Tornado™

Getting Started Guide

(Windows Version)

2.0

Edition 1

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Please provide your license number when contacting Customer Support.

Tornado Getting Started Guide, 2.0 (Windows Version)
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1 Overview

1.1 Introduction

Thank you for purchasing Tornado!

Tornado 2.0 provides a greater level of accessibility for users unfamiliar with Tornado, and increased productivity for experienced developers. Key features of this release are:

- an integrated version of the VxWorks target simulator (VxSim)
- an integrated version of the WindView logic analyzer for the target simulator
- a new project facility
- a new debugger engine and GUI

The target simulator allows you to experience Tornado — as well as begin developing hardware-independent modules — without target hardware. The integrated version of WindView provides dynamic visualization of application behavior on the simulator. The new project facility provides automated graphical features for managing project files, configuring VxWorks, and building applications. The new debugger GUI is easier to use and provides more direct access to debug information.

This guide describes how to install Tornado and other compatible products. It also provides a simple tutorial that demonstrates the use of the project facility, the integrated versions of the target simulator and WindView, and the Tornado debugger. The tutorial is designed to provide new users with an accessible introduction to the key features of Tornado and their use in application development. It is also intended to provide experienced Tornado users with an introduction to major innovations in the development environment.

NOTE: The integrated target simulator (VxSim-Lite) runs as a single instance per user, without networking support. Optional products such as STREAMS, SNMP, and Wind Foundation Classes are not available for this version. The full-scale version of the simulator, VxSim, is available as an optional product. It supports multiple-instance use, networking, and all other optional products.

The integrated version of WindView is designed solely for use with the VxWorks target simulator. WindView is available as an optional product for all supported target architectures.

1.2 Terminology and Conventions

The following terms are used in this document:

host
A computer on which the Tornado IDE runs.

target
A processor board that runs VxWorks (Tornado's real-time operating system) and applications developed with Tornado.

target server
A service that runs on the host and manages communications between host tools (such as the Tornado shell, debugger, and browser), and the target system itself. One target server is required for each target.

Tornado registry
A Tornado service that keeps track of, and provides access to, target servers. Only one registry is required on a network, but registries may be run on each Tornado host.

The following conventions are used in this document:

- As a convenience, the drive and root installation directory are identified as **c:\tornado** in this document, but the location is determined by the user at installation.
- A series of items to be selected from the GUI is denoted by A>B>C. The elements A, B, and C may be menu items, buttons, or tabs.

2 Installing Tornado

2.1 Introduction

CAUTION: Before you install Tornado, see the *Tornado Release Notes* for information about host operating system requirements, including release levels, required patches, and upgrade methods.

In brief, installing Tornado involves:

(1) Locating the Tornado installation key.

(2) Selecting a user account to use for installation.

(3) Running the **SETUP** installation program, which requires an installation key, as well as some additional information about the user(s) and the project for which Tornado has been licensed.

These steps are described in detail below.

NOTE: The installation instructions in this section also apply to any Tornado-compatible Wind River Systems product (such as WindView) that you may purchase separately. Optional products should be installed in the same directory tree as the version of Tornado for which they have been released.

2.2 Locate the Installation Key

If you have purchased Tornado, your installation key is printed on a leaflet in the *Getting Started* packet that includes the CD-ROM and this guide. For the evaluation version of Tornado, the installation key is printed on the CD-ROM liner notes.

If you cannot find the installation key, contact Wind River Systems by e-mail at **license@wrs.com**. Please include your sales order number if you have purchased Tornado; otherwise indicate that you want to install the evaluation version of Tornado.

You can also call 1–800–545–WIND (1–800–545–9463) in North America and ask for Key Administration. In other locations, contact the nearest Wind River office.

2.3 Select a User Account for Installation

For Windows NT hosts, choose a user account to use for the installation procedure, and sign on to the host system as that user.

You may wish to use an account with administrative privileges. Doing so creates a common program group that is accessible by every user who signs onto that host.

2.4 Run SETUP

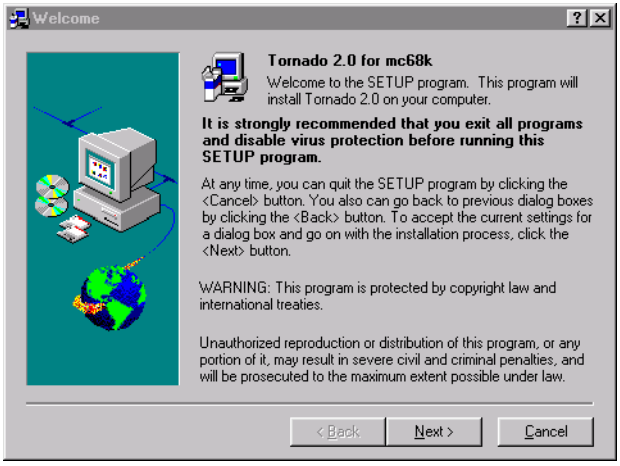
⚠ **CAUTION:** Before you install Tornado on your Windows host, TCP/IP networking must be installed. Tornado can operate over a raw serial connection between the host and target systems, and can operate on standalone systems that have no network connection with other hosts. However, the Tornado tools use the TCP/IP protocol to communicate with one another, and you must therefore have TCP/IP on your host even if it is not on a networked system. The Windows TCP/IP package is generally installed with the operating system. Consult your Windows documentation for information on installing and configuring TCP/IP.

CAUTION: Before you install Tornado, long file names must be enabled on your Windows host (the default for Windows installations).

Step 1: Start SETUP

Insert the Tornado CD-ROM in the CD-ROM drive. The **SETUP** program starts automatically.[1]

The Welcome dialog box appears. To continue, click Next.



NOTE: The **SETUP** GUI has context-sensitive help that provides detailed information about using **SETUP** and about the installation process. Click on the ? (question mark) in the title bar and then click on the object you want help with.

NOTE: Each **SETUP** dialog box has a Cancel button, which you can use to quit installing Tornado. To continue to the next box, click the Next button. To return to the previous box to review or change information you have entered, click the Back button (which is grayed-out if it cannot be used).

1. If you have cancelled or completed an installation, you can start **SETUP** again by displaying the contents of the CD-ROM drive (using Windows Explorer or a comparable file manager) and double-clicking on **SETUP.EXE**, which is at the root of the CD-ROM file system.

Step 2: Review the Readme Information

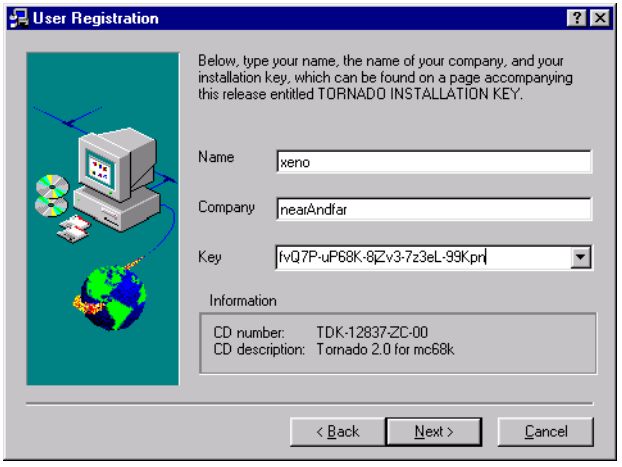
The README.TXT window appears, which contains important information developed after the *Tornado Release Notes* were completed. When you have finished reviewing this information, click Next.

Step 3: Review the License Agreement

Read the license agreement. If you agree with its conditions, click I Accept and Next to proceed with installation. If not, click Cancel.

Step 4: Enter User Information and Installation Key

Enter the primary user name, your company name, and the installation key in the User Registration dialog box. To continue, click Next.



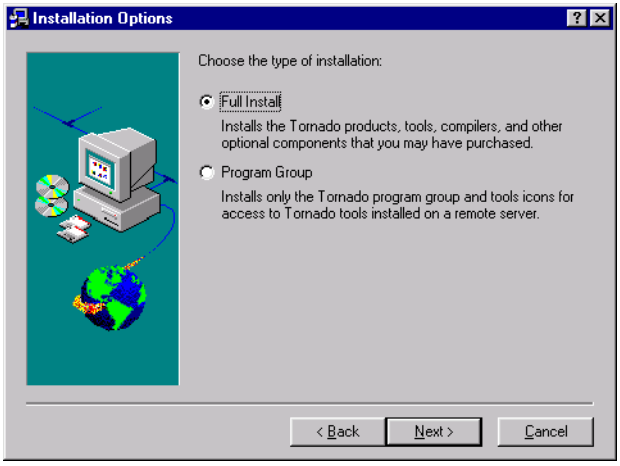
If you have already installed other Tornado products from the same CD-ROM, you can select the installation key from the drop-down list. Otherwise, copy it from the installation key leaflet.

If you are installing the evaluation version of Tornado, the installation key is printed on the CD-ROM liner notes.

Step 5: Choose the Type of Installation

You have the choice of installing Tornado on the local host, or of providing access to Tornado installed on a remote server. The first option installs the full Tornado program on the local host. The second option installs only the Tornado program

group in the local Start menu, so that the copy of Tornado on the remote server can be run from the local host. The second option can also be used to provide access to Tornado installed locally under a different version of Windows (for a dual-boot system).



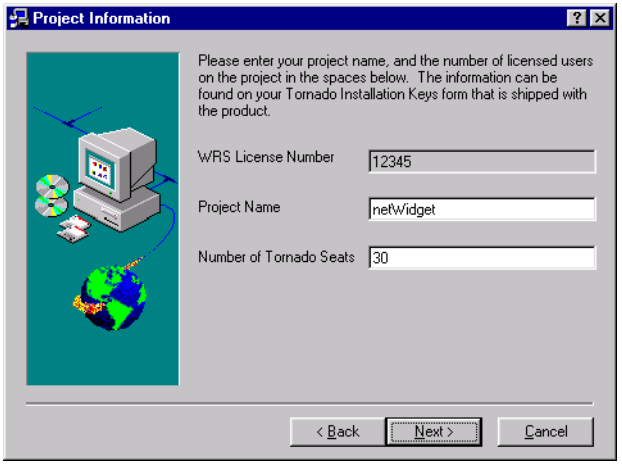
If you want to install on the local host, select Full Install and click Next.

If you want to provide access to Tornado installed on a server, or installed locally under another version of Windows, select Program Group and click Next. The Select Directory window appears. Enter the drive and directory path, or click Browse and use the browser to identify the drive and path. To continue, click Next.

NOTE: If you selected Program Group, rather than Full Install, go to *Step 9: Select a Name for the Start Menu Program Folder*, p.10, and skip the intervening steps in the installation process.

Step 6: Enter Project Information

Enter your project name and the number of users in the Project Information dialog box. The license number field is completed automatically. To continue, click Next.



Step 7: Specify the Installation Directory

Tornado and its related products are designed to be installed in a single directory tree. Specify the drive and root directory for that tree in the Select Directory dialog box.

WARNING: Do not install Tornado in a directory whose path includes embedded spaces (for example, **c:\Program Files\Tornado**). Installing Tornado in such a path causes **make** and other essential utilities to malfunction.

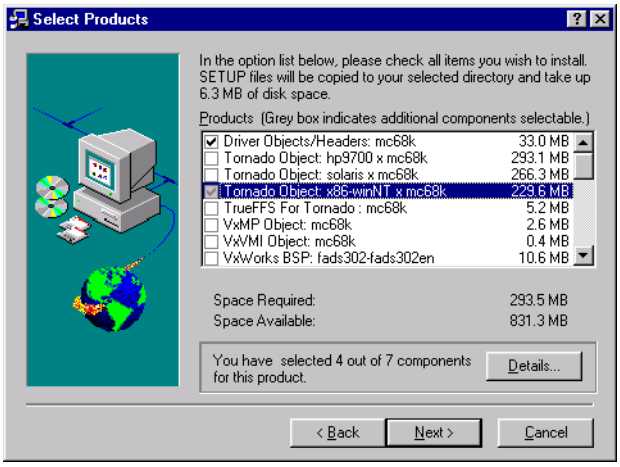
WARNING: Do not install Tornado in the same directory as a previous release of Tornado, or in the same directory as versions of Tornado for other target operating systems (such as Tornado for I_2O). Unpredictable behavior may result. To remove a previous release or another version of Tornado, see *2.5 Uninstalling Tornado*, p.13.

You can use the Browse button to display a file browser to locate and identify the installation directory. If the directory you specify does not exist, you will be prompted with the option to create it.

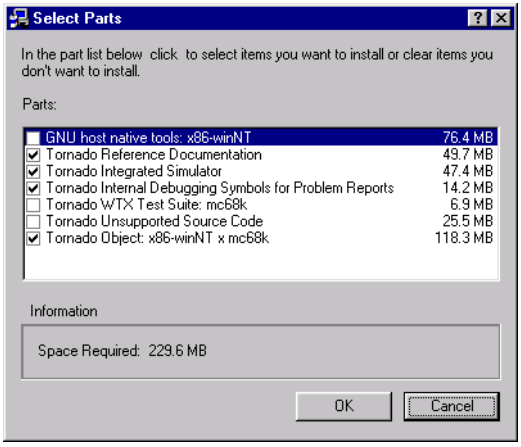
To continue, click Next.

Step 8: Review Product List for Installation

All of the products you ordered are marked as selected in the Select Products dialog box by a check in the box to the left of the product name.



If a product has more than one part, the Details button can be used to display information about them and modify the default selection.



To select or omit a product, click in the check-box next to the product name.

The Select Products dialog box displays both the approximate amount of disk space required and the disk space available.

To continue, click Next.

If there is not enough room for the products that are selected, SETUP warns you that there is not enough disk space and provides you with the option of going back to specify a directory on a larger disk or partition. You can also go back and omit some products. Click Go Back to return to the Select Directory dialog box, or No to continue.[2]

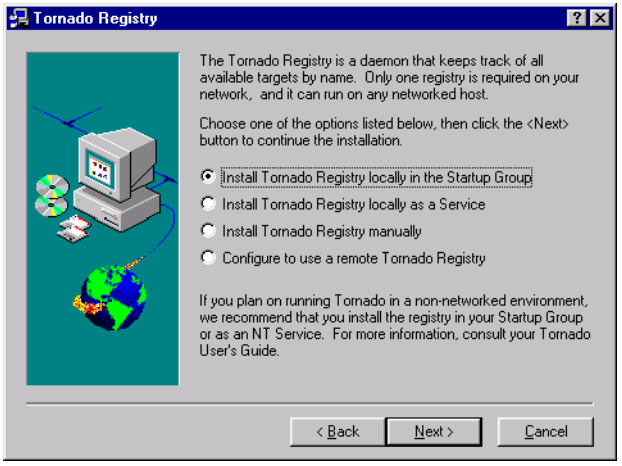
Step 9: Select a Name for the Start Menu Program Folder

Select a Windows Start menu program-folder name for Tornado with the Select Folder dialog box. By default, a Tornado entry is created under Programs in the Start menu. To continue, click Next.

Step 10: Set Up the Tornado Registry

The Tornado registry is a service that keeps track of all available target servers. A target server is a service that runs on the host and manages communications between host tools such as the Tornado shell, debugger, and browser, and the target system itself. A Tornado registry must be running before target servers can be started and before Tornado tools can communicate with a target.

Tornado hosts can be configured to access a local Tornado registry or a registry on a remote host that is on a shared network. Only one registry is required on a network, and if a single network registry is used it provides access to all targets from all Tornado hosts.



2. If you click No and continue, you will later be prompted to free up disk space.

The Registry dialog box offers the following options:

Install Tornado Registry locally in the Startup Group
: Select this option to have the Tornado registry started automatically on the local host when the current user logs on.

Install Tornado Registry locally as a Service
: Select this option to have the Tornado registry started on the local host at boot time. This option is available only for Windows NT.

Install Tornado Registry manually
: This option makes no arrangements for the Tornado registry. You must start the registry on the local host manually before you run Tornado.

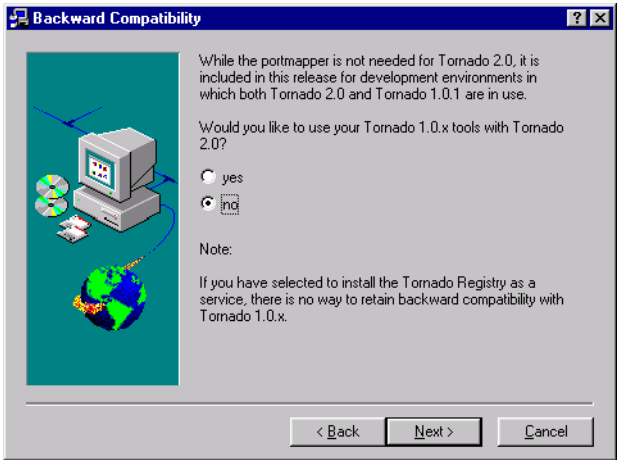
Configure to use a remote Tornado Registry
: Select this option to use a Tornado registry on another networked host. If you select this option, the Tornado Registry dialog box is displayed. Enter the name of the network host on which the registry runs.

To continue, click Next.

Step 11: Configure for Tornado 1.0.1 Tools Compatibility

If plan to use Tornado 1.0.1 and Tornado 2.0 tools in the same development environment, select yes in the Backward Compatibility dialog box. See the *Tornado Release Notes* for information about mixed-release development environments and portmapper usage.

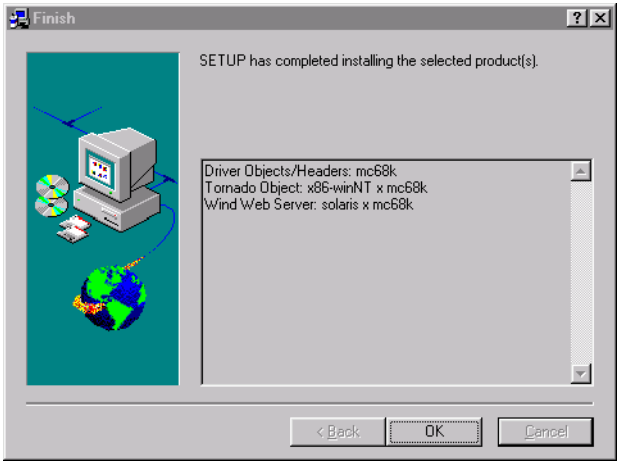
NOTE: If you selected to install the Tornado registry as a service in *Step 10*, you will be unable to use Tornado 1.0.1 tools with Tornado 2.0. You can use the Back button to return to the Tornado Registry dialog box, and change your selection.



To continue, click Next.

SETUP begins installing Tornado. During installation, it displays information about Tornado, as well as the names of the files being installed and the progress of installation. Then **SETUP** updates the VxWorks libraries, registers Tornado DLLs, and displays progress information. The installation process may take several minutes.

When **SETUP** has finished installing Tornado, a final dialog box confirms installation of the products you selected.



Click OK to close the box. You have successfully installed Tornado!

WARNING: If you set up your Tornado registry to run on your local host and to start automatically (in *Step 10*), you need to reboot your PC before automatic startup will take effect. Otherwise, you must start a Tornado registry manually before you can use Tornado.

For an introductory tutorial on Tornado usage, see *3. Tornado Tutorial*. For information about Tornado and VxWorks, see *3.12 What Next?*, p.40.

2.5 Uninstalling Tornado

WARNING: Before uninstalling Tornado, make copies of any Tornado files you have modified. Uninstalling Tornado removes all files that were part of the original distribution list. You are likely to have modified files in the BSP directories under **c:\tornado\target\config**, the initialization files in **c:\tornado\.wind**, and the sample programs under **c:\tornado\target\src\demo**.

To remove Tornado from your host system, you can use standard Windows facilities or the Tornado **Uninstall** program. Before you remove Tornado, you must shut down all Tornado programs, including those you may have arranged to start automatically, such as the Tornado target server registry and the FTP server.

- To use Windows to remove Tornado, select Start>Settings>Control Panel. Then double-click Add/Remove Programs, select Tornado Version 2.0 from the list, and click the Add/Remove button.
- To use the Tornado Uninstall program, select the Tornado program folder from the Start menu under the Programs folder.[3] Then select Tornado Uninstall.

3. This is the default folder name and location; others may have been selected at installation.

3 Tornado Tutorial

3.1 Introduction

This tutorial is designed to introduce you to key features of Tornado 2.0 using the integrated VxWorks target simulator. It does not require any target hardware or special configuration of your host system. It is not a programming tutorial; the sample program was written to exercise Tornado in illustrative ways.

While simply reading the tutorial may be edifying, we encourage you to perform the steps described in this chapter so that you can experience Tornado first hand. In the course of the tutorial, you will:

- Use the project facility to create a workspace and project for a sample program.
- Build the program from the project facility GUI.
- Download the program to the VxWorks target simulator on your host system.
- Use the Tornado shell to run the sample program.
- Use the browser to observe memory usage on the target simulator.
- Use the WindView software logic analyzer to graphically display the execution flow of the sample program and to identify a problem with task prioritization.
- Use the debugger to identify a runtime application error.

Naturally, you will have several opportunities to modify the program to correct its runtime behavior, rebuild it, download it, and run it again.

The tutorial assumes minimal knowledge of multi-threaded programming in C, and basic Windows usage.

You might approach the tutorial with the following scenario in mind:

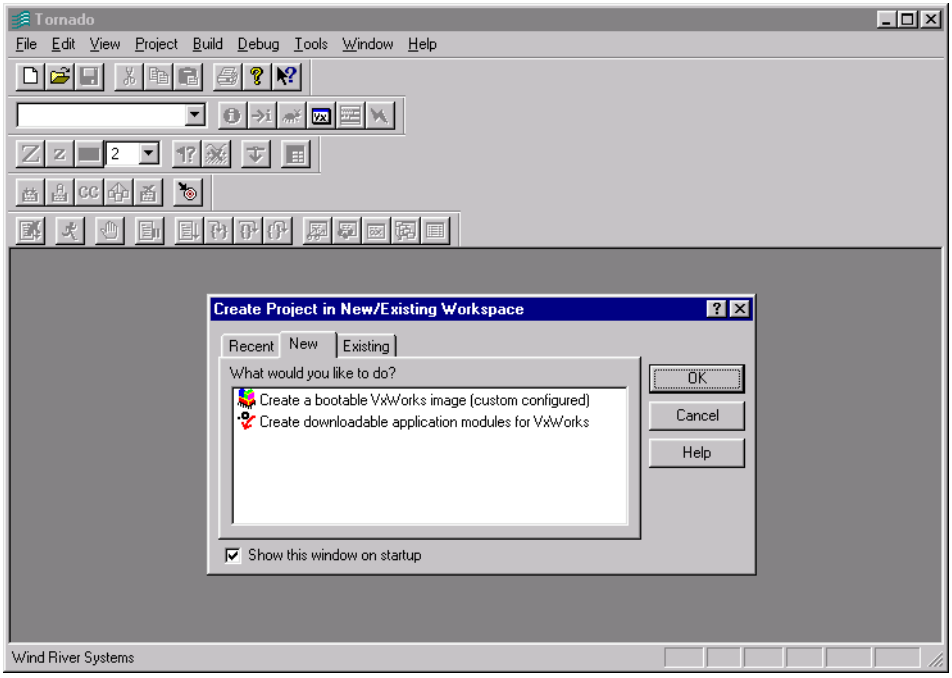
> *A colleague has abruptly announced that he is going on vacation, and the VP of Engineering has handed you the delinquent's portion of The Project. You are alarmed. His code is typically cryptic, poorly documented, and full of run-time mischief. The thought of reading his source gives you a headache. And the target hardware seems to have gone on vacation with him. You decide to use Tornado's target simulator and analytical tools to see how the code behaves ...*

3.2 Start Tornado

To start Tornado, use the Start button on the Windows task bar and select Programs. Then select the Tornado program group (which is called Tornado with a default installation) and click on Tornado.

If Tornado is unable to connect to a Tornado registry, you will be prompted to start one. See *Step 10: Set Up the Tornado Registry*, p.10 for information about registry configuration options at installation. You can start a registry manually by selecting the Tornado Registry option from the Tornado program group menu.

When you first start Tornado, the main Tornado window appears with the Create Project dialog box open by default:

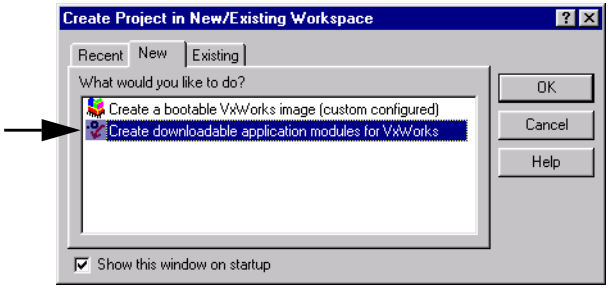


You can use the toolbars as floating palettes or dock them on the sides, top, or bottom of the main Tornado window.

3.3 Create a Project

If the Create Project in New/Existing Workspace dialog box is not displayed, click File>New Project.

Then select the option for a downloadable application:



Click OK to continue.

The Tornado application wizard appears. This wizard guides you through the steps of creating a new project. In the first step, the wizard prompts you for:

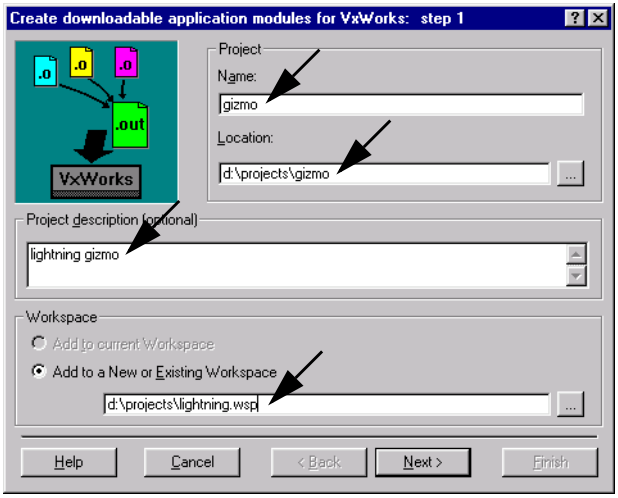
- A name for the project.
- The full path and name of the directory you want to use for the project files.
- An optional description of the project.
- The name and location of the workspace file, which contains information about the workspace, including which projects belong to it.

A *project* consists of the source code files, build settings, and binaries that are used to create an application.

A *workspace* is simply a grouping of one or more projects, which provides a useful means of working with related material, sharing code between projects, and associating related applications. Once a project and workspace have been created, a workspace window displays information about the projects that it contains.

You can accept the wizard's defaults for the project and workspace, but it is preferable to set them up outside of the Tornado installation tree. (If you do so, you won't have to untangle your work from the Tornado tree when you upgrade Tornado.)

In the wizard dialog displayed below, the project name is gizmo; the project directory is **d:\projects\gizmo**; the project description is lightning gizmo; and the path and file name for the workspace are **d:\projects\lightning.wsp**:



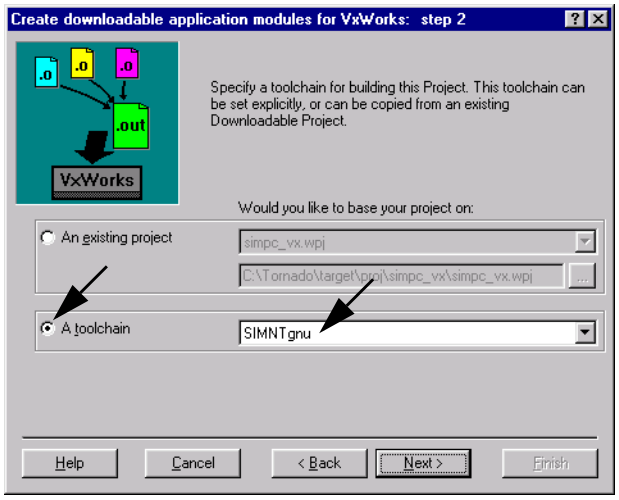
NOTE: The base directory (or directories) for the project and workspace must exist before the wizard can create the project directory and workspace file. In this example, **d:\projects** must exist for project creation to continue.

Click Next to continue.

In the second wizard dialog, you identify the toolchain with which the downloadable application will be built.

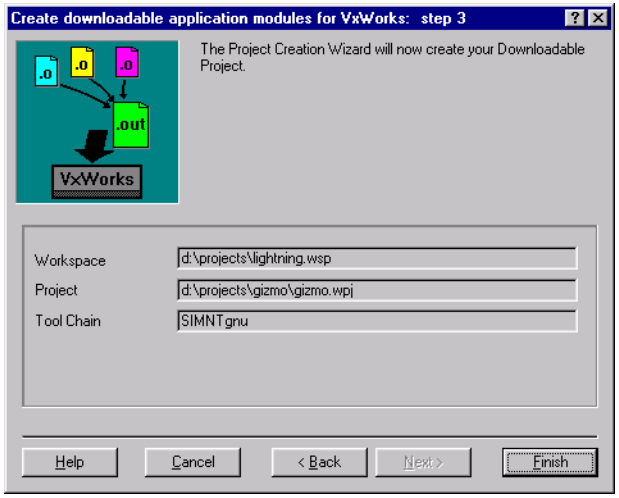
A *toolchain* is a set of cross-development tools used to build applications for a specific target processor. The toolchains provided with Tornado are based on the GNU preprocessor, compiler, assembler, and linker. The default toolchain names for target simulators take the form SIM*hostOs*gnu (for example, SIMNTgnu).

Select A toolchain and the default option for the target simulator from the drop-down list, as illustrated below:



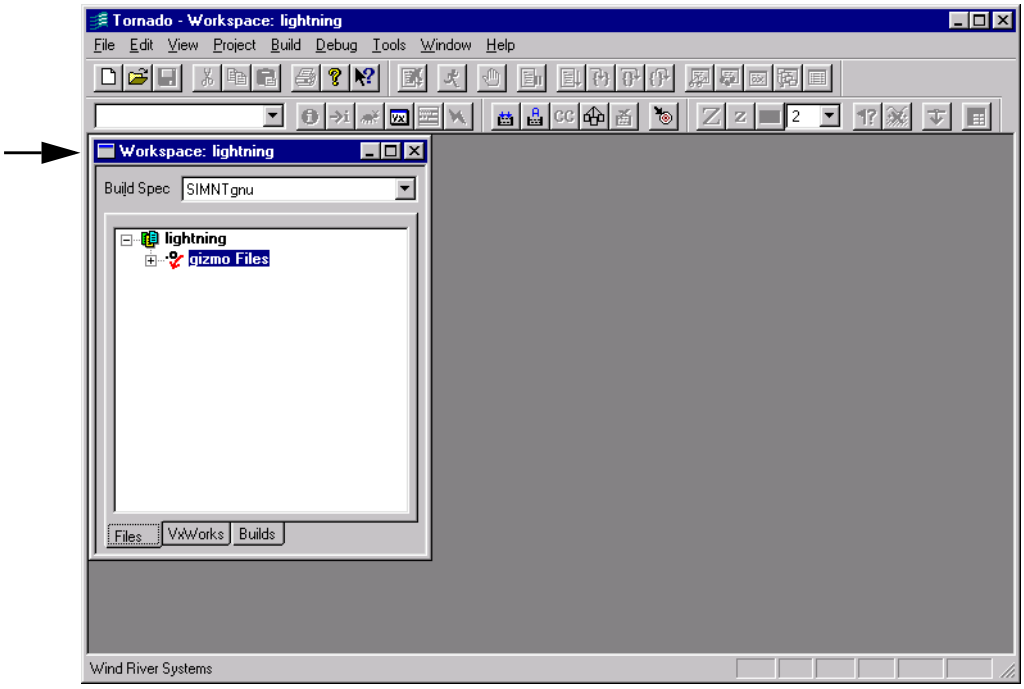
Click Next to continue.

The final wizard dialog confirms your selections:



Click Finish to continue.

The Workspace window appears. The workspace window title includes the name of the workspace, and the window itself includes a folder for the project:



NOTE: Context menus provide access to all commands that can be used with the objects displayed in, and the pages that make up, the Workspace window. Use the right mouse button to display an object's context menu.

3.4 Add the Sample Source File to the Project

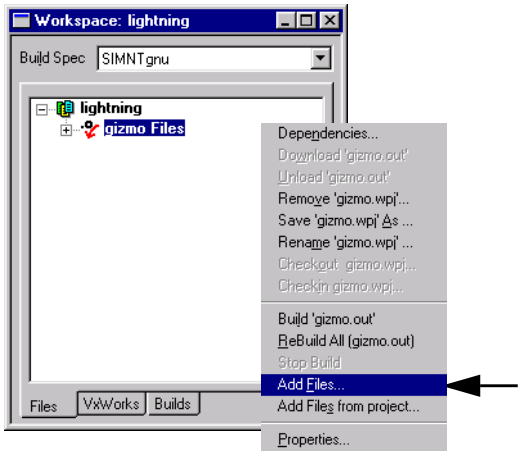
The sample program is **cobble.c**. It is a simple multi-task application that simulates a data collection system in which data is retrieved from an external source (for example, a device that generates interrupts as data comes in). One task simulates an ISR and generates new data. A second task collects the data. A third task performs calculations on the data to obtain a result value. The result is monitored by a fourth task, which prints a warning message whenever it is out of the safety range.

Before you add the sample program to the project, copy it from the Tornado installation tree to another location, such as the project directory you have set up with the Tornado project wizard.

The sample file **cobble.c** is located in **c:\tornado\target\src\demo\start** (assuming you have used the default **c:\tornado** directory for your installation).

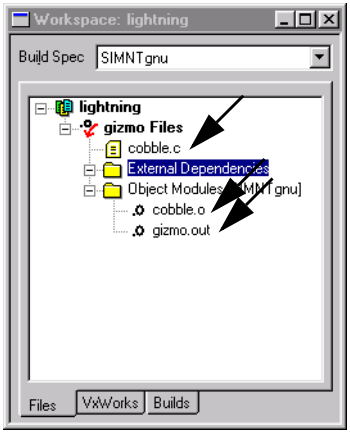
In the examples provided thus far in the tutorial, **d:\projects** has been used as the base directory for our project work, and subsequent examples are based on **cobble.c** being copied to that directory.

After you have copied **cobble.c** to another location, add it to the project. Select Add Files from the context menu in the File view of the workspace:



Then use the file browser that appears to select **cobble.c**.

Open the Object Modules folder in the Files view to display the names of both the source file and the object files that can be built from it:



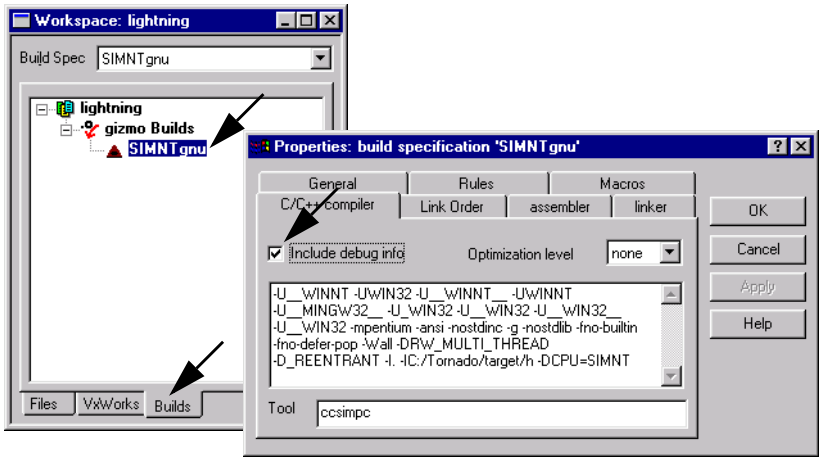
The Tornado project facility automatically creates the file *projectName*.**out** as a single, partially linked module when a project is built. It comprises all of the individual object modules in a downloadable application project, and provides for downloading them all to the target simultaneously.

3.5 Build the Project

To review the default build settings defined when you created the project, select the Builds tab on the Workspace window, open the gizmo Builds folder, and double-click on the default build name (for example, SIMNTgnu).

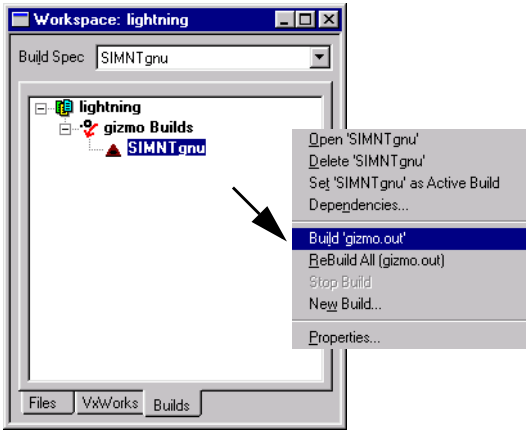
The properties sheet for the build appears, which you can use to review makefile rules and macros, as well as the compiler, assembler, and linker options used for the build.

When you display the C/C++ compiler page, you will note that the Include debug info checkbox is selected by default. This selection ensures that optimization is turned off when the project is compiled with debug information:



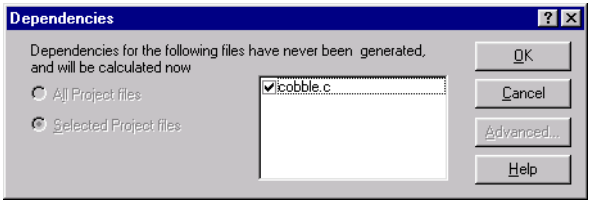
Close the property sheet by clicking on the Cancel button.

Build the project by selecting Build 'gizmo.out' from the context menu:



The option Build '*projectName*.out' builds all project modules as a single, partially linked module that is optimal for downloading to a target.

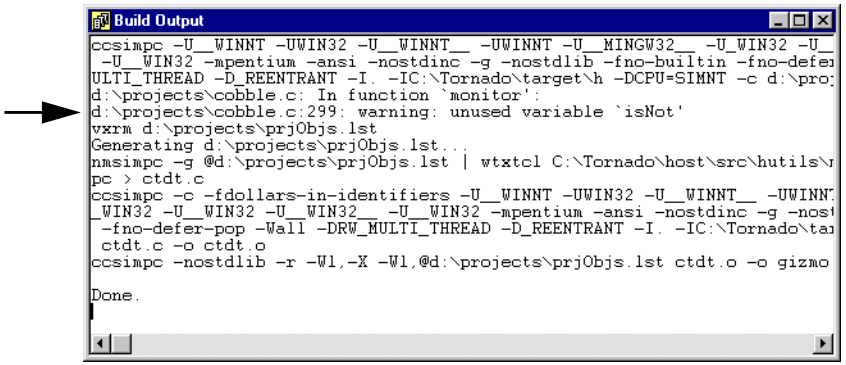
Before Tornado builds the project, the Dependencies dialog box warns you that makefile dependencies have not been calculated for **cobble.c**:



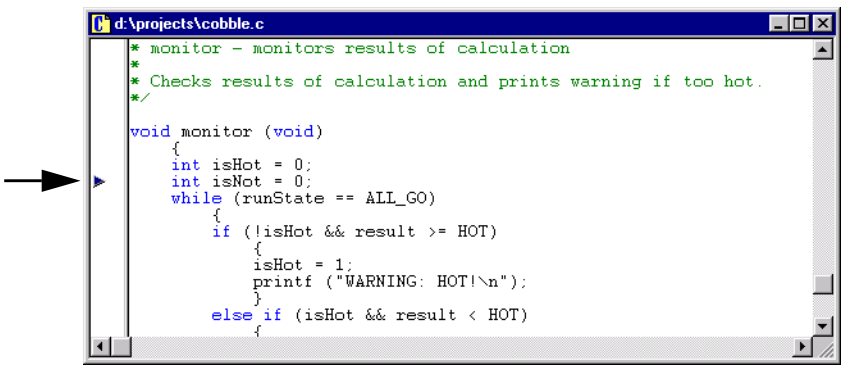
Click OK to continue.

Tornado calculates makefile dependencies and proceeds with building the project. If any external dependencies are found, they are automatically included in the project and listed in the External Dependencies folder in the Files view of the workspace.

The build output window displays any errors and warnings. In this case, the compiler has detected an extraneous variable:



If you double-click on an error or warning message, the source file is opened in the editor, and a context pointer marks the offending line:



If you wish to, remove the unused integer variable **isNot**, save the file with **CTRL+S** or File>Save, and rebuild the project. The Tornado editor includes standard Windows text manipulation capabilities.

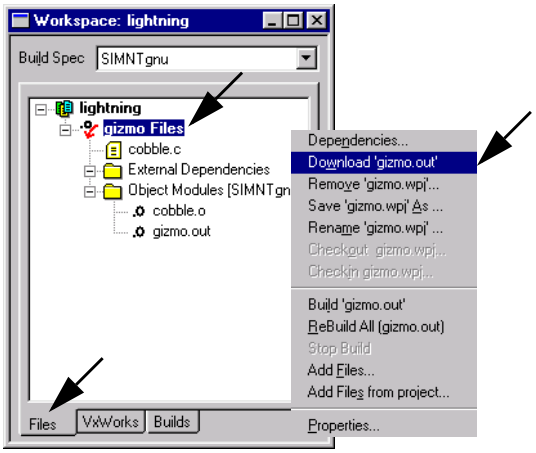
Close the Build Output window with the window control.

3.6 Download the Project to the VxWorks Target Simulator

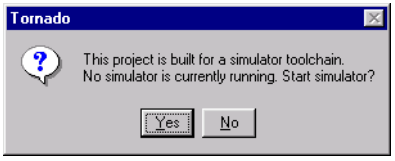
You can download your project from the Files view of the workspace, and start the integrated simulator, all as part of the same process.

First display the Files view of the workspace window.

Then select the project folder name with the right mouse button and select the Download 'gizmo.out' option from the context menu:

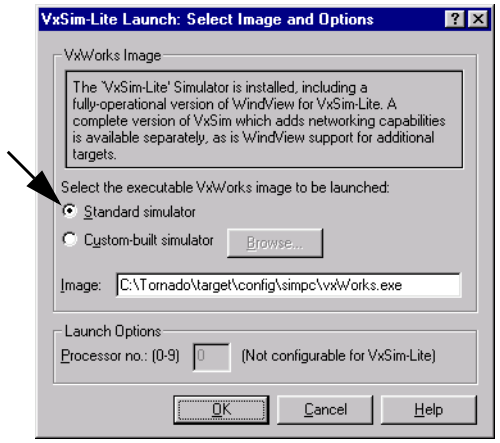


Tornado prompts you to start a simulator:



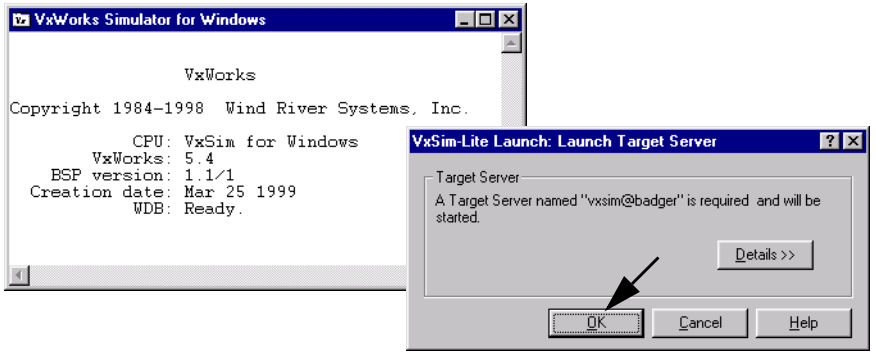
Click Yes to continue.

The VxSim-Lite Launch dialog box appears:



Leave Standard Simulator selected, and click OK to continue.

The target simulator window opens, and Tornado prompts you to start a target server. Click OK in the VxSim-Lite Launch dialog to continue:



NOTE: Only one instance of the integrated VxWorks target simulator (VxSim-Lite) can be run at a time. (To stop the simulator, close the VxWorks Simulator window.)

A target server manages all communication between Tornado host tools, such as the debugger, and the target. The convention for target server names is *targetName@hostName*. In this example, the name of the target is vxsim (the default for the integrated simulator), and the name of the PC host is badger.

The name of the target server is displayed in the Tornado launch toolbar:

The toolbar includes buttons for starting Tornado tools such as the browser, shell, and debugger. The buttons are activated when the target server is started.

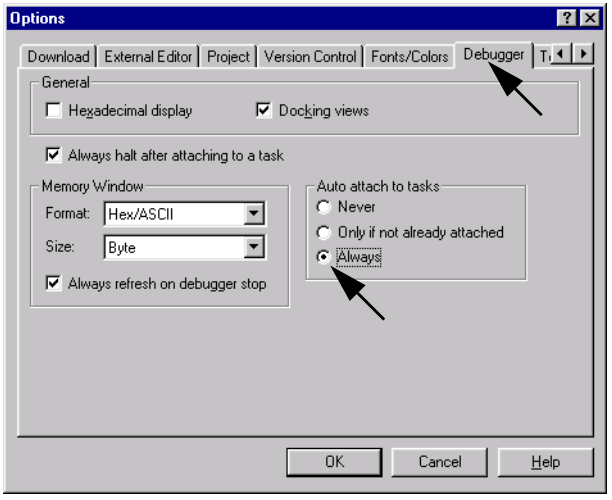
NOTE: Both the browser button and the shell button both have the letter **i** in them, which may be confusing. The **i** in the shell button follows the **->** shell command prompt, where it is a shell command that displays target system information. The **i** in the browser button stands for *information* about the target.

3.7 Run the Application from the Tornado Shell

Before you run an application, it is often useful to configure and start the Tornado debugger first, so that the debugger can respond automatically to any program exception.

The Tornado debugger (CrossWind) combines the best features of graphical and command-line debugging interfaces. The most common debugging activities, such as setting breakpoints and controlling program execution, are available through convenient point-and-click interfaces. Similarly, program listings and data-inspection windows provide an immediate visual context for the crucial portions of your application.

To configure the debugger, select Tools>Options>Debugger from the main Tornado window. When the Options dialog appears, select Always under Auto attach to tasks, so that the debugger will automatically attach to a task when an exception occurs:



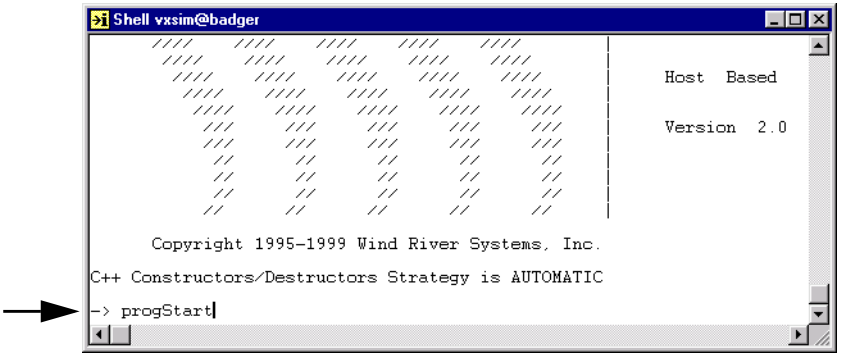
Click OK to continue.

To start the debugger, use the debugger button in the Tornado launch toolbar. After a few seconds, the status line at the bottom of the main Tornado window announces that the debugger is running:

The Tornado shell (also known as WindSh) is a C-language command interpreter that allows you to invoke any routine from the shell command line that has been downloaded to the target. The shell also includes its own set of commands for managing tasks, accessing system information, debugging, and so on.

You can run the program from the shell command line. To start a shell, click the shell button  .

When the shell window opens, run the program by entering the name of the main routine, ***progStart( )***, at the command line:

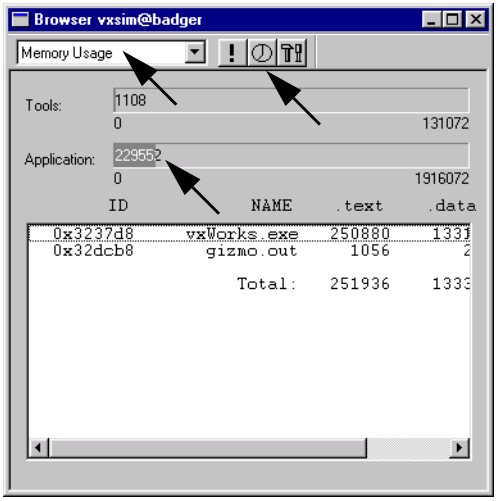


3.8 Examine Target Memory Consumption

The Tornado browser is a system-object viewer that is a graphical companion to the Tornado shell. The browser provides display facilities to monitor the state of the target system, including summaries of active tasks, memory allocation, and so on.

To start the browser, click the browser button in the Tornado launch toolbar.

When the browser appears, Select Memory Usage from the drop down list and click the periodic refresh button. This will update the display every few seconds, and you will note that **cobble.c** has a voracious appetite for memory:

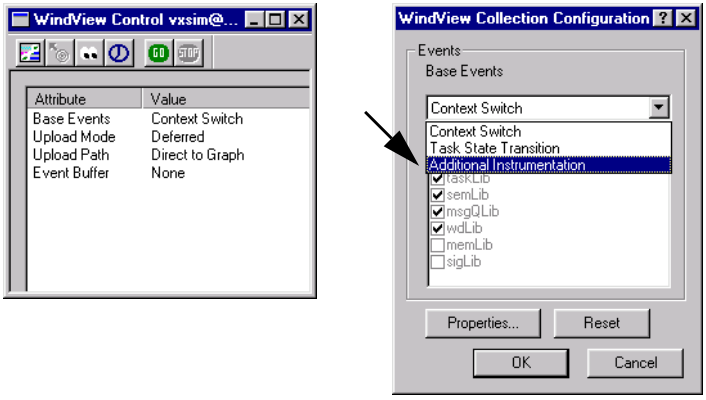


Stop the browser with the window control in the title bar.

3.9 Examine Task Activity

WindView is the Tornado logic analyzer for real-time applications. It is a dynamic visualization tool that provides information about context switches, and the events that lead to them, as well as information about instrumented objects such as semaphores, message queues, and watchdog timers.

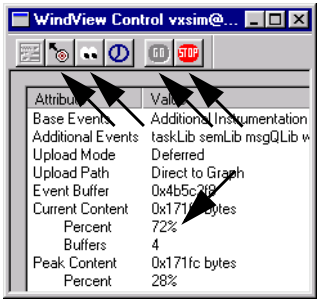
Click the WindView button in the Tornado launch toolbar to display the WindView Control window. The WindView Collection Configuration dialog box also appears. Select Additional Instrumentation from the drop-down list and click OK:



To begin data collection, click the GO button in the WindView Control window.

NOTE: Except where otherwise specified, the default configuration of WindView is used for this exercise. If WindView settings have been changed during another session, the behavior may vary from the description below.

Wait a few seconds, and then click the update button in the WindView Control window to update the status of data collection:



Once you have roughly fifty percent or so of the data buffer filled, click the Stop button  to end data collection.

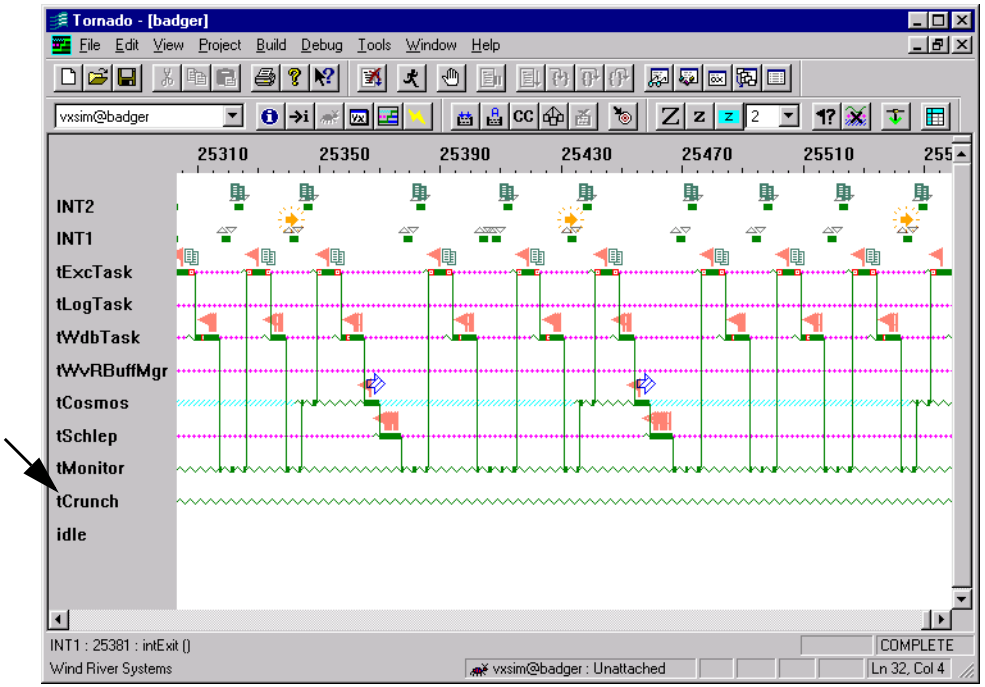
You may notice a certain sluggishness in your machine's performance, which is due to the sample program's runtime misbehavior on the integrated simulator.

Before you upload the WindView data from the simulator target to the host, stop the sample program by entering **progStop** at the shell command line.

Then use the upload button  to upload the data.

A view graph is displayed while the data is uploaded, and a message box announces completion of the upload. Click OK to continue.

When you maximize the view graph window, the data display should look something like the following:[1]



1. The color of the view graph display can be changed with Tools>WindView>Options.

You can use the zoom buttons  on the WindView toolbar to enlarge or decrease the size of the scope of the display, and scroll bar at the bottom of the view graph to display the rest of the data. (The zoom 100% button  displays all of the data at once.) The flag-shaped icons indicate semaphore gives and takes. The horizontal lines indicate task states (executing, pending, ready, and so on). For information about the meaning of the WindView icons, select Help>WindView Help>Legend.

Note that **tCrunch**, the task that processes data and removes nodes from a linked list, never runs.

Close the view graph and click No in response to the dialog that prompts you to save the data with: Save changes to *hostName*?

Close the WindView Control window as well.

3.10 Fix Task Priorities and Find the Next Bug

Open the source in the editor by double-clicking on **cobble.c** in the workspace Files view. Then find the ***progStart*( )** routine, where you'll discover that **tCrunch** is assigned a lower priority (240) than **tMonitor** (230), which never allows it to run. As a consequence, data is never processed, and nodes are never deleted from the linked list.

Edit the source file to reverse the priorities between the two tasks:

- Change the 240 argument in the ***taskSpawn*( )** call for **tCrunch** to 230.
- Change the 230 argument in the ***taskSpawn*( )** call for **tMonitor** to 240.

Then save the file.

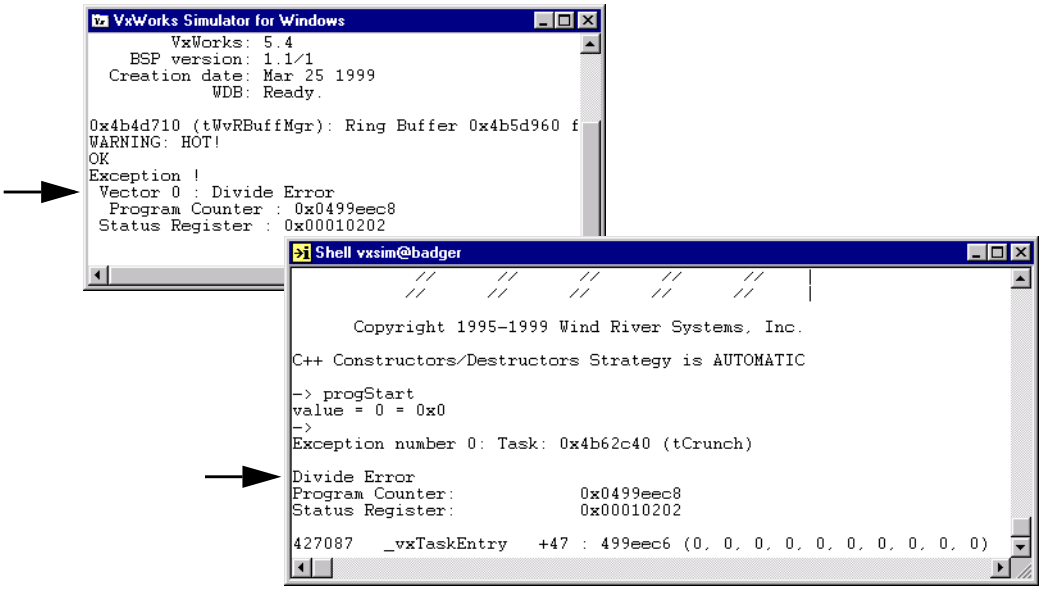
Use the context menu in the Files view of the workspace, select the ReBuild All (gizmo.out) option to rebuild the project. When it is done, close the Build Output window.

Then download the project to the target with the Download 'gizmo.out' option from the context menu.

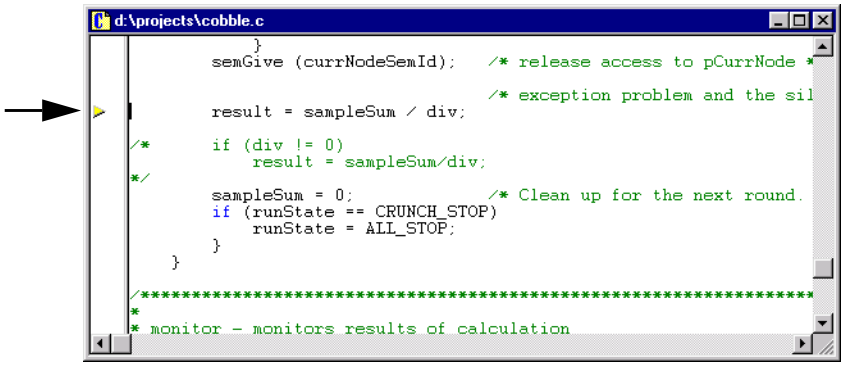
NOTE: Do not forget to download the new **gizmo.out** to the target! And if you have stopped the debugger, restart it with the debugger button .

Start the program again from the Tornado shell with the command **progStart**.

You will see application output in the simulator window. And after a few seconds both the simulator and shell windows announce a divide error:



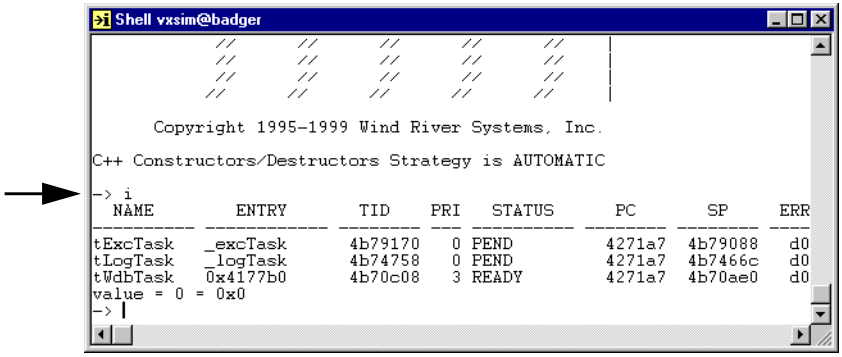
In addition, the debugger opens the editor window automatically with a context pointer marking the position in the ***crunch*( )** routine where the error was generated:



Before you proceed, you might want to stop the program from going on a memory binge again.

To do so, enter the **reboot** command in the shell window (press **ENTER** to display the prompt). A message box announces that the target connection has been lost, and that the debugger is being stopped. Click OK.

If you use the **i** command in the shell window after you have rebooted the simulator, you see that only VxWorks system tasks are now running:



3.11 Fix the Last Bug and Take it for a Spin

Fix the source of the divide-by-zero error in the ***crunch*( )** routine by using the commented code immediately below the division operation (or something more interesting!), and save the file.

Then use the context menu in the Files view of the workspace to select the ReBuild All (gizmo.out) option. When the build is done, close the Build Output window.

Download the application to the target with the Download 'gizmo.out' option from the context menu.

To be sure that everything is working, start the debugger with the debugger button  .

Start the program again from the Tornado shell with the command **progStart**.

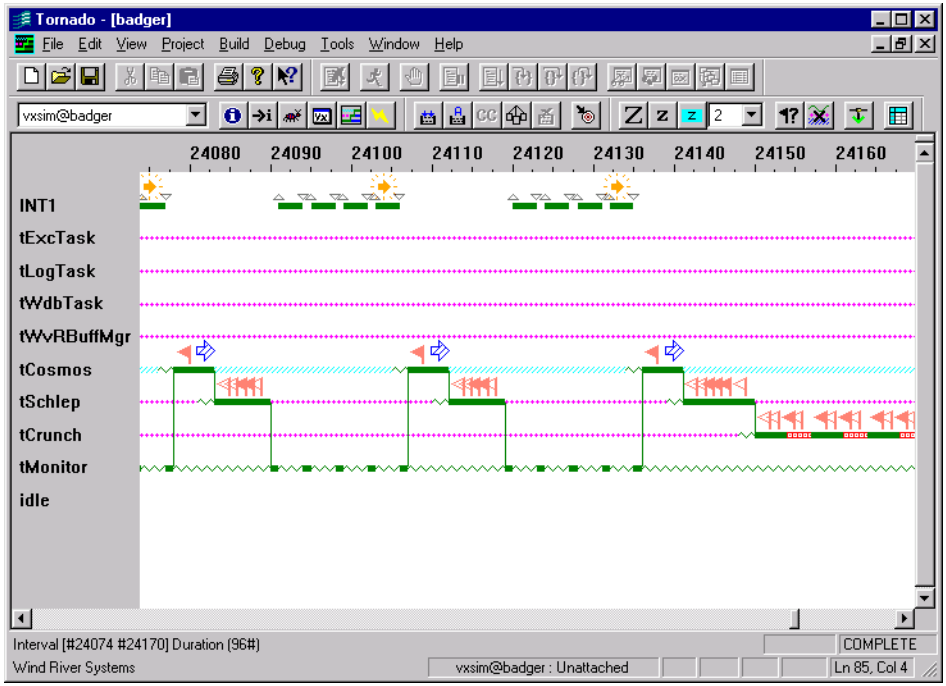
Click on the Windview button to display the WindView Control window. Then click the GO button in the WindView Control window to begin data collection.

Wait a few seconds, and click the update button in the WindView Control window to update the status of data collection.

Once you have roughly fifty percent of the data buffer filled, click the Stop button to end data collection. Then use the upload button to upload the data.

A view graph is displayed while the data is uploaded, and a message box announces completion of the upload. Click OK to continue.

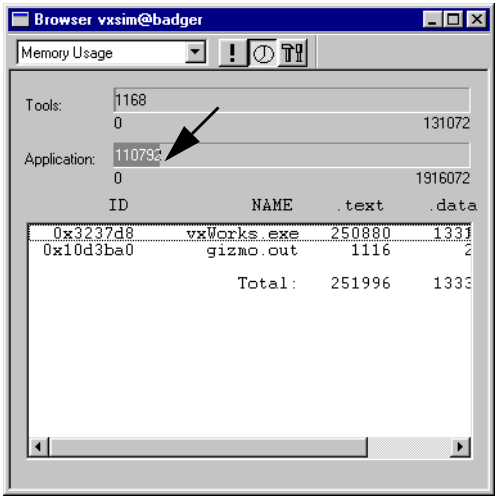
Maximize the view graph window and scroll through the WindView data. You should find that all tasks, including **tCrunch**, are running in an orderly manner, and the view graph data should look like the following:



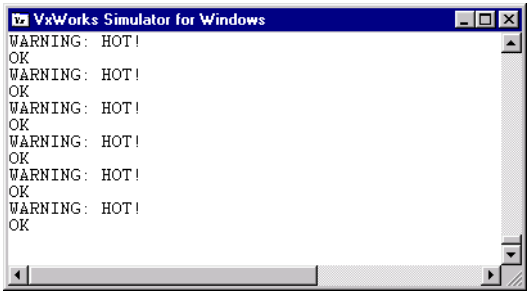
You can check memory consumption once again with the browser by clicking the browser button in the Tornado launch toolbar.

When the browser appears, select Memory Usage from the drop-down list and click the browser's periodic refresh button . Every few seconds the display will be updated.

Notice that memory consumption fluctuates modestly within a constant range:



Moreover, output in the simulator window indicates that the program is humming along nicely, providing you with information about when it's hot and when it's not:



Stop the program by entering **progStop** at the shell command line to restore full vigor to your host system.

3.12 What Next?

For detailed information about using features of the Tornado IDE such as the project facility, shell, browser, and debugger, see the *Tornado User's Guide*. The guide also provides information about setting up your Tornado development environment with target hardware.

For information about integrating existing development work with the Tornado 2.0 project facility, using BSPs from previous releases, and so on, see the *Tornado Release Notes*.[2]

For information about VxWorks itself, see the *VxWorks Programmer's Guide*, the *VxWorks Network Programmer's Guide*, and the *VxWorks Reference Manual*.

Most of the Tornado documentation set is available online in HTML format from the main Tornado menu Help>Manuals Contents, or directly from the top level HTML file **c:\tornado\docs\books.html**.

See the *Tornado User's Guide: Documentation Guide* for a full description of the Tornado documentation set.

2. A Board Support Package (BSP) consists primarily of the hardware-specific VxWorks code (much of it in source code) for a particular target board. A BSP includes facilities for hardware initialization, interrupt handling and generation, hardware clock and timer management, mapping of local and bus memory space, and so on.