NEW CHALLENGES IN PERFORMANCE ENGINEERING

Dr. Amnon Naamad, EMC
Data Center Change Drivers

Older forces
- Cost
- HW improvement
- Data growth
- Consolidation
- Green operations

Newer forces
- Major new innovations
- New use paradigms
# Data and Capacity Growth Trends

<table>
<thead>
<tr>
<th>Period</th>
<th>Capacity Growth</th>
<th>Actual Max Capacities</th>
</tr>
</thead>
<tbody>
<tr>
<td>1970 – 1990</td>
<td>14X</td>
<td>1.6 GB → 22 GB</td>
</tr>
<tr>
<td>1990 – 2000</td>
<td>90X</td>
<td>22 GB → 2 TB</td>
</tr>
<tr>
<td>2000 – 2010</td>
<td>1000X</td>
<td>2 TB → 2 PB</td>
</tr>
</tbody>
</table>

© Copyright 2012 EMC Corporation. All rights reserved.
Major New Technological Innovations

- Flash Drives & Memory
- Large, Inexpensive Drives
- Server, Storage Virtualization
EFDs are in a league of their own

Significantly More IOPS per Drive at Much Lower Response Time

EMC²

© Copyright 2012 EMC Corporation. All rights reserved.
New Use Paradigms, New Expectations

Cloud & Service Providers

Big Data & Analytics

Globalization
Modeling Has Become Critical

Common sense is insufficient
- Product design
- Product planning/configuration
- Application placement
- TOO MANY LEVERS

Must be right the first time
- In consolidated environments, making changes is difficult, risky, and expensive
Performance – More than Speeds & Feeds

THE CHALLENGE:

How to achieve SLAs efficiently and easily

- Predictability
- High resource utilization
- Appropriate technology
- Performance/application
- Ease of management
Tiered Storage
## 2008 – Fundamental Storage Media Shift

<table>
<thead>
<tr>
<th>Disk</th>
<th>Cost/GB</th>
<th>IOPS/GB</th>
<th>Response Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>15 K RPM</td>
<td>1</td>
<td>1</td>
<td>6 ms</td>
</tr>
<tr>
<td>Serial ATA (SATA) 7,200 RPM</td>
<td>1/3</td>
<td>1/6</td>
<td>12 ms</td>
</tr>
<tr>
<td>Enterprise Flash Drive (EFD)</td>
<td>8</td>
<td>30</td>
<td>&lt; 1 ms</td>
</tr>
</tbody>
</table>
The Tiered Storage Opportunity

**Configuration 1**
- 100% I/Os

**Configuration 2**
- 4% of capacity
- 90% I/Os
- 10%

**BENEFITS**
- Costs reduced 30-40%
- Response time improved 70%
- Power consumption reduced 60-70%
- Management easier with automation
Measuring Asymmetry in Access Patterns – Skew

- Enterprise Flash Drive targets
- FC targets
- SATA II targets

Data Extents – Sorted by Activity Level
Volume Activity vs Time

Day 1 | Day 2 | Day 3
One Volume –
Address Range Activity vs Time
Challenges for Performance Engineers

Is this opportunity real?
- How many customers can benefit from Automated Tiered Storage?
- Is it worth the effort?
  Estimate the real value.

Come up with effective algorithms
- # of tiers?
- Extent Size?
- When to demote/promote?
Challenges for Performance Engineers

Is this opportunity real?
- How many customers can benefit from Automated Tiered Storage?
- Is it worth the effort? Estimate the real value.

Come up with effective algorithms
- # of tiers?
- Extent Size?
- When to demote/promote?
Done Well, Tiered Storage has Great Potential

Possible Tiered Configurations

<table>
<thead>
<tr>
<th>Name</th>
<th>Rel Cost</th>
<th>Rel ST</th>
<th>Rel Pwr</th>
<th>EFD</th>
<th>FC</th>
<th>SATA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ref Config</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0%</td>
<td>100%</td>
<td>0%</td>
</tr>
<tr>
<td>Proposed</td>
<td>-27%</td>
<td>-47%</td>
<td>-75%</td>
<td>3%</td>
<td>27%</td>
<td>70%</td>
</tr>
</tbody>
</table>

Configuration: **Proposed**

IO/Sec: 31554  BE* IO/Sec: 20230  BE* Writes (%): 44.9

Disk Utilization: 52 Disk, EFD 200 Utilization

Policy Relative Service Time

99.0% Capacity
# More Challenges and Opportunities in Storage Tiering

<table>
<thead>
<tr>
<th>Proactive management</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less expensive tiers</td>
</tr>
<tr>
<td>Application awareness</td>
</tr>
<tr>
<td>Tiering among several systems</td>
</tr>
<tr>
<td>Server cache integrated with tiered storage</td>
</tr>
<tr>
<td>Automatic improvement over time</td>
</tr>
<tr>
<td>Subject</td>
</tr>
<tr>
<td>---------------------------------</td>
</tr>
<tr>
<td>Predictability</td>
</tr>
<tr>
<td>High resource utilization</td>
</tr>
<tr>
<td>Appropriate technology</td>
</tr>
<tr>
<td>Performance/application</td>
</tr>
<tr>
<td>Ease of management</td>
</tr>
</tbody>
</table>
QoS
Predictability vs High Utilization

**Predictability**

**USER PERSPECTIVE**

**SYSTEM PERSPECTIVE**

*Predictable response times & throughput*

*Certain amounts of resources allocated to applications - when needed*

Predictability requires separation of resources

High utilization requires sharing of resources
Dynamic Cache Partitioning

Each application or each user is guaranteed to have a certain portion of the cache
   – Only when it needs it

Any application can “donate” cache when it is not active or when it does not benefit from larger cache
Disk QOS is More Challenging

Disks Realities
- Disks can optimize the order in which I/Os are executed
- Optimization is more effective as the queue length increases
- As queue lengths increase, response time increase

The Challenge
- How to configure systems with Response Times and Throughput requirements, and how to set the policy ...
New Expectations and Needs

Performance Management – not just monitoring / Reporting

Automatic Attainment of user-defined goals
- Requires a leap of faith, people need to think differently
- Smart algorithms that allocate resources to achieve these goals are needed
  - Multi dimension dynamic packing

SLAs from the application perspective
- How to describe business value, and then translate it to performance goals
- How to achieve the business goals

Performance Management products should improve automatically over time!!
THANK YOU