Performance Results

Chapel Team, Cray Inc.

Chapel version 1.13

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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

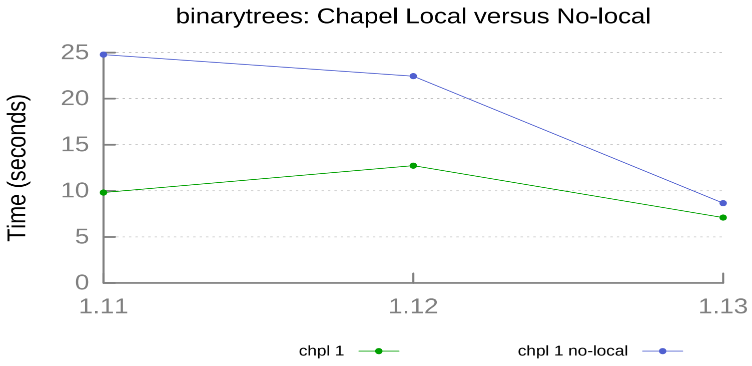
Outline

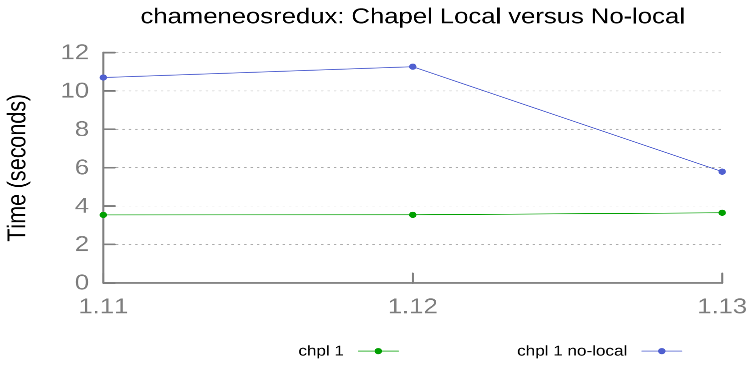
- Shootout Benchmarks Status
- Single-Locale Performance Trends
- Multi-Locale Performance Trends
- Performance Scalability Study

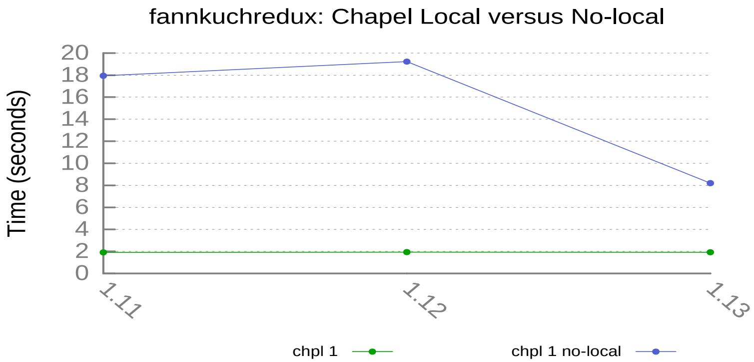
Shootout Benchmarks Status

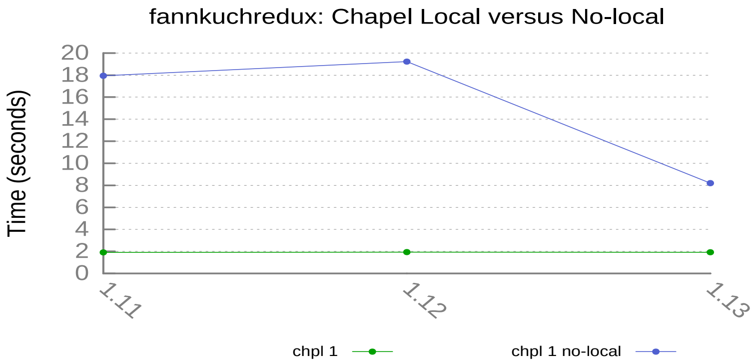
Shootout Benchmark Summary

- **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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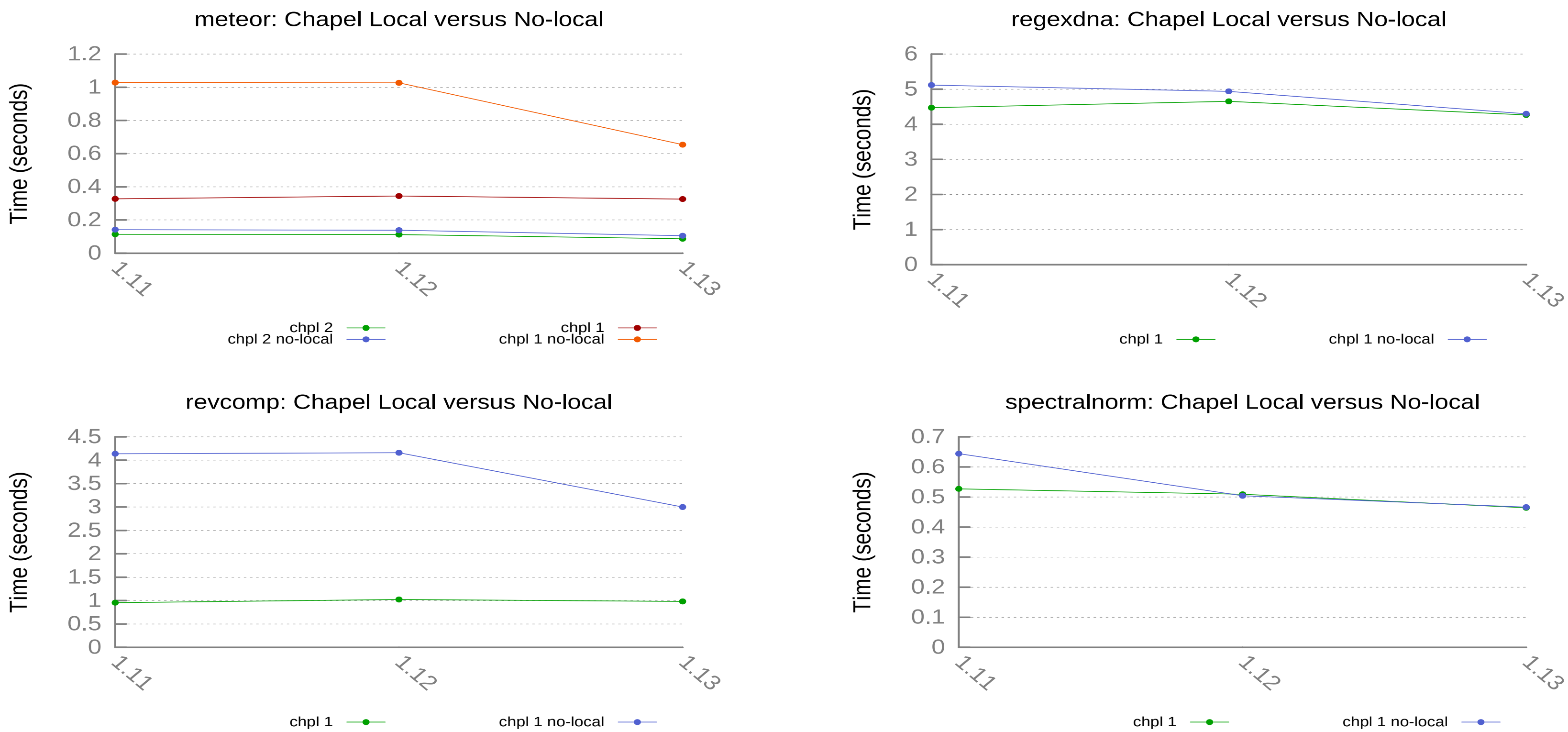
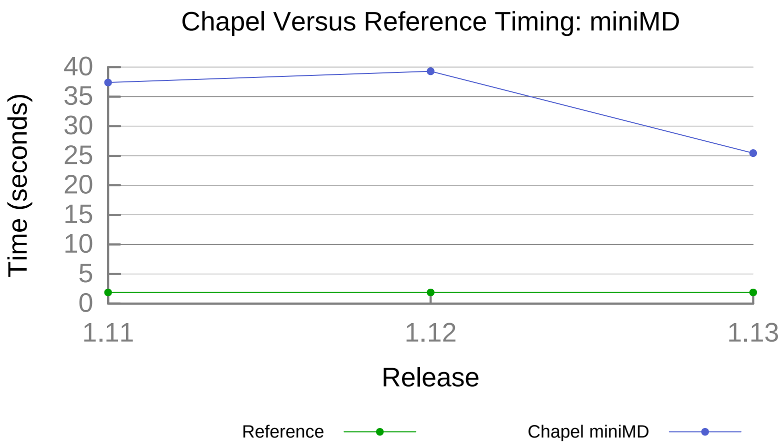
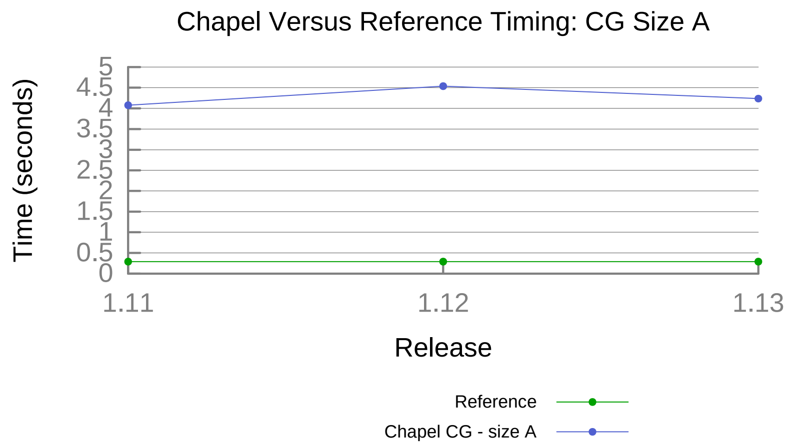


Single-Locale Performance Trends

Single-Locale Performance

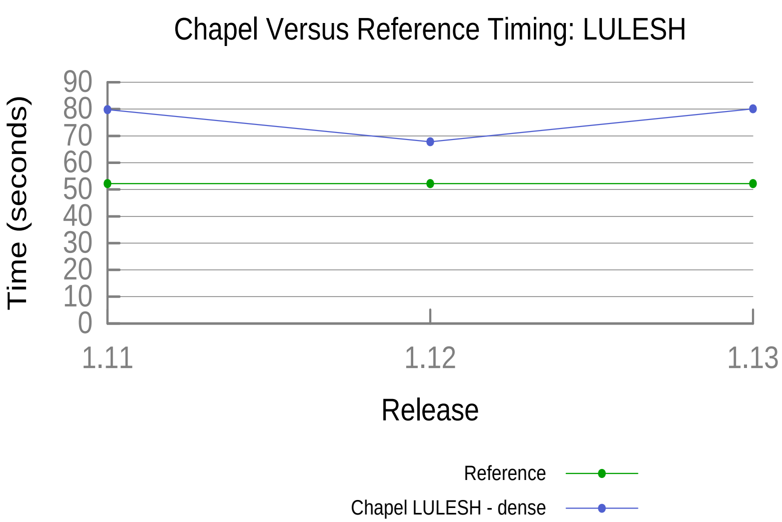
- Overall, single-locale performance improved

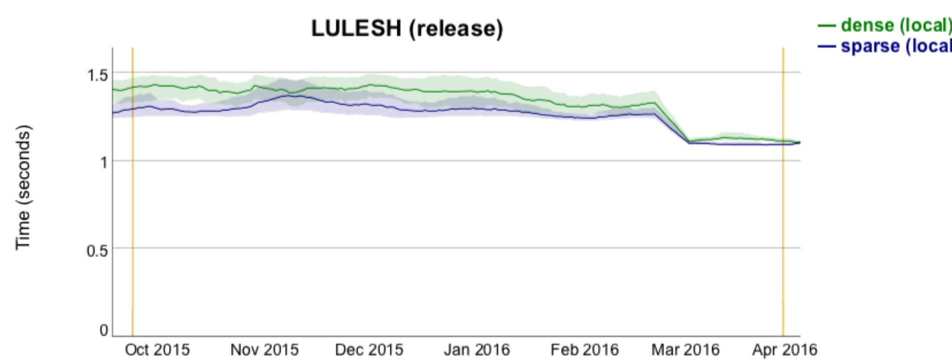




Single-Locale Performance

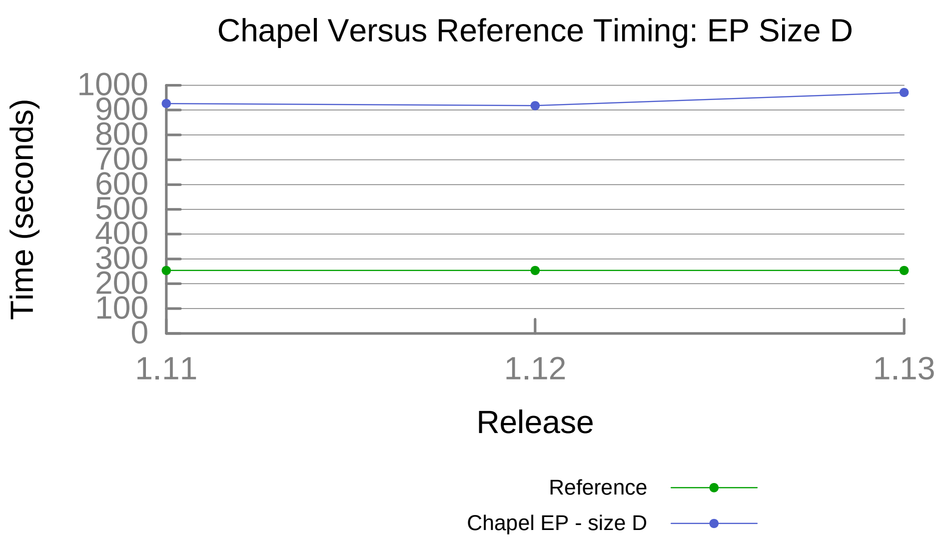
- **Surprising single-locale regression for LULESH**
  - nightly testing showed improvement
    - (uses a different problem size)
  - still need to investigate root cause





Single-Locale Performance

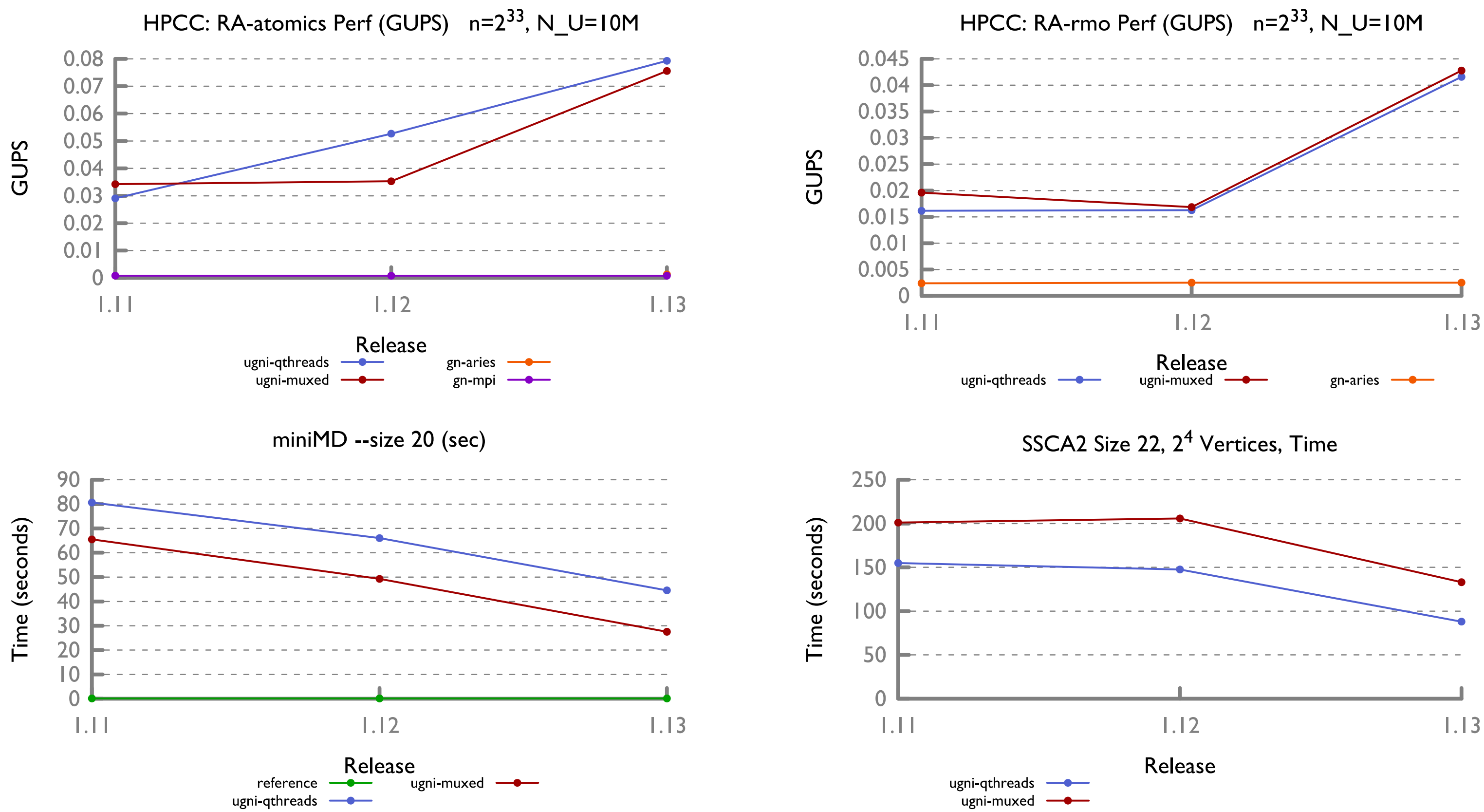
- **Known single-locale regression for NAS EP**
  - result of making jemalloc the default allocator
    - known ahead of time, but overall performance trend was extremely positive
  - have not investigated further yet



Multi-Locale Performance Trends

Multi-locale Performance

- **Multi-locale improvements for many benchmarks**
  - no known regressions



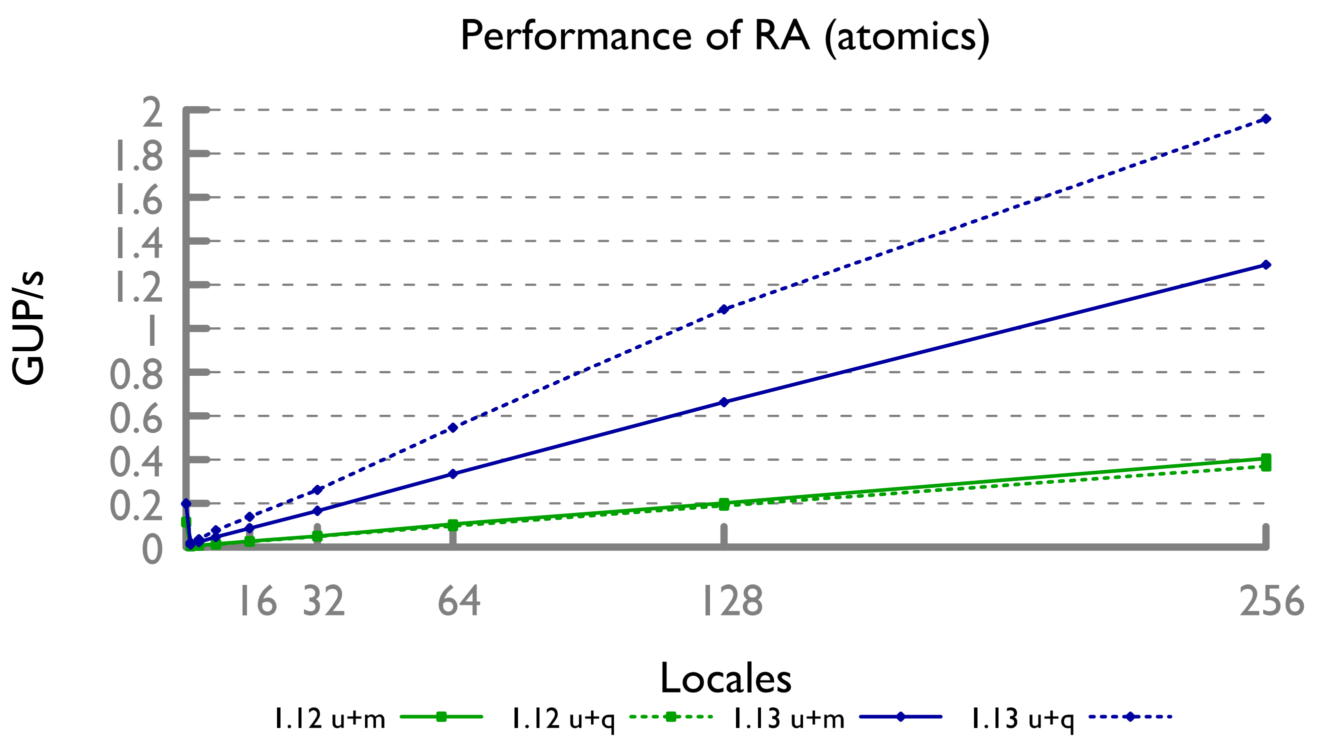
Performance Scalability Study

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)

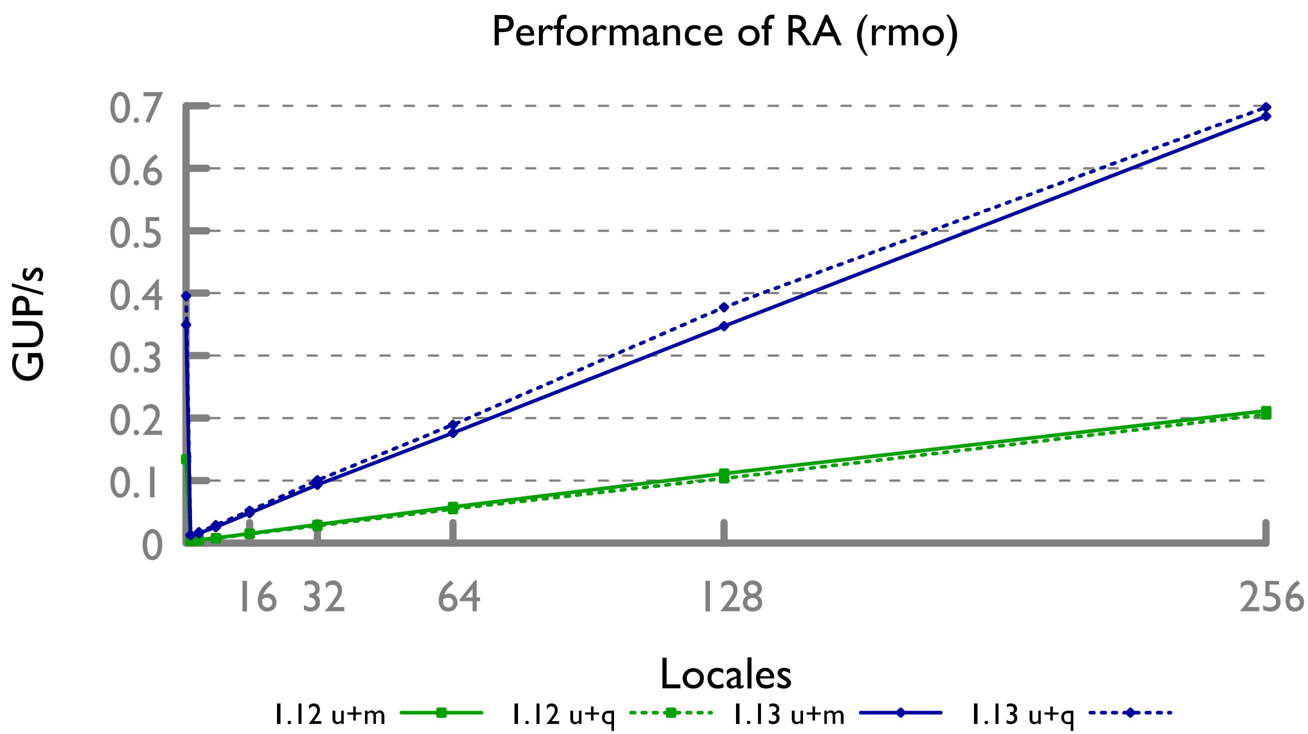
Scalability: RA (atomics) Performance

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



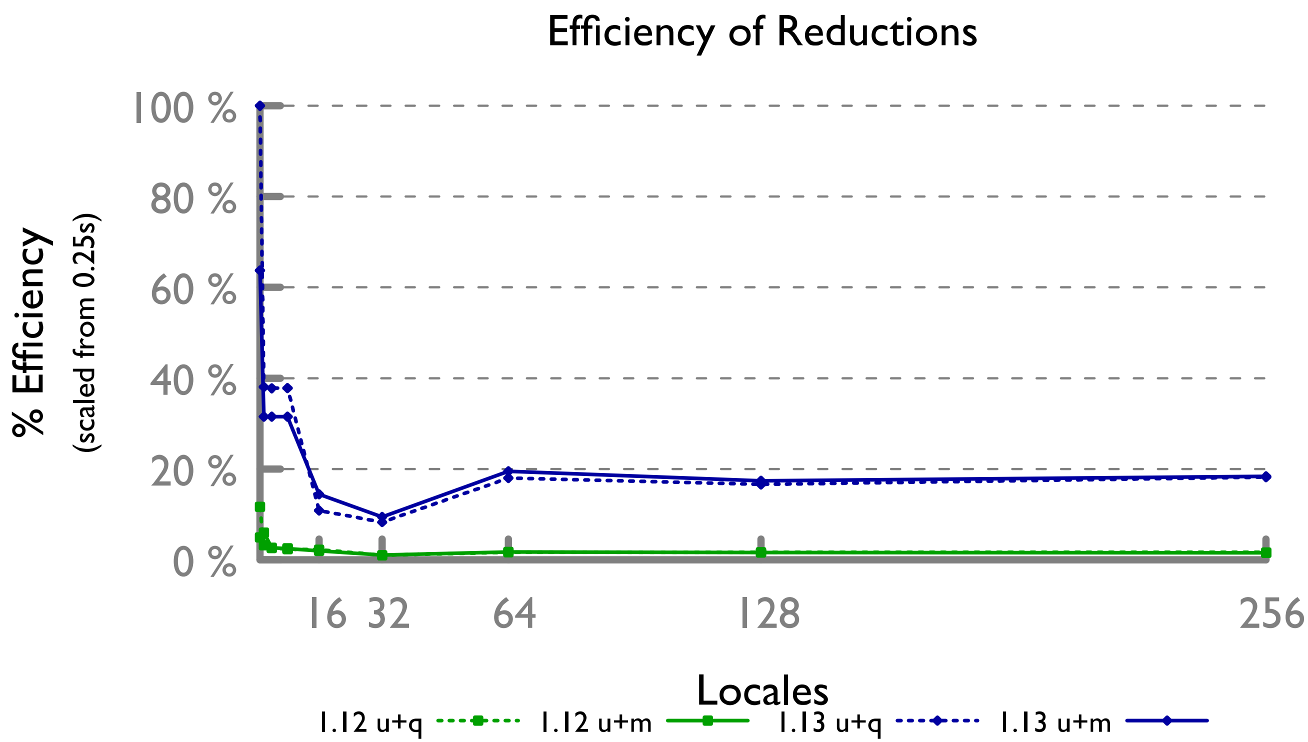
Scalability: RA (rmo) Performance

- **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

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- **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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