ERIKA3 pre-built Virtual Machine

with support for Arduino and Jetson TX1/TX2

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For more information see: http://www.evidence.eu.com

Contact Info

Evidence Srl,
Via Carducci 56
Località Ghezzano
56010 S.Giuliano Terme
PISA Italy

Tel: +39 050 99 11 224
Fax: +39 050 99 10 812

For more information about Evidence products, please send an e-mail to the following address: info@evidence.eu.com. Other information about the Evidence product line can be found at the Evidence web site at: http://www.evidence.eu.com.

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About this document

This document describes the installation, first setup and first demo run of the ERIKA3 pre-built Virtual Machine for Nvidia Jetson TX1/TX2 and Arduino UNO.

Function of the document

The function of this document is to provide a quick start guide for using the Virtual Machine with a demo example.

Document history

Version	Date	Author	Company	Change Description
0.1	March 2018	Claudio Scordino	Evidence Srl	Initial version.
1.0	April 2018	Giuseppe Serano	Evidence Srl	Added Arduino UNO support.
1.1	April 2018	Paolo Gai	Evidence Srl	Document check.
1.2	April 2018	Claudio Scordino	Evidence Srl	Advanced Jailhouse configuration.
1.3	May 2018	Claudio Scordino	Evidence Srl	Commands changed for the new version of Jailhouse.
1.4	May 2018	Claudio Scordino	Evidence Srl	How to add libc support on TX1.
1.5	June 2018	Claudio Scordino	Evidence Srl	Support for TX2.

1. Introduction

Installing a complete development and debugging environment for an embedded board always involves a lot of work in installing compilers, debuggers, development environments, makefiles, and so on. This Virtual Machine aims at providing a quick solution for all these issues, providing a Linux platform with all software preinstalled and ready to work, allowing you to compile and flash OSEK/VDX applications on the specified target boards.

In particular, this Virtual Machine provides a complete virtual environment where you will be able to:

- edit the configuration of your OSEK/VDX application using the Eclipse-based RT-Druid environment;
- automatically generate the configuration files;
- build your application and link it to the ERIKA3 RTOS using a pre-installed open-source compiler.

Additionally, in case of the Nvidia Jetson development boards, the virtual machine also allows to configure and build the Linux kernel and the Jailhouse hypervisor for the board.

1.1. Requirements

The only requirement is the VirtualBox tool (`https://www.virtualbox.org/`) for running the Virtual machine.

1.2. Supported boards

The virtual machine has been tested on the following boards:

- Nvidia Jetson TX1;
- Nvidia Jetson TX2;
- Arduino UNO;

1.3. Licensing

The Virtual Machine described in this document includes various open-source software. The following items shortly describe the main licenses of the tools which have been integrated during this work:

- The Linux Distribution is a standard Ubuntu distribution. For more information about Ubuntu and the software licenses included in this Linux distribution please refer to the following website: `http://www.ubuntu.com/`.
- The ERIKA3 RTOS is distributed under the GPL2 license, whereas the RT-druid plugin is distributed under a proprietary license (see `http://www.erika-enterprise.com/index.php/erika3/licensing.html`); please contact Evidence for different licensing options.
- Eclipse, EMF, Acceleo and other Eclipse plugins are distributed under the EPL License (`http://en.wikipedia.org/wiki/Eclipse_Public_License`).
- The additional compiler for AVR and Cortex-M pre-installed on this virtual machine are based on GCC, which is distributed under the GNU GPL License.
- The Linux kernel is distributed under the GPL License.
- The Jailhouse hypervisor is distributed under the GPL2 license; the Jailhouse inmate library is also available under the BSD license. For more information, please refer to the official project page: `https://github.com/siemens/jailhouse/` .

1.4. Feedback, bugs, and additional examples

We care about your feedback! Information, feedback, and new demos about ERIKA3 can be provided directly on the ERIKA3 website:

`http://www.erika-enterprise.com`

For commercial technical support, sales, pricing, order status, and general information and feedback, please contact Evidence Srl directly at the address and phone numbers available at the following web page:

`http://www.evidence.eu.com/en/contact-us.html`

2. Installing the Virtual Machine

2.1. Installing VirtualBox

VirtualBox can be freely downloaded and used also for commercial use from the following website:

`https://www.virtualbox.org/wiki/Downloads`

All you need to do is to download the VirtualBox installer, and install it on your PC. All the following screenshots will refer to the usage of VirtualBox on a Windows 7 Host machine.

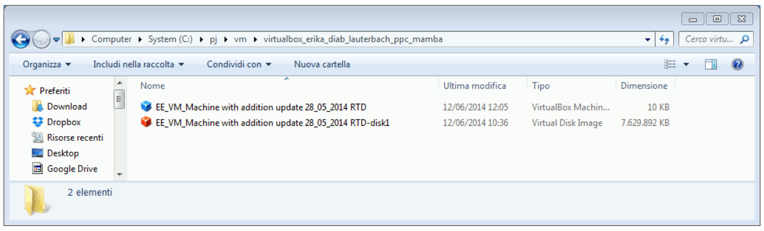
2.2. Downloading the Virtual Machine

The ERIKA3 Virtual Machine can be downloaded from the following website:

`http://www.erika-enterprise.com`

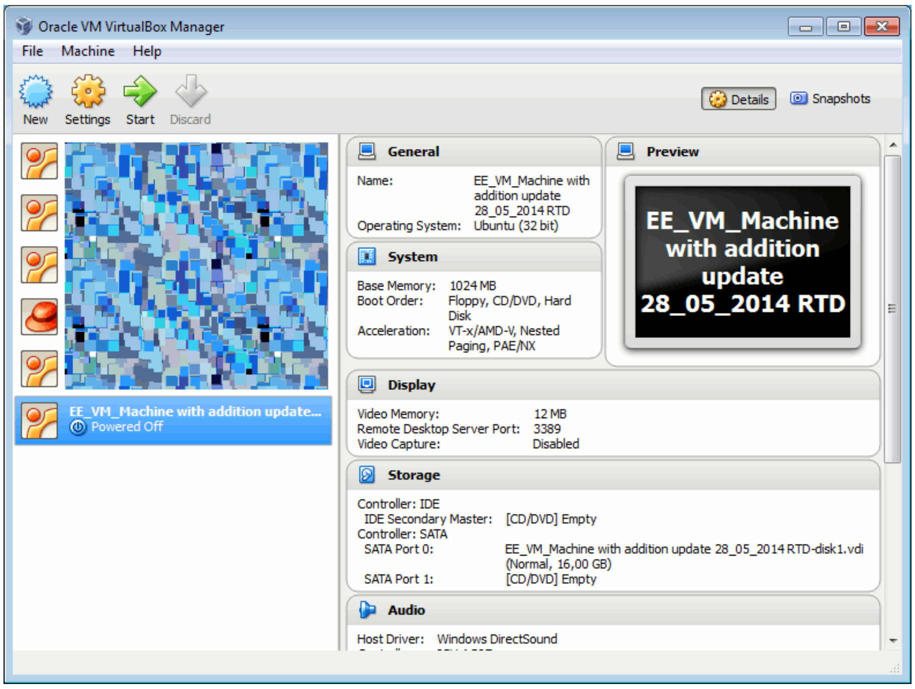
The Virtual Machine is typically distributed as a compressed file. Please decompress it. You will find at least two files, as in Figure 2.1. Note that actual file names may vary. The file with the `vbox` extension is the file containing the settings of the virtual machine (describing the guest hardware, memory, disks, ...). The file with the `vdi` extension is the virtual hard disk used by the virtual machine.

On a typical VirtualBox setup, just double clicking on the file with `vbox` extension will open VirtualBox as in Figure 2.2. Just click on the Start button to boot the Virtual Machine.



Nome	Ultima modifica	Tipo	Dimensione
EE_VM_Machine with addition update 28_05_2014 RTD	12/06/2014 12:05	VirtualBox Machin...	10 KB
EE_VM_Machine with addition update 28_05_2014 RTD-disk1	12/06/2014 10:36	Virtual Disk Image	7.629.892 KB

Figure 2.1.: Files obtained when unpacking the virtual machine.



EE_VM_Machine with addition update...
Powered Off

General
Name: EE_VM_Machine with addition update 28_05_2014 RTD
Operating System: Ubuntu (32 bit)

System
Base Memory: 1024 MB
Boot Order: Floppy, CD/DVD, Hard Disk
Acceleration: VT-x/AMD-V, Nested Paging, PAE/NX

Preview
EE_VM_Machine with addition update 28_05_2014 RTD

Display
Video Memory: 12 MB
Remote Desktop Server Port: 3389
Video Capture: Disabled

Storage
Controller: IDE
 IDE Secondary Master: [CD/DVD] Empty
Controller: SATA
 SATA Port 0: EE_VM_Machine with addition update 28_05_2014 RTD-disk1.vdi (Normal, 16,00 GB)
 SATA Port 1: [CD/DVD] Empty

Audio
Host Driver: Windows DirectSound

Figure 2.2.: VirtualBox opened after clicking on the `vbox` file.

2.3. VirtualBox settings

The following is a list of the main settings of the Virtual machine, useful if, for some reason, you need to recreate the `vbox` file from scratch. Those information must be set on a new virtual machine by clicking on the "Settings" button in Figure 2.2.

1. `General` Tab, `Basic` subtab: The Type of virtual machine must be Linux / Ubuntu 32 bit.

2. `System` tab: We suggest a 1Gb system memory, I/O APIC active, and as many processors as you have in your physical machine.

Please note that the virtual machine comes with the VirtualBox Guest Additions already installed. This turns out to be very convenient as the X Server will automatically recognize a resize of the VirtualBox window. In case you have a different version of the VirtualBox player you may need to re-install the Guest Additions (please, refer to the VirtualBox documentation for proper instructions).

Once powered up, Linux will boot, and the Ubuntu Desktop will appear.

2.4. Username and password of the Linux virtual machine

All the activities described in this document have been executed by the following username:

Username: `evidence`

Password: `evidence`

You will typically need to enter username and password when logging in, when using `sudo`, and everytime you are required to perform an action with administrator privileges.

3. Compiling and running ERIKA3 On Jetson TX1/TX2

3.1. Platform setup

3.1.1. Serial interface

A FTDI USB cable can be used to physically connect the platform's serial console to the host machine. This is particularly useful to get output messages from the ERIKA3 guest (as shown in the example below).

The Figure 3.1 shows how the UART pins must be connected on the Jetson platform. The USB Type-A connector side must be then connected to the PC running the Virtual Machine as shown in Figure 3.2

Once the physical connection has been established, proceed as follows:

1. On Virtual Box assign the peripheral to the virtual machine as shown in Figure 3.3 (note that the actual name of the USB-Serial converter may change on your machine).

2. Open a Terminal by clicking on the icon available on the Top-Bar of the virtual machine, shown in Figure 3.4 .

3. Type `dmesg` command and press return key as shown in Figure 3.5 .

4. Look at `dmesg` command output to identify the serial device identifier on which the Nvidia Jetson board is attached (usually `ttyUSB*`), as shown in Figure 3.6.

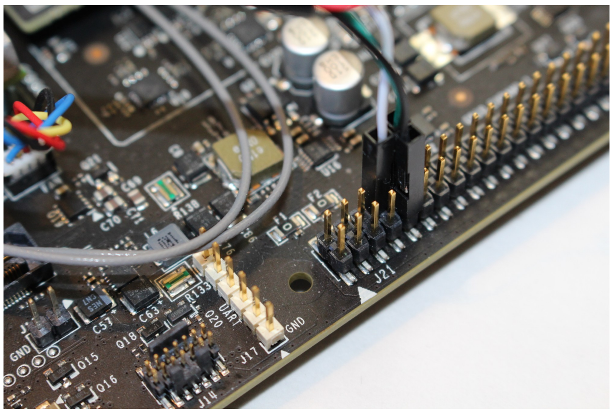
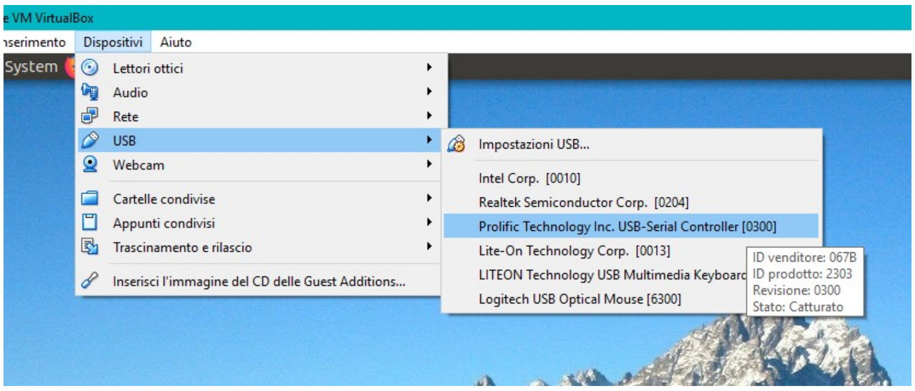


Figure 3.1.: Jetson serial interface.

Figure 3.2.: USB Type-A Connector.


e VM VirtualBox
ıserimento
Dispositivi
Aiuto
System
Lettori ottici
Audio
Rete
USB
Webcam
Cartelle condivise
Appunti condivisi
Trascinamento e rilascio
Inserisci l'immagine del CD delle Guest Additions...
Impostazioni USB...
Intel Corp. [0010]
Realtek Semiconductor Corp. [0204]
Prolific Technology Inc. USB-Serial Controller [0300]
Lite-On Technology Corp. [0013]
LITEON Technology USB Multimedia Keyboard
Logitech USB Optical Mouse [6300]

ID venditore: 067B
ID prodotto: 2303
Revisione: 0300
Stato: Catturato

Figure 3.3.: Assigning the serial interface to VirtualBox.

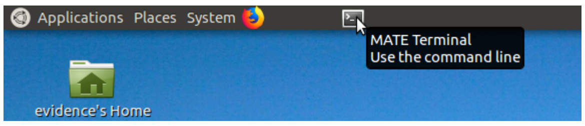
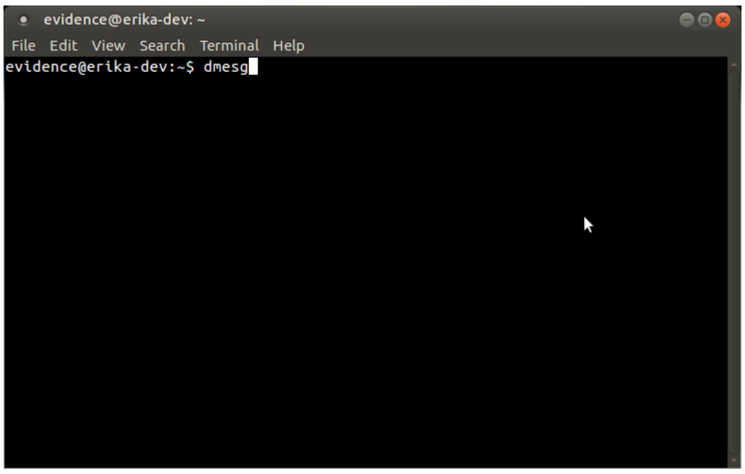
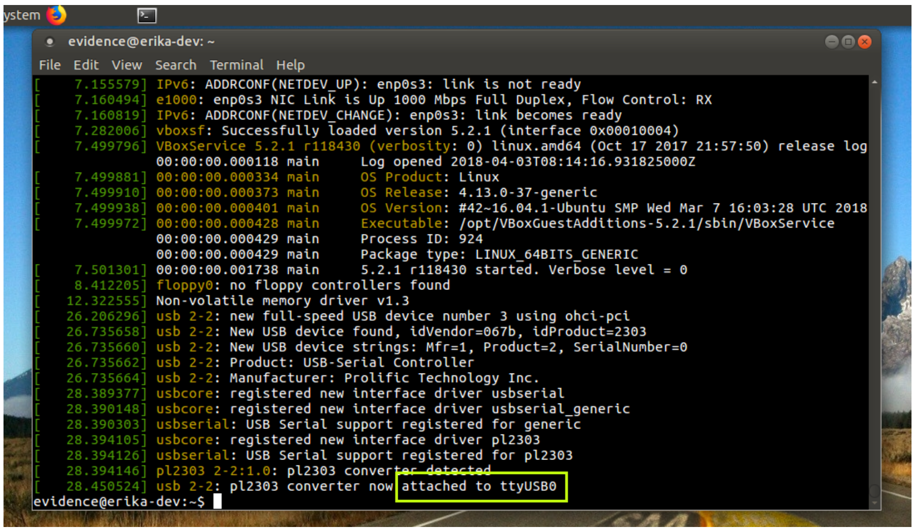


Figure 3.4.: How to run a terminal.



```
evidence@erika-dev:~$ dmesg
```

Figure 3.5.: `dmesg` command.



```
[    7.155579] IPv6: ADDRCONF(NETDEV_UP): enp0s3: link is not ready
[    7.160494] e1000: enp0s3 NIC Link is Up 1000 Mbps Full Duplex, Flow Control: RX
[    7.160819] IPv6: ADDRCONF(NETDEV_CHANGE): enp0s3: link becomes ready
[    7.282006] vboxsf: Successfully loaded version 5.2.1 (interface 0x00010004)
[    7.499796] VBoxService 5.2.1 r118430 (verbosity: 0) linux.amd64 (Oct 17 2017 21:57:50) release log
               00:00:00.000118 main     Log opened 2018-04-03T08:14:16.931825000Z
[    7.499881] 00:00:00.000334 main     OS Product: Linux
[    7.499910] 00:00:00.000373 main     OS Release: 4.13.0-37-generic
[    7.499938] 00:00:00.000401 main     OS Version: #42~16.04.1-Ubuntu SMP Wed Mar 7 16:03:28 UTC 2018
[    7.499972] 00:00:00.000428 main     Executable: /opt/VBoxGuestAdditions-5.2.1/sbin/VBoxService
               00:00:00.000429 main     Process ID: 924
               00:00:00.000429 main     Package type: LINUX_64BITS_GENERIC
[    7.501301] 00:00:00.001738 main     5.2.1 r118430 started. Verbose level = 0
[    8.412205] floppy0: no floppy controllers found
[   12.322555] Non-volatile memory driver v1.3
[   26.206296] usb 2-2: new full-speed USB device number 3 using ohci-pci
[   26.735658] usb 2-2: New USB device found, idVendor=067b, idProduct=2303
[   26.735660] usb 2-2: New USB device strings: Mfr=1, Product=2, SerialNumber=0
[   26.735662] usb 2-2: Product: USB-Serial Controller
[   26.735664] usb 2-2: Manufacturer: Prolific Technology Inc.
[   28.389377] usbcore: registered new interface driver usbserial
[   28.390148] usbcore: registered new interface driver usbserial_generic
[   28.390303] usbserial: USB Serial support registered for generic
[   28.394105] usbcore: registered new interface driver pl2303
[   28.394126] usbserial: USB Serial support registered for pl2303
[   28.394146] pl2303 2-2:1.0: pl2303 converter detected
[   28.450524] usb 2-2: pl2303 converter now attached to ttyUSB0
evidence@erika-dev:~$
```

Figure 3.6.: `dmesg` command output.

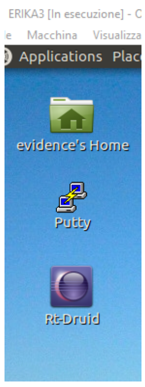


Figure 3.7.: Putty and RT-Druid icons on Desktop.

5. Run the Putty program by clicking on the icon available on the Desktop of the virtual machine, shown in Figure 3.7.
6. On Putty (see Figure 3.8), set:
   - Serial line: `/dev/ttyUSB0`
   - Baurdate: 115200
   - No flow control
7. Start the connection by clicking on `Open`.

3.1.2. Static IP address

There are mainly 3 ways for logging into the Jetson platform:

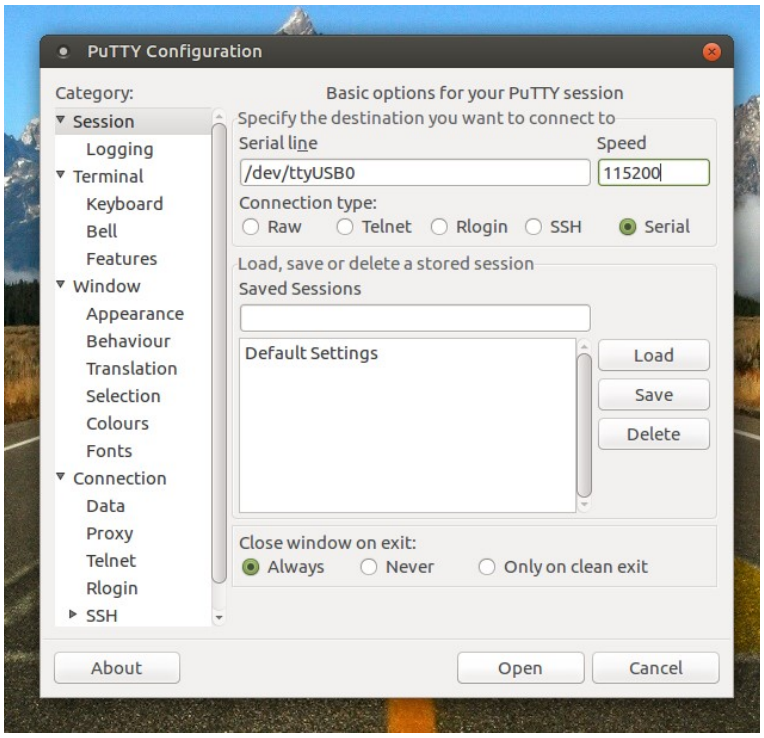
1. Through an SSH connection over the Ethernet cable.
2. Through the serial interface (see previous Section).
3. Through the graphical interface on HDMI .

If you want to assign a static IP address to the platform (useful for being able to log in into the machine even when the serial interface has been exclusively assigned to the ERIKA3 guest OS), open the `/etc/network/interfaces` file and append the following information:

```
auto eth0
iface eth0 inet static
address ...
netmask ...
gateway ...
```

To reach the external network, you may also need to explicitly add the DNS server by appending the following information to the `/etc/resolv.conf` file:

```
nameserver ...
```


PuTTY Configuration

Basic options for your PuTTY session

Specify the destination you want to connect to

Serial line: /dev/ttyUSB0

Speed: 115200

Connection type: Raw Telnet Rlogin SSH [✓ Serial]

Load, save or delete a stored session

Saved Sessions

Default Settings

Close window on exit: [✓ Always] Never Only on clean exit

Figure 3.8.: Putty configuration.

3.2. Building the Linux kernel and Jailhouse

On the virtual machine, open a terminal as shown in Figure 3.4 and:

1. Enter the board-specific directory.
   - For the tx1 board type:
     ```
     cd /home/evidence/tx1
     ```
   - For the tx2 board, instead, type:
     ```
     cd /home/evidence/tx2
     ```

2. Build the Linux kernel and Jailhouse by typing:
   ```
   ./build.sh
   ```
   Note that before running this command, it is possible to run `./configure.sh` for changing the Linux kernel configuration.

3. Transfer the file `target.tgz` to the Jetson platform. This can be done, for example, by using the `scp` command:
   ```
   scp target.tgz nvidia@<Jetson IP address>:
   ```

3.3. Installing the Linux kernel and Jailhouse

This section explains how to install the Linux kernel and the Jailhouse hypervisor on the Jetson platform. It assumes that the `target.tgz` file (mentioned in the previous section) has been already transferred to the Jetson platform.

On the Linux console of the Jetson platform:

1. For installing Jailhouse, type:

   ```
   sudo tar -xmf target.tgz -C /

   cd /boot

   sudo ./install.sh
   ```

2. Reboot the platform.

On the U-Boot console:

1. Stop the U-boot countdown by pressing a key.

2. On the U-Boot console type (only needed the first time):

   ```
   load mmc 0:1 $scriptaddr /boot/linux-console-handler.scr

   source $scriptaddr
   ```

3. Disable the Linux serial console by typing:

   ```
   run linux_console_disable
   ```

4. If you want to disable the Linux serial console permanently[1] (i.e. also for the next times) then type:

   ```
   saveenv
   ```

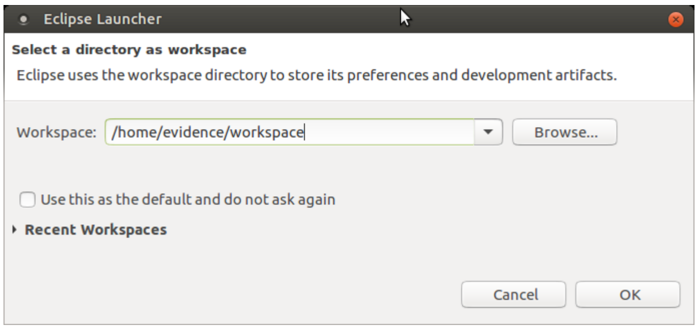
5. Continue booting Linux by typing:

   ```
   boot
   ```

3.4. Running Linux

Once Linux has been configured as explained in the previous section, just select ***`jailhouse kernel`*** in the 2nd stage bootloader.

[1]Note that you will be always able to restore the Linux serial console by typing: `run linux_console_enable` .


Eclipse Launcher

Select a directory as workspace

Eclipse uses the workspace directory to store its preferences and development artifacts.

Workspace: /home/evidence/workspace

☐ Use this as the default and do not ask again

Figure 3.9.: RT-Druid Eclipse Workspace Selection.

3.5. Compiling an ERIKA3 application

On the host virtual machine:

1. Double click the RT-Druid Desktop icon for starting RT-Druid. Then confirm the default location `/home/evidence/workspace` as shown in Figure 3.9.
2. Create a new **RT-Druid v3 Oil and C/C++** project as shown in Figure 3.10.
3. Name the project (e.g., "mytest") and select the Cross GCC toolchain as shown in Figure 3.14.
4. Check the box for using an existing template and select `aarch64`→`Jailhouse`→ `Helloworld OSEK demo on Jailhouse` as shown in Figure 3.12.
5. Eclipse will then show the new project, and RT-Druid will generate the configuration files, as shown in Figure 3.13.
6. **Attention:** Ensure that the `SOC_DATA` variable is set to `NVIDIA_TEGRA_X1` for TX1 and to `NVIDIA_TEGRA_X2` for TX2 inside the `conf.oil` file.
7. Click with the right mouse key on the project and select `Build project` as shown in Figure 3.14. This will create the `erika_inmate.bin` file in the workspace.
8. Transfer the file `erika_inmate.bin` to the Jetson platform. This can be done, for example, by using the `scp` command:

```
scp erika_inmate.bin  nvidia@<Jetson IP address>:
```

3.6. Executing an ERIKA3 application

On the Jetson platform (Linux console):

1. Set the CPU to maximum performance by typing:

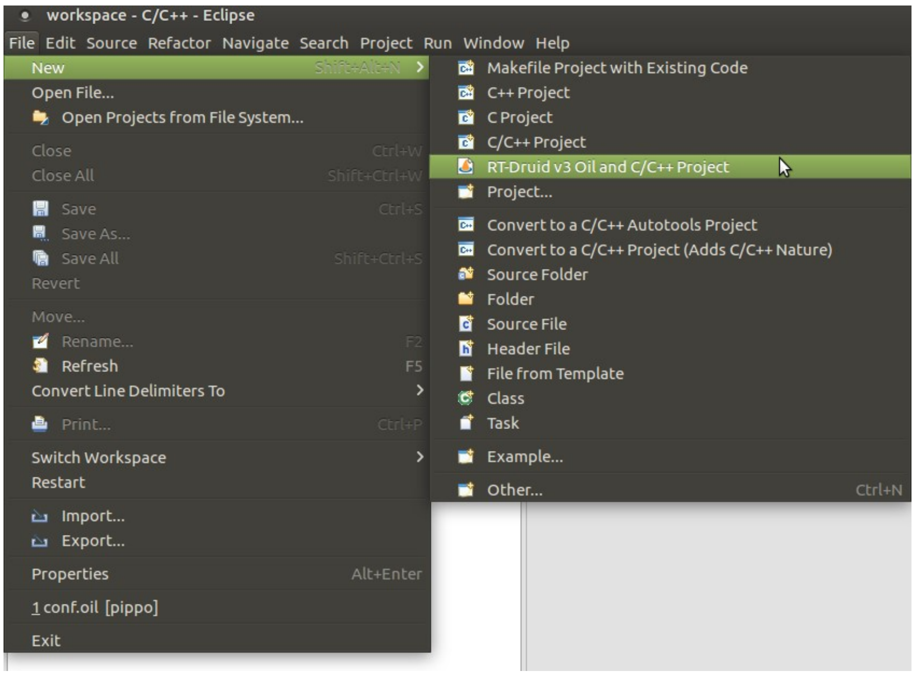
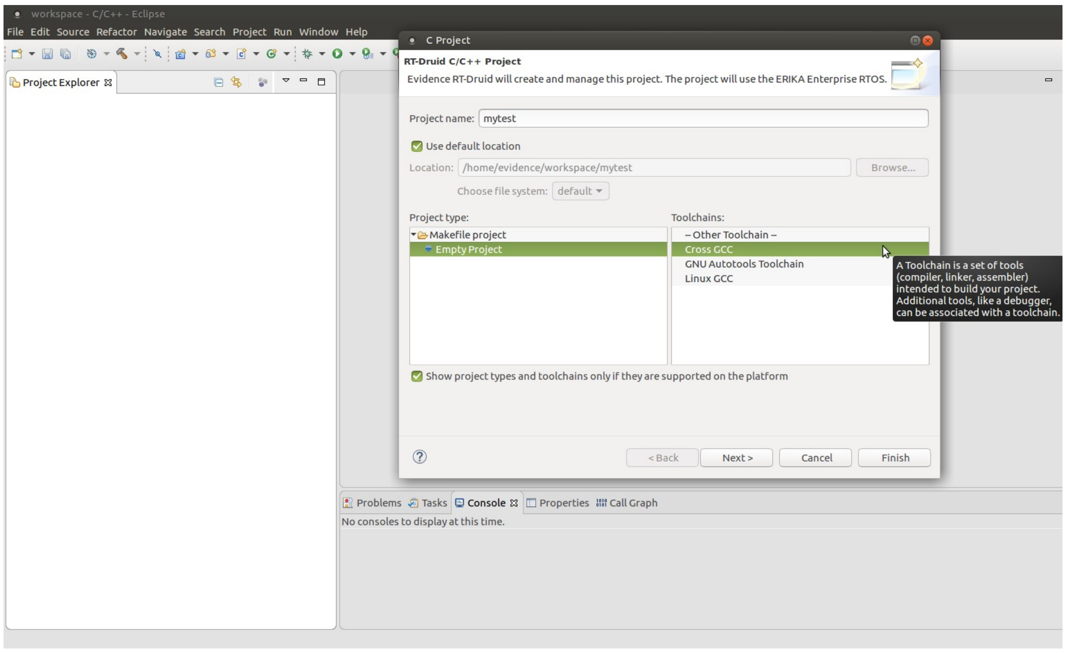


Figure 3.10.: New RT-Druid project.


workspace - C/C++ - Eclipse
File Edit Source Refactor Navigate Search Project Run Window Help
Project Explorer
C Project
Problems Tasks Console Properties Call Graph
No consoles to display at this time.

RT-Druid C/C++ Project

Evidence RT-Druid will create and manage this project. The project will use the ERIKA Enterprise RTOS.

Project name: mytest

☑ Use default location

Location: /home/evidence/workspace/mytest Browse...

Choose file system: default

Project type:
- Makefile project
  - Empty Project

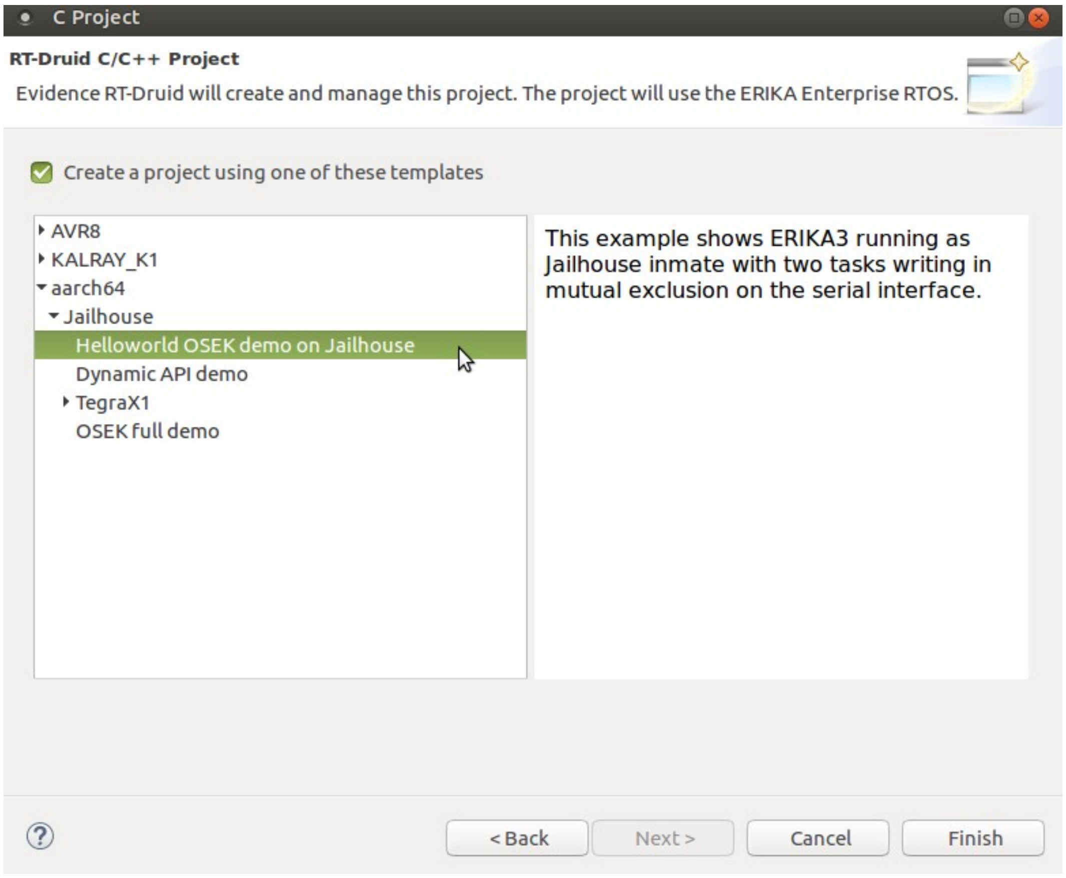
Toolchains:
- – Other Toolchain –
- Cross GCC
- GNU Autotools Toolchain
- Linux GCC

A Toolchain is a set of tools (compiler, linker, assembler) intended to build your project. Additional tools, like a debugger, can be associated with a toolchain.

☑ Show project types and toolchains only if they are supported on the platform

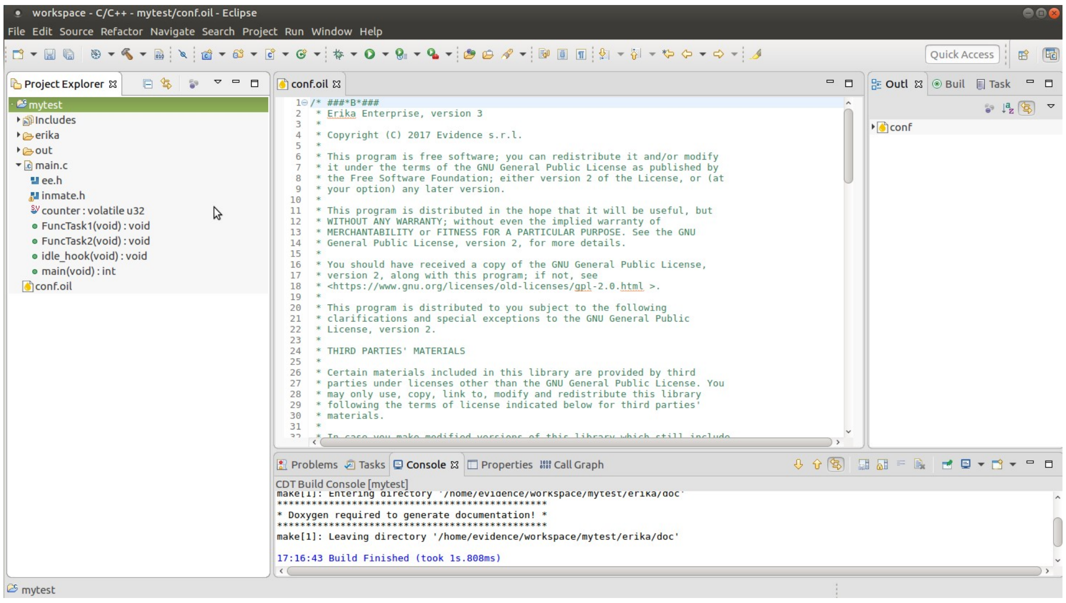
< Back Next > Cancel Finish

Figure 3.11.: Naming the RT-Druid project.


C Project
RT-Druid C/C++ Project
Evidence RT-Druid will create and manage this project. The project will use the ERIKA Enterprise RTOS.
Create a project using one of these templates
AVR8
KALRAY_K1
aarch64
Jailhouse
Helloworld OSEK demo on Jailhouse
Dynamic API demo
TegraX1
OSEK full demo
< Back
Next >
Cancel
Finish

This example shows ERIKA3 running as Jailhouse inmate with two tasks writing in mutual exclusion on the serial interface.

Figure 3.12.: Selecting the template for the RT-Druid project.



```
/* ###*B*###
 * Erika Enterprise, version 3
 *
 * Copyright (C) 2017 Evidence s.r.l.
 *
 * This program is free software; you can redistribute it and/or modify
 * it under the terms of the GNU General Public License as published by
 * the Free Software Foundation; either version 2 of the License, or (at
 * your option) any later version.
 *
 * This program is distributed in the hope that it will be useful, but
 * WITHOUT ANY WARRANTY; without even the implied warranty of
 * MERCHANTABILITY or FITNESS FOR A PARTICULAR PURPOSE. See the GNU
 * General Public License, version 2, for more details.
 *
 * You should have received a copy of the GNU General Public License,
 * version 2, along with this program; if not, see
 * <https://www.gnu.org/licenses/old-licenses/gpl-2.0.html >.
 *
 * This program is distributed to you subject to the following
 * clarifications and special exceptions to the GNU General Public
 * License, version 2.
 *
 * THIRD PARTIES' MATERIALS
 *
 * Certain materials included in this library are provided by third
 * parties under licenses other than the GNU General Public License. You
 * may only use, copy, link to, modify and redistribute this library
 * following the terms of license indicated below for third parties'
 * materials.
 *
```

```
make[1]: Entering directory '/home/evidence/workspace/mytest/erika/doc'
***********************************************
* Doxygen required to generate documentation! *
***********************************************
make[1]: Leaving directory '/home/evidence/workspace/mytest/erika/doc'

17:16:43 Build Finished (took 1s.808ms)
```

Figure 3.13.: New project created.

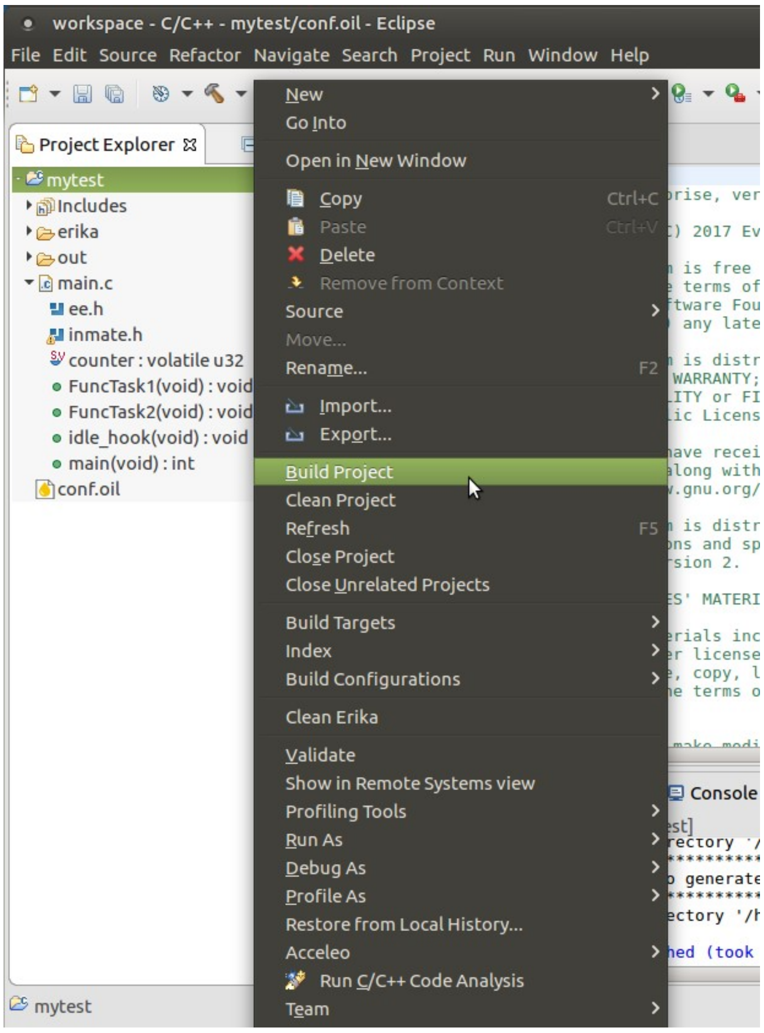


Figure 3.14.: Building the project.

```
sudo su

cd /sys/devices/system/cpu/cpufreq/policy0

echo performance > scaling_governor

exit
```

2. Insert the Jailhouse kernel module by typing:

   ```
   sudo modprobe jailhouse
   ```

3. Enter the directory containing the Jailhouse cell configurations:

   ```
   cd /jailhouse/configs/arm64/
   ```

4. Enable the Jailhouse hypervisor.
   - For the TX1 board type:

     ```
     sudo jailhouse enable jetson-tx1.cell
     ```

   - For the TX2 board type:

     ```
     sudo jailhouse enable jetson-tx2.cell
     ```

5. Create the Jailhouse cell for running the ERIKA3 application.
   - For the TX1 board type:

     ```
     sudo jailhouse cell create jetson-tx1-demo.cell
     ```

   - For the TX2 board type:

     ```
     sudo jailhouse cell create jetson-tx2-demo.cell
     ```

6. Load the ERIKA3 binary into the cell.
   - For the TX1 board type:

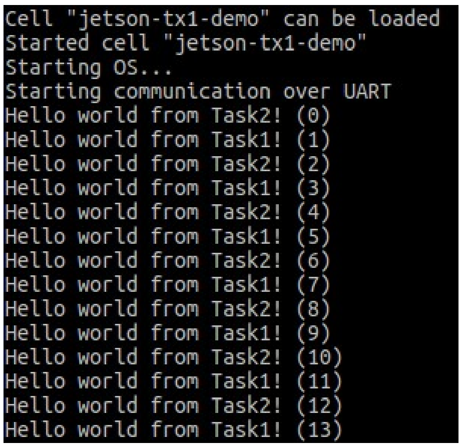
     ```
     sudo jailhouse cell load jetson-tx1-demo erika_inmate.bin
     ```

   - For the TX2 board type:

     ```
     sudo jailhouse cell load jetson-tx2-demo erika_inmate.bin
     ```

7. Start the ERIKA3 binary.
   - For the TX1 board type:

     ```
     sudo jailhouse cell start jetson-tx1-demo
     ```



```
Cell "jetson-tx1-demo" can be loaded
Started cell "jetson-tx1-demo"
Starting OS...
Starting communication over UART
Hello world from Task2! (0)
Hello world from Task1! (1)
Hello world from Task2! (2)
Hello world from Task1! (3)
Hello world from Task2! (4)
Hello world from Task1! (5)
Hello world from Task2! (6)
Hello world from Task1! (7)
Hello world from Task2! (8)
Hello world from Task1! (9)
Hello world from Task2! (10)
Hello world from Task1! (11)
Hello world from Task2! (12)
Hello world from Task1! (13)
```

Figure 3.15.: ERIKA3 application output on the serial interface.

- For the TX2 board type:

  ```
  sudo jailhouse cell start jetson-tx2-demo
  ```

8. On the serial console, the ERIKA3 tasks will start printing the messages as shown in Figure 3.15.

9. Stop the ERIKA3 application.
   - For the TX1 board type:

     ```
     sudo jailhouse cell shutdown jetson-tx1-demo
     ```

   - For the TX2 board type:

     ```
     sudo jailhouse cell shutdown jetson-tx2-demo
     ```

3.7. Libc support

Most toolchains available in Ubuntu's repositories (e.g. `gcc-aarch64-linux-gnu`) are suitable for cross-compiling all the various components: the Linux kernel, Jailhouse's firmware, Jailhouse's kernel driver, the inmate library and the inmate containing ERIKA. However, they usually rely on libc libraries meant to be used on top of the Linux OS, and are not suitable for building bare-metal RTOSs like ERIKA. For this reason, the Virtual Machine provides a version of Jailhouse enhanced to use different toolchains for compiling the inmate library and the rest of the hypervisor.

The only action needed for adding libc support to an ERIKA application is to put the following statements inside the OIL file:

```
LIBS = "-lc";
LDFLAGS = "-L /home/evidence/aarch64-elf/aarch64-elf/libc/usr/lib";
```

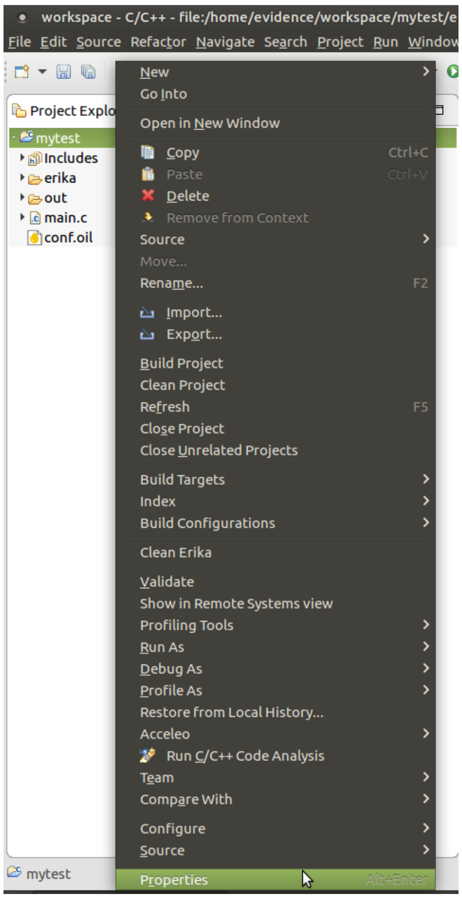


Figure 3.16.: Eclipse project properties.

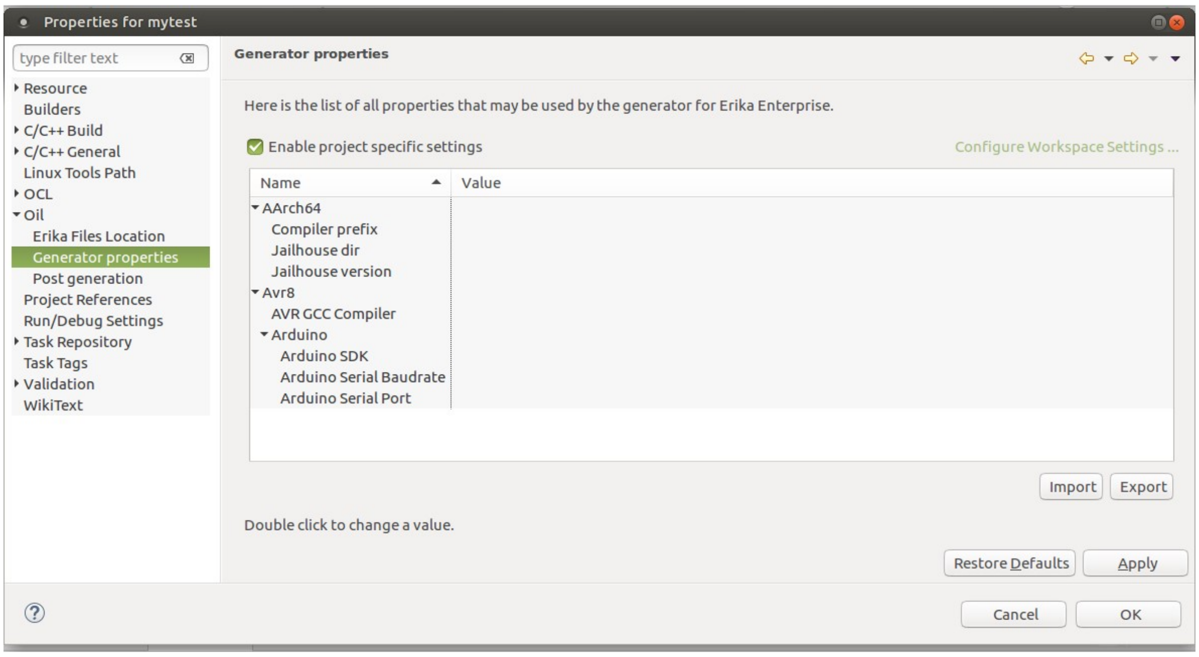
Additionally, you should set proper alignment for accessing data structures by putting the following statements inside the OIL file:

```
CFLAGS = "-mstrict-align";
```

3.8. Advanced configuration

In case you want to build ERIKA Enterprise for a version of Jailhouse different than the one shipped within the Virtual Machine, press the right mouse button on the Eclipse project and select Properties as shown in Figure 3.16 .

Then, select Generator properties, enable project specific settings (as shown in Figure 3.17), and set the desired Jailhouse version and path (you can set the Compiler prefix equal to `aarch64-linux-gnu-`).



Here is the list of all properties that may be used by the generator for Erika Enterprise.

✓ Enable project specific settings

Name	Value
AArch64	
Compiler prefix	
Jailhouse dir	
Jailhouse version	
Avr8	
AVR GCC Compiler	
Arduino	
Arduino SDK	
Arduino Serial Baudrate	
Arduino Serial Port	

Double click to change a value.

Figure 3.17.: RT-Druid generator properties.

4. Compiling and running ERIKA3 on Arduino UNO

4.1. Platform setup

4.1.1. Serial interface

An USB (Type-A, Type-B) cable SHALL be used to physically connect the Arduino UNO to the host machine. This is particularly useful to program the board and get output messages from the ERIKA3 guest (as shown in the example below).

The Figure 4.1 shows how the USB Type-B connector must be connected on the Arduino UNO. The USB Type-A connector must be then connected to the PC running the Virtual Machine as shown in Figure 4.2 .

Once the physical connection has been established, proceed as follows:

1. On Virtual Box assign the peripheral to the Virtual Machine as shown in Figure 4.3. .

2. Open a Terminal by clicking on the icon available on the Top-Bar of the virtual machine, shown in Figure 4.4.

3. Type `dmesg` command and press return key as shown in Figure 4.5.

4. Look at `dmesg` command output to identify the serial device identifier on which Arduino UNO board is attached, as shown in Figure 4.6.

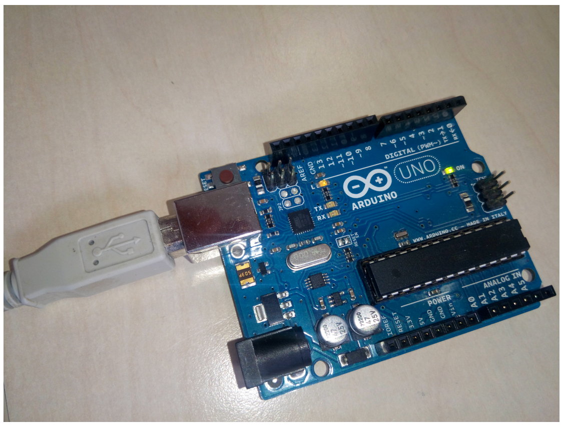


Figure 4.1.: Arduino USB Type-B Connector.

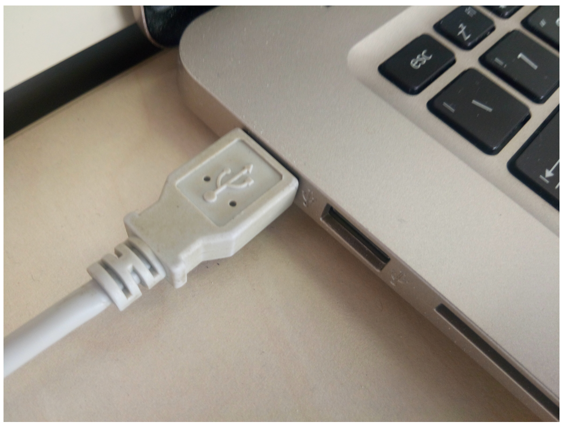
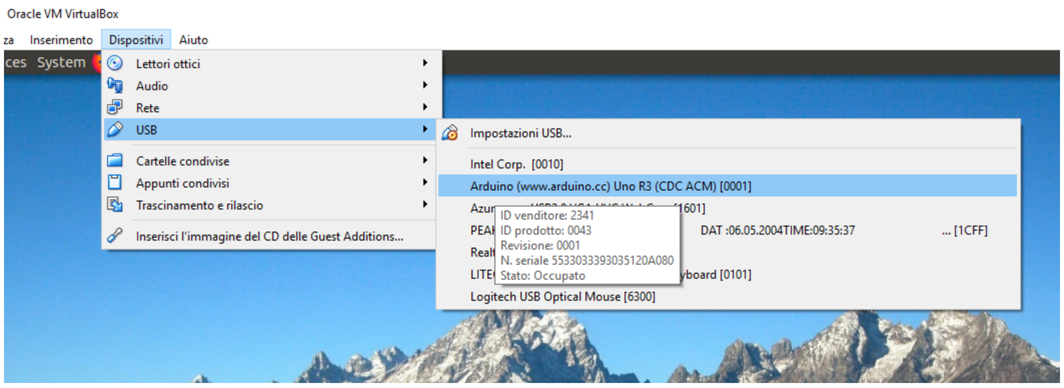


Figure 4.2.: Arduino USB Type-A Connector.



ID venditore: 2341
ID prodotto: 0043
Revisione: 0001
N. seriale 5533033393035120A080
Stato: Occupato

Figure 4.3.: Arduino USB Setup.

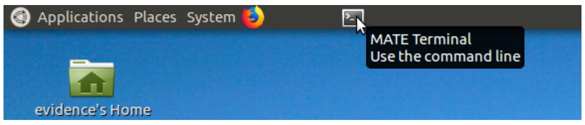
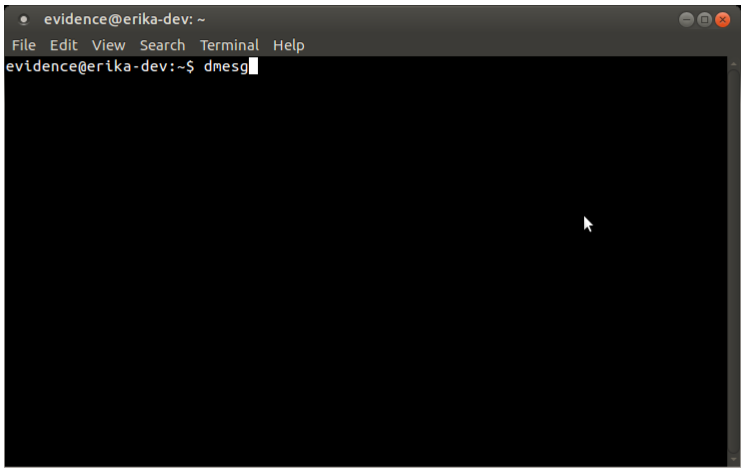
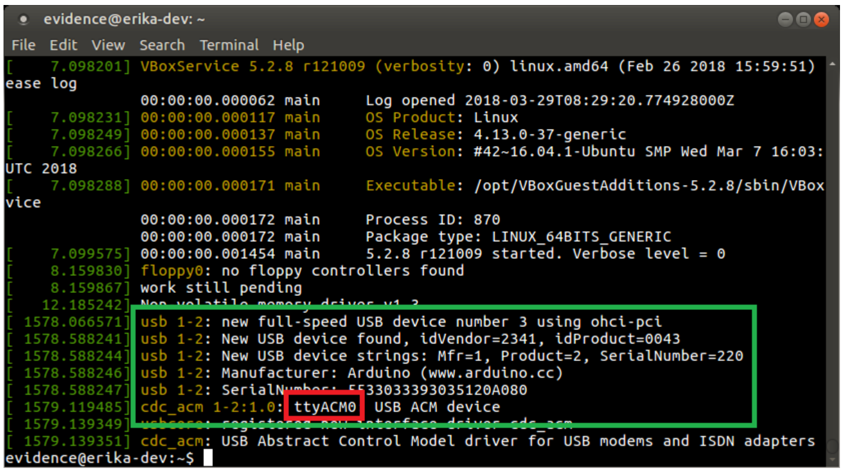


Figure 4.4.: Terminal Icon.



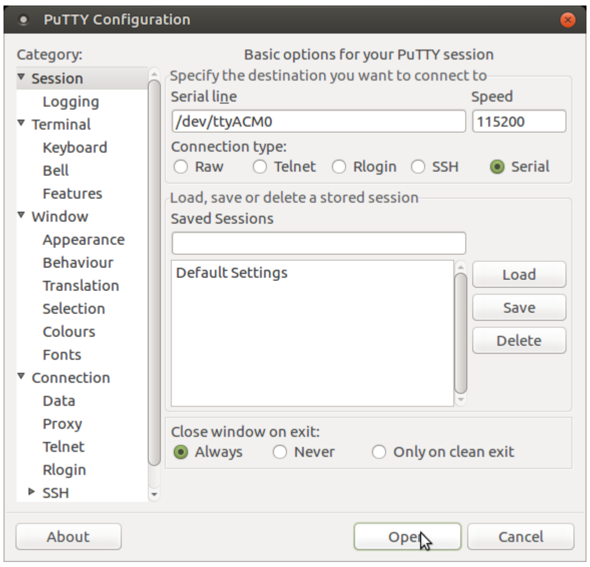
```
evidence@erika-dev:~$ dmesg
```

Figure 4.5.: `dmesg` command.



```
[    7.098201] VBoxService 5.2.8 r121009 (verbosity: 0) linux.amd64 (Feb 26 2018 15:59:51)
ease log
               00:00:00.000062 main     Log opened 2018-03-29T08:29:20.774928000Z
[    7.098231] 00:00:00.000117 main     OS Product: Linux
[    7.098249] 00:00:00.000137 main     OS Release: 4.13.0-37-generic
[    7.098266] 00:00:00.000155 main     OS Version: #42~16.04.1-Ubuntu SMP Wed Mar 7 16:03:
UTC 2018
[    7.098288] 00:00:00.000171 main     Executable: /opt/VBoxGuestAdditions-5.2.8/sbin/VBox
vice
               00:00:00.000172 main     Process ID: 870
               00:00:00.000172 main     Package type: LINUX_64BITS_GENERIC
[    7.099575] 00:00:00.001454 main     5.2.8 r121009 started. Verbose level = 0
[    8.159830] floppy0: no floppy controllers found
[    8.159867] work still pending
[   12.185242] Non-volatile memory driver v1.3
[ 1578.066571] usb 1-2: new full-speed USB device number 3 using ohci-pci
[ 1578.588241] usb 1-2: New USB device found, idVendor=2341, idProduct=0043
[ 1578.588244] usb 1-2: New USB device strings: Mfr=1, Product=2, SerialNumber=220
[ 1578.588246] usb 1-2: Manufacturer: Arduino (www.arduino.cc)
[ 1578.588247] usb 1-2: SerialNumber: 55330333930351 20A080
[ 1579.119485] cdc_acm 1-2:1.0: ttyACM0: USB ACM device
[ 1579.139349] usbcore: registered new interface driver cdc_acm
[ 1579.139351] cdc_acm: USB Abstract Control Model driver for USB modems and ISDN adapters
evidence@erika-dev:~$
```

Figure 4.6.: `dmesg` command output.



Basic options for your PuTTY session
Specify the destination you want to connect to
Serial line: /dev/ttyACM0
Speed: 115200
Connection type: Raw Telnet Rlogin SSH [✓ Serial]
Load, save or delete a stored session
Saved Sessions
Default Settings
Close window on exit: [✓ Always] Never Only on clean exit

Figure 4.7.: PuTTY Configuration.

5. Run the Putty program by clicking on the icon available on the Desktop of the virtual machine, shown in Figure 3.7.

6. On Putty (see Figure 4.7), set:

    - Serial line: depending the serial device Arduino UNO board is attached (E.g. `/dev/ttyACM0`).
    - Baurdate: 115200.
    - No flow control.

7. Start the connection by clicking on `Open`.

4.2. Running RT-Druid 3

The following steps will guide you in the compilation of a simple ERIKA3 application for Arduino UNO:

1. To compile your first application with ERIKA3, you need to open the Eclipse IDE. There is an `Rt-Druid` link on the Desktop as shown in Figure 3.7.

2. Double click on it, and Eclipse will open requiring the workspace location. Please confirm the default location `/home/evidence/workspace` as in Figure 4.8. The Eclipse welcome screen will appear as in Figure 4.9. Click on the `Workbench` icon as highlighted in Figure 4.9, and the default Eclipse view will appear.

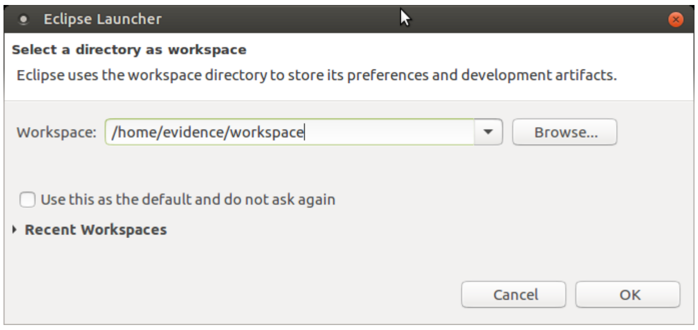

Eclipse Launcher
Select a directory as workspace
Eclipse uses the workspace directory to store its preferences and development artifacts.
Workspace: /home/evidence/workspace
Browse...
Use this as the default and do not ask again
Recent Workspaces
Cancel
OK

Figure 4.8.: RT-Druid Eclipse Workspace Selection.

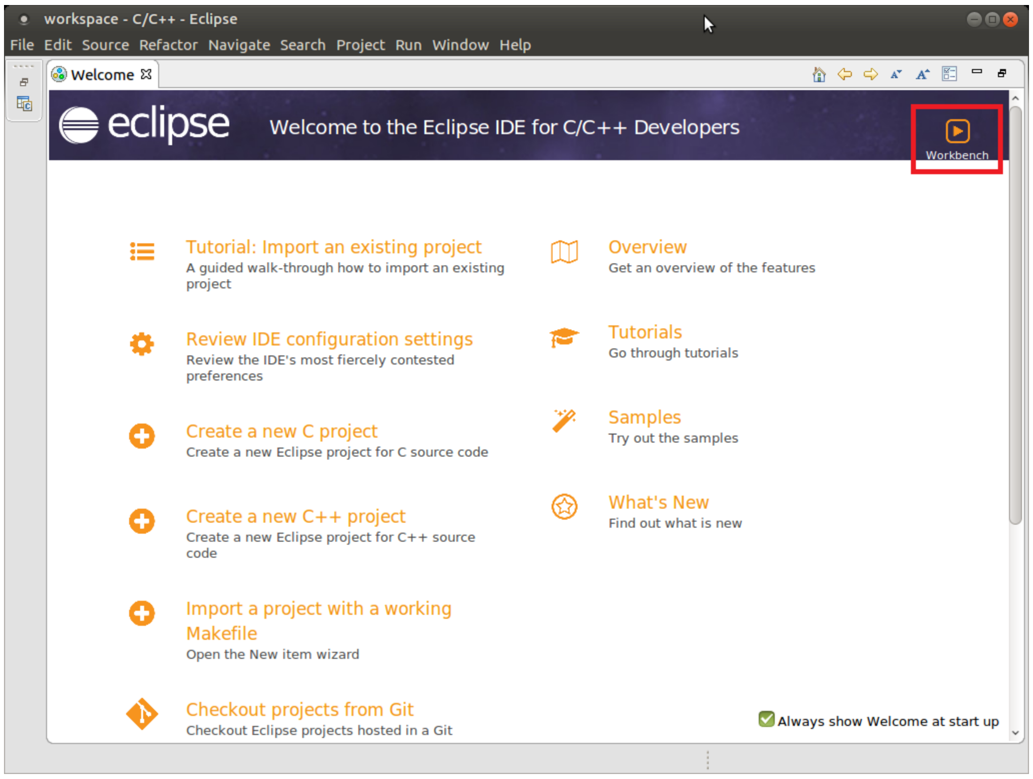

workspace - C/C++ - Eclipse
File Edit Source Refactor Navigate Search Project Run Window Help
Welcome
eclipse
Welcome to the Eclipse IDE for C/C++ Developers
Workbench
Tutorial: Import an existing project
A guided walk-through how to import an existing project
Review IDE configuration settings
Review the IDE's most fiercely contested preferences
Create a new C project
Create a new Eclipse project for C source code
Create a new C++ project
Create a new Eclipse project for C++ source code
Import a project with a working Makefile
Open the New item wizard
Checkout projects from Git
Checkout Eclipse projects hosted in a Git
Overview
Get an overview of the features
Tutorials
Go through tutorials
Samples
Try out the samples
What's New
Find out what is new
Always show Welcome at start up

Figure 4.9.: RT-Druid Eclipse Welcome.

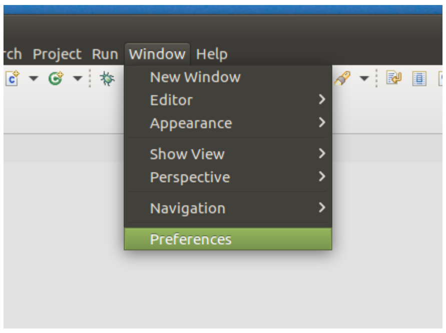
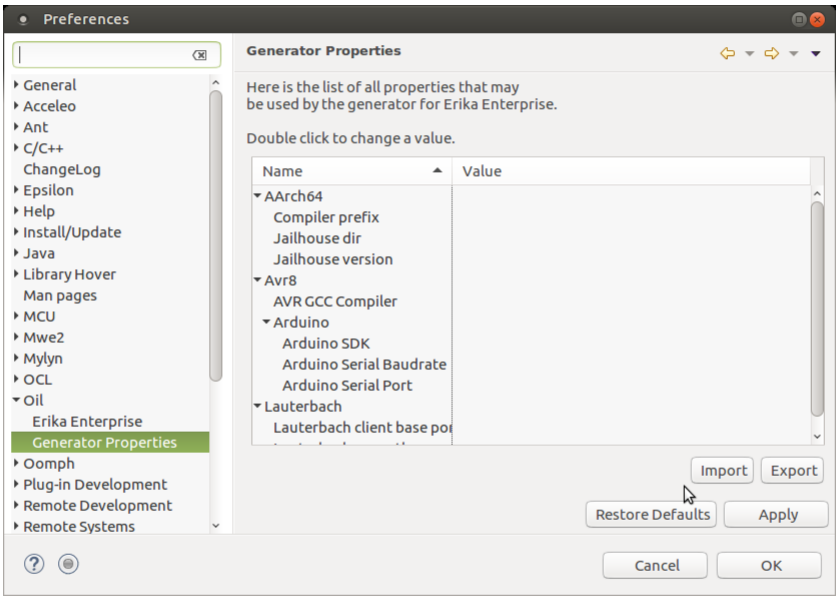


Figure 4.10.: **Preferences** entry of the **Window** menu.



Here is the list of all properties that may
be used by the generator for Erika Enterprise.

Double click to change a value.

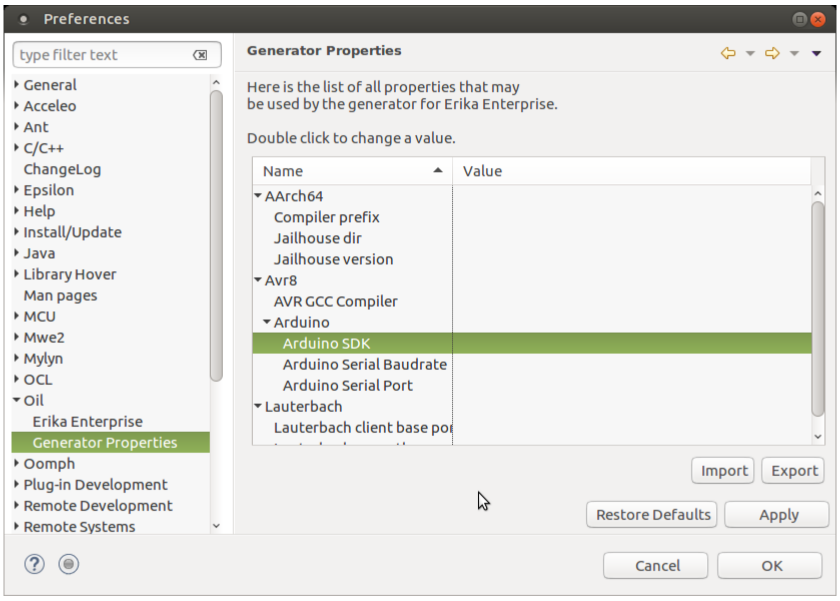
Name	Value
AArch64	
Compiler prefix	
Jailhouse dir	
Jailhouse version	
Avr8	
AVR GCC Compiler	
Arduino	
Arduino SDK	
Arduino Serial Baudrate	
Arduino Serial Port	
Lauterbach	
Lauterbach client base po	

Figure 4.11.: **Preferences** Window.

4.3. Configuring RT-Druid 3

The following steps will guide you in the RT-Druid configuration for Arduino UNO board:

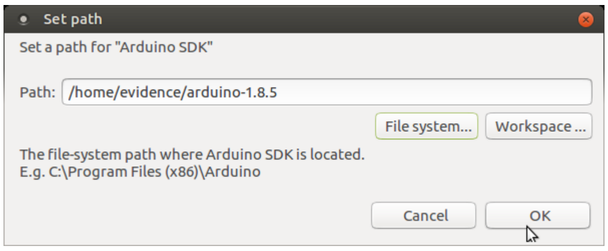
1. Click on the **Preferences** entry of the **Window** menu as shown in Figure 4.10.
2. The **Preferences** window will appear as shown in Figure 4.11. From the left panel expand **Oil** entry and selct **Generator Properties** as shown in Figure 4.11.
3. In the center panel double-click on the **Arduino SDK Property** entry as shown in Figure 4.12.
4. The **Arduino SDK Property** setup window will appear: browse the file-system to select the correct path of Arduino distribution (E.g. `/home/evidence/arduino-1.8.5`) and click **OK** button as shown in Figure 4.13.



Here is the list of all properties that may
be used by the generator for Erika Enterprise.

Double click to change a value.

Figure 4.12.: **Arduino SDK Property** selection.

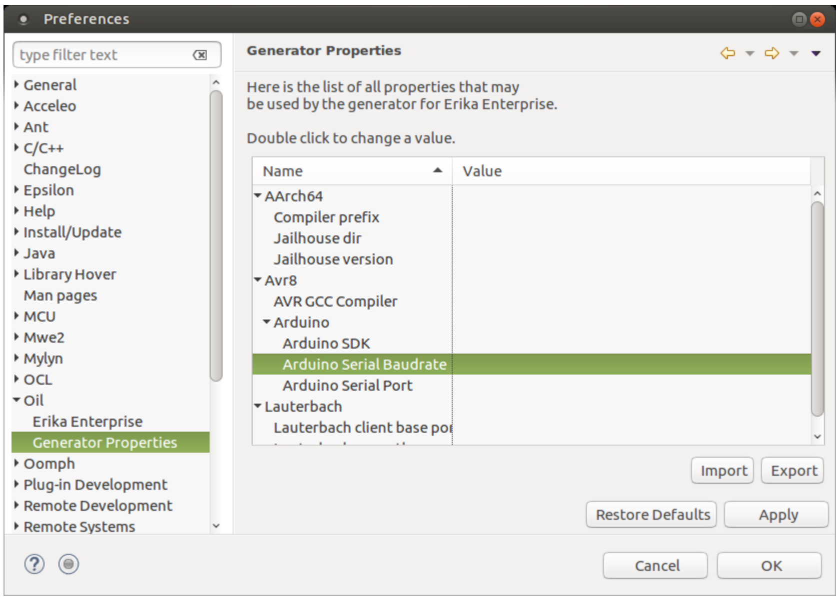


Set a path for "Arduino SDK"

Path: /home/evidence/arduino-1.8.5

The file-system path where Arduino SDK is located.
E.g. C:\Program Files (x86)\Arduino

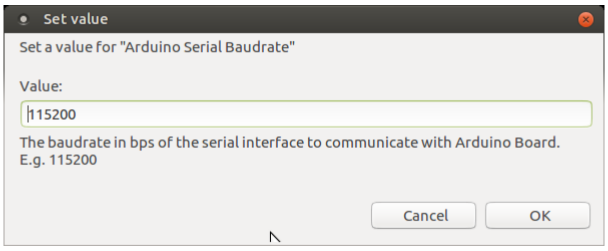
Figure 4.13.: **Arduino SDK Property** setup.



Here is the list of all properties that may be used by the generator for Erika Enterprise.

Double click to change a value.

Figure 4.14.: **Arduino Serial Baudrate Property** selection.



Set a value for "Arduino Serial Baudrate"

Value: 115200

The baudrate in bps of the serial interface to communicate with Arduino Board. E.g. 115200

Figure 4.15.: **Arduino Serial Baudrate Property** setup.

5. Please note that there is no need to specify the **AVR GCC Compiler** property, as it is automatically inherited from the Arduino SDK location.

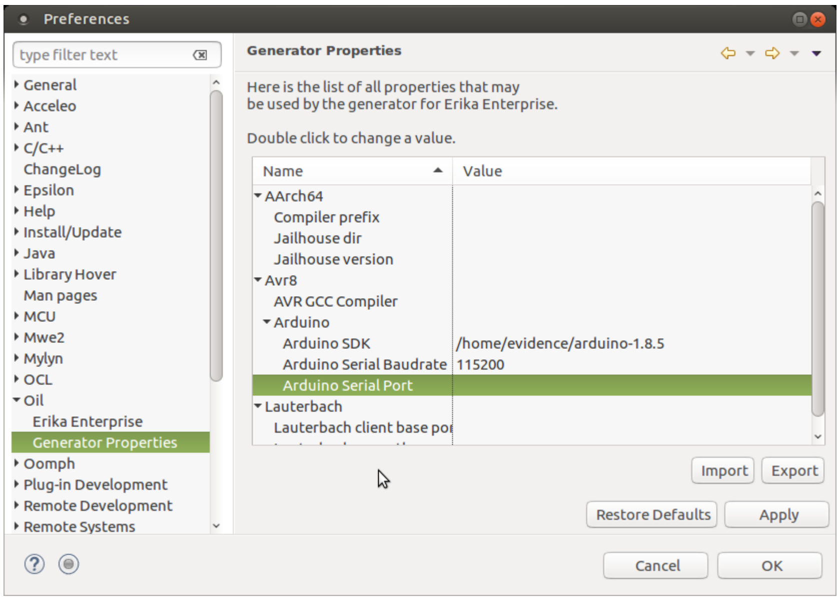
6. In the center panel of **Preferences** window double-click on the **Arduino Serial Baudrate Property** entry as shown in Figure 4.14.

7. The **Arduino Serial Baudrate Property** setup window will appear: type the value 115200 and click **OK** button as shown in Figure 4.15.

8. In the center panel of **Preferences** window double-click on the **Arduino Serial Port Property** entry as shown in Figure 4.16.

9. The **Arduino Serial Port Property** setup window will appear: type the USB Device identifier retrieved by `dmesg` command (E.g. `ttyACM0`) and click **OK** button as shown in Figure 4.17.

10. Finally click on **Apply** button and then click on **OK** button as shown in Figure 4.18.



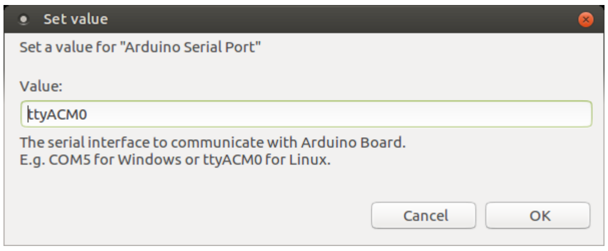
Generator Properties

Here is the list of all properties that may be used by the generator for Erika Enterprise.

Double click to change a value.

Name	Value
AArch64	
Compiler prefix	
Jailhouse dir	
Jailhouse version	
Avr8	
AVR GCC Compiler	
Arduino	
Arduino SDK	/home/evidence/arduino-1.8.5
Arduino Serial Baudrate	115200
Arduino Serial Port	
Lauterbach	
Lauterbach client base por	

Figure 4.16.: **Arduino Serial Port Property** selection.



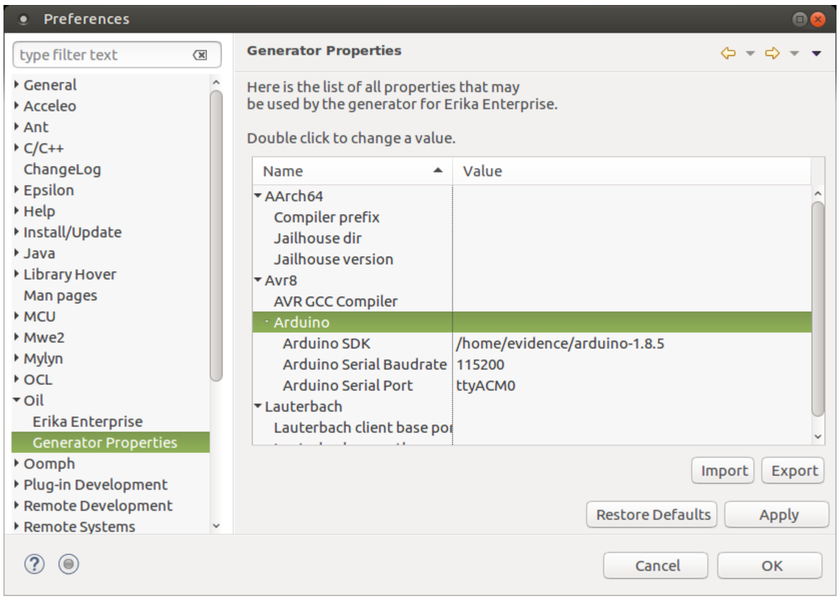
Set a value for "Arduino Serial Port"

Value:

ttyACM0

The serial interface to communicate with Arduino Board.
E.g. COM5 for Windows or ttyACM0 for Linux.

Figure 4.17.: **Arduino Serial Port Property** setup.


Preferences

type filter text

- General
- Acceleo
- Ant
- C/C++
- ChangeLog
- Epsilon
- Help
- Install/Update
- Java
- Library Hover
- Man pages
- MCU
- Mwe2
- Mylyn
- OCL
- Oil
  - Erika Enterprise
  - Generator Properties
- Oomph
- Plug-in Development
- Remote Development
- Remote Systems

Generator Properties

Here is the list of all properties that may
be used by the generator for Erika Enterprise.

Double click to change a value.

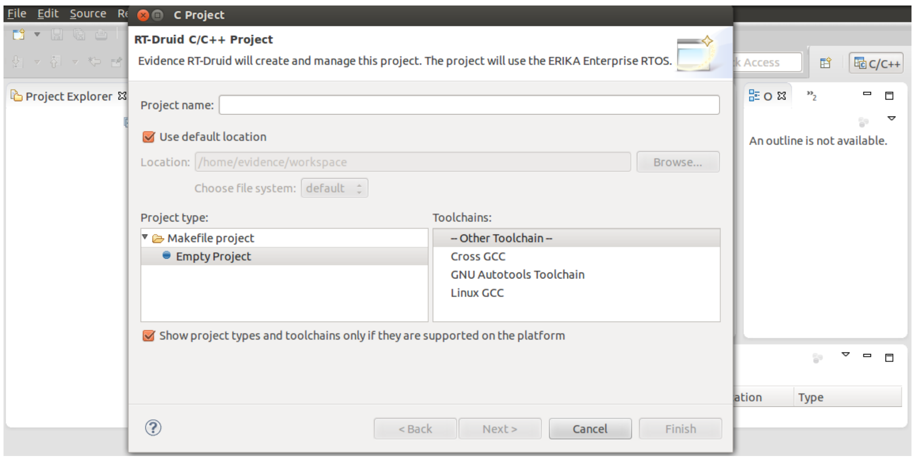
Name	Value
AArch64	
Compiler prefix	
Jailhouse dir	
Jailhouse version	
Avr8	
AVR GCC Compiler	
Arduino	
Arduino SDK	/home/evidence/arduino-1.8.5
Arduino Serial Baudrate	115200
Arduino Serial Port	ttyACM0
Lauterbach	
Lauterbach client base por	

Figure 4.18.: Arduino Properties confirmation.

4.4. Compiling an ERIKA3 application

The following steps will guide you in the compilation of a simple ERIKA3 application for Arduino UNO:

1. Create a new **RT-Druid v3 Oil and C/C++** project as shown in Figure 3.10.
2. A Dialog Box will appear as in Figure 4.19. Provide a name for the project (E.g. ArduinoEE3), select **Cross GCC** and press **Next** button.


C Project

RT-Druid C/C++ Project

Evidence RT-Druid will create and manage this project. The project will use the ERIKA Enterprise RTOS.

Project name:

☑ Use default location

Location: /home/evidence/workspace

Choose file system: default

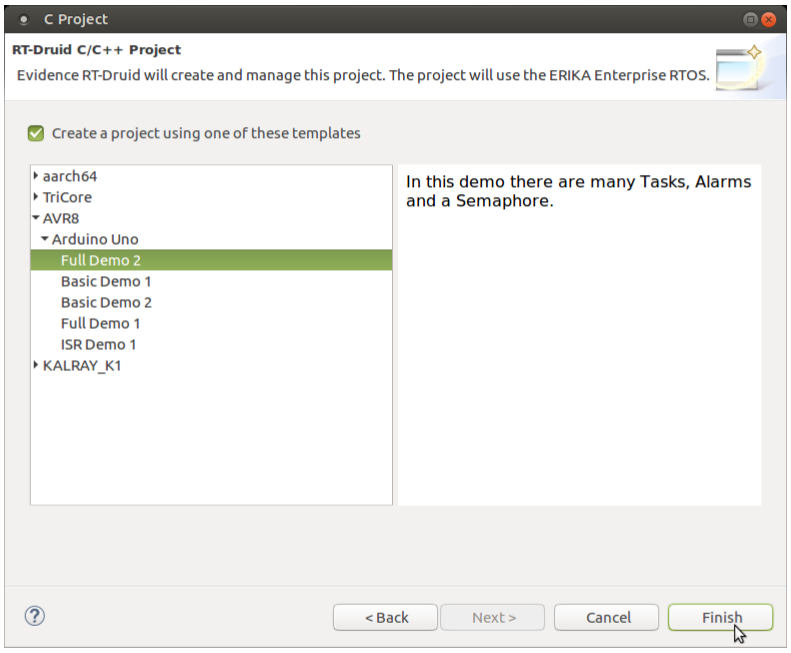
Project type:
- Makefile project
  - Empty Project

Toolchains:
- – Other Toolchain –
- Cross GCC
- GNU Autotools Toolchain
- Linux GCC

☑ Show project types and toolchains only if they are supported on the platform

Figure 4.19.: Provide a name for the Eclipse project containing the demo.

3. Select the checkbox “Create a project using one of these templates”, and select the **Full Demo 2** for the Arduino UNO board (see Figure 4.20).


C Project

RT-Druid C/C++ Project

Evidence RT-Druid will create and manage this project. The project will use the ERIKA Enterprise RTOS.

☑ Create a project using one of these templates

- aarch64
- TriCore
- AVR8
  - Arduino Uno
    - Full Demo 2
    - Basic Demo 1
    - Basic Demo 2
    - Full Demo 1
    - ISR Demo 1
- KALRAY_K1

In this demo there are many Tasks, Alarms and a Semaphore.

Figure 4.20.: How to select an Arduino UNO example.

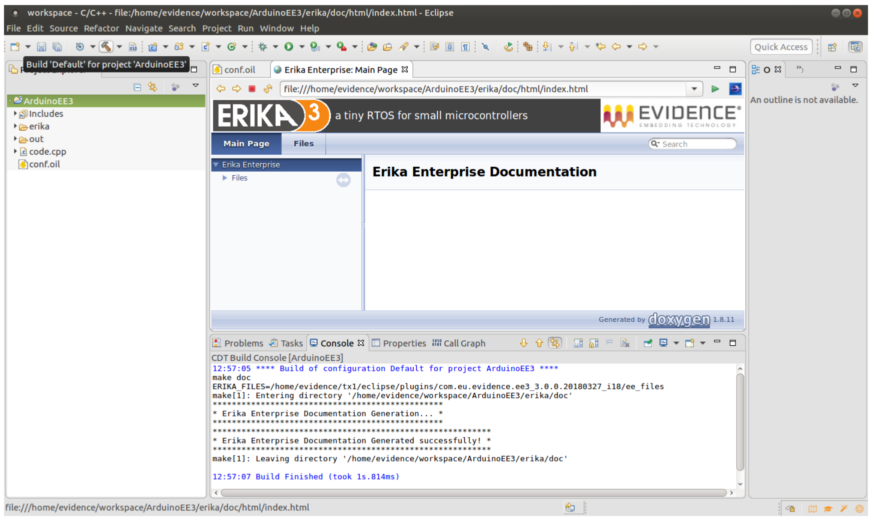
4. Click on the Finish button to create the example: the RT-Druid generator will pull ERIKA files into you project and the html documentation will be generated as shown on Figure 4.21.

5. At this point, you can explore the demo examples:
   - They are typically composed by several files:
     - a `conf.oil` file, containing the OIL description needed to statically configure the kernel and other files;
     - a `code.cpp`, containing the application code.
   - The target board selected for the specific demo is listed in the OIL file parameters.
   - A description of the typical layout of an EE3 workspace can be found at this link:

     `http://www.erika-enterprise.com/wiki/index.php?title=Quick_start_guide#Anatomy_of_an_ERIKA_v3_Project`

6. To compile the project, just right click on the project name and select "Build Project" as shown in Figure 3.14. As a result, the project is compiled using the GCC cross-compiler for the specific board. The output is printed on the Console view as shown on Figure 4.22.

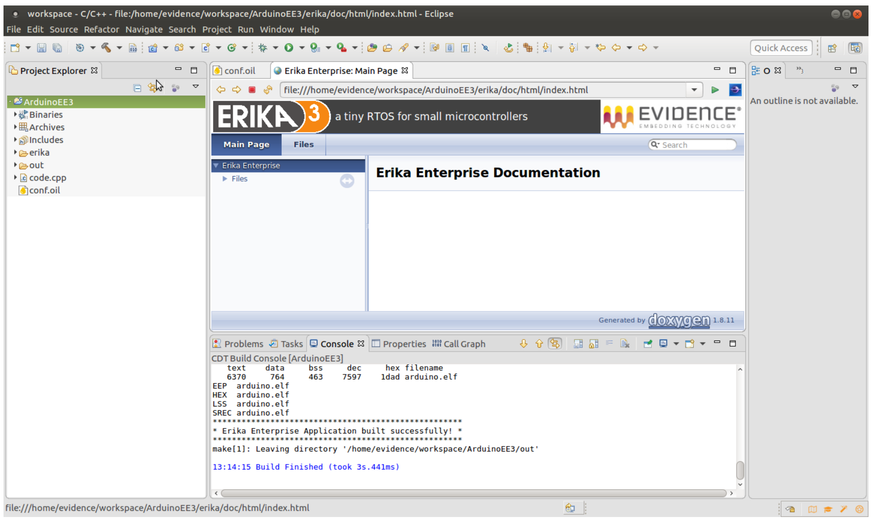
You are now ready to program the resulting files on the target board.


workspace - C/C++ - file:/home/evidence/workspace/ArduinoEE3/erika/doc/html/index.html - Eclipse
File Edit Source Refactor Navigate Search Project Run Window Help
Build 'Default' for project 'ArduinoEE3'
ArduinoEE3
Includes
erika
out
code.cpp
conf.oil
Erika Enterprise: Main Page
file:///home/evidence/workspace/ArduinoEE3/erika/doc/html/index.html
a tiny RTOS for small microcontrollers
Main Page
Files
Erika Enterprise
Erika Enterprise Documentation
Generated by doxygen 1.8.11
Problems Tasks Console Properties Call Graph
CDT Build Console [ArduinoEE3]
An outline is not available.
Quick Access

```
12:57:05 **** Build of configuration Default for project ArduinoEE3 ****
make doc
ERIKA_FILES=/home/evidence/tx1/eclipse/plugins/com.eu.evidence.ee3_3.0.0.20180327_i18/ee_files
make[1]: Entering directory '/home/evidence/workspace/ArduinoEE3/erika/doc'
************************************************
* Erika Enterprise Documentation Generation... *
************************************************
**********************************************************
* Erika Enterprise Documentation Generated successfully! *
**********************************************************
make[1]: Leaving directory '/home/evidence/workspace/ArduinoEE3/erika/doc'

12:57:07 Build Finished (took 1s.814ms)
```

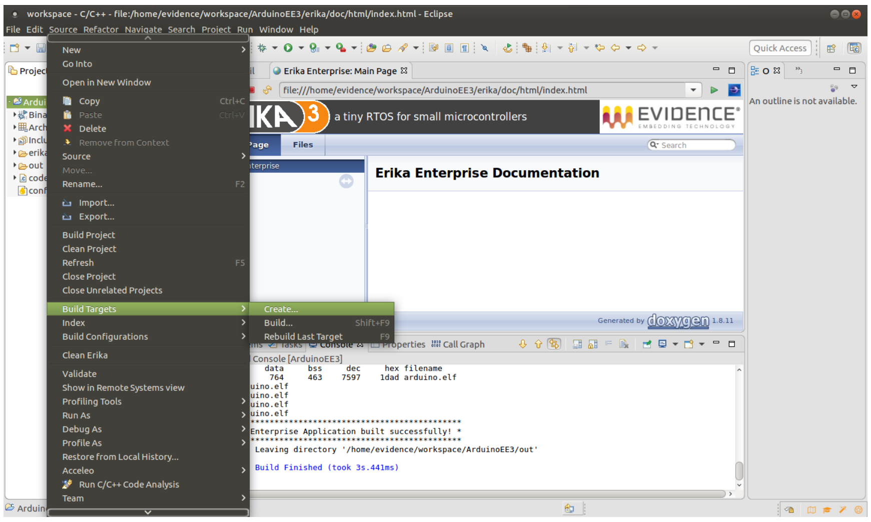
Figure 4.21.: The Arduino UNO demo after the creation and compilation of the Doxygen documentation.


workspace - C/C++ - file:/home/evidence/workspace/ArduinoEE3/erika/doc/html/index.html - Eclipse
File Edit Source Refactor Navigate Search Project Run Window Help
Project Explorer
ArduinoEE3
Binaries
Archives
Includes
erika
out
code.cpp
conf.oil
Erika Enterprise: Main Page
file:///home/evidence/workspace/ArduinoEE3/erika/doc/html/index.html
a tiny RTOS for small microcontrollers
Main Page
Files
Erika Enterprise
Erika Enterprise Documentation
Generated by doxygen 1.8.11
Problems Tasks Console Properties Call Graph
CDT Build Console [ArduinoEE3]
An outline is not available.
Quick Access

```
   text    data     bss     dec     hex filename
   6370     764     463    7597    1dad arduino.elf
EEP  arduino.elf
HEX  arduino.elf
LSS  arduino.elf
SREC arduino.elf
****************************************************
* Erika Enterprise Application built successfully! *
****************************************************
make[1]: Leaving directory '/home/evidence/workspace/ArduinoEE3/out'

13:14:15 Build Finished (took 3s.441ms)
```

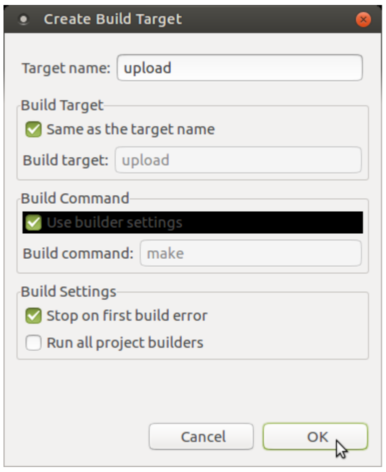
Figure 4.22.: Arduino UNO demo build successfull.


workspace - C/C++ - file:/home/evidence/workspace/ArduinoEE3/erika/doc/html/index.html - Eclipse
File Edit Source Refactor Navigate Search Project Run Window Help
New
Go Into
Open in New Window
Copy
Paste
Delete
Remove from Context
Source
Move...
Rename...
Import...
Export...
Build Project
Clean Project
Refresh
Close Project
Close Unrelated Projects
Build Targets
Index
Build Configurations
Clean Erika
Validate
Show in Remote Systems view
Profiling Tools
Run As
Debug As
Profile As
Restore from Local History...
Acceleo
Run C/C++ Code Analysis
Team
Create...
Build... Shift+F9
Rebuild Last Target F9
Erika Enterprise: Main Page
file:///home/evidence/workspace/ArduinoEE3/erika/doc/html/index.html
a tiny RTOS for small microcontrollers
Erika Enterprise Documentation
Generated by doxygen 1.8.11
Console
Properties
Call Graph
An outline is not available.

```
Console [ArduinoEE3]
   data     bss     dec     hex filename
    764     463    7597    1dad arduino.elf
uino.elf
uino.elf
uino.elf
uino.elf
*******************************************
Enterprise Application built successfully! *
*******************************************
 Leaving directory '/home/evidence/workspace/ArduinoEE3/out'

 Build Finished (took 3s.441ms)
```

Figure 4.23.: Arduino UNO build target creation.



Target name: upload

✓ Same as the target name

Build target: upload

✓ Use builder settings

Build command: make

✓ Stop on first build error

☐ Run all project builders

Figure 4.24.: **Create Build Target** dialog box.

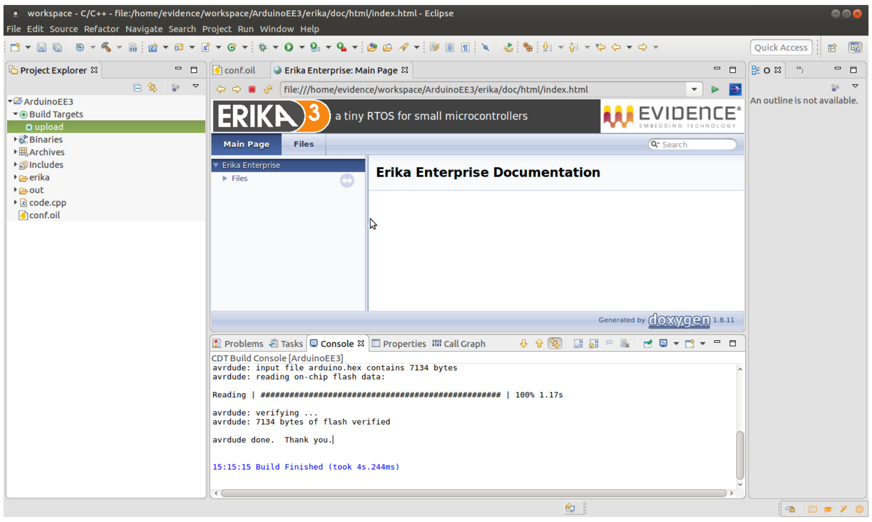
4.5. Programming the Arduino UNO board

To program the Arduino UNO board from the virtual machine, you can do the following steps:

1. Right click on the project name and select “Create...” entry from “Build Targets” menu as shown in Figure 4.23.

2. The “Create Build Target” Dialog Box will appear as in Figure 4.24. Provide a name for the build target (E.g. upload), uncheck the **Run all project builders** setting and press **OK** button.

3. The “upload” build target will be created on you project. Double-click on it to program the Arduino UNO board: the output is printed on the Console view as


workspace - C/C++ - file:/home/evidence/workspace/ArduinoEE3/erika/doc/html/index.html - Eclipse
File Edit Source Refactor Navigate Search Project Run Window Help
Project Explorer
ArduinoEE3
Build Targets
upload
Binaries
Archives
Includes
erika
out
code.cpp
conf.oil
Erika Enterprise: Main Page
a tiny RTOS for small microcontrollers
Main Page
Files
Erika Enterprise Documentation
Generated by doxygen 1.8.11
An outline is not available.
Problems
Tasks
Console
Properties
Call Graph

```
CDT Build Console [ArduinoEE3]
avrdude: input file arduino.hex contains 7134 bytes
avrdude: reading on-chip flash data:

Reading | ################################################## | 100% 1.17s

avrdude: verifying ...
avrdude: 7134 bytes of flash verified

avrdude done.  Thank you.


15:15:15 Build Finished (took 4s.244ms)
```

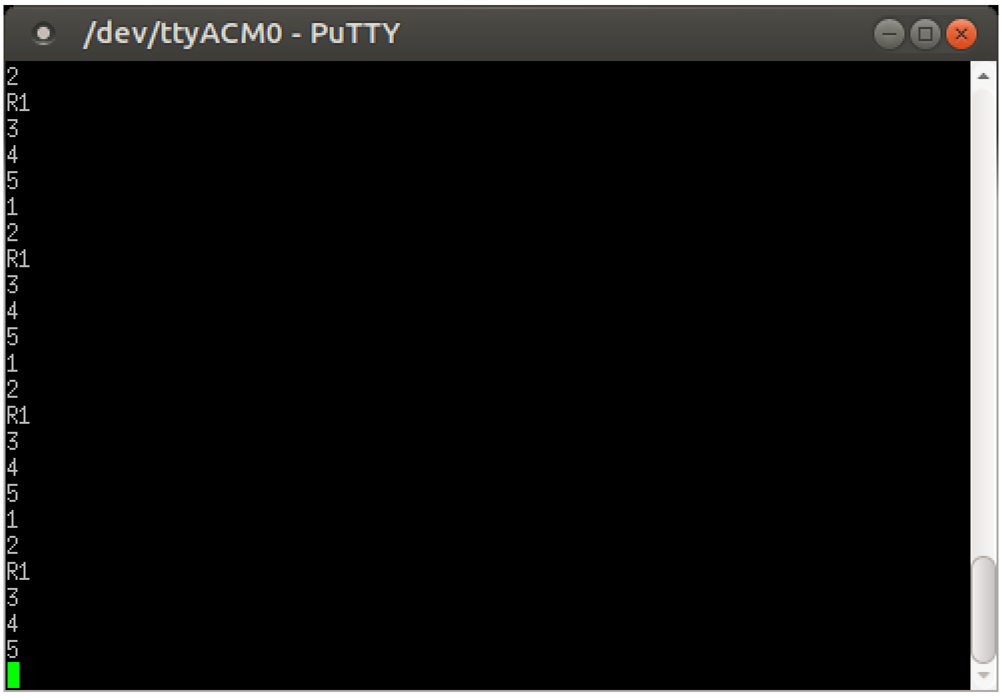
Figure 4.25.: Arduino UNO upload.

shown on Figure 4.25.

4. After that, the application will run on the Arduino UNO board and you can connect a Serial Terminal (e.g. PuTTY[1]) to the board to see the application output[2] as shown on Figure 4.26.

[1]Please select the same device you listed in Figure 4.17, as example `/dev/ttyACM0`. Also, please select `115200` for the Speed, and `Serial` for the Connection type.

[2]Please note that not all the Arduino demos use the serial output. For instance, the **Full Demo 2** demo suggested at the beginning of this chapter uses the serial output.



```
2
R1
3
4
5
1
2
R1
3
4
5
1
2
R1
3
4
5
1
2
R1
3
4
5
```

Figure 4.26.: Arduino UNO serial output.

5. Acknowledgements

The activity of porting Jailhouse and the ERIKA3 RTOS on the TX1 and TX2 boards has been funded by the European Commission under the HERCULES H2020 project (http://hercules2020.eu).

A. ERIKA3 version installed on the virtual machine

In order to understand the ERIKA3 version you are currently running on the virtual machine, you can do as follows:

1. Open Eclipse, and select Help → About Eclipse;
2. Click on the Evidence Logo. The list of Eclipse plugins provided by Evidence will appear.
3. In the version column, you will find a version code in the format:

   `release_series.date_version`

As an example, the code:

3.0.0.20180328_gh30

refers to:

3.0.0 ...which is ERIKA3;

20180328 ...which is the build day, 28th March, 2018;

GH30 ...which is the build number for the GitHub series, build number 30.

For more information about ERIKA3 version numbers, please refer to the following link:

`http://www.erika-enterprise.com/wiki/index.php?title=Release_schedule_and_build_numbers`