Module 7: Advanced Development

parallel tools platform

Objective

- Become familiar with other tools that help parallel application development
- Contents
 - Parallel Language Development Tools: MPI, OpenMP, UPC
 Overview of UPC tools
 - Performance Tuning and other external tools:
 - ◆PTP External Tools Framework (ETFw), TAU
 - Parallel Performance Wizard (PPW)
 - MPI Analysis: GEM (Graphical Explorer of MPI Programs)

Eclipse UPC Features

parallel tools platform

+ CDT:

- Parser/Editor support
- Code templates
- + IBM XLc (incl. xIUPC) remote
- Berkeley UPC toolchain local (see backup slides)

♦ PTP:

- Artifact identification; Hover/dynamic help assistance
- More Code templates
- Remote UPC parsing and builds with xlupc
- Parallel Performance Wizard integration with PTP

Demo

CDT - UPC Support

- Filetypes of "upc" will get UPC syntax highlighting, content assist, etc.
- Use Preferences to change default for *.c if you like (we'll show you how)



UPC Content Assist, Hover Help

- In Editor, type upc and hit controlspace (once)
- A list of possible completions is provided.
- Choose with mouse or cursor.

12 int main(int argc, char *argv[]) { 13 printf("Hello, I am %d of %d.\n", MYTHREAD, 14 15 upc_ 16 o upc_affinitysize(.,) 17 upc_all_lock_alloc(void) : * 18 upc_global_exit(int) : void 19 upc_global_lock_alloc(void) : * 20 upc_lock(*) : void 21 upc_lock_attempt(*) : int 22 int upc_lock_init(*) : void 23 int 24 upc_unlock(*) : void int 25 upc_ < 26 Press '

Space' to show Template Propos

parallel tools platform

Hover over API
Hyperlink too





UPC templates - viewing/adding

- Eclipse preferences: add more! Or just see what's there
 - + C/C++ > Editor > Templates

		Pref	erences		
type filter text ③	Templates				<
▶ General	Create edit or re-	move templates			
▼C/C++	create, edit of rei	nove templates.			
Appearance	Name	Context	Description	Auto Insi	New
▶Build	✓ if	C/C++	if statement	on	<u> </u>
Code Style	ifelse	C/C++	if else statement	on	
▶ Debug	🗹 main	C/C++	main method	on	Edit
▼Editor	🗹 mpiif	C/C++	MPI_Init and Finalize	on	
Content Assis	M mpisr	C/C++	MPI Send Receive	on	(Remove)
Folding	🗹 namespace	C/C++	namespace declaration	on	
Hovers	🗹 new	C/C++	create new object	on	
Mark Occurre	stderr	C/C++	print to standard error	on	(Restore Removed)
Save Actions	Stdout	C/C++	print to standard output	on	
Scalability	switch	C/C++	switch case statement	on	(Revert to Default)
Syntax Colori	🗹 try	C/C++	try catch block	on	
Templates	vpc_forall	C/C++	upc_forall loop	on	
Typing	🗹 upc_init_shar	ed_cC/C++	Initialize a UPC shared array	on	Import
Environment	🗹 upc init share	ed_aC/C++	Initialize a UPC shared array	on	
File Types	upc_max_bloc	cksi C/C++	UPC_MAX_BLOCKSIZE keywo	on	Export
Indexer	🗹 usina	C/C++	using a namespace	on	* Export
Language Mappi		*****			
▶New CDT Project	Preview:				
▶ Property Pages S					171
Task Tags	2.04. 0.527.				_
Template Defaul	int \${1};		# 542 8 # 542 F# 542 7		
▶Help	upc_forall(\${	1}=0; \${1} <n;< td=""><td>\${1}++; &\${A}[\${1}]) {</td><td></td><td></td></n;<>	\${1}++; &\${A}[\${1}]) {		
▶Install/Update	\${A}L\${L}	j= <init value=""></init>	•;		<u> </u>
▶Parallel Tools	3				Ŧ
🕨 Remote Systems 🛛 🍟					
▶Remote Tools	Use code form	atter			
▶Run/Debug		accer			
Service Configuration			Re	store Defa	Apply
4 () Þ					
?			(Cancel	ОК

Show UPC Artifacts

parallel tools platform

Add some UPC api's to your sample project

Show UPC Artifacts



Other UPC features

parallel tools platform

UPC parser is remote-enabled

- Remote UPC projects can be developed efficiently
- Remote xIUPC toolchain enables remote build of IBM xIUPC project
 - Managed Build (user-friendly) way to specify and manage complex build options without makefiles

More Advanced Features: Demos

parallel tools platform

 ETFw – External Tools Framework and TAU, Tuning and Analysis Utilities
 Wyatt Spear, U. Oregon
 PPW – Parallel Performance Wizard
 Max Billingsley III, U. Florida
 GEM – Graphical Explorer of MPI Programs Dynamic Formal Verification for MPI
 Alan Humphrey, U. Utah

PTP/External Tools Framework

formerly "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



parallel tools platform

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
- Compatible with Photran and CDT projects and with PTP parallel application launching
- Other plug-ins launch Paraprof from Eclipse too





TAU Integration with PTP

- TAU: Tuning and Analysis Utilities
 - Performance data collection and analysis for HPC codes
 - Numerous features
 - Command line interface
- The TAU Workflow:
 - Instrumentation
 - + Execution
 - Analysis



Parallel Performance Wizard (PPW)

- Full-featured performance tool for PGAS programming models
 - Currently supports UPC, SHMEM, and MPI
 - Extensible to support other models
 - PGAS support by way of Global Address Space Performance (GASP) interface (http://gasp.hcs.ufl.edu)
- PPW features:
 - Easy-to-use scripts for backend data collection
 - User-friendly GUI with familiar visualizations
 - Advanced automatic analysis support
- More information and free download: http://ppw.hcs.ufl.edu



parallel tools platform











PPW Integration via ETFw

- We implement the ETFw to make PPW's capabilities available within Eclipse
 - Compile with instrumentation, parallel launch with PPW
 - Generates performance data file in workspace, PPW GUI launched
- PPW is often used for UPC application analysis
 - ETFw extended to support UPC
 - Many UPC features in PTP
- + For more information:
 - http://ppw.hcs.ufl.edu
 - ppw@hcs.ufl.edu

2		prome commun	annone			
Create, manage, an	d rup configurations					
creace, manage, and	aren comgaracions					- (25)
						<u> </u>
19 De 18 ID 8-						
⊔ ≊ • + -2*•		Name restProject				
type filter text		🚯 Debugger 🕅 Argument	s 📴 Source 📠 Envi	ronment 🗖 Comm	or Performance Ane	lyeis "a
🕨 Launch Group		Tool Selection	199W Cornailer Wr	apper UPC	PPW Program Bun	- LIEC
→ Parallel Performa	ance Analysis	- ou select on			r a riogramman	one p
testProject		ind functions and ocal				
Performance An	alys s					
		instrument functions				
		Record date for shared-li	ocal accesses			
		Use polite synchronizatio	on			
_						
C		Profile Cont	figurations			
Create, manage,	and non-configurations					
	k					
		Name: cestProject				
type filter text		Dobuggor (00- Arou	monts 🕄 Source 🕅	= mireament (=	Common Porforman	neo Analysis "
I launch Grou	dı.		June Come	uler Wanner Lun	PUW PRAM	miun - un
	ormance Analysis	• Dursciellun	Prive Comp	nita w appearente.	FEWFING	
testProjec	r t	and a second sec				
Eertormance	- Analusie	Take commissais				
	27 mary and					
		i ⊨nable tracing				
	_			/		
	A Parallel Performance Wize	ard - sar_upc_v1_5_t.par				
	Parallel Performance Wize Ele Edit Options Analysis Hel	ard - sar_upc_v1_5_t.par p				
	Parallel Performance Wizz Ele Edt Options Analysis Hel SAR v1	ard - sar_upc_v1_5_t.par p Profile Charts Profile Table Tree Tel	ble Data Transfers Arr	ay Distribution Analysis	8	
	Parallel Performance Wize Ele Edt Options Analysis Hel SAR V1 SAR V1 Sar ucc V1 0 Liber Ser ucc V1 12 Liber	ard - sar_upc_v1_5_t.par p Profile Charts Profile Table Tree Ta	Deta Transfers Arr	ay Distribution Analysi	8	
	Parallel Performance Wizz Ele Edt Ostions Analysis Hel SAR v1 SAR v1 e Sar_usc_v1_5_t.par e sar_usc_v1_12_t.par	ard - sar_upc_v1_5_t.par p Profile Charts Profile Table Tree Tab	Deta Transfers Arr	ay Distribution Analysi Metric: Time	s Thread: Al	Threads
	Parallel Performance Wizz Pe Edt Options Analysis Hel Compared Star V1 Compared Star V1 Compared Star V1_12_tper	ard - sar_upc_v1_5_t.par p Profile Charts Profile Table Tree Tab Name	Deta Transfers Arr Calisite	ay Distribution Analysi Metric: Time Total - S	s Thread: All	Threads
	Parallel Performance Wizz Efe Edit gotons Analyss (sel SAR v1 SAR v1 SAR v1 Sar_ucc_v1_51_case Sar_ucc_v1_12_cpar	ard sar_upc_v1_5_t.par p Profie Charts Profie Table Tree Tab Name > Application - • Lose man	Deta Transfers Arr Calisite	ay Distribution Analysis Metric: Time Total - S 138.84714 s 138.0292 s	s Thread: All telf Colls 23.81195 ms 54.94937 ms	Threads
	Parallel Performance Wizz ble tak options gradyss ten Solver 1 • Solver 1	ard -sar_upc_v1_5_1.par p Profile Charts Profile Table Tree Tal Name > Application -> setundh_congression	De Data Transfers Arr Collete Ser_upc_v1.c113 azmuth_compres	ay Distribution Analysis Metric: Time Total • 5 138.84714 s 130.02302 s 69.02407 s	s Thread: All left Cols 23.81195 ms 54.94037 ms 69.02407 s	Threads
	Parallel Performance Wizz Ple tak gotors gnayse ten Se 20 SNev1 e assessed States e source v1_State e source v1_State	ard - sar_upc_v1_5_i.par p Profile churts Profile Table Tree Tal Name > Application = + use_man = + asmuth_compression > ange_migration	be Data Transfers Arr Callate Sar upc_v1.ct13 acmuth_compres range_migration	ay Distribution Analysis Metric: Time Total - 5 138.84714 s 130.02322 s 69.02407 s 23.15037 s	s 23.81195 ms 54.96027 ms 69.02407 s 23.15037 s	Treads
	Parallel Performance Wiz Be (dt gotors grakyse get Seviewerte grakyse get Seviewerte grakyse get Seviewerte grakyse get Seviewerte grakyse get	ard - sar_upt_v1_5_i.par p Rodia Charts Podia Table Tree Tal Name > Agaitation ⇒ Agaitation ⇒ Agaitation ⇒ Agaitation ⇒ Agaitation ⇒ Agaitation	Callate Sar_upc_v1.c113 acmuth_compress range_maption range_compress rande_compress rande_compress	ay Distribution Analyss Metric: Time Total • 5 138.84714 s 130.02302 s 69.02407 s 13.3102 s 69.02407 s 10.33102 s 6.8037 s 10.33102 s 6.8037 s 10.33102 s 6.8037 s 10.33102 s 6.8037 s 10.33102 s 6.8037 s 10.33102 s 1	s Thread: All edf Cals 23.81195 ms 69.02407 s 23.50307 s 18.33102 s 5.83900 s	Threads
Tite matched 4 of	Parallel Performance Wiz Be Edit gotons graiyse bei Saveri Saveri Saveri Saveri Saveri Saveri Saveri Saveri	ard ser_upc_v1_5_t.par p Profie charts Profie Table Tree Table Name > Argelaction ⇒ Ar	Callste Callste Sar_upc_v1.ct13 acmuth_compres range_migration range_repress util.c-44 acmuth_transfor	ay Distribution Analysis Metric: Time Total ▼ 5 138.84714 s 199.0232 s 69.02407 s 23.15037 s 18.33102 s 5.92800 µs 15.1001 s	s Thread: All set Cals 23.81195 ms 54.94027 ms 69.02407 s 23.15037 s 16.33002 s 5.92800 µs 15.02000 t s	Threads
Titer matched 4 of	Parallel Performance Wiz De tat gotors grayse ge Source grayse ge Source grayse ge Source grayse ge Source grayse grayse Source grayse grayse	ard - sar_upc_v1_5_Lpar p Profile charts Profile Table Tree Tal Name > Application ⇒ sust_man → sarut_compression → range_migration → ansut_pranform → acmut_pranform	de Data Transfers Arr Caliste sarupo_v1.ci13 amuth_compres range_migration uk.ci44 amuth_transfor	Arabysis Metric: Time 138.84714 s 138.84714 s 138.94714 s 139.94814 s 139.94814 s 139.94814 s 149.94814 s 149.94	K K K	Treads
The metched 4 of	Parallel Performance Wiz Be (dt options graiyse ge Seviet Seviet (t) Seviet (t) Seviet (t) Seviet (t) Seviet (t) Seviet (t)	ard sar_upt_v1_5_ipar p Rodie Charts (Poolie Table) Tree Tal Neme > Aquication ⇒	Calate Ser_upc_v1.cit3 acmuth_compres v1.cit.4 acmuth_tompres v1.cit.4 acmuth_transfor pre_upc_v1.cit20	ay Distribution Analysis Metric: Time Tokal - 5 138.047145 130.02322 6 09.02007 8 10.0300 p 16.0300 p 15.0300 15 10.7299 8 5.4000 15 10.7299 8 5.4000 15 10.7299 8 5.4000 15 5.4000 15 5.400000	Cols	Treads V
<u>Fler matched 4 of</u>	Parallel Performance Wizz Be tot goons analyse tel Second State Second State Second State Second State Second State Second State	and - sar_upc_v1_5_i.par p Profie Charts Profie Table Tree Table Name > Acquication ⇒	Data Transfers Arr Calate Say ppc_v1.cli3 armsh, compress vid.ord4 armsh, transfers yan ppc_v1.cli3 say ppc_v1.cli3 say ppc_v1.cli3 say ppc_v1.cli4	ay Distribution Analysis Metric: Time Total • 5 138.64714 100.02322 69.02407 80.0207 10.02332 10.0232 10.0232 10.02		Treads
The metched 4 of	Parallel Performance Wiz Be (dt gotors grahyse ges Society (dt gotors grahyse ges Society (dt gotors)	ard - sar_upr_v1_5_Lpar p notile charts Profile Table Tree Table > Aquitation ⇒ Aquitation	Caliste Sar_upc_v1.ci13 amm/h_compres ufi.c44 ammuh_transference sar_upc_v1.ci18 sar_upc_v1.ci18 sar_upc_v1.ci18 sar_upc_v1.ci19	ay Distribution Analysis Metric: Time 5 138.84714s	e V Treest: [Al 16] v Treest: [Al 16] 54,462776 54,462776 54,462776 54,462776 5,42600 pc 13,10001 s 10,72974 s 9,425293 1,11001 s 129,94463 ms 6,0012 s	Threads
The metched 4 of	Parallel Performance Wiz Be gåt gotons gravse ge Safavit	ard - sar_upc_v1_5_rar P Profile Charts Profile Table Tree Tal Neme > Aquidation ⇒ Aquidation ⇒ Harginguidan → Harginguid	Data Transfers Arr Calate Ser_upc_v1.ci13 amnth,somes range_nomerss udL.ci4 amnth,som(rs per_ucc_v1.ci10 se_upc_v1.ci72 fe_b.ci119	ay Distribution Analysis Methici, Time 138,4974.5 138,4974.5 138,4974.5 138,4974.5 138,00007.5 5,92000,15 10,7394.6 9,4450.5 10,7394.6 9,4450.5 10,7394.6 9,4450.5 1,11901.5 10,7394.6 9,4450.5 1,11901.5 10,9394.6 1,11901.5 10,9394.6 1,11901.5 10,9394.6 1,11901.5 10,9394.6 1,11901.5 10,9394.6 1,11901.5 10,9394.6 1,11901.5	Image: Control of the second	Trreads
<u>[]ler metched & of</u>	Parallel Performance Wiz Be tat gotors graves ge Source graves ge Source graves Source graves Source graves Source graves	and sar_upc_v1_5_i.par p Profie Charts [Profie Table Tree Table Name > Acalexation ⇒ Acale	Caliste Calist	ay Distribution Analysis Metric: Time Total ♥ 5 20.16007 + 20.16007 + 20.16007 + 20.16007 + 50.8000 µs 50.8000 µs 50.8000 µs 10.23003 + 10.23003 + 10.23003 + 10.23003 + 10.23003 + 10.25003 + 10	e V Treed: [AI 195 ms 54.94627 ms 54.94627 ms 54.94627 ms 54.94627 ms 54.94627 ms 5.92800 µs 15.02003 μs 1.15001 s 1.15001 s 1.15001 s 1.59245 ms 5.02007 ms 5.0	Treads
The matched 4 of	Parallel Performance Wiz Be (dt gotors grakyse gen Sevier	ard sar_upt_v1_5_Lpar P Rofile Charts [Profile Table Tree Tal Neme > Application > Application > Application > anoth_compression - anoth_compression	Data Transfers Arr Calate Sar upc_v1.ci13 amuth_comes range_compress ull.ci4 saruth_transfer poc_v1.ci19 file_col19 file_col19 file_col19 anuth_transfer	ay Distribution Analysis Metric: Time Total ▼ 5 138.04774 5 138.04774 5 138.04774 5 138.04774 5 138.04774 5 10.02026 2 0.02076 5 10.0210 5 10.	s 23.81195 ns 54.94027 ns 64.94027 ns 54.94027 ns 54.94027 ns 54.94027 ns 54.94027 ns 54.94027 ns 54.94027 ns 54.9402 ns 54.940	Threads
File metched 4 of	Parallel Performance Wiz Be (dt gotors graiys ge Source graiys ge Source graiges graiges Source graiges graiges Source graiges graiges Source graiges graiges	ard sar_upc_v1_5_t.par p Podia charts Profia Table Tree Tal Name > Application ⇒ Applicati	Calate Calate Sor_upc_vt.ct13 armsh, compress udi.c-44 armsh, uranform. Sor_upc_vt.ct19 file_loc.t19 file_loc.t19 file_loc.t20 armsh, tranform. udi.c-120 armsh, tranform. udi.c-12	ay Distribution Analysis Metric: Time Total • 5 138.04714 130.02326 69.02402 69.02402 10.02302 10.		Threads
<u>File</u> metched & of ?	Parallel Performance Wiz De Lot School Gudyse (en Second School Gudyse) Second School Gudyse Second School Gudyse Seco	ard - sar_upt_v1_5_Lpar p India charts Profile Table Tree Table > Aquitation > Aquitation	Data Transfers Arr Calate Sar upc_v1.cl13 sarmdh_compres v1.cl4 anmdh_transfer yngoto v1.cl4 anmdh_transfer yngoto	ay Distribution Analysis Metric: Time Total	e V Tread: [A 10 V Tread: [A 10 54,060776 54,060776 54,060776 54,060776 54,060076 54,060076 54,00005 54,0000 p 10,70904 s 54,0000 p 11,0001 s 10,07904 s 5,020706 1,02012 s 0,02076 1,02012 s 0,02076 1,02015 1	Threads
The matched 4 of	Parallel Performance Wiz. Be (dt options grakyse ges Se (dt options grakyse ges Se (dt options)	rd sar_upt_v1_5_i.par p Podla Charts [Podla Table] Tree Tal Name > Aquication ⇒	Data Transfers Arr Calate Sar_upc_v1ci13 amoth_iongress udi.c-4 amoth_iongress udi.c-4 saruch_iongress dif.c-4 saruch_iongress dif.c-4 saruch_iongress dif.c-4 amoth_iongress dif.c-4 amoth_iongr	ay Distribution Analysis Metrici, Time 138.04774 5 138.04774 5 100.02322 6 09.02402 6 09.02402 6 09.02402 6 09.02402 6 10.02322 6 10.02405 ap 10.04605 ap 1.02405 ap 1.02405 ap 1.02405 ap 1.02405 ap 1.02405 ap 1.02405 ap 1.02405 ap	s eff Colo 22.8.1195 ms 5.4.9027 ms 6.9.02497 s 1.2.1907 s 5.4.9027 s 1.3.3102 s 5.4.9027 s 1.1.1901 s 1.0.7924 s 5.4.002 s 1.1.1901 s 1.2.4.002 s	Threads
<u>File matched 4 of</u>	Parallel Performance Wiz De tat gotors gravyas ge So Solution gravyas Solution gravyas Solution graves are grav	and sar_upc_v1_5_Lpar p Profile charts Profile Table Tree Tal Name > Application ⇒ App	Calate Calate Sey upc_v1.ci13 sey upc_v1.ci13 armsh, compress udi.c-44 armsh, transform Sey upc_v1.ci163 Sey upc_v1.ci169 Sey upc_v1.ci169 file lo.ci19 file lo.ci170 armsh transform.c udi.c transform.c tran	ay Distribution Analysis Metric: Time Total v 5 20.10007 + 20.10007 + 20.10007 + 50.0000 + 50.0000 + 10.33002 + 50.0000 + 10.33003 + 10.33003 + 10.33003 + 10.33003 + 10.33015 + 10.35015 + 10.3515 + 10.35	e V Tread: [Al 195 ms 54.94627 ms 54.94627 ms 54.94627 ms 54.94627 ms 54.94627 ms 54.94627 ms 5.92800 µs 15.02003 ms 5.92800 µs 1.15001 s 1.027034 s 5.92800 µs 1.15001 s 1.02934 s 5.92800 µs 1.02934 s 5.92800 µs 1.02944 s 1.02944 s 1.02	Threads
The matched & of	Parallel Performance Wiz Be (dt gotors graiyse ge Softwil	ard sar_upt_v1_5_Lpar p notile charts [Profile Table Tree Table > Agailation ⇒	Cable Outa Transfers Arr Cable Sar_upc_v1.ci3 ammth_compes range_compress udi.cd4 sarupt_vardor sarupt_vardor sarupt_v1.ci34 sar	ay Distribution Analysis Metric: Time Total ▼ 5 138.84714 + 138.84714 + 138.8	e	Threads
The metched 4 of	Parallel Performance Wiz. Be (dt options graiyse gel Se (dt options gel	ard - sar_uptv1_5_i.par p Profile Charts Profile Table Tree Tal Neme > Aquilation ⇒ Aqui	Data Transfers Arr Calate Ser_upc_v1.cil3 amoth_compress uds.c4 amoth_compress uds.c4 ser_upc_v1.cil4 Ser_upc_v1.cil7 fe_bc.cil7 fe_bc.cil7 fe_bc.cil7 compress uds.c4 uds.c4 uds.c4 compress compress compress uds.c4 compress compress uds.c4 compress uds.c4 compress compress.	ay Distribution Analysis Methic: Time Total * 5 138.04714 5 138.04714 5 138.04714 5 138.04714 5 138.04714 5 138.04714 5 109.0405 5 9.42000 µ 1.11901 5 9.42000 µ 1.11901 5 9.42000 µ 1.11901 5 9.42000 µ 1.11901 5 1.02175 5 0.00125 5 0.	s s s 23.81195 ms 54.9027 ms 69.02407 s 53.9027 ms 69.02407 s 10.3300 s 5.90200 µs 10.7304 s 5.10001 s 10.7304 s 5.10001 s 10.7304 s 6.00112 s 2.00270 s 1.11401 s 5.0012 s 2.00270 s 1.3041 s 6.00112 s 2.00270 s 1.3041 s 5.0012 s 2.00270 s 5.0012 s 5.	Threads
The matched & of	Parallel Performance Wiz Be (dt gotors grahyse ges Societarian (dt gotors) Societarian Societarian Societarian Societarian Societarian	ard - sar_upt_v1_5_1.par p notile charts Profile Table Tree Table > Aquitation > Aquitation	Cable Data Transfers Ar Cable Sar, upc_v1.cl13 sarmsh, compres rengs, mysion vii.cl4 asmuth, transfers vii.cl4 sarmsh, transfers vii.cl4 sarmsh, transfers vii.cl19 fel.oc.170 asmuth, transfers vii.c	ay Distribution Analysis Metric: Time Total → 5 138.04774 ± 20.05207 ± 20.05207 ± 20.05207 ± 20.05207 ± 20.05207 ± 20.05207 ± 20.05207 ± 20.0520 ± 10.7390 ± 10.7390 ± 10.7390 ± 10.7390 ± 10.7391 ± 10.73	e V Tread: [A U V Tread: [A U 2.3 41156 ms 5.4 06077 ms 5.4 06077 ms 5.4 06077 ms 5.4 06007 ms 5.4 0000 s 1.3 00000 s 1.3 00000 s 1.3 00000 s 1.3 00000 s 1.3 00000 s 1.3 000	Threads
The matched 4 of	Parallel Performance Wiz ple (dt gotons grakyse gen Secure and the secure and	ard sar_upt_v1_5_Lpar p Rodie Charts [Poolis Table Tree Table > Application ⇒ Application	Data Transfers Arr Calate Sar_upc_v1.cill amoth_compest range_nomeress udi.c4t amoth_compress udi.c4t amoth_transfers file_bocill9 file_bocil0 file_bocil0 cdi.c cdi.cdi.c	ay Distribution Analysis Metric: Tme Total - 138.047745 138.047745 100.02222 00.02007 6 00.02007 6 00.02007 6 00.02007 6 103.04007 8 00.02007 6 103.04453 ms 00.02007 6 103.04453 ms 00.0212 5 0.02007 6 0.0212 5 0.02007 6 0.0212 5 0.02007 6 0.0212 5 0.02007 6 0.0212 5 0.0212 5 0.021	Cob Cob Cob Cob Cob S.4000 ps Cob S.4000 ps S.400	Threads
The metched 4 of	Barallel Performance Wiz De tot gotors graves ge ⇒ 0.54 v1 → 0.64 u2000 00000000 → 0.64 u2000 00000000000000000000000000000000	ard sor_up(_v)_5_1.par p notie charts Profis Table Tree Tel Aceletion → Aceletion → Acelet	Data Transfers Arr Calate se_upc_v1cil3 armsth_compress. range_compress. udi.c+4 armsth_transform. se_upc_v1cil03 se_upc_v1cil03 se_upc_v1cil04	ay Distribution Analyss Metric: Time Total v 5 20.10007 + 20.10007 + 20.10007 + 20.10007 + 20.10007 + 20.10007 + 10.33002 + 5.02000 µs 5.02000 µs 5.02000 µs 10.33003 + 10.33003 + 10.33003 + 10.33003 + 10.33015 + 10.3015	s → Tread: [A] 2.1 1195 ms 54.94627 ms 69.04007 s 54.94627 ms 69.04007 s 23.15007 s 1.13001 s 10.72034 s 5.02000 µs 1.13001 s 1.02034 s 5.02000 µs 1.13001 s 1.03011 s 1.0	Threads
The matched 4 of	Parallel Performance Wiz Be (dt gotors gradyse gen Second gradyse gen	rrd - sar_uptv1_5_1.par p notile charts [Profile Table Tree Table > Agailation ⇒ Agailation	Data Transfers Arr Cabate Sar_upc_v1.ci3 amoth_compest range_compress udi.cdt amoth_torners udi.cdt samoth_torners di.cdt samoth_torners di.cdt samoth_torners di.cdt samoth_torners udi.cdt samoth_torners udi.cdt samoth_torners udi.cdt conde 0 (i*num_valid_as*pp inputfile(ifile;) pain.hea 0 { cot reading input AIUDF2; } } }	ay Distribution Analyss Medici: Time Todal - 5 138.847145 138.847145 138.847145 138.847145 139.02222 0.022225 0.0225 0.02225 0.02225 0.02225 0.02255 0.02555 0.02555 0.02555 0.02555 0.0255 0.025555 0.02555 0.025555 0.025555 0.02555 0.0255555 0.0255555 0.0255555 0.0	e CAB → Thread: (AB 54,94027 ms 54,94027 ms 54,94027 ms 54,94027 ms 54,94027 ms 54,94027 ms 54,9402 ms 5	Threads
The matched 4 of	Parallel Performance Wiz Be (dt options grakyse get Se of the second seco	ard sar_upt_v1_5_i.par p Profile Charts [Profile Table] Tree Tal Name > Aquication ⇒ Aquicatio	Data Transfers Arr Calate Sar Jack - Vi.(13) amoth_compres range_compress ull.c-4 amoth_compress ull.c-4 saruch_transform.c vull.c-170 File loc.170 File loc.170 code 0 (input.claid_arrpi pat.head 0) (code code inputClaid_arrpi code code inputClaid_arrpi pat.head 0) (code code inputClaid_arrpi code code inputClaid_arrpi pat.head 0) (code code inputClaid_arrpi code co	ay Distribution Analysis Medici, Time Total * 138.047145 100.02322 6 00.02322 6 00.02322 6 00.02322 6 00.02322 6 00.02322 6 00.02322 6 00.0232 6 0.0232 6 00.0232 6	s eff Cab cat Cab 5.4,8407 ms 6.0,02407 ms 5.4,8407 ms 6.0,02407 s 1.13015 s 5.4,0207 s 1.13015 s 5.4,0207 s 1.11001 s 1.0,024 s 1	Threads
The metched & of	Property Value Prope	rrd - sor_upt_v1_5_1.par p notile Charts Profile Table Tree Table > Aquitation > Aquitation	Data Transfers Arr Calate Sar_upc_v1.cll3 ampth_compres renge_mignion di.c-4 sampth_tompres di.c-4 sampth_transfers di.c-4 fm_bo.cll9 fm_bo.cll9 fm_bo.cll9 fm_bo.cll9 informs_valid_ar*pp muputfil(file;) informs_valid_ar*pp muputfil(file;) informs_train(file;) fm_bo.cll9 informs_valid_ar*pp muputfil(file;) informs_valid_ar*pp in	ay Distribution Analysis Metric: Time Todal - S 138.847145 138.847145 138.847145 138.02217 23.10207 5.02007 5.0	e	Threads
The metched 4 of	Parallel Performance Wiz Performance Wiz Performance Wiz Performance Wiz Performance	ard sar_upt_v1_5_1.par p notile charts [Poolis Table Tree Table > Application ⇒ Applicati	Data Transfers Arr Calate Ss _upc_v1.cill amoth_compest. range_nomeress. uds.c4 amoth_compest. uds.c4 ss_upc_v1.cill0 Ss_upc_v1.cill0 file_bocill0 file_bocill0 file_bocill0 insuth_transform.c uds.c uds.c4 u	ay Distribution Analysis Medici: Time Toda - S 138.047745 138.047745 100.02222 100.02007 100	s 23.81195 ns 54.94027 ms 64.02407 ms 54.94027 ms 54.94027 ms 54.94027 ms 54.94027 ms 54.94027 ms 54.94027 ms 54.94027 ms 54.9402 ms 54.94	Threads
The matched 4 of	Parallel Performance Wiz Be (24 gotors gralyse get Society State So	ard - sor_upr_v1_5_1.par p notile charts notile Table Tree Table > Application ⇒ Application ⇒ Application ⇒ Application ⇒ range_rigration ⇒ range_rigration ⇒ range_rompresson ⇒ range_rompres	<pre>de Data Transfers Arr Calate</pre>	ay Distribution Analyss Metric: Time Total = 5 20.1007 + 10 20.1007 + 20.1007 + 20.1007 + 10.00000 + 10.0000 + 10.0000 + 10.00000 + 10.00000 + 10.0000 + 10.00000	s v V Tread: [A] v V Tread: [A] Cob 2.1.81195 ms 5.4.94027 ms 5.4.94027 ms 5.4.94027 ms 5.4.94027 ms 5.4.9400 ms 1.5.9100 s 1.5.9200 ms 1.5.9200 ms 1.5.9219 ms 6.00112 s 3.9.9270 s 1.5.9115 ms 6.00112 s 3.9.9270 s 5.9.9270 s 5.9	Threads
The matched 4 of	Barallel Performance Wiz Be (dt gotors grakyse (gel Sorgerty State) Sorgerty Value Forgerty Value Property Value Prop	ard sar_upt_v1_5_1.par p notile charts [Profile Table Tree Table > Agailation ⇒	Data Transfers Arr Cabate Sar_upc_v1.cill amoth_compest range_compress uds.cdt amoth_tweator samuch_tweator samuch_tweator samuch_tweator samuch_tweator samuch_tweator dis.cliP file_loc.liP anoth_tweator uds.cdt (i*num_valid_as*ps inputfile(ifile, ps ppat.hes) ppat.tellP ppat.tellP conde 0 (i*num_valid_as*ps ppat.tellP ppat.tell	ay Distribution Analysis Medici: Time Todal - 5 138.847145 138.847145 138.847145 138.847145 139.02222 0.022225 0.0225 0.0255 0.02555 0.0255 0.0255 0.02555	e CAB → Treast: (Al 54,8407 ms 54,9407 ms 54,9407 ms 54,9407 ms 54,9407 ms 54,9407 ms 54,9407 ms 54,9407 ms 54,9407 ms 54,9408 ms 54,9408 ms 54,9408 ms 54,9408 ms 54,9509 js 11,11001 s 129,94403 ms 64,0012 s 3,96270 s 1,11001 s 1,000 s	Threads

7-13

GEM - Graphical Explorer of MPI Programs

parallel tools platform

Contributed to PTP by the University of Utah

Available with PTP since v3.0

Dynamic verification for MPI C/C++ that detects:

- Deadlocks
- Local assertion violations
- ✦ MPI object leaks
- Functionally irrelevant barriers

Offers rigorous coverage guarantees

- Complete nondeterministic coverage for MPI
- Communication / synchronization behaviors
- Determines relevant interleavings, replaying as necessary

parallel tools platform

GEM - Overview





- Front-end for In-situ Partial Order (ISP), Developed at U. Utah
- Offers "push-button" verification from within the Eclipse IDE
- Automatically instruments and runs user code, displaying post verification results
- Variety of views & tools to facilitate debugging and code understanding



(Image courtesy of Steve Parker, U of Utah)

7-15

parallel tools platform

GEM – Views & Tools

<u>Analyzer View</u> Highlights Bugs, and facilitates Post-Verification Review / Debugging

<u>Happens-Before Viewer</u> Shows required orderings and communication matches



Download / documentation:

http://www.cs.utah.edu/fv/GEM

Using GEM – ISP Installation

ISP itself must be installed prior to using GEM

Download ISP at http://www.cs.utah.edu/fv/ISP

Make sure libtool, automake and autoconf are installed.

Just untar isp-0.2.0.tar.gz into a tmp directory and:

- Execute the following commands from tmp directory
 - + ./configure
 - + make
 - + make install
 - Do this with root privelage, sudo, etc. Puts binaries and necessary scripts in /usr/local/bin, /usr/local/lib, etc

Using GEM

Create an MPI C Project within C/C++ Perspective
 Make sure your project builds correctly

Set preferences via GEM Preference Page

From the trident icon or context menus user can:

Set Number of Processes
 Formally Verify MPI Program
 View GEM Console Output

Formally Verifying MPI Program

- Launches ISP
- Generates log file for postverification analysis views
- Opens relevant GEM views



parallel tools platform

GEM Analyzer View

Reports program errors, and runtime statistics

Debug-style source code stepping of interleavings

Point-to-point / Collective Operation matches

- Internal Issue Order / Program Order views
- Rank Lock feature focus in on a particular process

One click to visit the Eclipse editor, to examine:

- Calls involved in deadlock
 - Helps find root-cause
- MPI Object Leaks sites
 - Locates allocated object
- Local Assertion Violations
 - Takes user to failing assertion



parallel tools platform

GEM – Help Plugin

parallel tools platform

Extensive how-to sections, graphical aids and trouble shooting section



GEM/ISP Success Stories

Umpire Tests

- http://www.cs.utah.edu/fv/ISP-Tests
- Documents bugs missed by tests, caught by ISP
- MADRE (EuroPVM/MPI 2007)
 - Previously documented deadlock detected
- N-Body Simulation Code
 - Previously unknown resource leak caught during EuroPVM/MPI 2009 tutorial !
- Large Case Studies
 - ParMETIS, MPI-BLAST, IRS (Sequoia Benchmark), and a few SPEC-MPI benchmarks could be handled
- Full Tutorial including LiveDVD ISO available
 - Visit http://www.cs.utah.edu/fv/GEM

GEM Future Plans

- Tabbed browsing for each type of error
- Each error mapped to offending line of source code in Eclipse editor

Adding more error and property checks, e.g.
MPI send/recv type mismatch
Insufficient recv buffer
MPI argument mismatch
List unfreed requests at finalize



GEM Future Plans

GEM will serve as a front-end for other tools

- Integration of Distributed Analyzer of MPI Programs (DAMPI), developed at University of Utah
 - ISP scales to 10s of processes
 - DAMPI scales to 1000s of processes (C/C++/Fortran)
 - Decentralized scheduler uses Lamport Clocks





parallel tools platform

Use **ISP** at small scale, then launch **DAMPI** at scale on a cluster

PTP Adv. Development: Summary

parallel tools platform

A diversity of other tools aid parallel development

- Parallel Language Development Tools: MPI, OpenMP, UPC, LAPI, etc.
- External Tools Framework (ETFw) eases integration of existing (command-line, etc.) tools

TAU Performance Tuning uses ETFw

◆PPW (Parallel Perf. Wizard) uses ETFw for UPC analysis

Feedback view maps tool findings with source code

✦ MPI Analysis: GEM

A diversity of contributors too!

+ We welcome other contributions. Let us help!

Λ	loo	IJ	le.	7
1	U U	a	\mathbf{C}	/

Backup

parallel tools platform

Not covered in today's tutorial, but included for reference

Creating a local MPI project, and using the wizards

- MPI Assistance tools
- MPI Barrier analysis on a local project
- OpenMP tools
- UPC tools installation and local projects
- External Tools Framework (ETFw) details, overview of integrating other tools into PTP
- ETFw Feedback view incl. sample exercise

Parallel Lang. Dev. Tools

PLDT Features

- Analysis of C and C++ code to determine the location of MPI, OpenMP, and UPC Artifacts
- Content assist via ctrl+space ("completion")
- Hover help
- Reference information about the API calls via Dynamic Help
- New project wizard automatically configures managed build projects for MPI & OpenMP
- OpenMP problems view of common errors
- OpenMP "show #pragma region", "show concurrency"
- MPI Barrier analysis detects potential deadlocks

Some MPI features were covered in Module 4 Note: Some PLDT features don't work on remote (RDT) projects

MPI Assistance Tools

Added by PLDT (Parallel Lang. Dev. Tools) feature of PTP

- MPI Context sensitive help
- MPI artifact locations
- MPI barrier analysis
- MPI templates

 For this part, we will use the *local* MPI New Project Wizard and the "MPI Hello World" project

Creating Local Project

- The next slide shows you how to create a local MPI project.
- If you do not have MPI on your local machine, you can't build or run.
- But you should be able to demonstrate the MPI features in PTP's PLDT regardless.
- Several PLDT MPI features pertain to developing code – just using the local editor, etc.
- Most PLDT features do work on remote projects.



Create local MPI Project

Using a Managed Build Project – for a quick sample local **MPI** project +File > New > C Project ✦Give Project a name, e.g. HelloMPI ✦Confirm Toolchain Select MPI Hello World C Project

00	C Project
C Project Create C p	project of selected type
Project na	me: HelloMPI
🗹 Use de	fault location
Location:	/Users/beth/ews/testptp/HelloMPI Browse
	Choose file system: default
Project typ	e: Toolchains:
Show p	Acutable Empty Project Hello World ANSI C Project MPI Hello World C Project MPI Pi C Project MPI Pi C ++ Project MPI Empty C Project OpenMP Hello World C Project cutable (XL UPC) Project types and toolchains only if they are supported on the platform
? (< Back Next > Cancel Finish



Set MPI Preferences

- When creating a local MPI project with the wizard, you need to set MPI Preferences (once)
- This assures the include paths, etc. will be set for new MPI projects – for building, and for Eclipse assistance features for MPI.
- Select Yes to set the MPI preferences.



Note: if you do not have MPI on your local machine, you can use just an MPI header file (mpi.h) so you play with the PTP MPI development features without building or running on your local machine.

Module 7

$\Theta \cap \Theta$	Preferences	
MPI	MPI	
7	MPI include paths:	
	/usr/local/openmpi-1.3.3/include	Remove Up Down
	MPI build command (C): mpicc MPI build command (C++): mpic++ Prompt to include MPI APIs found in other Restore Defaults	locations (C only)?
?	Cancel	ок



Set MPI Preferences (2)

- On the MPI Preferences page, add a new MPI include path.
- ✤ New ... and point to the *directory* containing your MPI header file (mpi.h)
- ✦ Select OK
- Back on New Project Wizard page, select Next> and fill in Author name, etc.

. \varTheta 🤇		Preferences		
mp	i ®	MPI		\$.\$.
▼Pa	arallel Tools Parallel Language E MPI	Recognize MPI Artifact	ts by prefix (MPI_) alon	e?
		/usr/local/openmpi-1.4.	2/include	New Remove Up Down
		MPI build command (C): MPI build command (C++ I Prompt to include MPI	mpicc -): mpic++ APIs found in other lo	cations (C only)?
00	C Project		Restore Defaults	Apply
Basic Settings Basic properties of a p	project		Cancel	ОК
Author				<i>II.</i>
Copyright notice	Your copyright notice			
Hello world greeting	Hello MPI World			
Source	src			
< Back	Next >	Cancel Finish	7	7-32



Review MPI Project Settings

- On the next wizard page, review the MPI project settings based on the information you have provided.
- Make changes if you wish.
- The defaults should be fine.
- + Click Finish.
- You will be prompted to switch perspectives

Open Associated Perspective?

This kind of project is associated with the C/C++ perspective. Do you want to open this perspective now?

No

Remember my decision

💛 🔘 💟	C Project	
MPI Project Settings		
Select the MPI include pat command information to project.	th, lib name, library search path, and buil be automatically be added to the new	d 📃
🗹 Add MPI project settin	igs to this project	
🗹 Use default informatio	on	
Include path:	/usr/local/include/openmpi	Browse
Library name:	mpi	
Library search path:	/usr/local/include/lib	Browse
MPI compile command:	mpicc	
MPI link command:	mpicc	
? < Back	Next > Cancel	Finish

parallel tools platfor

Create MPI Project

Recap:

- ✦ File > New > C Project
- Give Project a name, e.g. HelloMPI
- ✦ Select Toolchain
- Select MPI Hello World C Project
- ✦ Set MPI Prefs, if first time
- ✦ Click Finish
- Note: if it doesn't build on your machine, you can still continue with this exercise

00	C Project
C Project	
Create C p	roject of selected type
Project nar	me: HelloMPI
🗹 Use de	fault location
Location:	/Users/beth/ews/testptp/HelloMPI Browse
	Choose file system: default +
Project typ	e: Toolchains:
🔻 🧁 Exe	cutable 🔺 MacOSX GCC
🗎 🗧 E	Empty Project XL C/C++ Tool Chain
• N	MPI Hello World C Project
N	MPI Pi C Project
	MPI Pi C++ Project
	DoenMP Hello World C Proje
	DpenMP Empty C Project
🕨 🏳 Exe	cutable (XL UPC)
Show p	roject types and toolchains only if they are supported on the platform
0	< Back Next > Cancel Finish
	Carter Carter

Project Properties: Managed Build Project

parallel tools platform

- Right-click on project in Project Explorer view and select Properties
- Project Properties for Managed Build project
 Compiler, Linker, etc. settings set automatically without a Makefile

	Properties for HelloMPI	
type filter text	Settings 🔅 🔹 🕫	-
 Resource Builders C/C++ Build Build Variables Discovery Options Environment 	Configuration: Debug [Active] Manage Configurations)	Î
Logging	🛞 Tool Settings 🎤 Build Steps 🔮 Build Artifact 📓 Binary Parsers 👩 Error Parsers	
Tool Chain Editor	MacOS X C Linker Command: mpicc	
 ►C/C++ General Project References Run/Debug Settings Service Configurations ► Task Repository WikiText 	Ceneral All options: -I/usr/local/openmpi-1.4.2/include -O0 -g3 -Wall -c -fmessage-length=0 Shared Library Settings SGCC Assembler	
	Command line pattern:	
∢()) ►	Image: Construction of the second) •
?	Cancel OK	

Modu



MPI Barrier Analysis



C/C++ - MyBarrier/src/MyB	Barrier.c - Eclipse S	SDK - C:\ews\r	untime-cdt40					
File Edit Refactor Source Statist	ics Navigate Search	Project Run	Window Help					
: <mark>□1 •</mark> :	Გ*• €*• €*•		® - ≬ ∳ - 0	• 04 • 1	اھ 🕭	₽ : ┓ ⊑ :	Ů ▼ 🗄 🗟 C/C++ C Resource	
Project Explorer 🙁 📃 🗖	matrixio.c	zzzzTemplateTe	est.c 🔂 MyBarrie	.c 🛛 🎽	14		🗉 Outline 🔀 🔵 Make Ta	rgets 🗖 🗖
WyBarrier WyBarrier WyBarrier.c WyBarrier.c WyCproject WyCompleProject	<pre>if (m;</pre>	<pre>y_rank !=0) ' create me printf(mess sst = 0; ' use strle PI_Send(mess dest, tag PI_Send(mess dest, tag PI_Barrier(' MPI_Recv</pre>	<pre>{ ssage */ age, "Greeting n+1 so that '\' sage, strlen(m , MPI_COMM_WORLD process 0: Nu: = 1; source</pre>	<pre>s from pi o' get ti assage)+1 LD); ; ; m process p; source MPI_CHAI Sstatus); ; LD);</pre>	roces ransm 1, MP ses: 2++) R, sc ;	ss %d! = nittec PI_CHF %d\n' = purce, =	Jª ∑ Stdio.h string.h mpi.h Barrier(): void main(int, char*[]): in	<u></u>
	((~ -			M	
Function	Problems 🖉 1	asks 🖳 Conso	Barrier Matches	~		Barrier Errors	ω	
main Manain				i		Barrier Matching	g Set	Function
main main	Barrier Matching Set	t Function	Filename	LineNo		Error		main
main		Barrier	MyBarrier.c	8		🕀 🚧 Path	1 (1 barrier(s))	
w main	Barrier 1	Barrier	MyBarrier.c	8		M Path	n 2 (0 barrier(s))	
W Barrier	Barrier 3	riv.m	MyBarrier.c	41		Error		main
Denner	Barrier 2 (1)	main	MyBarrier.c	31		± M Loop	o (dynamic number of barriers)	
	Barrier 2	main	MyBarrier.c	31				
	Barrier 3 (2)	main	MyBarrier.c	41				
	Barrier 1	Barrier	MyBarrier, c	8				
	Barrier 2	main	MyBarrier.c	41				
			ingenierie.					
	Barrier 4 (0)	main	MyBarrier.c	57				
	Barrier 4 (0)	main	MyBarrier.c	57				
	Barrier 4 (0)	main	MyBarrier.c MyBarrier.c	57 62				

Verify barrier synchronization in C/MPI programs

parallel tools platforn

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 – Try it

Add some barriers:

- Inside the sample if(rank...) add a barrier:
- Use Content Assist to help you type
- Type: MPI_ and press Ctrl-space. See completion alternatives. Keep typing until you see MPI_Barrier and hit enter.
- For args, start typing MPI_Comm_ etc. and it will also complete MPI_COMM_WORLD
- Add the same barrier statement at the end of the else as well.



parallel tools platforn

MPI_Barrier(MPI_COMM_WORLD);

Resulting statement

MPI Barrier Analysis – Try it (2)

11

11

Run the Analysis:

 In the Project Explorer, Select the source file (or directory, or project) of file(s) to analyze



Select the MPI Barrier Analysis action in the menu



€ HelloMPI.c 🖾 if (my_rank !=0){ /* create message */ sprintf(message, "Hello MPI World from proc dest = 0; /* use strlen+1 so that '\0' get transmitte MPI_Send(message, strlen(message)+1, MPI_CH dest, tag, MPI_COMM_WORLD); MPI_Barrier(MPI_COMM_WORLD); 3 else{ printf("Hello MPI World From process 0: Num for (source = 1: source < p: source++) {</pre> MPI_Recv(message, 100, MPI_CHAR, source MPI_COMM_WORLD, &status); printf("%s\n".message); MPI_Barrier(MPI_COMM_WORLD);

parallel tools platforr

MPI Barrier Analysis - views

77 M	IPI Barriers		🛃 Problems 🧔	Tasks 📃 Co	nsole 🧰 Barrier Matches	× -	' 🗖	M Barrier Errors 🕱 i	~ - 8
		i ~				i	$\overline{\nabla}$	Barrier Matching Set	Function
	Function		Barrier Matching Se	t Function	Filename	LineNo	^	Error	main
///	main			Barrier	MyBarrier.c	8		⊕	
111	main		M Barrier 1	1 Barrier	MyBarrier.c	8		Path 2 (0 barrier(s))	
///	main		M Barrier 3	3 main	MyBarrier.c	41		Error	main
///	main		🖃 🚧 Barrier 2 (1)	main	MyBarrier.c	31		⊞ M Loop (dynamic number of barriers)	
///	main		M Barrier 2	2 main	MyBarrier.c	31			
///	Barrier		🖶 🚧 Barrier 3 (2)	main	MyBarrier.c	41			
				1 Barrier	MyBarrier.c	8			
			M Barrier 3	3 main	MyBarrier.c	41			
	7		M Barrier 4 (0)	main	MyBarrier.c	57			
			🗄 🚧 Barrier 5 (1)	main	MyBarrier.c	62			
<		>	<	1111		>			>
	۵					1		i 🔊 🖉	😻 🔶

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

parallel tools platform

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

MPI Templates

- Allows quick entry of common patterns in MPI programming
- Example: MPI sendreceive
- Enter: mpisr <ctrlspace>
- Expands to the code shown at right
- Highlighted variable names can all be changed at once
- Type mpi <ctrl-space>
 <ctrl-space> to see all 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);
   }
```

parallel tools platforr

Eclipse preferences: add more!
 C/C++ > Editor > Templates
 Extend to other common patterns

OpenMP Managed Build Project

- This will need OpenMP preferences (e.g. include file location) set up as well
- Create a new OpenMP project
 - + File ► New ► C Project
 - Name the project e.g.
 'MyOpenMPproject'
 - Select Toolchain
 - Select OpenMP Hello
 World C Project
 - Select Next, then fill in other info like MPI project.



parallel tools platform

Local

files only

Setting OpenMP Special Build Options

- OpenMP typically requires special compiler options.
 - Open the project properties
 - Expand C/C++ Build
 - Select Settings
 - Select C Compiler
 - In Miscellaneous, add option(s).
 -fopenmp
- Click OK; Project should attempt to build



Show OpenMP Artifacts

 Select source file, folder, or project

✦ Run analysis



See artifacts in –
 OpenMP Artifact view



Show Pragma Region

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

<pre>#pragma omp parallel for for (i = 0: i < arraySize: i++)</pre>	
<pre></pre>	د]
Problems 🕢 Tasks 📮 Console 🛠 Debug 🗢 OpenMP Problems 🇭 OpenMP Artifact View 🔀	
OpenMP Artifact Filename Line	No
mp_in_parallel MyOpenMPproject.c 26	
*pragma omp parallel for Show pragma region pject.c 34	

parallel tools platform

See highlighted region in C editor



UPC Features Installation

- If you installed PTP PLDT UPC feature, you should have CDT UPC feature too
 Name
 Image: Compared to the parallel Tools Platform
- See Also:
 - http://wiki.eclipse.org/PTP/other_tools_setup#Using_UPC_features
- You can also install UPC features from the CDT-specific update site
 - Enable it in update manager
 - + Help, Install New Software, Click available Software Sites link
 - Check the CDT site: <u>http://download.eclipse.org/tools/cdt/releases/helios</u>
 - Click OK to return to Install dialog
 - In Work with: select the CDT site you enabled

BUPC toolchain only on CDT site

parallel tools platform

PTP Parallel Language Development Tools UPC Support

- + Check UPC features
- Finish install and restart

 Name

 ■
 ▼ IIII CDT Optional Features

 ✓
 Inified Parallel C Berkeley UPC Toolchain Support

 ✓
 Inified Parallel C Support

 ✓
 Inified Parallel C Support SDK

 7-47

UPC syntax in .c files

- UPC syntax is recognized by the parser in *.upc files
- Copy helloUPC.upc to hello.c to see the difference



parallel tools platform

Keywords as well as new syntax are recognized

UPC syntax in .c files (2)

- To enable UPC syntax in *.c files, we will change the language mappings
- Preferences, C/C++, Language Mappings
- Click the Add... button to add a Language mapping.
- For Content Type,
 C Source File
- For Language, select UPC
 Click OK, OK



UPC syntax in .c files (3)

- Now UPC syntax is recognized in both types of files
- You may need to close and re-open a file to see the change.



parallel tools platform

 Note: in Project Properties, you can do this for just individual projects.

Berkeley UPC toolchain

Local projects only

- File > New > C project
- Hello World
 UPC project
- Select toolchain

 (if you don't have
 the toolchain, it just
 won't build.)
- Next, Next, Finish

$\bigcirc \bigcirc \bigcirc$	C Pr	oject	
C Project Create C p	roject of selected type		
Project nar	me: helloUPC fault location /Users/beth/ews/test0917c/hello Choose file system: default	bUPC	Browse
Project typ	ee: cutable Empty Project Hello World ANSI C 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 Hello World UC Project red Library ic Library sefile project note Makefile Project	Toolchains: Cygwin GCC Linux Berkeley UPC Linux GCC MacOSX Berkeley UPC MacOSX GCC MinCW GCC Solaris GCC	
Show p	roject types and toolchains only if	they are supported on the	platform
J			

BUPC toolchain

 Bring up Project
 Properties to see details
 of BUPC
 toolchain:

Project,
 right mouse,
 Properties

0 0	Properties	for helloUPC	_	
type filter text	Settings			⇔ • ⇔ • ▼
 Resource Builders C/C++ Build Build Variables Discovery Options Environment Logging Settings Tool Chain Editor C/C++ General Project References Run/Debug Settings Service Configurations Task Repository WikiText 	Configuration:	Debug [Active Tool So UPC Compiler ral options ols tories need options UPC Linker ral options ries need options	Expert setting Command: All options: Expert setting Command line pattern:	Build Steps Upcc -g -c S{COMMAND} S
↓ ()) +	•)+
?		\subset	Cancel	ОК

Hello World UPC project

Hello (Berkeley) World UPC project
Note UPC syntax highlighting
Toolchain has been modified for UPC

Project Explorer 🛛 🗖 🗖	c helloUPC.upc 🛛 🖸 hello.c 🖳 helloMPI.c 🖳 omp.c 🎇	}
 hello helloMPI helloUPC helloUPC bebug src helloUPC.upc helloUPC.upc helloUPC.upc helloWP 	<pre>1/* 2</pre>	;

UPC on abe.ncsa.uiuc.edu

BUPC is located at:

+ /usr/apps/mpi/upc/berkeley_upc

To run from cmd line on abe:

setenv PATH /usr/apps/mpi/upc/berkeley_upc/bin:\${PATH} TO RUN FROM PTP/ECLIPSE:

In your home dir on abe: use 'helloUPC' to make a remote proj

Set Remote Paths and Symbols to include:

/usr/apps/mpi/upc/berkeley_upc/opt/include/upcr_preinclude

- To run: use a Generic Remote Launch for Resource Manager
- + Run config:
 - Application program:
 - /usr/apps/mpi/upc/berkeley_upc/bin/upcrun
 - Arguments tab: -q -n 4 ~/helloUPC/helloUPC

External Tools Framework ETFw Motivation

- There are numerous command-line oriented development tools employed in HPC
- These can be complicated or time consuming to use
- IDE integration for individual development tools is slow and inconsistent
- We want all our development tools in one place with one interface
- We want our development tools to work together

ETFw: Development Tool Workflows

- Variations on 'Compile, Execute, Analyze-Results' are common to most software development
- These steps may be tedious and time consuming, especially over multiple iterations
- By defining both tool interfaces and behavior in an XML document these steps can be simplified and automated

ETFw: The Build Phase

<compile>

<!-- By default the compiler commands set here prepend whatever compiler is already in use in Eclipse. If you set the tag replace="true" for the compile element the compilers will be replaced entirely with the command specified here. Each compiler type, c, c++ and fortran, is defined as shown below. -->

parallel tools platform

<!-- Every command referencing a file on the system should include a group tag. The group tag indicates that the relevant binary files or scripts are located in the same place for each command sharing that tag -->

<CC command="vtcc" group="vampirtrace">

```
<argument value="-vt:cc"/>
</CC>
<CXX command="vtoxx" group="vampirtrace">
<argument value="-vt:cxx"/>
</CXX>
<F90 command="vtf90" group="vampirtrace">
<argument value="-vt:f90"/>
</F90>
</compile>
```

 Set compilers and arguments for each language
 Define UI for compiler/compiler-wrapper configuration

ETFw: The Execution Phase

parallel tools platform

<execute> <utility command="mpirun" group="mpi"> <utility command="mpirun" group="mpi"> <utility> <utility> <utility command="psrun" group="perfsuite"> </utility> </utility> </execute>

- Specify composed execution tools such as Perfsuite or Valgrind
- Set launch environment variables
- Define variables and tool options in XML or provide a UI in the IDE
- Integrates with PTP parallel launch environment

ETFw: The Analysis/Post-Processing Phase



- Sequentially run tools on program output
- Launch external visualization tools



parallel tools platform

. . .

parallel tools platform ETFw: XML-Defined UI Components

<utility <="" command="bash" th=""><th>group="inbin"/></th></utility>	group="inbin"/>
<utility <="" command="valgring" td=""><th>nd" group="valgrind"></th></utility>	nd" group="valgrind">
<pre><optionpane seperatewith=" " title="V</pre></td><th>algrind2"></optionpane></pre>	
<togoption label<="" td=""><th>="Leak Check" optname="leak-check=full" tooltip="Full memory leak check" defstate="true"/></th></togoption>	="Leak Check" optname="leak-check=full" tooltip="Full memory leak check" defstate="true"/>
<togoption label<="" td=""><th>="Show Reachable" optname="show-reachable=yes" tooltip="Show reachable units"/></th></togoption>	="Show Reachable" optname="show-reachable=yes" tooltip="Show reachable units"/>
<togoption label<="" td=""><th>="Verbose" optname="verbose" tooltip="Verbose output"/></th></togoption>	="Verbose" optname="verbose" tooltip="Verbose output"/>
/tool>	

- Each pane constructs a set of options Tool Selection Valgrind Valgrind2 sent to a tool or a set of environment variables
- Numerous options for converting a command line interface into an intelligent GUI without Eclipse coding

t	
L	leak-check=full
	🗹 Leak Check
	🗌 Verbose

ETFw: Advanced Components

- Extension points allow integration with UIs and workflow behavior too complex to define in XML
- Logical and iterative workflows for successive executions and parametric studies



ETFw: Using Workflows

- New workflows are added to the ETFw launch configuration system
- Multiple workflow configurations can be defined and saved for different use cases
- XML Workflow definitions can be saved and reused in different environments



parallel tools platform

ETFw: General Purpose Workflow



- Automated
- Generalized
- Quick performance analysis and other development tool integration

parallel tools platform

 Exposes tool capabilities to the user

ETFw: Continuing Development

Plans:

- Integration with PTP Remote Development Tools
- Additional options for GUI definition
- Generalization of TAU specific features such as hardware counter selection and performance data storage



ETFw Feedback view

- Many existing tools provide information that can be mapped to source code lines
 - Compiler errors, warnings, suggestions
 - Performance tool findings
- ETFw feedback view provided to aid construction of these views
 - Currently geared toward data provided by tools in XML files
- Original ETFw facilities aid the CALL of external tools from PTP
 - Feedback view aids the exposition of results to the user



parallel tools platform

Examples:

- Compiler optimization report
- Performance tool data
- Refactoring tool uses
 "advice" from external files

Feedback Sample

parallel tools platform

- Download a sample implementation of the feedback view:
- Complete instructions here: http://wiki.eclipse.org/PTP/ETFw/feedback

And on following slide...

<u>Feedback Sample – (1) Install</u>



Download the plugin jar file

http://download.eclipse.org/tools/ptp/misc/feedback/org.eclipse .ptp.etfw.feedback.sample_1.0.0.201010280927.jar

Save it in your eclipse/dropins directory
 This is a "quick and dirty" type of installation
 Eclipse knows to look here when it starts, and it installs whatever it finds here

Then restart eclipse

You should see the feedback icon



parallel tools platform



Feedback Sample – (2) data files

You have the Feedback sample plug-in installed

Now you need some sample files for it to process

- sample.c and sample.xml
- They are hidden in the plug-in!
- Let's take it apart to find them
- Unzip the jar file; they are in the data/ directory
 - ✦Alternate instructions on the wiki page
- Put them in a (local) eclipse project

parallel tools platform



Feedback Sample – (3) Try it

You have the Feedback sample plug-in installed
You have an xml file that it can parse, and the source file that it refers to.

- 1. Select xml file
- 2. Click feedback button
- 3. See Sample Feedback view
- Double-click in view to navigate to source code lines



