Next-Gen Data Center
Improving TCO & ROI in Data Centers thru Virtualization and Blade Servers

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Chaos in the Enterprise . . .

(1) Scales poorly  (2) Difficult to manage (3) Reliability is questionable  (4) Management costs out of control
Genesis of NGDC

CFO vs. CIO - Shocking Observations

- IT Infrastructure Investments yet to achieve TCO/ROI Financial Objectives
- Expected Boost in Corporate Productivity not Visible to CFO/CEOs
- Post 2000 Dictum  Do More with Less

Reason – IT Spiral

- **Web Growth** → New Apps Mushroom → Low Cost Windows (Tier-1) Servers Sprawl
- **Business Growth** → More Computing Power
  → Applications/DB → (Tier-2,3) Servers Sprawl
- More Servers → ↑ Storage → ↑ DC Facilities → ↑ IT Support → ↑ IT Staff
- IT Costs $\neq$ Business Growth
DC Infrastructure Nightmares of CIOs

- **Servers Utilization**
  - Today: Win 5-10%, SMP 20-35%, MF 30-50%
  - Targeted: 80+%%
  - Today: 15-30
  - Targeted: 300+

- **Storage Utilization**
  - Today: 30-45% Disk, 20-40% Tape
  - Targeted: 75+%%
  - Today: 1TB
  - Targeted: 100TB

- **MIS Alerts**
  - Today: 3-5 Alert/Day
  - Targeted: 20-40

- **System Availability**
  - Today: HAL-3 (99.9%)
  - Targeted: HAL-5 (99.999%)

- **Power & Cooling kW/Rack Capability**
  - Today: 2-5 kW/Rack
  - Targeted: 15-25 kW/Rack
Follow SIVA® for a Scalable & Dynamic NGDC

- **Integration**: Integrates physical infrastructure sing Scalable Blades to Optimize CAPSIMS: Cost, Availability, Performance, Scalability, Inter-operability, manageability & Security

- **Virtualization**: Pools Resources, Optimally Provisions them for given Usage/Application to Deliver Business Service, Monitors Usage

- **Automation**: Automatically Maintains App Service Level Objectives using Policy Based ILM

- **Standardization**: Reduce CAPEX via using Industry Standard Infrastructure - HW, Interfaces, Open Source SW – OS, Middleware, and Shrink Wrap Applications > Reduced OPEX in Support, Training for Delivery of Business Services

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Key to Integration: Interconnect Fabrics

- Ethernet, Wi-Fi
- Quadrics, Myrinet, SCI InfiniBand, Ethernet / IP, Ethernet IP w/TOE, Ethernet IP w/TOE and RDMA
- SCSI, Fiber Channel, iSCSI
Blade Infrastructure: Local Area Grid (LAG©)

- **Processor Blades** (6-24 typically)
- **Midplane** W/Connectors To Blades & Back Modules
- **Networking**: Gbit Ethernet Switches
- **Storage**: IP NAS or FC SAN Switch
- **Cooling**: N+1 Fans/Cooling Modules
- **Power**: N+1 Power Supplies

**Management Modules** Remote Mgmt+KVM over IP

**Networking**
- GbE Switch supports
  - Trunking/Port Aggregation
  - Flow Control
  - QoS Packet Prioritization
  - SNMP/RMON
  - IGMP/BOOTP/TFTP

**Memory** DDR w ECC

**Micro-Processors**

**Systems Monitor Module**

**Gbit Ethernet I/F**
Blades - TCO Savings & ROI

3 Year TCO Savings Rack vs. Blade Servers

<table>
<thead>
<tr>
<th>% Contribution</th>
<th>OPEX</th>
<th>CAPEX</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rack Servers</td>
<td>33%</td>
<td>25%</td>
</tr>
<tr>
<td>Blade Servers</td>
<td>67%</td>
<td>46%</td>
</tr>
</tbody>
</table>

TCO Savings in...

- **OPEX**
  - Staff/Support: 25%
  - Maintenance/Downtime: 54%
  - Facilities/Power: 21%

- **CAPEX**
  - Servers: 46%
  - SW Infrastructure: 22%
  - Networking: 19%
  - Storage Infrastructure: 13%

Data: IMEX Research 2004
DC Power/Cooling Spending to rise dramatically

Power & Cooling Spending to rise to 40% of DC Infrastructure Spending by 2010

OPEX to reach over 80% of New Server Spending $B

Top Data Center Challenges

- Power Capacity
- Cooling
- Server & Storage Growth
- Availability / Recovery
- Footprint / Space
- Change Mgmt
- Operational Cost

Power & Cooling to reach 40% of DC Server Infrastructure Spending by 2010

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**Data Center Cooling**

Where does the power go in Data Centers?

![Pie chart showing IT Equipment, Cooling, Air Movement, and Lighting](source: Liebert)

- **IT Equipment**: 50%
- **Cooling**: 25%
- **Air Movement**: 12%
- **Electricity Transformer/UPS**: 10%
- **Lighting, etc.**: 3%

Many techniques, methodologies and equipments from air cooling to liquid assisted cooling available form a variety of vendors and Consultants .... (Email imex@imexresearch.com for more info and Assessment of competitive vendor products, consultants and data center power & cooling integrators)

![Computer Simulation](source: IBM 2005)

Computer Simulation using widely available software (e.g. Fluent Airpack Ansys CFD ...) to verify Cooling Designed is the most cost effective before committing to final implementation.
*I/Os per second for a required response time (ms)
State of DB Applications

Large Databases by OS

Storage Usage vs DB Capacity

Large DB Size Growth by Market Segment

Yearly Storage Growth % 2005-06
The rapid rise of Clusters in HPC

<table>
<thead>
<tr>
<th></th>
<th>Ten years ago</th>
<th>Five years ago</th>
<th>Today</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Largest system</strong></td>
<td>143 Gflops</td>
<td>2.1 Tflops</td>
<td>70.7 Tflops</td>
</tr>
<tr>
<td><strong>Teraflop systems</strong></td>
<td>0</td>
<td>2</td>
<td>398</td>
</tr>
<tr>
<td><strong>Research/Academic</strong></td>
<td>60%</td>
<td>48%</td>
<td>41%</td>
</tr>
<tr>
<td><strong>Industry</strong></td>
<td>24%</td>
<td>46%</td>
<td>55%</td>
</tr>
<tr>
<td><strong>Linux clusters</strong></td>
<td>0</td>
<td>6</td>
<td>294</td>
</tr>
</tbody>
</table>

**Rise of Cluster Computing**

- SIMD
- Single Processor
- Cluster
- Constellations
- SMP
- MPP

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HPC – From Academia to Wall St. to Hollywood

**High Performance Computing**
- 100+ Teraflops
- Throughput = 100 GB/s

**Commercial Visualization**
- Rendering (Texture & Polygons)
- Throughput = 1.2 GB/s

**Bioinformatics**

**Decision-Support Systems**
- Data rate & capacity
- Throughput: DSL/Cable

**Entertainment**
- Audio/Video OnDemand

Data: IMEX Research & Panasas

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Implementing Virtualization

At Various Levels
Microprocessor
- Intel VT, AMD-Pacific

OS
- zOS, pOS, UNIX, Windows, Linux
- IBM, HP, Sun, VMWare, Xen, SWSoft

File System
- DFS

Networking
- Multiport

Storage
- Host, SAN, Controller
- In-Band, Out-of-Band Management
Virtualization Models

**Hypervisor Model**

- Features
  - Guest OS - Each app contained by its own OS instance
  - VZ layer spoofs each OS into believing as if its the only OS on the system
  - Users can mix and match guest OS’s with various versions of Windows or Linux.

- Major Players
  - VMWare, Microsoft, XenSource

**OS Virtualization**

- Features
  - A single OS hosts multiple applications.
  - VZ layer handles resource allocation between apps
  - VZ layer also provides protection to the host OS so that a misbehaving application does not cause problems for the system as a whole

- Major Players
  - SWSoft, Sun/Containers
Workloads Consolidation using VZ

- A single server 1.5x larger than standard 2-way server will handle consolidated load of 6 servers.
- VZ manages the workloads + important apps get the compute resources they need automatically w/o operator intervention.
- Physical consolidation of 15-20:1 is easily possible
- Reasonable goal for VZ x86 servers – 40-50% utilization on large systems (>4way), rising as dual/quad core processors becomes available
- Savings result in Real Estate, Power & Cooling, High Availability, Hardware, Management
**HW Assisted Virtualization**

**VZ Extensions at Processor**

- Guest OS’s run unmodified for a larger base of virtualization software
- Increased isolation to improve security of virtual machines
- Offers architectural enhancements to improve efficiency of switching between hypervisor and the guest OS’s
- Implemented primarily in I/O bridges and other system core logic
- Enables virtualization software to map devices directly to virtual machines
Storage Virtualization – Desired Features

### Storage VZ - Must Have Features

**Scale Non-Disruptively in Capacity**
- Snapshot Point-In-Time across Stg.devices
- Remote Replication across Heterogeneous Stg. Devices
- Policy Based Non-Disruptive Data Migration between Heterogeneous Stg Systems & Between Stg Tiers
- Centralized Mgmt of all Stg.VZ under Single Image
- Support Tiered Storage
- Volume Management for Multivendor Stg. Systems
- Common Set of Tools: Provisioning, Mgmt & Replication

### Storage VZ - Vendors

- Cloverleaf, Datacore, EMC
- FalconStor, Fujitsu Computer Systems
- Hitachi Data Systems
- IBM, Network Appliance
- StorageAge, Sun
- Symantec/Veritas ...

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Future: Storage Management

Host Services Integration

| File system monitoring | Storage provisioning | Win, LINUX, Solaris |

SAN Management

| Management Console | Management of iSCSI HBAs | MultiPath IO Supp and Failover | Security (iSNS, CHAP, SRP) |

Virtualization | Mirroring | Snapshot | Fail-Over |

iSCSI Target Management
LVM, Error Handling, SCSI Daemon, API Interoperability

HW Acceleration: TOE, iSCSI Offload, IPsec
TCO Savings with Virtualization

ROI Payback ~9.1 Mo

Servers Consolidation
Pre-VZ = 995 → After VZ=78

For copy of TCO Analysis
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Provisioning
Downtime
Disaster Recovery
DC Real Estate
Power & Cooling
Network
SAN
Hardware
VZ SW Licences & Support

Cost over 3 years

w/o VZ
w VZ

Pre-VZ = 995
After VZ = 78
**Data Center Trends - Summary**

- **WW 5.1 million data centers, Costs $100-175M to build a large DC**
  - ~$1005/Sqft, $40,000/Rack, $2,500/Server, 2.5U
  - 82% of installed equipment (Server, Storage, Network) has only 10% utilization
  - For every $1 invested in new IT infrastructure, $7 spent to maintain
  - For every $1 in new Server spending, 42c spent on Power & Cooling /2006
  - Virtual Servers growth outstrip Physical servers by 50% > Rise in managing VMs
  - Blades increasing Power/Rack by 10x Need Power/Cooling, Weight, Solutions to pursue

- **Consolidation**
  - IT in Mega Data Centers, Data & Video Info Vaults at SPs

- **New Technologies Adoption Necessary – as a Competitive Weapon**
  - Hi Density Blades, Multicore CPUs, Industry Std Computing Infrastructure, TB Disks,
  - Fast Networks: 10GbE, MPLS; Global Reach
  - Convergence (Voice Video, Data): Unified Communications, VoIP
  - Mobility & Wireless

- **Focus On**
  - Consolidation & Virtualization
  - IT Services and not IT Resources or Infrastructure
  - Rise of Cloud Computing and SaaS, SOA in its wake
  - Control over Complex Systems Interdependencies to avoid creating system wide instabilities
  - Automation of Low-Level Risks to free up on Initiatives aligning IT (CIO) to Business (CEO)
Summary - Virtualization & Automation

• **Follow SIVA© in executing your DC strategy**
  – **Standardize** (Windows/Linux, GbE, IP Storage/iSCSI,SATA..)
  – **Integrate** (Blades, Management Tools..)
  – **Virtualize** (Infrastructure-uP,Servers, Storage, Networks,Clients w P2V tools)
  – **Automate** (Provide important Apps required resources automatically w/o intervention to ↓OPEX costs)

• **Server Virtualization (VZ) now a mainstream technology**
  – VZ turning DC core infrastructure upside down, DC Professionals very happy with its future use
  – VZ means “Doing More for Less” (finally making CFOs get off your back)
  – Combined with VZ & Consolidation TCO Reduction of 60-70% over 3 years, ROI >58%
Virtualizing your IT Infrastructure

SLA

- Business Priorities
- Cost of IT Ops/Charge Back Methods
- Response Time/Availability/Throughput/QoS
- Transactions/Sessions/Events/Analysis/Reporting
- Business Services Managed & Charged

Virtualization Utility - P2V

Usage

Dept/Owner

- Usage Profiles
- Users/Services/Workloads
- Applications (OLTP/BI/HPC/Data Streaming)
- Execution: Rules Driven, Adaptive Provisioning
- Services Abstraction, Adaptive Provisioning

Assets

Location

- Host Name (Mfr/Model/SN,
  - Platform – OS/Processors/#/Speed/Type
  - Pooled Infrastructure Resources by Application Metrics
  - Pooled Capacity Provisioning:
    Processing, Bandwidth, Storage, Repository

For copy of case study on how a major financial institution implemented virtualization email imex@imexresearch.com
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For TCO/ROI Financial Worksheets & DataCenter Analysis & NGDC Industry Report
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