Object Storage: Storage for Developers

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Need to

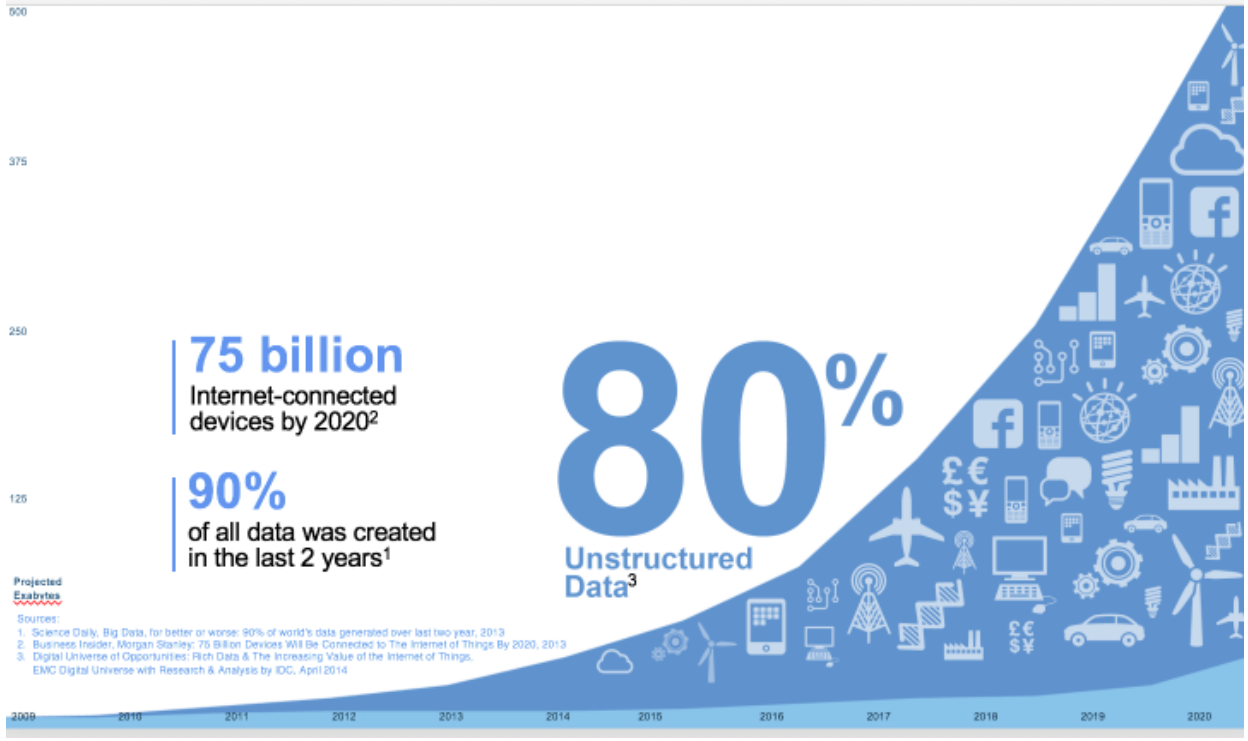
- Store
- Manage
- Protect
- Secure

while addressing

- Scale
- Cost

the data enabling developers to

- Collect
- Clean/transform
- Analyze



How should we do this?

And the answer is . . .

. . . Object Storage

What is object storage?

Block, File and Object

- **Block**: An array of bytes
- **File**: Explicitly managed hierarchy of randomly accessed blobs
- **Object**: Key-value (object)

Typical object storage features

- Buckets containing keys for objects
  - Hierarchy is in eyes of beholder
- RESTful (HTTP) access
- All or nothing atomic writes – no update in place
- Data with metadata
- Secure in flight and at rest
- Designed for scale out and durability

- Ideal for unstructured data and batch rectangular data

Designed for developers

- Simple, RESTful API
- Atomic operations
- Globally accessible
- “Limitless”

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How the APIs vary

Block

- READ
- WRITE
- FORMAT
- . . .

Table 62 — WRITE (10) command

Byte\Bit	7	6	5	4	3	2	1	0
0	OPERATION CODE (2Ah)							
1	WRPROTECT			DPO	FUA	Reserved	FUA_NV	Obsolete
2	(MSB)							
5	LOGICAL BLOCK ADDRESS							(LSB)
6	Reserved			GROUP NUMBER				
7	(MSB)							
8	TRANSFER LENGTH							(LSB)
9	CONTROL							

http://t10.org/ftp/t10/document.05/05-344r0.pdf

File

- OPEN
- CLOSE
- RENAME
- WRITE
- . . .

```
fd=open(”tmp.tmp”, O_WRONLY);
for(i=0;i<LIMIT;i++)
   write(fd,
         buffer[i*WRITE_SZ],
         WRITE_SZ);
close(fd)
rename(”tmp.tmp”, “real.name”)
```

Object

- PUT
- GET
- HEAD
- POST

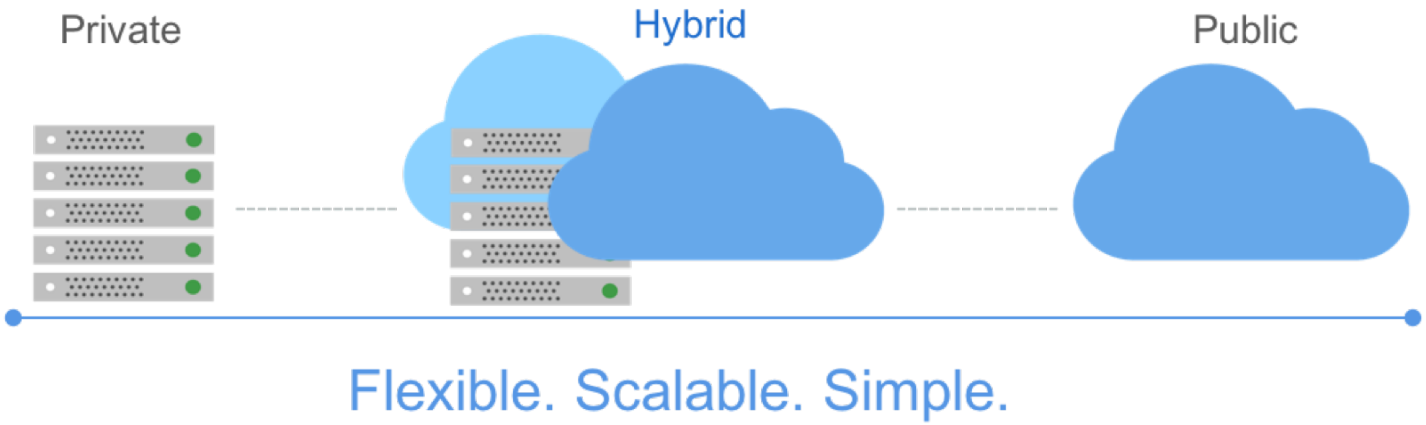
```
PUT /bucket/object HTTP/1.1
Authorization: {auth}
Content-MD5: 3097216...
Host: …storage.softlayer…
Content-Length: 533
```

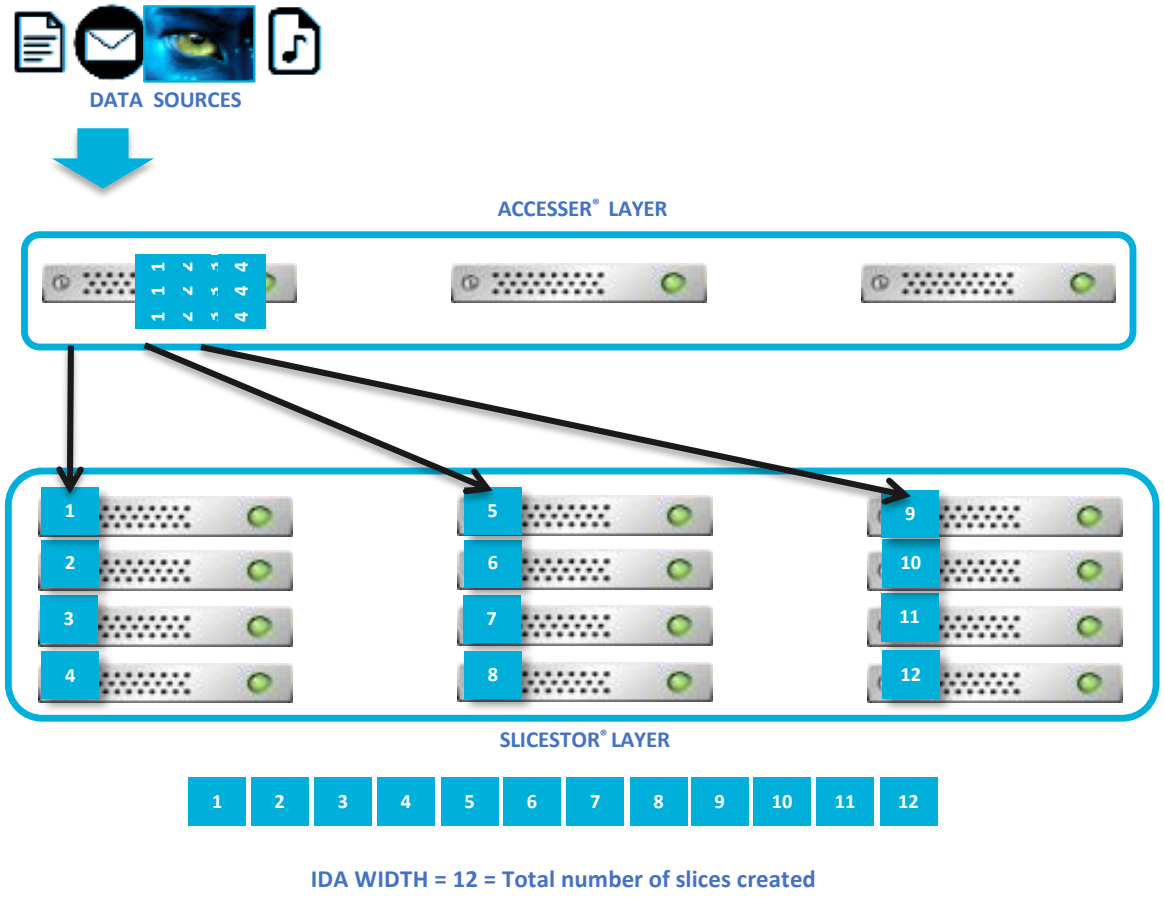
The 'queen' bee . . .

Under the covers of one object store: IBM Cloud Object Storage

IBM Cloud Object Storage

- Two tiered, fully distributed, architecture
  - Can be deployed in multiple data centers – survive a data center outage
- Distributed erasure coding to protect the data
- RESTful protocol for data access (S3-compatible)
- Security via AONT-RS (All Or Nothing Transform-Reed Solomon)

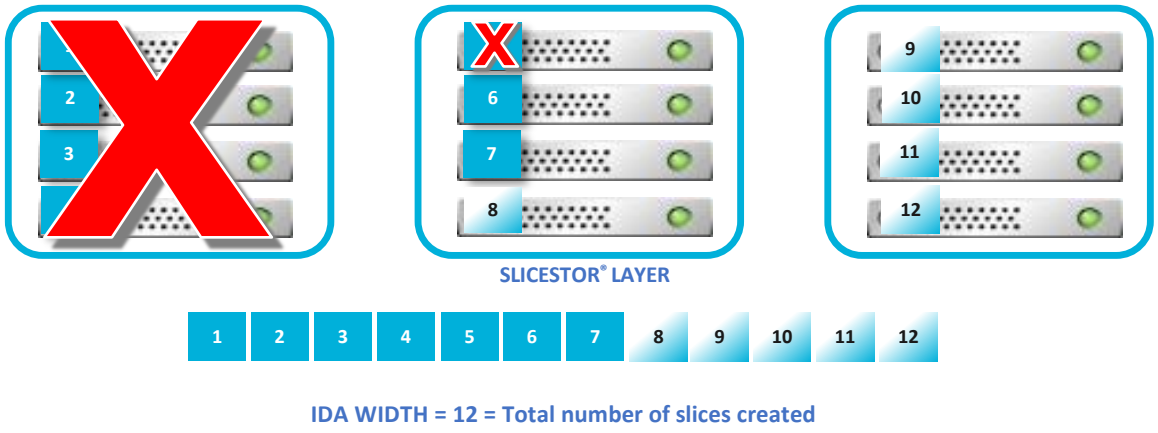




1 Data is encrypted, and sliced using Information Dispersal Algorithms (IDA).

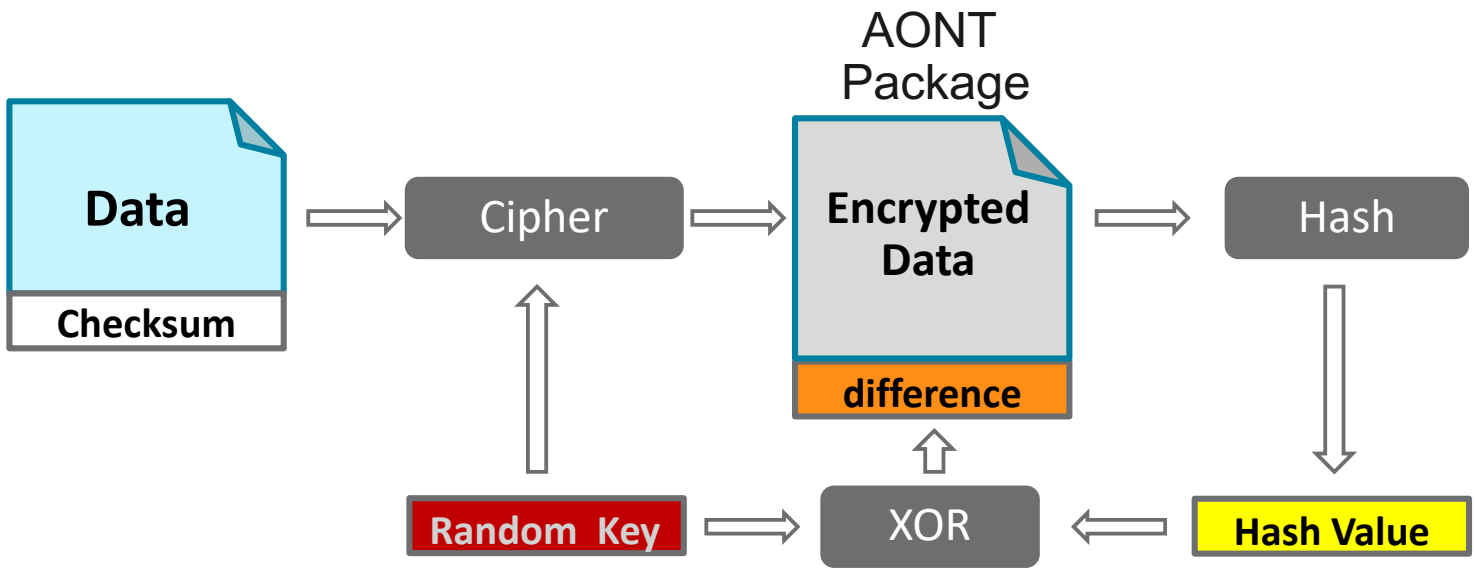
2 Slices are dispersed to separate disks, storage nodes and/or geographic locations.

- With a 7+5 RS encoding, can read data from any 7 slices
  - If distributed over three data centers, can lose an entire data center with no loss of data or access
  - Space overhead of 71% as compared to 200% with triplication



AONT-RS: Keyless Encryption

All Or Nothing Transform – Reed-Solomon



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AONT-RS: Keyless Encryption
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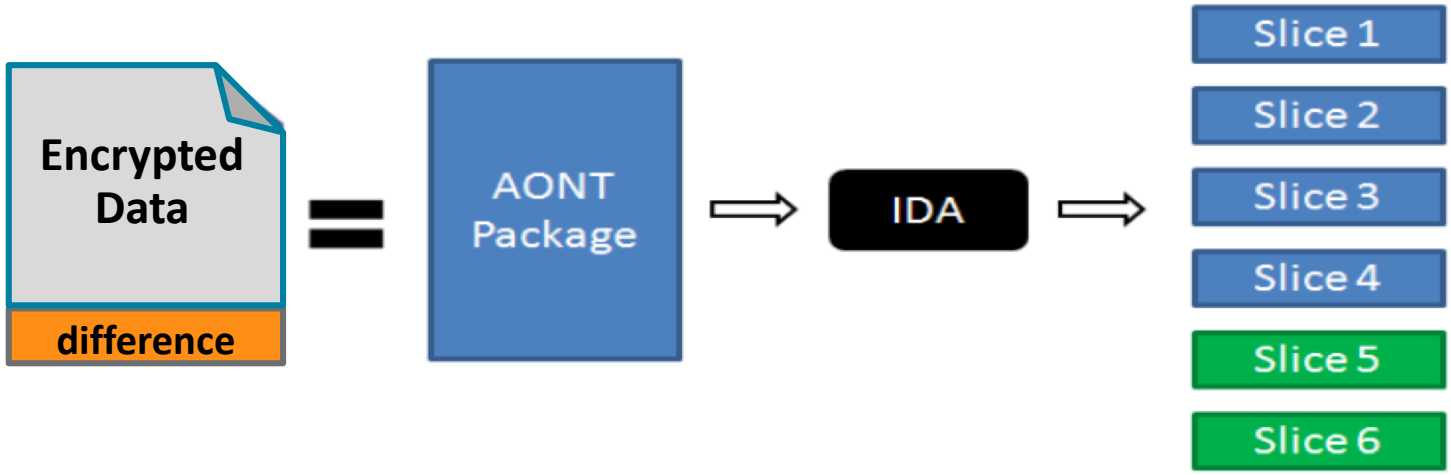

- Without a threshold number of slices, cannot calculate hash and thus cannot separate key out of **difference** which is XOR of key and hash

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Putting data to work

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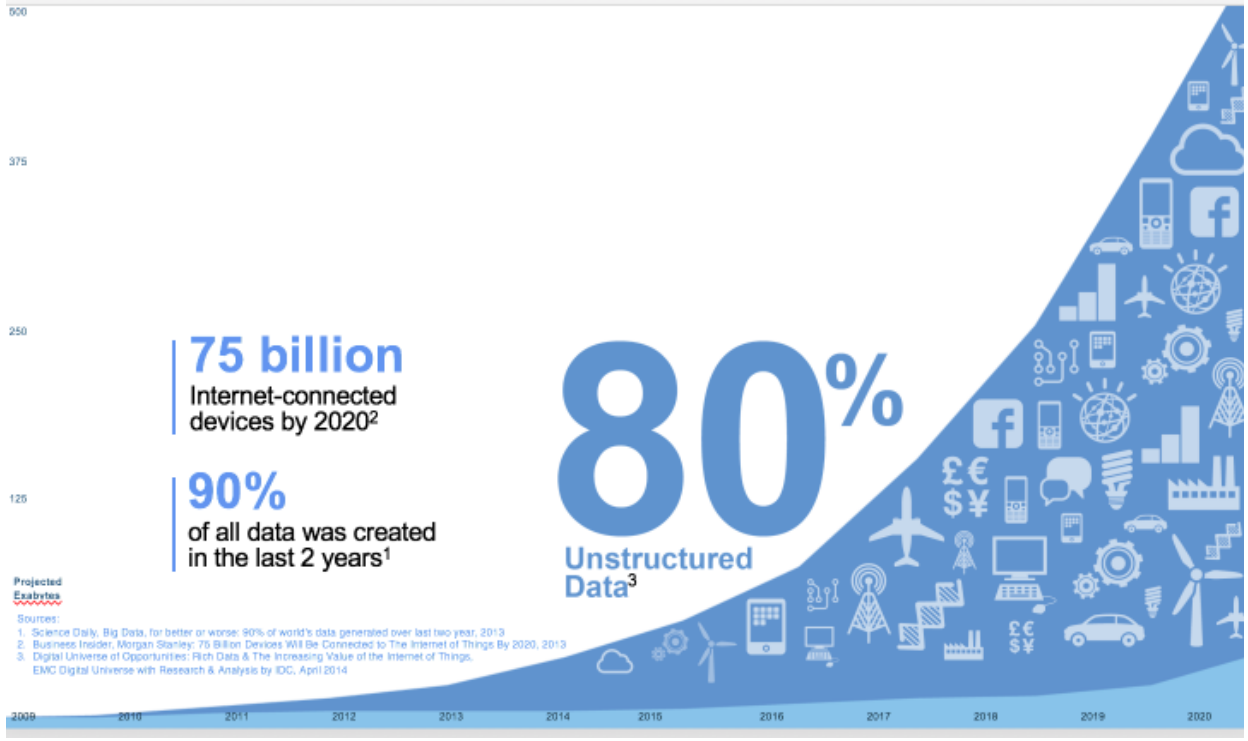
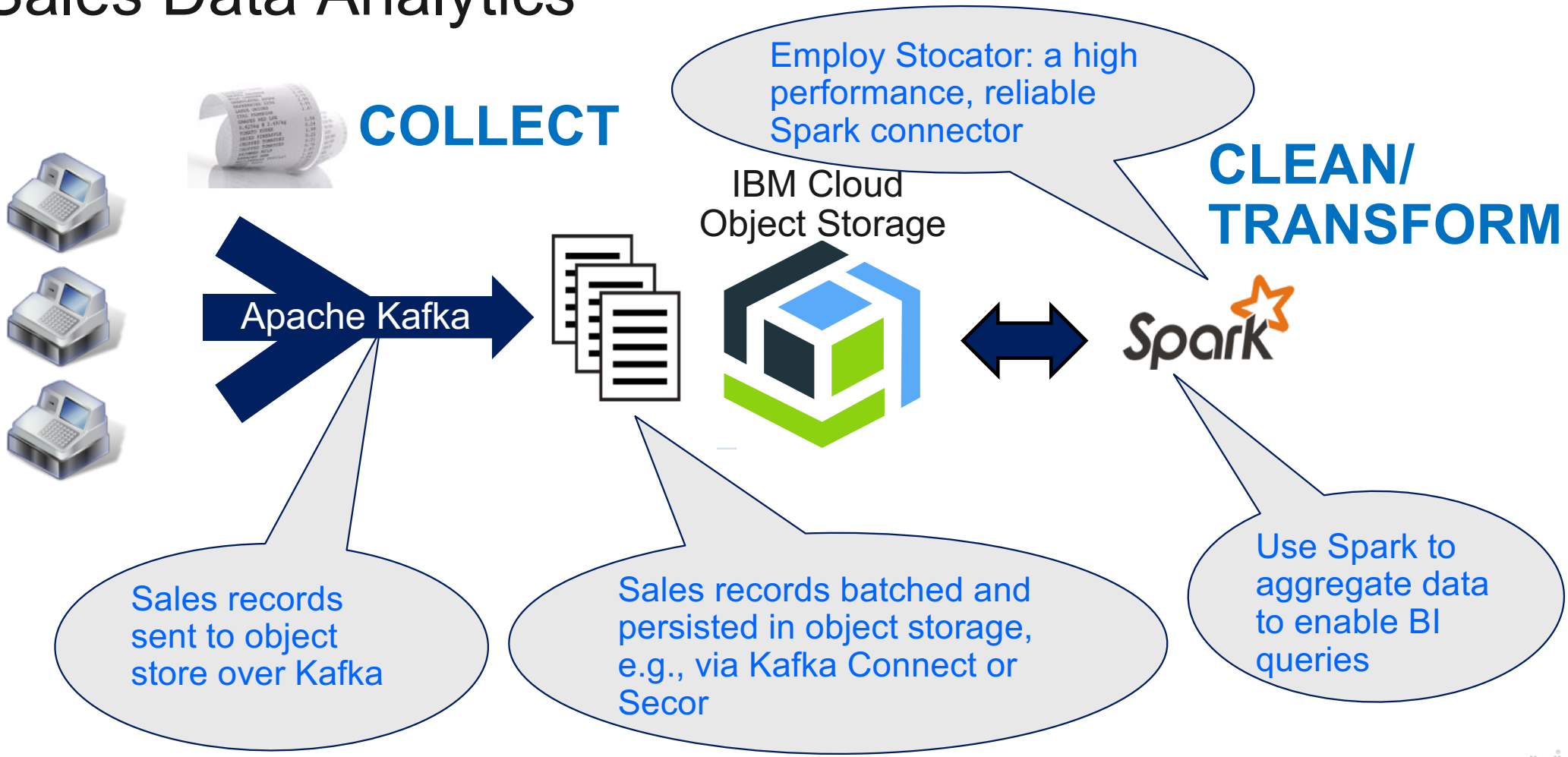


Sales Data Analytics



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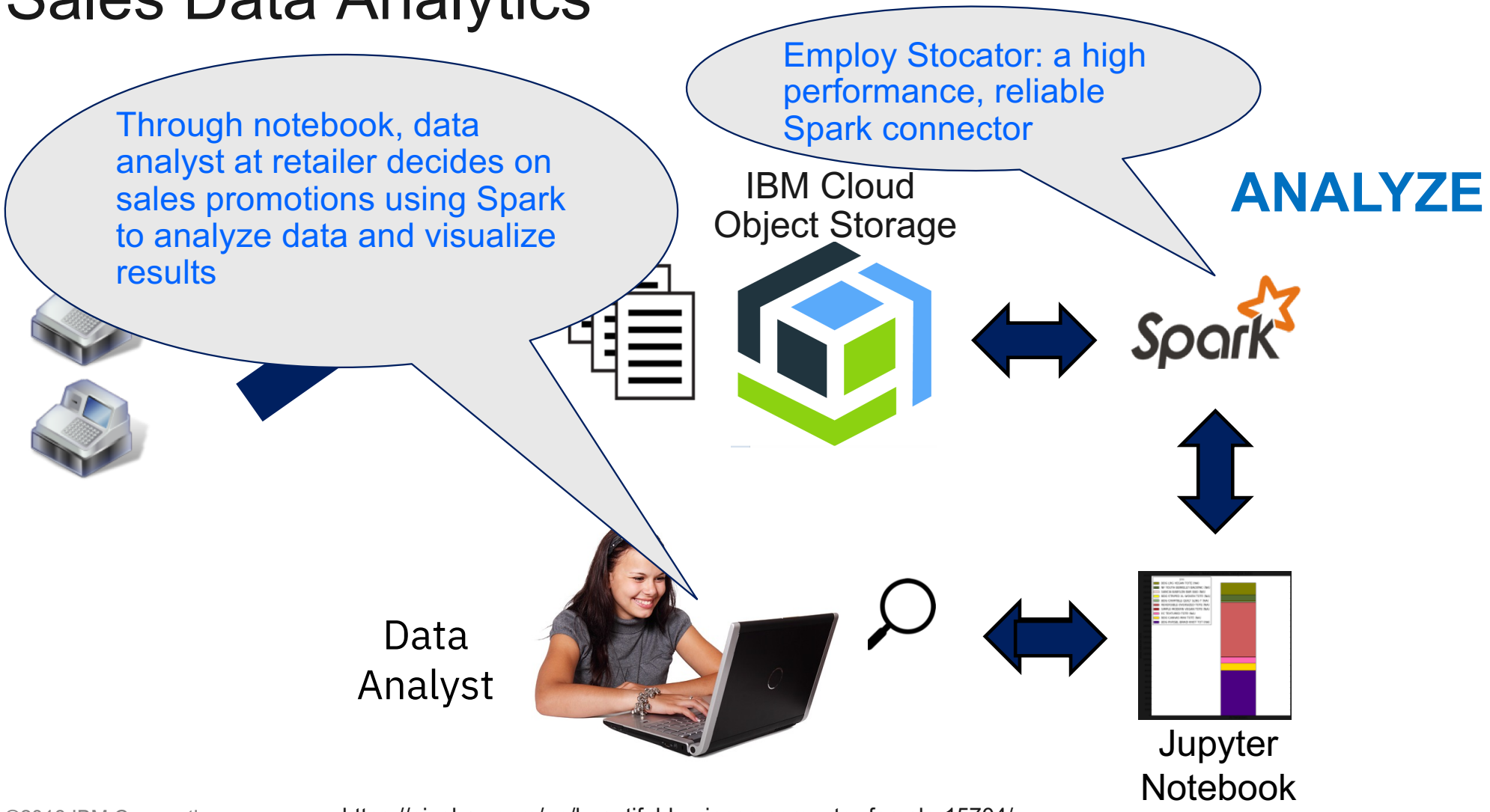

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A right way and a wrong way to use object storage

Wrong Way

Pretend it is a file system

Emulate design patterns such as write to temp file and rename to prevent partial data

Create empty objects to represent directories

Right Way

Leverage object storage semantics and scale

Use atomicity of PUTs to prevent partial data

Just create objects with hierarchical name

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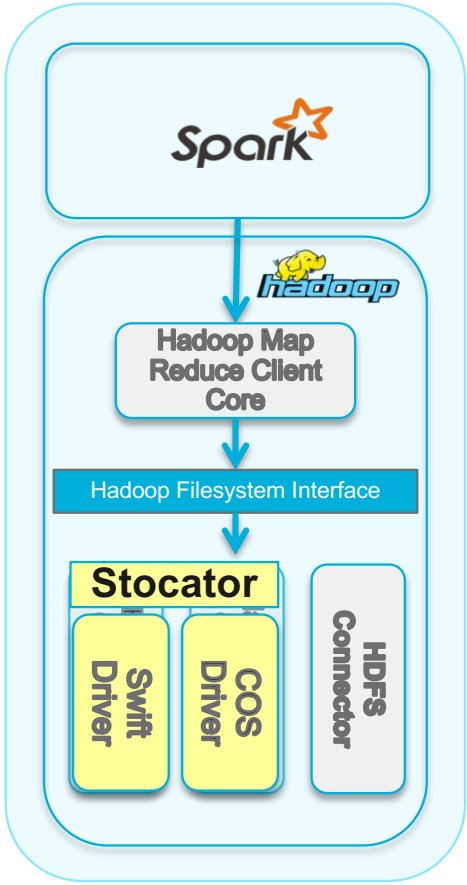
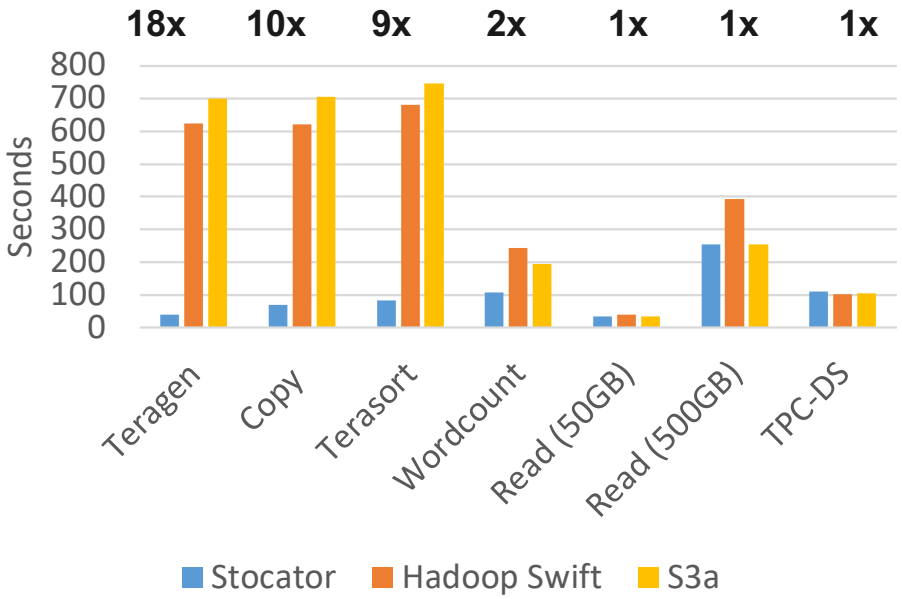
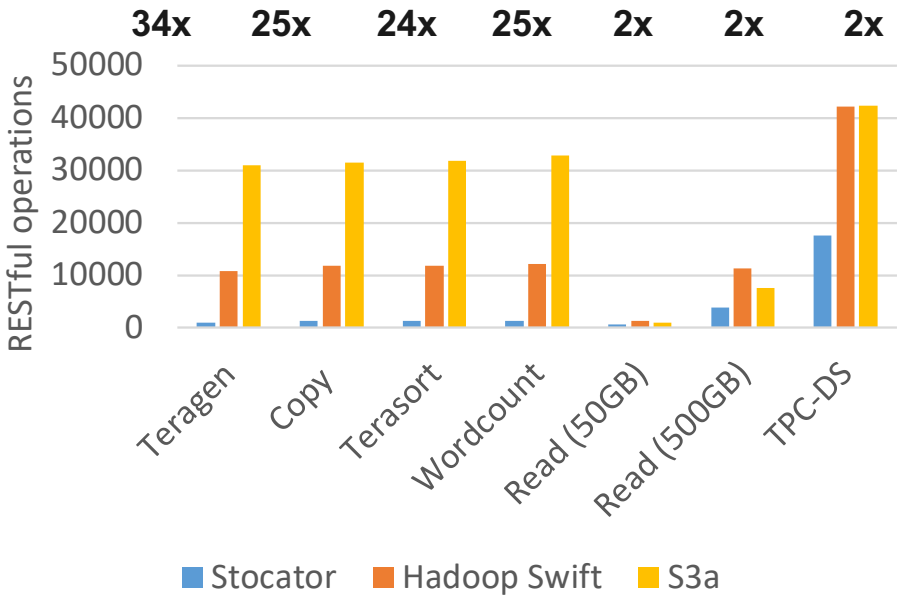
Stocator: Enabling Apache Spark for IBM Cloud Object Storage

- Historically community treated objects stores as file systems
  - Leads to inefficiencies and races
    - e.g., multiple non-atomic operations where a single operation would suffice
- Stocator is our opinionated alternative
  - Knows it is talking to an object store
    - Uses atomic PUTs and not renames
    - No dummy objects for directories
    - . . .
  - Both fast and correct
- Stocator is in open source
  - https://github.com/SparkTC/stocator



Stocator is much faster for write-intensive workloads; has equivalent performance for read workloads; and issues many fewer REST requests





As compared with the object storage connectors of Hadoop 2.7.3 run with their default parameters with Spark 2.0.1
See https://arxiv.org/abs/1709.01812

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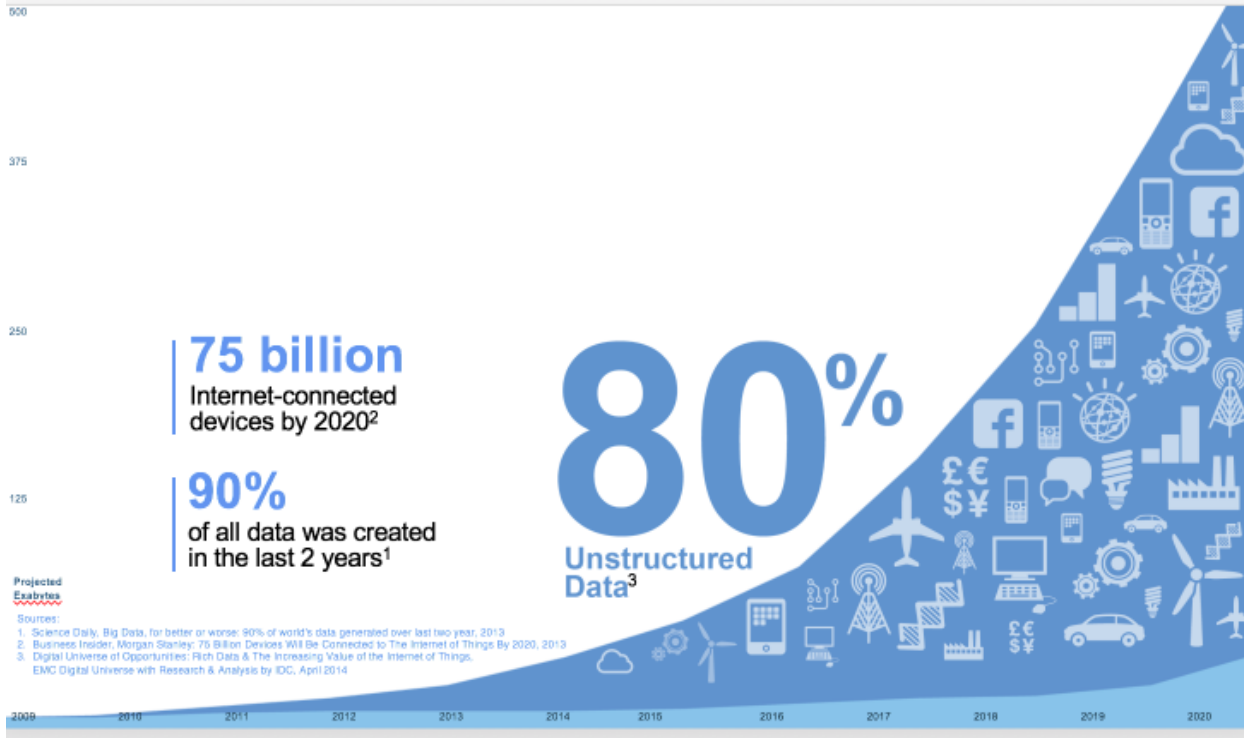

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