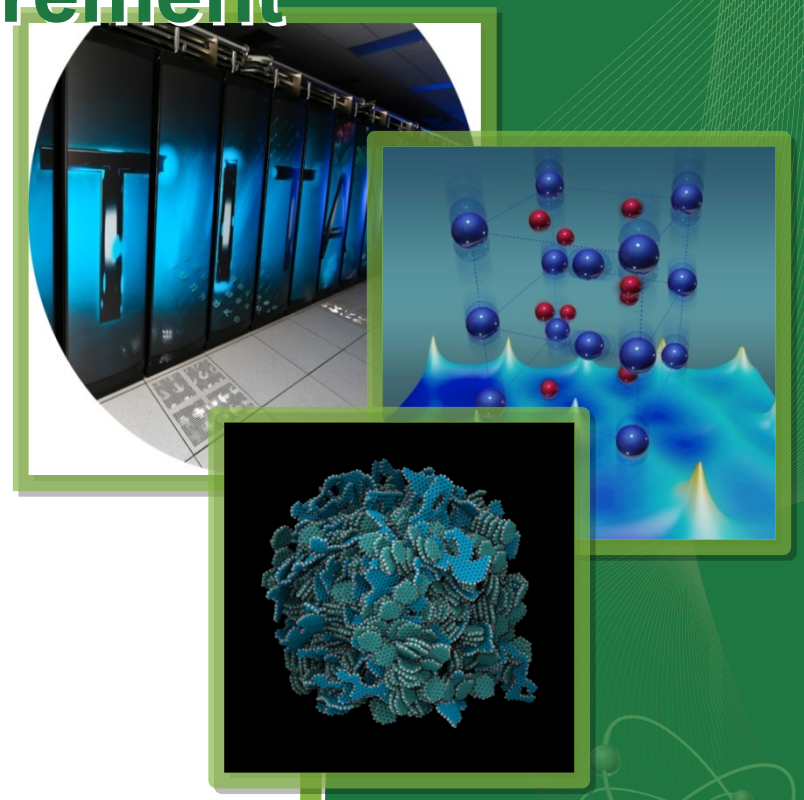
Generic Library Interception for Improved Performance Measurement and Insight



Ronny Brendel, Bert Wesarg, Ronny Tschüter, Matthias Weber, Thomas Ilsche, Sebastian Oeste

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Motivation & Related Work

- Libraries are increasingly important
  - Automatic compiler instrumentation does not provide instrumentation for external code
  - Sampling does not measure exact time and call counts

- Fixed wrappers are commonplace in performance analysis tools
- Aside from performance analysis, library interception is desirable for:
  - Providing wrappers for other languages (SWIG/CLIF)
  - Performance tuning (Spectrum MPI)
  - and e.g. correctness checking (MUST)

Methodology

- A wrapper library has to look exactly the same as the original one
  - Exact same symbol names (function names + signatures)
- And has to forward the calls
  - Needs to know all the return and argument types so that it can forward them
- C/C++ makes this very hard

Methodology

```
int printf(const char *format, ...);
int function_pointer_arg(int (* f)(double));
int function_pointer_without_star_arg(int (f)(double));


typedef int (*fn_t)(double);
fn_t return_function_pointer_typedef(void);      1
int(*)(double) return_function_pointer(void);    2
int (*return_function_pointer(void)) (double);   3
```

Methodology

```
int printf(const char *format, ...);
int function_pointer_arg(int (* f)(double));
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int (*return_function_pointer(void)) (double);   3
```

Methodology

```
typedef int array_type[2];
int typedef_array_return(void)[2];
array_type typedef_array_return(void);
array_type* typedef_array_return(void);  1
int[2]* array_return_1(void);            2
int array_return_2(void)[2]*;            3
```

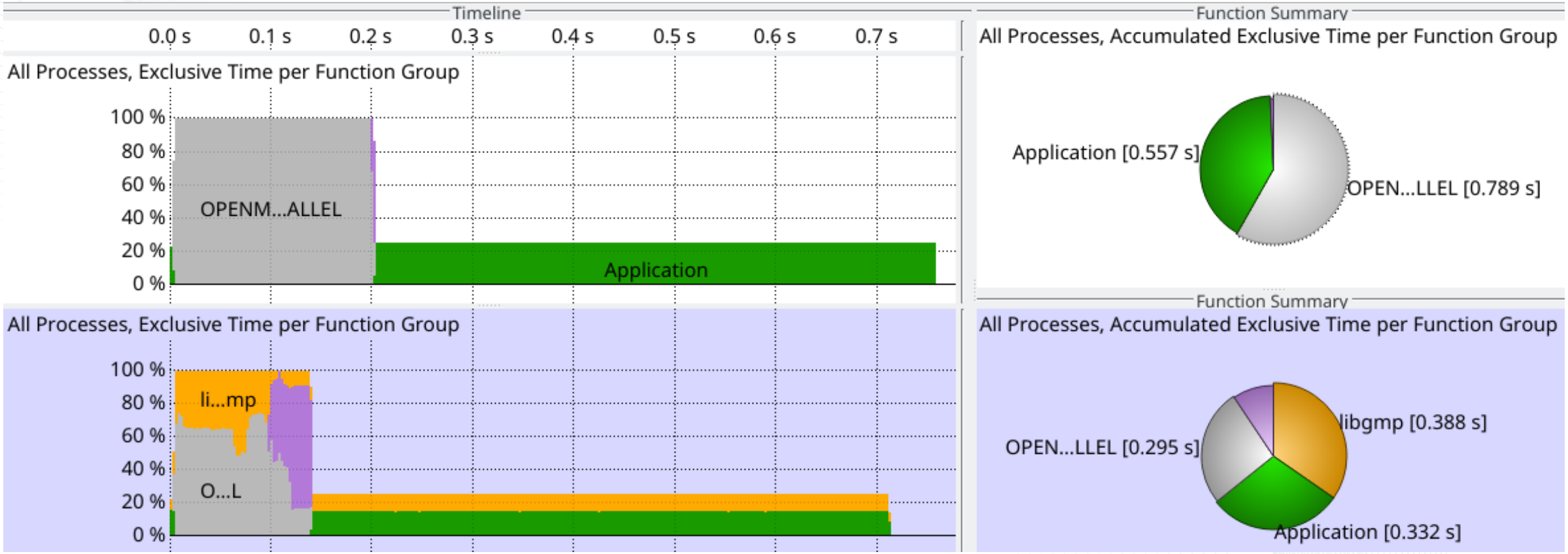
Methodology

```
typedef int array_type[2];
int typedef_array_return(void)[2];
array_type typedef_array_return(void);
array_type* typedef_array_return(void);  1
int[2]* array_return_1(void);            2
int array_return_2(void)[2]*;            3
```

Methodology

- The symbol corresponding to the function has to exist
- Other caveats
  - Macros in headers
  - Compile flags, compiler wrappers
  - Static versus dynamic library linking and wrapping
  - Multiple headers, multiple libraries
- All these considerations led to us conceiving a **library wrapper creation and usage workflow**

Workflow (Live)



Case Studies

- Gromacs (FFTW)
- PERMON (PETSc)

- Examples:
  - Qt Widgets & Qt Gui
  - GNU GMP
  - math.h

Conclusions

- Usable C/C++ library wrapping
- Provides insight into
  - Library Usage
  - Closed-source libraries
  - Interaction between libraries

Future Work

- Support staff friendliness
  - Automation
  - Reuse
  - Versioning
- Score-P for unmodified binaries
- Record function arguments
- Independence from Score-P

Thank you

- http://automaton2000.com/espt.pdf
- https://github.com/score-p/scorep_libwrap_examples

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