SC14 New Orleans, LA | hpc matters.

November 16-21, 2014

Intuitive Performance Engineering at the Exascale with TAU and TAU Commander

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ParaTools, Inc.

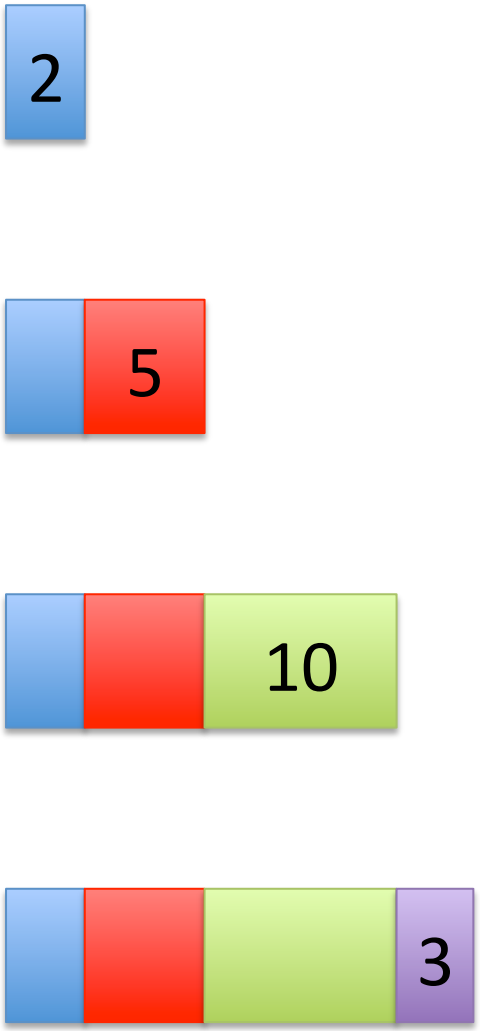
3rd Workshop on Extreme-Scale Programming Tools

17 November 2014, SC'14

ParaTools

Overview

- Motivation
- TAU
- TAU Commander
- Questions



Intuitive Performance Engineering

MOTIVATION

The Metrics We Care About

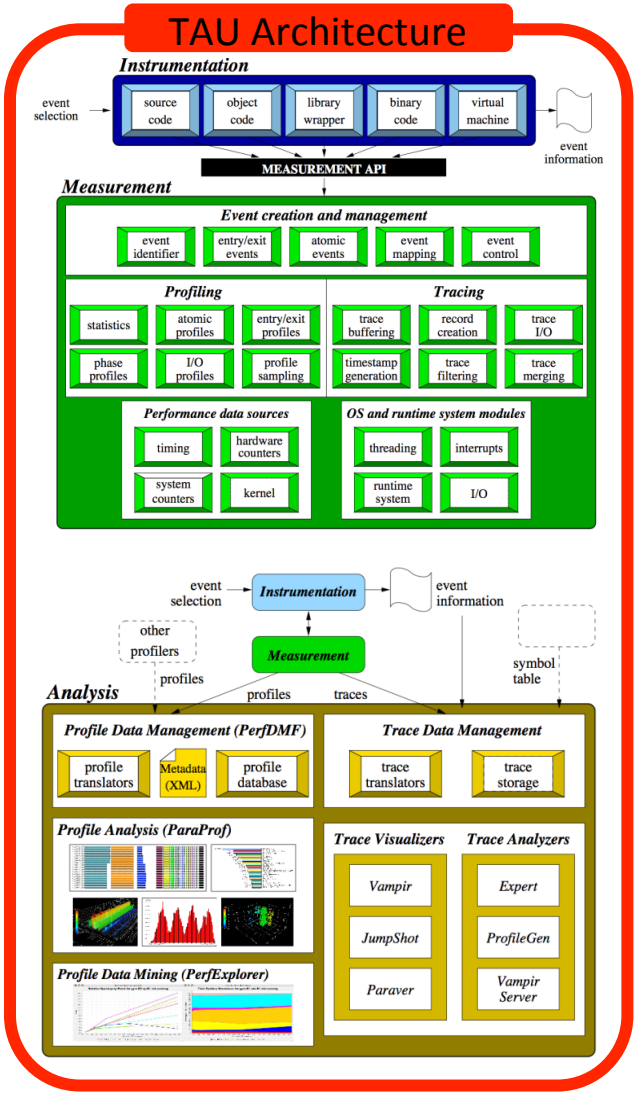
Performance

Efficiency

Productivity

The TAU Performance System®

- *Integrated toolkit* for performance problem solving
  - Instrumentation, measurement, analysis, visualization
  - Portable profiling and tracing
  - Performance data management and data mining
- Direct and indirect measurement
- *Free, open source, BSD license*
- Available on all HPC platforms (and some non-HPC)
- http://tau.uoregon.edu/



How do we Improve Productivity?

TAU Commander

An intuitive interface to
the TAU Performance System

Intuitive Performance Engineering

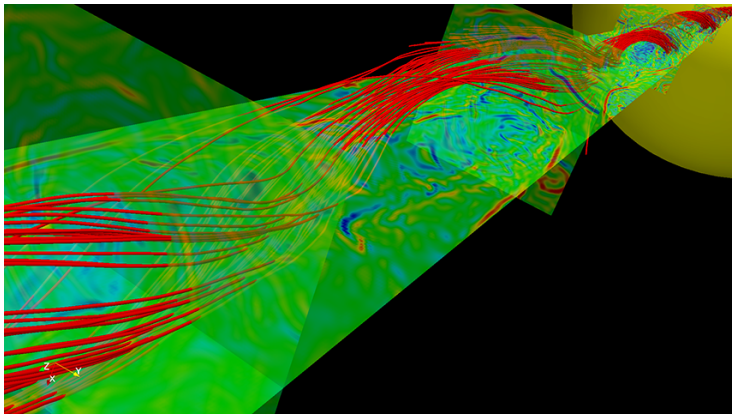
THE TAU PERFORMANCE SYSTEM

The TAU Performance System®

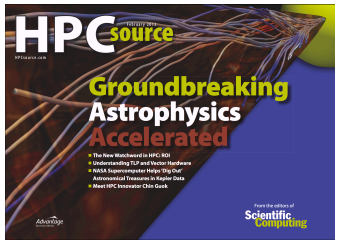
- Tuning and Analysis Utilities (**20+ year project**)
- Comprehensive performance profiling and tracing
  - Integrated, scalable, flexible, portable
  - Targets all parallel programming/execution paradigms
- Integrated performance toolkit
  - Instrumentation, measurement, analysis, visualization
  - Widely-ported performance profiling / tracing system
  - Performance data management and data mining
  - Open source (BSD-style license)
- Integrates with application frameworks

TAU Success Story: IRMHD

- INCITE magnetohydrodynamcis simulation to understand solar winds and coronal heating
  - First direct numerical simulations of Alfvén wave (AW) turbulence in extended solar atmosphere accounting for inhomogeneities
  - Team
    - University of New Hampshire (Jean Perez and Benjamin Chandran)
    - ALCF (Tim Williams)
    - University of Oregon (Sameer Shende)

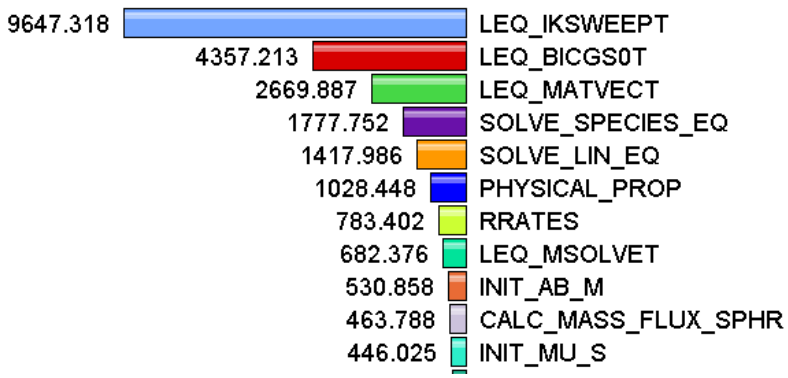


- IRMHD (Inhomogeneous Reduced Magnetohydrodynamics)
  - Fortran 90 and MPI
  - Excellent weak and strong scaling properties
  - Tested and benchmarked on Intrepid and Mira
- HPC Source article and ALCF news
  https://www.alcf.anl.gov/articles/furthering-understanding-coronal-heating-and-solar-wind-origin



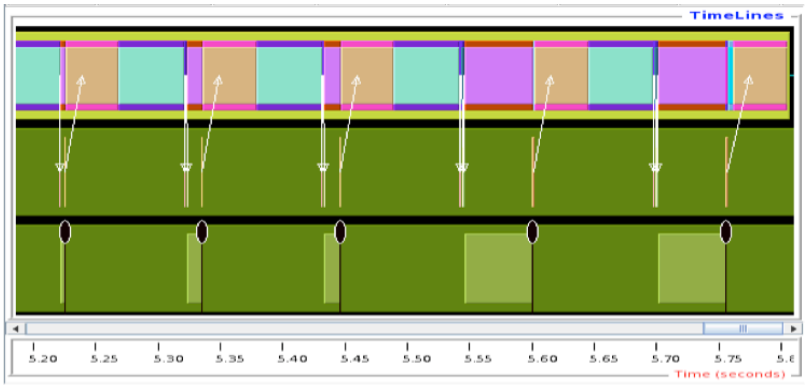
Measurement Approaches

Profiling



Shows **how much** time was spent in each routine

Tracing



Shows **when** events take place on a timeline

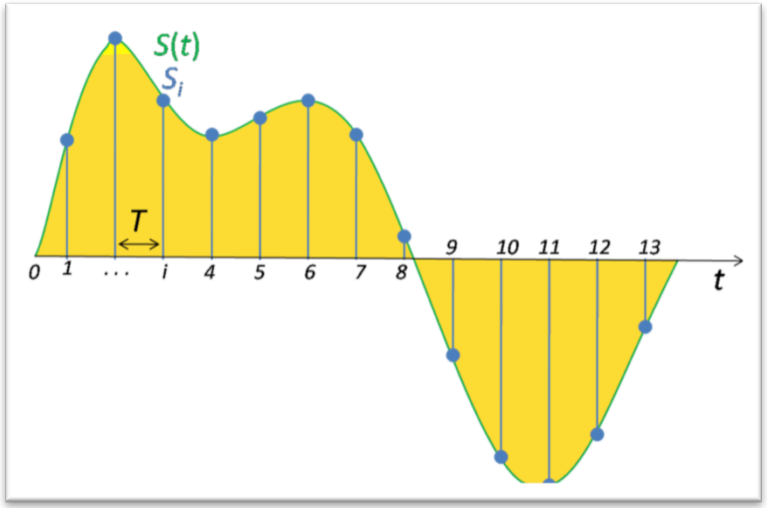
Performance Data Measurement

Direct via Probes

```
call TAU_START('potential')
// code
call TAU_STOP('potential')
```

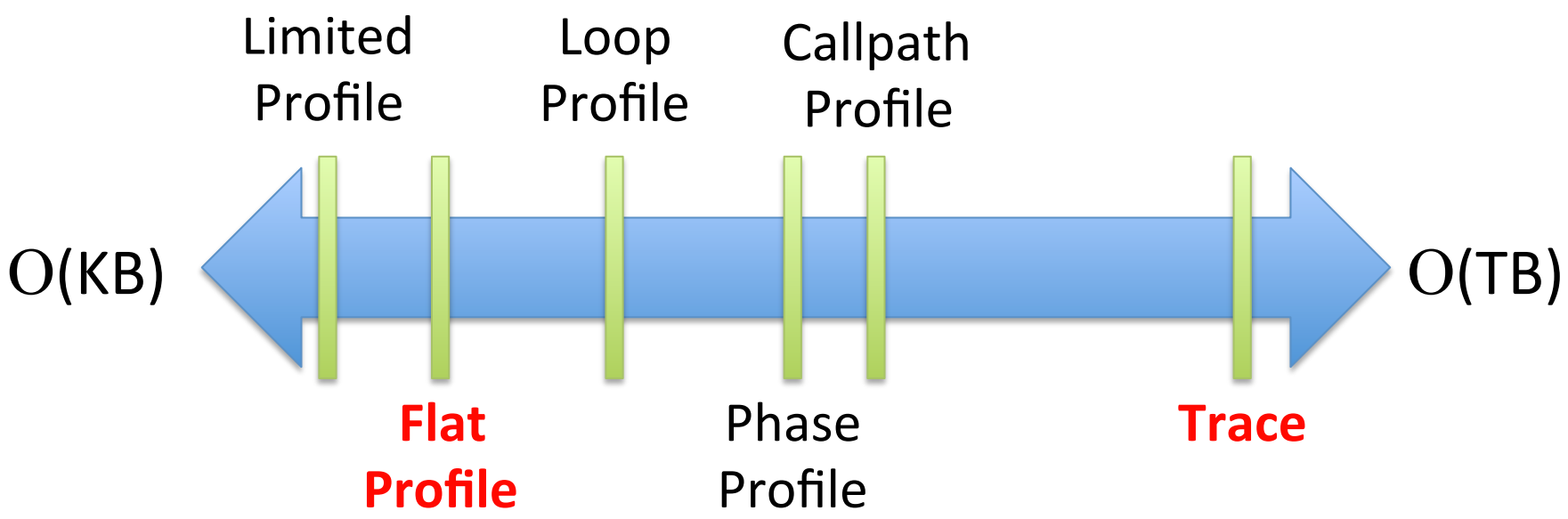
- Exact measurement
- Fine-grain control
- Calls inserted into code

Indirect via Sampling



- No code modification
- Minimal effort
- Relies on debug symbols (**-g** option)

How much data do you want?



All levels support multiple metrics/counters

TAU Supports All HPC Platforms

C/C++ CUDA UPC Python

GPI

Fortran OpenACC Java MPI

pthreads Intel MIC OpenMP

Intel GNU

LLVM PGI Cray Sun

MinGW

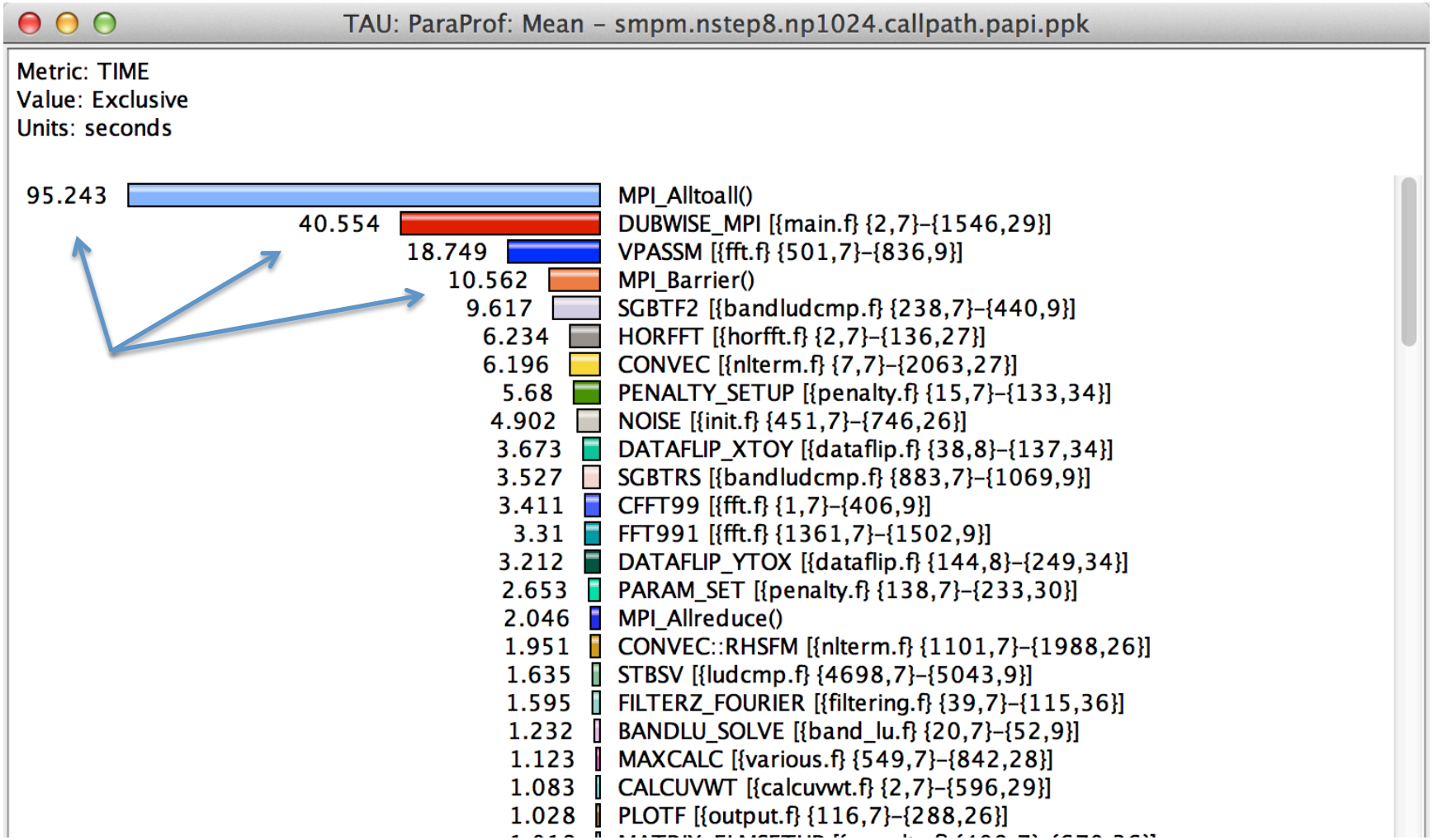
Linux Windows AIX

Insert yours here

BlueGene Fujitsu ARM

Android MPC OS X

How Much Time per Code Region?



`% paraprof` **(Click on label, e.g. “Mean” or “node 0”)**

How Many Instructions per Code Region?

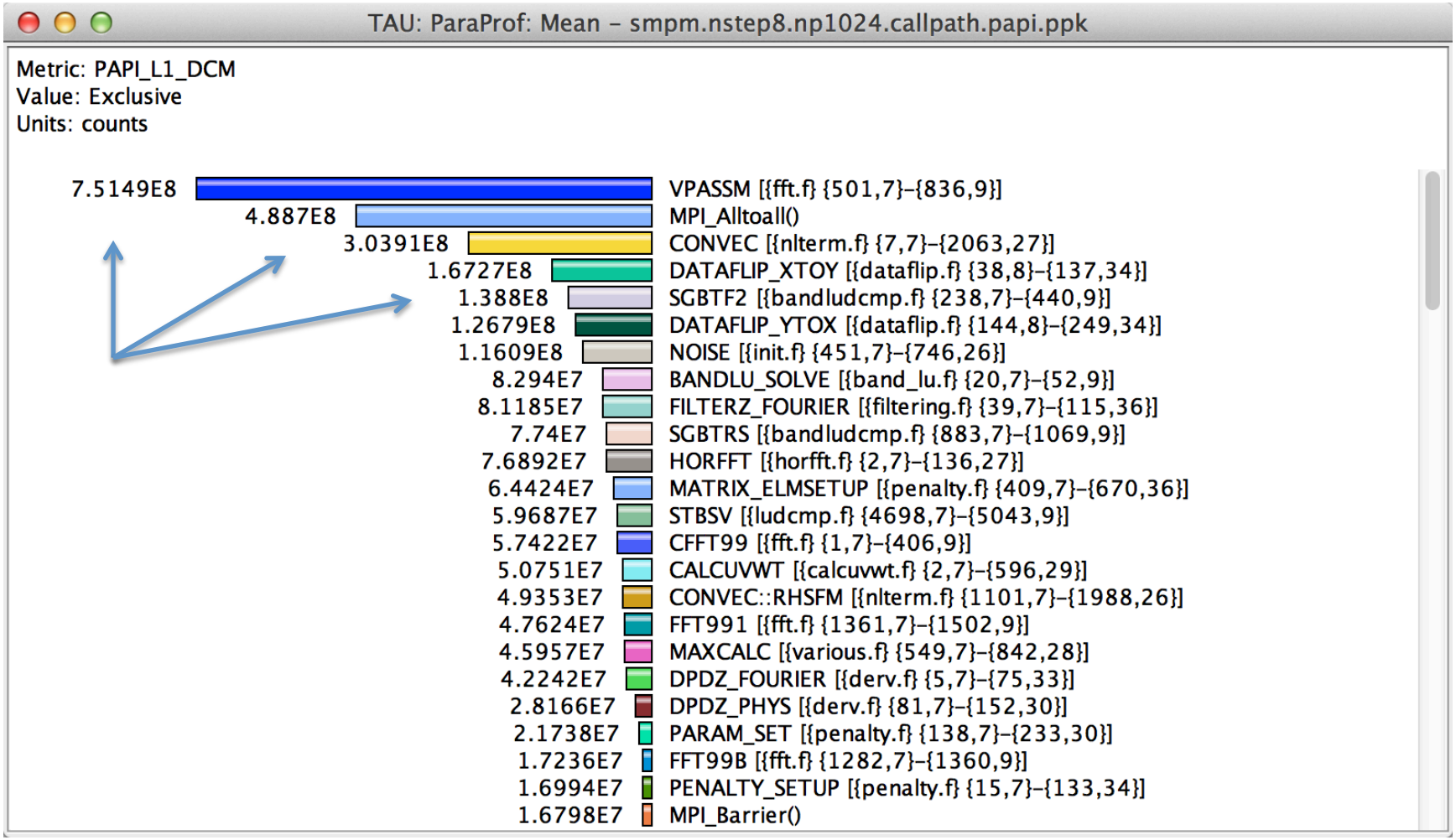
TAU: ParaProf: Mean – smpm.nstep8.np1024.callpath.papi.ppk

Metric: PAPI_FP_INS
Value: Exclusive
Units: counts

8.8479E9	VPASSM [{fft.f} {501,7}-{836,9}]
4.1824E9	SGBTF2 [{bandludcmp.f} {238,7}-{440,9}]
4.0701E9	NOISE [{init.f} {451,7}-{746,26}]
1.384E9	FILTERZ_FOURIER [{filtering.f} {39,7}-{115,36}]
1.1515E9	STBSV [{ludcmp.f} {4698,7}-{5043,9}]
7.8914E8	DPDZ_FOURIER [{derv.f} {5,7}-{75,33}]
6.3193E8	DPDZ_PHYS [{derv.f} {81,7}-{152,30}]
6.0732E8	SGBTRS [{bandludcmp.f} {883,7}-{1069,9}]
5.4591E8	FFT99B [{fft.f} {1282,7}-{1360,9}]
5.1141E8	FILTERXY_FOURIER [{filtering.f} {119,7}-{172,37}]
4.2268E8	FFT99A [{fft.f} {1208,7}-{1281,9}]
4.0761E8	CONVEC::RHSFM [{nlterm.f} {1101,7}-{1988,26}]
3.2453E8	MATRIX_ELMSETUP [{penalty.f} {409,7}-{670,36}]
3.0524E8	CONVEC [{nlterm.f} {7,7}-{2063,27}]
1.6188E8	DIVCOLC [{derv.f} {207,7}-{273,29}]
1.269E8	HORFFT [{horfft.f} {2,7}-{136,27}]
1.1585E8	CONVEC::ROTVISC [{nlterm.f} {1994,8}-{2038,29}]
7.4375E7	DPDZCOL [{derv.f} {159,7}-{203,28}] [THROTTLED]
5.8376E7	UPDATE [{calcuvwt.f} {603,7}-{726,27}]
4.669E7	MAXCALC [{various.f} {549,7}-{842,28}]
4.0317E7	RELAX_RESET [{postp.f} {765,7}-{868,32}]
3.6434E7	PERTURBCALC [{postp.f} {693,7}-{759,32}]
2.6551E7	CALCUVWT [{calcuvwt.f} {2,7}-{596,29}]
2.1258E7	PENALTY_MAIN [{penalty.f} {237,7}-{286,33}]

% **`paraprof`** **(Options → Select Metric... → Exclusive... → PAPI_FP_INS)**

How Many L1 or L2 Cache Misses?



% `paraprof` (Options → Select Metric… → Exclusive… → PAPI_L1_DCM)

How Much Memory Does the Code Use?

TAU: ParaProf: Mean Context Events – sphere_np32_nsteps5_mem.ppk

Name	Total	NumSamples	MaxValue	MinValue	MeanValue	Std. Dev.
.TAU application						
free size (bytes)	14,236,992.16	27,169.781	49,152	1	524.001	2,013.103
malloc size (bytes)	13,132,932	23,292	262,144	1	563.839	4,492.057
MPI_Finalize()						
OurMain()						
free size (bytes)	1,298,918.679	1,495.125	461,766.25	4	868.769	16,928.073
malloc size (bytes)	48,150	20	36,032	11	2,407.5	7,911.992
OurMain						
free size (bytes)	3,465	9	769	32	385	260.2
malloc size (bytes)	4,314	12	769	32	359.5	240.981
<module>						
free size (bytes)	293,088	449	32,564	32	652.757	1,526.875
malloc size (bytes)	311,966	493	32,564	32	632.791	1,460.941
staticCFD						
__init__						
<module>						
Memory Utilization (heap, in KB)		849,270.344	192,825.168	0.078	147,832.141	62,621.576
Message size for all-gather	4,096	1	4,096	4,096	4,096	0
Message size for all-reduce	23,340	843	320	4	27.687	64.653
Message size for all-to-all	104	26	4	4	4	0
Message size for broadcast	24,923	206	8,788	4	120.985	860.992
Message size for reduce	8,912	8	8,788	4	1,114	2,900.511
free size (bytes)	27,417,881,391.51	413,600.719	24,025,667	1	66,290.701	199,538.234
malloc size (bytes)	27,468,709,355.914	435,669.625	24,025,667	0	63,049.402	195,561.193

High-water mark

% **`paraprof`** **(Right-click label [e.g "node 0"] → Show Context Event Window)**

What are the I/O Characteristics?

TAU: ParaProf: Context Events for thread: n,c,t, 1,0,0 – samarc_obe_4p_iomem_cp.ppk

Name	Total	MeanValue	NumSamples	MinValue	MaxValue	Std. Dev.
.TAU application						
read()						
fopen64()						
fclose()						
OurMain()						
malloc size	25,235	1,097.174	23	11	12,032	2,851.143
free size	22,707	1,746.692	13	11	12,032	3,660.642
OurMain [{wrapper.py}{3}]						
read()						
malloc size	3,877	323.083	12	32	981	252.72
free size	1,536	219.429	7	32	464	148.122
fopen64()						
fclose()						
<module> [{obe.py}{8}]						
writeRestartData [{samarcInterface.py}{145}]						
samarcWriteRestartData						
write()						
WRITE Bandwidth (MB/s) <file="samarc/restore.00002/nodes.00004/proc.00001">		74.565	117	0	2,156.889	246.386
WRITE Bandwidth (MB/s) <file="samarc/restore.00001/nodes.00004/proc.00001">		77.594	117	0	1,941.2	228.366
WRITE Bandwidth (MB/s)		76.08	234	0	2,156.889	237.551
Bytes Written <file="samarc/restore.00002/nodes.00004/proc.00001">	2,097,552	17,927.795	117	1	1,048,576	133,362.946
Bytes Written <file="samarc/restore.00001/nodes.00004/proc.00001">	2,097,552	17,927.795	117	1	1,048,576	133,362.946
Bytes Written	4,195,104	17,927.795	234	1	1,048,576	133,362.946
open64()						

Write bandwidth per file

Bytes written to each file

% **`paraprof`** **(Right-click label [e.g "node 0"] → Show Context Event Window)**

What are the I/O Characteristics?

Name △	Total	NumSamples	MaxValue	MinValue	MeanValue	Std. Dev.
▶ Incl						
▶ Initialize						
▶ LoadBodyEuler						
▶ LoadMesh						
MPI-IO Bytes Written	4,328,712	144	893,152	0	30,060.5	128,042.696
MPI-IO Write Bandwidth (MB/s)		144	196.86	0	3.421	16.87
▶ MPI_Allgatherv()						
▶ MPI_Bcast()						
▶ MPI_Comm_create()						
▶ MPI_File_close()						
▶ MPI_File_open()						
▶ MPI_File_write_all()						
▶ MPI_File_write_at()						
▶ MPI_Finalize()						
▶ MPI_Gather()						
▶ MPI_Gatherv()						

Peak MPI-IO Write Bandwidth

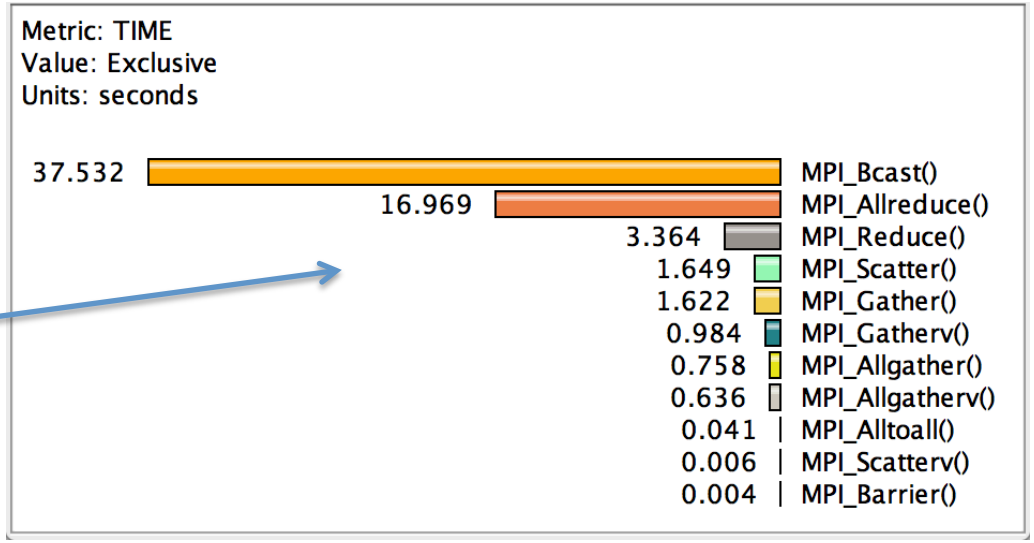
% **`paraprof`** **(Right-click label [e.g "node 0"] → Show Context Event Window)**

How Much Time is spent in Collectives?

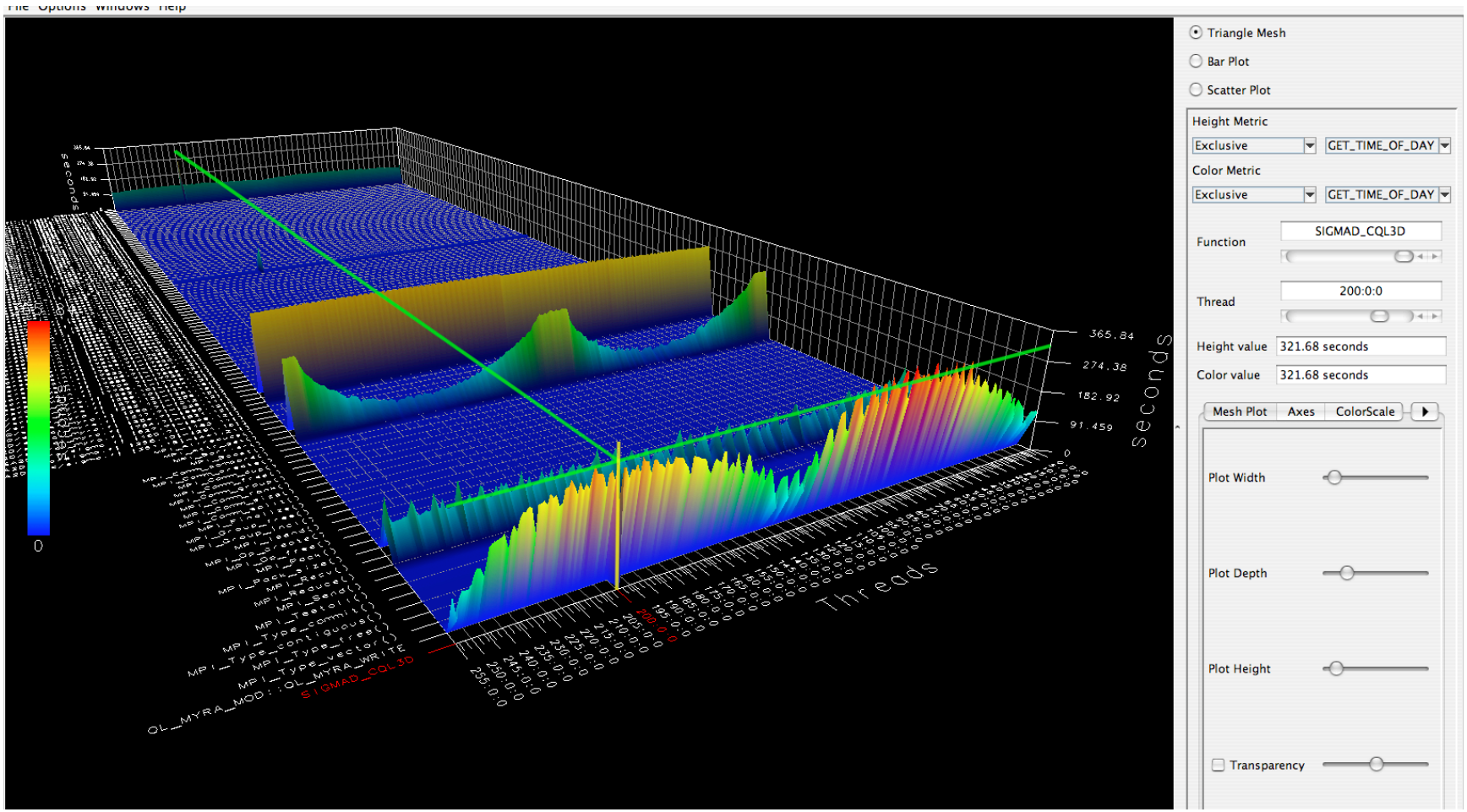
Name △	Total	Num...	MaxValue	MinValue	MeanValue	Std. Dev.
▶ MPI_Wait()						
▶ MPI_Waitall()						
Message size for all-gather	305,753,268	72	172,215,296	4	4,246,573.167	22,551,605.859
Message size for all-reduce	163,308	632	21,908	4	258.399	897.725
Message size for all-to-all	112	14	8	8	8	0
Message size for broadcast	692,208,045.5	3,346	18,117,620	0	206,876.284	1,284,673.036
Message size for gather	6,901,452.378	15.312	1,387,306.625	4	450,707.094	483,216.499
Message size for reduce	66,812	1,520	56	4	43.955	21.598
Message size for scatter	63,147.906	146	62,567.906	4	432.52	5,160.063

Message sizes

Time spent in collectives

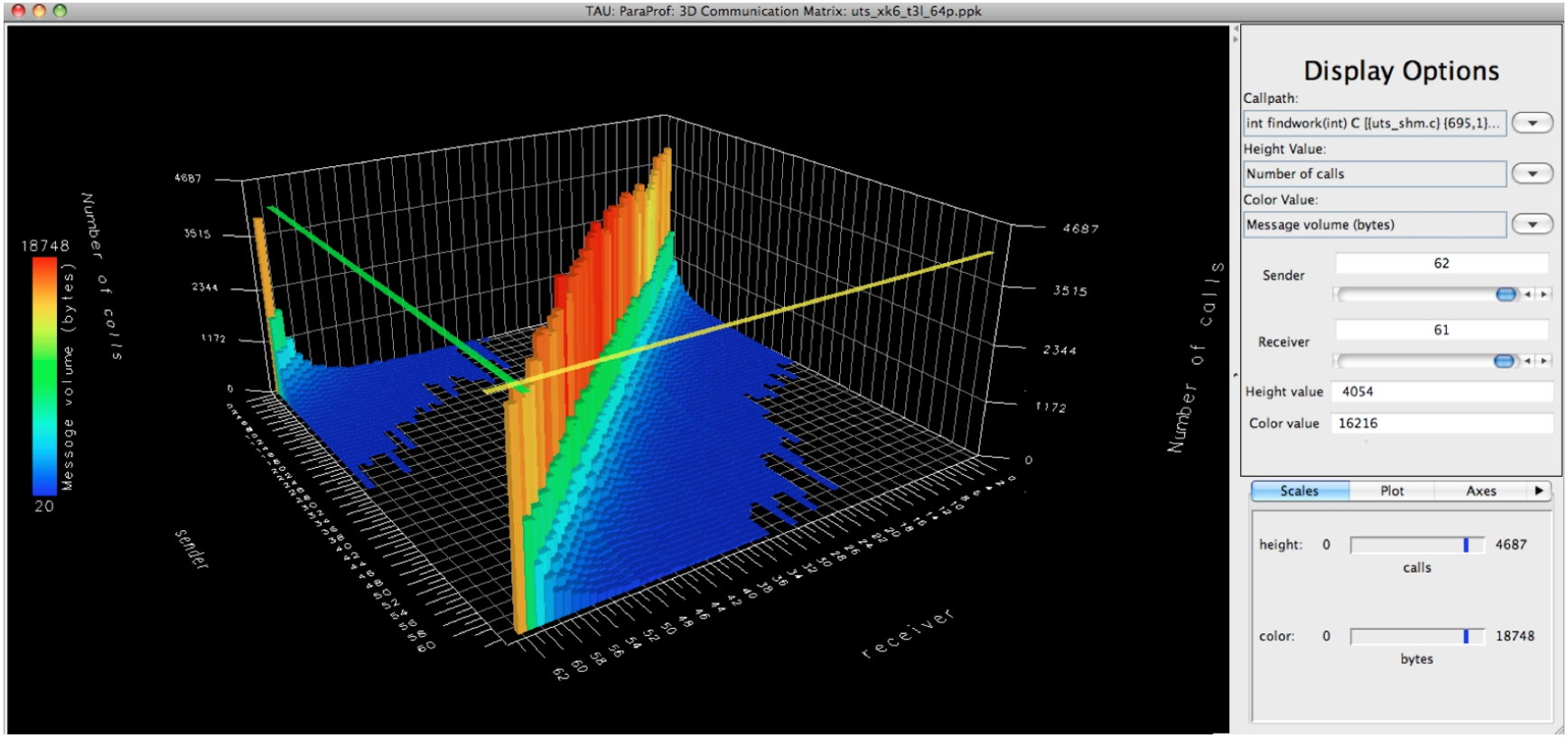


3D Profile Visualization



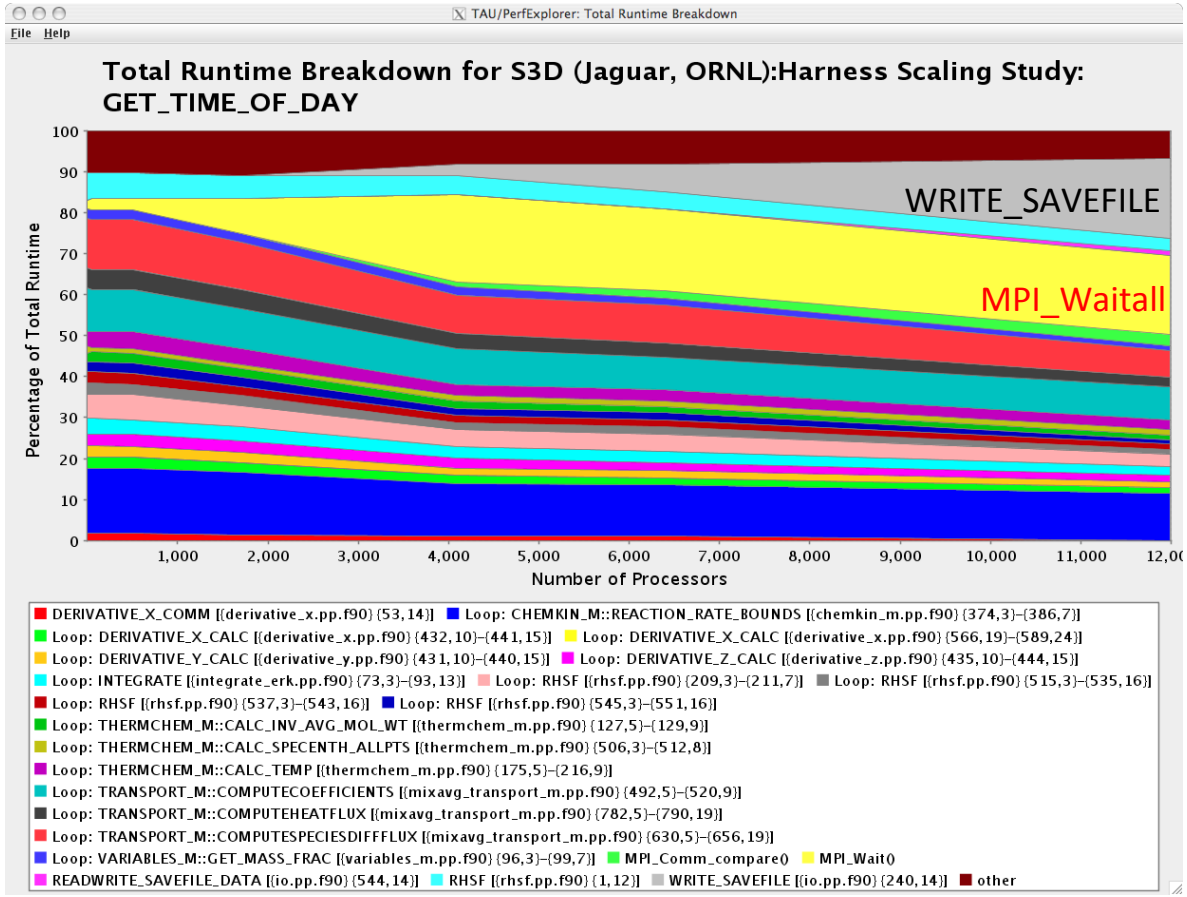
% `paraprof` (Windows → 3D Visualization)

3D Communication Visualization



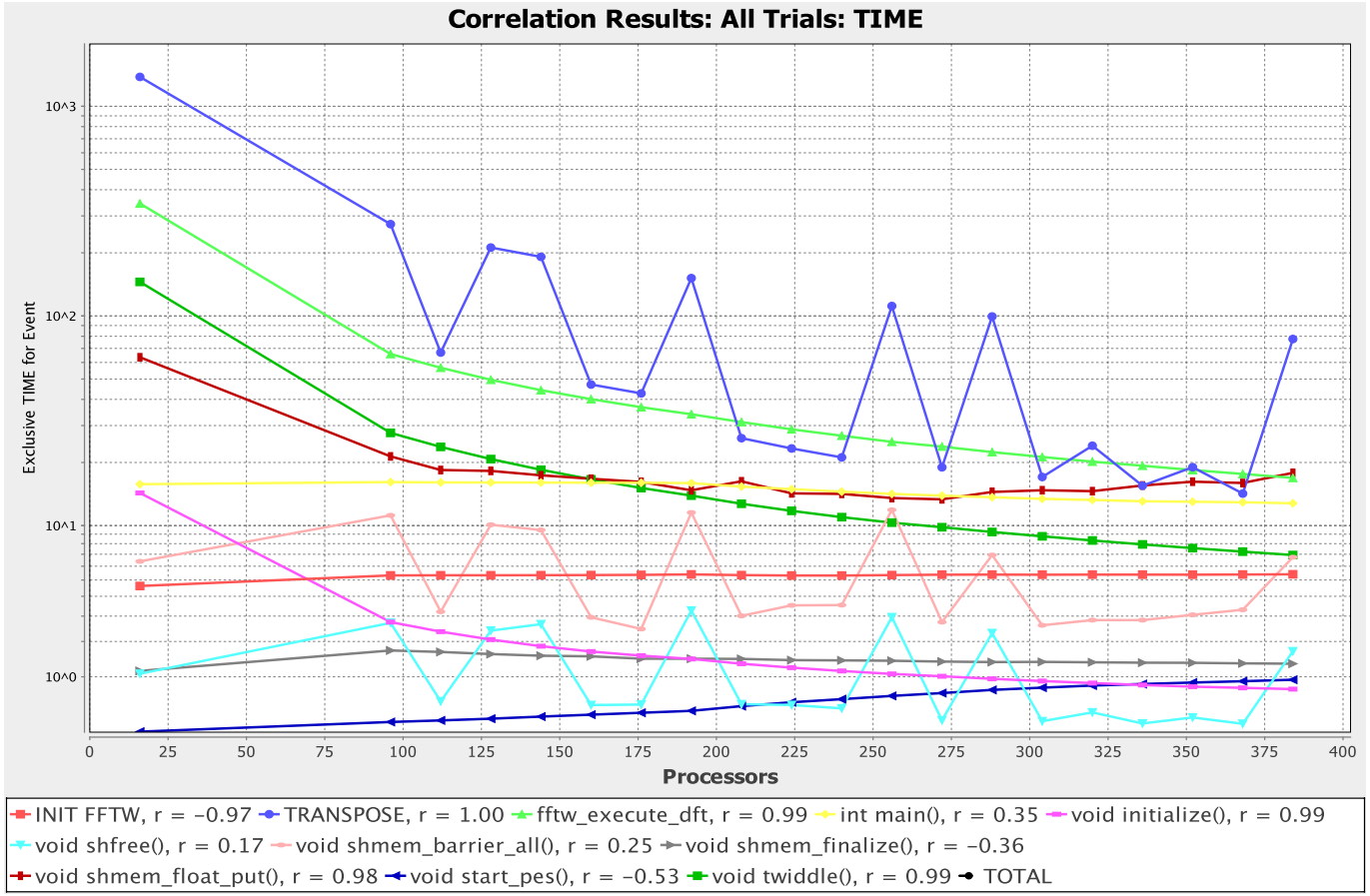

```
% qsub –env TAU_COMM_MATRIX=1 …
% paraprof (Windows → 3D Communication Matrix)
```

How Does Each Routine Scale?



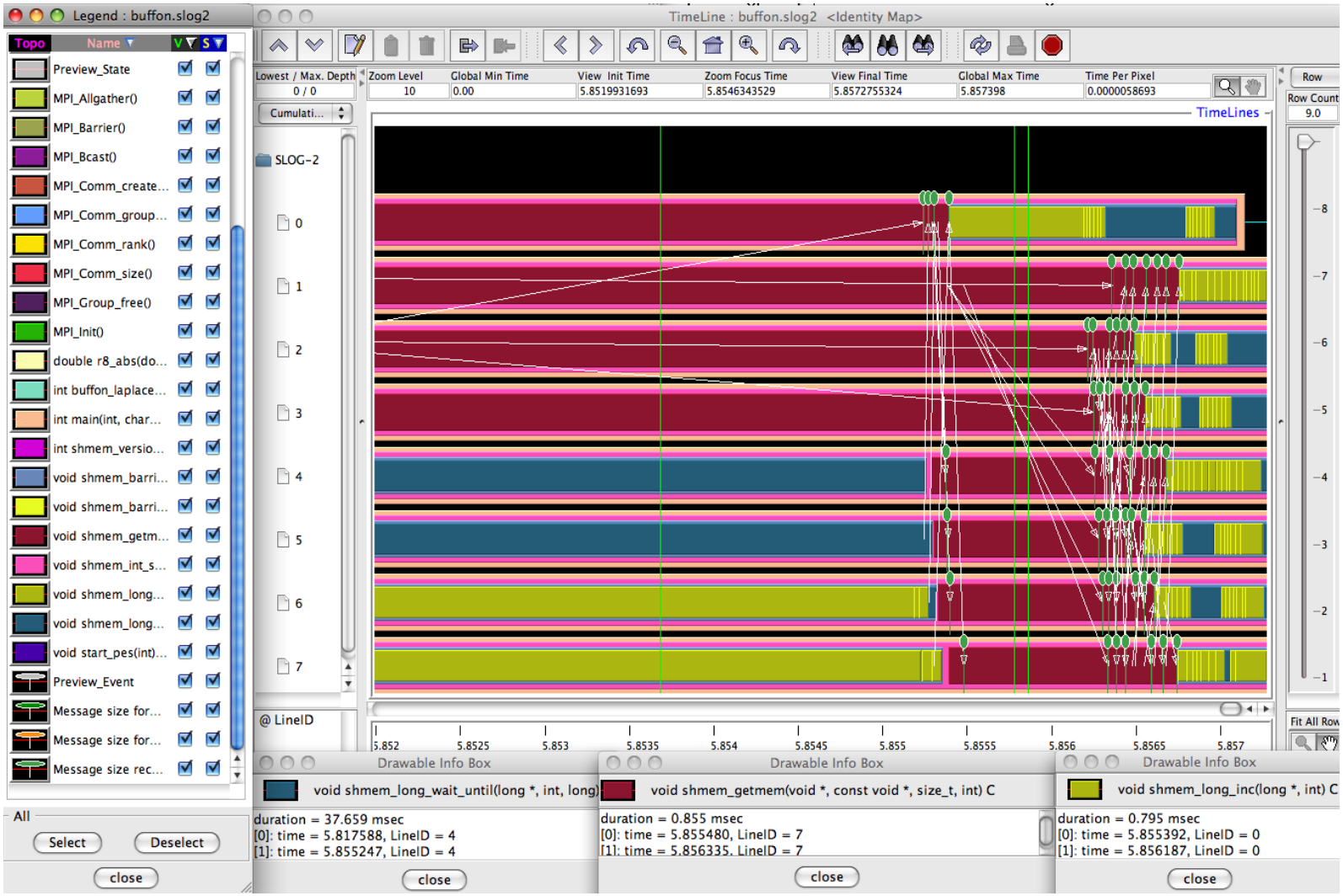
% `perfexplorer` (Charts → Runtime Breakdown)

Which Events Correlate with Runtime?



% `perfexplorer` (Charts → Correlate Events with Total Runtime)

When do Events Occur?



What Caused My Application to Crash?

TAU: ParaProf Manager

Options Help

pplications
- Standard Applications
- Default App
  - Default Exp
    - py-c++-f90-create.ppk
      - TIME

TrialField	Value
Name	py-c++-f90-create.ppk
Application ID	0
Experiment ID	0
Trial ID	0
BACKTRACE 1	[SAMINT::timestep(double, double)] [/mnt/home/jlinford/py-c++-f90-create/SAMINT.C:77] [/mnt/home/jlinford/py-c++-f90-create/_samint.so]
BACKTRACE 2	[samarcStep(double, double)] [/mnt/home/jlinford/py-c++-f90-create/pycintfc.C:57] [/mnt/home/jlinford/py-c++-f90-create/_samint.so]
BACKTRACE 3	[_wrap_samarcStep] [/mnt/home/jlinford/py-c++-f90-create/samint_wrap.c:3883] [/mnt/home/jlinford/py-c++-f90-create/_samint.so]
BACKTRACE 4	[call_function] [/mnt/home/jlinford/0.55/build/Python-2.7.2/Python/ceval.c:4013] [/mnt/cfs/pkgs/PTOOLS/pkgs/ptoolsrte-0.55/packages/Python-2.7.2/lib/libpython2.7.so.1.0
BACKTRACE 5	[fast_function] [/mnt/home/jlinford/0.55/build/Python-2.7.2/Python/ceval.c:4099] [/mnt/cfs/pkgs/PTOOLS/pkgs/ptoolsrte-0.55/packages/Python-2.7.2/lib/libpython2.7.so.1...
BACKTRACE 6	[PyEval_EvalCodeEx] [/mnt/home/jlinford/0.55/build/Python-2.7.2/Python/ceval.c:3253] [/mnt/cfs/pkgs/PTOOLS/pkgs/ptoolsrte-0.55/packages/Python-2.7.2/lib/libpython2...
BACKTRACE 7	[PyEval_EvalCode] [/mnt/home/jlinford/0.55/build/Python-2.7.2/Python/ceval.c:667] [/mnt/cfs/pkgs/PTOOLS/pkgs/ptoolsrte-0.55/packages/Python-2.7.2/lib/libpython2.7.so...
BACKTRACE 8	[PyImport_ExecCodeModuleEx] [/mnt/home/jlinford/0.55/build/Python-2.7.2/Python/import.c:681] [/mnt/cfs/pkgs/PTOOLS/pkgs/ptoolsrte-0.55/packages/Python-2.7.2/lib/li...
BACKTRACE 9	[load_source_module] [/mnt/home/jlinford/0.55/build/Python-2.7.2/Python/import.c:1021] [/mnt/cfs/pkgs/PTOOLS/pkgs/ptoolsrte-0.55/packages/Python-2.7.2/lib/libpytho...
BACKTRACE 10	[import_submodule] [/mnt/home/jlinford/0.55/build/Python-2.7.2/Python/import.c:2596] [/mnt/cfs/pkgs/PTOOLS/pkgs/ptoolsrte-0.55/packages/Python-2.7.2/lib/libpython...
BACKTRACE 11	[load_next] [/mnt/home/jlinford/0.55/build/Python-2.7.2/Python/import.c:2416] [/mnt/cfs/pkgs/PTOOLS/pkgs/ptoolsrte-0.55/packages/Python-2.7.2/lib/libpython2.7.so.1.0]
BACKTRACE 12	[import_module_level] [/mnt/home/jlinford/0.55/build/Python-2.7.2/Python/import.c:2137] [/mnt/cfs/pkgs/PTOOLS/pkgs/ptoolsrte-0.55/packages/Python-2.7.2/lib/libpytho...
BACKTRACE 13	[builtin___import__] [/mnt/home/jlinford/0.55/build/Python-2.7.2/Python/bltinmodule.c:49] [/mnt/cfs/pkgs/PTOOLS/pkgs/ptoolsrte-0.55/packages/Python-2.7.2/lib/libpytho...
BACKTRACE 14	[PyObject_Call] [/mnt/home/jlinford/0.55/build/Python-2.7.2/Objects/abstract.c:2529] [/mnt/cfs/pkgs/PTOOLS/pkgs/ptoolsrte-0.55/packages/Python-2.7.2/lib/libpython2.7...
BACKTRACE 15	[PyEval_CallObjectWithKeywords] [/mnt/home/jlinford/0.55/build/Python-2.7.2/Python/ceval.c:3882] [/mnt/cfs/pkgs/PTOOLS/pkgs/ptoolsrte-0.55/packages/Python-2.7.2/lib...
BACKTRACE 16	[PyEval_EvalFrameEx] [/mnt/home/jlinford/0.55/build/Python-2.7.2/Python/ceval.c:2333] [/mnt/cfs/pkgs/PTOOLS/pkgs/ptoolsrte-0.55/packages/Python-2.7.2/lib/libpython2...
BACKTRACE 17	[fast_function] [/mnt/home/jlinford/0.55/build/Python-2.7.2/Python/ceval.c:4099] [/mnt/cfs/pkgs/PTOOLS/pkgs/ptoolsrte-0.55/packages/Python-2.7.2/lib/libpython2.7.so.1...
BACKTRACE 18	[PyEval_EvalCodeEx] [/mnt/home/jlinford/0.55/build/Python-2.7.2/Python/ceval.c:3253] [/mnt/cfs/pkgs/PTOOLS/pkgs/ptoolsrte-0.55/packages/Python-2.7.2/lib/libpython2...
BACKTRACE 19	[PyEval_EvalCode] [/mnt/home/jlinford/0.55/build/Python-2.7.2/Python/ceval.c:667] [/mnt/cfs/pkgs/PTOOLS/pkgs/ptoolsrte-0.55/packages/Python-2.7.2/lib/libpython2.7.so...
BACKTRACE 20	[run_mod] [/mnt/home/jlinford/0.55/build/Python-2.7.2/Python/pythonrun.c:1346] [/mnt/cfs/pkgs/PTOOLS/pkgs/ptoolsrte-0.55/packages/Python-2.7.2/lib/libpython2.7.so...
BACKTRACE 21	[exec_statement] [/mnt/home/jlinford/0.55/build/Python-2.7.2/Python/ceval.c:4746] [/mnt/cfs/pkgs/PTOOLS/pkgs/ptoolsrte-0.55/packages/Python-2.7.2/lib/libpython2.7.s...
BACKTRACE 22	[PyEval_EvalCodeEx] [/mnt/home/jlinford/0.55/build/Python-2.7.2/Python/ceval.c:3253] [/mnt/cfs/pkgs/PTOOLS/pkgs/ptoolsrte-0.55/packages/Python-2.7.2/lib/libpython2...
BACKTRACE 23	[fast_function] [/mnt/home/jlinford/0.55/build/Python-2.7.2/Python/ceval.c:4109] [/mnt/cfs/pkgs/PTOOLS/pkgs/ptoolsrte-0.55/packages/Python-2.7.2/lib/libpython2.7.so.1...
BACKTRACE 24	[fast_function] [/mnt/home/jlinford/0.55/build/Python-2.7.2/Python/ceval.c:4099] [/mnt/cfs/pkgs/PTOOLS/pkgs/ptoolsrte-0.55/packages/Python-2.7.2/lib/libpython2.7.so.1...
BACKTRACE 25	[PyEval_EvalCodeEx] [/mnt/home/jlinford/0.55/build/Python-2.7.2/Python/ceval.c:3253] [/mnt/cfs/pkgs/PTOOLS/pkgs/ptoolsrte-0.55/packages/Python-2.7.2/lib/libpython2...
BACKTRACE 26	[fast_function] [/mnt/home/jlinford/0.55/build/Python-2.7.2/Python/ceval.c:4109] [/mnt/cfs/pkgs/PTOOLS/pkgs/ptoolsrte-0.55/packages/Python-2.7.2/lib/libpython2.7.so.1...
BACKTRACE 27	[PyEval_EvalCodeEx] [/mnt/home/jlinford/0.55/build/Python-2.7.2/Python/ceval.c:3253] [/mnt/cfs/pkgs/PTOOLS/pkgs/ptoolsrte-0.55/packages/Python-2.7.2/lib/libpython2...
BACKTRACE 28	[PyEval_EvalCode] [/mnt/home/jlinford/0.55/build/Python-2.7.2/Python/ceval.c:667] [/mnt/cfs/pkgs/PTOOLS/pkgs/ptoolsrte-0.55/packages/Python-2.7.2/lib/libpython2.7.so...
BACKTRACE 29	[run_mod] [/mnt/home/jlinford/0.55/build/Python-2.7.2/Python/pythonrun.c:1346] [/mnt/cfs/pkgs/PTOOLS/pkgs/ptoolsrte-0.55/packages/Python-2.7.2/lib/libpython2.7.so...
BACKTRACE 30	[PyRun_SimpleFileExFlags] [/mnt/home/jlinford/0.55/build/Python-2.7.2/Python/pythonrun.c:936] [/mnt/cfs/pkgs/PTOOLS/pkgs/ptoolsrte-0.55/packages/Python-2.7.2/lib/lib...
BACKTRACE 31	[Py_Main] [/mnt/home/jlinford/0.55/build/Python-2.7.2/Modules/main.c:599] [/mnt/cfs/pkgs/PTOOLS/pkgs/ptoolsrte-0.55/packages/Python-2.7.2/lib/libpython2.7.so.1.0]
BACKTRACE 32	[pyMPI_Main_with_communicator] [(unknown):0] [/mnt/cfs/pkgs/PTOOLS/pkgs/ptoolsrte-0.55/packages/pyMPI-2.5b0/bin/pyMPI]

```
% qsub –env TAU_TRACK_SIGNALS=1 …
% paraprof
```

What Caused My Application to Crash?

TAU: ParaProf: Source Browser: /mnt/home/jlinford/py-c++-f90-create/SAMINT.C

File Help

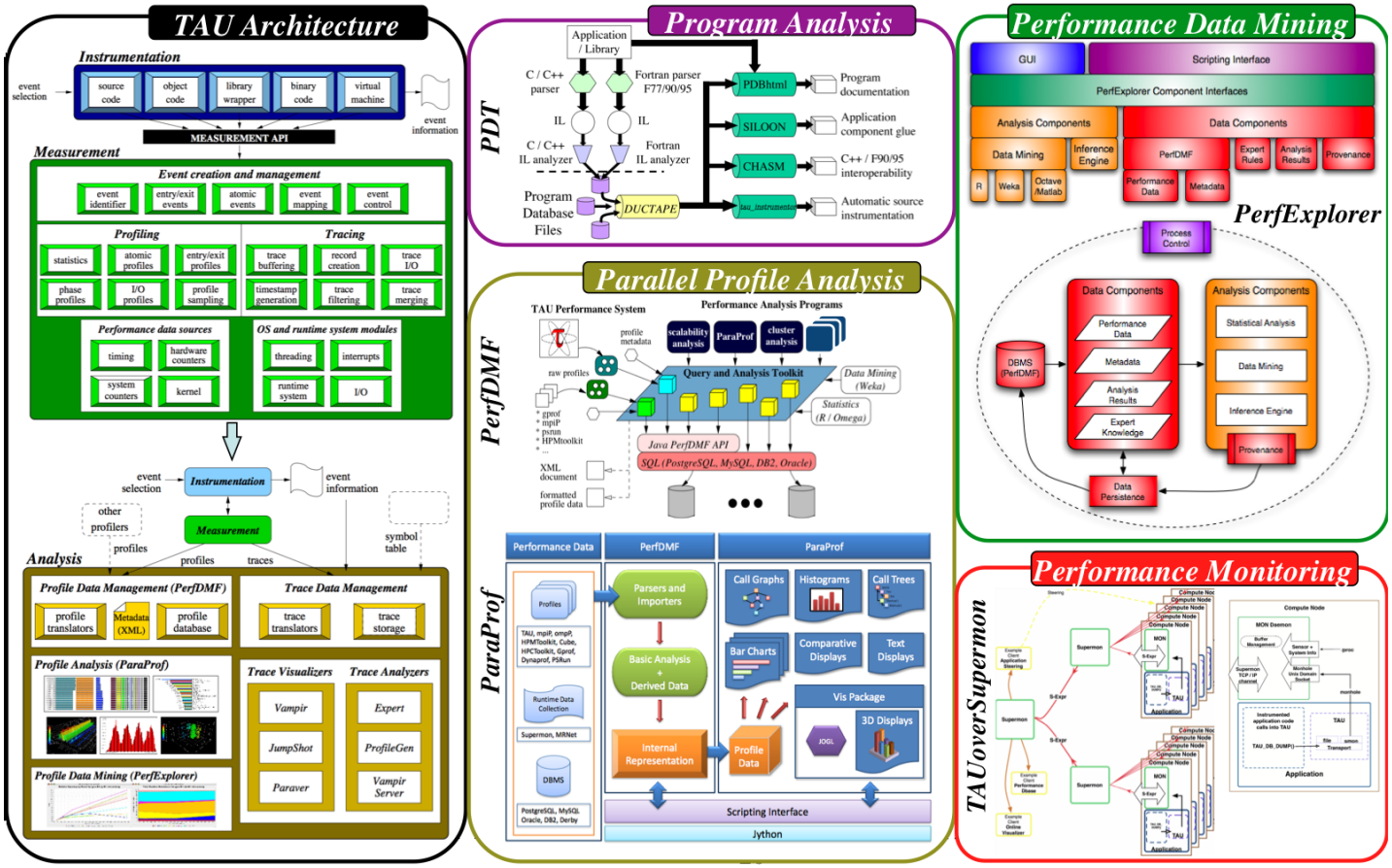
```
65      /*
66      ************************************************************************
67      *
68      * Take a timestep - advance solution from "time" to "time + dt"
69      *
70      ************************************************************************
71      */
72      void SAMINT::timestep(const double time,
73                            const double dt)
74      {
75         cout << "SAMINT::timestep()" << endl;
76         timestep_(time,dt);
77         int  x = 4 / (4-4);
78         cout <<" x = "<<x<<endl;
79
80      }
81
82      /*
83      ************************************************************************
84      *
85      * Write data to output
86      * (visit, fieldview, or overgrid - set in samarc input file)
87      *
88      ************************************************************************
89      */
90      void SAMINT::writePlotData(const double time,
91                                 const int step)
92      {
93         cout << "SAMINT::writePlotData()" << endl;
```

Error shown in ParaProf Source Browser

Intuitive Performance Engineering

TAU COMMANDER

TAU: Powerful and Complex



How do we navigate?

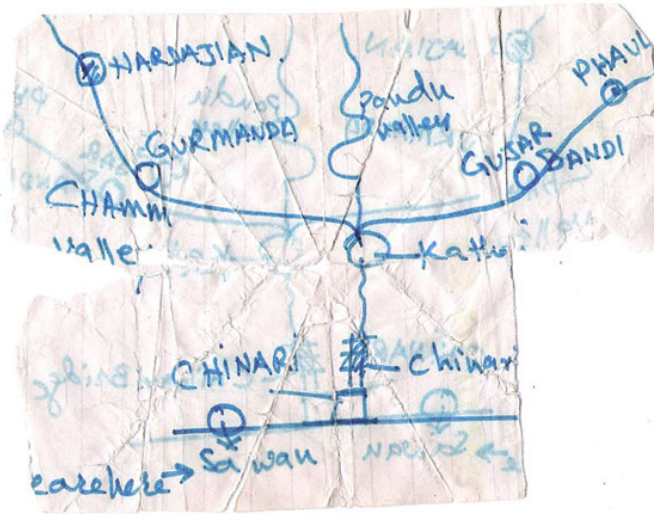
TAU Commander

- DOE SBIR Phase II
- Simplify TAU usage
  - Develop a common framework for TAU user interface
  - Develop an intuitive, high-productivity user interface
- Phase I results:
  - Study of 124 workflows involving eleven test cases on six computing systems
  - TAU Commander reduces number of steps in TAU workflow by approximately 50%
  - Reduces the number of commands a user must know from approximately eight to exactly one

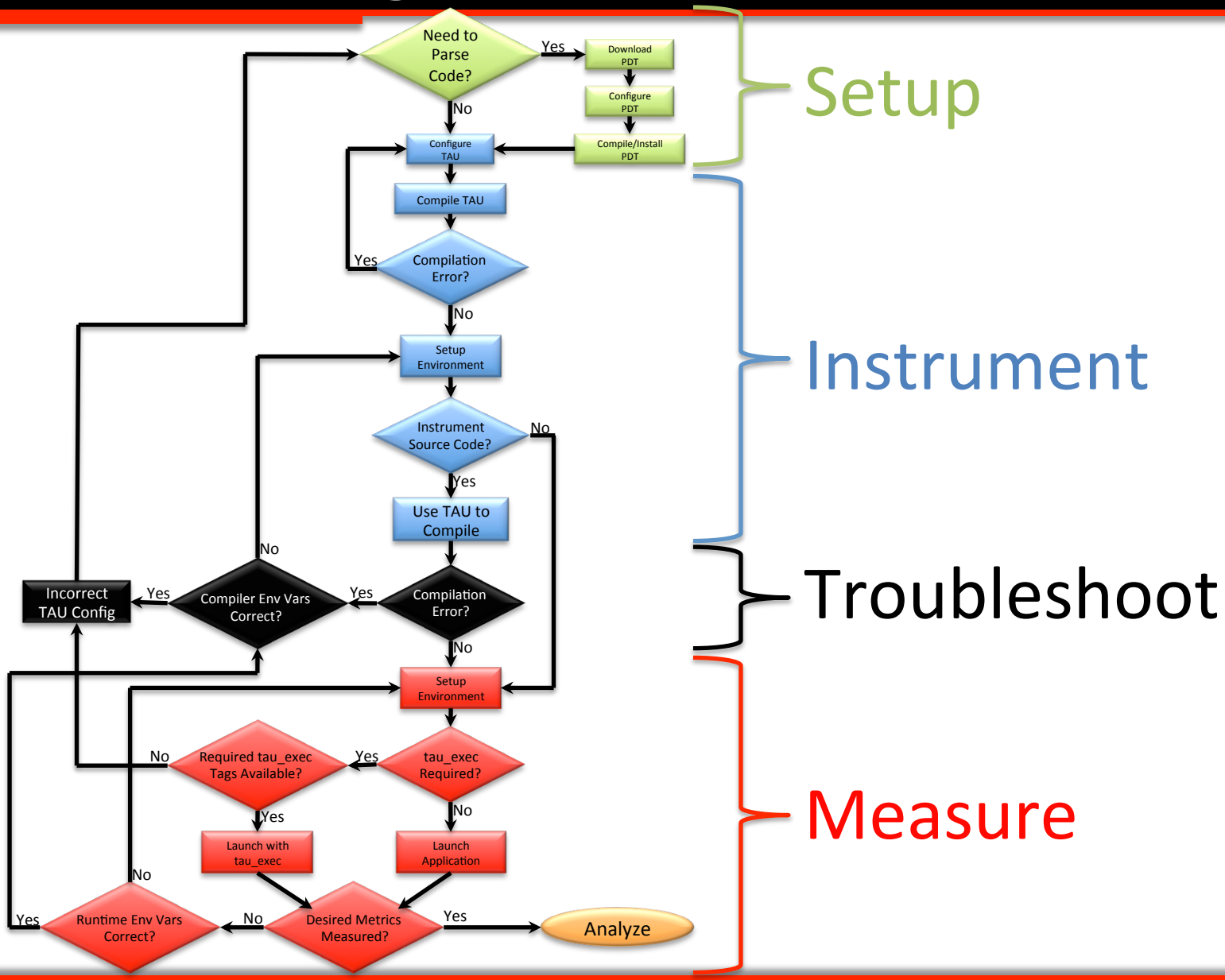
The TAU Commander Approach

- Say where you're going, not how to get there
- **TAU Projects** give context to the user's actions
  - Defines desired metrics and measurement approach
  - Defines operating environment
  - Establishes a baseline for error checking

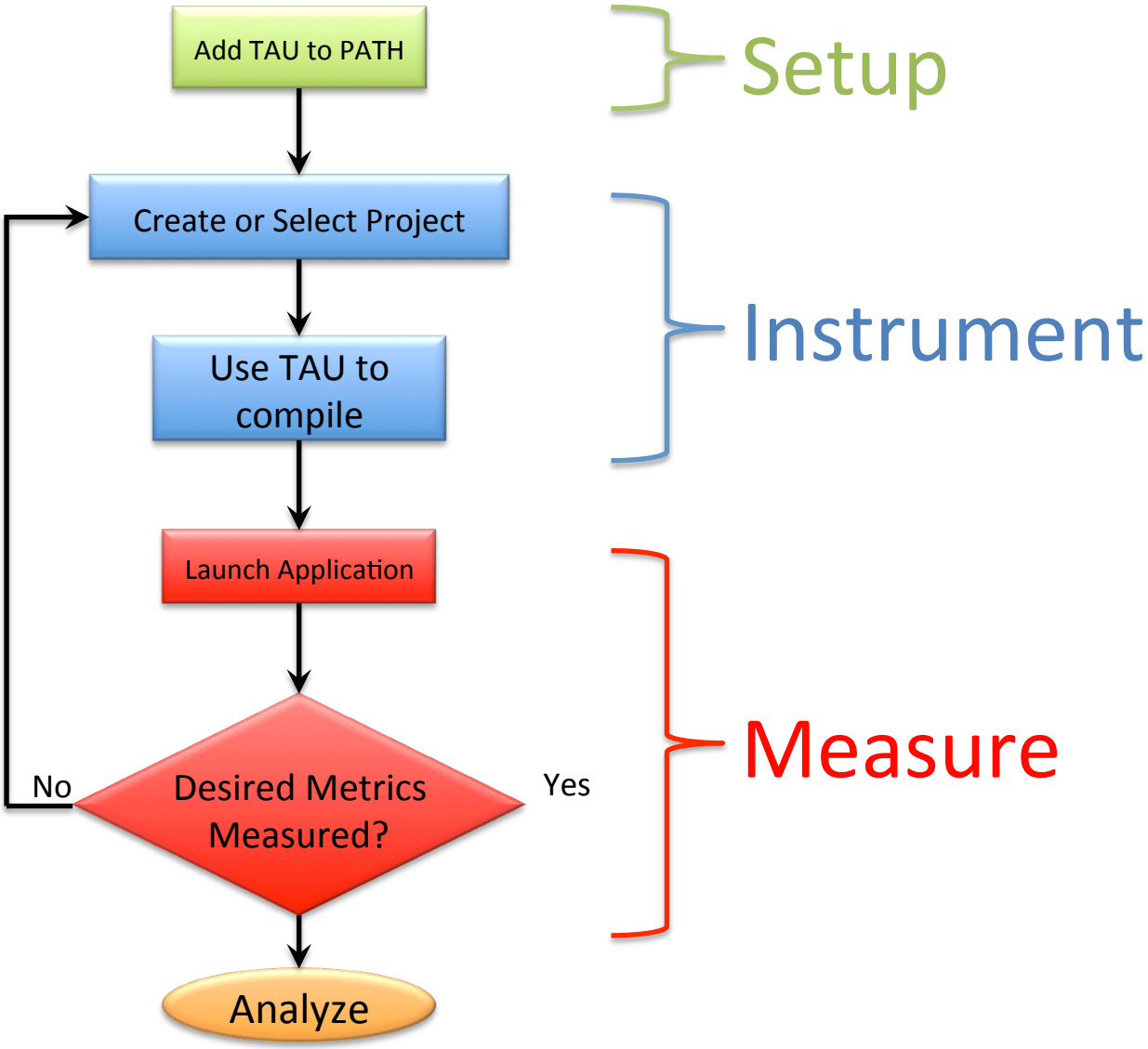
vs.



TAU Usage (SBIR Phase I)

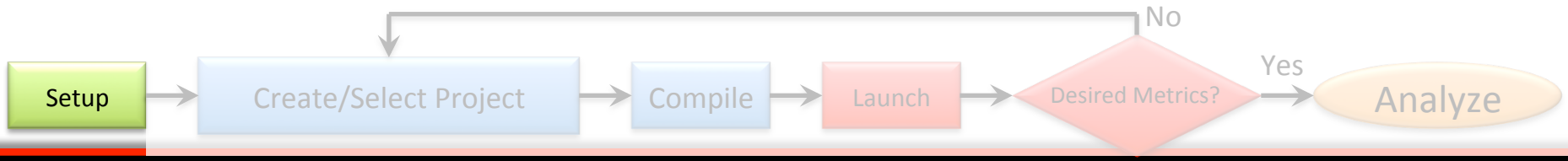


TAU Commander Usage (SBIR Phase I)



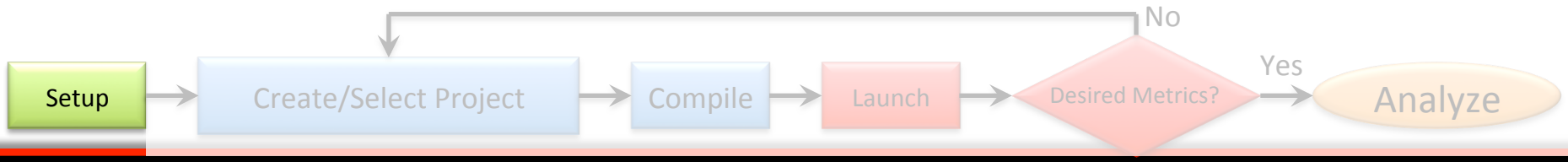
TAU Commander Usage Example

```
jlinford@east03 /tmp/matmult $ ls
Makefile  matmult.c  matmult_initialize.c  matmult_initialize.h
```



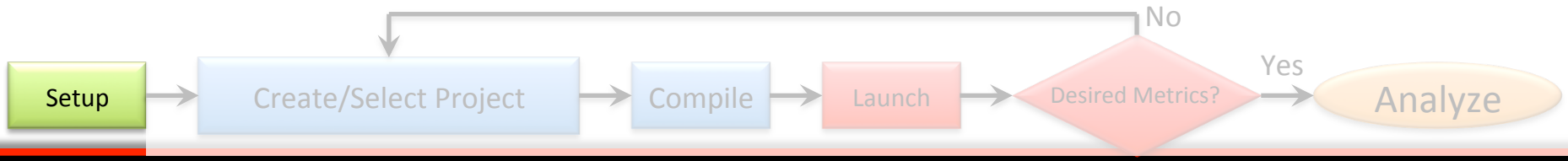
TAU Commander Usage Example

```
jlinford@east03 /tmp/matmult $ export PATH=$HOME/workspace/taucmdr/bin:$PATH
```



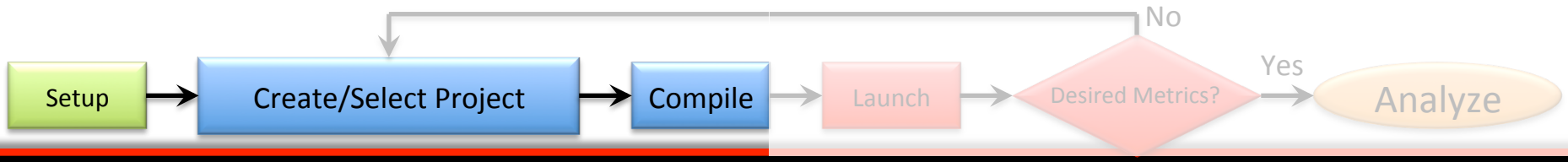
TAU Commander Usage Example

```
jlinford@east03 /tmp/matmult $ tau --help
The Tau Performance System (2.22.3-git)
http://tau.uoregon.edu/

Usage:
  tau [options] <command> [<args>...]
  tau -h | --help
  tau --version

Options:
  --project=<name> Use the specified project instead of the default for this run only.
  --log=<level>    Output level, one of CRITICAL, ERRROR, WARNING, INFO, or DEBUG.
  --verbose        Same as --log=DEBUG

Commands:
  build            Instrument programs during compilation and/or linking.
  help             Get help with a command.
  make             Build your application with 'make' and the TAU compilers.
  pack             Package profile files into a PPK file.
  project          Create and manage TAU projects.
  run              Gather measurements from an application.
  show             Display application profile or trace data.
```



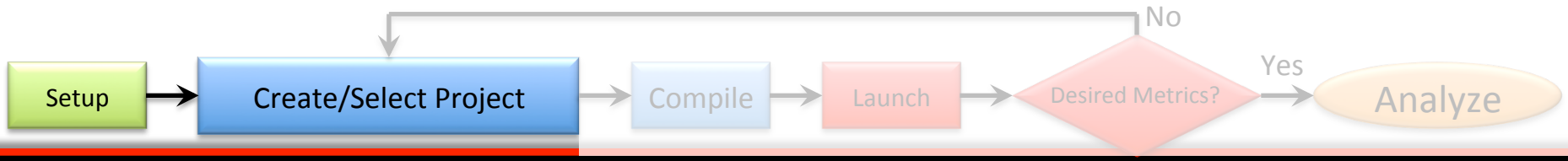
TAU Commander Usage Example

```
jlinford@east03 /tmp/matmult $ ls
Makefile  matmult.c  matmult_initialize.c  matmult_initialize.h
```



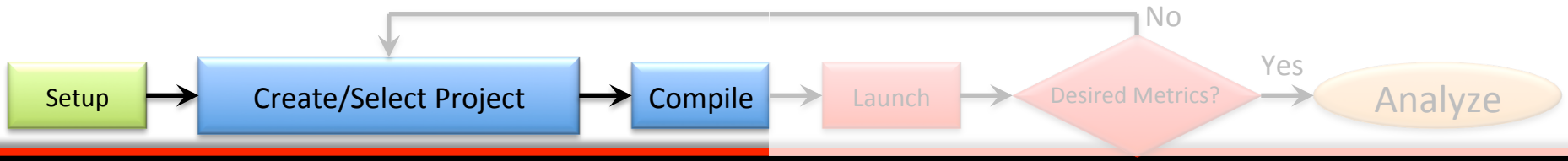
TAU Commander Usage Example

```
jlinford@east03 /tmp/matmult $ tau project create --mpi
TAU: == New project settings ==================================================
TAU: bfd          : 'download'
TAU: c++          : 'g++'
TAU: callpath     : 2
TAU: cc           : 'gcc'
TAU: fortran      : 'gfortran'
TAU: mpi          : True
TAU: pdt          : 'download'
TAU: profile      : True
TAU: target-arch  : 'x86_64'
TAU: unwind       : 'download'
TAU: Enter project name> matmult.mpi
TAU: 'matmult.mpi' is now the new user default project
TAU: Created a new project named 'matmult.mpi'.
jlinford@east03 /tmp/matmult $
```



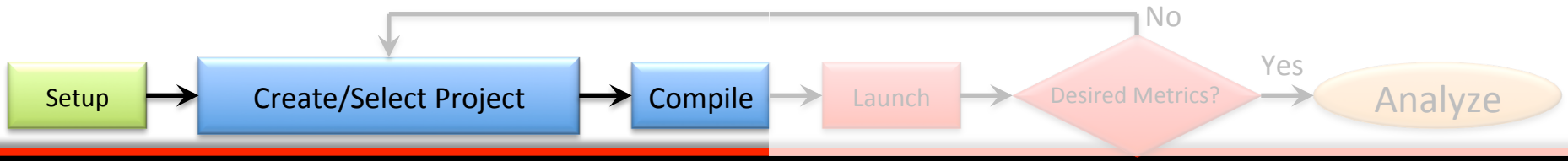
TAU Commander Usage Example

```
jlinford@east03 /tmp/matmult $ ls
Makefile  matmult.c  matmult_initialize.c  matmult_initialize.h
jlinford@east03 /tmp/matmult $ tau mpicc *.c -o matmult
```



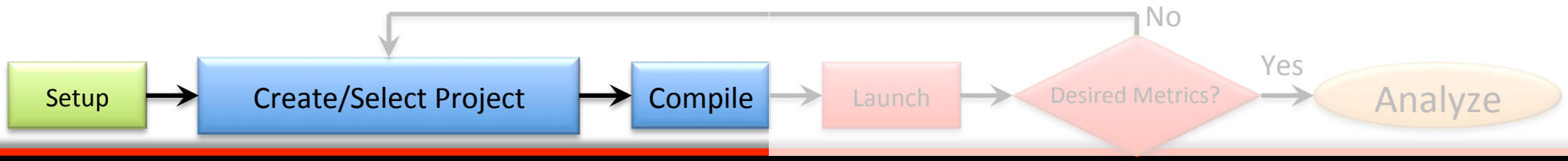
TAU Commander Usage Example

```
jlinford@east03 /tmp/matmult $ ls
Makefile  matmult.c  matmult_initialize.c  matmult_initialize.h
jlinford@east03 /tmp/matmult $ tau mpicc *.c -o matmult
TAU: Using TAU project 'matmult.mpi'
TAU: Compiling project 'matmult.mpi'. This will be done only once.
TAU: Installing BFD at
TAU:   '/home/jlinford/workspace/taucmdr/installed/x86_64_g++_gcc_gfortran/bfd'
TAU: Downloading
TAU:   'http://www.cs.uoregon.edu/research/paracomp/tau/tauprofile/dist/binutils-2.23.2.tar.gz'
TAU: Extracting '/home/jlinford/.tau/src/binutils-2.23.2.tar.gz'
TAU: Configuring BFD...
TAU: ./configure
TAU:   --prefix=/home/jlinford/workspace/taucmdr/installed/x86_64_g++_gcc_gfortran/bfd
TAU:    CXXFLAGS=-fPIC --disable-werror --disable-nls CFLAGS=-fPIC
TAU: Compiling BFD...
TAU: make
TAU: Installing BFD...
TAU: make install
TAU: BFD installation complete.
TAU: Installing PDT at
TAU:   '/home/jlinford/workspace/taucmdr/installed/x86_64_g++_gcc_gfortran/pdt'
TAU: Downloading 'http://tau.uoregon.edu/pdt.tgz'
```



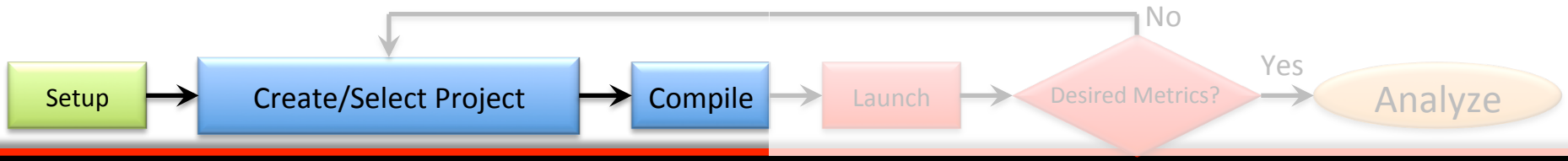
TAU Commander Usage Example

```
TAU: BFD installation complete.
TAU: Installing PDT at
TAU:   '/home/jlinford/workspace/taucmdr/installed/x86_64_g++_gcc_gfortran/pdt'
TAU: Downloading 'http://tau.uoregon.edu/pdt.tgz'
TAU: Extracting '/home/jlinford/.tau/src/pdt.tgz'
TAU: Configuring PDT...
TAU: ./configure -GNU
TAU:   -prefix=/home/jlinford/workspace/taucmdr/installed/x86_64_g++_gcc_gfortran/pdt
TAU: Compiling PDT...
TAU: make -j
TAU: Installing PDT...
TAU: make install
TAU: PDT installation complete.
TAU: Installing TAU at
TAU:   '/home/jlinford/.tau/x86_64_g++_gcc_gfortran/tau/bfd_mpi_pdt'
TAU: Creating new copy of TAU at '/home/jlinford/.tau/src/tau'.  This will only
TAU:   be done once.
TAU: Configuring TAU...
TAU: ./configure
TAU:   -prefix=/home/jlinford/.tau/x86_64_g++_gcc_gfortran/tau/bfd_mpi_pdt
TAU:   -unwind=download -cc=gcc
TAU:   -bfd=/home/jlinford/workspace/taucmdr/installed/x86_64_g++_gcc_gfortran/bfd
TAU:    -fortran=gfortran -mpi -arch=x86_64
TAU:   -pdt=/home/jlinford/workspace/taucmdr/installed/x86_64_g++_gcc_gfortran/pdt
TAU:    -c++=g++
TAU: Compiling TAU...
TAU: make -j install
TAU: TAU installation complete.
```



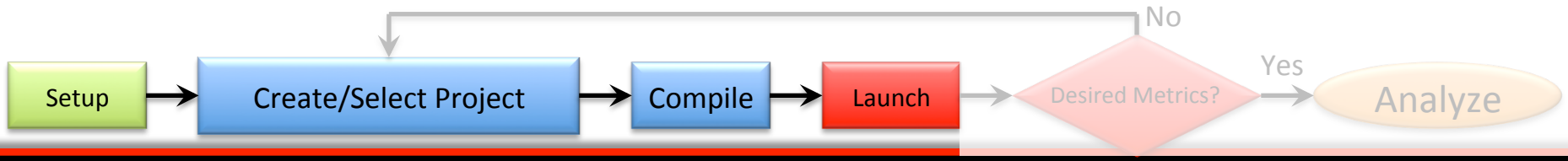
TAU Commander Usage Example

```
TAU: Compiling TAU...
TAU: make -j install
TAU: TAU installation complete.
TAU: TAU_MASTER_SRC_DIR=/home/jlinford/workspace/taucmdr/tau
TAU: TAU_OPTIONS=-optRevert -optQuiet
TAU: TAU_MAKEFILE=/home/jlinford/.tau/x86_64_g++_gcc_gfortran/tau/bfd_mpi_pdt/x86_64/lib/Makefile.tau
-mpi-pdt
TAU: TAU_HOME=/home/jlinford/workspace/taucmdr
TAU: tau_cc.sh matmult.c matmult_initialize.c -o matmult

jlinford@east03 /tmp/matmult $
```



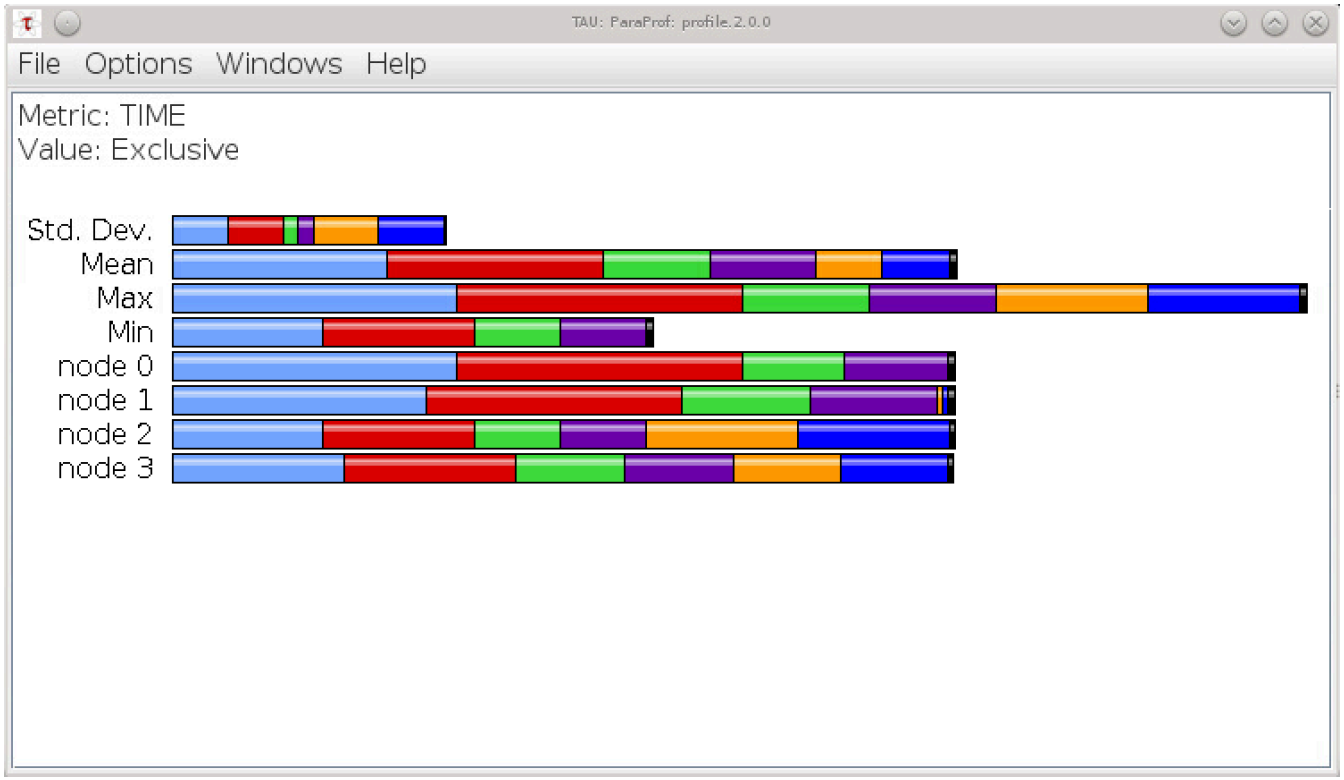
TAU Commander Usage Example

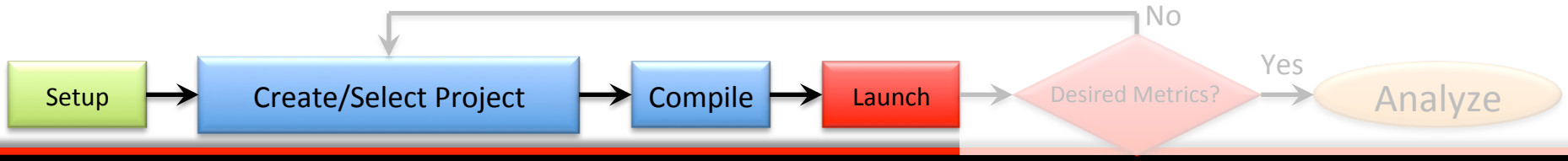
```
jlinford@east03 /tmp/matmult $ tau mpirun -np 4 ./matmult
TAU: Using TAU project 'matmult.mpi'
TAU: TAU_MASTER_SRC_DIR=/home/jlinford/workspace/taucmdr/tau
TAU: TAU_CALLPATH=1
TAU: TAU_CALLPATH_DEPTH=2
TAU: TAU_PROFILE=1
TAU: TAU_HOME=/home/jlinford/workspace/taucmdr
TAU: mpirun -np 4 tau_exec -T MPI,PDT ./matmult
Done.
Done.
Done.
Done.
```



TAU Commander Usage Example

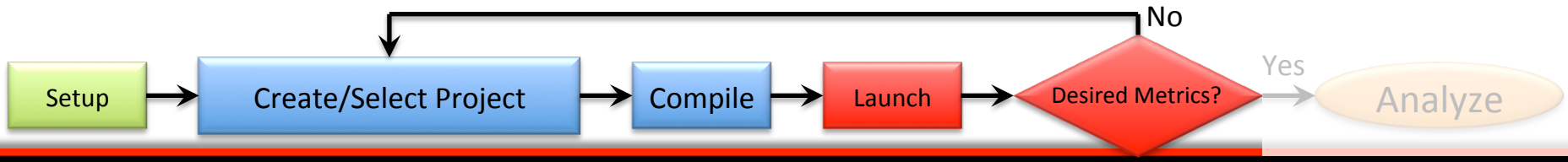
```
jlinford@east03 /tmp/matmult $ tau show
TAU: Using TAU project 'matmult.mpi'
```





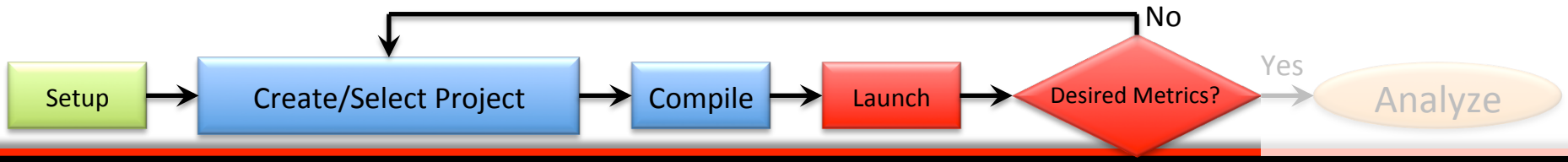
TAU Commander Usage Example

```
jlinford@east03 /tmp/matmult $ tau project create --help
Usage:
  tau project create [options]
  tau project create -h | --help

Subcommand Options:
  --name=<name>     Set the project name.
  --default         After creating the project, make it the default project.
  --system          Create project in TAU installation at '/home/jlinford/workspace/taucmdr/installed'.

Architecture Options:
  --target-arch=<arch>         Set target architecture.             [default: x86_64]

Compiler Options:
  --cc=<compiler>              Set C compiler.                      [default: gcc]
  --c++=<compiler>             Set C++ compiler.                    [default: g++]
  --fortran=<compiler>         Set Fortran compiler.                [default: gfortran]

Assisting Library Options:
  --pdt=(download|<path>)      PDT installation path.               [default: download]
  --bfd=(download|<path>)      GNU Binutils installation path.      [default: download]
  --unwind=(download|<path>)   libunwind installation path.         [default: download]
  --papi=(download|<path>)     PAPI installation path.              [default: disabled]
  --dyninst=(download|<path>)  DyninstAPI installation path.        [default: disabled]

Thread Options:
  --openmp                     Enable OpenMP measurement.           [default: disabled]
  --pthreads                   Enable pthreads measurement.         [default: disabled]
```



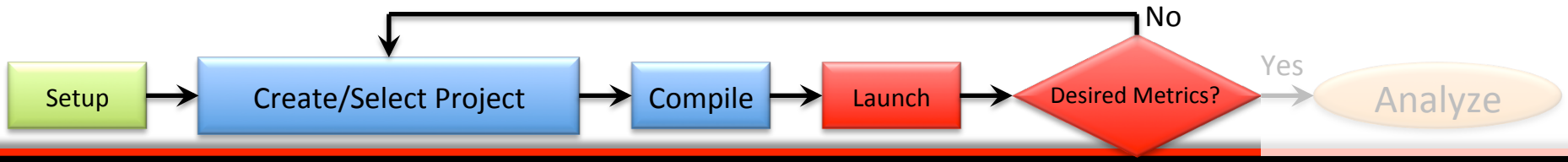
TAU Commander Usage Example

```
jlinford@east03 /tmp/matmult $ tau project create --mpi --openmp --name=matmult.mpi.openmp
TAU: == New project settings ====================================================
TAU: bfd         : 'download'
TAU: c++         : 'g++'
TAU: callpath    : 2
TAU: cc          : 'gcc'
TAU: fortran     : 'gfortran'
TAU: mpi         : True
TAU: name        : 'matmult.mpi.openmp'
TAU: openmp      : True
TAU: pdt         : 'download'
TAU: profile     : True
TAU: target-arch : 'x86_64'
TAU: unwind      : 'download'
TAU: Use 'tau project default matmult.mpi.openmp' to select a default project.
TAU: Created a new project named 'matmult.mpi.openmp'.
jlinford@east03 /tmp/matmult $ tau project default matmult.mpi.openmp
TAU:
TAU: == System Projects (/home/jlinford/workspace/taucmdr/installed) ===========
TAU: No projects. See 'tau project create --help'
TAU:
TAU: == User Projects (/home/jlinford/.tau) ======================================
TAU: matmult.mpi
TAU: matmult.mpi.openmp [default]
TAU:
jlinford@east03 /tmp/matmult $
```



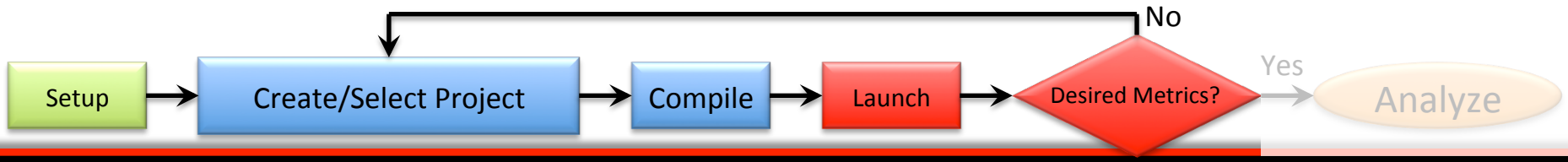
TAU Commander Usage Example

```
jlinford@east03 /tmp/matmult $ tau mpicc *.c -o matmult
TAU: Using TAU project 'matmult.mpi.openmp'
TAU: Compiling project 'matmult.mpi.openmp'. This will be done only once.
TAU: Using BFD installation found at
TAU:   /home/jlinford/workspace/taucmdr/installed/x86_64_g++_gcc_gfortran/bfd
TAU: Using PDT installation found at
TAU:   /home/jlinford/workspace/taucmdr/installed/x86_64_g++_gcc_gfortran/pdt
TAU: Installing TAU at
TAU:   '/home/jlinford/.tau/x86_64_g++_gcc_gfortran/tau/bfd_mpi_openmp_pdt'
TAU: Configuring TAU...
TAU: ./configure
TAU:   -prefix=/home/jlinford/.tau/x86_64_g++_gcc_gfortran/tau/bfd_mpi_openmp_pdt
TAU:    -unwind=download -cc=gcc
TAU:   -bfd=/home/jlinford/workspace/taucmdr/installed/x86_64_g++_gcc_gfortran/bfd
TAU:    -fortran=gfortran -mpi -arch=x86_64 -opari
TAU:   -pdt=/home/jlinford/workspace/taucmdr/installed/x86_64_g++_gcc_gfortran/pdt
TAU:    -c++=g++
TAU: Compiling TAU...
TAU: make -j install
TAU: TAU installation complete.
TAU: TAU_MASTER_SRC_DIR=/home/jlinford/workspace/taucmdr/tau
TAU: TAU_OPTIONS=-optRevert -optQuiet
TAU: TAU_MAKEFILE=/home/jlinford/.tau/x86_64_g++_gcc_gfortran/tau/bfd_mpi_openmp_pdt/x86_64/lib/Makefile
.tau-mpi-pdt-openmp-opari
TAU: TAU_HOME=/home/jlinford/workspace/taucmdr
TAU: tau_cc.sh matmult.c matmult_initialize.c -o matmult

jlinford@east03 /tmp/matmult $
```



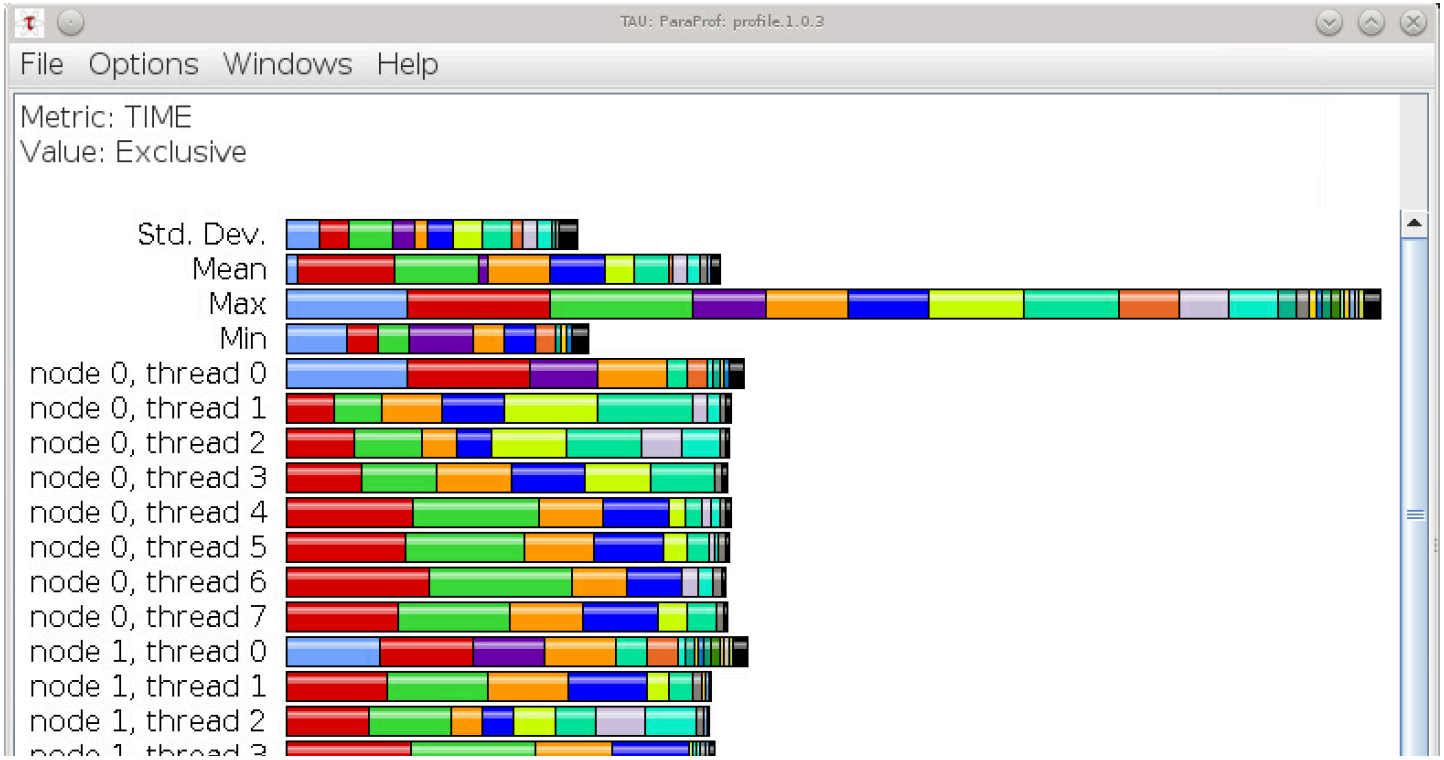
TAU Commander Usage Example

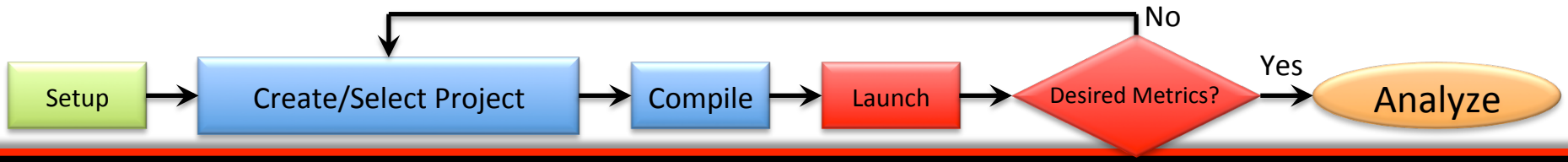
```
jlinford@east03 /tmp/matmult $ tau mpirun -np 4 ./matmult
TAU: Using TAU project 'matmult.mpi.openmp'
TAU: TAU_MASTER_SRC_DIR=/home/jlinford/workspace/taucmdr/tau
TAU: TAU_CALLPATH=1
TAU: TAU_CALLPATH_DEPTH=2
TAU: TAU_PROFILE=1
TAU: TAU_HOME=/home/jlinford/workspace/taucmdr
TAU: mpirun -np 4 tau_exec -T MPI,PDT,OPENMP,OPARI ./matmult
MPI_Init_thread: provided = 1, MPI_THREAD_FUNNELED=1
MPI_Init_thread: provided = 1, MPI_THREAD_FUNNELED=1
MPI_Init_thread: provided = 1, MPI_THREAD_FUNNELED=1
MPI_Init_thread: provided = 1, MPI_THREAD_FUNNELED=1
provided is MPI_THREAD_FUNNELED
provided is MPI_THREAD_FUNNELED
provided is MPI_THREAD_FUNNELED
provided is MPI_THREAD_FUNNELED
Done.
Done.
Done.
Done.
```



TAU Commander Usage Example

```
jlinford@east03 /tmp/matmult $ tau show
TAU: Using TAU project 'matmult.mpi.openmp'
```





Usage Summary

Step	Action	Commands
1	Add TAU to path	`export PATH=$HOME/workspace/taucmd:$PATH`

2	Create project	`cd matmult`
		`tau project create matmult --openmp --mpi \`
		`  --callpath=100 --memory`

3	Instrument with TAU	`tau mpif90 *.f90 -o matmult`
4	Execute instrumented application	`tau qsub –A <queue> –q R.bc –n 256 –t 10 ./matmult`
5	Visualize data	`tau show`

Download TAU from U. Oregon

http://tau.uoregon.edu
https://github.com/jlinford/taucmdr

Free download, open source, BSD license

http://www.hpclinux.com [LiveDVD]

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