Service Management

Exploring Options

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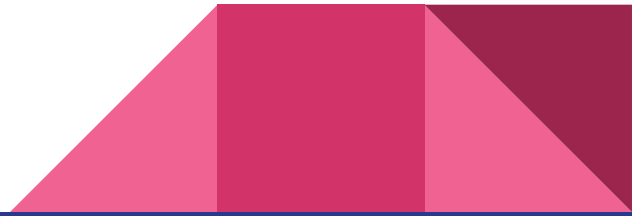
Service Discovery & Communication

Vanderbilt's CS-6381 - Distributed Systems Principles class focused on concepts governing large, interconnected systems.

In the programming assignments, students saw that managing multiple services at scale can be difficult.

- Where do services go to find other critical services?
- Which services are active in the network?
- Are all instances of a service healthy and alive?



Service Management Options

There are many approaches to handling Service Management. Some teams and projects want flexibility to build a solution that meets specific needs. Others are okay with an opinionated Service Management solution that allows for focusing more on the core product.

Building-Blocks

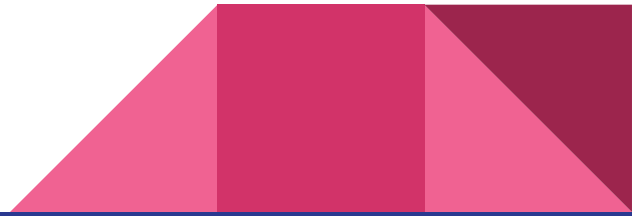
- Apache Zookeeper
- CNCF etcd

Out-of-Box Solutions

- Hashicorp Consul
- Traefik

Evaluation Criteria

- Architecture
- Key features
- Limitations
- Ecosystem (activity, roadmap, collaboration)
- Pricing models and unique offerings
- Analytics



Zookeeper

Serving as a baseline for other experimentation, Zookeeper provides a starting point to begin comparing other offerings on multiple fronts.

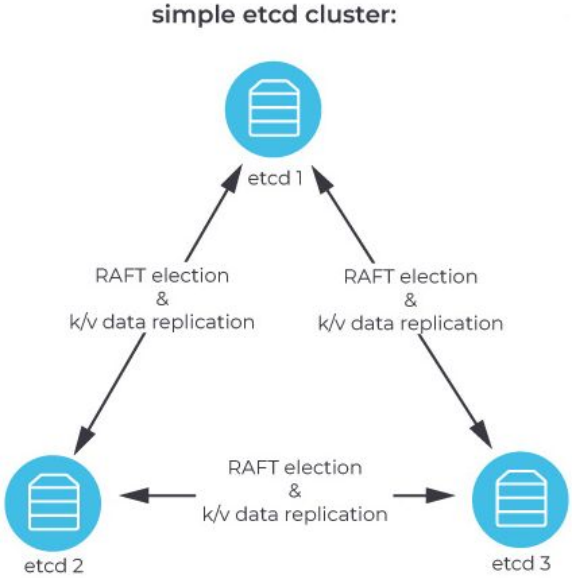
What is etcd?

- etcd is an open source distributed key-value store used to hold and manage the critical information for distributed systems including state data, configuration data, and metadata.
- Famous for adoption as a core component of Kubernetes.
- The name “etcd” originated from two ideas, the unix “/etc” folder and “d"istributed systems. The “/etc” folder is a place to store configuration data for a single system whereas etcd stores configuration information for large scale distributed systems. Hence, a “d"istributed “/etc” is “etcd”.

Source: https://etcd.io/docs/v3.3/learning/why/

etcd Architecture

- Fully replicated
- Reliably consistent
- Highly available
- Fast
- Secure
- Simple



Sources: https://www.ibm.com/topics/etcd
https://www.cybertec-postgresql.com/en/introduction-and-how-to-etcd-clusters-for-patroni/

etcd Key Features

- Raft consensus algorithm
- Distributed key-value store
- Leader election, heartbeat mech.
- Distributed lock mechanism
- Log replication using WAL
- TTL-based expirations
- Load balancing
- Atomic transactions
- Multi-datacenter support
- Barrier synchronization
- REST API
- Watch mechanism
- Transport Layer Security (TLS)

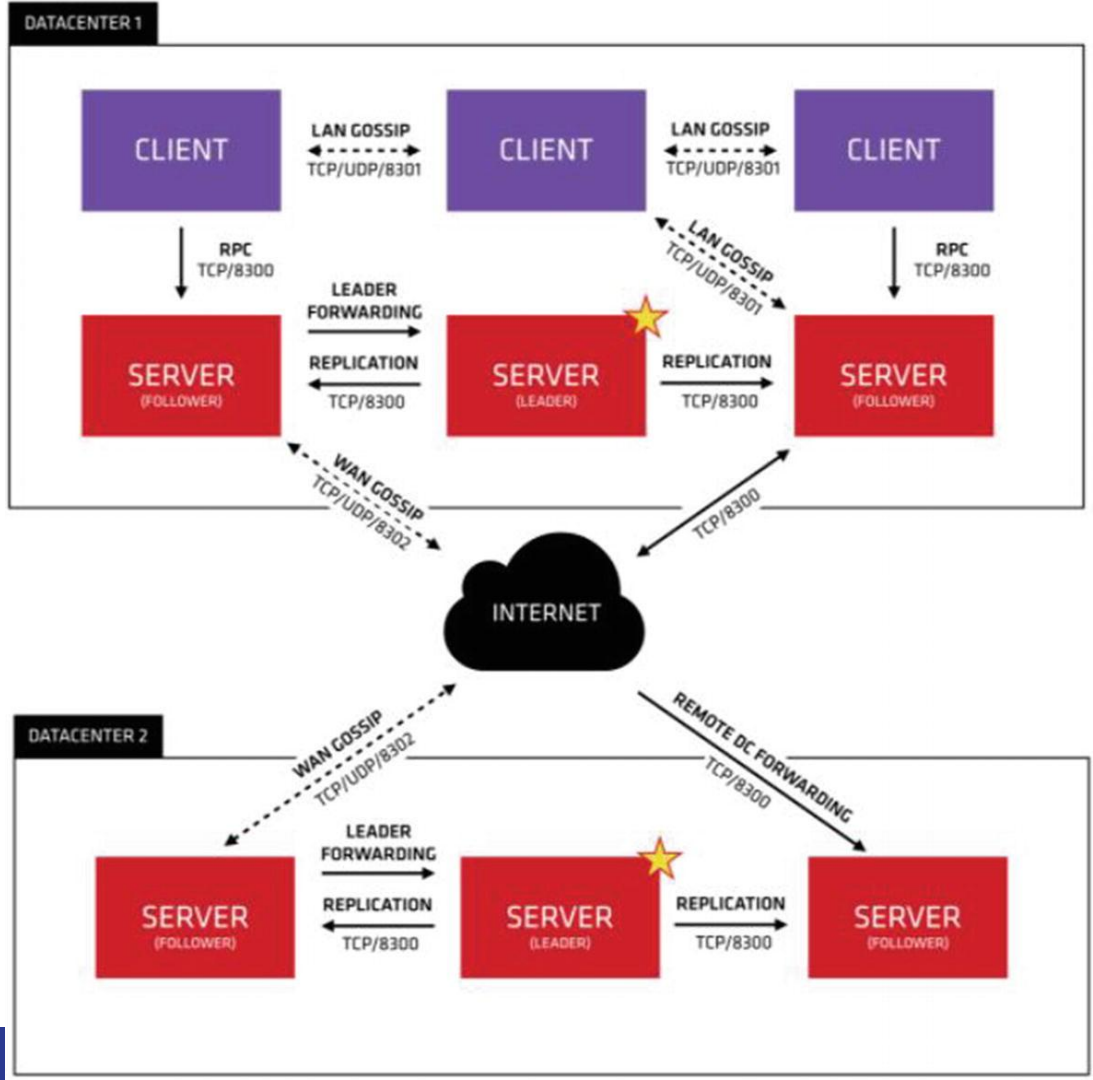
Sources: https://etcd.io/docs/v3.5/learning/

HashiCorp Consul

- HashiCorp Consul is a service networking platform that provides a service mesh, service discovery, configuration management, segmentation, and API gateway functionality across a distributed network infrastructure.
- Consul is platform agnostic
  - Support for K8, EKS, VMs, Lambda, Nomad, etc runtimes
  - Ability to run the control plane (maintains central registry / operational concerns) and data plane (handles communication) in different runtimes
- Consul increases resilience, security, and accelerates application deployment

Consul Architecture

- Datacenters
  - Minimum one server agent
- Cluster
  - collection of agents
- Agents
  - Server
    - Consensus (Raft algorithm) to Server Cluster
  - Client
    - Remote Procedure Calls (RPC) to interact with servers



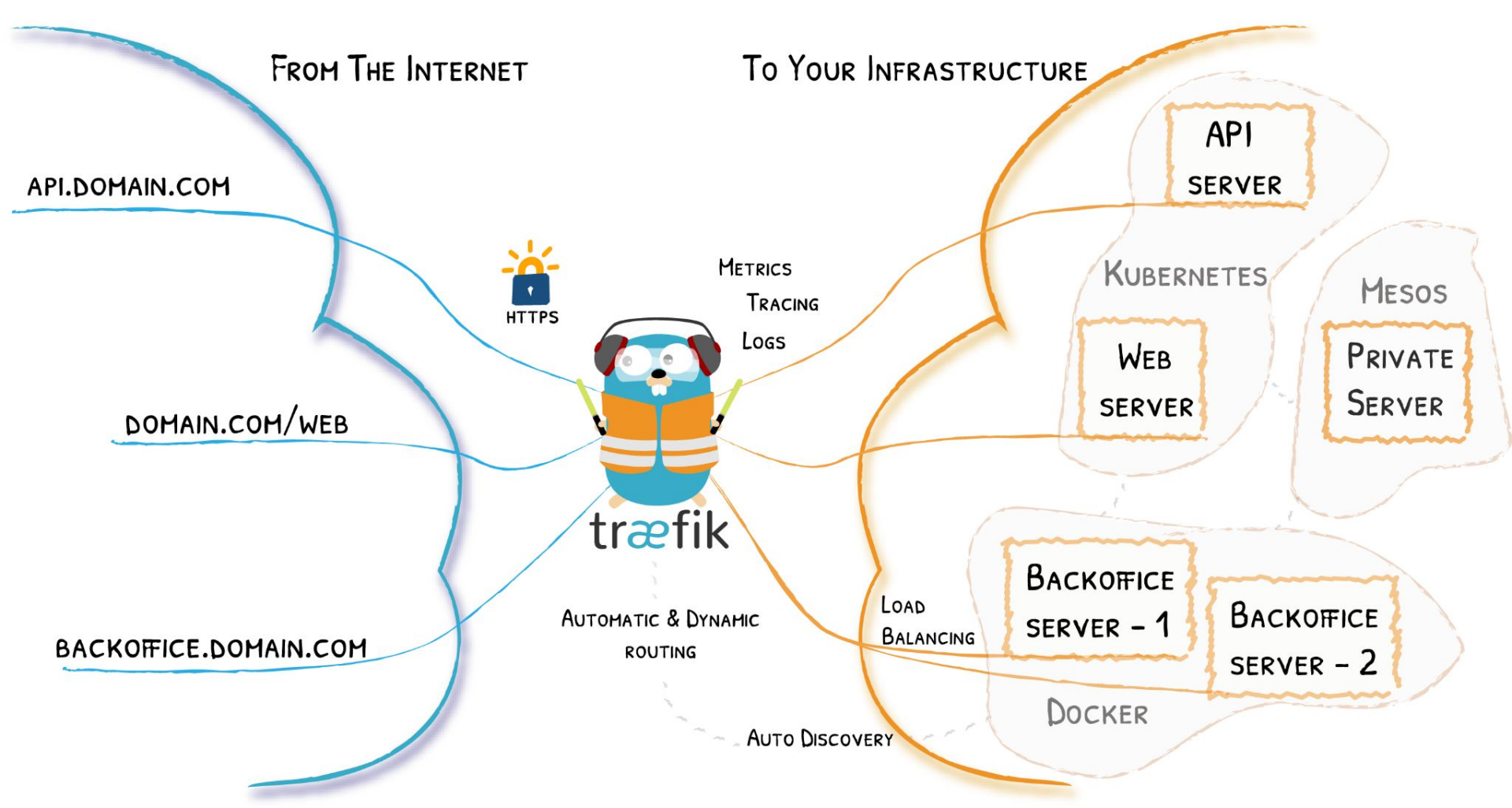
Consul Key Features

- Key/Value KV
- Health checks
- Load balancing
- Service Graphs
- Identity enforcement via TLS
- Network Segmentation
- Distributed service configuration management
- Multi-Datacenter support
- Platform Agnostic
- Observability and traceability
- Automatic failover

Traefik

Traefik (pronounced *traffic*) is a modern HTTP reverse proxy and load balancer that makes deploying microservices easy.

It sits on top of other cluster technologies and leverages them to dynamically configure paths and load balancing to defined services.


From The Internet
To Your Infrastructure
API.DOMAIN.COM
DOMAIN.COM/WEB
BACKOFFICE.DOMAIN.COM
HTTPS
Metrics
Tracing
Logs
træfik
Automatic & Dynamic routing
Load Balancing
Auto Discovery
API server
Kubernetes
Web server
Mesos
Private Server
Backoffice server - 1
Backoffice server - 2
Docker

Traefik Key Features

- Auto Service Discovery
- Dynamic Configuration
- Multi-Provider Support
- Certificate Issuing & Renewal (cert-manager integration)
- Robust Middleware Options (retries, circuit breakers, rate limits)
- Multiple Observability Sinks (Prometheus, Datadog, InfluxDB)

Property Comparison

Properties	Consul	Etcd	Zoo Keeper	Traefik
User Interface	Available			Available
RPC	Available	Available		
Health Check	HTTP API / TCP	HTTP API / TCP	HTTP API / TCP	HTTP API / TCP
Key Value	3 Consistency modes	Good Consistency	Strong Consistency	Strong Consistency
Token System	Available			Available
Language	Golang	Golang	Java	Golang

Additional Information

etcd vs Zookeeper

- Dynamic cluster membership reconfiguration
- Stable read/write under high load
- A multi-version concurrency control (MVCC) data model
- Reliable key monitoring which never silently drop events
- Lease primitives decoupling connections from sessions
- APIs for safe distributed shared locks

Sources: https://etcd.io/docs/v3.3/learning/why/

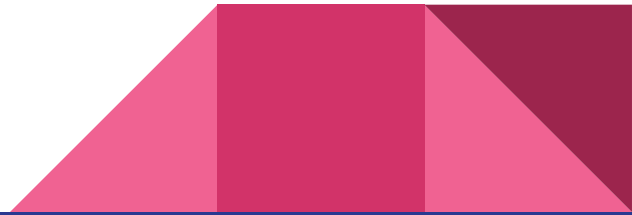
Research Papers

Reverse Proxy and Load Balancers Comparison - 2022
(traefik, nginx, HAProxy, Envoy)
https://www.diva-portal.org/smash/get/diva2:1678660/FULLTEXT01.pdf

Evaluation of key-value stores for Distributed Locking Purposes - 2019
(Zookeeper, Consul, Etcd)
https://link-springer-com.proxy.library.vanderbilt.edu/chapter/10.1007/978-3-030-19093-4_6

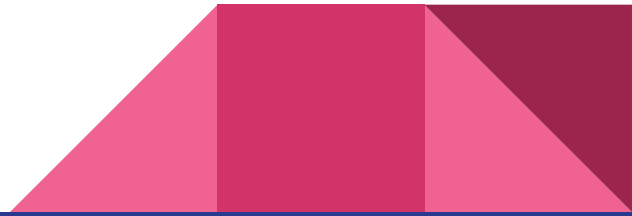
Distributed database benchmark tester: etcd, Zookeeper, Consul - 2020

https://github.com/etcd-io/dbtester/tree/master/test-results/2018Q1-02-etcd-zookeeper-consul



Consul Pricing Models

- Free open source option
- 5 Tier pricing options
  - HCP Development $0.027/hr (non-production)
  - HCP Standard $0.069/hr
  - HCP Plus $0.104/hr
  - HCP Premium custom
  - Enterprise custom



etcd Pricing Models

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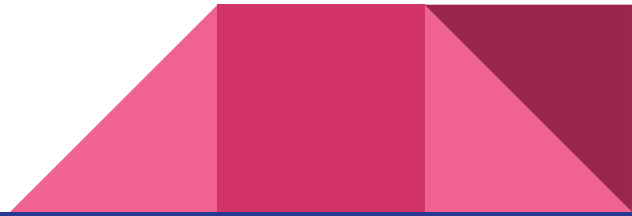
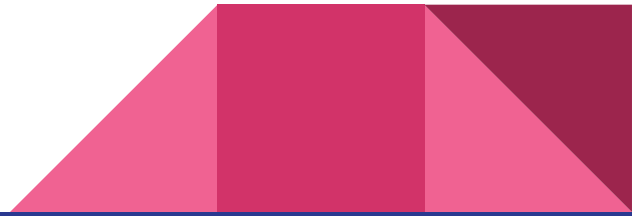


Traefik Pricing Models

- Free open source option
- SaaS offering for enterprise
  - Free 30-day Trial
  - Contact for pricing quotes
  - ~$20k per cluster annually



etcd3

- **Performance and Scalability**: Etcd3 has been optimized for high performance and scalability, with support for millions of keys and transactions per second.
- **New API and Language Bindings**: Etcd3 provides a more flexible and user-friendly API, with support for multiple language bindings and improved support for RESTful APIs.
- **Better Security and Authentication**: Etcd3 includes support for transport layer security (TLS) and mutual authentication, as well as improved authentication and authorization mechanisms.
- **Improved Clustering and High Availability**: Etcd3 includes improved clustering and high availability features, with better handling of node failures and automatic leader election.
- **Better Integration with Kubernetes**: Etcd3 is the recommended key-value store for use with Kubernetes, with improved integration and support for Kubernetes APIs and tooling.