COHX:
CHAPEL ON
HSA+XTQ

Adventures of a
PGAS Language in a
Heterogeneous World

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MOTIVATION

- Heterogeneous architectures are here to stay
  - Exist in current mobiles to super-computers

- PGAS language support for modern heterogeneous architectures is in its initial stages
  - Support necessary for wider adaptation of such languages

- Support Chapel on leading heterogeneous architectures
  - HSA (Heterogeneous System Architecture)
  - XTQ (eXtended Task Queuing)
CHAPEL ON HSA + XTQ

Current Chapel Framework
- Local tasks via Threads
- Remote tasks via GASNet
  Active Messages

Proposed Chapel Framework
- Local tasks via HSA
- Remote tasks via XTQ
APPRAOCH

Target Chapel tasks to generate HSAIL
- Focus on “for loops” to target GPUs

Extend the “on” construct of Chapel
- Use HSA if execution is on a local locale
- Use XTQ for execution on a remote locale

Build an active message interface similar to GASNet AMs on top of XTQ
- Use existing GASNet RDMA

Unified memory support in HSA avoids data copies to/from GPU
FEW IMPLEMENTATION CHALLENGES

- Chapel threading layer assumes thread local storage
  - HSA has no such feature

- Improve generated C code
  - Need “clean loops” for better performance on GPU
  - Perform loop invariant code motion

- Need support for user annotations
  - Hints for the compiler to target a specific processor
CONCLUSION

- Need to support Chapel on current heterogeneous architectures for wider adaptation

- Newer heterogeneous architectures with HSA support require little compiler development effort

- Few implementation challenges which can be resolved with effort from Chapel community
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**HSA**

**HETEROGENEOUS SYSTEM ARCHITECTURE**

- Improved processor design to efficiently program heterogeneous architectures
  - User level task queues provide lightweight task execution
  - “True” unified address space with the help of hardware support
  - Seamless use of different compute units present

- **HSAIL: HSA Intermediate Language**
  - Interface to expose underlying hardware capabilities to the software

![Heterogeneous System Architecture (HSA) with CPU + GPU](http://amd-dev.wpengine.netdna-cdn.com/wordpress/media/2012/10/HSAAcceleratedProcessingUnit.png)
XTQ
EXTENDED TASK QUEUING

▲ Motivation: *Extend HSA to a distributed computing environment*

▲ XTQ (eXtended Task Queuing)
  – A light weight remote task execution framework.