Benchmarks and Performance Results

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Executive Summary

- Generally speaking, performance has improved with 1.12
- Previous slide decks have shown performance changes:
  - due to new interpretation of formal array arguments
  - due to optimizations motivated by stream
  - due to compiler locality optimizations
- These slides contain additional v1.12 performance results
  - Not tied to any specific effort, just comparisons across releases
Outline

- **Shootout Benchmarks Status**
- **Single-Locale Performance Trends**
- **Multi-Locale Performance Trends**
- **ugni+qthreads as default**
- **Performance Scalability Study**
Shootout Benchmarks Status
Shootout Benchmark Summary

- By design, not much effort put into shootouts for 1.12
  - Wanted to focus primarily on multi-locale performance improvements
  - Official entry blocked by improved string support
  - A few of our fastest versions improved, but most stayed the same
  - Several of our non-fastest versions also improved
    ⇒ Chapel becoming less sensitive to writing in a specific style
Single-Locale Performance Trends
Single-Locale Performance

- Overall, single-locale performance remained the same
- A few benchmarks such as lulesh showed improvements
Single-Locale Performance

- Overall, single-locale performance remained the same
  - One known (and acceptable) regression for reverse-complement
    - result of a bug fix in I/O code (original code was fast, but wrong)
Single-Locale Performance

- No-local execution improved due to locality optimizations

![Graphs showing performance comparison between local and non-local execution]
Single-Locale Performance

- **Surprising no-local regression for miniMD**
  - Still investigating the root cause
  - Not seen in our nightly multi-locale or no-local performance testing
  - in fact multi-locale performance improved since last release
Multi-Locale Performance Trends
Multi-locale Performance

- Multi-locale improvements for many benchmarks
- Result of optimizations motivated by stream case study

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**HPCC: STREAM-EP Perf (GB/s)**  
$n = 5,723,827,200$

**HPCC FFT Perf (Gflop/s)**  
$n = 2^{20}$

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**HPCC: RA-atomics Perf (GUPS)**  
$n = 2^{33}$, $N_U = 10M$

**NPB: EP Perf (Mop/s)**  
Size D
ugi$+$qthreads as default
ugi+qthreads as default

- Saw ugni+qthreads becoming more competitive
- Decided to make it our default instead of ugni+muxed
  - puts us one step closer to retiring muxed

**Graphs:**
- HPCC: RA-atomics Perf (GUPS) $n=2^{33}$, $N_U=10M$
- SSRA2 Size 22, $2^4$ Vertices, Time
ugni+qthreads as default

- As a result, we left some muxed regressions unresolved
  - For cases where qthreads was already outperforming muxed
ugi+qthreads as default

- Still some cases where ugni+muxed outperforms
  - Mostly for benchmarks we have not examined very closely yet
  - Will work on these remaining cases before retiring muxed
Performance Scalability Study
Scalability Study: Background

- **We continued the scalability study from the last 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 will highlight a few notable cases**
  - Stream improved dramatically as seen in previous slides decks
  - RA generally improved for qthreads, but got worse for muxed
    - 1.12 qthreads is close to 1.11 muxed performance
    - muxed declined due to using more tasks as described in optimization slides
      - not very concerned about muxed regressions now that qthreads is the default
  - Reduction performance has not changed since last release
    - (graph omitted for this reason)
Scalability: STREAM Performance

- Stream performance more than doubled since last release
  - EP is on par with the reference
  - Global is very competitive

![Performance of STREAM](image)
Scalability: STREAM Efficiency

- Stream efficiency more than doubled since last release
  - EP efficiency is 100% at all locale counts
  - Global efficiency is 97% at 256 locales
Scalability: RA (atomics) Performance

- RA (atomics) summary:
  - qthreads performance improved (very close to 1.11 muxed)
  - muxed performance got worse
Scalability: RA (on) Performance

- RA (on) summary:
  - qthreads performance remained the same (better than muxed)
  - muxed performance got worse

![Graph showing performance of RA (on)]
Scalability: RA (rmo) Performance

● RA (rmo) summary:
  ● qthreads performance improved (on par with 1.11 muxed)
  ● muxed performance got worse

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Performance of RA (rmo)

![Graph showing the performance of RA (rmo) with Locales ranging from 16 to 256. The graph includes lines for 1.11 u+m, 1.11 u+q, 1.12 u+m, and 1.12 u+q.]
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**
  ● more focus on NUMA locale model
  ● particularly address representation at execution time
  ● 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

● **Continue scalability studies**
  ● Reduce unnecessary communication code
  ● Improve implementation of reductions
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