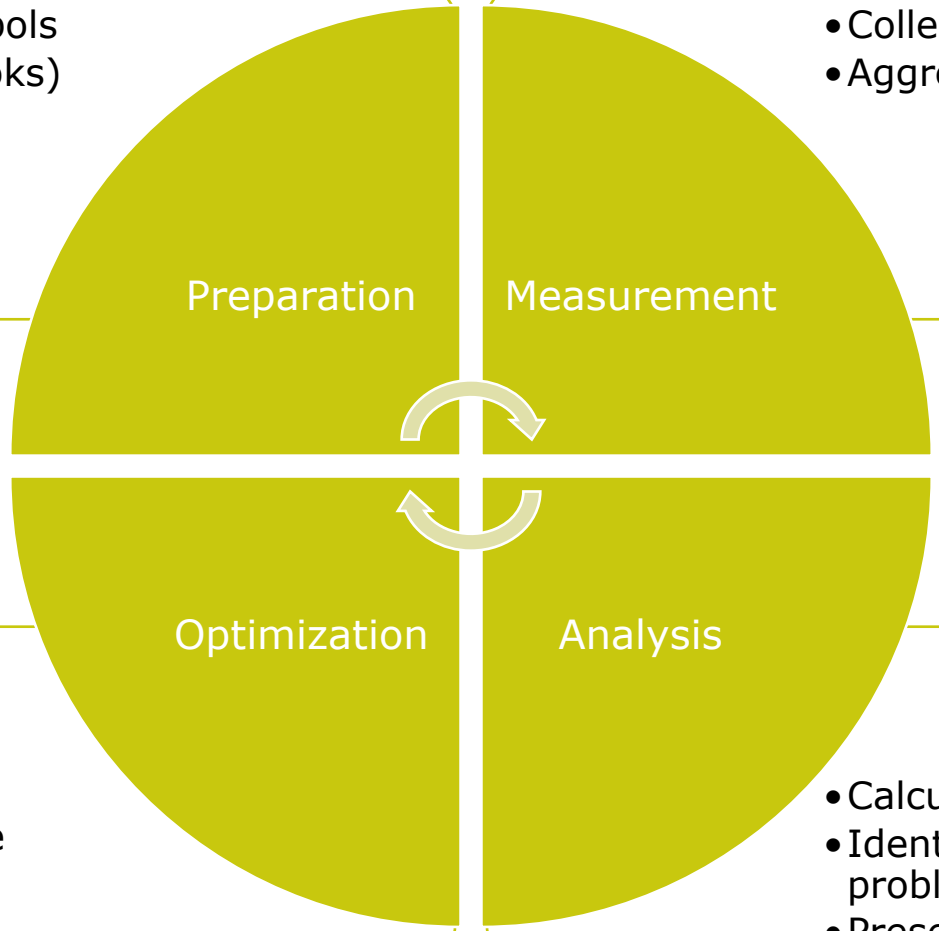
Score-P – A Joint Performance Measurement Run-Time Infrastructure for Periscope, Scalasca, TAU, and Vampir: Basic Usage

VI-HPS Team

Performance engineering workflow

- Prepare application with symbols
- Insert extra code (probes/hooks)



- Collection of performance data
- Aggregation of performance data

- Modifications intended to eliminate/reduce performance problem

- Calculation of metrics
- Identification of performance problems
- Presentation of results

Fragmentation of tools landscape

- Several performance tools co-exist
  - Separate measurement systems and output formats
- Complementary features and overlapping functionality
- Redundant effort for development and maintenance
  - Limited or expensive interoperability
- Complications for user experience, support, training

Vampir	Scalasca	TAU	Periscope
VampirTrace OTF	EPILOG / CUBE	TAU native formats	Online measurement

Score-P functionality

- Provide typical functionality for HPC performance tools
- Support all fundamental concepts of partner's tools

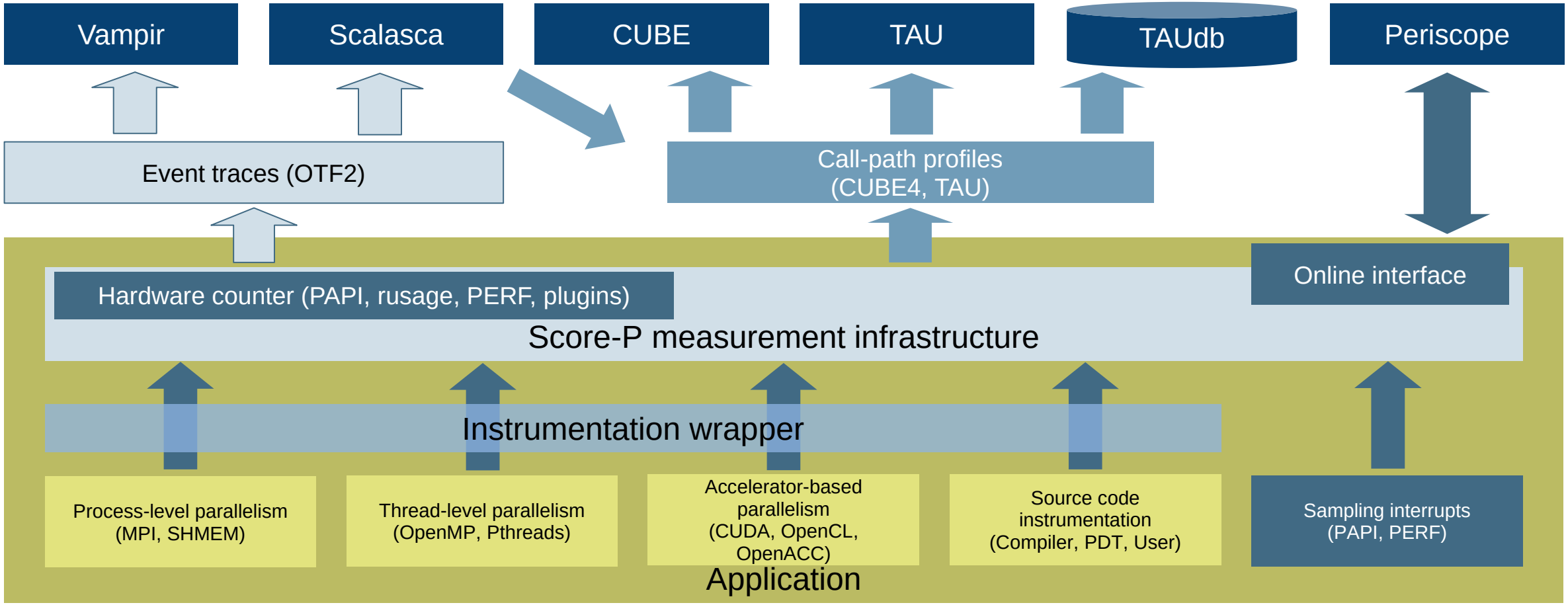
- Instrumentation (various methods)
- Flexible measurement without re-compilation:
  - Basic and advanced profile generation
  - Event trace recording
  - Online access to profiling data

- MPI/SHMEM, OpenMP/Pthreads, and hybrid parallelism (and serial)
- Enhanced functionality (CUDA, OpenCL, OpenACC, highly scalable I/O)

Design goals

- Functional requirements
  - Generation of call-path profiles and event traces
  - Using direct instrumentation and sampling
  - Recording time, visits, communication data, hardware counters
  - Access and reconfiguration also at runtime
  - Support for MPI, SHMEM, OpenMP, Pthreads, CUDA, OpenCL, OpenACC and their valid combinations
- Non-functional requirements
  - Portability: all major HPC platforms
  - Scalability: petascale
  - Low measurement overhead
  - Robustness
  - Open Source: 3-clause BSD license

Score-P overview



Hands-on:
NPB-MZ-MPI / BT

Performance analysis steps

- 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

Recap: Compiler and MPI modules (CooLMUC-3)

- Ensure that desired compiler and MPI modules (toolchain) are loaded first

```
% module list
Currently Loaded Modulefiles:
 1) admin/1.0      3) intel/17.0    5) mpi.intel/2017
 2) tempdir/1.0    4) mkl/2017      6) lrz/default
```

- Set-up and load the required VI-HPS tools modules (when needed)

```
% source /home/hpc/a2c06/lu23voh/load-vihps
```

- Move to working directory with tutorial exercise

```
% cd $SCRATCH_LEGACY/NPB3.3-MZ-MPI
```

NPB-MZ-MPI / BT instrumentation

```
#---------------------------------------------------------------
# The Fortran compiler used for MPI programs
#---------------------------------------------------------------
MPIF77 = mpif77

# Alternative variants to perform instrumentation
...
MPIF77 = scorep --user  mpif77
...
#MPIF77 = $(PREP) mpif77

# This links MPI Fortran programs; usually the same as ${MPIF
FLINK   = $(MPIF77)
...
```

- Edit config/make.def to adjust build configuration
  - Modify specification of compiler/linker: MPIF77

Uncomment the compiler wrapper specification

NPB-MZ-MPI / BT instrumented build

```
% make clean

% make bt-mz CLASS=C NPROCS=32
cd BT-MZ; make CLASS=C NPROCS=32 VERSION=
make: Entering directory 'BT-MZ'
cd ../sys; cc -o setparams setparams.c -lm
../sys/setparams bt-mz 32 C
scorep --user mpif77 -c  -O3 -qopenmp -xMIC-AVX512 bt.f
 [...]
cd ../common; scorep --user mpif77 -c  -O3 -qopenmp \
-xMIC-AVX512 timers.f
scorep --user mpif77 -O3 -qopenmp -xMIC-AVX512 \
-o ../bin.scorep/bt-mz_C.32 bt.o initialize.o exact_solution.o \
exact_rhs.o set_constants.o adi.o rhs.o zone_setup.o x_solve.o \
y_solve.o exch_qbc.o solve_subs.o z_solve.o add.o error.o \
verify.o mpi_setup.o ../common/print_results.o ../common/timers.o
Built executable ../bin.scorep/bt-mz_C.32
make: Leaving directory 'BT-MZ'
```

- Return to root directory and clean-up
- Re-build executable using Score-P compiler wrapper

Measurement configuration: scorep-info

```
% scorep-info config-vars --full
SCOREP_ENABLE_PROFILING
  Description: Enable profiling
 [...]
SCOREP_ENABLE_TRACING
  Description: Enable tracing
 [...]
SCOREP_TOTAL_MEMORY
  Description: Total memory in bytes for the measurement system
 [...]
SCOREP_EXPERIMENT_DIRECTORY
  Description: Name of the experiment directory
 [...]
SCOREP_FILTERING_FILE
  Description: A file name which contain the filter rules
 [...]
SCOREP_METRIC_PAPI
  Description: PAPI metric names to measure
 [...]
SCOREP_METRIC_RUSAGE
  Description: Resource usage metric names to measure
 [... More configuration variables ...]
```

- Score-P measurements are configured via environmental variables

Summary measurement collection

```
% cd bin.scorep
% cp ../jobscript/coolmuc3/scorep.sbatch .
% cat scorep.sbatch

[...]
export SCOREP_EXPERIMENT_DIRECTORY=scorep_bt-mz_sum
[...]

% sbatch scorep.sbatch
```

- Change to the directory containing the new executable before running it with the desired configuration
- Check settings

Leave other lines commented out for the moment

- Submit job

Summary measurement collection

```
% less npb_btmz.o<job_id>

 NAS Parallel Benchmarks (NPB3.3-MZ-MPI) - BT-MZ \
 MPI+OpenMP Benchmark
 Number of zones:  16 x  16
 Iterations: 200    dt:   0.000100
 Number of active processes:    32

 Use the default load factors with threads
 Total number of threads:    128  (  4.0 threads/process)

 Calculated speedup =   125.90

 Time step    1

 [... More application output ...]
```

- Check the output of the application run

BT-MZ summary analysis report examination

```
% ls
bt-mz_C.32  npb_btmz.o<job_id>  scorep_bt-mz_sum  scorep.sbatch
% ls scorep_bt-mz_sum
profile.cubex  scorep.cfg




% cube scorep_bt-mz_sum/profile.cubex

      [CUBE GUI showing summary analysis report]
```

- Creates experiment directory including
  - A record of the measurement configuration (scorep.cfg)
  - The analysis report that was collated after measurement (profile.cubex)
- Interactive exploration with Cube