TACC

Scientific Software Days

The Eclipse Parallel Tools Platform *and Scientific Application Development*

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parallel tools platform
http://eclipse.org/ptp

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TACC 5/16/08

Tutorial Outline

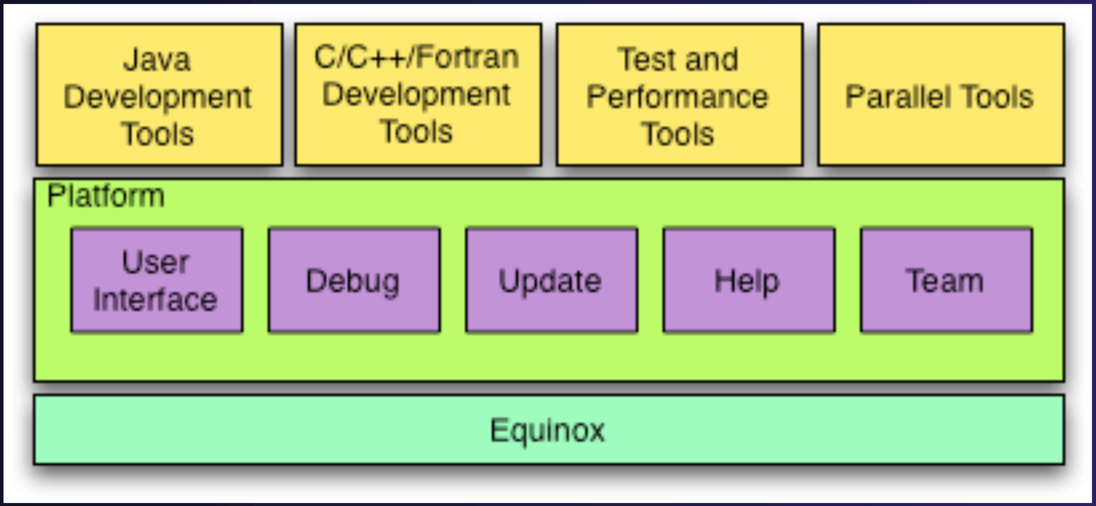
Time (est.)	Module	Outcomes	Presenter
9:00-10:10	1. Overview of Eclipse and PTP	✦ Introduction to PTP ✦ Eclipse basics ✦ Configuring Resource Managers & setup	Greg
10:10-10:30	2. Creating and Running MPI Programs	✦PTP project creation ✦New project wizards ✦PTP Runtime Perspective	Beth
10:30-10:45	Break		
10:45-11:10	3. Parallel Language Development Tools (PLDT)	✦ MPI, OpenMP analysis features	Beth
11:10-11:45	4. Parallel Debugger	✦ Debug Perspective, breakpoints, variables, stepping, etc.	Greg
11:45-12:15	5. Advanced Eclipse and PTP features	✦ CVS, Makefiles, autoconf, Search, Refactoring, UPC, Remote debugging, MPICH2, IBM PE & LoadLeveler	Greg
12:15-12:30	6. Other, Summary, Wrapup	✦ Perf. tools, website, mailing lists, more info, participation	Beth

Module 1: Overview of Eclipse and PTP

- Objective
  - To introduce the Eclipse platform and PTP
  - To learn the basics of Eclipse
- Contents
  - What is Eclipse? Who is using Eclipse?
  - What is PTP?
  - Eclipse basics
  - Configuring a Resource Manager

What is Eclipse?

- A vendor-neutral open source development platform
- A universal platform for tool integration
- Plug-in based framework to create, integrate and utilize software tools



Eclipse Platform

- Core frameworks and services with which all plug-in extensions are created
- Represents the common facilities required by most tool builders:
  - Workbench user interface
  - Project model for resource management
  - Portable user interface libraries (SWT and JFace)
  - Automatic resource delta management for incremental compilers and builders
  - Language-independent debug infrastructure
  - Distributed multi-user versioned resource management (CVS supported in base install)
  - Dynamic update/install service

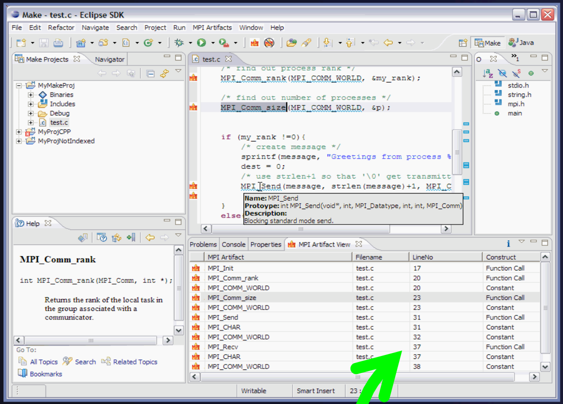
Plug-ins

- Java Development Tools (JDT)
- Plug-in Development Environment (PDE)
- C/C++ Development Tools (CDT)
- Parallel Tools Platform (PTP)
- Fortran Development Tools (Photran)
- Test and Performance Tools Platform (TPTP)
- Business Intelligence and Reporting Tools (BIRT)
- Web Tools Platform (WTP)
- Data Tools Platform (DTP)
- Device Software Development Platform (DSDP)
- Many more…

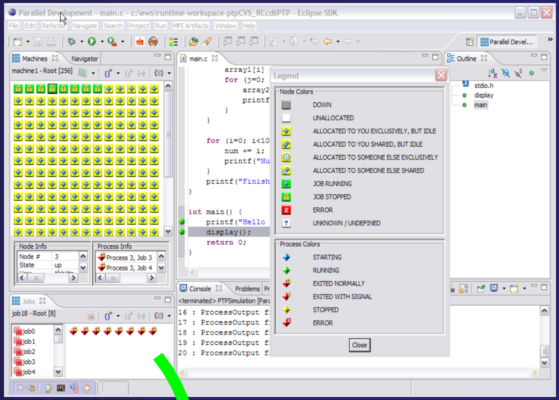
Eclipse PTP: Parallel Tools Platform

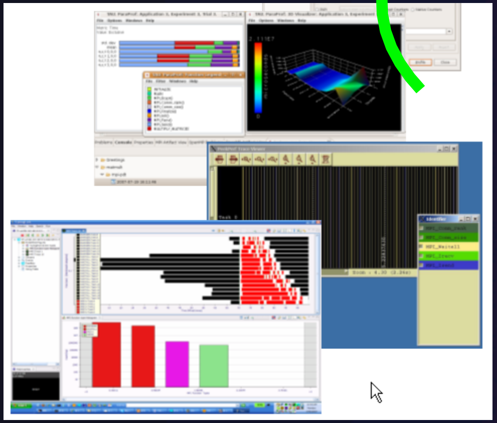
http://eclipse.org/ptp

Coding & Analysis

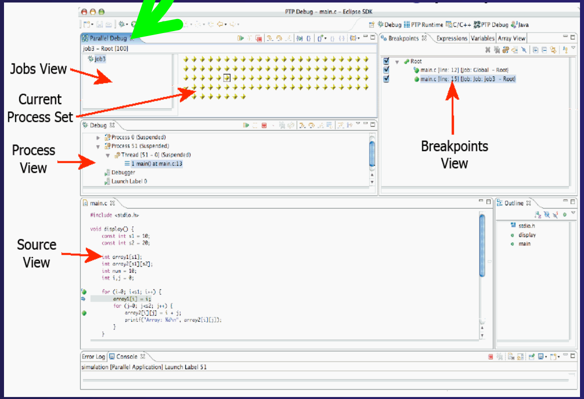


Launching & Monitoring





Performance Tuning



Debugging

Eclipse History

- Originally developed by Object Technology International (OTI) and purchased by IBM for use by internal developers
- Released to open-source community in 2001, managed by consortium
  - Eclipse Public License (EPL)
  - Based on IBM Common Public License (CPL)
- Consortium reorganized into independent not-for-profit corporation, the Eclipse Foundation, in early 2004
  - Participants from over 100 companies

Eclipse Foundation & Members

- Board of Directors and full-time Eclipse management organization
- Councils guide the development done by Eclipse Open Source projects
- 180 members (March '08)
  - 21 strategic members
- 942 committers, representing 50+ organizations

Strategic Members
ACTUATE
bea
SOPERA
Borland
ca Computer Associates
INNOOPRACT
WIND RIVER
SAP
IBM
intel
DEVZUZ
SYBASE
itemis
open methods
NOKIA
CLOUDSMITH
Zend The php Company
ORACLE
brox
IONA

TIBCO The Power of Now · ST · cenit · BlackBerry · BROCADE · spike source · spring source · iWay Software · STAR · CAPECLEAR · tensilica · CLOUDSMITH

The RCP Company · IDG · itemis · BZ Media · Google · open methods · SYBASE · Telelogic

SIEMENS · ORACLE · aptana · NOKIA Connecting People · Novell · GERHARDT INFORMATICS · BANDXI

Klocwork · ACTUATE · metallect · POLARION · JASPERSOFT · nexaweb · TEI of Western Macedonia

SKYWAY SOFTWARE Simplifying Software Delivery · REPLAY SOLUTIONS · gentleware model to business · nexB · GENERALITAT VALENCIANA · DSDM consortium · jiva Medical · PALAMIDA · LSI

Business Objects · PARASOFT · DDC-I · RedmondMediaGroup · ARM · COMPUWARE · protecode · HITACHI Inspire the Next

OCDemon MACRAIGOR SYSTEMS · sas · MICRO FOCUS · cisco · INSTITUTE FOR SOFTWARE · ACCESS · CWI · DEVZUZ · NetApp Simplifying Data Management · BREDEX Software-Entwicklung und Beratung · slickedit

Carleton University Canada's Capital University · redhat · beo · AvantSoft, Inc. · compeople · IONA · OW2 Consortium

LYNUXWORKS · IBM · metafinanz our power is your success · EADS · Lombardi · Mentor Graphics

RoweBots · PERFORCE · MBProject MEDICAL BANKING POLICY RESEARCH · EMBARCADERO TECHNOLOGIES · NEC · PROGRESS SOFTWARE

芒果软件 MANGO SOFTWARE · brox · SOPERA · genuitec · ca Transforming IT Management · FUJITSU · OM OpenMake Software · AdaCore · ENEA

teamprise · SERENA · ALGO · tni SOFTWARE · instantiations · REMAIN

intervoice · TietoEnator · AOL · etish · OpenSystems Publishing · Addison Wesley · MySQL · IBS Powerful software Passionate people · OSL OPEN SOURCE LAB · empolis arvato

INNOOPRACT · ETRI · OC SYSTEMS · anyware TECHNOLOGIES · QNX SOFTWARE SYSTEMS · Inpriva VISIT INPRIVA.COM · Laszlo

virtualLogix · ILOG · ProSyst · TEXAS INSTRUMENTS · froglogic · FOKUS · mds technology · SIGS DATACOM · bea

blackduck · virtutech · TimeSys · eteration · KPIT Cummins Infosystems Limited · ANCIT CONSULTING · mValent · Sony Ericsson

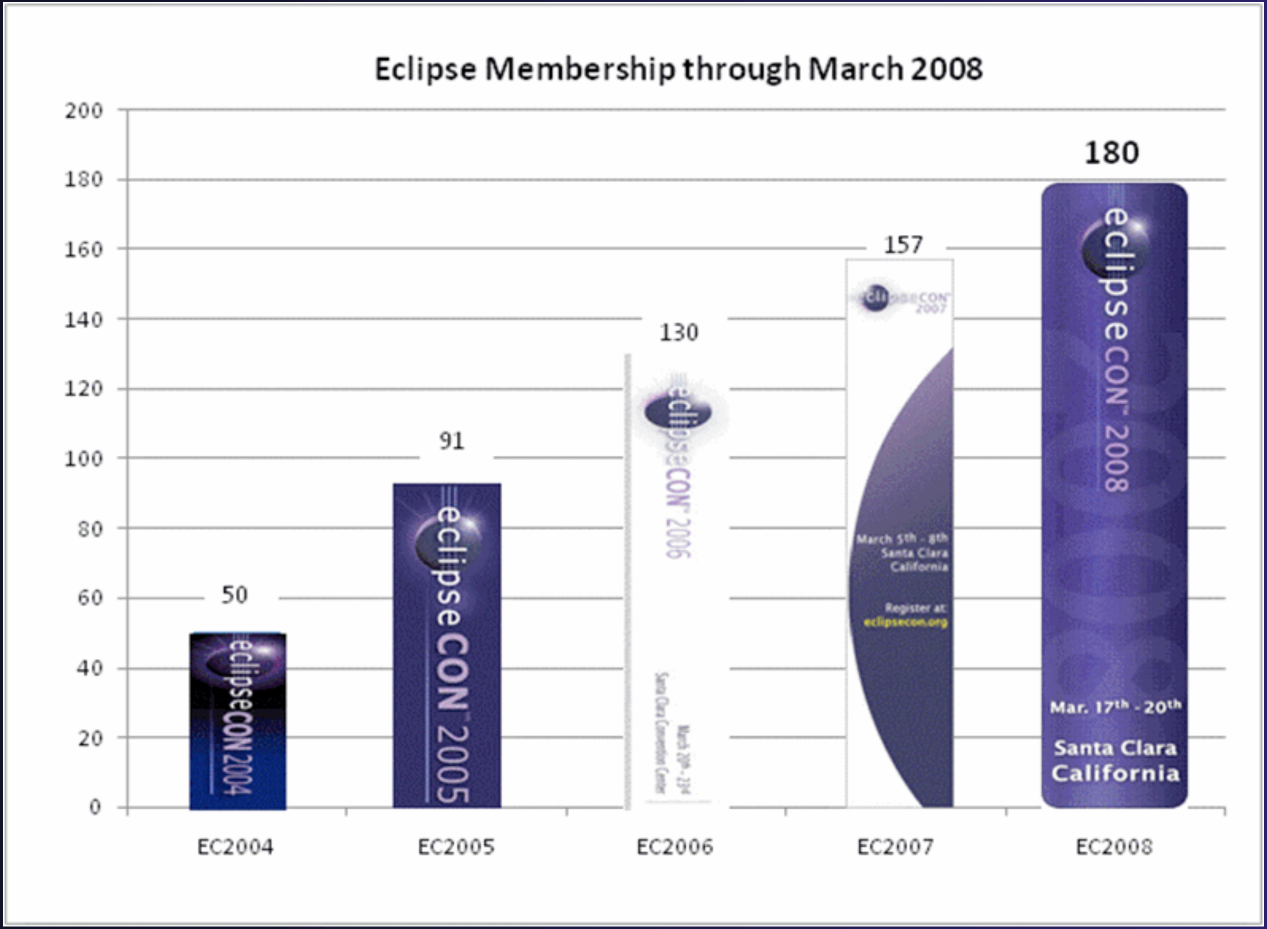
W · webtide · MANCHESTER 1824 · S&S Software & Support Verlag · intel · software AG · MicroDoc · RTC Group · MISYS · OMG · innovations · montavista · krugle

ERICSSON · AccuRev · COLLABNET · THALES

WIND RIVER · vector · TOSHIBA · acm queue · salesforce.com · ObjectWeb · Agitar SOFTWARE · ALDON · SAP · mks · symbian

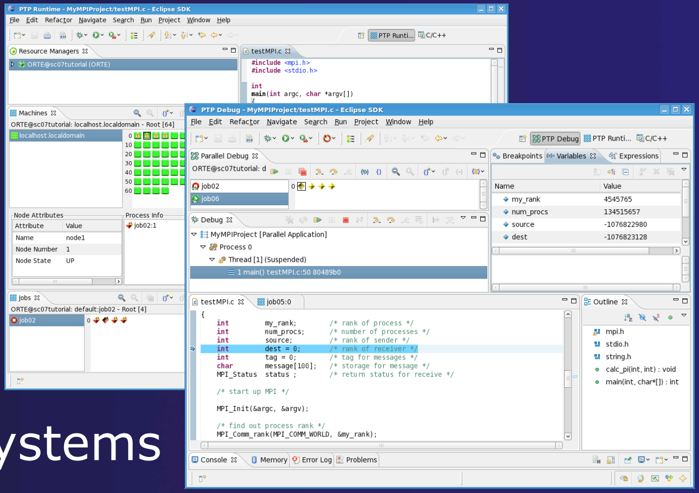
Zend The php Company · VTT · TROLLTECH · INGRES · Borland THE OPEN ALM COMPANY · INTALIO · AMD Smarter Choice · hp invent · Adobe · Tsinghua University 1911

Eclipse Member companies



Parallel Tools Platform (PTP)

- The Parallel Tools Platform aims to provide a highly integrated environment specifically designed for parallel application development
- Features include:
  - An integrated development environment (IDE) that supports a wide range of parallel architectures and runtime systems
  - A scalable parallel debugger
  - Parallel programming tools (MPI/OpenMP)
  - Support for the integration of parallel tools
  - An environment that simplifies the end-user interaction with parallel systems
- http://www.eclipse.org/ptp



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

int
main(int argc, char *argv[])
```

Name	Value
my_rank	4545765
num_procs	134515657
source	-1076822980
dest	-1076823128

```
{
    int         my_rank;       /* rank of process */
    int         num_procs;     /* number of processes */
    int         source;        /* rank of sender */
    int         dest = 0;      /* rank of receiver */
    int         tag = 0;       /* tag for messages */
    char        message[100];  /* storage for message */
    MPI_Status  status ;       /* return status for receive */

    /* start up MPI */

    MPI_Init(&argc, &argv);

    /* find out process rank */
    MPI_Comm_rank(MPI_COMM_WORLD, &my_rank);
```

PTP Software Prerequisites

- Java (1.5 or later)
- Cygwin or MinGW (for Windows)
- make, gcc, and gdb (or other vendor compilers)
- OpenMPI or MPICH2 (only required for PTP Runtime)

Note:

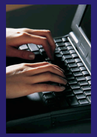
- Linux & Mac have full PTP support
- Windows can be used for Eclipse, targeting a remote parallel machine

Java Prerequisite

- Eclipse requires Sun or IBM versions of Java
  - Only need Java runtime environment (JRE)
  - Java 1.5 is the same as JRE 5.0
  - The GNU Java Compiler (GCJ), which comes standard on Linux, will not work!

Eclipse and PTP Installation

- Eclipse is installed in two steps
  - First, the ‘base’ Eclipse is downloaded and installed
    - This provides a number of pre-configured ‘features’
  - Additional functionality is obtained by adding more ‘features’
    - This can be done via an `update site’ that automatically downloads and installs the features
    - Features can also be downloaded and manually installed
- PTP requires the following features
  - C/C++ Development Tools (CDT)
  - Parallel Tools Platform (PTP)

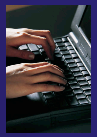


Eclipse Installation

- Two alternatives for installation:
  - The *Eclipse Classic* is the full software development kit (SDK), including Java and Plug-in development tools
  - The *Eclipse IDE for C/C++ developers* is the base Eclipse platform plus the CDT (C/C++ Development tools). This is ideal for PTP use (included on the tutorial CD)
- Eclipse is downloaded as a single zip or gzipped tar file from http://eclipse.org/downloads
- You must have the correct file for your operating system and windowing system
- Unzipping or untarring this file creates a directory containing the main executable

Platform Differences

- Single button mouse (e.g. MacBook)
  - Use Control-click for right mouse / context menu
- Context-sensitive help key differences
  - Windows: use **F1** key
  - Linux: use **Shift-F1** keys
  - MacOS X
    - Full keyboard, use **Help** key
    - MacBooks or aluminum keyboard, create a key binding for **Dynamic Help** to any key you want
- Accessing preferences
  - Windows & Linux: **Window▶Preferences…**
  - MacOS X: **Eclipse▶Preferences…**



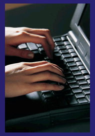
Starting Eclipse

- **Linux**
  - From a terminal window, enter

```
<eclipse_installation>/eclipse/eclipse &
```

- **MacOS X**
  - From finder, open the **Applications▶eclipse** folder
  - Double-click on the **Eclipse** application
- **Windows**
  - Open the **eclipse** folder
  - Double-click on the **eclipse** executable

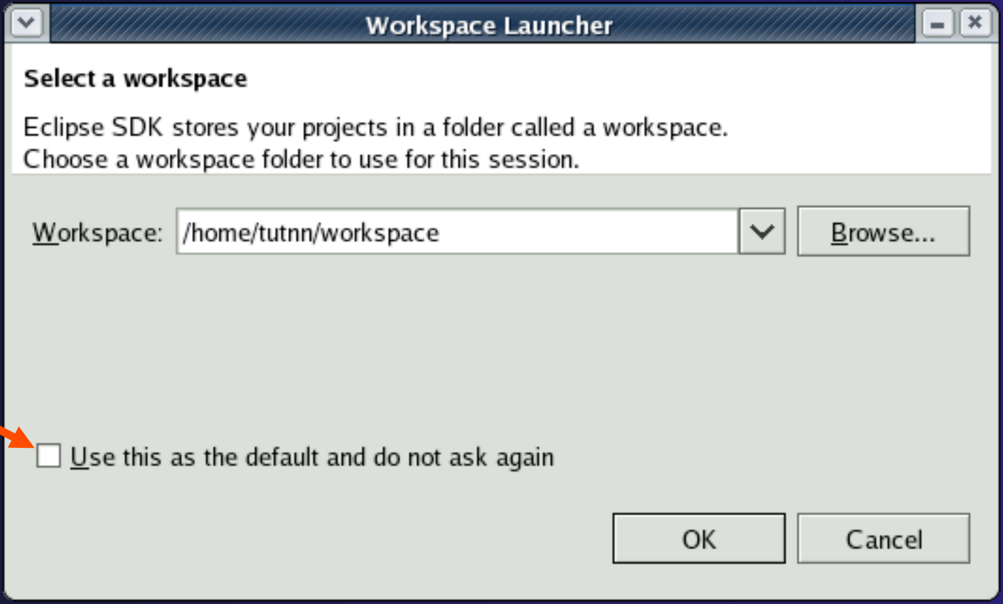
- Accept default workspace when asked
- Select workbench icon from welcome page



Specifying A Workspace

- Eclipse prompts for a workspace location at startup time
- The workspace contains all user-defined data
  - Projects and resources such as folders and files

The prompt can be turned off



Select a workspace

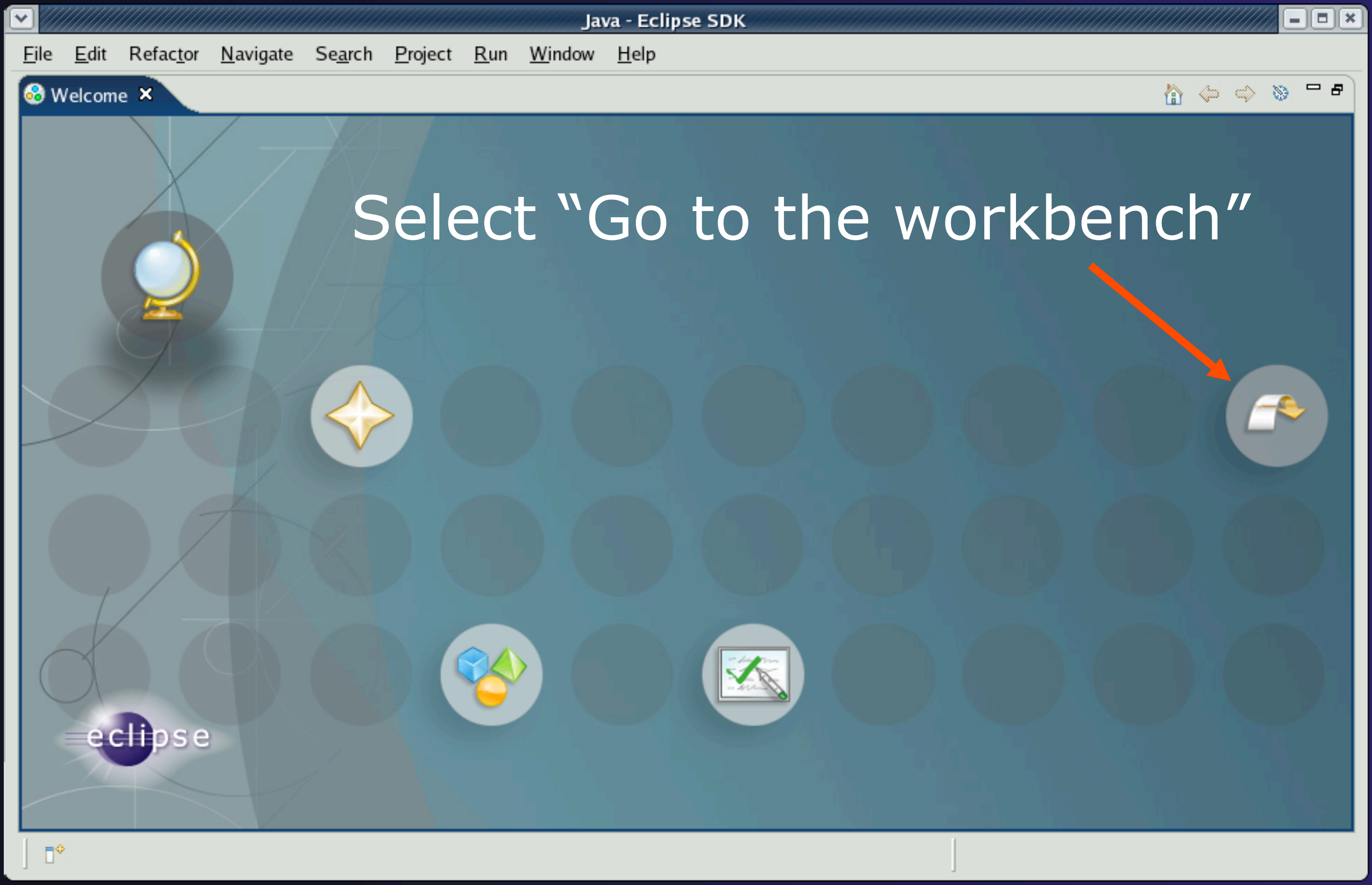
Eclipse SDK stores your projects in a folder called a workspace.
Choose a workspace folder to use for this session.

Workspace: /home/tutnn/workspace

☐ Use this as the default and do not ask again

Eclipse Welcome Page

- Displayed when Eclipse is run for the first time

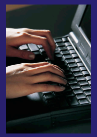

Java - Eclipse SDK
File Edit Refactor Navigate Search Project Run Window Help
Welcome
Select "Go to the workbench"
eclipse

Adding Features

- New functionality is added to Eclipse using *features*
- Features are obtained and installed from an update site (like a web site)
- Features can also be installed manually by copying files to the features and plugins directories in the main eclipse directory

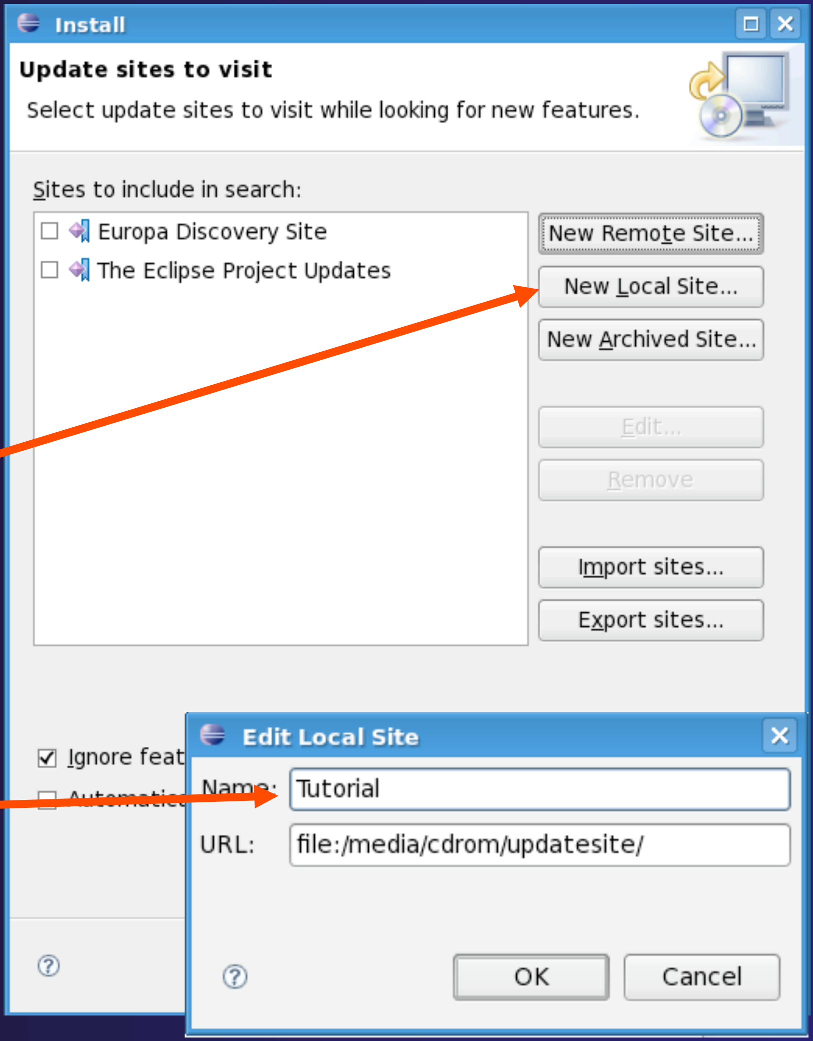
Installing Eclipse Features from an Update Site

- Three types of update sites
  - **Remote** - download and install from remote server
  - **Local** - install from local directory
  - **Archived** - a local site packaged as a zip or jar file
- Eclipse 3.3.2 comes preconfigured with a link to the **Europa Discovery Site**
  - This is a remote site that contains a large number of official features
  - Europa projects are guaranteed to work with Eclipse 3.3.2
- Many other sites offer Eclipse features
  - Use at own risk



Installing from a Local Update Site

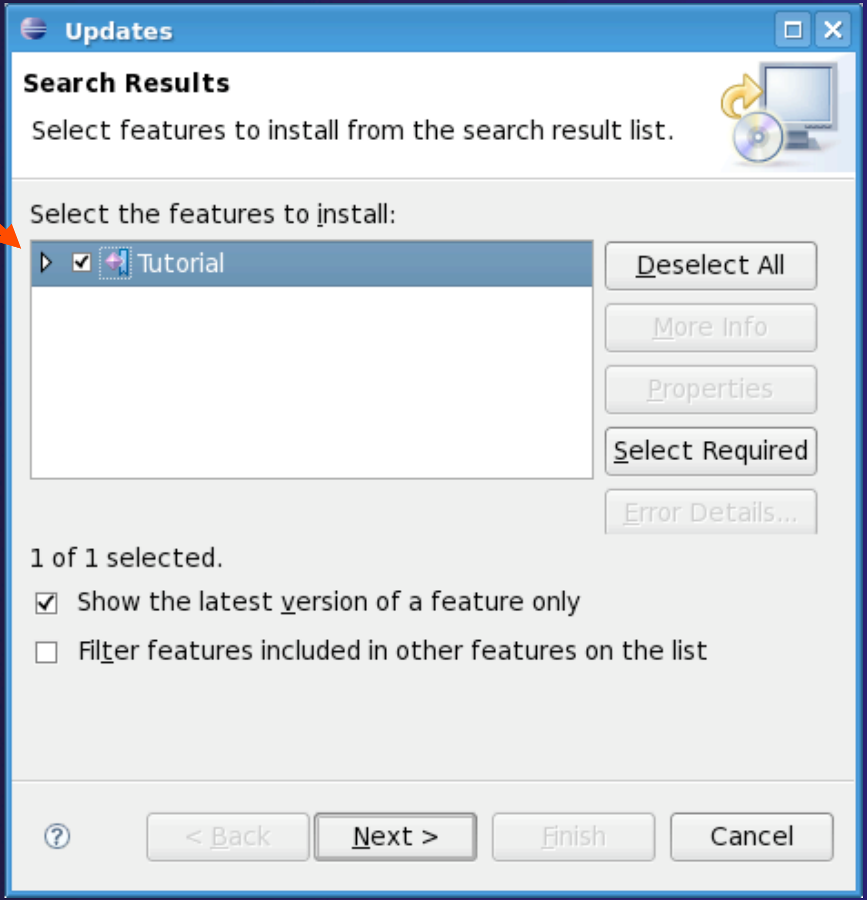
- We have combined everything needed for the tutorial onto a local update site on the CDROM
- From the **Help** menu, choose **Software Updates▶Find and Install…**
- Select **Search for new features to install**
- Click **Next >**
- Click **New Local Site…**
- Navigate to your CDROM, select the **updatesite** folder and click **Choose** (**OK** on Linux or Windows)
- Enter **Tutorial** for the **Name** (or use default: TutorialCD/ updatesite)
- Click **OK**



Name: Tutorial
URL: file:/media/cdrom/updatesite/

Installing Tutorial Features

- Make sure only **Tutorial** is selected, other options as defaults
- Click **Finish**
- From **Search Results**, select **Tutorial** (open the twisty to see the contents)


Updates

Search Results

Select features to install from the search result list.

Select the features to install:

☑ Tutorial

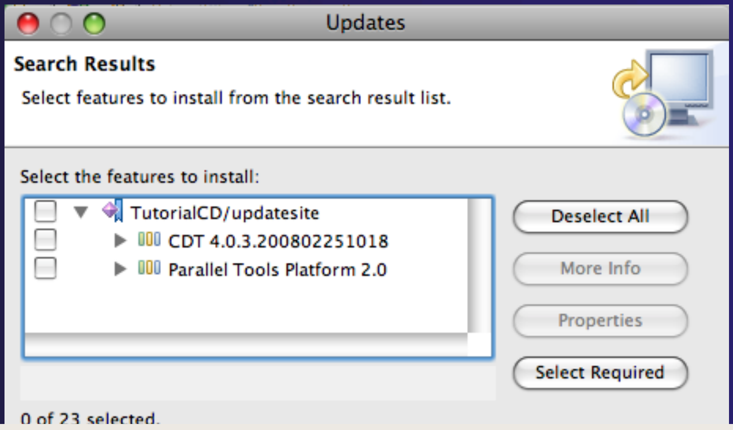
1 of 1 selected.

☑ Show the latest version of a feature only

☐ Filter features included in other features on the list

Choose features

- Choose PTP features to install
- Easy way to choose:
  - Select all
  - Unselect anything with red "X"
  - This omits features for which you lack the pre-requisites



Updates

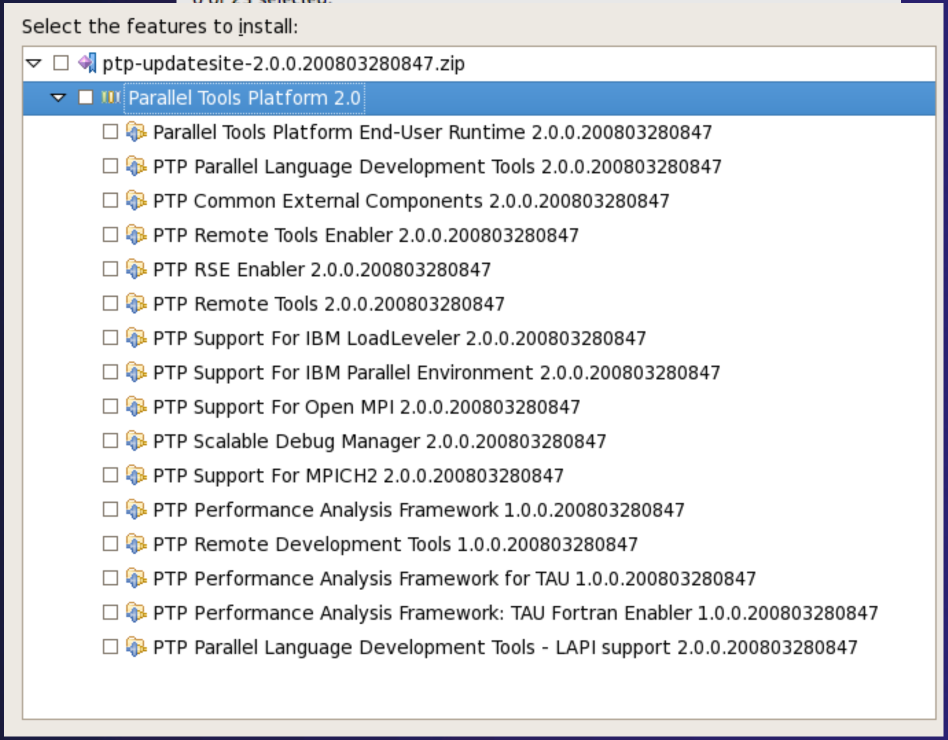
Search Results

Select features to install from the search result list.

Select the features to install:

- ☐ TutorialCD/updatesite
  - ☐ CDT 4.0.3.200802251018
  - ☐ Parallel Tools Platform 2.0

0 of 23 selected.

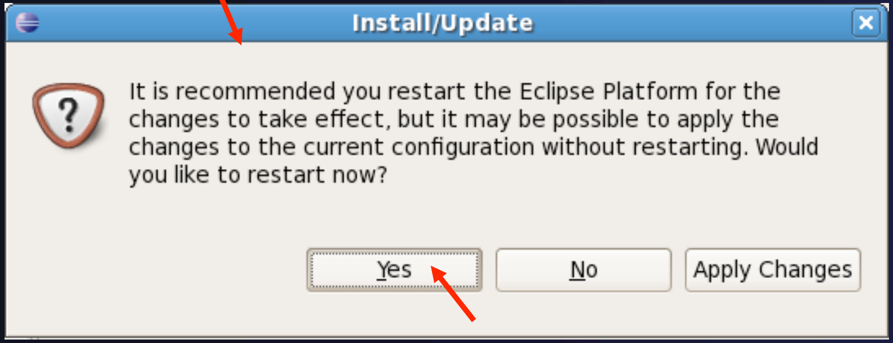


Select the features to install:

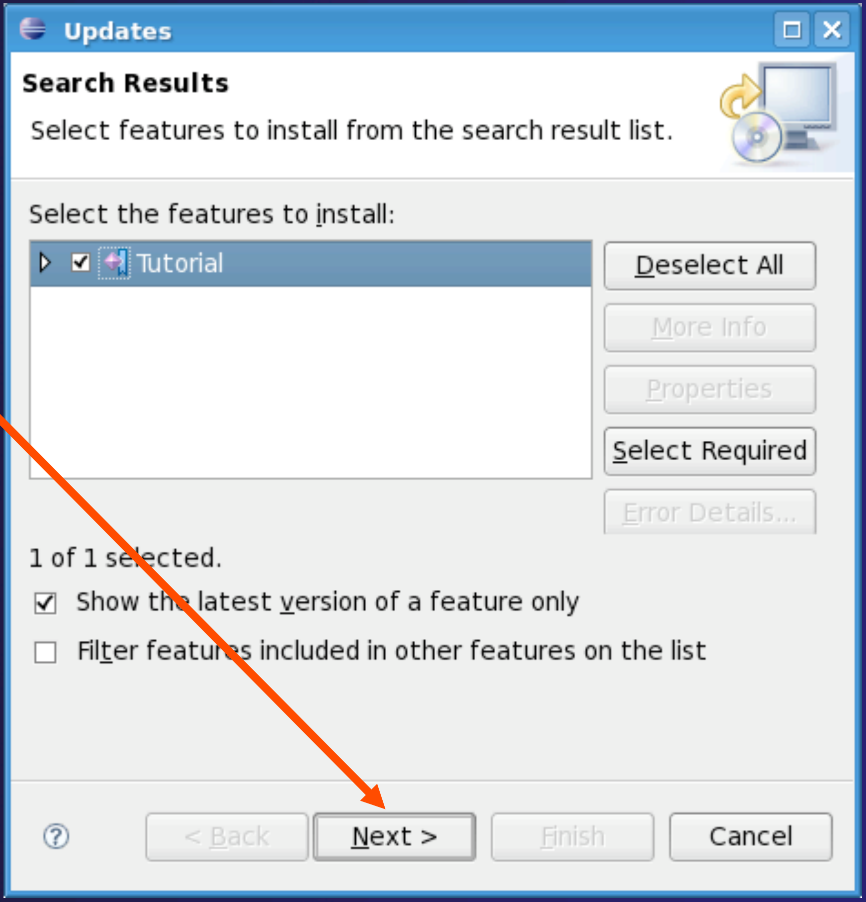
- ☐ ptp-updatesite-2.0.0.200803280847.zip
  - ☐ Parallel Tools Platform 2.0
    - ☐ Parallel Tools Platform End-User Runtime 2.0.0.200803280847
    - ☐ PTP Parallel Language Development Tools 2.0.0.200803280847
    - ☐ PTP Common External Components 2.0.0.200803280847
    - ☐ PTP Remote Tools Enabler 2.0.0.200803280847
    - ☐ PTP RSE Enabler 2.0.0.200803280847
    - ☐ PTP Remote Tools 2.0.0.200803280847
    - ☐ PTP Support For IBM LoadLeveler 2.0.0.200803280847
    - ☐ PTP Support For IBM Parallel Environment 2.0.0.200803280847
    - ☐ PTP Support For Open MPI 2.0.0.200803280847
    - ☐ PTP Scalable Debug Manager 2.0.0.200803280847
    - ☐ PTP Support For MPICH2 2.0.0.200803280847
    - ☐ PTP Performance Analysis Framework 1.0.0.200803280847
    - ☐ PTP Remote Development Tools 1.0.0.200803280847
    - ☐ PTP Performance Analysis Framework for TAU 1.0.0.200803280847
    - ☐ PTP Performance Analysis Framework: TAU Fortran Enabler 1.0.0.200803280847
    - ☐ PTP Parallel Language Development Tools - LAPI support 2.0.0.200803280847

Finishing Installation

- Click **Next >**
- Accept the license terms
- Click **Next >**
- Click **Finish**
- For **Feature Verification**, click **Install All**
- Restart the Eclipse Platform when asked


Install/Update

It is recommended you restart the Eclipse Platform for the changes to take effect, but it may be possible to apply the changes to the current configuration without restarting. Would you like to restart now?


Updates

Search Results

Select features to install from the search result list.

Select the features to install:

[✓] Tutorial

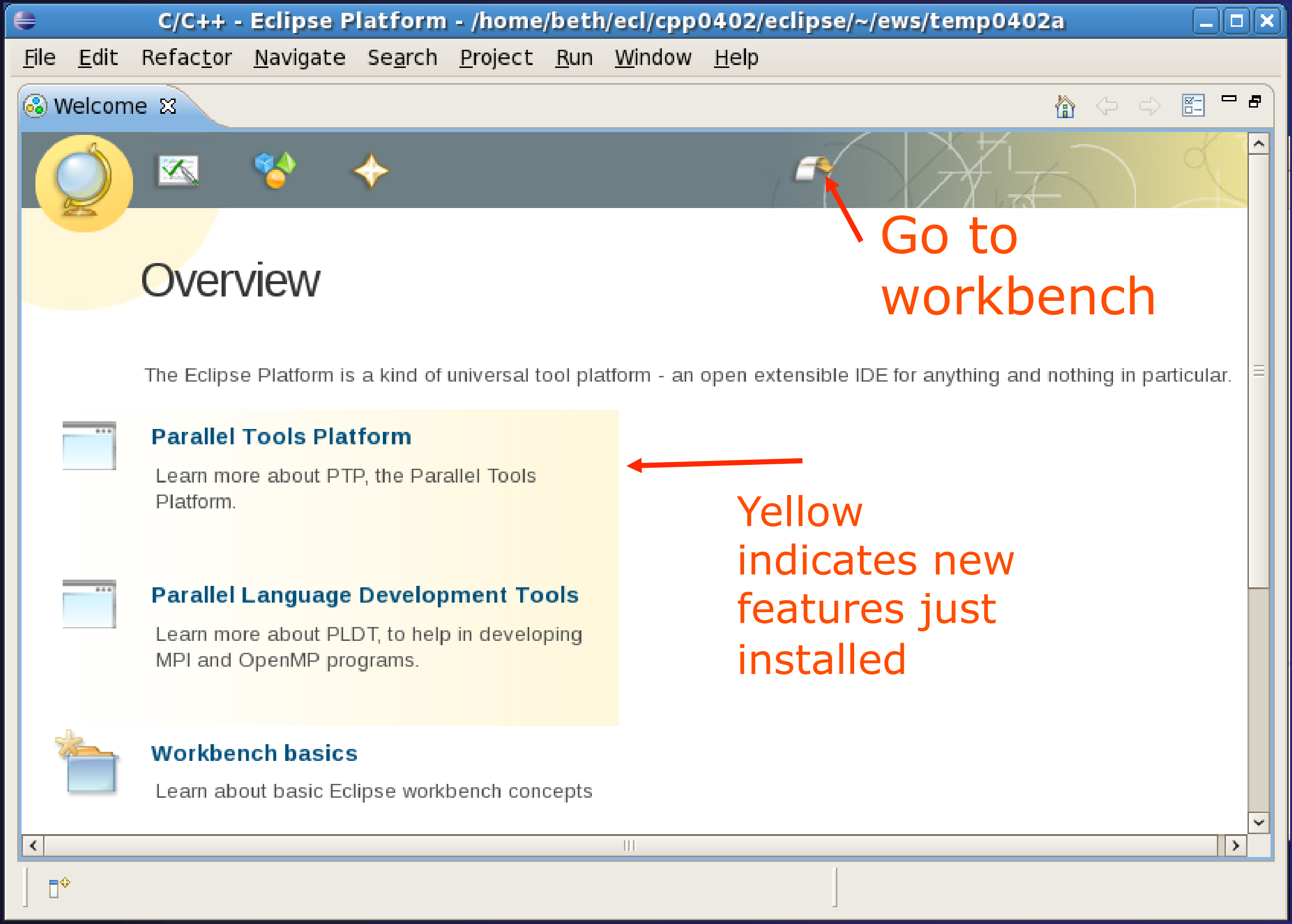
1 of 1 selected.

[✓] Show the latest version of a feature only

[ ] Filter features included in other features on the list

Restarting Eclipse

- Welcome page informs you of new features installed
- Select workbench icon to go to workbench


C/C++ - Eclipse Platform - /home/beth/ecl/cpp0402/eclipse/~/ews/temp0402a
File Edit Refactor Navigate Search Project Run Window Help
Welcome
Go to workbench
Yellow indicates new features just installed

Overview

The Eclipse Platform is a kind of universal tool platform - an open extensible IDE for anything and nothing in particular.

Parallel Tools Platform

Learn more about PTP, the Parallel Tools Platform.

Parallel Language Development Tools

Learn more about PLDT, to help in developing MPI and OpenMP programs.

Workbench basics

Learn about basic Eclipse workbench concepts

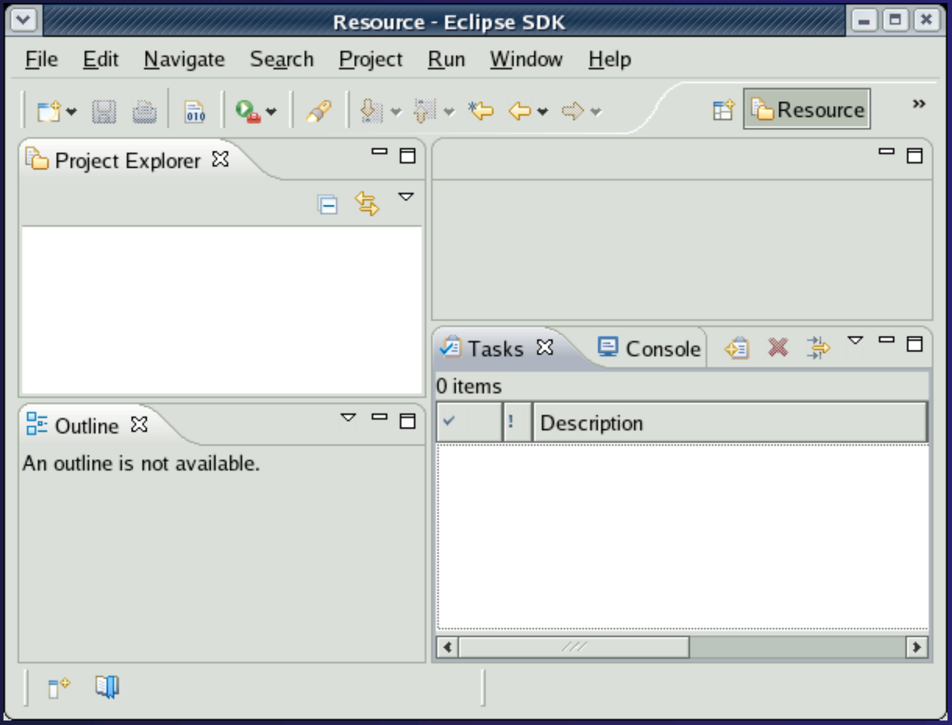
(Installing the PTP Proxy)

- Normally installed on a parallel machine
  - e.g. a cluster
  - Can install on a non-parallel system
- Not available for Windows
- Requires OpenMPI to be built and installed
  - This process depends on the type of machine
  - Beyond the scope of this tutorial
- To install the proxy, do the following steps from a terminal
  - Change to your Eclipse installation directory
  - Change to `plugins/org.eclipse.ptp.`***`os`***`.`***`arch`***`_2.0`*, where ***`os`*** is your operating system (`macosx` or `linux`), ***`arch`*** is your architecture (`ppc`, `x86`, or `x86_64`)
  - Run the command: `sh BUILD`

* Directory may include a suffix of build date timestamp.

Workbench

- The Workbench represents the desktop development environment
  - It contains a set of tools for resource management
  - It provides a common way of navigating through the resources
- Multiple workbenches can be opened at the same time



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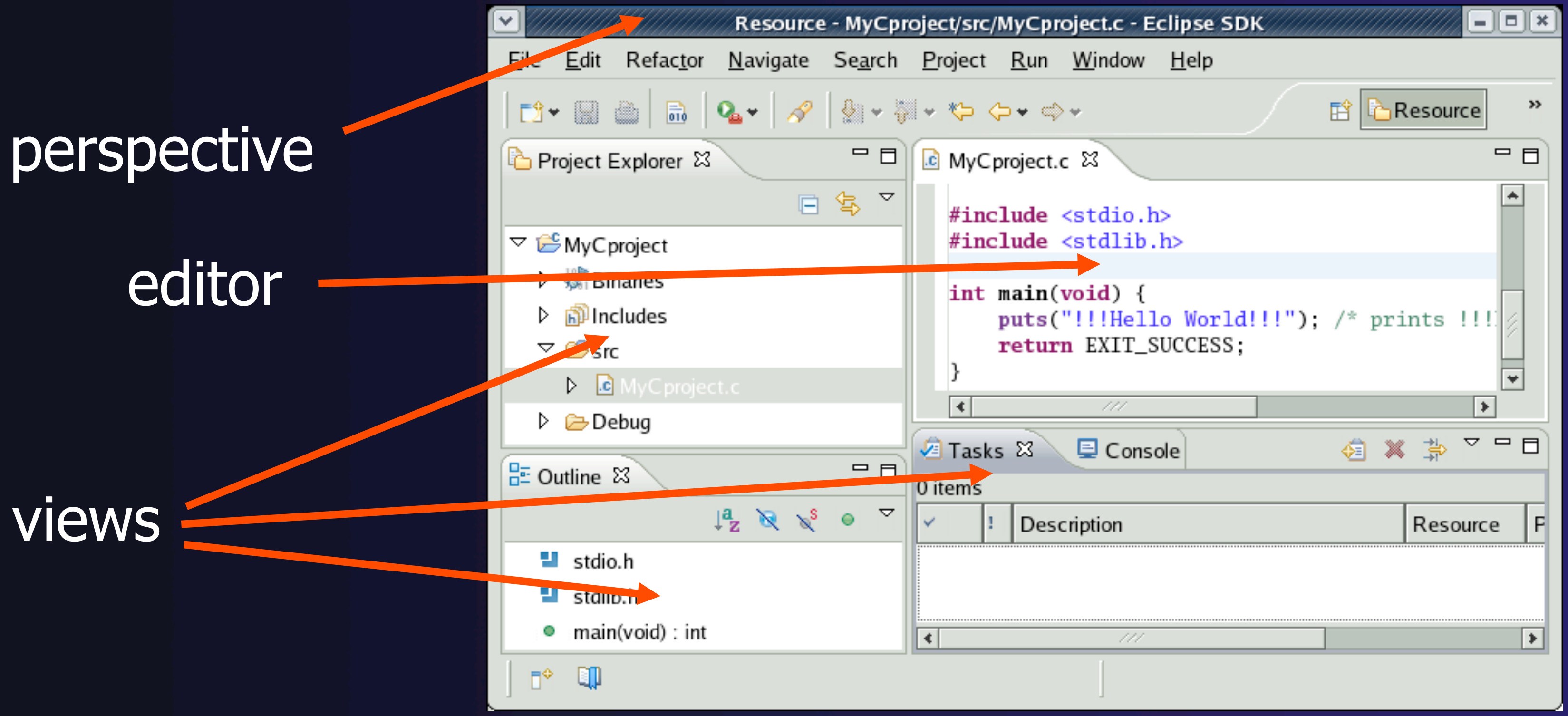
An outline is not available.

Workbench Components

- A Workbench contains perspectives
- A Perspective contains views and editors



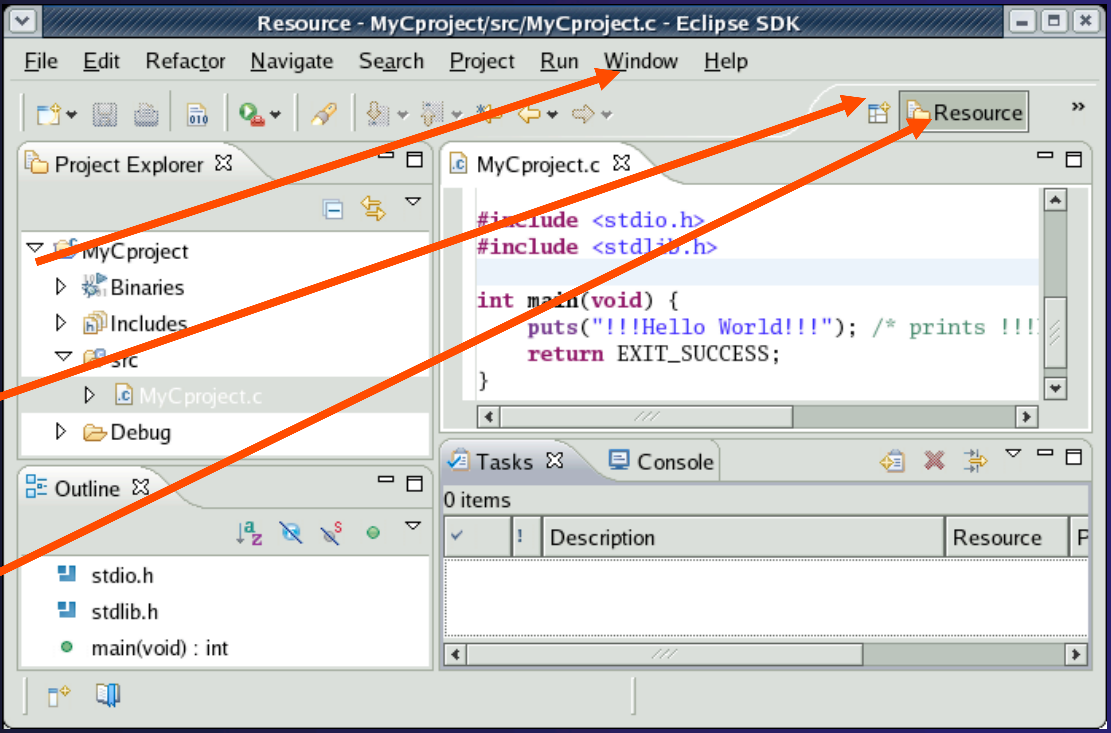
```
#include <stdio.h>
#include <stdlib.h>

int main(void) {
    puts("!!!Hello World!!!"); /* prints !!!
    return EXIT_SUCCESS;
}
```

Perspectives

- Perspectives define the layout of views in the Workbench
- They are task oriented, i.e. they contain specific views for doing certain tasks:
  - There is a Resource Perspective for manipulating resources
  - C/C++ Perspective for manipulating compiled code
  - Debug Perspective for debugging applications
- You can easily switch between perspectives

Switching Perspectives

- You can switch Perspectives by:
  - Choosing the **Window▸Open Perspective** menu option
  - Clicking on the **Open Perspective** button
  - Clicking on a perspective shortcut button

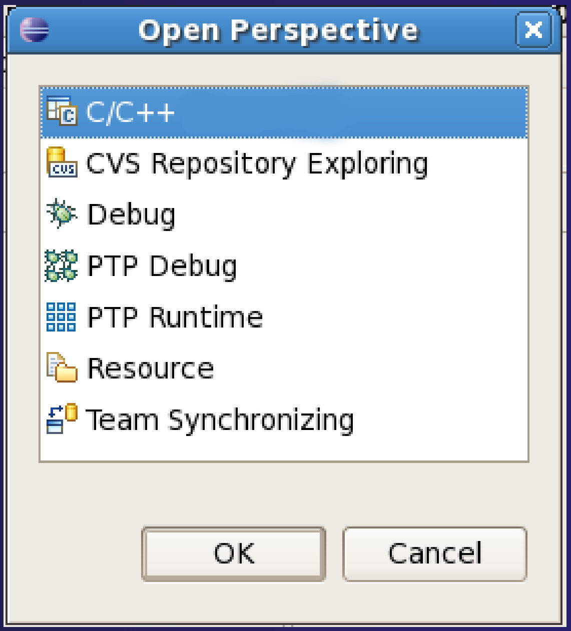


```
#include <stdio.h>
#include <stdlib.h>

int main(void) {
    puts("!!!Hello World!!!"); /* prints !!!
    return EXIT_SUCCESS;
}
```

Available Perspectives

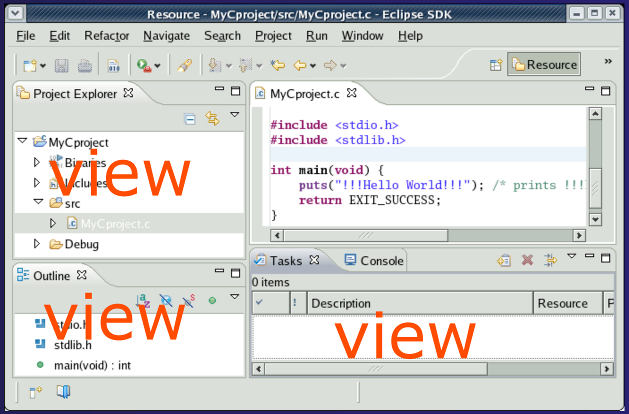
- By default, certain perspectives are available in the Workbench
- We'll use:
  - C/C++
  - PTP Runtime
  - PTP Debug

Window ▸ Open Perspective


Open Perspective

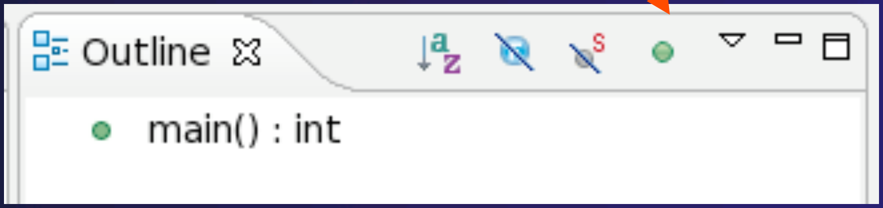
- C/C++
- CVS Repository Exploring
- Debug
- PTP Debug
- PTP Runtime
- Resource
- Team Synchronizing

Views



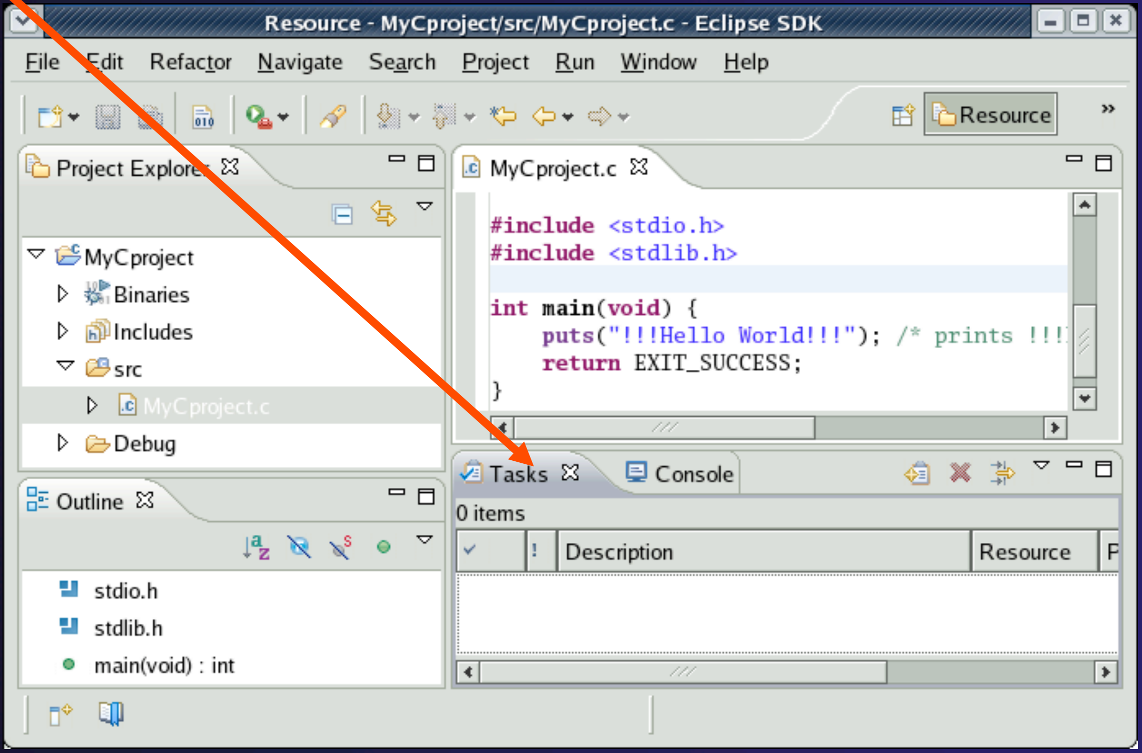
```
#include <stdio.h>
#include <stdlib.h>

int main(void) {
    puts("!!!Hello World!!!"); /* prints !!!
    return EXIT_SUCCESS;
}
```

- ✦ The workbench window is divided up into Views
- ✦ The main purpose of a view is:
  - ✦ To provide alternative ways of presenting information
  - ✦ For navigation
  - ✦ For editing and modifying information
- ✦ Views can have their own menus and toolbars
  - ✦ Items available in menus and toolbars are available only in that view
  - ✦ Menu actions only apply to the view
- ✦ Views can be resized



Stacked Views

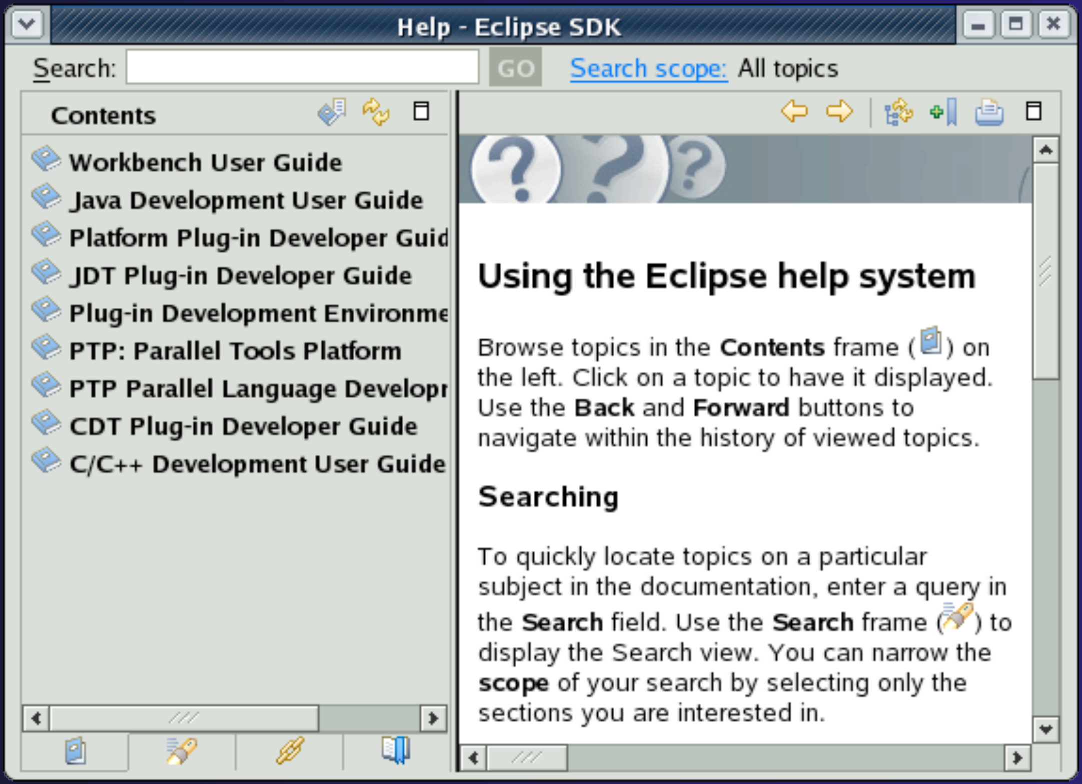
- Stacked views appear as tabs
- Selecting a tab brings that view to the foreground



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

int main(void) {
    puts("!!!Hello World!!!"); /* prints !!!
    return EXIT_SUCCESS;
}
```

Help

- Access help
  - **Help▶Help Contents**
  - **Help▶Search**
  - **Help▶Dynamic Help**
- **Help Contents** provides detailed help on different Eclipse features
- **Search** allows you to search for help locally, or using Google or the Eclipse web site
- **Dynamic Help** shows help related to the current context (perspective, view, etc.)


Help - Eclipse SDK
Search:
GO
Search scope: All topics
Contents
Workbench User Guide
Java Development User Guide
Platform Plug-in Developer Guid
JDT Plug-in Developer Guide
Plug-in Development Environme
PTP: Parallel Tools Platform
PTP Parallel Language Developr
CDT Plug-in Developer Guide
C/C++ Development User Guide

Using the Eclipse help system

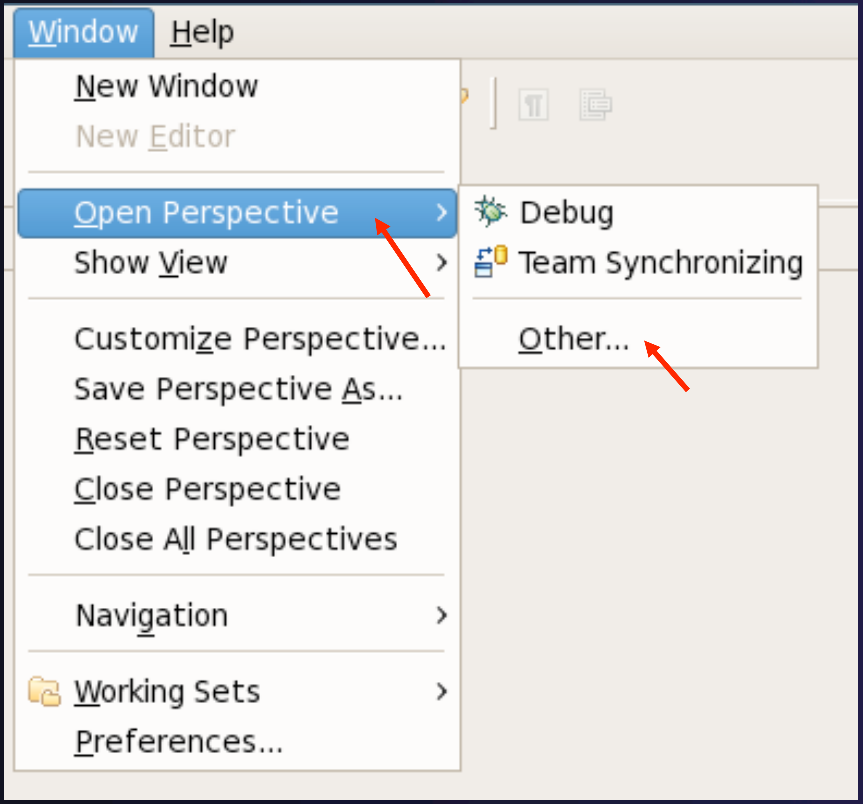
Browse topics in the **Contents** frame ( ) on the left. Click on a topic to have it displayed. Use the **Back** and **Forward** buttons to navigate within the history of viewed topics.

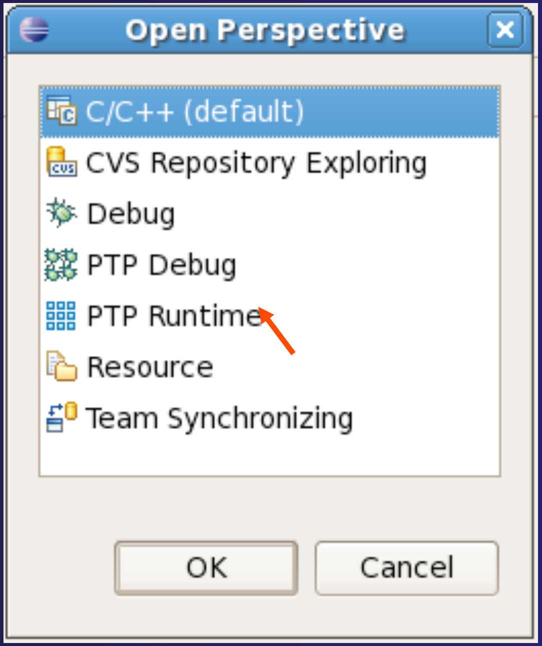
Searching

To quickly locate topics on a particular subject in the documentation, enter a query in the **Search** field. Use the **Search** frame ( ) to display the Search view. You can narrow the **scope** of your search by selecting only the sections you are interested in.

Open PTP Runtime Perspective

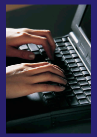
Window > Open Perspective > Other…





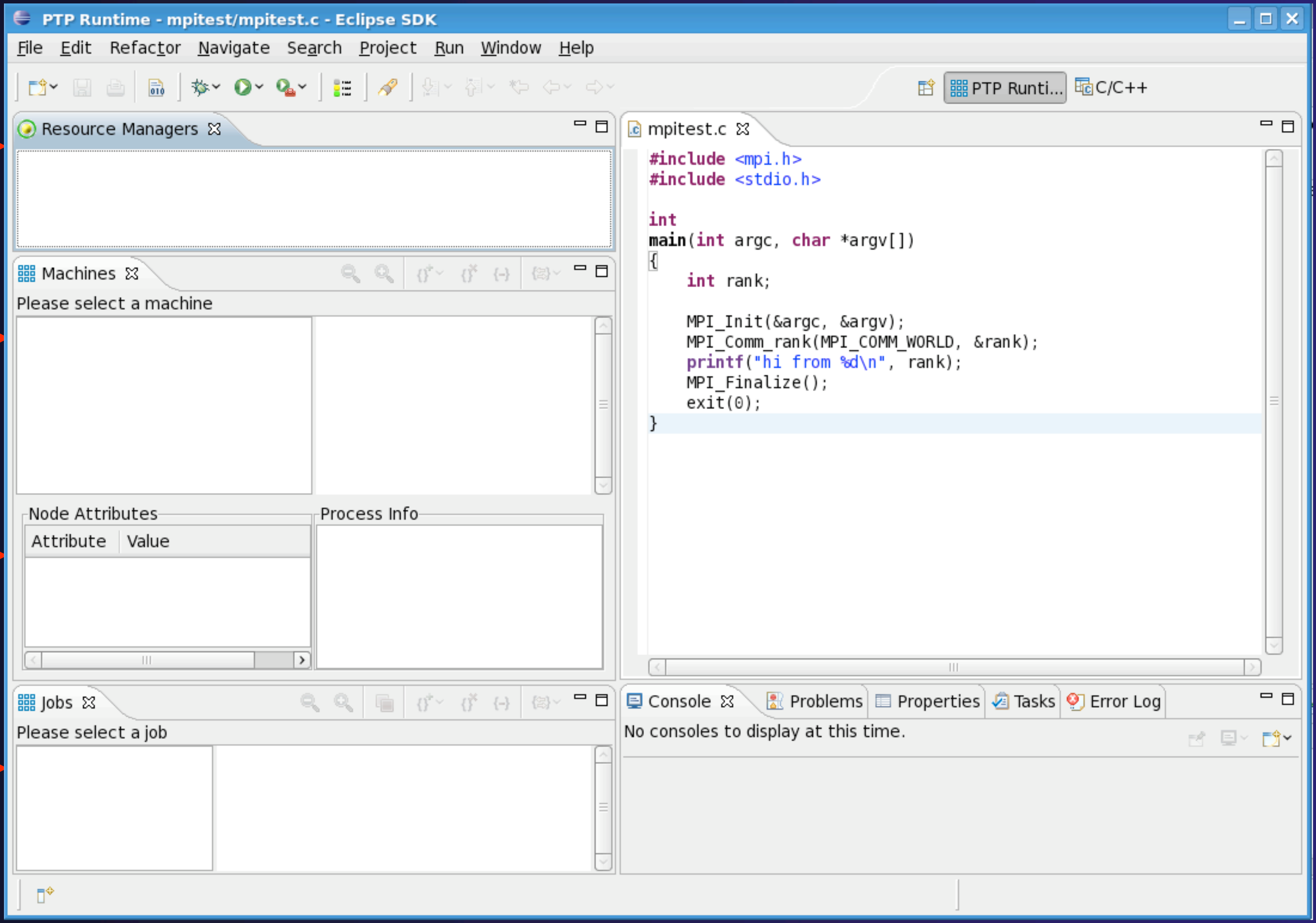
Terminology

- The **PTP Runtime** perspective is provided for monitoring and controlling applications
- Some terminology
  - **Resource manager** - Corresponds to an instance of a resource management system (e.g. a job scheduler). You can have multiple resource mangers connected to different machines.
  - **Queue** - A queue of pending jobs
  - **Job** - A parallel application
  - **Machine** - A parallel computer system
  - **Node** - Some form of computational resource
  - **Process** - An execution unit (may be multiple threads of execution)



PTP Runtime Perspective

- Resource managers view
- Machines view
- Node details view
- Jobs view



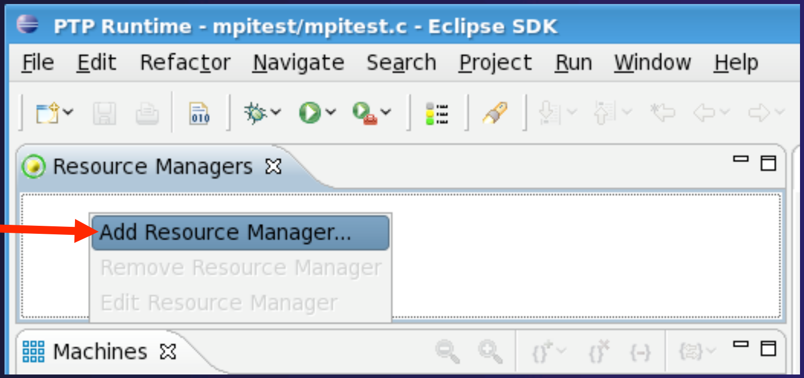
```
#include <mpi.h>
#include <stdio.h>

int
main(int argc, char *argv[])
{
    int rank;

    MPI_Init(&argc, &argv);
    MPI_Comm_rank(MPI_COMM_WORLD, &rank);
    printf("hi from %d\n", rank);
    MPI_Finalize();
    exit(0);
}
```

Resource Managers

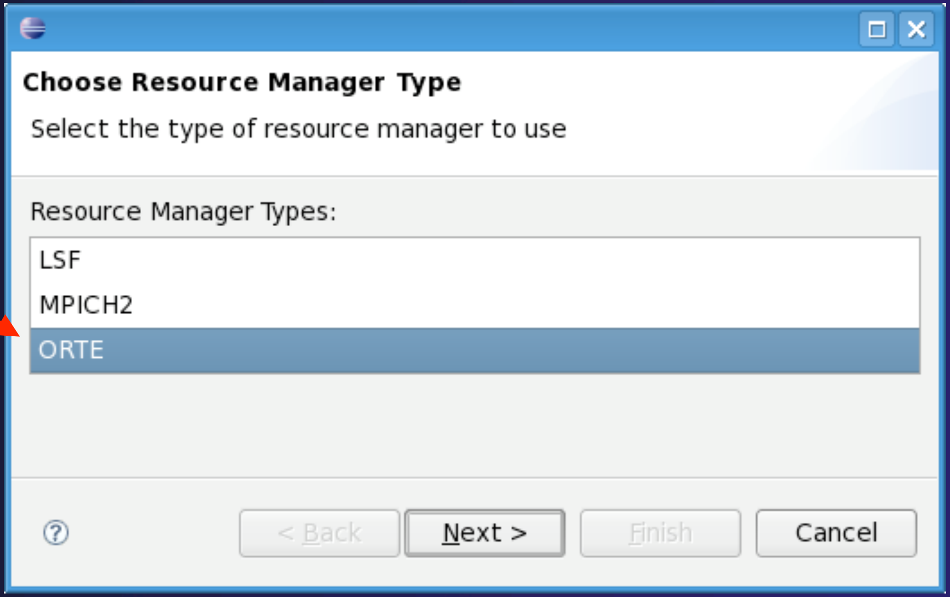
- PTP uses the term *resource manager* to refer to any subsystem that controls the resources required for launching a parallel job.
- Examples:
  - Job scheduler (e.g. LoadLeveler)
  - Open MPI Runtime Environment (ORTE)
- Each resource manager controls one target system
- Resource Managers can be local or remote

Adding a Resource Manager

- Right-click in Resource Managers view and select **Add Resource Manager**


PTP Runtime - mpitest/mpitest.c - Eclipse SDK
File Edit Refactor Navigate Search Project Run Window Help
Resource Managers
Add Resource Manager...
Remove Resource Manager
Edit Resource Manager
Machines

- Choose the **ORTE Resource Manager Type**


Choose Resource Manager Type

Select the type of resource manager to use

Resource Manager Types:

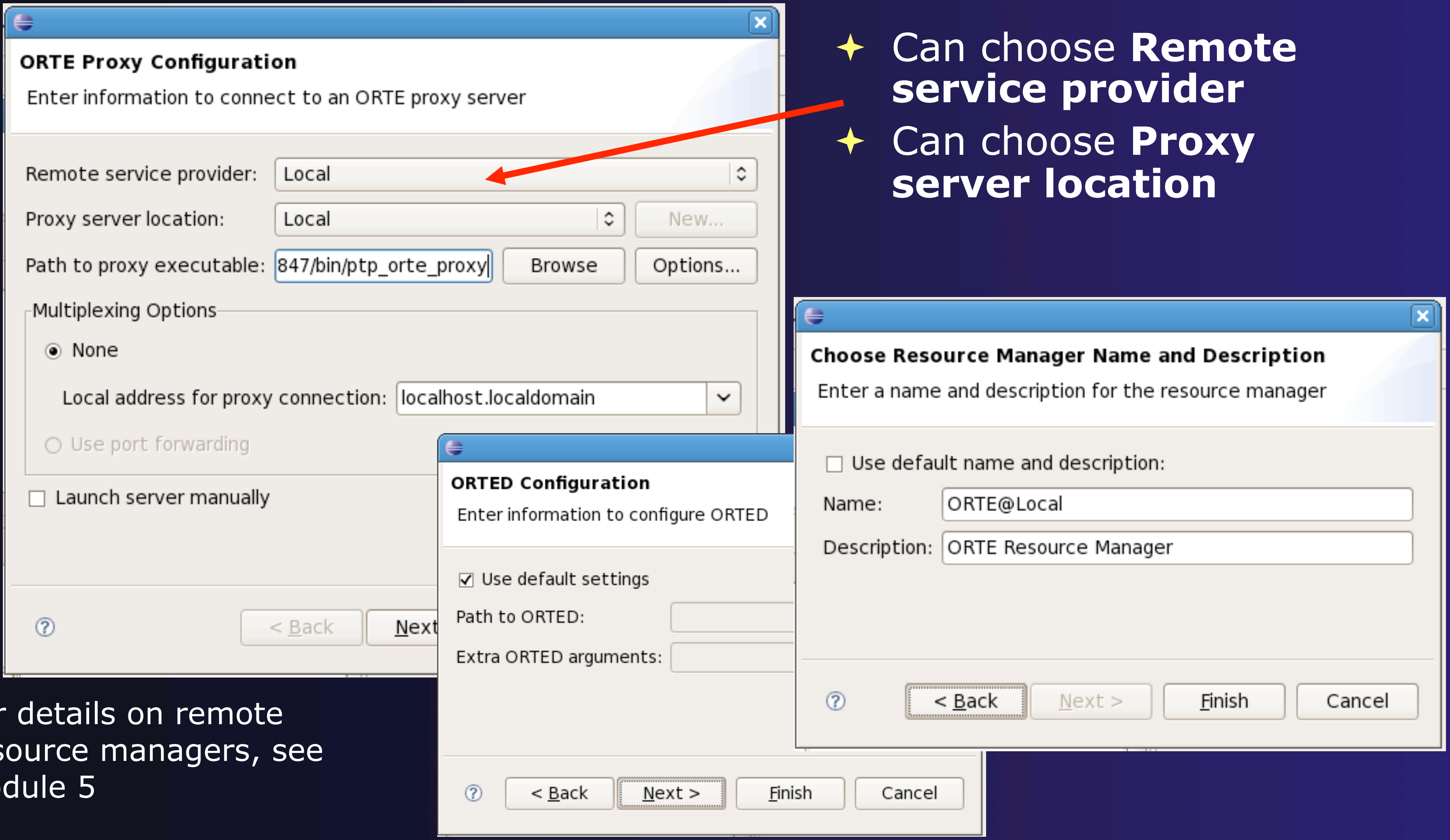
LSF

MPICH2

ORTE

- Select **Next>**

Configure the Resource Manager



ORTE Proxy Configuration

Enter information to connect to an ORTE proxy server

Remote service provider: Local

Proxy server location: Local

Path to proxy executable: 847/bin/ptp_orte_proxy

Multiplexing Options

● None

Local address for proxy connection: localhost.localdomain

○ Use port forwarding

☐ Launch server manually

ORTED Configuration

Enter information to configure ORTED

☑ Use default settings

Path to ORTED:

Extra ORTED arguments:

Choose Resource Manager Name and Description

Enter a name and description for the resource manager

☐ Use default name and description:

Name: ORTE@Local

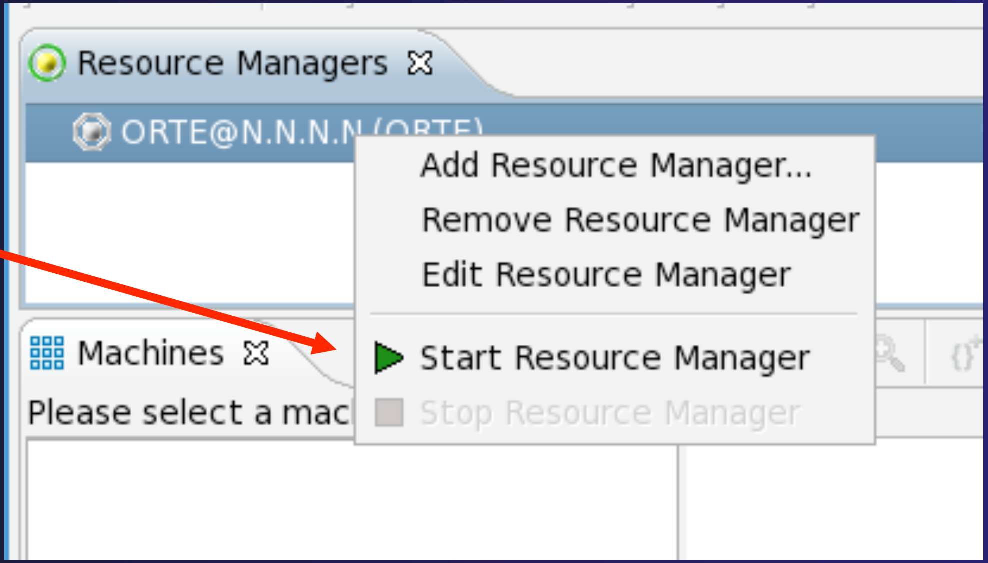
Description: ORTE Resource Manager

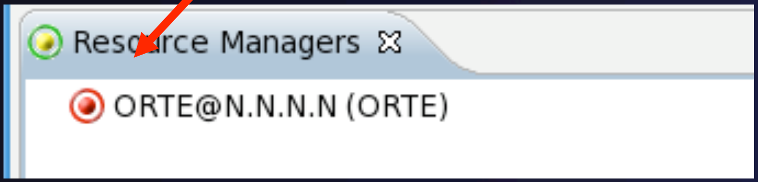
- Can choose **Remote service provider**
- Can choose **Proxy server location**

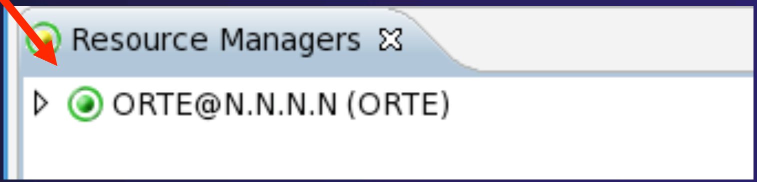
For details on remote resource managers, see Module 5

Starting the Resource Manager

- Right click on new resource manager and select **Start resource manager**
- If everything is ok, you should see the resource manager change to green
- If something goes wrong, it will change to red

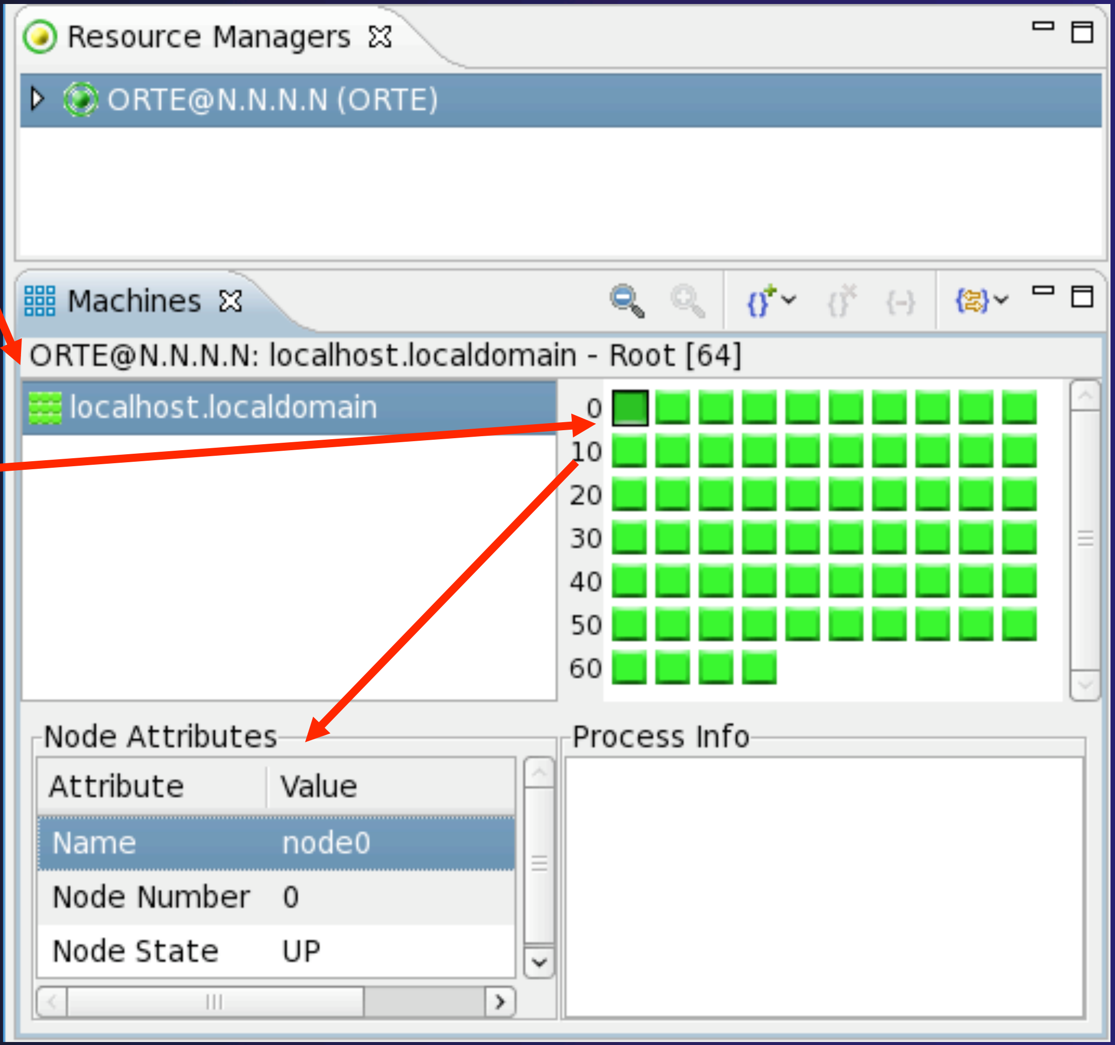






System Monitoring

- Machine status shown in **Machines** view
- Node status also shown **Machines** view
- Hover over node to see node name
- Double-click on node to show attributes



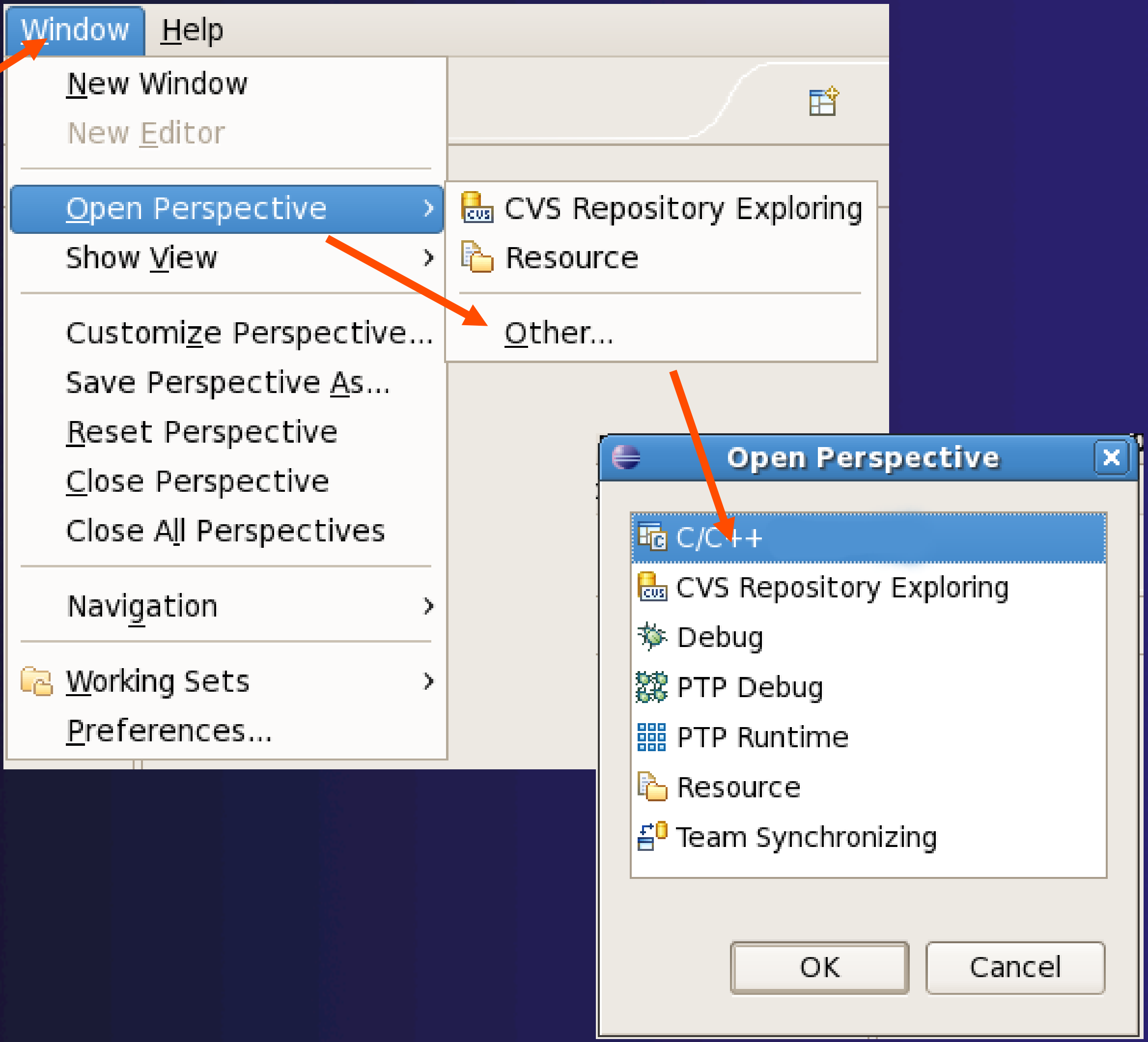
Attribute	Value
Name	node0
Node Number	0
Node State	UP

Module 2: Creating and Running MPI Programs

- Objective
  - Learn how to use Eclipse to develop parallel programs
  - Learn how to run and monitor a parallel program
- Contents
  - Brief introduction to the C/C++ Development Tools
  - Create a simple application
  - Learn to launch a parallel job and view it via the PTP Runtime Perspective

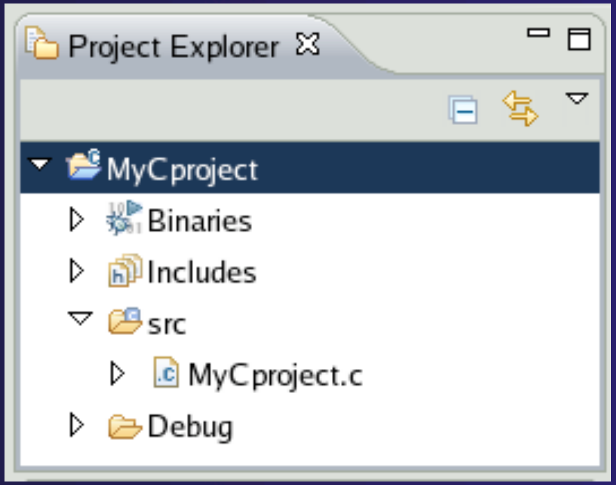
Switch to C/C++ Perspective

- Only needed if you're not already in the perspective

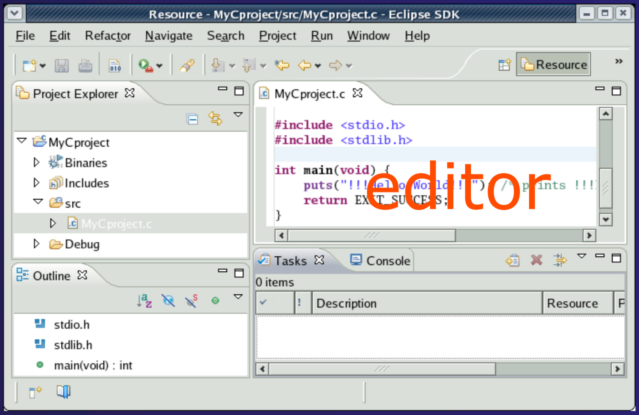


Project Explorer View

- Represents user's data
- It is a set of user defined resources
  - Files
  - Folders
  - Projects
    - Collections of files and folders
    - Plus meta-data
- Resources are visible in the Project Explorer View

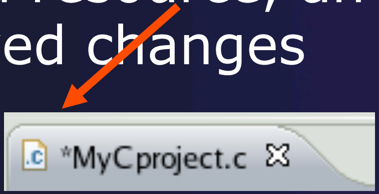


Editors



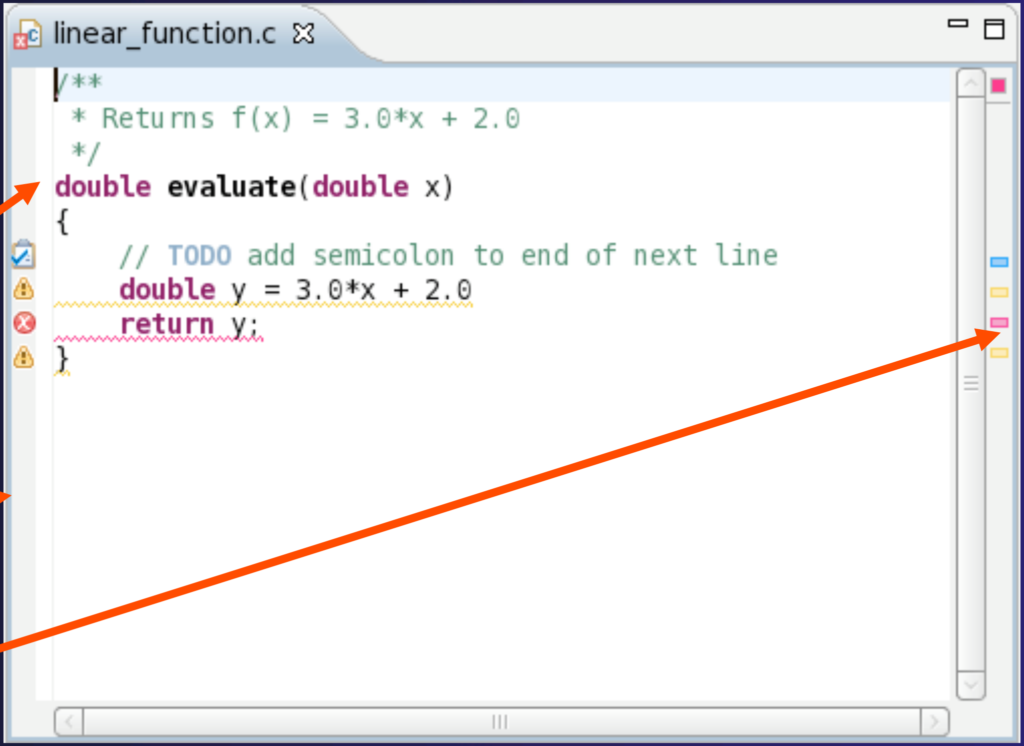
```
#include <stdio.h>
#include <stdlib.h>

int main(void) {
    puts("!!!Hello World!!!"); /* prints !!!
    return EXIT_SUCCESS;
}
```

- An editor for a resource (e.g. a file) opens when you double-click on a resource
- The type of editor depends on the type of the resource
  - .c files are opened with the C/C++ editor
  - Some editors do not just edit text
- When an editor opens on a resource, it stays open across different perspectives
- An active editor contains menus and toolbars specific to that editor
- When you change a resource, an asterisk on the editor's title bar indicates unsaved changes



Source Code Editors

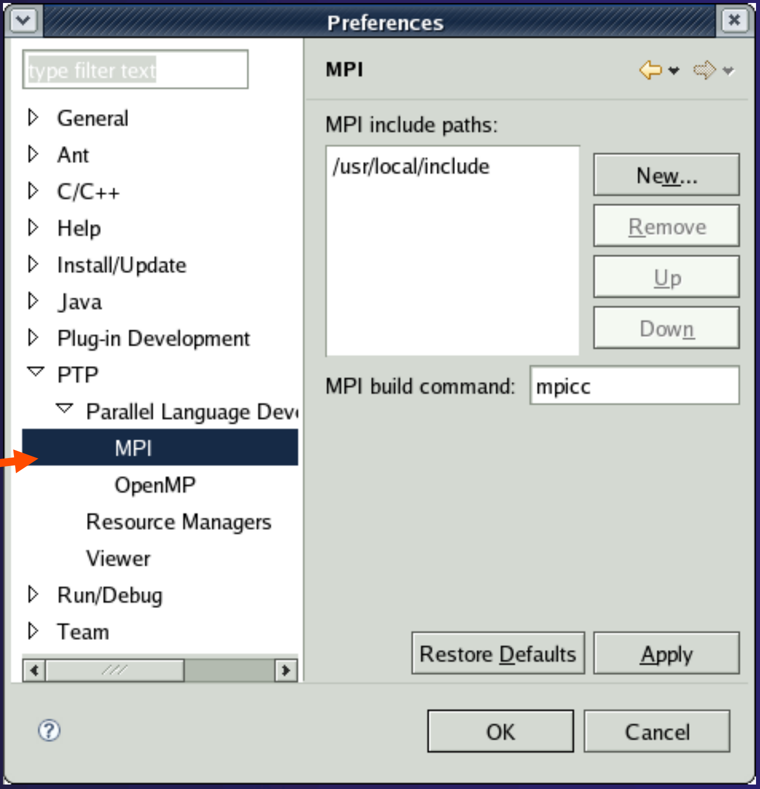
- A source code editor is a special type of editor for manipulating source code
- Language features are highlighted
- Marker bars for showing
  - Breakpoints
  - Errors/warnings
  - Tasks
- Location bar for navigating to interesting features



```
/**
 * Returns f(x) = 3.0*x + 2.0
 */
double evaluate(double x)
{
    // TODO add semicolon to end of next line
    double y = 3.0*x + 2.0
    return y;
}
```

Set up for MPI development Preferences

- To use the PTP Parallel Language Development Tools feature for MPI development, you need to
  - Specify the MPI include path
  - Specify the MPI build command
- Open **Window▶Preferences…**
  - Open the **PTP** item
  - Open the **Parallel Language Development Tools** item
  - Select **MPI**
  - Select **New…** to add MPI include path
- If running OpenMP, add its include file location here too (we will cover that later)



MPI

MPI include paths:

/usr/local/include

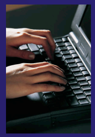
MPI build command: mpicc

Creating a Parallel Application

Steps:

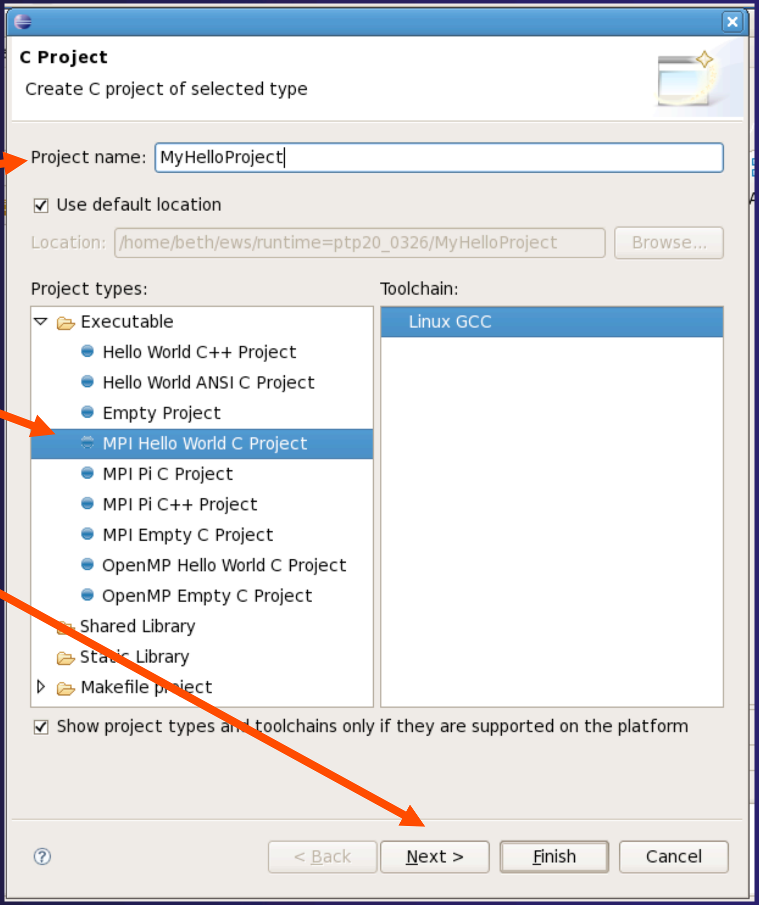
- Create a new C project
- Edit source code
- Save and build

Creating a simple MPI Project (1)



Create a new MPI project

- **File▸New▸C Project**
- Name the project 'MyHelloProject'
- Under Project types, under Executable, select **MPI Hello World C Project** and hit **Next**
- On **Basic Settings** page, fill in information for your new project (**Author name** etc.) and hit **Next**



C Project
Create C project of selected type

Project name: MyHelloProject

☑ Use default location

Location: /home/beth/ews/runtime=ptp20_0326/MyHelloProject

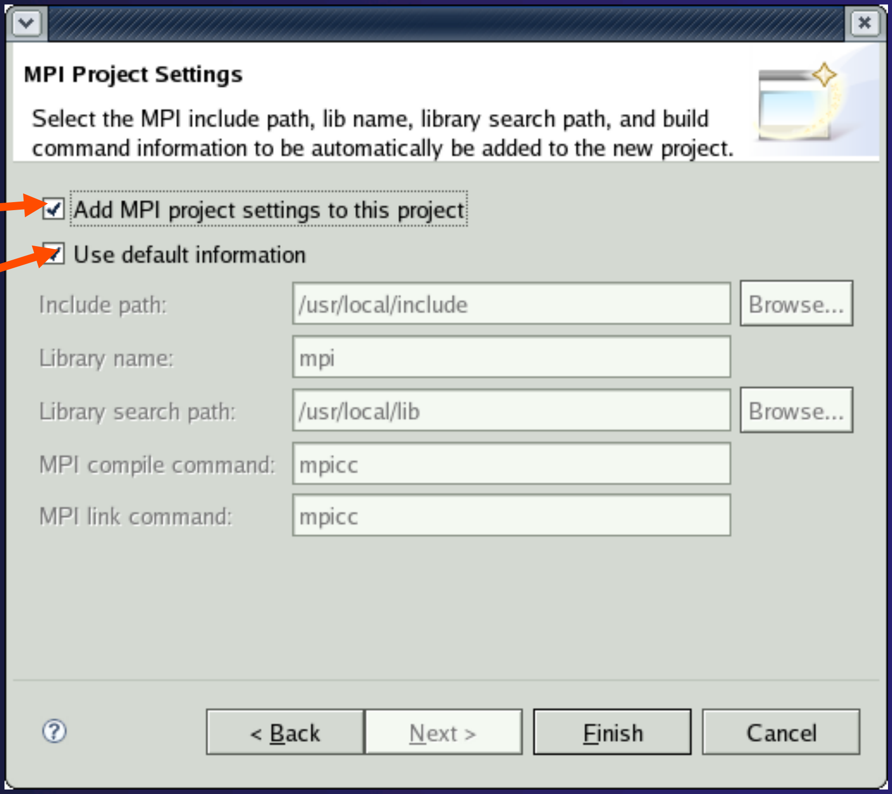
Project types:
- Executable
  - Hello World C++ Project
  - Hello World ANSI C Project
  - Empty Project
  - MPI Hello World C Project
  - MPI Pi C Project
  - MPI Pi C++ Project
  - MPI Empty C Project
  - OpenMP Hello World C Project
  - OpenMP Empty C Project
- Shared Library
- Static Library
- Makefile project

Toolchain:
- Linux GCC

☑ Show project types and toolchains only if they are supported on the platform

Creating a simple MPI Project (2)

- On the **MPI Project Settings** wizard page, make sure **Add MPI project settings to this project** is checked.
- Change default paths, etc. if necessary (they are probably OK)
- Hit **Finish***.
- *If you instead hit **Next**, then on the **Select Configurations** page, you can alter Project settings. Hit **Finish.**



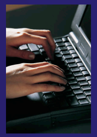
MPI Project Settings

Select the MPI include path, lib name, library search path, and build command information to be automatically be added to the new project.

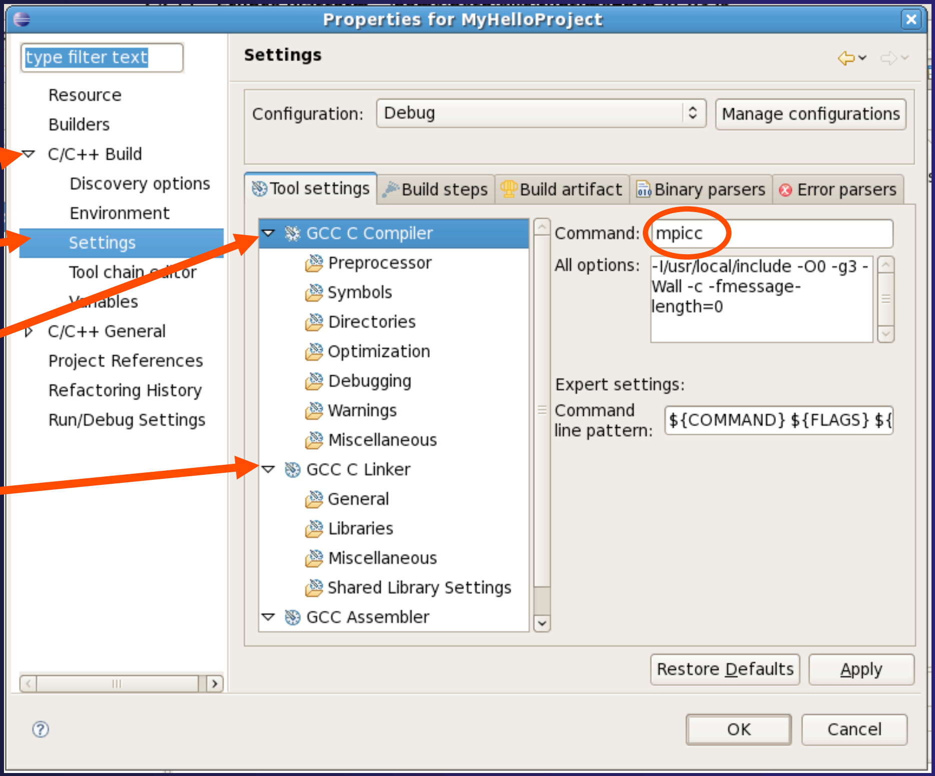
- [✓] Add MPI project settings to this project
- [✓] Use default information

Include path:	/usr/local/include
Library name:	mpi
Library search path:	/usr/local/lib
MPI compile command:	mpicc
MPI link command:	mpicc

Changing the C/C++ Build Settings Manually



- Open the project properties by right-mouse clicking on project and select **Properties**
- Open **C/C++ Build**
- Select **Settings**
- Select **GCC C Compiler** to change compiler settings
- Select **GCC C Linker** to change linker settings
- It's also possible to change compiler/linker arguments



Configuration: Debug

Command: mpicc

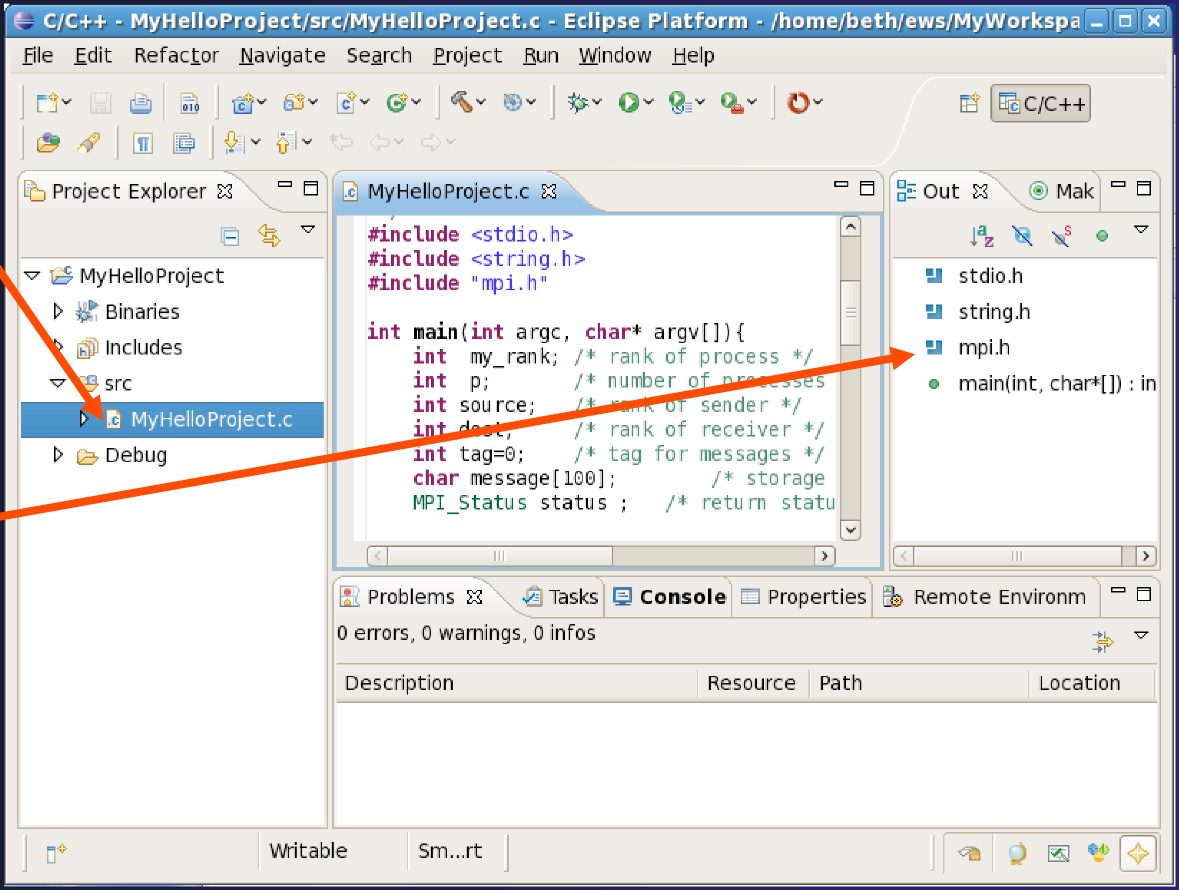
All options: -I/usr/local/include -O0 -g3 -Wall -c -fmessage-length=0

Expert settings:

Command line pattern: ${COMMAND} ${FLAGS} ${

Editor and Outline View

- Double-click on source file in the **Project Explorer** to open C editor
- Outline view is shown for file in editor

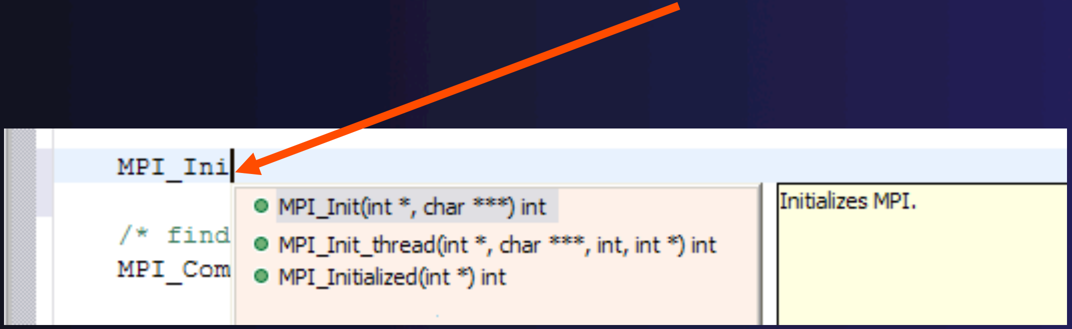


```
#include <stdio.h>
#include <string.h>
#include "mpi.h"

int main(int argc, char* argv[]){
    int  my_rank; /* rank of process */
    int  p;       /* number of processes
    int source;   /* rank of sender */
    int dest;     /* rank of receiver */
    int tag=0;    /* tag for messages */
    char message[100];       /* storage
    MPI_Status status ;   /* return statu
```

0 errors, 0 warnings, 0 infos

Content Assist

- Type an incomplete MPI function name e.g. "MPI_Ini" into the editor, and hit **ctrl-space**
- Select desired completion value with cursor or mouse

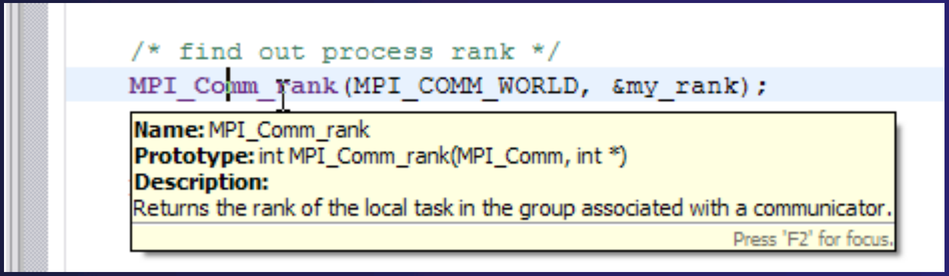


```
MPI_Ini

/* find
MPI_Com
```

MPI_Init(int *, char ***) int
MPI_Init_thread(int *, char ***, int, int *) int
MPI_Initialized(int *) int

Initializes MPI.

- Hover over the MPI Artifact identified in the source file to see additional information about that function call, for example



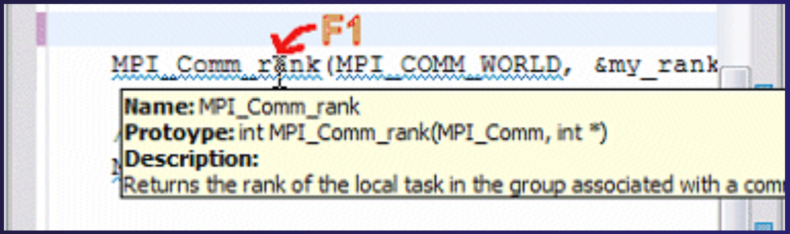
```
/* find out process rank */
MPI_Comm_rank(MPI_COMM_WORLD, &my_rank);
```

Name: MPI_Comm_rank
Prototype: int MPI_Comm_rank(MPI_Comm, int *)
Description:
Returns the rank of the local task in the group associated with a communicator.

Press 'F2' for focus.

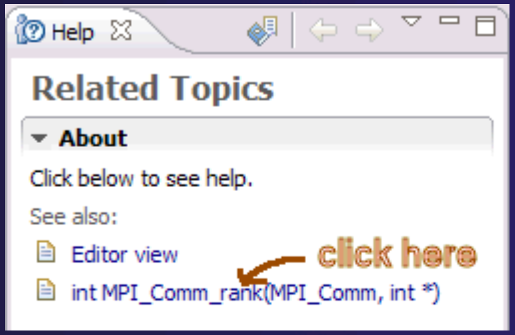
Context Sensitive Help

- Click mouse, then press help key when the cursor is within a function name
  - Windows: **F1** key
  - Linux: **ctrl-F1** key
  - MacOS X: **Help** key or **Help▸Dynamic Help**
- A help view appears (**Related Topics**) which shows additional information
- Click on the function name to see more information
- Move the help view within your Eclipse workbench, if you like, by dragging its title tab



```
MPI_Comm_rank(MPI_COMM_WORLD, &my_rank
```

Name: MPI_Comm_rank
Protoype: int MPI_Comm_rank(MPI_Comm, int *)
Description:
Returns the rank of the local task in the group associated with a com



Related Topics

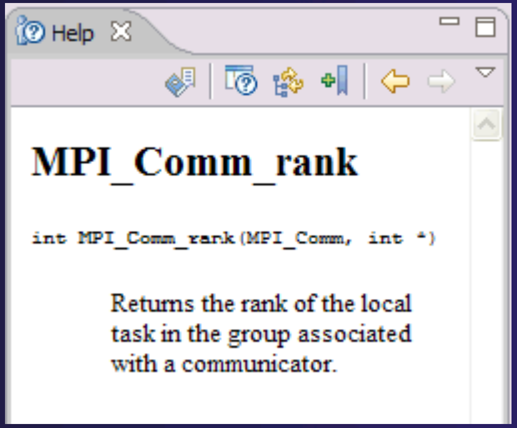
About

Click below to see help.

See also:

Editor view

int MPI_Comm_rank(MPI_Comm, int *)



MPI_Comm_rank

```
int MPI_Comm_rank(MPI_Comm, int *)
```

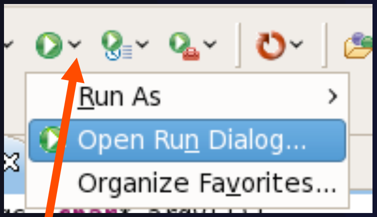
Returns the rank of the local task in the group associated with a communicator.

Running a Parallel Application

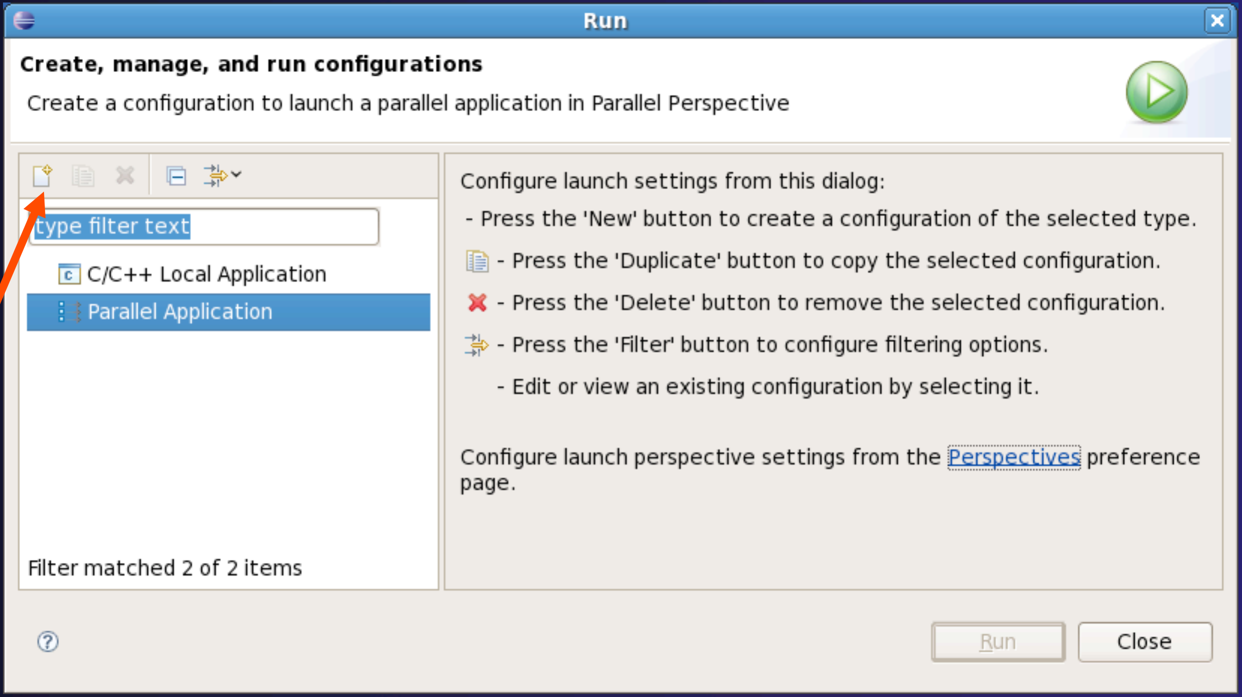
Steps:

- Create a launch configuration
- Run the application
- Monitor its progress in the PTP Runtime Perspective

Create a Launch Configuration



- Open the run configuration dialog **Run ▶ Open Run Dialog…**
- Select **Parallel Application**
- Select the **New** button



Create, manage, and run configurations

Create a configuration to launch a parallel application in Parallel Perspective

Configure launch settings from this dialog:

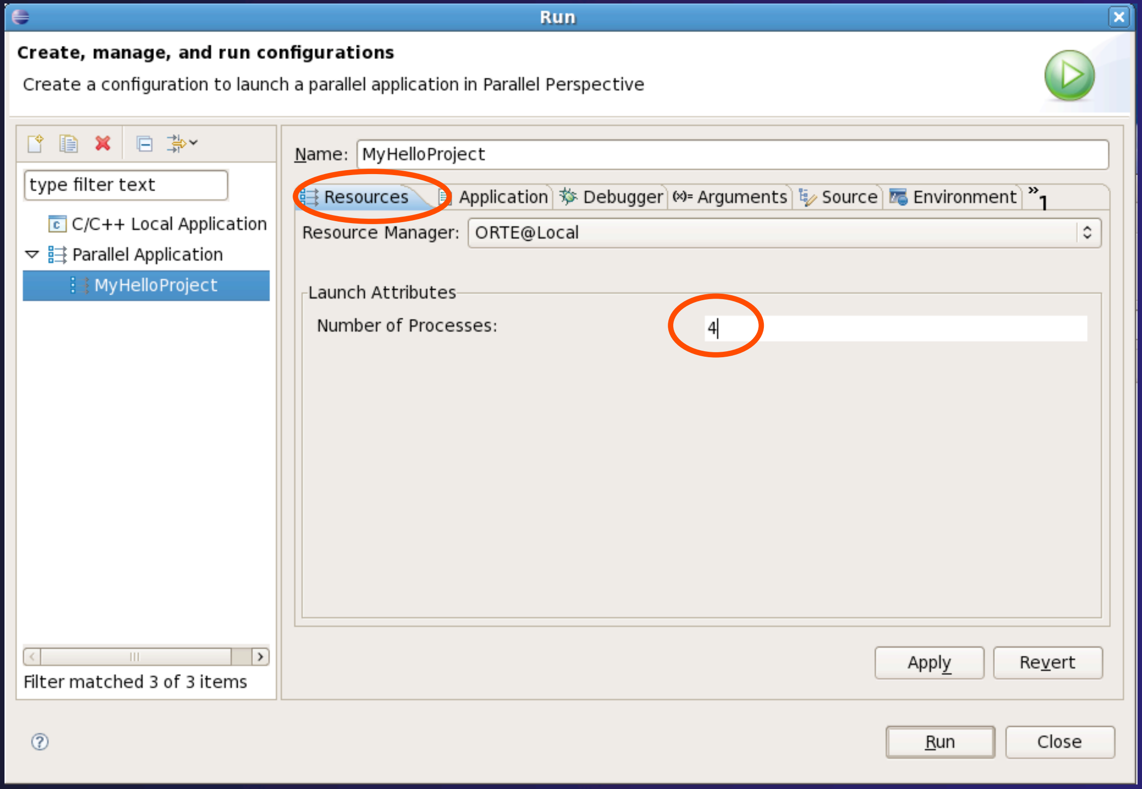
- Press the 'New' button to create a configuration of the selected type.
- Press the 'Duplicate' button to copy the selected configuration.
- Press the 'Delete' button to remove the selected configuration.
- Press the 'Filter' button to configure filtering options.
- Edit or view an existing configuration by selecting it.

Configure launch perspective settings from the Perspectives preference page.

Filter matched 2 of 2 items

Complete the Resources Tab

- In **Resources** tab, select the resource manager you want to use to launch this job
- Enter a value in the **Number of Processes** field



Run

Create, manage, and run configurations

Create a configuration to launch a parallel application in Parallel Perspective

type filter text

C/C++ Local Application
Parallel Application
MyHelloProject

Filter matched 3 of 3 items

Name: MyHelloProject

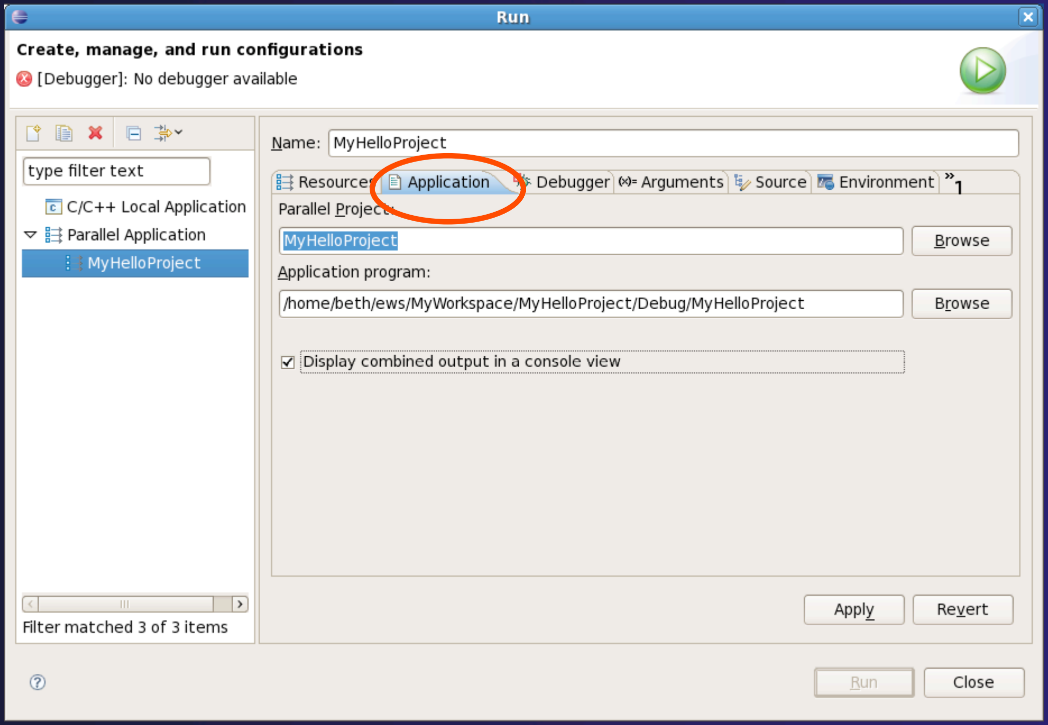
Resource Manager: ORTE@Local

Launch Attributes

Number of Processes: 4

Complete the Application Tab

- Ensure that the correct **Parallel Project** is selected
- Select the **Application program** (executable) by clicking the **Browse** button
  - Local program: executable is under Debug folder in the project
  - Remote program: must copy to remote machine; navigate to its location on the remote machine here.
- Select **Display combined output in a console view** if desired



Name: MyHelloProject

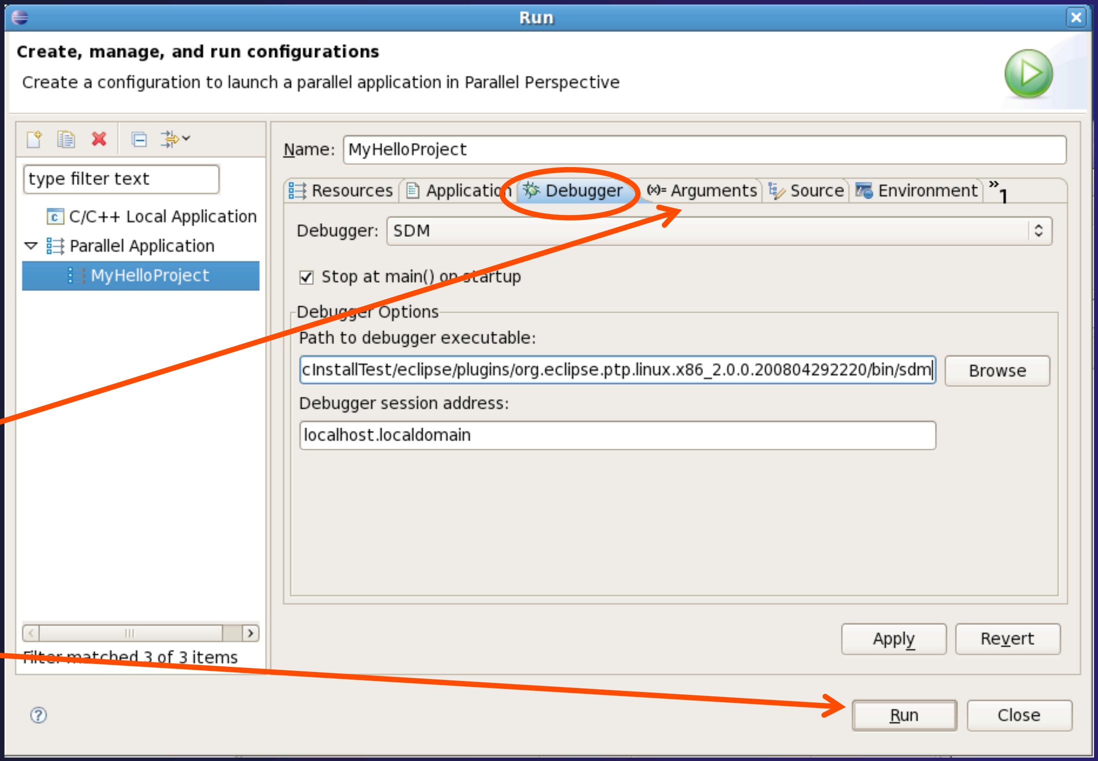
Parallel Project:
MyHelloProject
Browse

Application program:
/home/beth/ews/MyWorkspace/MyHelloProject/Debug/MyHelloProject
Browse

[✓] Display combined output in a console view

Complete the Debugger Tab

- Select **Debugger** tab
- Choose **SDM** from the **Debugger** dropdown
- Confirm the debugger executable
- Set debugger session address
- In **Arguments** tab, enter arguments and working directory
- Click on **Run** to launch the program


Run

Create, manage, and run configurations

Create a configuration to launch a parallel application in Parallel Perspective

Name: MyHelloProject

Debugger: SDM

☑ Stop at main() on startup

Debugger Options

Path to debugger executable:

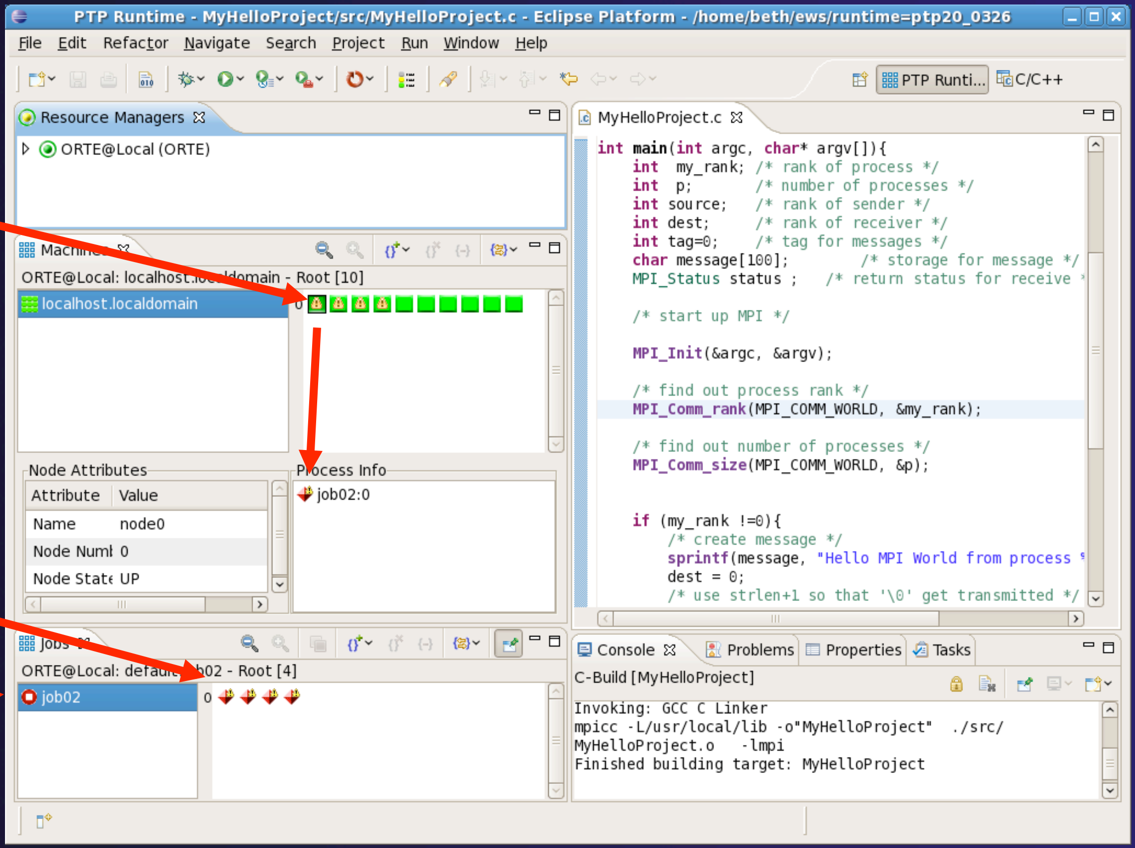
cInstallTest/eclipse/plugins/org.eclipse.ptp.linux.x86_2.0.0.200804292220/bin/sdm

Debugger session address:

localhost.localdomain

Viewing The Run

- Double-click a node in machines view to see which processes ran on the node
- Hover over a process for tooltip popup
- Job and processes shown in jobs view


PTP Runtime - MyHelloProject/src/MyHelloProject.c - Eclipse Platform - /home/beth/ews/runtime=ptp20_0326
File Edit Refactor Navigate Search Project Run Window Help
PTP Runti...
C/C++
Resource Managers
ORTE@Local (ORTE)
Machines
ORTE@Local: localhost.localdomain - Root [10]
localhost.localdomain
0
Node Attributes
Process Info
job02:0
Jobs
ORTE@Local: default job02 - Root [4]
job02
0
MyHelloProject.c
Console
Problems
Properties
Tasks
C-Build [MyHelloProject]

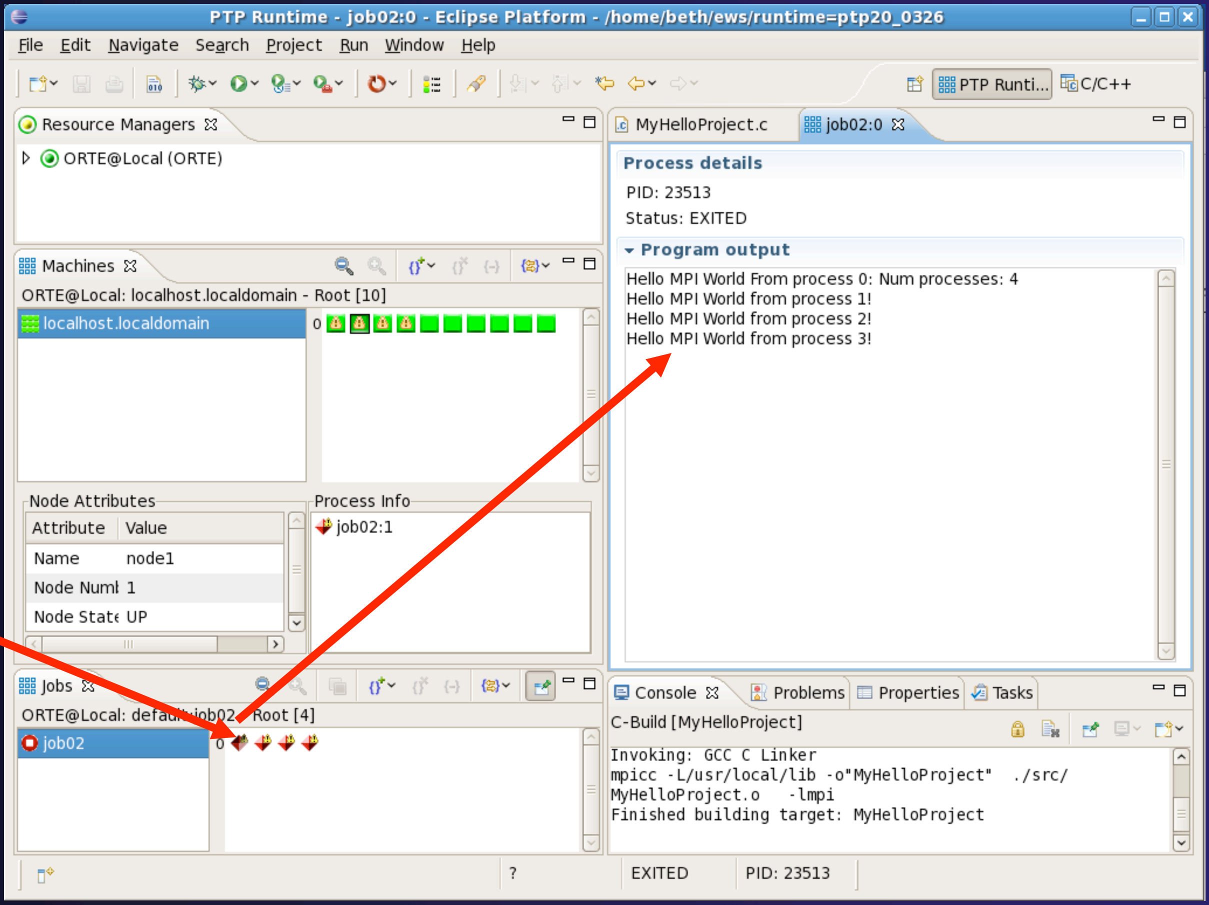
Attribute	Value
Name	node0
Node Numl	0
Node State	UP

```
int main(int argc, char* argv[]){
    int  my_rank; /* rank of process */
    int  p;       /* number of processes */
    int source;   /* rank of sender */
    int dest;     /* rank of receiver */
    int tag=0;    /* tag for messages */
    char message[100];          /* storage for message */
    MPI_Status status ;   /* return status for receive *

    /* start up MPI */

    MPI_Init(&argc, &argv);

    /* find out process rank */
    MPI_Comm_rank(MPI_COMM_WORLD, &my_rank);

    /* find out number of processes */
    MPI_Comm_size(MPI_COMM_WORLD, &p);


    if (my_rank !=0){
        /* create message */
        sprintf(message, "Hello MPI World from process %
        dest = 0;
        /* use strlen+1 so that '\0' get transmitted */
```

```
Invoking: GCC C Linker
mpicc -L/usr/local/lib -o"MyHelloProject"  ./src/
MyHelloProject.o   -lmpi
Finished building target: MyHelloProject
```

Viewing Program Output

- Double-click a process to see process detail and standard output from the process


PTP Runtime - job02:0 - Eclipse Platform - /home/beth/ews/runtime=ptp20_0326
File Edit Navigate Search Project Run Window Help
PTP Runti... C/C++
Resource Managers
ORTE@Local (ORTE)
Machines
ORTE@Local: localhost.localdomain - Root [10]
localhost.localdomain
Node Attributes
Process Info
job02:1
Jobs
ORTE@Local: default:job02 - Root [4]
job02
MyHelloProject.c
job02:0
Console
Problems
Properties
Tasks
C-Build [MyHelloProject]

Attribute	Value
Name	node1
Node Numl	1
Node State	UP

Process details

PID: 23513

Status: EXITED

Program output

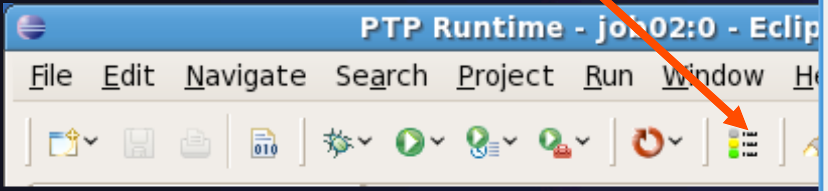
```
Hello MPI World From process 0: Num processes: 4
Hello MPI World from process 1!
Hello MPI World from process 2!
Hello MPI World from process 3!
```

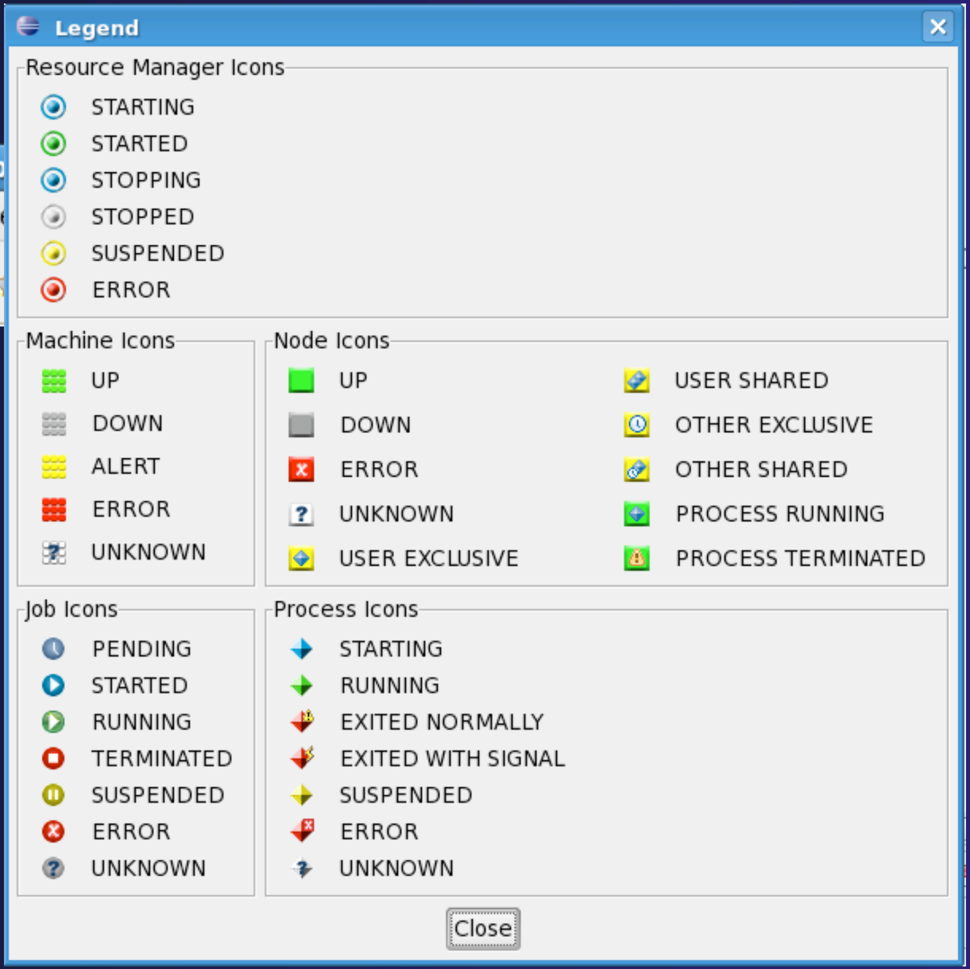
```
Invoking: GCC C Linker
mpicc -L/usr/local/lib -o"MyHelloProject"  ./src/
MyHelloProject.o   -lmpi
Finished building target: MyHelloProject
```

EXITED PID: 23513

About PTP Icons

- Open using legend icon in toolbar





Resource Manager Icons
- STARTING
- STARTED
- STOPPING
- STOPPED
- SUSPENDED
- ERROR

Machine Icons
- UP
- DOWN
- ALERT
- ERROR
- UNKNOWN

Node Icons
- UP
- DOWN
- ERROR
- UNKNOWN
- USER EXCLUSIVE
- USER SHARED
- OTHER EXCLUSIVE
- OTHER SHARED
- PROCESS RUNNING
- PROCESS TERMINATED

Job Icons
- PENDING
- STARTED
- RUNNING
- TERMINATED
- SUSPENDED
- ERROR
- UNKNOWN

Process Icons
- STARTING
- RUNNING
- EXITED NORMALLY
- EXITED WITH SIGNAL
- SUSPENDED
- ERROR
- UNKNOWN

Module 3: PTP and Parallel Language Development Tools

- Objective
  - Learn to develop a parallel program
  - Learn to analyse with PLDT
- Contents
  - Learn to use PTP's Parallel Language Development Tools
  - Learn to find MPI & OpenMP artifacts
  - Learn how to do MPI and OpenMP Specific analysis

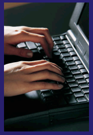
Parallel Language Development Tools (1)

- Features
  - Analysis of C and C++ code to determine the location of MPI and OpenMP Artifacts (Fortran planned)
  - "Artifact View" indicates locations of Artifacts found in source code
  - Navigation to source code location of artifacts
  - Content assist via **ctrl+space** (“completion”)
  - Hover help
  - Reference information about the MPI and OpenMP calls via Dynamic Help

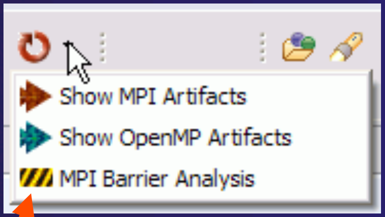
Parallel Language Development Tools (2)

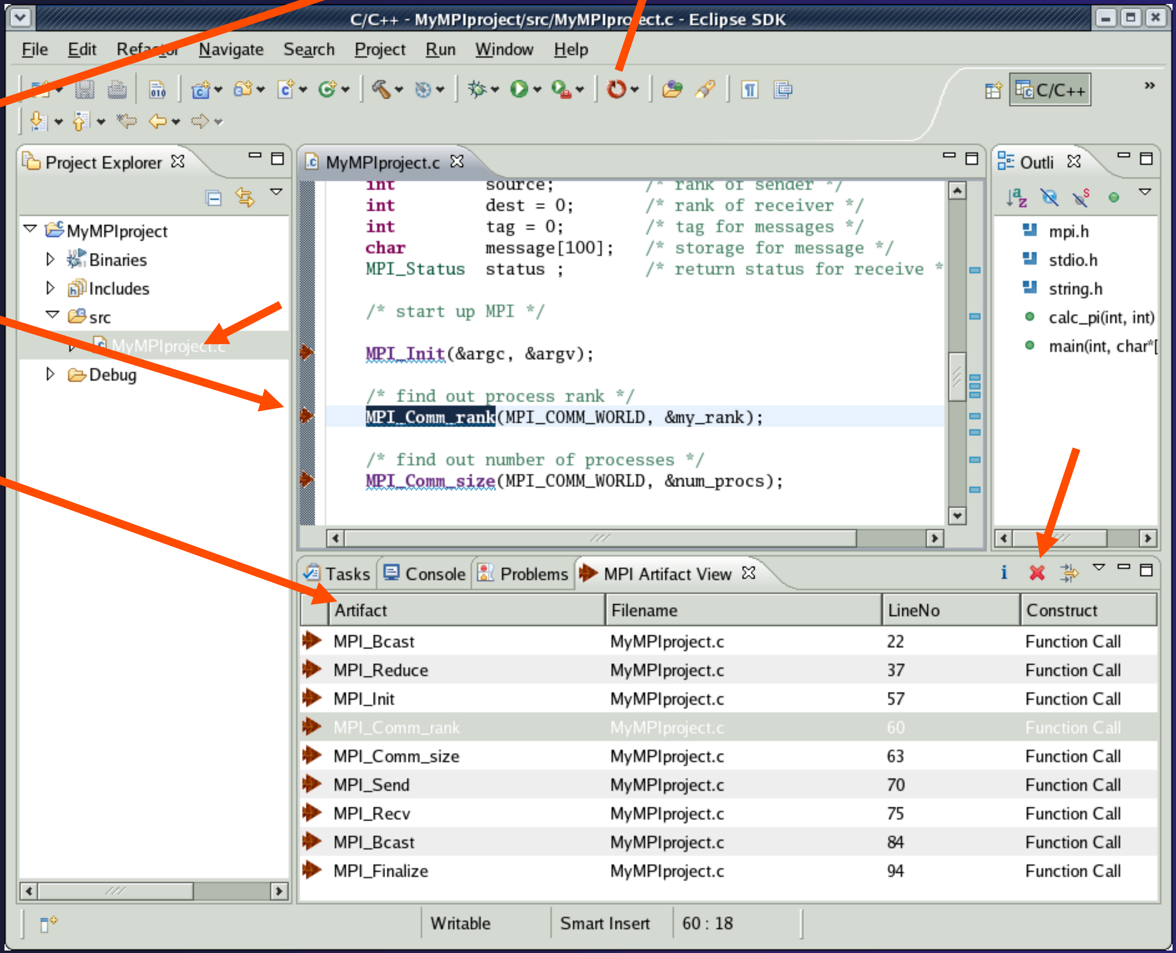
- More PLDT features:
  - New project wizard automatically configures managed build projects for MPI & OpenMP
  - OpenMP problems view of common errors
  - OpenMP “show #pragma region” action
  - OpenMP “show concurrency” action
  - MPI Barrier analysis - detects potential deadlocks

Show MPI Artifacts



- Select source file; Run analysis by clicking on drop-down menu next to the analysis button and selecting **Show MPI Artifacts**
- Markers indicate the location of artifacts in editor
- In **MPI Artifact View** sort by any column (click on col. heading)
- Navigate to source code line by double-clicking on the artifact
- Run the analysis on another file and its markers will be added to the view
- Remove markers via



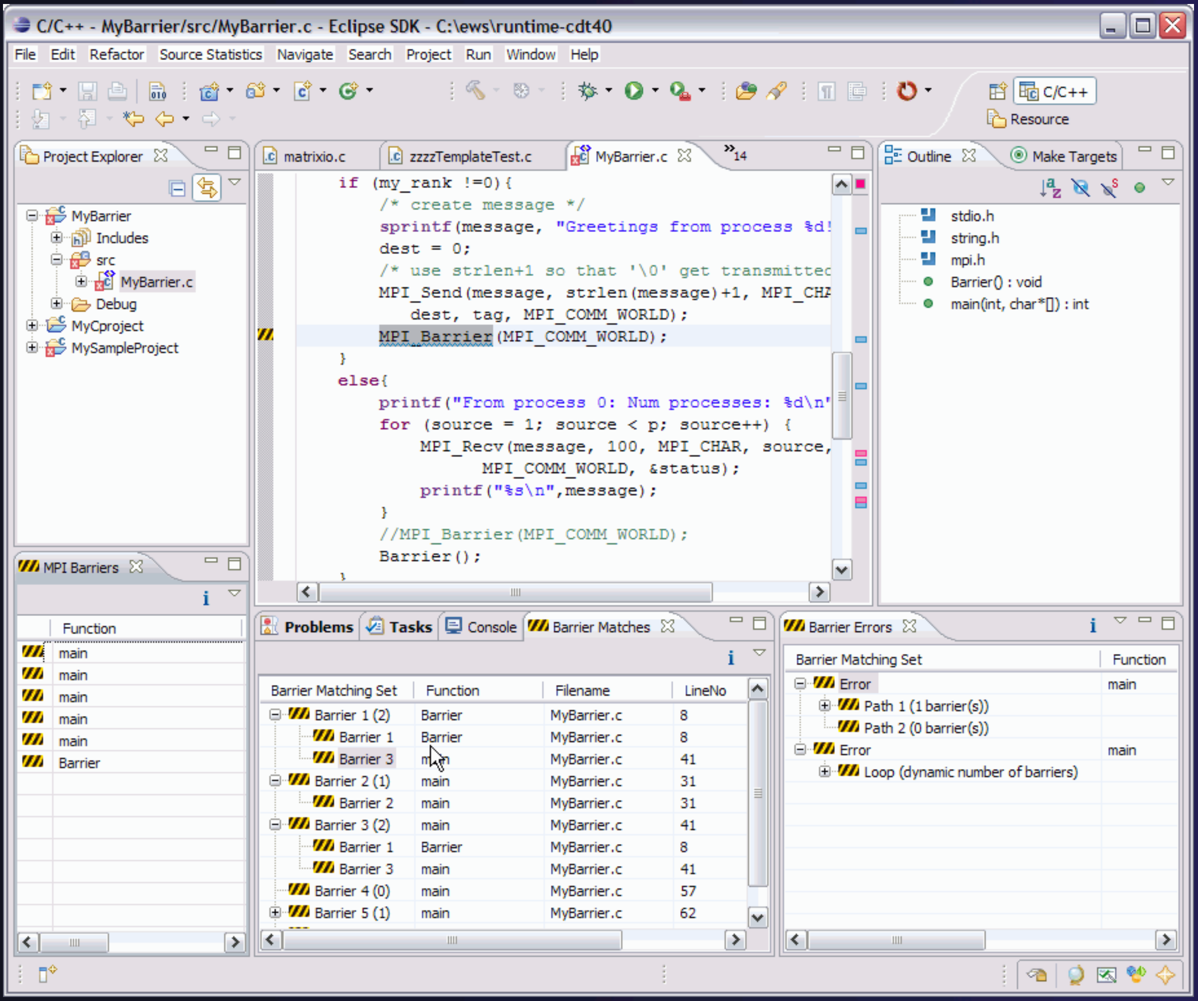


```
    int         source;         /* rank of sender */
    int         dest = 0;       /* rank of receiver */
    int         tag = 0;        /* tag for messages */
    char        message[100];   /* storage for message */
    MPI_Status  status ;        /* return status for receive *

    /* start up MPI */

    MPI_Init(&argc, &argv);

    /* find out process rank */
    MPI_Comm_rank(MPI_COMM_WORLD, &my_rank);

    /* find out number of processes */
    MPI_Comm_size(MPI_COMM_WORLD, &num_procs);
```

Artifact	Filename	LineNo	Construct
MPI_Bcast	MyMPIproject.c	22	Function Call
MPI_Reduce	MyMPIproject.c	37	Function Call
MPI_Init	MyMPIproject.c	57	Function Call
MPI_Comm_rank	MyMPIproject.c	60	Function Call
MPI_Comm_size	MyMPIproject.c	63	Function Call
MPI_Send	MyMPIproject.c	70	Function Call
MPI_Recv	MyMPIproject.c	75	Function Call
MPI_Bcast	MyMPIproject.c	84	Function Call
MPI_Finalize	MyMPIproject.c	94	Function Call

Writable   Smart Insert   60 : 18

MPI Barrier Analysis



```
    if (my_rank !=0){
        /* create message */
        sprintf(message, "Greetings from process %d!
        dest = 0;
        /* use strlen+1 so that '\0' get transmittec
        MPI_Send(message, strlen(message)+1, MPI_CHA
           dest, tag, MPI_COMM_WORLD);
        MPI_Barrier(MPI_COMM_WORLD);
    }
    else{
        printf("From process 0: Num processes: %d\n"
        for (source = 1; source < p; source++) {
            MPI_Recv(message, 100, MPI_CHAR, source,
                  MPI_COMM_WORLD, &status);
            printf("%s\n",message);
        }
        //MPI_Barrier(MPI_COMM_WORLD);
        Barrier();
```

Function
main
main
main
main
main
Barrier

Barrier Matching Set	Function	Filename	LineNo
Barrier 1 (2)	Barrier	MyBarrier.c	8
Barrier 1	Barrier	MyBarrier.c	8
Barrier 3	main	MyBarrier.c	41
Barrier 2 (1)	main	MyBarrier.c	31
Barrier 2	main	MyBarrier.c	31
Barrier 3 (2)	main	MyBarrier.c	41
Barrier 1	Barrier	MyBarrier.c	8
Barrier 3	main	MyBarrier.c	41
Barrier 4 (0)	main	MyBarrier.c	57
Barrier 5 (1)	main	MyBarrier.c	62

Barrier Matching Set	Function
Error	main
Path 1 (1 barrier(s))	
Path 2 (0 barrier(s))	
Error	main
Loop (dynamic number of barriers)	

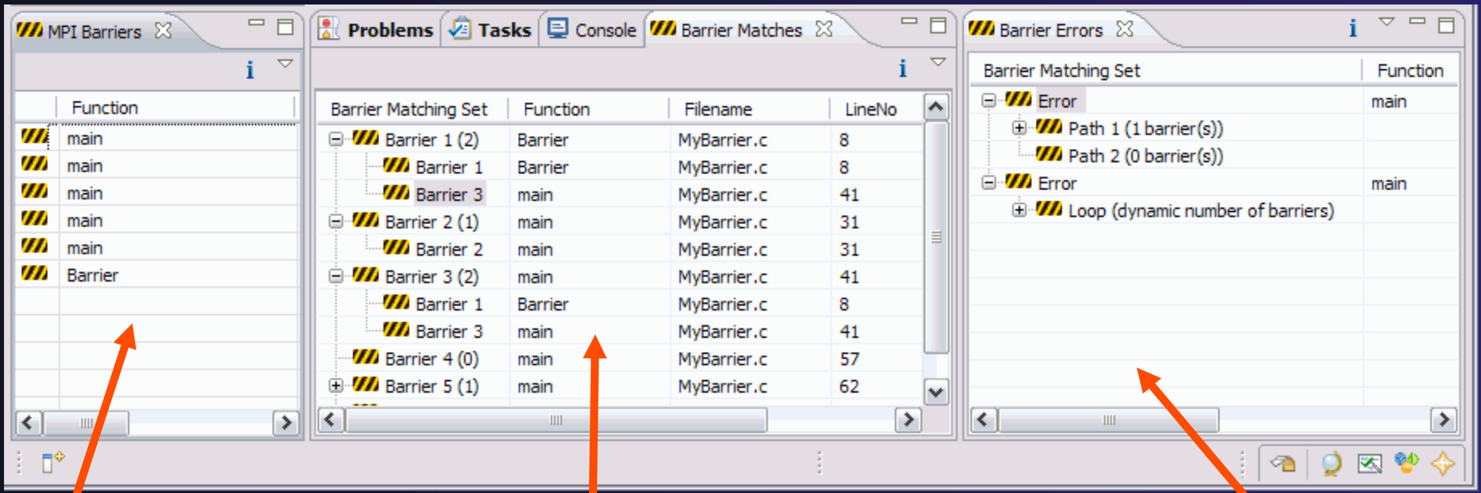
Verify barrier synchronization in C/MPI programs

Interprocedural static analysis outputs:

✦For verified programs, lists barrier statements that synchronize together (match)

✦ For synchronization errors, reports counter example that illustrates and explains the error.

MPI Barrier Analysis - views



MPI Barriers

Function
main
main
main
main
main
Barrier

Problems | Tasks | Console | Barrier Matches

Barrier Matching Set	Function	Filename	LineNo
Barrier 1 (2)	Barrier	MyBarrier.c	8
Barrier 1	Barrier	MyBarrier.c	8
Barrier 3	main	MyBarrier.c	41
Barrier 2 (1)	main	MyBarrier.c	31
Barrier 2	main	MyBarrier.c	31
Barrier 3 (2)	main	MyBarrier.c	41
Barrier 1	Barrier	MyBarrier.c	8
Barrier 3	main	MyBarrier.c	41
Barrier 4 (0)	main	MyBarrier.c	57
Barrier 5 (1)	main	MyBarrier.c	62

Barrier Errors

Barrier Matching Set	Function
Error	main
Path 1 (1 barrier(s))	
Path 2 (0 barrier(s))	
Error	main
Loop (dynamic number of barriers)	

MPI Barriers view

Simply lists the barriers

Like MPI Artifacts view, double-click to navigate to source code line (all 3 views)

Barrier Matches view

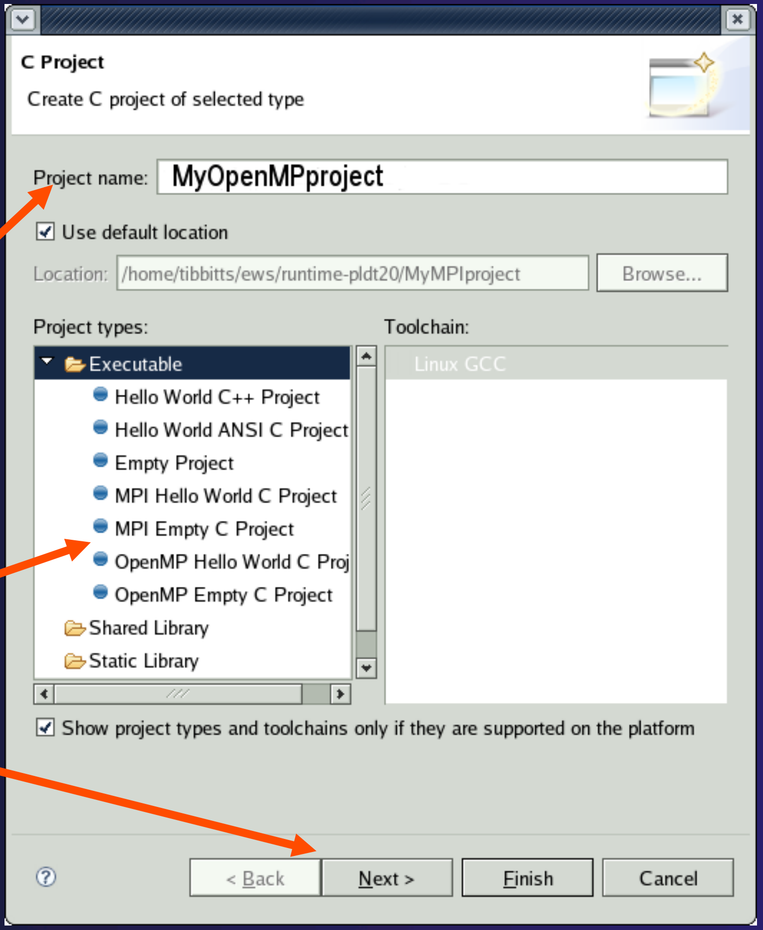
Groups barriers that match together in a barrier set – all processes must go through a barrier in the set to prevent a deadlock

Barrier Errors view

If there are errors, a counter-example shows paths with mismatched number of barriers

OpenMP Managed Build Project

- If you haven't set up OpenMP preferences e.g. include file location, do it now
- Create a new OpenMP project
  - **File▶New▶C Project**
  - Name the project e.g. 'MyOpenMPproject'
  - Select **OpenMP Hello World C Project**
  - Select **Next,** then fill in other info like MPI project



C Project

Create C project of selected type

Project name: MyOpenMPproject

☑ Use default location

Location: /home/tibbitts/ews/runtime-pldt20/MyMPIproject

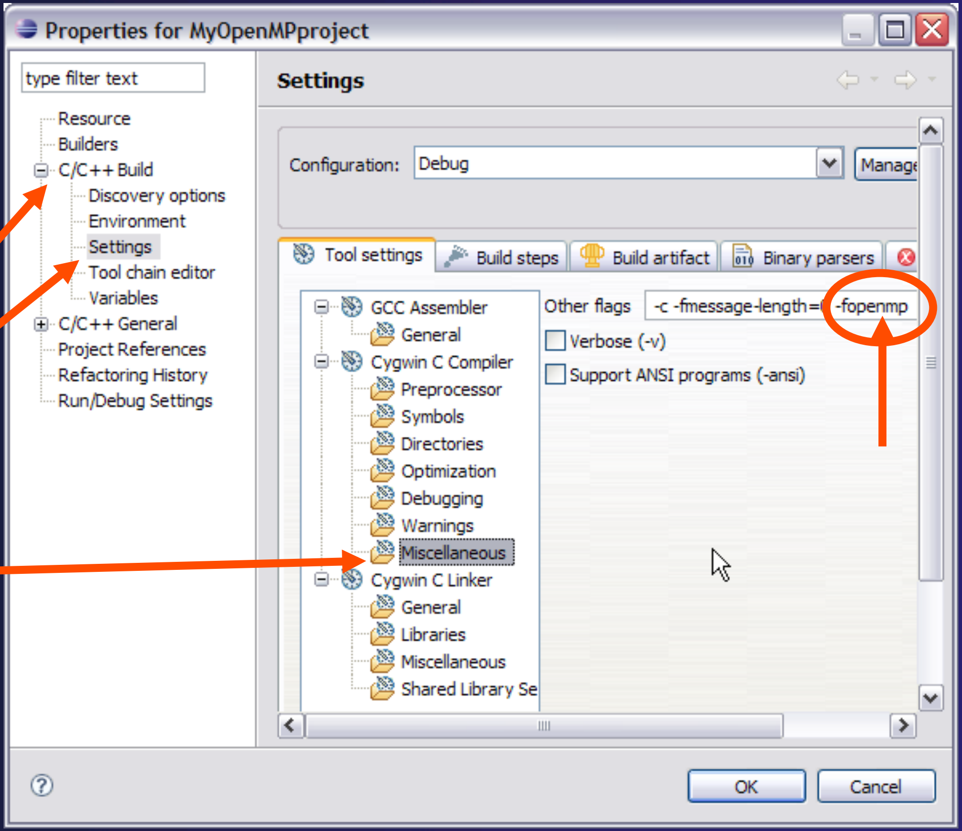
Project types:
- Executable
  - Hello World C++ Project
  - Hello World ANSI C Project
  - Empty Project
  - MPI Hello World C Project
  - MPI Empty C Project
  - OpenMP Hello World C Proj
  - OpenMP Empty C Project
- Shared Library
- Static Library

Toolchain: Linux GCC

☑ Show project types and toolchains only if they are supported on the platform

Setting OpenMP Special Build Options

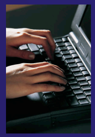
- OpenMP typically requires special compiler options.
  - Open the project properties
  - Select **C/C++ Build**
  - Select **Settings**
  - Select **C Compiler**
    - In Miscellaneous, add option(s).



Other flags: -c -fmessage-length=0 -fopenmp

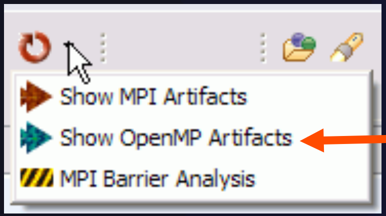
☐ Verbose (-v)

☐ Support ANSI programs (-ansi)

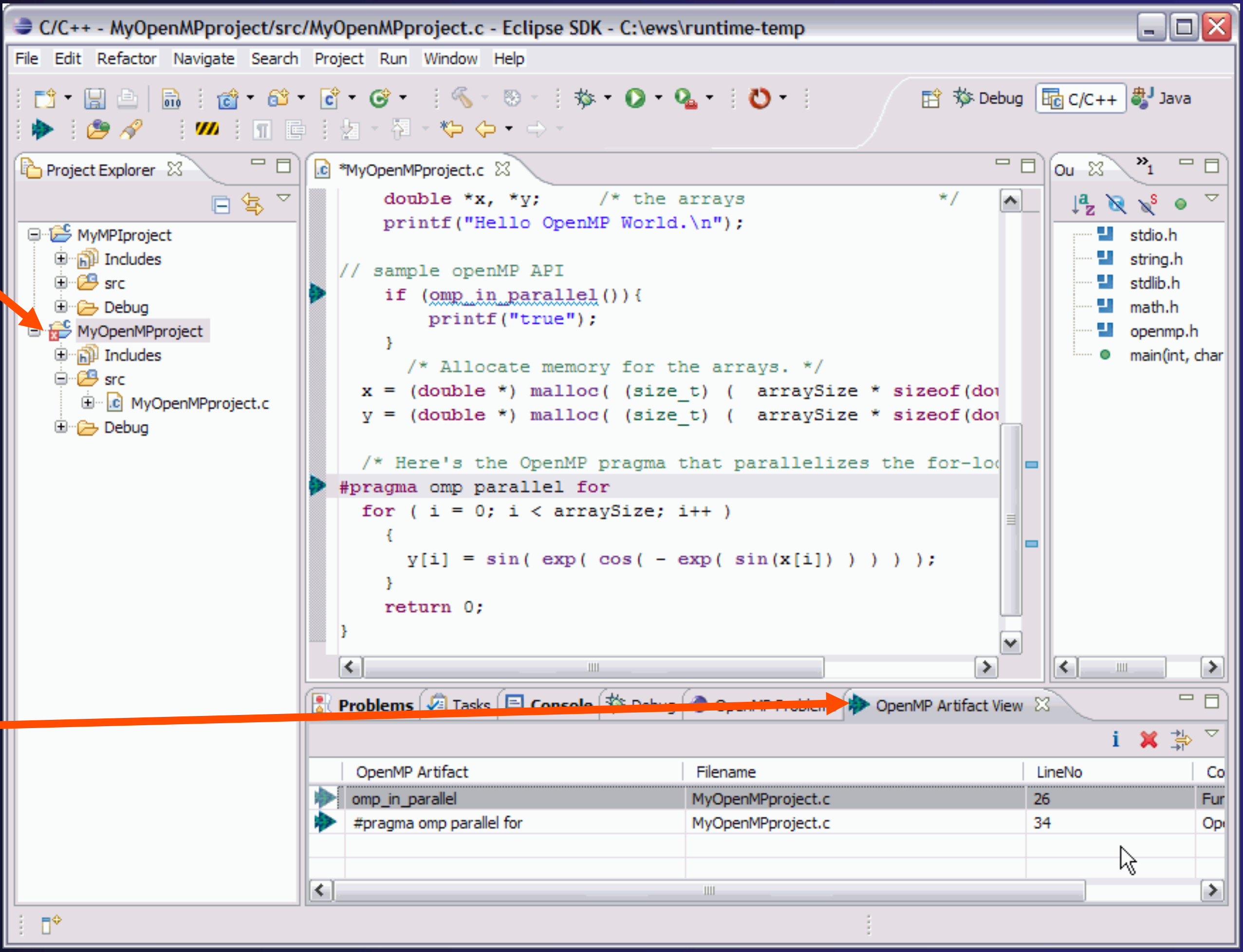


Show OpenMP Artifacts

- Select source file, folder, or project
- Run analysis



- See artifacts in **OpenMP Artifact view**

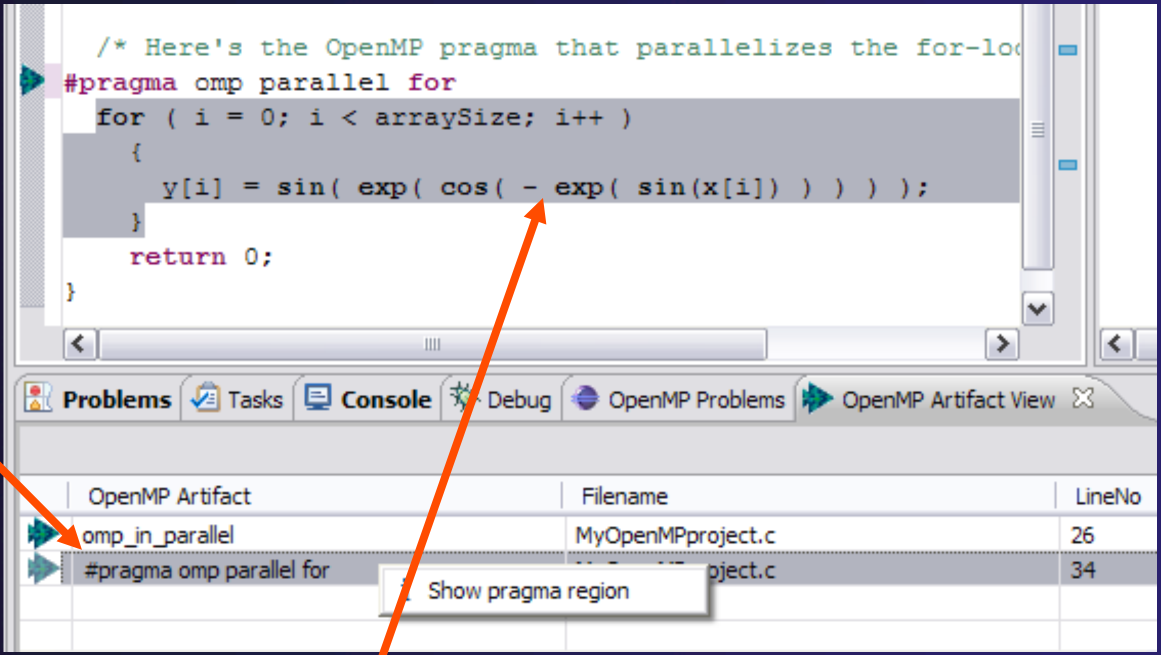


```
   double *x, *y;      /* the arrays                    */
   printf("Hello OpenMP World.\n");

// sample openMP API
   if (omp_in_parallel()){
      printf("true");
   }
     /* Allocate memory for the arrays. */
  x = (double *) malloc( (size_t) (  arraySize * sizeof(dou
  y = (double *) malloc( (size_t) (  arraySize * sizeof(dou

  /* Here's the OpenMP pragma that parallelizes the for-loo
#pragma omp parallel for
  for ( i = 0; i < arraySize; i++ )
    {
      y[i] = sin( exp( cos( - exp( sin(x[i]) ) ) ) );
    }
    return 0;
}
```

OpenMP Artifact	Filename	LineNo	Co
omp_in_parallel	MyOpenMPproject.c	26	Fur
#pragma omp parallel for	MyOpenMPproject.c	34	Op

Show Pragma Region

- Run OpenMP analysis
- Right click on pragma in artifact view
- Select **Show pragma region**



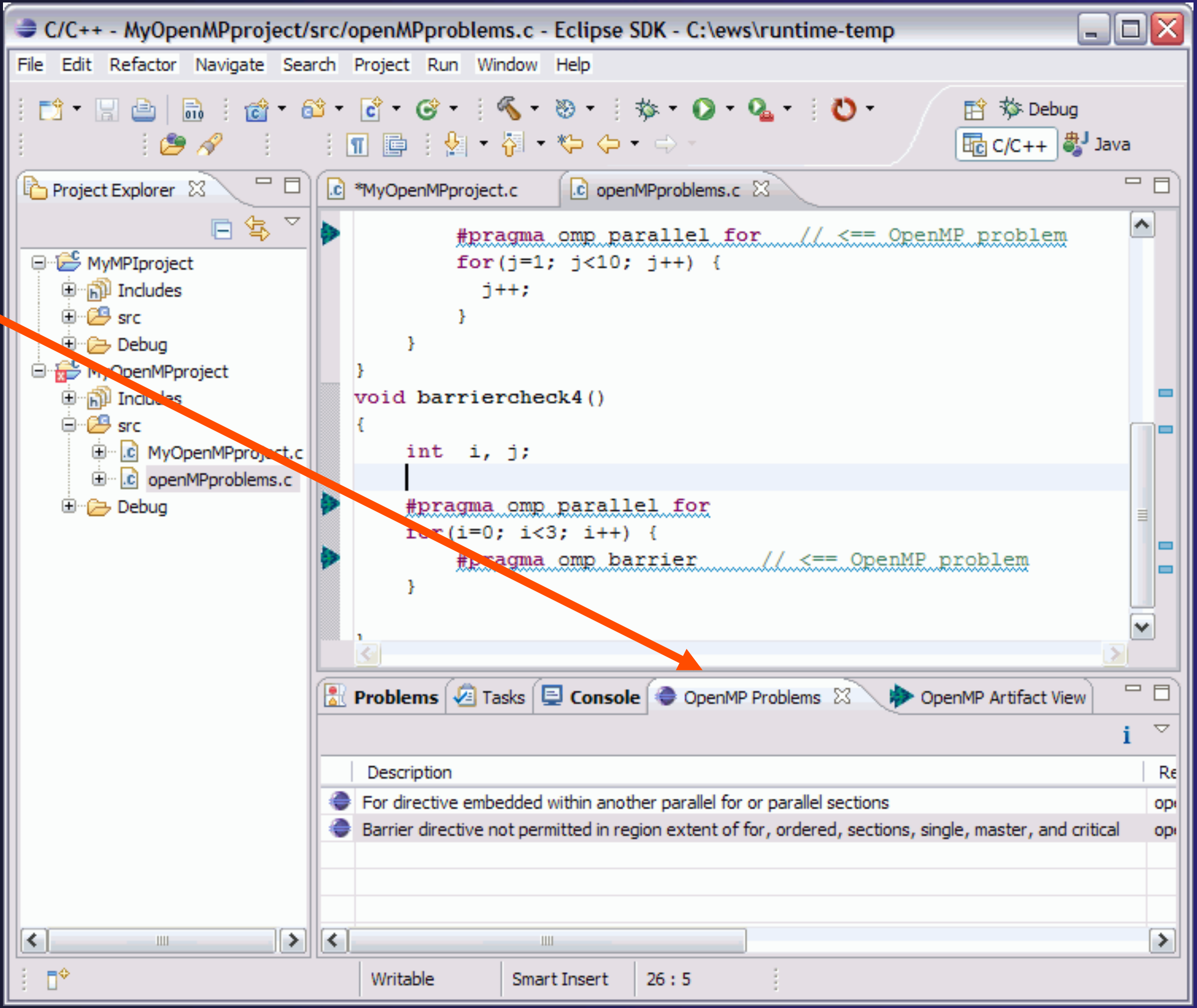
```
  /* Here's the OpenMP pragma that parallelizes the for-loo
#pragma omp parallel for
  for ( i = 0; i < arraySize; i++ )
    {
      y[i] = sin( exp( cos( - exp( sin(x[i]) ) ) ) );
    }
    return 0;
}
```

OpenMP Artifact	Filename	LineNo
omp_in_parallel	MyOpenMPproject.c	26
#pragma omp parallel for	MyOpenMPproject.c	34

- See highlighted region in C editor

Show OpenMP Problems

- Select **OpenMP problems view**
- Will identify standard OpenMP restrictions

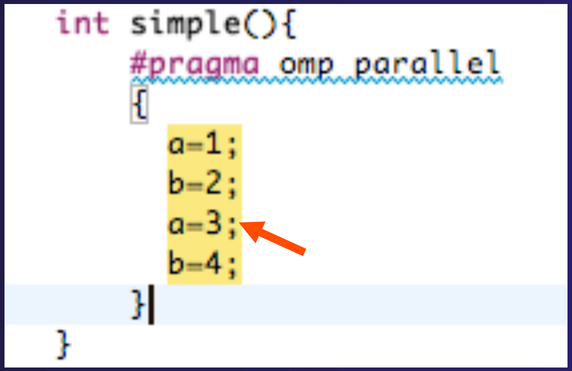


```
        #pragma omp parallel for    // <== OpenMP problem
        for(j=1; j<10; j++) {
          j++;
        }
    }
}
void barriercheck4()
{
    int  i, j;

    #pragma omp parallel for
    for(i=0; i<3; i++) {
        #pragma omp barrier      // <== OpenMP problem
    }
```

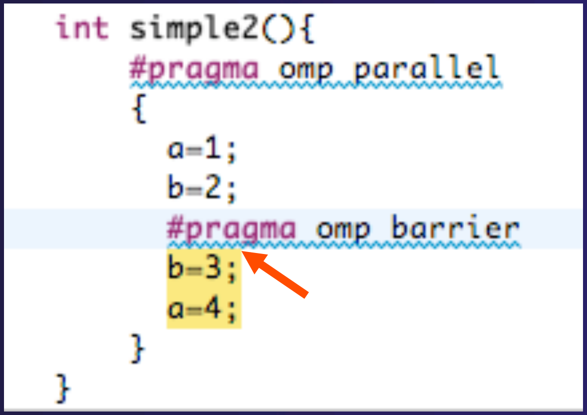
Description	Re
For directive embedded within another parallel for or parallel sections	op
Barrier directive not permitted in region extent of for, ordered, sections, single, master, and critical	op

Show Concurrency

- Highlight a statement
- Select the context menu on the highlighted statement, and click **Show concurrency**
- Other statements will be highlighted in yellow
- The yellow highlighted statements *might* execute concurrently to the selected statement



```
int simple(){
    #pragma omp parallel
    {
        a=1;
        b=2;
        a=3;
        b=4;
    }
}
```



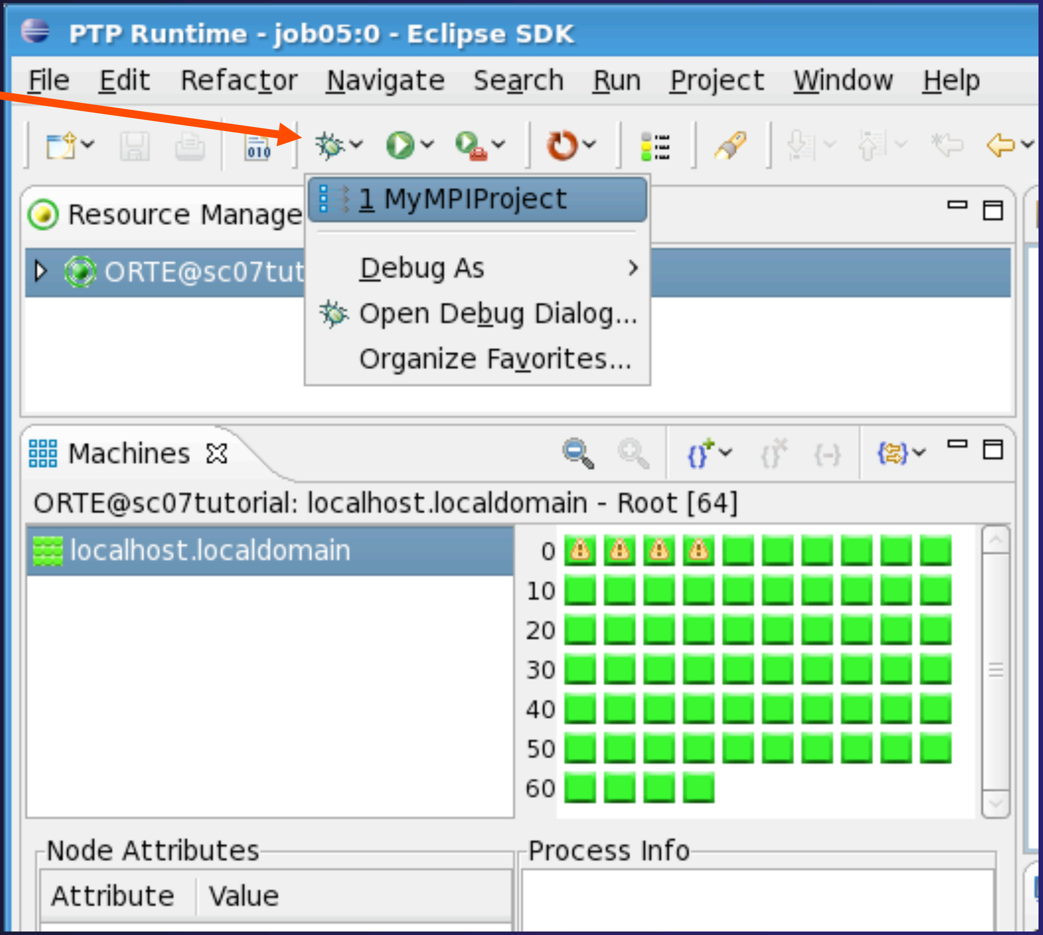
```
int simple2(){
    #pragma omp parallel
    {
        a=1;
        b=2;
        #pragma omp barrier
        b=3;
        a=4;
    }
}
```

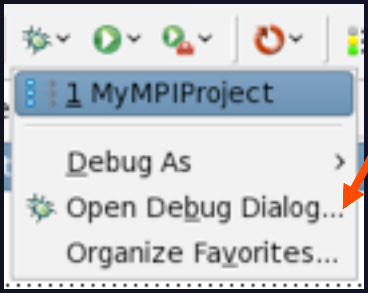
Module 4: Parallel Debugging

- Objective
  - Learn the basics of debugging parallel programs with PTP
- Contents
  - Launching a parallel debug session
  - The PTP Debug Perspective
  - Controlling sets of processes
  - Controlling individual processes
  - Parallel Breakpoints
  - Terminating processes

Launching A Debug Session

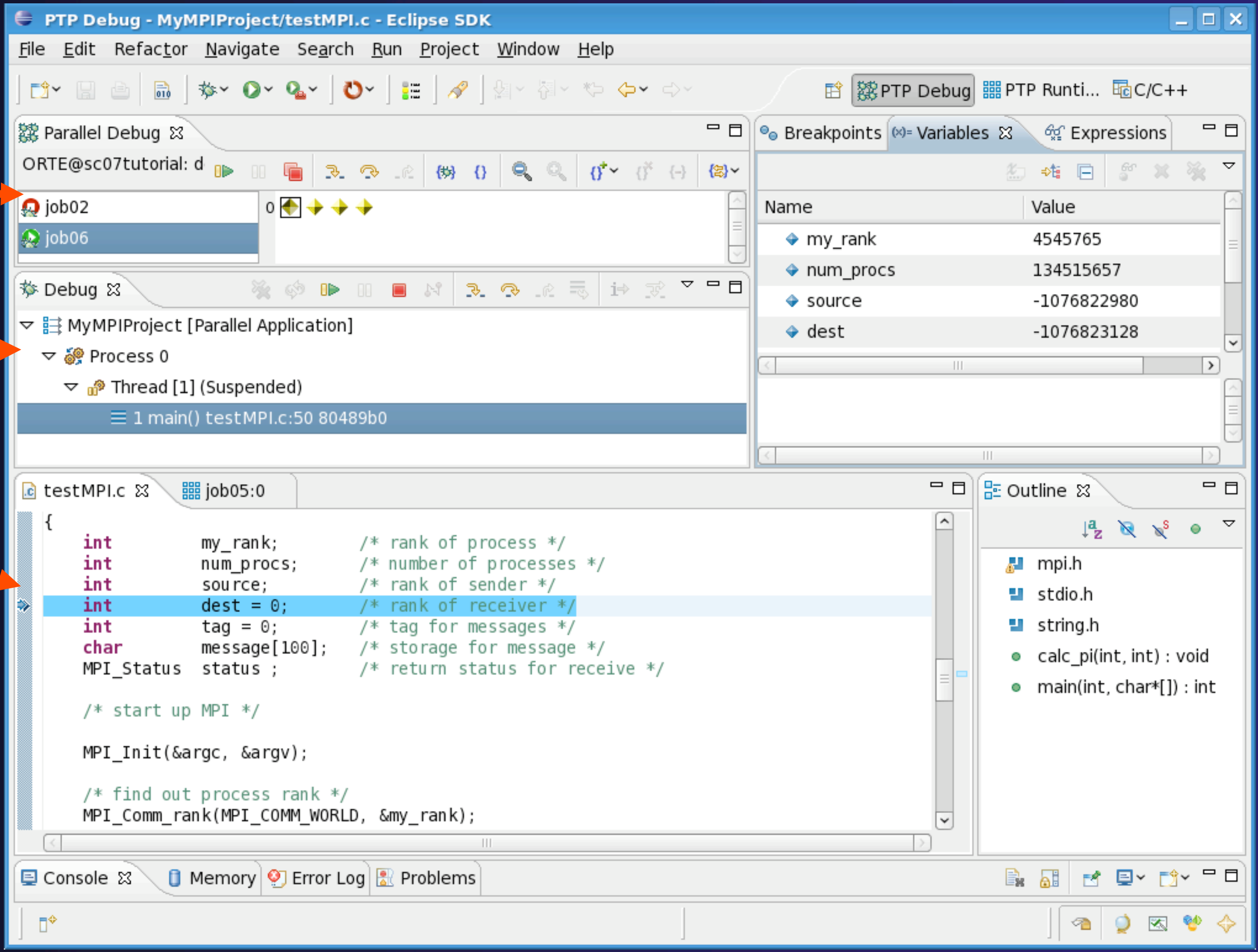
- Use the drop-down next to the debug button (bug icon) instead of run button
- Select the project to launch
- The debug launch will use the same number of processes that the normal launch used (edit the **Debug Launch Configuration** to change)





The PTP Debug Perspective (1)

- **Parallel Debug view** shows job and processes being debugged
- **Debug** view shows threads and call stack for individual processes
- **Source** view shows a **current line marker** for all processes



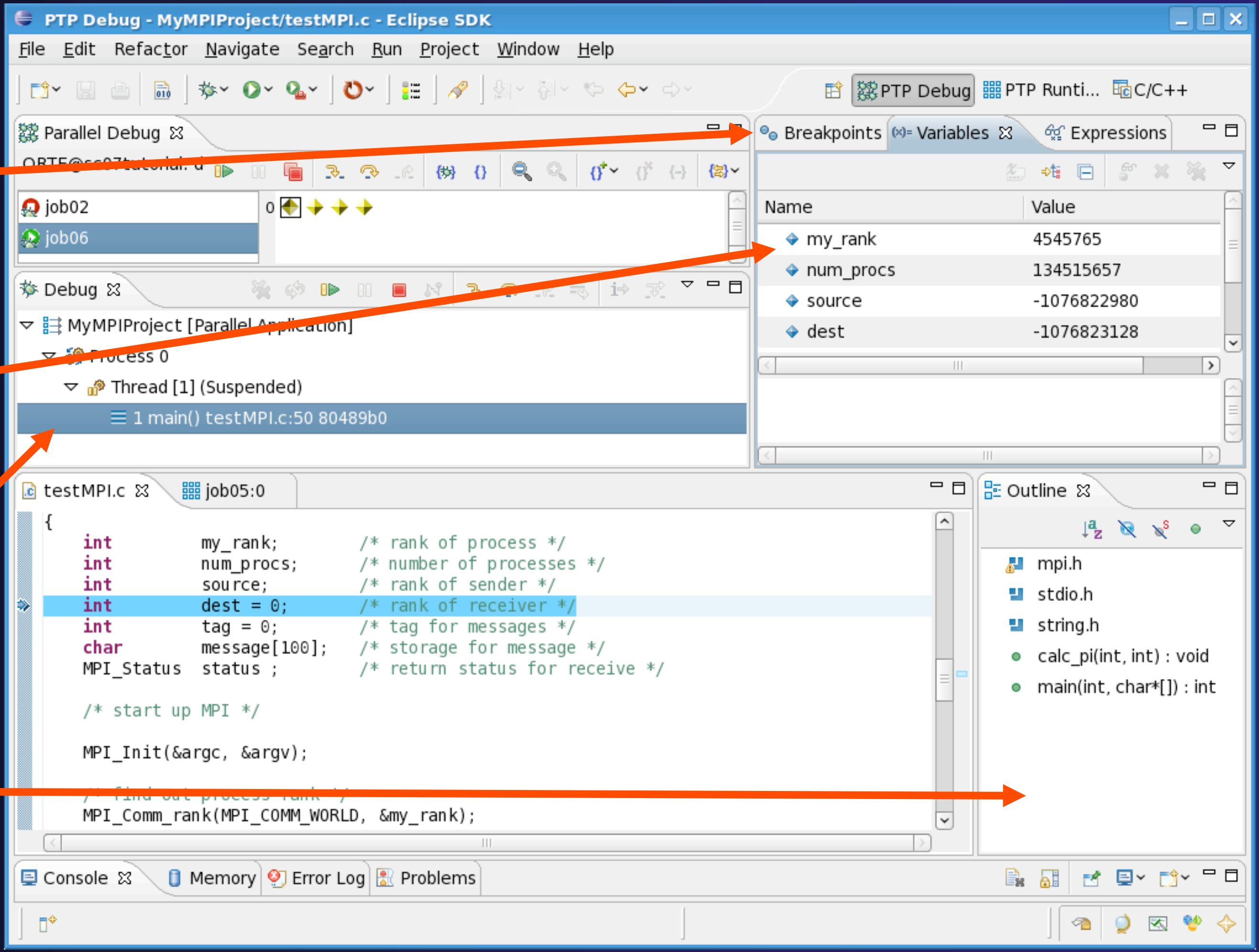
```
MyMPIProject [Parallel Application]
  Process 0
    Thread [1] (Suspended)
      1 main() testMPI.c:50 80489b0
```

Name	Value
my_rank	4545765
num_procs	134515657
source	-1076822980
dest	-1076823128

```
{
    int         my_rank;        /* rank of process */
    int         num_procs;      /* number of processes */
    int         source;         /* rank of sender */
    int         dest = 0;       /* rank of receiver */
    int         tag = 0;        /* tag for messages */
    char        message[100];   /* storage for message */
    MPI_Status  status ;        /* return status for receive */

    /* start up MPI */

    MPI_Init(&argc, &argv);

    /* find out process rank */
    MPI_Comm_rank(MPI_COMM_WORLD, &my_rank);
```

The PTP Debug Perspective (2)

- **Breakpoints** view shows breakpoints that have been set (more on this later)
- **Variables** view shows the current values of variables for the currently selected process in the **Debug** view
- **Outline** view (from CDT) of source code



```
MyMPIProject [Parallel Application]
  Process 0
    Thread [1] (Suspended)
      1 main() testMPI.c:50 80489b0
```

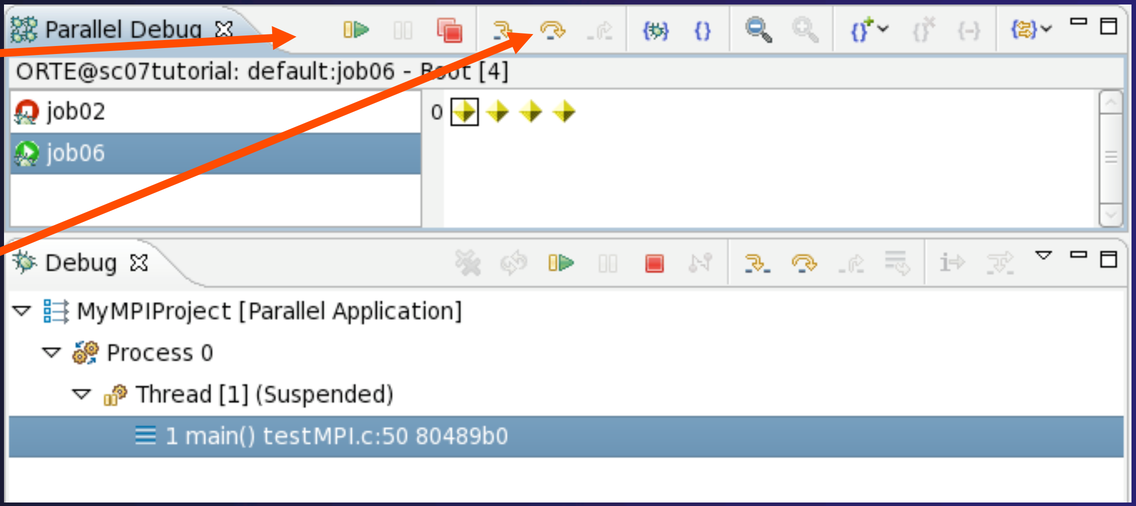
Name	Value
my_rank	4545765
num_procs	134515657
source	-1076822980
dest	-1076823128

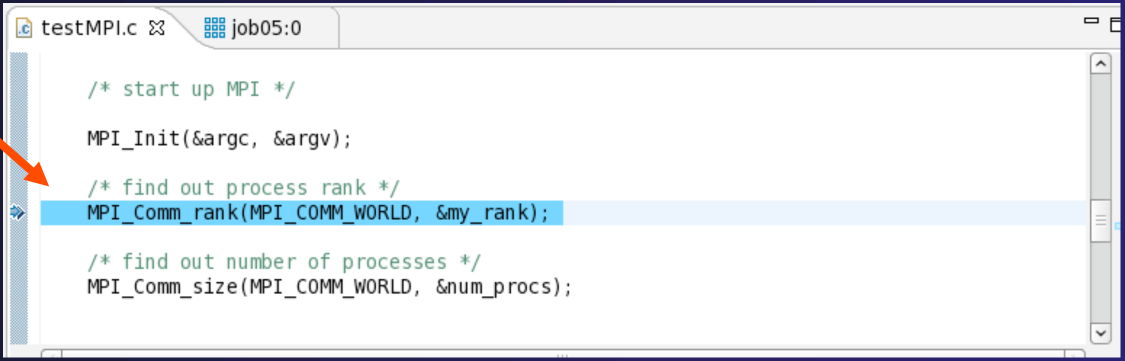
```
{
    int         my_rank;        /* rank of process */
    int         num_procs;      /* number of processes */
    int         source;         /* rank of sender */
    int         dest = 0;       /* rank of receiver */
    int         tag = 0;        /* tag for messages */
    char        message[100];   /* storage for message */
    MPI_Status  status ;        /* return status for receive */

    /* start up MPI */

    MPI_Init(&argc, &argv);

    /* find out process rank */
    MPI_Comm_rank(MPI_COMM_WORLD, &my_rank);
```

```
mpi.h
stdio.h
string.h
calc_pi(int, int) : void
main(int, char*[]) : int
```

Stepping All Processes

- The buttons in the **Parallel Debug View** control groups of processes
- Click on the **Step Over** button
- Observe that all process icons change to green, then back to yellow
- Notice that the current line marker has moved to the next source line

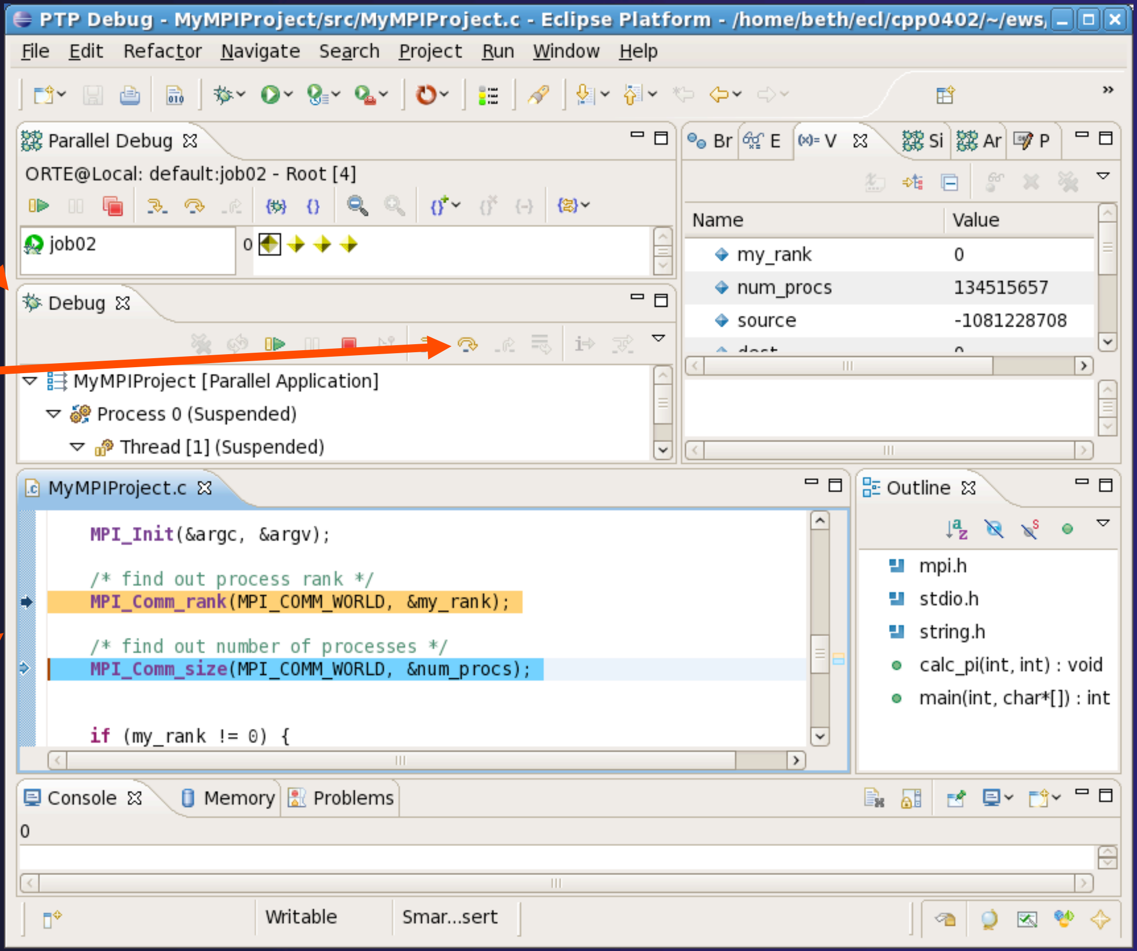

Parallel Debug
ORTE@sc07tutorial: default:job06 - Root [4]
job02
job06
0
Debug
MyMPIProject [Parallel Application]
Process 0
Thread [1] (Suspended)
1 main() testMPI.c:50 80489b0



```
    /* start up MPI */

    MPI_Init(&argc, &argv);

    /* find out process rank */
    MPI_Comm_rank(MPI_COMM_WORLD, &my_rank);

    /* find out number of processes */
    MPI_Comm_size(MPI_COMM_WORLD, &num_procs);
```

Stepping An Individual Process

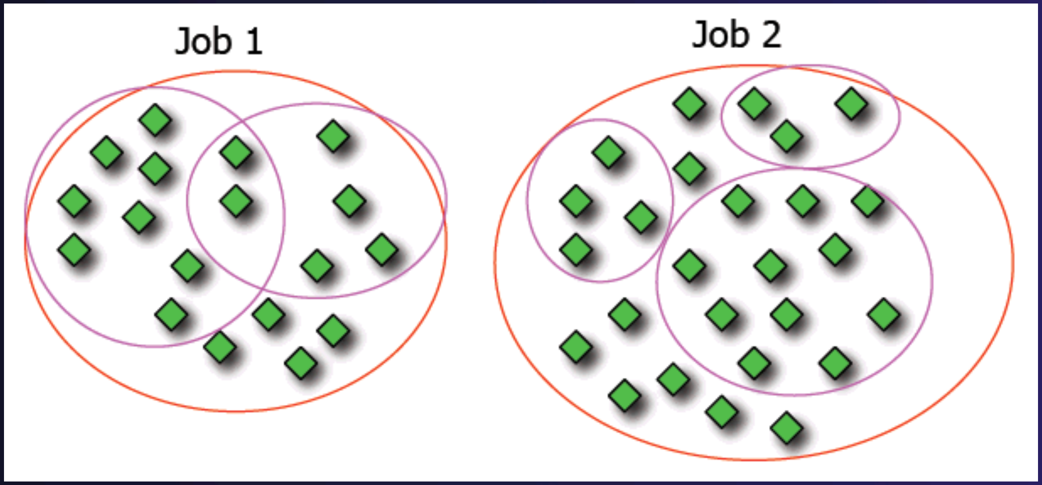
- The buttons in the **Debug view** are used to control an individual process, in this case process 0
- Click the **Step Over** button
- You will now see two current line markers, the first shows the position of process 0, the second shows the positions of processes 1-3



```
MPI_Init(&argc, &argv);

/* find out process rank */
MPI_Comm_rank(MPI_COMM_WORLD, &my_rank);

/* find out number of processes */
MPI_Comm_size(MPI_COMM_WORLD, &num_procs);


if (my_rank != 0) {
```

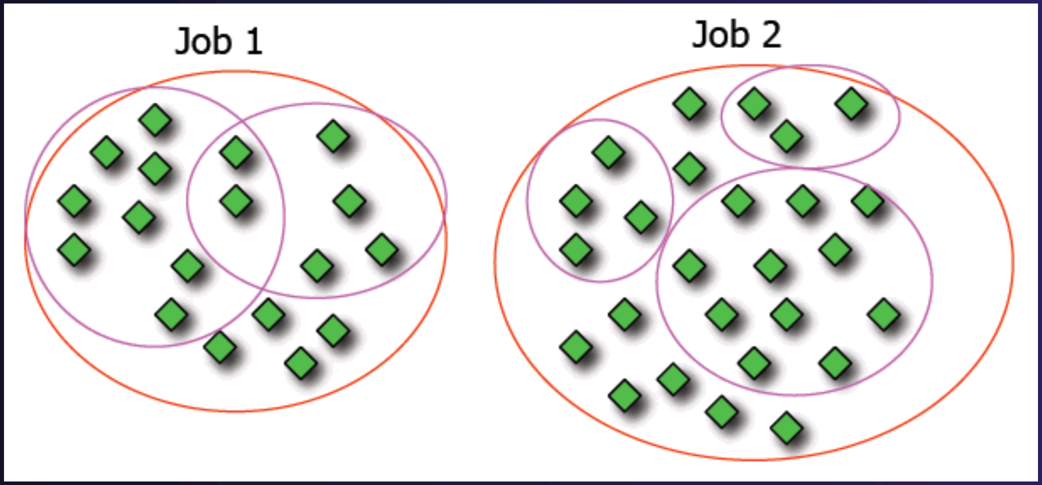
Process Sets (1)

- Traditional debuggers apply operations to a single process
- Parallel debugging operations apply to a single process or to arbitrary collections of processes
- A process set is a means of simultaneously referring to one or more processes



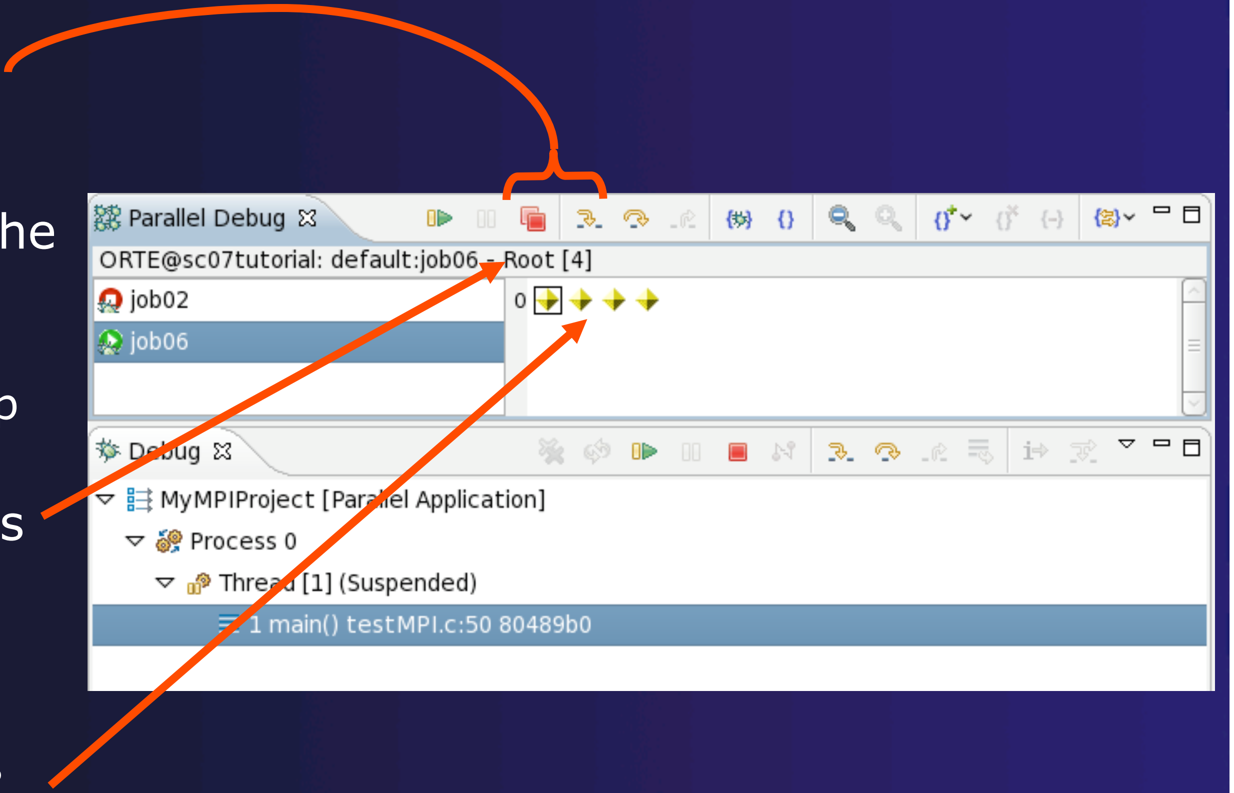
Process Sets (2)

- When a parallel debug session is first started, all processes are placed in a set, called the **Root** set
- Sets are always associated with a single job
- A job can have any number of process sets
- A set can contain from 1 to the number of processes in a job



Operations On Process Sets

- Debug operations on the **Parallel Debug view** toolbar always apply to the current set:
  - Resume, suspend, stop, step into, step over, step return
- The current process set is listed next to job name along with number of processes in the set
- The processes in process set are visible in right hand part of the view

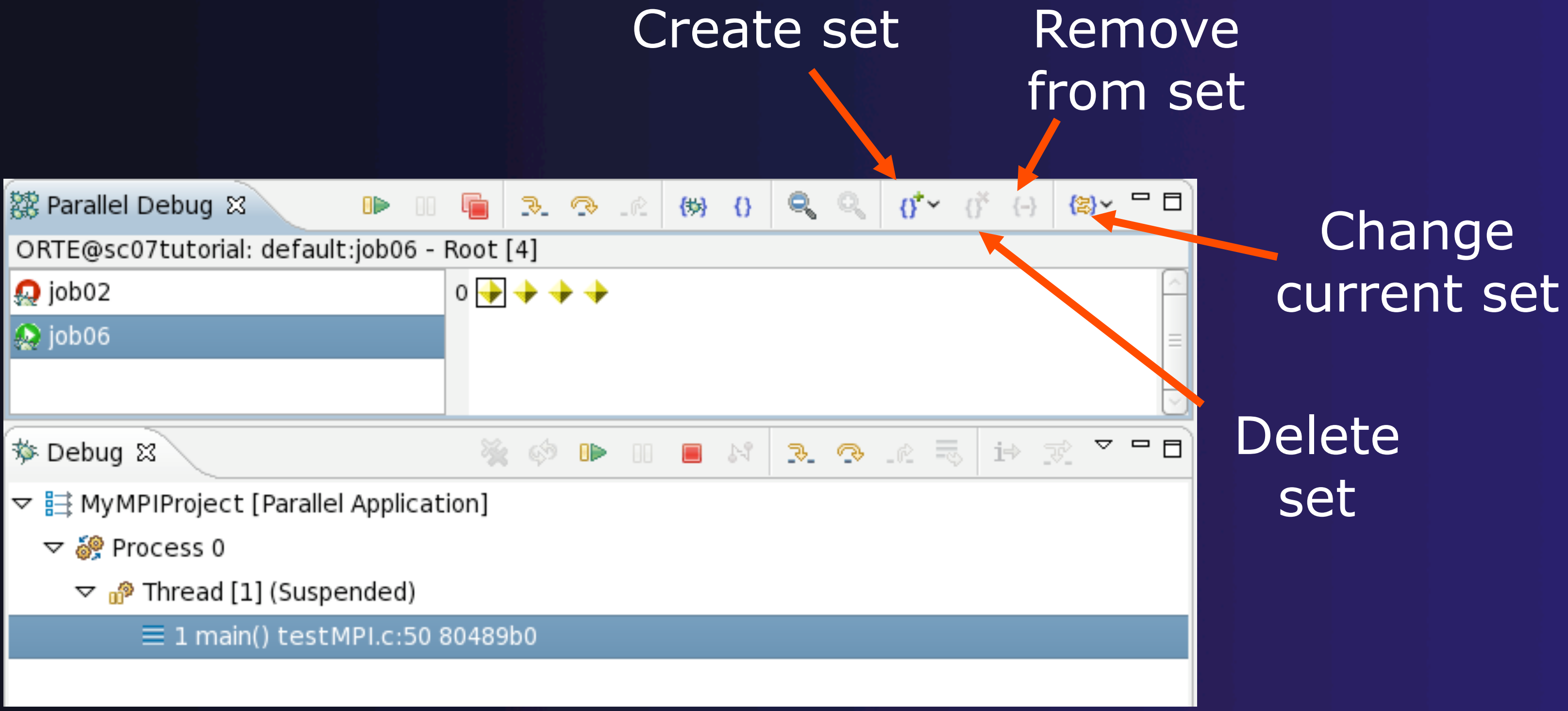

Parallel Debug
job02
job06
0
Debug
MyMPIProject [Parallel Application]
Process 0
Thread [1] (Suspended)
1 main() testMPI.c:50 80489b0

ORTE@sc07tutorial: default:job06 - Root [4]

Root set = all processes

Managing Process Sets

- The remaining icons in the toolbar of the **Parallel Debug view** allow you to create, modify, and delete process sets, and to change the current process set



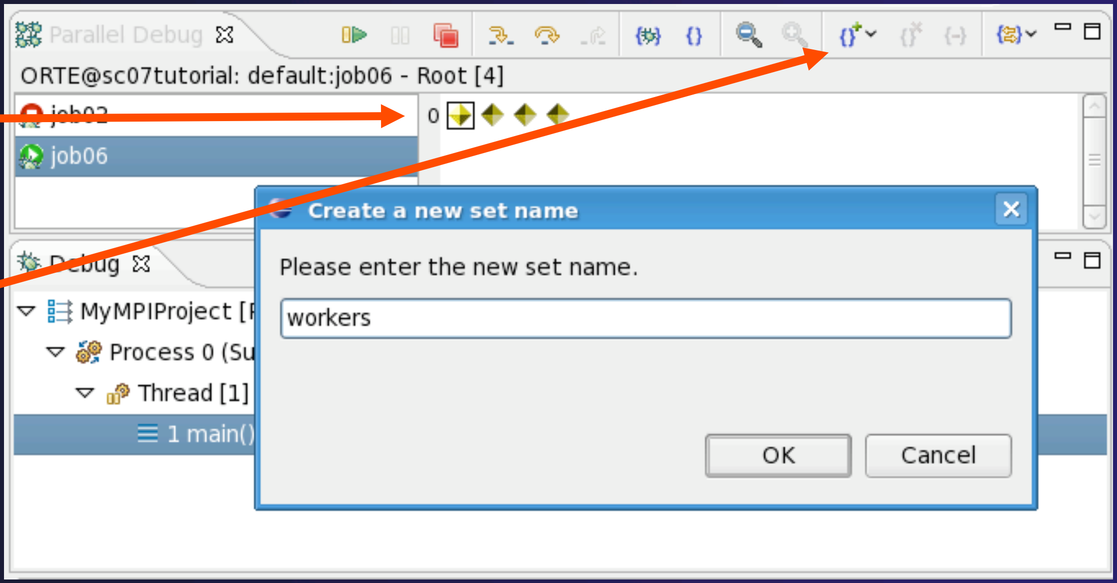
ORTE@sc07tutorial: default:job06 - Root [4]

job02
job06

MyMPIProject [Parallel Application]
Process 0
Thread [1] (Suspended)
1 main() testMPI.c:50 80489b0

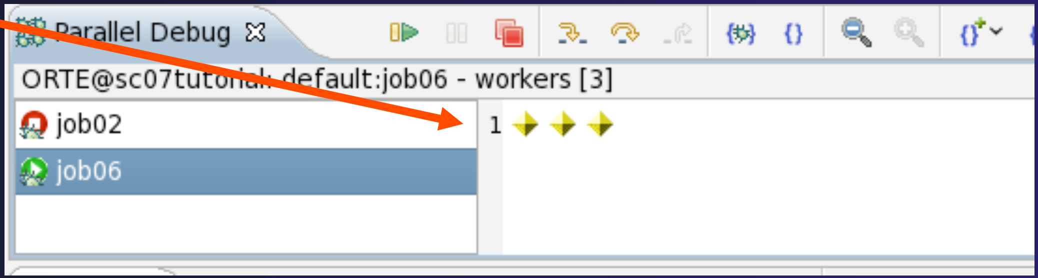
Creating A New Process Set

- Select the processes you want in the set by clicking and dragging, in this case, the last three
- Click on the **Create Set** button
- Enter a name for the set, in this case **workers**, and click **OK**
- You will see the view change to display only the selected processes



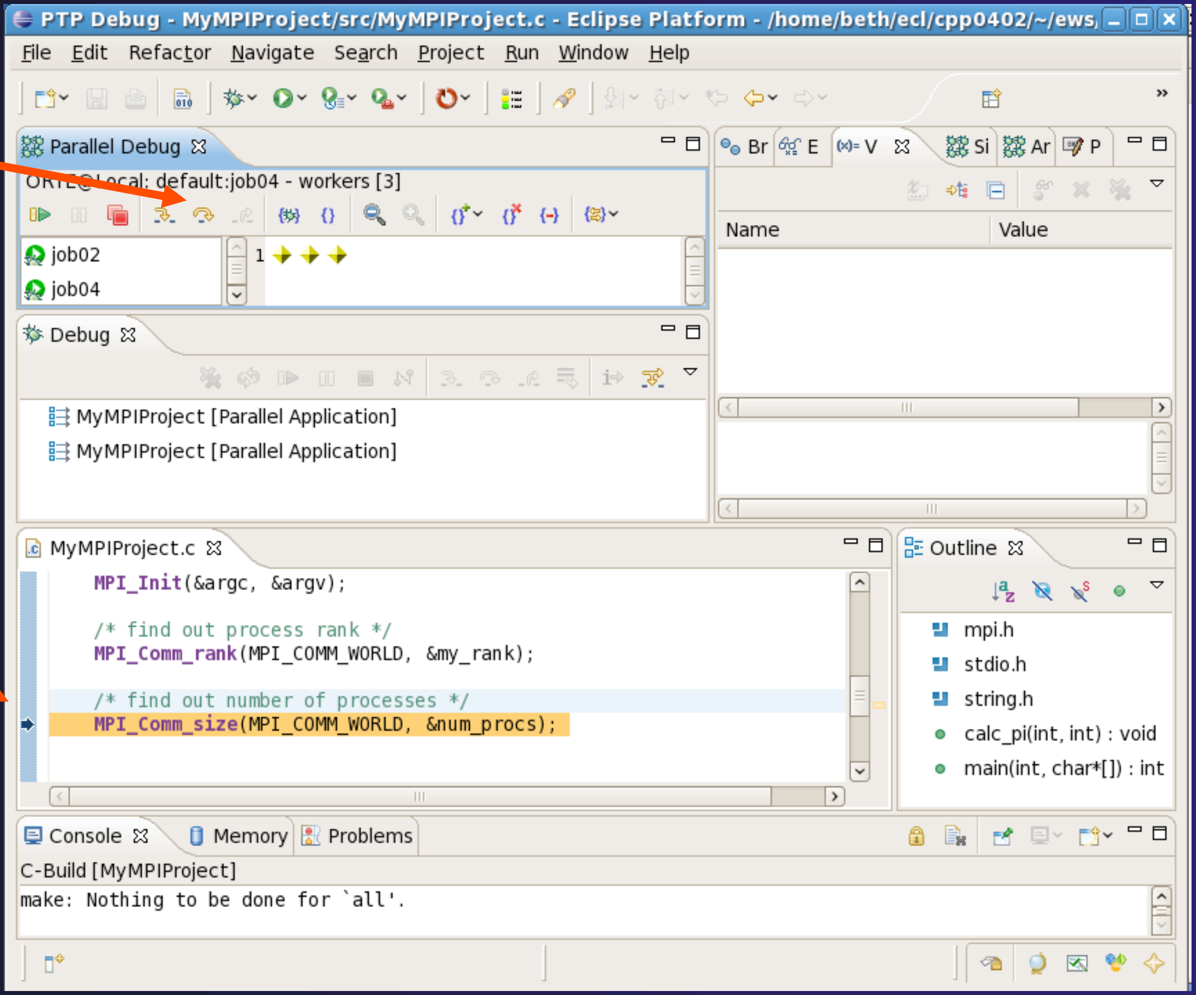
Please enter the new set name.

workers



Stepping Using New Process Set

- With the **workers** set active, click the **Step Over** button
- You will see only the first current line marker move
- If all processes are now at the same line, you will only see one line marker again


PTP Debug - MyMPIProject/src/MyMPIProject.c - Eclipse Platform - /home/beth/ecl/cpp0402/~/ews,
File Edit Refactor Navigate Search Project Run Window Help
Parallel Debug
ORTE@Local: default:job04 - workers [3]
job02
job04
1
Debug
MyMPIProject [Parallel Application]
MyMPIProject [Parallel Application]
Br E V Si Ar P
Name Value
MyMPIProject.c
Outline
mpi.h
stdio.h
string.h
calc_pi(int, int) : void
main(int, char*[]) : int
Console Memory Problems
C-Build [MyMPIProject]

```
    MPI_Init(&argc, &argv);

    /* find out process rank */
    MPI_Comm_rank(MPI_COMM_WORLD, &my_rank);

    /* find out number of processes */
    MPI_Comm_size(MPI_COMM_WORLD, &num_procs);
```

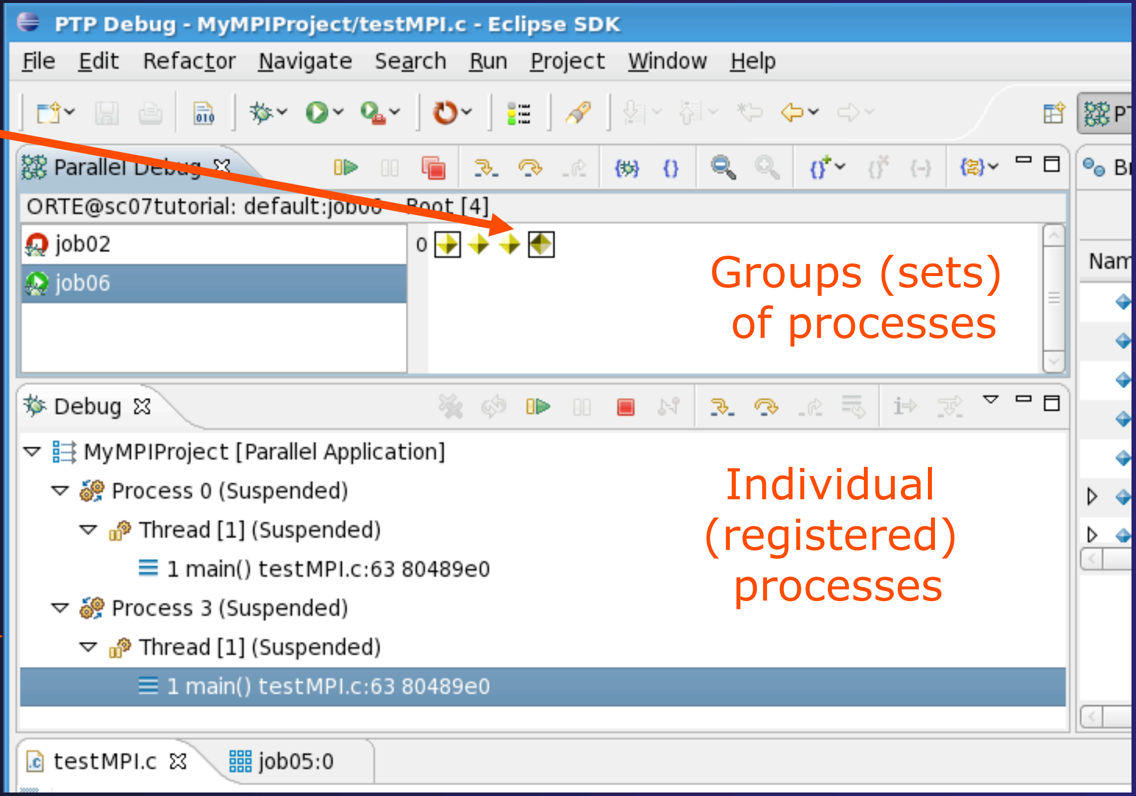
```
make: Nothing to be done for `all'.
```

Process Registration

- Process set commands apply to groups of processes
- For finer control and more detailed information, a process can be registered and isolated in the **Debug view**
- Registered processes, including their stack traces and threads, appear in the **Debug view**
- Any number of processes can be registered, and processes can be registered or un-registered at any time

Registering A Process

- To register a process, double-click its process icon in the **Parallel Debug view** or select a number of processes and click on the **register** button
- The process icon will be surrounded by a box and the process appears in the **Debug view**
- To un-register a process, double-click on the process icon or select a process icon or select a number of processes and click on the **unregister** button


PTP Debug - MyMPIProject/testMPI.c - Eclipse SDK
File Edit Refactor Navigate Search Run Project Window Help
Parallel Debug
ORTE@sc07tutorial: default:job06 - Root [4]
job02
job06
0
Groups (sets) of processes
Debug
Individual (registered) processes
testMPI.c
job05:0

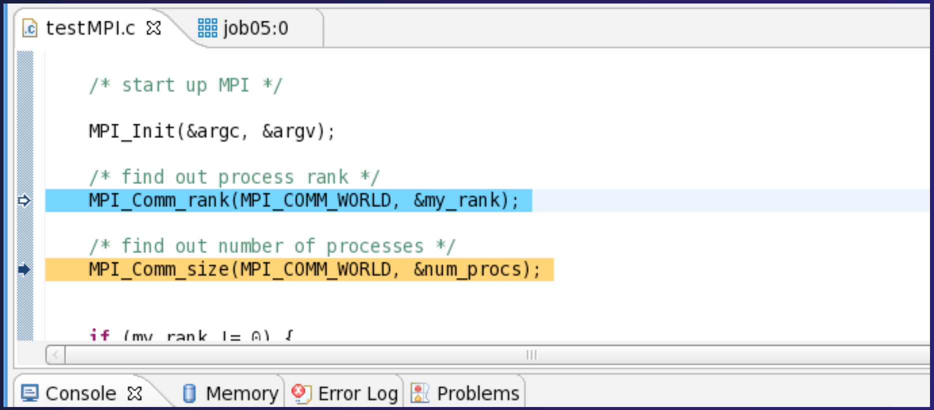
MyMPIProject [Parallel Application]
Process 0 (Suspended)
Thread [1] (Suspended)
1 main() testMPI.c:63 80489e0
Process 3 (Suspended)
Thread [1] (Suspended)
1 main() testMPI.c:63 80489e0

Current Line Marker

- The current line marker is used to show the current location of suspended processes
- In traditional programs, there is a single current line marker (the exception to this is multi-threaded programs)
- In parallel programs, there is a current line marker for every process
- The PTP debugger shows one current line marker for every group of processes at the same location

Colors And Markers

- The highlight color depends on the processes suspended at that line:
  - **Blue:** All registered process(es)
  - **Orange:** All unregistered process(es)
  - **Green:** Registered or unregistered process with no source line (e.g. suspended in a library routine)
- The marker depends on the type of process stopped at that location
- Hover over marker for more details about the processes suspend at that location

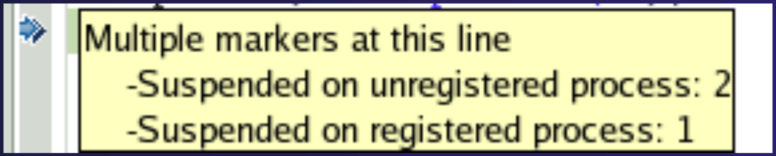


```
/* start up MPI */

MPI_Init(&argc, &argv);

/* find out process rank */
MPI_Comm_rank(MPI_COMM_WORLD, &my_rank);

/* find out number of processes */
MPI_Comm_size(MPI_COMM_WORLD, &num_procs);


if (my_rank != 0) {
```

Multiple processes marker

Registered process marker

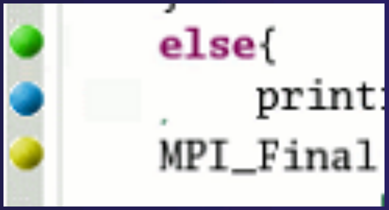
Un-registered process marker



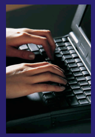
Multiple markers at this line
-Suspended on unregistered process: 2
-Suspended on registered process: 1

Breakpoints

- Apply only to processes in the particular set that is active in the **Parallel Debug view** when the breakpoint is created
- Breakpoints are colored depending on the active process set and the set the breakpoint applies to:
  - Green indicates the breakpoint set is the same as the active set.
  - Blue indicates some processes in the breakpoint set are also in the active set (i.e. the process sets overlap)
  - Yellow indicates the breakpoint set is different from the active set (i.e. the process sets are disjoint)
- When the job completes, the breakpoints are automatically removed

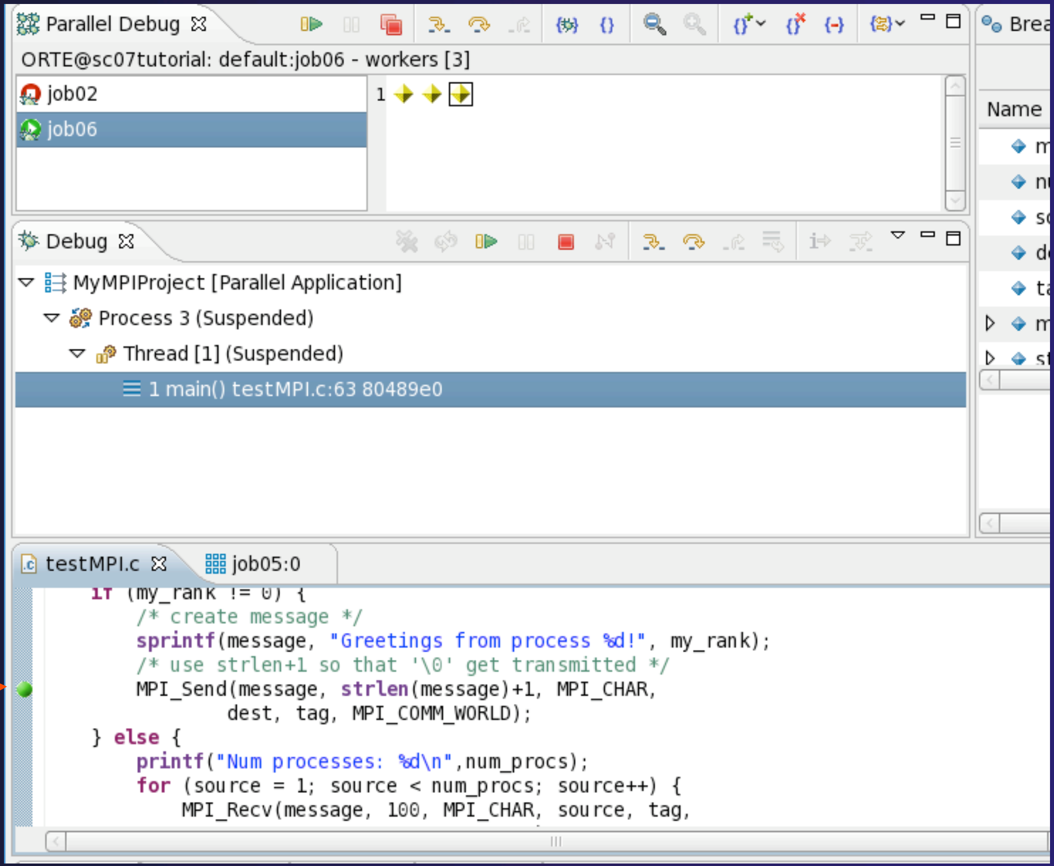


```
else{
    print
MPI_Final
```



Creating A Breakpoint

- Select the process set that the breakpoint should apply to, in this case, the **workers** set
- Double-click on the left edge of an editor window, at the line on which you want to set the breakpoint, or right click and use the **Parallel Breakpoint▶Toggle Breakpoint** context menu
- The breakpoint on the call to `MPI_Send()`

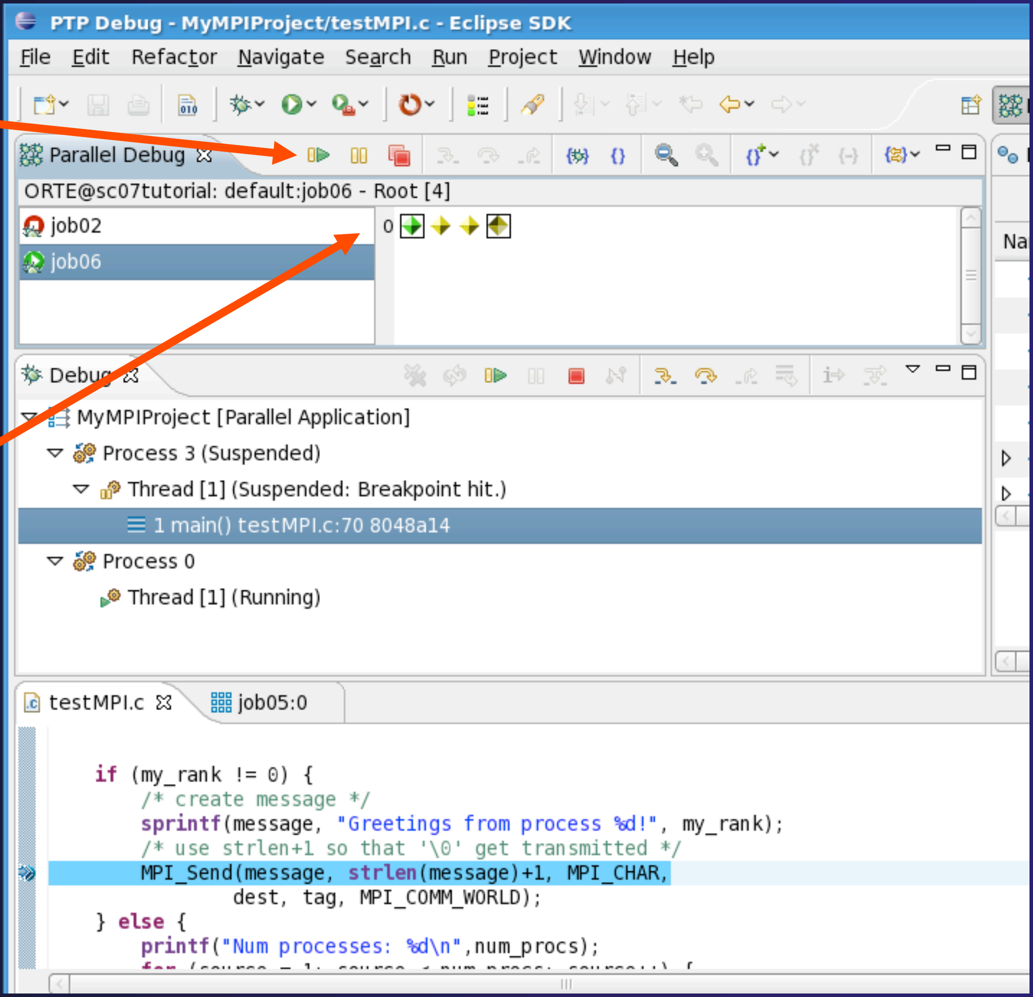


Parallel Debug
ORTE@sc07tutorial: default:job06 - workers [3]
job02
job06
1
Debug
MyMPIProject [Parallel Application]
Process 3 (Suspended)
Thread [1] (Suspended)
1 main() testMPI.c:63 80489e0
testMPI.c
job05:0
Brea
Name

```
    if (my_rank != 0) {
        /* create message */
        sprintf(message, "Greetings from process %d!", my_rank);
        /* use strlen+1 so that '\0' get transmitted */
        MPI_Send(message, strlen(message)+1, MPI_CHAR,
            dest, tag, MPI_COMM_WORLD);
    } else {
        printf("Num processes: %d\n",num_procs);
        for (source = 1; source < num_procs; source++) {
            MPI_Recv(message, 100, MPI_CHAR, source, tag,
```

Hitting the Breakpoint

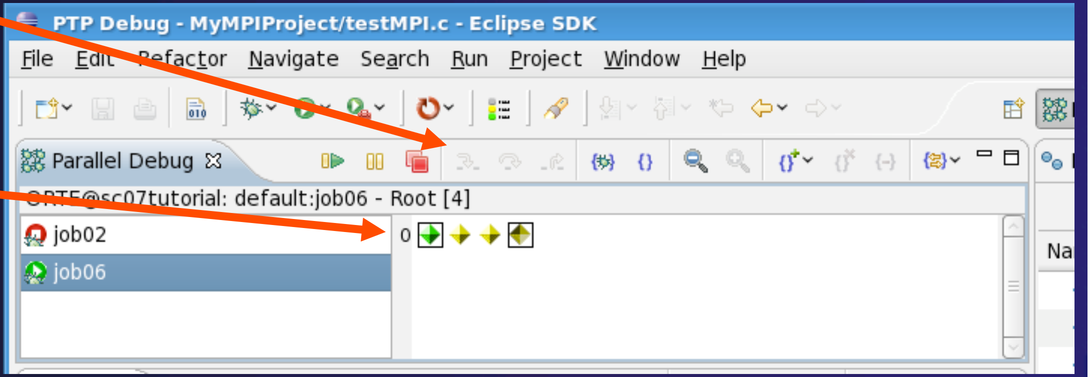
- Click on the **Resume** button in the **Parallel Debug view**
- In this example, the three worker processes have hit the breakpoint, as indicated by the yellow process icons and the current line marker
- Process 0 is still running as its icon is green


PTP Debug - MyMPIProject/testMPI.c - Eclipse SDK
File Edit Refactor Navigate Search Run Project Window Help
Parallel Debug
ORTE@sc07tutorial: default:job06 - Root [4]
job02
job06
0
Debug
MyMPIProject [Parallel Application]
Process 3 (Suspended)
Thread [1] (Suspended: Breakpoint hit.)
1 main() testMPI.c:70 8048a14
Process 0
Thread [1] (Running)
testMPI.c
job05:0

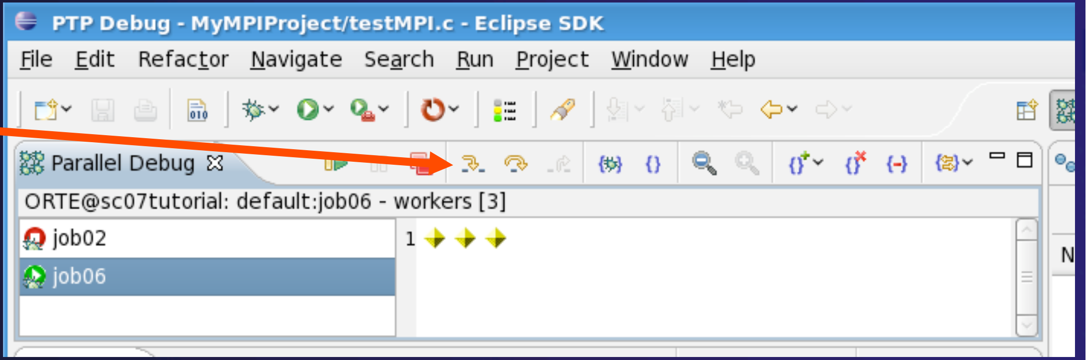
```
    if (my_rank != 0) {
        /* create message */
        sprintf(message, "Greetings from process %d!", my_rank);
        /* use strlen+1 so that '\0' get transmitted */
        MPI_Send(message, strlen(message)+1, MPI_CHAR,
                 dest, tag, MPI_COMM_WORLD);
    } else {
        printf("Num processes: %d\n",num_procs);
```

More On Stepping

- The **Step** buttons are only enabled when all processes in the active set are **suspended** (yellow icon)
- In this case, process 0 is still running

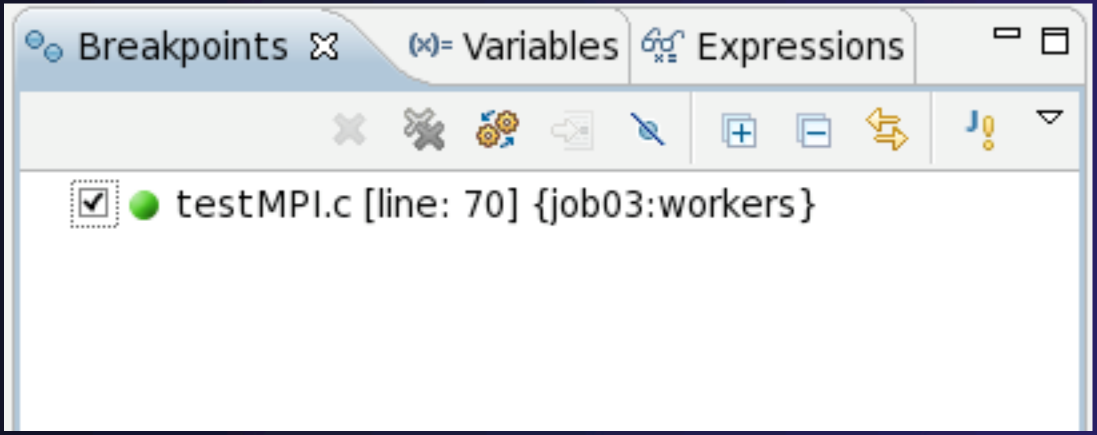

PTP Debug - MyMPIProject/testMPI.c - Eclipse SDK
File Edit Refactor Navigate Search Run Project Window Help
Parallel Debug
ORTE@sc07tutorial: default:job06 - Root [4]
job02
job06
0

- Switch to the set of suspended processes (the **workers** set)
- You will now see the **Step** buttons become enabled


PTP Debug - MyMPIProject/testMPI.c - Eclipse SDK
File Edit Refactor Navigate Search Run Project Window Help
Parallel Debug
ORTE@sc07tutorial: default:job06 - workers [3]
job02
job06
1

Breakpoint Information

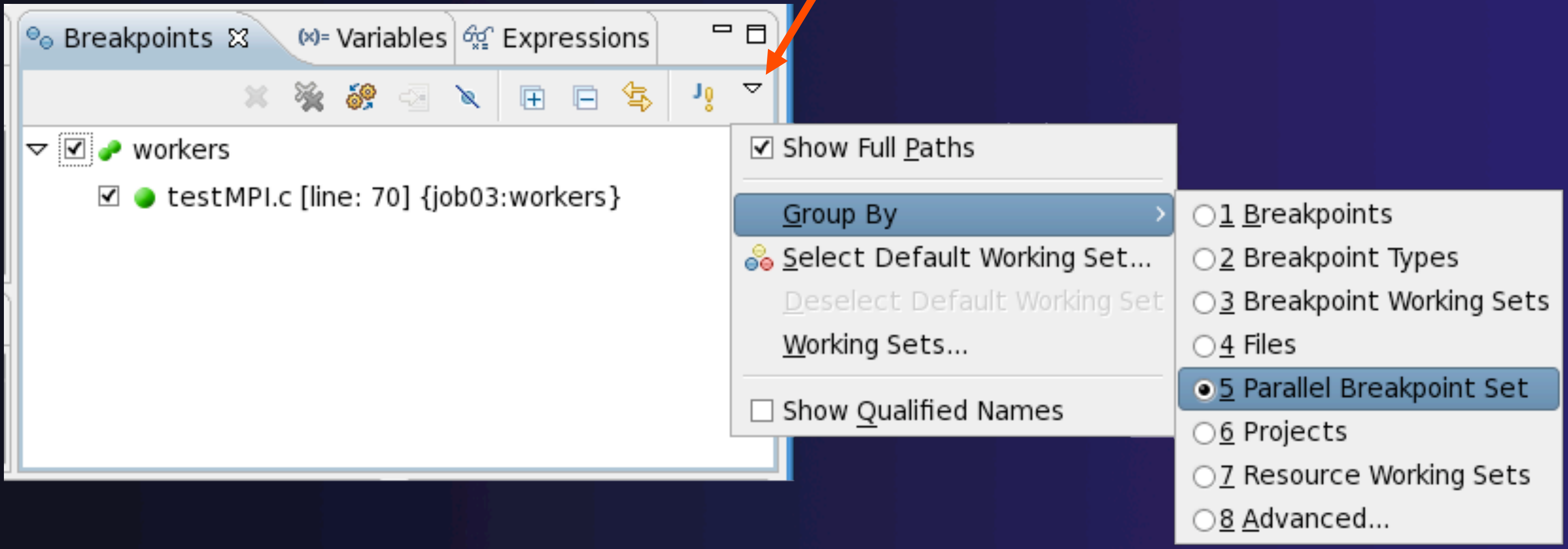
- Hover over breakpoint icon
  - Will show the sets this breakpoint applies to
- Select **Breakpoints** view
  - Will show all breakpoints in all projects



testMPI.c [line: 70] {job03:workers}

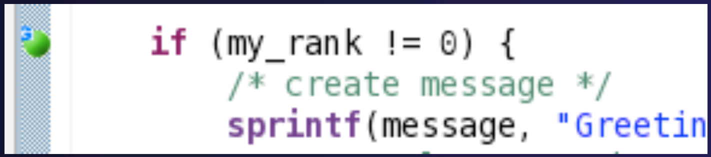
Breakpoints View

- Use the menu in the breakpoints view to group breakpoints by type
- Breakpoints sorted by breakpoint set (process set)



Global Breakpoints

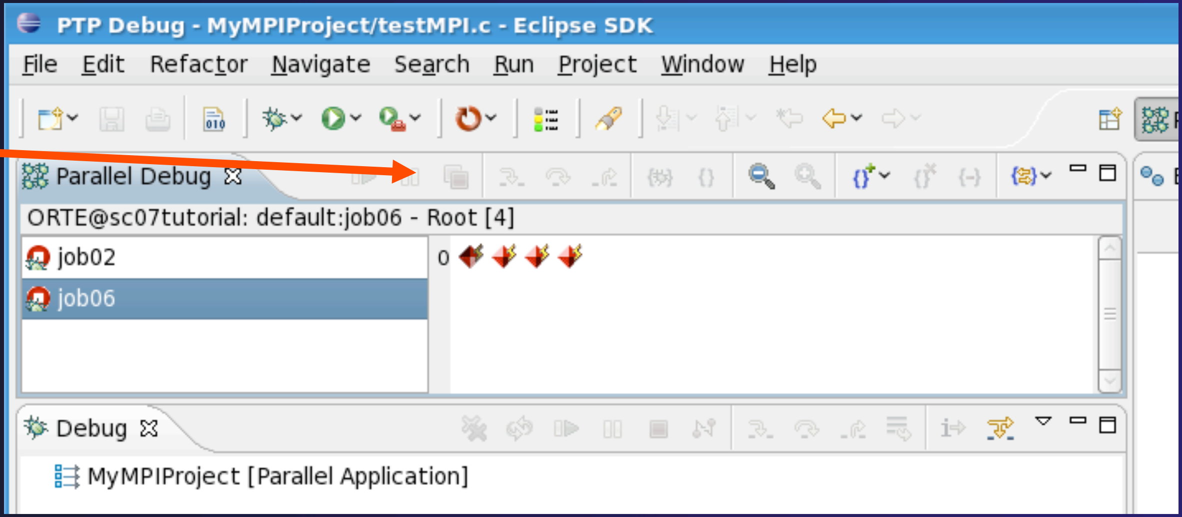
- Apply to all processes and all jobs
- Used for gaining control at debugger startup
- To create a global breakpoint
  - First make sure that no jobs are selected (click in white part of jobs view if necessary)
  - Double-click on the left edge of an editor window
  - Note that if a job is selected, the breakpoint will apply to the current set



```
    if (my_rank != 0) {
        /* create message */
        sprintf(message, "Greetin
```

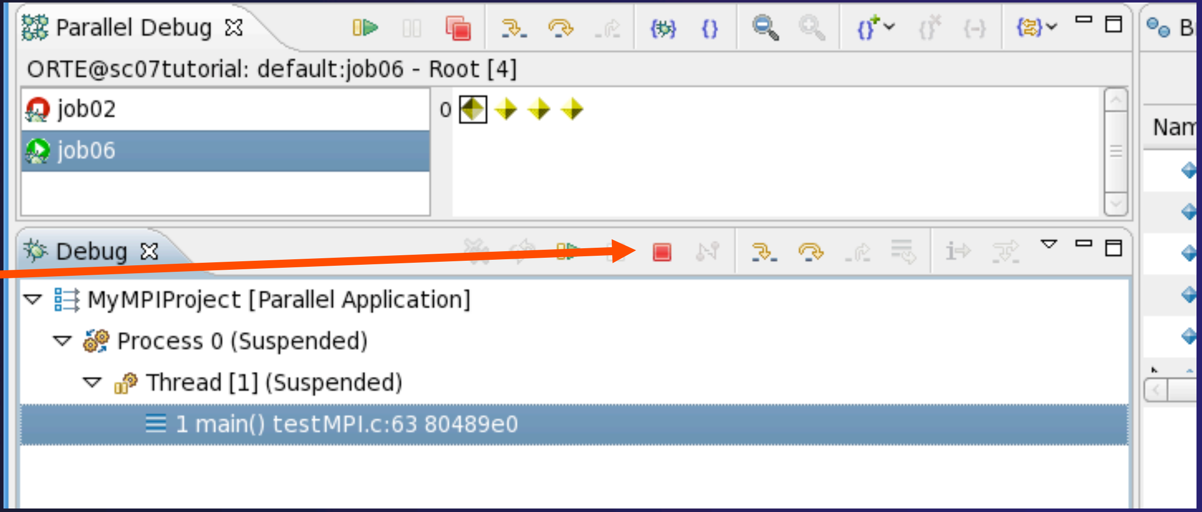
Terminating A Debug Session

- Click on the **Terminate** icon in the **Parallel Debug view** to terminate all processes in the active set
- Make sure the **Root** set is active if you want to terminate all processes


PTP Debug - MyMPIProject/testMPI.c - Eclipse SDK
File Edit Refactor Navigate Search Run Project Window Help
Parallel Debug
Debug

ORTE@sc07tutorial: default:job06 - Root [4]
job02
job06
MyMPIProject [Parallel Application]

- You can also use the terminate icon in the **Debug** view to terminate the currently selected process



ORTE@sc07tutorial: default:job06 - Root [4]
job02
job06
MyMPIProject [Parallel Application]
Process 0 (Suspended)
Thread [1] (Suspended)
1 main() testMPI.c:63 80489e0

Module 5: Advanced Development

- Objective
    - Explore advanced features of Eclipse and PTP
- Contents
    - Advanced Eclipse Features
    - Advanced PTP Features

Advanced Eclipse Concepts

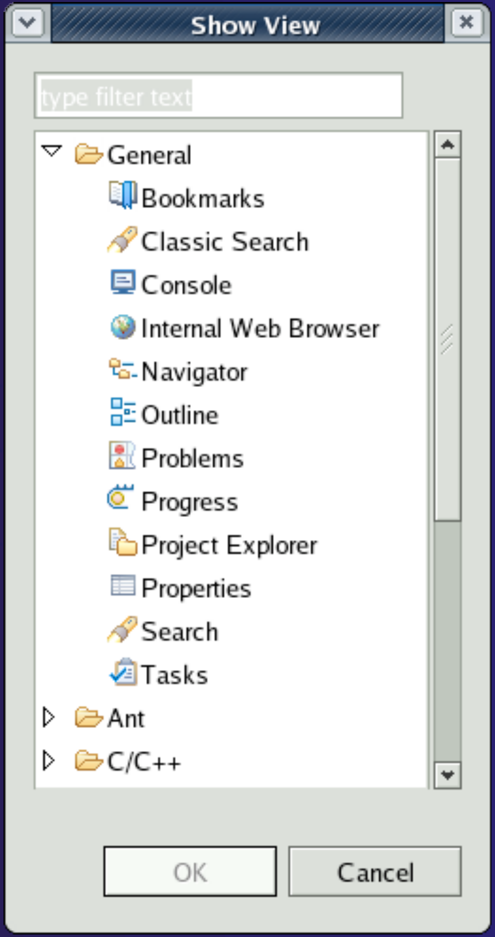
- Perspectives, views and preferences
- Version control
- Makefiles and autoconf
- Task Tags
- Searching
- Refactoring

Customizing Perspectives

- Items such as shortcuts, menu items and views may be customized
  - **Window▸Customize Perspective…**
- Save changes
  - **Window▸Save Perspective As…**
- Close Perspective
  - Right-click on perspective title and select **Close**
- Reset Perspective
  - **Window▸Reset Perspective** resets the current perspective to its default layout

Opening New Views

- To open a view:
  - Choose **Window▶Show View▶Other…**
  - The **Show View** dialog comes up
  - Select the view to be shown
  - Select **OK**

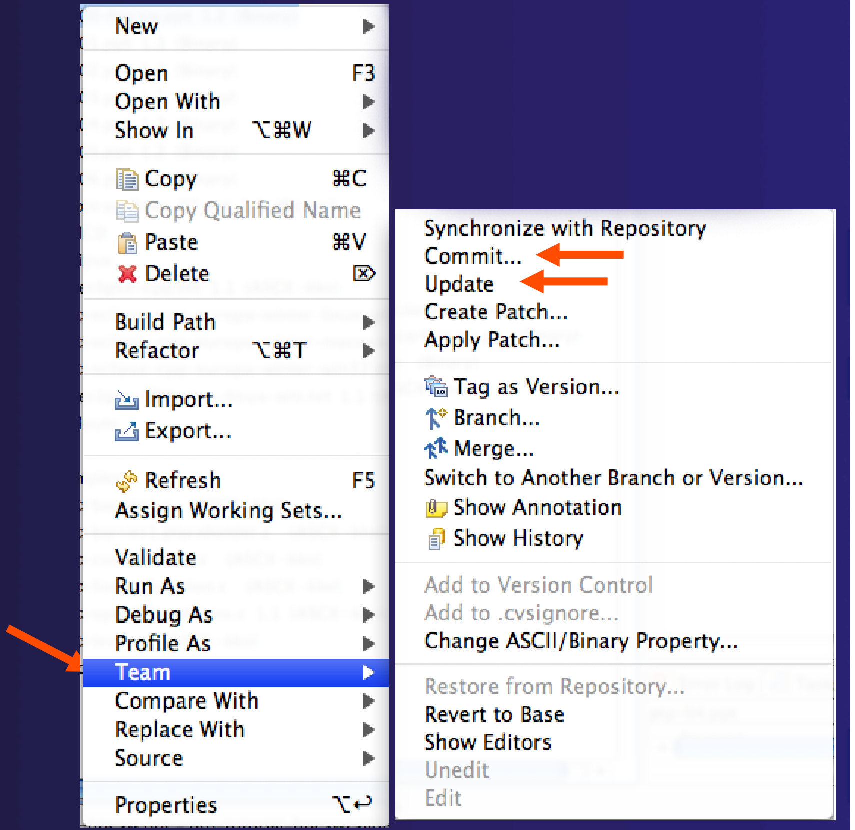


Workbench Preferences

- Preferences provide a way for you to customize your Workbench
  - By selecting **Window▶Preferences…** or **Eclipse▶Preferences…** (Mac)
- Examples of preference settings
  - Use Emacs bindings for editor **keys**
  - Modify editor folding defaults
    - E.g., fold all macro definitions
  - Associate file types with file extensions
    - E.g., *.f03 with the Fortran editor
  - Toggle automatic builds
  - Change key sequence shortcuts
    - E.g., Ctrl+/ for Comment

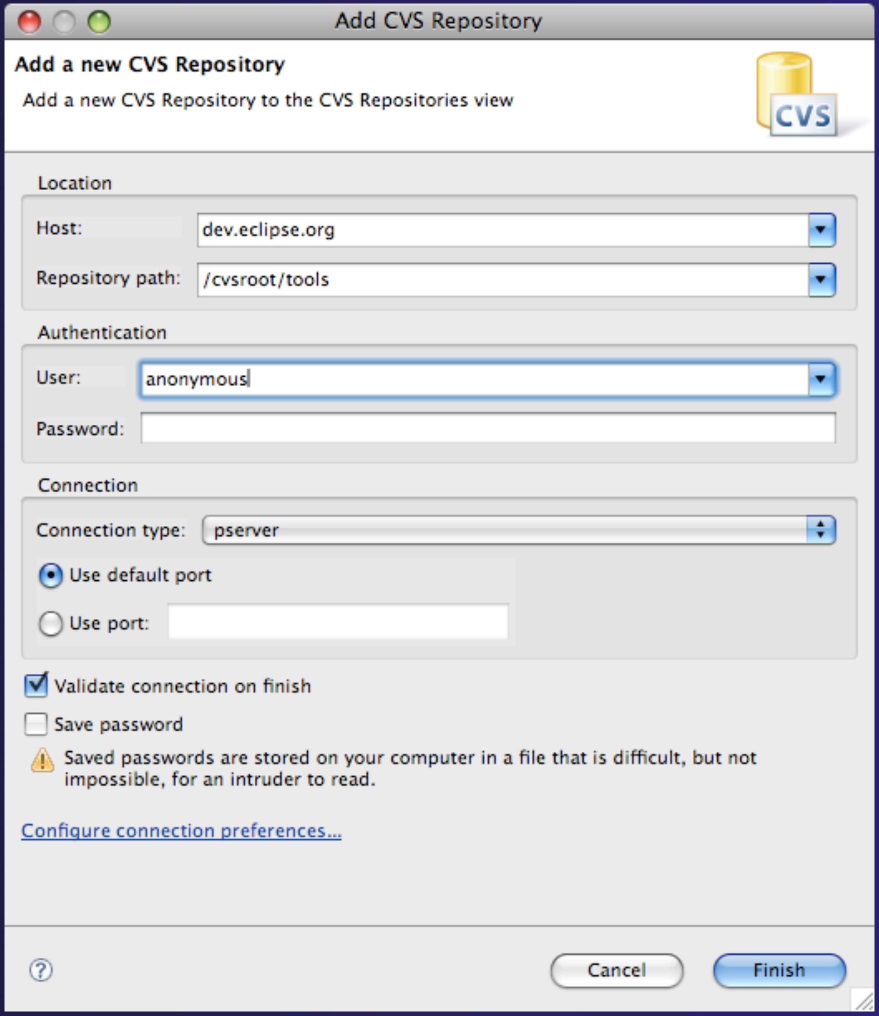
Version Control (CVS)

- Version control provided through the **Project Explorer View**, in the **Team** context menu
- Provides familiar actions:
  - Commit…
  - Update…
- Also less used tasks:
  - Create/Apply Patch…
  - Tag as Version
  - Branch…
  - Merge…
  - Add to .cvsignore…



Specify Repository Locations

- Select **Window▶Open Perspective▶Other…**
- Select **CVS Repository Exploring** then **OK**
- Right-click in **CVS Repositories View**, then select **New▶Repository Location…**
- Set **Host** to the hostname of remote machine
- Set **Repository path**
- Fill in **Username** and **Password**
- Set **Connection type**
- Check **Save password**
- Select **Finish**



Add a new CVS Repository

Add a new CVS Repository to the CVS Repositories view

Location

Host: dev.eclipse.org

Repository path: /cvsroot/tools

Authentication

User: anonymous

Password:

Connection

Connection type: pserver

[✓ Use default port]

Use port:

[✓] Validate connection on finish

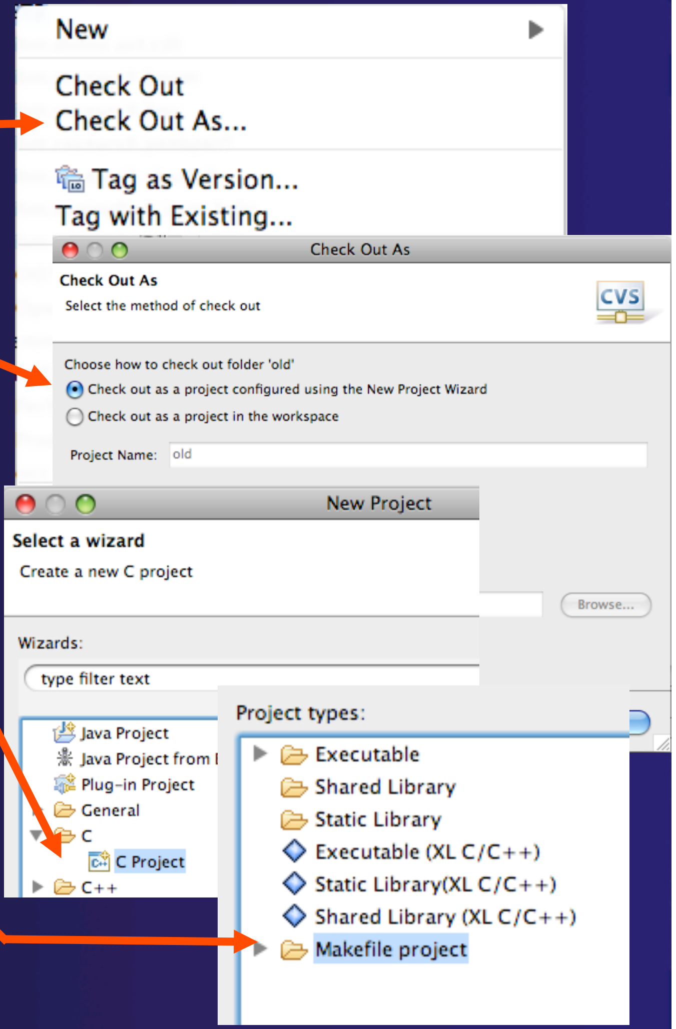
[ ] Save password

Saved passwords are stored on your computer in a file that is difficult, but not impossible, for an intruder to read.

Configure connection preferences...

Checkout a non-Eclipse project as an Eclipse C Project

- Open Repository, open HEAD
  - Locate project, right-click on **Project▶Check out As…**
    - Make sure **Check out as a project configured using the New Project Wizard** is selected
  - Select **Finish**
  - Select **C▶C project**
  - Select **Next>**
- Enter **Project name**
- Under **Project Types**, select **Makefile project**
  - Ensures that CDT will use existing makefiles
- Select **Finish**
- Switch to the **C/C++ Perspective**

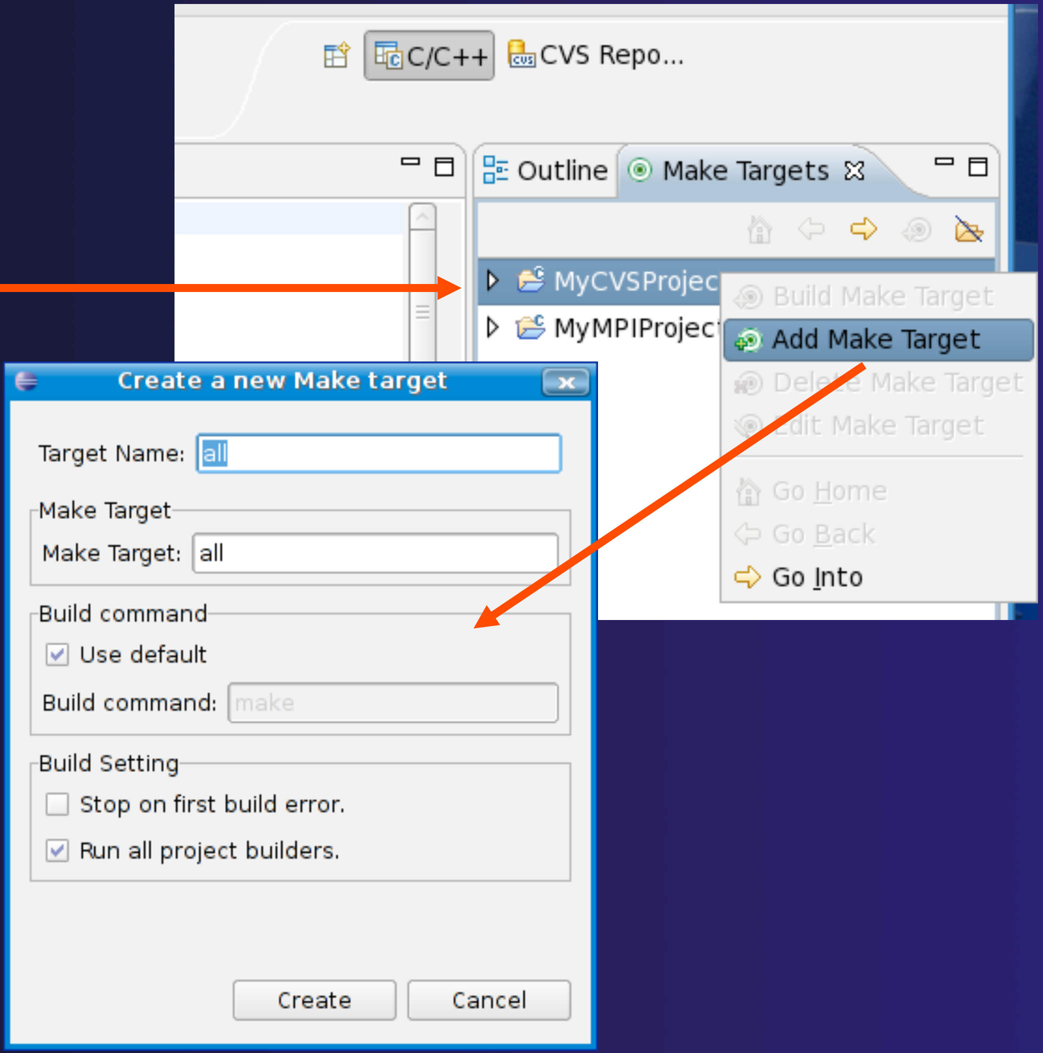


About Makefiles and autoconf

- Can create project Makefiles with the Makefile Editor
  - Syntax highlighting and Outline view
- `autoconf` often used to create Makefiles for open source projects
- Run `configure` manually, or from External Tools Launch Configuration
  - Must refresh after running `configure` script
- Refresh whenever file system is modified outside of Eclipse

Building with Makefiles

- Create a Make Target named 'all'
  - Right-click on the project in **Make Targets View**
  - Select **Add Make Target**
- Select **Create**
- Double click on new make target to initiate the build



Target Name: all

Make Target

Make Target: all

Build command

☑ Use default

Build command: make

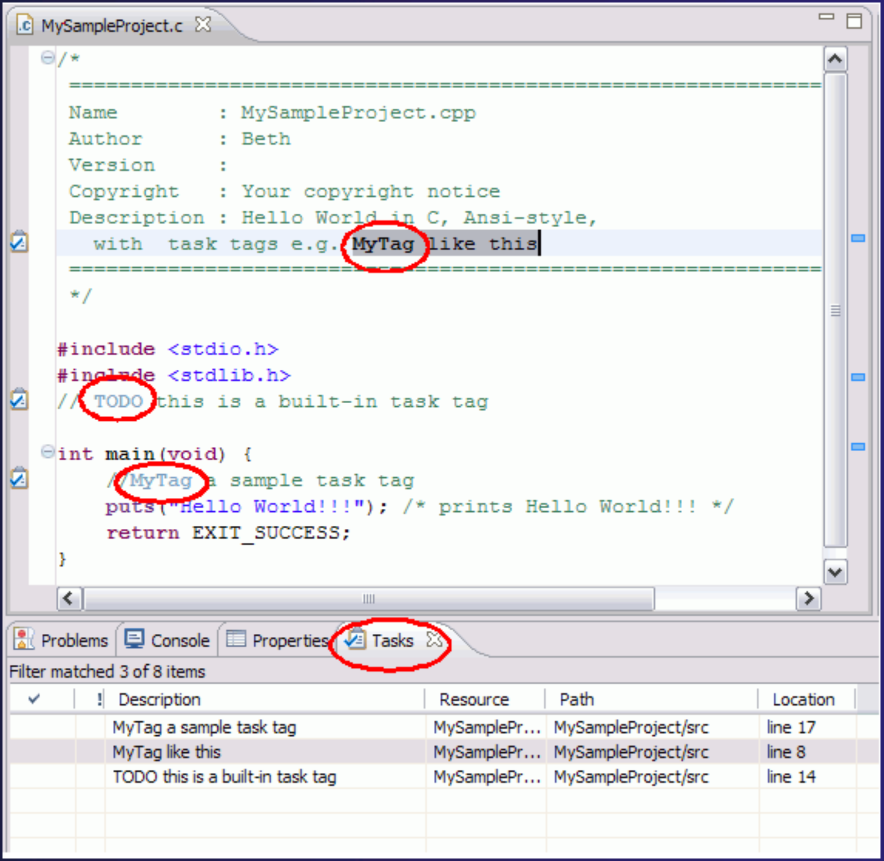
Build Setting

☐ Stop on first build error.

☑ Run all project builders.

Task Tags

- Task tags are identifiers in C/C++ comments
- TODO is a built-in task tag
- The build locates task tags during compilation
- View task tags in Tasks View
  - If it's not shown, **Window ▶ Show View ▶ Other…** Open **General** and select **Tasks**
- Configure your own task tag in **Window ▶ Preferences**
  - Under C/C++, select Task Tags



MySampleProject.c

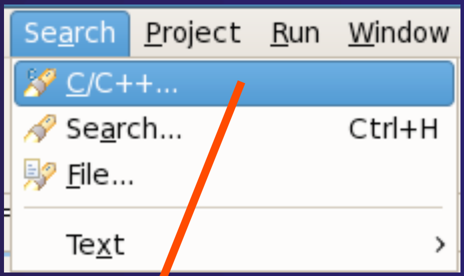
```
/*
 ============================================================
 Name        : MySampleProject.cpp
 Author      : Beth
 Version     :
 Copyright   : Your copyright notice
 Description : Hello World in C, Ansi-style,
   with  task tags e.g. MyTag like this
 ============================================================
 */

#include <stdio.h>
#include <stdlib.h>
// TODO this is a built-in task tag

int main(void) {
	//MyTag a sample task tag
	puts("Hello World!!!"); /* prints Hello World!!! */
	return EXIT_SUCCESS;
}
```

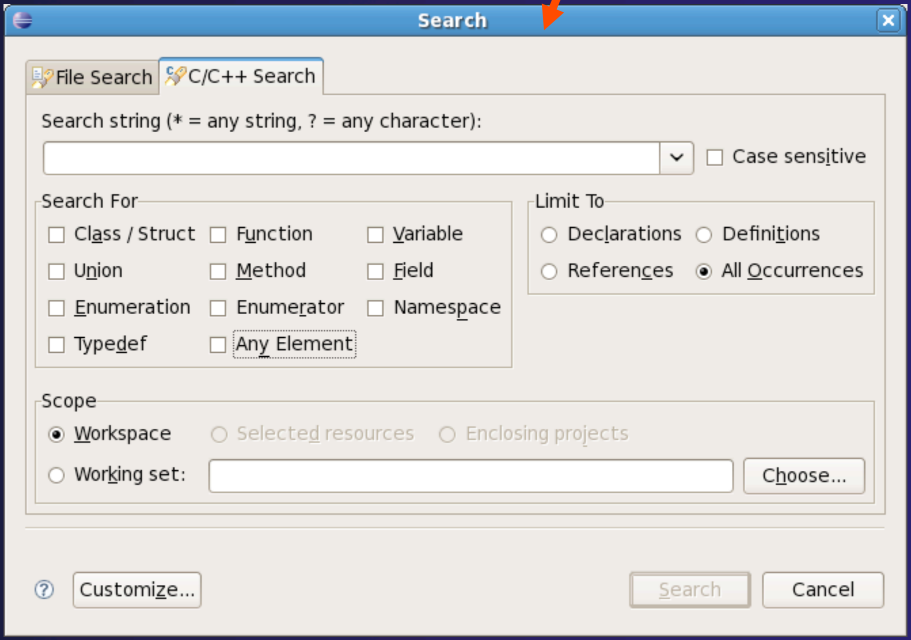
Filter matched 3 of 8 items

✓	!	Description	Resource	Path	Location
		MyTag a sample task tag	MySamplePr…	MySampleProject/src	line 17
		MyTag like this	MySamplePr…	MySampleProject/src	line 8
		TODO this is a built-in task tag	MySamplePr…	MySampleProject/src	line 14

Searching

- Language-based searching
- Search for Language Elements
  - e.g., C++ Class, Function, Method, Variable, Field, Namespace
- Can Limit search to Declarations, Definitions, References
- Type navigation




Search

File Search | C/C++ Search

Search string (* = any string, ? = any character):

[ ] Case sensitive

Search For

[ ] Class / Struct	[ ] Function	[ ] Variable
[ ] Union	[ ] Method	[ ] Field
[ ] Enumeration	[ ] Enumerator	[ ] Namespace
[ ] Typedef	[ ] Any Element	

Limit To

○ Declarations	○ Definitions
○ References	● All Occurrences

Scope

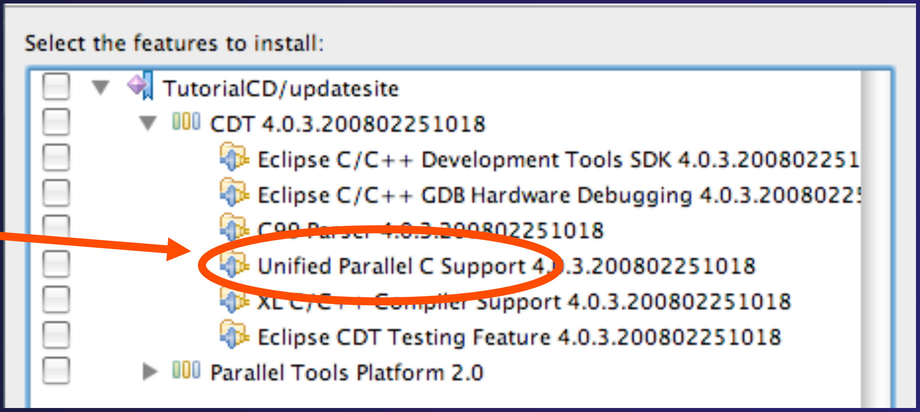
● Workspace ○ Selected resources ○ Enclosing projects

○ Working set: Choose...

Customize... Search Cancel

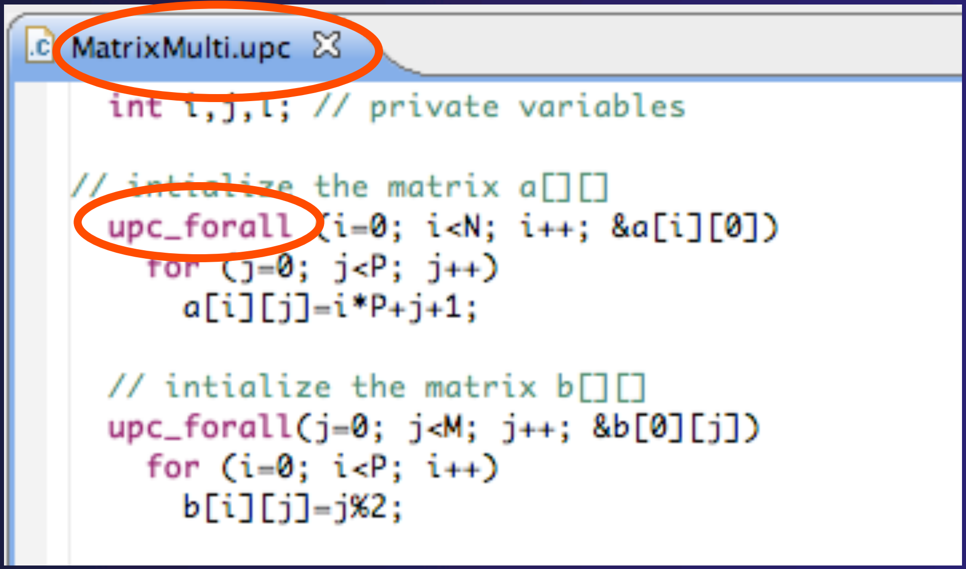
UPC Support

- To see UPC support in C editor, install the optional feature from CDT
- Filetypes of “upc” will get UPC syntax high-lighting, content assist, etc.



Select the features to install:

```
TutorialCD/updatesite
  CDT 4.0.3.200802251018
    Eclipse C/C++ Development Tools SDK 4.0.3.200802251
    Eclipse C/C++ GDB Hardware Debugging 4.0.3.2008022
    C99 Parser 4.0.3.200802251018
    Unified Parallel C Support 4.0.3.200802251018
    XL C/C++ Compiler Support 4.0.3.200802251018
    Eclipse CDT Testing Feature 4.0.3.200802251018
  Parallel Tools Platform 2.0
```

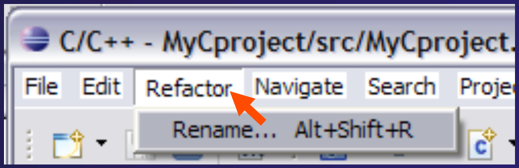


MatrixMulti.upc

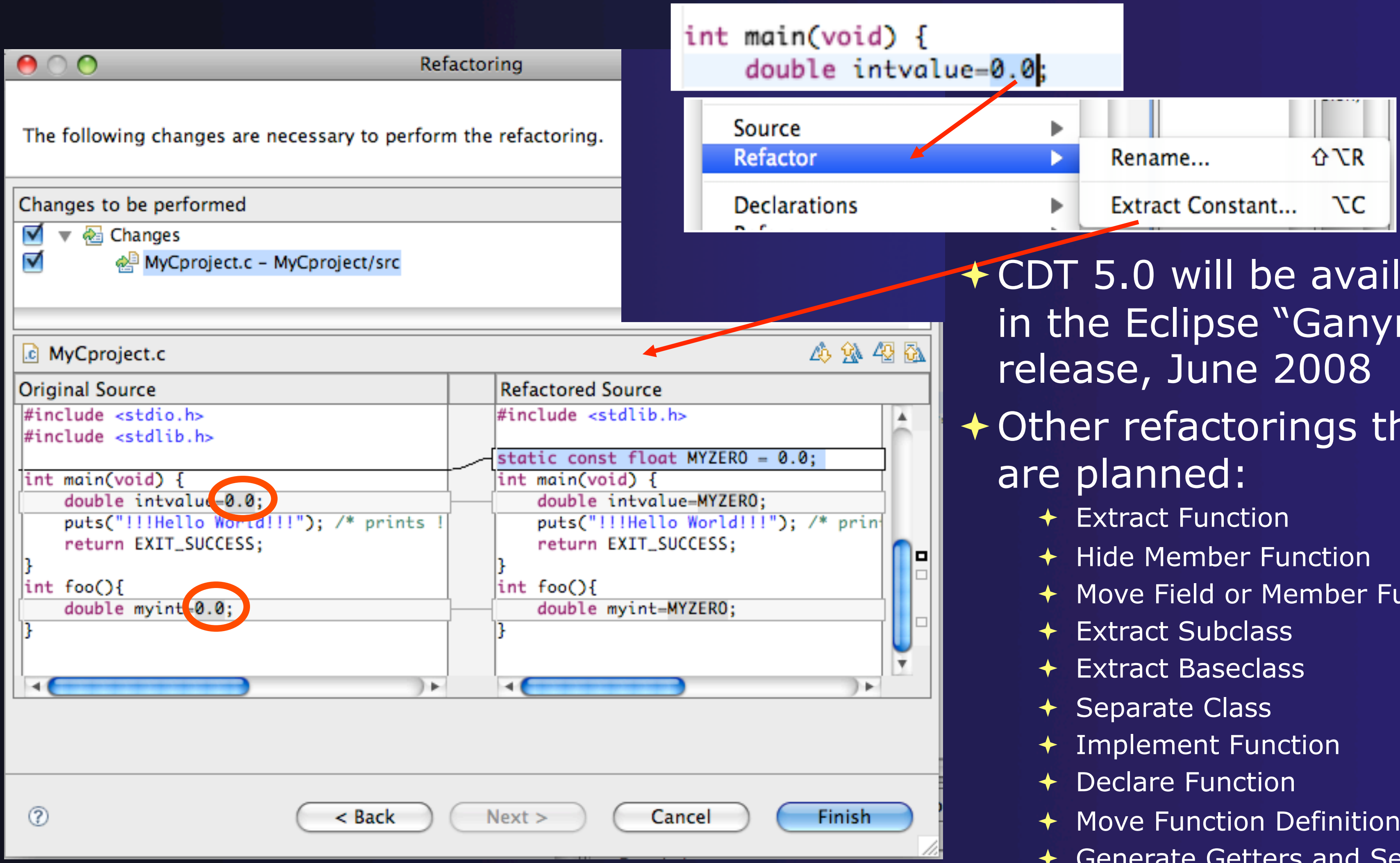
```
 int i,j,l; // private variables

// initialize the matrix a[][]
 upc_forall (i=0; i<N; i++; &a[i][0])
   for (j=0; j<P; j++)
     a[i][j]=i*P+j+1;

 // intialize the matrix b[][]
 upc_forall(j=0; j<M; j++; &b[0][j])
   for (i=0; i<P; i++)
     b[i][j]=j%2;
```

Refactoring

- Source-to-source transformation that preserves behavior
- Rename
  - Select **C/C++ Perspective**
  - Open a source file
  - Click in editor view on declaration of a variable
  - Select menu item **Refactor▸Rename**
    - Or use context menu
  - Change variable name
  - Notice that change is semantic not textual



CDT 5.0 Refactoring: Extract Constant



```
int main(void) {
    double intvalue=0.0;
```

The following changes are necessary to perform the refactoring.

Changes to be performed

- ✓ Changes
  - ✓ MyCproject.c – MyCproject/src

MyCproject.c

Original Source

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

int main(void) {
    double intvalue=0.0;
    puts("!!!Hello World!!!"); /* prints !
    return EXIT_SUCCESS;
}
int foo(){
    double myint=0.0;
}
```

Refactored Source

```
#include <stdlib.h>

static const float MYZERO = 0.0;
int main(void) {
    double intvalue=MYZERO;
    puts("!!!Hello World!!!"); /* prin
    return EXIT_SUCCESS;
}
int foo(){
    double myint=MYZERO;
}
```

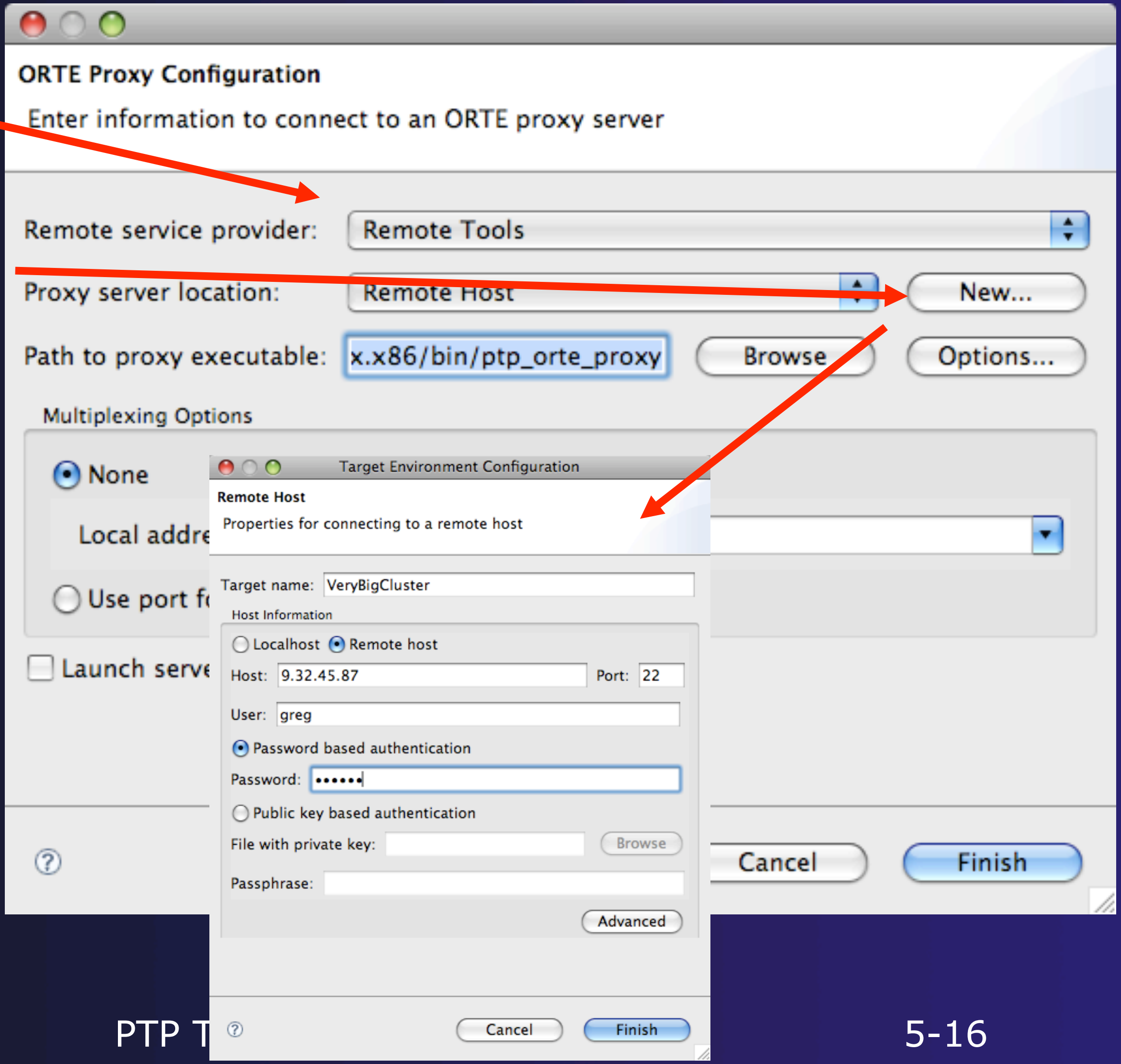
- CDT 5.0 will be available in the Eclipse "Ganymede" release, June 2008
- Other refactorings that are planned:
  - Extract Function
  - Hide Member Function
  - Move Field or Member Function
  - Extract Subclass
  - Extract Baseclass
  - Separate Class
  - Implement Function
  - Declare Function
  - Move Function Definition
  - Generate Getters and Setters

Advanced PTP Concepts

- Remote resource managers
- Debugging remotely
- MPICH2, IBM PE and LoadLeveler

Remote Resource Manager

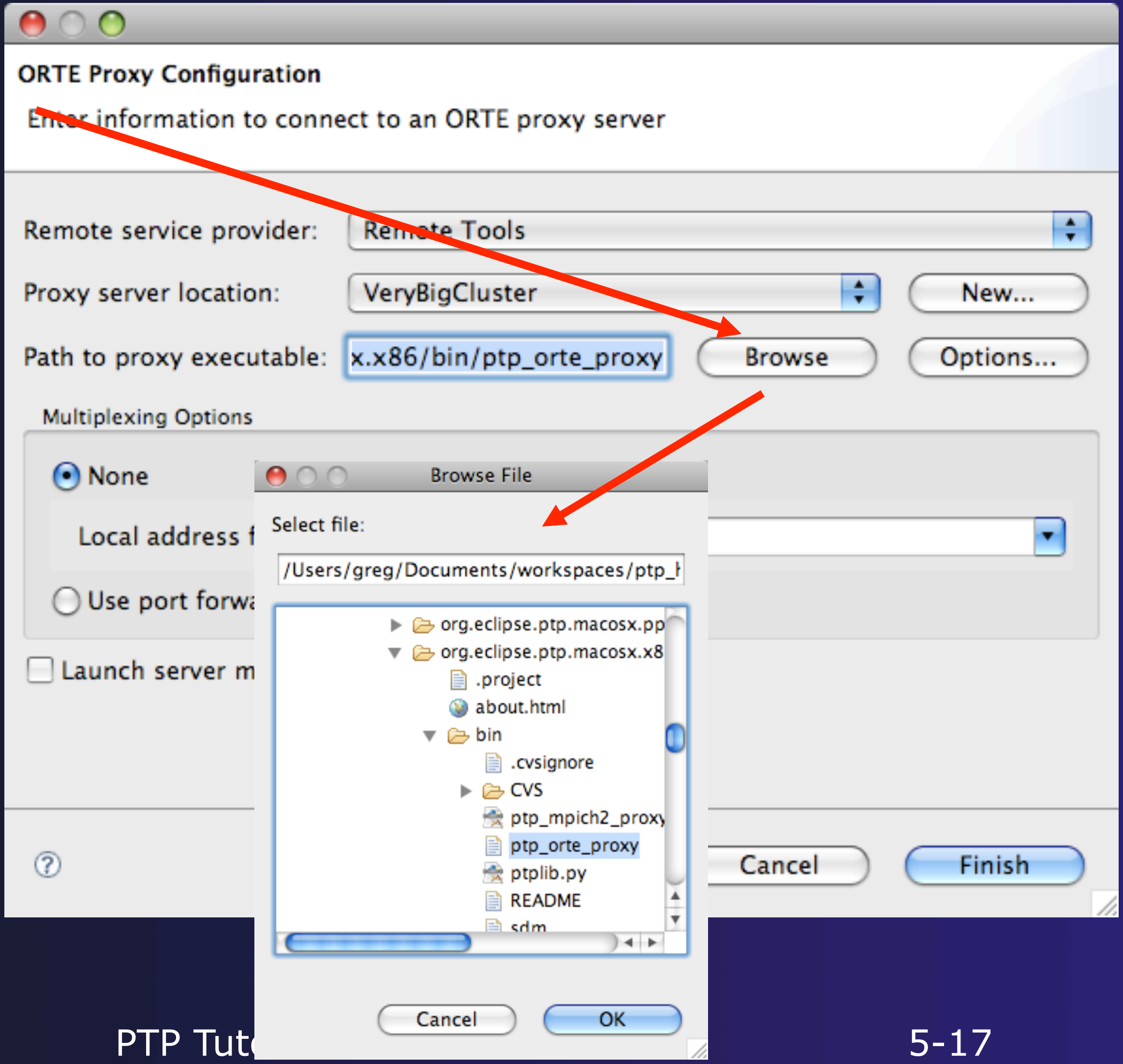
- Select **Remote Tools** as the **Remote service provider**
- Click **New…** to create a new location
- Enter a **Target Name**, IP address or host name of the remote machine, and credentials
- Select **Finish**
- Select the **Target Name** you just created for **Proxy server location** if it is not visible in the dropdown


ORTE Proxy Configuration
Enter information to connect to an ORTE proxy server
Remote service provider: Remote Tools
Proxy server location: Remote Host
Path to proxy executable: x.x86/bin/ptp_orte_proxy
Multiplexing Options
None
Local addre
Use port f
Launch serve

Target Environment Configuration
Remote Host
Properties for connecting to a remote host
Target name: VeryBigCluster
Host Information
Localhost [✓ Remote host]
Host: 9.32.45.87 Port: 22
User: greg
[✓ Password based authentication]
Password: ••••••
Public key based authentication
File with private key:
Passphrase:

Select Proxy Agent

- Click **Browse** to select the proxy server executable
- Open **Root** twisty
- Now navigate to and select the proxy executable
- Click **OK**



ORTE Proxy Configuration

Enter information to connect to an ORTE proxy server

Remote service provider: Remote Tools

Proxy server location: VeryBigCluster

Path to proxy executable: x.x86/bin/ptp_orte_proxy

Multiplexing Options

[✓ None]

Local address f

Use port forwa

Launch server m

Browse File

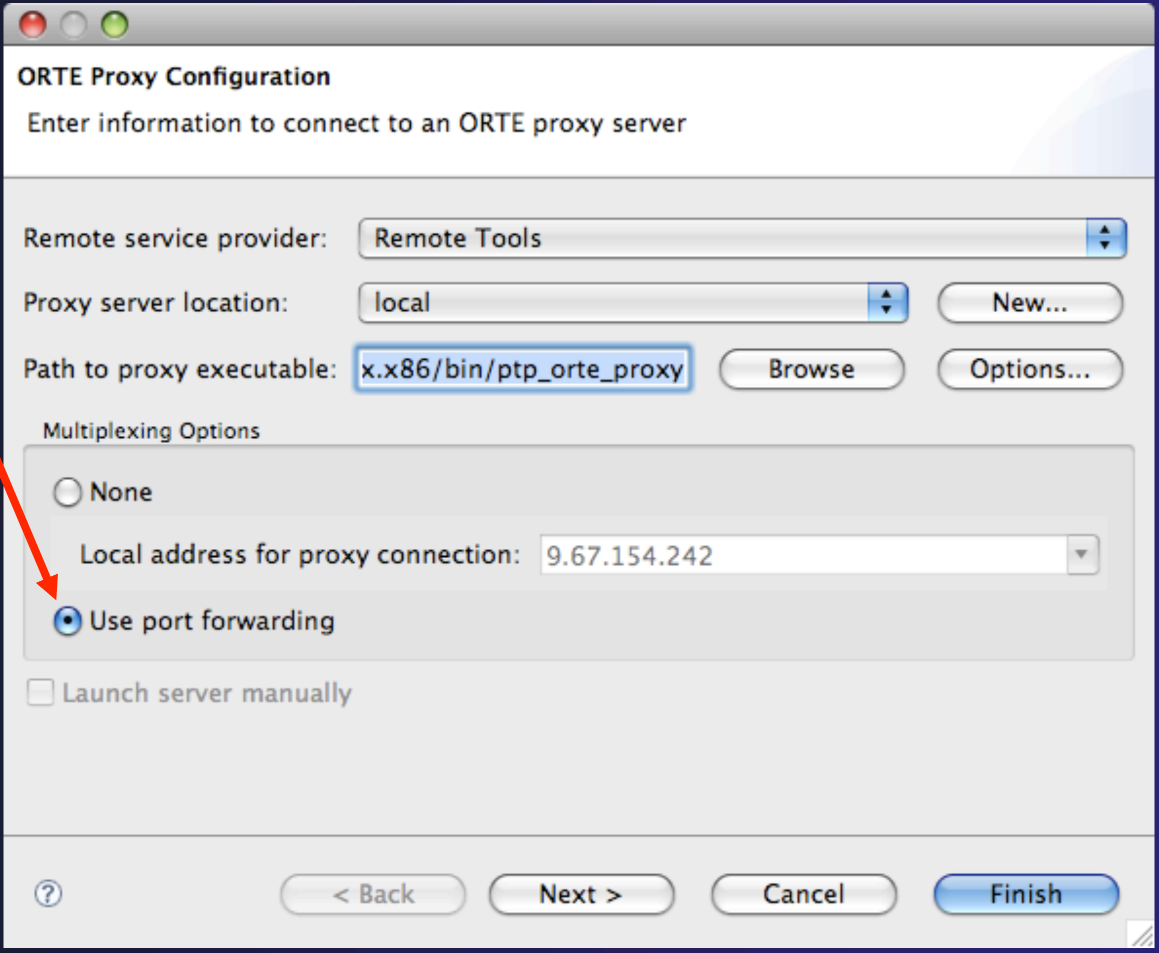
Select file:

/Users/greg/Documents/workspaces/ptp_h

```
▶ org.eclipse.ptp.macosx.pp
▼ org.eclipse.ptp.macosx.x8
    .project
    about.html
  ▼ bin
      .cvsignore
    ▶ CVS
      ptp_mpich2_proxy
      ptp_orte_proxy
      ptplib.py
      README
      sdm
```

Using Port Forwarding

- Port forwarding can be enabled to tunnel all communication over a single connection
- If you don't want to use port forwarding, your local machine must be accessible from the remote machine
  - Select your local machine's IP address from the dropdown
  - Enter it manually if it's not visible
- Click **Finish**



ORTE Proxy Configuration

Enter information to connect to an ORTE proxy server

Remote service provider: Remote Tools

Proxy server location: local

Path to proxy executable: x.x86/bin/ptp_orte_proxy

Multiplexing Options

( ) None

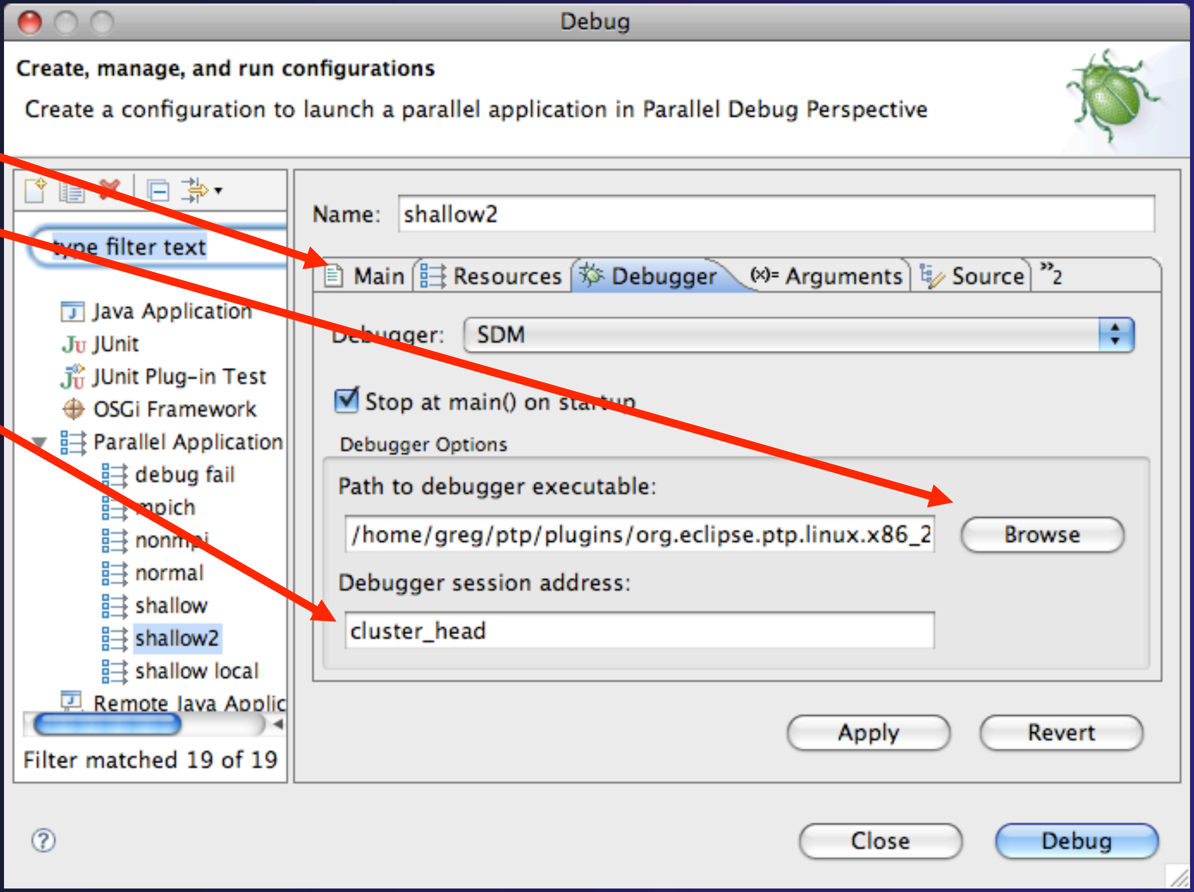
Local address for proxy connection: 9.67.154.242

(●) Use port forwarding

[ ] Launch server manually

Debugging Remotely

- Choose remote resource manager in **Main** tab
- Click **Browse** and select **sdm** executable on remote machine (if path is not correct)
- Set **Debugger session address** to the address of the machine running the proxy agent
  - The address must be accessible from a cluster node
- Click **Finish**



Create, manage, and run configurations

Create a configuration to launch a parallel application in Parallel Debug Perspective

Name: shallow2

Debugger: SDM

☑ Stop at main() on startup

Debugger Options

Path to debugger executable: /home/greg/ptp/plugins/org.eclipse.ptp.linux.x86_2

Debugger session address: cluster_head

Filter matched 19 of 19

Alternate Resource Managers

- An MPICH2 resource manager is provided
  - Use `ptp_mpich2_proxy` when selecting proxy executable
- PE and LoadLeveler
  - See help documentation that comes with PTP for information on configuring and using
- Debugging support for alternate resource managers will be available in next version of PTP

Module 6: Where To Go Next

- Objective
  - How to find more information on PTP
  - Learn about other tools related to PTP
  - See PTP upcoming features
- Contents
  - Links to other tools, including performance tools
  - Planned features for new versions of PTP
  - Additional documentation
  - How to get involved

Information About PTP

- Main web site for downloads, documentation, etc.
  - http://eclipse.org/ptp
- Developers' wiki for designs, planning, meetings, etc.
  - http://wiki.eclipse.org/PTP
- Mailing lists
  - Major announcements (new releases, etc.) - low volume
    - http://dev.eclipse.org/mailman/listinfo/ptp-announce
  - User discussion and queries - medium volume
    - http://dev.eclipse.org/mailman/listinfo/ptp-user
  - Developer discussions - high volume
    - http://dev.eclipse.org/mailman/listinfo/ptp-dev

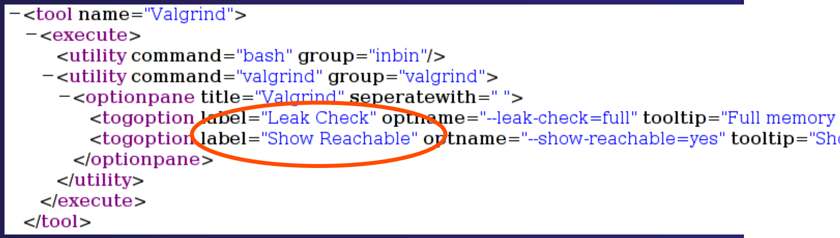
PTP-Related Tools

- ✦ Performance Tools Framework
- ✦ Tuning and Analysis Utilities (TAU)
- ✦ TuningFork - Performance Visualization
- ✦ Photran – Fortran Development Tools

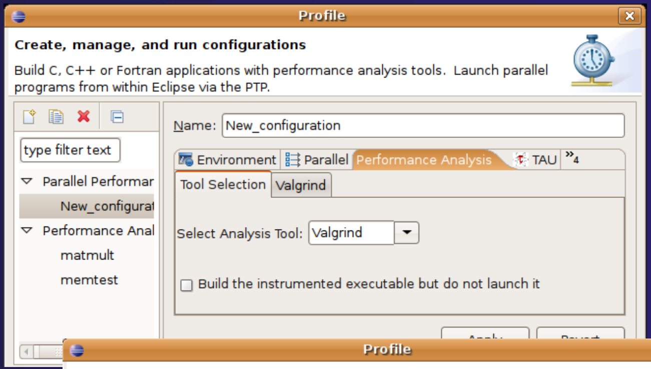
PTP / Performance Tools Framework

Goal:

- **Reduce the "eclipse plumbing" necessary to integrate tools**
- Provide integration for instrumentation, measurement, and analysis for a variety of performance tools
  - Dynamic Tool Definitions: Workflows & UI
  - Tools and tool workflows are specified in an XML file
  - Tools are selected and configured in the launch configuration window
  - Output is generated, managed and analyzed as specified in the workflow



```
-<tool name="Valgrind">
  -<execute>
     <utility command="bash" group="inbin"/>
    -<utility command="valgrind" group="valgrind">
      -<optionpane title="Valgrind" seperatewith=" ">
         <togoption label="Leak Check" optname="--leak-check=full" tooltip="Full memory
         <togoption label="Show Reachable" optname="--show-reachable=yes" tooltip="Sh
       </optionpane>
     </utility>
   </execute>
 </tool>
```



Profile

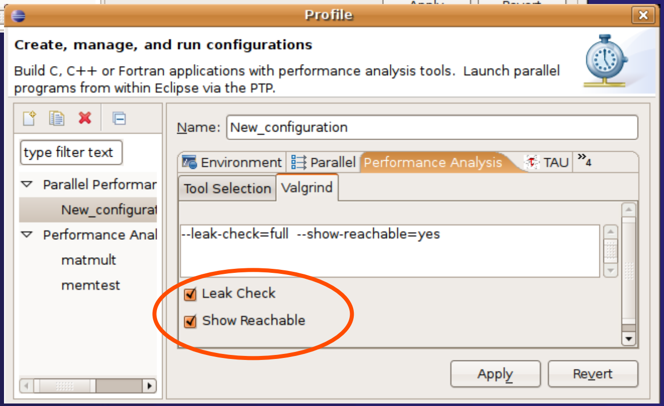
Create, manage, and run configurations

Build C, C++ or Fortran applications with performance analysis tools. Launch parallel programs from within Eclipse via the PTP.

Name: New_configuration

Select Analysis Tool: Valgrind

☐ Build the instrumented executable but do not launch it



Profile

Create, manage, and run configurations

Build C, C++ or Fortran applications with performance analysis tools. Launch parallel programs from within Eclipse via the PTP.

Name: New_configuration

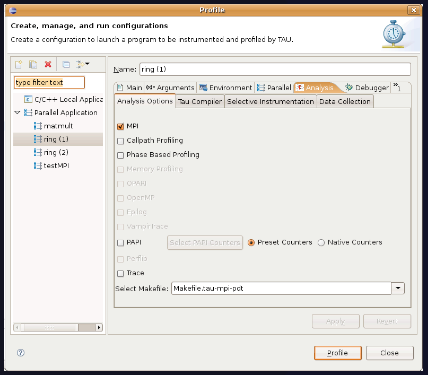
--leak-check=full --show-reachable=yes

☑ Leak Check

☑ Show Reachable

PTP TAU plug-ins http://www.cs.uoregon.edu/research/tau/home.php

- TAU (Tuning and Analysis Utilities)
- First implementation of Performance Tools Framework
- Eclipse plug-ins wrap TAU functions, make them available from Eclipse
- Compatible with Photran and CDT projects and with PTP parallel application launching
- Other plug-ins launch Paraprof from Eclipse too



Profile

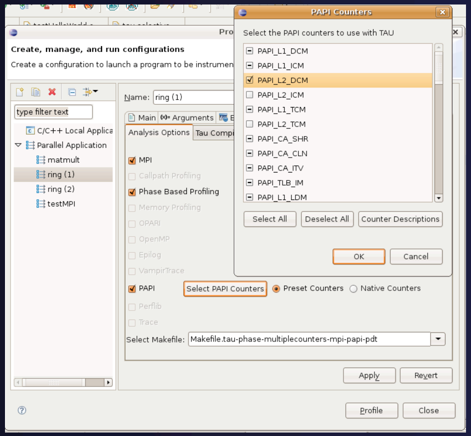
Create, manage, and run configurations

Create a configuration to launch a program to be instrumented and profiled by TAU.

Name: ring (1)

Analysis Options: [✓ MPI], Callpath Profiling, Phase Based Profiling, Memory Profiling, OPARI, OpenMP, Epilog, VampirTrace, PAPI, Select PAPI Counters, [✓ Preset Counters] Native Counters, Perflib, Trace

Select Makefile: Makefile.tau-mpi-pdt



PAPI Counters

Select the PAPI counters to use with TAU

- PAPI_L1_DCM
- PAPI_L1_ICM
- ✓ PAPI_L2_DCM
- PAPI_L2_ICM
- PAPI_L1_TCM
- PAPI_L2_TCM
- PAPI_CA_SHR
- PAPI_CA_CLN
- PAPI_CA_ITV
- PAPI_TLB_IM
- PAPI_L1_LDM

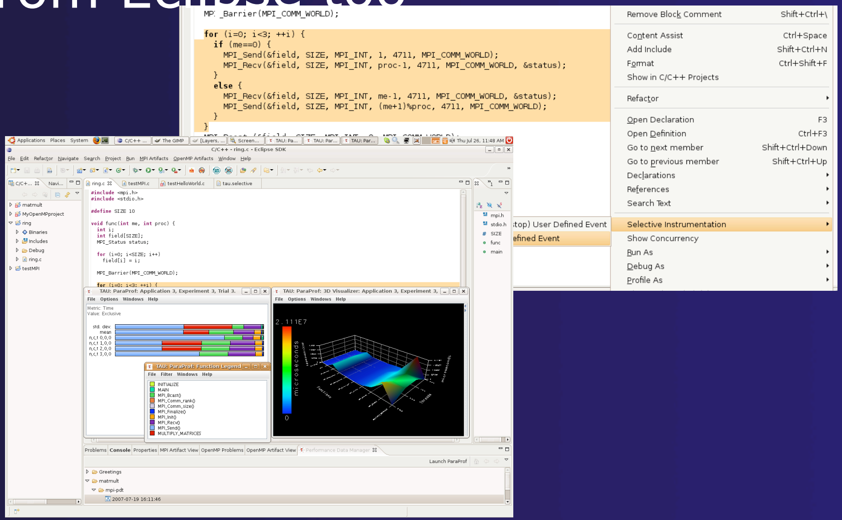
Create, manage, and run configurations

Create a configuration to launch a program to be instrumen

Name: ring (1)

Analysis Options: [✓ MPI], Callpath Profiling, [✓ Phase Based Profiling], Memory Profiling, OPARI, OpenMP, Epilog, VampirTrace, [✓ PAPI], Select PAPI Counters, [✓ Preset Counters] Native Counters, Perflib, Trace

Select Makefile: Makefile.tau-phase-multiplecounters-mpi-papi-pdt

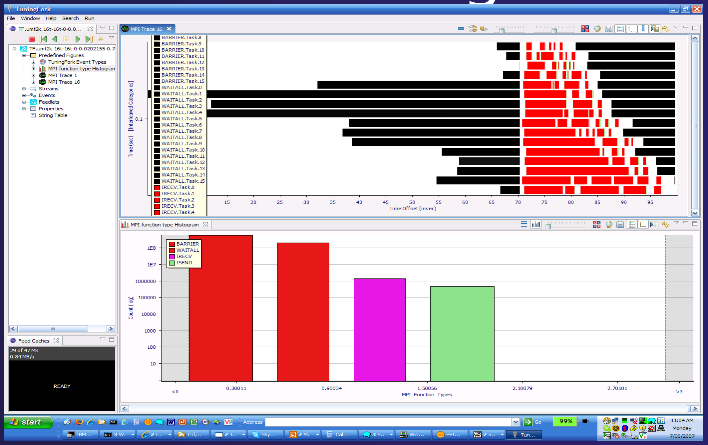


```
MPI_Barrier(MPI_COMM_WORLD);

for (i=0; i<3; ++i) {
  if (me==0) {
    MPI_Send(&field, SIZE, MPI_INT, 1, 4711, MPI_COMM_WORLD);
    MPI_Recv(&field, SIZE, MPI_INT, proc-1, 4711, MPI_COMM_WORLD, &status);
  }
  else {
    MPI_Recv(&field, SIZE, MPI_INT, me-1, 4711, MPI_COMM_WORLD, &status);
    MPI_Send(&field, SIZE, MPI_INT, (me+1)%proc, 4711, MPI_COMM_WORLD);
  }
}
```

Remove Block Comment Shift+Ctrl+\
Content Assist Ctrl+Space
Add Include Shift+Ctrl+N
Format Ctrl+Shift+F
Show in C/C++ Projects
Refactor
Open Declaration F3
Open Definition Ctrl+F3
Go to next member Shift+Ctrl+Down
Go to previous member Shift+Ctrl+Up
Declarations
References
Search Text
Selective Instrumentation
Show Concurrency
Run As
Debug As
Profile As
top) User Defined Event
efined Event
C/C++ - ring.c - Eclipse SDK
testHelloWorld.c
tau.selective
mpi.h
stdio.h
SIZE
func
main
TAU: ParaProf: Application 3, Experiment 3, Trial 3.
TAU: ParaProf: 3D Visualizer: Application 3, Experiment 3,
TAU: ParaProf: Function Legend
2.111E7
microseconds

TuningFork

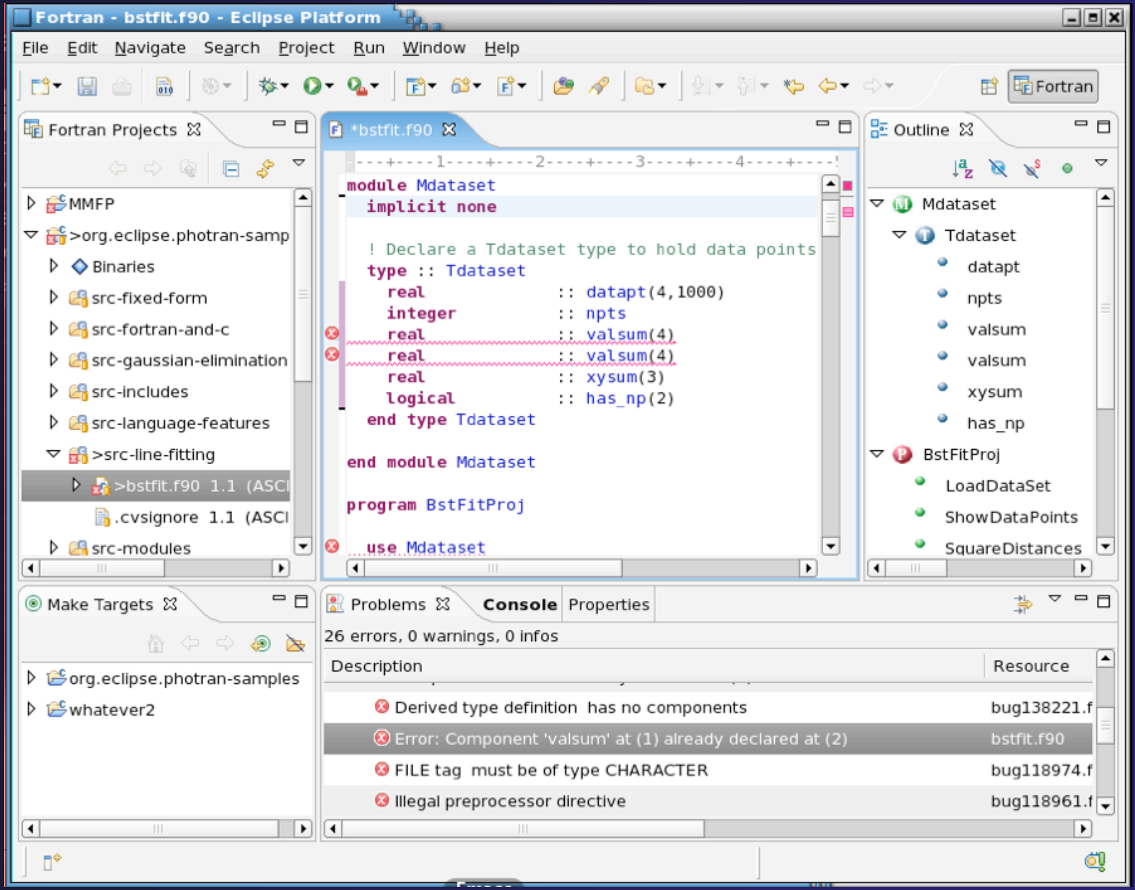
- http://www.alphaworks.ibm.com/tech/tuningfork
- Performance visualization Eclipse plug-ins from IBM Research
- Rich Client Platform; IDE version in progress
- Designed for real-time visualization of large data sets
- Will be available open source on Source Forge
- Enhancements for parallel computing underway



Photran

http://eclipse.org/photran

- Supports Fortran in the Eclipse workbench
- Supports Fortran 77, 90, and 95
  It includes:
- Syntax-highlighting editor
- CVS support
- GUI interface to *gdb*
- Makefile-based compilation
- Compiler error extraction
- Outline view
- Open declaration
- *Rename* and *Introduce Implicit None* refactorings



```
module Mdataset
  implicit none

  ! Declare a Tdataset type to hold data points
  type :: Tdataset
    real             :: datapt(4,1000)
    integer          :: npts
    real             :: valsum(4)
    real             :: valsum(4)
    real             :: xysum(3)
    logical          :: has_np(2)
  end type Tdataset

end module Mdataset

program BstFitProj

  use Mdataset
```

26 errors, 0 warnings, 0 infos

Description	Resource
Derived type definition has no components	bug138221.f
Error: Component 'valsum' at (1) already declared at (2)	bstfit.f90
FILE tag must be of type CHARACTER	bug118974.f
Illegal preprocessor directive	bug118961.f

Useful Eclipse Tools

- Python
  - http://pydev.sourceforge.net
- Subversion (CVS replacement)
  - http://subclipse.tigris.org
  - Now an Eclipse Technology project
- … and many more!

Future PTP Features

- Resource manager support for SLURM, PBS, LSF, BG/P
- Simplified runtime system interface (plus support for other MPI runtimes)
- Debugging support for a broad range of architectures
- Full remote project support (combined with CDT)
  - Remote build and indexing
  - Remote launch/debug
- Performance analysis tools integration

PTP Publications

- "Developing Scientific Applications Using Eclipse," Computing in Science & Engineering, vol. 8, no. 4, July/August 2006, pp. 50-61
  - Link on http://eclipse.org/ptp web page
- "A Model-Based Framework for the Integration of Parallel Tools", Proceedings of the IEEE International Conference on Cluster Computing, Barcelona, September 2006
  - Link on http://eclipse.org/ptp web page
- IBM developerWorks article:
  - http://www-128.ibm.com/developerworks/edu/os-dw-os-ecl-ptp.html
- "An Integrated Tools Platform for Multi-Core Enablement," Beth Tibbitts & Evelyn Duesterwald, STMCS: Second Workshop on Software Tools for Multi-Core Systems, March 2007
  - http://www.isi.edu/~mhall/stmcs07/program.html

Getting Involved

- See http://eclipse.org/ptp
- Read the developer documentation on the wiki
- Join the mailing lists
  - ptp-dev@eclipse.org; ptp-user@eclipse.org
- Attend the monthly developer teleconference
- Attend the annual workshop

- PTP will only succeed with your participation!

PTP Tutorial Feedback

- Please complete feedback form
- Your feedback is valuable!

Thanks for attending
We hope you found it useful