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LeoFS

The Lion of storage systems

Rakuten. Inc, Yosuke Hara Mar 21, 2013

LeoFS

The Lion of storage systems

http://www.leofs.org

LeoFS v0.14.0 was released!

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Motivation

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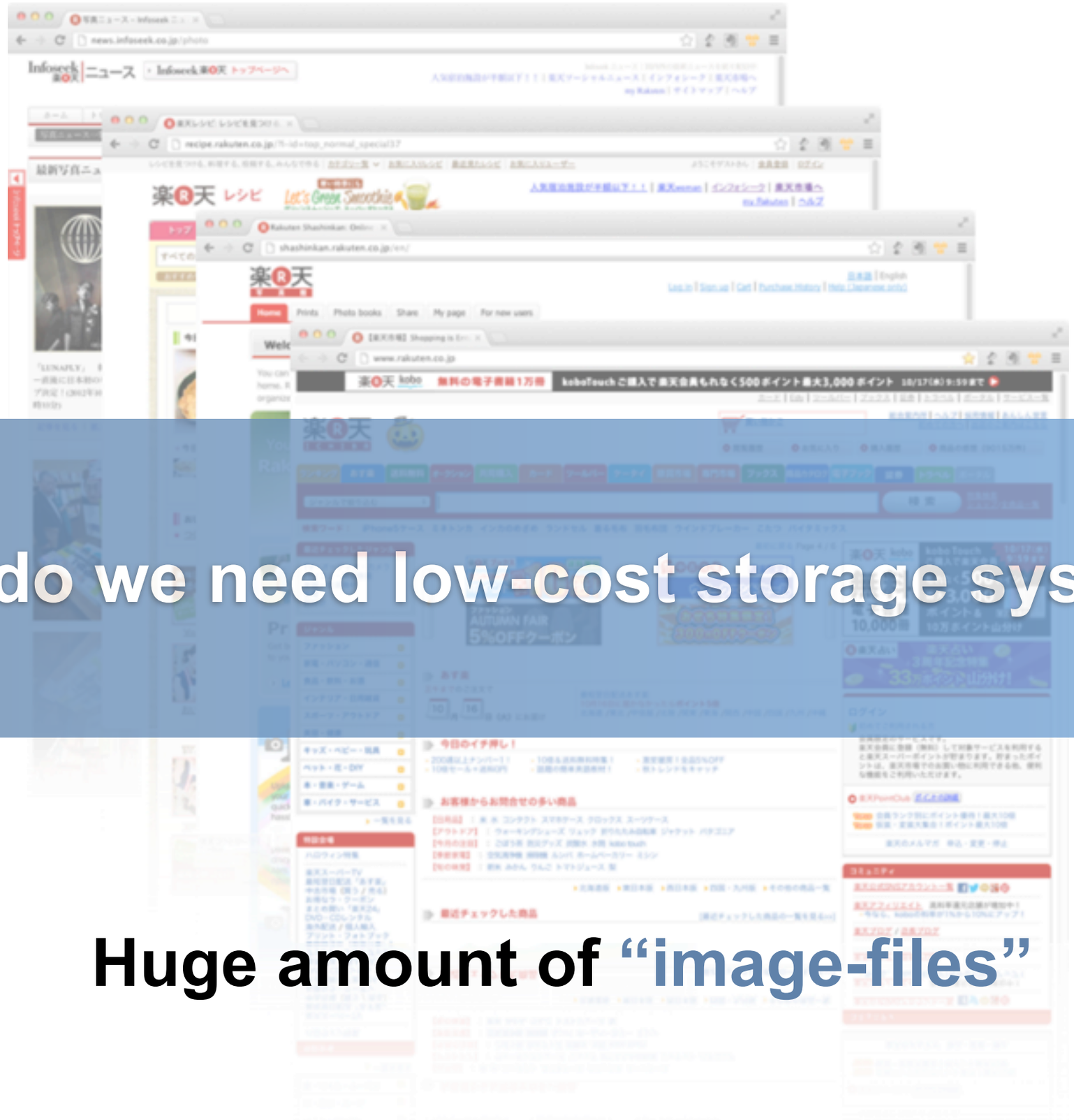
2010

“We need to store and manage huge amount of Files at low-cost”



Why do we need low-cost storage system?

Huge amount of “image-files”

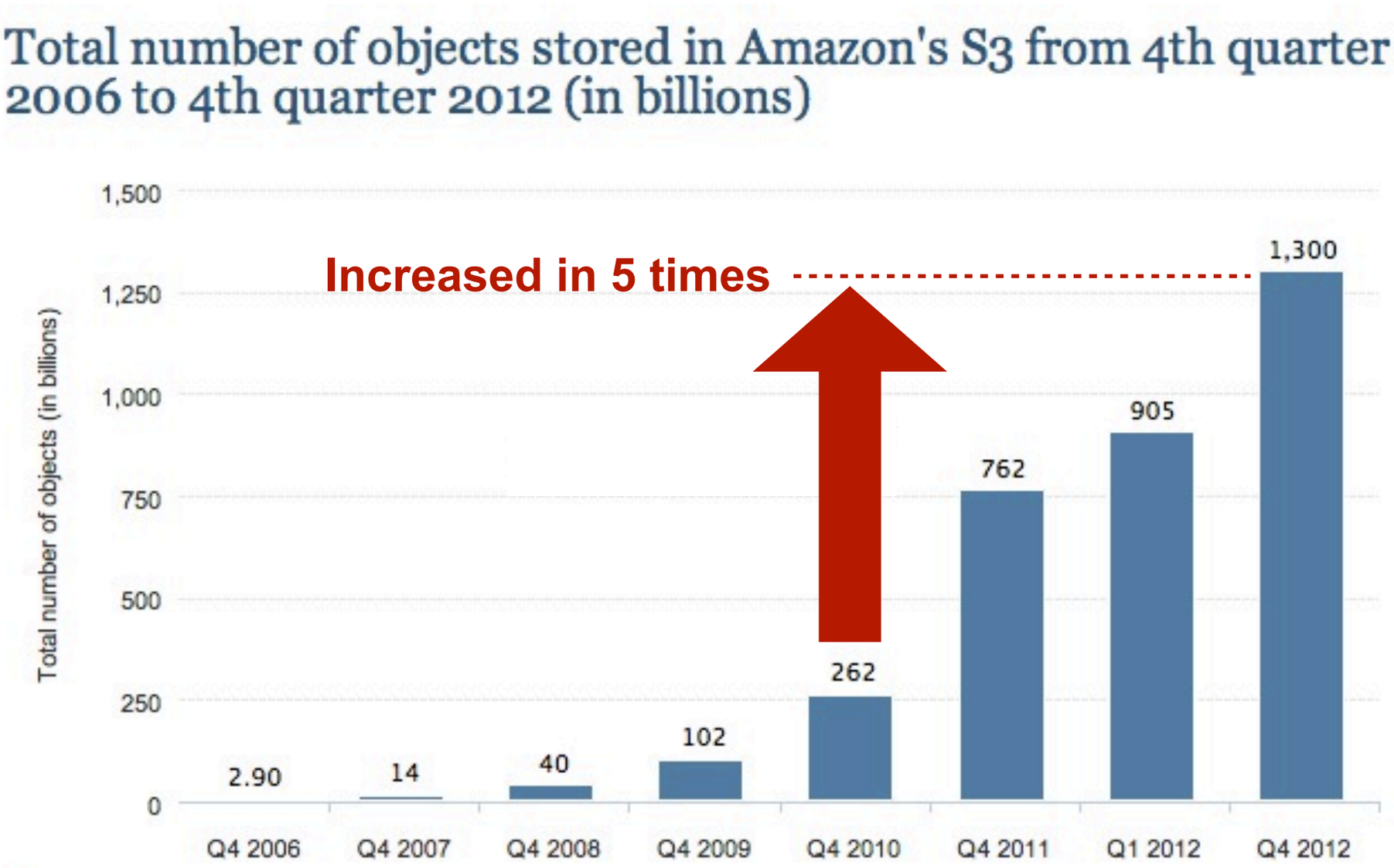
Motivation

“Need to move
from expensive storage to something”

Problems:

1. **Low ROI**
2. **Possibility of SPOF**
3. **Storage Expansion is difficult during increasing data**

Face Same Situation



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Introducing LeoFS

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What kind of storage we need for web-services?

1. ONE-Huge Storage

2. Non-Stop Storage

3. Specialized in the Web

Not FUSE But REST-API over HTTP

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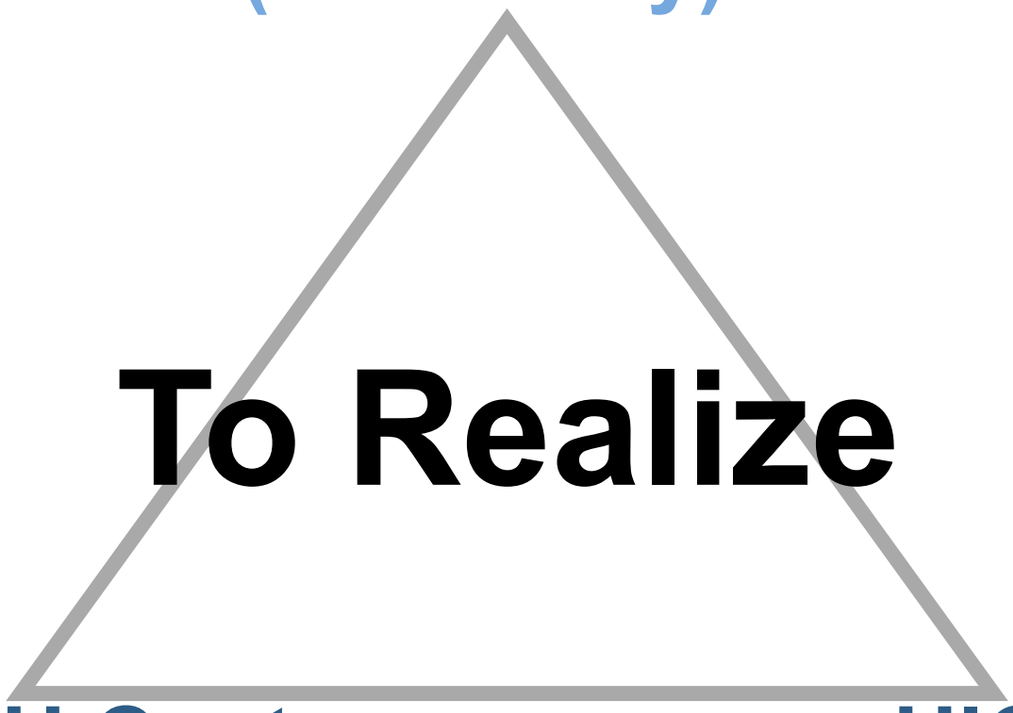
What should we realize?

HIGH Availability
(Reliability)



To Realize

HIGH Cost Performance Ratio

HIGH Scalability

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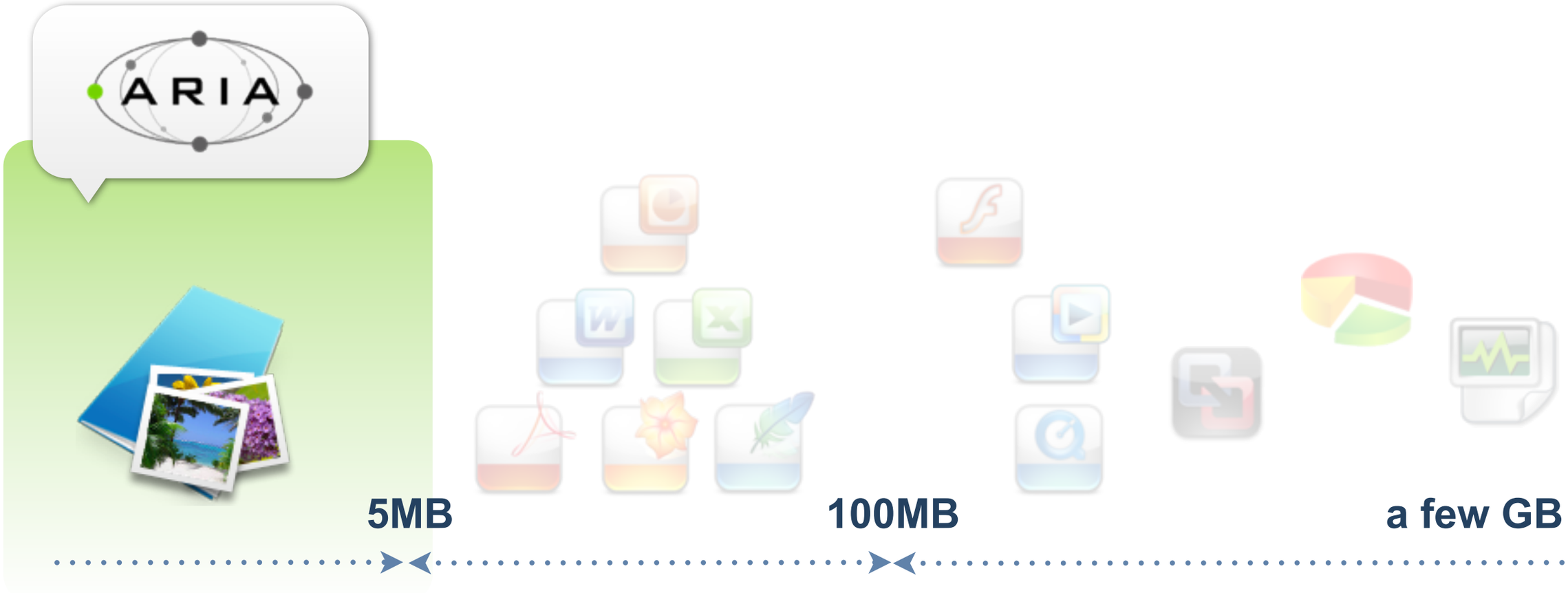
From Photo Storage To Cloud Storage



1st step as Cloud Storage

→ Specialize in “Photo”

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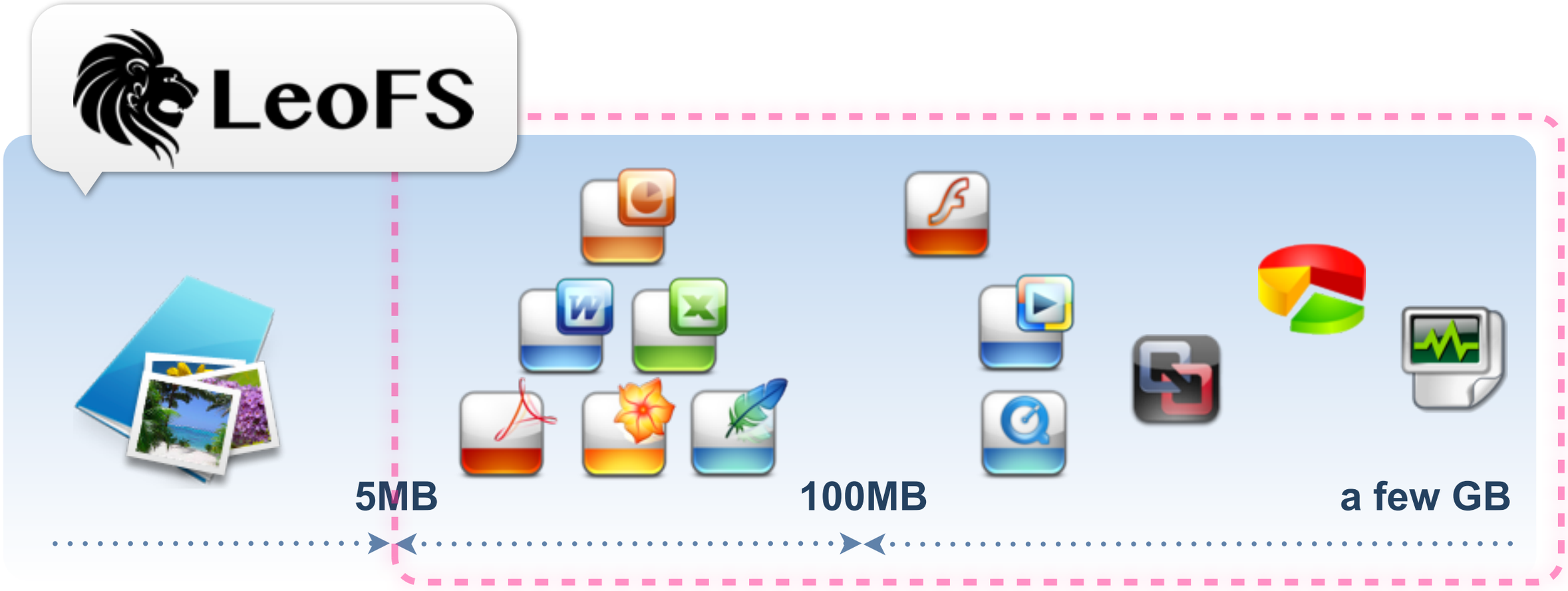
From Photo Storage To Cloud Storage



Aim to "Storage Platform" in the Cloud

→ Able to store various unstructured-data

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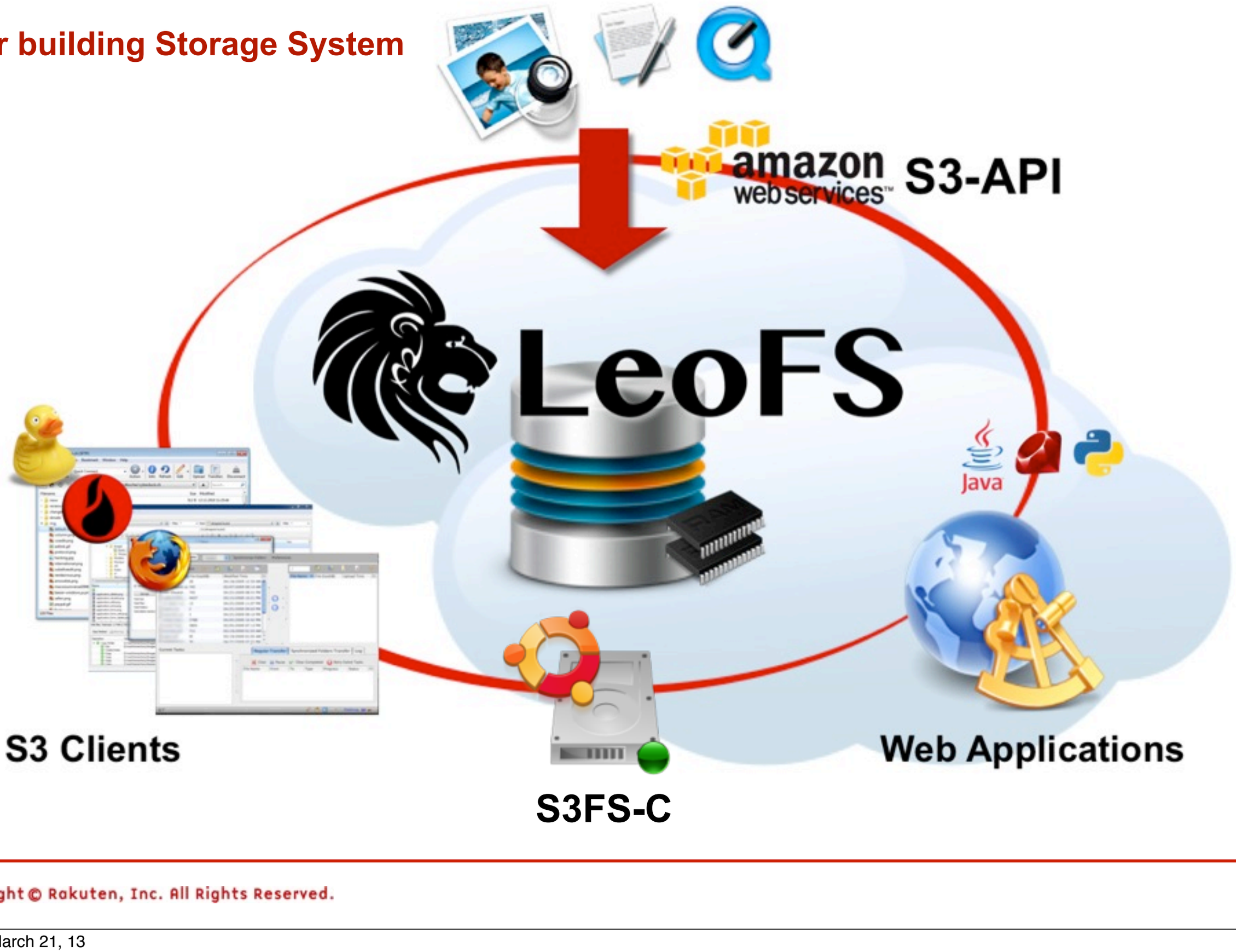
For building Storage System



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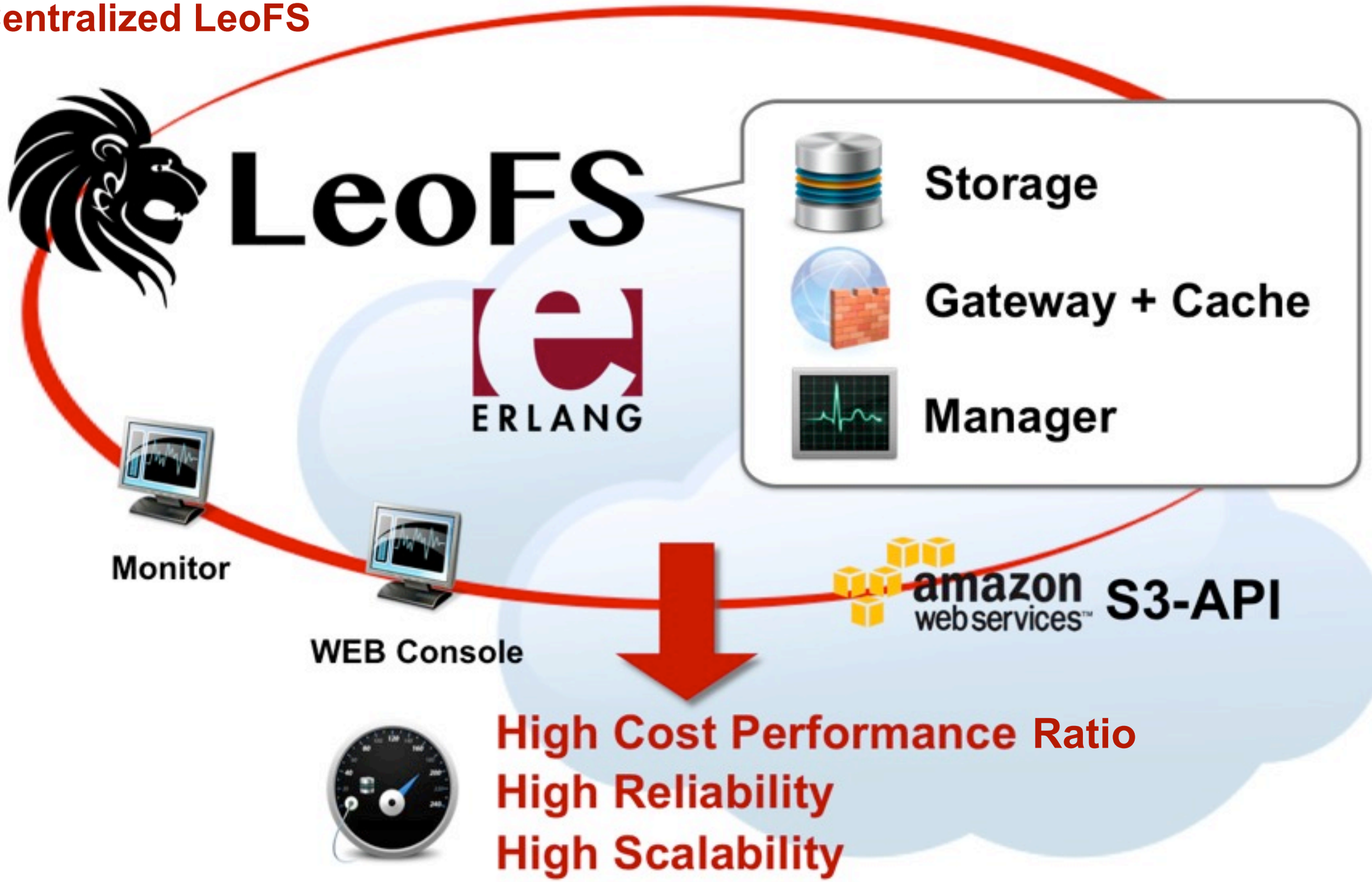
In Centralized LeoFS



High Cost Performance Ratio
High Reliability
High Scalability

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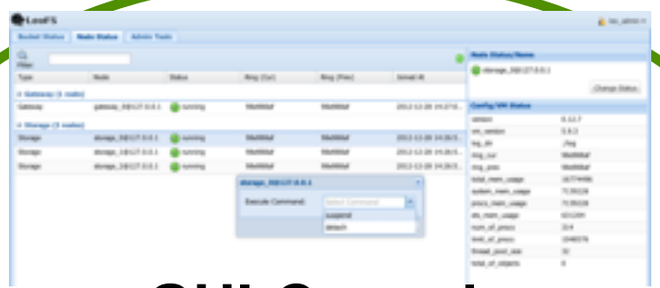
To Realize “Storage Platform”



GUI-Console

LeoTamer

QoS

LeoDenebola

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Overview

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2010

ERLANG

Concurrency

Distribution

Fault tolerance

Using in Telecom, Banking, e-commerce, Instant messaging,...

“Robust” + “Scalable”
Storage System

LeoFS Overview

Gateway (Stateless Proxy)

HTTP Request/Response Handling

+

w/Object Cache

Manager

System Management

Monitor Storage/Gateway

RoutingTable Monitor

NodeState Monitor

Keep running + Keep Consistency

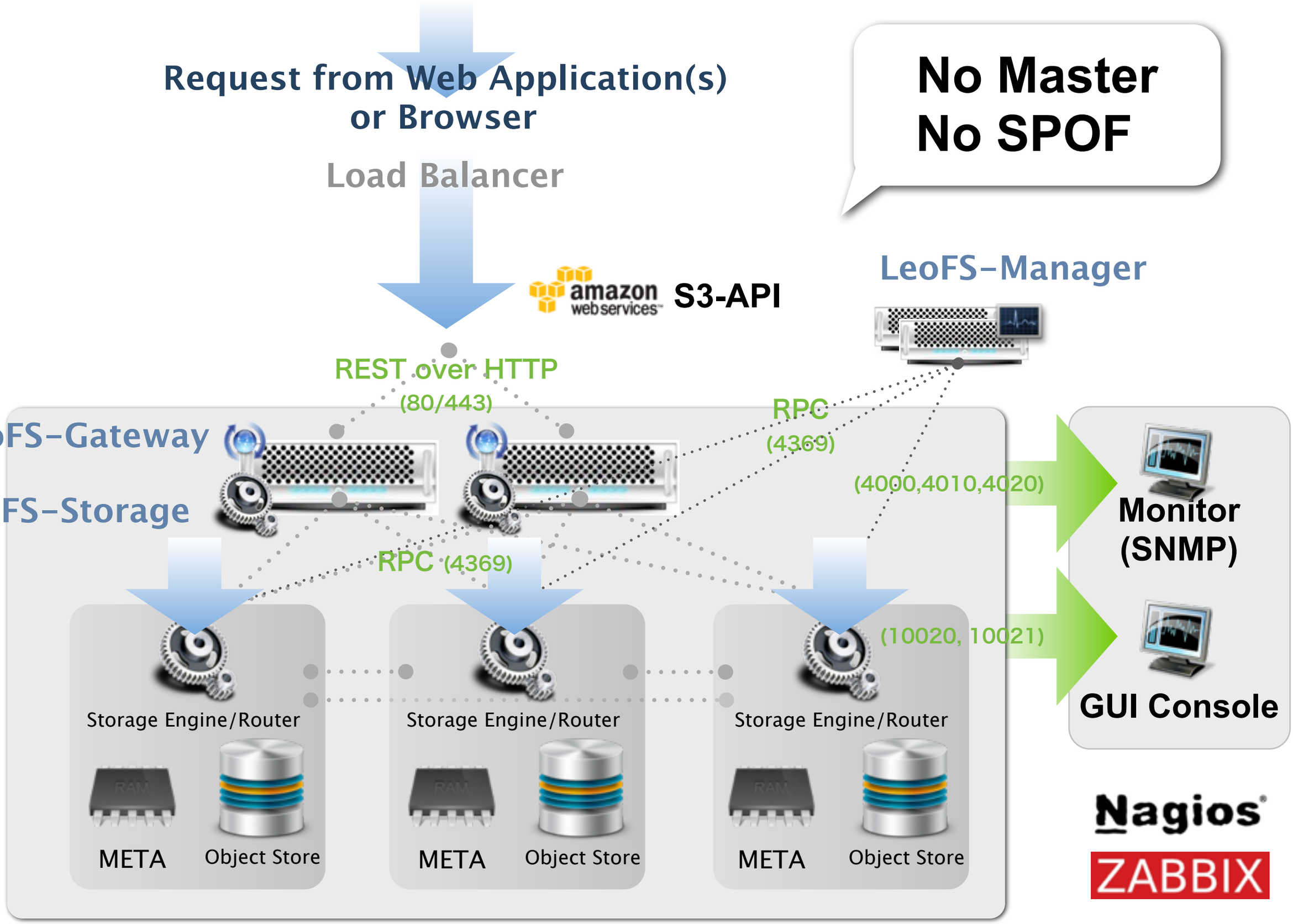
Storage

Object Storage, Meta data Storage

+

Replicator/Recoverer, Queue

LeoFS Overview



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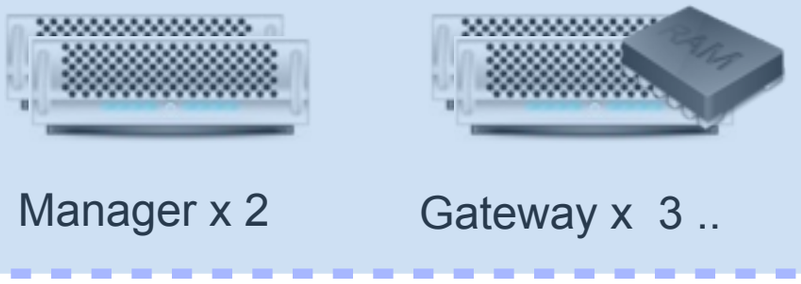
1 – Minimum for Development

Manager x 1 Gateway x 1 Storage x 1

20 – 50TB Storage System (# of replicas = 3)



Manager x 2 Gateway x 3 ..

10TB .. 20TB / server

Storage x 8 - 15

50 – 300TB Storage System (# of replicas = 3)

Manager x 2 Gateway x 4 ..

10TB .. 20TB / server

Storage x 45 - 90

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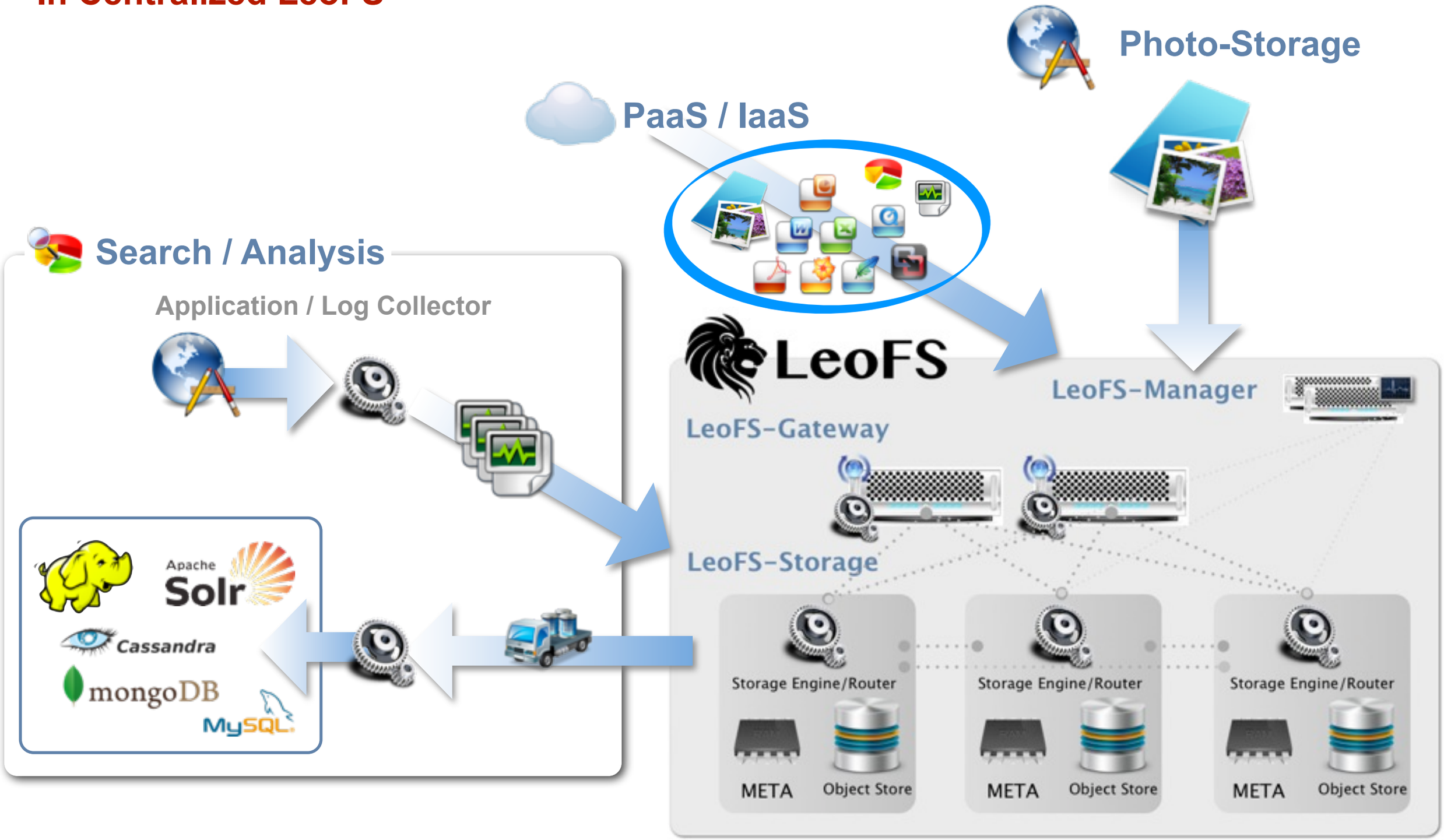
In Centralized LeoFS



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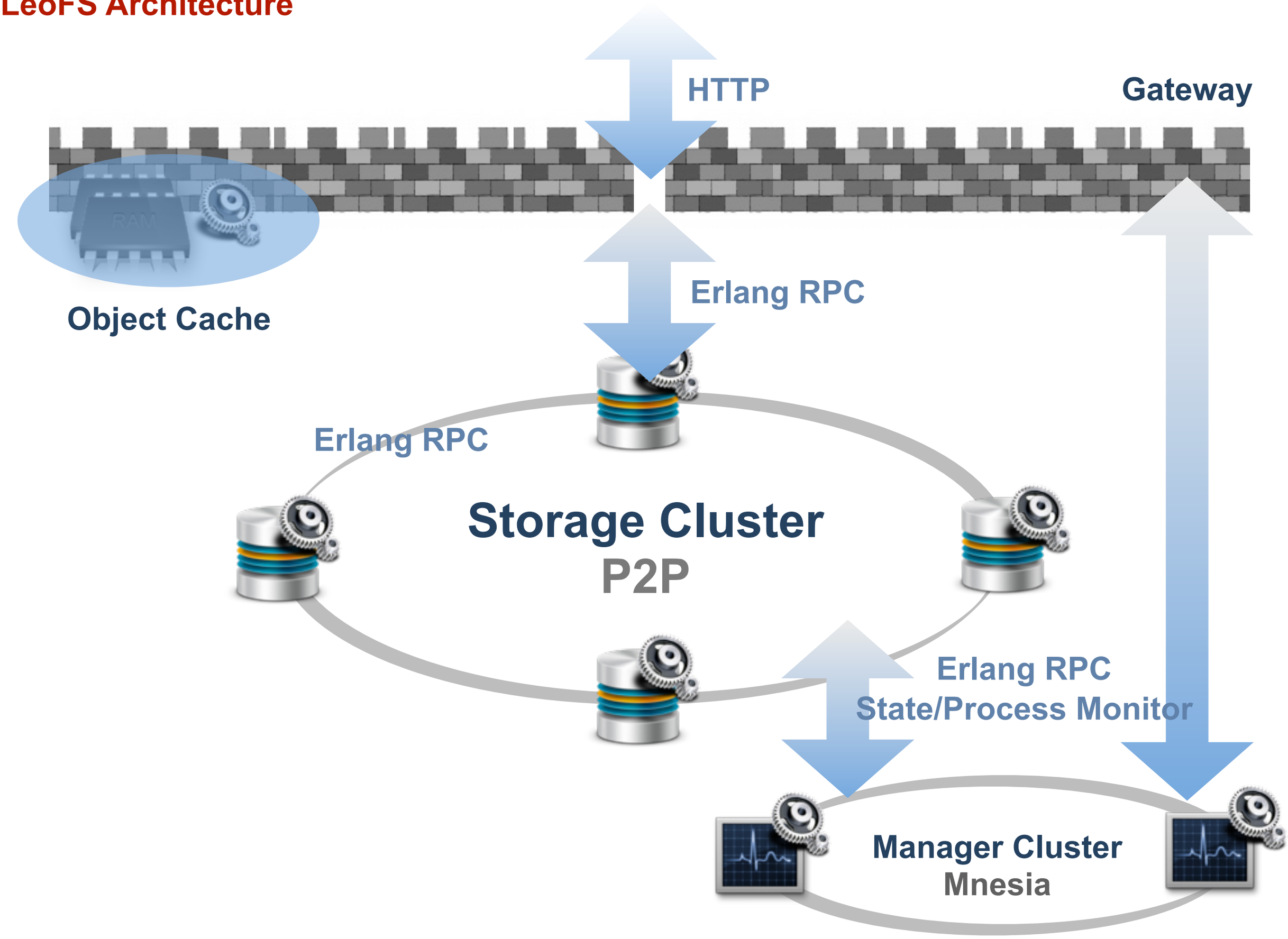
Inside LeoFS

LeoFS Architecture



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LeoFS Gateway

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“Stateless Proxy”

“Cowboy”

From Applications

amazon web services S3-API

Gateway

RAM

Object Cache

[LRU, Slab allocator, Skip graph]

Consistent Hashing

Horizontal Distribution

Storage Nodes

Replicate when using RPC

*Cowboy: Erlang light-weight HTTP-Server - http://http://www.ninenines.eu/

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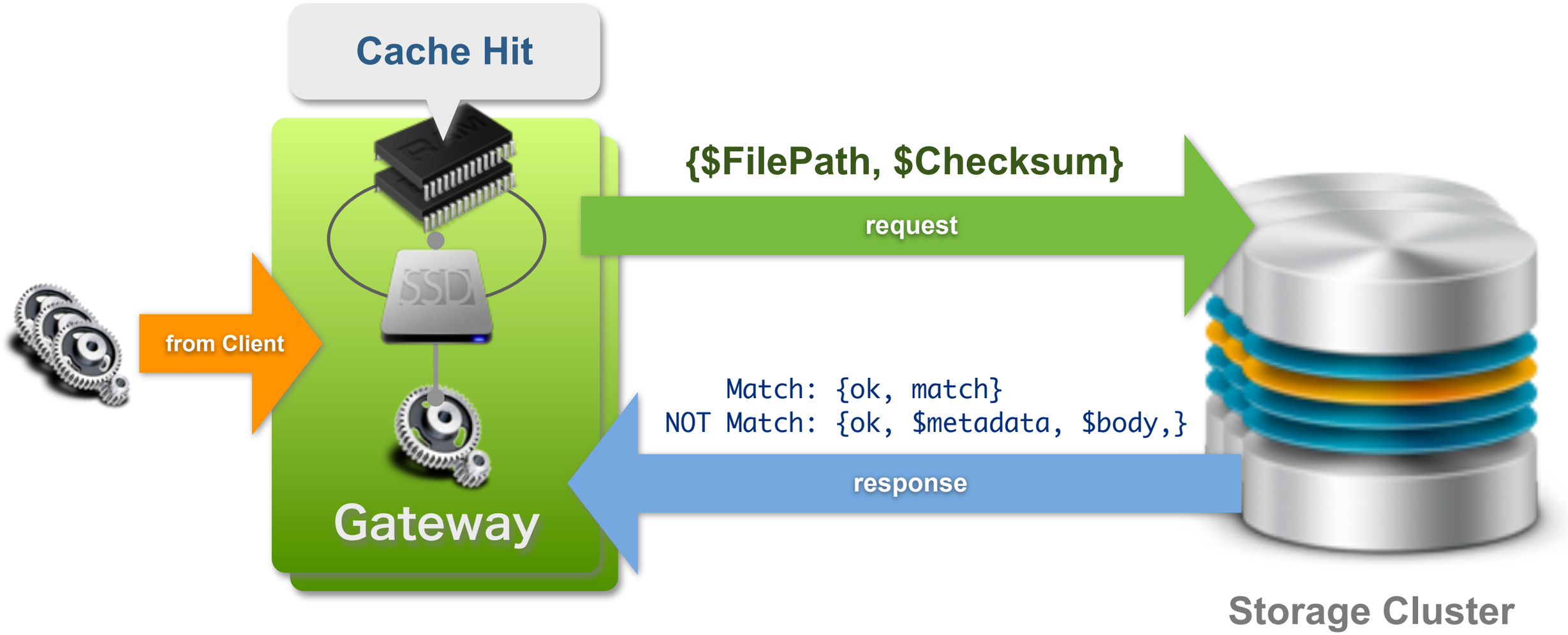
Object Cache Behavior



Object Cache always keep an object consistency

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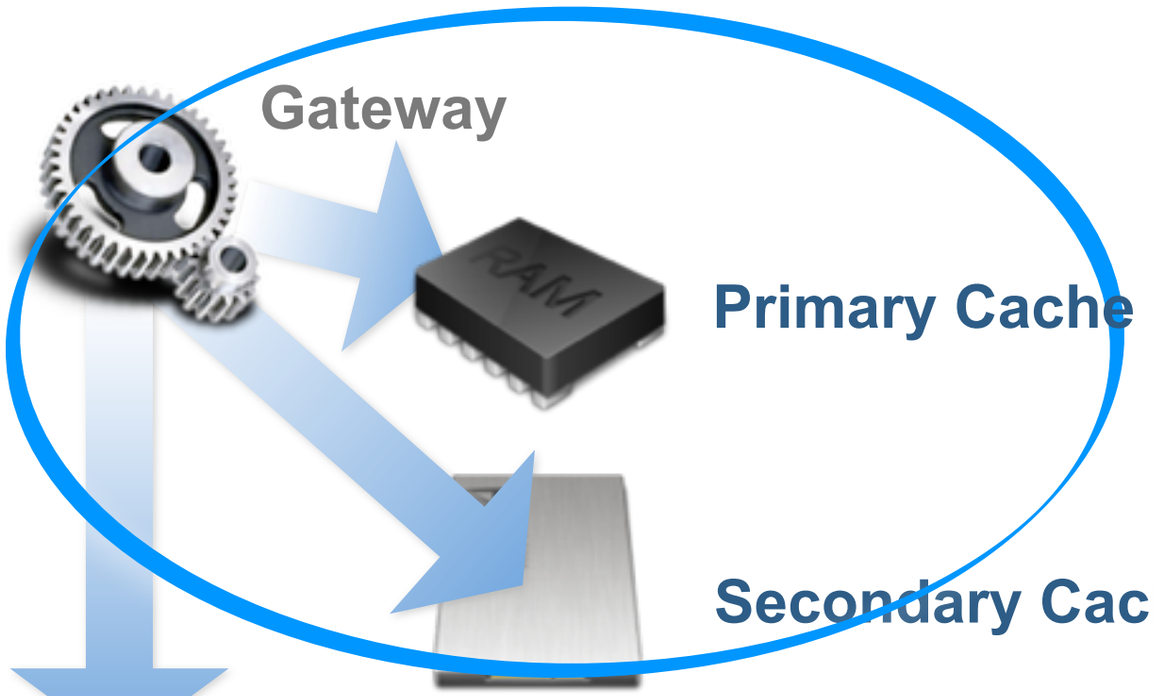
Hierarchical Object Cache (Using RAM, SSD)

HIGH-Performance (Low latency)

High I/O efficiency



Storage Cluster

Reduce traffic between Gateway and Storage

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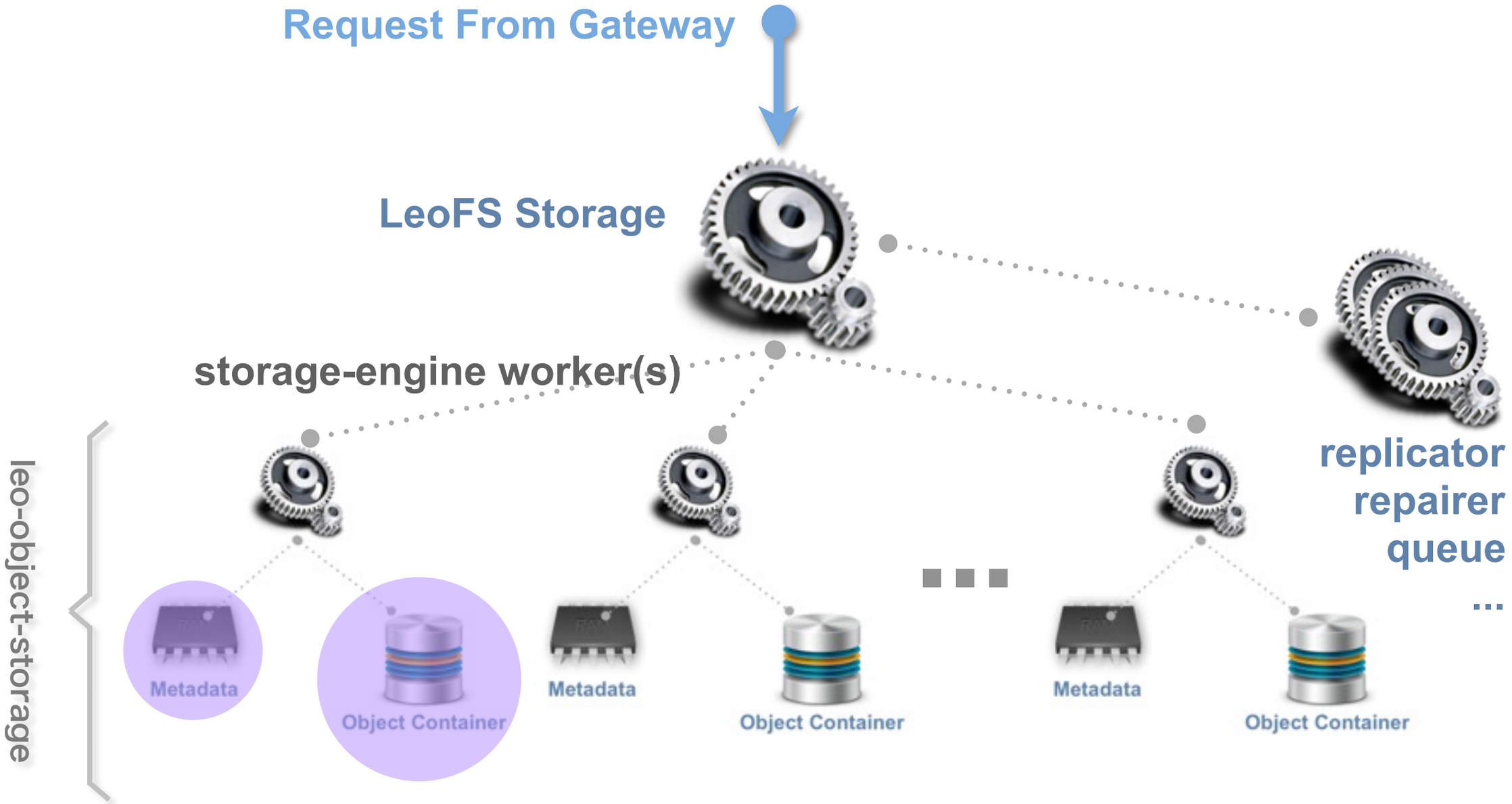
LeoFS Storage

LeoFS Storage Engine



Metadata : Keeps an in-memory index of all data
Object Container : Log structured (append-only) file

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Why do we need the original storage engine?

1. Input and Retrieve various data
2. Controllable “Compaction”

LeoFS Storage Engine - Data Structure

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for Retrieve an File (Object)

for Sync

<Metadata>

{VNodeId, Key} | KeySize | Custom Meta Size | File Size | Offset | Version | Time-stamp | Checksum

<Needle>

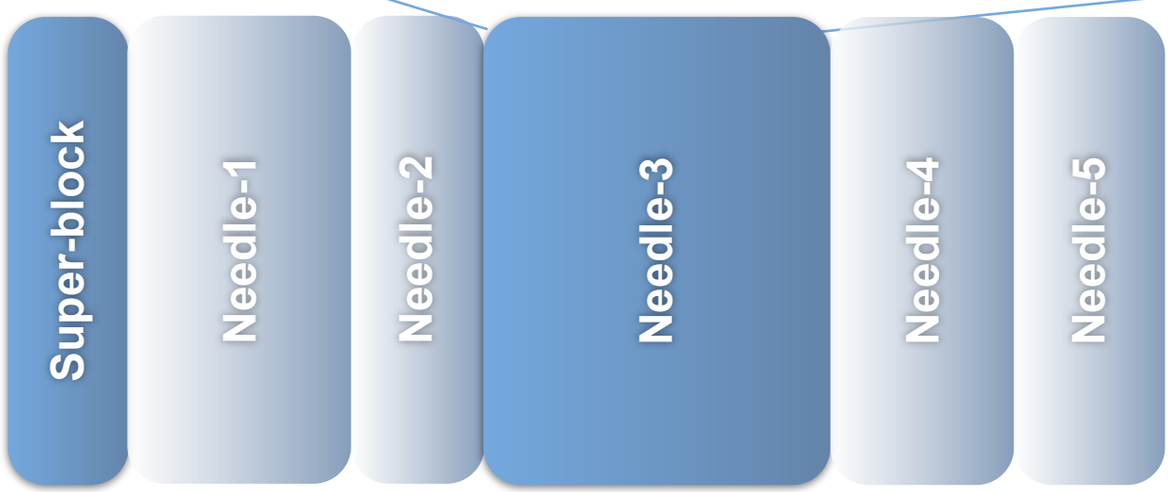
Checksum | KeySize | User-Meta Size | DataSize | Offset | Version | Time-stamp | {VNodeId, Key} | User-Meta | Actual File | Footer

Header (Metadata - Fixed length)

Body (Variable Length)

Footer (8B)

<Object Container>



LeoFS Storage Engine - Retrieve an object from the storage

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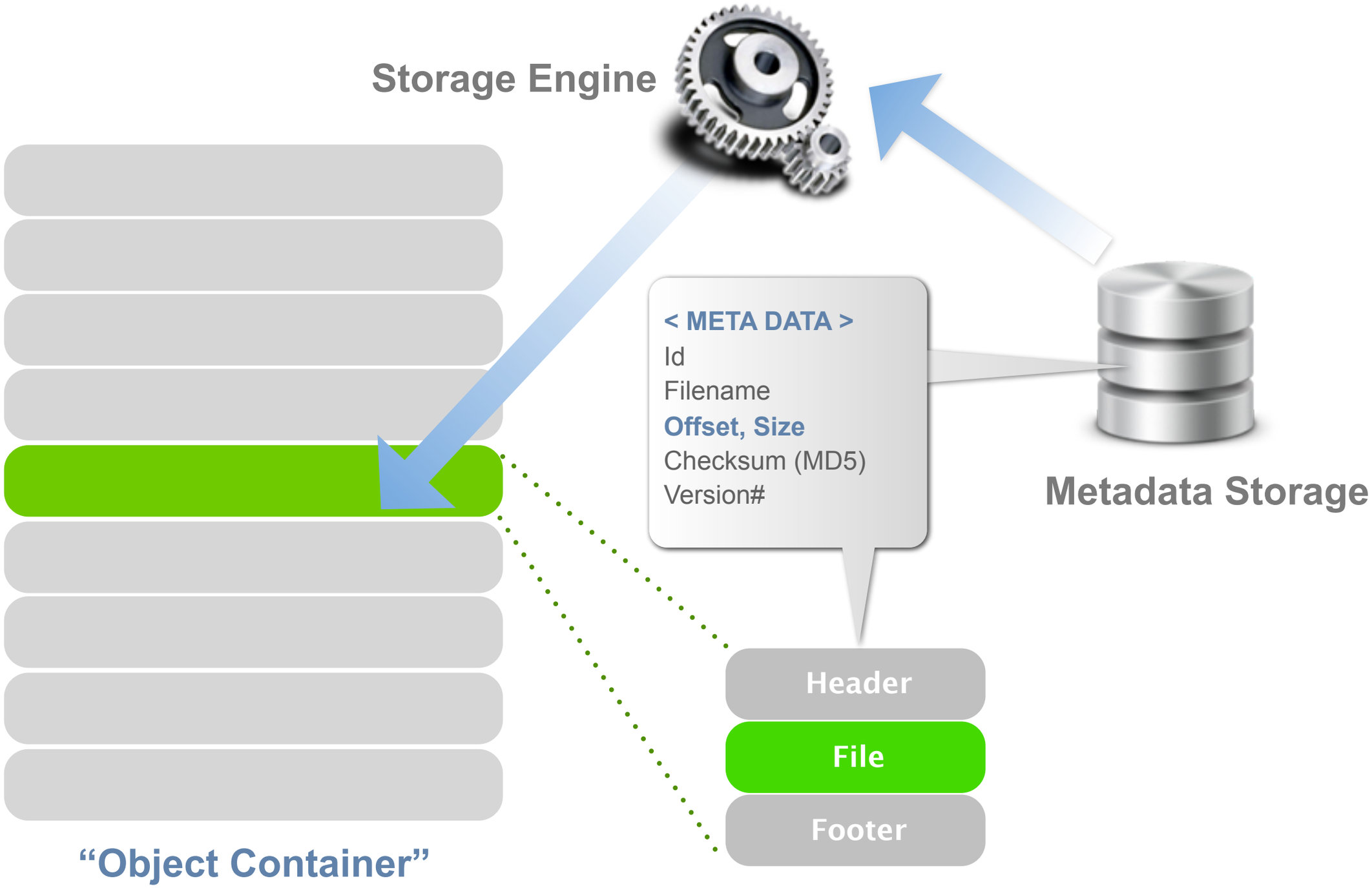

LeoFS Storage Engine - Insert an object into the storage

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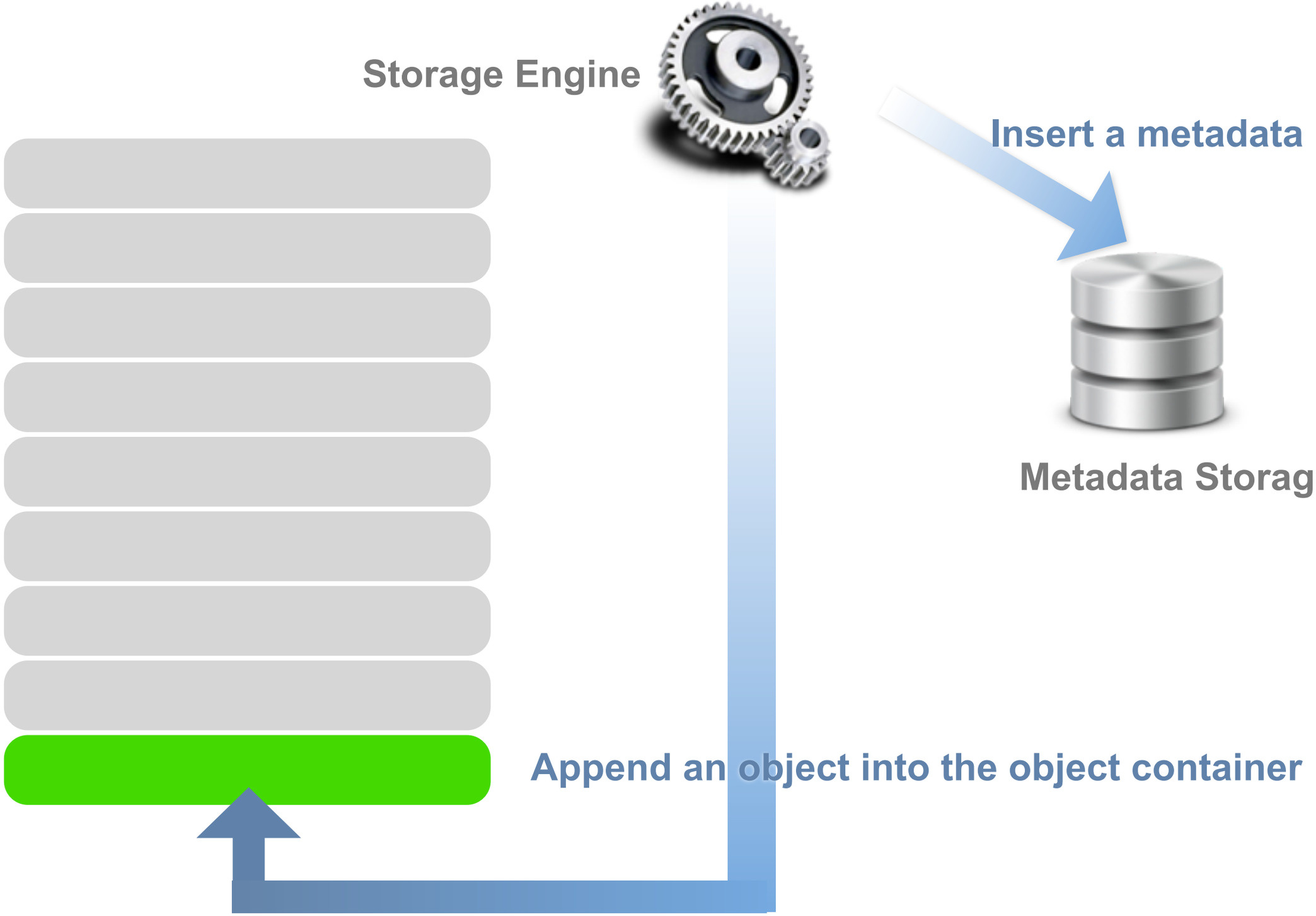

LeoFS Storage Engine - Remove unnecessary objects from the storage

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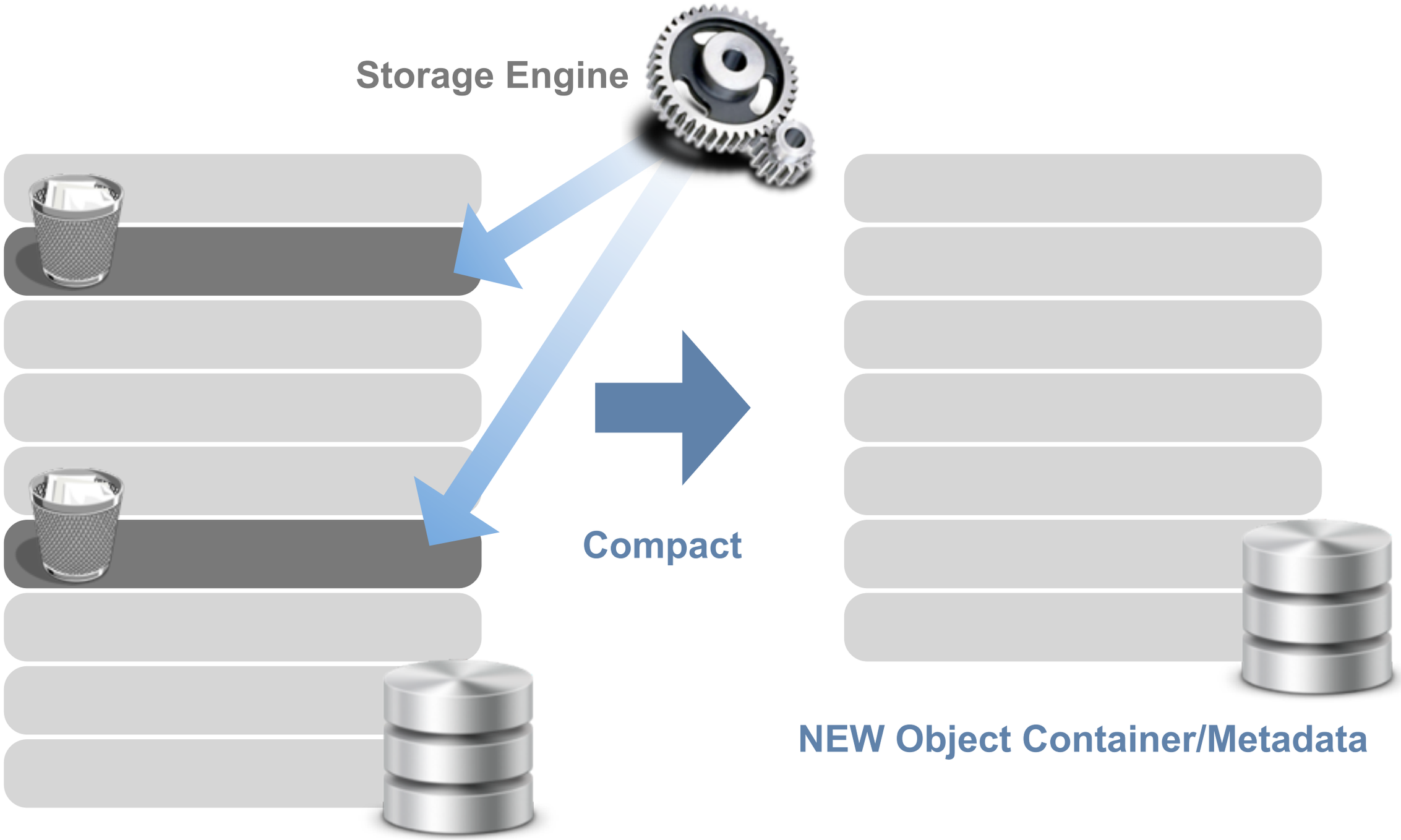
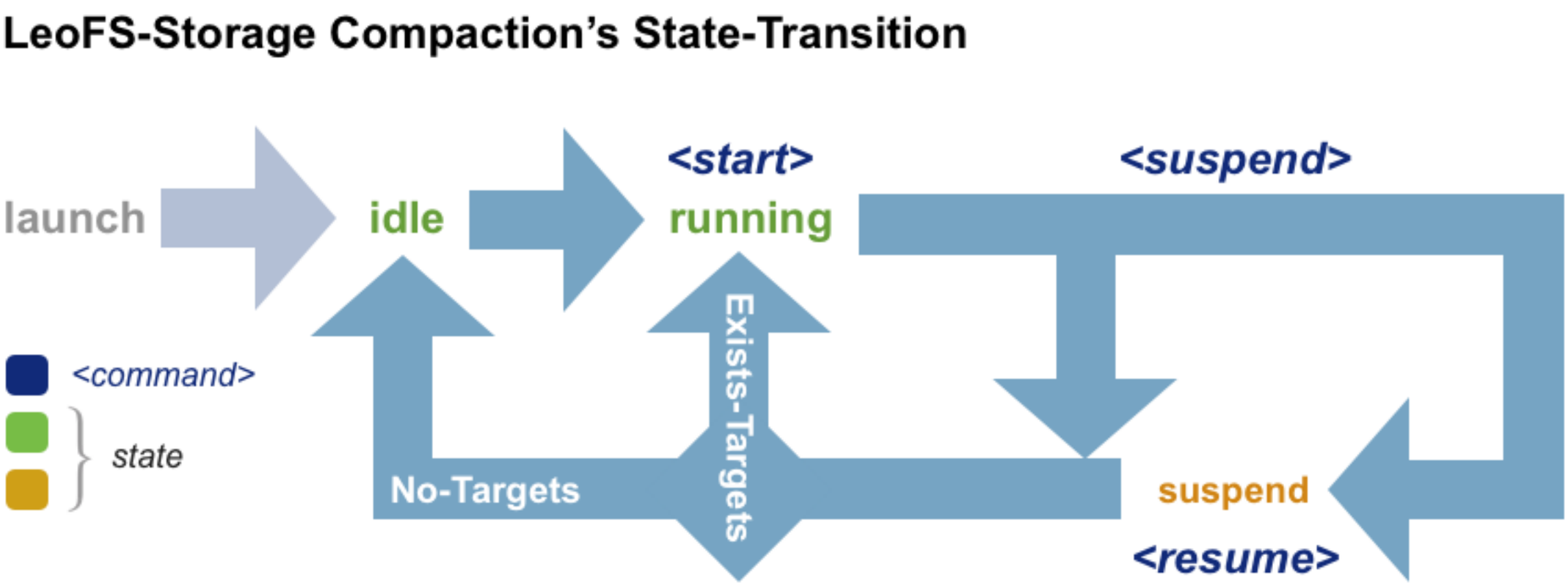


Compaction Manager = “FSM”



“Phased Compaction”

Plan to support “auto-compaction”

with v0.14.2

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Large object Support

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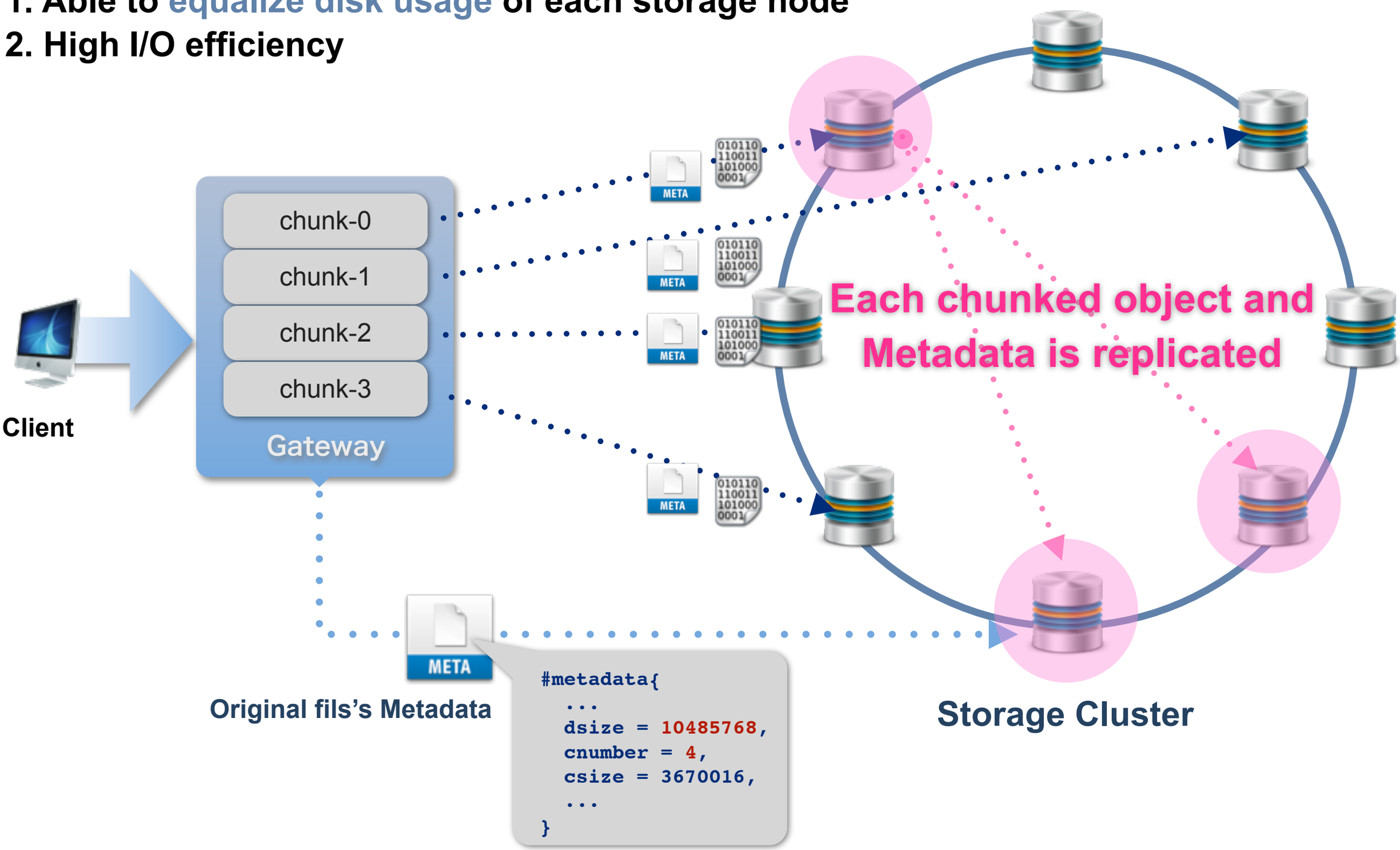
1. Able to equalize disk usage of each storage node
2. High I/O efficiency



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LeoFS Manager

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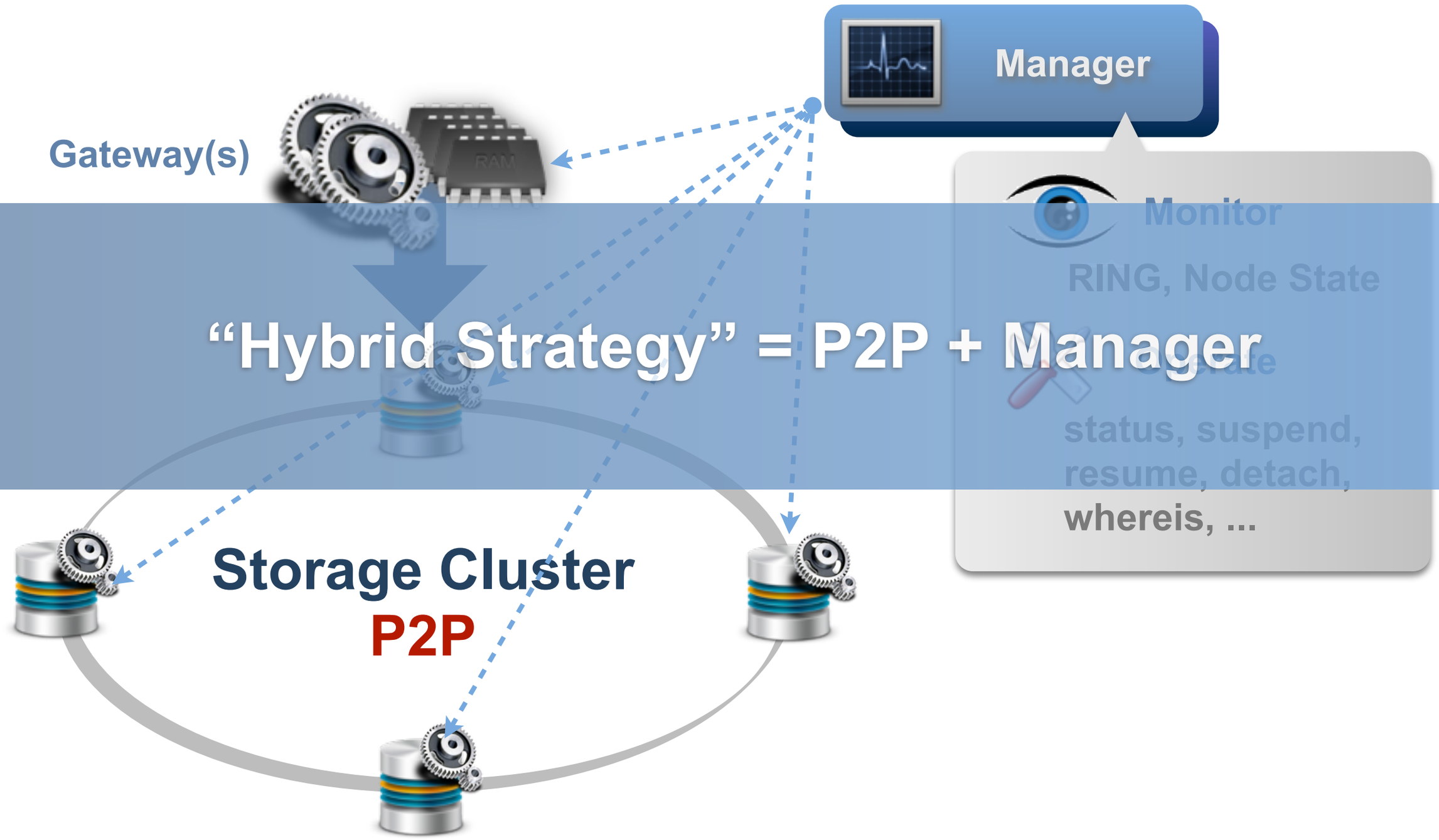
For Keep High-Availability and Easy System Operation



“Hybrid Strategy” = P2P + Manager

Integrated Storage System

Request from Web Application(s)
or Browser

Load Balancer

amazon web services S3-API

REST over HTTP
(80/443)

LeoFS-Manager

RPC
(4369)

(4000,4010,4020)

LeoFS-Gateway

Monitor
(SNMP)

LeoFS-Storage

RPC (4369)

(10020, 10021)

GUI Console

Storage Engine/Router

RAM

META

Object Store

Storage Engine/Router

RAM

META

Object Store

Storage Engine/Router

RAM

META

Object Store

Brief benchmark report

Benchmark

LeoFS v0.12.7

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Benchmark-er [2]

amazon web services S3-API

# of concurrent = 100

[Condition]

```
# of Replica           = 3
# of Successful WRITE  = 2
# of Successful READ   = 1
```

REST over HTTP
(80/443)

LeoFS-Gateway [1]

LeoFS-Manager

RPC (4369)

RPC
(4369)

LeoFS-Storage [5]

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Item	Value
Network	2Gbps (bonding 1Gbps*2)
OS	Ubuntu 12.04 LTS Server
CPU	XEON 2.2GHz (2Core/4Thread)
HDD	RAID-0 / HDD x 6
RAM	16GB
Erlang's version	R15B03-1
At the start of # of objects	1,000,000
# of replicas	3
# of successful write	2

Benchmark-1

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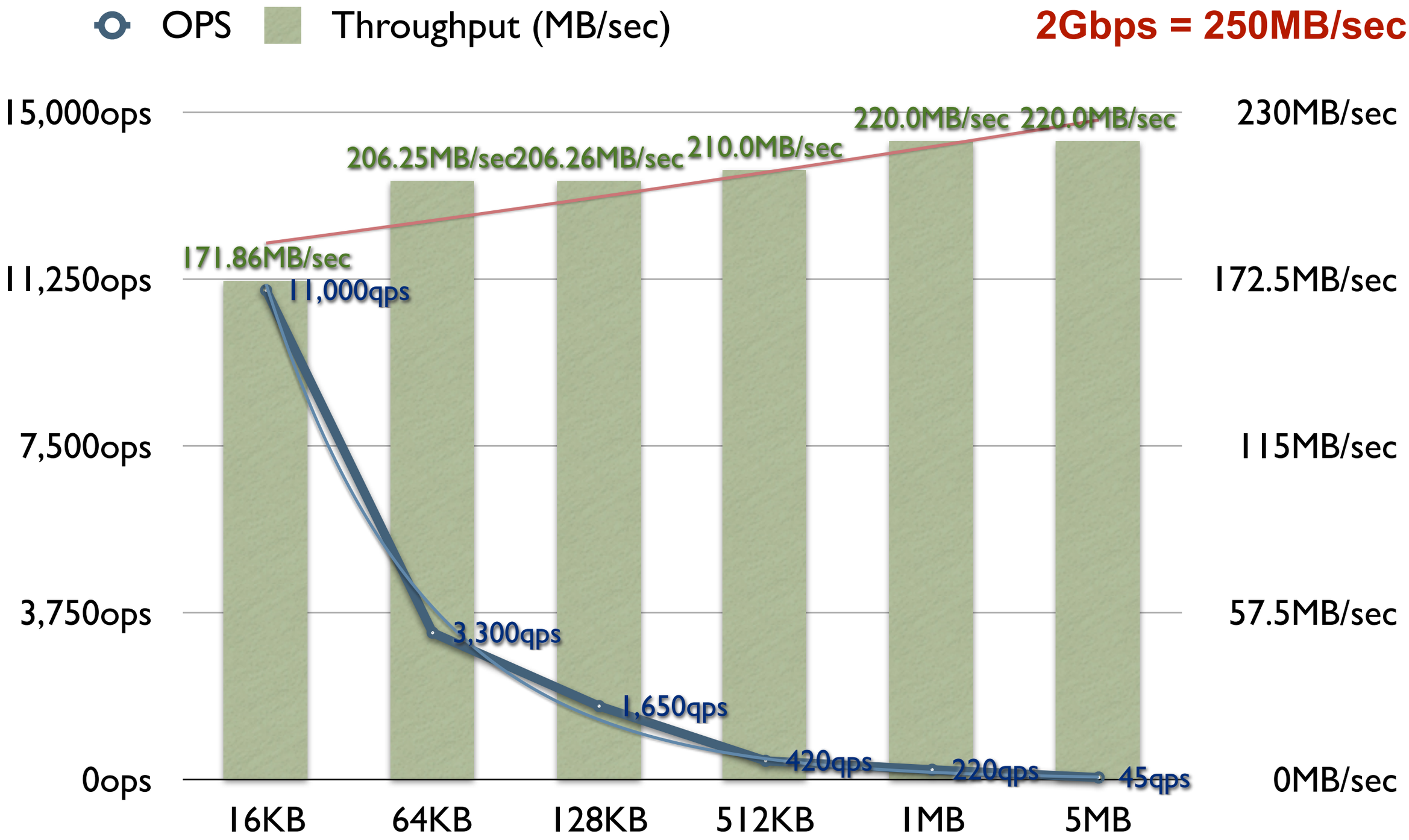
READ : WRITE = 8 : 2



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Demo

Future Works

Future Works - LeoFS QoS

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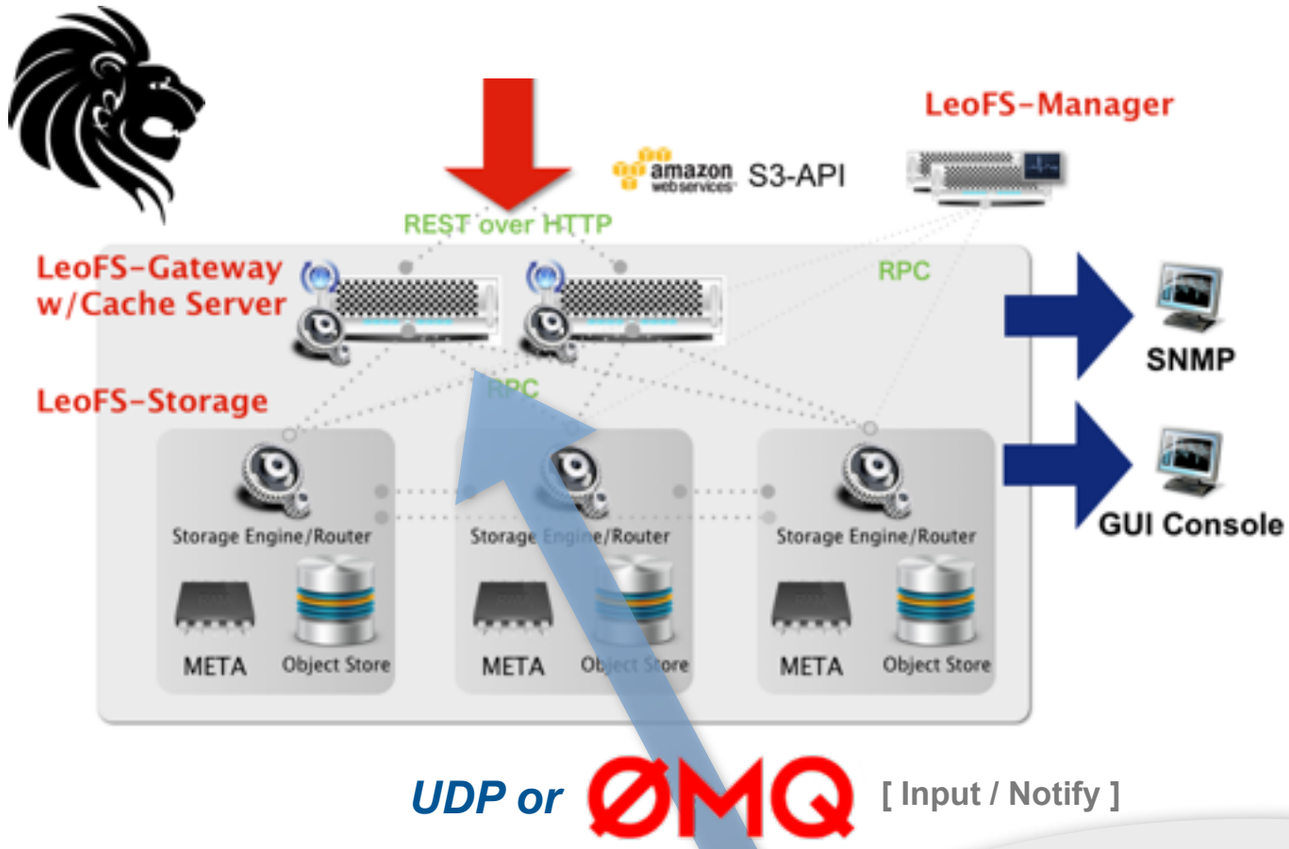

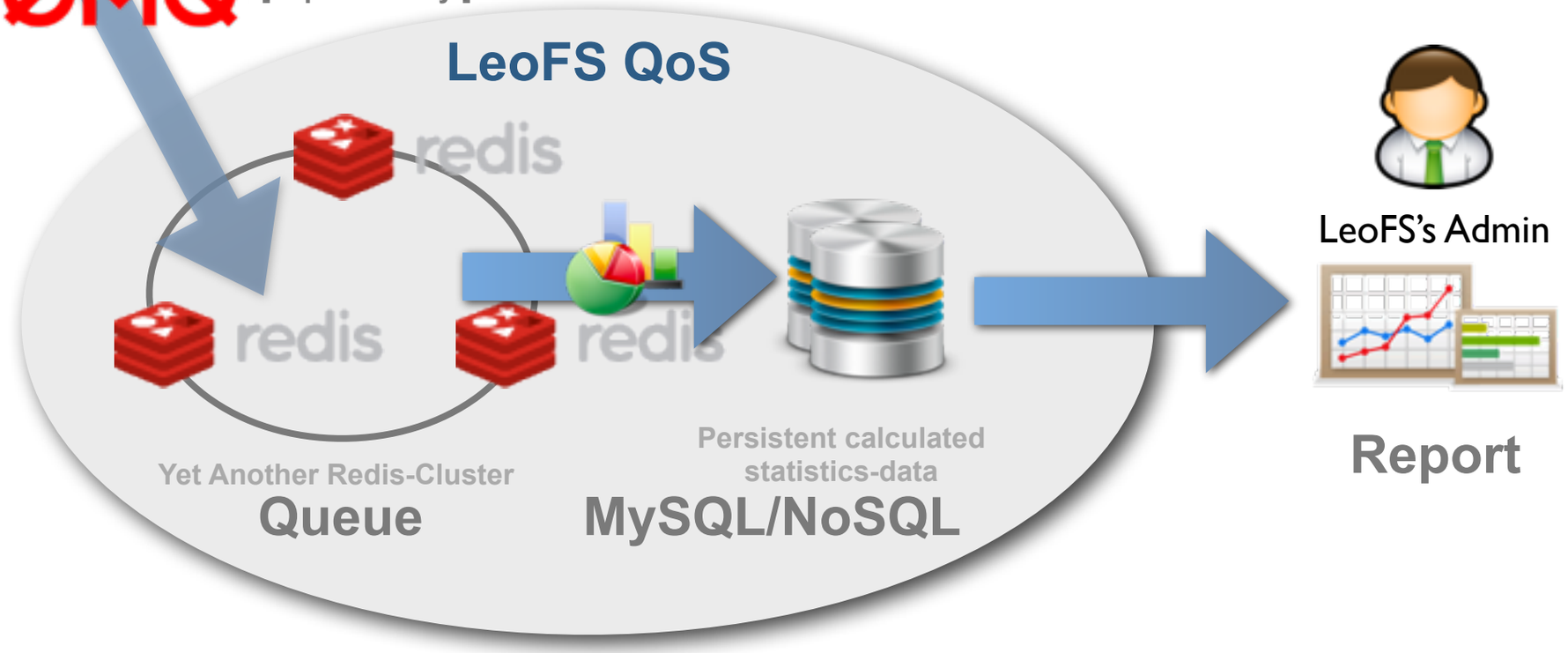

[Purpose]

1. **Able to control request from clients to LeoFS**
2. **Able to store/see LeoFS's traffic data**

* The **quality of service** (**QoS**) refers to several related aspects of telephony and computer networks that allow the transport of traffic with special requirements.

Future Works - Multi-Datacenter Replication

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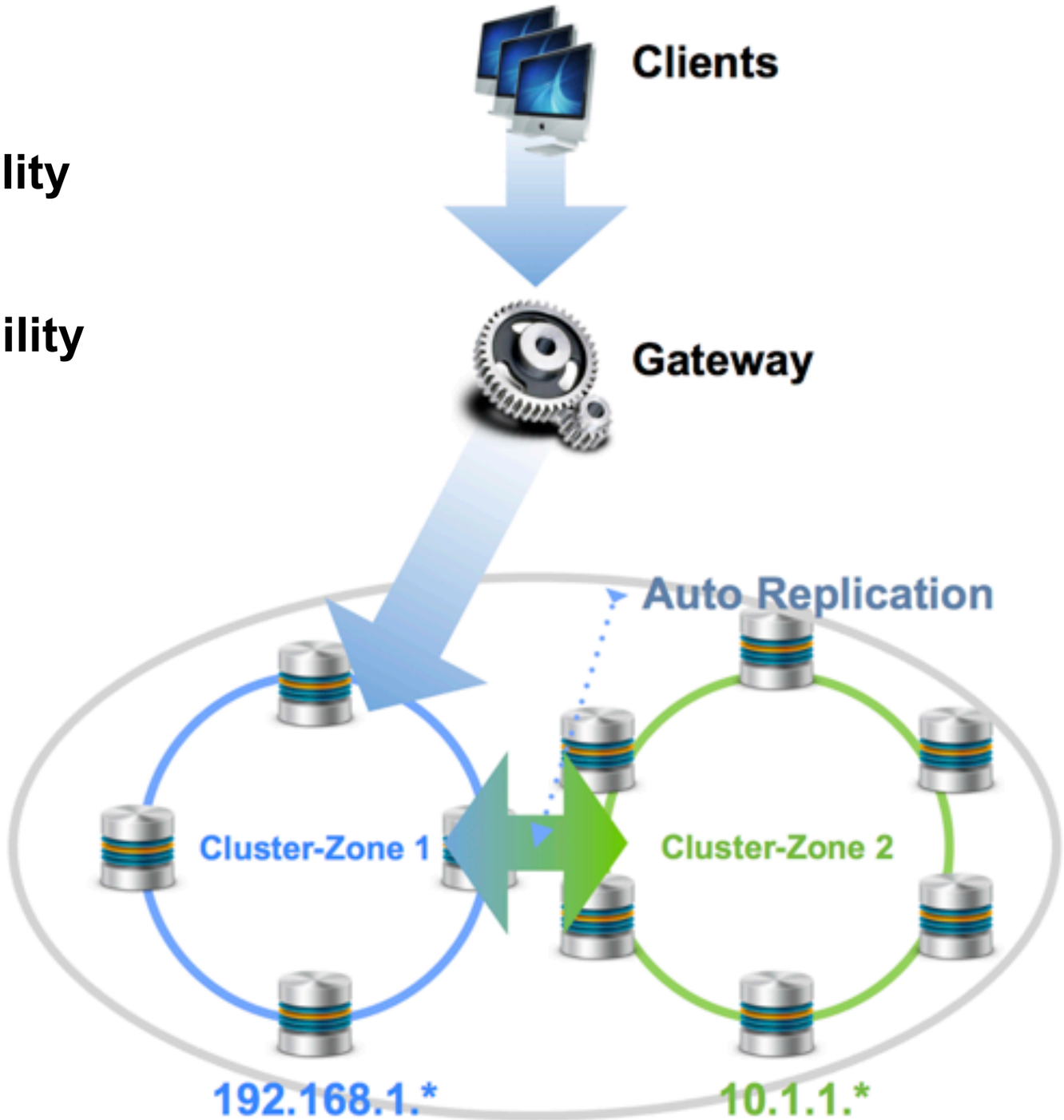
[Purpose]

HIGH-Scalability

HIGH-Availability



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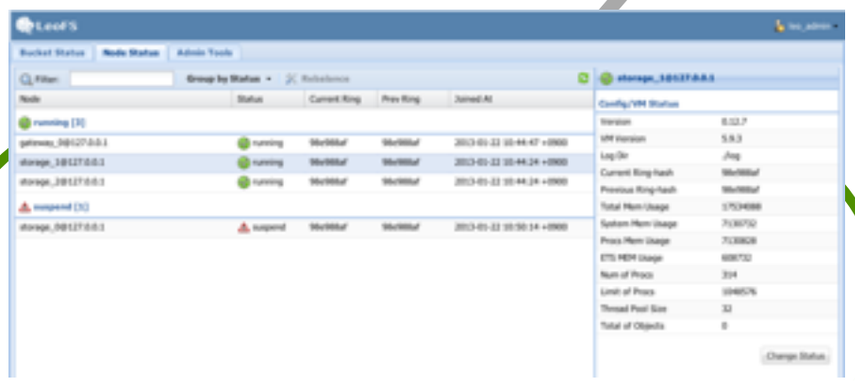
Wrap Up

Wrap Up



LeoFS GUI-Console

LeoFS QoS

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Q & A


Thank you for your time
LeoFS - http://www.leofs.org