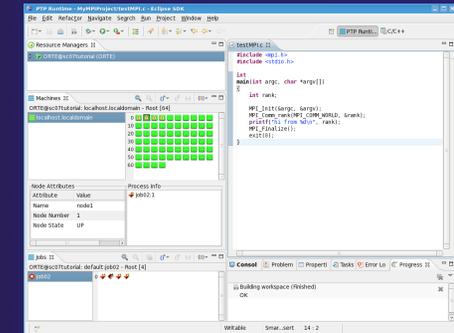
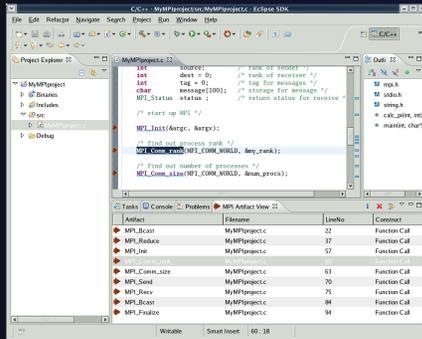


Parallel Tools Platform SC08 BOF

5:30-7:00 PM, 11/19/08



Beth R. Tibbitts

IBM T.J. Watson Research Center
tibbitts@us.ibm.com

Eclipse PTP - Parallel Tools Platform PLDT - Parallel Language Development Tools

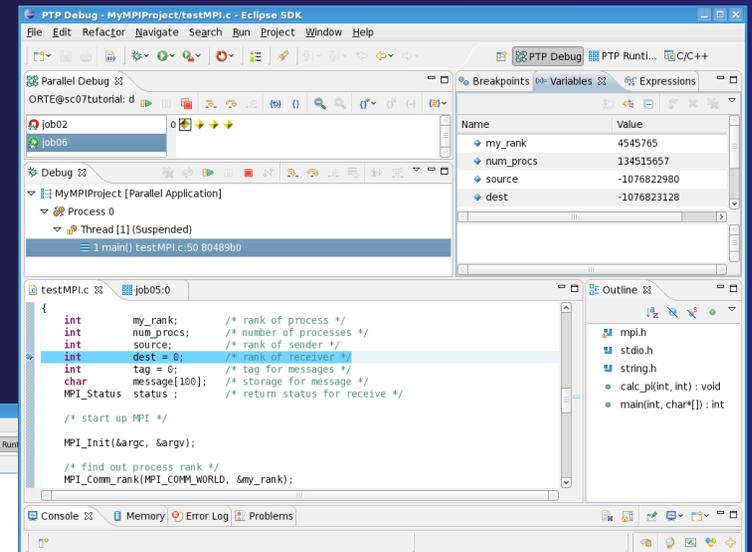
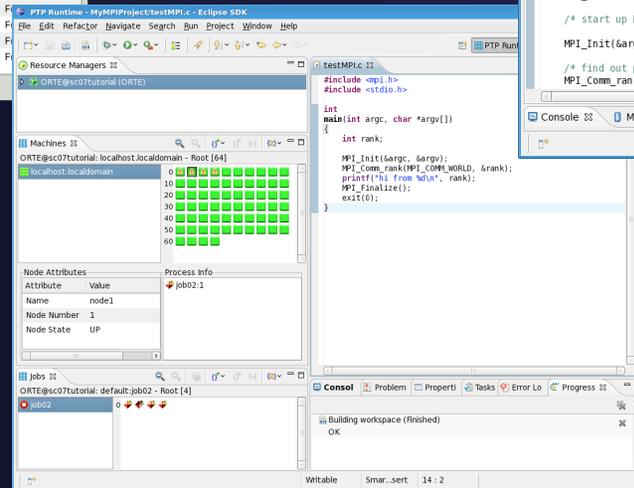
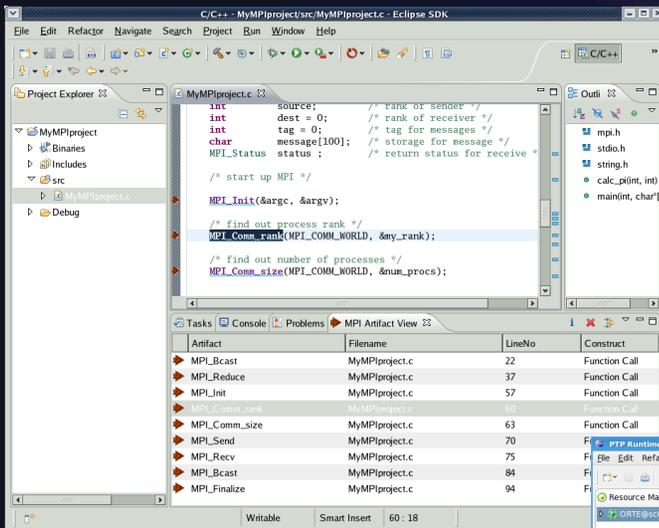
Local
and
Remote

PTP Runtime

PTP Debugger

And...

- External Tools Framework
- Performance Tools



MPI, OpenMP, UPC
program
Analysis Tools

Leverages
Eclipse CDT
(C/C++ Development Tools)

PTP BOF @ SC08

Agenda

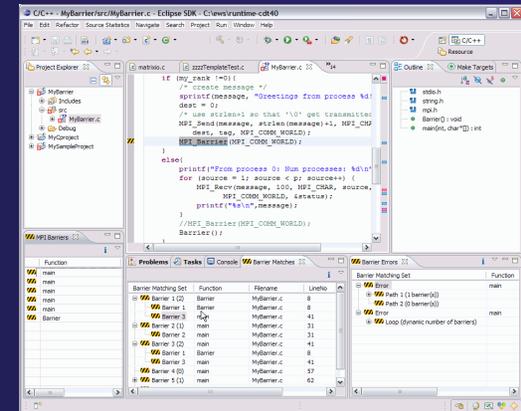
- ★ PTP (quick) Feature overview; New in 2.1 Release (11/3/08)
 - ★ Beth Tibbitts, IBM
- ★ Remote exec/debug for IBM PE/LoadLeveler
 - ★ Dave Wootton, IBM
- ★ PTP External Tools Framework
 - ★ Wyatt Spear, U.Oregon
- ★ Photran status
 - ★ Jeffrey Overbey, UIUC (Beth Tibbitts as proxy)
- ★ NCSA/Blue Waters use and plans for PTP
 - ★ Jay Alameda, NCSA
- ★ Questions, comments, ...etc

PTP Committers

- ✦ Greg Watson (Project Lead), IBM Research
- ✦ Beth Tibbitts, IBM Research
- ✦ Wyatt Spear, U. Oregon
- ✦ Craig Rasmussen, Los Alamos NL
- ✦ Chris Recoskie, IBM
- ✦ Clement Chu, Monash University
- ✦ Daniel Ferber, IBM
- ✦ Randy Roberts, Los Alamos NL

Eclipse Parallel Tools - Features

- ✦ Parallel Applications
 - ✦ Develop, monitor, debug
- ✦ PTP Analysis tools –
 - PLDT (Parallel Language Development Tools)
 - ✦ Assistance tools, MPI (& Barrier Analysis), OpenMP, UPC, LAPI
- ✦ CDT – Eclipse C/C++ Development Tools
 - ✦ UPC syntax, content assist, etc.
 - ✦ Scalability mode, Remote Dev. Tools

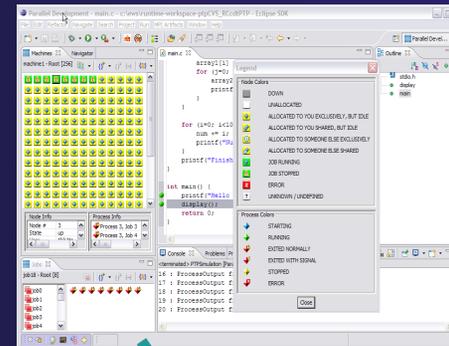
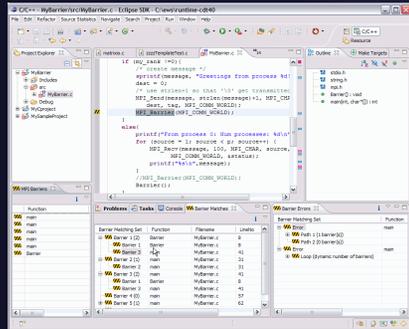


Eclipse PTP: Parallel Tools Platform

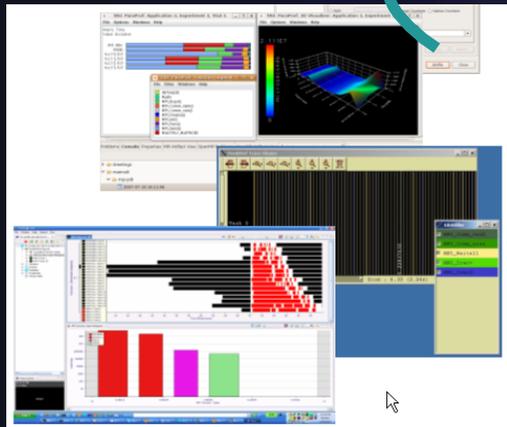
<http://eclipse.org/ptp>

- Bring richness of commercial development tools to the parallel programmer
 - Open and extensible platform to encourage further development -- great platform for further research

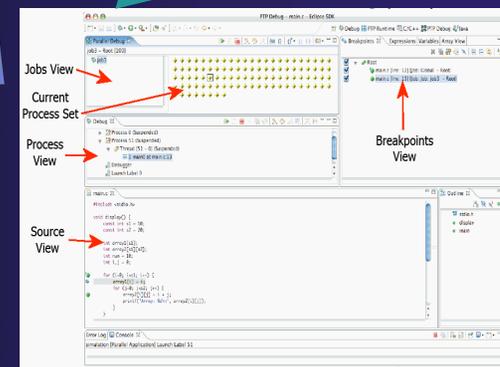
Coding & Analysis (CDT, PLDT)



Launching & Monitoring



5 Performance Tuning



Debugging

A word about versions

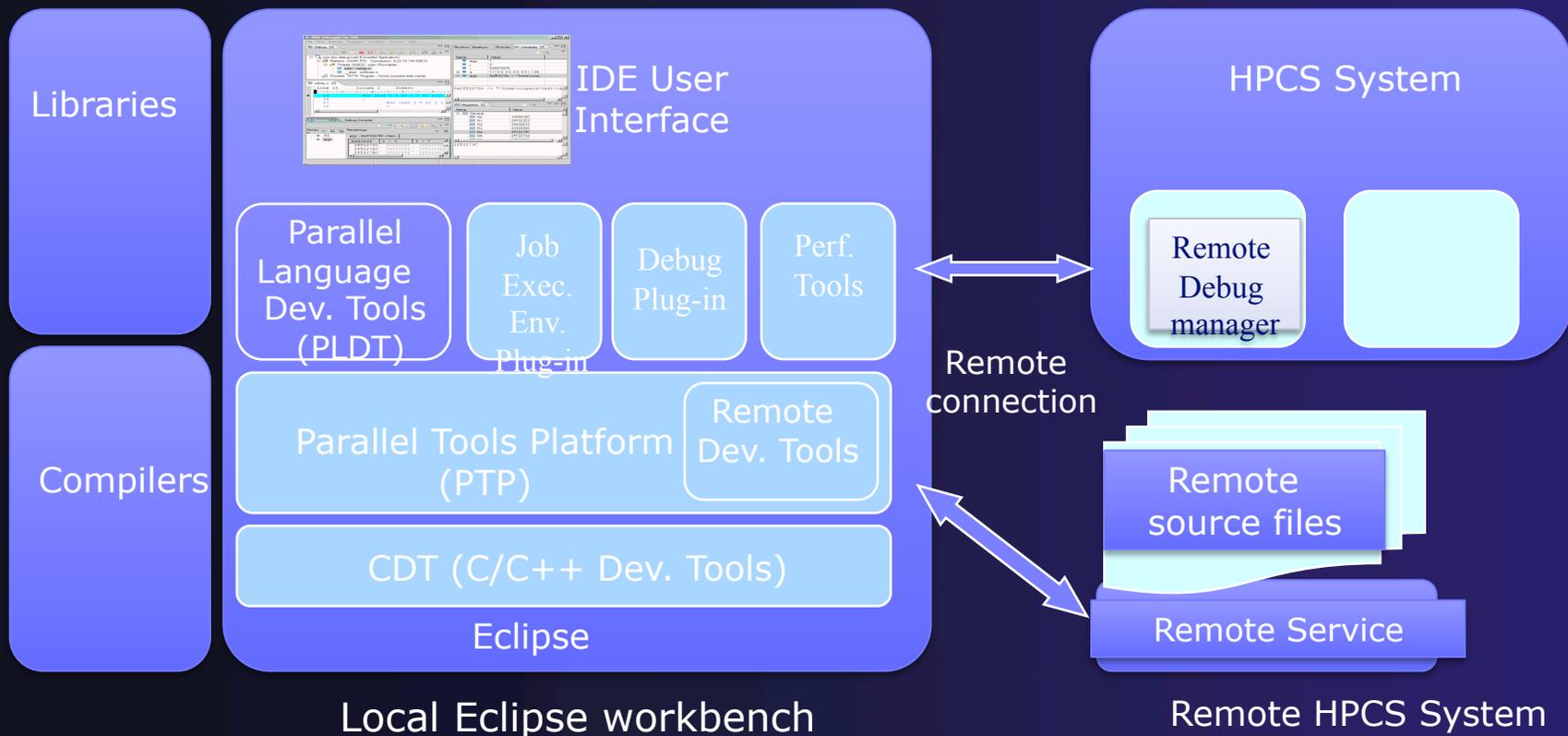
PTP: Parallel Tools Platform
CDT: C/C++ Development Tools
PLDT: Parallel Lang. Dev. Tools
RDT: CDT's Remote Dev. Tools

- ✧ Eclipse 3.3 = "Europa" – June 2007
 - ✧ CDT 4.0
 - ✧ PTP 2.0 (released March '08)
 - Includes PLDT 2.0

- ✧ Eclipse 3.4 = "Ganymede" – June 2008
 - ✧ CDT 5.0
 - ✧ PTP 2.1 (released Nov. '08)
 - Includes PLDT 2.1
 - Includes RDT 1.0

Application Development Environment

- Running the development environment on the remote HPC server is undesirable
 - Latency issues, lack of graphics support, etc.
- Decoupled remote development model to hide the complexities of “remoteness”
 - Remote file navigation, remote build, remote launch, remote debugging
- Reduced development time through an integrated set of tools



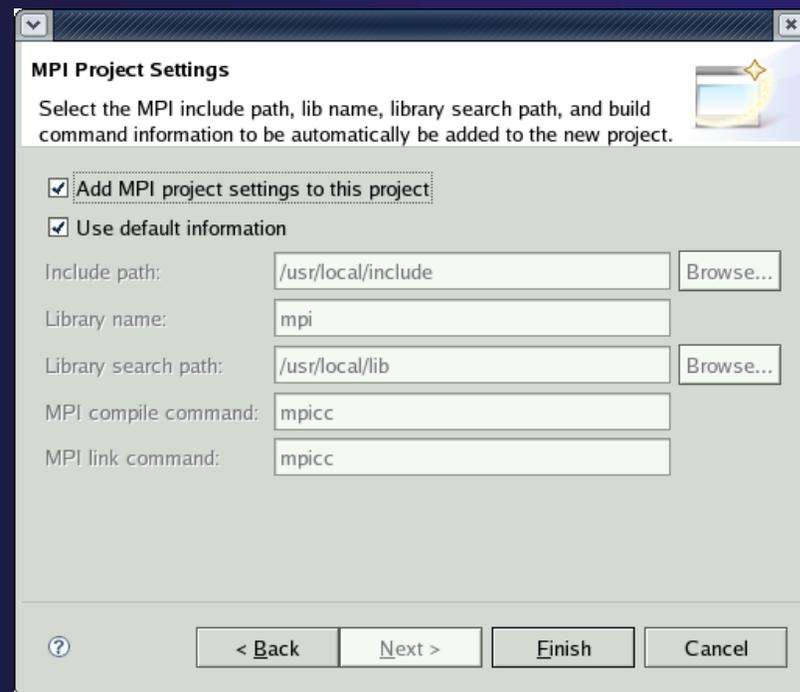
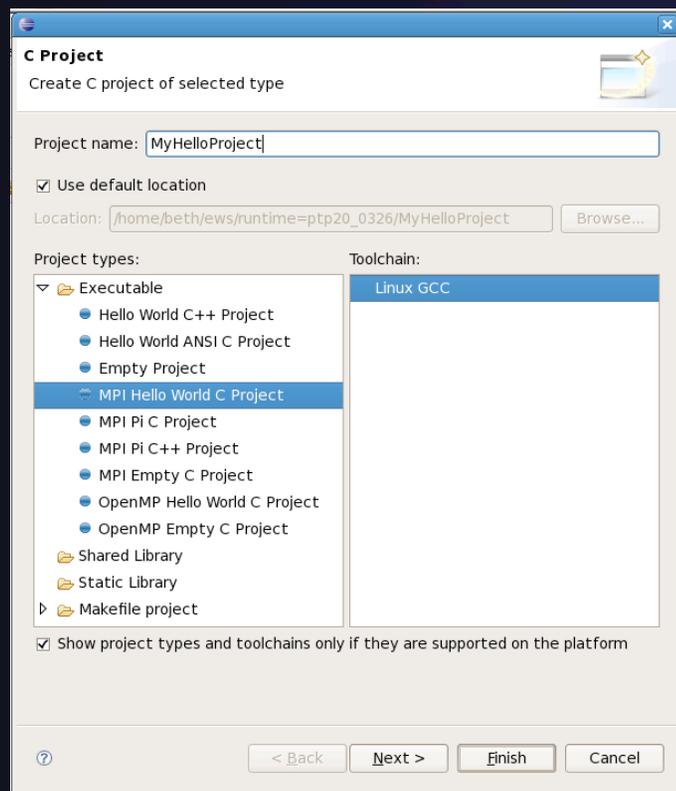
PTP/PLDT/CDT

Features

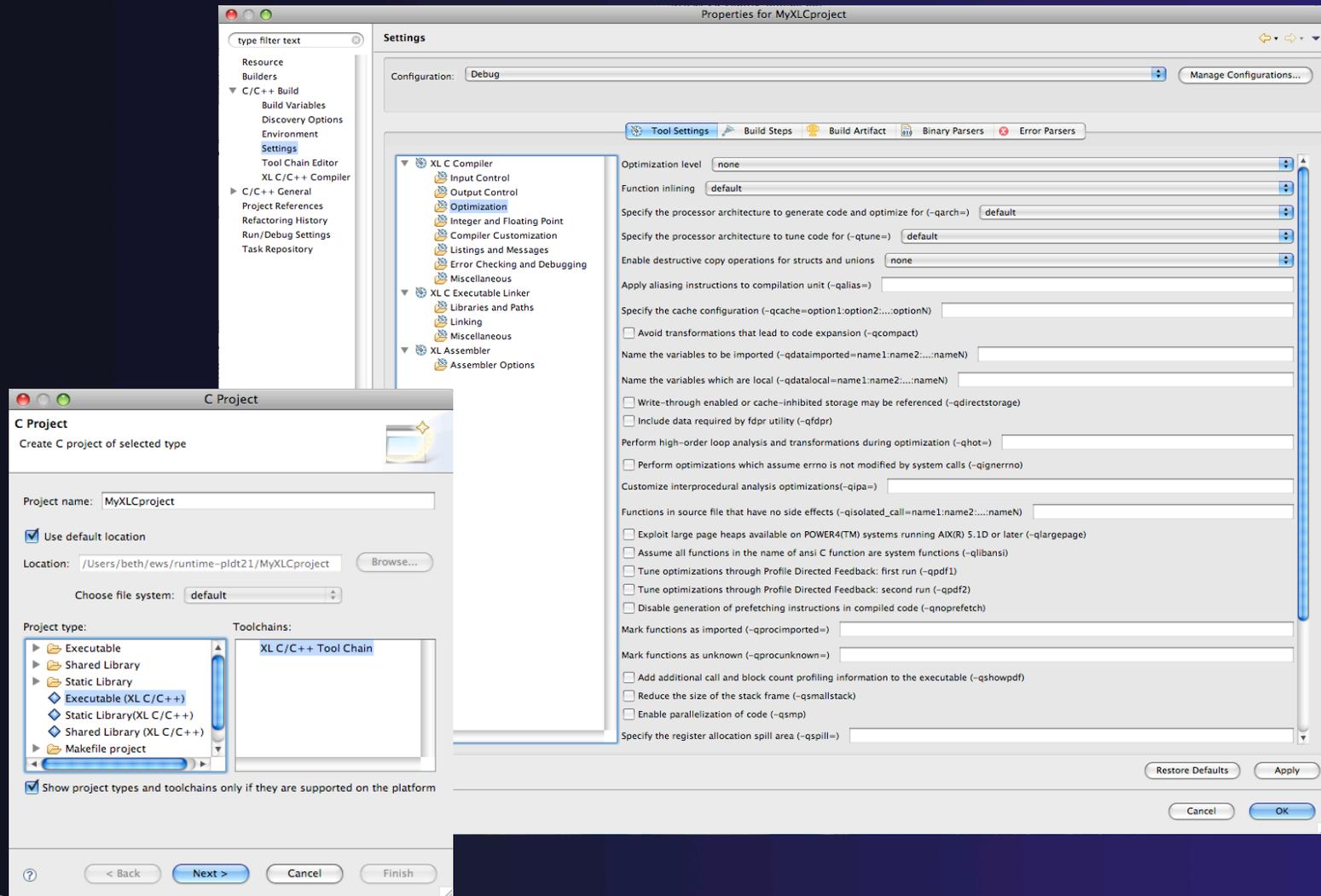
Assistance / Static Analysis tools

New Project Wizards

Create MPI, OpenMP projects for C/C++ with CDT



XLC project settings (CDT)



Content Assist

```
MPI_Ini|
/* find
MPI_Com
```

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

Initializes MPI.

- Ctrl-space expands possible completions
- Hover shows API info
- MPI, OpenMP, UPC supported

```
/* 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.

Help key shows API info in help view

```
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 com

Help X

MPI_Comm_rank

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

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

MPI Code Templates

- Allows quick entry of common patterns in MPI programming
- Example: MPI send-receive
- Enter: `mpisr <ctrl-space>`
- Expands to 

```
MPI_Comm_rank(MPI_COMM_WORLD, &rank);
MPI_Comm_size(MPI_COMM_WORLD, &p);
if (rank == 0){ //master task
    printf("Hello From process 0: Num processes: %d\n",p);
    for (source = 1; source < p; source++) {
        MPI_Recv(message, 100, MPI_CHAR, source, tag,
                MPI_COMM_WORLD, &status);
        printf("%s\n",message);
    }
}
else{ // worker tasks
    /* create message */
    sprintf(message, "Hello from process %d!", my_rank);
    dest = 0;
    /* use strlen+1 so that '\0' get transmitted */
    MPI_Send(message, strlen(message)+1, MPI_CHAR,
             dest, tag, MPI_COMM_WORLD);
}
```

- Extend to other common patterns

New in PLDT 2.1

UPC Assistance Tools

- Syntax highlighting
- since CDT 4.0
- UPC artifacts,
assistance tools
- PLDT

```

for(int kk=(M/B)*B;kk>=0;kk=kk-B)
{
  int m = min(M-kk,B); // lines in block
  if (MYTHREAD == upc_threadof (&A[kk][N-1]))
  {
    int one = 1;
    double alpha = 1.0;
    double * y = (double *)&A[kk][N-1];
    double a_kk [B*B];
    upc_memget(a_kk, &A[kk][kk], B*B*sizeof(double));

    dtrsm ("R", "L", "N", "N", &one, &m, &alpha, a_kk, &blk, y, &blk);
  }
  upc_barrier; /* wait for A[kk:kk+m][N-1] to be ready */
  /* broadcast A[kk:kk+m][N-1] everywhere */
  upc_all_broadcast(x_k, &A[kk][N-1], B * B * sizeof(double), 0);
  /* update A[ii:kk][N-1] vector */
  upc_forall ( /* ii = 0; ii < kk; ii+=B; &A[ii][N-1] */
  {
    double alpha = -1.0;
    double beta = 1.0;
    int n = min(M-ii,B);
    double a_ik [B*B];
    upc_memget (a_ik, &A[ii][kk], B*B*sizeof(double));
    double * y = (double *)&A[ii][N-1];

    dgemv("T", &m, &n, &alpha, a_ik, &blk,
          (double *)&x_k[0][MYTHREAD], &blk, &beta, y, &blk);
  }
}

```

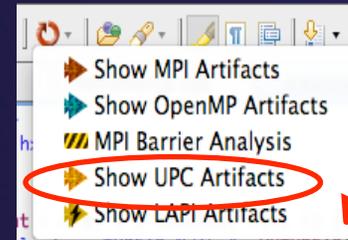
UPC Artifact View

UPC Artifact	Filename	LineNo	Construct
upc_threadof	backsolve.upc	20	Function Call
upc_memget	backsolve.upc	26	Function Call
upc_memget	backsolve.upc	40	Function Call

Find Artifacts

MPI, OpenMP, LAPI, UPC

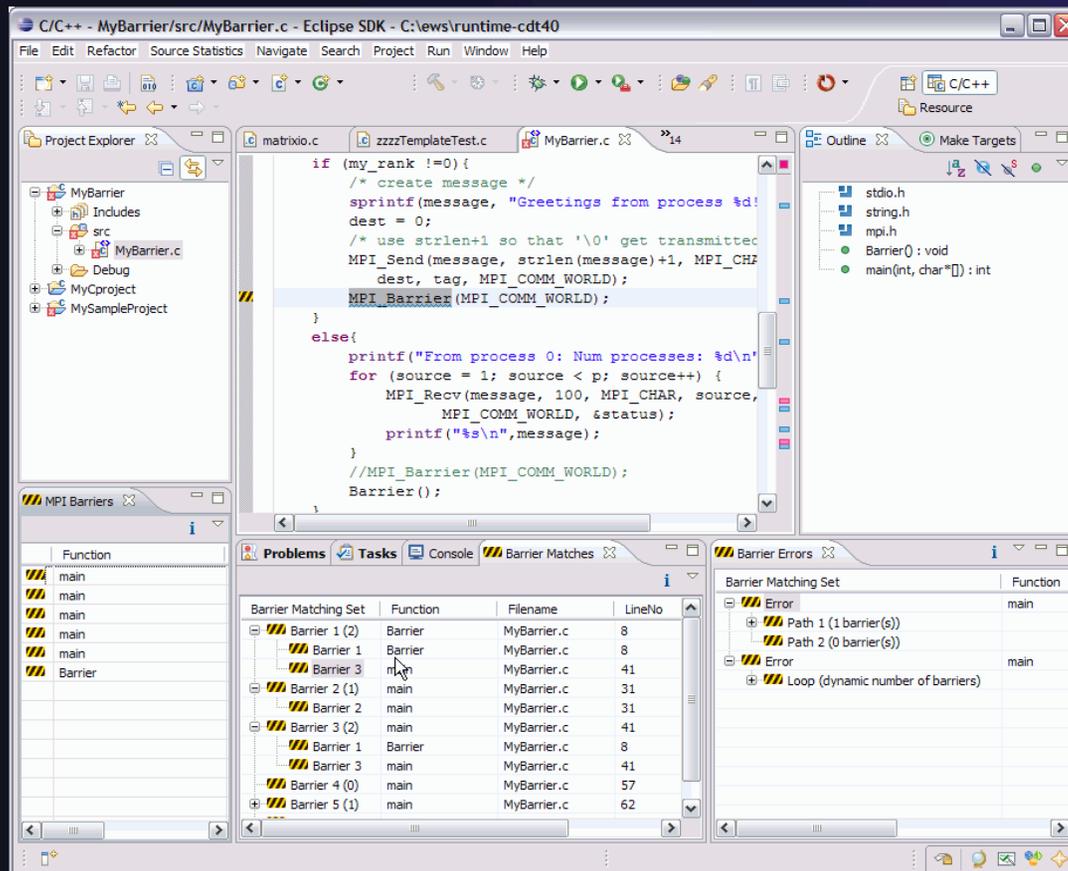
- Finds locations of MPI artifacts in source code
- Navigation to source code line
- Easy to find MPI communication, etc.



2.1

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

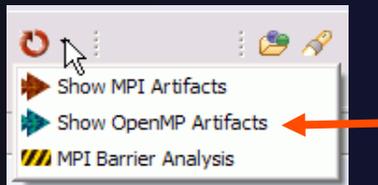
MPI Barrier Analysis



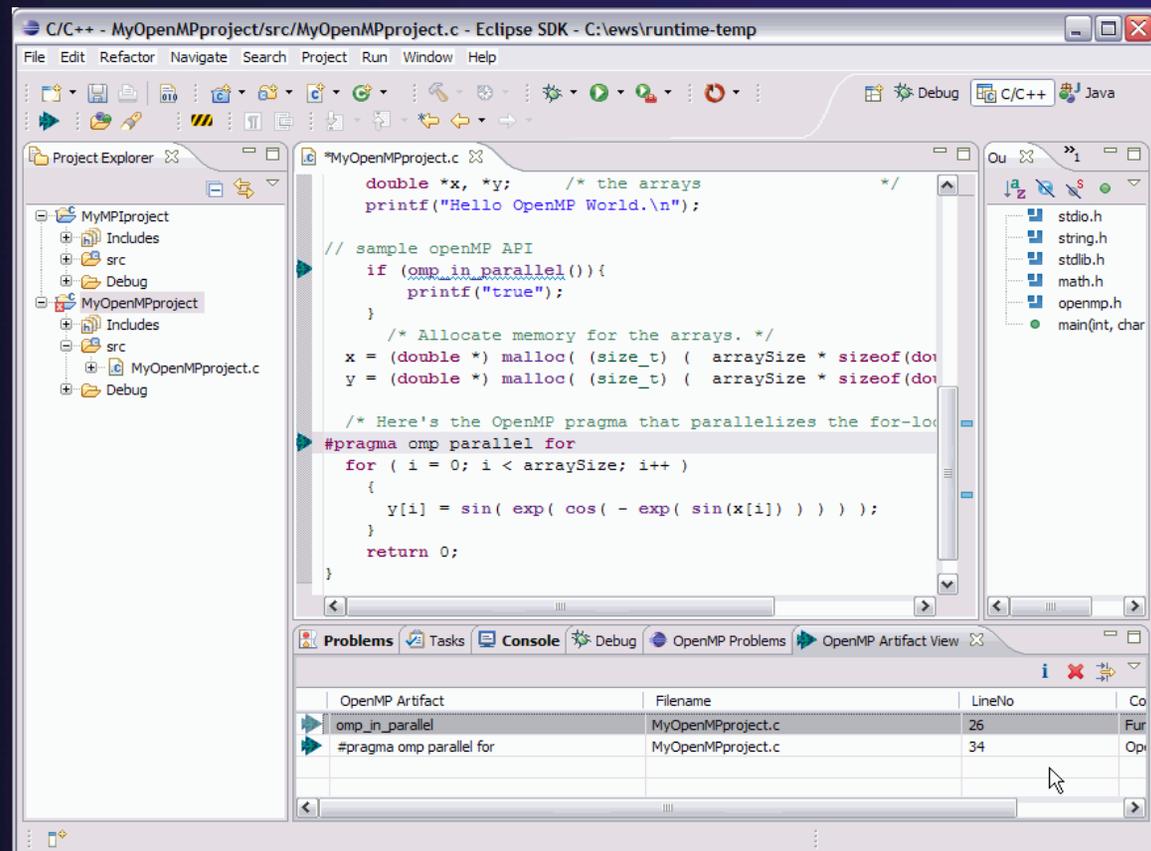
Verify barrier synchronization in C/MPI programs
Interprocedural static analysis outputs:

- ✦ For verified programs, lists barrier statements that synchronize together (match)
- ✦ For synchronization errors, reports counter example that illustrates and explains the error.

Show OpenMP Artifacts



- Show artifacts
- Show #pragma region
- Show common problems
- Concurrency Analysis



PTP / ~~Performance~~ Tools Framework*

External

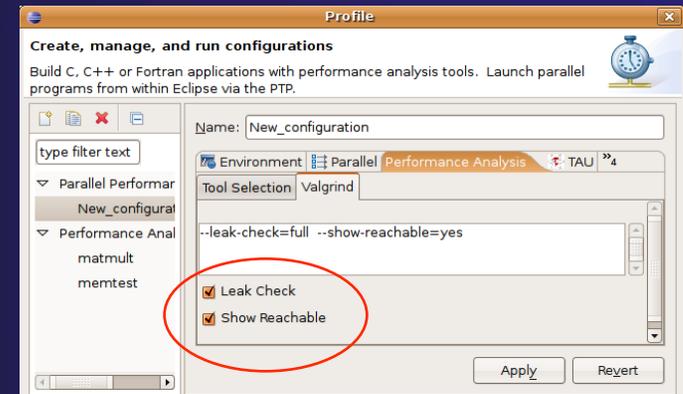
Reduce the "eclipse plumbing" necessary to integrate existing command-line based external tools

Approach:

- ★ Tool developer provides XML specifications for:
 - ★ Tool definition file to automatically generate of tool-specific GUI elements
 - ★ Tool workflows define compilation, execution, data collection, processing and visualization steps of tool operation
- ★ Tools are selected and configured in the launch configuration window
- ★ Tool output is generated, managed and analyzed as specified in the workflow
- ★ Compatible with Photran and CDT projects and with PTP parallel application launching

Integrated Tools:

- ★ U.Oregon TAU performance tools
- ★ IBM TaskFinder



Valgrind

```

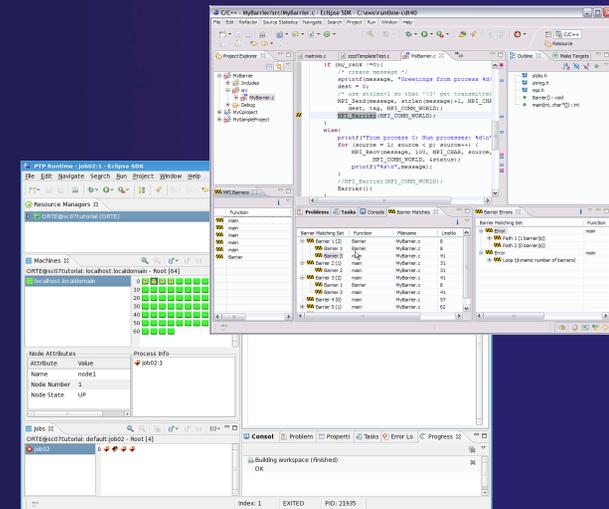
-<tool name="Valgrind">
-<execute>
  <utility command="bash" group="inbin"/>
  <utility command="valgrind" group="valgrind">
    <optionpane title="Valgrind" separateWith=" " >
      <togoption label="Leak Check" optname="--leak-check=full" tooltip="Full memory leak check"/>
      <togoption label="Show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

```

*Work done jointly with the TAU team at
the Univ. of Oregon

PTP Update

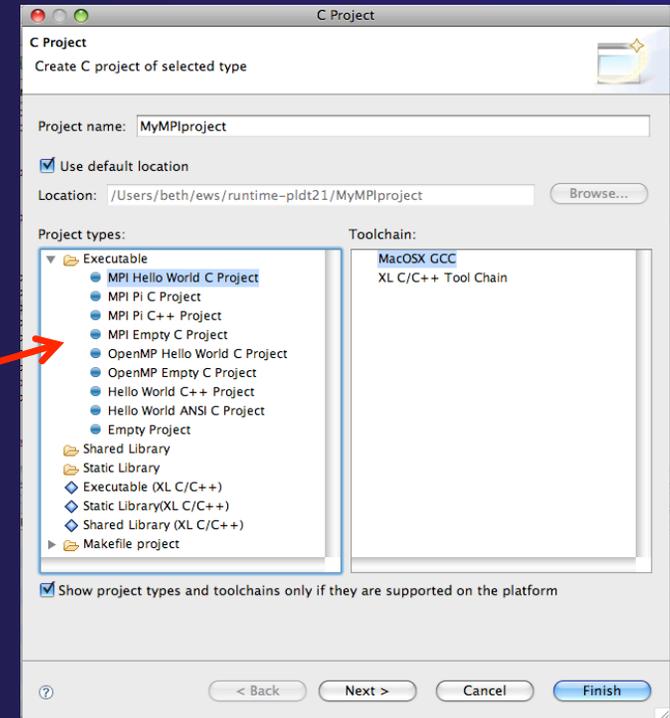
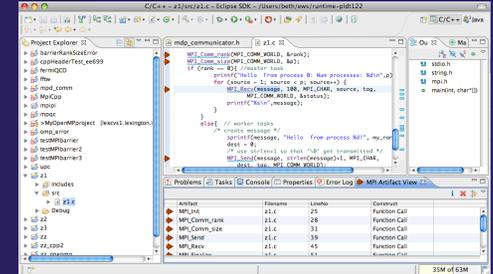
- ✦ **PTP Version 2.0 released in March, 2007**
- ✦ **PTP Version 2.1 release in Nov, 2008**
- ✦ **PTP Contributors:**
 - ✦ IBM
 - ✦ Los Alamos National Laboratory
 - ✦ Oak Ridge National Laboratory
 - ✦ University of Oregon
 - ✦ Monash University
 - ✦ Technical University of Munich
 - ✦ University of Tennessee
- ✦ **PTP User community building/ Tutorials:**
 - ✦ SC06, SC07 full-day hands-on tutorials
 - ✦ April '08: High Performance Computer Science Week (HPCSW)
 - ✦ May '08: Univ. of Texas at Austin (invited)
 - ✦ July '08: OSCON
- ✦ **Use of PTP for teaching High Performance Computing**
 - ✦ University of Kentucky
 - ✦ Technical University Munich
 - ✦ Calvin College ... and others
- ✦ **Adoption elsewhere**
 - ✦ NCSA
 - ✦ Defense Univ. of China, ... numerous other universities



Eclipse Ganymede (3.4) features: Parallel Tools & CDT

- ★ CDT Features
 - Increasing the usability of C/C++ tools for HPC users*
 - ★ Scalability Mode
 - ★ Remote project performance features
 - ★ Wizards for creation of remote projects
 - ★ Running UI tools on remote source files

- ★ PLDT (Parallel Language Development Tools) Features
 - Productivity improvements for developers of parallel codes*
 - New features for PLDT 2.1:*
 - ★ Add'l Wizards for project creation; more setup flexibility
 - ★ Now includes OpenMP, more choices for MPI
 - ★ UPC assistance features
 - ★ MPI Code templates

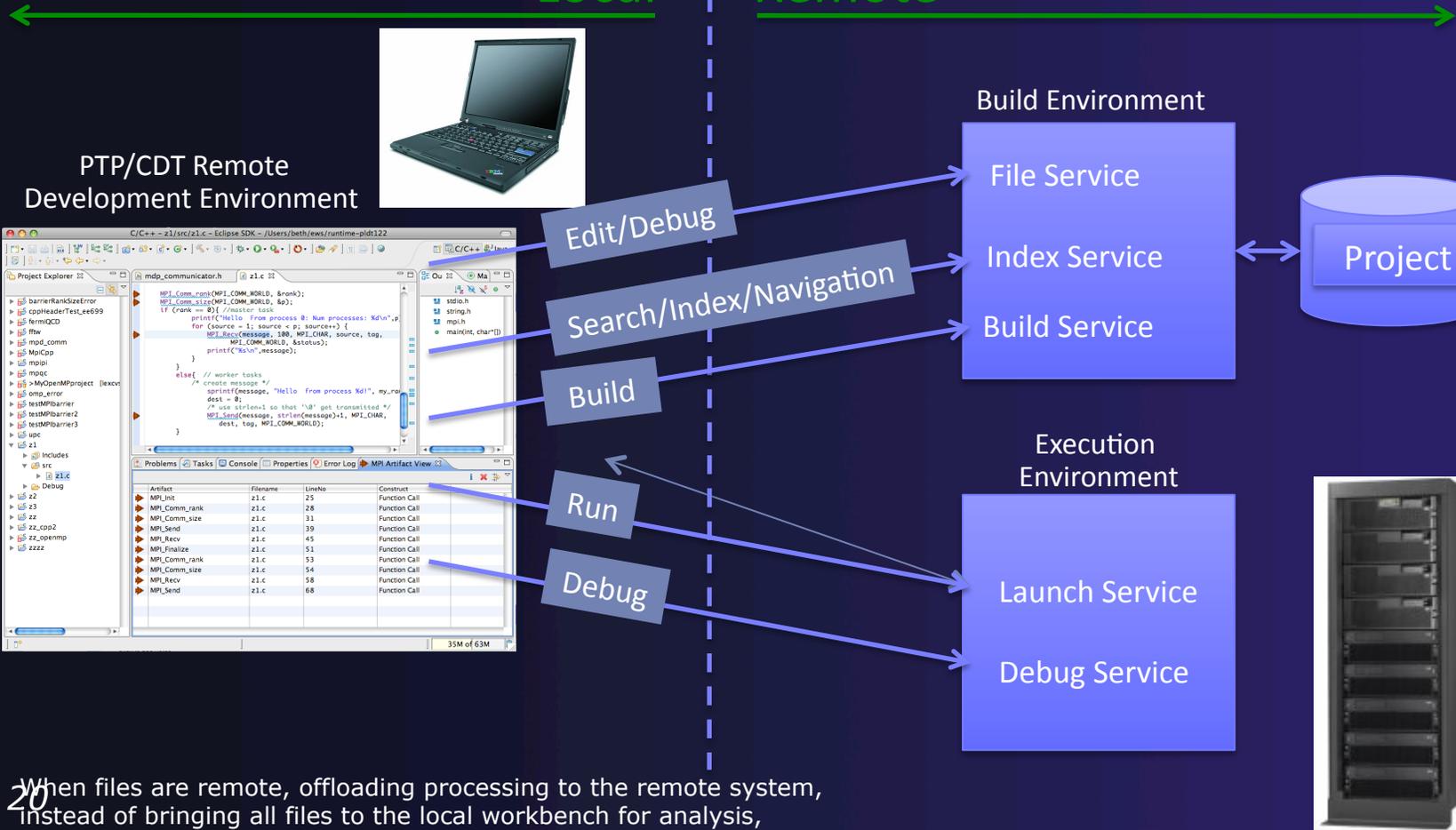


Remote Development

PTP 2.1 - contains RDT 1.0 (Nov. 2008)

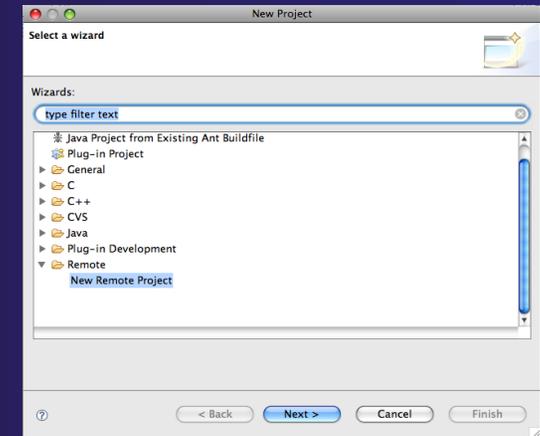
Local

Remote



When files are remote, offloading processing to the remote system, instead of bringing all files to the local workbench for analysis, Improves workbench responsiveness

Remote Dev. Tools (RDT)



Remote Indexing

New Remote C++ Project wizard extends CDT wizard

- Adds RDT remote project nature (way to identify all RDT projects)

- Presents a page to configure the service model (see below)

Remote Fast Indexer

- New indexer contributed to CDT indexer framework, configured via same UI as existing indexers

- Automatically reacts to resource deltas when the user modifies/adds/removes files in their project (prototype didn't do this)

- Allows user to manage their project via existing Project Explorer (prototype required RSE UI and had no real notion of projects, just a flat file system)

Service Model

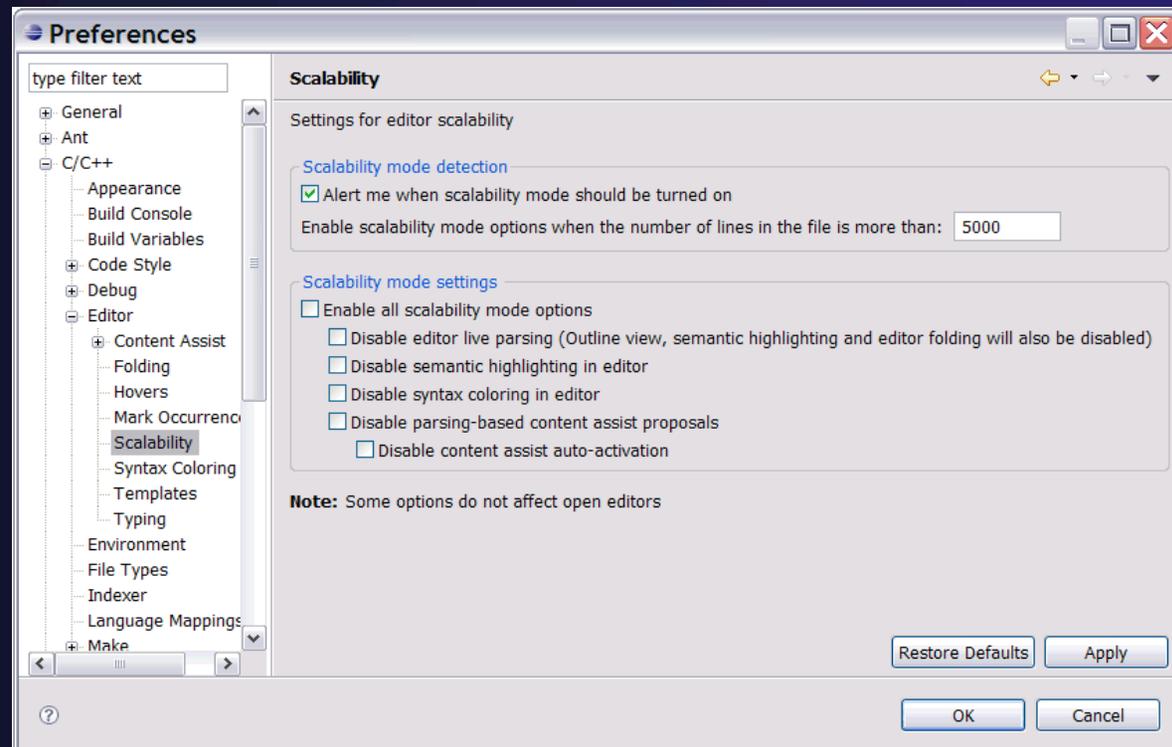
- Dictates which services are used in a given project and a mapping of services to service providers

- Allows for different services to be served from different machines, including the local machine (prototype was hardcoded for a single remote machine)

CDT : Scalability Mode

- ✦ Editor Scalability Mode
- ✦ Detects when large files are being opened in the editor and prompts the user to enter Scalability Mode
- ✦ Various features are then disabled (all by default, or can be re-enabled piecemeal)
- ✦ Features that are scaled:

- ✦ Not part of PTP, but useful for HPC users



PTP 2.1 Features

PTP Core

- Resource Managers-
 - New more flexible resource manager for Open MPI. This resource manager does not require a proxy agent to be running on the target system, and can be use as a template to target other MPI implementations. It also works with Open MPI 1.2 and 1.3.
 - Improvements to the Parallel Environment resource manager, as well as support for the new debugger.
- Parallel Debugger-
 - Removed the dependency on MPI. This allows the debugger to work with virtually any MPI implementation.
 - Flexible architecture allows different routing and communication layers
 - Full asynchronous command support
- Parallel Language Development Tools (PLDT) –
 - Unified Parallel C (UPC) support
 - MPI code templates
- External Tools Framework (formerly the Performance Tools Framework) ...

PTP 2.1 Features

Remote Development Tools

- Enables C and C++ projects to be located on a remote machine
- Provides remote indexing and parsing services
- New remote C/C++ project wizard
- Automatic source code delta handling (the index is automatically updated when files in your project are added/removed/changed)
- Remote "scanner info" support to allow the user to define include paths and defined preprocessor macros as a context for the parser to operate
- Remote Search, Call Hierarchy, Navigation (e.g. Go To Declaration), Content Assist, Type Hierarchy
- Remote Standard Make for building remote makefile-based projects

PTP 2.1 Features

Cell B.E. IDE

Now part of PTP Eclipse project

- Custom source code templates for Cell development
- Full configurable build properties for PPU and SPU using GNU and XL compilers
- Managed Build for PPU and SPU using GNU and XL compilers
- Remote launch and debug of Cell Applications
- Support for PPU & SPU combined remote debugger
- Cell performance tools support
- ALF programming model support
- IBM PDT (Performance Debug Tools) instrumentation plugins..
- Mambo Simulator plugins
- Five pre-configured Cell projects

Let's hear from others

- ★ IBM PE/LoadLeveler plugins
 - ★ Dave Wootton, IBM (PE/LoadLeveler Plugins)
 - ★ Wyatt Spear, U.Oregon (ETF, Perf. Tools)
 - ★ Jay Alameda, NCSA (PTP in Blue Waters)
 - ★ Jeff Overbey (proxy), UIUC (Photran)

Photran

- ✦ Eclipse support for Fortran
- ✦ Originated at UIUC

Photran

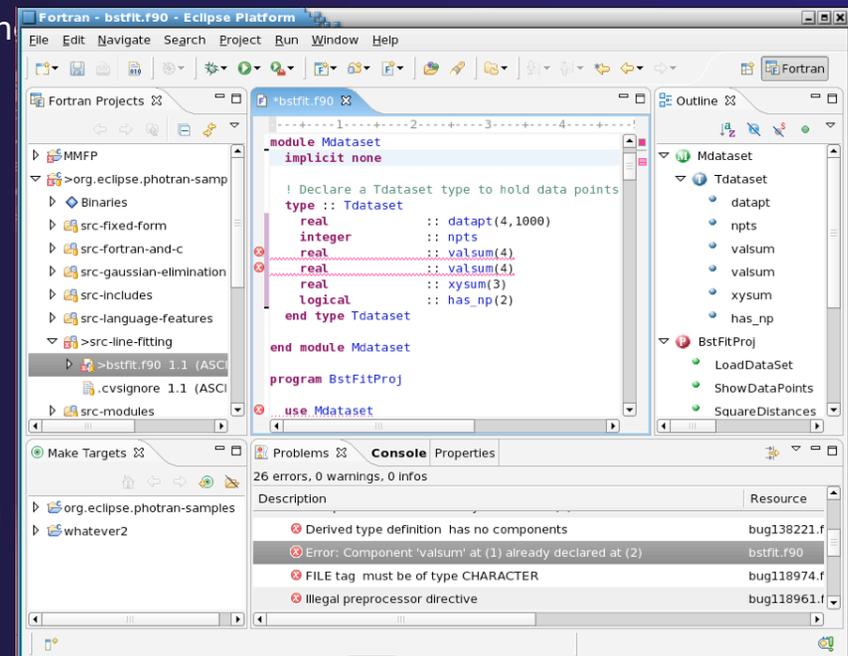
- ✦ Eclipse support for Fortran
- ✦ Originated at UIUC



Photran: Fortran for Eclipse

- ★ Fortran support for Eclipse
- ★ Current beta release: Photran 4.0 beta 4 (CDT 5.0, Eclipse 3.4)
- ★ Many features stable from previous versions: editor/syntax highlighting, Outline view, gdb GUI, binary launcher, Fortran compiler error parsers, Open Declaration, Rename refactoring, Introduce Implicit None refactoring
- ★ New features in this beta (features added during 2008): content assist, Fortran Declaration view, Find All References, many internal improvements to the refactoring engine
- ★ Under active development:
 - ★ Fortran 2003 support (Fortran 2008 soon)
 - ★ Type checker and related refactorings (e.g., Extract Local Variable, Extract Subprogram)
 - ★ Common Block refactorings
 - ★ C preprocessor support
- ★ Requested next:
 - ★ Content Assist, the Declaration View, and Find All References.
- ★ Photran project may join PTP project soon

<http://eclipse.org/photran>



Jeff Overbey, UIUC

Mailing list: Photran-dev@eclipse.org

Wrap-up

- ✦ Questions?
- ✦ Comments?

<http://eclipse.org/ptp>
Mailing Lists

Let us hear from you!