PCF Basics

Yadhav Jayaraman - Sr. Platform Architect
yjayaraman@pivotal.io

The Pivotal value proposition

Developer Productivity

- Accelerate feedback loops by improving delivery velocity
- Focus on applications, not infrastructure
- Give developers the tools and frameworks to build resilient apps

Operational Efficiency

- Employ 500:1 developer to operator ratio
- Perform zero-downtime upgrades
- Runs the same way on every public/private cloud

Comprehensive Security

- Adopt a defense-in-depth approach
- Continuously update platforms to limit threat impact
- Apply the 3 R's → repair, repave, rotate

High Availability

- Run platforms that stays online under all circumstances
- Scale up and down, in and out, through automation
- Deploy multi-cloud resilience patterns

Speed

Deploy new code
thousands of times a month

- **Synchrony Financial:** 30% faster deployment
- **Verizon**: 86.8% faster time to market, 92.6% faster environment provisioning
- **Scotiabank**: 3k deployments per month
- **Allstate**: 11.5k production deployments per year
- **Liberty Mutual:** 1k production deployments per day

Pivotal

Speed

Deploy new code
thousands of times a month =
Faster MVPs and time to market

- **CoreLogic:** New data feature in 2 months
- **Boeing:** MVPs down from 1-3 years to 3-5 months
- **HCSC:** Reduced release cycles from 14 months to 14 weeks to 14 days
- **Mercedes Benz:** Reduced time from inception to production from ~30 days to 2-3 days

Pivotal

Stability & Scalability

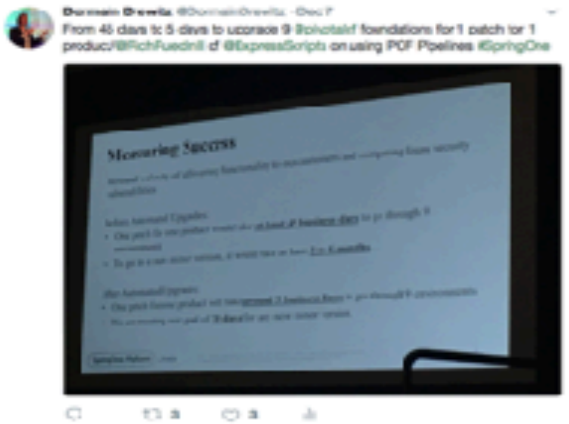
Delivering enterprise SLAs and breakthrough operational efficiency

- **Discover** has over 32 applications on PCF, 250 developers
- **Northern Trust** has 750 microservices running on 5 PCF Foundations. 2 Platform operators support 250 Spring Boot Developers
- **T-Mobile** has 11k app Instances supported b 8 Platform operators
- **Comcast** now running 19k App Instances across 12 Foundations
- **Verizon** now at 1800 services, running across 16 Foundations
- **Allstate** supports 1027 developers

Security

Improve your security posture with built-in capabilities

- **Express Scripts:** From 45 days to 5 days to upgrade 9 PCF Foundations, for 1 patch for 1 product
- **Verizon**: From patching every 6 months to weekly. 81.5% faster patching and scaling
- **Synchrony Financial:** 80% faster patching execution



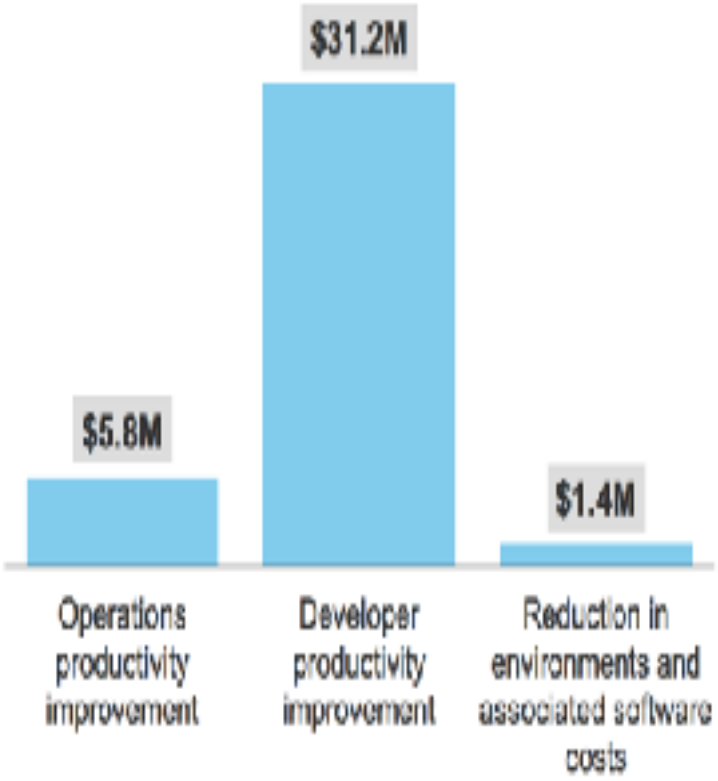
Benefits And Costs

Operations productivity improvement:
$5.8M

Developer productivity improvement:
$31.2M

PCF platform cost:
$16.4M

Benefits (Three-Year)



ROI
135%

Benefits PV
$38.4 million

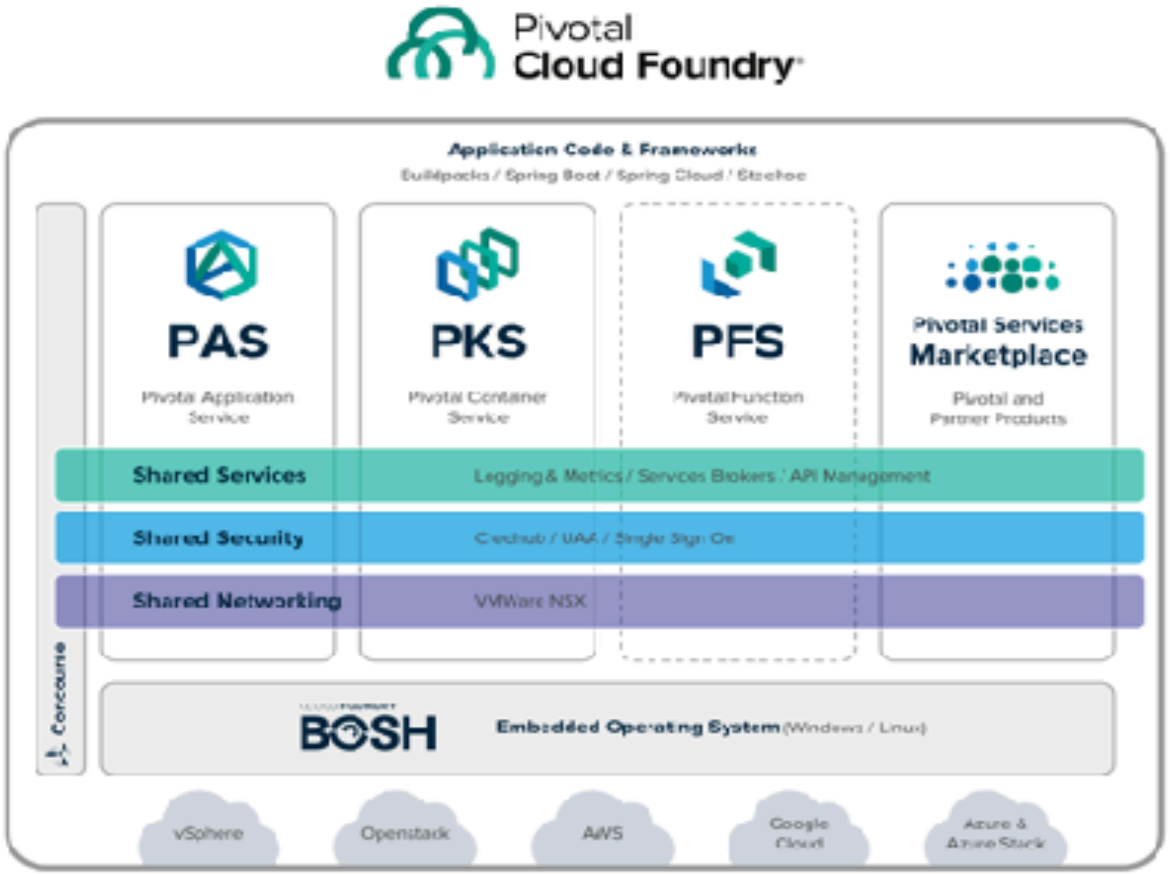
NPV
$22 million

A Forrester Total Economic Impact™ Study Commissioned By Pivotal
October 2017

What is Cloud Foundry

Any App
Every Cloud
One Platform

PCF 2.0 — for everything that matters



Pivotal

Applications

Compiled, staged, containerized, deployed and managed by platform

BYO container, deployed and managed by platform

Value Line

Elastic Container Runtime

- Container Scheduling
- Elastic (Auto) Scaling
- Dev/Ops Self Service
- Logging Metrics
- Self Healing HA
- Zero Downtime Patch/Upgrade

Managed Services

- Database
- Cache
- Messaging
- SSO
- SCM/CI
- NOSQL

Brokered Services

- API Mgmt
- Monitoring
- NOSQL
- SSO
- Database
- Messaging

Infrastructure Automation (BOSH)

Pivotal

Pivotal Application Service (PAS): A Runtime for Apps

Increase speed and deploy code to production thousands of times per month. Use PAS to run Java, .NET, and Node apps.

Pivotal
Application Service™

Best runtime for Spring and Spring Boot — Spring's microservice patterns—and Spring Boot's executable jars—are ready-made for PAS.

Turnkey microservices operations and security — Spring Cloud Services brings microservices best practices to PAS. It includes Config Server, Service Registry, and Circuit Breaker Dashboard.

A native Windows and .NET experience — Use PAS to run new apps built with .NET Core. Run your legacy .NET Framework apps on PAS too, using the .NET Hosted Web Core buildpack. Push applications to containers running on Windows Server 2016.

Built for apps — PAS has everything to need to run apps. Buildpacks manage runtime dependencies: metrics, logging, and scaling are done for you. Multitenancy, and blue/green deployment patterns are built-in. Extend apps with a rich service catalog.

Container-ready — PAS supports the OCI format for Docker images. Run platform-built and developer-built containers.

Enterprise Ready Services

MySQL for PCF

- Enterprise-ready MySQL for your developers
- Automate database operations in developer workflows
- **NEW:** Leader-follower for multi-site HA

Pivotal Cloud Cache

- High performance, in-memory, data at scale for microservices
- Look-aside caches & HTTP session state caching
- **NEW:** WAN replication

RabbitMQ for PCF

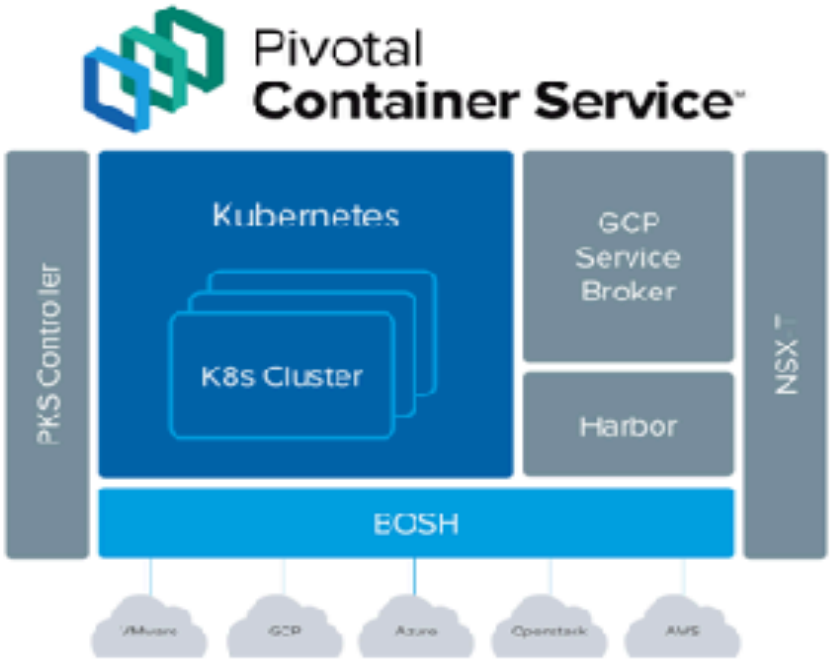
- Easily connect distributed applications with the most widely deployed open source message broker
- Enable connected scalable, distributed applications
- **NEW**: On-demand clusters

Redis for PCF

- In-Memory cache and datastore, configured for the enterprise
- Efficient provisioning matched to use cases

BOSH Managed | On-Demand Provisioning | Dedicated Instances | Custom Service Plans

Pivotal Container Service (PKS): A Runtime for Containers



Built with open-source Kubernetes — Constant compatibility with the current stable release of Kubernetes, operated by BOSH. No proprietary extensions.

Production-ready — Highly available from apps to infrastructure, no single points of failure. Built-in health checks, scaling, auto-healing and rolling upgrades.

Multicloud — BOSH provides a reliable and consistent operational experience. For any cloud.

Network management and security out-of-the-box with VMware NSX-T. Multi-cloud, multi-hypervisor.

GCP APIs access — The GCP Service Broker allows apps to transparently access Google Cloud APIs, from anywhere. Easily move workloads to/from Google Container Engine (GKE).

Fully automated Ops — Fully automated deploy, scale, patch, upgrade. No downtime. Use CD pipelines to deploy your platform, too.

Pivotal Function Service (PFS): A Runtime for Functions

Execute functions in response to events. Use PFS to handle web events, event-based integration, and large scale streaming data.

Pivotal
Function Service™

Trigger functions via HTTP/Message Broker — PFS is architected to support event stream processing, connecting to message topics via a language-neutral, function container interface.

Run functions anywhere — PFS lets you easily run functions on-premises and in the public cloud for maximum flexibility.

Use modern DevOps workflows — PFS allows you to use familiar, container-based workflows for serverless scenarios.

Pluggable event brokers — PFS can be connected easily with popular message brokers such as Kafka, RabbitMQ, Google Pub/Sub, and AWS Kinesis.

Polyglot — PFS supports the authoring of functions in your chosen framework - Node.js, Spring/Java, or Shell.

Kubernetes Native — PFS runs natively on top of Kubernetes, making it easy to trigger code or containers in response to events.

Using the right abstraction is key for results

Container Orchestrator (CaaS)

Application Platform (PaaS)

Serverless Functions (FaaS)

IaaS

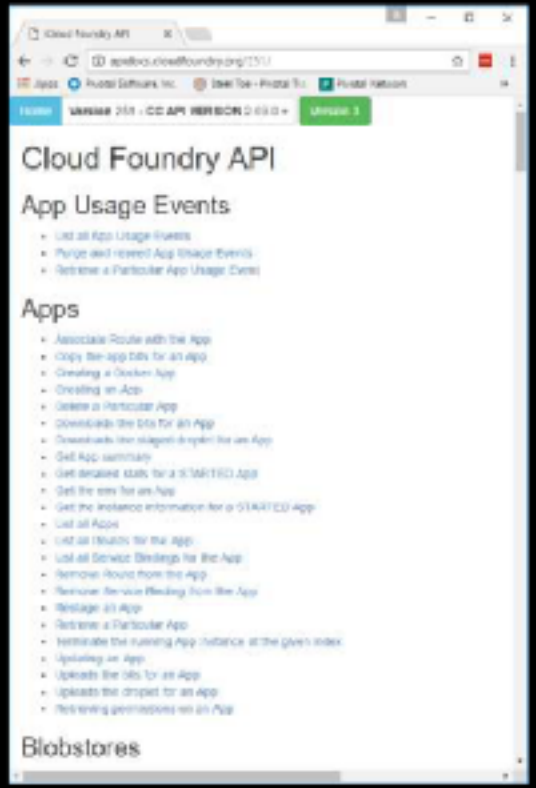
Pivotal

Demo

Interacting with PCF

Cloud Controller API

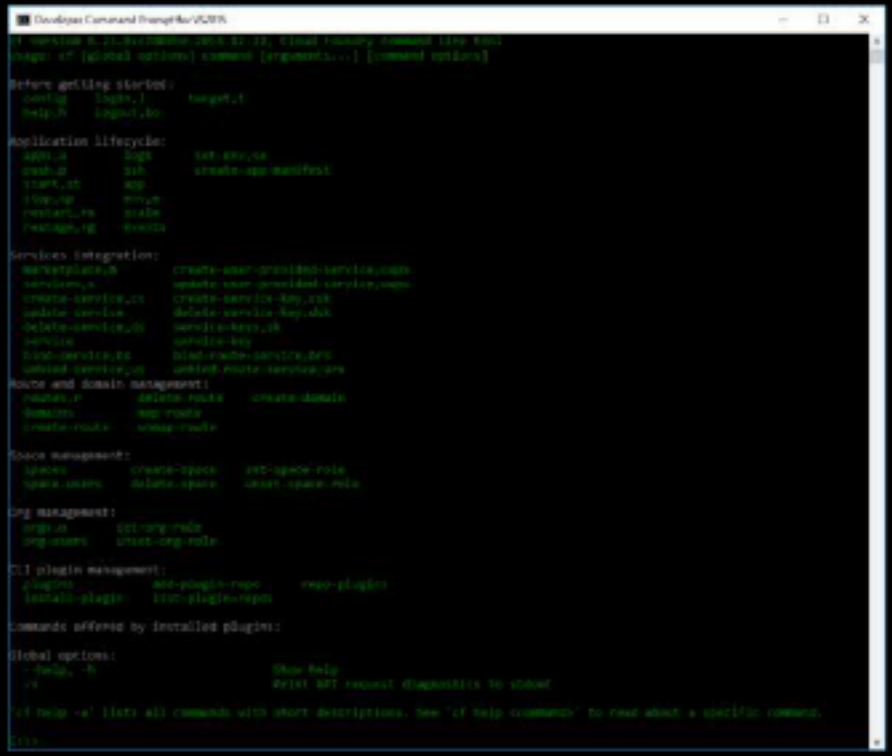
- Cloud Controller (CC) component of Elastic Runtime manages all Cloud Foundry APIs
- CF CLI and other clients like Apps Manager directly call this API
- Before accessing the CC API, you must get an access token from the User Account and Authentication (UAA) server
- http://apidocs.cloudfoundry.org



CLI – Command Line Interface

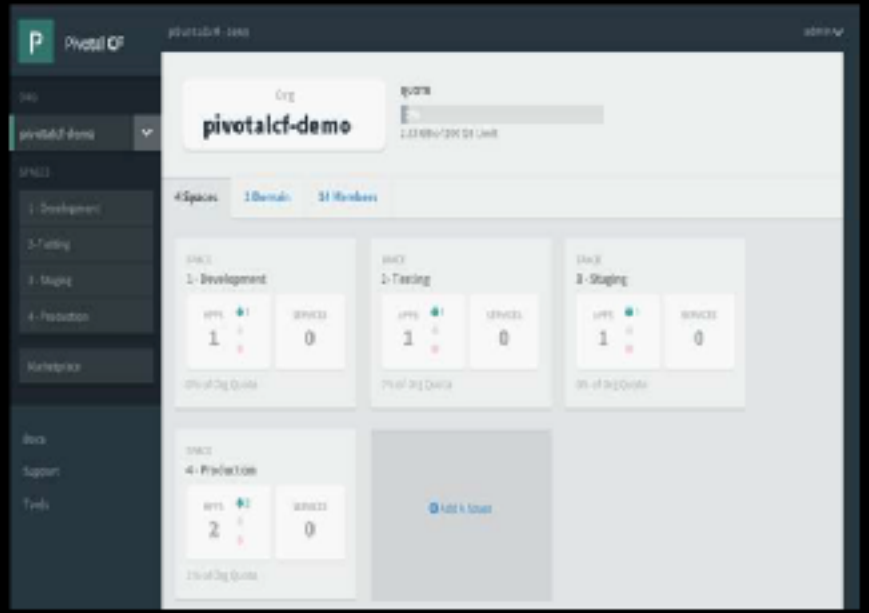
- Command line utility providing easy access to the Cloud Controller API.
- Scriptable
- Fully documented

```
cf help -a

cf help <command>

cf api http://foo.bar.com/

cf login <username>
```

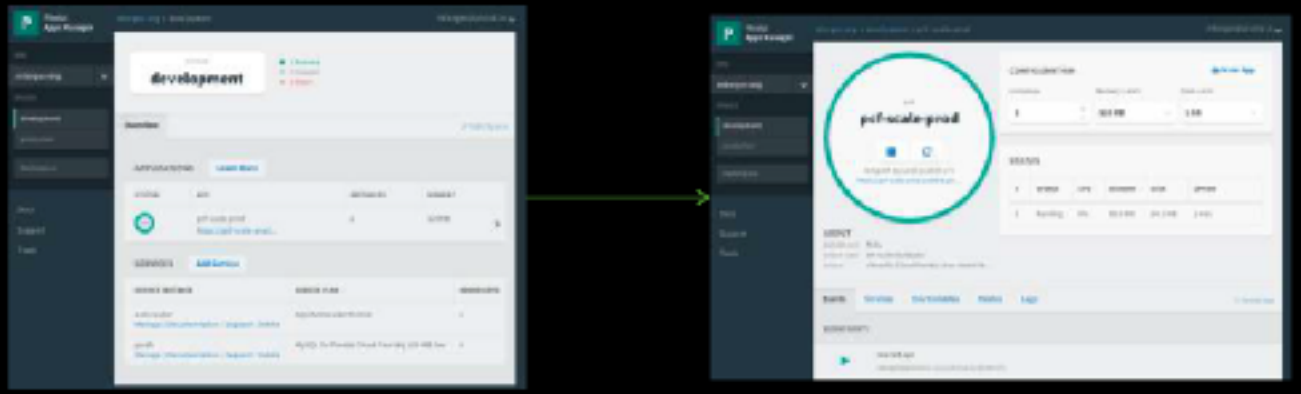


Pivotal Apps Manager

- Manage Organizations, users, applications and Spaces
- Monitor applications logs, services and routes
- Access Service Marketplace, create services and bind to applications

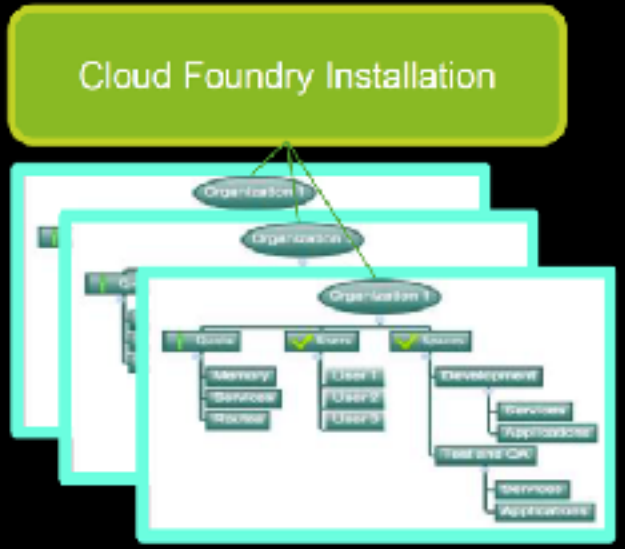


Pivotal Apps Manager – App View



- Drill into a space to see all application and services instances
- Then drill into an application to see configuration, status, event, logging, routes, environment variables and service instances bound to the application

Orgs, Spaces, Users and Quotas

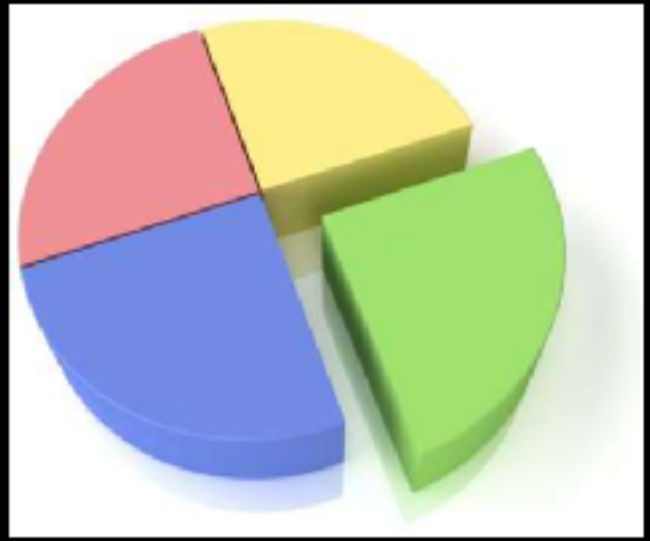


Organizations

- Top-most administrative unit
- Logical division within a Pivotal Cloud Foundry Install / Foundation
  - Typically a company, department, application suite or large project
- Each organization has its own users and assigned quota
- User permissions / Roles are specified per space within an organization
- Sub-divided into spaces

Quotas

- Different quota limits (e.g. small, enterprise, default, runaway) can be assigned per Organization
- Quotas define
  - Total Memory
  - Total # of services
  - Total # of Routes
- Sub-divided into spaces



Spaces

- Logical sub-division within an organization
- Users authorized at an organization level can have different roles per space
- Services and Applications are created / target per Space
- Same service name can have different meaning per space

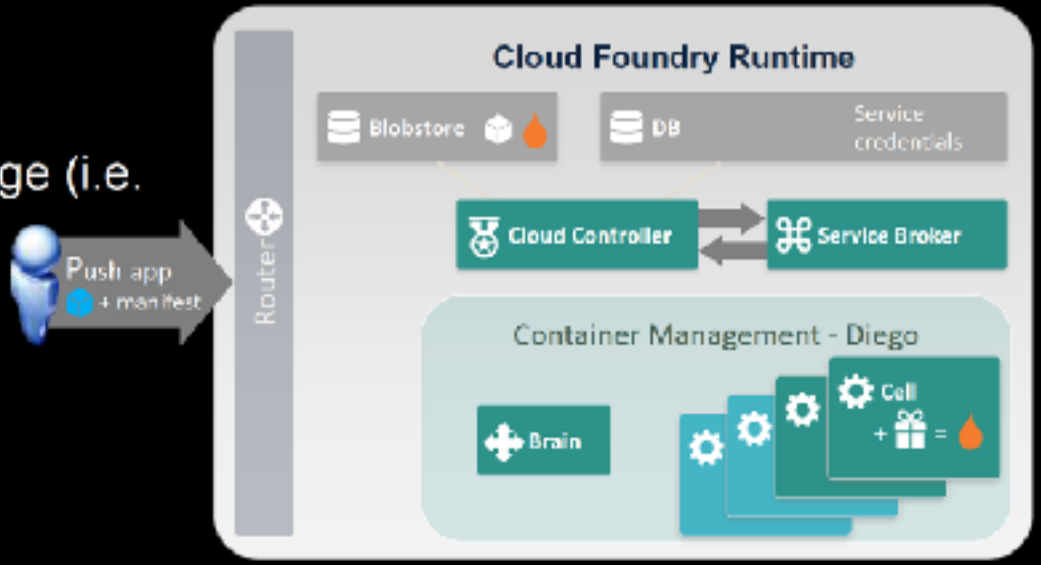
Users and Roles

- Users are members of an organization
  - Usually they are operators or developers (not application end users)
  - Users are sent an email invite and asked to create an account
- Users have specific organization and space roles
  - Organization roles grant permissions in an organization
  - Space roles grant permissions in a particular space
  - A combination defines the user's overall permissions

Running Apps

Pushing an Application

1. Upload app bits and metadata
2. Bind services
3. Stage application
4. Save staged application image (i.e. droplet)
5. Deploy image to container
6. Manage applications health




```
cf push appname -p <path to bits>
cf push appname -f <manifest> -p <pathtobits>
```

Manifest Files

- Application manifests tells `cf push` what to do with applications
- What OS stack to run on: Windows or Linux
- How many instances to create and how much memory to use.
- Helps automate deployment, specially of multiple apps at once
- Can list services to be bound to the application
- YAML format – http://yaml.org

```yaml
---
# all applications use these settings and services
domain: shared-domain.com
memory: 1G
instances: 1
services:
- clockwork-mysql
applications:
- name: springtock
  host: tock09876
  path: ./spring-music/build/libs/spring-music.war
- name: springtick
  host: tick09875
  path: ./spring-music/build/libs/spring-music.war
```

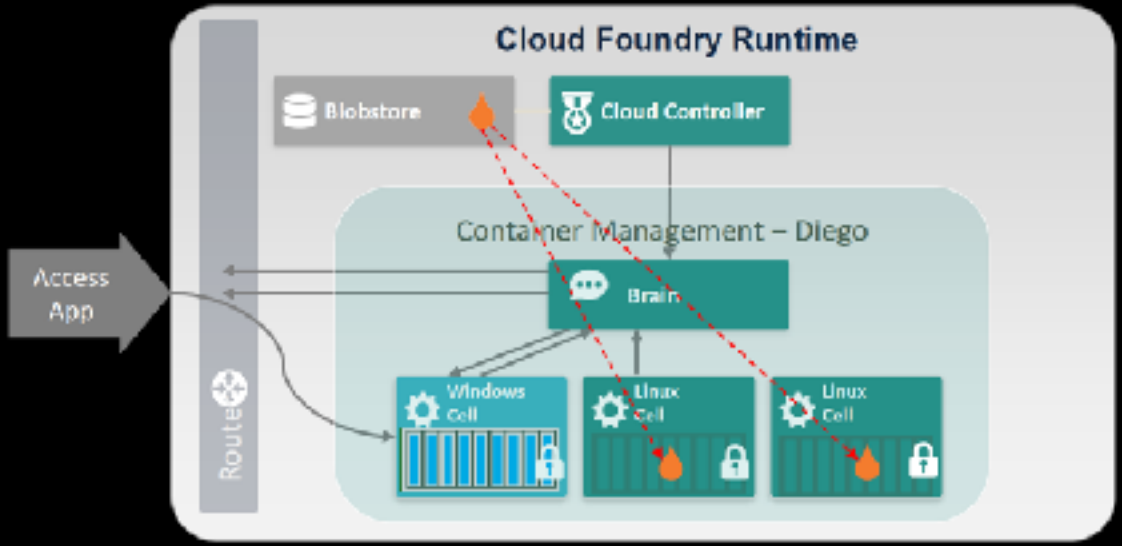
Staging an Application – Appling Buildpacks

- Buildpacks build container images
- Buildpacks take care of
  - Detecting which type of application is being pushed
  - Installing the appropriate run-time
  - Installing required dependencies or other artifacts
  - Creating the command used to start the application
- Lots of Buildpacks
  - Staticfile
  - Java
  - Ruby
  - Nodejs
  - Go
  - Python
  - PHP
  - .NET Core
  - Binary

Why Buildpacks

- Control what frameworks/runtimes are used on the platform
- Provides consistent deployments across environments
  - Stops deployments from piling up at operation's doorstep
  - Enables a self-service platform
- Eases ongoing operations burdens:
  - Security vulnerability is identified
  - Subsequently fixed with a new buildpack release
  - Restage applications

Deploying Image to Container



CF Push

Upload

'cf push' uploads the application bits and metadata to the Cloud Controller

Stage

Behind the scenes the code goes through a set of staging scripts called BuildPacks which create a container blueprint called 'Droplet'

Distribute

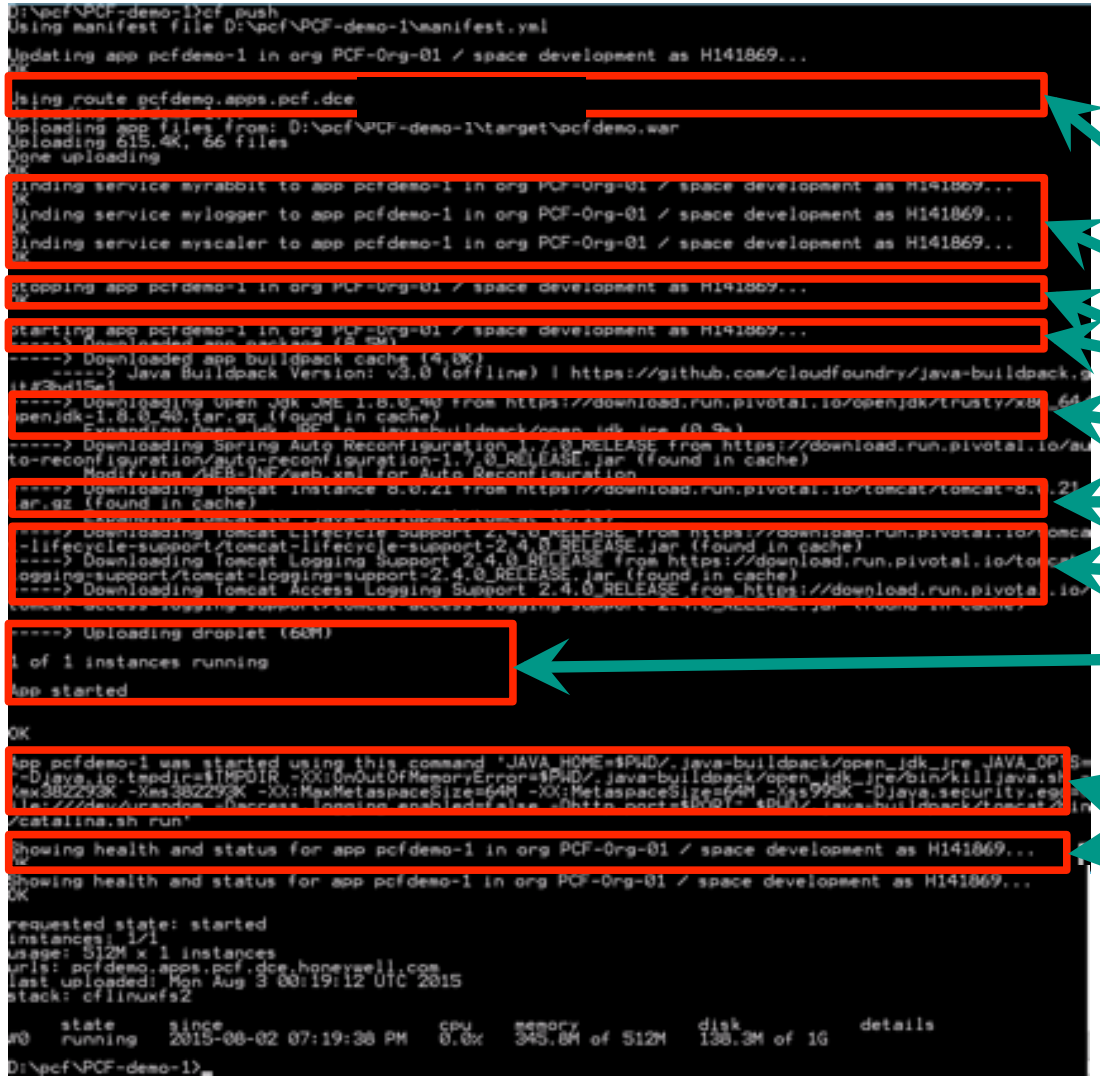
'Diego' which is an auction based workload scheduler spins up containers and with the 'Droplet' image, and alerts the 'Cloud Controller' that the app is ready to receive traffic

Route

Your app receives an entry in the routing tier which provides a dynamic loadbalancer

Pivotal

Eliminating Service Tickets



- Firewall & Routes
- Service Bindings
- App Lifecycle
- Runtime Installation & Config
- Middleware Installation & Config
- Application Installation & Config
- App Lifecycle
- Logging, Health, Telemetry

Pivotal

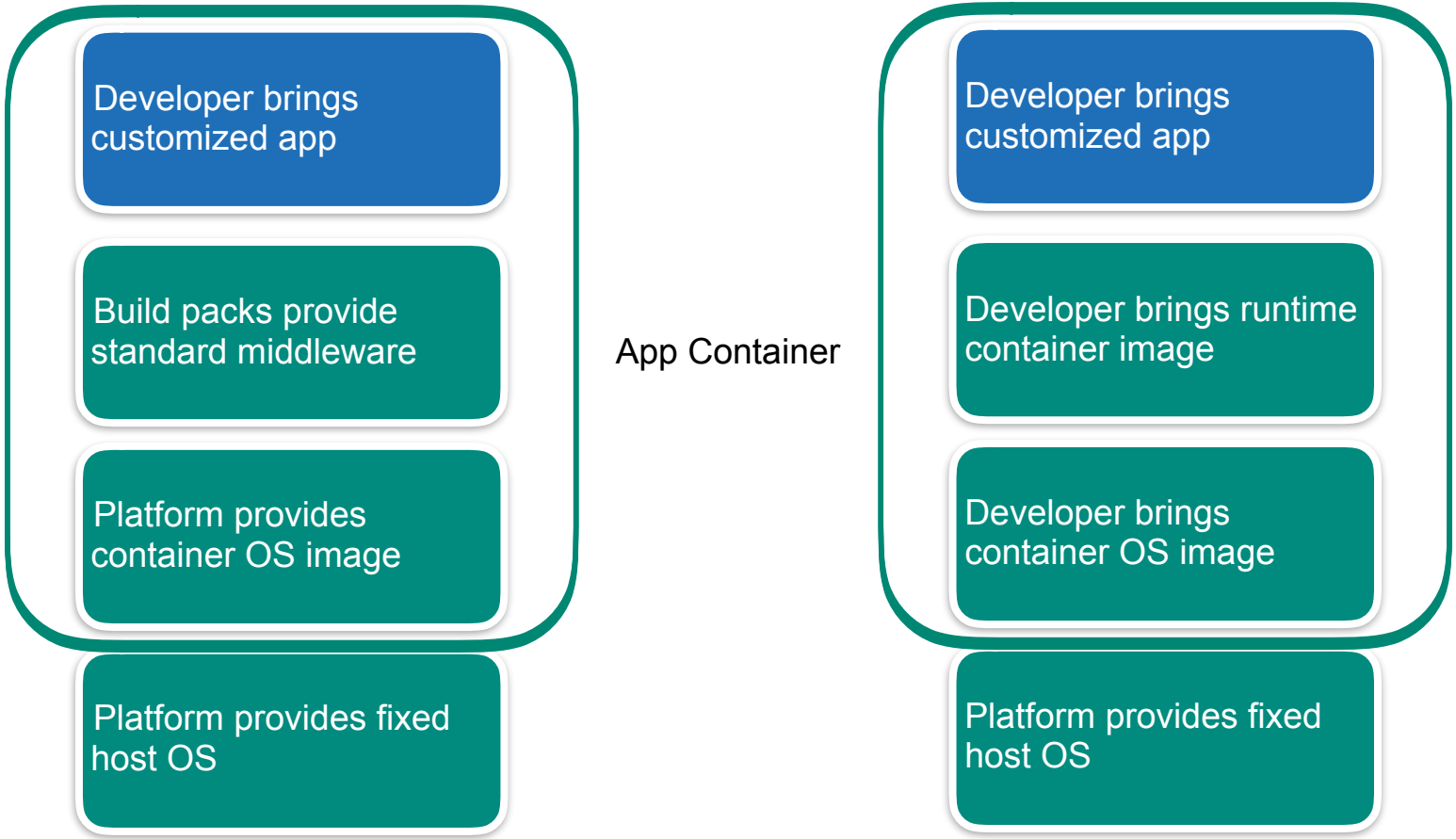
Container Environment Variables

- Used to communicate apps environment/config to deployed container
  - `VCAP_APPLICATION`
    - Application attributes – version, instance index, limits, URLs, etc.
  - `VCAP_SERVICES`
    - Bound services – name, label, credentials, etc.
  - `CF_INSTANCE_*`
    - `CF_INSTANCE_ADDR`, `CF_INSTANCE_INDEX`, etc.

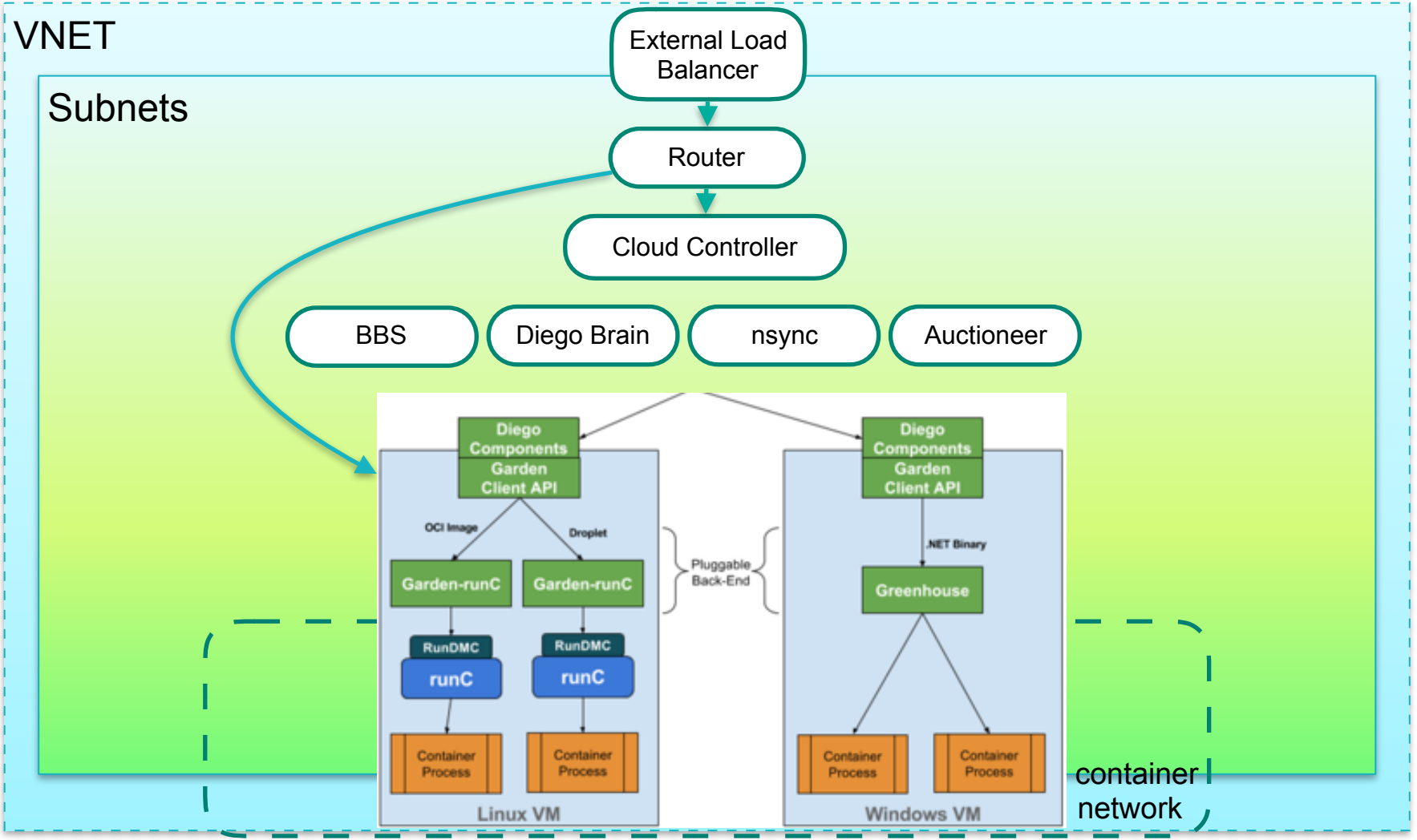
VCAP_APPLICATION

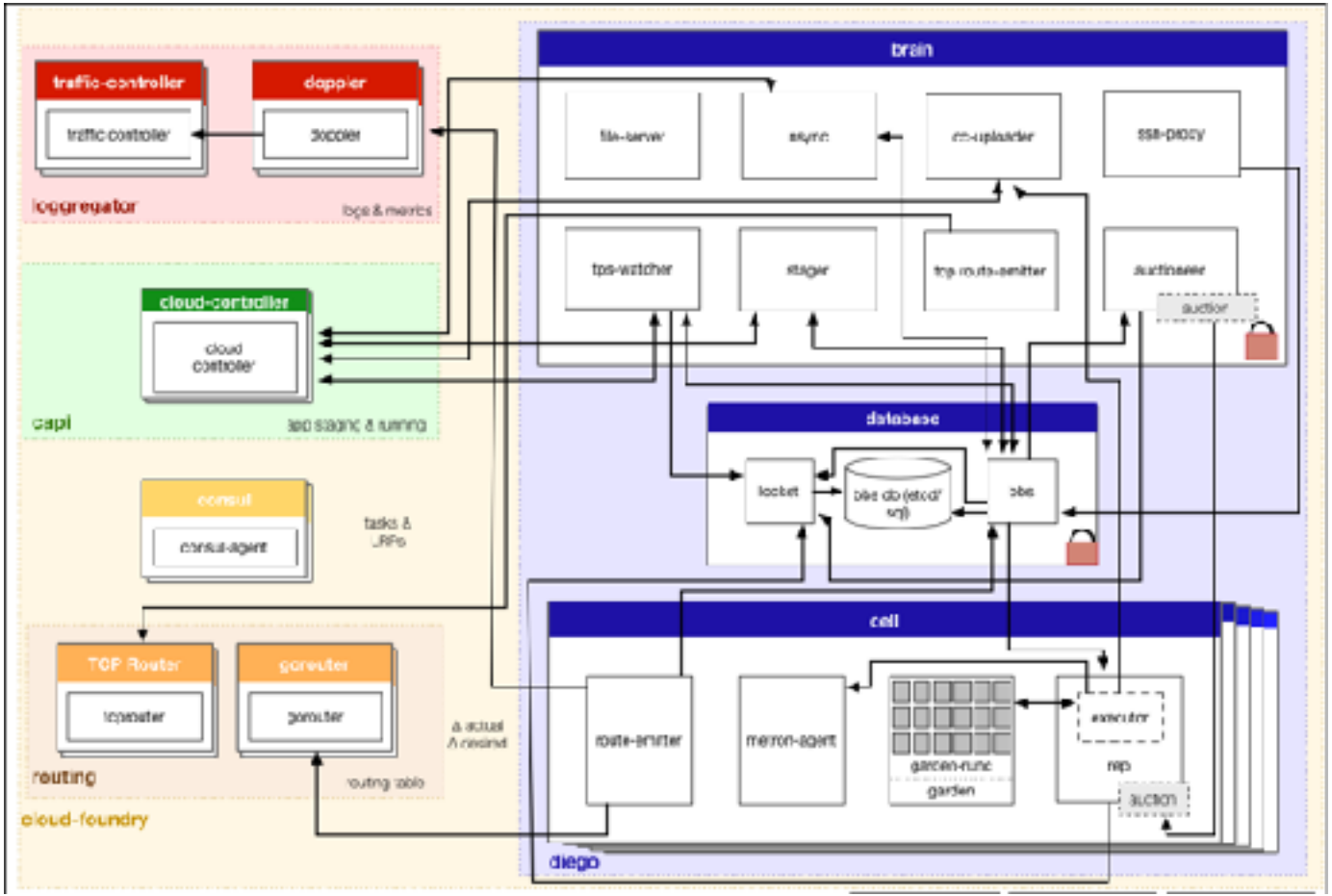

```
"VCAP_APPLICATION": {
  "application_id": "96bb5b88-3d35-4753-85ee-2d9d50aaec7c",
  "application_name": "fortuneService",
  "application_uris": [
    "fortuneservice-glottologic-neigh.apps.testcloud.com"
  ],
  "application_version": "40933f4c-75c5-4c61-b369-018febb0a347",
  "cf_api": "https://api.system.testcloud.com",
  "limits": {
    "disk": 1024,
    "fds": 16384,
    "mem": 512
  },
  "name": "fortuneService",
  "space_id": "86111584-e059-4eb0-b2e6-c89aa260453c",
  "space_name": "test",
  "uris": [
   "fortuneservice-glottologic-neigh.apps.testcloud.com"
  ],
  "users": null,
  "version": "40933f4c-75c5-4c61-b369-018febb0a347"
}
```

2 Workflows: Runtime vs No-Runtime



Pivotal


VNET
External Load Balancer
Subnets
Router
Cloud Controller
BBS
Diego Brain
nsync
Auctioneer
Diego Components
Garden Client API
OCI Image
Droplet
Garden-runC
Garden-runC
RunDMC
runC
RunDMC
runC
Container Process
Container Process
Linux VM
Pluggable Back-End
Diego Components
Garden Client API
.NET Binary
Greenhouse
Container Process
Container Process
Windows VM
container network


traffic-controller
traffic controller
doppler
doppler
loggregator
logs & metrics
brain
file-server
syncd
cc-uploader
ssh-proxy
tps-watcher
stager
tps-route-emitter
auctioneer
auctioneer
cloud-controller
cloud controller
capi
database
locket
bbs db (etcd/sql)
bbs
consul
consul-agent
tasks & LRPs
cell
TCP Router
tcprouter
gorouter
gorouter
routing
routing table
route-emitter
metron-agent
garden-runc
garden
executor
rep
auction
cloud-foundry
diego

Pivotal

Resilience and High Availability

Why Containers

- Containers are OS level virtualization (i.e. process isolation)
- They are small and allow for much higher packing density
- They are easy to move around and to replicate
- They do not have any redundant or unnecessary operating system elements; they don't need the care and feeding of a large OS stack.
- They are lightweight and have fast startup times,
- Well suited for building hyper-scale, highly resilient infrastructure
- Typical container image is 10s of MB
- Containers start in msecs

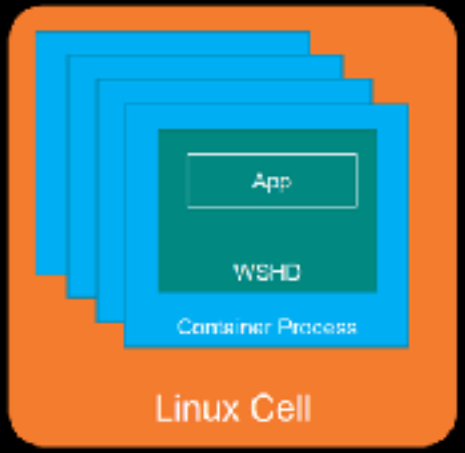
Windows Cells on Cloud Foundry

Traditional Windows Architecture

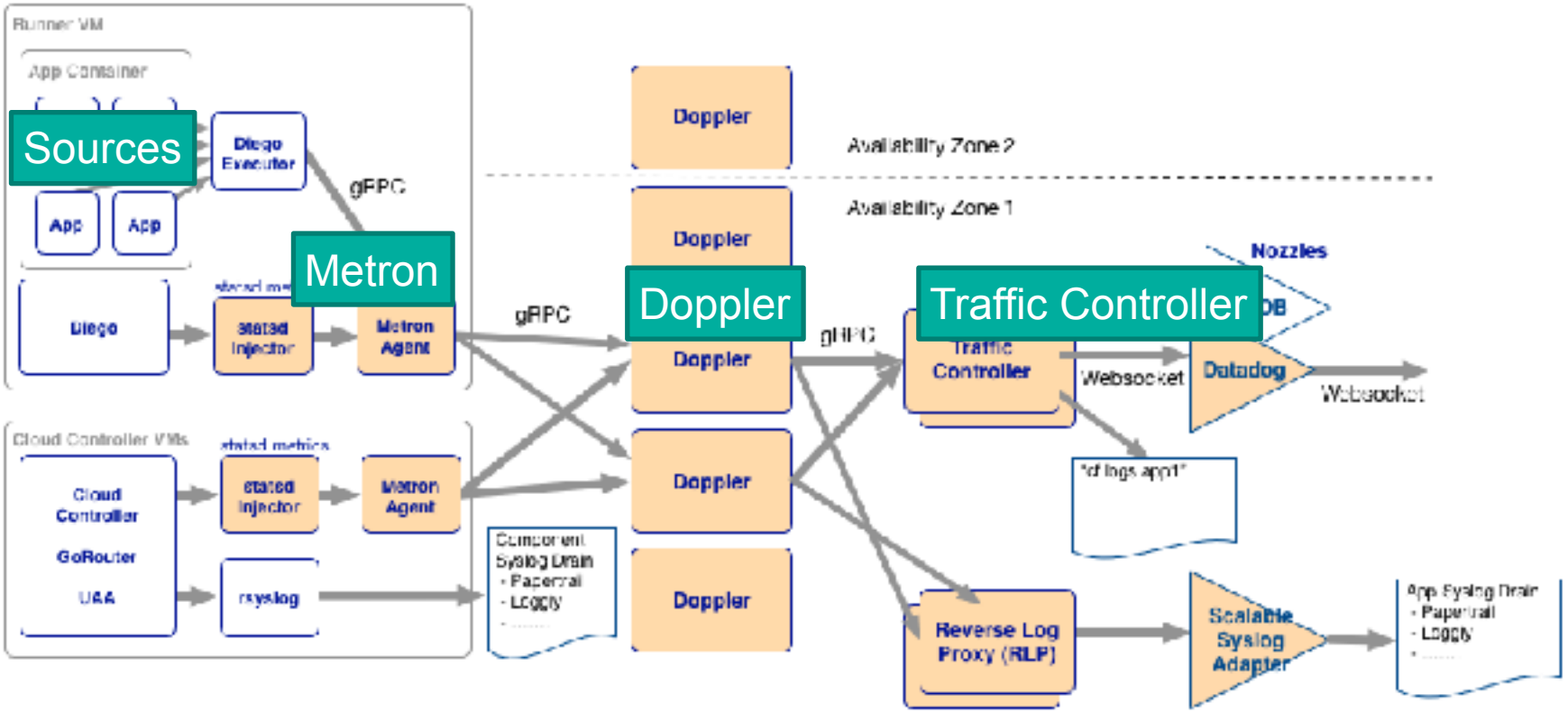
Cloud Foundry Architecture

Linux Cells on Cloud Foundry

Cloud Foundry Architecture



Debugging Apps


Sources
Metron
Doppler
Traffic Controller
Runner VM
App Container
App
App
Diego Executor
Diego
statsd injector
Metron Agent
gRPC
Cloud Controller VMs
Cloud Controller
GoRouter
UAA
statsd injector
Metron Agent
rsyslog
Component Syslog Drain
- Papertrail
- Loggly
Doppler
Doppler
Doppler
Doppler
Doppler
Availability Zone 2
Availability Zone 1
gRPC
Traffic Controller
Nozzles
Websocket
Datadog
Websocket
"cf logs app1"
Reverse Log Proxy (RLP)
Scalable Syslog Adapter
App Syslog Drain
- Papertrail
- Loggly

Application

PCF Metrics

- Network
- Container
- Log Events
- TX Trace (coming soon)

3rd Party

Tier 1	Dynatrace	App Dynamics	Splunk
Tier 2	New Relic	Interscope	Knowtify

Platform

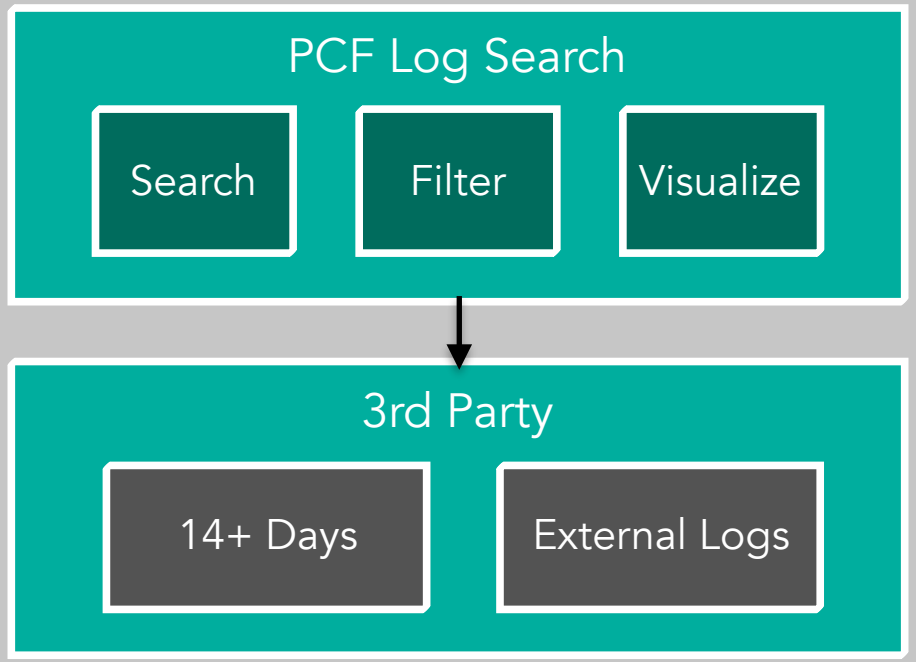
PCF JMX Bridge

- API Controller
- Router
- VM
- Workload Director

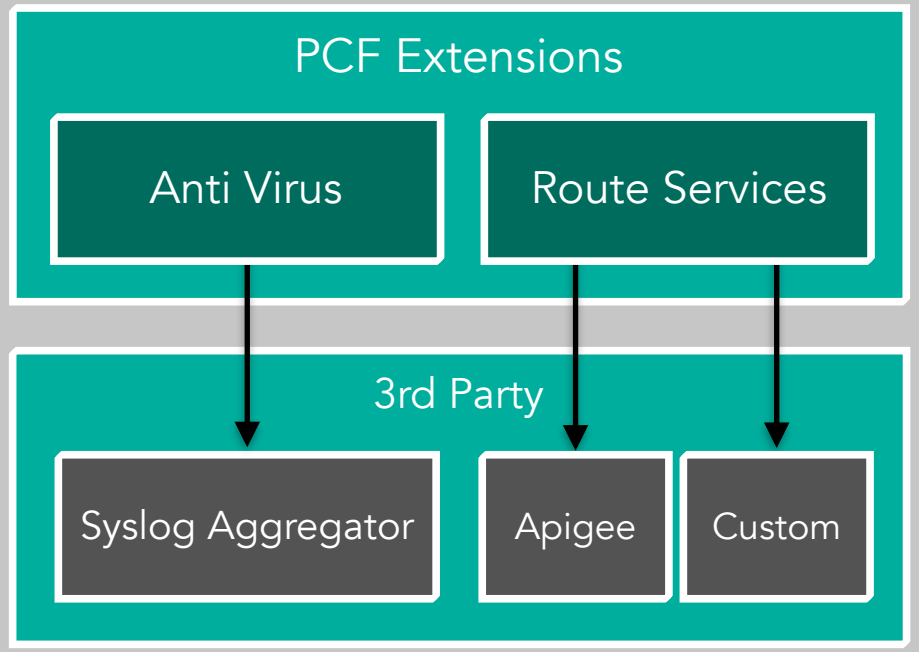
3rd Party

- VMware
- Data Dog
- Any JMX Visualizer

Logging

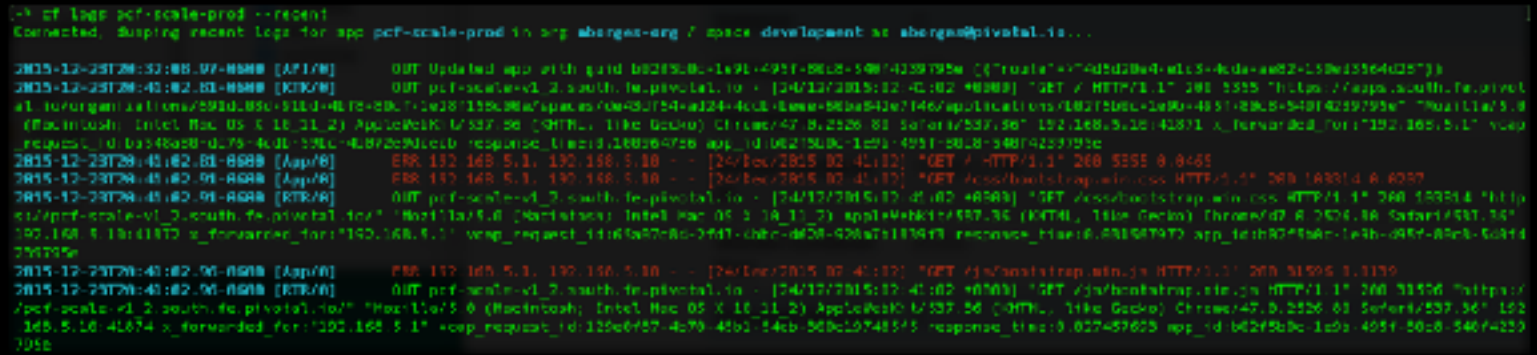


Auditing



Logs

- Cloud Foundry aggregates an applications logs
  - Application logs should be written to STDOUT /STDERR
- Use the CLI to view an applications logs
  - `` `cf logs APP_NAME` `` – allows you to tail and applications logs
  - `` `cf logs APP_NAME -recent` `` – allows you to view recent logs



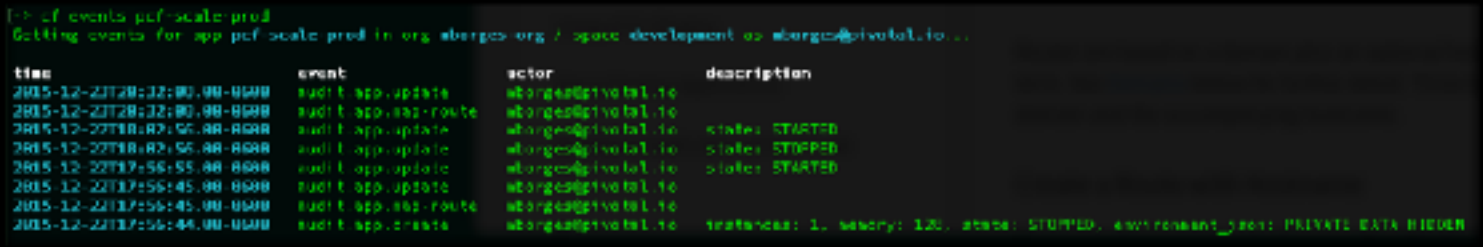
Health

- Cloud Foundry proactively monitors health of application containers
  - Restarts them if they fail
- Use the CLI to view an applications health & status
  - `` `cf app APP_NAME` `` – allows you view health status of an application

```
~> cf app pcf-scale-prod
Showing health and status for app pcf-scale-prod in org mborges-org / space development as mborges@pivotal.io...
OK

requested state: started
instances: 1/1
usage: 128M x 1 instances
urls: pcf-scale-prod.south.fe.pivotal.io, pcf-scale-v1_2.south.fe.pivotal.io
last uploaded: Tue Dec 22 23:56:50 UTC 2015
stack: cflinuxfs2
buildpack: Ruby

     state     since                  cpu    memory          disk          details
#0   running   2015-12-22 06:02:59 PM   0.1%   80.3M of 128M   84.2M of 1G
```

Application Events

- Cloud Foundry records all changes to an application as events
  - Container state changes
  - Configuration changes
- Use the CLI to view an applications events
  - `` `cf events APP_NAME` `` – allows you view recent events of an application



Services

What is a Service?

- Allows resources to be easily provisioned on-demand
- Typically an external "component" necessary for applications
  - Database, cache, message queue, microservice, etc.
- Can be a persistent, stateful layer

Types of Services

- Managed - Fully integrated, with fully lifecycle management
- User-Provided – Created and managed external to the platform

Managed Services

- Integrated with Cloud Foundry
  - Implements a required API for which the cloud controller is the client
- **Service Broker** implements the required API
  - Advertise a catalog of service offerings and service plans
  - Handle calls from the Cloud Controller
  - Fetch catalog
  - Create service instances
  - Bind applications to service instances
  - Unbind applications from service instances
  - Delete service instances

User Provided Services

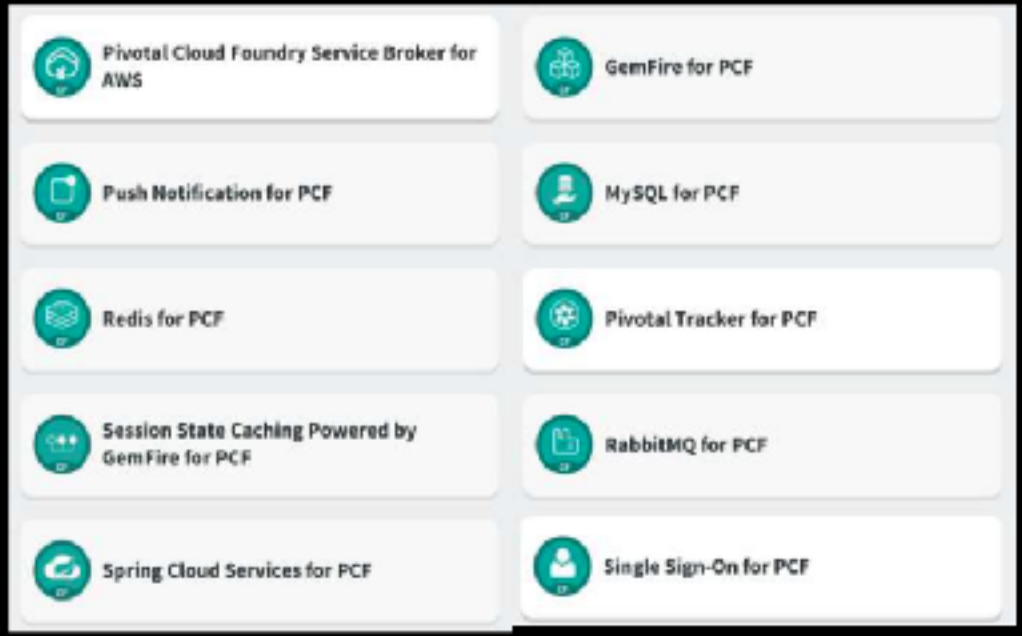
- Service instances managed outside of Cloud Foundry
- Behave like other service instances once created
- Familiar CLI commands ('create-service') provide service instance configuration

EXAMPLE: AN ORACLE DATABASE MANAGED OUTSIDE OF, AND UNKNOWN TO CLOUD FOUNDRY

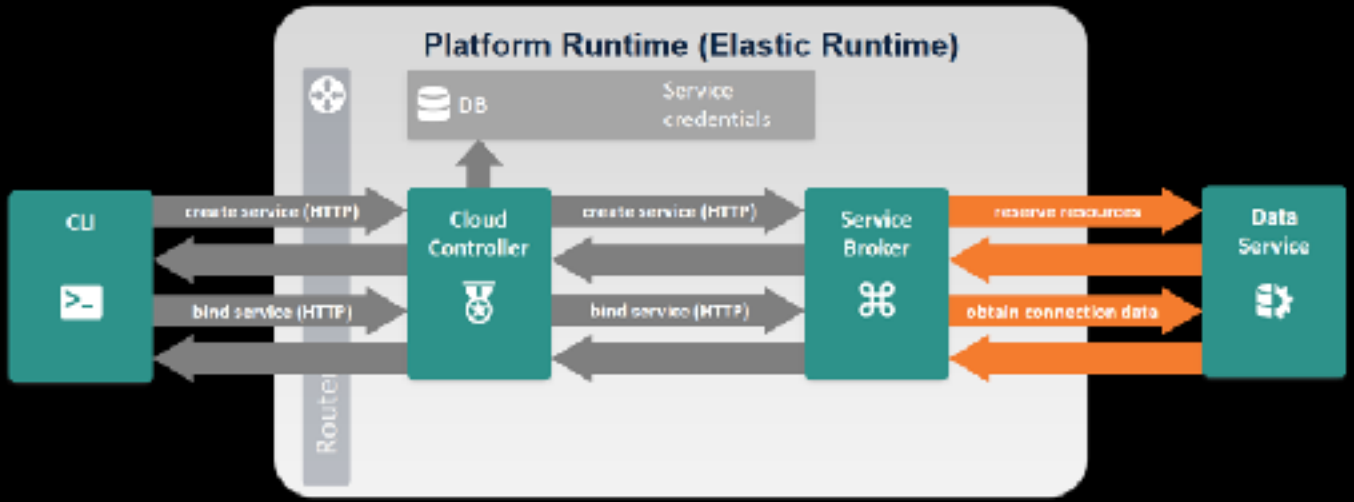
Examples of Managed Services

Pivotal Network

https://network.pivotal.io/



Creating and Binding Services



Container Environment Variables

- Used to communicate apps environment/config to deployed container
  - `VCAP_APPLICATION`
    - Application attributes – version, instance index, limits, URLs, etc.
  - `VCAP_SERVICES`
    - Bound services – name, label, credentials, etc.
  - `CF_INSTANCE_*`
    - `CF_INSTANCE_ADDR`, `CF_INSTANCE_INDEX`, etc.

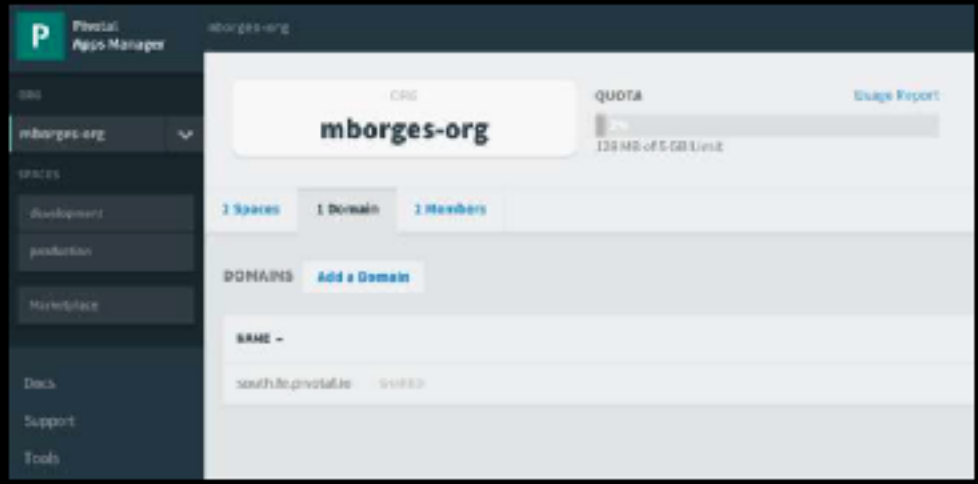
VCAP_SERVICES


```
"VCAP_SERVICES": {
  "p-identity": [
    {
      "credentials": {
        "client_id": "e3ca311d-999b-4e4f-b056-b50138cfff9f",
        "client_secret": "a995365e-d7b7-4727-95b8-463df2842f64",
        "auth_domain": "https://sso1.login.run.haas-76.pez.pivotal.io"
      },
      "syslog_drain_url": null,
      "label": "p-identity",
      "provider": null,
      "plan": "sso1",
      "name": "sso",
      "tags": []
    }
  ]
}
```

Domains and Routes

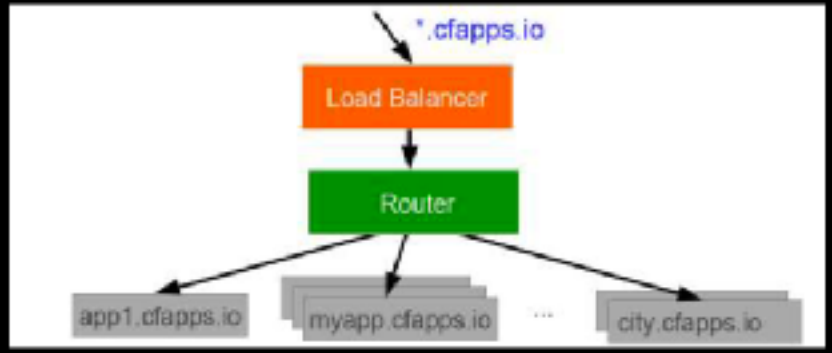
Domains

- Each Cloud Foundry installation has a default app domain
- Domains provide a namespace from which to create routes
- Requests for any routes created from the domain will be routed to Cloud Foundry.
- Domains can be shared or private in regards to PCF organizations



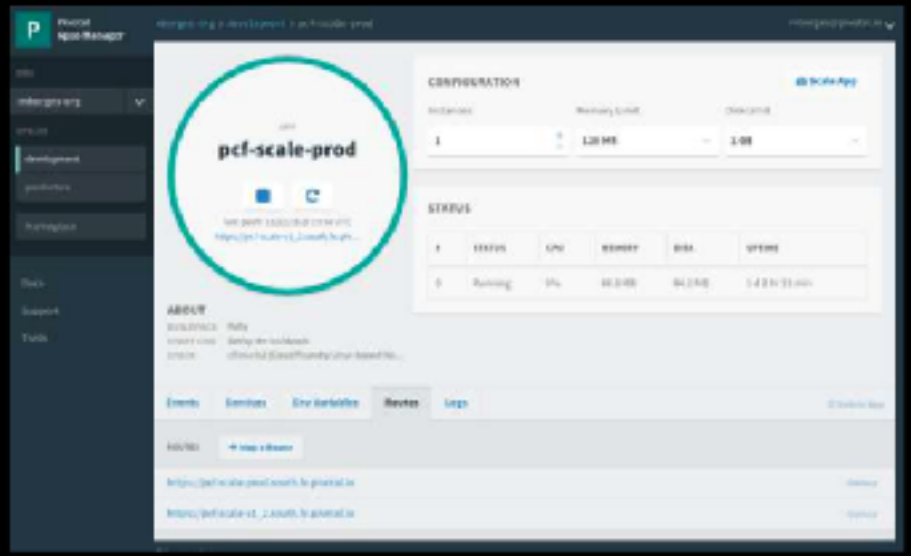
Domains – Behind the Scenes

- A wildcard entry (*) is added to the DNS for the app domain
- That DNS entry points to a load balancer (or Cloud Foundry's HA Proxy), which points to the Cloud Foundry Router
- The Router uses the subdomain to map to application instance(s)

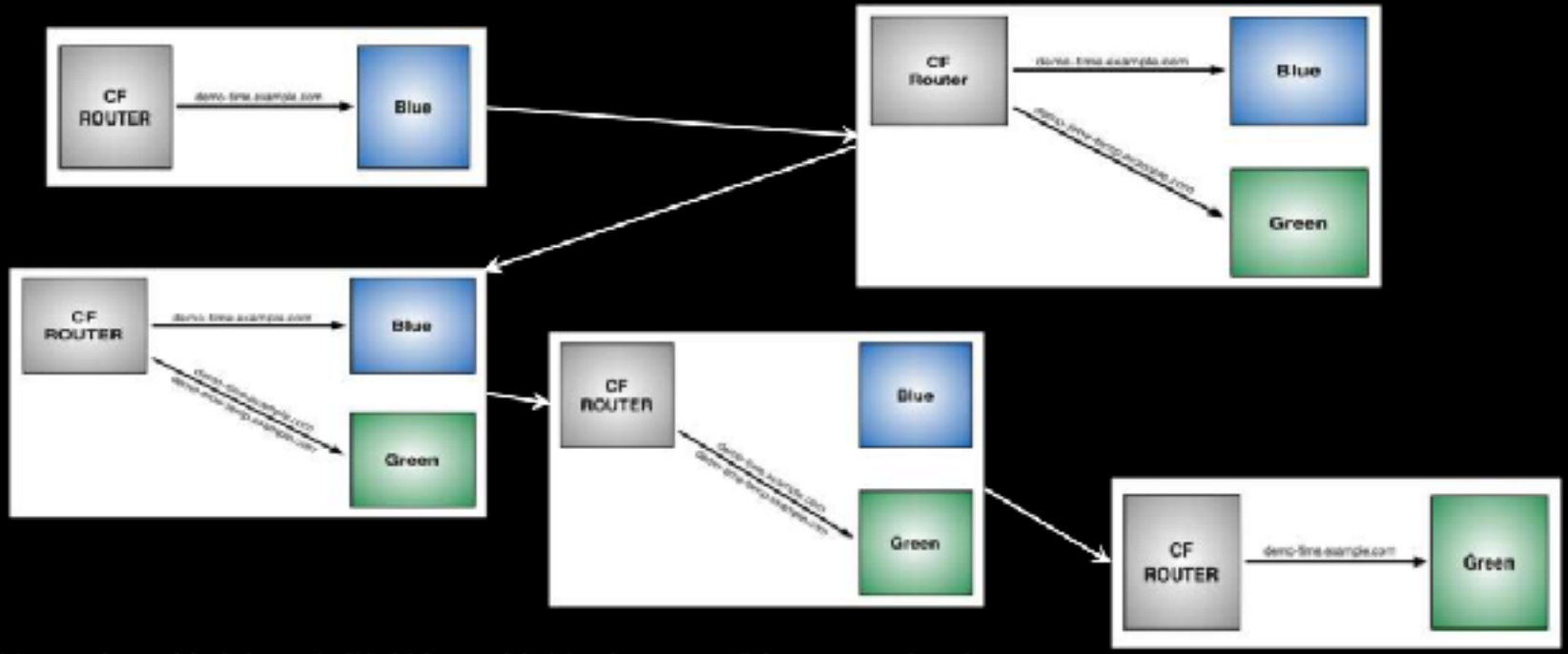


Routes

- HTTP requests are routed to apps pushed by associating a URL with an application, know as route
- Many app instances can be mapped to a single route resulting in load balanced requests
- Routes belong to a space
- Application can have multiple routes



Blue-Green Deployments



https://docs.pivotal.io/pivotalcf/1-8/devguide/deploy-apps/blue-green.html

Containers

Container Principles

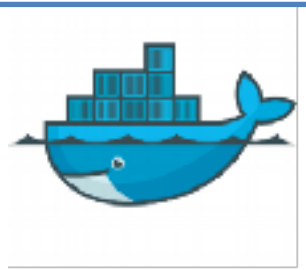
Control Resources
Isolate and Secure Processes

1. Quick To Create
2. Resource Consolidation
3. App Portability

Container Principles

File System

Docker Images
Droplets+Stack



Management

API-CLI

Docker-CLI
Garden

Runtime

Docker-Engine
Guardian

Implementation

RunC

cgroups

namespaces

Pivotal

Container Misconceptions

There Is No Container

Walls
Resource Limits
Namespace

Container Misconceptions

File System

Docker Images
Droplets+Stack

Management

API-CLI

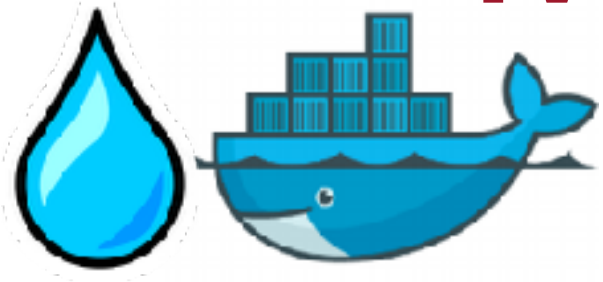
Docker-CLI
Garden

Runtime

Docker-Engine
Guardian

Implementation

RunC



IT DOES NOT MATTER

Pivotal

PivotalCloudFoundry
@pivotalcf

Follow

Read how our performance benchmark (250K Containers in Prod!) for @CloudFoundry supports real-world scenarios.

250k Containers In Production: A Real Test For The Real World

Real world conditions and results for a Cloud Foundry performance test that sustained an astonishing 250,000 containers in one environment. #cloudfoundry ...

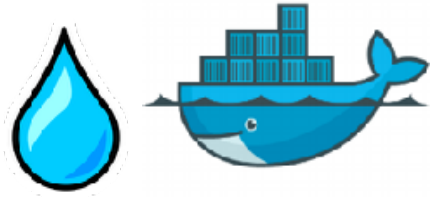
blog.pivotal.io

Pivotal

Containers In Cloud Foundry

File System

Docker Images
Droplets+Stack



Management

API-CLI

Garden

Runtime

Guardian

RunC

IronFrame

cgroups

namespaces

job objects

hwc

Security

Compliance and Security

Speed is the new security

Automation Pays Dividends

1. Consistency via pipeines
2. Continuous Deployment
3. Auditing
4. Security/Immutability
5. Upgradability
6. Recovery

https://compliance-viewer.18f.gov

Platform Trust

1. Repave, Repair, Rotate - more secure architecture
2. Zero downtime deployments and upgrades
3. Explicit, known dependencies
4. Homogeneity in the environment, no drift
5. Combined CVE / vulnerability management
6. Federated login with enterprise directories
7. Control access to services and other resources
8. Enforce policies (server, runtime, libraries, etc.)
9. IPSec on every network segment
10. Custom monitoring agents
11. RunC integration for AppArmor and user namespaces

Additional Host Security

1. Automated Pipelines to track and update Stemcells and buildpacks
2. Stemcell hardening
3. Vulnerability Scan - Nessus scan
4. Integrity and Intrusion management – TripWire
5. Anti-virus
6. Constant automated code quality testing
7. Automated Pen testing scans
8. Dashboard and alerts (e.g. https://compliance-viewer.18f.gov/)

Bold Audacious Moves

60%

Computing workloads to the cloud

75%

Technology staff writing code

50%

Code to production in a day

In Summary