Department of Electrical & Computer Engineering – Concordia University

ECE QNX Real-time Lab

User Guide

Dan Li

8/29/2020

User Guide of
ECE Real-time QNX Lab

Contents

1. About Real-time QNX Lab

Real-time QNX lab is in room H832 and equipped 12 real-time workstations. Each workstation is running Windows 7 with some real-time package.

Contacts

Real-time QNX lab is managed by ECE Engineering Specialist, Dan Li. Any problem regarding to this lab, you can contact him:

- Emai: danli@ece.concordia.ca
- Call: (514)8482424 x 3148

Packages on Real-time development Machine

a) QNX Momentics 6.4.1 (Momontics 4.6) - The QNX Software Development Platform 6.4.1 includes the QNX Neutrino RTOS 6.4.1 and QNX Momentics Tool Suite 6.4.1. It is a complete and comprehensive development environment for QNX Neutrino-based devices and system

b) VMware Server 2.0 - VMware Server is an easy-to-use Windows application that provides a superior introductory experience to server virtualization for Real-time lab to host a QNX target.

c) Matlab 2009b, etc.

2. Real-time User Accounts

Real-time account

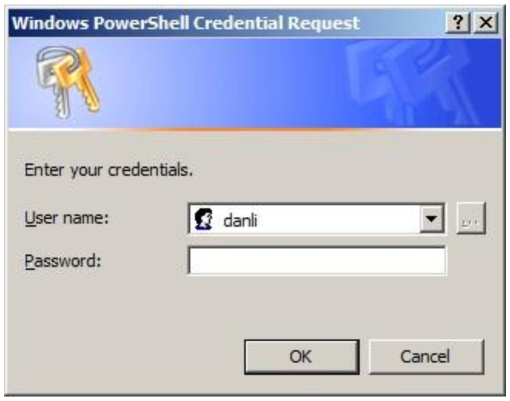
Once you have registered ECE real-time course, i.e. COEN320, COEN421, ELEC481, ELEC483, one specific real-time account shall be created after new semester starts. Real-time account is separated with your ENCS user account. Initially user's real-time account is created based-on ENCS account and managed on ECE real-time server 'Tissot.encs.concordia.ca'. One user real-time userID is same as his/her ENCS user ID but real-time password is created as same as the uer ID, e.g. if an user ID is named as 'a_student', then the pre-assigned password is ' student'.

Login Real-time Domain

Press 'Ctrl+lt+Del', input your real-time ID and password, you can login any workstation in the lab. When you first time login real-time domain, the workstation may take more time to create your profile.

Map ENCS Drives

Once you log on real-time workstation, the system shall run a script to map your ENCS network drives G: and U: . The log-in pop-up window is shown as the followed:

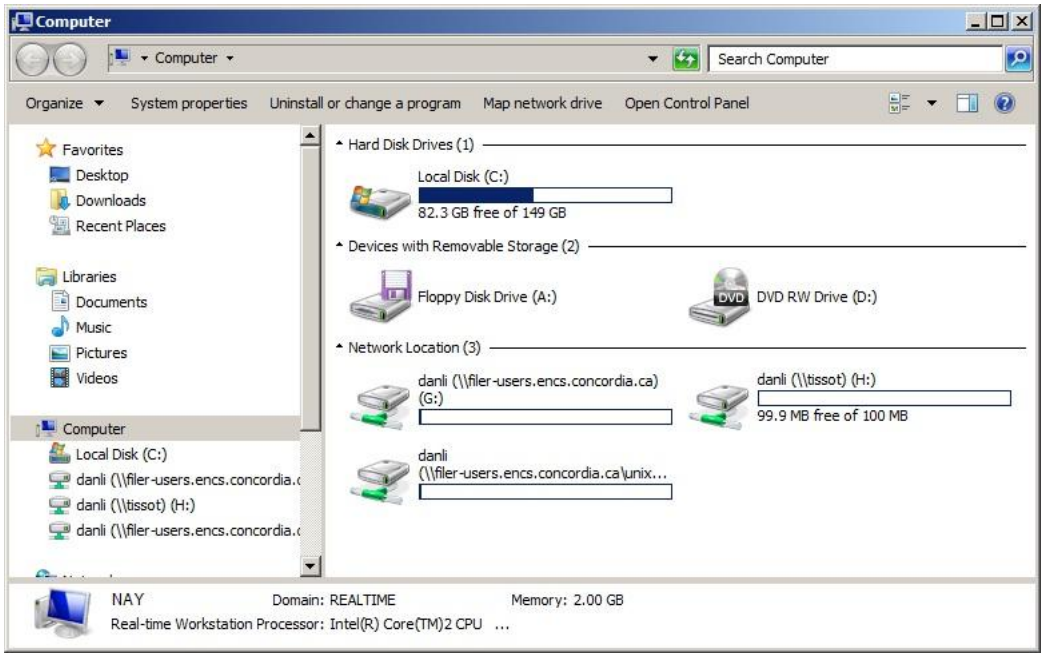

Windows PowerShell Credential Request

Enter your credentials.

User name: danli

Password:

The detailed information about these two network drives please refer to ENCS helpdesk webpage. After network drives are mounted, system shows your drives , see the followed screenshot.



Hard Disk Drives (1)

Local Disk (C:)
82.3 GB free of 149 GB

Devices with Removable Storage (2)

Floppy Disk Drive (A:)
DVD RW Drive (D:)

Network Location (3)

danli (\\filer-users.encs.concordia.ca) (G:)
danli (\\tissot) (H:)
99.9 MB free of 100 MB
danli (\\filer-users.encs.concordia.ca\unix…

NAY Domain: REALTIME Memory: 2.00 GB
Real-time Workstation Processor: Intel(R) Core(TM)2 CPU …

Drives

- G: \ - ENCS personal Windows home
- U: \ - ENCS personal Unix home
- H:\ - ECE real-time home

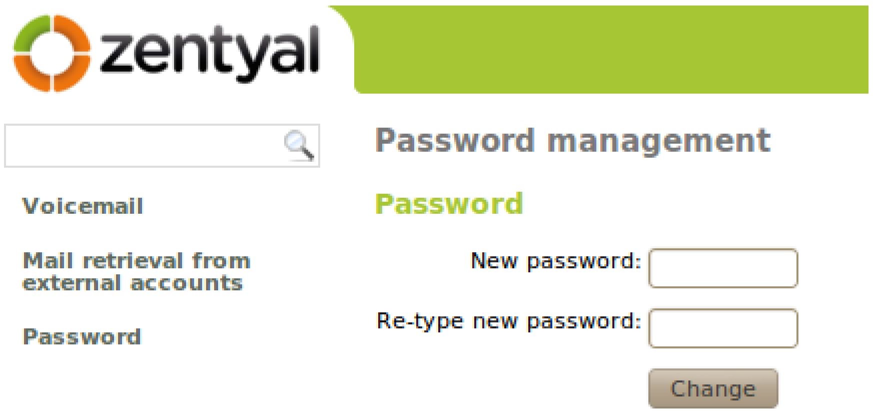
Real-time system will create a working directory at “G:\realtime” , when you first time log in. This directory is primary real-time workspace. You shall store your file and code under this directory. The reason is G:\ drive is easy to access and more safe than H:.

Change Real-time password

Once you log on real-time workstation with default password, you shall change it immediately. Launch a web browser, and input the URL:

https://tissot.encs.concordia.ca:8888/

Once the user enters his name and password, he can perform changes in his personal configuration. The showed functionality is the following:


Password management

Password

Voicemail

Mail retrieval from external accounts

Password

New password:

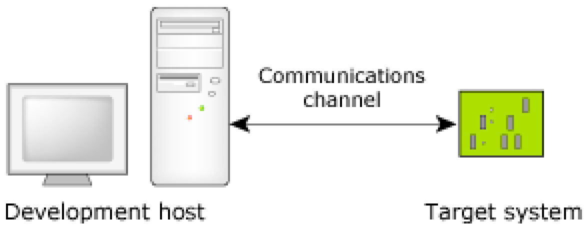
Re-type new password:

Change

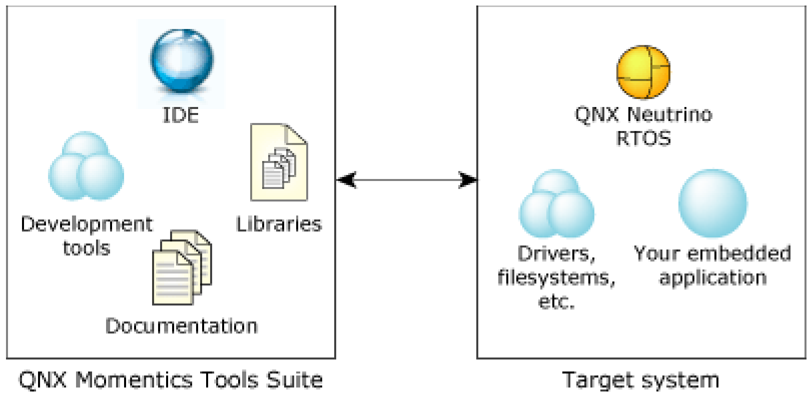
Then you can change the current password in user’s corner.

3. Real-time Environment

To write programs that run under the QNX Neutrino real-time operating system (RTOS), the first thing you need is the QNX Software Development Platform (SDP). This includes QNX Momentics Tool Suite, which contains everything you need to develop programs that run on Windows *development host*. The tool suite features an extensive Integrated Development Environment (IDE).



The development host runs the QNX Momentics Tool Suite; the target system runs the QNX Neutrino RTOS itself plus all the programs you're going to develop:


IDE
Development tools
Libraries
Documentation
QNX Momentics Tools Suite
QNX Neutrino RTOS
Drivers, filesystems, etc.
Your embedded application
Target system

Real-time Target machines

Regardless of whether you're connecting to a remote or a local target, as a real-time developer you have to prepare your target machine so that the IDE can interact with the QNX Neutrino image running on the target. The IDE supports host-target communications using either an IP or a serial connection. Target systems need to run the target agent (`qconn`). See Target agent in the IDE Concepts chapter for more information.

In ECE real-time QNX lab, there are two targets available for each workstation:

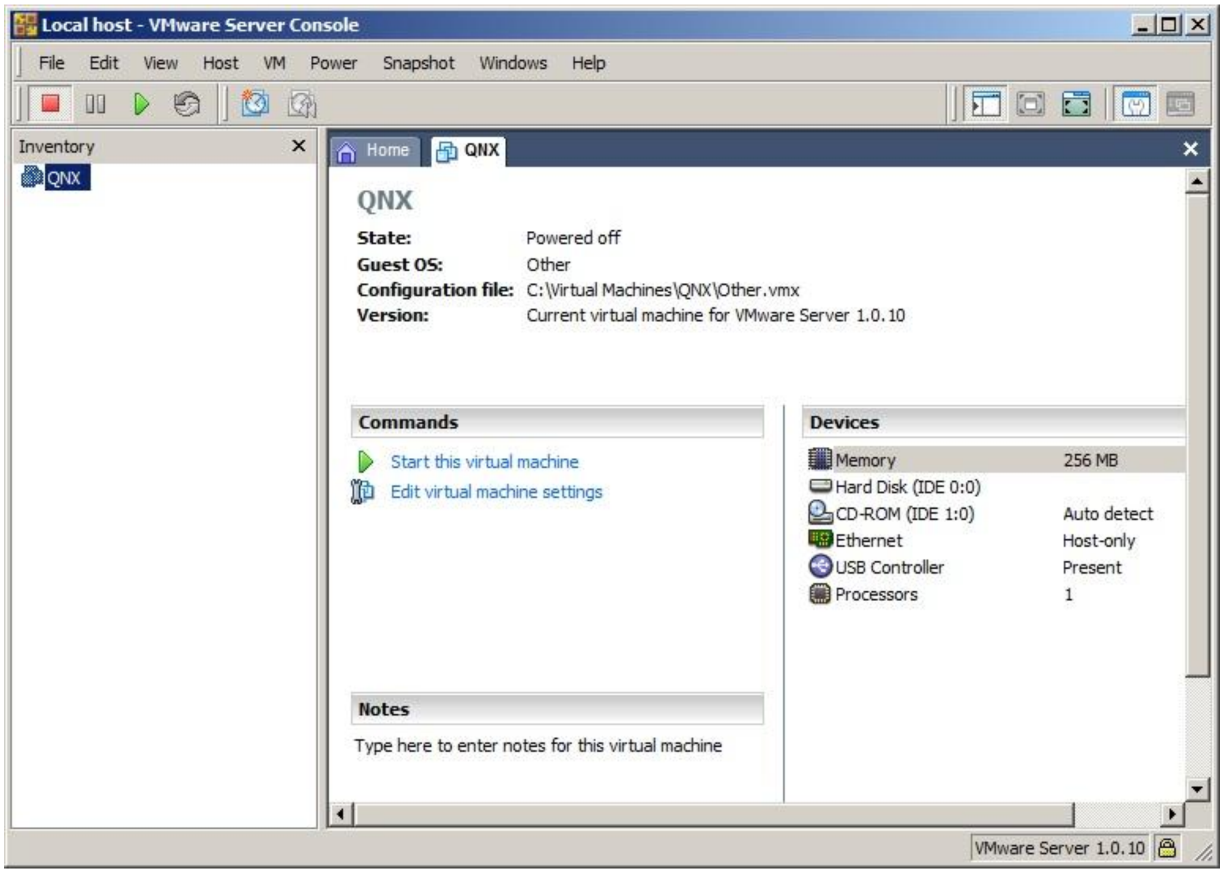
- Remote access server 'mackay.encs.concordia.ca' (192.168.141.3)
- QNX system running on local virtual machine. (192.168.246.2)

Run Vmware

Click the icon , or from 'start' –' All programs' –' Vmware server console'. Shown in the following figure. To start QNX Virtual machine, click the green arrow or click the command "**Start this virtual machine**'.

Note:

- The virtual machine may take serveral minutes to 'boot up'.
- Its IP is '192.168.246.2'.
- No user login needed for debugging.


Local host - VMware Server Console
File Edit View Host VM Power Snapshot Windows Help
Inventory
QNX
Home
QNX

QNX

State:	Powered off
Guest OS:	Other
Configuration file:	C:\Virtual Machines\QNX\Other.vmx
Version:	Current virtual machine for VMware Server 1.0.10

Commands

Start this virtual machine
Edit virtual machine settings

Devices

Memory	256 MB
Hard Disk (IDE 0:0)	
CD-ROM (IDE 1:0)	Auto detect
Ethernet	Host-only
USB Controller	Present
Processors	1

Notes

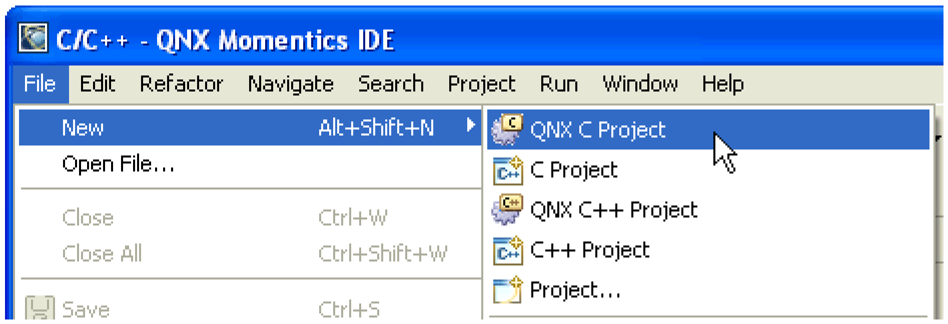
Type here to enter notes for this virtual machine

VMware Server 1.0.10

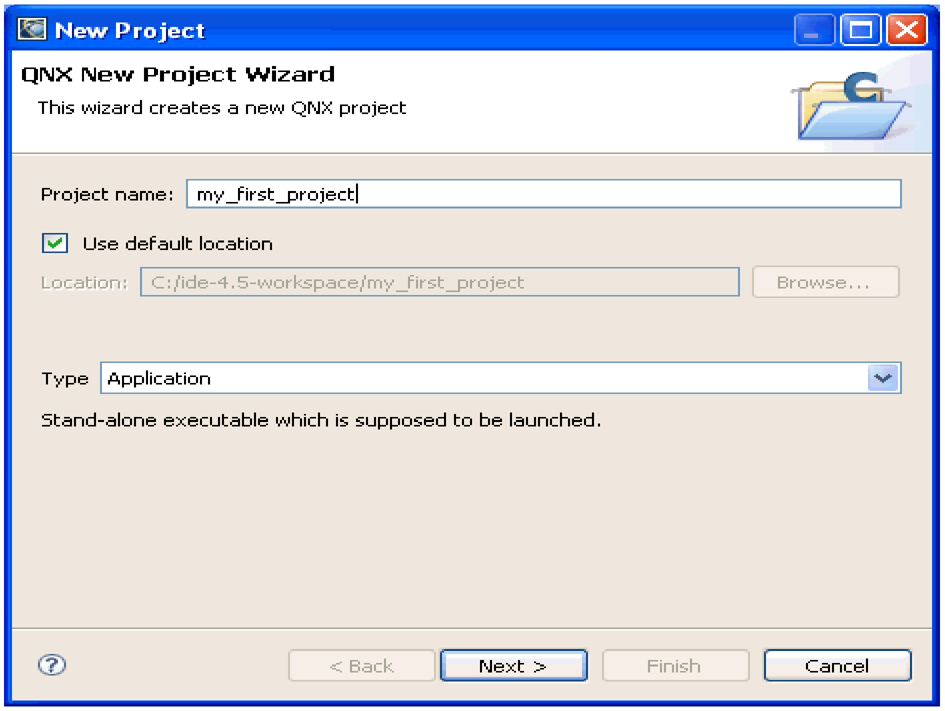
4. A Real-time Program Project

Start the QNX Momentics IDE on your development host. The first time you start the IDE, it asks you to choose a *workspace*, a folder where it can store your projects and other files. The IDE then displays its Welcome page. When you're ready to start, click the Momentics icon:

Now create a QNX C Project: from the File menu, select **New-->QNX C++ Project**:



In the resulting dialog, give your project a name:



Project name: my_first_project

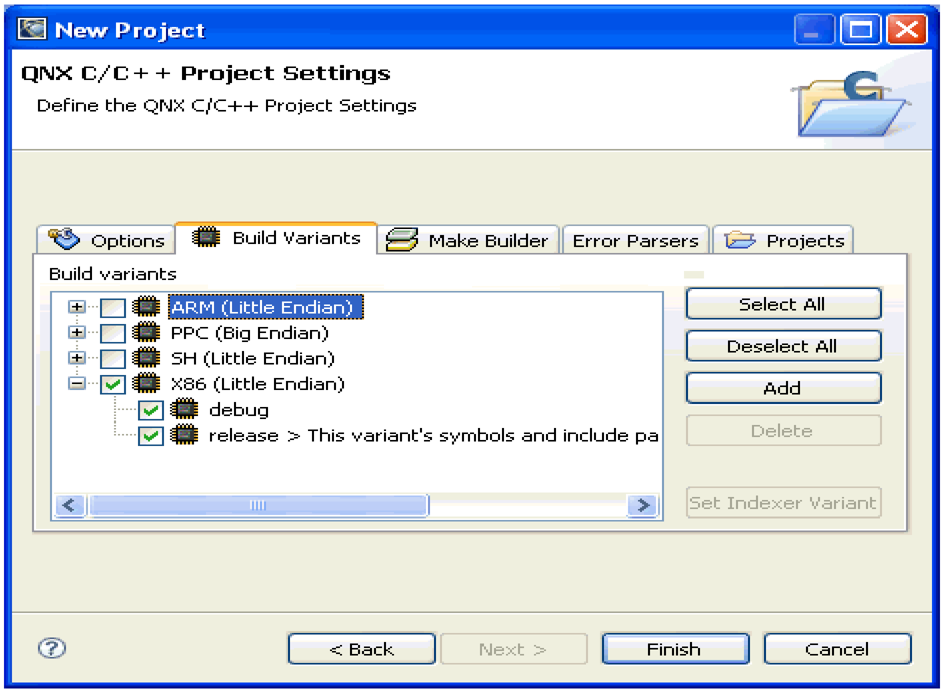
☑ Use default location

Location: C:/ide-4.5-workspace/my_first_project Browse...

Type Application

Stand-alone executable which is supposed to be launched.

And then click **Next**. You now need to select a CPU architecture for the binary you're creating. To do this, go to the Build Variants tab. For a PC as target, choose x86.

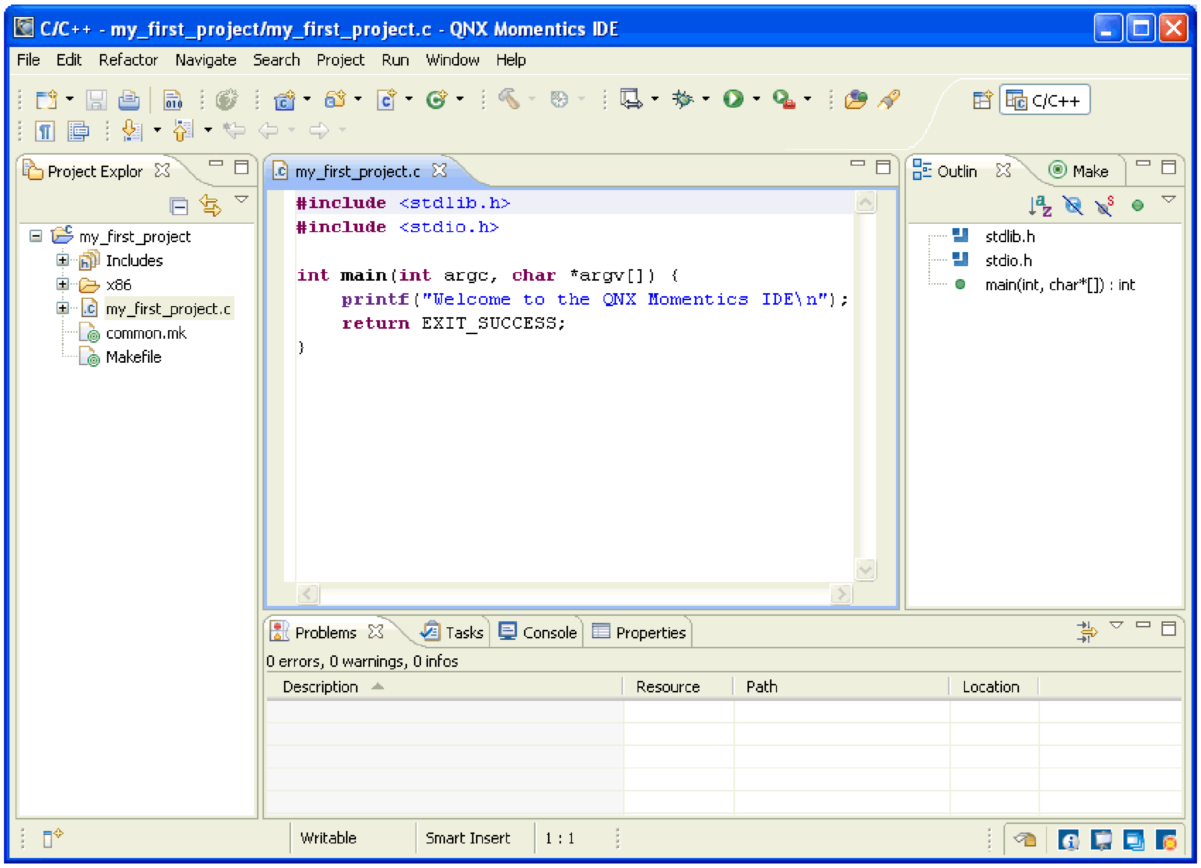


- [ ] ARM (Little Endian)
- [ ] PPC (Big Endian)
- [ ] SH (Little Endian)
- [✓] X86 (Little Endian)
  - [✓] debug
  - [✓] release > This variant's symbols and include pa

Selecting build variants.

Click **Finish**. A ready-to-use project structure with a `Makefile` is created for you, including a small program ("Welcome to the QNX Momentics IDE"), which you'll find in an automatically generated source code file.

The IDE now switches to the C/C++ perspective, which features the navigator, the editor, and other useful *views*, areas that display information that's relevant to the task at hand:

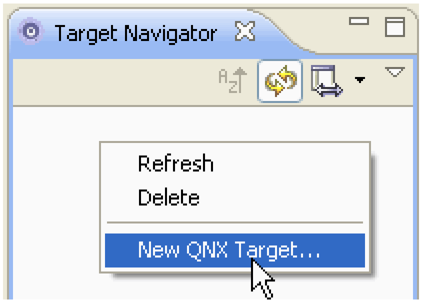


```
#include <stdlib.h>
#include <stdio.h>

int main(int argc, char *argv[]) {
    printf("Welcome to the QNX Momentics IDE\n");
    return EXIT_SUCCESS;
}
```

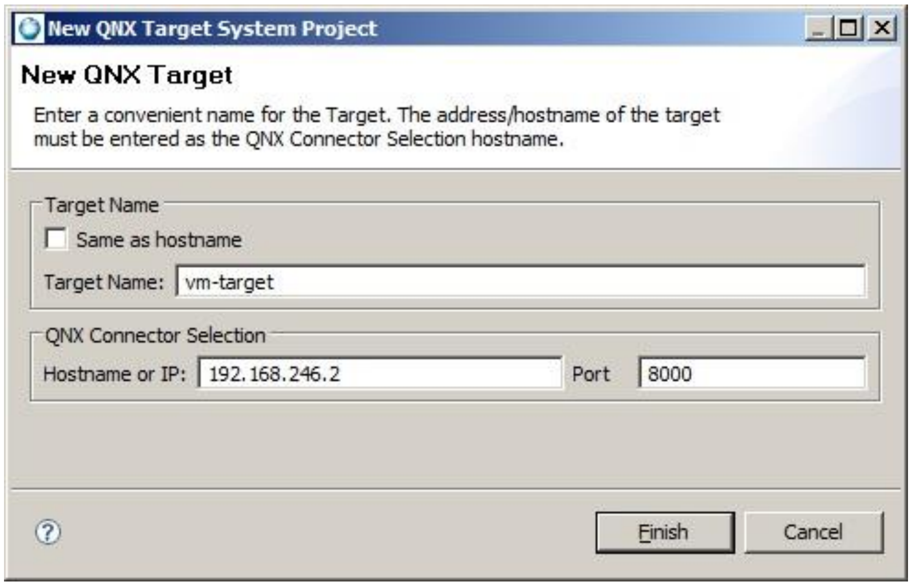
Communicating with QNX Neutrino (Target)

Your target system must be able to respond to requests from the development environment. To make this possible, you shall confirm a target available, see the section 3 – “Real-time Environment”

To access your target system from the IDE, you have to create a *target project*. Open the System Information perspective: in the Window menu, select **Open Perspective-->QNX System Information**. In the empty Target Navigator view, press the right mouse button and select **New QNX Target...** from the context menu:



Now provide a name for your target system and enter its IP address in the corresponding field:


New QNX Target System Project

New QNX Target

Enter a convenient name for the Target. The address/hostname of the target must be entered as the QNX Connector Selection hostname.

Target Name

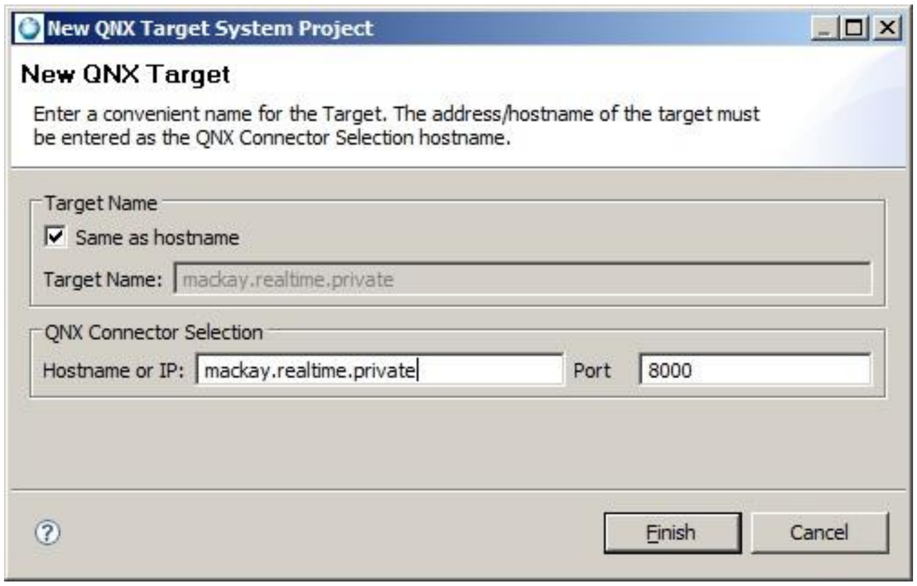
☐ Same as hostname

Target Name: vm-target

QNX Connector Selection

Hostname or IP: 192.168.246.2 Port 8000

or


New QNX Target System Project

New QNX Target

Enter a convenient name for the Target. The address/hostname of the target must be entered as the QNX Connector Selection hostname.

Target Name

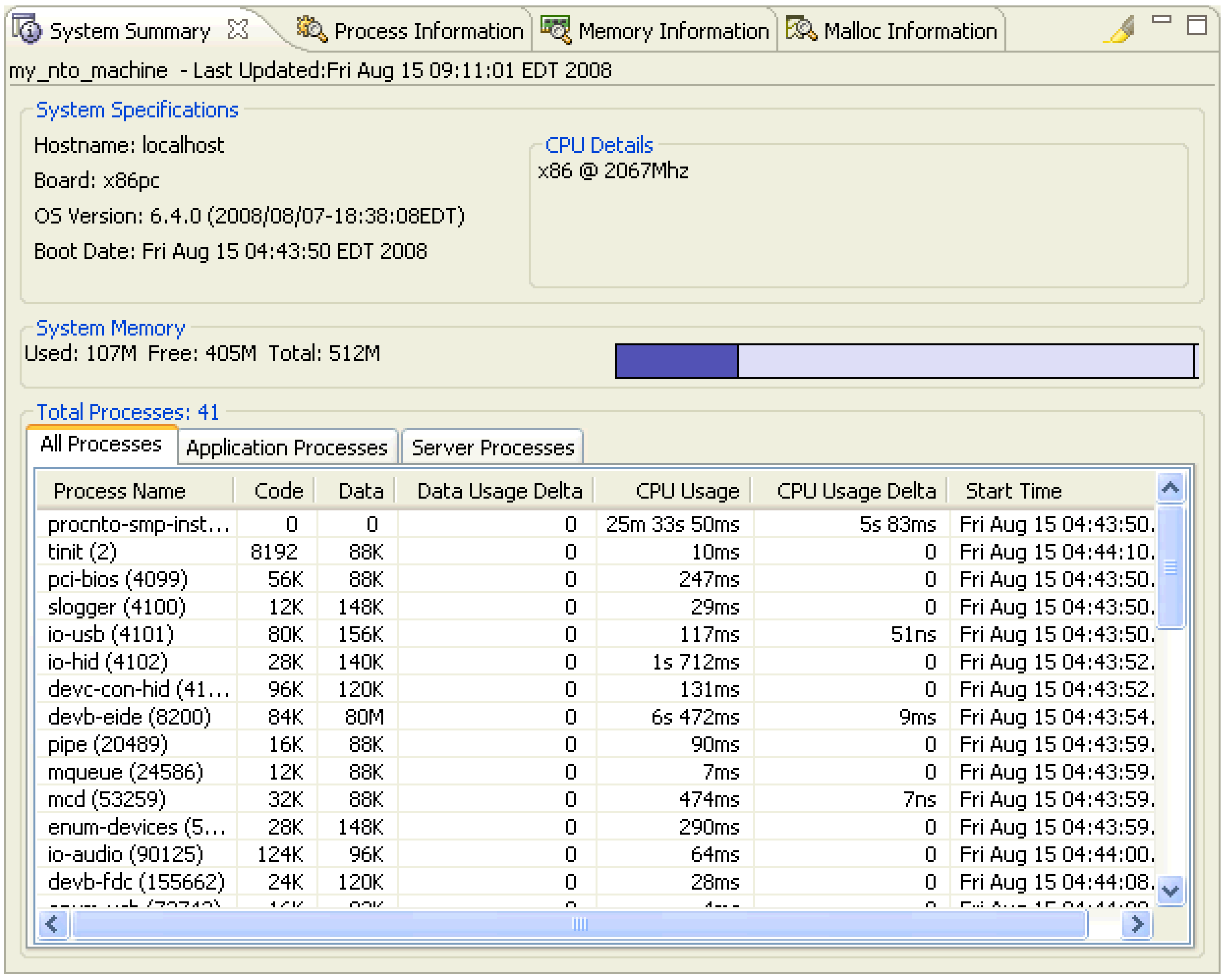
☑ Same as hostname

Target Name: mackay.realtime.private

QNX Connector Selection

Hostname or IP: mackay.realtime.private Port 8000

Click **Finish**, and then select your new target in the Target Navigator. You will now see a list of all the processes in your QNX Neutrino system. The views (the tabs at the top) provide other information to you. You can find even more useful views in the Window menu under **Show View**.



System Summary | Process Information | Memory Information | Malloc Information

my_nto_machine - Last Updated:Fri Aug 15 09:11:01 EDT 2008

System Specifications

Hostname: localhost

Board: x86pc

OS Version: 6.4.0 (2008/08/07-18:38:08EDT)

Boot Date: Fri Aug 15 04:43:50 EDT 2008

CPU Details

x86 @ 2067Mhz

System Memory

Used: 107M Free: 405M Total: 512M

Total Processes: 41

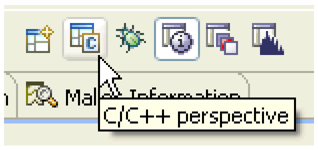
All Processes | Application Processes | Server Processes

Process Name	Code	Data	Data Usage Delta	CPU Usage	CPU Usage Delta	Start Time
procnto-smp-inst…	0	0	0	25m 33s 50ms	5s 83ms	Fri Aug 15 04:43:50.
tinit (2)	8192	88K	0	10ms	0	Fri Aug 15 04:44:10.
pci-bios (4099)	56K	88K	0	247ms	0	Fri Aug 15 04:43:50.
slogger (4100)	12K	148K	0	29ms	0	Fri Aug 15 04:43:50.
io-usb (4101)	80K	156K	0	117ms	51ns	Fri Aug 15 04:43:50.
io-hid (4102)	28K	140K	0	1s 712ms	0	Fri Aug 15 04:43:52.
devc-con-hid (41…	96K	120K	0	131ms	0	Fri Aug 15 04:43:52.
devb-eide (8200)	84K	80M	0	6s 472ms	9ms	Fri Aug 15 04:43:54.
pipe (20489)	16K	88K	0	90ms	0	Fri Aug 15 04:43:59.
mqueue (24586)	12K	88K	0	7ms	0	Fri Aug 15 04:43:59.
mcd (53259)	32K	88K	0	474ms	7ns	Fri Aug 15 04:43:59.
enum-devices (5…	28K	148K	0	290ms	0	Fri Aug 15 04:43:59.
io-audio (90125)	124K	96K	0	64ms	0	Fri Aug 15 04:44:00.
devb-fdc (155662)	24K	120K	0	28ms	0	Fri Aug 15 04:44:08.

Here you see what's going on inside your QNX Neutrino system.

Compiling and linking

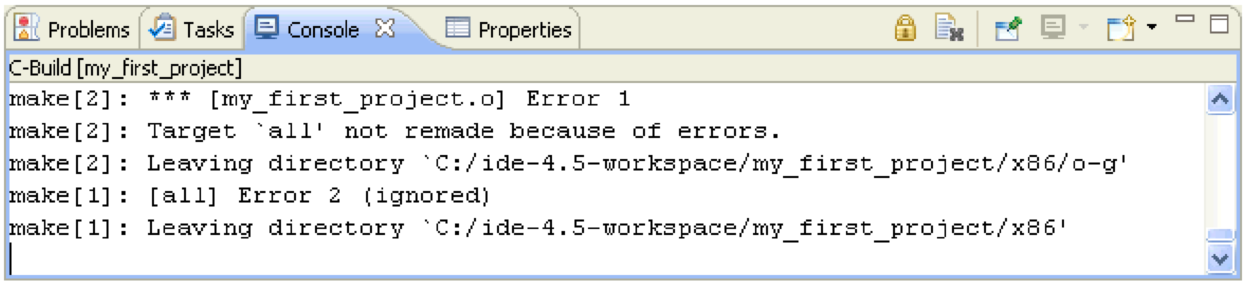
Now switch back to the C/C++ perspective by choosing its icon in the right side of the toolbar:



Before you compile, you may want to select compilation with or without debug information. To do so, right-click the project name in the C/C++ Projects view, and then choose **Properties**. Click **QNX C/C++ Project**, click **Build Variants**, and then click on the small **+** symbol next to x86. Make sure that both the debug and release variants are checked. Click **OK**; the IDE offers to rebuild the project.

During the creation of the QNX C Project, a QNX-made directory structure with `Makefile`s was generated. Now to create a binary, please right-click the project name, and then select **Build Project**. The compiler and linker will now do their work.

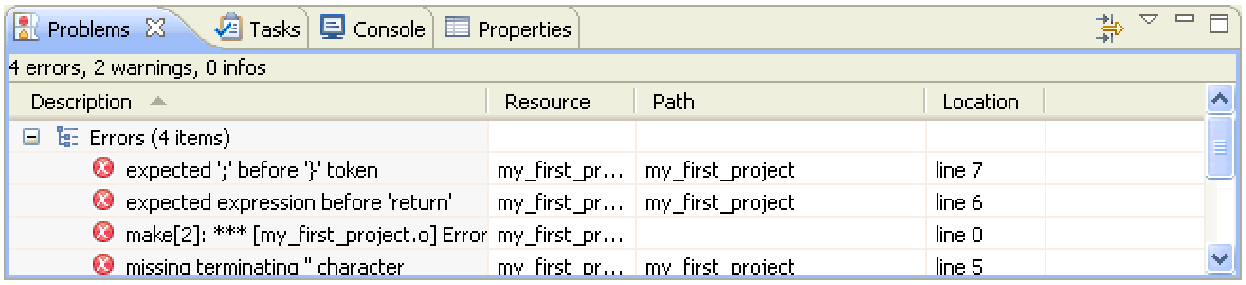
You will find the compiler output in the C-Build output in the Console view, including any errors (you shouldn't see any errors, but we've added one in the examples below):



C-Build [my_first_project]

```
make[2]: *** [my_first_project.o] Error 1
make[2]: Target `all' not remade because of errors.
make[2]: Leaving directory `C:/ide-4.5-workspace/my_first_project/x86/o-g'
make[1]: [all] Error 2 (ignored)
make[1]: Leaving directory `C:/ide-4.5-workspace/my_first_project/x86'
```

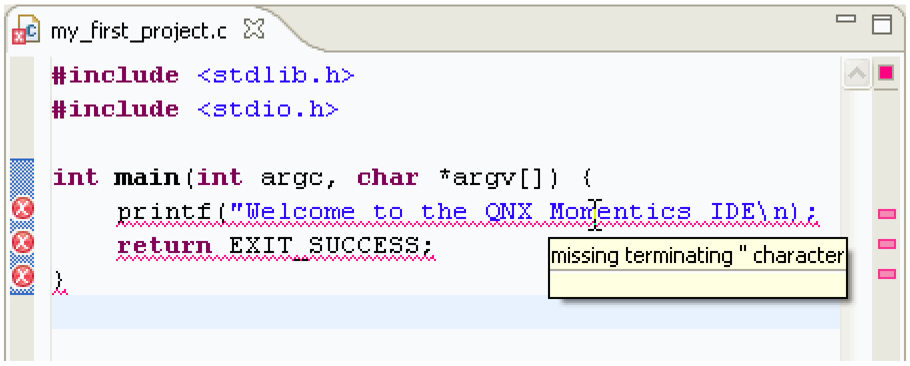
However, if errors occur during compiling, you will find the Problems view more useful, because it displays the output of the compiler in an interpreted and more readable fashion than the Console view:



4 errors, 2 warnings, 0 infos

Description	Resource	Path	Location
Errors (4 items)			
expected ';' before '}' token	my_first_pr...	my_first_project	line 7
expected expression before 'return'	my_first_pr...	my_first_project	line 6
make[2]: *** [my_first_project.o] Error	my_first_pr...		line 0
missing terminating " character	my_first_pr...	my_first_project	line 5

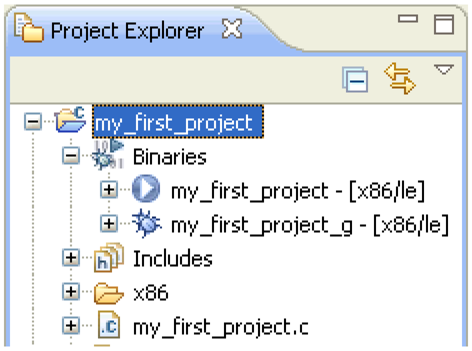
The Editor view also gives you information about an error if you leave the pointer over it:



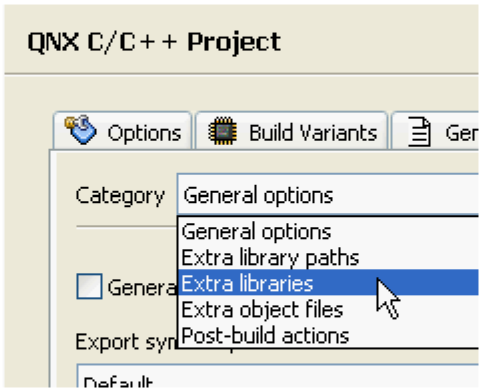
```
#include <stdlib.h>
#include <stdio.h>

int main(int argc, char *argv[]) {
    printf("Welcome to the QNX Momentics IDE\n);
    return EXIT_SUCCESS;
}
```

missing terminating " character

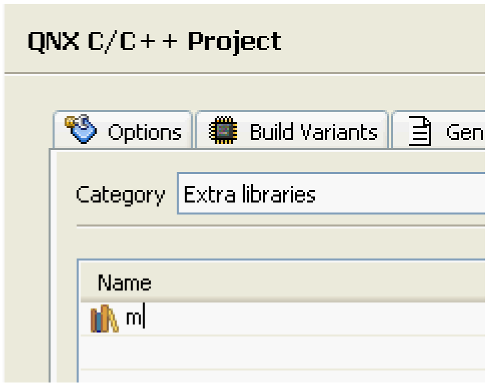
After the build operation, your binaries will be displayed in the `Binaries` folder. Physically, they're located in the CPU directory under `o` (for object) and `o-g` (`-g` for the debug option passed to the compiler). The IDE automatically created the corresponding `Makefile`s.



The QNX library `libc.so`, which contains many basic functions, is linked dynamically to your binary by default. If you want to add other libraries later, you can do so under the **Project-->Properties** section. From there, click on **QNX C/C++ Project**, then **Linker**, and then choose **Extra Libraries** in the **Category** field:



Click **Add**, and type the name of the library, without the `lib` prefix or the extension. For example, to add the math library, `libm.so`, you just have to type `m` in the Name field:

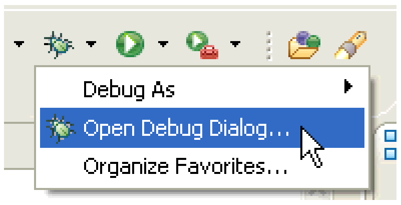


Click **OK**. The linker will now link the library when you build the project.

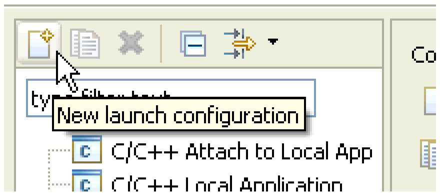
Preparing to launch the program

To run and debug the newly built program on your target system, you need to create a *launch configuration*. It consists of various settings that affect how the program starts (e.g. command-line parameters, environment variables). You enter these once, and then you can use this collection of settings again and again.

Now create your own launch configuration: from the dropdown menu beside the "bug" icon on the toolbar, select **Open Debug Dialog...**:



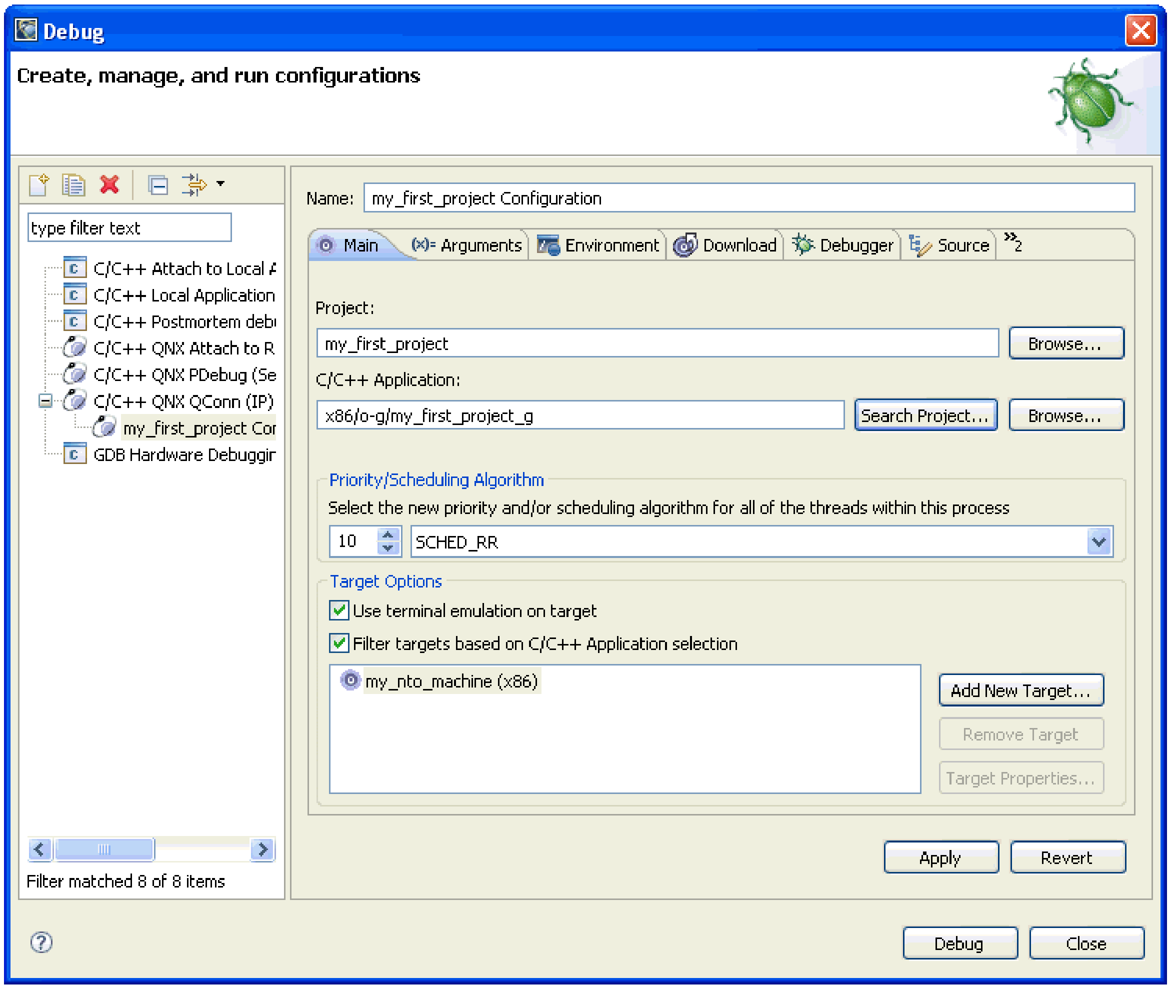
A dialog window opens, where you can start existing launch configurations, change them, or create new ones. On the left, select **C/C++ QNX QConn (IP)**. This type of launch configuration is meant for network-based (cross) development with QNX Neutrino running on the target system, using the `qconn` program. Now click on the **New launch configuration** icon:



You will now be presented with many configuration possibilities that all deal with starting your executable program. Right now, only the **Main** tab needs your input. Later, however, you should also take a look at what the other tabs have to offer.

Next to the **C/C++ Application** field, press the **Search Project** button and choose your binary. If you compiled it with debug information, its name includes a suffix of `_g`. If you compiled it without debug information, its name doesn't include this suffix. Since we would like to start the Debugger in the next step, please choose the binary with the debug information. Click **OK**.

Make sure your target system is listed under **Target Options**, and then click **Apply** -- the launch configuration is now ready:



Name: my_first_project Configuration

Project: my_first_project

C/C++ Application: x86/o-g/my_first_project_g

Priority/Scheduling Algorithm

Select the new priority and/or scheduling algorithm for all of the threads within this process

10 SCHED_RR

Target Options

✓ Use terminal emulation on target

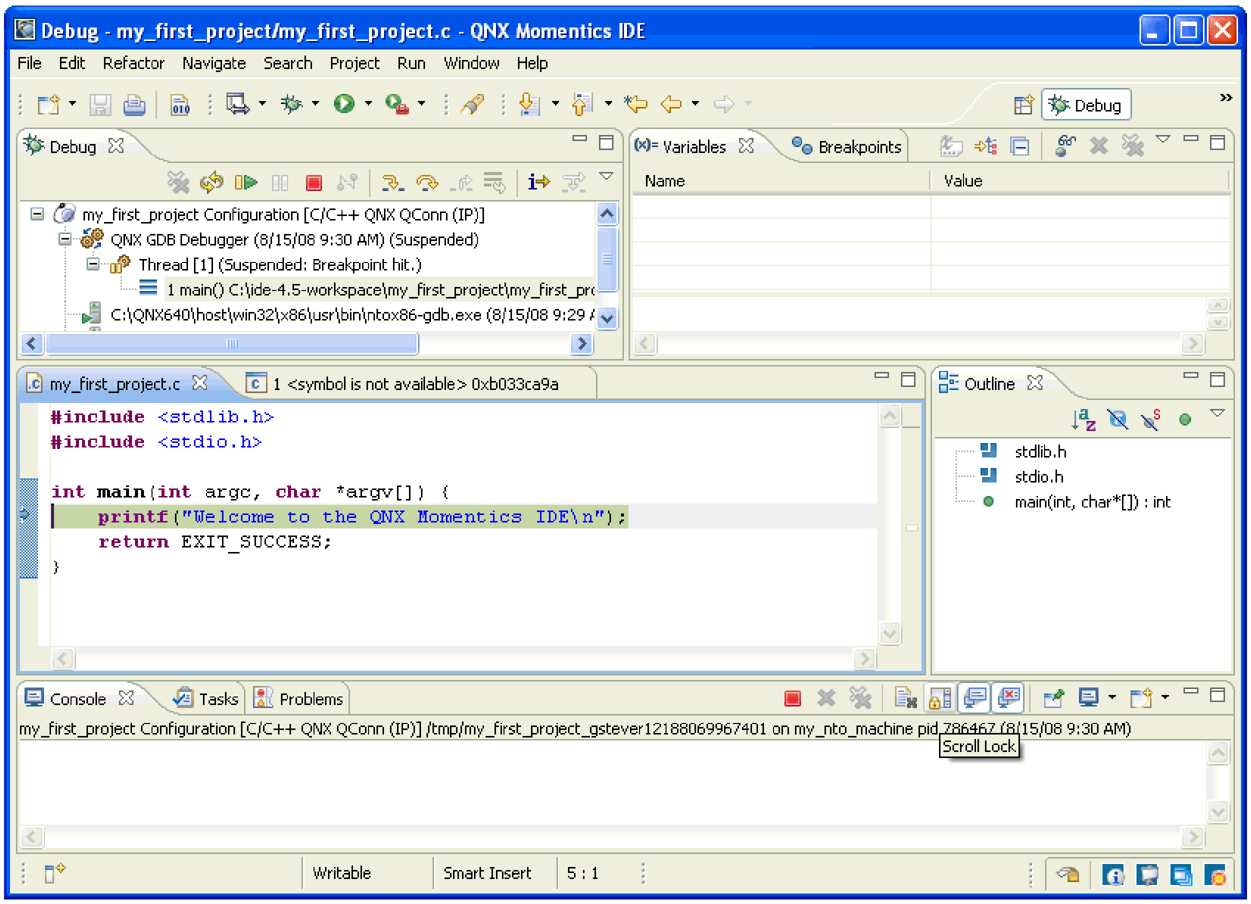
✓ Filter targets based on C/C++ Application selection

my_nto_machine (x86)

Starting and debugging

You should still be in the Debug launch configuration dialog. You just created a configuration for launching your program, which you now can start in the debugger. To do this, please click **Debug**.

The IDE now switches to the Debug perspective and transfers your program from your development machine across the network to your target QNX Neutrino system, and then starts it in the debugger. You will see that the debugger stops in the first line of your program. In the Debug view, you'll see an overview of your process, including the call stack. Using the buttons in the main bar of the Debug view, you can control the debugger.



```
my_first_project Configuration [C/C++ QNX QConn (IP)]
  QNX GDB Debugger (8/15/08 9:30 AM) (Suspended)
    Thread [1] (Suspended: Breakpoint hit.)
      1 main() C:\ide-4.5-workspace\my_first_project\my_first_pro
  C:\QNX640\host\win32\x86\usr\bin\ntox86-gdb.exe (8/15/08 9:29 A
```

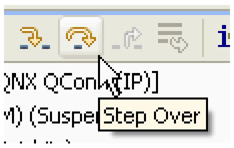
```c
#include <stdlib.h>
#include <stdio.h>

int main(int argc, char *argv[]) {
    printf("Welcome to the QNX Momentics IDE\n");
    return EXIT_SUCCESS;
}
```

```
my_first_project Configuration [C/C++ QNX QConn (IP)] /tmp/my_first_project_gstever12188069967401 on my_nto_machine pid 786467 (8/15/08 9:30 AM)
```

The Debug perspective.

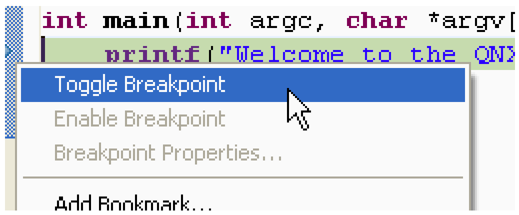
When you run or debug your application from the IDE, any input is read from the IDE's console, and any output goes to it. Once execution has passed the line that calls *printf()*, you should see the "Welcome to the QNX Momentics IDE" message in the Console window.

Using the **Step Over** button, you can jump to the next line of code:



During debugging, you can watch the Variables view on the right, which displays how your variables change. You can use the **Step Into** button to let the debugger go into the code of a function (which, of course, is useful only if you have the source code for this function).

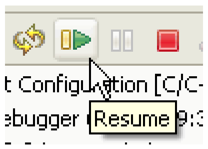
To set a breakpoint, place the mouse pointer over the left border of the source display, press the right mouse button and choose **Toggle Breakpoint** from the context menu. The breakpoint is shown as a little circle with a check mark, which you can also set or remove while you write your code.



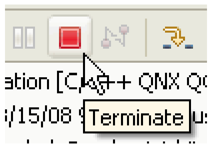
```
int main(int argc, char *argv[
    printf("Welcome to the QNX
```

Setting breakpoints.

When the running program hits a breakpoint, it stops in the debugger, and you can, for example, examine your variables. If you click the **Resume** button, your program continues until it hits the next breakpoint:

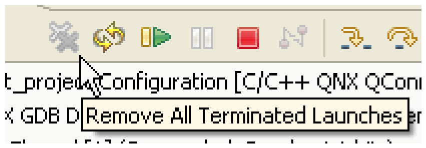


To abort program execution, use the **Terminate** button:

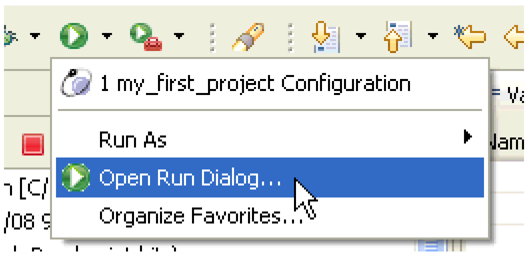


The debugger keeps the project's files open while the program is running. Be sure to terminate the debug session before you try to rebuild your project, or else the build will fail.

After the program has finished running, use the **Remove All Terminated Launches** button to end the debugger and have your binary (which was previously transferred) deleted from your target system.



To run your program as a standalone binary (without the debugger), open the dropdown menu beside the Run icon and choose **Open Run Dialog...**:



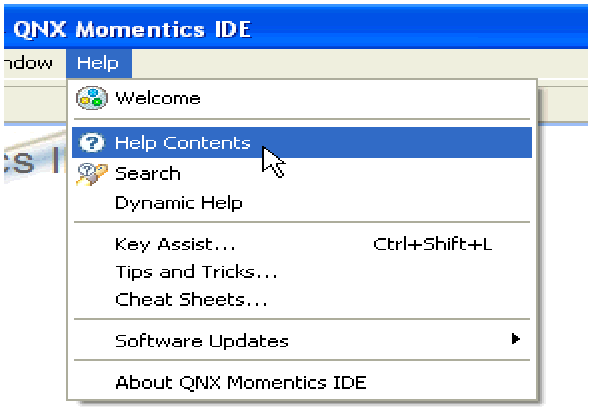
Then you can use the launch configuration (described in the previous step) to start your program. Or create a new launch configuration and select the binary without debug information. You can also transfer your binary manually using the System Information Perspective's Target File System Navigator (**Window-->Show View**) and start it from the terminal. Mounting a shared network drive is also possible (see the entry for `fs-cifs` in the QNX Neutrino *Utilities Reference*).

Making the program your own

To turn the whole thing into your own first QNX program, you can modify and extend the source code we just created. Try some of our sample programs and copy code from them into your project. And now that you've started, you'll probably want a lot more information, such as how to create your own threads, how the QNX Neutrino message-passing works, which process-synchronization methods are available, how to get access to I/O areas, or how to build a QNX Neutrino resource manager. But don't worry: all this is (almost) as simple as the quick start you just experienced!

The IDE includes a number of tutorials to help you get started. Choose **Help-->Welcome** from the IDE's toolbar, and then click the Tutorials icon:

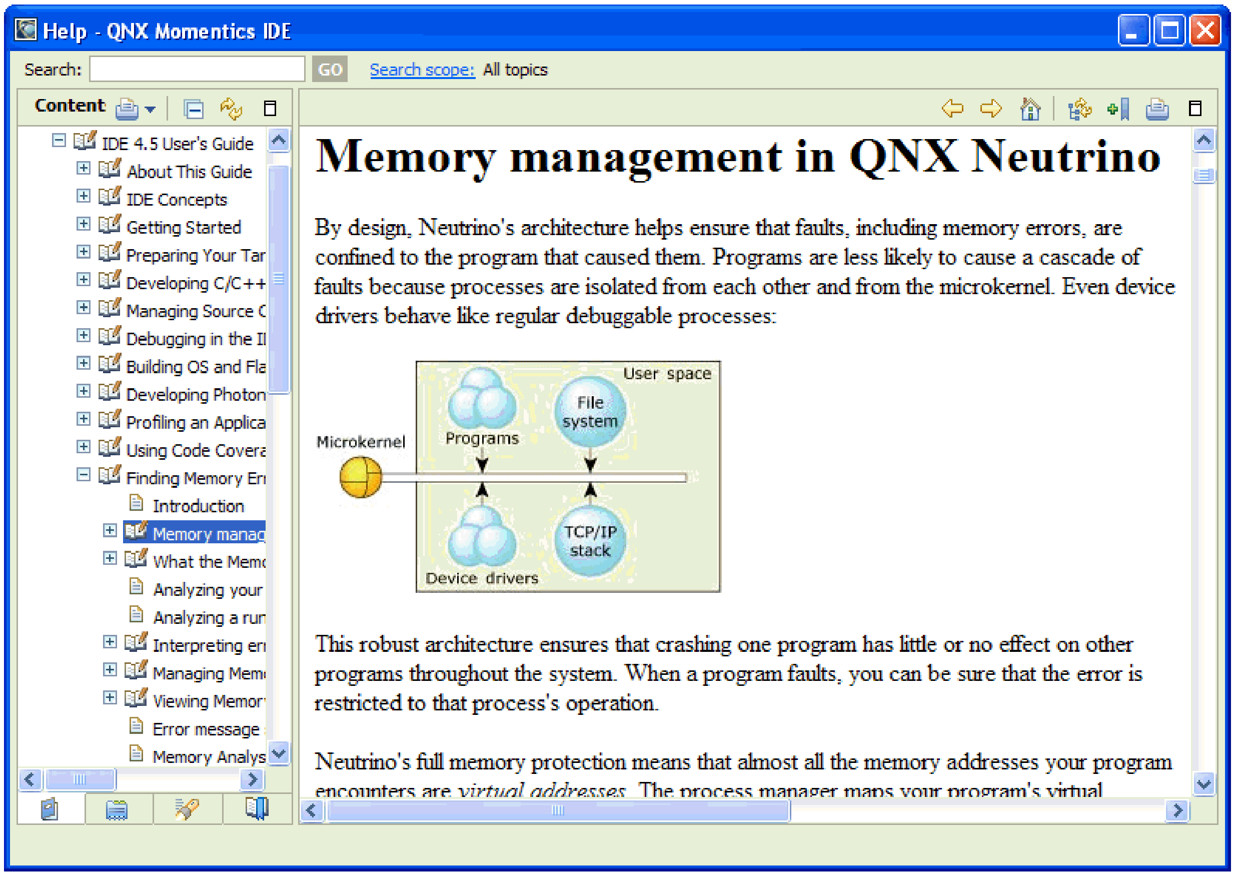
The IDE's Help system includes the QNX documentation, along with information about the Eclipse platform. In the Help menu, click **Help Contents**:



The *Welcome to the QNX Software Development Platform* guide helps you find out where to look in the documentation for the information you need. We recommend browsing the QNX Neutrino *System Architecture* guide, the IDE *User's Guide*, and the QNX Neutrino *Programmer's Guide*.

In the Help window, please choose:

- **A Roadmap to the QNX Software Development Platform** for information about the QNX Momentics Tool Suite and the QNX Neutrino RTOS
- **IDE User's Guide** for information about using the IDE



Memory management in QNX Neutrino

By design, Neutrino's architecture helps ensure that faults, including memory errors, are confined to the program that caused them. Programs are less likely to cause a cascade of faults because processes are isolated from each other and from the microkernel. Even device drivers behave like regular debuggable processes:

This robust architecture ensures that crashing one program has little or no effect on other programs throughout the system. When a program faults, you can be sure that the error is restricted to that process's operation.

Neutrino's full memory protection means that almost all the memory addresses your program encounters are *virtual addresses*. The process manager maps your program's virtual

To view the documentation on self-hosted QNX Neutrino systems, just click the **Help** button on the icon bar on the right of the screen:

Printed documentation is also available.

Source code examples covering thread creation, usage of mutexes, message-passing and other methods of interprocess communication as well as a QNX resource-manager template can be found on our FTP server `ftp.qnx.de`; just use an FTP client to log in as user `qnx` with the password `qnx!neutrino` and download the source package. It contains a `readme.txt` file that explains how to import the source examples into the QNX Momentics IDE. The source features extensive comments, explaining what is done there. For every function you are interested in, you also should consult the QNX Neutrino *Library Reference*.

While you explore the QNX Momentics tools and the QNX Neutrino RTOS, you will probably have further questions. Please contact your QNX Account Manager, Field Application Engineer, or our support department. We want to be with you from the start, because we are successful only if you are!

5. Reference

1. QNX Software system – http://www.qnx.com
2. Vmware server
3. others