Overview of Berkeley UPC

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Goals of the Berkeley UPC Project

• Make UPC Ubiquitous on
  - Parallel machines
  - Workstations and PCs for development
  - A portable compiler: for future machines too

• Components of research agenda:
  1. Runtime work for Partitioned Global Address Space (PGAS) languages in general
  2. Compiler optimizations for parallel languages
  3. Application demonstrations of UPC
Where Does Berkeley UPC Run?

- Runs on most SMPs, clusters & supercomputers

- Support Operating Systems:
  - Linux, FreeBSD, Tru64, AIX, IRIX, HPUX, Solaris, MSWindows(cygwin), MacOSX, Unicos, SuperUX

- Supported CPUs:
  - x86, Itanium, Alpha, Sparc, PowerPC, PA-RISC

- GASNet communication:
  - Myrinet GM, Quadrics Elan, Mellanox Infiniband VAPI, IBM LAPI, Cray X1, SGI Altix, Cray/SGI SHMEM

- Specific supercomputer platforms:
  - Cray T3e, Cray X1, IBM SP, NEC SX-6, Cluster X (Big Mac), SGI Altix 3000
Recent Progress on Runtime

• Runtime portability, interoperability [Jason]
  - New pthread version runs on SGI Altix, SMPs, clusters of SMPs
  - Support for Intrepid, C++, mixed MPI

• GASNet communication layer [Dan]
  - Previously existing ports: IBM LAPI, Myrinet GM, Quadrics Elan-3
  - FY04 Ports: Infiniband, UDP, Shmem, GM+threads, Elan-4
  - Research on support for pinning-based networks such as Infiniband and Myrinet
  - Third party ports: SCI by UFL
Recent Progress on Compiler

- Enabled optimizations in Open64 base
- Static analyses for parallel code
  - Understand when code motion is legal without changing views from other processors
  - Extended cycle detection to arrays with three different algorithms
- Message Coalescing
  - Replacing small messages with larger ones [Wei]
- Message strip-mining
  - Find optimal message size for pipelining [Costin]
- Experiments with vectorization on the X1
  - [Christian and Wei]
Recent Progress on Applications

• NAS PB-size problems
  - Berkeley NAS MG avoids most global barriers and relies on UPC relaxed memory model [Parry]
  - Berkeley NAS CG has several versions, including simpler, fine-grained communication
  - Berkeley NAS FT [Christian]
  - Sparse triangular solve [Rajesh]

• Algorithms that are challenging in MPI
  - 2D Delauney Triangulation [SIAM PP ‘04] [Parry]
  - AMR in UPC: Chombo Poisson solver [Mike]
  - Investigation into AMR potential
Progress on the Language

• Specification of UPC memory model in progress
  - Joint with MTU
  - Behavioral spec [Dagstuhl03]
• UPC IO nearly finalized
  - Joint with GWU and ANL
• UPC Collectives V 1.0 finalized
  - Effort led by MTU
  - Optimized version on GASNet underway [Paul]
  - Investigation of automatic tuning [Rajesh]
• Improvements to UPC Language Spec
  - Led by IDA
External Activities

- Participation in UPC bi-annual consortium meeting
- 4 Tutorials: PSC, SIAM PP04, SC02/SC03, IPDPS03
- UCB Parallel Computing course
  - Assignment using 4 problems in 2 PGAS languages
  - Slides used at elsewhere (UCSB,...)
- 10 Presentations at workshops, conferences, and panels, poster sessions
- 11 Publications
  - 7 in refereed conferences/journals
  - 4 are language or runtime interface specifications
Presentation Details

1. **Evaluating Support for Global Address Space Languages on the Cray X1**  

2. **Message Strip Mining Heuristics for High Speed Networks**  

3. **Problems with using MPI 1.1 and 2.0 as compilation targets for parallel language implementations**  
D. Bonachea and J. Duell. 2nd Workshop on Hardware/Software Support for High Perf. Scientific and Engineering Computing, SHPSEC-PACT03. (Also to appear in IJHPCN.)

4. **Polynomial-time Algorithms for Enforcing Sequential Consistency in SPMD Programs with Arrays**  

5. **A Performance Analysis of the Berkeley UPC Compiler**  

6. **A New DMA Registration Strategy for Pinning-Based High Performance Networks**  
C. Bell and D. Bonachea. Communication Architecture for Clusters (CAC'03), 2003.

7. **An Evaluation of Current High-Performance Networks**  

8. **Proposal for Extending the UPC Memory Copy Library Functions, v0.7**  

9. **A Proposal for a UPC Memory Consistency Model, v1.0**  

10. **UPC-IO: A Parallel I/O API for UPC, v1.0pre10**  

11. **GASNet Specification, v1.1**  
Schedule

Introduction
8:15  Coffee
8:30  Overview of Berkeley UPC

Runtime Session
8:40  Runtime (Duell)
9:00  Gasnet (Bonachea)
9:40  Collectives (Hargrove, Nishtala)

10:00 - Break (15 min)

Compiler Session
10:15  Berkeley UPC on the X1 (Bell, Chen)
11:00  Message Coalescing (Chen)
11:30  Message Stripmining (Iancu)

12:00 - Lunch (45 Minutes)

12:00 - Lunch (45 Minutes)
12:45  AMR in UPC (Welcome)
1:10   FFT (Bell)
1:20   Sparse Triangular Solve (Nishtala)
1:30   Scaling UPC Applications (Husbands)

Summary
1:45   Future Directions (Kathy Yelick)
2:30   Break and move to 50F conference room
2:45   Discussion