Design and Development Group

SOFTWARE DEVELOPMENT KIT v6.1 - NIMBUS

	Software Development Kit v6.1 - NIMBUS		
			A4

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I. Introduction

A. Objective

IONICS have compiled this Software Development Kit in the hopes that it would provide significant help to the user as he/she tries to familiarize himself/herself with the PlugComputer. The package contains source codes, configuration files, binary images, and relevant documentation that will help the user establish an environment for software customization.

B. Disc Contents

- Documentation
- Tools
- Binaries
- Source Codes

II. Setting-up the Host Computers

A. Tools

- GCC compiler - includes front ends for C, C++, Objective C, Fortran, Java, Ada and Go as well as libraries for these languages (libstdc++,libgcj,…). GCC was originally written as the compiler for the GNU operating system. The GNU system was developed to be 100% free software.
- Minicom – is a simple text-based modem control and terminal emulation program for Unix-like operating systems
- Network File System (NFS) – is a protocol originally developed by Sun Microsystems in 1984, allowing a user on a client computer to access files over a network in a manner similar to how local storage is accessed.
- Trivial File Transfer Protocol (TFTP) – is a file transfer protocol known for its simplicity. It is generally used for automated transfer of configuration or boot files between machines in a local environment.
- TeraTerm - is one of the serial communication applications for Windows which you can use to communicate with your PlugComputer after installing the required FTDI (usb-to-serial) device driver

B. Preparation

> Note: ***P****lease be aware that most of the activities that shall be performed on the Linux host require "root privileges". Though this could be easily done, the developer should take precaution since he/she may accidentally modify the system files which could lead to unwanted problems.*

❖ Installing Arm Compiler

- This should be installed in the developer's Linux Host Computer if he/she is planning to compile his/her own binaries.
- Copy the GCC compiler tarball "gcc.tar.bz2" from the DISC (/TOOLS.zip) and put it to the "(/home)" directory of your Linux Host. Decompress the tarball by issuing the following commands.

```
# cd /home
# tar -xvjpf gcc.tar.bz2
```

❖ Installing the USB-to-Serial Chip Driver for Linux

- Connect the mini-USB cable to the plugcomputer and connect it to the Linux Host Computer's USB port.
- Power-up the plugcomputer and issue "dmesg" on the terminal console

```
# dmesg
```

```
Usb 5-2: new full speed USB device using uhci_hcd and address 4
usb 5-2: configuration #1 chosen from 1 choice
ftdi_sio 5-2:1.0: FTDI USB Serial Device converter detected
usb 5-2: Detected FT2232C
usb 5-2: FTDI USB Serial Device converter now attached to ttyUSB0
ftdi_sio 5-2:1.1: FTDI USB Serial Device converter detected
usb 5-2: Detected FT2232C
usb 5-2: FTDI USB Serial Device converter now attached to
ttyUSB0
```

- Note: Some Linux Distributions like Ubuntu 10.10 Desktop edition already has built-in drivers for FTDI.
- If you need to manually install the FTDI driver, proceed with the instructions below:

- Copy the driver "ftdi_sio.tar.gz" from the SDK DISC (/TOOLS.zip) and put it to the "(/home/)" directory of your Linux PC Host
- Decompress the file tarball by issuing the following commands.

```
# cd /home/
# tar -xvzpf ftdi_sio.tar.gz
```

- Go to the directory created <ftdi_sio> and issue the commands

```
# cd ftdi_sio
# make
```

- Connect the Plugcomputer to the Linux PC Host using the mini-USB cable.
- Power-up the PlugComputer and check whether the device is recognized.

It should be able to see the following information after issuing the command below.

```
# dmesg
```

```
Usb 5-2: new full speed USB device using uhci_hcd and address 4
usb 5-2: configuration #1 chosen from 1 choice
ftdi_sio 5-2:1.0: FTDI USB Serial Device converter detected
usb 5-2: Detected FT2232C
usb 5-2: FTDI USB Serial Device converter now attached to ttyUSB0
ftdi_sio 5-2:1.1: FTDI USB Serial Device converter detected
usb 5-2: Detected FT2232C
usb 5-2: FTDI USB Serial Device converter now attached to
ttyUSB0
```

- If the information above were not shown, add the USB device ID of the IONICS JTAG module (vendor=0x1c0c; product=0x0102) by issuing the command

```
# modprobe ftdi_sio vendor=0x1c0c product=0x0102
```

- Reconnect the USB cable of the JTAG to the Linux host and check whether the device is detected using the "dmesg" command.

- Make a shortcut for this method by creating a file named "ftdi_sio" at the "/etc/modprobe.d/" directory:

```
# vi /etc/modprobe.d/ftdi_sio
```

- Write the following to the file:

```
# options ftdi_sio vendor=0x1c0c product=0x0102
```

- Issue the command after every host reboot:

```
# modprobe ftdi_sio
```

❖ **Installing Minicom**

- Install minicom from linux repository by issuing the command

```
# apt-get install minicom
```

- Configure minicom after installation

```
# minicom –s
```

- Select "Serial Port Setup" from the menu and ensure that the following settings are loaded:

Serial Device	=	/dev/ttyUSB0
Bps/Par/Bits	=	115200 8N1
HW Flow Ctrl	=	No
SW Flow Ctrl	=	No

- Select "Save setup as dfl" and "Exit", the developer should be able to see the serial console output after doing so. (Note: the developer may need to check the serial device location by issuing "dmesg" to your command line upon connecting the JTAG. Replace the "Serial Device" value accordingly.)

❖ **Additional tools for Compiling**

- Copy the "mkimage" binary from the DISC (/TOOLS.zip) and put it to the "(/usr/bin)" directory of your Linux PC Host.

- Some Linux distros don't have the curses.h header installed by default which is needed in making configuration menus. Install curses.h by typing the command:

```
# apt-get install libncurses5-dev
```

❖ **Installing NFS and TFTP Server on your Linux Host**

The following procedure will enable you to boot your plugcomputer via network connection. This is essential if you are planning to recompile your own filesystem binary for the plug.

- Setting-up the Network File System (NFS) Server.

  ✓ Install the NFS through apt-get.

```
# apt -get install nfs-kernel-server nfs-common portmap
```

  ✓ Make a directory named i.e. "/home/myFilesystem".

```
# mkdir /home/myFilesystem
```

  ✓ Copy the filesystem tarball from the DISC (/FILESYSTEM/SOURCE /rootfs.tar.gz) that will be used for the NFS boot and put it to the "/home/myFilesystem" directory in your Linux PC Host.

  ✓ Decompress the rootfilesystem.

```
# cd /home/myFilesystem
# tar –xvzf rootfs.tar.gz
# rm rootfs.tar.gz
```

✓ Open the "/etc/exports" file.

```
# vi /etc/exports
```

✓ Add the following lines to the "exports" file.

```
/home/myFilesystem/ * (rw, no_root_squash)
/tftpboot/ *(rw, no_root_squash)
```

✓ Activate the changes on "/etc/exports" by issuing the command:

```
# /etc/init.d/nfs-kernel-server restart
```

✓ Open the "/etc/network/interfaces" file.

```
# vi /etc/network/interfaces
```

✓ Edit and add a static IP address value:

```
iface eth0 inet static
address 192.168.0.3
netmask 255.255.255.0
gateway 192.168.0.1
```

➢ Setting-up the Trivial File Transfer Protocol (TFTP) Server

This should be installed if the developer is planning to boot the PlugComputer over the network.

✓ Install the xinetd, tftpd, and tftp packages through apt-get

```
# apt-get install xinetd tftpd tftp
```

✓ Create file "/etc/xinetd.d/tftp" and put the following:

```
# vi /etc/xinet.d/tftp
```

```
service tftp
{
      protocol          = udp
      socket_type       = dgram
      wait              = yes
      user              = nobody
      server            = /usr/sbin/in.tftpd
      server_args       = -s /tftpboot
      disable           = no
}
```

✓ Make a directory named "/tftpboot" at your Linux PC Host and change the permission and owner of the directory:

```
# mkdir /tftpboot
# chmod –R 777 /tftpboot
# chown –R nobody /tftpboot
```

✓ You may start the tftp through xinetd by issuing the command.

```
# /etc/init.d/xinetd restart
```

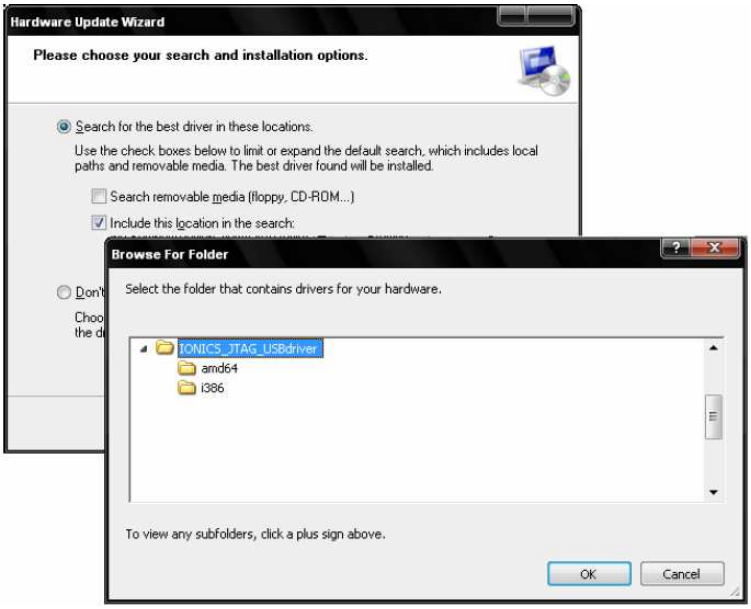
III. Preparing your Windows Host

Note: *The following instructions will prepare your Window's host in order to establish a serial communication with the PlugComputer.*

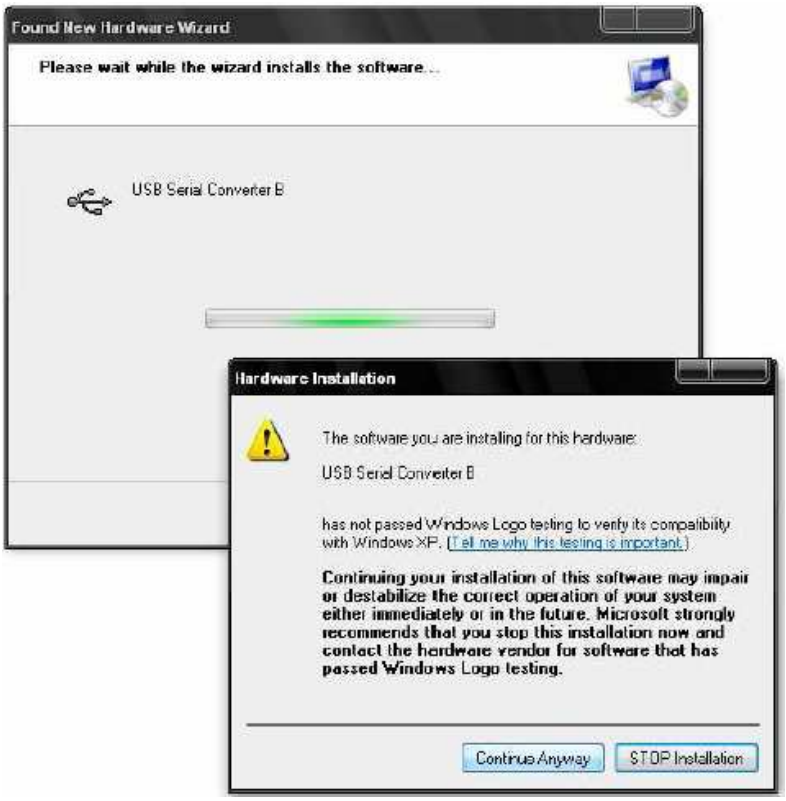
A. Installing the USB serial driver for Windows

- Copy the "IONICS_JTAG_USBdriver.zip" from the DISC (/TOOLS.zip) to your Windows host.
- Unzip the file
- Connect the PlugComputer into the Windows host using the mini USB cable
- Power-up the PlugComputer.
- Please refer to the instructions below on how to install the driver.

- Install the new hardware by using the Hardware Wizard.
- Select "**Install from a list or specific location**" and click next.



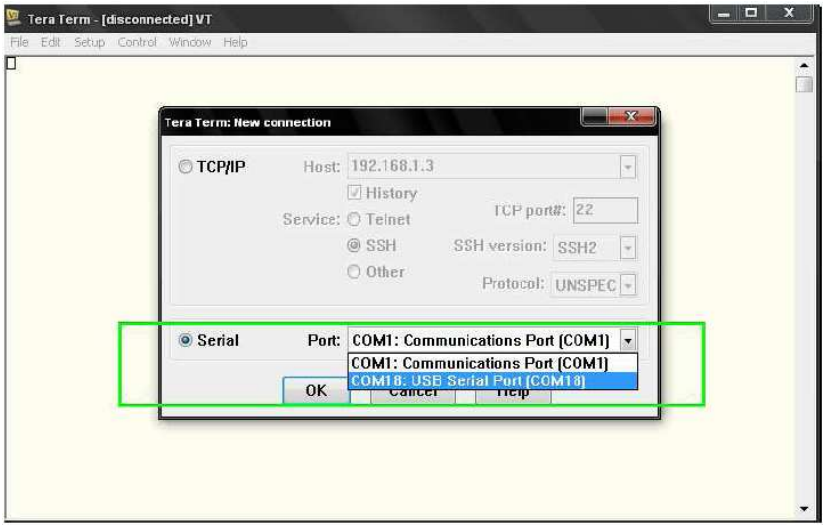
- Browse your windows host to locate the directory "IONICS_JTAG_USBdriver" and click **OK**.



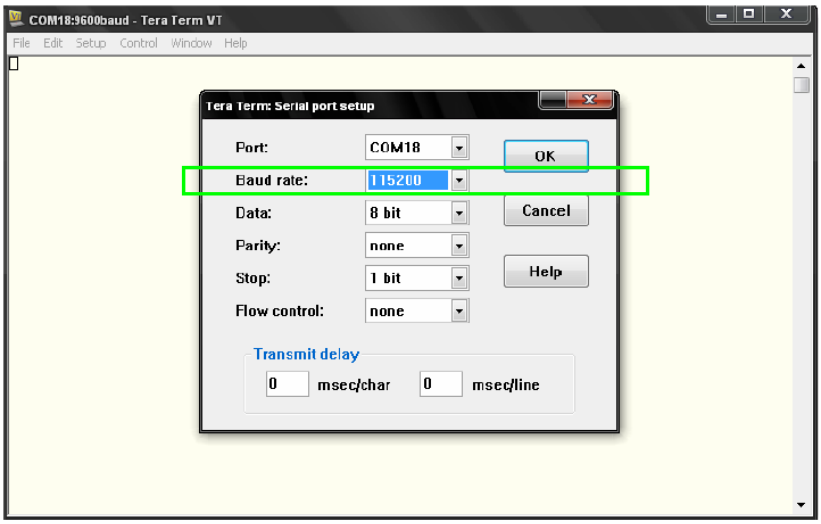
- Continue the installation when the prompt box appears.
- Repeat the installation procedure for **USB Serial Converter A**
- Repeat the installation procedure for **USB Serial Port**.

B. Installing and configuring Tera Term

- Copy the “teraterm-4.60.exe” from the DISC (/TOOLS.zip) to your Windows host
- Install TeraTerm
- After installation, attach the PlugComputer to your Windows host and run TeraTerm
- Configure the terminal by following the instructions below:



- Open TeraTerm and select “**Serial**” connection
- Select the **USB Serial Port**



- Go to **Setup->Serial Port** and configure the baud rate to 115200.
- Click **OK** and you should be able to see the logs generated by the plugcomputer.

IV. Uboot

A. Uboot introduction

Is a universal boot loader for embedded boards based on PowerPC, ARM, MIP and several other processors, which can be installed in a boot ROM and used to initialize and test the hardware or to download and run OS and applications.

B. Preparation

- Make a working directory at your Linux Host:

```
# mkdir /home/uboot
```

- Copy u-boot source from the DISC (/BOOTLOADER/SOURCE/u-boot-marvell tar.bz2) into your Linux PC Host or download the source code from DENX

http://git.denx.de/?p=u-boot/u-boot-marvell.git;a=summary

- Untar the u-boot source:

```
# cd /home/uboot
# tar xvjf u-boot-marvell.tar.bz2
```

- Copy and execute the uboot patch file from the DISC (/BOOTLOADER/PATCH/IONICS-NIME0-uboot.patch) into the u-boot source directory to update the codes to contain IONICS configurations.

- Check patch file before replacing:

```
# cd /home/uboot/ub-boot-marvell
# patch –p1 --dry-run < IONICS-NIME0-uboot.patch
```

- Execute patch by issuing:

```
# patch –p1 < IONICS-NIME0-uboot.patch
```

C. Compiling the image

- Build the u-boot image:

```
# make clean
# make mrproper
# make sheevaplug_config
# make -s u-boot.kwb ARCH=arm
CROSS_COMPILE=/home/gcc/bin/arm-none-linux-gnueabi-
```

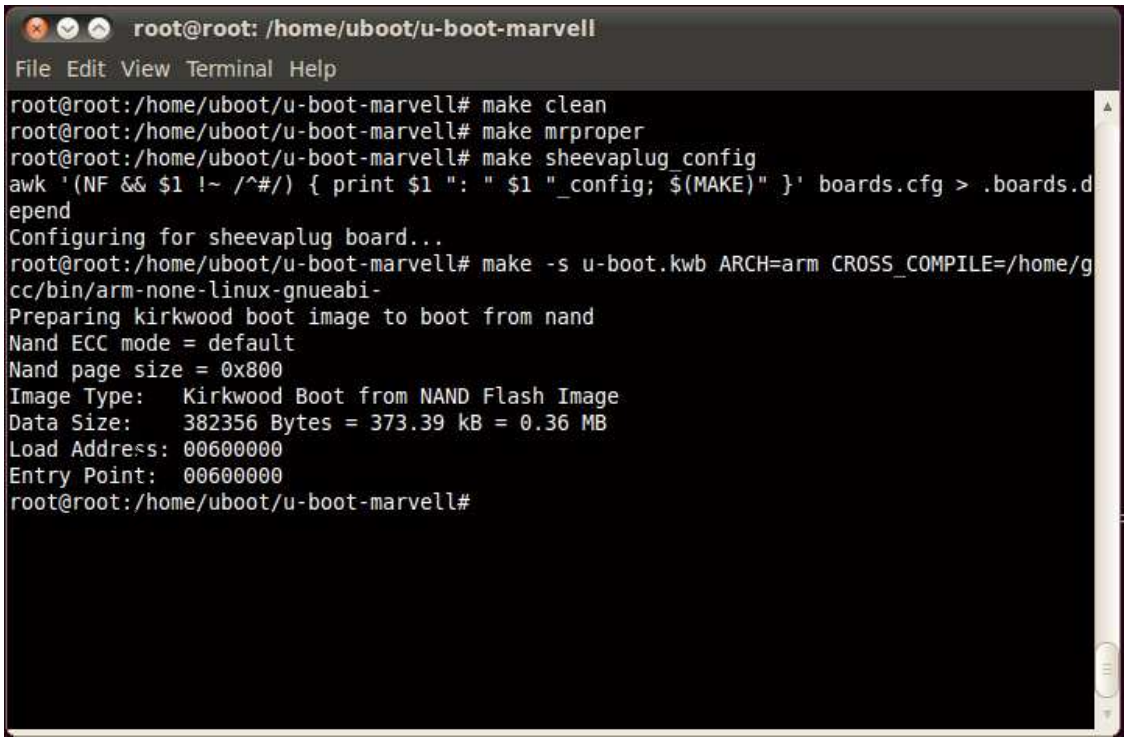


Figure 1: Uboot binary is ready

- Please see Chapter 7 (Flashing Procedures) on how to flash the compiled binary.

For Ubuntu users you may encounter an erros regarding "MV_BOOTSIZE undefined" and may need to do the following changes to the shell before building the image:

```
# ls –l /bin/sh
# ln –sf /bin/bash /bin/sh
```

V. Kernel

A. Linux Kernel Introduction

Linux Kernel is the essential center of a computer operating system, the core that provides basic services for all other parts of the operating system.

B. Preparation

- On the Linux PC Host create the directory "/home/kernel".

```
# mkdir /home/kernel
```

- Copy kernel source from the DISC (/KERNEL/SOURCE/linux-2.6.34.9.tar.bz2) into the "/home" directory of your Linux PC Host or download the source code from:

  http://www.kernel.org

- Decompress the kernel source

```
# cd /home/kernel
# tar xvjf linux-2.6.34.9.tar.bz2
```

- Copy and execute the kernel patch file from the DISC (/KERNEL/PATCH/IONICS-NIME0-kernel.patch) into the kernel source directory to update the codes to contain IONICS configurations.

- Check patch file before replacing:

```
# cd /home/kernel/linux-2.6.34.9
# patch –p1 --dry-run < IONICS-NIME0-kernel.patch
```

- Execute patch by issuing:

```
# patch –p1 < IONICS-NIME0-kernel.patch
```

C. Compiling the image and modules

- Ensure that the source is in a clean state before starting the compile.

```
# make clean
# make mrproper
```

- Configure the kernel by copying the config file to .config

```
# cp arch/arm/configs/ionics_defconfig .config
```

- Enable additional kernel features thru menuconfig

```
# make ARCH=arm menuconfig
```

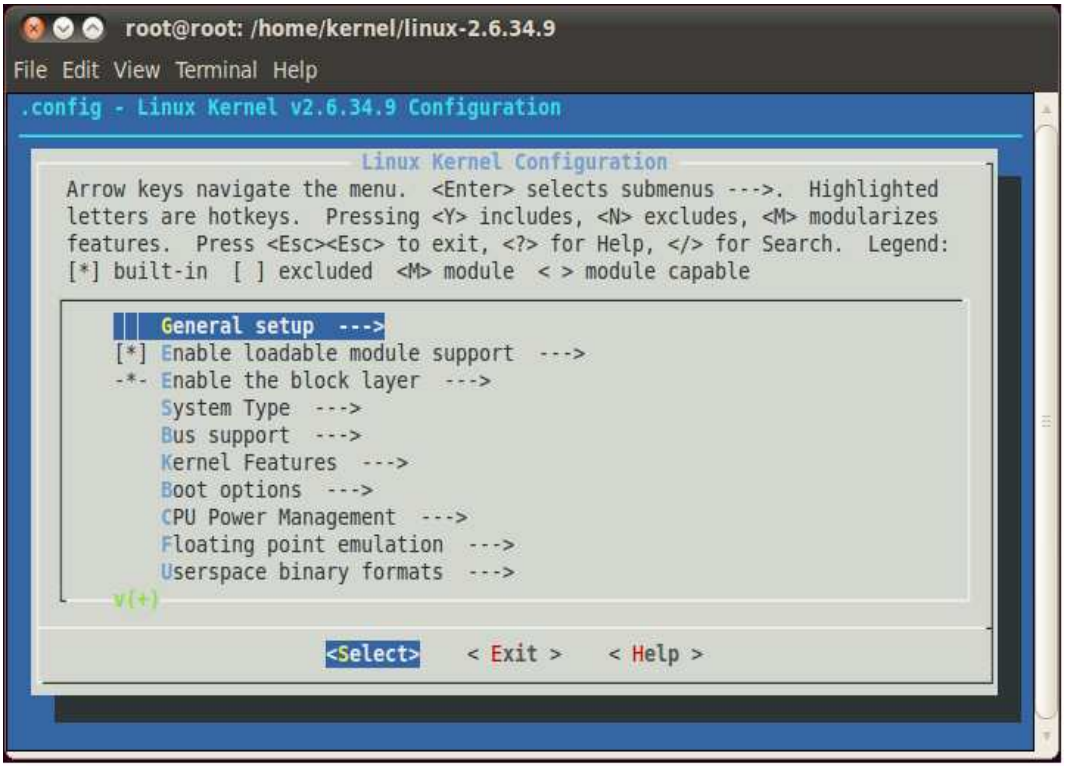


Figure 2: Kernel configuration

- Save the kernel configuration if you're done.

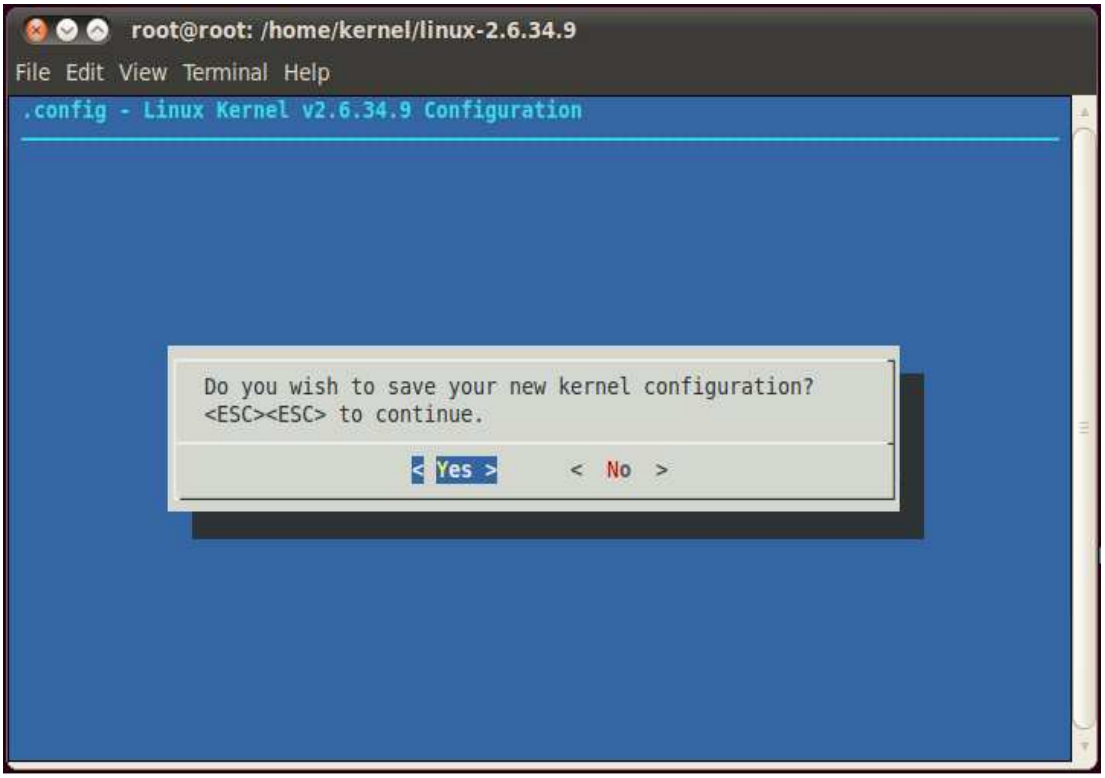


Figure 3: Save the configuration

- Compiling the kernel image:

```
# make –s uImage ARCH=arm CROSS_COMPILE=/home/gcc/bin/
arm-none-linux-gnueabi-
```

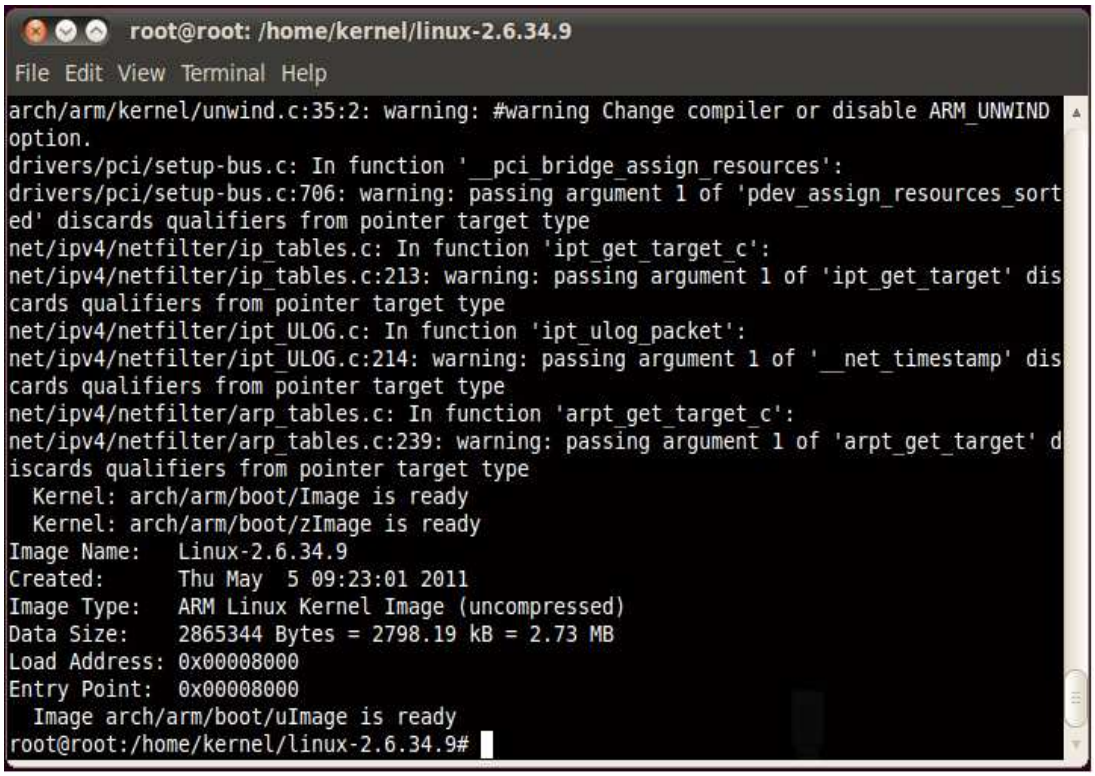


Figure 4: Image is ready

- Copy the .config file back to the config file

```
# cp .config arch/arm/configs/ionics_defconfig
```

- Build the kernel modules

```
#  make –s modules ARCH=arm CROSS_COMPILE=/home/gcc/bin/
arm-none-linux-gnueabi

# make –s modules_install ARCH=arm CROSS_COMPILE=/home/
gcc/bin/arm-none-linux-gnueabi INSTALL_MOD_PATH=<path>

# cd <path>
# tar –cvzpf modules.tar.gz lib/
```

- *Please see Chapter 7 (Flashing Procedures) on how to re-flash your compiled image.*

VI. Filesystem

A. Embedded Filesystem introduction

Embedded file system which can be used with any type of storage device, is a high performance library that has been optimized for; minimum memory consumptions in RAM and ROM, high speed, and versatility.

B. Preparation

B.1 Installing Softwares

There are several ways on how the developer could install applications into the PlugComputer. One of basic ways is to connect the PlugComputer to the internet and access the open-source repositories.

Sample: installing "usbutils" to obtain "lsusb" command

```
# apt-get update
# apt-get install <application>
```

B.2 Setup for NFS boot up

- Copy "uImage" from the DISC (/BINARIES.zip) to the "/tftpboot" directory of the Linux Host
- Access the plug computer via mini-USB cable
- Connect the plug computer and Linux PC Host to a network.
- Be sure to add an IP address that is a member of the network.
- Power up the PlugComputer access it via serial console. Stop auto-boot to access the uboot console.

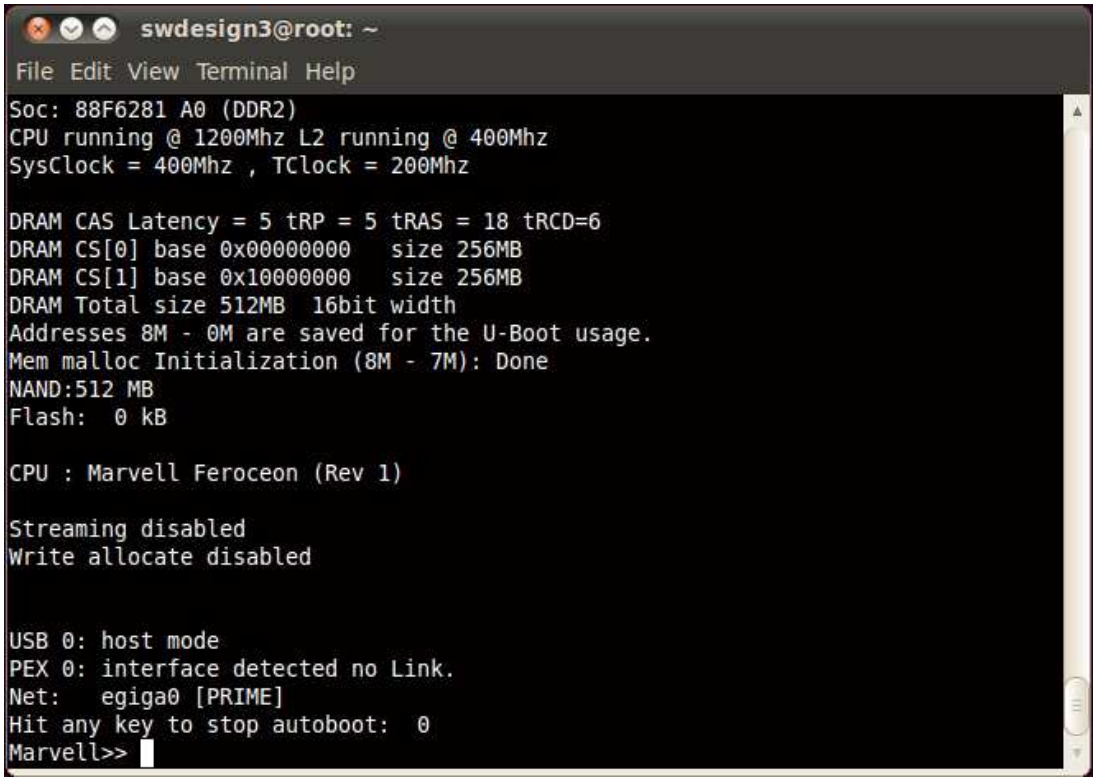


Figure 5: Stop auto-boot

- Type the following command in the u-boot console to create the needed u-boot environment variables

```
> set ipaddr <enter static ipaddress for the plug>
> set serverip <enter ipaddress of the Linux PC Host>
> set image_name uImage
> set rootpath '/home/myFilesystem'
> set bootargs_root_nfs 'root=/dev/nfs rw'
> set bootcmd_nfs 'tftpboot 0x2000000 $(image_name); setenv
bootargs          $(bootargs_root_nfs)          $(mtdparts)
nfsroot=$(serverip): $(rootpath) ip=$(ipaddr): $(serverip);
bootm 0x2000000'
> saveenv
```

- Temporarily boot via NFS by issuing the following command

```
> run bootcmd_nfs
```

- After boot-up, you can now log-in using the following details

```
Login: root
Password: root
```

C. Compiling Tarball

- After finalizing the rootfs contents, boot-up your PlugComputer via network
- Please see Chapter VI B.2 "Setup for NFS boot up" for instructions on how to boot via network"
- Mount the NAND rootfs partition by issuing the following commands on the PlugComputer's linux console:

```
# ubiattach /dev/ubi_ctrl –m 3
# mount –t ubifs ubi0:rootfs /mnt
```

- Remove the modules

```
# rm –rf /mnt/lib/modules/<module name>
```

- Create the tarball

```
# cd /mnt

# tar –cvzpf ../rootfs.tar.gz *
```

- The resulting tarball would be located on the "/" directory

D. Compiling UBIFS image

- After finalizing the rootfs contents, boot-up your PlugComputer via network or USB stick.
- Please see Chapter VI B.2 "Setup for NFS boot up" for instructions on how to boot via network"
- Create "/home/myFilesytem/ubi.cfg" file and put the following:

```
# vi /home/myFilesytem/ubi.cfg
```

```
[ubifs]
mode=[ubi]
image=ubifs.img
vol_id=0
vol_size=256MiB
vol_type=dynamic
vol_name=rootfs
vol_flags=autoresize
```

- Mount the NAND rootfs partition by issuing the following commands on the PlugComputer's linux console:

```
# ubiattach /dev/ubi_ctrl –m 3
# mount –t ubifs ubi0:rootfs /mnt
```

- Remove the modules

```
# rm –rf /mnt/lib/modules/<>
```

- Create UBI image (This make take some time without progress display)

```
# mkfs.ubifs –v –r /mnt –m 2048 –e 129024 –c 4096 –o
ubifs.img –x zlib

# ubinize –o rootfs-ubi.img –m 2048 –p 128KiB –s 512
ubi.cfg
```

- The resulting ubifs image would be located on the "/" directory

VII. Flashing procedures

A. Type of flashing techniques

1. Reflashing Method: "via OpenOCD"

> Warning: *This will replace the current bootloader. This procedure may render the Plugcomputer unbootable. All identification (i.e. S/N, MAC address, etc) info will be lost. Do not do this procedure unless you know what you are doing*

- Copy the OpenOCD installer tarball "OpenOCD.tar.bz2 " from the DISC (/TOOLS.zip) and extract it to the home directory "/home" of your Linux PC Host.

```
# cd /home
# tar –xvjf OpenOCD.tar.bz2
```

- Copy and unzip the binaries "BINARIES.zip" into a flash drive (uImage, rootfs-ubi.img, modules.tar.gz, initrd.usr, initrd.mfg, u-boot.kwb, checksum)
- Insert the flash drive into the Plugcomputer USB port
- Copy the uboot binary (u-boot.kwb) into the OpenOCD installer folder

```
# cp u-boot.kwb /home/OpenOCD/
# cd /home/OpenOCD/
# ls
```

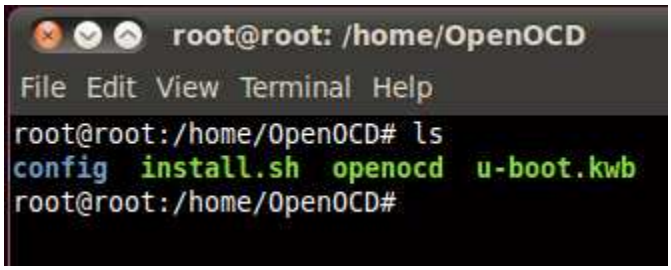


Figure 6: OpenOCD Files

- Flash the firmware by issuing the command

```
# ./install.sh
```

- Wait until uboot reflashing is complete.

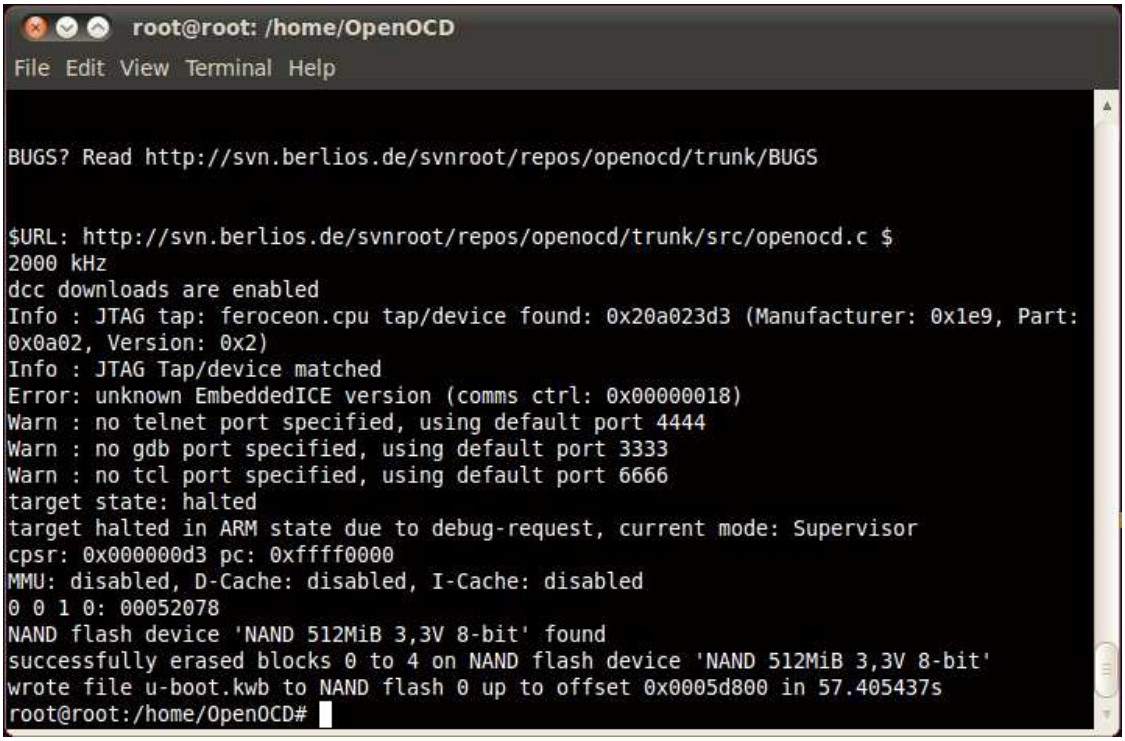


Figure 7: Uboot reflashing complete

- In the Linux host issue the command below to access the plugcomputers console:

```
# minicom –c on
```

- The binaries in the thumdrive will be automatically flashed to the plugcomputer i.e. filesystem and kernels

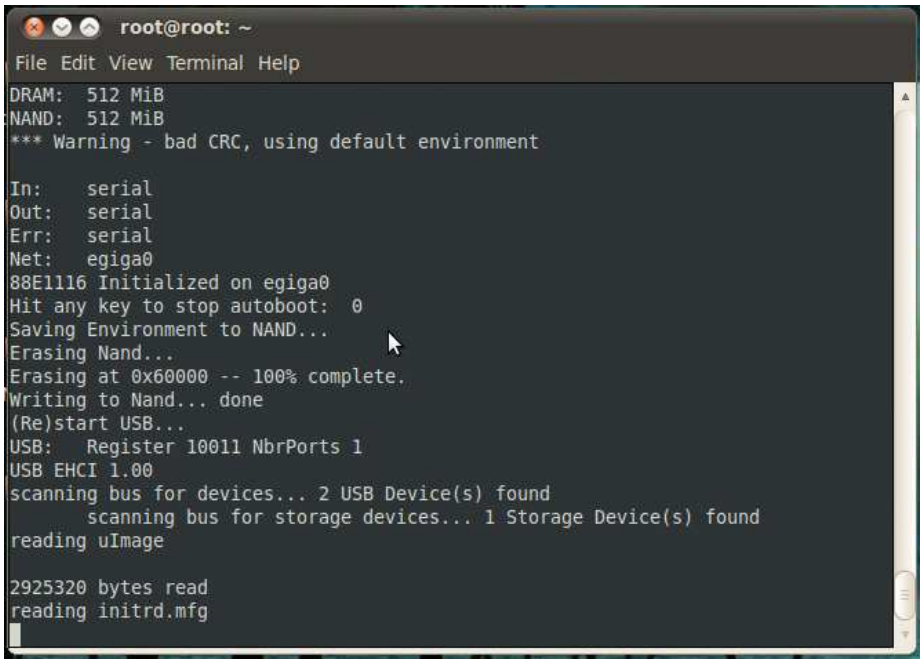


Figure 8: Reflashing the Plugcomputer (Filesystems and kernels)

- To access initrd.mfg console hit the keyboard else leave it as is to continue flashing

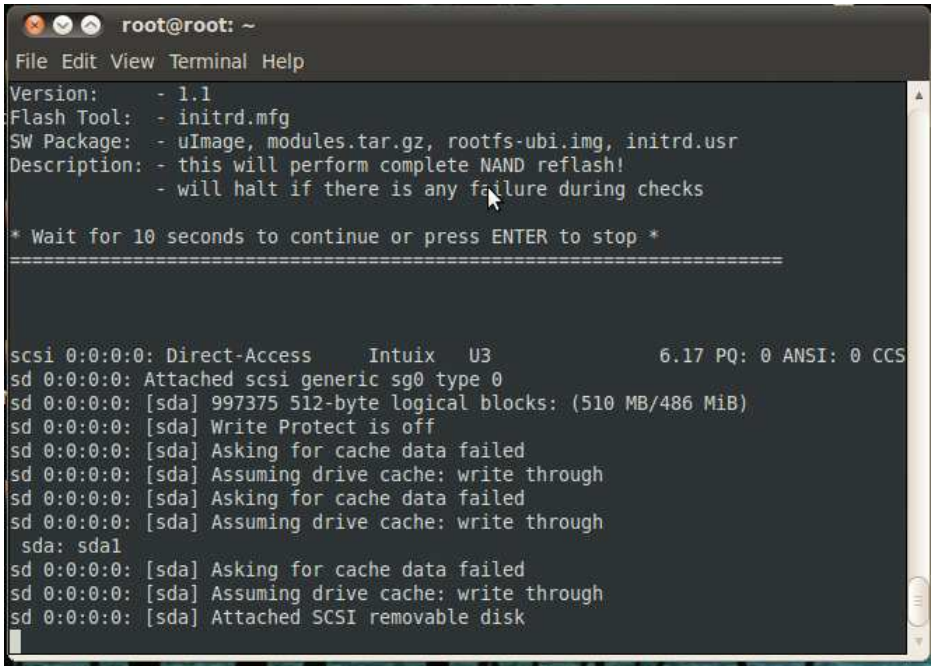


Figure 9: Halt for 10 seconds before reflashing

- After reflashing, the Plugcomputer will automatically reboot. After boot-up, you can now log-in using the following details

```
Login: root
Password: root
```

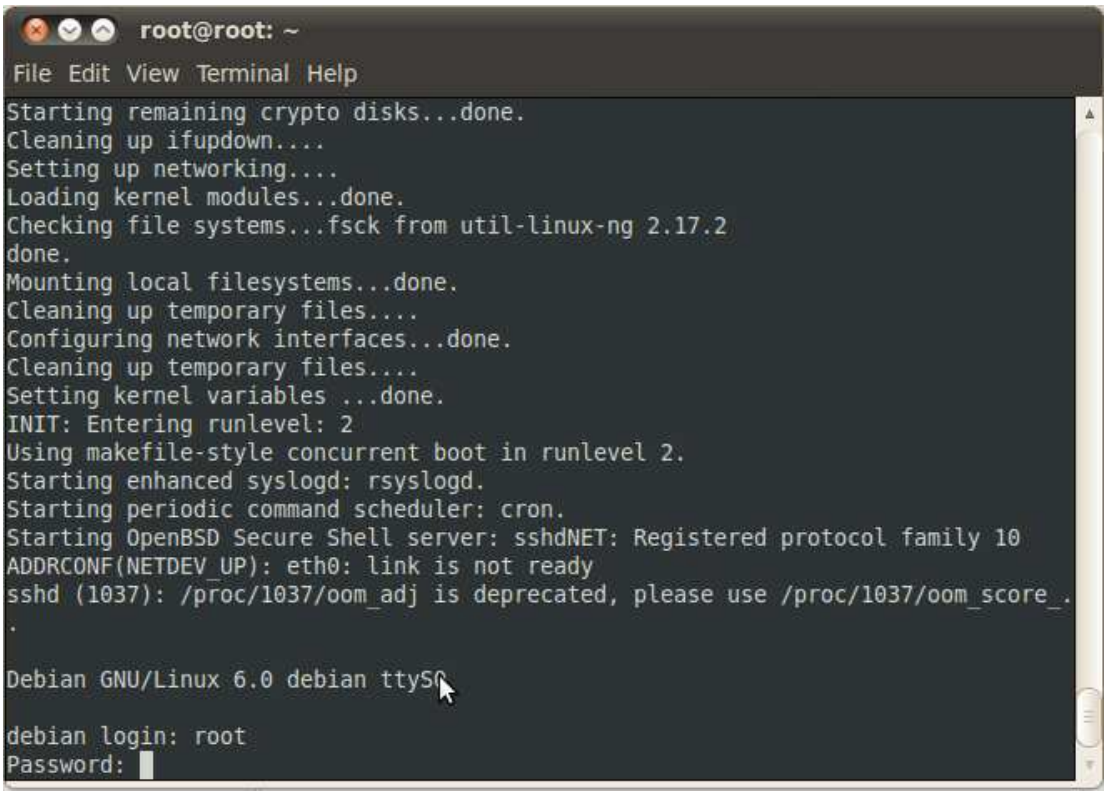


Figure 10: Login

2. Reflashing Method : "Interactive"

2.1 Menu-based Reflashing

- Copy and unzip the binaries "BINARIES.zip" into a flash drive (uImage, rootfs-ubi.img, modules.tar.gz, initrd.usr, initrd.mfg, u-boot.kwb, checksum)
- Power up the Plugcomputer
- Connect the flash drive to the Plugcomputers USB port
- Select different types of software updates from the menu by issuing:

```
# ./root/setup/plugflasher/reflash_interactive
```

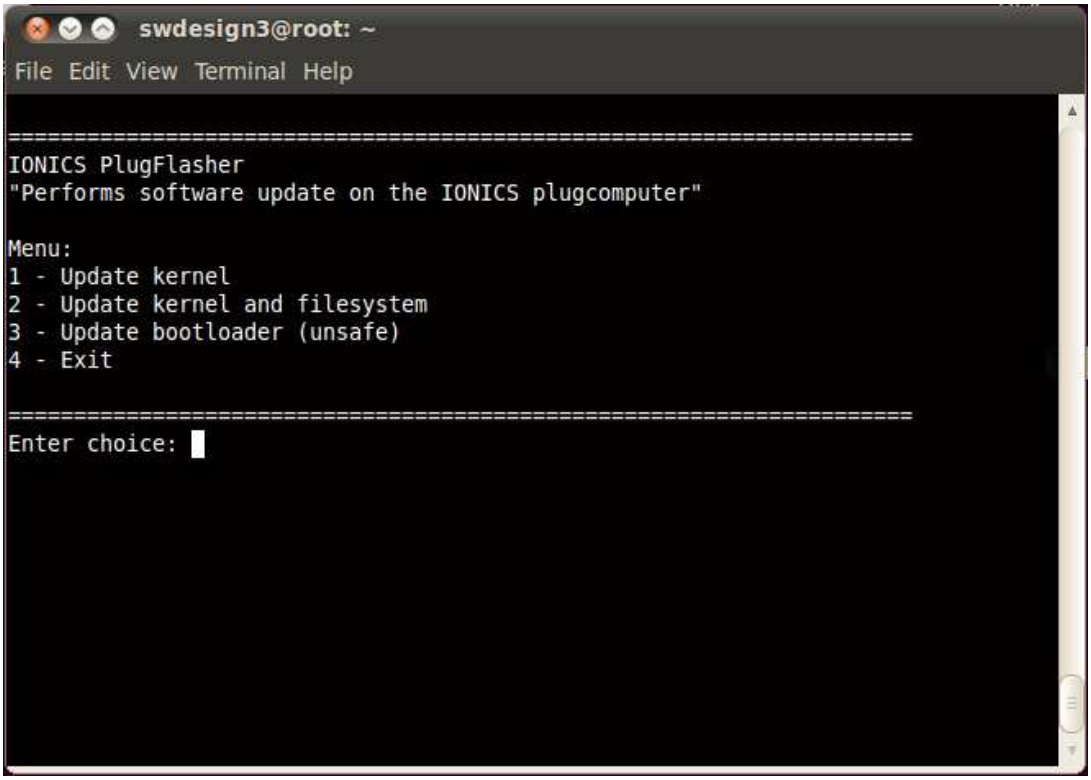


Figure 11: Interactive Reflashing

2.1 Reflashing Method: "via U-boot console"

- Copy and unzip the binaries "BINARIES.zip" into a flash drive (uImage, rootfs-ubi.img, modules.tar.gz, initrd.usr, initrd.mfg, u-boot.kwb, checksum)
- Insert the flash drive into the Plugcomputer USB port
- Boot-up the PlugComputer and stop auto-boot to access the u-boot console
- Issue "run reflash_usr" (This will preserve the plug test information), else
- Issue "run reflash_mfg" (Alternate method but will erase all information on the NAND)

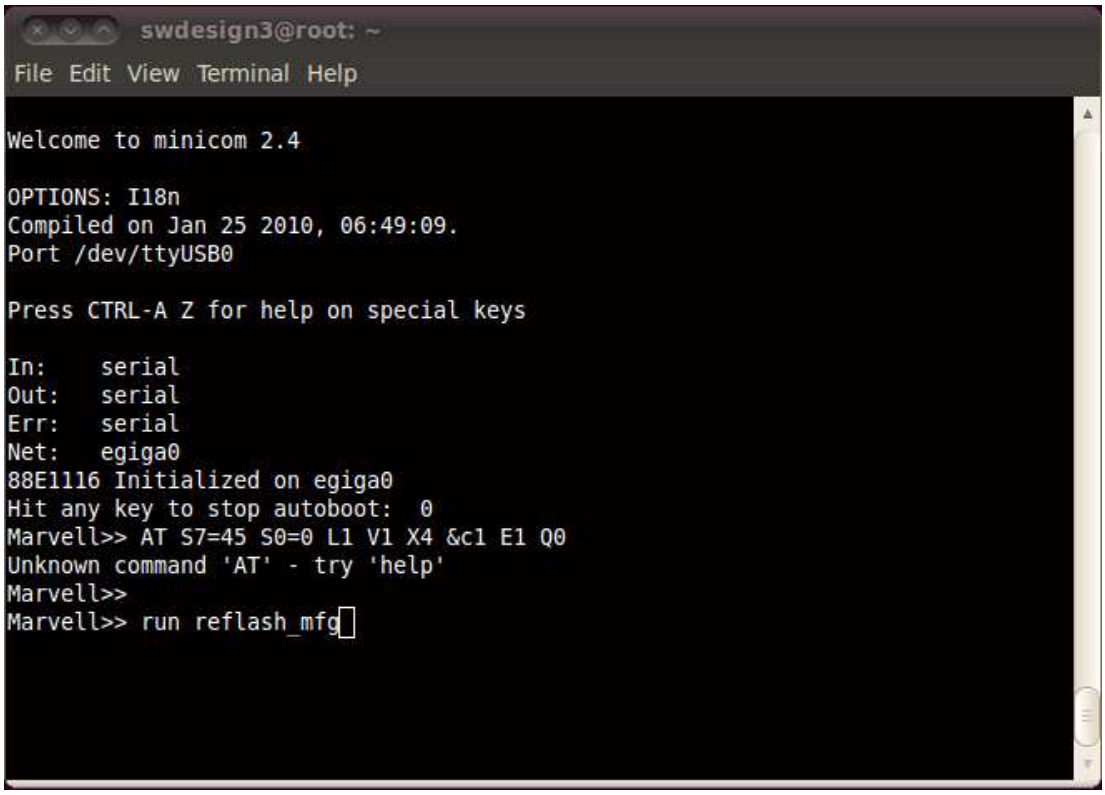


Figure 12: Reflash Manufacturing

- Wait until Reflashing is done

VIII. Software Features

1. LEDS Indicators

1.1 Controlling LED'S

- Options
  - nand-disk
  - mmc0
  - timer
  - ide-disk
  - heartbeat
  - default-on
- LED's assignment
  - led1 - green
  - led2 - red

➢ To control LEDS issue in the Plugcomputers console:

Syntax:

```
# echo <options>  > /sys/class/leds/<LED's assignment>/trigger
```

Sample:

```
# echo heartbeat > /sys/class/leds/led1/trigger
```

- You should be able to see the green LED blinking

1.2 Ethernet Ports status LED

The table below shows the NIMBUS' Ethernet port LED activities during different connection speed:

	Bootloader Version
	Marvell-Open Uboot
10 Mbps	orange LED only
100 Mbps	green and orange LEDs lights up
1000Mbps	green LED only

To verify the table above, the developer could force the connection speed to a different setting by doing the following:

- Force the ethernet connection speed to 100 Mbps (full-duplex) by

  `# mii-tool -F 100baseTx-FD`

- Force the ethernet connection speed to 100 Mbps (half-duplex) by

  `# mii-tool -F 100baseTx-HD`

- Force the ethernet connection speed to 10 Mbps (full-duplex) by issuing

  `# mii-tool -F 10baseT-FD`

- Force the ethernet connection speed to 10 Mbps (half-duplex) by issuing

  `# mii-tool -F 10baseT-HD`

Please be advised that the Ethernet port on the Plugcomputer still has auto-negotiating features. This means that when the unit is booted-up and is connected to a 1000 Mbps connection the green LED will light-up.

2. CPUinfo

- To see identification information about your Plugcomputer, isuue:

```
# cat /proc/cpuinfo
```

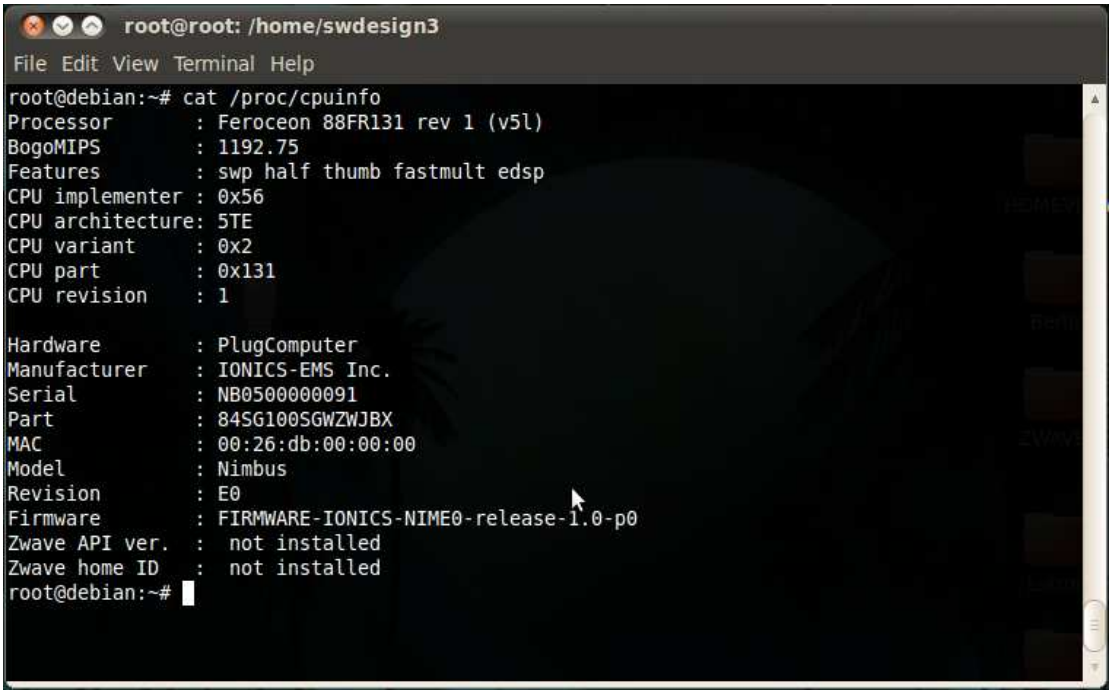


Figure 13: CPUinfo

- You should be able to see the identifications of your Plugcomputer, such as MAC address, Release package used, hardware model and etc.

3. Test Scripts

- /root/setup/test/persistent_off – moves the 75-persistent-net-generator.rules from /lib/udev/rules.d/ to /lib/udev/rules.d/disabled/; thus disabling the persistent-net-generator; for testing this script must be run; by default the system is persistent_off and should be tuned-on after test activities.

- /root/setup/test/persistent_on – moves the 75-persistent-net-generator.rules from /lib/udev/rules.d/disabled to /lib/udev/rules.d/; thus enabling the persistent-net-generator; for deployment this script must be run

- /root/setup/init_pluginfo – mounts the pluginfo partition; /pluginfo directory contains all the plug test information.

4. Accessing uboot environment variables via userspace

- Create the file "/etc/fw_env.config" and put the following

```
# vi /etc/fw_env.config
```

```
/dev/mtd0 0x60000 0x20000 0x20000
```

- Printing uboot variable values
  - Printing all environment variables at once

```
# fw_printenv
```

  - Printing specific environment variables

    Syntax:

```
# fw_printenv <environment variablename>
```

    Sample1: Printing MAC address

```
# fw_printenv ethaddr
```

    Sample2: Printing serial number

```
# fw_printenv ionicsplug_serial
```

- Setting uboot variables
  - Syntax:

```
# fw_setenv <environment variablename> <value>
```

    Sample 1: Setting serial number

```
# fw_setenv ionicsplug_serial NB0500000091
```

    Sample 2: Setting Ethernet address

```
# fw_setenv ionicsplug_part 84STSDKSWJZW0XC
```