• **Markets Drivers / Industry Dynamics**
  
  Mainframes to Blade Servers - Evolution in Tiered Computing
  Segmenting Applications/IT Workloads – TC, HPC
  Motivators, Inhibitors
  Market Penetration

• **Virtualization Implementation**
  
  Implementation At Various Levels – OS, Server, Network, Stg
  Economics of Virtualization

• **Futures**
  
  Next-Gen Data Center: Integration, Virtualization, Autonomics, Grids, Services
Chaos in the Enterprise . . .

(1) Scales poorly  (2) Difficult to manage  (3) Reliability is questionable  (4) Management costs out of control
DC Mgmt Nightmares Driving Virtualization

- **Servers Utilization**
  - Win 5-10%, SMP 20-35%, MF 30-50%
  - 80+% utilization

- **Servers/Server Admin**
  - 15-30 servers/admin
  - 300+ servers/admin

- **Application/Server**
  - 1 application/server
  - 20 applications/server

- **Storage Utilization**
  - 30-45% Disk, 20-40% Tape
  - 75+% utilization

- **Storage Terabytes/DBA**
  - 1TB storage
  - 100TB storage

- **MIS Alerts**
  - 4-5 urgent alerts/day
  - 20-40 urgent alerts/day

- **System Availability**
  - HAL- 3 (99.9%)
  - HAL- 5 (99.999%)
Market Segments by Applic./Workloads

- **Transaction Processing**
  - eCommerce
- **Data Warehousing**
- **DSS**
- **Visual DB**
- **Scientific Computing**
  - Imaging
  - Reference Data
  - Audio/Video
  - Streaming
  - HPC
  - TPC

*IOs per second for a required response time (ms)

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CFO vs. CIO - Shocking Observations

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

Reason – IT Spiral

- Web Growth > New Apps Mushroom > Lo Cost Win Servers Sprawl (Tier-1)
- Business Growth > Need More Computing Power > App/DB Servers (Tier-2,3)
- More Servers > Storage > DC Facilities > IT Support > IT Staff
- More Low Cost Servers > 5% Utilization > Scale Out Infrastr. (Racks & Blades)
- IT Costs ≠ Business Growth

Problem

Solution

1 Physical Server + VZ SW Multiport NIC = 4 Virtual Servers
**Next Gen Data Center – Key Initiatives**

- **Integration**: Integrates physical infrastructure using standardized devices for CAPSIMS: Cost, Availability, Performance, Scalability, Interoperability, manageability & Security

- **Virtualization**: Pools Resources. Allocates, Monitors, and Meters the Usage of Pooled Resources

- **Provisioning**: Provisions the Resources Required to Deliver a Business Service

- **Automation**: Automatically Maintains Application Service Level Objectives
Fabric based Integrated Architecture

- **Network Fabric**
  - Ethernet, Wi-Fi

- **Management Fabric**
  - SNMP, IETF/CIM, SMI-S, SMASH

- **System Fabric**
  - Quadrics, Myrinet, InfiniBand, Ethernet/IP, Ethernet IP w/TOE, Ethernet IP w/TOE and RDMA

- **Storage Fabric**
  - SCSI, Fiber Channel, iSCSI
TCO Savings with Virtualization

995 Servers Pre VZ → 78 VZ Servers

Provisioning
Downtime
Disaster Recovery
DC Real Estate
Power & Cooling
Network
SAN
Hardware
VZ SW & Supp

Cost over 3 years

w/o VZ

w VZ
Servers - TCO Savings & ROI w Blades

3 Year TCO Savings
Rack vs. Blade Servers

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

TCO Savings in..

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

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

Data: IMEX Research 2005
Implementing Virtualization

At Various Levels
Microprocessor
- Intel VT, AMD-Pacifica
OS
- zOS, pOS, UNIX, Windows, Linux
- IBM, HP, Sun, VMWare, Xen, SWSoft …
File System
- DFS …
Networking
- Multiport NICs
Storage
- Host, SAN, Controller
- In-Band, Out-of-Band Management
Processor 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

Source: AMD
Storage Virtualization

Storage Virtualization Implementations

<table>
<thead>
<tr>
<th></th>
<th>Host</th>
<th>SAN</th>
<th>CntrlIr.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Out-of-Band</td>
<td>Symantec, StorageAge</td>
<td>EMC, Fujitsu</td>
<td></td>
</tr>
<tr>
<td>In-Band</td>
<td>Cloverleaf, IBM, DataCore, DataCore, FalconStor</td>
<td>HDS, NetApp, Sun</td>
<td></td>
</tr>
</tbody>
</table>

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
Virtualization results in overall cost reduction 35-60%. Storage VZ alone has produced ~20% cost reductions.

Savings achieved through Storage Virtualization

- 21% /yr.
- 19%
- 16%
- 24%
Future: Storage Management on a chip

**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

**Device Service Layer**
- iSCSI Target Management
  - LVM, Error Handling, SCSI Daemon, API Interoperability
- HW Acceleration: TOE, iSCSI Offload, IPsec