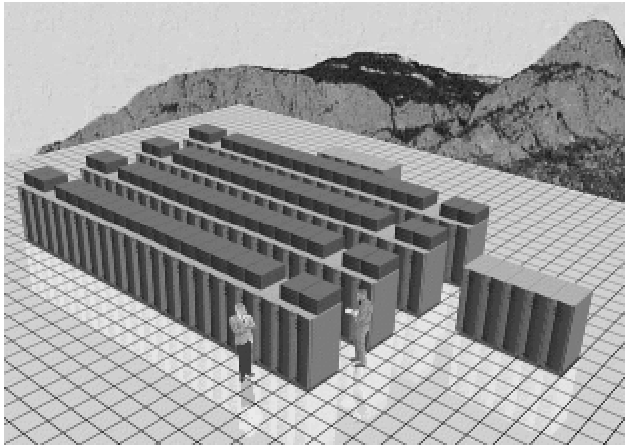


ASCI-RED Intro Course

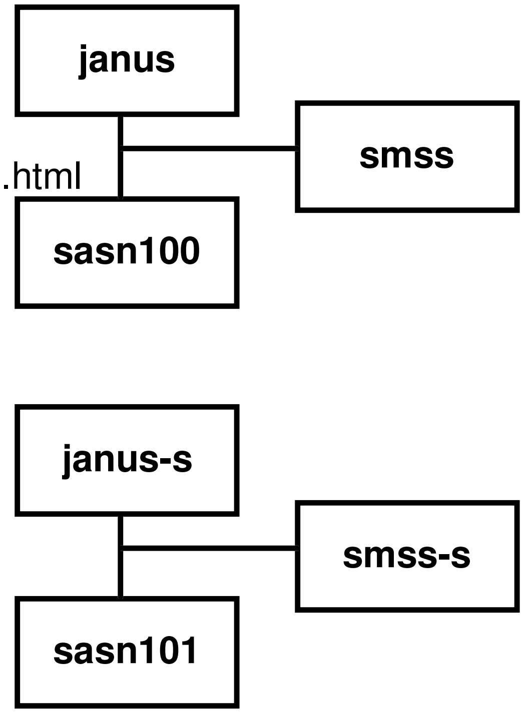
Patrick Fay
Computational Scientist, Intel Corp.
pfay@lanl.gov

Topics

- ASCI-RED LAN(s) Overview
  - System Overview
  - Filesystems
  - Accounts
  - Access
  - File Transfer
  - Getting Help
- janus Overview
- OS descriptions
- Interacting with the Compute Partition
- How to compile and run hello_world.[fc]
- Programming model
- Languages
- IO
- Message-passing
- Tools
- Performance Tips for the PPRO
- Getting to the 2nd processor
- How ASCI-RED differs from other Unix systems

ASCI-RED LAN(s) Overview

- System Overview - 2 LANs (black,red)
  - — black (open LAN):
    - – janus.sandia.gov
      Parallel supercomputer using P6 (Pentium Pro)
      System Overview:
      http://mephisto.ca.sandia.gov/TFLOP/sc96/index.html
      Used for running parallel applications (only)
    - – sasn100.sandia.gov
      Sun Ultrasparc server
      Used for code compilation, pre/post processing.
    - – smss
      archival tape storage (new NSS)
      SMSS Overview:
      http://www.sandia.gov/SMSS/smss_index.html
  - — red (classified LAN)
    Mirrors black side. email janus-help@sandia.gov
    if it doesn't
    - – janus-s.sandia.gov
    - – sasn101.sandia.gov, sun server
    - – smss-s, tape storage



Filesystem Diagram

- home areas are on sasn100(1)
  - Don't do parallel IO to your home. Slow...
  - limited disk space
- Large codes on /projects
  - email
  - janus-help@sandia.gov to get an area
- IO to local disks
  - /scratch, /pfs
  - aggressive purging policy
- DFS
  - to/from kerberized DCE cell, server
- Where to put your data:
  1. /scr area on sasn100
  2. Archival Storage (smss)
  3. Your own LAN

sasn100(1)	**janus(-s)**
/usr/home →	***/Net/usr/home***
/projects →	***/Net/projects***
/scratch →	***/Net/scratch***
/scr	**/scratch/io[123]_[01]**
	/pfs/io[123]_[01]
	/home/projects
	/pfs/multi/*

ASCI-RED Lan Overview (cont)

- Obtaining an account
  - who: ASCI work only
  - how:

    See for instructions: http://www.acl.lanl.gov/~pfay/teraflop/gaf2.html

    Follow the above instructions for an unclassified account (and classified account).

    Contact David Gardner drgardn@cs.sandia.gov for classified account

ASCI-RED LAN Access

- Access: ssh and xterm
  - — Must have gotten dce account and ASCI-RED account
  - — Workstation must have kerberos/dce software
  - — Kerberos supported (I have sgi versions of ssh/scp/ftp)

    .kent.pfay,/users/pfay {101} > **kinit -f pfay@dce.lanl.gov**

    Password for pfay@dce.lanl.gov:

    .kent.pfay,/users/pfay {102} > **ssh janus.sandia.gov**

    Last login: Sat Feb 15 15:09:23 1997 from kent.acl.lanl.go

    janus.sandia.gov -- the two-headed Intel TFLOP Supercomputer

    ****

    janus >
  - — ssh to do ‘secure telnet’ to ASCI-RED

    % **which ssh** #see me for sgi versions of ssh/kinit

    /Net/local/bin/ssh

    % **ssh sasn100.sandia.gov**

    your dce.lanl.gov password:

    ….

    sasn100% **xterm &**

ASCI-RED LAN Overview (Cont.)

- File Transfer
  - — scp from/to <local-lan> to/from ASCI-RED lan

    %**which scp** #see Pat Fay for sgi versions of scp

    /Net/local/bin/scp

    scp <local_filename> sasn100.sandia.gov:<pathname>

    your_dce_password: #your dce password, note that you won't be prompted for a password if

    # you have an up-to-date version of kinit,scp,ssh
  - — ftp from/to ASCI-RED lan to/from local lan

    .kent.pfay,/users/pfay {103} **> ftp sasn100.sandia.gov**

    Connected to sasn100.sandia.gov.

    220 sasn100 FTP server (Version 5.60) ready.

    334 Using authentication type GSSAPI; ADAT must follow

    GSSAPI accepted as authentication type

    GSSAPI error messages due to not running gssftpd daemon

    GSSAPI authentication succeeded

    Name (sasn100.sandia.gov:pfay): **(hit enter)**

    232 GSSAPI user pfay@ dce.lanl.gov is authorized as pfay

    230 User pfay logged in.

    Remote system type is UNIX.

    Using binary mode to transfer files.

    ftp> **passive** #*Necessary due to not running gssftpd daemon on kent.*

    Passive mode off.

Getting Help

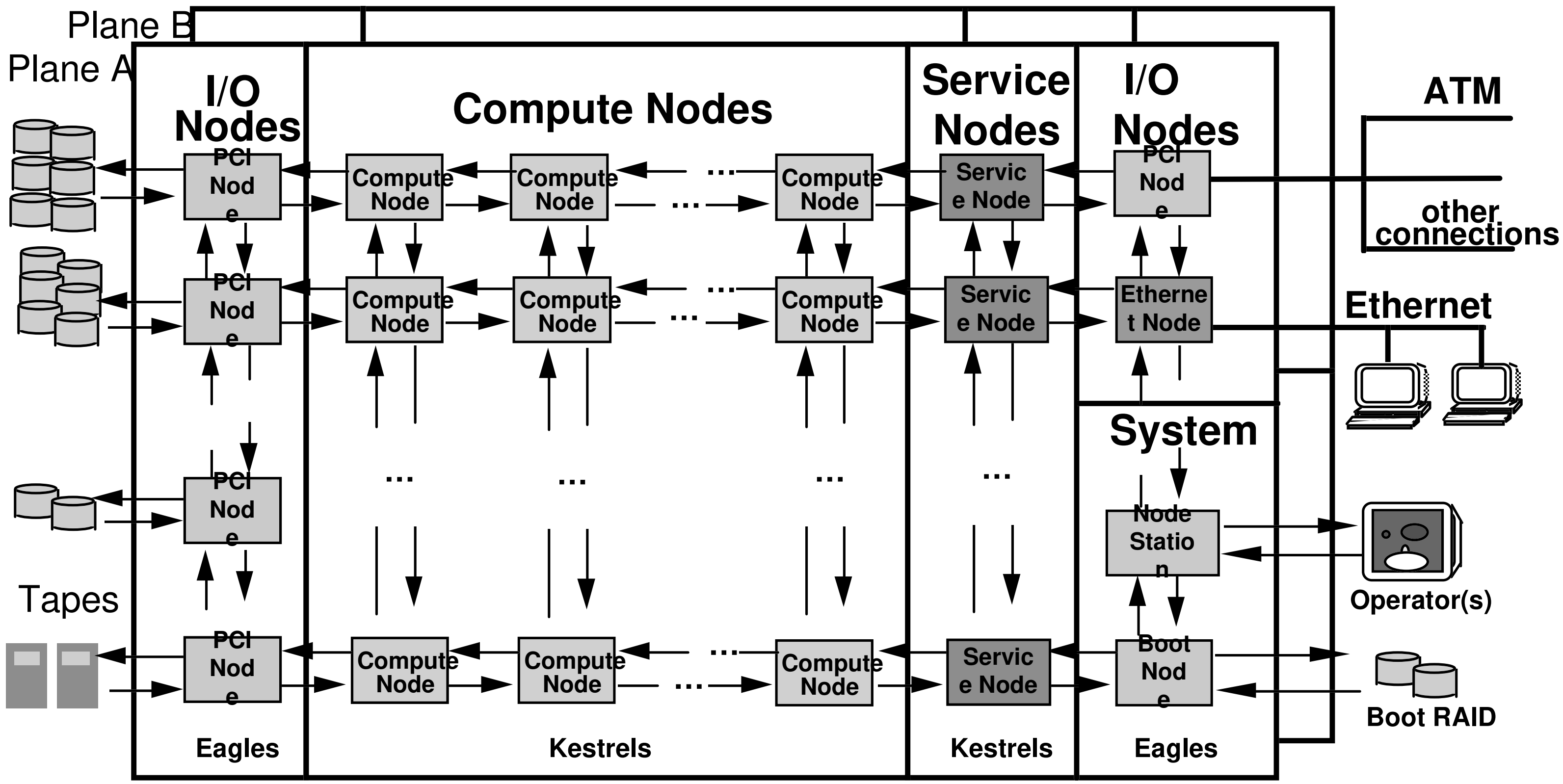
- ssh, scp, ftp on your workstations: your local sysadmin or Pat Fay
- Local sysadmin needs to install/config kerberos/dce software
- Usage problems: janus-help@sandia.gov
- Management/dedicated time request: janus-managers@sandia.gov
- mailing lists: janus-admin@sandia.gov
- Responses via:
  - — janus-isn-users: classified or both
  - — janus-irn-users: unclassified only
  - — janus-users: all users
  - — janus-info: users + other interested.
- News on sasn100

  sasn100% **news janus-dedicate** or **news -a** for all topics
- Online information
  - — General References

    http://mephisto.ca.sandia.gov/TFLOP/sc96/index.html

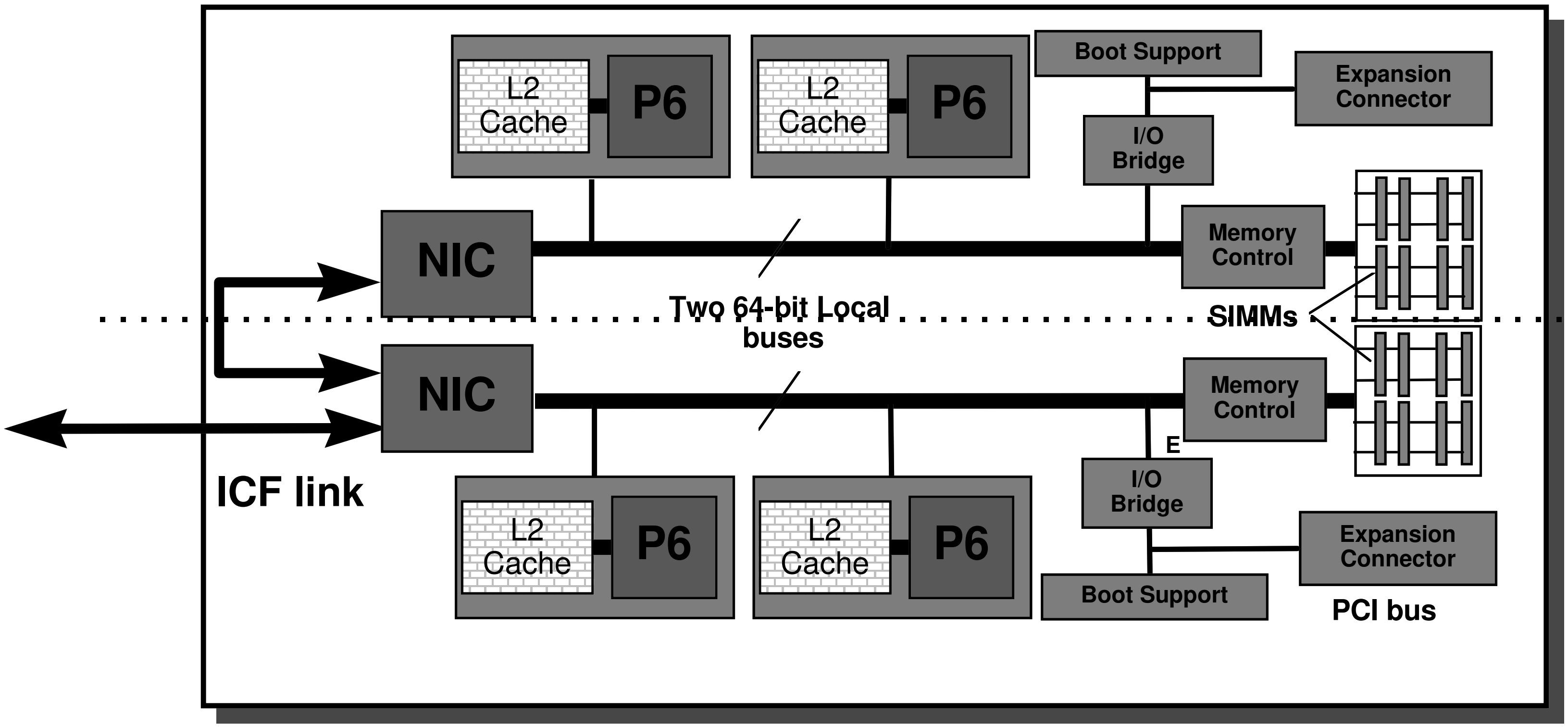
    http://www.acl.lanl.gov/~pfay/teraflop

janus Hardware View



- 2 planes
- Service nodes provide shell access, single-system image

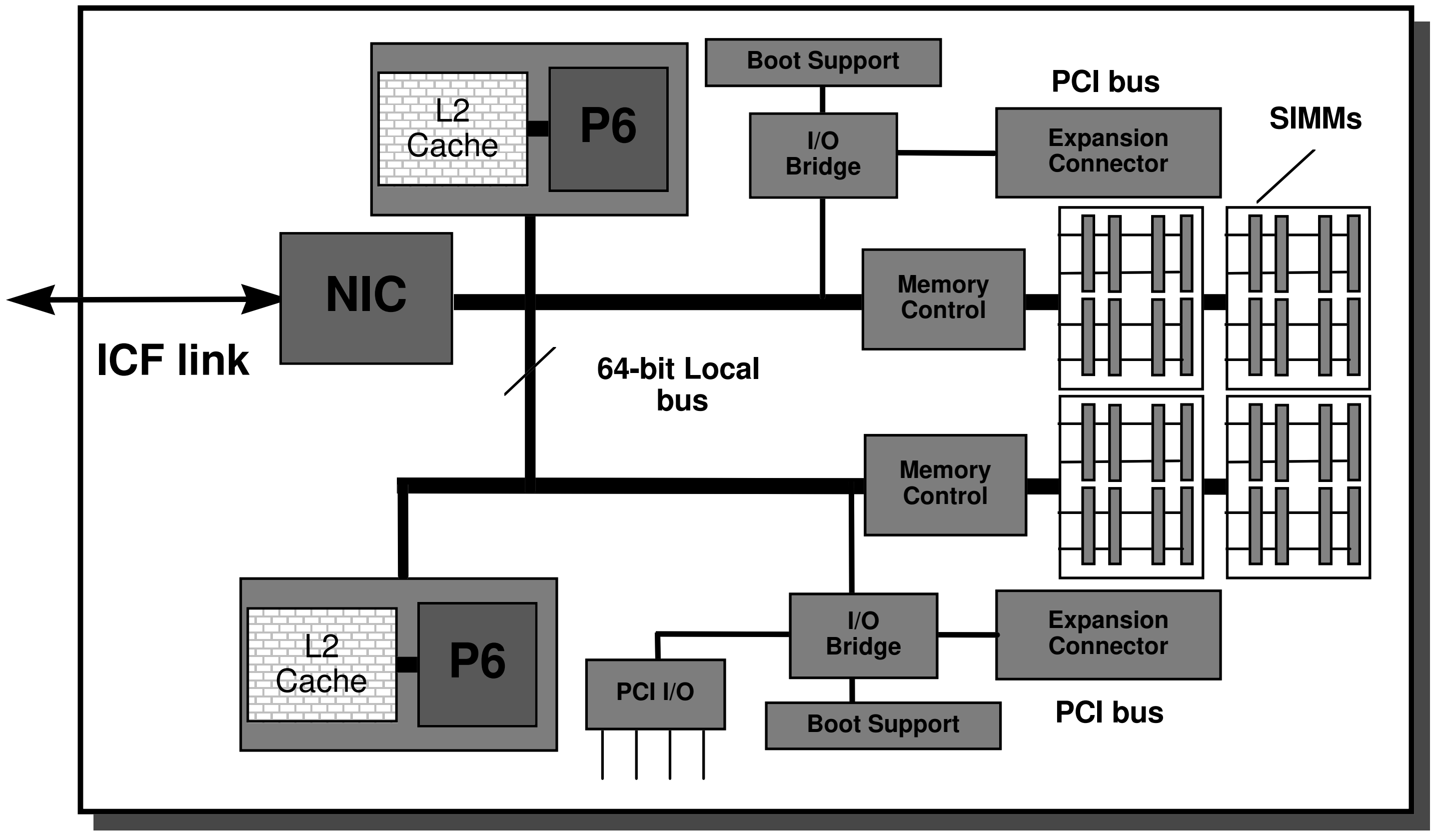
Kestrel Board: Compute & Service Nodes



Commodity components

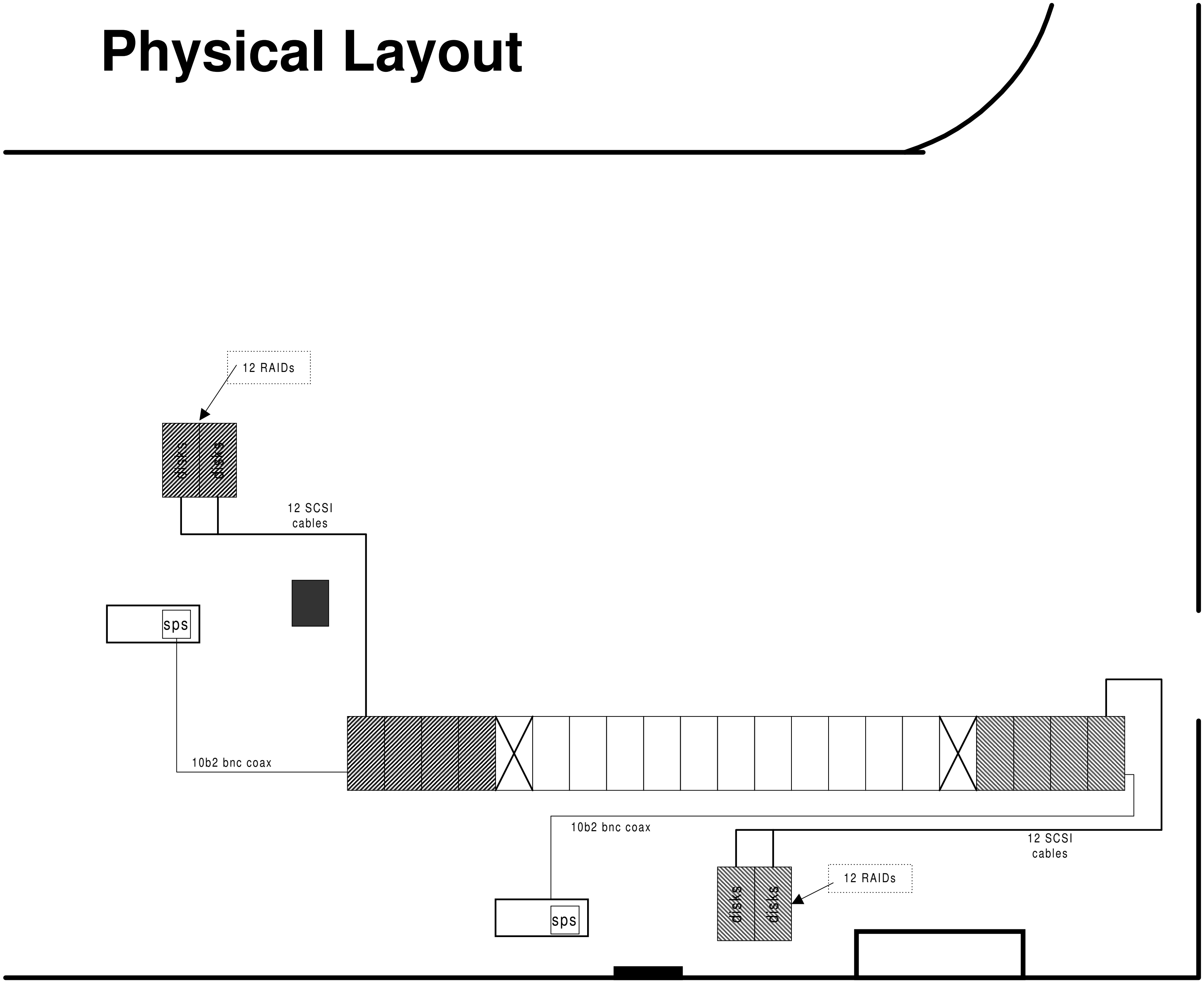
Scalability components

Eagle Board: System & I/O Nodes



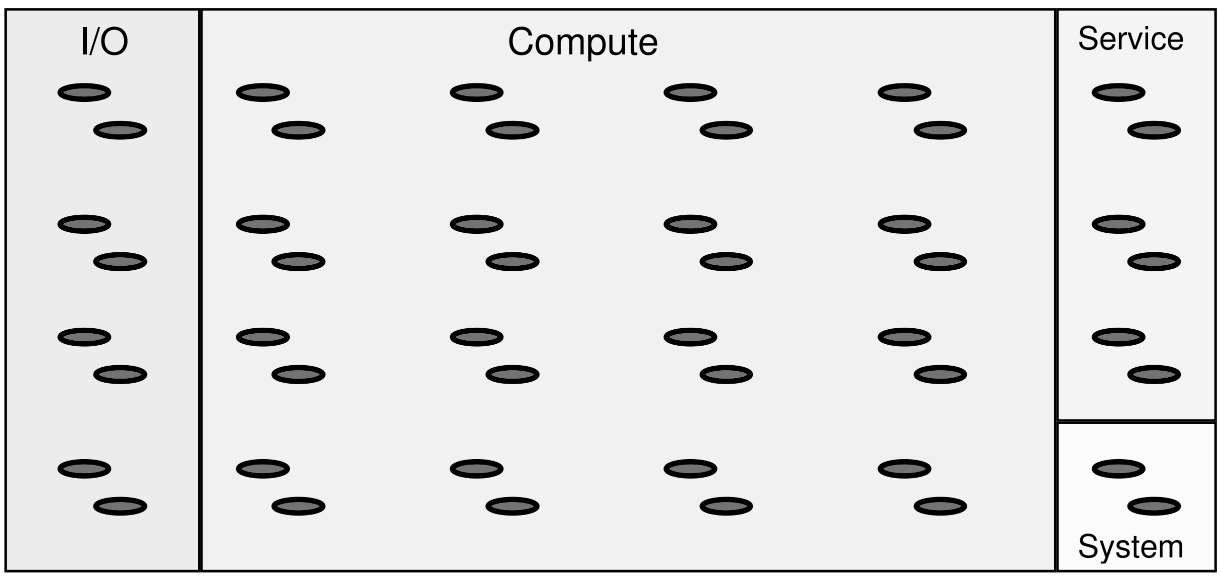
- Commodity components
- Scalability components

Physical Layout



janus applications view

- 4 partitions:
  - — Service partition: Supports interactive users and prog. builds.
  - — Compute partition: Where the parallel applications run.
  - — I/O partition: I/O to RAIDs, networking, etc.
  - — System partition: Booting, admin.



OS(es)

- Compute Partition: Minimum services required for computation.
  - Cougar: A small and efficient, light Weight OS.
    - Program Loading
    - Memory Management
    - Message Passing Support
    - Signal and Exit handling
    - Run time support for supported languages (C, Fortran, C++, HPF)
    - See http://www.acl.lanl.gov/~pfay/teraflop/ for PUMA/Cougar references
- Service/IO partitions: A common, full featured Unix.
  - The "Teraflops Operating System": A distributed OSF Unix
    - Boot and configuration support
    - system administration
    - user logins
    - user commands and services
    - development tools

Interacting with the Compute Partition

- yod -- launches parallel applications
  - yod: App Usage: yod [{-D <option>}] [-comm <size>] [-stack <size>] [-heap <size>] [-help] [-proc <mode=(0 single) (1 coproc) (2 assym)>] [-retry] [-sz <size> | -size <size>] [-fyod <num-fyods>] <file> <args>

    yod -sz 4 -stack 2M a.out > a.out.lst &

- showmesh

```
janus ~/tst 107 > showmesh
Current mesh allocation for janus (last booted Wed Dec 31 17:00:00 1969)
                  1         2         3         4         5
        012345678901234567890123456789012345678901234567890123456789
       +------------------------------------------------------------+
      0|                                            ..............DD|
     60|                                            ............EDaa|
    120|                                            ...............D|
    180|                                            ............DF..|
    240|                                            ................|
    300|                                            ................|
    360|                                            ................|
    420|                                            ................|
       +------------------------------------------------------------+
Legend:
B    boot node                D    OSF disk node (RAID)
     non-existant node        S    OSF service node
R    reserved node            H    OSF HiPPI node
F    other OSF node           A    OSF DAT (digital audio tape) node
.    free Puma node           |    free Puma NQS node
Job ID  User      Base OS     Size   Start           Partition_name/Command line
--- --- --------- ---- ------ ------ --------------- ---------------------------
 a  20  pfay      118  PUMA   4      Feb 15 16:07:15 /cougar/bin/yod.real -sz 4 a.out
```

Environment Setup

- Server
  - TFLOPS_XDEV=/usr/local/intel/tflop/current
  - Add to path: $(TFLOPS_XDEV)/tflops/bin.solaris
  - see ~pfay/.cshrc on janus/sasn100 or my teraflop web page
    http://www.acl.lanl.gov/~pfay/teraflop/cshrc.html
  - cicc, cif77, ciCC
- Service Node
  - Compilers are in /bin
  - cicc, cif77, ciCC
- Cross-compilers available on local LAN if purchase license
  - Environment variable will vary.
  - sun4 or solaris only.

How to compile/run hello_world.[fc]

- Fortran

```
include 'mpif.h'
integer*4 ierr,num_pe,my_pe
real*8 x
call mpi_init(ierr)
call mpi_comm_size(MPI_COMM_WORLD,num_pe,ierr)
call mpi_comm_rank(MPI_COMM_WORLD,my_pe,ierr)
call mpi_barrier(MPI_COMM_WORLD,ierr)
print *,'hello from node ', my_pe,' of ',num_pe
call mpi_finalize(ierr)
call exit
end
```

- Compile

  cif77 -o mine mine.f -lmpi

- C

```
#include <nx.h>
void main()
{
if (mynode() == 0)
      printf(“The number of nodes %d\n”,
     numnodes());
}
```

- Compile

  cicc -o mine mine.f

- Execute

  %**yod -sz 32 mine**

  %**yod -sz 32 -comm 6M -stack 2M progname -f file1 file2 file3**

  # -comm is only for NX message passing

  # see ‘yod -help’ for default stack size

Break

"Talk about Blue Mountain"

Programming Model

- Distributed Memory, MIMD architecture.
- Explicit Parallelism:
  - Decompose data structures into small chunks and distribute them among the nodes of the machine.
  - On each node, use standard programming languages for local computation.
  - Pass messages between nodes to update distributed data structures.
- Implicit Parallelism: HPF (not available yet on ASCI-RED)
  - Provide information about which data structures to distribute.
  - Let the compiler manage data distribution and concurrency.

intel

Message Passing

- Two Message-Passing Libraries
  - MPI:
    - The 1.1 specification.
    - 1-sided communication
  - NX: The native Paragon message passing library.
    - The Sunmos compatibility version of NX will be supported.
- Both libraries provide a full featured message passing environment
  - Synchronous and Asynchronous communication.
  - Broadcast
  - Global operations (global sum, max, min, etc).

Programming Languages

- The following languages will be supported
  - Fortran77
  - C
  - C++
  - HPF
  - Fortran90
- The compilers written by PGI.
- Libraries
  - libc.a
  - libm.a
  - libkmath.a (blas)
  - libperfmon.a
  - libdbmalloc.a
  - libmpi.a
- Signals (some)
- NagF90 being ported now

IO

- PFS
  - Optimized for large block transfers
    C: read/write
    Fortran: cread/cwrite
    (Note: Sandia Paragon was using fread/fwrite)
  - 64 KB stripe sizes currently -- Expect to increase
  - singly-striped vs. Multi
- UFS
  - /scratch
  - Standard Network and Unix File Systems

Moving Target--still being configured

Tools

- Debugging
  - Parallel Scalable Debugger.
  - MQM: Message Queue Manager.
  - Light weight Corefile browser (Ptools).
- Performance analysis
  - Compiler driven code instrumentation.
  - User callable library for control of NIC and P6 counters.
- Resource Management
  - MACS: resource accounting.
  - NQS: Tool for scheduling parallel batch jobs.

    Queues: (Day/Night)*(Full/End-only)*(SNL/LANL/LLNL)

    interactive during prime time

Performance Tips for the Pentium Pro

- Improve Branch Prediction (static algorithm)
  - Make forward branches usually not taken
  - Make backward branches usually taken
  - Compiler predicts if tests “true”

```
if <condition> {
    no performance hit
} else {
    performance hit
    }
```

- Use the cache
- Avoid floating point to integer conversions
- Avoid misaligned data (dynamic alloc), usually done by compiler
- Avoid divides

Reference URL: http://www.intel.com/design/pro/applnots

See App. Note 526

What about the Second Processor?

- There are three possible modes for the second processor:
  - — ignore the second processor.
  - — use it as a communication co-processor.
  - — use it to run an additional application thread.
- How to make use of the second processor in the application
  - — Math Libraries
  - — Compiler directives
  - — COP interface from Cougar.
- math libraries - just link in the right libraries and ??? argument to yod
- Use the -Mconcur compiler switch and source code directives.
- The Compiler's functionality will go well beyond the MP-Paragon:
  - — Parallel Loops - cyclic, block and with/without barrier
  - — Private data directives
  - — Parallel Sections
  - — Critical Sections
  - — Single user Section
  - — Barriers

Unique aspects

- No virtual Memory
- No Posix threads
- No sockets from parallel applications; must go through filesystem