Setup the software for the intercom beltpack

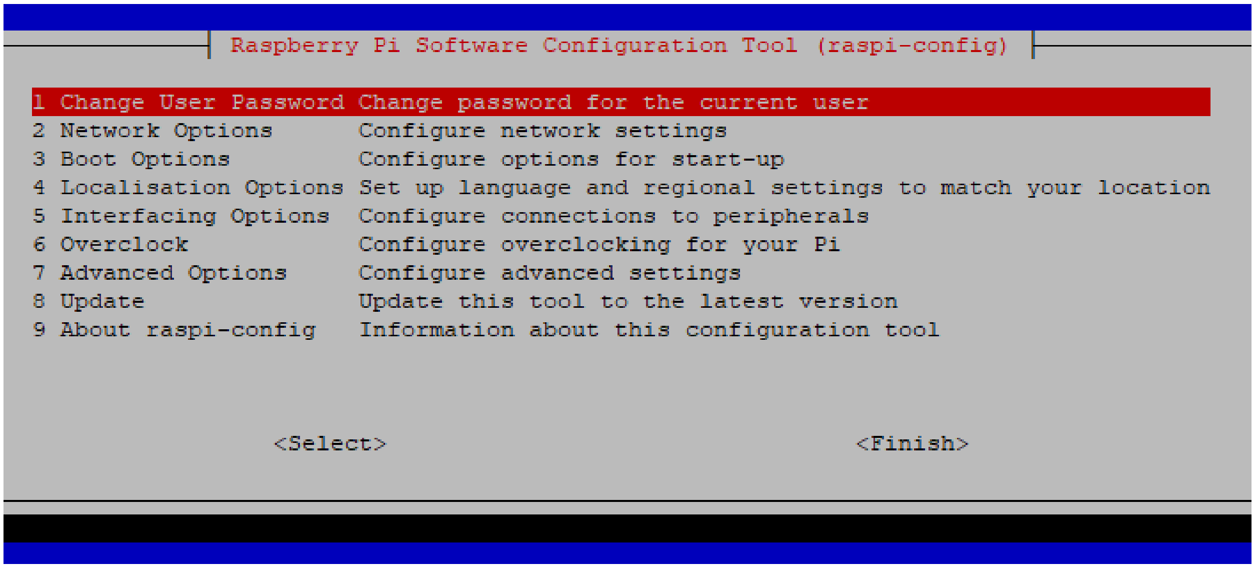
Requirements:
You have setup the server (Mumble, Mosquitto, Node.js) according to the server setup guide
Raspberry Pi 3 (tested with 3B, 3A+ will not fit the case as it is), required hardware and software
Download the latest Raspbian Stretch Lite image from https://www.raspberrypi.org/downloads/raspbian/

This guide assumes that you are using a Windows computer but both Mac and Linux can be used (you just have to find the tools needed). The setup is tested with Raspbian Stretch Lite image built on the 2018-10-09. When copying code from the blue fields remember to check that there are no whitespace characters (invisible spaces) at the end of the lines because that can break the code.

Etcher https://etcher.io/ is recommended to write the image to the sd card. Insert the card into the Raspberry Pi, connect a keyboard and monitor and power up, after a few seconds the Raspberry will resize the partition to fill the card used and reboot. After the reboot you will see a login screen prompting for a username, use pi as username and raspberry as password. The first task is to setup the Raspberry Pi as needed. Write the command below and press enter

```
sudo raspi-config
```

You will now see a menu like this



```
Raspberry Pi Software Configuration Tool (raspi-config)

1 Change User Password Change password for the current user
2 Network Options      Configure network settings
3 Boot Options         Configure options for start-up
4 Localisation Options Set up language and regional settings to match your location
5 Interfacing Options  Configure connections to peripherals
6 Overclock            Configure overclocking for your Pi
7 Advanced Options     Configure advanced settings
8 Update               Update this tool to the latest version
9 About raspi-config   Information about this configuration tool

                 <Select>                                <Finish>
```

1. Configure the Raspberry

1 Change User Password (to something you remember)

2 Network Options

N1 Hostname (beltpacks should be named icbp1, icbp2… use icbp1)

4 Localisation Options

I2 Timezone

I3 Change Keyboard-Layout

I4 Change Wi-fi Country

5 Interfacing options

P2 SSH Enable

P5 I2C Enable

7 Advanced options

A5 Resolution -> 1280x720 60Hz 16:9

Do NOT reboot on exit

2. Change I2C bus speed

```
sudo pico /boot/config.txt
```

Change line

```
dtparam=i2c_arm=on
```

to

```
dtparam=i2c_arm=on,i2c_arm_baudrate=400000
```

Save file (CTRL+x)

3. Setup WiFi

```
sudo pico /etc/wpa_supplicant/wpa_supplicant.conf
```

add to bottom of file and replace with your SSID and password

```
network={
    ssid="YOURSSID"
    psk="YOURNETWORKPASSWORD"
}
```

Save file (CTRL+x) and reboot

```
sudo reboot
```

You should now have a IP address (look for the line My IP address is:xxxx). Consider using a static IP if possible.

You can now decide if you prefer to work with the keyboard and screen or continue the setup over SSH (using for example putty)

4. Update the system

```
sudo apt update
sudo apt dist-upgrade
```

5. Install xfce4 (a minimal graphical interface)

```
sudo apt install --no-install-recommends xserver-xorg
sudo apt install --no-install-recommends xinit
sudo apt install xfce4 xfce4-terminal tango-icon-theme gnome-icon-theme lightdm
```

6. Setup auto-login

```
sudo raspi-config
```

3 Boot Options
    B1 Desktop / CLI
        B4 Desktop Autologin

Finish and do NOT reboot

7. Install X11VNC

This gives a possibility to access the desktop from another computer

```
sudo apt install x11vnc
```

Set VNC password

```
x11vnc –storepasswd
```

enter desired password and save to /home/pi/.vnc/passwd

8. Autostart X11VNC

```
sudo pico /etc/xdg/autostart/x11vnc.desktop
```

```
[Desktop Entry]
```

```
Type=Application
Name=X11VNC
Comment=VNC
Icon=preferences-desktop-screensaver
Exec=x11vnc -bg -forever -noxdamage -ncache_cr -rfbauth /home/pi/.vnc/passwd
TryExec=x11vnc
OnlyShowIn=XFCE;
```

Save file (CTRL+x)

9. Redirect error messages (do not log to file to extend the SD card lifetime)

```
sudo pico /etc/X11/Xsession
```

point your ERRFILE to /dev/null IE. Line 77

comment out this line (add # before the line)

```
  #exec >>"$ERRFILE" 2>&1
```

and add this below

```
  exec >> /dev/null 2>&1
```

Save file (CTRL+x) and reboot (before this you should attach your usb sound card)

```
sudo reboot
```

10. Install Tightvnc

Download tightvnc on your windows computer from https://www.tightvnc.com/ -> Download, when installing choose only client.

11. Start Tightvnc

Start tightvnc and enter the IP number of your Raspberry Pi, you will be asked for your VNC password. When logged in choose “Use default config” in the popup window.

12. Setup audio devices

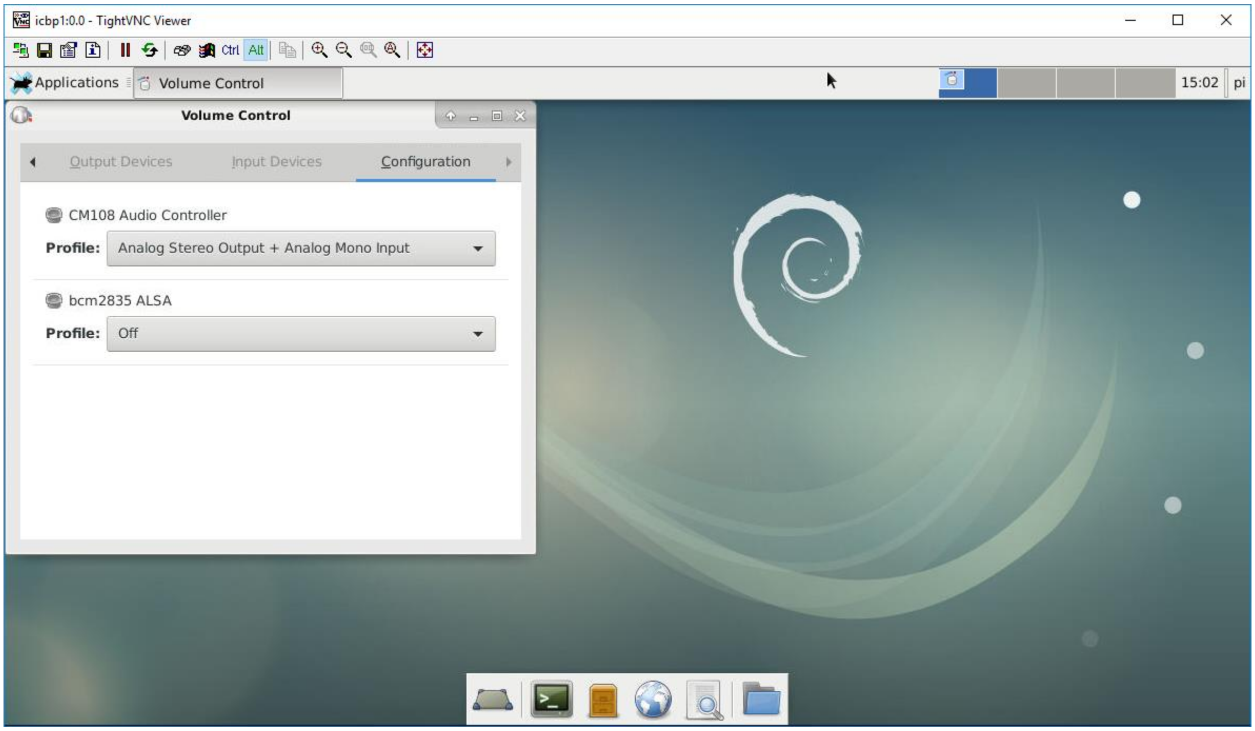
Click on the Applications button (upper left)

Applications -> Multimedia -> PulseAudio Volume Control

In the Configuration tab (press right arrow on keyboard to get to it)

bcm2835 ALSA Profile -> Off

USB Audio Device (CM108 Audio Controller) -> Analog Stereo Output + Analog Mono Input



CM108 Audio Controller

Profile: Analog Stereo Output + Analog Mono Input

bcm2835 ALSA

Profile: Off

Close the PulseAudio Window

13. Create intercom folders

Go to Applications -> Terminal Emulator

```
mkdir ~/intercom
mkdir ~/intercom/certs
cd ~/intercom
```

14. Copy certificate files to the Raspberry Pi

The certificate was generated in the server setup guide.

Download WinSCP (https://winscp.net/) on your Windows computer, install and start.

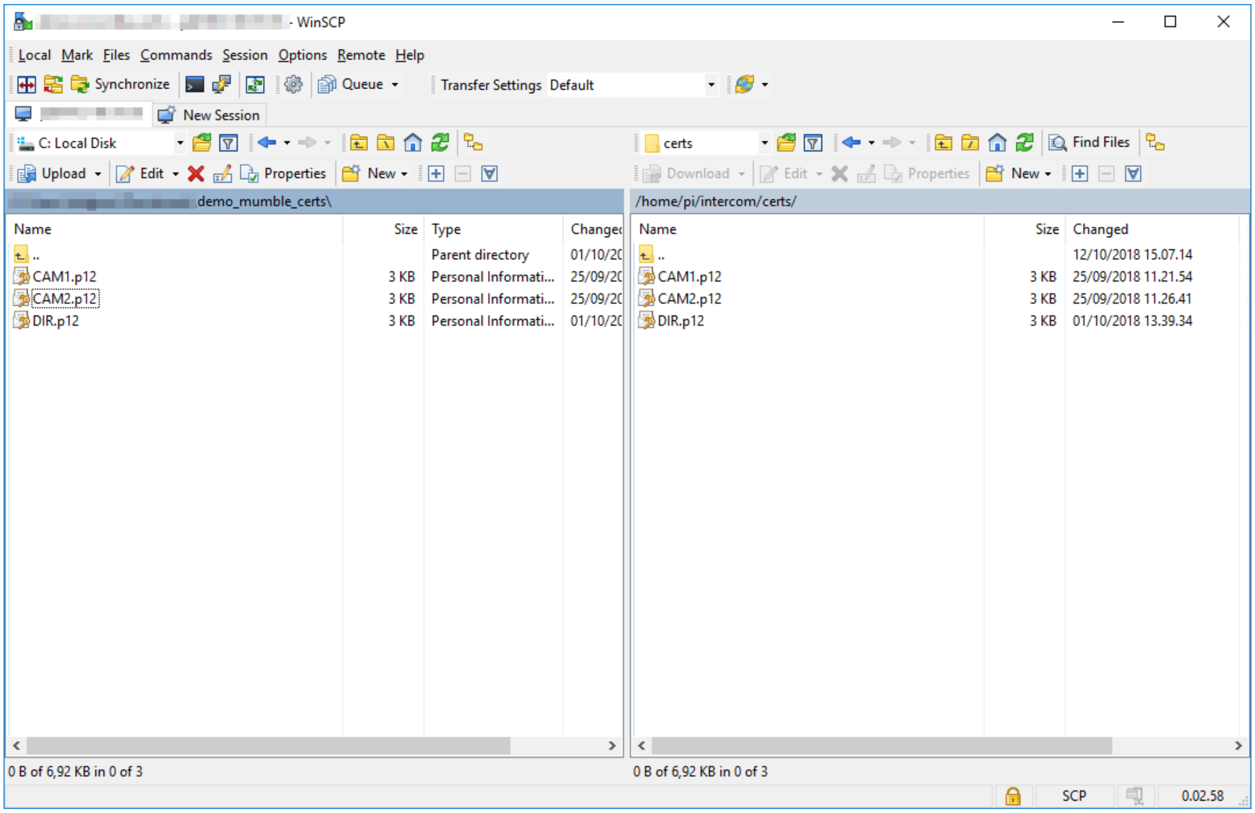
Under session choose SCP host name is your beltpack IP,

User name: pi, Password: (set in step 1)

When you are logged into the beltpack, on the left side you go to the folder where you exported the certs to in the server setup guide

On the right side you have your beltpack, double click intercom and then certs

Select all your certificates on the left side, right click and select Upload and OK



[redacted]demo_mumble_certs\

Name	Size	Type	Changed
..		Parent directory	01/10/20
CAM1.p12	3 KB	Personal Informati...	25/09/20
CAM2.p12	3 KB	Personal Informati...	25/09/20
DIR.p12	3 KB	Personal Informati...	01/10/20

0 B of 6,92 KB in 0 of 3

/home/pi/intercom/certs/

Name	Size	Changed
..		12/10/2018 15.07.14
CAM1.p12	3 KB	25/09/2018 11.21.54
CAM2.p12	3 KB	25/09/2018 11.26.41
DIR.p12	3 KB	01/10/2018 13.39.34

0 B of 6,92 KB in 0 of 3

SCP 0.02.58

15. Install Mumble

Back to the Raspberry Pi and the terminal emulator

```
sudo apt install mumble
```

Close the terminal (click X in right corner)

16. Setup Mumble

When Mumble starts for the first time the Audio Tuning Wizard will appear, click next on the first introduction screen

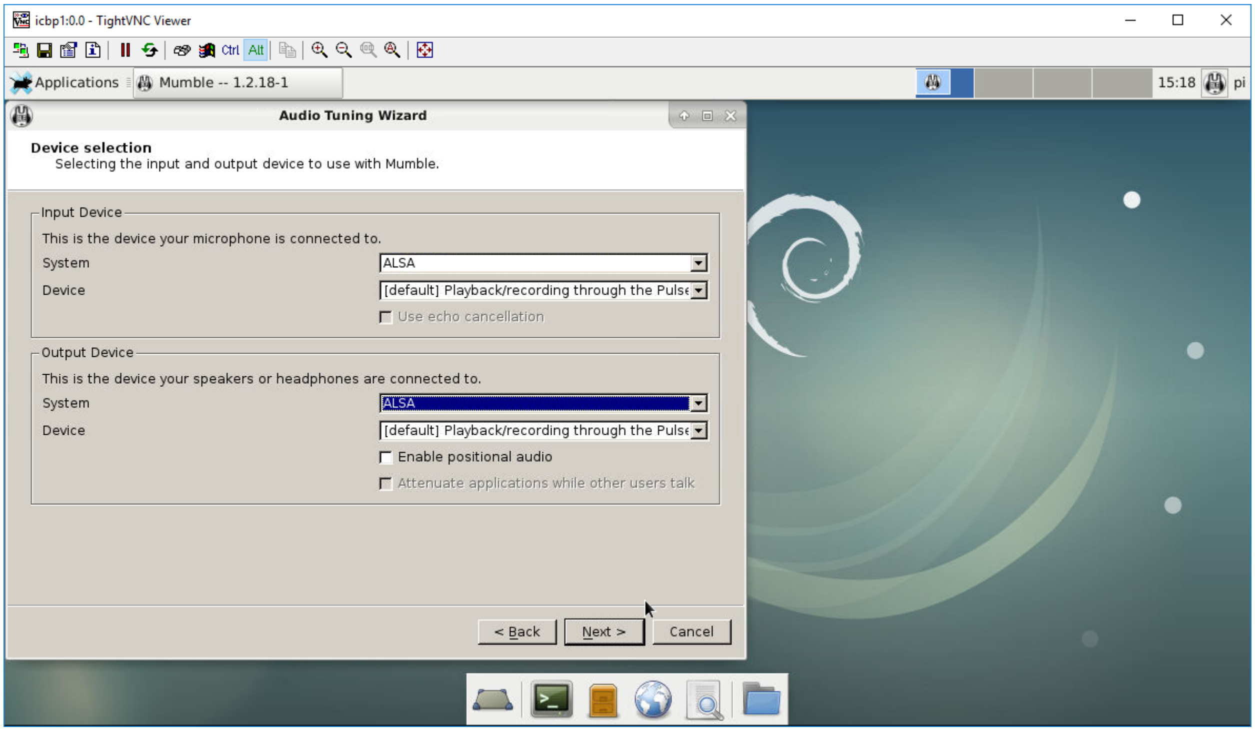
Device selection

System: ALSA

Device [default] Playback/recording through the PulseAudio sound server

on both Input and Output device,

Uncheck positional audio -> Next



Device selection

Selecting the input and output device to use with Mumble.

Input Device

This is the device your microphone is connected to.

System ALSA

Device [default] Playback/recording through the Pulse

□ Use echo cancellation

Output Device

This is the device your speakers or headphones are connected to.

System ALSA

Device [default] Playback/recording through the Pulse

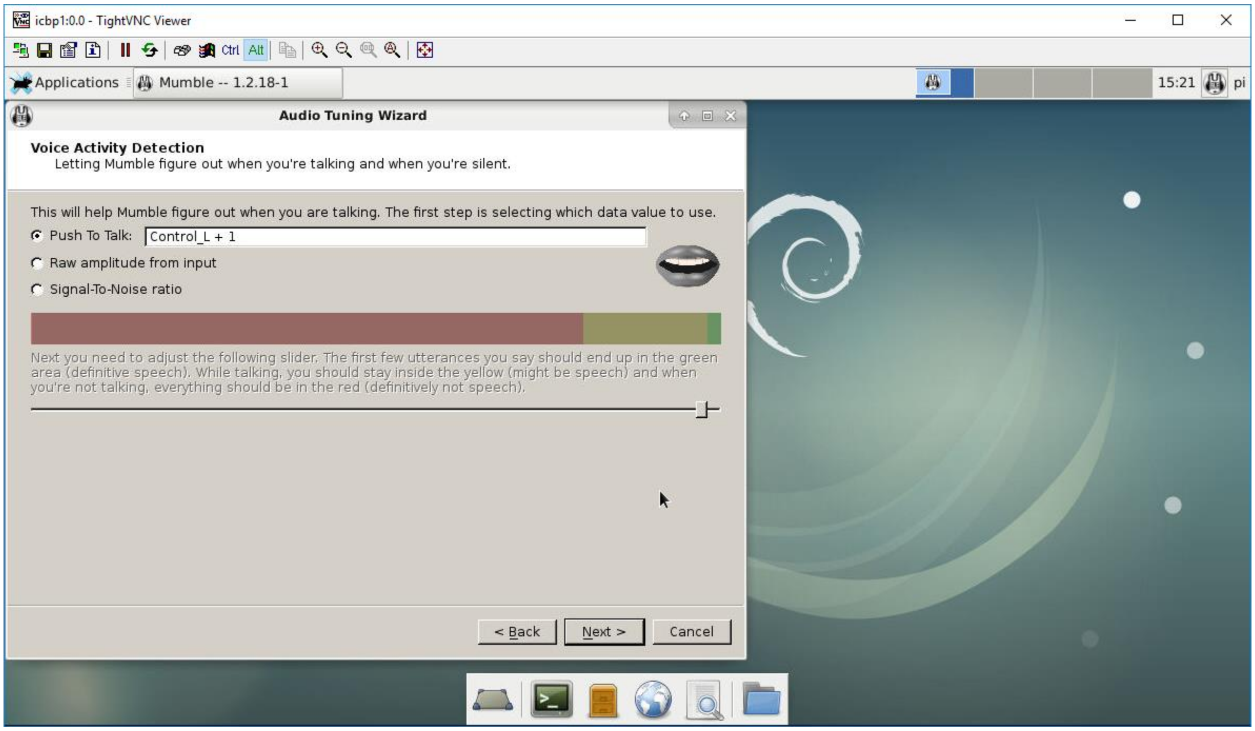
□ Enable positional audio

□ Attenuate applications while other users talk

Set the buffer to 10ms (you will not hear anything here) -> Next

Let the microphone tuning be at its preset -> Next

Voice Activity Detection, choose Push To Talk and click the white box next to it and press CTRL + 1 -> Next



Voice Activity Detection

Letting Mumble figure out when you're talking and when you're silent.

This will help Mumble figure out when you are talking. The first step is selecting which data value to use.

● Push To Talk: Control_L + 1

○ Raw amplitude from input

○ Signal-To-Noise ratio

Next you need to adjust the following slider. The first few utterances you say should end up in the green area (definitive speech). While talking, you should stay inside the yellow (might be speech) and when you're not talking, everything should be in the red (definitively not speech).

Quality and notifications, Quality settings -> High,

Uncheck Text-To-Speech and use sound instead -> Next

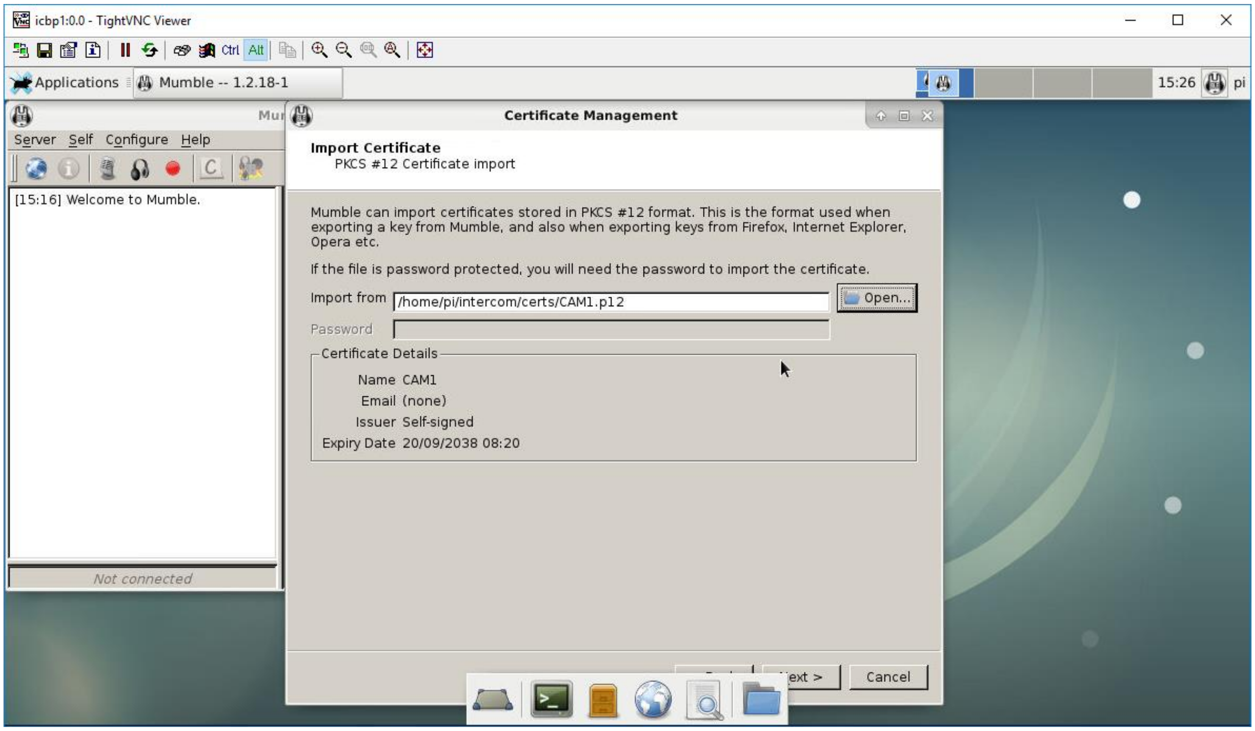
Choose if you want to submit anonymous statistics -> Finish

17. Import Mumble certificate

The Certificate Management should popup,

choose Import a certificate -> Next (you might have to scale the window to get to the next button)

Click Open and select the CAM1 certificate from /home/pi/intercom/certs/CAM1.p12 -> Open -> Next



[15:16] Welcome to Mumble.

Not connected

Import Certificate
PKCS #12 Certificate import

Mumble can import certificates stored in PKCS #12 format. This is the format used when exporting a key from Mumble, and also when exporting keys from Firefox, Internet Explorer, Opera etc.

If the file is password protected, you will need the password to import the certificate.

Import from: /home/pi/intercom/certs/CAM1.p12

Password:

Certificate Details

Name: CAM1
Email: (none)
Issuer: Self-signed
Expiry Date: 20/09/2038 08:20

Click Finish

18. Connect to Mumble server

The Mumble Server Connect screen should have popped up, if not go to Server -> Connect

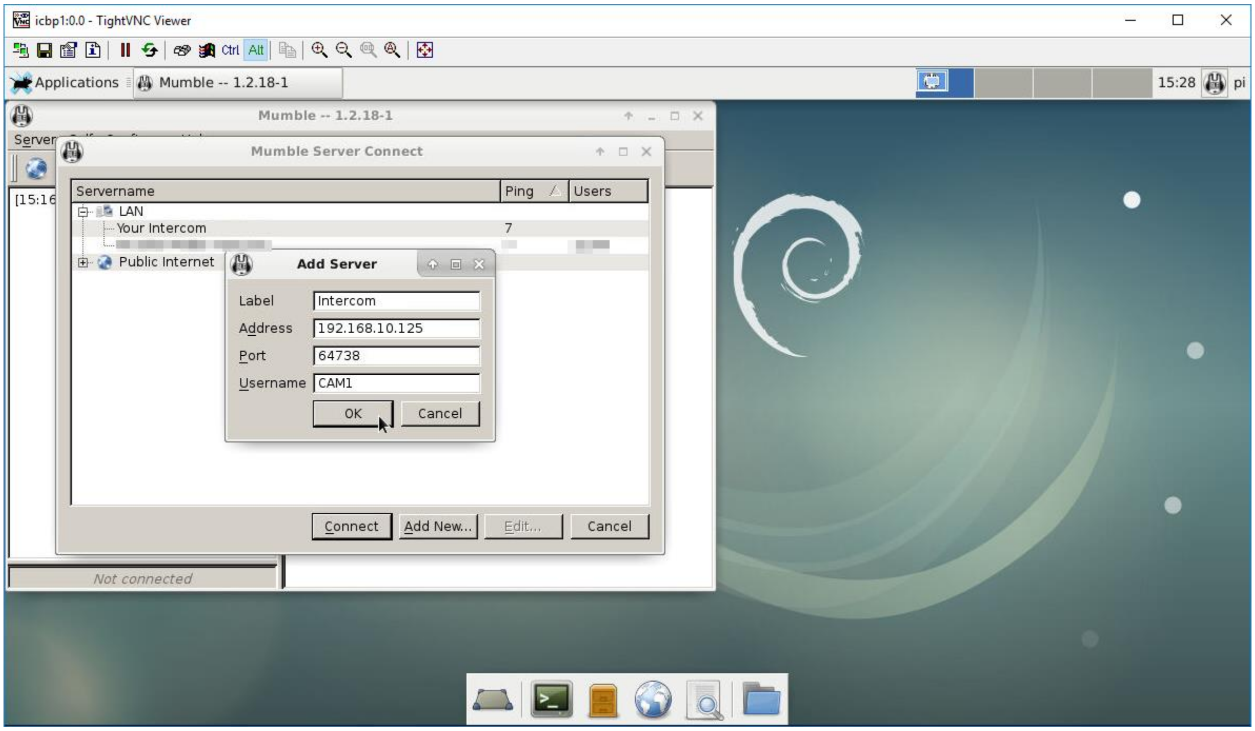
Click Add New,

Label: Intercom

Address: <YOURSERVERIP> in this example: 192.168.10.125

Port: 64738,

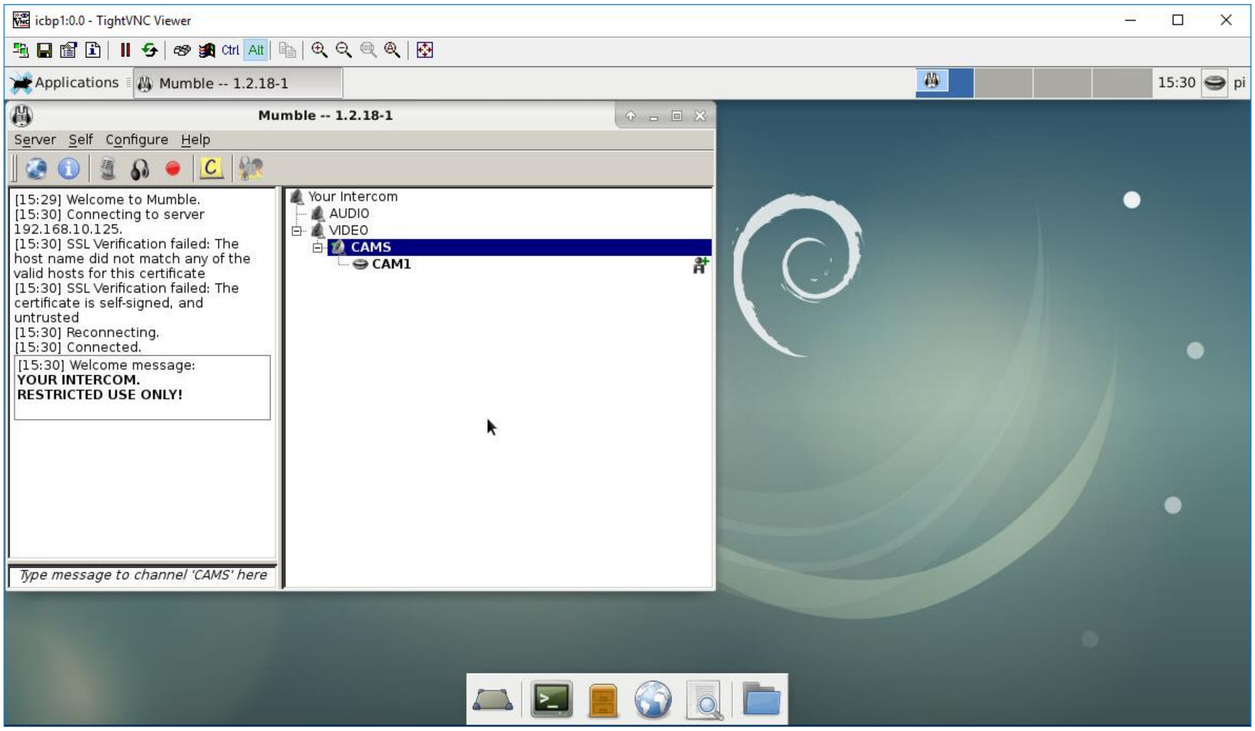
Username: CAM1 -> OK



Label: Intercom
Address: 192.168.10.125
Port: 64738
Username: CAM1

Under Favorite you should now see the Intercom server you just added, click Cancel and quit Mumble (Remember to ALWAYS quit/restart Mumble when making changes, settings are not saved when using poweroff/restart from command line).

Start Mumble again and connect to the Intercom server you just made, when you login to your server for the first time (with a new certificate) you will get a warning about the self-signed certificate, choose Yes and continue. You should now be logged in as CAM1 and put into the Video channel.



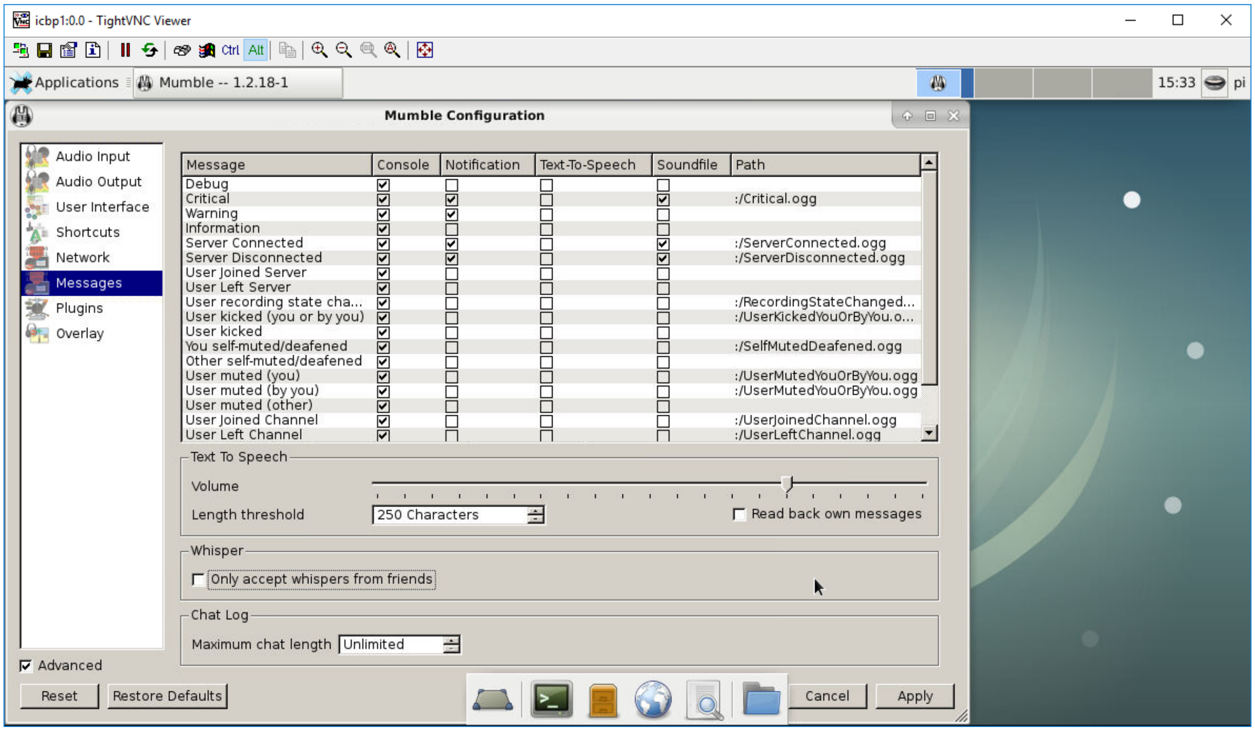
```
[15:29] Welcome to Mumble.
[15:30] Connecting to server
192.168.10.125.
[15:30] SSL Verification failed: The
host name did not match any of the
valid hosts for this certificate
[15:30] SSL Verification failed: The
certificate is self-signed, and
untrusted
[15:30] Reconnecting.
[15:30] Connected.
[15:30] Welcome message:
YOUR INTERCOM.
RESTRICTED USE ONLY!
```

19. Continue to configure Mumble part 1

Under Configure->Settings->Click Advanced (down left)

Under Network, click Reconnect to last server on startup

Under Messages, set the matrix as in the picture, Notifications and Soundfile are the important ones, otherwise you will hear sounds every time a user joins/leaves a channel, etc.



Message	Console	Notification	Text-To-Speech	Soundfile	Path
Debug	☑	□	□	□	
Critical	☑	☑	□	☑	:/Critical.ogg
Warning	☑	☑	□	□	
Information	☑	□	□	□	
Server Connected	☑	☑	□	☑	:/ServerConnected.ogg
Server Disconnected	☑	☑	□	☑	:/ServerDisconnected.ogg
User Joined Server	☑	□	□	□	
User Left Server	☑	□	□	□	
User recording state cha...	☑	□	□	□	:/RecordingStateChanged...
User kicked (you or by you)	☑	□	□	□	:/UserKickedYouOrByYou.o...
User kicked	☑	□	□	□	
You self-muted/deafened	☑	□	□	□	:/SelfMutedDeafened.ogg
Other self-muted/deafened	☑	□	□	□	
User muted (you)	☑	□	□	□	:/UserMutedYouOrByYou.ogg
User muted (by you)	☑	□	□	□	:/UserMutedYouOrByYou.ogg
User muted (other)	☑	□	□	□	
User Joined Channel	☑	□	□	□	:/UserJoinedChannel.ogg
User Left Channel	☑	□	□	□	:/UserLeftChannel.ogg

Text To Speech

Volume

Length threshold 250 Characters

□ Read back own messages

Whisper

□ Only accept whispers from friends

Chat Log

Maximum chat length Unlimited

☑ Advanced

Apply->OK (and remember to quit/restart Mumble after this)

20. Autostart Mumble

Using Application->Terminal emulator (or using the terminal over ssh) do the following

```
sudo pico /etc/xdg/autostart/start_mumble.desktop
```

```
[Desktop Entry]
Type=Application
Name=Mumble
Comment=Start Mumble client
Icon=preferences-desktop-screensaver
Exec=mumble
TryExec=mumble
OnlyShowIn=XFCE;
```

Save file (CTRL+x) and reboot

```
sudo reboot
```

Check (with tightvnc or screen) that Mumble starts and connects to server as CAM1 after reboot.

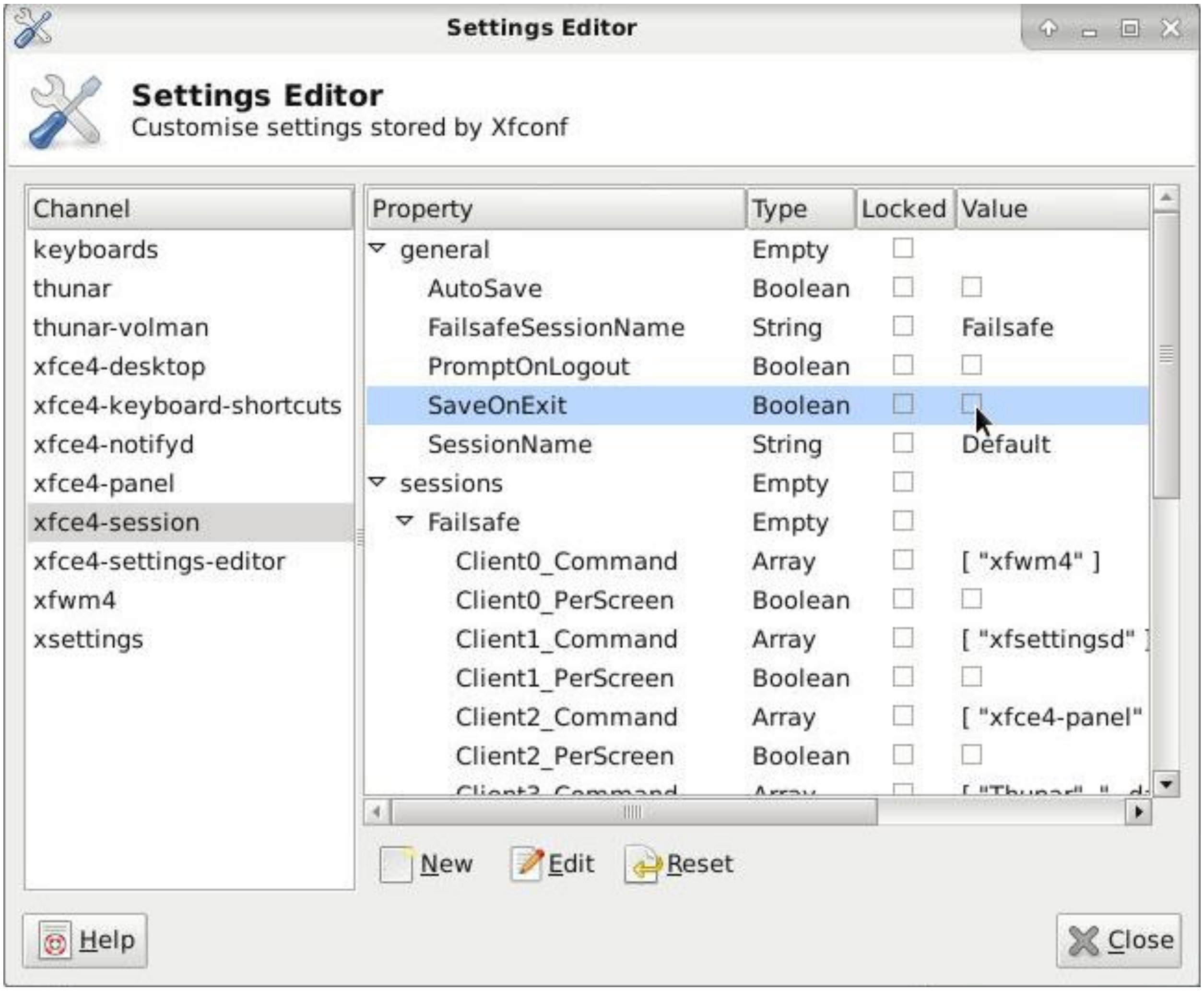
21. Correct session settings

Go to Applications->Settings->Session and Startup

Uncheck Automatically save session on logout under Logout Settings, and click Close

Go to Application->Terminal Emulator and write the following command

```
xfce4-settings-editor
```



Settings Editor

Settings Editor
Customise settings stored by Xfconf

Channel
keyboards
thunar
thunar-volman
xfce4-desktop
xfce4-keyboard-shortcuts
xfce4-notifyd
xfce4-panel
xfce4-session
xfce4-settings-editor
xfwm4
xsettings

Property	Type	Locked	Value
general	Empty	□	
AutoSave	Boolean	□	□
FailsafeSessionName	String	□	Failsafe
PromptOnLogout	Boolean	□	□
SaveOnExit	Boolean	□	□
SessionName	String	□	Default
sessions	Empty	□	
Failsafe	Empty	□	
Client0_Command	Array	□	["xfwm4"]
Client0_PerScreen	Boolean	□	□
Client1_Command	Array	□	["xfsettingsd"]
Client1_PerScreen	Boolean	□	□
Client2_Command	Array	□	["xfce4-panel"
Client2_PerScreen	Boolean	□	□

Under xfce4-session->Uncheck SaveOnExit if it is checked. Without this step, two Mumble clients will be running (one that is remembered from the last session and the new one that autostarts). Click Close and reboot once more to check that only one Mumble is running

```
sudo reboot
```

If everything is working, turn off the Raspberry Pi.

```
sudo poweroff
```

22. Install the Raspberry Pi into the enclosure

Consult the beltpack hardware installation guide.

23. Install python libraries

After the last step you can't access the screen as the Raspberry Pi is mounted in the base station enclosure. Instead you have to connect to it with putty (under hostname enter your beltpack IP) and click Open, login with pi and your password.

Install the OLED library

```
sudo apt install python3-dev python3-pip libfreetype6-dev libjpeg-dev
sudo pip3 install --upgrade pip
sudo pip3 install --upgrade setuptools
sudo pip3 install --upgrade luma.oled
```

Install GUI automation library

```
sudo apt install libx11-dev libxtst-dev
sudo pip3 install autopy3
```

Install MQTT library

```
sudo pip3 install paho-mqtt
```

24. Copy and extract beltpack script on Raspberry Pi

Use WinSCP on your Windows computer to copy the ic_beltpack_pi3.zip file to the beltpack (/home/pi/intercom/ic_beltpack_pi3.zip).

Back in putty

```
cd ~/intercom
unzip ic_beltpack_pi3.zip
rm ic_beltpack_pi3.zip
```

25. Copy MQTT server certificate

login in to your server (the example server is at 192.168.10.125)

```
ssh pi@192.168.10.125
```

(answer Yes)

Copy server cert to beltpack

```
scp /etc/mosquitto/certs/ca.crt pi@192.168.10.152:/home/pi/intercom
```

(replace IP with your basestations, answer yes and enter the beltpack password)

Disconnect from server CTRL+d

```
ls -la
```

(ca.crt should now be in the folder)

26. Test the OLED display and connections

```
python3 oled_test.py
```

watch display when pressing buttons, CTRL+c to quit test

27. Test the intercom script

Before you start the script you must edit it to connect to the right IP

```
pico ~/intercom/ ic_beltpack_pi3.py
```

edit the following lines to match your setup:

mqttServer

mqttUser

mqttPass

Save file (CTRL+x) and start script

```
python3 ic_beltpack_pi3.py
```

You should now see a wifi signal meter, the text UNKNOWN and your IP on the display. CTRL+c to quit

28. Make intercom start script

```
pico ~/start_intercom.sh
```

```
#!/bin/bash
#START INTERCOM
DISPLAY=:1.0 XAUTHORITY=/home/pi/.Xauthority sudo /usr/bin/python3
/home/pi/intercom/ic_beltpack_pi3.py &
```

Save file (CTRL+x)

observe that there should not be a line break after python3, everything should be on the same line like python3 /home/…

```
chmod +x start_intercom.sh
```

Make the intercom script start automatically

```
crontab -e
```

(choose 2 nano if asked)

add the following line to the bottom of the file

```
    @reboot /home/pi/start_intercom.sh
```

CTRL+x to exit and save changes (do not change filename)

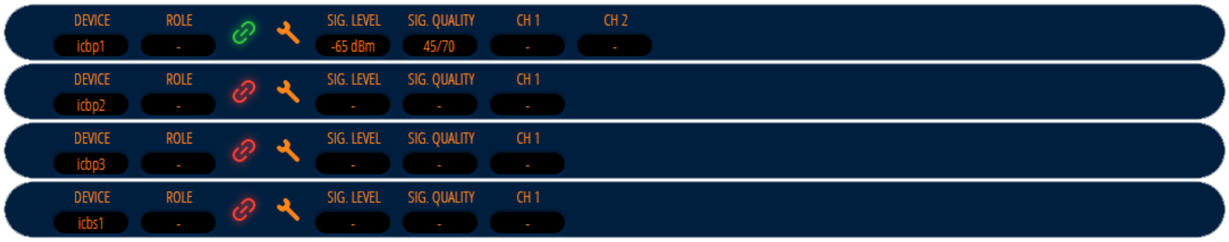
```
sudo reboot
```

After boot you should see a signal meter, the text UNKNOWN and your IP on the display

29. Configure the beltpack role

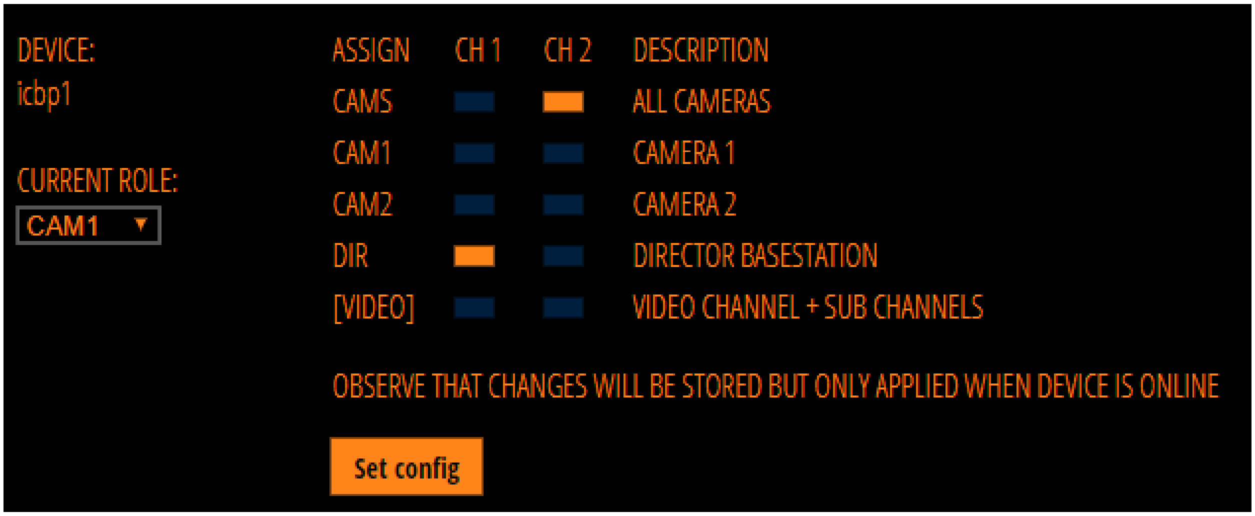
On your Windows computer open a browser and go to http://YOURSERVER_IP:3000

You now need to configure the beltpack, click the wrench (the connection symbol on the left should now be green because the beltpack is online) on icbp1



DEVICE	ROLE	SIG. LEVEL	SIG. QUALITY	CH 1	CH 2
icbp1	-	-65 dBm	45/70	-	-
icbp2	-	-	-	-	
icbp3	-	-	-	-	
icbs1	-	-	-	-	

Select CAM1 as Role and DIR on CH1 and CAMS on CH2 (YOU CAN ALSO CHOOSE MULTIPLE TARGETS PER CHANNEL), click Set config



DEVICE:
icbp1

CURRENT ROLE:
CAM1 ▼

ASSIGN	CH 1	CH 2	DESCRIPTION
CAMS	🟦	🟧	ALL CAMERAS
CAM1	🟦	🟦	CAMERA 1
CAM2	🟦	🟦	CAMERA 2
DIR	🟧	🟦	DIRECTOR BASESTATION
[VIDEO]	🟦	🟦	VIDEO CHANNEL + SUB CHANNELS

OBSERVE THAT CHANGES WILL BE STORED BUT ONLY APPLIED WHEN DEVICE IS ONLINE

Your beltpack display should now be updated accordingly, now it is time to setup Mumble to match the script role and who you can talk to.

30. Continue to configure Mumble part 2

Connect with tightvnc to your beltpack, you want to talk to the director (DIR) on channel 1 and all the cameras (CAMS) on channel 2.

In Mumble go to Configure -> Settings

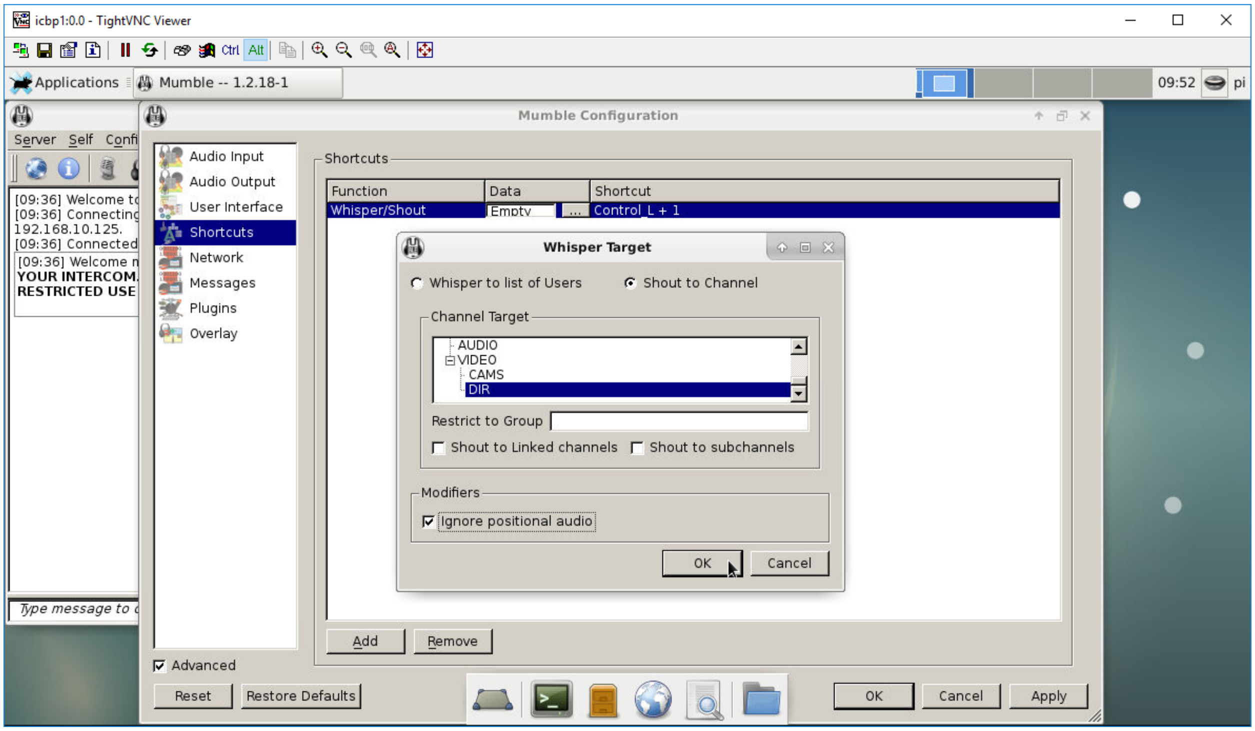
Under Audio Input -> Compression -> Quality 96.0 kb/s

First you add the DIR Channel

Under Shortcuts - > Change Push-to-Talk to Whisper/Shout ¨

(PTT transmits only to the channel you are in)

Under Shortcuts - > Click 3 dots under Data -> Choose Shout to channel -> Click on DIR (UNDER VIDEO), ignore positional audio and OK



[09:36] Welcome t
[09:36] Connecting
192.168.10.125.
[09:36] Connected
[09:36] Welcome n
YOUR INTERCOM.
RESTRICTED USE

Type message to c

Shortcuts

Function	Data	Shortcut
Whisper/Shout	Empty ...	Control_L + 1

○ Whisper to list of Users ● Shout to Channel

Channel Target

AUDIO
VIDEO
CAMS
DIR

Restrict to Group

☐ Shout to Linked channels ☐ Shout to subchannels

Modifiers

☑ Ignore positional audio

☑ Advanced

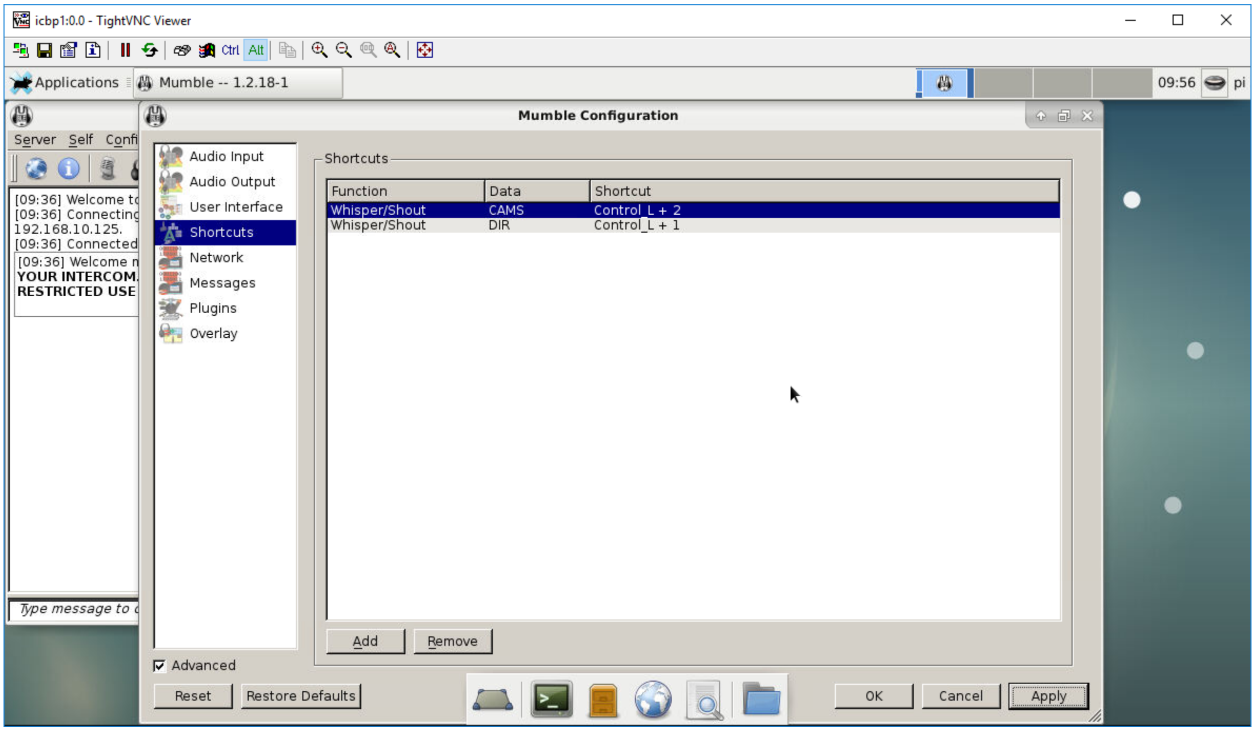
Then you add CAMS

Click ADD -> Double click Unassigned -> Select Whisper/shout -> Under Data click the three dots - > Choose Shout to channel -> Click on CAMS (UNDER VIDEO), ignore positional audio and OK

Click under Shortcut to assign keyboard shortcut (This should also be CTRL + 2)

The reason that DIR has its own channel is because you now can setup Mumble to talk to the director even if DIR is not connected to the server. If you choose "Whisper to list of Users" all users you want to whisper (talk to) must be connect to the server to be able to assign it.

As basestations might have some channels open all the time to for example the FM (Floor Manager) it is also a good practice to have the FM (Floor Manager) in his/her own channel. If the FM beltpack disconnects from the Mumble server even for just a second and you have the channel open from the basestation Mumble will close the connection but the basestation still shows (because the script do not know what Mumble is actually doing) that you are talking to the FM. You must then close the channel and re-open it to be able to talk to FM again. This is not necessary if FM is its own channel.

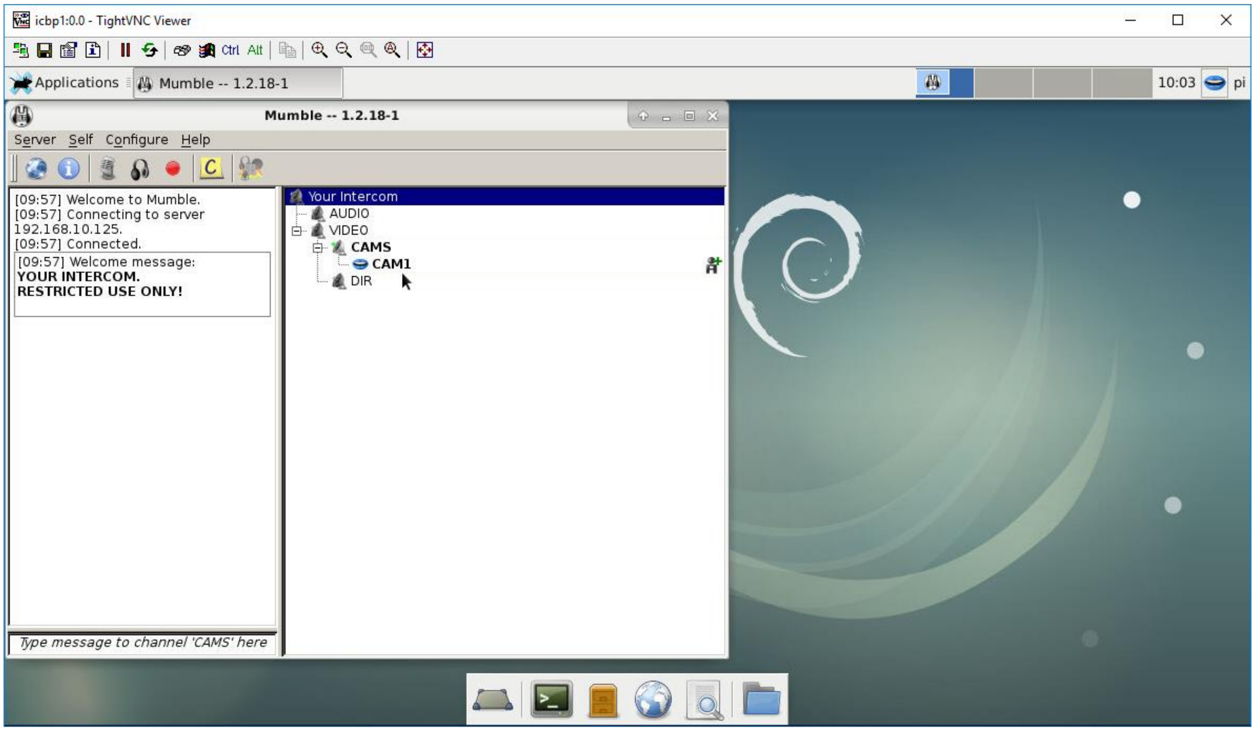


```
[09:36] Welcome t
[09:36] Connecting
192.168.10.125.
[09:36] Connected
[09:36] Welcome n
YOUR INTERCOM.
RESTRICTED USE
```

Function	Data	Shortcut
Whisper/Shout	CAMS	Control_L + 2
Whisper/Shout	DIR	Control_L + 1

Click Apply followed by OK (and remember to quit/start Mumble again)

If you now push the switch in the direction of the display your display should say "TALK TO DIR" (if it says "TALK TO CAMS", you must swap the wires on the Raspberry Pi (36&40)) and the lips in the Mumble interface should turn blue on CAM1.



[09:57] Welcome to Mumble.
[09:57] Connecting to server 192.168.10.125.
[09:57] Connected.
[09:57] Welcome message:
YOUR INTERCOM.
RESTRICTED USE ONLY!

31. Setup the volume control

Use Winscp to transfer the file volume_control.py to /home/pi/ in the terminal, edit the file

```
pico /home/pi/volume_control.py
```

Uncomment the line that contains print(raw_adc) (remove the hashtag), CTRL+x to end editing and save

Test the script and turn the knob to position 0, take note of the value and then to 100 and take note

```
python3 /home/pi/volume_control.py
```

I got ~20680 and ~-4600 using a 100k potentiometer and a 1k resistor on the input

Now you need to update the script with these values by editing the line that starts with volume =

```
pico /home/pi/volume_control.py
```

comment the print(raw_adc) line and uncomment the print("Digital Value... line

start the script again and see if you can reach 0 and 100, if not fine tune the values above then comment out the print line.

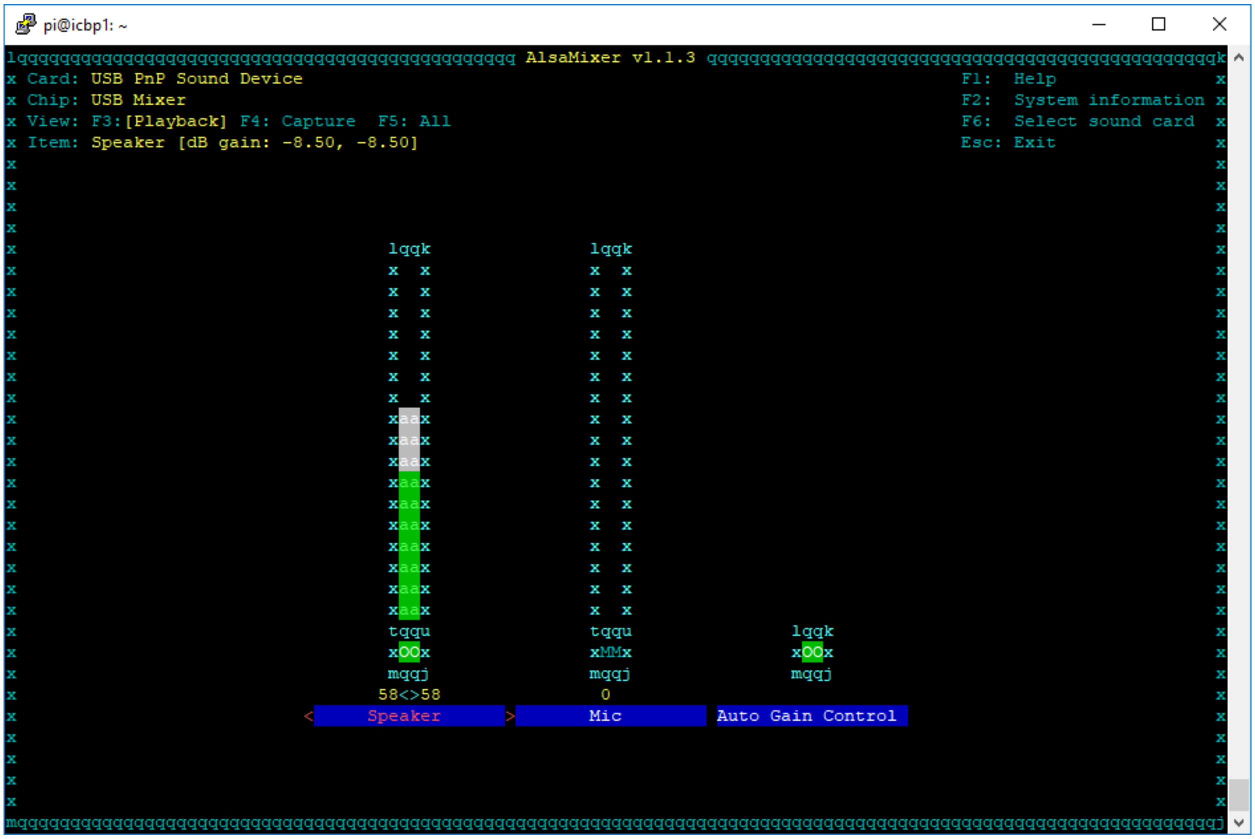
```
python3 /home/pi/volume_control.py
```

When you are ready you need to test that everything is working all the way to the soundcard, start the script in the background and open alsamixer (the & means that you leave the script running in the background, note the pid number you get, you need it if you need to to stop the process later). If you need to stop the process later use kill and PID.

```
python3 /home/pi/volume_control.py &
```

then start alsamixer (press F6 and choose USB Sound Device) and turn the knob to check that the soundcard volume changes from 0 to 100 (ESC to exit)

```
alsamixer
```



```
AlsaMixer v1.1.3
Card: USB PnP Sound Device                              F1:  Help
Chip: USB Mixer                                         F2:  System information
View: F3:[Playback] F4: Capture  F5: All                F6:  Select sound card
Item: Speaker [dB gain: -8.50, -8.50]                   Esc: Exit

                      OO             MM             OO
                    58<>58           0
                <  Speaker  >       Mic      Auto Gain Control
```

32. Edit the start_intercom.sh script

To start the volume control on boot you need to add it to the start script

```
pico /home/pi/start_intercom.sh
```

Add this line after the last line

```
/usr/bin/python3 /home/pi/volume_control.py &
```

CTRL+x to exit and save

Reboot and login and open alsamixer to check that it still works

```
sudo reboot
```

If it works you are now ready to start using the beltpack. No you can make an image of the sdcard so that you can easily duplicate it to other beltpacks.

If you have access to a linux machine, you can use ddrescue and pishrink (replace sdc with where your sd card is found, use sudo dmsg to find out)

sudo ddrescue /dev/sdc beltpack.img rescue.log

Download and read more here https://github.com/Drewsif/PiShrink

```
sudo pishrink.sh beltpack.img
```

Pishrink (without the –s) will automatically expand to use the whole sd card when started for the first time

When you deploy the image to new devices you must remember to do the following thing after deployment:

Change hostname (step 1) and IP if static IPs are used

Reboot to use the new name (and IP)

Load a new certificate in Mumble and setup who to talk to

Setup the same information in the intercom setup webgui.