GNATbench for Eclipse User's Guide

Release 27.0.20260427.w

AdaCore

Apr 28, 2026

CONTENTS

1 Getting Started **1**

1.1 Prior Required Tool Installations . . . 1
1.2 Conflicting Plug-In Removal . . . 1
1.3 Installing GNATbench . . . 1
1.4 Before Browsing and Navigating the Code . . . 2
1.5 Verifying Correct GNATbench Installation . . . 2
1.6 Introduction . . . 3
1.7 Intended Audience . . . 3
1.8 Scope . . . 4
1.9 For Additional Information and Help . . . 4
1.10 Creating and Building A Basic Native Project . . . 4
1.10.1 Creating and Configuring the Project . . . 4
1.10.2 Building the Project . . . 10
1.10.3 Congratulations! . . . 12
1.11 Creating and Building An Embedded Computer Project . . . 12
1.11.1 Creating and Configuring the Project . . . 12
1.11.2 Modifying the GNAT Project File . . . 21
1.11.3 Importing the Script and Sources . . . 22
1.11.4 Adding A Command . . . 24
1.11.5 Invoking the User-Defined Command . . . 25
1.11.6 Building the Project . . . 27
1.11.7 Congratulations! . . . 28
1.12 Using GPRbuild To Build An Embedded Computer Project . . . 29
1.12.1 Creating and Configuring the Project . . . 29
1.12.2 Modifying the GNAT Project File . . . 35
1.12.3 The Source Files . . . 37
1.12.4 Modifying the Main Subprogram Source File . . . 38
1.12.5 Building the Project . . . 39
1.12.6 Congratulations! . . . 40

2 Concepts **41**

2.1 GNAT Pro . . . 41
2.1.1 GNAT Projects . . . 41
2.1.2 Foreign Ada Source Files . . . 41
2.1.3 Project Files . . . 42
2.1.4 GNAT Project Manager . . . 43
2.1.5 Scenario Variables . . . 44
2.2 GNATbench . . . 46
2.2.1 Ada Perspective . . . 46
2.2.2 Ada Perspective Menus . . . 47

2.2.3 Ada Perspective Wizards . . . 51
2.2.4 GNATbench Project File Editor . . . 57
2.2.5 GNAT Project Properties Editor . . . 60
2.2.6 Outline View . . . 62
2.2.7 Scenario Variables View . . . 63
2.2.8 Call Hierarchy View . . . 64
2.2.9 GNAT Project Explorer . . . 65
2.2.10 Metrics View . . . 73
2.2.11 Opening GNATbench Views . . . 74
2.2.12 Ada Build Console . . . 75
2.3 Allocating Enough Memory and Solving OutOfMemoryErrors . . . 76

3 Setting Preferences **77**
3.1 GNATbench Preferences . . . 77
3.2 Builder Targets . . . 78
3.2.1 The Targets Tree . . . 78
3.2.2 The Properties Dialog . . . 79
3.2.3 The Command Line Dialog . . . 81
3.3 Syntax Coloring . . . 81
3.4 Editors' Font . . . 82
3.5 Coding Style . . . 83
3.6 Editor . . . 84
3.7 General Preferences . . . 85
3.7.1 Multi-language Builder . . . 86
3.7.2 Fast Project Loading . . . 87
3.7.3 Removal Policy When Fixing Code . . . 87
3.8 GNATbench Trace Log . . . 87
3.9 Toolchains . . . 88
3.10 External Commands . . . 89
3.11 Tools . . . 90

4 Creating and Configuring Projects **93**
4.1 Importing Existing GNAT Projects . . . 93
4.2 Creating New Projects . . . 99
4.2.1 Invoking the New-Project Wizard . . . 99
4.2.2 Walking Through the Wizard Pages . . . 99
4.3 Creating New Ada Source Files . . . 113
4.3.1 Invoking the New-File Wizards . . . 113
4.3.2 New Ada Source File Wizard . . . 114
4.3.3 Linked Source Files . . . 115
4.3.4 Header Text Insertion . . . 115
4.3.5 File Naming Conformance . . . 116
4.4 Creating New Ada Source Folders . . . 117
4.4.1 Invoking the New-Folder Wizards . . . 117
4.4.2 New Ada Source Folder Wizard . . . 117
4.5 Converting Existing Projects To GNATbench . . . 118
4.6 Using Non-Default Ada Source File Names . . . 121
4.6.1 Specifying the Naming Scheme In the Project File . . . 121
4.6.2 Associating the File Name Extension with the Ada Editor . . . 126

5 Browsing and Navigation **131**
5.1 Crucial Setup Requirement . . . 131
5.1.1 The cross-reference database . . . 131
5.1.2 Cross-references and partially compiled projects . . . 132

5.2 Browsing via Source Code Hyperlinks . . . 132
5.2.1 Configuring C/C++ Source Code Hyperlinks navigation . . . 137
5.3 Editor Tooltips . . . 137
5.4 Visiting Declarations and Bodies . . . 138
5.5 Visiting Declaration and Body Files . . . 140
5.6 Traversing Within Source Files . . . 142
5.7 Browsing via Reference Searching . . . 142
5.7.1 Advanced Options . . . 144

6 Developing Ada Source Code **147**
6.1 Language-Sensitive Editing . . . 147
6.1.1 Invoking the Ada Language-Sensitive Editor . . . 147
6.1.2 Syntax Coloring . . . 148
6.1.3 Formatting Source Code . . . 150
6.1.4 Block Folding . . . 159
6.1.5 Managing Comments . . . 160
6.1.6 Parentheses Highlighting . . . 164
6.1.7 Automatic Construct Closing . . . 164
6.1.8 Smart Enter Key . . . 165
6.1.9 Smart Space Key . . . 166
6.1.10 Smart Tab Key . . . 172
6.1.11 Smart Home Key . . . 173
6.1.12 Smart End Key . . . 174
6.2 Code Assist . . . 175
6.2.1 Code Assist . . . 175
6.2.2 Enabling Code Assist . . . 175
6.2.3 Invoking Code Assist . . . 176
6.2.4 Simple Name Completion . . . 177
6.2.5 Dotted Name Completion . . . 177
6.2.6 Formal Parameter Completion . . . 180
6.2.7 Limitations . . . 182
6.2.8 Ada Templates . . . 183
6.3 Quick Fix . . . 183

7 Building **187**
7.1 Project Builder Command Menus . . . 187
7.1.1 Project Menu . . . 187
7.1.2 Contextual Menus . . . 188
7.2 Project Builder Command Semantics . . . 189
7.2.1 Standard Eclipse Build Commands . . . 190
7.2.2 GNATbench Project-Specific Builder Commands . . . 190
7.3 Project Builder Key Bindings . . . 191
7.4 About the Build Automatically Option… . . . 192
7.5 Ada Build Console . . . 193
7.6 Compiling Individual Files . . . 194
7.6.1 Within the Ada Editor . . . 194
7.6.2 Within the GNAT Project Explorer . . . 196
7.7 Analyzing Individual Files . . . 198
7.8 Removing Compilation Artifacts . . . 200
7.9 Building Projects with Scenarios . . . 200
7.10 Cross Compiling . . . 203
7.11 Using Multiple Toolchains . . . 204
7.12 Building with Makefiles . . . 206
7.12.1 Modifying the “make” utility name . . . 207

7.12.2 Modifying the Makefile . . . 207
7.12.3 Makefile Name and Location . . . 208
7.13 User-Defined Builder Commands . . . 209
7.13.1 Defining Commands . . . 209
7.13.2 Invoking User-Defined Commands . . . 210
7.14 Build Mode . . . 211
7.15 Build Menu . . . 211
7.15.1 Check Syntax . . . 211
7.15.2 Check Semantic . . . 211
7.15.3 Compile File . . . 211
7.15.4 Project . . . 212
7.15.5 Clean . . . 212
7.15.6 Run . . . 212
7.16 Troubleshooting Builder Problems . . . 213
7.16.1 Eclipse and CDT Version Mismatch or Missing . . . 213
7.16.2 Conflicting Plug-Ins . . . 213

8 Executing **215**
8.1 Creating Launch Configurations for Native Ada Applications . . . 215
8.1.1 Creating A C++ Launch Configuration . . . 215
8.1.2 Creating an External Tools Launch Configuration . . . 218
8.2 Executing Native Ada Applications . . . 223
8.2.1 Using A C++ Launch Configuration . . . 224
8.2.2 Using An External Tool Launch Configuration . . . 226
8.3 Executing Embedded Ada Applications . . . 228

9 Debugging **229**
9.1 Introduction to Debugging with GNATbench . . . 229
9.1.1 Preparing to Debug . . . 229
9.1.2 Other Resources . . . 229
9.1.3 Overview . . . 230
9.2 Creating A Debug Configuration . . . 232
9.2.1 Quick Configuration Creation . . . 237
9.3 Launching A Debug Session . . . 240
9.3.1 Potential Trouble . . . 242
9.3.2 Build Prior to Launch . . . 243
9.4 Setting Breakpoints . . . 244
9.5 Breaking On Exceptions . . . 246
9.6 Controlling Execution . . . 248
9.7 Examining Data . . . 251
9.7.1 Examining Variables Declared in Subprograms and Tasks . . . 253
9.7.2 Examining Variables Declared in Packages . . . 253
9.8 Debugging Tasks . . . 256
9.9 Ending A Debug Session . . . 257
9.10 Using the GNAT Studio Debugger . . . 258
9.11 Troubleshooting . . . 259

10 Tool Integrations **261**
10.1 Pretty Printer . . . 261
10.2 Metrics Analysis . . . 262
10.2.1 Controls . . . 264
10.2.2 Results . . . 264
10.3 Style Checking . . . 266
10.3.1 Controls . . . 267

10.3.2 Results . . . 268

11 Using AJIS **271**
11.1 Creating and Building an AJIS Project . . . 271
11.1.1 Audience . . . 271
11.1.2 Before You Begin . . . 271
11.1.3 Create an Ada Project for AJIS . . . 272
11.1.4 Final Project Setup Steps . . . 279
11.1.5 Building the Ada Project . . . 285
11.2 Using AJIS Examples . . . 288
11.2.1 Before You Begin . . . 288
11.2.2 Import AJIS examples for GNATbench projects into workspace . . . 288
11.2.3 Build AJIS examples for GNATbench projects . . . 290
11.2.4 Run or Debug AJIS examples for GNATbench projects . . . 290
11.3 Using the AJIS Integration . . . 291
11.3.1 Installing the Required Tools . . . 291
11.3.2 Creating a Library and Sources . . . 291
11.3.3 Using the Library and Java Sources . . . 292
11.4 Manual Configuration of Java Build Path . . . 292
11.4.1 Setup . . . 292
11.4.2 Teardown . . . 294
11.5 Usage Notes . . . 295
11.5.1 Versions . . . 295
11.5.2 Modifying the Ada Sources . . . 295
11.5.3 Exporting the Java Project . . . 295
11.5.4 Optional additional arguments to `ada2java` . . . 297
11.5.5 Cleaning . . . 297
11.5.6 Limitations . . . 297

12 Developing Ada Applications for QNX **299**
12.1 Creating QNX projects containing Ada code . . . 299
12.1.1 Audience . . . 299
12.1.2 Before You Begin . . . 299
12.1.3 Create the Empty QNX Project that will contain Ada code . . . 300
12.1.4 Convert the empty QNX project to use Ada language . . . 303

13 Developing Ada Applications for DDC-I Deos **305**
13.1 Installing GNATbench . . . 305
13.1.1 Requirements . . . 305
13.1.2 Downloading GNATbench . . . 305
13.1.3 Installing . . . 306
13.1.4 Documentation . . . 306
13.2 Creating an Ada Application for Deos Processes . . . 306
13.2.1 Create a new DDC-I Executable Project . . . 307
13.2.2 Convert DDC-I Executable Project . . . 307
13.2.3 Add Deos Component Dependencies . . . 307
13.2.4 Deos Process Developer XML file . . . 307
13.2.5 Build the project . . . 309
13.2.6 Create the DDC-I Deos Platform Project . . . 309
13.2.7 Run the Deos project . . . 309
13.3 Creating an Ada 653 Partition . . . 309
13.3.1 Create a new DDC-I Executable Project . . . 309
13.3.2 Convert DDC-I Executable Project . . . 310
13.3.3 Add Deos Component Dependencies . . . 310

13.3.4 Deos Feature Provider XML file . . . 310
13.3.5 Build the project . . . 311
13.3.6 Create the Deos 653 Configuration Project . . . 311
13.3.7 Update the Deos Component Dependencies . . . 312
13.3.8 Create the Deos 653 Configuration File . . . 312
13.3.9 Create the DDC-I Deos Platform Project . . . 316
13.3.10 Run the Deos project . . . 316

14 Developing Ada Applications in Xilinx Vitis **317**

14.1 Installing GNATbench . . . 317
14.1.1 Requirements . . . 317
14.1.2 Downloading GNATbench . . . 317
14.1.3 Installing . . . 317
14.2 Creating an Ada Application in Xilinx Vitis . . . 320
14.2.1 Create a new Platform Project . . . 320
14.2.2 Create a new Application Project . . . 321
14.2.3 Convert the Application Project . . . 323
14.2.4 Build the Project . . . 328
14.2.5 Running and Debugging the Project . . . 329

CHAPTER

ONE

GETTING STARTED

1.1 Prior Required Tool Installations

Before you can use GNATbench you must install the required environments and tools.

The GNATbench plug-in for Eclipse requires the following to be installed prior to installing GNATbench itself:

For 64-bit Linux or Windows one of the following versions Eclipse 2018-09 (4.9) Eclipse 2019-06 (4.12) Eclipse 2019-12 (4.14) Eclipse 2020-03 (4.15) Eclipse 2020-06 (4.16)

The C/C++ Development Tools (CDT) plug-in for Eclipse, compatible with the version of Eclipse chosen. This should be the version released along with the version of Eclipse you are installing, or any compatible updates for it.

The official JRE from Oracle or Open JDK. GNATbench was not tested on IBM Java. Eclipse 2018-09 (4.9) requires JER-8. All others supported Eclipse versions requires JRE-8 or JRE-11.

Specifically, you must install Eclipse, the C/C++ Development Tools (CDT), and the AdaCore compilation tool-set **before** installing the GNATbench plug-in. For the CDT, install the version required by the version of Eclipse you are using. The easiest and most reliable approach is to install the Eclipse bundle that automatically includes the CDT, however you can also install them individually.

1.2 Conflicting Plug-In Removal

In all probability, you must remove or completely disable any other Ada development plug-in that includes the functionality that GNATbench provides. In particular, any plug-in that defines a project builder for Ada source code will likely prevent correct operation of GNATbench, and vice versa.

1.3 Installing GNATbench

The file gnatbench-<version>-<platform>-bin.zip is an archive to be installed through the regular Eclipse installation mechanism.

Open Eclipse or Workbench and select 'Help -> Install New Software' (if this menu is not available, it can be added through the Eclipse perspective customization panel).

Click on the 'Add' button to add a repository. Select 'Archive' and navigate to the zip file downloaded from AdaCore. The Location field will then reference that file. You can optionally enter a repository name for future reference, such as "GNATbench" (without the quotes). Click 'OK'.

The Eclipse installer will then offer the choice of different versions of GNATbench for installation. For Eclipse, select 'AdaCore Plugins for Eclipse/CDT'. Be certain to NOT also select an other version!

Click 'Next' and follow the installation wizard to completion. During the installation process, a dialog can be raised asking if you trust the AdaCore certificates. Check the mark next to the GNATbench certificate and press 'OK'.

Note: the GNATbench Ada Development User Guide could be accessed after installation, with all other User Guides, via the "Help -> Help Contents" menu entry.

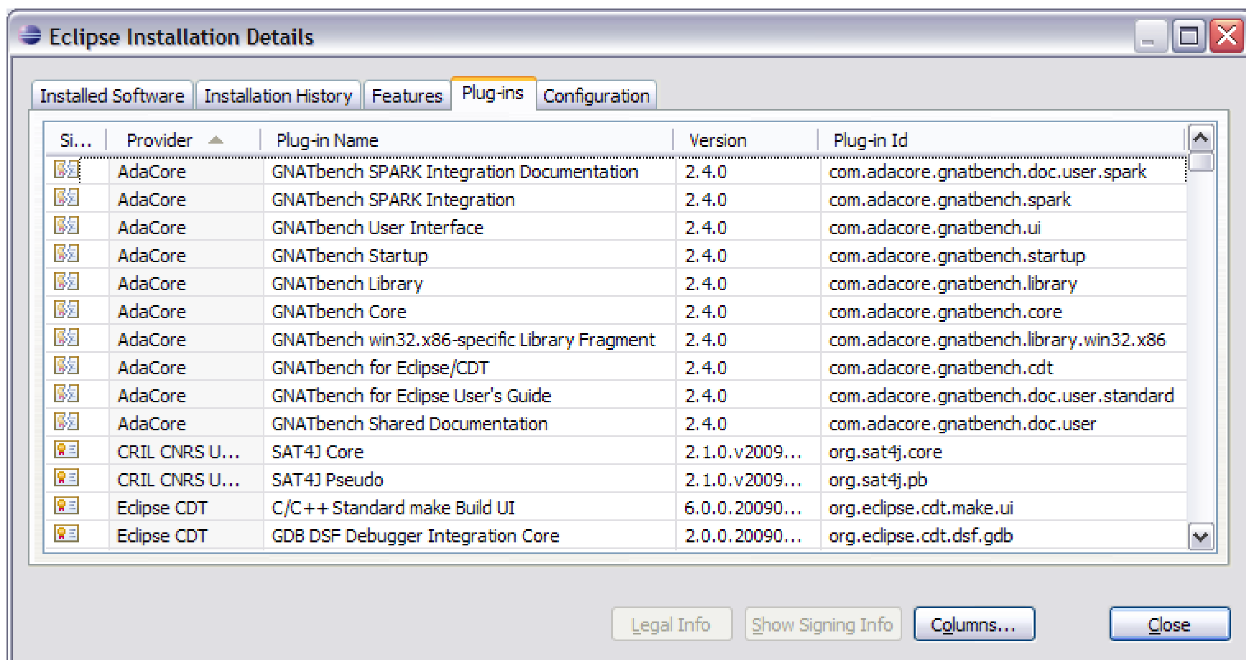
1.4 Before Browsing and Navigating the Code

You need to compile the code for full functionality, such as Ada editor hyper-links, to be available. Only partial support will be available until that occurs. Please see the 'Crucial Setup Requirement' section in the 'Browsing and Navigation' chapter of the GNATbench User Guide for details.

1.5 Verifying Correct GNATbench Installation

To verify that GNATbench has been installed into Eclipse, start with the Eclipse Help menu. First, select Help and then "About Eclipse" at the bottom of the selections. Then press the "Installation Details" button at the lower left of the resulting dialog box. Another pop-up dialog box will appear, with tabbed pages showing the installed software, features, plug-ins, installation history, and configuration. Click on the "Plug-ins" tab to show all the installed plug-ins. You should see a number of plug-ins with "AdaCore" shown in the Provider column. (Click on the Provider column header to sort by provider names.) If you see the AdaCore plug-ins, installation is likely fine. If not, installation has not occurred or did not complete successfully.

The list of plug-ins will look something (but not exactly) like the figure below.



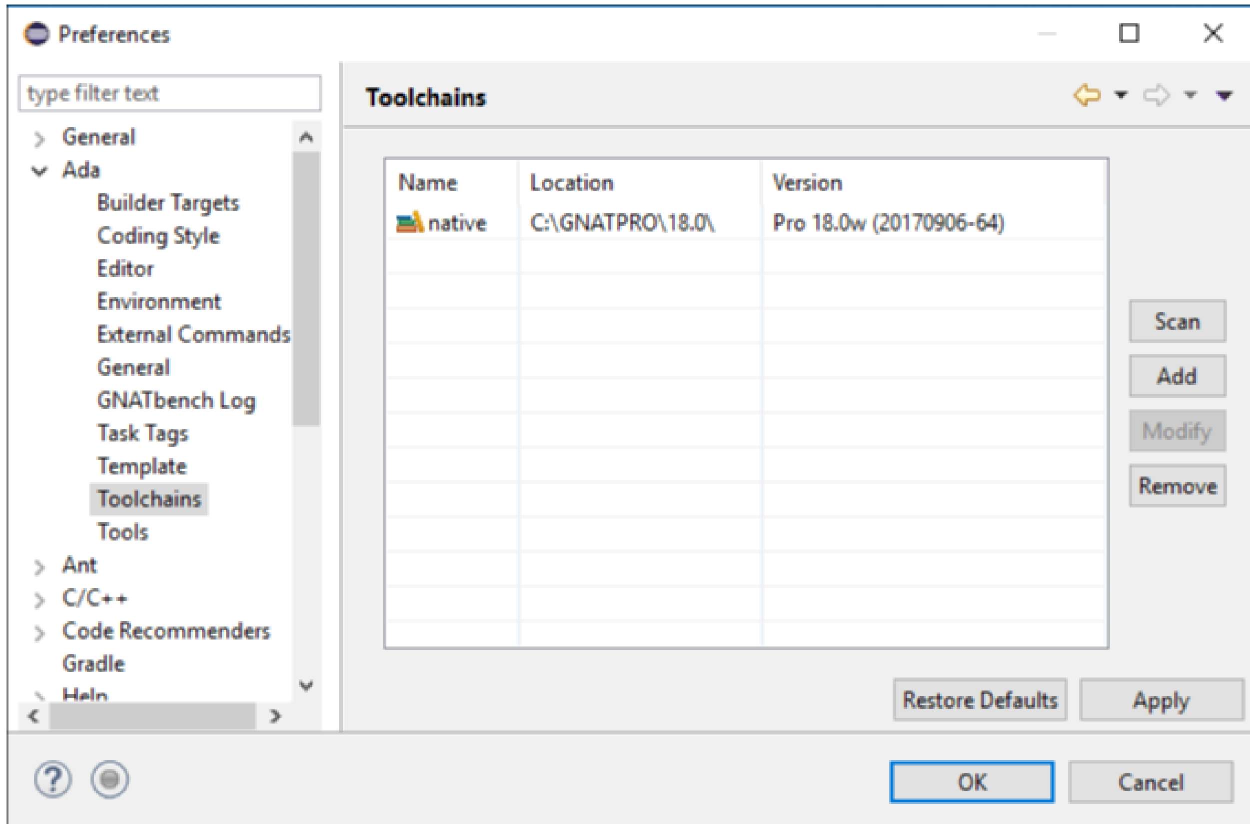
Finally, verify that GNATbench is ready to use installed GNAT compilers.

At least one GNAT compiler should be installed to use GNATbench. Please note that no GNAT compiler is installed during GNATbench installation.

If a GNAT compiler was previously installed, check that any required changes to environment during GNAT installation have been done. As an example of such changes, the GNAT tools path should be added to the PATH environment

variable. Otherwise, a GNAT compiler installation is requested and any required changes to environment variables must be performed. When a new compiler is installed, a workbench restart may be required to use the latest environment.

Successfully detected compilers are displayed in the /Ada/Toolchains preferences page accessible from the /Window/Preferences menu by selecting the Ada entry and then Toolchains.



If no toolchains are displayed, click on "Scan" button to start a toolchain scan.

1.6 Introduction

GNATbench supports sophisticated Ada-aware editing and browsing, code generation using GNAT, and Ada-aware debugging.

1.7 Intended Audience

This User's Guide is intended for Ada software developers using the GNAT Ada tools to develop applications within Eclipse.

1.8 Scope

This User's Guide describes how to use the GNATbench Ada plug-in for Eclipse. Specific help is provided for configuring projects, building systems, and debugging; please see the corresponding sections for details.

For help with the GNAT compiler and associated tools themselves, see the GNAT documentation corresponding to the specific compiler used.

1.9 For Additional Information and Help

Additional help and information is available online from AdaCore via the GNAT Tracker web interface.

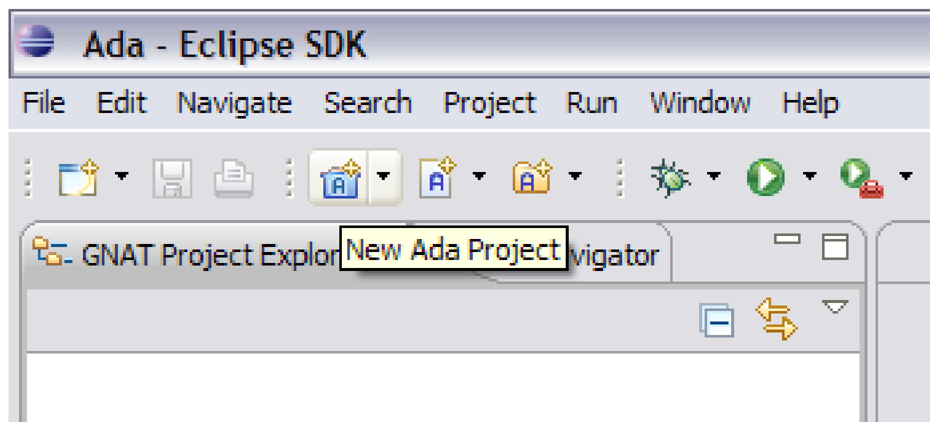
1.10 Creating and Building A Basic Native Project

In this tutorial we will create and build a fully executable simple "Hello World" project.

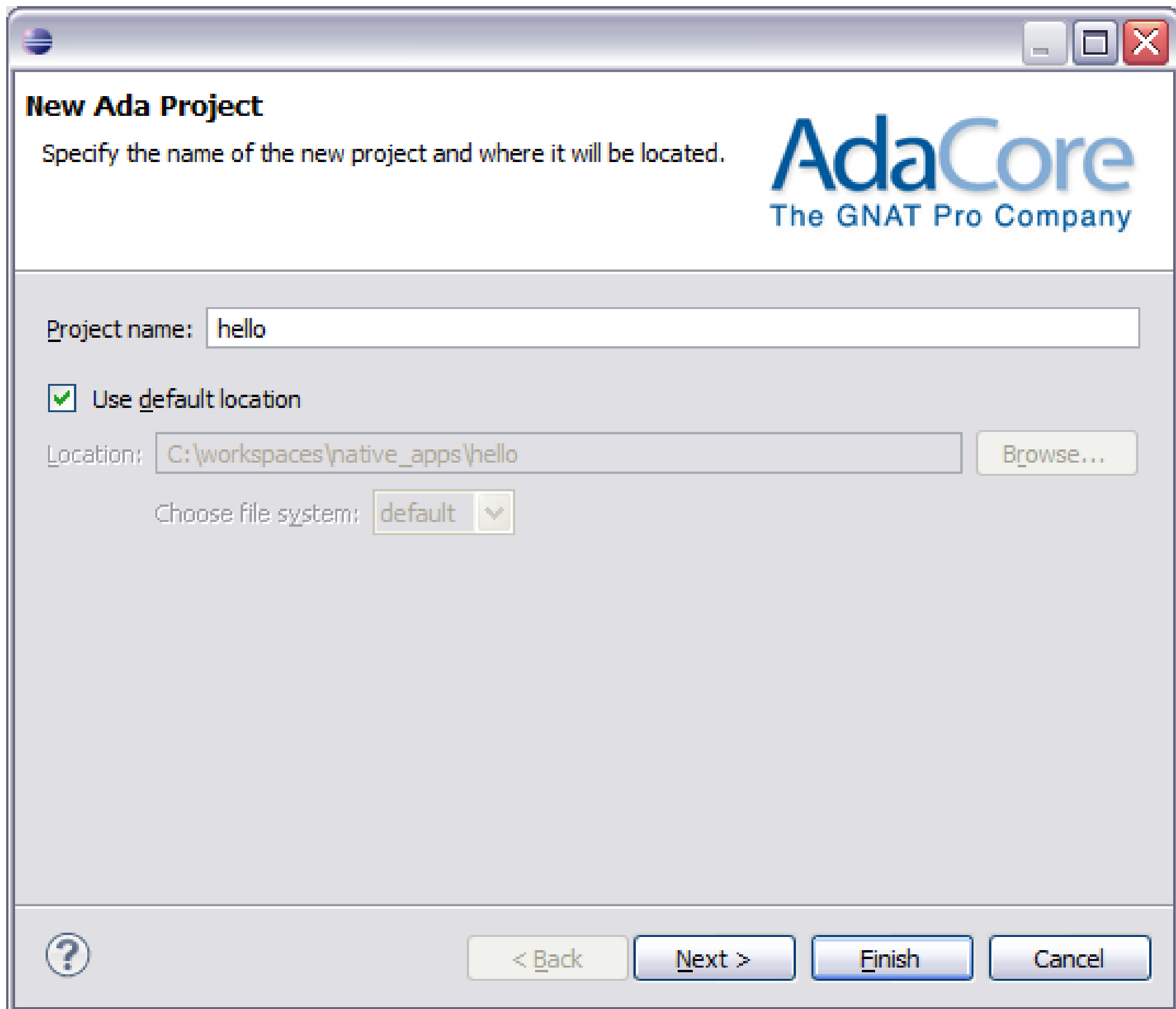
Creating a new project for Ada development is easy with GNATbench. The wizard will create and configure the project for us, and invoking the builder is simply a matter of selecting a command.

1.10.1 Creating and Configuring the Project

The first step is to invoke the wizard to create a new Ada project. Using the Ada toolbar addition, click on the "New Ada Project" icon, as shown in the following figure:

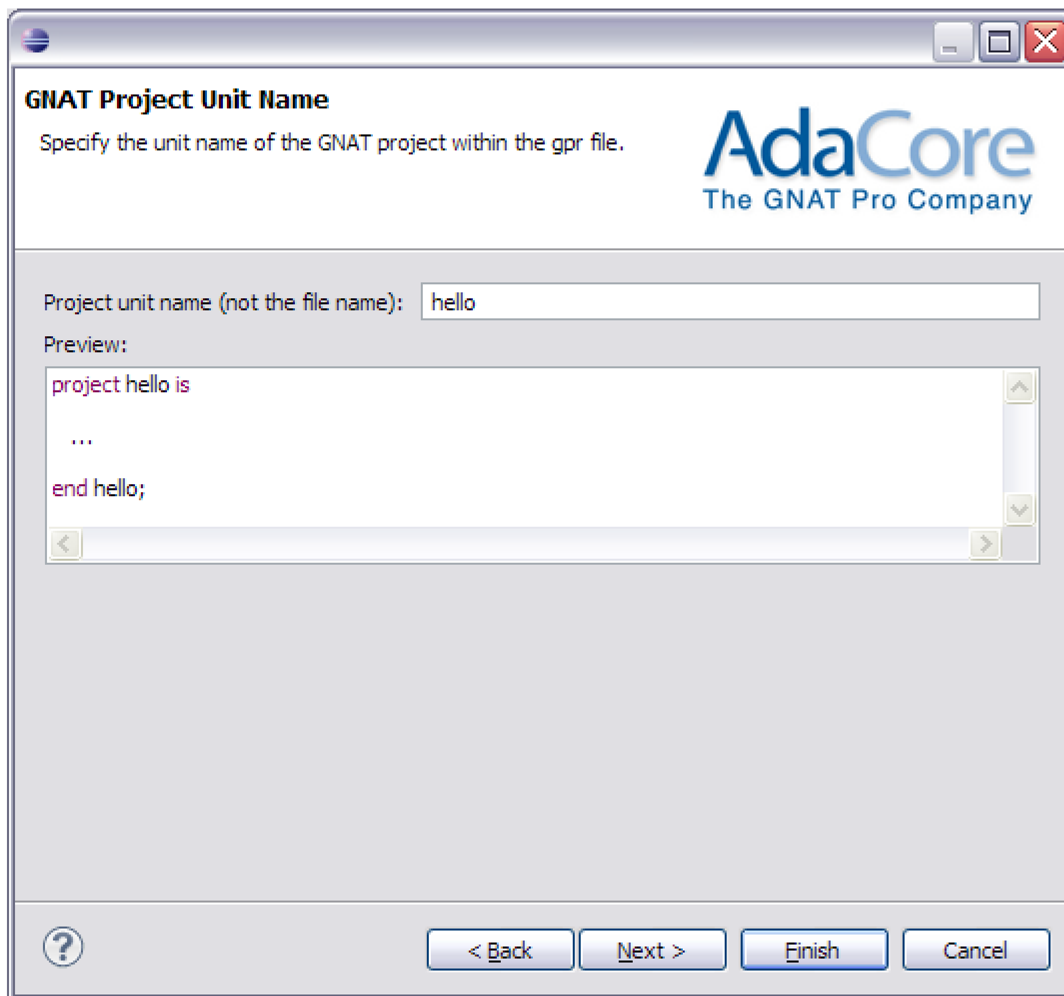


The first page of the new-project wizard (shown in the next figure) will appear. Enter the name of the new project. We have named this one "hello". We have the option of locating the new project in the default workspace or elsewhere in the file system. We'll take the default. Press Next.

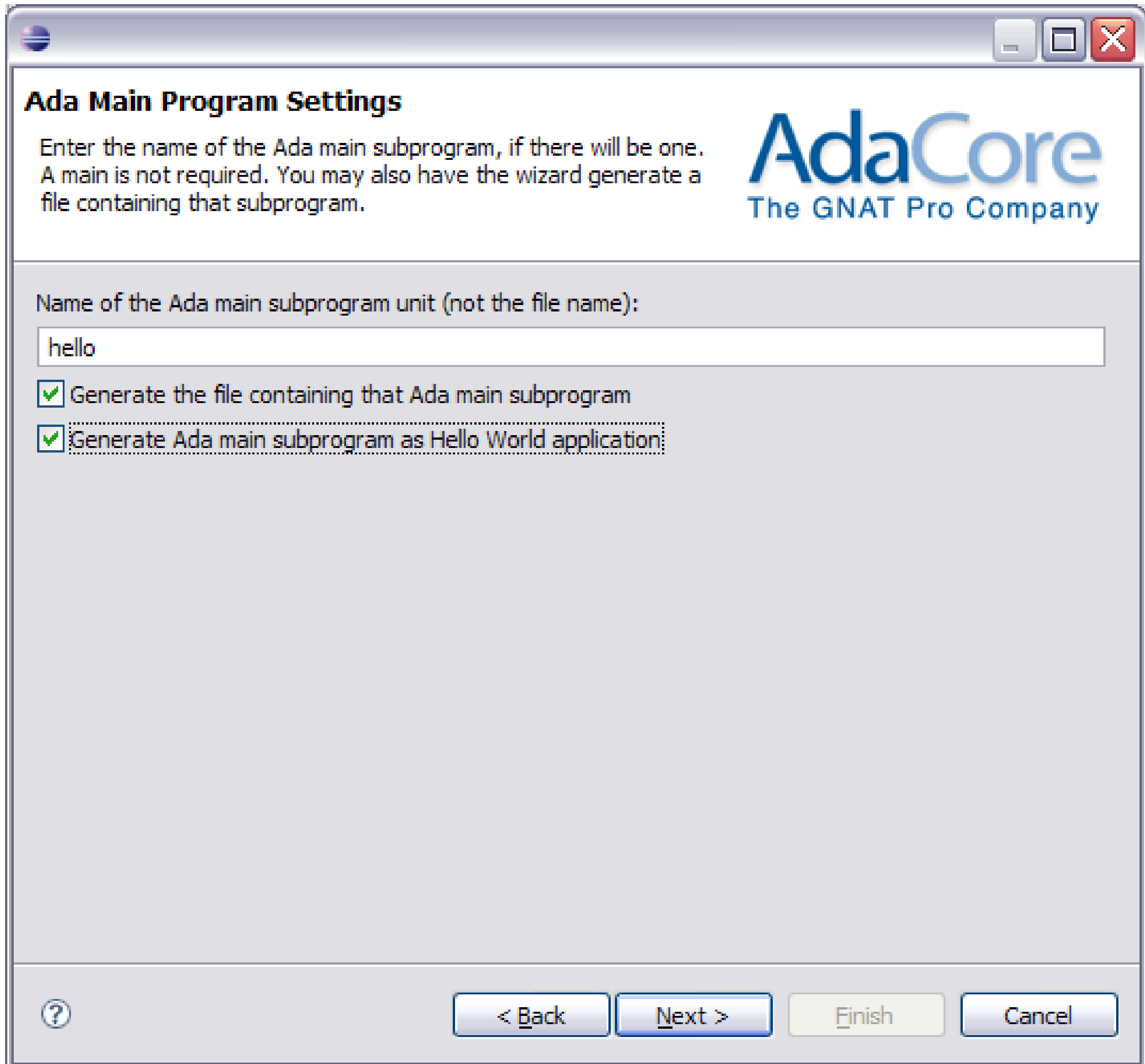


The next page asks us to specify the *unit* name of the GNAT project (not the file name), that is, the name within the gpr file.

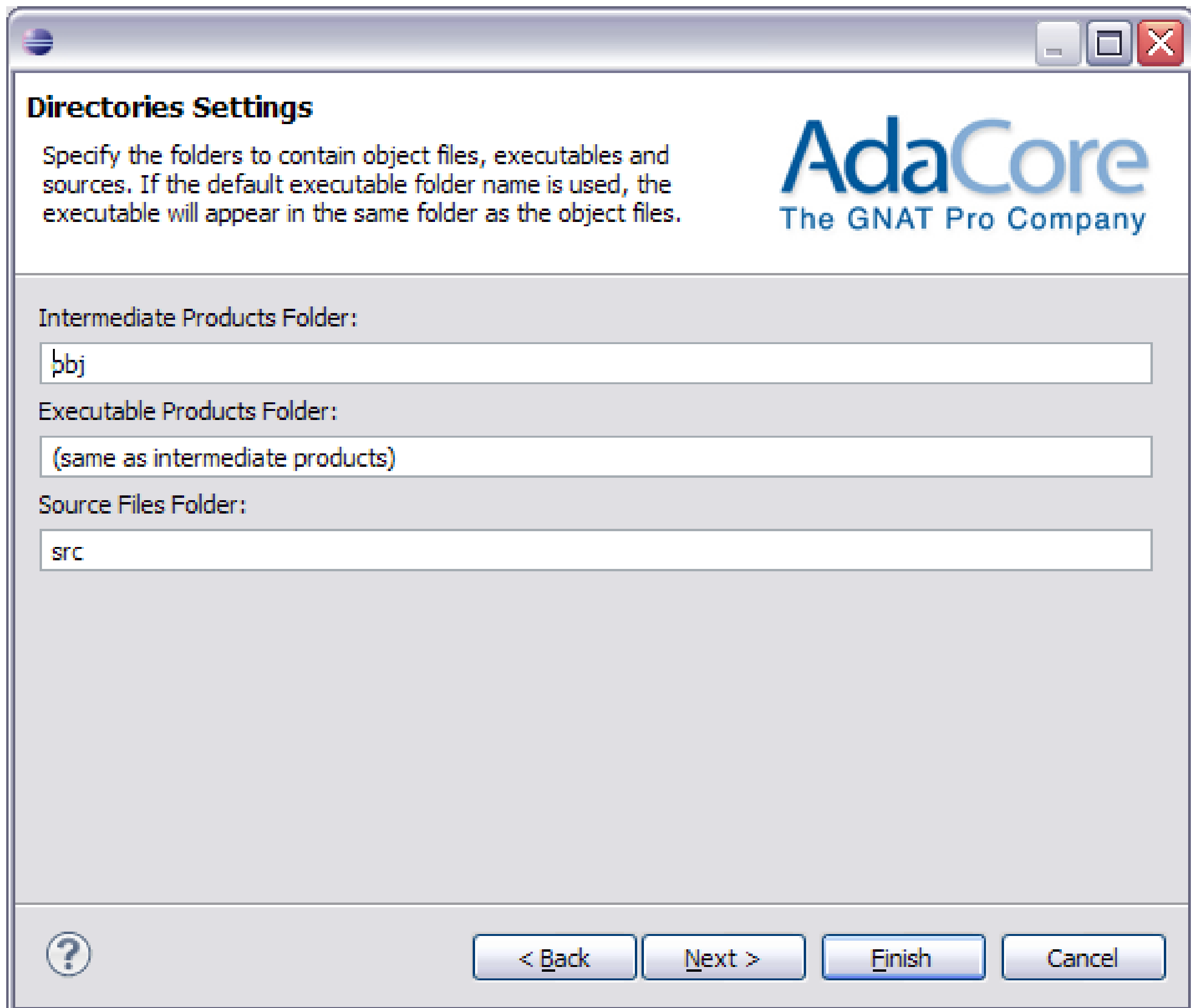
Unlike the Eclipse project name, the GNAT project unit name must be a legal Ada identifier. The wizard will try to make a legal Ada name from the Eclipse project name, for example, by substituting underscores for dashes. If the Eclipse project name is already a legal Ada identifier that name is used unchanged, as in this case:



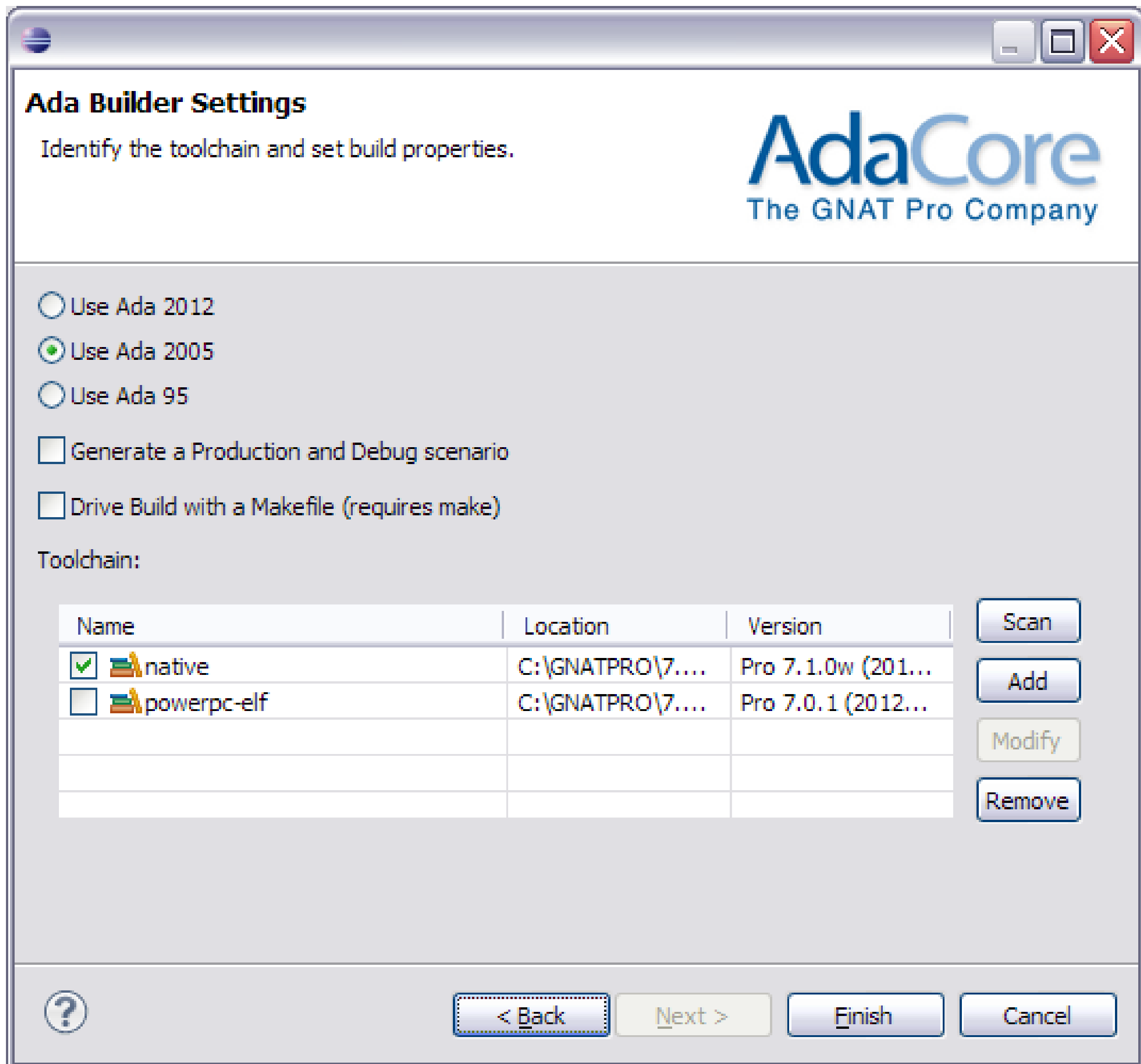
In the next page we enter the name of the Ada main subprogram – *not the file name* – and have the wizard generate the file containing that unit. We arbitrarily name the unit "hello" and have it generated as a program that prints "Hello World!" when executed.



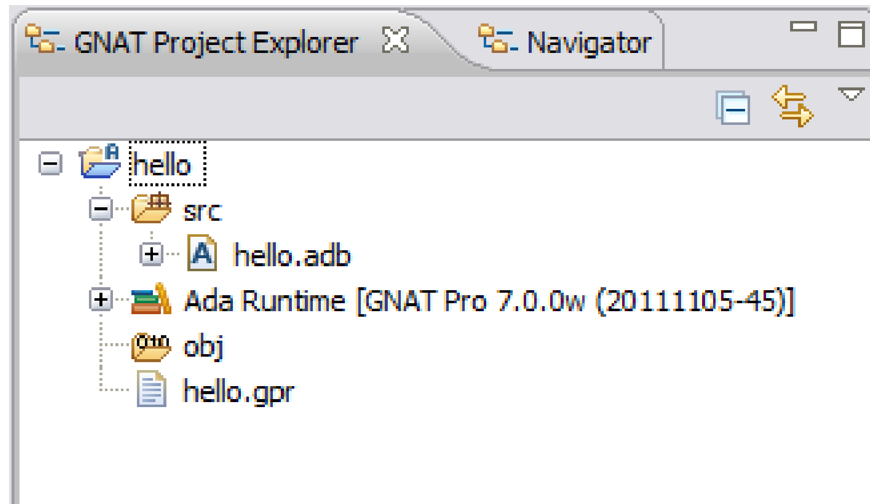
On the next page we then choose the locations for our source files and object files. The defaults, as shown below, will have all source files in the "src" folder, all object and "ali" files in the "obj" folder, and the executable also in the "obj" folder.



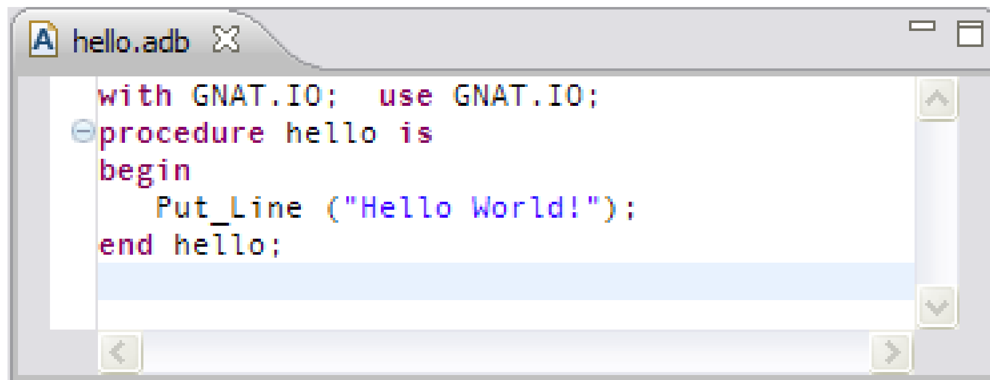
On the next page we choose the specific toolchain. The default native compiler is already selected, as shown below.



Press Finish. The new project will be created and you will see it in the GNAT Project Explorer, as in the following image. Note that we have expanded the "src" directory to show the source file within.



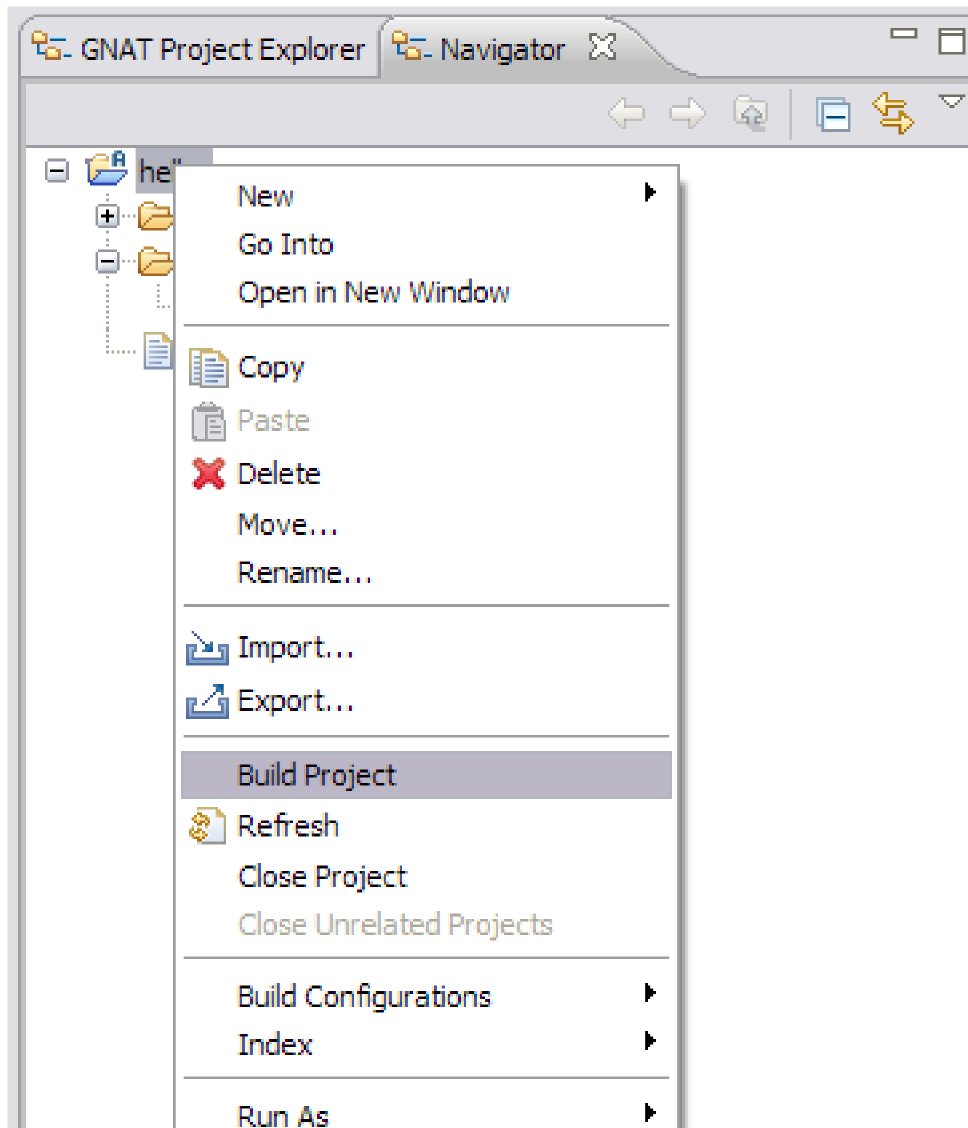
The source file contains the main subprogram. This file will have the name we specified, "hello.adb", and will contain a procedure with that unit name:



In a real application we would alter the content of the main subprogram. It is a buildable subprogram, though, without any changes, so for the purpose of this tutorial we can leave it as it is.

1.10.2 Building the Project

Now that the setup has completed we are ready to do the full build. In the GNAT Project Explorer, right-click on the project node and select "Build Project".



A successful build will appear in the Console view:

Problems Console Metrics

Messages [hello]

```
Build [hello]
gnatmake -d -PC:\runtime-GNATbench\hello\hello.gpr
gcc -c -g -g -gnato -gnatwa -gnatQ -gnat05 -I- -gnatA C:\runtime-GNATbench\hello\src\hello.adb
gnatbind -I- -x C:\runtime-GNATbench\hello\obj\hello.ali
gnatlink C:\runtime-GNATbench\hello\obj\hello.ali -g -o C:\runtime-GNATbench\hello\obj\hello.exe
Build for [hello] completed Oct 11, 2012 6:34:40 PM CDT.
```

1.10.3 Congratulations!

That's it! You have created and built a project using GNATbench for Eclipse.

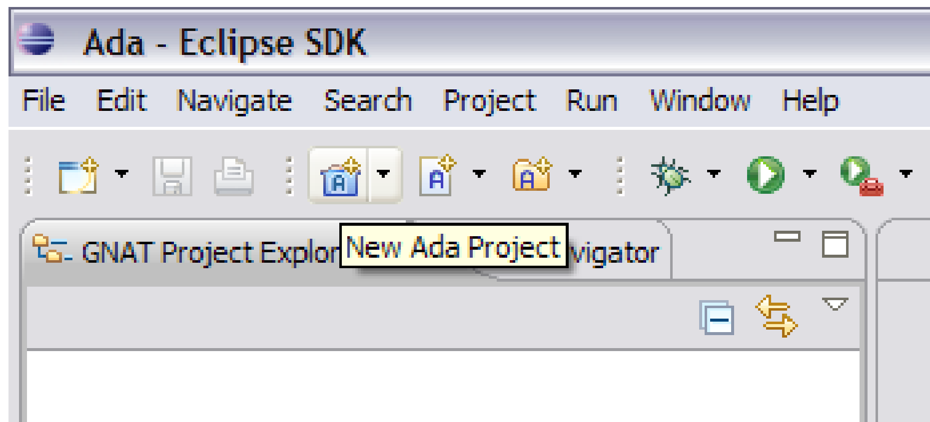
1.11 Creating and Building An Embedded Computer Project

In this tutorial we will create and build a fully executable (simple) project. We have chosen to create a project for an embedded computer because it highlights some of the additional capabilities provided by GNATbench; the process is almost exactly the same for creating executables for native execution on the host computer.

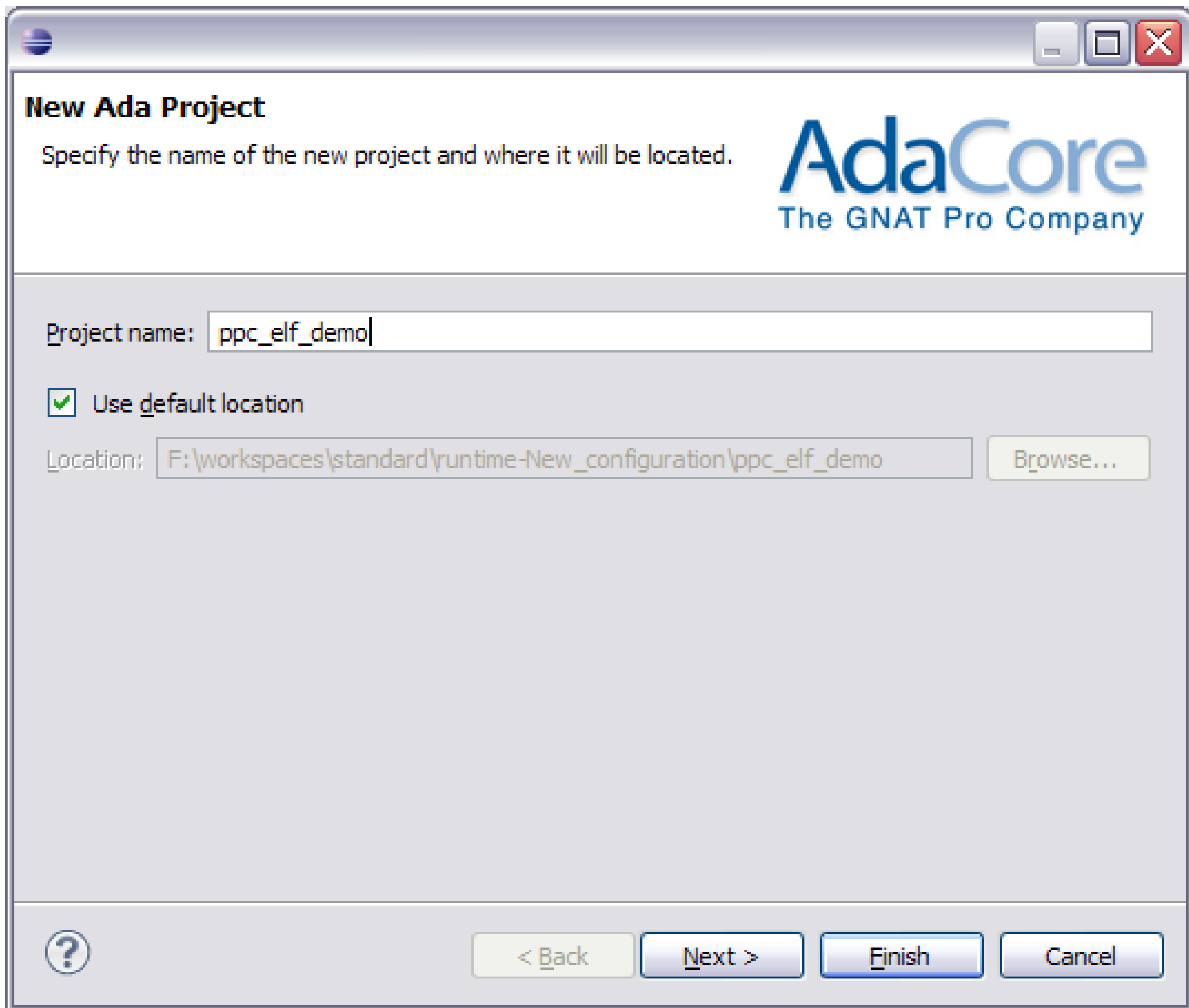
Creating a new project for Ada development is easy with GNATbench. The wizard will create and configure the project for us, and invoking the builder is simply a matter of selecting a command.

1.11.1 Creating and Configuring the Project

The first step is to invoke the wizard to create a new Ada project. Using the Ada toolbar addition, click on the "New Ada Project" icon, as shown in the following figure:

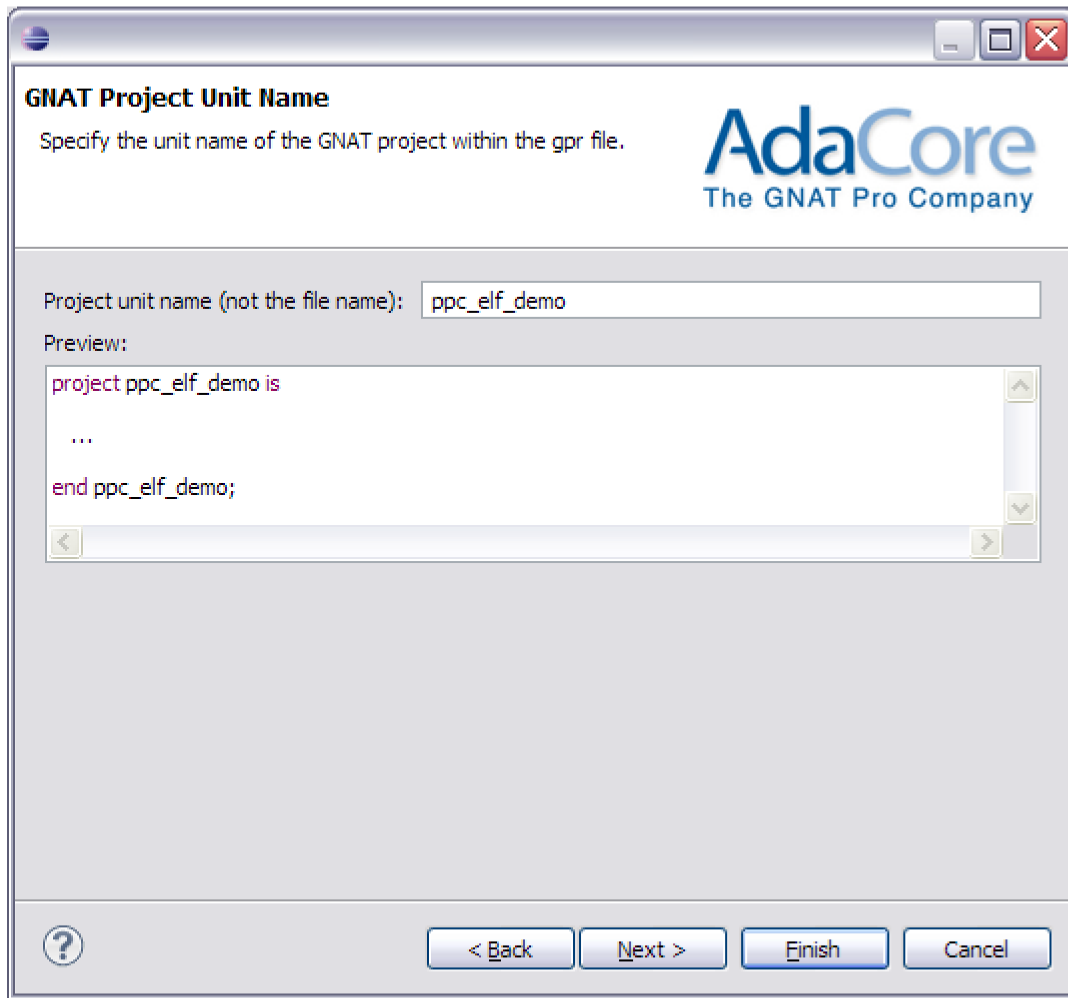


The first page of the new-project wizard (shown in the next figure) will appear. Enter the name of the new project. We have named this one "ppc_elf_demo". We have the option of locating the new project in the default workspace or elsewhere in the file system. We'll take the default. Press Next.

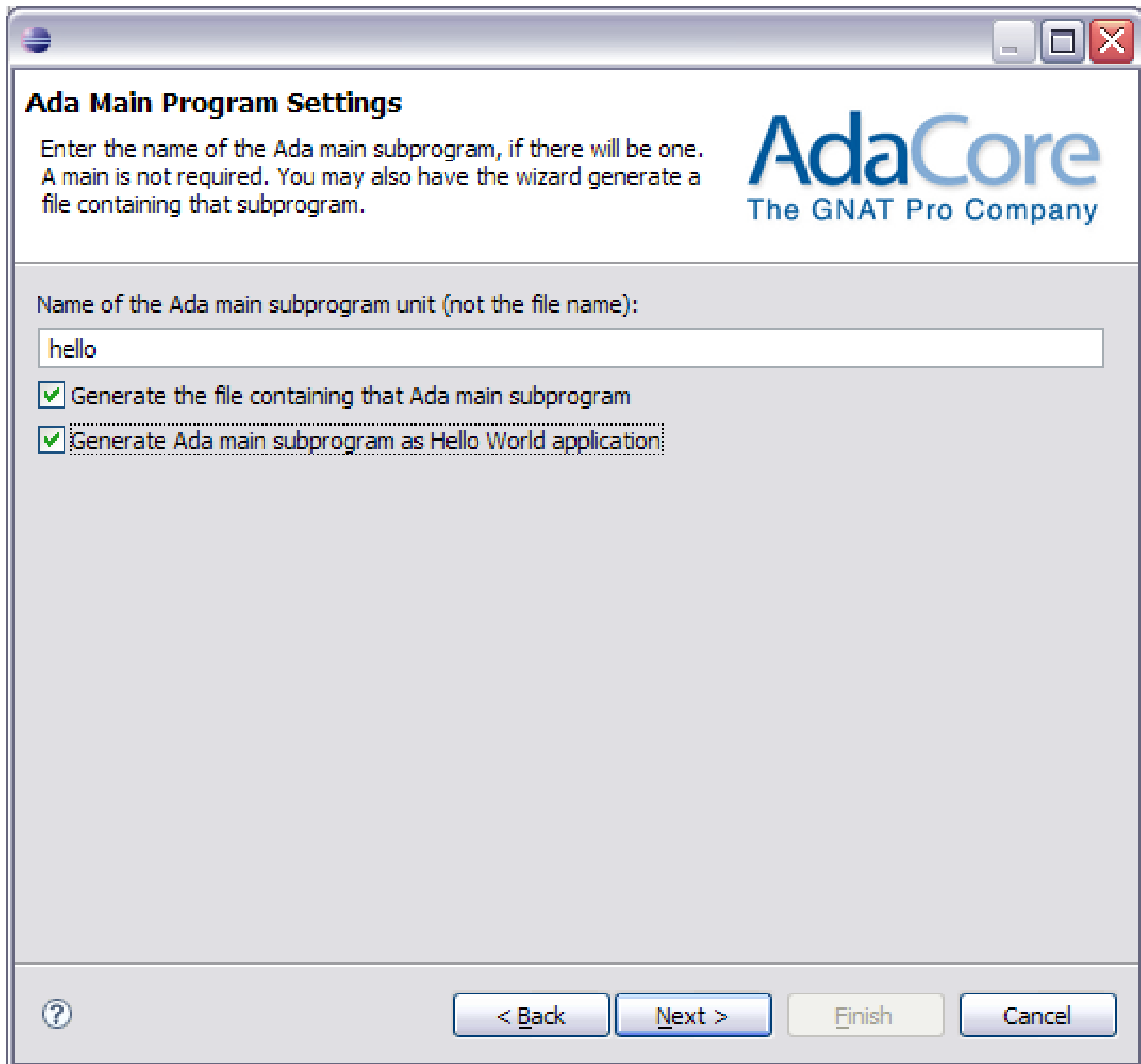


The next page asks us to specify the *unit* name of the GNAT project (not the file name), that is, the name within the gpr file.

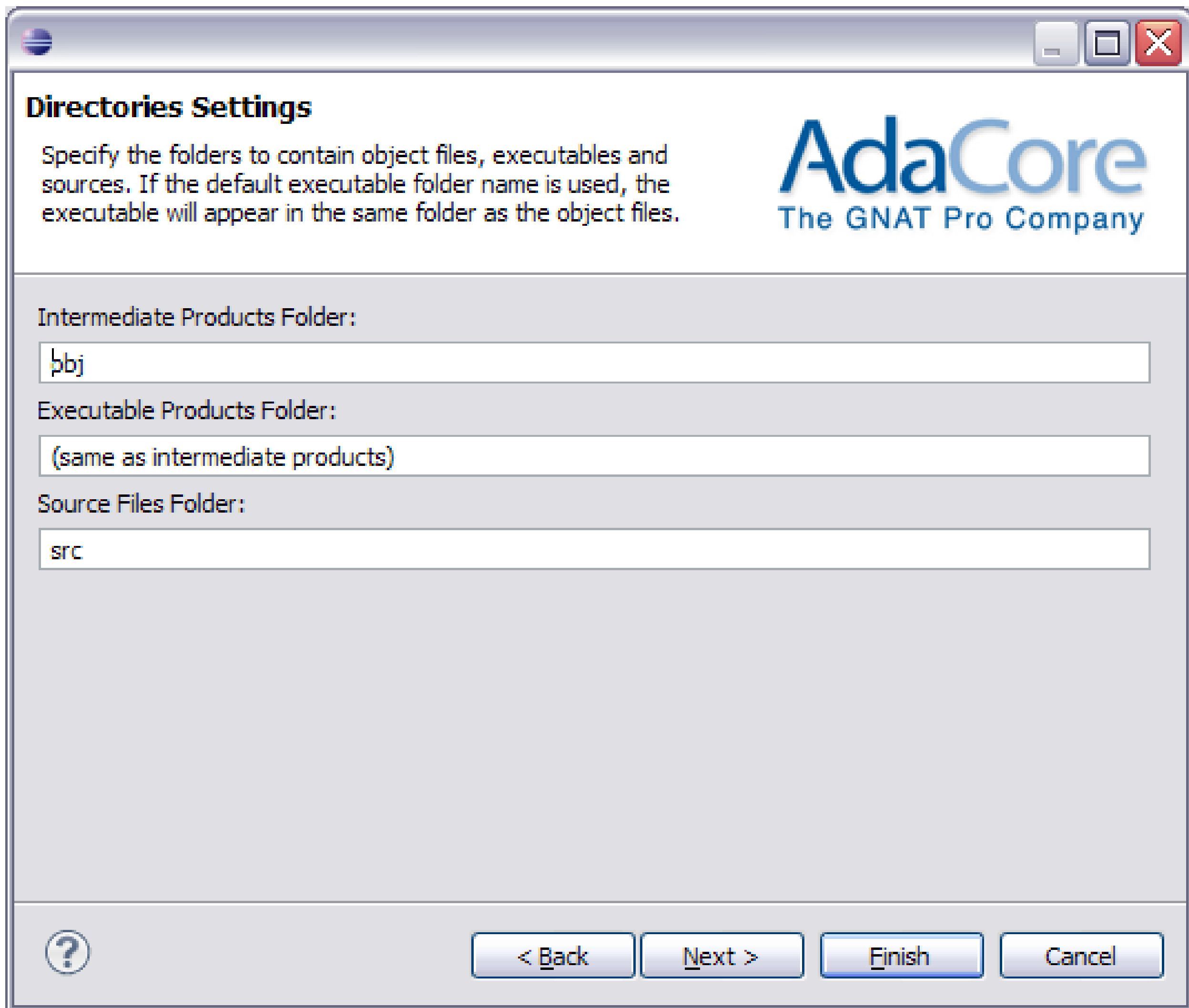
Unlike the Eclipse project name, the GNAT project unit name must be a legal Ada identifier. The wizard will try to make a legal Ada name from the Eclipse project name, by substituting underscores for dashes for example. If the Eclipse project name is already a legal Ada identifier that name is used unchanged, as in this case:



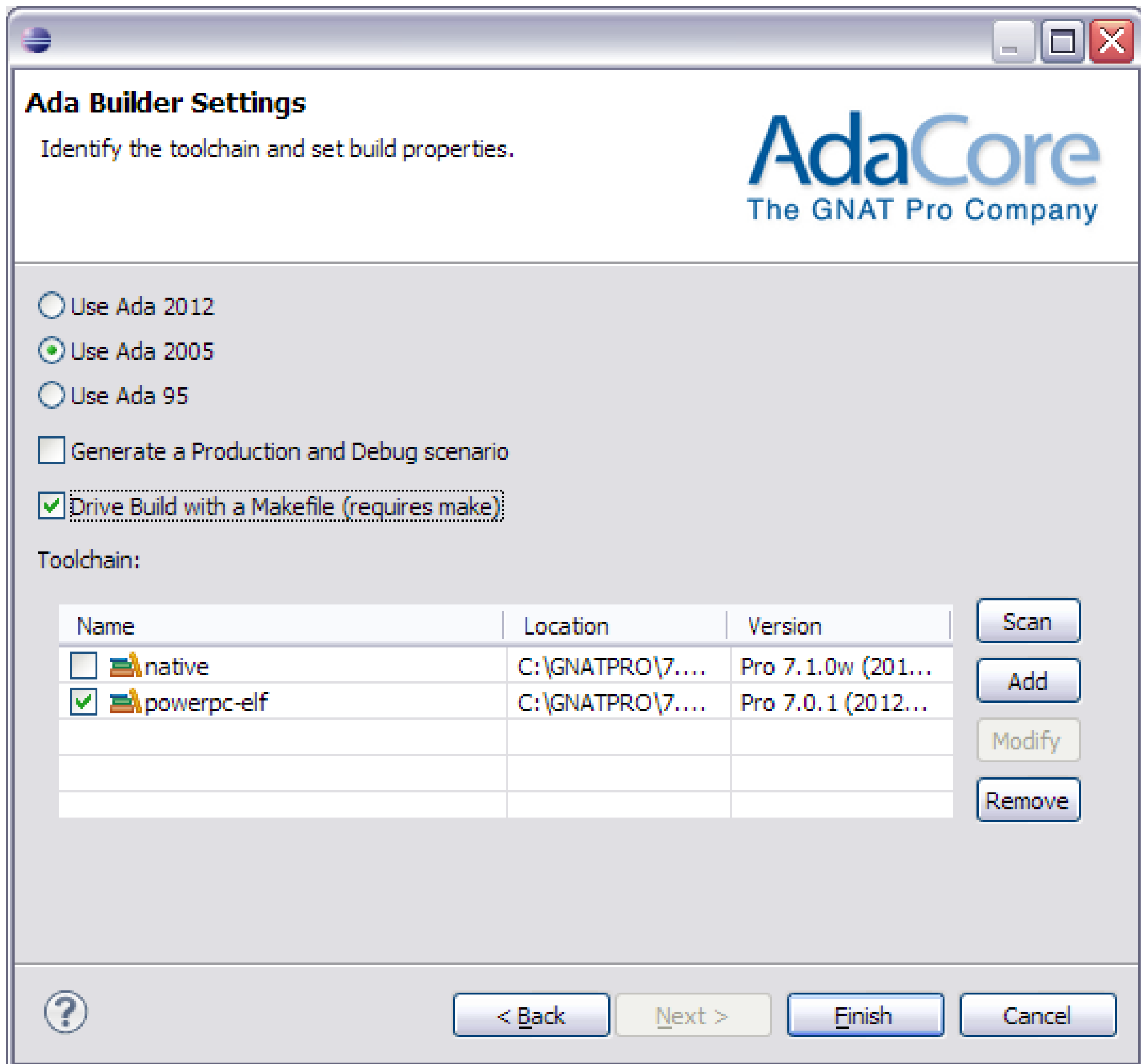
In the next page we enter the name of the Ada main subprogram – *not the file name* – and have the wizard generate the file containing that unit. We arbitrarily name the unit "hello" and have it generated as a program that prints "Hello World!" when executed.



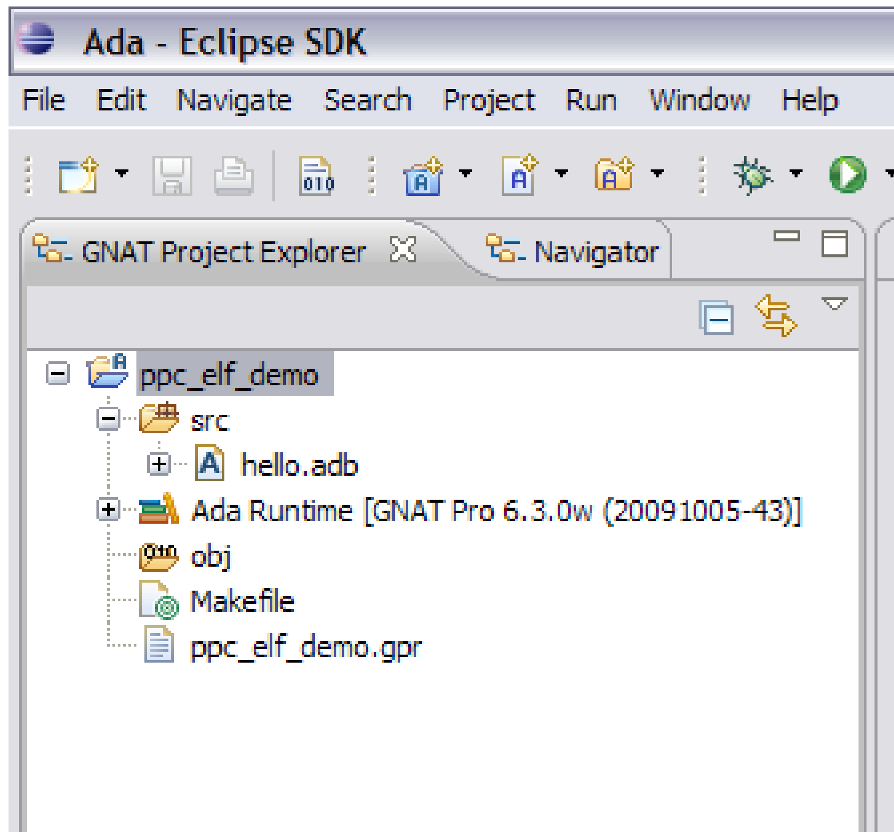
On the next page we then choose the locations for our source files and object files. The defaults, as shown below, will have all source files in the "src" folder, all object and "ali" files in the "obj" folder, and the executable also in the "obj" folder.



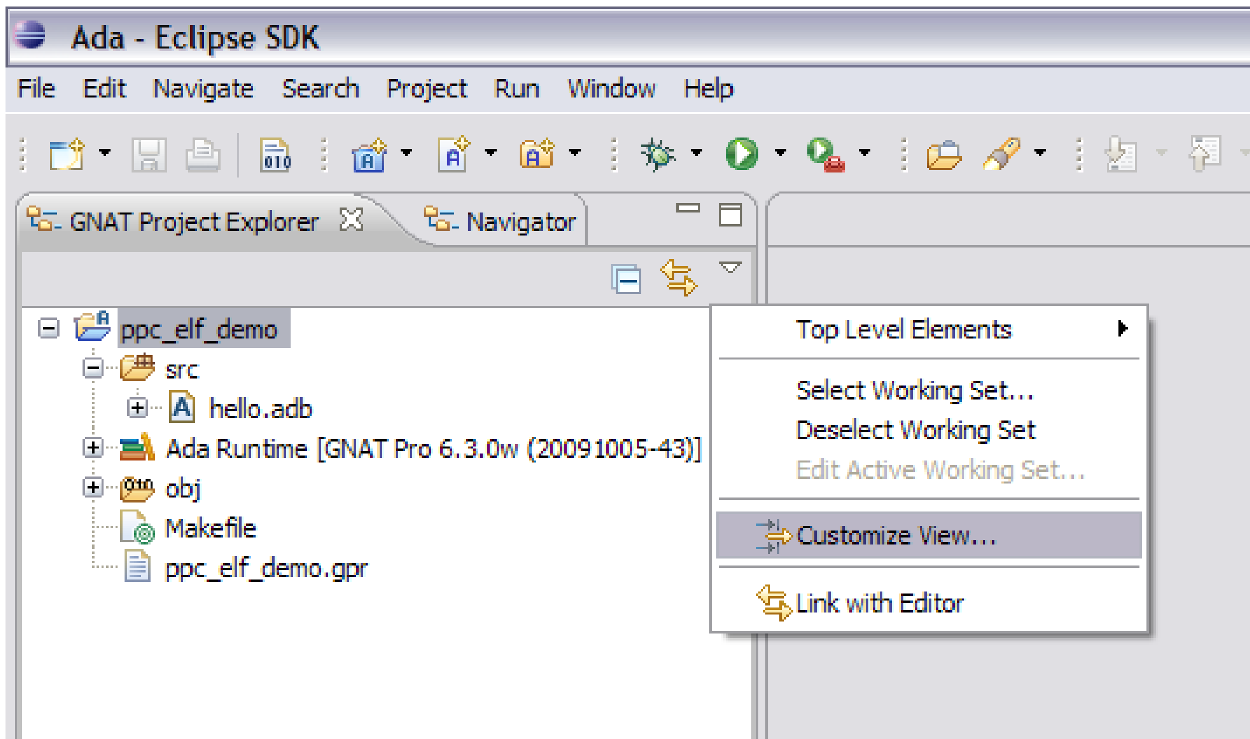
On the next page we choose the specific toolchain. We also enable the use of "make" to build the project. This usage is strictly optional – gprbuild could be used instead – but we want to illustrate makefile use as well in this example. The page with this set of selections is shown below.



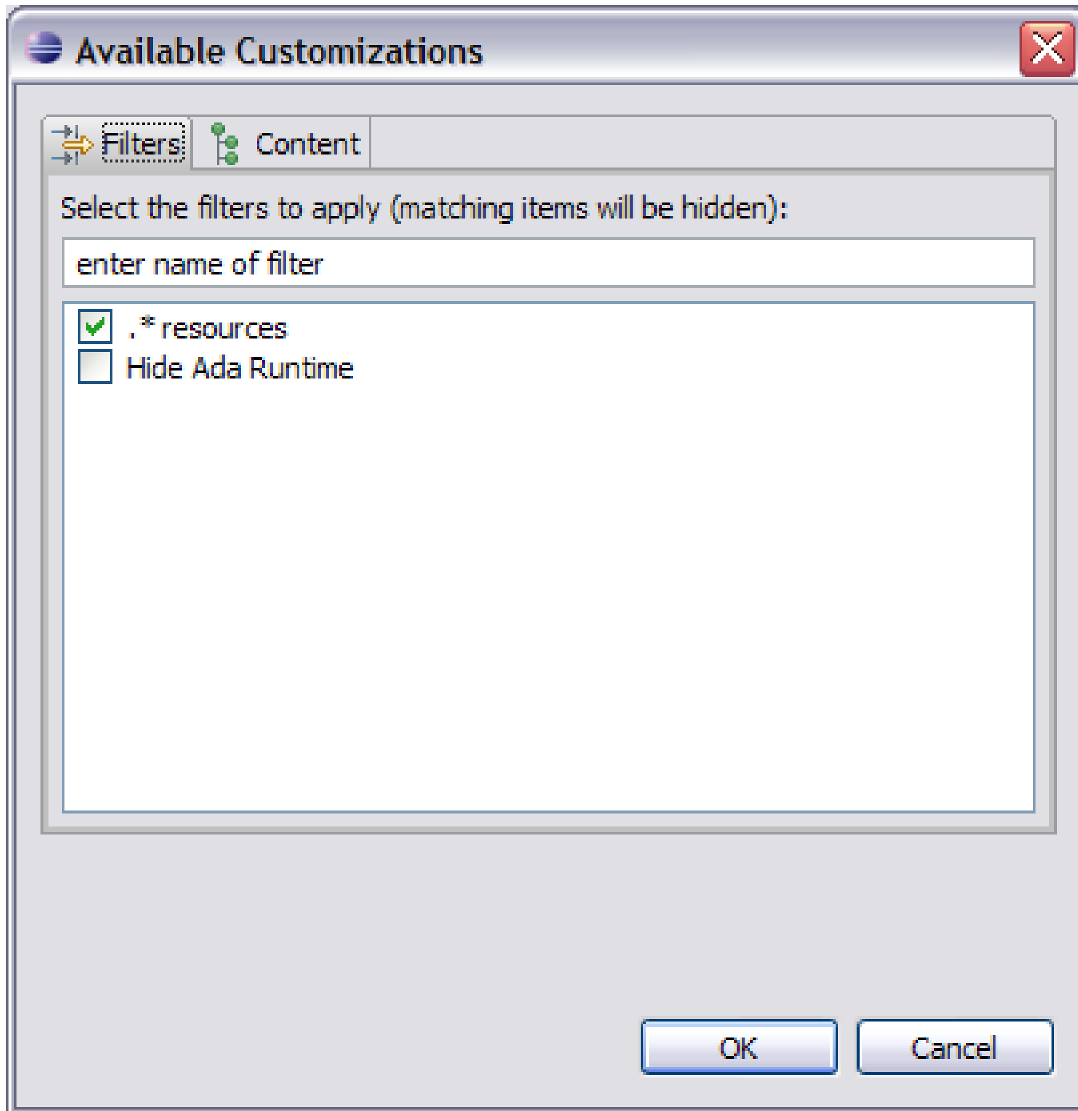
Press Finish. The new project will be created and you will see it in the GNAT Project Explorer, like so:



If you see files with names beginning with a dot, such as ".project", you can hide them by customizing the view. First, select the Customize View menu by clicking on the View Menu icon (the down-pointing arrow head at the far right of the GNAT Project Explorer view):

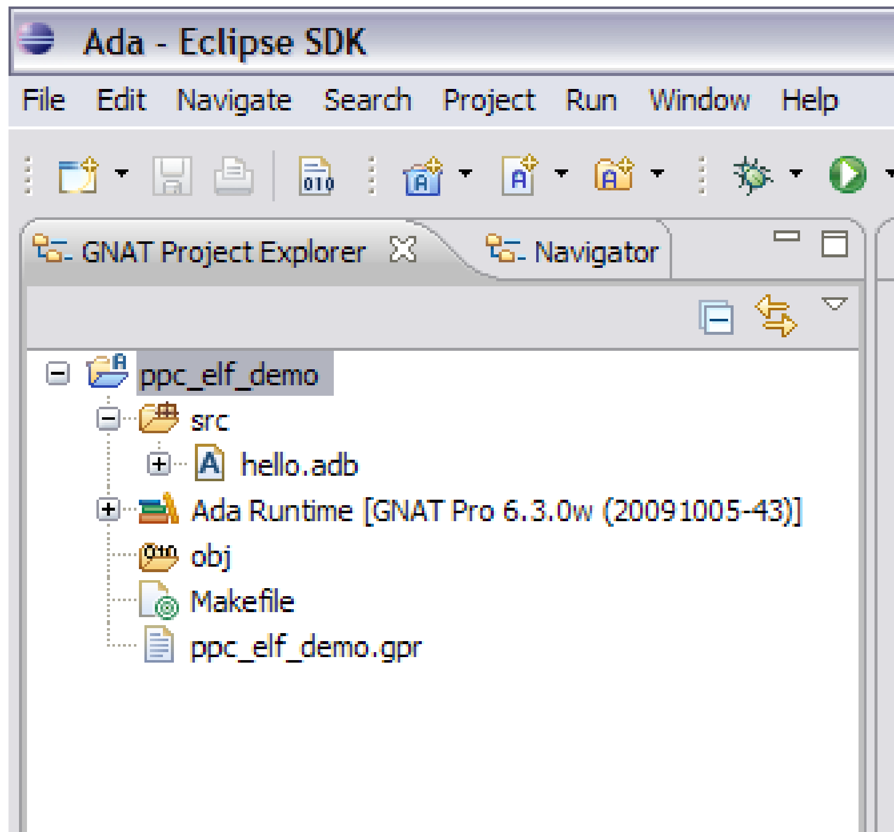


In the Customize View dialog, put a check-mark next to the ".* resources" option to hide all resources with names beginning with a dot, like so:

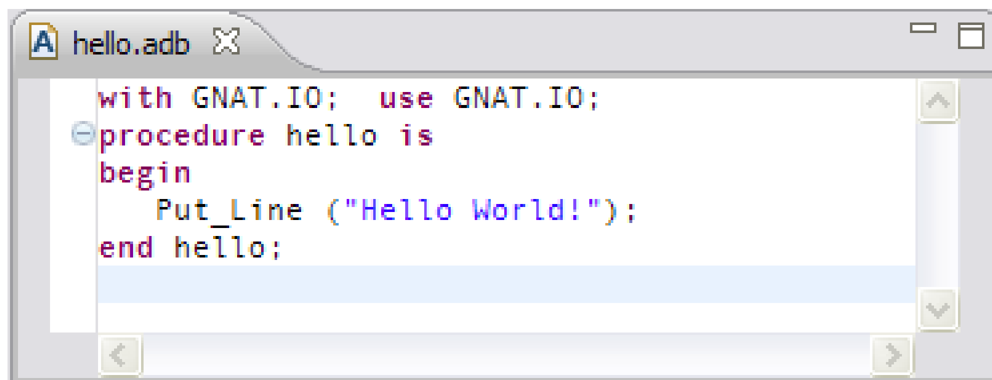


As a result, all files with that naming scheme will be hidden in the view.

In the view of the project (see the figure below), note the presence of the files named "Makefile" and "ppc_elf_demo.gpr". These are the makefile and GNAT project file, respectively. *These files may be edited but they must not be deleted.*



Also note the file containing the main subprogram underneath the source folder (we expanded it to show the file). This file will have the name we specified, "hello.adb", and will contain a procedure with that unit name:

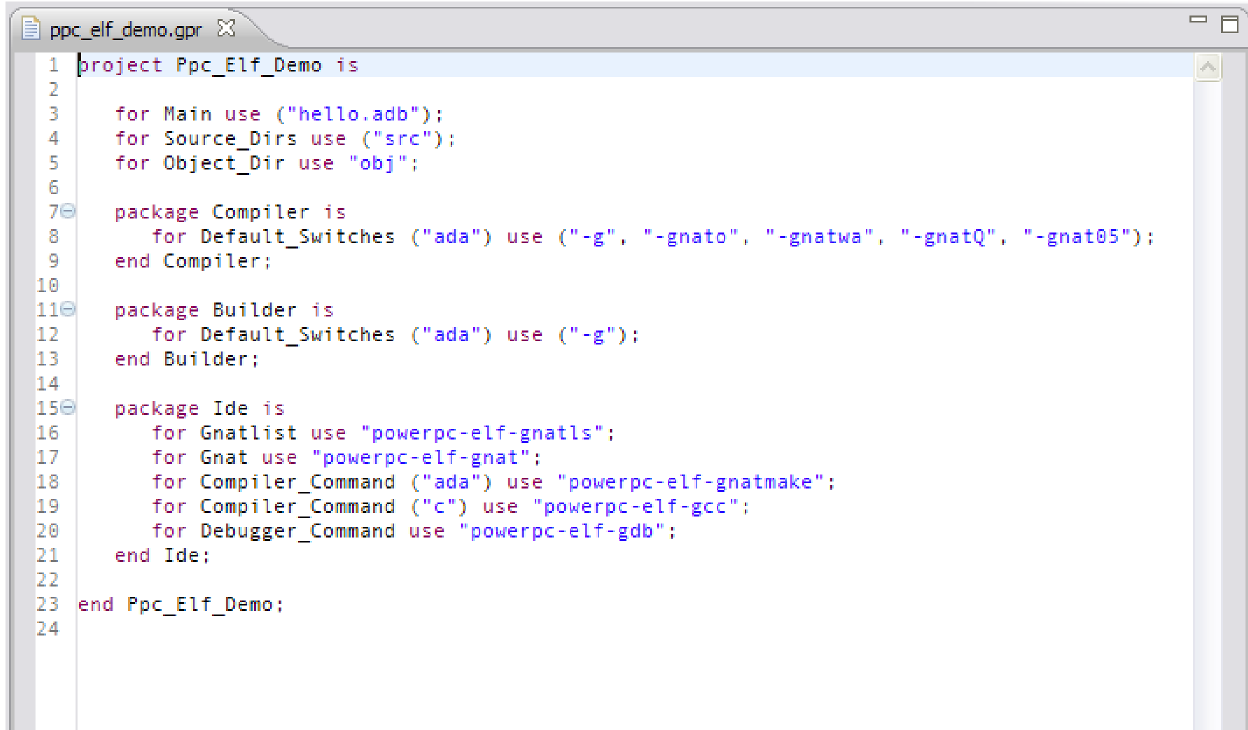


In a real application we would alter the content of the main subprogram. It is a buildable subprogram, though, without any changes, so for the purpose of this tutorial we can leave it as it is.

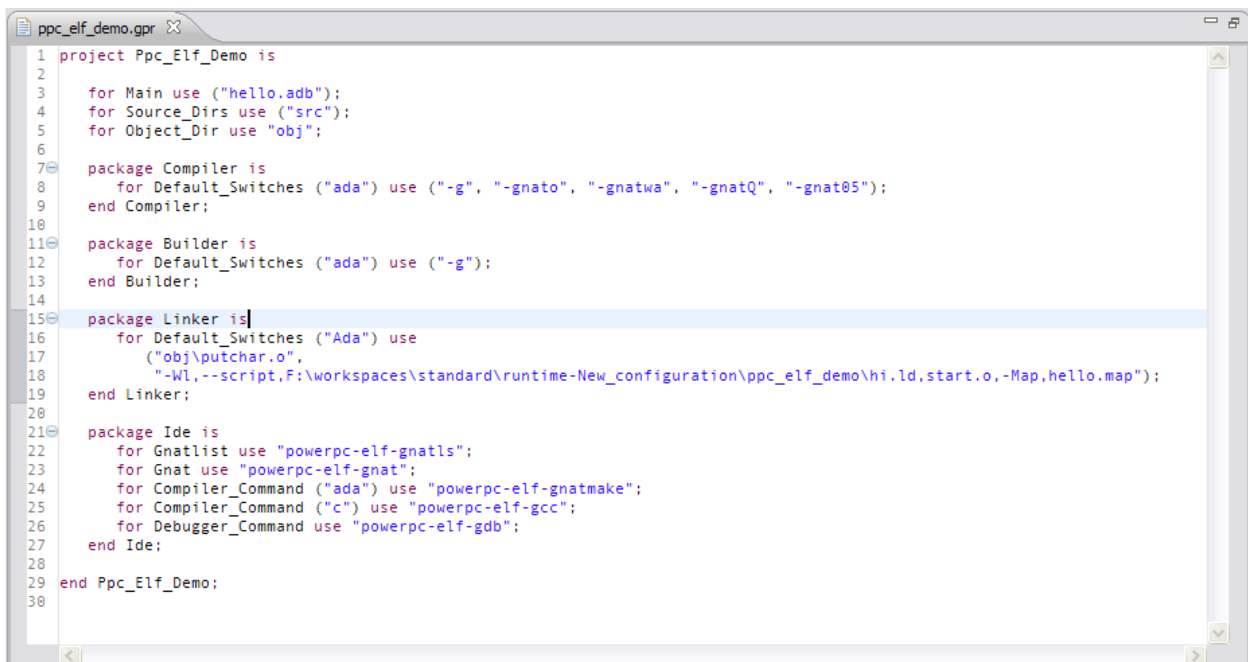
1.11.2 Modifying the GNAT Project File

We need a linker script to link the executable because this is a bare-board application. Hence we must tell the linker how to find this script so we modify the GNAT project file created by the wizard.

The original project file looks like this:



We then add the Linker package for the sake of the script:



We've also added a reference to an object file named "putchar.o" that will be explained momentarily.

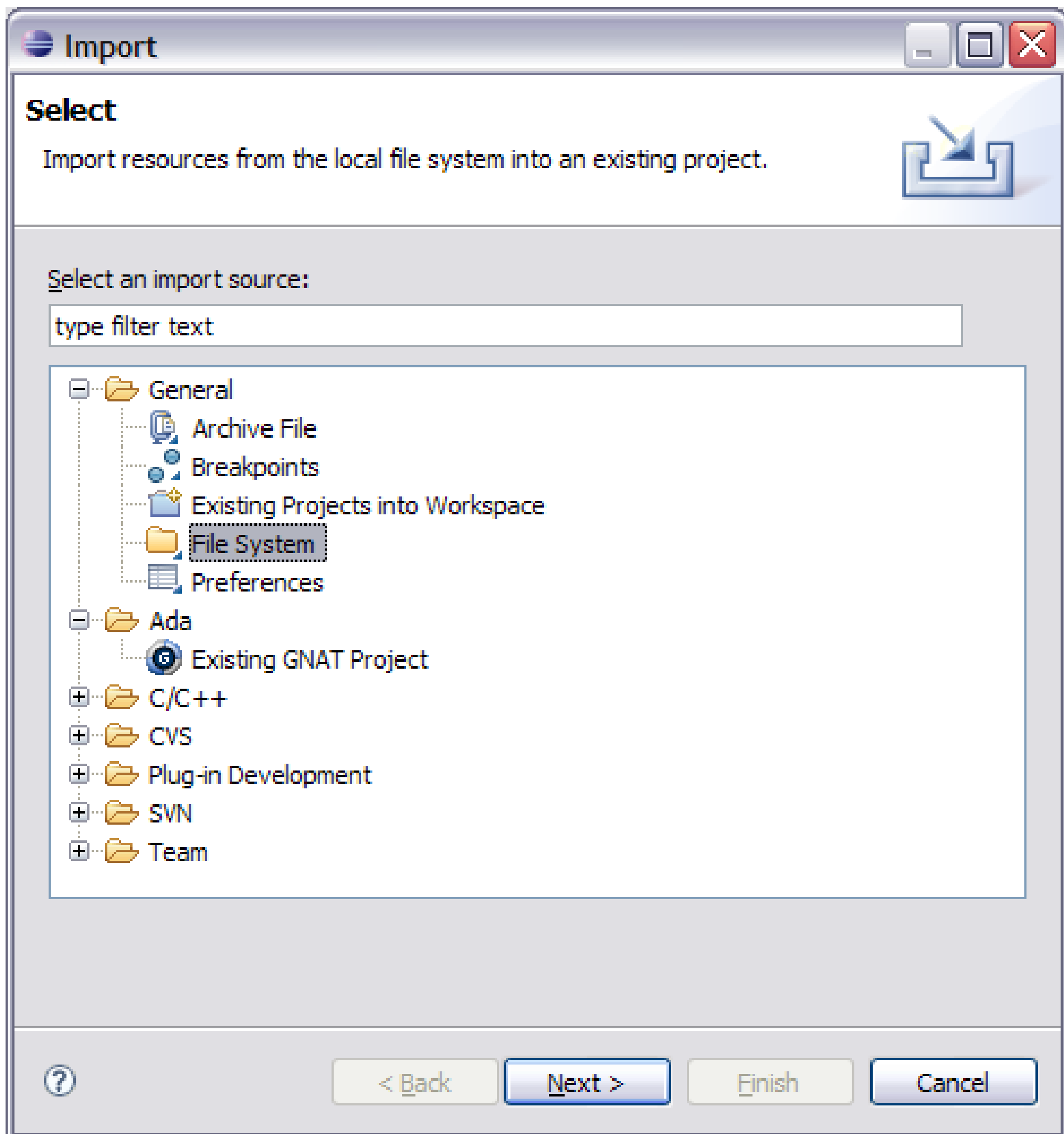
1.11.3 Importing the Script and Sources

We also have to insert this script into the workspace project. We have a stored copy on disk so an easy way to get it into the project is to use the Import… wizard from the Navigator and get the script from the file system.

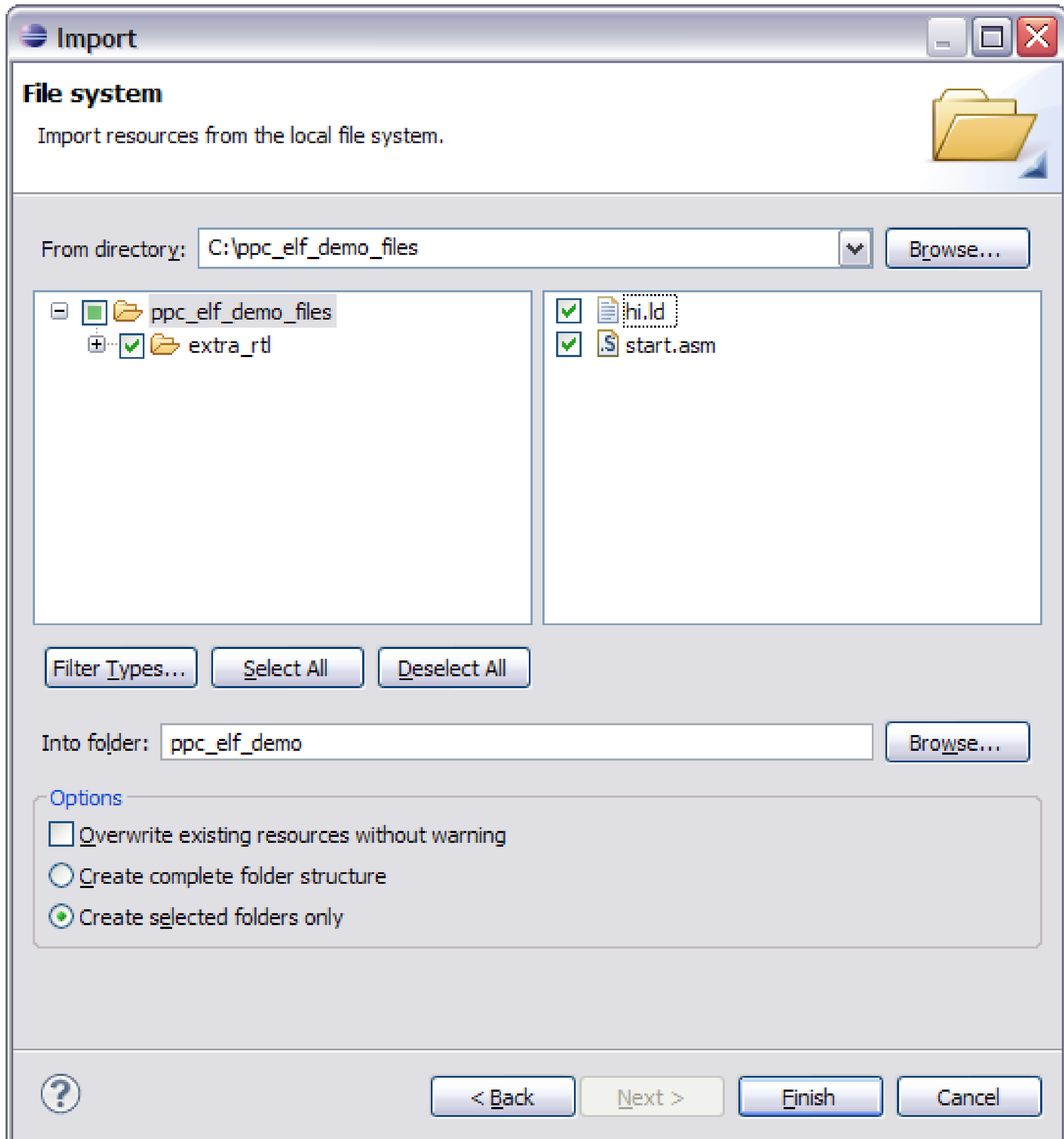
We also need to import an assembly language source file. This assembly source file contains startup code necessary for the application to run on the bare machine.

Similarly, we need the source files for an Ada procedure that defines how to output a character using the hardware on the bare board. That Ada procedure is the "putchar" routine mentioned earlier in the Linker package. The source files are located in the "extra_rtl" subdirectory.

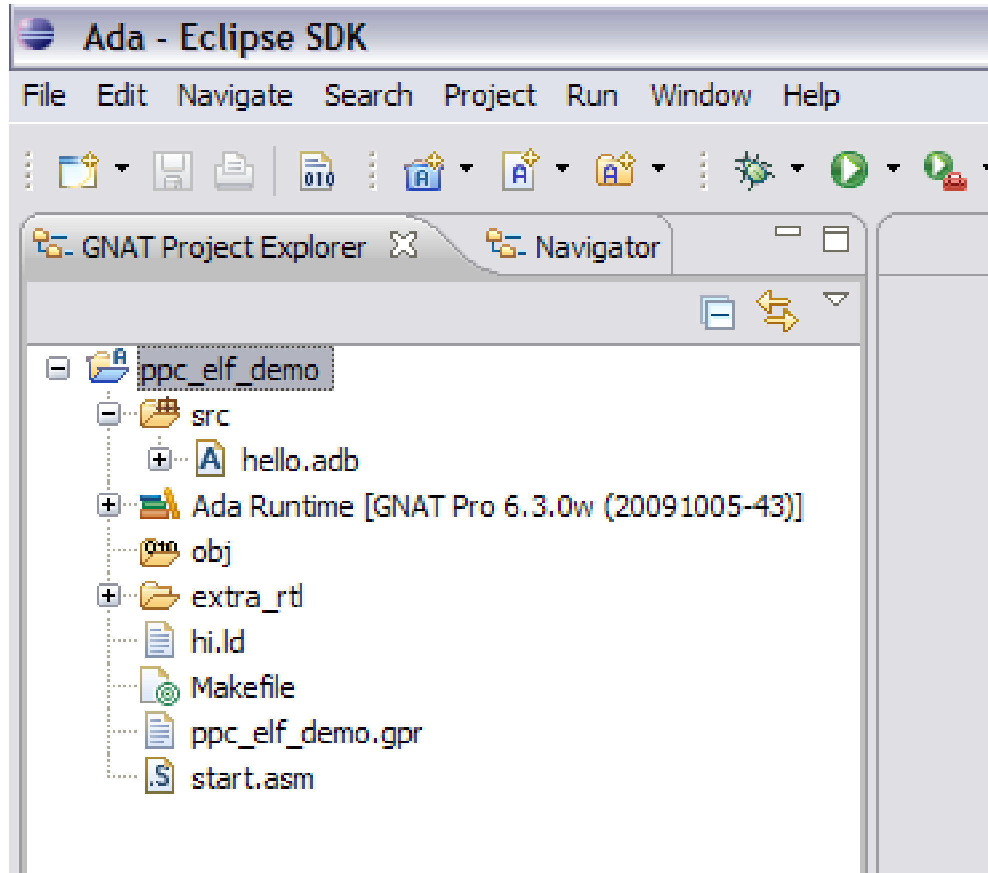
We import all of them by selecting "File System" under the "General" category and pressing Next.



After browsing to the location and selecting the two individual files required, we also select the directory named "extra_rtl" so that the putchar sources will be imported too. Then simply press Finish and the files will be imported into the project.



After importing the files, the project will now look like this:



1.11.4 Adding A Command

Now that we have the files, we need to compile them, once, before building the entire application. We will add a new command and name it "setup" since we only need to compile the source files once. In practice we would have the Makefile automatically invoke this command when necessary, but we will do it manually for the sake of this tutorial.

Therefore, we modify our "Makefile" file to add a "setup" command. This command will be added to the bottom of the Makefile:

Makefile

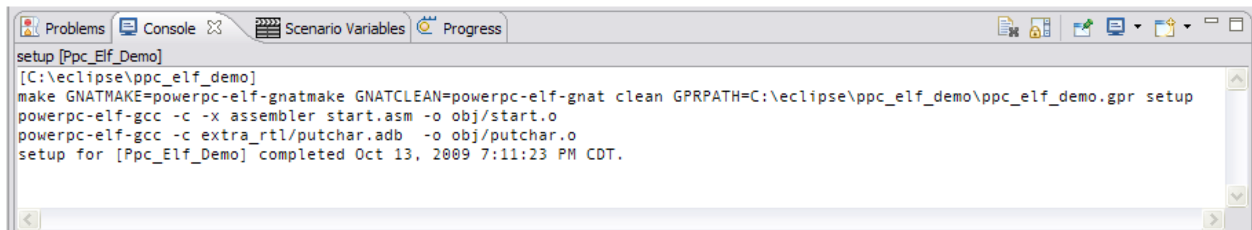
```
1# You may edit this makefile as long as you keep these original
2# target names defined.
3
4# Not intended for manual invocation.
5# Invoked if automatic builds are enabled.
6# Analyzes only on those sources that have changed.
7# Does not build executables.
8autobuild:
9	$(GNATMAKE) -gnatc -c -k  -d -P "$(GPRPATH)"
10
11# Clean the root project of all build products.
12clean:
13	$(GNATCLEAN) -P "$(GPRPATH)"
14
15# Clean root project and all imported projects too.
16clean_tree:
17	$(GNATCLEAN) -P "$(GPRPATH)" -r
18
19# Check *all* sources for errors, even those not changed.
20# Does not build executables.
21analyze:
22	$(GNATMAKE) -d -f  -gnatc -c -k  -P "$(GPRPATH)"
23
24# Build executables for all mains defined by the project.
25build:
26	$(GNATMAKE) -d -P "$(GPRPATH)"
27
28# Clean, then build executables for all mains defined by the project.
29rebuild: clean build
30
31# assembles the startup.asm file and compile output routine
32setup:
33	powerpc-elf-gcc -c -x assembler start.asm -o obj/start.o
34	powerpc-elf-gcc -c extra_rtl/putchar.adb  -o obj/putchar.o
35
```

Note the comment above the target name. This comment will appear in a dialog box to serve as a reminder of what the new command does.

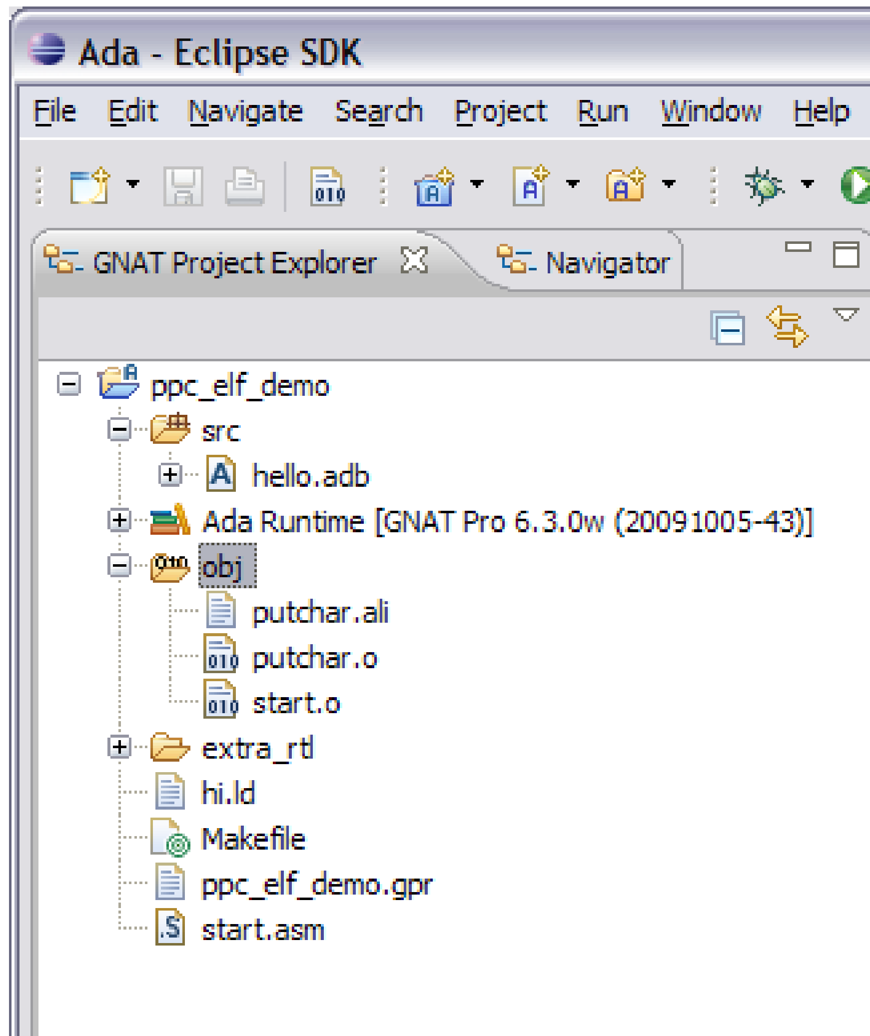
1.11.5 Invoking the User-Defined Command

We can now invoke the Project menu (or the Explorer's contextual menu) and choose "Invoke Makefile Target" to get the list of user-defined target commands available. Select the name "setup" among the listed build target names and press Invoke.

Command execution will be displayed in the console.

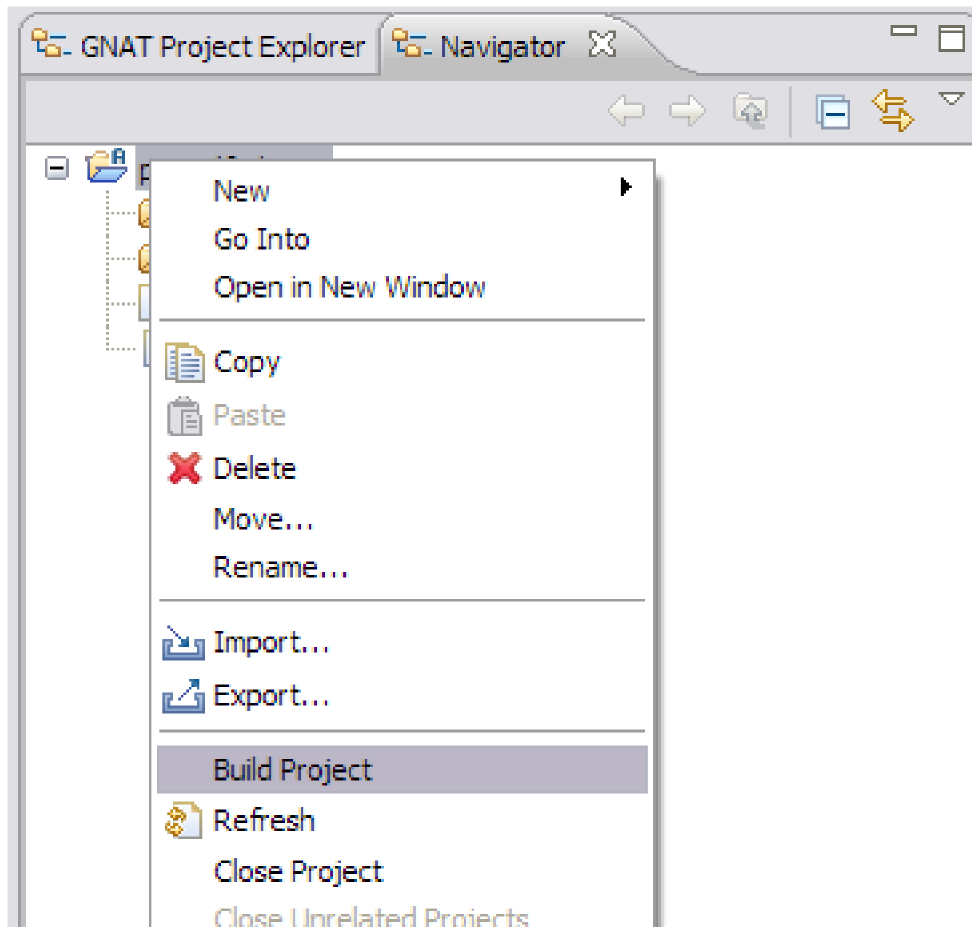


If we then expand the "obj" directory in the GNAT Project Explorer we see the resulting files:



1.11.6 Building the Project

Now that the setup has completed we are ready to do the full build. In the Eclipse menubar, open the Project menu and select "Build Project".



A successful build will appear in the Console view:

```
Problems  Console  Scenario Variables  Progress
Build [Ppc_Elf_Demo]
[C:\eclipse\ppc_elf_demo]
make GNATMAKE=powerpc-elf-gnatmake GNATCLEAN=powerpc-elf-gnat clean GPRPATH=C:\eclipse\ppc_elf_demo\ppc_elf_demo.gpr build
powerpc-elf-gnatmake -d -P "C:\eclipse\ppc_elf_demo\ppc_elf_demo.gpr"
powerpc-elf-gcc -c -g -g -gnato -gnatwa -gnatQ -gnat05 -I- -gnatA C:\eclipse\ppc_elf_demo\src\hello.adb
powerpc-elf-gnatbind -I- -x C:\eclipse\ppc_elf_demo\obj\hello.ali
powerpc-elf-gnatlink C:\eclipse\ppc_elf_demo\obj\hello.ali -g c:\eclipse\ppc_elf_demo\\obj\putchar.o -Wl,--script,C:\eclipse\ppc_elf_demo\h
Build for [Ppc_Elf_Demo] completed Oct 13, 2009 7:14:09 PM CDT.
```

1.11.7 Congratulations!

That's it! You have created and built a project for an embedded computer using GNATbench for Eclipse.

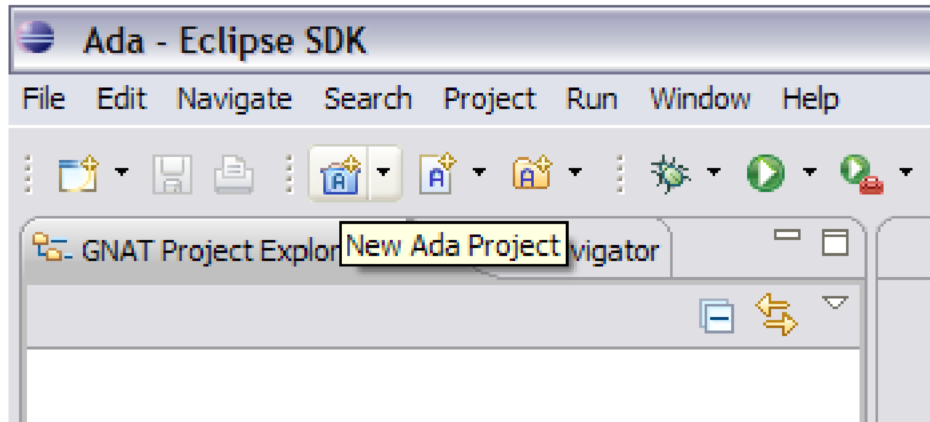
1.12 Using GPRbuild To Build An Embedded Computer Project

In this tutorial we will create and build a fully executable bare-board project using GPRbuild. In particular, we will build the executable from sources in Ada, C, and assembler.

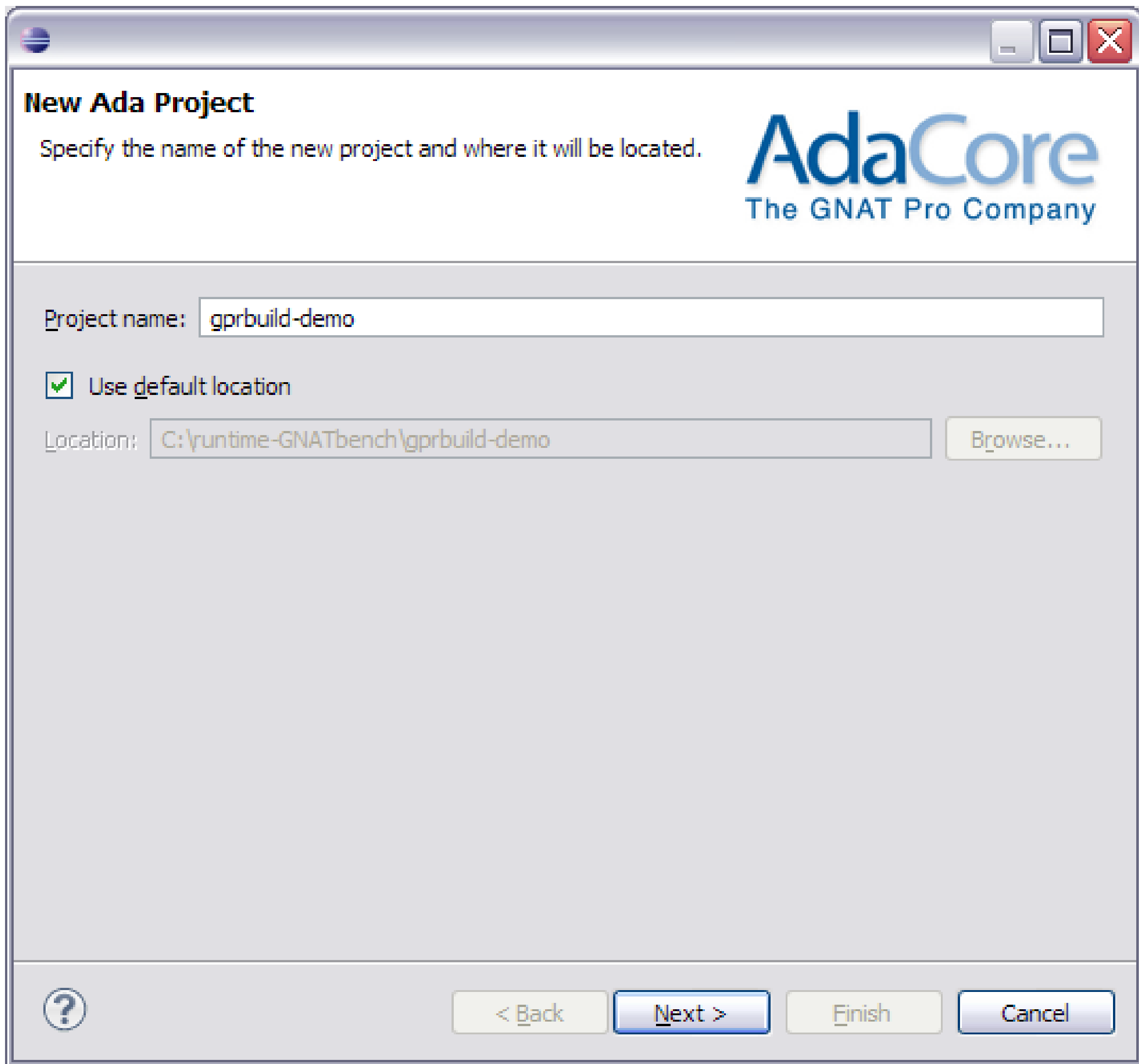
Creating a new project for Ada development is easy with GNATbench. The wizard will create and configure the project for us, and invoking the builder is simply a matter of selecting a command.

1.12.1 Creating and Configuring the Project

The first step is to invoke the wizard to create a new Ada project. Using the Ada toolbar addition, click on the "New Ada Project" icon, as shown in the following figure:

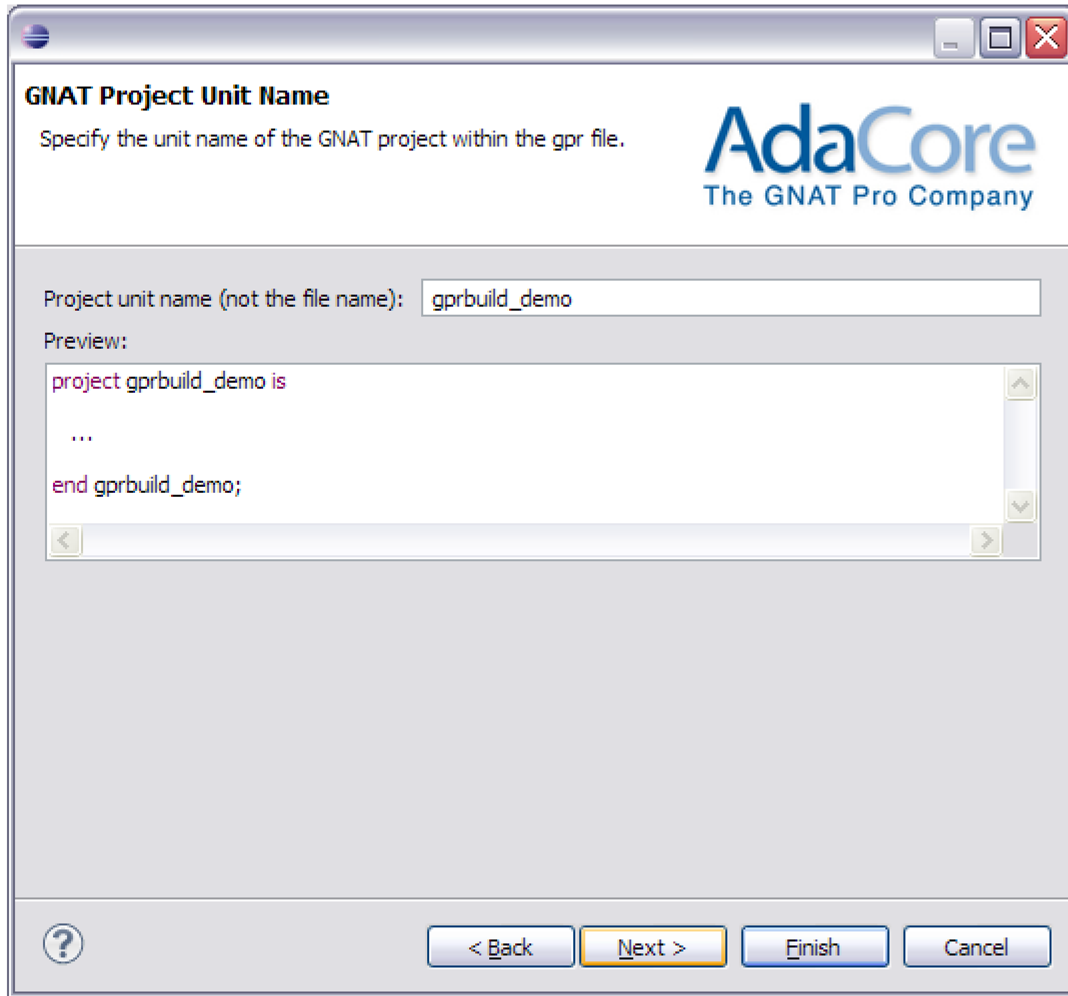


The first page of the new-project wizard (shown in the next figure) will appear. Enter the name of the new project. We have named this one "gprbuild-demo". We have the option of locating the new project in the default workspace or elsewhere in the file system. We'll take the default. Press Next.

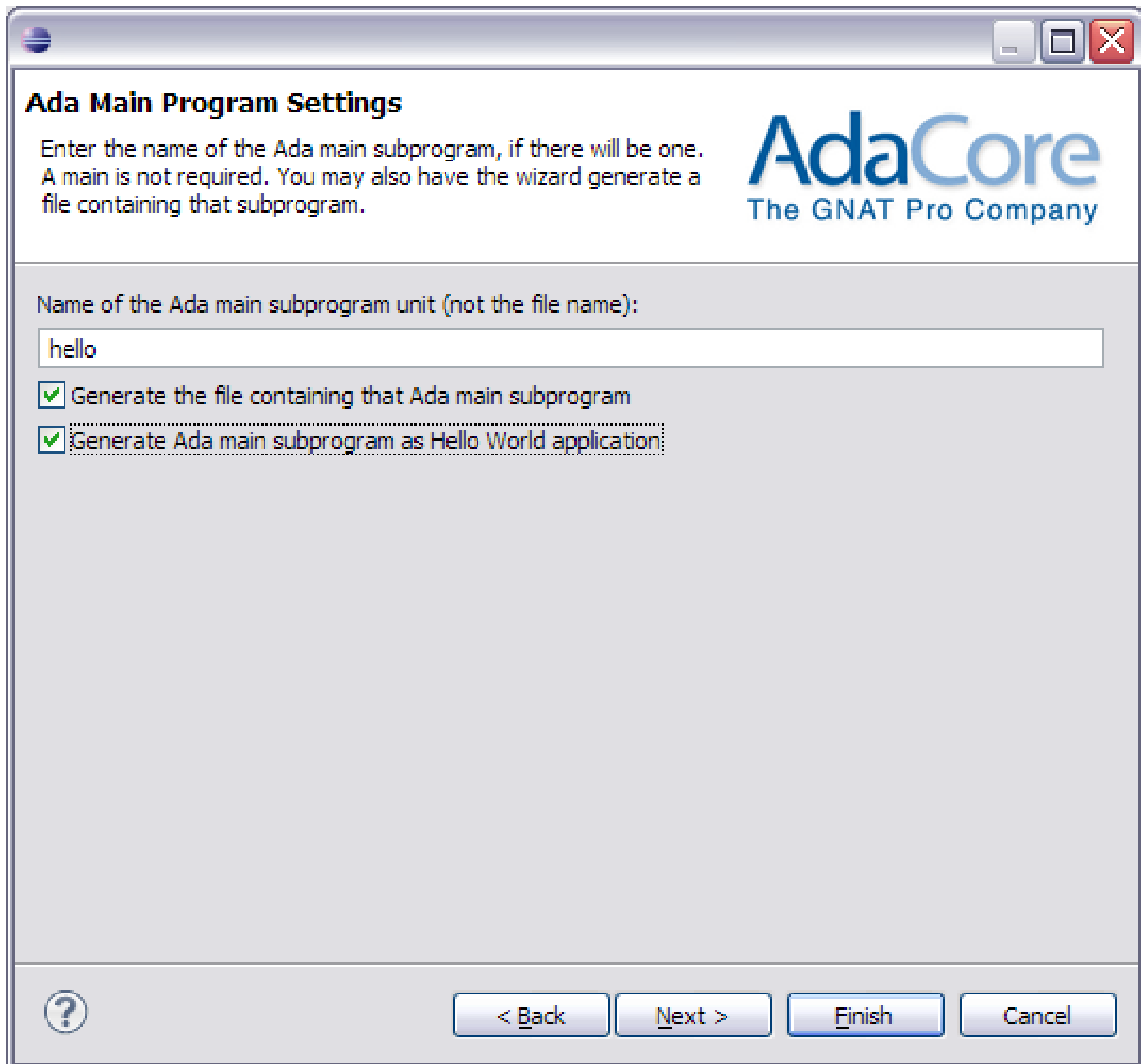


The next page asks us to specify the *unit* name of the GNAT project (not the file name), that is, the name within the gpr file.

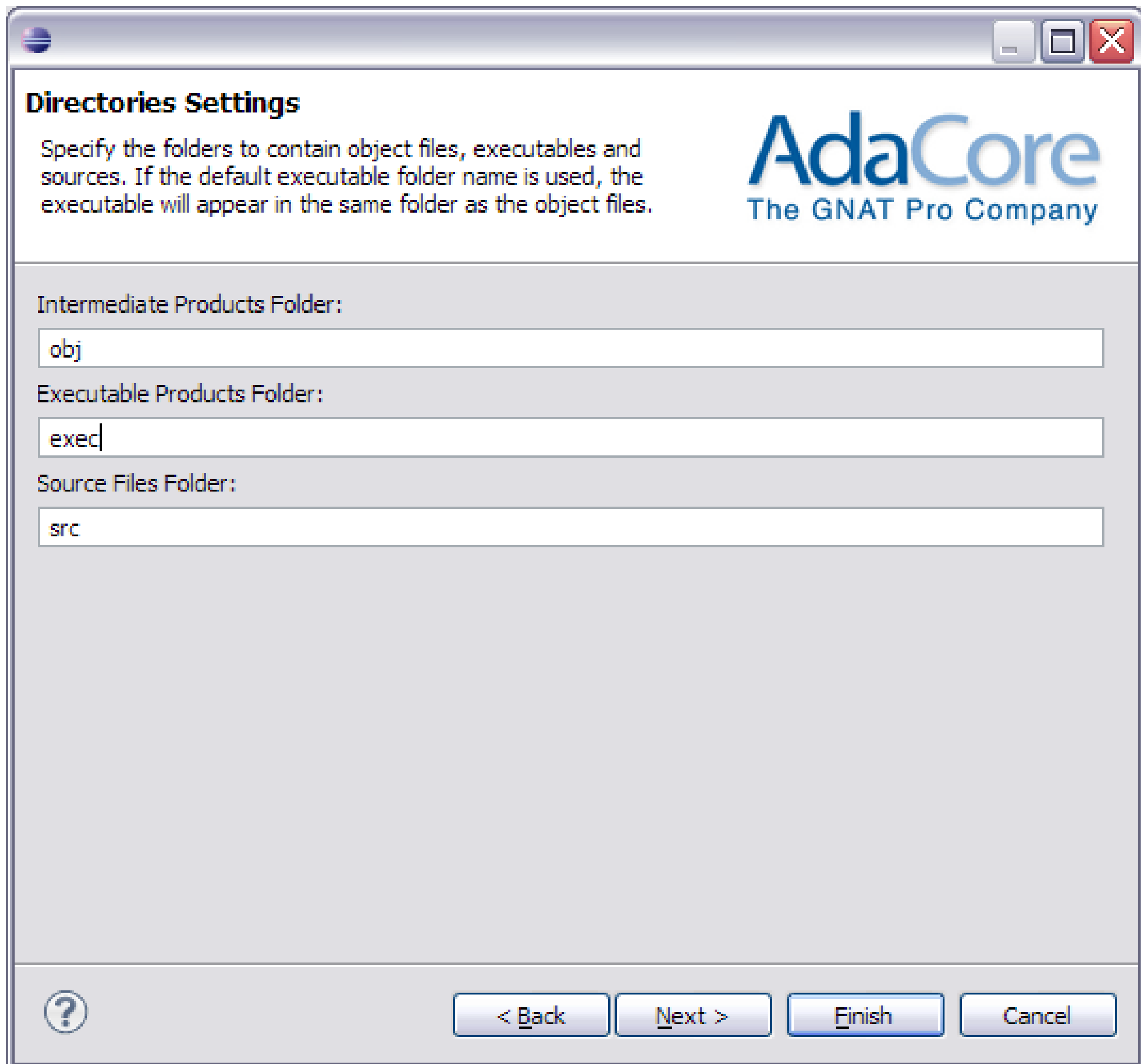
Unlike the Eclipse project name, the GNAT project unit name must be a legal Ada identifier. The wizard will try to make a legal Ada name from the Eclipse project name, by substituting underscores for dashes for example. (If the Eclipse project name is already a legal Ada identifier that name is used unchanged.) In this case the wizard changed the single dash to an underscore so we have a legal Ada name for the project:



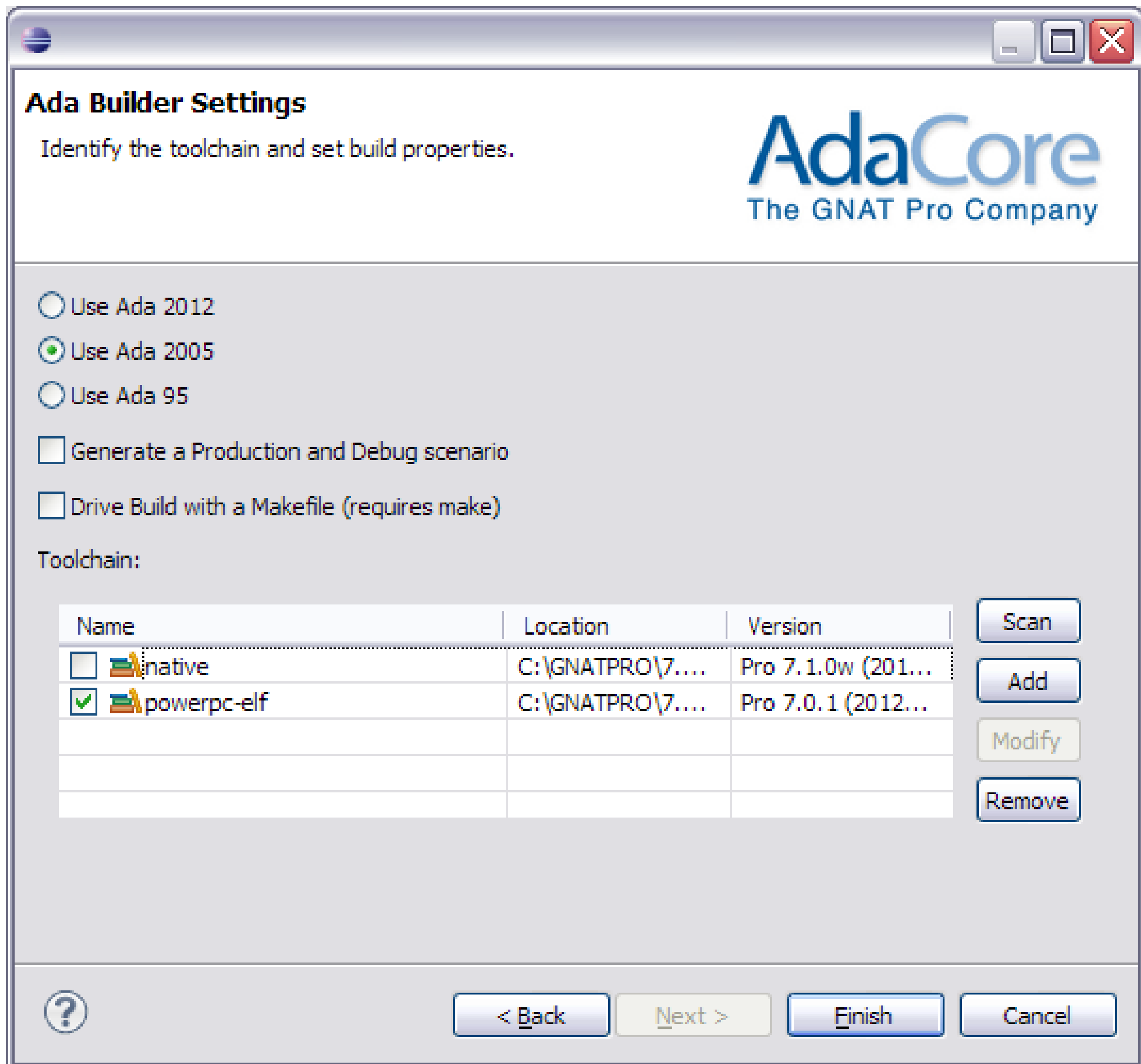
In the next page we enter the name of the Ada main subprogram – *not the file name* – and have the wizard generate the file containing that unit. We arbitrarily name the unit "hello" and have it generated as a program that prints "Hello World!" when executed.



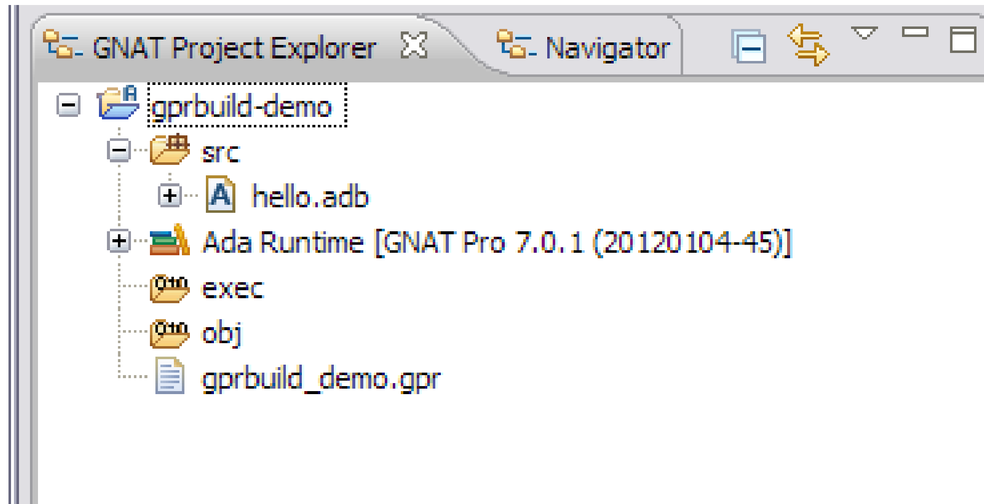
On the next page we then choose the locations for our source files and object files. The defaults will have all source files in the "src" folder, all object and "ali" files in the "obj" folder, and the executable also in the "obj" folder. We change the location of the executable so that it goes in a separate directory:



On the next page we choose the specific toolchain. We want the PowerPC-Elf toolchain for this demonstration, as shown below.

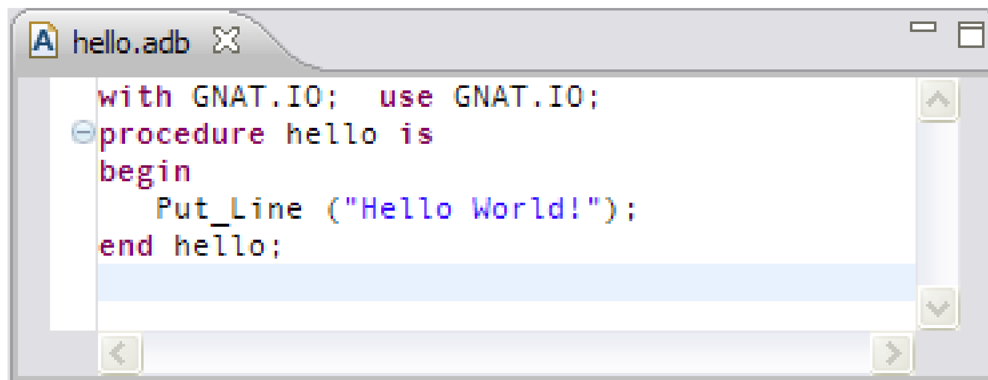


Press Finish. The new project will be created and you will see it in the GNAT Project Explorer, like so:



In the view of the project (see the figure above), note the presence of the file named "gprbuild_demo.gpr". This is the GNAT project file. *This file may be edited but it must not be deleted.*

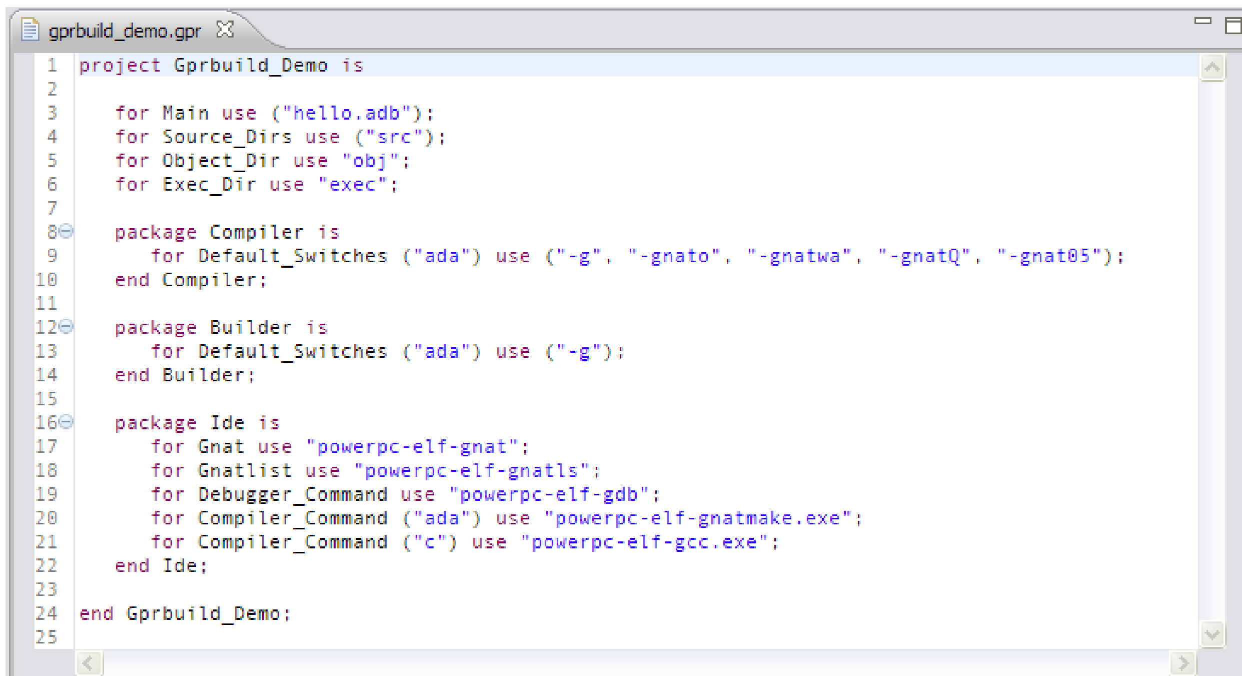
Also note the file containing the main subprogram underneath the source folder (we expanded it to show the file). This file will have the name we specified, "hello.adb", and will contain a procedure with that unit name:



We will alter the content of the main subprogram momentarily.

1.12.2 Modifying the GNAT Project File

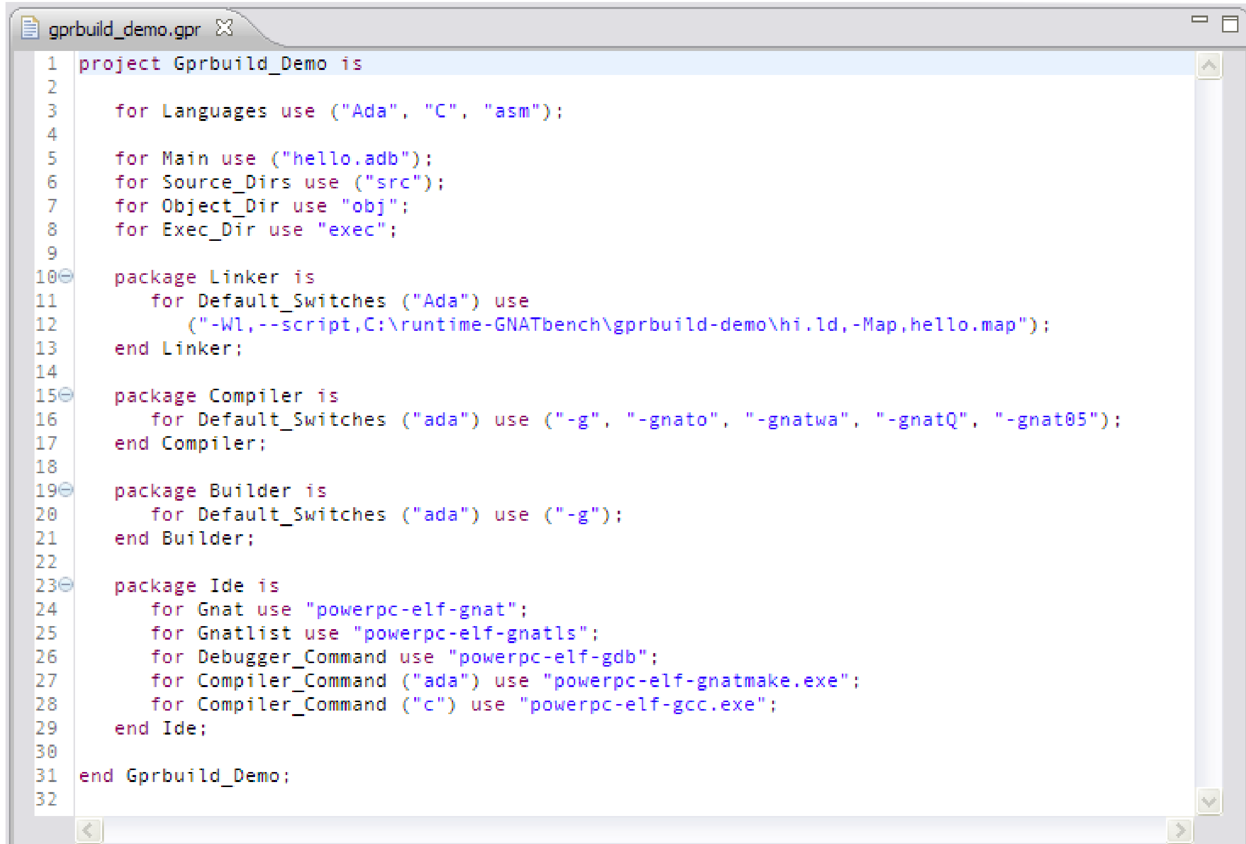
We must modify the GNAT project file created by the wizard. The original project file looks like this:



First, we need to tell the builder that we have more than Ada sources involved. This is accomplished via the Languages attribute. When this attribute is used and the "Multi-language Builder" preference is set to "Auto" the builder invokes gprbuild instead of gnatmake. This preference is located under the Ada "General" preferences category and is set to "Auto" by default.

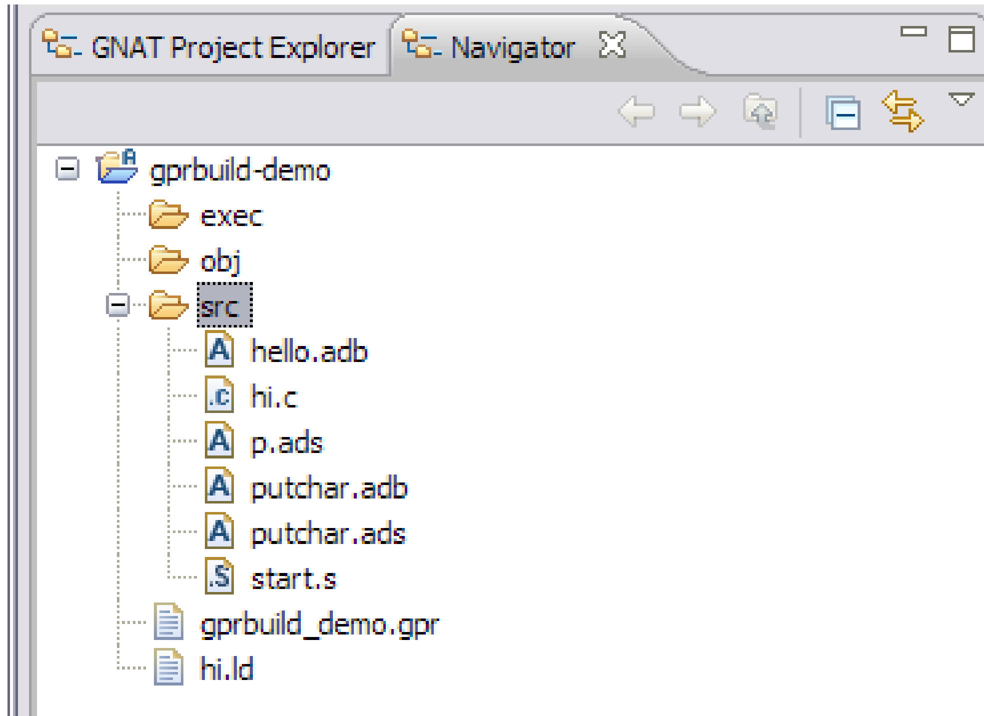
Second, we need a linker script to link the executable because this is a bare-board application. Hence we must tell the linker how to find this script. The linker script is named "hi.ld" and we have imported it into the root of the project.

Therefore, we add the Languages attribute (line 3) and the Linker package for the sake of the script (lines 10 through 13) and the modified project file now looks like the following:



1.12.3 The Source Files

As mentioned earlier we have sources in Ada, assembly, and C. You could have written these directly or imported them from the file system. We imported them in this case. We have expanded the src directory to show them in the project:



The assembly source file ("start.s") is a short initialization sequence that has to be included in the final image.

The C function is a simple function just for illustration purposes.

1.12.4 Modifying the Main Subprogram Source File

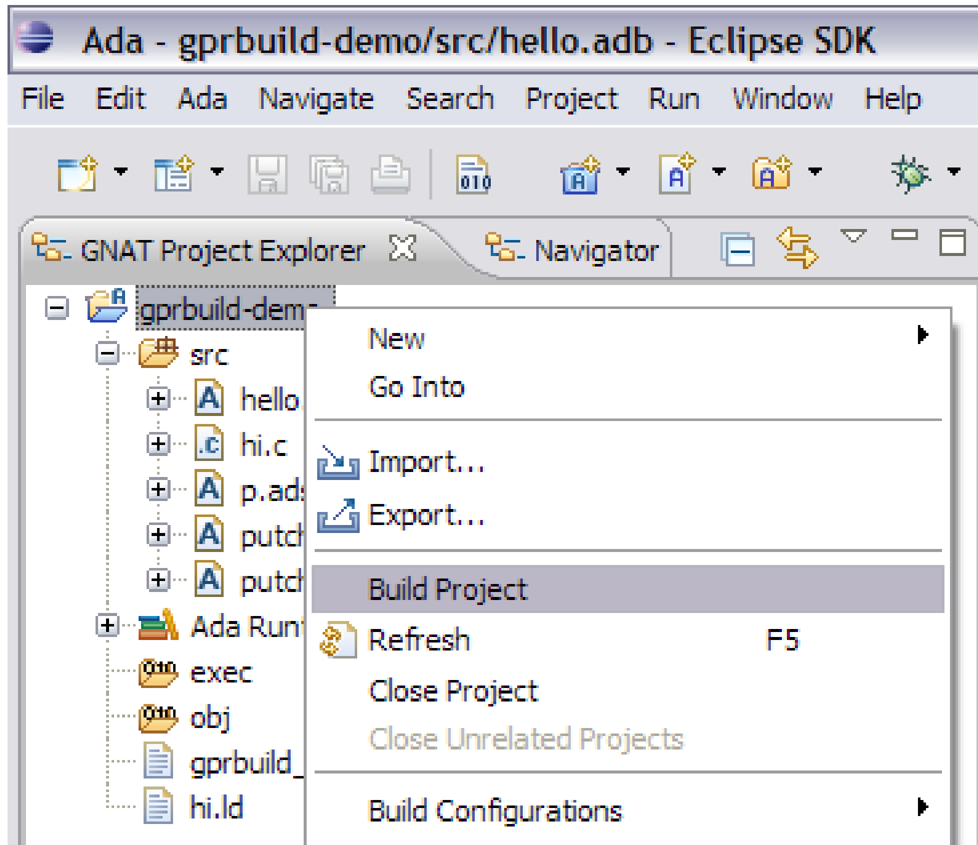
We have altered the main subprogram so that it calls the C function. It also has a with-clause so that the implementation of the putchar routine is included in the executable. (The body of Putchar is referenced by the run-time library implementation of the GNAT.IO package. We call Putchar indirectly, via procedure Put_Line.)

hello.adb

```
1  with Putchar;  pragma Unreferenced (Putchar); -- needed at link-time!
2  with GNAT.IO;  use GNAT.IO;
3  procedure Hello is
4     procedure hi;
5     pragma import (c, hi, "hi");
6  begin
7     Put_Line ("Hello World!");
8     Hi;
9  end Hello;
10
```

1.12.5 Building the Project

Now that the setup has completed we are ready to do the full build. In the GNAT Project Explorer, open the contextual menu and select "Build Project".



A successful build will appear in the Console view:

```
Problems  Console  Metrics
Messages [gprbuild-demo]
Build [gprbuild-demo]
gprbuild --target=powerpc-elf -d -PC:\runtime-GNATbench\gprbuild-demo\gprbuild_demo.gpr
powerpc-elf-gcc -c -g -g -gnato -gnatwa -gnatQ -gnat05 hello.adb
powerpc-elf-gcc -c start.s
powerpc-elf-gcc -c hi.c
powerpc-elf-gcc -c -g -g -gnato -gnatwa -gnatQ -gnat05 putchar.adb
gprbind hello.bexch
powerpc-elf-gnatbind hello.ali
powerpc-elf-gcc -c b__hello.adb
powerpc-elf-ar cr libgprbuild_demo.a ...
powerpc-elf-ranlib libgprbuild_demo.a
powerpc-elf-gcc hello.o -Wl,--script,C:\runtime-GNATbench\gprbuild-demo\hi.ld,-Map,hello.map -o hello
Build for [gprbuild-demo] completed Oct 12, 2012 5:33:31 PM CDT.
```

Note the invocations of the compiler for the main subprogram ("hello.adb"), the assembly code routine ("start.s"), the C function ("hi.c"), and the other Ada file ("putchar.adb").

1.12.6 Congratulations!

That's it! You have created and built a project for an embedded computer using GPRbuild.

CHAPTER

TWO

CONCEPTS

2.1 GNAT Pro

2.1.1 GNAT Projects

A “GNAT project” is a specific set of values specifying compilation properties, including the switches to be applied, the source files, their directories, their file naming scheme, the name of the executable (if any), and many other aspects.

A GNAT project is described by one or more “project files”, text files that contain specifications for the properties to be set. Project files can be used individually but can also be arranged into hierarchical subsystems, where build decisions are delegated to the subsystem level, and thus different compilation environments (switch settings) can be used for different subsystems.

Project files can be used on the command line and in scripts (e.g., makefiles). Using project files considerably simplifies command line and script usage because some or all of the switches are specified by the project file and, therefore, need not be written as explicit tool invocation arguments.

The settings specified by a project file become effective when using the GNAT Project Manager. The Project Manager interprets the content of the project file and applies all the corresponding settings when the tools are invoked.

The Project Explorer project presentation is oriented around GNAT projects and displays their sources accordingly. The source files or a project are made available for editing and it is these Ada source files that the Builder will build into an executable.

Because GNAT Project Files and the GNAT Project Manager control what is displayed to the user as well as what and how executables are built, they form the conceptual foundation for development using GNATbench and should be understood by the user.

See the GNAT User’s Guide, section 11 “GNAT Project Manager”, for full details of the Project Manager and project files.

2.1.2 Foreign Ada Source Files

A file containing Ada source code *must* be part of a GNATbench project in order for the relevant capabilities of GNAT-bench to function properly. For example, navigation based on the Ada constructs within the file cannot succeed if the file is not part of a GNATbench project.

Being “part of a GNATbench project” means that it is located in a “source directory”, i.e., one specified, directly or indirectly, in the Source_Dirs attribute of a project managed by GNATbench. All other Ada source files are “foreign” and will not be processed by GNATbench, except for the most basic of functions. Foreign files are not included in a project build, for example, and navigation and cross referencing for such files will also fail to operate properly.

Foreign files are an issue because there are ways within Eclipse to open arbitrary files, including files containing Ada source code, located either inside or outside the Eclipse workspace. Although the Ada editor will be opened for such a file, and will be able to function somewhat for editing, other functionality will fail.

When such files are intended to be part of GNATbench they should be located in a source directory specified in the Source_Dirs attribute of an existing GNATbench project. There are various ways to do so, including importing the containing folder from the file system via the "Import..." wizard and then ensuring it is in the list of directories in the Source_Dirs attribute. Alternatively, you can import an entire external GNAT (not GNATbench) project into Eclipse, so that it becomes a GNATbench project too. You could even simply copy the file to an existing source directory, but one way or the other, the directory containing the file in question must be a "source directory."

2.1.3 Project Files

Project file are text files written in a syntax close to that of Ada, using familiar notions such as packages, context clauses, declarations, default values, assignments, and inheritance.

Packages within project files correspond to individual tools and are thus defined not by the user but by AdaCore. For example, there is a package Compiler, a package Naming_Scheme, a package Builder, and so forth. Users set the values of switches for a given tool by defining the property settings within the corresponding package. Global properties may also be defined within a project file, for example the name of the directory to contain all intermediate build products (object files and .ali files).

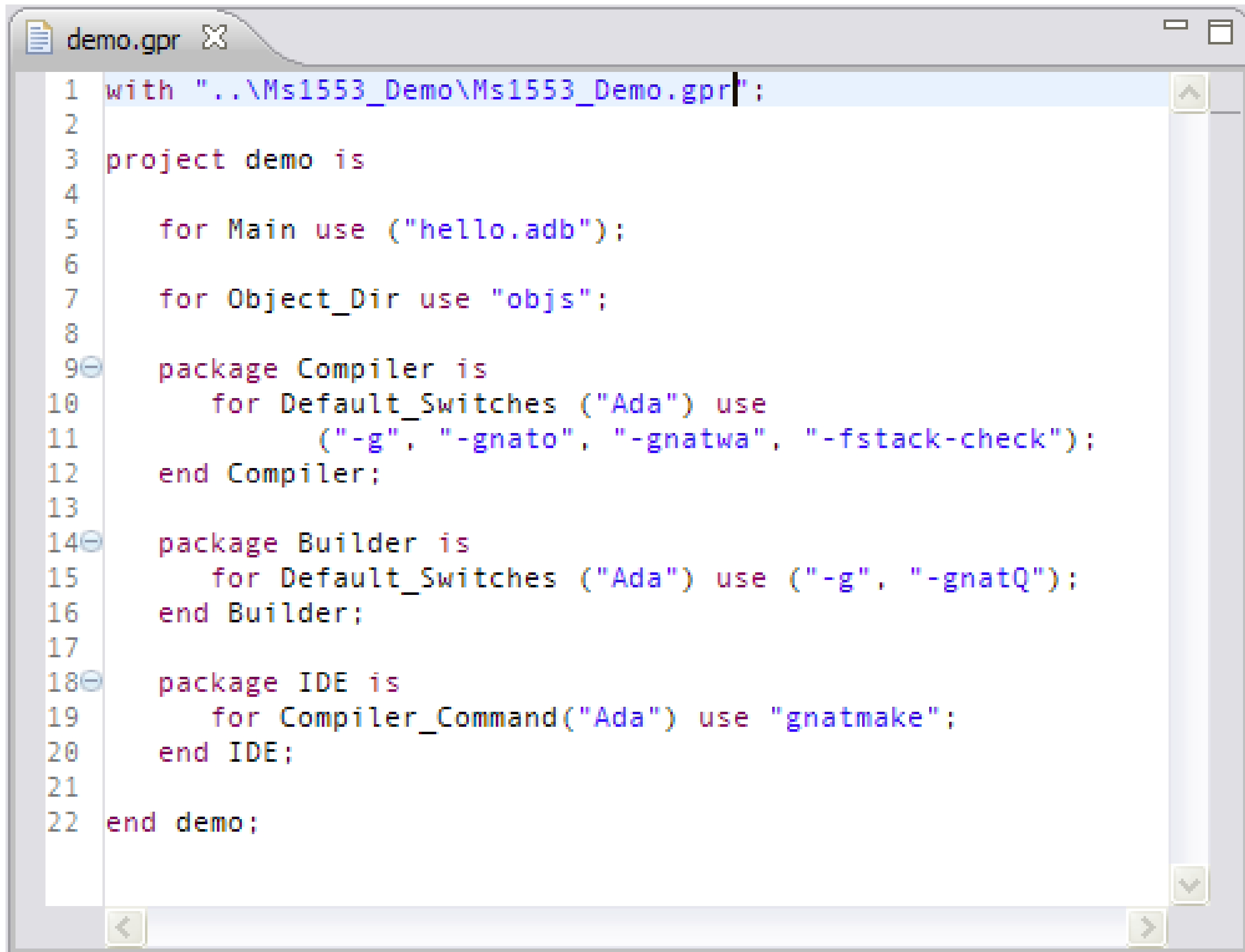
Property values in project files are either strings or lists of strings. Properties that are not explicitly set receive default values. A project file may interrogate the values of "external variables" (user-defined command-line switches or environment variables), and it may specify property settings conditionally, based on the value of such variables.

Users have available both a GUI interface and a syntax-driven text editor to specify the property values within project files. The following figure shows a simple project file inside the editor (see the corresponding Help files for the details of the GUI and this syntax-driven editor). In this case all defaults are taken for the tools and only global properties are defined. Specifically, the file name of the main subprogram is specified, the executable is directed to the same directory containing the project file itself, and all intermediate products are directed to a directory named "objs" located immediately underneath the directory containing the project file.

test.gpr

```
1 project test is
2
3    for Main use ("test.adb");
4
5    for Exec_Dir use ".";
6
7    for Object_Dir use "objs";
8
9 end test;
```

Project hierarchies are formed when the so-called "root" project file imports other GNAT project files via "with clauses", as illustrated in the first line of the following project file:



2.1.4 GNAT Project Manager

The Project Manager is invoked along with a specific tool and applies the properties of a project file to that tool. The specific project file to be applied is specified by the "-P" argument when the tool invoked.

For example, suppose we want to invoke the "gnatmake" tool to do a complete build of everything necessary to generate an executable for some main subprogram. If the project file "myproject.gpr" specifies the name of the main subprogram file, all we have to do is invoke gnatmake with the -P switch and specify the name of that project file:

```
gnatmake -P myproject.gpr
```

GNATbench will apply the -P switch for you when the builder is invoked, specifying automatically the project file that corresponds to the Ada project to be built. You can see the application of the -P switch when watching the build output in the Builder Console.

2.1.5 Scenario Variables

GNAT project files can define "scenario variables" that allow conditional specifications and external dependencies, among other capabilities.

For example, scenario variables could be used to define two build scenarios in which different switch settings are applied: one for a debugging release and one for a production release. The debugging release would enable debugging information, reduce optimizations for the sake of debugging, and turn on other checks. The production release would, in contrast, disable debugging information and enable extensive optimizations.

External dependencies are possible because the values of scenario variables can be read from environment variables defined at the operating system level. Access to the environment variables is via a function named `external`.

In the following figure, one scenario variable defines the two debug/release build scenarios described above. First, the type Build_modes defines two possible values (line 3). The a scenario variable of that type named Mode is declared (line 4). The initial value of Mode is from the function `external` that reads the value of an environment variable named "BUILD", with a default value of "Debug" corresponding to one of the two values that Mode can take on. The value of Mode is then used to further control switch settings. On line 10, for example, the location of the object directory is determined. On line 17 the default compilation switch settings are defined for the two builder modes: lines 19-21 specify the "Debug" mode compilation settings, whereas lines 22-23 do so for the "Release" mode compilation settings.

demo.gpr

```
project demo is

   type Build_Modes is ("Release", "Debug");
   Mode : Build_Modes := external ("BUILD", "Debug");

   for Main use ("demo.adb");

   for Exec_Dir use ".";

   case Mode is
      when "Debug" =>
         for Object_Dir use "debug_objs";
      when "Release" =>
         for Object_Dir use "release_objs";
   end case;

   package Compiler is
      case Mode is
         when "Debug" =>
            for Default_Switches ("Ada") use
               ("-g", "-gnato", "-gnatwa", "-fstack-check");
         when "Release" =>
            for Default_Switches ("Ada") use ("-O2");
      end case;
   end Compiler;

   package Builder is
      case Mode is
         when "Debug" =>
            for Default_Switches ("Ada") use ("-g");
         when "Release" =>
            for Default_Switches ("Ada") use ("");
      end case;
   end Builder;

   package IDE is
      for Compiler_Command("Ada") use "gnatmake";
   end IDE;

end demo;
```

GNATbench defines a wizard that creates a project file defining exactly this builder scenario. In fact, the project file in the figure above was generated entirely automatically by that wizard, with inputs from the user.

See section 11 of the GNAT User's Guide, "GNAT Project Manager", for full details on project files and scenario variables.

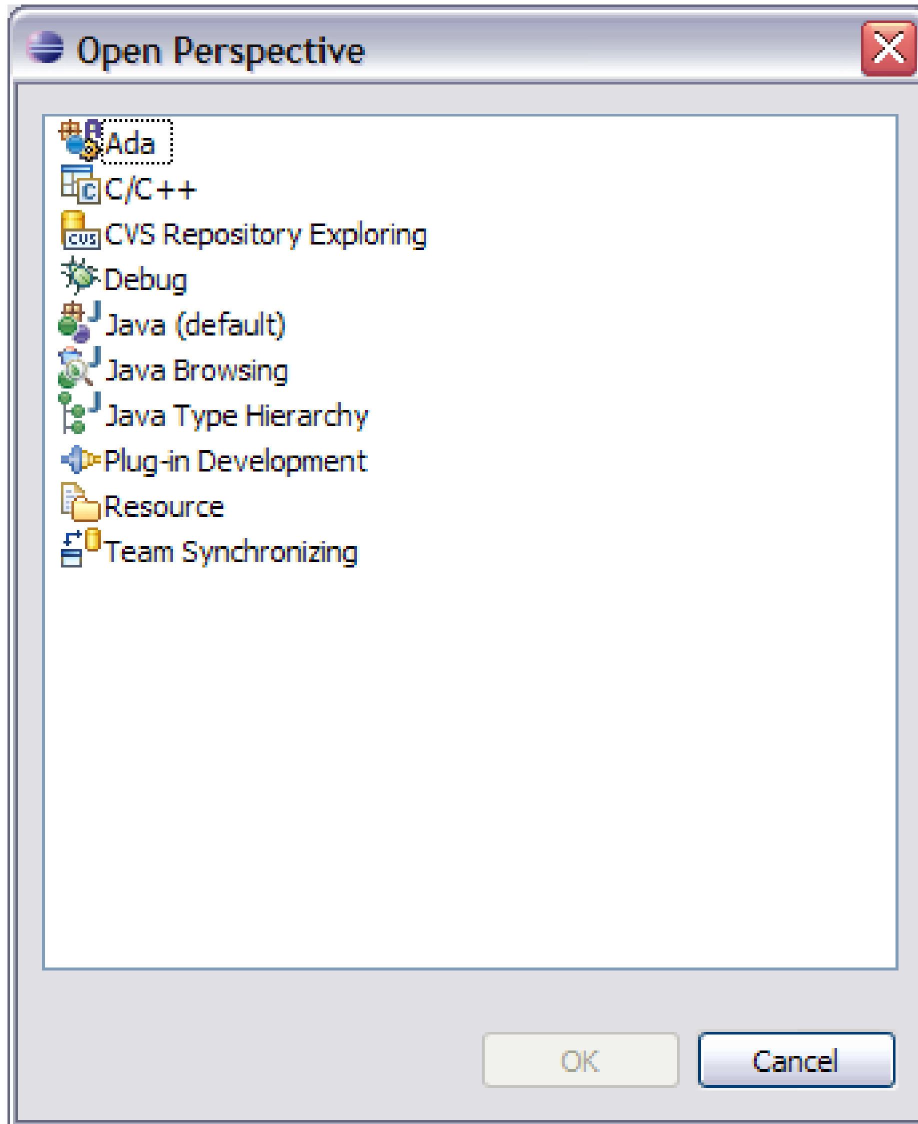
2.2 GNATbench

2.2.1 Ada Perspective

GNATbench defines a perspective dedicated to the Ada language. The icon representing this perspective (see the figure below) has the letter 'A' in the upper right, with standard Eclipse symbols denoting packages, types, and tasks in the center.

You can select this perspective by clicking on the Ada perspective icon at the upper right of the Eclipse window if the perspective is already opened. In the figure below, the Ada perspective icon is shown immediately to the right of the Workbench "open perspective" icon:

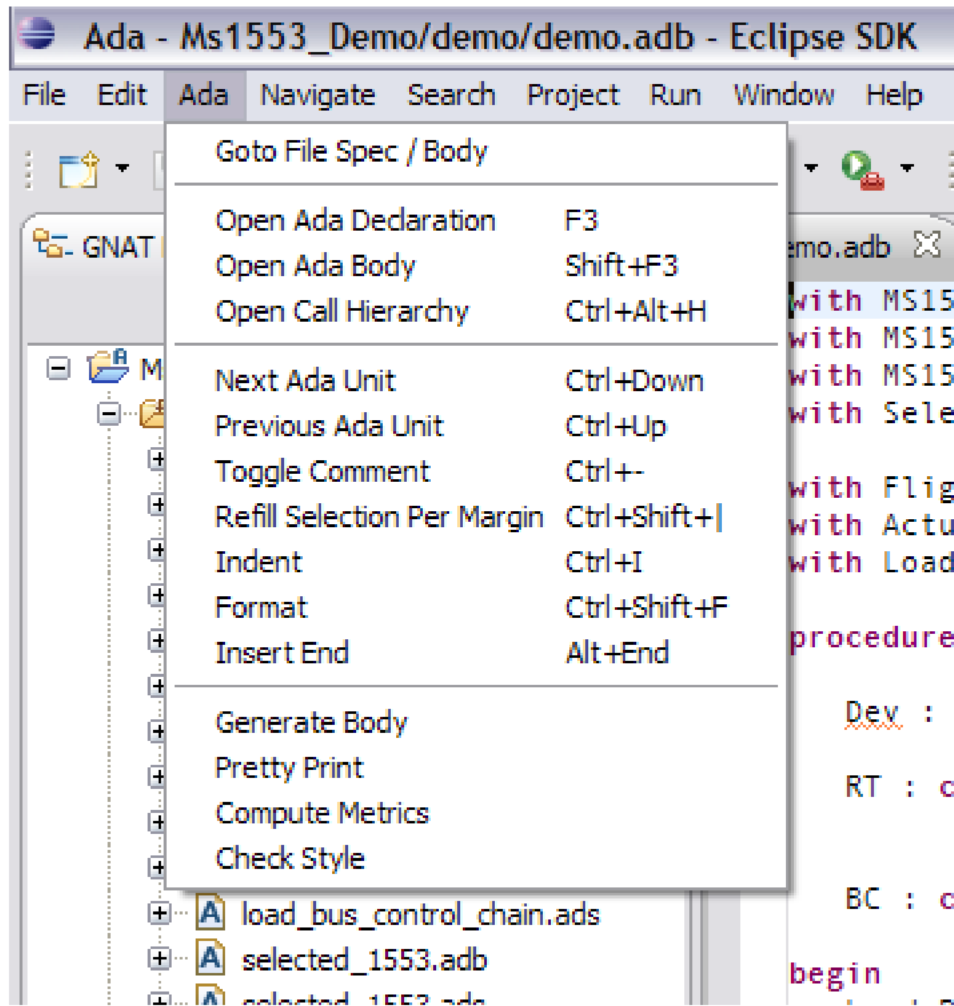
If it is not open already, you can activate the Ada perspective by clicking on the "open perspective" icon and choosing "Other…" and then Ada from the dialog box listing the perspectives. Alternatively, you can use the menu "Window-> Open Perspective-> Other…" to open that dialog box. The dialog box appears as follows:



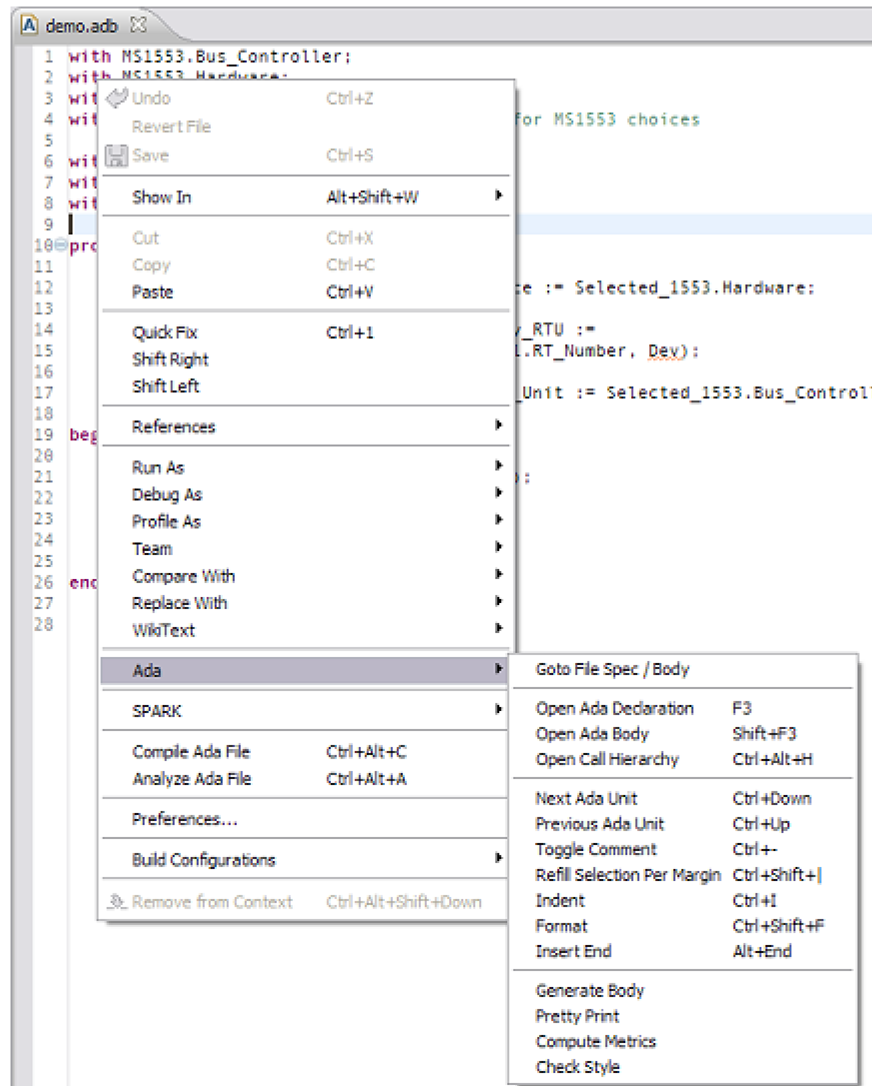
2.2.2 Ada Perspective Menus

The GNATbench Ada perspective adds menus for building, editing, and other activities. These menus are described in detail in other sections; they are enumerated here to facilitate familiarity.

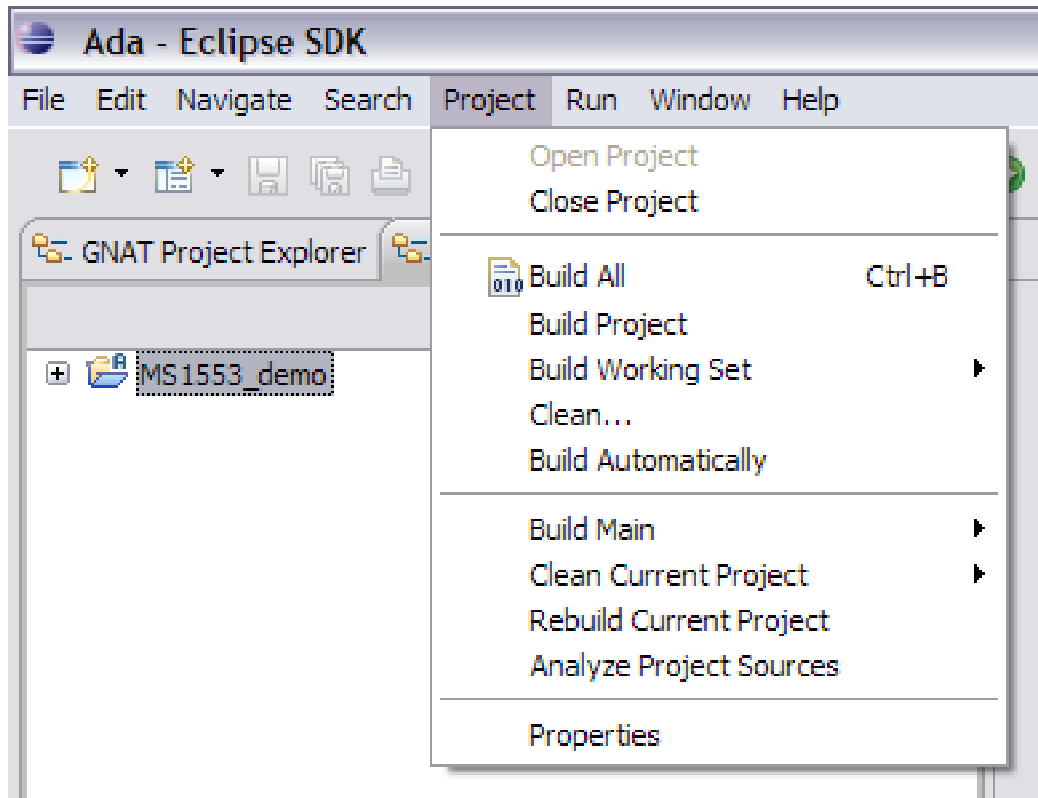
For example, an additional menu named "Ada" is added to the menu bar whenever an Ada source file is edited. This menu is illustrated in the figure below:

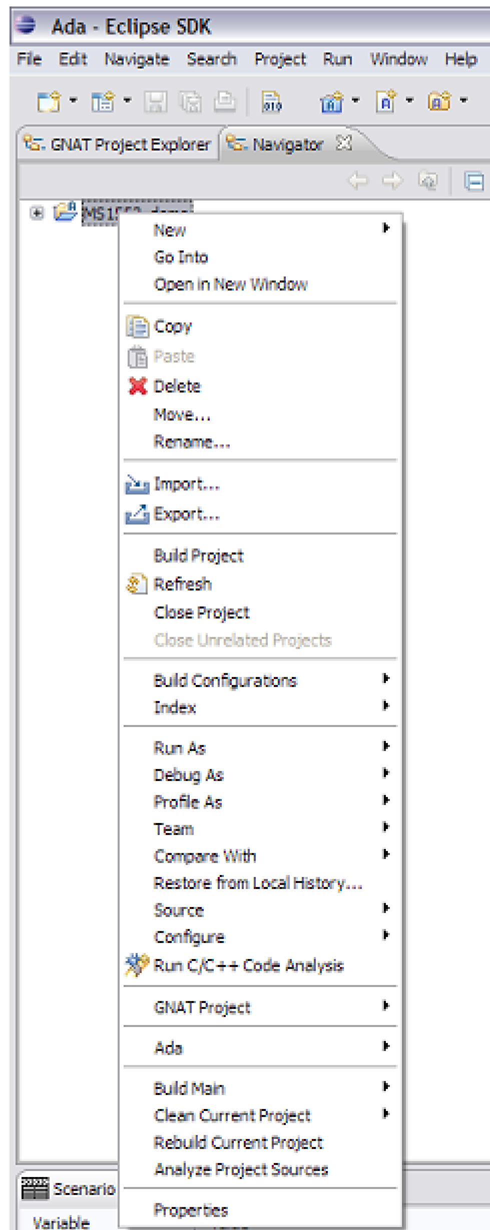


Similarly, addition menu entries are added to the editor's contextual menu when editing an Ada source file:



Finally, builder commands are added to the Project menu on the menu bar and the GNAT Project Explorer contextual menu:


Ada - Eclipse SDK
File
Edit
Navigate
Search
Project
Run
Window
Help
GNAT Project Explorer
MS1553_demo
Open Project
Close Project
Build All
Ctrl+B
Build Project
Build Working Set
Clean...
Build Automatically
Build Main
Clean Current Project
Rebuild Current Project
Analyze Project Sources
Properties

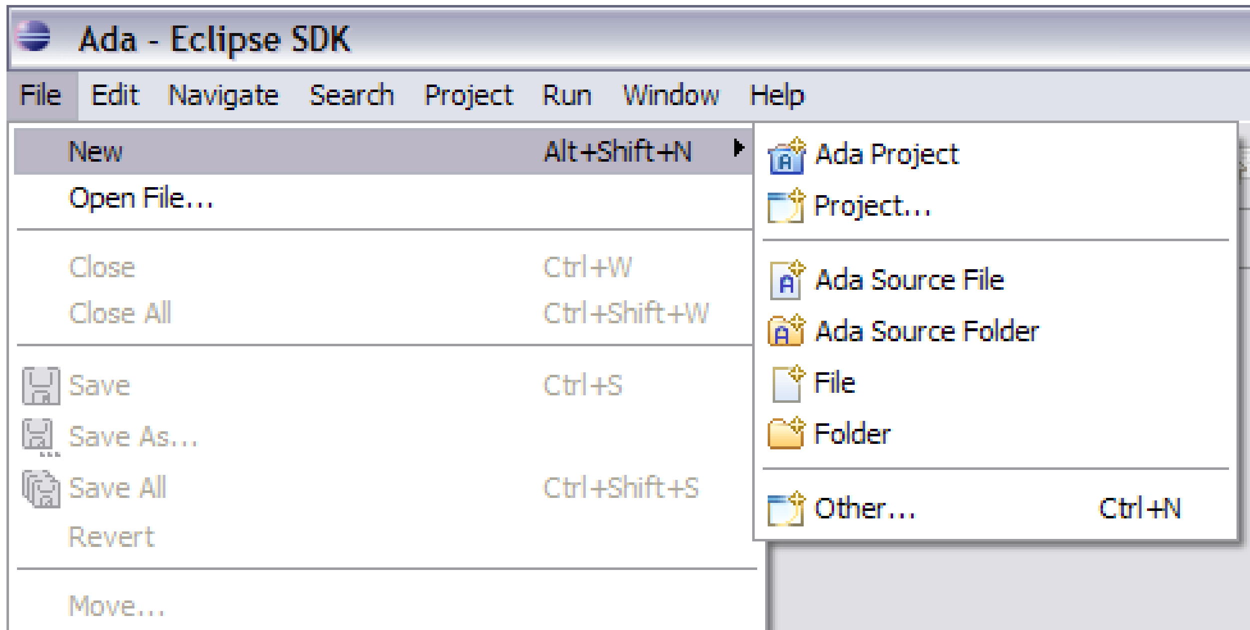


2.2.3 Ada Perspective Wizards

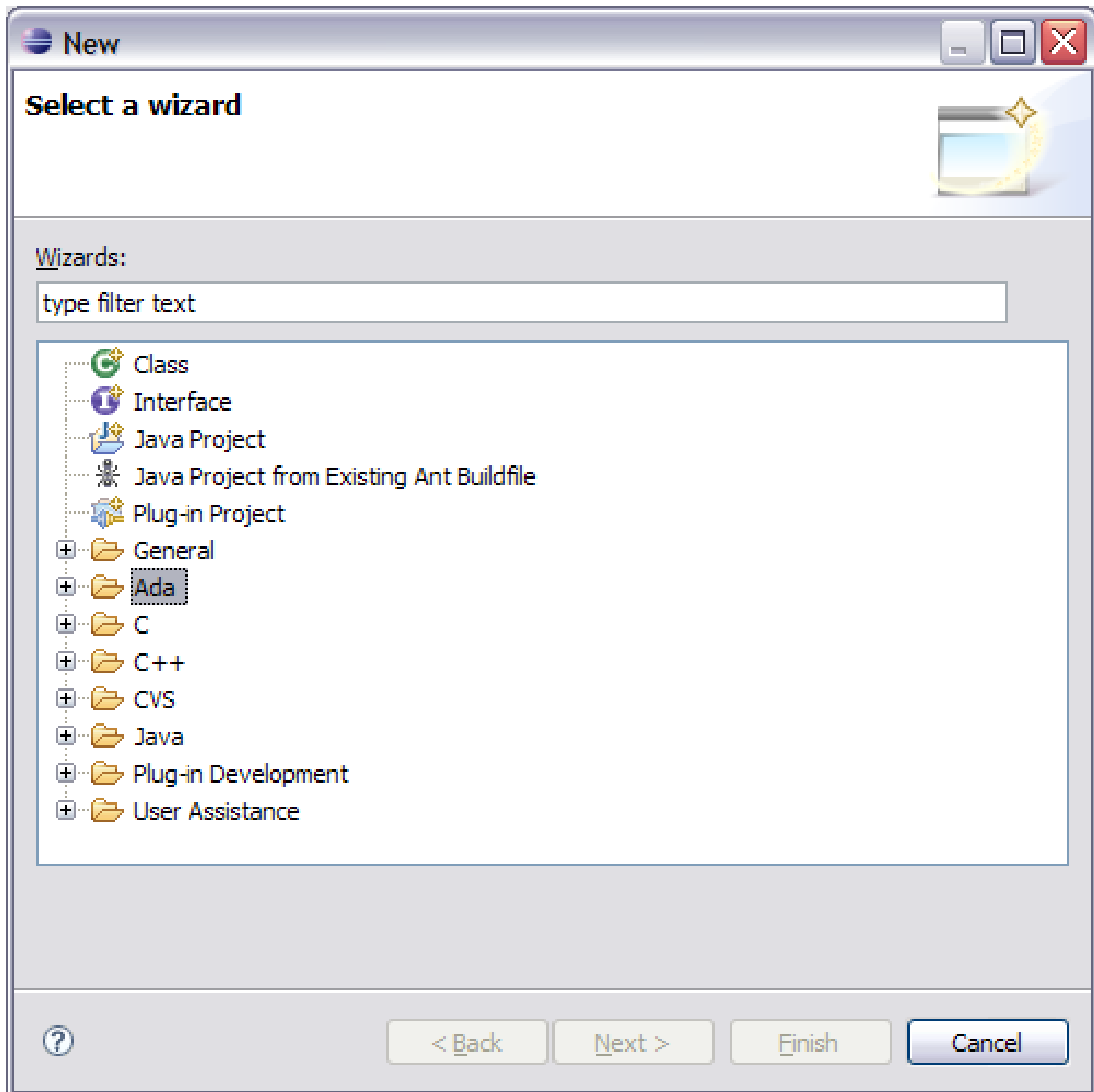
The GNATbench Ada perspective defines wizards for creating new Ada projects, new Ada source files, and new Ada source folders. There are multiple ways to select and invoke these wizards.

Using the File Menu

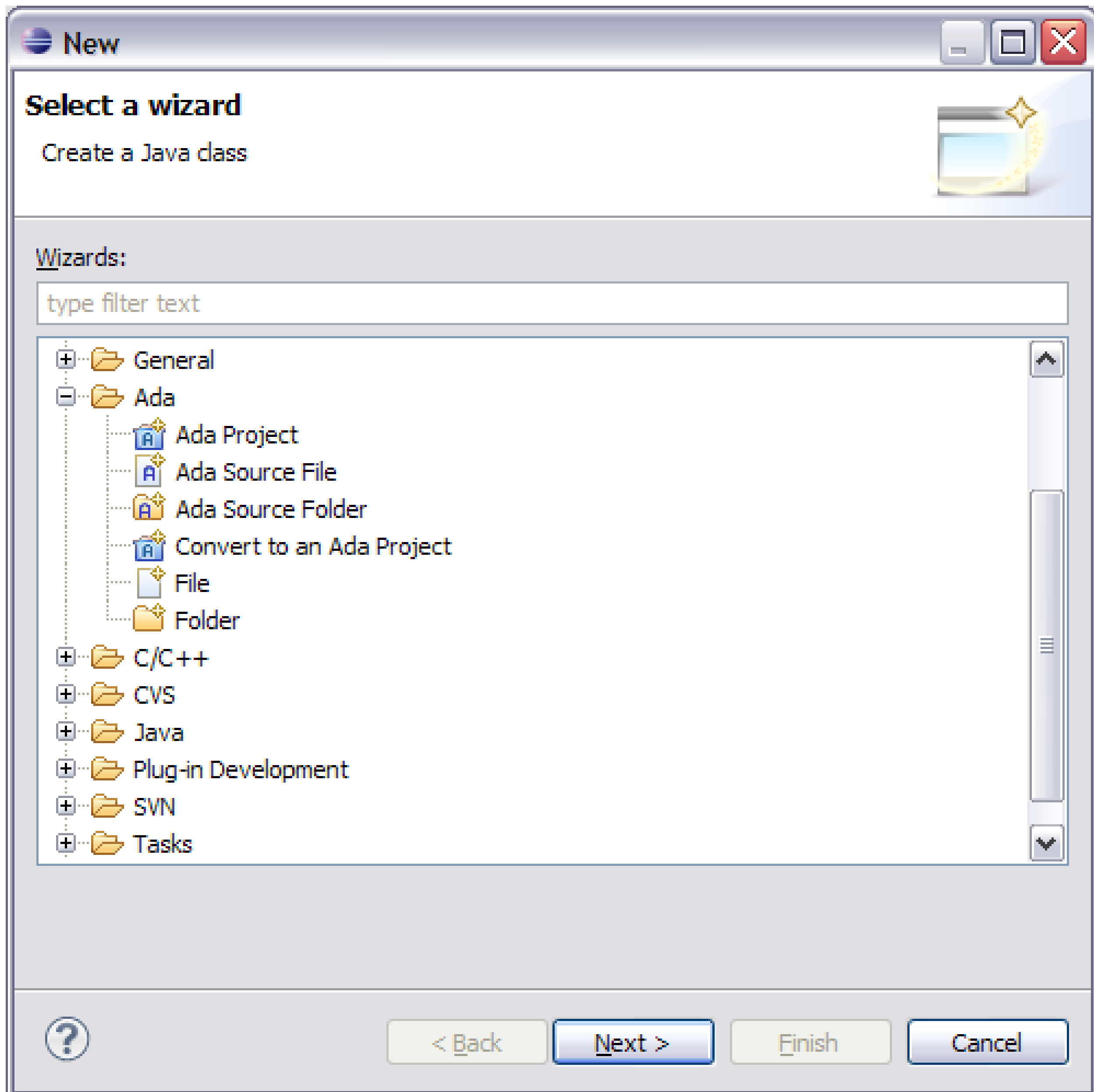
You can use the menu bar and select "File" and then "New", or use the contextual menu and select "New". In either case you can then select one of the wizards offered:



You could alternatively select "Other...", as shown in the figure above. This choice will bring up a dialog box showing all the "new" wizards, organized by category, so that you can choose which one to invoke. Note the "Ada" category.

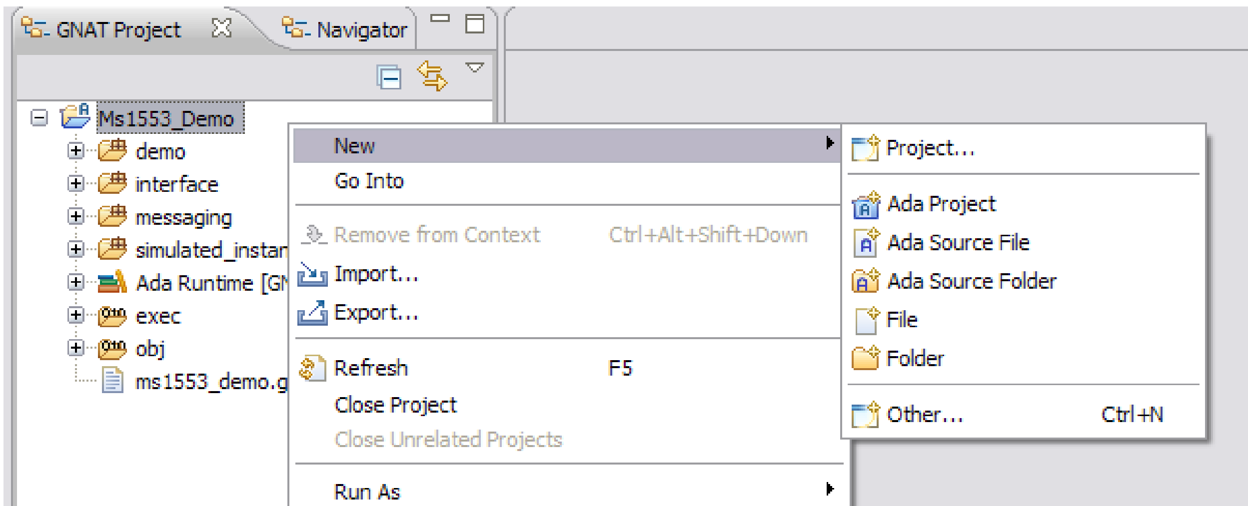


Expand the "Ada" category, if necessary, and choose between the wizards offered there.

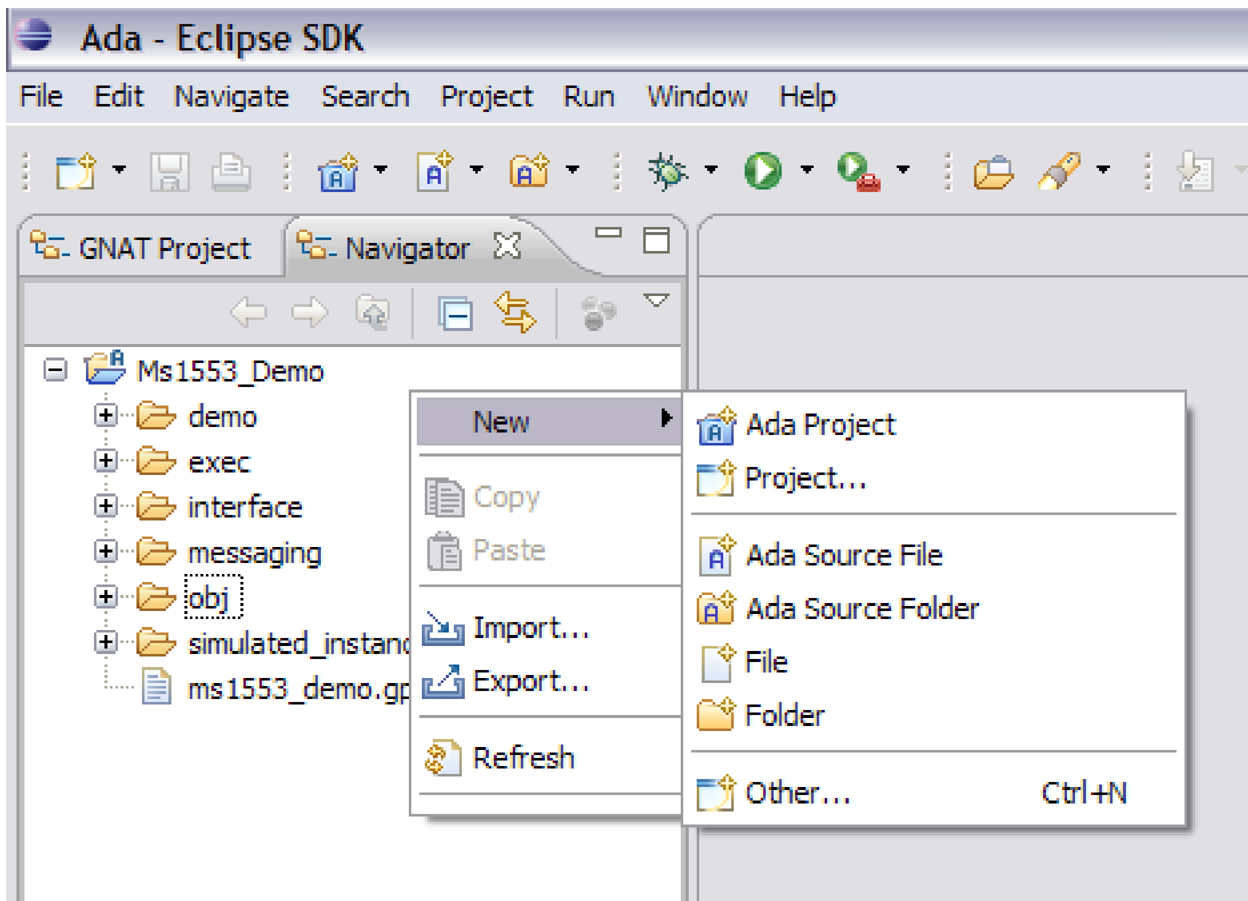


Using the Contextual Menu

You can also use the contextual menu of the GNAT Project Explorer:

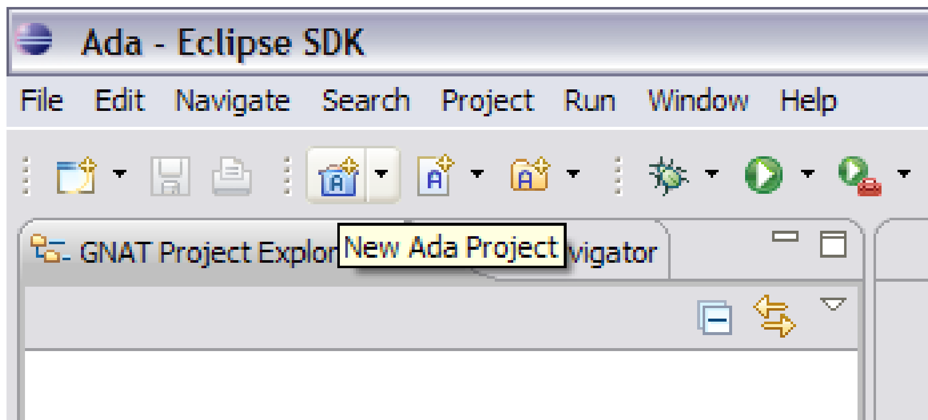


The contextual menu of the Navigator also provides these wizards:

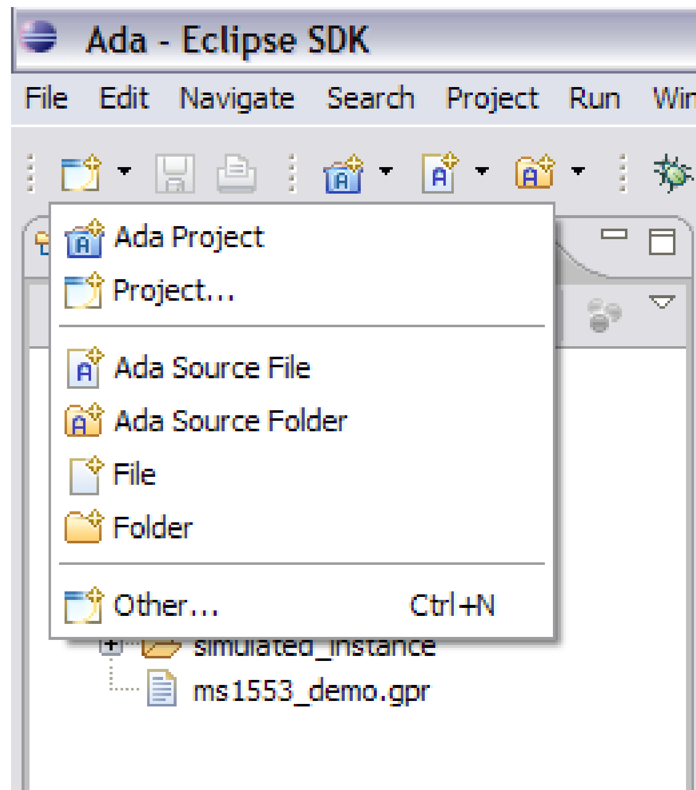


Using the Toolbar

GNATbench also provides additions to the Eclipse toolbar, for creating new Ada projects (highlighted by the tool-tip in this case), new Ada source files, and new Ada source folders (automatically added to the GNAT project file):



Finally, you can use the standard "New" button on the Eclipse toolbar:

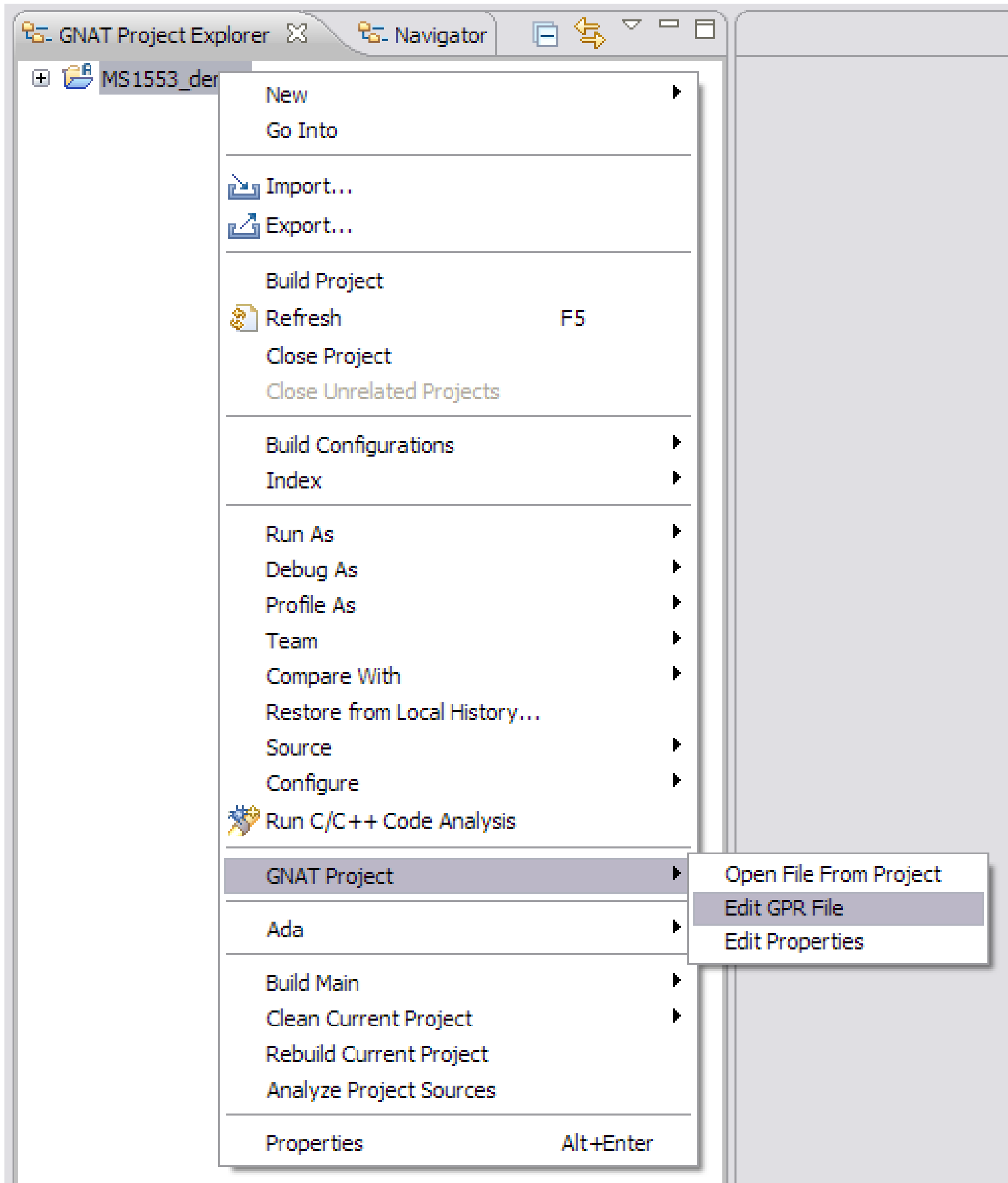


2.2.4 GNATbench Project File Editor

GNATbench provides a simple syntax-oriented editor for GNAT Project Files. Although the GUI interface discussed elsewhere is likely more convenient initially, eventually you may want to edit the file directly.

The editor is associated with files having an extension of ".gpr" (standing for "Gnat PRoject") and is thus invoked by double-clicking on the project file within the various viewers, such as the GNAT Project Explorer. (If the default system editor is invoked, you can reassign the GNATbench editor by selecting "Open With -> GNAT Project File Editor" in the contextual menu.)

Note also that you can invoke the editor on a project file even when the file is not visible within one of the viewers. This could be the case when the project file is not resident in the project root, for example. In this case, the viewer's contextual menu can be used, as shown below:



Project files are simply text files with an Ada-like syntax. The purpose of the editor is facilitate making syntactically correct changes to these files. To that end, the primary feature of the editor is syntax-driven entity coloring. The colors follow the selections made within the Ada editor for corresponding syntactic categories.

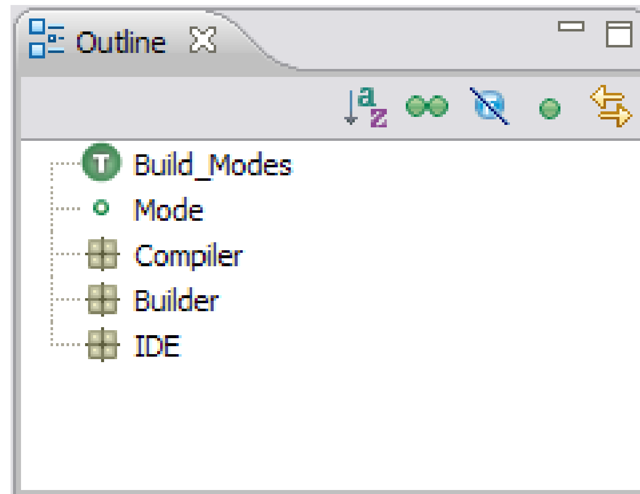
An example project file illustrating this coloring is shown in the figure below.

demo.gpr

```
project demo is

   type Build_Modes is ("Release", "Debug");
   Mode : Build_Modes := external ("BUILD", "Debug");

   for Main use ("demo.adb");

   for Exec_Dir use ".";

   case Mode is
      when "Debug" =>
         for Object_Dir use "debug_objs";
      when "Release" =>
         for Object_Dir use "release_objs";
   end case;

   package Compiler is
      case Mode is
         when "Debug" =>
            for Default_Switches ("Ada") use
               ("-g", "-gnato", "-gnatwa", "-fstack-check");
         when "Release" =>
            for Default_Switches ("Ada") use ("-O2");
      end case;
   end Compiler;

   package Builder is
      case Mode is
         when "Debug" =>
            for Default_Switches ("Ada") use ("-g");
         when "Release" =>
            for Default_Switches ("Ada") use ("");
      end case;
   end Builder;

   package IDE is
      for Compiler_Command("Ada") use "gnatmake";
   end IDE;

end demo;
```

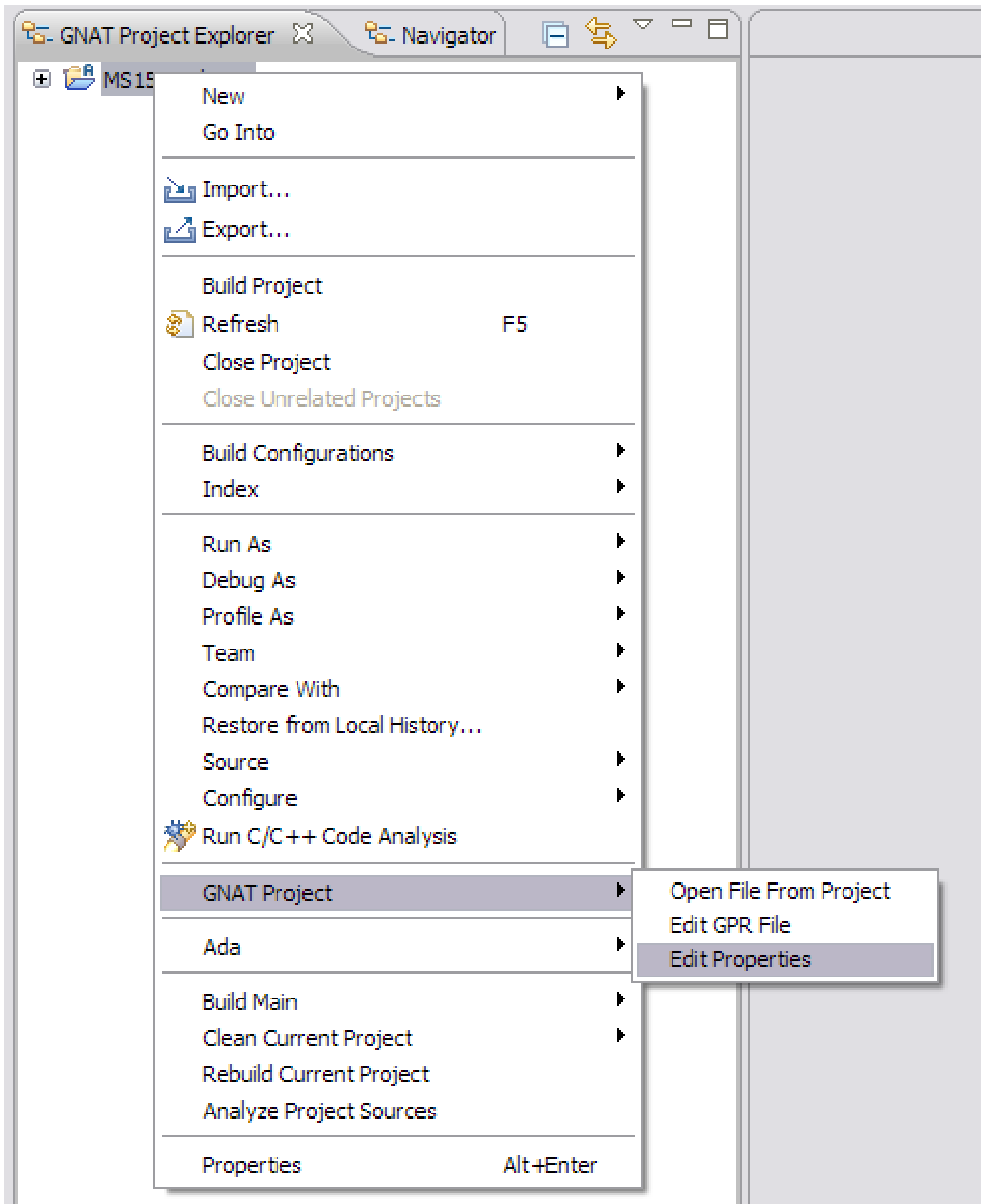
Additionally, the project file editor supports some of the same editor capabilities as the Ada source editor. Specifically, the comment toggle, text refill, smart indenting tab key, and construct closing commands are supported.

The Outline view is also supported for packages, variables, and types.



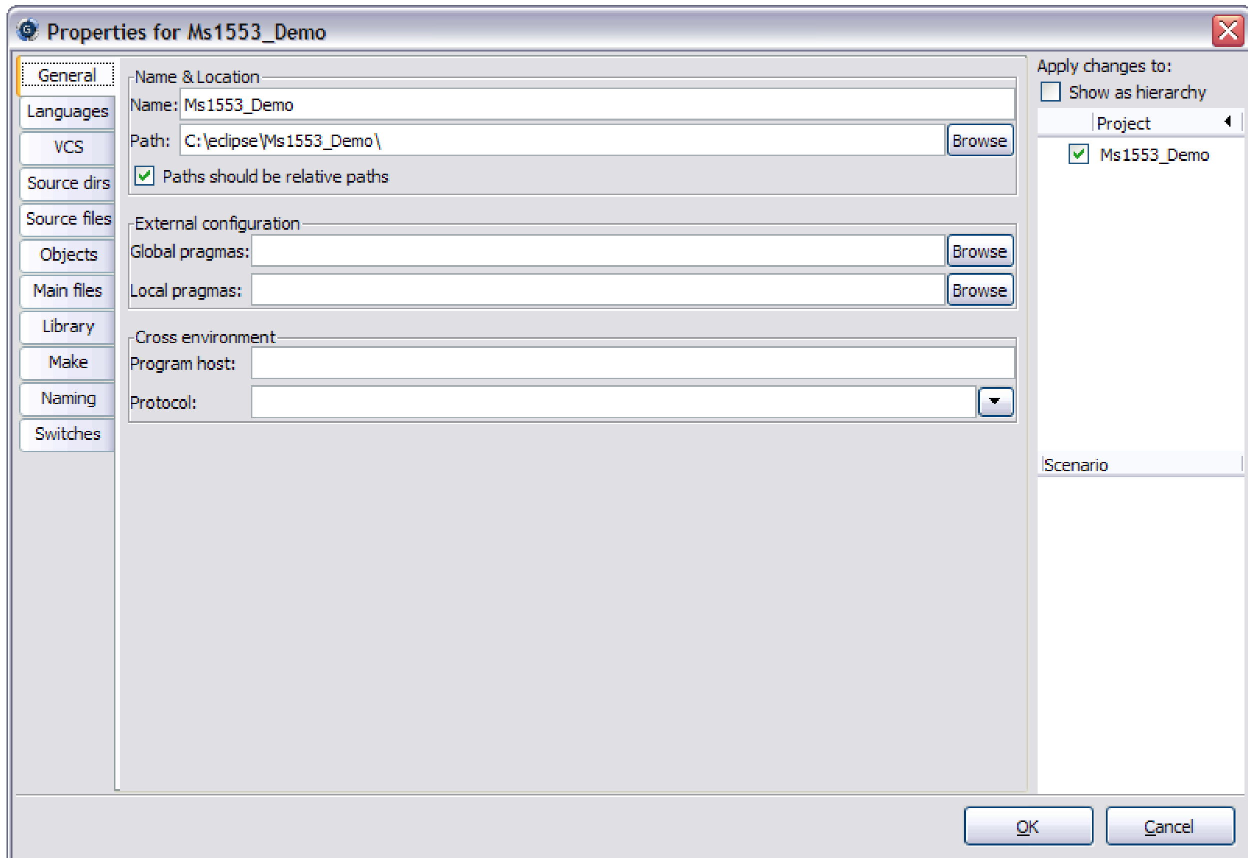
2.2.5 GNAT Project Properties Editor

In addition to manually editing the project file, the GNAT project properties can be also manipulated using a multi-tabbed properties dialog. This dialog box is invoked by right-clicking on the project node in the Project View and selecting "GNAT Project -> Edit Properties" from the contextual menu.



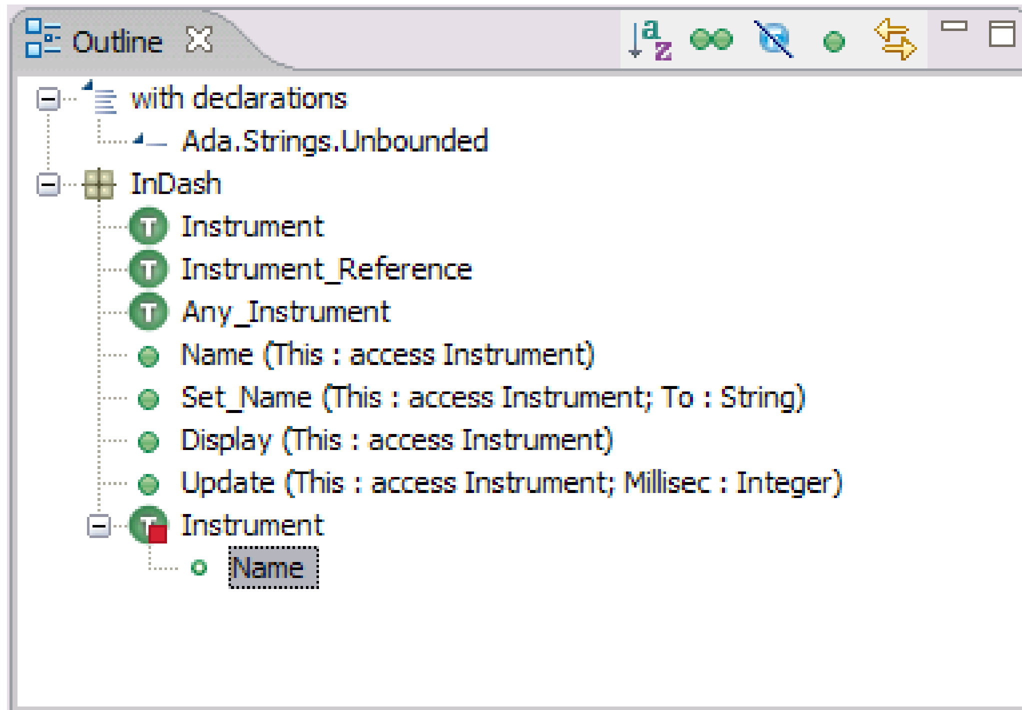
Note that the entry "Edit GPR File" will invoke the textual editor rather than the graphical editor discussed in this section.

The following tabbed dialog box will appear. Simply make the required changes and press OK, or press Cancel to abandon any changes.



2.2.6 Outline View

The Ada plugin supports the standard Workbench Outline view, such that a high-level view of the code is available to facilitate program comprehension and development.



Specifically, the Outline view presents a hierarchy of entity declarations in the file and annotates the presentation with indicators of entity visibility. Green icons indicate "public" entities and red icons indicate "private" entities. For Ada entities that can appear in both public and private sections, such as the partial and full views of private types, the public section icon will be green and the private section icon will be red.

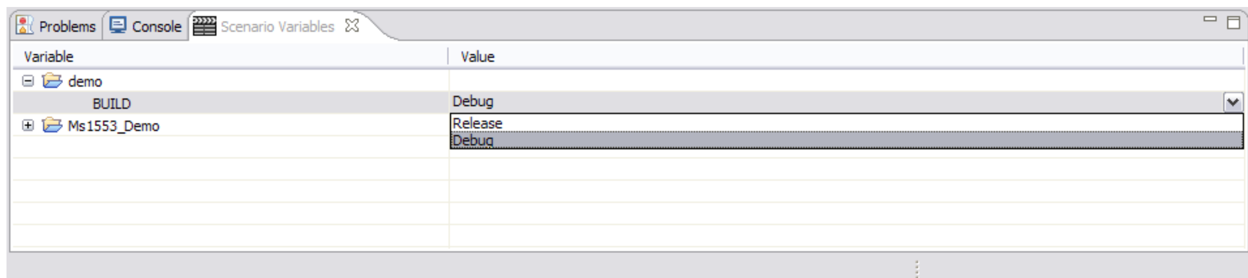
Entities displayed in the Outline view can be ordered by type, visibility, and name. Additionally, all private entities can be hidden so that only the public interfaces are presented.

Clicking on an entry of the outline will traverse to the corresponding location in the source file.

2.2.7 Scenario Variables View

You can view and modify the scenario variables currently defined by any GNAT project using the Scenario Variables view.

This view depicts the external scenario variables defined by all GNAT projects, allowing you to chose the values to apply to them. The external names of the variables appear underneath their defining project names, with the possible values for each variable in the corresponding pull-down list. You can click on the value to invoke the pull-down list, or click on the down-arrow at the right of the value.



If a given project does not define any scenario variables, none will appear underneath the project name. Projects that are not Ada projects will not appear in the view at all, nor will those Ada projects that are not root projects.

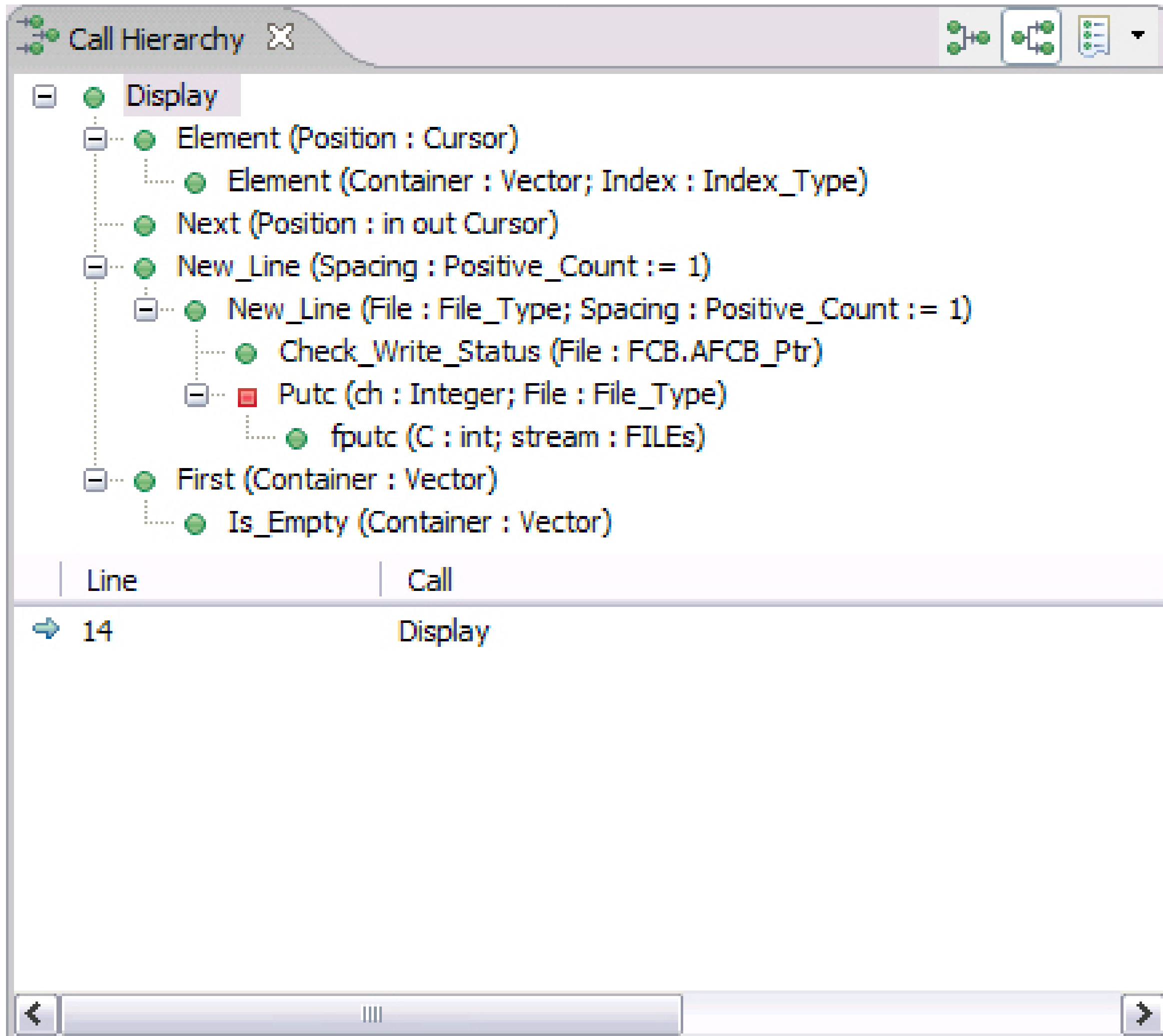
2.2.8 Call Hierarchy View

The GNATbench Ada plugin also supports the Call Hierarchy View. This view shows all the invocations of a given subprogram or, alternatively, all subprograms invoked by that selected subprogram.

The view is opened by selecting the subprogram in question, right-clicking to invoke the contextual menu, and then selecting Open Call Hierarchy in that menu.

Alternatively, pressing *control+alt+H* will open the view on the subprogram currently selected.

The following is a Call Hierarchy View for a procedure named Display, showing the routines it invokes.



2.2.9 GNAT Project Explorer

The GNAT Project Explorer provides a GNAT-specific view of the project, including a contextual menu, without the additional information provided by the Navigator (for example) that might be extraneous in normal use. Projects that are not configured as GNATbench projects are given the standard resource layout with no changes. With the GNAT Project Explorer you will not need to use the Eclipse Navigator except for a few Eclipse resource-oriented activities.

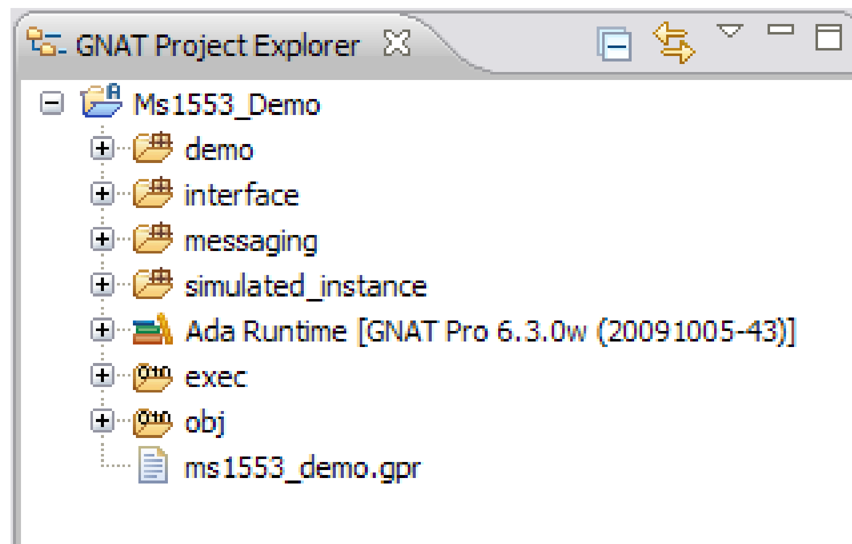
In this view, GNATbench projects contain four kind of entries: the source directories, the run-time library, the object directory, and finally the resources present in the project but not managed through the GNAT project file.

The source directories are listed at the beginning of the project. Their content is the exact sources of the project, filtering out non-source files.

The run-time library entry gives access to the run-time files currently used by the project.

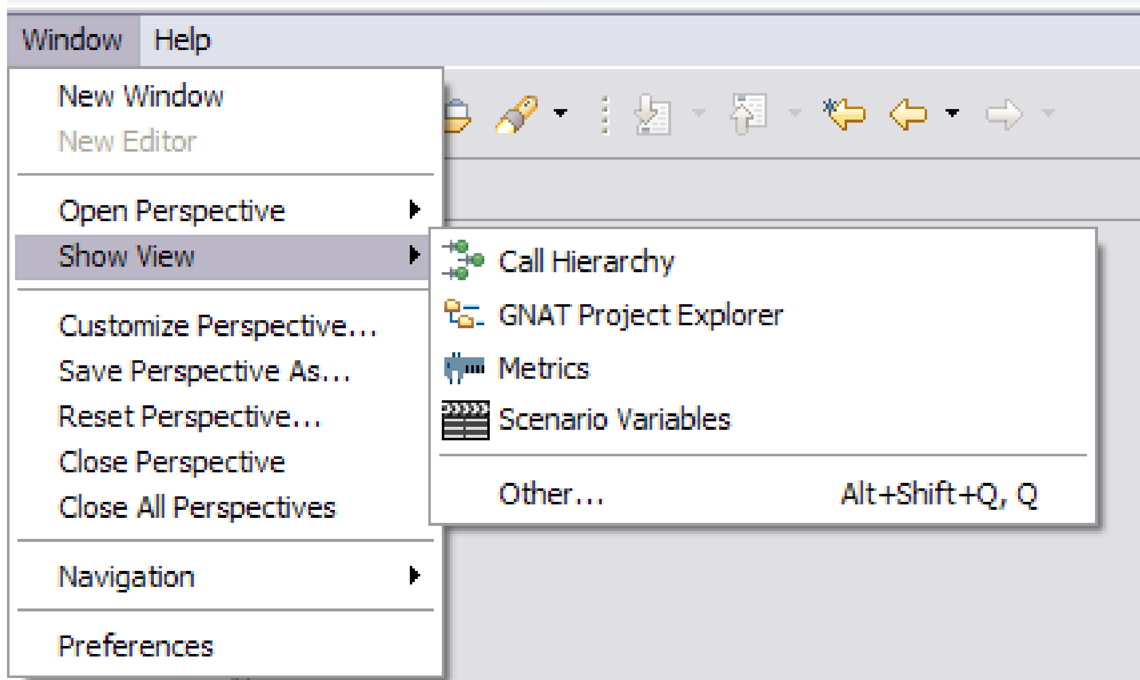
The object directory contains the object code files and the ali files generated by the compilation process. Unless you specify otherwise, this directory will also contain the executable image, but as shown below the executable can be in a dedicated directory as well.

A sample project in the GNAT Project Explorer is shown in the figure below.

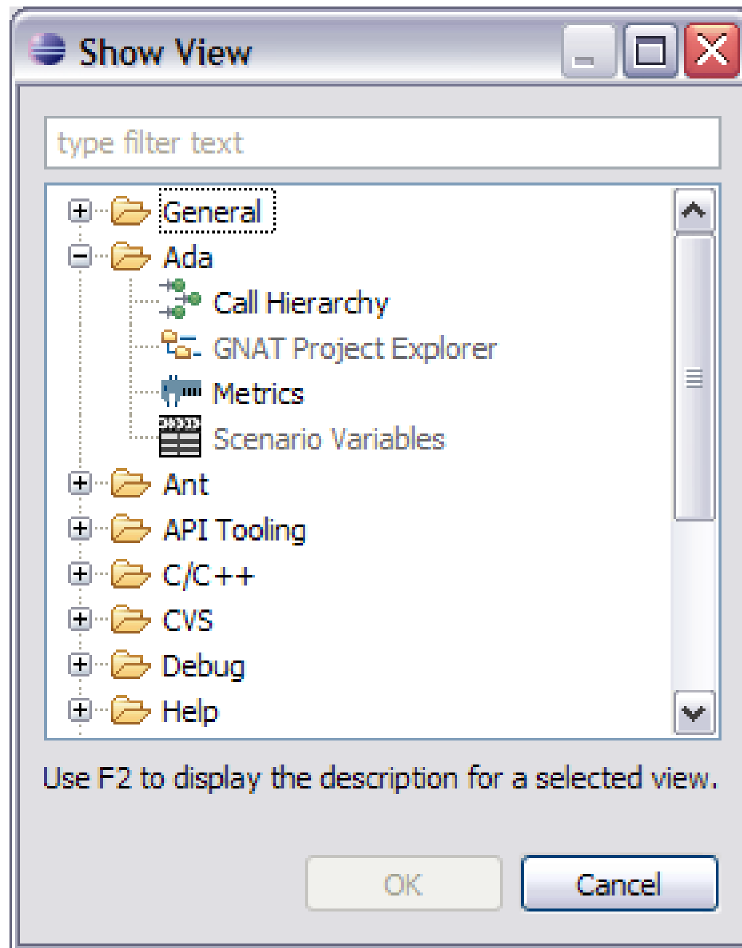


Enabling the GNAT Project Explorer

In the Ada perspective you can open the view by using the Window menu entry and selecting the shortcut to the view:



Otherwise you can use the Window menu entry and select "Show View" -> "Other…" to bring up the dialog box shown below. Expand the "Ada" category and select "GNAT Project Explorer".



Press OK and the Explorer will open.

Source Folders and Source Files

"Source folders" are those folders specified in the GNAT project file via the "Source_Dirs" attribute. Similarly, "binary folders" are those folders defined to contain compilation products, such as object files and executables, via the "Object_Dir" and "Exec_Dir" attributes. The figure below illustrates two of these attributes:

```
2
3    for Source_Dirs use ("src", "utils", "mains");
4    for Object_Dir use "obj";
5
```

"Source files" are files that are both located within "source folders" and are of recognized languages defined by GNAT and the GNAT project file. The next figure shows a typical definition of the Languages attribute in a project file:

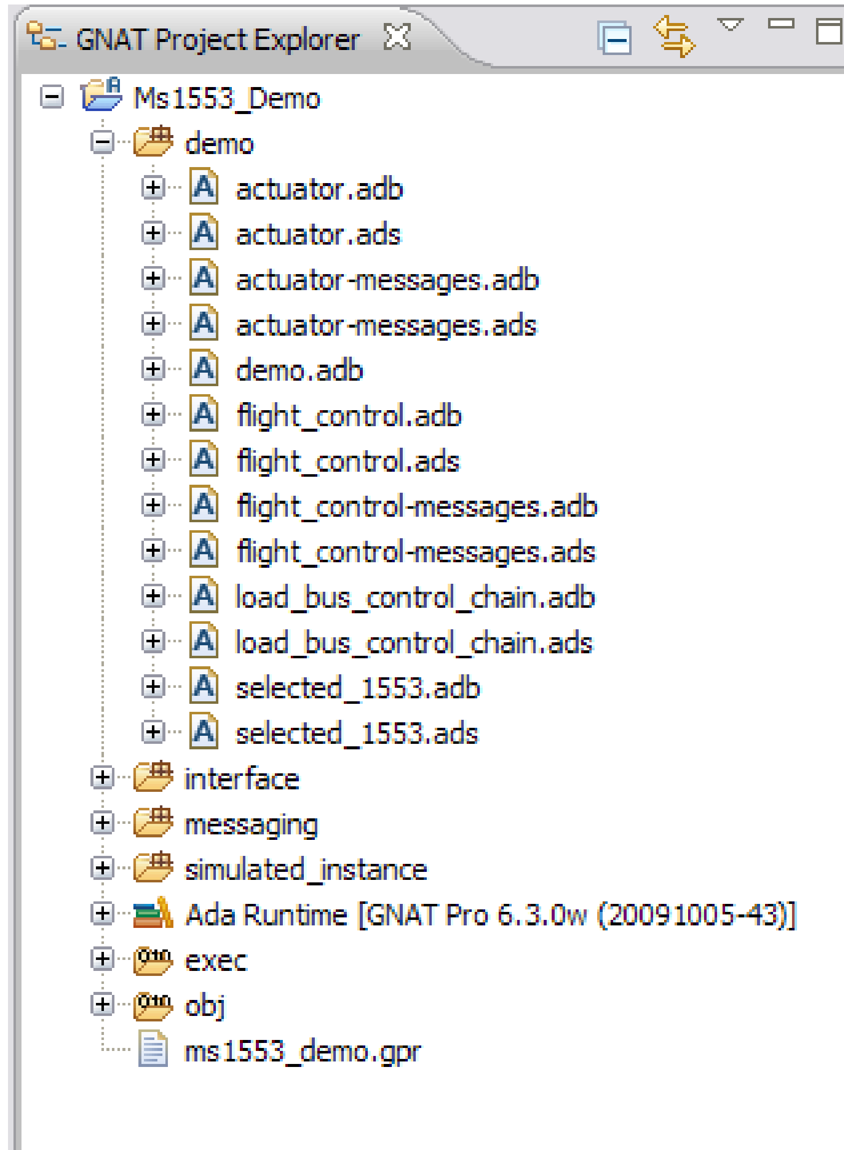
```
14
15    for Languages use ("Ada", "Index", "Listing", "Metafile", "Pogs Summary", "Siv", "Vcg");
16
```

The GNAT Project Explorer only shows the "source files" within a "source folder". If you want to maintain other files in folders, you should create additional folders to contain them rather than use a "source folder" for that purpose.

Viewing Project Source Folders and Files

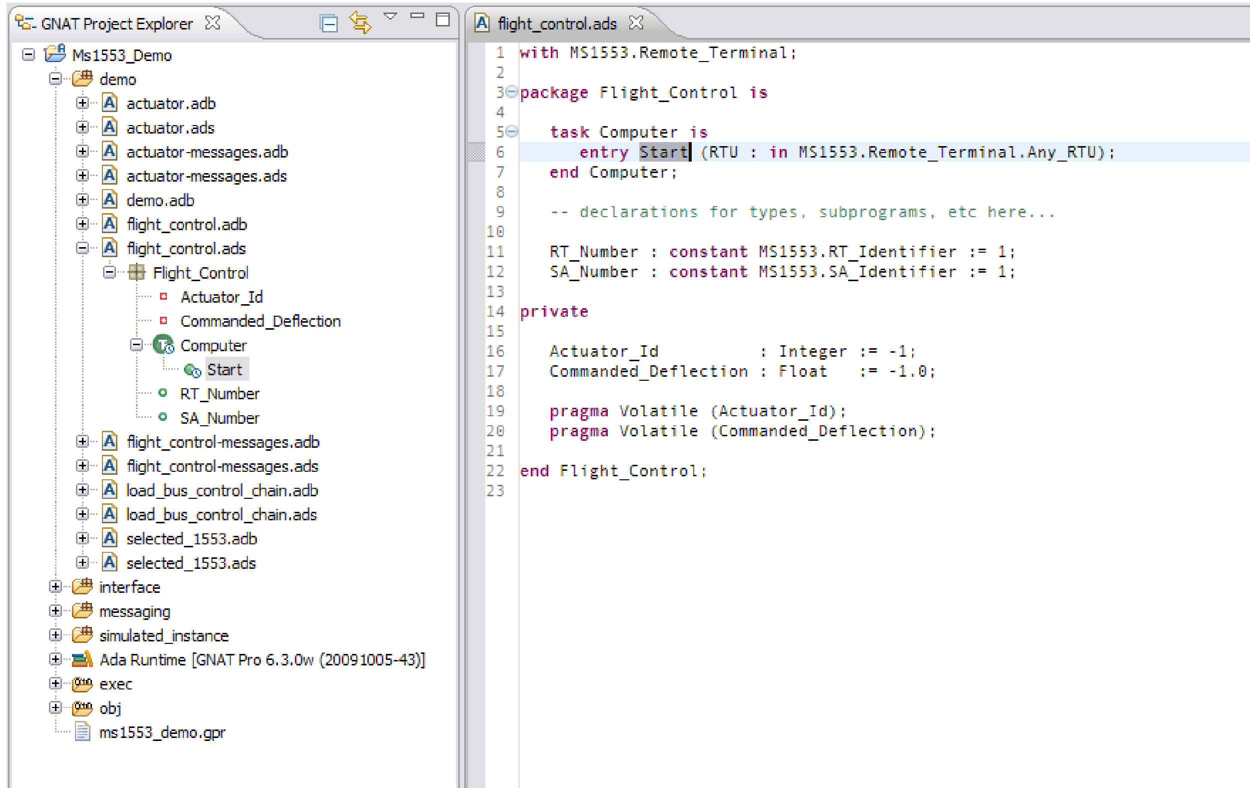
The GNAT Project Explorer shows the source folders and source files within those directories, in tree format, as the first node(s) in the project. The icon for the source folders is that of a folder containing a package, as shown below. Clicking on file names within these trees will open the corresponding files in the Ada-aware editor.

Note that the source folders are displayed as a flat list, regardless of how they are represented on the disk.



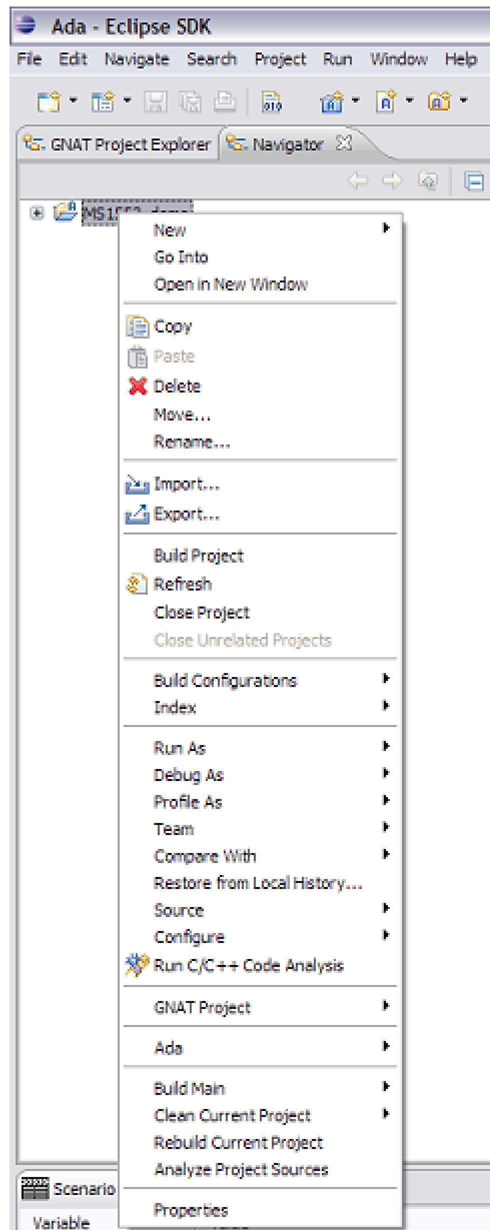
Browsing Unit Content

Additionally, the GNAT Project Explorer includes browser functionality similar to that of the Outline View. In particular, if you expand a given file node you will see icons for the language-specific contents of the file. Clicking on one of these entities in the Project Explorer will take you to the source code for that entity, opening the file in an editor if not already open.

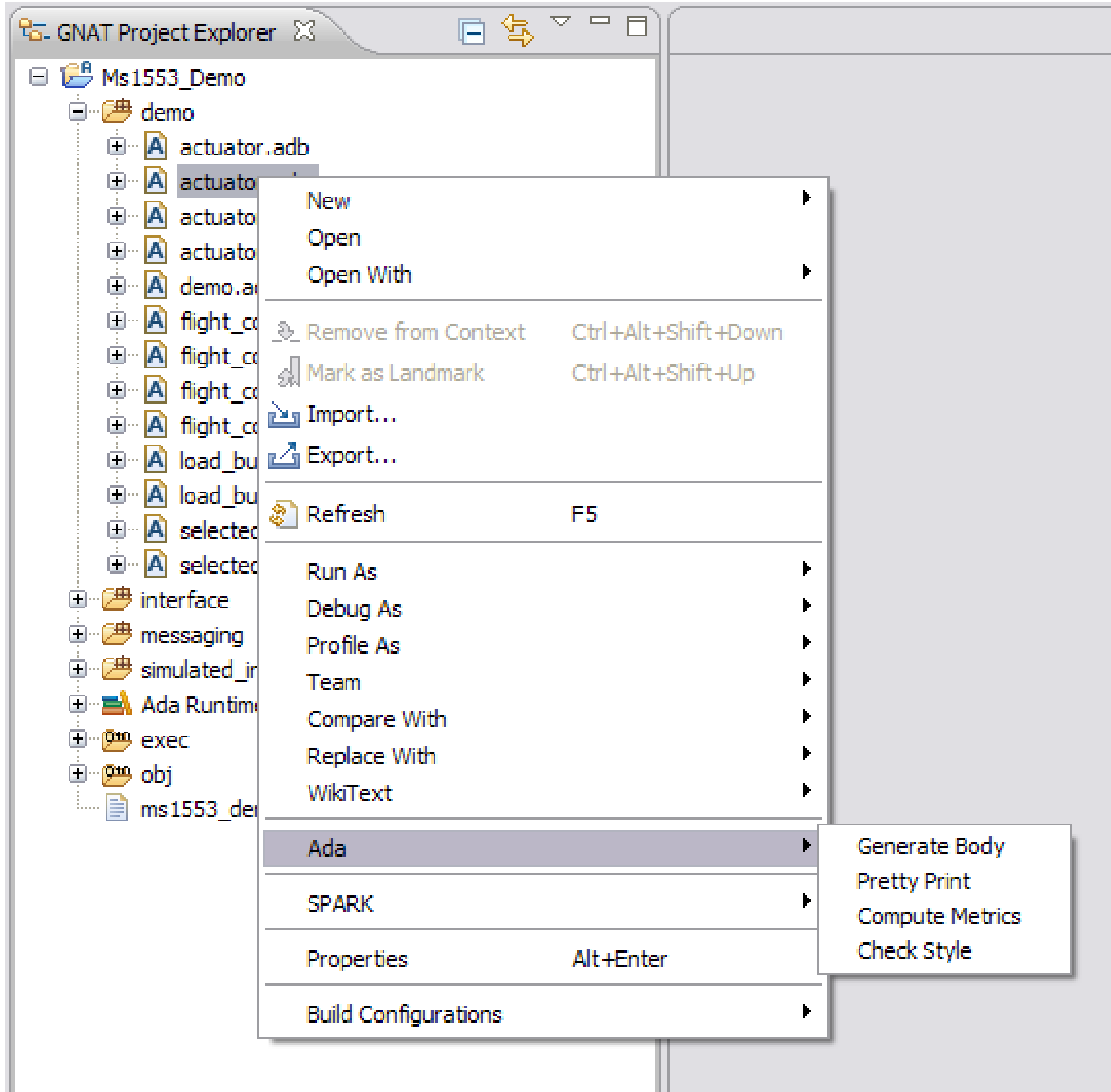


Contextual Menus

Project nodes within the GNAT Project Explorer have a contextual menu offering specific commands for Ada development, as well as some general capabilities. Additional menu entries for other external tools will also appear, in particular SPARK if it is installed.



Lower level nodes also have a contextual menu offering specific commands for Ada development. Note in particular the command to compile the corresponding file.



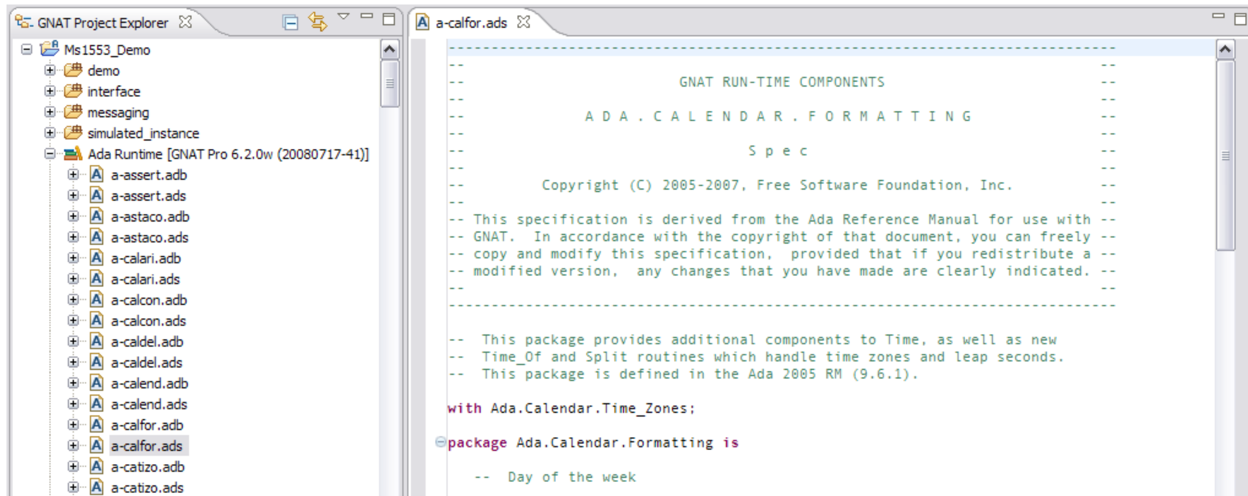
Viewing Run-Time Library Files

The run-time library entry gives access to the run-time files currently used by the project. You can open any of these files in the editor for browsing. You should not alter these files unless you intend to recompile the library.

Note that the run-time library files include the GNAT-provided utility packages in the GNAT.* hierarchy.

Note also that the displayed content may change if you install a new version of the compiler or if you change the settings of the project file to use a different compiler or run-time library.

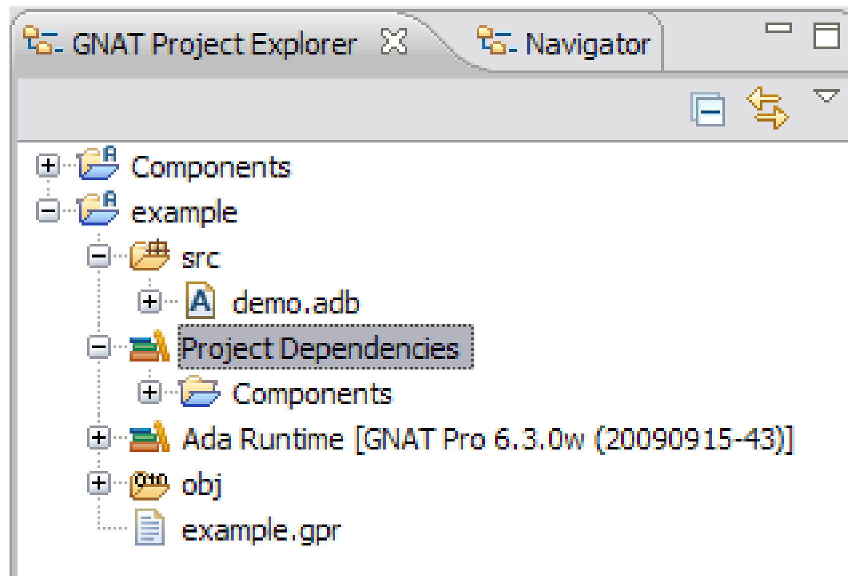
In the following figure we have expanded the run-time library node to show the source files and have opened the spec for package Ada.Calendar.Formatting in the file named "a-calfor.ads"



Viewing Project Dependencies

The GNAT Project Explorer displays the other projects, if any, that the current project depends upon. (One project depends upon another if its GNAT project file (the "gpr file") contains a "with-clause" specifying the other GNAT project file.) These dependencies are displayed in a sub-node named "Project Dependencies."

For example, the following figure illustrates the case in which the GNAT project "example" depends upon another project named "Components":

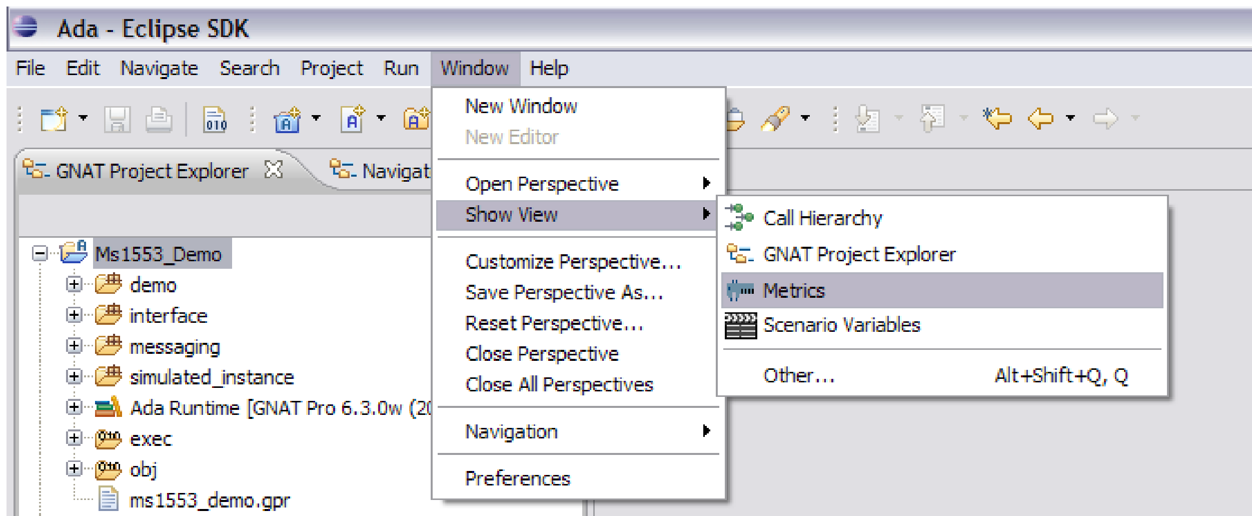


2.2.10 Metrics View

The Metrics view shows the results of performing a metrics analysis on Ada source files using several different metric quantifiers. See *Metrics Analysis* for the details.

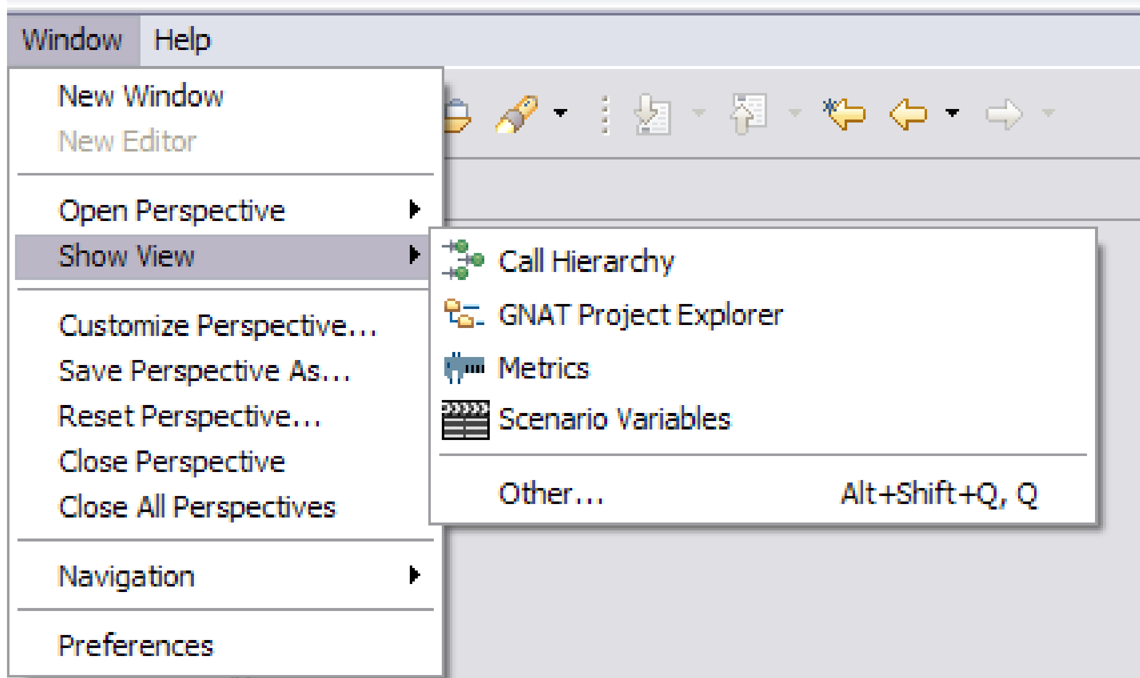
Results are shown in a tree format, with an overall project summary provided first. Results for each file then follow the project summary. In the figure below, the view has been maximized to show more of the results, and both the summary and the results for one of the subprograms have been expanded.

The Metrics view will be opened automatically after the analysis completes. You can open the view manually, using the shortcut:

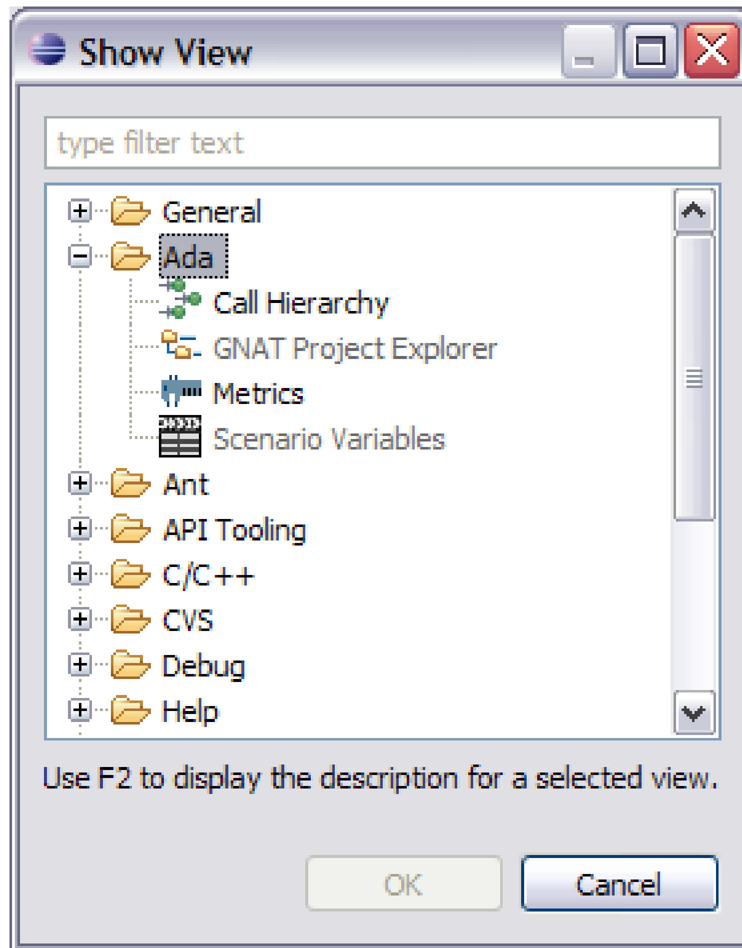


2.2.11 Opening GNATbench Views

In the Ada perspective, you can open a GNATbench view using the "Show View" menu entry (under the Window menubar entry):



When not in the Ada perspective, use the Window menubar entry select "Show View" as before, and then select "Other..." to bring up the dialog box shown below. Expand the "Ada" category and select the view desired.



2.2.12 Ada Build Console

GNATbench will show the steps for any project build command in a specific subconsole for that project. These commands include the user-defined commands invoked via the builder menus, as well as the standard builder commands (including project cleaning) and the GNATbench extended build commands.

The subconsole will have a title of "Ada build" followed by the name of the project enclosed within square brackets. For example, in the following figure, the project Ms1553_Demo has completed a full build:

Problems | Console | Scenario Variables

Ada build [Ms1553_Demo]

```
gcc -c -g -gnatQ -gnato -gnat05 -g -gnatwa -I- -gnatA C:\eclipse\workspace\Ms1553_Demo\simulated_instance\simulated-subaddress.adb
gcc -c -g -gnatQ -gnato -gnat05 -g -gnatwa -I- -gnatA C:\eclipse\workspace\Ms1553_Demo\messaging\ms1553-message_element.adb
gcc -c -g -gnatQ -gnato -gnat05 -g -gnatwa -I- -gnatA C:\eclipse\workspace\Ms1553_Demo\messaging\ms1553-message_element-predefined.adb
ms1553-message_element-predefined.adb:52:42: warning: formal parameter "From" is read but never assigned
ms1553-message_element-predefined.adb:105:49: warning: formal parameter "From" is read but never assigned
ms1553-message_element-predefined.adb:151:47: warning: formal parameter "From" is read but never assigned
gcc -c -g -gnatQ -gnato -gnat05 -g -gnatwa -I- -gnatA C:\eclipse\workspace\Ms1553_Demo\messaging\ms1553-message.adb
gcc -c -g -gnatQ -gnato -gnat05 -g -gnatwa -I- -gnatA C:\eclipse\workspace\Ms1553_Demo\simulated_instance\simulated-bus.adb
gcc -c -g -gnatQ -gnato -gnat05 -g -gnatwa -I- -gnatA C:\eclipse\workspace\Ms1553_Demo\messaging\ms1553-message_element-utils.adb
gnatbind -static -I- -x C:\eclipse\workspace\Ms1553_Demo\obj\demo.ali
gnatlink C:\eclipse\workspace\Ms1553_Demo\obj\demo.ali -g -g -o C:\eclipse\workspace\Ms1553_Demo\exec\demo.exe
Ada builder for [Ms1553_Demo] completed Jan 11, 2008 8:35:31 AM CST.
```

2.3 Allocating Enough Memory and Solving OutOfMemoryErrors

With GNATbench installed, you may get OutOfMemoryErrors raised by Eclipse. If this happens, it's likely the case that your Java Virtual Machine doesn't reserve enough memory for Eclipse. There are two ways of solving this problem. If the error is raised at startup, you may want to increase the initial amount of memory reserved by the virtual machine. By default, Eclipse will allocate up to 256 megabytes. But it allows you to pass arguments directly to the Java VM using the -vmargs command line argument, which must follow all other Eclipse specific arguments. Thus, to increase the available heap memory, you would typically use:

eclipse -vmargs -Xmx<*memory size*>

with the <*memory size*> value set to greater than "256M" (256 megabytes – the default).

When using a Sun VM, you may also need to increase the size of the permanent generation memory. The default maximum is 64 megabytes The maximum permanent generation size is increased using the -XX:MaxPermSize= argument:

eclipse -vmargs -XX:MaxPermSize=<*memory size*>

This argument may not be available for all VM versions and platforms; consult your VM documentation for more details.

Note that specifying memory sizes larger than the amount of available physical memory on your machine will cause Java to "thrash" as it copies objects back and forth to virtual memory, which will severely degrade your performance.

CHAPTER

THREE

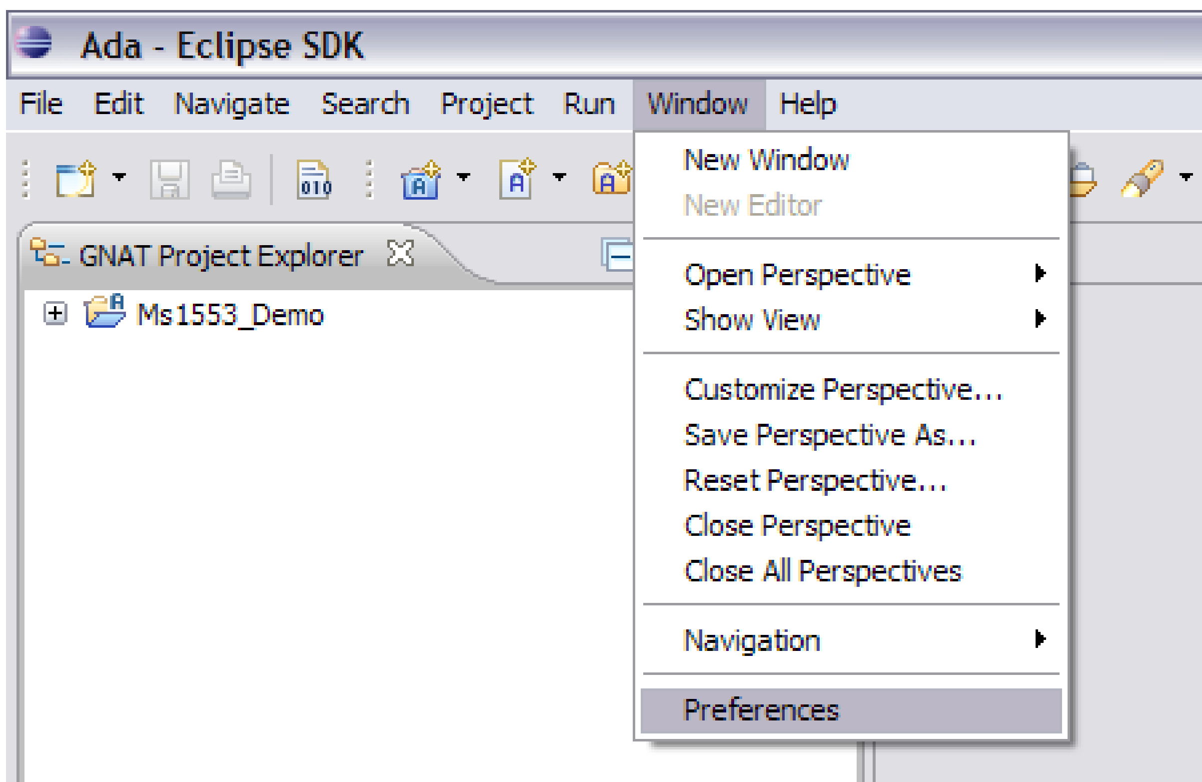
SETTING PREFERENCES

3.1 GNATbench Preferences

GNATbench allows the user to control a number of behaviors and presentation formats. This section introduces and summarizes the preferences providing those controls.

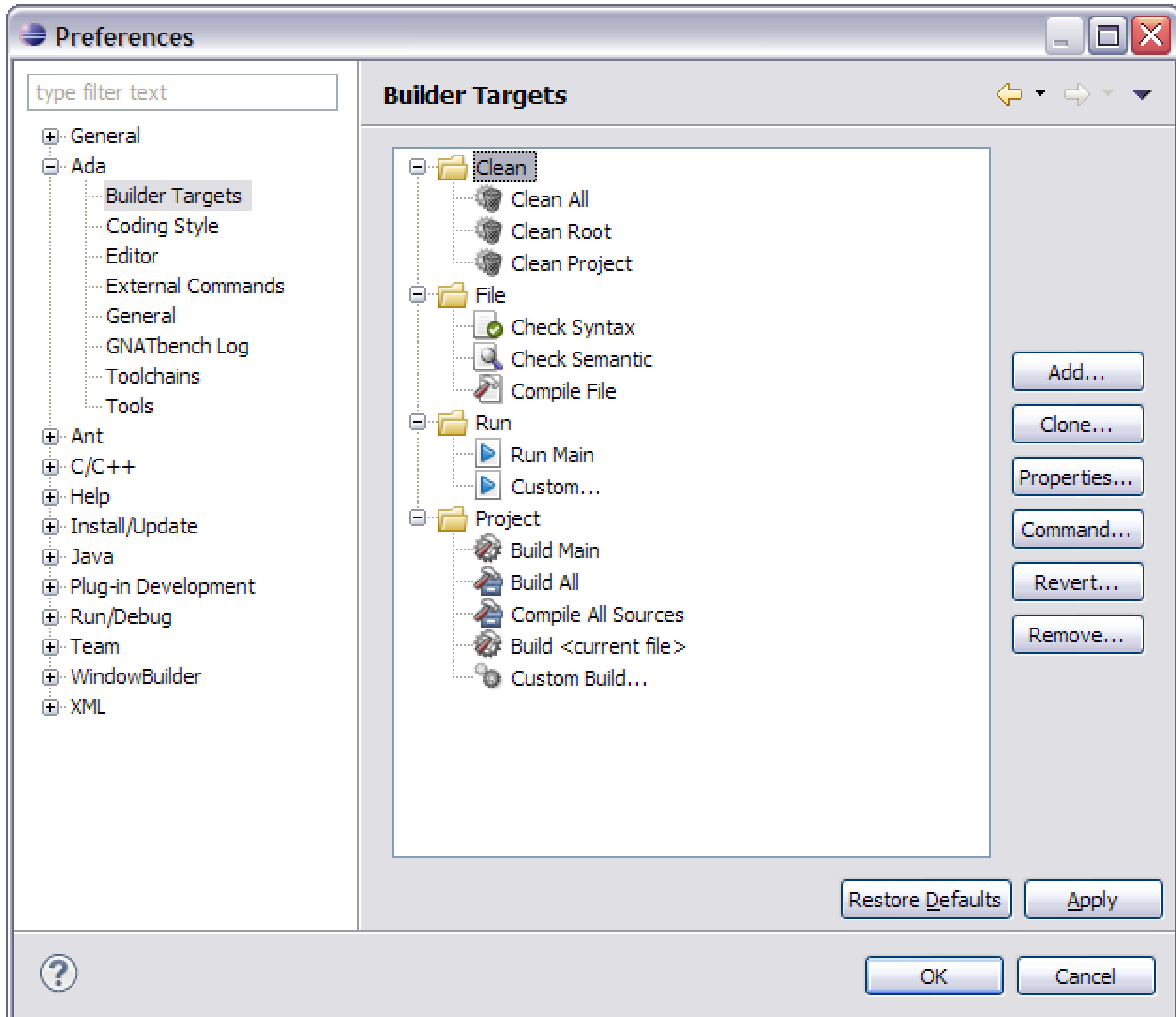
Most of these preferences are described in detail in the other sections specific to the preference (e.g., automatic indentation is discussed in the Editing section).

In all cases these preferences are initially accessed via the "Window" menu entry and the "Preferences" submenu entry that brings up the preferences dialog box.



3.2 Builder Targets

GNATbench provides an interface for launching operations like building projects, compiling individual files, performing syntax or semantic checks, and so on. All these operations involve launching an external command and parsing the output for error messages. These operations are called "Targets" and can be configured through this preference page.



3.2.1 The Targets Tree

The Targets Tree contains a list of targets organized by category. In the figure above, we have expanded the categories to show the individual targets currently defined.

To the right of the tree are several buttons:

- The Add button creates a new target.
- The Remove button removes the currently selected target. Note that only user-defined targets can be removed, the default targets created by GNATbench cannot be removed.
- The Clone button creates a new user-defined target which is identical to the currently selected target.

- The Revert button resets all target settings to their original value.
- The Properties and the Command buttons invoke the dialogs described below.

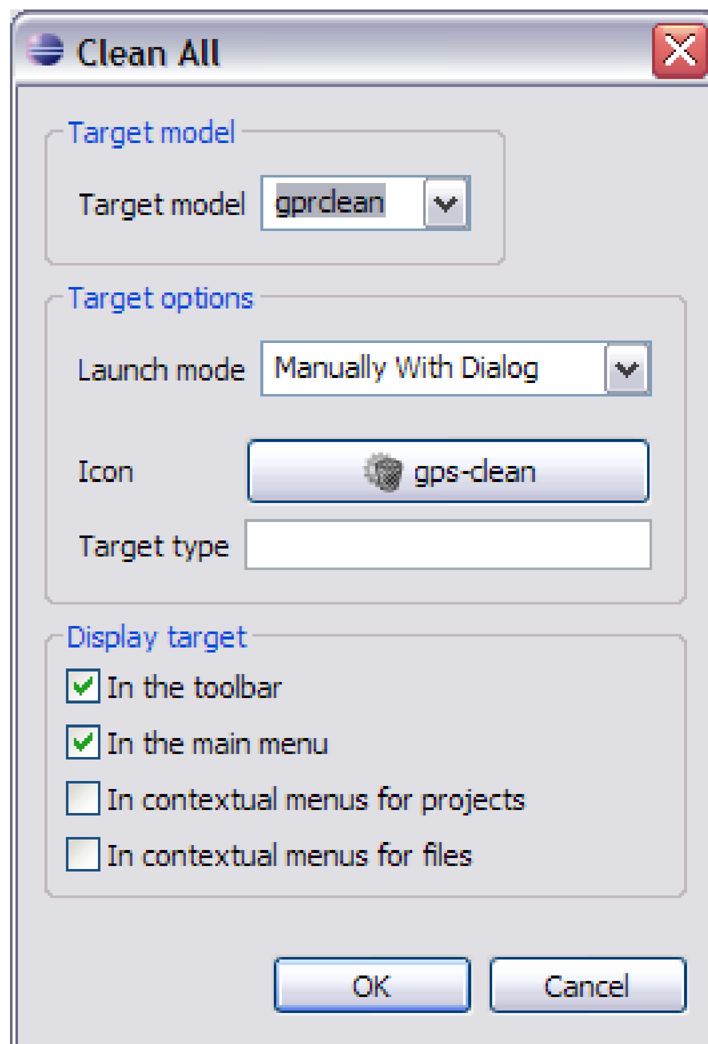
At the bottom of the tree are the following buttons:

- The Restore Defaults button delete all user-added targets, and revert the others.
- The Apply button saves the modifications and applies them to the platform.
- The OK button stores the modifications in the current workspace and closes the preference page.
- The Cancel button closes the preferences page without saving any further changes.

Note that any modifications saved as a result of previously pressing the Apply button will be retained, they are not undone by Cancel.

3.2.2 The Properties Dialog

The Properties dialog allows you to control how the individual command is presented and how it interacts with the user.



On top of the dialog one can select the Target model. The Model determines the graphical options available in the "Command line" frame.

The "Target Options" frame contains a number of options that are available for all Targets.

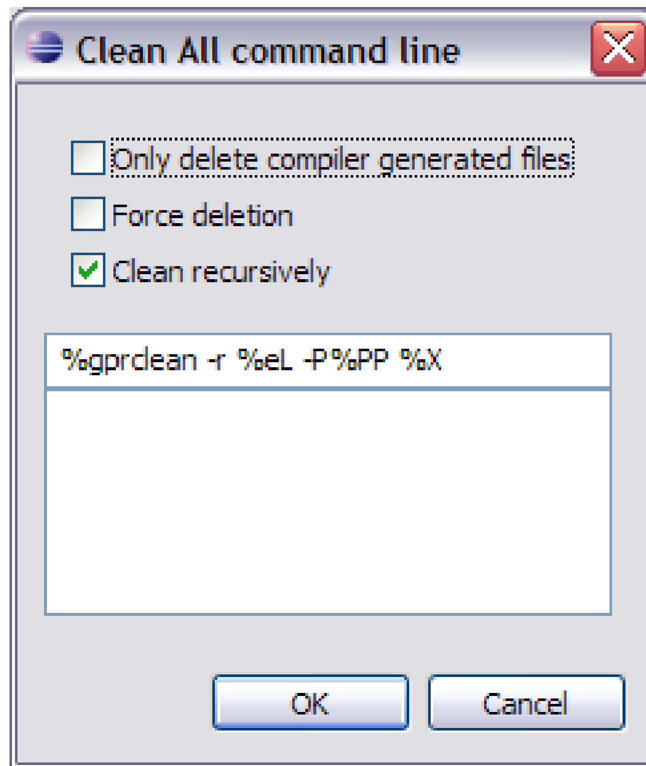
- The Launch mode indicates the way the target is launched:
  - Manually: the target is launched when clicking on the corresponding icon in the toolbar, or when activating the corresponding menu item. In the latter case, a dialog is displayed, allowing last-minute modifications of the command line.
  - Manually with dialog: same as Manually, but the dialog is always displayed, even when clicking on the toolbar icon.
  - Manually with no dialog: same as Manually, but the dialog is never displayed, even when activating the menu item.
  - On file save: the Target is launched automatically by GNATbench when a file is saved. The dialog is never displayed.
  - In background: the Target is launched automatically in the background after each modification in the source editor.
- Icon: the icon to use for representing this target in the menus and in the toolbar.
- Target type: type of target described. If empty, or set to *Normal*, represents a simple target. If set to another value, represents multiple subtargets. For example, if set to *main*, each subtarget corresponds to a Main source as defined in the currently loaded project.

The "Display" frame indicates where the launcher for this target should be visible.

- in the toolbar: when active, a button is displayed in the main toolbar, allowing to quickly launch a Target.
- in the main menu: whether to display a menu item corresponding to the Target in the build menu. By default, Targets in the "File" category are listed directly in the Build menu, and Targets in other categories are listed in a submenu corresponding to the name of the category.
- in contextual menus for projects: whether to display an item in the contextual menu for projects in the Project View
- in contextual menus for files: whether to display an item in the contextual menus for files, for instance in file items in the Project View or directly on source file editors.

3.2.3 The Command Line Dialog

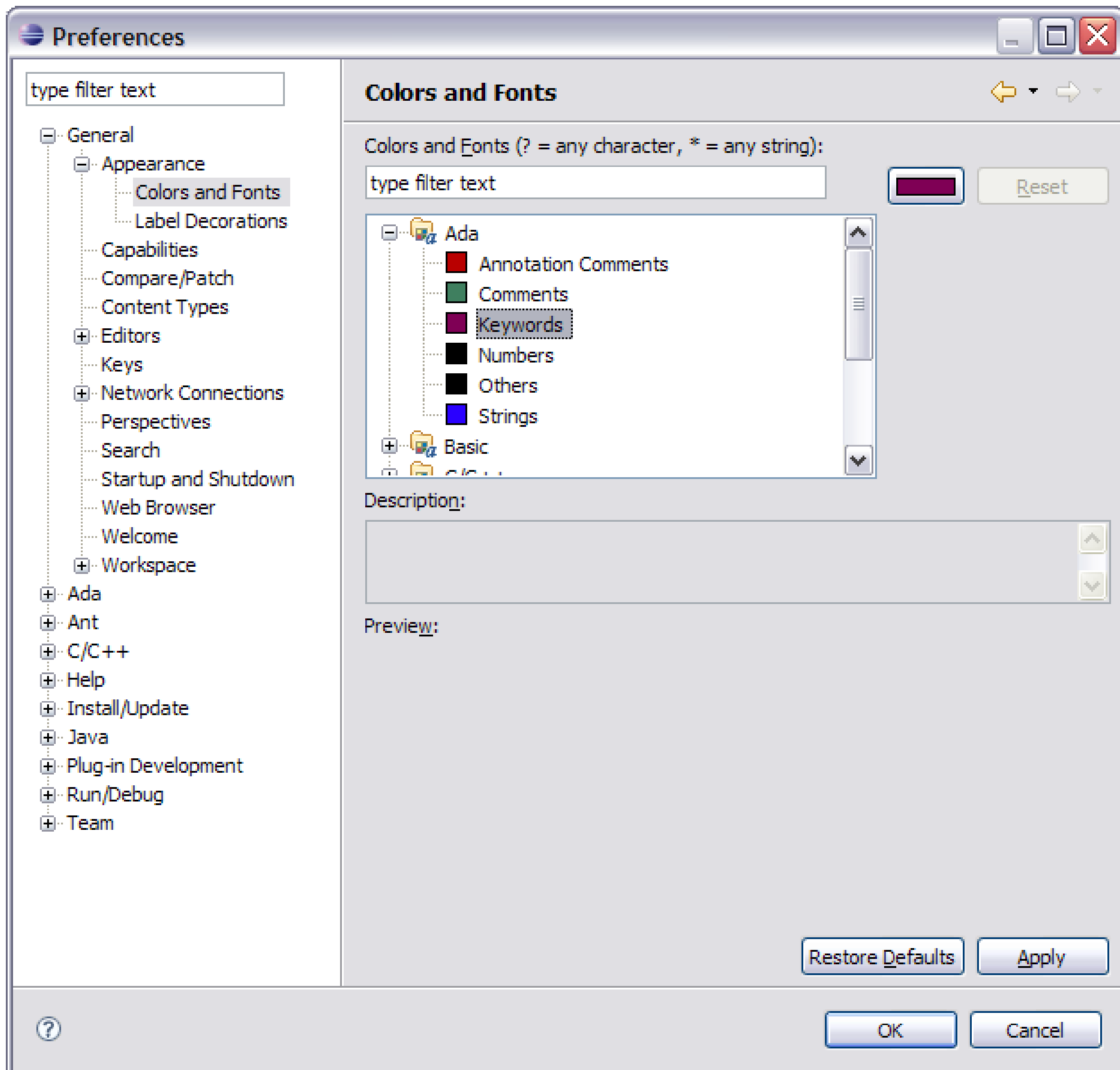
The "Command Line" dialog contains a graphical interface for some configurable elements of the Target that are specific to the Model of this Target.



The full command line is displayed at the bottom. Note that it may contain Macro Arguments. For instance if the command line contains the string "%PP", GNATbench will expand this to the full path to the current project.

3.3 Syntax Coloring

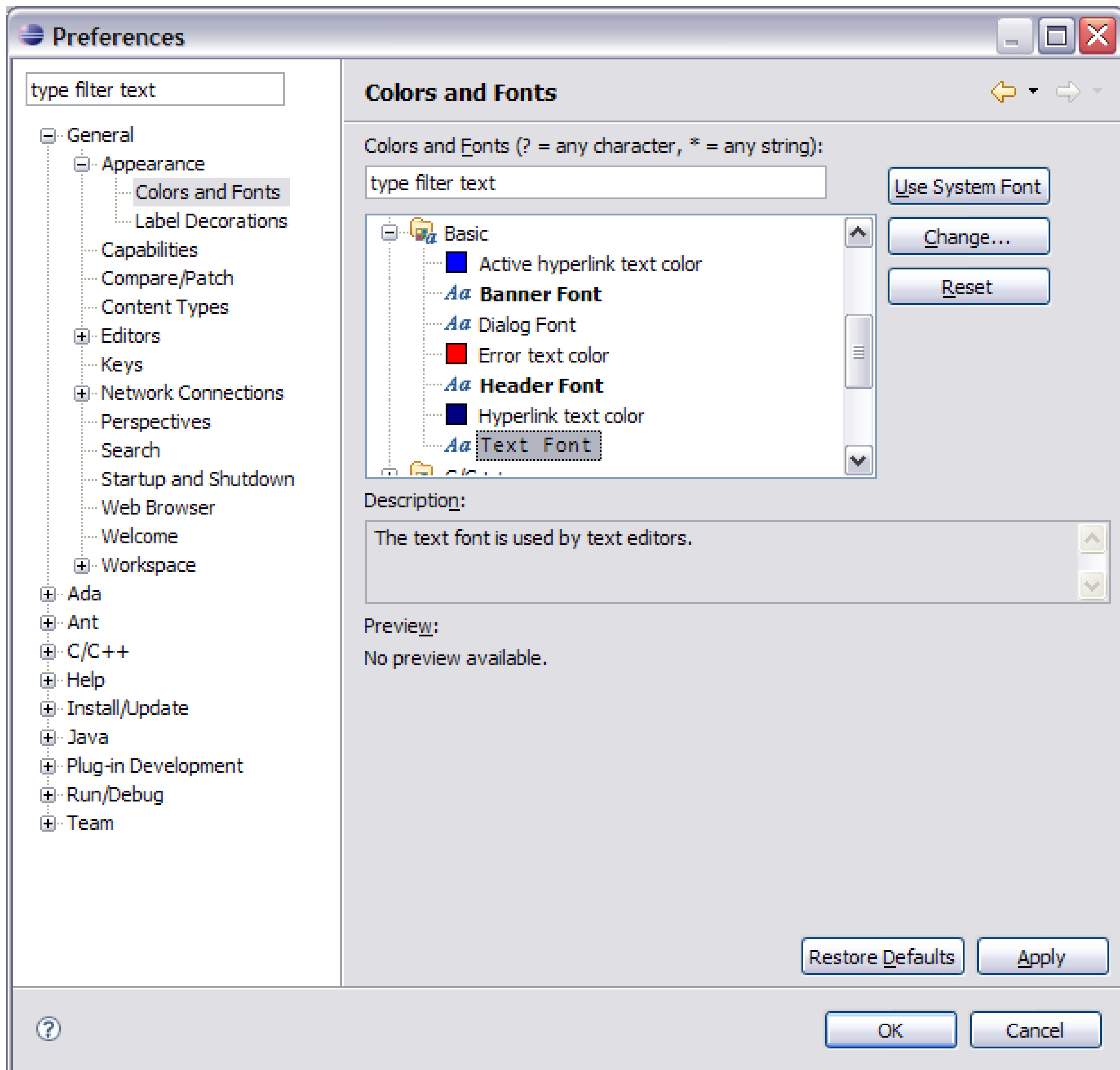
The colors for various Ada constructs can be specified via the "General/Appearance/Colors and Fonts" preferences page. In the resulting scrollable tree panel on the right, expand the "Ada" category to see the constructs that can be controlled, as shown in the following figure. To change a color, select the construct category and press the colored button on the upper right of the dialog box. The color of the button indicates the current color selection for that construct category.



3.4 Editors' Font

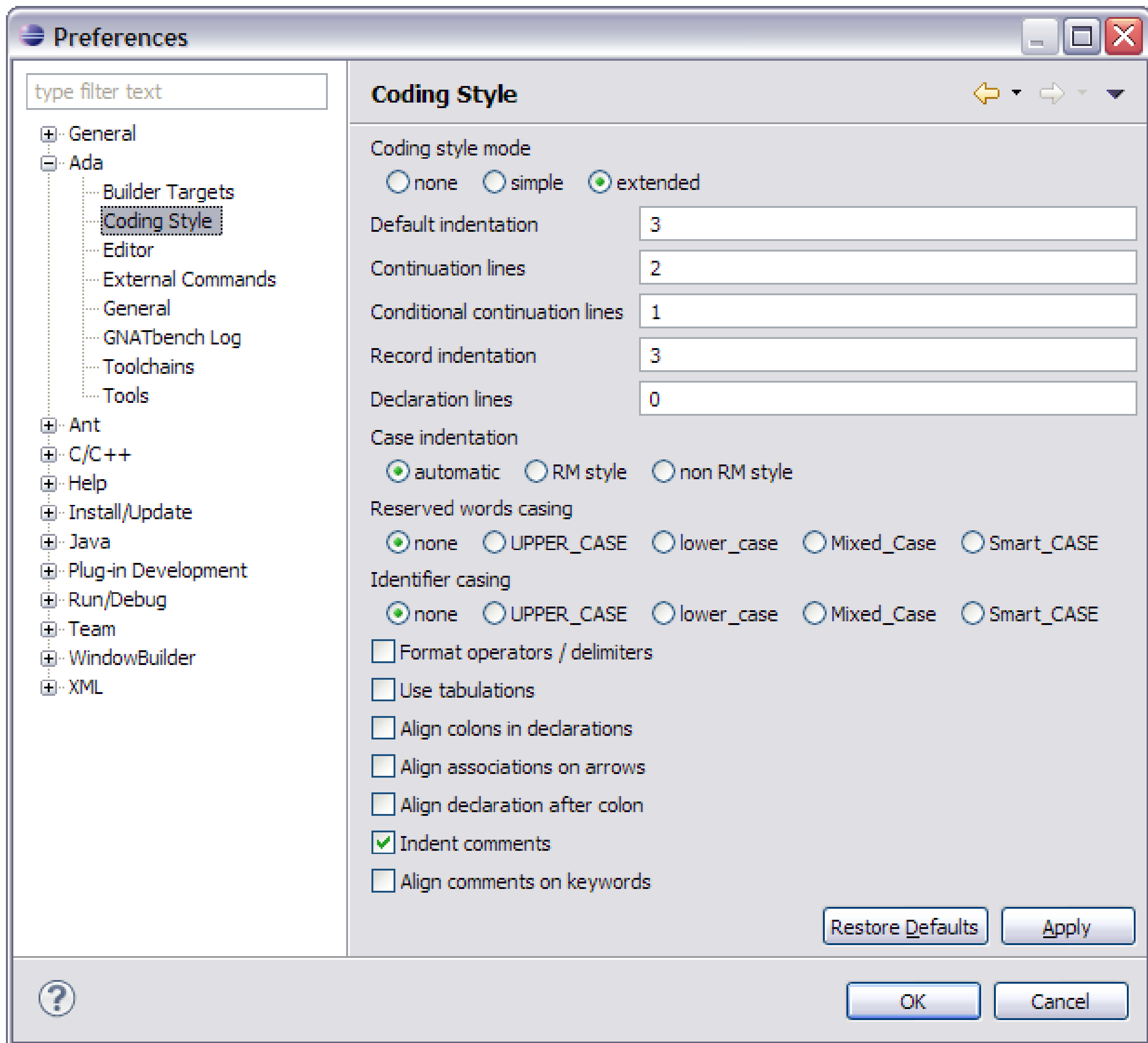
The overall text font used by the editors, including the Ada editor, can be selected via the normal Eclipse "Text Font" preference in the "Basic" category (directly below the "Ada" category in the scrollable tree pane on the "Colors and Fonts" page). Note that fonts are not specific to constructs.

To change the font, select "Text Font" and press the Change… button. This will invoke the font selection dialog.



3.5 Coding Style

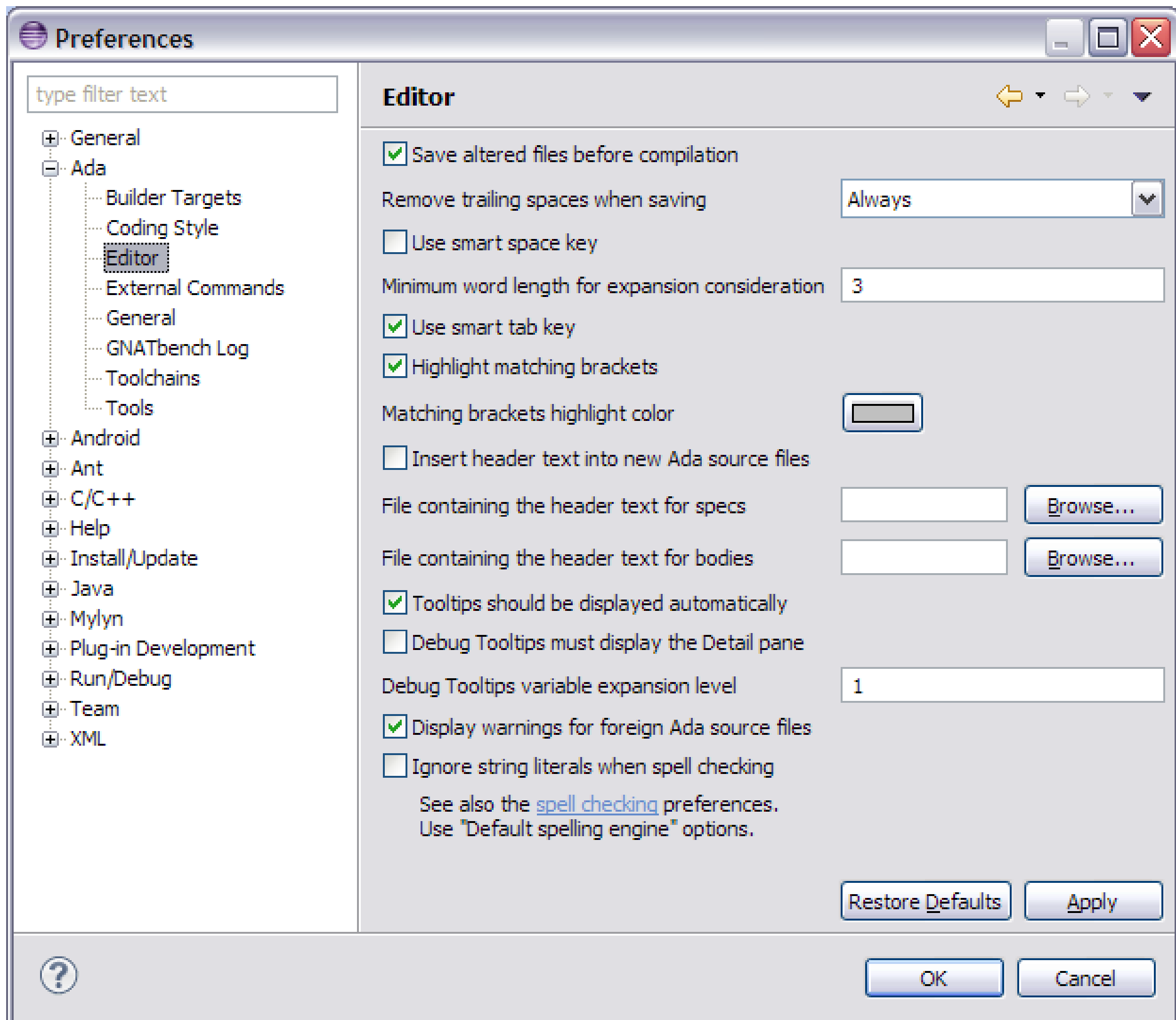
The many style and formatting preferences, including for example automatic indentation and letter casing preferences, are described in the Editing chapter and are controlled by the preferences page shown below. The default values are as shown.



3.6 Editor

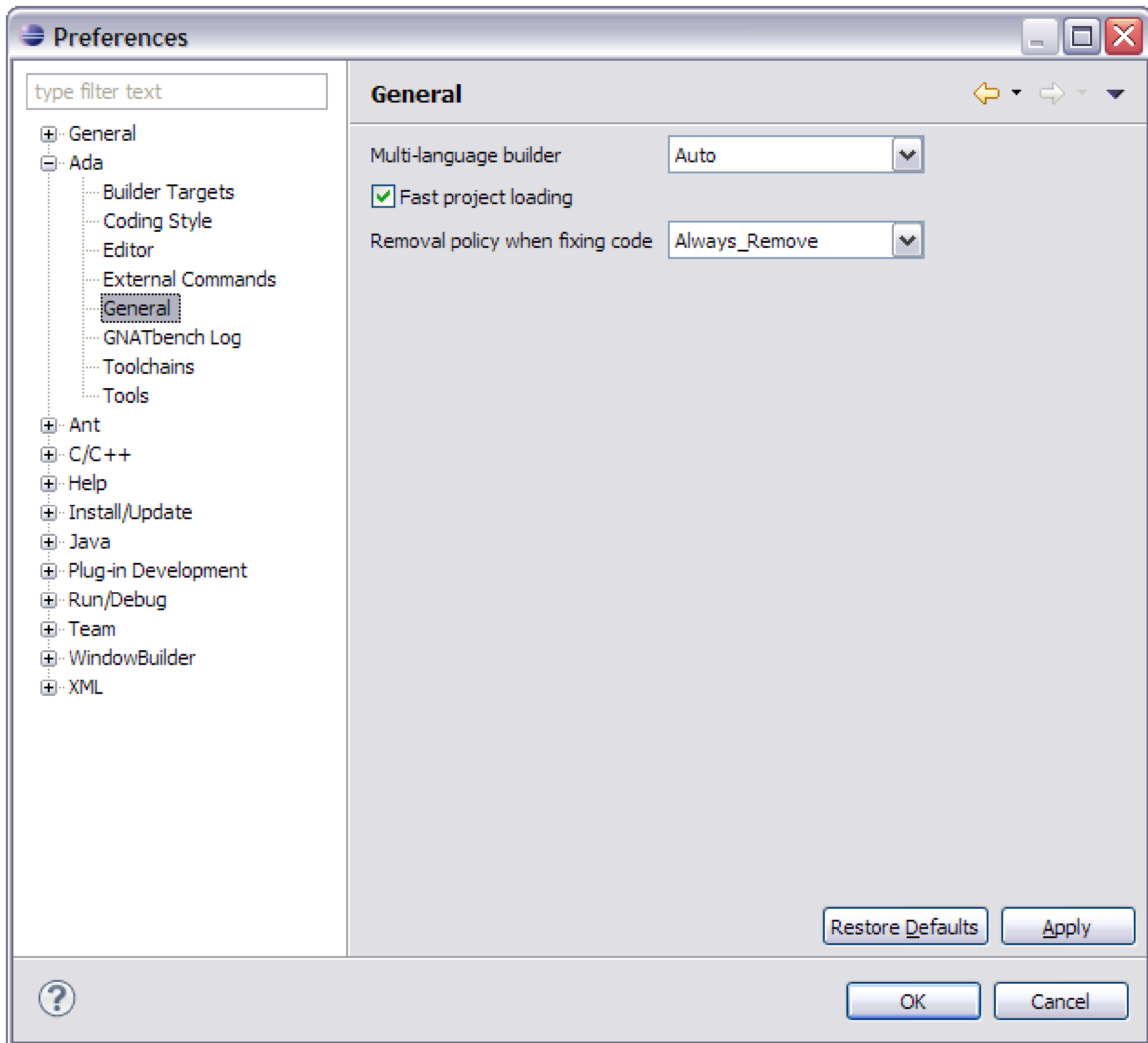
The editor behavior preferences are controlled by the preferences page shown below. All these preferences are described in the Language-Sensitive Editing chapter except for the following:

- The "remove trailing spaces when saving" preferences controls whether trailing blanks should be removed when Save or "Save As…" action is triggered. Choosing Autodetect will keep trailing blanks only if original file had already trailing blanks.
- The tooltips preference controls whether tooltips are displayed within the Ada editor. Tooltips are displayed whenever the cursor is "hovered" over an Ada entity.
- The spelling preference controls whether the text within string literals is checked for correctness.
- The "Display warnings for foreign Ada source files" preference controls whether a dialog is displayed when invoking the editor on an Ada source file that is not part of any GNATbench project. See *Foreign Ada Source Files* for details.



3.7 General Preferences

General purpose preferences for Ada are controlled by the dialog page in the following figure. The corresponding preferences dialog page is selected via the "General" page under the "Ada" category. The details of each preference are provided after the figure.



3.7.1 Multi-language Builder

This preference controls the builder to be invoked when building a project containing sources written in languages other than, or in addition to, Ada.

By default, `gprbuild` will be used. Alternatively, its prototype `gprmake` can be selected to help transition to gprbuild. General use of gprmake is not recommended.

To select gnatmake you can use the `gnatmake` setting, even for a project containing non-Ada sources, but *note that gnatmake will only process Ada source files, ignoring all others.* Use in a multi-lingual project is therefore not recommended.

Finally, to always use gprbuild, even when Ada is the only language involved, you can select the `gprbuild_always` setting.

3.7.2 Fast Project Loading

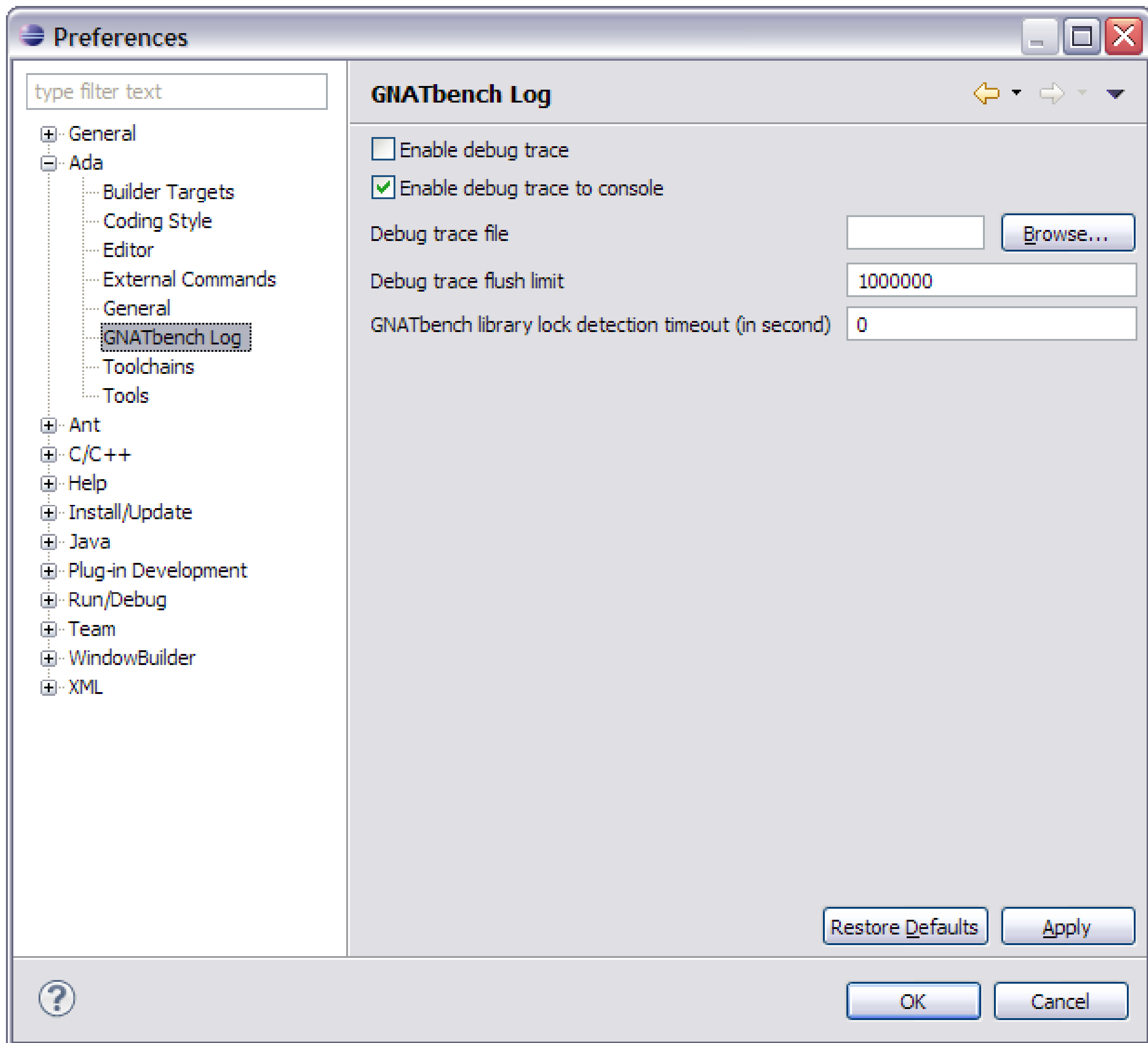
If enabled, the %eL token is replaced by -eL "Follow symbolic links when processing project files" when expanding builder commands. Symbolic links should **not** be used in the project. More precisely, you can only have symbolic links that point to files outside of the project, but not to files in the project.

3.7.3 Removal Policy When Fixing Code

This preference controls the way Quick Fix works when parts of the source code must be removed as part of the fix. `Always_Remove` means that the code will be removed. `Always_Comment` means that the code will always be commented out. `Propose_Both_Choices` will propose a menu with both choices.

3.8 GNATbench Trace Log

A "trace" log can be enabled for debugging GNATbench itself. (You will not need to enable this feature in normal operation.) This feature prints internal state information to a file (specified via this panel) and/or to the Eclipse console log. When AdaCore personnel ask you to enable this tracing, please also set the "Debug trace flush limit" preference to 0 to overcome any buffering of the information. See the figure below for these preference controls.



If you want the trace information to go to the Eclipse console log, the log can be enabled (if necessary) by adding the "-consolelog" option to the Eclipse invocation.

3.9 Toolchains

The toolchains presented to the user are stored and persist across sessions. These toolchains are presented by the wizard when creating a new project, for example, and in the properties page. You can manage the list with this preference page.

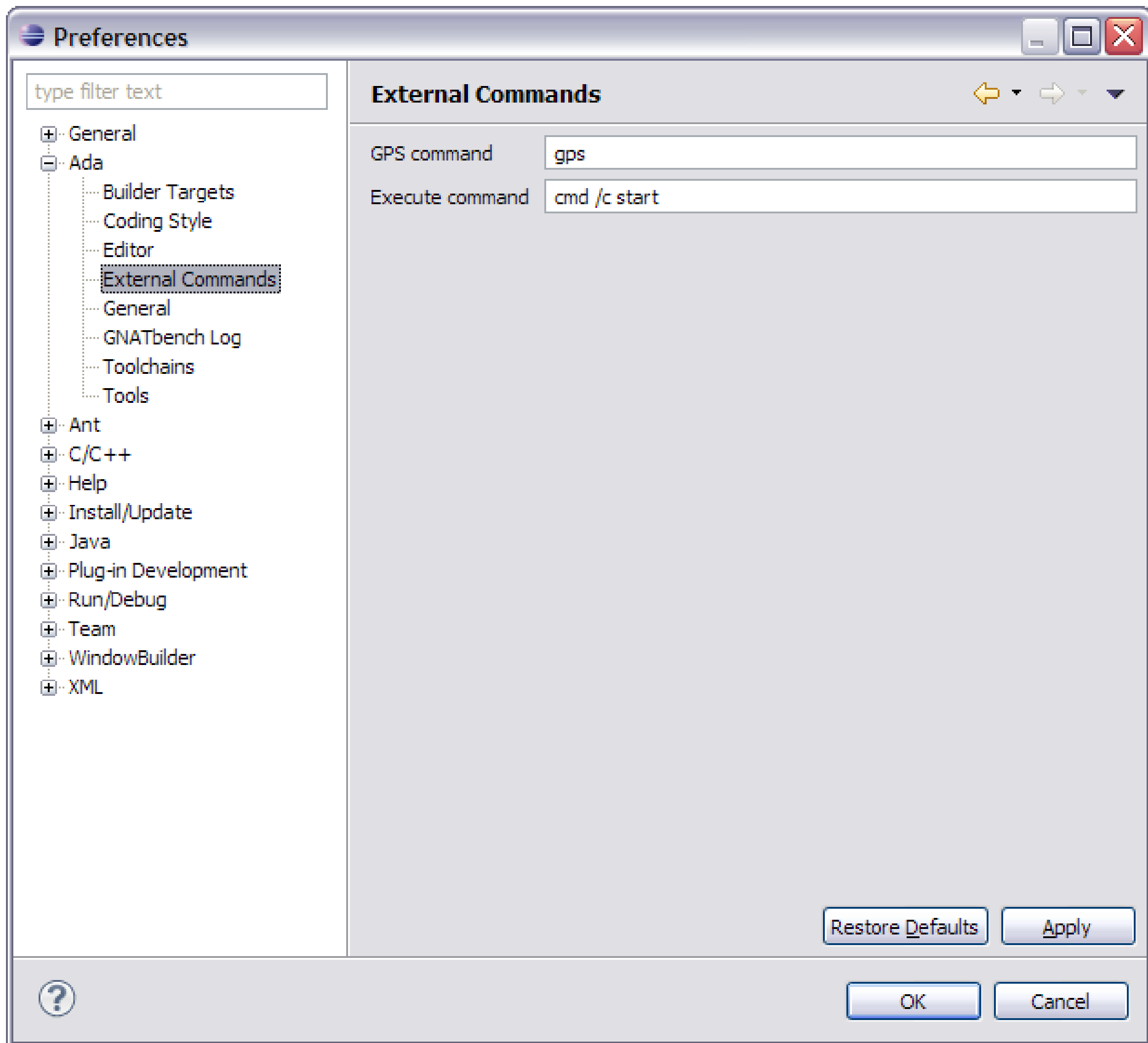
Note especially that you can update the list of known toolchains by pressing the Scan button, which will locate all GNAT compilers on the path.

3.10 External Commands

GNAT Studio can be invoked as an editor but is especially useful as an Ada-aware debugger and graphical interface. This preference specifies how to invoke GNAT Studio. The preference should only be changed at the suggestion of Ada personnel if a problem is encountered.

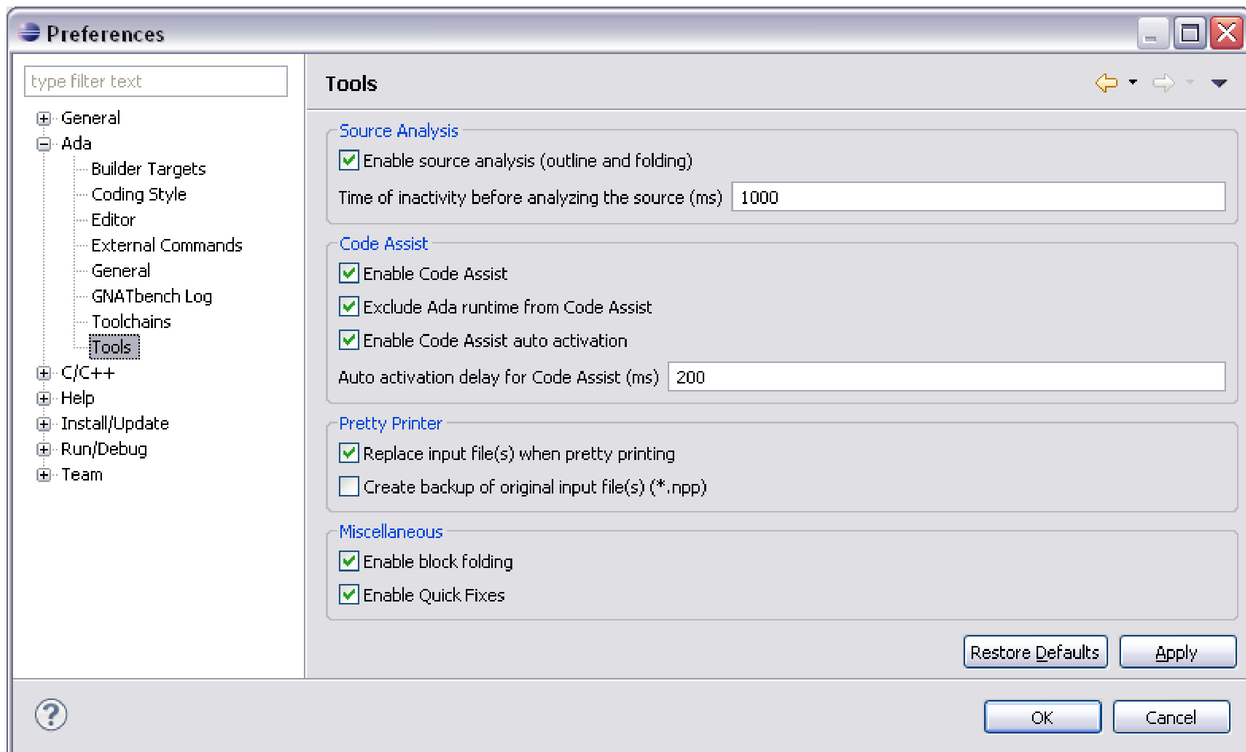
Execute command preference defines the program used to execute commands externally.

Make command preference defines the 'make' utility.



3.11 Tools

This page of preferences allows the user to configure the way the tools behave.



For example, you can disable the automatic scanning of the toolchains' run-time libraries for the symbols used by Code Assist. This scanning can take a long time and can therefore be disabled.

Similarly, Code Assist can be considered intrusive by touch-typists, so the facility can be entirely disabled, or if automatic invocation is enabled, the interval to delay can be specified.

CHAPTER FOUR

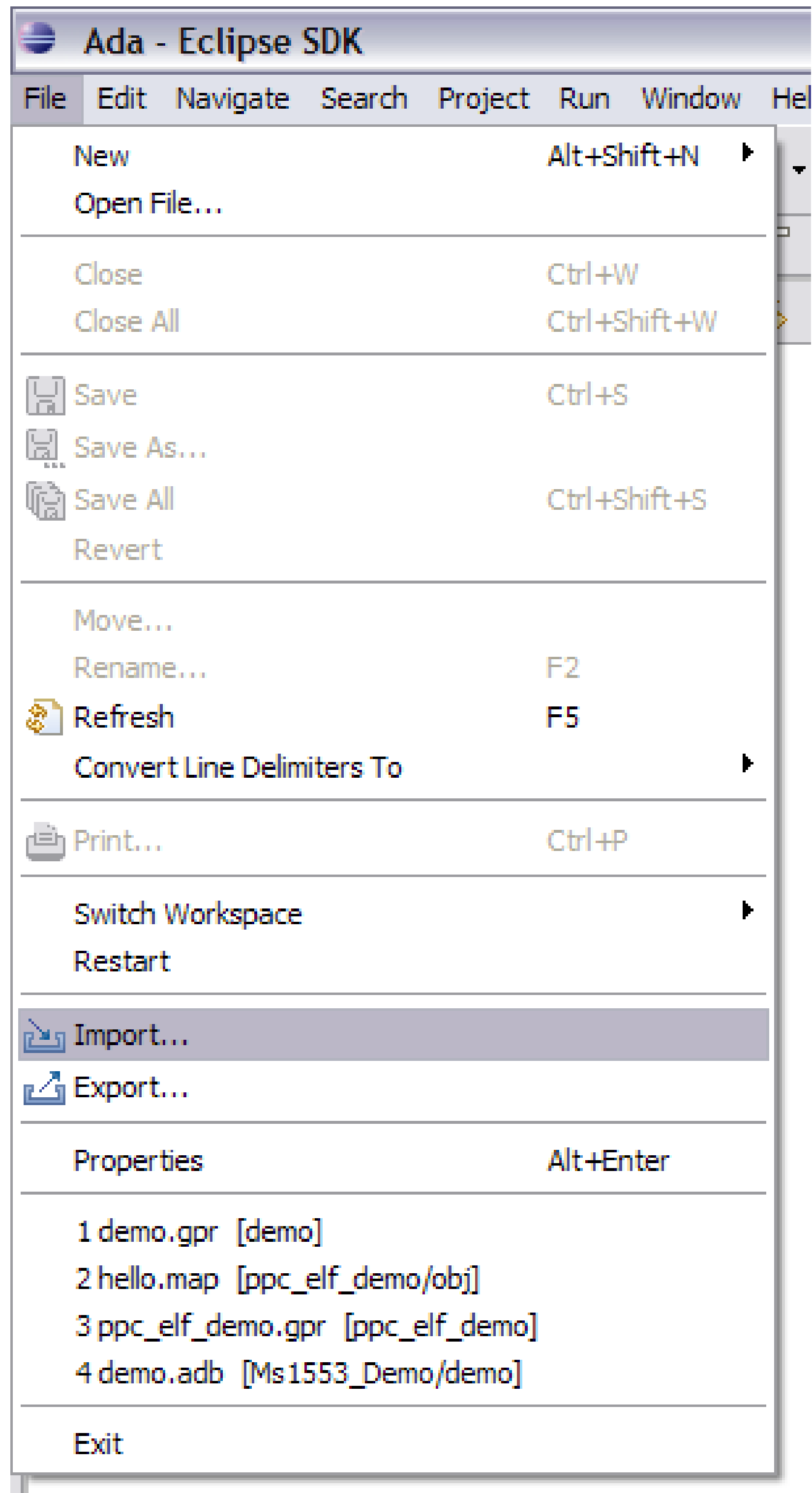
CREATING AND CONFIGURING PROJECTS

4.1 Importing Existing GNAT Projects

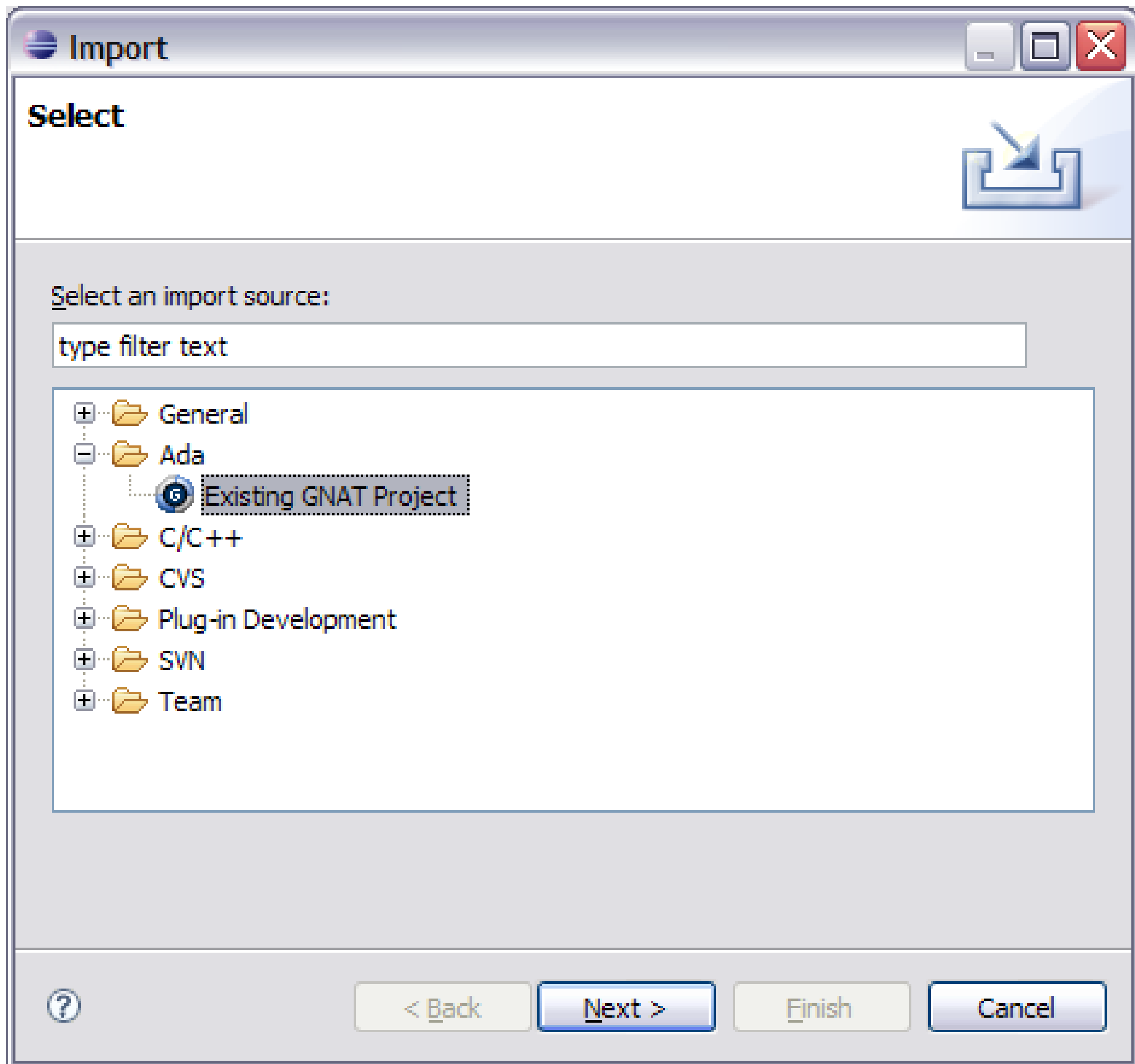
Importing existing GNAT projects (i.e., those defined by a GNAT project file) is accomplished using a GNATbench wizard. The wizard handles all the configuration details required to make the existing GNAT project into a GNATbench project.

Note that the GNATbench project import wizard cannot handle absolutely any arbitrary existing GNAT project. There may be complex configurations controlled by scenario variables, for example, that prevent a full import. In such a case the best approach is to import the project with the Eclipse project importing wizard, do any manual setup steps not handled by that wizard, and then convert the project to a GNATbench project using the *Converting Existing Projects To GNATbench* .

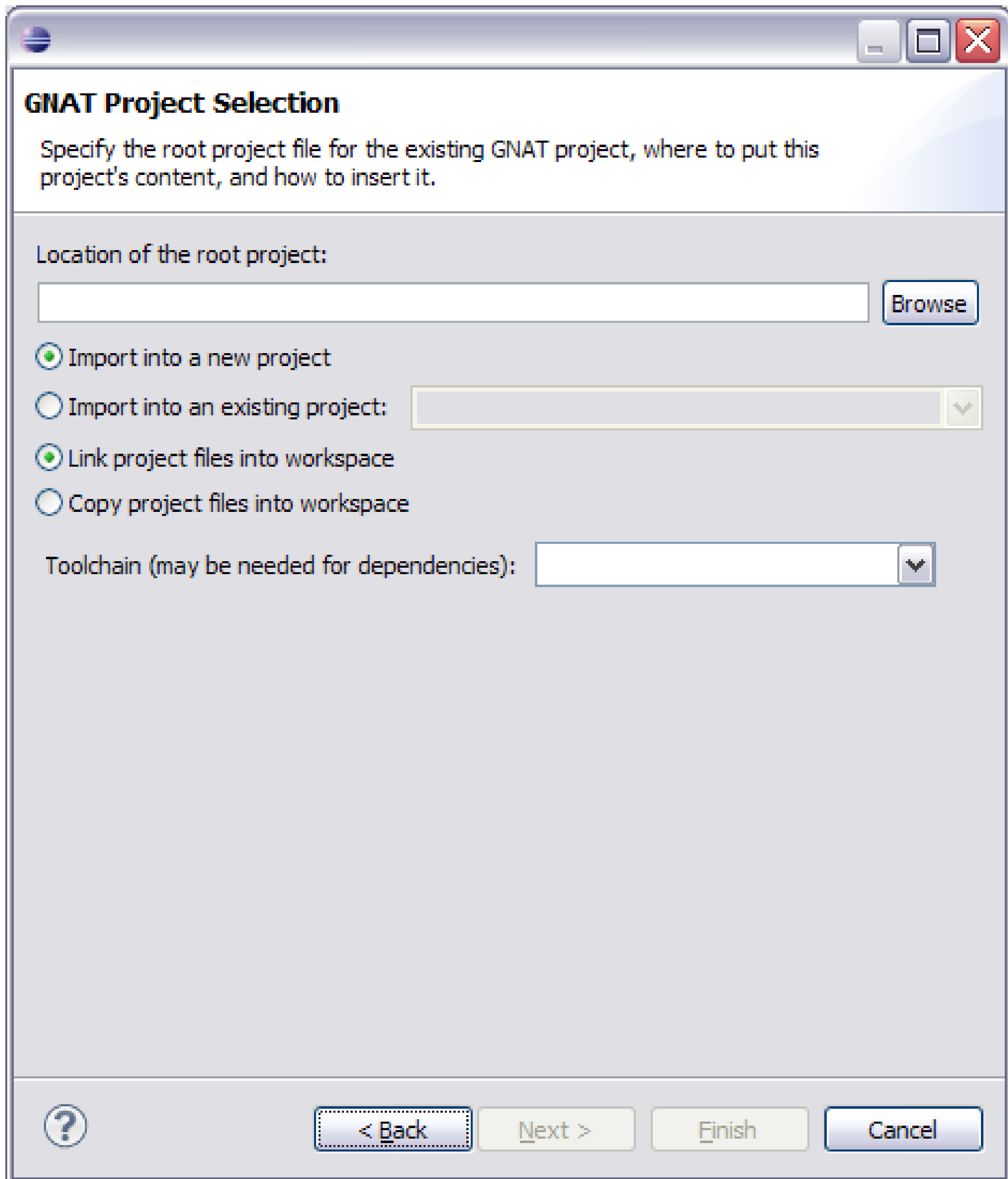
To invoke the wizard you may use either the “File” menu and select “Import…”, or use the contextual menu in the Navigator and again select “Import…” The first approach is illustrated below.



A new wizard page will appear (shown below), allowing you to choose which import wizard to apply. Workbench defines a number of import wizards so you may need to expand the "Ada" category. Select "Existing GNAT Project" and press Next.



The next wizard page appears (see the following figure) and requests the location of the GNAT project file defining the project to be imported. You may either enter the path manually or browse to it via the "Browse" button to the right of the text entry pane.



On that same page you also choose whether to import the GNAT project into an existing Eclipse project or into a new Eclipse project. Typically you will create a new project rather than import it into an existing project.

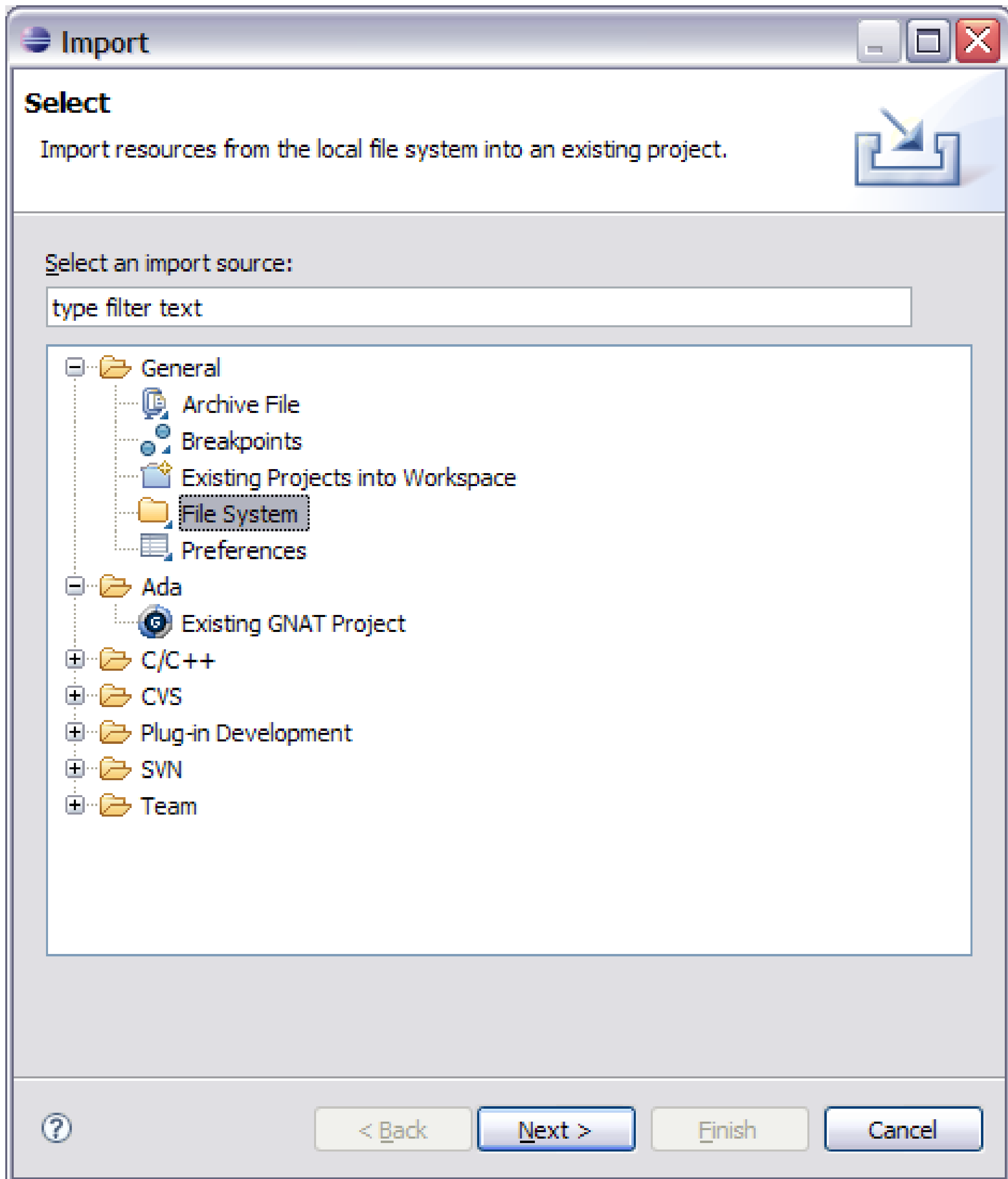
That page also offers the choice of whether to copy the files and folders of the GNAT project into the Eclipse project or only create links to the existing files and folders. Creating links does not make a copy of the files, but rather, creates transparent references to all the project resources in the file system outside of the Eclipse workspace. Changes to the files, compilation, and deletion within Eclipse will directly affect the files and folders in the external file system when the linking option is taken.

Additionally, you can select the toolchain to be used by the imported project. This selection may be required for the sake of proper handling of "dependent projects" – other projects referenced by the imported project via "with clauses". If no dependencies exist, or they will be found by default, the toolchain can be left unspecified here.

Press Finish after making all these choices. The new project will be created for you.

Note that you may have to modify the GNAT project file created by the wizard. For example, you might need to re-specify the location of the executable (a directory) if the original GNAT project file specified it with an absolute path. Similarly, the GNAT project file might specify multiple main programs or other properties that should be changed.

You might also need to use the Eclipse-defined import wizards to import additional folders and files. Use the "File System" option under the "General" wizard category to invoke these wizards:


Import
Select
Import resources from the local file system into an existing project.
Select an import source:
type filter text
General
Archive File
Breakpoints
Existing Projects into Workspace
File System
Preferences
Ada
Existing GNAT Project
C/C++
CVS
Plug-in Development
SVN
Team
< Back
Next >
Finish
Cancel

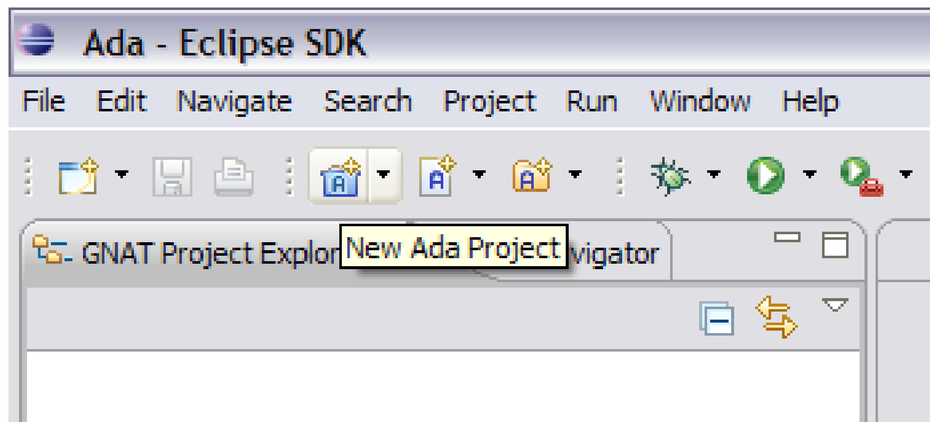
4.2 Creating New Projects

Creating a new project for Ada development is easy with the dedicated GNATbench wizard.

4.2.1 Invoking the New-Project Wizard

There are many ways to select and invoke the GNATbench new-project wizard. See *Ada Perspective Wizards* for illustrations of all the different methods.

Perhaps the easiest way to invoke the wizard is to click on the down-arrow next to the "New Ada Project" icon on the toolbar, as shown below:

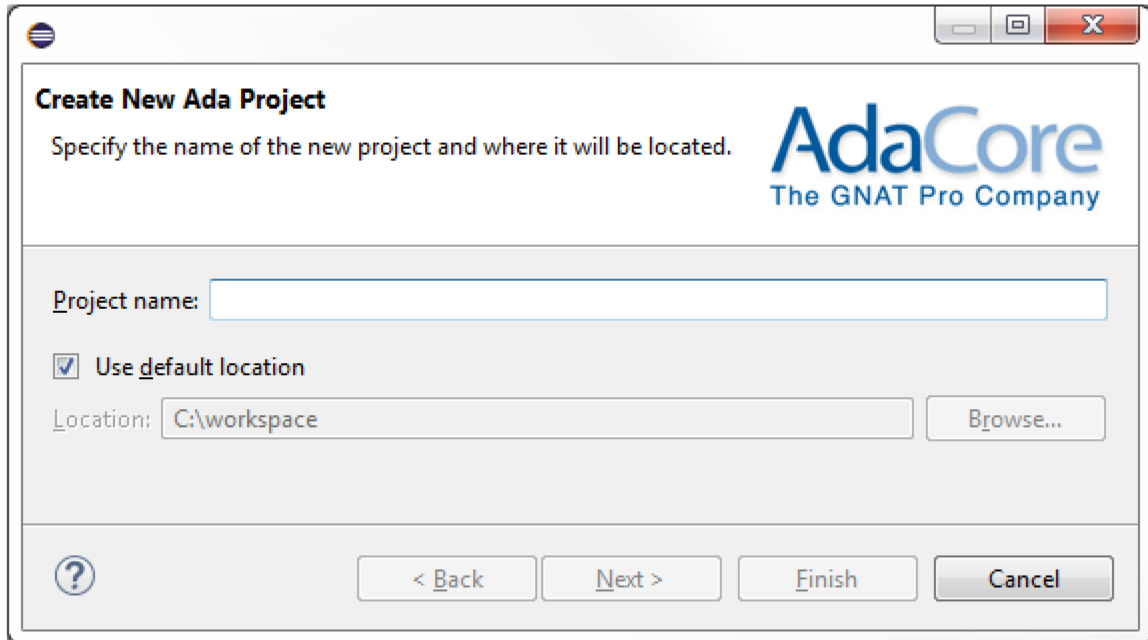


4.2.2 Walking Through the Wizard Pages

However you invoke the wizard, the first page of the wizard will appear. Note that all of the dialog box options and entries on a given page may not be visible if you resize the dialog box of the previous page. If so, simply enlarge the box.

Create New Ada Project page

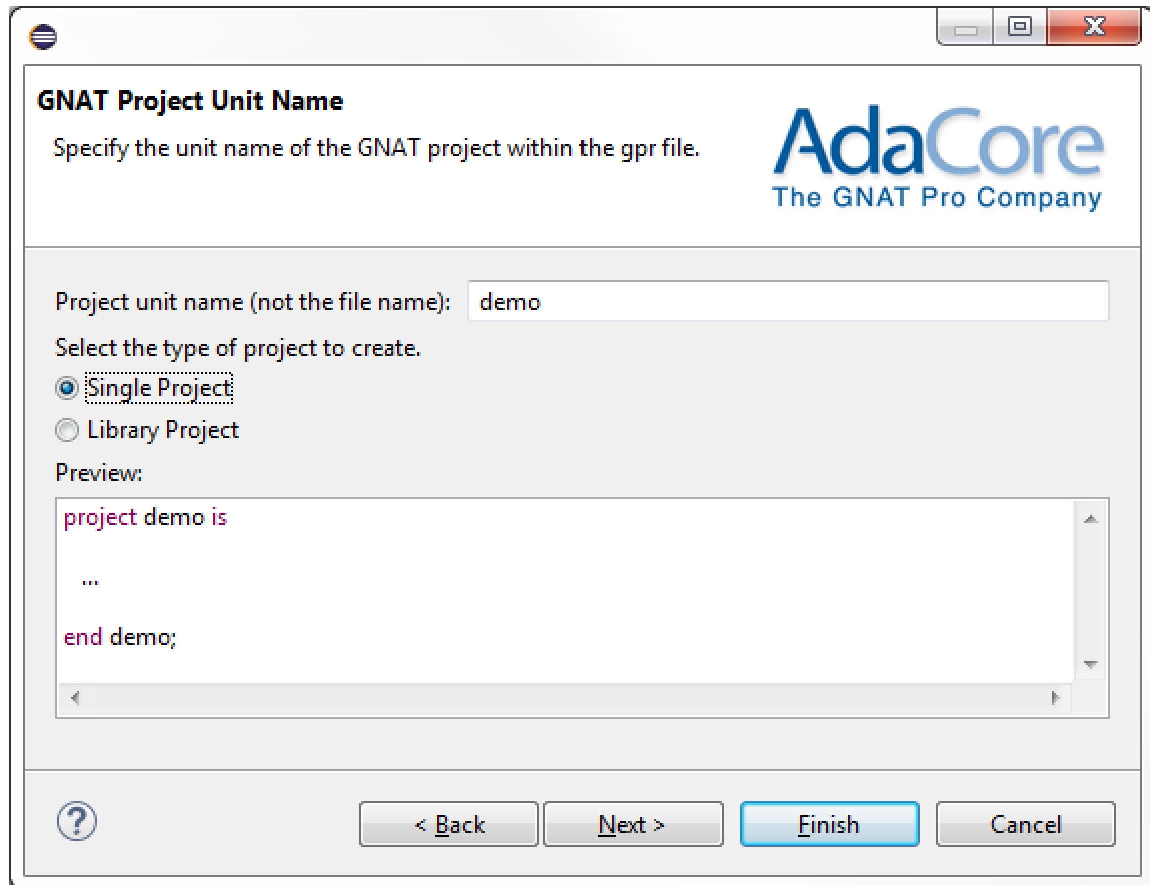
In the first page you always specify the name of the new project and choose where the new project will reside. Typically this location will be the workspace so you can take the default, but otherwise you can specify an external location on the file system.



GNAT Project Unit Name page

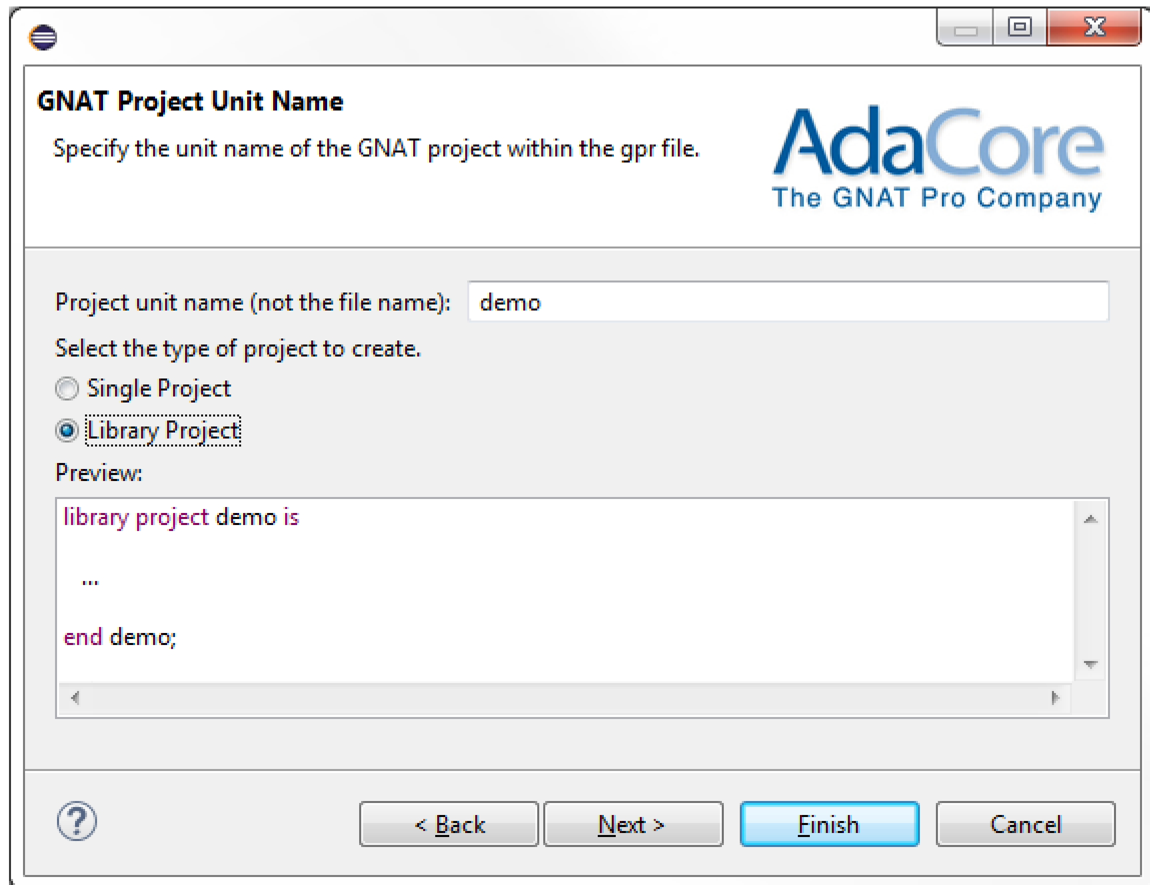
In the next wizard page you specify:

1. the unit name of the GNAT project. This is not the name of the file, also known as the "gpr file." Rather, it is the name of the unit inside the gpr file. The name you enter is displayed within a project unit declaration in a text frame, as you enter it, to make clear the use for the name requested.
2. the GNAT project type. It can be a single project or a library project if you want to generate a static or dynamic (relocatable) library.



The unit name need not be the same as the Eclipse project name, but it must be a legal Ada identifier. An error is indicated in the wizard page if this is not the case for the name you enter. The wizard will attempt to convert the Eclipse project name into a legal Ada identifier but might not succeed. In that case you must manually change the name, but, again, the unit name can be different from the Eclipse project name.

If you ask to create a library project, pressing Next will take you to the *Ada Library Settings page*.



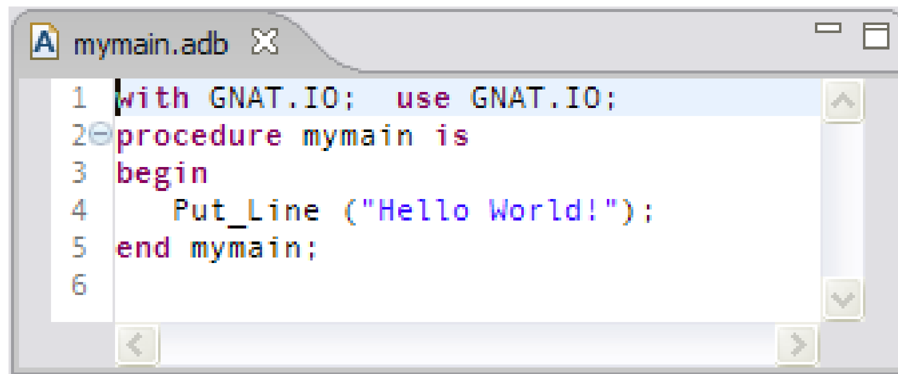
If you ask to create a single project, pressing Next will take you to the page shown below, where you specify information about the Ada main subprogram and make source code generation choices.

Ada Main Program Settings page

First comes the text entry box where you specify the unit name of the Ada main subprogram, if there is to be one. *Note that this is the name of the subprogram, not the name of the file*, so an extension is neither expected nor allowed. The field is not required because a main subprogram is not required for an Ada project. For example, if you are creating a library project a main unit is not expected.

The first option offered on the page is whether you want the wizard to generate a file containing the main subprogram on your behalf. If you do, the wizard will generate it with the unit name you specify. If no unit name is specified the option is disabled.

The next option, enabled if the first option is chosen, specifies whether this generated main subprogram implements the "hello world" application. This capability is purely for your convenience so that you can immediately have an "interesting" program to build and debug immediately after creating a new project. If chosen, the subprogram will look like the following (assuming the unit name is "mymain"):



If you do not enable the "hello world" option, the generated main subprogram will have a null statement body.

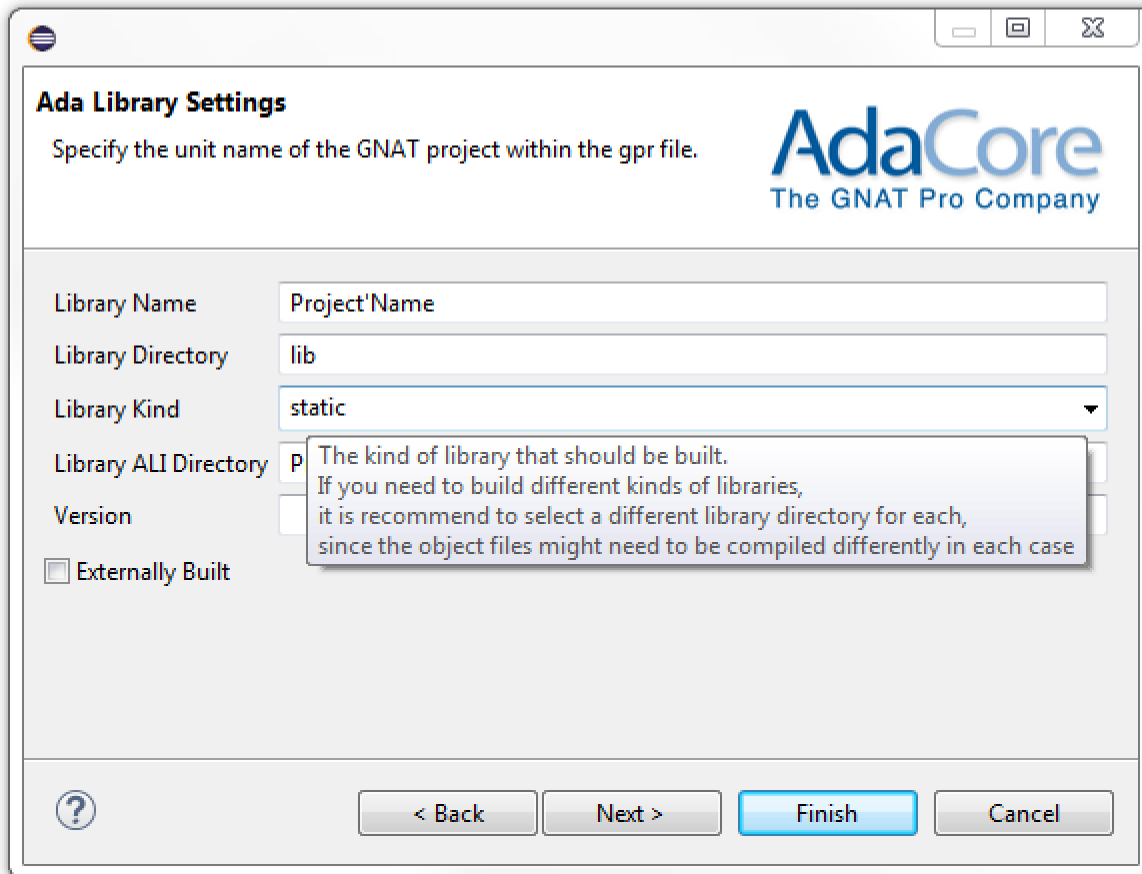
Pressing Next will take you to the *Directories Settings page*

Ada Library Settings page

This page allows to configure the following library project attributes:

- Library_Name
- Library_Dir
- Library_Kind
- Library_ALI_Dir
- Library_Version
- Externally_Built

Use tooltips to get documentation about these attributes or open GPRbuild and GPR Companion Tools User's Guide A copy should be available in "GNATbench Additional Guides" from Help contents menu.



Pressing Next will take you to the page shown below to finish to configure the library.

Ada Stand-alone Library Settings page

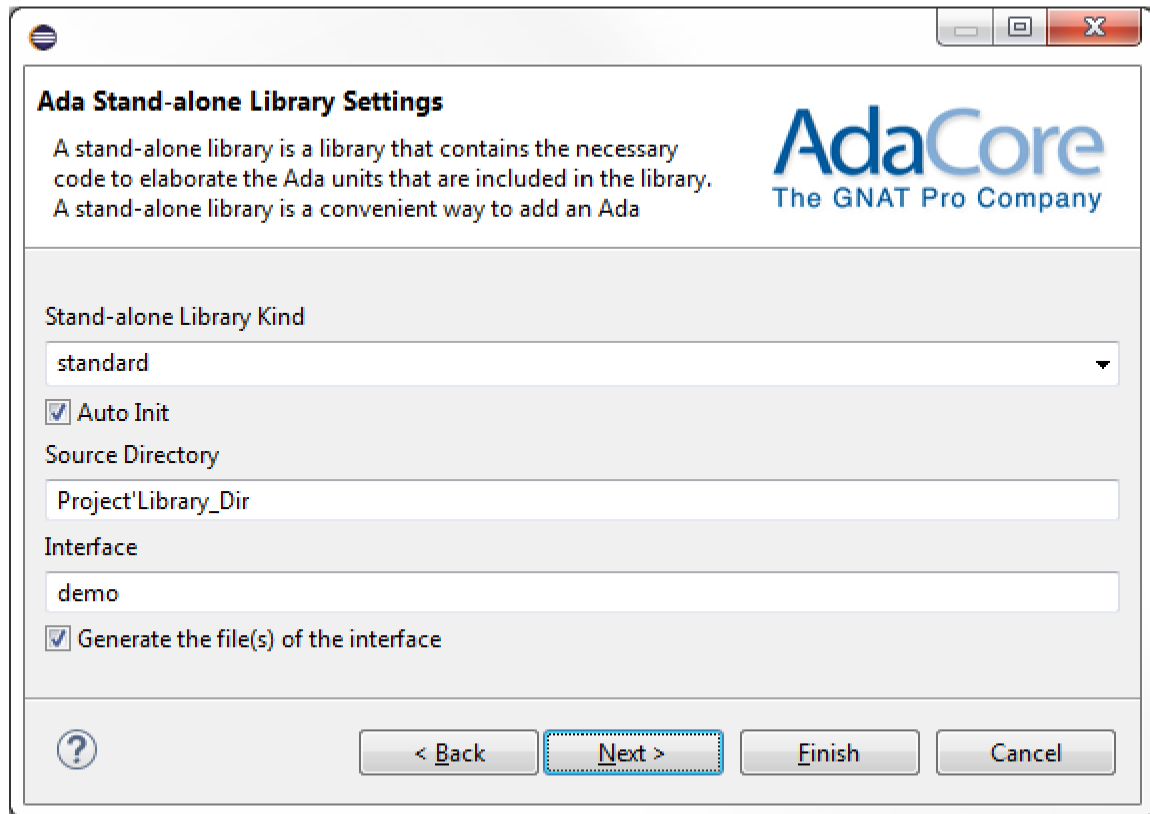
This page allows to configure the following library project attributes:

- Library_Standalone
- Library_Auto_Init
- Library_Src_Dir
- Library_Interface or Interfaces

Set Stand-alone Library Kind to no if your library should not be stand-alone.

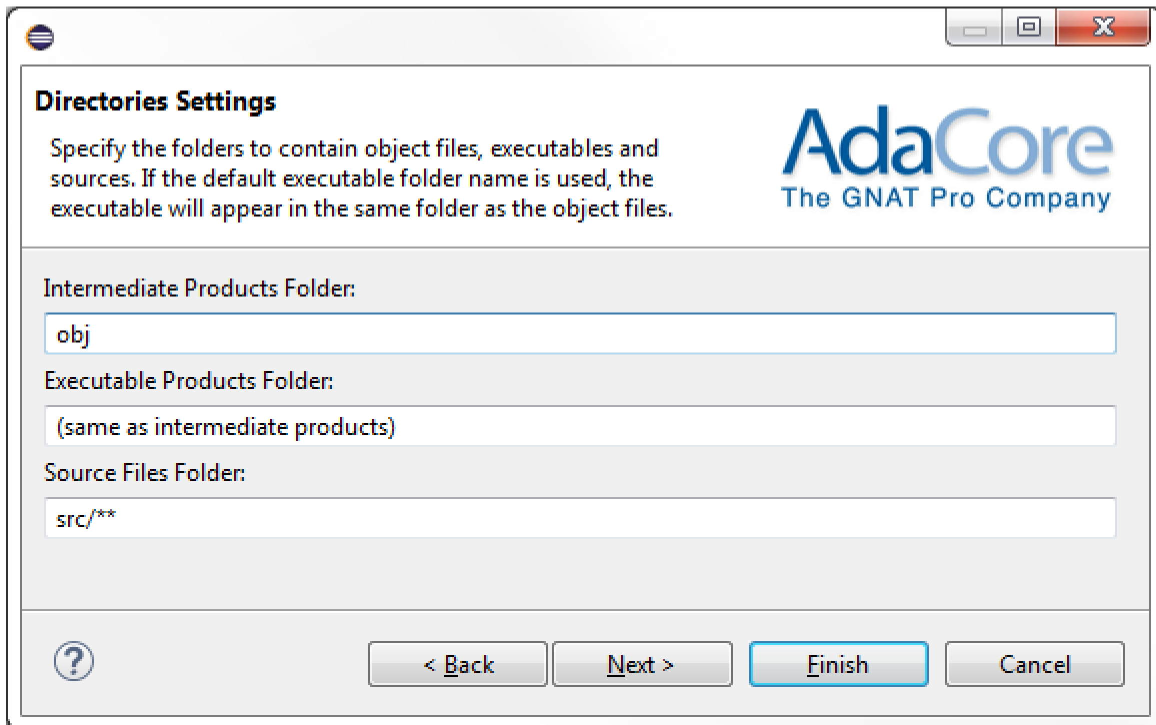
Keeping "Generate the files(s) of the interface" checked generates empty specification files.

```
package demo is
   pragma Pure;
end demo;
```



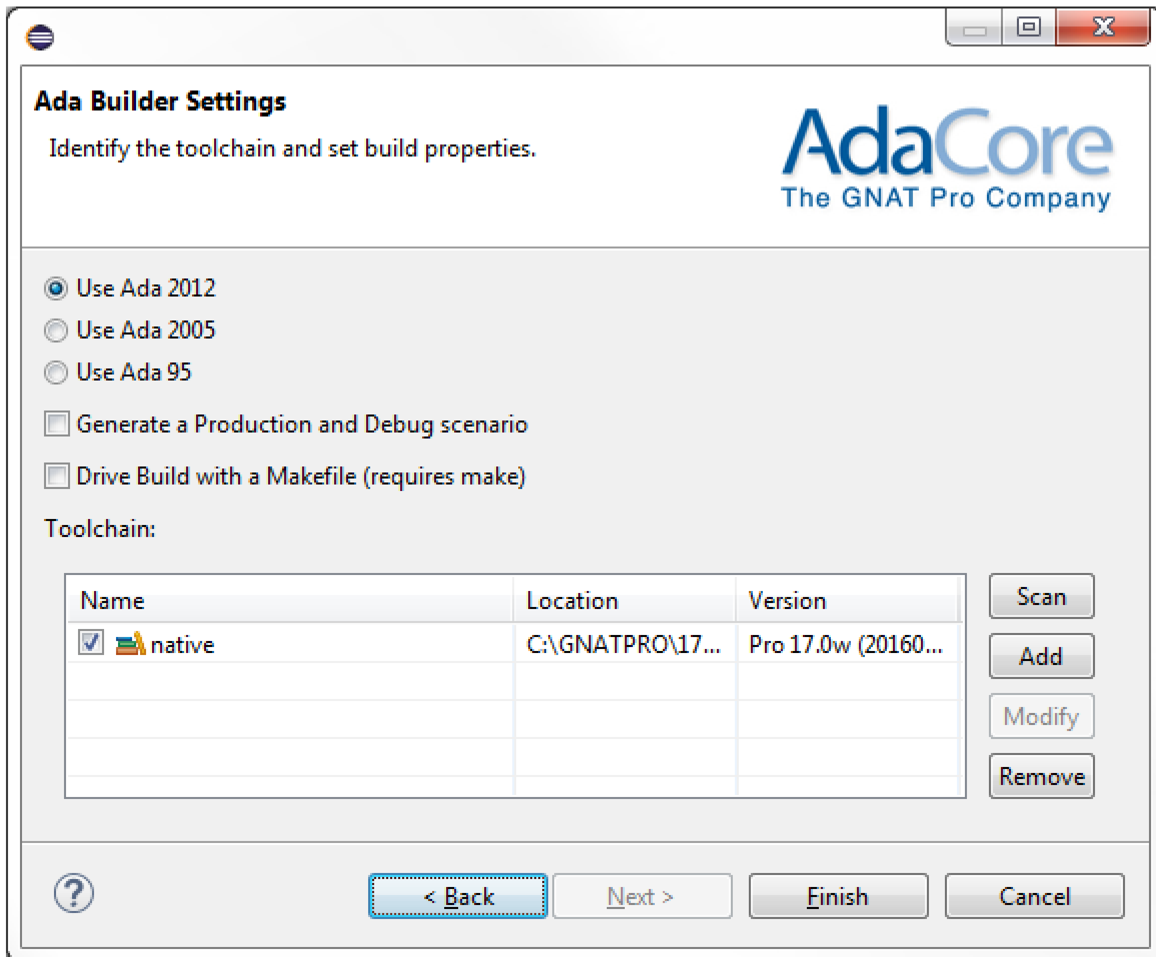
Directories Settings page

The next page allows you to specify directories to contain sources, intermediate products (object files and ali files), and the executable. By default, the executable is placed in the same directory as the intermediate products. Append "/**" to source files folder to include subdirectories.



Ada Builder Settings page

The next page is dedicated to the builder.



The first of these configuration choices concerns whether you want to compile using Ada 2012, Ada 2005 or Ada 95.

The next configuration choice determines whether to define two different build scenarios: one scenario for debugging and one for production. If enabled, a scenario variable will be defined to support these two situations, with appropriate switches set in the generated project file.

The next configuration choice determines whether the "make" utility, and associated Makefile, will be used to drive the build. If not enabled, no Makefile will be generated and none will be used to drive the build.

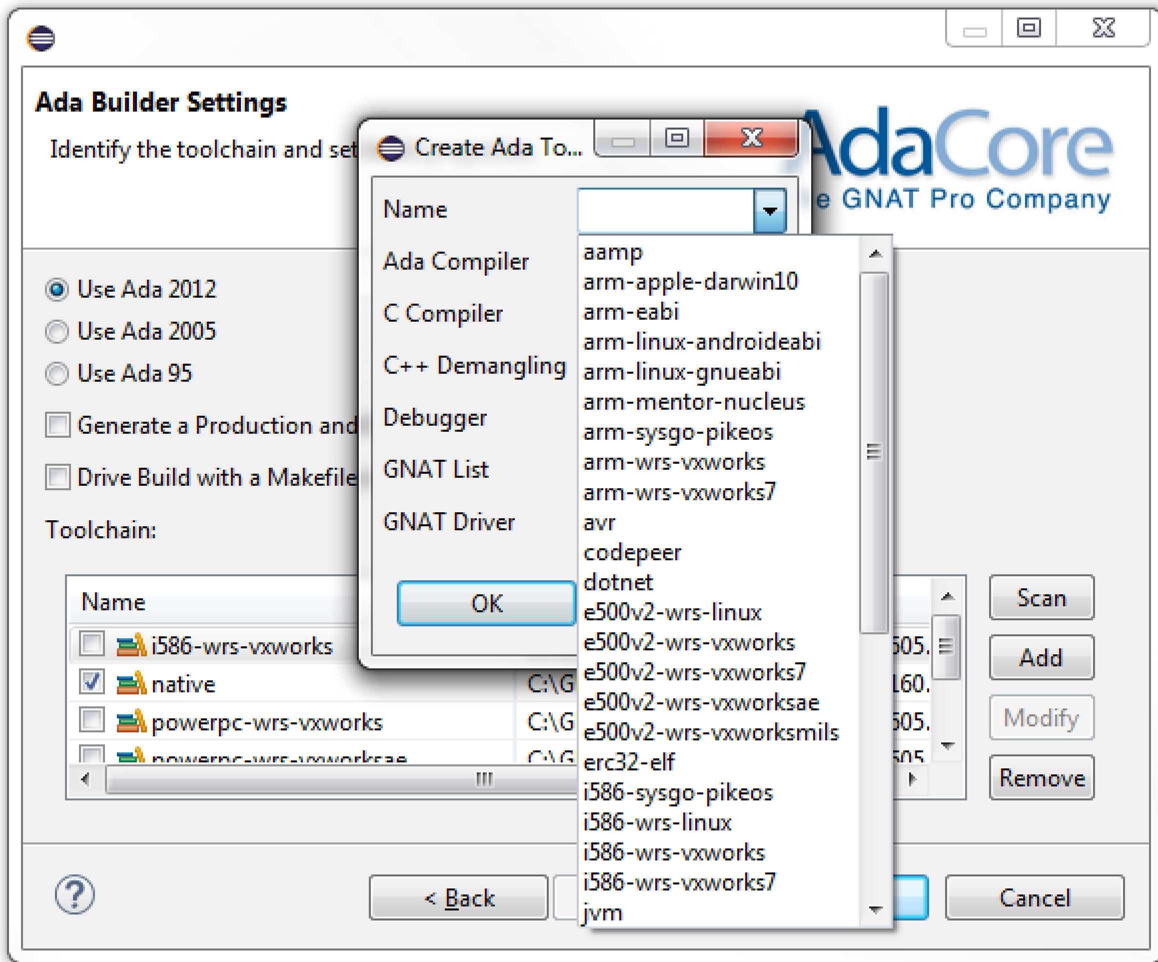
The name of the "make" utility can be changed using the "Ada - External Commands" preferences page. The preferences dialog is accessible via the Window->Preferences menu group.

Next you select the Ada toolchain to use. You select the name from the list of currently installed GNAT toolchains recognized by GNATbench, or you can define a toolchain manually.

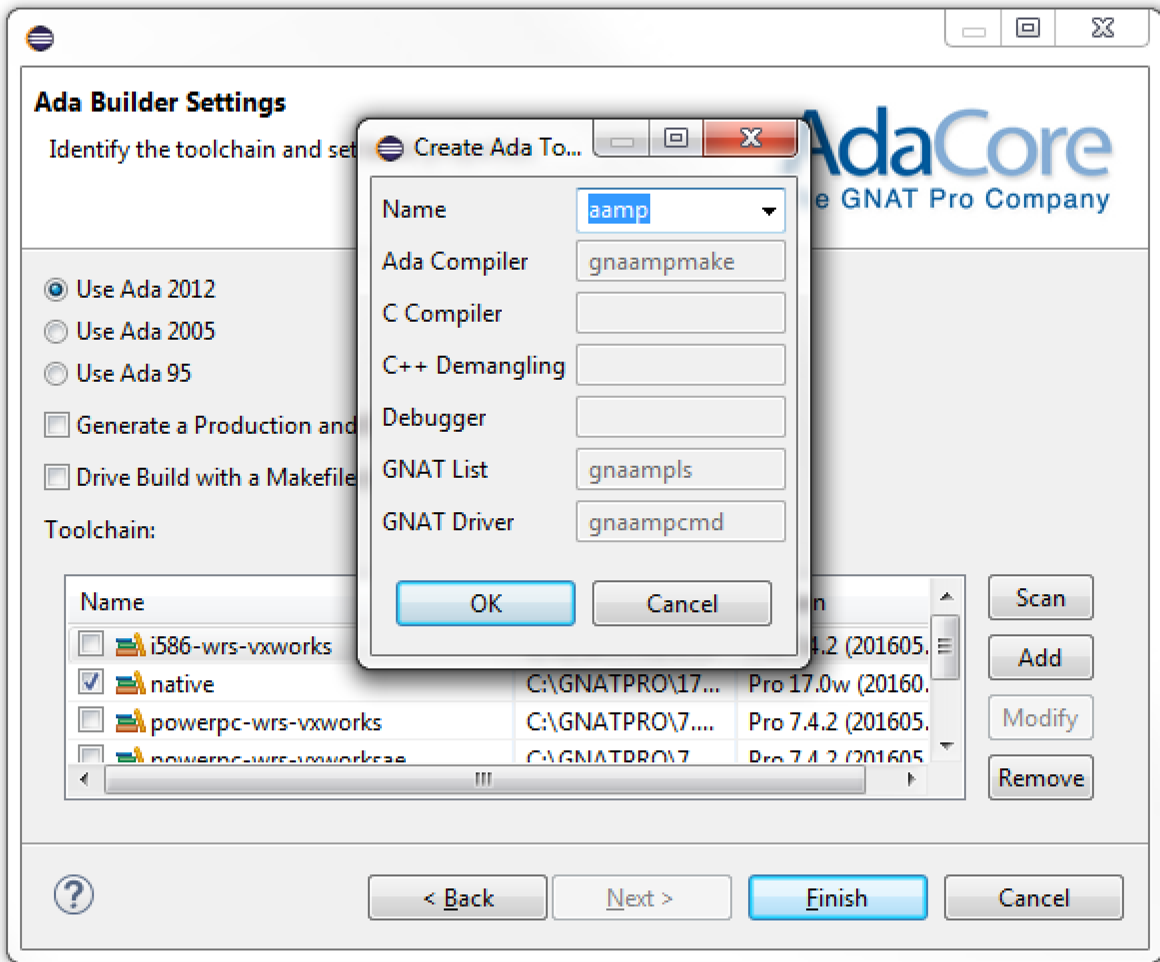
The list of currently installed builders may be incomplete when the dialog box is first displayed so you may need to update the list. To do so, press the "Scan" button. A notification dialog box will appear while GNATbench scans the machine for installed GNAT toolchains. When the notification disappears the list will have been updated with all installed GNAT toolchains. Put a check-mark next to the required toolchain, if it is not already selected, and press Finish.

Note that you can select multiple toolchains for a given project simply by placing a check-mark next to each required toolchain.

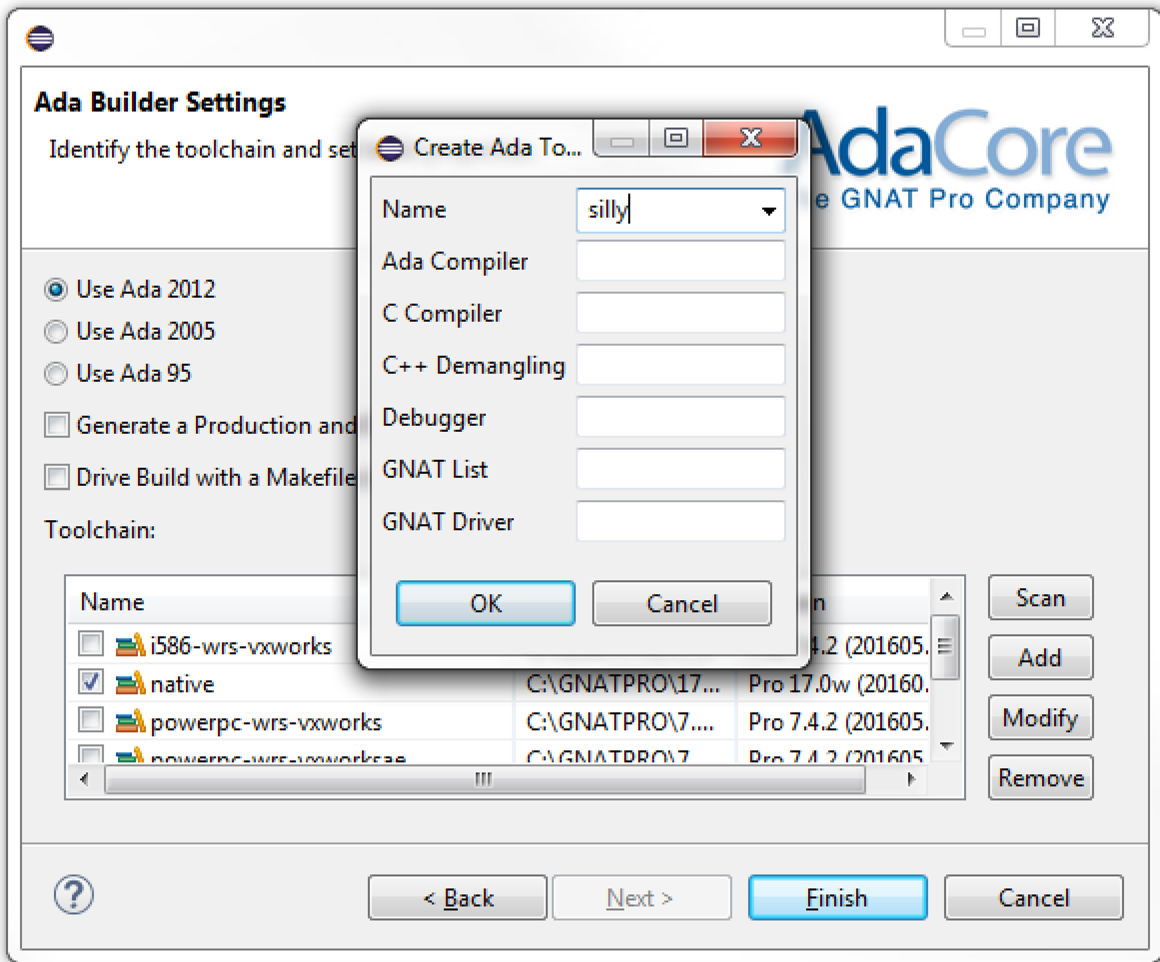
However, instead of selecting one of these toolchains you can create a new one, either by selecting from a predetermined list or by defining a completely new one "from scratch." To do so, press the "Add" button, which will result in another dialog box appearing, as shown below:



You can select a toolchain from the pull-down list and, in that case, the other fields will be filled in automatically (and cannot be changed), as indicated by the following figure:

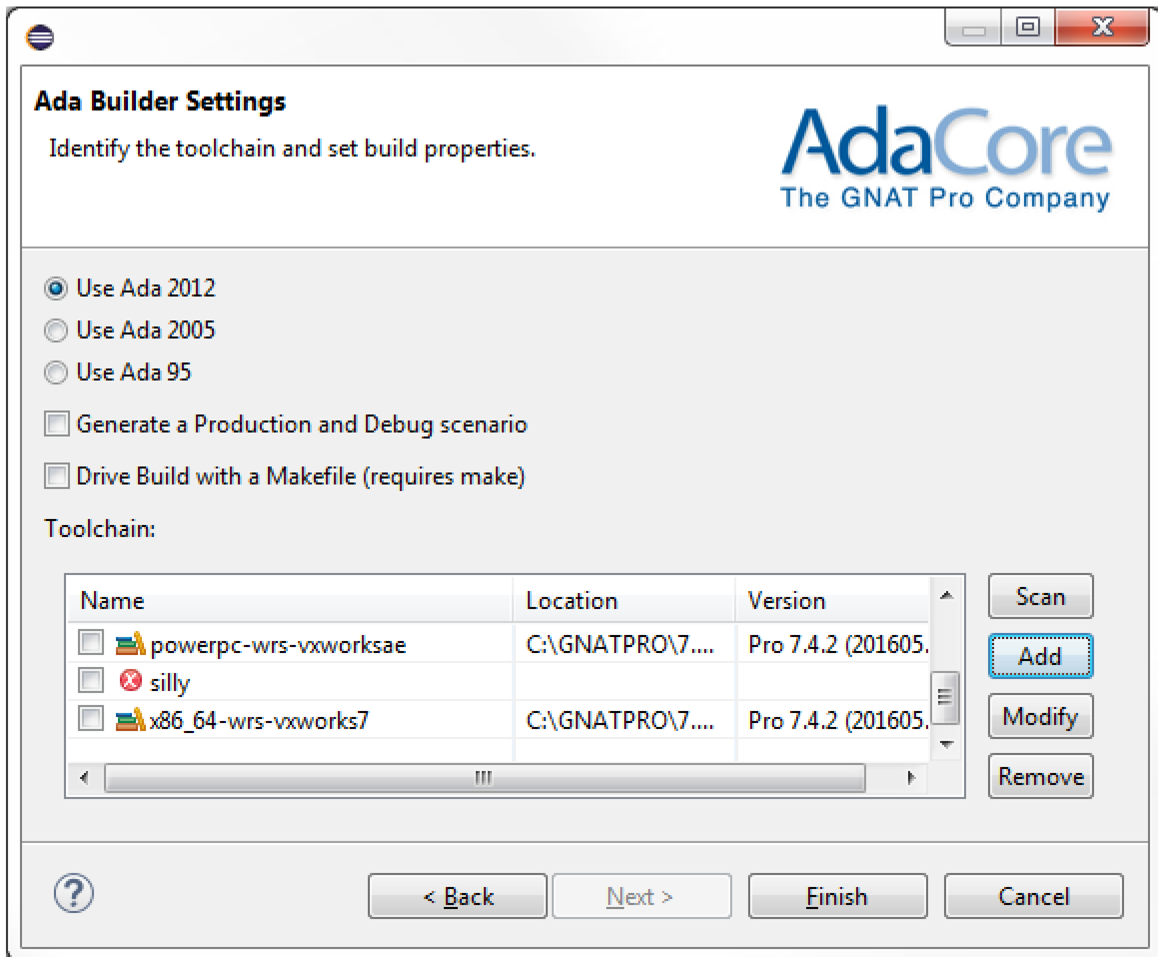


Alternatively, you can specify a completely new toolchain. You are required to enter the actual commands that GNATbench will invoke when using this toolchain. The corresponding text entry boxes become enabled, as shown in the following figure:



Specifically, you must enter the name of the toolchain and the invokable names of the Ada compiler, the GNAT driver, and the "GNAT List" command. The names for the C compiler and the C++ demangler, on the other hand, are optional.

Omitting the required values will result in a problem indicator appearing next to the new toolchain name in the list of all toolchain names. See the figure below for example.

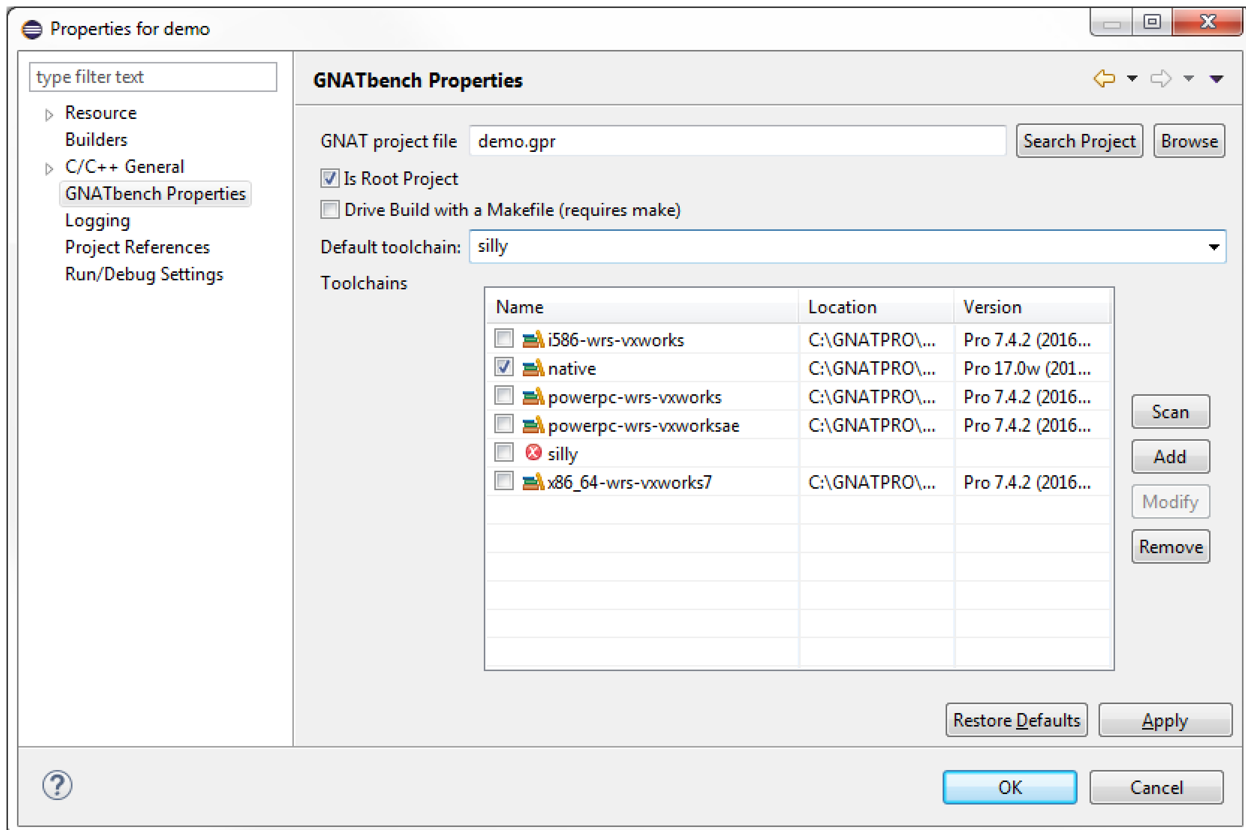


Note that you can modify a user-defined toolchain using the "Modify" button.

Toolchain definitions persist. You can remove them via the "Remove" button.

Once all the required entries are made you can then press Finish and the new project will be created for you.

At any time after the new project wizard completes, you retain the option of selecting and modifying the selected toolchains for the project. To do so, select the Properties menu entry for the project and then select the "GNATbench Properties" page. There you will see a similar interface to the last page of the wizard:



4.3 Creating New Ada Source Files

There are two wizards defined for creating new files. One wizard creates a new Ada source file and (optionally) inserts a header comment block at the top. Another wizard creates a "basic" file and in fact this wizard is just the standard Eclipse "new-file" wizard, provided here for convenience. We describe the Ada Source File wizard below.

4.3.1 Invoking the New-File Wizards

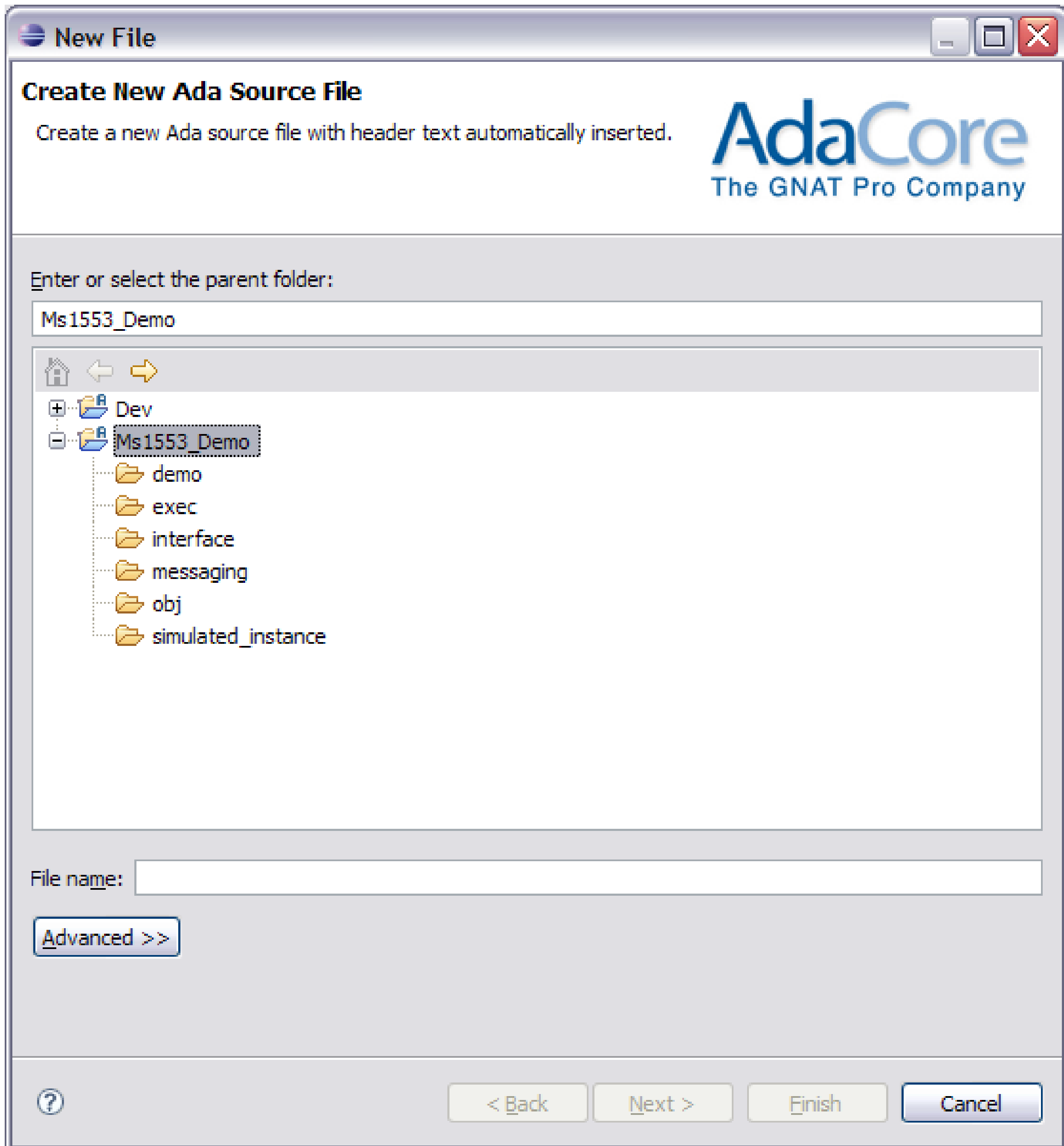
There are many ways to select and invoke the GNATbench wizards. See *Ada Perspective Wizards* for illustrations of all the different methods.

Perhaps the easiest way to invoke one of these new-file wizards is to click on the down-arrow next to the GNATbench new-file icon on the toolbar, as shown below, and select from the list. Clicking directly on the icon will invoke the "Ada Source File" wizard.

4.3.2 New Ada Source File Wizard

The "Ada Source File" wizard will automatically insert the content of a header file if the corresponding preference is enabled. Different header files can be inserted for specs and for bodies; selection is determined by the file name extension.

Like the standard new-file wizard, you choose the parent folder for the file and specify the name of the new file, including extension.



4.3.3 Linked Source Files

In the figure above, the "Advanced" button expands the dialog box to allow creating a source file that is linked to an existing file in the file system. **This option is not currently supported and should not be used.** (Linked *folders* are supported, however.)

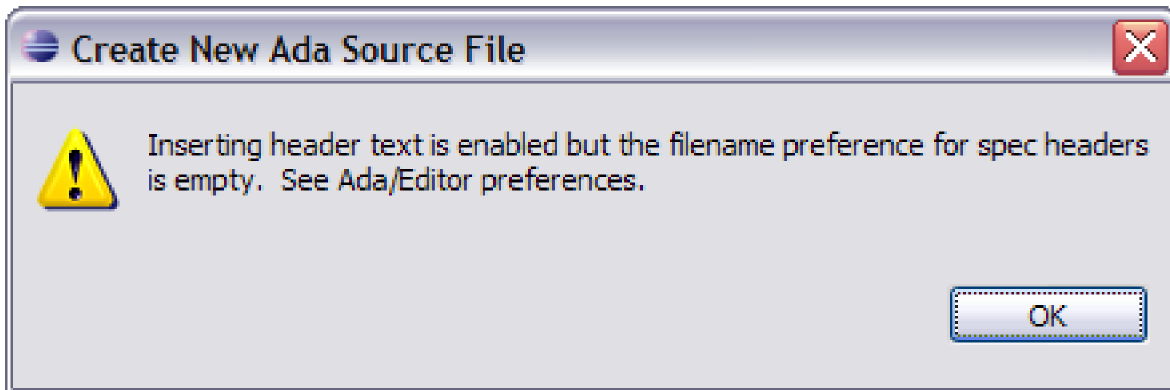
4.3.4 Header Text Insertion

See the *Editor* preference page for the preference controlling whether the header text is inserted and for the paths to the files containing the text. The preference is disabled by default.

The header file preferences are intended to designate regular text files containing text capable of being processed by an Eclipse text editor.

Separate text headers are possible for declaration and body files because separate file paths are provided in the preferences. However, there is no requirement that they be different so you can simply specify the same file in both preferences to have the same header text inserted.

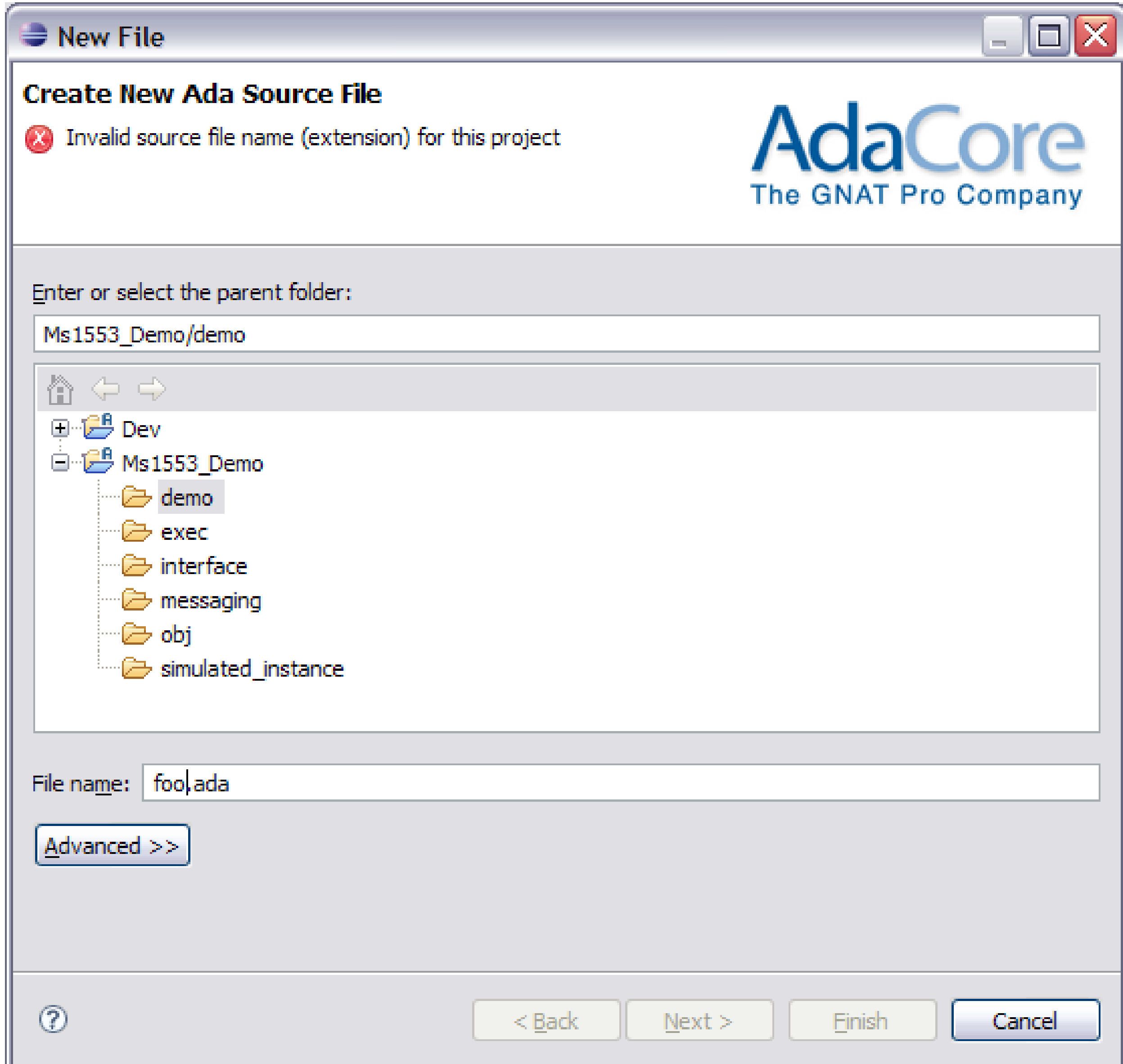
When the preference to insert the header is enabled but no file(s) containing the header text is also specified, the file is still created but the following dialog box will pop up, explaining why no text was inserted (this sample is for specs):



Note that if the overall enabling preference is checked, both file preferences must be specified (one each for both spec and body files). However, if only one kind of file should have a header inserted, simply specify the name of an existing empty file for the other preference.

4.3.5 File Naming Conformance

The wizard ensures that the new file's proposed extension is valid for the given project's source file naming scheme. For example, the following figure shows the error message displayed when the default GNAT naming scheme is in effect for the given project. Once a valid name is specified, the Finish button will be enabled.



4.4 Creating New Ada Source Folders

There are two wizards defined for creating new folders. One wizard creates a new Ada source folder and "inserts" it into the GNAT project file. Another wizard creates a regular folder and in fact this wizard is just the standard Eclipse "new-folder" wizard, provided here for convenience. We describe the Ada Source Folder wizard below.

4.4.1 Invoking the New-Folder Wizards

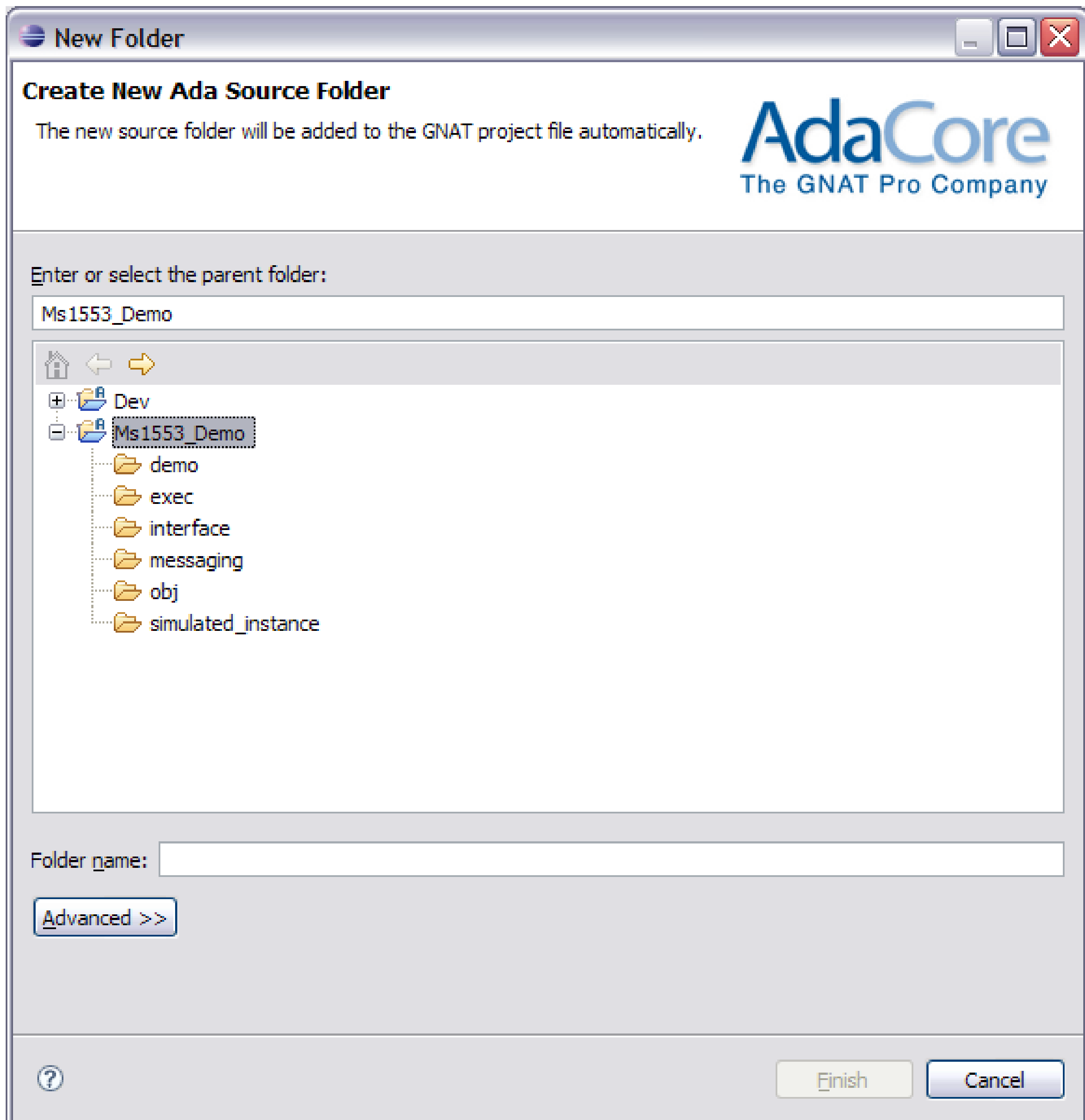
There are many ways to select and invoke the GNATbench wizards. See *Ada Perspective Wizards* for illustrations of all the different methods.

Perhaps the easiest way to invoke one of these new-folder wizards is to click on the down-arrow next to the GNATbench new-folder icon on the toolbar, as shown below, and select from the list. Clicking directly on the icon will invoke the "Ada Source Folder" wizard.

4.4.2 New Ada Source Folder Wizard

Like the standard new-folder wizard, this Ada wizard lets user create nested folders, but in addition the wizard automatically adds the new folder to the Source_Dirs attribute in the GNAT project file (the .gpr file) so that contained sources will be included in builds.

You specify the parent to contain the new folder and specify the new folder name. The "Advanced" button allows creating a linked folder.



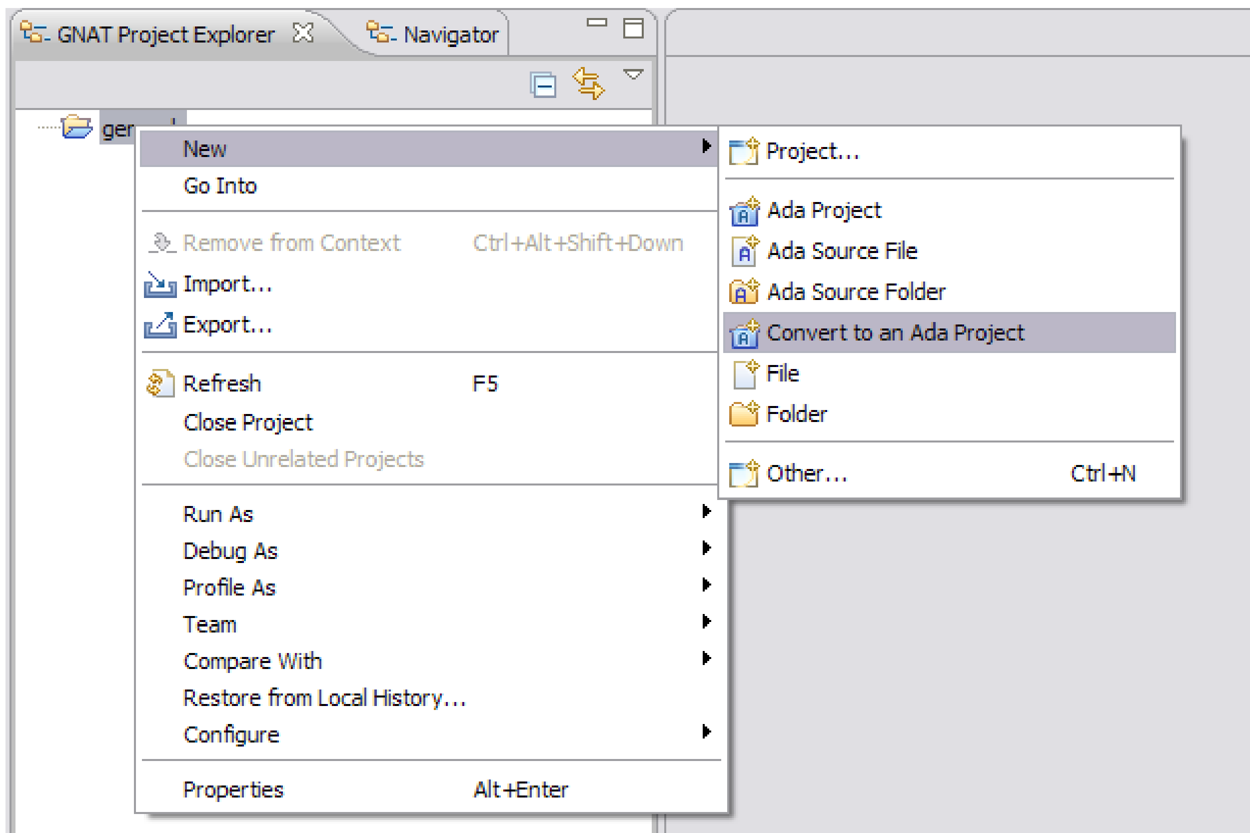
4.5 Converting Existing Projects To GNATbench

Converting an existing Eclipse project for Ada development with GNATbench is easy with the GNATbench project conversion wizard.

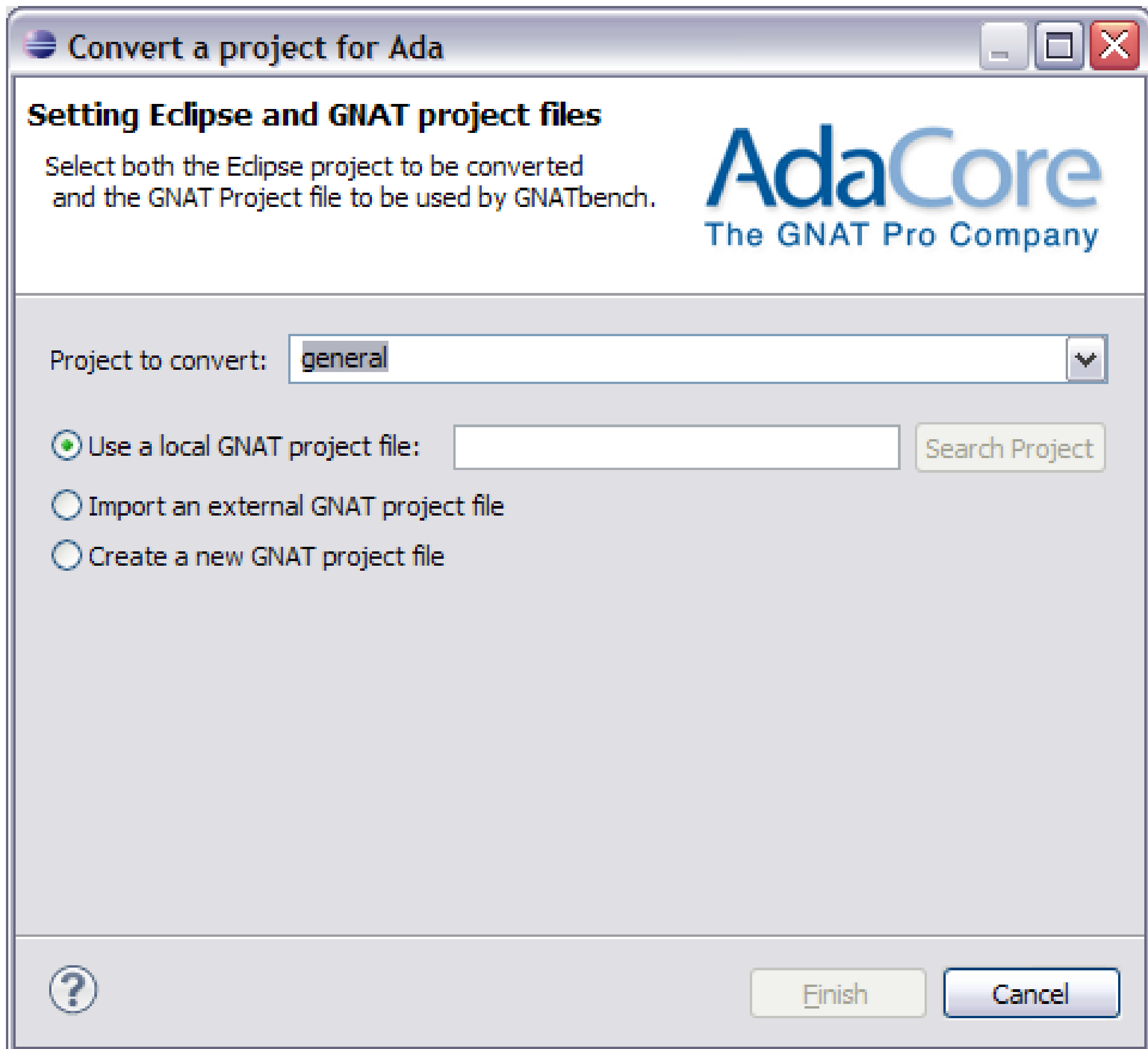
The wizard offers three alternative conversion approaches. You can apply a GNAT project file (a "gpr file") found within the existing Eclipse project being converted, you can import an existing GNAT project file located elsewhere, or you can create a new GNAT project file and GNATbench resources as part of the existing Eclipse project. The latter two approaches invoke the GNATbench import and new-project wizards, respectively.

To invoke the conversion wizard, right-click on the existing project node in the GNAT Project Explorer, choose "New" and then "Convert to an Ada project." In the figure below, a "general" Eclipse project has been created and is now being

converted:



In the resulting page you select the existing Eclipse project to be converted. By default the previously selected project is already specified. You also select the GNAT project file (the "gpr file") to be used once the project is converted.



Your choice for the GNAT project file determines whether more wizard invocations are required.

If you choose to apply an existing GNAT project file located in the project being converted, once you have specified the file (in the text entry pane) you can then simply press Finish. The existing local project file will be applied and the conversion wizard completes. This might be the situation when an Eclipse project is first checked out from a configuration management system, for example.

Alternatively, you can choose to import an external GNAT project file. In that case, when you press Finish the GNAT project import wizard will execute. The imported GNAT project file and associated resources will be used in the converted project. See *Importing Existing GNAT Projects* for the details of that wizard. As noted there, you should only use the import wizard for comparatively simple GNAT projects. For GNAT projects that are too complex to be imported successfully, you should do the manual setup yourself and then use one of the other two conversion options presented here.

Finally, you can choose to create a new GNAT project file. In that case when you press Finish the GNATbench New Ada Project wizard will execute. See *Creating New Projects* for the details of that wizard. The newly created GNAT project file and other resources (such as source and object folders) will be created as part of the existing project being converted.

4.6 Using Non-Default Ada Source File Names

By default, GNAT compilers require a specific Ada source file naming convention. In this default convention, "spec" files (those containing declarations) have an extension of ".ads" and "body" files (those containing completions) have an extension of ".adb" (i.e., 's' for "spec" and 'b' for "body").

GNATbench uses the convention for a given project when displaying and operating upon source files. For example, double-clicking on a file invokes the Ada language-sensitive editor only if the file has an extension indicating that it is indeed a source file. Similarly, only those files recognized as source files are displayed in source folders within the GNAT Project Explorer.

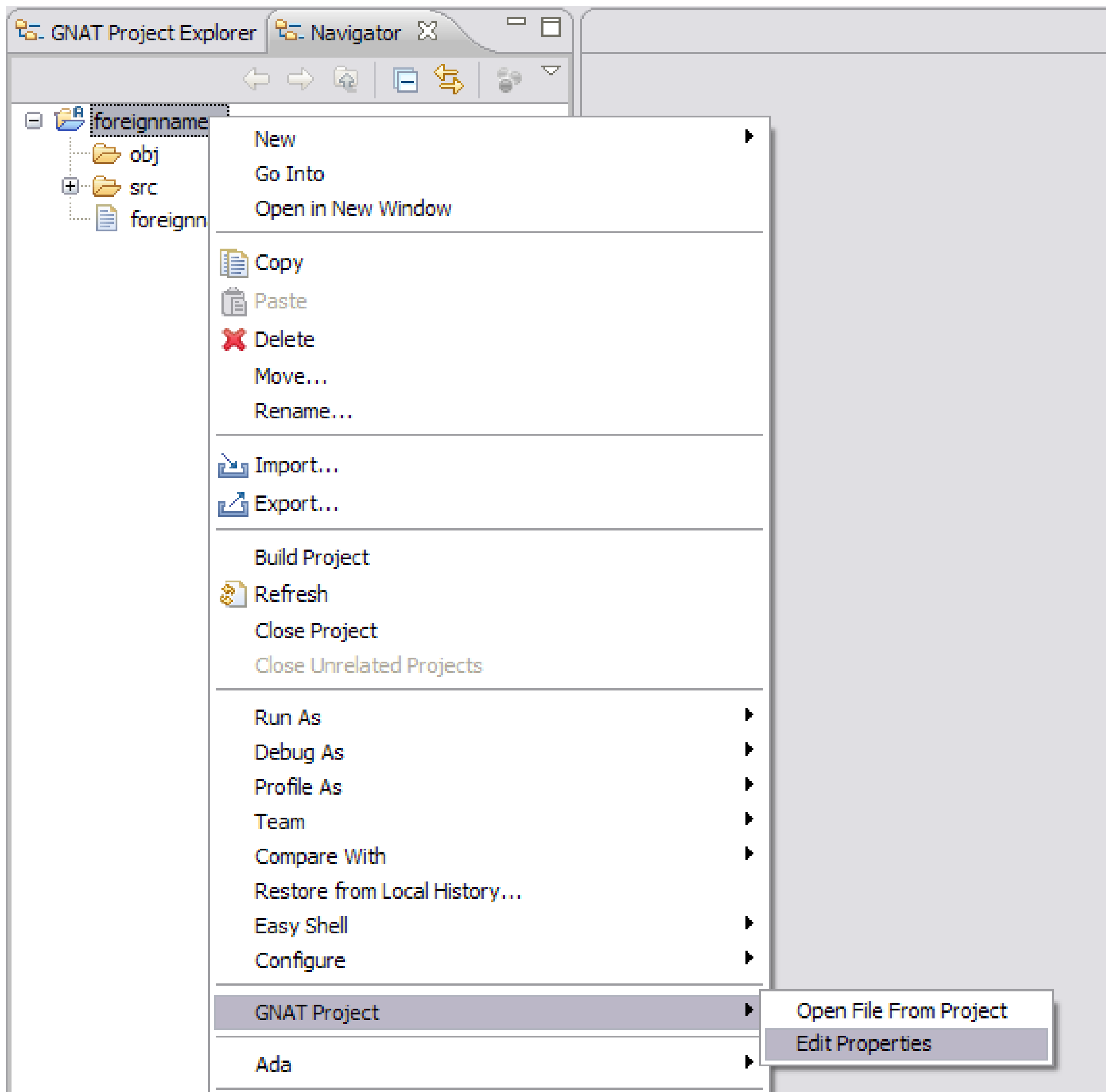
You can change the default Ada source file naming convention used by any given project.

To make the change requires two steps:

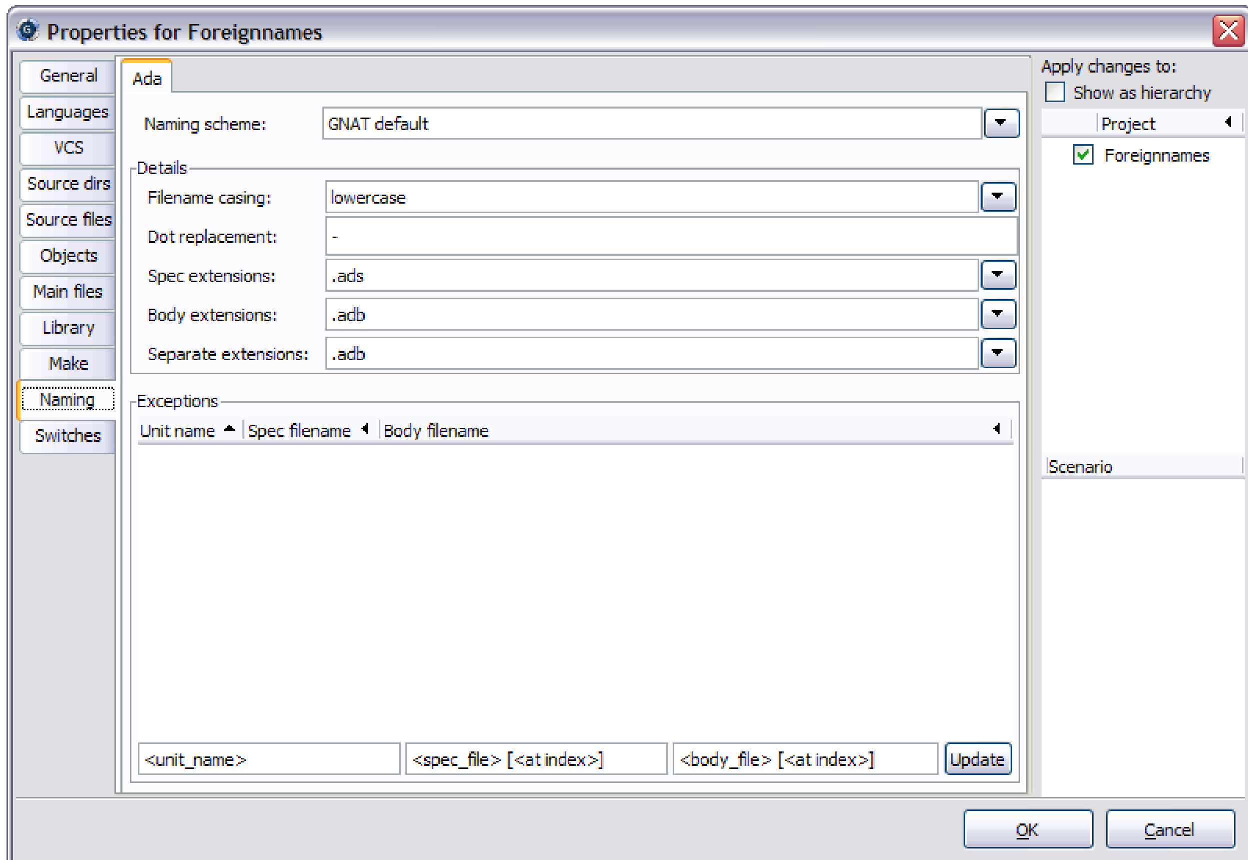
- You must specify the new naming scheme in the GNAT project file (the "gpr file"), and
- You must associate the file extension with the AdaCore language-sensitive editor within Eclipse itself.

4.6.1 Specifying the Naming Scheme In the Project File

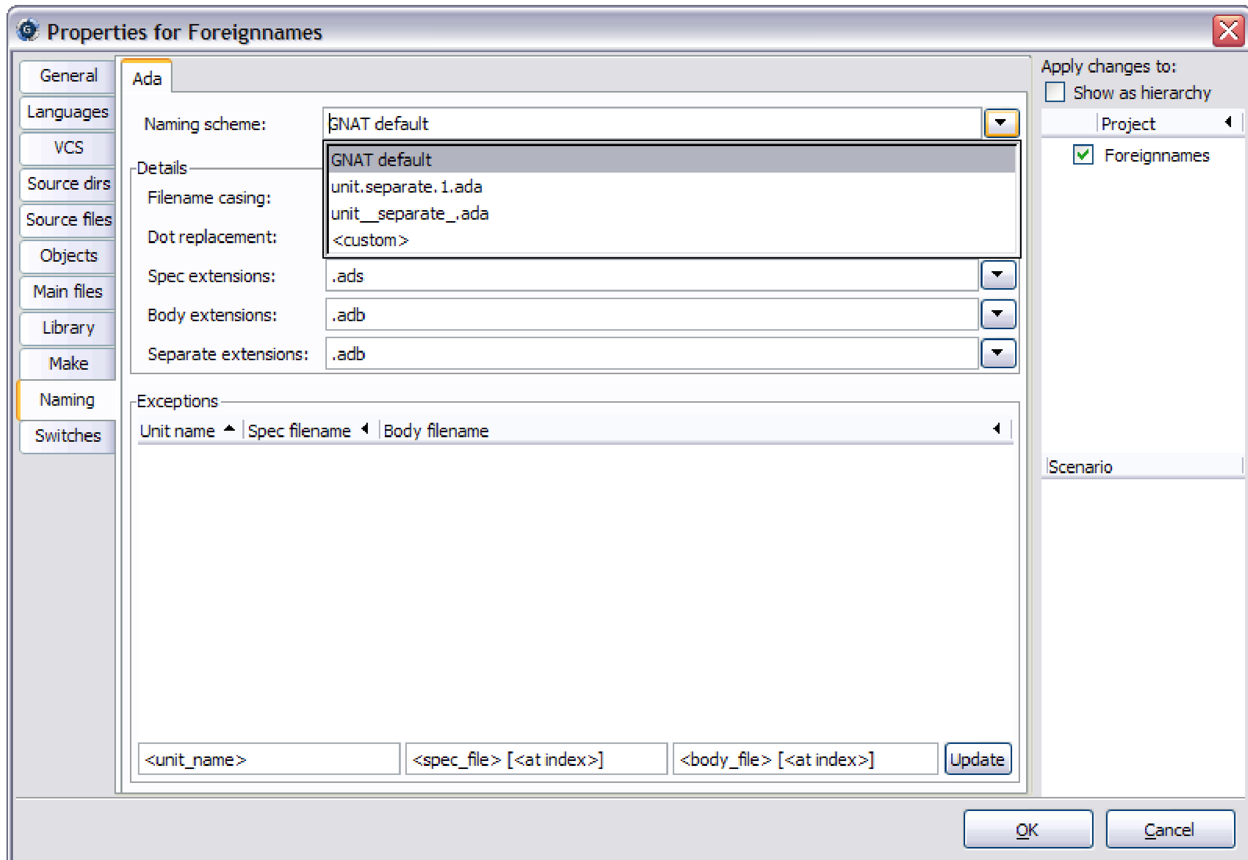
For the first step, you can use the GUI dialog to specify the naming scheme in the project properties. To invoke the dialog, right-click on the project node in the GNAT Project Explorer, select "GNAT Project", then select "Edit Properties" as shown below. Note that the first time you invoke the dialog it may take a little while to appear.



In the resulting dialog, select the Naming tab:

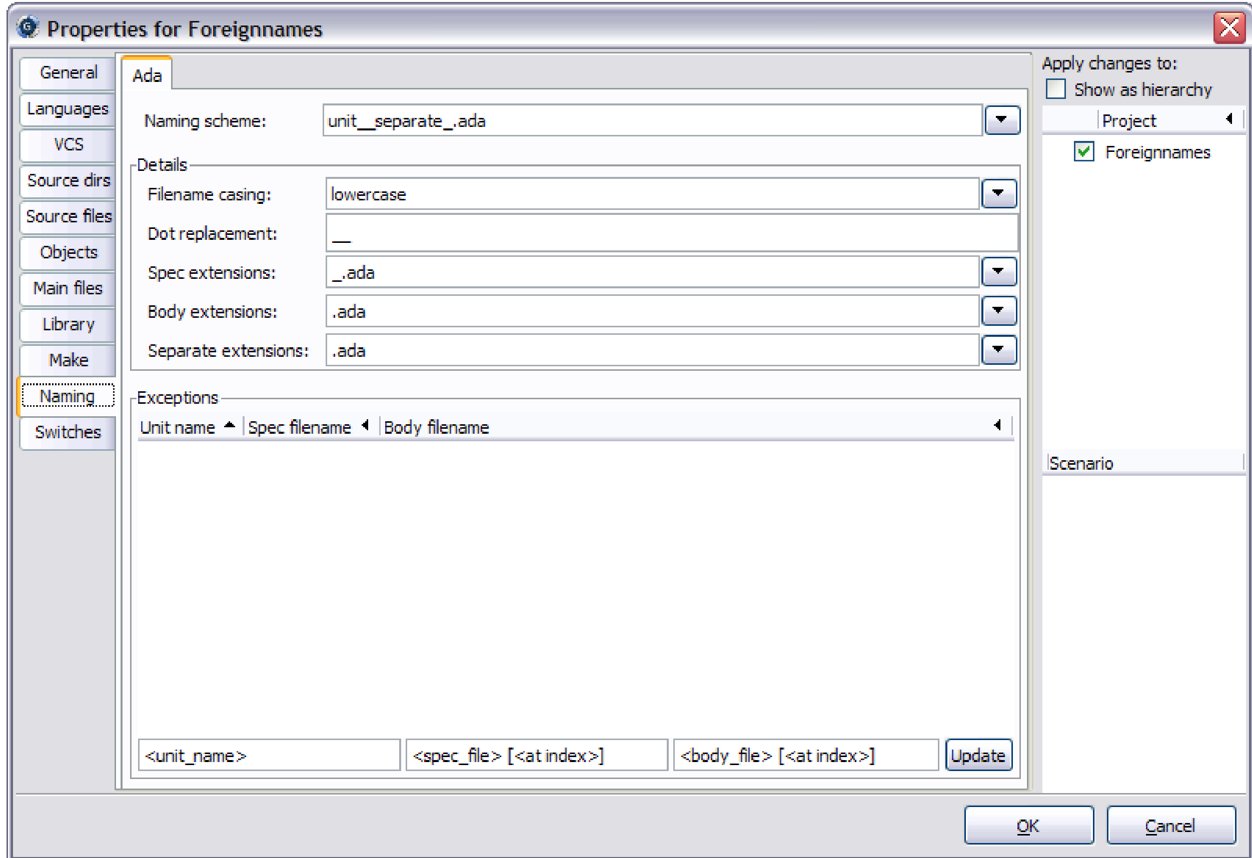


There are a few alternative naming schemes already defined. Active the pull-down menu to see these alternatives. If one of them matches your scheme you simply select that scheme and press OK to finish. Press OK when asked if you want to save the project file changes.

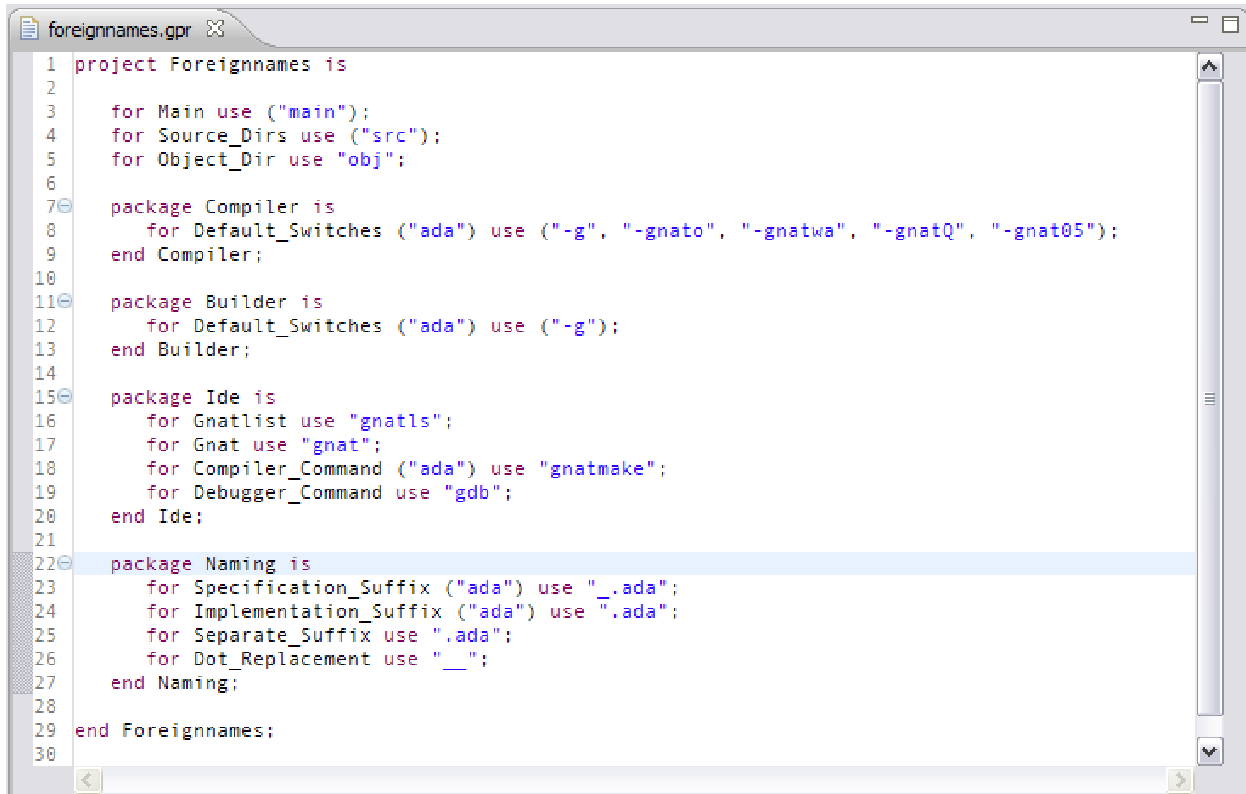


If none of the predefined schemes match your convention you may create a new convention by selecting "custom" in the pull-down list, giving the scheme a new name to replace "custom" and then specifying the details of the convention in the various "Details" entry panes.

In the following figure we have selected a common scheme in which spec file names end with an underscore, both kinds of file end with ".ada", and dots in Ada unit names are replaced by a a double underscore.



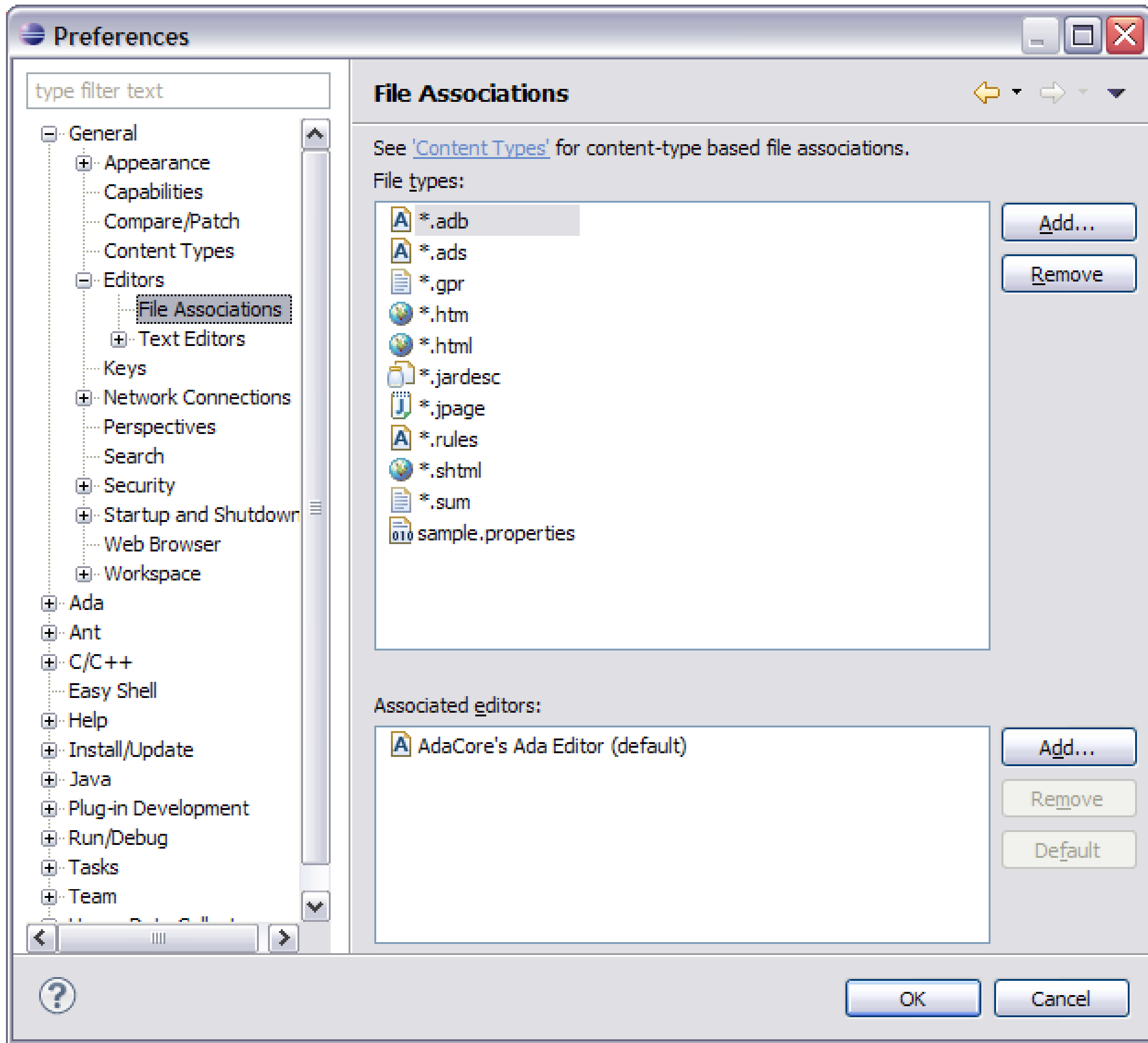
The GUI makes your changes effective by modifying the GNAT project file (the "gpr file") if you choose to save the changes. In this case, it either adds or changes a package named "Naming" within the file. For the above selections these changes would look like the following:



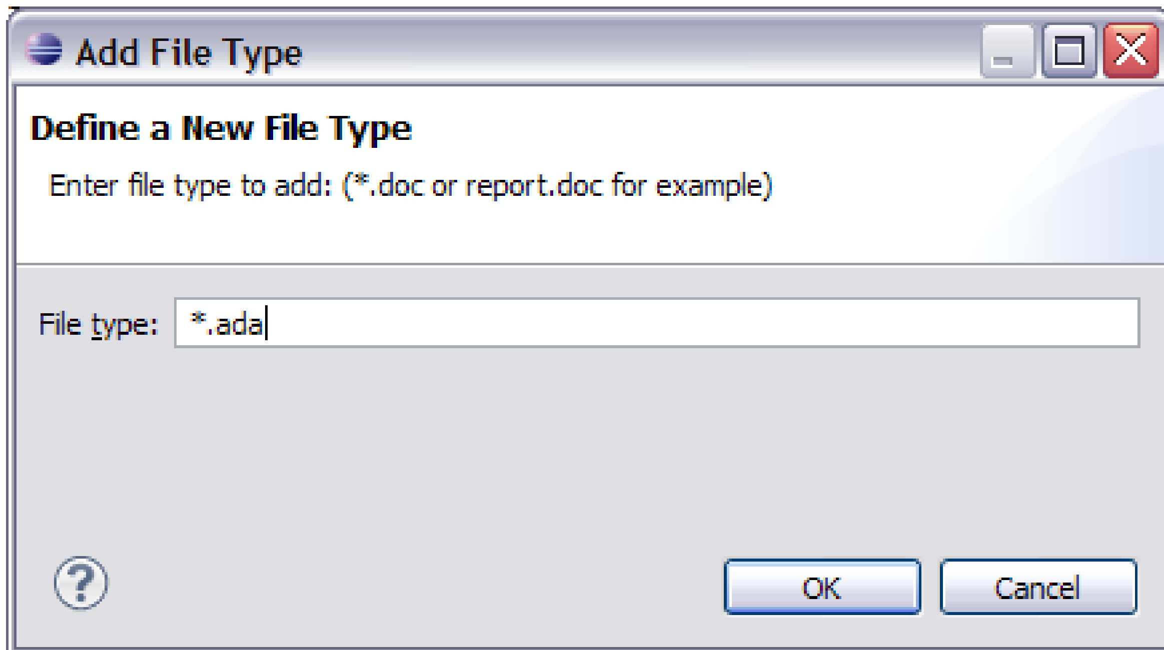
As an alternative to the GUI, you may also simply edit the gpr file manually and insert the package Naming and its contents.

4.6.2 Associating the File Name Extension with the Ada Editor

For the second step, you set the file associations via Eclipse preferences. Specifically, invoke the Window menu and select Preferences to invoke the dialog. Then expand the General and Editors categories. You should now see a choice "File Associations" underneath the Editors category. Click it to open that page.

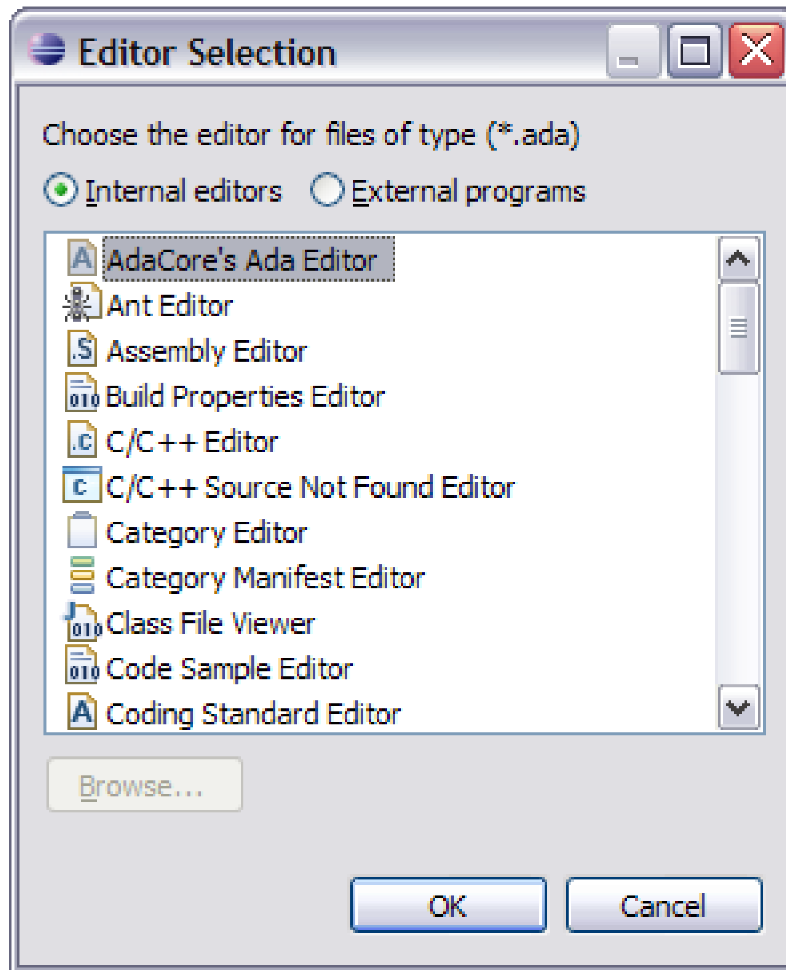


In that page you will see a list of file name extensions on the upper part of the page, and associated editors in the lower part. If your extension is not defined, click the Add button to open a new dialog and specify your extension (e.g., "*.ada", but without the quotes). For example, the following figure illustrates the Add button dialog with "*.ada" specified:

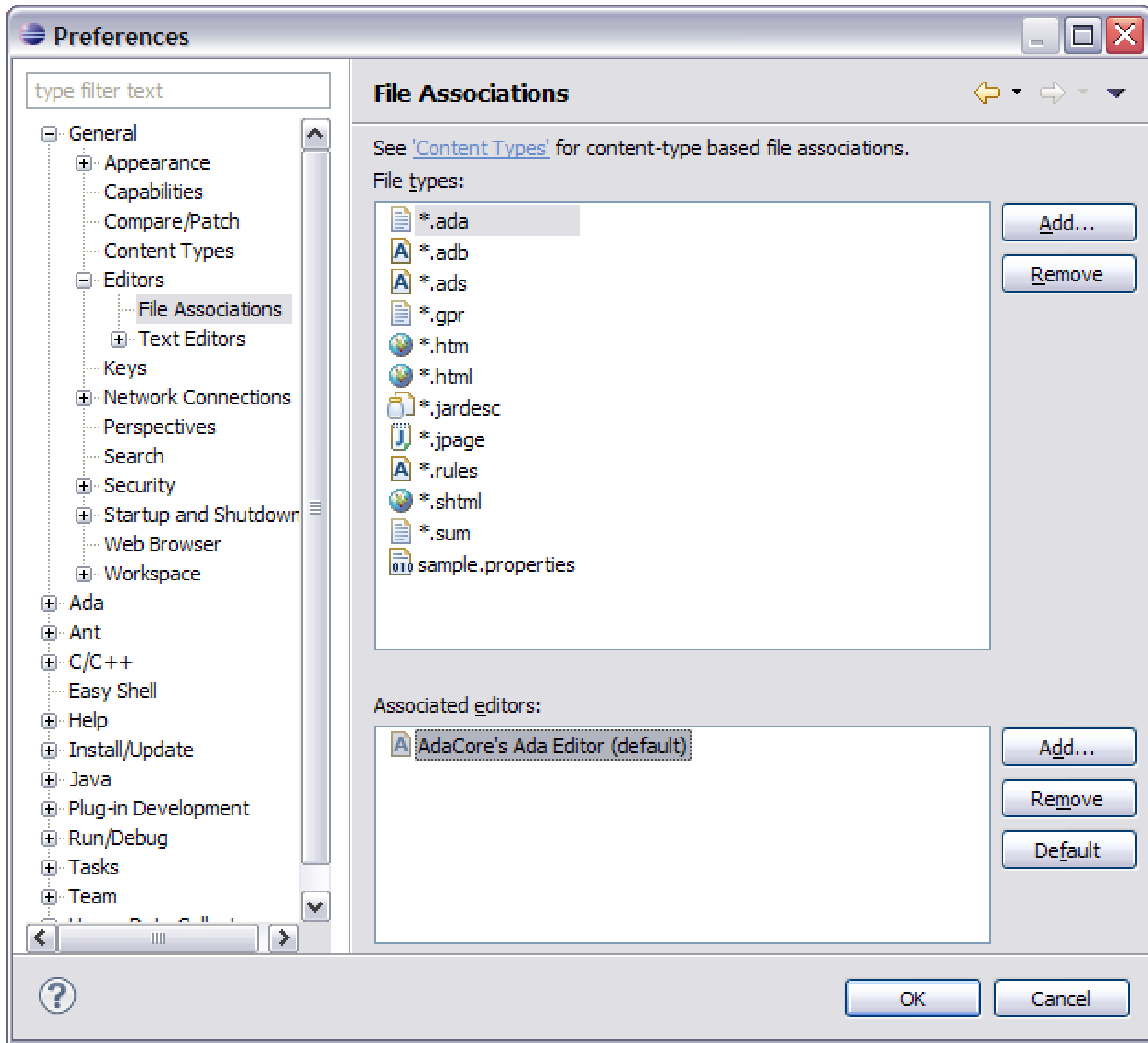


Press OK to close the Add extension dialog.

Then, back in the File Associations page of the original dialog, select your new extension in the upper part of the page and press the other Add button, the one for the editors in the lower part of the page. Another popup will appear, in which you will select "AdaCore's Ada Editor":



Press OK to close the editor selection dialog. The completed association will appear in the File Associations page:



Press OK again to close the Preferences dialog and you're done.

CHAPTER

FIVE

BROWSING AND NAVIGATION

5.1 Crucial Setup Requirement

Unlike Ada-aware editing, which will work for any properly-named Ada source file, browsing and navigating require some processing prior to use. **Specifically, these facilities require the Ada source code to be in a GNATbench project and to have been analyzed by the GNAT Pro compiler.** Failure to meet these requirements will result in either unsuccessful invocations or missing menu entries in some menus.

Being "in" a GNATbench project means that the source code is in a file residing within one of the directories specified by the Source_Dirs attribute of a GNATbench project file (the project "gpr file"). Implicit inclusion by residence within the same directory as the project file will also suffice.

Analysis by the GNAT Pro compiler happens either automatically, as a result of normal compilation, or explicitly, by manual invocation of the compiler in a special mode to perform the analysis.

Therefore, building the entire project will make all the sources navigable. Of course, those Ada files not in a GNATbench project are not compiled when building the project so they are not analyzed. That means they will not support navigation and browsing, even though the Ada editor will open them.

You can compile individual files via the Ada editor's contextual menu. Manually compiling some of the files will make some of the files navigable.

Analysis results are stored in a cross-reference database. By default this database is named 'gnatinspect.db' and is located in the project's object directory.

For your convenience, GNATbench attempts to support navigation prior to the corresponding files' analysis, but to ensure full functionality you must use the compiler to analyze the sources. When the functionality is not possible a dialog box will notify you of that fact, suggesting the cause of the problem.

Also for your convenience, GNATbench attempts to support navigation even in the face of changes to the source code. Such changes can invalidate any previous analysis, however, so ensuring accurate navigation functionality requires that you re-analyze the code.

5.1.1 The cross-reference database

GNATbench parses the cross-reference information generated by the compiler (the `.ali` and `.gli`) files into an **`sqlite`** database. This database can become quite large and should preferably be on a fast local disk.

By default, GNATbench places this database in the object directory of the currently-loaded root project. Override this choice by adding an attribute *Xref_Database* in the *IDE* package of your project file, either as an absolute path or a path relative to the location of the project file. We recommend this path be specific to each use, and to each project this user might be working on, as in the following examples:

```
--  assume this is in /home/user1/work/default.gpr
project Default is
   for Object_Dir use "obj";

   package IDE is
      for Xref_Database use "xref_database.db";
      --  This would be /home/user1/work/xref_database.db

      for Xref_Database use Project'Object_Dir & "/xref_database.db";
      --  This would be /home/user1/work/obj/xref_database.db
      --  This is the default when this attribute is not specified

      for Xref_Database use external("HOME") & "/prj1/database.db";
      --  This would be /home/user1/prj1/database.db
   end IDE;
end Default;
```

One drawback in altering the default location is that **gprclean** will not remove this database when you clean your project. But it might speed up GNATbench if your project is not on a fast local disk and you can put the database there.

WARNING: You should not store this file in a directory that is accessed via a network filesystem, like NFS, or Clearcase's MVFS. If your obj directory is on such a filesystem, be sure to specify a custom Xref_Database directory in your project file.

5.1.2 Cross-references and partially compiled projects

The cross-reference engine works best when the cross-reference information generated by the compiler (the `.ali` files) is fully up to date.

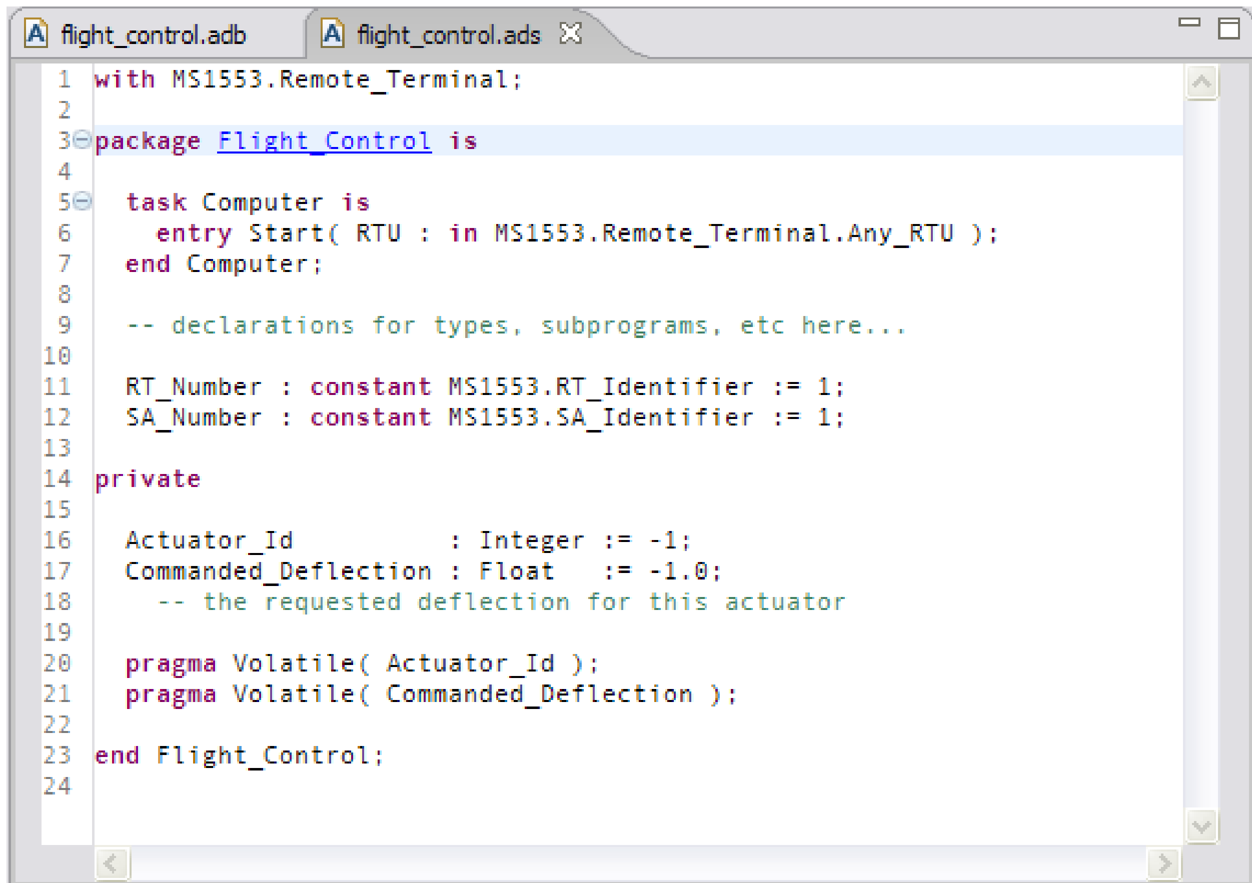
If you start from such a state and then modify the spec or body of an Ada package and recompile only that file, any reference to entities declared in that spec in other packages might no longer be found (until you recompile those other packages, as **gprbuild** would).

This is because GNATbench has no way to know for sure whether an entity `Foo` in the spec is the same entity as before or is a new one with the same name. It uses an approximate algorithm where the references are only preserved if an entity with the same name remains at precisely the same location in the new version of the source. But if a blank line in the file will change the declaration line for all entities declared further in the file, so those will lose their references from other source files.

5.2 Browsing via Source Code Hyperlinks

Users can browse through the source code by treating any name in an Ada editor as a hyperlink. Clicking on the name while holding down the control key will place the cursor on the corresponding specification (for program units) or declaration (for other entities, such as objects and types). Traversing the defining name within a program unit declaration will display the corresponding body if the body exists.

In the figure below, the user is pressing the control key and moving the mouse over the name of the package, so the editor has indicated that the name can be treated as a hyperlink by changing the color to blue and underlining it.

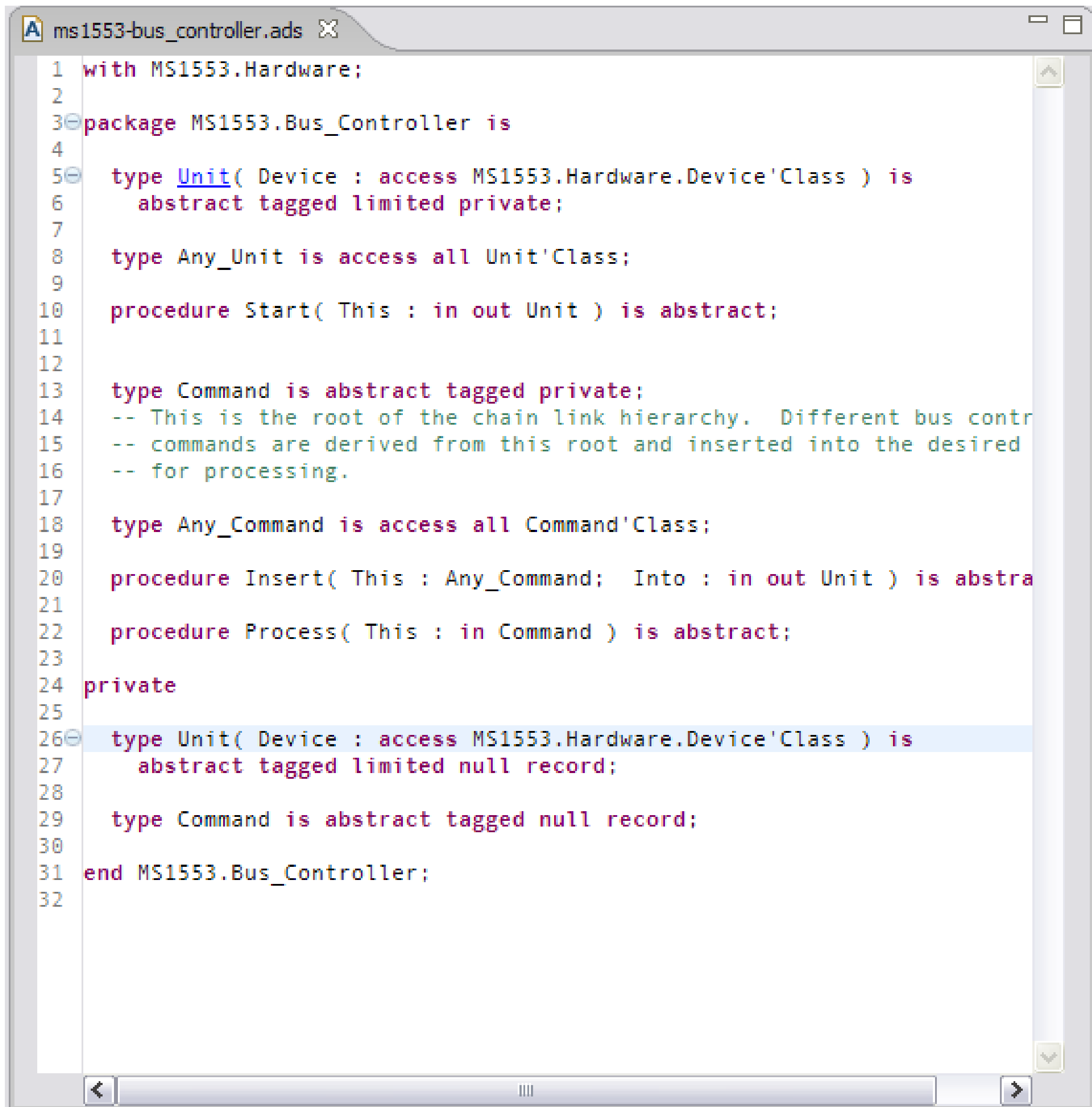


If the user then clicks on the package name, the editor opens the file containing the corresponding package body and places the cursor on that line, as shown in this figure:

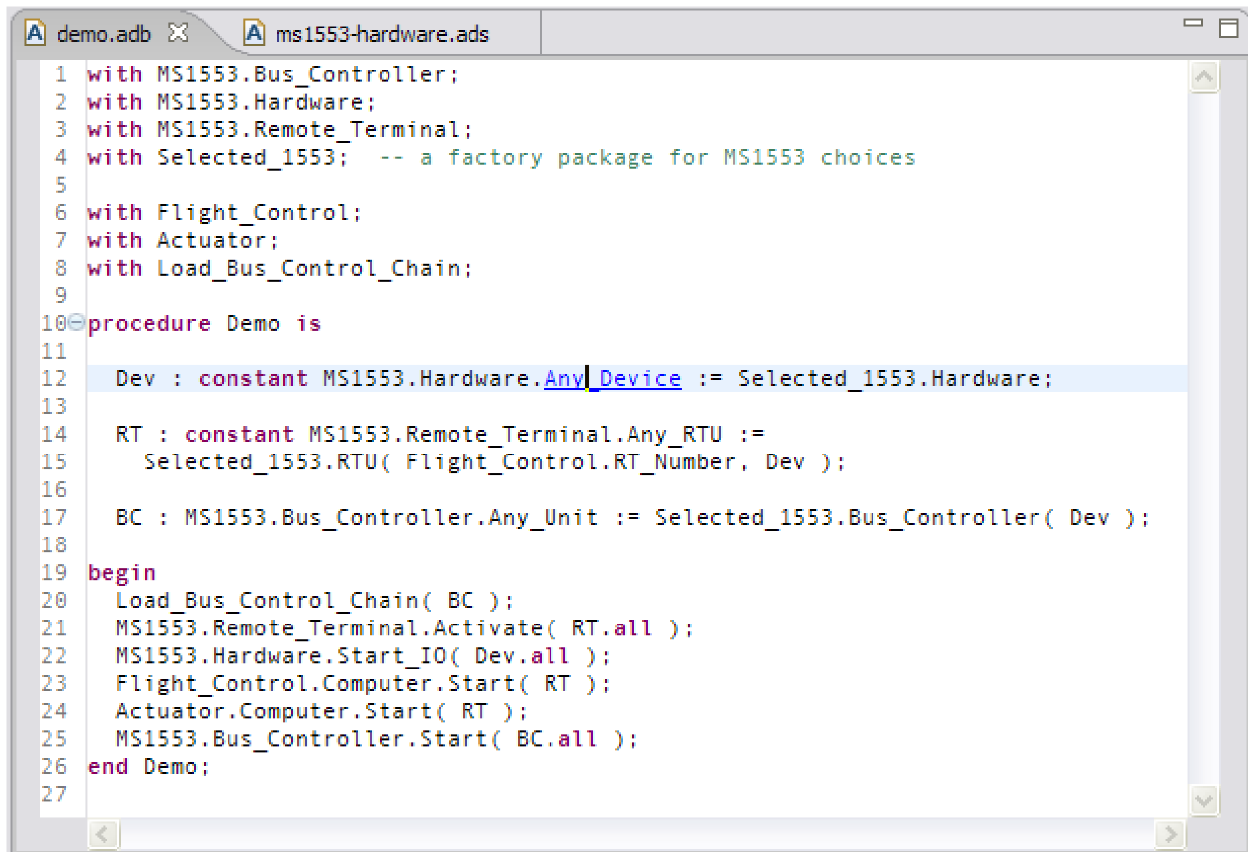
flight_control.adb flight_control.ads

```
1  with Flight_Control.Messages;
2  with MS1553.Subaddress.IO;       pragma Elaborate_All( MS1553.Subaddress
3  with Selected_1553;              pragma Elaborate_All( Selected_1553 );
4  with Ada.Text_IO;
5
6  package body Flight_Control is
7
8
9    task body Computer is
10     Xmitter    : MS1553.Subaddress.Any_Transceiver;
11     Msg_Status : constant MS1553.Subaddress.Any_Status := Selected_1553
12     use Flight_Control.Messages;
13   begin
14     accept Start( RTU : in MS1553.Remote_Terminal.Any_RTU ) do
15       Xmitter := Selected_1553.Transceiver( Number => SA_Number, RT =>
16     end Start;
17     MS1553.Subaddress.Initialize( Xmitter.all );
18     Actuator_Id := 15;
19     Commanded_Deflection := 0.0;
20     loop
21       MS1553.Subaddress.IO.Send( Xmitter.all, Deflection_Command, Msg_S
22       if MS1553.Subaddress.Success( Msg_Status.all ) then
23         Commanded_Deflection := Commanded_Deflection + 0.25;
24       else
25         Ada.Text_IO.Put_Line( "Transmission did not occur!" );
```

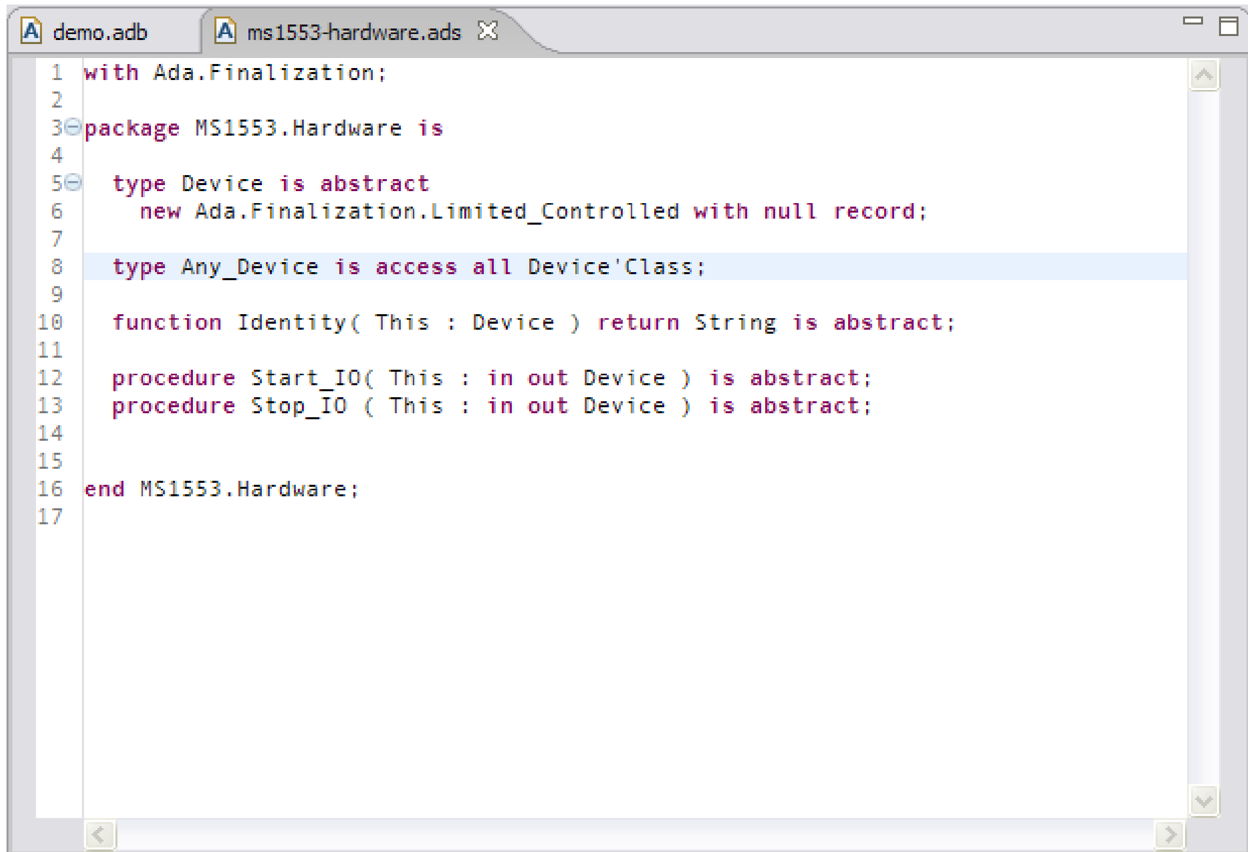
Hyperlinks work for the visible and private parts of packages so the full declaration of a private type can be visited from the partial view, and vice versa.



Client code will frequently want to visit the declaration of a type (or object) and the hyperlink mechanism will handle that usage:



When clicked, the editor then takes the user to the corresponding declaration:



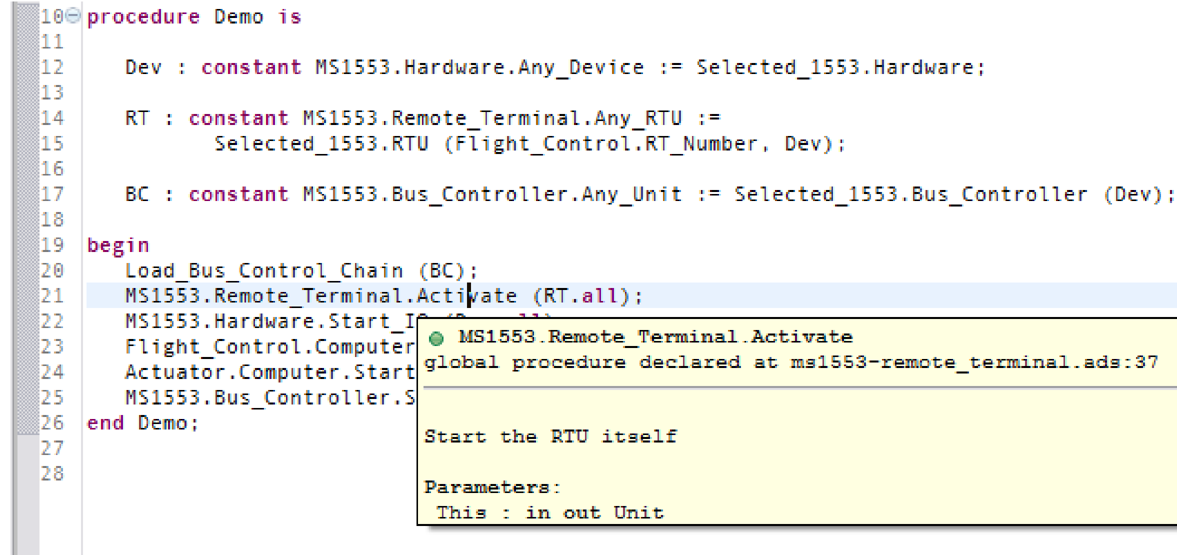
5.2.1 Configuring C/C++ Source Code Hyperlinks navigation

C/C++ source code hyperlinks navigation requires C/C++ indexer. It should be also enabled for source files not included in the build.

see "Index source files not included in the build" indexer option in C/C++ > Indexer preferences page accessible through Windows > Preferences menu.

5.3 Editor Tooltips

Hovering the mouse cursor over an entity in the Ada editor causes the profile and documentation to appear in a tooltip. For example, in the following image, the mouse is hovering over the name "Activate", resulting in the tooltip shown:



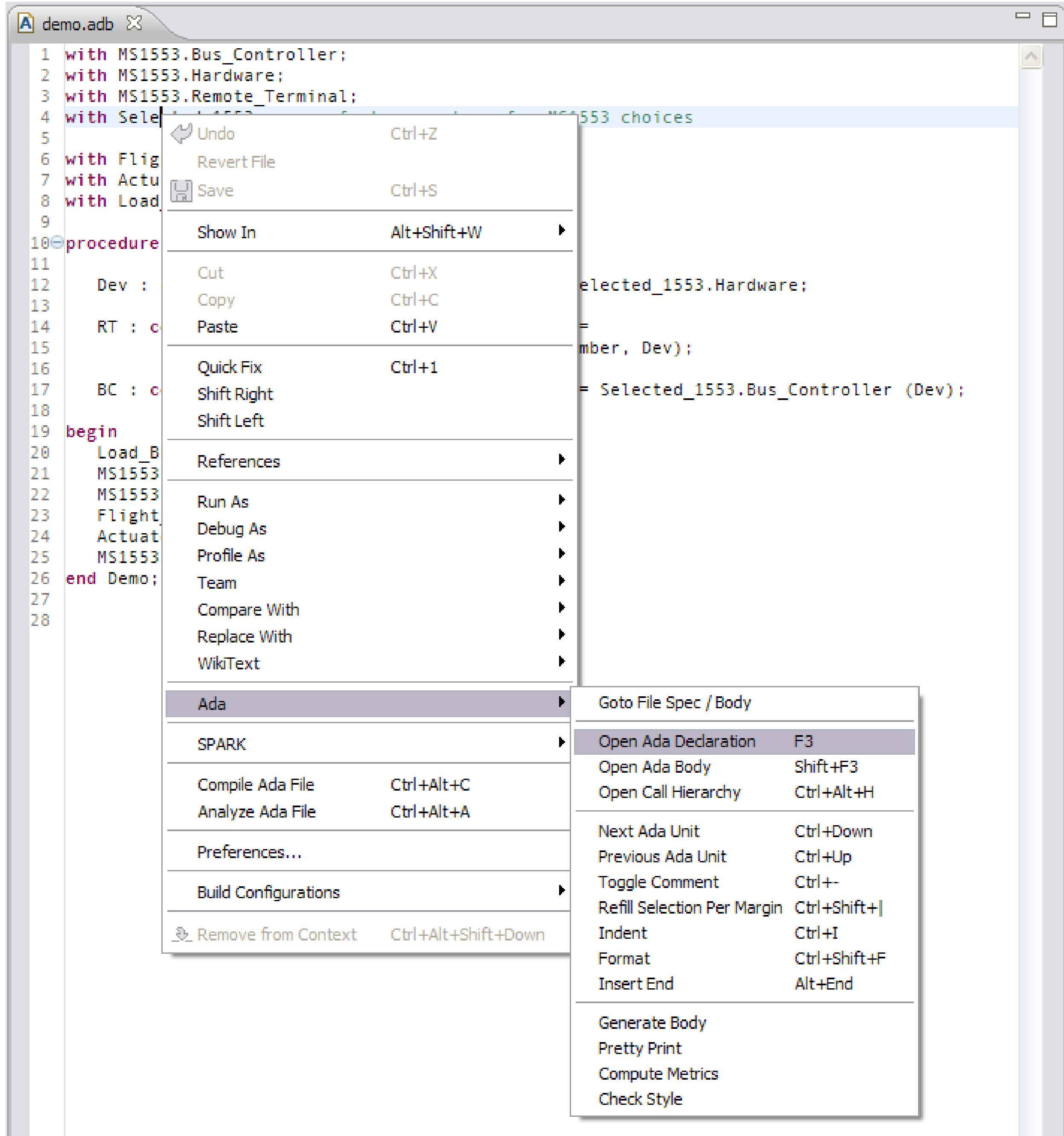
Note the green dot symbol indicating that this is a visible procedure, as is employed elsewhere such as the Outline view. Note also the text describing the purpose of the procedure, taken from a comment next to the procedure declaration. The formal parameters, if any, are also indicated.

These tooltips can be disabled via the Ada Editor preferences page.

5.4 Visiting Declarations and Bodies

The Ada language-sensitive editor supports navigation and browsing via menu entries in the contextual menu. Given an existing identifier, you may visit the corresponding declaration or body.

You may either left-click on the target and press F3, or right-click and select Open Declaration (or Open Body) from the editor's contextual menu. If the cursor is not on an entity when visitation is requested, GNATbench will attempt to determine the enclosing program unit and visit the corresponding declaration or body.



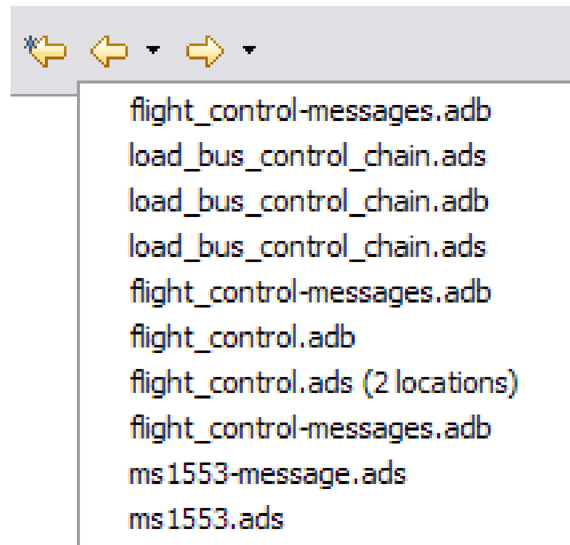
The declarations and bodies of packages, protected types, tasks, procedures, and functions can be visited. In addition, you can navigate from an Ada declaration directly to its C or C++ implementation if the Ada declaration is completed by a pragma Import specifying convention C or CPP.

The declarations of types and objects may also be visited, in addition to the program units listed above. For example, given the use of a type in an object declaration, you may go to the declaration of that type using this interface.

Note that language-defined types declared in package Standard are not supported because there is no actual package Standard. However, language-defined types in other language-defined packages, such as System and Interfaces, **are** physically represented and are, therefore, supported.

Eclipse maintains a list of files visited in the editor and allows you revisit them using the yellow "Forward" and "Back" navigation arrows on the toolbar. (The left-arrow with an asterisk next to it, to the left of the Forward and Back

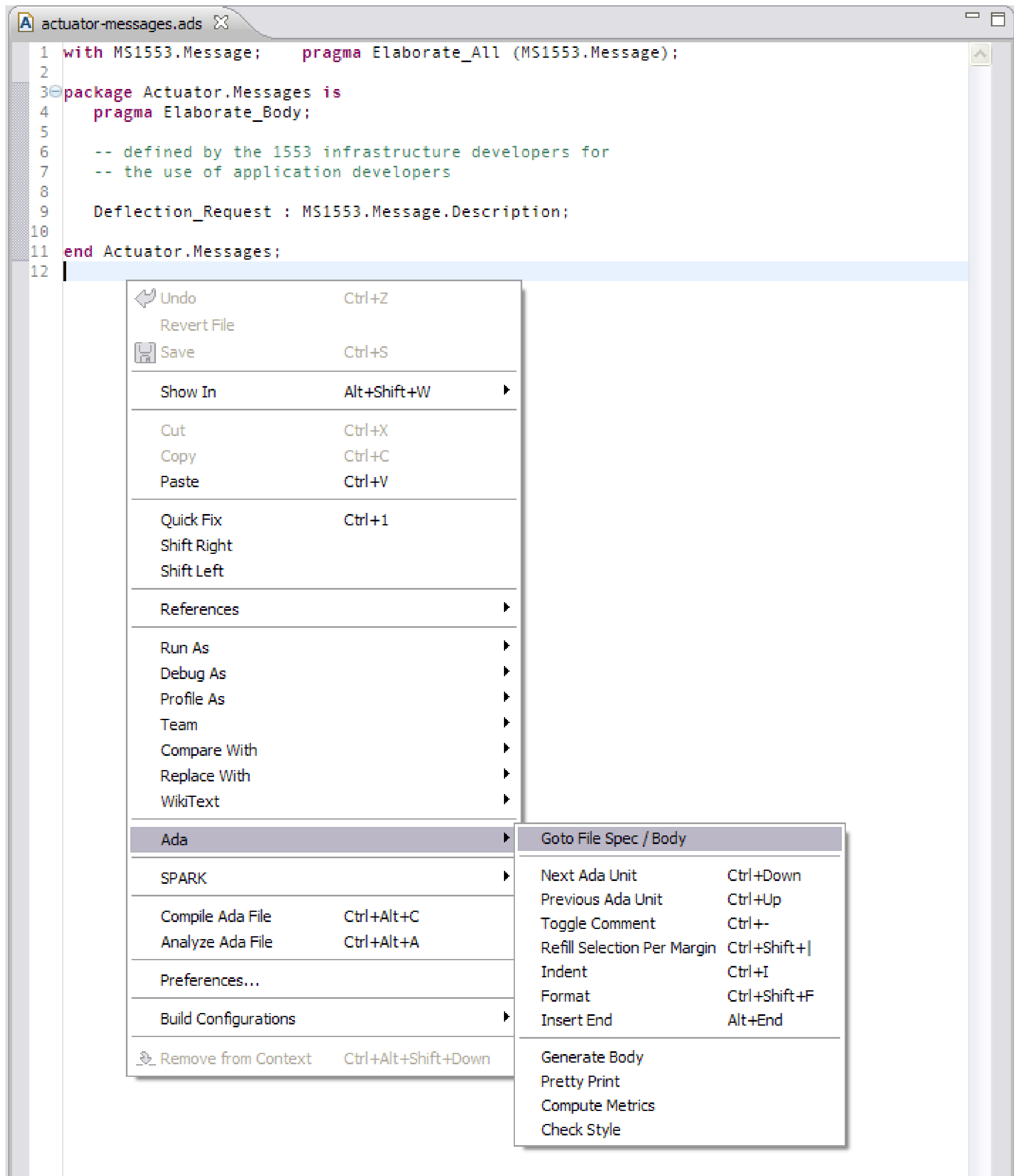
buttons, visits the last location at which an actual editing change was made.) GNATbench is fully integrated with these navigation controls. Clicking one of these buttons visits the next or previous location visited, linearly. You may jump directly to any specific location in the list by clicking on the black down-arrow controls next to the buttons and selecting a file from the resulting list. The following figure shows a sample list:



5.5 Visiting Declaration and Body Files

In addition to navigating and browsing by selecting individual entities in a source file, you can also navigate back and forth in terms of the files themselves, *without first selecting the entity name*. To do so, simply place the cursor anywhere within the file containing the declaration or body and invoke "Goto File Spec / Body", in either the Ada menubar entry or the Ada menu in the editor contextual menu. The file containing the corresponding declaration or body will open.

In the following figure the cursor is in the file but is past the end of the package when the contextual menu is invoked. The corresponding body file will be opened as a result of the invocation.


actuator-messages.ads
1 with MS1553.Message; pragma Elaborate_All (MS1553.Message);
2
3 package Actuator.Messages is
4 pragma Elaborate_Body;
5
6 -- defined by the 1553 infrastructure developers for
7 -- the use of application developers
8
9 Deflection_Request : MS1553.Message.Description;
10
11 end Actuator.Messages;
12
Undo Ctrl+Z
Revert File
Save Ctrl+S
Show In Alt+Shift+W
Cut Ctrl+X
Copy Ctrl+C
Paste Ctrl+V
Quick Fix Ctrl+1
Shift Right
Shift Left
References
Run As
Debug As
Profile As
Team
Compare With
Replace With
WikiText
Ada
SPARK
Compile Ada File Ctrl+Alt+C
Analyze Ada File Ctrl+Alt+A
Preferences...
Build Configurations
Remove from Context Ctrl+Alt+Shift+Down
Goto File Spec / Body
Next Ada Unit Ctrl+Down
Previous Ada Unit Ctrl+Up
Toggle Comment Ctrl+-
Refill Selection Per Margin Ctrl+Shift+|
Indent Ctrl+I
Format Ctrl+Shift+F
Insert End Alt+End
Generate Body
Pretty Print
Compute Metrics
Check Style

5.6 Traversing Within Source Files

You may visit the next or previous unit within an Ada source file using the "Goto Next Unit" and "Goto Previous Unit" commands. These commands will skip to the next/previous procedure, function, or entry in the file. Both declarations and bodies for these units in a given file will be visited.

By default these editor actions are bound to the Ctrl+Up_arrow and Ctrl+Down_arrow keys (for visiting the previous and next units, respectively). You may change these bindings if desired, as usual.

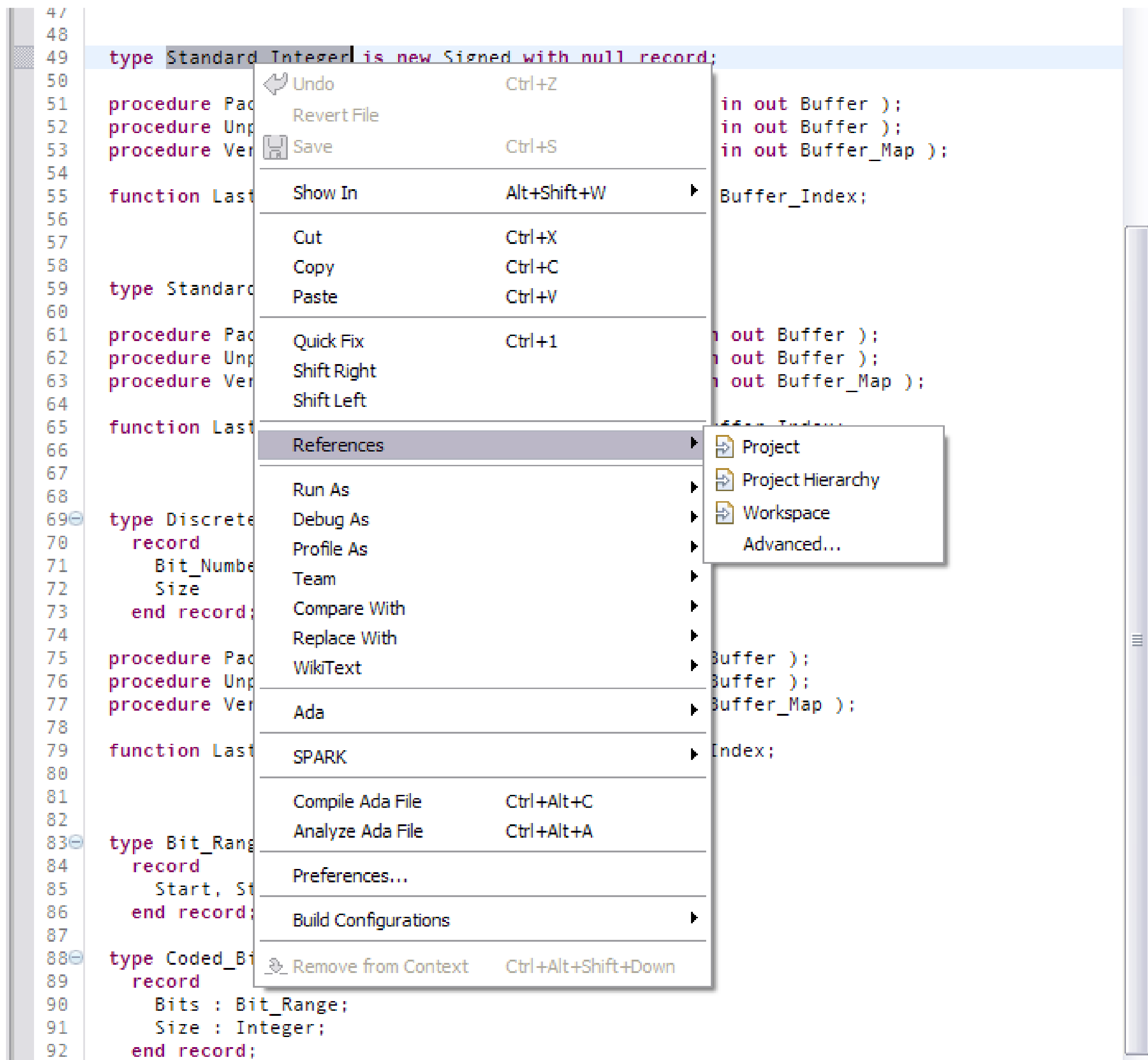
The commands are also available via the Ada menu on the menubar and the editor's contextual menu.

If there is no next or previous unit, these actions have no effect.

5.7 Browsing via Reference Searching

In addition to browsing by navigating along the hyperlinks of individual Ada entities, you can also browse the code in a more "global" manner by searching for *all* references to a selected entity.

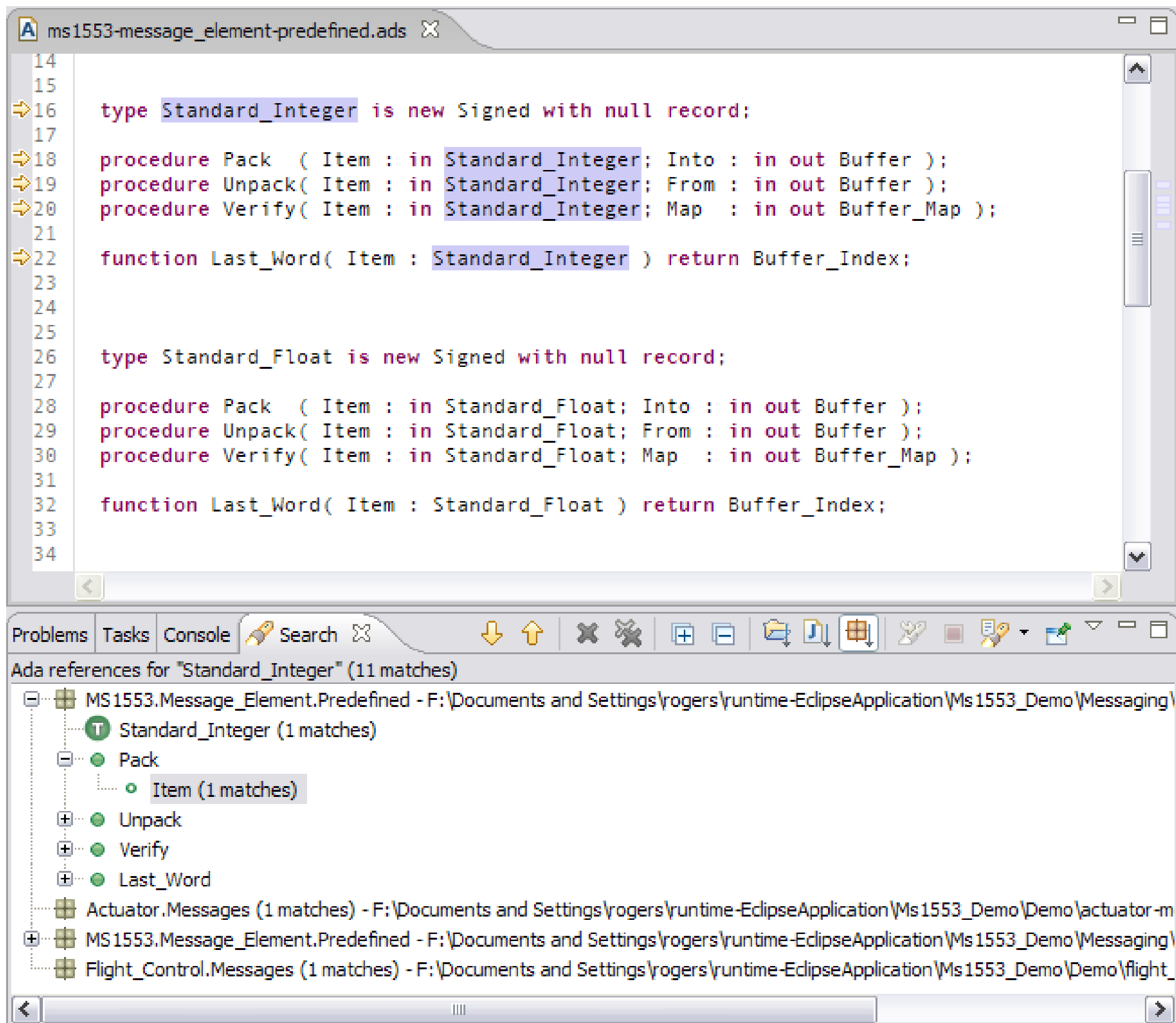
When the editor cursor (not the mouse cursor) is over a given entity in the Ada editor, or when the entity is selected, right-clicking with the mouse invokes a contextual menu that allows you to request a display of all references to that entity. (The menu entry is named "References".)



You control the scope of the search by selecting either "Project" or "Workspace" (or "Project Hierarchy"). Typically you will want to search within a single project but you can search all open projects by selecting "Workspace".

The search results appear in the Search view. Clicking on one of these entries will traverse to the reference in the corresponding file, opening the file in the Ada editor if necessary. Within the editor, links to these references are added to the overview ruler and arrows are added to the annotation ruler.

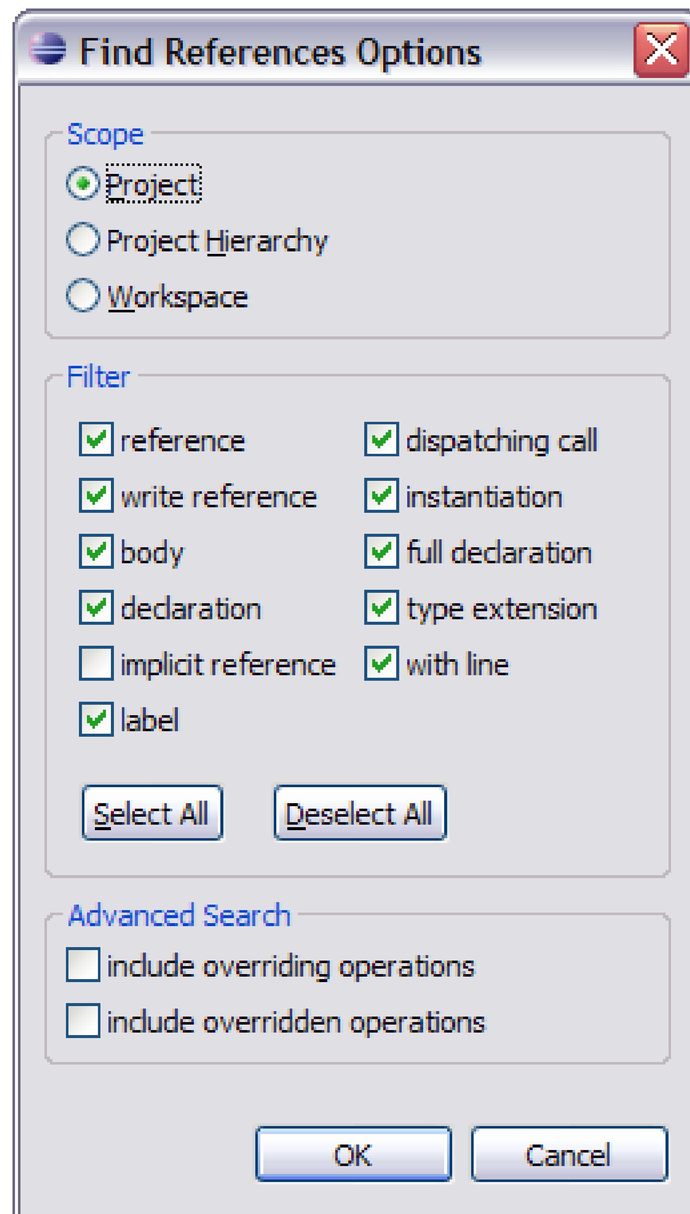
The following figure illustrates the result of searching for the entity "Standard_Integer" in an Ada file. The Search view shows that the entity is declared in package "MS1553.Message_Element.Predefined" because of the icon appearing as a green circle with a 'T' in the middle. It further shows that "Standard_Integer" is referenced in a subprogram named "Pack" in that package. We have clicked on that Search entry so the editor has opened that file and highlighted the occurrences. Other references to "Standard_Integer" occur in three other packages and we could visit those occurrences in the same manner.



5.7.1 Advanced Options

You can refine the parameters of the references search in terms of Ada language features.

To do so, select "Advanced…" under the "References" submenu. Doing so will bring up the following dialog box, allowing you to select additional criteria for the search. You can also specify the same options as you would have without choosing the advanced options entry, namely the extent of the search itself (project, workspace, or project hierarchy).


Find References Options
Scope
Project
Project Hierarchy
Workspace
Filter
reference
dispatching call
write reference
instantiation
body
full declaration
declaration
type extension
implicit reference
with line
label
Select All
Deselect All
Advanced Search
include overriding operations
include overridden operations
OK
Cancel

CHAPTER

SIX

DEVELOPING ADA SOURCE CODE

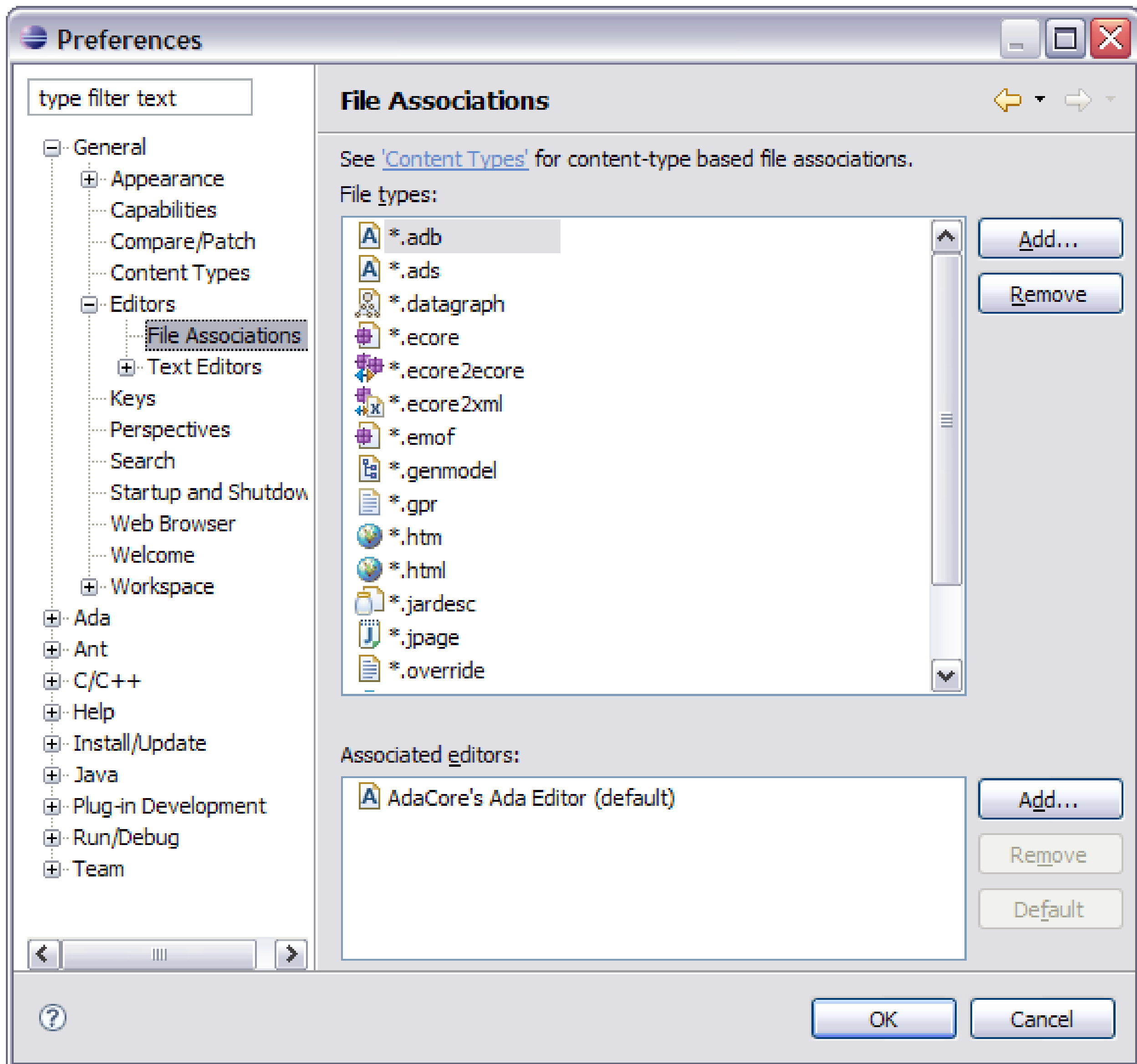
6.1 Language-Sensitive Editing

6.1.1 Invoking the Ada Language-Sensitive Editor

Simply double-click on an Ada file in either the GNAT Project Explorer or the Navigator to invoke the GNATbench language-sensitive editor. You can also right-click on the file in the Navigator and select "Open" from the contextual menu.

If opening an Ada source file does not invoke the GNATbench editor by default, there are two options available. The first is to right-click on the file icon in the Project Navigator, select "Open With" in the contextual menu, and then select "AdaCore's Ada Editor". This approach, however, must be followed each time a file is to be edited.

The much more convenient alternative is to associate the GNATbench editor with Ada files by default. This effect is achieved by associating the editor with the appropriate file name extensions, as illustrated below. Note that in the illustration we are associating the editor with the GNAT default Ada file name extensions; other extensions are equally possible.



6.1.2 Syntax Coloring

Using the *Syntax Coloring*, users specify the colors displayed for reserved words, comments, annotation comments, string literals, numeric literals, character literals, and user-defined text. The defaults are as shown below, in which the reserved words are in magenta, string and character literals are in blue, numeric literals are in black, comments are in light green, and user-defined text is in black.

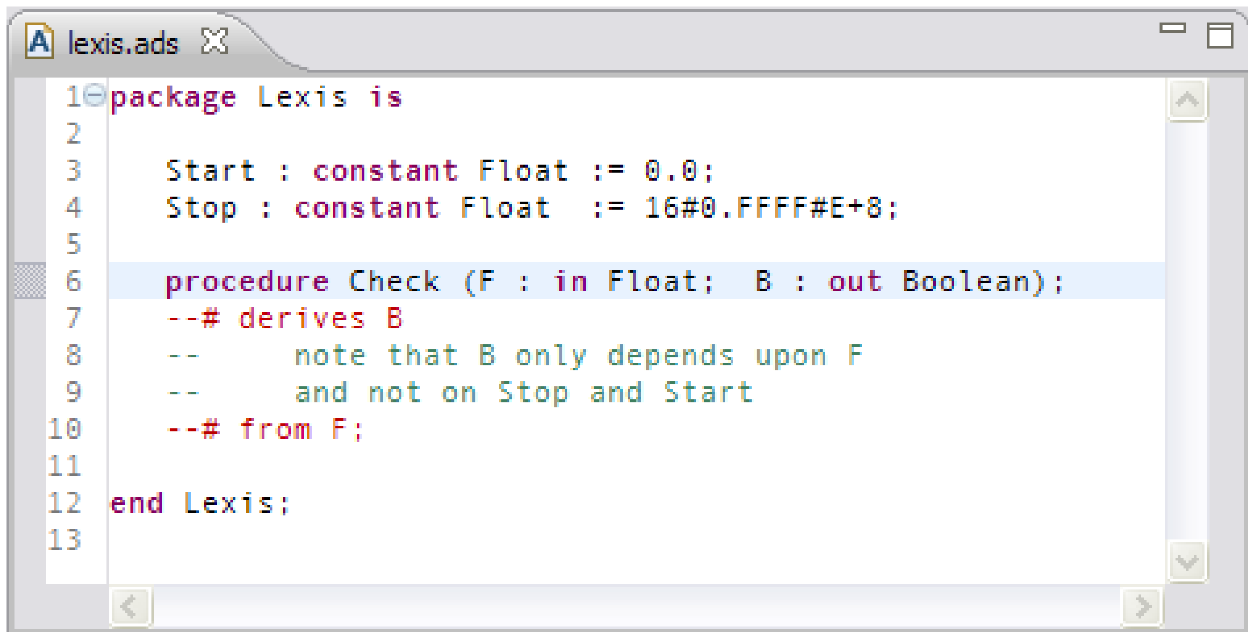
```
actuator.adb

with Actuator.Messages;
with MS1553.Subaddress.IO;      pragma Elaborate_All( MS1553.Subaddress.IO );
with Selected_1553;             pragma Elaborate_All( Selected_1553 );
with Ada.Text_IO;               use Ada.Text_IO;

package body Actuator is


  task body Computer is
    Receiver   : MS1553.Subaddress.Any_Transceiver;
    Msg_Status : constant MS1553.Subaddress.Any_Status := Selected_1553.Message_Status;

    use Actuator.Messages;  -- for Deflection_Request
    use MS1553.Subaddress;  -- for status functions
  begin
    accept Start( RTU : in MS1553.Remote_Terminal.Any_RTU ) do
      Receiver := Selected_1553.Transceiver( Number => SA_Number, RT => RTU );
    end Start;
    MS1553.Subaddress.Initialize( Receiver.all );
    loop
      MS1553.Subaddress.IO.Receive( Receiver.all, Deflection_Request, Msg_Status.all );
      if Success( Msg_Status.all ) then
        Put( Integer'Image(Requested_Actuator_Id) );
        Put( ", " );
        Put_Line( Float'Image(Requested_Deflection) );
      else
        Put_Line( "Reception failed!" );
      end if;
      delay 0.5;
    end loop;
  end Computer;


end Actuator;
```

Annotation Comments

Annotation comments are Ada comments recognized by the editor as having additional meaning and therefore to be colored distinctly from regular comments. By default, these comments are colored red.

Lexically, annotation comments are those that have a non-whitespace or non-alphanumeric character immediately following the initial "–", other than another dash. All annotation comments appear in the same color.

For example, the SPARK language defines annotation comments as starting with the sequence "–#", as in the following example taken from John Barnes' *High Integrity Software: The SPARK Approach to Safety and Security*:



6.1.3 Formatting Source Code

The GNATbench Ada language-sensitive editor provides a large number of built-in formatting controls that can be applied manually or automatically. These formatting controls are described in this chapter.

Note that you can format an entire file using the external pretty printer tool. See *Pretty Printer* for details.

Specific aspects of formatting are controlled by the *Coding Style* preference page.

Each of these formatting controls is applied when the formatting command is invoked, but in general they can be individually configured to have no effect if that is the desired behavior.

Manual Invocation

The formatter is manually invoked by pressing Ctrl+Shift+F, or by selecting "Format" under the Ada menubar entry and the editor's Ada contextual menu. This command corrects applies the formatting options, including indentation.

Individual lines can also be formatted: if no selection is active when the command is invoked, only the current line is formatted.

In addition, indentation can be manually corrected by pressing Ctrl+I, or by selecting "Indent" under the Ada menubar entry and the editor's Ada contextual menu. No other formatting options are applied in this case.

Automatic Invocation

The editor can format code automatically as you press the Enter key, depending on the value of the "Coding style mode" preference on the "Coding Style" preference page.

Selecting the mode "None" means no formatting will be applied; the cursor will simply go column 1 of the new line.

The "Simple" mode means that the indentation from the previous line will be used for the next line; the beginning of the new line will be indented to the same amount as the line containing the cursor when the Enter key was pressed. No other formatting is applied.

For example, in the following figure the mode is "Simple" and the Enter key is about to be pressed:

```
19 begin
20    Load_Bus_Control_Chain (BC);
21    MS1553.Remote_Terminal.Activate (RT.all);
22    MS1553.Hardware.Start_IO (Dev.all);
23    Flight_Control.Computer.Start (RT);
24    Actuator.Computer.Start (RT);
25    MS1553.Bus_Controller.Start (BC.all);
26 end Demo;
```

After the Enter key is pressed, a new line is opened and indented to the same amount as the line above:

```
19 begin
20    Load_Bus_Control_Chain (BC);
21    
22    MS1553.Remote_Terminal.Activate (RT.all);
23    MS1553.Hardware.Start_IO (Dev.all);
24    Flight_Control.Computer.Start (RT);
25    Actuator.Computer.Start (RT);
26    MS1553.Bus_Controller.Start (BC.all);
27 end Demo;
```

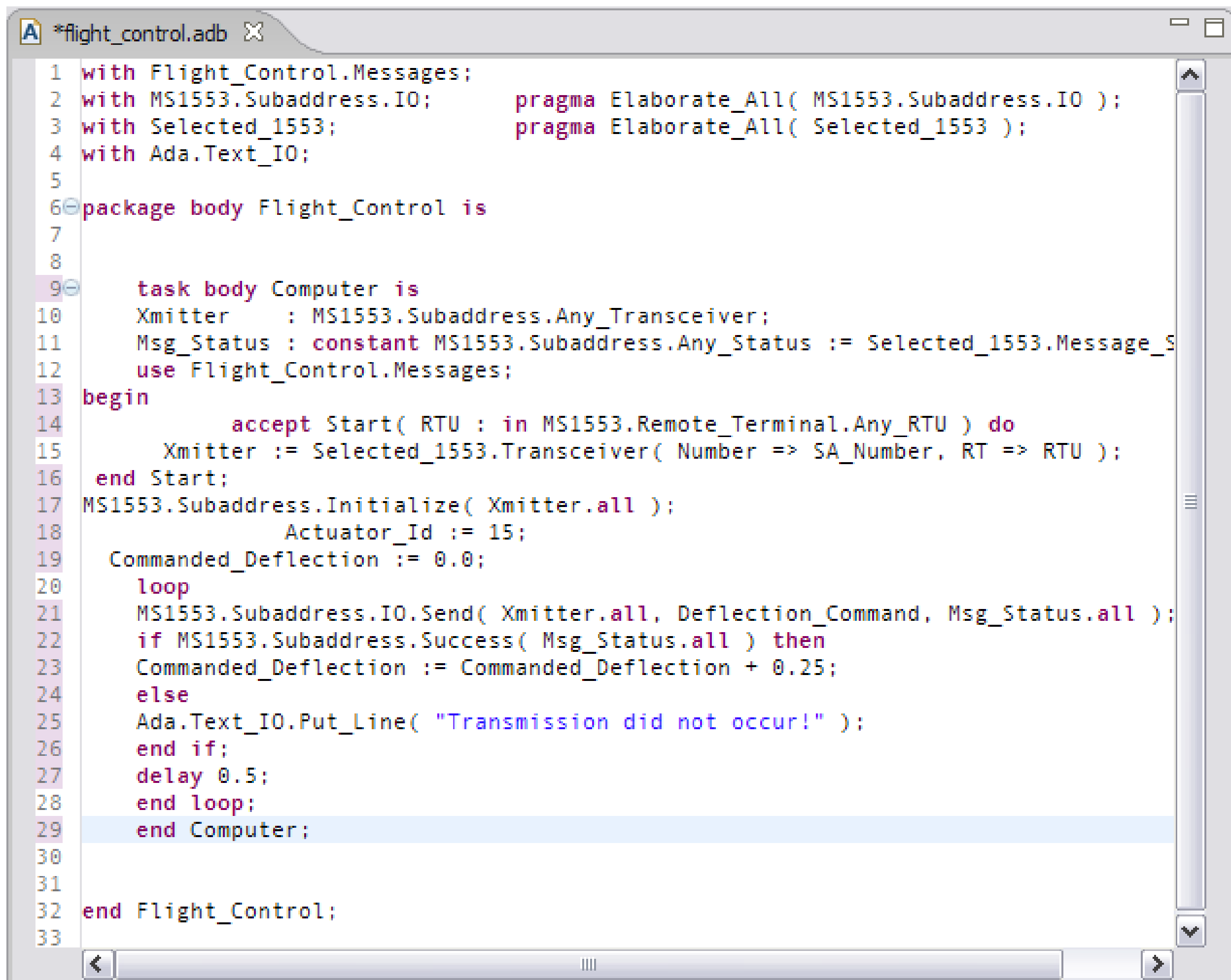
In the "Extended" mode, the line is automatically formatted. The formatter indents the new line as you would indent it yourself, based on the context. For example, if you start a new sequence of statements with the reserved word "begin" and press the Enter key, the new line after the "begin" will be indented to the next level. All other formatting options are also applied.

See *Smart Enter Key* for an example.

Formatting Selected Lines

When a number of lines of source are selected, the selected code will be formatted based on an analysis of the selection as well as the surrounding code. In particular, the selection will be indented relative to that of the surrounding code.

In this initial figure, the lines for the task body are incorrectly indented (in an admittedly unlikely extreme).



We select those lines that require reformatting in the next figure. In this case all of the task body is selected:

*flight_control.adb

```
with Flight_Control.Messages;
with MS1553.Subaddress.IO;      pragma Elaborate_All( MS1553.Subaddress.IO );
with Selected_1553;             pragma Elaborate_All( Selected_1553 );
with Ada.Text_IO;

package body Flight_Control is


    task body Computer is
    Xmitter    : MS1553.Subaddress.Any_Transceiver;
    Msg_Status : constant MS1553.Subaddress.Any_Status := Selected_1553.Message_S
    use Flight_Control.Messages;
begin
           accept Start( RTU : in MS1553.Remote_Terminal.Any_RTU ) do
      Xmitter := Selected_1553.Transceiver( Number => SA_Number, RT => RTU );
 end Start;
MS1553.Subaddress.Initialize( Xmitter.all );
               Actuator_Id := 15;
  Commanded_Deflection := 0.0;
    loop
    MS1553.Subaddress.IO.Send( Xmitter.all, Deflection_Command, Msg_Status.all );
    if MS1553.Subaddress.Success( Msg_Status.all ) then
    Commanded_Deflection := Commanded_Deflection + 0.25;
    else
    Ada.Text_IO.Put_Line( "Transmission did not occur!" );
    end if;
    delay 0.5;
    end loop;
    end Computer;


end Flight_Control;
```

The following figure shows the result after formatting. The selection itself is now properly indented but, in addition, its indentation is consistent with the surrounding code.

*flight_control.adb

```
1  with Flight_Control.Messages;
2  with MS1553.Subaddress.IO;       pragma Elaborate_All( MS1553.Subaddress.IO );
3  with Selected_1553;              pragma Elaborate_All( Selected_1553 );
4  with Ada.Text_IO;
5
6  package body Flight_Control is
7
8
9     task body Computer is
10       Xmitter    : MS1553.Subaddress.Any_Transceiver;
11       Msg_Status : constant MS1553.Subaddress.Any_Status := Selected_1553.Message
12       use Flight_Control.Messages;
13    begin
14       accept Start( RTU : in MS1553.Remote_Terminal.Any_RTU ) do
15          Xmitter := Selected_1553.Transceiver( Number => SA_Number, RT => RTU );
16       end Start;
17       MS1553.Subaddress.Initialize( Xmitter.all );
18       Actuator_Id := 15;
19       Commanded_Deflection := 0.0;
20       loop
21          MS1553.Subaddress.IO.Send( Xmitter.all, Deflection_Command, Msg_Status.a
22          if MS1553.Subaddress.Success( Msg_Status.all ) then
23             Commanded_Deflection := Commanded_Deflection + 0.25;
24          else
25             Ada.Text_IO.Put_Line( "Transmission did not occur!" );
26          end if;
27          delay 0.5;
28       end loop;
29    end Computer;
30
31
32 end Flight_Control;
33
```

Indenting Continuation Lines

The numeric preference value "Continuation lines" specifies the amount to indent when the Enter key is pressed before the end of a line, thereby continuing that line on a new line below. This new line is indented by the value of the preference. In the following example, the Enter key was pressed on line 10, just before the semicolon of the assignment operation. All text to the right of the cursor was then moved down to a new line, now line 11, with the indentation preference value applied.

```
6  package body Actuator is
7
8     task body Computer is
9        Receiver   : MS1553.Subaddress.Any_Transceiver;
10       Msg_Status : constant MS1553.Subaddress.Any_Status
11          := Selected_1553.Message_Status;
12
13       use Actuator.Messages;  -- for Deflection_Request
14       use MS1553.Subaddress;  -- for status functions
15    begin
```

Indenting Declaration Lines

The numeric preference value "Declaration lines" specifies the amount to indent multiple-line declarations. For example, using a value of 3, the following figure illustrates how three variables declared with one declaration would be indented:

```
6  package body Actuator is
7
8     task body Computer is
9        Variable1,
10          Variable2,
11          Variable : Integer;
12
```

Indenting Conditional Continuation Lines

The numeric preference value "Conditional continuation lines" specifies the amount to indent multiple-line conditional expressions within parentheses.

For example, when this preference is set to 1, continuation lines are indented based on the previous parenthesis plus one space:

```
61  procedure Verify( Item : in Prepacked;  Map : in out Buffer_Map ) is
62     In_Use : Buffer_Map renames Map;
63  begin
64     for K in 1..Item.Number_Of_Elements loop
65        if (Item.First_Element+K-1 > Buffer_Index'Last) or else
66          In_Use(Item.First_Element+K-1) /= All_False
67        then
```

When this preference is set to 3, this gives:

```
61  procedure Verify( Item : in Prepacked;  Map : in out Buffer_Map ) is
62     In_Use : Buffer_Map renames Map;
63  begin
64     for K in 1..Item.Number_Of_Elements loop
65        if (Item.First_Element+K-1 > Buffer_Index'Last) or else
66            In_Use(Item.First_Element+K-1) /= All_False
67        then
```

Indenting Record Definitions

The numeric preference value "Record indentation" specifies the amount to indent record definitions when the reserved word "record" appears on its own line.

For example, when this preference is set to 3, the following sample will be indented as shown:

```
27  type Locus is
28     record
29        RT : RT_Identifier;
30        SA : SA_Identifier;
31     end record;
```

If this preference were to be set to 1, the formatting would be as follows:

```
27   type Locus is
28    record
29       RT : RT_Identifier;
30       SA : SA_Identifier;
31    end record;
```

Indenting Case Statement Alternatives

The radio button preference "Case indentation" specifies whether GNATbench should indent case statement alternatives with an extra level, as is done in the Ada Reference Manual, e.g:

```
27   case RT is
28      when others =>
29         null;
30   end case;
```

If this preference is set to Non_Rm_Style, this code would be indented as:

```
27   case RT is
28   when others =>
29      null;
30   end case;
```

By default (Automatic), GNATbench will choose whether to indent based on the first "case alternative" construct: if the first "when" is indented by an extra level, the whole case statement will be indented following the RM style.

Correcting Letter Casing

Reserved words and identifiers can be formatted per the letter casing specified by the user. Reserved words and identifiers are configured individually in the *Coding Style* preferences via the "Reserved words casing" and "Identifier casing" preferences.

There are five letter casing modes supported. These modes are described in the following paragraphs and are cased in a manner indicating their effect.

With the first mode, "none", no formatting changes occur.

Using the second mode, "lower_case", reserved words and/or identifiers are changed to all lower-case.

Using the third mode, "UPPER_CASE", reserved words and/or identifiers are changed to all upper-case.

Using the fourth mode, "Mixed_Case", reserved words and/or identifiers are changed such that the first letter of the word and any letter immediately following an underscore are in upper-case, with all other letters in lower-case.

The fifth mode, "Smart_CASE", is similar to Mixed_Case except that upper-case letters remain in upper-case. For example, "text_IO" becomes "Text_IO" in this mode. The benefit of this mode is that upper-case acronyms in the identifier are retained.

Formatting Operators and Delimiters

The checkbox preference "Format operators / delimiters" specifies whether the editor should add extra spaces around operators and delimiters, if needed. If enabled, an extra space will be added when needed in the following cases: before an opening parenthesis; after a closing parenthesis, comma, semicolon; around all Ada operators.

Indenting with Tab Characters

The checkbox preference "Use tabulations" specifies whether the editor should use tab characters when indenting. Space characters are used unless this preference is enabled.

Aligning Colons in Declarations

The checkbox preference "Align colons in declarations" specifies whether the editor should automatically align colons in declarations and parameter lists.

Consider the following code, in which the colons are not aligned:

```
84  procedure Pack ( Item : in Standard_Integer; Into : in out MS1553.Buffer ) is
85     Value : constant Integer := To_Pointer (Item.Variable_Location).all;
86     Storage : Huge_Integer;
87     Output : Buffer_Index := Item.First_Element;
88     Input : Positive := Words'Length - Item.Allocated_Words + 1;
89     Storage_As_Words : Words;
90  begin
```

After formatting, the colons would be aligned as follows:

```
84  procedure Pack ( Item : in Standard_Integer; Into : in out MS1553.Buffer ) is
85     Value            : constant Integer := To_Pointer (Item.Variable_Location).all;
86     Storage          : Huge_Integer;
87     Output           : Buffer_Index := Item.First_Element;
88     Input            : Positive := Words'Length - Item.Allocated_Words + 1;
89     Storage_As_Words : Words;
90  begin
```

Note that the colons in the declarations within the selection were aligned with those of another declaration, that of line 89, even though the other declaration was not in the selection. The other declaration was considered in the same "block" of declarations because there was nothing separating them, such as a blank line. Hence, the general rule is that the colons of declarations in the same block are aligned, even if not in the selection when formatting was applied. The colons of separate declaration blocks are not aligned, even if selected together, unless by coincidence.

In the following example, two separate blocks of declarations are selected:

```
84  procedure Pack ( Item : in Standard_Integer; Into : in out MS1553.Buffer ) is
85     Value : constant Integer := To_Pointer (Item.Variable_Location).all;
86     Storage : Huge_Integer;
87     Output : Buffer_Index := Item.First_Element;
88     Input : Positive := Words'Length - Item.Allocated_Words + 1;
89
90     Storage_As_Words : Words;
91  begin
```

After formatting, the colons would be aligned as follows:

```
84   procedure Pack ( Item : in Standard_Integer; Into : in out MS1553.Buffer ) is
85      Value   : constant Integer := To_Pointer (Item.Variable_Location).all;
86      Storage : Huge_Integer;
87      Output  : Buffer_Index := Item.First_Element;
88      Input   : Positive := Words'Length - Item.Allocated_Words + 1;
89
90      Storage_As_Words : Words;
91   begin
```

Aligning Associations on Arrow Symbols

The checkbox preference "Align associations on arrows" specifies whether the editor should automatically align arrows in associations (e.g., aggregates or function calls).

Consider the following code, in which the arrow symbols are not aligned on lines 10 through 13:

```
 9   Message.Append_Descriptor (
10     Msgs.Standard_Integer'(Variable_Location => Requested_Actuator_Id'Address,
11                            First_Element => 1,
12                            Scaling_Factor => 1.0,
13                            Allocated_Words => 2),
14     To => Deflection_Request);
```

With this preference enabled, this code would be indented as:

```
 9   Message.Append_Descriptor (
10     Msgs.Standard_Integer'(Variable_Location => Requested_Actuator_Id'Address,
11                            First_Element     => 1,
12                            Scaling_Factor    => 1.0,
13                            Allocated_Words   => 2),
14     To => Deflection_Request);
```

Aligning Declarations After the Colon

The checkbox preference "Align declarations after colon" specifies whether the editor should align continuation lines in variable declarations based on the colon character.

Consider the following declaration, in which the initial (only) value in the continuation line is in the column before that of the colon:

```
16      Variable : constant String :=
17        "a string";
```

With this preference enabled, it will be indented as follows:

```
16   Variable : constant String :=
17                "a string";
```

Indenting Comments

The checkbox preference "Indent comments" specifies whether to indent lines containing only comments and blanks, or to keep the indentation of these lines unchanged.

Aligning Comments on Keywords

The checkbox preference "Align comments on keywords" specifies whether to align comment lines following the reserved words "record" and "is" immediately, with no extra space.

Note that the "Indent comment" preference must be enabled before comments are formatted.

Consider the following source code, in which the comment is indented relative to the line above. This would be the effect of formatting the code with the preference disabled:

```
3 package Flight_Control is
4       -- a comment about this package
```

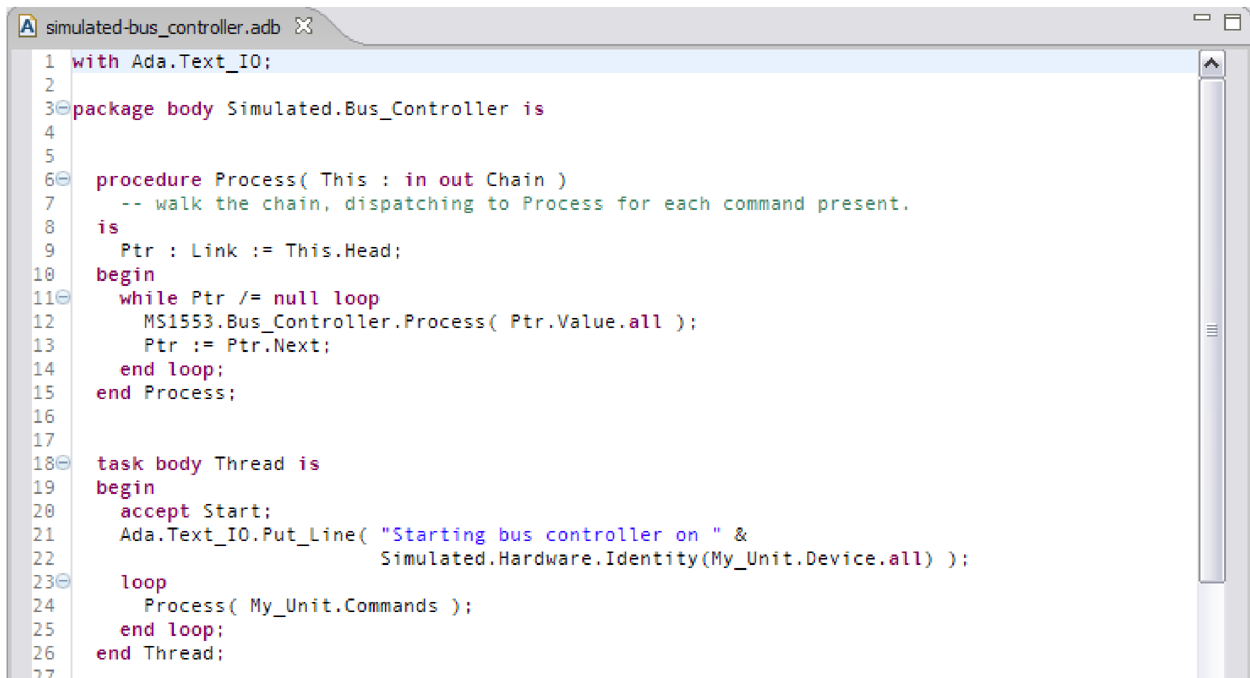
With this preference enabled (and with the "Indent comment" preference enabled), formatting the code would result in the following:

```
3 package Flight_Control is
4 -- a comment about this package
```

6.1.4 Block Folding

To facilitate comprehension of the program, blocks of text can be elided so that they do not appear. Each construct that spans more than one line has a control on the left of the screen that allows the user to expand or collapse the corresponding text.

The following illustration shows the folding control (the blue "lozenge" with a dash inside) to the left of procedure Process, prior to the user invoking the elision.



By clicking on the dash, the user elides the procedure Process, as the following illustration shows. Note the dash becomes a plus sign, indicating that the control will now expand the unit if invoked. Note also the elision marker at the end of the elided declaration of Process.

```
simulated-bus_controller.adb
1  with Ada.Text_IO;
2
3  package body Simulated.Bus_Controller is
4
5
6    procedure Process( This : in out Chain )
16
17
18   task body Thread is
19   begin
20     accept Start;
21     Ada.Text_IO.Put_Line( "Starting bus controller on " &
22                           Simulated.Hardware.Identity(My_Unit.Device.all) );
23     loop
24       Process( My_Unit.Commands );
25     end loop;
26   end Thread;
27
```

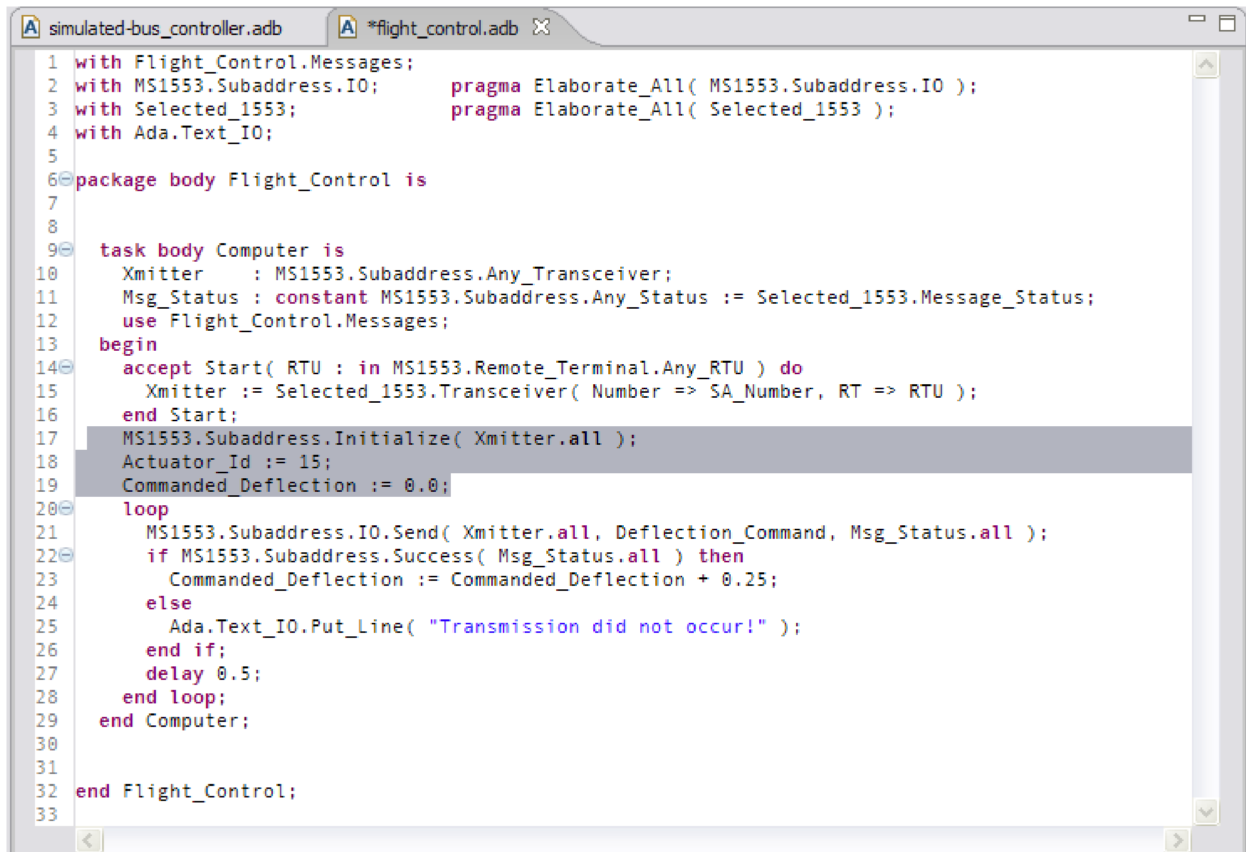
6.1.5 Managing Comments

The Ada language-sensitive editor makes it easy to convert existing text to comments, to convert comments back to non-comment text, and to format comments so that they adhere to margin constraints.

Toggling Comments

The current non-comment source code selection will be converted to comments by pressing *control*+- (control dash). Similarly, comment lines are converted back to regular code by the same key sequence. Alternatively, the transformation can be achieved by invoking the "Toggle Comment" command available under the Ada menubar entry and the editor's Ada contextual menu. using the contextual menu invoked by right-clicking in the source file and selecting Toggle Comment.

The following figure illustrates a selection of non-comment code about to be converted into comments:



After invoking the command the selected lines are commented, as the following figure shows.

simulated-bus_controller.adb | *flight_control.adb

```
with Flight_Control.Messages;
with MS1553.Subaddress.IO;      pragma Elaborate_All( MS1553.Subaddress.IO );
with Selected_1553;             pragma Elaborate_All( Selected_1553 );
with Ada.Text_IO;

package body Flight_Control is


  task body Computer is
    Xmitter    : MS1553.Subaddress.Any_Transceiver;
    Msg_Status : constant MS1553.Subaddress.Any_Status := Selected_1553.Message_Status;
    use Flight_Control.Messages;
  begin
    accept Start( RTU : in MS1553.Remote_Terminal.Any_RTU ) do
      Xmitter := Selected_1553.Transceiver( Number => SA_Number, RT => RTU );
    end Start;
--      MS1553.Subaddress.Initialize( Xmitter.all );
--      Actuator_Id := 15;
--      Commanded_Deflection := 0.0;
    loop
      MS1553.Subaddress.IO.Send( Xmitter.all, Deflection_Command, Msg_Status.all );
      if MS1553.Subaddress.Success( Msg_Status.all ) then
        Commanded_Deflection := Commanded_Deflection + 0.25;
      else
        Ada.Text_IO.Put_Line( "Transmission did not occur!" );
      end if;
      delay 0.5;
    end loop;
  end Computer;


end Flight_Control;

```

Reformatting Comments

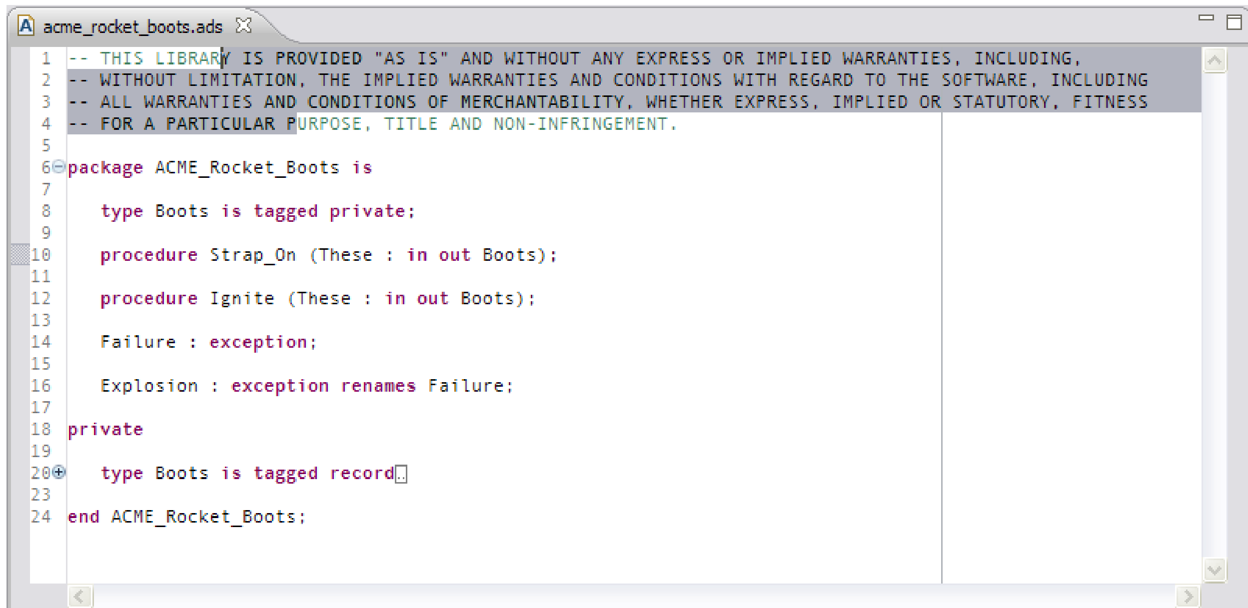
Comment lines as well as lines of arbitrary text within an Ada source file can be adjusted so that none of the text flows past the Eclipse "print margin" boundary. Comment lines remain as comments after this reformatting; non-comment lines remain non-comments.

The action can be applied to individual lines or to a selection of lines within an Ada source file. If no selection is active when the command is invoked, only the line containing the cursor will be reformatted.

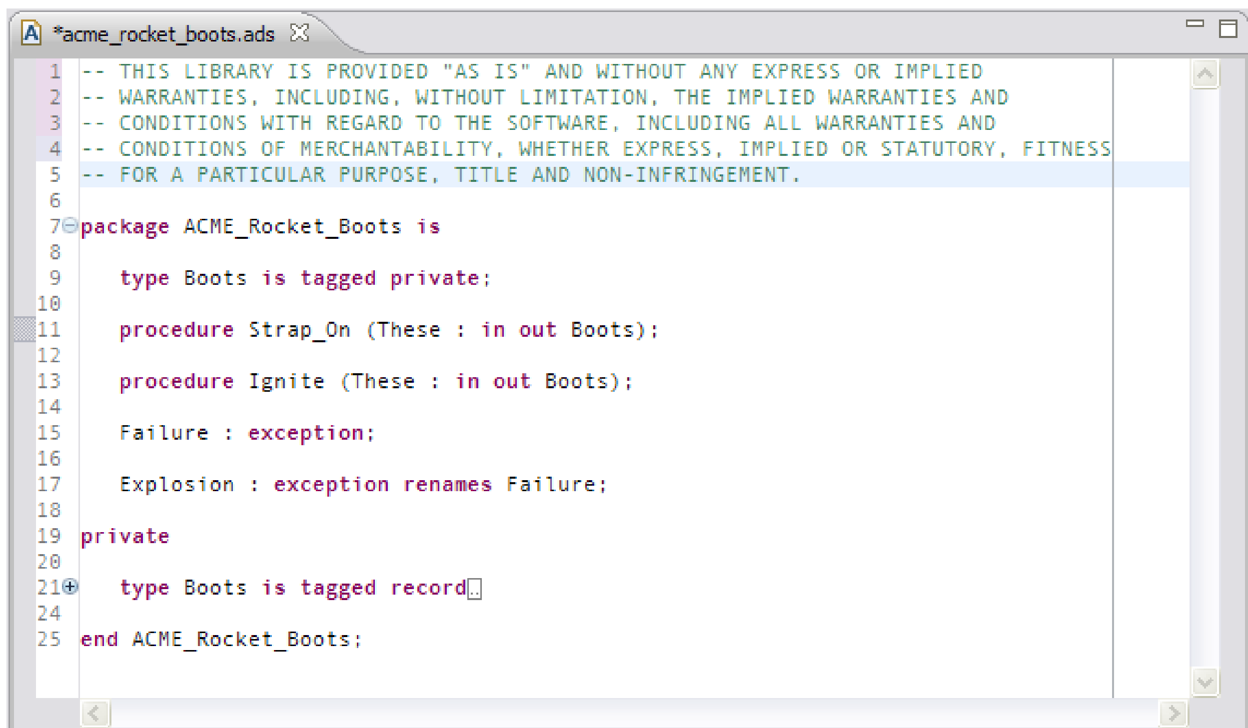
The command is invoked by simultaneously pressing the Alt+Shift+| keys, or by invoking the "Refill Selection to Margin" command available under the Ada menubar entry and the editor's Ada contextual menu.

If the Eclipse print margin margin is not enabled no reformatting will occur. You can tell if the margin is set by the appearance of a colored vertical line in the editor immediately after the column corresponding to the margin. Use the General/Editors/Text Editors preference page and look for the "Show print margin" check-box. On that page you also specify the column for the margin and can control the color of the resulting line.

The figures below illustrate the application of the editor action. In the first figure, a block of comments that goes past the print margin is selected. The margin is indicated by the vertical gray line to the right inside the editor box.



The command is then invoked and the text is refilled so that none of the text goes past the print margin:



6.1.6 Parentheses Highlighting

Moving the cursor after a parenthesis highlights the corresponding parenthesis.

In the following figure, the cursor is immediately after the inner parenthesis on line 10. Note the box highlighting the matching parenthesis on line 13.

```
 7    use MS1553;
 8  begin
 9    Message.Append_Descriptor(
10      Msgs.Standard_Integer'( Variable_Location => Requested_Actuator_Id'Address,
11                              First_Element     => 1,
12                              Scaling_Factor    => 1.0,
13                              Allocated_Words   => 2 ),
14      To => Deflection_Request );
15
```

You may enable or disable this action as well as control the color of the highlighting box using the "Highlight matching brackets" preference on the *Editor* page.

6.1.7 Automatic Construct Closing

While editing Ada source files, you can invoke the "Insert End" command to insert the required text to close a construct.

The editor command is bound to the Alt+End key sequence and is also available via the Ada menu on the menubar and the editor's contextual menu.

For constructs without an associated name, such as record type definitions and if-statements, the Insert End command will insert the corresponding simple completion.

For example, the following figure shows an incomplete record type definition with the Insert End command about to be invoked:

```
43    type Node is
44       record
45          Element : MS1553.Message_Element.Any_Descriptor;
46          Next    : Link;
47          
48
49
```

After invocation, the closing "end record;" sequence has been inserted and properly indented relative to the word "record":

```
43    type Node is
44       record
45          Element : MS1553.Message_Element.Any_Descriptor;
46          Next    : Link;
47       end record;
48
49
```

For the end of a program unit's sequence of statements, the action will insert the "end" followed by the name of the unit.

For example, the next figure shows a procedure Demo without the closing "end". Note that the cursor is indented as if another statement is about to be entered:

```
10 procedure Demo is
11
12    Dev : constant MS1553.Hardware.Any_Device := Selected_1553.Hardware;
13
14    RT  : constant MS1553.Remote_Terminal.Any_RTU :=
15              Selected_1553.RTU (Flight_Control.RT_Number, Dev);
16
17    BC  : MS1553.Bus_Controller.Any_Unit := Selected_1553.Bus_Controller (Dev);
18
19 begin
20    Load_Bus_Control_Chain (BC);
21    MS1553.Remote_Terminal.Activate (RT.all);
22    MS1553.Hardware.Start_IO (Dev.all);
23    Flight_Control.Computer.Start (RT);
24    Actuator.Computer.Start (RT);
25    MS1553.Bus_Controller.Start (BC.all);
26    
27
```

After invocation, the closing "end Demo;" sequence has been inserted and properly indented:

```
10 procedure Demo is
11
12    Dev : constant MS1553.Hardware.Any_Device := Selected_1553.Hardware;
13
14    RT  : constant MS1553.Remote_Terminal.Any_RTU :=
15              Selected_1553.RTU (Flight_Control.RT_Number, Dev);
16
17    BC  : MS1553.Bus_Controller.Any_Unit := Selected_1553.Bus_Controller (Dev);
18
19 begin
20    Load_Bus_Control_Chain (BC);
21    MS1553.Remote_Terminal.Activate (RT.all);
22    MS1553.Hardware.Start_IO (Dev.all);
23    Flight_Control.Computer.Start (RT);
24    Actuator.Computer.Start (RT);
25    MS1553.Bus_Controller.Start (BC.all);
26 end Demo;
27
```

Constructs with labels are completed in a similar manner.

6.1.8 Smart Enter Key

The Smart Enter key will automatically format the code of the current line if the "Coding style mode" preference is set to "extended" in the *Coding Style* preferences page. The effect is as if manually applying the Format command to the line.

See *Formatting Source Code* for the details of the formatting applied.

In this initial figure, assume the "Coding style mode" is set to "extended". Also assume that reserved words are to be in lower-case, identifiers are to be Smart_CASED, and that the default indentation is 3. The cursor is at the end of the line:

```
19 begin
20 IF rt = NULL THEN
21    Load_Bus_Control_Chain (BC);
22    MS1553.Remote_Terminal.Activate (RT.all);
23    MS1553.Hardware.Start_IO (Dev.all);
24    Flight_Control.Computer.Start (RT);
25    Actuator.Computer.Start (RT);
26    MS1553.Bus_Controller.Start (BC.all);
27 end Demo;
```

When we press the Enter key, the line is automatically formatted and the cursor is automatically indented to the appropriate location for the sequence of statements within the if-statement:

```
19 begin
20    if Rt = null then
21       
22    Load_Bus_Control_Chain (BC);
23    MS1553.Remote_Terminal.Activate (RT.all);
24    MS1553.Hardware.Start_IO (Dev.all);
25    Flight_Control.Computer.Start (RT);
26    Actuator.Computer.Start (RT);
27    MS1553.Bus_Controller.Start (BC.all);
28 end Demo;
```

Note that, after the line is formatted, the identifier appears as "Rt" even though it appears as "RT" elsewhere. Since the identifier was "rt" before formatting and the casing policy was "Smart_CASED", it becomes "Rt" after formatting.

6.1.9 Smart Space Key

The Smart Space Key will expand abbreviations for Ada reserved words and will, for those constructs that take a name or a label on the "end", also expand those abbreviations into partially-complete constructs with the corresponding name or label included.

Expansions follow the user's letter casing preferences for reserved words and identifiers.

The Smart Space Key is disabled by default and is controlled by preferences on the *Editor* preference page.

If the action is enabled, the additional relevant preference is the length of words considered as candidate abbreviations to be expanded. The default length is three characters, meaning that only words three characters or longer will be considered. Thus the facility is minimally intrusive and, moreover, the degree of intrusion is under your control.

If the preference is disabled, pressing the space key will insert one space, as usual.

Reserved Word Expansion

If an abbreviation of a reserved word is either on a line by itself or follows only a label, that abbreviation is expanded into the full spelling. Note that not all reserved words are candidates for expansion: they must be long enough for expansion to be of use in the first place.

For example, in the following figure the word "proc" has been entered and the space key is about to be pressed:

```
10 procedure Demo is
11
12    Dev : constant MS1553.Hardware.Any_Device := Selected_1553.Hardware;
13
14    RT  : constant MS1553.Remote_Terminal.Any_RTU :=
15             Selected_1553.RTU (Flight_Control.RT_Number, Dev);
16
17    BC  : MS1553.Bus_Controller.Any_Unit := Selected_1553.Bus_Controller (Dev);
18
19    proc
20
21 begin
22    Load_Bus_Control_Chain (BC);
23    MS1553.Remote_Terminal.Activate (RT.all);
24    MS1553.Hardware.Start_IO (Dev.all);
25    Flight_Control.Computer.Start (RT);
26    Actuator.Computer.Start (RT);
27    MS1553.Bus_Controller.Start (BC.all);
28 end Demo;
```

After the space key is pressed the abbreviation has been expanded to the full reserved word (and a trailing space has been inserted):

```
10 procedure Demo is
11
12    Dev : constant MS1553.Hardware.Any_Device := Selected_1553.Hardware;
13
14    RT  : constant MS1553.Remote_Terminal.Any_RTU :=
15             Selected_1553.RTU (Flight_Control.RT_Number, Dev);
16
17    BC  : MS1553.Bus_Controller.Any_Unit := Selected_1553.Bus_Controller (Dev);
18
19    procedure 
20
21 begin
22    Load_Bus_Control_Chain (BC);
23    MS1553.Remote_Terminal.Activate (RT.all);
24    MS1553.Hardware.Start_IO (Dev.all);
25    Flight_Control.Computer.Start (RT);
26    Actuator.Computer.Start (RT);
27    MS1553.Bus_Controller.Start (BC.all);
28 end Demo;
```

A reserved word that is fully spelled does not require expansion itself, but, for the sake of minimal intrusion, also does not invoke the construct expansion described below. Thus a user who types everything will not be intruded upon except for the case in which a user-defined identifier matches an abbreviation for a reserved word. To mitigate this effect the minimum abbreviation length may be set to a larger value by altering the preference.

Note that "for" is treated specially. It is a complete reserved word but is nonetheless expanded. Also, "for" is the start of an attribute definition clause so it will not expand unless it appears in a sequence of statements.

Begin-End Pair Expansion

Begin-end pairs for program units are expanded to include the corresponding unit name. Nested declarations are ignored such that the correct name is used in the expansion.

For example, in the following figure the abbreviation "beg" has been entered on line 20 and the space key is about to be pressed:

```
10 procedure Demo is
11
12    Dev : constant MS1553.Hardware.Any_Device := Selected_1553.Hardware;
13
14    RT  : constant MS1553.Remote_Terminal.Any_RTU :=
15             Selected_1553.RTU (Flight_Control.RT_Number, Dev);
16
17    BC  : MS1553.Bus_Controller.Any_Unit := Selected_1553.Bus_Controller (Dev);
18
19    procedure P is
20    beg
21
22 begin
23    Load_Bus_Control_Chain (BC);
24    MS1553.Remote_Terminal.Activate (RT.all);
25    MS1553.Hardware.Start_IO (Dev.all);
26    Flight_Control.Computer.Start (RT);
27    Actuator.Computer.Start (RT);
28    MS1553.Bus_Controller.Start (BC.all);
29 end Demo;
```

After the space key is pressed the abbreviation for "begin" has been expanded to the full begin-end par with the name of the procedure included. The cursor is placed inside the sequence of statements at the initial indentation level, to a depth specified by the indentation preference:

```
10 procedure Demo is
11
12    Dev : constant MS1553.Hardware.Any_Device := Selected_1553.Hardware;
13
14    RT  : constant MS1553.Remote_Terminal.Any_RTU :=
15             Selected_1553.RTU (Flight_Control.RT_Number, Dev);
16
17    BC  : MS1553.Bus_Controller.Any_Unit := Selected_1553.Bus_Controller (Dev);
18
19    procedure P is
20    begin
21       
22    end P;
23
24 begin
25    Load_Bus_Control_Chain (BC);
26    MS1553.Remote_Terminal.Activate (RT.all);
27    MS1553.Hardware.Start_IO (Dev.all);
28    Flight_Control.Computer.Start (RT);
29    Actuator.Computer.Start (RT);
30    MS1553.Bus_Controller.Start (BC.all);
31 end Demo;
```

Named Statement Expansion

Constructs that require a trailing name are expanded to include that name. These include named block statements, named basic loops, named while-loops, and named for-loops.

For example, a named loop is required to have the loop name follow the "end loop". In the following figure the name and loop abbreviation have been entered and the space key is about to be pressed:

```
10 procedure Demo is
11
12    Dev : constant MS1553.Hardware.Any_Device := Selected_1553.Hardware;
13
14    RT  : constant MS1553.Remote_Terminal.Any_RTU :=
15             Selected_1553.RTU (Flight_Control.RT_Number, Dev);
16
17    BC  : MS1553.Bus_Controller.Any_Unit := Selected_1553.Bus_Controller (Dev);
18
19    procedure P is
20    begin
21       foo : loo
22    end P;
23
24 begin
25    Load_Bus_Control_Chain (BC);
26    MS1553.Remote_Terminal.Activate (RT.all);
27    MS1553.Hardware.Start_IO (Dev.all);
28    Flight_Control.Computer.Start (RT);
29    Actuator.Computer.Start (RT);
30    MS1553.Bus_Controller.Start (BC.all);
31 end Demo;
```

After the space key is pressed the loop has been expanded with the name of the loop included. The cursor is placed inside the sequence of statements at the initial indentation level, to a depth specified by the indentation preference:

```
10 procedure Demo is
11
12    Dev : constant MS1553.Hardware.Any_Device := Selected_1553.Hardware;
13
14    RT  : constant MS1553.Remote_Terminal.Any_RTU :=
15             Selected_1553.RTU (Flight_Control.RT_Number, Dev);
16
17    BC  : MS1553.Bus_Controller.Any_Unit := Selected_1553.Bus_Controller (Dev);
18
19    procedure P is
20    begin
21       Foo : loop
22          
23       end loop Foo;
24    end P;
25
26 begin
27    Load_Bus_Control_Chain (BC);
28    MS1553.Remote_Terminal.Activate (RT.all);
29    MS1553.Hardware.Start_IO (Dev.all);
30    Flight_Control.Computer.Start (RT);
31    Actuator.Computer.Start (RT);
32    MS1553.Bus_Controller.Start (BC.all);
33 end Demo;
```

Note also that the user-specified letter casing has been applied to the name (in this example the "Smart_CASED" policy was in force) and the reserved words are similarly formatted (with the "lowercase" policy in this instance).

Continuing the example, we can now insert a named declare block. In the following figure the name and abbreviation have been entered and the space key is about to be pressed:

```
10 procedure Demo is
11
12    Dev : constant MS1553.Hardware.Any_Device := Selected_1553.Hardware;
13
14    RT  : constant MS1553.Remote_Terminal.Any_RTU :=
15             Selected_1553.RTU (Flight_Control.RT_Number, Dev);
16
17    BC  : MS1553.Bus_Controller.Any_Unit := Selected_1553.Bus_Controller (Dev);
18
19    procedure P is
20    begin
21       Foo : loop
22          Bar : decl
23       end loop Foo;
24    end P;
25
26 begin
27    Load_Bus_Control_Chain (BC);
28    MS1553.Remote_Terminal.Activate (RT.all);
29    MS1553.Hardware.Start_IO (Dev.all);
30    Flight_Control.Computer.Start (RT);
31    Actuator.Computer.Start (RT);
32    MS1553.Bus_Controller.Start (BC.all);
33 end Demo;
```

After the space key is pressed the declare block has been expanded with the name of the block included. Since this is a block statement with a declarative part, the editor expects that declarations are intended and places the cursor in the declarative region:

```
10 procedure Demo is
11
12    Dev : constant MS1553.Hardware.Any_Device := Selected_1553.Hardware;
13
14    RT  : constant MS1553.Remote_Terminal.Any_RTU :=
15             Selected_1553.RTU (Flight_Control.RT_Number, Dev);
16
17    BC  : MS1553.Bus_Controller.Any_Unit := Selected_1553.Bus_Controller (Dev);
18
19    procedure P is
20    begin
21       Foo : loop
22          Bar : declare
23
24          begin
25          end Bar;
26       end loop Foo;
27    end P;
28
29 begin
30    Load_Bus_Control_Chain (BC);
31    MS1553.Remote_Terminal.Activate (RT.all);
32    MS1553.Hardware.Start_IO (Dev.all);
33    Flight_Control.Computer.Start (RT);
34    Actuator.Computer.Start (RT);
35    MS1553.Bus_Controller.Start (BC.all);
36 end Demo;
```

Unnamed Statement Expansion

The named constructs above do not *require* names, they just require the name to be repeated if a name *is* given in the first place. For completeness these constructs will also expand when no name is applied.

For example, in the following figure the word "for" has been entered on line 21 and the space key is about to be pressed:

```
10 procedure Demo is
11
12    Dev : constant MS1553.Hardware.Any_Device := Selected_1553.Hardware;
13
14    RT  : constant MS1553.Remote_Terminal.Any_RTU :=
15            Selected_1553.RTU (Flight_Control.RT_Number, Dev);
16
17    BC  : MS1553.Bus_Controller.Any_Unit := Selected_1553.Bus_Controller (Dev);
18
19    procedure P is
20    begin
21       for
22    end P;
23
24 begin
25    Load_Bus_Control_Chain (BC);
26    MS1553.Remote_Terminal.Activate (RT.all);
27    MS1553.Hardware.Start_IO (Dev.all);
28    Flight_Control.Computer.Start (RT);
29    Actuator.Computer.Start (RT);
30    MS1553.Bus_Controller.Start (BC.all);
31 end Demo;
```

After the space key is pressed the loop has been expanded and the cursor is placed so that the loop parameter specification can be entered:

```
10 procedure Demo is
11
12    Dev : constant MS1553.Hardware.Any_Device := Selected_1553.Hardware;
13
14    RT  : constant MS1553.Remote_Terminal.Any_RTU :=
15            Selected_1553.RTU (Flight_Control.RT_Number, Dev);
16
17    BC  : MS1553.Bus_Controller.Any_Unit := Selected_1553.Bus_Controller (Dev);
18
19    procedure P is
20    begin
21       for  loop
22       end loop;
23    end P;
24
25 begin
26    Load_Bus_Control_Chain (BC);
27    MS1553.Remote_Terminal.Activate (RT.all);
28    MS1553.Hardware.Start_IO (Dev.all);
29    Flight_Control.Computer.Start (RT);
30    Actuator.Computer.Start (RT);
31    MS1553.Bus_Controller.Start (BC.all);
32 end Demo;
```

After entering the loop parameter specification you press the End key to go to the end of the line and then press the Enter key to open a new line within the loop:

```
10 procedure Demo is
11
12    Dev : constant MS1553.Hardware.Any_Device := Selected_1553.Hardware;
13
14    RT  : constant MS1553.Remote_Terminal.Any_RTU :=
15             Selected_1553.RTU (Flight_Control.RT_Number, Dev);
16
17    BC  : MS1553.Bus_Controller.Any_Unit := Selected_1553.Bus_Controller (Dev);
18
19    procedure P is
20    begin
21       for K in Long_Integer range -1 .. 10 loop
22       
23       end loop;
24    end P;
25
26 begin
27    Load_Bus_Control_Chain (BC);
28    MS1553.Remote_Terminal.Activate (RT.all);
29    MS1553.Hardware.Start_IO (Dev.all);
30    Flight_Control.Computer.Start (RT);
31    Actuator.Computer.Start (RT);
32    MS1553.Bus_Controller.Start (BC.all);
33 end Demo;
```

6.1.10 Smart Tab Key

Pressing the Smart Tab key will indent to the next "logical indentation" column on the line. It does so by inserting spaces, but *only the required number of spaces are inserted* so that this next position is reached, rather than always inserting a fixed number of spaces.

The "logical indentation" columns are determined by the numeric "Default indentation" preference on the *Coding Style* preference page. The first "logical indentation" position is at column 1. Each subsequent position is calculated by adding the value of the "Default indentation" preference to the previous position.

The Smart Tab Key is enabled by default and is controlled by the "Use smart tab key" preference on the *Editor* preference page.

If the preference is disabled, pressing the tab key will insert the number of spaces specified by the "Default indentation" preference.

For the following example, assume the "Default indentation" value is 3. As a result, the logical indentation positions are 1, 4, 7, 10, and so on.

In this first figure the cursor is on column 1. We have included a comment indicating the column numbers for the sake of illustration:

```
19 begin
20    for K in 1 .. 10 loop
21 -- 4567890
22 
23    end loop;
```

Pressing the Smart Tab key indents to column 4:

```
19 begin
20    for K in 1 .. 10 loop
21 -- 4567890
22
23    end loop;
```

If we enter a space character, the cursor will then be on column 5.

```
19 begin
20    for K in 1 .. 10 loop
21 -- 4567890
22
23    end loop;
```

Pressing the Smart Tab key again now inserts only two spaces to get to the next "logical indentation" column, i.e., column 7:

```
19 begin
20    for K in 1 .. 10 loop
21 -- 4567890
22
23    end loop;
```

Pressing the Smart Tab key again inserts three spaces to get to column 10:

```
19 begin
20    for K in 1 .. 10 loop
21 -- 4567890
22
23    end loop;
```

6.1.11 Smart Home Key

When first pressed on a given line, the Smart Home key will place the cursor on the column containing the first non-blank character of that line. Subsequent presses will cause the cursor to toggle back and forth between column 1 and the column of the first non-blank character.

In the following figure, the cursor is in the middle of a line of Ada source code:

```
1 with Interfaces;
2
3 package MS1553 is -- MIL-STD-1553B
4
5    type Buffer_Index is range 1 .. 32;
6
```

If you press the Smart Home key, the cursor moves to the column of the first non-blank character on that line:

```
1 with Interfaces;
2
3 package MS1553 is -- MIL-STD-1553B
4
5    type Buffer_Index is range 1 .. 32;
6
```

If you press the Smart Home key again, the cursor moves to column 1 of that line:

```
1 with Interfaces;
2
3 package MS1553 is -- MIL-STD-1553B
4
5    type Buffer_Index is range 1 .. 32;
6
```

If you press the Smart Home key yet again, the cursor moves back to the column of the first non-blank column:

```
1 with Interfaces;
2
3 package MS1553 is -- MIL-STD-1553B
4
5    type Buffer_Index is range 1 .. 32;
6
```

All subsequent presses on the same line will continue to toggle back and forth.

6.1.12 Smart End Key

The Smart End key works in a manner analogous to the Smart Home key, with the obvious difference that it works with the end of the line instead of the beginning. Another difference is that there may not be any characters after the last non-blank character, in which case the cursor will remain on the column of the last non-blank for subsequent presses of the key on that line.

Note that the "Remove trailing spaces when saving" preference on the *Editor* preference page will remove trailing spaces when an Ada source file is saved.

If there *are* whitespace characters after the last non-blank character on the line, the Smart Home key will toggle back and forth between the last of them and the last non-blank, as illustrated in the figures below.

In this first figure, the Smart End key has been pressed and therefore the cursor is on the last non-blank character:

```
1 with Interfaces;
2
3 package MS1553 is -- MIL-STD-1553B
4
5    type Buffer_Index is range 1 .. 32;
6
7    type Buffer_Element is new Interfaces.Unsigned_16;
```

There is whitespace after that column in this example, so pressing the Smart End key again moves the cursor to the last of them:

```
1 with Interfaces;
2
3 package MS1553 is -- MIL-STD-1553B
4
5    type Buffer_Index is range 1 .. 32;
6
7    type Buffer_Element is new Interfaces.Unsigned_16;
```

Pressing the Smart Home key again moves the cursor back to the last non-blank character:

```
1 with Interfaces;
2
3 package MS1553 is -- MIL-STD-1553B
4
5    type Buffer_Index is range 1 .. 32;
6
7    type Buffer_Element is new Interfaces.Unsigned_16;
```

All subsequent presses on the same line will continue to toggle back and forth in that manner.

6.2 Code Assist

6.2.1 Code Assist

Code Assist is an editing capability provided by programming-language-oriented editors in Eclipse that completes identifiers based on semantic analysis and context. Simple identifiers, subprogram formal parameters, and entities named using the "dot notation" are candidates for completion. GNATbench implements Code Assist for Ada 83, Ada 95, and Ada 2005.

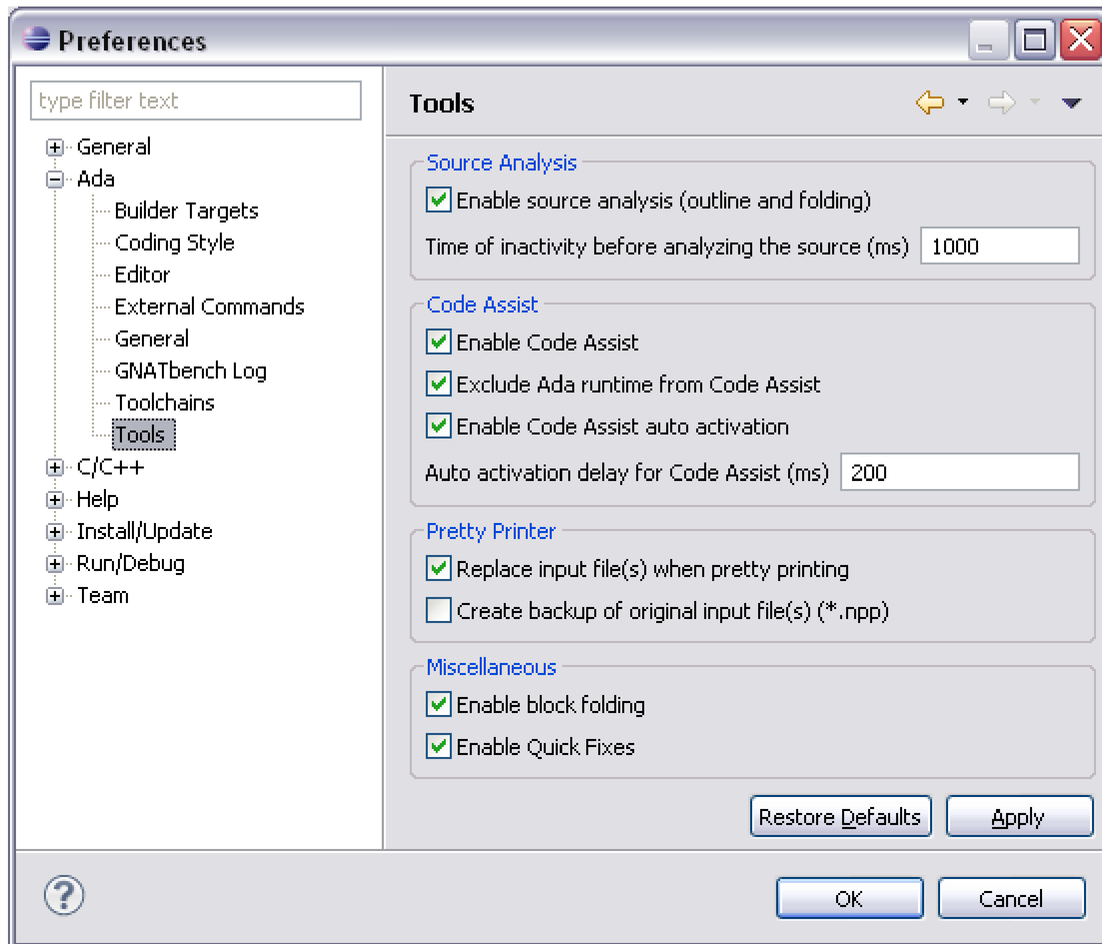
When invoked, Code Assist displays the candidate completions in a pop-up window (the "smart completion window"), including information about each candidate to facilitate selection. The specific information displayed depends on the candidate. For example, the type of a candidate variable will be displayed, as well as documentation extracted from comments surrounding the declaration of the candidate. Similarly, if the completion candidate is a subprogram invocation, the formal parameters will also be displayed so that you can choose among possibly overloaded subprogram choices.

GNATbench keeps track of your previous selections and will put them at the top of the list of proposals when they are accurate.

No pop-up window is displayed when, based on the current partial entry, no candidates are available.

6.2.2 Enabling Code Assist

Code Assist for Ada can offer completion candidates from the entire project. To do so, an entity database must be loaded. This loading occurs in the background, asynchronously, and does not force you to wait. However, if you want to disable this loading, simply disable the Code Assist preference. The preference is enabled initially, and, as a result, by default the entity database is loaded when GNATbench starts.



6.2.3 Invoking Code Assist

Code Assist for identifiers is invoked by pressing the *control+space* key combination inside any Ada source file. This is the default key binding for all Eclipse editors that support the feature but users can change the key binding, as always.

To use this feature for simple identifiers, begin to type a name inside an Ada source file. This identifier must be declared either in the current file (and prior to the cursor location) or in one of the packages of the project loaded. With the cursor right after the last character of the incomplete identifier, press the Code Assist key sequence. Eclipse will open the Smart Completion window displaying all the known identifiers beginning with the prefix you typed. You can then browse among the various proposals using the Up and Down keys or using the scrollbar. Typing additional letters of the identifier will reduce the range of proposals as long as possible candidates remain.

Once you've selected the intended completion you can apply it by pressing Enter. The identifier will be completed with that selection and you can continue to enter further text.

You may reject the list of candidates and terminate Code Assist by pressing the Escape key.

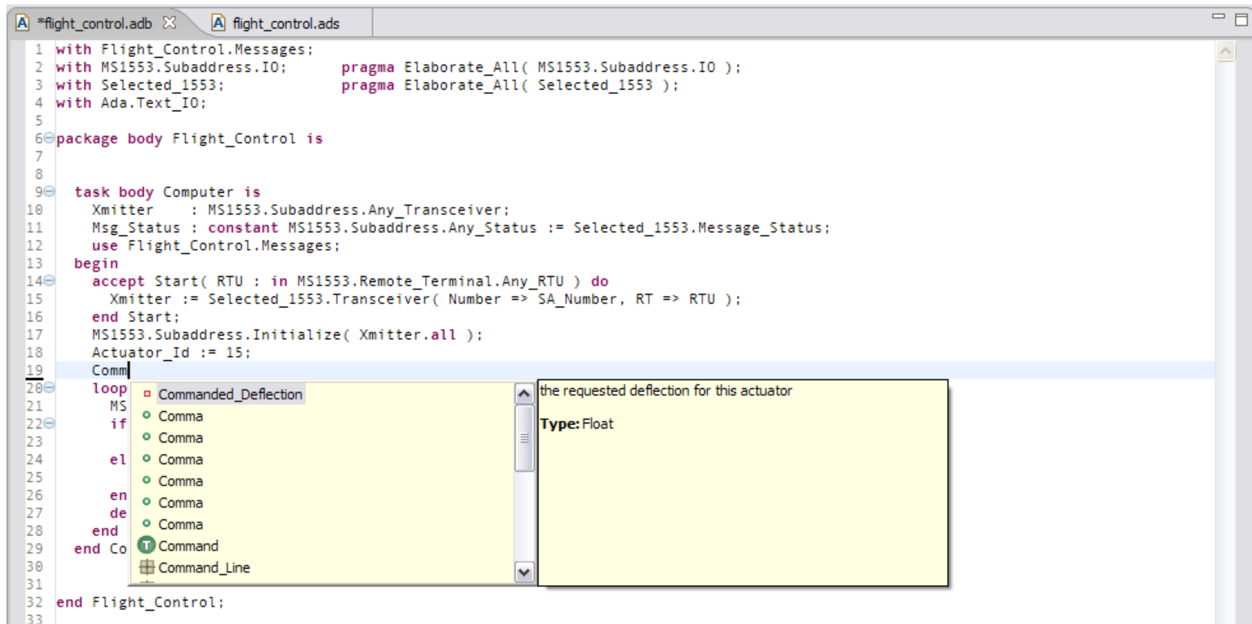
Code Assist is automatically invoked when entering dotted names and when entering parameters for a subprogram call. The Smart Completion window will open when the dot or the open (i.e., left) parenthesis is entered. Code Assist is not invoked if another character is entered in a short amount of time, so that touch typists are not inconvenienced.

When entering parameters for a subprogram call, you can manually invoke Code Assist after entering some of the parameters to see proposals for the remaining parameters, if any.

6.2.4 Simple Name Completion

Much like the name completion provided by the alt+/ key binding, Code Assist will complete the name of an identifier by itself. It need not be a part of some other name or a formal parameter. Just press the Code Assist key sequence and any candidates will be presented.

In the following figure we invoke Code Assist in the middle of entering the text "Comm" so we get all possible completions starting with that character sequence. Note the descriptive text in the window for Commanded_Deflection. This description comes from the comment(s) following the declaration of the object.



6.2.5 Dotted Name Completion

Any identifier that immediately follows a dot can be completed by Code Assist, particularly entities declared within packages and within record objects. For example, if you type "with Ada." the smart completion window will appear automatically, listing all the child and nested packages of Ada. You can also write the beginning of the package, e.g.: entering "with Ada.Text" and pressing the Code Assist key will offer you "Text_IO".

In the following figure, we invoke Code Assist after entering the name of the package MS1553. The completion window then proposes candidates consisting of the entities declared within the package as well as child packages rooted at MS1553. Note the icons indicating the kinds of entity proposed. In this case types and child packages are depicted:

simulated-bus_controller.ads | *flight_control.adb | ms1553-subaddress-io.ads | ms1553-subaddress-io.adb

```
 1 with Flight_Control.Messages;
 2 with MS1553.Subaddress.IO;      pragma Elaborate_All( MS1553.Subaddress.IO );
 3 with Selected_1553;             pragma Elaborate_All( Selected_1553 );
 4 with Ada.Text_IO;
 5
 6 package body Flight_Control is
 7
 8
 9   task body Computer is
10     Xmitter    : MS1553.Subaddress.Any_Transceiver;
11     Msg_Status : constant MS1553.Subaddress.Any_Status := Selected_1553.Message_Status;
12     use Flight_Control.Messages;
13   begin
14     accept Start( RTU : in MS1553.Remote_Terminal.Any_RTU ) do
15       Xmitter := Selected_1553.Transceiver( Number => SA_Number, RT => RTU );
16     end Start;
17     MS1553.Subaddress.Initialize( Xmitter.all );
18     Actuator_Id := 15;
19     Commanded_Deflection := 0.0;
20     loop
21       MS1553.
22       MS1553.
23       if MS15
24         Comma
25       else
26         Ada.T
27       end if;
28       delay 0
29     end loop;
30   end Compute
31
32
33 end Flight_Co
34
```

Buffer_Index
Buffer_Element
Buffer
Bit_Numbers
RT_Identifier
SA_Identifier
Locus
Built_In_Test
Bus_Controller

This is the Data Word that the standard describes.
Deriving from a type in Interfaces inherits the additional operators.

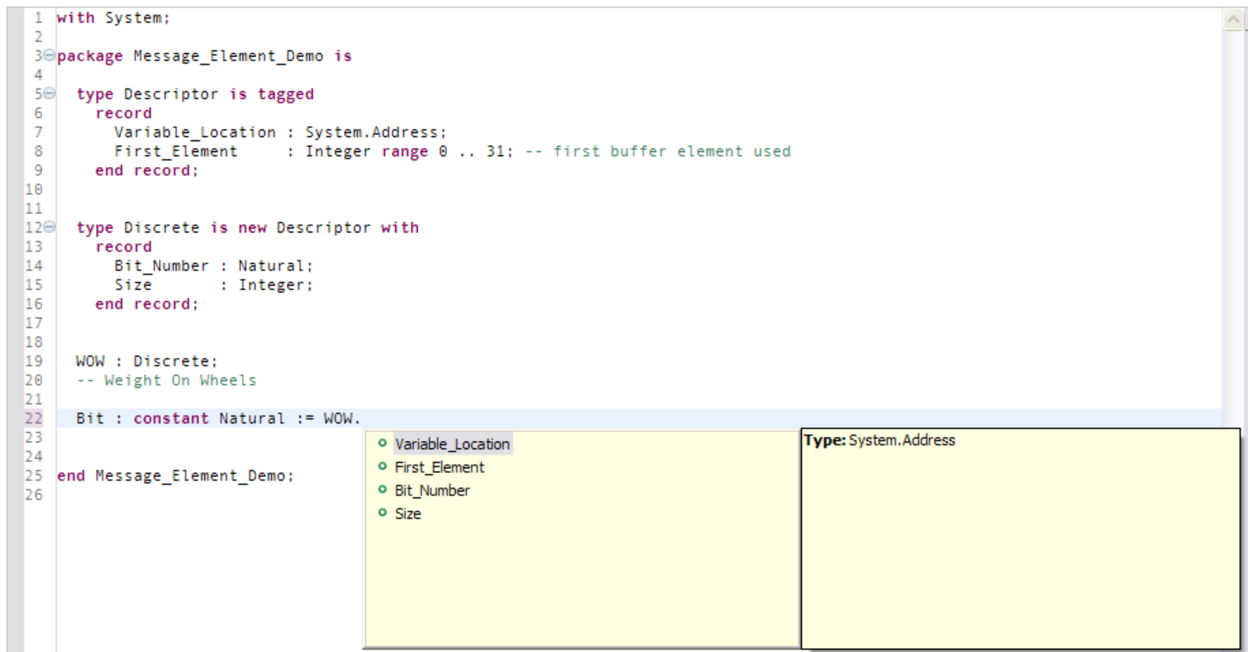
Code Assist is proposing the components of a record object in the following figure. Here, the object WOW is of type type Discrete, a record type containing the four components indicated in the smart completion window:

```
 1 with System;
 2
 3 package Message_Element_Demo is
 4
 5   type Discrete is
 6     record
 7       Variable_Location : System.Address;
 8       First_Element     : Integer range 0 .. 31; -- first buffer element used
 9       Bit_Number : Natural;
10       Size       : Integer;
11     end record;
12
13
14   WOW : Discrete;
15   -- Weight On Wheels
16
17   Bit : constant Natural := WOW.
18
19
20
21 end Message_Element_Demo;
22
```

Variable_Location
First_Element
Bit_Number
Size

Type: System.Address

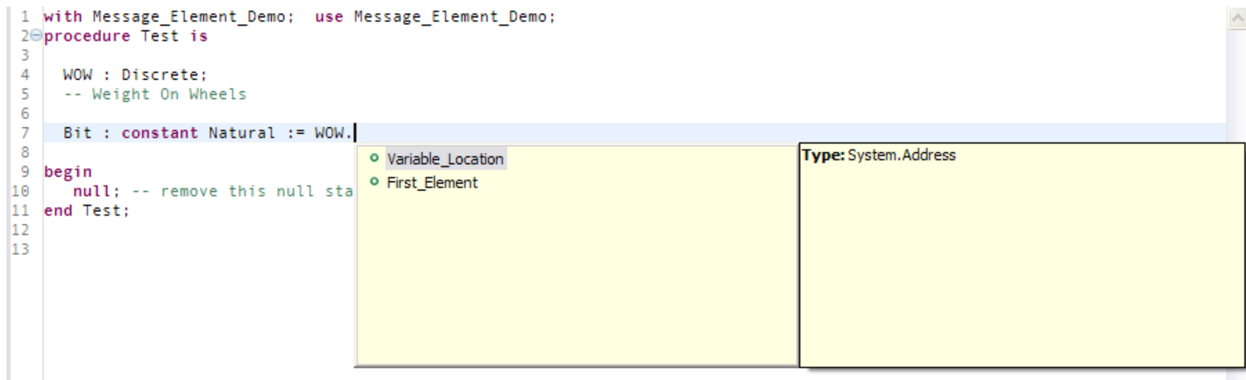
Code Assist can handle derived record types too, and will include in the smart completion window all inherited record components that are visible at the point of the invocation.



In keeping with the Ada visibility rules, components of private types are not proposed if they are not visible. In this next figure we declare type Discrete as a private extension so outside the package the components are not visible (except to child units):

```
 1  with System;
 2
 3  package Message_Element_Demo is
 4
 5    type Descriptor is tagged
 6      record
 7        Variable_Location : System.Address;
 8        First_Element     : Integer range 0 .. 31; -- first buffer element used
 9      end record;
10
11    type Discrete is new Descriptor with private;
12
13  private
14
15    type Discrete is new Descriptor with
16      record
17        Bit_Number : Natural;
18        Size       : Integer;
19      end record;
20
21  end Message_Element_Demo;
22
```

Then, when we invoke Code Assist outside the package, only the visible components are proposed:

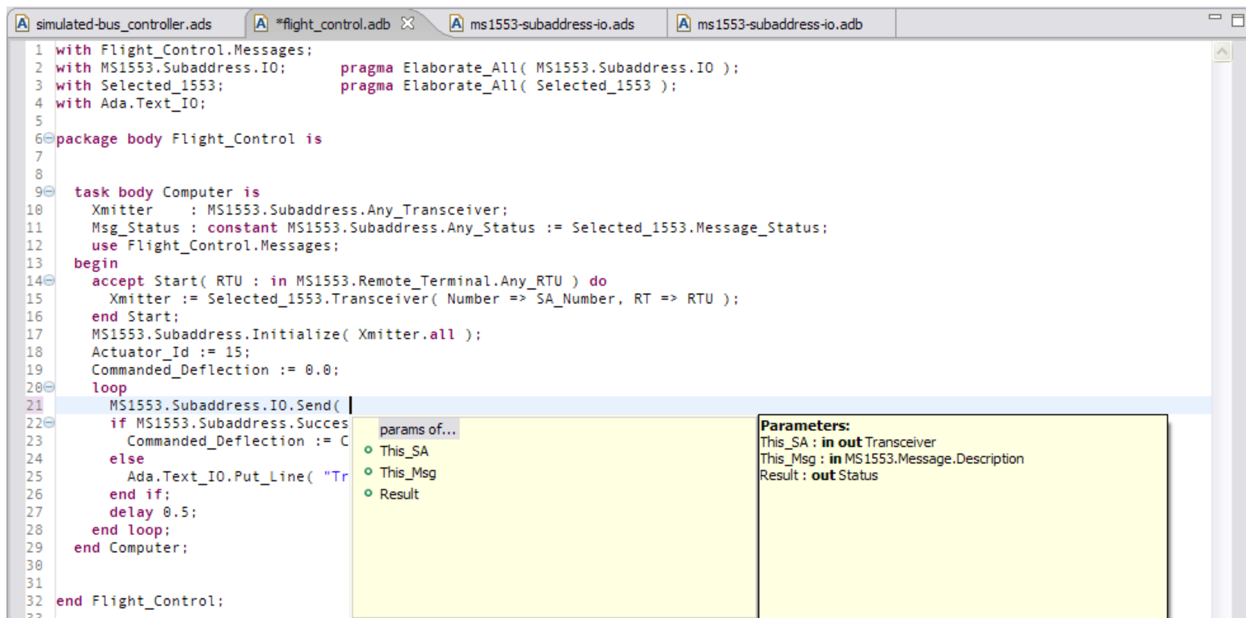


6.2.6 Formal Parameter Completion

Code Assist can suggest the possible formal parameters of a subprogram call you're currently writing. For example, the figure below shows a call to a procedure declared as folows:

```
procedure Send( This_SA : in out Transceiver'Class; This_Msg :  in MS1553.Message.
Description; Result :  out Status'Class );
```

After you type the opening parenthesis, Code Assist will automatically propose a completion consisting of all the formal parameters, as well as proposing each formal as an individual completion. That is the case in the following example:



Selecting "params of. . ." inserts all the (remaining) formal parameters using the named parameter association format, and places the cursor where the first actual parameter will go:

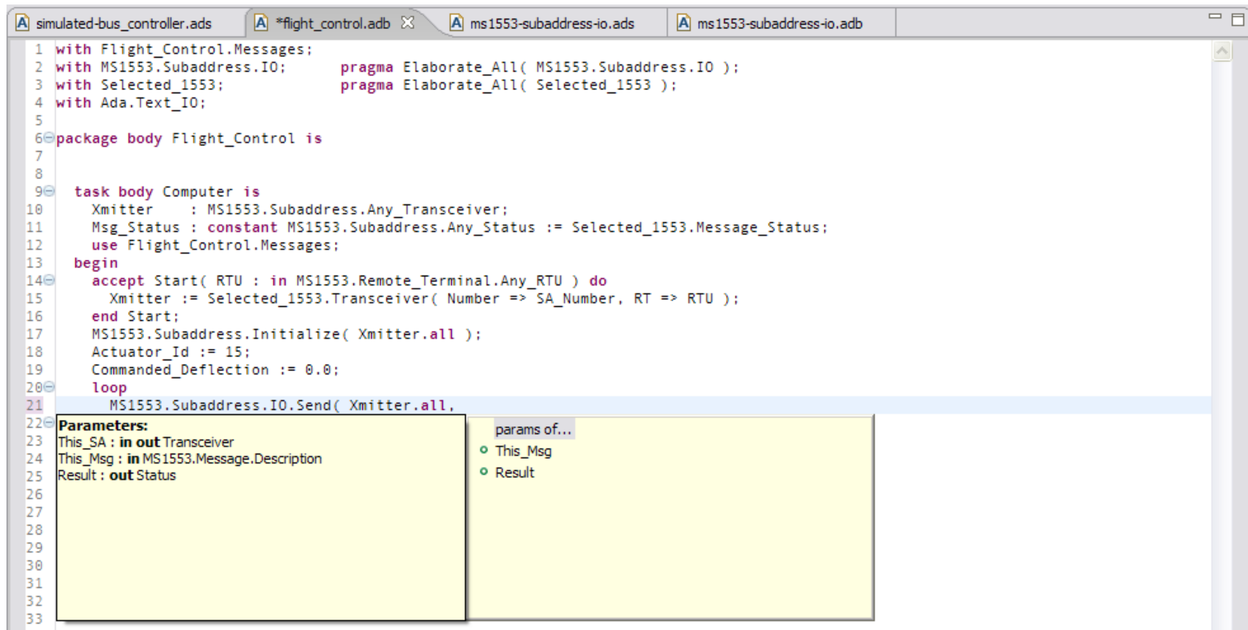
```
task body Computer is
  Xmitter    : MS1553.Subaddress.Any_Transceiver;
  Msg_Status : constant MS1553.Subaddress.Any_Status := Selected_1553.Message_Status;
  use Flight_Control.Messages;
begin
  accept Start( RTU : in MS1553.Remote_Terminal.Any_RTU ) do
    Xmitter := Selected_1553.Transceiver( Number => SA_Number, RT => RTU );
  end Start;
  MS1553.Subaddress.Initialize( Xmitter.all );
  Actuator_Id := 15;
  Commanded_Deflection := 0.0;
  loop
    MS1553.Subaddress.IO.Send( This_SA  => ,
This_Msg => ,
Result   => )
    if MS1553.Subaddress.Success( Msg_Status.all ) then
      Commanded_Deflection := Commanded_Deflection + 0.25;
    else
      Ada.Text_IO.Put_Line( "Transmission did not occur!" );
    end if;
    delay 0.5;
  end loop;
end Computer;
```

You can, of course, also select an individual formal parameter candidate and it will be inserted next, again using the named association format.

Alternatively, only the remaining formals are proposed if you manually invoke Code Assist in the middle of entering the actual parameters. Thus you can either choose a completion containing all the remaining formal parameters, or individual completions from the remaining formals. Continuing the example, invoking Code Assist after the comma in the following situation:

```
Send( Xmitter.all,
```

would cause the completion engine to propose parameters This_Msg and Result but not This_SA, as well as all those remaining:



When multiple subprograms are overloaded the parameters for each subprogram are indicated, separated into their corresponding groups. In the following figure there are two procedures named Send. We have selected the formal

parameters of the procedure with four formals instead of three:

```
 9   task body Computer is
10     Xmitter    : MS1553.Subaddress.Any_Transceiver;
11     Msg_Status : constant MS1553.Subaddress.Any_Status := Selected_1553.Message_Status;
12     use Flight_Control.Messages;
13   begin
14     accept Start( RTU : in MS1553.Remote_Terminal.Any_RTU ) do
15       Xmitter := Selected_1553.Transceiver( Number => SA_Number, RT => RTU );
16     end Start;
17     MS1553.Subaddress.Initialize( Xmitter.all );
18     Actuator_Id := 15;
19     Commanded_Deflection := 0.0;
20     loop
21       MS1553.Subaddress.IO.Send(
22       if MS1553.Subaddress.Succe
23         Commanded_Deflection :=
24       else
25         Ada.Text_IO.Put_Line( "T
26       end if;
27       delay 0.5;
28     end loop;
29   end Computer;
30
31
32 end Flight_Control;
33
```

```
params of Send
  This_SA
  This_Msg
  Result
params of Send
  This_SA
  This_Msg
  These
  Result

Parameters:
This_SA : in out Transceiver
This_Msg : in MS1553.Message.Description
These : in MS1553.Message.Subset
Result : out Status
```

6.2.7 Limitations

Code Assist does not take into account the association between generic formal parameter types and generic actual parameter types when attempting to complete a reference via the formal.

For example, in the following figure, the generic formal type T is matched during the instantiation with generic actual type R. Type R has record components, but these components are not available as candidates via objects *viewed as of type T*. Therefore, in the figure we can request a completion of P. and the engine will propose the function name F, but there is no further completion proposed for P.F. because P.F returns a value of type T and the components are not known to the engine via that type name.

```
test.adb    message_element_demo.ads

 1 with Ada.Text_IO;  use Ada.Text_IO;
 2 procedure Test is
 3
 4    generic
 5       type T is private;
 6    package G is
 7       function F return T;
 8    end G;
 9
10    package body G is
17
18    type R is record
19       A, B : Integer;
20    end record;
21
22    package P is new G (R);
23
24    X : constant Integer := P.
25
26 begin
27    Put_Line (X'Img);
28 end Test;
29
```

```
F

Return:
T
```

6.2.8 Ada Templates

Templates are a structured description of coding patterns that occur frequently in source code. The Ada editor supports the use of templates to fill in commonly used source patterns. Templates are inserted using content assist (Ctrl+Space).

For example, a common coding pattern is to iterate over elements of an array using a for loop that indexes into the array. By using a template for this pattern, you can avoid typing in the complete code for the loop. Invoking content assist after typing the word for will present you a possible template. Please select the template and the editor will insert the code into the editor and position the cursor so that you can edit the details.

Templates can contain template variables. Variables mark the editable locations. To edit the next variables press Tab key. When you have terminated to edit the variables, press Enter key to go to the location defined by the ${cursor} variable.

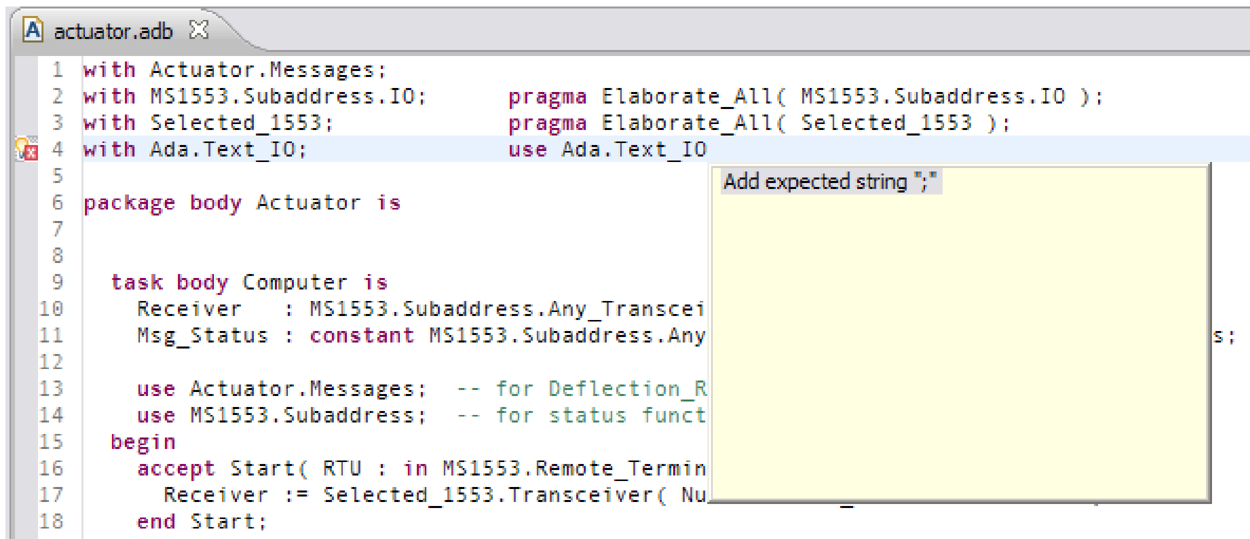
Many common templates (e.g. procedure,function,for,while,do,if ...) are already defined. These can be viewed with the Window -> Preferences -> Ada -> Template preference page. This preference page allows to create your own templates or edit the existing ones. Below is a list of the buttons and the descriptions.

- The New button opens the Template dialog to create a new template.
- The Edit button opens the Template dialog to edit the currently selected template.
- The Remove button removes all selected templates.
- The Restore Removed button restores any pre-configured templates that have been removed.
- The Revert to Default button restores any pre-configured templates to their default. This does not modify user created templates.
- The Import button imports templates from the file system.
- The Export button exports all selected templates to the file system.

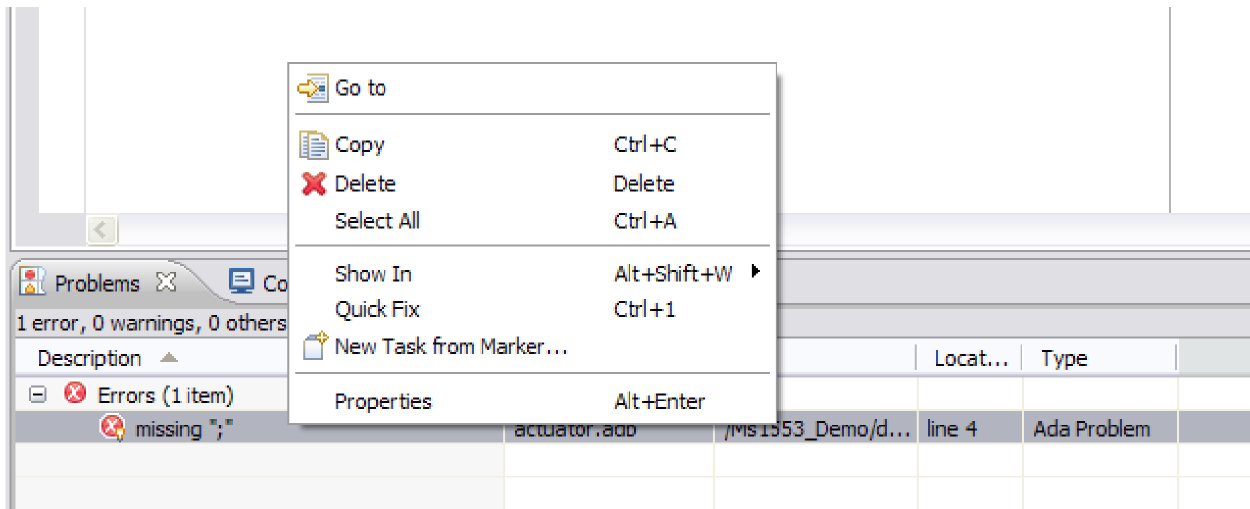
6.3 Quick Fix

The GNATbench language-sensitive editor may be able to propose corrections for problems identified by the compiler. This possibility is indicated by the "light bulb" shown in the editor marker bar, opposite the source line containing the problem. Note that Quick Fix is under the control of a preference on the Ada Tools preference page and is enabled by default.

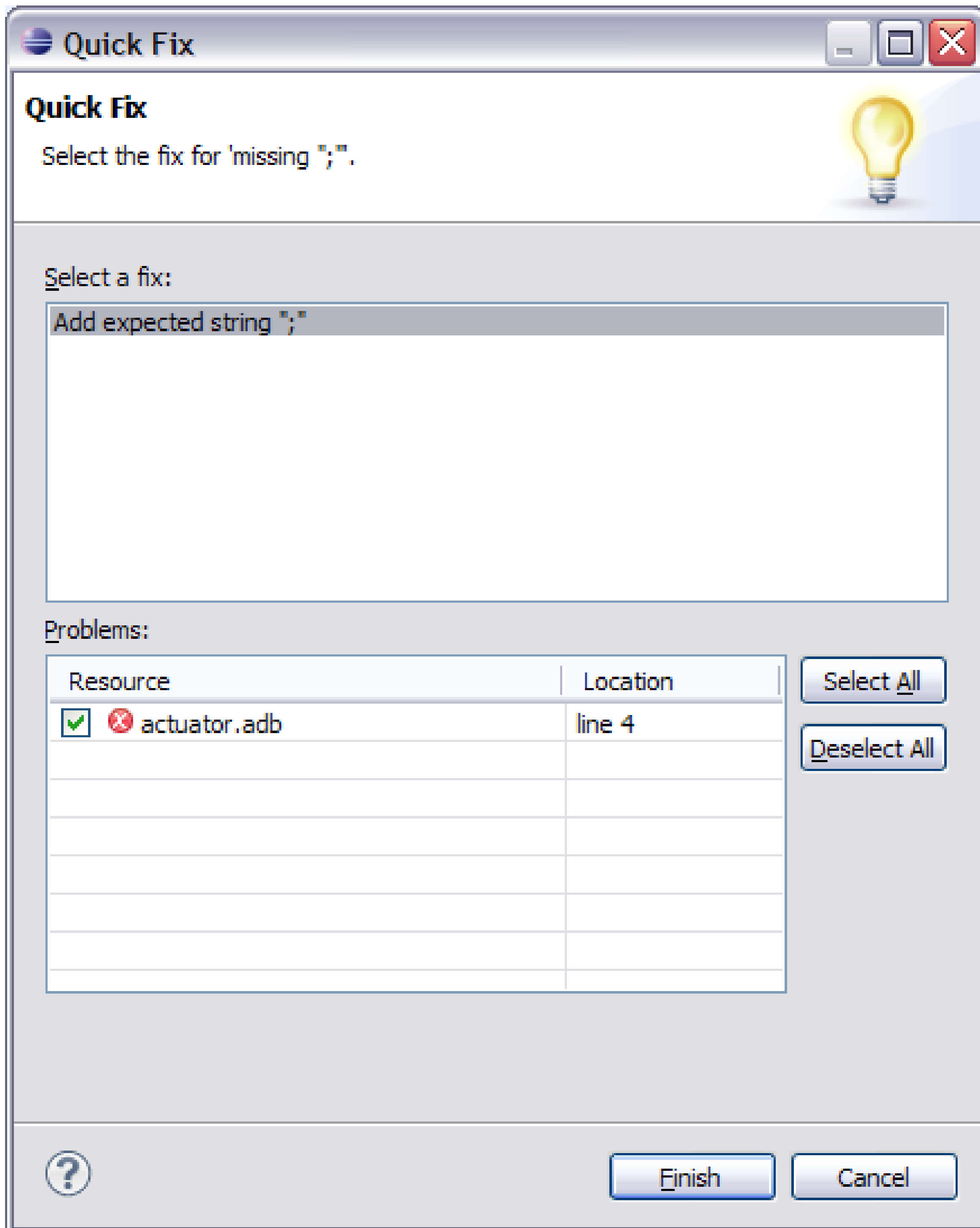
To see the correction proposals use the Quick Fix action. Simply click on the light bulb in the editor marker bar and a window containing the proposed fix (or fixes) will appear, as illustrated below:



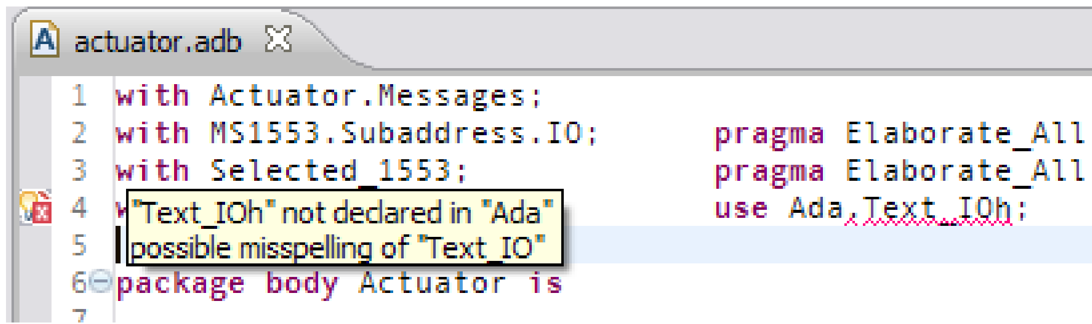
Quick Fix can also be invoked via entries in the Problems view. Click (single-click) on the entry in the Problems view and enter Ctrl+1, or right-click on the entry and select Quick Fix from the contextual menu:



Selecting the Quick Fix action will open a dialog to select and apply the correction.



Note that the light bulb is only a hint. It is possible that even with the light bulb shown that no corrections can be offered.


actuator.adb
1 with Actuator.Messages;
2 with MS1553.Subaddress.IO; pragma Elaborate_All
3 with Selected_1553; pragma Elaborate_All
4 use Ada.Text_IOh;
"Text_IOh" not declared in "Ada"
possible misspelling of "Text_IO"
5
6 package body Actuator is

CHAPTER

SEVEN

BUILDING

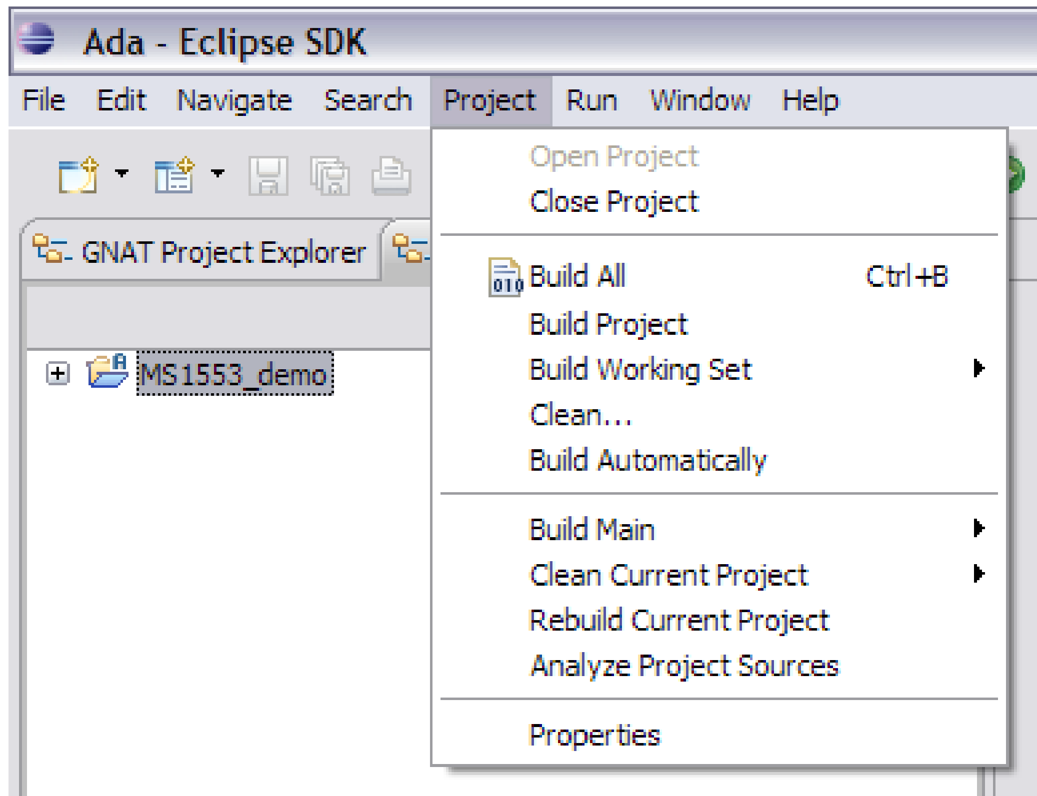
7.1 Project Builder Command Menus

GNATbench provides project-level builder commands in two menus: the Project menu and the project contextual menus of the GNAT Project Explorer and the Navigator. These commands include the standard project builder commands defined by Eclipse, with additional builder commands defined by GNATbench. Other “builder” commands are also included, such as those that clean the project of compilation products.

We describe the semantics of the standard and additional commands in *Project Builder Command Semantics*. This section describes the menu entry locations.

7.1.1 Project Menu

The Project menu on the menubar defines the standard Eclipse project build commands, Build All through Build Automatically, as shown in the following figure. The GNATbench project-specific builder extensions appear further down.

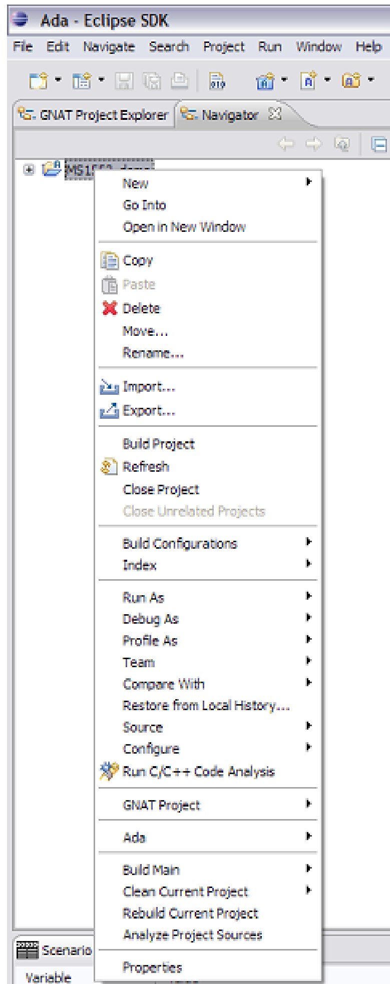


7.1.2 Contextual Menus

The contextual menu of the GNAT Project Explorer (and the Navigator) includes the standard Build Project command, as shown below. It appears in the standard "project" section of the menu, just below the import/export menu entries. This is the same command as in the Project menu on the menubar so it will also be disabled when Eclipse considers a build unnecessary.

Note that you must right-click on the name of the project itself to get to the menu with the project builder commands, not on some entity within the project.

The GNATbench extensions to the project contextual menus of the GNAT Project Explorer and the Navigator appear near the bottom of the contextual menus. These extensions include those added to the Project menu as well as two additional builder commands that are less frequently used.



7.2 Project Builder Command Semantics

GNATbench provides the standard project builder commands defined by Eclipse, with some changes for the sake of building in the context of a distinct linking phase, and augments them with builder commands specific to a given project. All these commands display their execution in the Console view and any compilation warnings and errors are reported in the Problems View. The builder commands defined by GNATbench are typically used in preference to the Eclipse-defined commands.

The project builder commands build the project based on the definition within the GNAT project file (*.gpr file) controlling the GNATbench project. For example, if one or more main programs are defined by the GNAT project file, building the project creates the executables corresponding to those main subprograms. As an alternative example, the GNAT project file may describe a library project, in which case the library is created when the project is built.

GNAT project files may define a project hierarchy, when the so-called "root" project imports other GNAT project files via "with clauses". When a root project is built, all the imported projects will also be built, as necessary, using the compilation switches defined by the root project. Thus, for example, an imported library project might be built along with executable images requiring that library in the root project.

See *GNAT Projects* for a description of GNAT projects and project files.

Note that Eclipse projects may reference other Eclipse projects. Since a GNATbench project is also an Eclipse project, project hierarchies need not be contained within one Eclipse project.

Build steps and resulting messages are displayed on the standard Eclipse Console view in a subconsole specific to the command. You can show this view using the standard Eclipse Window -> Show View command if the Console is not already open. See *Ada Build Console* for the details of using the builders' subconsoles.

The progress indicator at the lower right of the Eclipse window will show the command as it runs, including the percentage complete. You can also interrupt build commands using the Progress view controls.

Note that Ada source files are saved automatically when a project is built if they are within that specific project and if they have been altered but not yet saved. This effect is controlled by a preference and is enabled by default. See the *Editor* preference page for the location of the controlling preference.

7.2.1 Standard Eclipse Build Commands

The Project menu and the GNAT Project Explorer contextual menu provide the standard Eclipse project commands and GNATbench implements the standard semantics. These are the menu entries "Build All" through "Build Automatically" in the Project menu and "Build Project" in the contextual menu. See *Project Builder Command Menus* for the locations and content of these menus.

The various build commands and the "Clean…" command operate based on the build history, that is, they perform their action only if Eclipse believes them necessary. Indeed, the build commands will be disabled whenever a build previously succeeded and nothing has changed to make Eclipse believe another build is necessary.

Build Project and Build All

The commands "Build Project" and "Build All" will invoke the GNAT builder for the GNAT toolchain specified by the user when creating the project. Alternatively, if a user-defined toolchain is specified during project creation, the corresponding command specified by the user will be invoked.

Clean…

Similarly, the Eclipse "Clean…" command in the Project menu will invoke the GNAT cleaner for the GNAT toolchain specified by the user when creating the project. (The "Clean…" command offers the option to clean all projects or just a subset of selected projects.)

Build Automatically

We describe the semantics of "Build Automatically" in a separate section of this chapter. See *About the Build Automatically Option…* for the details.

7.2.2 GNATbench Project-Specific Builder Commands

GNATbench defines additional builder commands that provide the convenience of operating specifically on the currently selected project. These enhancements appear in the next section down in the Project menu and at the bottom of the GNAT Project Explorer project-level contextual menu.

Clean Current Project

The "Clean Current Project" command removes compilation products from the project. Like the standard Eclipse "Clean…" command, it calls the cleaner (gnatclean or gprclean) for the toolchain defined for the project, but can also clean project hierarchies.

If a user-defined toolchain is specified during project creation the user-defined command will be invoked.

See *Removing Compilation Artifacts* for the details.

Rebuild Current Project

The "Rebuild Current Project" command first "cleans" the root project and then invokes the builder. A full build of the root project is thus performed. Note that rebuilding an entire project hierarchy requires first cleaning the entire project tree using the Clean Current Project/Tree command.

Analyze Project Sources

The "Analyze Project Sources" command will check all the sources in the project, including those that have not changed, for syntax and semantic errors. Any warnings and errors are sent to the problems view as usual. Note that this command does not create an executable.

The "Analyze Project Sources" command will also generate the required information to support those browsing and navigation commands that require it, without also producing object code.

Note that you can analyze individual Ada source files instead of analyzing the entire project. See *Analyzing Individual Files*.

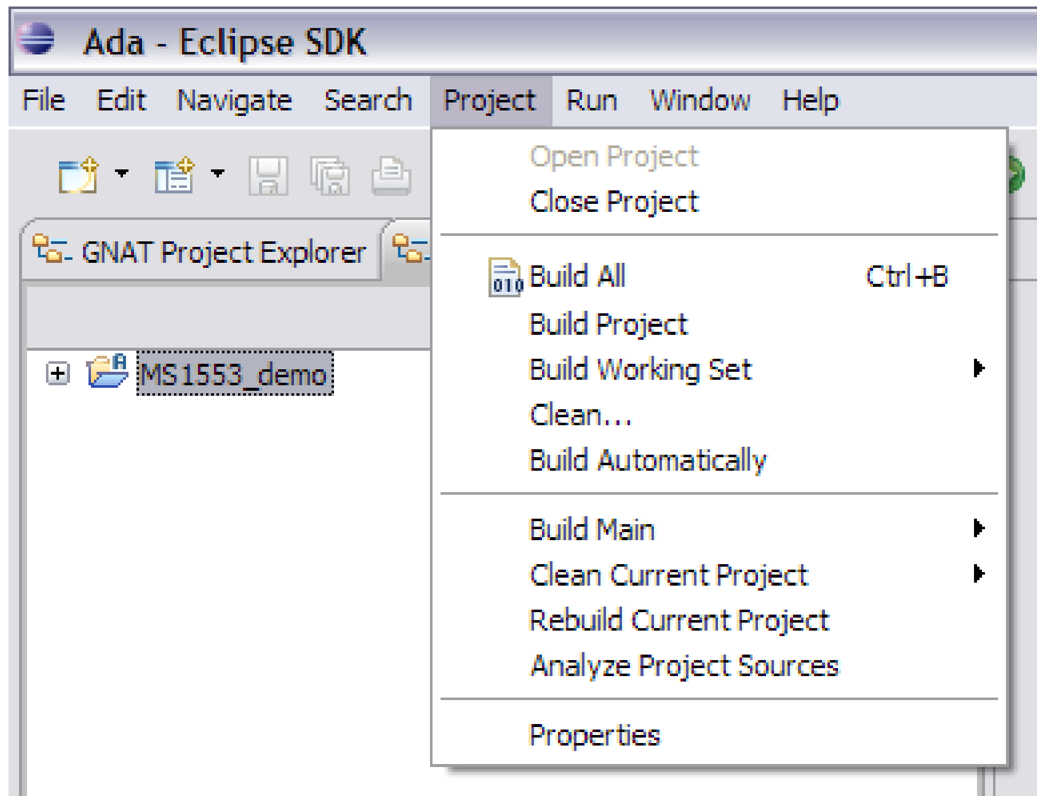
Invoke Makefile In Target

The "Invoke Makefile In Target" command allows you to invoke user-defined builder commands. We cover the details of this command in a separate part of this "Building" chapter. See *User-Defined Builder Commands* for the details.

Note that there is no compelling reason to use "Invoke Makefile In Target" to invoke the builder commands predefined by Eclipse and GNATbench, unless, of course, those commands have been changed by the user in the makefile. This menu entry is primarily intended for invoking user-defined builder commands that GNATbech and Eclipse do not invoke.

7.3 Project Builder Key Bindings

The GNATbench builder commands do not have keys bound to them, as shown in the figure below. Eclipse itself binds Ctrl-B to the Build All project command and it will indeed build all GNATbench projects in addition to any other non-Ada projects. Note the additional project-specific commands further down in the menu that are added by GNATbench.



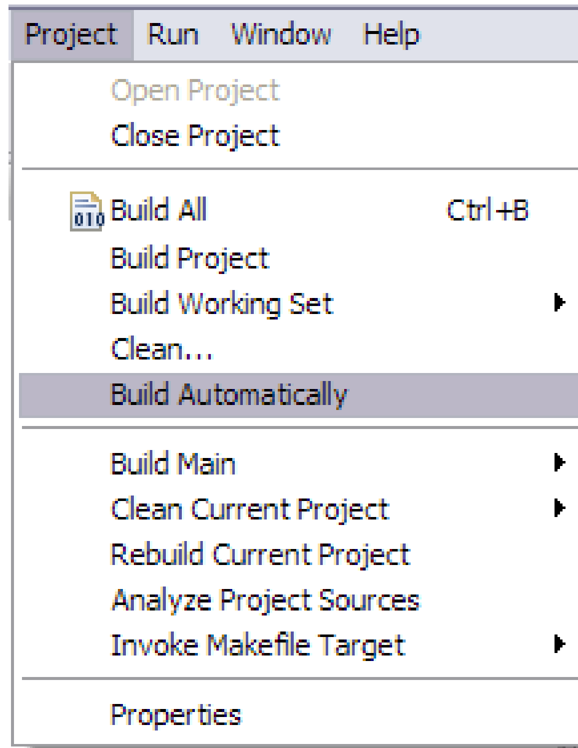
Defining global, "MDI-level" key bindings (such as Ctrl-B) is best left to the user because many plug-ins are likely to be loaded in an Eclipse installation and each is likely to define global key bindings. A great many bindings are thus possible but when these bindings conflict, *none* of them take effect, except for bindings defined directly by Eclipse itself. The user, however, can unbind key bindings and redefine them as desired, including those defined by Eclipse. Therefore, we have not bound builder commands to keys.

You may define your own bindings to all these builder commands, if desired. To define or redefine key bindings, use the Window -> Preferences menu, then expand the General category and select the Keys page.

In contrast to global key bindings, context-specific bindings do not conflict with one another and therefore GNATbench defines many such bindings. For example, editor commands are language-specific so they can have identical bindings without conflicting. These bindings are discussed in the chapters corresponding to the specific capabilities.

7.4 About the Build Automatically Option...

The Project menu on the menubar defines the standard Eclipse project build commands, including "Build Automatically". (See the figure below for the location of the menu entry.) Build Automatically is actually an option, not a command, and will have a check-mark next to it when it is enabled.



When the Build Automatically option is enabled and an Ada source file is changed and saved (or after the overall project is cleaned), the builder is automatically invoked.

If the project is clean (or has never been built in the first place), Eclipse invokes a full build and an executable will be generated if possible.

However, a full build is not invoked when Eclipse does not consider it to be required. For example, after a full build, changing a single file invokes an *incremental* build. In this mode the compiler will perform syntax and semantic analysis on the unit in the changed source file and all of its dependent units, transitively, but the binder or linker phases are not performed. Errors are thus detected as early as possible but without the expense of a full build.

Note that the Ada editor has a preference, enabled by default, to save altered project source files before a build begins. If multiple source files are altered but not yet saved and the Build Automatically option is enabled, saving any one of those files will invoke the builder and thus all of the altered source files in that project will be saved as well.

7.5 Ada Build Console

When the builder is invoked (including when cleaning), the Console view is made visible and a project-specific builder "subconsole" is shown. The focus is not given to the Console view, the view is just made visible so that work in another view or editor can continue uninterrupted. Build steps and any resulting messages are displayed in the subconsole as the command executes.

The subconsole will have a title of "Ada build" followed by the name of the project enclosed within square brackets. For example, in the following figure, the project Ms1553_Demo has completed a full build:

```
Problems  Console  Scenario Variables
Ada build [Ms1553_Demo]
gcc -c -g -gnatQ -gnato -gnat05 -g -gnatwa -I- -gnatA C:\eclipse\workspace\Ms1553_Demo\simulated_instance\simulated-subaddress.adb
gcc -c -g -gnatQ -gnato -gnat05 -g -gnatwa -I- -gnatA C:\eclipse\workspace\Ms1553_Demo\messaging\ms1553-message_element.adb
gcc -c -g -gnatQ -gnato -gnat05 -g -gnatwa -I- -gnatA C:\eclipse\workspace\Ms1553_Demo\messaging\ms1553-message_element-predefined.adb
ms1553-message_element-predefined.adb:52:42: warning: formal parameter "From" is read but never assigned
ms1553-message_element-predefined.adb:105:49: warning: formal parameter "From" is read but never assigned
ms1553-message_element-predefined.adb:151:47: warning: formal parameter "From" is read but never assigned
gcc -c -g -gnatQ -gnato -gnat05 -g -gnatwa -I- -gnatA C:\eclipse\workspace\Ms1553_Demo\messaging\ms1553-message.adb
gcc -c -g -gnatQ -gnato -gnat05 -g -gnatwa -I- -gnatA C:\eclipse\workspace\Ms1553_Demo\simulated_instance\simulated-bus.adb
gcc -c -g -gnatQ -gnato -gnat05 -g -gnatwa -I- -gnatA C:\eclipse\workspace\Ms1553_Demo\messaging\ms1553-message_element-utils.adb
gnatbind -static -I- -x C:\eclipse\workspace\Ms1553_Demo\obj\demo.ali
gnatlink C:\eclipse\workspace\Ms1553_Demo\obj\demo.ali -g -g -o C:\eclipse\workspace\Ms1553_Demo\exec\demo.exe
Ada builder for [Ms1553_Demo] completed Jan 11, 2008 8:35:31 AM CST.
```

You can use the standard contextual menu within the subconsole to copy the contents, clear it, and so forth.

There may be multiple build subconsoles within the Console view since multiple projects can exist and be built independently. You can choose among these subconsoles by clicking on the down-arrow next to the "Console" icon and selecting from those that appear in the popup menu. The Console icon is the fourth from the left in the following figure and looks like a computer monitor. This figure also shows the console selection popup menu containing two open subconsole names. Note that the Console icon will be disabled if no other subconsoles exist to be selected.

```
Problems  Console  Scenario Variables
Ada build [Ms1553_Demo]                                         1 Ada build [Dev]
                                                              • 2 Ada build [Ms1553_Demo]
gcc -c -g -gnatQ -gnato -gnat05 -g -gnatwa -I- -gnatA C:\eclipse\workspace\Ms1553_Demo\messaging\ms1553-message_
gcc -c -g -gnatQ -gnato -gnat05 -g -gnatwa -I- -gnatA C:\eclipse\workspace\Ms1553_Demo\messaging\ms1553-message_element-predefined.adb
ms1553-message_element-predefined.adb:52:42: warning: formal parameter "From" is read but never assigned
ms1553-message_element-predefined.adb:105:49: warning: formal parameter "From" is read but never assigned
ms1553-message_element-predefined.adb:151:47: warning: formal parameter "From" is read but never assigned
gcc -c -g -gnatQ -gnato -gnat05 -g -gnatwa -I- -gnatA C:\eclipse\workspace\Ms1553_Demo\messaging\ms1553-message.adb
gcc -c -g -gnatQ -gnato -gnat05 -g -gnatwa -I- -gnatA C:\eclipse\workspace\Ms1553_Demo\simulated_instance\simulated-bus.adb
gcc -c -g -gnatQ -gnato -gnat05 -g -gnatwa -I- -gnatA C:\eclipse\workspace\Ms1553_Demo\messaging\ms1553-message_element-utils.adb
gnatbind -static -I- -x C:\eclipse\workspace\Ms1553_Demo\obj\demo.ali
gnatlink C:\eclipse\workspace\Ms1553_Demo\obj\demo.ali -g -g -o C:\eclipse\workspace\Ms1553_Demo\exec\demo.exe
Ada builder for [Ms1553_Demo] completed Jan 11, 2008 8:10:17 AM CST.
```

You can traverse through the various open subconsoles by simply clicking directly on the Console icon.

Note that if another view within the same group containing the Console view already has the focus, for example if the Problems view or the Scenario Variables view is being examined, the specific project's build subconsole is not brought to the front so that working with the other view in that group is not interrupted.

7.6 Compiling Individual Files

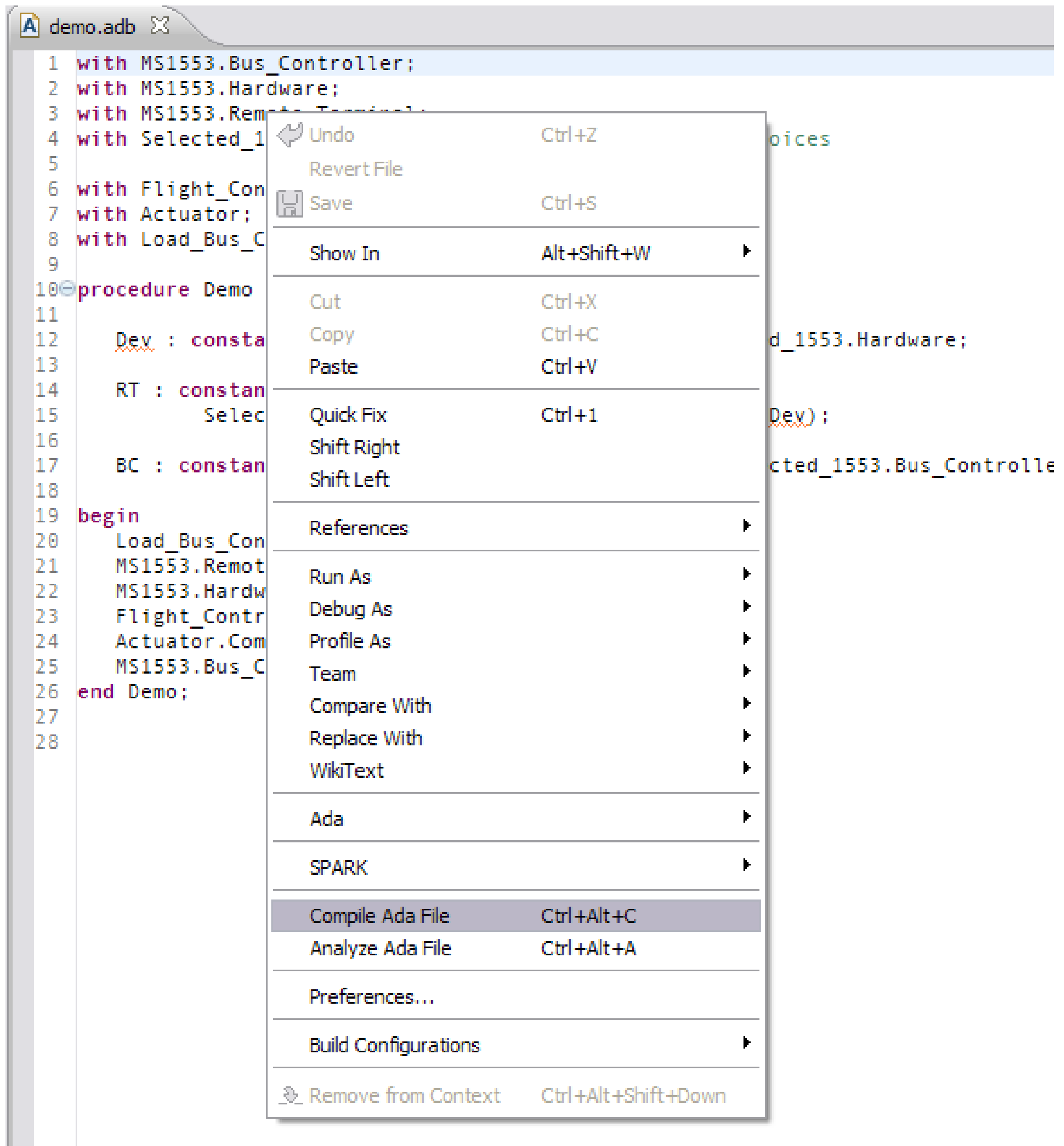
GNATbench defines menu entries for compiling individual files in addition to building complete projects.

Compilation steps and messages are displayed on the standard Console view in a subconsole specific to the command. You can show this view using the standard Eclipse Window -> Show View command if the Console is not already open. See *Ada Build Console* for the details of using the builders' subconsoles.

The progress indicator at the lower right of the Eclipse window will show the command as it runs, including the percentage complete.

7.6.1 Within the Ada Editor

The GNATbench Ada editor extends the contextual menu with an entry "Compile Ada File" (shown in the figure below) that will attempt to compile the compilation unit in that file. Note the key binding in this context.

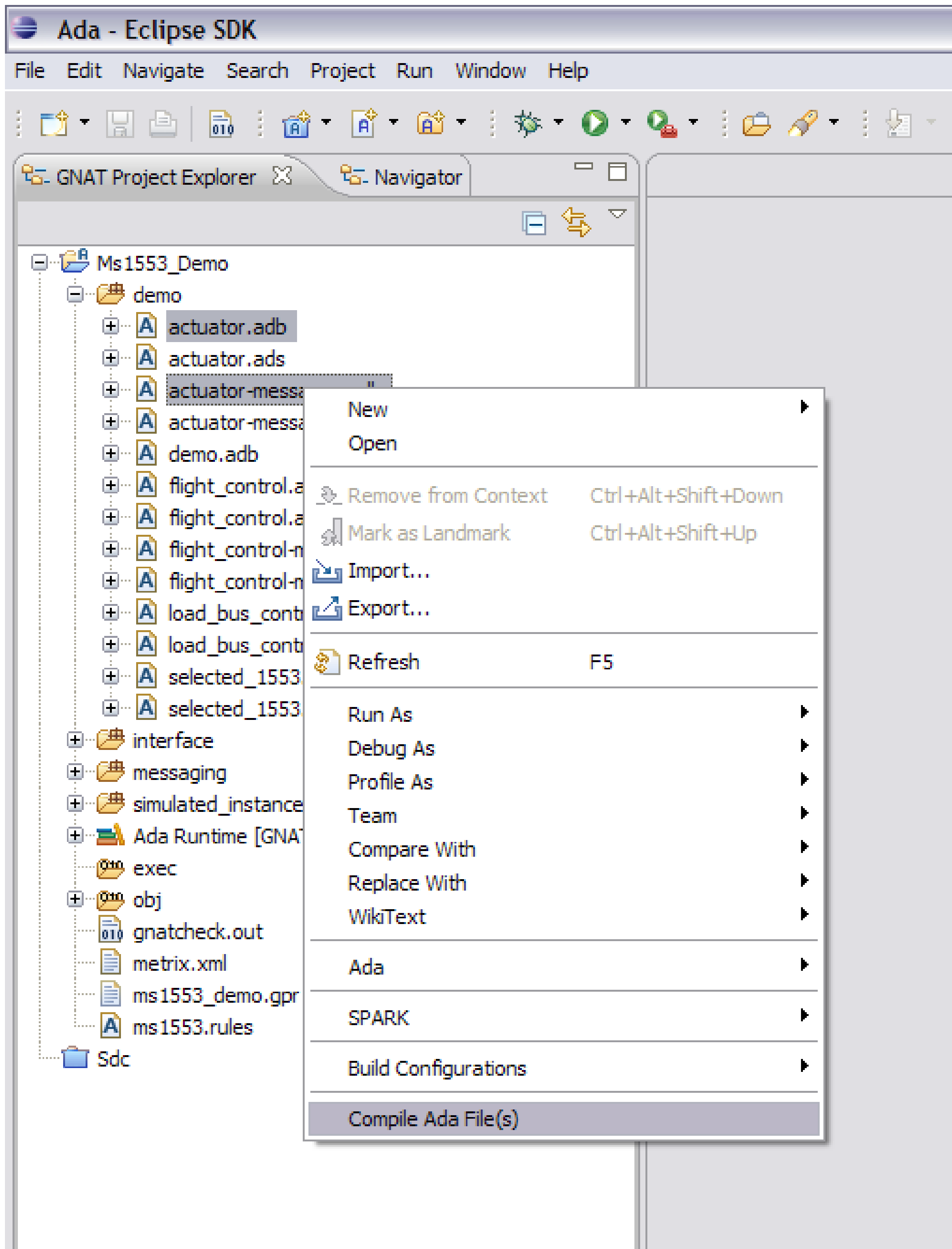

demo.adb
with MS1553.Bus_Controller;
with MS1553.Hardware;
with Selected_1
with Flight_Con
with Actuator;
with Load_Bus_C
procedure Demo
Dev : consta
RT : constan
Selec
BC : constan
begin
Load_Bus_Con
MS1553.Remot
MS1553.Hardw
Flight_Contr
Actuator.Com
MS1553.Bus_C
end Demo;
oices
d_1553.Hardware;
Dev);
cted_1553.Bus_Controlle
Undo Ctrl+Z
Revert File
Save Ctrl+S
Show In Alt+Shift+W
Cut Ctrl+X
Copy Ctrl+C
Paste Ctrl+V
Quick Fix Ctrl+1
Shift Right
Shift Left
References
Run As
Debug As
Profile As
Team
Compare With
Replace With
WikiText
Ada
SPARK
Compile Ada File Ctrl+Alt+C
Analyze Ada File Ctrl+Alt+A
Preferences...
Build Configurations
Remove from Context Ctrl+Alt+Shift+Down

7.6.2 Within the GNAT Project Explorer

You can also compile individual Ada source files using the contextual menu of the file nodes in the GNAT Project Explorer. The menu command is "Compile Ada File(s)".

Right-click on a file node in the Project Explorer to get the file-specific contextual menu, as opposed to the project-level contextual menu.

In addition, you can compile multiple Ada source files by selecting several nodes before invoking the command. The figure below illustrates selecting several files within the GNAT Project Explorer for compilation.


Ada - Eclipse SDK
File Edit Navigate Search Project Run Window Help
GNAT Project Explorer
Navigator
Ms1553_Demo
demo
actuator.adb
actuator.ads
demo.adb
interface
messaging
exec
obj
gnatcheck.out
metrix.xml
ms1553_demo.gpr
ms1553.rules
Sdc
New
Open
Remove from Context Ctrl+Alt+Shift+Down
Mark as Landmark Ctrl+Alt+Shift+Up
Import...
Export...
Refresh F5
Run As
Debug As
Profile As
Team
Compare With
Replace With
WikiText
Ada
SPARK
Build Configurations
Compile Ada File(s)

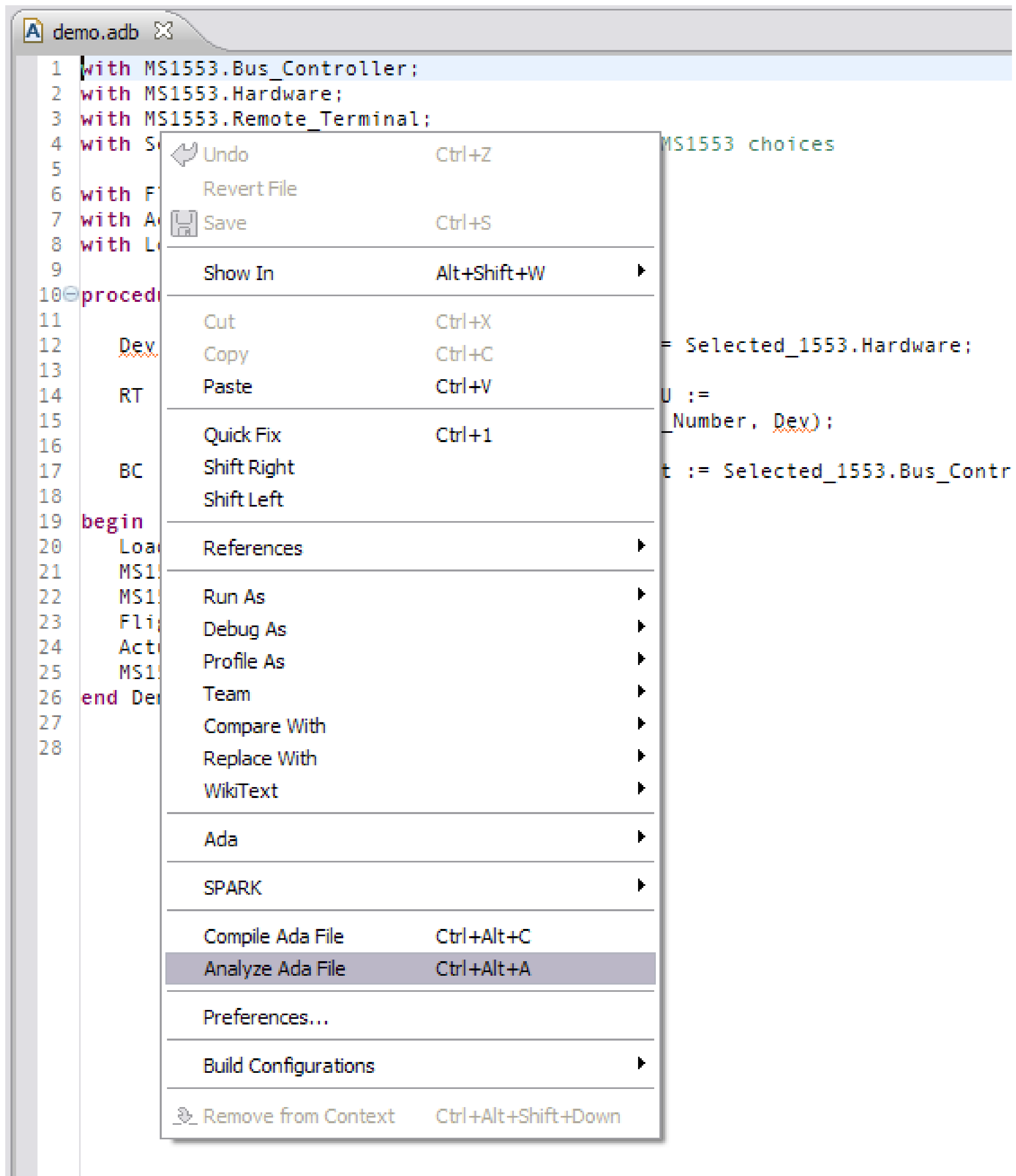
7.7 Analyzing Individual Files

GNATbench provides a capability to analyze an individual source file as an alternative to analyzing all the source files in the project. Like the project-level command, this command checks syntax and semantics but will also generate the required information to support those browsing and navigation commands that require it, without also producing object code or an executable.

Analysis results are displayed on the standard Eclipse Console view in a subconsole specific to the command. You can show this view using the standard Eclipse Window -> Show View command if the Console is not already open. See

Ada Build Console for the details of using the builders' subconsoles.

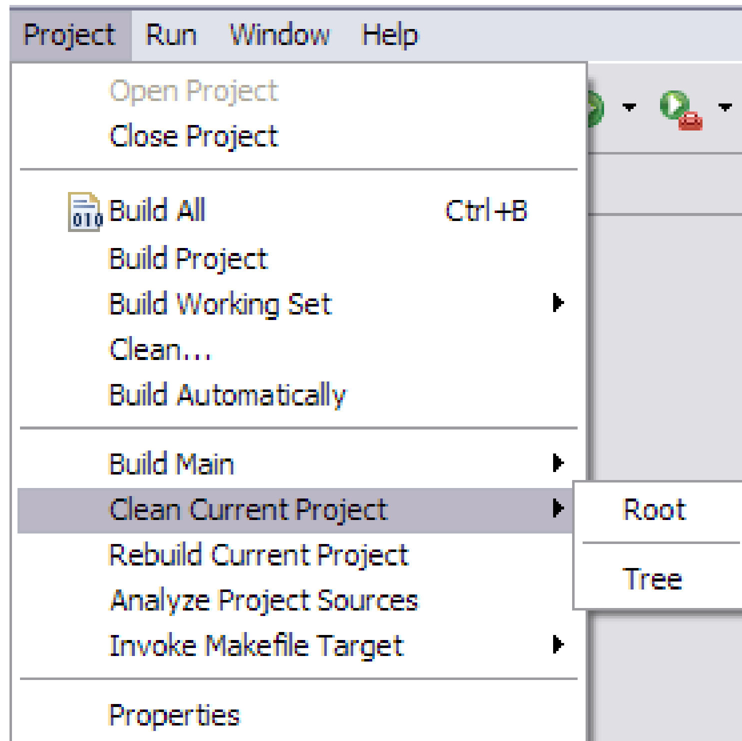
The command is in the contextual menu of the Ada editor and is named "Analyze Ada File" (as shown in the figure below). Note the key binding.


demo.adb
with MS1553.Bus_Controller;
with MS1553.Hardware;
with MS1553.Remote_Terminal;
MS1553 choices
begin
end
Undo Ctrl+Z
Revert File
Save Ctrl+S
Show In Alt+Shift+W
Cut Ctrl+X
Copy Ctrl+C
Paste Ctrl+V
Quick Fix Ctrl+1
Shift Right
Shift Left
References
Run As
Debug As
Profile As
Team
Compare With
Replace With
WikiText
Ada
SPARK
Compile Ada File Ctrl+Alt+C
Analyze Ada File Ctrl+Alt+A
Preferences...
Build Configurations
Remove from Context Ctrl+Alt+Shift+Down

7.8 Removing Compilation Artifacts

All compilation products specified implicitly or explicitly by the GNAT project file (*.gpr file) can be removed using the project cleaning menu defined by the Project menu and the contextual menus of the GNAT Project Explorer and Navigator. Specifically, the object files (*.o), "ali" files (*.ali), and executable images (e.g., *.exe on Windows) can be removed.

The menu entry is named "Clean Current Project" and is actually two submenus: one to clean the currently selected project root, and one to clean the root as well as the "tree" of projects imported by the root project. (Imported projects are those named in "with clauses" in a project's GNAT project file.) These two submenu entries are shown in the following figure:



7.9 Building Projects with Scenarios

GNAT project files have the concept of scenario variables that allow considerable flexibility in controlling how the tools build an executable, among other possible uses. (See *Scenario Variables* for details on scenario variables, and *GNAT Projects* for the details of GNAT project files.) You can define, for example, different scenarios for debugging and releases, in which optimization and symbolic information are either present or not, respectively.

GNATbench provides the Scenario View for managing scenario variables. The idea is that you can view and control the build by changing the values of the scenario variables within this view. (See *Scenario Variables View* for details.)

Note that scenario variable settings persist across Workbench sessions so there is no need to set them again whenever Workbench is started or a closed project is re-opened.

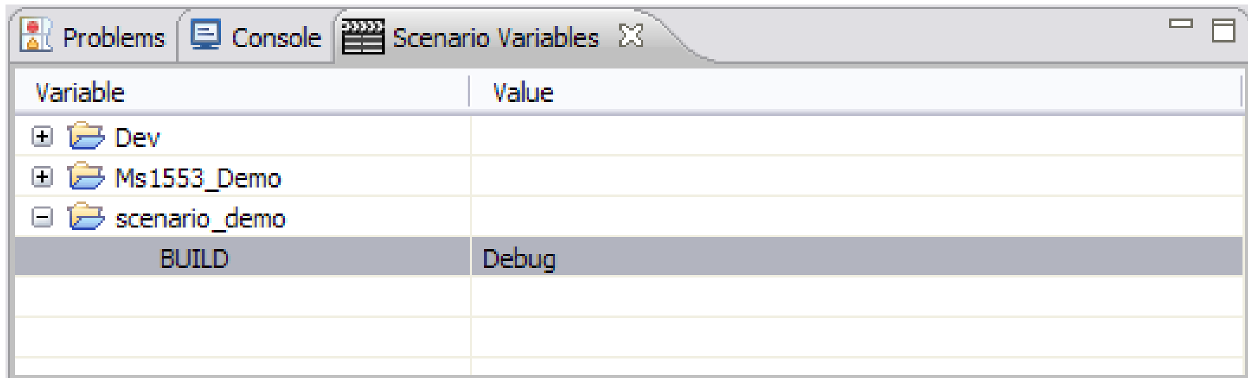
The wizard that created our new project also created the corresponding GNAT project file for us. It is shown below. Note the scenario variable named "Mode".

scenario_demo.gpr

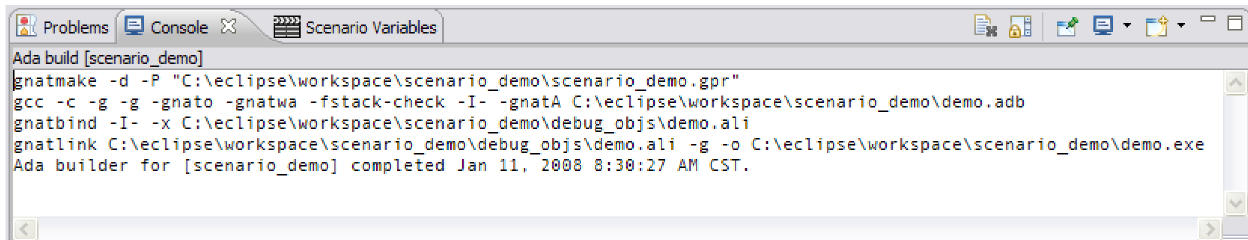
```
project scenario_demo is

   type Build_Modes is ("Release", "Debug");
   Mode : Build_Modes := external ("BUILD", "Debug");

   for Main use ("demo.adb");

   for Exec_Dir use ".";

   case Mode is
      when "Debug" =>
         for Object_Dir use "debug_objs";
      when "Release" =>
         for Object_Dir use "release_objs";
   end case;

   package Compiler is
      case Mode is
         when "Debug" =>
            for Default_Switches ("Ada") use
                ("-g", "-gnato", "-gnatwa", "-fstack-check");
         when "Release" =>
            for Default_Switches ("Ada") use ("-O2");
      end case;
   end Compiler;

   package Builder is
      case Mode is
         when "Debug" =>
            for Default_Switches ("Ada") use ("-g");
         when "Release" =>
            for Default_Switches ("Ada") use ("");
      end case;
   end Builder;

   package IDE is
      for Compiler_Command("Ada") use "gnatmake";
   end IDE;

end scenario_demo;
```

The variable Mode has two possible values because of its type: "Release" and "Debug". (These values are case-sensitive because they are strings.) As you have guessed, these two values represent two different build scenarios. "Release" corresponds to the scenario in which you build for actual delivery. The "Debug" scenario is for development and testing. Therefore, these scenarios require different switches to be applied and this fact is reflected in the content of the project file. Note in particular the switches set in the package Compiler depending on the value of Mode. You will see these switches applied in the build console.

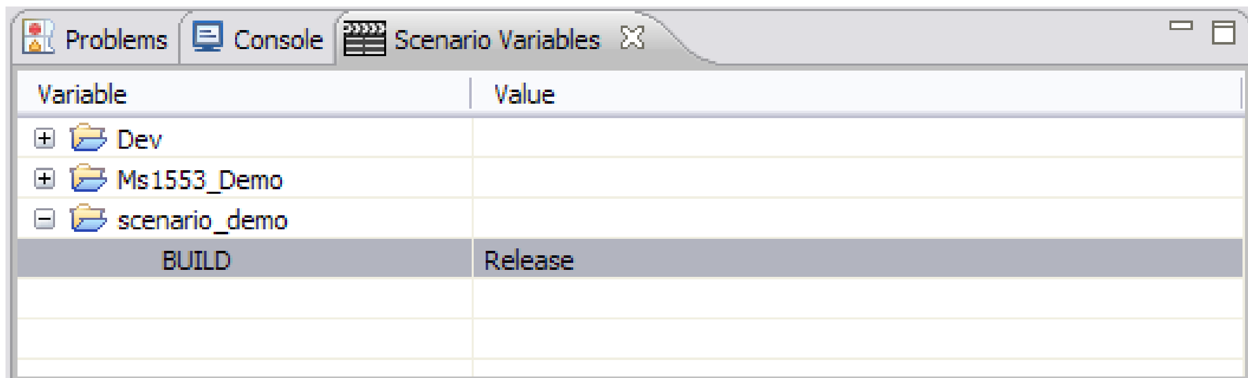
The initial value of Mode is "Debug" because that is the default:



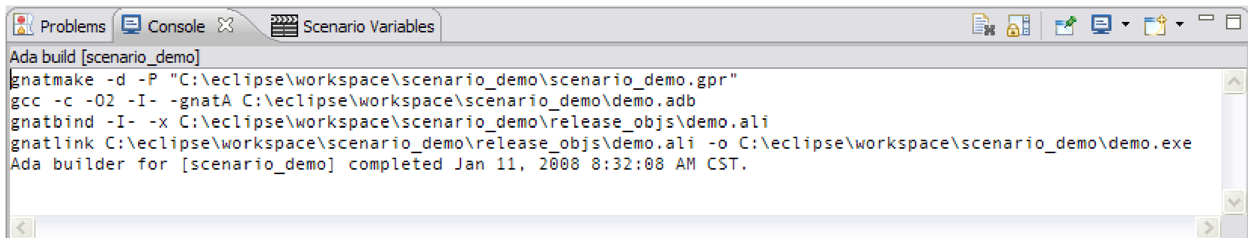
If we build the project with that value for Mode we will see the corresponding debugging switches set:



If we change the value of "BUILD" to "Release"



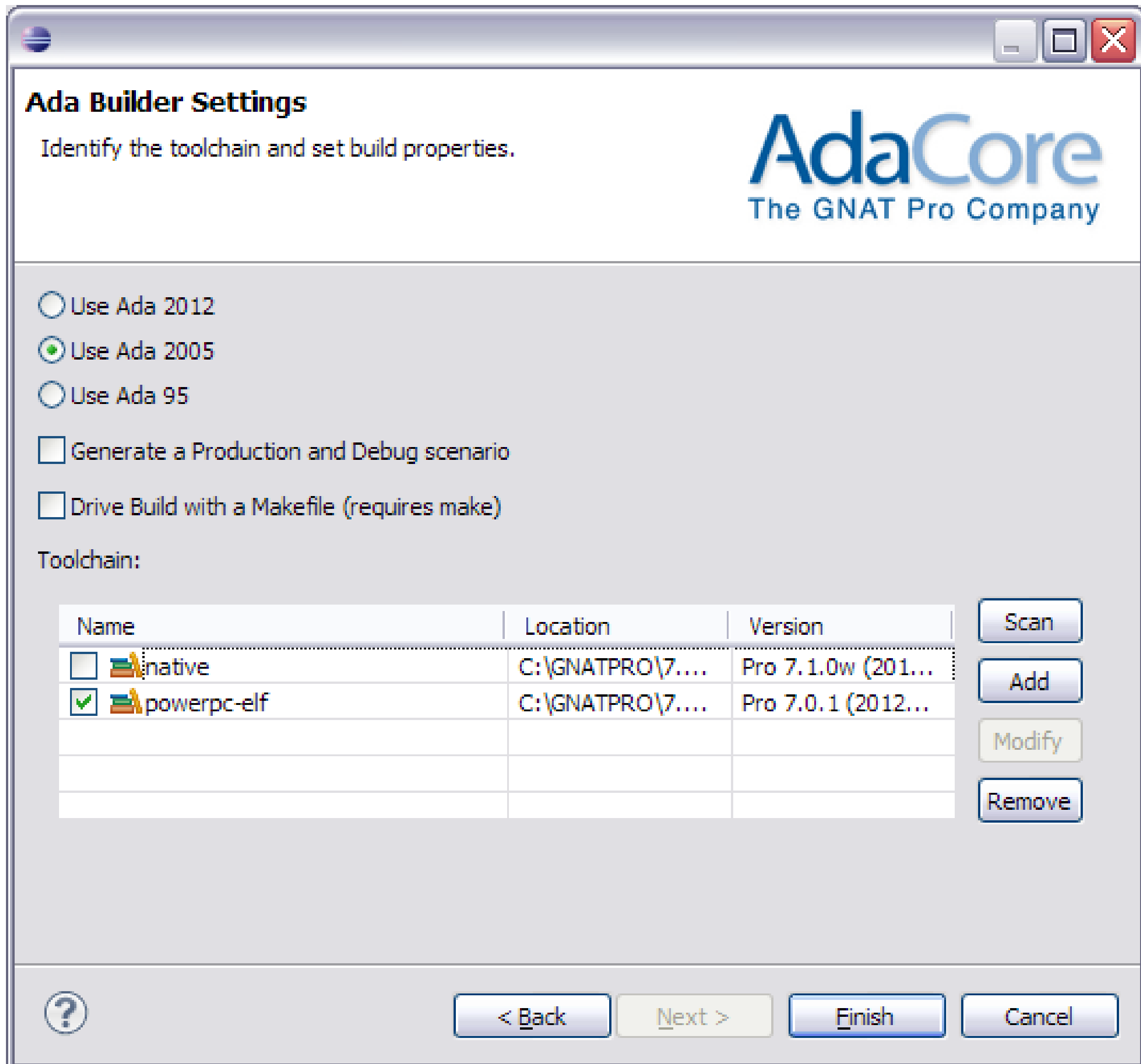
and then rebuild we will see the different switches applied:



7.10 Cross Compiling

GNATbench supports building systems for execution on the host machine as well as on an embedded computer. The difference is merely a matter of selecting the appropriate cross compiler when creating the project.

In particular, the new-project wizard requires you to specify the toolchain, by either selecting from a predefined list or by manually entering the name and commands for a new toolchain. Multiple native and cross toolchains may be in the list, as depicted in the figure below (not all appear):

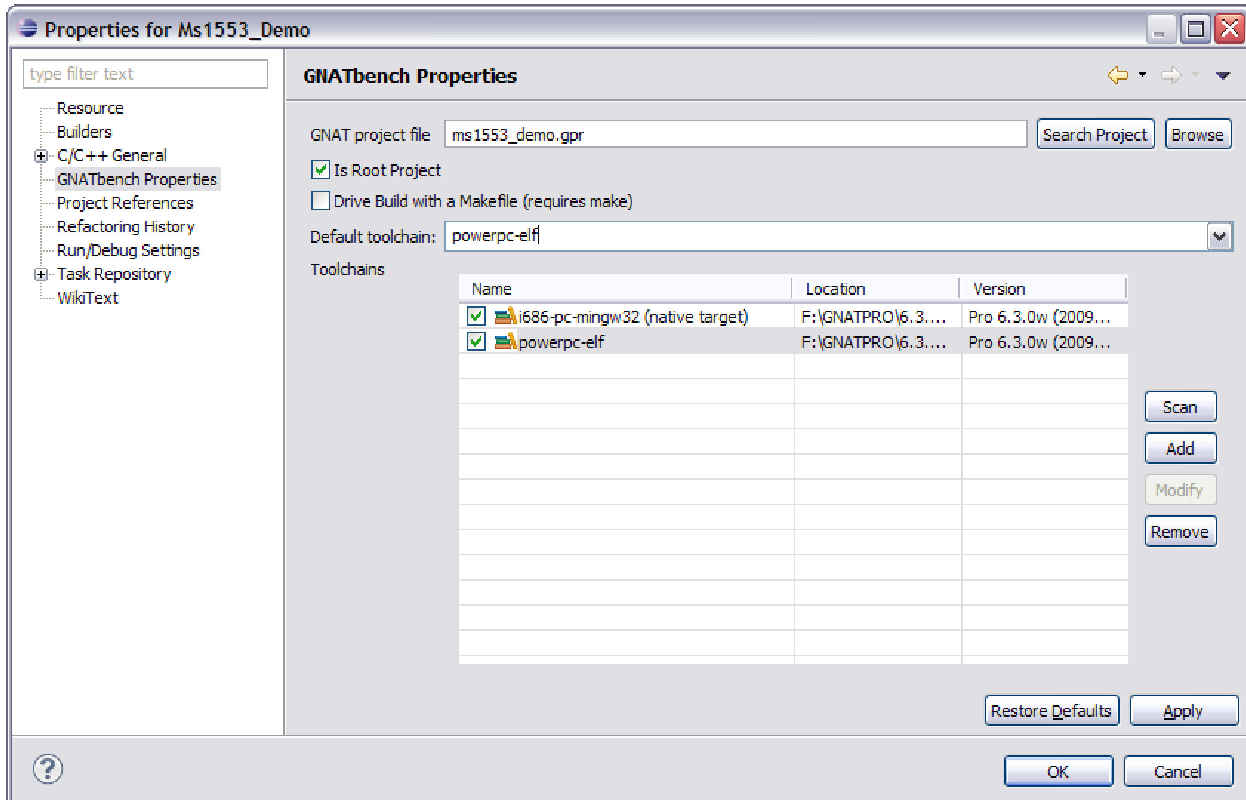


See *Creating New Projects* for the details of selecting toolchains when creating projects.

7.11 Using Multiple Toolchains

When creating a new project, the wizard requires you to specify at least one toolchain, but you can select more than one. Both native and cross toolchains may be selected. You can also change your toolchain selections after a project is created. See *Creating New Projects* for the details of selecting toolchains when creating projects and changing them later.

The figure below shows the Properties dialog presenting the GNATbench Properties page. Note that both a native and a cross toolchain are selected, and that the cross compiler will be used by default.

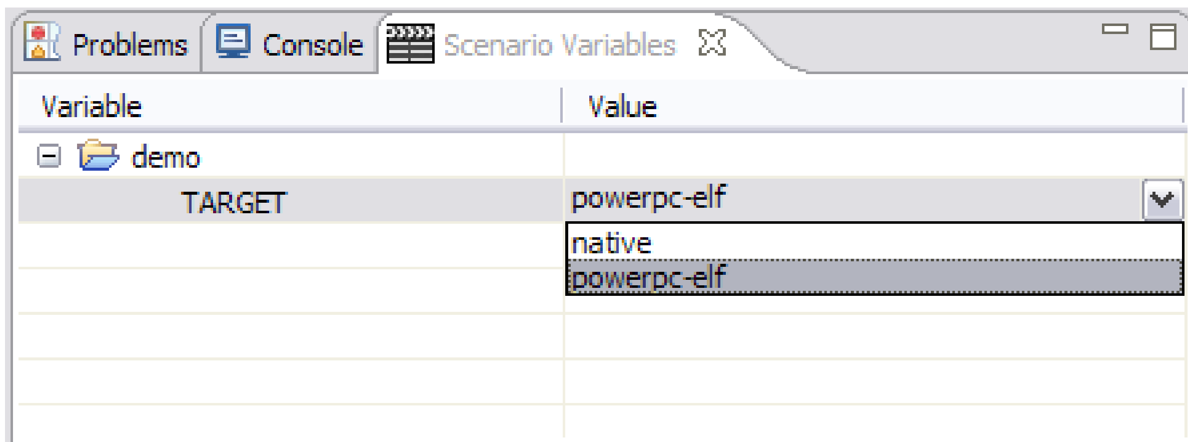


When multiple toolchains are selected, the GNATbench wizard alters the GNAT Project file (the "gpr file") so that a new scenario variable named "Target" is declared, with possible values representing each selected toolchain. The wizard also alters the IDE package within the project file so that the "Target" scenario variable controls which toolchain will be applied. The following figure illustrates these alterations:

demo.gpr

```
project Demo is

   type Target_Type is
      ("native", "powerpc-elf");
   Target : Target_Type := external ("TARGET", "native");

   package Ide is

      case Target is

         when "native" =>
            for Gnatlist use "gnatls";
            for Gnat use "gnat";
            for Compiler_Command ("ada") use "gnatmake";
            for Compiler_Command ("c") use "gcc";
            for Debugger_Command use "gdb";

         when others =>
            for Gnatlist use Target & "-gnatls";
            for Gnat use Target & "-gnat";
            for Compiler_Command ("ada") use Target & "-gnatmake";
            for Compiler_Command ("c") use Target & "-gcc";
            for Debugger_Command use Target & "-gdb";
      end case;
   end Ide;

   for Main use ("hello.adb");
   for Source_Dirs use ("src");
   for Object_Dir use "obj";

   package Compiler is
      for Default_Switches ("ada") use ("-g", "-gnato", "-gnatwa", "-gnatQ", "-gnat05");
   end Compiler;

   package Builder is
      for Default_Switches ("ada") use ("-g");
   end Builder;

end Demo;
```

The wizard makes the necessary additions and alternations to the gpr file. You use the Scenario Variables view to select which toolchain to apply, just as would be done for any other scenario variable.

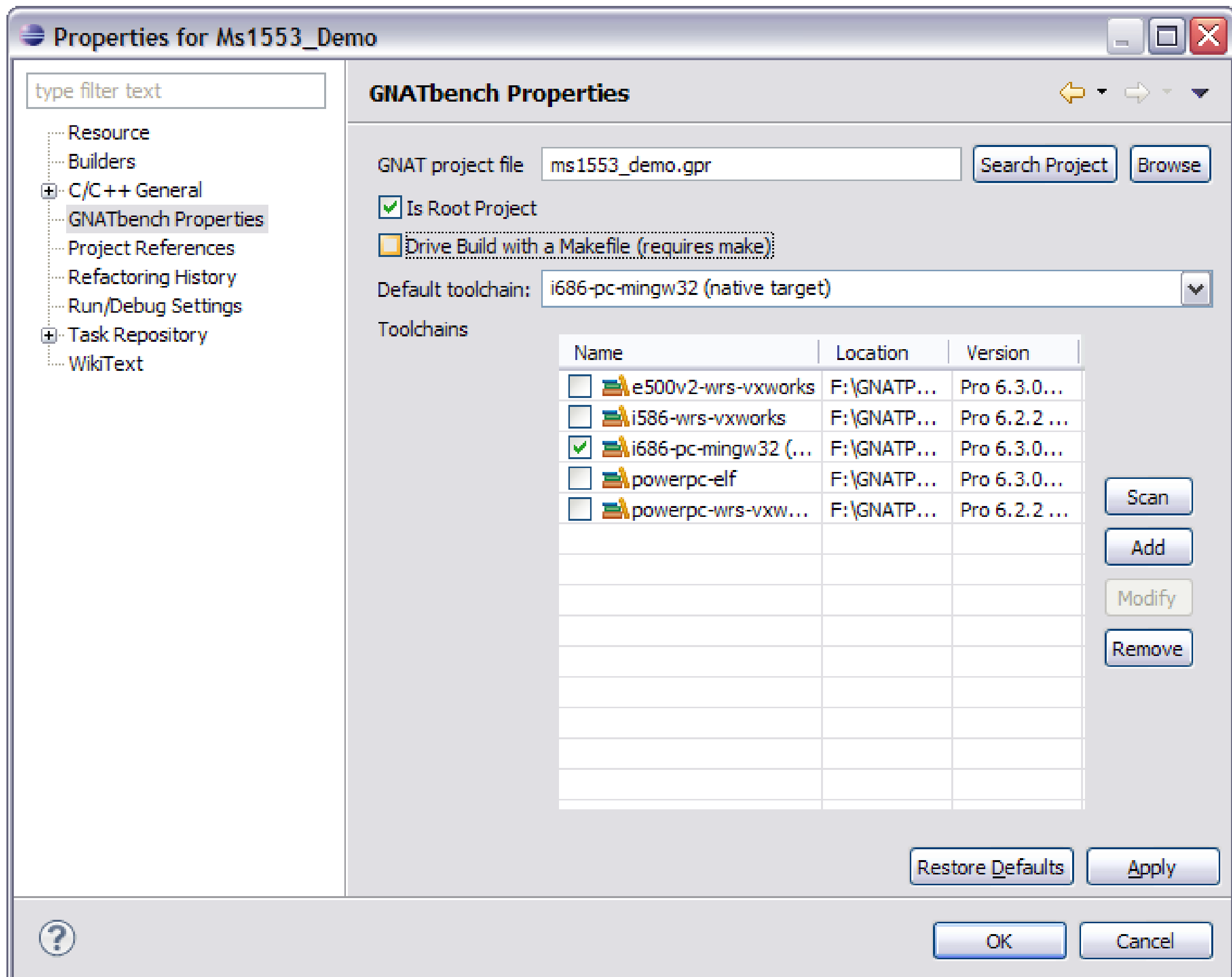


7.12 Building with Makefiles

When requested by the user, GNATbench can use a project-specific makefile to drive project builds. The makefile is created by the wizard when creating the project. (See *Creating New Projects* for the details of creating a new project.)

Naturally, driving the build with a makefile requires the 'make' utility to be installed and on the path. GNATbench does not include the 'make' utility. You are responsible for installing it if you choose to use it.

You can revisit the choice of whether to drive the build with a makefile, after a project is created, by editing the project properties. To do so, invoke the Properties menu entry for the given project and then select the "GNATbench Properties" page. There is a check-box controlling the option:



Although GNATbench does not require a makefile and the corresponding make utility, there are two primary reasons to allow makefiles to be used. The first reason is that developers can use a script to build their executables. A script is a means of demonstrating repeatable executable image construction, a typical requirement, for example, of high-integrity applications. Developers can reference the makefile as part of their demonstration. The second reason to allow a makefile is so that project-specific user-defined build commands can be defined. These commands might be required, for example, to do some extra setup steps not known to the GNAT compiler. We illustrate this situation in *User-Defined Builder Commands*.

7.12.1 Modifying the "make" utility name

The 'make' utility name can be changed using the "Ada - External Commands" preferences page. The preferences dialog is accessible via the Window->Preferences menu group.

7.12.2 Modifying the Makefile

As generated, the makefile only invokes the build commands and does not use any additional 'make' capabilities such as defining dependencies between files and makefile targets. For example, here is a sample makefile generated by the new-project wizard:

```
# You may edit this makefile as long as you keep these original
# target names defined.

# Not intended for manual invocation.
# Invoked if automatic builds are enabled.
# Analyzes only on those sources that have changed.
# Does not build executables.
autobuild:
	$(GNATMAKE) -gnatc -c -k  -P "$(GPRPATH)"

# Clean the root project of all build products.
clean:
	$(GNATCLEAN) -P "$(GPRPATH)"

# Clean root project and all imported projects too.
clean_tree:
	$(GNATCLEAN) -P "$(GPRPATH)" -r

# Check *all* sources for errors, even those not changed.
# Does not build executables.
analyze:
	$(GNATMAKE) -f  -gnatc -c -k  -P "$(GPRPATH)"

# Build executables for all mains defined by the project.
build:
	$(GNATMAKE) -P "$(GPRPATH)"

# Clean, then build executables for all mains defined by the project.
rebuild: clean build

```

The project-specific makefile and GNAT project file work together to define the effective command. That fact is reflected in the use of the "-P" switch followed by the macro variable that references the GNAT project file ("gpr file") in the figure above.

You can edit the makefile to use as much of the 'make' tool capabilities as you feel appropriate, and thus perhaps put less in the GNAT project file, but doing so will reduce interoperability with GNAT Studio. GNAT Studio is also conceptually based on GNAT project files and in general the two IDE's can share GNAT project files without changes.

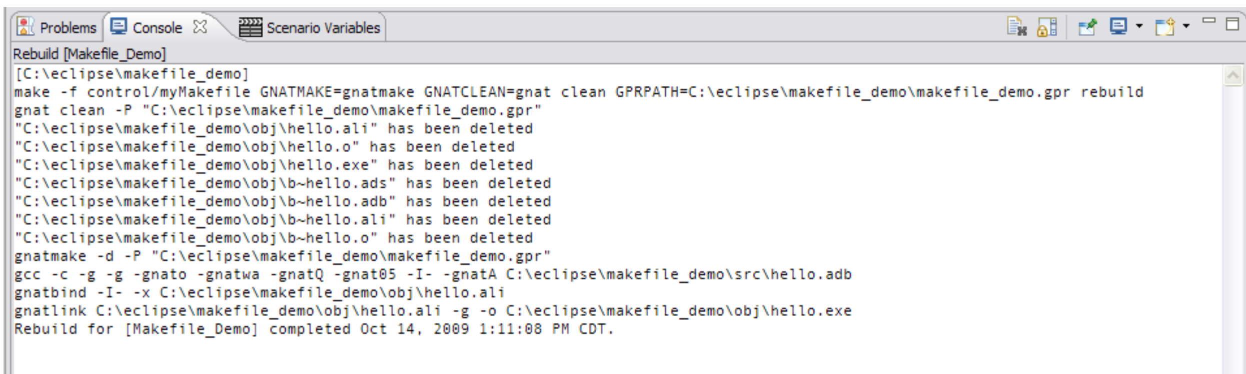
If you do edit the makefile, for whatever reason, be sure to retain the existing target names. These targets are used by GNATbench when invoking the various build-related commands. You can change what they do, just don't delete them.

7.12.3 Makefile Name and Location

GNATbench will read the Make package of the GNAT Project file, if present, to determine the name and location of the makefile to use. If the makefile name is not specified, 'make' will be launched without a makefile file name argument, in which case the default name "Makefile" will be used. Also by default, the file is assumed to be in the same location as the GNAT Project (gpr) file.

The following figure contains an example Make package in a project file. Here we have specified that the makefile file is named "mymakefile" and that it is located in a folder named "control". Note that any name other than "Makefile" will not be recognized by the Outline view as a genuine makefile, although it will be properly processed as such by 'make'.

When a builder command is invoked, the specified makefile is named explicitly as a parameter to make, as shown in the following figure (in which the "rebuild" command has been issued). Note in particular the second line, where 'make' is invoked with the "-f" switch naming the user-specified makefile.

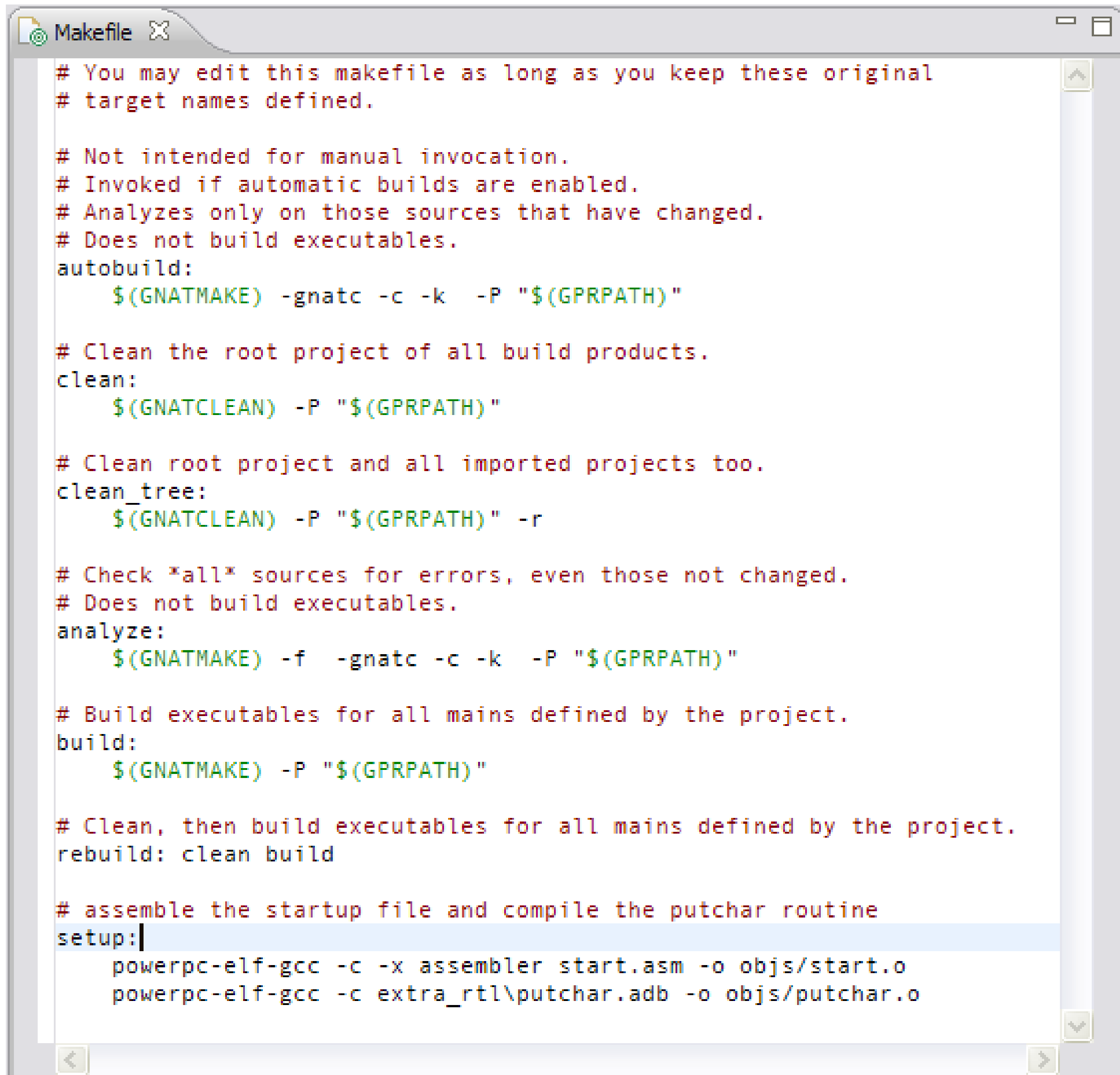


7.13 User-Defined Builder Commands

GNATbench can optionally use a project-specific makefile to drive project builds. (See *Building with Makefiles* for the details.) User-defined builder commands are defined in these makefiles.

7.13.1 Defining Commands

You create a user-defined command by adding a new makefile target and associated tool invocation to an existing makefile. In the following figure, we have added a command that assembles a small file written in assembly language and compiles an Ada source file. This new command (makefile target) is named "setup" and appears at the end of the makefile.

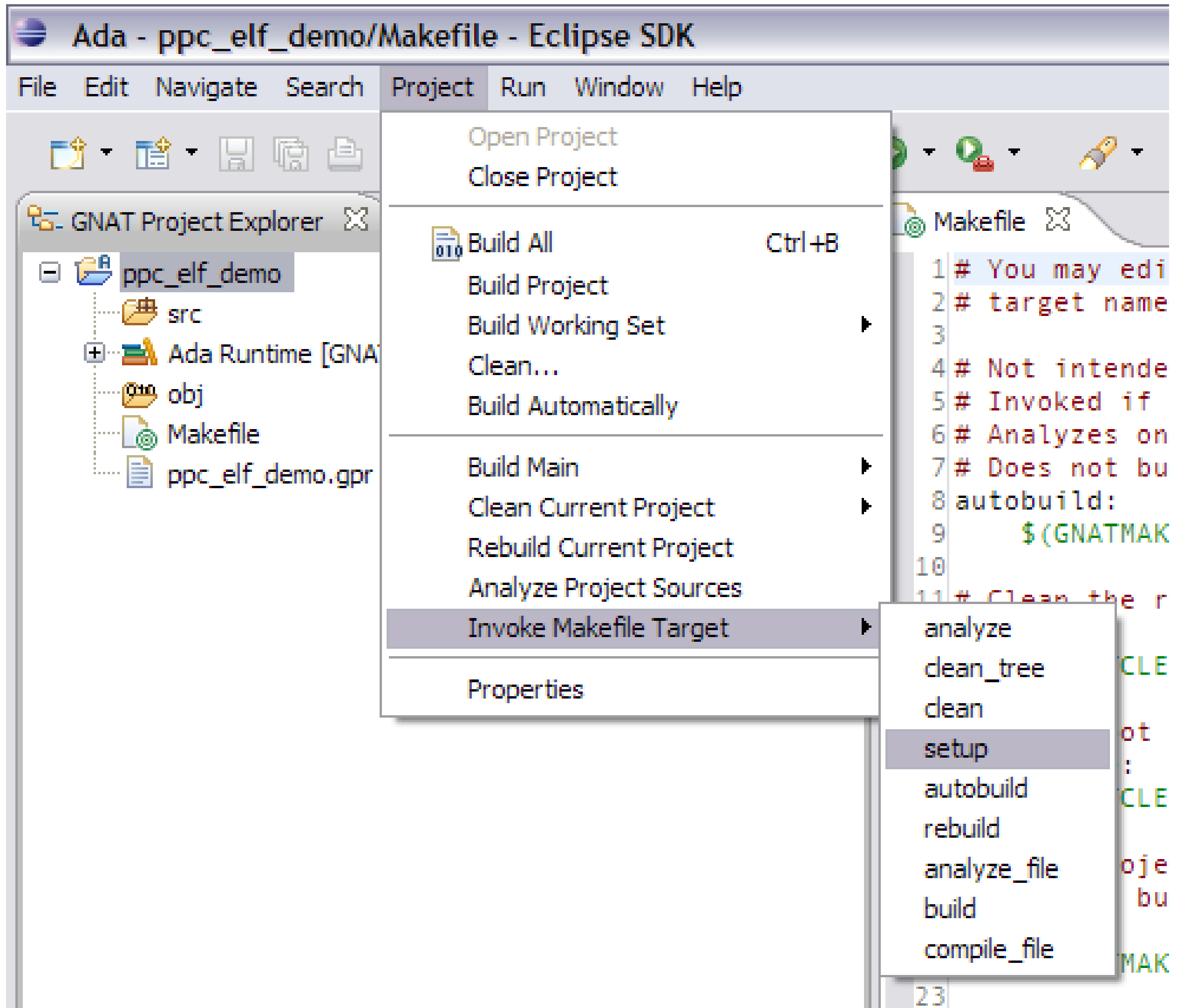



```
# You may edit this makefile as long as you keep these original
# target names defined.

# Not intended for manual invocation.
# Invoked if automatic builds are enabled.
# Analyzes only on those sources that have changed.
# Does not build executables.
autobuild:
    $(GNATMAKE) -gnatc -c -k  -P "$(GPRPATH)"

# Clean the root project of all build products.
clean:
    $(GNATCLEAN) -P "$(GPRPATH)"

# Clean root project and all imported projects too.
clean_tree:
    $(GNATCLEAN) -P "$(GPRPATH)" -r

# Check *all* sources for errors, even those not changed.
# Does not build executables.
analyze:
    $(GNATMAKE) -f  -gnatc -c -k  -P "$(GPRPATH)"

# Build executables for all mains defined by the project.
build:
    $(GNATMAKE) -P "$(GPRPATH)"

# Clean, then build executables for all mains defined by the project.
rebuild: clean build

# assemble the startup file and compile the putchar routine
setup:
    powerpc-elf-gcc -c -x assembler start.asm -o objs/start.o
    powerpc-elf-gcc -c extra_rtl\putchar.adb -o objs/putchar.o
```

We could have used the 'make' dependency capability to have this command executed automatically when necessary, but in this simple example the user will invoke the command when first building the project.

7.13.2 Invoking User-Defined Commands

The "Invoke Makefile Target" command allows you to invoke the low-level commands represented by the makefile targets. All targets defined by the makefile are presented as submenu entries, including user-defined targets. For example, the following figure illustrates selection of the user-defined target named "setup":



Simply select the name of the target to invoke it. The command execution and any resulting messages will be displayed in the project-specific console.

7.14 Build Mode

GNATbench provides an easy way to build your project with different options, through the Mode selection, located in the main toolbar. It can be displayed enabling "GNATbench Build Mode Menu" command group through Window -> Customize Perspective… -> Command Groups Availability menus.

When the Mode selection is set to *default*, the build is done using the switches defined in the project. When the Mode selection is set to another value, then specialized parameters are passed to the builder. For instance, the *gcov* Mode adds all the compilation parameters needed to instrument the produced objects and executables to work with the *gcov* tool.

In addition to changing the build parameters, the Mode selection has the effect of changing the output directory for objects and executables. For instance, objects produced under the *debug* mode will be located in the *debug* subdirectories of the object directories defined by the project. This allows switching from one Mode to another without having to erase the objects pertaining to a different Mode.

Note that the Build Mode affects only builds done using recent versions of gnatmake and gprbuild. The Mode selection has no effect on builds done through Targets that launch other builders.

7.15 Build Menu

The build menu gives access to capabilities related to checking, parsing and compiling files, as well as creating and running executables. Note that this menu is fully configurable via the `Ada Builder Targets` preference page, so what is documented in this manual are the default menus. Use "GNATbench Build Toolbar, Contextual or Menubar Menus' command groups through "Window -> Customize Perspective.. -> Command Groups Availability" menu to enable these menus visibility.

See the *Builder Targets Editor*

7.15.1 Check Syntax

Check the syntax of the current source file. Display an error message dialog if no file is currently selected.

7.15.2 Check Semantic

Check the semantic of the current source file. Display an error message dialog if no file is currently selected.

7.15.3 Compile File

Compile the current file. Display an error dialog if no file is selected.

If errors or warnings occur during the compilation, the corresponding locations will appear in the Problems View.

7.15.4 Project

Build <main>

The menu will list of all mains defined in your project hierarchy. Each menu item will build the selected main.

Build All

Build and link all main units defined in your project. If no main unit is specified in your project, build all files defined in your project and subprojects recursively.

For a library project file, compile sources and recreate the library when needed.

Compile All Sources

Compile all source files defined in the top level project.

Build <current file>

Consider the currently selected file as a main file, and build it.

Custom Build...

Display a text entry where you can enter any external command. This menu is very useful when you already have existing build scripts, make files, ... and want to invoke them from GNATbench.

7.15.5 Clean

Clean All

Remove all object files and other compilation artifacts associated to all projects related to the current one. It allows to restart a complete build from scratch.

Clean Root

Remove all object files and other compilation artifacts associated to the root project. It does not clean objects from other related projects.

7.15.6 Run

main

For each main source file defined in your top level project, an entry is listed to run the executable associated with this main file. Running an application will first open a dialog where you can specify command line arguments to your application, if needed. You can also specify whether the application should be run within GNATbench (the default), or using an external terminal.

When running an application within GNATbench, the Messages [$PROJECT] console is displayed in the Console view. It is where inputs and outputs of the launched application are handled. This window is never closed automatically, even

when the application terminates, so that you can still have access to the application's output. If you explicitly close the Console view while an application is still running, the application will still run in background. To terminate it use to Cancel Operation button of this job in the Progress view. The Progress view can be displayed using "Windows /Show View / Other… / General / Progress" menu or clicking the "Shows background operations in Progress view" button displayed the the right of the status bar.

When using an external terminal, GNATbench launches an external terminal utility that will take care of the execution and input/output of your application. This external utility can be configured in the preferences dialog (*External Commands->Execute command*).

The GNATbench execution Messages in Console view have several limitations compared to external terminals. In particular, it displays only the latest launched application user interface and it do not handle signals like <ctrl-z> and <control-c>. In general, if you are running an interactive application, we strongly encourage you to run in an external terminal.

Similarly, the `Run` contextual menu accessible from a project entity contains the same entries.

Custom…

Similar to the entry above, except that you can run any arbitrary executable.

7.16 Troubleshooting Builder Problems

7.16.1 Eclipse and CDT Version Mismatch or Missing

You must install the latest versions of Eclipse, the corresponding version of the C/C++ Development Tools (CDT), and the AdaCore compilation toolset ***before*** installing the GNATbench plug-in. If these tools are not installed, with the proper versions, behavior is generally unpredictable.

See *Prior Required Tool Installations* for the current versions required.

7.16.2 Conflicting Plug-Ins

In all probability, you must remove or completely disable any other Ada development plug-in that includes the functionality that GNATbench provides. In particular, any plug-in that defines a project builder for Ada source code will likely prevent correct operation of GNATbench, and vice versa.

CHAPTER EIGHT

EXECUTING

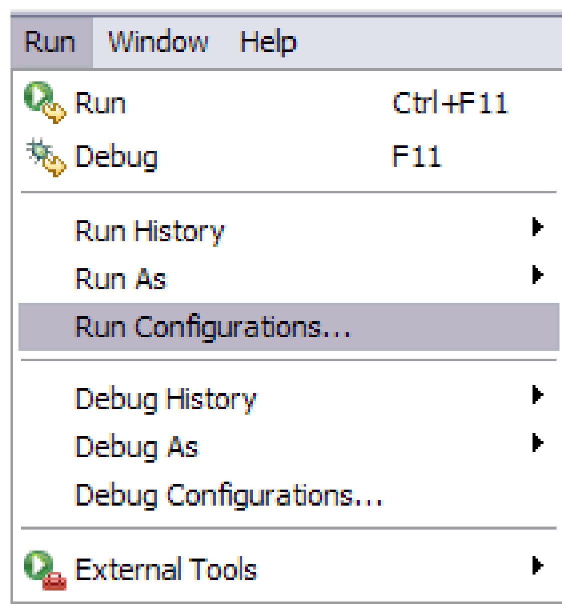
8.1 Creating Launch Configurations for Native Ada Applications

Ada applications can be executed natively by creating and applying either an External Tools launch configuration or a C++ Application launch configuration. Remember that launch configurations can be reused indefinitely; they need not be created anew each time a given application is to be executed.

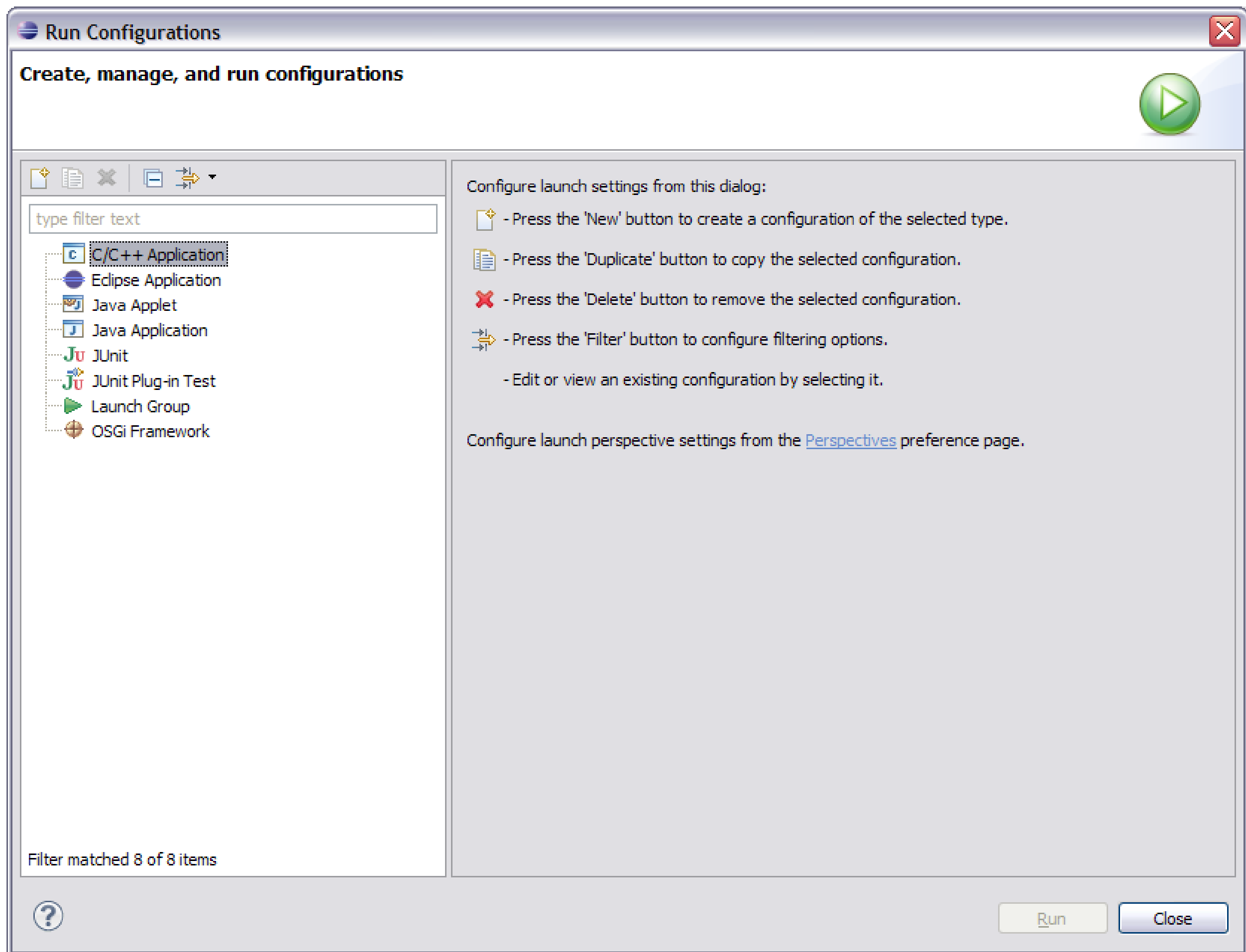
Although not mandatory, building your project beforehand will facilitate creating the corresponding launch configuration. In particular, it will make it possible to browse and search for some of the required entries instead of manually entering the values.

8.1.1 Creating A C++ Launch Configuration

First, open the Run configuration dialog. Select "Run Configurations…" from the Run menu, or click on the down-arrow next to the Run button on the toolbar and make the same selection there.

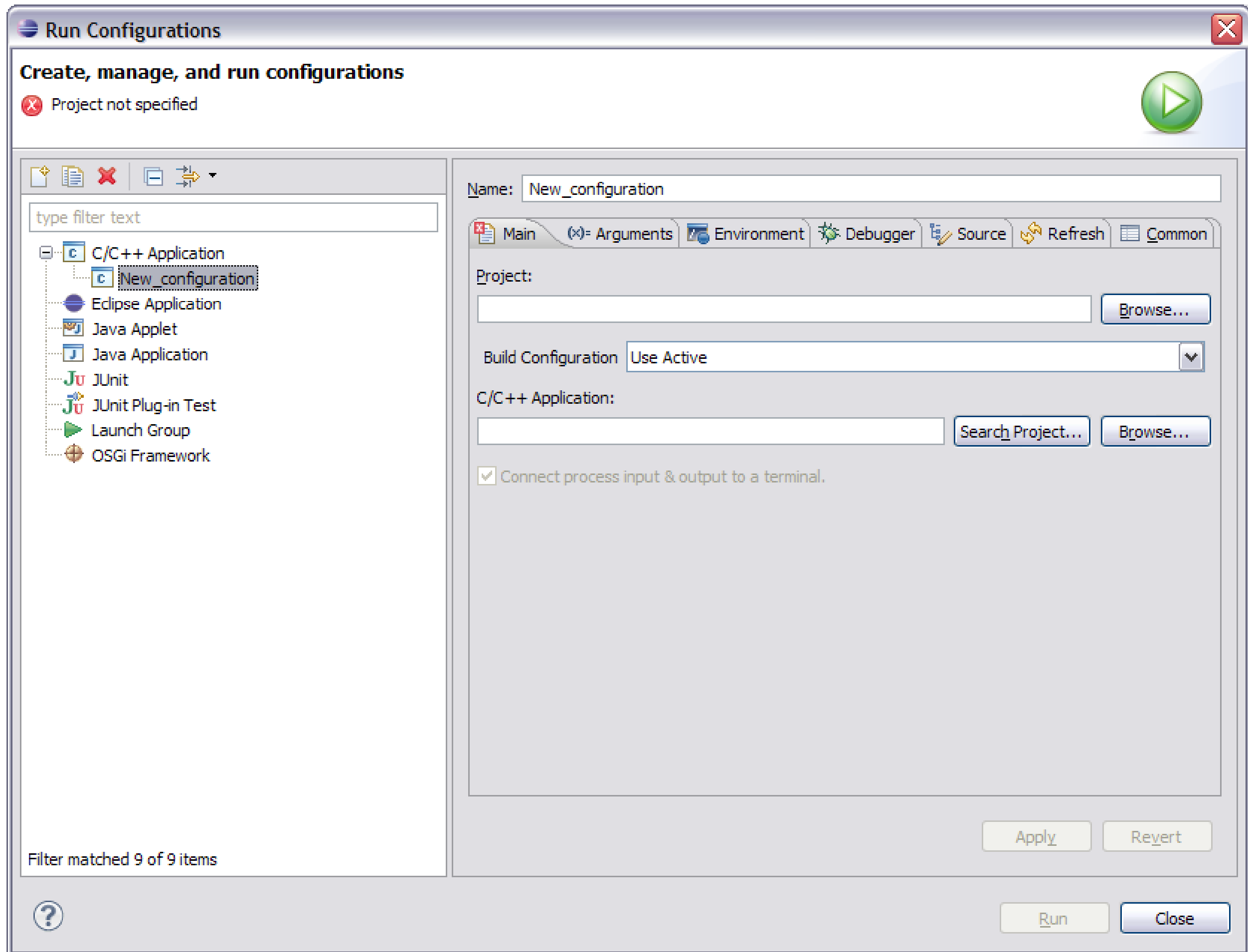


The following dialog box will appear. (In this figure there are no existing user-defined launch configurations; yours may have some already.)



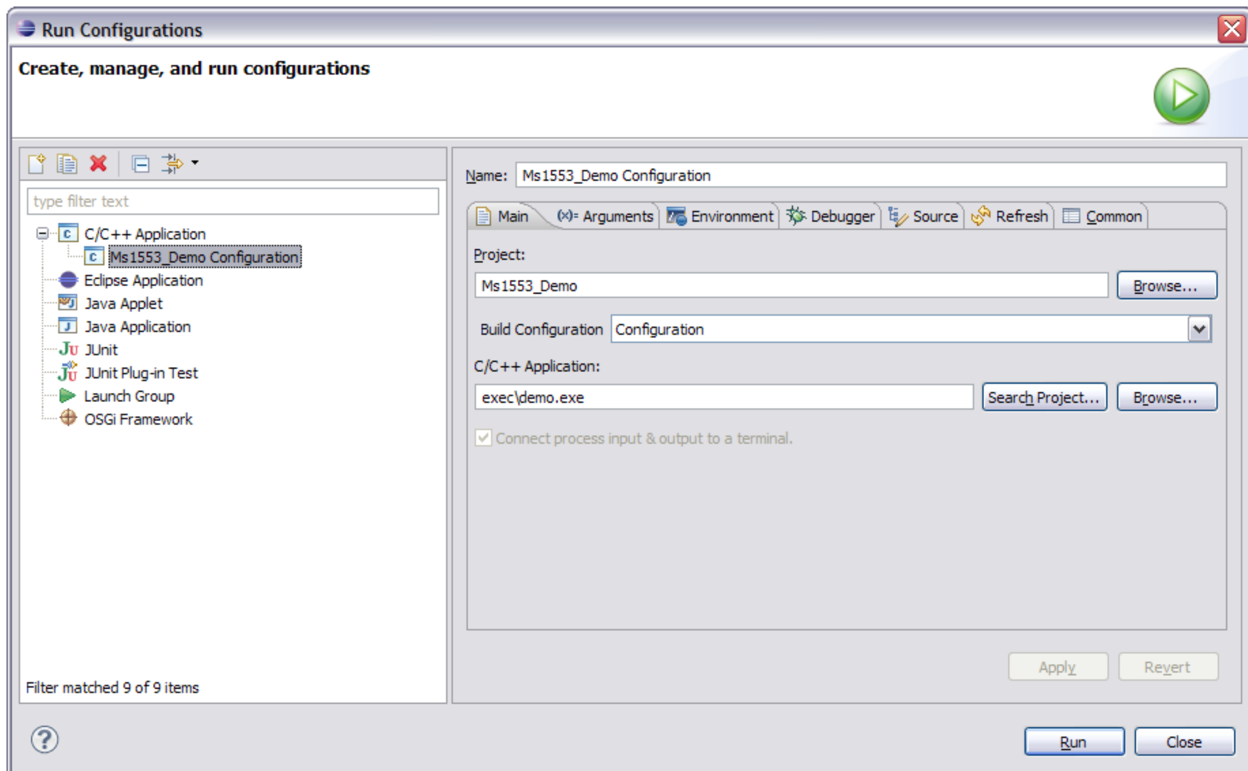
In the left-hand pane of the dialog, double-click on "C/C++ Application."

If you had a project actively selected in the GNAT Project Explorer when you double-clicked, Eclipse (really, the CDT launch facility) will have automatically filled in the Main page on the right of the dialog. Otherwise, you should see an empty new configuration, like the following:



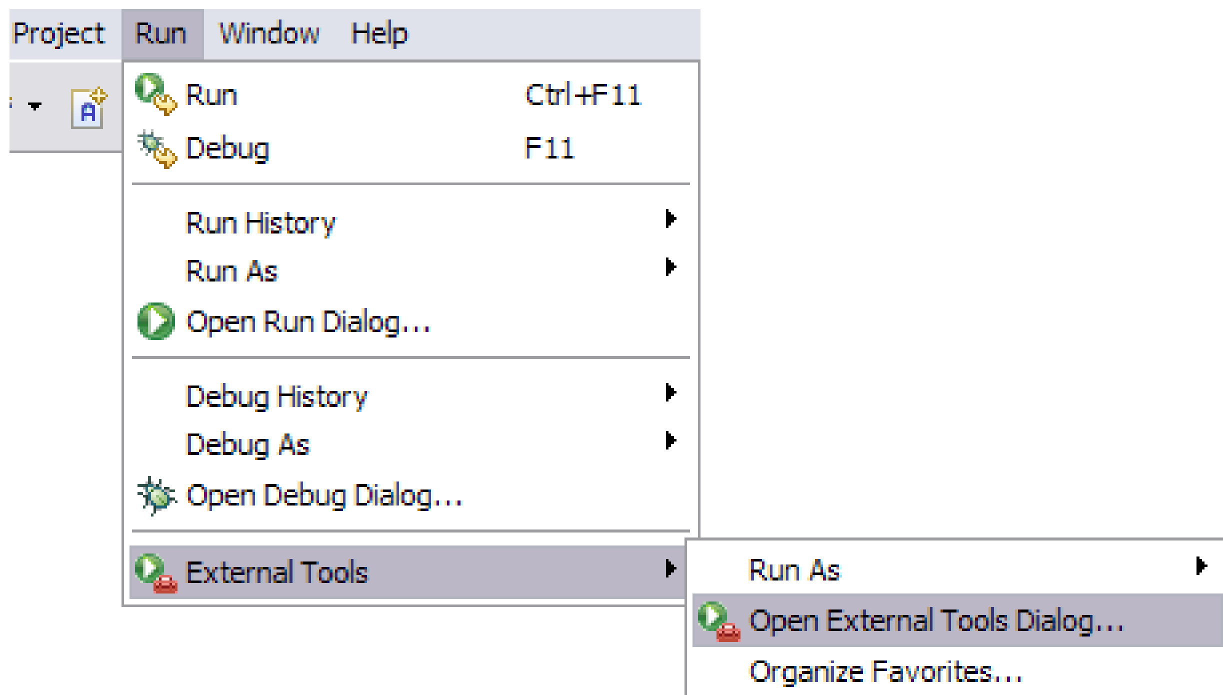
Using the tabbed dialog on the right, you will specify various different configuration options. For instance you specify the name of the configuration, the executable you wish to run, the arguments you wish to pass to it when it's launched, if any, the environment under which it will run, and so on.

When everything necessary is correctly specified, press Apply. The new launch configuration name will appear in the list of known configurations and the page will appear similar to the figure below. You can now press Close to exit the dialog; the new launch configuration is ready to use. Alternatively, you can launch the application by pressing Run. We discuss launching in *Executing Native Ada Applications*

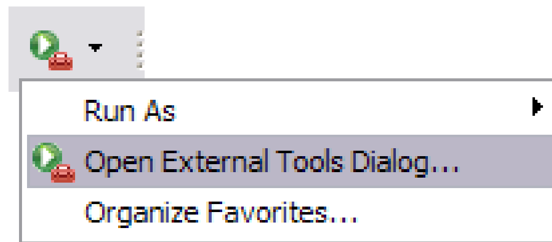


8.1.2 Creating an External Tools Launch Configuration

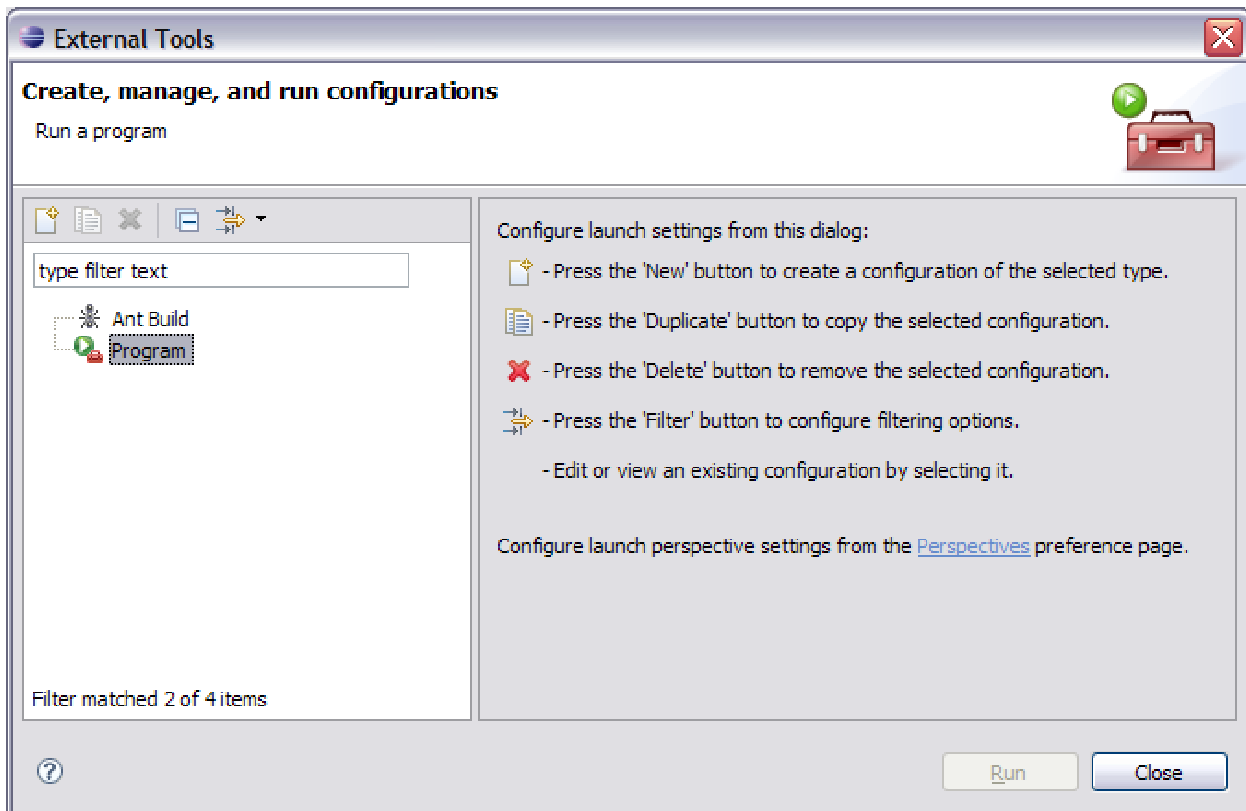
To create a new External Tools launch configuration, use the External Tools dialog, which can be invoked using either the Run menu or the External Tools button and selecting the Open External Tools Dialog… entry. The following figure illustrates use of the Run menu:



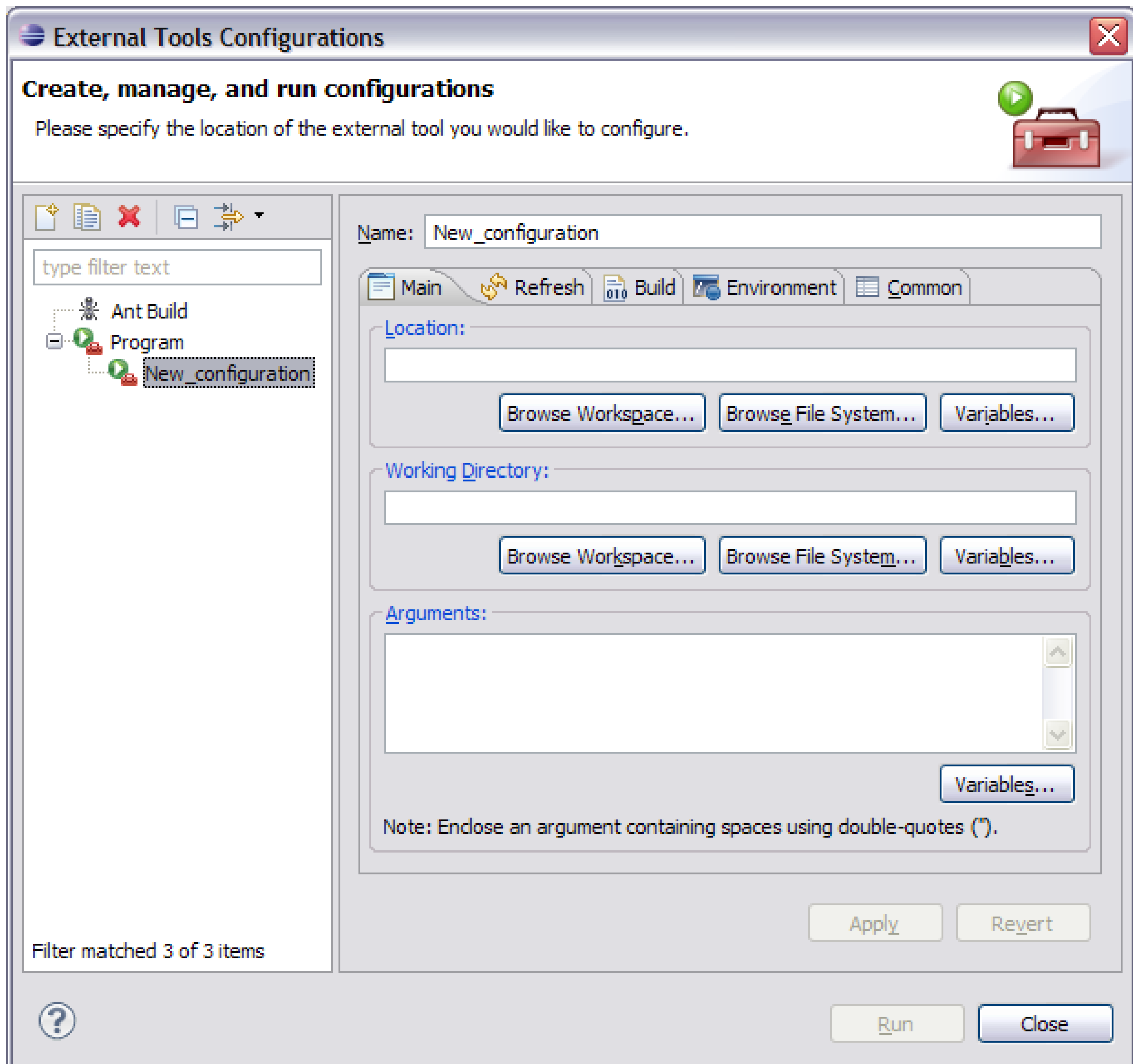
Using the External Tools button on the button bar is shown in this figure:



Once invoked, the External Tools dialog page will pop up. Initially, when no launch configurations have yet been created, it will appear as follows. Note the buttons above the list of configurations on the left of the page. Their descriptions are on the right side of the page.



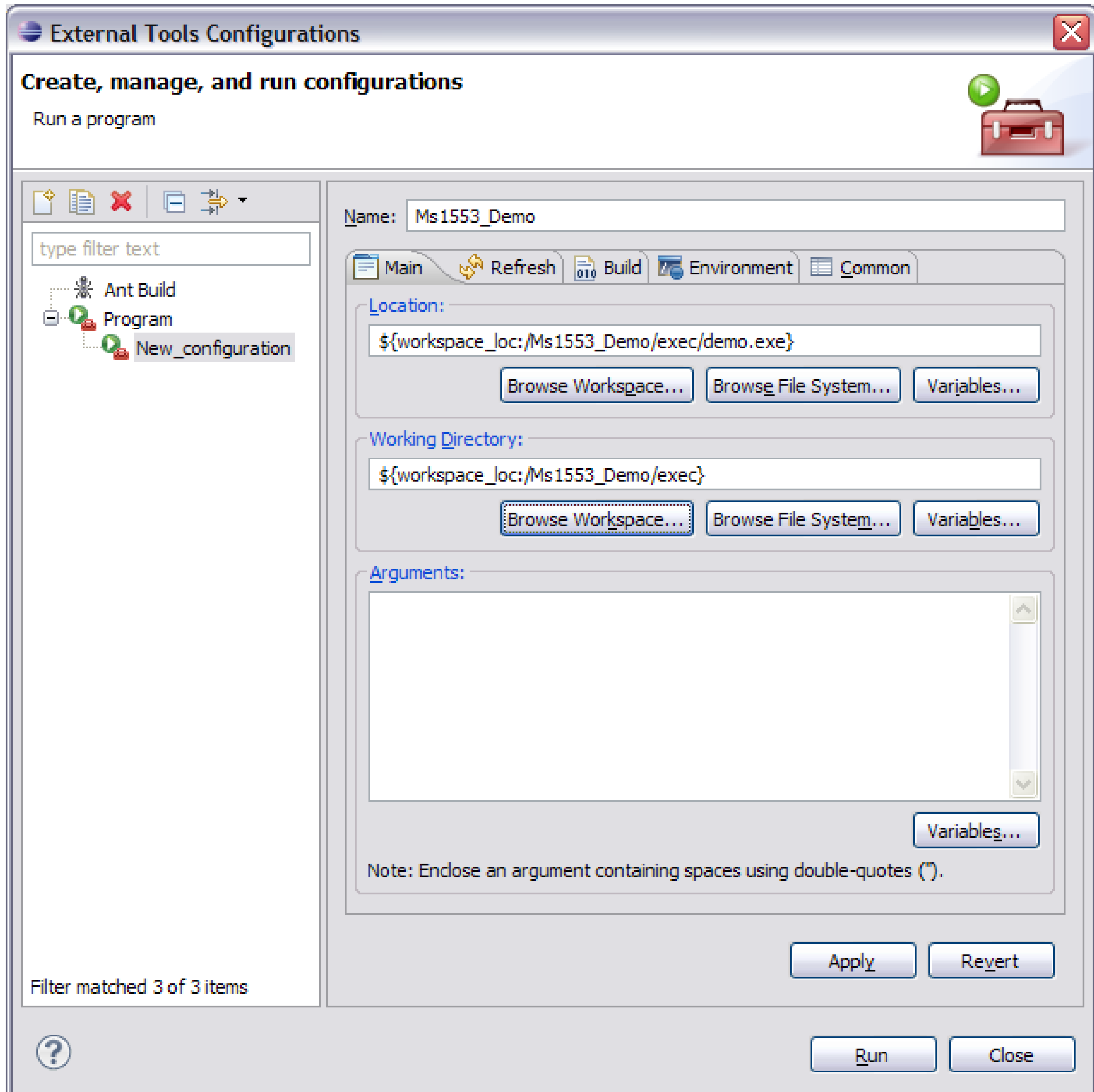
Create a new configuration by selecting the "Program" category and then pressing the "New launch configuration" button above the category list. This will invoke the wizard to walk you through the creation steps. The initial new configuration page will appear as follows:



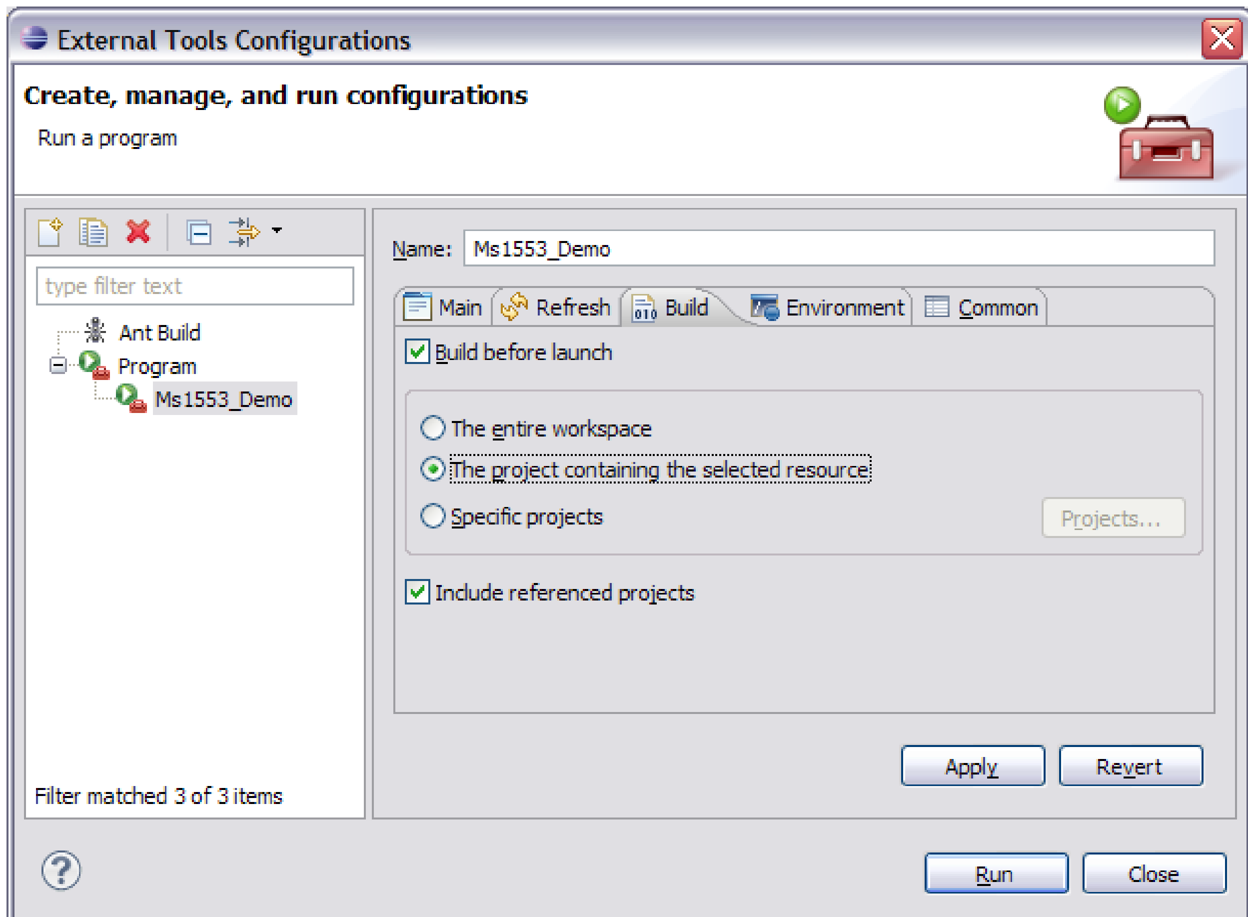
Change the name of the configuration to something meaningful, unless you do not intend to save and reuse this configuration. Then, in the "Main" tab, either enter the location of the executable or browse to it. Similarly, specify the path to the directory in which the executable should be launched. You may also specify any command line parameters to apply when invoking the executable.

Once you have entered the information for the "Main" tab, press the Apply button to save the information. The other tabs ("Refresh", etc.) can be left unchanged in typical usage.

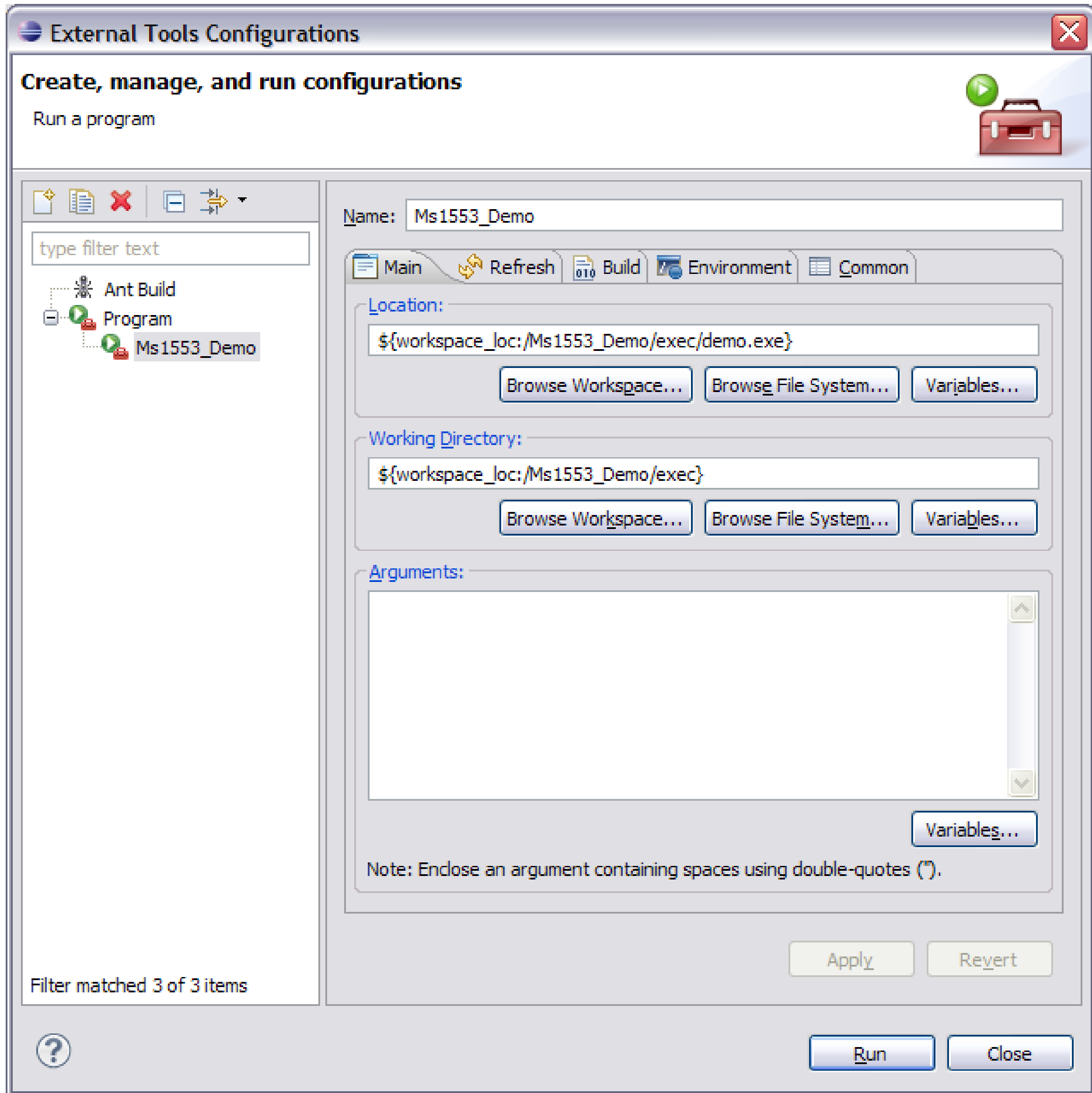
The sample configuration for our Mil-Std-1553 demonstration application is shown below, prior to pressing Apply (because the configuration is still named "New_configuration" in the list of all known Program configurations).



You can also specify other aspects of the configuration, including whether the enclosing project (or workspace, etc.) is built prior to each launch execution. The image below shows the Build page, for example. By default, the entire workspace is built prior to execution. You may want to build only the project containing the executable associated with the specific launch.



When everything necessary is correctly specified, press Apply. The new launch configuration name will appear in the list of known configurations and the page will appear similar the the figure below. You can now press Close to exit the dialog; the new launch configuration is ready to use. Alternatively, you can launch the application by pressing Run. We discuss launching in *Executing Native Ada Applications*



8.2 Executing Native Ada Applications

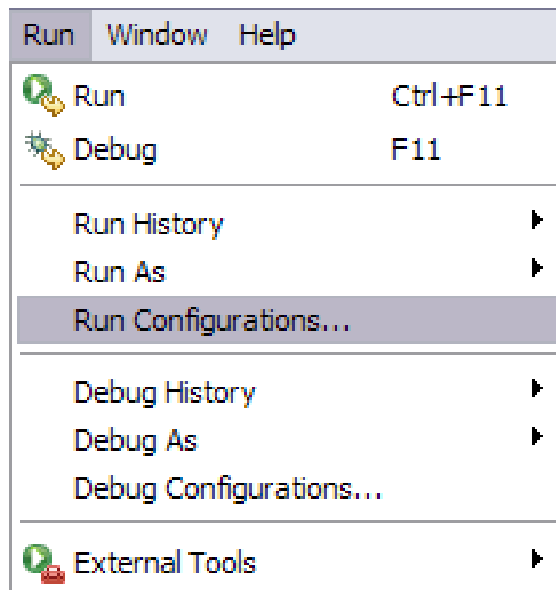
You may execute a native Ada application using either an external tool launch configuration or a C++ application launch configuration.

Note that you can reuse launch configurations indefinitely, unless some aspect of the launch changes. See *Creating Launch Configurations for Native Ada Applications* for the details.

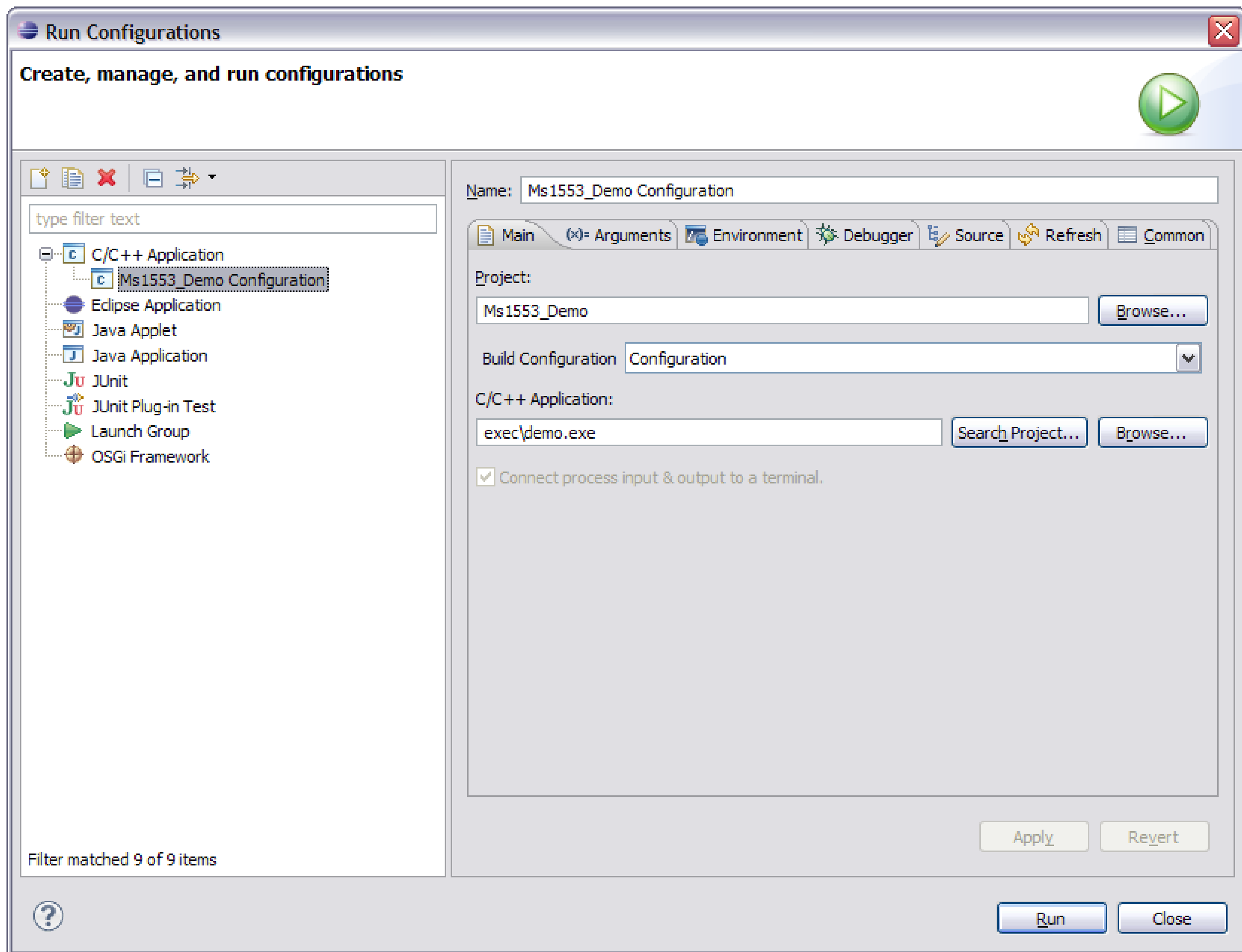
8.2.1 Using A C++ Launch Configuration

You can execute a native Ada application as if it is a C++ application, thereby reusing the CDT facilities. To do so, you apply an existing C++ launch configuration.

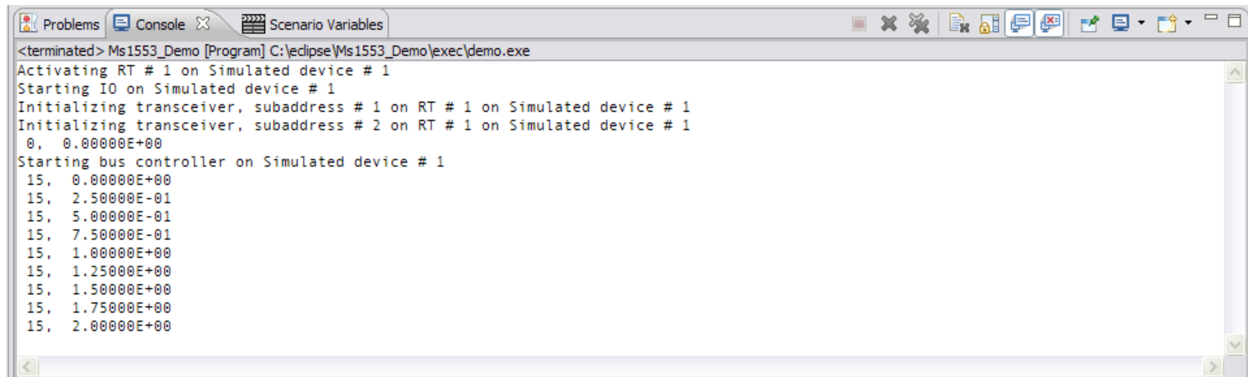
Select the launch configuration using the Run… dialog, which can be invoked using either the Run menu or the Run button on the toolbar, and then select the Run Configurations… entry. The following figure illustrates use of the Run menu:



The resulting dialog will list all the known launch configurations. Select the intended configuration and press Run.

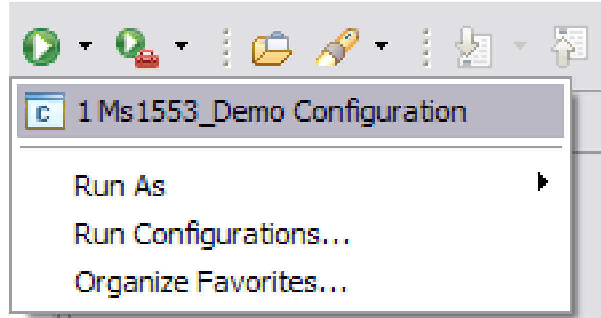


Execution will commence and any output will appear in a dedicated console in the Console view. You can use the console controls to terminate the execution if required.



Once you have applied a given launch configuration, Eclipse places it into the Run menu so it is easy to apply it again. From then on you can launch the application from the menu without having to invoke the dialog. You may also include the configuration in your "launch favorites" and it will then be available in the menu until you remove it.

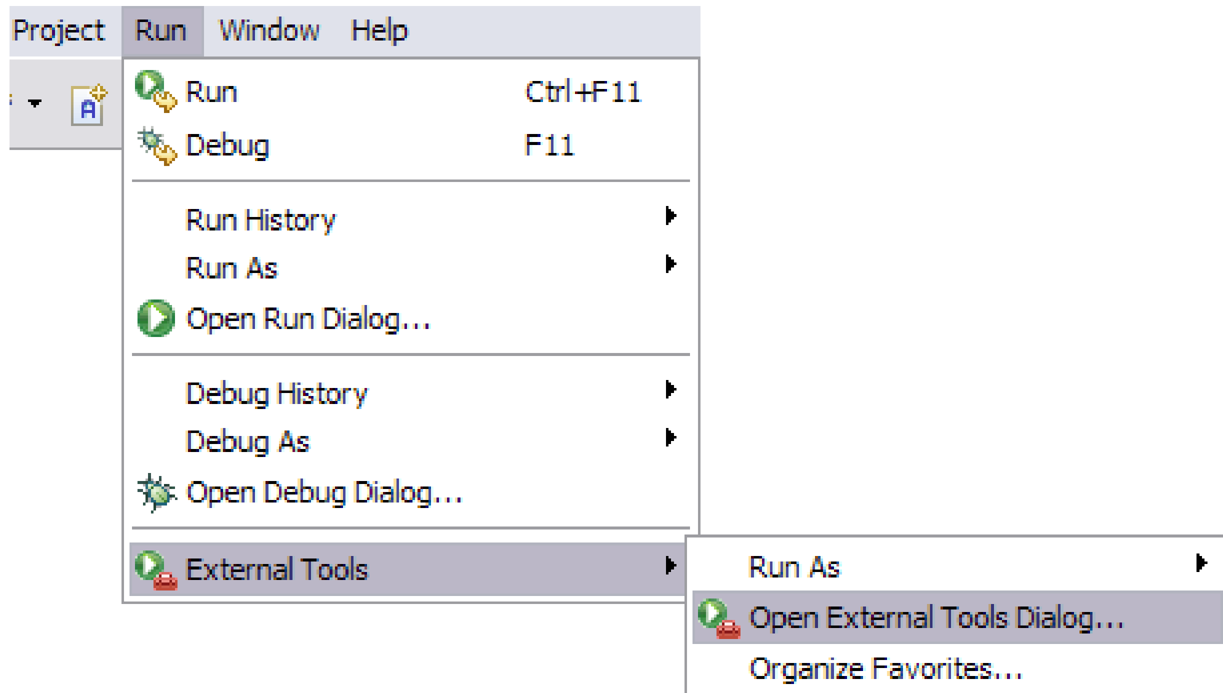
For example, the following figure illustrates our Mil-Std-1553 demo launch configuration within the Run menu:



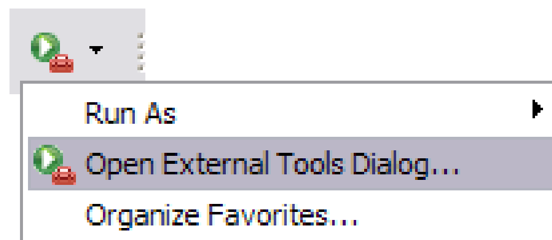
8.2.2 Using An External Tool Launch Configuration

To execute a native Ada application as an external tool, apply an existing External Tools launch configuration.

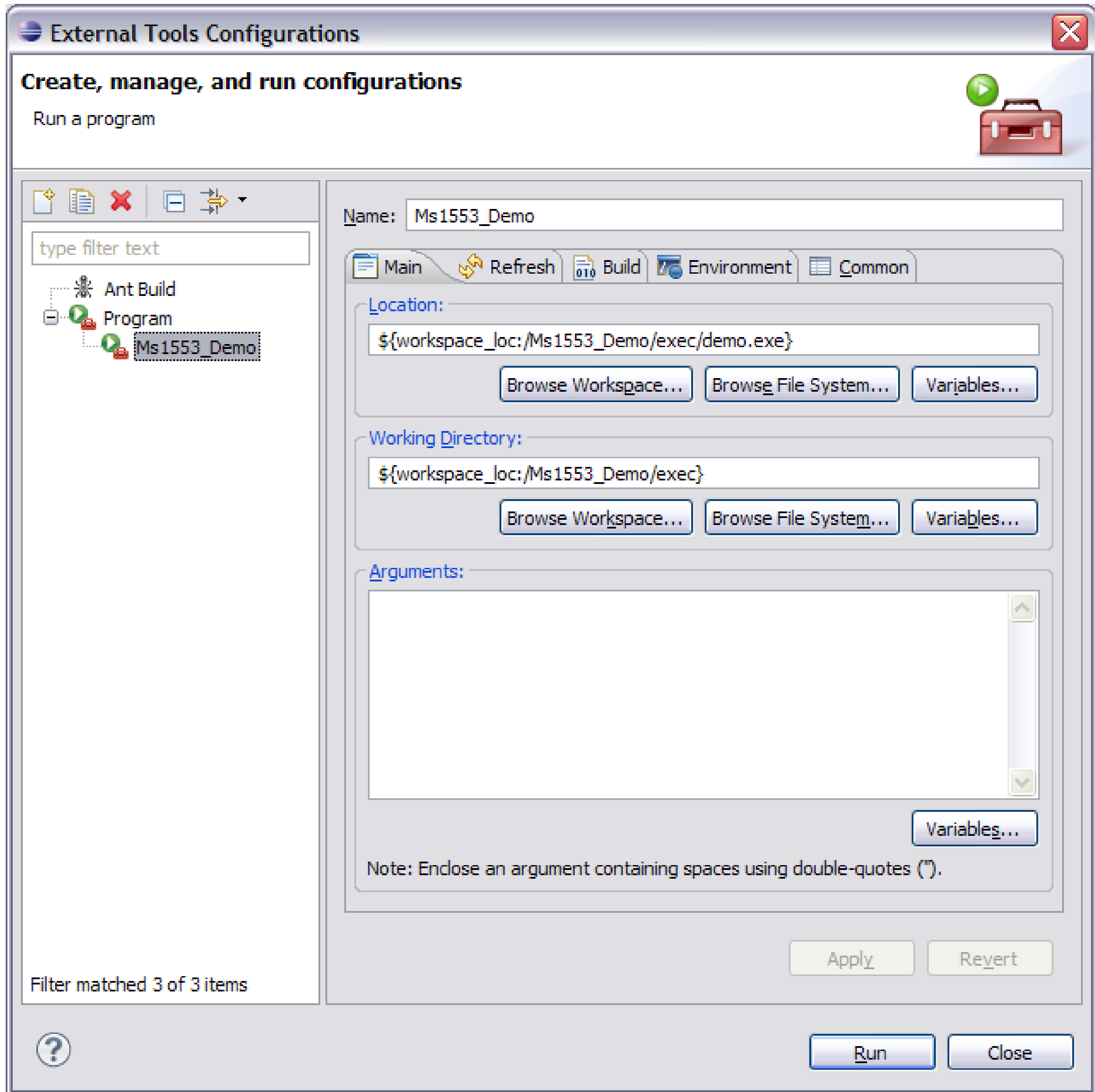
Select the launch configuration using the External Tools dialog, which can be invoked using either the Run menu or the External Tools button and selecting the Open External Tools Dialog... entry. The following figure illustrates use of the Run menu:



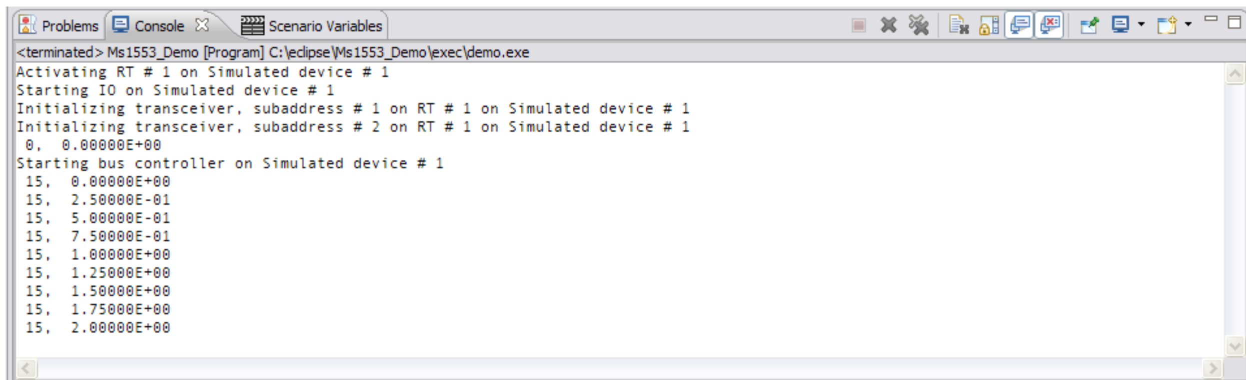
Using the External Tools button on the button bar is shown in this figure:



The resulting dialog will list all the known launch configurations. Select the intended configuration and press Run.

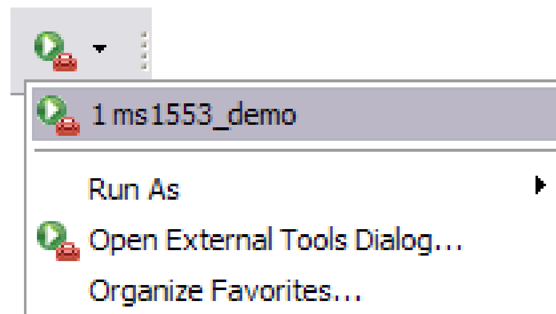


Execution will commence and any output will appear in a dedicated console in the Console view. You can use the console controls to terminate the execution if required.



Once you have applied a given launch configuration, Eclipse places it into the External Tools menu so it is easy to apply it again. From then on you can launch the application from the menu without having to invoke the External Tools dialog. You may also include the configuration in your “launch favorites” and it will then be available in the menu until you remove it.

For example, the following figure illustrates our Mil-Std-1553 demo launch configuration within the External Tools menu:



8.3 Executing Embedded Ada Applications

GNATbench supports development of both native and embedded applications. For example, a cross compiler can just as easily be used as a native compiler. Execution in an embedded context, however, involves a number of differences, such as debugger probes, emulators, and so forth, that are beyond the scope of this general User’s Guide. Please refer to the specific documentation supplied with your cross development system for the details of remote execution.

CHAPTER

NINE

DEBUGGING

9.1 Introduction to Debugging with GNATbench

Debugging Ada applications is supported via the GDB debugger, tailored for Ada by AdaCore, and the CDT interactive debugging perspective.

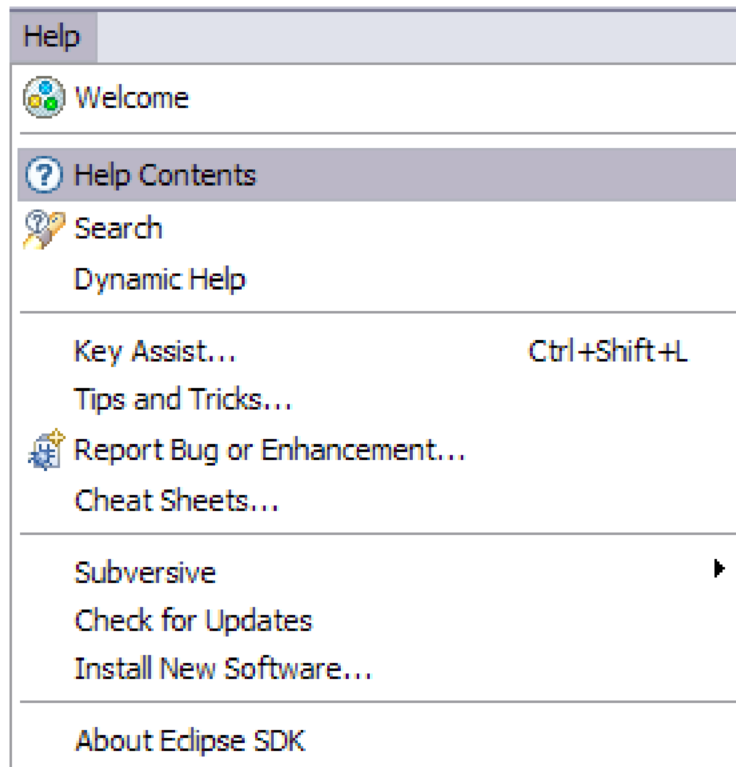
The screenshots in this section use the project “sdc.gpr” from the GNAT Studio tutorial. That project and its associated code can be found under the GNAT installation in the directory share/examples/gnatstudio/tutorial.

9.1.1 Preparing to Debug

Before you begin to debug your project, make sure your project has built properly and you can see the executable in the GNAT Project Explorer. In particular, make sure to apply the “-g” switch when building.

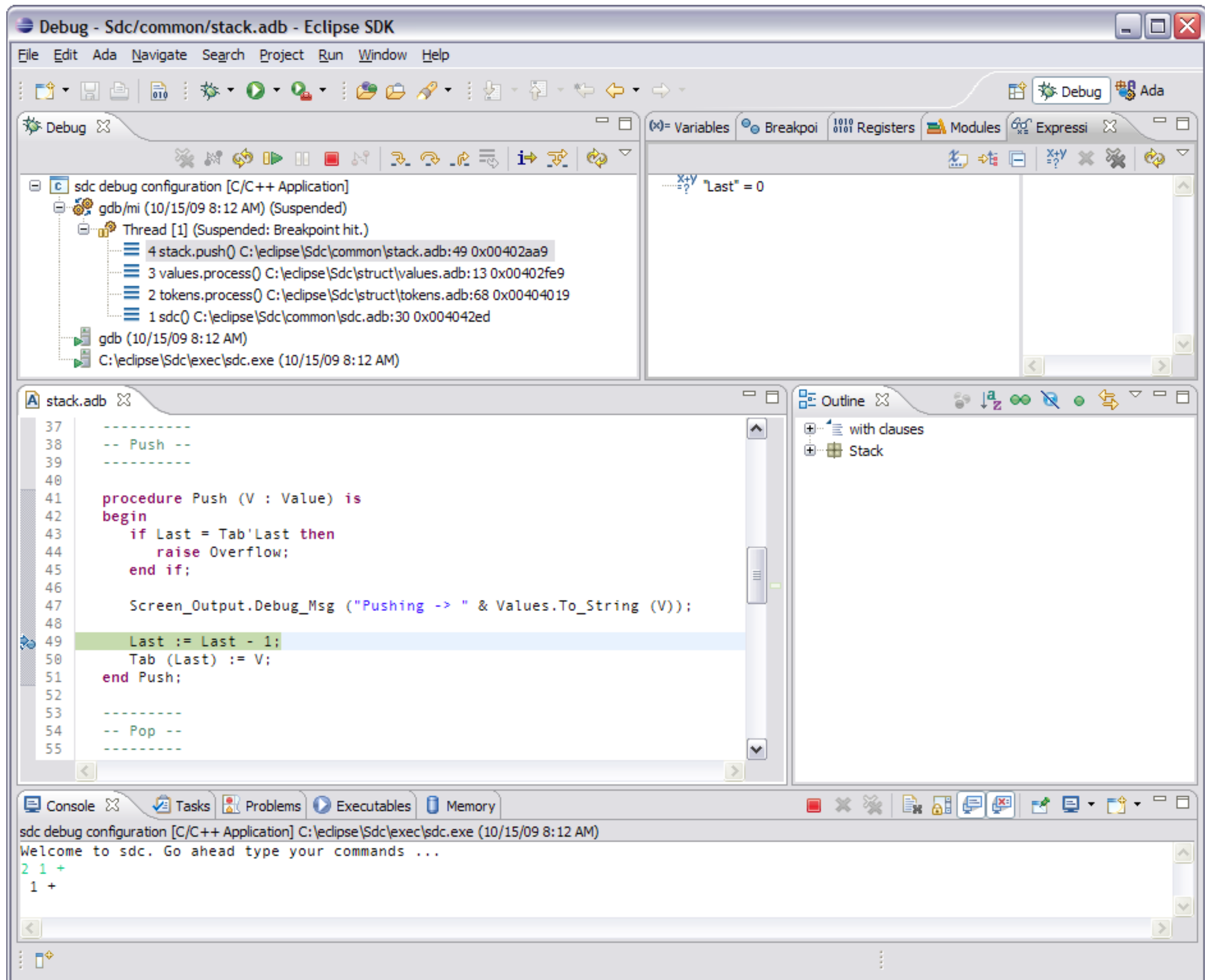
9.1.2 Other Resources

We provide an overview of some of the material, delving into the details only when they pertain to debugging Ada applications. You can find details about the CDT debugger interface in the C/C++ Developer User Guide. All the User Guides are available via the Eclipse Help menu, under “Help Contents”.



9.1.3 Overview

The following figure shows the result of selecting Run and allowing the debugger to halt at a breakpoint.



To the right, a tabbed dialog presents various views for inspecting local variables, breakpoints, and registers. These tabs provide a variety of different tools for exploring information about the state of your halted application.

Eclipse provides additional optional views through the Window -> Show View menu item. In the screenshot, the "Expressions" view has been added by clicking Window -> Show View -> Expressions. In this example, a watchpoint expression has been added by double-clicking inside the expressions window and adding an entry for the local variable "Last."

A tabbed dialog in the middle of the perspective provides a number of editor windows, in which the point at which the debugger is currently halted is shown by an arrow in the left gray border.

At the bottom of the screen, a tabbed dialog provides access to the console for the process being debugged. This window allows text input and allows the user to provide input to a process that expects to read text input for the console. Additional entries provide interfaces for working with tasks and inspecting the state of memory.

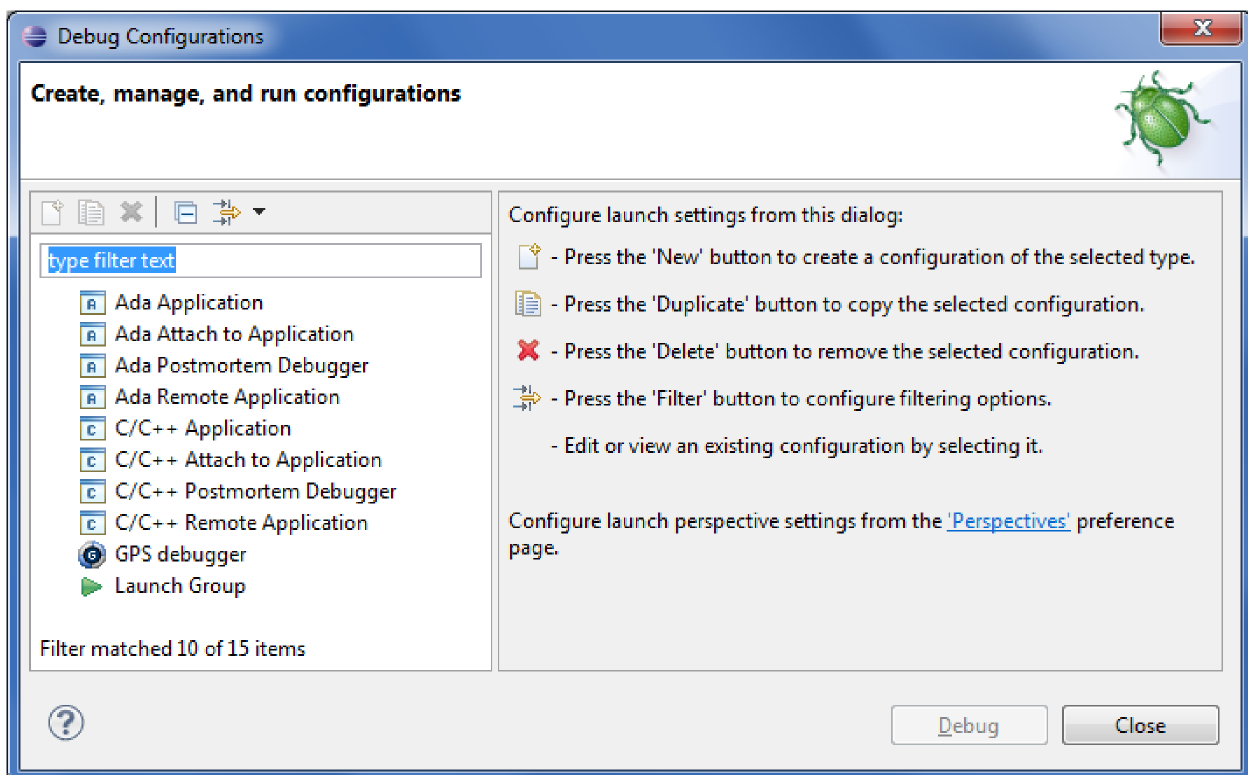
9.2 Creating A Debug Configuration

Eclipse allows you to maintain configuration options and preferences from debug session to session via the "debug configuration" mechanism. The first step in debugging under Eclipse is to create such a configuration. You can then reuse the configuration indefinitely unless/until some aspect changes.

Although not mandatory, compiling your project beforehand will facilitate creating the corresponding debug launch configuration. In particular, it will make it possible to browse and search for some of the required entries instead of manually entering the values. Also, it is most convenient to first select a project before creating a new launch configuration for that project because much of the required information will be filled in automatically.

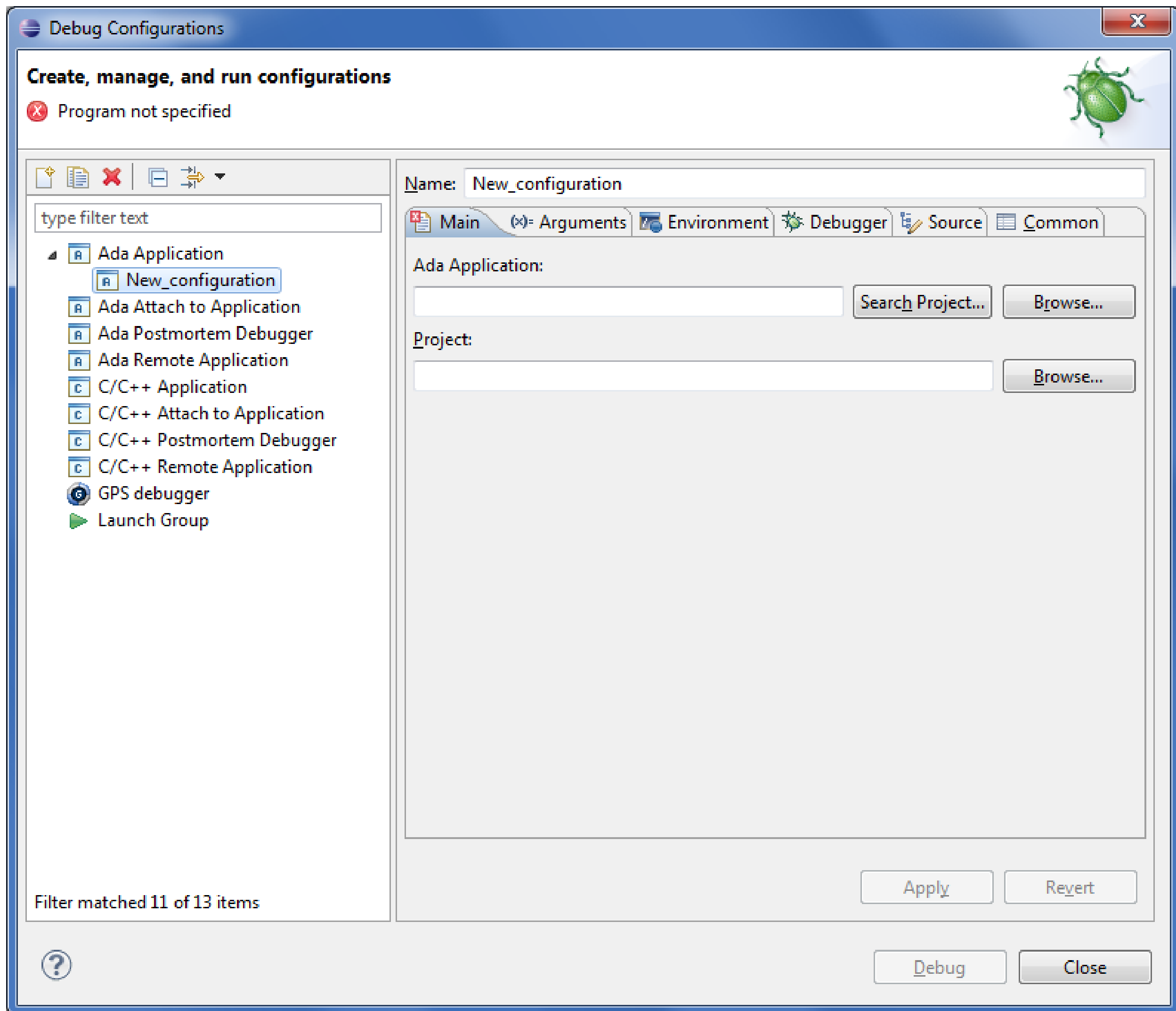
See *Quick Configuration Creation* below for a convenient way to create a new debugger launch configuration for an Ada application.

First, open the Debug launch dialog. Select "Debug Configurations..." from the Run menu, or click on the down-arrow next to the Debug button on the toolbar and make the same selection there. The following dialog box will appear. (In this figure there are no existing user-defined launch configurations; yours may have some already.)



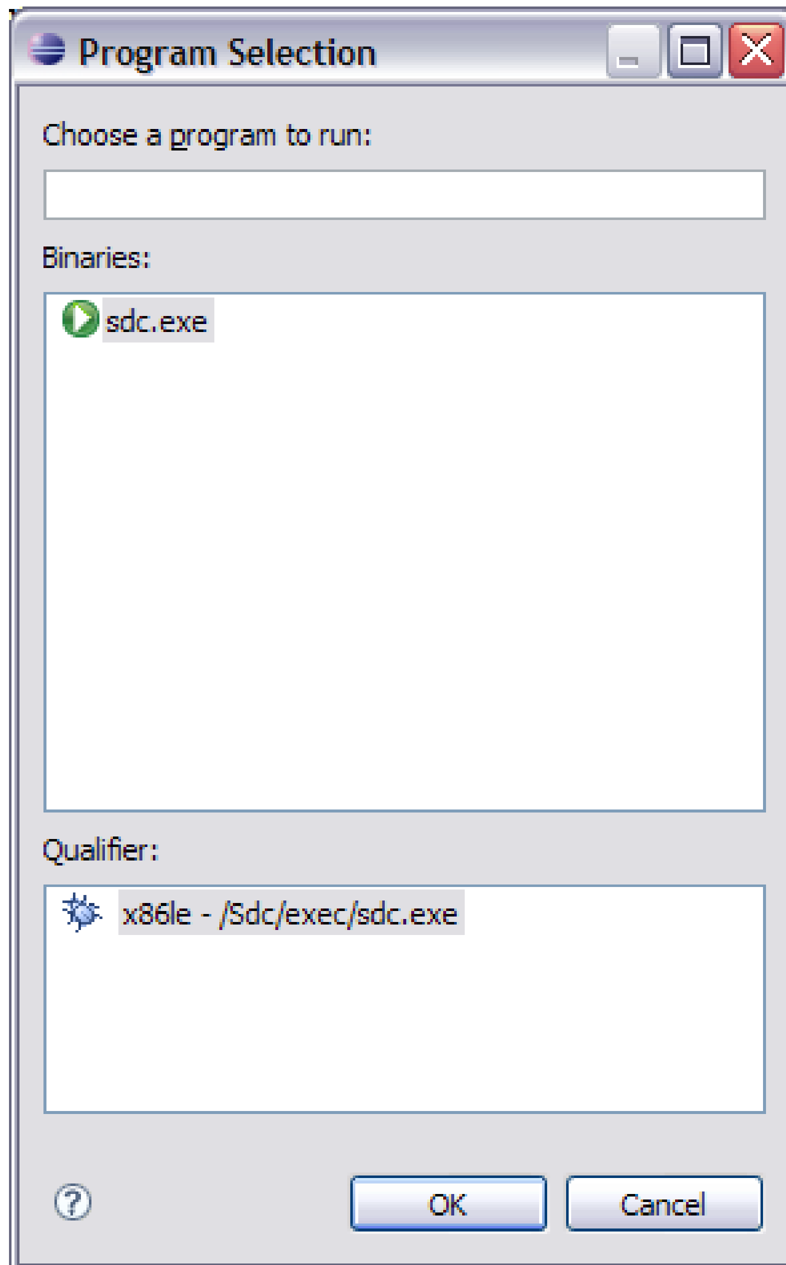
In the left-hand pane of the dialog, double-click on "Ada Application."

If you had a project actively selected in the GNAT Project Explorer when you started, Eclipse (really, the CDT launch facility) will have automatically filled in the name of the new configuration and the information for the "Main" tab on the right of the dialog. Otherwise, you should see an empty new configuration, like the following:

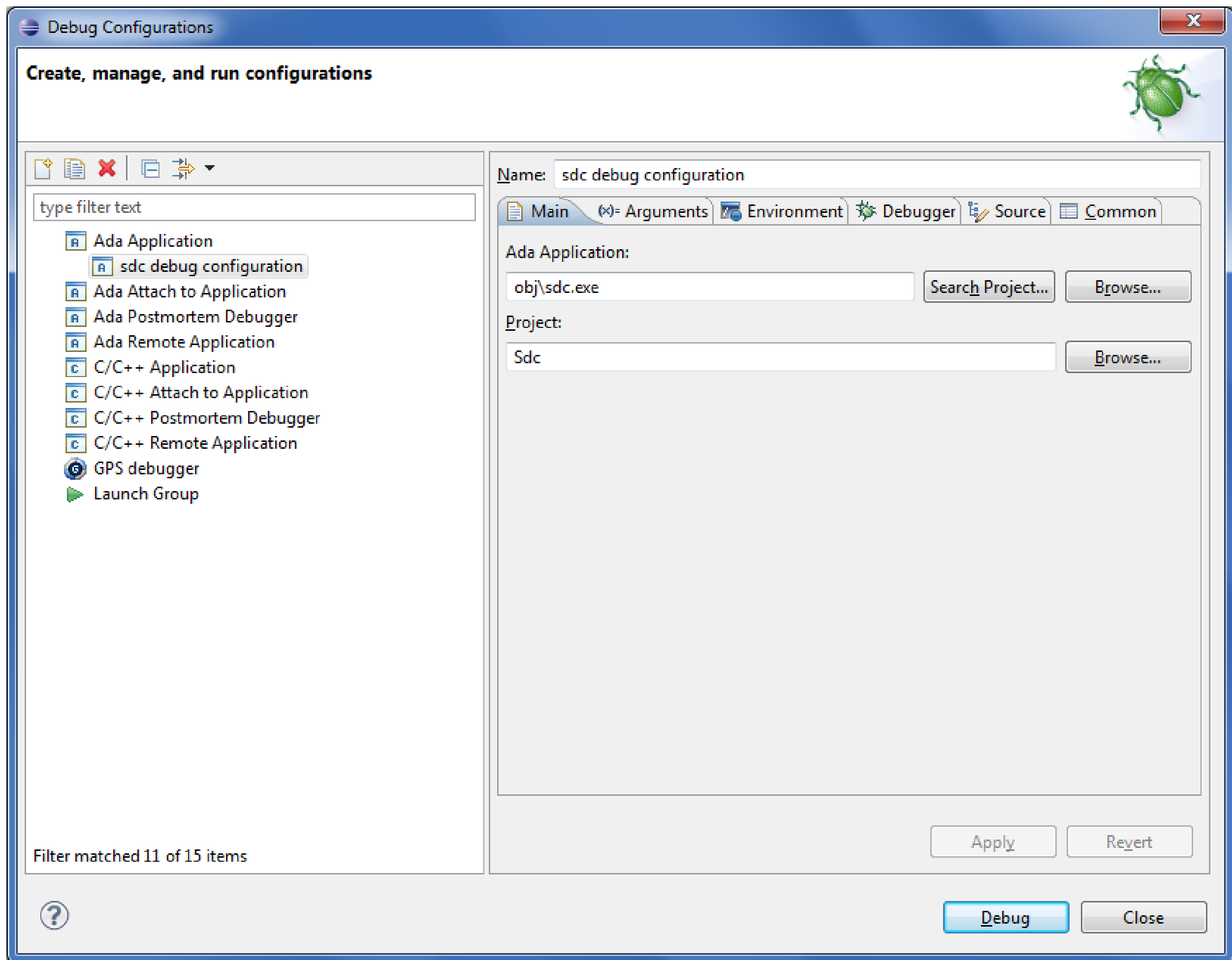


Using the tabbed dialog on the right, you will specify various different configuration options. For example, you can specify the name of the configuration, the executable you wish to debug, the arguments you wish to pass to it when it's launched, if any, the environment under which it will run, the debugger to use, and so forth.

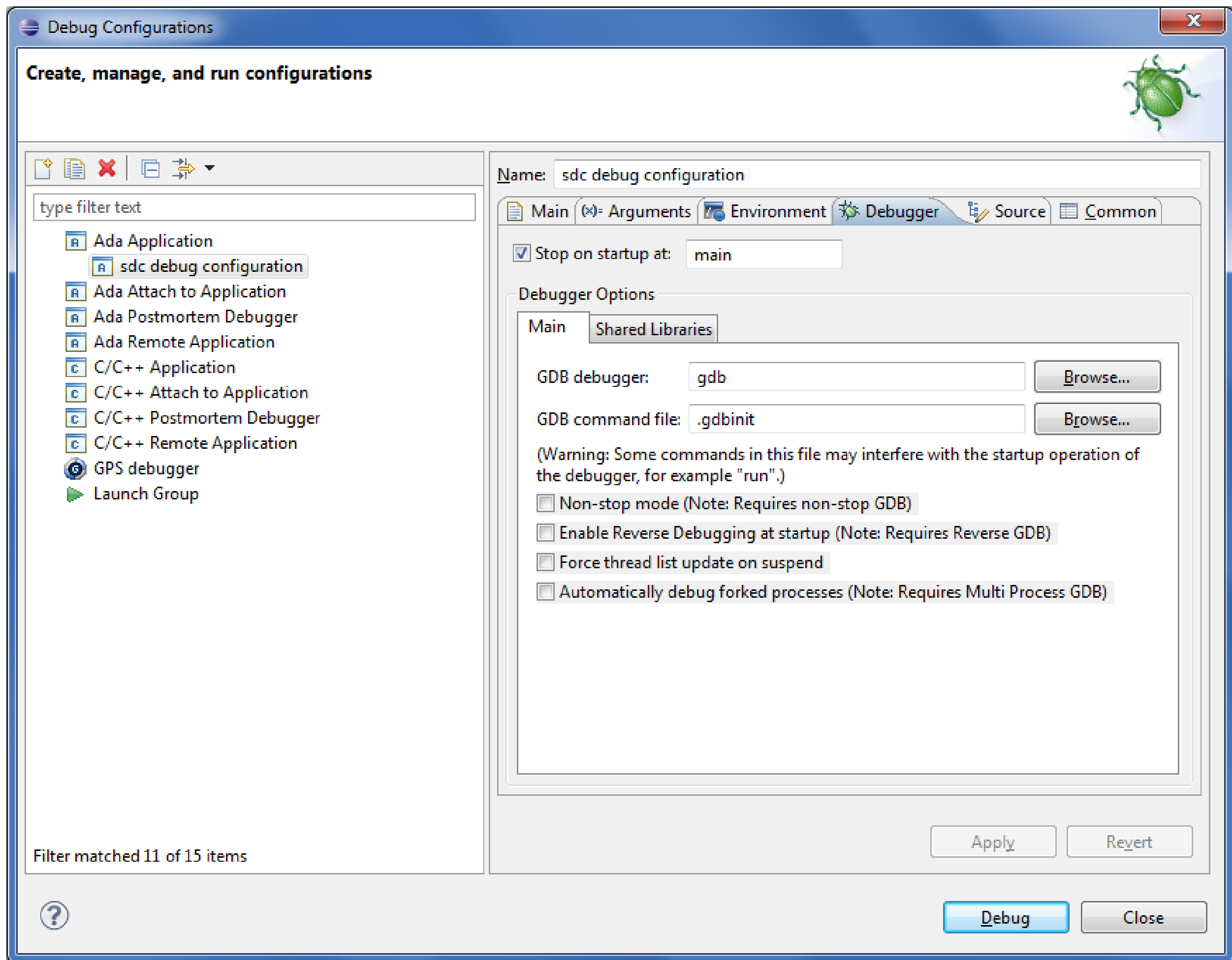
Enter the name for the new configuration at the top of the page. Then, in the "Main" tab, first enter the project name and then the location of the executable. You can manually enter the project name and executable location or you can browse for them. For example, clicking on the "Search Project…" button will invoke this dialog box:



Once filled in, the "Main" tab content will appear something like this:



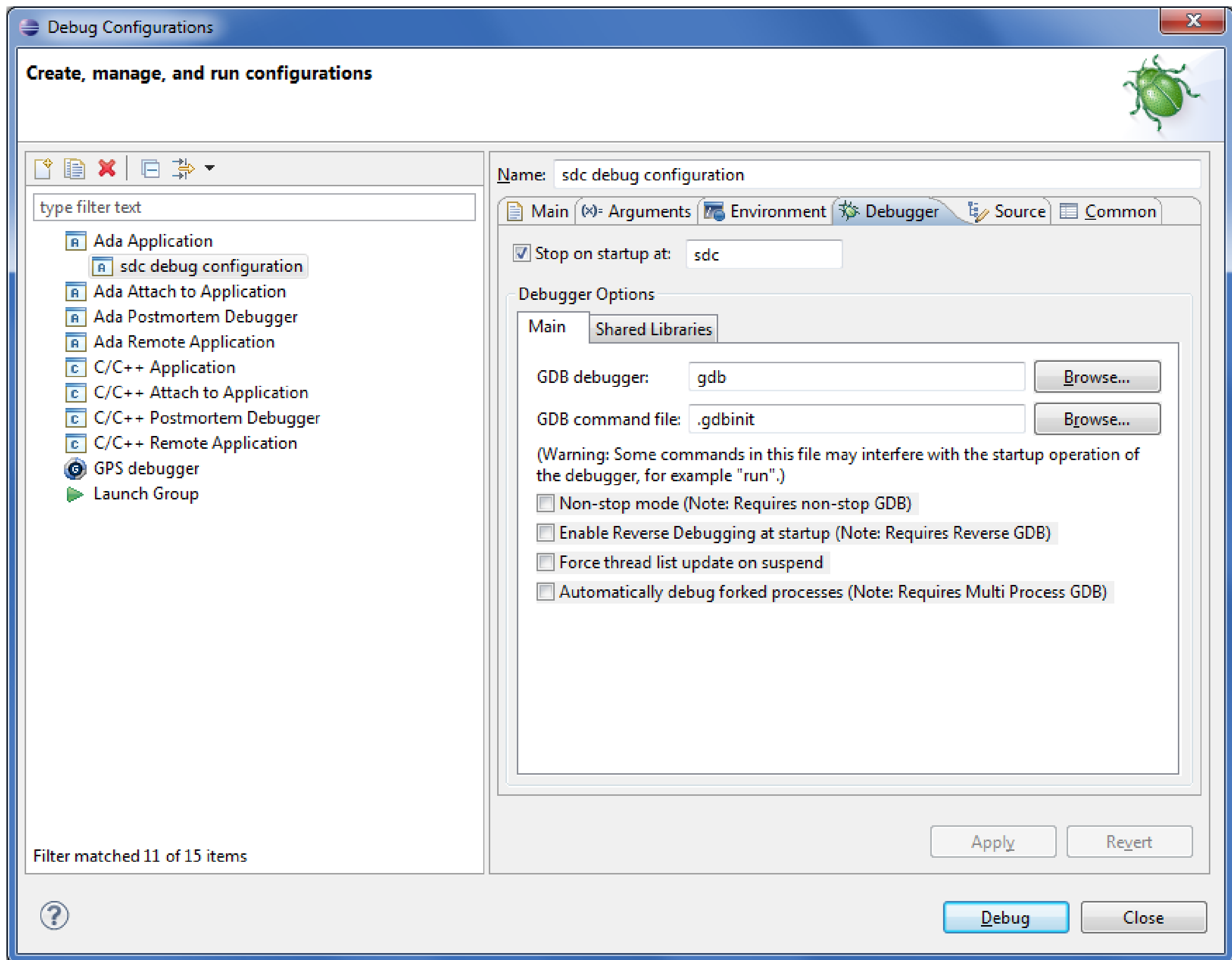
Next, you will likely want to change some settings in the "Debugger" tab. Initially the page will appear as follows:



If you want to debug library unit elaboration, leave the entry point name in the text pane labeled "Stop on startup at:" set to "main". You can then step through the elaboration of all the library units.

Typically, however, you will want to stop at (the elaboration of) the main subprogram, in which case you will replace "main" with the name of the Ada main subprogram unit. In this example the name would be "sdc".

Once filled in, the "Debugger" page will appear something like this:



Generally you can leave the other tabs with their contents unchanged.

Press the Apply button to save the changes, and then press either Close or Debug, depending upon whether or not you want to use the configuration immediately.

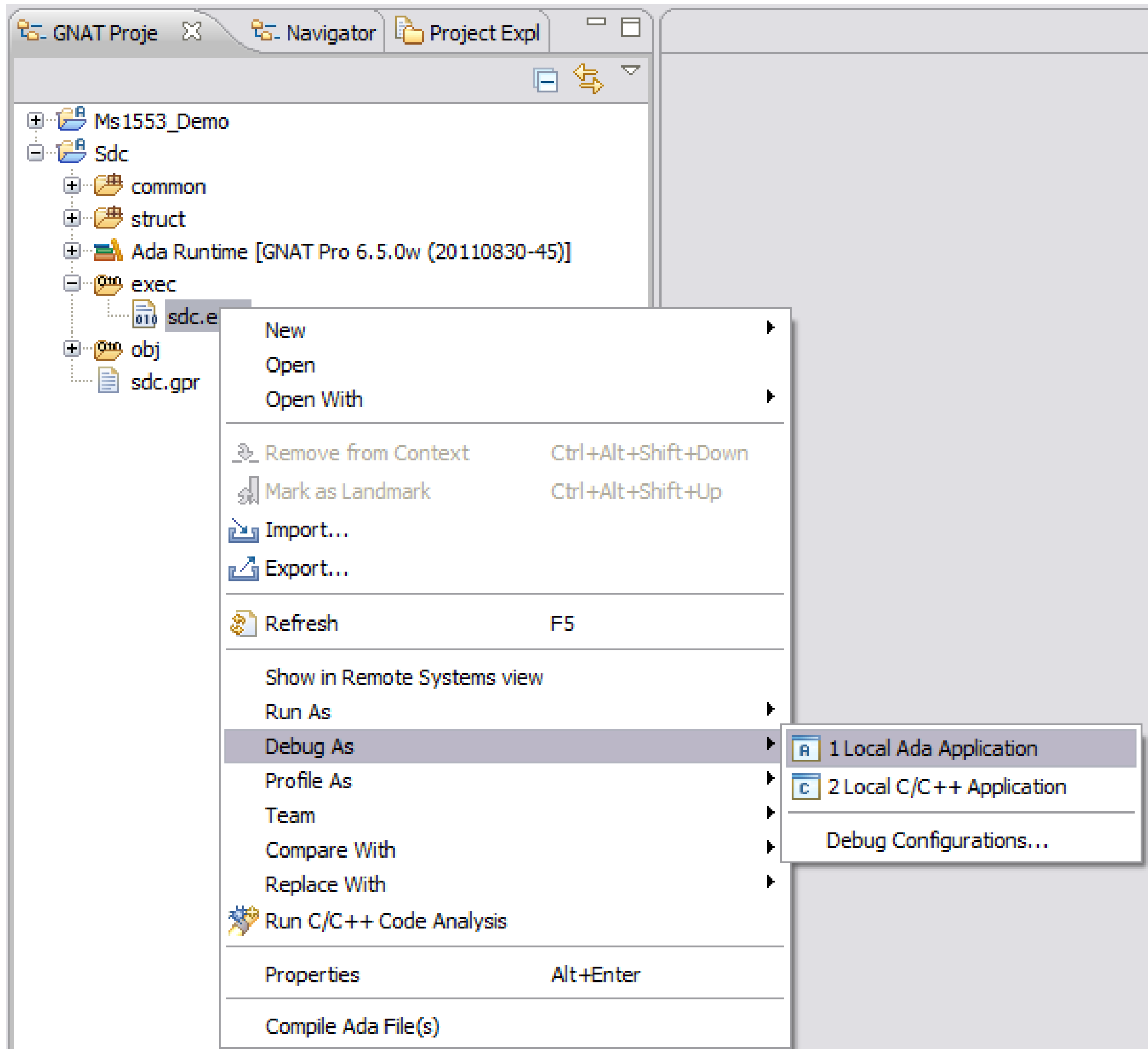
9.2.1 Quick Configuration Creation

You can quickly create a new Ada debug configuration in several convenient ways. Note, however, that not all the settings described above are automatically specified. For example, the entry point will remain set to "main" rather than the name of your actual Ada main procedure.

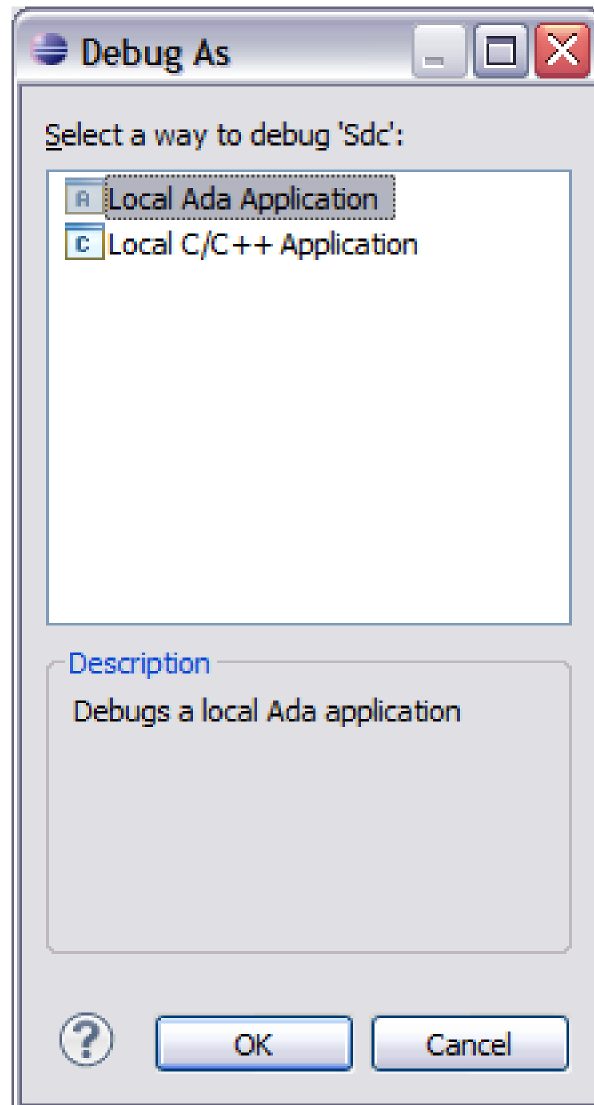
In all cases, you *first select the node for an Ada project or an Ada executable* in the GNAT Project Explorer. This step is essential. Next, either:

- right-click to get the contextual menu and select the "Debug As" menu entry;
- use the "Debug" toolbar icon;
- use the "Run -> Debug" menu entry.

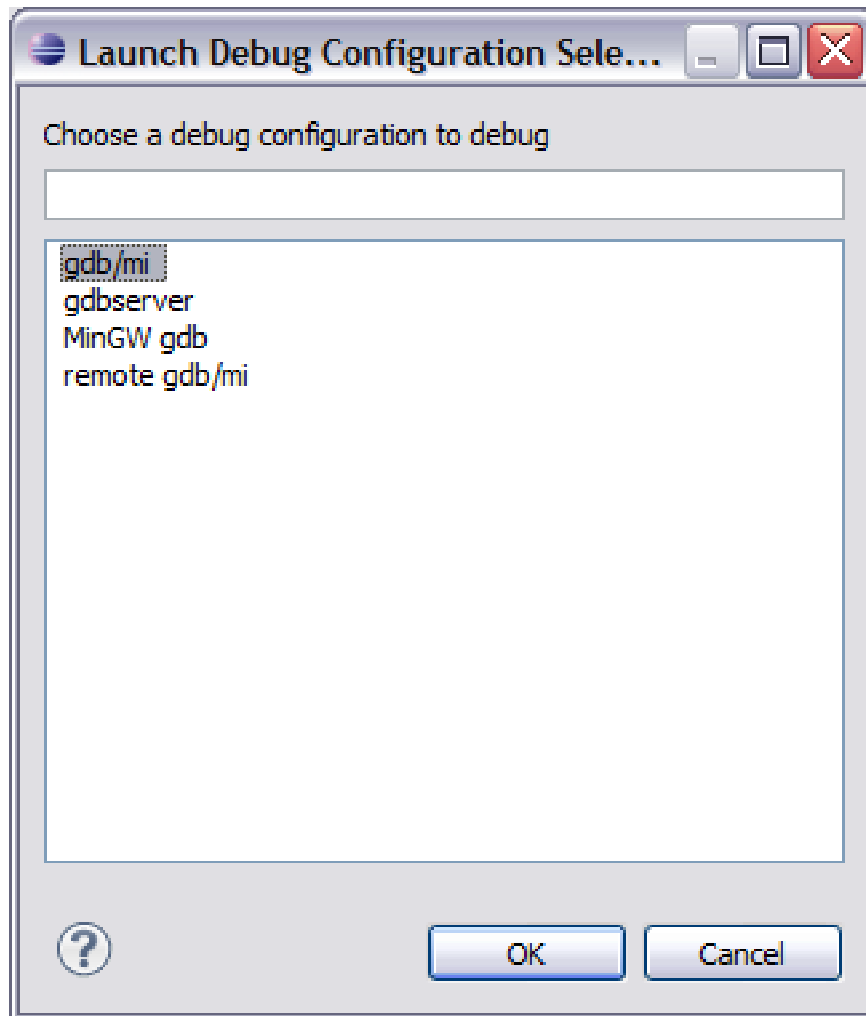
For example, in the following figure we have right-clicked on the executable:



If instead you use the "Run -> Debug" menu entry, you must then specify how to debug the application. Choose "Local Ada Application" and press OK, as shown below:



Finally, select the "gdb/mi" debug configuration to finish the launch configuration process. Press OK to launch the debugger.

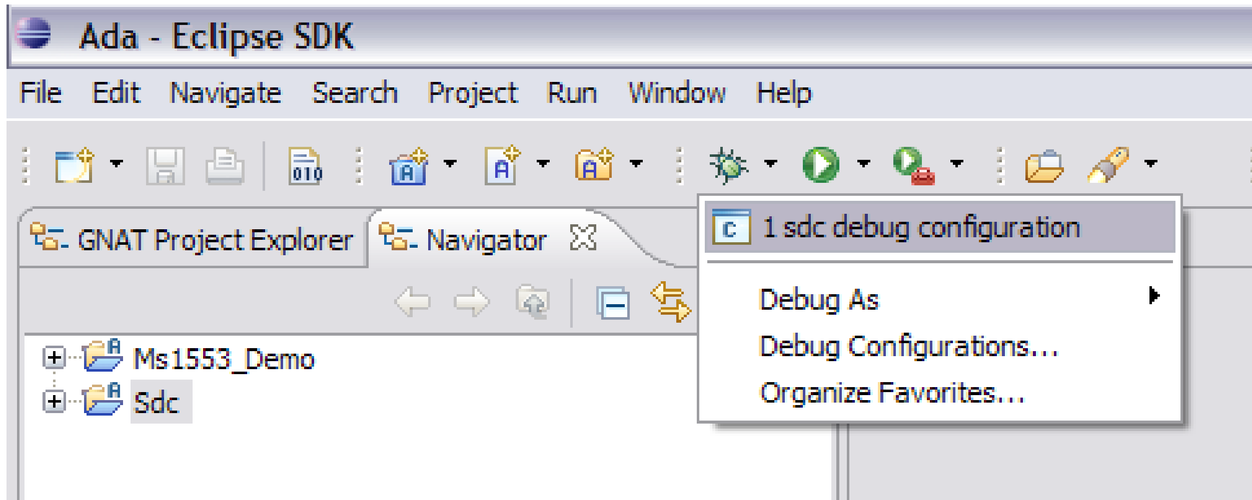


9.3 Launching A Debug Session

See

Creating A Debug Configuration for the details of the creating new debugger launch configurations.

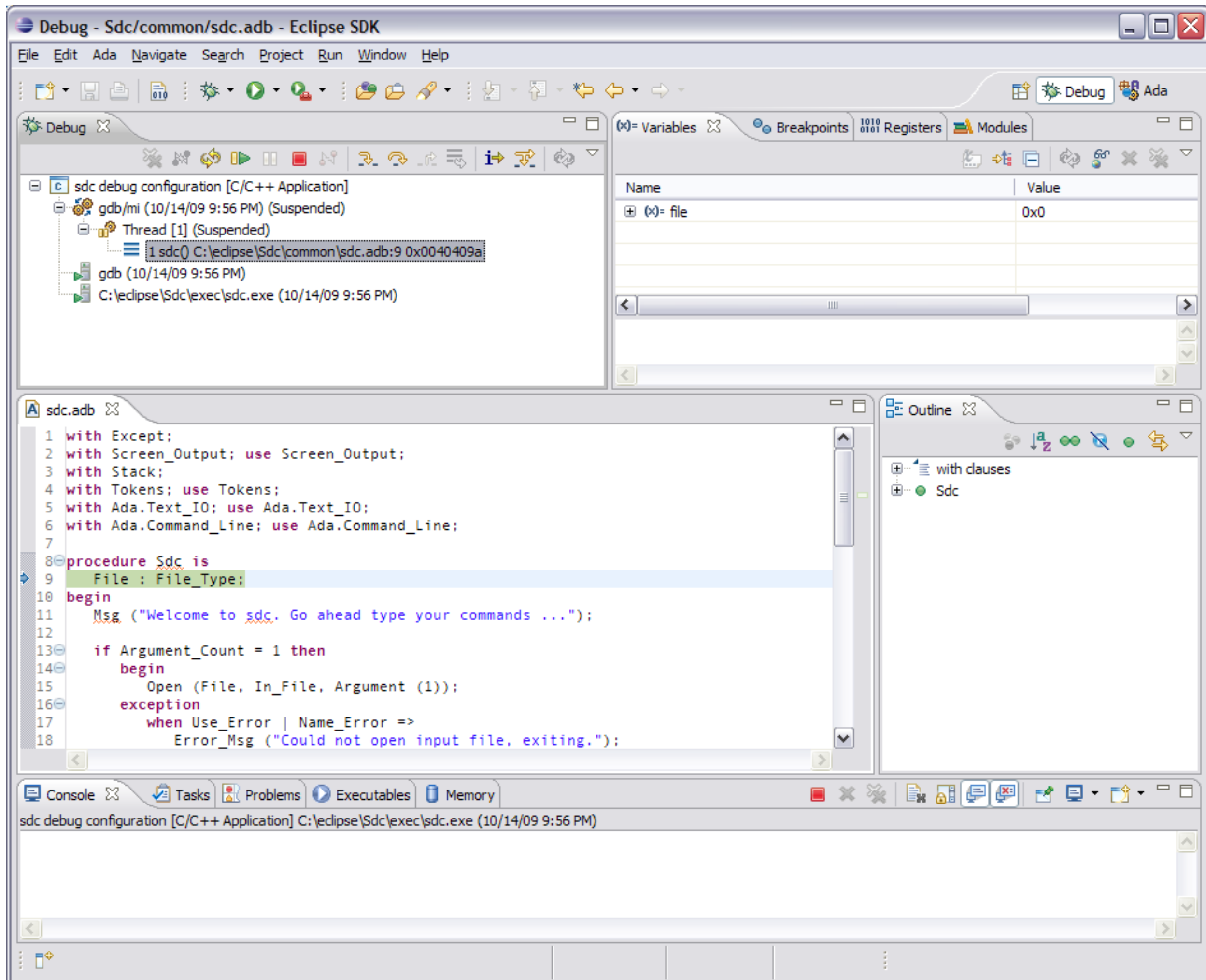
Once you have created a debug configuration, you can launch it from the Debug dialog (assuming it is still open) by clicking the "Debug" button. Alternatively, if you have an existing configuration you can re-apply it in various ways to launch the debugger. If you have only one such configuration you can simply press the Debug toolbar icon. Usually you will have more than one launch configuration so perhaps the easiest way is by clicking on the down-arrow next to the Debug button on the toolbar and selecting the desired configuration from the list.



If you are not in the Debug perspective when launching a debug configuration, Eclipse will ask whether you to want to switch to that perspective. (Eclipse will remember your answer if you tell it to do so, and in that case will not ask again.) Once in the Debug perspective you will see your application in the debugger.

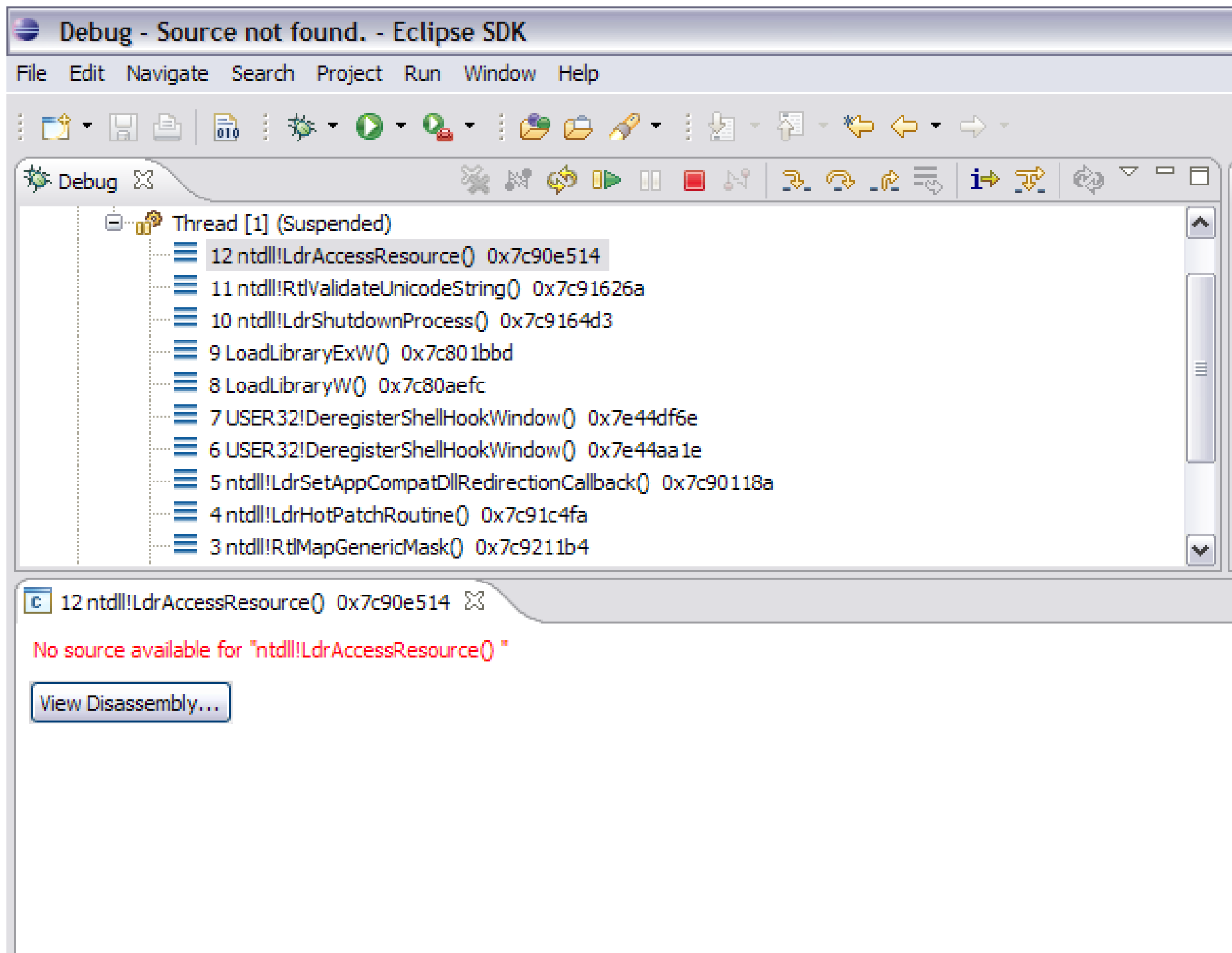
The upper left pane contains the debugger controls and stacks view. At the upper right are the variables and breakpoints views, among others. The source files appear in the middle on the left, with the Outline view to the right. The debugger Console view is on the bottom.

The source view will initially show the source file containing the next line to execute, which in this case will be the elaboration of the main subprogram (if that is the entry point specified in the launch configuration). The green line and blue arrow highlight that line, as shown in the figure below.



9.3.1 Potential Trouble

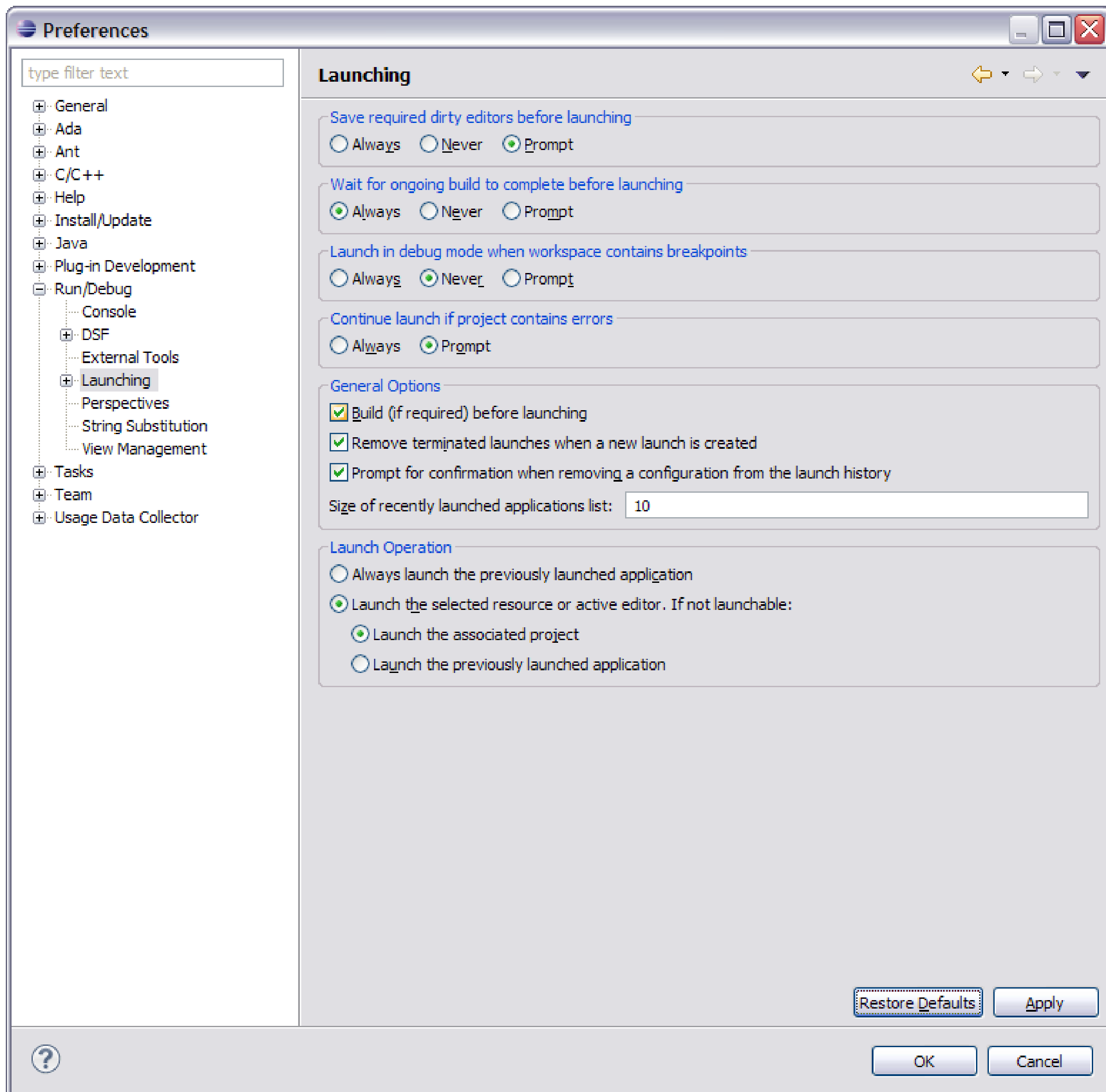
When the debugger first comes up you might see an error indicating that no source is available for the first code entered (on Windows XP, in particular, due to Windows code that is initially required). In that situation the source file and debugger pane will look something like the following:



In that case, pressing the Resume button (or F8) a few times will eventually get to the elaboration of the main subprogram.

9.3.2 Build Prior to Launch

When a debug configuration is launched, Eclipse will first check to see if a new build is required. You can control that behavior with a preference, located under the "General Options" section of the "Run/Debug/Launching" preference page. A number of useful options are controlled on that page.



9.4 Setting Breakpoints

You can create breakpoints in the source editor by double clicking in the gray column on the left-hand side of the editor window, to the left of the line numbers. A blue dot will appear there.

In the following figure two breakpoints have been set: one on line 15 and one on line 30:

```
1  with Except;
2  with Screen_Output; use Screen_Output;
3  with Stack;
4  with Tokens; use Tokens;
5  with Ada.Text_IO; use Ada.Text_IO;
6  with Ada.Command_Line; use Ada.Command_Line;
7
8  procedure Sdc is
9     File : File_Type;
10 begin
11    Msg ("Welcome to sdc. Go ahead type your commands ...");
12
13    if Argument_Count = 1 then
14       begin
15          Open (File, In_File, Argument (1));
16       exception
17          when Use_Error | Name_Error =>
18             Error_Msg ("Could not open input file, exiting.");
19             return;
20       end;
21
22       Set_Input (File);
23    end if;
24
25    loop
26       --  Open a block to catch Stack Overflow and Underflow exceptions.
27
28       begin
29
30          Process (Next);
31          --  Read the next Token from the input and process it.
32
```

Note that you may need to switch back and forth between the Debug and Ada perspectives because the Ada perspective displays the source files for editing. Setting breakpoints in an open file is the easiest method of setting breakpoints.

You can enable line numbers in the source view by a preference. Use the Window menu entry and select "Preferences…", then expand the "General/Editors/Text Editors" nodes and select "Show line numbers."

Also note that you can create breakpoints in this fashion before beginning your debug session. You may also switch back and forth between the Debug and Ada perspectives at any time by clicking on the "Ada" and "Debug" perspective icons in the top right-hand corner of the display.

When a breakpoint has been hit the source view will highlight it:

```
 8 procedure Sdc is
 9    File : File_Type;
10 begin
11    Msg ("Welcome to sdc. Go ahead type your commands ...");
12
13    if Argument_Count = 1 then
14       begin
15          Open (File, In_File, Argument (1));
16       exception
17          when Use_Error | Name_Error =>
18             Error_Msg ("Could not open input file, exiting.");
19             return;
20       end;
21
22       Set_Input (File);
23    end if;
24
25    loop
26       --  Open a block to catch Stack Overflow and Underflow exceptions.
27
28       begin
29
30          Process (Next);
31          --  Read the next Token from the input and process it.
32
33       exception
34          when Stack.Underflow =>
35             Error_Msg ("Not enough values in the Stack.");
36
37          when Stack.Overflow =>
38             null;
39       end;
```

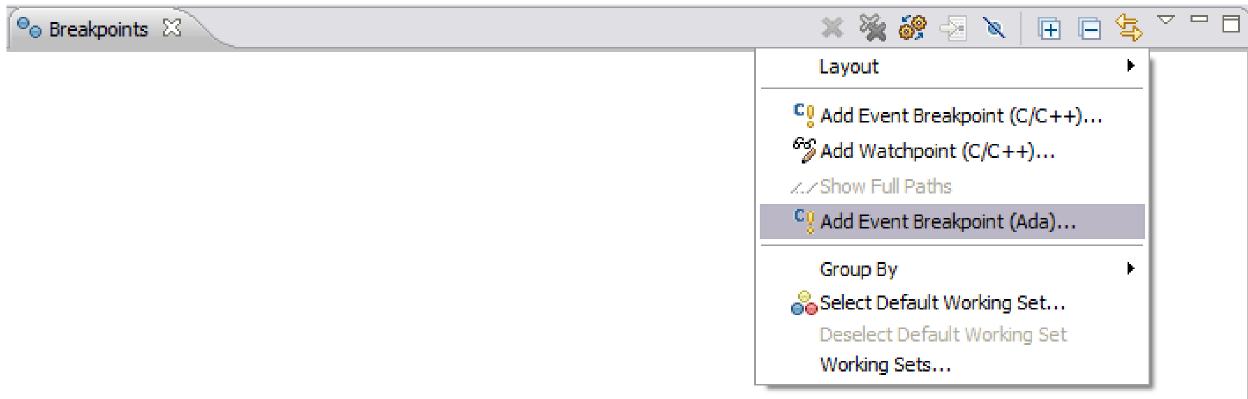
9.5 Breaking On Exceptions

If you are running Eclipse Helios (3.6) or later, you can stop execution when an exception becomes active. Specifically, you can stop execution whenever any of the following take place:

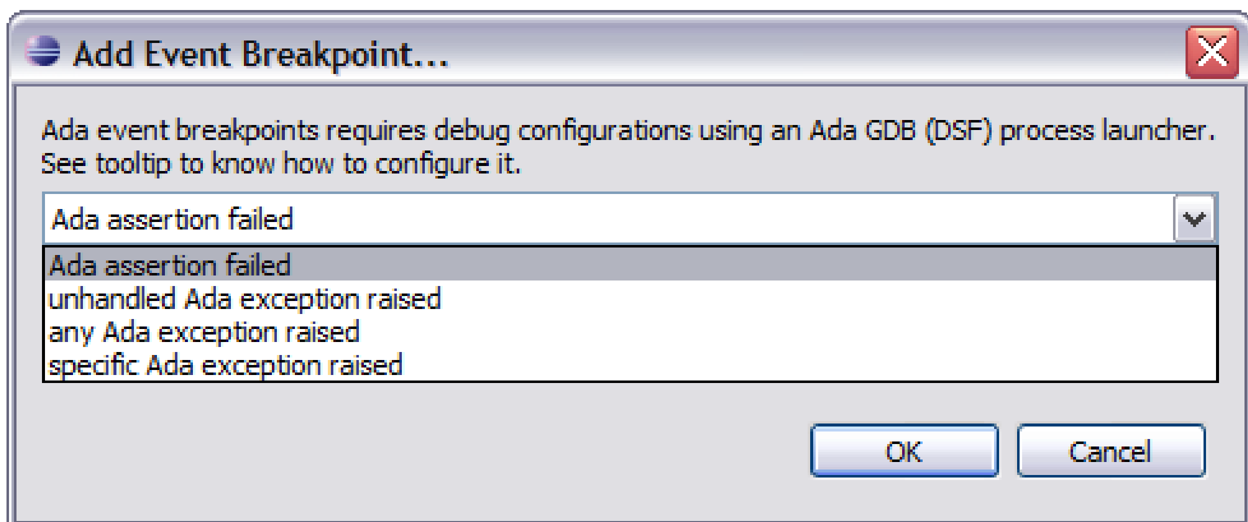
- Any exception raised
- Any unhandled exception raised
- A specific exception raised
- An assertion in pragma Assert evaluating to False

To set a breakpoint on an Ada exception, first use the View Menu control to activate that menu. The View menu control is the downward-pointing triangle next to the view's Minimize control at the far upper right of the view:

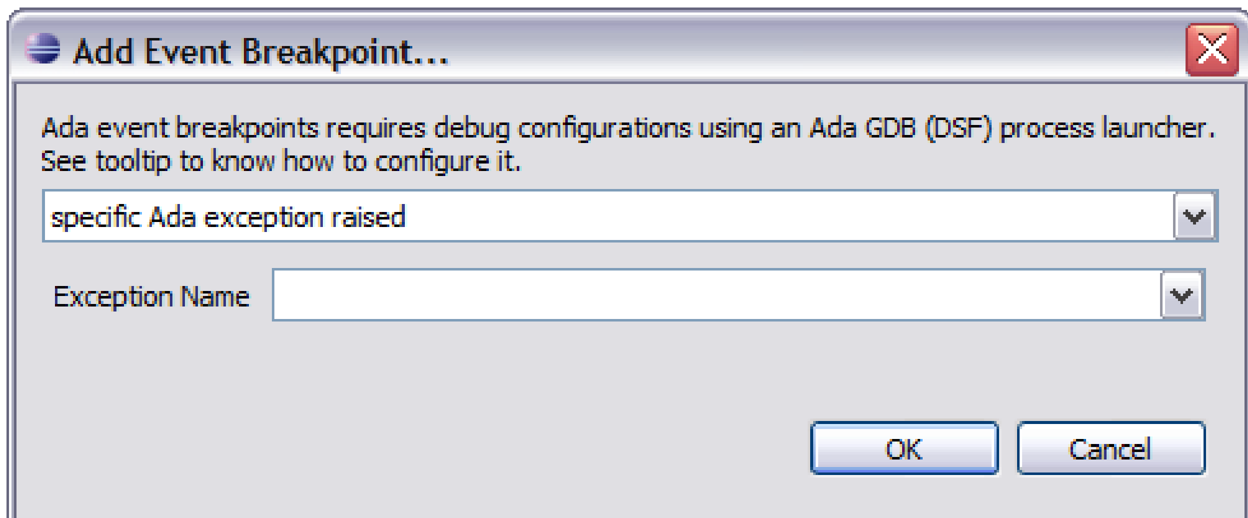
Clicking on the View Menu control invokes the corresponding menu. In the following figure we have highlighted the entry for Ada events:



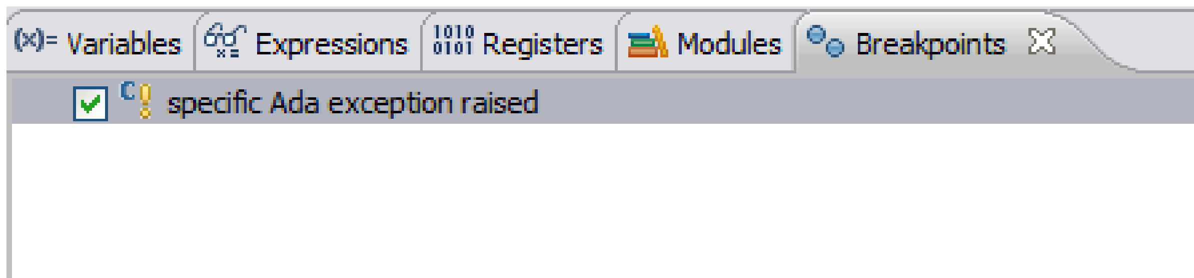
Selecting the entry for Ada exception events brings up the dialog box in which you can select the specific event intended. In the following figure we have used the pull-down list to show the choices:



If you specify that the breakpoint should occur whenever a specific exception is raised, you will then be asked to specify the name of that exception. As soon as an Ada debug session is started, the exception name combo box is automatically filled with the names of the exceptions your programs can raise.

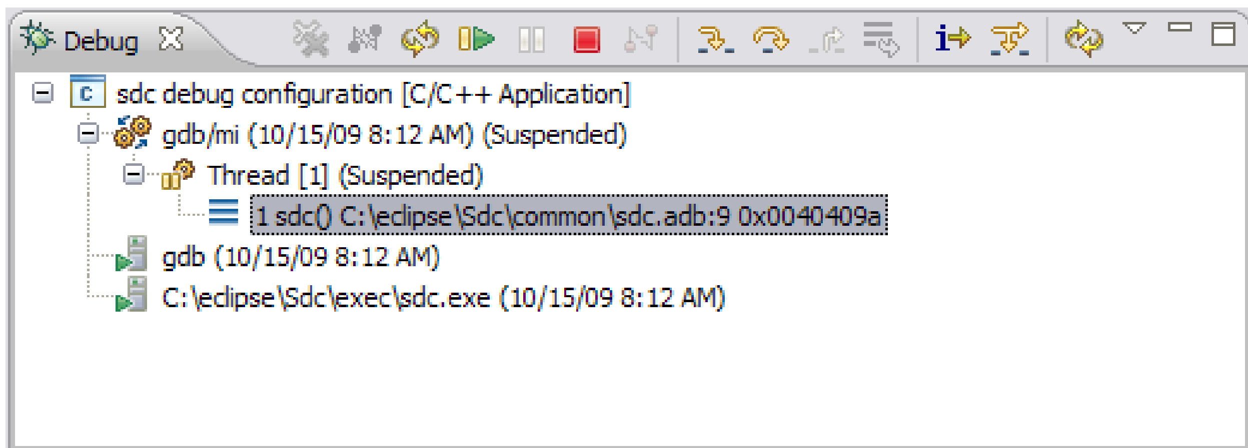


Once you have specified the event, the breakpoint will appear in the list of known breakpoints, along with any others:



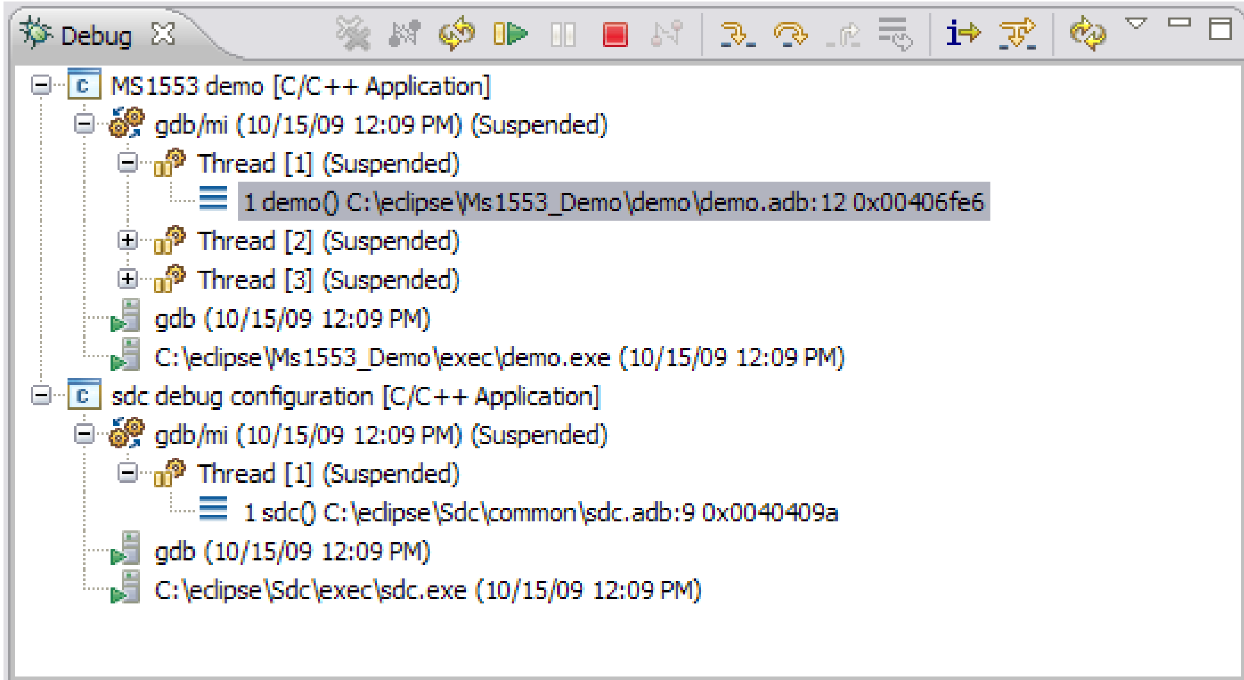
9.6 Controlling Execution

In the upper left hand corner you will find the "Debug" view.

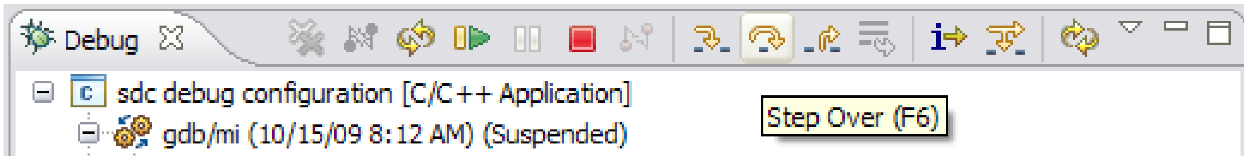


From this view you may control overall execution, navigate between debugging sessions, navigate between threads in a given session, and traverse up and down the call stack, among other actions.

For example, the figure below shows two debugger sessions active. You can control either session by clicking on the corresponding entries in the Debug view. The other views will automatically reflect the selected application and thread.



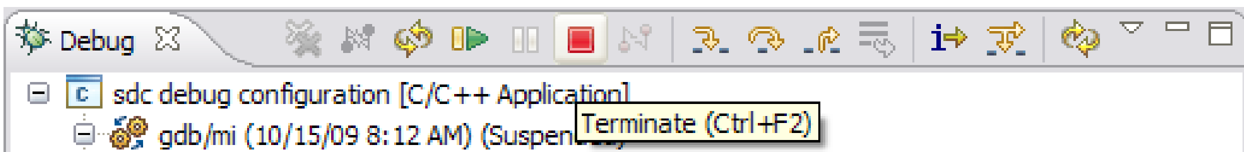
The tool bar in the Debug view includes buttons for running, halting, and stepping your application. In the figure below the mouse cursor is over the "Step Over" button so the tooltip is displayed. Note the key binding.



The "Step Over" button will go to the next Ada statement in the same call frame. In other words, if the next statement is a subprogram call, the debugger will not step into the code for that subprogram.

To the left of the "Step Over" button is the "Step Into" button. The "Step Into" button *will* step into the code for a subprogram call (when a call is the next statement).

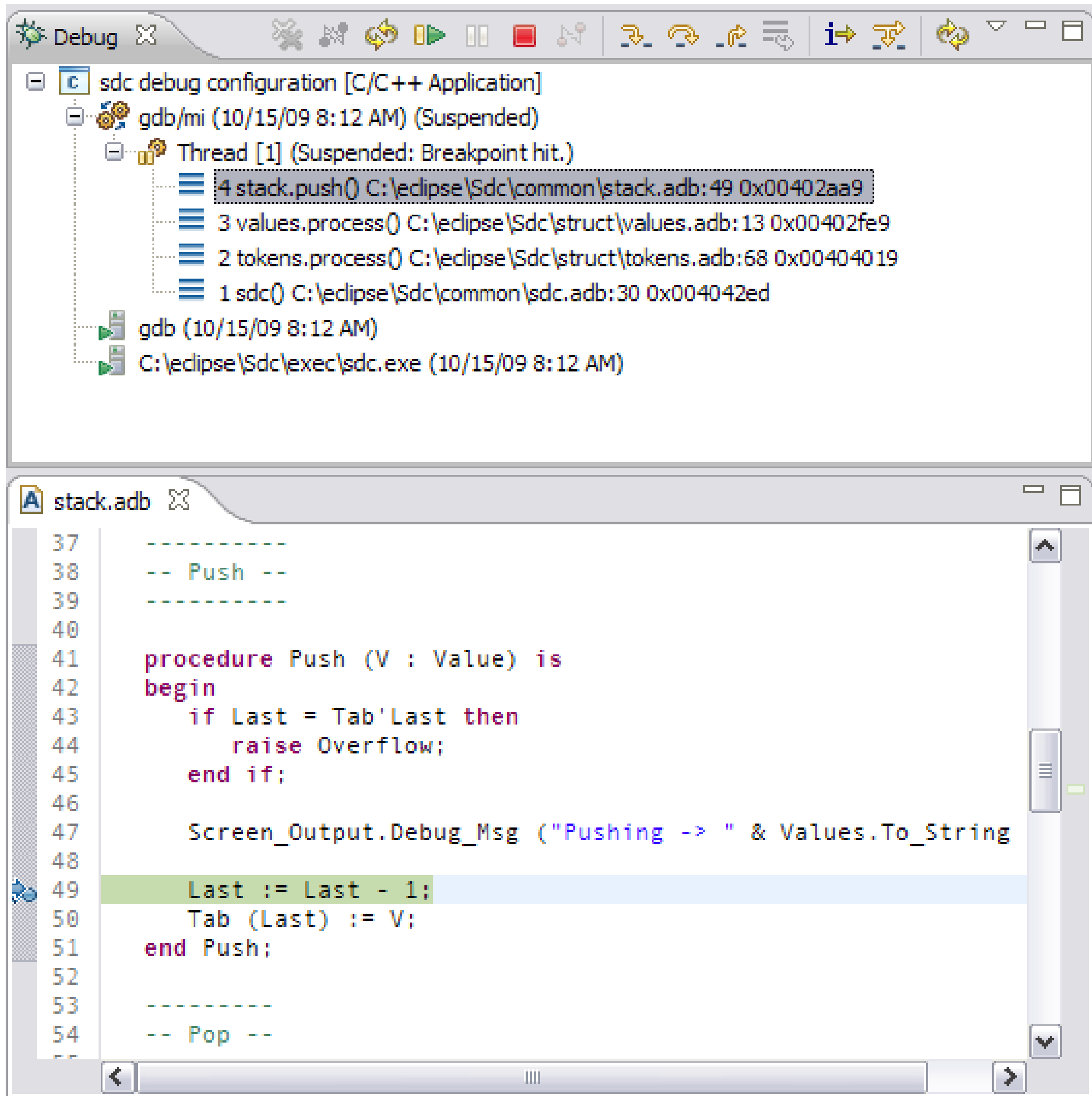
Moving further left, the red box is the "Terminate" button that terminates execution of the debugging session:



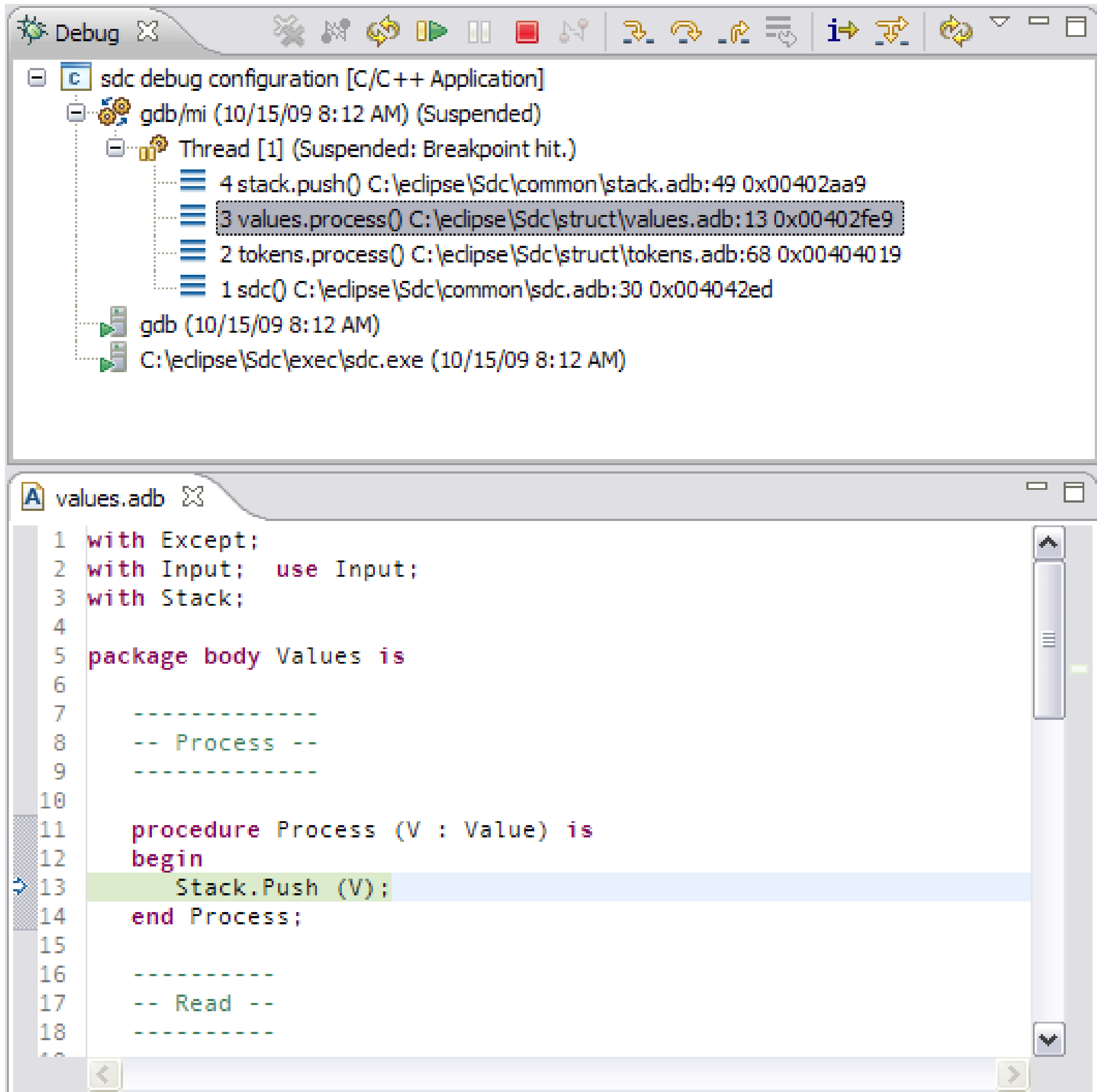
Next to the "Terminate" button is the "Suspend" button, which in this case is disabled because the debugger is already suspended (on a breakpoint).

To the left of the "Suspend" button is the "Resume" button, a green-tipped arrow.

These are the primary buttons for controlling the program's execution. See the C/C++ Developer Guide for further details of the Debug view controls. Note the call stack in the Debug view, and the corresponding source code displayed in the source window:



If we select a different call stack frame in the Debug view we see the displayed source code change to the source corresponding to that call:

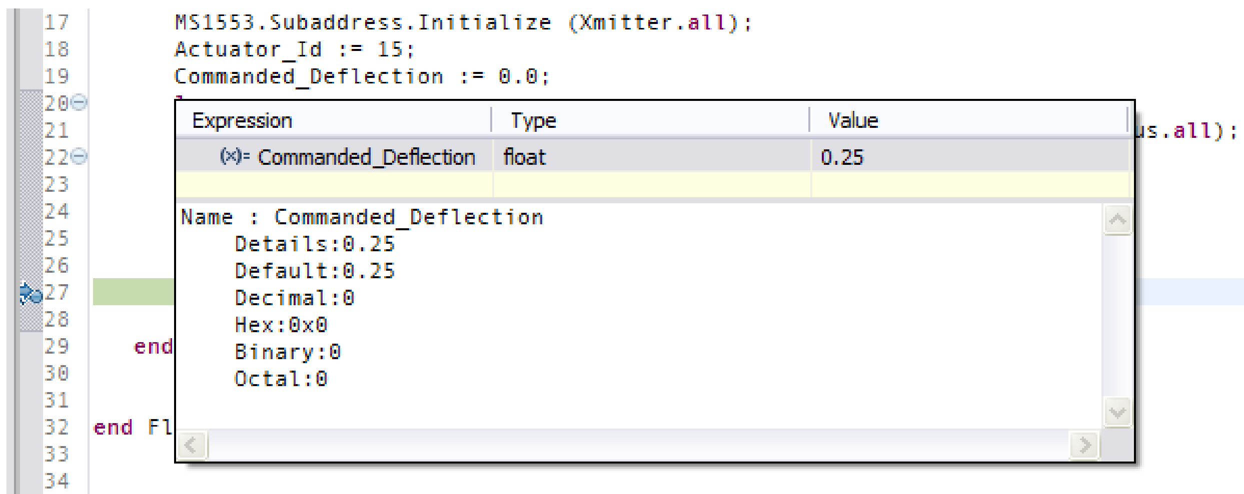


Traversing the call stack can go in both directions, for any thread, from the current frame all the way back to the first frame for the thread.

9.7 Examining Data

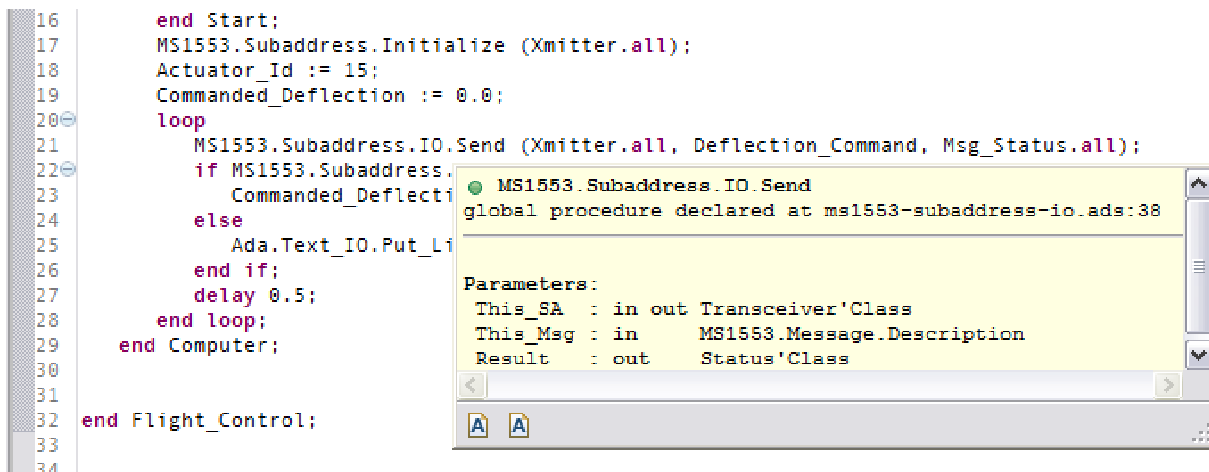
Note that application execution must be suspended to examine data.

Perhaps the simplest way to examine the value of a variable (strictly, an expression) while debugging is to hover the mouse cursor over the variable in the source editor. A tooltip will then appear showing the value. For example, as indicated in the following figure, the mouse cursor has been hovered over the variable "Commanded_Deflection":



You can see that the earlier value of 0.0 has been replaced by subsequent execution.

As usual with Eclipse, moving the mouse over the tooltip will make it persist so that you can resize and reposition it. In addition, when made persistent, you can traverse to the corresponding declaration and body (if extant) using icons presented at the bottom left of the tooltip pane. For example, the following figure shows the persistent tooltip resulting from hovering the mouse over the call to procedure Send:

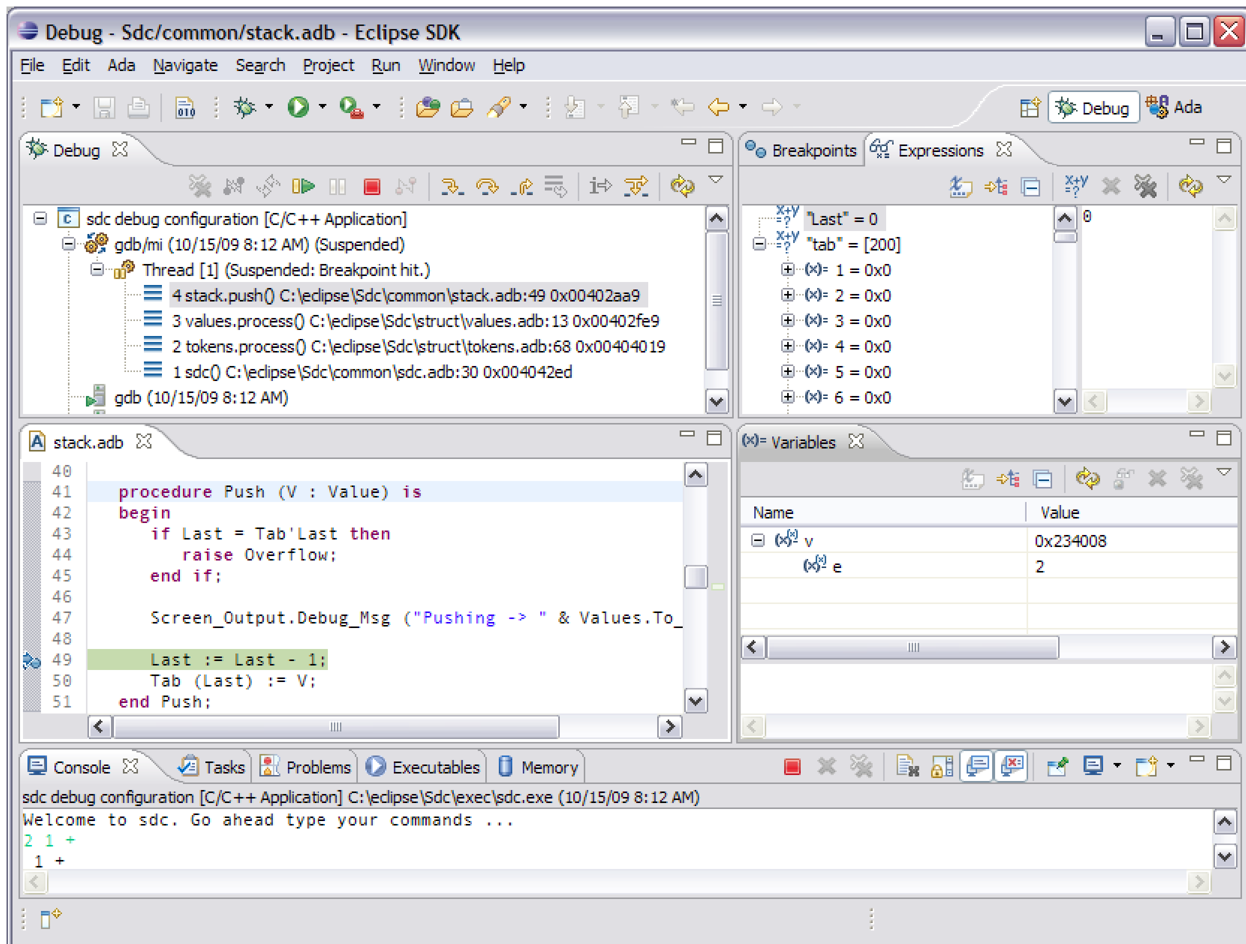


Note the two Ada "file" icons at the bottom left. Clicking on the leftmost icon will open the declaration for procedure Send, whereas clicking on the icon to the right will open the corresponding body.

More sophisticated facilities are also available. In the Debug perspective, a tabbed dialog presents various views for inspecting local variables, breakpoints, and registers. These tabs provide a variety of different tools for exploring information about the state of your application.

The tabbed dialogs can be repositioned within the perspective. In the figure below the Variables view has been moved down and then to the right of the source view. The perspective provides additional, optional debugger views available via the Window -> Show View menu item. The "Expressions" view has been added in the same figure. The Variables and Expressions views are the two primary views for examining Ada objects.

Note that the CDT debugger interface is responsible for displaying the values of variables, but it does not understand how to display values of every possible Ada type. As a result, some variables may not be displayed. The common types are fully supported.



9.7.1 Examining Variables Declared in Subprograms and Tasks

Variables declared within the declarative regions of subprograms and tasks are most easily examined using the Variables view. These variables will appear automatically when the execution frame is currently selected. In the figure above, the call frame for the call to Stack.Push is currently selected so the formal parameter "V" appears in the Variables view.

Note that in the current version of the CDT debugger perspective, names are mapped to lower case.

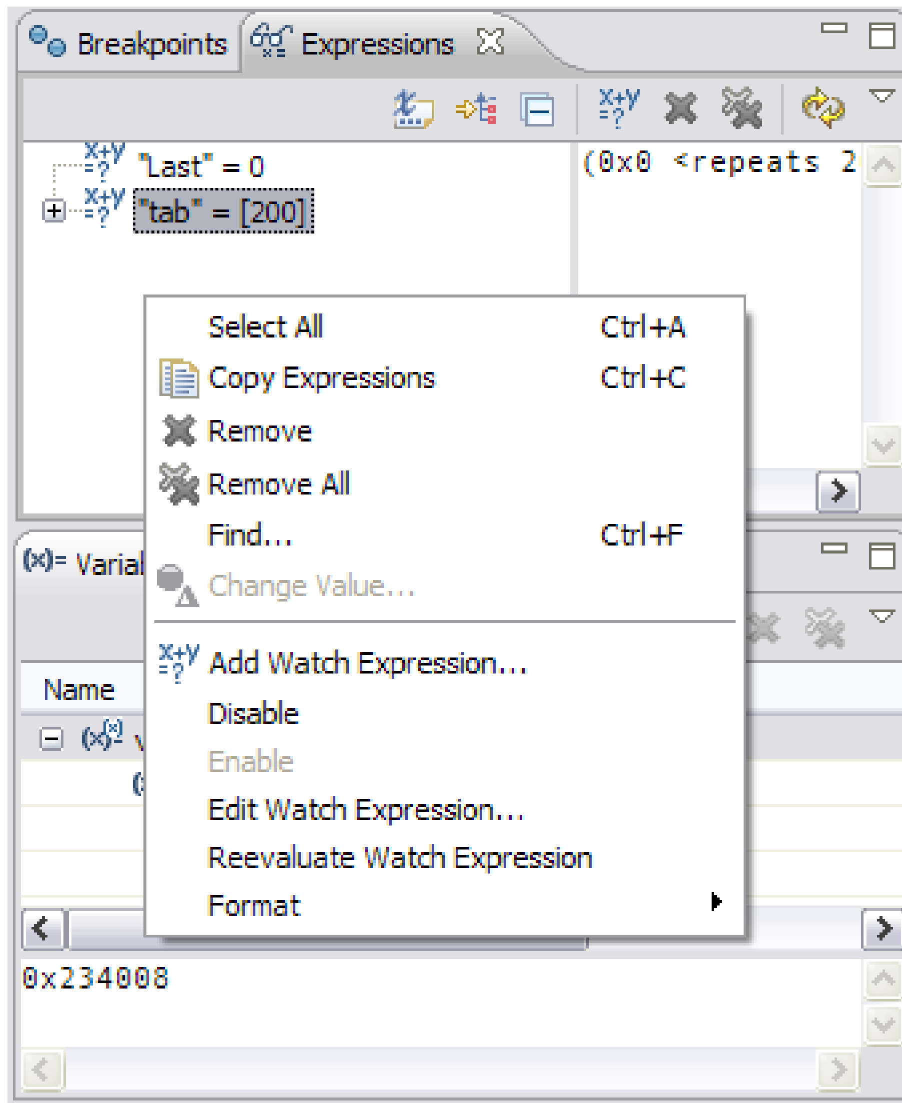
The variable V is an object of an access type so the value displayed in the Variables view is an address literal. We can dereference the address by clicking on the expansion control next to the variable name in the Variables view. In this case we see that V designates a record with a component named "E" having a value of two.

9.7.2 Examining Variables Declared in Packages

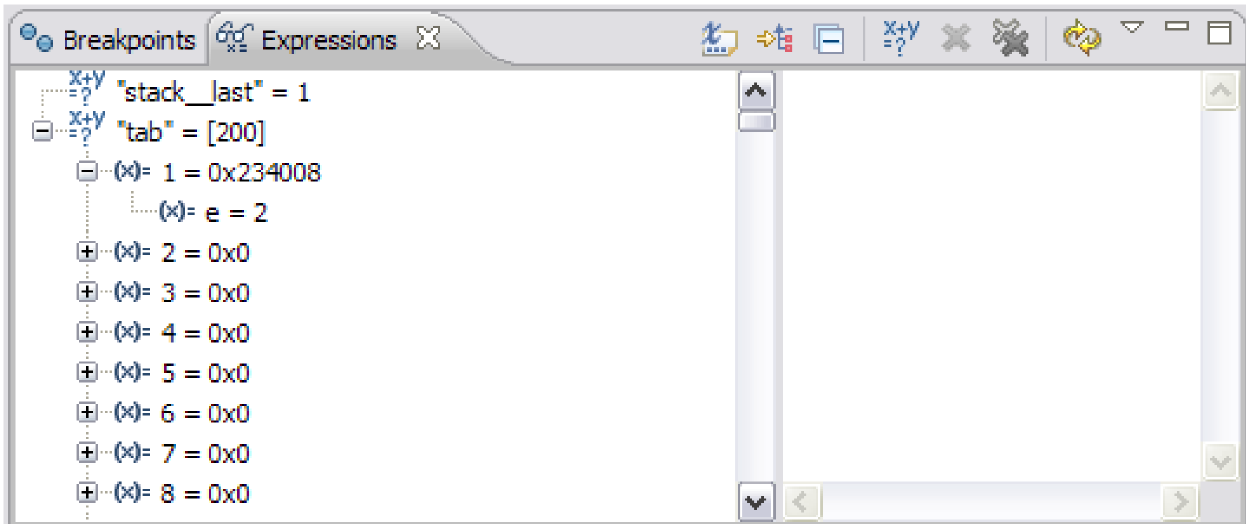
Variables declared within the declarative regions of packages are examined using the Expressions view.

In the figure above, a "watchpoint" expression has been added for the variable named "Last" that is declared within package Stack. We have also added an expression for the variable "Tab", a table of 200 pointers, and expanded it so the individual components are displayed.

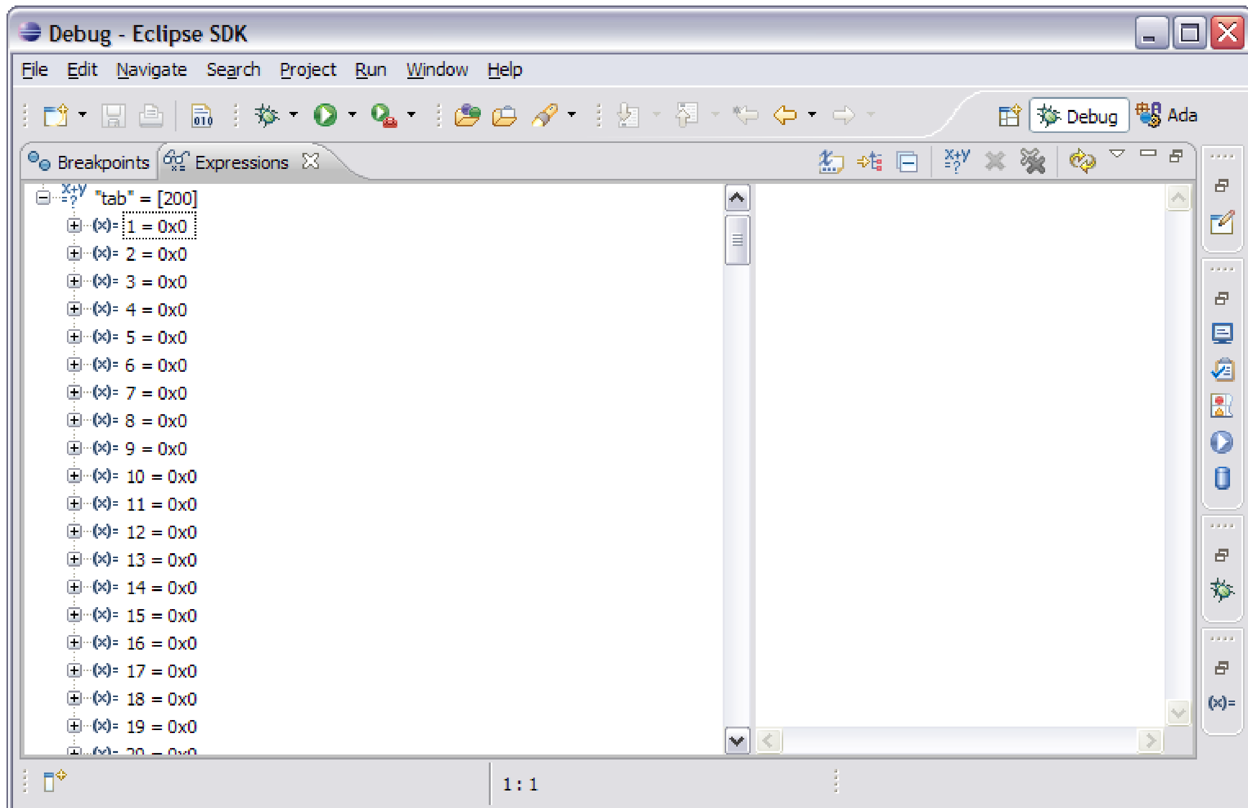
Expressions can be added and removed via the contextual menu for the view:



When the name of the variable to be used in the expression is not unique, you can use the full name, including the package name, to qualify it. However, in place of the dot between the package name and the variable name, the CDT debugger requires you to use two consecutive underscores. Thus, for example, in the following figure we have specified the full name for the variable Stack.Last as "stack__last":



Note that the Variables and Expressions view, like all views, can be maximized to make it easier for large amounts of data to be visible in the view:

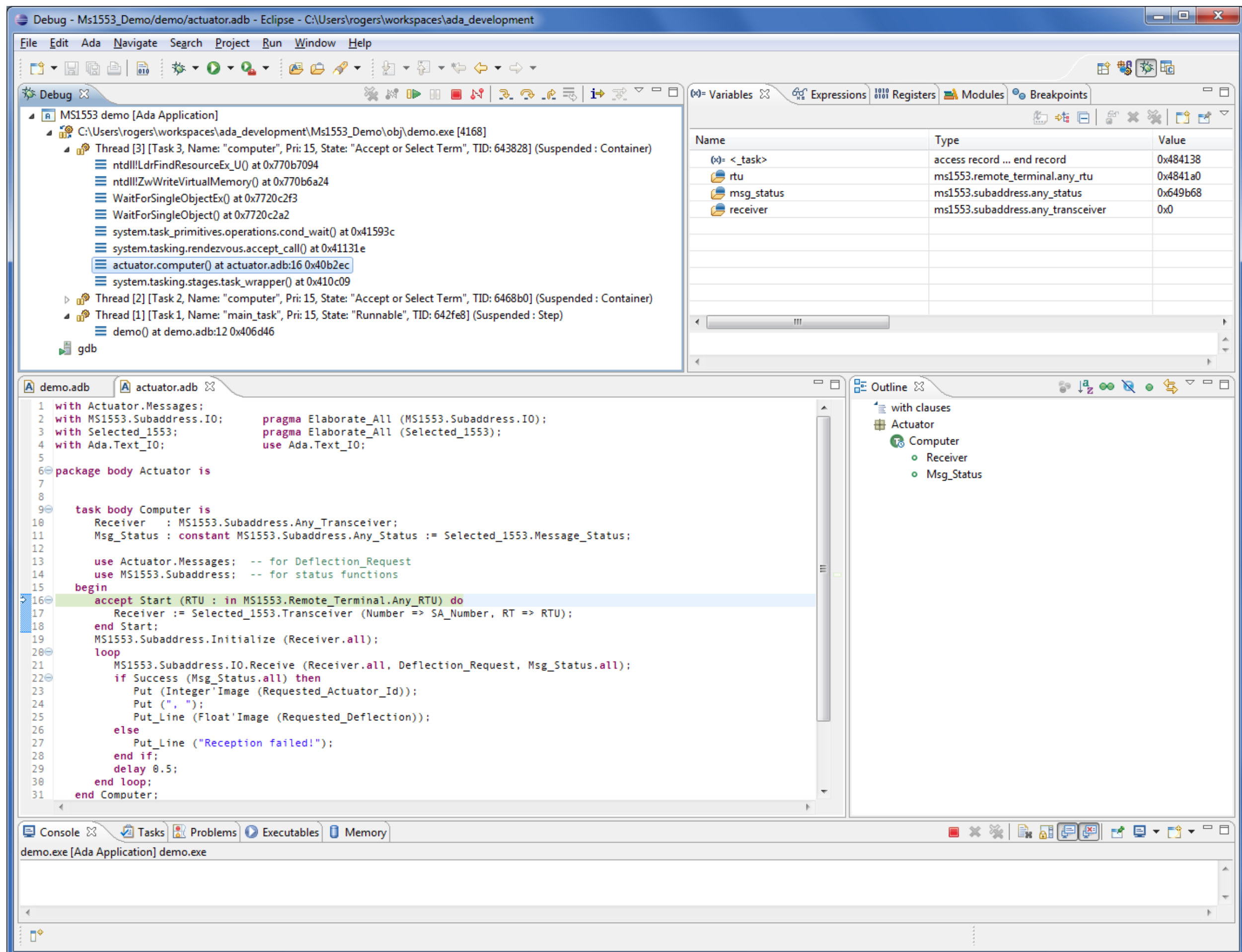


9.8 Debugging Tasks

It is possible to debug a multitasking application with GNATbench and the CDT debugger GUI. The version of GDB that comes with the GNAT compiler is Ada-aware and is therefore strongly suggested. Note also that a recent version of GDB is required for the task information enhancements shown in the Debug view.

To debug individual tasks set breakpoints in those tasks using the source view.

After hitting a breakpoint you should see something similar to the figure below.



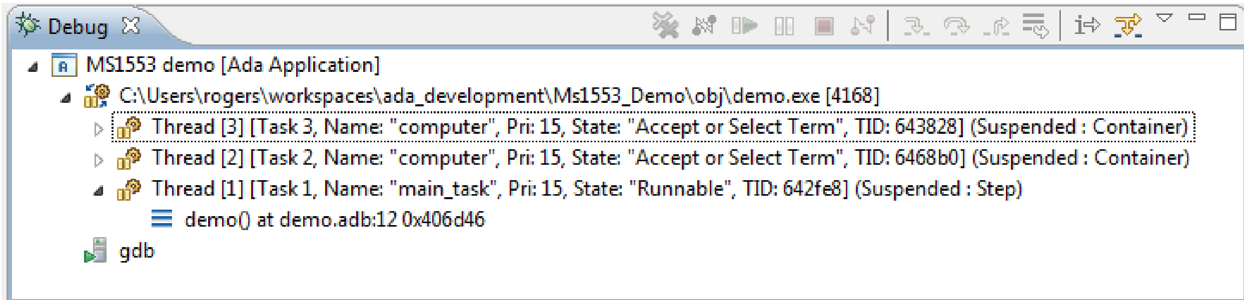

```
 1  with Actuator.Messages;
 2  with MS1553.Subaddress.IO;      pragma Elaborate_All (MS1553.Subaddress.IO);
 3  with Selected_1553;             pragma Elaborate_All (Selected_1553);
 4  with Ada.Text_IO;               use Ada.Text_IO;
 5
 6  package body Actuator is
 7
 8
 9     task body Computer is
10        Receiver   : MS1553.Subaddress.Any_Transceiver;
11        Msg_Status : constant MS1553.Subaddress.Any_Status := Selected_1553.Message_Status;
12
13        use Actuator.Messages;  -- for Deflection_Request
14        use MS1553.Subaddress;  -- for status functions
15     begin
16        accept Start (RTU : in MS1553.Remote_Terminal.Any_RTU) do
17           Receiver := Selected_1553.Transceiver (Number => SA_Number, RT => RTU);
18        end Start;
19        MS1553.Subaddress.Initialize (Receiver.all);
20        loop
21           MS1553.Subaddress.IO.Receive (Receiver.all, Deflection_Request, Msg_Status.all);
22           if Success (Msg_Status.all) then
23              Put (Integer'Image (Requested_Actuator_Id));
24              Put (", ");
25              Put_Line (Float'Image (Requested_Deflection));
26           else
27              Put_Line ("Reception failed!");
28           end if;
29           delay 0.5;
30        end loop;
31     end Computer;
```

Instead of seeing one task and one stack in the Debug view, we now have a number of them displayed in a tree. You can navigate from thread to thread and up and down the threads' individual stacks. This allows you to view local variables or evaluate expressions in the context of the thread and stack frame of your choosing. In the figure above we have clicked in the stack frame of thread 3, so the corresponding source for that task at that line is displayed.

Note that the call stack frames for the underlying run-time library and operating systems calls are displayed but are not traversable (unless you make the corresponding sources available to the debugger).

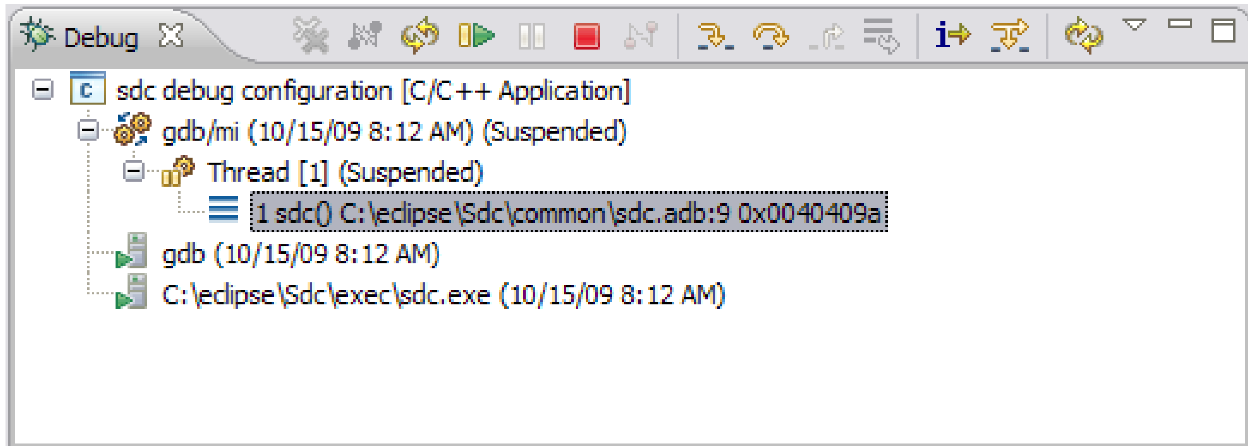
In addition to the lower-level thread-oriented information, the thread data also include higher-level Ada-oriented task information. For example, the following figure shows three threads in the application. Task 1 is the main procedure called by the environment task and is thus named "main_task" automatically. It is at priority 15 and is runnable. Tasks 2 and 3 are both suspended in either an accept statement (which is actually the case) or select-or-terminate alternative. Both have priority 15 as well. Both tasks are indicated as "computer" because that is the actual task object name in the source code. (Each is declared in a separate package so the same name could be used, such as "Flight.Computer" and

"Actuator.Computer" but only the object name is shown). Note that the thread number and the task number need not be identical, but are the same in this example.

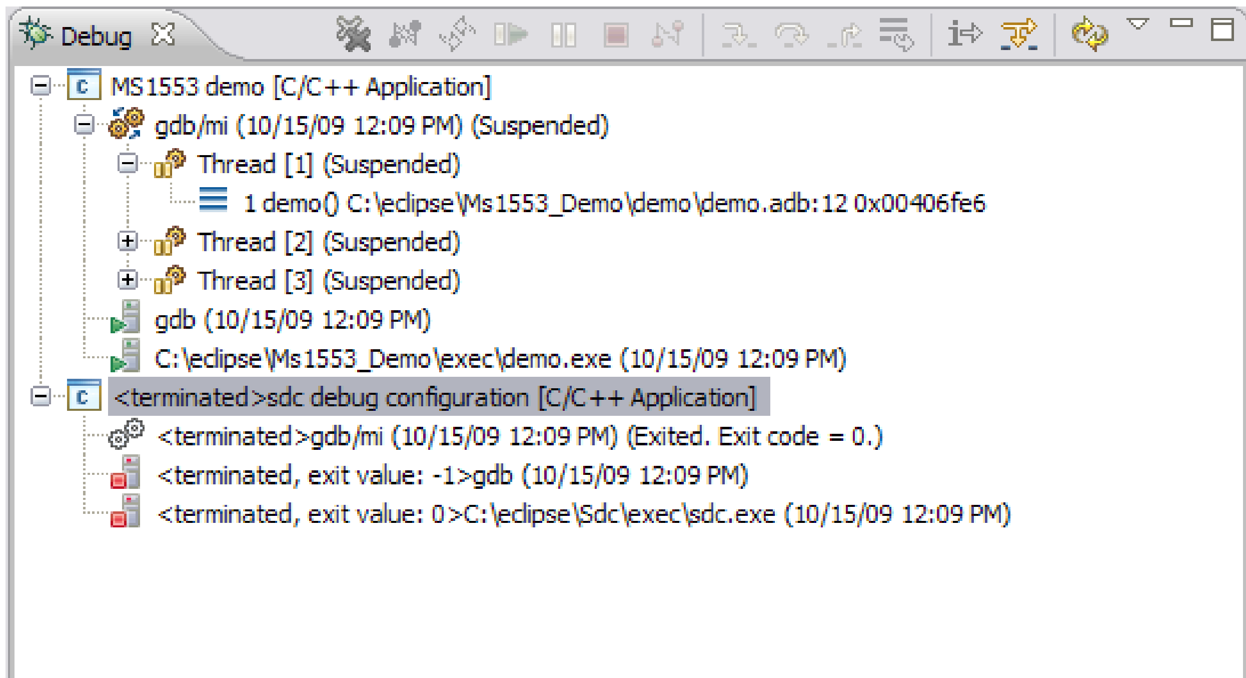


9.9 Ending A Debug Session

To finish your debug session, either allow your application to run to completion or halt it using the square red button in the debug tool bar.



If you had more than one session active, the other sessions will remain active and the terminated session will indicate the terminated status:



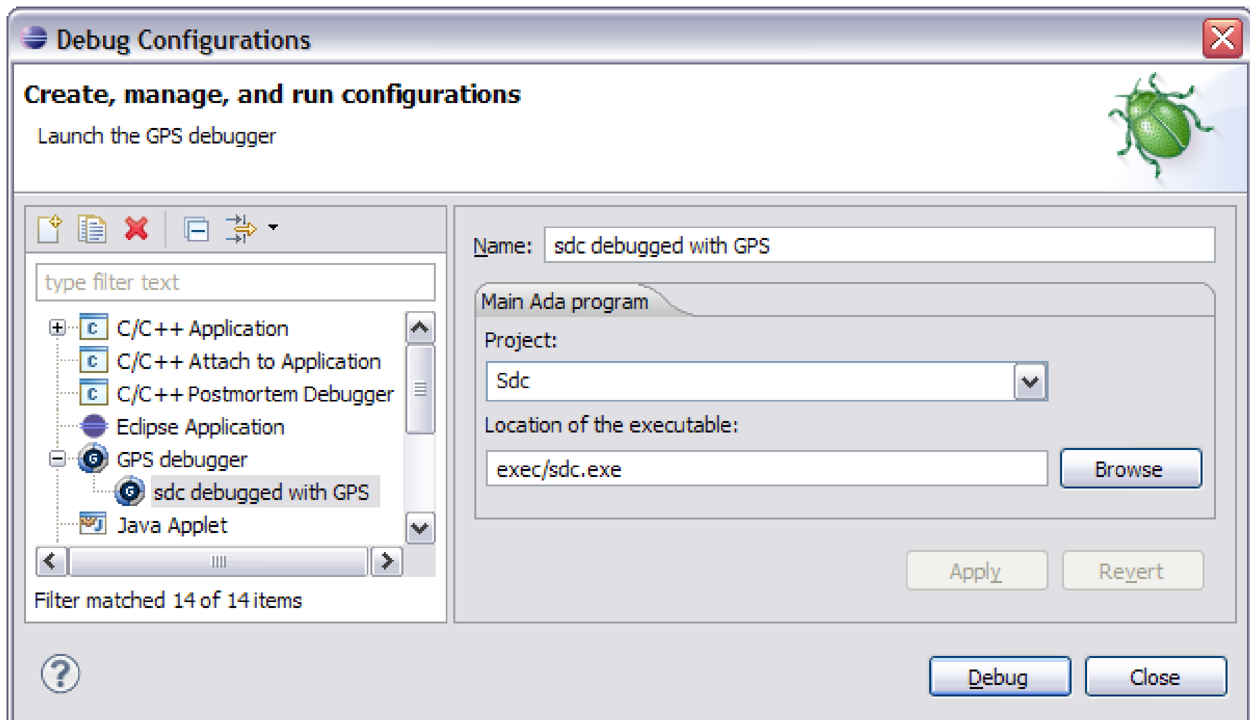
You can go back to the Ada perspective (or any other) by clicking on the Ada perspective icon at the upper right of the Eclipse window. You can close the Debug perspective or leave it open, as you wish. Leaving it open does not make it visible. To close it, right-click on the "Debug" perspective icon and then click on "Close" to close the perspective.

9.10 Using the GNAT Studio Debugger

As an alternative to using the GNATbench debugger, you have the option of launching the GNAT Studio debugger from Eclipse. This option may be attractive for users who are more familiar with or prefer the GNAT Studio debugger.

To debug your application under GNAT Studio, you need to create a new debug configuration, just as if you were going to use the built-in debugger. Select "Debug Configurations…" from the Run menu, or click on the down-arrow next to the Debug button on the toolbar and make the same selection there.

Next, in the left hand pane of the resulting Debug dialog, double click on "GNAT Studio debugger." You will then need to configure the name of the project to use and executable to run. You should see something like the following after pressing the Apply button:



You can now launch a GNAT Studio debug session by pressing "Apply" (if you have not already done so) and then "Debug".

9.11 Troubleshooting

If your GNAT Studio debugger session does not open the file in the source editor and instead indicates a strange file name in the GNAT Studio debugger console for the "file" command, it may be that you have one or more blanks in the path to the file. This is an easy situation to get into on Windows because of the blanks in the actual pathnames for the Desktop, "My Documents", and so on. For example, the typical pathname used for items located on the Windows desktop is "C:\Documents and Settings*user-name*\Desktop*item-name*".

For that same reason you may instead see a simple error dialog box pop up, titled "Launching", when you attempt to launch a GNAT Studio configuration. In this case GNAT Studio is not even started.

Assuming that removing these blanks is difficult, the alternative is to invoke GNAT Studio externally and select (browse to) the GNAT project file, then enter the debug mode from within GNAT Studio. (See the GNAT Studio User's Guide for details regarding the GNAT Studio debugger.)

CHAPTER TEN

TOOL INTEGRATIONS

10.1 Pretty Printer

The command “Pretty Print” allows you to format Ada source files using a number of language-specific options. The command is provided in the Ada menu on the menubar and in the contextual menus of the editor and the GNAT Project Explorer.

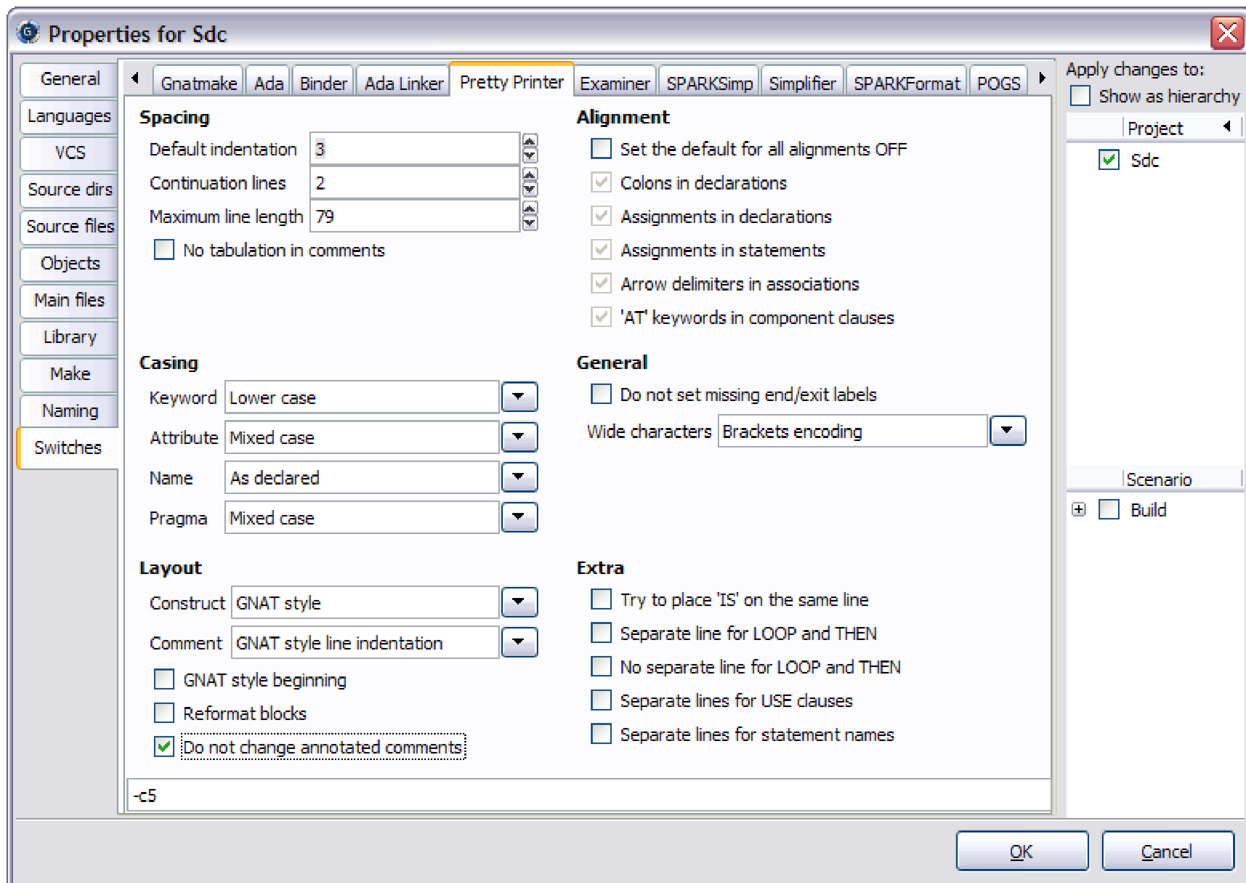
Note that in addition to formatting individual files, you can format all the files in an entire project by selecting the project node in the GNAT Project Explorer.

The actual formatting is provided by the external tool “gnatpp”, with switches specified in the GNAT project file. You can either edit the project file manually, as usual, or use the GNAT Project GUI properties editor to set them.

If you edit the GNAT project file manually, the package corresponding to the tool is named “Pretty_Printer” and it uses the Default_Switches attribute for language “Ada”. The following GNAT project file fragment provides an example:

```
38    package Pretty_Printer is
39       for Default_Switches ("ada") use ("-c5");
40    end Pretty_Printer;
```

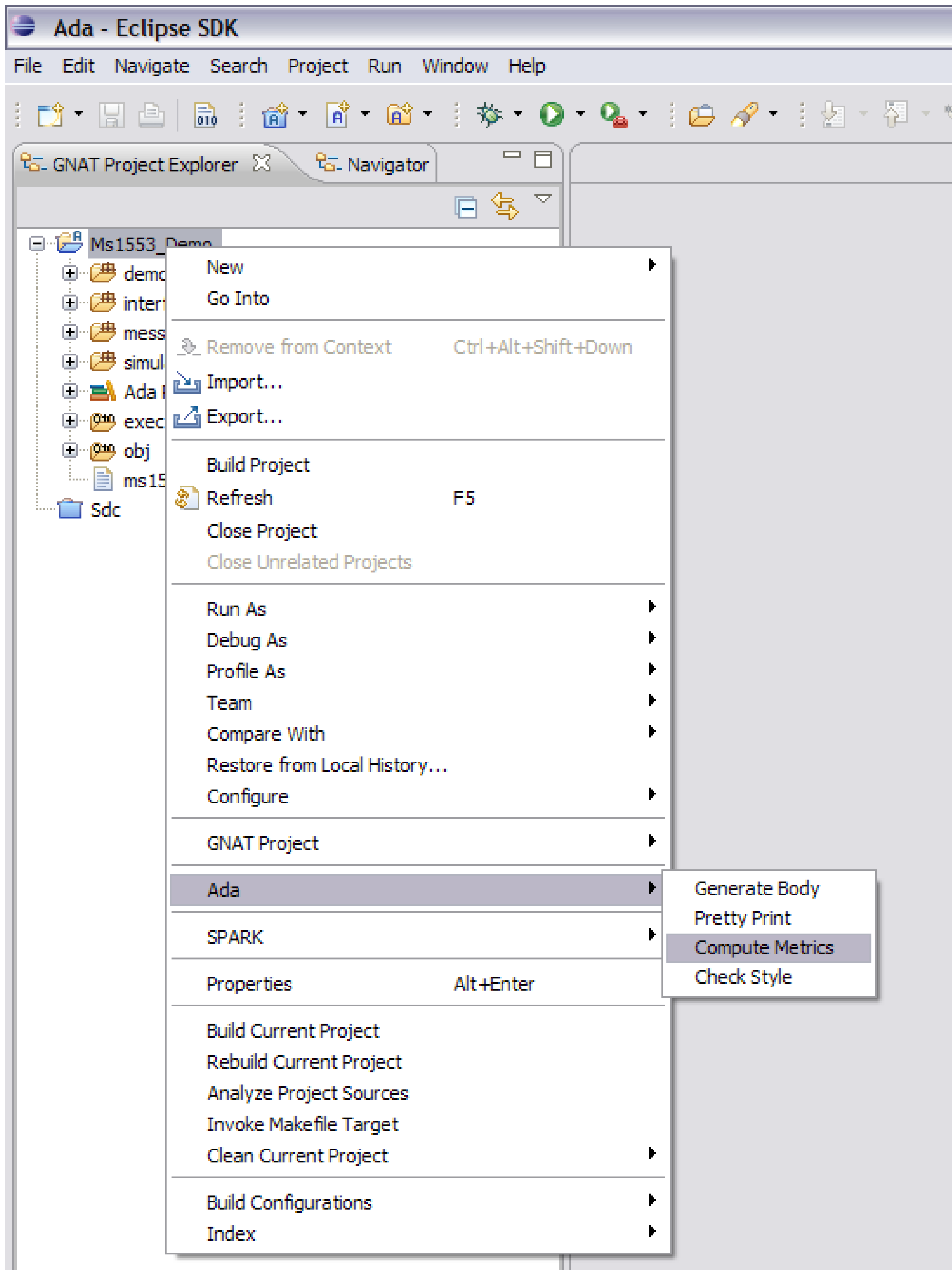
As usual it will be easier to use the interactive dialog to set the switches. To invoke the dialog, select GNAT Project -> Edit Properties from the GNAT Project Explorer’s contextual menu. The dialog will appear as follows:



10.2 Metrics Analysis

The command "Compute Metrics" allows you to analyze Ada source files using several different metric quantifiers. The command is provided in the Ada & Analyze menus on the menubar and in the contextual menus of the editor and the GNAT Project Explorer.

Note that in addition to analyzing individual files, you can analyze all the files in an entire project by selecting the project node in the GNAT Project Explorer. This option is illustrated below:


Ada - Eclipse SDK
File Edit Navigate Search Project Run Window Help
GNAT Project Explorer
Navigator
Ms1553_Demo
Sdc
New
Go Into
Remove from Context Ctrl+Alt+Shift+Down
Import...
Export...
Build Project
Refresh F5
Close Project
Close Unrelated Projects
Run As
Debug As
Profile As
Team
Compare With
Restore from Local History...
Configure
GNAT Project
Ada
SPARK
Properties Alt+Enter
Build Current Project
Rebuild Current Project
Analyze Project Sources
Invoke Makefile Target
Clean Current Project
Build Configurations
Index
Generate Body
Pretty Print
Compute Metrics
Check Style

10.2.1 Controls

The actual analysis is provided by the external tool "gnatmetric". See the GNAT User's Guide for the details of using the tool. The specific switches applied are controlled via the "Metrics" package in the project's GNAT project file (the "gpr file").

Note that re-issuing the command only performs the analysis again if necessary; specifically, if the GNAT project file has changed or if there are no prior results in the first place.

10.2.2 Results

Analysis results are displayed in the Metrics view, with an overall summary in the Console view.

Problems | Console | Scenario Variables | Metrics

Metrics [Ms1553_Demo]

```
[C:\eclipse\Ms1553_Demo]
gnat metric -x -dd -P C:\eclipse\Ms1553_Demo\ms1553_demo.gpr
Line metrics summed over 47 units
  all lines            : 2584
  code lines           : 1534
  comment lines        : 619
  end-of-line comments : 16
  comment percentage   : 29.49
  blank lines          : 431

Average lines in body: 11.07

Element metrics summed over 47 units
  all statements      : 278
  all declarations    : 819
  logical SLOC        : 1097

 57 public types in 18 units
 including
    7 abstract types
    9 tagged types
    15 private types

 65 type declarations in 20 units

 86 public subprograms in 21 units

 79 subprogram bodies in 16 units

Average cyclomatic complexity: 1.67
Metrics for [Ms1553_Demo] completed Oct 15, 2009 6:58:07 PM CDT.
```

The Metrics view shows the results in a tree format, with an overall project summary provided first. Results for each file then follow the project summary. In the figure below, the view has been maximized to show more of the results, and both the summary and the results for one of the subprograms have been expanded.

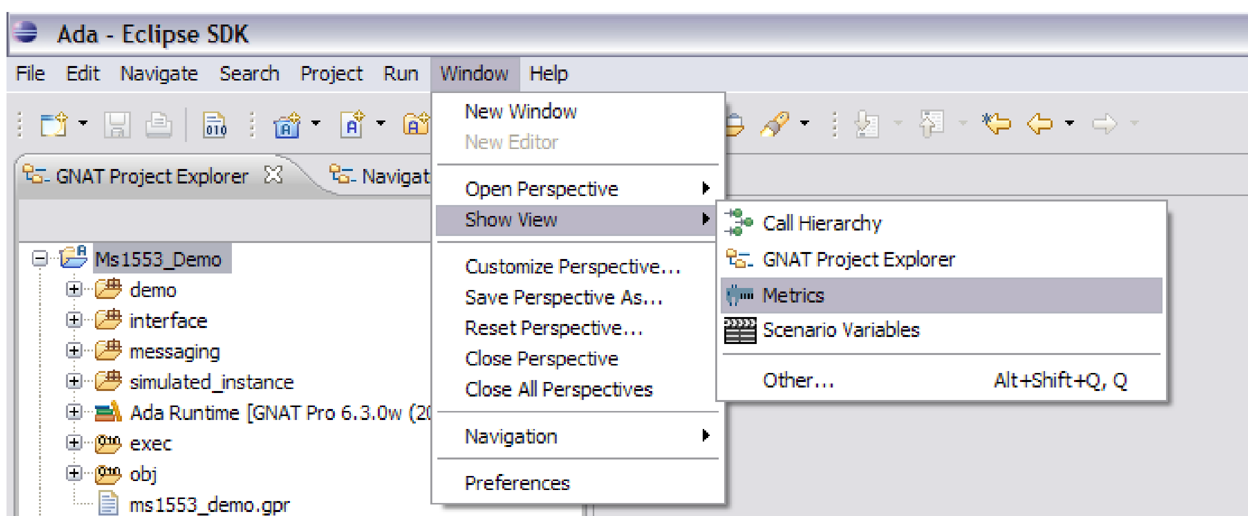
Ada - Eclipse SDK

File Edit Navigate Search Project Run Window Help

Problems | Console | Scenario Variables | Metrics

File	Value
Ms1553_Demo	
Whole project	
all_dds	819
all_lines	2584
all_stmts	278
all_subprograms	79
all_types	65
average_complexity	1.67
average_lines_in_bodies	11.07
blank_lines	431
code_lines	1534
comment_lines	619
comment_percentage	29.49
eol_comments	16
lsloc	1097
public_subprograms	86
public_types	57
actuator.adb	
actuator.ads	
actuator-messages.adb	
actuator-messages.ads	
demo.adb	
all_lines	27
blank_lines	6
code_lines	21
comment_lines	0
comment_percentage	4.76
eol_comments	1
Demo	
all_dcls	4
all_lines	18
all_stmts	6
all_subprograms	1
blank_lines	4
code_lines	14
comment_lines	0
comment_percentage	0.00
construct_nesting	1
cyclomatic_complexity	1
eol_comments	0
essential_complexity	1
extra_exit_points	0
lsloc	10
max_loop_nesting	0
public_subprograms	1
short_circuit_complexity	0
statement_complexity	1
flight_control.adb	
flight_control.ads	
flight_control-messages.adb	
flight_control-messages.ads	

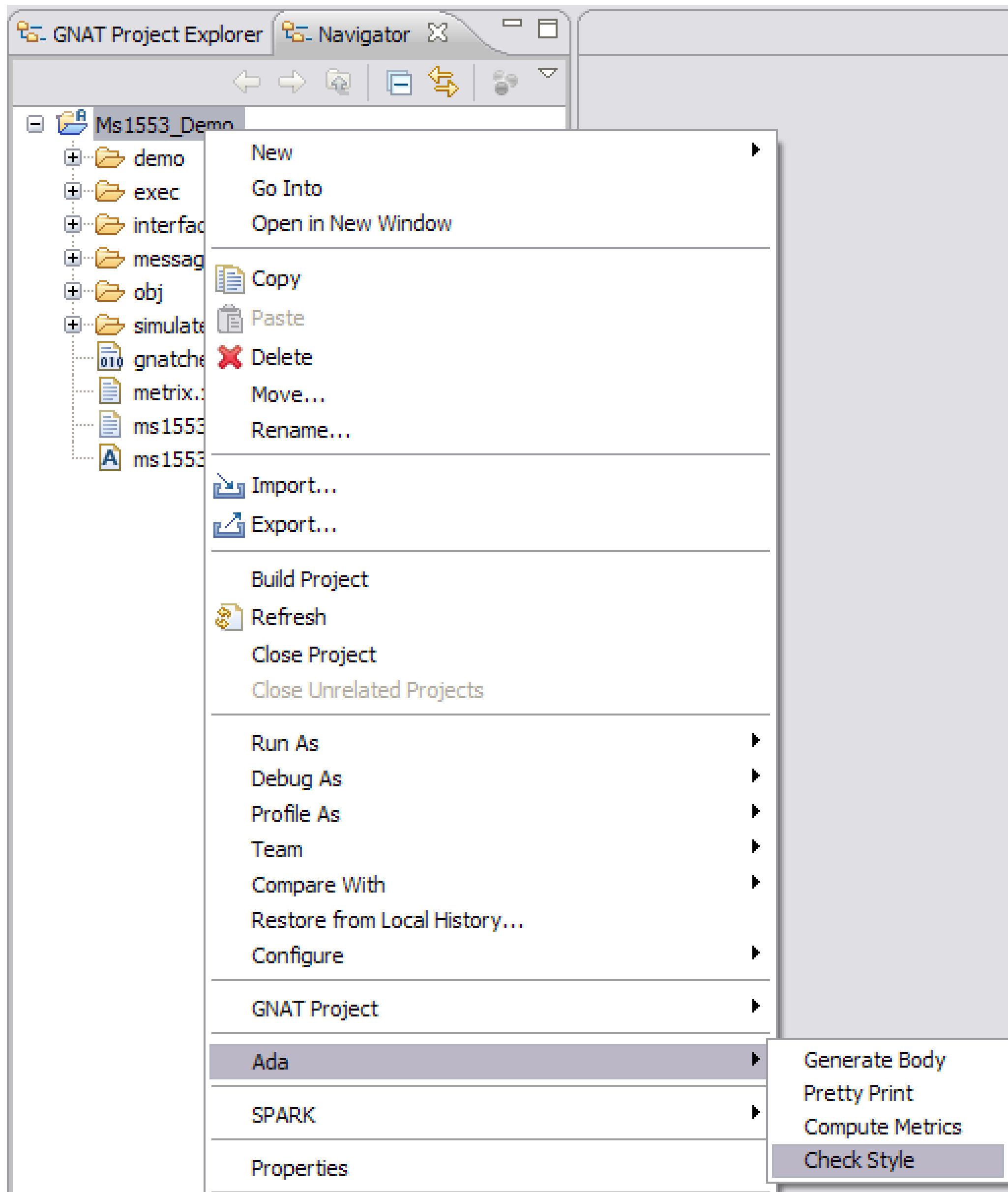
The Metrics view will be opened automatically after the analysis completes. You can open the view manually, using the shortcut:



10.3 Style Checking

The command "Check Style" allows you to analyze Ada source files using several different coding style rules. The command is provided in the Ada & Analyze menus on the menubar and in the contextual menus of the editor and the GNAT Project Explorer.

Note that in addition to analyzing individual files, you can analyze all the files in an entire project by choosing the command from the contextual menu when the project node in the GNAT Project Explorer is selected. This approach is illustrated below:



10.3.1 Controls

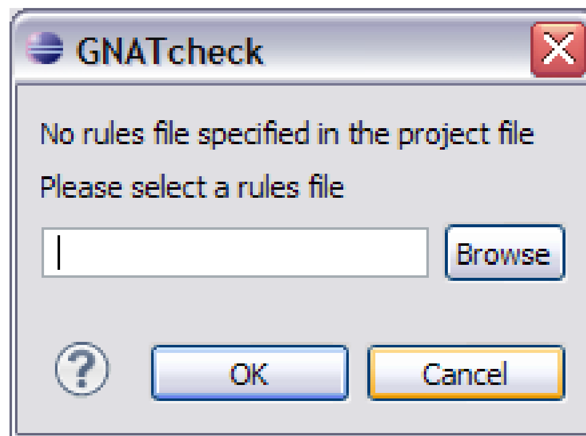
The actual analysis is provided by the external tool "gnatcheck". See the GNAT User's Guide for the details of using the tool.

The specific switches applied are controlled by means of a "rules" file. The name and location of this file can be specified in the package Check in the GNAT project file. The various switches may be specified there as well.

To specify the rules files, within the package Check specify the Default_Switches attribute for language "Ada". In that attribute, you must specify both the "-rules" switch as well as the name of the rules file itself using the "-from=" switch. For example, in the following GNAT project file fragment we specify the switch file name "ms1553.rules":

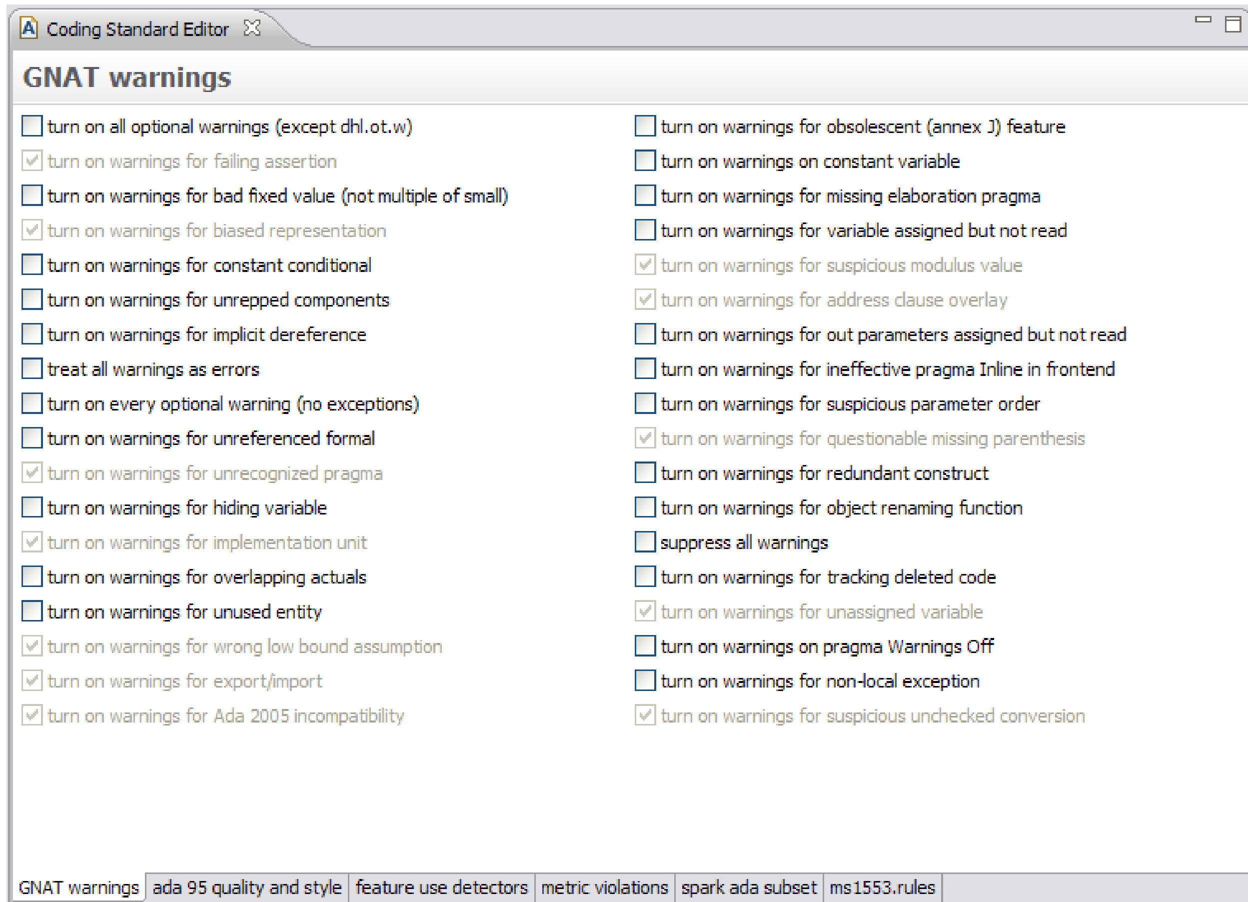
```
26
27    package Check is
28       for Default_Switches ("ada") use ("-rules", "-from=ms1553.rules");
29    end Check;
30
```

If you don't specify a rules file in the project file, the command will open a dialog box to prompt you for the file name and location:



In addition to setting the individual rules switches manually in the project file, you can also set the rules switches via a multipage graphical editor. The editor will be opened whenever you double-click on a file with the extension "rules", such as "ada.rules" or any similarly named file. To create a new rules file, just use the new-file wizard to create a file with an extension of ".rules" and the editor will open for it automatically.

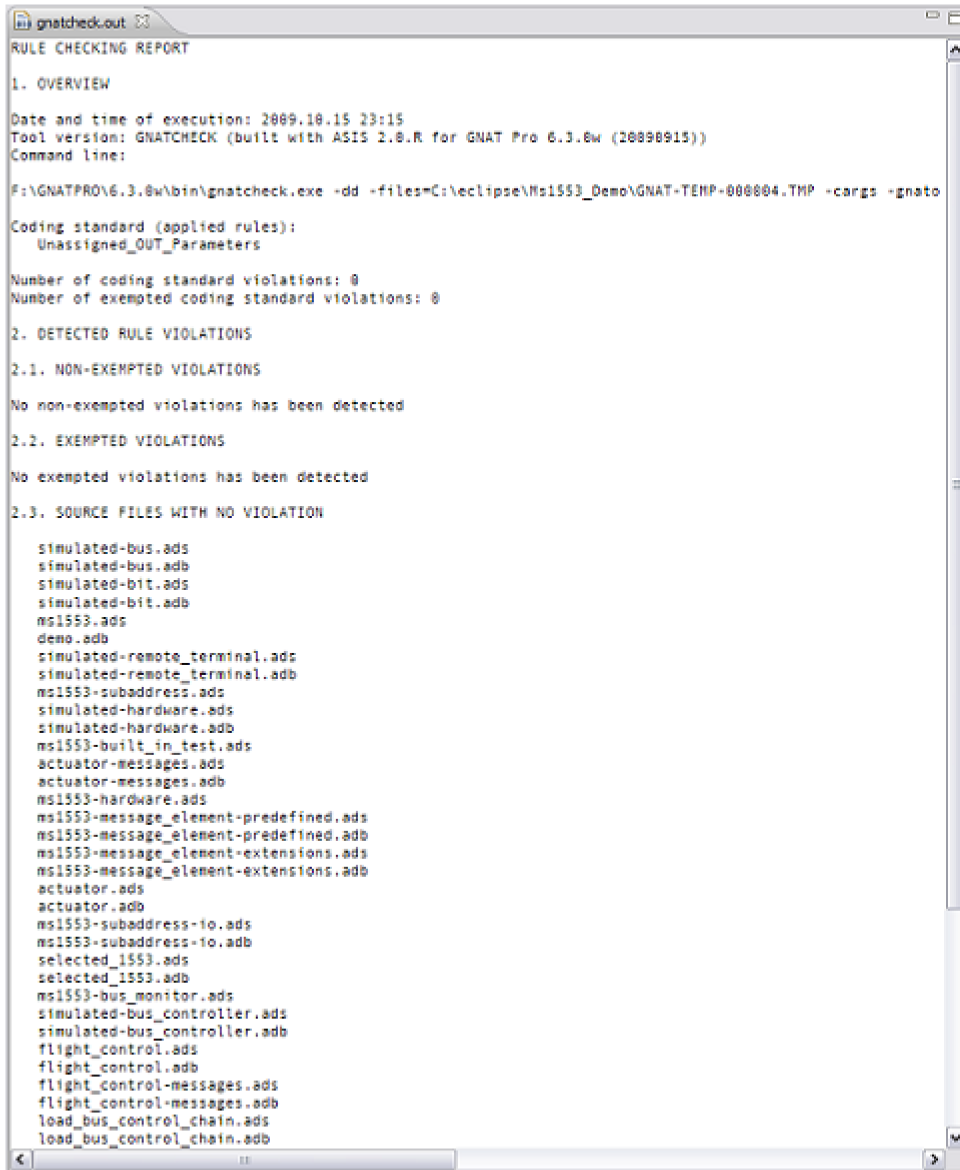
In the following, the file "ms1553.rules" has been opened:



Note the tabs at the bottom. The rules are separated into logical sections, based in part on their point of origin (e.g., the Ada 95 Quality and Style Guide, or the GNAT style warnings provided by the compiler). Each tabbed page contains options to be enabled or disabled by check-boxes, except for the last page on the far right. That page, labeled with the file name itself, contains the file in textual form.

10.3.2 Results

The results of the analysis appear in a text file. By default the file is named "gnatcheck.out", but you can specify the name in the GNAT project file.


gnatcheck.out
RULE CHECKING REPORT
1. OVERVIEW
Date and time of execution: 2009.10.15 23:15
Tool version: GNATCHECK (built with ASIS 2.0.R for GNAT Pro 6.3.0w (20090915))
Command line:
F:\GNATPRO\6.3.0w\bin\gnatcheck.exe -dd -files=C:\eclipse\Ms1553_Demo\GNAT-TEMP-000004.TMP -cargs -gnato
Coding standard (applied rules):
Unassigned_OUT_Parameters
Number of coding standard violations: 0
Number of exempted coding standard violations: 0
2. DETECTED RULE VIOLATIONS
2.1. NON-EXEMPTED VIOLATIONS
No non-exempted violations has been detected
2.2. EXEMPTED VIOLATIONS
No exempted violations has been detected
2.3. SOURCE FILES WITH NO VIOLATION
simulated-bus.ads
simulated-bus.adb
simulated-bit.ads
simulated-bit.adb
ms1553.ads
demo.adb
simulated-remote_terminal.ads
simulated-remote_terminal.adb
ms1553-subaddress.ads
simulated-hardware.ads
simulated-hardware.adb
ms1553-built_in_test.ads
actuator-messages.ads
actuator-messages.adb
ms1553-hardware.ads
ms1553-message_element-predefined.ads
ms1553-message_element-predefined.adb
ms1553-message_element-extensions.ads
ms1553-message_element-extensions.adb
actuator.ads
actuator.adb
ms1553-subaddress-io.ads
ms1553-subaddress-io.adb
selected_1553.ads
selected_1553.adb
ms1553-bus_monitor.ads
simulated-bus_controller.ads
simulated-bus_controller.adb
flight_control.ads
flight_control.adb
flight_control-messages.ads
flight_control-messages.adb
load_bus_control_chain.ads
load_bus_control_chain.adb

CHAPTER

ELEVEN

USING AJIS

11.1 Creating and Building an AJIS Project

11.1.1 Audience

This document is intended for users already somewhat familiar with Eclipse, the JDT, and GNATbench. Some familiarity with AJIS may be useful.

11.1.2 Before You Begin

Install AJIS (remember to set the path and classpath). Make sure that the version of AJIS matches the compiler date and the minimum requirements for the GNATbench AJIS integration.

Install the "make" utility if it is not already installed. Windows users can download the GNU version via the "Miscellaneous/Utils" section of the "Downloads" page on GNAT Tracker. The file to download is named "gnumake-3.79.1-pentium-mingw32msv.exe" or something similar (i.e., the version number could be different). Once downloaded, rename the file to "make.exe" and put it somewhere on your path.

Consider disabling automatic builds, at least until the new Ada project has been fully configured.

Optionally, set Eclipse to refresh resources on access (as of Eclipse 3.7). This is a workspace preference. It is changed via the `Window -> Preferences` menu; the specific property is on the `General / Workspace` page. Occasionally you will still need to manually refresh the Java projects that have corresponding Ada interfaces generated, but this preference can help.

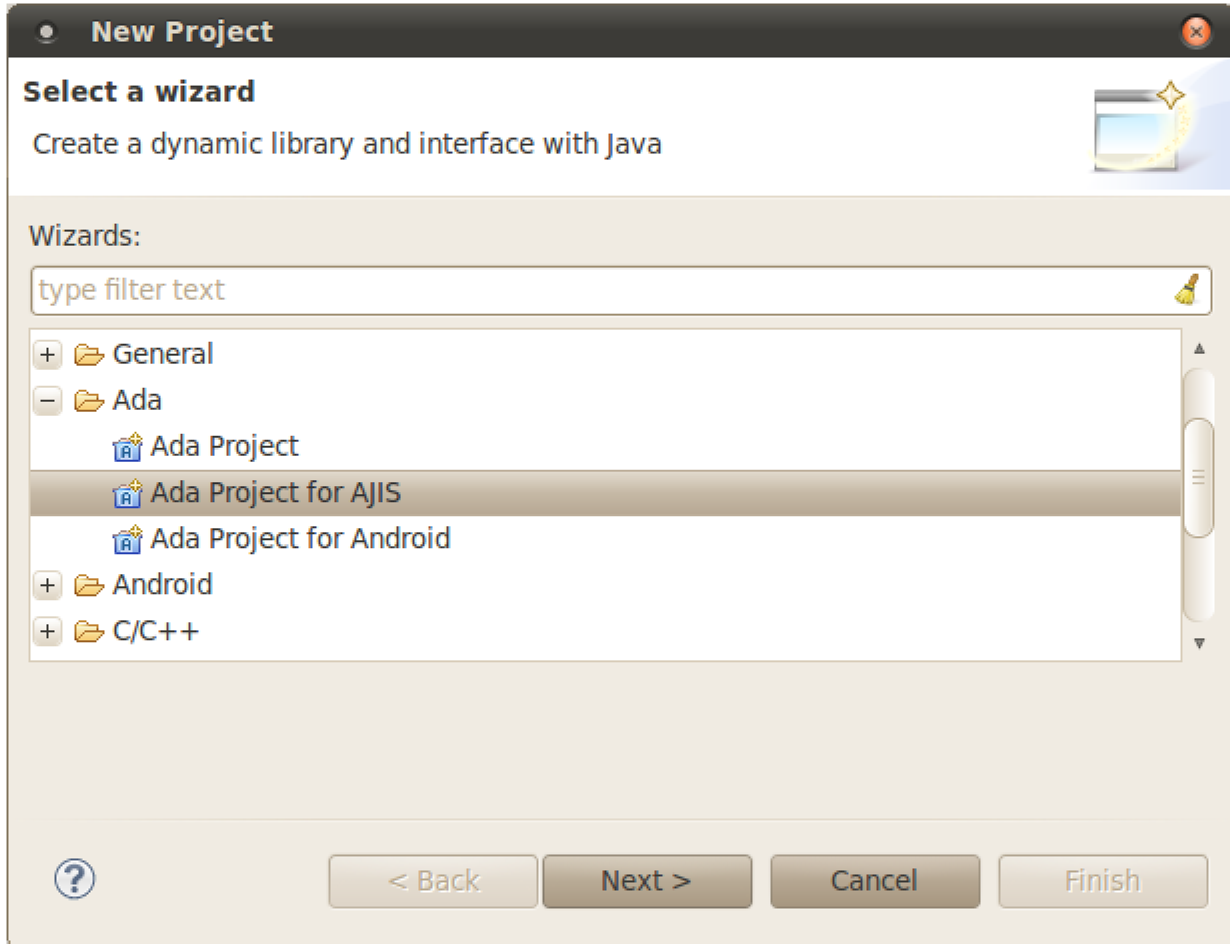
Important

Before you create an Ada project for use with Java and AJIS, first create a new client Java project using the JDT. This Java project will be used for primary Java development. Prior project creation is not strictly required but will be convenient because the Ada new-project wizard can automatically make the modifications to the client Java project required for the sake of the Ada project. Otherwise, you will have to modify the Java project yourself.

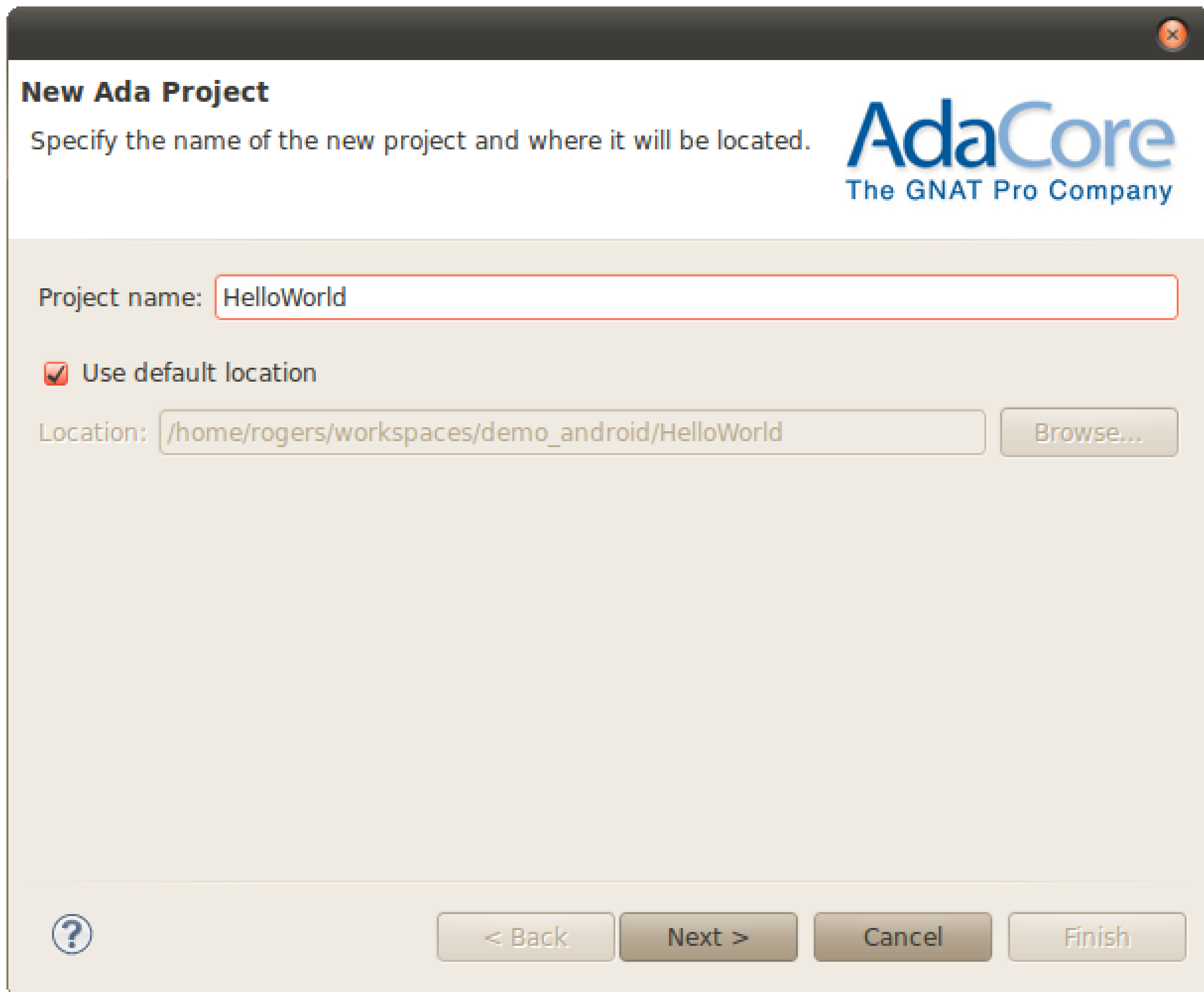
11.1.3 Create an Ada Project for AJIS

Once the client Java project exists, you are ready to create the new Ada AJIS project.

First, open the New Project Wizard with `File -> New -> Project`, then select "Ada Project for AJIS" under the Ada category.



In the resulting wizard page, name the new Eclipse project:

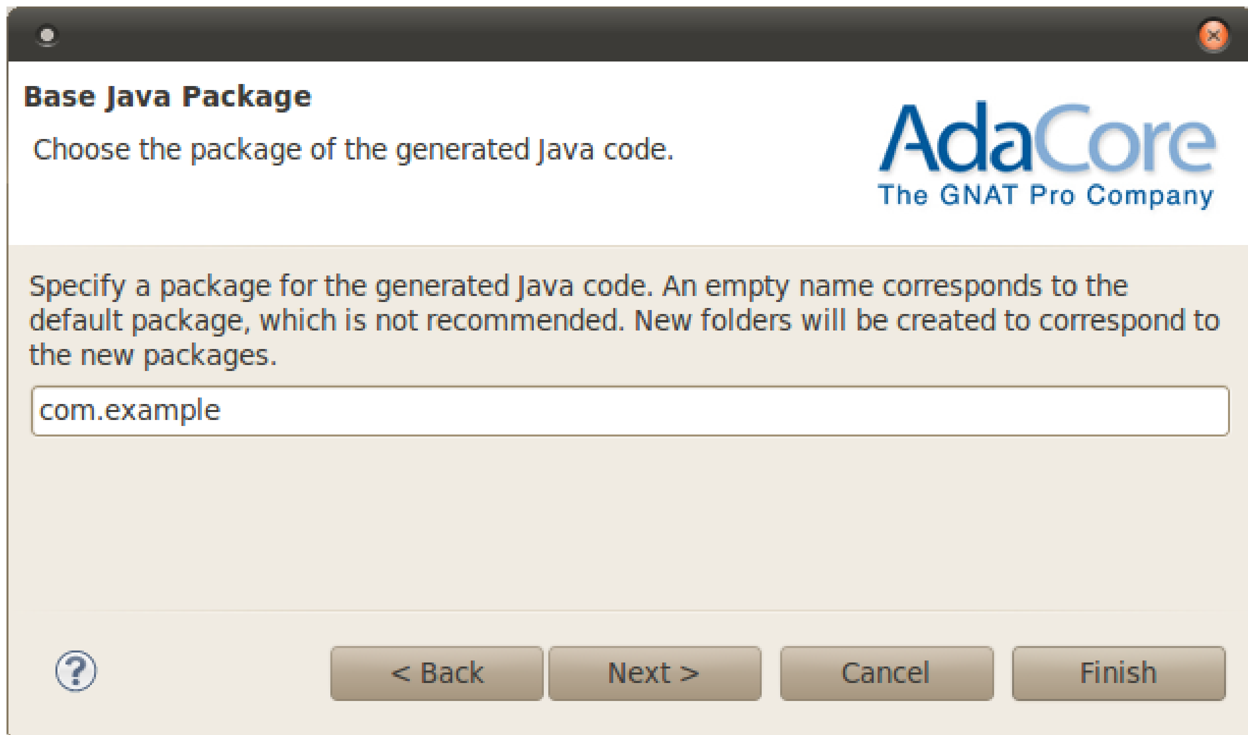


Then on the next wizard page specify the GNAT project unit name. The names can be the same but need not be. However, the GNAT project unit name must be a legal Ada identifier.

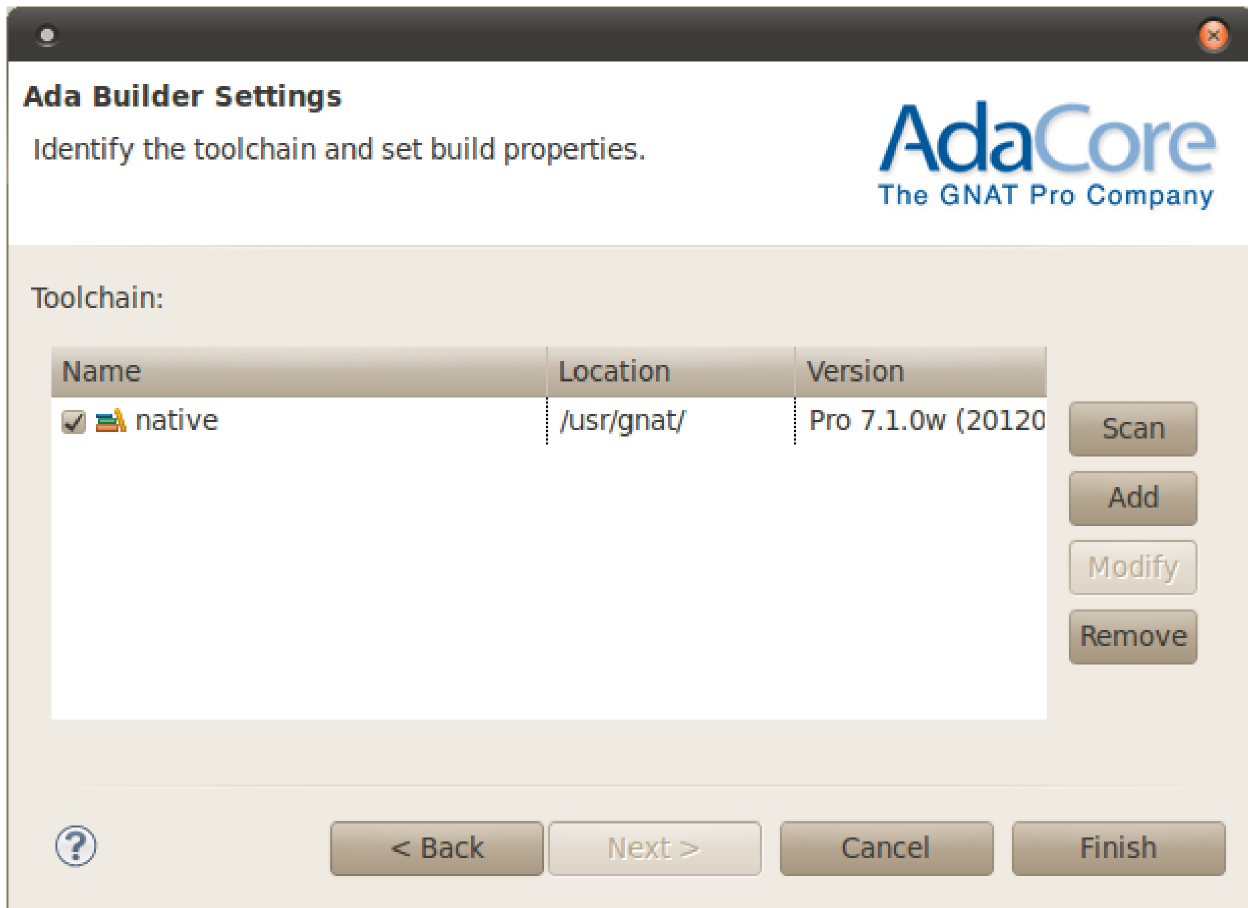
On the next page, specify the name for the dynamic library that will contain your Ada code. This dynamic library will be produced when the Ada project is built, and is used by the client Java project.

On the next page, specify the names of the folders where the AJIS-generated code will be placed. Enter two, one each for the Ada and Java code. The names may also be paths to the folders. Folders that do not exist will be created by the wizard. Relative paths are treated as subdirectories of the Eclipse project root within the workspace.

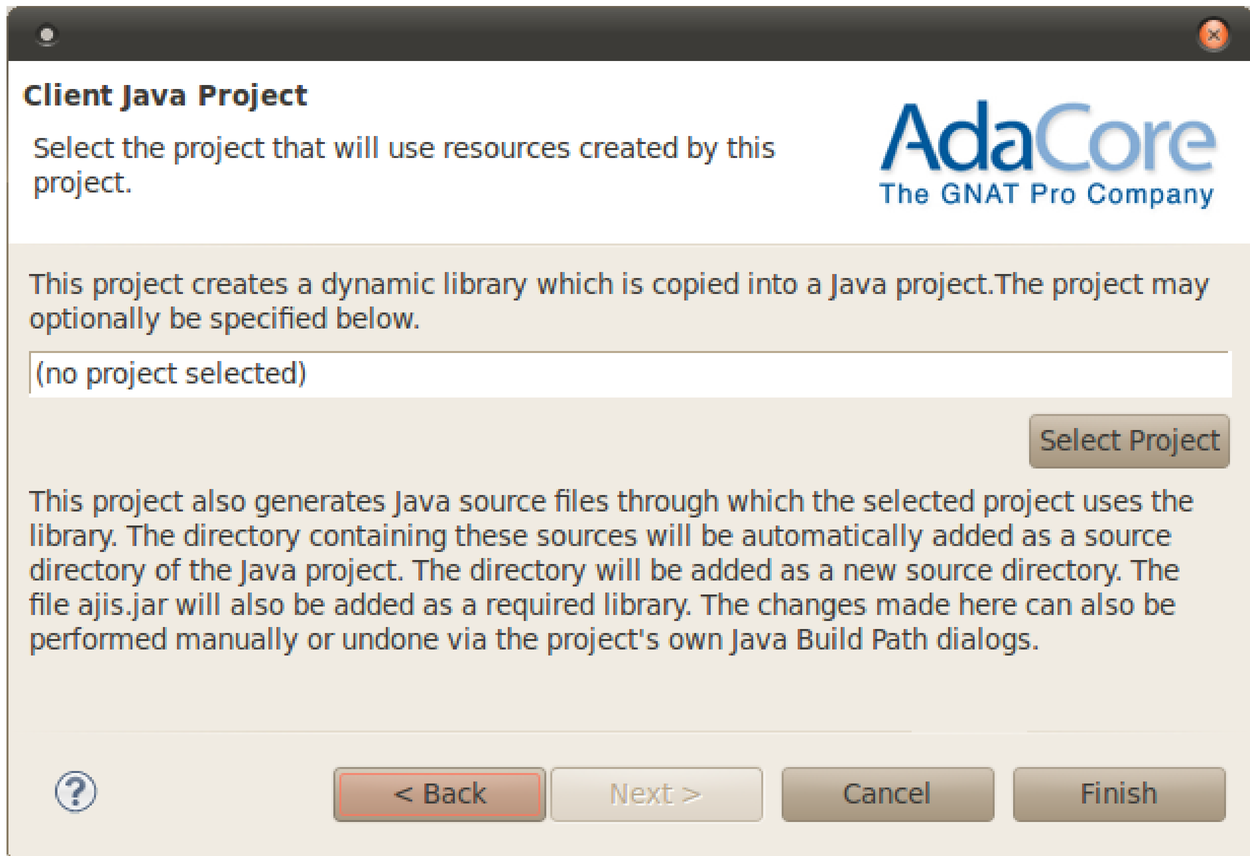
Next, specify the name of the Java package that will contain the generated Java code. Alternatively, you can perform this step by editing this Ada project's properties later, after the wizard completes.



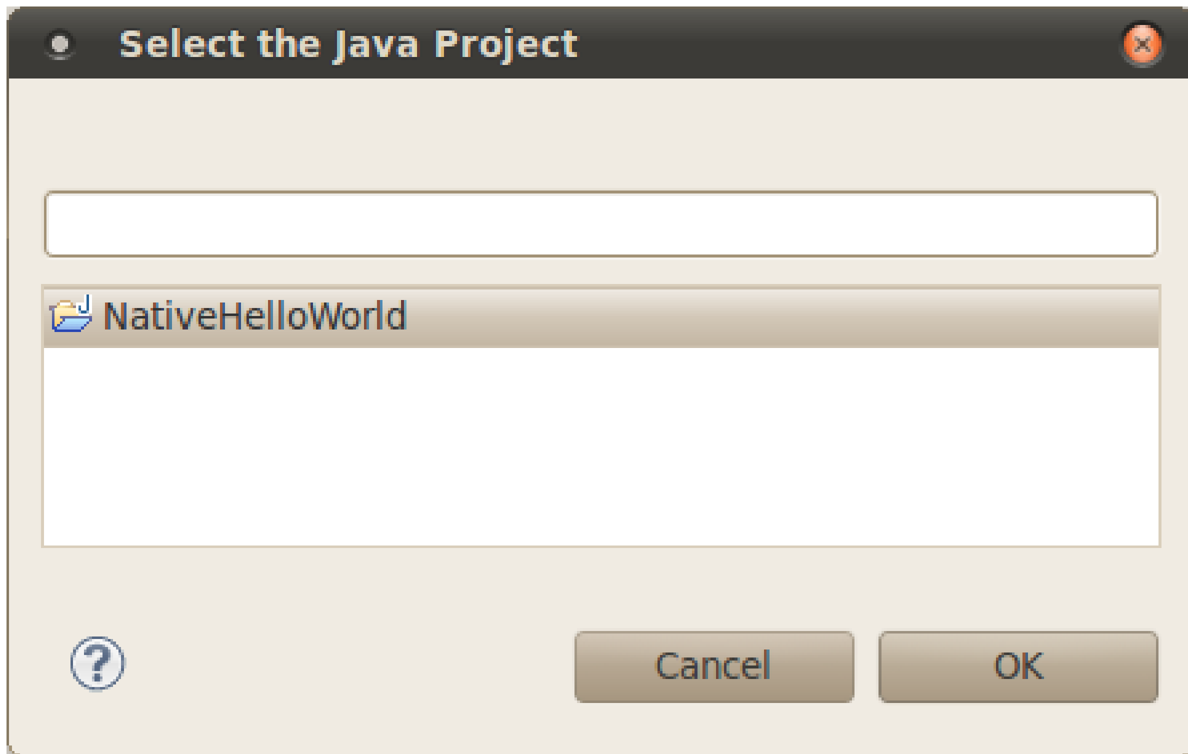
Then select the toolchain used to build the project. Presumably you will want the native Ada toolchain.



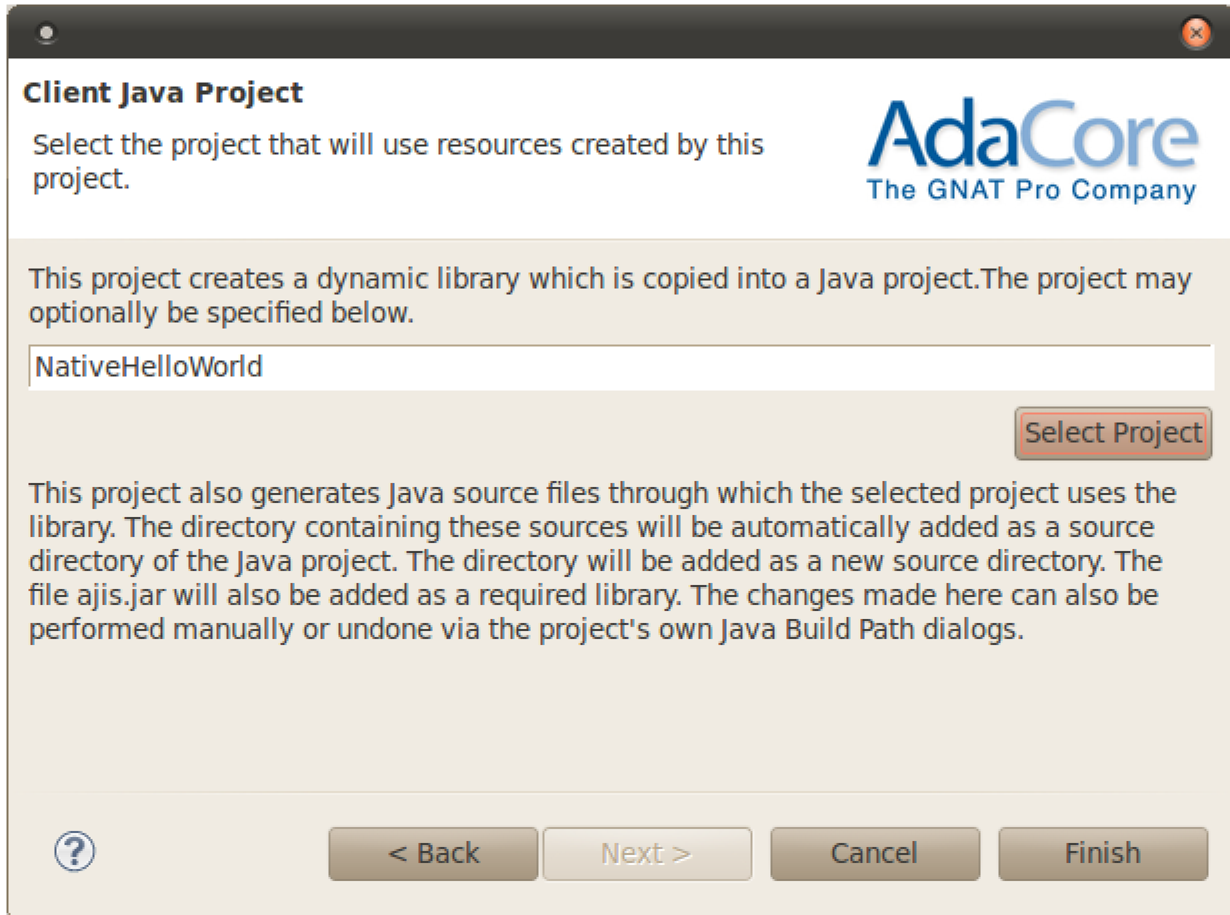
Next select the existing client Java project that will use the Ada dynamic library created by this new Ada project. The Java project must be configured to reference this dynamic library and generated Java code. This configuration step will be performed automatically if a project is selected. Alternatively, you can either perform this step manually with the JDT Build Path dialogs, or edit this Ada project's properties.



Click "Select Project" to open a project selection dialog and choose an open Java project in the current workspace. Then press OK.



The selected project will then appear in the wizard dialog page.



(If the AJIS jar file is not found on the system classpath the user is asked to select the file. Note that this should have been set as part of the AJIS installation.)

Press Finish and the wizard will complete. At this point, the new Ada project is almost, but not quite, ready to be built. Ada sources must be specified so that the corresponding Java interfaces can be generated by AJIS. These Ada sources don't necessarily exist yet – certainly not within the project we just created – so we specify them after the wizard completes.

11.1.4 Final Project Setup Steps

The last steps to be taken are to 1) populate the project with Ada sources, and 2) select a subset of them to be used as interfaces for the client Java code. These interface packages will be passed to AJIS (ada2java) during the Ada project build so that corresponding Java code is produced to call the Ada code.

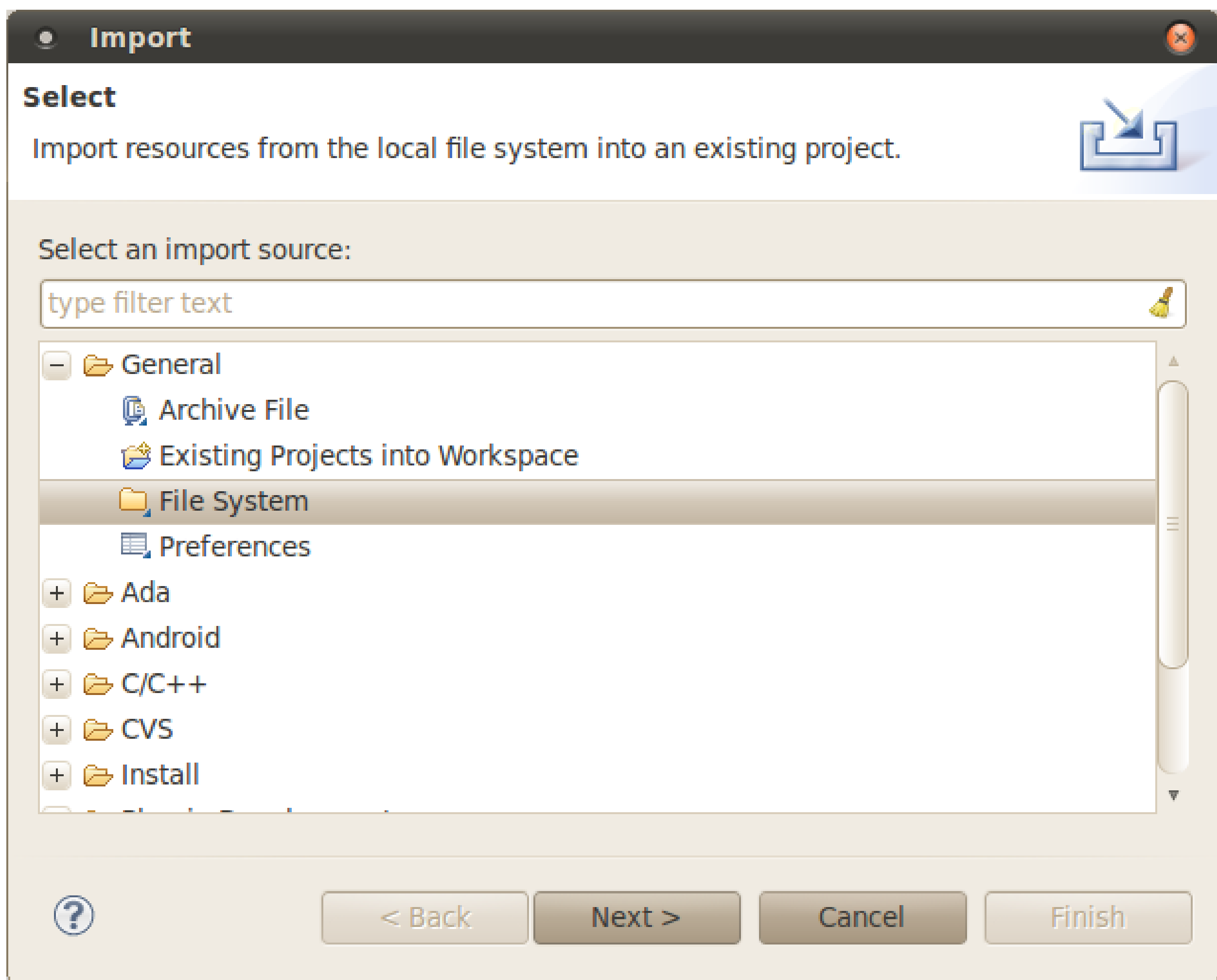
Populating with Ada Sources

The wizard creates an empty directory named "src" to contain Ada source files. Use of this directory is optional; you could use others, or just use the project root. We suggest using explicit source directories, however, for the sake of keeping everthing simple. New source directories can be created via the GNATbench New Source Folder toolbar button. Using that facility will automatically update the GNAT project file contents so that the resulting source directories are known to the builder.

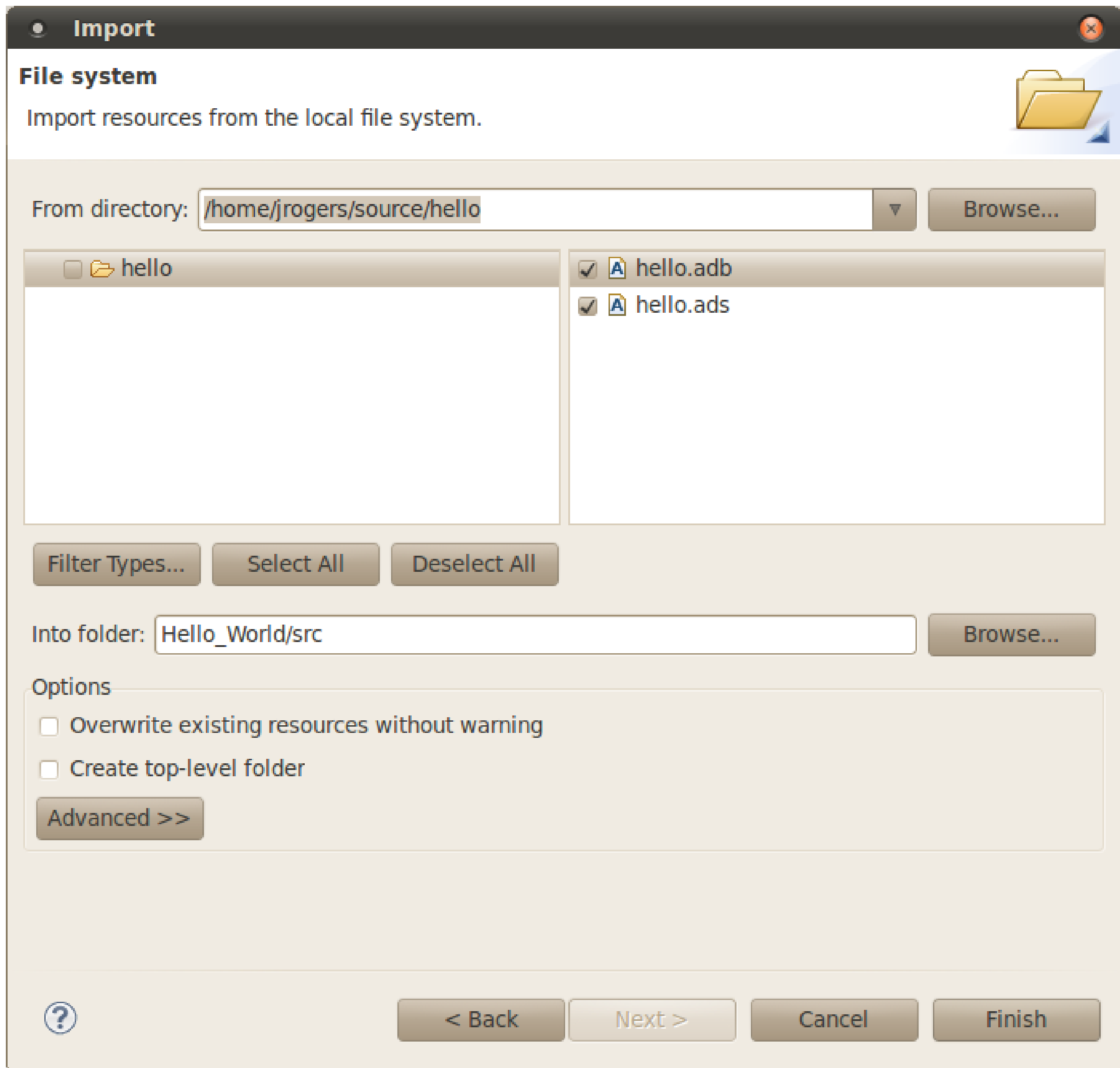
Once the source folders are to your liking you may use the editor to create the Ada source files. Alternatively, existing source directories and files outside the workspace may be imported through the Eclipse Import wizard. Imported source directories must be specified manually in the GNAT project file since the New Source Folder wizard is not used to create them.

This example describes how to import two existing source files into the default source folder.

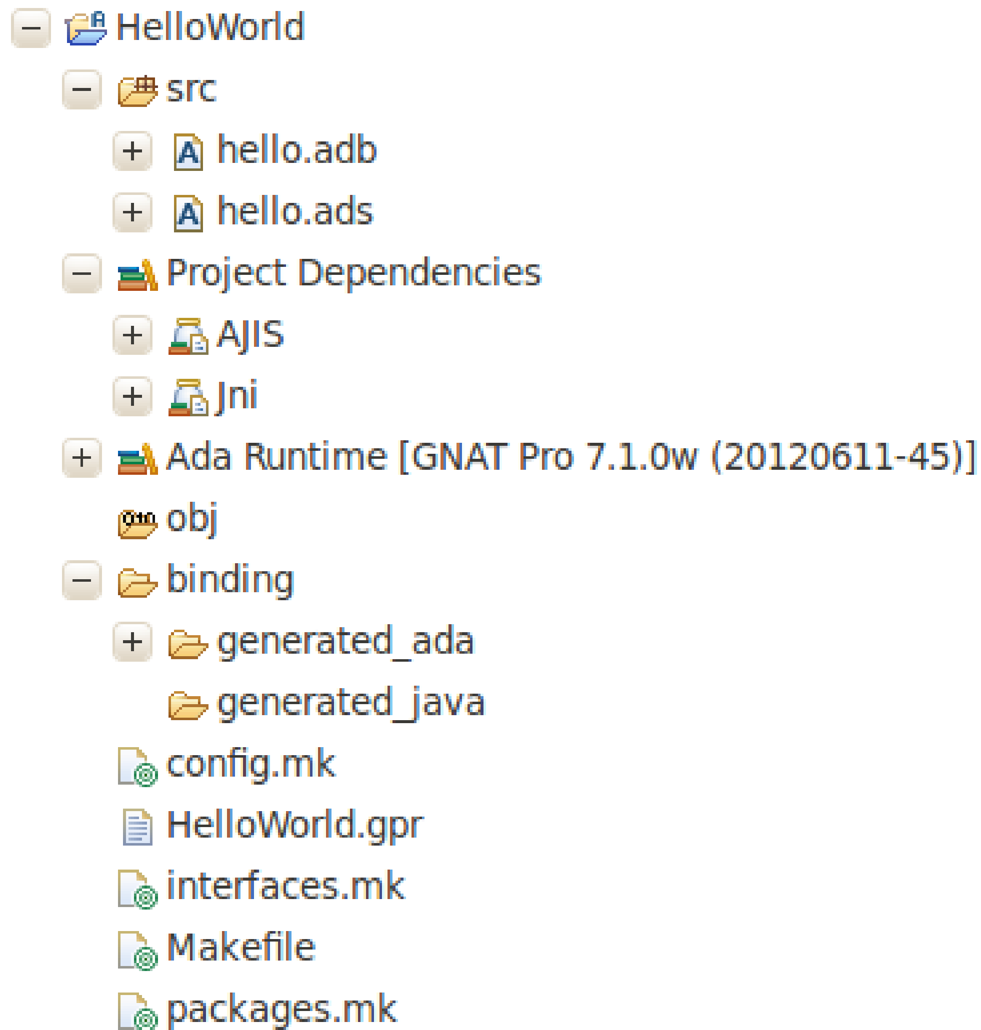
Right-click the "src" directory of the project and select "Import" and then "File System."



Select a directory containing source files. Check the boxes corresponding to the necesssary files.



After you press "Finish" the project should look something like this (although some names will vary). Note the two source files under "src" that have been imported.



In this example, the source files are `hello.ads`:

```
package Hello is

   function Greeting (Item : in Integer) return String;

end Hello;
```

and `hello.adb`:

```
with Ada.Characters.Latin_1;
with Ada.Numerics.Long_Elementary_Functions;

package body Hello is

   function Greeting (Item : in Integer) return String is
   begin
      return "Hello from Ada! Java passed "
         & Integer'Image (Item)
         & Ada.Characters.Latin_1.LF
```

(continues on next page)

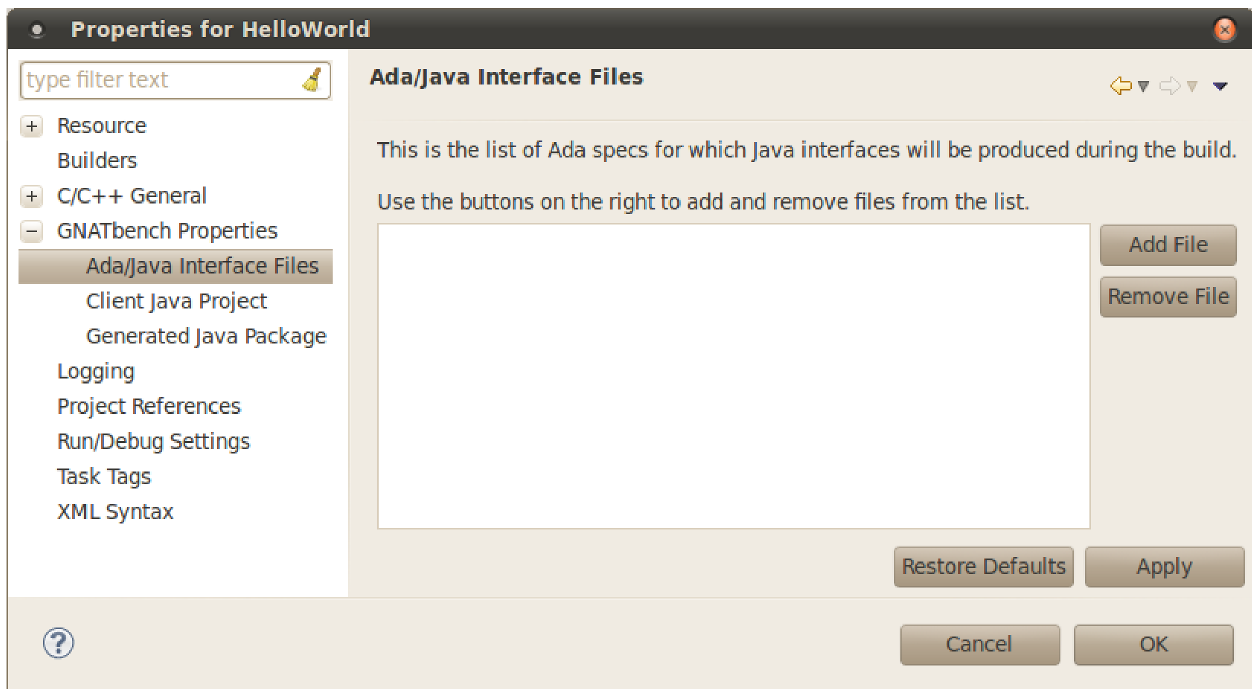
(continued from previous page)

```
        & "which has square root "
        & Long_Float'Image
           (Ada.Numerics.Long_Elementary_Functions.Sqrt
              (Long_Float (Item)));
  end Greeting;

end Hello;
```

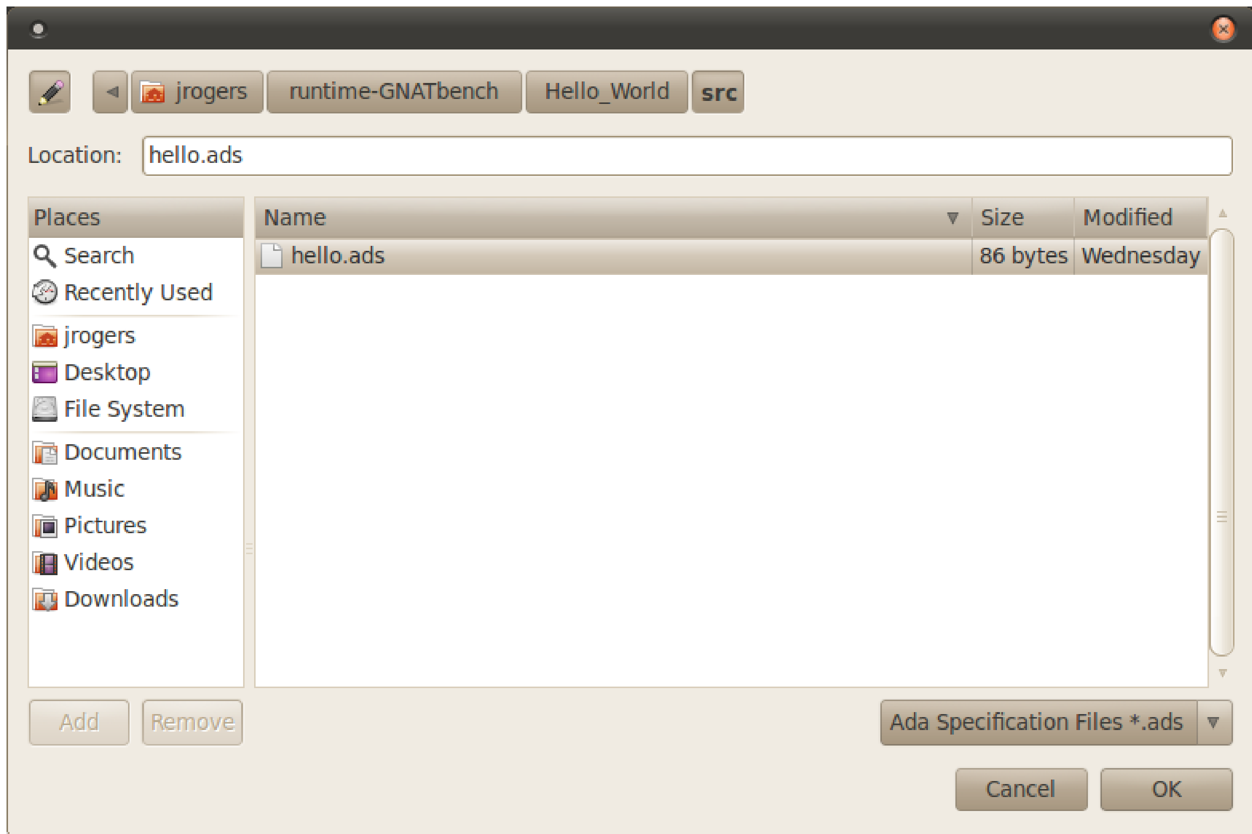
Selecting Interface Files

The user must select which Ada specification files will be used by the Java application in the client Java project. The AJIS tools create Java source files corresponding to the selected Ada specification files. Select *only* the files which are needed directly in Java, as specified by the AJIS documentation.

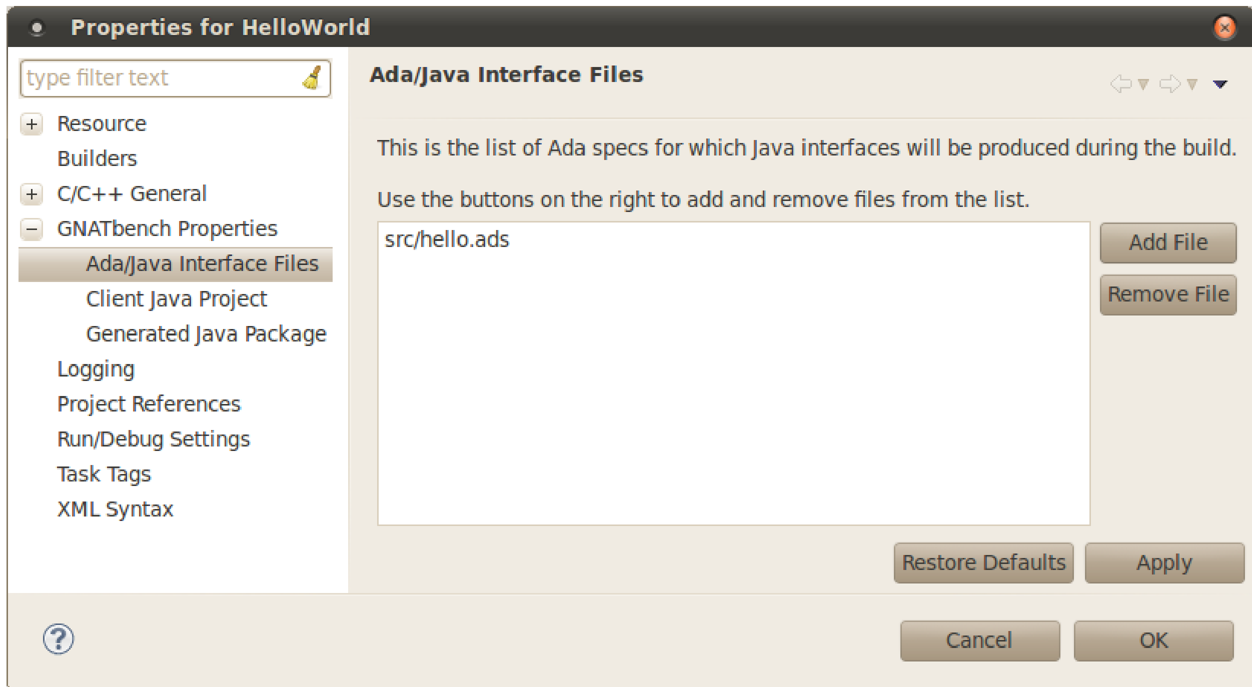
To do so, open the Project Properties for the project. (`Right-Click -> Properties` or `Alt+Enter`). Expand the category "GNATbench Properties" and select "Ada/Java Interface Files".



Click "Add File" and an operating-system-dependent file selection dialog will appear. Navigate to the location of the Ada specification files.



Select one or more files and press "OK". The selected files will appear in the list.



IMPORTANT NOTE

At least one Ada interface file must be selected before the project can be successfully built.

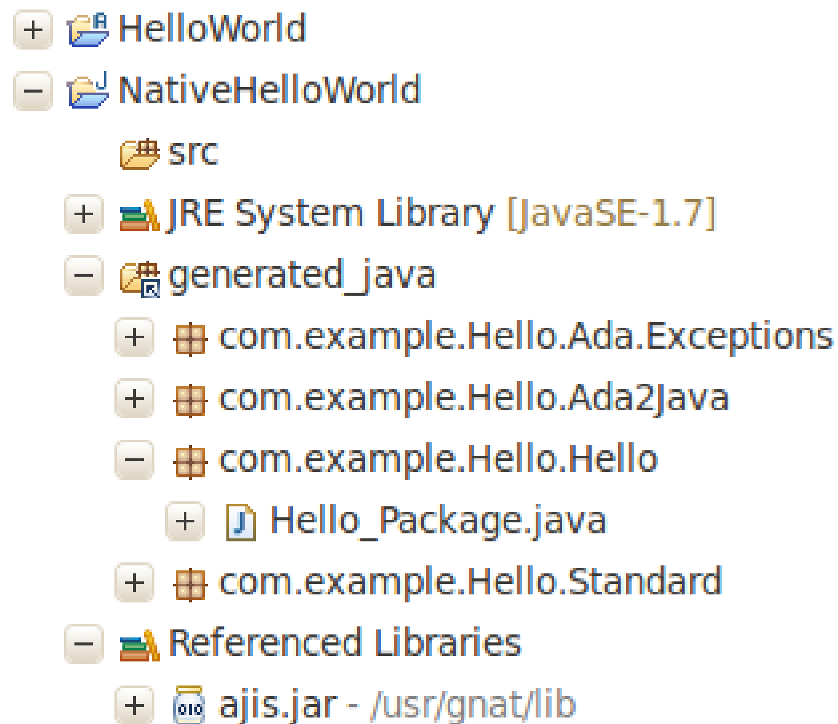
11.1.5 Building the Ada Project

Set the scenario variable name "Externally_Built" to "false" using the Scenario Variable view. This setting will allow the AJIS library to be rebuilt if necessary. A rebuild would be required, for example, if a different toolchain (e.g., the Android cross-compiler) had been used with AJIS most recently. Once it is rebuilt with the right toolchain you can set the scenario variable back to "true," or just leave it set to "false" all the time; it will only be rebuilt if necessary.

Now the project is ready to be built, e.g., with `Project -> Build Project`. Doing so will invoke AJIS to generate the Java sources corresponding to the Ada packages you specified in the wizard, compile the Ada code as usual, and generate the dynamic library. Note that these individual steps are only taken if necessary. When no significant changes have been made to the project the builder will not do more than determine that fact.

Commands to clean and rebuild (i.e., a clean followed by a build) are supported. Individual Ada file compilation is available via the context menu.

Next, refresh the Java project, whose linked resources have been changed by the Ada build. (This can be accomplished by selecting the project in the Navigator or Explorer and pressing F5.)



In the "generated_java" source folder of the Java project, there are now several packages, some of which correspond to the Ada packages selected as interfaces files (in the above example, the Java package `com.example.Hello.Hello`). The others (`Ada.Exceptions`, `Ada2Java`, and `Standard`) are always created, and are responsible for loading the library and interfacing between Ada and Java.

At this point a Java application can be written, with some sources referencing the Ada code through the generated Java interface code.

In our example, this is the main method of the Java application code:

```
public static void main(String[] args) {
        java.util.Scanner input = new java.util.Scanner(System.in);
        System.out.println(Hello_Package.Greeting(input.nextInt()).toString());
}
```

Note that you will need to import the Java code interfacing to Ada, using the normal Java "import" statement. The usual JDT tools can facilitate that, as ususal.

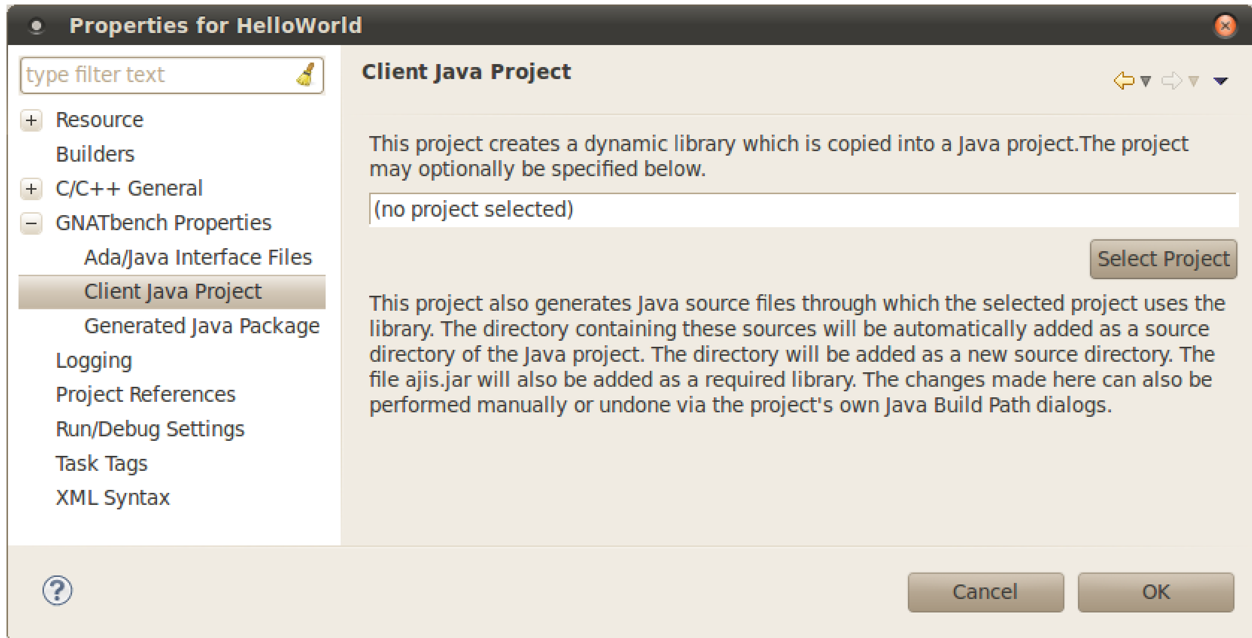
The Java project can now be built and run through the standard Eclipse and JDT tools.

Congratulations! You have created and built an Ada/Java application.

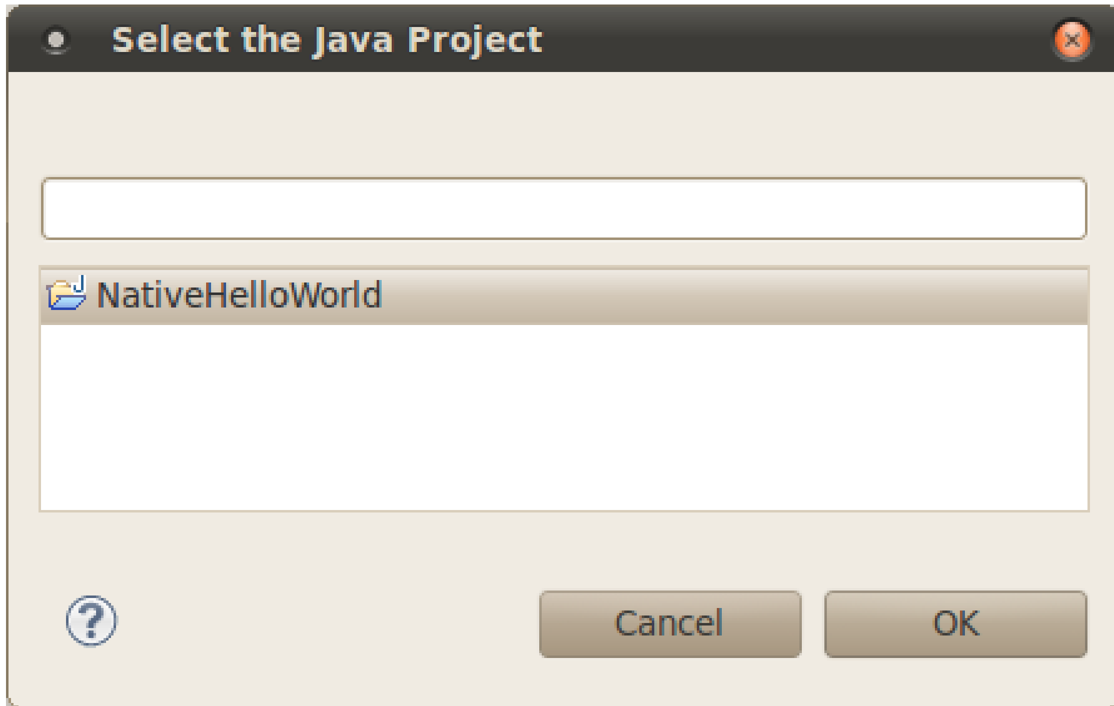
Alternative Ways to Select the Client Java Project

If you did not use the wizard to choose a client Java project (or just wish to change it), you may do so by editing the Ada project properties as described below. Alternatively, you can use the JDT Build Path dialog of the client Java project itself.

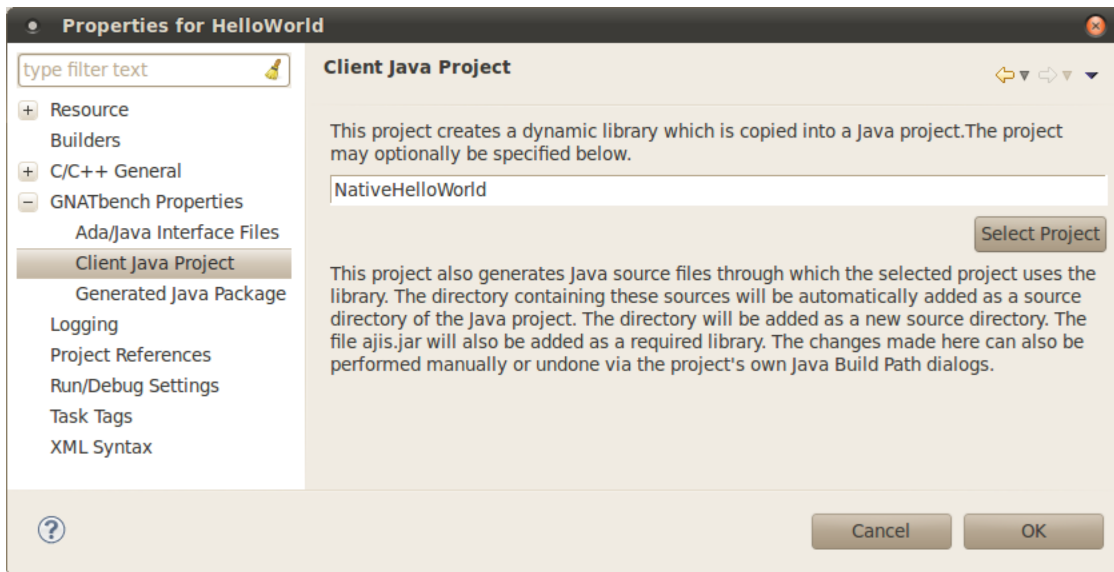
Under the Project Properties for the project, select "Client Java Project".



Click "Select Project" and choose an open Java project in the list presented.



Once the selection is made press OK to return to the properties page.



Press OK to close the page. As a result, the properties editor does three things to the Java project:

a. It creates a link to the generated Java code so that the Java project can build with those sources included.

b. It configures the Java project's build path to use the dynamic library. (This is a per-source-folder setting.)

c. It configures the Java project's build path to reference `ajis.jar`, a library necessary for building against the generated Java code. If the file is not found on the system classpath, which should have been set after the AJIS installation, the user will be asked to select the file.

IMPORTANT NOTE

The user may return to this property and change the selected project. Changes to the previously selected project will *not* be undone. The user should modify or remove that project so that it does not contain its links to the Ada project.

11.2 Using AJIS Examples

GNAT-AJIS version 17.0 or later contains a GNATbench version of the examples at <GNAT-AJIS-INSTALL-PATH>/share/examples/ajis/GNATbench.

If you have such version installed, you can follow this procedure to have the examples available in your workspace.

11.2.1 Before You Begin

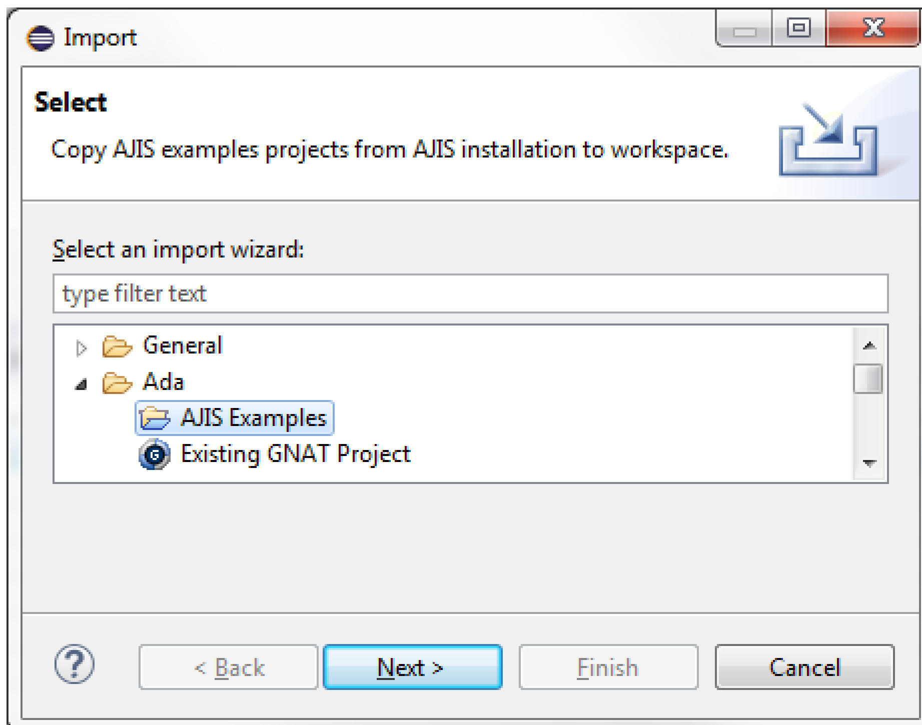
Install AJIS (remember to set the path and classpath). Make sure that the version of AJIS matches the compiler date and the minimum requirements for the GNATbench AJIS integration.

Install the "make" utility if it is not already installed. Windows users can download the GNU version via the "Miscellaneous/Utils" section of the "Downloads" page on GNAT Tracker. The file to download is named "gnumake-3.79.1-pentium-mingw32msv.exe" or something similar (i.e., the version number could be different). Once downloaded, rename the file to "make.exe" and put it somewhere on your path.

Consider enabling automatic builds (see menu Project > Build Automatically), to have the AJIS examples for GNATbench projects automatically built after import.

11.2.2 Import AJIS examples for GNATbench projects into workspace

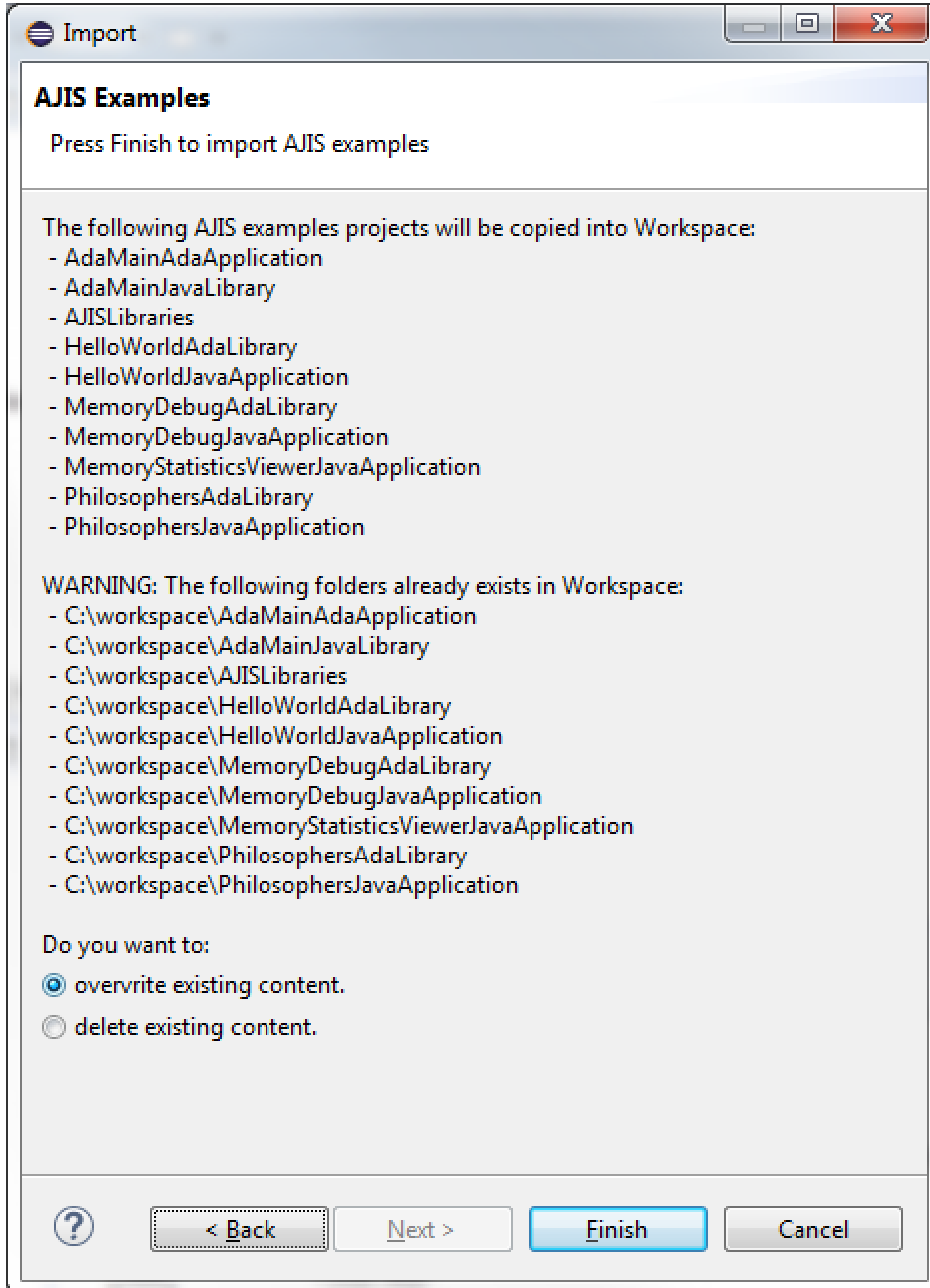
First, run File > Import… menu. Select Ada/AJIS Examples import wizard.



Click Next > button

The AJIS Examples page will display the operation to process during the import operation.

If AJIS examples folders are found in workspace, a warning is displayed. You can overwrite or reset these folders. Press Cancel if you want to keep the folders unchanged and cancel import operation.

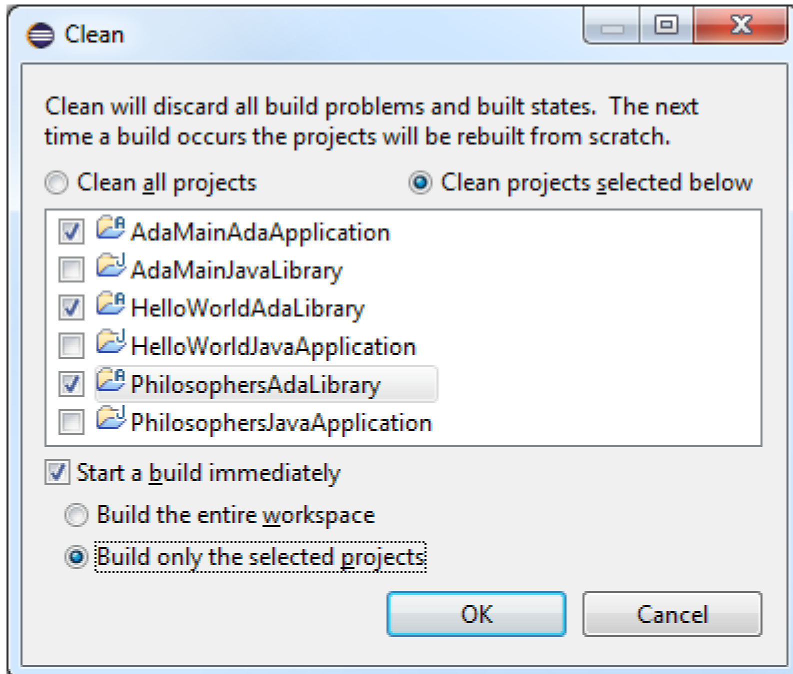


Click Finish button to import the projects

11.2.3 Build AJIS examples for GNATbench projects

If automatic build is enabled (see menu Project > Build Automatically), all the imported projects will be built automatically.

Otherwise select all imported AJIS examples Ada projects in Project Explorer view, and then run Project > Clean… menu. Ask to clean only selected projects, and to start immediately a build of the selected projects.

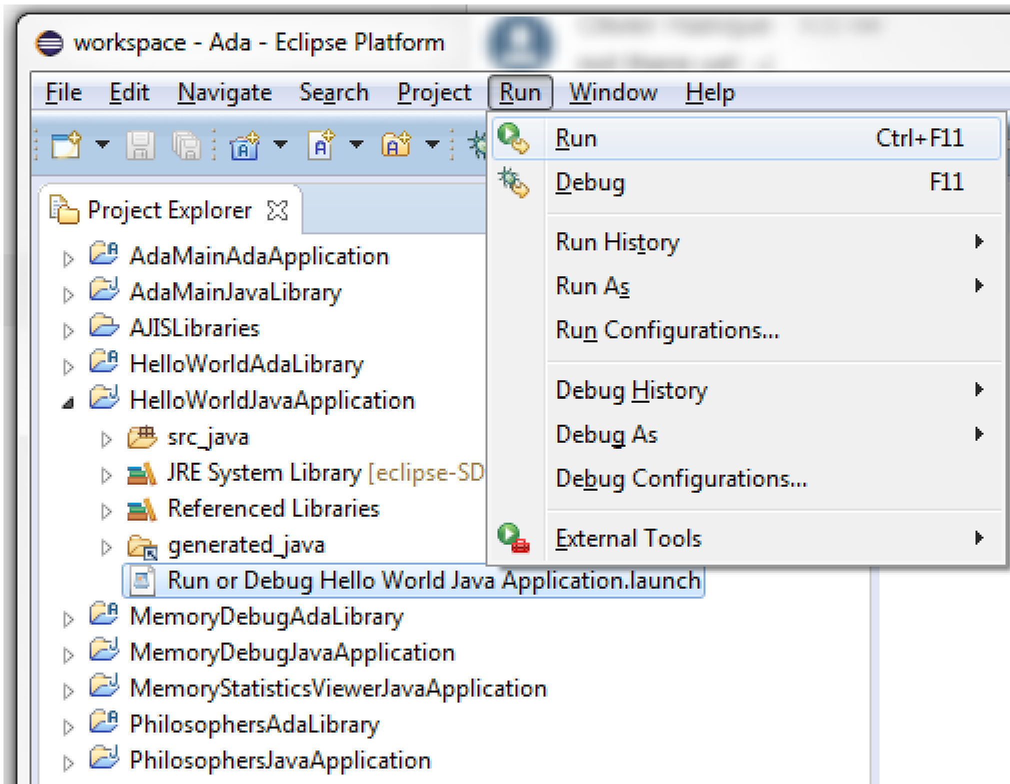


Then, do the same for all imported AJIS examples Java projects

11.2.4 Run or Debug AJIS examples for GNATbench projects

All the examples have Run or Debug configurations. (*.launch files)

Select a launch configuration and select Run (Ctrl+F11) or Debug (F11) command.



11.3 Using the AJIS Integration

11.3.1 Installing the Required Tools

First install "AJIS for GNATbench" feature that can be found in "AdaCore Plugins for Eclipse/CDT" category.

Then install AJIS. Remember to set the path and classpath, as described by the AJIS User's Guide. The AJIS tools are responsible for generating the Java source files and configuring how the library is built, as well as creating Ada sources that are needed by the library.

11.3.2 Creating a Library and Sources

An AJIS Ada Project creates a dynamic library and a set of Java source files that invoke code in that library.

In order to do that, the user must select the Ada specification source files for which Java source files that will be generated. These specification files are sometimes referred to as "Interface Files." Any methods needed to make use of the generated library should be available in interface files.

Not all Ada language features are supported by the underlying AJIS tools, so not all specification files may be selected as interface files. See the AJIS documentation for more information.

Interface file selection is available as an interactive project property under the `GNATbench Project Properties` category. At least one interface file must be selected for an AJIS Ada Project to be built.

The generated Java code includes several Java packages. The user may specify a new base package that contains the generated packages. If such a package is not specified, the packages will be generated and rooted in the default package.

For example, if the base package is `com.example`, and an Ada package named `devices` is an interface file, then the generated Java would be in package `com.example.devices`.

Java base package selection is available as an interactive project property under the `GNATbench Project Properties` category.

11.3.3 Using the Library and Java Sources

A Java project that uses the library must be configured to use the generated sources as well. This Java project is called the "client" project.

The directory containing the generated Java sources must be on the classpath. In Eclipse, this is done by creating a new source folder that contains the generated Java code.

The generated Java sources depend on a Java library distributed with AJIS; it is named `ajis.jar`. The full path to this jar (not just the directory containing it) must also be found on the classpath. In Eclipse, this is done by adding the jar as an External Jar on the Java build path.

The directory containing the dynamic library must be on the `java.library.path` property. In Eclipse, the property is set when the source folder has a "Native library location" set.

When the client Java project is run, Eclipse will calculate the classpath and library path automatically.

Although these operations can be performed manually using the Java Build Path dialogs, all three can be performed automatically by the Ada AJIS Project tools. The feature is available both at the end of the New Project wizard and as a project property named `Client Java Project` under the `GNATbench Project Properties` category .

When a Java project is selected there, GNATbench attempts to modify the Java project's Build Path settings such that it:

- Contains a new source folder that is linked to the folder containing the generated Java
- Specifies the directory containing the dynamic library as that source folder's "Native library location"
- References `ajis.jar`. It checks the system's classpath to determine the jar's location; if the classpath has not been set, it asks the user for the location.

However, there is no way to *automatically* undo the above configuration steps. If desired, the user must invoke the Java Build Path dialogs to either undo the settings or change them to use a different project. The automatic configuration will fail if a previous automatic configuration has not been undone.

11.4 Manual Configuration of Java Build Path

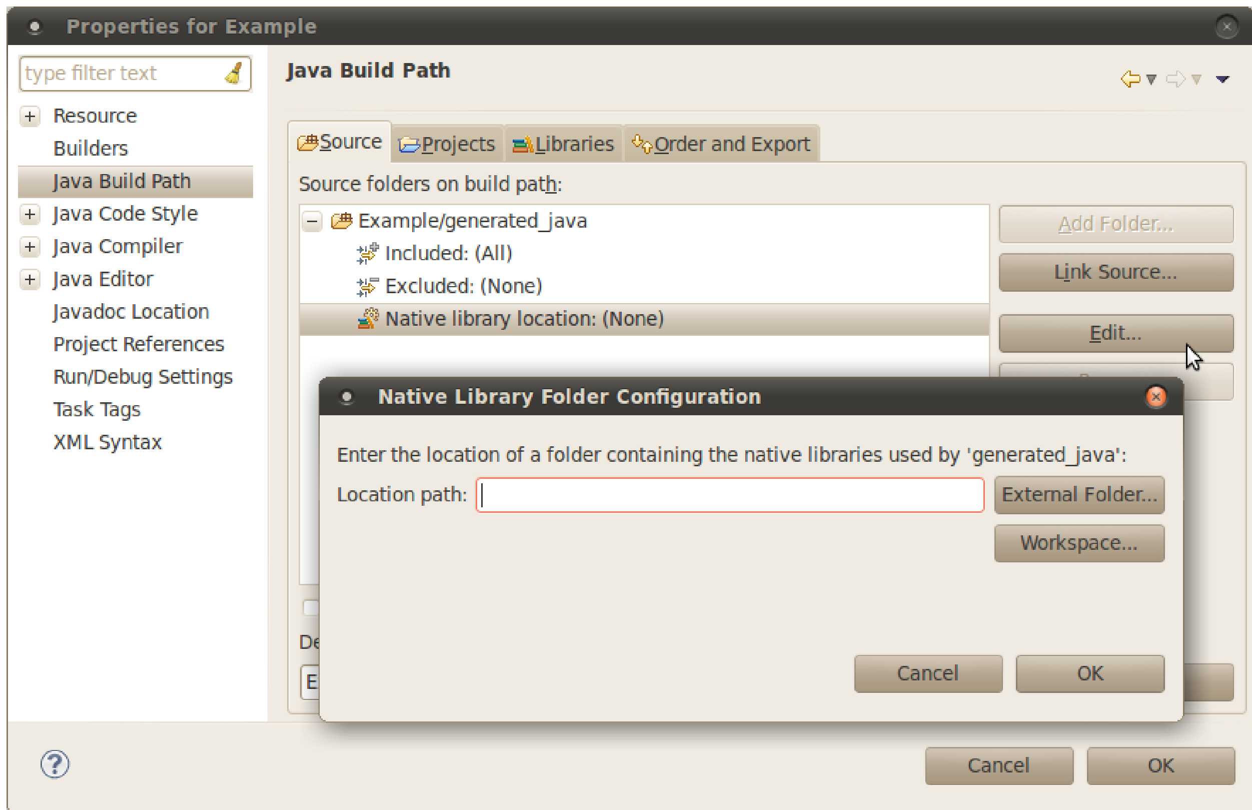
11.4.1 Setup

1. Link the source folder

   Under the Java Project Properties, select "Java Build Path" and then the "Source" tab.

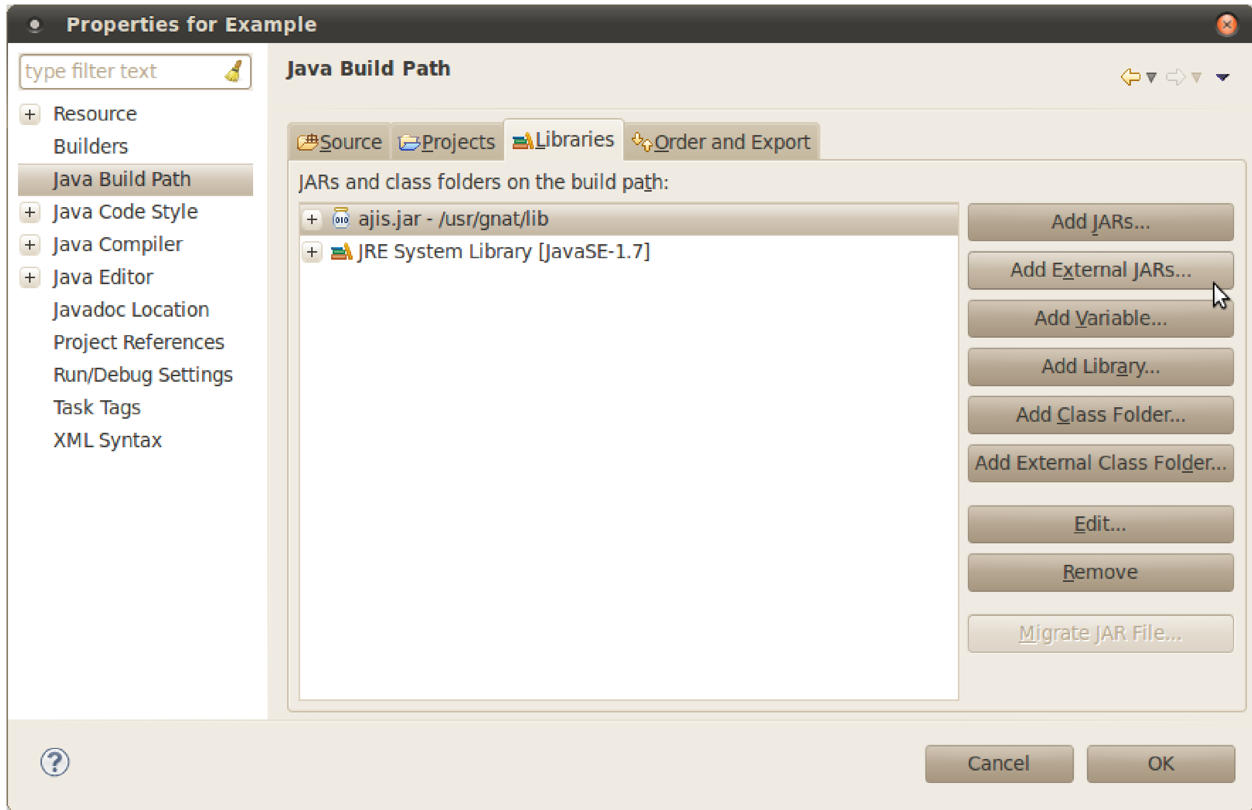
   a. Click "Link Source" and navigate to the generated Java directory in the Ada project.

   b. Expand the generated directory and select the Native library location. Edit it and select the directory containing your native library (usually the "lib" directory of the generated Ada directory).



2. Include the `ajis.jar` library on the build path.

   Switch to the "Libraries" tab and click "Add External JARs…", then navigate to the `ajis.jar` file in the AJIS installation directory.



Hint: You might have put it on the system classpath per the AJIS installation instructions.

11.4.2 Teardown

1. Remove the source folder from the build path.

   Under the Java Project Properties, select "Java Build Path" and then the "Source" tab.

   Remove the generated Java source directory from the build path by selecting it and using the button on the right.

2. Remove the `ajis.jar` library from the build path.

   Switch to the "Libraries" tab, select `ajis.jar`, and click the "Remove" button. Click "OK" to close the "Java Build Path" dialog and confirm the changes.

3. Delete the linked source folder from the client Java project.

11.5 Usage Notes

11.5.1 Versions

The installed version of the AJIS tools should be gnat-ajis-7.1.0w-20120611-* or later (although some earlier versions may work).

AJIS must be used with a compiler from the same date.

Install the "make" utility if it is not already installed. Windows users can download the GNU version via the "Miscellaneous/Utils" section of the "Downloads" page on GNAT Tracker. The file to download is named "gnumake-3.79.1-pentium-mingw32msv.exe" or something similar (i.e., the version number could be different). Once downloaded, rename the file to "make.exe" and put it somewhere on your path.

11.5.2 Modifying the Ada Sources

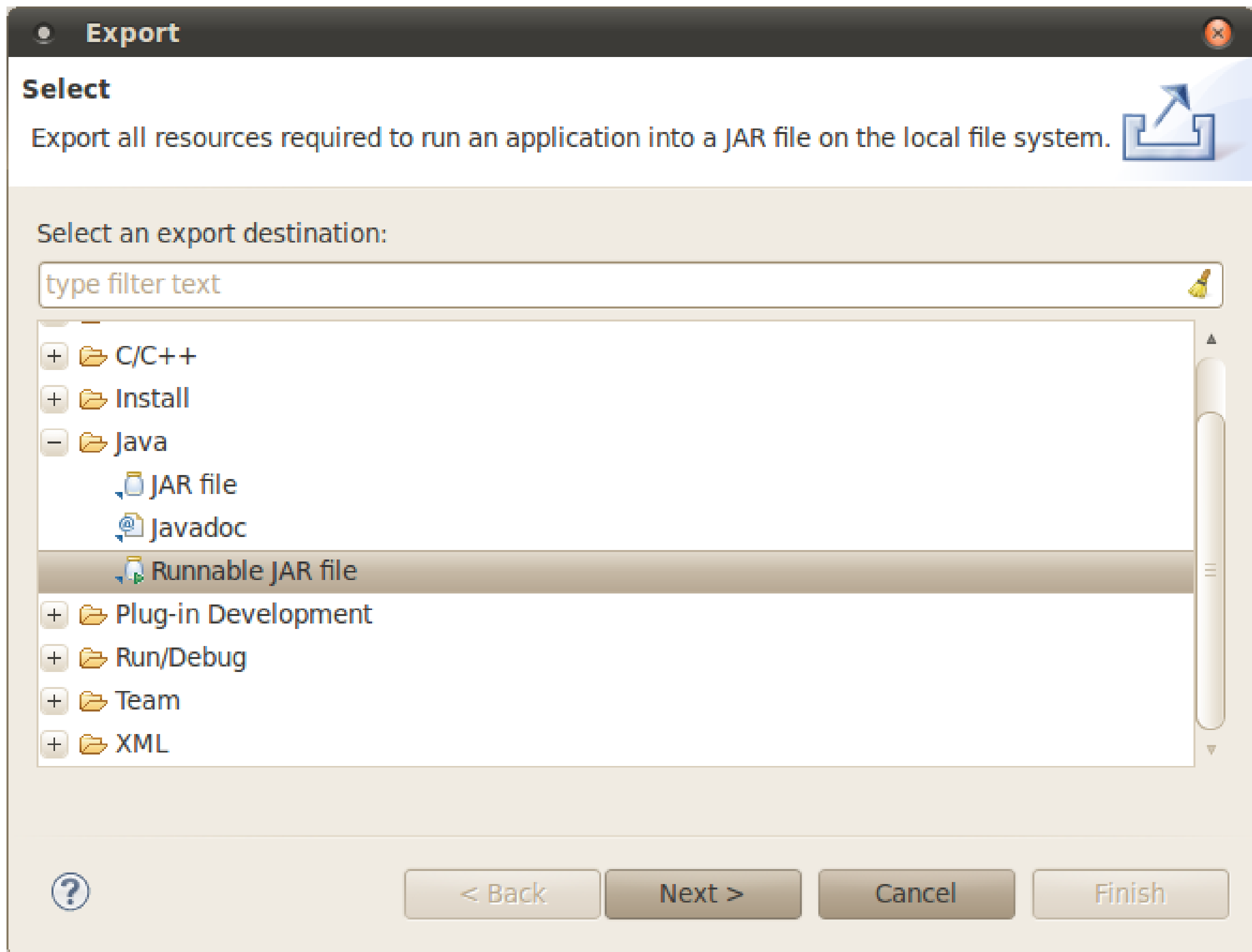
The user may change the Ada source files. If changes are made to any of the Ada source files which are selected as interface files, the generated Java sources will be automatically changed by the next build of the Ada project.

This allows the user to make changes as necessary.

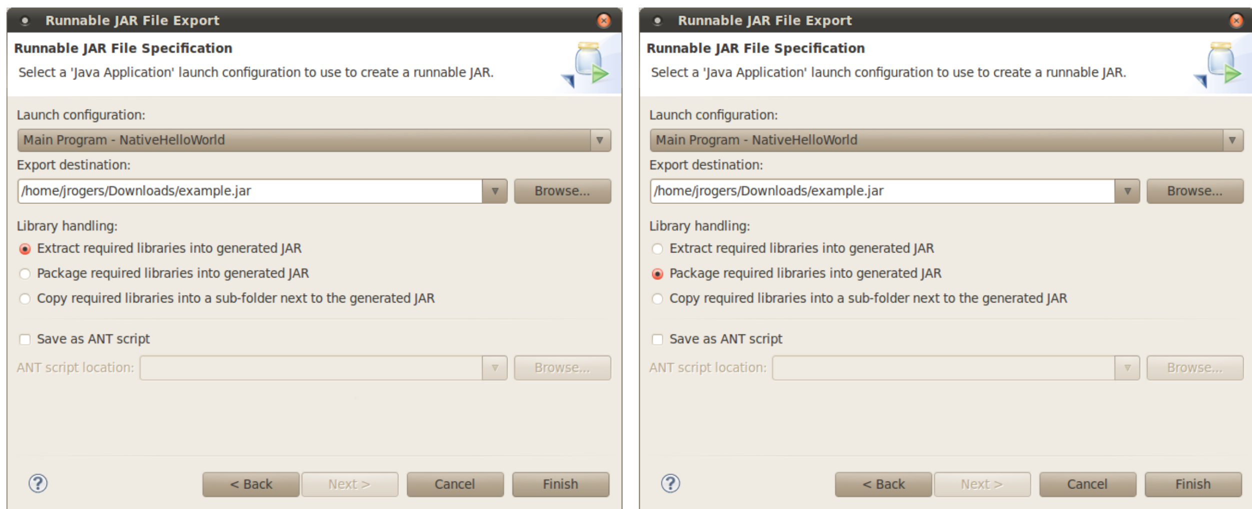
11.5.3 Exporting the Java Project

The Java project may be deployed outside of Eclipse using the normal JDT tools. Both `ajis.jar` and the generated library will still be required to run the project, but the `ajis.jar` library can be bundled in with the Java sources. These steps describe how to ensure that `ajis.jar` is included in the application jar.

1. Export the Java Project as a Runnable Jar.



2. Select a launch configuration and export destination.
3. For library handling, select either "extract" or "package" to bundle in the required jar files.



The exported jar can be run from the command line; it still requires the path to the native library, which is set with the property `java.library.path`. For example, given that `/home/jrogers/runtime-GNATbench/Hello_World/binding/generated_ada/lib/` contains the dynamic library, the command would be:

```
$ java -Djava.library.path=/home/jrogers/runtime-GNATbench/Hello_World/binding/generated_
↪ada/lib/ -jar example.jar
```

Note: Do not directly set the `java.library.path` property when running the application in Eclipse; this is done by Java tools. Instead, use the Java Build Path page of the Project Properties or specify a Target Project from the Ada project properties.

11.5.4 Optional additional arguments to `ada2java`

`ada2java` is the executable that generates the source files used to interface between Ada and Java. It has a number of options, some of which may be useful to clients.

These Ada projects are makefile-driven, so the makefile calls ada2java. If the user would like to pass additional options to ada2java, the macro named `CUSTOM_OPTIONS` in "config.mk" may be changed. "config.mk" is imported by the Makefile and is not modified by GNATbench. `$(CUSTOM_OPTIONS)` is appended to the end of the call to ada2java. It defaults to the empty string, but it may contain some options allowed by ada2java. It should *not* contain interface files or include options that conflict with options already specified in the project's `Makefile`.

Several options relating to aliasing and memory may be of interest in some cases.

11.5.5 Cleaning

Note that cleaning the Ada project removes the compilation objects (`*.ali` and `*.o` files) but also the generated Java files.

11.5.6 Limitations

At present, only one AJIS project can be used per Java project.

Operating Systems

Linux and Unix-like operating systems are supported. Windows users must install Cygwin for equivalent functionality.

The .gpr file

The gpr file should not be manually modified except to change the Source_Dirs, which can be done using the GNAT-bench toolbar and menu.

The gpr file may not have additional dependencies beyond the defaults (AJIS and JNI). Rather than reference another project, simply add its sources to the Source_Dirs attribute.

Scenarios

The project contains several scenario variables by default. No new scenarios may be added.

`Build` may be set to either `Production` or `Debug`.

`External_Build` should be set to `true`. If it is set to `false` the AJIS and JNI libraries are rebuilt. In most cases this is unnecessary.

`OS` is referenced when AJIS and JNI are built, and does not affect the library built by this project.

`LIBRARY_KIND` is a scenario variable referenced by AJIS and JNI. By default its value is **ignored** and static libraries are produced and included in the encapsulated dynamic library created by this project.

If the user does not wish to create an encapsulated dynamic library,

1. Unset the macro variable `FORCE_ENCAPSULATED` in the Makefile.
2. Set `External_Build` to `false`. AJIS and JNI will be built as static libraries.
3. Clean and build (or rebuild). The AJIS and JNI libraries will be rebuilt as dynamic libraries. The project's library will be dynamic but not encapsulated.

The GNATbench integration features only support encapsulated dynamic libraries by default.

Interface files

The AJIS tools do not support all Ada language features. This restricts which files may be used as interface files. See the AJIS documentation for more information.

Supported builders

This makefile must use gprbuild. It does not respect the setting that uses gnatmake instead. This is because other libraries are needed to provide the Ada runtime, AJIS, and JNI. These libraries are included in the dynamic library using the encapsulated library functionality of gprbuild; gnatmake does not support this feature at the time of this writing.

CHAPTER

TWELVE

DEVELOPING ADA APPLICATIONS FOR QNX

12.1 Creating QNX projects containing Ada code

12.1.1 Audience

This document is intended for users already somewhat familiar with QNX Momentics, and GNATbench. Some familiarity with GNAT cross compilers may also be useful.

12.1.2 Before You Begin

Install Ada cross-compiler toolchain for QNX.

On linux at the end of the install process, you'll be asked to update your environment, to add cross compiler binaries path to PATH variable for example. Update your environment, prior to launch QNX Momentics and use GNATbench menus.

You can check correct cross compiler installation displaying Ada/Toolchains preferences page. QNX installed toolchains should be displayed without any error decorator.

At startup GNATbench automatically create and fill "Ada runtime libraries for QNX" project. The libraries copied in this project will be automatically uploaded into QNX target when a QNX project linked dynamically to Ada runtime is launched on the target.

This project creation/update can be disabled through Ada/QNX preferences page.

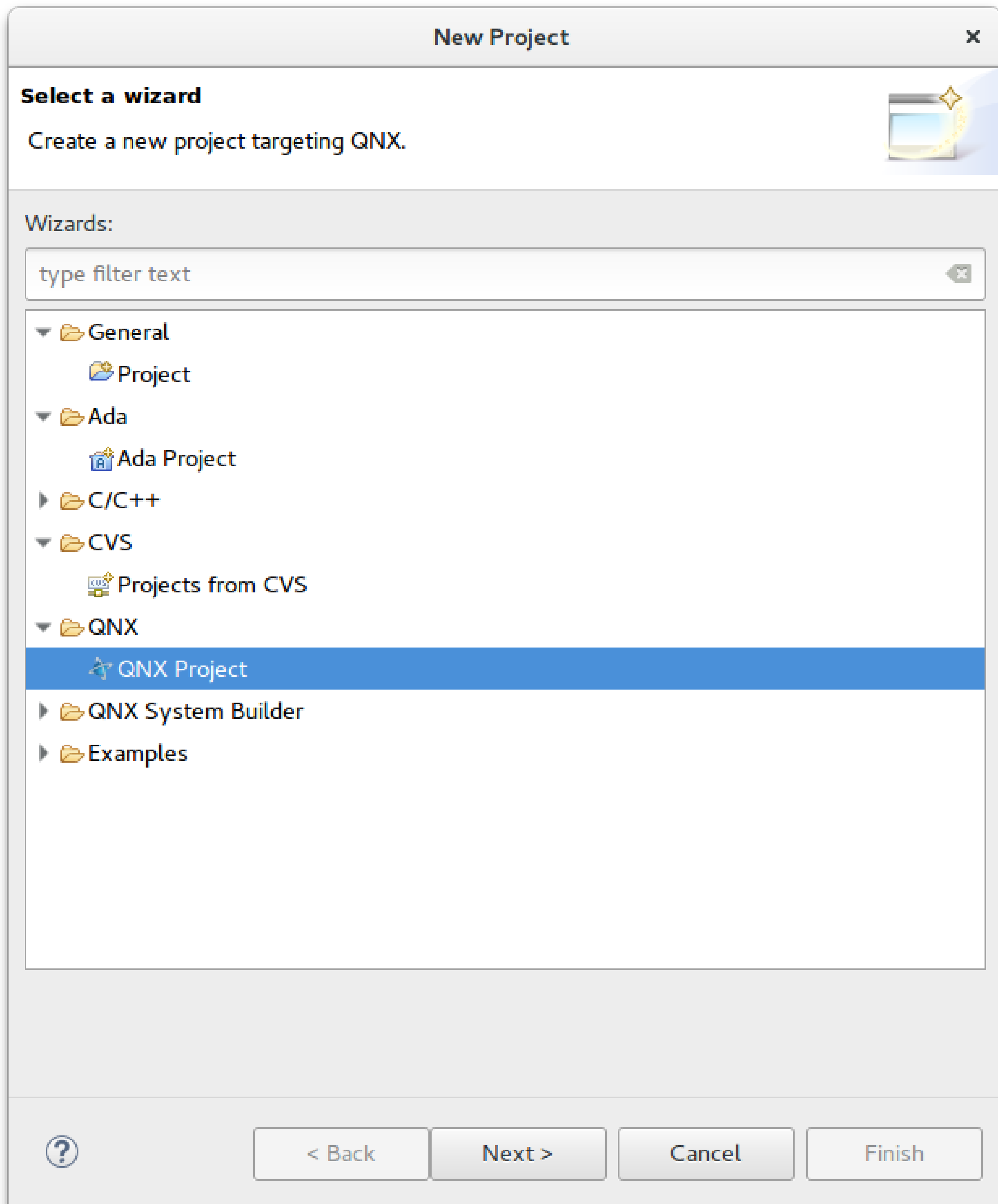
If Ada runtime libraries are not made visible to QNX loader 'ldd:FATAL: Could not load library libgnat-19.so' errors will be reported when launching such QNX executables.

Important

You cannot create directly a QNX project containing Ada code. You need first to create an empty QNX project, and then convert it to a QNX executable or shared/static library project using "Ada/Convert an empty QNX Project to use Ada Language" wizard.

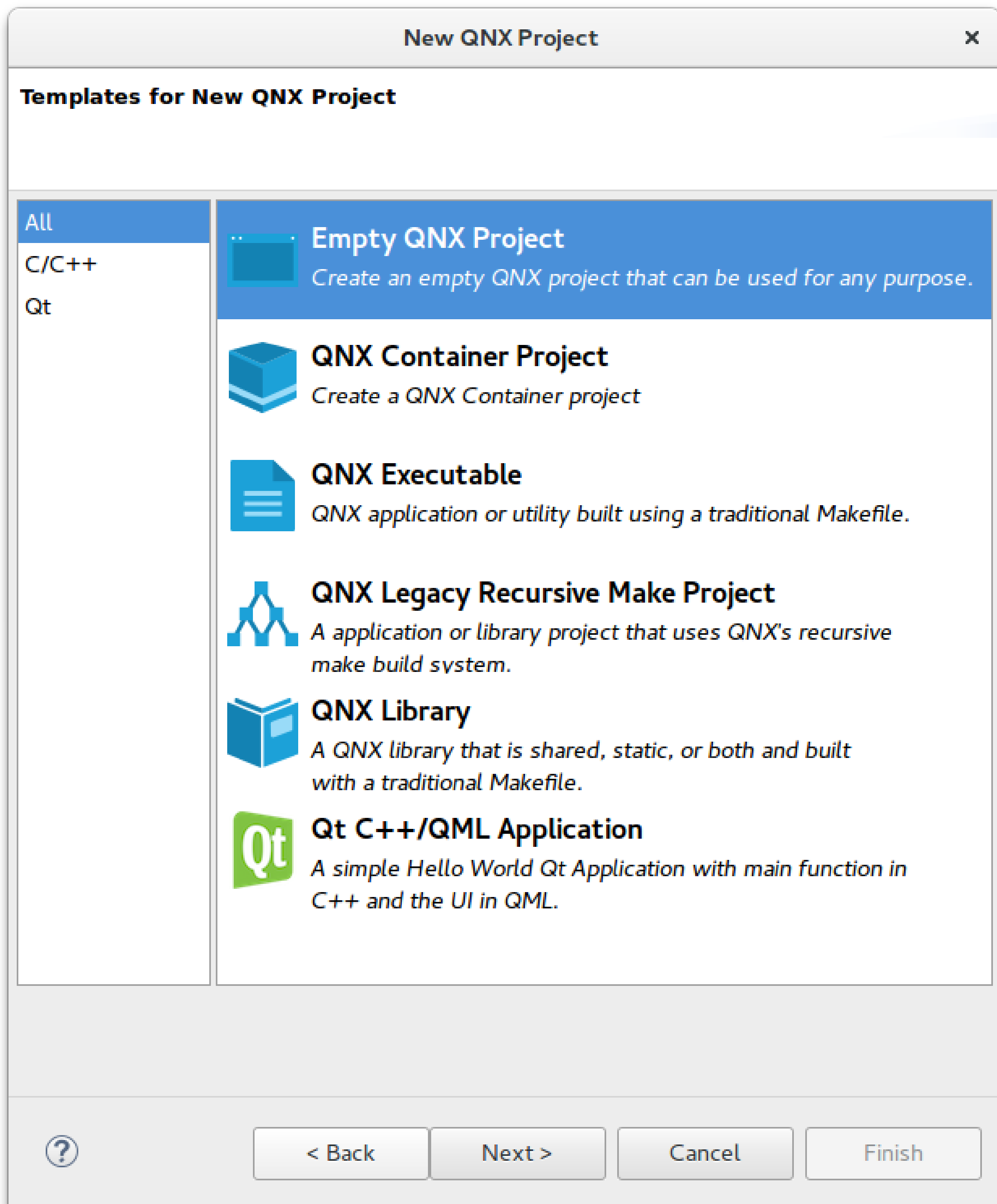
12.1.3 Create the Empty QNX Project that will contain Ada code

We will create a new QNX project using the wizard via `File -> New -> Project` and then selecting `QNX Project` as shown below.



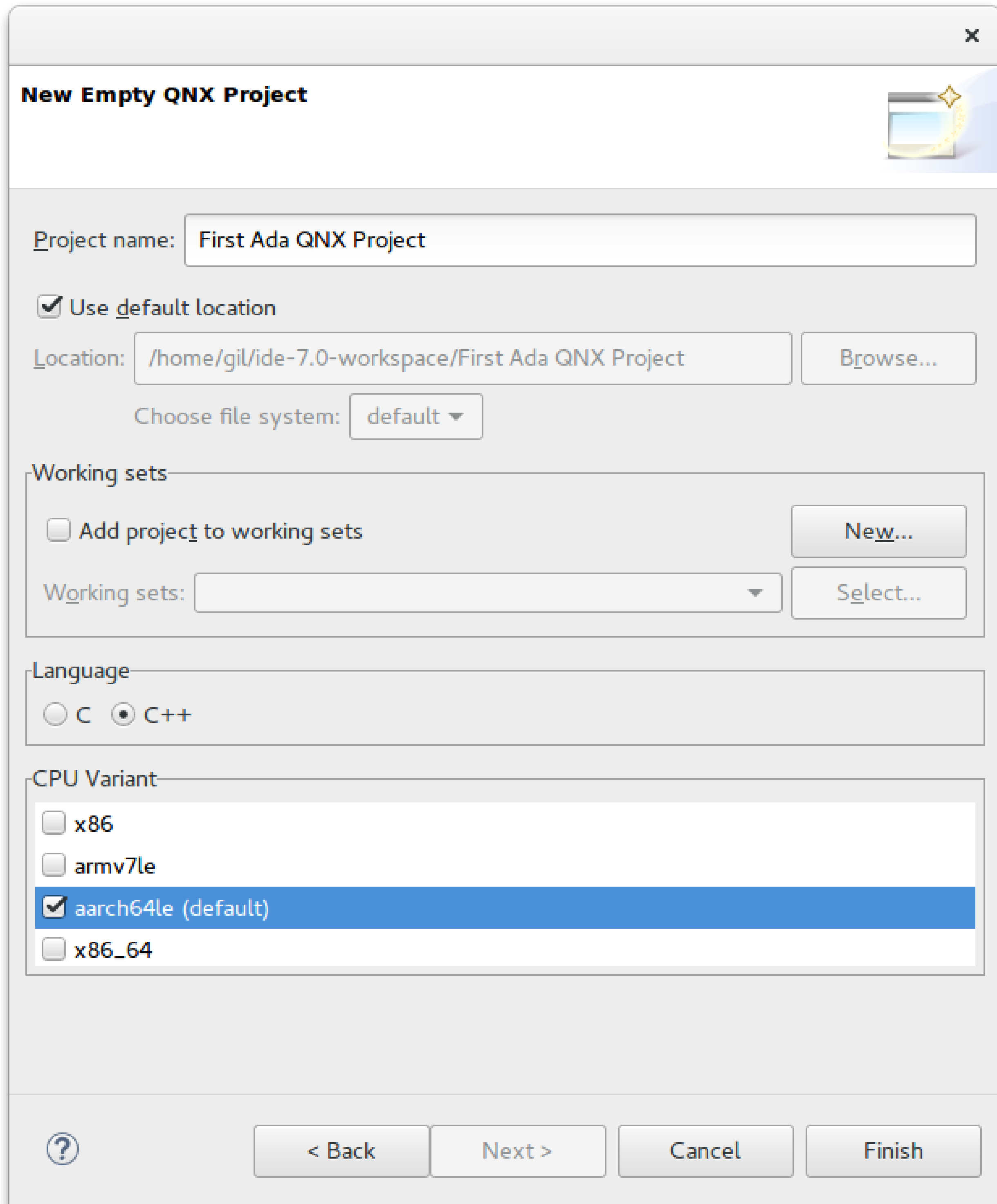
Press Next.

This brings up the first wizard page. As shown below, we have selected "Empty QNX Project" template.



Press Next.

This brings up the last wizard page. As shown below, we have provided a name for the empty QNX project we will create. Select C++ language if you plan to put C++ code in your project, otherwise you can keep C language selection. Select the CPU variant of the cross compilers you have installed.

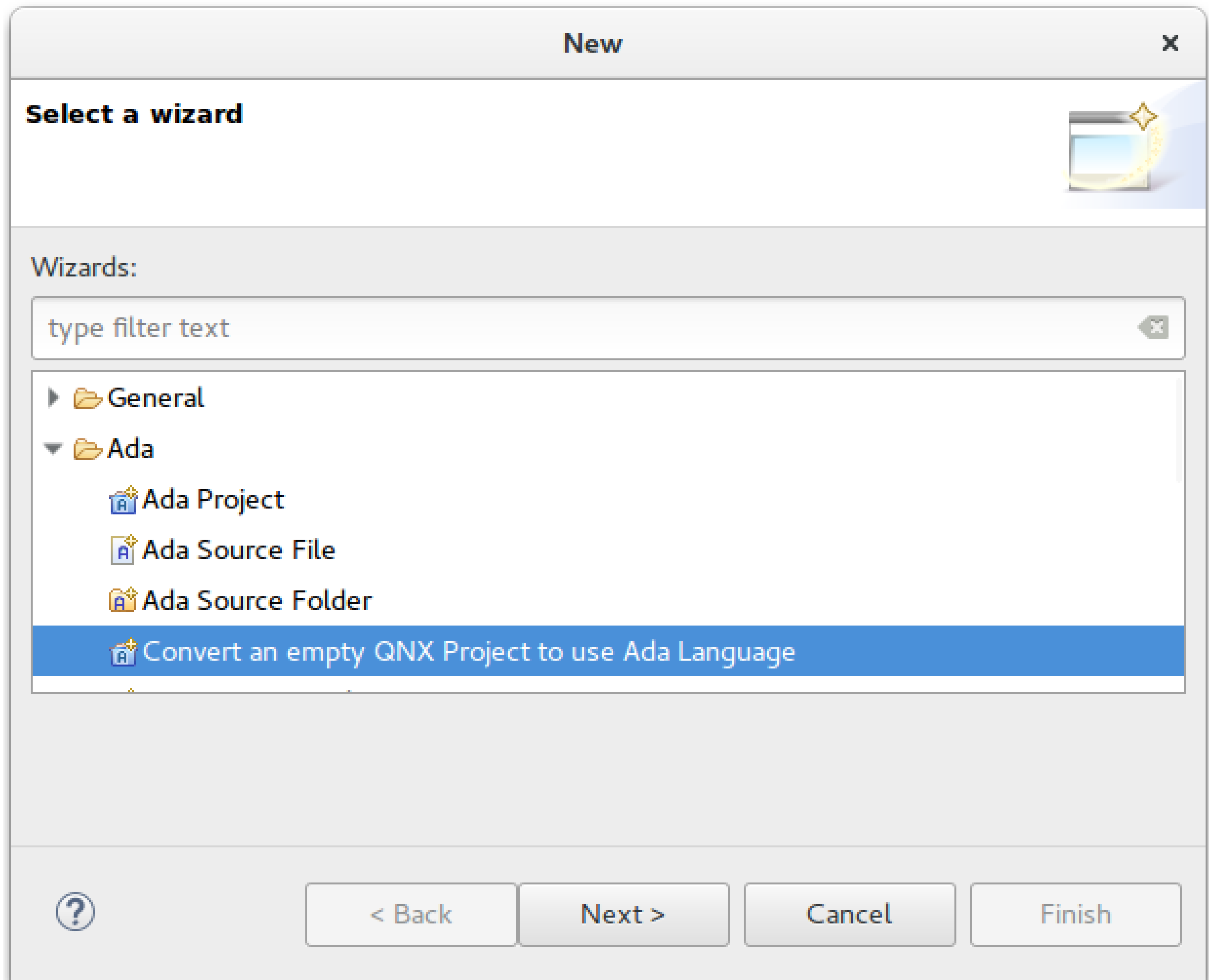


Press Finish

The QNX project is created. Ignore the "No rule to make target 'all'" problem.

12.1.4 Convert the empty QNX project to use Ada language

We will add Ada language use to this empty QNX project using the wizard via `File -> New -> Other...` and then selecting `Convert an empty QNX Project to use Ada Language` as shown below.



Press Next

Set the name of executable or library you want to create. It has to be an Ada valid identifier starting with a letter and containing only 'a-z', '0-9' and '_' characters.

Select the type of QNX project you want to build.

Enhance an empty QNX project to a QNX Executable using Ada language

QNX Ada Project configuration

Specify the unit name of the GNAT project within the gpr file, and the QNX project type

AdaCore The GNAT Pro Company

Project unit name (not the file name): first_ada_qnx_project

Select the type of QNX Ada project.

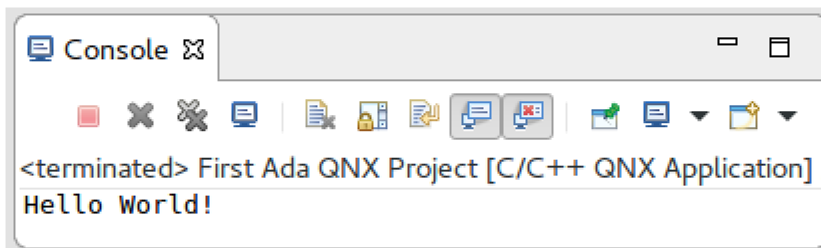
- (•) QNX Executable
- ( ) QNX Static Library
- ( ) QNX Shared Library

< Back | Next > | Cancel | Finish

Press Finish to launch project conversion.

Once created, run Build Project menu to verify that the project can be built.

If you have asked for a QNX executable, you can run it on your QNX target. The 'Hello World!' string is displayed in the Console view



CHAPTER

THIRTEEN

DEVELOPING ADA APPLICATIONS FOR DDC-I DEOS

This chapter is intended for users already familiar with DDC-I OpenArbor and GNATbench. Some familiarity with GNAT Pro is also useful. For more information on *GNAT Pro* and *GNAT Pro for Deos* please refer to the *GNAT Pro User's Guide* and the *GNAT User's Guide Supplement for Cross Platforms*, available on *GNAT Tracker*.

This chapter contains two tutorials: one for developing Ada applications using Deos processes and one for developing Ada applications using Deos 653 partitions.

Note: at the moment, GNATbench does not support converting existing Deos executable projects nor can it import existing Ada project. If you have such projects, follow the tutorials on how to create a new Ada application and copy the code and configuration files from your previous project to the new project. Do note that if you have an existing GPR file, look at the GPR file created by GNATbench for any modification you may need to apply to your own GPR file. Please contact AdaCore if you need any help.

13.1 Installing GNATbench

13.1.1 Requirements

GNATbench for DDC-I OpenArbor requires DDC-I OpenArbor 10 or later.

Prior to installing GNATbench, first install *GNAT Pro for Deos* and ensure it binaries are located on your path before starting OpenArbor. On Windows, the installer will update your environment path to include *GNAT Pro for Deos* if the option is selected during installation. On Linux, the installer will provide instructions on how to update `PATH` variable at the end of the install.

13.1.2 Downloading GNATbench

GNATbench is downloadable from GNAT Tracker and can be found on the *Release Download* page under the *IDE* section. Download the GNATbench ZIP archive that corresponds to your host platform. Once downloaded, you will install the plug-in through the Eclipse plug-in installer, so there is no need to expand the ZIP archive.

13.1.3 Installing

GNATbench requires an Eclipse plug-in that is not installed by default in OpenArbor (`org.eclipse.equinox.p2.iu`). To have OpenArbor install this plug-in during the GNATbench install, add the appropriate Eclipse release repository to OpenArbor:

1. Find the version of Eclipse your copy of OpenArbor is based on. This can be done by selecting `About OpenArbor` from the `Help` and then clicking on the red DDC-I logo (the tooltip for the button will read `DDC-I`). In the lower half of the window that opens, look for the line that read *This offering is powered by Eclipse <version>-R*, where *<version>* will correspond to the Eclipse version in the form *yyyy-mm*. For example, OpenArbor 10.4 is based on *2020-12*. You can now close the *About OpenArbor Features* and *About OpenArbor* windows.
2. Open the OpenArbor plug-in installer by selecting `Install New Software` from the `Help` menu.
3. Click the `Add` button near the top right of the `Install` window to open the `Add Repository` dialog.
4. Under `Name` enter `Eclipse <version>` and then enter as the `Location` `https://download.eclipse.org/releases/<version>/`. For example, for OpenArbor 10.4, you would enter `Eclipse 2020.12` and `https://download.eclipse.org/releases/2020-12/` respectively.
5. Click `Add` to add the Eclipse repository.

Once done, GNATbench can now be installed:

1. Click the `Add` button on the `Install` window again.
2. Select 'Archive' from the resulting `Add Repository` dialog and navigate to the zip file downloaded from GNAT Tracker. The Location field will then reflect the path that file.
3. The `Install` dialog will then list a number of different variants of GNATbench to install. Select 'AdaCore Plugins for DDC-I OpenArbor IDE' from the list.
4. Click `Next` and follow the installation wizard to completion. During the install, a dialog may appear asking you trust the AdaCore certificates. Chec k the mark next to the GNATbench certificate and press 'OK'.

Once GNATbench is installed and OpenArbor has been restarted, confirm that GNATbench can find the *GNAT Pro for Deos* toolchain by opening the Eclipse preferences and selecting the `Ada/Toolchains` page. *GNAT Pro for Arm Deos* should be listed as `arm-eabi`.

13.1.4 Documentation

The *GNATbench for Eclipse User's Guide* and other AdaCore documentation can be found in the OpenArbor help system, by selecting "Help Contents" from the `Help` menu. Please read the next section on creating an Ada application for Deos before using the plug-in.

13.2 Creating an Ada Application for Deos Processes

This tutorial walks you through the process of creating a new Ada Deos application for Arm Deos using the `qemu-arm` platform.

13.2.1 Create a new DDC-I Executable Project

To create an Ada application for Deos, first create a new *DDC-I Executable Project* by selecting the `File` → `New` → `DDC-I Executable Project` menu item.

If you do not see the `DDC-I Executable Project` menu item, you will need to switch to the *DDC-I Perspective*. This can be done by selecting the `Window` → `Perspective` → `Open Perspective` → `Other...` menu item and selecting the `DDC-I (default)` perspective.

In the *New DDC-I Executable Project* window, enter `hello_world` as the project name and select `ARM` as the target. Finally, click the `Finish` button to create the `hello_world` project.

13.2.2 Convert DDC-I Executable Project

To use the *GNAT Pro for Deos* toolchain with your new *DDC-I Executable Project* you first need to convert the project for use with GNATbench. To do this:

1. Right click on the `hello_world` project.
2. Select the `New` → `Other...` menu item.
3. From the *Select a wizard* dialog, expand the `Ada` folder and select `Convert an empty DDC-I Executable Project to use Ada Language`.
4. Click the `Next` button and confirm the project unit name is correct (this is the name GPR file without the extension). For this tutorial we will leave the name as `hello_world`.
5. Click the `Finish` button to perform the conversion.

The converted project will have a new `code` folder containing a simple hello_world procedure called `hello_world.adb`.

13.2.3 Add Deos Component Dependencies

GNAT Pro for Deos requires *Deos Executable Projects* to include `ansi` and `gnu-language` components. For this tutorial, we also want to print to the video console, so we need to also include the `vfile` component.

To add these components to our executable project:

1. Expand the `hello_world` project in the *DDC-I Project* window.
2. Expand `Deos Component`, right click on `Dependencies` and select `Add Dependency`.
3. Select `ansi` from the drop down menu.
4. Repeat for the `gnu-language` and `vfile` components.

13.2.4 Deos Process Developer XML file

The *Deos Process Developer XML* contain the Deos process settings. To create the XML file, first create a folder at the top level of your `hello_world` project called `xml` by right clicking on the `hello_world` project and select `New` → `Folder`.

Next, right click on the `xml` folder and select `New` → `Other...`. In the *Select a wizard* dialog expand the *DDC-I* folder and select *Deos Process Developer XML file*. In the resulting dialog, name the process `hello_world` and click on the `Next` button. On the next page enter `20` into the *How many 4k pages of stack space this thread need* field and click `Finish`.

Edit the hello_world.pd.xml by expanding the xml folder and double click on hello_world.pd.xml. Perform the following modifications:

1. Change the tlsSpaceInBytes attribute to 128.
2. Change ramPagesQuota to 100. If you cannot find ramPagesQuota, continue to the next step.
3. Save hello_world.pd.xml and rebuild the project by right clicking on the hello_world project and select Rebuild Project.
4. If you could not find ramPagesQuota before, expand the logicalMemoryPools attribute and the pool attribute within it. Change the pagesNeeded attribute to 100.
5. At the bottom of the hello_world.pd.xml window, select Source. Add the following XML code after </logicalMemoryPools>:

```
<usedFeatureSets>
   <usedFeatureSet
        name = "libansi"
        versionRequirement = "none"
        versionNumber = "none"
        featureSetUndefinedAction = "ignore"
      >
   </usedFeatureSet>
   <usedFeatureSet
        name = "vfile"
        versionRequirement = "none"
        versionNumber = "none"
        featureSetUndefinedAction = "error"
      >
      <usedFeature
           name = "vfile"
         >
         <usedFeatureParameter
              name = "ProcessInstanceName"
              value = "hello_world"
         ></usedFeatureParameter>
      </usedFeature>
   </usedFeatureSet>
</usedFeatureSets>
```

Save the file.

13.2.5 Build the project

Build the executable by right clicking on the `hello_world` project and select `Build Project` if you do not have automatic builds turned on (`Project` → `Build Automatically`).

13.2.6 Create the DDC-I Deos Platform Project

With the executable project built, create a new `DDC-I Platform Project` and select `qemu-arm`. In the project window, expand the `qemu-arm` project and then `Deos Components`. Right click on `Dependencies` and add a new dependency. In the resulting window, select `All` in the registry filter drop down menu and then select `hello_world` as a dependencies.

Next, in the project window expand `Complete Integration` and double click on `Components`. Expand `platreg` in the window that opens and then right click on `vfile` and select `Debug Variant`. Build the platform project by right clicking on the project and selecting `Project`.

13.2.7 Run the Deos project

Click on the *Target Manager* window on near the top left corner of the screen and click the left most button on that window to create a new target. The tooltip for the button should read *New Remote Target*. Click OK to accept the defaults and then click the play button.

QEMU will launch and the hello world message will print to the video monitor.

This concludes the tutorial. .. _creating-ddci-deos_653-executable-tutorial:

13.3 Creating an Ada 653 Partition

This tutorial walks you through the process of creating a new Ada Deos 653 application for Arm Deos using the `qemu-arm` platform.

13.3.1 Create a new DDC-I Executable Project

To create an Ada application for Deos, first create a new *DDC-I Executable Project* by selecting the `File` → `New` → `DDC-I Executable Project` menu item.

If you do not see the `DDC-I Executable Project` menu item, you will need to switch to the *DDC-I Perspective*. This can be done by selecting the `Window` → `Perspective` → `Open Perspective` → `Other...` menu item and selecting the `DDC-I (default)` perspective.

In the *New DDC-I Executable Project* window, enter `hello_653` as the project name and select `ARM` as the target. Finally, click the `Finish` button to create the `hello_653` project.

Next, right click the new project and select `Properties`. On the *DDC-I Options* page, select the `Project` tab. Under `General` check the check box `Uses thread_local`. Click `Apply and Close`.

13.3.2 Convert DDC-I Executable Project

To use the *GNAT Pro for Deos* toolchain with your new *DDC-I Executable Project* you first need to convert the project for use with GNATbench. To do this:

1. Right click on the `hello_653` project.
2. Select the `New` → `Other...` menu item.
3. From the *Select a wizard* dialog, expand the `Ada` folder and select `Convert an empty DDC-I Executable Project to use Ada Language`.
4. Click the `Next` button and confirm the project unit name is correct (this is the name GPR file without the extension). For this tutorial we will leave the name as `hello_653`.
5. Click the `Finish` button to perform the conversion.

The converted project will have a new `code` folder containing a simple hello_653 procedure called `hello_653.adb`.

13.3.3 Add Deos Component Dependencies

GNAT Pro for Deos requires Deos 653 partitions to include `ansi`, `deos-653-p1` and `gnu-language` components. For this tutorial, we also want to print to the video console, so we need to also include the `vfile` component.

To add these components to our executable project:

1. Expand the `hello_653` project in the *DDC-I Project* window.
2. Expand `Deos Component`, right click on `Dependencies` and select `Add Dependency`.
3. Select `ansi` from the drop down menu.
4. Repeat for the `gnu-language`, `deos-653-p1` and `vfile` components.

13.3.4 Deos Feature Provider XML file

Deos 653 auto-generates the *Deos Process Developer XML* for our 653 partition. To add the required feature sets to the auto-generate *Deos Process Developer XML* we need to create a *Deos Feature Provider XML file* in our project. To create this file, first create a folder at the top level of your `hello_653` project called `xml` by right clicking on the `hello_653` project and select `New` → `Folder`.

Next, right click on the `xml` folder and select `New` → `File`. In the *Create New File* dialog name the file `hello_653.fp.xml` and click `Finish`.

If the XML file does not open automatically, open it from the *DDC-I Project Windows*. At the bottom of the `hello_653.fp.xml` window, select `Source` and add the following XML code:

```
<?xml version = "1.0" encoding="UTF-8"?>
<featureSet
     name = "hello_653"
     versionNumber = "1.0.0"
     validityKey = "1891889728"
     comment = "653 partition extensions to PD XML"
     toolVersion = "3.61.3"
     xmlns:xsi = "http://www.w3.org/2001/XMLSchema-instance"
     xsi:noNamespaceSchemaLocation = "ddci:/xsd/fp.xsd"
   >
   <feature
```

(continues on next page)

(continued from previous page)

```
        name = "oncePerUsingProcessTemplate"
        description = "usage required by partition"
      >
      <usedFeatureSetAction
          featureSetName = "libansi"
          featureName = "oncePerUsingProcessTemplate"
          featureSetUndefinedAction = "error"
          usingProcessTemplate = ""
      ></usedFeatureSetAction>
      <usedFeatureSetAction
          featureSetName = "vfile"
          featureName = "oncePerUsingProcessTemplate"
          featureSetUndefinedAction = "error"
          usingProcessTemplate = ""
      ></usedFeatureSetAction>
      <usedFeatureSetAction
          featureSetName = "vfile"
          featureName = "vfile"
          featureSetUndefinedAction = "error"
          usingProcessTemplate = ""
        >
        <methodParameter
            parameterName = "ProcessInstanceName"
            value = "hello_653"
        ></methodParameter>
      </usedFeatureSetAction>
   </feature>
</featureSet>
```

Save and close the file.

13.3.5 Build the project

Build the executable by right clicking on the `hello_653` project and select `Build Project` if you do not have automatic builds turned on (`Project → Build Automatically`).

13.3.6 Create the Deos 653 Configuration Project

To create the Deos 653 configuration project for our application, create another new *DDC-I Executable Project* by selecting the `File → New → DDC-I Executable Project` menu item.

In the *New DDC-I Executable Project* window:

1. Enter `tutorial_653_configuration` as the project name.
2. Select `Deos Metadata Project` as the *Project Type*.
3. Select `ARM` as the target.

Click the `Finish` button to create the `tutorial_653_configuration` project.

13.3.7 Update the Deos Component Dependencies

Right click on the `tutorial_653_configuration` project in the *DDC-I Project* window and select `Properties`. Click on the *DDC-I Options`` page and select the *Deos* tab. On the *Dependencies* page, click `Add` and select `hello_653` from the drop down menu. Click the `OK` button to close the dialog and click `Apply and Close` to close the properties dialog.

13.3.8 Create the Deos 653 Configuration File

Create a new `xml` folder and within it a new file called `tutorial_config.653.xml`. With the *Source* view selected at the bottom of the `tutorial_config.653.xml` window add the following XML:

```
<?xml version = "1.0" encoding="UTF-8"?>
<Deos653Config
     name = "Sample-Configuration"
     validityKey = "-1118335824"
     toolVersion = "1.27.1"
     comment = ""
     hmShutdownRegistry = "platreg.bin"
     hmShutdownHyperstartIndex = "2"
     minimumWindowDurationInNs = "100000"
     xmlns = "http://ddci.com/ARINC653"
     xmlns:xsi = "http://www.w3.org/2001/XMLSchema-instance"
     xsi:schemaLocation = "deos653.xsd"
   >
   <Partitions>
      <Partition
           Name = "hello_653"
           Identifier = "1"
           Period = "12500000"
           Duration = "8000000"
           ExecutableImageName = "hello_653.exe"
           MainProcessStackSizeInPages = "10"
           BreakAtStartup = "false"
           InDebugSet = "false"
           MapConfigurationFileTo = "RAM"
           ExecuteFrom = "RAM"
           PartitionUsesFPU = "true"
           ProcessStackSpaceInPages = "1000"
           MinimumProcessStackSizeInBytes = "1024"
           ProcessQuota = "4"
           BlackboardQuota = "16"
           BlackboardMessageSpaceInBytes = "128"
           BufferQuota = "0"
           BufferMessageSpaceInBytes = "0"
           SemaphoreQuota = "0"
           EventQuota = "0"
           QueuingPortListQuota = "0"
           MaximumPartitionLockLevel = "16"
           MinimumProcessPriority = "1"
           MaximumProcessPriority = "239"
           LoggingFunction = ""
```

(continues on next page)

(continued from previous page)

```
            DeosKernelAttributeAccess = "true"
            ProcessStackGapSizeInDwords = "0"
            ProcessStackTagIntervalInDwords = "0"
            SourcePortSharedMemoryType = "DeosSharedMemory"
            SourcePortPlatformMemoryPool = "0"
            PlatformResourcePhysicalAddress = "0x0"
            PlatformResourceSizeInPages = "0"
            PlatformResourceCachePolicy = "off"
            HealthMonitorEventLogSize = "30"
            EventLoggingEnabled = "true"
            Core = "0"
            Type = "653"
            ProcessSwitchHook = ""
            PartitionModeChangeHook = ""
            SetModuleSchedule = "false"
            LinguisticTLSSpaceInBytes = "1280"
            ScheduleChangeAction = "IGNORE"
            PartitionCapabilities = ""
          >
          <MemoryRegions>
             <MemoryRegion
                  Name = "Initial RAM Pool"
                  Type = "Initial RAM Pool"
                  Address = "0x0"
                  Size = "0x80000"
                  AccessRights = "READ_WRITE"
                  PlatformMemoryPool = "0"
             ></MemoryRegion>
          </MemoryRegions>
       </Partition>
    </Partitions>
    <Schedule
         MinorFrameLength = "Automatic"
         ScheduleName = "default-wat"
         ScheduleID = "1"
         InitialModuleSchedule = "true"
       >
       <PartitionTimeWindow
            PartitionNameRef = "hello_653"
            Duration = "8000000"
            Offset = "0"
            PeriodicProcessingStart = "true"
            RepeatWindowAtNanosecondInterval = "PartitionPeriod"
            MayStartEarly = "false"
            MayFinishEarly = "true"
            MayUseSlack = "false"
       ></PartitionTimeWindow>
    </Schedule>
    <HealthMonitoring>
       <SystemErrors>
          <SystemError
               ErrorIdentifier = "1"
```

(continues on next page)

(continued from previous page)

```
            Description = "processorSpecific"
        ></SystemError>
        <SystemError
            ErrorIdentifier = "2"
            Description = "floatingPoint"
        ></SystemError>
        <SystemError
            ErrorIdentifier = "3"
            Description = "accessViolation"
        ></SystemError>
        <SystemError
            ErrorIdentifier = "4"
            Description = "powerTransient"
        ></SystemError>
        <SystemError
            ErrorIdentifier = "5"
            Description = "platformSpecific"
        ></SystemError>
        <SystemError
            ErrorIdentifier = "6"
            Description = "frameResync"
        ></SystemError>
        <SystemError
            ErrorIdentifier = "7"
            Description = "deadlineMissed"
        ></SystemError>
        <SystemError
            ErrorIdentifier = "8"
            Description = "applicationError"
        ></SystemError>
        <SystemError
            ErrorIdentifier = "9"
            Description = "illegalRequest"
        ></SystemError>
        <SystemError
            ErrorIdentifier = "10"
            Description = "stackOverflow"
        ></SystemError>
    </SystemErrors>
    <MultiPartitionHM
          TableIdentifier = "1"
          TableName = "default MultiPartitionHM"
        >
        <ErrorAction
            ErrorIdentifierRef = "1"
            ErrorLevel = "MODULE"
            ModuleRecoveryAction = "IGNORE"
        ></ErrorAction>
        <ErrorAction
            ErrorIdentifierRef = "2"
            ErrorLevel = "MODULE"
            ModuleRecoveryAction = "IGNORE"
```

(continues on next page)

(continued from previous page)

```
        ></ErrorAction>
        <ErrorAction
             ErrorIdentifierRef = "3"
             ErrorLevel = "MODULE"
             ModuleRecoveryAction = "IGNORE"
        ></ErrorAction>
        <ErrorAction
             ErrorIdentifierRef = "4"
             ErrorLevel = "MODULE"
             ModuleRecoveryAction = "IGNORE"
        ></ErrorAction>
        <ErrorAction
             ErrorIdentifierRef = "5"
             ErrorLevel = "MODULE"
             ModuleRecoveryAction = "IGNORE"
        ></ErrorAction>
        <ErrorAction
             ErrorIdentifierRef = "6"
             ErrorLevel = "MODULE"
             ModuleRecoveryAction = "IGNORE"
        ></ErrorAction>
        <ErrorAction
             ErrorIdentifierRef = "7"
             ErrorLevel = "PARTITION"
             ModuleRecoveryAction = ""
        ></ErrorAction>
        <ErrorAction
             ErrorIdentifierRef = "8"
             ErrorLevel = "PARTITION"
             ModuleRecoveryAction = ""
        ></ErrorAction>
        <ErrorAction
             ErrorIdentifierRef = "9"
             ErrorLevel = "MODULE"
             ModuleRecoveryAction = "IGNORE"
        ></ErrorAction>
        <ErrorAction
             ErrorIdentifierRef = "10"
             ErrorLevel = "MODULE"
             ModuleRecoveryAction = "IGNORE"
        ></ErrorAction>
     </MultiPartitionHM>
     <PartitionHM
          TableIdentifier = "1"
          TableName = "required unique name 1"
          MultiPartitionHMTableNameRef = "default MultiPartitionHM"
        >
        <ErrorAction
             ErrorIdentifierRef = "7"
             ErrorLevel = "PROCESS"
             PartitionRecoveryAction = "WARM_RESTART"
             ErrorCode = "DEADLINE_MISSED"
```

(continues on next page)

(continued from previous page)

```
        ></ErrorAction>
        <ErrorAction
            ErrorIdentifierRef = "8"
            ErrorLevel = "PROCESS"
            PartitionRecoveryAction = "WARM_RESTART"
            ErrorCode = "APPLICATION_ERROR"
        ></ErrorAction>
      </PartitionHM>
   </HealthMonitoring>
</Deos653Config>
```

Save and close the file.

13.3.9 Create the DDC-I Deos Platform Project

With the executable project built, create a new `DDC-I Platform Project` and select `qemu-arm`. In the project window, expand the `qemu-arm` project and then `Deos Components`. Right click on `Dependencies` and add a new dependency. In the resulting window, select `All` in the registry filter drop down menu and then select `tutorial_653_configuration` as a dependencies.

Next, in the project window expand `Complete Integration` and double click on `Components`. Expand `platreg` in the window that opens and then right click on `vfile` and select `Debug Variant`. Build the platform project by right clicking on the project and selecting `Project`.

13.3.10 Run the Deos project

Click on the *Target Manager* window on near the top left corner of the screen and click the left most button on that window to create a new target. The tooltip for the button should read *New Remote Target*. Click OK to accept the defaults and then click the play button.

QEMU will launch and the hello world message will print to the video monitor.

This concludes the tutorial.

CHAPTER

FOURTEEN

DEVELOPING ADA APPLICATIONS IN XILINX VITIS

This chapter is intended for users already familiar with Xilinx Vitis and GNATbench. Some familiarity with GNAT Pro is also useful. For more information on *GNAT Pro* please refer to the *GNAT Pro User's Guide* and the *GNAT User's Guide Supplement for Cross Platforms*, available on *GNAT Tracker*.

Note: at the moment, importing existing Ada projects into GNATbench on Xilinx Vitis is not tested. If you have such projects, follow the tutorial on how to create a new Ada application and copy the code and configuration files from your previous project to the new project. Do note that if you have an existing GPR file, look at the GPR file created by GNATbench for any modification you may need to apply to your own GPR file.

This process works with Xilinx Vitis 2021.x and 2022.x. On 2022.x however installing GNATbench fails due to a problem in Vitis. The problem with a workaround is described in this support thread.

Please contact AdaCore if you need any help.

14.1 Installing GNATbench

14.1.1 Requirements

Prior to installing GNATbench, first install *GNAT Pro* and ensure its binaries are located on your path before starting Xilinx Vitis. On Windows, the installer will update your environment path to include *GNAT Pro* if the option is selected during installation. On Linux, the installer will provide instructions on how to update `PATH` variable at the end of the install.

14.1.2 Downloading GNATbench

GNATbench is downloadable from GNAT Tracker and can be found on the *Release Download* page under the *IDE* section. Download the GNATbench ZIP archive that corresponds to your host platform. Once downloaded, you will install the plug-in through the Eclipse plug-in installer, so there is no need to expand the ZIP archive.

14.1.3 Installing

Install GNATbench in Vitis. To do this click on `Help` → `Install New Software`. The plugin install window will open. Click on `Add` to add the gnatbench archive.

Install

Available Software

Select a site or enter the location of a site.

Work with: type or select a site | Add... | Manage...

type filter text | Select All

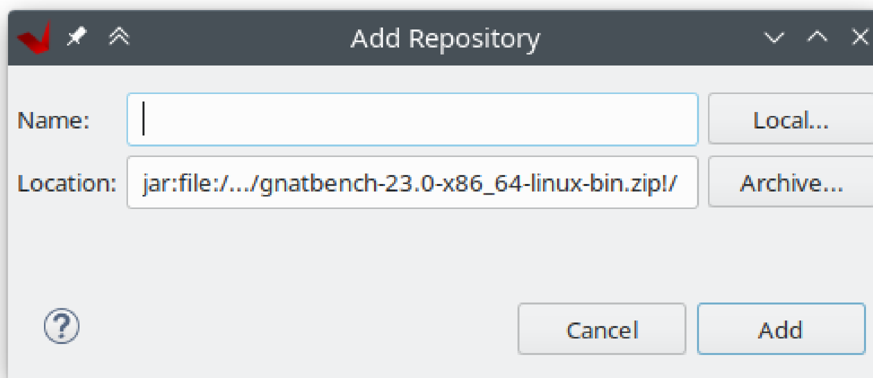
Name	Version
There is no site selected.	

Deselect All

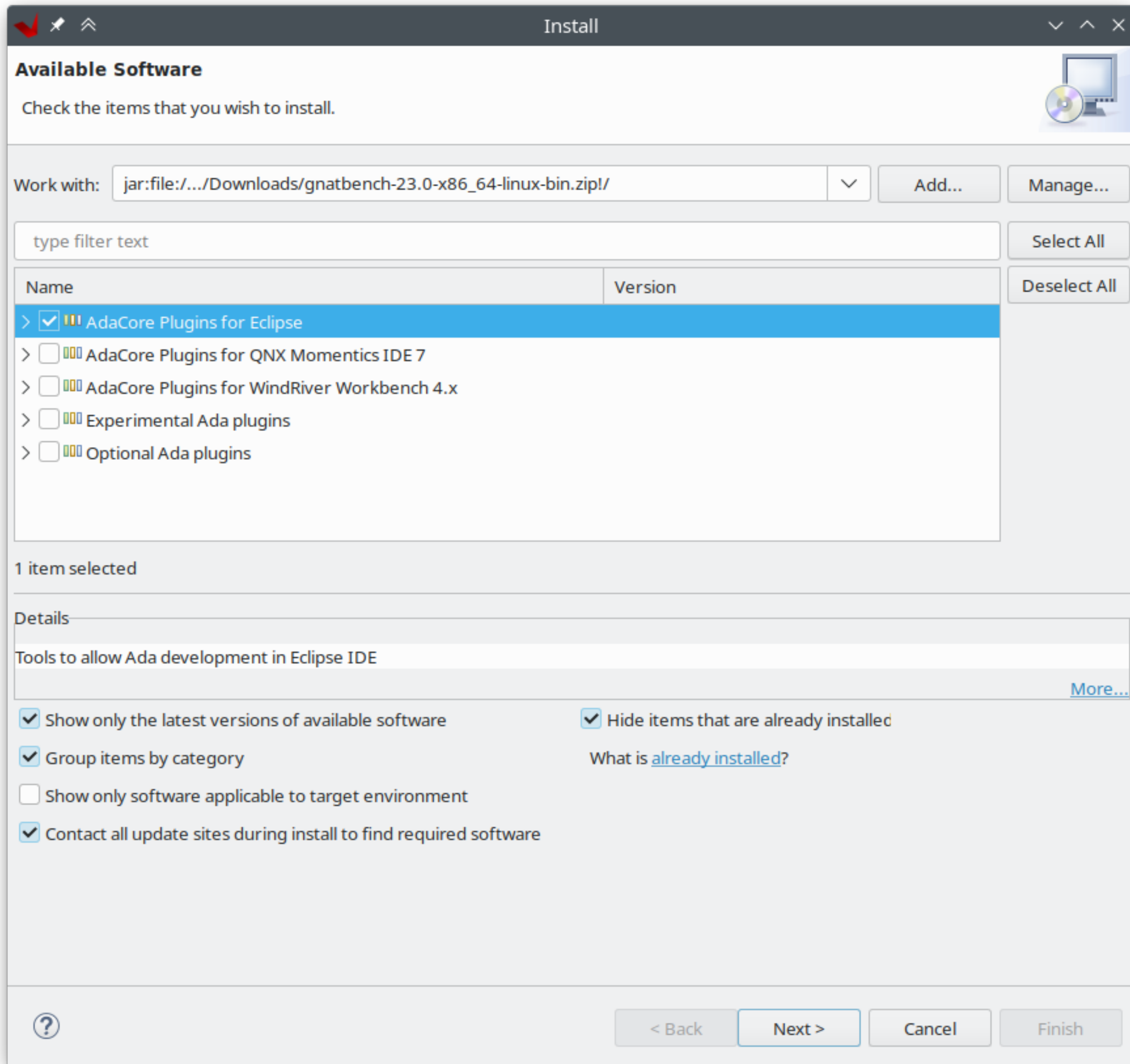
Details

- [x] Show only the latest versions of available software
- [x] Hide items that are already installed
- [x] Group items by category
- What is already installed?
- [ ] Show only software applicable to target environment
- [x] Contact all update sites during install to find required software

< Back | Next > | Cancel | Finish



The GNATbench plugins will show up in the installation window. Select `AdaCore Plugins for Eclipse`, click on `Next` and follow the installation process.



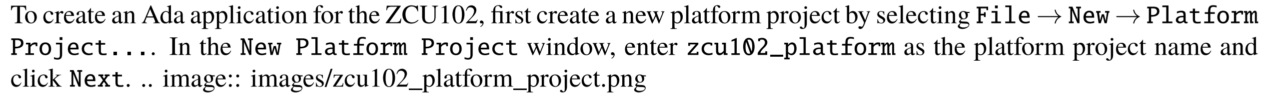
Once the installation has finished, restart the Vitis.

Once GNATbench is installed and Xilinx Vitis has been restarted, confirm that GNATbench can find the *GNAT Pro* toolchain for your target by opening the Eclipse properties and selecting the `GNATbench properties` page. *GNAT Pro* for your target should be listed below.

14.2 Creating an Ada Application in Xilinx Vitis

This tutorial walks you through the process of creating a new Ada application for the Xilinx Zynq UltraScale+ MPSoC ZCU102 Evaluation Kit in Xilinx Vitis.

14.2.1 Create a new Platform Project

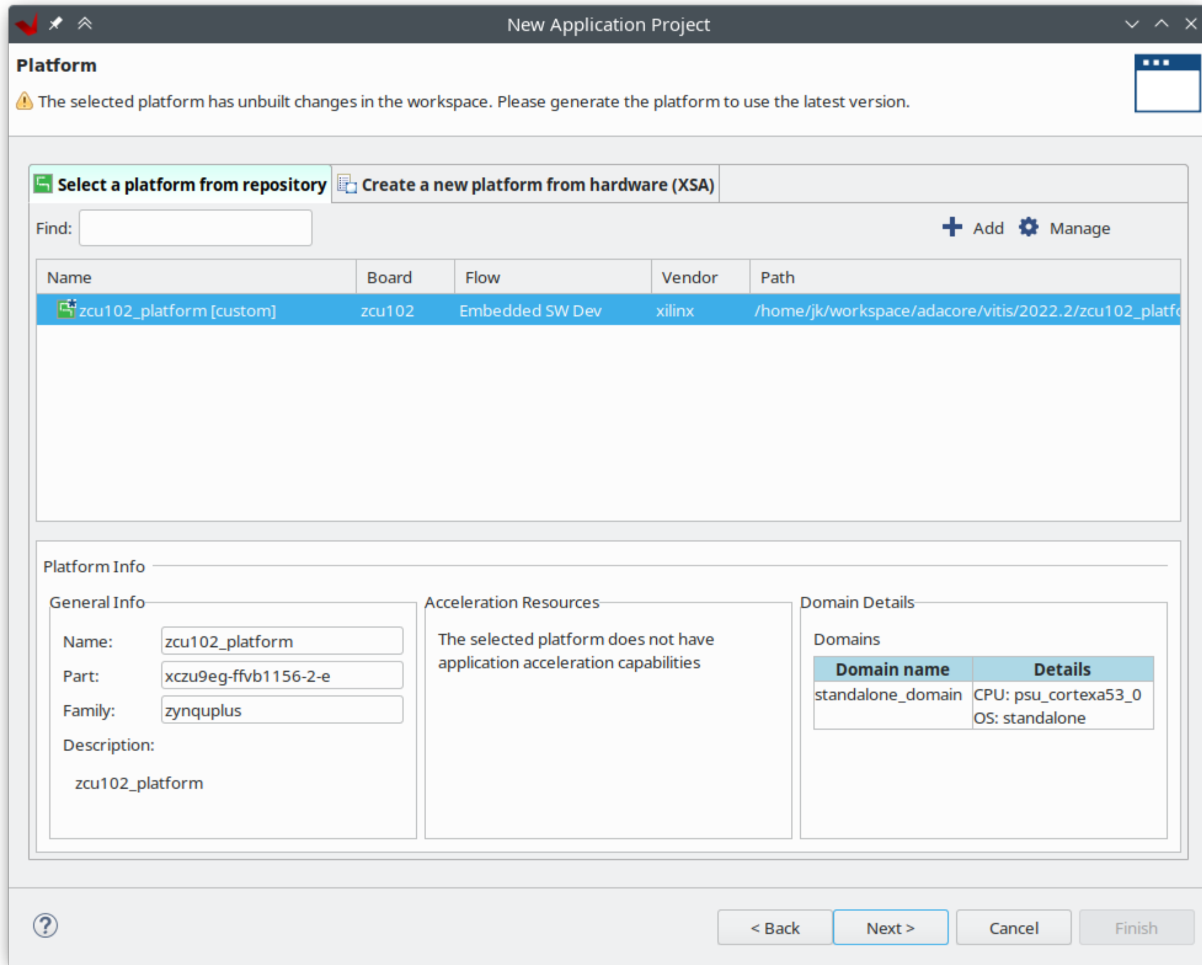


To create an Ada application for the ZCU102, first create a new platform project by selecting `File` → `New` → `Platform Project...`. In the `New Platform Project` window, enter `zcu102_platform` as the platform project name and click `Next`. .. image:: images/zcu102_platform_project.png

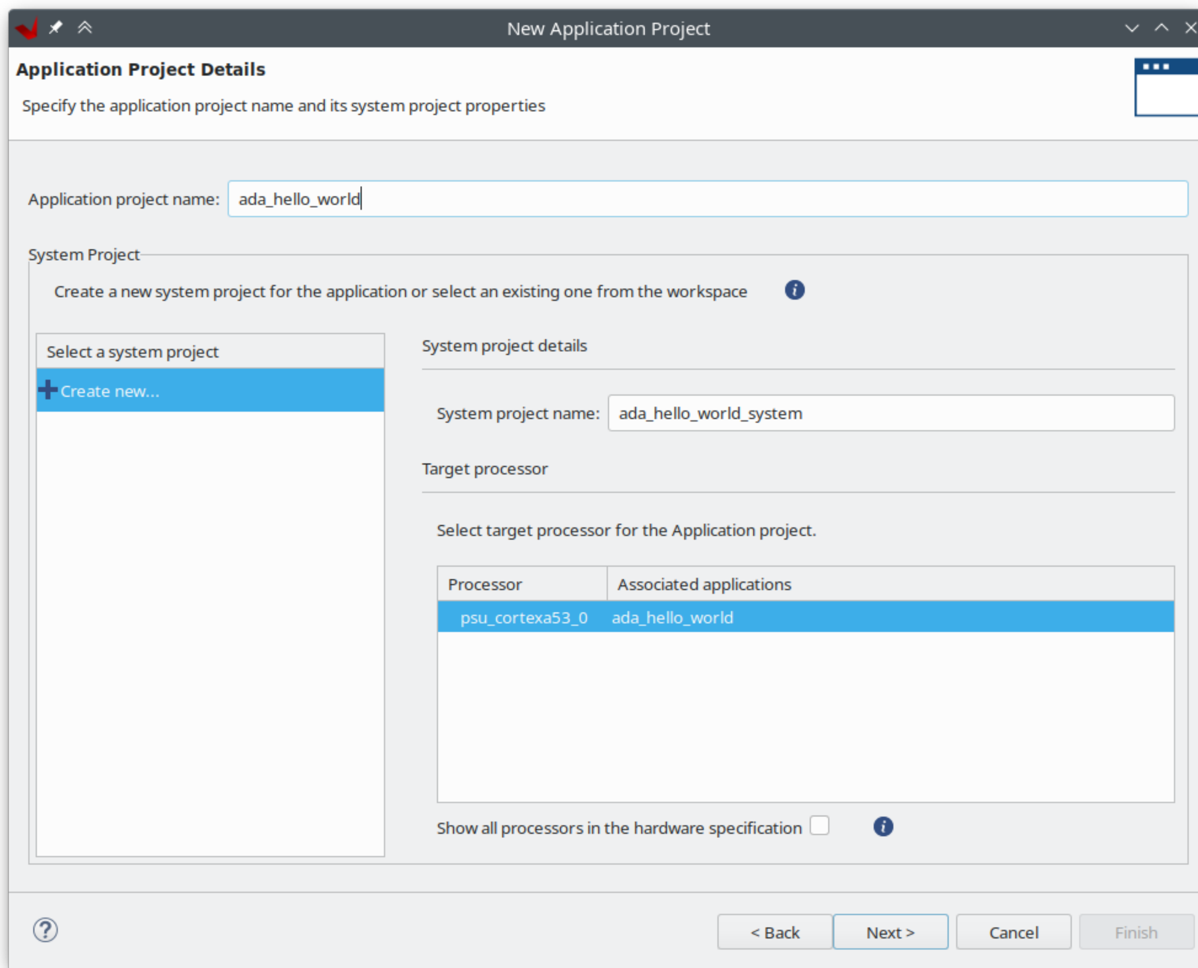
Under `Hardware Specification`, select `zcu102` from the `XSA` dropdown menu. Keep the default values and click `Finish`.

14.2.2 Create a new Application Project

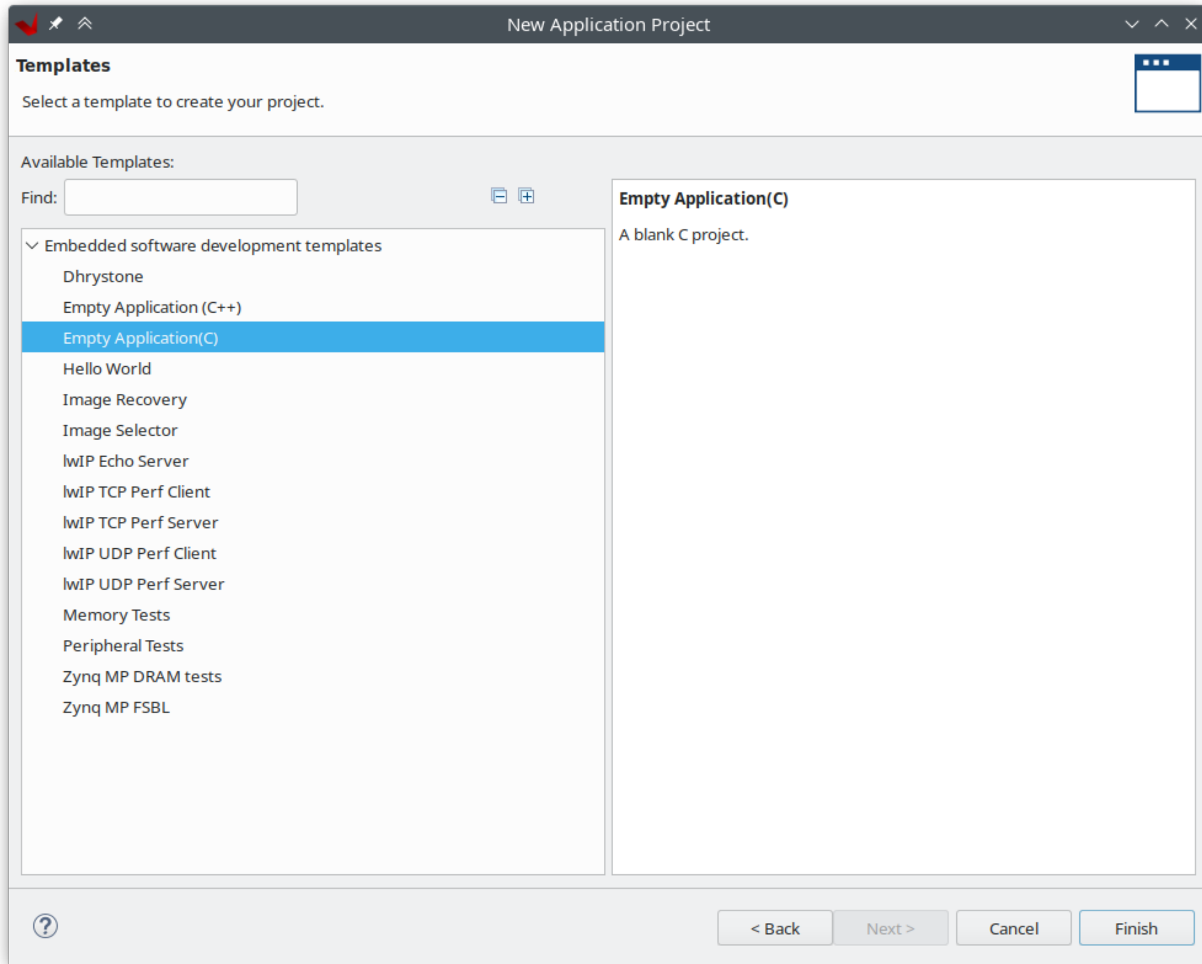
Create a new application project by selecting `File` → `New` → `Application Project...` In the wizard that opens, select the previously created `zcu102_platform` platform project.



Click `Next` and name the application `ada_hello_world`.



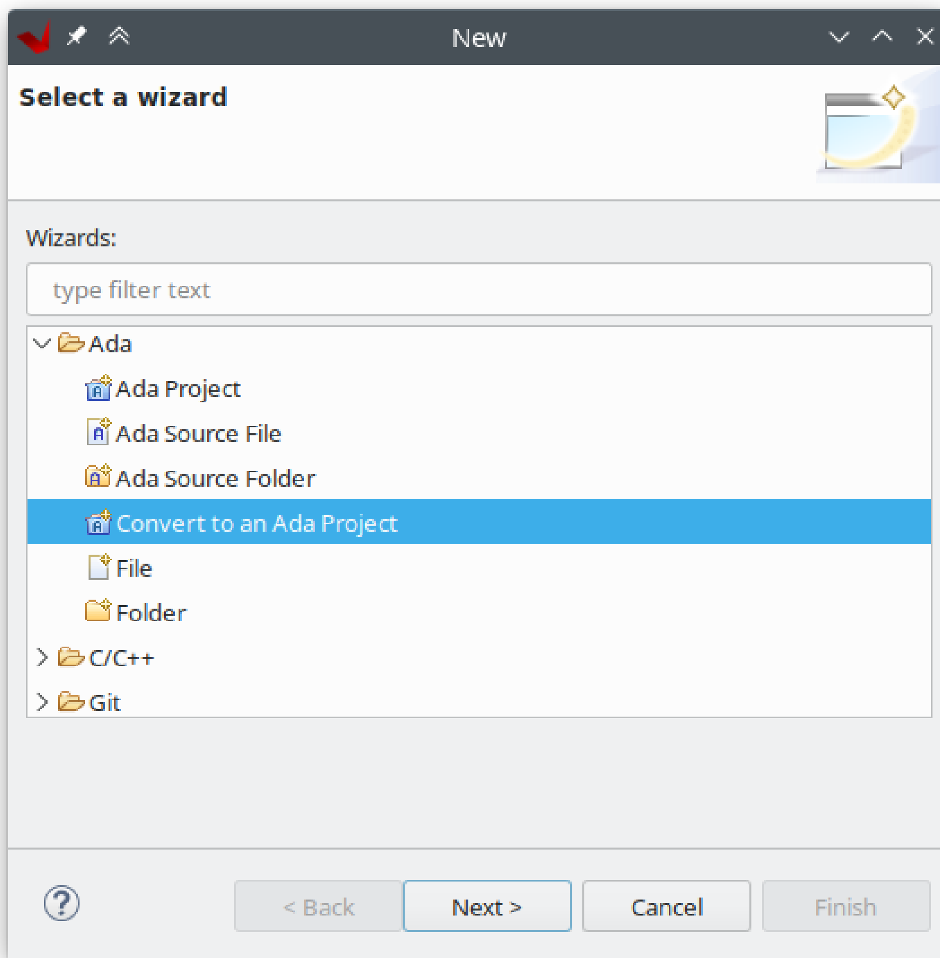
Click `Next` until template selection window appears. Chose `Empty Application (C)` and click `Finish`.



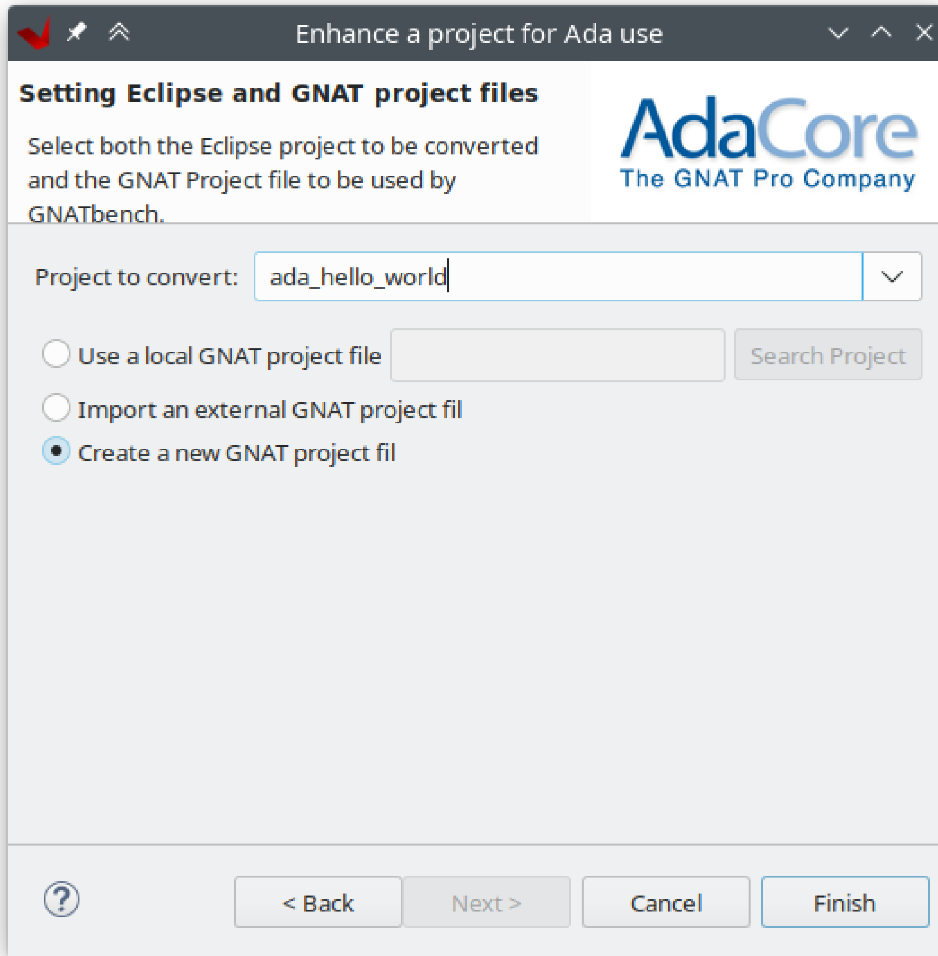
This will create two new projects, a system project called `ada_hello_world_system` and the application project called `ada_hello_world`.

14.2.3 Convert the Application Project

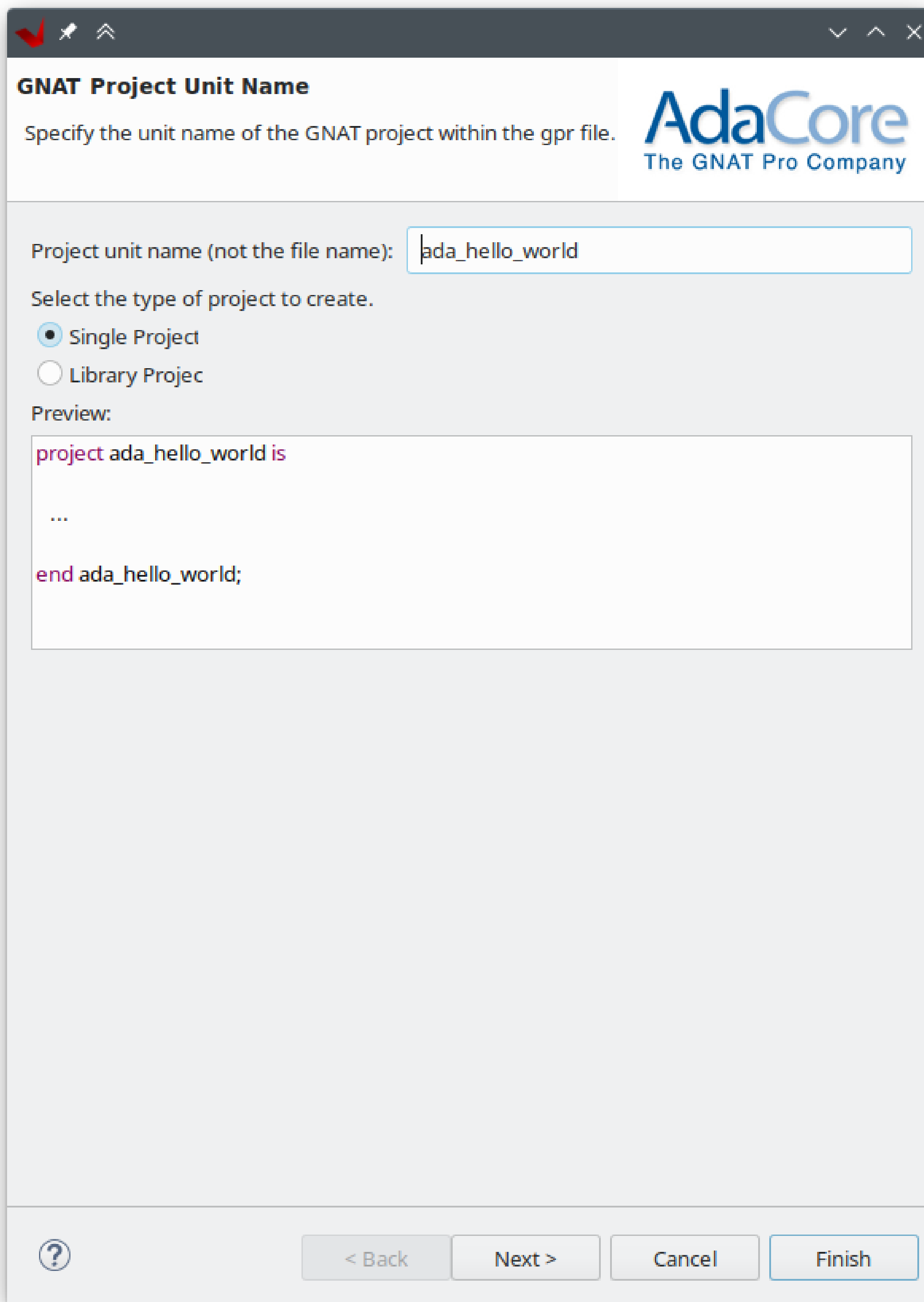
To convert the `ada_hello_world` project to an Ada project right click on the project and select `New` → `other`. Expand the `Ada` folder and select `Convert to an Ada project`.



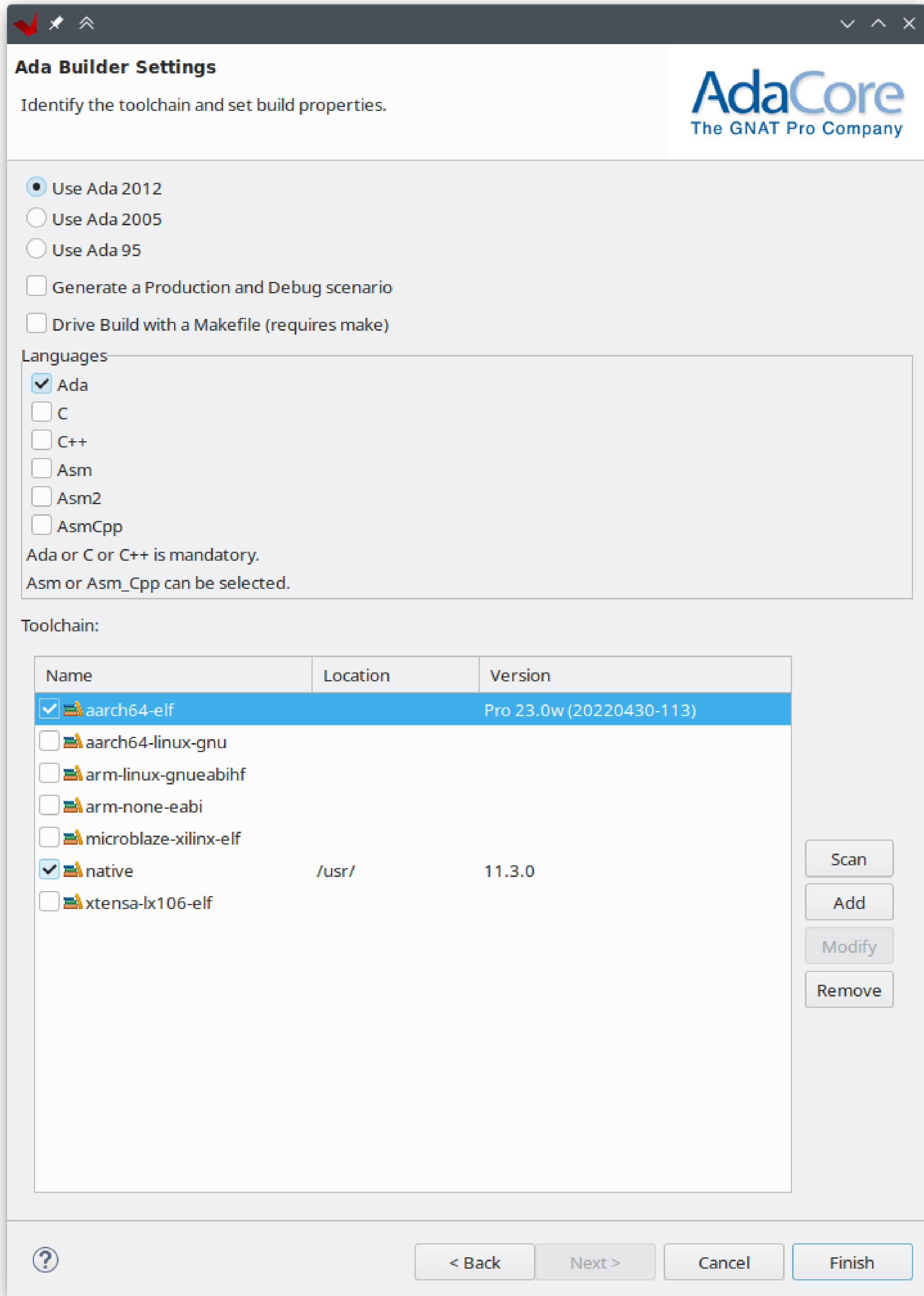
The next screen will ask which project file is going to be used with the newly created Ada project. Select `Create a new GNAT project file`.



In the last step you can decide if the project is a single project or a library. Select `Single Project` and keep the project unit name as `ada_hello_world`.



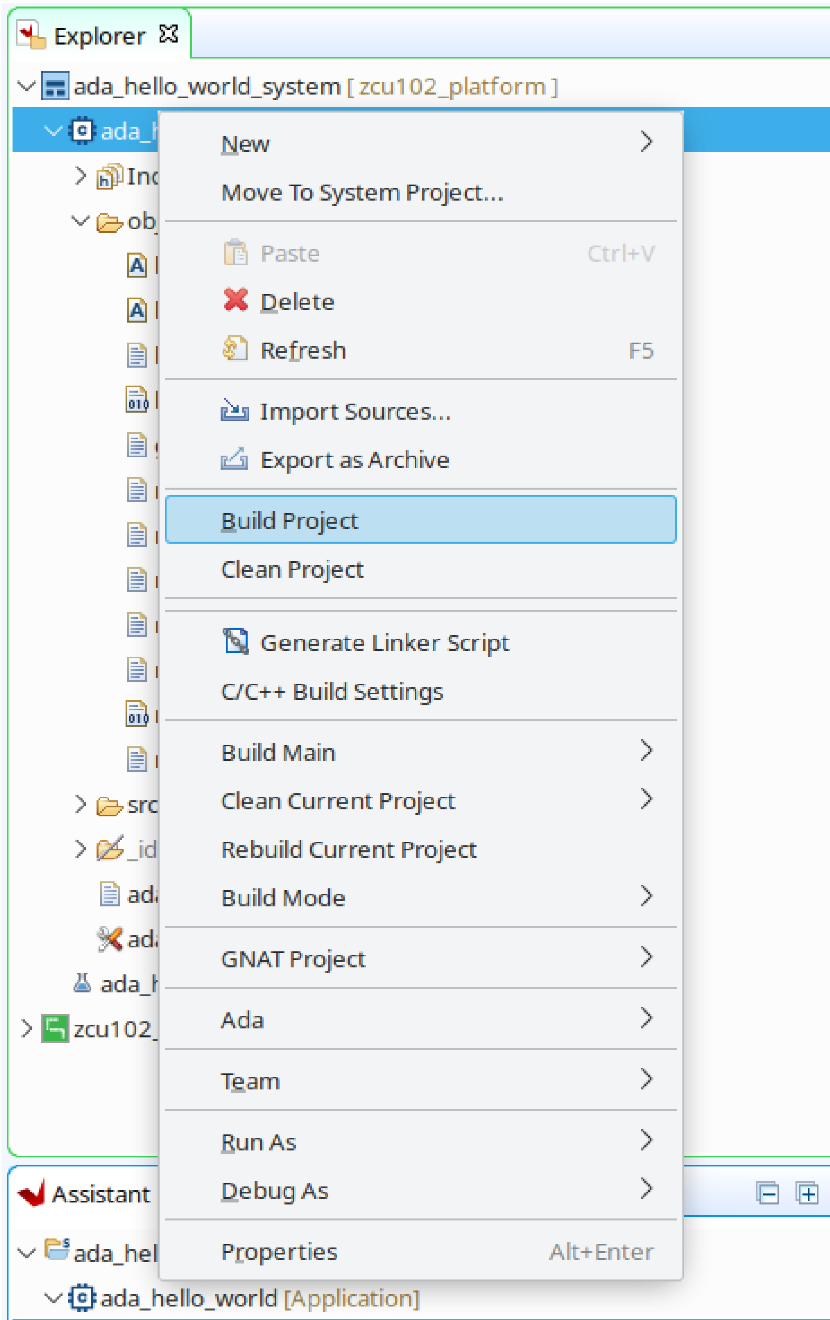
Click Next until you reach the `Ada Building Setting` page. Ensure `Ada` is selected under languages and the `aarch64-elf` is selected as the toolchain.


Ada Builder Settings
Identify the toolchain and set build properties.
AdaCore
The GNAT Pro Company
Use Ada 2012
Use Ada 2005
Use Ada 95
Generate a Production and Debug scenario
Drive Build with a Makefile (requires make)
Languages
Ada
C
C++
Asm
Asm2
AsmCpp
Ada or C or C++ is mandatory.
Asm or Asm_Cpp can be selected.
Toolchain:
Name
Location
Version
aarch64-elf
Pro 23.0w (20220430-113)
aarch64-linux-gnu
arm-linux-gnueabihf
arm-none-eabi
microblaze-xilinx-elf
native
/usr/
11.3.0
xtensa-lx106-elf
Scan
Add
Modify
Remove
< Back
Next >
Cancel
Finish

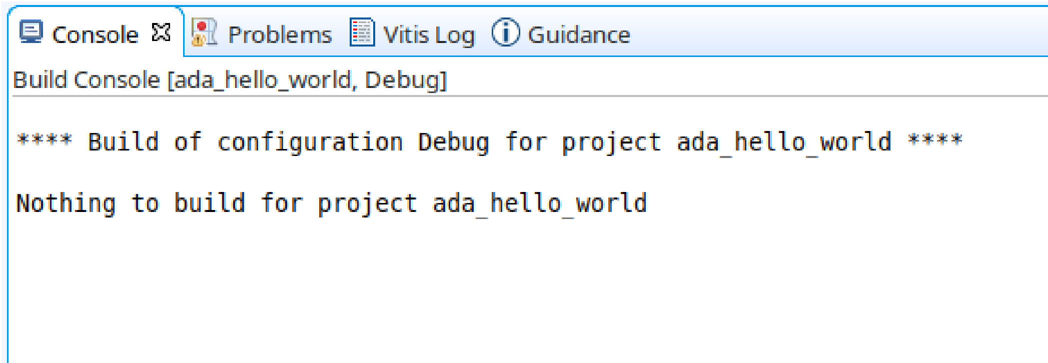
Click the `Finish` button to perform the conversion.

14.2.4 Build the Project

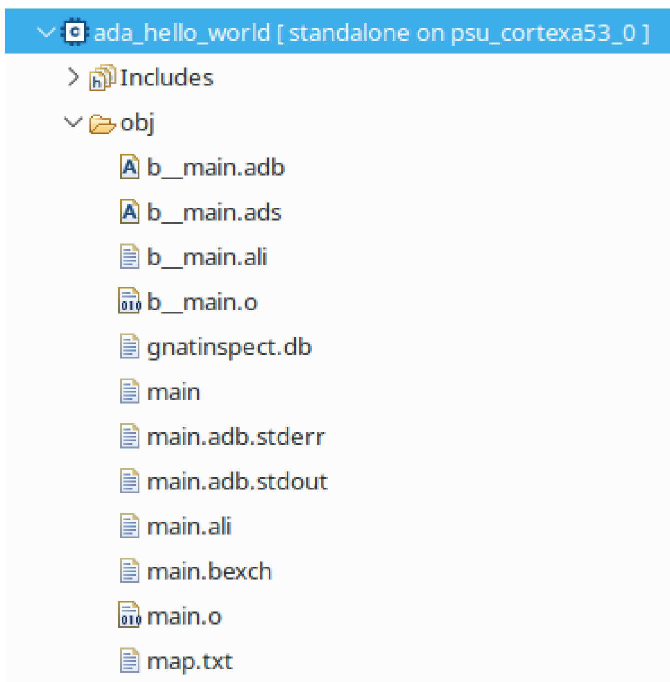
The project is now ready for development. Build the application by right clicking on the `ada_hello_world` project and select `Build project`.



The project will then be built. Vitis may show that there is nothing to build for this project.



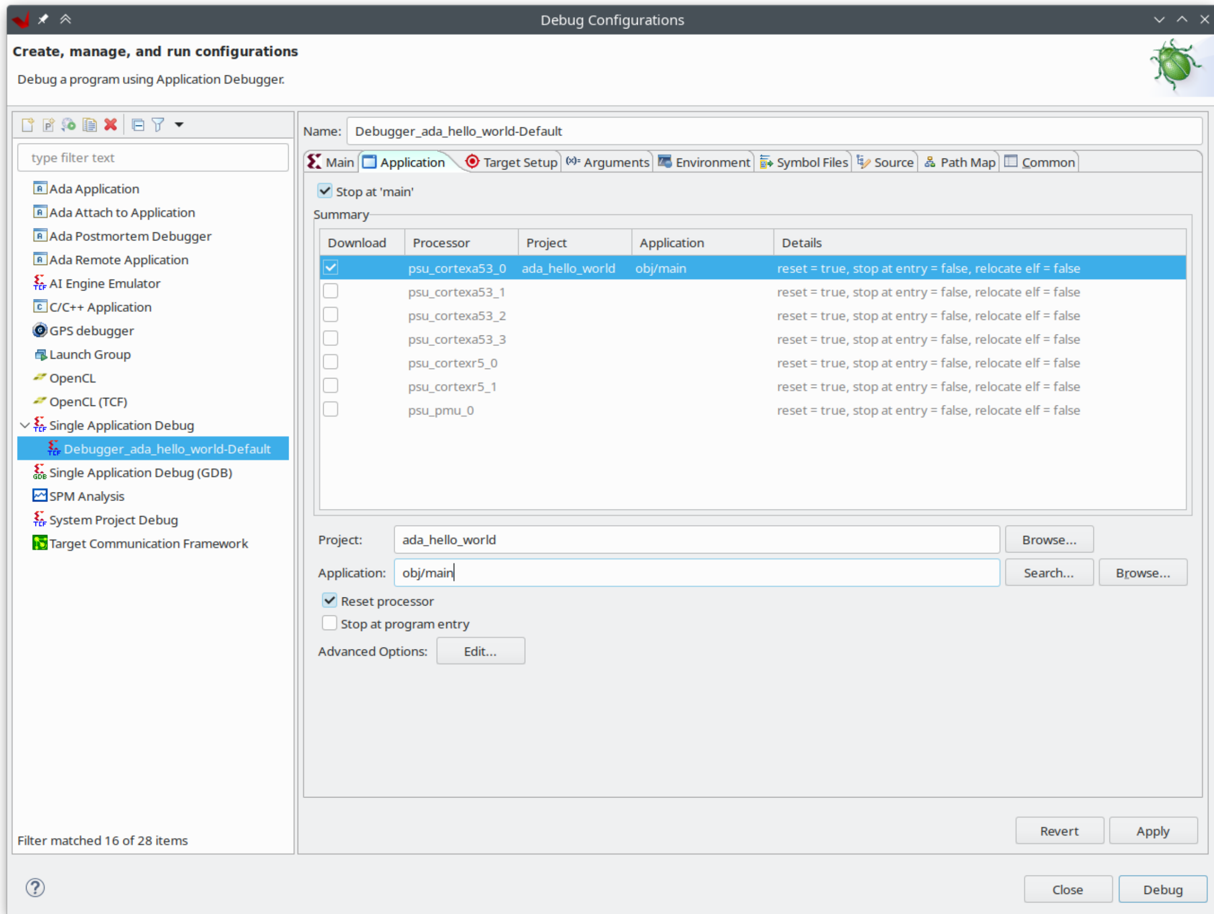
The build consolse will indicate a successful build with `Nothing to build for project ada_hello_world` as the IDE does not check for `gprbuild` by itself. You can validate that the build was successfull by checking that `main` exists in the `obj` directory:



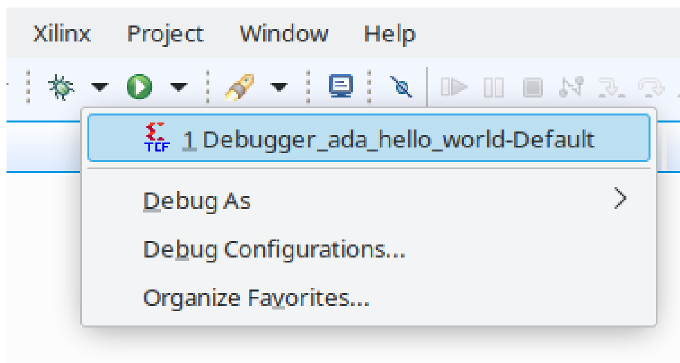
14.2.5 Running and Debugging the Project

To debug an Ada project a new debug configuration needs to be added. This can be done by clicking `Debug As` → `Debug Configurations`.

In the window that opens double click on `Single Application Debug` to create a new configuration. Go to the `Application` tab and change the default value of `Application` which is `Debug/ada_hello_world.elf` to the file generated by `gprbuild`. In our case that is `obj/main`. Click `Apply` to create the new debug configuration.



You can now debug the application by selecting the newly created configuration from the debugging menu.



Version 27.0.20260427.w

Date: 2026-04-28

Copyright (c) 2006-2026 AdaCore

This document may be copied, in whole or in part, in any form or by any means, as is or with alterations, provided that (1) alterations are clearly marked as alterations and (2) this copyright notice is included unmodified in any copy.