



National Aeronautics and Space  
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Jet Propulsion Laboratory  
California Institute of Technology



Hardware

# Processing System Hardware

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WISE Science Data Center CDR – January 29-30, 2008

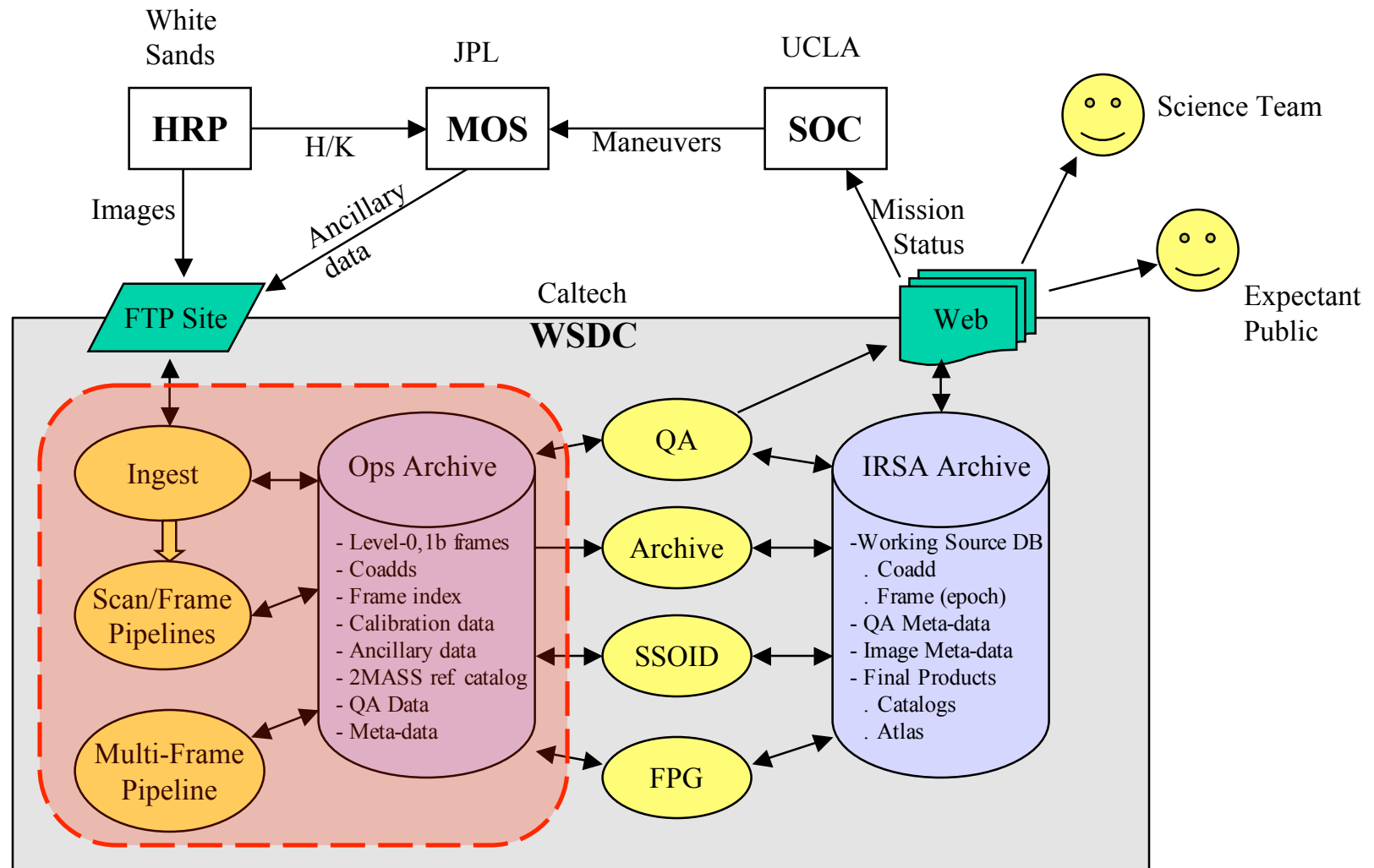
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# WSDC Functional Block Diagram



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# Driving Requirements



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- Must deliver processed data in time to meet the operations scenario.
- Budget. This implies commodity hardware and free/Open Source software tools.
- Scalable. Start with a little now, add more with need.
- Heterogeneous.

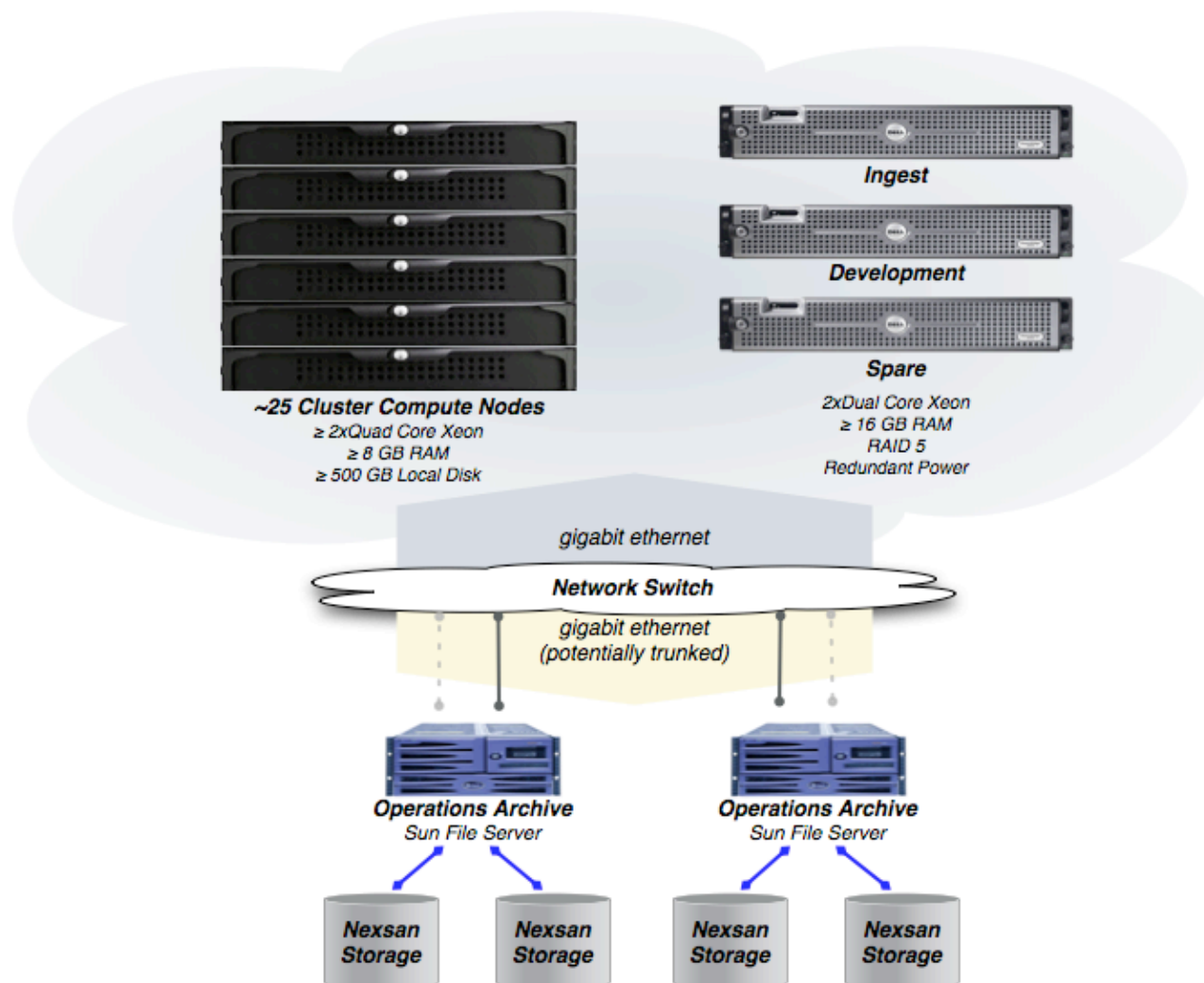




# Processing System Hardware



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# Current Status



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# Cluster



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- ~25 2xQuad-core Commodity Dell servers. 1U, 8 GB RAM, 500GB SATA storage
- Some machines will have better resources: more RAM/faster CPUS
- We run RHEL4.
- Current frame pipeline scales with increasing cores and increasing number of cluster nodes\*

\* Scales as long as we can push data in and out fast enough, of course.



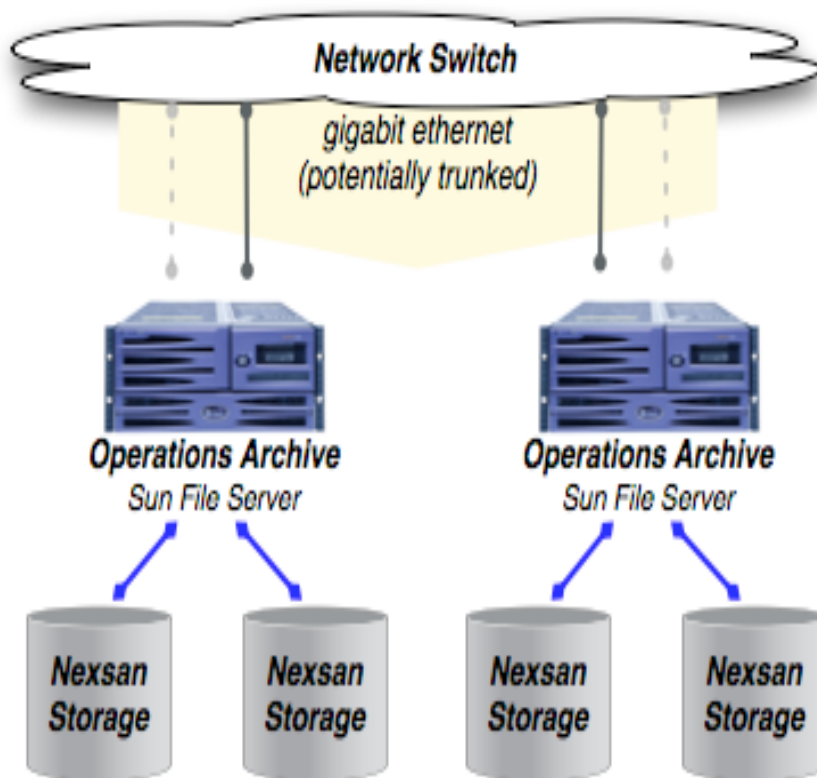




# Operations Archive



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- The operations archive hosts the WSDC software tree and functions as persistent data store for L0, L1, and L3 products
- Accessed by pipelines to retrieve their inputs and push their (minimal) products
- Critically important that the operations archive can support the data rate required to meet the mission operations scenario. Currently we calculate this as 2Gbs.

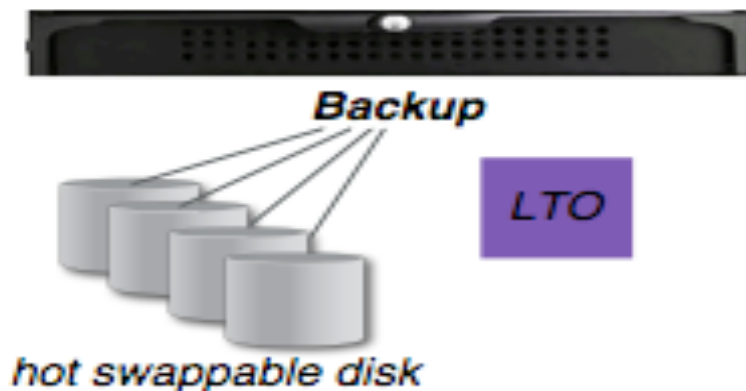




# Backup



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- Current backup provided by IPAC Systems Group
- Future backup of operations archive occurs on WISE hardware
- Utilize hot swappable disk for local, cycling backup
- Utilize LTO for long term offsite backup (Telemetry, expanded L0 products, Archive)







# Disaster Recovery



- In case of disaster WSDC provides minimal functionality: ingest of telemetry and housekeeping, generation of L0 images, and quicklook pipeline processing to assess spacecraft health.
- These functions can be provided by single offsite machine, configured as a normal cluster node, with attached storage and a copy of the WSDC software tree.

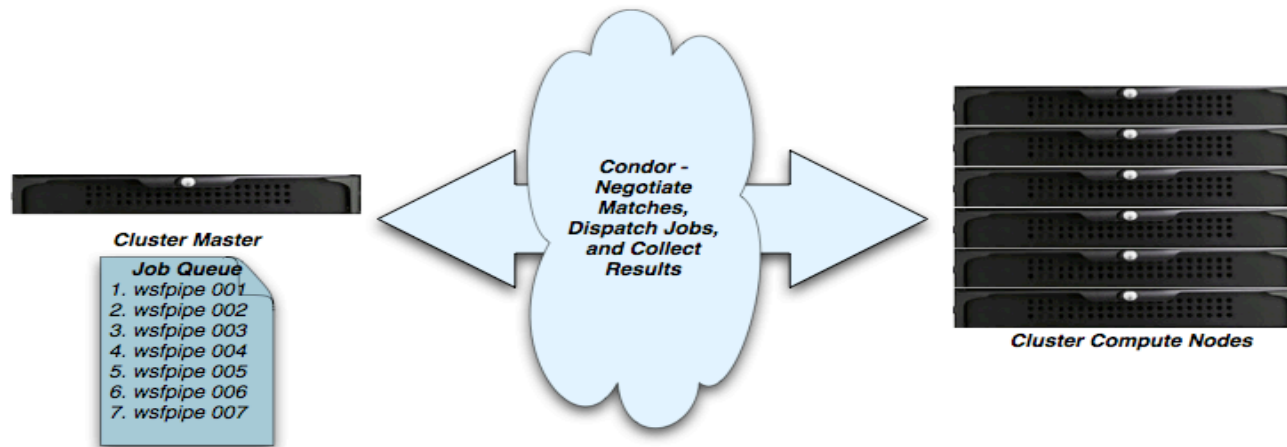




# Job Scheduling



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- Use Condor, a cluster scheduling package from the University of Wisconsin.
  - WISE has a simple use case: first pipeline in is the first pipeline executed
  - We don't use MPI, checkpointing, backfilling or other fancy cluster technologies available with Condor
  - Condor can match jobs with big resource needs to the machines with those resources (example: Condor matches a big coadd to a machine with > 16 GB RAM)





# Cluster Resource Monitoring



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- Use Ganglia, an open source project for accumulating, collecting, and displaying near-realtime resource use measurements for clusters
- Can be expanded with custom monitors





# Frame Pipeline Execution



- Depending on the simulated scene current frame pipeline executes in 150-180 seconds CPU time.
- On an unloaded node, elapsed clock time is *less* than time on CPU, typically resulting in CPU utilization of 110-120%
- CPU bound





## Concurrent execution via Condor



Hardware

- Condor partitions a node into 8 “virtual machines” - 1 per core
- Condor dispatches 1 job to each virtual machine
- Ran experiments queuing different numbers of frames through Condor. For runs with a fill ratio  $> 1$ , execution clock times are flat, with  $\sim 98\%$  of time spent on CPU
- With nodes fully loaded, one pipeline per core, we are close to using our full 8GB RAM in portions of the frame pipeline.
- Still not waiting on IO.

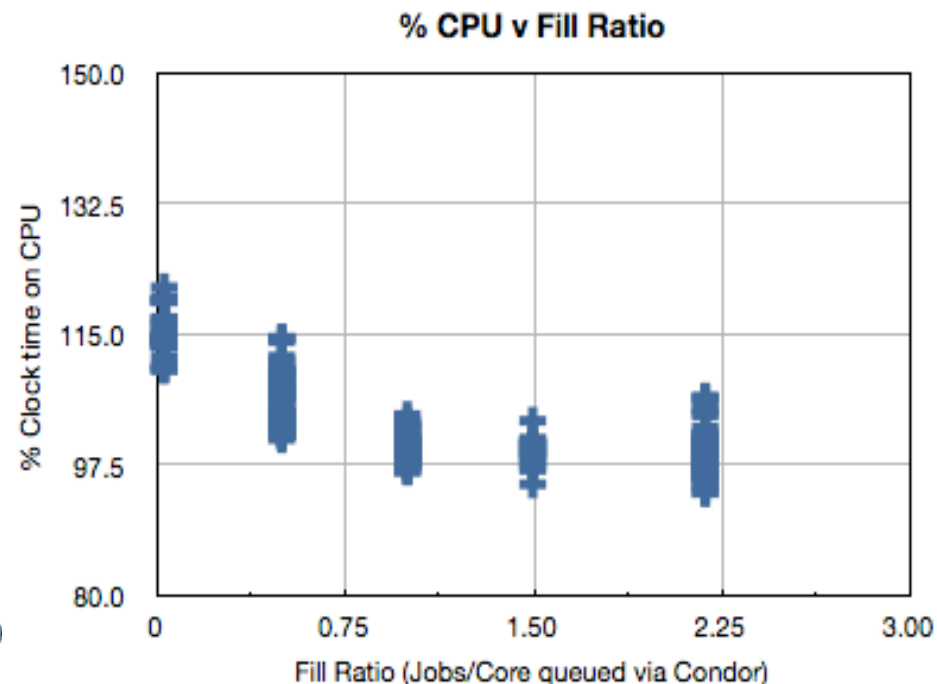
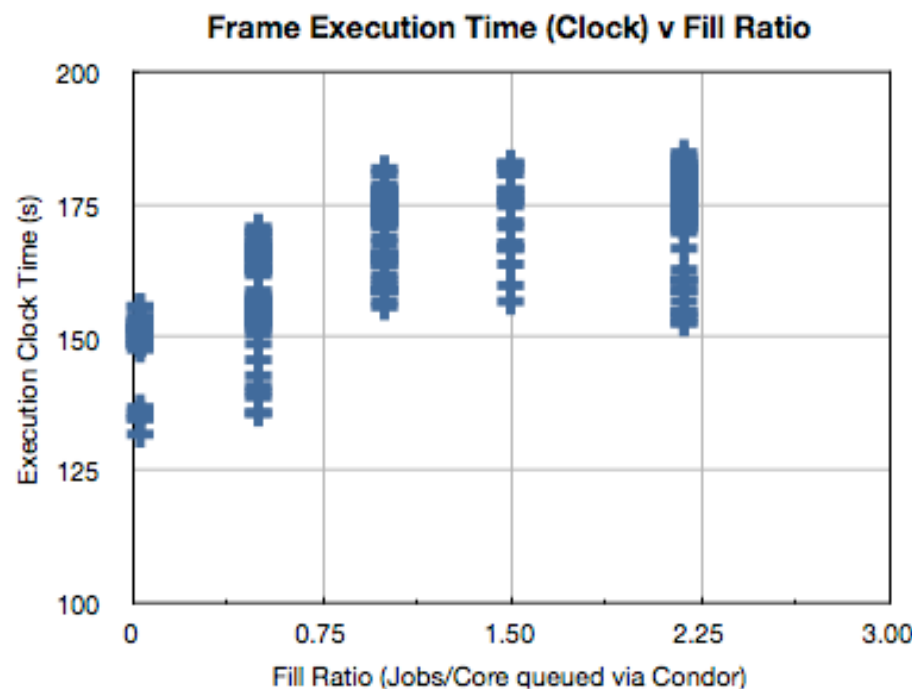




# Concurrent execution via Condor



Hardware





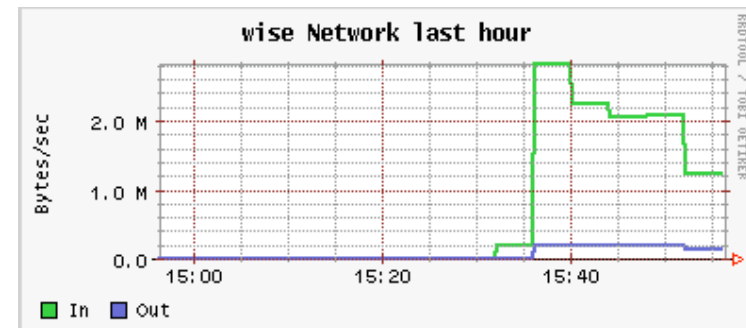
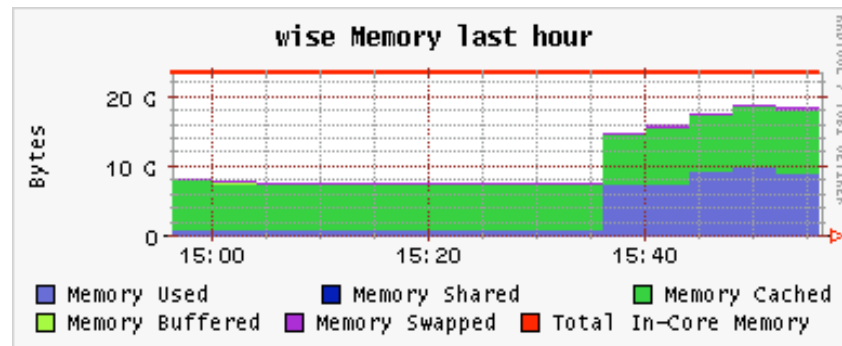
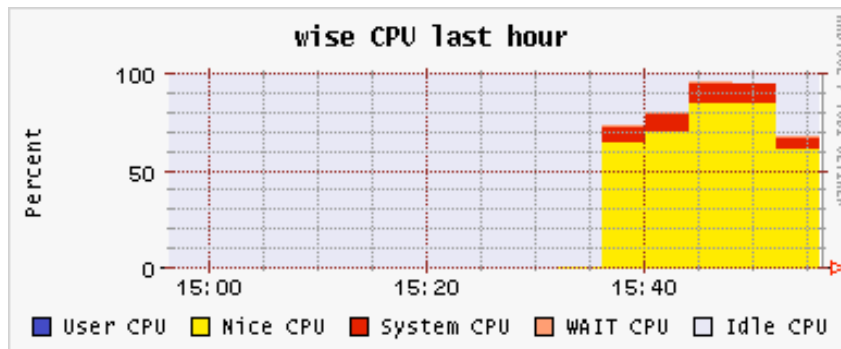


# Simulated Scan Execution



Hardware

- 250 frame simulated scan
- Run on 4 machine development cluster
- Ops Archive disk mounted on dev server, exported to cluster via NFS



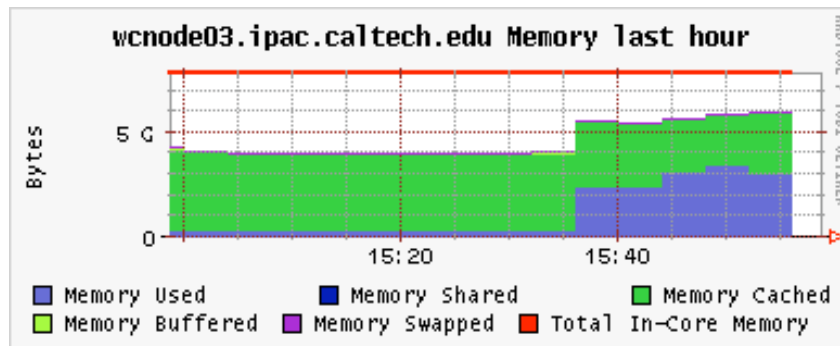
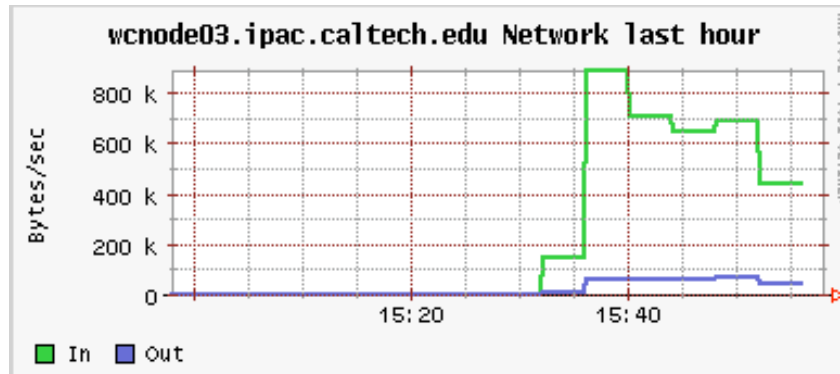


# Simulated Scan Execution



Hardware

- Single node statistics





- Tests were done by loading more than 8 pipelines onto cluster nodes
  - At 12 pipelines/node seeing IO waits to node local storage
  - At greater numbers of pipelines, started paging
  - Largest 5 minute average traffic on the cluster network ~40Mbps
- Unable to properly test network loading scenarios via frame pipeline with current cluster hardware





# Deployment Schedule



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- Phase 1 / WSDS v2
  - Support mission scenario testing
  - 10 cluster nodes + 1 master
  - 1 fileserver, 1 disk array (v2 - 4 months)
  - Ingest machine
- Phase 2 / WSDS v3
  - Support ops readiness tests, launch, IOC
  - 24 cluster nodes + 1 master
  - 2 fileservers, 2 disk arrays (v3 - 2 months)
  - Backup System (v3 - 4 months)
  - System complete as specified
- Phase 3 / Q2 2010 (or 3 months post launch)
  - Purchase additional disk and CPU based on measured needs for final processing



## Issues/Concerns

- Testing network & operations archive scalability to 20 cluster nodes
- Condor job management tools are command-line and based upon its own job abstractions & terminology. TBD need for job management tools targeted at a human operator working on scans, frames, and coadds.