FermiCloud: A private cloud to support Fermilab Scientific Users

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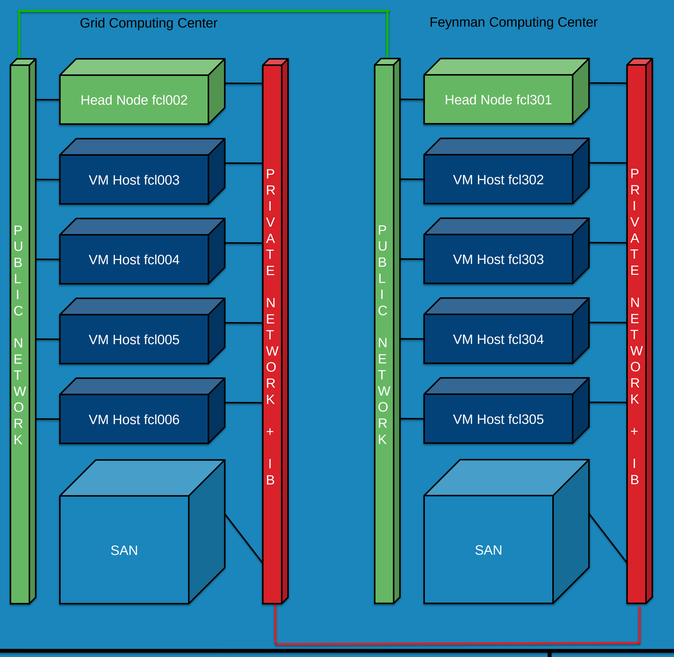
What is FermiCloud?

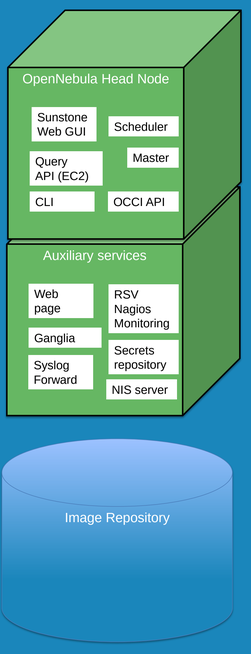
- Infrastructure-as-a-service private cloud for Fermilab Scientific Program.
- Integrated into Fermilab site security structure.
- Virtual machines have full access to existing Fermilab network and mass storage devices.
- Scientific stakeholders get on-demand access to virtual machines without system administrator intervention.
- Virtual machines created by users and destroyed or suspended when no longer needed.
- Testbed for developers and integrators to evaluate new grid and storage applications on behalf of scientific stakeholders.
- Ongoing project to build and expand the facility:
  - I. Technology evaluation, requirements, deployment.
  - II. Scalability, monitoring, performance improvement.
  - III. High availability and reliability

FermiCloud Operations

- Stock virtual machine images are provided for new users.
- Active virtual machines get security patches from site patching services.
- Dormant virtual machines get woken up periodically to get their patches.
- New virtual machines scanned by site anti-virus and vulnerability scanners, don't get network access until they pass.
- Three levels of service:
- 24 by 7 high availability, can have fixed IP number,
- 9 by 5 development/integration, use one of a pool of fixed IP's,
- Opportunistic—Can be pre-empted if idle or if higher-priority users need cloud.

FermiCloud Architecture Diagrams





X.509 Authentication

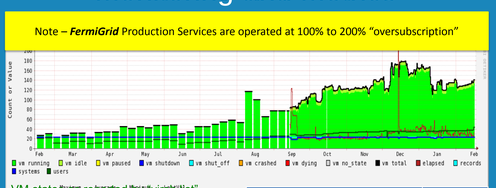
- Use OpenNebula Pluggable authentication feature.
- Wrote X.509 authentication plugin and contributed back to OpenNebula, included in OpenNebula 3.
- X.509 Authentication is integrated into command line tools, EC2 Query API, OCCI API, SunStone management GUI.
- Contributing to standards bodies to make authorization callout to external services, similar to Grid authentication.

Virtualization and MPI

Configuration	#Host Systems	#VM/ host	#CPU	Total Physical CPU	HPL Benchmark (Gflops)
Bare Metal without pinning	2	--	8	16	13.9
Bare Metal with pinning (Note 2)	2	--	8	16	24.5
VM no pinning (Notes 2,3)	2	8	1 vCPU	16	8.2
VM with pinning (Notes 2,3)	2	8	1 vCPU	16	17.5
VM+SRIOV with pinning (Notes 2,4)	2	7	2 vCPU	14	23.6

Notes: (1) Work performed by Dr. Hyunwoo Kim of KISTI in collaboration with Dr. Steven Timm of Fermilab.
(2) Process/Virtual Machine "pinned" to CPU and associated NUMA memory via use of numactl.
(3) Software Bridged Virtual Network using IP over IB (seen by Virtual Machine as a virtual Ethernet).
(4) SRIOV driver presents native InfiniBand to virtual machine(s), 2nd virtual CPU is required to start SRIOV, but is only a virtual CPU, not an actual physical CPU.

Monitoring and Metrics



VM states as reported by "virsh list"

records	23	23	23	23
systems	23	23	18	23
vm total	172	83	22	133
vm running	172	83	22	133
vm idle	7	7	6	7
vm paused	1	0	0	0
vm shutdown	0	0	0	0
vm shut off	0	0	0	0
vm crashed	0	0	0	0
vm dying	0	0	0	0
vm no state	0	0	0	0
users	43	24	9	43
elapsed	305	31	17	32

Note - vm states as reported by virsh list
Data for form
Plot generated

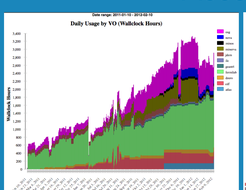
FermiCloud Target

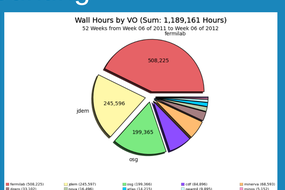
FermiCloud Capacity	# of Units
Nominal (1 physical core = 1 VM)	184
50% over subscription	276
100% over subscription (1 HT core = 1 VM)	368
200% over subscription	552

Grid Cluster On Demand

- Define policy-based expressions for "Idle"
- Detect Idle virtual machines
- Suspend idle virtual machines
- Use vCluster package:
- Look ahead at batch queue
- Submit correct virtual machine to FermiCloud
- Submit to Amazon EC2 if extra capacity needed
- vCluster a collaboration between Fermilab and KISTI

Accounting





High Availability

- Machines in two different buildings
- Mirrored SAN between buildings
- Global shared file system between all nodes
- Copies of all VM's available in both buildings
- Network routable from each building
- Pre-emptive live migration for scheduled outage
- Restart of VM's after unscheduled building failure

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