An Integrated HPC Performance Tool Suite

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The State of
Linux Performance Tools

- Linux kernel has no code to support profiling in production (non-root user) environments.*

  - Despite highly stable kernel patches being available for > 10 years on some platforms.

  - Patch deployment complicated for smaller users where support agreements preclude patching of the kernel.

- No major commercial Linux distribution contains anything beyond OProfile and Gprof.*

  - Gprof: requires recompilation, does not support threads

  - Oprofile: requires root privileges to use, does not allow sharing of the PMU resources

* except IA64, which has kernel support and pfmon

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The State of
Linux Performance Tools

- Vendors have developed some tools, but kept much of the private.
  - This is changing as more adopt standardized kernel support (Perfmon2) and middleware (libpfm and PAPI).

- Numerous quality open-source tools exist but lack real standardization:
  - Build system
  - Documentation
  - Installation
  - Usage semantics
  - Parallel run-time integration and interoperability
  - Distribution (no RPM's, Ebuilds, Debs...)

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Our Tools Strategy

- Leverage best-of-breed Open Source tools.
  - Foster relationships with original authors.
  - Propagate changes back to public source trees.
- Provide a drill-down hierarchy driven by needs of the customers and the AE's.
- Uniform user interface and semantics.
  - Observe linux standards. (LSB and beyond)
- Develop value added extensions.
- Guarantee full interoperability.
- Contract expertise where appropriate.

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Productizing Open Source Tools

- The model works really well for
  - Innovation
  - Evolution
  - Distribution
  - Support*
  - Standardization*
- The bad news?
  - Specialization
  - Documentation
  - Verification
  - Integration
- Focus resources where needed, drive that 'last mile'.

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Basic Needs of Users

- **Application and System Characterization**
  - Overall evaluation of performance
  - Identify specific components of interest
  - Black box monitoring

- **Analysis and Dptimization**
  - Improve over baseline performance through changes to the code
  - Repeated experimentation and optimization passes
  - Analyze at full optimization levels

- **Performance Development**
  - Integration of robust performance evaluation into a code's lifecycle
  - Regular performance regression testing

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Performance Criteria for the Tools Suite

- Quick and easy characterization of:
  - Hardware utilization (on and off-core)
  - Memory
  - I/O
  - Communication
  - Thread/Task load balance
- Detailed analysis using sampling
- Work on unmodified codes whenever possible
- Simple instrumentation
- Adv. instrumentation and tracing
- Trace-based visualization
- 'Expert-level' control of the PMU and perfmon2

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SiCortex Performance Tools Stack

- Perfmon2 – Kernel support
- Libpfm – Counter programming
- Monitor – Library interposition
- Pfmon – Low level access
- Papi – Portable PMU infrastructure
- GPTL – Simple instrumentation
- MpiP – MPI profiling
- HPCToolkit – Statistical profiling
- TAU – Tuning and Analysis Utilities
- Vampir – Scalable trace visualization
- Epilog (Kojak) – Trace generation

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Performance **Ex**periment Tools

- Set of commands that provide the interface to the underlying performance monitoring tools.
  - All are based on Monitor and PAPI
- papiex, mpipex, ioex, hpcex, gptlex, tauex
  - Easy to use as /bin/time, on unmodified executables
  - Generate concise textual output where appropriate
  - Take the same arguments, except for tool-specific options
  - Standardized installation and documentation

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Additional Software

- EPILOG
  - Trace library from the KOJAK suite
- OProfile
  - Ported to use the Perfmon2 kernel infrastructure
- Other quality software not included:
  - OpenSpeedShop: LANL
  - PerfSuite: NCSA
  - ParaVer: BSC
  - EXPERT/CUBE from KOJAK: Juelich
  - DynInstAPI: Wisconsin
  - Others...

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Summary

- ~1.5 man-years of effort has produced a leading tool suite where none existed.
  - Open Source can truly mean standing on the shoulders of giants.
- Continued success and R.O.I gained by following through on the strategy.
  - Integration and cooperation lowers support cost

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