Essential Elements of Intelligently Managed Tiered Storage Infrastructures

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Agenda

- Business Issues and Challenges
- Essential Elements
- Methodology and Technology
- Oracle Archive Technologies Overview
- A Little Bit about OnX
- References and Acknowledgements
Source: "When Will the World Reach 8 Zetabytes of Stored Data?" SiliconAngle, 2013
BER & Storage Infrastructure Components

Quotes from standards/specifications

- NIC/Link/HBA: $10^{-10}$ (1 bit in ~1.1 GB)
  - Check-summed, retransmit if necessary
- Memory: $10^{-12}$ (1 bit in ~116 GB)
  - ECC
- Desktop Disk: $10^{-14}$ (1 bit in ~11.3 TB)
  - Various error correction codes
- Enterprise Disk: $10^{-16}$ (1 bit in ~113 TB)
  - Various error correction codes
- Tape: $10^{-19}$ (1 bit in ~1.11 PB)
  - Various error correction codes

Note: Data maybe encoded up to five or more times as it travels from memory to the physical disk!

Challenges for Public Cloud Archives...

- Lack of uniform semantics and standard interfaces
- Interoperability between public cloud providers
- Managing data format changes over time
- Authenticity verification
- Compliance and Governance
- Risk Management & Litigation
- Data Migration
  - Every time a data object is moved it runs the risk of corruption due to increasing variety of traversed.
  - Even data at rest can be corrupted via bit-rot, malicious attack, or user error
- Bit-integrity preservation
  - Data management and curation can monitor the integrity of data stored in a Digital Archive.
  - Often checksums are used to verify that there is no variance between two copies of the same piece of data over time.
  - A Cloud Archive must ensure that data migration does not affect the integrity of the data object stored.

Source: Cloud Archive and Long Term Preservation Challenges and Best Practices
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• **Essential Elements**
• Oracle Archive Technologies Overview
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Essential Elements of Intelligently Managed Tiered Storage Infrastructures

1. Data / Information Classification
2. Intelligent Tiered Storage Management
3. 3-Dimensional Scalability
4. Adaptability (Transformer) to changes in Workload Demands
5. Exit Strategy
Defining Backup and Archive Environments

Backup *Data Protects* the Business, Archive *Information Is* the Business

### Backup

- **Restore** lost or corrupted content
  - *Business Continuity* (BC) – day-to-day restores of applications, user files, emails, etc.
  - *Disaster Recovery* (DR) – massive restores of disk arrays, server nodes, or entire data centers

### Archive

- **Access** strategic content
  - Permanent record of fixed content
  - Provides for collaboration and global sharing of archive data
  - Content Availability: 24 hours/day, 7 days/week, 52 weeks/year – *10 years/decade, 10 decades/century!*

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The combined strengths of disk *and* tape technology are needed to meet the challenges of each environment.
1. Data/Information Classification

• A most important 1st step!
• Understanding of data/information usage patterns
  – Identify access patterns in real-time workloads in order to separate data types for storage tier placement policies
  – Matching of data value to media attribute improving storage efficiency
  – Not always easy to ascertain
  – Must involve business units/developers/users/prospective users of the data
• Requires regular review and adjustment
• Required for most effective tiered storage implementation
• Automated classification software
2. **Intelligent Tiered Storage Management**

- Policy driven data movement among storage tiers based upon data/information classification
- Storage media abstraction
- Transparent data migration
- Transparent media migration
- Transparent media maintenance
- Integrity
3-Dimensional Scalability
Performance vs. Capacity vs. Functionality

• Add more raw storage capacity resources without affecting performance or flexibility
  – Disk(spindles), Tape Library Slots/Cartridges, Remote media
• Add more performance resources without affecting capacity or flexibility
  – Controllers heads(additional Dram, flash), Servers(onboard flash technology, PCI cards, etc.)
• Add new functionality without affecting capacity or performance
  – Replication, Snapshot, Deduplication, RAID levels, compression, encryption, etc.
4. Ability to Adapt (Transform itself)

- Ability to dynamically adapt (divert resources) to sudden changes in workload demand
  - Seasonal (Higher-Ed term changes, corporate periodic accounting, retail selling seasons, etc.)
  - World Events (weather, major announcements regarding world figures, entertainers, scientific breakthroughs, war, etc.)
  - Immediate Requests (i.e. legal, regulatory compliance, research, etc.)
5-Exit Strategy

• When planning a long-term archive ask yourself these few questions –
  – What happens, some 10, 20, 50 or more years down the road and for some reason your archive needs to be replaced with some other archive technology?
  – Does your existing archive store your data in proprietary format?
  – Will the vendor(s) that installed your archive still be around?
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Hardware Technology Alternatives

• **Purpose-built Integrated, Converged, Engineered Systems or Appliances**
  • Consolidated(servers, storage, networking, software) rack systems
  • Usually comprised of a single vendor’s components

• **Custom Developed Infrastructure**
  • Components are determined by more finely tuned requirements of the archive
  • Components can be chosen from among best of breed as opposed to individual vendor bias
  • Solution can be developed with the assistance of experienced and unbiased systems integrators

• **Adhoc or Home Grown**
  • In the past often considered in entry-level or for less demanding archive solutions but gaining acceptance as user requirements have become more refined and field experience grows
  • Components usually chosen based upon cost and implementers' experience
Hardware Technology Alternatives

Pros and Cons

- **Purpose-built Integrated, Engineered or Appliance Systems**
  - Pro: Vendors integrated and tested stack, less administration required
  - Con: Potential vendor lock-in, potentially limited archive storage
  - performance/capacity/functionality independent scaling options

- **Custom Developed Infrastructure**
  - Pro: Avoid vendor lock-in, more flexible scale-out options, more robust archive storage
  - performance/capacity/functionality independent scaling options
  - Con: Implementation can be onerous without experienced integrators and synergistic
  - implementation partners

- **Adhoc or Home Grown**
  - Pro: Often greater flexibility of design. Often leads to greater exploitation of technology and
  - solutions innovation. Greater adoption to open standards
  - Con: Potential system instability as result of tendency to component incompatibility, scaling and
  - migration options my limited or non-existent, requires more highly skilled people
Economics of Tiered Storage

Tape is the foundation: most of the data; lowest cost
A Tape Tier Lowers Costs while Increasing Robustness and Efficiency

100% Single Tier of Disk Storage
20% Disk Multi-tiered Storage
15% Modern Multi-tiered Storage

Flash Storage $50 - $100/GB
Performance Disk $7 - $20/GB
Capacity Disk $1 - $8/GB
Tape Storage $0.1 - $0.2/GB

Source: Horison Information Strategies, Digital Curator Paper, Average Selling Prices, updated with T10000C
Oracle Archive Technologies Overview
Oracle’s Complete Storage Portfolio
Engineered for Data Centers. Optimized for Oracle Software.

Engineered Systems
- Exadata
- Exalogic
- SPARC
- SuperCluster
- Big Data Appliance

NAS Storage
- ZFS Storage Appliances

SAN Storage
- FS1

Tape and Virtual Tape
- SL8500
- SL3000
- SL150
- LTO
- T9840
- T10K

Cloud Storage
- Deployment Options: Private, Public, Hybrid
- Services: IaaS, PaaS, SaaS
- Consumption Options: Build, Manage, Subscribe

Storage Software
- Storage Management: OEM, ASM, Storage Analytics, CAM, ACSLS, ELS
- Automated Tiering: Partitions, SAM QFS, Hybrid Storage Pools, VSM
- Data Reduction: 11g ACO, HCC, RMAN, ZFS Storage Appliance Dedup/Comp
- Data Protection: Data Guard, RMAN, OSB, ZFS Storage Appliance Snap/Rep, MaxRep
- Security/Encryption: ASO, Oracle Key Manager, Disk/Tape Encryption

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Flash-Optimized Performance

• Scales to Petabytes of Flash, Up to 2M IOPS, QoS-driven Read/Write Flash, Multiple Flash Options, Performance + Capacity SSD, Fast learning, No cache warm up, No persistence issues, No failover issues;

QoS Plus: QoS-Driven Automated Tiering

• QoS-driven automated tiering adapts data movement to the most cost-effective $/IOP and $/GB;

Engineered for Oracle Applications & Databases

• Engineered to leverage Oracle’s Hybrid Columnar Compression, ASM, ADO, Oracle Linux, Cloud Services, and Fusion Application profiles;

Enterprise-Grade

• < 1 second failover, Warmstart technology, No SPOF, Pre-emptive Copy, SSD gauges, T10-PI, Replication and Copy Services, Ships fully tested and racked, Business Critical Service for Systems;
Oracle’s ZFS Storage Appliance Series

ZFS Storage Operating System
Most powerful storage software suite
Engineered Integration with Oracle software

Hybrid Storage Pools
Extensive Data Services and Protocols
OS⁸ Storage OS Support

ZS3-2
• Single or Dual Controllers
• 32 Cores
• 1TB DRAM
• 8 PCIe Slots
• 16 Disk Enclosures*
• 12TB Read Flash
• 4TB Write Flash*

ZS4-4
• Single or Dual Controllers
• 120 Cores
• 3TB DRAM
• 14 PCIe Slots
• 36 Disk Enclosures
• 12TB Read Flash
• 10TB Write Flash

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Some Fun Facts About Tape(is alive!) vs. Disk

- **Lower price/TB**
  - Gap is widening!

- **Technology**
  - Faster data access (252 MB/sec.)
  - Similar to disk data access (LTFS)
  - Higher Capacity, Encryption, Compression

- **Longer shelf life for tape**
  - More robust data integrity ($10^{-19}$ vs. $10^{-16}$)
  - Minimizes data migrations as technology ages
  - Tape media, libraries can be monitored more effectively for proactive maintenance

- **Far better environmentals**
  - Clipper Group study shows disk using 238x more power
    - Power consumption of disk alone over 12 years > total cost of any tape solution

- **More secure**
  - Immune from corruption (lower bit error rates than disk) / virus / hackers when offline vs. online
Automated Tape(is alive!) Storage…then and now

From the TimberLine tape drive to the T10000C (launched Feb 2011)

1998
- 6000 tapes
- TimberLine 9490EE – 1.6 GB
- 357 sq. ft.
- 8200 lbs.

2013
- 2 tapes
- T10K-C/D – 5.0/8.5TB
- 0.3 sq. ft.
- 1.2 lbs.
Oracle StorageTek Libraries – SL8500, SL3000, S150(1,2,3,4,5)

• Oracle tape offers **exascale capacity at the lowest cost**
  – much more economical, with 4% of the TCO and 1/4\textsuperscript{th} the footprint of disk\textsuperscript{*}
  – enables data growth on a massive scale with less maintenance complexity

• Oracle tape offers **data integrity validation**
  – detects corrupted data before it is written to tape and simplifies digital auditing

• Oracle tape eases **technology migration**
  – offers longer technology lifecycles and the ability to reuse existing media

• Oracle tape offers **scalable performance**
  – additional tape drives are added non-disruptively to increase parallel access to data
### Archive Reliability Features

#### SafeGuide Tape Path
- Contacts only the non-data side of the media
- Up to 8.5 TB Native Capacity
- 252 MB/Sec Data Rate (uncompressed)

#### StorageTek T10000 T2 Media
- Highest stability materials for long term data readability
- Read media written with previous generation tape drives (T10K-A, T10K-B, T10K-C)
- Re-write existing media to a higher capacity with new generation tape drive
- Compatible with SL8500, SL3000 & Rackmount

#### StorageTek Data Integrity Validation
- Detects corrupted data from host before it is written to tape
- Media validation enables policy-based data integrity audits of your digital assets residing on tape

#### Dual 32-Channel Dual Recording Head Technology
- 32 channels are written and read in parallel
- Ensures robust write performance and minimizes tape speeds

#### Advanced Error Correction
- Writes 100X more data than LTO-6 before an uncorrectable bit error
Proactively Manage and Monitor the Entire Tape Storage System from a Single Interface (3,4)

- **Simplify Tape Management**
  Monitors your drives and media

- **Leverage Intelligent Analytics**
  Provides proactive health indicators

- **Worry Free Deployment**
  Collects performance data without entering your live data path

- **Grow with Peace of Mind**
  Scales easily and monitors globally dispersed libraries from a single interface
Oracle’s Intelligent Tiered Storage Archive Solution (1,2,3,4,5)

StorageTek Storage Archive Manager

Primary Disk

Disk Archive

Tape Archive

SEAMLESS
Mature Automated Hierarchical Tiered Storage Management
Scalable and flexible archive disk, tape and remote storage for unstructured data
Provides Lowest TCO

PROACTIVE
Intelligent Monitoring Ensures Data Access
Dynamically managed, policy-based storage tier
Policy engine provides dynamic management of the archive and data protection copies

FUTURE-PROOF
Limitless Capacity and Performance for Worry Free Seamless Capacity Growth
Seamless Technology Migrations
Open Source Data format

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So Let’s Recap…

- Tape is alive! Tape horror stories are just FUD.
- Long-term digital information retention and preservation is here to stay.
- Backup/Recovery planners and Digital Archive designers must accept that there will always be several practical media types, all having different price, performance, energy and ROI profiles. Deploying them effectively will take care. Hence, intelligently managed tiered storage (including tape, where appropriate) practices are essential to efficient archive development and maintenance.
- The Essential Elements, Data/Information Classification, Intelligent Tiered Storage Management, 3-Dimensional Scalability, Adaptability (Transformer) to changes in Workload Demands and Exit Strategy.
- OnX architects and supports Oracle archive solutions that methods of provide a variety of alternatives that employ the Essential Elements.
References & Acknowledgments

- Oracle

- OnX Enterprise Solutions
  - http://www.onx.com/

- Eliminate the Management Complexity Common with Tiered Storage
  - http://wikibon.org/wiki/Eliminate_the_Management_Complexity_Common_with_Tiered_Storage

- SOAR™ - Scalable Online Archive & Repository Solution
  - http://www.trumantechnologies.com/

- When Will the World Reach 8 Zetabytes of Stored Data?
  - http://siliconangle.com/blog/2012/05/21/when-will-the-world-reach-8-zetabytes-of-stored-data-infographic/

- Why Tape is Back, Although It Never Left

- Tape Storage Future Directions and the Data Explosion

- SNIA (Storage Networking Industry Association)
  - http://www.snia.org
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Thank You!