21 Sep 2011 /TBS

### FYS4220 / 9220

**RT-lab no 1 - 2011** 

# The ROBOT

### 1 Introduction

The documentation for this exercise is structured in two parts.

The first part describes i) the **VxWorks** systems in the lab, ii) organization of user accounts and file space, and iii) introduction to the Wind River Workbench 2.4 Development Suite.

The second part presents the RT-exercise no 1: the ROBOT. A baseline source is given. The code also includes a demonstration of **StethoScope**, which is a real-time graphical monitoring and data collection suite for VxWorks.

#### Important information for starting Workbench, see chapter 4.

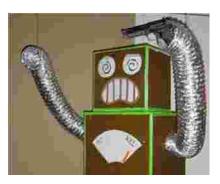
#### 1.1 Lab journal and approval of lab exercises

The lab groups are the same as for the FPGA/VHDL exercises. The lab is located in room 318V.

The lab journal shall contain the source code plus any user defined header files, such that the lab supervisor can have the pleasure of running the program. Output (for instance a screen dump) from the program shall be included, together with a short note explaining the choice of implementation.

Deliver electronically to <u>t.b.skaali@fys.uio.no</u>. Do not forget the group ID for identification.

The deadline for approval of all exercises is 1 December.



### 2 VxWorks and Workbench 2.4

**VxWorks** is an embedded Real-Time Operating System (RTOS) from Wind River <u>http://www.windriver.com/</u> Based on the Eclipse platform, the Wind River **Workbench** is a collection of tools for embedded software development for VxWorks.

**Workbench 2.4** with **VxWorks 6.2** is installed on two Windows XP host PCs in the lab room 318V. The computer names are *fys-lab-sci-01* and *fys-lab-sci-02*. Due to security restrictions both PCs are placed behind a firewall blocking traffic initiated from outside. However, normal terminal and file access from the PCs to external computers are allowed.

**VxWorks** is described in the RTOS lecture. S/W development for VxWorks is done on a "host" machine running Linux, Unix, or Microsoft Windows, crosscompiling target software to run on various "target" CPU architectures. The target architecture specific code is called a Board Specific Package (BSP). At boot time the VxWorks kernel is downloaded to the target. User code is dynamically linked to the kernel at download time. Host and target are connected over Ethernet, but also a serial link can be used.

In addition to architecture dependent BSPs, a generic target simulator  $\mathbf{vxs}$  im is included in the Workbench suite. Software which is not architecture specific can be executed under  $\mathbf{vxs}$  im.

FYS 4220 Workbench configurations:

```
fys-lab-sci-01target #1: vxsim0fys-lab-sci-02target #1: vxsim0target #2: M5000 VME module, "tgt_192.168.0.12" (IP-address)M5000 is a VME Single Board Computer (SBC) from VMETRO<br/>(now Curtiss Wright) with a PPC440 processor.<br/>The BSP for this target is has been supplied by VMETRO.<br/>The terminal port of M5000 is connected to VxWorks COM1.
```

Additional target simulators can be added, they will be named vxsim1, vxsim2 and so on.

For lab exercises which does include the M5000 module it is recommended to use the **vxs im** simulator. (A bonus is that one does not have to listen to the fan noise from the VME crate).

### 3 User accounts

Individual group accounts for the lab course have been defined on the two host PC's. The groups are the same as for the FPGA/VHDL lab.

**fys-lab-sci-01**: accounts GR1, GR2, GR3, GR4, GR5, GR11 **fys-lab-sci-02**: accounts GR6, GR7, GR8, GR9, GR10, GR12

Passwords are distributed to the groups. Only the owner of a group account can access their own files under *My Documents* (assuming that you don't give your password away).

An identical baseline directory structure has been set up for all accounts, shown below is the structure for GR5. (Ignore that disk address is D: and not C: and that the first part of the path may differ from that on the host PCs, because the structure has been generated on another XP platform).

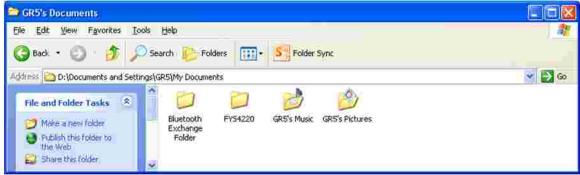


Figure 1 Baseline directory structure for FYS4220 lab group

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Figure 2 Directory src contains source files, directory Workbench the project workspace(s)

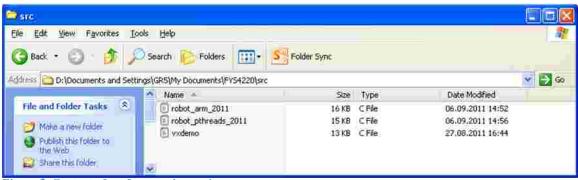


Figure 3 Content of src for exercise no. 1

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Figure 4 Workspace files for ROBOT project

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Address D:\Documents and Settings\GR5\My Documents\FY54220\Workbench\ROBOT	💌 🋃 GO
File and Folder Tasks  SUMNTgnu_DEBUG File an ew folder SUMNTgnu_DEBUG	
Publish this folder to the Wab     .wrmakefile       Image: Share this folder     .wrmakefile	
Other Places	

Figure 5 Content of ROBOT workspace for vxsim target with gnu compiler

Note! <u>The source code (C File) stored in a workspace is an imported copy of the original stored elsewhere.</u> All editing under Workbench is done on the workspace copy only. There is no automatic write-back of source files that have been modified. When a project is deleted, one can specify if the workspace files shall be deleted or not.

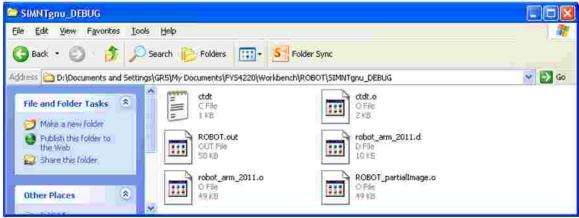


Figure 6 Content of workspace directory SIMNTgnu\_DEBUG for ROBOT project

# 4 Workbench 2.4

The Workbench GUI is based on the ECLIPSE software development environment, and most students are familiar with this environment.

Workbench is started from the Wind River program menu, see Figure 7. <u>Start first *Registry* for</u> <u>host-target communication if it is</u> <u>not already running</u>. The *Registry* symbol on the Taskbar Registry is



Wind River Registry Version 4.0 Copyright (c) 1998-2005 Wind River Systems: Inc.



Figure 7 Startup of Workbench 2.4

shown here.

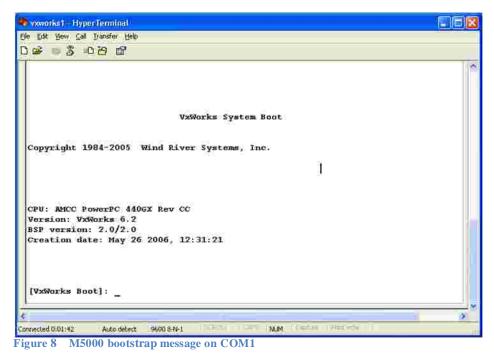
*Registry* must be started manually since the lab accounts GR1,---- GR12 are of type *Limited*, i.e. no administrative privileges. Logout from a lab account will shutdown *Registry*. However, an exit from Workbench will not stop *Registry*, so one can restart Workbench with a running *Registry*. When the session is over terminate with *Log Off* and not *Switch User* !

Skip Chapter 4.1 if you are only going to work on vxs im.

#### 4.1 Booting the VME Single Board Computer M5000 target

On **fys-lab-sci-02**, follow the link *VxWorks 6.2 and General Purpose Technologies* for starting COM1 if it is not already active. The serial port of M5000 is connected to COM1.

Power up the VME crate, or RESET the M5000 module. The boot COM1 screen is shown on Figure 8.



Type @ to download VxWorks kernel from host **fys-lab-sci-02**. If everything goes OK, the boot messages are shown on Figure 9 and Figure 10.

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[VxWorks Boot]: 8		^
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boot device	: emac	
unit number	: 0	
processor number host name	: 0	
file name	: fys-lab-sci-02 : vxworks	
inet on ethernet (e)		
host inet (h)	: 192.168.0.12	
gateway inet (g)	: 192.168.0.1	
user (u)	: vxworks	
ftp password (pw)	: vxworks	
flags (f)	: 0x4	
target name (tn)	: tgt_192.168.0.12	
Attaching interface 1	lo0 done	
Attached IPv4 interfa	ace to emac unit 0	
Loading 1882800		
Starting at 0x10000.	64C	
Auto configuring PCI	devices	
Reserved Universe A32	2 space at 0xc0000000, size:0x11000000	
Reserved Universe A24	space at 0xd1000000, size:0x1000000	
	5 space at 0xd2000000, size:0x10000	
Auto configuration fi	inished.	
6		>
Connected 0:02:51 Auto detect	9600 6-N-1 2214 242 NLM Cattle Parada	

Figure 9 M5000 boot message on COM1

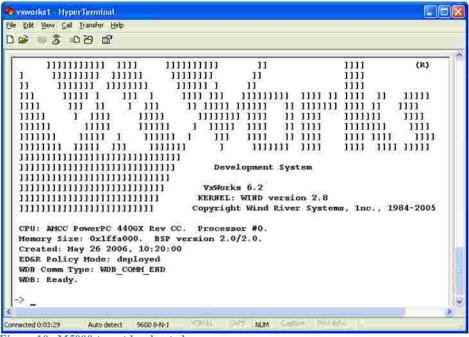


Figure 10 M5000 target has booted

### 4.2 Your first Workbench session

The very first time Workbench is run, the start page contains links to various help facilities. Even if it is a sign of weakness to read documentation, I suggest that one starts with the Wind River Workbench USER'S GUIDE, which can also be downloaded from the FYS4220 home page Lab Documentation.

At start-up, Workbench asks for **Select a workspace**, see Figure 11. Use the Workbench sub-directory, but on can of course define another path.

The Workbench sub-directory has been set up as default workspace for all groups!

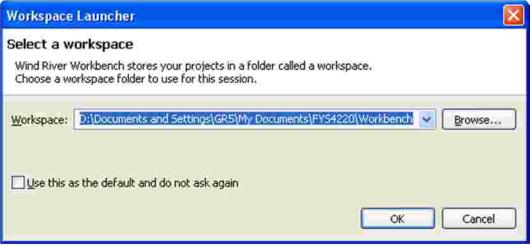


Figure 11 Workbench start-up, select workspace

The Workbench screen at first start-up is shown in Figure 12. The perspective (see upper menu in upper right corner) is "Application Development". No projects are defined, and the **vxs im** target has not been connected.

Shown below is the procedure for creating a Workbench project which is given the name ROBOT. Select **New VxWorks Downloadable Kernel Module Project**, give it the name ROBOT, and **Create project in Workspace**, see Figure 13 and Figure 14. Use the default **Build Support**, Figure 15.

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Figure 12 Workbench screen at first start-up

When Figure 16 Active build spec SIMNT gnu (for vxsim) pops up, first **Deselect** All and then select Active Build Specs **SIMNT gnu** (Wind River GNU Compiler 3.3.2) for **vxsim**. (An alternative is SIMNT diab using the Wind River compiler 5.3).

The two last steps are shown in Figure 17 and Figure 18, use default settings.

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Figure 13 Select New project

🚳 New VxV	Vorks Downloadable Kernel Module Project	
Project Create a nev	v VxWorks downloadable kernel module project with all available kernel build specs.	
O Create ;	e: ROBOT project in workspace project at external location D:(Documents and Settings)/GR5\(My Documents)FYS4220\Workbench(ROBOT	Browse
figure 14 Def	ïne Project name ROBOT	Cancel

🥸 New VxWorks Downloadable Kernel Module Project 🛛 🛛 🔀
Build Support Choose the build support and specify the build command.
Build support Managed build (makefiles generated by the IDE) User-defined build (based on existing makefiles) Disabled
Build command: %makeprefix% makeno-print-directory
Make Rules for User-defined build
Build Protect rule:
Rebuild Project nite(s): dean all
Clean Project ruler dean
Build output passing         Pass received and current objects to next level         Pass received build targets to next level         Note: If no build targets are defined at the current level and the "Pass received and current objects to next level" option is disabled, no objects will be built at the current level.
Build path
Redirection root directory: Browse
Note: Leave this field blank to store build output together with the sources, or enter an absolute path (environment variables are permissible) to redirect the output.
< <u>Back</u> <u>Next</u> <u>Finish</u> Cancel

Figure 15 Build support

🥸 New VxWorks Downloadable Kernel Module Project	
Build Specs Select available and enabled build specs.	
Available and enabled build specs Select All Deselect All	
PPC440gnu     PPC440sfdiab     PPC440sfgnu     PPC603diab     PPC603gnu     PPC603gnu     PPC604diab     PPC604diab     PPC604gnu     PPC85XXdiab	
PPC85XXgnu     PPC85XXsfdiab     PPC85XXsfgnu     PPC860sfdiab     PPC860sfgnu     SH7750diab     SH7750diable     SH7750gnu	
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Active build spec: SIMNTgnu	
< <u>Back</u> Next > Einish	Cancel

Figure 16 Active build spec SIMNT gnu (for vxsim)

New VxWorks	Downloadable	Kernel Mo	dule Proje	et		
<b>uild Target</b> Specify a build targ	et.					
Build target name:	ROBOT					
Build tool;	Linker		~			
Build output passir						
Pass build targe	st to next level					
		ſ	< <u>B</u> ack	Next >	Einish	Cancel
ıre 17 Build Ta	rat tool					

🕸 New VxWorks Downloadable Kernel Module Project	
Static Analysis Configure the process of analyzing your source code.	
Basic Configuration	
Enable Static Analysis	
Generate cross reference information	
< <u>Back</u> Next > Einish	Cancel

Figure 18 Static Analysis and the Finish

After <u>Finish</u> the Workbench screen looks like Figure 19.

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Figure 19 Project defined in workspace, no source files imported

The next step is to import the source file(s) for the project.

Under the File menu select Import which pops up Figure 20, and choose File system.

😻 Import 🔣
Select Import resources from the local file system into an existing project.
Select an import source:
<ul> <li>Archive file</li> <li>Build Settings</li> <li>Checkout Projects from CVS</li> <li>Existing Projects into Workspace</li> <li>Existing SNIFF+ Native Application Project into Workspace</li> <li>Existing SNIFF+ VxWorks Application Project into Workspace</li> <li>Existing Tornado 2.x Bootable VxWorks Image Project into Workspace</li> <li>Existing Tornado 2.x Downloadable Application Project into Workspace</li> <li>Existing VxWorks 6.x Image Project into Workspace</li> <li>Existing WIND POWER IDE 1.x Application Project into Workspace</li> <li>First System</li> <li>Import Breakpoints</li> <li>Preferences</li> <li>Team Project Set</li> </ul>
< Back Next > Erith Cancel

Figure 20 Import resources, select File system for source file

Then browse to the directory with the source file, in this case ...\**FYS4220**\src and tick off *robot\_arm\_2011.c*, and <u>Finish</u>. Now this source file has been imported.

🥸 Import	
File system Import resources from the local file system.	
From directory: D:\Documents and Settings\GR5\M	y Documents\FYS4220\src Srowse
- 🔲 🦢 src	Crobot_arm_2011.c Crobot_pthreads_2011.c Cvxdemo.c
Filter Types	
Into folder: ROBOT	Browse
Overwrite existing resources without warning     Ocreate complete folder structure     Ocreate selected folders only	
< <u>B</u> ack	Next > Einish Cancel

Figure 21 Import source code from the file system

Double-click on the file name in the Workbench project, and a source listing with Outline information is shown, Figure 22.

Note that this copy of the source file is stored in the workspace, and any editing on the file is not reflected in the original version. Therefore, if one wants to backup the workspace copy this must be done manually!

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Figure 22 Workbench with imported source file

Great, now the stage is set for building and maybe even running this piece of software. Click the project to be built, and select **Build Project** under the **Project** menu.

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Figure 23 Build project

Probably you will have to define the include search paths, see Figure 24, Figure 27, Figure 28 and Figure 29.

🧐 Buil	d 🛛 🔀
٤	You may need to set the include search path for 'ROBOT' . If the included files are unambiguous and visible in the workspace, you can generate the path now and the build will proceed. To manually set the project's build properties, cancel the build. To proceed without generating the include search path, click Continue.
	Generate Includes Cancel Continue

Figure 24 Definition of Include paths

The very first time Build is selected, Figure 25 and Figure 26 may pop up.

😻 Gen	nerate Include Search Paths 🛛 🛛 🔀
?	Static Analysis must be enabled in the Project Properties to generate Include Search Paths. Open Project Properties now?

Figure 25 Select YES to continue

ype filter text 🛛 🗸	Static Analysis	(p. + 4) -
Info Builders Build Properties Project References Static Analysis Target Operating System	Configure the process of analyzing your source code!  Basic Configuration  Cenable Analysis  Generate cross reference information  Assume C++ syntax for headers never included  Compiler Simulation  CyC++ Dialect:  District Compiler Options:  Preprocessing Options	
	Append my workspace options:	
	-DLOCAL=static -DIMPORT=extern	Configure
	Append my project options:	Configure
	(	Restore Defaults Apply

Figure 26 Select OK

Generate Inc	clude Search Paths	L
nclude Paths		
Configure include	directives and reverse macro-substitution in paths!	
		_
Project: ROBOT	*	
Ignore non-act	tive includes.	
Ignore system		
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Substitute naths (r	(or path segments) with selected build macros:	
Path Segment	nel Ban collection in a second se	~
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	Files/Common Files	
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Figure 27 Default Include paths, just take all

🥸 Generate Include Search Paths	
Configure the Include Search Path	
Add and remove folders to the Include Search Path and define their ordering.	·
Found 0 Unresolved Include Directives:	Resolve
	Resolve All
	Show in Editor
Include Search Paths	
(WIND_BASE)/target/h     (WIND_BASE)/target/h/wrn/coreip     \$(WIND_BASE)/target/h/wrn/coreip	Add Folder
	Up
	Down
	Remove
	Show in Editor
< <u>Back</u> Next > Enish	Cancel

Figure 28 Any unresolved Include paths can now be repaired

🎯 Generate Include Search Pa	ths	
Scope of Include Search Path	IS	1.1
Specify how the include search paths	are applied!	
Scope: Project-wide or folder-specific		
Include Search Path	Scope	
\$(WIND_BASE)/target/h	project-wide	
\$(WIND_BASE)/target/h/wrn/coreip	project-wide	Full Scope
		Minimal Scope
	1 <u> </u>	
Modify include search paths for the se	lected build specs:	
SIMLINUXanu	~	
SIMNTdiab		
SIMNTgnu		
SIMSPARCSOLARISdiab		Check All
XSCALEdiab		Uncheck All
XSCALEdiabbe		
XSCALEgnu XSCALEgnube		
Replace the existing include search	i pauls.	
< Back	Next > Einish	Cancel
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Figure 29 Uncheck All and Check SIMNT

Since the code is perfect, the compilation goes through with flying colours with no error messages, Figure 30.

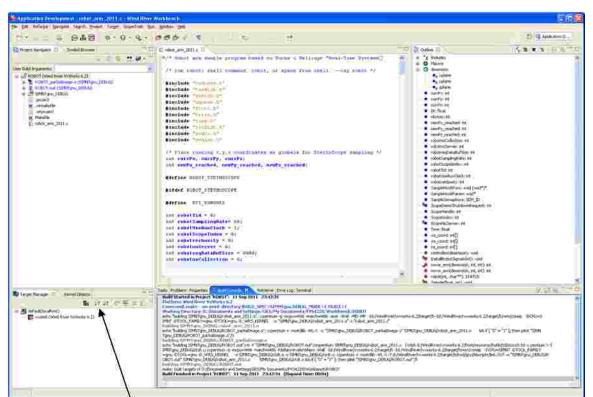


Figure 30 The ROBOT project has been successfully built.

The next step is now to launch the target **vxs im**. The arrow points to the **Connect** symbol in the Target Manager. Click first on *vxsim0*. If the target Connect succeeds, the content of the Target window is shown in Figure 31. The next symbol stands for **Disconnect** target. A terminal window to vxsim0 is opened, see Figure 32.

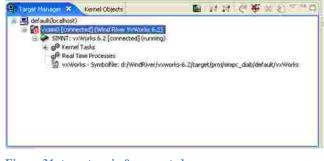


Figure 31 target vxsim0 connected

W VxSim0	×
1)))))))))))))))       1))))))))))))))))))))))))))))))))))))	100 million (100 million)
CPU: Windows 5.1 Service Pack 3. Processor #0. Memory Size: 0x1f00000. BSP version 2.0/3. Created: Oct 18 2005. 23.14.34 ED&R Policy Mode: Deployed WDB Comm Type: WDB_COMM_PIPE WDB: Ready. -> Figure 32 target Vxsim0 terminal window	×

Continue from section 4.3 if **vxs im** is used.

#### 4.2.1 Connecting the M5000 target to host fys-lab-sci-02

This target name is *tgt\_192.168.0.12*, see Figure 33.

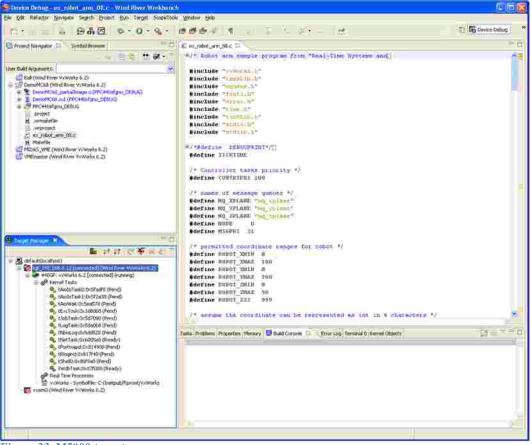


Figure 33 M5000 target

# 4.2.2 Building a project for the M5000 target

The procedure is the same as for **vxs im**, as **Build Specs** one chooses **PPC440s fgnu.** 

🥸 New VxWorks Downloadable Kernel Module Project	
Build Specs Select available and enabled build specs.	
Available and enabled build specs Select All Deselect All  PENTIUM4gnu PENTIUMdiab PENTIUMgnu PPC32diab PPC32gnu PPC32sfdiab	
<ul> <li>PPC32sfgnu</li> <li>PPC403diab</li> <li>PPC405gnu</li> <li>PPC405gnu</li> <li>PPC405sfdiab</li> <li>PPC405sfgnu</li> <li>PPC440sfgnu</li> <li>PPC440sfdiab</li> <li>PPC440sfdiab</li> <li>PPC440sfgnu</li> <li>PPC440sfgnu</li> <li>PPC440sfgnu</li> <li>PPC603diab</li> </ul>	
PPC603gnu PPC604diab PPC604gnu PPC85XXdiab	
Active build spec: PPC440sfgnu	
☑ Debug Mode	
< <u>Back</u> <u>N</u> ext > <u>Finish</u>	Cancel

Figure 34 Build Specs PPC440sfgnu for M5000 target

### 4.3 Downloading the project kernel module

Click on the Download symbol as marked in Figure 35.

Browse the workspace and select the wanted **.out** file as shown in Figure 36. Click OK.

After download the **.out** file will show up in the Target Manager window.

If there are unresolved symbols in the object file an error message will appear. This will happen is a header file is missing, or if a library has to be loaded prior to the object file.



Figure 35 Download symbol

Ø Downloa	d				
Download:	Workbench/R	OBOT/SIMNTg	nu_DEBUG/ROI	BOT.oL 👻	Browse
to: SIMNT		-			~
Advanced	options	erver			
				ж [	Cancel

Figure 36 Download of project .out file

#### 4.4 Executing the kernel module

Type the start address in the target terminal window, or COM1 window for M5000 target, or a host shell window (see below). If one has to abort the module, disconnect the target. After a fatal error one will usually have to reboot the target.

One can also open another host shell from the Workbench Target menu with the *Host Shell* command.

A task can be deleted with the shell command td <name>. Do not delete system tasks! The shell command ->help displays the available commands. The command ->i list all kernel tasks.

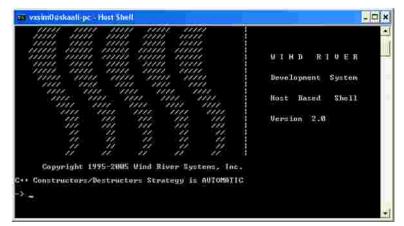


Figure 37 VxWorks host shell

#### PART 2

# 5 The ROBOT

The source code which is the basis for the exercise is stored under ...\FYS4220\src, see Figure 3. One can choose between two versions, robot\_arm\_2011.c based on VxWorks tasks and robot\_pthreads\_2011.c based on POSIX pthreads. Furthermore the directory contains vxdemo.c which demonstrates various *StethoScope* facilities.

### 5.1 What to do

The program mimics the X, Y and Z movements of a robot. The coordinate sets are stored in an array. The output in Figure 38 shows that the movements along the three axis's are completely independent, which is hardly a good marketing argument for a robot. (Note that if the program is started from a target shell the "RT-clock" and "tickGet" printouts are not mixed.)

The goal of the exercise is to synchronize the X, Y and Z movements such that all three reach a coordinate waypoint before continuing. Methods for synchronization between tasks / threads have been presented in the lectures. There is no requirement that  $X_i$ ,  $Y_i$  and  $Z_i$  are reached at the same time.

Furthermore, the code demonstrates:

- Concurrency
- Communication via POSIX Message Queues
- A half-hearted attempt to handle error conditions
- POSIX pthreads if one prefers that version

Included in the source code is the use of **StethoScope** for visual tracking of the movements in real time. This tool can be disabled by commenting out the declaration #define ROBOT\_STETHOSCOPE, see Figure 39.

The building and download of project ROBOT have been explained in PART 1.

If the project is built without StethoScope, the status of **vxs im** after ROBOT download is displayed in Figure 40.

#### W VxSim0

-> robot

Robot control initialization ...

Robot is starting up

RT-clock tick 788: next x-y-z = 0 = 0RT-clock tick 788: next x-y-z = 7 = 20tickGet 788: moved to x=0tickGet 788: moved to y=011 35 RT-clock tick 788: next x-y-z = 5 33 55 tickGet 788: moved to z=0tickGet 788: moved to z=0 RT-clock tick 788: next x-y-z = 15 42 66 tickGet 802: moved to x=7 tickGet 806: moved to x=5 tickGet 826: moved to x=15 tickGet 828: moved to y=20 tickGet 854: moved to y=33 tickGet 858: moved to z=35 RT-clock tick 858; next x-y-z = 30 50 90 tickGet 872: moved to y=42 tickGet 888: moved to y=50 tickGet 888: moved to x=30 tickGet 898: moved to x=30RT-clock tick 898: next x-y-z = 12 36 tickGet 920: moved to z=66RT-clock tick 920: next x-y-z = 25 47 tickGet 926 moved to 77 62 tickGet 926; moved to x=12 tickGet 934; moved to x=12 tickGet 934; moved to x=12 tickGet 948; moved to x=25 tickGet 968; moved to x=25 tickGet 968: moved to z=90RT-clock tick 968: next x-y-z = 0 0 Û RT-clock tick 968: next x-y-z = 0 = 0tickGet 994: moved to z=77RT-clock tick 994: next x-y-z = 18 = 32 89 tickGet 1018: moved to x=0tickGet 1024: moved to z=62RT-clock tick 1024: next x-y-z = 14 = 26 = 50tickGet 1054: moved to x=18tickGet 1062: moved to x=14tickGet 1062: moved to y=0tickGet 1126: moved to y=32tickGet 1128: moved to y=26tickGet 1138; moved to tickGet 1148; moved to y=26 RT-clock tick 1148: moved to z=0tickGet 1154: next x-y-z = 17 41 69 tickGet 1154: moved to x=17 tickGet 1178: moved to y=41 tickGet 1326: moved to z=89 RT-clock tick 1226: moved to z=89 The lock tick 1326: next x-y-z = 9 49 77 tickGet 1342: moved to x=9tickGet 1342: moved to y=49tickGet 1404: moved to y=50RT-clock tick 1404: next x-y-z = 15 20 tickGet 1416: moved to x=15 tickGet 1442: moved to z=69 59 RT-clock tick 1442: next x-y-z = 0 tickGet 1458: moved to z= 0 0 z=77 RT-clock tick 1458: next x-y-z =999 999 999 RI-CLOCK 11CK 1458: hext X-y-Z = 399 999 tickGet 1462: moved to y=20 tickGet 1472: moved to x=0 tick 1472: X shutdown tickGet 1494: moved to z=59 tickGet 1502: moved to y=0 tick 1502: Y shutdown tick 1594: removing the message queues Pobot operation terminated OK z=59 Robot operation terminated OK value =  $0 = 0 \times 0$ tickGet 1612: moved to tick 1612: Z shutdown z=0

Figure 38 Non-coordinated X, Y and Z robot movements

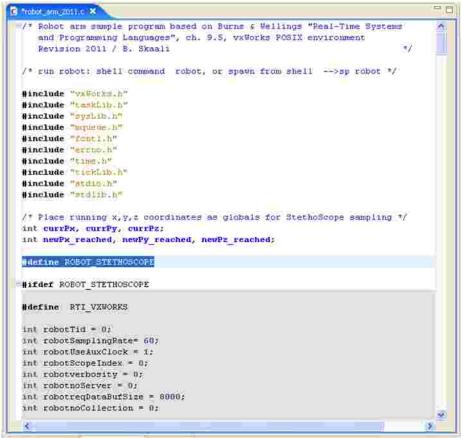


Figure 39 robot\_arm\_2011.c source



Figure 40 vxsim0 status after download of project ROBOT

### 5.2 StethoScope

Workbench supplies three **ScopeTools** for monitoring of VxWorks tasks / pthreads in real time: **MemScope**, **ProfileScope** and **StethoScope**. To quote from the **StethoScope** Users Guide:

StethoScope is the user-friendly, real-time graphical-monitoring and data-collection tool from Wind River. It lets you monitor and analyze the values of variables in your real-time application while the application is running. StethoScope is more than an easy-to-use data-collection tool—it is a powerful debugging aid for both hardware and software. You can use its multi-window environment to track down performance problems, "glitches," and program errors.

The Guide covers 283 pages, is available in the lab, and can be downloaded from the FYS4220 home page.

#### 5.2.1 StethoScope with the ROBOT module

Compile with

#define ROBOT\_STETHOSCOPE

Inspect the ROBOT source code and see where the StethoScope information is collected.

Before downloading the .out file, the StethoScope library must be downloaded to the target.

Select **ScopeTools** -> **StethoScope**, specify Target Type VxWorks, see Figure 41.

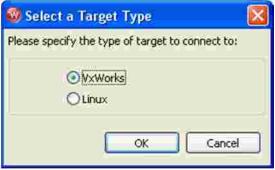


Figure 41 StethoScope Target Type

Specify the Setup Options as shown in Figure 42. If more printout is wanted the Verbosity value can be increased. Do NOT use Aux Clock.

🕿 StethoScope Setup Options							
Start StethoScope GUI on the host							
Connection		Execution Mode					
Scope index:	0	Spawn sampler task					
Target server:	vxsim0@skaali-pc 💌	The sampler task repeatedly calls ScopeCollectSignals(). You can then install signals					
Connection type:	WTX 💌	from StethoScope GUI or host shell.					
Verbosity: 0 - Silent							
Sampler Task							
Use Aux Clock							
Data buffer size:	32768	O Load libraries only					
Signal buffer size:	2048	Will simply load the required ScopeTools libraries. You can then load your application module					
Sampling rate:	60	instrumented with StethoScope API.					
Sampling task priorit	ty: 110						
Link task priority:	252						
Probe task priority:	250						
		OK Cancel					

Figure 42 StethoScope Setup Options

The Workbench Target Manager window after download of the StethoScope library and GUI is shown in Figure 43, and the initial GUI plot window in Figure 44.

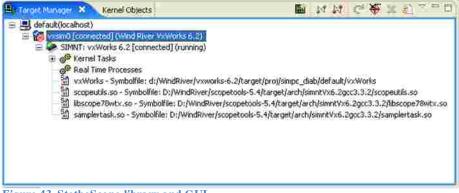


Figure 43 StethoScope library and GUI

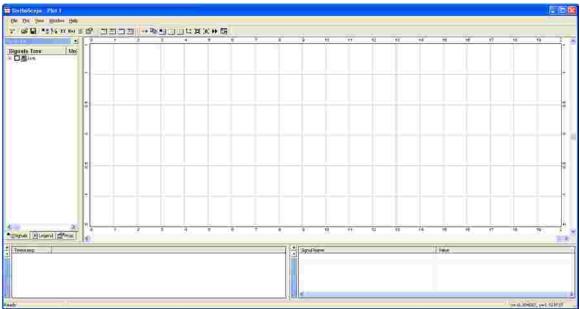


Figure 44 StethoScope GUI Plot window

Now the ROBOT module can be downloaded, and it is linked automatically to StethoScope. Start the ROBOT. In parallel with terminal printout the StethoScope window displays the progress of the robot, according to the Signals Tree window options. Figure 45 shows how **currX**, **currY** and **currZ** values change with time when the associated task executes. In Figure 46 the **Event** information has been included as well.

Options for presenting the information are chosen by means of mouse clicks on the monitored values displayed in the Signals Tree window.

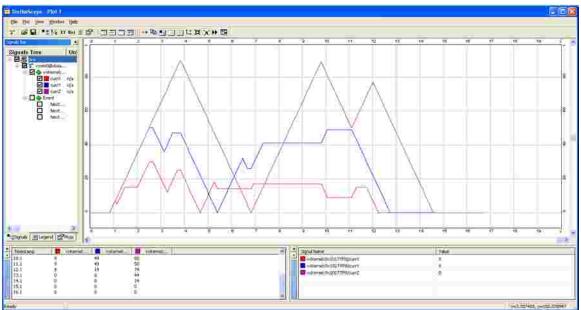


Figure 45 StethoScope Plot of currX, currY and currZ coordinates

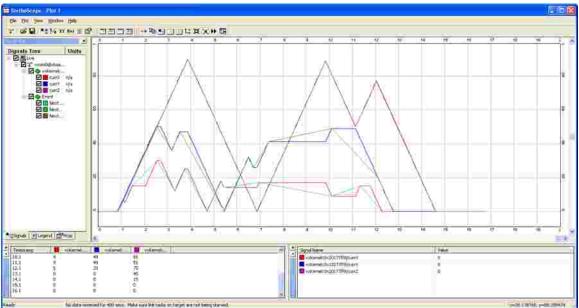


Figure 46 StethoScop Plot of coordinates and Events

### 5.2.2 Errors during download of project .out file

It is observed that the system sometimes crashes when a project **.out** file is downloaded again after modification and relinked with StethoScope. The reason for this not known. Disconnect the target and then reconnect again, and start from scratch.

### 5.3 StethoScope demonstrator

Build a project with the ...\src\vxdemo.c source file, and execute it with

-> ScopeDemo 1,0,3,0,0,0