Optical Disc Archive

Tested 3rd vendor products

FC Switch

- Brocade 300,   DCX-8510 Core
- Qlogic Sanbox 5800 series
- HP SN3000B (16Gb, StoreFabric series, Brocade 6505 OEM)
- Cisco MDS series (8Gb MDS9148 etc.)

HBA

- Qlogic
  - QLE2560, QLE2562 (8Gb)
  - QLE2570, QLE2572 (16Gb)
  - QLE2690, QLE2692 (16Gb) (Newly tested)
- Emulex
  - LPe12000, LPe12002 (8Gb)
- HP
  - 81Q, 82Q (8Gb, Qlogic OEM)
  - 81E, 82E (8Gb, Emulex OEM)
  - SN1000Q (16Gb, 2-port, Qlogic QLE2662 OEM)
- Brocade
  - Brocade 815, 825 (8Gb)

Cable

- Fibre type: Multi Mode fibre, OM3 compliant
- Connector type : Duplex LC – Duplex LC (See below)

Rack

- Schneider Electric (APC Japan)
  - AR3300 (1200 mm in depth)
  - AR3100 (1070 mm)
  - ➢ For AR3100, the rear door should be removed. Otherwise, purchase AR7000A for the rear door.
- Settsu Metal Industrial
  - SSR-42U60C0V2B (1200 mm, black)
  - SSR-42U60C0V2W (1200 mm, white gray)
  - SSR-42U60B0V2B (1100 mm, black)
  - SSR-42U60B0V2W (1100 mm, white gray)

Duplex LC connector

Sony Professional Solution Group

SONY

Gen 1 vs Gen 2

Condition : Write with verify

Drive	Cartridge	ODC-3300R		ODC-1500R		ODC-1200RE		ODC-600RE	
		Read	Write once	Read	Write once	Read	Re-Write	Read	Re-Write
ODS-D77U/F	Operation	NO	NO	YES	YES	YES	YES	YES	YES
	Speed			1,170 Mbps	380 Mbps	660 Mbps	160 Mbps	1,070 Mbps	130 Mbps
ODS-D280 U/F	Operation	YES	YES	YES	TBD	YES	YES	YES	TBD
	Speed	2000 Mbps	1000 Mbps	1,170 Mbps		660 Mbps	160 Mbps	1,070 Mbps	

ODA Gen2 drive can write data to ODC1200RE. It'll be available by E/Oct/2016 with firmware version-up.
For other Gen1 cartridges, we decided not to support at first release (Aug/2016). Sony continues to study based on market demand.
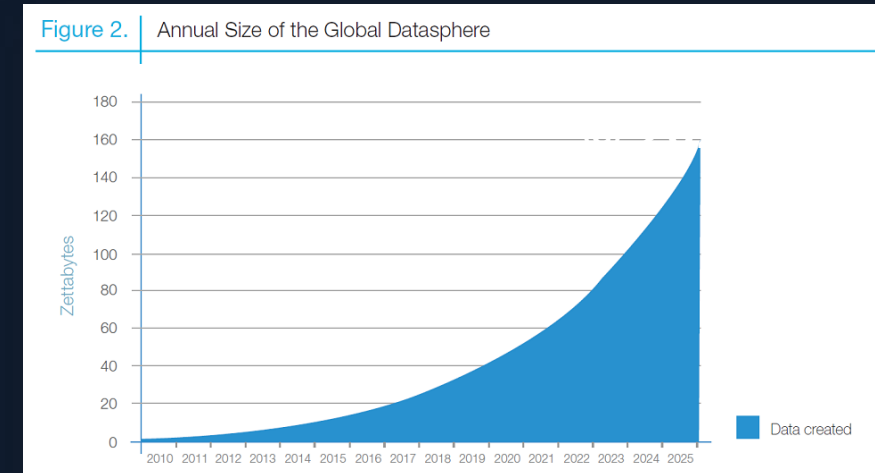
SONY

Data Storage market trend

According to IDC, 163ZB data will be created/copied per year until CY2025.

Source: IDC Digital Universe Report, 2014
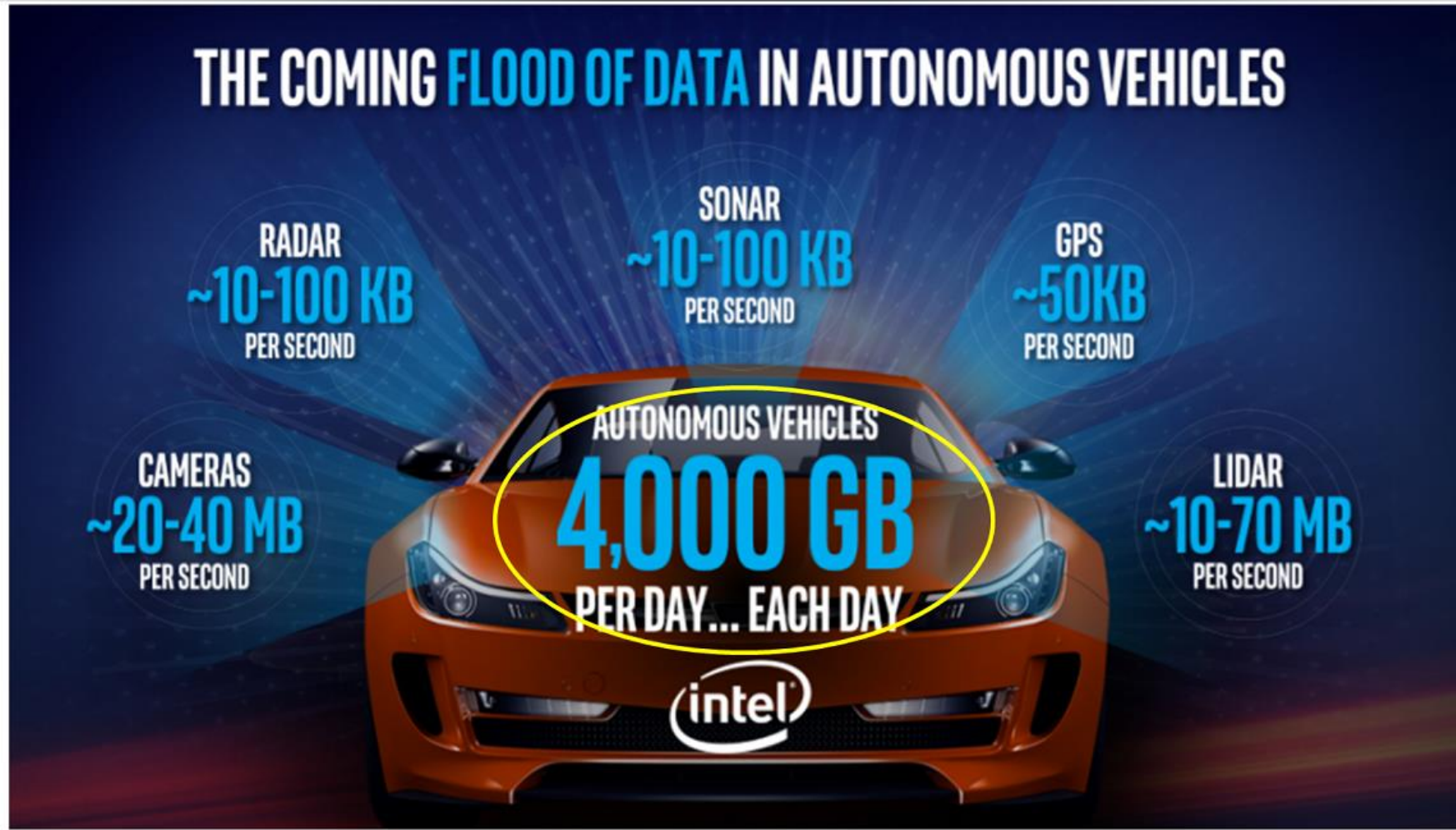

Source: IDC Data Age 2025 Study, 2017

Example from Auto vehicle industry

1台の車が 1 日に生成するデータ量

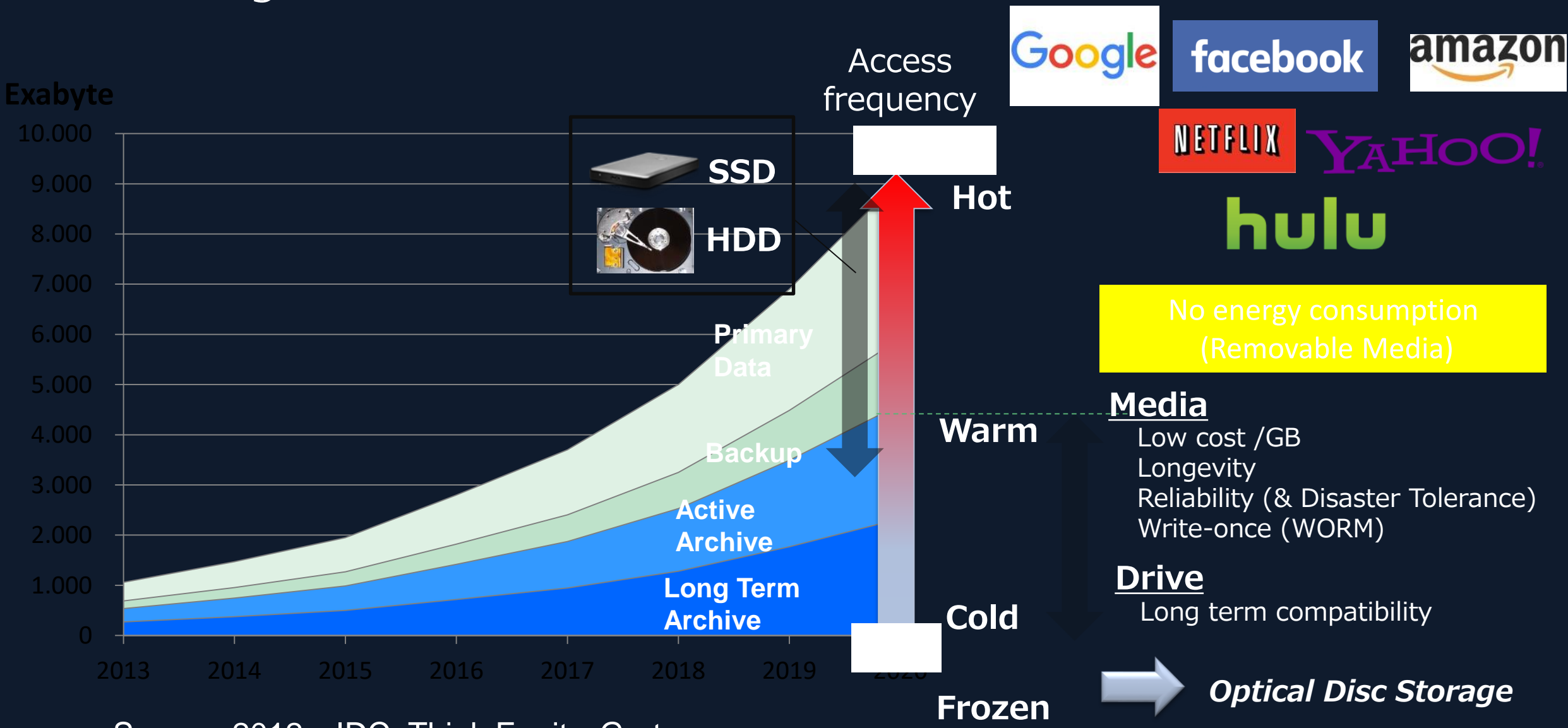# WW Storage Market Trend – Best solution for Cold data

Exabyte

Chart Y-axis (Exabyte): 10.000, 9.000, 8.000, 7.000, 6.000, 5.000, 4.000, 3.000, 2.000, 1.000, 0

Chart X-axis (Years): 2013, 2014, 2015, 2016, 2017, 2018, 2019, 2020

Chart area labels:
- SSD
- HDD
- Primary Data
- Backup
- Active Archive
- Long Term Archive

Access frequency
- Hot
- Warm
- Cold
- Frozen

No energy consumption (Removable Media)

Media
Low cost /GB
Longevity
Reliability (& Disaster Tolerance)
Write-once (WORM)

Drive
Long term compatibility

Optical Disc Storage

Google | facebook | amazon
NETFLIX | YAHOO!
hulu

Next Generation Optical Disc Format

Sony and Panasonic formulated a new standard of next-generation optical disc

Press Release on March 10, 2014.

"Archival Disc" standard formulated for professional-use next-generation optical discs

Sony Corporation
Panasonic Corporation

Tokyo, Japan - March 10, 2014 - Sony Corporation ("Sony") and Panasonic Corporation ("P

formulated "Archival Disc", a new standard for professional-use, next-generation optical dis

long-term digital data storage.

Optical discs have excellent properties to protect themselves against the environment, suc

can also withstand changes in temperature and humidity when stored. They also allow inte

formats, ensuring that data can continue to be read even as formats evolve. This makes th

Recognizing that optical discs will need to accommodate much larger volumes of storage

future growth in the archive market, Sony and Panasonic have been engaged in the joint de

-generation optical discs.

Roadmap

Both Sony and Panasonic aim to launch systems with a recording capacity of 300 GB per disc from summer 2015, onwards. In addition, both companies plan to leverage their respective technologies to further expand the recording capacity per disc to 500 GB and 1 TB.

Archival Disc

	Archival Disc Roadmap		
Capacity	300GB	500GB	1TB
Signal Processing Technology			High Linear Density (Multi Level Recording Technology)
		High Linear Density (Inter Symbol Interference Cancellation Technology)	
	Narrow Track Pitch (Crosstalk Cancellation Technology)		
Basic Specification	Double-Sided Disc Technology λ=405nm, NA=0.85, Layer Structure: 3Layers/side		

Optical Bare Disc Format History and evolution

	Capacity	Format Name	Symbol Logo
2015	1TB 500GB 300GB	**Archival Disc**	**Generation-2**
2003	QL 128GB TL 100GB DL 50GB SL 23.3/25GB	**Blu-ray Disc**	**Generation-1**
1996	4.7GB	**DVD**	
1982	650MB	**Compact Disc (CD)**	

Customer benefit of ODA

Long life

Eco

Disaster Tolerance
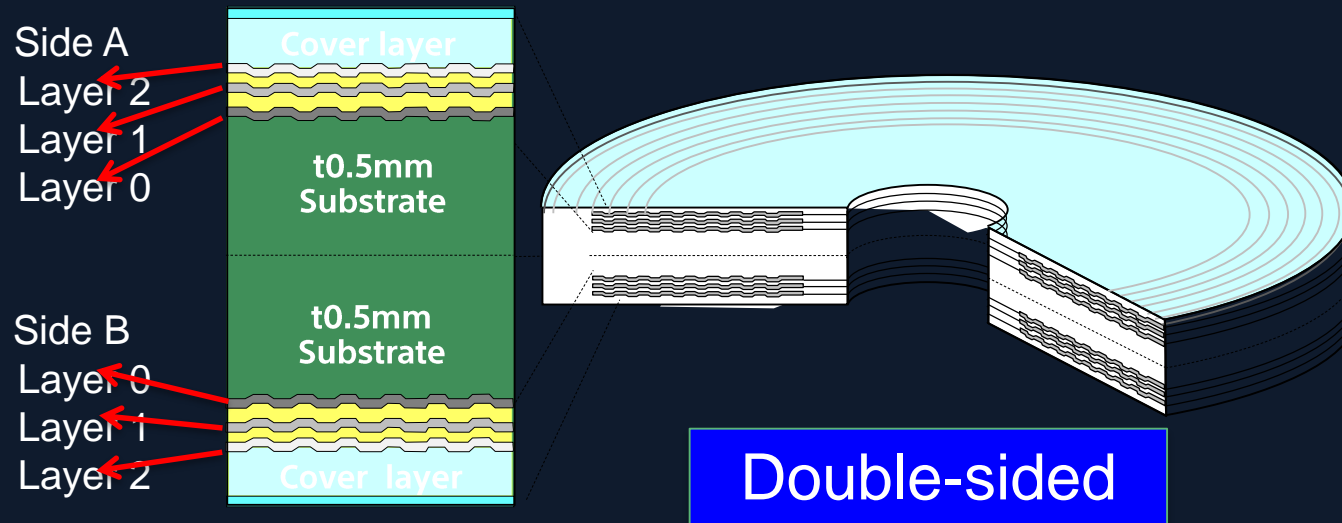
True WORM

Fast

Key technology

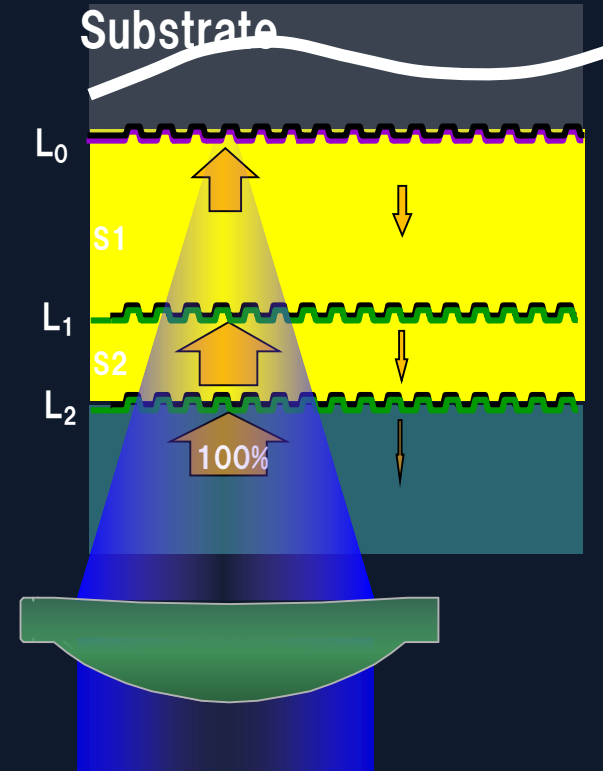# New Technology for high capacity (Archival Disc Format)

1) Multi Layer & Double-sided

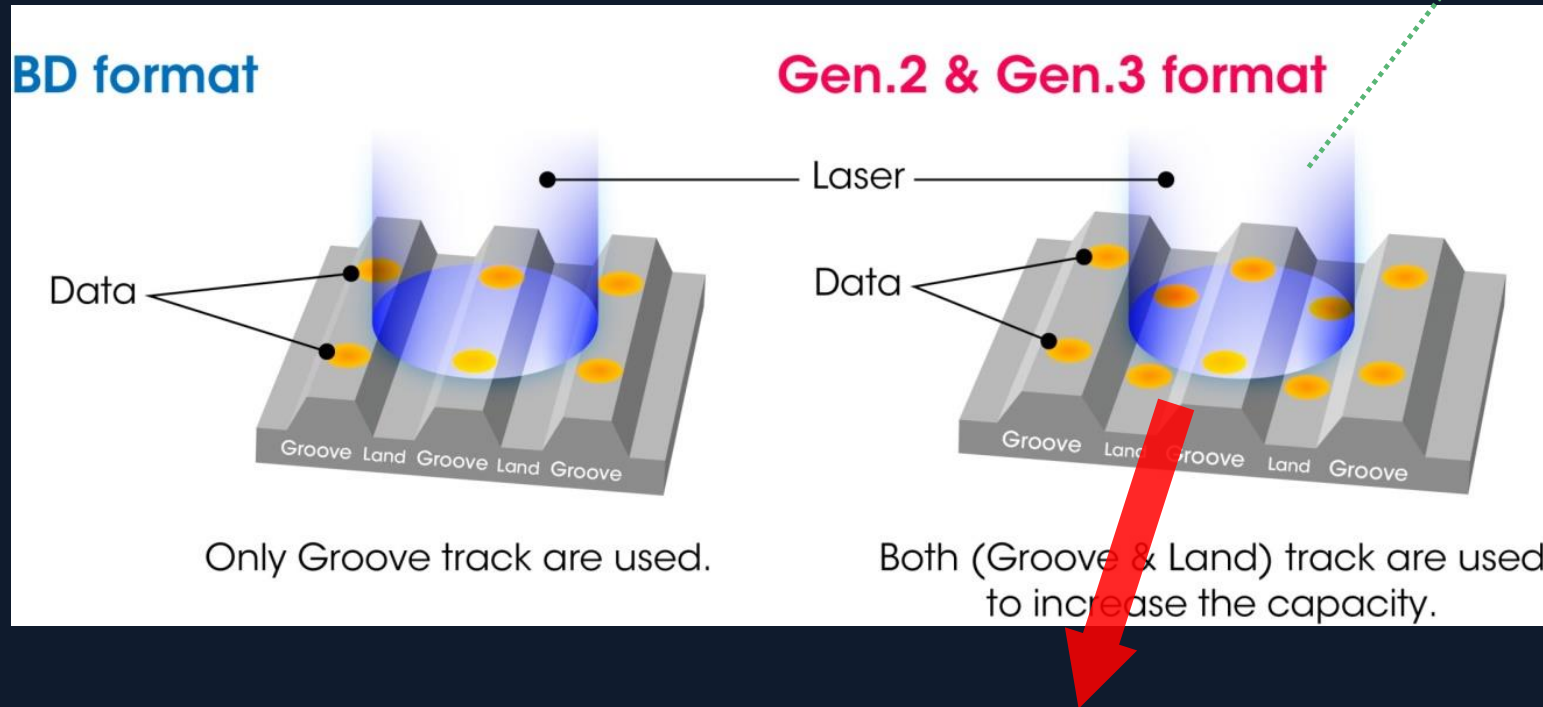3 layers per side & Double-sided structure   -> 300GB/Disc

Triple Layer Structure

Substrate

Recoding Layer

Side A
Layer 2
Layer 1
Layer 0

Cover layer
t0.5mm Substrate
t0.5mm Substrate
Cover layer

Side B
Layer 0
Layer 1
Layer 2

Double-sided

L_0

S1

L_1

S2

L_2

100%

New Technology for high capacity (Archival Disc Format)

1) Multi Layer & Double-sided

2) Narrow Track Pitch (Land & Groove format)

Blue Laser specification is same
λ = 405nm, NA=0.85

Easy to keep the compatibility

BD format

Laser

Data

Groove Land Groove Land Groove

Only Groove track are used.

Gen.2 & Gen.3 format

Laser

Data

Groove Land Groove Land Groove

Both (Groove & Land) track are used to increase the capacity.

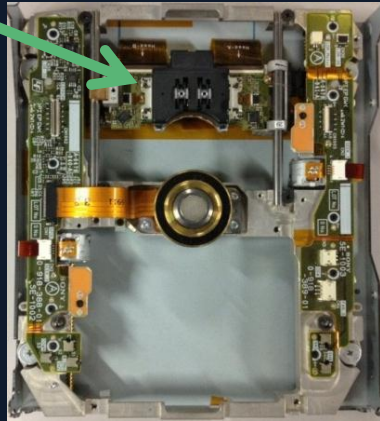## 3) Cross Talk Cancellation   Electrically removes crosstalk from the adjacent tracks.
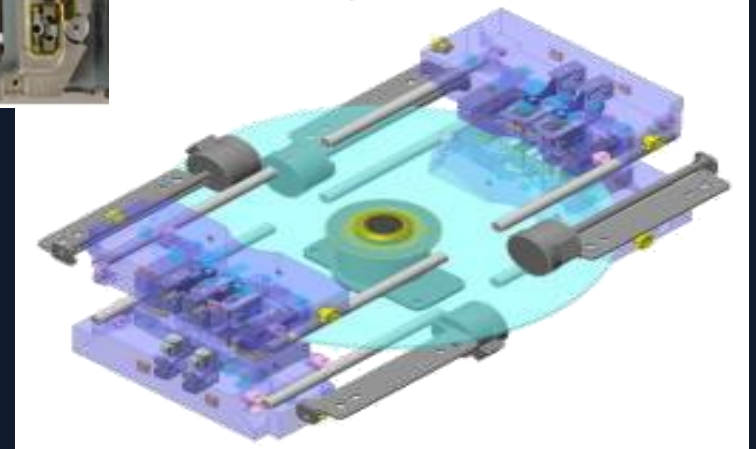
Generation 2 – Double Speed
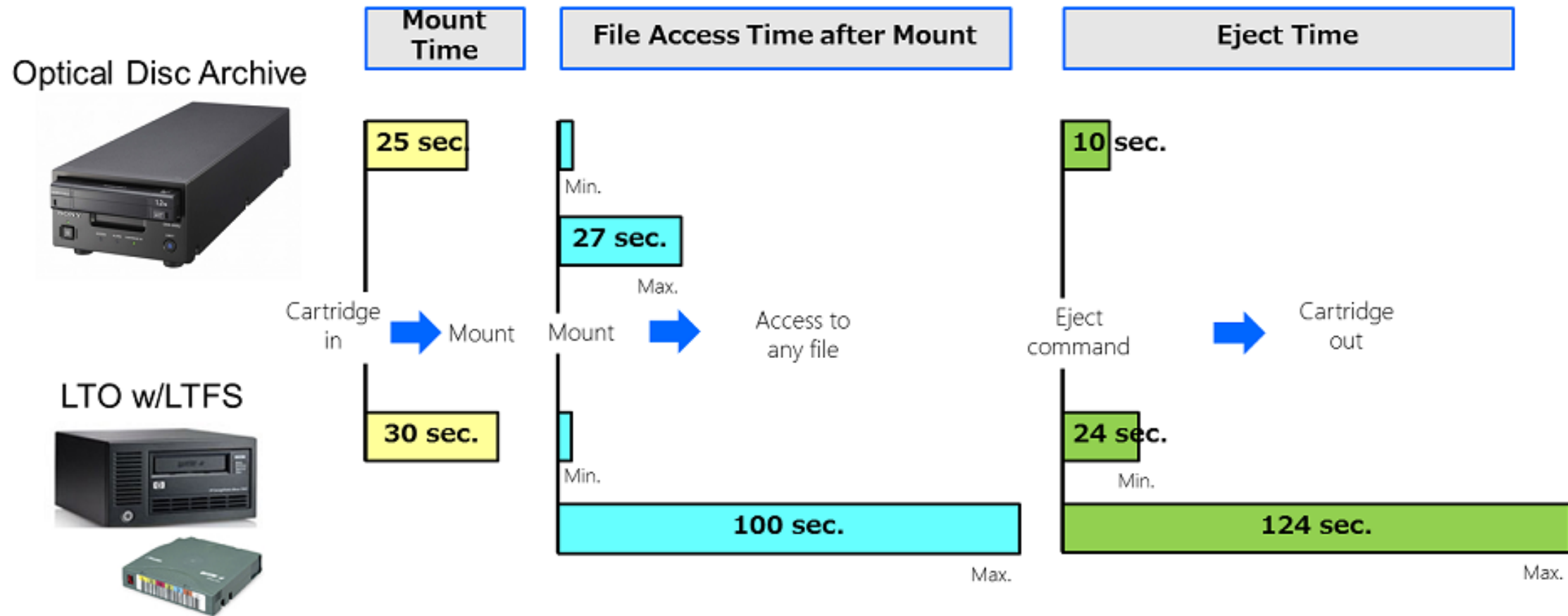
Generation 1
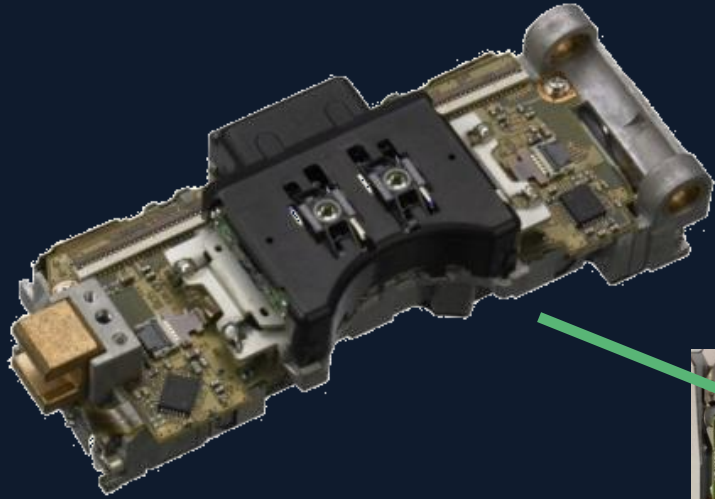
Generation 2

ODA Initial design 2
Lasers/Head

2 Heads incorporated
= 4 Lasers

Gen 2 = Dual Side in same Form factor
= 8 Lasers

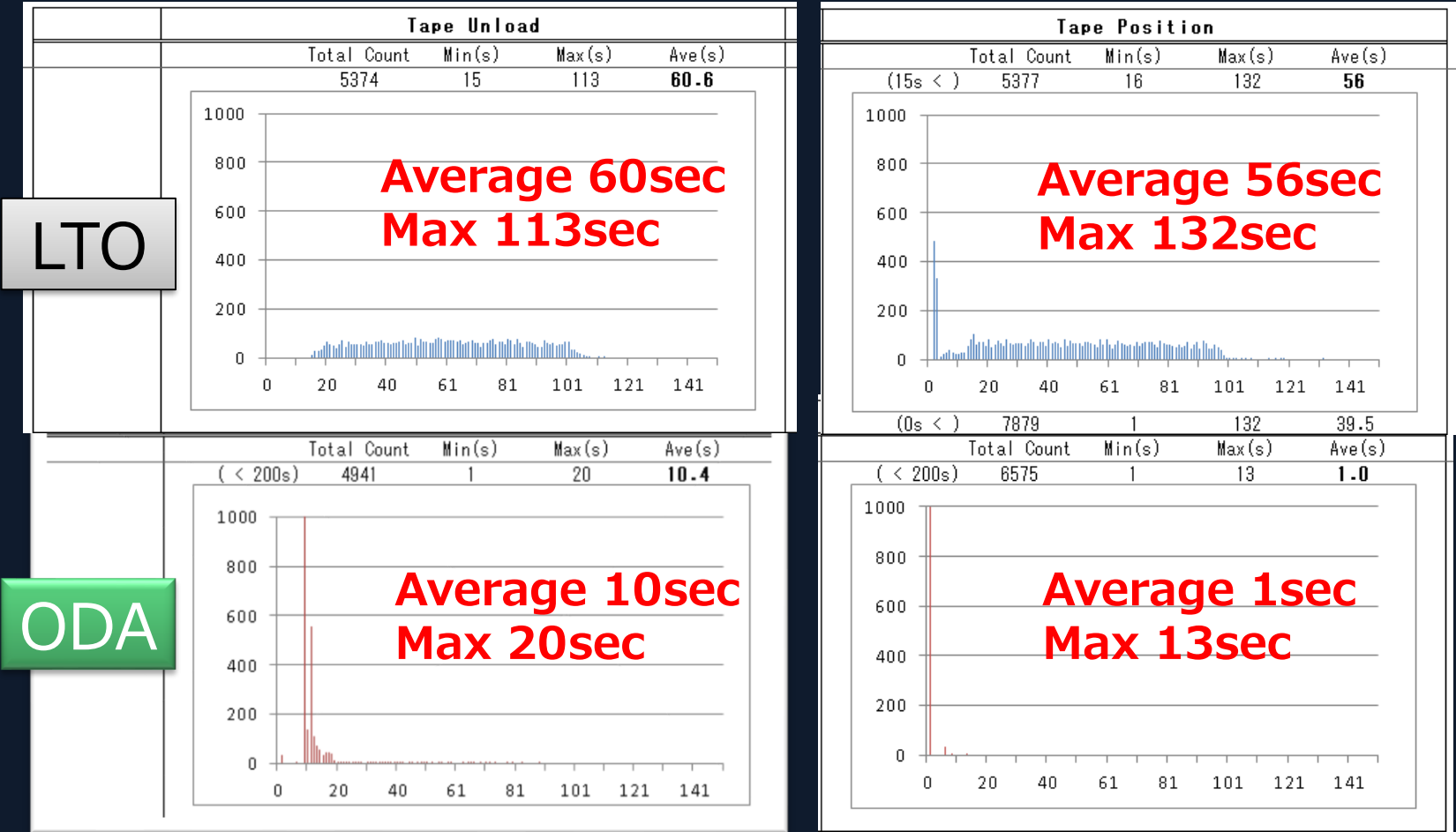# High-Speed Random Access ～Good first-byte access (Drive)～

High-Speed Random Access ～Good first-byte access (Library)～

Comparison of statistical information for a year for library system

| Eject time | File Access ～ Transfer start |

Front   Rear

LTO

Tape Unload

Total Count	Min(s)	Max(s)	Ave(s)
5374	15	113	**60.6**

**Average 60sec
Max 113sec**

Tape Position

	Total Count	Min(s)	Max(s)	Ave(s)
(15s <)	5377	16	132	**56**

**Average 56sec
Max 132sec**

ODA

	Total Count	Min(s)	Max(s)	Ave(s)
(< 200s)	4941	1	20	**10.4**

**Average 10sec
Max 20sec**

	Total Count	Min(s)	Max(s)	Ave(s)
(0s <)	7879	1	132	39.5
(< 200s)	6575	1	13	**1.0**

**Average 1sec
Max 13sec**

After mounting, Carrying out Tape Positioning
The mean value of mounting: About 40sec for both Tape and ODA
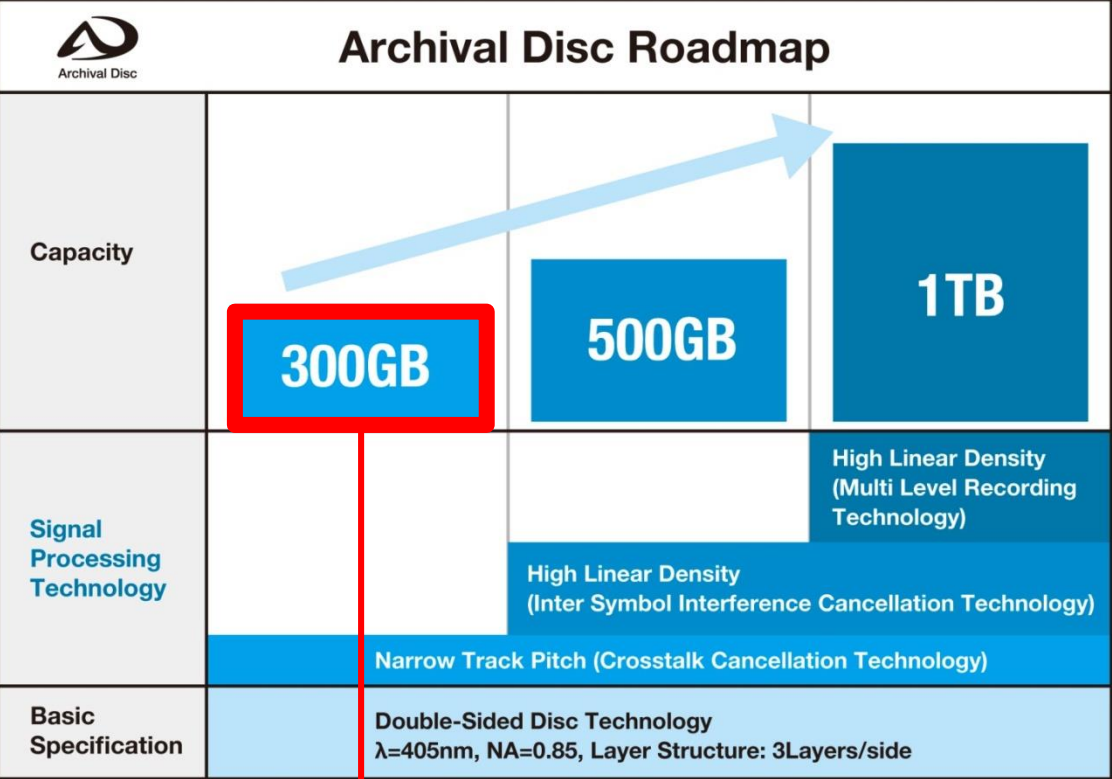
Inner structure of
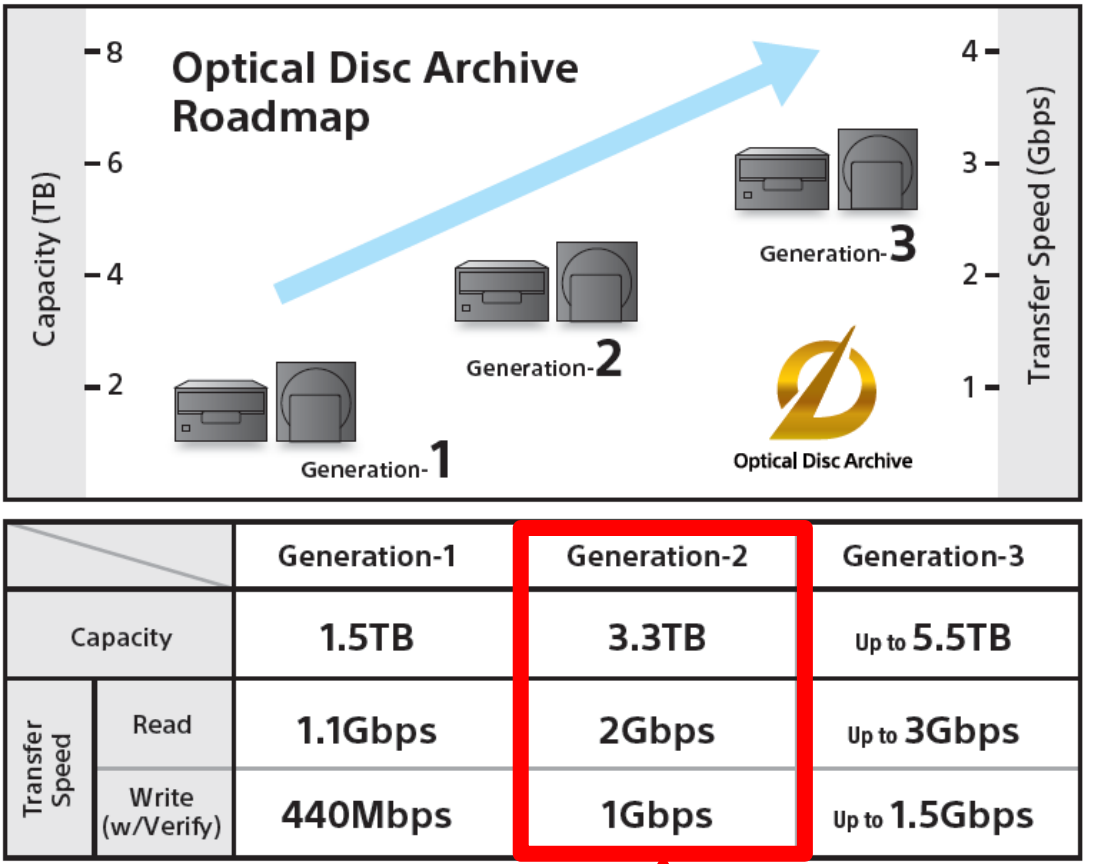
Future technology

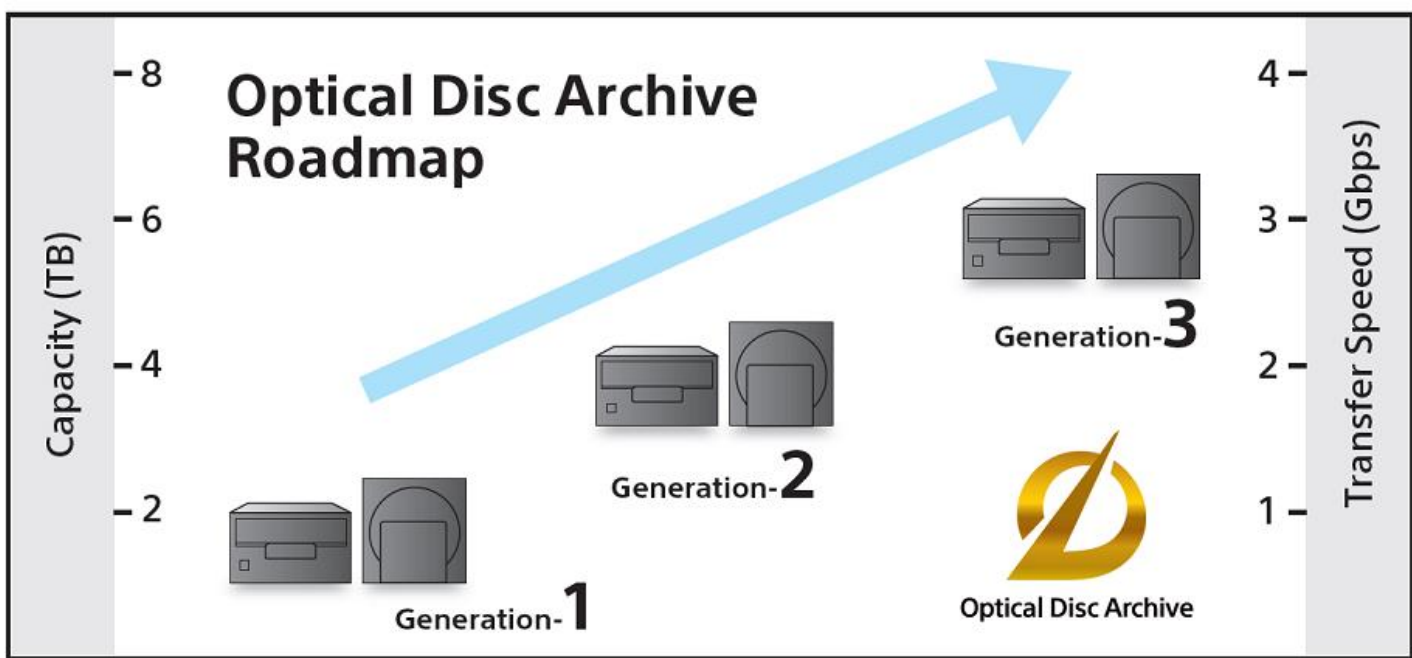# Evolution of optical

Bare disc Roadmap and ODA Roadmap

Archival Disc Roadmap

Capacity		300GB	500GB	1TB

Signal Processing Technology
- High Linear Density (Multi Level Recording Technology)
- High Linear Density (Inter Symbol Interference Cancellation Technology)
- Narrow Track Pitch (Crosstalk Cancellation Technology)

Basic Specification
- Double-Sided Disc Technology λ=405nm, NA=0.85, Layer Structure: 3Layers/side

Optical Disc Archive Roadmap

		Generation-1	Generation-2	Generation-3
Capacity		1.5TB	3.3TB	Up to 5.5TB
Transfer Speed	Read	1.1Gbps	2Gbps	Up to 3Gbps
	Write (w/Verify)	440Mbps	1Gbps	Up to 1.5Gbps

Optical Disc Archive Roadmap & Technology

		Generation-1	Generation-2	Generation-3
Capacity		1.5TB	3.3TB	Up to 5.5TB
Transfer Speed	Read	1.1Gbps	2Gbps	Up to 3Gbps
	Write (w/Verify)	440Mbps	1Gbps	Up to 1.5Gbps

Latest archive storage manufacturer

ODA has advantage for "confidence for long term archive", which is required by customer.

	Drive	Media	Read backward compatibility	Remarks
LTO	IBM	Fujifilm Sony	1 Gen	
Oracle T10000	Oracle	Fujifilm	All Gen	将来への投資ストップ
IBM TS3592	IBM	Fujifilm	3 Gen	
ODA Gen2	Sony	Sony MCM	All Gen	
Archival Disc	Sony Panasonic	Sony Panasonic		

Same or even better!

Better confidence in terms of basic technology

Format Stack

Optical Disc Archive file system comply with UDF and ECMA.
(The same as blu-ray format)

Blu-ray (for reference)		**Optical Disc Archive**
Blu-ray Part 3 (AV Specifications)	File Format Layer	Not Defined Some guidelines may be provided.
Blu-ray Part 2 (File System)	File System Layer	Optical Disc Archive file system
OSTA UDF 2.5/2.6		OSTA UDF 2.5/2.6
ECMA-167		ECMA-167
Blu-ray Part 1 (Basic Specifications)	Physical Layer	Similar to Blu-ray Part 1

Definition of "Volume Set"

"Volume Set" is defined in ECMA as follows.

"A collection of one or more volumes"

Usually, "volume" means "medium" or "disc"
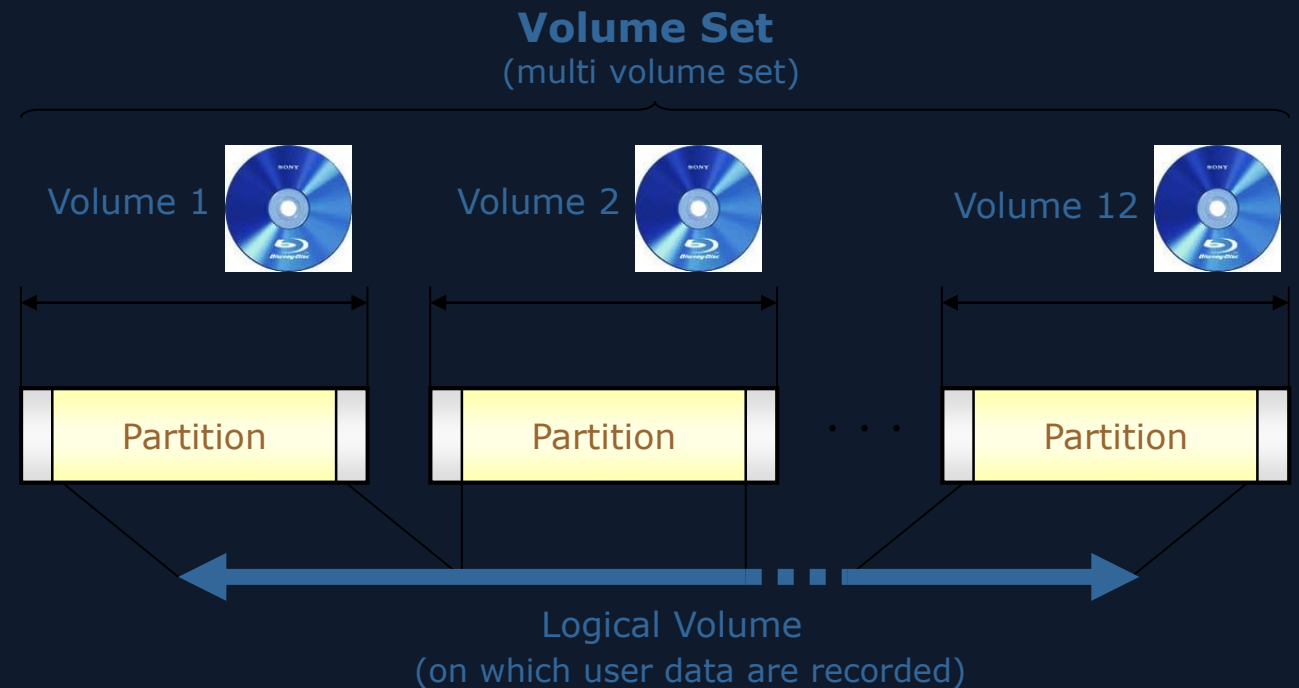
**For blu-ray file system,
A volume set shall consist of only one volume.**

**For Optical Disc Archive file system,
A volume set shall consist of 12 volumes.**

Optical Disc Archive product

Scalable Solutions
Optical Disc Archive

Optical Disc Archive

**Stand alone drive
USB connect**

**library
30slot**

Scalable library

Optical Disc Archive Generation 2

ODS-D280U
Stand-alone USB Drive Unit

ODS-D280F
Fibre-Channel Library Drive Unit

ODC3300R
Optical Disc Archive Cartridge

Future plan

ODA Enterprise library project

ODA Enterprise library


Sony plans to productize ODA enterprise library

- Target schedule: 1H/FY2019
- 900 - 8000 slots (3PB ~ 26PB)
- Better cost per GB
- IE port: up to 84 cartridge slots
- # of drives: 20 for single drive module (max 80 as a total)
- Redundant robotics arm
- Less than 1 hour downtime
- User friendly maintenance (touch panel, web remote maintenance, internal camera)
- Hot swappable (PSU, drive, fan)

Beyond Definition

Sony Enterprise Library – Top view
(Tentative design plan)
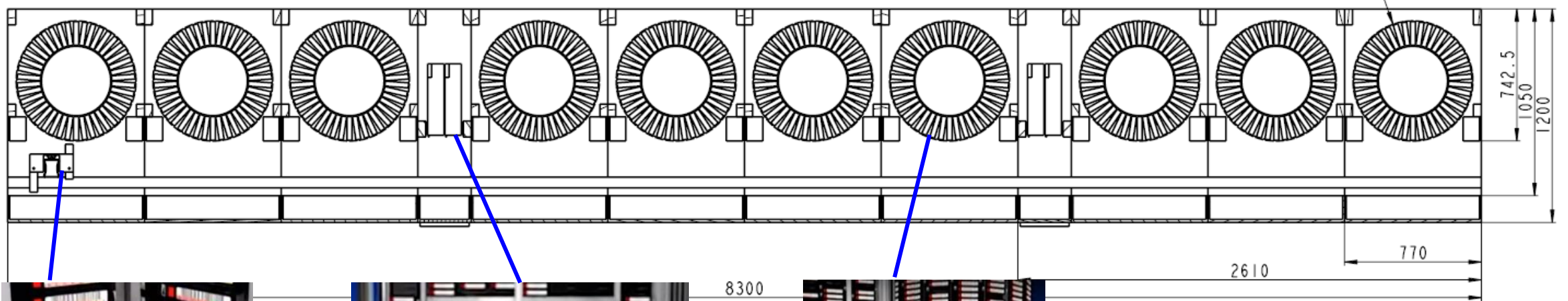
Robot arm

*Robot arm will be redundant*

Drive space
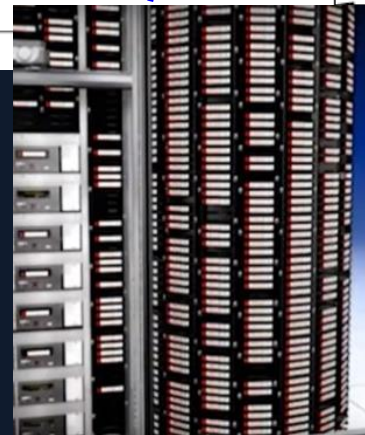
Cartridge space

ODA Gen2 Estimated Archival Life

- ✓ By changing both recording material and its structure, more reliable Gen2 data recording has been achieved.
- ✓ Oxide material recording layer sandwiched by oxide material protective layers was adopted for ODA Gen2.
- ✓ More precise sputtering technology has been also adopted to achieve Land & Groove recording.
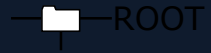- → Achieved longer media life for Gen 2
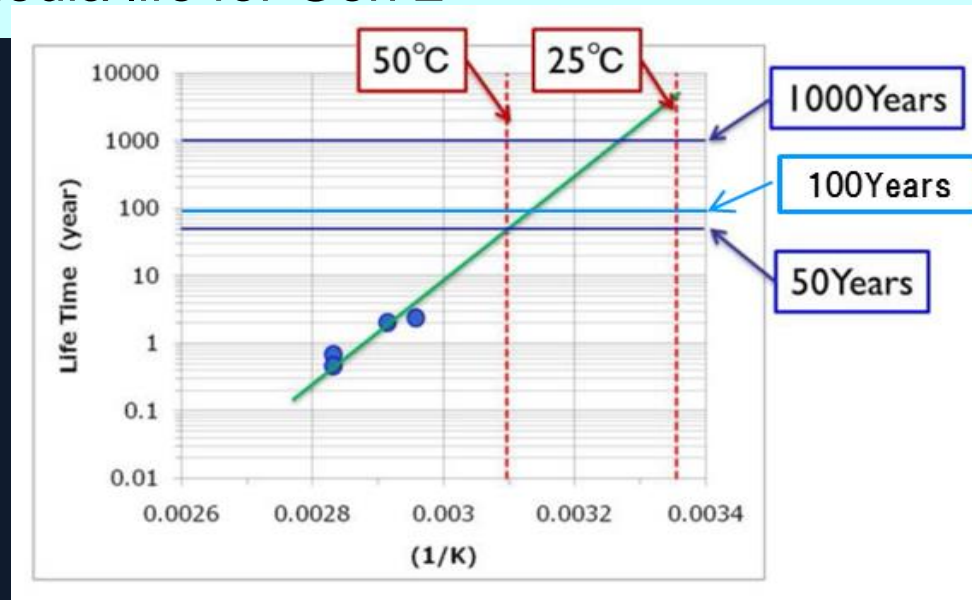
Source :AD White Paper
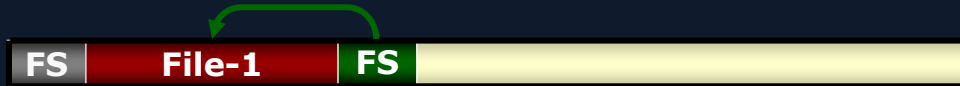
ODA Format Basic

Sequential Recording

Data are recorded sequentially on a disc. (Both of WO/RE)
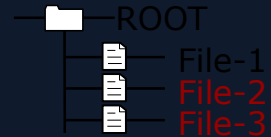
1. Just formatted.

─📁─ROOT

FS	

Initial FS (file system) data are written.

2. Put one file.

─📁─ROOT
└─📄─ File-1

FS	File-1	FS	

The file data followed by updated FS data are written.

3. Put other two files.

─📁─ROOT
├─📄─ File-1
├─📄─ File-2
└─📄─ File-3

FS	File-1	FS	File-2	File-3	FS	

No FS data is written between the files written consecutively.
(within 5 sec.)

4. Delete File-1.

─📁─ROOT
├─📄─ ~~File-1~~
├─📄─ File-2
└─📄─ File-3

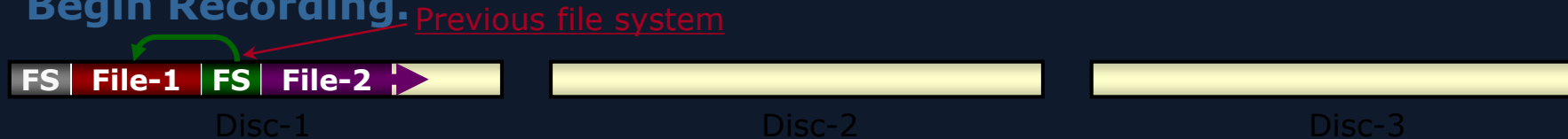| FS	File-1	FS	File-2	File-3	FS	FS	
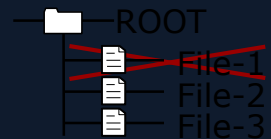
Only the file system data are updated.
The deleted file data still remains, but is not referred by the updated FS.
Available capacity is NOT increased at this time. Need to be re-formatted.
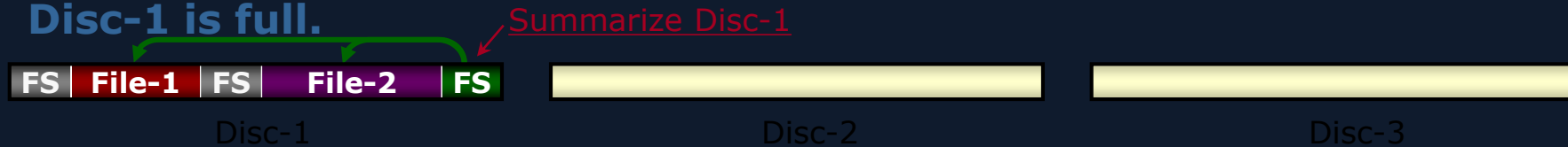
Disc spanning

A file can be spanned across multiple discs. **(by using UDF multi-volume set)**

- The spanning process (w/ disc exchange) is performed by file system driver.
- Non real-time application does NOT need to be aware the file is spanned or not.
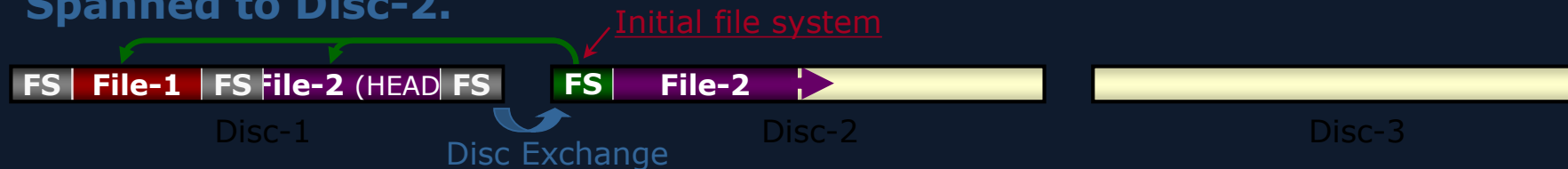- Real-time application should consider the disc exchange time for spanned file.

1. **Begin Recording.** Previous file system

| FS | File-1 | FS | File-2 ▶ |

Disc-1   Disc-2   Disc-3

2. **Disc-1 is full.** Summarize Disc-1

| FS | File-1 | FS | File-2 | FS |

Disc-1   Disc-2   Disc-3

3. **Spanned to Disc-2.** Initial file system

| FS | File-1 | FS | File-2 (HEAD | FS | | FS | File-2 ▶ |

Disc Exchange

Disc-1   Disc-2   Disc-3

4. **End Recording.** Newest file system

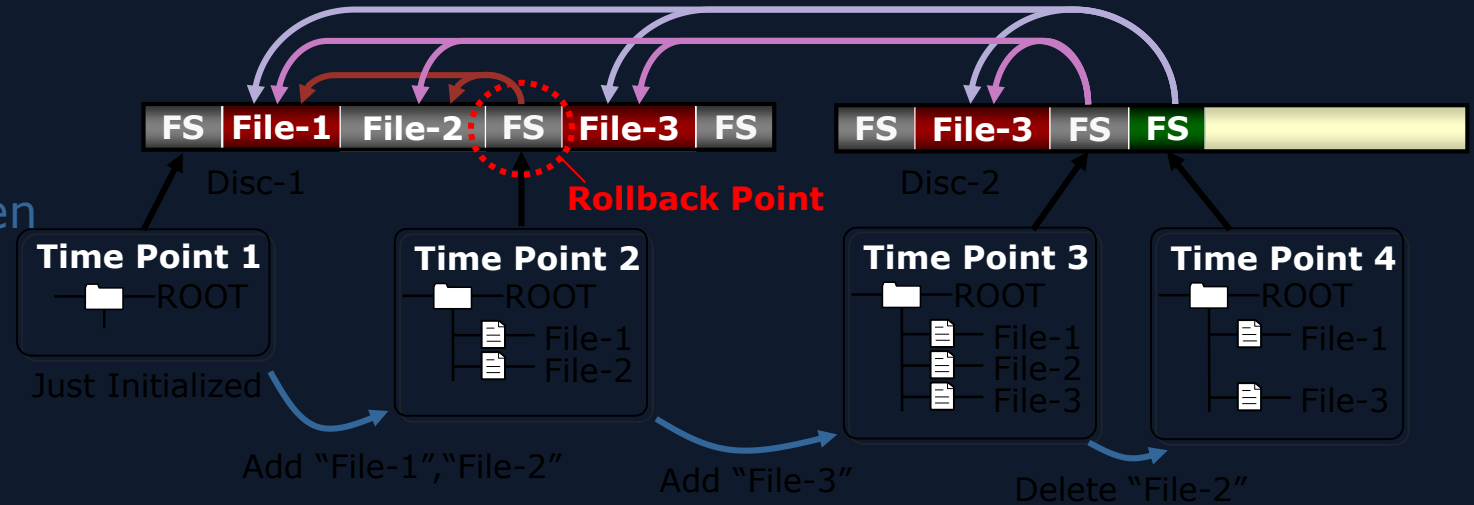| FS | File-1 | FS | File-2 (HEAD | FS | | FS | File-2 (MID) | FS | | FS | File-2 (TAIL) | FS |

Disc-1   Disc-2   Disc-3

Disc Exchange

When the cartridge is ejected from the drive, the disc number where the latest file system is recorded is stored to the cartridge memory and when the cartridge is loaded this disc number in the cartridge memory is read first and the disc which includes the latest file system is immediately loaded.

Rollback

By using ODA utility, the file system can be rolled back to arbitrary point in the past.

On the sequential recorded medium, the file data and the FS data once written are not removed physically.

| FS | File-1 | File-2 | FS | File-3 | FS |
Disc-1

Rollback Point

| FS | File-3 | FS | FS |
Disc-2

Time Point 1
ROOT
Just Initialized

Time Point 2
ROOT
├─ File-1
└─ File-2

Time Point 3
ROOT
├─ File-1
├─ File-2
└─ File-3

Time Point 4
ROOT
├─ File-1
└─ File-3

Add "File-1","File-2"   Add "File-3"   Delete "File-2"

Rollback w/o de-allocate (WO/RE)

- Free space is NOT regained.
- "Undo" or "Redo" operations are available.

| FS | File-1 | File-2 | FS | File-3 | FS |
Disc-1

| FS | File-3 | FS | FS | FS | ▶ New Files |
Disc-2

Copy

Rollback w/ de-allocate (RE only)

- Free Space is regained.
- "Undo" or "Redo" operations are NOT available.

| FS | File-1 | File-2 | FS | ▶ New Files |
Disc-1

Disc-2
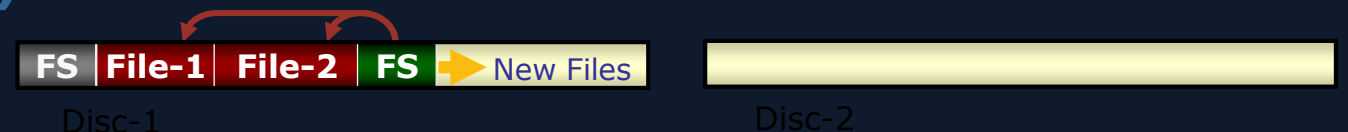
Limitation

In case of re-writable media, only when the last clip is deleted, free disc space can be recovered. (LTO/LTFS cannot do this operation)

Each files can be deleted from browser, but it's not physically erased(except the last file on RE media) and the rollback function does work. (Same as LTO LTFS)

The other limitation is basically same as User Data Area of XDCAM "Professional Disc".

　　1) Only one file can be write-opened simultaneously.
　　2) Only "new file" can be write-opened. An "existing file" can not be write-opened.
　　3) More than one file can be read-opened simultaneously. However we don't recommend this operation as many disc change will happen.

Parity

More robustness for archival use
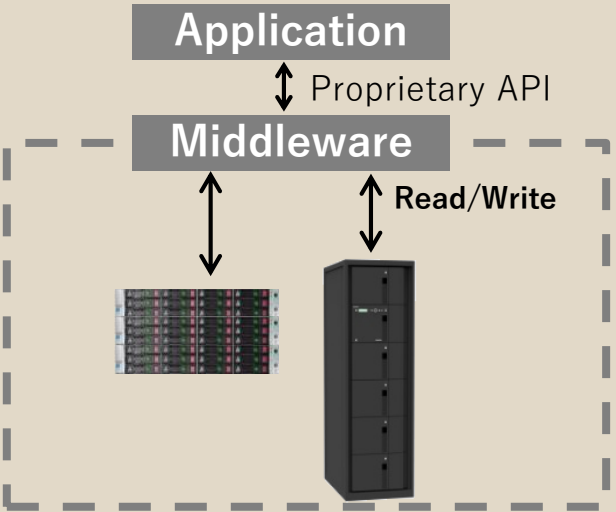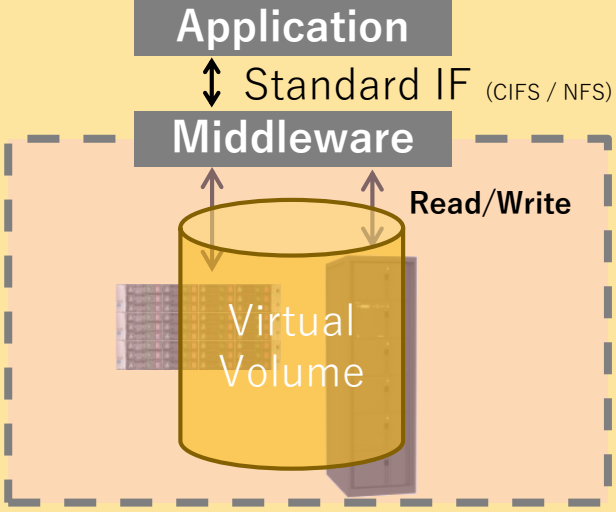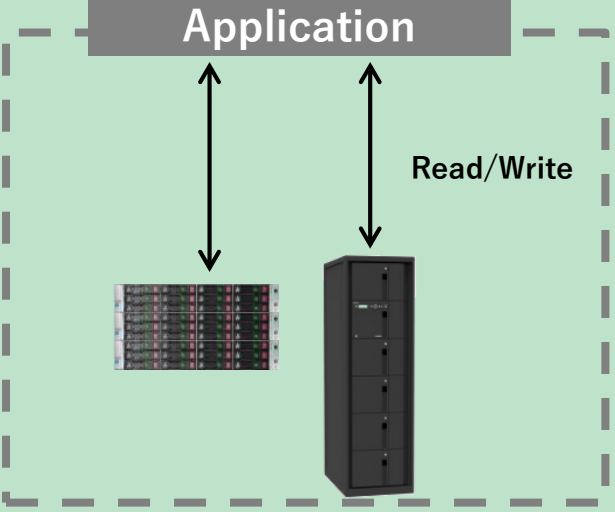
In addition to higher reliability of Optical Disc Archive medium than blu-ray disc, "parity mechanism" is implemented in the file system driver in order to provide more robustness for archival use,
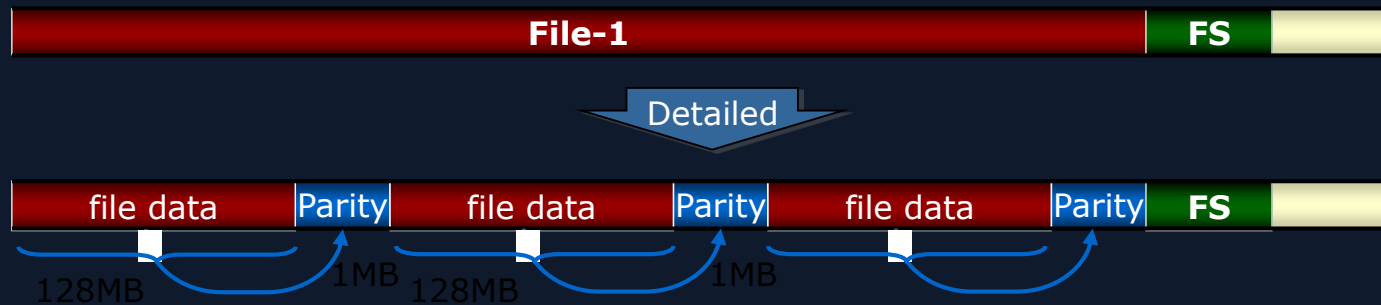
- User file data is divided into 128MBytes, and 1MBytes of parity data is added to each of them.
- The parities are computed and written by the file system driver during write operation.
- The parities are not accessed by the file system driver during normal read operation.
- The parities are used by the utility to recover damaged file.

- The FS data has no parties, but they are duplicated by sequential recording implicitly.

ODA basis Storage solution type

Middleware	FRONT PORCH DIGITAL DIVArchive / sgl FlashNet	XenData / QSTAR TECHNOLOGIES	Small MAM Application
Typical Configuration	Application is responsible for content location. Middleware just works based on application request. **Application** ↕ Proprietary API **Middleware** Read/Write	Middleware virtualize cache storage and ODA onto one big OS volume. Application access to the volume via standard protocol. **Application** ↕ Standard IF (CIFS / NFS) **Middleware** Read/Write Virtual Volume	Application is responsible for content and needs to recognize each cartridge as well. **Application** Read/Write
Typical recording format	**FPD records content with AXF format.** AXF	**Record file with own object format. Or, record file with native file as it is.** 9c5f4a8c4 a8f6b4a5 6f5c145a 640··· MXF	**Typically, file is recorded as it is. Good solution for offline shelf archive.** MXF

RackRail Alignement Tool (Part number J-7121-510-A)