A Crash course to (The) Bighouse CAEN Brown Bag

Brock Palen
brockp@umich.edu

CAEN Brown Bag, Oct 10th

Outline

1. Resources
   - Configuration
   - Hardware

2. Architecture
   - ccNUMA
   - Altix 4700 Brick
   - Dual Fat Tree
   - cpu sets
   - NUMA Effects

3. Software Performance
   - MPI Code
   - OpenMP Code

Hardware: bighouse

- bighouse is our Itanium SMP machine;
- Login: bighouse.engin.umich.edu
- Shares nyx's 6TB NFS file system
- Running SUsE Linux Enterprise Server 10
- ProPack 5 from SGI

ProPack: Provides performance tools, hardware tools and MPT(MPI) libraries
Bighouse Hardware

Current Hardware
- Cache Coherency NonUniform Memory Access (ccNUMA)
- 16 CPU, 32 core Intel Itanium II’s
- Measured 5.5 Gflop/cpu running 4 way
- 171.9 Gflop running 32 way
- 96 GB Ram
- Max 41 GB/s Aggregate Memory bandwidth
- NUMAlink4 3.2GByte/s, 1µ Second Latency

Bighouse Crash

1. Keeps cache lines in sync both good and bad
   Makes for easy programming, places upper limit vs. CRAY
2. HPL P=2 Q=2 N=20000, MKL no threads, MPT
3. HPL P=4 Q=8 N=20000, MKL no threads, MPT
4. 2 nodes have 24GB, 6 have 8GB

ccNUMA

Itanium II’s 9000’s.
L1 16k/d 16k/i
L2 256k/d 1024/i
L3 4MB

2. SHUB2 I FORGOT IT!
   It Sits between the cpus and memory Numa link connects to it.
   This is where the magic happens
1. Each blade has 2 NUMAlink connections, each goes to a different router, each router has a 200 nanoSec pass time.

1. This would be our layout but turns out it's not this would apply to the 450 if we had it.
1. This is our layout (at 8 blades), we only have half the ring though, max number of hops will equal up to 16 blades 64 cores.

1. Provides 1024 cores 512 sockets. This is the max supported config from SGI, system can add one more router out for 1024 sockets 2048 cores, MTTF is too high though.
**What is MPI?**
- Message Passing Interface
- DMP Distributed Memory Parallel
- Hard to Program, Uses Function calls
- Hardware is Cheap
- Scales to 1000’s of CPUS (Bluegene/L)

**MPT**
- MPT SGI MPI-1/2 Implementation
- Makes Strong Use of NUMAlink
- Lots of Copy on Write

---

1. www.mpi-forum.org
2. We have similar SM ability on nyx though OpenMPI

---

1. Duplicates allot of data between processes
2. nothing shared unless given
1. **Hardware:**
   'hpl.bighouse' is bighouse
   - mpt
   - mkl no thread
   'hpl.801' is nyx801
   'hpl.ib' is EMike Nodes, dual core dual socket opt2220, 16 GB ram,
   DDR Infiniband 20Gbit/s < 4/µ Sec. Latency
   - openmpi-1.2-pgi, OFED
   - goto-blas

2. point out gapping as number of CPUS increase
   Why Bighouse is superior, but not at this size and price
OpenMP

- Shared Memory Parallel
- Easy to Program, Uses Pragmas
- Hardware is Expensive and Proprietary
- Can Solve Any Problem (DMP or SMP)
- Scaling Issues, Hybrid Programming
- More important with Dual/Quad/Many Core CPU’s

OpenMP Fork and Join

1. This is what allot of Direct CAE apps use (Nastran Abaqus)
   Most interative solvers are dense matrix solvers in DMP (LS-DYNA)
2. STRESS This is bighouse’s benefit, it can the ram and SMP ability to run these codes at a speed a regular cluster could never do
OpenMP Performance/dgemm 36,621 MByte

1. www.netlib.org/blas
   Bighouse uses MKL
   nyx801 Uses ACML-pgi-mp
2 equal square matrix’s of random numbers with a dim of: 40,000 Doubles.
This is 3,200,000,000 (3.2 billion numbers)
Same building block used in hpl

Example Cases

- NUMA Memory Placement dlook(1) dplace(1) cpuset(1)
- Example Cpuset OH NO SWAP
- Memory placement ccNUMA Knows where to put memory (numa_hit numa_miss)
- Example stream.c measures memory bandwidth

Example 1, cpu sets
- cpuset -c brockp -f brockp/cpuset.conf
- echo $$ >> /dev/cpusets/brockp/tasks

Example 2, link speeds
- linkstat -A
- pmchart numa.mem.util.used
- pmchart numa.link.send_bytes
- run stream.c
Questions?

Questions?
http://cac.engin.umich.edu/resources/bighouse.html
cac-support@umich.edu