Performance Analysis with Vampir

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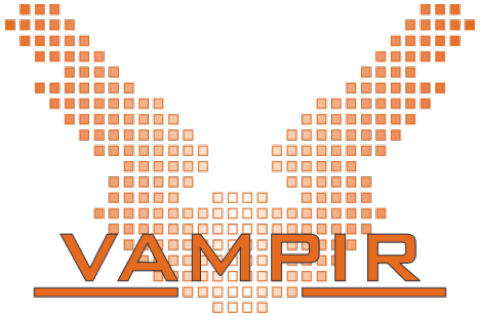
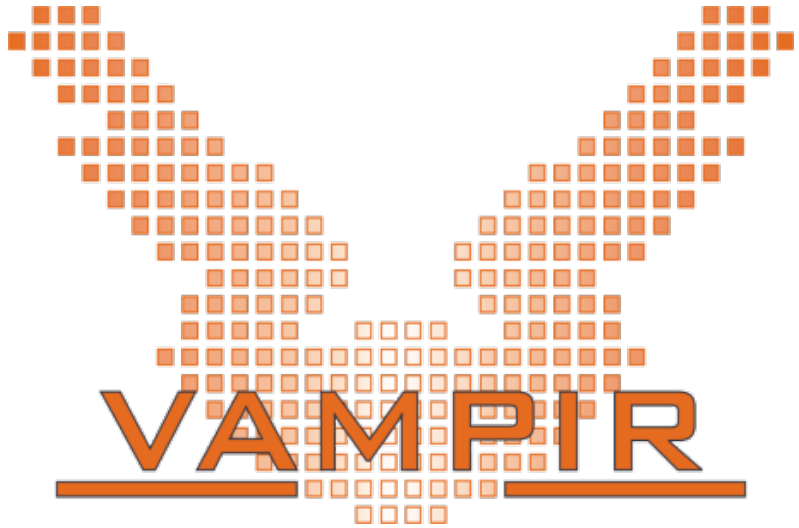


Outline

- **Part I: Welcome to the Vampir Tool Suite**
  - Event Trace Visualization
  - The Vampir Displays
  - Vampir & VampirServer
- **Part II: Vampir Hands-On**
  - Visualizing and Analyzing NPB-MZ-MPI / BT

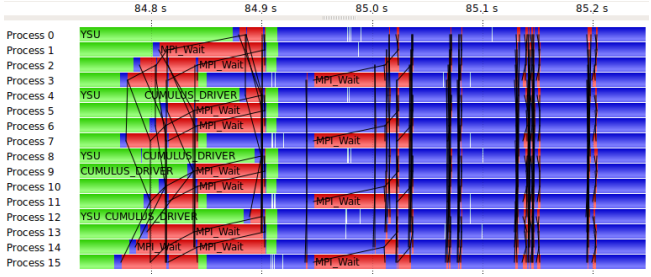


Event Trace Visualization with Vampir

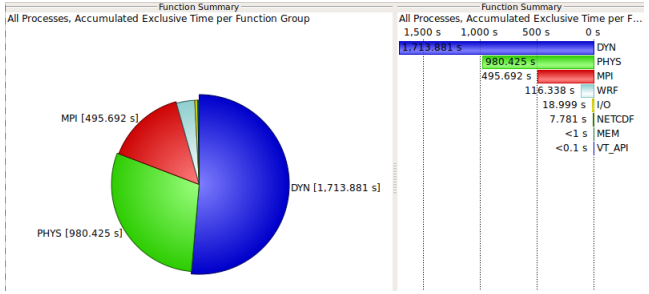
- Visualization of dynamic runtime behaviour at any level of detail along with statistics and performance metrics
- Alternative and supplement to automatic analysis

- **Typical questions that Vampir helps to answer**
  - What happens in my application execution during a given time in a given process or thread?
  - How do the communication patterns of my application execute on a real system?
  - Are there any imbalances in computation, I/O or memory usage and how do they affect the parallel execution of my application?

- **Timeline charts**
  - Application activities and communication along a time axis



- **Summary charts**
  - Quantitative results for the currently selected time interval

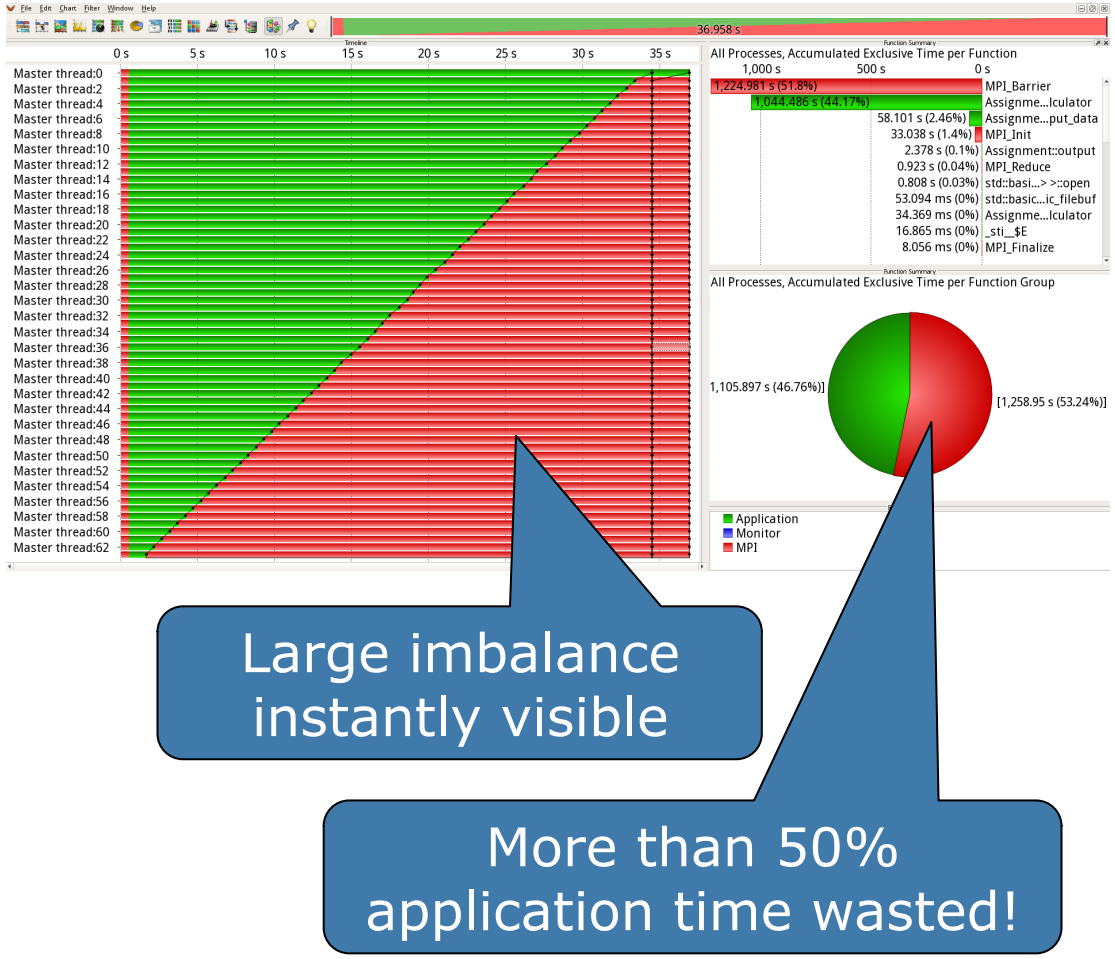


Event Trace Visualization with Vampir

The value of seeing how an application executes on the machine

- Application code computing coulomb forces
- The workload was distributed evenly across available processes
- The user expected perfect parallelized code
- However the underlying algorithm worked differently than expected

Visualization of the application execution instantly shows a problem in the parallelization approach



Main Performance Charts of Vampir

Timeline Charts


Master Timeline → *all threads' activities*


Process Timeline → *single thread's activities*


Summary Timeline → *all threads' function call statistics*


Performance Radar → *all threads' performance metrics*


Counter Data Timeline → *single threads' performance metrics*


I/O Timeline → *all threads' I/O activities*

Summary Charts


Function Summary


Message Summary


I/O Summary

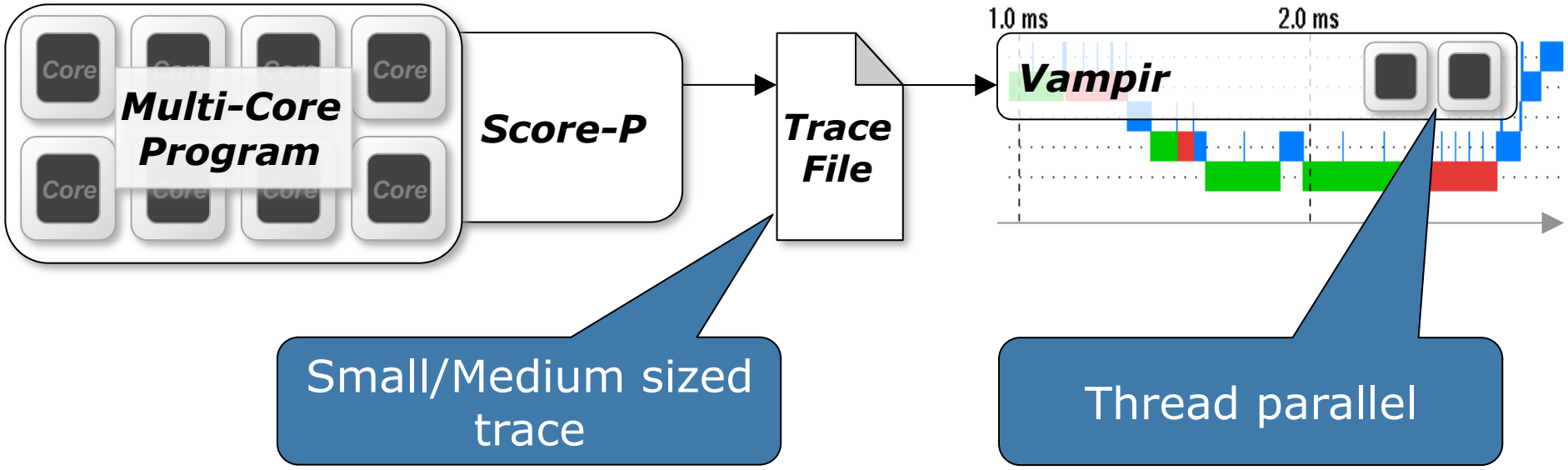

Process Summary


Communication Matrix View


Call Tree

Visualization Modes (1)
Directly on front end or local machine

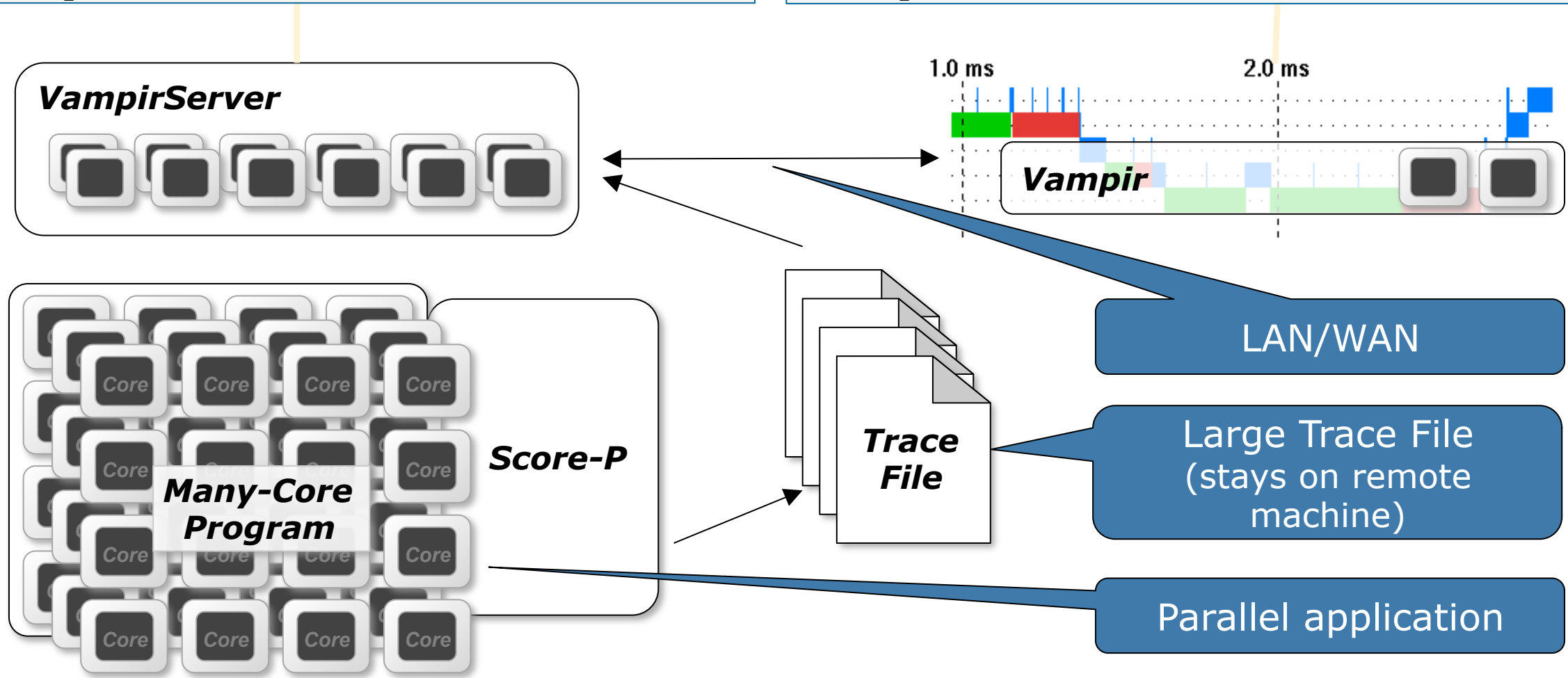
```
% vampir
```



Visualization Modes (2)
On local machine with remote VampirServer

```
% vampirserver start
```

```
% vampir
```



Hands-on:
Visualizing and analyzing NPB-MZ-MPI / BT

Help! Where is my trace file?

```
% ls <working_directory>/NPB3.3-MZ-MPI/bin.scorep/
> scorep_bt-mz_C_8x4_trace
profile.cubex  scorep.cfg    traces/   traces.def  traces.otf2
```

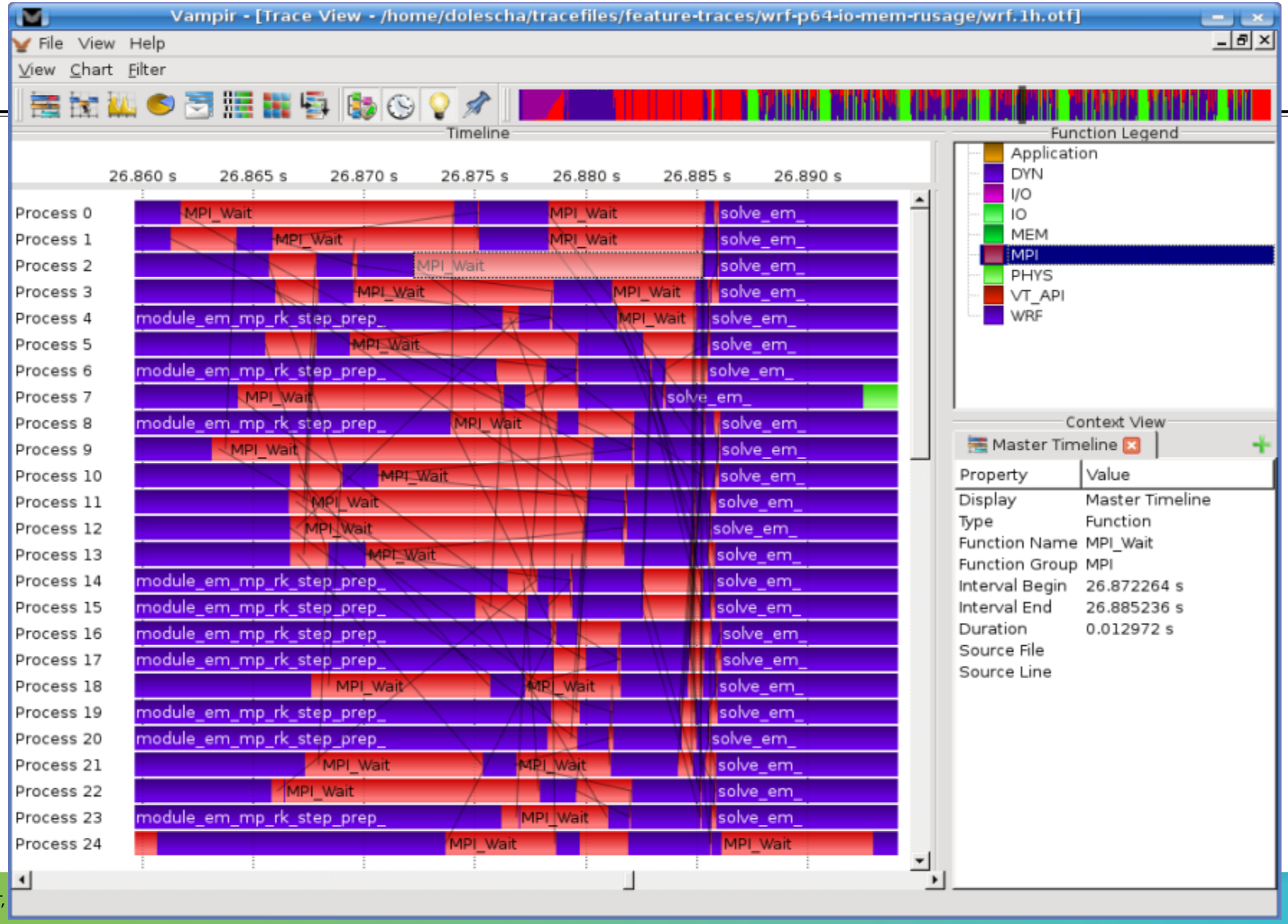
```
% ls /home/nct00/nct00006/trace-examples
> scorep_bt-mz_C_8x4_trace
profile.cubex  scorep.cfg    traces/   traces.def  traces.otf2
```

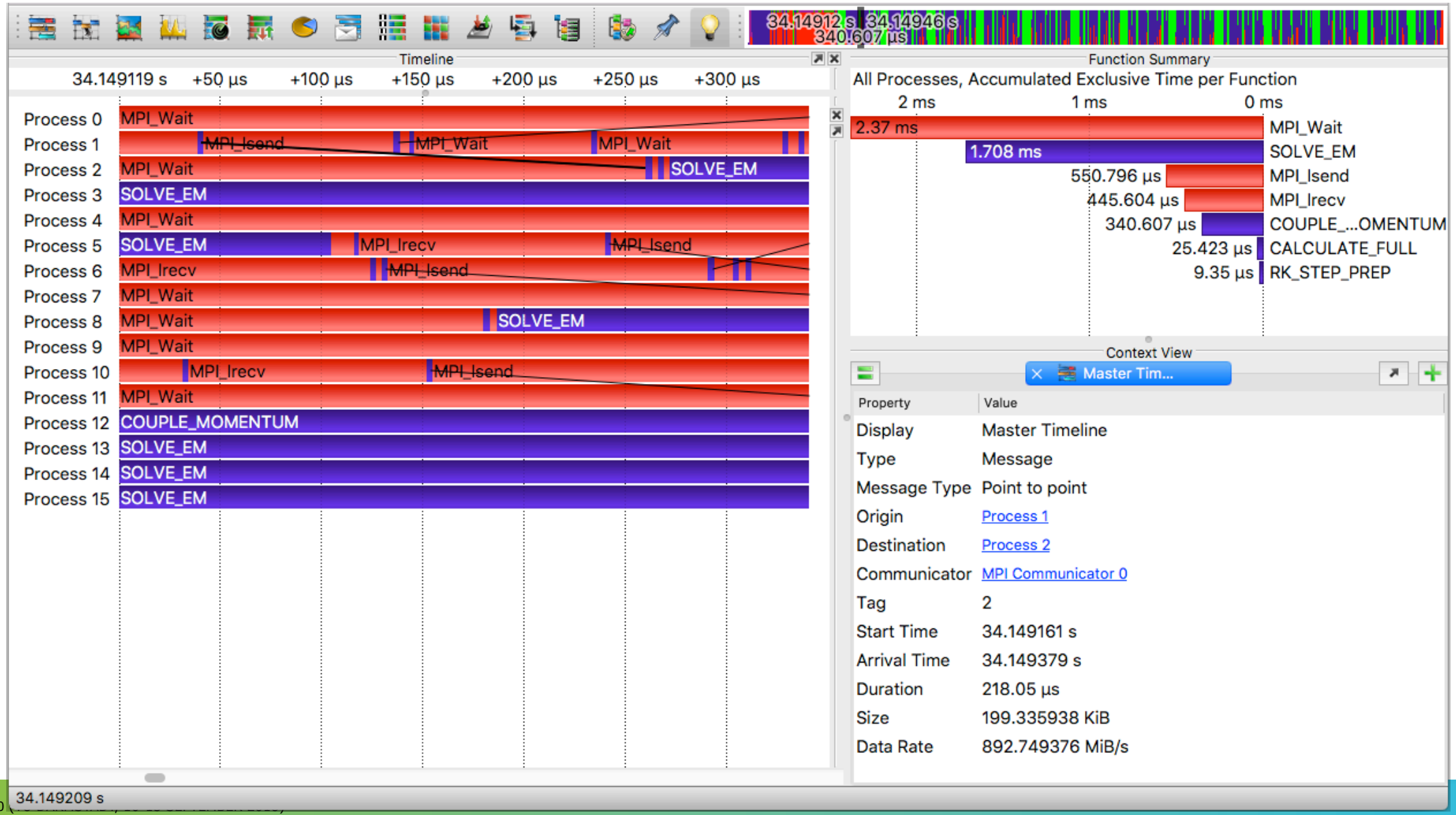
- If you followed the Score-P hands-on up to the trace experiment
- If you did not follow to that point, take a prepared trace

Start Vampir

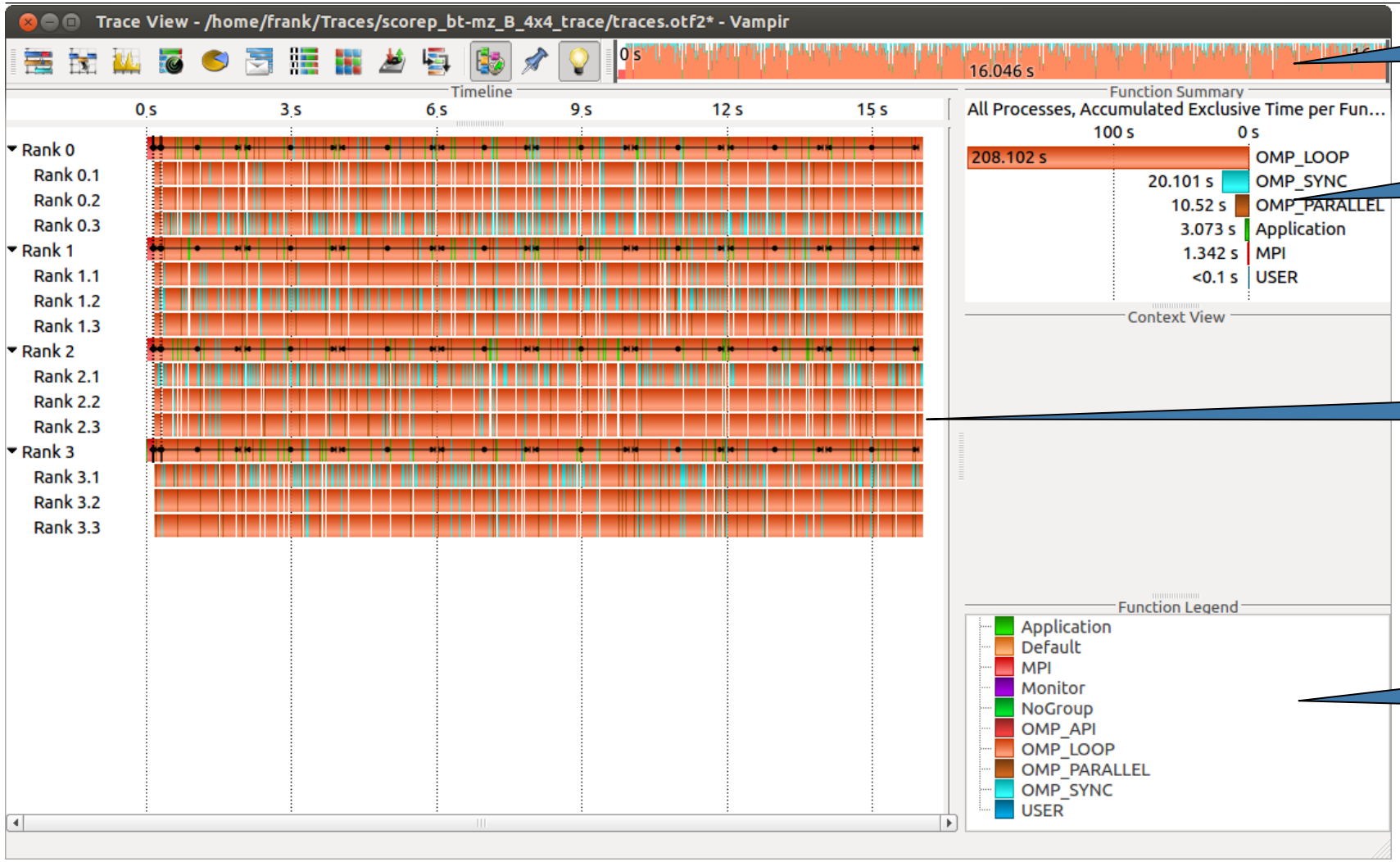
```
% export PATH=$PATH:/home/nct00/nct00006/bin



% vampir <working_directory>/NPB3.3-MZ-MPI/bin.scorep/\
> scorep_bt-mz_C_8x4_trace/traces.otf2
```

- Load correct module to add local tool installations to $PATH (required for each shell session)
- Start Vampir on the current login-node
  (requires ssh X-forwarding)


Vampir - [Trace View - /home/dolescha/tracefiles/feature-traces/wrf-p64-io-mem-rusage/wrf.1h.otf]
File View Help
View Chart Filter
Timeline
26.860 s
26.865 s
26.870 s
26.875 s
26.880 s
26.885 s
26.890 s
Process 0
Process 1
Process 2
Process 3
Process 4
Process 5
Process 6
Process 7
Process 8
Process 9
Process 10
Process 11
Process 12
Process 13
Process 14
Process 15
Process 16
Process 17
Process 18
Process 19
Process 20
Process 21
Process 22
Process 23
Process 24
MPI_Wait
solve_em_
module_em_mp_rk_step_prep_
Function Legend
Application
DYN
I/O
IO
MEM
MPI
PHYS
VT_API
WRF
Context View
Master Timeline
Property
Value
Display
Master Timeline
Type
Function
Function Name
MPI_Wait
Function Group
MPI
Interval Begin
26.872264 s
Interval End
26.885236 s
Duration
0.012972 s
Source File
Source Line


34.14912 s 34.14946 s
340.607 µs
Timeline
34.149119 s +50 µs +100 µs +150 µs +200 µs +250 µs +300 µs
Process 0 MPI_Wait
Process 1 MPI_Isend MPI_Wait MPI_Wait
Process 2 MPI_Wait SOLVE_EM
Process 3 SOLVE_EM
Process 4 MPI_Wait
Process 5 SOLVE_EM MPI_Irecv MPI_Isend
Process 6 MPI_Irecv MPI_Isend
Process 7 MPI_Wait
Process 8 MPI_Wait SOLVE_EM
Process 9 MPI_Wait
Process 10 MPI_Irecv MPI_Isend
Process 11 MPI_Wait
Process 12 COUPLE_MOMENTUM
Process 13 SOLVE_EM
Process 14 SOLVE_EM
Process 15 SOLVE_EM
34.149209 s
Function Summary
All Processes, Accumulated Exclusive Time per Function
2 ms 1 ms 0 ms
2.37 ms MPI_Wait
1.708 ms SOLVE_EM
550.796 µs MPI_Isend
445.604 µs MPI_Irecv
340.607 µs COUPLE_...OMENTUM
25.423 µs CALCULATE_FULL
9.35 µs RK_STEP_PREP
Context View
Master Tim...
Property Value
Display Master Timeline
Type Message
Message Type Point to point
Origin Process 1
Destination Process 2
Communicator MPI Communicator 0
Tag 2
Start Time 34.149161 s
Arrival Time 34.149379 s
Duration 218.05 µs
Size 199.335938 KiB
Data Rate 892.749376 MiB/s

Visualization of the NPB-MZ-MPI / BT trace



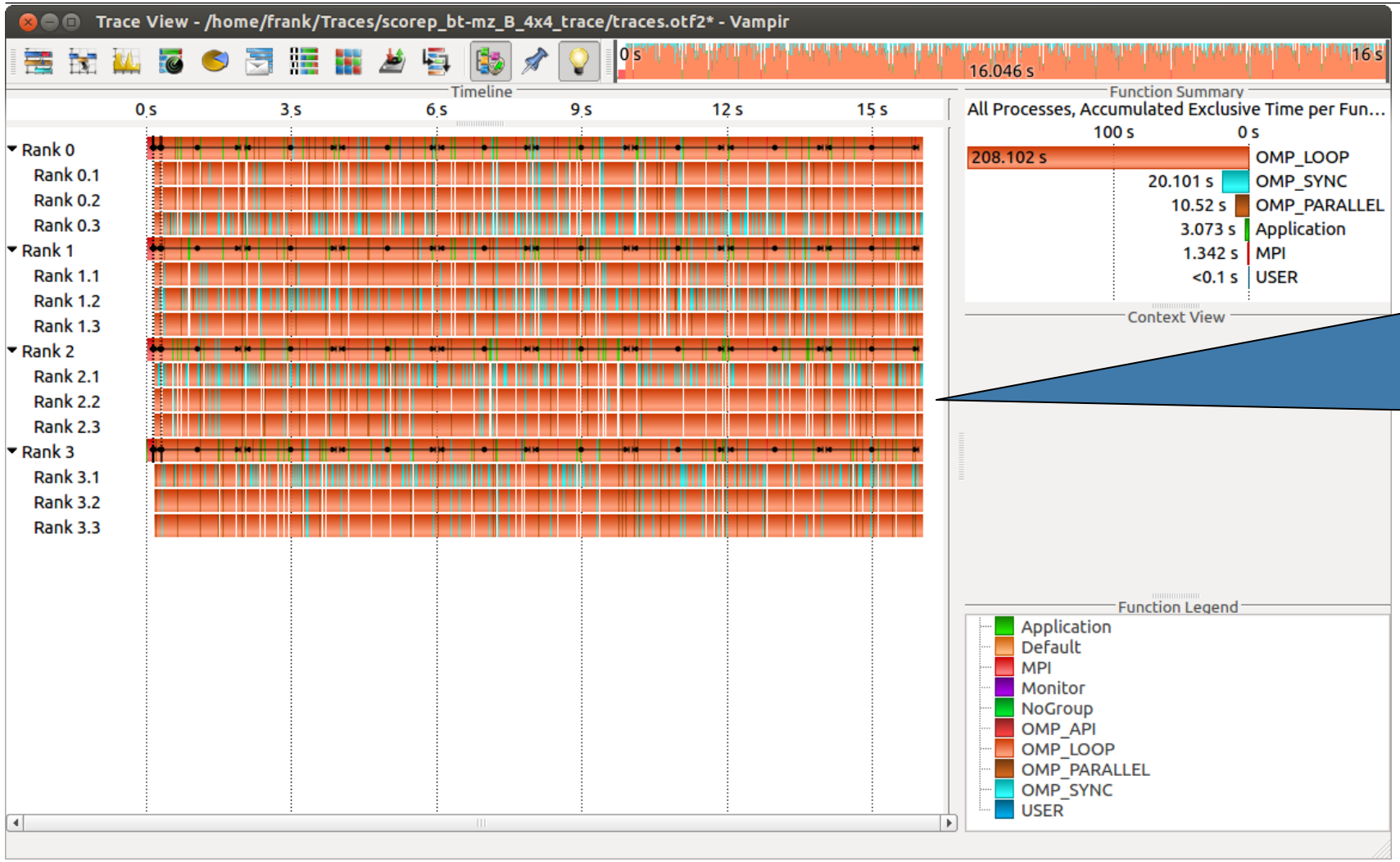
Navigation Toolbar

Function Summary

Master Timeline

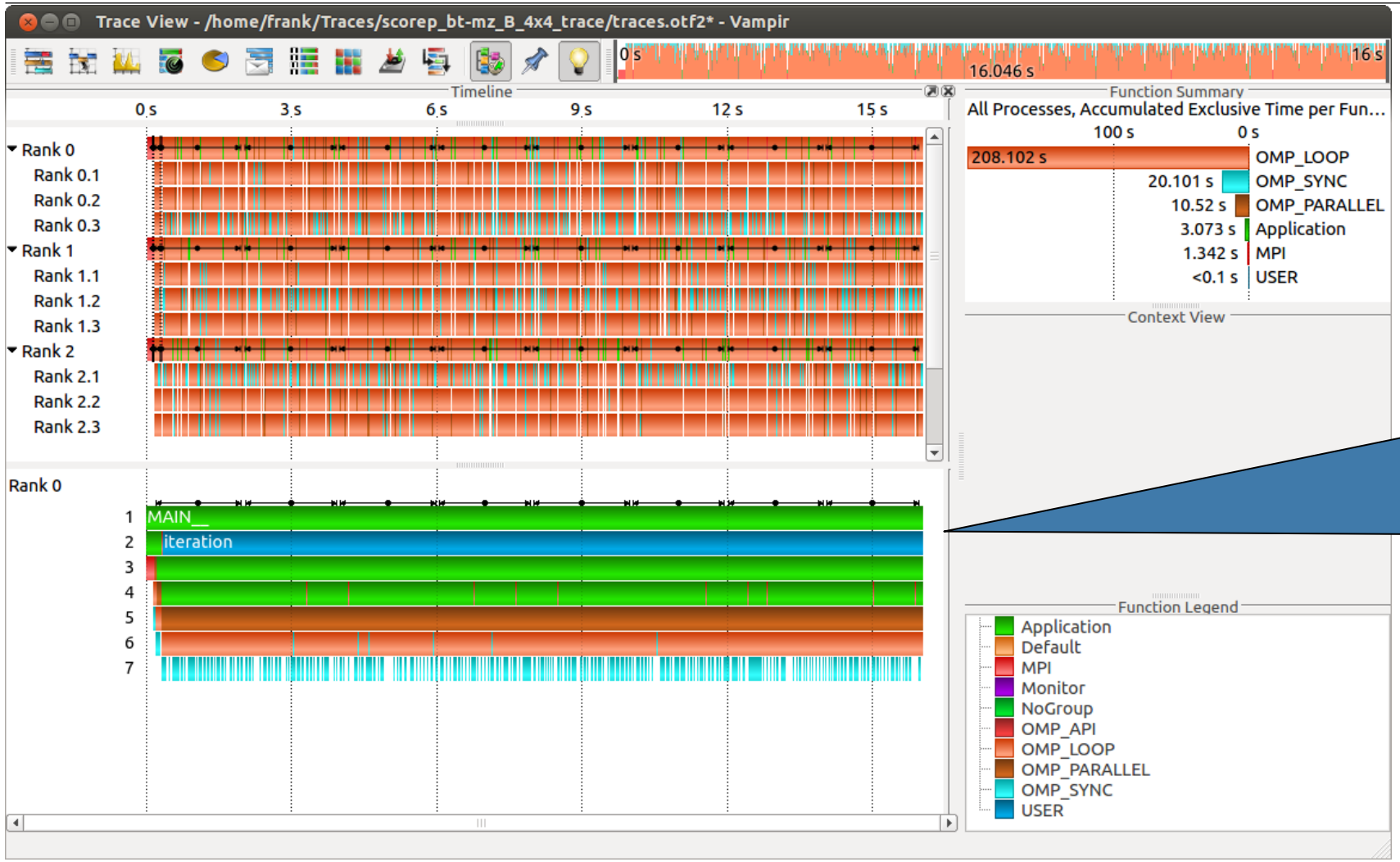
Function Legend

Visualization of the NPB-MZ-MPI / BT trace
Master Timeline



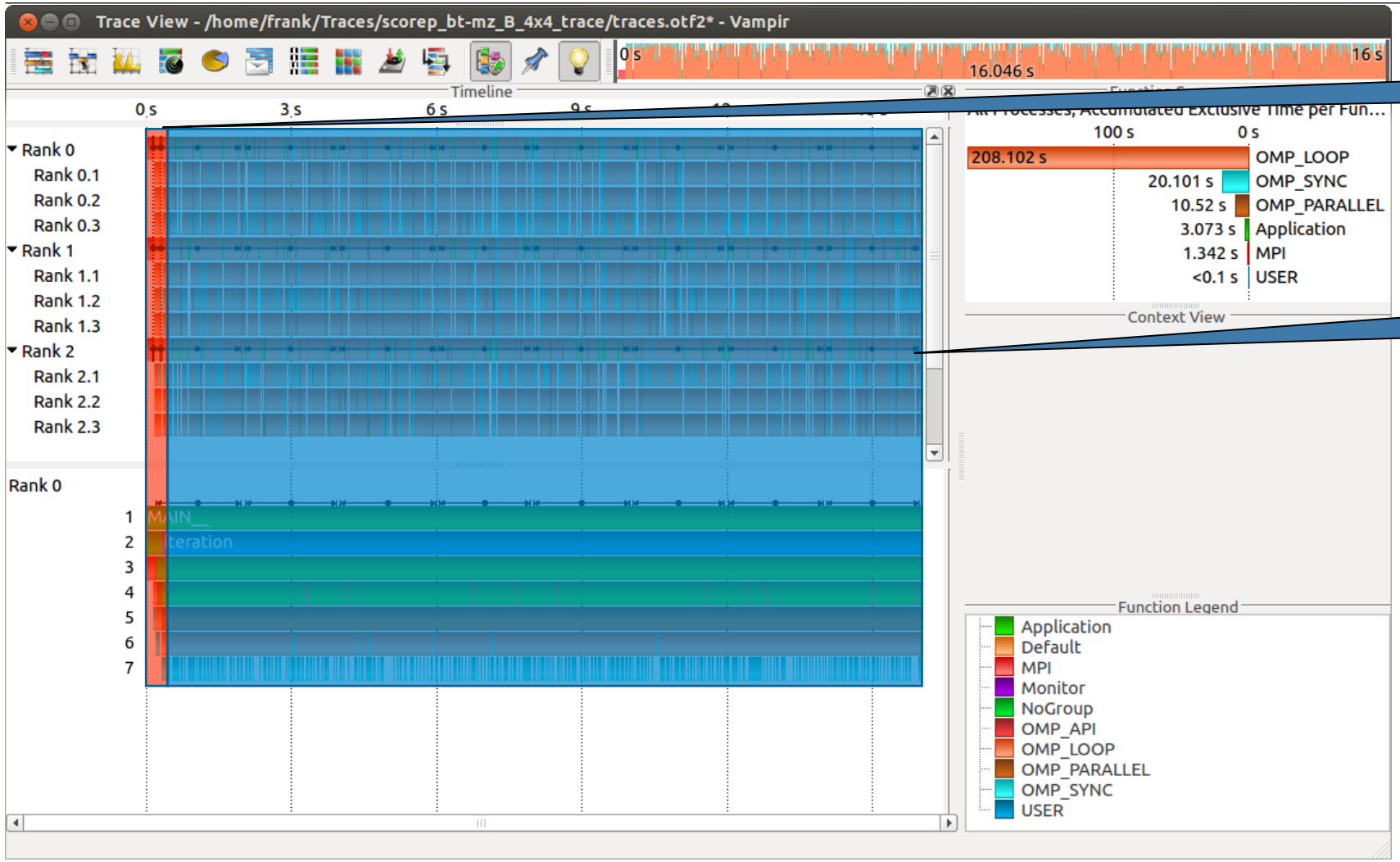
Detailed information about functions, communication and synchronization events for collection of processes.

Visualization of the NPB-MZ-MPI / BT trace
Process Timeline



Detailed information about different levels of function calls in a stacked bar chart for an individual process.

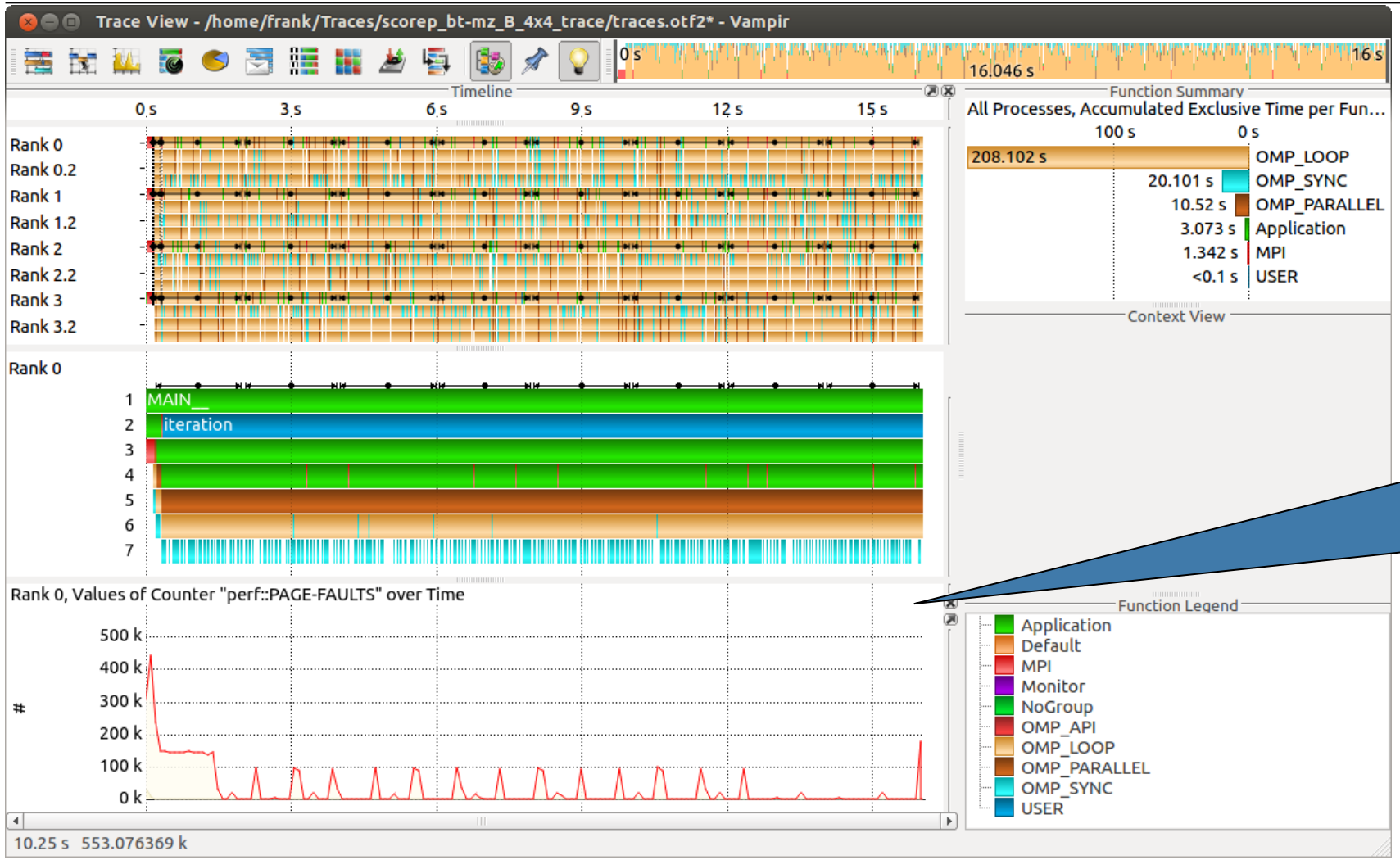
Visualization of the NPB-MZ-MPI / BT trace
Typical program phases



Initialisation Phase

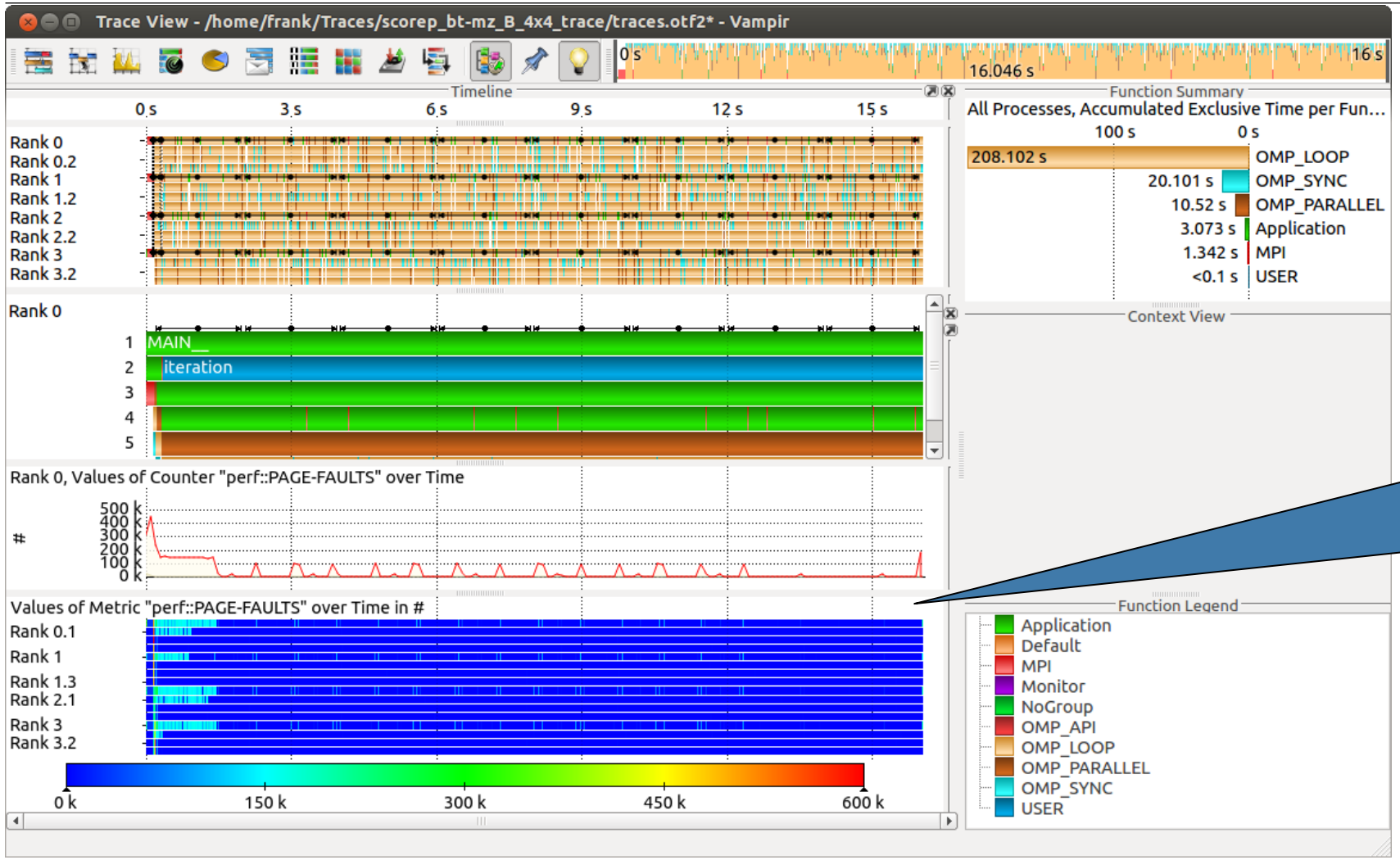
Computation Phase

Visualization of the NPB-MZ-MPI / BT trace
Counter Data Timeline



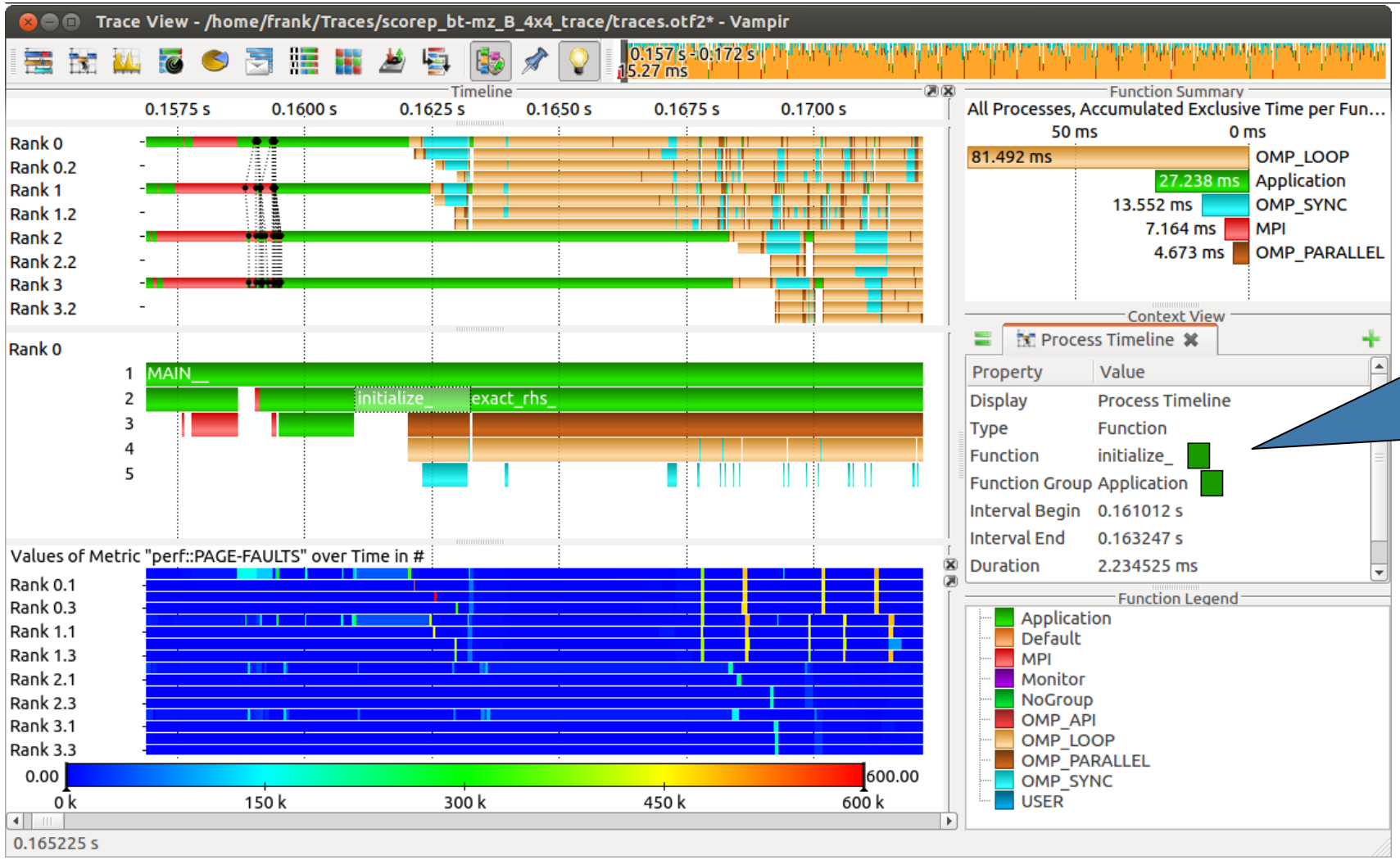
Detailed counter information over time for an individual process.

Visualization of the NPB-MZ-MPI / BT trace
Performance Radar



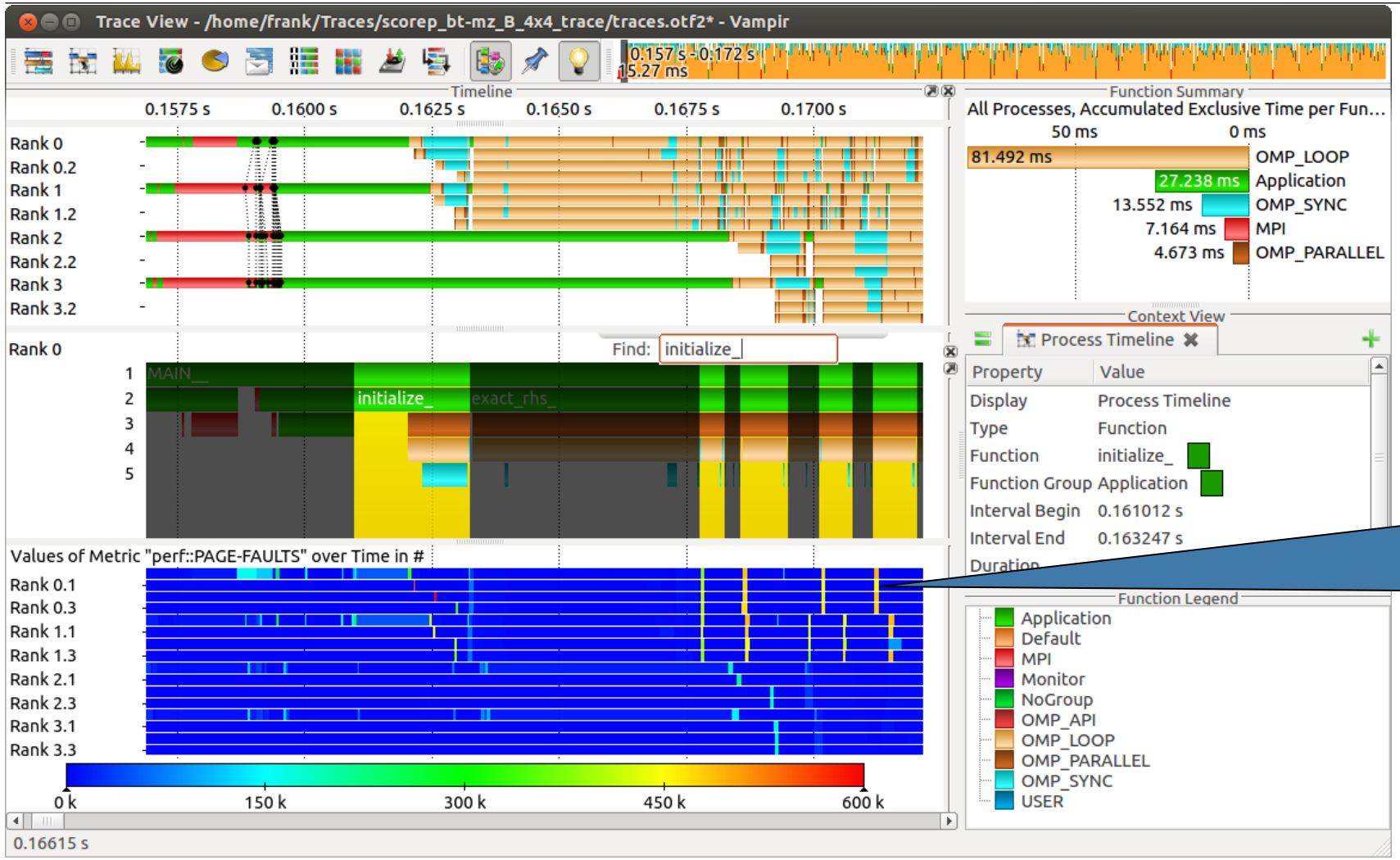
Detailed counter information over time for a collection of processes.

Visualization of the NPB-MZ-MPI / BT trace
Zoom in: Inititialisation Phase



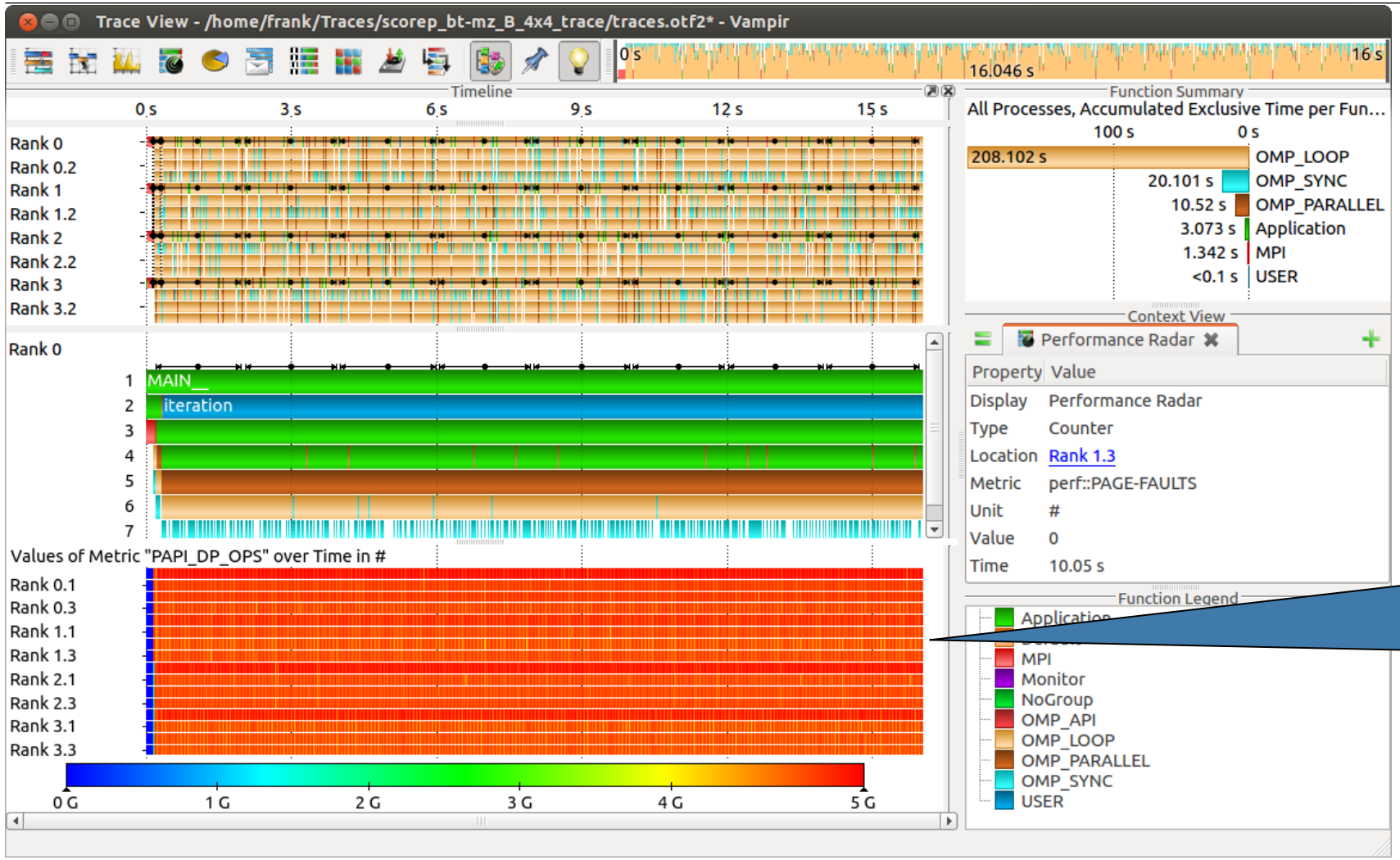
Context View: Detailed information about function “initialize_”.

Visualization of the NPB-MZ-MPI / BT trace
Find Function



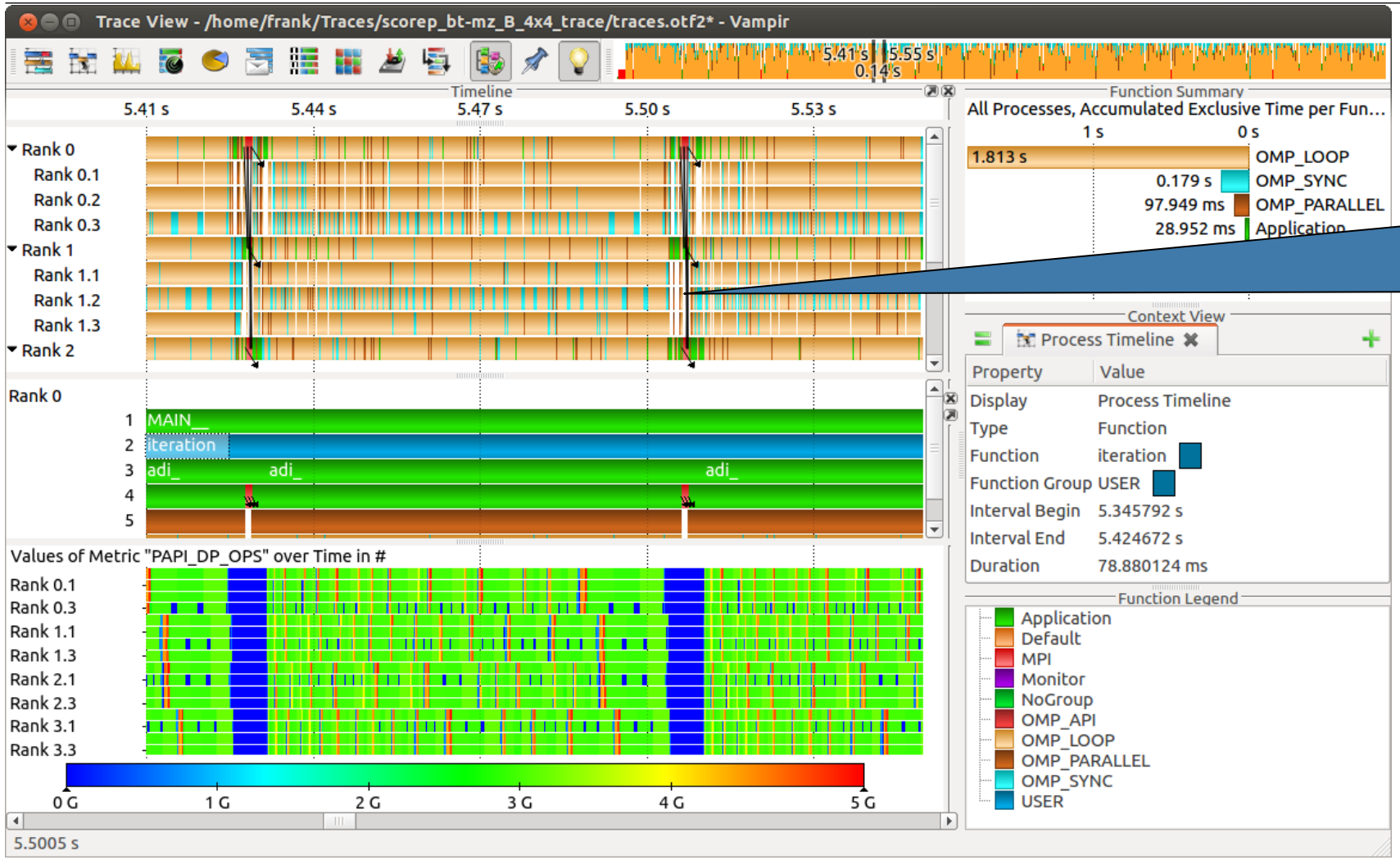
Execution of function "initialize_" results in higher page fault rates.

Visualization of the NPB-MZ-MPI / BT trace
Computation Phase



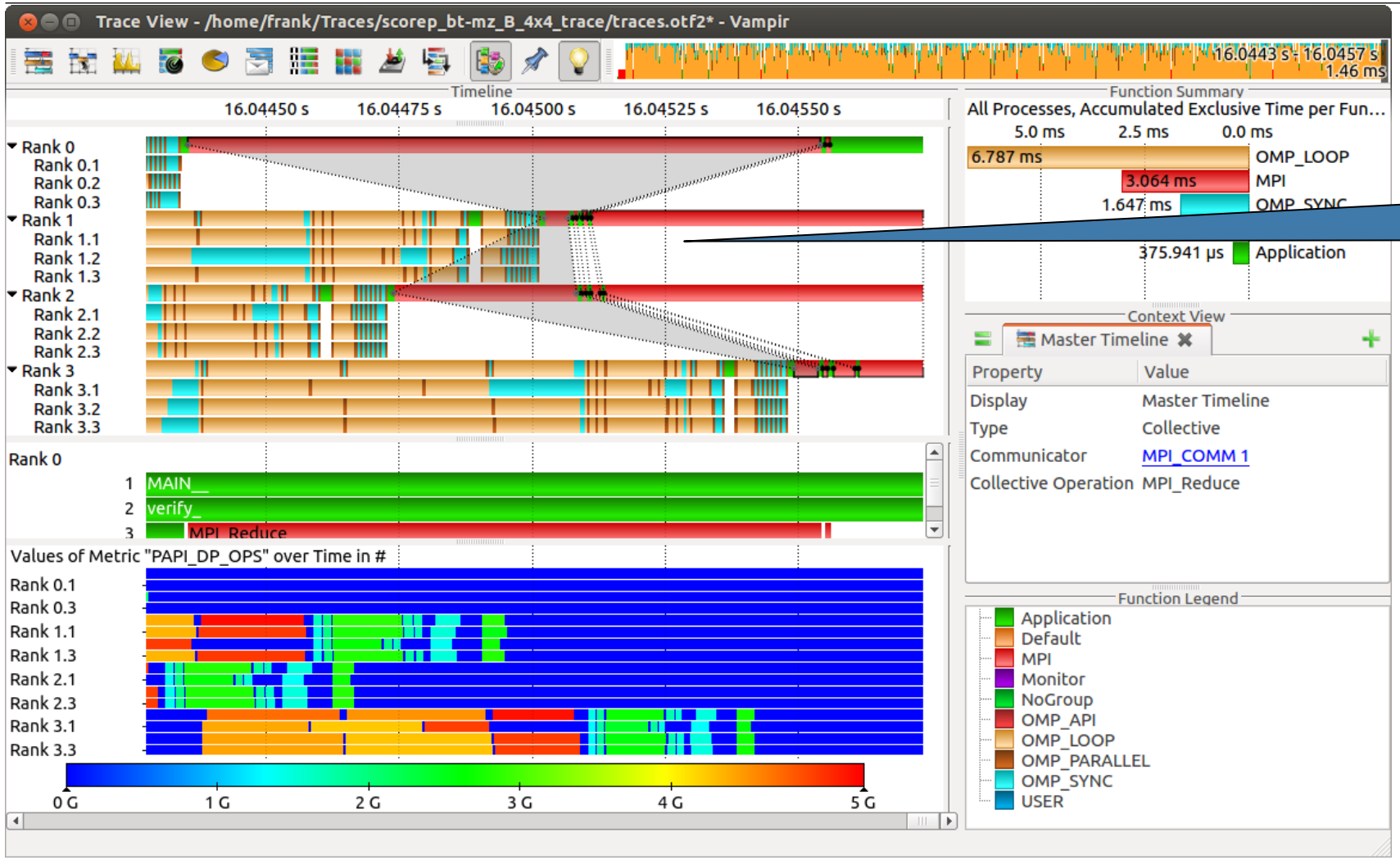
Computation phase results in higher floating point operations.

Visualization of the NPB-MZ-MPI / BT trace
Zoom in: Computation Phase



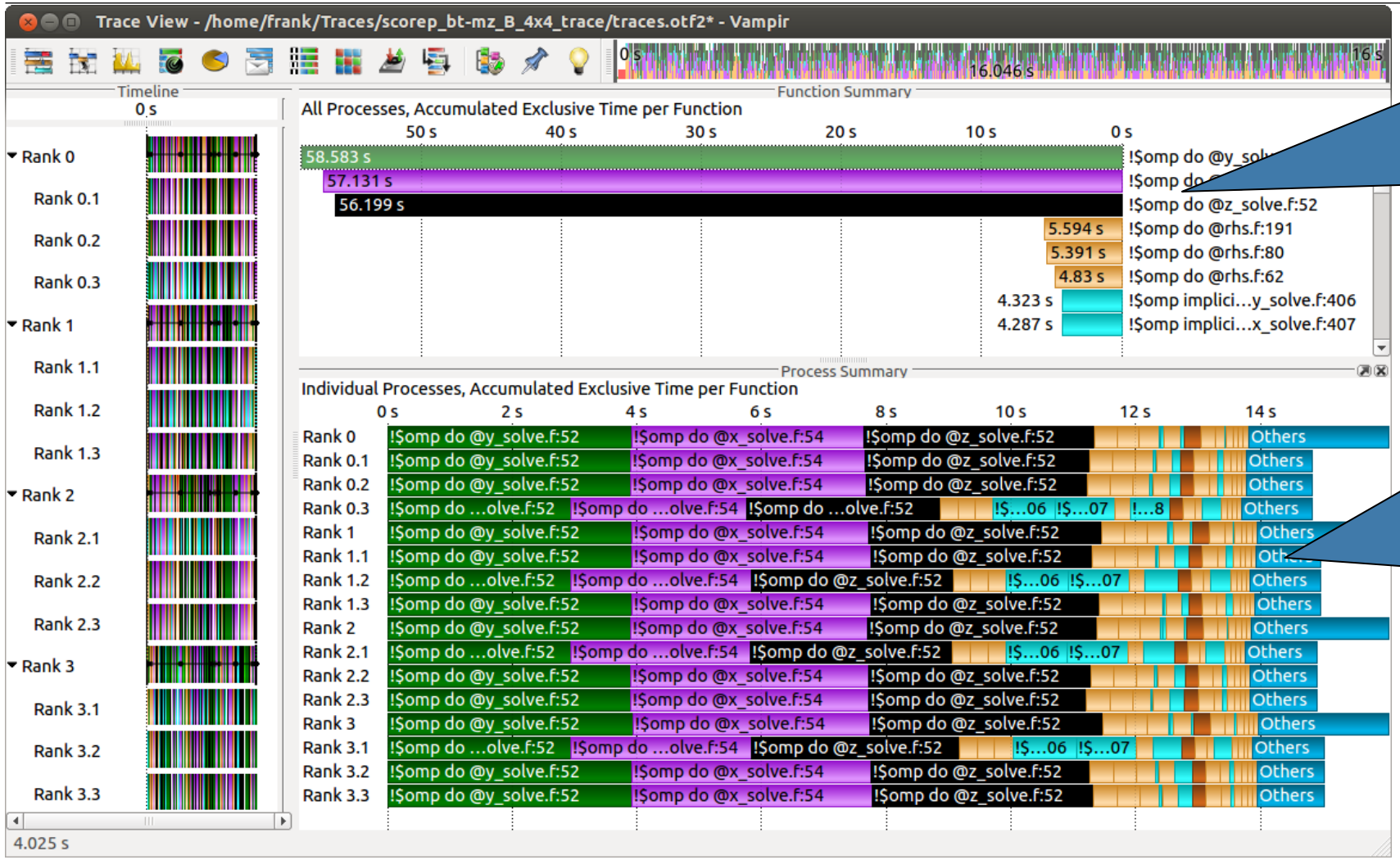
MPI communication results in lower floating point operations.

Visualization of the NPB-MZ-MPI / BT trace
Zoom in: Finalisation Phase



"Early reduce" bottleneck.

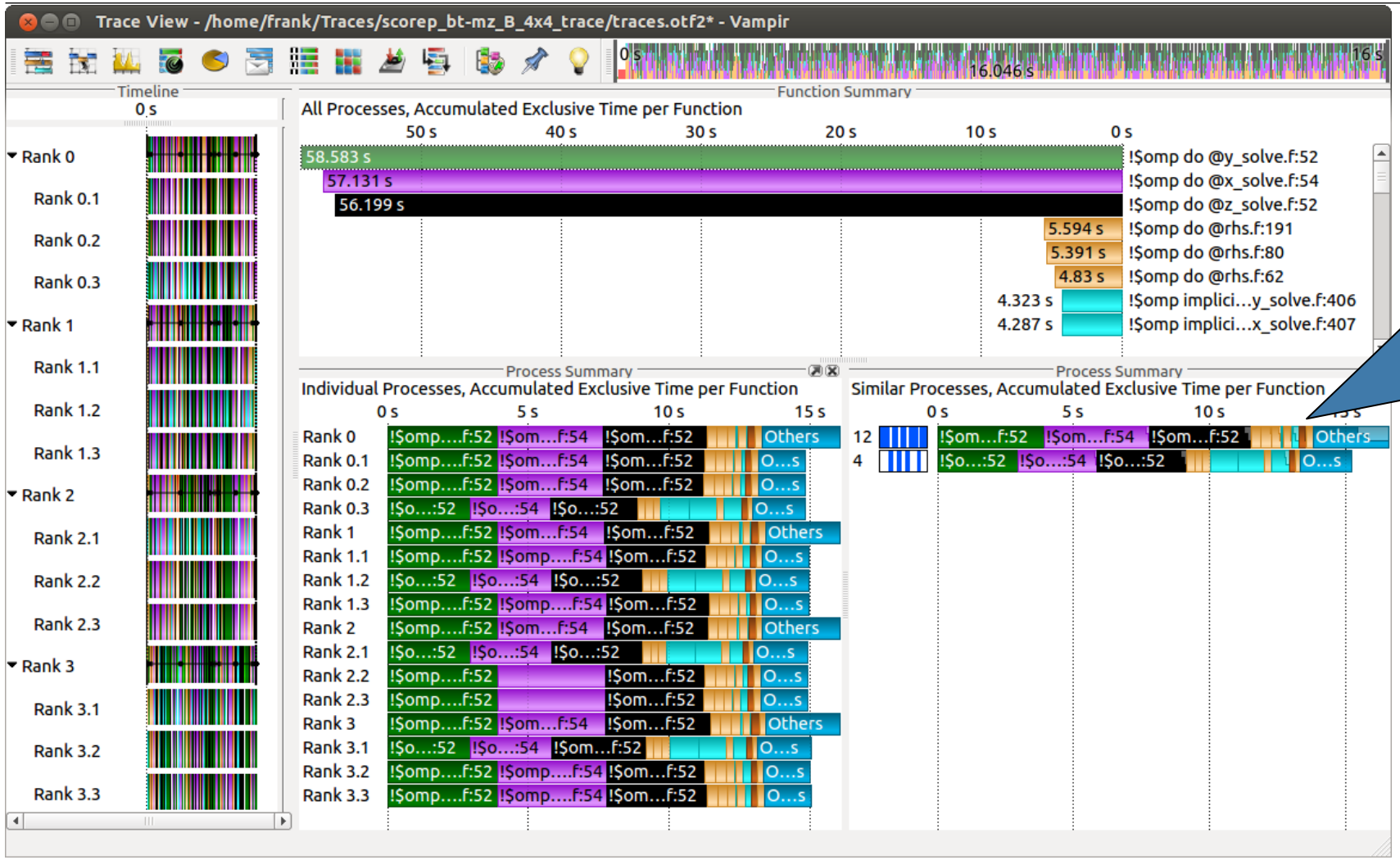
Visualization of the NPB-MZ-MPI / BT trace
Process Summary



Function Summary: Overview of the accumulated information across all functions and for a collection of processes.

Process Summary: Overview of the accumulated information across all functions and for every process independently.

Visualization of the NPB-MZ-MPI / BT trace
Process Summary



Find groups of similar processes and threads by using summarized function information.

Summary and Conclusion

Summary

- Vampir & VampirServer
  - Interactive trace visualization and analysis
  - Intuitive browsing and zooming
  - Scalable to large trace data sizes (20 TiByte)
  - Scalable to high parallelism (200,000 processes)

- Vampir for Linux, Windows, and Mac OS X

http://www.vampir.eu

vampirsupport@zih.tu-dresden.de