# USENIX LISA 2007

**Opening Session**

* 55 papers submitted, 22 accepted, over 1,000 attendees

**VMWare**

* VMotion: Ability to hot move VMs
* Storage VMotion: ability to migrate storage between machines while hot
  + Move storage LUNS hot (from small to big, from expensive to cheap, allows hot storage array maintenance
* VMFS (filesystems) will support ability to hot expand file system size in near future
* ESX3i is about to release this quarter.
* Virtual appliance as small as 32meg
* Question came up frequently: can you remove msft dependence from Virtual Center.
* VCB: VMWare Consolidated Backup (backup interface for partners supporting image based backup)
  + Freeze/thaw interface
* Several customers are using block level transfer between VMs
  + One was going 7 miles async, another 350 miles sync
* Speaker believes that iSCSI will replace Fiber (SAN based systems).  Some say NFS as good but he doesn’t believe it.
* Some customers report iSCSI slower than Fiber Channel but works “very well”
* One reports iSCSI a great way to reclaim massive amount of storage not being used (storage virtualization)
* Talked about mixing workloads such that I/O bound and CPU bound on the same server can better utilize a given server.
* They now support P-to-V (physical to virtual) migration
* VMWare capacity planner: predicts number of servers needed for consolidation.
* Biggest driver is out of power and cooling (not out of space). “Consolidation of low utilization servers saved tremendous amount of power …. Went from near 100% power down to about 52%”
* ESX now supports power management: low utilized VMs are migrated off servers when cold and the servers are put in a low power sleep.  When load climbs back up, they are migrated back.
  + Some customers report 50% power savings over the year
* Customers kept pounding for port of all the admin functionality to Linux. Don’t want to have Windows only for admin functionality.
  + They eventually gave up and said “we agree … I don’t know why we haven’t done this”
  + Said that they went first to Windows because “that’s where the problem children are”. Windows customers have more problems and lower utilization.   Linux community is only just starting to virtualize in a big way.

**Google: Scaling Production Repairs and QA Ops in a Live Environment**

* Shane Knapp (at Google since2003)
  + Leads the Data Center Tech team (fix machines and do burn in test)
  + There are 30 to 40 people in his team all over the world (sounds like that is the entire team of HWOps)
* We have been growing more than exponentially throughout the full period so the only option is to test in production
* Not going to tell you about machine counts, power consumption, or SEO
* Started with 1 data center technician in 1998 and grew to three in 2003
  + They now have hundreds of DC techs now
* In 2003, all ops work was manual
* AI2 is Auto-installer 2 (big python daemon that manages the system repair workflow)
  + Data Driven installation workflow engine.  New phases can be added via DB update
* Touch Pad is a hand held system that DC techs can use to enter data on machine state during repair
* Workflow:
  + Machine assigned to repair
  + AI2 installs
  + Burn-in
  + Moves to machpool if it fails (needs repair)
* Now using statistical methods to figure out how to run more efficiently.
  + E.g. how short can burn-in be without giving up effectiveness
* They have a central DB that tracks all H/W work done on any machine
* He’s a big believer in standardized, central tracking, locked down processes, & coding guidelines
* Gradual releases are a reality. All software admin or otherwise gets deployed incrementally and there will be multiple versions running.
* Choose technologies carefully.  Don’t want write only languages.  We need to have a stable environment and new people are joining every day.  Perl, for example, is a poor choice. We don’t use Ruby either.  Lots of Python throughout Google.
* “Databases: Sleeping with the enemy”
* Statistical analysis is your friend.
* Biggest lesson learned: Be careful!
* “Automate everything”
  + Wrap everything in workflows
* Always be able to rollback (always have an exit path)
* Be careful of state changes and who and/or what can do them: we once accidentally put all machines into a repaired state.  Broken machines and machines in burn-in went into production.

**Hardware Ops Release Engineering (how I learned to stop worrying and love red tape)**

* Speaker: Avleen Vig
* At Google since 2005, Earthlink previously
* Need approval processes and/or change control boards depending upon criticality of the software.  Need some sort of approval mechanism
* Release notification from 0 to 7 days depending upon criticality of s/w.
* Need separation of responsibilities: devs develop and ssyadmins deploy (devs don’t have root).
* Don’t rollout software when few folks around to fix problems.
* Lessons Learned:
  + Developers will be developers (and have a negative view of release engineering)
  + Obsess on reducing red tape
  + Flexibility is more important than rigid procedure

**No Terabyte Left Behind: A Crisis of Space**

* Intro: “if we were to bug each of  your phones (hypothetically), well, it would be a LOT of information”
* Speaker: Andrew Hume (AT&T Research)
* One of the most useful talks of the conference.  Key points mostly focused on the unreliability of the storage stack and the need to checksum everything and store all data redundantly.
* Server storage cost plummeting
* ½ to 2TB of local disk common on most clients)
  + How do you back it up? Dump over network very slow.
* Still backup to tape (and likes it)
  + $0.10/GB not including people costs and the tape library costs
  + Recommends hot data cached on disk in front of the library
* You need to verify all backups and restores (errors will be found).
* All I/O is managing disk heads
* I’ve given up on iSCSI: too many silent errors (likes fiber channel)
* Check your data!  Trust no one and recomputed checksums frequently.  Must be checked end-to-end.
  + Many stories about failures up and down the I/O and networking stack
* Bill Bower (ZFS): 1 uncorrectable error every 10 to 20 TB (hasn’t been changing).

**The Large Hadron Computing Challenge**

* Speaker: Tony Cass, Leader, FabricInfrastructure & Operations Group (CERN)
* LHC: Trillions of protons race around 27km ring in opposity directions 11,000 times per second
* Operating temp of over -271C (just 1.9 Kelvin) – colder than outer space (3K)
* Liquid helium cooled
* At CERN: 10,000 people ,38 countries, 111 nationalities
* 40M particle collisions/second
  + Data reduction to a few hundred “good” events/second
  + 100MB/sec to 1GB/sec yielding 15PB/year
* Compute clusters
  + 2,500 compute servers
  + 1,500 used for storage servers
* Distributed data center design:
  + Tier 0: CERN
  + Tier 1: 10 centers over the world
  + Tier 2: 100 centers in 40 countries (simulation and end user analysis)
* Commercial systems management too expensive and didn’t save enough to justify their costs
  + They roll their own as do most high energy physics projects
* They track power consumption of all systems. They also track UPS status, temp, etc.
  + Able to trigger power down if over cooling capacity or power limit
* They purchase servers 400 at a time
* Power graphs showed one data center in the 88 to 90% of max power which is fairly high.
* Dataflows and rates:
  + 1.2 GB/s to tape (can peak at 2GB/s
  + 1.5GB/s to T1 sites (in aggregate)
* Can run disk drives at 80MB/s
* Hand crafted their own storage manager (CASTOR) as these high scale experiments typically do. Fermilab has one called dCache.  DPM is also in use.  Stroage Resource Manager from LBL is a common interface over all the hand crafted storage managers to insulate programmers from change.
* Use a custom built file transfer system to move data between sites:
  + Supports prioritization and policy
  + Peaks at 1.3 to 1.4 GB/s
* Private optical network between all Tier1 sites (10 Gb/s)
* Due to technology changes, they will reprocess all data every 2 to 3 years and expect to want to keep it current until 2020 or later
* Disks:
  + 1996: 4GB & 10MB/s
  + 2000: 50GB & 20 MB/s
  + 2006: 500GB & 60MB/s
  + They two storage models: 1) Capacity or 2) throughput oriented
* Showed a server status visualization system that used treemaps showing each data center but “importance” (can be largest, most jobs, criticality,…) and then colors the regions green, yellow, or red. SLAC uses Magnaview ([www.magnaview.com](http://www.magnaview.com))

**Ganeti: An open source high availability cluster based on Xen**

* Speaker: Guido Trotter, Google Ganeti team
* System admin at Google and member of Debian development team
* Open source: <http://code.google.com/p/ganeti/>
* Used in production with 20 nodes at Google in a single instance. Can support 100’s of instances.
* Users DRDB (block replication service between servers)
* One node in the cluster is nominated as master (all commands go to master)
* Xen can do hot migration but it’s not yet supported by Ganeti (coming soon)
* Xen & Ganeti used in Google IT shop (corporate use rather than handling google.com traffic)
* Typically run a separate replication network (but not required)
* Ganeti is typically implemented in 20 machine racks
  + Typically use 64 bit nodes
  + Typically run 80 virtual instances
* Licensed using GPLv2

**The Economic Meltdown of Moore’s Law**

* Speaker Kenneth G. Brill, Executive Director, Uptime Institute
* White paper on this topic: <http://www.uptimeinstitute.org/wp_pdf/(TUI3008)Moore'sLawWP_080107.pdf>.
* Why facility costs are growing from 1 to 3% of IT budget annual to 5 to 15%
* The rate of computation increase (Moors Law) is greater than the rate of power efficiency increase
  + This spread is worsening
* East coast is paying as much as $0.15 kw/hr
* Dr. Koomey: servers not including SAN, tape, and other IT usage: 1.2% of total US power consumption (was 0.6% in 2000).
  + Expect to double by 2010
* Data Center floor space is irrelevant and anyone trying to reduce costs via floor space reduction is using very out of date data.
* Assuming $0.07 kw/hr, what’s is the cost to power a $1M IT spend:
  + 2000: 32 kw ($0.5m site IT spend)
  + 2003: 63 kw ($0.9m site IT spend)
  + 2006: 109 kw ($1.8m site IT spend)
  + 2009: 283 kw ($2.5m site IT spend)
  + 2012: 398 kw ($7.0m site IT spend)
* Four consumption metrics determine data center greenness:
  + It strategy optimization
  + IT hardware asset utilization
  + IT energy efficient hardware deployment
  + Site infrastructure overhead minimization
* Up to 30% of servers in data centers could be turned off
  + My experience is that there is lots of very nearly idle equipment but most if it does a tiny amount. If they were doing nothing, we could pull the plug – that’s easy.
* Need to charge business units for what they really consume in total.  Also need to charge them to get them to do proper capacity planning.  It should cost more if they don’t.
* Most are using 2 to 3 times the cooling actually required (bad data center design and practices)