Locale Models

Chapel Team, Cray Inc.

Chapel version 1.16

October 5, 2017

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Outline

- APU Locale Model
- Locale Model deinit()
- Numa Locale Model

APU Locale Model
(contributed by Mike Chu, AMD)

APU Locale Model

Background:

- APU: Accelerated Processing Unit
  - AMD term for co-packaged CPU and GPU
- GPU can access CPU's virtual memory through MMU and cache
  - allows shared pointers
  - avoids copying data
- AMD is interested in having Chapel support APUs

This Effort:

- Added an APU locale model, consistent with other locale models

APU Locale Model

Impact:

- Foundation of APU support is in place

Status:

- Tested at AMD
- The first of a series of contributions to support APUs
  - needs runtime additions to interface with Radeon Open Compute Platform
  - needs compiler changes to generate GPU executable code
  - both additions function in AMD fork, currently working on merging to master

Next Steps:

- Incorporate AMD runtime and compiler changes
- Establish regular testing
- Consider GPU-related language extensions (CHIP 22)
  - allow users to specify the natural width of a forall loop

Locale Model deinit()

Locale Model deinit()

Background:

- Locale model data structures were not torn down upon Chapel exit
  - existing locale models had no special clean-up requirements
- Some GPUs require tear-down to leave hardware in a sane state

This Effort:

- Started deleting locale model data structures on exit
  - added deinit() to existing cases (flat, numa, knl)

Impact:

- Supplies a hook for any special hardware actions at exit
- Used by the APU locale model
  - provides a place to reset the GPU hardware

Next steps:

- Ensure that any future locale models supply deinit()

Numa Locale Model

Numa: Background

- **Introduced ‘multi-ddata’ arrays for locModel=numa in 1.15**
  - Achieved perfect affinity (i.e. matched execution locality) for arrays
  - Performance was great for some iteration styles
  - Horrible for others
- **Not addressed: pre-existing locality**
  - Memory with undesirable NUMA localization before being allocated (previously allocated and thus localized, then freed, then re-allocated)
  - Only option seems to be migration (copying) to desired NUMA domain
- **Prompted a step back to review options and paths forward**

Numa: This Effort (quoting 1.15 'Next Steps')

- **Major 1.16 decision: stay with multi-ddata?**
- **If retaining multi-ddata:**
  - reduce array access overhead; how much can we achieve?
  - provide for programmer specification re: single- vs. multi-ddata
- **If reverting to single-ddata:**
  - how (whether) to handle pre-existing locality?
  - how to handle NIC-registered heaps?
- **Improve NUMA-aware memory allocation**
  - do more sublocale-aware allocation (task stacks, etc.)
  - reduce migration by allocating memory with proper locality

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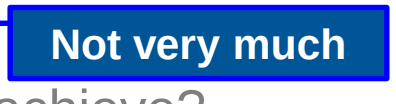

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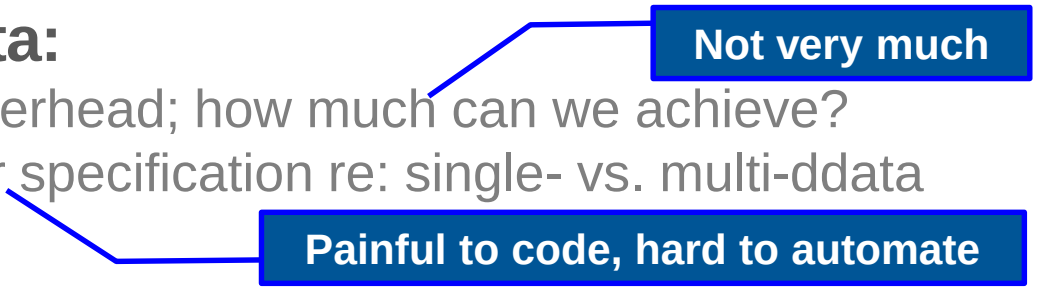

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Not very much

Painful to code, hard to automate

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  - ✗ provide for programmer specification re: single- vs. multi-ddata — **Painful to code, hard to automate**
- **If reverting to single-ddata:**
  - ? how (whether) to handle pre-existing locality? — **Don't know**
  - ✓ how to handle NIC-registered heaps? — **Dynamic registration**
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Dynamic registration

Extendable heap

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Dynamic registration

Extendable heap

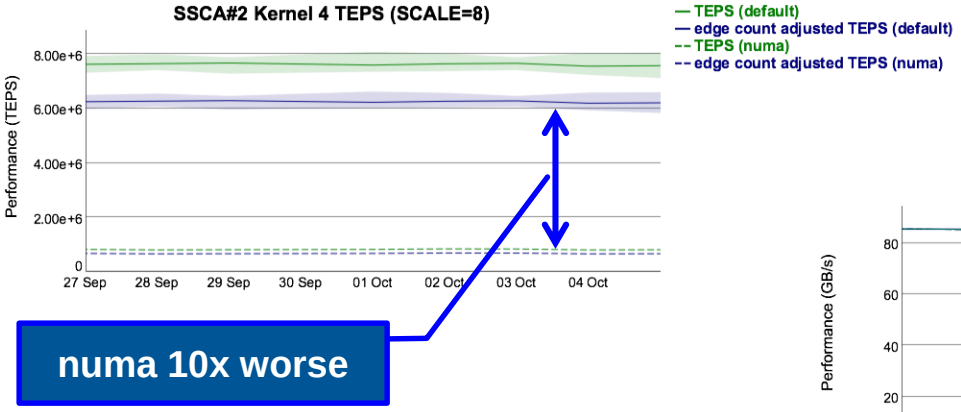
Not needed?

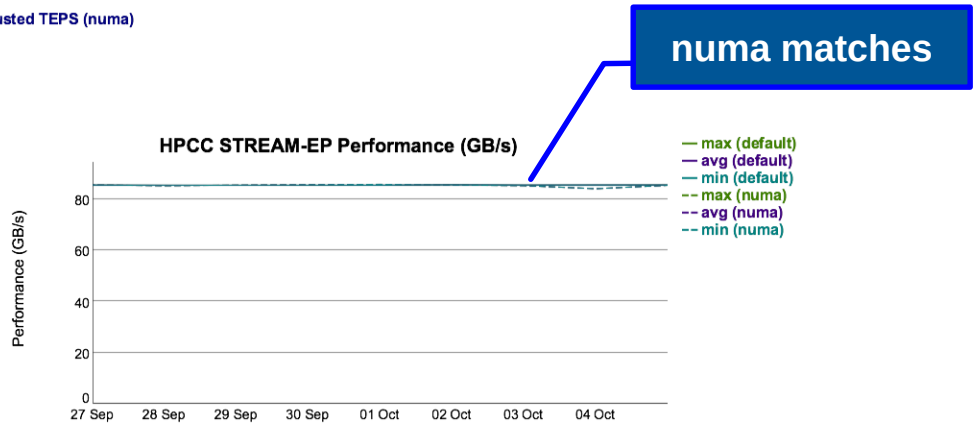
Numa: Status

- **Numa locale model was on hold for this release cycle**
- **Focused on single-ddata improvements**
- **Dynamic NIC registration helps flat LM as much as numa**
  - See ugni comm layer slides in Runtime/Third Party deck for details

Numa: Next Steps

- **Can we get rid of the numa locale model altogether?**
  - No; sometimes we want architectural NUMA domains to be explicit
  - But performance needs to be nearly on par with flat, and often is not
    - Due to wide pointer overhead, Qthreads scheduler issues, likely others





- **Explore:**
  - Locality queries in place of wide pointers
  - Qthreads scheduler improvements
  - Other things?

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