Scalable Computing (CS7NS1) Assignment 2
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Paper: Nile: A Programmable Monitoring Coprocessor

Contributions:

- Nile is a proposed new programmable coprocessor for tracking complex semantic events.
- It consists of MU's to monitor events and count, and AU's for interrupts and memory R/W.
- MU's interfaced, configured using new functions, which are custom RISC-V ISA instructions.
- Benchmarking with shadow stack shows 0.78% performance overhead with Nile added.

Technological Insights:

- Low level hardware event exposure can be composed into high level actions.
- Nile can be used for many applications such as attack detection and online profiling.
- Altering Linux allows for full OS support for new architectures, with possible Kernel fixes.
- Nile can detect call/ret mismatches due to the commit log, used for execution information.

Insights of relevance to Scalable Computing:

- Coprocessors improvements to GPU tech allow for powerful scalability.
- Extending instructions sets allows for increasing GPU applications.

Paper: Optimizations of Unstructured Aerodynamics Computations for Many-core Architectures

Contributions/Findings:

- Fine-grained workload distribution mechanism performs actions to utilize thread-level parallelism.
- Data-level parallelism extracted by vectorising edge based loop kernels and fine-grained data partitioning.
- Demonstrate how to adapt unstructured mesh PDE kernels to multi-core arch's using shared memory code optimizations.
- Achieved 2.9x (versus baseline) improvement in flux kernel.

Technological Insights:

- Around 73 percent of the entire runtime is spent in Edge-based loop kernels pre-optimization.
- Compiler auto-vectorization can solve many issues, but in complex kernels it can fail.

Insights of relevance to Scalable Computing:

- Strong scaling within shared memory node needed to fully exploit modern supercomputing.
- KNL and Skylake arch's bring new required study to node level scaling with PETSc-FUN3D.
- Performance of a shared-memory multi and many-core compute nodes crucial in next-gen supercomputing scalability.
- For single node scalability, the key optimization mechanisms are data layout transformation and memory access patterns.