

# Gumstix Bluetooth Guide for Linux

*18–349 Embedded Real-Time Systems*

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# 1 Introduction

## 1.1 Brief Disclaimer

This guide is meant for Linux-based computers. It may or may not work for Mac OSX, and would have to be adapted for Windows. Even though most of the details in this guide are Linux specific, it may still be beneficial to read through it because of the details that are universal to the Bluetooth protocol for all OSes.

## 1.2 A Word on Motivation

Using Bluetooth rather than RS-232 to connect to the gumstix is incredibly valuable and *will* decrease your development time. It will also make your development experience much more pleasant. We highly recommend getting this to work. This guide should make the process relatively straightforward.

## 1.3 Background Information

The Bluetooth protocol is a protocol that supports several different services. One of these services is an Ethernet emulation protocol (called BNEP) layered on top of L2CAP[1]. This protocol will allow you to use SSH/SCP to communicate with your gumstix as if it were a computer on an ethernet network. This local network is referred to as the Personal Area Network (PAN) in Bluetooth literature.

The de facto Bluetooth protocol stack for Linux is called BlueZ, and can be downloaded/compiled from their website [2]. You may also use your favorite package manager to install it. BlueZ contains a suite of binaries for configuring Bluetooth connections. A binary called `pand` (Personal Area Network Daemon) needs to be configured on both gumstix and computer in order for a PAN to be established, which will allow you to SSH into the gumstix like any other computer on an ethernet network. The SSH will go over the `bnep0` interface (as opposed to `eth0`, `wlan0` or similar interfaces). Consult your distribution's documentation and use `ifconfig` to do this. On Debian derivatives such as Ubuntu, you can define your interfaces in the `/etc/network/interfaces` file.

Please note that the `bnep` interface is not created until the two devices (your computer and the gumstix Bluetooth controller) pair and connect over `pand`. Once that happens, `bnep0` will be visible in `ifconfig`. You can now try to ping/SSH to your gumstix. Phrased differently, `bnep0` will not appear in `ifconfig` until the devices are paired. Therefore, if you don't see it there, don't be afraid unless you think your devices have already initiated a connection.

# 2 Configuring Bluetooth

## 2.1 General Configuration Philosophy

There are two well supported and robust ways to connect Bluetooth devices over a PAN. You can setup `pand` to listen for connections on one end of the connection (e.g. gumstix) and specify a MAC address to connect to (e.g. the gumstix' MAC address) at the other end (e.g. computer).

You have to choose one of the following

- the gumstix specifies your computer's MAC address
- your computer specifies the gumstix' MAC address

It works either way, but there are inherent advantages and disadvantages with each method.

The advantage of the first method is that when the gumstix boots, it can initiate the connection and pair with the computer's "listening" `pand` automatically. You simply have to connect to the gumstix as soon as it is booted using SSH or SCP. The disadvantage is that only one computer will be able to easily connect with the gumstix. This is because the gumstix has the MAC address of the computer hardcoded in its Bluetooth configuration file. You may still use different computers if you share the same Bluetooth

dongle amongst them. To connect a computer with a completely different Bluetooth adapter MAC address, relaunch `pand` using a serial connection (ugh!) or use an older Bluetooth connection (probably inconvenient or else you would be using the older computer) to edit the configuration file and/or edit the `pand` config file.

The advantage of specifying the gumstix' MAC address on the computer is the ability for multiple computers to easily connect to one gumstix. The disadvantage of this method is that in order to have a successful connection, `pand` must be run on your computer after the gumstix has finished booting. This equates to restarting the Bluetooth drivers by calling `/etc/init.d/bluetooth restart`. This isn't a big deal, but it does add an extra step during boot time, which can get annoying.

If you plan on using only one machine/dongle to connect to the gumstix and do not foresee that changing, I would personally use method one.

## 2.2 Setting up `pand`

In order to setup `pand`, you have to edit the `/etc/default/bluetooth` file on both the gumstix and your local filesystem. On the gumstix, you already have root privilege. On your computer, you have to have root privileges to write to the file (use `sudo`).

### 2.2.1 Configuration on the Computer

Regardless of whether the computer will serve as listener or initiator, open up `/etc/default/bluetooth` on the computer's file system. Change the line

```
PAND_ENABLE=false
to
PAND_ENABLE=true
```

Occasionally `1/0s` will be there instead of `true/false` on some systems.

If your computer is a listener, change

```
PAND_OPTIONS=""
to
PAND_OPTIONS="--listen -M --role=NAP"
```

If your computer will initiate the connection change

```
PAND_OPTIONS=""
to
PAND_OPTIONS="--connect XX:XX:XX:XX:XX -M --persist"
```

The X's are the gumstix's MAC address determinable by running `hciconfig` on the command line.

### 2.2.2 Configuration on the Gumstix

Again, change file `/etc/default/bluetooth` on the gumstix's file system:

```
PAND_ENABLE=false
to
PAND_ENABLE=true
```

If the gumstix will listen for connection initiations, replace:

```
PAND_OPTIONS=""
with
PAND_OPTIONS="--listen --role=NAP"
```

If the gumstix will initiate connections, replace:

```
PAND_OPTIONS=""  
with  
PAND_OPTIONS="--connect XX:XX:XX:XX:XX:XX --persist"
```

The X's are the computer's MAC address determinable by running `hciconfig` on the command line.

The bottom line is that one `pand` must be configured to initiate a connection and the other to listen for it.

## 2.3 Configuring Interfaces

On your computer, this is quite simple. Paste this into your `/etc/network/interfaces` file located on your personal computer's file system:

```
auto bnep0  
iface bnep0 inet static  
address 172.16.0.1  
netmask 255.255.255.0  
network 172.16.0.0  
broadcast 172.16.0.255  
mode ad-hoc
```

For non-Debian based systems, modify your interface files accordingly.

For the gumstix, add the following to the `/etc/network/interfaces` file located on the gumstix file system:

```
auto bnep0  
iface bnep0 inet static  
address 172.16.0.2  
netmask 255.255.255.0  
network 172.16.0.0  
broadcast 172.16.0.255
```

### 2.3.1 Misc Info

A Bluetooth driver restart on the computer should look more or less like this:

```
%> sudo /etc/init.d/bluetooth restart  
* Restarting bluetooth  
...done.
```

A Bluetooth driver restart on the gumstix should look more or less like this:

```
[root@winterfresh ~]# /etc/init.d/S30bluetooth stop  
Stopping Bluetooth subsystem: pand dund rfcomm hidd sdpd hcid ttyS3.
```

```
[root@winterfresh ~]# /etc/init.d/S30bluetooth start  
Starting 32kHz clock...Settled  
Set (AF1,out,set) via /proc/gpio/GPI012  
Starting Bluetooth subsystem:Trying baud rate 57600...  
Set (GPIO,out,clear) via /proc/gpio/GPI07  
Set (GPIO,out,set) via /proc/gpio/GPI07  
Got response after reset... gobbling  
Error reading response: Success  
Trying baud rate 921600...  
Set (GPIO,out,clear) via /proc/gpio/GPI07  
Set (GPIO,out,set) via /proc/gpio/GPI07
```

```
Got response after reset... gobbling
Detected bluetooth module at 921600 baud
Got: status=0x00, hci_ver=0x03, hci_rev=0x62b9, lmp_ver=0x03,
manuf=0x0009, lmp_subver=0x62b9 ttyS3 hcid sdpd rfcomm
pand --connect 00:15:E9:6A:05:BE --persist
Bluetooth: RFCOMM socket layer initialized
Bluetooth: RFCOMM TTY layer initialized <-- This is a very good sign
Bluetooth: RFCOMM ver 1.8
```

A successful l2ping should look more or less like this:

```
%> sudo l2ping 00:80:37:2E:45:EC
Ping: 00:80:37:2E:45:EC from 00:15:E9:6A:05:BE (data size 44) ...
44 bytes from 00:80:37:2E:45:EC id 0 time 48.51ms
44 bytes from 00:80:37:2E:45:EC id 1 time 50.46ms
44 bytes from 00:80:37:2E:45:EC id 2 time 66.94ms
44 bytes from 00:80:37:2E:45:EC id 3 time 56.98ms
```

A successful hciconfig should look more or less like this:

```
%> hciconfig
hci0: Type: USB
BD Address: 00:15:E9:6A:05:BE ACL MTU: 192:8 SCO MTU: 64:8
UP RUNNING PSCAN ISCAN
RX bytes:8331479 acl:133480 sco:0 events:640705 errors:0
TX bytes:193319944 acl:1008817 sco:0 commands:57 errors:0
```

### 3 Troubleshooting

Remember, it always helps to do `/etc/init.d/bluetooth restart` on the computer and `/etc/init.d/S30bluetooth stop && /etc/init.d/S30bluetooth start` on the gumstix. Do this especially after you made changes to configuration files.

**Q** *bnep0 interface is formed, but I can't ping the gumstix!*

**A** Turn off your firewall. For example run `gksu firestarter&` and then press then "turn off firewall" button, as this firewall is turned on by default on Ubuntu.

**Q** *bnep0 interface doesn't exist anywhere (when I call ifconfig)!*

**A** Make sure that there is an instance of pand running on the host that initiates the connection (runs `-c <MAC ADDRESS>`) by running the command

```
%> ps -C pand
```

If pand is running you should see a line that gives you the PID of pand as well as some other less useful information.

**Q** *Ah, pand isn't running either!*

**A** If pand is not running, first make sure that the your two Bluetooth modules are able to communicate by running:

```
%> l2ping XX:XX:XX:XX:XX:XX
```

using the MAC address of the Bluetooth module that you are pinging.

**Q** *l2ping does not work (packets don't make it through; should be obvious)!*

**A** If `l2ping` does not work, try turning on your Bluetooth module. Occasionally, pressing `Fn+F3` or something similar on some computers activates the Bluetooth hardware if the Bluetooth module is built in. If both Bluetooth modules are on, make sure `HCI` is running.

**Q** *What is the HCI daemon?*

**A** Also make sure that `hcid` (Host Controller Interface daemon) is running. This daemon manages all Bluetooth devices. Hence, if it is not running, nothing will work. Check this by executing

```
%> ps -C hcid
```

In case it is not running try running

```
%> hcid -d
```

This should display some debug data, and run it as well. We recommend that you use `/var/log/messages` and `dmesg` to assist you during any troubleshooting operation.

```
%> tail -f /var/log/messages
```

or

```
%> dmesg | tail
```

Note that this is not the optimal way to run `hcid`. You should now debug the root cause of any other trouble you have. If everything is working fine, kill `hcid` and restart it without the `-d` flag.

**Q** *l2ping actually worked! What now?*

**A** If this works, try running

```
%> pand -c XX:XX:XX:XX:XX:XX
```

and then trying to see if `bnep0` came up. If this produced no effect, then `pand` is still not running. Look into `dmesg` and `/var/log/messages` to see if you're getting trouble.

**Q** *pand is running, and yet, nothing works!*

**A** If `pand` is running but `bnep0` is nowhere to be seen, try manually bringing up the interface with

```
%> ifup bnep0
```

Remember to `sudo` if this command is being run on computer rather than `gumstix`.

**Q** *What the hell! It says the interface is already up!*

**A** Just do `ifdown bnep0` first and then `ifup bnep0` again. Remember to turn off firewalls if you have them.

**Q** *It says "No such interface".*

**A** This means that `pand` is not working for some reason or the other; troubleshoot that first.

## References

- [1] Bluetooth. Bluetooth network encapsulation protocol (bnep) [online]. Available from World Wide Web: <http://bluetooth.com/Bluetooth/Technology/Works/BNEP.htm>.
- [2] BlueZ. Bluez — official linux bluetooth protocol stack [online]. Available from World Wide Web: <http://www.bluez.org/>.