



parallel tools platform

<http://eclipse.org/ptp>

Development Environments for HPC: The View from NCSA

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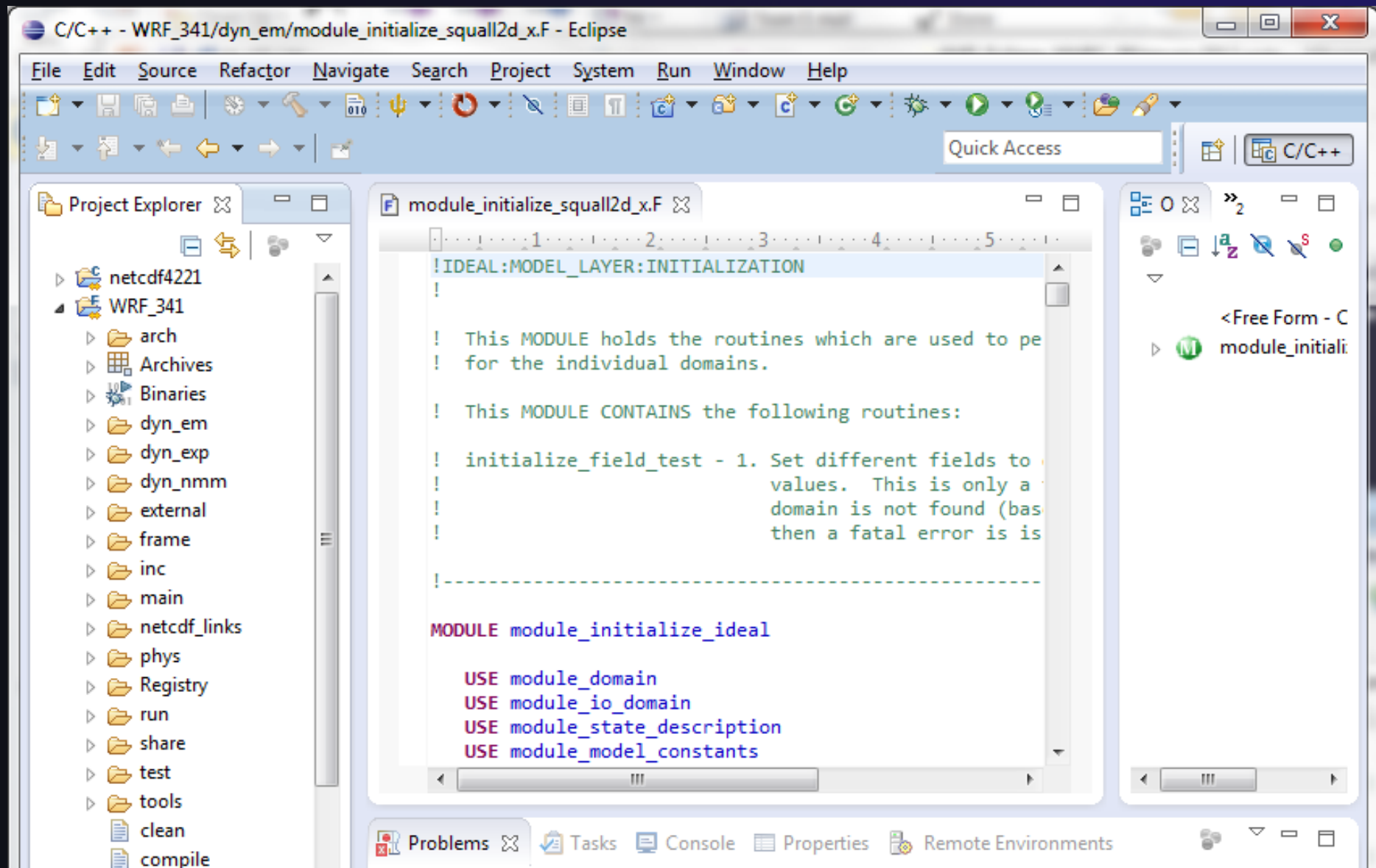
Outline

- ★ Overview of Eclipse and the Parallel Tools Platform (PTP)
- ★ Motivation for Workbench for High Performance Computing (WHPC)
- ★ Advantages of Eclipse for HPC Software Developers
- ★ Sustainability, Investment, Collaboration: Building Community
- ★ Challenges with DEHPC
- ★ Opportunities (for discussion)

Eclipse

- ✦ Integrated development environment (IDE)
 - ✦ Edit code, compile, run, debug without leaving Eclipse
 - ✦ Graphical user interface

Eclipse



Eclipse

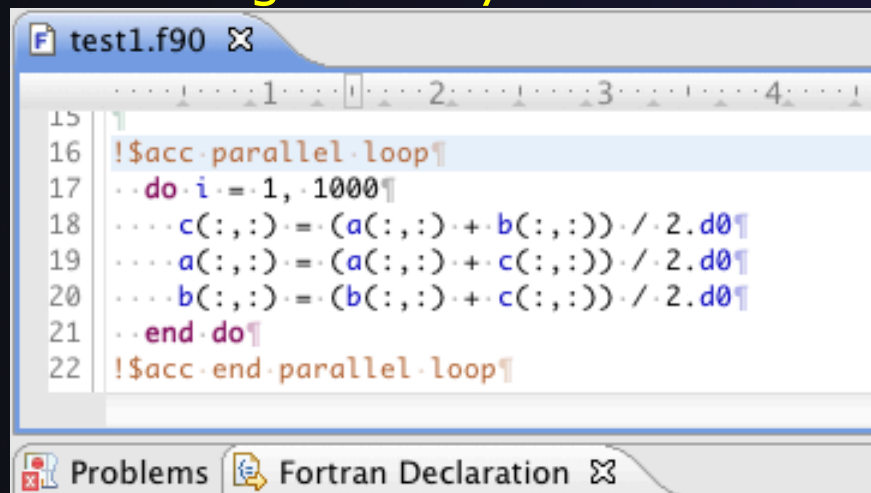
- ★ Integrated development environment (IDE)
 - ★ Edit code, compile, run, debug without leaving Eclipse
 - ★ Graphical user interface
- ★ **Plug-ins** add new functionality to Eclipse
 - ★ Support languages: C/C++, Fortran, Python, ...
 - ★ Support version control systems: Git, Subversion, ...
 - ★ Support issue tracking systems: Bugzilla, Jira, ...
 - ★ Support HPC development (?!)

Parallel Tools Platform (PTP)

- ★ **PTP:** a set of plug-ins that extend Eclipse to support HPC development
 - ★ Write code on your laptop
 - ★ Build it on a remote HPC system using its compilers
 - ★ Run it on the remote HPC system (qsub)
 - ★ Debug it on the remote system (MPI debugger)
 - ★ Tune it for performance on the remote system
 - ★ ...all inside Eclipse!

Eclipse Parallel Tools Platform (PTP)

Coding & Analysis

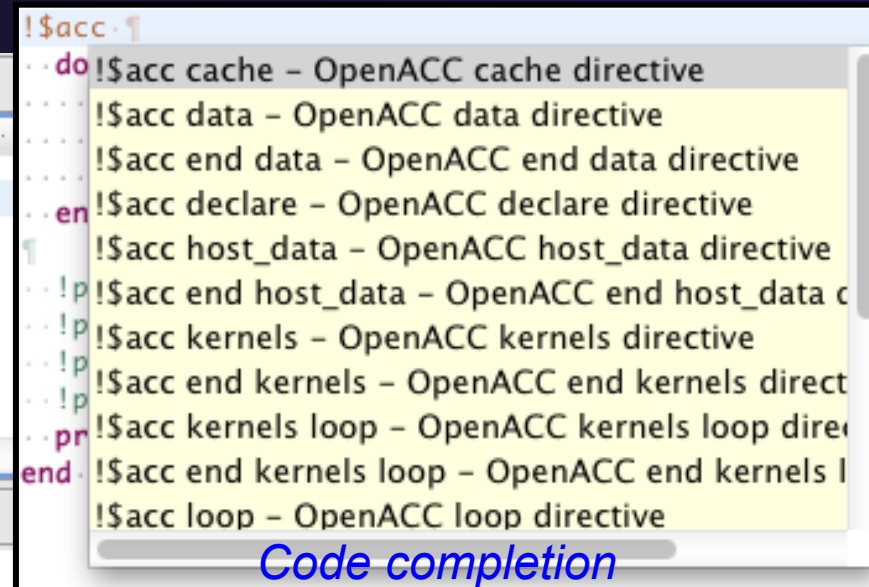


```

15
16 !$acc parallel loop
17 ..do i = 1, 1000
18 ...c(:, :) = (a(:, :) + b(:, :)) / 2.d0
19 ...a(:, :) = (a(:, :) + c(:, :)) / 2.d0
20 ...b(:, :) = (b(:, :) + c(:, :)) / 2.d0
21 ..end do
22 !$acc end parallel loop

```

Problems Fortran Declaration



```

!$acc
do !$acc cache - OpenACC cache directive
!$acc data - OpenACC data directive
!$acc end data - OpenACC end data directive
en !$acc declare - OpenACC declare directive
!$acc host_data - OpenACC host_data directive
!p !$acc end host_data - OpenACC end host_data c
!p !$acc kernels - OpenACC kernels directive
!p !$acc end kernels - OpenACC end kernels direct
!p !$acc kernels loop - OpenACC kernels loop direc
end !$acc end kernels loop - OpenACC end kernels l
!$acc loop - OpenACC loop directive

```

Code completion

OpenACC™ parallel directive

Delineates a block of code that will be executed on an accelerator device.

```

!$acc parallel [clause [, clause ...]]
    block
!$acc end parallel

```

```

#pragma acc parallel [clause [, clause ...]]
    block

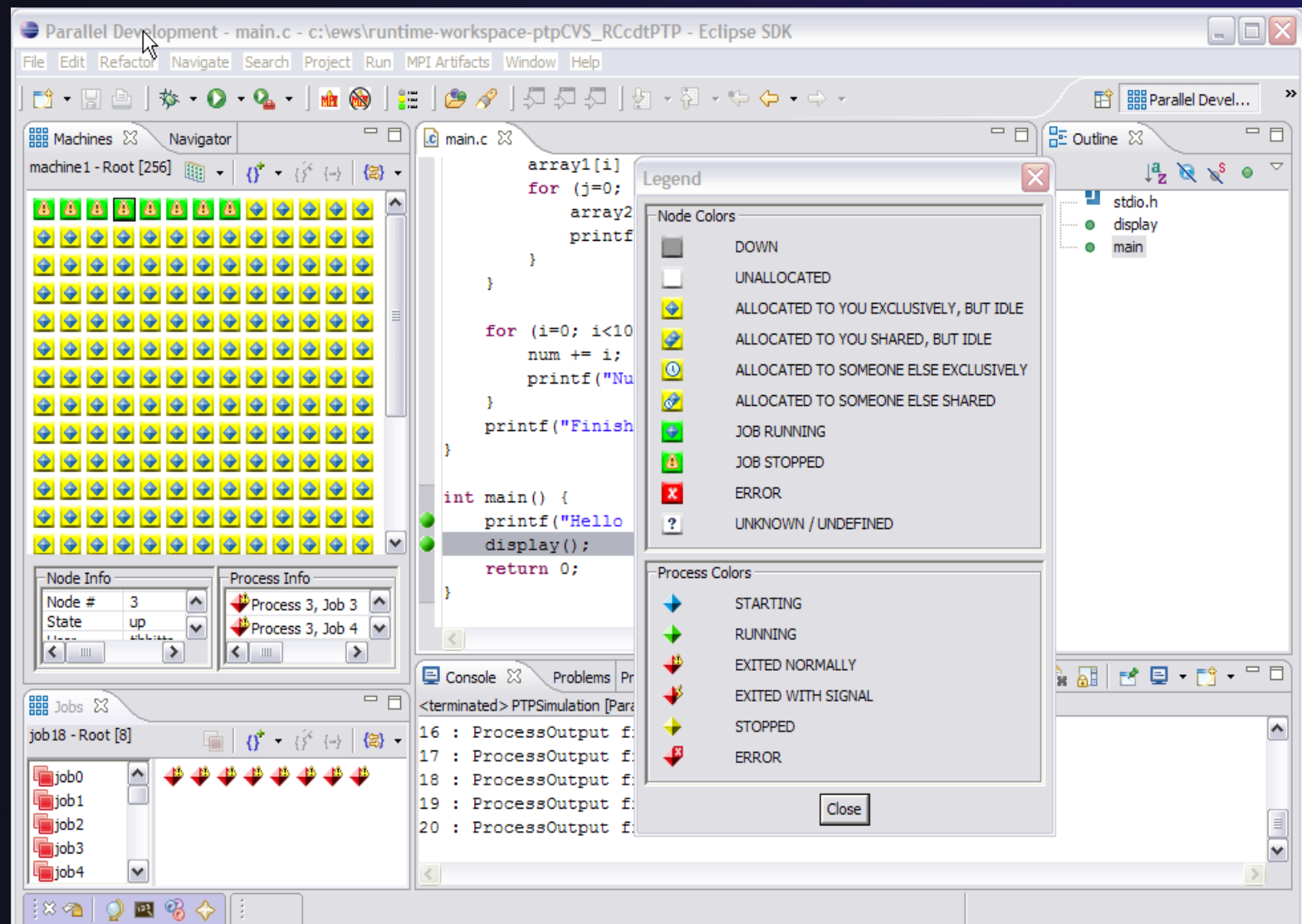
```

Supported clauses are `if`, `async`, `num_gangs`, `num_workers`, `vector_length`, `reduction`, `copy`, `copyin`, `copyout`, `create`, `present`, `present_or_copy`, `present_or_copyin`, `present_or_copyout`, `present_or_create`, `deviceptr`, `private`, `firstprivate`.

Eclipse Parallel Tools Platform (PTP)

Coding & Analysis

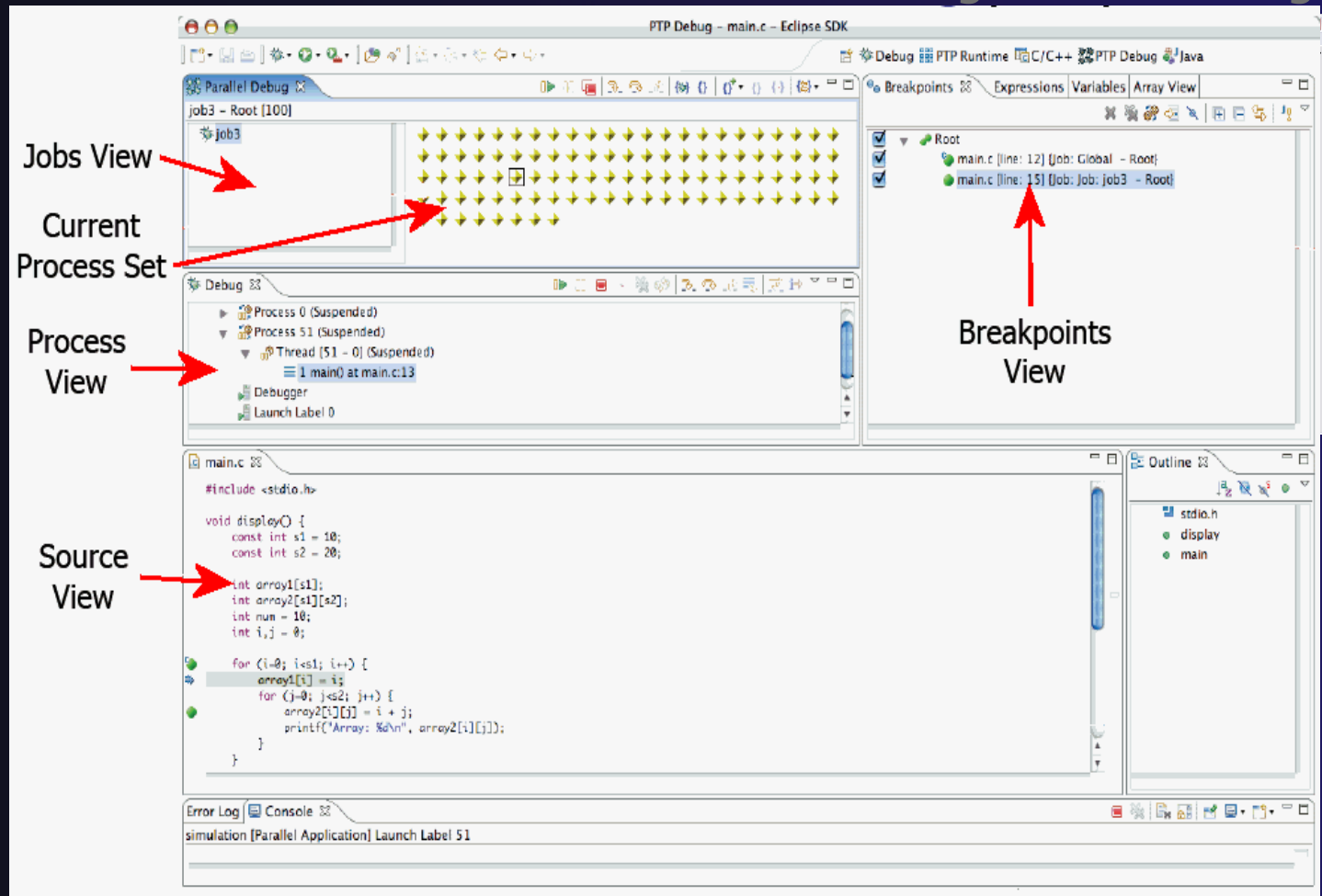
Launching & Monitoring



Eclipse Parallel Tools Platform (PTP)

Coding & Analysis

Launching & Monitoring

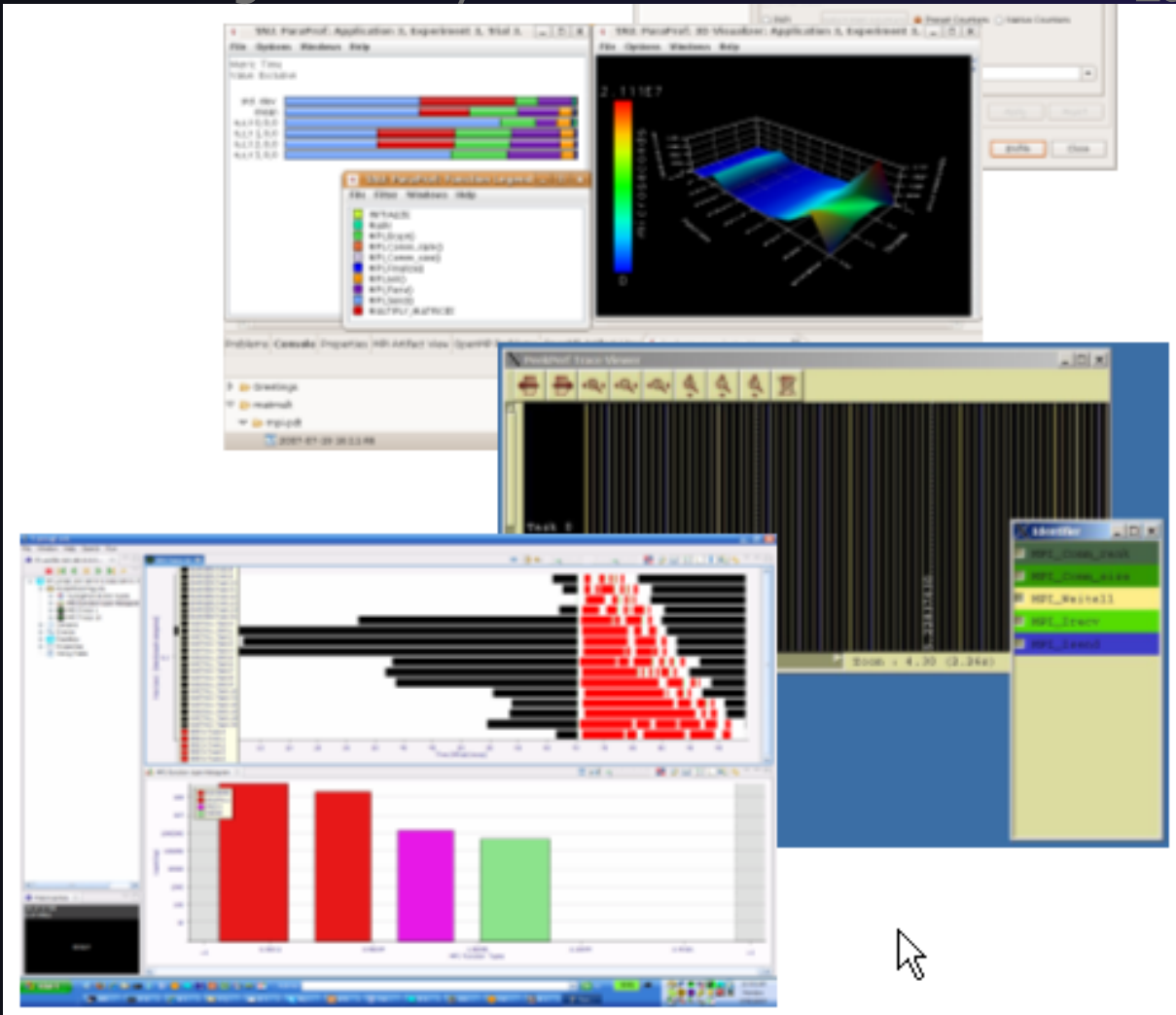


Debugging

Eclipse Parallel Tools Platform (PTP)

Coding & Analysis

Launching & Monitoring

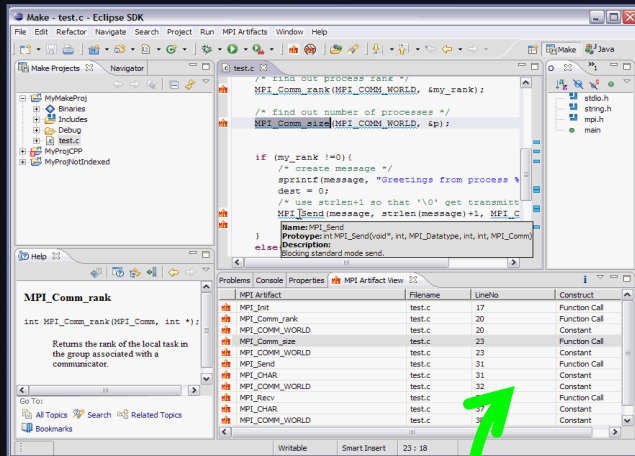


Debugging

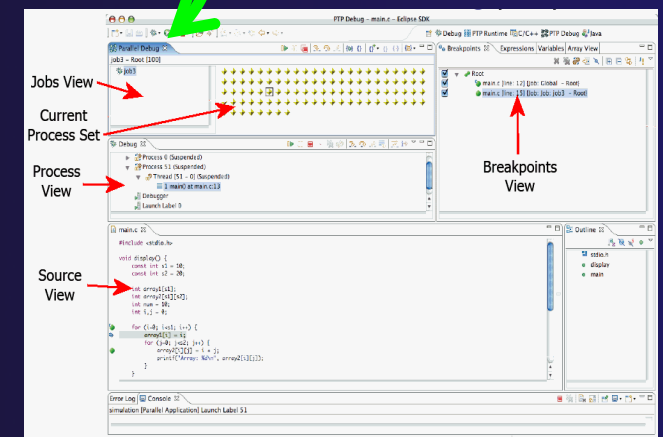
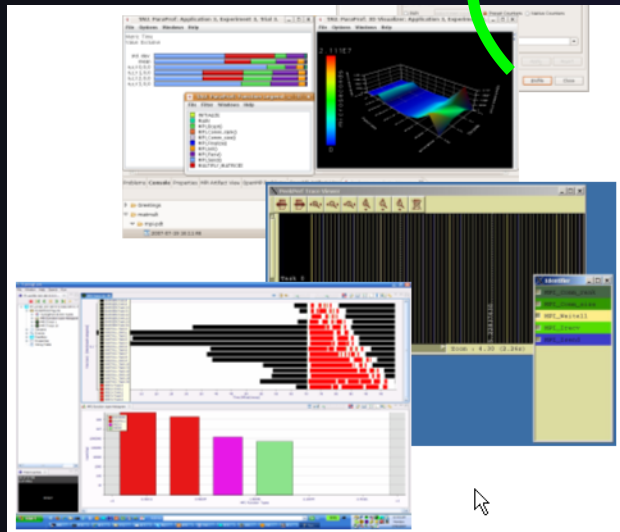
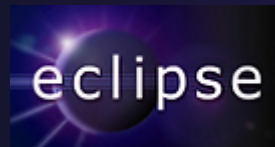
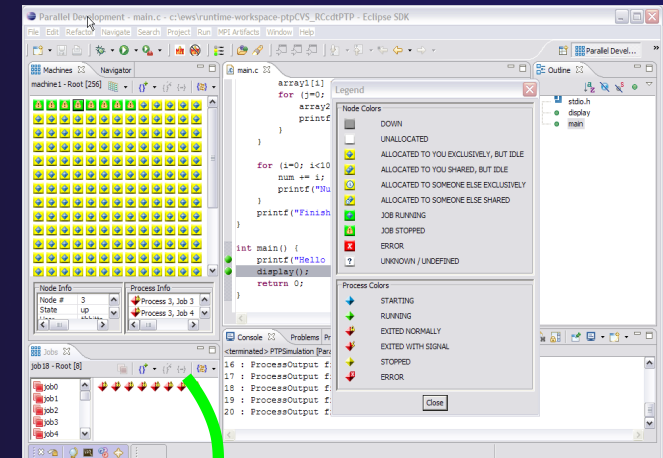
Performance Tuning

Eclipse Parallel Tools Platform (PTP)

Coding & Analysis



Launching & Monitoring



Debugging

Motivation for Workbench for High Performance Computing (WHPC)

- ★ Context
 - ★ NSF 1047956: SI2-SSI: A Productive and Accessible Development Workbench for HPC Applications Using the Eclipse Parallel Tools Platform
- ★ Stable, portable platform for tool development
 - ★ Focus on tool functionality, manage rapid evolution of HPC platforms
 - ★ Encourage consistent tool look and feel
 - ★ Support for HPC application development practices
- ★ Why Parallel Tools Platform?
 - ★ High potential to meet needs of a WHPC.
 - ★ Target next generation of HPC developers growing up with IDEs (Eclipse, Visual Studio, ...)
 - ★ Need to cultivate community of users!

Improvements

- ✦ Work within Eclipse release cycle
 - ✦ Major (API-breaking) improvements with coordinated June release
 - ✦ Last major release Eclipse 4.5 “Mars” released June 2015
 - ✦ Minor enhancements and bug-fixes with two coordinated service releases in September and February
 - ✦ Eclipse 4.5 SR1 Released September, 2015.
- ✦ Foci of improvements
 - ✦ Improve usability
 - ✦ Improve productivity

Consider 2 possible types of users of Eclipse Parallel Tools ...

- ★ Science code users/modelers
 - ★ Need to build science code
 - ★ May need to modify science code (and rebuild)
- ★ Software specialists enabling modeling projects
 - ★ Lots of software engineering concerns
- ★ Next set of slides address some of those concerns.

Science code users/modelers

★ Some of the challenges

- ★ Complex codes (eg WRF)
- ★ Codes + HPC architectures can be daunting
- ★ Adding user code not always easy

★ WRF: from http://wrf-model.org/PRESENTATIONS/2000_04_18_Klemp/sld007.htm

WRF Hierarchical Software Architecture

■ Top-level “Driver” layer

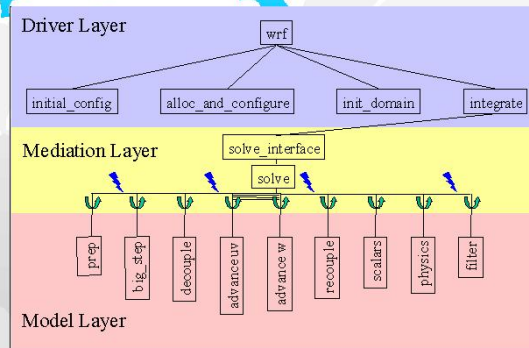
- Isolates computer architecture concerns
- Manages execution over multiple nested domains
- Provides top level control over parallelism
 - » patch-decomposition
 - » inter-processor communication
 - » shared-memory parallelism
- Controls Input/Output

■ “Mediation” Layer

- Specific calls to parallel mechanisms

■ Low-Level “Model” layer

- Performs actual model computations
- Tile-callable
- Scientists insulated from parallelism
- General, fully reusable



Navigating Computational Science Codes

The screenshot displays the Eclipse IDE interface with the following components and annotations:

- Code navigation:** A red arrow points from the label to the Project Explorer on the left, which shows a tree view of the project structure including folders like `netcdf4221`, `WRF_341`, `arch`, `Archives`, `Binaries`, `dyn_em`, `dyn_exp`, `dyn_nmm`, `external`, `frame`, `inc`, `main`, `netcdf_links`, `phys`, `Registry`, `run`, `share`, `test`, `tools`, `clean`, `compile`, `configure`, and `configure.wrf`.
- Code Outline:** A red arrow points from the label to the right-hand pane, which displays a hierarchical outline of the current file `module_initialize_squall2d_x.F`, showing sections like `<Free Form - C` and `module_initiali`.
- Syntax-aware editing (navigate to program units and declarations):** A red arrow points from the label to the main code editor, which shows the source code of `module_initialize_squall2d_x.F`. The code includes comments and declarations, such as `! IDEAL:MODEL_LAYER:INITIALIZATION`, `! This MODULE holds the routines which are used to pe`, `! for the individual domains.`, `! This MODULE CONTAINS the following routines:`, `! initialize_field_test - 1. Set different fields to`, `! values. This is only a`, `! domain is not found (bas`, `! then a fatal error is is`, and `MODULE module_initialize_ideal`.

The bottom status bar indicates `2 errors, 0 warnings, 0 others` and provides a table with columns `Description`, `Resource`, `Path`, and `Location`.

Eclipse aiding in a typical code workflow...

- ✦ May want to add a model output variable
- ✦ Eclipse PTP makes it easy to navigate source, make changes
- ✦ Drive remote builds on HPC resources
 - ✦ Make, autotools...
- ✦ Run – can generate a run configuration for particular system, batch environment

Software Specialists enabling modeling projects

- ★ Need a wider array of software engineering tools
 - ★ Source repository
 - ★ Issue tracking
 - ★ Documentation
 - ★ Performance tuning...
- ★ Eclipse Parallel Tools can help with many of these concerns

Source Code Control: “Team” Features

- ★ Eclipse supports integration with multiple version control systems (VCS)
 - ★ CVS, SVN, Git, and others
 - ★ Collectively known as “Team” services
- ★ Many features are common across VCS
 - ★ Compare/merge
 - ★ History
 - ★ Check-in/check-out
- ★ Some differences
 - ★ Version numbers
 - ★ Branching

Issue Tracking

✦ Mylyn Bridge

✦ Tracks tasks, links to source and bug repositories

nit jobs on jyc (mpp* arguments are not supported on this sytem ...) - Eclipse

or Navigate Search Project System Run Window Help

Quick Access C/C++ CVS Repository Exploring System Monitoring Parallel Debug Remote System Explorer

Issue BWDSPCH-515 NCSA Submit

ddt doesn't submit jobs on jyc (mpp* arguments are not supported on ...)

Status: In Progress Created: Oct 3, 2012 Modified: Oct 3, 2012 11:38 AM
Reported by: Galen Arnold Assigned to: Unassigned

Attributes

Project: BW Dispatch Priority: Normal

Type: Ticket Due Date: 0m

Affects Versions: Components:

Fix Versions: Security Level: Private Ticket

First Responder: gbauer PI: Kramer

Environment:

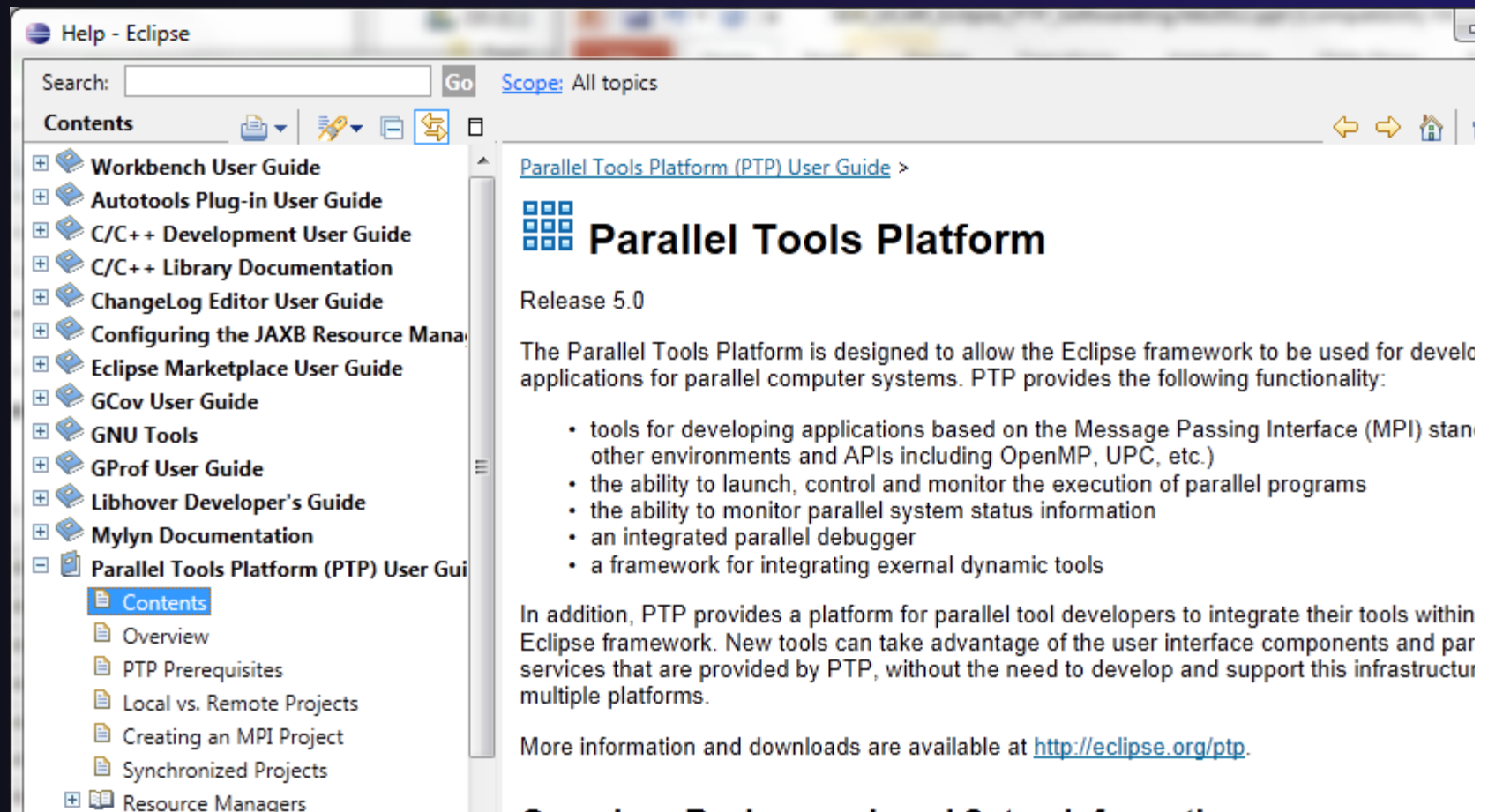
Find All Activa...

Unsubmitted [NCSA]
Added recently (BW Disp
Added recently (whpc)
Assigned to me (All Proje
BW's unassigned issues
BWDSPCH-481: sett
BWAM-525: Re: Blu
BWDSPCH-502: BW
BWDSPCH-515: ddt
Open BW tickets [NCSA
PTP 6.0 Bugs [Eclipse.o
PTP version 7.0 [Eclipse
whpc-anybug [NCSA
Unmatched [NCSA]

Connections to Jira, bugzilla, ...

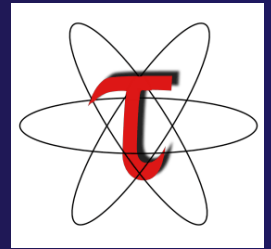
Eclipse Documentation

- ✦ Eclipse Help System – built in and standalone (<http://help.eclipse.org>)

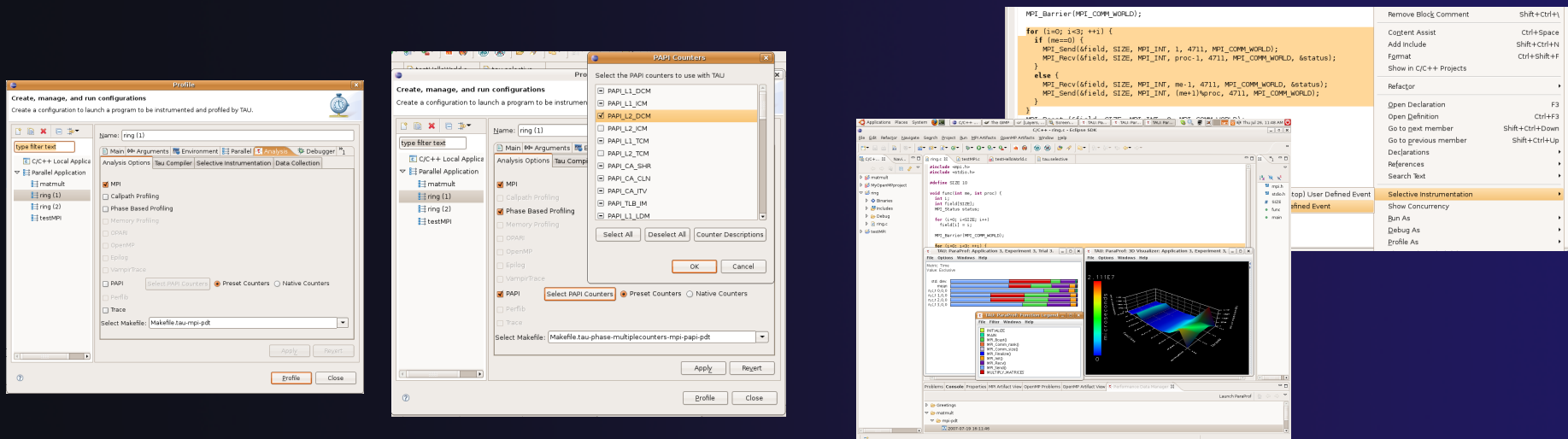


Performance Tuning: PTP TAU plug-ins

<http://www.cs.uoregon.edu/research/tau>



- ★ TAU (Tuning and Analysis Utilities)
- ★ First implementation of External Tools Framework (ETFw)
- ★ Eclipse plug-ins wrap TAU functions, make them available from Eclipse
- ★ Full GUI support for the TAU command line interface
- ★ Performance analysis integrated with development environment



Sustainability, Investment, Collaboration: Building Community

- ★ Stakeholders/investors
 - ★ Funding agencies → innovative capability
 - ★ HPC vendors
 - ★ contribute to open source foundational software
 - ★ basis for proprietary or open-source add-ons
 - ★ Supercomputing centers
 - ★ user support and training
 - ★ xml documents for batch system and local policy integration

Sustainability, Investment, Collaboration: Building Community II

- ★ Stakeholders/investors continued
 - ★ Supercomputing integrating organizations (eg, XSEDE):
 - ★ user support
 - ★ single sign-on support (?)
 - ★ training
 - ★ education support
 - ★ Tool providers
 - ★ xml documents for integration of command line tools
 - ★ extra value-add from tool-specific plugins?
 - ★ Anyone else?

Challenges for DEHPC

- ★ Budgetary pressure on supercomputing centers and integrating organizations
- ★ Challenges successfully competing proposals in open calls (eg, NSF SI2).
 - ★ Innovation, impact are paramount here
- ★ User community is large, disperse (eg lots of downloads of PTP, hard to connect to user community)

Opportunities (for discussion)

- ★ Can we build a community to support a DEHPC?
 - ★ PIs proposing to funding agencies for innovative additions?
 - ★ Vendor contributions to DEHPC?
 - ★ Supercomputing centers and integrating organizations support?
 - ★ Eg, User support, training, configuration (xml) documents

Eclipse Parallel Tools Platform

www.eclipse.org/ptp