Benchmarks and Performance Results

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Executive Summary

- Generally speaking, performance has improved with 1.11
- Previous slide decks have shown performance changes:
  - ...due to vectorization
  - ...due to LICM improvements
  - ...due to ugni+muxed as default
  - ...due to parallel range iteration improvements
  - ...due to the local field pragma

- These slides contain additional v1.11 performance results
  - not tied to any specific effort, just comparisons across releases
Outline

- **Shootout Benchmark Status**
- **SingleLocale Performance Trends**
- **Compiler Performance Trends**
- **Multi-locale Performance Trends**
- **ugni+qthreads Performance Trends**
- **Performance Scalability Study**
- **Performance Priorities and Next Steps**
Shootout Benchmarks Status
Shootout Benchmark Summary

- By design, not much effort put into shootouts for 1.11
  - No-local timings improved for some cases due to locality work
  - 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
Shootout Performance Standings

- Chapel versions (purple) compared to C/C++ references
- Timings taken on 2x4-core Intel Xeon processors w/ gcc 4.7.2
Note: two Chapel versions above, one faster, one more elegant
The following cases deserve additional notes:

**fannkuch-redux:**
- reference versions hard-code #threads for the 4-core shootout system
- Chapel doesn’t, to its benefit on this 8-core system

**nbody:**
- the five fastest reference versions use vector intrinsics
- the Chapel version vectorizes, yet not with gcc 4.7.2, so no benefit there

**pidigits:**
- the reference versions use an older system installation of GMP
- Chapel uses a newer, bundled version that results in the difference
Single Locale Performance Trends
**Single Locale Performance**

- No-local execution improved due to better local analysis
  - More no-local executions complete without timing out in test system
  - e.g., FT size B, IS size A

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**Chapel Local Versus No-local Timing: FT Size A**

**fasta: Chapel Local versus No-local**

**knucleotide: Chapel Local versus No-local**
Single Locale Performance

- Improvements to sparse iterators helped CG performance

Chapel Versus Reference Timing: CG Size A

Time (seconds)

Release

Chapel CG - size A

Reference
Compiler Performance Trends
Compiler Performance

- Compilation time has improved by ~1 second for all tests
Multi-Locale Performance Trends
Multi-locale Performance

- Most benchmarks have remained the same or improved slightly
Multi-locale Performance

- miniMD has gotten ~10% slower for gasnet-aries
  - seemingly related to local class optimization
    - regression discovered while assembling this report
    - not yet sure what happened yet
ugi+qthreads Performance Trends
ugi+qthreads Performance

- ugni+qthreads is sometimes competitive with ugni+muxed

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**UGNI QTHREADS PERFORMANCE**

- **HPCC FFT Perf (Gflop/s)**: $n=2^{20}$
- **HPCC HPL Release Perf (Gflop/s)**: $n=255$, $nb=32$
- **HPCC: RA-atomics Perf (GUPS)**: $n=2^{33}$, $N_U=10M$
- **HPCC: PTRANS Perf (GB/sec)**: $n=2,000$, $nb=100$
In other cases ugni+qthreads outperforms ugni+muxed
Performance Scalability Study
Scalability Study: Background

● We continued the scalability study from last release
  ● 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 (up from 1-64 from last release)
  ● ugni+muxed and ugni+qthreads runtimes

● The following slides highlight a few notable cases
Scalability: STREAM-EP Efficiency

Efficiency of STREAM-EP

% Efficiency (relative to 1 locale)

Locales

EP (1.10 u+m)  EP (1.11 u+m)  EP (1.11 u+q)
Scalability: STREAM Global Efficiency

Efficiency of STREAM Global

% Efficiency (relative to 1 locale)

Locales
Global (1.10 u+m)  Global (1.11 u+m)  Global (1.11 u+q)
Scalability: RA Performance

- for RA, ugni+muxed has not changed significantly
  - More interesting is ugni+muxed vs. ugni+qthreads
Scalability: Reductions Efficiency

Efficiency of Reductions

% Efficiency (relative to 1 locale)

Locales

1.10 u+m

1.11 u+m

1.11 u+q

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Performance Priorities and Next Steps
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- **Continue to explore ugni+qthreads performance**
  - understand differences compared to ugni+muxed
    - if possible, close performance gap and retire muxed tasking

- **NUMA-aware performance**
  - more focus on NUMA locale model
    - particularly execution-time address representation
  - improve array initialization (parallel, appropriate first-touch)
    - currently gated by constructor/default init/noinit capabilities
  - explore the impact of using NUMA by default

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