

# Trampoline on LEGO MINDSTORMS NXT2 (from zero)

Florent PAVIN

February 1, 2010

## Contents

<b>1</b>	<b>Introduction</b>	<b>2</b>
<b>2</b>	<b>Trampoline</b>	<b>2</b>
<b>3</b>	<b>GNUARM</b>	<b>2</b>
<b>4</b>	<b>Nexttool + Lego Drivers</b>	<b>4</b>
4.1	MAC OS . . . . .	4
4.2	Linux . . . . .	4
4.3	Windows . . . . .	5
<b>A</b>	<b>Launching Trampoline tests</b>	<b>6</b>
<b>B</b>	<b>Cross-Compile an application</b>	<b>6</b>
<b>C</b>	<b>Upload a program</b>	<b>6</b>
C.1	MAC OS . . . . .	6
C.2	Linux . . . . .	7
C.3	Windows . . . . .	7

# 1 Introduction

This document describes how to get started a Trampoline <sup>1</sup> application on Lego Mindstorms NXT2.

The following steps will be overviewed :

- Trampoline installation
- GCC compilation for ARM platform
- Installation of drivers and softwares to be able to upload programs on the NXT.

This document is explained from a UNIX side. If you are on a Windows system, download and install Cygwin as it is explained on NXTOSEK website (<http://lejos-osek.sourceforge.net/installation-windows.htm>) first.

# 2 Trampoline

To download Trampoline, type in a terminal :

```
$svn checkout https://trampoline.rts-software.org/svn/trunk
```

Download the libpm (<http://galgas.rts-software.org/download/>) for your architecture and copy it in trunk/.

To compile GOIL, go in goil/makefile\_[ARCH] depending on your architecture and type in a terminal (you can add -j2 if you have 2 processors) :

```
$make goil
```

This will generate the GOIL executable you'll need. You can add the path to your GOIL (in ~/.profile), adding :

```
export PATH=[TRAMPOLINE_REPOSITORY]/goil/makefile_[ARCH]/:$PATH
```

You can now use Trampoline on Unix system by executing the tests as described in Annex A.

# 3 GNUARM

Download and unpack the necessary packages: binutils, gcc, newlib and gdb.

---

<sup>1</sup>Trampoline is an open source RTOS which, once certified, could be compliant with the OSEK/VDX specification. Currently it is not the case, so while Trampoline has the same API as OSEK/VDX, it is not officially compliant. Trampoline is available under the GNU Lesser General Public License V2 and **is maintained by gcc-4.0.1**. Trampoline runs on several platforms like POSIX, C166 with Keil compiler, Star12X (courtesy of Geensys), PowerPC, ARM (NXT2 for example)

```
$ mkdir ~/crossgcc && cd ~/crossgcc
$ wget ftp://sourceware.org/pub/binutils/snapshots/binutils-2.18.50.tar.bz2
$ tar jxf binutils-2.18.50.tar.bz2
$ wget http://ftp.gnu.org/pub/gnu/gcc/gcc-4.2.3/gcc-4.2.3.tar.bz2
$ tar jxf gcc-4.2.3.tar.bz2
$ wget ftp://sources.redhat.com/pub/newlib/newlib-1.16.0.tar.gz
$ tar zxf newlib-1.16.0.tar.gz
$ wget http://ftp.gnu.org/pub/gnu/gdb/gdb-6.6.tar.gz
$ tar zxf gdb-6.6.tar.gz
```

The installation directory should be /usr/local/crossgcc.

```
$ sudo mkdir /usr/local/crossgcc
$ sudo chmod 777 /usr/local/crossgcc
```

First we build the binutils:

```
$ mkdir build-binutils && cd build-binutils
$ ../binutils-2.18.50/configure --target=arm-elf \
--prefix=/usr/local/crossgcc/ 2>&1 | tee configure.log
$ make all install 2>&1 | tee make.log
$ export PATH=$PATH:/usr/local/crossgcc/bin
```

Build the gcc compiler with C/C++ support:

```
$ cd ../gcc-4.2.3
$ ln -s ../newlib-1.16.0/newlib .
$ ln -s ../newlib-1.16.0/libgloss .
$ cd ..
$ mkdir build-gcc && cd build-gcc
$ ../gcc-4.2.3/configure --target=arm-elf \
--prefix=/usr/local/crossgcc/ --with-newlib \
--with-gnu-as --with-gnu-ld --enable-languages=c,c++ 2>&1 | tee configure.log
$ make all install 2>&1 | tee make.log
```

Build the gdb debugger:

```
$ cd ..
$ mkdir build-gdb && cd build-gdb
$ ../gdb-6.6/configure --target=arm-elf --prefix=/usr/local/crossgcc/
$ make all install 2>&1 | tee make.log
```

You can now compile an application for ARM as described in Annex B.

## 4 Nexttool + Lego Drivers

### 4.1 MAC OS

Download and install the Lego Drivers (<http://mindstorms.lego.com/en-us/support/files/default.aspx#Driver>) and the firmware update (<http://mindstorms.lego.com/en-us/support/files/default.aspx#Firmware>) for MAC OS.

Download Nexttool (<http://bricxcc.sourceforge.net/utilities.html>) and a new firmware ([http://bricxcc.sourceforge.net/lms\\_arm\\_jch.zip](http://bricxcc.sourceforge.net/lms_arm_jch.zip)) and update the firmware as explained below :

- Reset the NXT : To go into firmware update mode, press the reset button (at the back of the NXT, upper left corner beneath the USB connector) for more than 5 seconds while the NXT is turned on. The NXT will audibly tick when it is in firmware update mode.
- Copy an Enhanced NXT firmware (i.e. `lms_arm_nbcnxc_107.rfw`) to NeXT-Tool extracted directory.
- Launch Nexttool, and upload the Enhanced NXT firmware to the NXT (clicking on "Download firmware"), selecting it.



- Remove the battery from the NXT and insert it again, and then press orange rectangle button on the NXT to turn on the Enhanced NXT firmware. The Enhanced NXT firmware has same GUI as the LEGO standard firmware.

To upload a program into the NXT, go to the Annex C.

### 4.2 Linux

Follow the instructions in the NXTOSEK website [http://lejos-osek.sourceforge.net/installation\\_linux.htm](http://lejos-osek.sourceforge.net/installation_linux.htm).

### 4.3 Windows

Download and install the Lego Drivers (<http://mindstorms.lego.com/en-us/support/files/default.aspx?Driver>) for PC.

Download Nexttool (<http://bricxcc.sourceforge.net/nexttool.zip>) and a new firmware ([http://bricxcc.sourceforge.net/lms\\_arm\\_jch.zip](http://bricxcc.sourceforge.net/lms_arm_jch.zip)) and update the firmware as explained below :

- Reset the NXT : To go into firmware update mode, press the reset button (at the back of the NXT, upper left corner beneath the USB connector) for more than 5 seconds while the NXT is turned on. The NXT will audibly tick when it is in firmware update mode.
- Copy an Enhanced NXT firmware (i.e. `lms_arm_nbcnxc_107.rfw`) to NeXTTool extracted directory.
- Execute Cygwin and type the following command to change the current directory to the NeXTTool extracted directory. (NeXTTool is assumed to be extracted under `C:\cygwin\nexttool` directory)

```
$cd C:\cygwin\nexttool
```

- Connect PC and the NXT by USB cable.
- Type the following command in Cygwin to upload the Enhanced NXT firmware to the NXT (Program upload may take around half minutes and then, NXT LCD is turned to display some chunk from blank).

```
$/NeXTTool.exe /COM=usb -firmware=lms\_arm\_nbcnxc\_107.rfw
```

- Remove the battery from the NXT and insert it again, and then press orange rectangle button on the NXT to turn on the Enhanced NXT firmware. The Enhanced NXT firmware has same GUI as the LEGO standard firmware.

You can now upload a program into the NXT as described in the Annex C.

## A Launching Trampoline tests

To launch the tests you have to compile ViPER <sup>2</sup> first. Go in viper/ and type in a terminal :

```
$make
```

To launch the tests, go in check/ and type in a terminal :

```
$./tests.sh -t=[ARCH]
```

with [ARCH] equals to posix or libpcl depending which port you'd like to use. At the end of the tests you should see :

```
...  
Compare results with the expected ones...  
Functional tests Succeed!!  
GOIL tests Succeed!!
```

If an error occurs, you can visit Trampoline's forum (<http://trampoline.rts-software.org/bb/>).

## B Cross-Compile an application

To cross-compile a Trampoline application for ARM ports, you need to set :

- COMPILER = "arm-elf-gcc";
- ASSEMBLER = "arm-elf-as";
- LINKER = "arm-elf-ld";

in your oil file as you can see in examples/arm/nxt/lonely.oil.

And then, compile your application typing in a terminal (from the example in examples/arm/nxt) :

```
$goil -t=arm/nxt --templates=../../goil/templates -g -i lonely.oil  
$make
```

Then you need to upload the \*.rxex file (see Annex C- after installing drivers and softwares on your platform (4))

## C Upload a program

### C.1 MAC OS

To upload a program in the NXT (the next example examples/arm/nxt/lonely\_exe.rxe)

- Connect the PC and the NXT by USB cable.



- Launch Nexttool, select "usb port".
- Go to "NXT Explorer"



- Click on the "Download selected files to the NXT" and select the lonely\_exe.rxe file.
- If program upload was succeeded, you can see the lonely\_exe.rxe file in the files list as below.
- To execute a program on the NXT, go in "My files" / "Software files".

## C.2 Linux

Follow the instructions in the NXTOSEK website [http://lejos-osek.sourceforge.net/installation\\_linux.htm](http://lejos-osek.sourceforge.net/installation_linux.htm).

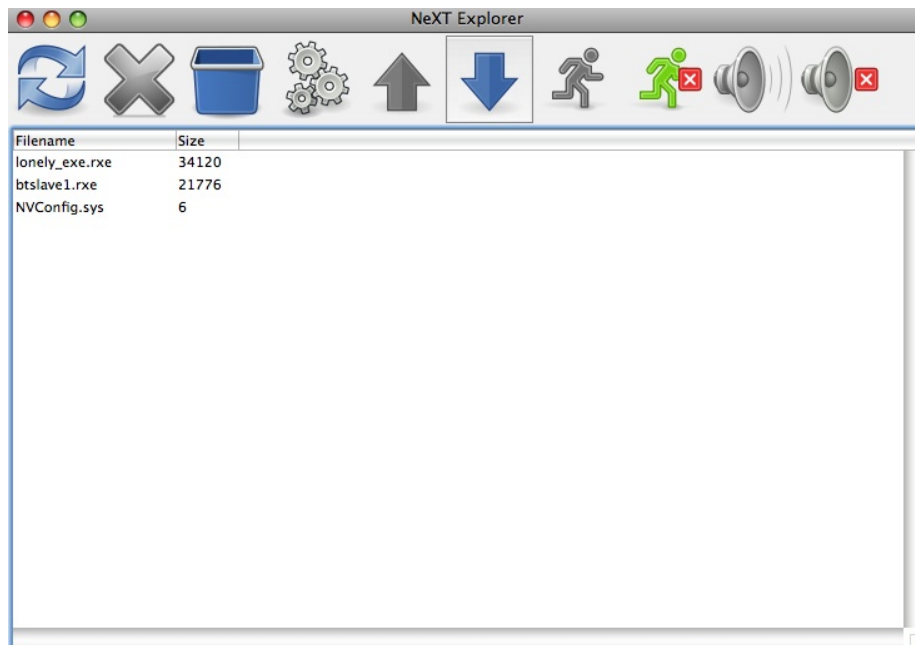
## C.3 Windows

To upload a program in the NXT (the next example examples/arm/nxt/lonely\_exe.rxe) follow the steps below :

- Connect the PC and the NXT by USB cable.
- Type the following command in Cygwin (from examples/arm/nxt) :

---

<sup>2</sup>Virtual Processor Emulator, ViPER is used on Posix system to send interrupts to Trampoline to emulate the timers. It is launched by Trampoline.



```
$wine NeXTTool.exe /COM=usb -download=lonely_exe.rxe  
$wine NeXTTool.exe /COM=usb -listfiles=lonely_exe.rxe
```

- If program upload was succeeded, program size could be displayed in Cygwin such as the second line in the below command outputs.

```
Executing NeXTTool to upload helloworld.rxe...  
helloworld.rxe=15280  
NeXTTool is terminated.
```

- To execute a program on the NXT, go in "My files"/"Software files".