Locale Models

Chapel Team, Cray Inc.
Chapel version 1.16
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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: 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
Numa: This Effort (quoting 1.15 ‘Next Steps’)

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  - **If retaining multi-ddata:**
    - X reduce array access overhead; how much can we achieve?
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- If retaining multi-ddata:
  - Reduce array access overhead; how much can we achieve? \(\times\)
  - Provide for programmer specification re: single- vs. multi-ddata

- If reverting to single-ddata:
  - Don’t know
  - How (whether) to handle pre-existing locality?
  - How to handle NIC-registered heaps?

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- Major 1.16 decision: stay with multi-ddata? **no**

  - If retaining multi-ddata:
    - x reduce array access overhead; how much can we achieve?
    - x provide for programmer specification re: single- vs. multi-ddata
    - Not very much

  - If reverting to single-ddata:
    - ? how (whether) to handle pre-existing locality?
    - ✓ how to handle NIC-registered heaps?
    - Dynamic registration
    - Painful to code, hard to automate
    - Don’t know

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- Improve NUMA-aware memory allocation
  - ✓ do more sublocale-aware allocation (task stacks, etc.)
  - ? reduce migration by allocating memory with proper locality

- Not very much
- Painful to code, hard to automate
- Don’t know
- Dynamic registration
- Extendable heap
- Not needed?
Numa: Status

- Numa locale model was on hold for this release cycle

- Focused on single-data 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

  ![Graph 1](image1)

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

  ![Graph 2](image2)
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