



How to Reduce Data Capacity in Object-based Storage: Dedup and More

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Unstructured Data Explosion

- ❑ A big paradigm shift how to generate and consume data
 - ❑ Transactional data → unstructured data
 - ❑ Over 70% of world's data is unstructured
 - ❑ Growing 100x every 10 years
- ❑ Object-based storage: new storage architecture for harnessing explosion in unstructured data.
 - ❑ Scales uniformly, simply, and inexpensively

Characterizing Unstructured Data

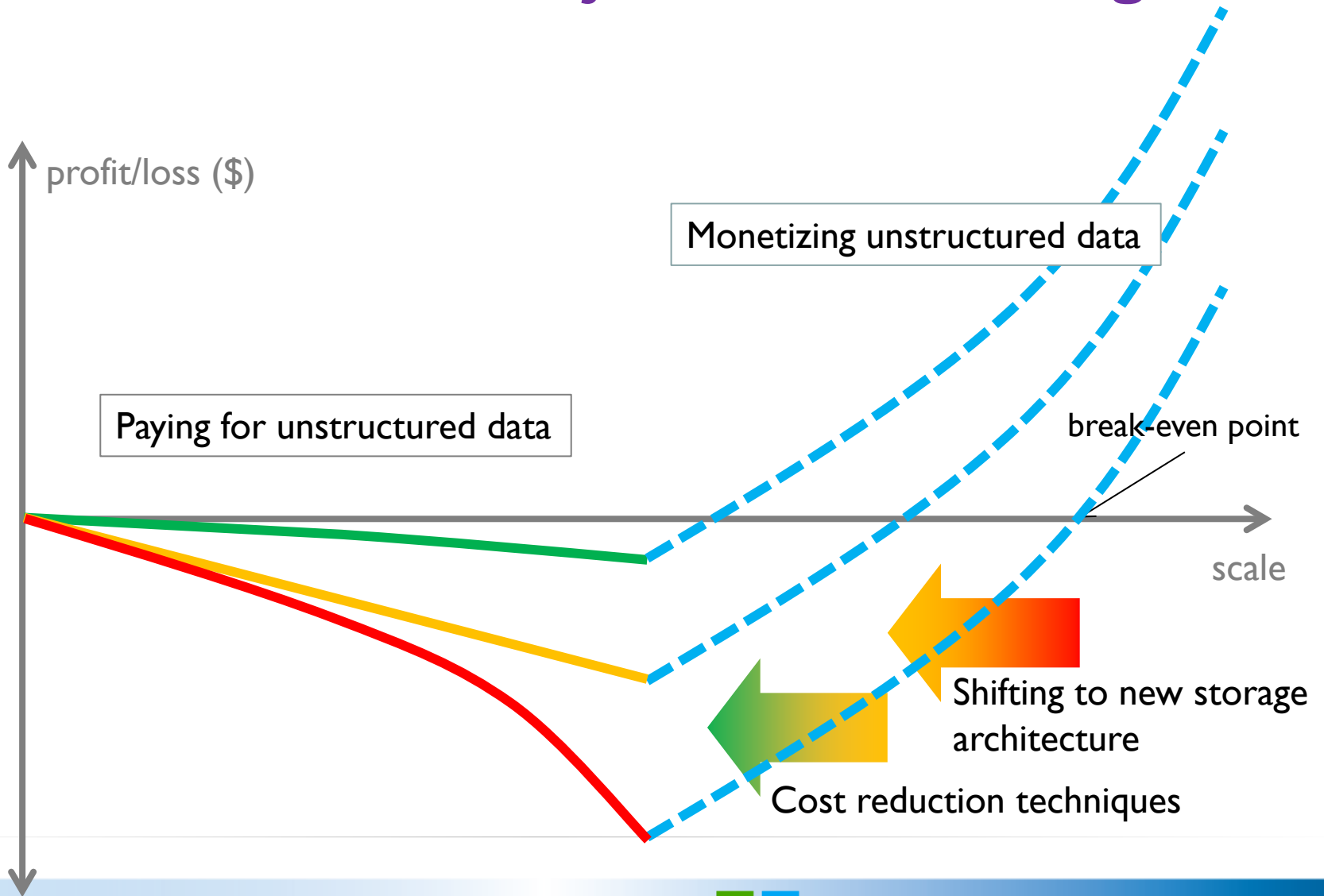
 Massive	 Large	 Many	private or secure	 long	<div style="background-color: red; color: white; padding: 5px;"> ✓ artificial intelligence ✓ sensors </div> <div style="background-color: green; color: white; padding: 5px; margin-top: 10px;"> ✓ smart devices </div> <div style="background-color: yellow; color: black; padding: 5px; margin-top: 10px;"> ✓ media service </div> <div style="background-color: blue; color: white; padding: 5px; margin-top: 10px;"> ✓ backup, snapshot </div>
 Large	Small 	  small	public (plain)	medium  short 	
data volume	object size	duplicated data	encryption	life span	data sources

* “Best Practices for Object Storage”, DSI 2015

Object-based Storage Features

- ❑ **Scalable**
- ❑ **Flexible**
- ❑ **mostly immutable data**
- ❑ **Low TCO**
- ❑ No locking mechanisms
- ❑ Simple API (Restful)
- ❑ **Large metadata**

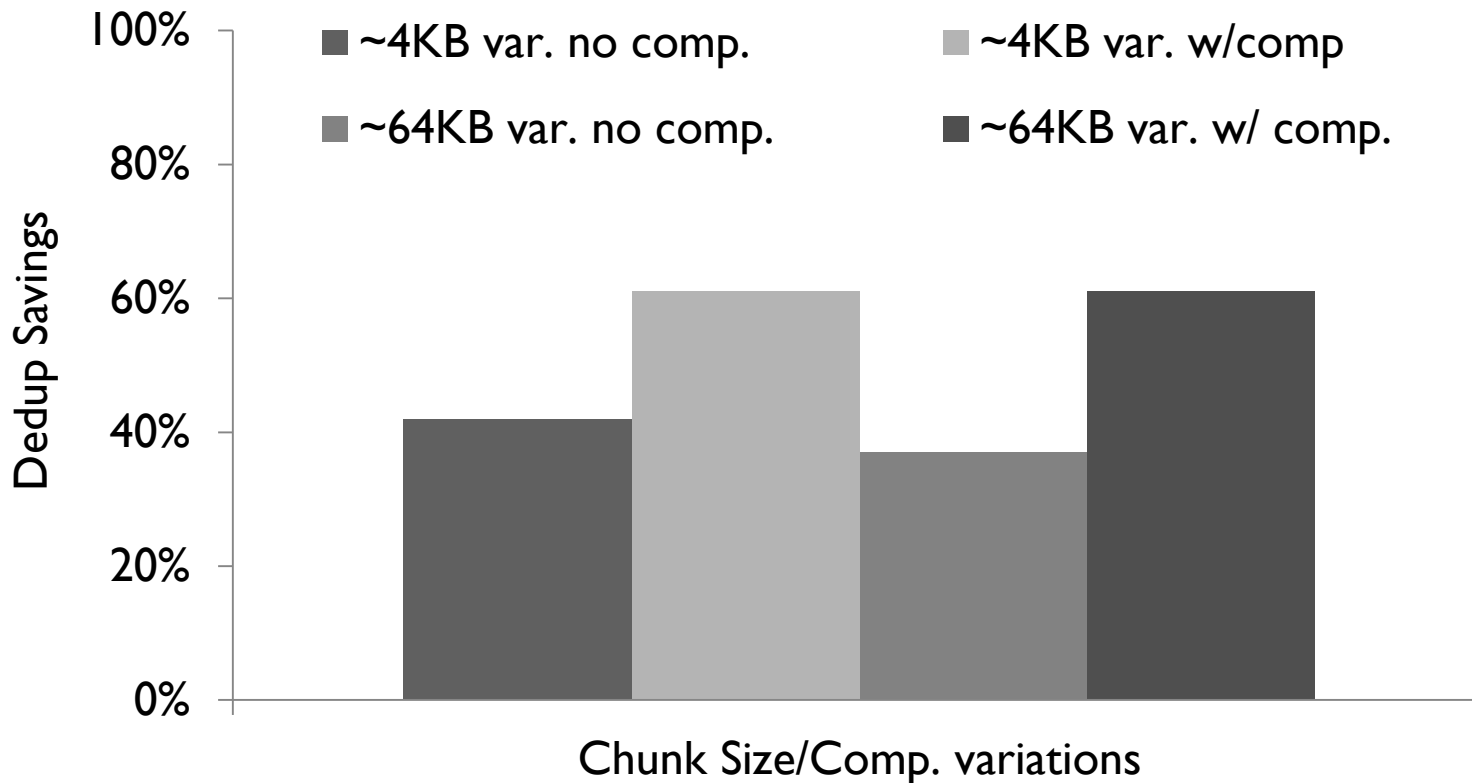
Cost Reduction in Object-based Storage



Data Reduction Techniques

- ❑ Eliminating duplicate copies of repeating data
 - ❑ Data deduplication: Replace multiple copies of data with references to a shared copy.
 - ❑ File-based, Fixed-sized, Variable-size (window-based)
 - ❑ Compression: Encode data to reduce its size.

Small Chunks of Deduplication



* "Primary Data Deduplication in Windows Server 2012", 2012 Storage Developer Conference

Deduplication in Object-based Storage

Deduplication terms	in Object-based Storage
file	an object whose record is metadata list of chunks
chunk	an object whose unique ID is dedup hash key
index table of chunks	OBS namespace of chunk objects
lookup/create/delete chunk from index table	lookup/create/delete chunk objects in OBS namespace
duplicated chunks	obj's reference count in its metadata

Capacity Optimization Technique

- ❑ Reducing storage cost of data protection method
 - ❑ Erasure coding
 - ❑ Splitting user data into several data fragments, and calculating coding fragments.
 - ❑ Disperse the fragments over separate storage servers to prevent data loss against N concurrent system & hardware failure.
 - ❑ Reed solomon coding (4:2) can achieve a high level of data reliability similar to a 3-copy replication only with additional 50% storage overhead.

Internal Fragmentation

- ❑ Due to the rules governing space allocation, storage space is divided into a series of fixed-size unit (e.g, 512B sector in HDD).
- ❑ Fragmentation is a phenomenon in which storage space is used (=allocated) inefficiently, reducing capacity or performance .
- ❑ Internal fragmentation is difficult to reclaim because the wasted space is too small to be re-allocated.

Internal Fragmentation in Filesystem

- ❑ When does internal fragmentation occur in filesystem?
 - ❑ Small-size data less than filesystem block size.
 - ❑ Extended file attributes to store additional metadata-info.
- ❑ E.g., Extended attributes in XFS
 - ❑ 256 bytes name in length, 64KB binary data value.
 - ❑ When the number of the attributes increases, they are stored as
 - ❑ **shortform attributes**: embedded in inode → **leaf attributes**: migrated to “extents” → **node attributes**: B+ tree structure

Large Metadata in Object

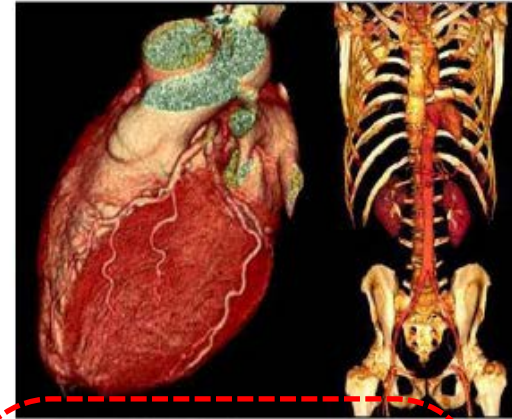
File



File Name: CATSCANJQSMITH
Created By: Technician 1
Created On: 01-01-2001
File Type: .DICOM

VS.

Object



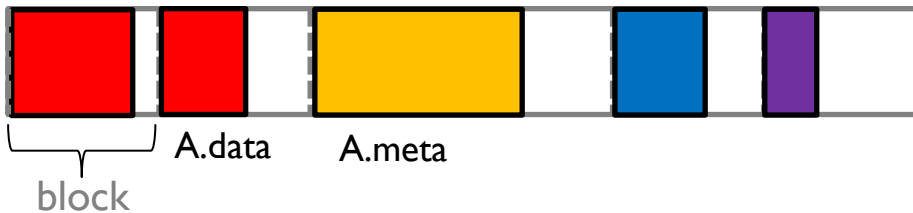
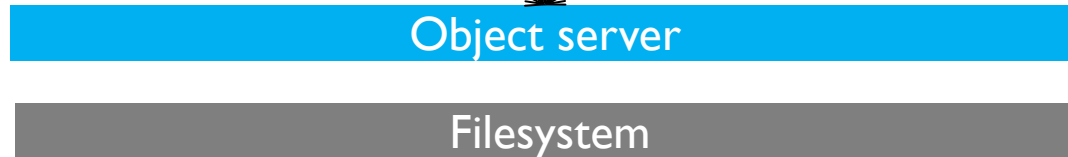
Object ID: 12345
File Type: .DICOM
Patient Name: John Q. Smith
Patient ID: 555-55-5555
Procedure Date: 01-1-2001
Physician Name: Dr. Organ
Physician Notes: .WAV File
Prior 1: XYZ.DICOM
Modality: XYZ
Manufacturer: XYZ
Diagnosis: XYZ
Description: XYZ
Custom Metadata: XYZ
Custom Metadata: XYZ

* source: Dell

Data Layout in Object-based Storage

Logical view

infinite-sized object storage (flat namespace, unique object-id)

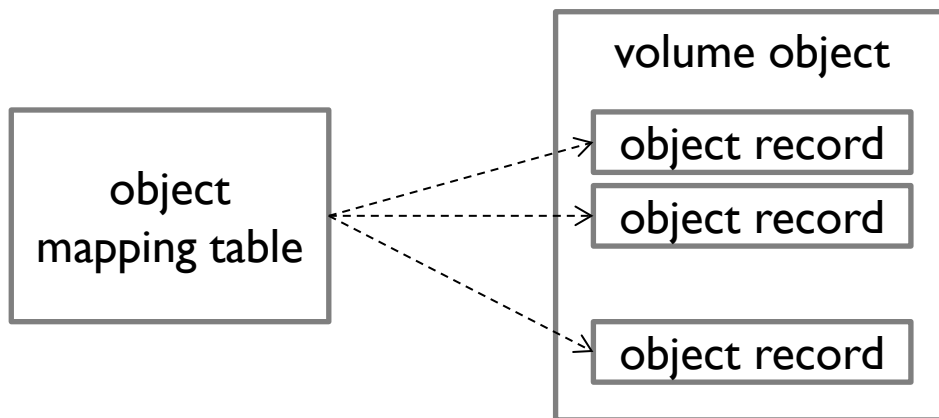


white: internal fragments

Physical layout in object-server's storage device

Defragmentation: Capacity Optimization Methods

- ❑ Volume object
 - ❑ store many small objects in sequence.
- ❑ Object mapping table
 - ❑ index objects stored in the volume objects
 - ❑ B-tree type for efficiency.



Effectiveness of Defragmentation

- About **38%** of total storage space has been going to waste due to its internal fragmentation, and we have saved almost all of them : **33% of total storage space**
 - When 1M objects (4KB size in average) had beend stored at object-based storage with some additional user metadata totally 512B.

Summary & Lessons

- ❑ Data reduction techniques → reducing costs for managing massive unstructured data
- ❑ A variety of reduction techniques can be applied as being complementary.
- ❑ More knowledge about data is very important for making the techniques more effective.

Thank you!