A Progress Report on COHX: Chapel on HSA+XTQ

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HSA & XTQ

**hUMA**
Heterogeneous Unified Memory Architecture

**hQ**
Heterogeneous Queuing

**HSAIL**
HSA Intermediate Language

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EQUAL ACCESS TO ENTIRE MEMORY

- hUMA
  - CPU
  - GPU

GPU and CPU have uniform visibility into entire memory space

ALL-PROCESSORS-EQUAL

- hQ
  - CPU
  - GPU

GPU and CPU have equal flexibility to be used to create and dispatch work items
A locale is a unit of storage and processing
Specify at run-time the number of locales
Can specify at which locale objects are stored, computations performed
Can specify locale by a variable
- `on TaskLocalA do taskA()`
Can specify locale by data location
- `forall i in D on(a(i)) do ...`
Focus of changes for XTQ
EXAMPLE: TWO-NODE CHAPEL EXECUTION

(a) GasNET  
(b) XTQ+HSA
CHAPEL: ‘ON’ INVOCATION AND REMOTE DATA ACCESS

- `chpl_executeOn()`
- `chpl_comm_fork()`
- `memcpy`
- `chpl_comm_get()`
- `memcpy`
- `chpl_comm_put()`

The main program on `localhost` uses the following API:

- GASNet Active Message
- GASNet Get
- GASNet Put
CHAPEL PROGRAM INITIALIZATION

main()

- chpl_comm_init()
- chpl_mem_init()
- CreateConfigVarTable()
- chpl_task_init()
- chpl_comm_post_task_init()
- chpl_task_callMain(chpl_main)

Spawns the polling task on each locale

SPMD
CHAPEL ACTIVE MESSAGES OVER XTQ

chpl_executeOn() Before

- chpl_comma_fork()
- gasnet_AMRequestMedium0

FORK(AM_FORK)
FORK(AM_FORK_FAST)

fork_t
Similar to HSA Agent dispatch Packet
Context of the task

chpl_executeOn() with XTQ

- chpl_xtq_put()
- send_xtq_rdma

FORK(XTQ_RDMA_REQ)

xtq_rdma_handler
Context of the task

XTQ dispatch packet (different size)
CHAPEL REMOTE LAUNCH LATENCY MICROBENCHMARK

Simple active message invokes remote method

```
if (here.id == 0 ) {
  tstart();
  for i in 1..1000 {
    on Locales[(1-here.id)] {
      global += 1;
    };
  }
  tfinish();
}
```

Chapel Microbenchmark
XTQ MICROBENCHMARK – QUALITATIVE SPEEDUP

XTQ Microbenchmark - Qualitative Speedup

Chapel 1.9 pthread: 1.47
Chapel 1.11 pthread: 1.50
Chapel 1.11 qthread: 1.73
CONCLUSIONS AND POTENTIAL FUTURE DIRECTIONS

- XTQ provides Chapel Runtime Speedup
- ExecuteOn utilized by Runtime $\rightarrow$ speedup?
- LocaleInference + Aggregation $\rightarrow$ XTQ: data + remote method
- HSA generation
- HSA signals
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