Performance Optimizations

Chapel Team, Cray Inc.
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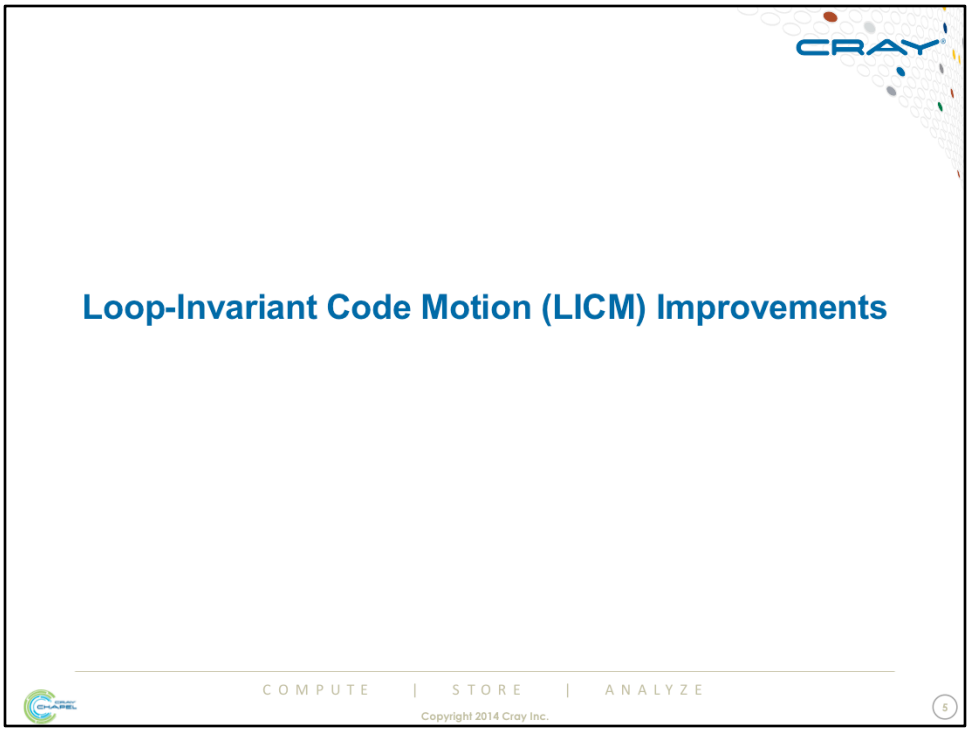
Executive Summary

- **Performance optimizations did not receive a large effort in this release cycle**
  - Some changes that we expected to benefit performance did not
    - e.g., improvements to generated code (see later deck)
  - Yet, a few focused changes had a significant impact in key cases

Outline

- Loop-Invariant Code Motion (LICM) Improvements
- CHPL_TARGET_ARCH and --specialize
- Other Performance Optimizations


Loop-Invariant Code Motion (LICM) Improvements
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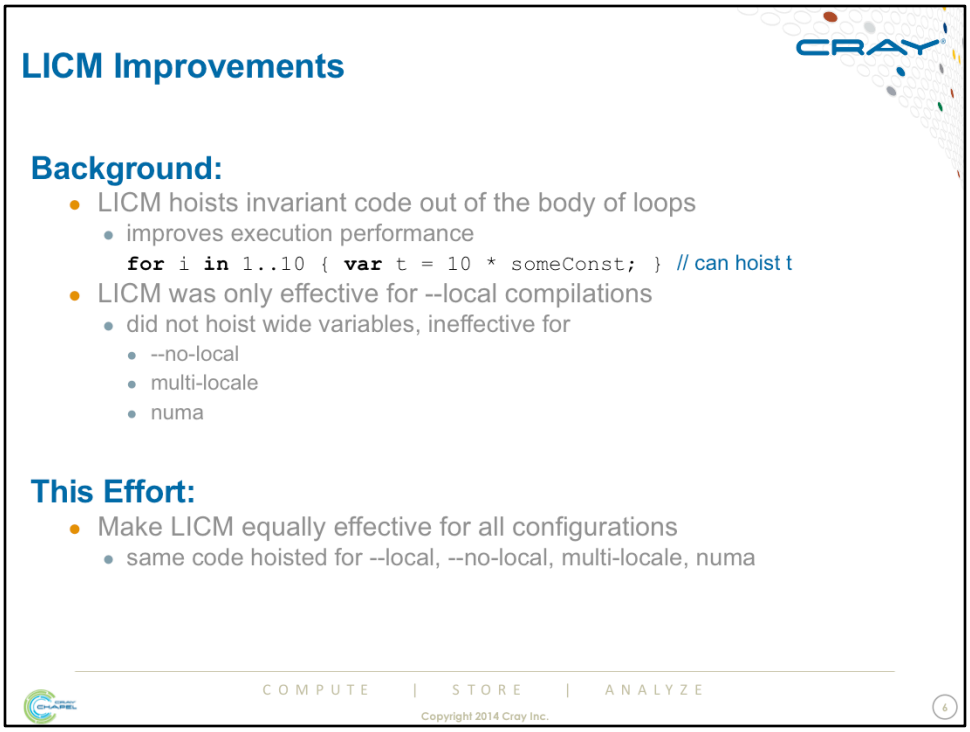
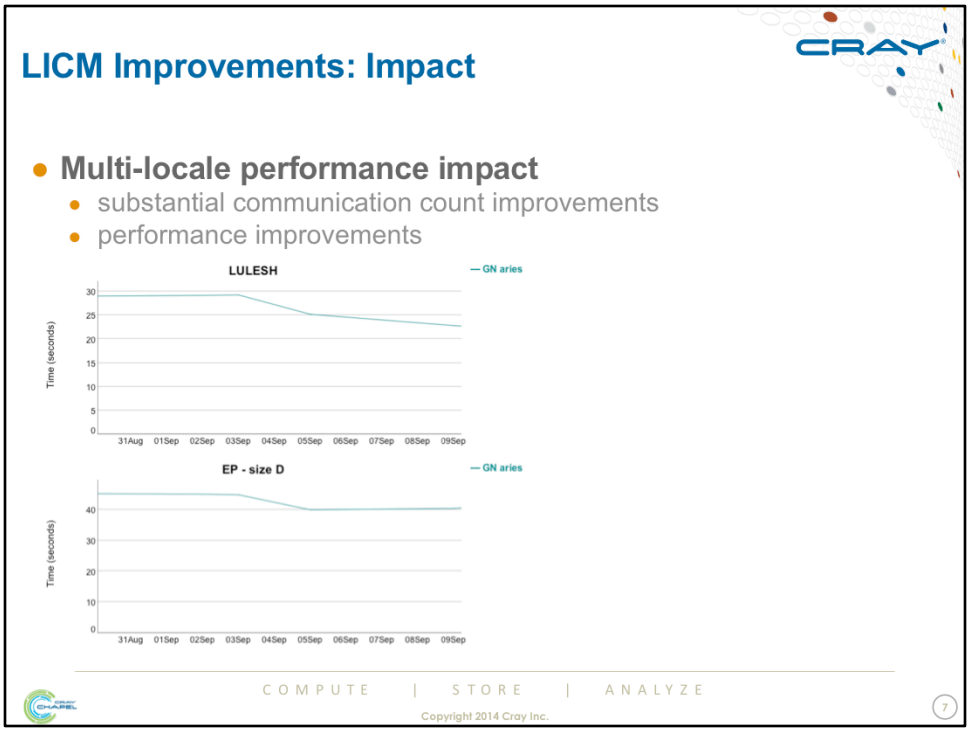


Checks in loop invariant code motion accidently prevented wide variables form being hoisted, which meant LICM was largely ineffective for everything except for --local.

To fix this, the check that prevented hoisting of wide variables was removed, and two latent bugs were discovered and fixed.



There were some substantial communication (comm) count improvements. Most notably tests in test/performance/ferguson. These test the comm counts for some basic chapel communication idioms:

```
remote-array-read   : #gets 200011 => 100012
remote-array-write  : #gets 100011 => 12
remote-class-read   : #gets 700011 => 600012
remote-class-write  : #gets 400011 => 300012
remote-record-read  : #gets 400011 => 300012
remote-record-write : #gets 100011 => 12
remote-tuple-read   : #gets 400011 => 300012
remote-tuple-write  : #gets 100011 => 12
```

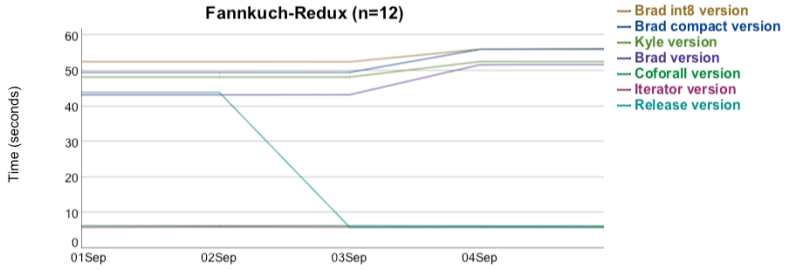
```
There were a few other improvements in real tests such as SSCA

ssca2 kernel #3     : #gets 239 => 158
```

```
There would have been more comm count improvements but LICM is
not very effective with bounds-checks on, and tests in test/
```
performance/ferguson, SSCA, and the other improvements happen to throw –fast

LICM Improvements: Impact (continued)

- **Single locale performance impact**
  - some variations of Fannkuch took a performance hit
    - result of a latent bug that was discovered and fixed as part of this work
    - did not affect the fastest versions



LICM Improvements: Next Steps

- **Fix Fannkuch performance regression**
  - source of regression has been identified
  - fix would have come too late in the release cycle
    - was not a high priority since fastest versions were unaffected


CHPL_TARGET_ARCH and --specialize
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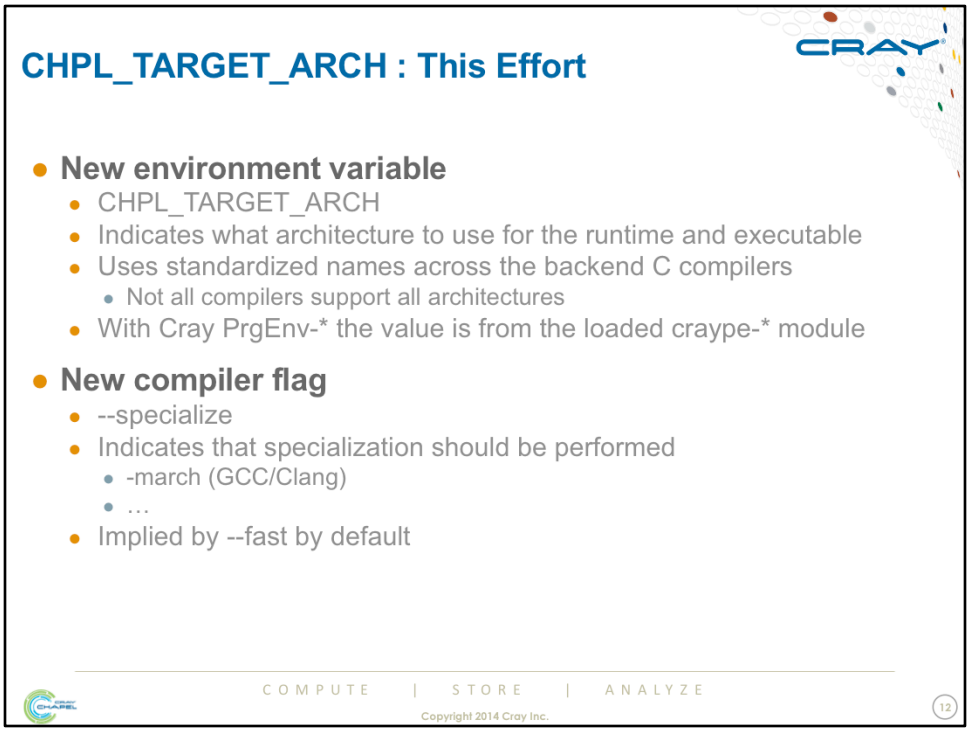
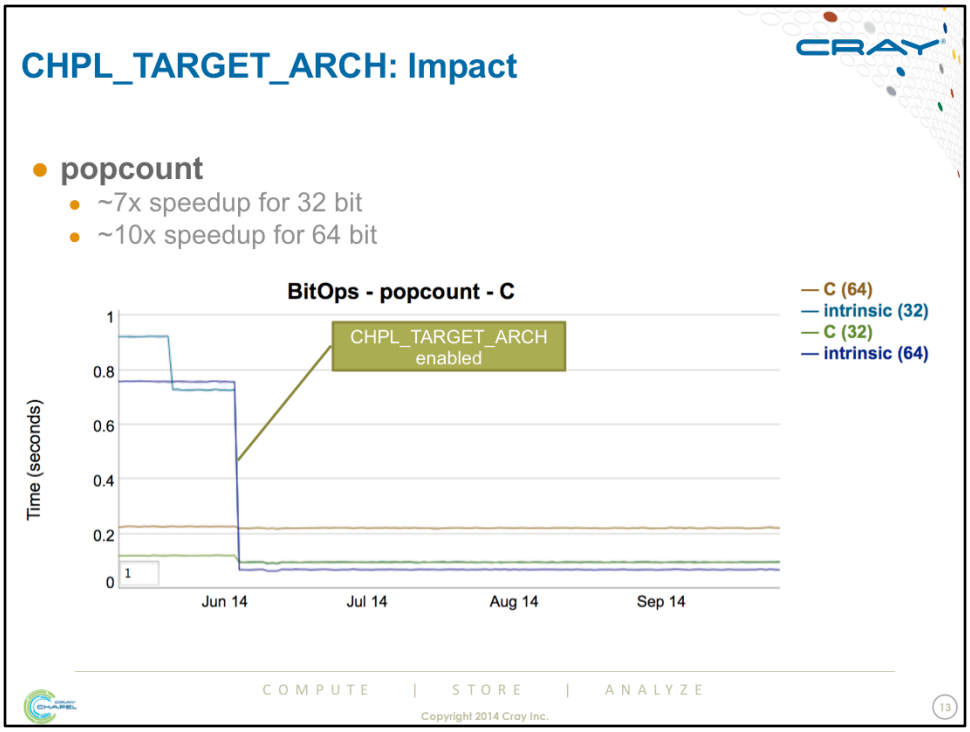
CHPL_TARGET_ARCH : Background

- **C compilers can optimize for the target architecture**
  - We needed some way to expose this in Chapel
- **Some operations based on intrinsics are slow**
  - By default, C compilers won't emit instructions added by recent ISAs
- **A target architecture is required to get good vectorization**
  - No AVX or SSE newer than SSE2 without specifying the architecture



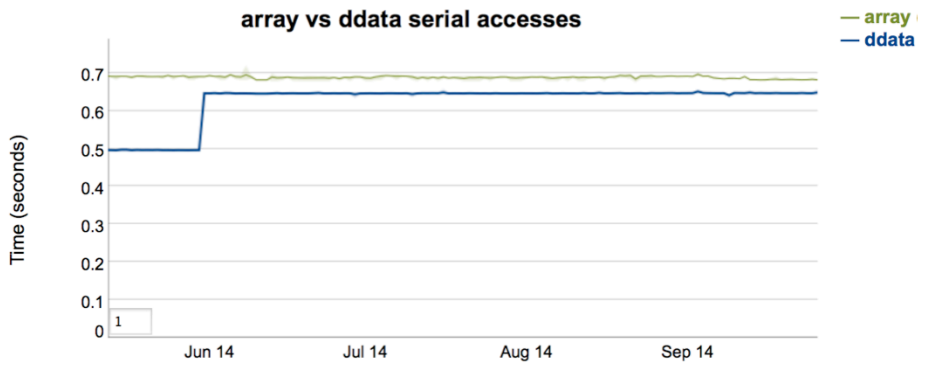
See README.chplenv for more details on the supported options for CHPL_TARGET_ARCH



GCC's __builtin_popcount is slower than the straight C version without allowing specialization.

CHPL_TARGET_ARCH: Impact

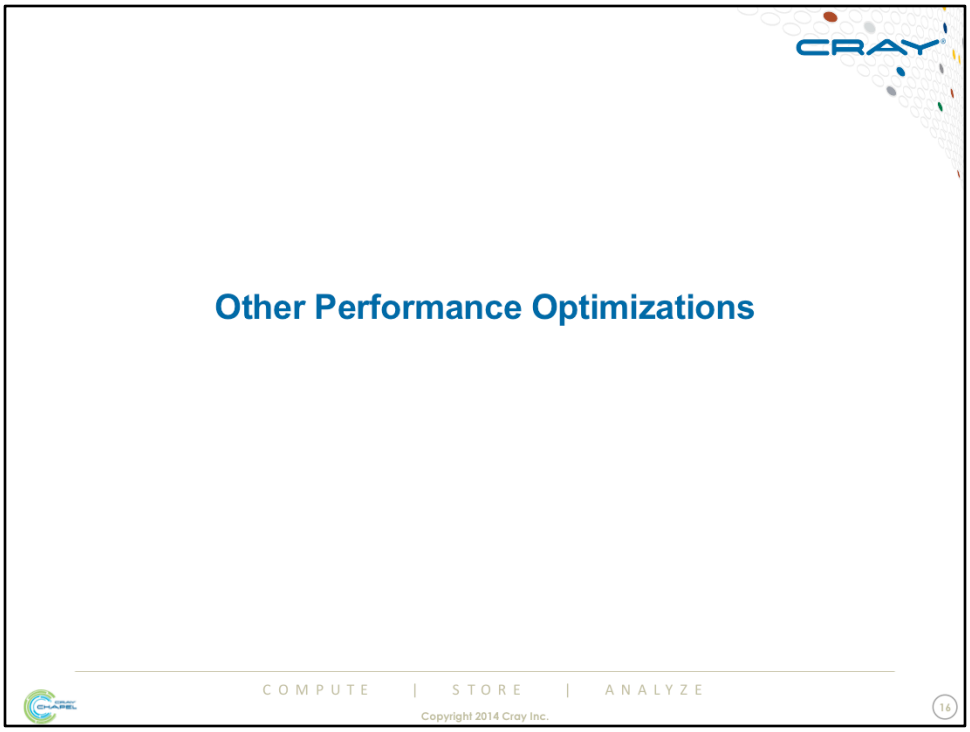
- **array vs ddata serial accesses**
  - ~1.4x slowdown for ddata
  - Not clear why this happens



Little to no impact on other tests.

CHPL_TARGET_ARCH: Next Steps

- Investigate why the timings went up for ddata


Other Performance Optimizations
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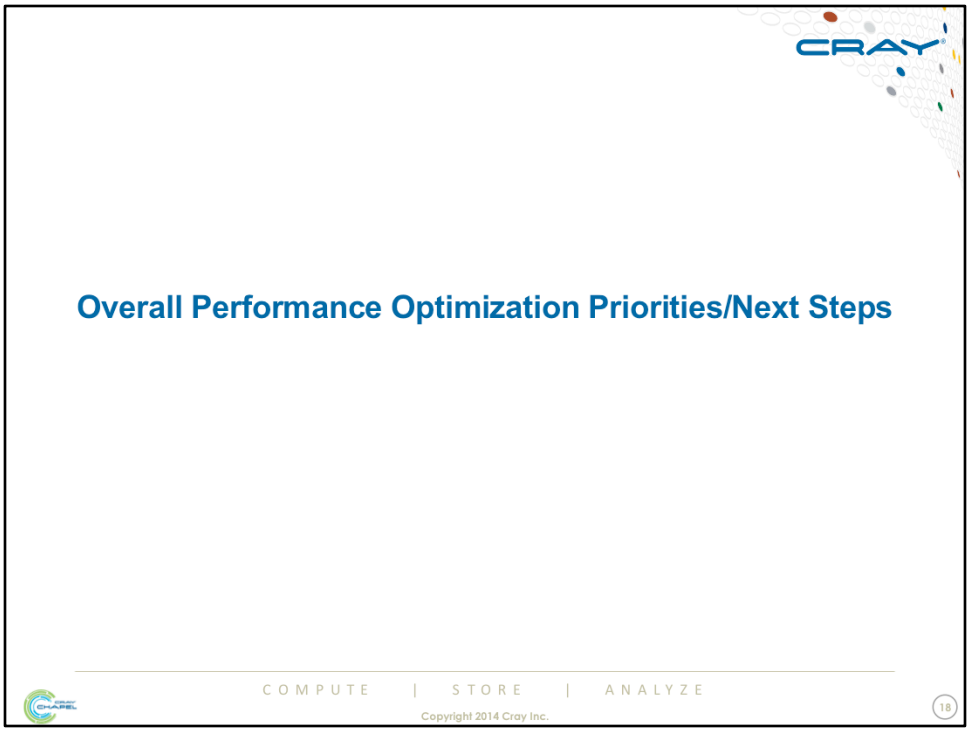
Other Performance Optimizations

- **Switch to Qthreads tasking layer (see 'Runtime' slides)**
  - and switch in thread counts from logical to physical cores by default
- **Improved the performance of the 1D array serial iterator**
  - previously, we were using a more expensive (strided) idiom
- **Made task counters use network atomics when available**
  - previously, they used processor atomics and active messages
- **Improved the performance of readstring()**
- **Reduced communication counts due to other refactorings**


Overall Performance Optimization Priorities/Next Steps
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Overall Perf. Opt. Priorities/Next Steps

- Focus on SIMD-ization of generated code
- Reduce amount of unnecessary communication code
  - Relates to earlier item about --local vs. --no-local
- Add support for standalone parallel iterators
- Optimize reductions
- Improve LICM for cases like Fannkuch that backslid

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