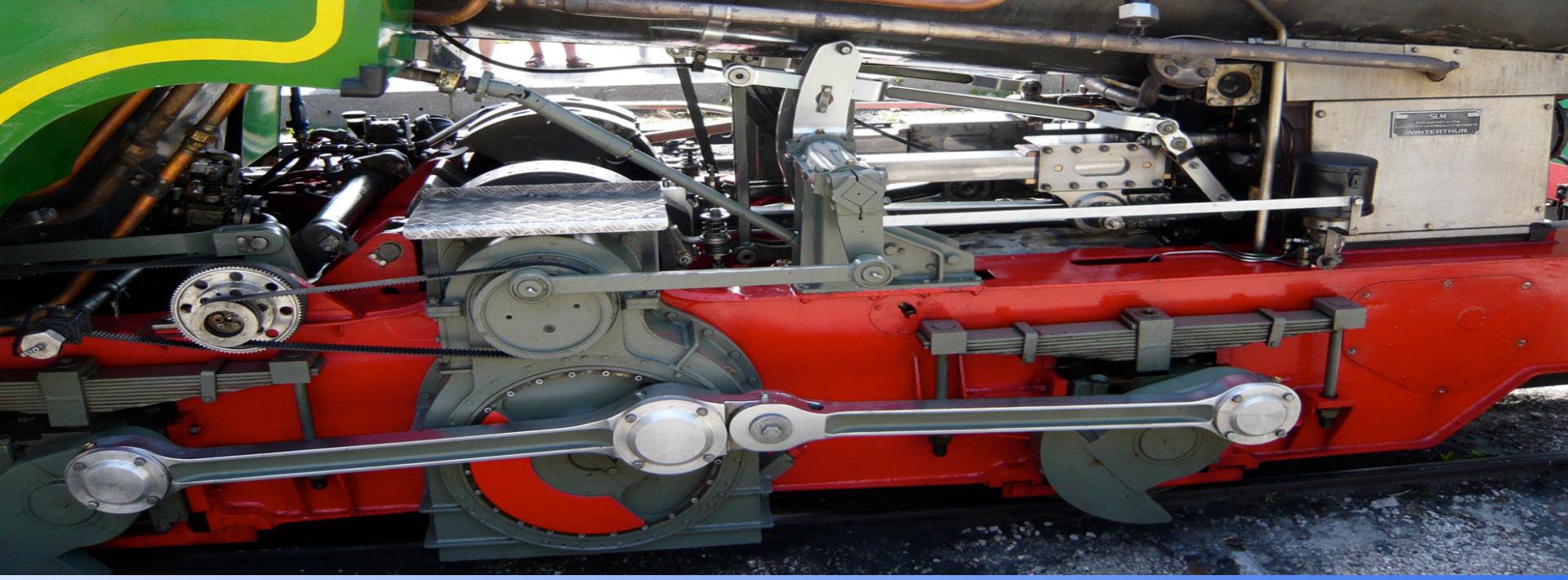


RestFS

Fabrizio Manfredi Furuholmen
Federico Mosca

Beolink.org

Agenda

RestFS

- Introduction
  - Storage System
  - Storage Evolution
- RestFS
  - Goals
  - Architecture
  - Internals
  - Sub project
- Demo
- Conclusion

John H. Terpstra

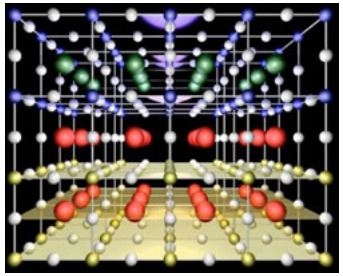
"Data stored globally is expected to grow by 40-60% compounded annually through 2020. Many factors account for this rapid rate of growth, though one thing is clear – the information technology industry needs to rethink how data is shared, stored and managed…"

By the Chairman of SambaXP 2012

Introduction

Introduction

70's	Inode
	Tree view
80's	Network filesystem (NFS/OpenAFS)
	RPC
90's	Object Storage (OSD)
	Parallel transfer
00's	Storage Service
	WEB Base
	Key Value

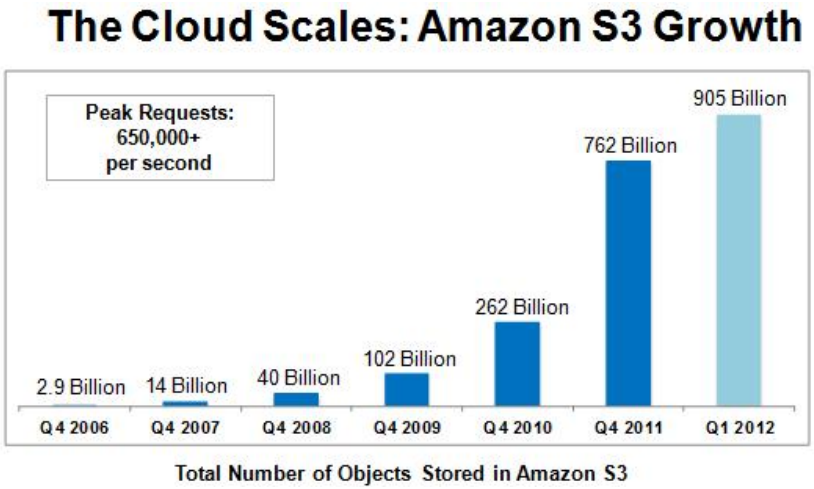


Introduction

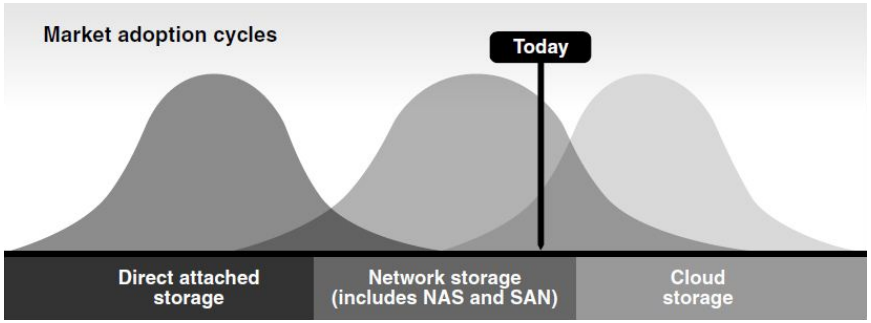
"Late last week the number of objects stored in Amazon S3 reached one trillion (1,000,000,000,000 or 1012). That's 142 objects for every person on Planet Earth or 3.3 objects for every star in our Galaxy. If you could count one object per second it would take you 31,710 years to count them all.

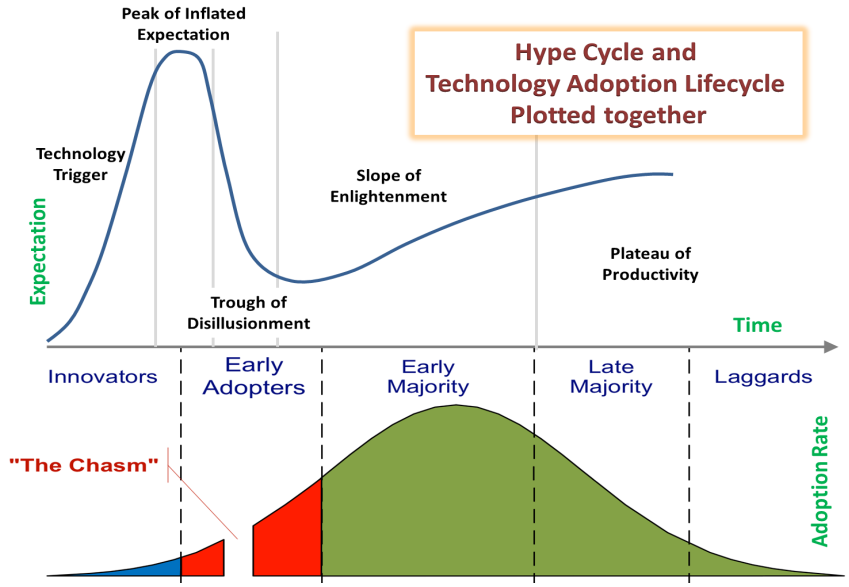
We knew this day was coming! Lately, we've seen the object count grow by up to 3.5 billion objects in a single day (that's over 40,000 new objects per second)..."

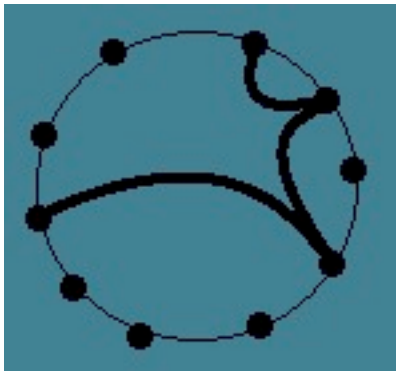
Amazon Web Services Blog, June 12th



John's words + new usage + new services + ...







RestFS

The RestFS is an experimental open-source project with the goal to create a distributed FileSystem for large environments.

It is designed to scale up from a single server to thousand of nodes and delivering a high availability storage system

The Perfect Solution

Uniform Access

- Global name support

Security

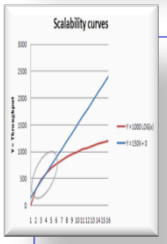
- Global authentication/ authorization

Reliability

- No single point of failure

Availability

- Maintenance without disrupting the user's routines

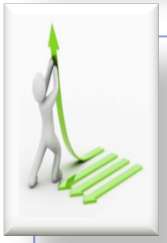


Scalability

- **T**era/Peta/… bytes of data

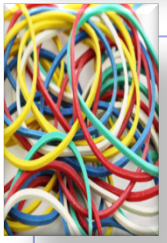
Standard conformance:

Standard semantics



Performance:

- **H**igh performance



Elastic

- Bandwidth and capacity on demand

“Moving Computation is Cheaper than Moving Data”

Five main areas

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Objects

- Separation btw data and metadata
- Each element is marked with a revision
- Each element is marked with an hash.

Cache

- Client side
- Callback/ Notify
- Persistent

Transmission

- Parallel operation
- Http like protocol
- Compression
- Transfer by difference

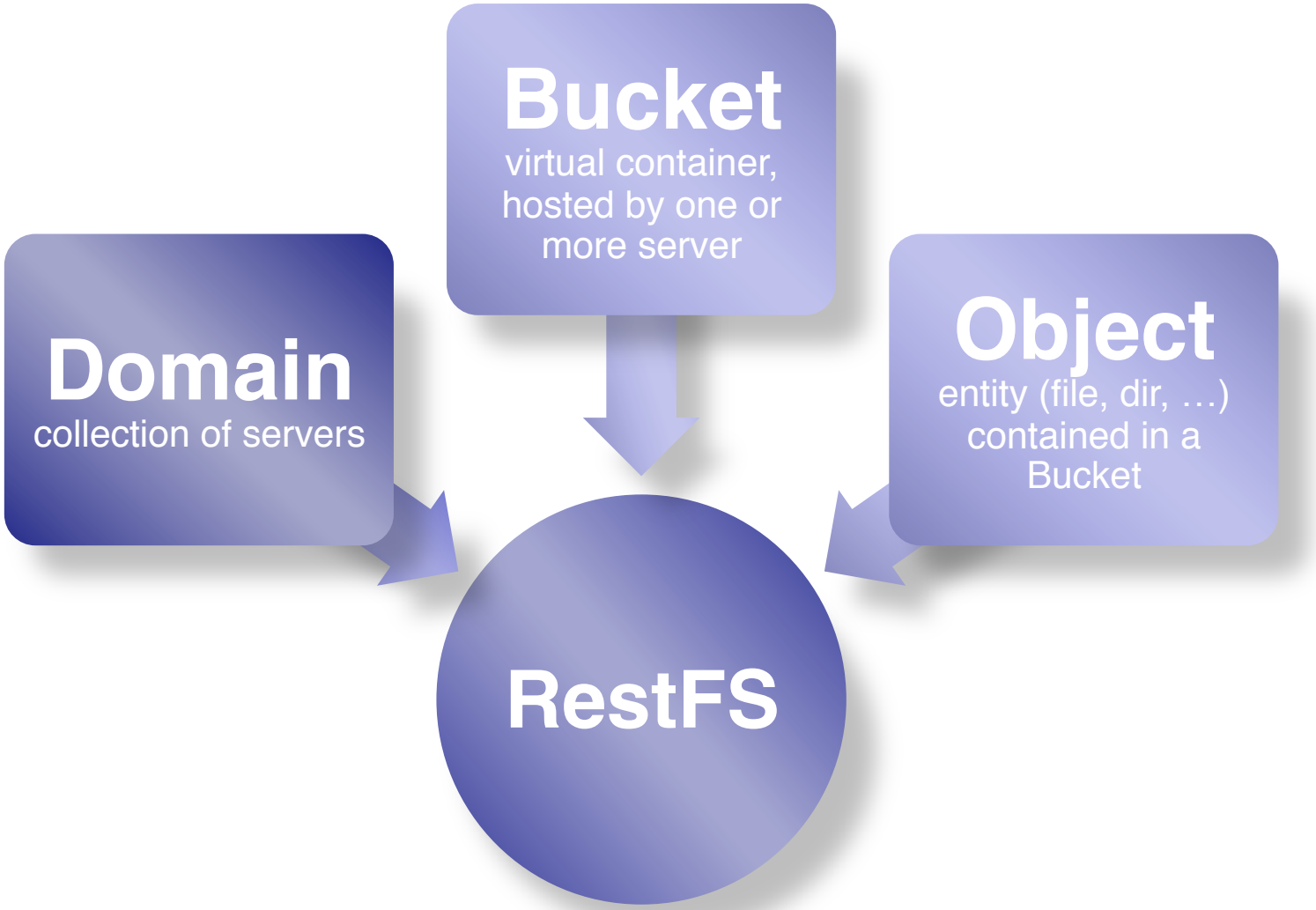
Distribution

- Resource discovery by DNS
- Data spread on multi node cluster
- Decentralize
- Independents cluster
- Data Replication

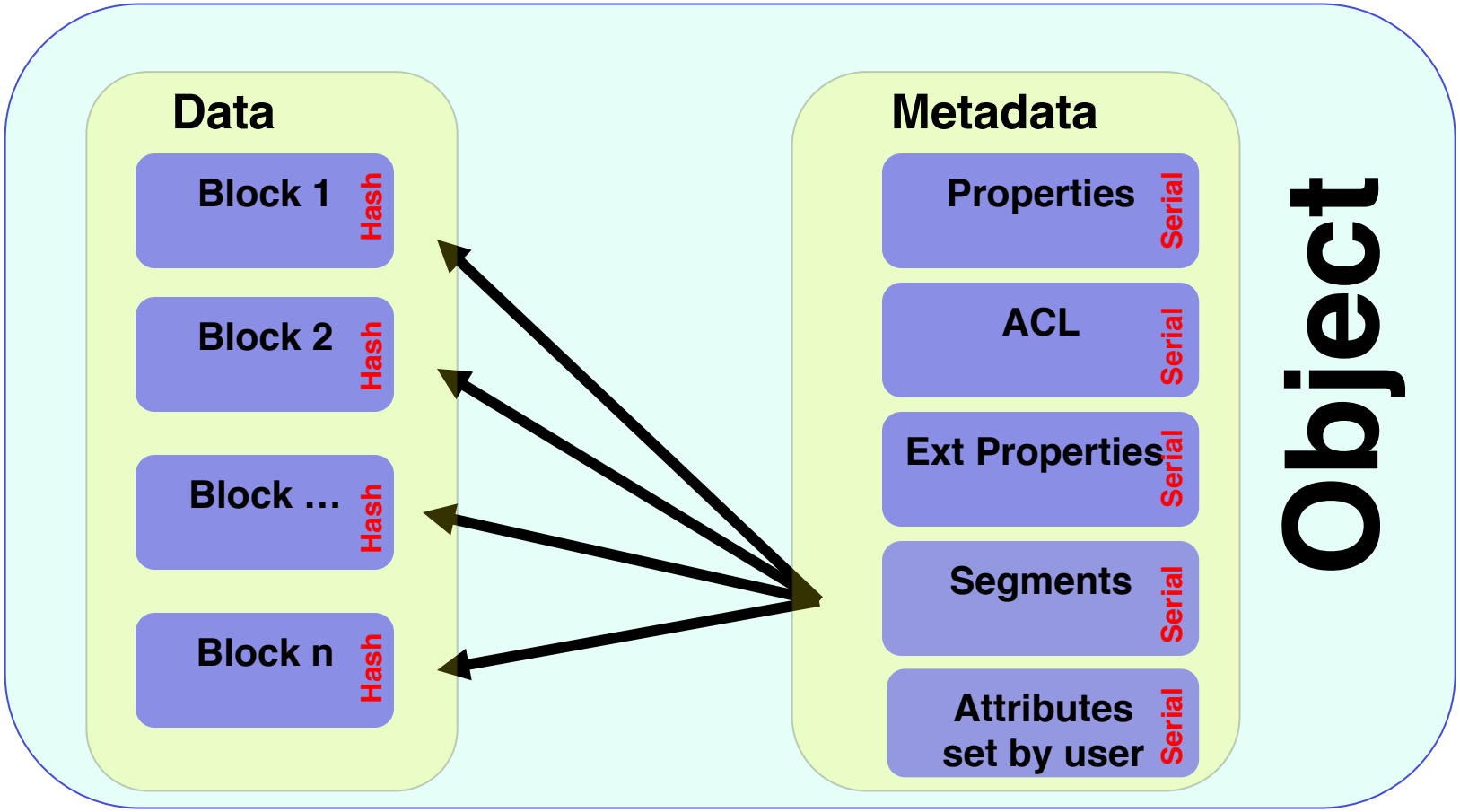
Security

- Secure connection
- Encryption client side,
- Extend ACL
- Delegation/ Federation
- Admin Delegation

RestFS Key Words



Object


Data
Block 1
Hash
Block 2
Hash
Block ...
Hash
Block n
Hash
Metadata
Properties
Serial
ACL
Serial
Ext Properties
Serial
Segments
Serial
Attributes set by user
Serial
Object

Discovery Bucket

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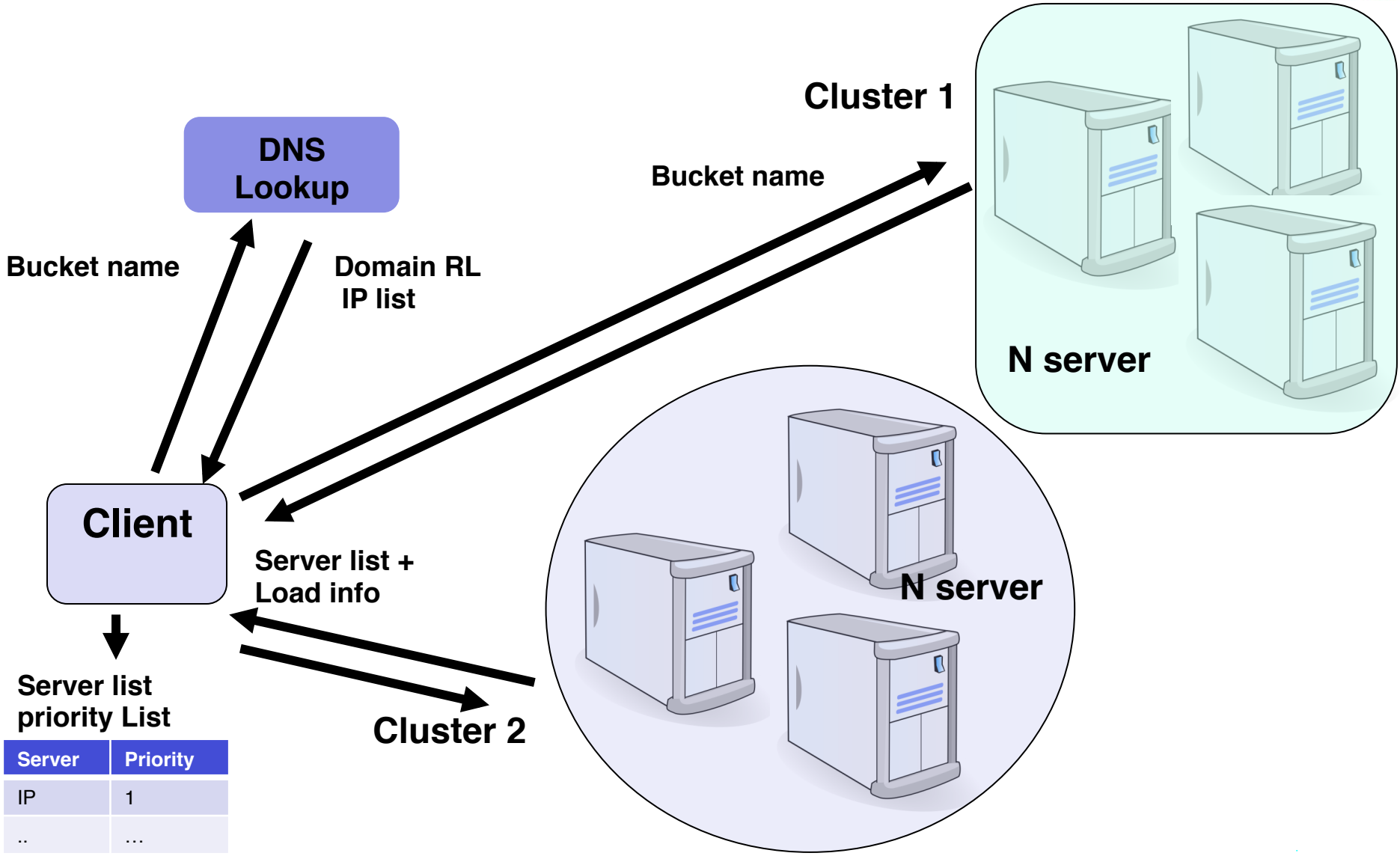
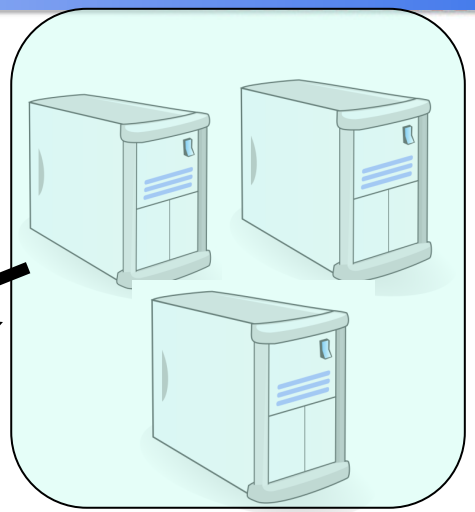


Server	Priority
IP	1
..	…

Retrieve Data

Server	Priority
IP	1
IP	2
IP	3
..	..



Metadata

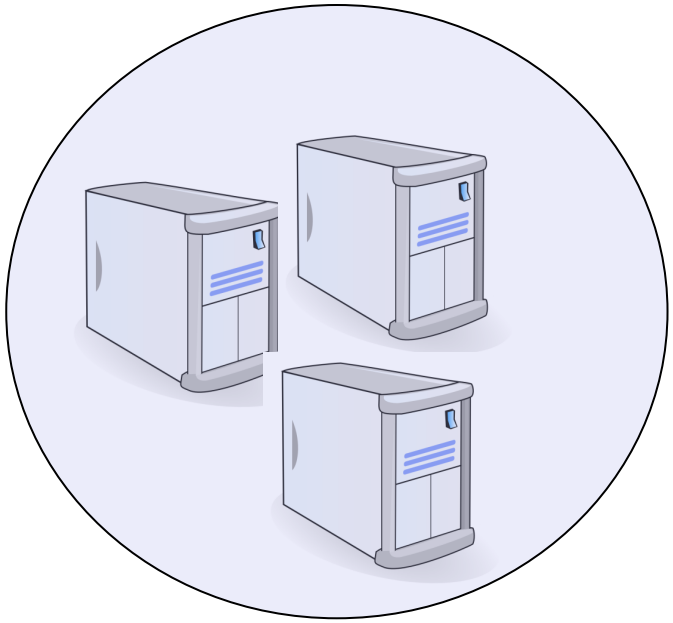
Object
- Property
- Segment

Client

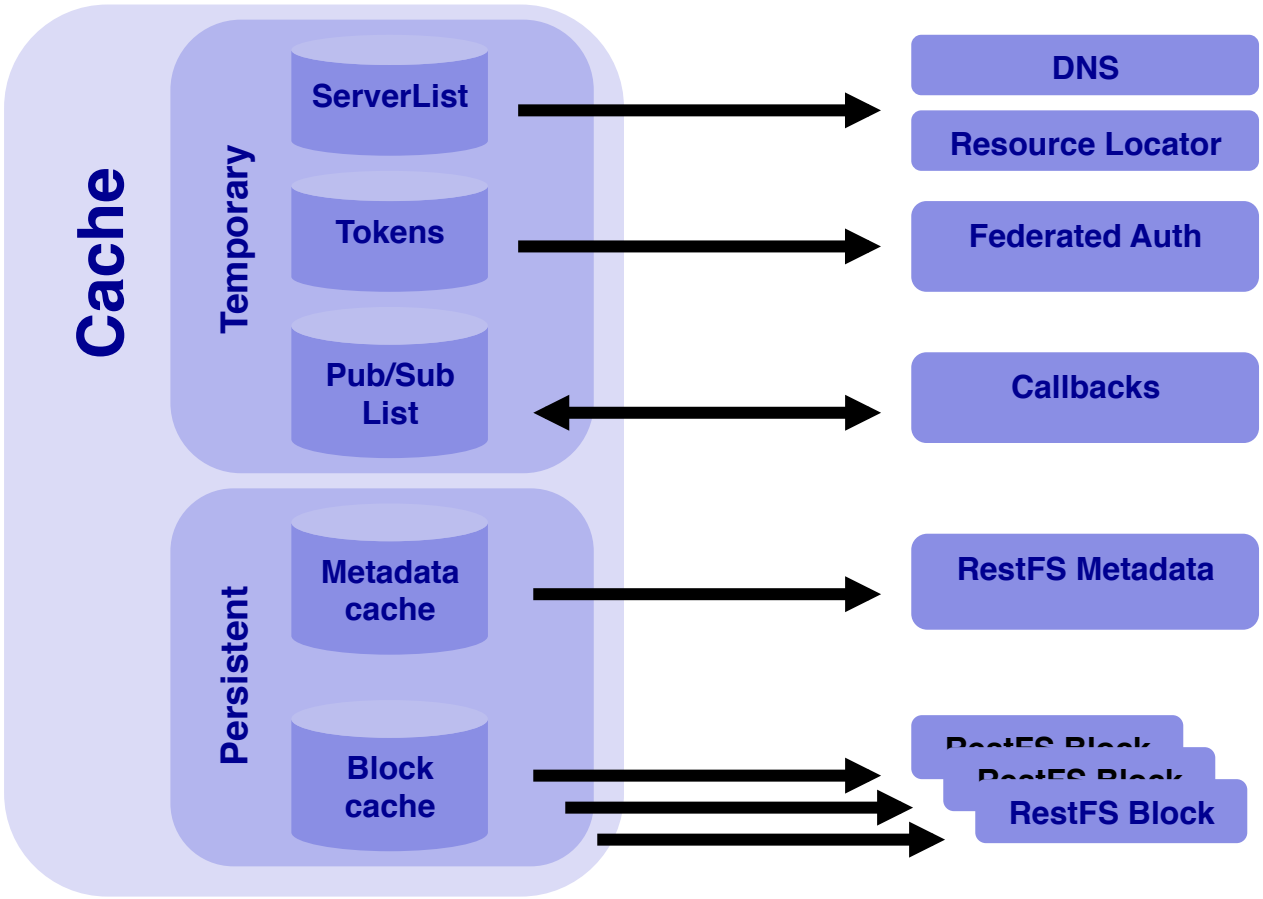
Subscribe/
publish

Block
Data

Client Cache



Cache client side



Server Architecture

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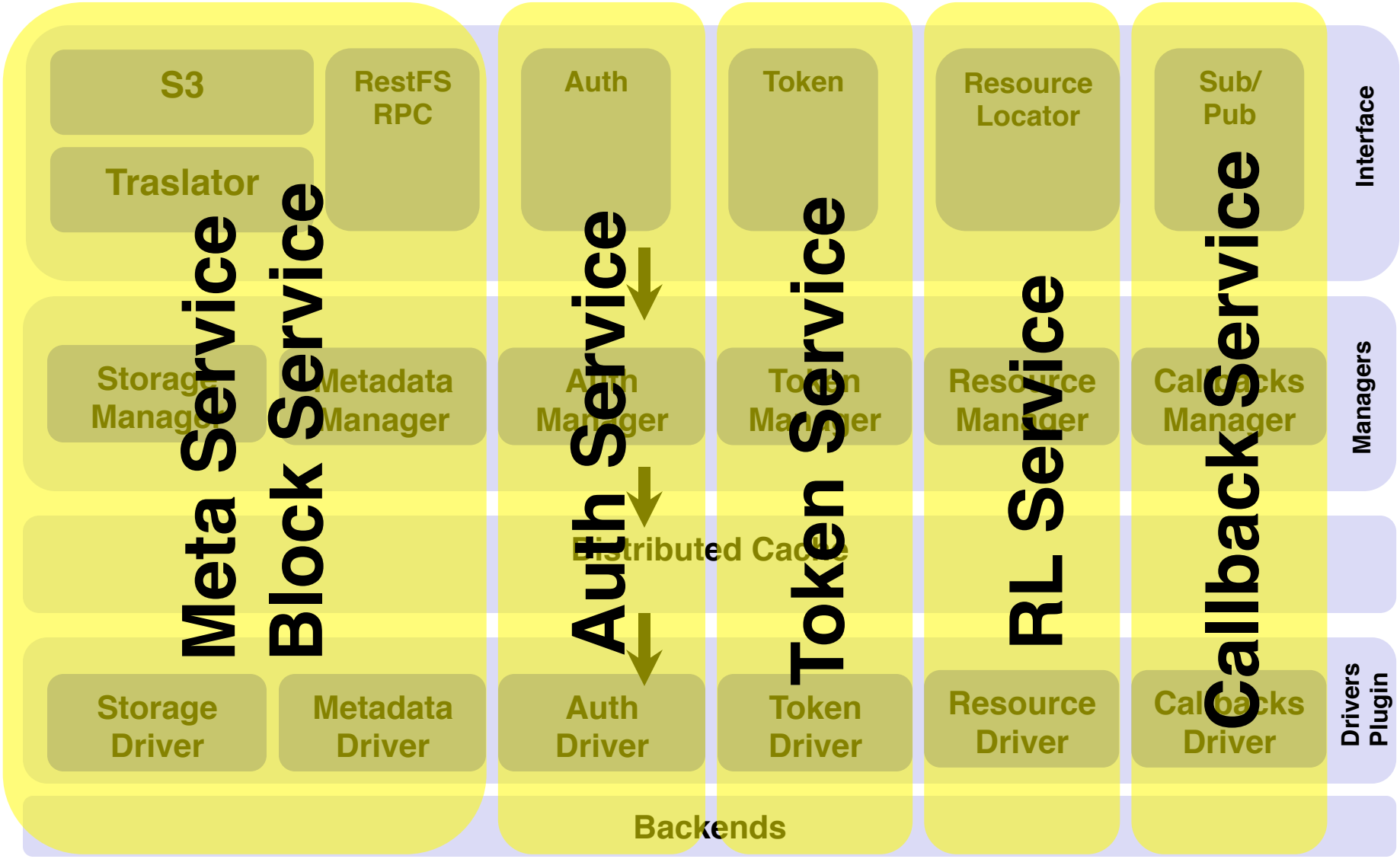
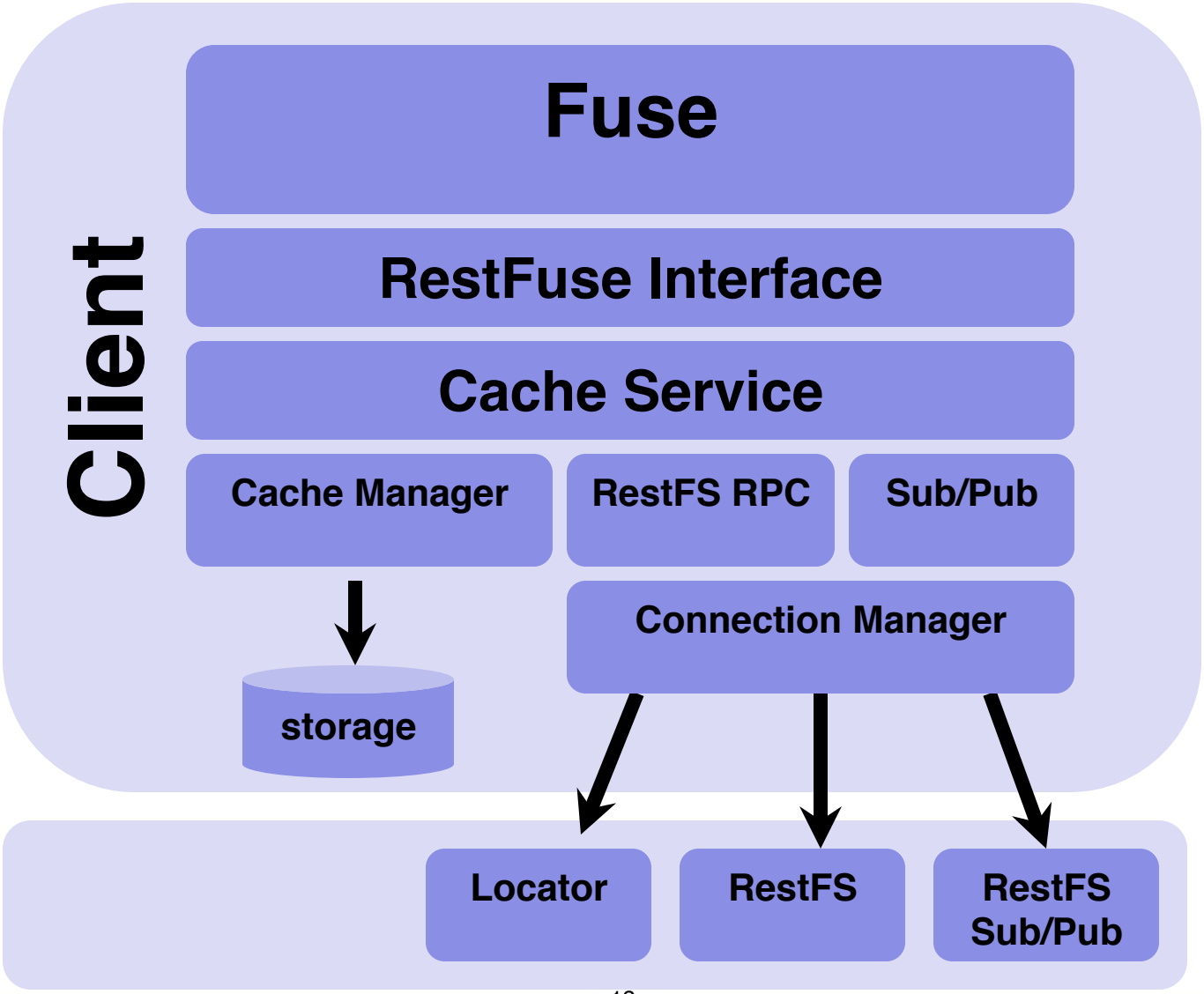


Client Architecture



Is everything ok ?

Demo

Object

Key Value Pair

Key for everything

- Metadata: BUCKET_NAME.UUID
- Block: BUCKET_NAME.UUID

HASH

Each block has an hash to identify the content

Serial

Each element has a version which is identified by a serial.

Property

The property element is a collection of object information, with this element you can retrieve the most important metadata.

Object Serialized

Backends agnostic on information stored

Object

zebra.c1d2197420bd41ef24fc665f228e2c76e98da247

Segment-id

1:zebra.16db0420c9cc29a9d89ff89cd191bd2045e47378
2:zebra.9bcf720b1d5aa9b78eb1bcdbf3d14c353517986c
3:zebra.158aa47df63f79fd5bc227d32d52a97e1451828c
4:zebra.1ee794c0785c7991f986afc199a6eee1fa4
5:zebra.c3c662928ac93e206e025a1b08b14ad02e77b29d
…
vers:1335519328.091779

Segment-hash

1:7d565defe000db37ad09925996fb407568466ce0
2:cc6c44efcbe4c8899d9ca68b7089506b7435fc74
3:660db9e7cd5b615173c9dc7daf955647db544580
4:fb8a076b04b550ff9d1b14a2bc655a29dcb341c4
5:b2c1ace2823620e8735dd0212e5424da976f27bc
...

Property

segment_size= 512
block_size = 16k
content_type =
md5=ab86d732d11beb65ed0183d6a87b9b0
max_read'=1000
storage_class=STANDARD
compression= none
…

Publish–subscribe

"… is a messaging pattern where senders of messages, called publishers, do not program the messages to be sent directly to specific receivers, called subscribers. Published messages are characterized into classes, without knowledge of what, if any, subscribers there may be. Subscribers express interest in one or more classes, and only receive messages that are of interest, without knowledge of what, if any, publishers there are… " Wikipedia

Pattern matching

Clients may subscribe to glob-style patterns in order to receive all the messages sent to channel names matching a given pattern.

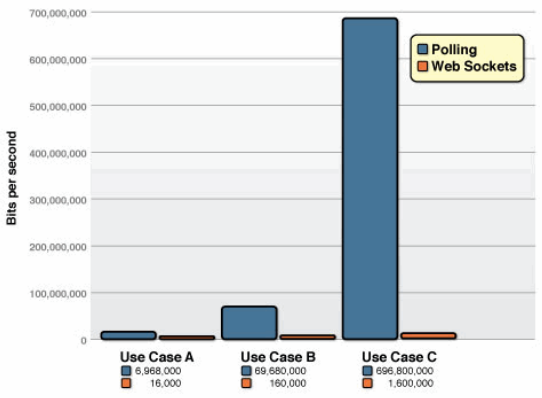
Distributed Cache

For server side the server share information over distributed cache to reduce the use of backend

Client Cache

Pre allocated block with circular cache
write-through cache

Demo http://www.websocket.org/echo.html



Use case A: 1,000
Use case B: 10,000
Use case C: 100,000

WebSocket

is a web technology for multiplexing bi-directional, full-duplex communications channels over a single TCP connection.

This is made possible by providing a standardized way for the server to send content to the browser without being solicited by the client, and allowing for messages to be passed back and forth while keeping the connection open…

```
GET /mychat HTTP/1.1
Host: server.example.com
Upgrade: websocket
Connection: Upgrade
Sec-WebSocket-Key: x3JJHMbDL1EzLkh9GBhXDw==
Sec-WebSocket-Protocol: chat
Sec-WebSocket-Version: 13
Origin: http://example.com
```

```
HTTP/1.1 101 Switching Protocols
Upgrade: websocket
Connection: Upgrade
Sec-WebSocket-Accept: HSmrc0sMlYUkAGmm5OPpG2HaGWk=
Sec-WebSocket-Protocol: chat
```

JSON-RPC

is lightweight remote procedure call protocol similar to XML-RPC. It's designed to be simple

```
--> { "method": "echo", "params": ["Hello JSON-RPC"], "id": 1}
<-- { "result": "Hello JSON-RPC", "error": null, "id": 1}
```

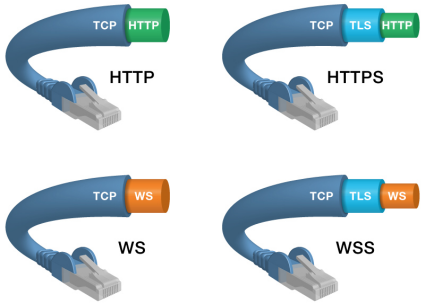
BSON

short for Binary JSON,
is a binary-encoded serialization of JSON-like documents. Like JSON, BSON supports the embedding of documents and arrays within other documents and arrays.
BSON can be compared to binary interchange formats

```
{"hello": "world"}
→
"\x16\x00\x00\x00\x02hello\x00
 \x06\x00\x00\x00world\x00\x00"
```

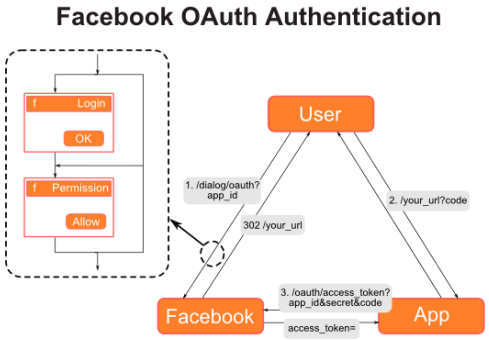
Security Channel

Communication over S3 protocol is based on SSL
Communication over RestFS RPC is based on WSS



Identification

Internal or through identity provider like Google, Facebook..



Token

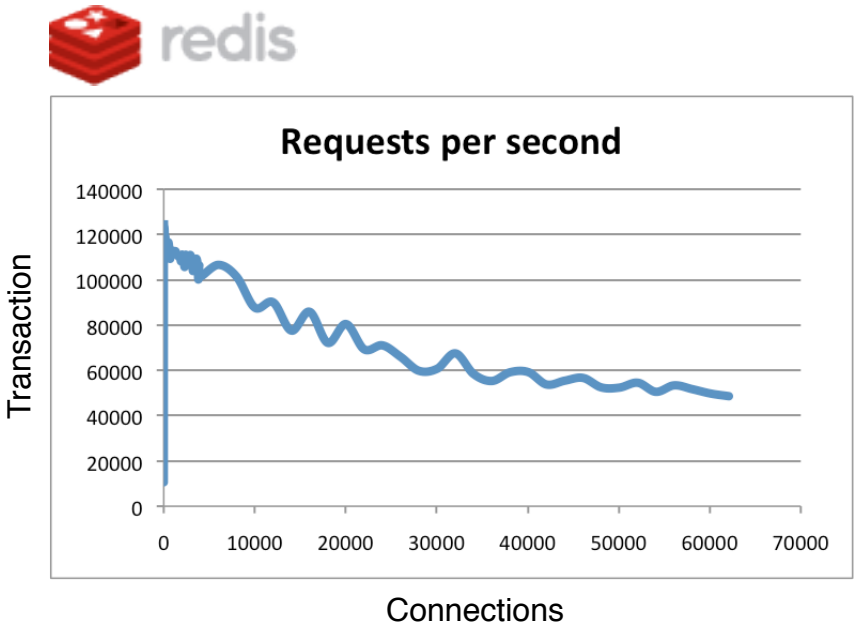
For each identity is possible to assign more devices with different token. This operation permits to exclude a stolen device or enable a time period based one.

Authorization

The security control is based on extended ACL (nfs4)

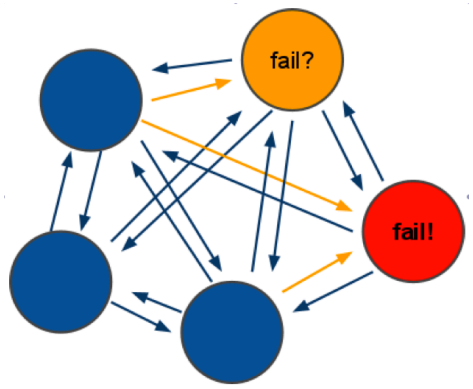
Encryption

The user can encrypt the data with personal password, share information through gnuPG framework (under development)



Example of benchmark result

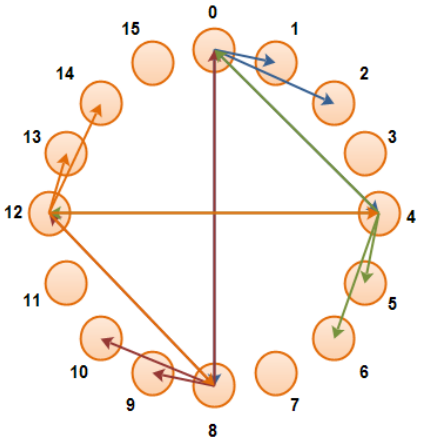
The test was done with 50 simultaneous clients performing 100000 requests.
The value SET and GET is a 256 bytes string.
The Linux box is running Linux 2.6, it's Xeon X3320 2.5 GHz.
Text executed using the loopback interface (127.0.0.1).



Cluster

Multi-master
Auto recovery

Backend: Storage



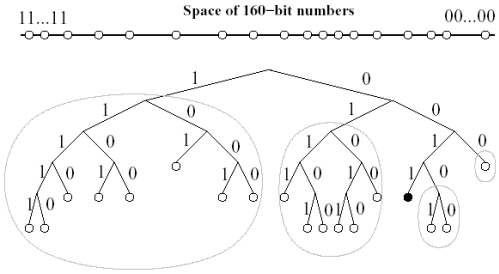


Fig. 1: Kademlia binary tree. The black dot shows the loation of node 0011... in the tree. Grey ovals show subtrees in which node 0011... must have a contact.

Kademlia's XOR distance is easier to calculate.

Kademlia's routing tables makes routing table management a bit easier.

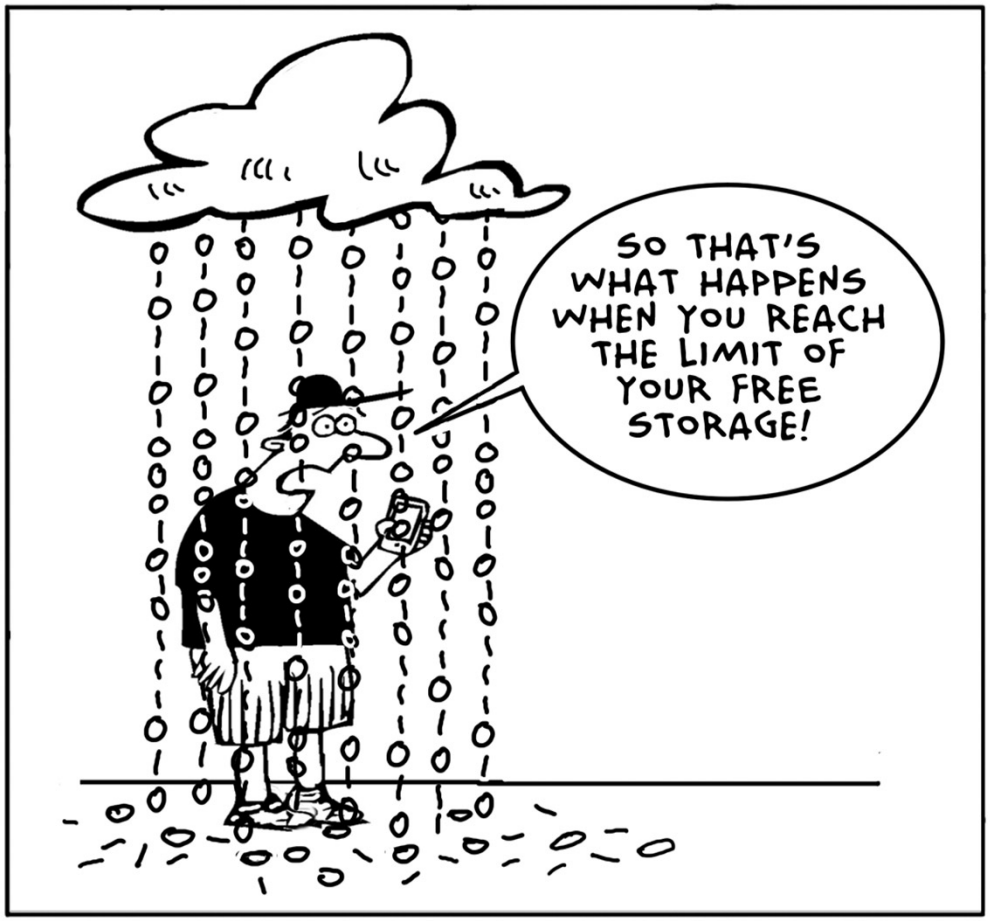
Each node in the network keeps contact information for only log n other nodes

Kademlia implements a "least recently seen" eviction policy, removing contacts that have not been heard from for the longest period of time.

Key/value pair is stored on the node whose 160-bit nodeID is closest to the key

Closest node, send a copy to neighbor

What happens when you have finished the space ?



What we are using

Module	Software
Storage	Filesystem, DHT (kademlia, Pastry*)
Metadata	SQL(mysql,sqlite), Nosql (Redis)
Auth	Oauth(google, twitter, facebook), kerberos*, internal
Protocol	Websocket
Message Format	JSON-RPC 2.0, Amazon S3
Encoding	Plain, bson
CallBack	Subscribe/Publish Websocket/Redis, Async I/O TornadoWeb, AMPQ*
HASH	Sha-XXX, MD5-XXX, AES
Encryption	SSL, ciphers supported by crypto++
Discovery	DNS, file base

* are planned

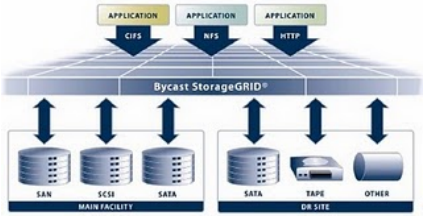
What is it good for ?

User

- Home directory
- Remote/Internet disks

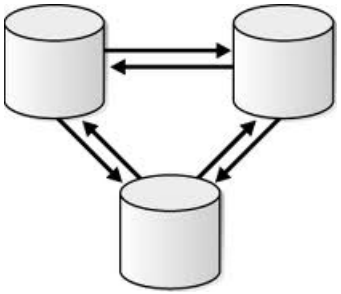
Application

- Object storage
- Shared space
- Virtual Machine



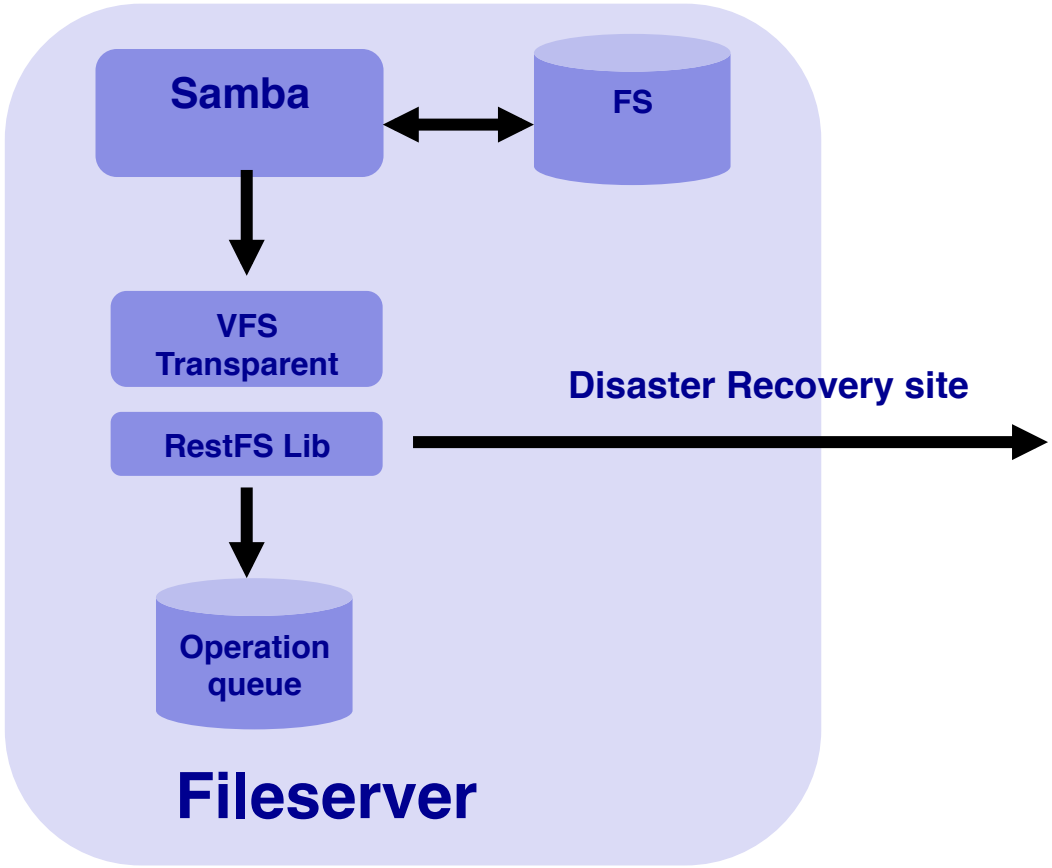
Distribution

- CDN (Multimedia)
- Data replication
- Disaster Recovery



Subproject: Disaster Recovery

Element	Configuration
Interface	VFX
Auth	Samba
ACL	Samba
Cache	Queue mode
Space	One bucket per share



* Under development

Advantages

High reliability	Distributed
	Decentralized
	Data replication
Nearly unlimited scalability	Horizontal scalability
	Multi tier scalability
Cost-efficient	Cheap HW
	Optimized resource usage
Flexible	User Property
	Extended values and info
Enhanced security	Extended ACL
	OAUTH / Federation
	Encryption
	Token for single device
Simple to Extend	Plugin
	Bricks

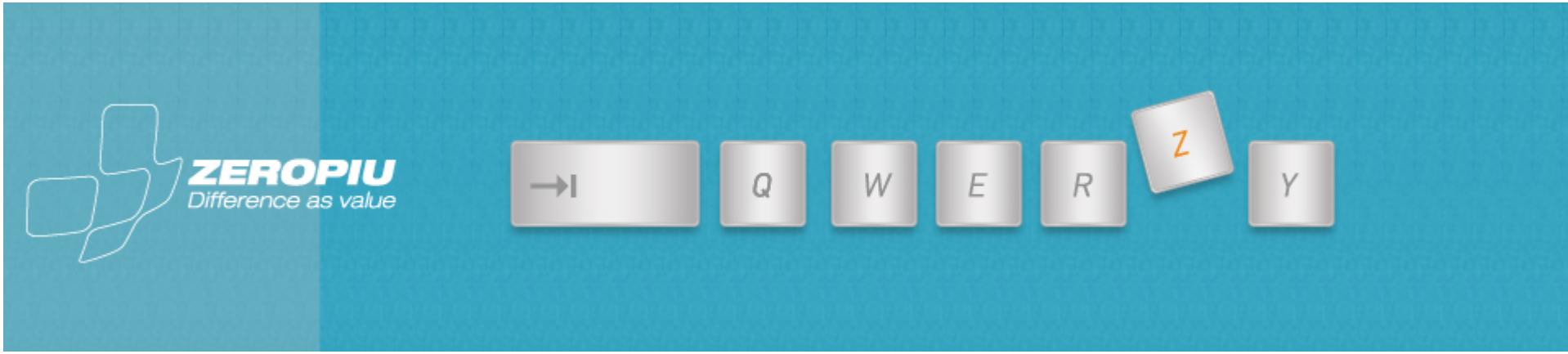
Roadmap

- **0.1 Released Today**
  - Single server on storage (No DHT)
  - S3 Interface
  - Federated Authentication
- **0.2 Release September (codename WorstFS)**
  - DHT on storage
  - Storage Encryption and compression
  - FUSE
- **0.3 Release TBD (codename WorstFS++)**
  - Deduplication
  - pub/sub
  - ACL
  - …
- **Next**

Clone function, Versioning, Disconnected operation, Logging, Locks, Dlocks, Mount Bucket in Bucket, Bucket automate provisioning, Distribution algorithms, Load balancing, samba module, more async i/o, block replication control, negative cache, index, user defined index

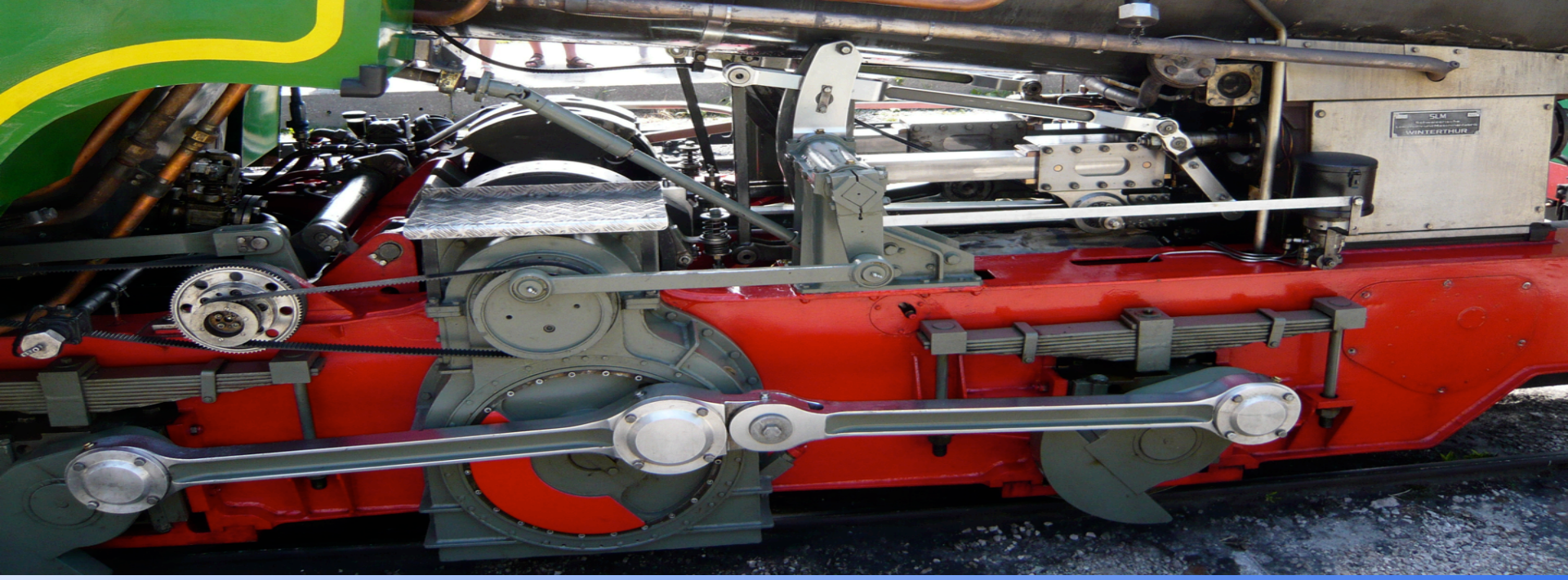
Thanks

Thanks to Zeropiu for the support



Code, ideas, testing, insults **… everything**

25./26. August 2012
Sankt Augustin
Cologne DE
www.froscon.de



Thank you

http://restfs.beolink.org

manfred.furuholmen@gmail.com
fege85@gmail.com

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