Performance Results

Chapel Team, Cray Inc.
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Executive Summary

- Generally speaking, performance has improved with 1.13
- Previous slide decks have shown performance changes:
  - ...due to communication and locality optimizations
  - ...due to performance optimizations in the compiler and libraries
  - ...due to making jemalloc the default allocator
  - ...due to improving the ugni communication layer
- These slides contain additional v1.13 performance results
  - Not tied to any specific effort, just comparisons across releases
Outline

- Shootout Benchmarks Status
- Single-Locale Performance Trends
- Multi-Locale Performance Trends
- Performance Scalability Study
Shootout Benchmarks Status
Shootout Benchmark Summary

- By design, not much effort put into shootouts for 1.13
- however, other work resulted in significant speedups
  - particularly for --no-local timings
Shootout Benchmark Summary

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Single-Locale Performance Trends
Single-Locale Performance

- Overall, single-locale performance improved
Single-Locale Performance

- Surprising single-locale regression for LULESH
  - nightly testing showed improvement
    - (uses a different problem size)
  - still need to investigate root cause

![Chapel Versus Reference Timing: LULESH](image)

![LULESH (release)](image)
Single-Locale Performance

- **Known single-locale regression for NAS EP**
  - Result of making jemalloc the default allocator
    - Known ahead of time, but overall performance trend was extremely positive
  - Have not investigated further yet

![Chapel Versus Reference Timing: EP Size D](image)

- Time (seconds)
- Release
  - Reference
  - Chapel EP - size D

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Multi-Locale Performance Trends
Multi-locale Performance

- Multi-locale improvements for many benchmarks
- No known regressions

Graphs showing performance improvements for various benchmarks.
Performance Scalability Study
Scalability Study: Background

● We continued the scalability study from past releases
  ● HPCC Stream: EP and Global
  ● HPCC RA: atomic, on-based, and remote memory operations (rmo)
    ● these test network atomics, active messages, and puts/gets, respectively
    ● Reduction of an array

● All experiments shown here were performed on a Cray XC
  ● 1-256 locales

● The following slides highlight a few notable cases
  ● RA (atomics and rmo) performance has improved dramatically
    ● up to 5x increase for ra-atomics and 3x for ra-rmo
  ● Reductions are significantly more efficient
  ● Stream and ra-on performance has not changed
    ● (graphs omitted for this reason)
Scalability: RA (atomics) Performance

- **RA (atomics) summary**
  - 5x better performance for ugni-qthreads
  - 3x better performance for ugni-muxed

![Performance of RA (atomics)](image-url)
Scalability: RA (rmo) Performance

- RA (rmo) summary
  - 3x better performance for ugni-qthreads and ugni-muxed
Scalability: Reduction Efficiency

- **Reduction efficiency summary**
  - improved scalability
  - significantly improved raw performance
Performance Priorities and Next Steps
Performance Priorities and Next Steps

● **Continue to focus on ugni+qthreads performance**
  ● understand differences compared to ugni+muxed
  ● strive to close performance gaps and retire muxed tasking

● **NUMA-aware performance**
  ● improve array initialization (parallel, appropriate first-touch)
    ● currently gated by constructor/default init/noinit capabilities
  ● strive to support NUMA by default w/out performance loss

● **KNL performance**
  ● improve vectorization performance
  ● explore benefits of high bandwidth memory

● **Continue benchmark-driven multi-locale improvements**
  ● Reduce unnecessary communication code
  ● Optimize scalability of core algorithms such as task spawning, barrier
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