VAMPIR & VAMPIRTRACE Hands On

8th VI-HPS Tuning Workshop at RWTH Aachen
September, 2011

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Hands-on: NPB – Build

- Copy the tutorial directory (if necessary)

```
% cp -r ~hpclab01/tutorial/NPB3.3-MZ-MPI/ ./
```

- Move into tutorial directory in your home directory

```
% cd NPB3.3-MZ-MPI
```

- Select the VampirTrace compiler wrappers

```
% vim config/make.def
      -> comment out line 32, resulting in:
                  ...
                  33: #MPIF77 = mpif77
                  ...
      -> remove the comment from line 40, resulting in:
                  ...
                  40: MPIF77 = vtf77 –vt:hyb –vt:f77 mpif77
                  …
```

Hands-on: NPB – Run

- Set up modules

```
module switch openmpi intelmpi
module load UNITE \
       vampirtrace/5.11-intel2-intel-marmot-papi
```

Aachen (Cluster-beta)

```
module load UNITE vampirtrace
```

Juropa

- Build benchmark

```
% make clean; make suite
```

- Go to bin directory

```
% cd bin.vampir
```

Hands-on: NPB – Run

- Create and edit the jobscript

```
cp ../jobscript/run.lsf ./
vim run.lsf
```

```
cp ../jobscript/run.msub ./
vim run.msub
```

- Jobscript:

```
#!/usr/bin/env zsh
# submit this job with "bsub < run.lsf"

#BSUB -J mzmpibt
…
#BSUB -U vihps

export OMP_NUM_THREADS=6

module swap openmpi intelmpi
module load UNITE \
       vampirtrace/5.11-intel2-intel-marmot-papi
module list

set -x

$MPIEXEC $FLAGS_MPI_BATCH  bt-mz_B.4
```

```
#!/bin/bash
# submit with "msub run.msub"
#MSUB -N mzmpibt
…
#MSUB -j oe

cd $PBS_O_WORKDIR

# benchmark configuration
export OMP_NUM_THREADS=4
PROCS=4
CLASS=B
EXE=./bt-mz_$CLASS.$PROCS

module load UNITE vampirtrace

mpiexec -np $PROCS --envall $EXE
```

Hands-on: NPB – Run

- Submit the job

```
bsub < run.lsf
```

```
msub run.msub
```

- Investigate the output file

```
% cat mzmpibt.<ID>

NAS Parallel Benchmarks (NPB3.2-MZ-MPI) - BT-MZ MPI+OpenMP Benchmark

Number of zones:   4 x   4
Iterations: 200    dt:   0.000800
Number of active processes:     4

Use the default load factors with threads
Total number of threads:     16   (  4.0 threads/process)
Calculated speedup =     15.64
Time step    1
[0]VampirTrace: Maximum number of buffer flushes reached \
(VT_MAX_FLUSHES=1)
[0]VampirTrace: Tracing switched off permanently
…
```

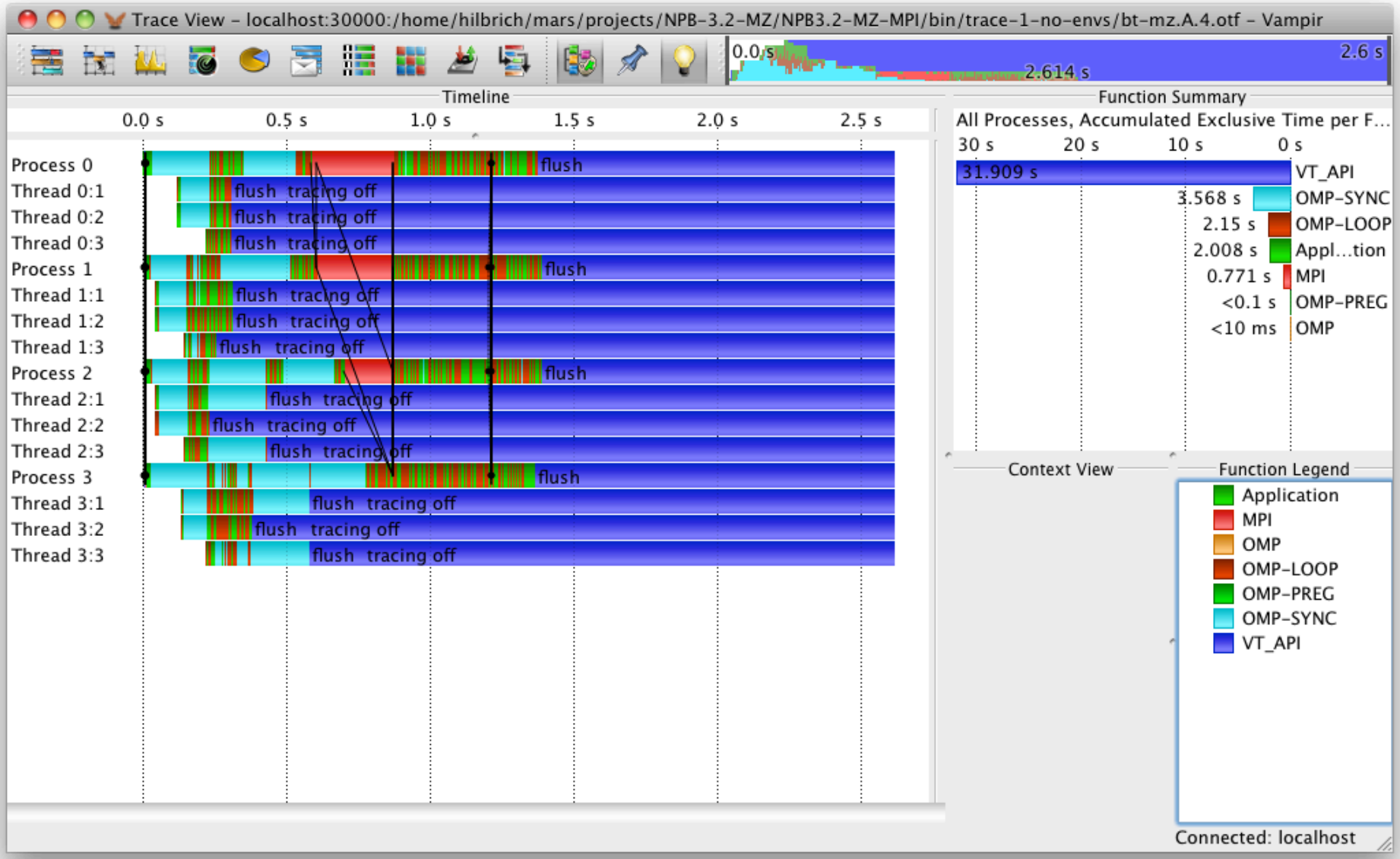
- Resulting trace files

```
% ls
bt-mz_B.4
bt-mz_B.4.0.def.z
bt-mz_B.4.1.events.z
bt-mz_B.4.10001.events.z
bt-mz_B.4.10002.events.z
...
bt-mz_B.4.40004.events.z
bt-mz_B.4.50001.events.z
bt-mz_B.4.50002.events.z
bt-mz_B.4.50003.events.z
bt-mz_B.4.50004.events.z
bt-mz_B.4.otf
```

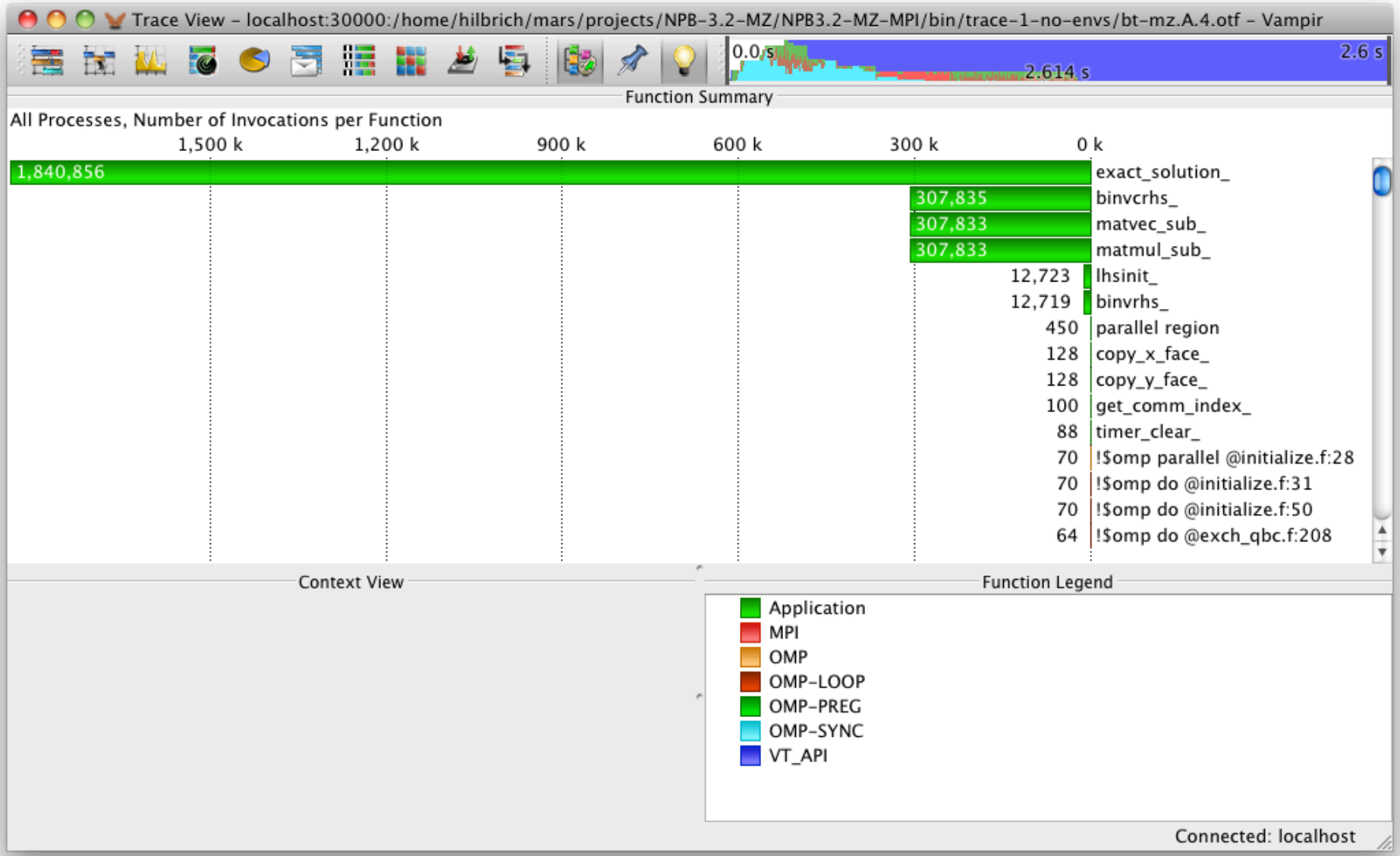
- Visualization with Vampir7

```
% module load vampir
% vampir bt-mz_B.4.otf
```

Hands-on: NPB – Initial Trace



Hands-on: NPB – Initial Trace



Hands-on: NPB – Buffer Size

- Decrease number of buffer flushes by increasing the buffer size

```
% export VT_BUFFER_SIZE=350M
```

- Set a new file prefix

Add both to your jobscript

```
% export VT_FILE_PREFIX=bt_2_buffer_350M
```

- Resubmit your jobscript

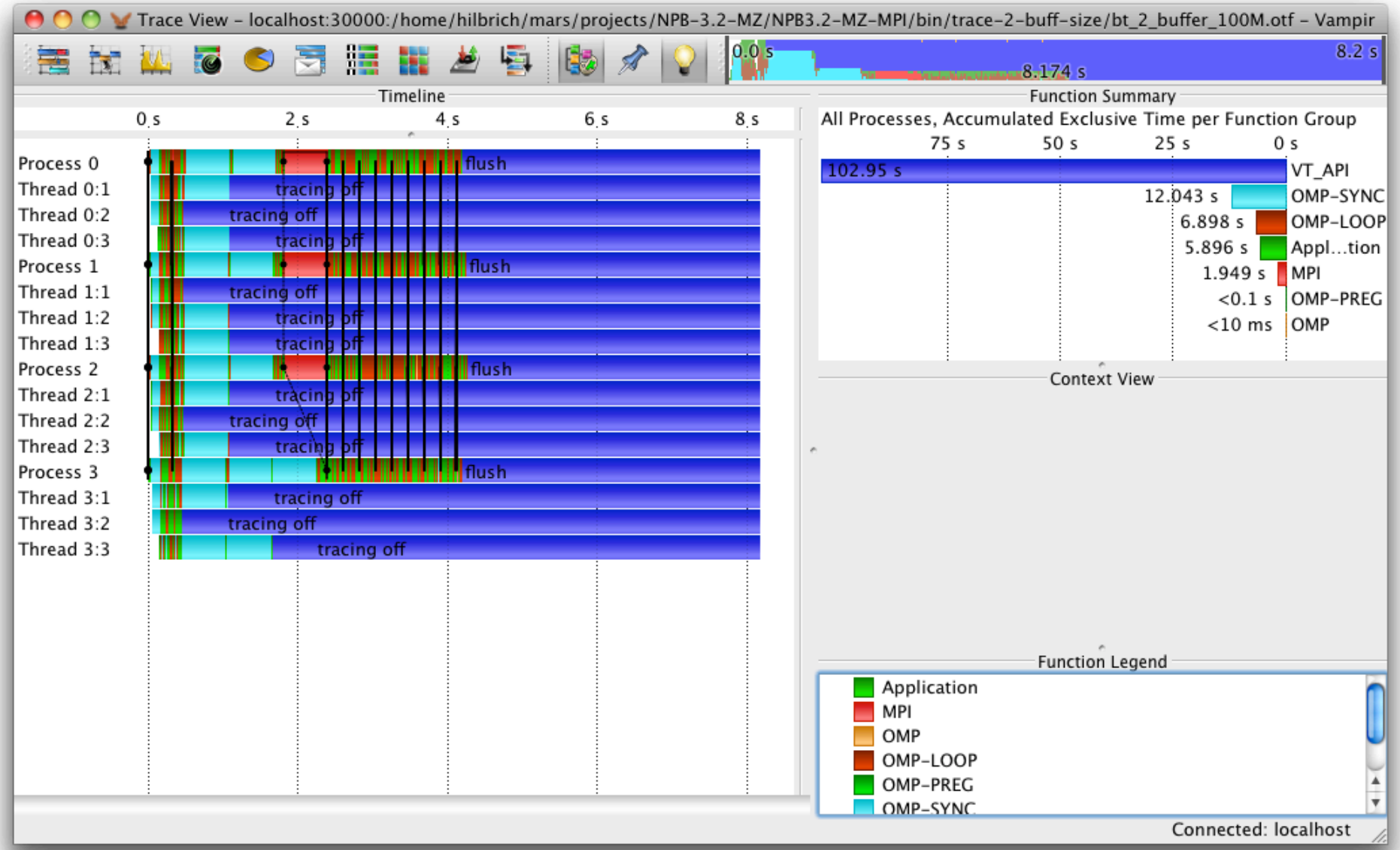
```
bsub < run.lsf
```

```
msub run.msub
```

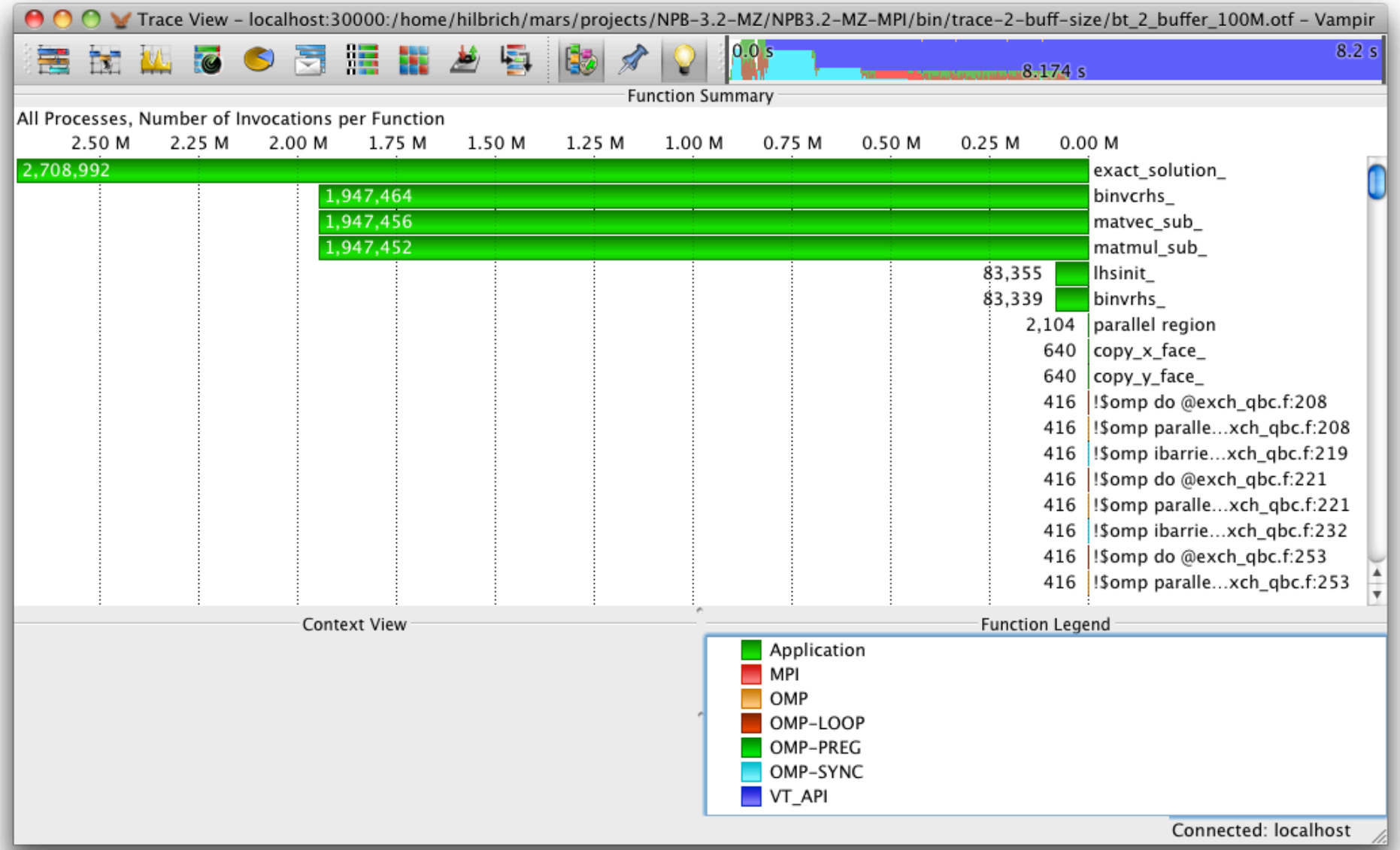
- Analyze the new trace

```
% vampir bt_2_buffer_350M.otf
```

Hands-on: NPB – Second Trace



Hands-on: NPB – Second Trace



Function Filtering

- Limit trace size with filtering
- Environment variable VT_FILTER_SPEC

Example, don't type it into the shell

```
% export VT_FILTER_SPEC = /home/user/filter.spec
```

- Filter definition file contains a list of filters

```
my_*;test_* -- 1000
debug_* -- 0
calculate -- -1
* -- 1000000
```

- See also the vtfilter tool
  - can generate a customized filter file
  - can reduce the size of existing trace files

Function Grouping

- Groups can be defined for related functions
  - Groups can be assigned different colors, highlighting different activities
- Environment variable VT_GROUPS_SPEC

```
% export VT_GROUPS_SPEC = /home/user/groups.spec
```

- Group file contains a list of associated entries

```
CALC=calculate
MISC=my*;test
UNKNOWN=*
```

Hands-on: NPB – Filtering

- Write a filter specification

```
% vim vt_filter.txt
      exact_solution_ -- 0
      binvcrhs_ -- 0
      matvec_sub_ -- 0
      matmul_sub_ -- 0
      lhsinit_ -- 0
      binvrhs_ -- 0
```

- Activate filtering and set a new file prefix

```
% export VT_FILTER_SPEC=vt_filter.txt
% export VT_FILE_PREFIX=bt_3_filter
```

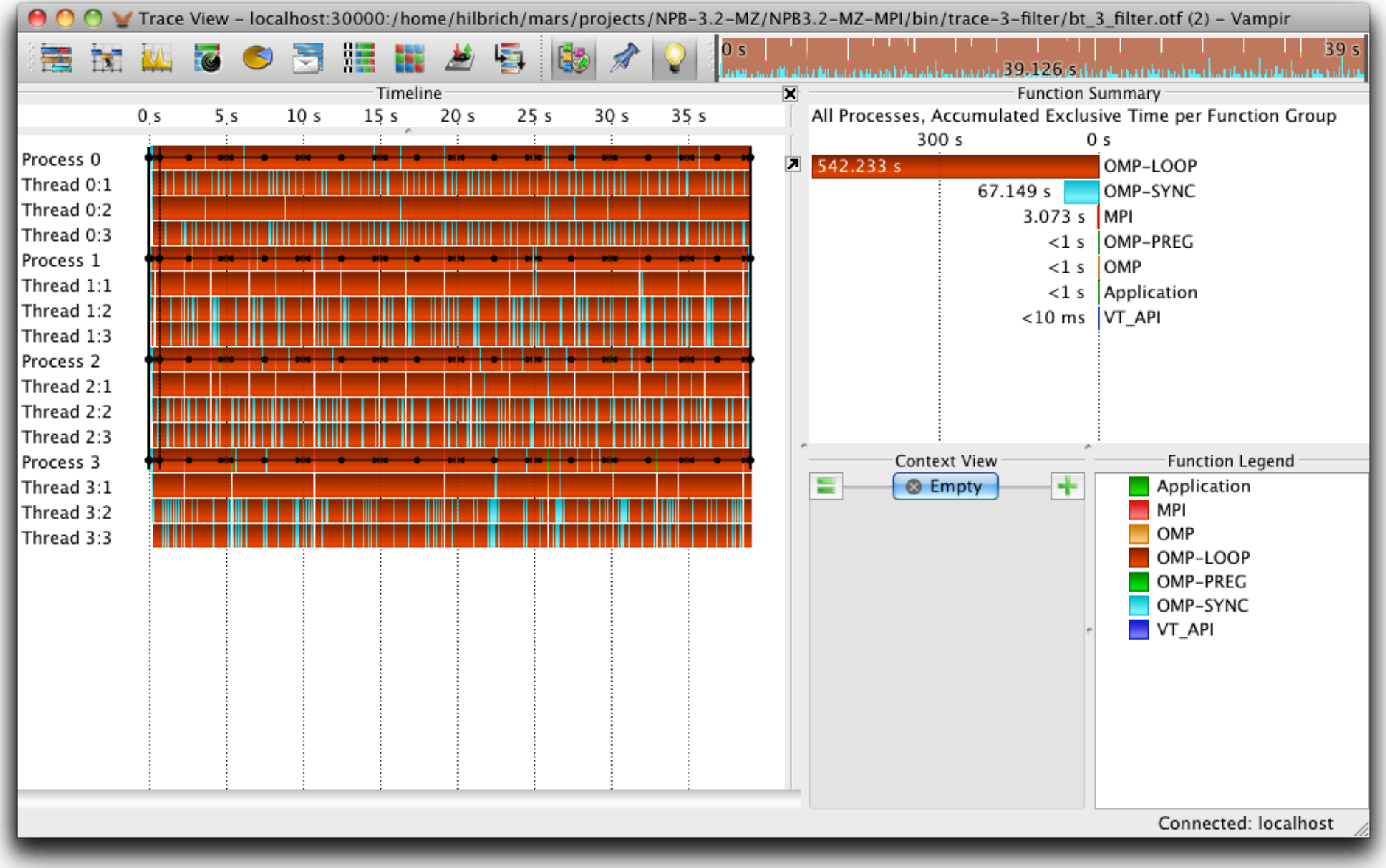
- Resubmit jobscript

Add both to your jobscript, keep "export VT_BUFFER_SIZE=350M"

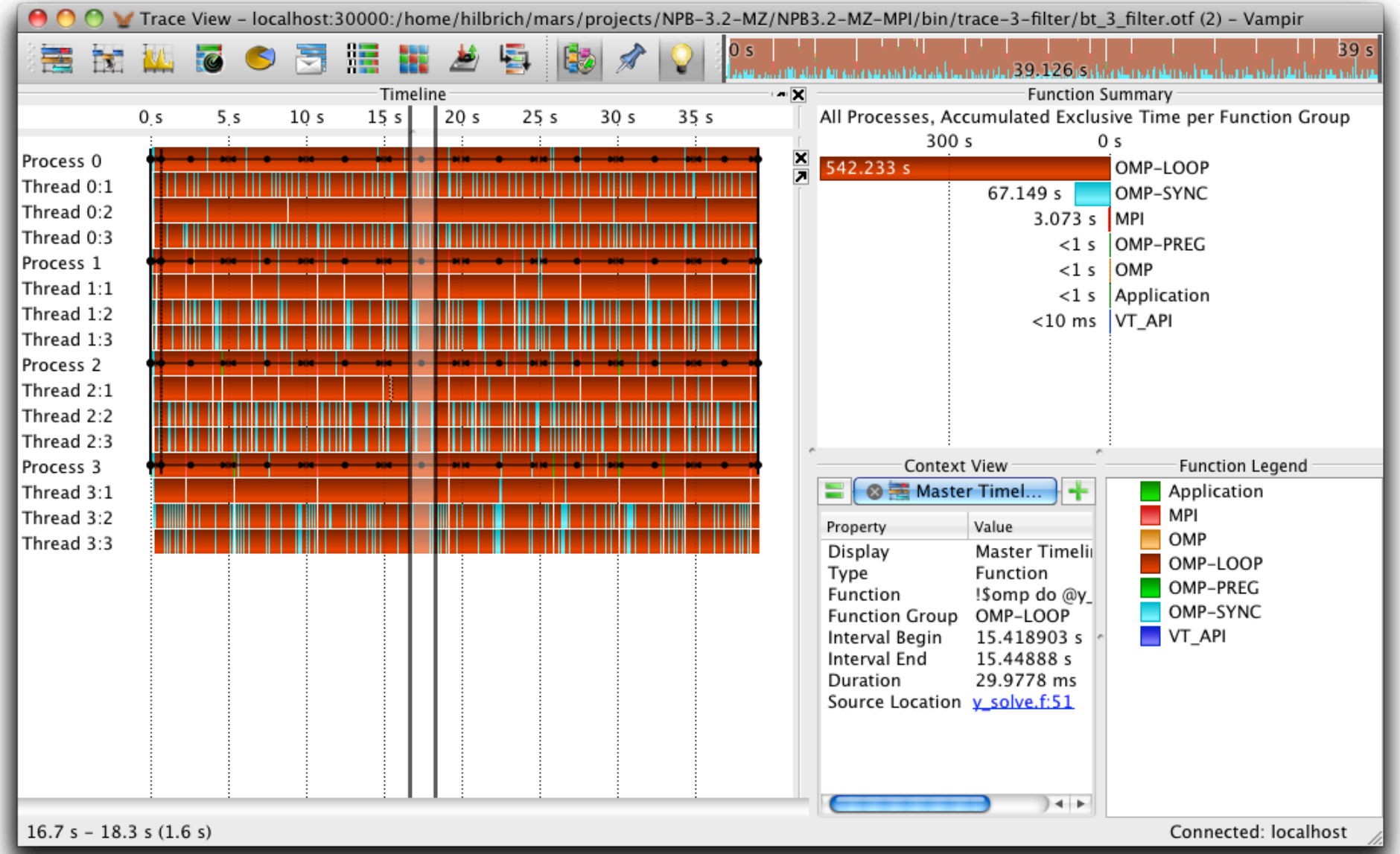
```
bsub < run.lsf
```

```
msub run.msub
```

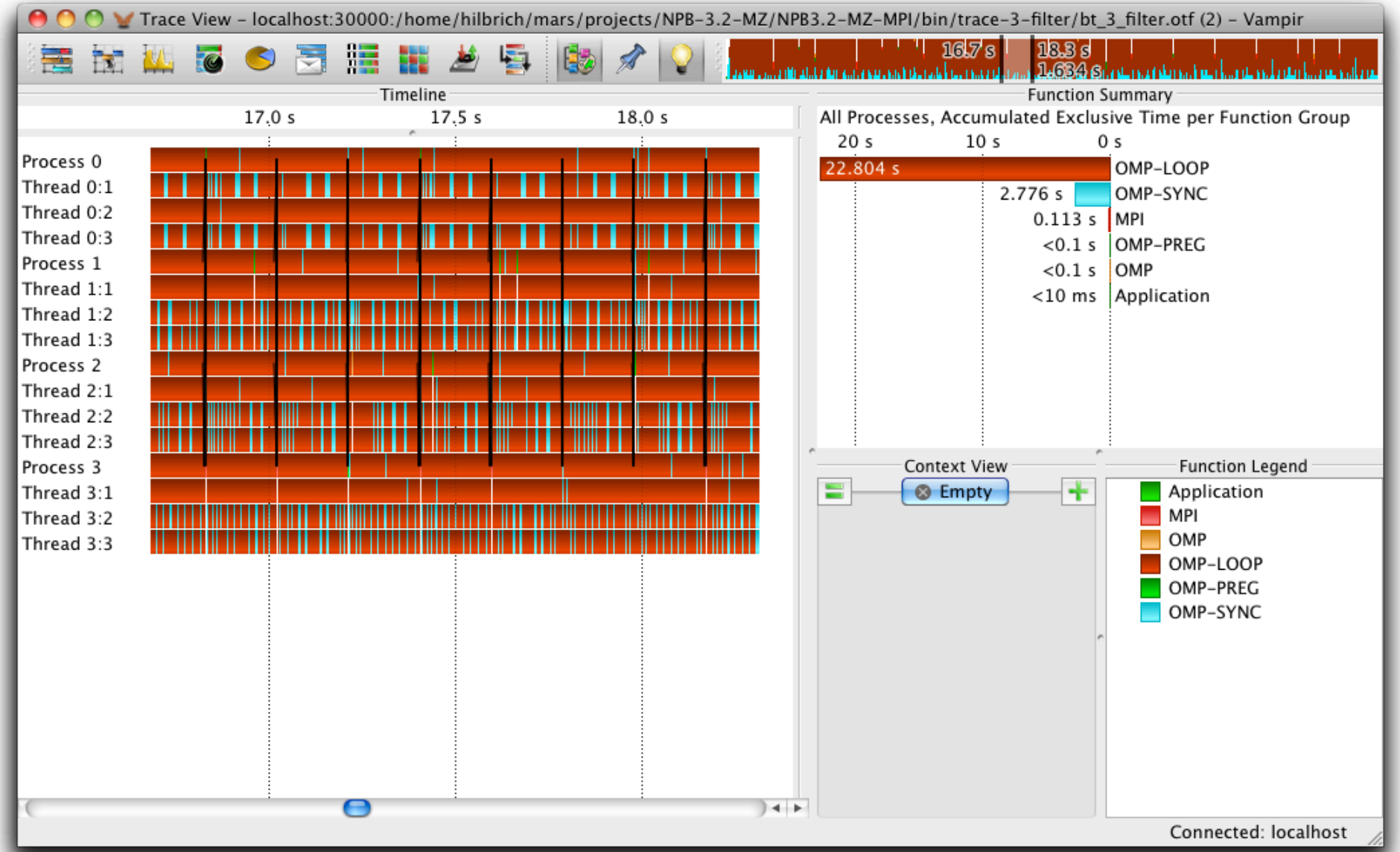
Hands-on: NPB – Filtered Trace



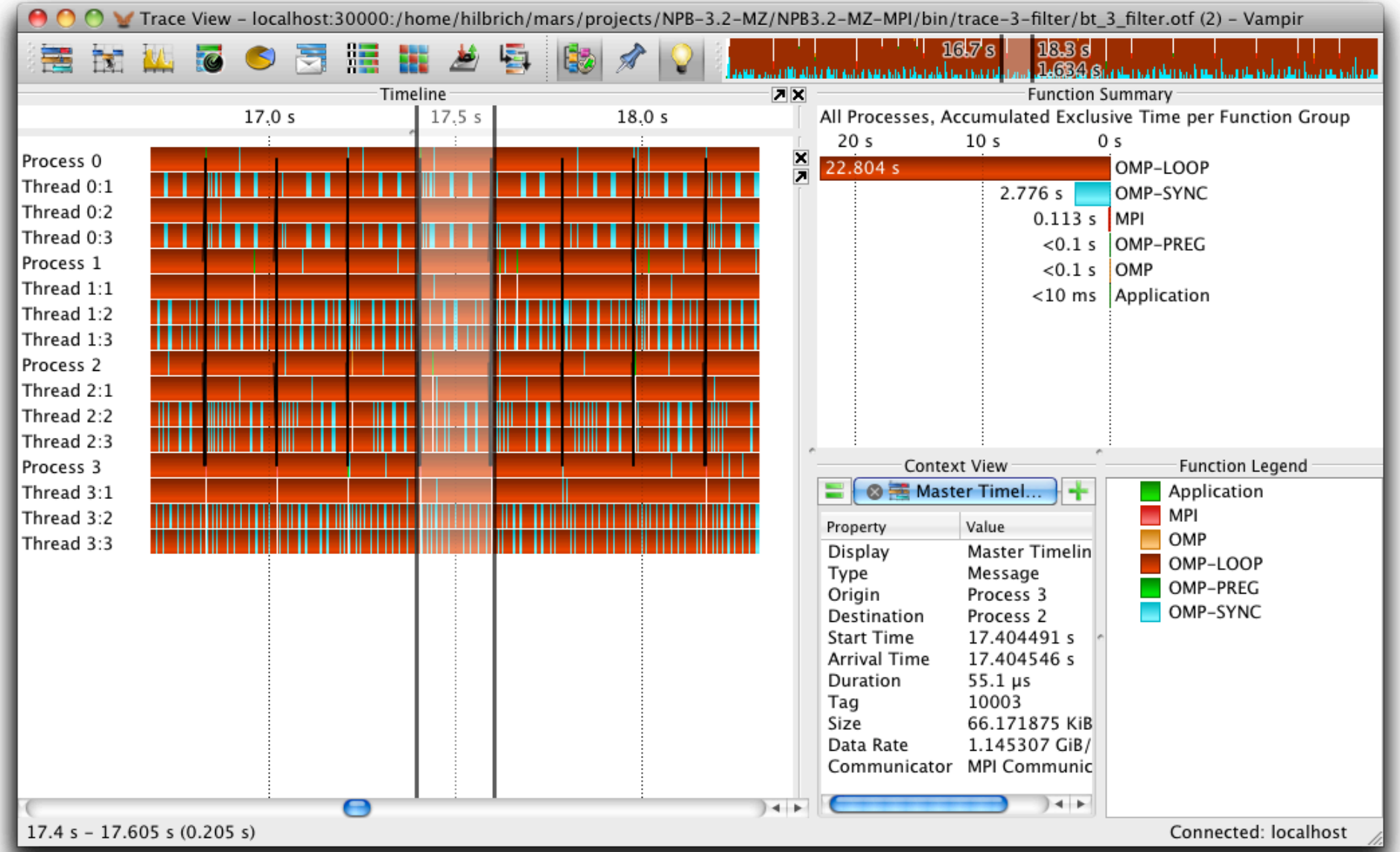
Hands-on: NPB – Filtered Trace



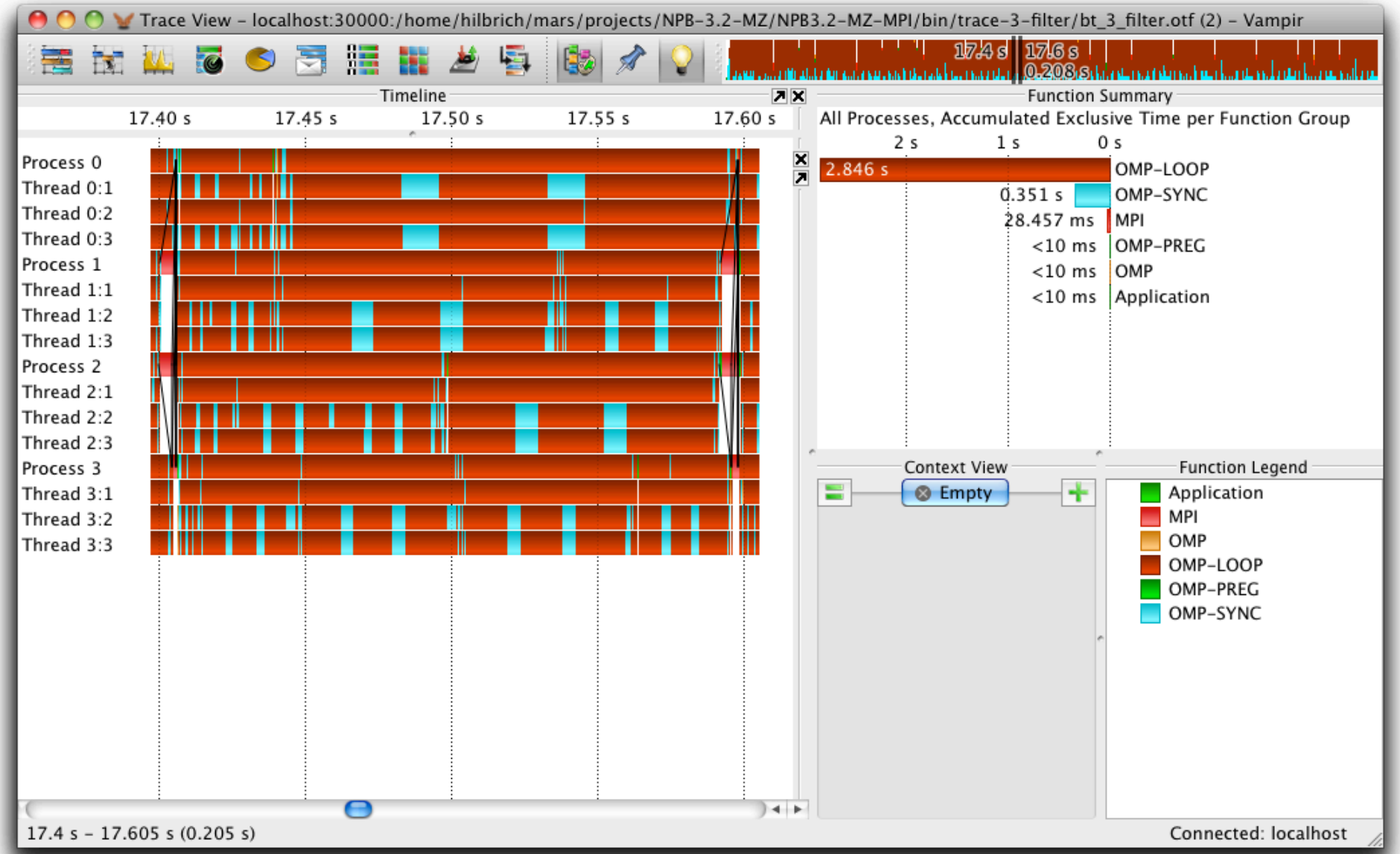
Hands-on: NPB – Filtered Trace



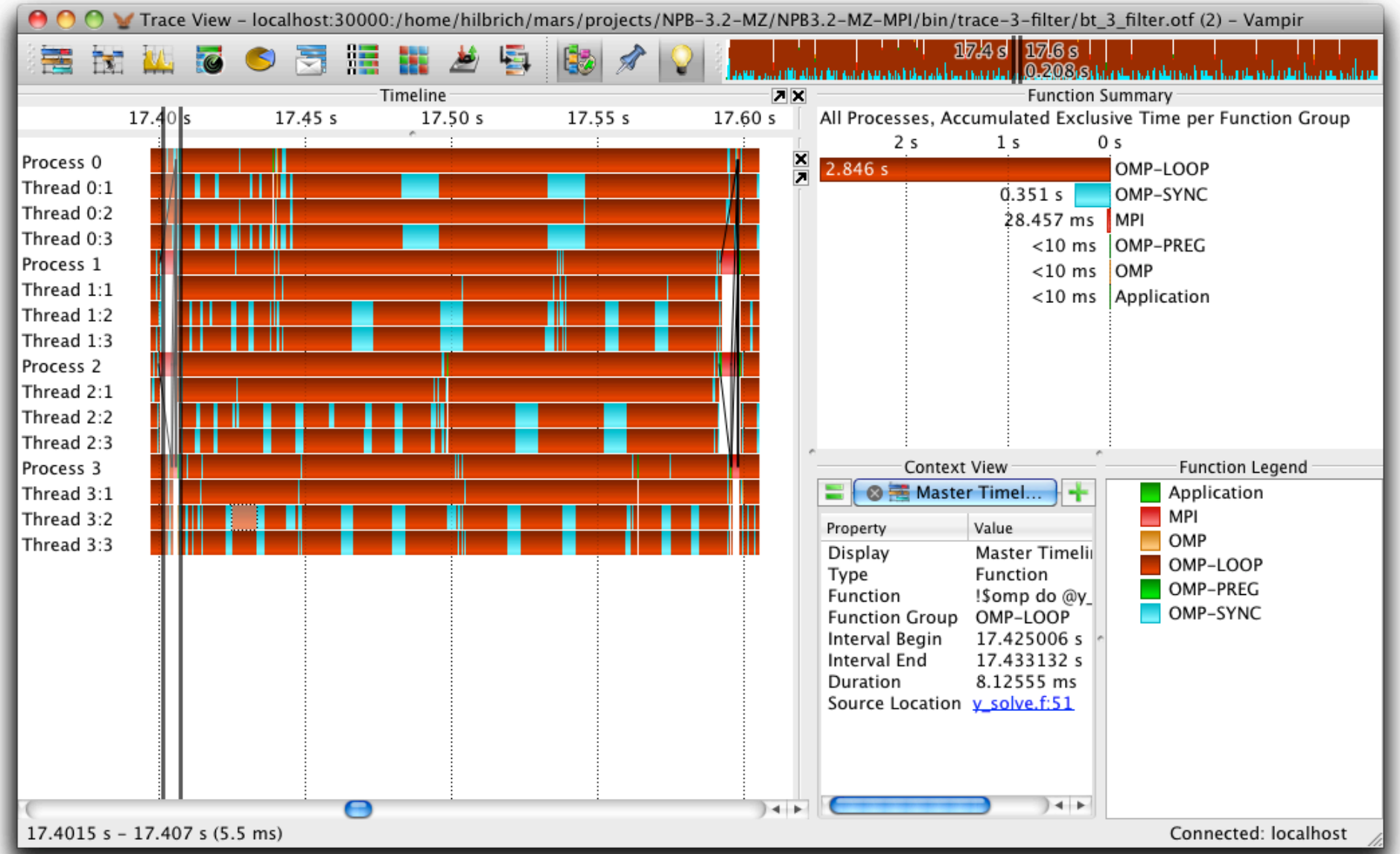
Hands-on: NPB – Filtered Trace



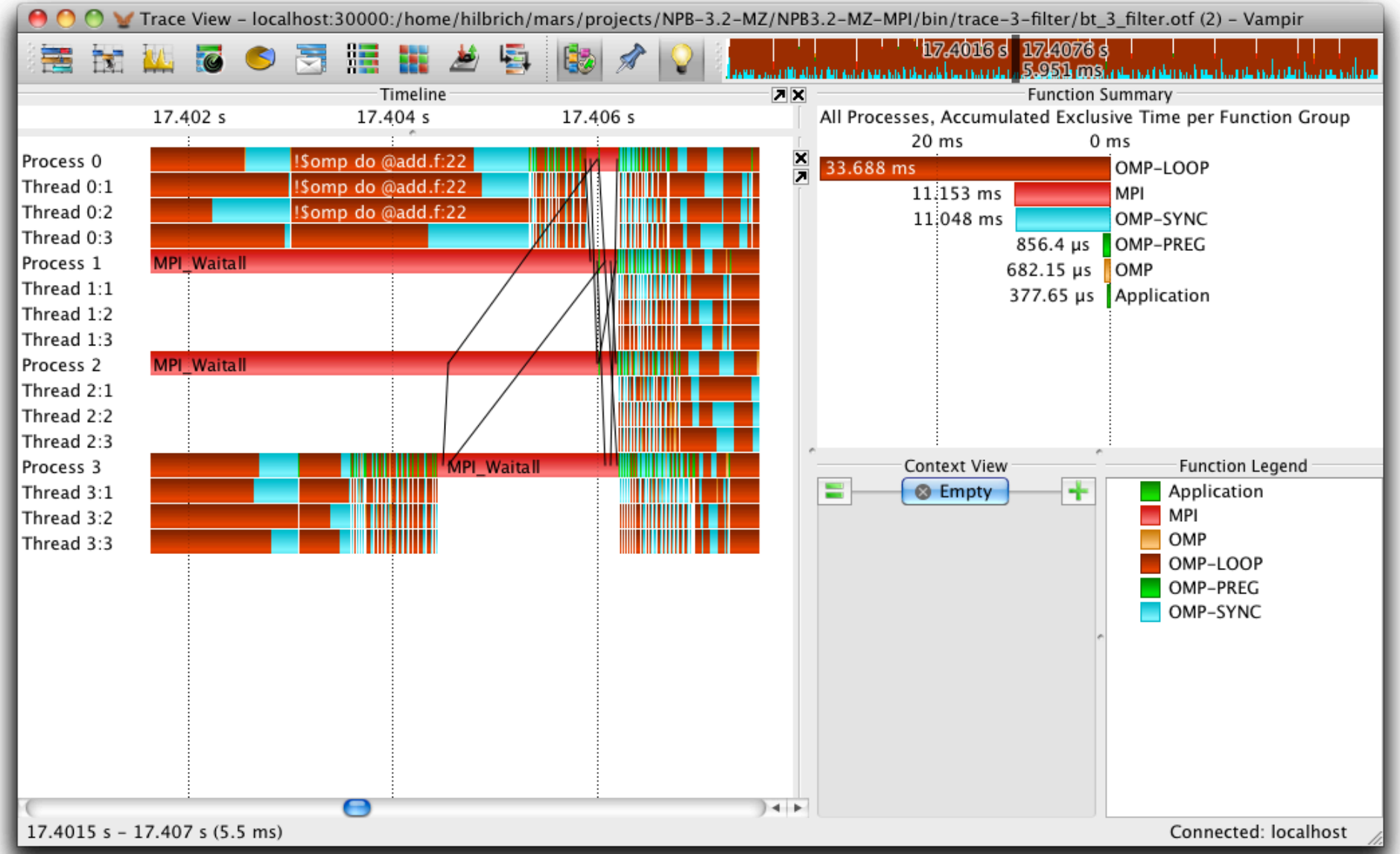
Hands-on: NPB – Filtered Trace



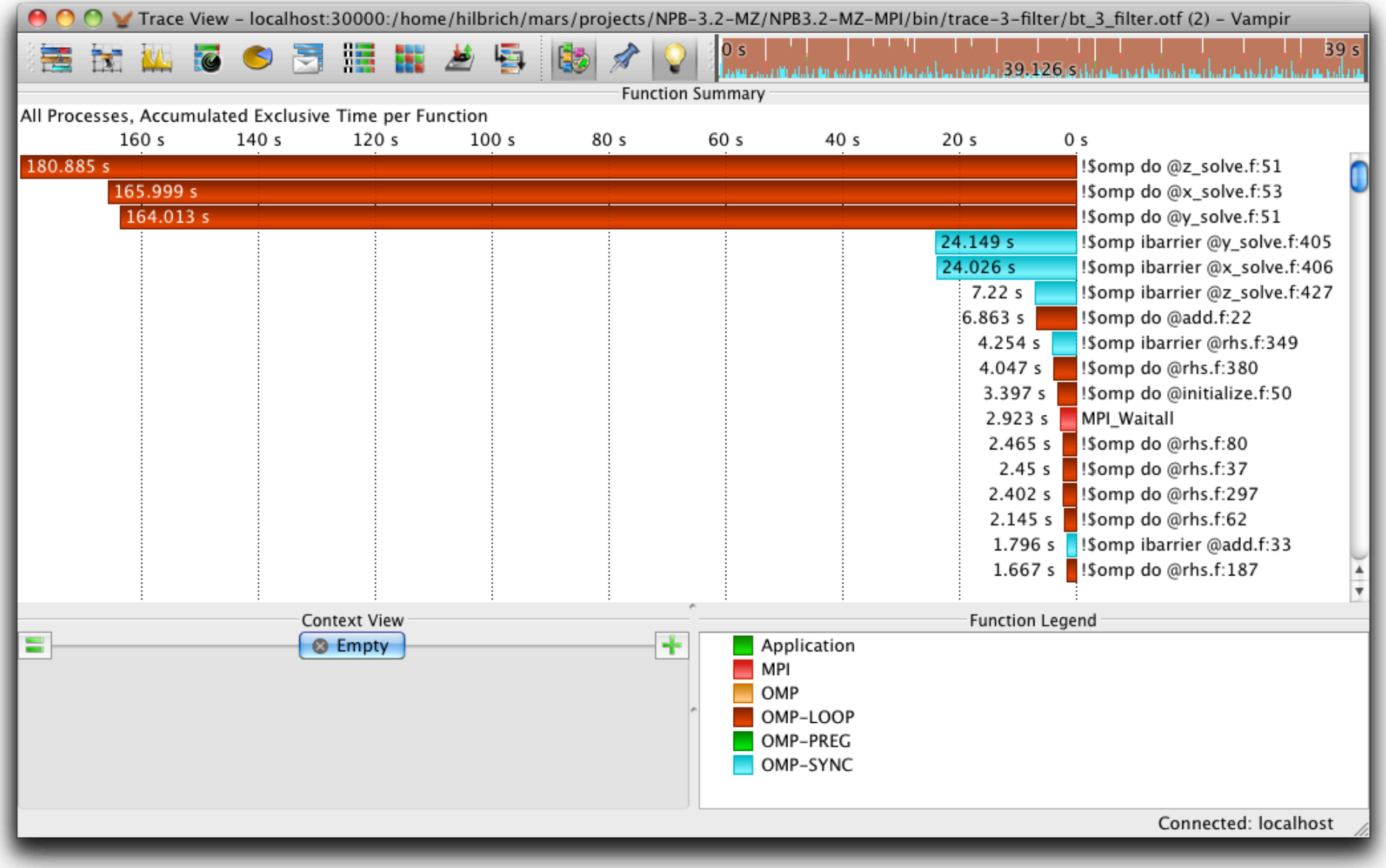
Hands-on: NPB – Filtered Trace



Hands-on: NPB – Filtered Trace



Hands-on: NPB – Filtered Trace



PAPI

- PAPI counters can be included in traces
  - If VampirTrace was build with PAPI support
  - If PAPI is available on the platform
- VT_METRICS specifies a list of PAPI counters

```
% export VT_METRICS = PAPI_FP_OPS:PAPI_L2_TCM
```

- see also the PAPI commands papi_avail and papi_command_line

Memory Allocation and I/O counters

- Memory allocation counters can be recorded:
  - If VampirTrace build with memory allocation tracing support
  - If GNU glibc is used on the platform
- intercept glibc functions like “malloc” and “free”
- Environment variable VT_MEMTRACE

```
% export VT_MEMTRACE = yes
```

- I/O counters can be included in traces
  - If VampirTrace was build with I/O tracing support
- Standard I/O calls like “open” and “read” are recorded
- Environment variable VT_IOTRACE

```
% export VT_IOTRACE = yes
```

- Record PAPI hardware counters

```
% export VT_METRICS=PAPI_FP_OPS:PAPI_L2_TCM
```

- Set a new file prefix

```
% export VT_FILE_PREFIX=bt_4_papi
```

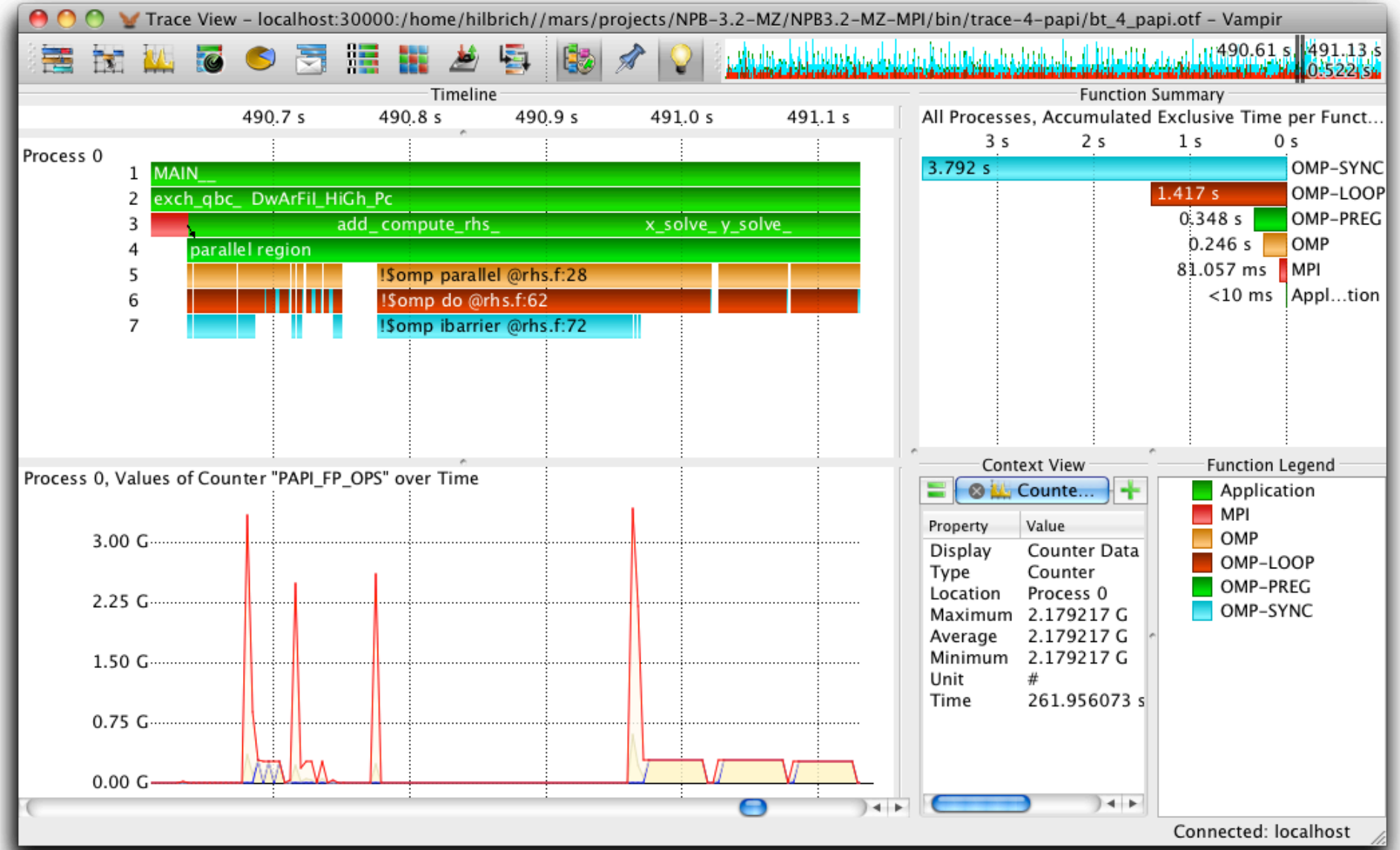
Add both to your jobscript, keep filtering and buffer size environmentals

- Resubmit jobscript

```
bsub < run.lsf
```

```
msub run.msub
```

Hands-on: NPB – Filter & Counter Trace



VampirTrace Run-Time Options

- control options by environment variables:

– VT_PFORM_GDIR	Directory for final trace files
– VT_PFORM_LDIR	Directory for intermediate files
– VT_FILE_PREFIX	Trace file name
– VT_BUFFER_SIZE	Internal trace buffer size
– VT_MAX_FLUSHES	Max number of buffer flushes
– VT_MEMTRACE	Enable memory allocation tracing
– VT_MPICHECK	Enable MPI checking
– VT_IOTRACE	Enable I/O tracing
– VT_MPITRACE	Enable MPI tracing
– VT_FILTER_SPEC	Name of filter definition file
– VT_GROUPS_SPEC	Name of grouping definition file
– VT_METRICS	PAPI counter selection

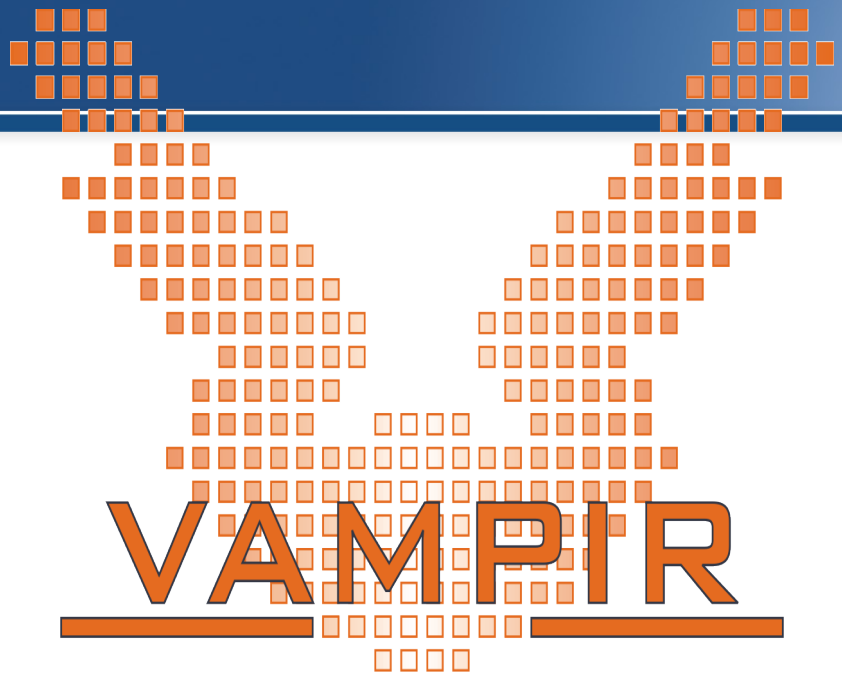
Conclusions and Outlook

- performance analysis very important in HPC

- use performance analysis tools for profiling and tracing
- do not spend effort in DIY solutions,
  e.g. like printf-debugging

- use tracing tools with some precautions
  - overhead
  - data volume

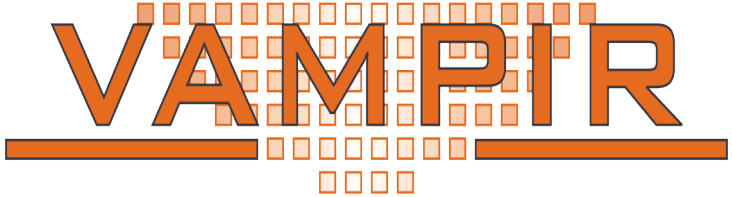
- let us know about problems and about feature wishes
- vampirsupport@zih.tu-dresden.de



Vampir and VampirTraces are available at http://www.vampir.eu and http://www.tu-dresden.de/zih/vampirtrace/ ,

get support via vampirsupport@zih.tu-dresden.de

Acknowledgement:



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