Introducing the view of SNIA Japan Cold Storage TWG on "Cold Storage"

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Sony Corporation
COLD STORAGE IS STORAGE FOR COLD DATA
Agenda

1. Introduction
   - Why we are focusing on Cold Storage?
   - About us (SNIA-J CSTWG)

2. Discussion Part-1
   - Definition of Cold Storage

3. Discussion Part-2
   - Taxonomy for Cold Storage
     - Activity summary and next steps

4. Latest optical technology (Sony’s approach to Cold Storage)
   - Archival Disc Technology
   - Trial mapping of Cold Storage media
Your data can be Cold, Colder, Coldest..

The Bulk of Data Storage market!

Mapping

always access
frequently
sometimes
almost no access

Source: IDC Worldwide Cold Storage Ecosystem Taxonomy, 2014 #246732

System Type
Active or Online Archive (chilled or traditional)
Deep Archive (cold)
Extreme Archive (colder than cold or deep freeze)
What’s your image for Cold Storage?
Why you don’t care for Cold data?

- Excuse 1
  - There are no clear border lines between hot, warm and cold data and you think you can’t help this situation.

- Excuse 2
  - Cold data is old and not mission critical, thus it is something you can defer your decision.

- Excuse 3
  - Some imagines that Cold data is useless, simply because it is not earning money for now.

Where is cold data … Cold data should be found everywhere!
Compliance with 20,000 regulations worldwide
- Scope: Data retention and data security
- Level: International, national, state and local regulations
- Depth: Industry-specific, Private, Public, Government

This results in:
- Cost to comply or remediate
- Significant penalties for non-compliance
- Potential damage to business reputation

Archiving is Mandatory!
Cold data is accumulating

After uploading to SNS, frequent accesses start within several minutes.

Accesses decrease steeply after a short while.

Almost no access

Must stay as cold data forever

Access Frequency

Cost

Access

minutes hours days weeks months years

Flash card SSD HDD large capacity HDD SMR-HDD/Blu-ray/Tape

Adding more and more data, without updating.

After uploading to SNS, frequent accesses start within several minutes.

Accesses decrease steeply after a short while.

Almost no access

Must stay as cold data forever

Cloud Service (ex. Amazon S3, …)

Archive Cloud Service (ex. Google Nearline, Glacier)
There is no single device for all needs

- Ideal device for **Hot**, **Warm** to **Cold** data?
  - Nano-sec latency
  - Great throughput
  - Large capacity, Unlimited expansion
  - Data migration free
  - Excellent tolerance to any disasters
  ..and at an **affordable cost**.

Do you believe it??

Forget about “one-size-fits-all” type of approach.
We should combine multiple devices for efficient data management.
General Assembly

Audit
Office

Board Meeting

Technical Committee
- Cold Storage TWG
- NG NVM* TWG
- Green Storage TWG

Marketing Committee

Education Committee

Executive Director

40 members from 13 organizations

*) NG NVM: Next Generation Non-Volatile Memory
Cold Storage Technical Working Group

Academic / Others
- Shibaura Institute of Technology
- National Institute of Informatics
- TÜV Rheinland

Research for Long-term Archive

Hardware / System vendors
- FUJITSU
- HITACHI
- Panasonic
- Tokyo Electron Device
- HITACHI LG
- HGST
- TOSHIBA
- SONY
- NEC

Tapes, Optical, HDD, Memory, Cloud, Object Storage

Media vendors
- FUJIFILM
- MITSUBISHI KAGAKU MEDIA

Tapes
Optical Discs
Definition of Cold Storage
(“SNIA Japan” official version)
Tape vendors’ opinions

Strong market demand for Tape-based Cold Storage

- Most commonly used media as low-cost storage, large-capacity, and suitable for long-term archive.

Good features for Cold storage

- Large capacity: Max 10TB (30TB with data compression)
- High transfer rate: Max 360MB/s (1080MB/s with compression)
- Low cost: Low-cost media, Low power consumption
- Long-term data preservation: More than 30 years of shelf life
- Security: Anti-Tamper specification (WORM), Encryption
- Availability: Data durability
  - Verify while Writing, Strong error correction

Linear Serpentine recording technology
Optical vendors’ opinions

- Long-life and Highly reliable media
  - Media life is over 50 years at normal temperature
  - Excellent tolerance to any disasters
  - Non-contact reading
- Most suitable media for compliance purpose
  - True WORM
  - Highly compatible between generations
    - The first CD 34 years ago can be played back on current BD players!!
- Environmentally friendly media
  - Can be stored OFFLINE without air-conditioning
  - Reduced waste thanks to its migration free feature
- Advent of next generation optical technologies
  - Much larger capacity & greater throughput
## HDD vendors’ opinions

- **Background of HDD based Cold Storage market demand**
  - Explosion of data requires **Active Archive**
  - “Cold data” is getting warmer.
  - When data becomes more accessible, its value increases.

- **Required specification for HDD as Cold Storage**
  - Lower Cost: 20~30% lower cost against Near-line HDD
  - Latency: Less than a second
  - Reliability: Same as Near-line HDD

### New segmentation with nearline HDD

<table>
<thead>
<tr>
<th>Nearline (PMR, He-PMR)</th>
<th>Cold Storage (SMR)</th>
</tr>
</thead>
</table>
| • Any application
  • Large capacity, High performance, Random access
  • High reliability, Many functionality
| • Sequential write, Write in-frequently/ Read many
  • Low latency against Tape/Optical disc
  • Trade-off between performance & functionality and reliability

- **Active Archive (SMR)**
  - Write once/Read many
  - High latency
  - Lowest price/GB

- **Deep Archive (optical disc, tape)**
  - Low latency against Tape/Optical disc
## SSD vendors’ opinions

|                        | SSD by NGD Systems  
<table>
<thead>
<tr>
<th></th>
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<tbody>
<tr>
<td></td>
<td>formerly NxGn Data</td>
</tr>
<tr>
<td></td>
<td>2x PCIe/NVMe FH-FL</td>
</tr>
<tr>
<td>Capacity</td>
<td>The same 128TB</td>
</tr>
<tr>
<td>Active Power</td>
<td>90% savings 50 W</td>
</tr>
<tr>
<td>Idle Power</td>
<td>99% savings 2 W</td>
</tr>
<tr>
<td>Peak Power</td>
<td>91% savings 50 W</td>
</tr>
<tr>
<td>Physical Space</td>
<td>95% savings 112 cubic inches</td>
</tr>
<tr>
<td>Weight</td>
<td>96% savings 1.5 lbs</td>
</tr>
<tr>
<td></td>
<td>30x 3.5” (4TB) SAS</td>
</tr>
<tr>
<td></td>
<td>120TB</td>
</tr>
<tr>
<td></td>
<td>2 W</td>
</tr>
<tr>
<td></td>
<td>500 W</td>
</tr>
<tr>
<td></td>
<td>600 W</td>
</tr>
<tr>
<td></td>
<td>2400 cubic inches</td>
</tr>
<tr>
<td></td>
<td>43 lbs</td>
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</table>

**Operational Savings:**
- Energy Savings (for operation)
- Energy Savings (for cooling)
- Mechanical Failures
- Physical space
SDS vendors’ opinions

- **Lower cost configuration by using Common PC servers**

- **Scale-out storage** for unstructured data
  - Automatically adding data-node up to PB class capacity

- **Expandability**
  - CIFS/NFS are supported via gateway

- **Availability**
  - Error correction, Replication among Datacenters

- **Media**
  - Integrated HDDs in PC servers
  - **Trial to combine Optical storage**

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**Data Center A**

**Data Center B**

**Data Center C**

![Cluster diagram with X86 servers, OS, and data replication]

**Example of distributed object storage**

- Get/Put/Delete by http(RestAPI)
- CIFS/NFS access by 3rd party gateway

**SDC 16**
Graph shows relationship between **Cloud Service Cost** and **Latency**, media by media.

Devices aligned in a line on logarithmic scale.

Good matching with SNIA Japan Forum End Users survey result.

#1 Storage service price includes not only storage unit cost but also operation cost, electricity cost, DC facility cost, maintenance cost, and margin.

#2 This does not include additional/optional cost such as optional data transfer cost, communication cost, etc.
## Definition of Cold Storage

Cold Storage is ...

“Data storage to store data which has relatively less demand for access (i.e. cold data) at a low cost.”

- It can be a Hardware, System or even Service.
- Sacrifice performance to achieve lower cost
- It typically includes features like below.
  - Large capacity
  - Long-term data preservation
  - Lower power consumption, etc.

Not always needed!
Cold Storage Seminars (in 2015)


Turnout: 176
Discussion Part-2: (2016.5 – ongoing)

Taxonomy for Cold Storage
(on the way..)
Basic HSM pyramid

Is your requirement simple enough like this?

In reality, Things are not always so simple...
“Cold Storage” yardstick

- Prepare various yardsticks for “Cold Storage”
“Cold Storage” yardsticks

1. Cost
2. Performance
3. Security
4. Capacity
5. Retention
## Yardsticks we should consider (under review)

<table>
<thead>
<tr>
<th>No.</th>
<th>Characteristics</th>
<th>Example of included items</th>
<th>Unit example</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Cat-1 Cost</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.1</td>
<td>Initial Cost</td>
<td>System Cost, Installation Cost</td>
<td>$$</td>
</tr>
<tr>
<td>1.2</td>
<td>Running Cost</td>
<td>Maintenance, Electricity, Media, Subscription</td>
<td>Cost/GB/Year</td>
</tr>
<tr>
<td>1.3</td>
<td>Recall Cost</td>
<td>Unique cost for Cloud services</td>
<td>Cost/GB</td>
</tr>
<tr>
<td>1.4</td>
<td>Migration Cost</td>
<td>Cost for system upgrade, data migration</td>
<td>Years</td>
</tr>
<tr>
<td><strong>Cat-2 Performance</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.1</td>
<td>Latency</td>
<td>Time to access the first 1 byte</td>
<td>Sec</td>
</tr>
<tr>
<td>2.2</td>
<td>Throughput</td>
<td>Time to restore the whole file</td>
<td>MB/s</td>
</tr>
<tr>
<td>2.3</td>
<td>Random Access</td>
<td>Seek time, Media exchange time</td>
<td>IOPS</td>
</tr>
<tr>
<td><strong>Cat-3 Security</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.1</td>
<td>Error rate</td>
<td>Bits written per error</td>
<td>$2 \times 10^{28}$</td>
</tr>
<tr>
<td>3.2</td>
<td>Media Lifetime</td>
<td>Average shelf life under normal environment</td>
<td>Years</td>
</tr>
<tr>
<td>3.3</td>
<td>Tolerance to disaster</td>
<td>Heat, Humidity, Air pollution, UV light, EMI</td>
<td>N.A</td>
</tr>
<tr>
<td>3.4</td>
<td>Tamper-proof</td>
<td>Strength of tamper-proof</td>
<td>N.A</td>
</tr>
<tr>
<td><strong>Cat-4 Capacity</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.1</td>
<td>Media Capacity</td>
<td>User data capacity per media</td>
<td>GB</td>
</tr>
<tr>
<td>4.2</td>
<td>Scalability</td>
<td>Expansion by libraries, servers or software</td>
<td>PB</td>
</tr>
<tr>
<td><strong>Cat-5 Retention</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.1</td>
<td>by Compliance</td>
<td>Regulated retention period by law</td>
<td>Years</td>
</tr>
<tr>
<td>5.2</td>
<td>by Other reasons</td>
<td>Data value may arise in future</td>
<td>Years</td>
</tr>
</tbody>
</table>
How to utilize yardsticks

Which one has a better fit? Compare patterns to find more suitable Cold Storage

Cold Storage A: [Diagram]

Cold Storage B: [Diagram]

User Requirement for Cold Data:

Which one has a better fit? Compare patterns to find more suitable Cold Storage.
Summary of our activities

Part-1: **Convergence**
- Cold Storage Definition
- Cold Storage Taxonomy
- Cold Storage Case Studies

Part-2: **Divergence**

Storage Vendors’ Views/Opinions

- Users’ feedback (Survey)
- Seminars
- Tutorials
- Website

End users’ Convenience
- Improve Visibility
- Ease the pain of choosing suitable devices and solutions.

Cold Data
Next steps..

❖ Put existing products on each yardstick and find appropriate calibration. Prepare more case studies and choose Cold Storage yardsticks to compare.

❖ Discuss Auto-tiering technology, which is another important item for managing cold data and storage.

❖ More seminars to raise awareness for Cold Storage!

Our discussion continues..
Latest Optical Technology
Archival Disc

SONY
Panasonic
Archival Disc
History of Optical technology

**Consumer**

- **CD (1982)**
  - 650nm
  - 650MB
- **DVD (1996)**
  - 650nm
  - 4.7GB
- **Blu-ray™ (2003)**
  - 405nm
  - 50/100GB

**Professional**

- **Archival Disc (2015)**
  - 300GB
Archival Disc technology

**Archival Disc**

- 6 layers in Double-sided structure
- Protective cover layer
- Land & Groove recording format

**300GB / disc**

**Disc structure**

- Side A
  - Layer 2
  - Layer 1
  - Layer 0

- Side B
  - Layer 0
  - Layer 1
  - Layer 2

**Drive**

**Key technologies**

- 8ch Optical Array Heads
- Simultaneous access on both sides

**Read:**
- 2Gbps

**Write:**
- 1Gbps (with verify)

- 405nm
Archival Disc based products

- **Cartridge type** for general ID purpose.
- **Bare-disc type** for Data Centers

Optical Disc Archive

- EverSpan
Acceleration Tests to prove “Robustness”

Media Life | Temp. | R.H
---|---|---
100 Year | 35°C (95°F) | 95%

High Temp. & Humidity

ISO/IEC 16963 (85°C/80%, 70°C/75%, 60 °C/70%, 60 °C/80%)

H₂S: 0.07 ppm  
NO₂: 1.4 ppm  
Cl₂: 0.07 ppm  
SO₂: 1.40 ppm

Under Corrosive Gases

Media Life Temp. R.H
100 Year 35°C (95°F) 95%

Ready for 100+ years archive

Irradiance: 130W/cm²  
Wave length: 300-400nm

Exposure equivalent of 1 year

5 weeks

Ultraviolet irradiation

Seawater soak test
Mapping of Cold Storage media (trial)

- **HDD**: High performance, Low Cost, Low Life
- **SSD**: Higher performance, Low Cost, Long Life
- **TAPE**: Low Cost, Long Life
- **OPTICAL**: Low Cost, Longer Life

**Note**: This is Sony’s view.
Thank you!
Backup
Variation of Archival Disc products

The cartridge type offers Easy handling, Offline capability as well as scalable library system.

Optical Disc Archive

The DC type offers excellent $/GB feature as well as enormous scalability. (181PB)
SNIA Japan Forum
End users survey 2016
(Excerpt)
Attributes of users

**Employee number**

- Less than 99: 19%
- 100 - 199: 15%
- 200 - 299: 7%
- 300 - 499: 10%
- 500 - 999: 11%
- 1,000 - 4,999: 19%
- 5,000 - 9,999: 6%
- More than 10,000: 13%

**Category of Business**

- Agriculture, Forestry and Fisheries: 1%
- Construction: 7%
- Manufacturing: 1%
- Electricity, gas and water supply: 6%
- Transport, Telecommunication: 9%
- Wholesale and retail trade: 3%
- Finance, Insurance: 2%
- Real Estate business: 1%
- Information Handling Service (IHS): 24%
- Services (excluding IHS): 9%
- Healthcare: 3%
- Broadcast, Post Production: 0%
- Others: 10%
Survey Result  (Usage situation)

**Usage situation for Cold Storage**

- **In Use**: 51%
- **In Planning**: 35%
- **No Plan**: 14%

**n=252**

**How often Cold Storage is accessed?**

- **Seldom or Never**: 63%
- **Occasionally**: 37%

**n=217**
Survey Result (Storage devices in use)

n=213
Storage Media or Device currently used for Backup and Archive

- Cold data is not separated: 31%
- Archived to low-cost HDD: 41%
- Archived to Tape and migrate them periodically: 22%
- Archived to primary-level HDD or SSD: 18%
- Archived to Optical discs: 14%
- Archived to Tapes, but never migrated: 12%
- Use of Cloud Service: 12%
- Archived to Dedupe Storage System: 3%
Survey Result  (Issues for Cold Storage)

Issues about Cold Storage and its management  (n=217)

- About 35% of users are concerned about the data migration.
- About 30% are expecting unlimited capacity and indefinite preservation.