Parallel Tools Platform SC08 BOF 5:30-7:00 PM, 11/19/08





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<u>File Edit Refactor Navigate Search Run Project Window Help</u>

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

Local

and

Remote



C/C++ - MvMPIproject/src/MvMPIproject.c - Eclipse

MPI, OpenMP, UPC program Analysis Tools

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

Attribute

Name

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Building workspace (Finished)

Smar...sert 14 : :



PTP Debugger

And... ♦ External Tools Framework \diamond Performance Tools

PTP BOF @ SC08 Agenda

parallel tools platform

- 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



PTP: Parallel Tools Platform

```
A word about versions
                                    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.
- <u>Decoupled remote development model</u> 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

e	×			
C Project Create C project of selected type		MPI Project Settings Select the MPI include pa	th. lib name. library search path. and build	~
Project name: MyHelloProject		command information to b	e automatically be added to the new project	
☑ Use default location	4	Add MPI project setti	ngs to this project	
Location: [/home/beth/ews/runtime=ptp20_0326/MyHelloProject Bi	rowse	✓ Use default information)n	
Project types: Toolchain:		Include path:	/usr/local/include	Browse
マ ▷ Executable Linux GCC				2.50000
Hello World C++ Project Hello World ANGL C Project		Library name:	mpi	
Empty Project		Library search path:	/usr/local/lib	Browse.
🐡 MPI Hello World C Project				
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MPI Pi C++ Project		MPI link command:	mpicc	
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✓ Show project types and toolchains only if they are supported on the plat	tform	? < <u>B</u> a	ack <u>N</u> ext > <u>F</u> inish	Cancel
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XLC project settings (CDT)

$\Theta \cap \Theta$		Properties for MyXLCproject
(type filter text ③	Settings	(\$+\$)+ ▼
Resource Builders	Configuration: Debug	Manage Configurations)
▼ C/C++ Build Build Variables		
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Environment Settings		💭 rooracennya go anno stepa 🛣 bund Artinaet 🔠 binary raisera 🧭 error raisera
Tool Chain Editor XI. C/C++ Compiler	XL C Compiler	Optimization level none
► C/C++ General	Output Control	Function inlining default
Project References Refactoring History	Optimization Integer and Floating Point	Specify the processor architecture to generate code and optimize for (-qarch=) default
Run/Debug Settings Task Repository	Compiler Customization	Specify the processor architecture to tune code for (-qtune=) default
	Error Checking and Debugging	Enable destructive copy operations for structs and unions none
	Wiscellaneous XL C Executable Linker	Apply aliasing instructions to compilation unit (-qalias=)
	Libraries and Paths	Specify the cache configuration (-qcache=option1:option2::optionN)
	Miscellaneous	Avoid transformations that lead to code expansion (-qcompact)
	XL Assembler	Name the variables to be imported (-qdataimported=name1:name2::nameN)
		Name the variables which are local (-qdatalocal=name1:name2::nameN)
O C Project		Write-through enabled or cache-inhibited storage may be referenced (-qdirectstorage)
C Project		Include data required by fdpr utility (-qfdpr) Perform high order loss analysis and transformations during antimization (abot-)
Create C project of selected type		Perform nigh-order loop analysis and transformations during optimization (-qnot=)
		Customize interprocedural analysis optimizations(-pipa=)
Project name: MyXLCproject		Functions in source file that have no side effects (-oisolated, call=name1:name2::nameN)
V Use default location		Exploit large page heaps available on POWER4(TM) systems running AIX(R) 5.1D or later (-glargepage)
	Browice	Assume all functions in the name of ansi C function are system functions (-glibansi)
Location: /osers/beth/ews/runtime-plot21/MyxLCproject	browsen	Tune optimizations through Profile Directed Feedback: first run (-qpdf1)
Choose file system: default \$		Tune optimizations through Profile Directed Feedback: second run (-qpdf2) Disable generation of prefetching instructions in compiled code (-gnoprefetch)
Project type: Toolchains:		Mark functions as imported (-qprocimported=)
Executable	n	Mark functions as unknown (-gprocunknown=)
Shared Library		Add additional call and block count profiling information to the executable (-qshowpdf)
Executable (XL C/C++)		Reduce the size of the stack frame (-qsmallstack)
Static Library(XL C/C++)		Enable parallelization of code (-qsmp)
Shared Library (XL C/C++) Akefile project		Specify the register allocation spill area (-qspill=)
·())		(Restore Defaults) (Apply
Show project types and toolchains only if they are supported on	the platform	
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Content Assist

MPI_Ini				
•	MPI_Init(int *, char ***) int		Initializes MPI.	
/* find 💿	MPI_Init_thread(int *, char ***	, int, int *) int		
MPI_Com	MPI_Initialized(int *) int			
	and the second			
/* find o	ut process rank */			
MPI_Comm_	rank (MPI_COMM_WORLD,	&my_rank);		
Name: MPI_C	omm_rank			
Description:	It MPI_Comm_rank(MPI_Comm, in	nt *)		
Returns the ra	nk of the local task in the group a	associated with a co	ommunicator.	

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

Help key shows API info in help view

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

Press 'F2' for foc



New in PLDT 2.1

MPI Code Templates

```
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++) {</pre>
            MPI_Recv(message, 100, MPI_CHAR, source, tag,
                  MPI_COMM_WORLD, &status);
            printf("%s\n",message);
        3
    }
    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);
    ł
```

•Extend to other common patterns

New in PLDT 2.1

UPC Assistance Tools

Syntax highlighting

since CDT 4.0

UPC artifacts,

assistance tools
PLDT



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.







MPI Barrier Analysis

😂 C/C++ - MyBarrier/src/MyB	Barrier.c - Eclipse SD	K - C:\ews\runtin	ne-cdt40				_ 0 🛛
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	Barrier 2	main	MyBarrier.c	31			
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	Barrier 4 (0)	main	MyBarrier.c	57			
	🕀 🚧 Barrier 5 (1)	main	MyBarrier.c	62	▼		
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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:
 - <u>Tool definition file</u> to automatically generates of toolspecific GUI elements
 - <u>Tool workflows</u> 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

	Profile	×
Create, manage, an Build C, C++ or Fortrar programs from within E	d run configurations applications with performance analysis tools. Launch parallel clipse via the PTP.	
type filter text ▼ Parallel Performar New_configural ♥ Performance Anal matmult memtest	Name: New_configuration Image: Environment Image: Performance Analysis Tool Selection Valgrind leak-check=full show-reachable=yes Image: Leak Check Image: Show Reachable Apply F	»4

Valgrind



*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



\varTheta 🔿 🔿 C Pr	roject
C Project Create C project of selected type	
Project name: MyMPlproject Vuse default location Location: //Users/beth/ews/runtime-pldt21/M	AyMPIproject Browse
Project types: Project types: Project types: Project WPI Pi C Project	MacOSX GCC XL C/C++ Tool Chain
Show project types and toolchains only if th	ey are supported on the platform

Next >

Finish

Cancel



parallel tools platform Remote Dev. Tools (RDT)

Select a wizard		
Wizards:		
type filter text		
 ※ Java Project ※ Plug-in Proj ▷ ⊘ Ceneral ▷ ⊘ C++ ▷ ⊘ C++ ▷ ⊘ Cvs ▷ ⊘ Plug-in Dev ♥ ⊘ Remote New Remote 	from Existing Ant Buildfile ject velopment te Project	
0	< Back Next > C	ancel Finish

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



parallel tools platform

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 FortranOriginated 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 Referen 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

Jeff Overbey, UIUC Mailing list: Photran-dev@eclipse.org

http://eclipse.org/photran



Wrap-up

Questions? Comments?

http://eclipse.org/ptp Mailing Lists

Let us hear from you!