

# Score-P – A Joint Performance Measurement Run-Time Infrastructure for Periscope, Scalasca, TAU, and Vampir

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VI-HPS Team



# Congratulations!?

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- If you made it this far, you successfully used Score-P to
  - instrument the application
  - analyze its execution with a summary measurement, and
  - examine it with one of the interactive analysis report explorer GUIs
- ... revealing the call-path profile annotated with
  - the “Time” metric
  - Visit counts
  - MPI message statistics (bytes sent/received)
- ... but how **good** was the measurement?
  - The measured execution produced the desired valid result
  - however, the execution took rather longer than expected!
    - even when ignoring measurement start-up/completion, therefore
    - it was probably dilated by instrumentation/measurement overhead

# Performance analysis steps

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- 0.0 Reference preparation for validation
  
- 1.0 Program instrumentation
  - 1.1 Summary measurement collection
  - 1.2 Summary analysis report examination
  
- 2.0 Summary experiment scoring
  - 2.1 Summary measurement collection with filtering
  - 2.2 Filtered summary analysis report examination
  
- 3.0 Event trace collection
  - 3.1 Event trace examination & analysis

# BT-MZ summary analysis result scoring

```
% scorep-score scorep_bt-mz_sum/profile.cubex
```

Estimated aggregate size of event trace:

Estimated requirements for largest trace buffer (max\_buf):

Estimated memory requirements (SCOREP\_TOTAL\_MEMORY):

(warning: The memory requirements cannot be satisfied by Score-P to avoid intermediate flushes when tracing. Set SCOREP\_TOTAL\_MEMORY=4G to get the maximum supported memory or reduce requirements using USR regions filters.)

flt	type	max_buf[B]	visits	time[s]	time[%]	time/visit[us]	region
	ALL	10,812,127,459	6,597,418,411	2384.04	100.0	0.36	ALL
	USR	10,754,591,276	6,574,805,745	875.54	36.7	0.13	USR
	OMP	55,782,528	21,743,616	1483.16	62.2	68.21	OMP
	COM	1,178,450	725,200	13.63	0.6	18.79	COM
	MPI	616,168	143,834	11.68	0.5	81.23	MPI
	SCOREP	41	16	0.03	0.0	1696.03	SCOREP

161GB

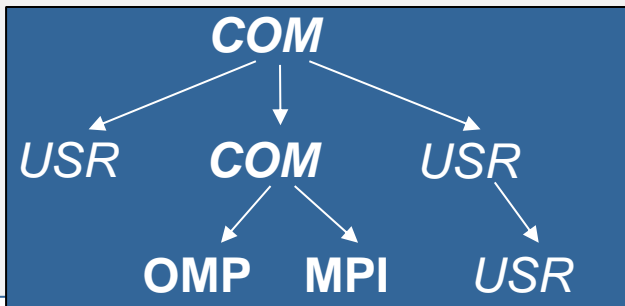
11GB

11GB

- Report scoring as textual output

161 GB total memory  
11 GB per rank!

- Region/callpath classification
  - MPI** pure MPI functions
  - OMP** pure OpenMP regions
  - USR** user-level computation
  - COM** "combined" USR+OpenMP/MPI
  - ALL** aggregate of all region types



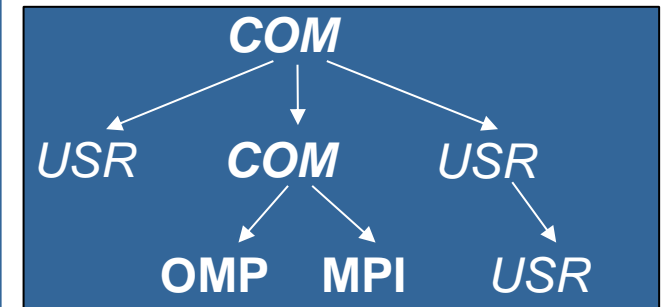
# BT-MZ summary analysis report breakdown

```
% scorep-score -r scorep_bt-mz_sum/profile.cubex
```

```
[...]
[...]
```

flt	type	max_buf[B]	visits	time[s]	time[%]	time/visit[us]	region
	ALL	10,812,127,459	6,597,418,411	2384.04	100.0	0.36	ALL
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	COM	1,178,450	725,200	13.63	0.6	18.79	COM
	MPI	616,168	143,834	11.68	0.5	81.23	MPI
	SCOREP	41	16	0.03	0.0	1696.03	SCOREP

USR	3,454,903,374	2,110,313,472	190.79	8.0	0.09	matvec_sub
USR	3,454,903,374	2,110,313,472	260.27	10.9	0.12	matmul_sub
USR	3,454,903,374	2,110,313,472	389.81	16.4	0.18	binvcrhs
USR	149,170,944	87,475,200	12.06	0.5	0.14	binvrhs
USR	149,170,944	87,475,200	16.38	0.7	0.19	lhsinit
USR	112,148,088	68,892,672	6.23	0.3	0.09	exact_solution



More than  
10 GB just for these  
6 regions

## BT-MZ summary analysis score

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- Summary measurement analysis score reveals
  - Total size of event trace would be ~161 GB
  - Maximum trace buffer size would be ~11 GB per rank
    - smaller buffer would require flushes to disk during measurement resulting in substantial perturbation
  - 99.5% of the trace requirements are for USR regions
    - purely computational routines never found on COM call-paths common to communication routines or OpenMP parallel regions
  - These USR regions contribute around 37% of total time
    - however, much of that is very likely to be measurement overhead for frequently-executed small routines
- Advisable to tune measurement configuration
  - Specify an adequate trace buffer size
  - Specify a filter file listing (USR) regions not to be measured

## BT-MZ summary analysis report filtering

```
% cat ../config/scorep.filt
SCOREP_REGION_NAMES_BEGIN
EXCLUDE
  binvcrhs*
  matmul_sub*
  matvec_sub*
  exact_solution*
  binvrhs*
  lhs*init*
  timer_*
SCOREP_REGION_NAMES_END

% scorep-score -f ../config/scorep.filt -c 2 \
  scorep_bt-mz_sum/profile.cubex
```

```
Estimated aggregate size of event trace:
Estimated requirements for largest trace buffer (max_buf):
Estimated memory requirements (SCOREP_TOTAL_MEMORY):
(hint: When tracing set SCOREP_TOTAL_MEMORY=151MB to avoid \
>intermediate flushes
or reduce requirements using USR regions filters.)
```

2153MB  
135MB  
151MB

- Report scoring with prospective filter listing 6 USR regions

2,1 GB of memory in total,  
151 MB per rank!  
(Including 2 metric values)

# BT-MZ summary analysis report filtering

```
% scorep-score -r -f ../config/scorep.filt \
  scorep_bt-mz_sum/profile.cubex
```

flt	type	max_buf[B]	visits	time[s]	time[%]	time/ visit[us]	region
-	ALL	10,812,127,459	6,597,418,411	2384.04	100.0	0.36	ALL
-	USR	10,754,591,276	6,574,805,745	875.54	36.7	0.13	USR
-	OMP	55,782,528	21,743,616	1483.16	62.2	68.21	OMP
-	COM	1,178,450	725,200	13.63	0.6	18.79	COM
-	MPI	616,168	143,834	11.68	0.5	81.23	MPI
-	SCOREP	41	16	0.03	0.0	1696.03	SCOREP
* +	ALL	57,612,729	22,634,523	1508.51	63.3	66.65	ALL-FLT
+ -	FLT	10,754,555,760	6,574,783,888	875.54	36.7	0.13	FLT
- *	OMP	55,782,528	21,743,616	1483.16	62.2	68.21	OMP-FLT
* -	COM	1,178,450	725,200	13.63	0.6	18.79	COM-FLT
- *	MPI	616,168	143,834	11.68	0.5	81.23	MPI-FLT
* -	USR	35,542	21,857	0.01	0.0	0.28	USR-FLT
-	SCOREP	41	16	0.03	0.0	1696.03	SCOREP-FLT
+ + + + + +	USR	3,454,903,374	2,110,313,472	190.79	8.0	0.09	matvec_sub
	USR	3,454,903,374	2,110,313,472	260.27	10.9	0.12	matmul_sub
	USR	3,454,903,374	2,110,313,472	389.81	16.4	0.18	binvrhs
	USR	149,170,944	87,475,200	12.06	0.5	0.14	binvrhs
	USR	149,170,944	87,475,200	16.38	0.7	0.19	lhsinit
	USR	112,148,088	68,892,672	6.23	0.3	0.09	exact_solution

- Score report breakdown by region (w/o additional metrics)

Filtered routines marked with '+'



## BT-MZ filtered summary measurement

---

```
% cd bin.scorep
% cp ../jobscript/jureca/scorep.sbatch .
% vim scorep.sbatch

[...]
# Score-P measurement configuration
export SCOREP_EXPERIMENT_DIRECTORY=scorep_bt-mz_sum_filter
export SCOREP_FILTERING_FILE=../config/scorep.filt
#export SCOREP_METRIC_PAPI=PAPI_TOT_INS,PAPI_FP_INS
[...]

% sbatch ./scorep.sbatch
```

- Set new experiment directory and re-run measurement with new filter configuration
  
- Submit job

# Score-P filtering

```
% cat ../config/scorep.filt
SCOREP_REGION_NAMES_BEGIN
EXCLUDE
  binvcrhs*
  matmul_sub*
  matvec_sub*
  exact_solution*
  binvrhs*
  lhs*init*
  timer_*
SCOREP_REGION_NAMES_END

% export SCOREP_FILTERING_FILE=\
../config/scorep.filt
```

Region name  
filter block  
using wildcards

Apply filter

- Filtering by source file name
  - All regions in files that are excluded by the filter are ignored
- Filtering by region name
  - All regions that are excluded by the filter are ignored
  - Overruled by source file filter for excluded files
- Apply filter by
  - exporting `SCOREP_FILTERING_FILE` environment variable
- Apply filter at
  - Run-time
  - Compile-time (GCC-plugin only)
    - Add cmd-line option `--instrument-filter`
    - No overhead for filtered regions but recompilation

# Source file name filter block

---

- Keywords
  - Case-sensitive
  - SCOREP\_FILE\_NAMES\_BEGIN, SCOREP\_FILE\_NAMES\_END
    - Define the source file name filter block
    - Block contains EXCLUDE, INCLUDE rules
  - EXCLUDE, INCLUDE rules
    - Followed by one or multiple white-space separated source file names
    - Names can contain bash-like wildcards \*, ?, []
    - Unlike bash, \* may match a string that contains slashes
- EXCLUDE, INCLUDE rules are applied in sequential order
- Regions in source files that are excluded after all rules are evaluated, get filtered

```
# This is a comment
SCOREP_FILE_NAMES_BEGIN
# by default, everything is included
EXCLUDE */foo/bar*
INCLUDE */filter_test.c
SCOREP_FILE_NAMES_END
```

# Region name filter block

---

- Keywords
  - Case-sensitive
  - SCOREP\_REGION\_NAMES\_BEGIN,  
SCOREP\_REGION\_NAMES\_END
    - Define the region name filter block
    - Block contains EXCLUDE, INCLUDE rules
  - EXCLUDE, INCLUDE rules
    - Followed by one or multiple white-space separated region names
    - Names can contain bash-like wildcards \*, ?, []
- EXCLUDE, INCLUDE rules are applied in sequential order
- Regions that are excluded after all rules are evaluated, get filtered

```
# This is a comment
SCOREP_REGION_NAMES_BEGIN
# by default, everything is included
EXCLUDE *
INCLUDE bar foo
        baz
        main
SCOREP_REGION_NAMES_END
```

## Region name filter block, mangling

- Name mangling
  - Filtering based on names seen by the measurement system
    - Dependent on compiler
    - Actual name may be mangled
- `scorep-score` names as starting point  
(e.g. `matvec_sub_`)
  - Use `*` for Fortran trailing underscore(s) for portability
  - Use `?` and `*` as needed for full signatures or overloading
  - Use `\` to escape special characters

```
void bar(int* a) {
    *a++;
}
int main() {
    int i = 42;
    bar(&i);
    return 0;
}
```

```
# filter bar:
# for gcc-plugin, scorep-score
# displays 'void bar(int*)',
# other compilers may differ

SCOREP_REGION_NAMES_BEGIN
    EXCLUDE void?bar(int?)
SCOREP_REGION_NAMES_END
```

## Further information

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- Community instrumentation & measurement infrastructure
  - Instrumentation (various methods)
  - Basic and advanced profile generation
  - Event trace recording
  - Online access to profiling data
- Available under 3-clause BSD open-source license
- Documentation & Sources:
  - <http://www.score-p.org>
- User guide also part of installation:
  - `<prefix>/share/doc/scorep/{pdf,html}/`
- Support and feedback: [support@score-p.org](mailto:support@score-p.org)
- Subscribe to [news@score-p.org](mailto:news@score-p.org), to be up to date