



# FreeSWITCH Setup Document

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## General Comments:

This document is designed to assist with setting up FreeSWITCH 1.4.20 (current production release) to work with Sangoma's Wanpipe drivers and Sangoma's FreeTDM 1.9.0. Visytel accepts no liability for any loss of business or costs incurred by following these instructions. This documentation is aimed at users that are new to Linux and wish to get FreeSWITCH up and running using Sangoma hardware. Please also refer to the Sangoma support wiki for further information and guidance: <http://wiki.sangoma.com/>



## Initial Hardware Setup

{Optional} The first task is to make sure that hardware RAID is used via the RAID controller at boot and that the hard disks are setup in the appropriate RAID configuration. If unsure about this please contact your supplier or consult the associated manuals that came with the hardware. Generally RAID-1 is best for telephony systems.

Once RAID is configured then the Operating System (in this case CentOS 6.6 can be installed).

## CentOS 6.6 Linux root user login

*... Throughout this document there will be instructions like "Login as **root** user", here are the instructions to perform this when logged into the CentOS 6.6 Desktop as a different user. Obviously if connecting via SSH (eg. via Putty) then you would simply login using user: **root** and when prompted enter the root password.*

To login as root user from the CentOS 6.6 Desktop:

1. Go to **Applications->System Tools->Terminal**
2. Type: **su -** <Enter> {this will default to root user}
3. Enter root user password (see point (12) under CentOS 6.6 Installation below) when prompted

## CentOS 6.6 Installation

*... This section may need to be changed slightly since your hardware may come with an operating system installation CD/DVD that assists with setting up an Operating System with the appropriate drivers etc. Please note that CentOS 6.6 is similar to RHEL 6 (ie. Red Hat Enterprise Linux 6) so any drivers targeting RHEL 6 should work following the same instructions on CentOS 6.6.*

The instructions below assume that this is a fresh installation using the CentOS 6.6 DVD only.

1. First download the CentOS 6.6 64-bit ISO image via: <http://wiki.centos.org/Download>
  - a. Under CD and DVD ISO images
  - b. Next to CentOS 6.6 select **x86\_64** (for 64-bit CentOS 6.6)
  - c. Via one of the mirror sites download: **CentOS-6.6-x86\_64-bin-DVD1.iso**
  - d. Then burn ISO image to a data DVD via these instructions (this is for Ubuntu Linux but applies the same for CentOS):  
<http://www.ubuntu.com/download/desktop/burn-a-dvd-on-windows>
    - i. Note: Visytel used a DVD-R 4.7GB DVD media
2. Insert the CentOS 6.6 64-bit DVD (just created from the ISO image explained in point (1)) and boot to this when powering on the server.
3. When prompted: **Skip** media test
4. Next>
5. **English (English)**
6. Keyboard: {select the appropriate keyboard for the UK select **United Kingdom**}
7. **Basic storage devices**



8. You may be prompted to select a **Fresh Installation** {if there was data already on the hard disks, if this was the case then please select Fresh Installation}
9. Storage Device Warning: **Yes, discard any data**
10. Hostname: **freeswitch01.centos**
  - a. Obviously each FreeSWITCH server you can then increment the last two digits
    - i. Eg. The second FreeSWITCH server will be freeswitch02.centos and so on
  - b. Currently the domain is centos (you can change this to your domain)
11. Set the locale (eg. For the UK: **London, Europe** (system clock uses UTC))
12. Root password: **<You need to generate this and document it>**
13. **Use All Space**
14. Warning message: select: **Write changes to disk**
15. Select **Software Development Workstation** {customise later}
16. Installation will now progress...
17. Reboot when prompted
18. Forward
19. Yes, I agree to the License Agreement – Forward>
20. Enter Username: **sangoma**
21. Full Name: **Sangoma**
22. Password: **<You need to generate this and document it>**
23. Forward>
24. Tick Synchronise date and time over the network
25. Forward>
26. Finish
27. Yes when prompted to reboot to activate Kdump
28. Login as **sangoma**
29. You should notice an (x) next to the Network icon on the top tool bar
  - a. To setup the Network side open **System->Preferences->Network Connection**
  - b. Select Wired **System eth0** and press the Edit... button
  - c. Tick **Connect automatically**
  - d. Under **IPv4 Settings** tab
    - i. Add Address, Netmask & Gateway
    - ii. Add DNS Server(s) (using a ',' to separate them)
  - e. Press **Apply** and enter the root user password (see point (12)) and press **Authenticate**
  - f. Tested via Mozilla Firefox web browser (by clicking on the icon on the top toolbar next to System) and the internet connection should be OK – the (x) should have gone next to the Network icon on the top tool bar



30. Run all system updates:
  - a. Login as **root** user
  - b. Typed: **yum update** <Enter> {this is similar to Windows Updates!}
  - c. Press **y** when prompted
  - d. Press **y** when prompted
  - e. Wait for all the updates to complete...
31. Click on the Date/Time on the top toolbar next to **Sangoma**
  - a. **Edit** locations
  - b. Remove the location if it is not currently correct
  - c. Press **Add**
  - d. Type location name: (for the UK: **London, East and South East England, United Kingdom**)
  - e. Press OK
  - f. Under the **General tab** and **Weather tab** update the formatting to suite your location (eg. 24 hour clock format and C instead of F for the temperature unit)
  - g. Press Close
  - h. Click on the Date/Time on the top toolbar next to **Sangoma** to close the window
32. Install Fedora EPEL library support:
  - a. Open Mozilla Firefox web browser (by clicking on the icon on the top toolbar next to System)
  - b. Open link: [http://download.fedoraproject.org/pub/epel/6/x86\\_64/epel-release-6-8.noarch.rpm](http://download.fedoraproject.org/pub/epel/6/x86_64/epel-release-6-8.noarch.rpm)
  - c. Select Open with **Package Installer (default)**
  - d. Press OK
  - e. Press Install
  - f. Enter root password when prompted
  - g. Complete install
33. Install Remote Desktop Access via XRDP (optional):
  - a. Login as **root** user
  - b. Type: **yum install xrdp -y**
  - c. Wait for installation to complete
  - d. Type: **chkconfig --levels 5 xrdp on**
  - e. Type: **service xrdp start**
  - f. Close the Terminal
  - g. Open TCP Port 3389 on the firewall:
    - i. Open **System->Administration->Firewall**
    - ii. Press Close (enter root user password and press Authenticate)
    - iii. Select **Other Ports** and press **Add**
    - iv. Add **3389 tcp ms-wbt-server**
    - v. Press **Apply** and press **Yes**
    - vi. Close Firewall Administrator
  - h. Logout by press **Sangoma** on the top toolbar and selecting **Quit** and press **Log Out**
  - i. Now connect via Windows Remote Desktop Connection logging in as user **sangoma** (using the password set at point (22)) – you should be able to save your credentials.



## Sangoma Hardware Drivers Installation

... This section can be done with or without the Sangoma A104DE card installed.

The instructions below assume that CentOS 6.6 has been setup as per the CentOS 6.6 Installation instructions above and CentOS is booted up and the **sangoma** user is logged in.

### Install Sangoma Wanpipe drivers:

1. Login as **root** user
2. **cd /usr/local/src**
3. **wget [ftp://ftp.sangoma.com/linux/current\\_wanpipe/wanpipe-current.tgz](ftp://ftp.sangoma.com/linux/current_wanpipe/wanpipe-current.tgz)**
4. **tar xzf wanpipe-current.tgz**
5. **cd wanpipe-7.0.14** {this is the current version of the wanpipe drivers}
6. **yum -y install kernel-devel-\$(uname -r) libtool\* make gcc patch perl bison gcc-c++ ncurses-devel flex flex-devel libtermcap-devel autoconf\* automake\* autoconf**
7. **make freetdm**
8. **make install**
9. If Sangoma A104DE hardware installed:
  - a. **wanrouter hwprobe** {output should similar to what is shown below}

```
-----  
| Wanpipe Hardware Probe Info |  
-----  
1 . AFT-A104-SH : SLOT=4 : BUS=4 : IRQ=7 : CPU=A : PORT=1 : HWEC=128 : V=45  
2 . AFT-A104-SH : SLOT=4 : BUS=4 : IRQ=7 : CPU=A : PORT=2 : HWEC=128 : V=45  
3 . AFT-A104-SH : SLOT=4 : BUS=4 : IRQ=7 : CPU=A : PORT=3 : HWEC=128 : V=45  
4 . AFT-A104-SH : SLOT=4 : BUS=4 : IRQ=7 : CPU=A : PORT=4 : HWEC=128 : V=45  
  
Sangoma Card Count: A104=1
```

### Next install the PRI ISDN library:

1. **cd /usr/local/src**
2. **wget [ftp://ftp.sangoma.com/linux/libsng\\_isdn/libsng\\_isdn-current.x86\\_64.tgz](ftp://ftp.sangoma.com/linux/libsng_isdn/libsng_isdn-current.x86_64.tgz)**
3. **tar xzf libsng\_isdn-current.x86\_64.tgz**
4. **cd libsng\_isdn-8.3.0.x86\_64** {this is the current version of the ISDN library}
5. **make install**
6. Close the Terminal (Type exit <Enter> twice or press X and press Close Terminal)



## FreeSWITCH Installation

*... This section covers the basic vanilla FreeSWITCH installation*

The instructions below assume that CentOS 6.6 has been setup as per the CentOS 6.6 Installation instructions above and the Sangoma hardware drivers have been installed.

Install FreeSWITCH source code and extra system requirements:

1. Login as **root** user
2. **cd /usr/local/src**
3. **git clone -b v1.4 <https://freeswitch.org/stash/scm/fs/freeswitch.git>**
  - a. This downloads the current production release of FreeSWITCH to **/usr/local/src/freeswitch**
4. **yum install git gcc-c++ autoconf automake libtool wget python ncurses-devel zlib-devel libjpeg-devel openssl-devel e2fsprogs-devel sqlite-devel libcurl-devel pcre-devel speex-devel ldns-devel libedit-devel libxml2-devel**
  - a. This installs all the required prerequisites for FreeSWITCH to build successfully
  - b. Note: libxml2-devel was added to the list due to freetdm requirements

Install Sangoma FreeTDM updates from Visytel:

1. **cd /usr/local/src**
2. **wget <ftp://ftp.visytel.com/sangoma/visytel-freetdm-1.9.0.tar.gz>**
3. **tar xvzf visytel-freetdm-1.9.0.tar.gz**
4. **cd /usr/local/src/freeswitch/libs**
5. **rm -rf freetdm**
6. **cd /usr/local/src**
7. **\cp -rf /usr/local/src/visytel-freetdm-1.9.0/freeswitch /usr/local/src**

Prepare FreeSWITCH for make process:

1. **cd /usr/local/src/freeswitch**
2. **./bootstrap.sh**
3. **vi modules.conf** {see **Handy Linux Commands** section for vi editing tips}
  - a. Scroll to near the bottom
  - b. Uncomment the following line (remove the '#' at the front):  

```
#../libs/freetdm/mod_freetdm
```

Becomes:  

```
../libs/freetdm/mod_freetdm
```
  - c. Save and exit (**<Esc> :wq!**)
4. **./configure**

Make and install FreeSWITCH:

1. **cd /usr/local/src/freeswitch**
2. **make && make install**
  - a. Disregard WARNINGS for ftmod\_\*.so at the very end



Install FreeSWITCH sound files and music on hold sound files:

1. **cd /usr/local/src/freeswitch**
2. **make cd-sounds-install**
3. **make cd-moh-install**

Update FreeSWITCH default password setting:

1. **cd /usr/local/freeswitch/conf**
2. **vi vars.xml** {see **Handy Linux Commands** section for vi editing tips}
  - a. Change the default\_password from 1234 to a new password inside the line:  
`<X-PRE-PROCESS cmd="set" data="default_password=1234"/>`
  - b. Save and close (**<Esc> :wq!**)

Open both TCP and UDP ports 5060 inside the CentOS firewall:

1. From the top menu bar select **System->Administration->Firewall**
2. Press **Close**
3. Enter the **root password** and press **Authenticate**
4. Select **Other Ports** and **Add**
5. Scroll down to **Port 5060** and select the **tcp** sip Service and press OK
6. Press **Add** once more and select **Port 5060** and select the **udp** sip Service and press OK
7. Press the **Apply** tick
8. Press **Yes**
9. Close the Firewall Configuration application

Test starting FreeSWITCH:

1. **cd /usr/local/freeswitch/bin**
2. **./freeswitch -nonat -nonatmap**
3. **version**
  - a. This should show something like:

FreeSWITCH **Version 1.4.20**+git~20150703T164215Z~b95362f965~64bit (git b95362f 2015-07-03 16:42:15Z 64bit)

4. **status**
  - a. This should show something like:

UP 0 years, 0 days, 0 hours, 2 minutes, 53 seconds, 564 milliseconds, 914 microseconds  
FreeSWITCH (Version 1.4.20 git b95362f 2015-07-03 16:42:15Z 64bit) is ready  
0 session(s) since startup  
0 session(s) - peak 0, last 5min 0  
0 session(s) per Sec out of max 30, peak 0, last 5min 0  
1000 session(s) max  
min idle cpu 0.00/99.47  
Current Stack Size/Max 240K/8192K

5. ... {ie. three dots followed by **<Enter>** - this will exit from FreeSWITCH}



## SAMBA Installation and Configuration

*... This section covers setting up SAMBA and the freeswitch share*

The instructions below assume that everything above has been done successfully.

Note: The purpose of the SAMBA **freeswitch** share (/usr/local/freeswitch) is to enable Windows PCs to be able to access the freeswitch files. This will enable easy audio and service loading. Perhaps the aim will be to lock down the directories inside /usr/local/freeswitch to their own shares to improve further the security level, however initially the simple freeswitch share will be fine.

Open SAMBA ports inside the CentOS firewall:

1. From the top menu bar select **System->Administration->Firewall**
2. Press **Close**
3. Enter the **root password** and press **Authenticate**
4. Select from **Trusted Services** and tick the following:
  - a. **Samba**
  - b. **Samba Client**
5. Press the **Apply** tick
6. Press **Yes**
7. Close the Firewall Configuration application

Setup SAMBA server on CentOS:

1. Login as **root** user
2. **yum install samba samba-client samba-common**
3. Type **y** when prompted
4. **smbpasswd -a sangoma**
5. Enter the password for user **sangoma** twice as entered under CentOS 6.6 Installation point (22)
6. **groupadd smbgrp**
7. **usermod -a -G smbgrp sangoma**
8. **cd /usr/local**
9. **chown -R sangoma:smbgrp freeswitch/**
10. **chmod -R 0770 freeswitch/**





11. **vi /etc/samba/smb.conf** {see **Handy Linux Commands** section for vi editing tips}
  - a. Make the following changes (this is for a simple Windows WORKGROUP):
    - i. **workgroup = WORKGROUP**
    - ii. uncomment **netbios name =**
    - iii. and set **netbios name = FREESWITCH01**
    - iv. comment out everything under **[homes]** and also comment out **[homes]**
    - v. comment out everything under **[printers]** and also comment out **[printers]**
    - vi. **Add:**

```
[freeswitchshare]
comment = Freeswitch
path = /usr/local/freeswitch
guest ok = no
writable = yes
browsable = yes
valid users = @smbgrp
```
12. **Save and Close (<Esc> :wq!)**
13. **service smb start** {if not already started} or **service smb restart**
14. **service nmb start** {if not already started} or **service nmb restart**
15. **chkconfig smb on**
16. **chkconfig nmb on**
17. **chcon -t samba\_share\_t -R /usr/local/freeswitch/**
  - b. This allows access through SELINUX without disabling SELINUX
18. You should now be able to browse to the **freeswitch** share from a Windows PC (using the WORKGROUP domain) and login using user **sangoma** with the password as entered under CentOS 6.6 Installation point (22)

Windows Domain Notes for SAMBA:

... This link is a good place to start: <https://www.samba.org/>



## FreeSWITCH Configuration Notes

*... This section covers the management and configuration of the FreeSWITCH installation*

Setup FreeSWITCH to auto-start when CentOS is booted:

1. Login as **root** user
2. **cd /etc/rc.d/init.d**
3. **wget <ftp://ftp.visytel.com/sangoma/freeswitch>**
4. **chmod 0750 freeswitch**
5. **chkconfig --add freeswitch && chkconfig --levels 35 freeswitch on**
6. **service freeswitch start**

How to manage FreeSWITCH service:

1. Login as **root** user
2. To check the status of the FreeSWITCH service:  
**service freeswitch status**
3. To stop the FreeSWITCH service:  
**service freeswitch stop**
4. To start the FreeSWITCH service:  
**service freeswitch start**

Turn off **ipv6** support:

1. Login as **root** user
2. **service freeswitch stop**
3. **cd /usr/local/freeswitch/conf/sip\_profiles**
4. **mv internal-ipv6.xml internal-ipv6.xml.removed**
5. **mv external-ipv6.xml external-ipv6.xml.removed**
6. **service freeswitch start**

Configure **irqbalance** service to start when CentOS is booted:

1. Login as **root** user
2. **service freeswitch stop**
3. **wanrouter stop**
4. **cd /etc/rc.d/init.d**
5. **chkconfig --add irqbalance && chkconfig --levels 35 irqbalance on**
6. **service irqbalance start**
7. **wanrouter start**
8. **service freeswitch start**



Configure Sangoma to work with FreeSWITCH:

1. Login as **root** user
2. **service freeswitch stop**
3. **wanrouter stop**
4. **wancfg\_fs**
  - a. **<Enter>** {default: NO (change the FreeSWITCH path)}
  - b. **2 <Enter>** {for E1}
  - c. **<Enter>** {default: YES (line coding: HDB3, framing: CRC4)}
  - d. **1 <Enter>** {for NORMAL clock}
  - e. **1 <Enter>** {for EuroISDN/ETSI}
  - f. **1 <Enter>** {for PRI CPE}
  - g. **1 <Enter>** {for default dialplan context}
  - h. **1 <Enter>** {for dialing group 1}
  - i. **<Enter>** {default: YES (enable hardware DTMF detection)}
  - j. **<Enter>** {default: NO (enable hardware fax detection)}
  - k. **<Enter>**
  - l. ... Then simply continue to press **<Enter>** to setup the other 3 E1 ports
  - m. ... Press **<Enter>** when prompted under Configuring ISDN BRI cards
  - n. ... Press **<Enter>** when prompted under Configuring GSM cards
  - o. **1 <Enter>** {to Continue}
  - p. **1 <Enter>** {to Save cfg: Stop Wanpipe now}
  - q. **1 <Enter>** {to start wanrouter on system boot}
5. **cd /usr/local**
6. **chown -R sangoma:smbgrp freeswitch/**
7. **chmod -R 0770 freeswitch/**
8. **wanrouter start**
9. **Change /usr/local/freeswitch/conf/autoload\_configs/modules.conf.xml**
  - a. Uncomment out the following line:
    - i. From: **<!-- <load module="mod\_freetdm"/> -->**
    - ii. To: **<load module="mod\_freetdm"/>**
10. **service freeswitch start**



## Sangoma Testing and Debugging

*... This section is based on the Sangoma Support Wiki and forms the basis for what Sangoma support engineers do first. Hence by doing this prior to contacting Sangoma support then the support process would be much faster. These notes are based on a single Sangoma A104DE card installed, however can be modified for other types of Sangoma hardware.*

### File locations:

- Sangoma configuration files (created when wancfg\_fs is run) are stored inside: **/etc/wanpipe/wan\***
  - See inside the file **/etc/wanpipe/wanrouter.rc** for further file location paths
- Sangoma live files when wanrouter starts: **/dev/wan\***
- Useful scripts are located inside **/etc/wanpipe/scripts**
  - For example:
    - `cd /etc/wanpipe/scripts`
    - `./perf.sh w1g1`
    - `<Ctrl>+C` to exit

### Sangoma testing and debugging process:

1. Login as **root** user
2. **wanrouter version**
  - a. This gives the wanpipe release – in this case 7.0.14
3. **wanrouter status**
  - a. Check for Status “Connected” on all wanpipe ports, if it is showing as “Disconnected” then there is no need to run any further tests since either the ISDN cables are not connected or the ISDN link is DOWN.
  - b. You may need to run this more than once in order to see if the Status is switching from status “Disconnected” to “Connected”. Should it be switching back and forth then this could indicate a clocking issue.
4. **wanpipemon -p aft**
  - a. This lists all the possible commands/switches available with some examples
5. **wanpipemon -i w<x>g1 -c Ta** {where <x> is 1, 2, 3 or 4}
  - a. This should show no E1 Rx Alarms (Framer) - all should be OFF
  - b. For the E1 Rx Alarms (LIU) – all should be OFF, however Open Circuit may be ON {this can be disregarded if Rx Level: > -2.5db}
  - c. For the E1 Tx Alarms – all should be OFF
  - d. The E1 Performance monitoring counters should stay constant and not be counting up
  - e. The Rx Level should be -2.5db if all is OK
  - f. See: <http://wiki.sangoma.com/Wanpipemon-T1-E1-physical-Line-alarms>
  - g. Could run this using watch:
    - i. **watch -d -n 0.5 wanpipemon -i w<x>g1 -c Ta** {where <x> is 1, 2, 3 or 4}
    - ii. Performance Monitoring Counters should not be increasing otherwise there is an issue
    - iii. `<Ctrl>+C` to exit



6. **watch -d -n 0.5 ifconfig w<x>g1** {where <x> is 1, 2, 3 or 4}
  - a. Errors, Dropped, Overruns should not be increasing otherwise there is an issue
  - b. <Ctrl>+C to exit
7. Handy tracing of the ISDN protocol: <http://wiki.sangoma.com/wanpipe-wireshark-pcap-pri-bri-wan-t1-e1-tracing>



## FreeSWITCH upgrade to new version:

*... This section covers how to upgrade to a new production release of FreeSWITCH*

The instructions below assume that FreeSWITCH is already running. Prior to any upgrade Visytel should be contacted in advance ([support@visytel.com](mailto:support@visytel.com)) to make sure that the FreeTDM components are also ready and match the FreeSWITCH upgraded version.

### Upgrade process:

1. Login as **root** user
2. **cd /usr/local/src**
3. **mv freeswitch freeswitch-YYYYMMDD** {create a backup}
  - a. Where YYYY = Year ; MM – Month ; DD – Day
4. **git clone -b v1.4** <https://freeswitch.org/stash/scm/fs/freeswitch.git>
  - a. This downloads the current production release of FreeSWITCH to **/usr/local/src/freeswitch**
5. **rm -rf visytel-freetdm-1.9.0**
6. **mv visytel-freetdm-1.9.0.tar.gz visytel-freetdm-1.9.0.tar.gz-YYYYMMDD** {create a backup}
  - a. Where YYYY = Year ; MM – Month ; DD – Day
7. **wget** <ftp://ftp.visytel.com/sangoma/visytel-freetdm-1.9.0.tar.gz>
8. **tar xvf visytel-freetdm-1.9.0.tar.gz**
9. **cd /usr/local/src/freeswitch/libs**
10. **rm -rf freetdm**
11. **cd /usr/local/src**
12. **\cp -rf /usr/local/src/visytel-freetdm-1.9.0/freeswitch /usr/local/src**
13. **cd /usr/local/src/freeswitch**
14. **./bootstrap.sh**
15. **vi modules.conf** {see **Handy Linux Commands** section for vi editing tips}
  - a. Scroll to near the bottom
  - b. Uncomment the following line (remove the '#' at the front):  

~~#../libs/freetdm/mod\_freetdm~~

Becomes:  

../libs/freetdm/mod\_freetdm
  - c. Save and exit (**<Esc> :wq!**)
16. **./configure**
17. **make**
18. At this point the running version of FreeSWITCH will be stopped
19. **service freeswitch stop**
20. **wanrouter stop**
21. **make install**
22. **cd /usr/local**
23. **chown -R sangoma:smbgrp freeswitch/**
24. **chmod -R 0770 freeswitch/**
25. **wanrouter start**
26. **service freeswitch start**
27. The upgrade is now complete and FreeSWITCH should be taking calls again



## Handy Linux Commands

... This section just lists some Linux terminal commands that are handy to know

- List the current directory and permissions for files
  - **ls -l**
- List the current directory and permissions for all files (including files starting with ".")
  - **ls -la**
- Archive a directory tree:
  - From the directory above the directory tree that you wish to archive
  - **tar cvzf archivename.tar.gz directoryname**
- To extract the archive you would use:
  - **tar xvzf archivename.tar.gz**
- Remove directory tree (no prompting):
  - From the directory above the directory tree that you wish to remove
  - **rm -rf directoryname**
- Rename a file (simply move the file):
  - **mv oldfilename newfilename**
- To create an empty file (or update the file date/time to the current date/time (if it exists)):
  - **touch filename**
- Edit a text file:
  - **vim textfilename** {or **vi textfilename** if vim is not installed}
    - Basic commands:
      - **i** – Insert at cursor position {<Esc> to exit insert mode}
      - **:q!** – Quit without save
      - **:wq!** – Save and quit
    - Extra commands see: <http://bullium.com/support/vim.html>
- Monitor system performance:
  - **top**
    - While inside top the following commands are handy:
      - **1** - to display all the CPUs
      - **k** – to kill a process by entering the PID
      - **h** - to display help
      - **q** to exit
- Monitor CPU performance:
  - **mpstat -P ALL**
- List interrupts (should show interrupts shared between CPUs):
  - **cat /proc/interrupts**
- Get help on a particular linux command
  - **man commandname** {eg. man top}
  - <Enter> to scroll
  - **q** to exit
- To kill all stopped jobs (type: **jobs <Enter>** to list all the stopped jobs):
  - **kill -9 `jobs -p`**
- If copying a folder from Windows to Linux then normally you need to run:
  - **chmod -R 0755 directoryname**