Review

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Summary

You've been introduced to a variety of tools

- with hints to apply and use the tools effectively

- Tools provide complementary capabilities
  - computational kernel & processor analyses
  - communication/synchronization analyses
  - load-balance, scheduling, scaling, …
- Tools are designed with various trade-offs
  - general-purpose versus specialized
  - platform-specific versus agnostic
  - simple/basic versus complex/powerful

Tool selection

- Which tools you use and when you use them likely to depend on situation
  - which are available on (or for) your computer system
  - which support your programming paradigms and languages
  - which you are familiar (comfortable) with using
- also depends on the type of issue you have or suspect

- Awareness of (potentially) available tools can help finding the most appropriate tools

Workflow (getting started)

- First ensure that the parallel application runs correctly
  - no-one will care how quickly you can get invalid answers or produce a directory full of corefiles
  - parallel debuggers help isolate known problems
  - correctness checking tools can help identify other issues
  - (that might not cause problems right now, but will eventually)
    - e.g., race conditions, invalid/non-compliant usage
- Generally valuable to start with an overview of execution performance
  - fraction of time spent in computation vs comm/synch vs I/O
  - which sections of the application/library code are most costly
- and how it changes with scale or different configurations
  - processes vs threads, mappings, bindings

Workflow (communication/synchronization)

- Communication/synchronization issues generally apply to every computer system (to different extents) and typically grow with the number of processes/threads
  - *Weak scaling*: fixed computation per thread, and perhaps fixed localities, but increasingly distributed
  - *Strong scaling*: constant total computation, increasingly divided amongst threads, while communication grows
  - Collective communication (particularly of type “all-to-all”) result in increasing data movement
  - Synchronizations of larger groups are increasingly costly
  - Load-balancing becomes increasingly challenging, and imbalances increasingly expensive
    - generally manifests as waiting time at following collective ops

Workflow (wasted waiting time)

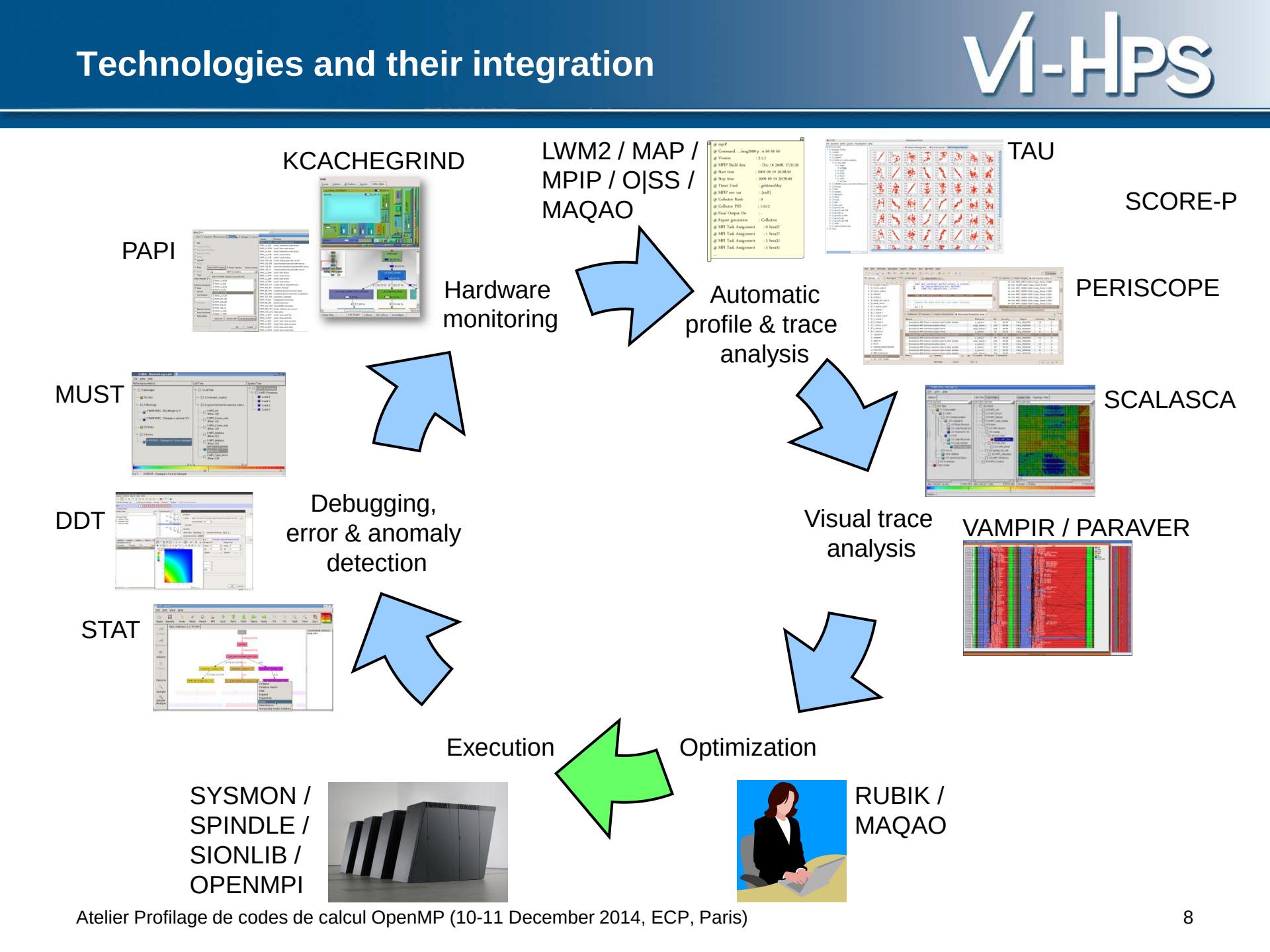
- Waiting times are difficult to determine in basic profiles
  - Part of the time each process/thread spends in communication & synchronization operations may be wasted waiting time
  - Need to correlate event times between processes/threads
    - *Periscope* uses augmented messages to transfer timestamps and additional on-line analysis processes
    - Post-mortem event trace analysis avoids interference and provides a complete history
    - *Scalasca* automates trace analysis and ensures waiting times are completely quantified
    - *Vampir* allows interactive exploration and detailed examination of reasons for inefficiencies

Workflow (core computation)

Effective computation within processors/cores is also vital

- Optimized libraries may already be available
- Optimizing compilers can also do a lot
  - provided the code is clearly written and not too complex
  - appropriate directives and other hints can also help
- Processor hardware counters can also provide insight
  - although hardware-specific interpretation required
- Tools available from processor and system vendors help navigate and interpret processor-specific performance issues

Technologies and their integration



Featured VI-HPS tools

- **Score-P**
  - community-developed instrumenter & measurement libraries for parallel profiling and event tracing
- **CUBE**
  - interactive parallel profile analyses
- **Scalasca**
  - automated event-trace analysis

Further information

- Website
  - Introductory information about the VI-HPS portfolio of tools for high-productivity parallel application development
    - VI-HPS Tools Guide
    - links to individual tools sites for details and download
  - Training material
    - tutorial slides
    - latest ISO image of VI-HPS Linux DVD with productivity tools
    - user guides and reference manuals for tools
  - News of upcoming events
    - tutorials and workshops
    - mailing-list sign-up for announcements

http://www.vi-hps.org