Deploying the Sun Magnum System: The Beginning of NSF Petascale Computing

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- This is a **capability** system, not only a capacity system: balanced & tightly coupled
- Jobs will run on the **entire system**; it will not be partitioned into smaller systems
- There was **no unique deal** from AMD (but we’ll take one if they offer!)

And Some Presentation Caveats

- The system does not exist yet
  - It is not yet doing science or even drawing power!
  - Key components are to be delivered in 2007
- Some system details are still non-disclosure
  - Ask Giri Chukkapalli
- Our experience with 50K general-purpose CPUs is zero; even with 5K, it’s only 3 weeks
  - This is new territory—none of us are experts *yet*

NSF HPC Vision & Strategy

- Context: NSF Cyberinfrastructure Strategic Plan
- NSF now investing in world-class HPC systems
  - Annual track 2 solicitations ($30M)
  - Single five-year Track1 solicitation ($200M)
- Complementary solicitations forthcoming
  - petascale applications development solicitations
  - Software Development for CI has an HPC component
  - Etc.

Sun System Configuration

[Some data non-disclosure]

- Compute power
  - 13152 Opteron “Deerhound” processors
    - Quad-core, four flops/cycle (dual pipelines)
    - Initial deployment with SantaRosa processors
  - 421 teraflops aggregate peak (at least)
- Memory
  - 2GB/core
  - 105 TB total

Sun System Configuration

[Some data non-disclosure]

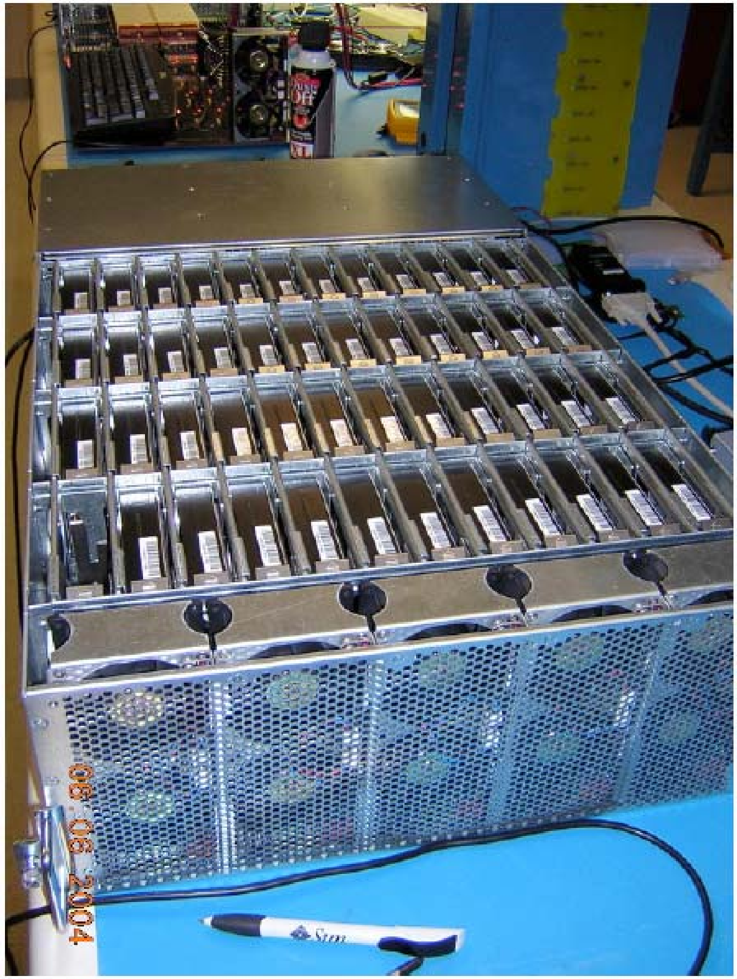
- Interconnect
  - – Sun proprietary switch based on IB
    - Minimum cabling: robustness and simplicity!
  - – PathScale adapters (PCI-Express)
  - – MPI latency: 1.6-1.8 microsec
  - – Peak bi-directional b/w: ~ 1 GB/sec
  - – Total backplane b/w: 13.8 TB/sec

Sun System Configuration

[Some data non-disclosure]

- File system
  - 72 Sun X4500s (“Thumper”)
    - 48 500GB disks per 4U!
  - 1.7 PB total disk
    - 1 PB in largest /work file system
  - Lustre file system
  - Aggregate b/w: 40 GB/s

Thumper Photos

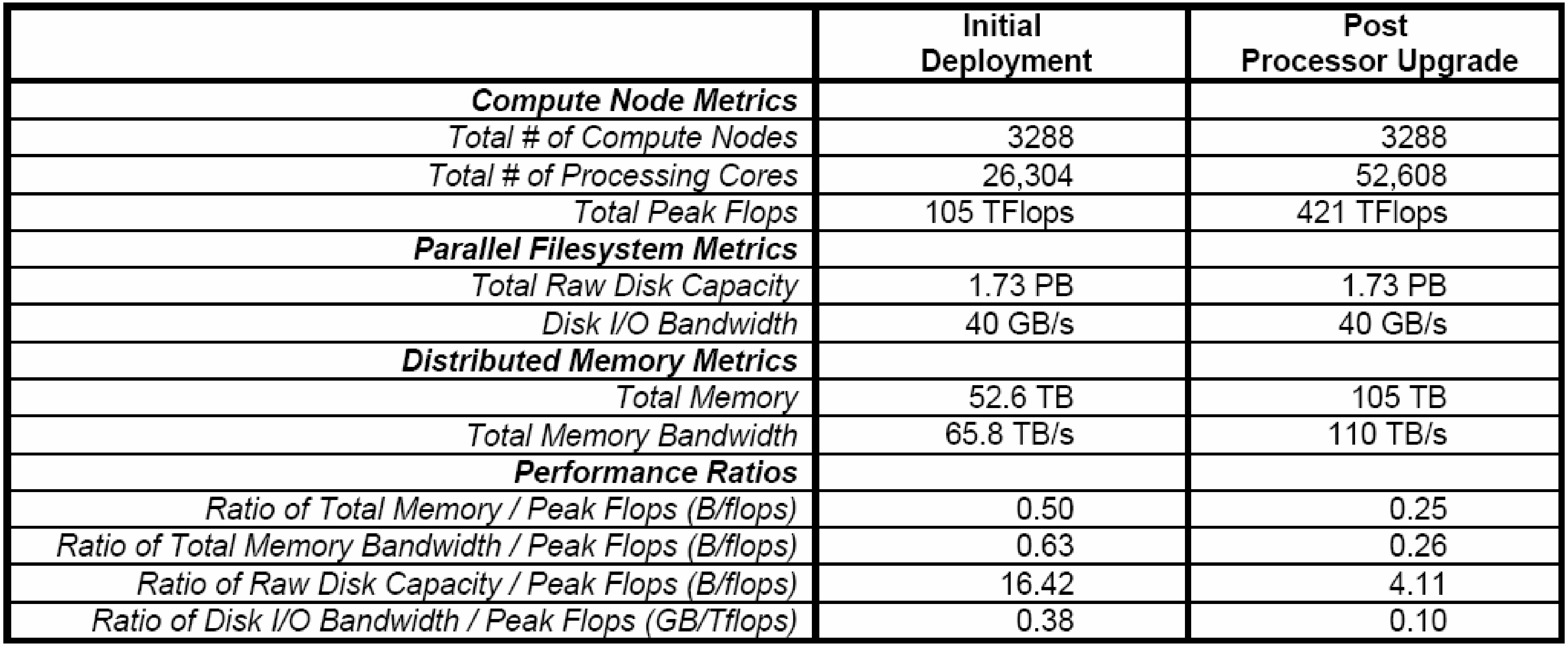


Sun System Configuration

[Some data non-disclosure]

- System Management
  - ROCKS (customized) Cluster Kit
    - *perfctr* patch, etc.
  - Sun N1SM for lights-out management
  - Sun N1GE for job submission
    - Backfill, fairshare, reservations, etc.

Speeds & Feeds



	Initial Deployment	Post Processor Upgrade
Compute Node Metrics		
Total # of Compute Nodes	3288	3288
Total # of Processing Cores	26,304	52,608
Total Peak Flops	105 TFlops	421 TFlops
Parallel Filesystem Metrics		
Total Raw Disk Capacity	1.73 PB	1.73 PB
Disk I/O Bandwidth	40 GB/s	40 GB/s
Distributed Memory Metrics		
Total Memory	52.6 TB	105 TB
Total Memory Bandwidth	65.8 TB/s	110 TB/s
Performance Ratios		
Ratio of Total Memory / Peak Flops (B/flops)	0.50	0.25
Ratio of Total Memory Bandwidth / Peak Flops (B/flops)	0.63	0.26
Ratio of Raw Disk Capacity / Peak Flops (B/flops)	16.42	4.11
Ratio of Disk I/O Bandwidth / Peak Flops (GB/Tflops)	0.38	0.10

Space & Watts

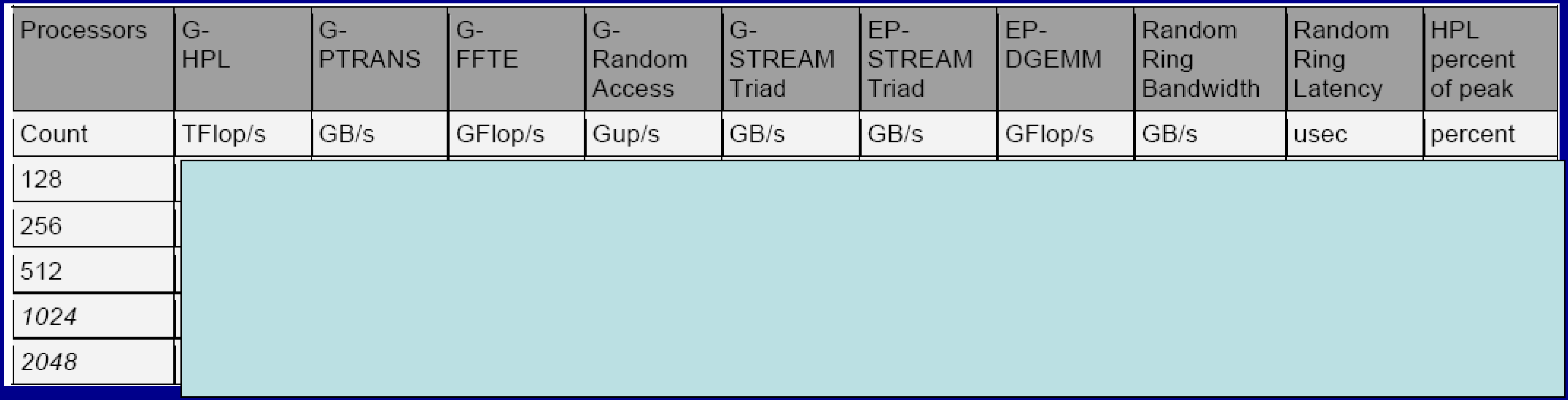
- System power: 2.162 MW
- System space
  - ~80 racks
  - ~1500 sqft for system racks and in-row cooling equipment
  - ~3000 sqft total
- Cooling:
  - In-row units and chillers
  - ~0.6 MW
- Observations:
  - space less an issue than power
  - power distribution less an issue than generation!

Applications Performance Notes

- Obviously, no data for final system
  - Switch doesn’t exist yet
  - Processors don’t exist yet
- Performance predictions can be made from previous & pre-production versions
- Applications performance projections for NSF benchmarks look very promising (MPI only)

Applications Performance Notes

- *Hope to be able to reveal projections at SC06*



Processors	G-HPL	G-PTRANS	G-FFTE	G-Random Access	G-STREAM Triad	EP-STREAM Triad	EP-DGEMM	Random Ring Bandwidth	Random Ring Latency	HPL percent of peak
Count	TFlop/s	GB/s	GFlop/s	Gup/s	GB/s	GB/s	GFlop/s	GB/s	usec	percent
128										
256										
512										
1024										
2048										

- Applications: *WRF, OOCORE, MILC, GAMESS, HOMME…*

User Support Challenges

- NO systems like this exist yet!
  - Will be the first general-purpose system at ½ Pflop
  - Quad-core, massive memory/disk, etc.
- New opportunities, new apps challenges
  - Multi-core optimization
  - Extreme scalability
  - Fault tolerance in apps
  - Petascale data analysis
- Initially, the only such NSF system: demand?

User Support Plans

- User support: the “usual” +
  - User Committee dedicated to this system
  - Applications Engineering
    - algorithmic consulting
    - technology selection
    - performance/scalability optimization
    - data analysis
  - Applications Collaborations
    - Partnership with petascale apps developers and software developers

User Support Plans

- Also
  - Strong support of ‘professionally optimized’ software
    - Community apps
    - Frameworks
    - Libraries
  - *Extensive* Training
    - On-site at TACC, partners, and major user sites, and at workshops/conferences
    - Advanced topics in multi-core, scalability, etc
    - Virtual workshops
  - Increased contact with users in TACC User Group

Technology Insertion

- Again, NO systems like this exist yet!
  - Workshops like this are excellent to start thinking, planning
- System will stimulate new R&D
- System will operate for four years
- Technology identification, tracking, evaluation and insertion will be important!
- Chief Technologist will work with team to:
  - identify new apps, libs, tools, etc.
  - improve perf, ease-of-use, reliability, security

Access & Allocations

- System is primarily NSF funded
  - 90% allocable via the TeraGrid
- System hosted by UT, supported by TX $:
  - 5% for Texas institutions, from R1s to JuCos
    - Excellent EOT opportunities
- System will foster academic/industry collaborations and tech transfer
  - 5% for industrial partners
    - Work with Council on Competitiveness
    - Learn from INCITE

Impact in TeraGrid

- 400M CPU hours to TeraGrid: more than double current total of all TG HPC systems
- 421 Tflops peak
  - 3x total perf of all TG HPC systems
  - 10x top TG HPC system in perf, memory, disk
- Reestablish NSF as a leader in HPC
- Jumpstarts progress to petascale for entire US academic research community

Practice Makes Perfect

- **Lonestar** is the fastest US academic supercomputer in operation
  - – 1300 Dell PowerEdge 1955 blade servers
  - – 2600 Intel Xeon dual-core processors

    5200 cores at 2.66 GHz each
  - – Cisco InfiniBand interconnect

    10 gigabit/sec bandwidth, < 5 microsec latency

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Project Timeline

Sep06	award, press, relief, beers
Jan07	equipment begins arriving
Mar07	facilities upgrades complete
May07	allocations requests due (TeraGrid)
May07	very friendly users on <100 Tflops system (dual-core, 2 flop/cycle Santa Rosa procs)
Jun07	friendly users on 100 Tflops system
Jul07	full operations, relief, beers
3Q07	processor upgrade to Deerhound (quad-core, 4 flops/cycle)

Team Partners & Roles

- TACC / UT Austin: project leadership, system hosting & ops, user support, apps collaborations, tech evaluation & dev
- ICES / UT Austin: apps collaborations, algorithm/technique dev & transfer
- Cornell Theory Center: large-scale data management & analysis, user support
- Arizona State HPCI: tech evaluation & dev, user support

Team Partners & Roles

- Project Director: Jay Boisseau (TACC)
- Project Manager: Tommy Minyard (TACC)
- Chief Applications Scientists: Omar Ghattas (ICES / UT Austin), Giri Chukkapalli (Sun)
- Chief Technologists: Jim Browne (ICES / UT Austin)
- Many other TACC, ICES, CTC, ASU staff playing important roles (~25 FTEs)
- Strengthening relationships with other petascale centers

Summary

- Track2 Sun system will be one of most powerful general-purpose open computing system in the world in Oct07
- System will be *balanced, capability* system for scalable numerically- and data-intensive apps
- System will present tremendous opps for applications developers, and s/w developers
- Allocations 1 July 2007, apply by 1 May 2007

Ideas, Suggestions, and Users Welcome!

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