Transformation of a Mature Data Center

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Presented by:

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Sandia is a multiprogram laboratory operated by Sandia Corporation, a Lockheed Martin Company, for the United States Department of Energy's National Nuclear Security Administration under contract DE-AC04-94AL85000

The Facility

- 40+ year old facility
- Multiple remodels & additions
  - project driven
  - typically constrained to project needs
  - some future foresight for power & cooling but limited by project budgets
- 7 different rooms comprising 32,000 square feet
- Raised floor varying from 12” to 18”
- Chilled Water Plant - 3,000 tons capacity
- Power – 7 Meg available
  - standardized feeds from 1500 KVA transformers

What We've Been Able To Do

- Housed the 1st Teraflop
- Housed the 6th fastest computer in the world - Thunderbird
- Currently houses Red Sky
  - regarded as one of the most energy efficient in the world
- Years past housed Paragon, Cray XMP's & YMP's and other water cooled systems
- Also all Sandia Enterprise and business application computing resides in the facility

How is this possible?

Change in Values

Today's economic times and pressures to reduce energy consumption mean the data center must operate both effectively and efficiently.

We have managed to utilize an existing mature data center to respond to an increasing demand for compute power
and
simultaneously achieve reductions in energy consumption and a more efficient data center.

First and foremost was the change in how we looked at the data center function and costs.

"IT administrators see the cost of a server, but not the cost of the facility to house it or the energy required to keep it running, which over the life of the server will be three to five times the cost of the server."

Kenneth Brill & Gail Dutton, AFCOM Data Center Management, Sept/Oct 2008

Importance of Infrastructure

Past - Infrastructure was an afterthought

- Reactionary retrofit of existing facilities based on computer system design
- Modernization, remodel or upgrade of infrastructure considered only on a project-by-project basis not as part of a master plan

Data center plans failed to be "complete" because there was no connection between system administration and the facilities infrastructure …until it simply cost too much.

Today - Infrastructure recognized as a critical and costly part of the Total Cost of Operations (TCO).

Our continued success is due to combining our computer systems plans and decisions with the facility infrastructure plans and decisions.

Facility Plans - Past

There was no plan

- Rack Placement Random
- PDUs Placement Random
- Cabinets, Desks & Other Storage on Raised Floor
- No Power or Cooling metrics
- SNL Facilities Org Determined Infrastructure
- Customers Dictated Facility Management
- Power and Network Cables Under Floor
- No Active Decommission & Consolidation Plans
- No Air Flow Management
- Floor Leaked Air & Needed Repair
- Customers Not Accountable for Equipment/Floor Space
- Racks and Cables Not Labeled
- Facility Maintenance Parts and Equipment in Disarray
- Only 1 Power Feed plus UPS to Each Room
- Chiller Plant Temperature at 41 Degrees
- Under Floor Temperature Maintained at 55 Degrees

Facility Plans – Where Were We Going?

Developed a plan to get data center operations more efficient and incorporate future needs

Key factors in the plan:

- Raised Floor Space will Be Managed
- Data Center Facilities Team Defines Infrastructure Requirements
- Customers Held Accountable for Equipment & Floor Space
- All Infrastructure Work include Eye to the Future
- Metrics will be Maintained to Gauge Effectiveness and Efficiency of Data Center Operations

Results – Small Wins Yield More Efficient Operations

- Racks Rows & Planned Placement
- Standardized Cables & Wire
- Cabinets & Desks Removed from Raised Floor
- Floor Repaired and Koldlocs Mitigate Air Losses
- Customers Recognize Need for Efficient Operations
- Raised Chiller Plant Temperature to 45 Degrees
- PDUs in Strategic Locations
- Racks and Cables Labeled
- Automated controls on CRACs and PDUs to Provide Metrics
- Overhead Cable Trays for Network and Fiber
- Actively Decommissioning & Consolidating
- Under Floor Temperature Raised 8-10 Degrees

Results – Impact on Operations

- Shutdown one-third of CRAC units due to improved air flow management

- 85% of PDUs have been strategically placed
- 90% of cabinets, desk & storage removed from floor
  - ✓ gained 3,600 square feet of usable raised floor space

- Purchase decisions include operational efficiency not just system performance

- SNL Electrical Safety Committee sited data center as:

  "model electrical safety operations"

Results – Operational Changes

- VFDs
- Cold Side Control
- HPC machine built with power & cooling critical decision factor
- Rooms segregated by machine density
- Thermography
- Cold Aisle Containment
- Partnership with organization for lease of 3,000 sq ft
  - Unused raised floor
  - 500 kW power/cool 50+ racks
- Direct Cooled Machine

Results – Future Preparedness

- Sized piping larger to accommodate Indirect or Direct cooling
- Larger pump size on chilled water system for flexible gpm
  - spin pump faster
  - install larger impeller
- Baseline light audit to take advantage of remodel or upgrade opportunity
- Conduits strategically installed so can plug and place transformers and switchboards
- Removed wet pipe sprinkler system and replaced with FM200
  - Frees under floor
  - Better fire suppression
- Updated environmental monitoring & automated equipment provides path towards “lights-out” operations

Overview of Our Data Center Past, Present & Today

Past 3 kW to 10 kW per Rack Medium Density	**Past** 10 kW to 24 kW per Rack High Density	**Today's Systems** 18 kW to 40 kW per Rack Higher Density
100% Air Cooled CRACs with Centrifugal Fans	**100% Air Cooled** CRACs with Plug Fan	**10% Air Cooled** CRACs with Plug Fan
		90% Direct Cooled
•Return Air Control (Temp) •Hot-Cold Aisle Configuration Required	•Cold Side Control •Direct Drives •Hot-Cold Aisle Configuration Typical	•Refrigerant Heat Exchange •Passive Cooling •Efficient Cool Air Delivery
Efficiency *Losses*: •Rack placement critical due to Venturi effect •Fans non-variable (runs full speed 100% of the time) •Belt driven requiring maintenance and down time •Inherent inefficiencies required 1.5 CRACs for needs ❖Consumed more: ▪Chilled water ▪Space ▪Energy	Efficiency Gains: •Rack placement not critical •Fan speed driven by compute load •Cold side control even control of pump for chilled water –Less energy consumed at the chiller ❖Consumed less: ▪Chilled water ▪Space ▪Energy	Efficiency Gains: •No compressor to pump refrigerant •Rack placement supports air flow •Don't consume energy to pre-cool the rack ❖Significantly less consumption: ▪Chilled water ▪Space ▪Energy
65% Sensible Cooling	75% Sensible Cooling	97% Sensible Cooling

Air Plenums

Reduce Amount of Lost Air from CRAC Units (Short Cycling Room Air)

Initial Install (early 1980's)

Latest Install

Air Flow Management

Using Overhead Air Confinement Space to Provide Improved Cooling Efficiency in Hot/Cold Aisle Configuration

Balloon Fabric

Containment Curtain

Cable Management

Improved Room Cooling Efficiency and Safer Operations

Overhead Cable Trays for Network and Fiber

Power & Network Under Floor

No Cable Management

Incorporating Renewable Energy Technologies

Collaboration with Distributed Energy Technology Laboratory (DETL) for Center 9300 owned photovoltaic panels

- Installing 160 photovoltaic (PV) panels at the DETL site
- DETL will use Center 9300 PV for project tests
- Center 9300 will reap all energy credits from DETL-owned panels and Center 9300 panels
- Approximately XXX Energy credits applied to Red Sky

Fuel Cell Technology

Wind Technology

Sandia recently won a Pollution Prevention award for recycling of electronic components such as computer boards and hardware.

Every piece of computer packaging we recycle. We are one of the largest recyclers (per ton) at Sandia.

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Questions?

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