Storage Concepts

Steve Kellogg
Director
Applied Information Technologies
Information Technologies Services
Penn State University
Storage/Memory

- Basic terminology and concepts
- Memory Hierarchies
- Filesystems
Terminology

- Memory v. Storage
  - data elements v. files
- Cache memory: Highest speed memory
- Main Memory
- Paging or swap: Addressing larger than main memory
- Block I/O
- RAID: Redundant Array of Independent Devices
- JBOD: Just a bunch of disks
Terminology

- Memory Addressing
  - Real
  - VMM: virtual memory management
- Disk Technologies: DASD, SCSI, IDE, ATA, SATA, Fibre Channel, SSA
- HDAs: Head Disk Assemblies
- Hierarchical Storage
- Memory interleave: noncontiguous arrangement of data
### RAID

Redundant Array of independent Devices

<table>
<thead>
<tr>
<th>RAID</th>
<th>Description</th>
<th>Advantage</th>
<th>Disadvantage</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Striping</td>
<td>Highest perf.</td>
<td>No Redundancy</td>
</tr>
<tr>
<td>1</td>
<td>Mirroring</td>
<td>Redunancy</td>
<td>Low Performance</td>
</tr>
<tr>
<td>3</td>
<td>Striping w/ Parity Drive</td>
<td>High throughput</td>
<td>Poor perf. For random, small I/O</td>
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<tr>
<td></td>
<td></td>
<td>Data protection</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Striping &amp; Parity spread out</td>
<td>High read rate</td>
<td>Can have poor write perf.</td>
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<tr>
<td></td>
<td></td>
<td>Data protection</td>
<td>Disk failure adversely affect perf</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>Most common</td>
</tr>
<tr>
<td>10</td>
<td>RAID 0 + 1</td>
<td>High perf</td>
<td>Expensive</td>
</tr>
<tr>
<td></td>
<td>W/ data protection</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Good for databases</td>
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</table>
Typical Memory Hierarchy

- CPU
  - L1 Cache
  - L2 Cache
  - Interleaved Memory
  - Disks, SSD, ...
  - Tape, Optical, ...

- Access Speed Increasing
- Capacity Increasing
- Virtual Memory

- File
- Page
- Line
- Word

- Virtual Memory
- CPU
- CPU
Basic Tenants of performance

- Concern yourself with where your data is.
- Understand the relative speed of access for all of your data.
- Cache hit is good
- Cache miss is not so good.
- Different systems have different memory designs
- Paging (or swap) is bad for performance
Filesystems

• Local
  – A file store available to a given system
    • NTFS, UFS, XFS, JFS, JFS2, FAT

• Distributed
  – Access to files from multiple systems

• Either can be backed by a hierarchy
  – Filesystem has an data structure in the filesystem that points to the location of file and the file can be on tape or other mass store device
Distributed Filesystems

• Filesystem accessible from multiple systems
  – NFS: Network File System (SUN)
  – CIFS: Common Internet File System (Microsoft)
  – AFS: Andrew File System (CMU/Transarc)
  – DFS: Distributed Filesystem (DCE)
  – GPFS: General Parallel File System (IBM)

• Tradeoffs:
  – Simplicity v. complexity, workgroup v. enterprise-wide, performance, cost, manageability
Distributed Filesystems

- Ubiquitous access to files
  - All types of files
  - Personal
    - Home directories
  - Shared files
    - Binaries
    - Data
    - Spread sheets
    - ...
  - EMAIL IS NOT A SHARED FILESYSTEM!!!!!!!!!!
Distributed Filesystems

- Enterprise-WIDE
  - Easy access throughout the enterprise
  - Opportunity to leverage reference of locality
    - Caching
    - Replication
    - Distributed servers that have rw files
  - SINGLE GLOBAL Namespace!!

- Truly Standards based
  - The world IS NOT all Windows (not yet, anyways)
Distributed Filesystems

- Needs to exist within the enterprise identity management system.
  - Single identity
    - Kerberos
    - Registry (LDAP)
  - AUTH/AUTHZ
    - Group and/or roll based authz
Distributed Filesystems

• Needs to be secured
  – Spectrum of security options
  – W/ a rich, reliable ACL capability
  – User AND Group based
Distributed Filesystems

• Yield significant efficiencies in disk utilization.
• Yield significant efficiencies in distributed system's administration.
  – Large-scale user management
  – Large-scale data management
  – Large-scale application management
• Yield simplified data policy enforcement.
  – Location in the namespace...
An Example of a Distributed File System

- One global name space
  - /.../dce.psu.edu/fs/

- Everyone get's personal disk space
  - 500MB
    - /.../dce.psu.edu/fs/users/k/e/kellogg
  - 10MB for www.personal.psu.edu
    - /.../dce.psu.edu/fs/users/k/e/kellogg/www
  - WebMail (and IMAP)
    - /.../dce.psu.edu/fs/users/k/e/kellogg/mail
DFS cont'd

• **Web services**
  - [www.its.psu.edu](http://www.its.psu.edu)
    - /.../dce.psu.edu/fs/services/www/dept/its/
  - [www.clubs.psu.edu](http://www.clubs.psu.edu)
    - /.../dce.psu.edu/fs/services/www/clubs/wwwroot/

• **Administrative Data**
  - /.../dce.psu.edu/fs/admin/
Use of DFS at Penn State

Data feeds
AIS, OHR, Registrar

/s/de.psu.edu/fs

/services/www/dept/hbg/

Client Access:
Windows
Mac
Unix
Linux

Webmail Svrs
Sun

www.personal.psu.edu
AIX

www.hbg.psu.edu
AIX

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