Highly Available Distributed Configuration Stores

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Agenda

1. Motivation

Why not just plain old configuration files?

Reasons

- Scenario: Services start & stop often
  - ▷ Hostnames in our configuration have to be changed frequently & clients have to pull often

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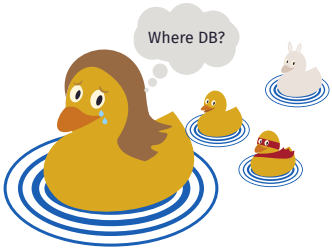
Solution: Configuration Store with monitoring ⇒ changes can be pushed to clients

Use Cases

For Highly Available Distributed Configuration Stores

- Service Discovery
- Configuration of Applications
- (Node Coordination)



2. Consul

2.1 Overview

General

- Developed by *Hashicorp*
- Released in 2014 as a Service Discovery Platform
- Implemented in *Go*
- Now: Service-To-Service encryption, Health Checks, KV Store, ...
- Leader-based replication with Raft

Communication Types

Raft Protocol (Consensus)

Surf Protocol (Gossip)

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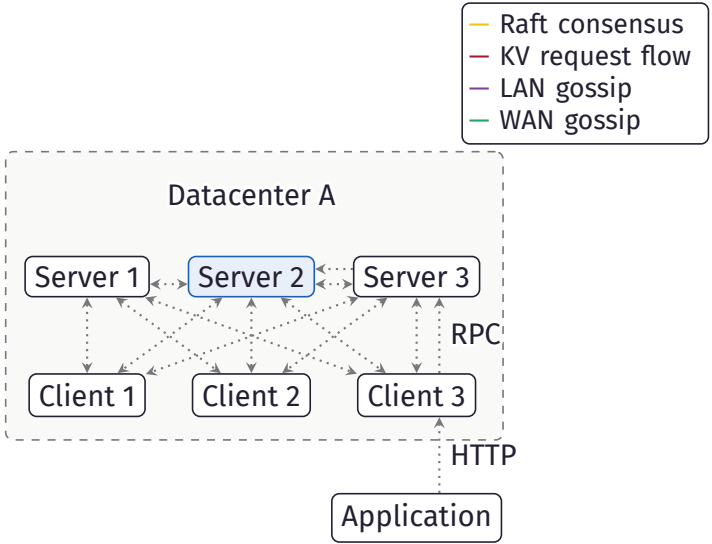
Surf Protocol (Gossip)

- Perform and distribute *service health checks*
- Examples for health checks: via HTTP GET Request, gRPC, TCP, UDP

Architecture



Based on [Has23, Consul Architecture]

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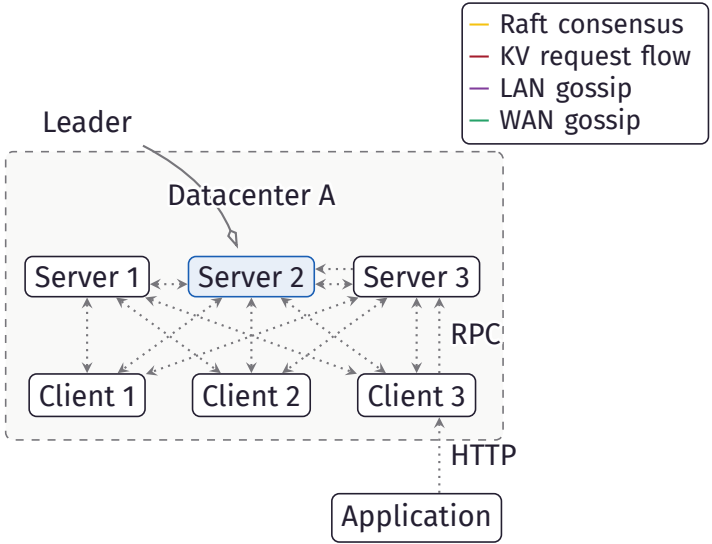

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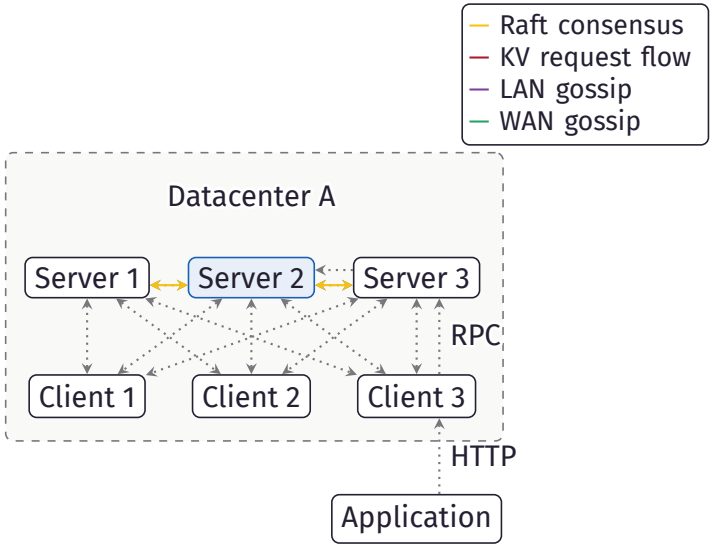

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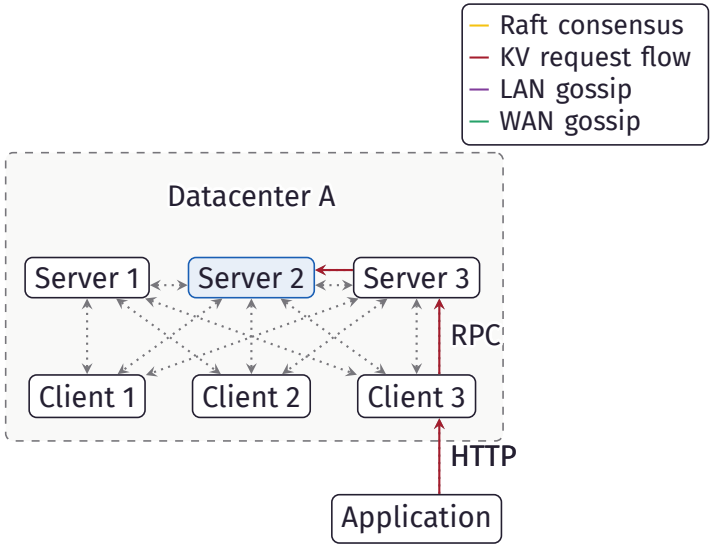

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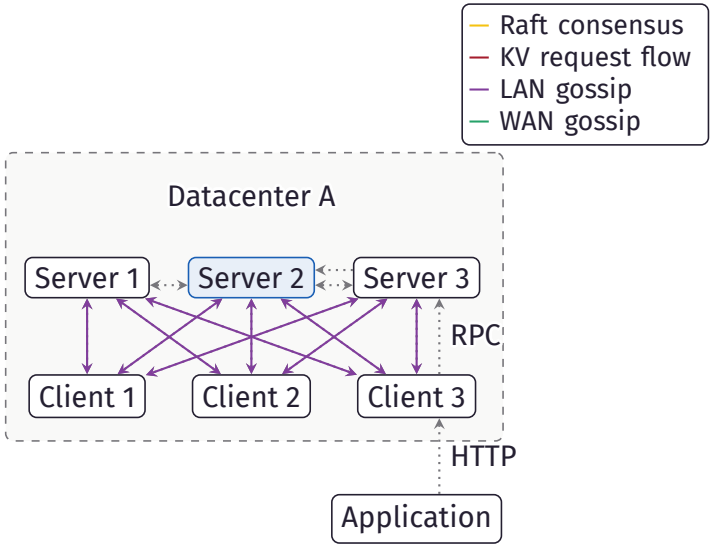

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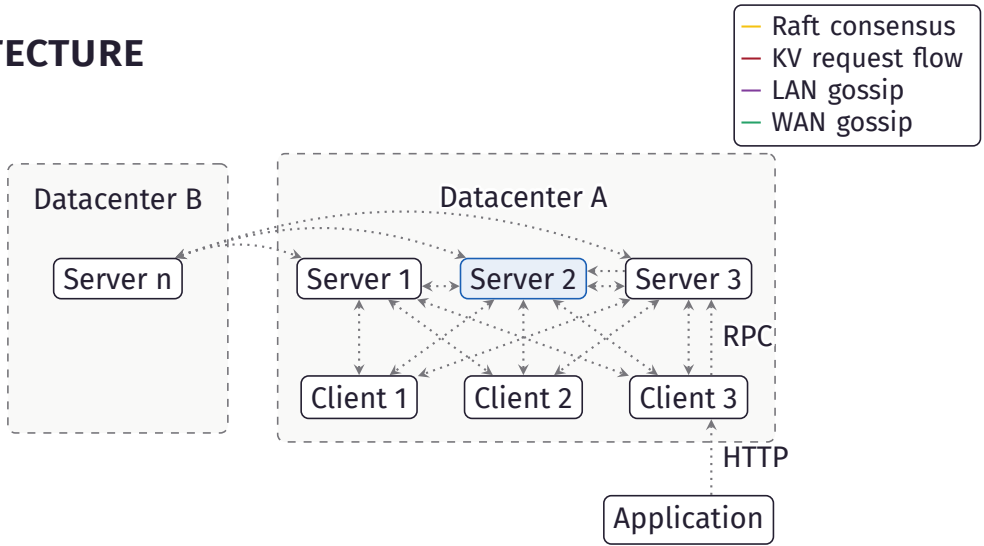

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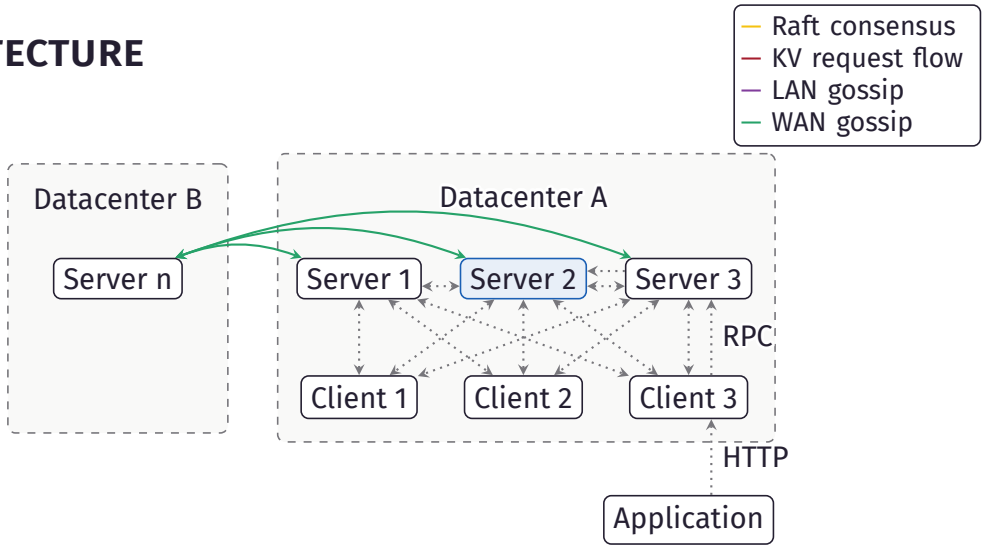

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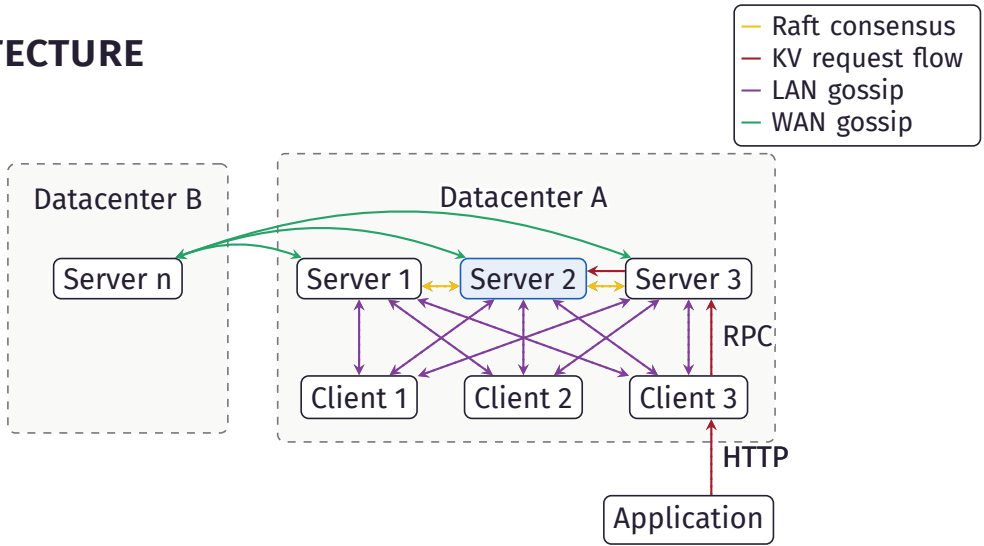

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Consistency
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(However: risk of 2 concurrent leaders $\Rightarrow$ stale reads)

consistent leader has to verify its role before responding

stale any server agent (leader & follower) can respond

2.2 Usage

CLI AGENT
for KV store

```
$ consul agent -dev

# other shell:
$ consul kv put my/key 123
$ consul kv get my/key
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KV Store

- For configuration, locks, metadata, ...

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KV Store

- For configuration, locks, metadata, ...
- Max value size of 512 KB
- Requests to KV store via CLI or HTTP API

Long Polling

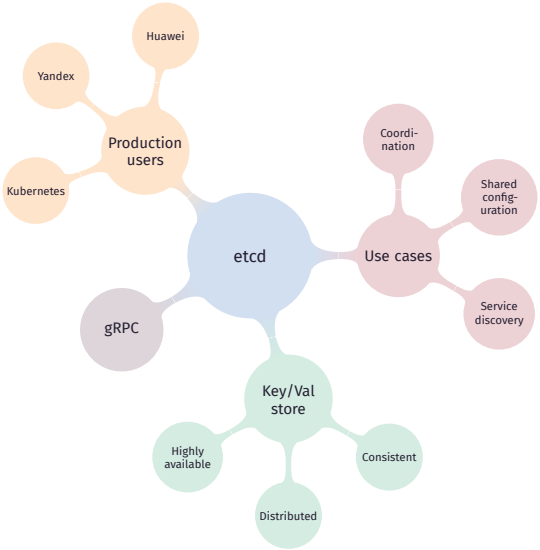
```
$ curl -v http://localhost:8500/v1/kv/my/key
# ...
< X-Consul-Index: 19
# ...

$ curl -v http://localhost:8500/v1/kv/my/key?index=19
# blocks until value is changed or timeout is reached
# (max. 10 minutes)
```

3. ETCD

3.1 Overview

Overview


Huawei
Yandex
Production users
Kubernetes
etcd
Coordi-nation
Shared config-uration
Use cases
Service discovery
gRPC
Key/Val store
Highly available
Consistent
Distributed

History

1. First commit 2013 by CoreOS
2. 2014 etcd V0.2 - Kubernetes V0.4
3. 2015 First Stable Release of V2.0
   - includes Raft
4. 2018 CNCF (**C**loud **N**ative **C**omputing **F**oundation) Incubation
5. 2019 etcd V3.4
6. 2021 etcd V3.5

3.2 Architecture

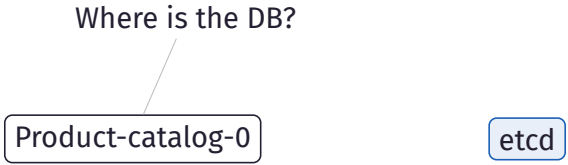
Architecture

- Operates across multiple nodes (cluster)
- Employs Raft algorithm
- Leader election if current leader crashes
- ▷ high availability, consistency, distribution

3.3 Use cases

Service discovery

Service discovery



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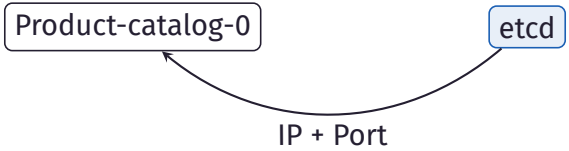

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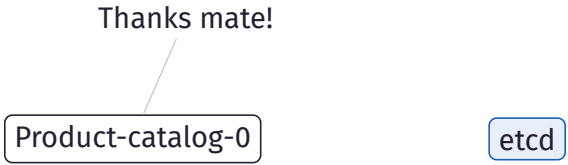
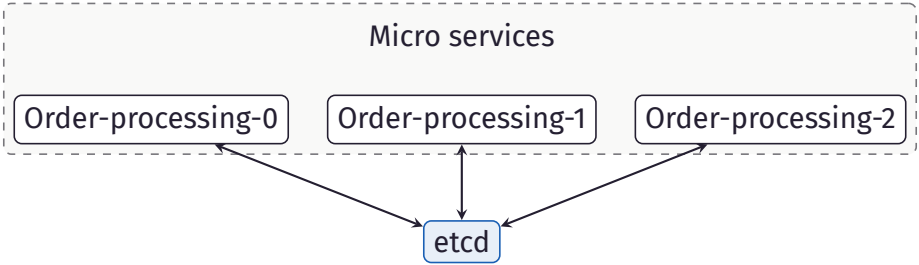


Distributed coordination



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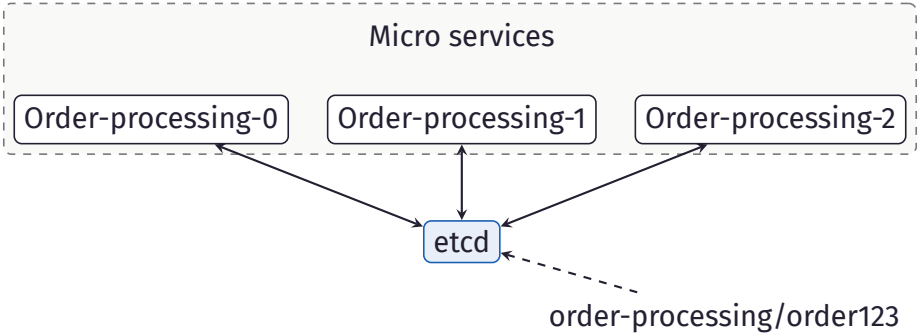

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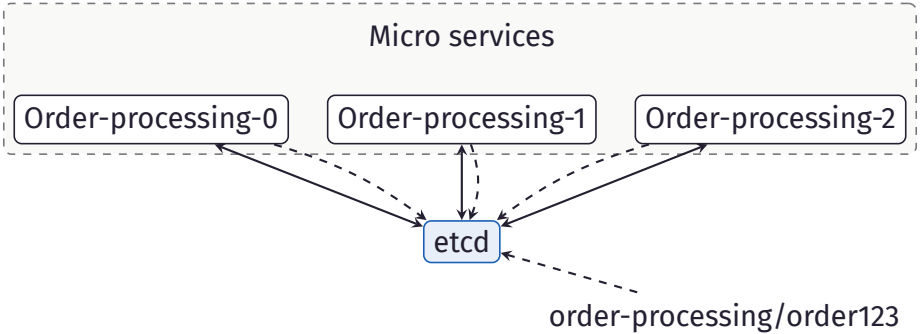

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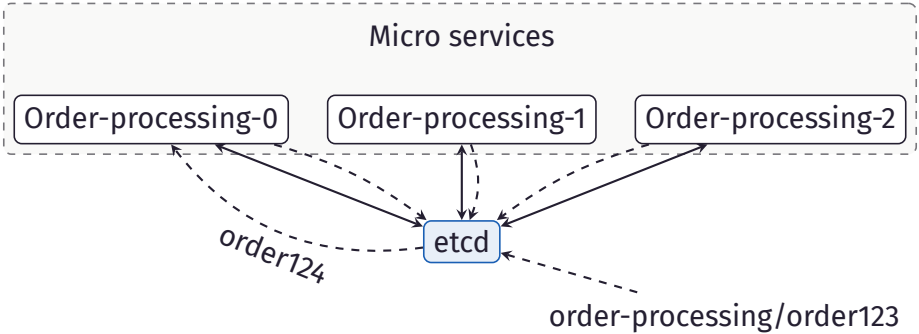
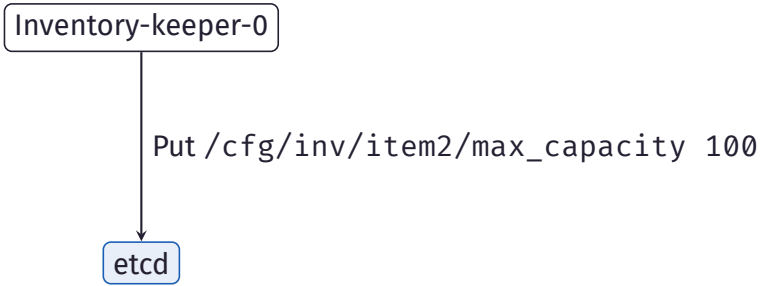


Configuration management



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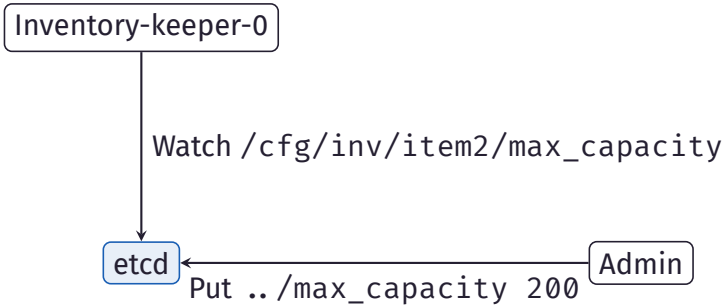

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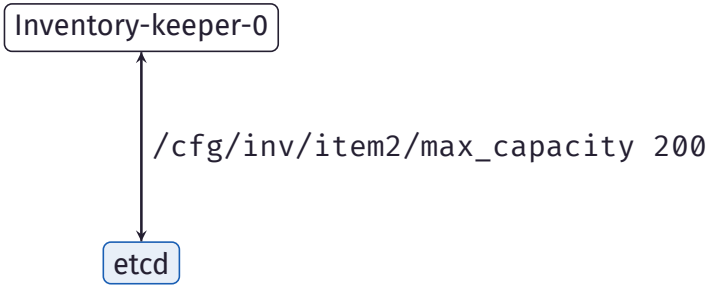


4. ZooKeeper

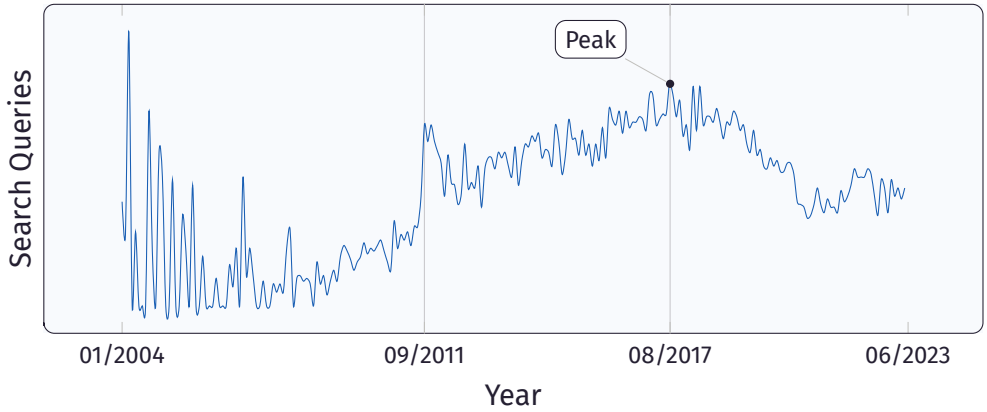
4.1 Overview

History

December 2006 First commit
November 2007 Version 0.0.1 on Sourceforge
June 2008 Moved to Apache
June 2010 First Paper [Hun+10]
November 2010 ZooKeeper becomes a top level project
Januar 2023 Version 3.8.1

Popularity

According to Google



What is ZooKeeper?

ZooKeeper is ...

... a (1) highly available, (2) scalable, (3) distributed, (4) configuration, (5) consensus, (6) group membership, (7) leader election, (8) naming, and (9) coordination service

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What is ZooKeeper again?

Use cases

Solve various coordination problems in large distributed system

- Leader election
- Barrier
- Queue
- Lock
- Service discovery
- Group services

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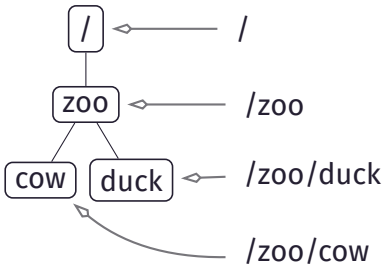
- Configuration Stores

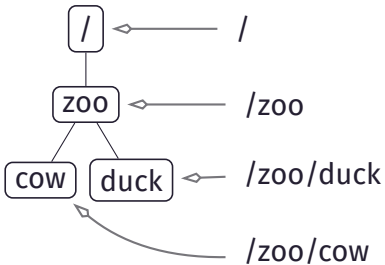
4.2 Data model

Data model



- File system nodes

Data model



- ~~File system nodes~~ Namespaces

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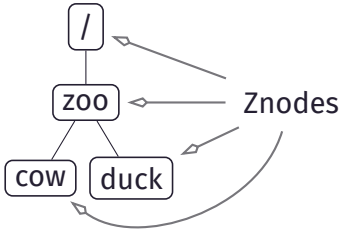

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- Three types of Znodes:
  - Persistent
  - Ephemeral
  - Sequential

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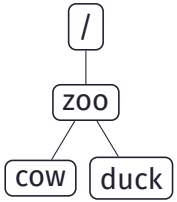

- ~~File system nodes~~ Namespaces
- Three types of Znodes:
  - Persistent
  - Ephemeral
  - Sequential
- Not designed to store arbitrary blobs

Operations

Znodes

- create
- delete
- exists
- getChildren

Operations

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Operations

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Data

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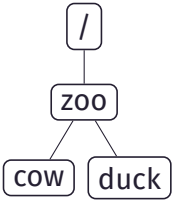
- getAcl
- setAcl
- sync

Watches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cow
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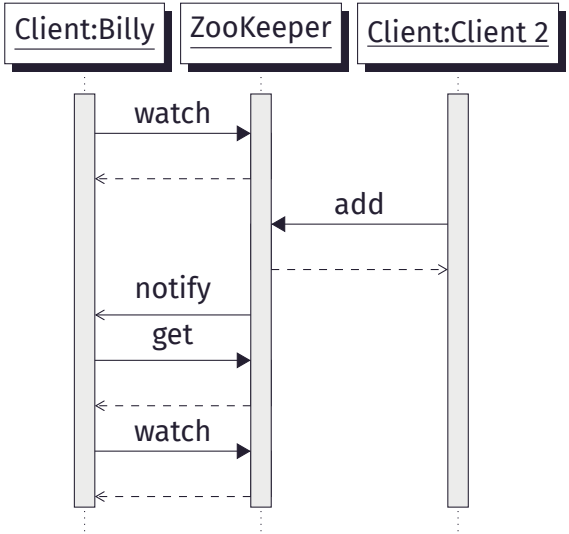
Client:Billy
ZooKeeper
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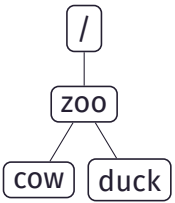
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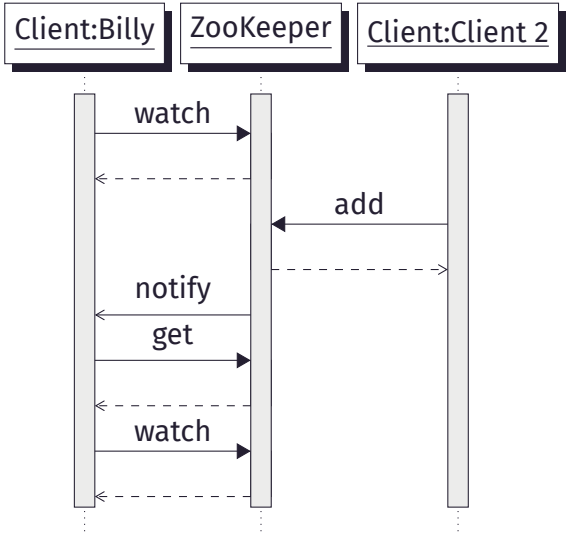
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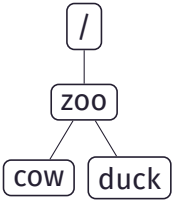
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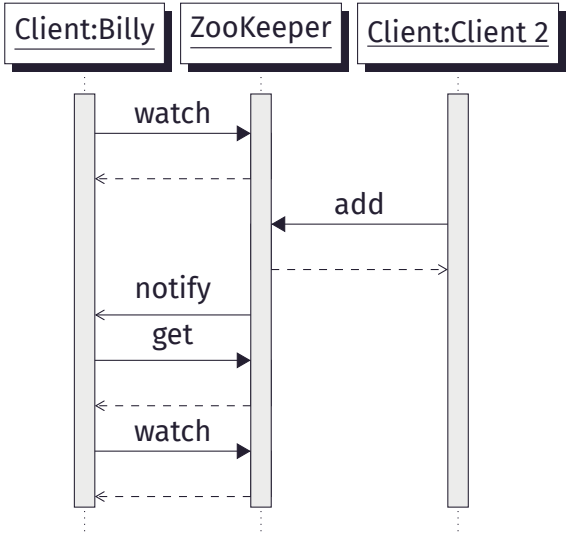
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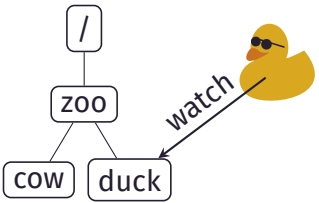
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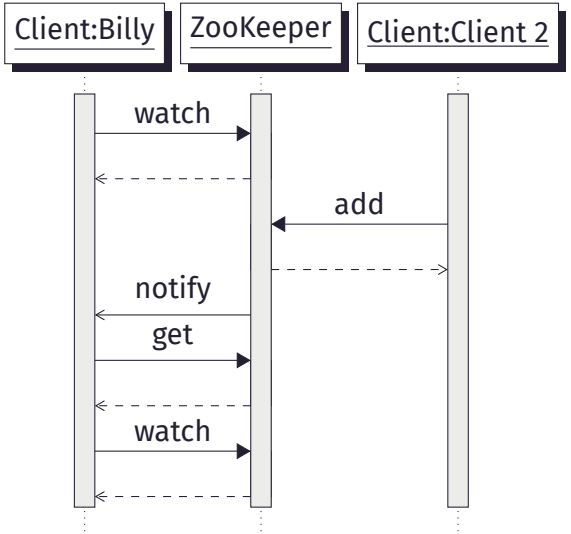
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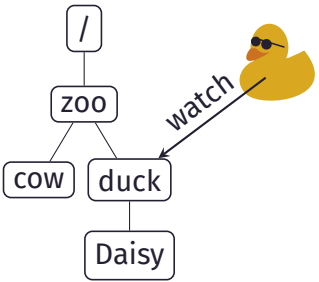
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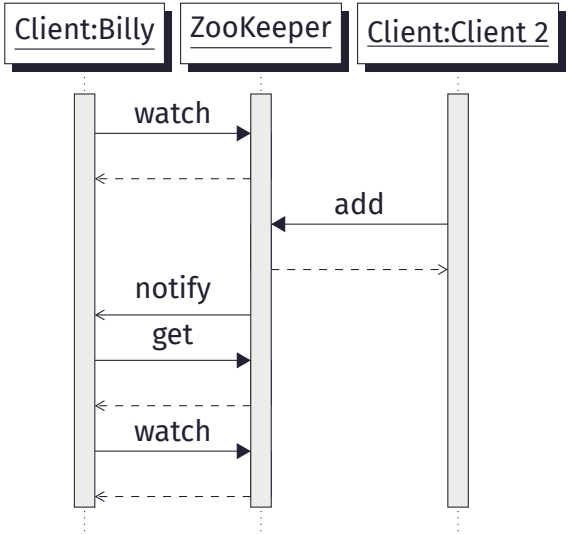
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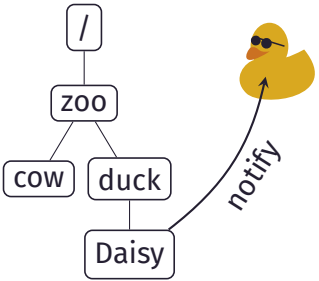
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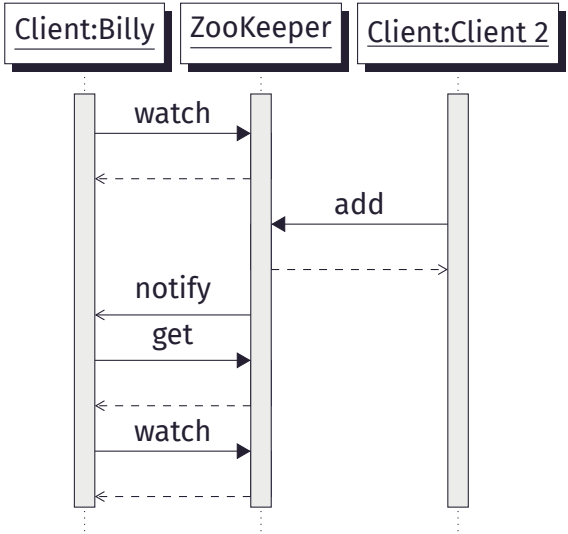
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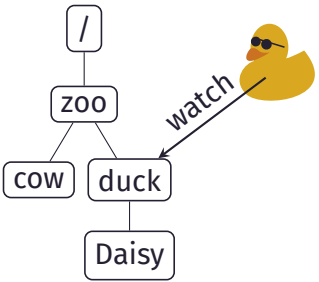
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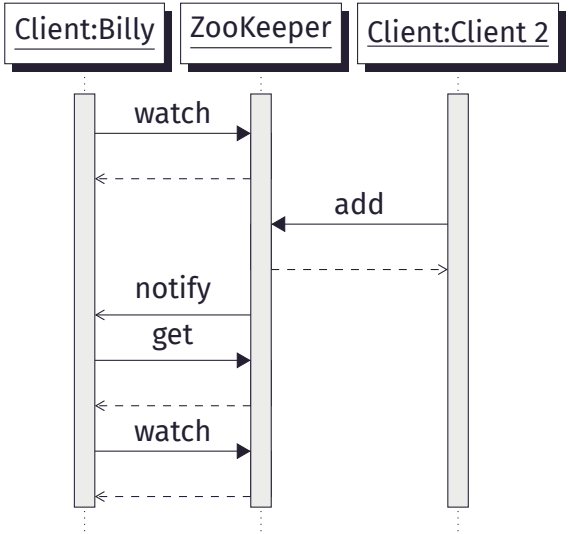
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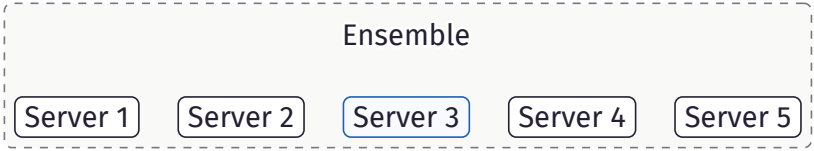

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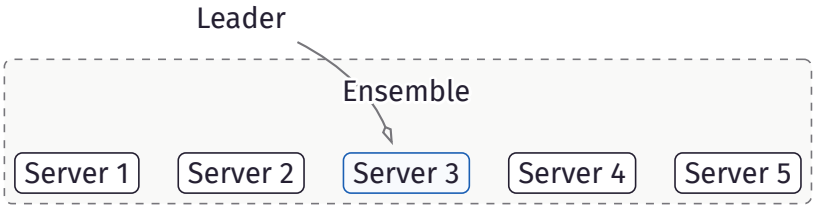
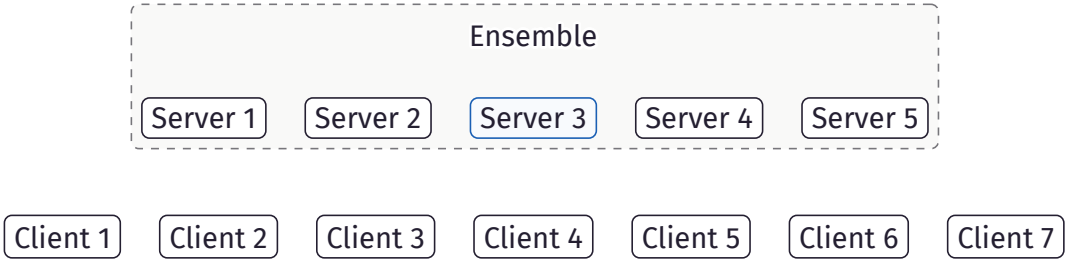


Architecture



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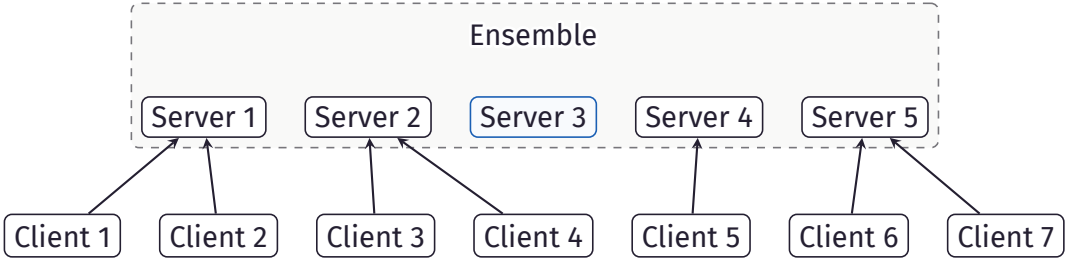

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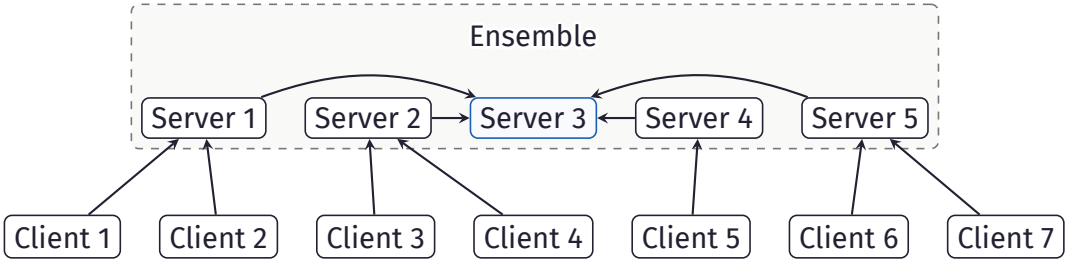
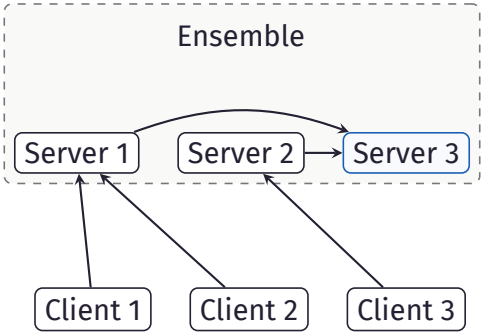


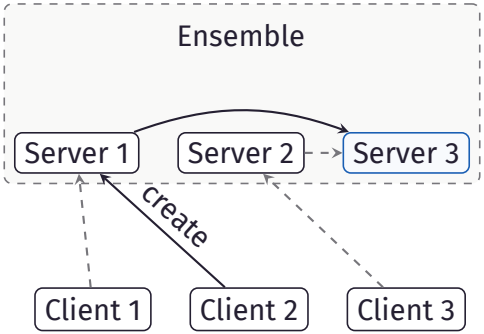
Architecture

An example



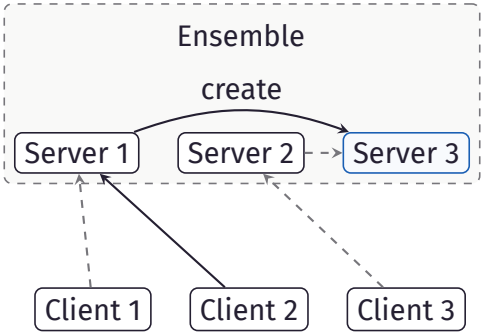
Architecture

An example



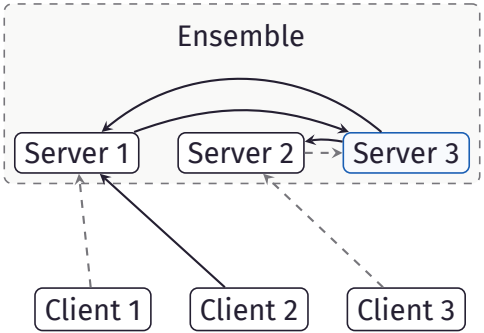
Architecture

An example



Architecture

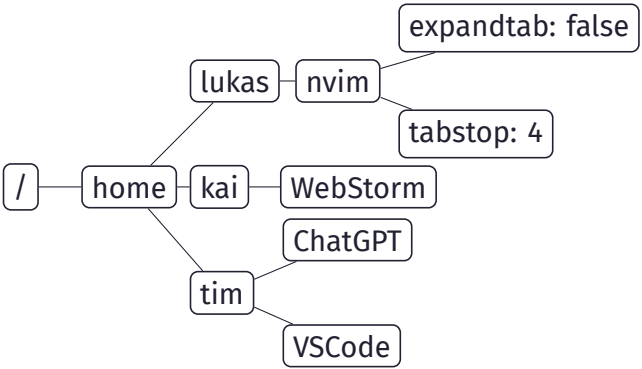
An example



4.4 Configuration management

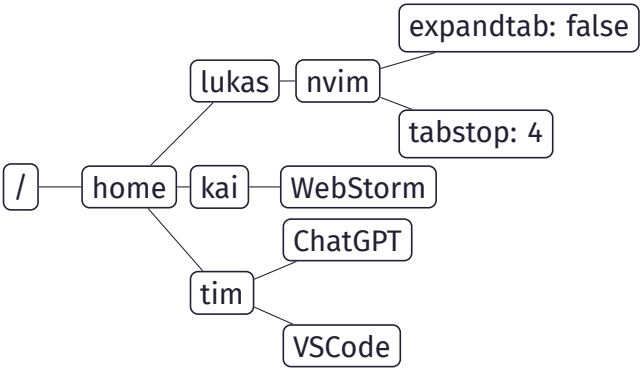
Workflow

Absolutely simplified



Workflow

Absolutely simplified

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set noexpandtab
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5. Summary

Take-home message

- If you need *all inclusive* service discovery framework: Consul
- If you need a fast distributed key-value store: etcd
- If you like legacy systems: ZooKeeper

6. References

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Ulm, 07/26/2023