# Leveraging Docker and CoreOS

## to provide always available Cassandra at Instaclustr

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# Instaclustr

- Managed Apache Cassandra and DataStax Enterprise in the ☁️ (AWS, Azure, GCP, SoftLayer)
- Self-service dashboard — create, manage & monitor clusters
- Grew from a need for Cassandra in a project
  - No one on the market that offered what we wanted.
  - One service existed, but ran C* behind a HTTP/JSON API — *SLOW!*
  - Stopped the project, turned the ship around and sailed in a different direction

# Ubuntu — The Early Years

- Initially we ran a custom Ubuntu AMI (Amazon Machine Image)
- Based on stock Ubuntu AMI
- Custom cloud-init scripts — RAID disks, fetch config, etc.
- Cassandra installed with `apt-get install cassandra` / `dse`

# AWS

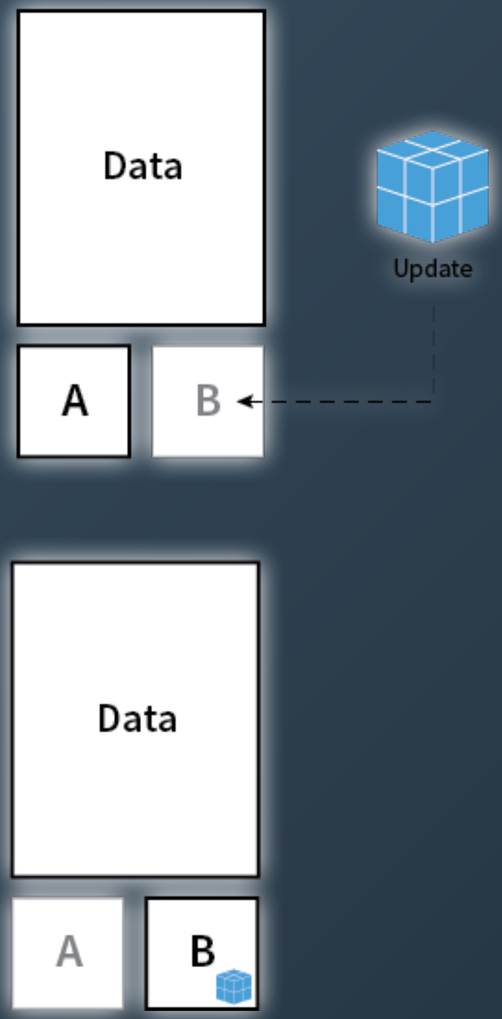
- We use *instance storage* backed AWS instances
  - Instance storage is *fast* (SSDs) and *low latency* (local disk) but is volatile — terminate the machine and it's gone!
  - The alternative, EBS (Elastic Block Storage) is basically SAN — slow, higher latency and shares instance network bandwidth
- Only way to change AMIs is to start a new machine
- Not possible to use *immutable images* with persistent ephemeral data
- Only feasible solution for updates is `apt-get install`

# CoreOS

- One of the first “Docker Operating Systems”
- Small and minimalist — not much userland (not even `man` — gah!)
- Other useful software — `etcd`, `fleet`, etc.
  (we currently don’t use them — but in the future)
- In-use by some big players (Rackspace, PlayStation, Instaclustr 😀)
- Recent funding from Google Ventures
- Available on GCP (Google Cloud Platform) — oddly, Ubuntu wasn’t (huh?)
- Runs `systemd` (vs. Ubuntu’s at-the-time upstart) & `dbus` — more on this later

# CoreOS cont'd

- CoreOS is responsible for building images for AWS, Azure, GCP, etc. — one less step in our build process
- In-place updates and rollback on failure
  - 2 system partitions, `USR-A` and `USR-B`
  - One is flagged active, other is inactive
  - Updates are installed to inactive partition and active flags swapped
  - Failed updates rolled back by swapping the active flag



# Docker

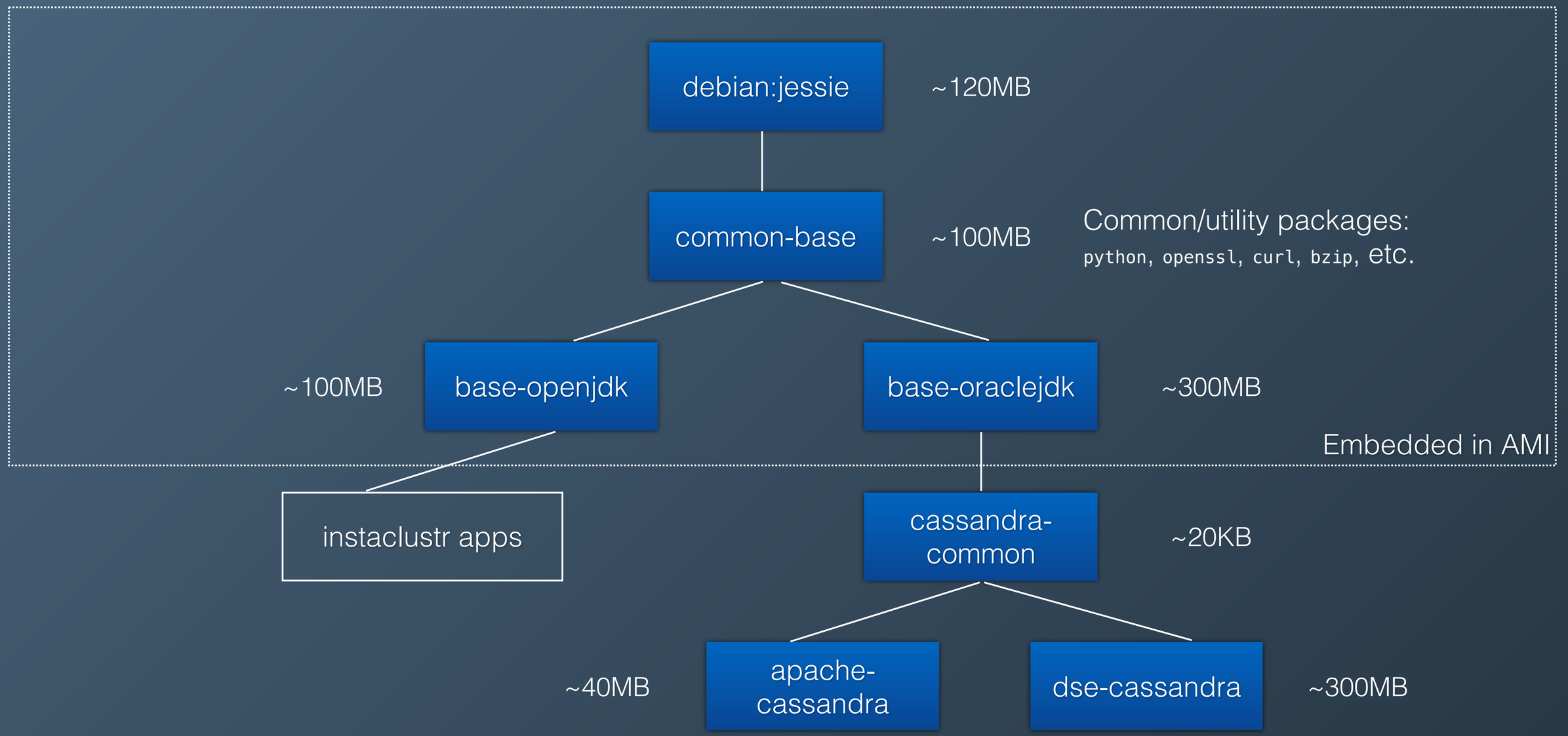
- Container runtime + standardised image distribution & hosting + ecosystem
  - Private image hosting options available, such as quay.io
- Immutable images — Yay! 🎉
- Images running in dev, test and production environments are equal
- Software installs, upgrades and uninstalls are clean
- Components are isolated — potentially conflicting components (different library versions, JVM versions, etc.) can co-exist
  - Even different userland layouts (Ubuntu, Debian, CentOS, etc)

# Docker + CoreOS

- Docker gives us immutable images for our components without instance replacement
  - CoreOS handles the rest (OS-level) via in-place updates
- Docker is provider agnostic
  - CoreOS runs on all major cloud providers and bare-metal
  - Instaclustr-managed C* can run anywhere

# Integration

- Cassandra data and configuration is persistent
  - Survives container restart
  - Cassandra data and configuration directories mounted from host
    `-v /var/lib/instaclustr/etc/cassandra:/etc/cassandra …`
- We containerise everything — internal services, node management and monitoring apps, and C*
  - Single, well understood, image build and deploy process — `docker build & docker push`
    (psst! We use script that via `Makefiles` — one target per image)
  - Helps that all our internal apps are Java-based too


debian:jessie
~120MB
common-base
~100MB
Common/utility packages:
python, openssl, curl, bzip, etc.
~100MB
base-openjdk
base-oraclejdk
~300MB
Embedded in AMI
instaclustr apps
cassandra-common
~20KB
~40MB
apache-cassandra
dse-cassandra
~300MB

# DataStax OpsCenter

- 1 instance per cluster
  - Accessible by users via our dashboard
  - Segregated for security
  - Hosted independently of the cluster
- 1 instance = 1 Docker container
- Multiple instances per host = cost effective

# Cassandra Versioning

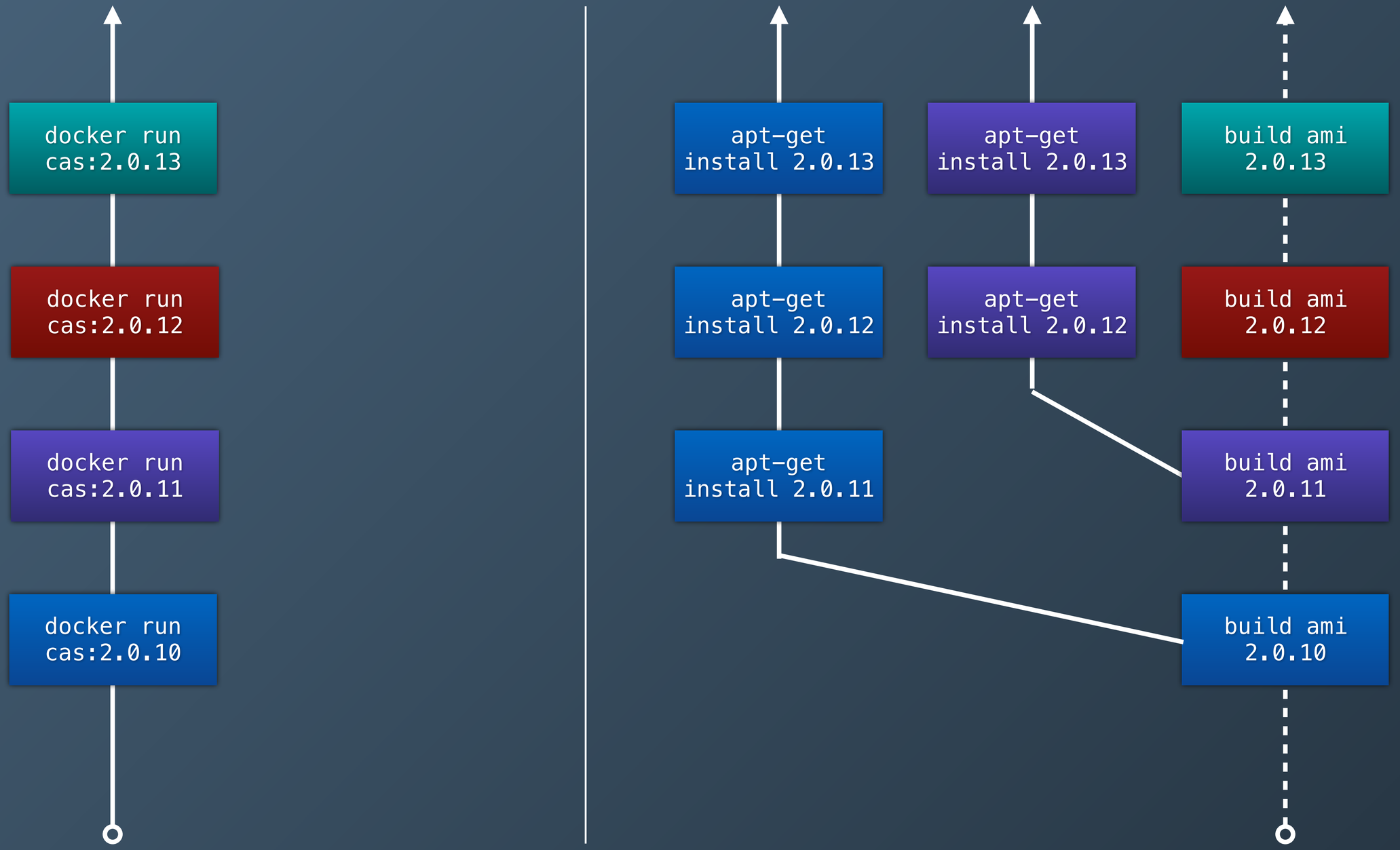
- We support multiple versions of Cassandra
  - 2.0.x vs. 2.1.x
  - Apache (ASF) vs. DataStax Enterprise
  - Rollback for when new versions have serious bugs
- 1 docker image per C* distribution (ASF/DSE). 1 tag per version (e.g., 2.1.x)
  - vs. *distribution version* × *provider region*
    (e.g, on AWS, one C* version = 9 images, one per region)
    - We currently support 2 distributions, with a total of 13 versions between them, on 3 providers, with a total of 29 regions (each requiring a separate image)
    - 13 versions × 29 provider regions = 377 images! 😳

# Versioning cont'd

- Every Instaclustr cluster has a specific C* version
  - Selected by user at creation time
  - Version = C* version + distribution (ASF/DSE)
- New & replaced nodes run the exact same version
- Known, sane configuration on every node cluster wide

# Update Rollout

- Build docker image for new Cassandra version
- Deploy to our testing environments
  - Perform clean installs and rolling upgrades of test clusters to verify reliability
- Enable in production to select customers (or internal support) for field testing
- Make generally available
  - New clusters will run new version by default
- Liaise with customers to perform a rolling, cluster-wide upgrade


docker run
cas:2.0.13
docker run
cas:2.0.12
docker run
cas:2.0.11
docker run
cas:2.0.10
apt-get
install 2.0.13
apt-get
install 2.0.13
build ami
2.0.13
apt-get
install 2.0.12
apt-get
install 2.0.12
build ami
2.0.12
apt-get
install 2.0.11
build ami
2.0.11
build ami
2.0.10

```
docker run cassandra:2.0.9

docker run cassandra:2.0.10

docker run cassandra:2.0.14
```

😎🍻🎉

```
apt-get install cassandra:2.0.9

apt-get install cassandra:2.0.10

apt-get install cassandra:2.0.14
```
*(hm, the 2.0.14 package changes a few things, and now there is junk left over from the 2.0.10 install and conflicts)*

```
rm …; vim …
```

😫

```
docker run cassandra:2.0.9

docker run cassandra:2.0.10
(oops, botched update)

docker run cassandra:2.0.9
(rollback!)
```

😎🍺🎉

```
apt-get install cassandra:2.0.9

apt-get install cassandra:2.0.10
(hm, now C* doesn't start)

apt-get purge cassandra
apt-get autoremove --purge
(hope this fixes everything)

apt-get install cassandra:2.0.9
(ah crap, the package doesn't
exist any more)
```

😫

# systemd

- CoreOS uses `systemd` for service management
- `systemd` supports inter-service dependencies (of course!)
  - e.g. `snapshotd.service` requires `cassandra.service`
    - aka, `snapshotd` only runs when `cassandra` is running
- `systemd` automatically restarts services
  - Our services are fail-fast
  - Cassandra not so much — in some cases

# dbus

- RPC between applications/services
- Notifications
- Socket-based (typically UNIX sockets)
- Multiple language bindings, including Java
- `systemd` is controlable via `dbus`
  - Control host `systemd` inside a Docker container
  - No need to fork/exec to run `systemctl` and co.
    (in-fact, `systemctl` is a wrapper around `dbus` calls)

# dbus-java

`systemctl restart cassandra` ⇨ `systemdManager.RestartUnit(“cassandra.service”, “replace”)`

SystemdExample.java - [node-agent] - instaclustr - [~/Development/instaclustr]

```java
import java.nio.file.Paths;
import java.util.Map;

public class SystemdExample {
    static final String BUSNAME = "org.freedesktop.systemd1";
    static final String MANAGER_OBJECT_PATH = "/org/freedesktop/systemd1";

    public static void main(String[] args) throws DBusException, IOException {
        final Map<String, Multimap<String, String>> unit = null;//

        final DBusConnection connection = DBusConnection.getConnection(DBusConnection.SYSTEM);
        final Manager systemdManager = connection.getRemoteObject(BUSNAME, MANAGER_OBJECT_PATH, Manager.class)

        writeSystemdUnit(unit, "cassandra.service");

        systemdManager.Reload();
        systemdManager.ReenableUnitFiles(ImmutableList.of("cassandra.service"), false, false);

        systemdManager.RestartUnit("cassandra.service", "replace");
    }

    public static void writeSystemdUnit(final Map<String, Multimap<String, String>> definition, final String na
        try (final BufferedWriter writer = Files.newBufferedWriter(Paths.get("/etc/systemd/system").resolve(nar
            // write unit definition
        }
    }
}
```

# systemd + dbus + C*

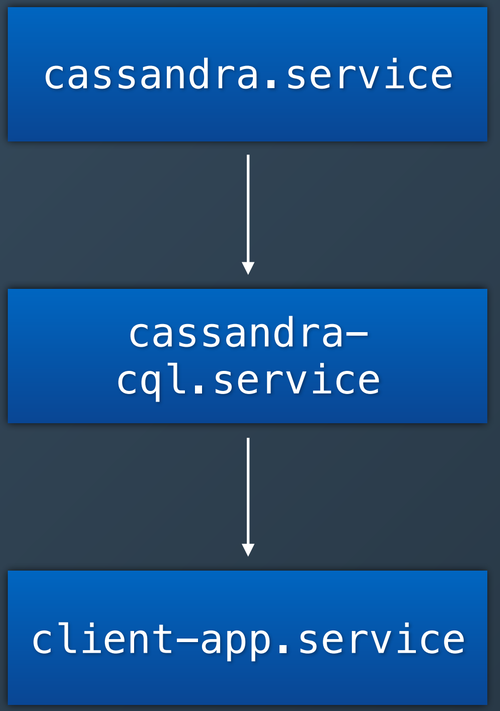
- Service status = “active” — process running, or something more?
  - Cassandra `java` process running vs. C* accepting CQL connections
- `systemd` dependencies start when required units become active
  - CQL clients are dependencies, but shouldn’t start until CQL is available
    - Small clients could fail-fast on no connectivity
    - Larger, complex clients require a reconnect loop
- Cassandra is more than just CQL — Thrift + JMX too.

# systemd + dbus + C* cont'd

- Notify `systemd` when Cassandra is accepting CQL connections
  - Has to be done from the same process — `systemd` restriction
  - Java agent (`java -javaagent:agent.jar …`) is best
    - Agent attempts connections to CQL port.
      When successful notifies `systemd` via `dbus`
    - No code modification. Works with DSE
  - Timeout issues when C* bootstrap takes longer. Set `TimeoutStartSec=0`

# systemd + dbus + C* cont'd

- Simple service `cassandra-cql` inserted in dependency chain
- Simple tool that watches a port for connectivity
  - Active when connection succeeds
  - Exits/inactive if connection fails or drops
- Shift the Java agent logic here
- Works for multiple ports — Thrift, JMX




# Thanks

Questions?

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