Implementing distributed systems with

HashiCorp
Consul

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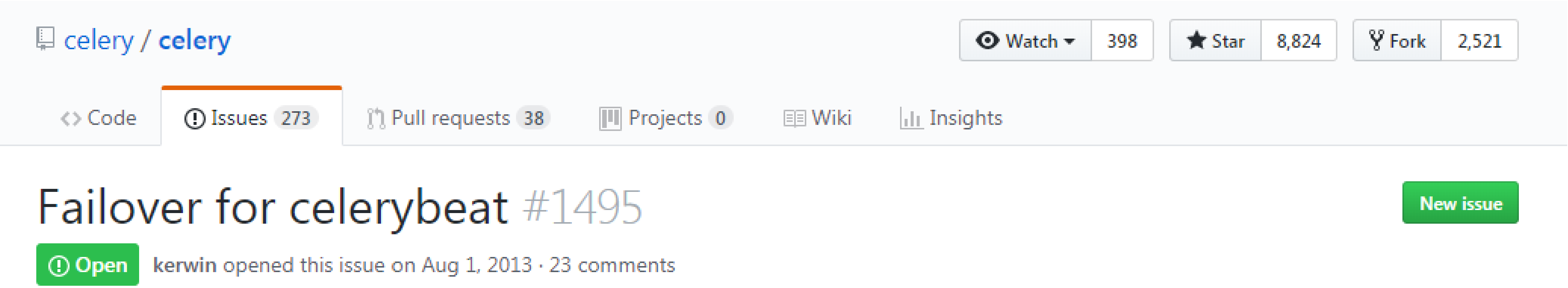
Distributed systems

- Programming distributed systems is **hard**
- Challenges [1]:
  - Service access and configuration
  - Event handling
  - Concurrency
  - Synchronization
- Single point of failure problem
- Split brain problem
- CAP theorem

[1] D. Schmidt, M. Stahl, H. Rohnert, F. Buschmann: *Pattern-Oriented Software Architecture vol. 2*, John Wiley Sons, 2000

Failover Celery Beat

- **celery beat** is a scheduler; It kicks off tasks at regular intervals, that are then executed by available worker nodes in the cluster.



Failover for celerybeat #1495

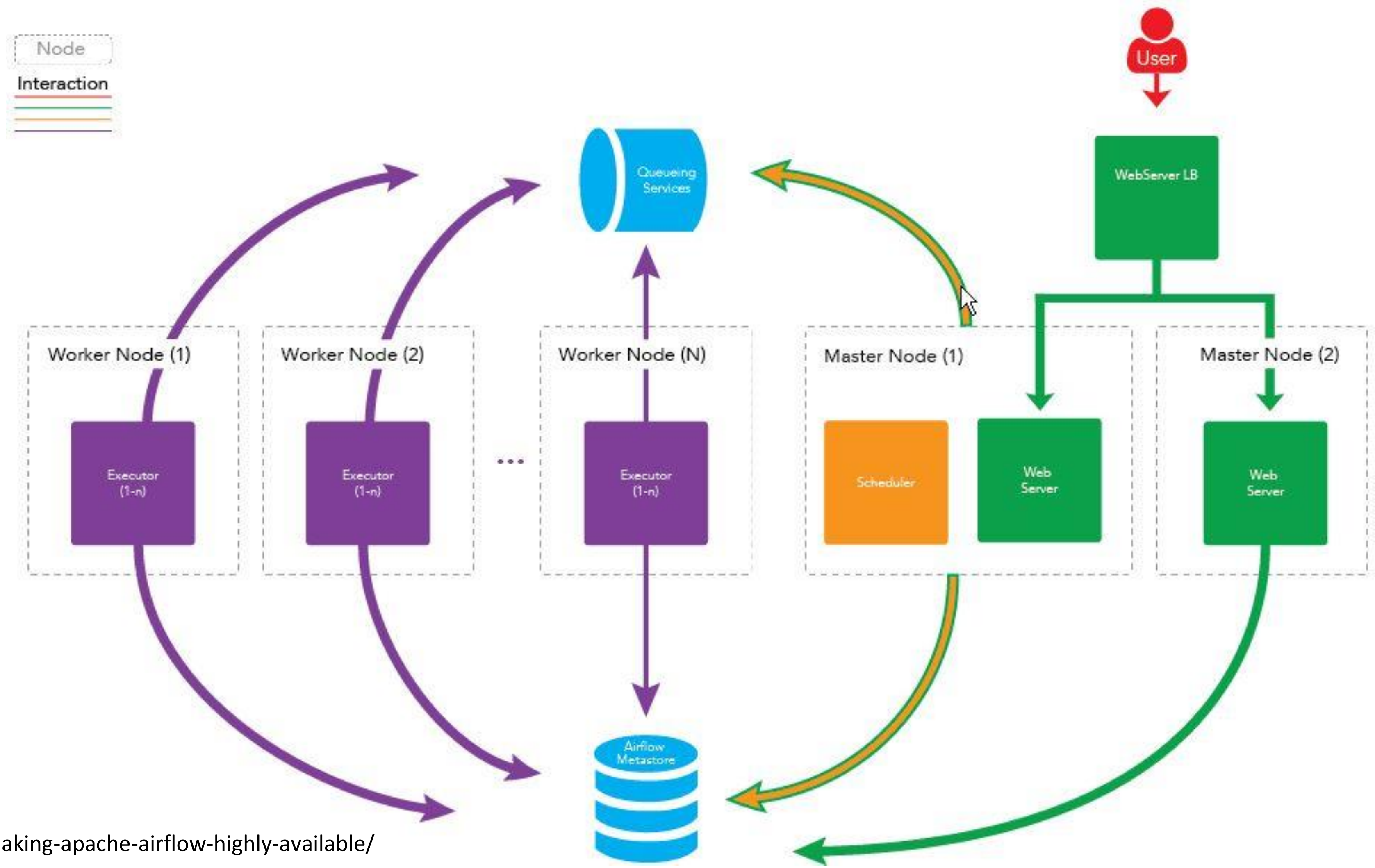
kerwin opened this issue on Aug 1, 2013 · 23 comments

Highly Available Airflow

- Airflow is a platform to programmatically author, schedule and monitor workflows.
- Workflows are Directed acyclic graphs (DAGs) of tasks
- Scheduler executes tasks on an array of workers while following the specified dependencies.
- Currently, Airflow has single point of failure – Scheduler [1]
- Multiple attempts exists for solving this issue including home-brew solutions [2]

[1] http://site.clairvoyantsoft.com/making-apache-airflow-highly-available/
[2] https://github.com/teamclairvoyant/airflow-scheduler-failover-controller

Highly Available Airflow



http://site.clairvoyantsoft.com/making-apache-airflow-highly-available/

Why Consul?

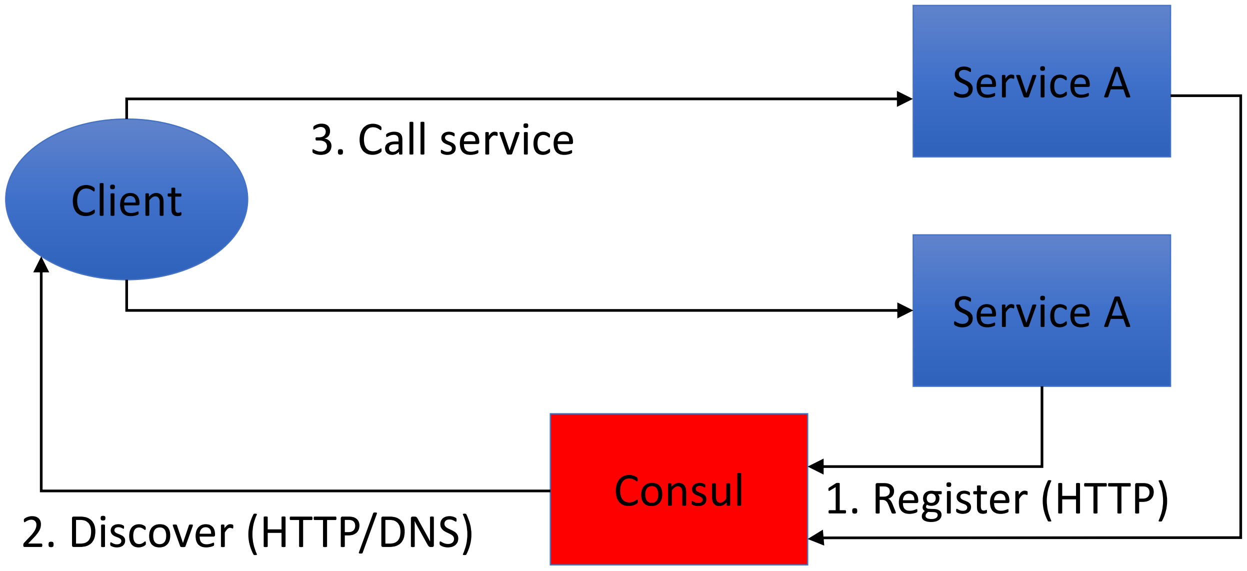
- **Consul is clustered and highly available.**
- **Consul enables easy development of distributed and highly available systems.**
- Consul makes it simple for services to register themselves and to discover this services via a DNS or HTTP interface.
- Pairing service discovery with health checking prevents routing requests to unhealthy hosts and enables services to easily provide circuit breakers.
- Consul scales to multiple datacenters out of the box with no complicated configuration. Look up services in other datacenters, or keep the request local.
- Flexible key/value store for dynamic configuration, feature flagging, coordination, leader election and more.

Consul Cluster

- Consul cluster consists from at least 3 nodes (supports 1 node failure)
- When higher failure tolerance is needed:
  - 5 nodes (supports 2 node failure)
  - 7 nodes (supports 3 node failure)
- When new cluster is created it needs to be bootstrapped:
  - each node is started in bootstrap mode using `-bootstrap-expect BNODES` parameter. `BNODES` is the initial number of nodes in cluster.
  - nodes are joined together using `consul join` command
- consul supports special single node DEV mode for developing purposes.

Service Discovery

- Useful for scalable distributed system, where new nodes needs to be discovered automatically.
- Distributed component can register at startup and from that point is visible



- Service Registration

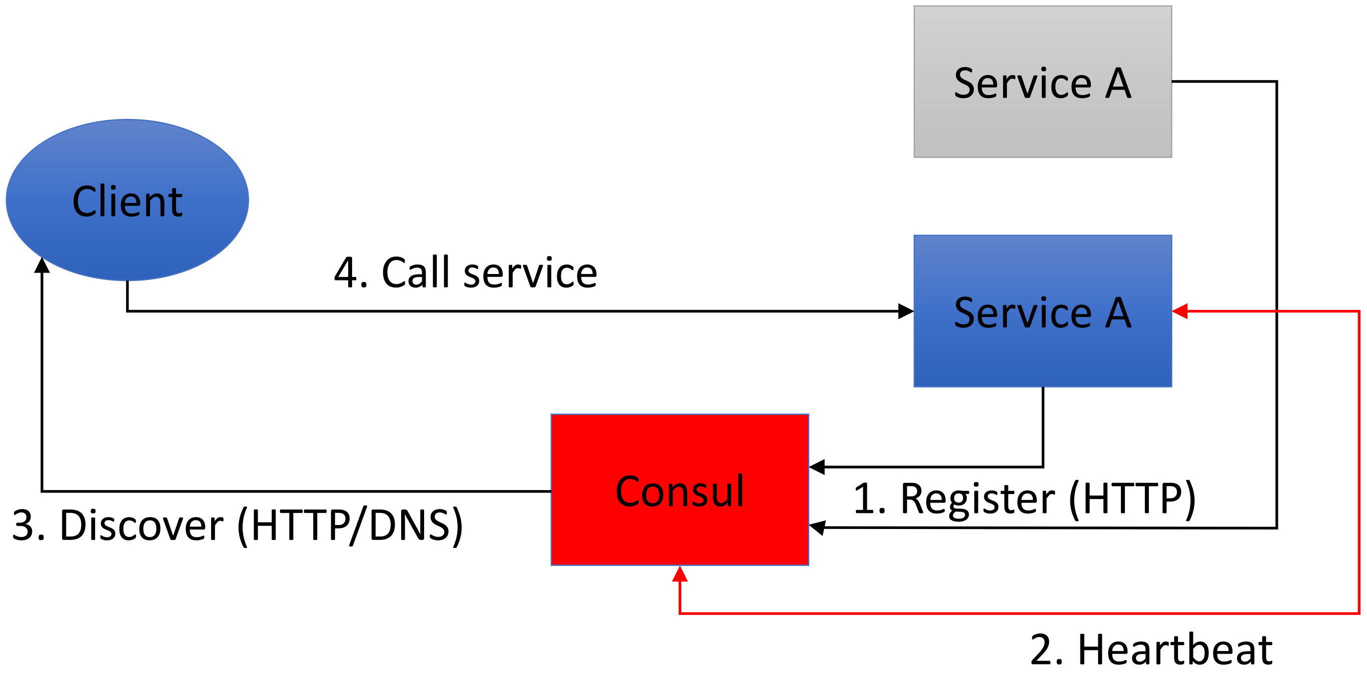
```
$ cat servicea.json
{
  "ID": "servicea1",
  "Name": "serviceA",
  "Tags": ["primary", "v1"],
  "Address": "servicea.example.com",
  "Port": 8000
}
$ curl -X PUT -d @servicea.json localhost:8500/v1/agent/service/register
```

- Service discovery (DNS Interface)

```
$ dig -p 8600 servicea.service.consul @t3dredis01
/// OUTPUT OMMITED
;; ANSWER SECTION:
servicea.service.consul. 0      IN      CNAME   servicea.example.com.
/// OUTPUT OMMITED
$ dig -p 8600 servicea.service.consul @t3dredis01 SRV
```

Health check

- Service can ask consul to track availability of service using heartbeat (HB)
- Multiple ways of HB are supported: HTTP, raw TCP/IP, Custom Script, Docker container check



- Service registration

```
$ cat servicea.json
{
  "ID": "servicea1",
  "Name": "serviceA",
  "Tags": ["primary", "v1"],
  "Address": "servicea.example.com",
  "Port": 8000,
  "Check": {
    "DeregisterCriticalServiceAfter": "90m",
    "HTTP": "http://servicea.example.com:5000/health",
    "Interval": "10s"
  }
}
$ curl -X PUT -d @servicea.json localhost:8500/v1/agent/service/register
```

- Service discovery (HTTP interface)

```
$ curl localhost:8500/v1/health/service/servicea?passing=true
```

```
[
    {
        "Node": {
            "ID": "3114d0f7-ff8b-fcc9-a8b8-82fde8cc6a4f",
            "Node": "mynode.example.com",
            "Address": "192.168.10.10",
            "Datacenter": "dc1",
            /// OUTPUT OMMITED
        },
        "Service": {
            "ID": "servicea1",
            "Service": "serviceA",
            "Tags": ["primary", "v1"],
            "Address": "servicea.example.com",
            "Port": 8000,
            /// OUTPUT OMMITED
        },
        "Checks": [ /// OUTPUT OMMITED ]
    }
]
```

K/V Storage

- Consul provides Key/Value Storage which is distributed and highly available.
- Any data can be stored in form “`Key`”: “`Value`”
  - “`Value`” can store any JSON value encoded as base64
- K/V Storage has CLI or HTTP API (easy to use)
- Consul also provides additional functionality:
  - transactions – multiple operations on K/V storage with atomic execution.
  - atomic key updates using a Check-And-Set operation

- Setting value to K/V storage

```
$ curl -X PUT -d '{"hello":"world"}' localhost:8500/v1/kv/hello
true
```

- Getting value from K/V storage

```
$ curl localhost:8500/v1/kv/hello
[
    {
        "LockIndex": 0,
        "Key": "hello",
        "Flags": 0,
        "Value": "eyJoZWxsbyI6IndvcmxkIn0=",
        "CreateIndex": 87,
        "ModifyIndex": 87
    }
]
```

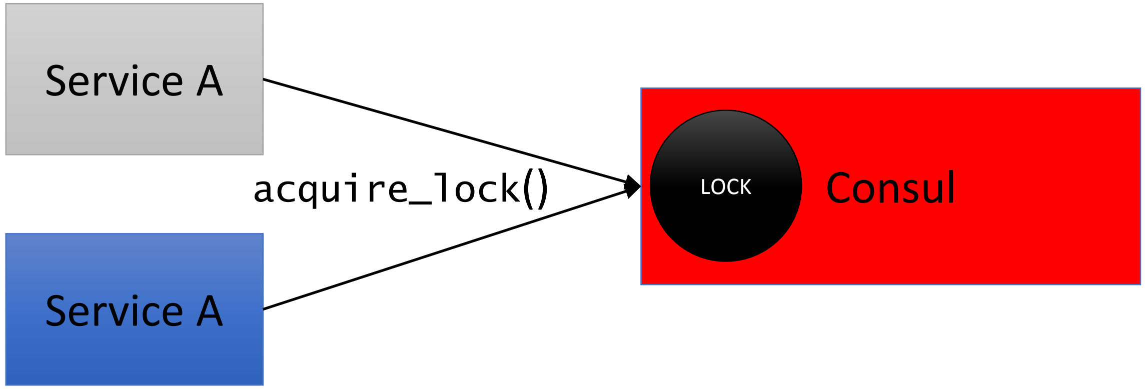
This is base64 value of json:
`{"hello":"world"}`

- Deleting value from K/V storage

```
$ curl -X DELETE localhost:8500/v1/kv/hello
true
```

Distributed locks

- Semantic of Consul locks is similar to the mutex (mutual exclusion) but can be used also as a semaphore
- Consul agent must be present on client
- To start process holding lock: `consul lock [options] <LOCK> <CMD>`
- This guarantee that only one single `<CMD>` is executed in cluster
- When `<CMD>` exists/crash the lock is automatically freed.



```
[Unit]
Description=Failover Service
After=consul.service
Requires=consul.service

[Service]
ExecStart=/usr/local/bin/consul lock -verbose <LOCK_NAME> <EXECUTABLE>
Restart=always
KillSignal=SIGQUIT
Type=simple
StandardError=syslog
NotifyAccess=all

[Install]
WantedBy=multi-user.target
```

Implementing failover Celery Beat

1. Implement custom scheduler with central storage
   e.g. DatabaseScheduler from django-celery-beat
2. Start celery beat on at least two nodes using consul distributed lock with custom scheduler

```
$ consul lock celery_beat_lock celery -A proj beat --scheduler
django_celery_beat.schedulers:DatabaseScheduler
```

Additional Consul features

- Access Control List (ACL) system
- Multi Datacenter
- Commercial support
- Watches and Events
- Web UI
- Libraries for multiple languages (python-consul)

Thank you