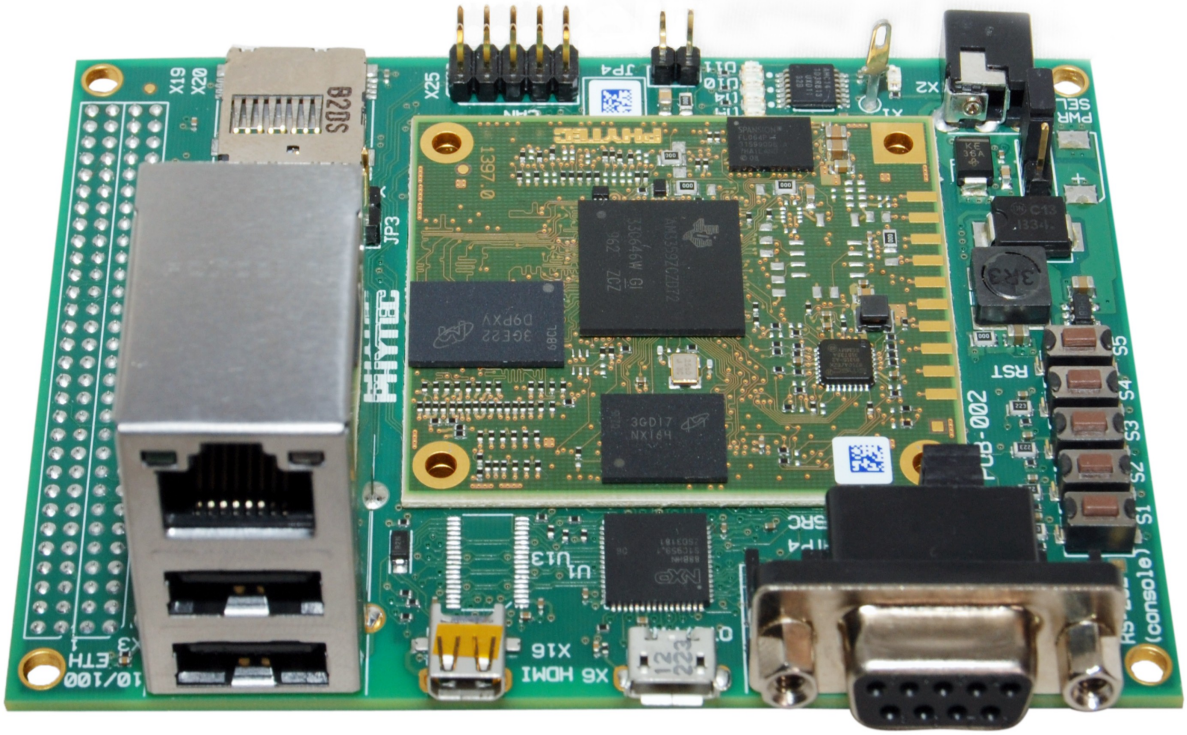
Cosmic Board for phyCORE-AM335x System on Module and Carrier Board

Application Development User Manual



Product No: PCL-051/POB-002
SOM PCB No: 1397.0
CB PCB No: 1396.1
Edition: October ,2013

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Table of Contents

Embedded Linux Application Development for Cosmic-AM335x

In this Manual we are going to describe how to use this Cosmic Board for application development. Our first chapter is dealing with the installation of eclipse and how a user can develop his own application which would run on cosmic board easilly with the help of eclipse. In our second chapter we will describe how to write an application using console terminal. After going through this manual you will have an idea how to use eclipse and console terminal for application development.

1. Application development using Eclipse IDE

With the help of example projects, we will teach you how to work with eclipse. First we take a look on the C programming language. At the end of this chapter we explain how to debug your written programs when running on the target.

1.1. Eclipse IDE Installation

First of all get the latest eclipse i.e, **Eclipse IDE for C/C++ Developers** and install it.

Eclipse IDE for C/C++ Developers

http://www.eclipse.org/downloads/packages/eclipse-ide-cc-developers/junosr1

Eclipse IDE for C/C++ Developers for Windows 32-bit

http://www.eclipse.org/downloads/download.php?file=/technology/epp/downloads/release/juno/SR1/eclipse-cpp-juno-SR1-win32.zip

Note: Eclipse required java also so we need to install the java.

http://www.oracle.com/technetwork/java/javase/downloads/jre7-downloads-1880261.html

Eclipse IDE for C/C++ Developers for Windows 64-bit

http://www.eclipse.org/downloads/download.php?file=/technology/epp/downloads/release/juno/SR1/eclipse-cpp-juno-SR1-win32-x86_64.zip

Eclipse IDE for C/C++ Developers for Linux 32-bit

http://www.eclipse.org/downloads/download.php?file=/technology/epp/downloads/release/juno/SR1/eclipse-cpp-juno-SR1-linux-gtk.tar.gz

Note: Eclipse required java also so we need to install the java using this command.

sudo apt-get install openjdk-7-jdk openjdk-7-jre

Eclipse IDE for C/C++ Developers for Linux 64-bit

http://www.eclipse.org/downloads/download.php?file=/technology/epp/downloads/release/juno/SR1/eclipse-cpp-juno-SR1-linux-gtk-x86_64.tar.gz

Eclipse IDE for C/C++ Developers for Mac OS X(Cocoa 32)

http://www.eclipse.org/downloads/download.php?file=/technology/epp/downloads/release/juno/SR1/eclipse-cpp-juno-SR1-macosx-cocoa.tar.gz

Eclipse IDE for C/C++ Developers for Mac OS X(Cocoa 64)

http://www.eclipse.org/downloads/download.php?file=/technology/epp/downloads/release/juno/SR1/eclipse-cpp-juno-SR1-macosx-cocoa-x86_64.tar.gz

1.2. Eclipse IDE Configuration for Cosmic-AM335x

1.2.1. Host Setup

Toolchain: For Compiling the Application we need the toolchain which you can easily download from the below link.

For Linux:

ftp://ftp.phytec.de/pub/Products/India/Cosmic-AM335x/Linux/PD13.0.0/tools/toolchain/arm-cortexa8-linux-gnueabi.tar.bz2

Untar the toolchain first the prefix of the toolchain is **arm-cortexa8-linux-gnueabi-**

For Window:

http://sourcery.mentor.com/public/gnu_toolchain/arm-none-linux-gnueabi/arm-2012.09-64-arm-none-linux-gnueabi.exe

Install the toolchain
The prefix of the toolchain is **arm-none-linux-gnueabi-** and default path is ***C:\Program Files\CodeSourcery\Sourcery_CodeBench_Lite_for_ARM_GNU_Linux\bin***

1.2.2. Target Setup

Connect the power adaptor, serial cable, ethernet cable to the Cosmic board & Boot the Cosmic board.

1.2.1.1. Set the ip for the Cosmic board.

To see all the interfaces present on the Cosmic board

ifconfig -a

Configure eth0.

ifconfig eth0 192.168.1.11 up

where eth0 is the LAN interface.
Check whether eth0 is configured or not

ifconfig -a

Set the gateway

route add default gw 192.168.1.1

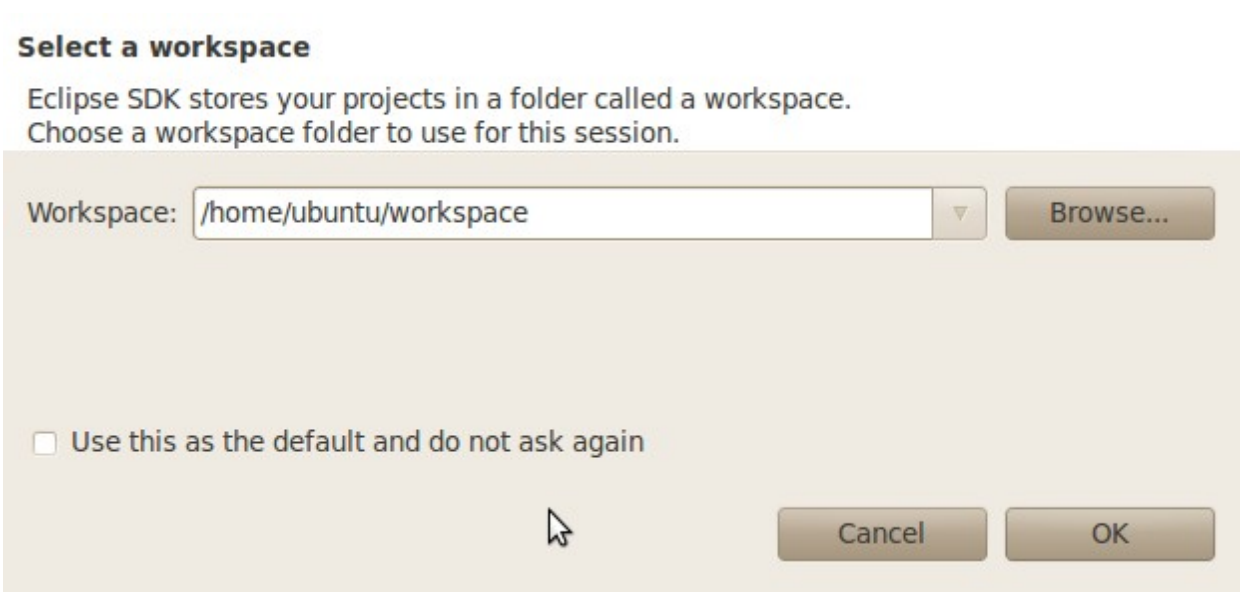
To see the change in the gateway.

route

1.3. Creating a New Project

In this section you will learn how to create a new project with Eclipse and how to configure the project for use with the GNU C/C++ cross development toolchain. Click the Eclipse icon to start the application. You can find this icon where you have extracted the Eclipse IDE for C/C++ Developers .

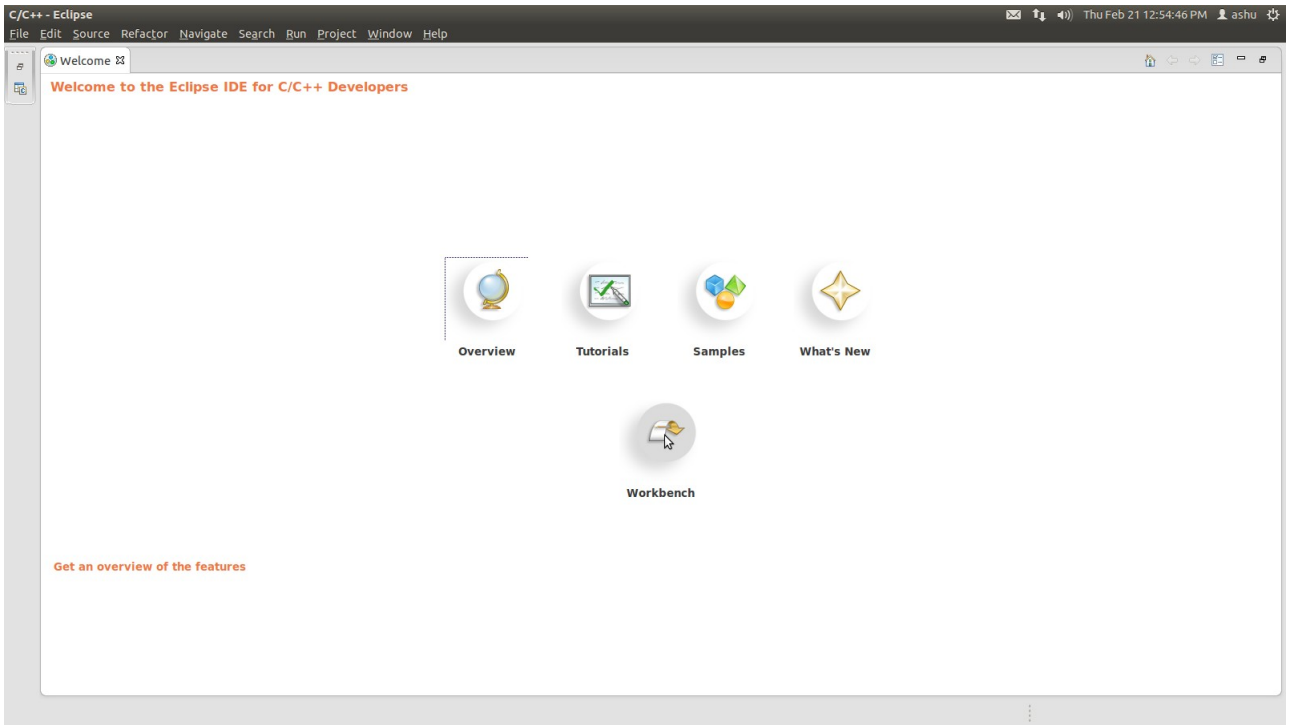
1.3.1. How to open eclipse



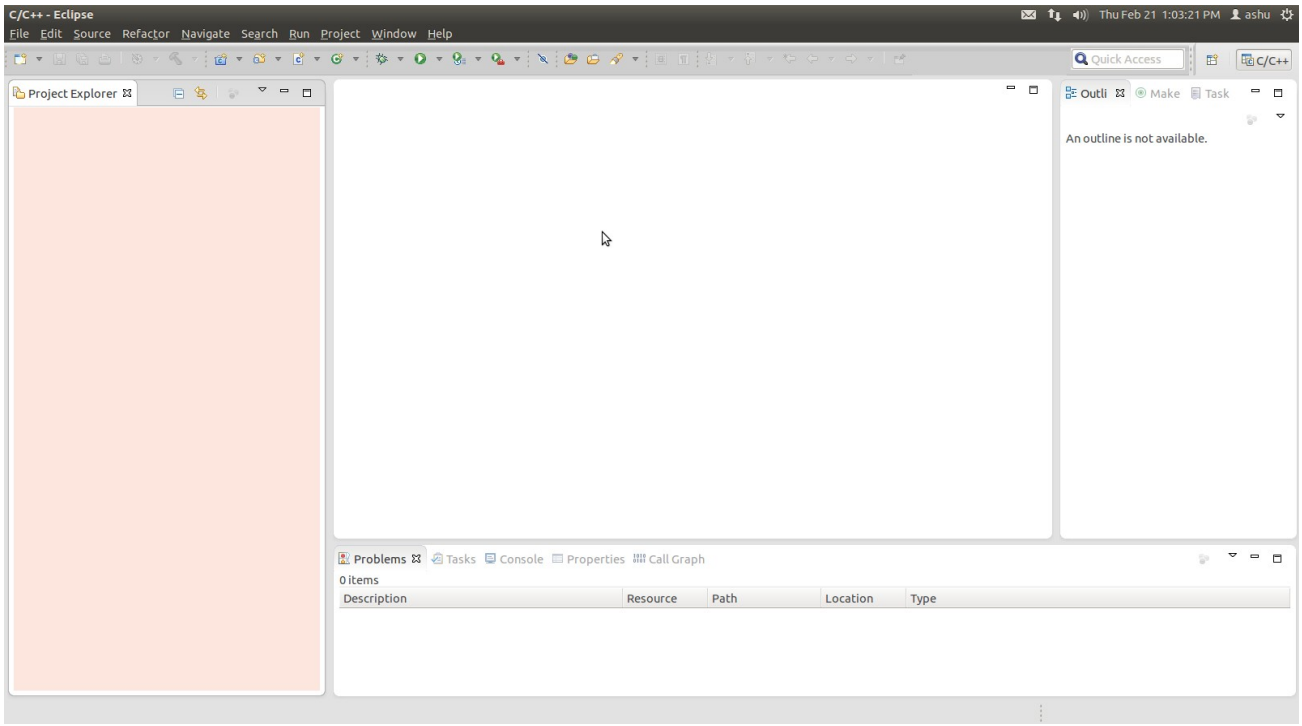
Confirm the workspace directory with OK

1.3.2. Welcome to Eclipse

Close the "Welcome to Eclipse" screen by clicking on the "Go to the workbench" button

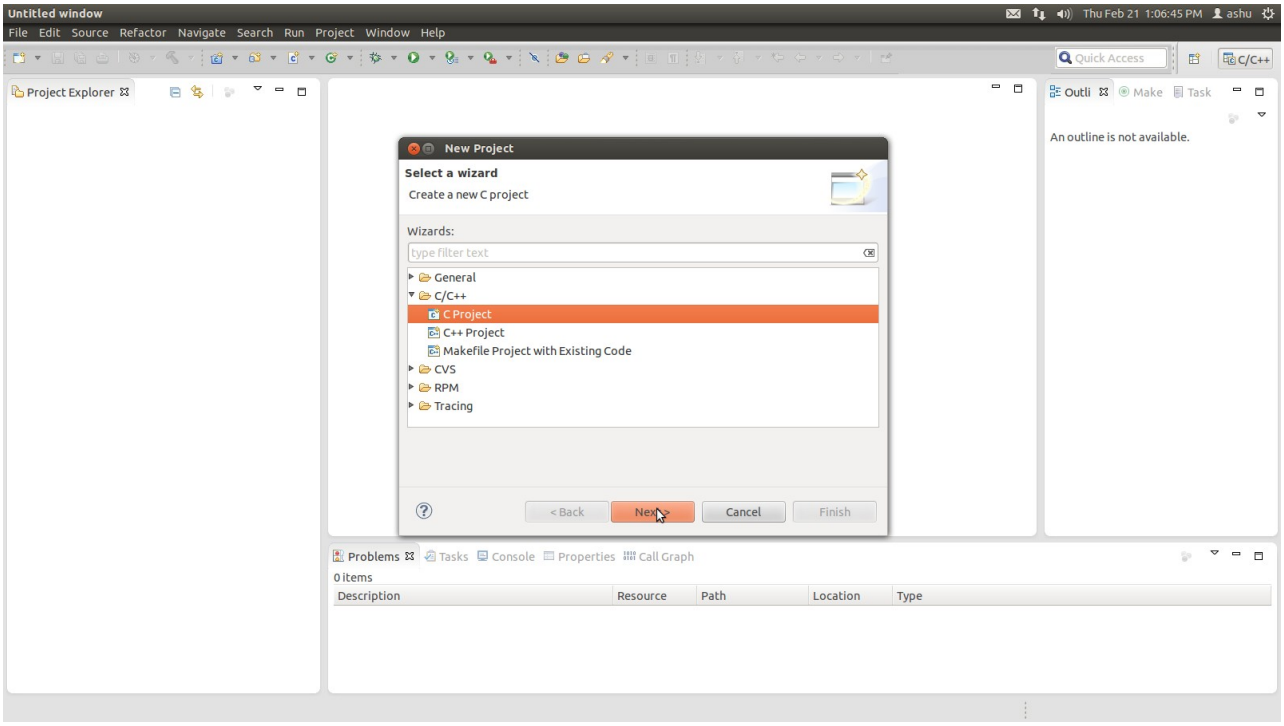


1.3.3. Open a new project



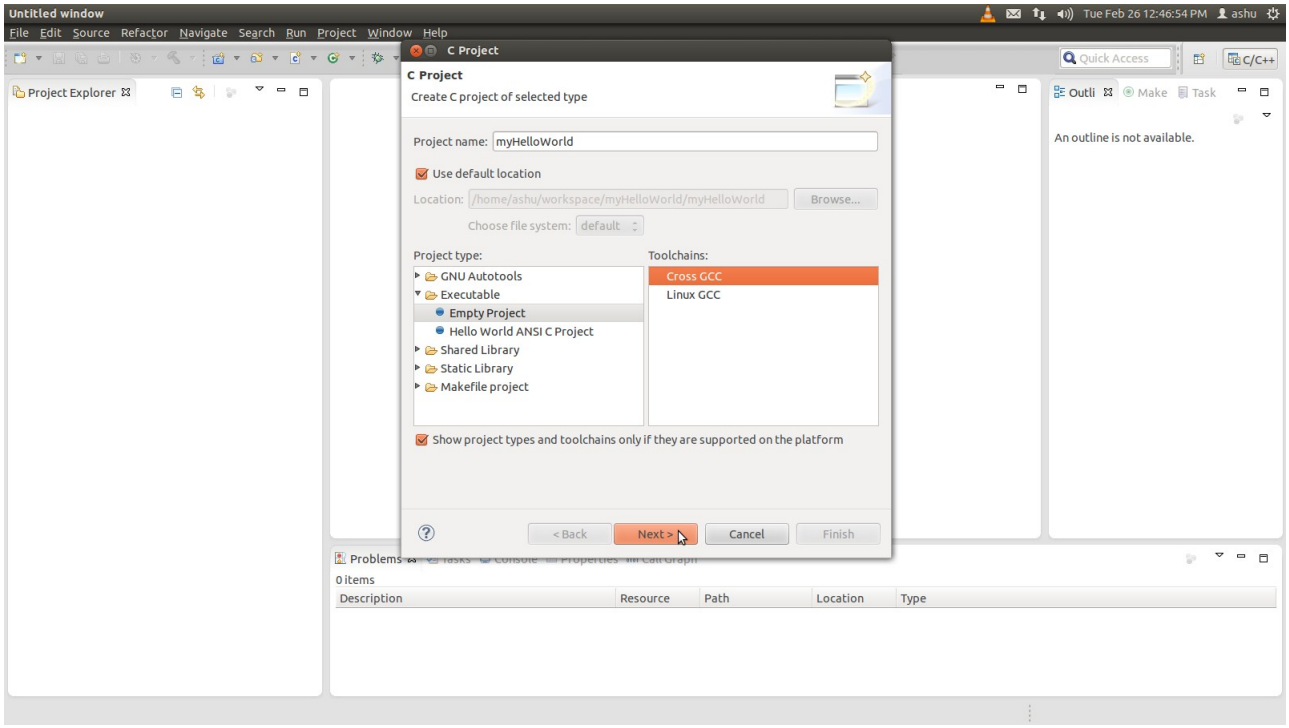
Select File ► New ► Project from the menu bar
A new dialog will open.

1.3.4. Select C Project



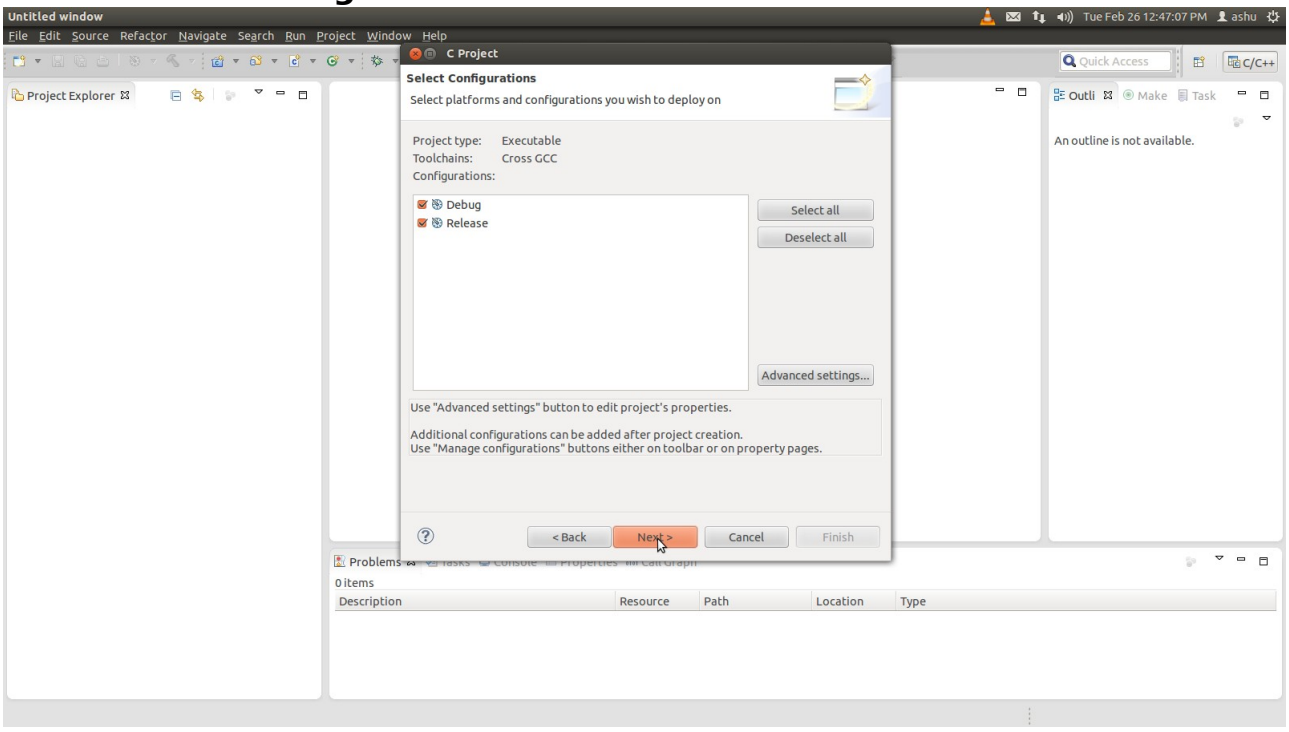
Select C Project and click Next

1.3.5. Select the Cross GCC



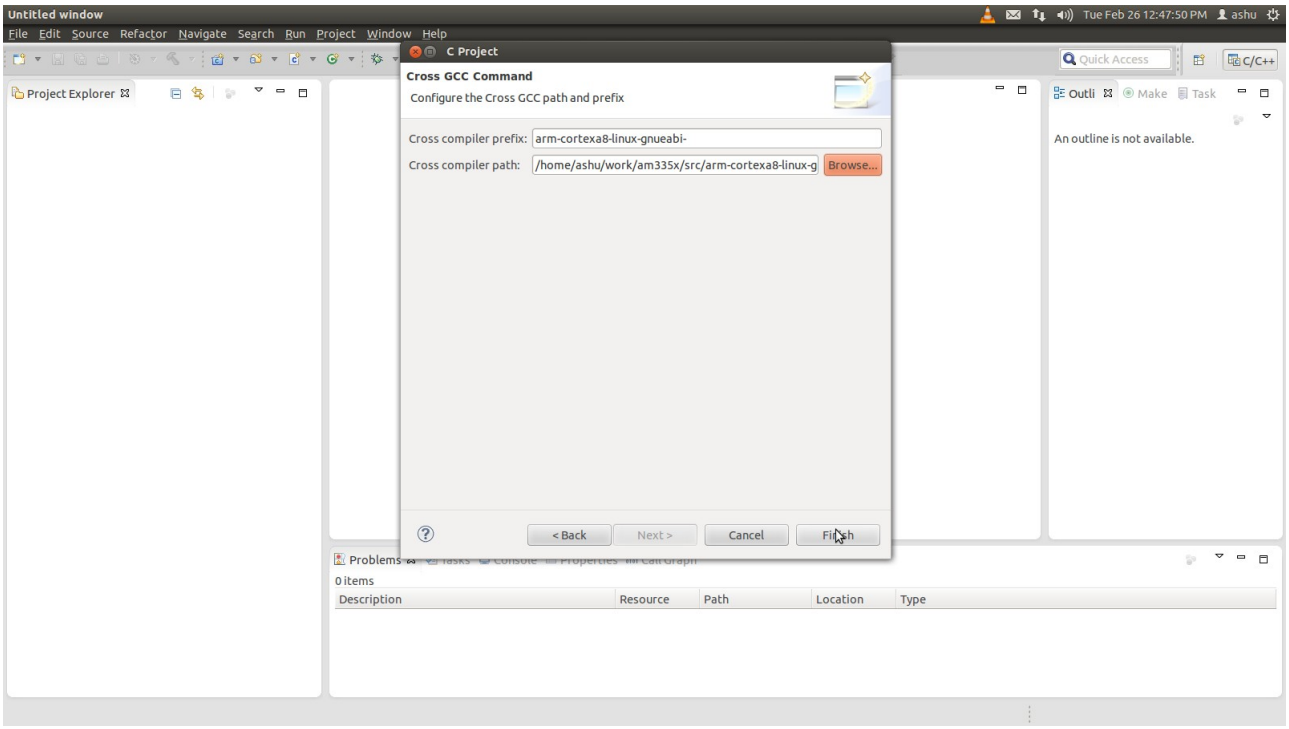
Enter the project name myHelloWorld and Toolchain as Cross GCC then click Next

1.3.6. Select Debug Facilities



Click Next

1.3.7 Toolchain Prefix & Path

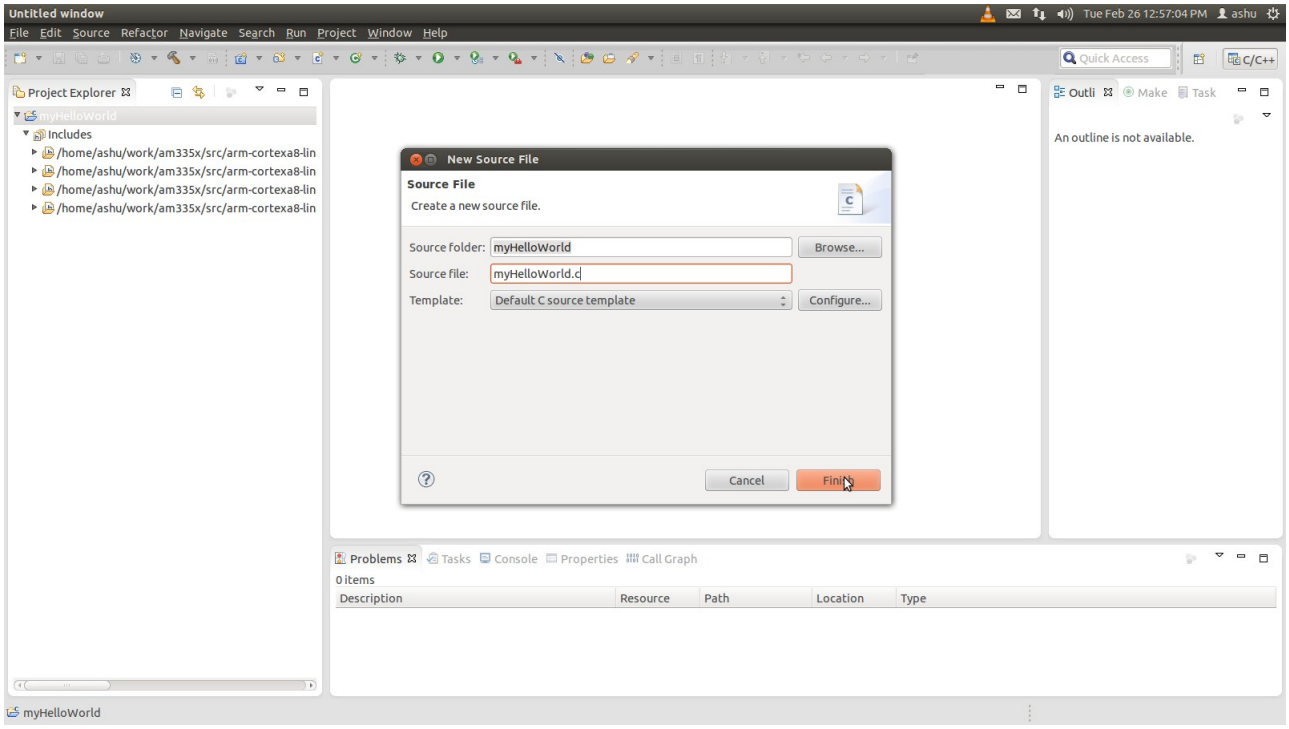


Select the Cross Compiler Prefix as **arm-cortexa8-linux-gnueabi-**
and Cross Compiler Path as <path of toolchain bin>

Note: For windows you have to select the arm-none-linux-gnueabi- and the

appropriate path of the toolchain.

1.3.8. Open new C source file



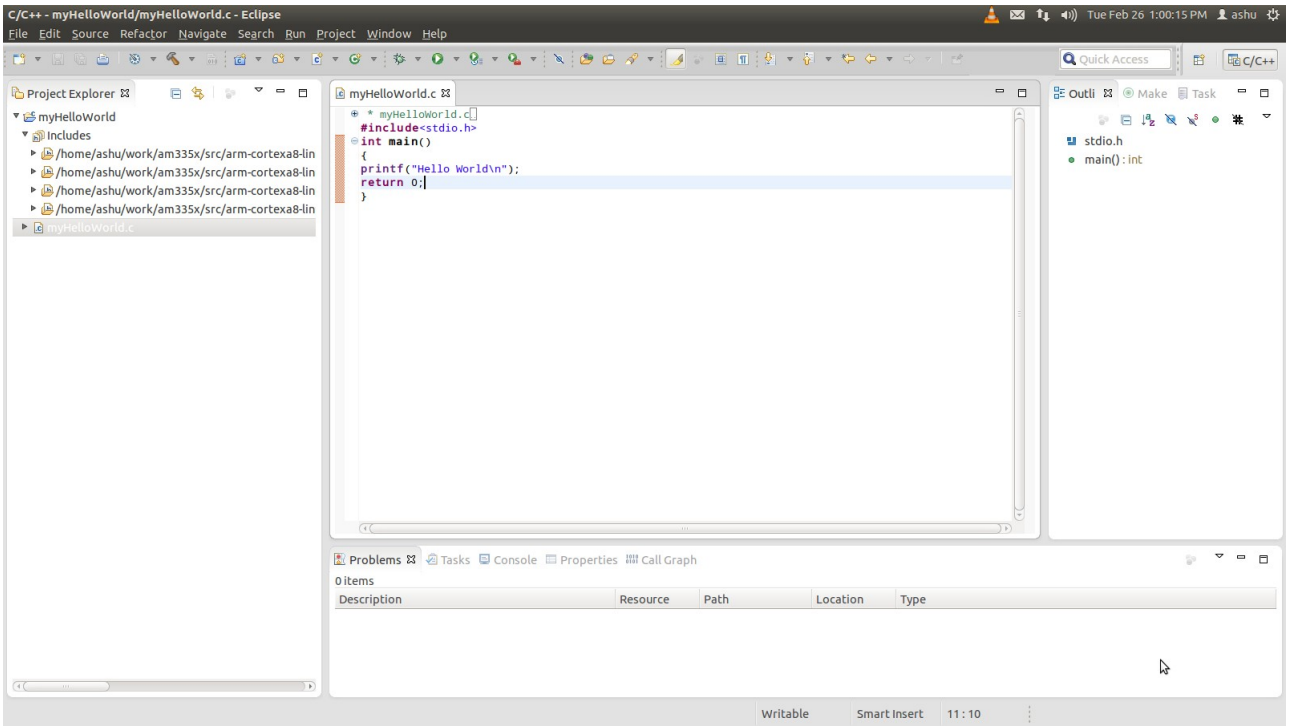
You will see the C/C++ IDE with the myHelloWorld project.

Right-click on HelloWorld project

Select File ► New ► Source file from the menu bar

In Source file write myHelloWorld.c and click on finish.

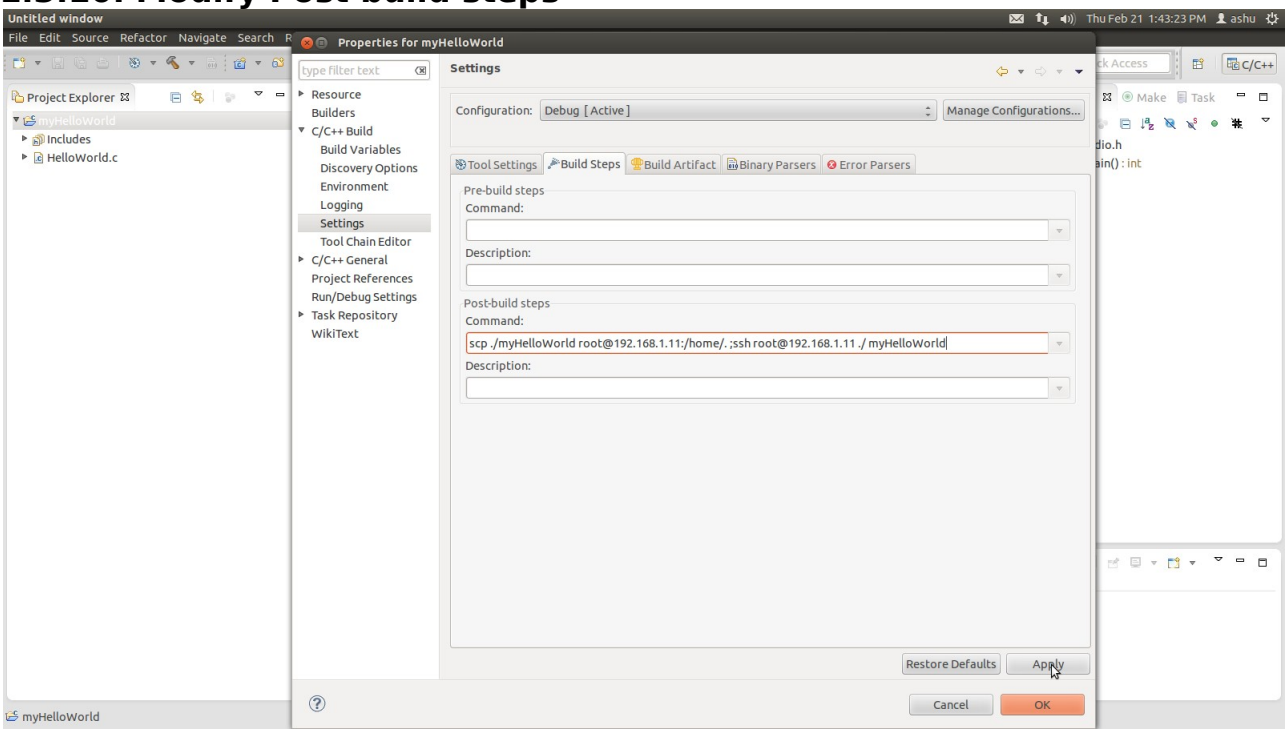
1.3.9. Write simple Hello Application



Write a simple Hello Application in C.

To compile your project for the Cosmic-AM335x instead, you will have to use the GNU C/C++ cross compiler.

1.3.10. Modify Post build steps



Right-click the myHelloWorld project and chose Properties

The Properties dialog appears.

Select C/C++ Build ► Setting ► Select the Build Steps tab

Enter the following command in the Post-build steps Command input field:

scp ./myHelloWorld root@192.168.1.11:/home/.
;sshroot@192.168.1.11 **./myHelloWorld**

Note: If you are using windows so you have to use Winscp or directly copy the binary into target board using pen drive or sd card.

You can download the winscp from the below link:

http://download.winscp.net/download/files/201302271159a5e0d9e193373cacc9998a2df283e19a/winscp514setup.exe

Click Apply

Click OK

Select Project ► Build project from the menu bar

The project will be built.

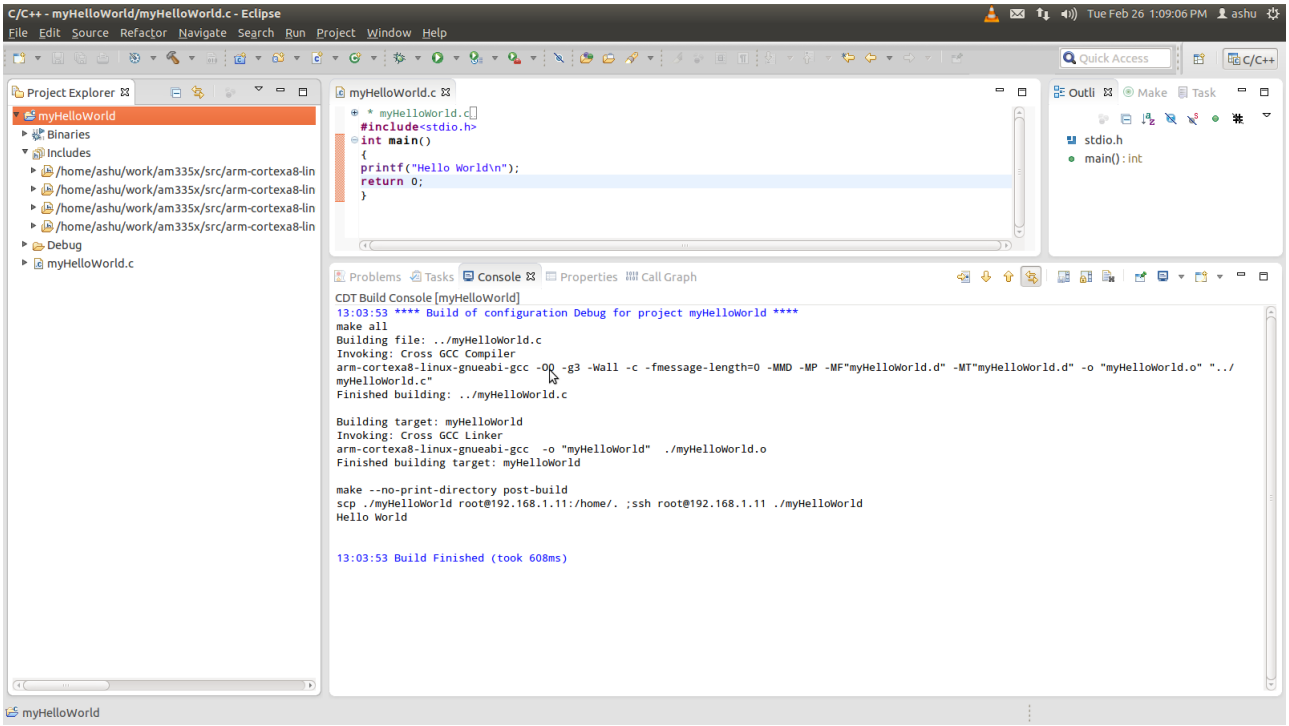
Select the Console tab.

if no errors occur while building the project, you will see the following output:

Note: If you are using Window machine then you need the make utils using the below link.

ftp://ftp.equation.com/make/32/make.exe

1.3.11. Finally Build the project



1.4. Changing the Demo Application

Now we will extend the myHelloWorld application. The extended myHelloWorld application will write an output to the first serial interface as well as to the standard output.

Open Eclipse if it is not opened yet

Double-click HelloWorld.c in the myHelloWorld project

First include the following two additional header files:

```
#include <unistd.h>
#include <fcntl.h>
```

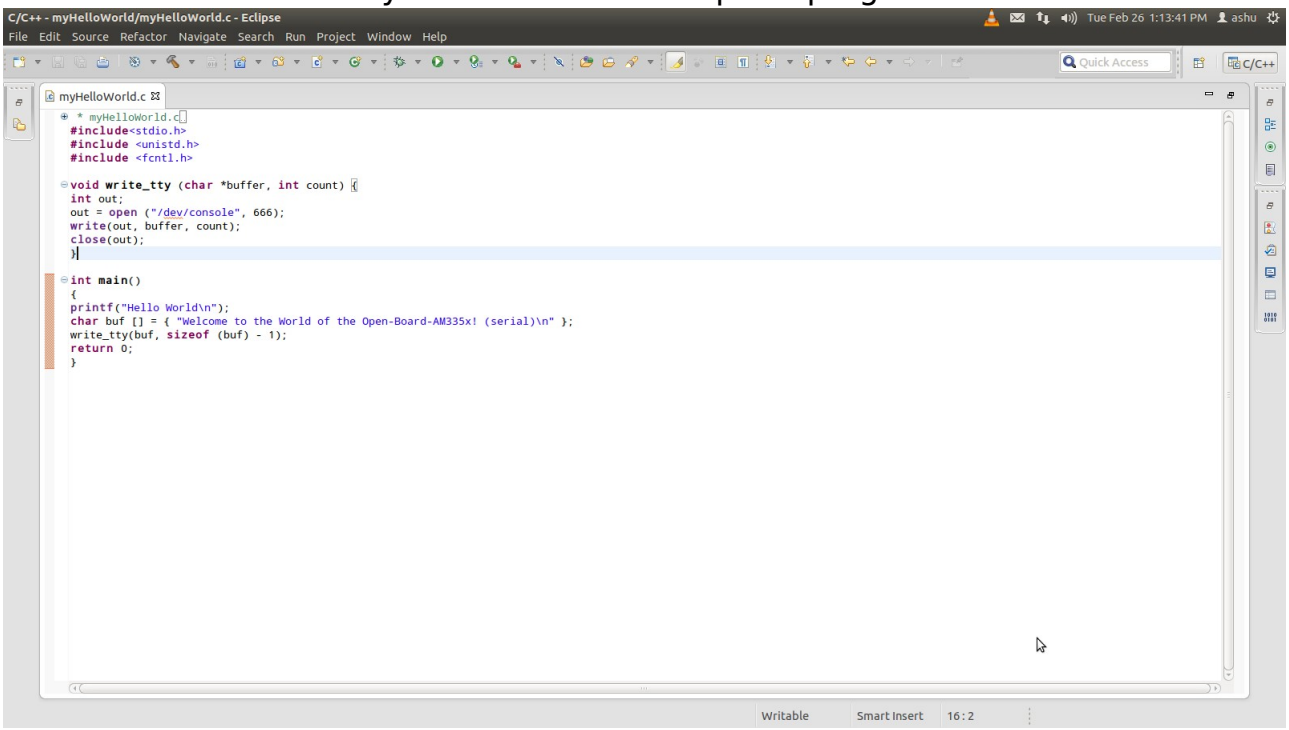
Then add the function write_tty(), which writes n bytes to the first serial interface (which, on the Cosmic-AM335x, is connected to the system console /dev/console):

```
void write_tty (char *buffer, int count) {
int out;
out = open ("/dev/console", 666);
write(out, buffer, count);
close(out);
}
```

Enter the following two lines in the main() function to declare the buffer and call the write_tty() function.

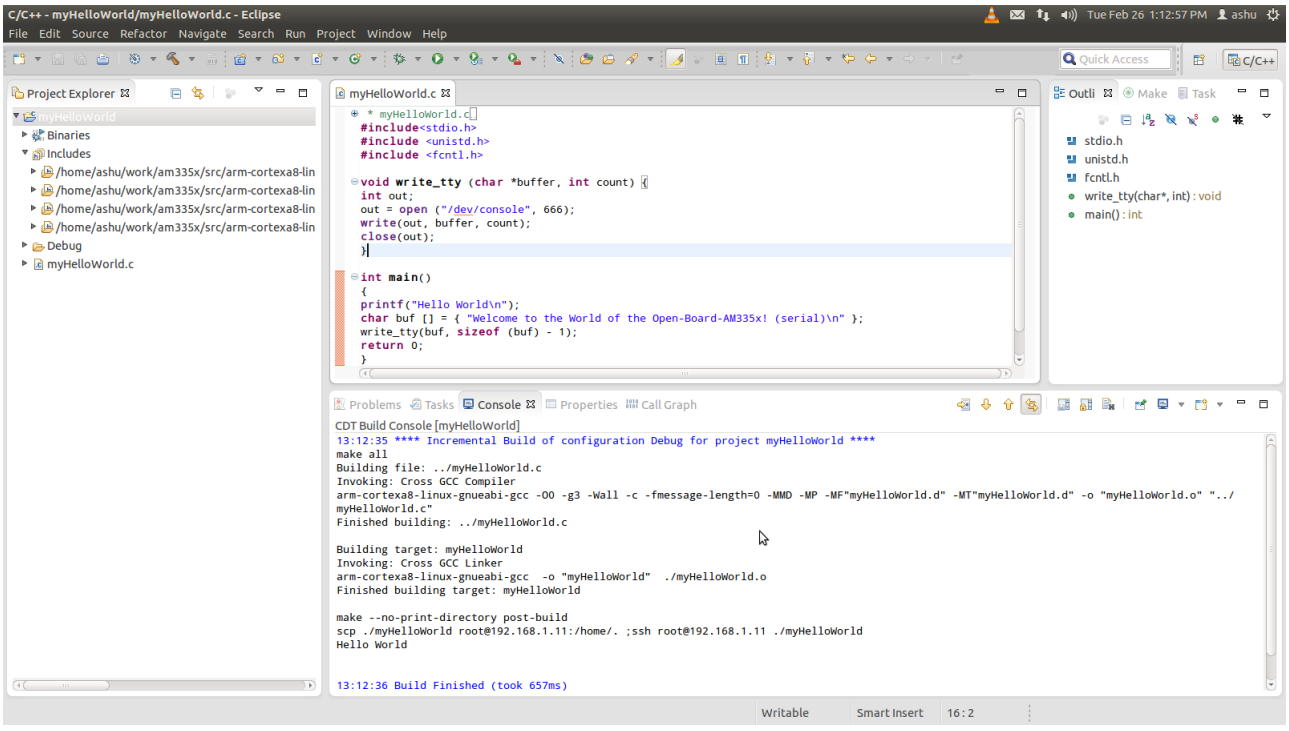
```
char buf [] = { "Welcome to the World of the Open-Board-AM335x! (serial)\n" };
write_tty(buf, sizeof (buf) - 1);
```

In the next screenshot you can see the complete program.



Save your program after changing the code.

The application will be compiled, built, copied to the target and executed.



1.4.1. Open Target Board using Minicom

Open the terminal using minicom

minicom -D /dev/ttyXX

If you are not logged in, enter root and press Enter then type ls to see all the file.

ls

Type ./myHelloWorld to start the application

./myHelloWorld

Hello World

Welcome to the World of the Open-Board-AM335x! (serial)

close minicom.

In this section you have changed an existing application. You also learned how to access the serial interface. First you called the function open() on the device /dev/console. The return value of this function was a file descriptor. With the file descriptor you called the function write() to send n bytes to the device /dev/console. After that, the file descriptor was closed with the function close().

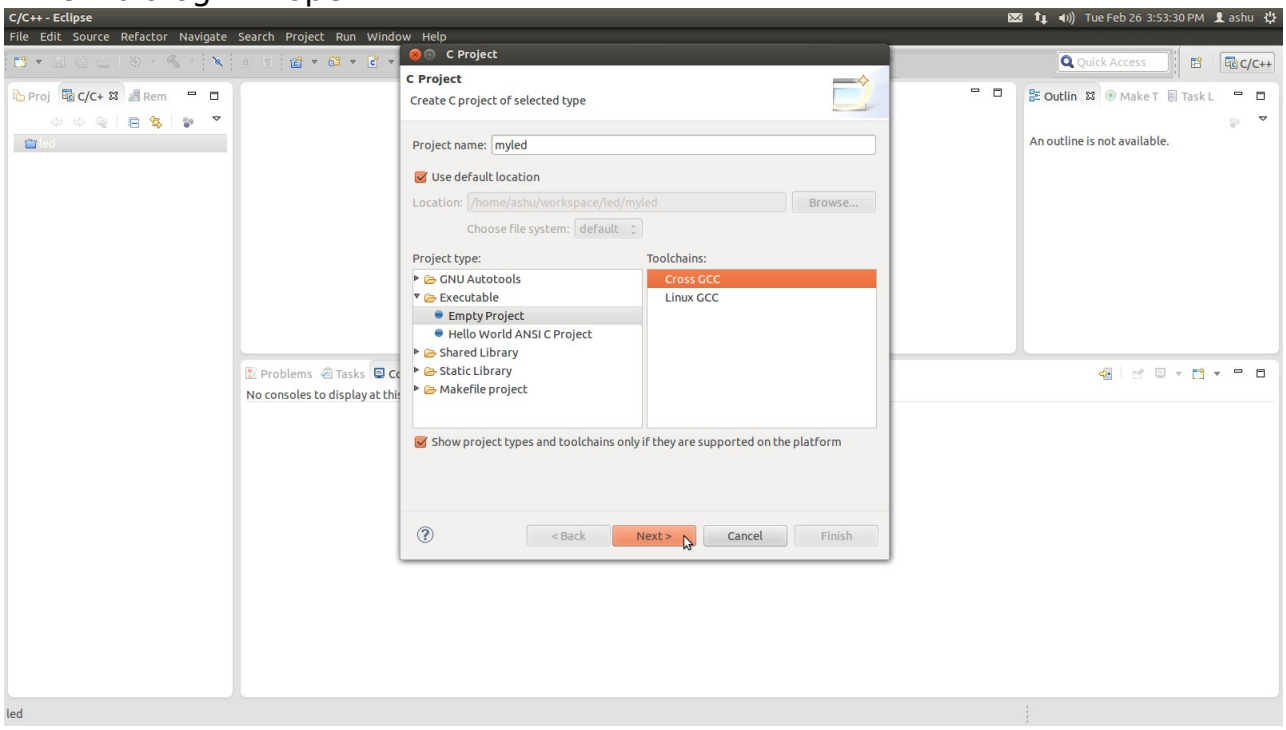
1.5. Led Blinking Application

In this section we are dealing with some hardware such as led on the Cosmic Board. For writing an application for led first follows Step 1.3.1. to Step -1.3.4. as discussed above.

1.5.1. Select the Cross GCC

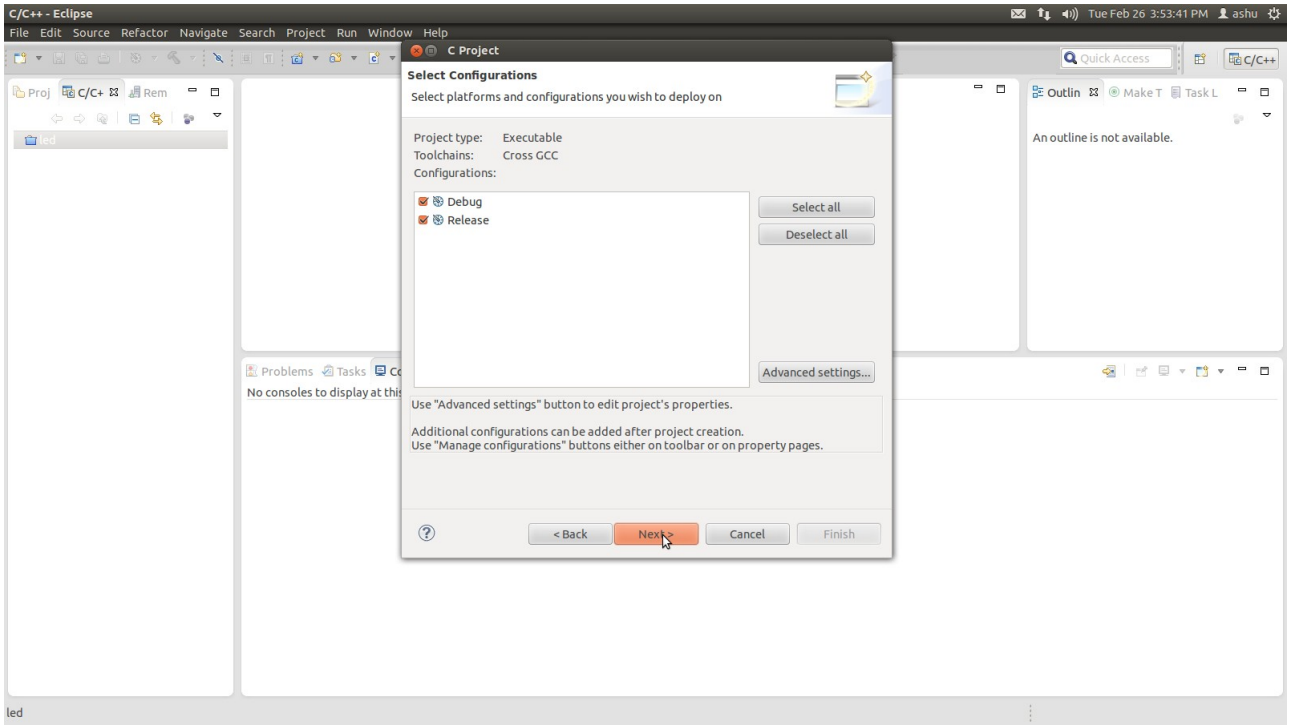
Select File ► New ► C Project from the menu bar

A new dialog will open.



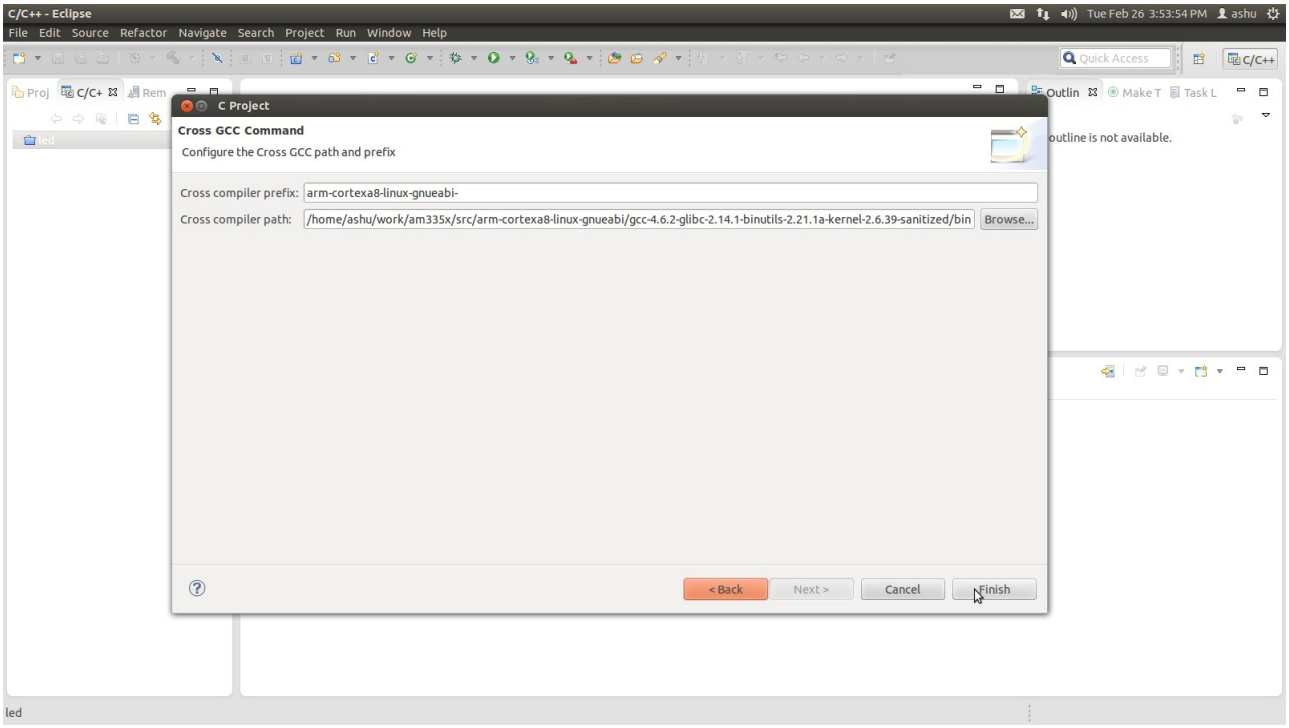
Enter the project name myled and Toolchain as Cross GCC then click Next

1.5.2. Select Debug Facilities



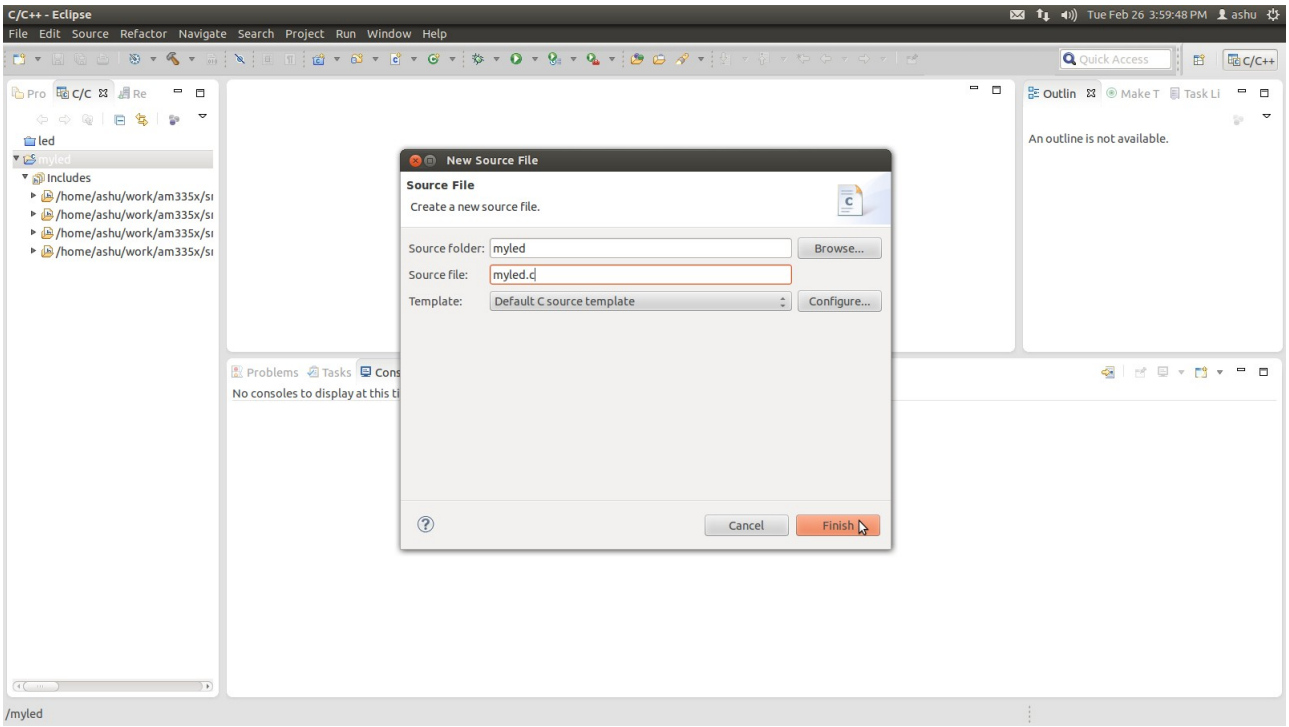
Click Next

1.5.3. Toolchain Prefix & Path



Select the Cross Compiler Prefix as **arm-cortexa8-linux-gnueabi-** and Cross Compiler Path as <path of toolchain bin>

1.5.4. Open new C source file



You will see the C/C++ IDE with the led project.

Right-click on led project

Select File ► New ► Source file from the menu bar

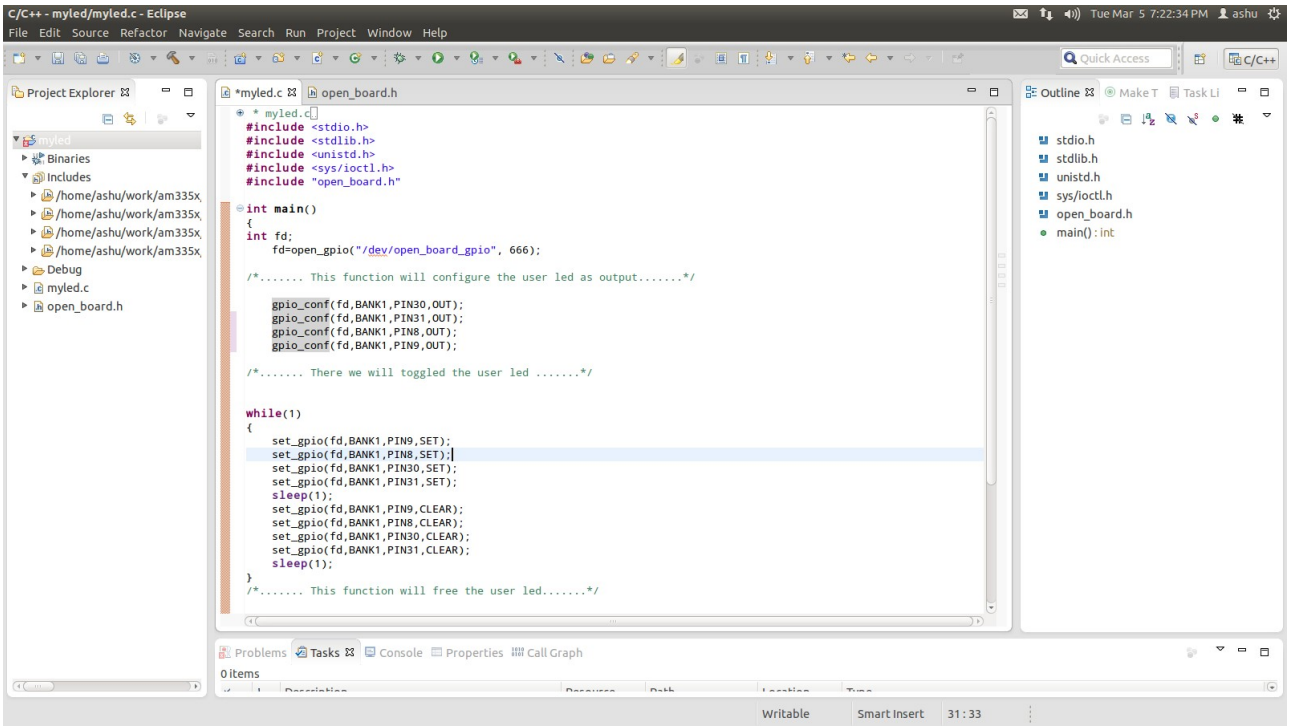
In Source file write myled.c and click on finish

1.5.5. Write Led Application

Then write a led application as:

```
/*************************************************************************
        Simple Application for blinking the user led on Cosmic-AM335x
                                File name: myled.c
*************************************************************************/

#include <stdio.h>
#include <stdlib.h>
#include <unistd.h>
#include <sys/ioctl.h>
#include "open_board.h"

int main()
{
        int fd;
        fd=open_gpio("/dev/open_board_gpio", 666);

/*..... This function will configure the user led as output.....*/

        gpio_conf(fd,BANK3,PIN7,OUT);
        gpio_conf(fd,BANK1,PIN27,OUT);
        gpio_conf(fd,BANK1,PIN26,OUT);
        gpio_conf(fd,BANK1,PIN21,OUT);

/*..... There we will toggled the user led .....*/

        while(1) {
                set_gpio(fd,BANK3,PIN7,SET);
                set_gpio(fd,BANK1,PIN27,SET);
                set_gpio(fd,BANK1,PIN26,SET);
                set_gpio(fd,BANK1,PIN21,SET);
                sleep(1);
                set_gpio(fd,BANK3,PIN7,CLEAR);
                set_gpio(fd,BANK1,PIN27,CLEAR);
                set_gpio(fd,BANK1,PIN26,CLEAR);
                set_gpio(fd,BANK1,PIN21,CLEAR);
                sleep(1);
        }

/*..... This function will free the user led.....*/
```

```
        gpio_free(fd,BANK3,PIN7);
        gpio_free(fd,BANK1,PIN27);
        gpio_free(fd,BANK1,PIN26);
        gpio_free(fd,BANK1,PIN21);

/*..... This function will close the node.....*/

        close_gpio(fd);
        return 0;
}
```



1.5.6. Write Cosmic Board Header

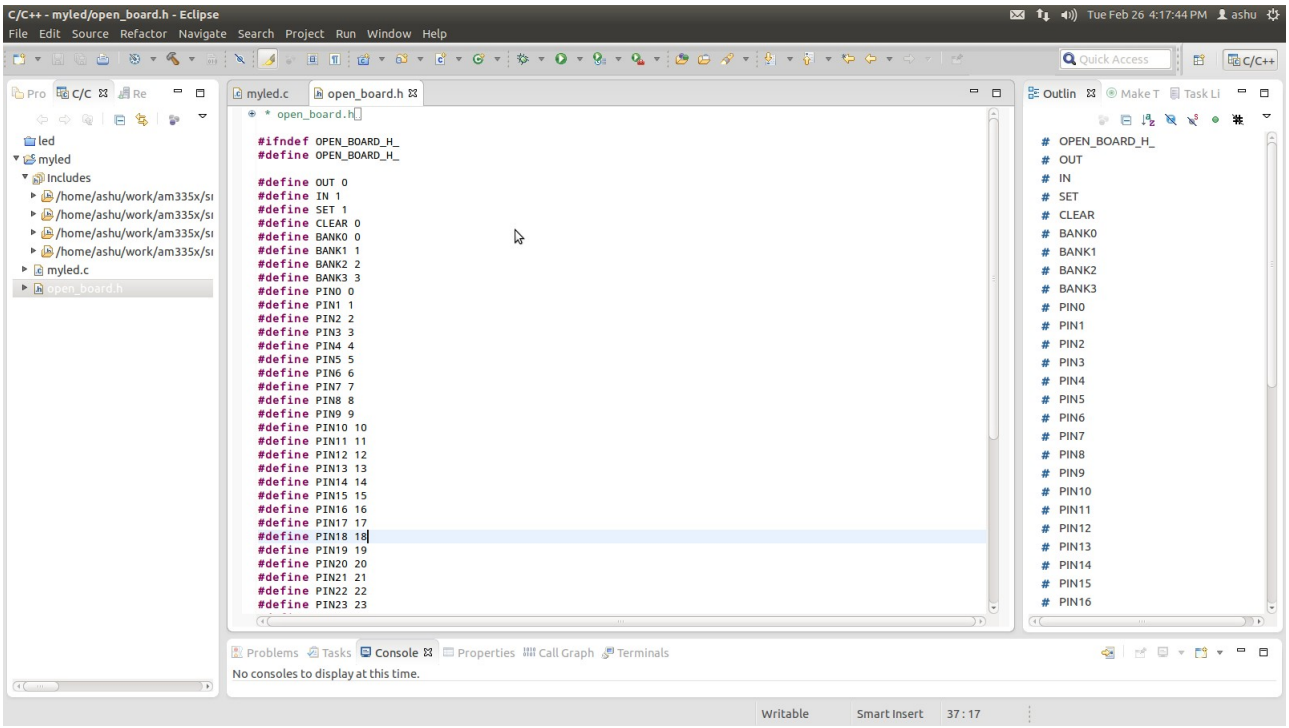
Select File ► New ► Header file from the menu bar

In Header file write open_board.h and click on finish

Then write the Header file as.

```
/*************************************************************************
        Simple Application for blinking the user led on Cosmic-AM335x
                        File name: open_board.h
*************************************************************************/

#ifndef OPEN_BOARD_H_
#define OPEN_BOARD_H_
#define OUT 0
#define IN 1
#define SET 1
```

```
#define CLEAR 0
#define BANK0 0
#define BANK1 1
#define BANK2 2
#define BANK3 3
#define PIN0 0
#define PIN1 1
#define PIN2 2
#define PIN3 3
#define PIN4 4
#define PIN5 5
#define PIN6 6
#define PIN7 7
#define PIN8 8
#define PIN9 9
#define PIN10 10
#define PIN11 11
#define PIN12 12
#define PIN13 13
#define PIN14 14
#define PIN15 15
#define PIN16 16
#define PIN17 17
#define PIN18 18
#define PIN19 19
#define PIN20 20
#define PIN21 21
#define PIN22 22
#define PIN23 23
#define PIN24 24
#define PIN25 25
#define PIN26 26
#define PIN27 27
#define PIN28 28
#define PIN29 29
#define PIN30 30
#define PIN31 31

int open_gpio(char *node, int per);
int gpio_conf(int fd, int bank, int pin, int dir);
int gpio_intr_conf(int fd, int bank, int pin, int dir);
int gpio_free(int fd, int bank, int pin);
int gpio_intr_free(int fd, int bank, int pin);
int set_gpio(int fd, int bank, int pin, int value);
int close_gpio(int fd);
unsigned int read_interupt(int fd, int bank, int pin);

#endif /* OPEN_BOARD_H_ */
```



1.5.7. Modify the Library Path

These above functions are in the shared library so we are going to add our shared library to this project. You can download led and user button library from Phytec FTP using this link

ftp://ftp.phytec.de/pub/Products/India/Cosmic-AM335x/Linux/PD13.0.0/src/apps/apps.tar.bz2

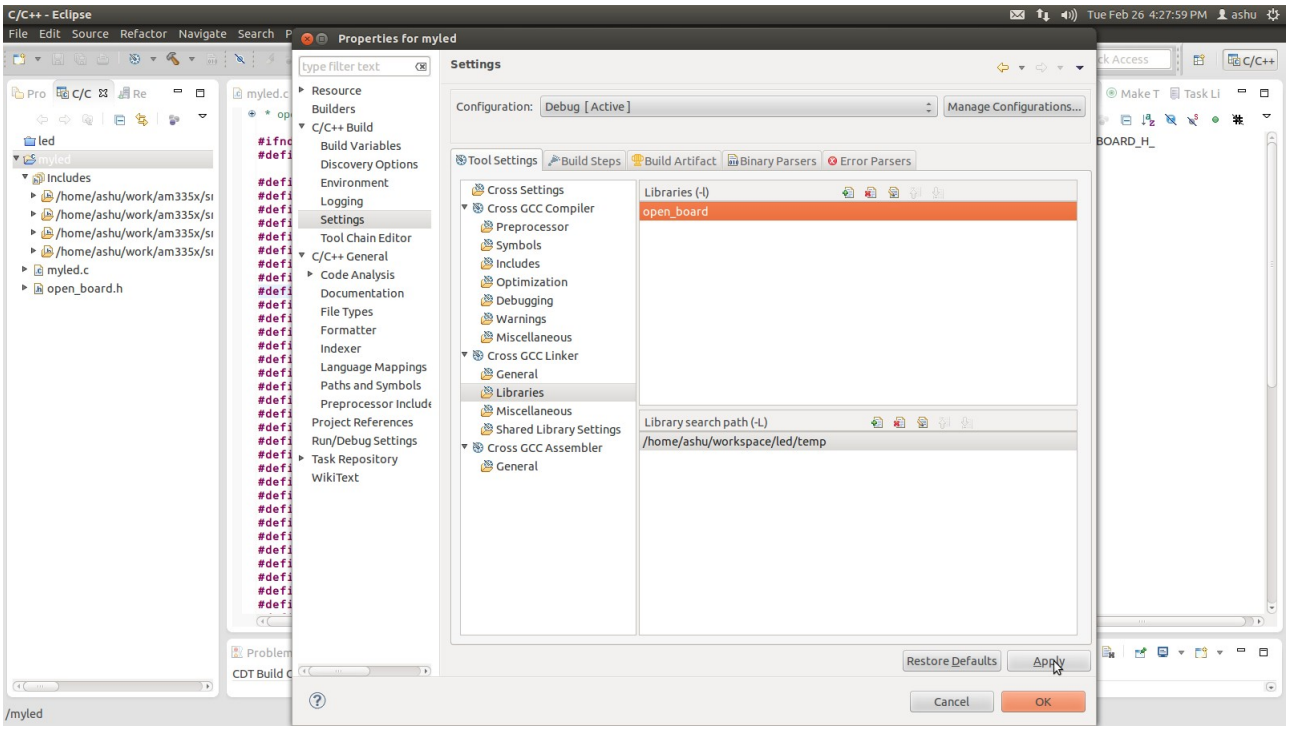
untar it and go to the led app directory where you find the library file, this is your library path.

Right-click the led project and chose Properties

The Properties dialog appears.

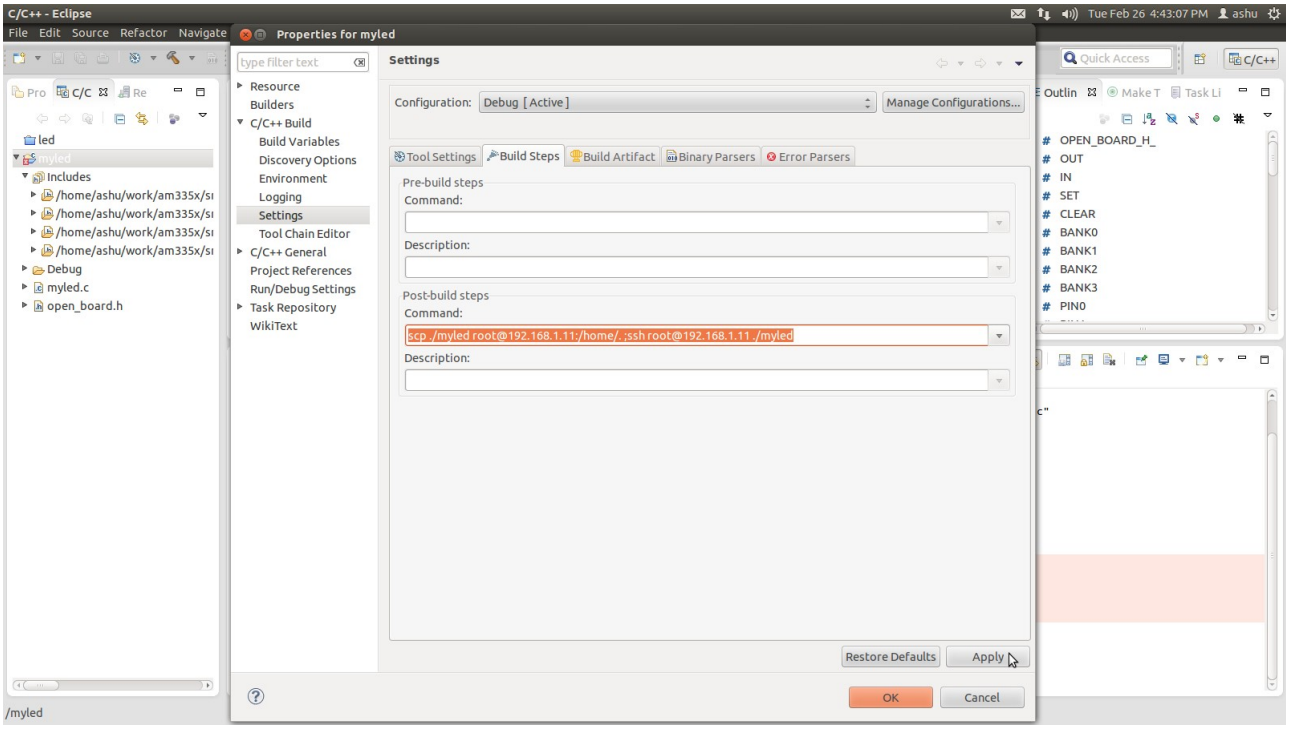
Select C/C++ Build ► Setting ► tools setting ► Cross GCC Linker ► Libraries

There add new Libraries (-l) as open_board
and Library search path (-L) as <location of your library >



1.5.8. Modify Post build steps

Select the Build Steps tab



Enter the following command in the Post-build steps Command input field:

scp ./myled root@192.168.1.11:/home/. ;ssh root@192.168.1.11 ./myled

Click Apply and then Click OK
Before building your application we need the drivers for led which is already in the Cosmic Board root file in home directory:

/home/led/driver.ko

we have to insert this driver before using the application so for this you have a remote access of the Cosmic board.

Note: Led driver (driver.ko) is default inserted.

1.5.9. Remote System Access using Eclipse

For Windows :

You have to set the address manually

connect ethernet cable

Go to network connections

right click on "Local area connection" ► properties ► under general tab

double click on "Internet Protocol(TCP/IP)"

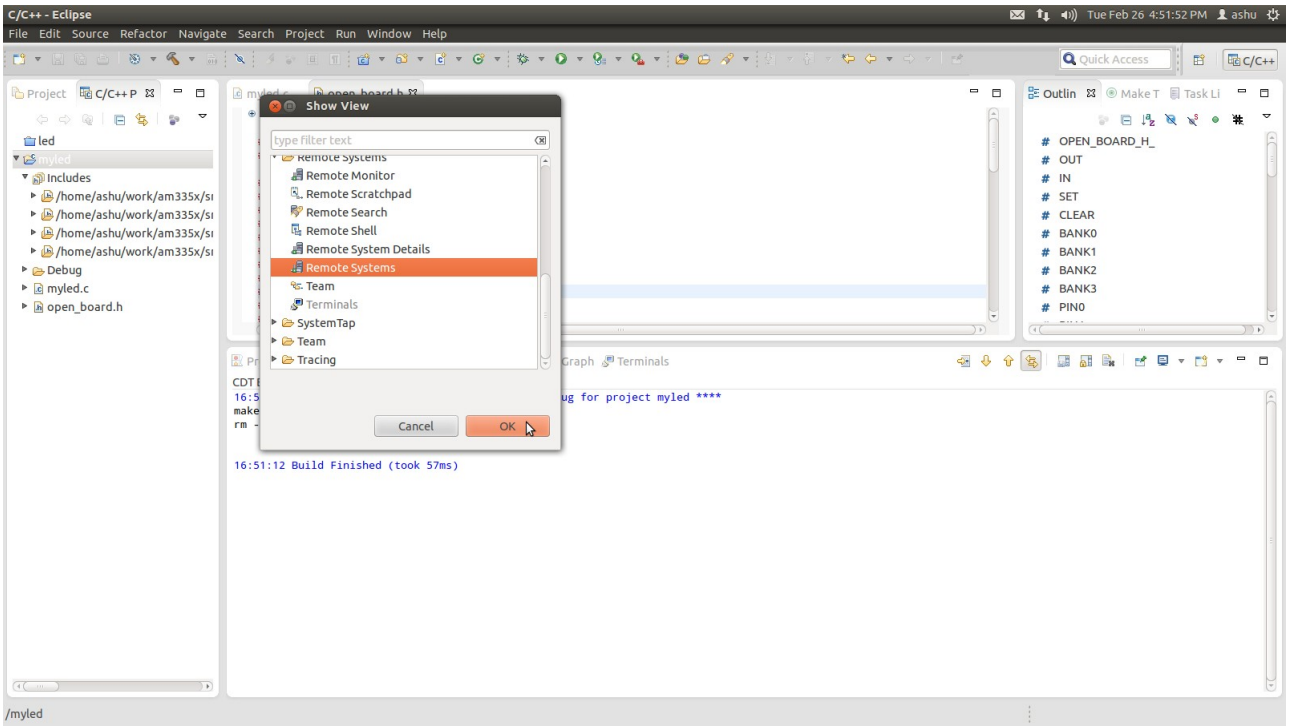
change the parameters

For Linux :

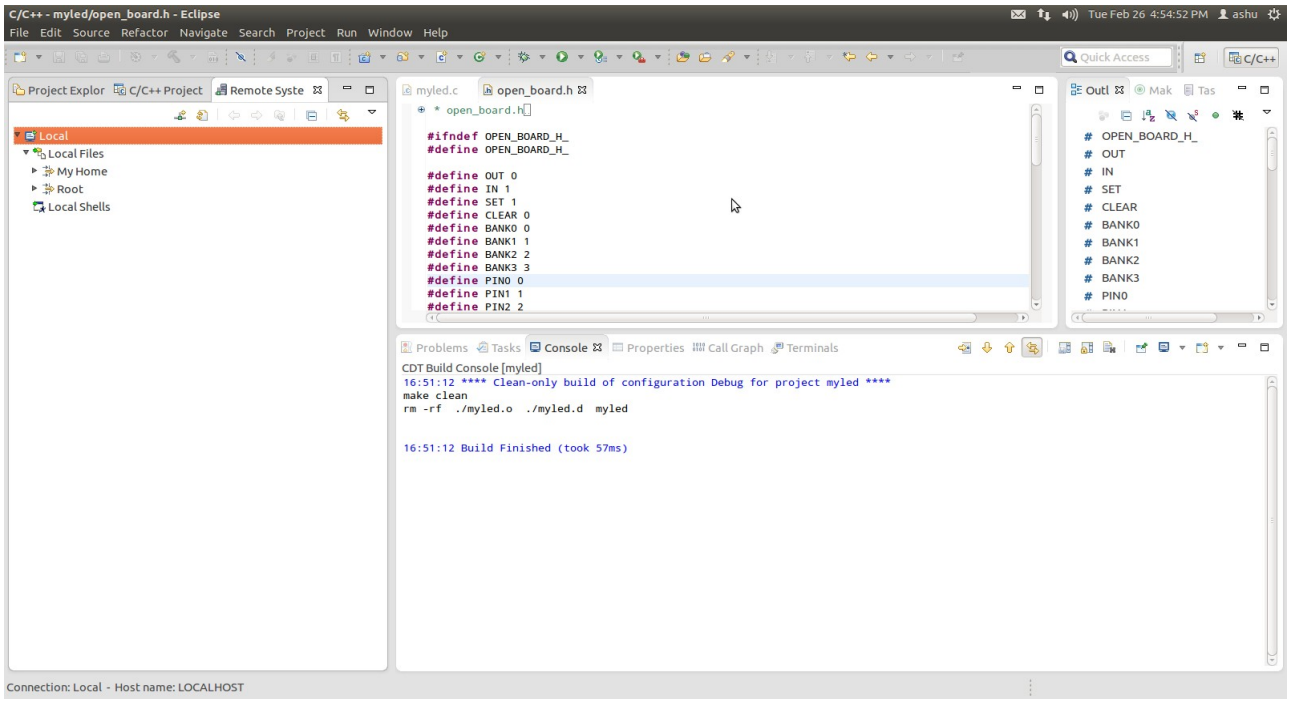
You have to set the address manually ,for this refer section 1.2.1.1

Left-click the Window tab.

Show view ► others ► Remote Systems
and ok



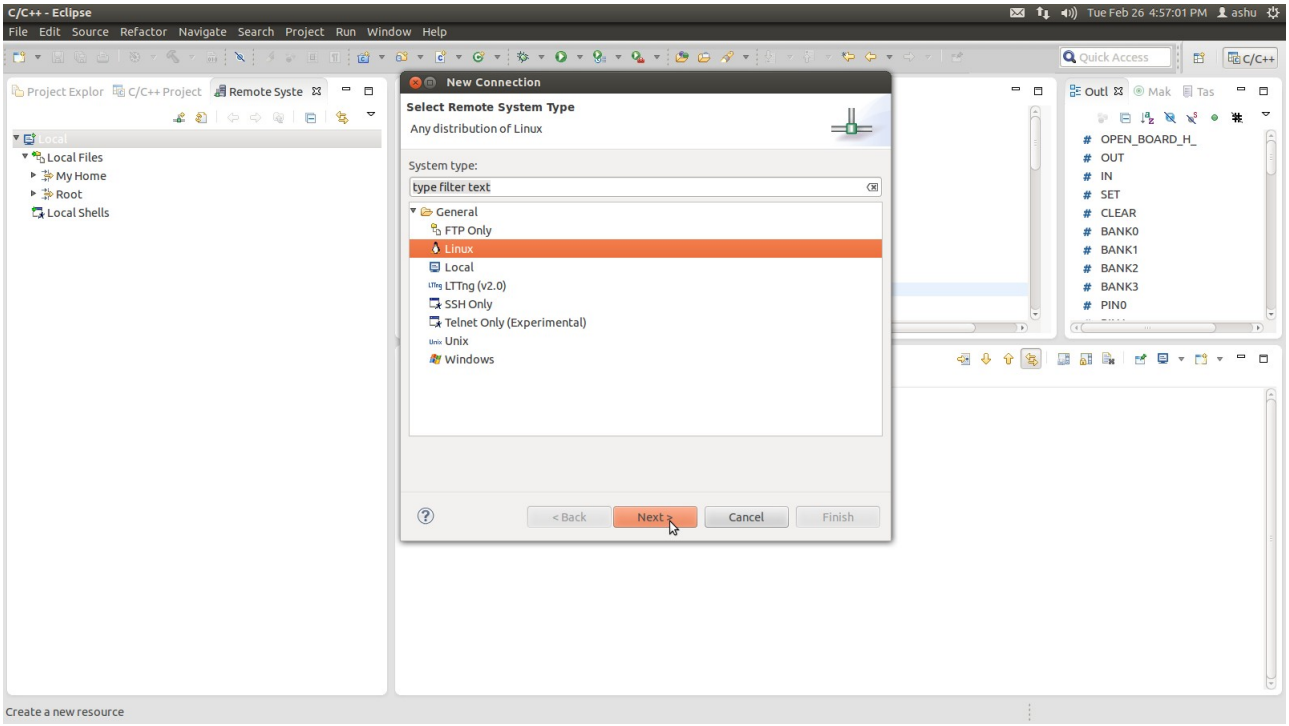
Now you are able to see the remote system page.



1.5.10. Create New Connection for Remote System login

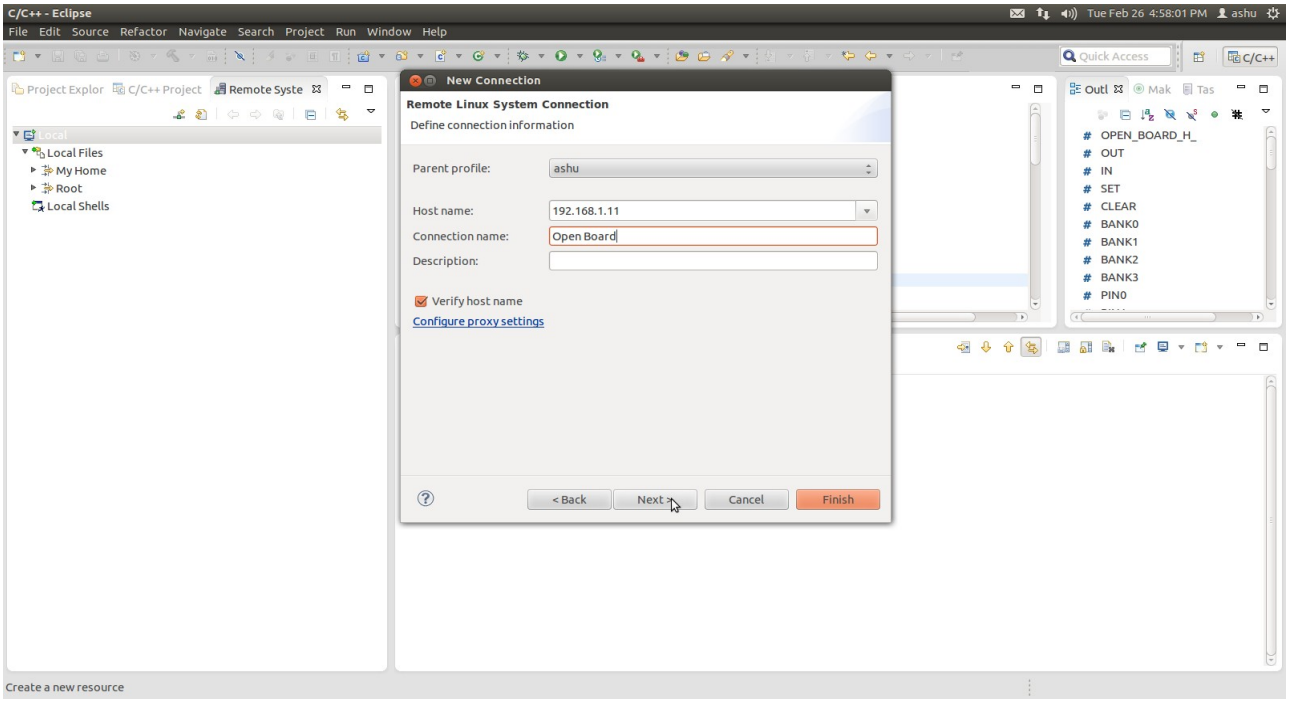
Right Click on Local select new connection

select linux

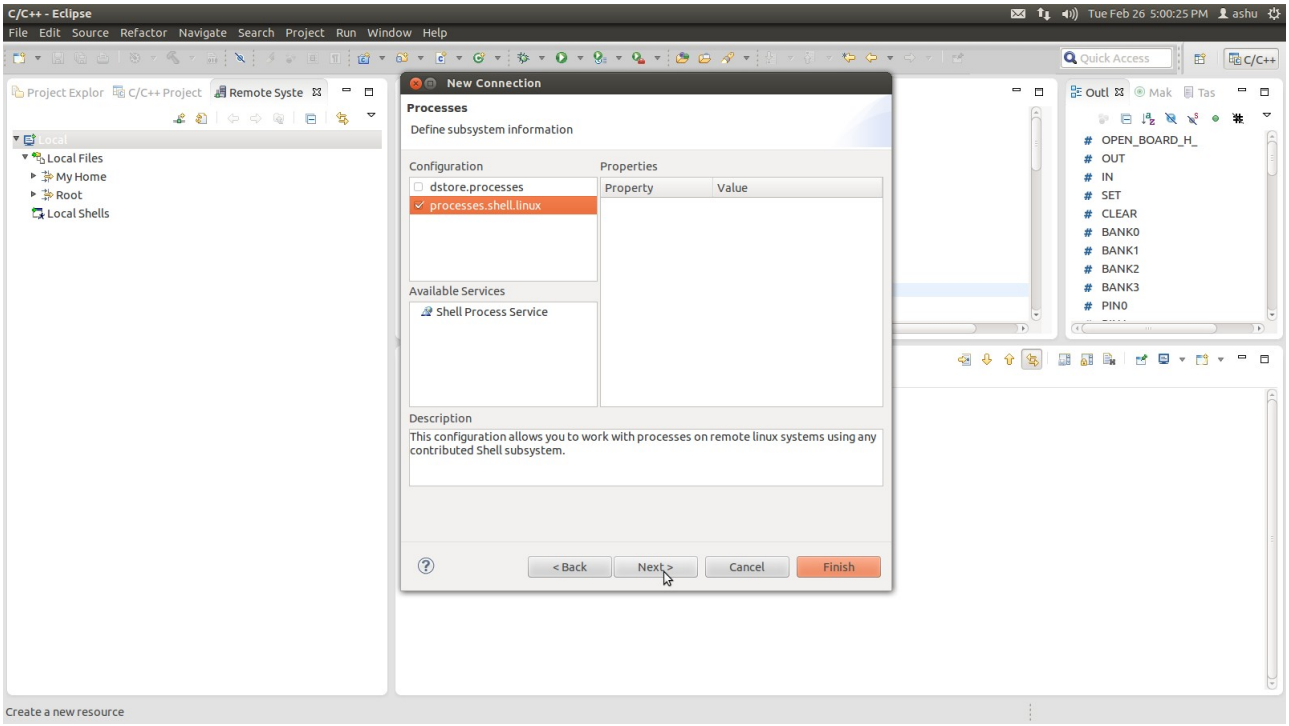


1.5.11. Set the Host Name and IP

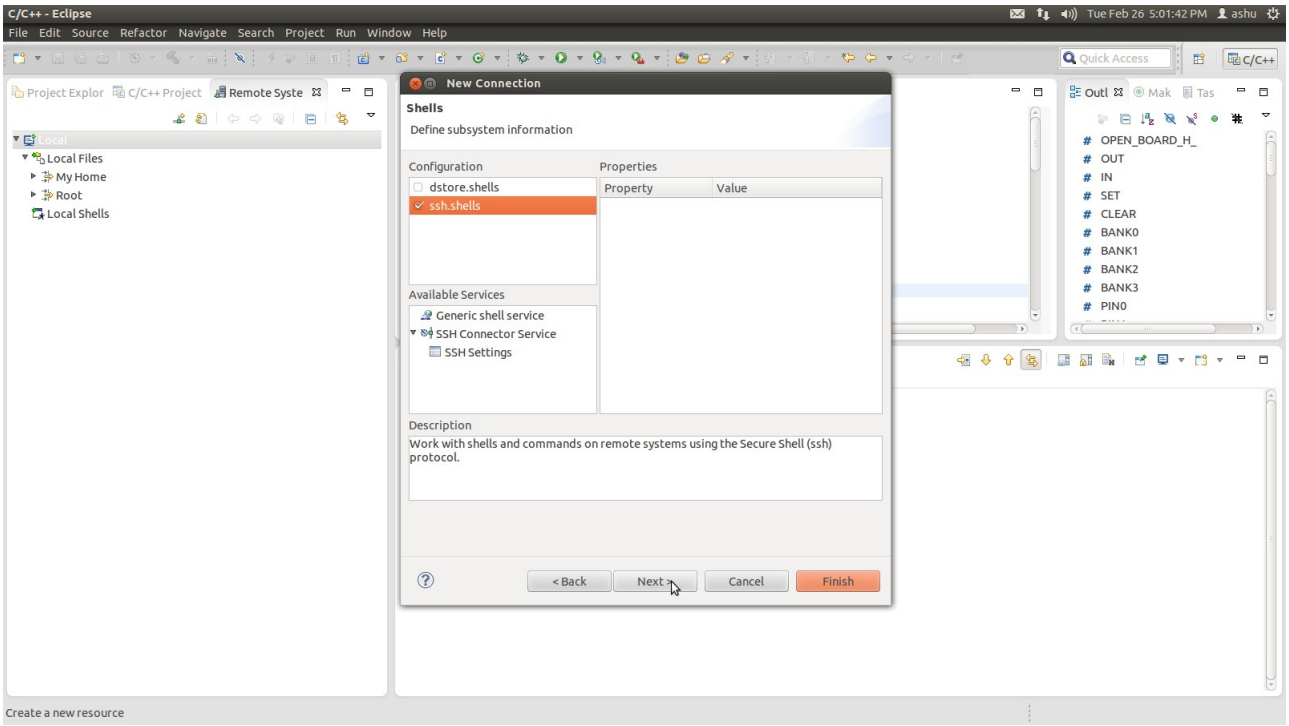
Then write Host name as 192.168.1.11 and connection name as OpenBoard.



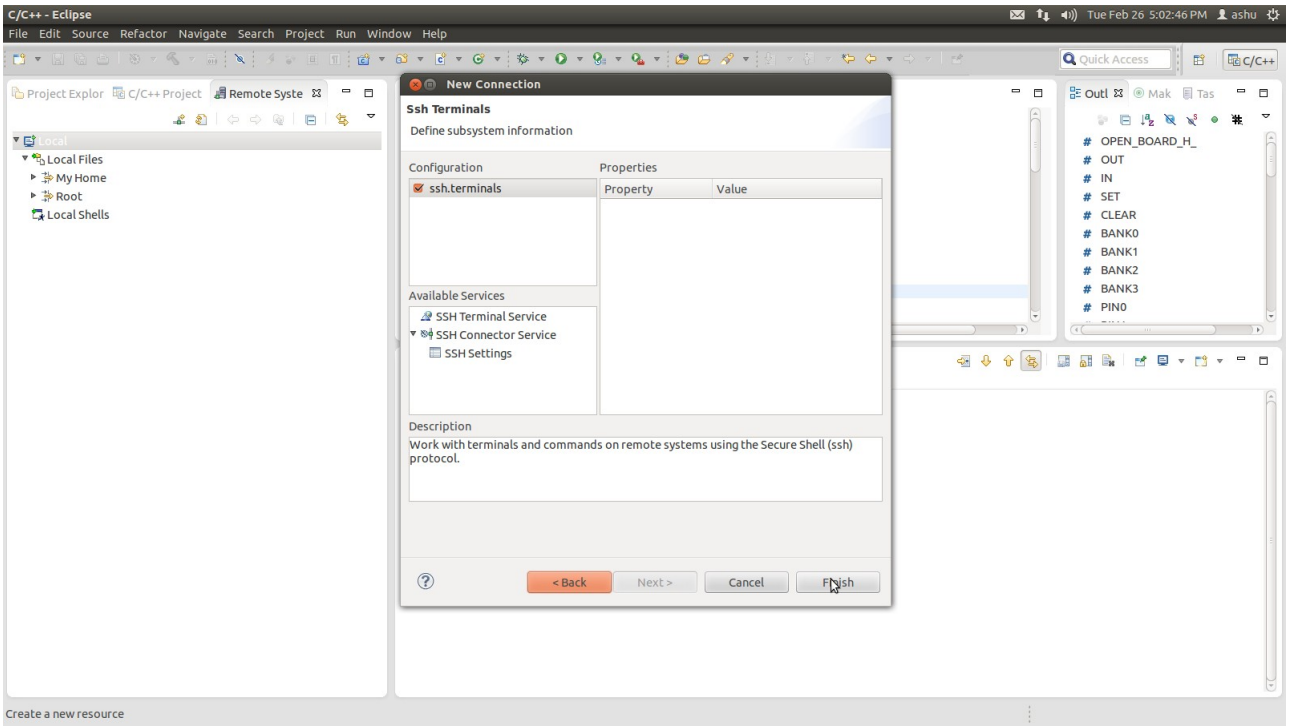
Select ssh.files



select processes.shell.linux and next

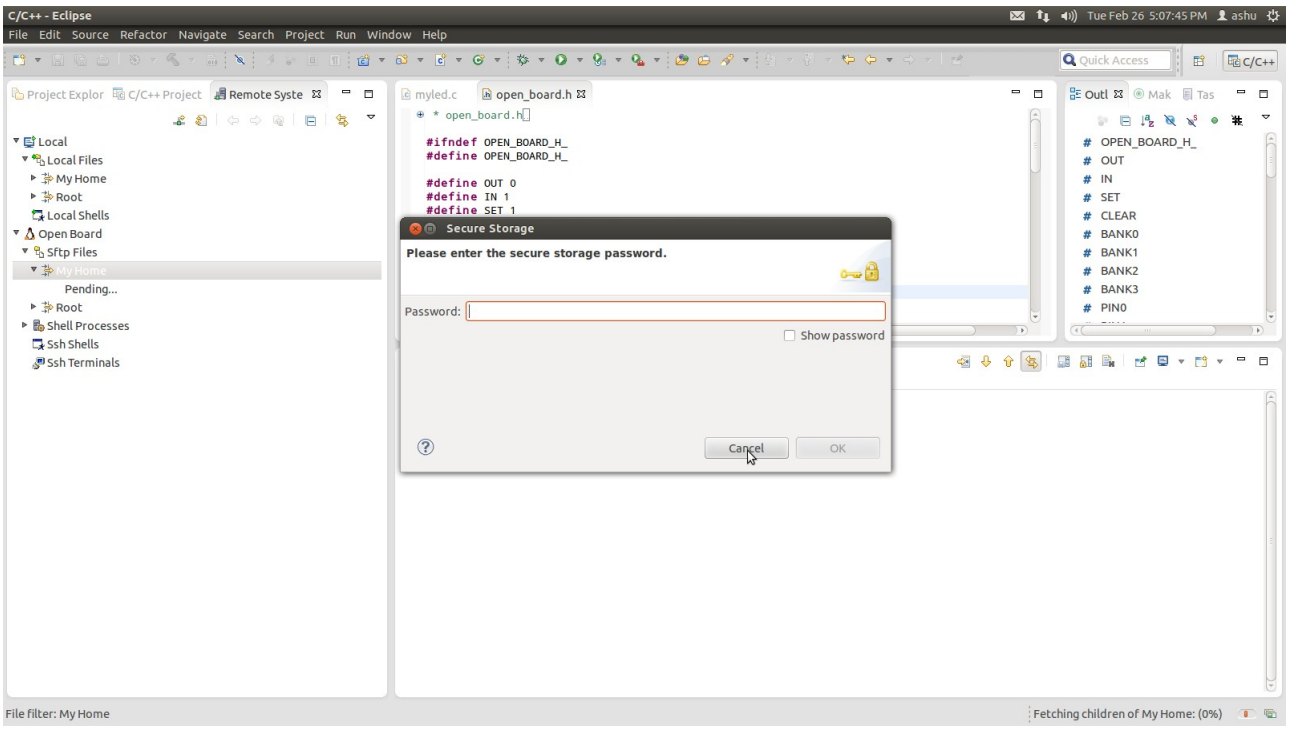


select ssh.shells and next

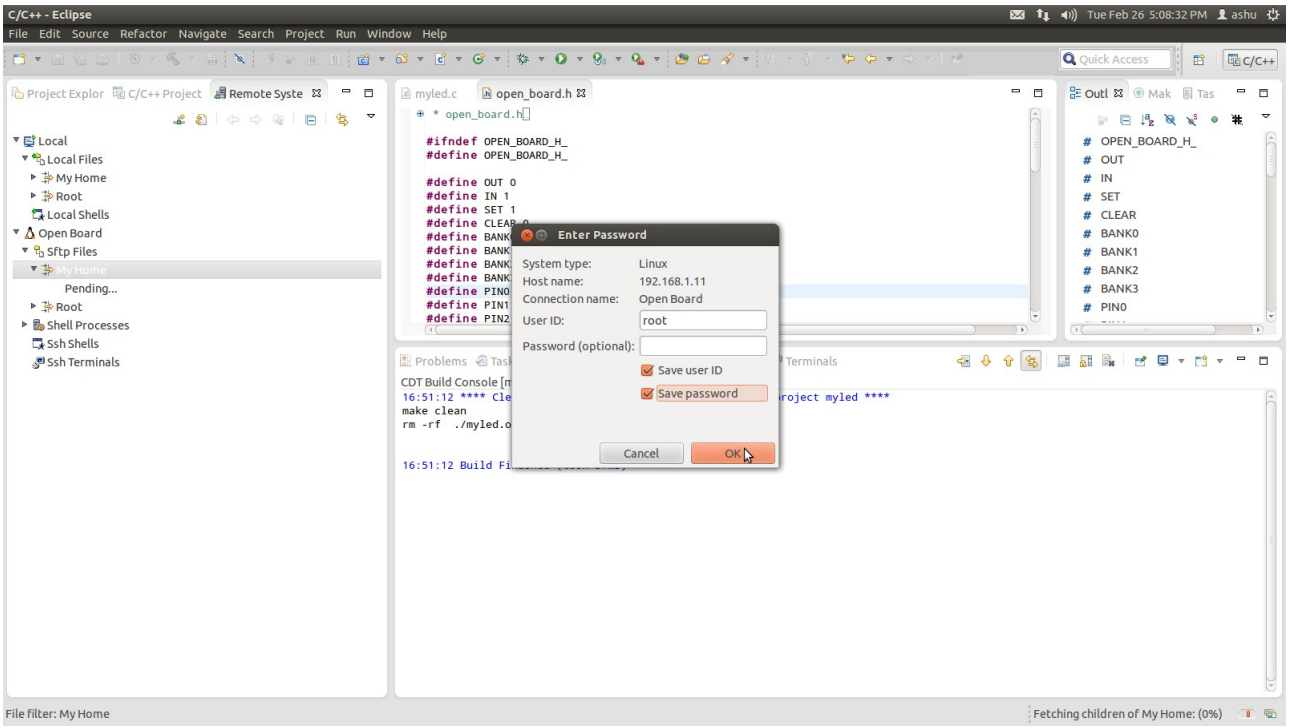


select ssh.terminals and finish

Now we successfully create the connection.
Click on the Open Board My Home

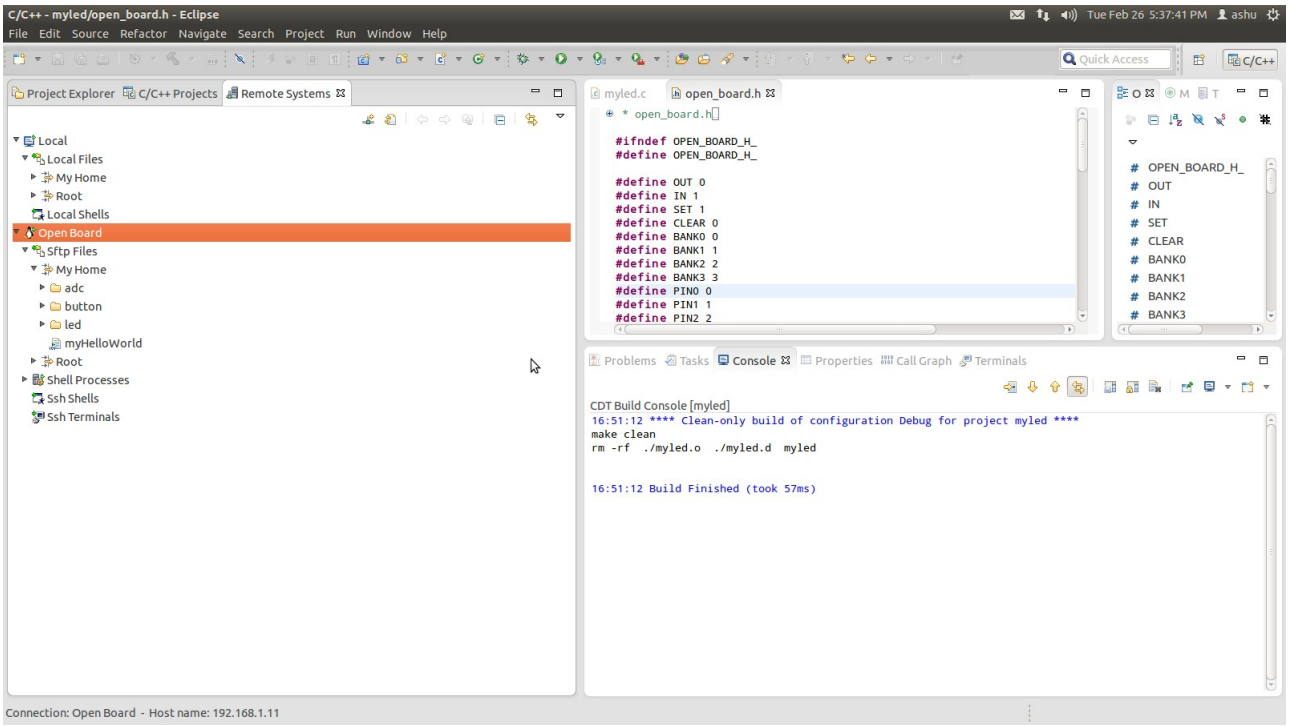


Then a secure Storage tab is opened just cancelled it.



Type User ID as **root**
leave password as blank. Then press OK.

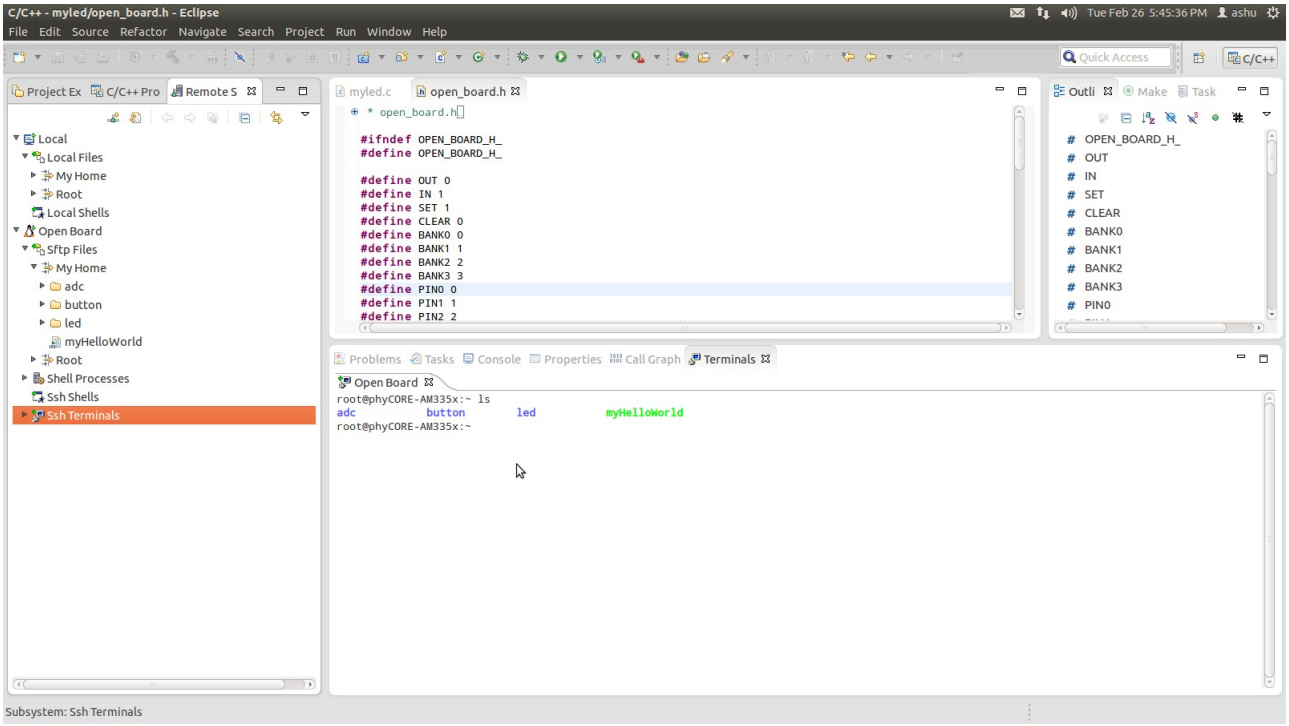
1.5.12. Launch the Remote Terminal



Now we can see all the contents of Open Board.

If you want to open the Cosmic Board terminal just Right click on ssh Terminal

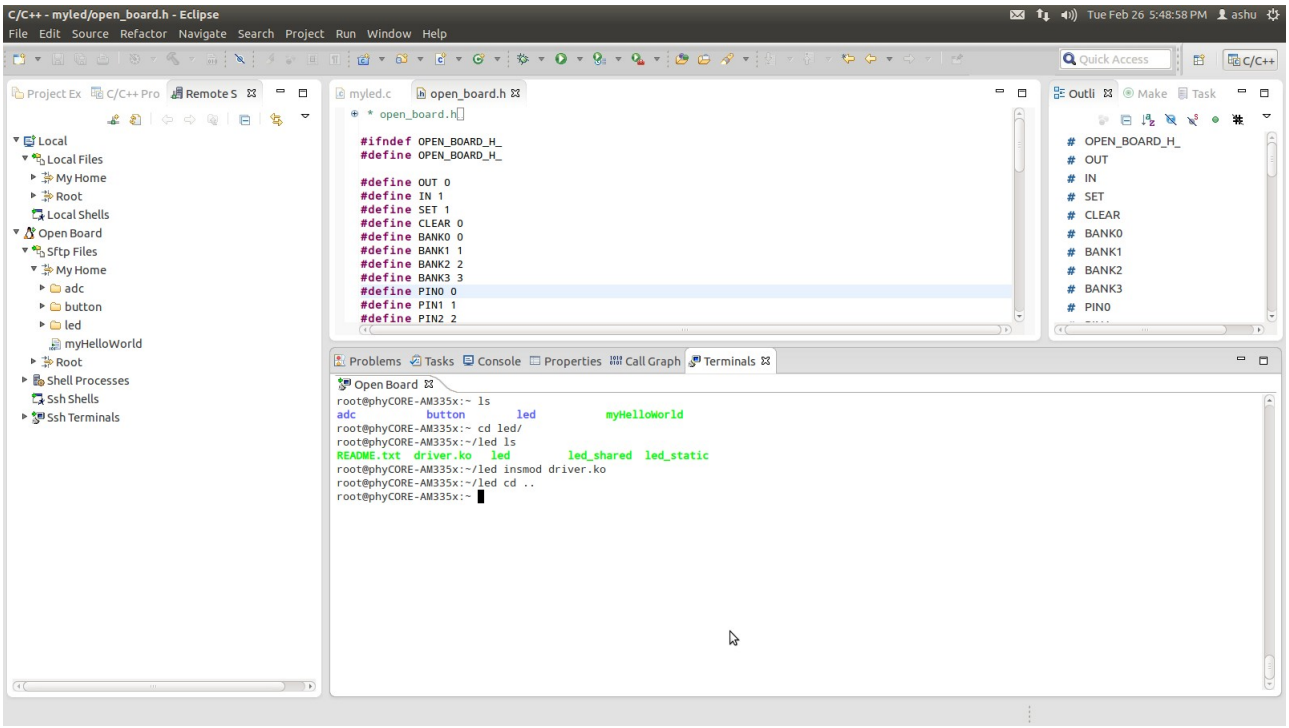
and click on the Launch Terminal.



1.5.13. Insert the driver using the Remote Terminal

Go to the led directory and insert the driver into the kernel space.

```
# cd led
# ls
# insmod driver.ko
```



Since the driver is inserted in the kernel space now we can run our application

1.5.13. Finally Build the project

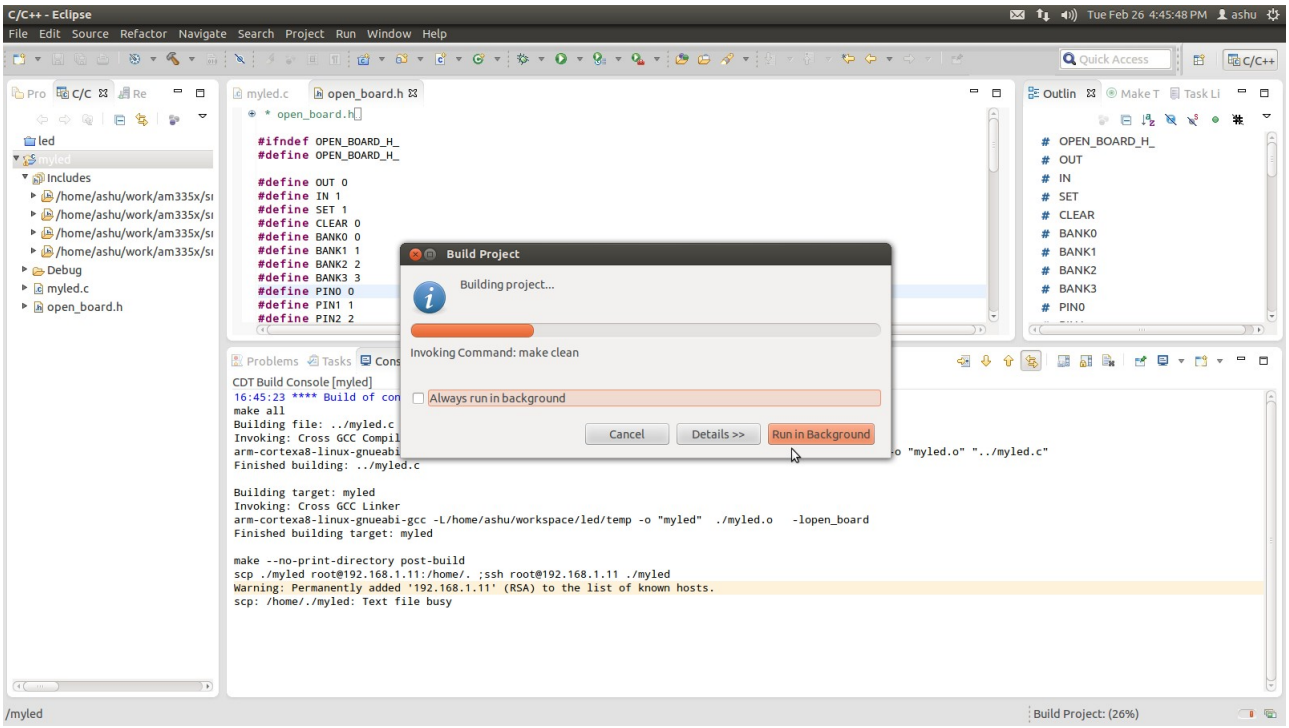
Select Project ► Build project from the menu bar

The project will be built.

Select the Console tab.

if no errors occur while building the project, you will see the following output:

It will ask for a confirmation the type **yes** to allow.



All 4 led's starts blinking.

1.6. Debugging an example project

In this chapter you will learn using the GNU debugger GDB on the host for remote debugging in conjunction with the GDB server on the target. GDB is the symbolic debugger of the GNU project and is arguably the most important debugging tool for any Linux system. First you will start the GDB server on the target. Then you will configure the Eclipse platform and start the GNU debugger out of Eclipse using the Debug view. The CDT extends the standard Eclipse Debug view with functions for debugging C/C++ code. The Debug view allows you to manage the debugging and running of a program in the workbench. Using the Debug view you will be able to set breakpoints/watchpoints in the code and trace variables and registers. The Debug view displays the stack frame for the threads of each target you are debugging. Each thread in your program appears as a node in the tree, and the Debug view displays the process for each target you are running. The GDB client is running on the host and is used to control the GDB server on the target, which in turn controls the application running on the target. GDB client and GDB server can communicate over a TCP/IP network connection as well as via a serial interface. In this Quickstart we will only describe debugging via TCP/IP.

1.6.1. Starting the GDB server on the target

In this passage you will learn how to start the GDB server on the target. The GDB server will be used to start and control the myHelloWorld program.

To debug a program with GDB, the program needs extended debugging symbols.

This has already been added while building the program.

Open Minicom

minicom -D /dev/ttyXX

Type “root” and press Enter

Start the GDB server:

gdbserver 192.168.1.11:10000 myled

You have started the GDB server on the target. The GDB server is now waiting for

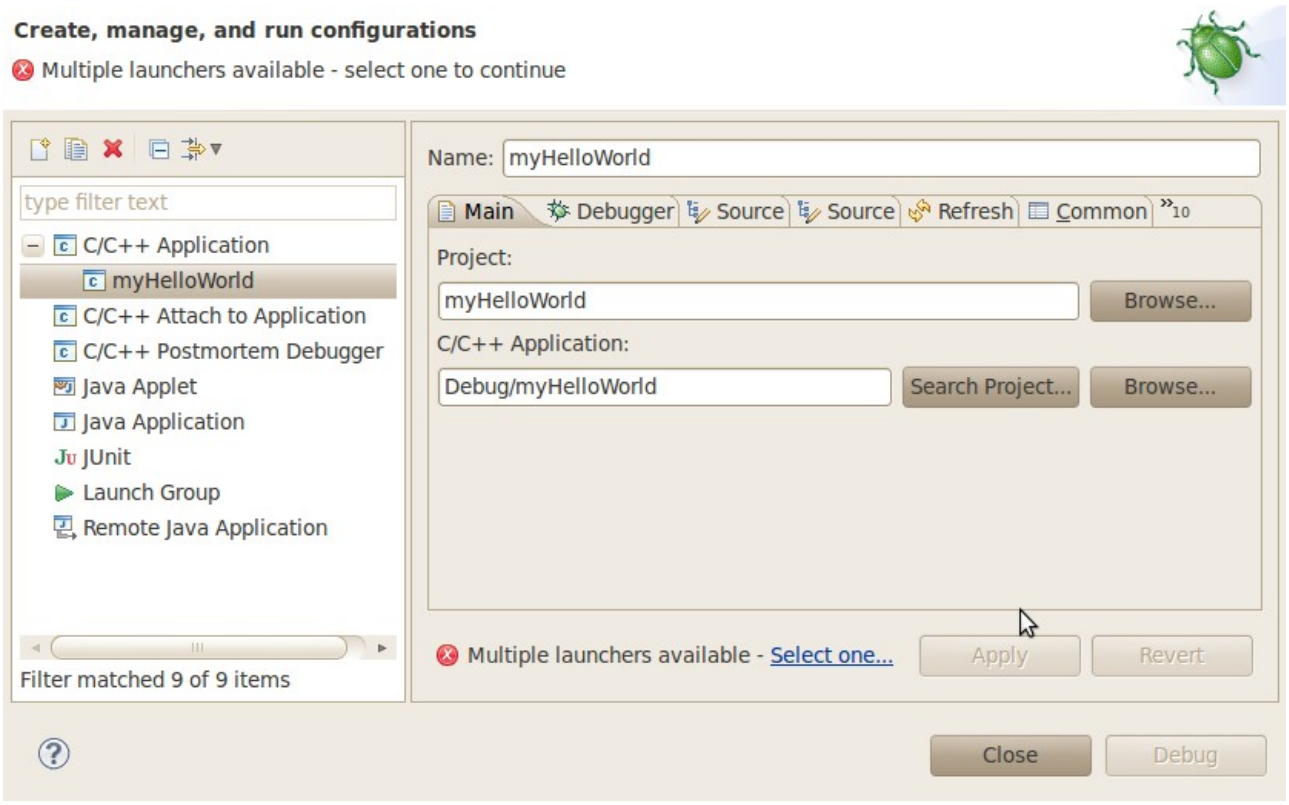
connections on TCP port 10000.

1.6.2. Configuring and starting the debugger in Eclipse

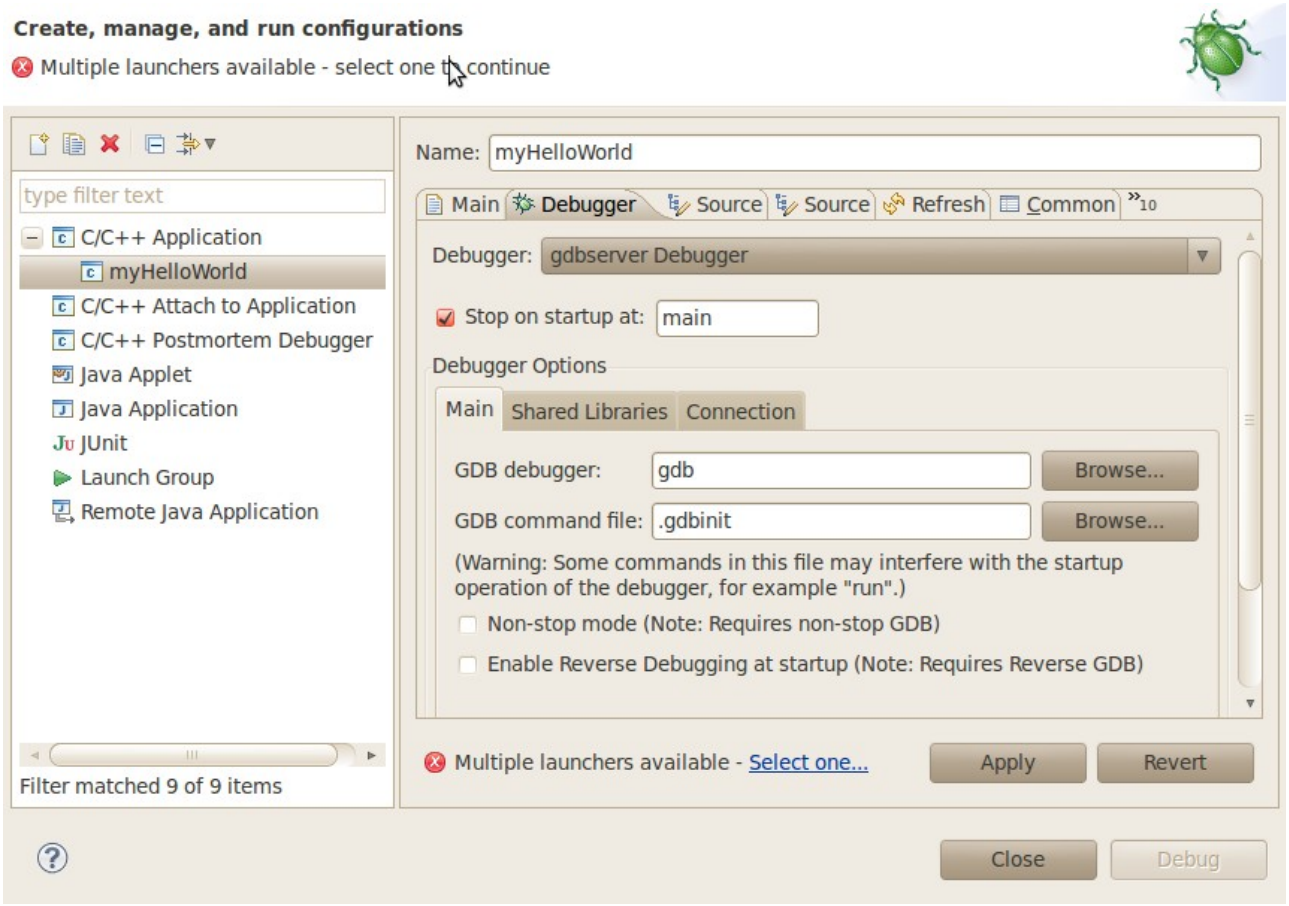
In this passage you will learn how to configure your project settings to use Eclipse with the GNU debugger. After the configuration of your project settings, the GNU debugger will start and connect to the GDB server on the target.

- Start Eclipse if the application is not started yet
- Right-click on the myHelloWorld project in the Navigator window
- Select Debug As ► Debug Configurations

  A dialog to create, manage and run applications appears.
- Select myHelloWorld under C/C++ Application



Select the Debugger tab



Select gdbserver Debugger from the Debugger drop-down box

Click the Browse button right beside the GDB debugger input field.

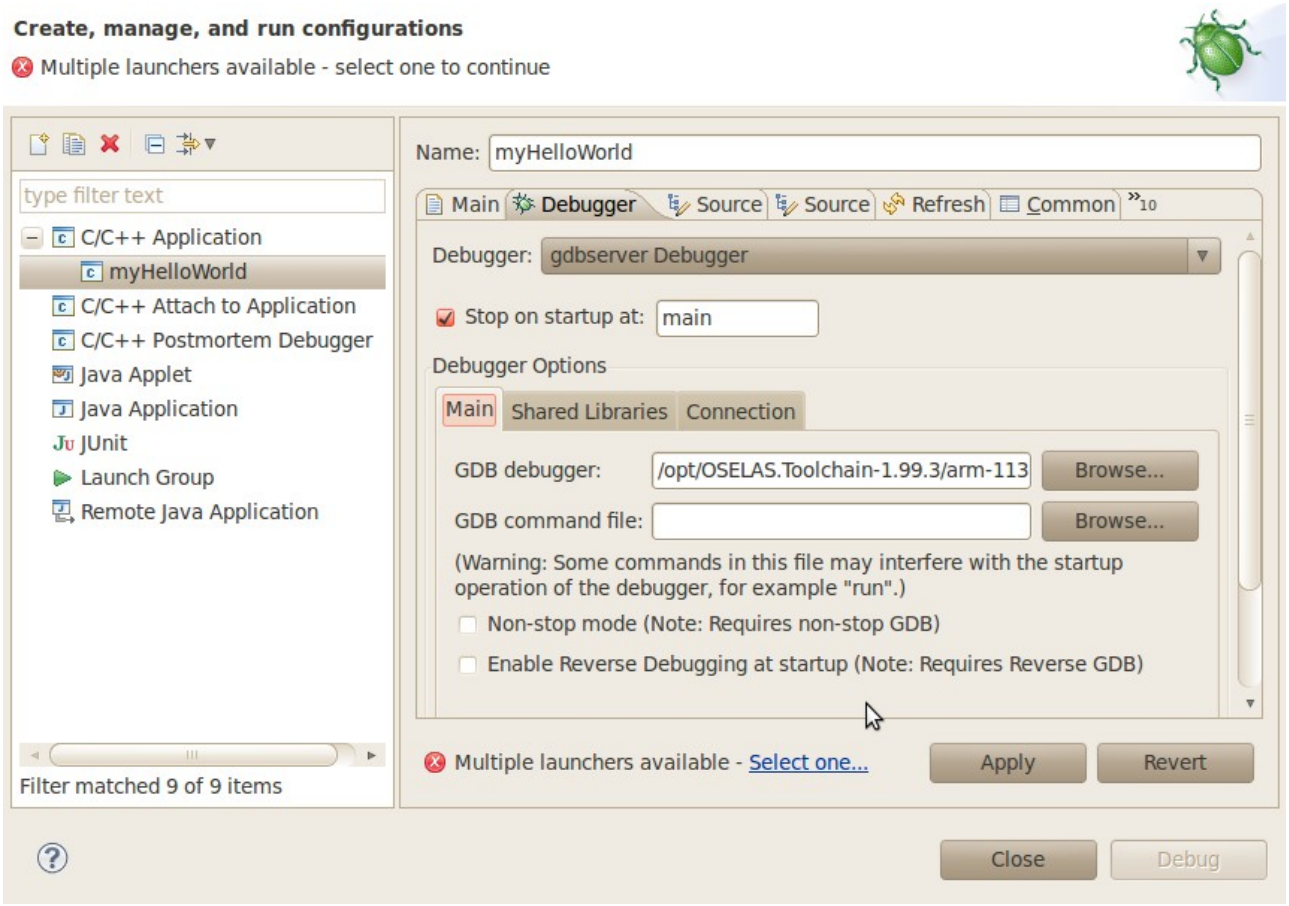
A new dialog opens to choose the GDB executable.

Click on File System

Navigate to the directory <Path of the Toolchain>/bin

Select the file arm-cortexa8-linux-gnueabi-gdb

Click OK

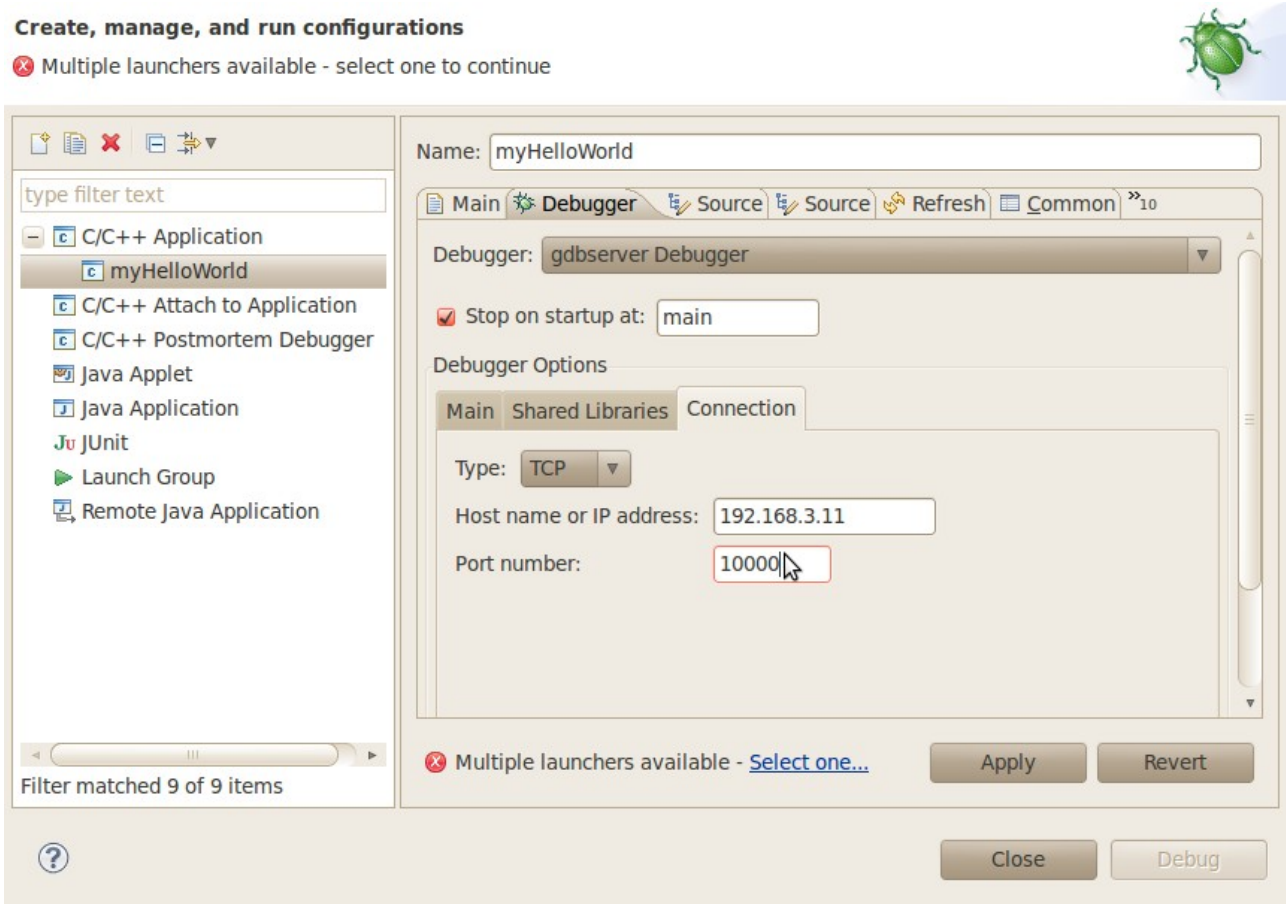


Keep the GDB command file field empty

Select the Connection tab and select TCP in the drop-down box

Enter 192.168.1.11 (the target's IP address) in the Host name input field.

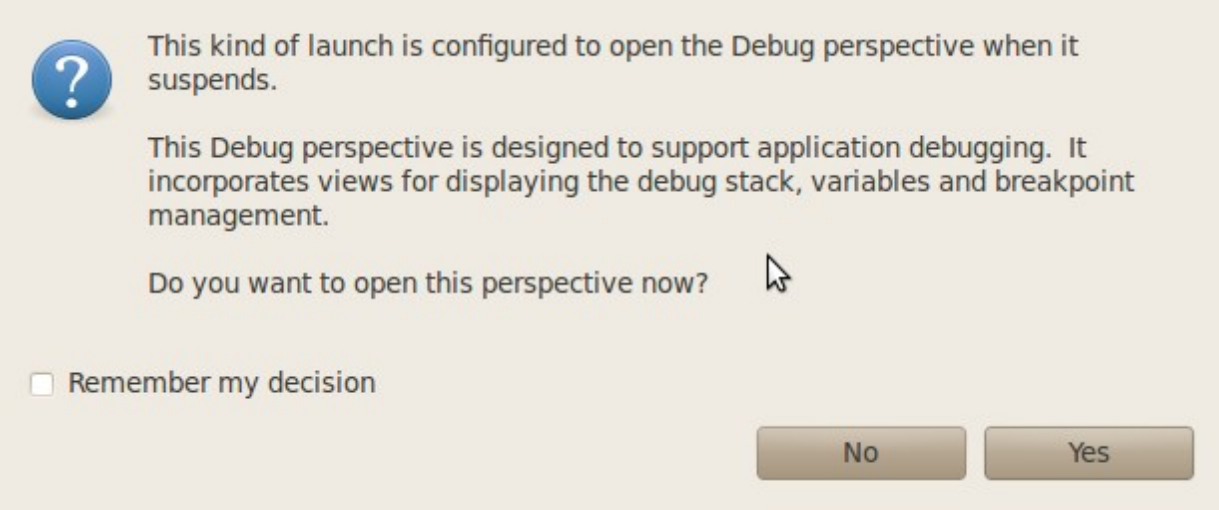
The host's GDB will connect to this IP address to communicate with the target's GDB server



Click Apply

Click Debug

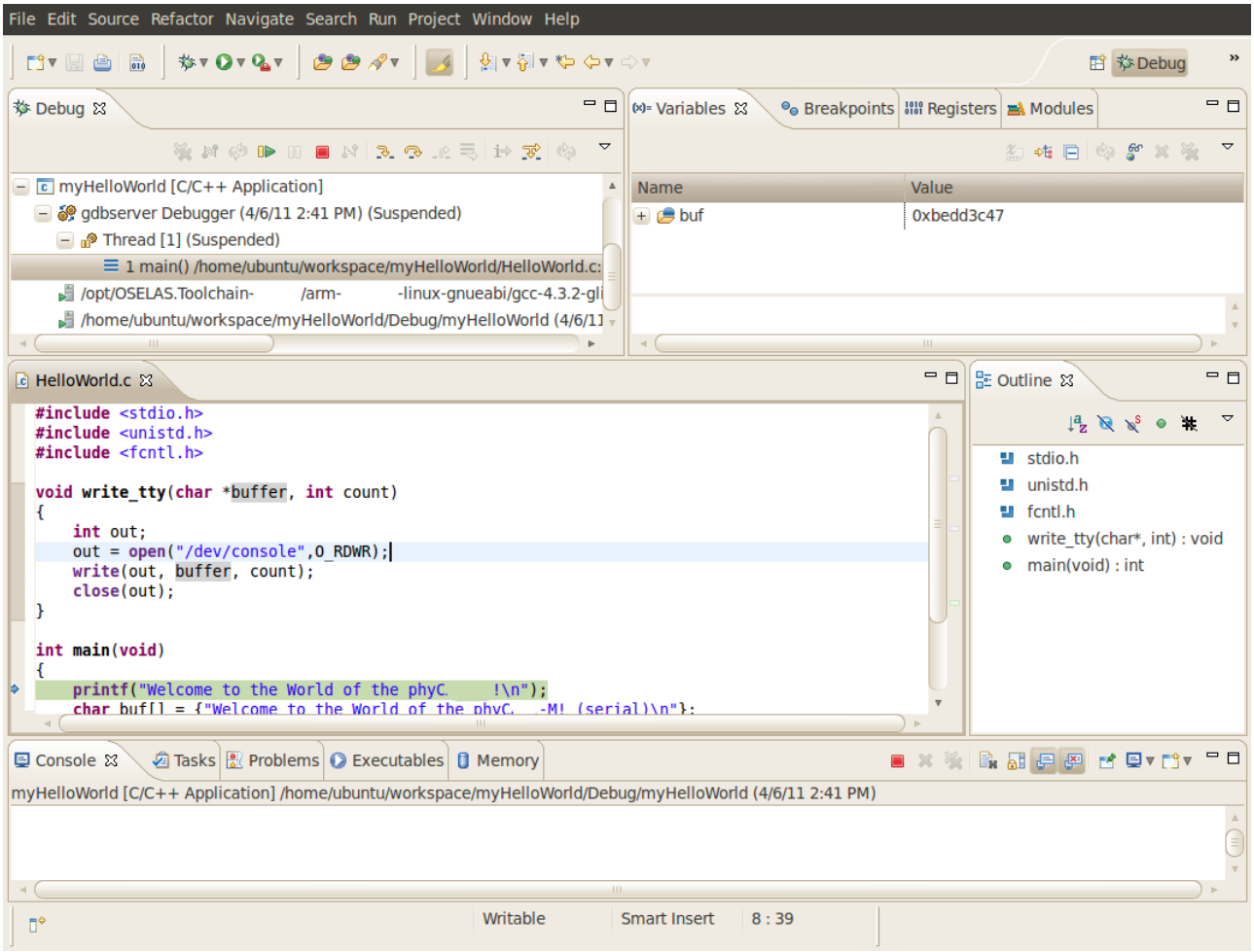
A new dialog appears.



Select Yes to switch to the Debug perspective

The debug perspective opens and the debugger stops automatically at the first line.

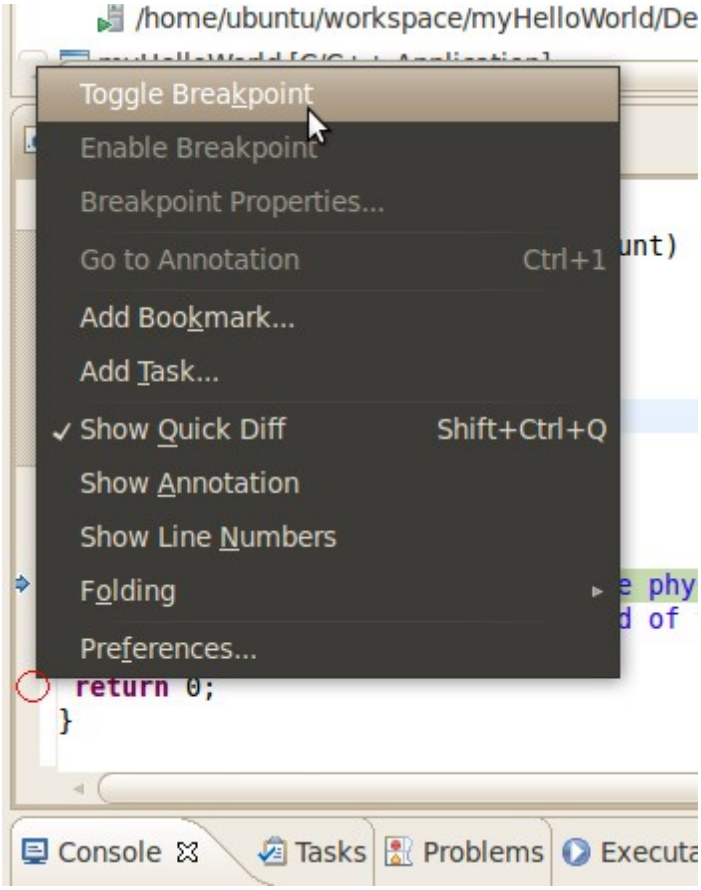
The host's GDB is now connected to the GDB server on the target.



You have configured your project for remote debugging. You have started the GNU debugger in Eclipse and connected the host's GDB with the target's GDB server. You can now start to debug the project.

1.6.3. Setting a Breakpoint

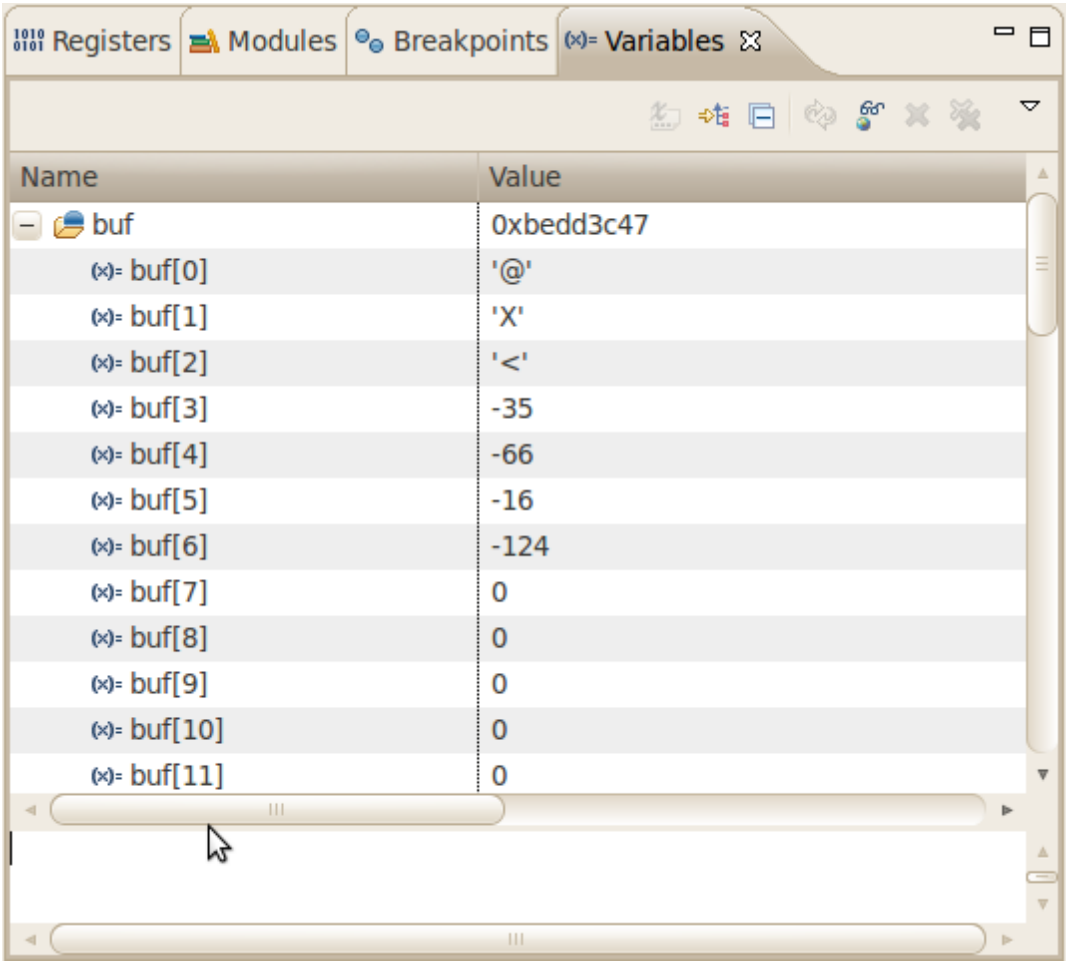
Now you will set a breakpoint in your program. The breakpoint will be set on the last line of the function main(). If you resume the application, the debugger will stop on this line.



Select the last line in main() .Right-click into the small grey border on the left-hand side and select Toggle Breakpoint to set a new breakpoint

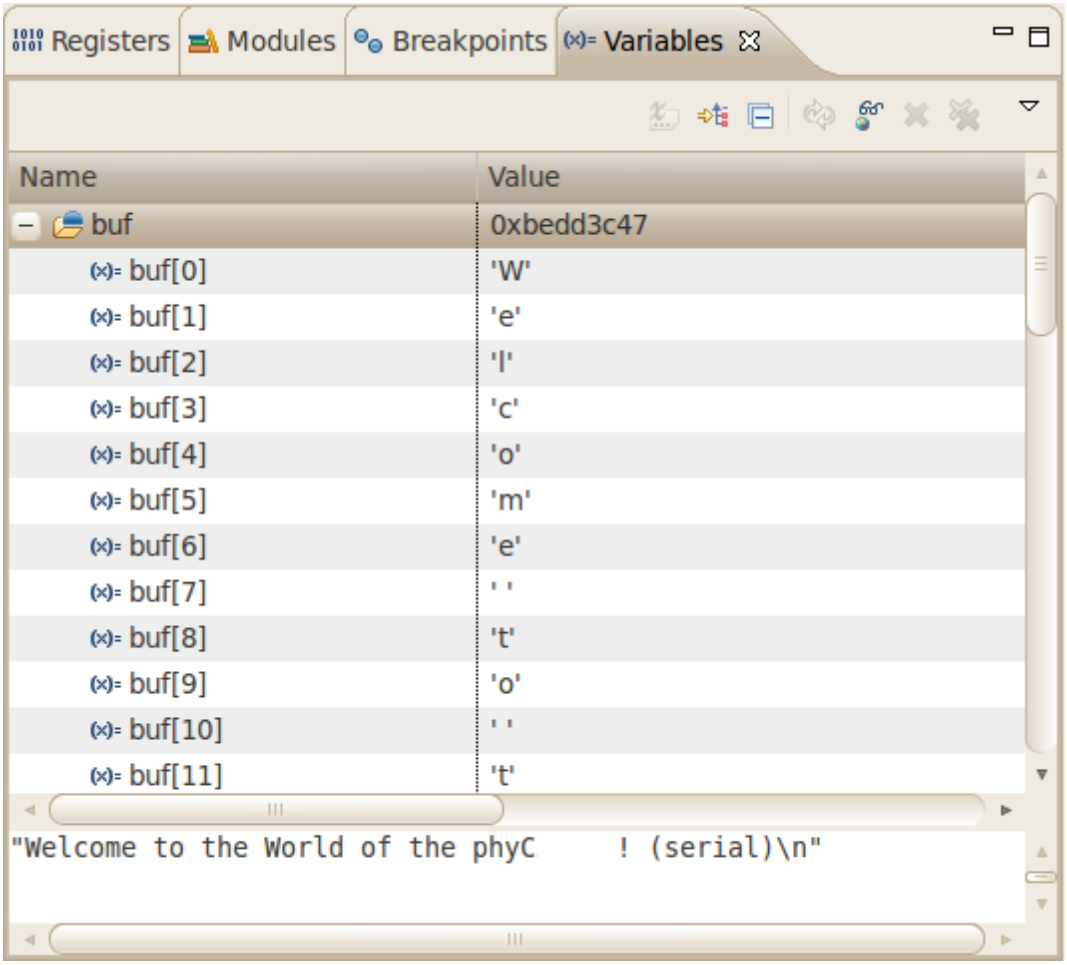
1.6.4. Stepping and Watching Variable Contents

In this part you will step through the example project with the debugger. You will also learn how to check the content of a variable. Expand buf in the Variables window



Click the Step Over button in the Debug window to step to the next line

You will see the content of the buf variable in the Variables window.

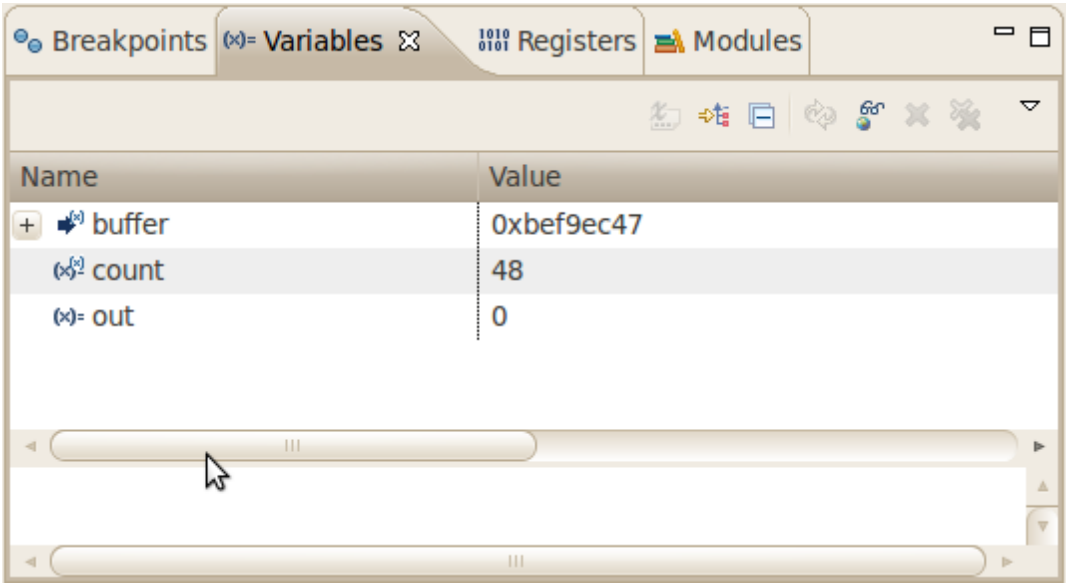


Click on the variable buf

Then click the button Step into to enter the function write_tty()

The debugger stops in write_tty().

You will see the following variable window:



Click on the variable buffer

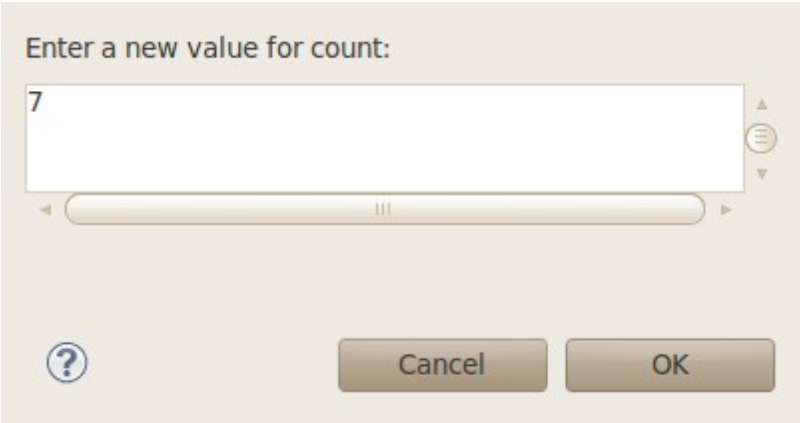
You will probably see a different address on the buffer pointer. Remember what address is shown in your case; you will need this address later.

1.6.5. Stepping and Watching Variable Contents

In this section you will change the value of a variable. At the end of this part you will see the effect of this change.

Select the count variable in the Variables window

Right-click on count and select Change Value



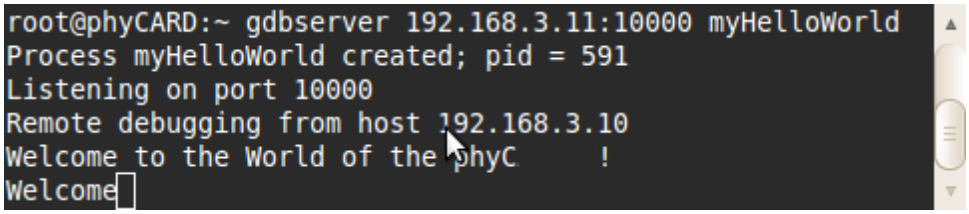
Change the value of count to 7 and click OK

After that open minicom

Go back to Eclipse

Click the Step Overbutton two times

Change to Minicom



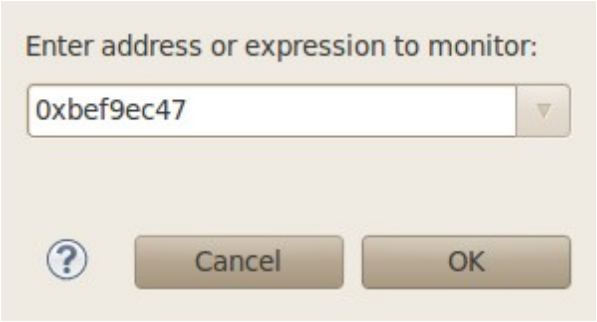
You will see the output Welcome in the Microcom window. This shows when changing the counter variable's value to 7 only the first seven characters of the buffer are output, instead of the whole sentence.

1.6.6. Using the Memory Monitor

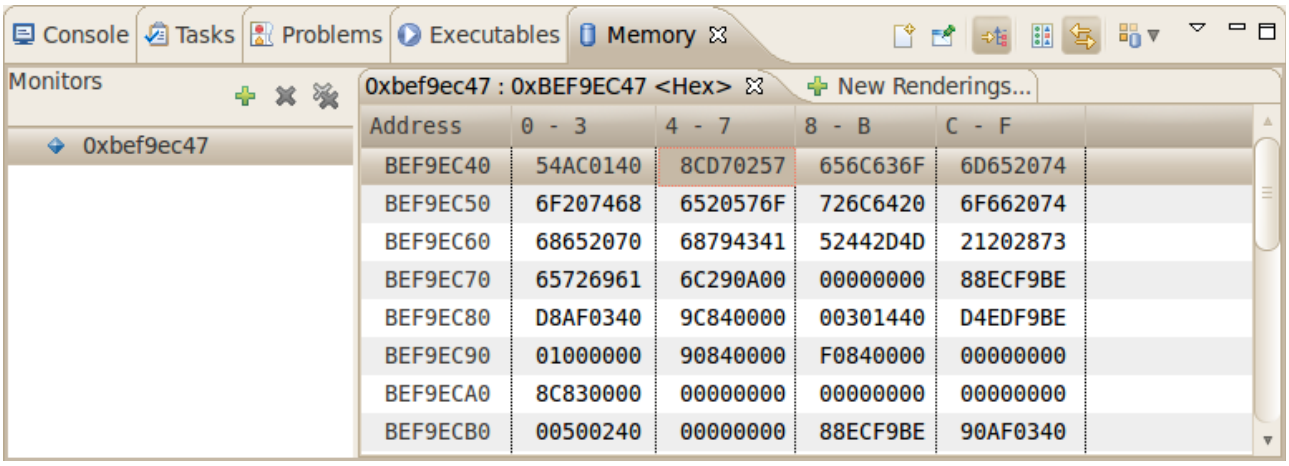
In the last section of this chapter you will use the memory monitor to control the content at a memory address.

Select the Memory tab

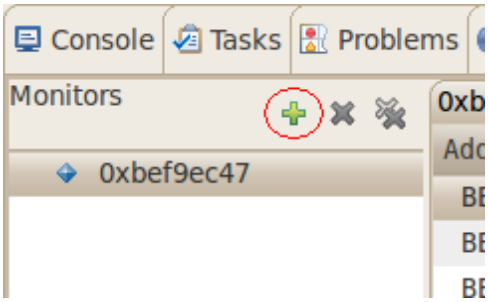
Click Add Memory Monitor



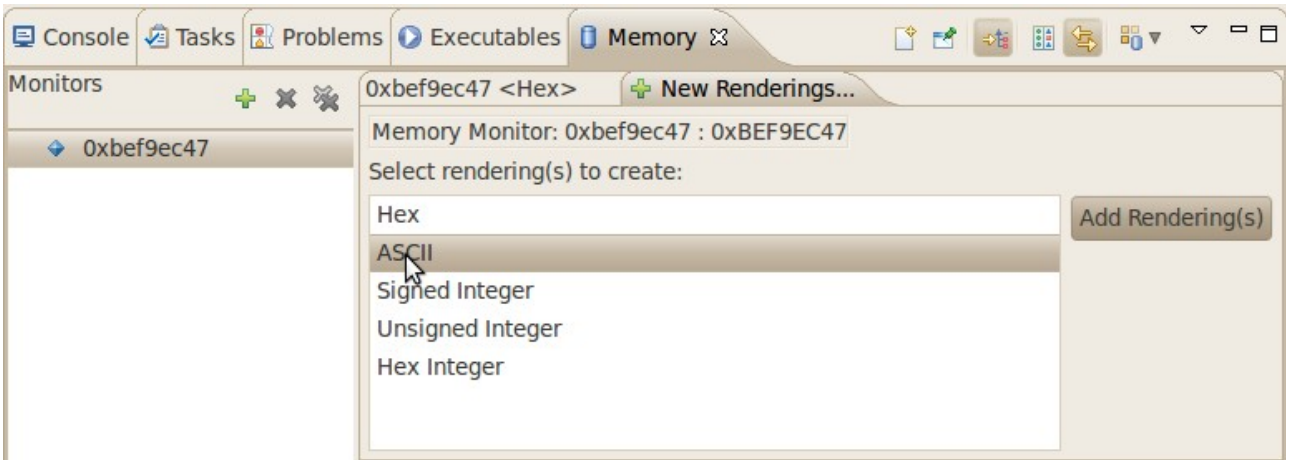
Enter the address of buffer and click OK. Remember that the variable's address might differ from your system.



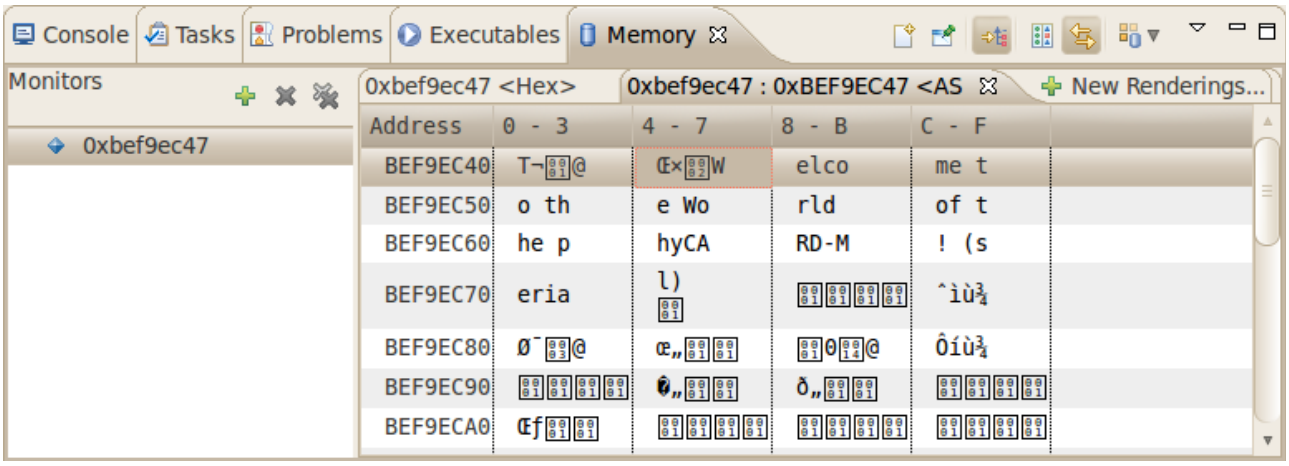
Change the window size



Click Add Rendering

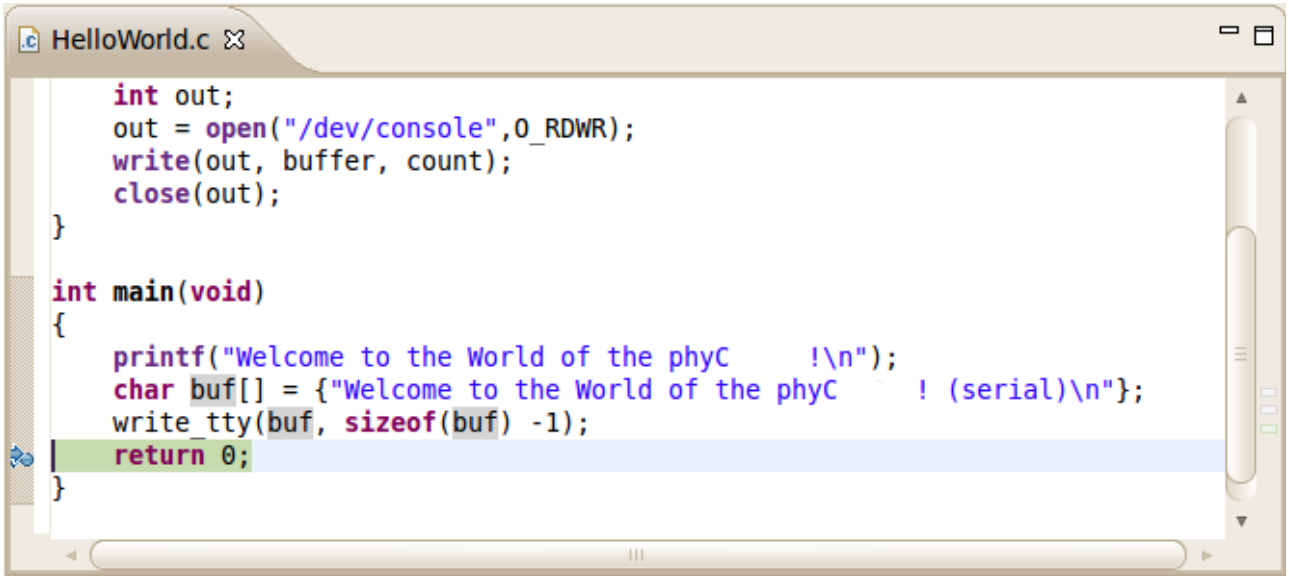


Select ASCII and click OK



You can see the contents of the variable buffer at the address 0xbee13ca7 (or whatever address is used on your system).

Now click the Resume button from the menu bar



The debugger stops at the breakpoint in the last line of main().

Click the Resume button to end the application.

2. Application development using Console Terminal

You can download the demo application from the phytec ftp using below link. After downloading just extract the file.

ftp://ftp.phytec.de/pub/Products/India/Cosmic-AM335x/Linux/PD13.0.0/src/apps/apps.tar.bz2

tar -xvf apps.tar.gz
cd final

Before doing any thing please read the README.txt

We have to resolve some dependencies as given below:

HOST SIDE:

Step-1: set the toolchain path edit the .bashrc file

vi ~/.bashrc

Step-2: Add the path of your toolchain at the last of this file and close the terminal

export PATH=$PATH:<the path of toolchain bin> (eg. go to toolchain/bin and type pwd)

Step-3: Export the path of your kernel source location (eg. go to kernel source and type pwd)

export K_SRC=<path of your kernel source>

Step-4: Run the Makefile

make

Finally you got all binary in bin directory.

2.1. User LED'S

The Cosmic-AM335x includes 4 LEDs listed as D4, D5, D10, D11 on the board.

2.1.1.Compiling User Led Application

2.1.1.1. Host Side

First go to the application directory and then to the led directory.

cd final/led

Export the kernel source directory path, architecture, cross compiler

export K_SRC=/home/phytec/work/linux-3.2 (This is the path of your kernel source)
export ARCH=arm

export CROSS_COMPILE=arm-cortexa8-linux-gnueabi-

After exporting these things just simply type make

make

It will create a bin directory where driver.ko (driver to be inserted) and led_shared, led_static (application to be executed) is created.

2.1.1.2. Target Side

Copy the contents of the bin directory into the target using SD-CARD, SSH, TFTP, USB.

SSH

scp driver.ko led_shared root@192.168.1.11:/home

Insert the driver.ko into the kernel space using insmod

insmod driver.ko

Then run the Application

./led_shared

It will blink the 4 leds 5 times.

2.2. User BUTTON'S

The Cosmic-AM335x includes 4 BUTTON'S listed as S1, S2, S3, S4 on the board.

2.2.1. Compiling User Switch Application

2.2.1.1. Host Side

First go to the application directory and then to the button directory.

cd final/button

Export the kernel source directory path, architecture, cross compiler

export K_SRC=/home/phytec/work/linux-3.2 (This is the path of your kernel source)

export ARCH=arm

export CROSS_COMPILE=arm-cortexa8-linux-gnueabi-

After exporting these things just simply type make

make

It will create a bin directory where driver.ko (driver to be inserted) and button_shared, button_static (application to be executed) is created.

2.2.1.2. Target Side

Copy the contents of the bin directory into the target using SD-CARD, TFTP, USB, etc.

Insert the driver.ko into the kernel space using insmod

insmod driver.ko

Then run the Application

./button_shared

It will blink the leds depends on the buttons pressed.

Note: The LED and Buttons uses the same driver. There is no need of inserting driver again if it is inserted in LED test case. Even it gives error that driver already exists if you try to insert it twice.

Get the dialog going ...
... and stay in touch

India

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.....We are looking forward to hearing from you!.....