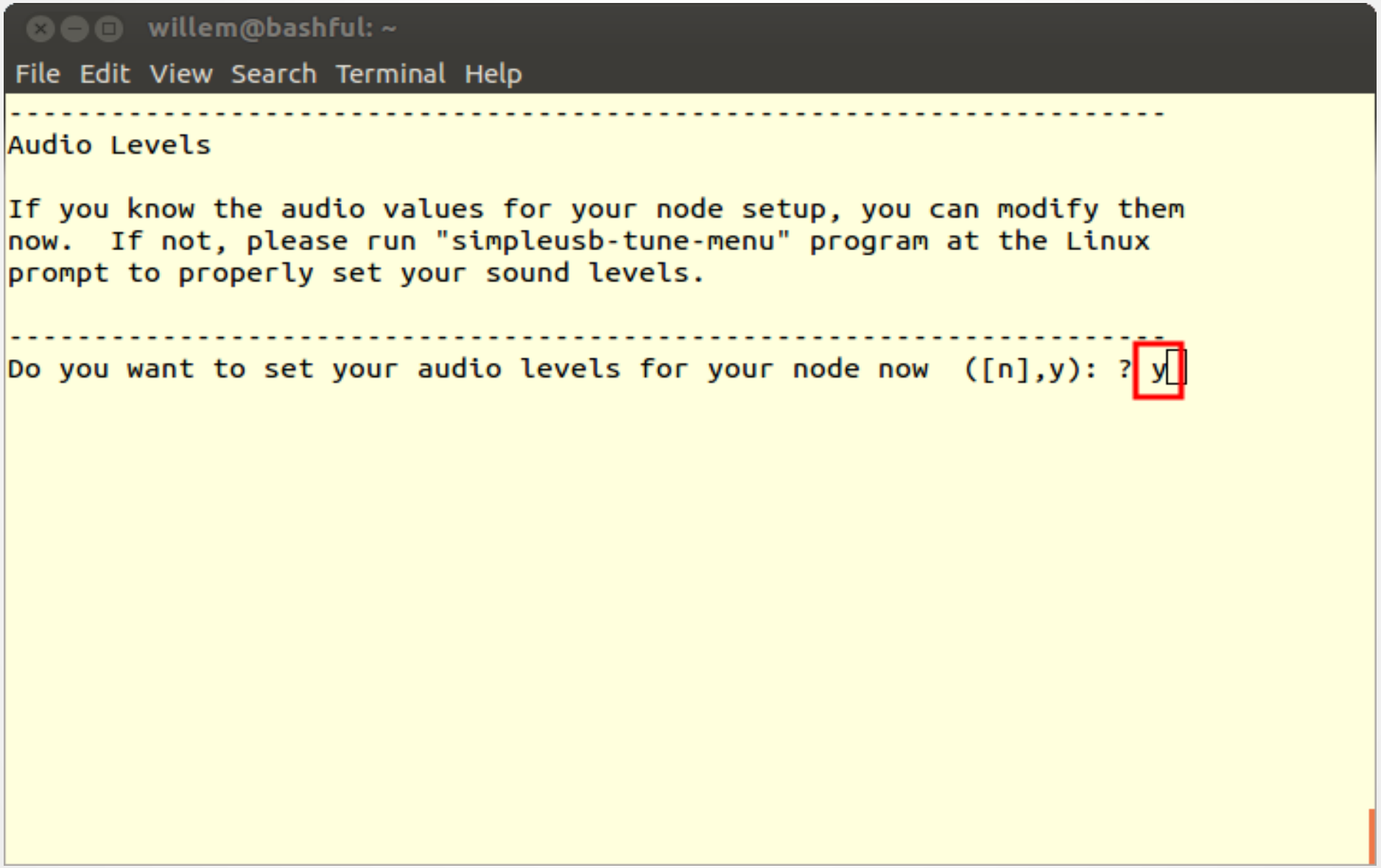
Flat or Mic Audio



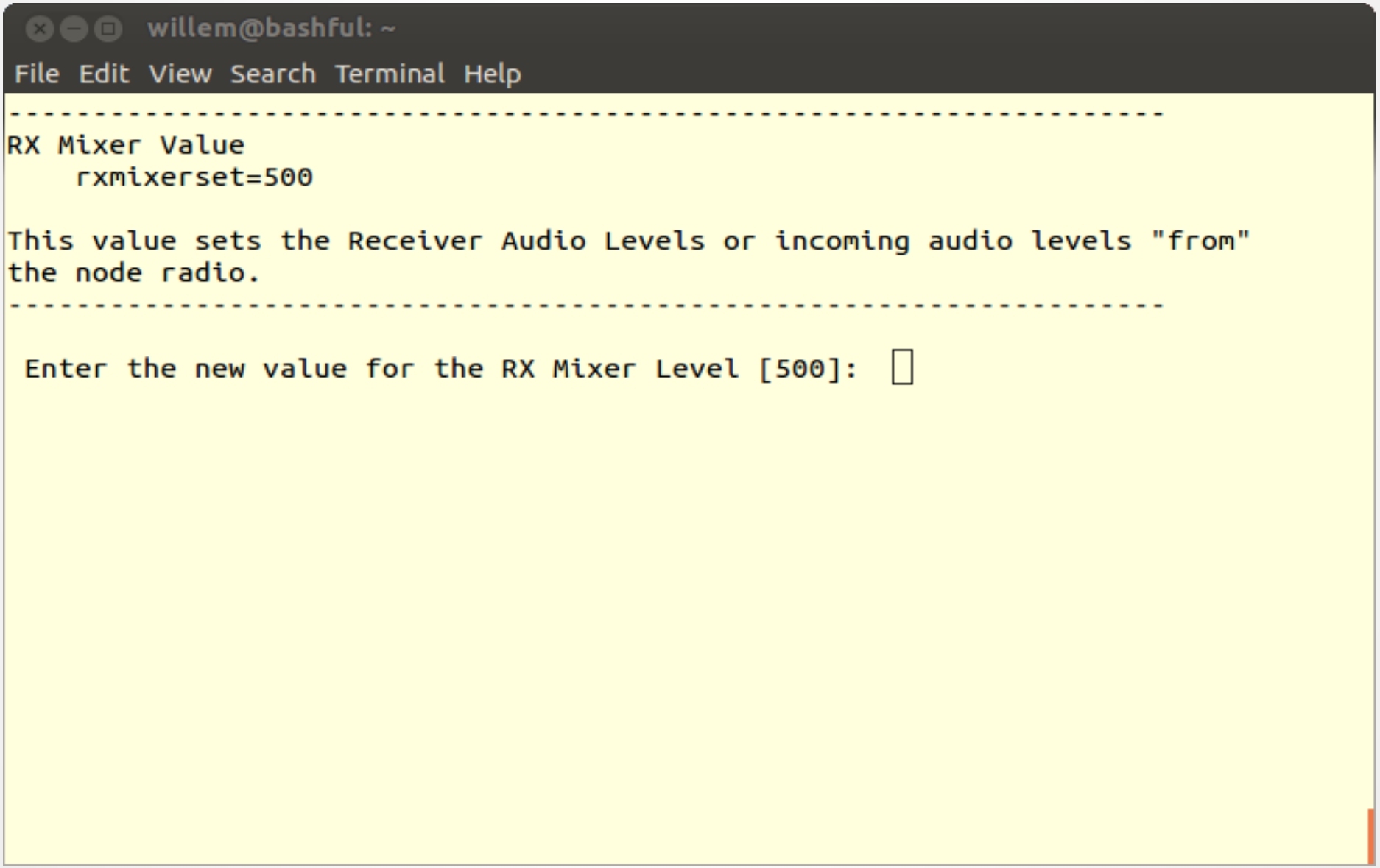
Audio Delay


willem@bashful: ~
File Edit View Search Terminal Help
rxaudiodelay parameter
rxaudiodelay=0
; default value is 0
; Squelch tail delay in 20ms frames. Values are 0
; (no delay) to 24 (480ms delay)
; Typical values would range from 3-12 (60-240ms)
Please refer to the documentation prior to changing from the default
value.
Enter the value of rxaudiodelay [0] :

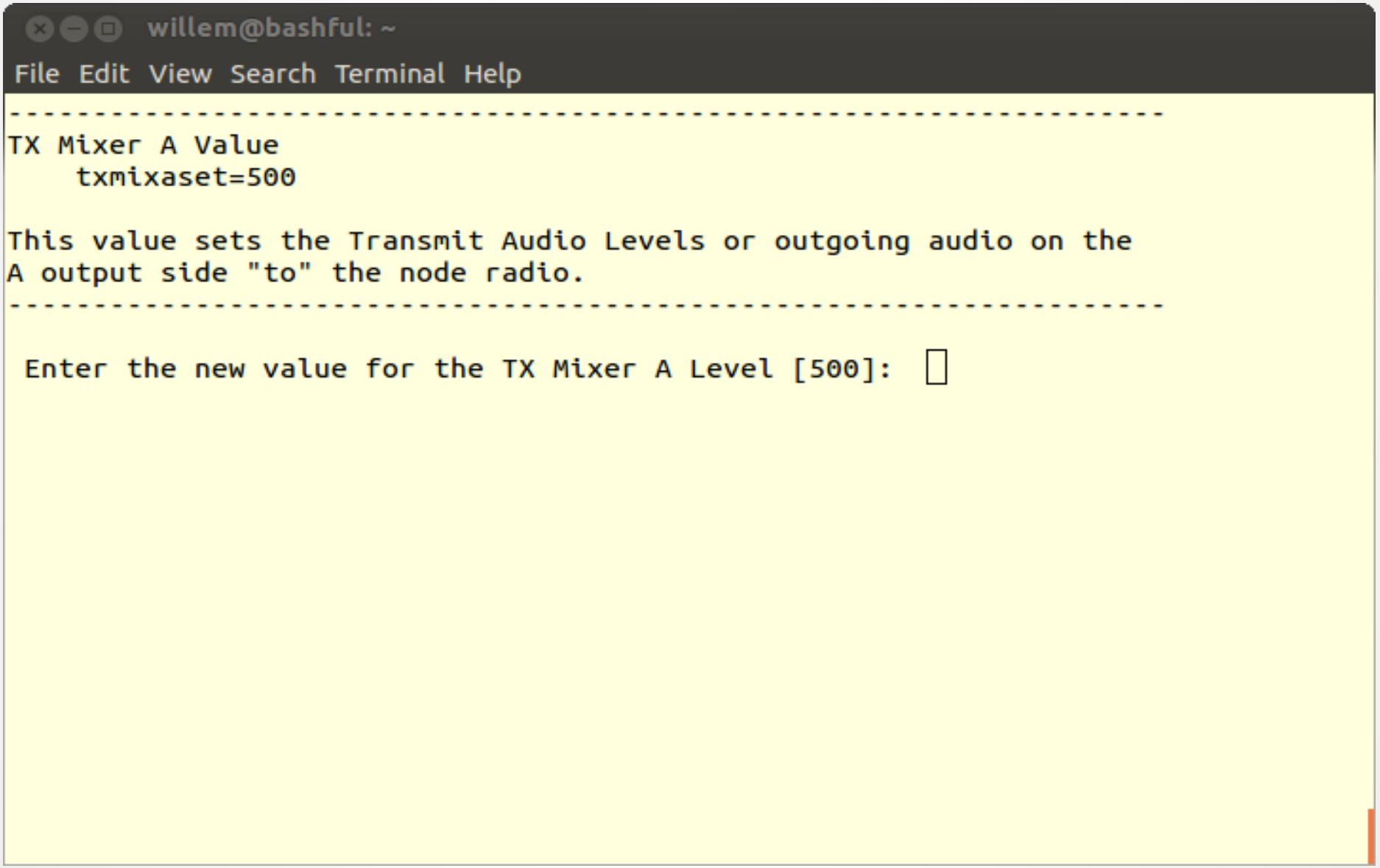
Set Audio Levels



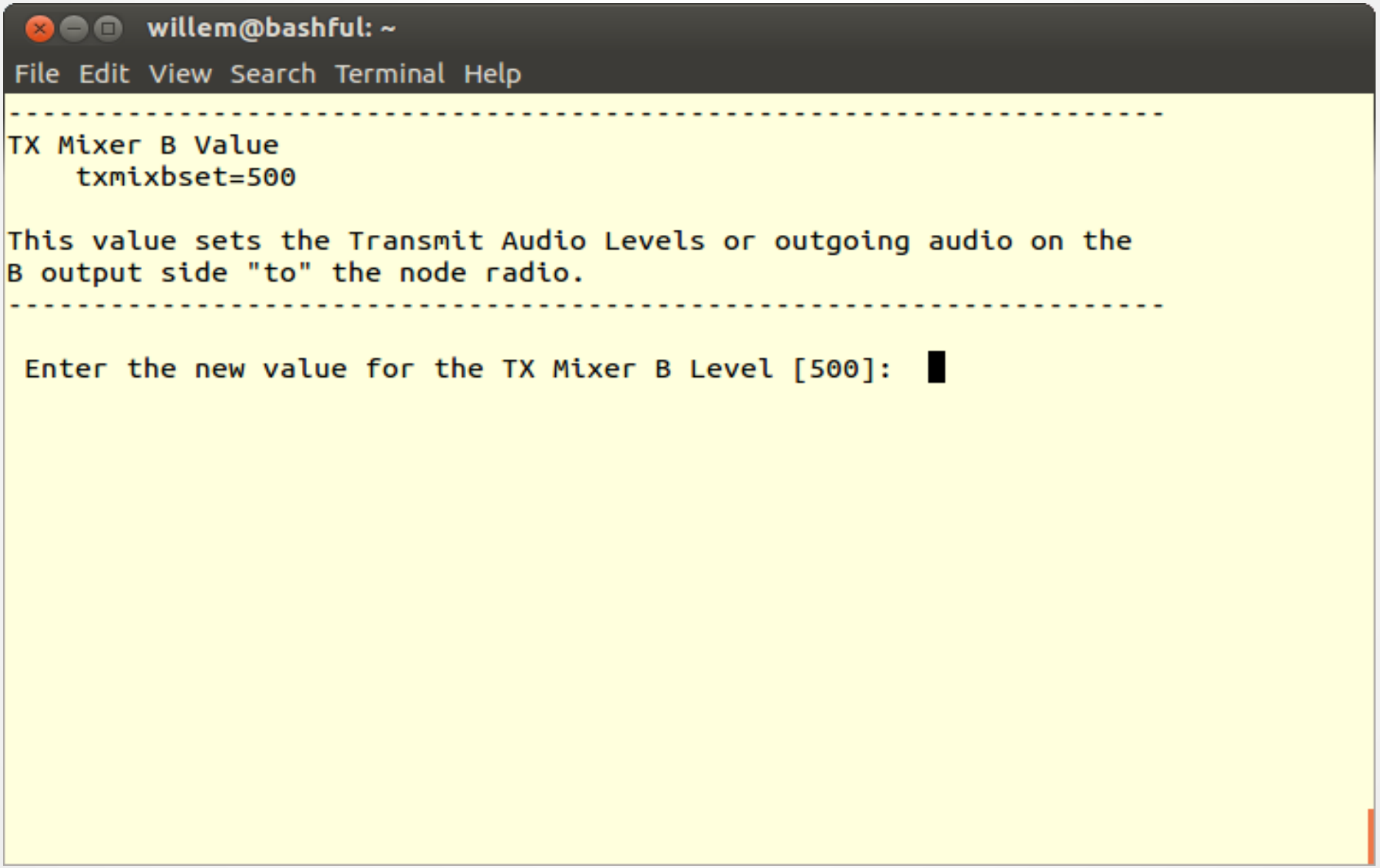
Receive Audio Levels



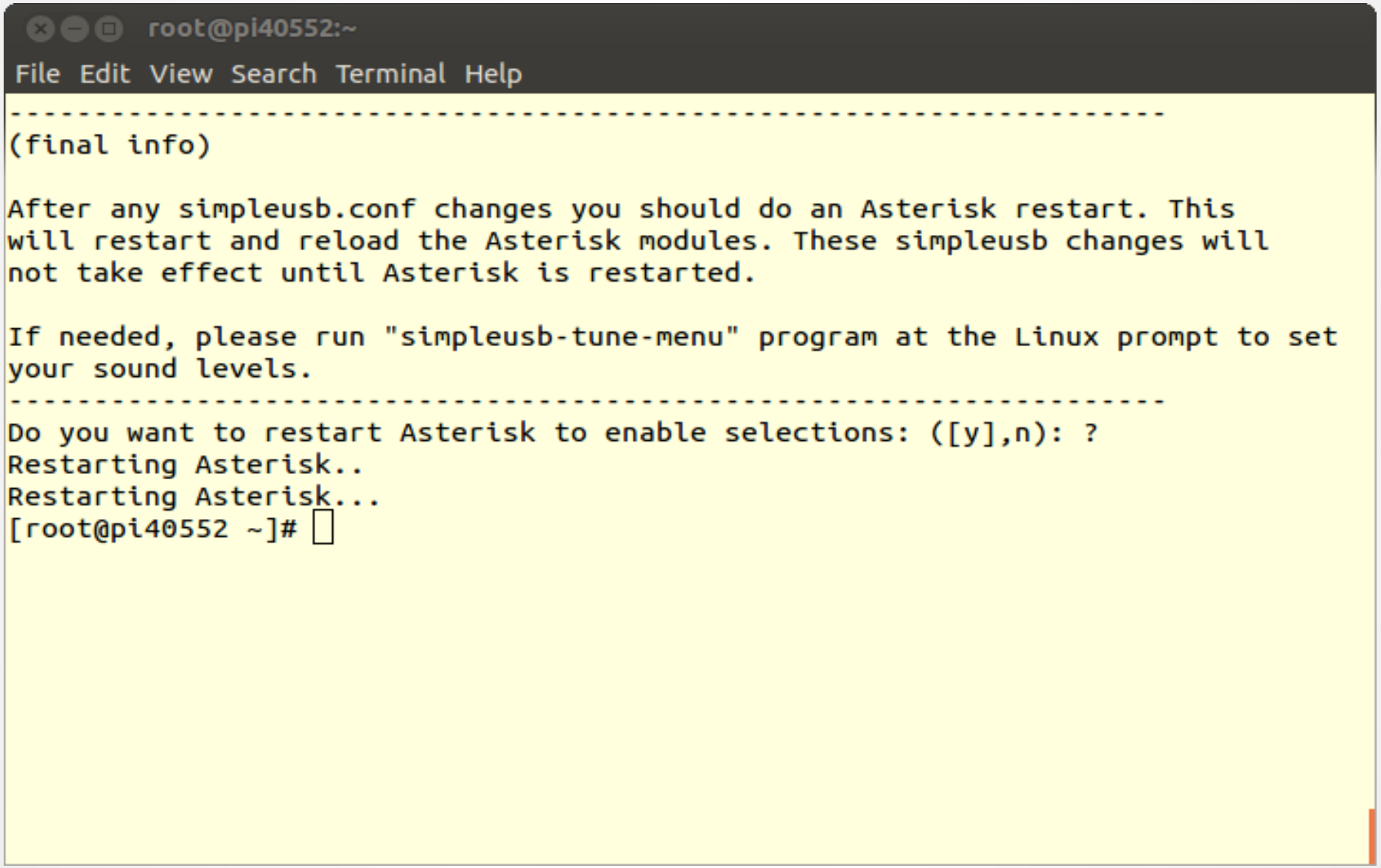
Transmit Left Audio Levels



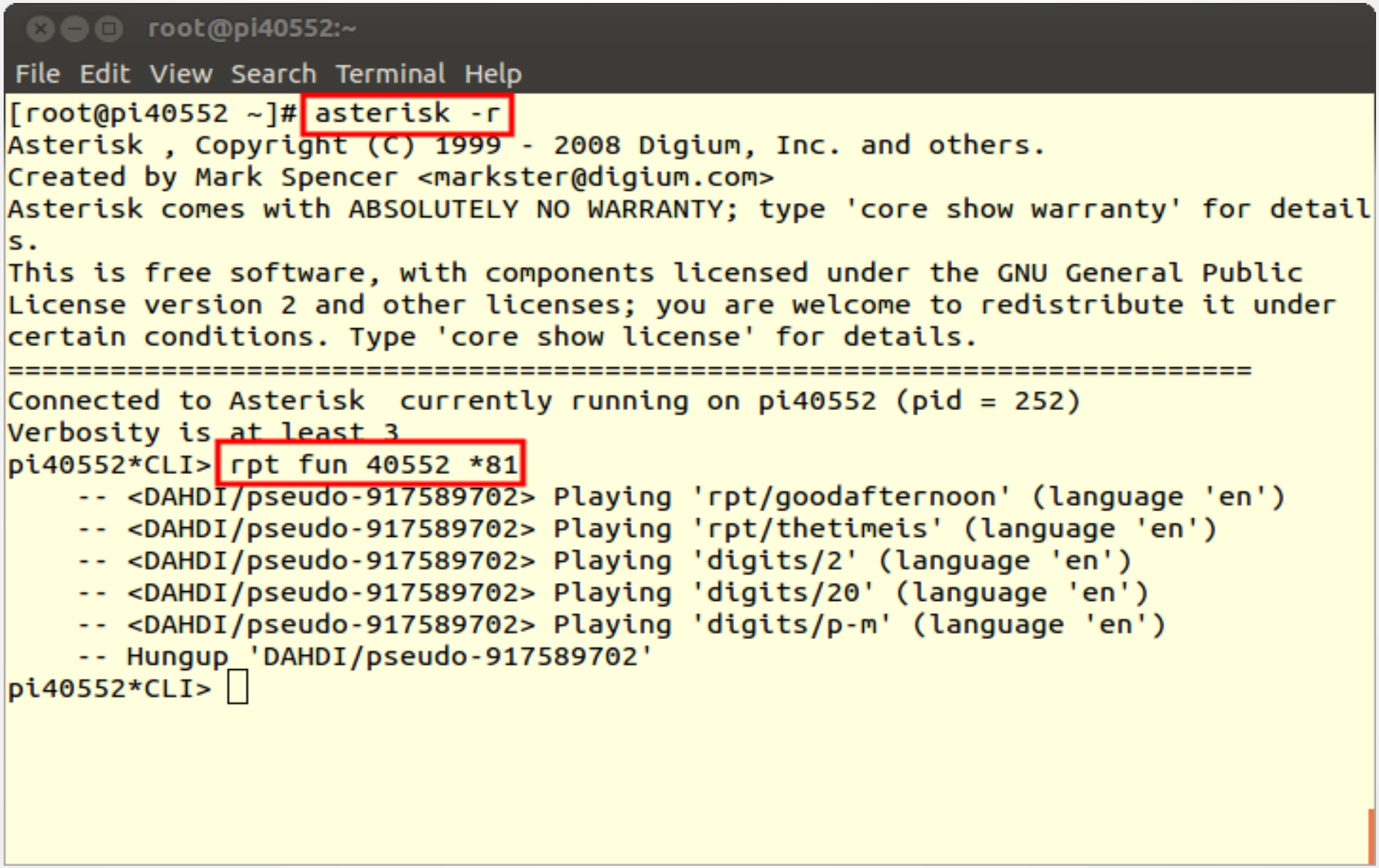
Transmit Right Audio Levels



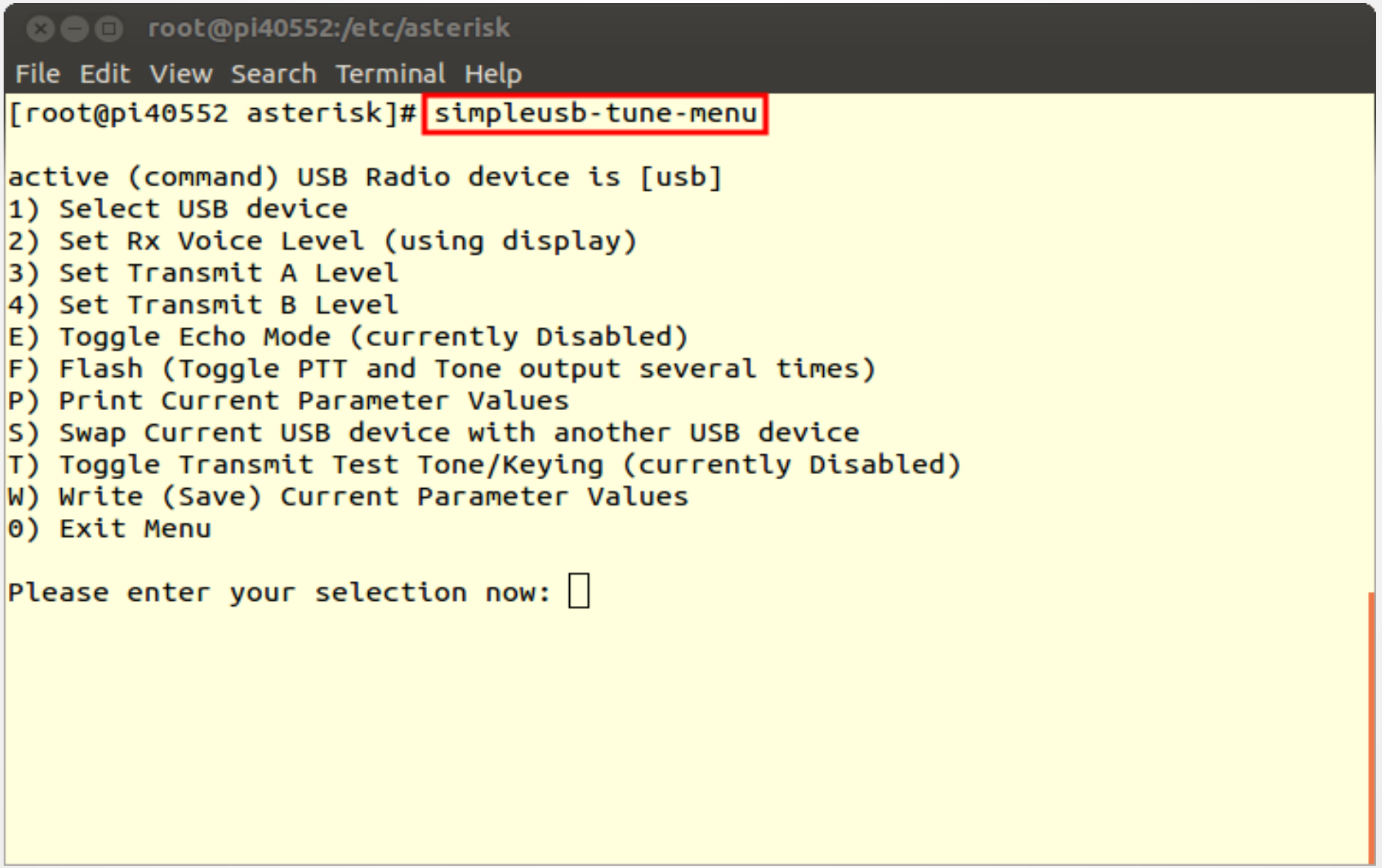
Done


root@pi40552:~
File Edit View Search Terminal Help
(final info)
After any simpleusb.conf changes you should do an Asterisk restart. This
will restart and reload the Asterisk modules. These simpleusb changes will
not take effect until Asterisk is restarted.
If needed, please run "simpleusb-tune-menu" program at the Linux prompt to set
your sound levels.
Do you want to restart Asterisk to enable selections: ([y],n): ?
Restarting Asterisk..
Restarting Asterisk...
[root@pi40552 ~]#

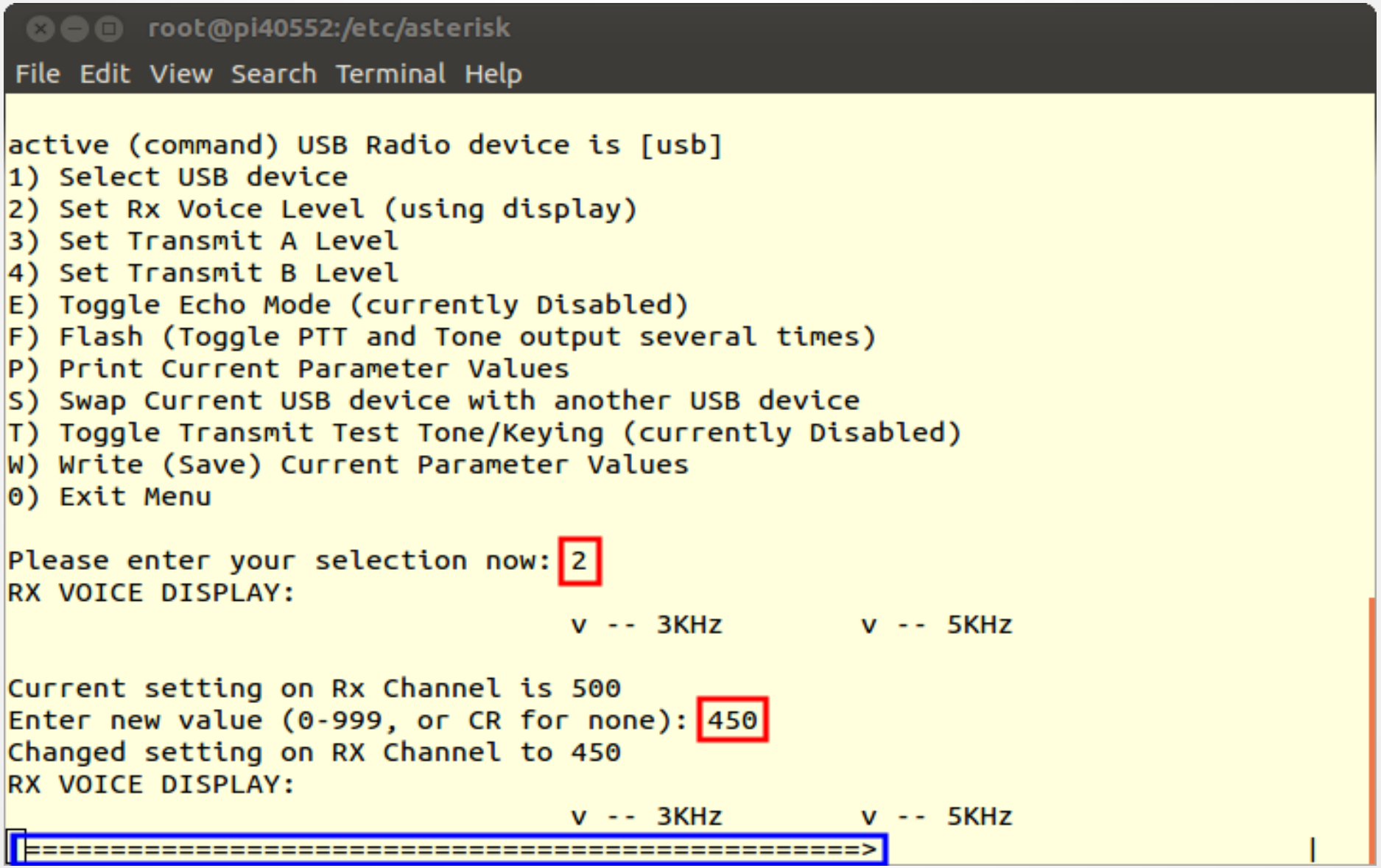
Make it Transmit



Set Levels


root@pi40552:/etc/asterisk
File Edit View Search Terminal Help
[root@pi40552 asterisk]# simpleusb-tune-menu
active (command) USB Radio device is [usb]
1) Select USB device
2) Set Rx Voice Level (using display)
3) Set Transmit A Level
4) Set Transmit B Level
E) Toggle Echo Mode (currently Disabled)
F) Flash (Toggle PTT and Tone output several times)
P) Print Current Parameter Values
S) Swap Current USB device with another USB device
T) Toggle Transmit Test Tone/Keying (currently Disabled)
W) Write (Save) Current Parameter Values
0) Exit Menu
Please enter your selection now:

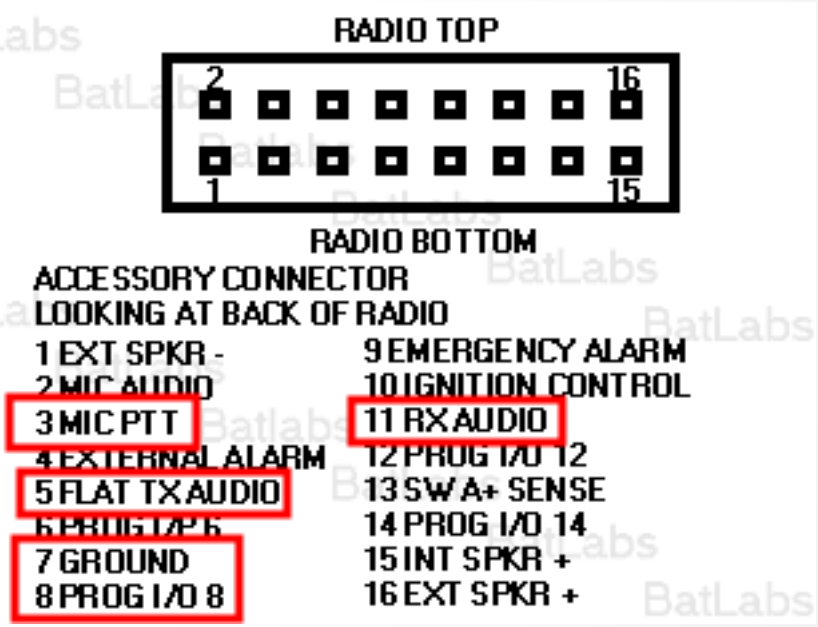
Set Receive Levels



/etc/asterisk/simpleusb.conf

- Configuration for Motorola SM50

```
[usb]
eeprom=0
hdwtype=0
rxboost=1
carrierfrom=usb
ctcssfrom=usb
txmixa=voice
txmixb=no
invertptt=0
duplex=0
plfilter=yes
deemphasis=no
preemphasis=yes
rxaudiodelay=0
```



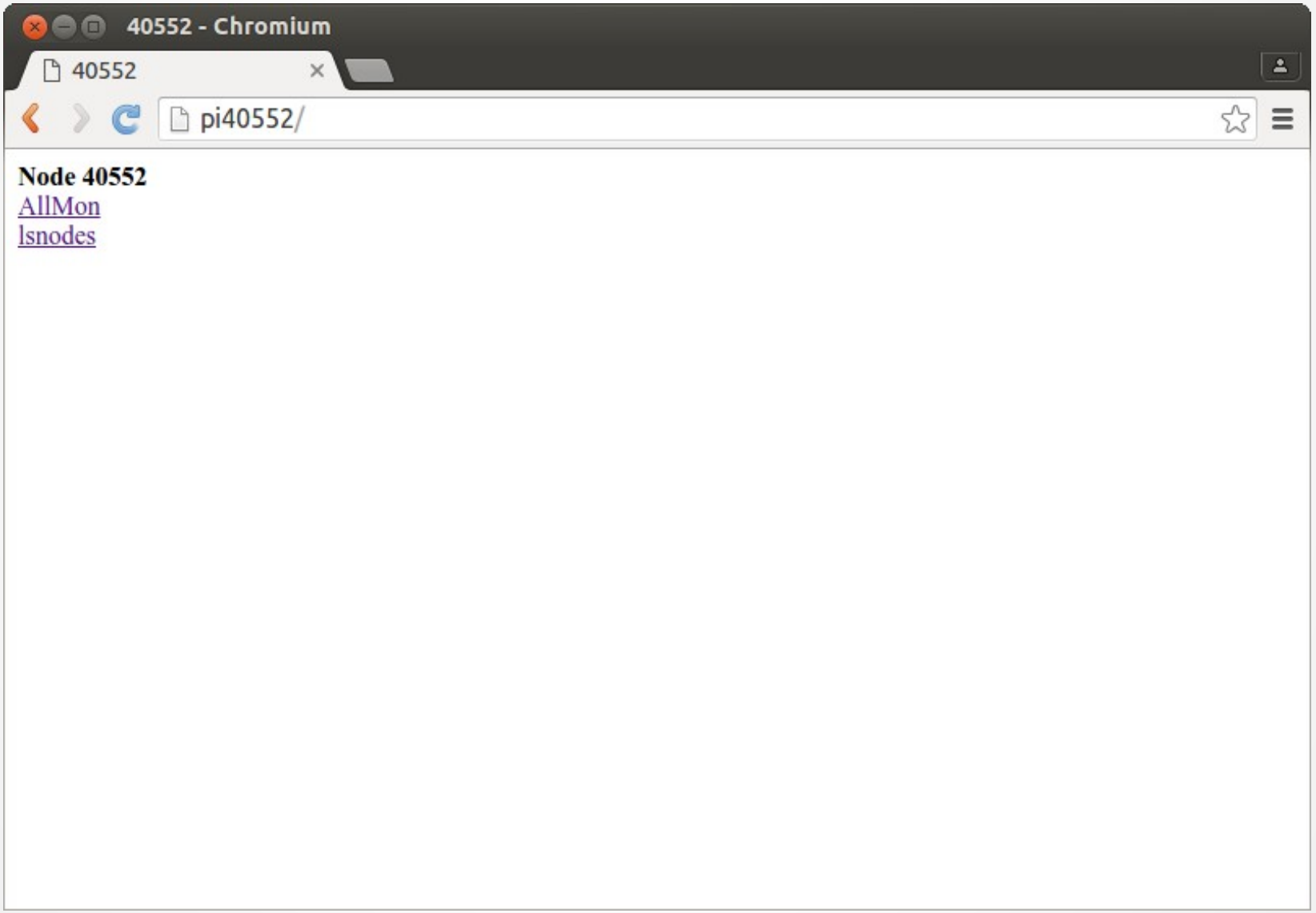
Update /srv/httpd/index.html

```
<html>
<head>
<title>40552</title>
</head>
<body>
<b>Node 40552</b>
<br><a href=allmon2/link.php?nodes=40552>AllMon</a>
<br><a href=cgi-bin/lsnodes_web?node=40552>lsnodes</a>
</body>
</html>
```

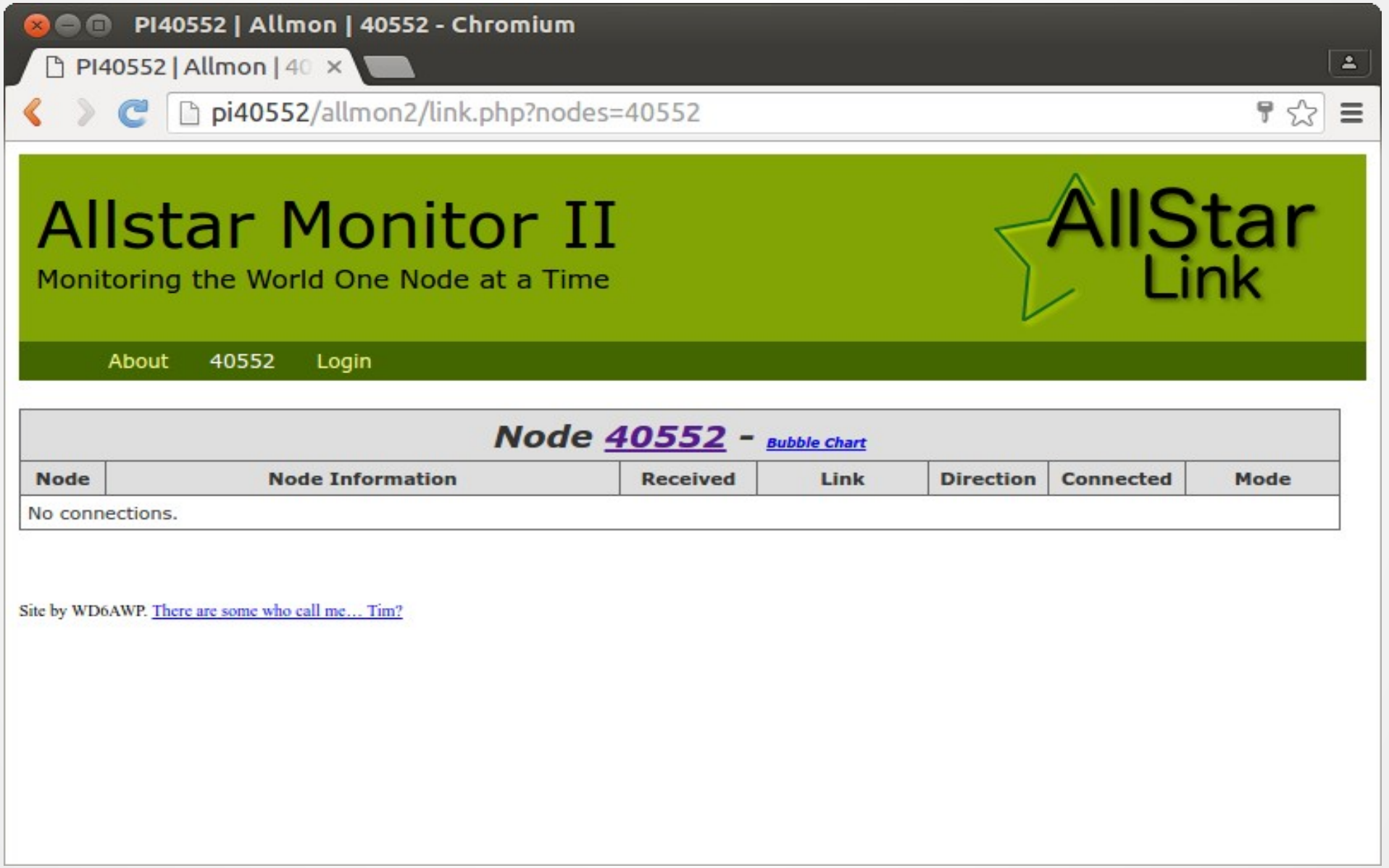
Edit AllMon Files

- Edit /srv/httpd/allmon2/allmon.ini.php
  - Change XXXXX to node number
  - Change passwd
- Edit /etc/asterisk/manager.conf
  - Add the same password to secret =
- Restart allstar
  - astres.sh

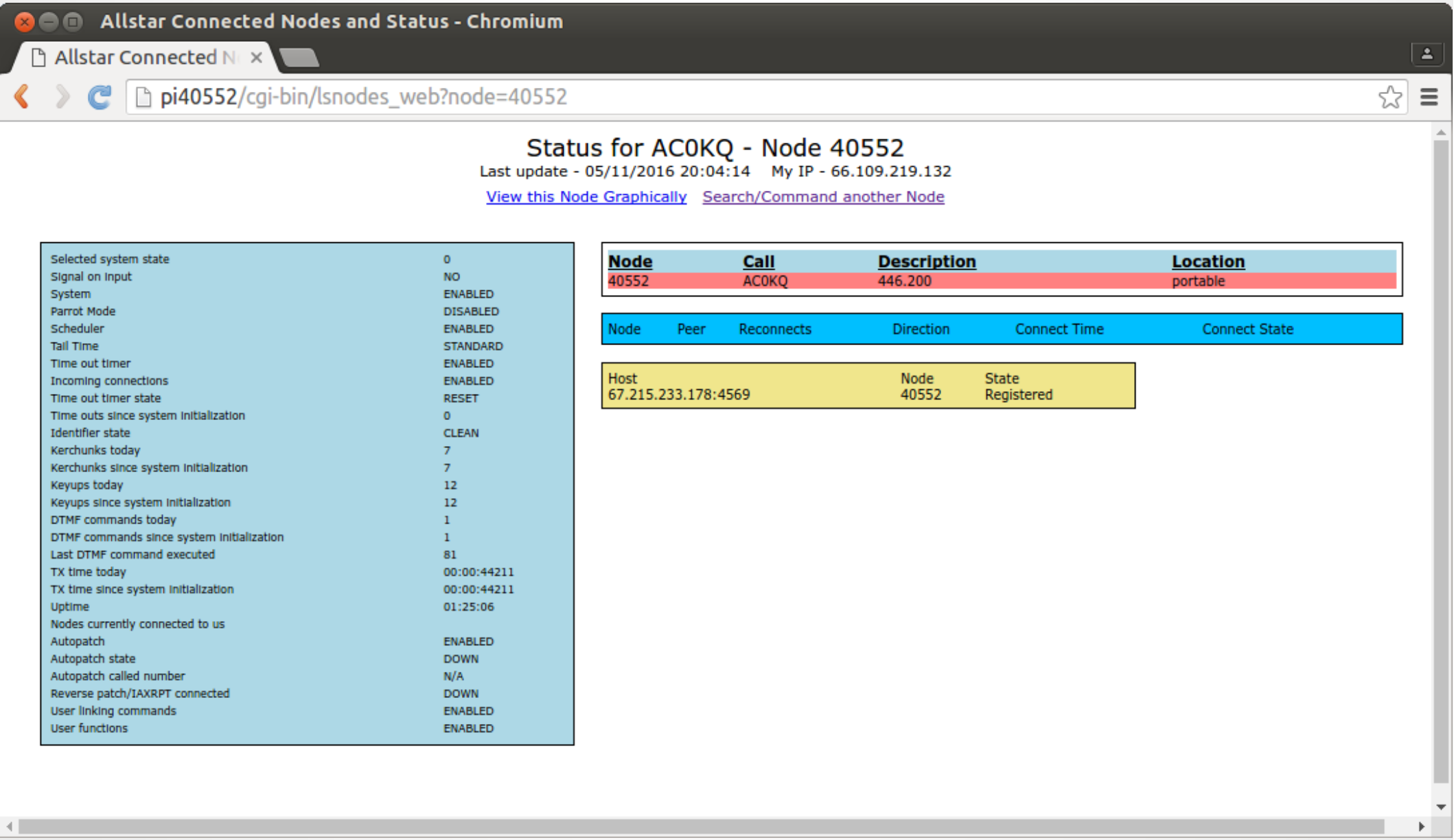
Base Access



AllMon2


PI40552 | Allmon | 40552 - Chromium
PI40552 | Allmon | 40
pi40552/allmon2/link.php?nodes=40552
Allstar Monitor II
Monitoring the World One Node at a Time
AllStar Link
About
40552
Login
Node 40552 - Bubble Chart
Node
Node Information
Received
Link
Direction
Connected
Mode
No connections.
Site by WD6AWP. There are some who call me… Tim?

lsnode



Status for AC0KQ - Node 40552

Last update - 05/11/2016 20:04:14 My IP - 66.109.219.132

View this Node Graphically Search/Command another Node

Selected system state	0
Signal on input	NO
System	ENABLED
Parrot Mode	DISABLED
Scheduler	ENABLED
Tail Time	STANDARD
Time out timer	ENABLED
Incoming connections	ENABLED
Time out timer state	RESET
Time outs since system initialization	0
Identifier state	CLEAN
Kerchunks today	7
Kerchunks since system initialization	7
Keyups today	12
Keyups since system initialization	12
DTMF commands today	1
DTMF commands since system initialization	1
Last DTMF command executed	81
TX time today	00:00:44211
TX time since system initialization	00:00:44211
Uptime	01:25:06
Nodes currently connected to us	
Autopatch	ENABLED
Autopatch state	DOWN
Autopatch called number	N/A
Reverse patch/IAXRPT connected	DOWN
User linking commands	ENABLED
User functions	ENABLED

Node	Call	Description	Location
40552	AC0KQ	446.200	portable

Node	Peer	Reconnects	Direction	Connect Time	Connect State

Host	Node	State
67.215.233.178:4569	40552	Registered

Observations

- By default the node list is updated daily via a cron job
- The rPi uses simpleusb due to limited CPU performance
- AllStar uses ArchLinux
- There is no need to expand the OS to fill the SD card (image size 4GB)

ADSB SDR Receiver

- Receiver based on RTL2832 USB
- About $20 on Amazon
- Also used in many ham related SDR projects

Software Build

Build and install rtl-sdr module

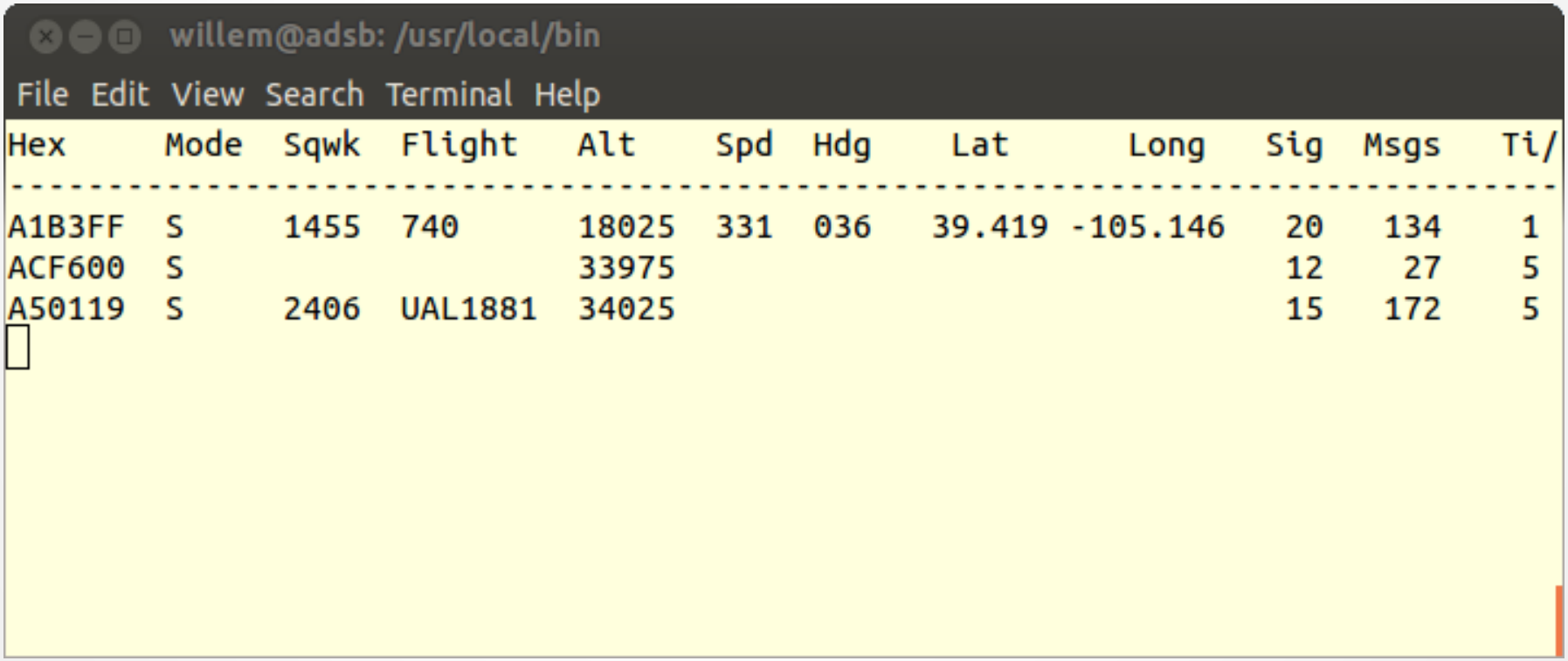
```
git clone git://git.osmocom.org/rtl-sdr.git
cd rtl-sdr
mkdir build
cd build
cmake ../ -DINSTALL_UDEV_RULES=ON
make
cd ..
```

Build and install dump1090

```
git clone git://github.com/MalcolmRobb/dump1090.git
cd dump1090
make
cd ..
```

Command line interface

- ./view1019

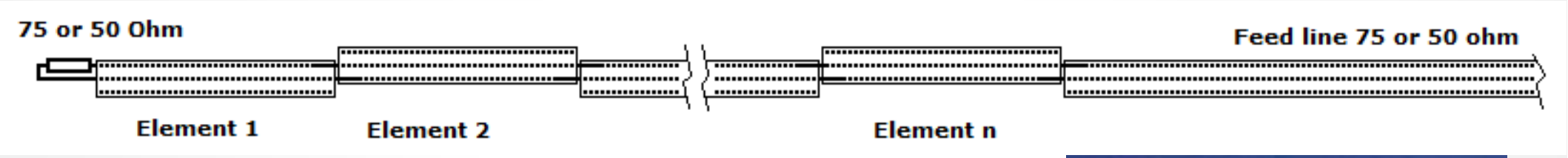


Running web interface

- ./dump1090 --net --lon -105 --lat 39
  - --net enables web interface port 8080
  - --lon and –lat sets location
- Run at boot from rc.local

Building a high gain antenna

- Colinear made from coax

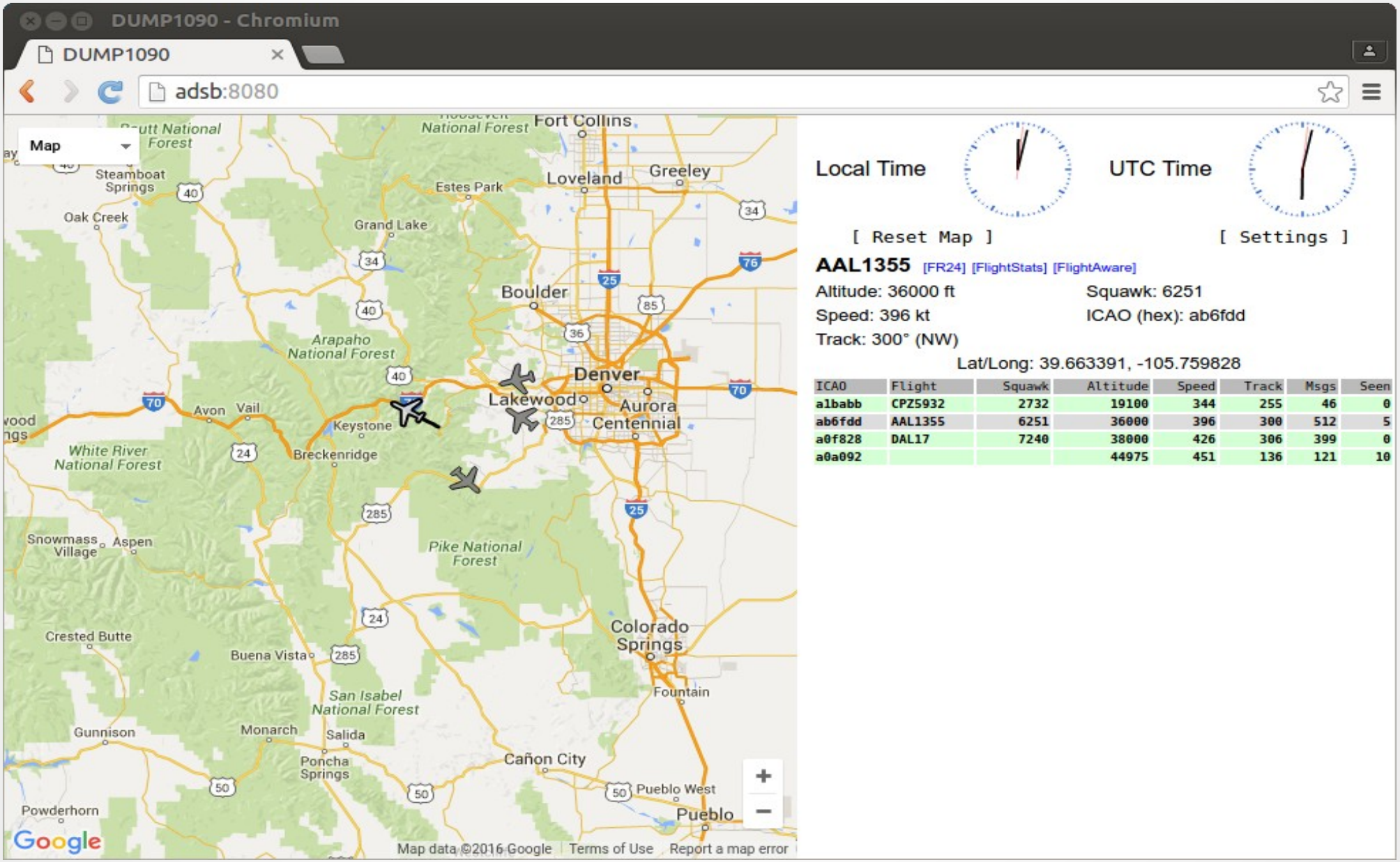


- Mount on N female inside PVC pipe

Installation

- Mount the receiver as close to the antenna as possible
  - RTL-SDR is not weather proof
  - 18” N to micro-UHF jumper
- Run long USB cable to rPi

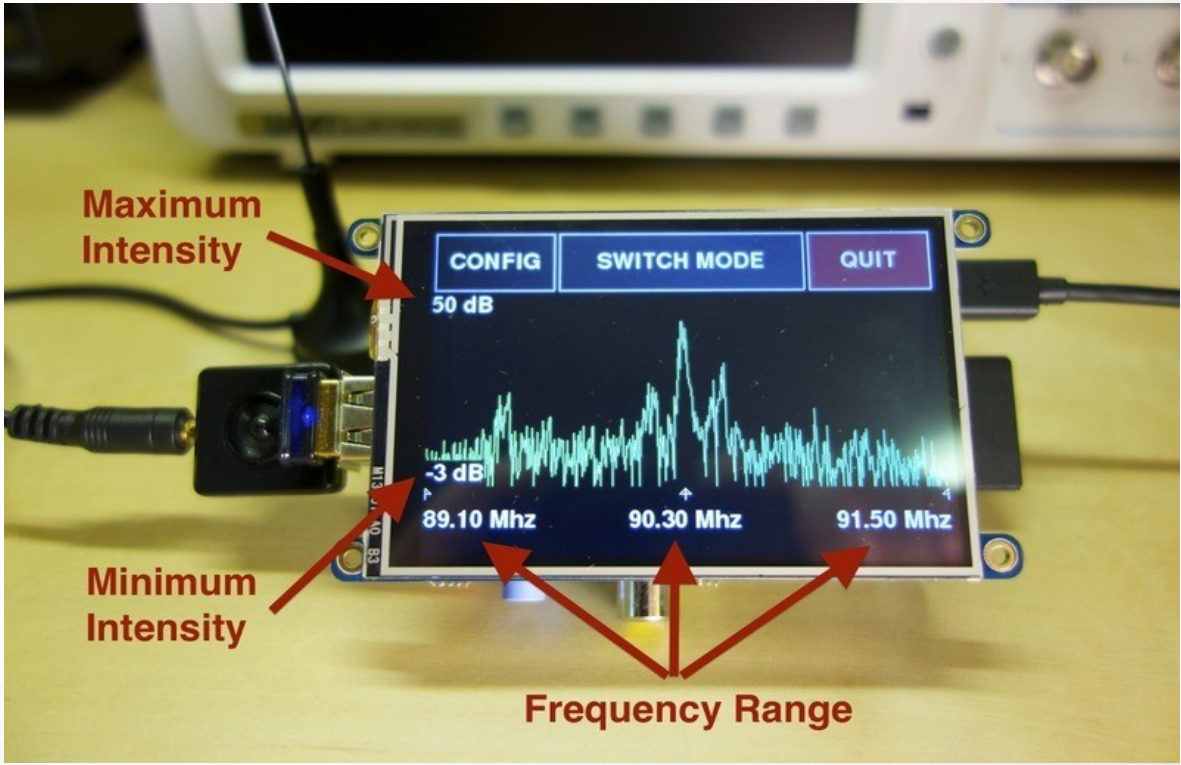
Running



ICAO	Flight	Squawk	Altitude	Speed	Track	Msgs	Seen
a1babb	CPZ5932	2732	19100	344	255	46	0
ab6fdd	AAL1355	6251	36000	396	300	512	5
a0f828	DAL17	7240	38000	426	306	399	0
a0a092			44975	451	136	121	10

Other Projects

- The rPi 3 is a 1.2GHz 64 bit quad core machine with 1GB memory
  - Processing power to do cool stuff
- GNU radio
- Adafruit Freq Show



SmokePi (SmokePing rPi)

SmokePi = Bad Idea

- SD storage not suitable for database applications
  - Lots of writes wears out flash
- SmokePi generates lots of graphs
  - SD slow compared to disk
  - Lots of writes wears out flash

Questions?