

Advanced TAU Commander

ParaTools, Inc.

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Webex from Baltimore, MD

ParaTools, Inc.

BUILD SYSTEMS AND LAUNCHERS

Autotools

- Initialize before running configure:
 - tau initialize
- If the project is already initialized, be sure you don't have an “expensive” experiment selected, e.g. tracing or profiling with lots of options.
- ./configure CC="tau gcc"
 - Recommend --disable-dependency-tracking to avoid problems with source-based instrumentation. No worries if only sampling.
- make && make install
- If you change your experiment you do not have to reconfigure, just recompile:
 - make clean
 - make && make install

CMake

- This should work:
 - `cmake -DCMAKE_C_COMPILER="tau gcc"`
- If it doesn't, use the wrapper scripts:
 - `export PATH=$PWD/.tau/bin/<target_name>`
 - `cmake -DCMAKE_C_COMPILER="tau_gcc"`
- Wrapper scripts are automatically generated for all compilers supported by the target.
 - Wrapper for <compiler> is “`tau_<compiler>`”
 - E.g. `tau_gcc`, `tau_mpicc`, `tau_oshcc`, etc.
- Wrappers can be used for **any build system** that doesn't like spaces in the compiler name.

Running with custom launchers

```
tau trial create \  
  --launcher mylauncher -np 4 -- \  
    ./a.out bar baz
```

- Use the `--launcher` flag to indicate the launcher command and arguments.
- Use “`--`” to mark the beginning of the application command line.
- `tau mpirun -np 4 ./a.out 20` is shorthand for:
`tau trial create --launcher mpirun -np 4 -- ./a.out 20`

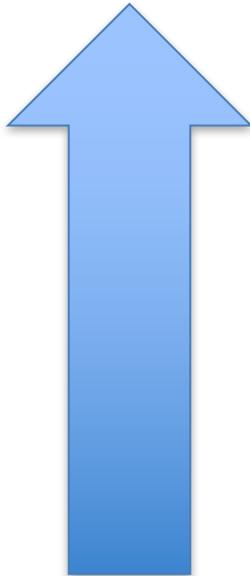
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PROFILING PARALLEL APPLICATIONS

Step 1: Initialize TAU Project

```
$ cp -R /path/to/taucmdr-1.2.0/examples $HOME  
$ cd $HOME/examples/matmult_omp  
$ ls  
Makefile matmult.f90
```

```
$ tau initialize --mpi --openmp
```



- Creates a new project configuration using defaults
- Project files exist in a directory named “.tau”
- Like git, all directories below the directory containing the “.tau” directory can access the project
 - E.g. `tau dashboard` works in miniapp1/baseline

**WARNING: Don't execute tau initialize in \$HOME!
(this bug is fixed in version 1.2.0.4)**

matmult_omp Dashboard

```
jlinford@east03:~/examples/matmult_omp$ tau init --mpi --openmp
[TAU] System MPI C compiler '/opt/intel/compilers_and_libraries_2017.2.174/linux/mpi/intel64/bin/mpicc' wraps
[TAU]   '/usr/bin/gcc'
[TAU] System MPI C++ compiler '/opt/intel/compilers_and_libraries_2017.2.174/linux/mpi/intel64/bin/mpicxx' wraps
[TAU]   '/usr/bin/g++'
[TAU] System MPI Fortran compiler '/opt/intel/compilers_and_libraries_2017.2.174/linux/mpi/intel64/bin/mpif90' wraps
[TAU]   '/usr/bin/gfortran'
[TAU] Created a new project named 'matmult_omp'.
[TAU] Added application 'matmult_omp' to project configuration 'matmult_omp'.
[TAU] Added target 'east03' to project configuration 'matmult_omp'.
[TAU] Added measurement 'sample' to project configuration 'matmult_omp'.
[TAU] Added measurement 'profile' to project configuration 'matmult_omp'.
[TAU] Added measurement 'trace' to project configuration 'matmult_omp'.
[TAU] Created a new experiment 'east03-matmult_omp-sample'.
[TAU] Selected experiment 'east03-matmult_omp-sample'.

== Project Configuration (/home/jlinford/examples/matmult_omp/.tau/project.json) =====

+-----+
| Name | Targets | Applications | Measurements | # Experiments |
+-----+
| matmult_omp | east03 | matmult_omp | sample, profile, trace | 1 |
+-----+

== Targets in project 'matmult_omp' =====

+-----+
| Name | Host OS | Host Arch | Host Compilers | MPI Compilers | SHMEM Compilers |
+-----+
| east03 | Linux | x86_64 | GNU | System | None |
+-----+

== Applications in project 'matmult_omp' =====

+-----+
| Name | Linkage | OpenMP | Pthreads | TBB | MPI | CUDA | OpenCL | SHMEM | MPC |
+-----+
| matmult_omp | dynamic | Yes | No | No | Yes | No | No | No | No |
+-----+

== Measurements in project 'matmult_omp' =====

+-----+
| Name | Profile | Trace | Sample | Source Inst. | Compiler Inst. | OpenMP | CUDA | I/O | MPI | SHMEM |
+-----+
| sample | tau | none | Yes | never | never | ignore | No | No | Yes | No |
| profile | tau | none | No | automatic | never | ignore | No | No | Yes | No |
| trace | none | otf2 | No | automatic | never | ignore | No | No | Yes | No |
+-----+

== Experiments in project 'matmult_omp' =====

+-----+
| Name | Trials | Data Size | Target | Application | Measurement | TAU Makefile |
+-----+
| east03 | 0 | 0.0B | east03 | matmult_omp | sample | Makefile.tau-beec6777-mpi-pthread |
| -matmult_omp-
| -sample |
+-----+

Selected Experiment: east03-matmult_omp-sample
jlinford@east03:~/examples/matmult_omp$
```

Edit matmult_omp/Makefile

Before

```
1 F90 = mpifort  
2 FFLAGS = -O -g  
3 LIBS= -fopenmp
```

After

```
1 F90 = tau mpif90  
2 FFLAGS = -O -g  
3 LIBS= -fopenmp
```

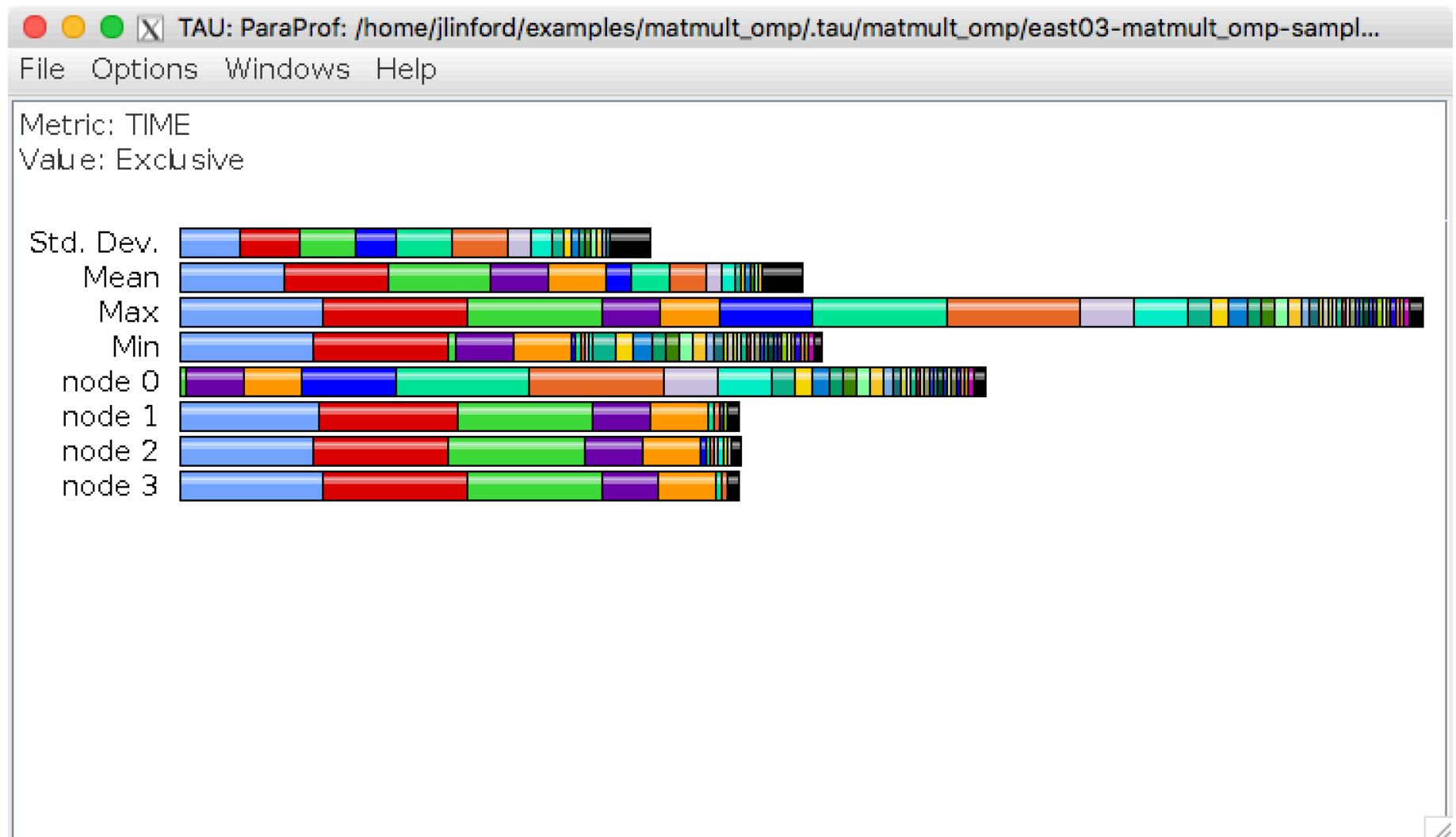
Build matmult_omp

```
jlinford — jlinford@east03: ~/examples/matmult_omp — ssh east04.paratools.com — 120x16
[jlinford@east03:~/examples/matmult_omp$ make
echo "Building matmult.o from matmult.f90"
Building matmult.o from matmult.f90
tau mpif90 -fopenmp -c matmult.f90 -o matmult.o
[TAU] System MPI Fortran compiler '/opt/intel/compilers_and_libraries_2017.2.174/linux/mpi/intel64/bin/mpif90' wraps
[TAU]   '/usr/bin/gfortran'
[TAU] TAU_MAKEFILE=/home/jlinford/taucmdr-1.2.0.4/system/tau./tau-2.26.3/x86_64/lib/Makefile.tau-beec6777-mpi-pthread
[TAU] TAU_OPTIONS=-optNoCompInst -optLinkOnly -optQuiet
[TAU] /opt/intel/compilers_and_libraries_2017.2.174/linux/mpi/intel64/bin/mpif90 -g -fopenmp -c matmult.f90 -o matmult.o
tau mpif90 matmult.o -o matmult -fopenmp
[TAU] System MPI Fortran compiler '/opt/intel/compilers_and_libraries_2017.2.174/linux/mpi/intel64/bin/mpif90' wraps
[TAU]   '/usr/bin/gfortran'
[TAU] TAU_MAKEFILE=/home/jlinford/taucmdr-1.2.0.4/system/tau./tau-2.26.3/x86_64/lib/Makefile.tau-beec6777-mpi-pthread
[TAU] TAU_OPTIONS=-optNoCompInst -optLinkOnly -optQuiet
[TAU] /opt/intel/compilers_and_libraries_2017.2.174/linux/mpi/intel64/bin/mpif90 -g matmult.o -o matmult -fopenmp
jlinford@east03:~/examples/matmult_omp$ ]
```

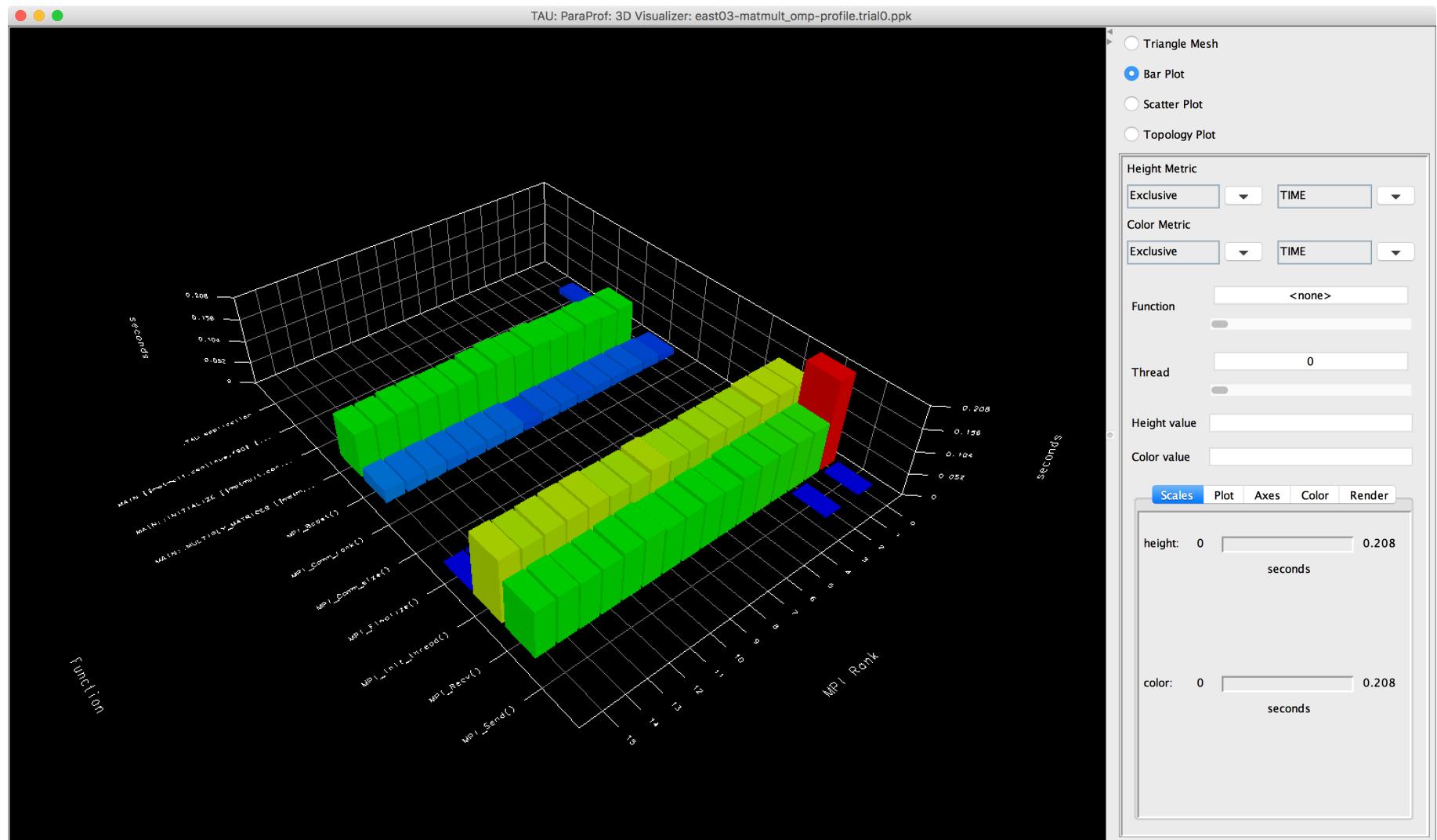
Run matmult_omp

```
jlinford — jlinford@east03: ~/examples/matmult_omp — ssh east03.paratools.com — 120x47
[jlinford@east03:~/examples/matmult_omp$ ls
Makefile  matmult  matmult.f90  matmult.o
[jlinford@east03:~/examples/matmult_omp$ export OMP_NUM_THREADS=4
[jlinford@east03:~/examples/matmult_omp$ tau mpirun -np 4 ./matmult
[TAU]
[TAU] == BEGIN Experiment at 2017-09-28 01:34:04.122771 =====
[TAU]
[TAU] PROFILEDIR=/home/jlinford/examples/matmult_omp/.tau/matmult_omp/east03-matmult_omp-sample/0
[TAU] SCOREP_ENABLE_TRACING=false
[TAU] TAU_CALLPATH=1
[TAU] TAU_CALLPATH_DEPTH=100
[TAU] TAU_CALLSITE=0
[TAU] TAU_COMM_MATRIX=0
[TAU] TAU_MERGE_METADATA=1
[TAU] TAU_METRICS=TIME,
[TAU] TAU_PROFILE=1
[TAU] TAU_SAMPLING=1
[TAU] TAU_THROTTLE=1
[TAU] TAU_THROTTLE_NUMCALLS=100000
[TAU] TAU_THROTTLE_PERCALL=10
[TAU] TAU_TRACE=0
[TAU] TAU_TRACK_HEAP=0
[TAU] TAU_VERBOSE=0
[TAU] TRACEDIR=/home/jlinford/examples/matmult_omp/.tau/matmult_omp/east03-matmult_omp-sample/0
[TAU] mpirun -np 4 tau_exec -T beec6777(pthread,mpi -ebs ./matmult
Process 1 of 4 is active
hello world from thread 0
number of threads = 1
Process 2 of 4 is active
hello world from thread 0
number of threads = 1
Process 3 of 4 is active
hello world from thread 0
number of threads = 1
Process 0 of 4 is active
hello world from thread 0
number of threads = 1
c(1000,1000) =      5.00500000000000E+08
[TAU] Trial 0 produced 4 profile files.
[TAU]
[TAU] == END Experiment at 2017-09-28 01:34:04.670656 =====
[TAU]
[TAU] Experiment: east03-matmult_omp-sample
[TAU] Command: mpirun -np 4 tau_exec -T beec6777(pthread,mpi -ebs ./matmult
[TAU] Current working directory: /home/jlinford/examples/matmult_omp
[TAU] Data size: 22.7KiB bytes
jlinford@east03:~/examples/matmult_omp$ ]
```

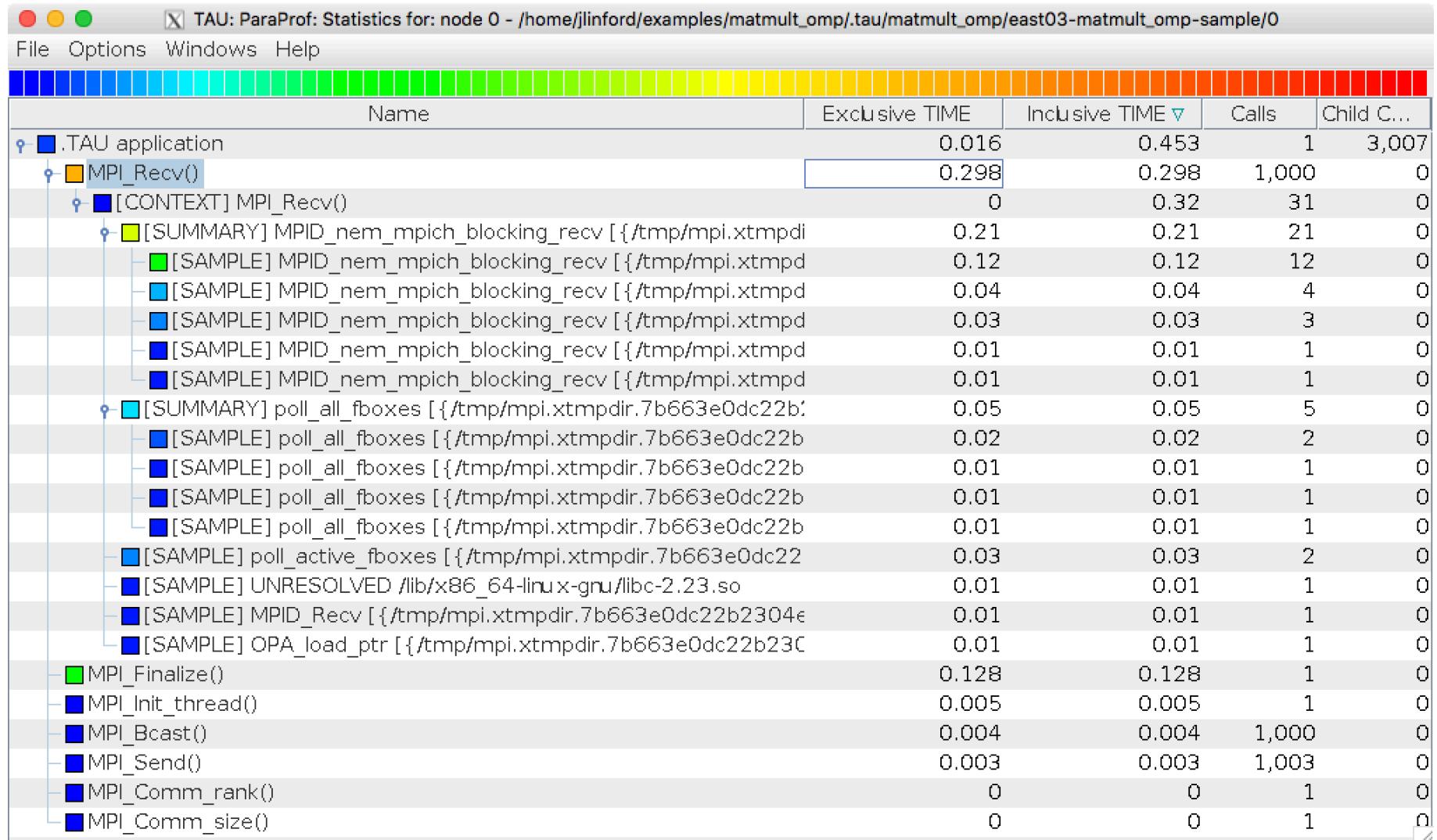
Node for each MPI process



Open Windows | 3D Visualization

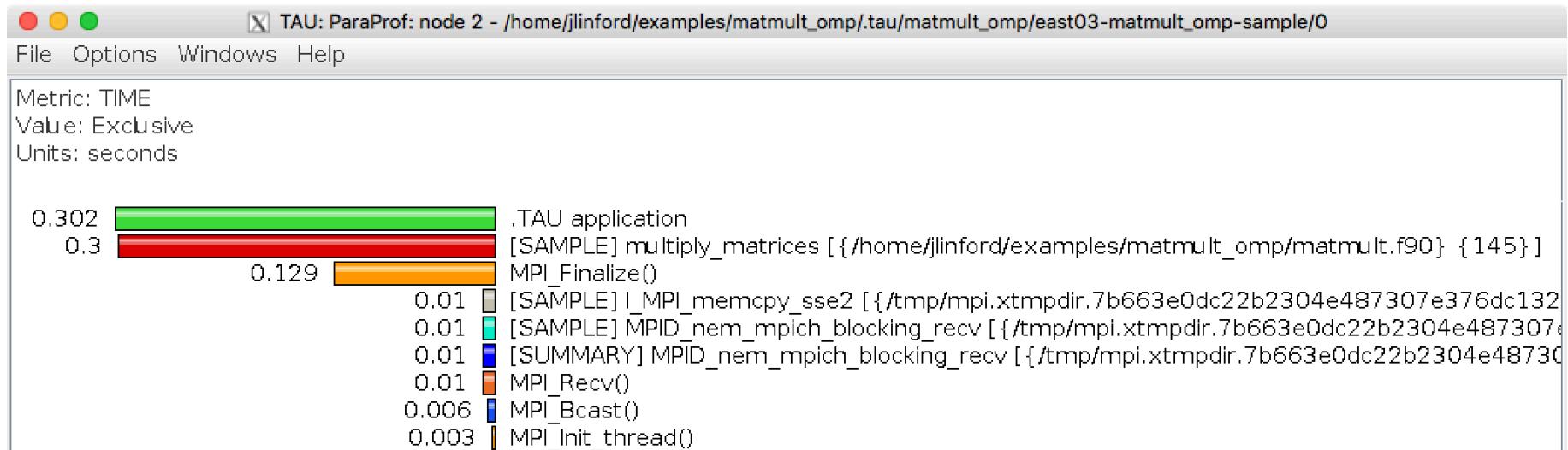


Event-based Sampling Data from Rank 0

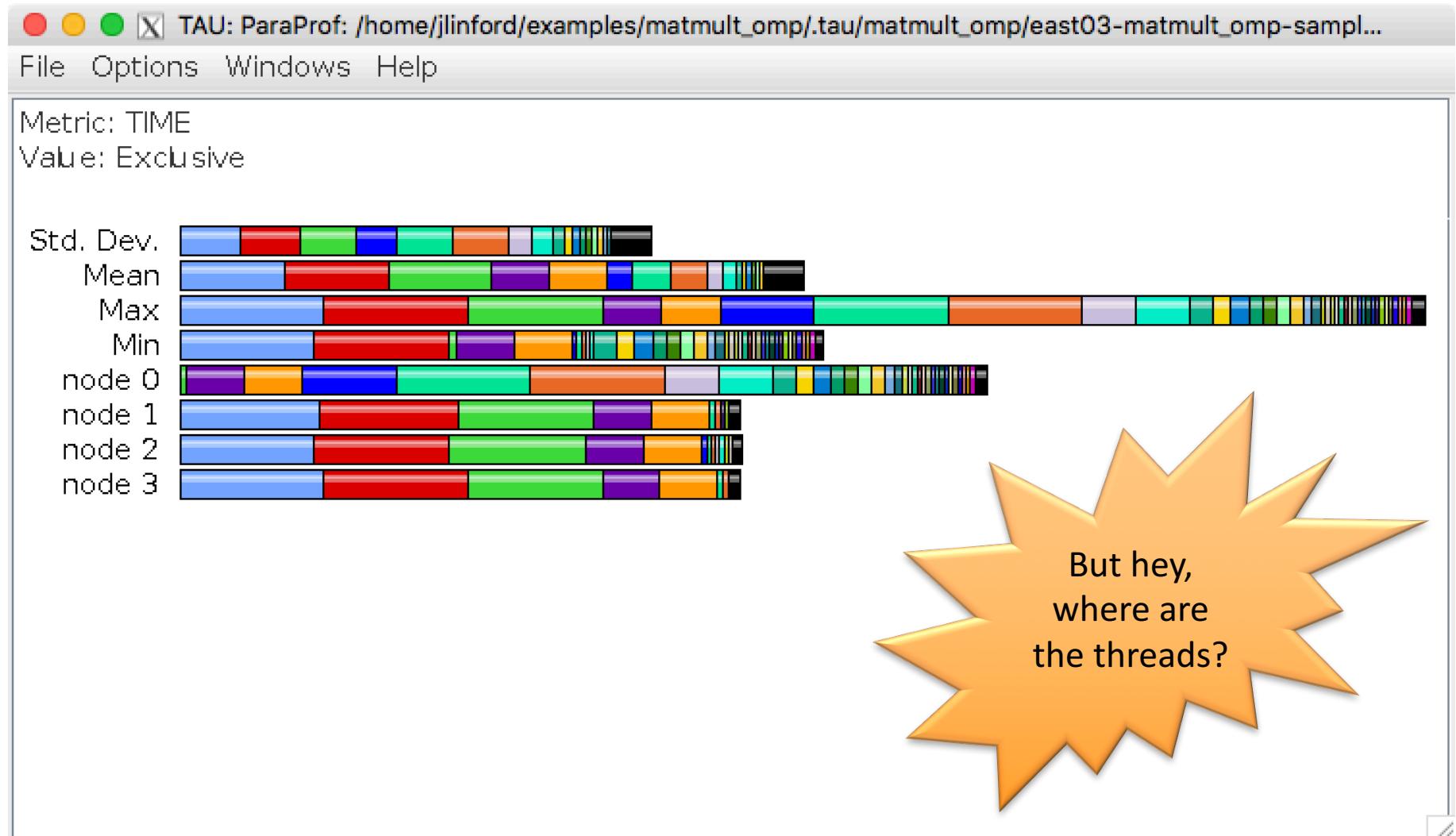


Event-based Sampling Data from Rank 1&2

	Name	Exclusive TIME	Inclusive TIME ▼	Calls	Child Calls
↳	.TAU application	0.299	0.453	1	1,671
↳	[CONTEXT] .TAU application	0	0.31	30	0
↳	[SAMPLE] multiply_matrices [{/home/jlinford/examples/matmult_omp/matmult.f90} {145}]	0.31	0.31	30	0
↳	MPI_Finalize()	0.129	0.129	1	0
↳	MPI_Recv()	0.013	0.013	334	0
↳	MPI_Bcast()	0.006	0.006	1,000	0
↳	MPI_Init_thread()	0.004	0.004	1	0
↳	MPI_Send()	0.003	0.003	333	0
↳	[CONTEXT] MPI_Send()	0	0.01	1	0
↳	[SAMPLE] PMPI_Send [{/tmp/mpi.xtmpdir.7b663e0dc22b2304e487307e376dc132.9725_32e/mpi.3}	0.01	0.01	1	0
↳	MPI_Comm_rank()	0	0	1	0
↳	MPI_Comm_size()	0	0	1	0

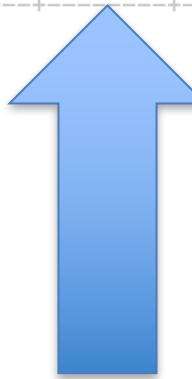


Node for each MPI process



Threads Not Instrumented by Default

```
jlinford — jlinford@east03: ~/examples/matmult_omp — ssh -Y east03.paratools.com — 120x14
[jlinford@east03:~/examples/matmult_omp$ tau measurement list
== Measurement Configurations (/home/jlinford/examples/matmult_omp/.tau/project.json) =====
+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
| Name | Profile | Trace | Sample | Source Inst. | Compiler Inst. | OpenMP | CUDA | I/O | MPI | SHMEM |
+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
| sample | tau | none | Yes | never | never | ignore | No | No | Yes | No |
+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
| profile | tau | none | No | automatic | never | ignore | No | No | Yes | No |
+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
| trace | none | otf2 | No | automatic | never | ignore | No | No | Yes | No |
+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
jlinford@east03:~/examples/matmult_omp$
```



To keep overhead low,
OpenMP directives are not
instrumented by default

**Create a new measurement (or edit an existing measurement)
to enable thread-level instrumentation.**

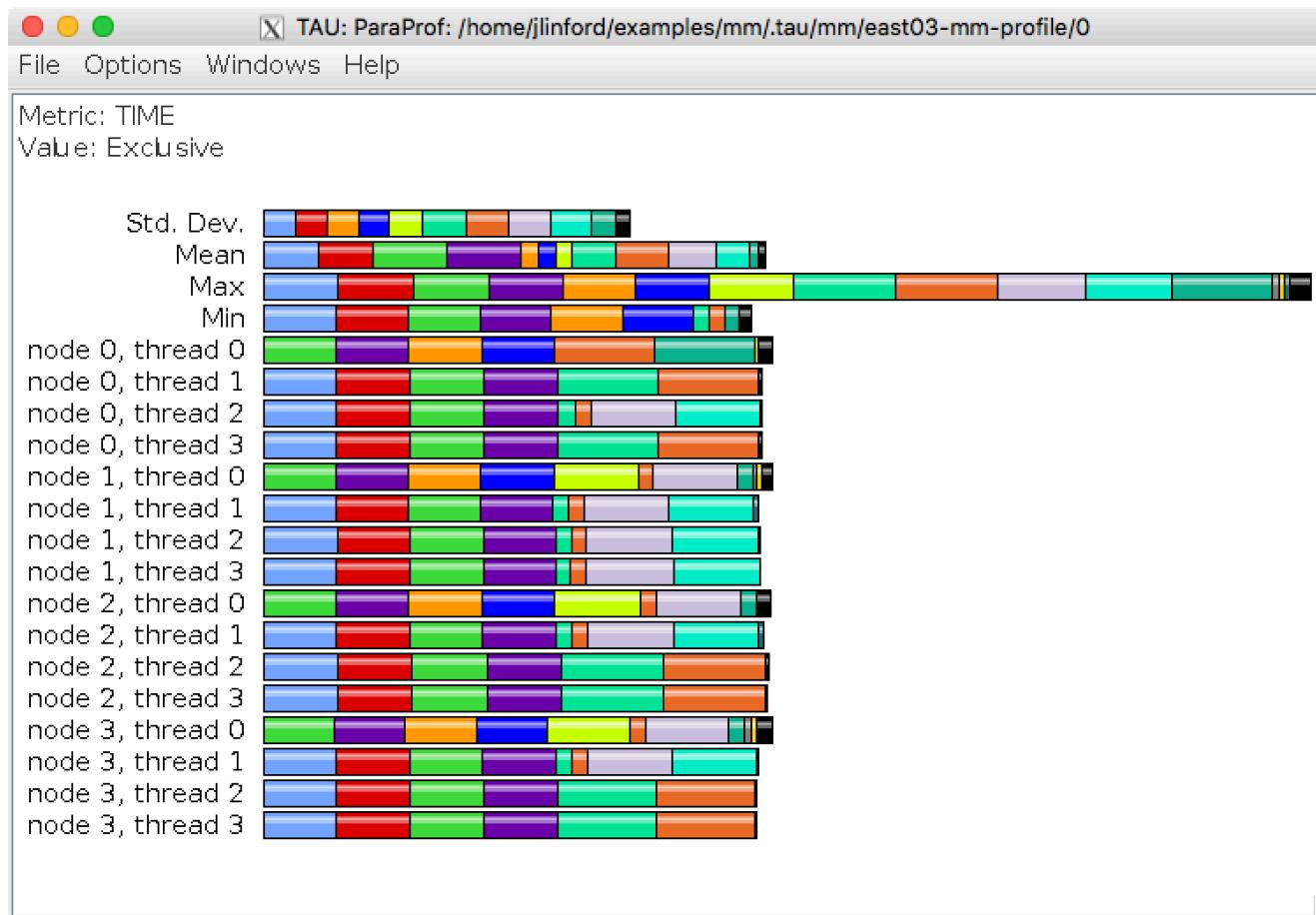
From `tau measurement edit -help`

Measurement Arguments:

<measurement_name>	Measurement configuration name.
--callsite [T/F]	Record event callsites.
--comm-matrix [T/F]	Record the point-to-point communication matrix.
--cuda [T/F]	Measure cuda events via the CUPTI interface.
--io [T/F]	Measure time spent in POSIX I/O calls.
--metadata-merge [T/F]	Merge metadata of TAU profiles.
--mpi [T/F]	Use MPI library wrapper to measure time spent in MPI methods.
--new-name <new_name>	Change the configuration's name.
--opencl [T/F]	Measure openCL events.
--openmp library	Use specified library to measure time spent in OpenMP directives. - library: ignore, opari, ompt
--chrom [T/F]	Use CHROM library wrapper to measure time spent in CHROM methods.
--throttle [T/F]	Throttle lightweight events to reduce overhead.
--throttle-num-calls [count]	Lightweight event call count threshold.
--throttle-per-call [us]	Lightweight event duration threshold in microseconds.

Rebuild to instrument OpenMP with OMPT

```
$ tau measurement copy profile profile.ompt \
--openmp=ompt
```

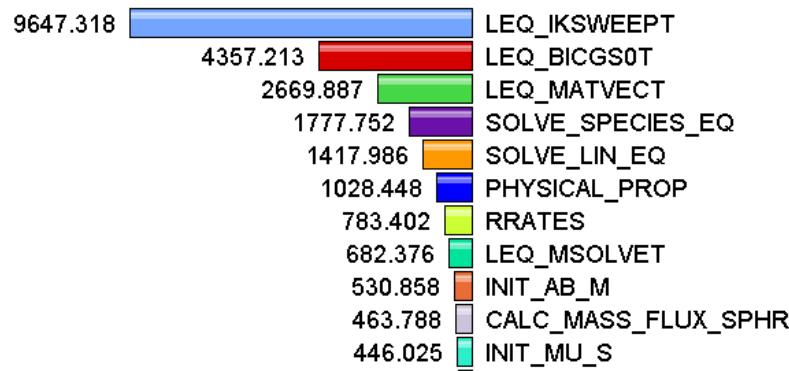


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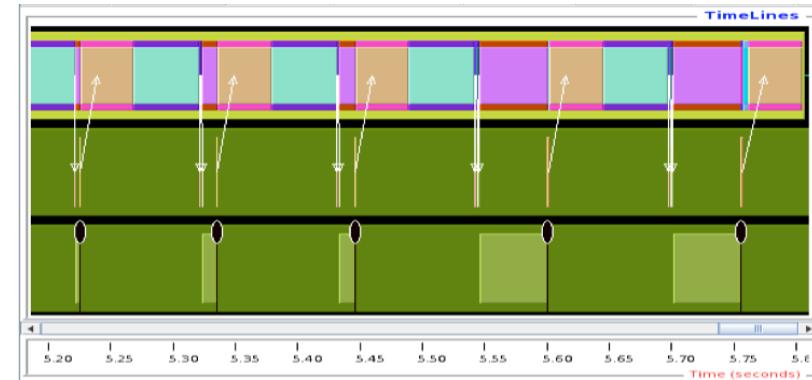
TRACING PARALLEL APPLICATIONS

Measurement Approaches

Profiling



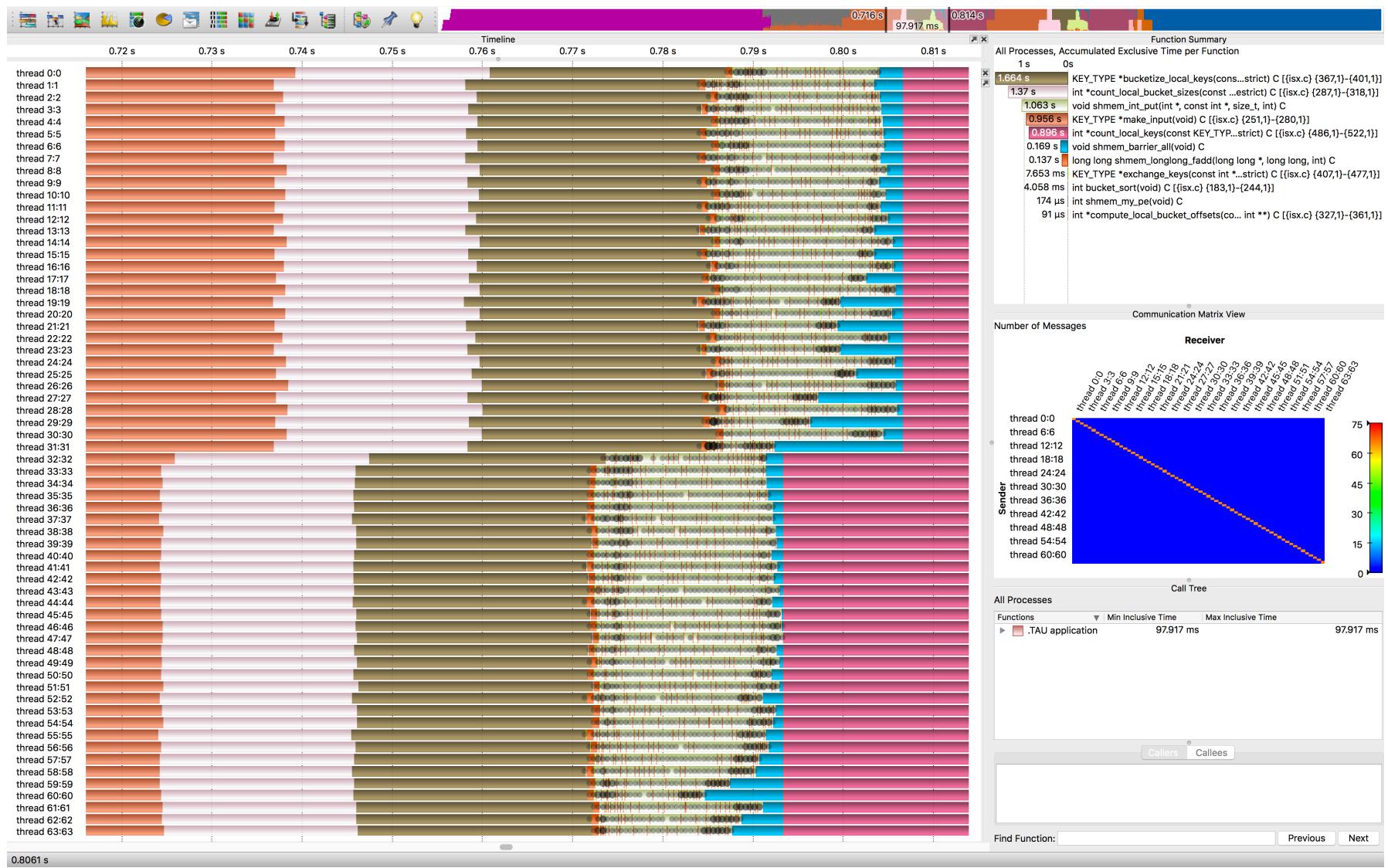
Tracing



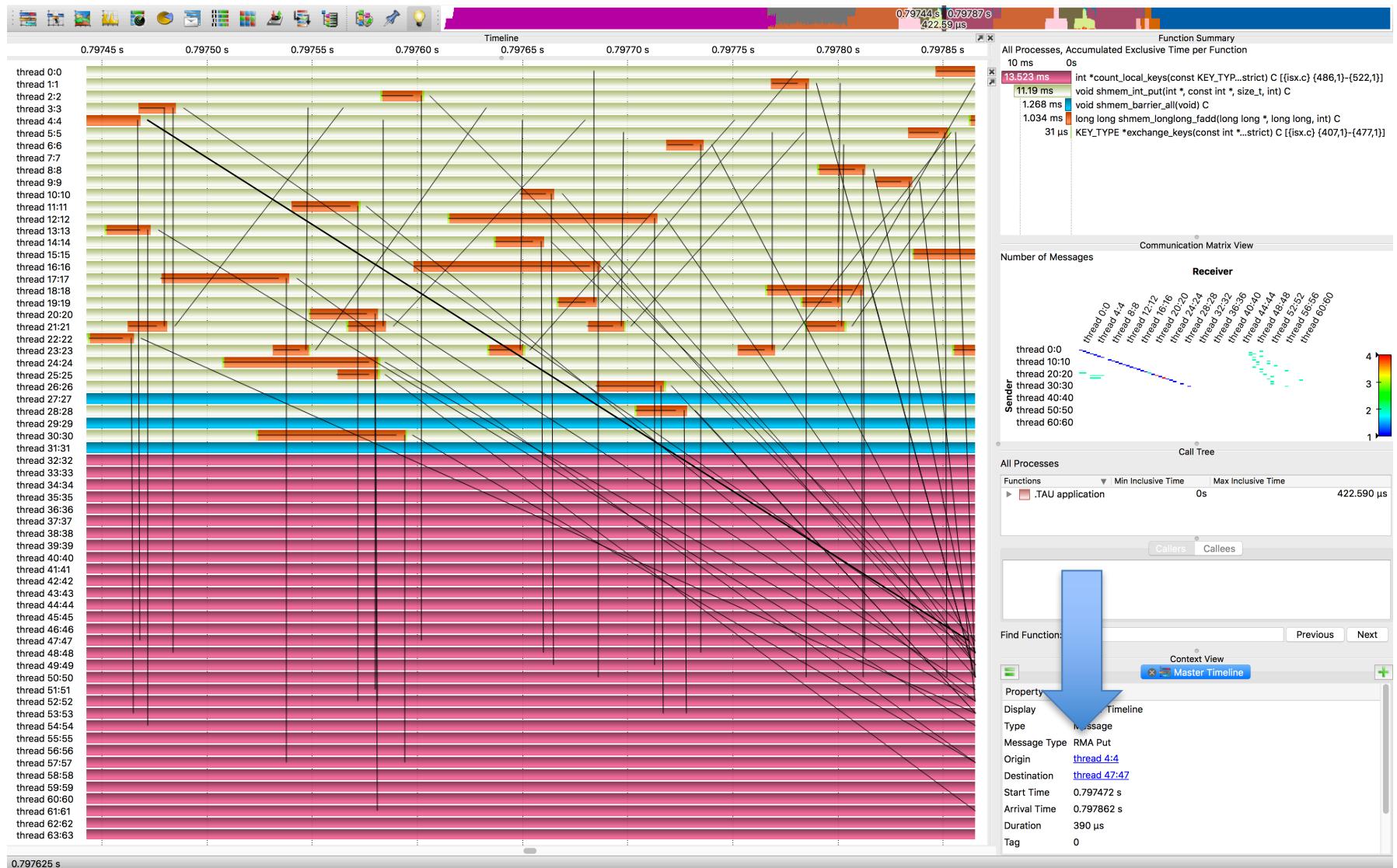
Shows
how much time
was spent in each
routine

Shows
when events
take place on a
timeline

Different Nodes, Different Timelines



View Time Lost Waiting for Send or Receive

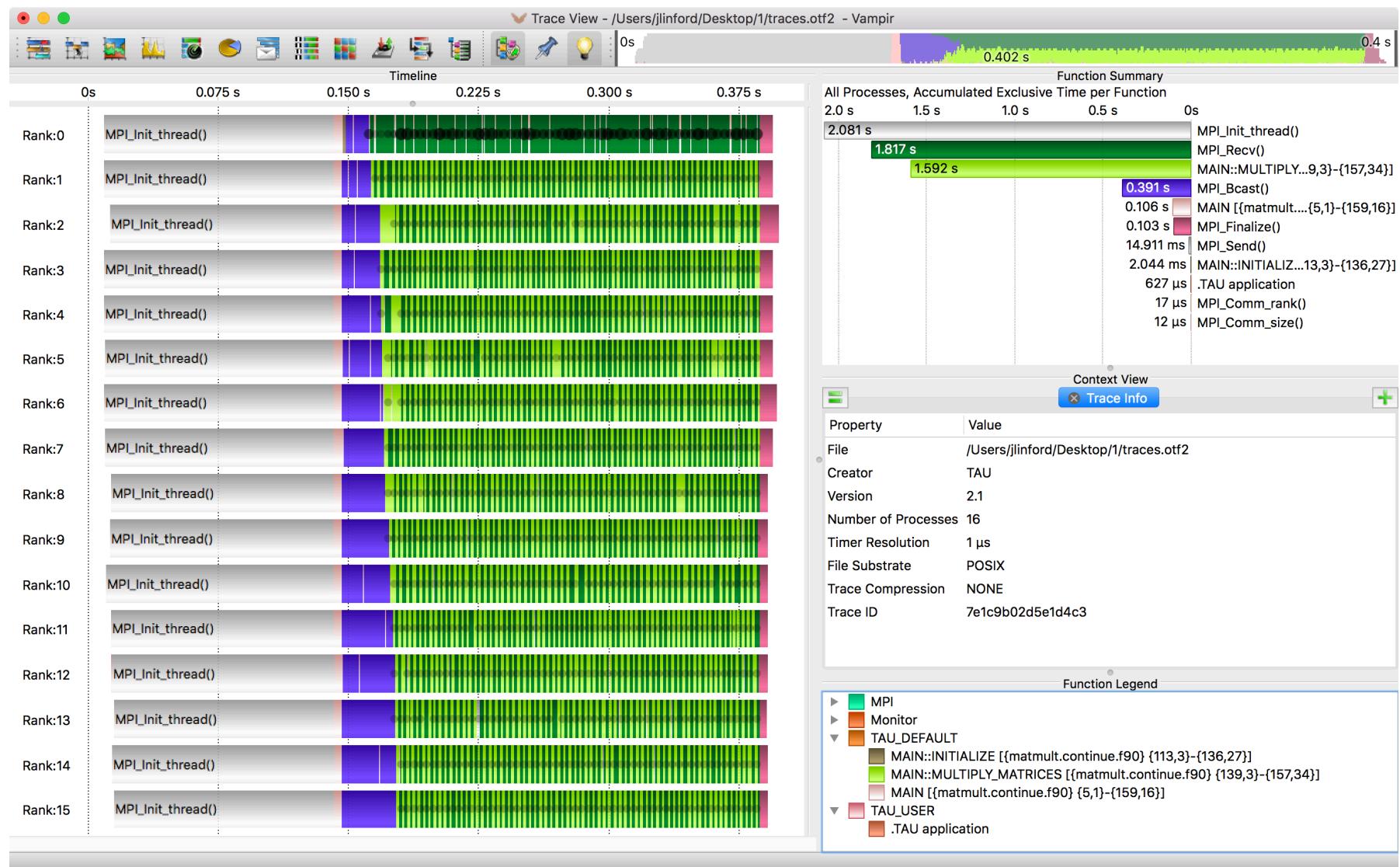


Select the “trace” Measurement to Trace

```
$ tau select trace  
$ tau mpirun -np 16 ./matmult
```

```
jlinford@east03:~/examples/matmult_omp$ tau mpirun -np 16 ./matmult  
[TAU]  
[TAU] == BEGIN Experiment at 2017-09-28 02:34:29.279019 =====  
[TAU]  
[TAU] PROFILEDIR=/home/jlinford/examples/matmult_omp/.tau/matmult_omp/east03-matmult_omp-trace/1  
[TAU] SCOREP_ENABLE_PROFILING=false  
[TAU] SCOREP_EXPERIMENT_DIRECTORY=/home/jlinford/examples/matmult_omp/.tau/matmult_omp/east03-matmult_omp-trace/1  
[TAU] TAU_CALLSITE=0  
[TAU] TAU_COMM_MATRIX=0  
[TAU] TAU_MERGE_METADATA=1  
[TAU] TAU_METRICS=TIME,  
[TAU] TAU_PROFILE=0  
[TAU] TAU_SAMPLING=0  
[TAU] TAU_THROTTLE=1  
[TAU] TAU_THROTTLE_NUMCALLS=100000  
[TAU] TAU_THROTTLE_PERCALL=10  
[TAU] TAU_TRACE=1  
[TAU] TAU_TRACE_FORMAT=otf2  
[TAU] TAU_TRACK_HEAP=0  
[TAU] TAU_VERBOSE=0  
[TAU] TRACEDIR=/home/jlinford/examples/matmult_omp/.tau/matmult_omp/east03-matmult_omp-trace/1  
[TAU] mpirun -np 16 ./matmult  
  
c(1000,1000) =      5.00500000000000E+08  
[TAU] Trial 1 produced 33 trace files.  
[TAU]  
[TAU] == END Experiment at 2017-09-28 02:34:29.801282 =====  
[TAU]  
[TAU] Experiment: east03-matmult_omp-trace  
[TAU] Command: mpirun -np 16 ./matmult  
[TAU] Current working directory: /home/jlinford/examples/matmult_omp  
[TAU] Data size: 763.4KiB bytes  
jlinford@east03:~/examples/matmult_omp$
```

`tau show` Displays the Trace in Vampir



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PROFILING HEAP MEMORY

Measure Heap Memory Usage

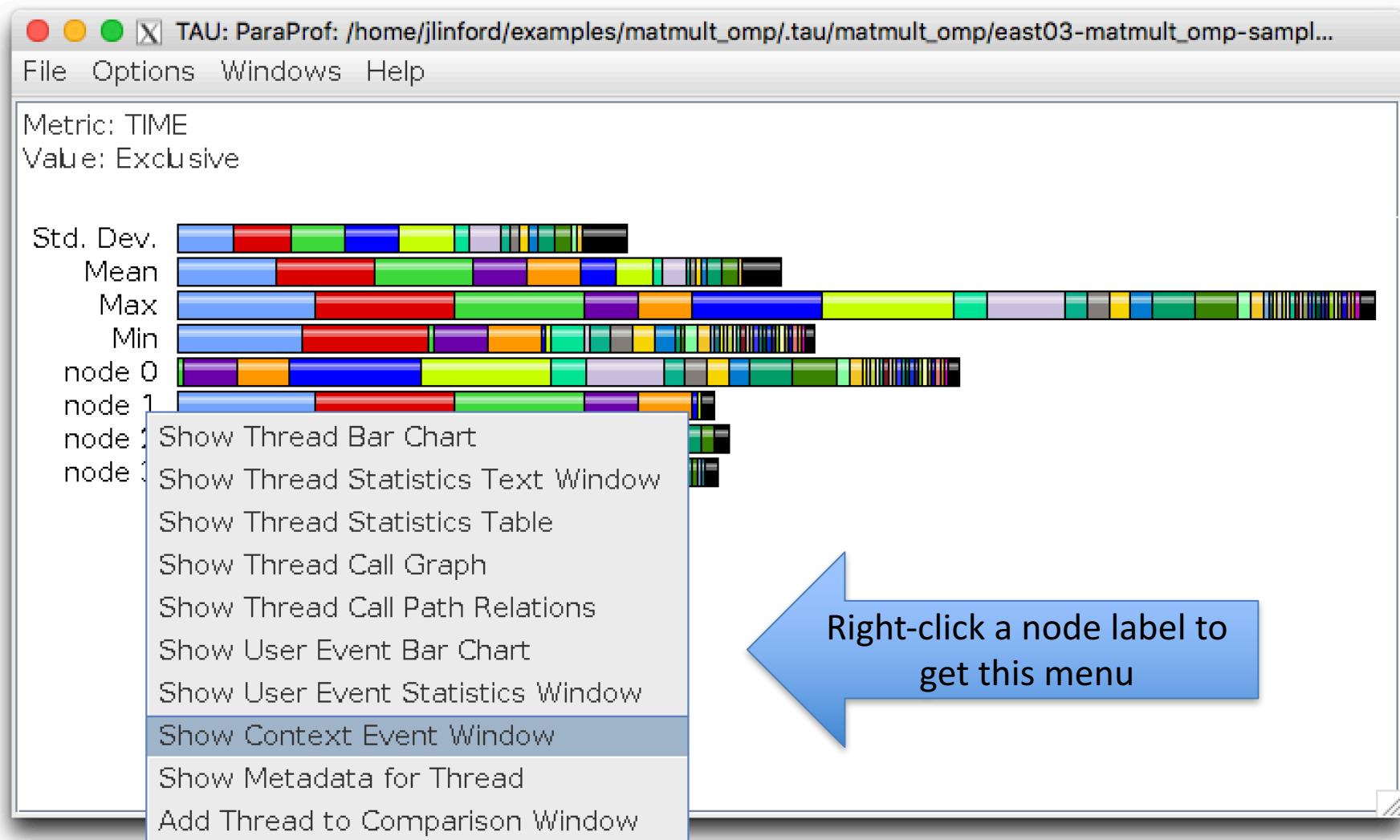
From `tau measurement edit -help`

Memory Arguments:

--heap-usage [T/F]	Measure heap memory usage.
--memory-alloc [T/F]	Record memory allocation/deallocation events and detect leaks.

```
$ tau measurement edit sample --heap-usage
$ tau select sample
$ make clean
$ make
$ tau mpirun -np 4 ./matmult
```

Open the Context Event Window to See Heap Memory Usage



Heap Memory Usage on MPI Rank 1

Name	Total	NumSamples	MaxValue	MinValue	MeanValue	Std. Dev.
.TAU application						
└ Heap Memory Used (KB) at Exit	2,377.703	1	2,377.703	2,377.703	2,377.703	0
└ Increase in Heap Memory (KB)	2,226.188	1	2,226.188	2,226.188	2,226.188	0
└ Heap Memory Used (KB) at Entry	151.516	1	151.516	151.516	151.516	0
• MPI_Bcast()						
• MPI_Comm_rank()						
• MPI_Comm_size()						
• MPI_Finalize()						
• MPI_Init_thread()						
└ Heap Memory Used (KB) at Exit	4,838.438	1	4,838.438	4,838.438	4,838.438	0
└ Increase in Heap Memory (KB)	4,462.234	1	4,462.234	4,462.234	4,462.234	0
└ Heap Memory Used (KB) at Entry	376.203	1	376.203	376.203	376.203	0
• MPI_Recv()						
• MPI_Send()						
└ Heap Memory Used (KB) at Exit	9,520,400.172	1,672	5,967.5	2,377.703	5,694.019	248.519
└ Heap Memory Used (KB) at Entry	9,517,525.125	1,672	6,191.078	151.516	5,692.3	289.135
└ Message size for broadcast	8,000,000	1,000	8,000	8,000	8,000	0
└ Increase in Heap Memory (KB)	6,688.422	2	4,462.234	2,226.188	3,344.211	1,118.023
└ Decrease in Heap Memory (KB)	3,813.375	1	3,813.375	3,813.375	3,813.375	0

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PROFILING CUDA / OPENCL

```
`tau init --cuda`
```

```
[jlinford@godzilla ~]$ tau init --cuda
[TAU] System MPI C++ compiler '/packages/openmpi/2.0_intel-17-tm/bin/mpic++' wraps '/packages/intel/17/linux/bin/intel64/icpc'
[TAU] System MPI C compiler '/packages/openmpi/2.0_intel-17-tm/bin/mpicc' wraps '/packages/intel/17/linux/bin/intel64/icc'
[TAU] System MPI Fortran compiler '/packages/openmpi/2.0_intel-17-tm/bin/mpif90' wraps '/packages/intel/17/linux/bin/intel64/ifort'
[TAU] Created a new project named 'gpu_suite.1.1.0'.
[TAU] Added application 'gpu_suite.1.1.0' to project configuration 'gpu_suite.1.1.0'.
[TAU] Added target 'godzilla' to project configuration 'gpu_suite.1.1.0'.
[TAU] Added measurement 'sample' to project configuration 'gpu_suite.1.1.0'.
[TAU] Added measurement 'profile' to project configuration 'gpu_suite.1.1.0'.
[TAU] Added measurement 'trace' to project configuration 'gpu_suite.1.1.0'.
[TAU] Created a new experiment 'godzilla-gpu_suite.1.1.0-sample'.
[TAU] Selected experiment 'godzilla-gpu_suite.1.1.0-sample'.

== Project Configuration (/storage/users/jlinford/gpu_suite.1.1.0/.tau/project.json) =====

+-----+
| Name | Targets | Applications | Measurements | # Experiments |
+-----+
| gpu_suite.1.1.0 | godzilla | gpu_suite.1.1.0 | sample, profile, trace | 1 |
+-----+

== Targets in project 'gpu_suite.1.1.0' =====

+-----+
| Name | Host OS | Host Arch | Host Compilers | MPI Compilers | SHMEM Compilers |
+-----+
| godzilla | Linux | x86_64 | GNU | System | OpenSHMEM |
+-----+

== Applications in project 'gpu_suite.1.1.0' =====

+-----+
| Name | Linkage | OpenMP | Pthreads | TBB | MPI | CUDA | OpenCL | SHMEM | MPC |
+-----+
| gpu_suite.1.1.0 | dynamic | No | No | No | No | Yes | No | No | No |
+-----+

== Measurements in project 'gpu_suite.1.1.0' =====

+-----+
| Name | Profile | Trace | Sample | Source Inst. | Compiler Inst. | OpenMP | CUDA | I/O | MPI | SHMEM |
+-----+
| sample | tau | none | Yes | never | never | ignore | Yes | No | No | No |
| profile | tau | none | No | automatic | never | ignore | Yes | No | No | No |
| trace | none | otf2 | No | automatic | never | ignore | Yes | No | No | No |
+-----+

== Experiments in project 'gpu_suite.1.1.0' =====

+-----+
| Name | Trials | Data Size | Target | Application | Measurement | TAU Makefile |
+-----+
| godzilla-gpu_suite.1.1.0-sample | 0 | 0.0B | godzilla | gpu_suite.1.1.0 | sample | Makefile.tau-092e8e8f-cupti |
+-----+

Selected Experiment: godzilla-gpu_suite.1.1.0-sample

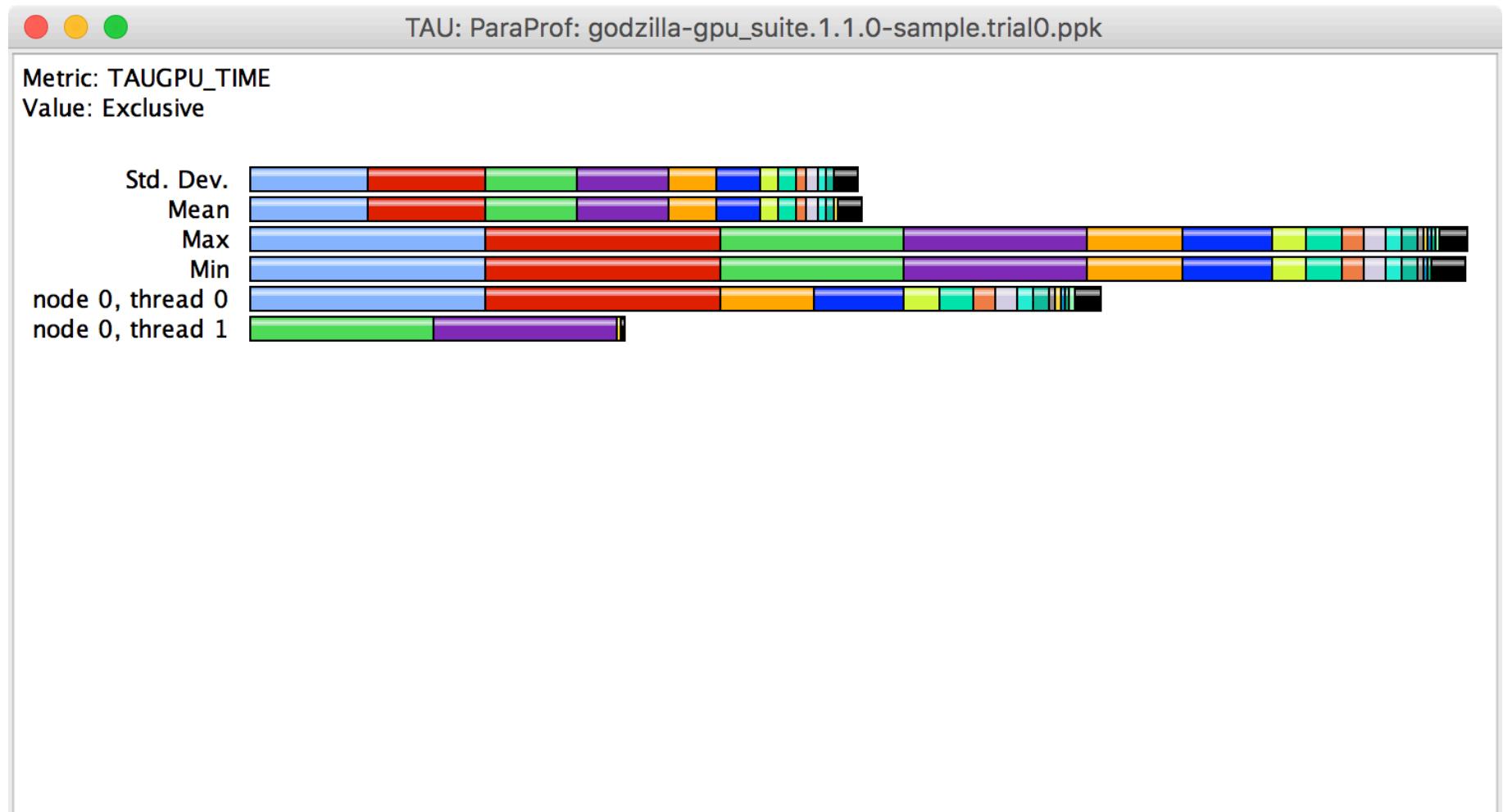
jlinford@godzilla ~$
```

Run with `tau` as usual

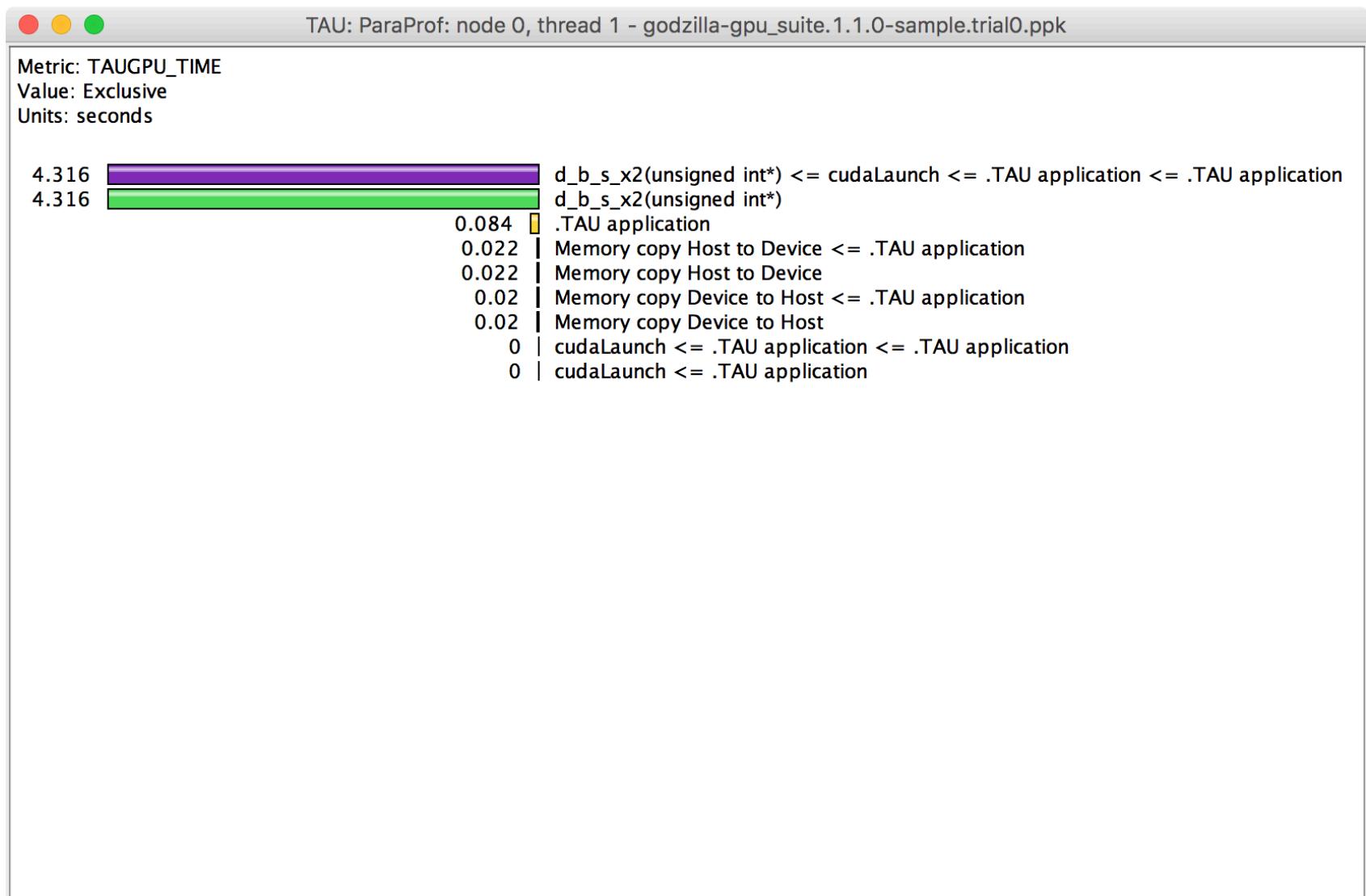
```
jlinford@godzilla ~gpu_suite.1.1.0$ GPU_ID=0 tau ./bin/gpu_bs2 -l 4000
[TAU]
[TAU] Ignoring TAU environment variables set in user's environment:
[TAU] TAU_MPI=-mpiinc=/packages/openmpi/2.0_intel-17-tm/include -mpilib=/packages/openmpi/2.0_intel-17-tm/lib
[TAU]
[TAU]
[TAU] == BEGIN Experiment at 2017-09-08 03:09:47.166546 =====
[TAU]
[TAU] PROFILEDIR=/storage/users/jlinford/gpu_suite.1.1.0/.tau/gpu_suite.1.1.0/godzilla-gpu_suite.1.1.0-sample/0
[TAU] SCOREP_ENABLE_TRACING=false
[TAU] TAU_CALLPATH=1
[TAU] TAU_CALLPATH_DEPTH=100
[TAU] TAU_CALLSITE=0
[TAU] TAU_COMM_MATRIX=0
[TAU] TAU_MERGE_METADATA=1
[TAU] TAU_METRICS=TIME,
[TAU] TAU_PROFILE=1
[TAU] TAU_SAMPLING=1
[TAU] TAU_THROTTLE=1
[TAU] TAU_THROTTLE_NUMCALLS=100000
[TAU] TAU_THROTTLE_PERCALL=10
[TAU] TAU_TRACE=0
[TAU] TAU_TRACK_HEAP=0
[TAU] TAU_VERBOSE=0
[TAU] TRACEDIR=/storage/users/jlinford/gpu_suite.1.1.0/.tau/gpu_suite.1.1.0/godzilla-gpu_suite.1.1.0-sample/0
[TAU] tau_exec -T serial,cupti,092e8e8f -cupti -ebs ./bin/gpu_bs2 -l 4000
Using device 0 (3 present)
Device: Tesla P100-PCIE-16GB (v6.0) at 1328 MHz
16276 MB of device memory, 48 KB of shared memory, 65536 available registers

[gpu_bs2] Running 4000 runs of 134215680 squares each.
[gpu_bs2] elapsed time: 5.724s (4000 runs)
[gpu_bs2] 93791.69 million squares per second
[TAU] Trial 0 produced 2 profile files.
[TAU]
[TAU] == END Experiment at 2017-09-08 03:10:00.078788 =====
[TAU]
[TAU] Experiment: godzilla-gpu_suite.1.1.0-sample
[TAU] Command: tau_exec -T serial,cupti,092e8e8f -cupti -ebs ./bin/gpu_bs2 -l 4000
[TAU] Current working directory: /storage/users/jlinford/gpu_suite.1.1.0
[TAU] Data size: 25.4KiB bytes
jlinford@godzilla ~gpu_suite.1.1.0$
```

GPUs are shown as “Threads”



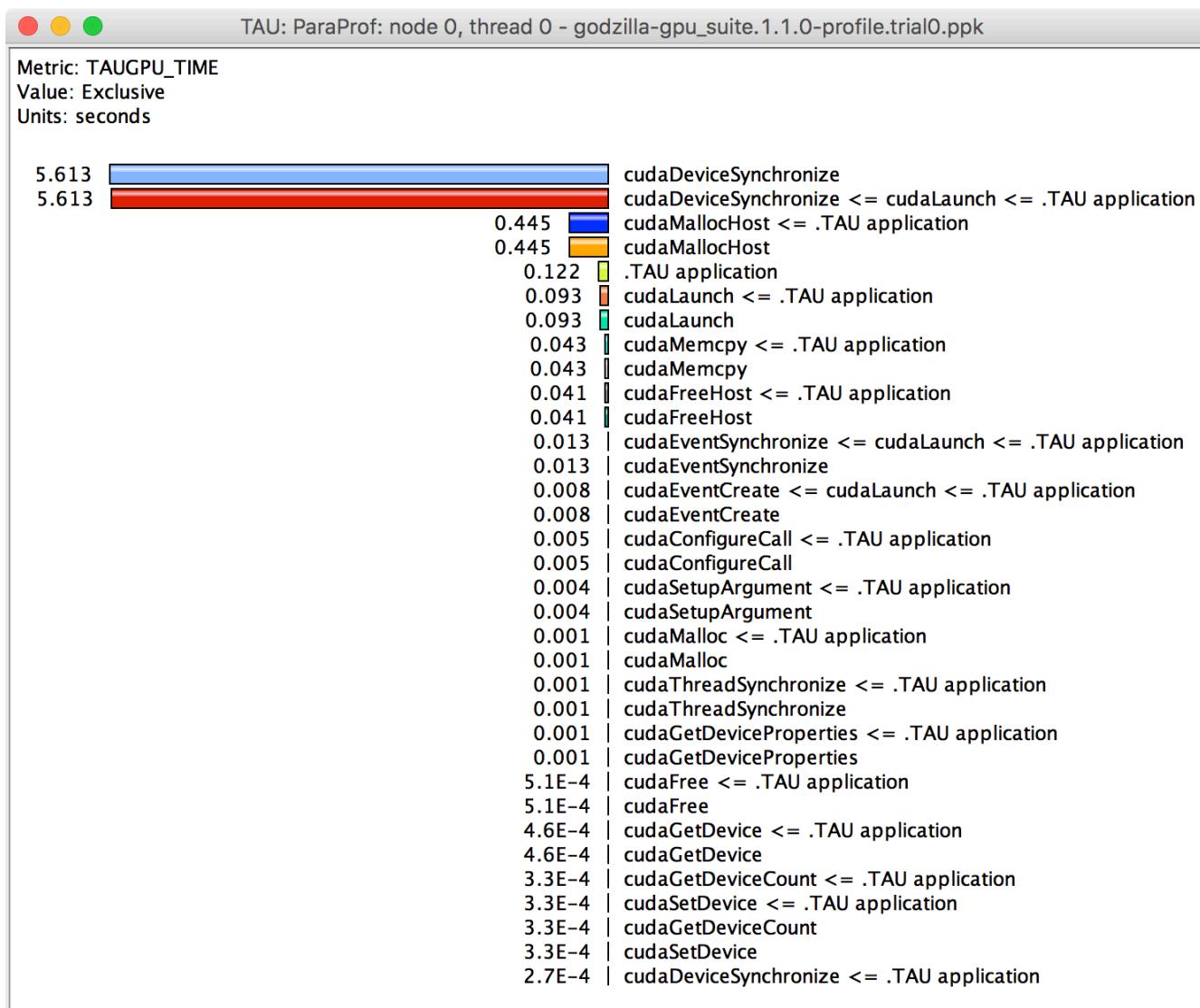
Open the GPU “Thread” to see kernel time



Non-GPU threads show CUDA calls

TAU: ParaProf: Statistics for: node 0, thread 0 - godzilla-gpu_suite.1.1.0-sample.trial0.ppk					
	Name	Exclusive TAUGPU_TIME	Inclusive TAUGPU_TIME ▼	Calls	Child Calls
▼	.TAU application	0.128	6.402	1	12,018
▼	cudaLaunch	0.115	5.662	4,001	12,003
►	cudaDeviceSynchronize	5.521	5.521	4,001	0
►	[CONTEXT] cudaLaunch	0	0.05	5	0
■	cudaEventSynchronize	0.015	0.015	4,001	0
■	cudaEventCreate	0.01	0.01	4,001	0
►	cudaMallocHost	0.508	0.508	1	0
►	[CONTEXT] .TAU application	0	0.104	10	0
■	cudaMemcpy	0.043	0.043	2	0
■	cudaFreeHost	0.04	0.04	1	0
■	cudaConfigureCall	0.007	0.007	4,001	0
■	cudaSetupArgument	0.005	0.005	4,001	0
►	cudaGetDeviceProperties	0.002	0.002	1	0
■	cudaMalloc	0.002	0.002	1	0
■	cudaDeviceSynchronize	0.001	0.001	2	0
■	cudaThreadSynchronize	0.001	0.001	1	0
■	cudaFree	0.001	0.001	1	0
■	cudaGetDevice	0.001	0.001	2	0
■	cudaSetDevice	0	0	1	0
■	cudaGetDeviceCount	0	0	2	0

Compiler-based Instrumentation



OpenCL

- OpenCL is pretty much the same:
 - tau init --opencl
 - tau gcc *.c
 - tau ./a.out