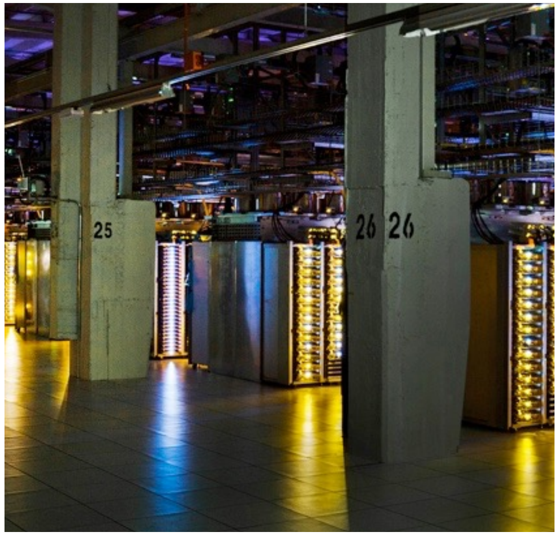
HES-SO | Master of Science in Engineering

Cloud Computing — Introduction to Cloud Foundry



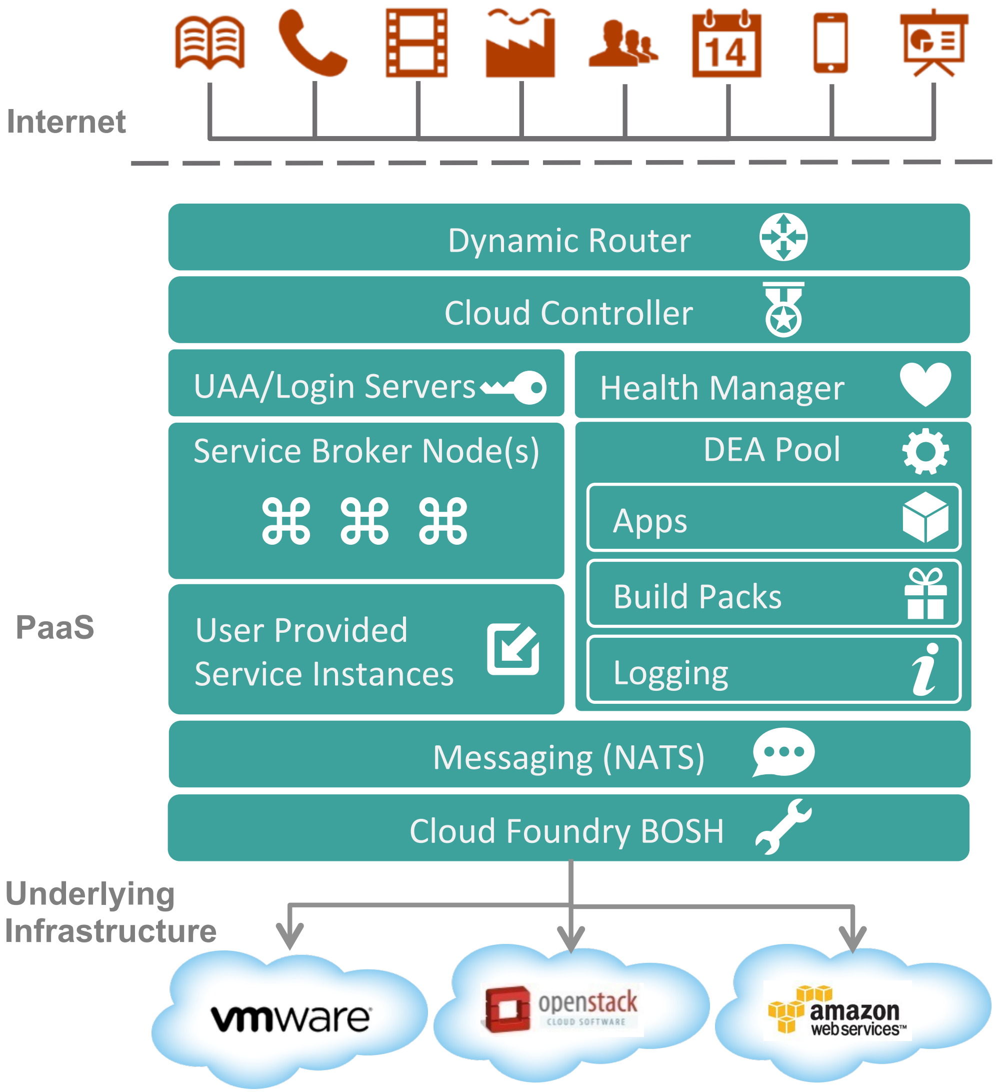
Academic year 2015/16

Cloud Foundry
Introduction

- Cloud Foundry is an Open Source project developing **software** for Platform-as-a-Service
  - Initially developed by VMware and released in 2011
  - Primarily written in Ruby and Go
- A number of companies offer public PaaS cloud services based on Cloud Foundry:
  - Pivotal Web Services
  - IBM Bluemix
  - SAP HANA Cloud Platform
  - CenturyLink AppFog
  - HPE Helion Stackato
  - Swisscom Application Cloud
  - anynines (Avarteq)

Cloud Foundry
Layering

- Out-of-the-box Cloud Foundry can be deployed on private and public IaaS clouds:
  - Private clouds:
    - OpenStack
    - VMware vSphere
  - Public clouds:
    - Any cloud based on OpenStack
    - Amazon Web Services
    - VMware vCloud Air, vCloud Director
  - Local machine (for development and testing):
    - Vagrant
- Cloud Foundry can be deployed on other IaaS clouds by implementing its **Cloud Provider Interface** (CPI)



Source: Pivotal, Cloud Foundry Technical Overview, http://www.slideshare.net/cdavisafc/cloud-foundry-technical-overview

Cloud Foundry

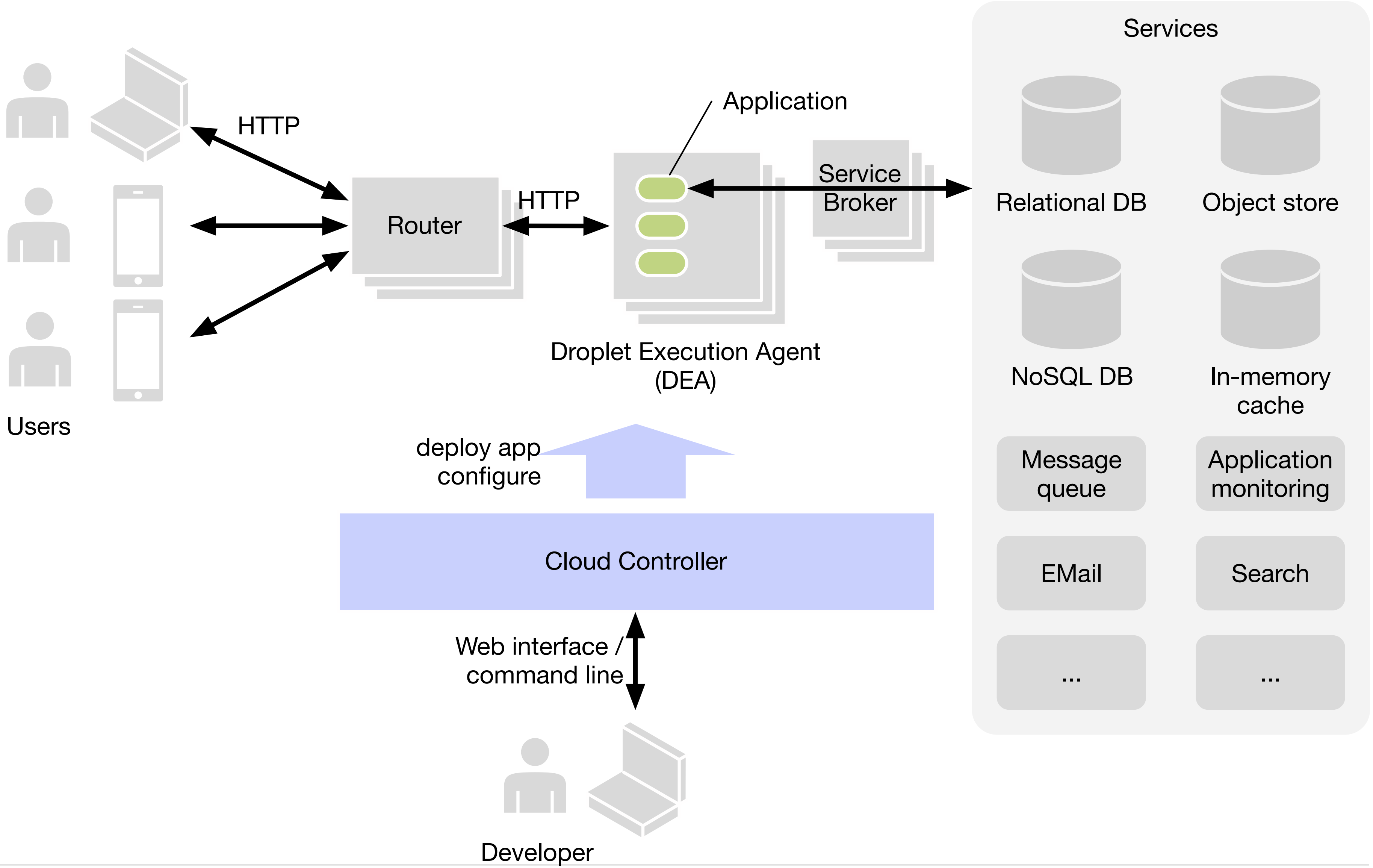
Supported languages and frameworks

- CloudFoundry supports many languages and frameworks via the *Buildpack* concept.
- Buildpacks are scripts for deploying applications. They build an application (including its dependencies) on the target server.
- There are Buildpacks for various languages (see table), plus
  - Buildpack for precompiled binaries
  - Buildpack for static web files
- Your favorite language is not supported? Write a Buildpack for it!

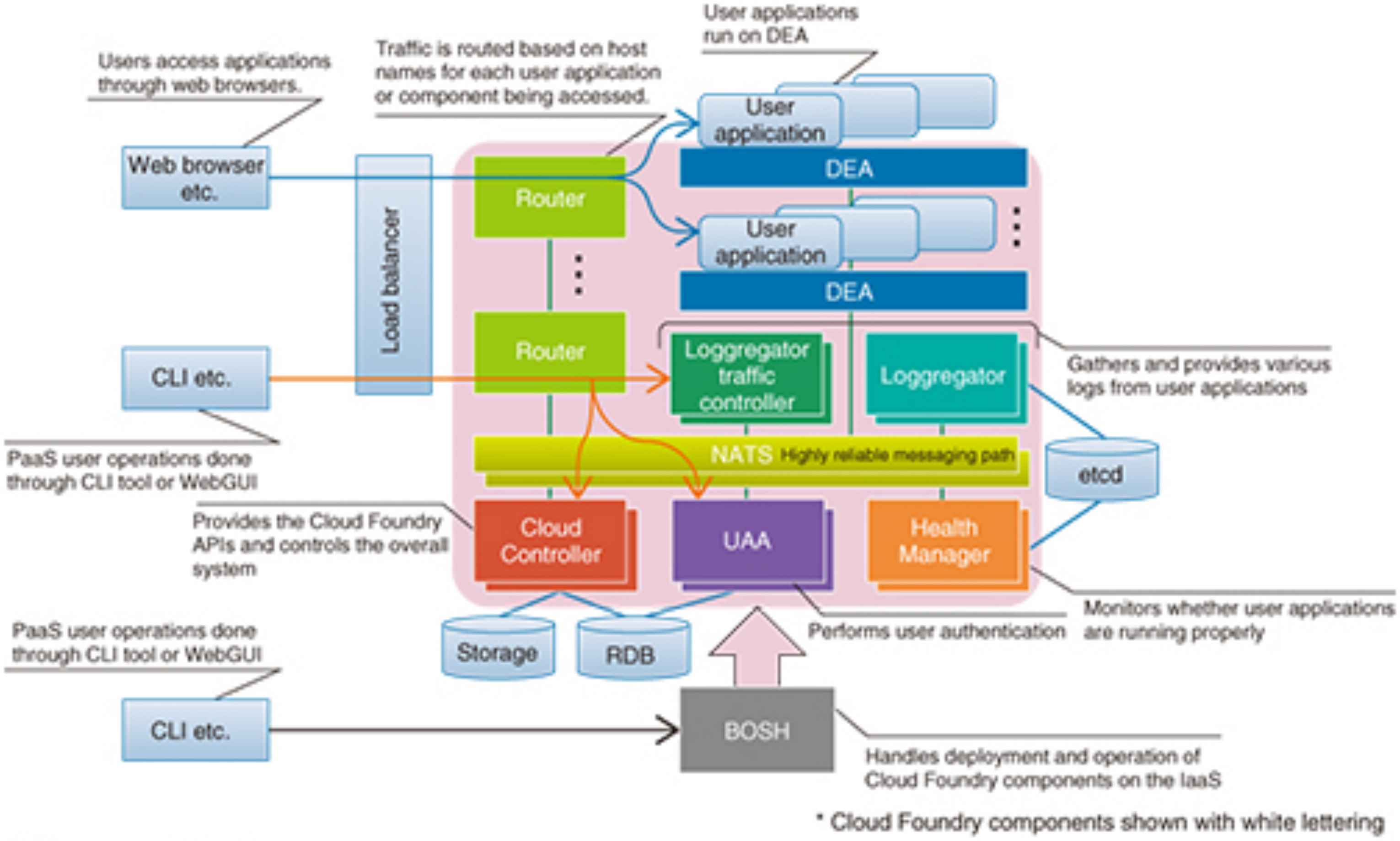
Language	**Frameworks**
Java	Spring, Play, Ratpack
Ruby	Rails, Sinatra, Rack
Node.js	Node
Groovy	Grails
Scala	Play
Python	
PHP	
Go	

Cloud Foundry

Architecture — Developer view



Cloud Foundry
Architecture — Full view


Users access applications through web browsers.
Traffic is routed based on host names for each user application or component being accessed.
User applications run on DEA
Web browser etc.
Load balancer
Router
Router
User application
DEA
User application
DEA
CLI etc.
Loggregator traffic controller
Loggregator
Gathers and provides various logs from user applications
PaaS user operations done through CLI tool or WebGUI
NATS Highly reliable messaging path
etcd
Provides the Cloud Foundry APIs and controls the overall system
Cloud Controller
UAA
Health Manager
Monitors whether user applications are running properly
Performs user authentication
PaaS user operations done through CLI tool or WebGUI
Storage
RDB
CLI etc.
BOSH
Handles deployment and operation of Cloud Foundry components on the IaaS
* Cloud Foundry components shown with white lettering

CLI: command line interface
DEA: droplet execution agent
UAA: User Account and Authentication

Source: NTT, PaaS Platform Based on Cloud Foundry, https://www.ntt-review.jp/archive/ntttechnical.php?contents=ntr201502fa2.html

Cloud Foundry

History

- 2008-08 A startup company named Cloud Foundry develops a PaaS, hosted on cloudfoundry.com
  - Written in Java
- 2009-08 SpringSource acquires Cloud Foundry
- 2009-08 VMware acquires SpringSource
- 2011-04 VMware announces beta of an Open Source project called "Cloud Foundry"
  - PaaS solution
  - Integrates with Java Spring framework, supports also Ruby and Node.js
  - Complete rewrite in Ruby
- 2012-12 VMware announces to spin out the Cloud Foundry project into Pivotal
- 2013-04 Project hand-over to Pivotal
- 2013-08 Creation of Cloud Foundry Advisory Board
  - Members: IBM, CenturyLink, Piston, Intel, Pivotal, ActiveState, Stark & Wayne, Canonical, CloudCredo
- 2013-12 First production release of Cloud Foundry
- 2014-02 Creation of Cloud Foundry Foundation
  - Platinum sponsors: EMC, IBM, HP, Pivotal, Rackspace, SAP, VMware
- 2015-11 Microsoft announces general availability of Cloud Foundry on Azure
- 2015-12 Cloud Foundry announces certification program

Source: Phil Whelan, A Brief History Of Cloud Foundry and Stackato, http://www.activestate.com/blog/2014/03/brief-history-cloud-foundry-and-stackato

Cloud Foundry

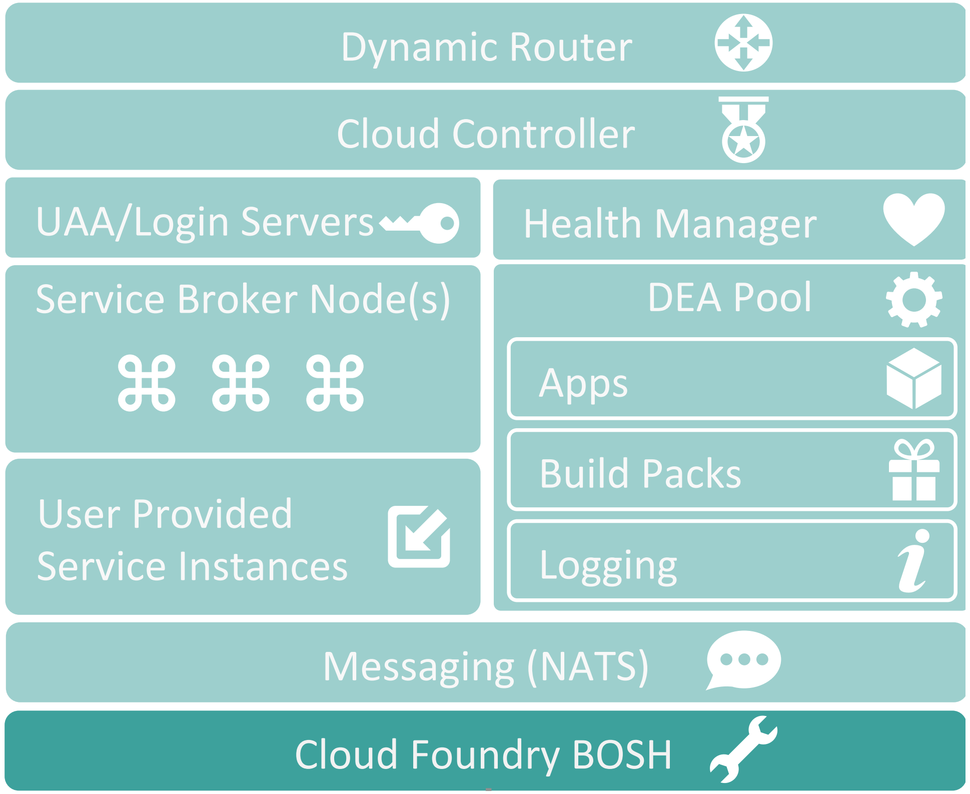
Certification

- The Cloud Foundry Foundation runs a certification program for Cloud Foundry-based offerings
  - Ensures portability across vendors
  - All certified offerings are using the same core Cloud Foundry software
  - Products need to recertify annually
- Vendors having earned the certification as of 2015-12:
  - CenturyLink AppFog
  - HPE Helion Cloud Foundry
  - Huawei FusionStage
  - IBM Bluemix
  - Pivotal Cloud Foundry
  - SAP HANA Cloud Platform
  - Swisscom Application Cloud

Cloud Foundry Components

BOSH

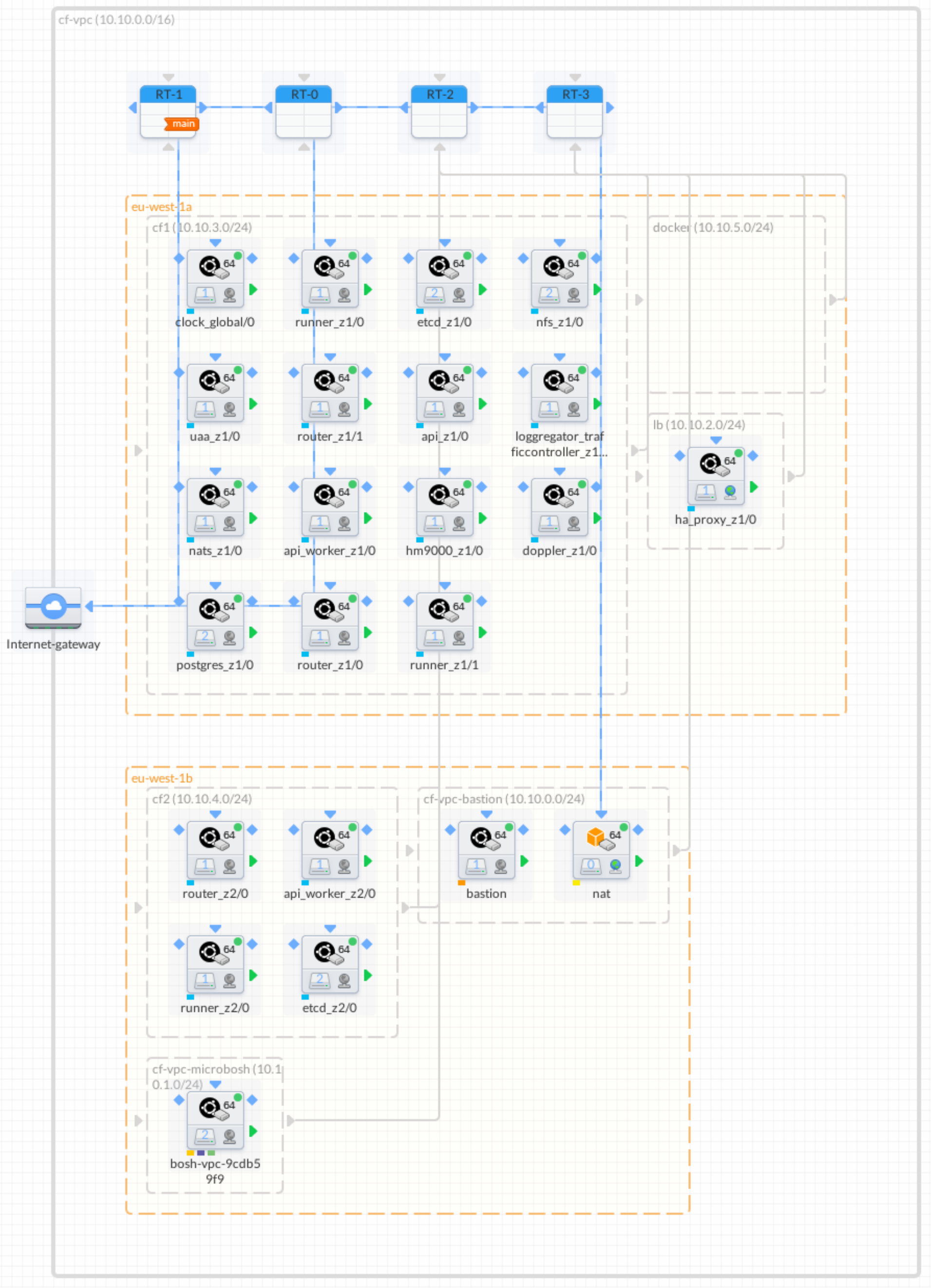
- CloudFoundry runs on top of an IaaS. BOSH (bosh outer shell) installs CloudFoundry on the IaaS automatically by creating VMs, installing and configuring CloudFoundry packages inside the VMs. During operations it scales up or down parts of CloudFoundry by allocating or freeing VMs. The system administrator accesses BOSH via a remote CLI.
- Responsible for:
  - Deployment and
  - Operations (life-cycle management) of CloudFoundry components on the IaaS
  - Monitoring
  - Failure recovery
  - Software updates



Cloud Foundry

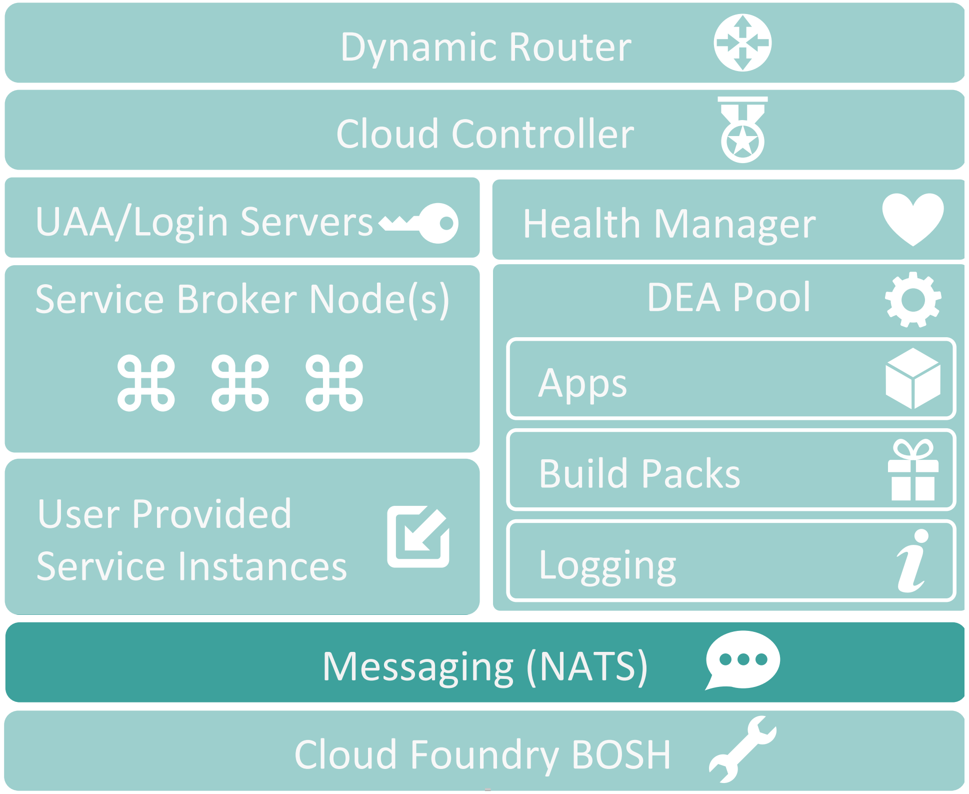
Deployment

- As an example, a typical CloudFoundry deployment on AWS uses
  - 23 virtual machines
  - 6 virtual subnets
  - 4 virtual routers
  - 1 VPC



Cloud Foundry Components
Messaging

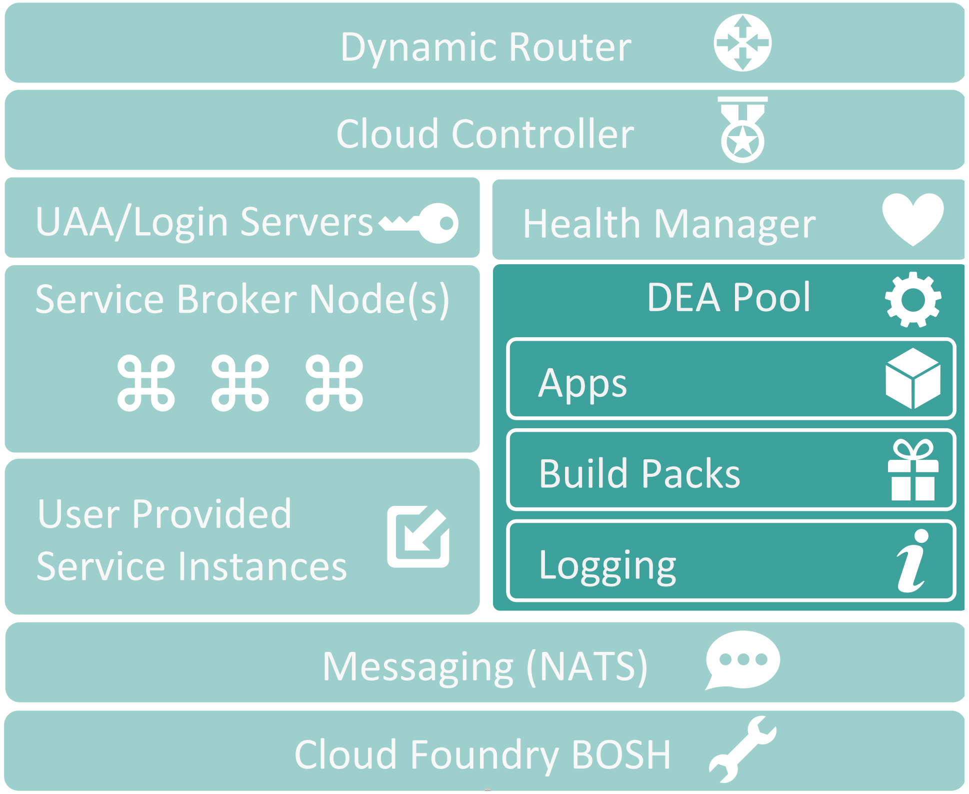
- NATS is a fast **internal** messaging bus to manage system wide communication via a publish-and-subscribe mechanism.
- Responsible for:
  - Non-Persistent messaging
  - Pub/Sub
  - Queues (app events)
  - Directed messages (INBOX)



Cloud Foundry Components

Droplet Execution Agent (DEA)

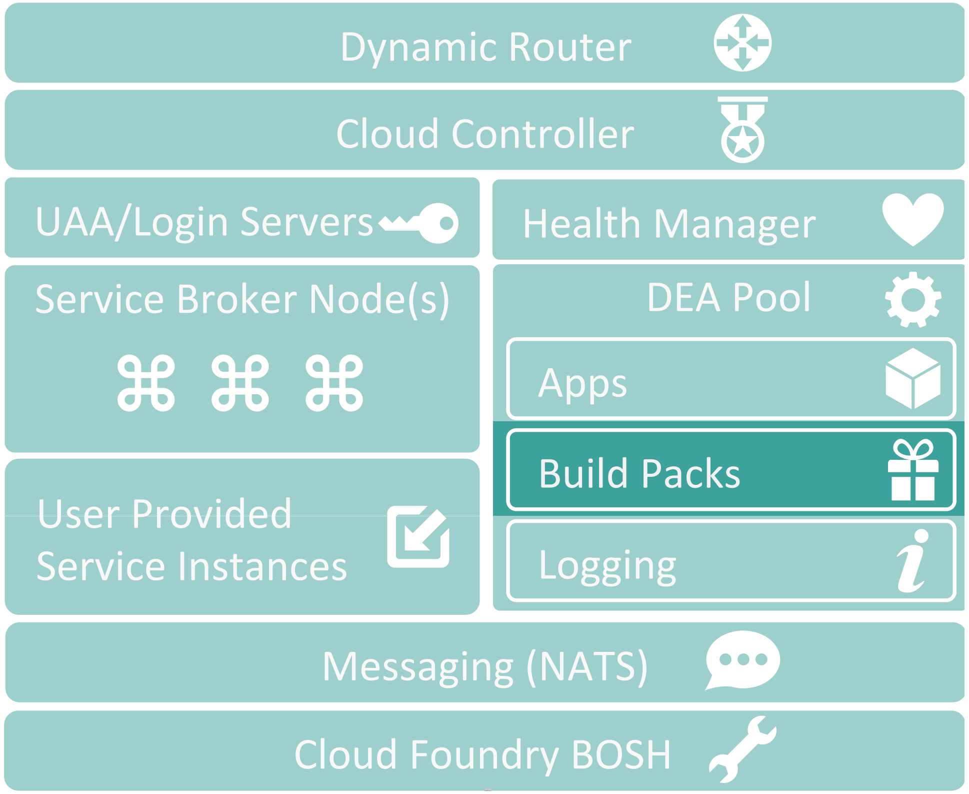
- Droplet Execution Agents (DEA) are secure and fully isolated containers. DEAs are responsible for an Apps lifecycle: building, starting and stopping Apps as instructed. They periodically broadcast messages about their state via the NATS message bus.
- Responsible for:
  - Managing Linux containers (Warden)
  - Monitoring resource pools
    - Process
    - File system
    - Network
    - Memory
  - Managing app lifecycle
  - App log and file streaming
  - DEA heartbeats (NATS to CC, HM)



Cloud Foundry Components

Buildpacks

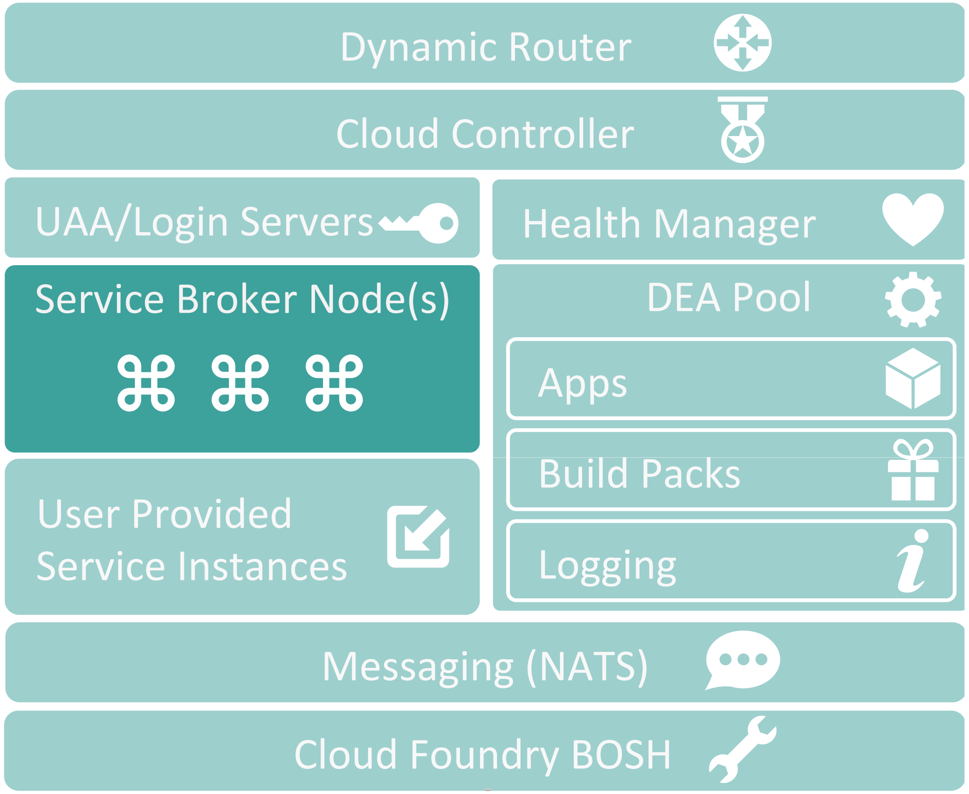
- Buildpacks are Ruby scripts that detect application runtimes/frameworks/plugins, compile the source code into executable binaries, and release the app to an assigned DEA. Runtime components can be cached for faster execution of subsequent app pushes.
- Responsible for:
  - Staging*
    - /bin/detect
    - /bin/compile
    - /bin/release
  - Configure droplet
    - Runtime (Ruby/Java/Node/Python)
    - Container (Tomcat/Websphere/Jetty)
    - Application (.WAR, .rb, .js, .py)



Cloud Foundry Components

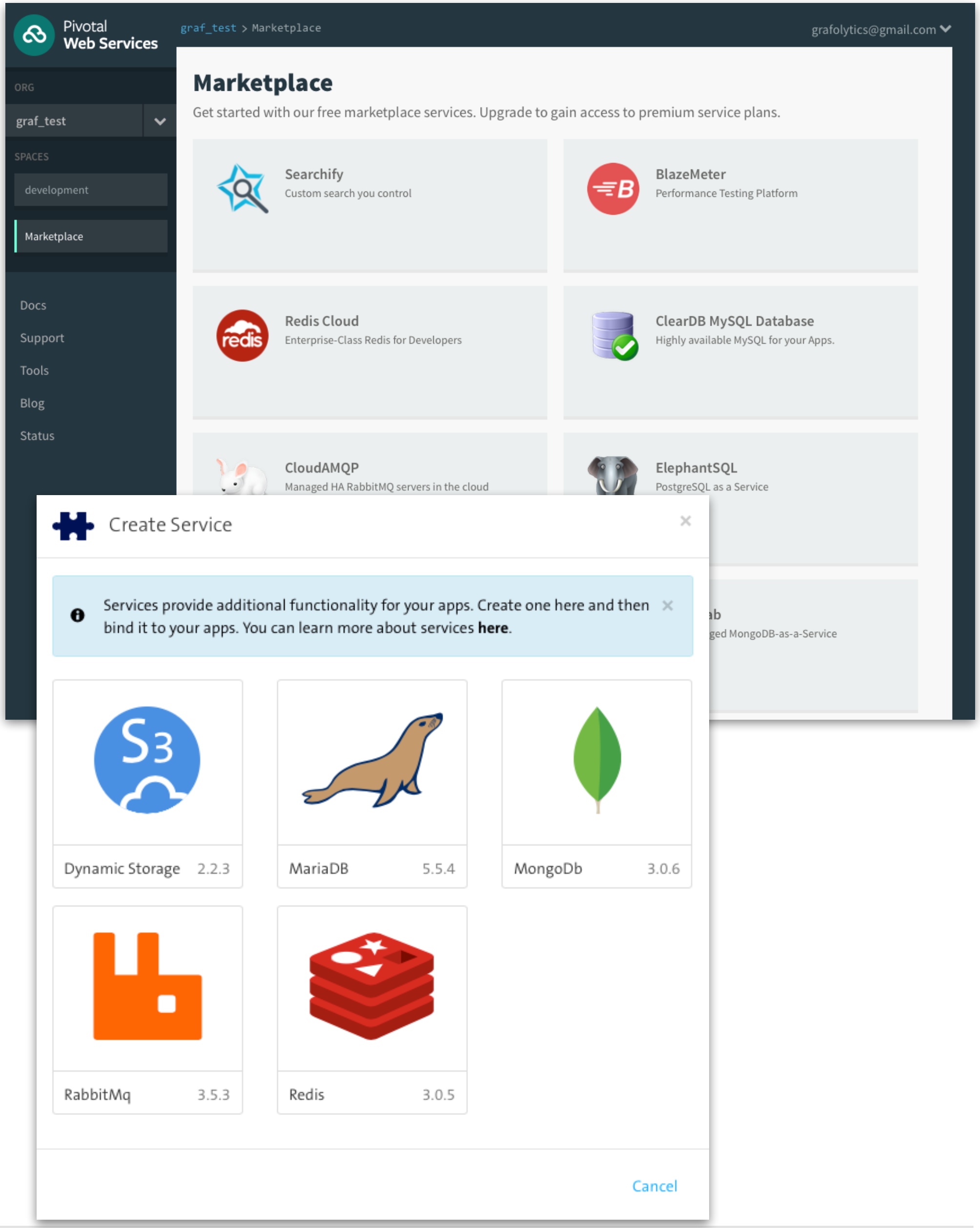
Service Broker

- Service Brokers provide an interface for native and external 3rd party services. Service processes run on Service Nodes or with external as-a-service providers (e.g., email, database, messaging, etc.)
- Responsible for:
  - Advertising service catalog
  - Makes create/delete/bind/unbind calls to service nodes
  - Requests inventory of existing instances and bindings from cloud controller for caching, orphan management
  - SaaS marketplace gateway
  - Implemented as HTTP endpoint, written in any language.



Cloud Foundry Components
Services Marketplace

- The services offered via the Service Broker differ from provider to provider.
- Typically one finds among the services
    - Relational databases (e.g., MySQL, PostGres)
    - Object stores
    - NoSQL databases (e.g., MongoDB, Redis)
    - In-memory caches (e.g., memcached)
    - Message queues (e.g., RabbitMQ)
- Typically database services are provided as dedicated instance (think Amazon RDS), not as a multi-tenant database (like Google Datastore).
- A service is not necessarily provided by the PaaS provider, it may be provided by a third party.



Marketplace

Get started with our free marketplace services. Upgrade to gain access to premium service plans.

Searchify
Custom search you control

BlazeMeter
Performance Testing Platform

Redis Cloud
Enterprise-Class Redis for Developers

ClearDB MySQL Database
Highly available MySQL for your Apps.

CloudAMQP
Managed HA RabbitMQ servers in the cloud

ElephantSQL
PostgreSQL as a Service

ab
ged MongoDB-as-a-Service

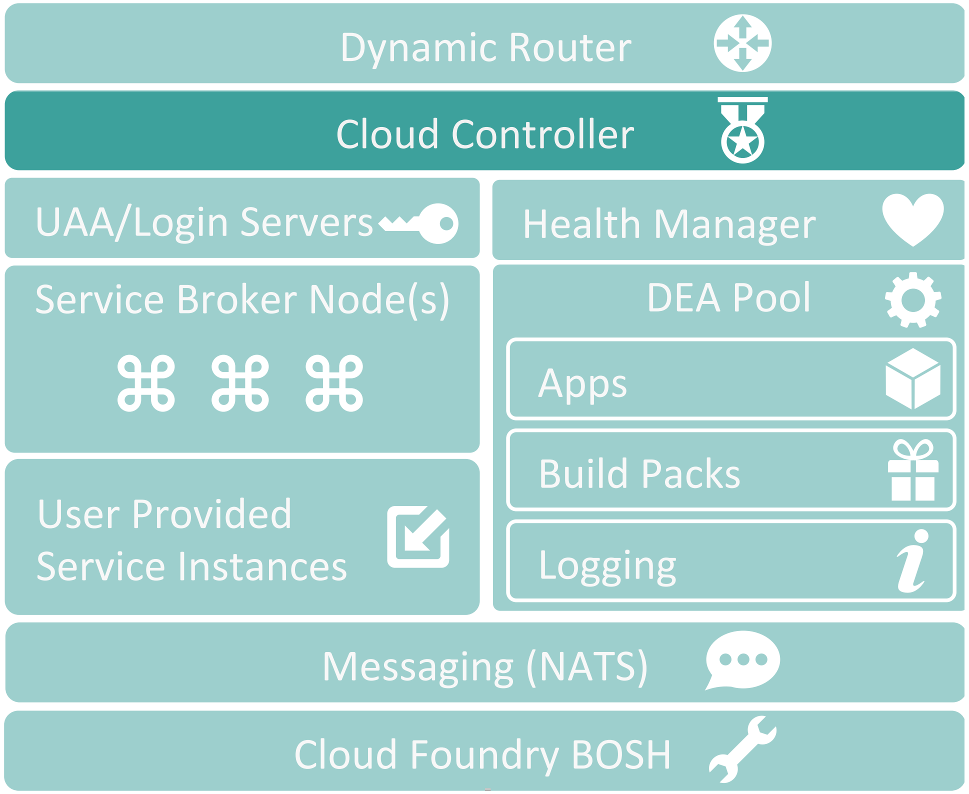
Create Service

Services provide additional functionality for your apps. Create one here and then bind it to your apps. You can learn more about services **here**.

Dynamic Storage	2.2.3
MariaDB	5.5.4
MongoDb	3.0.6
RabbitMq	3.5.3
Redis	3.0.5

Cloud Foundry Components
Cloud Controller

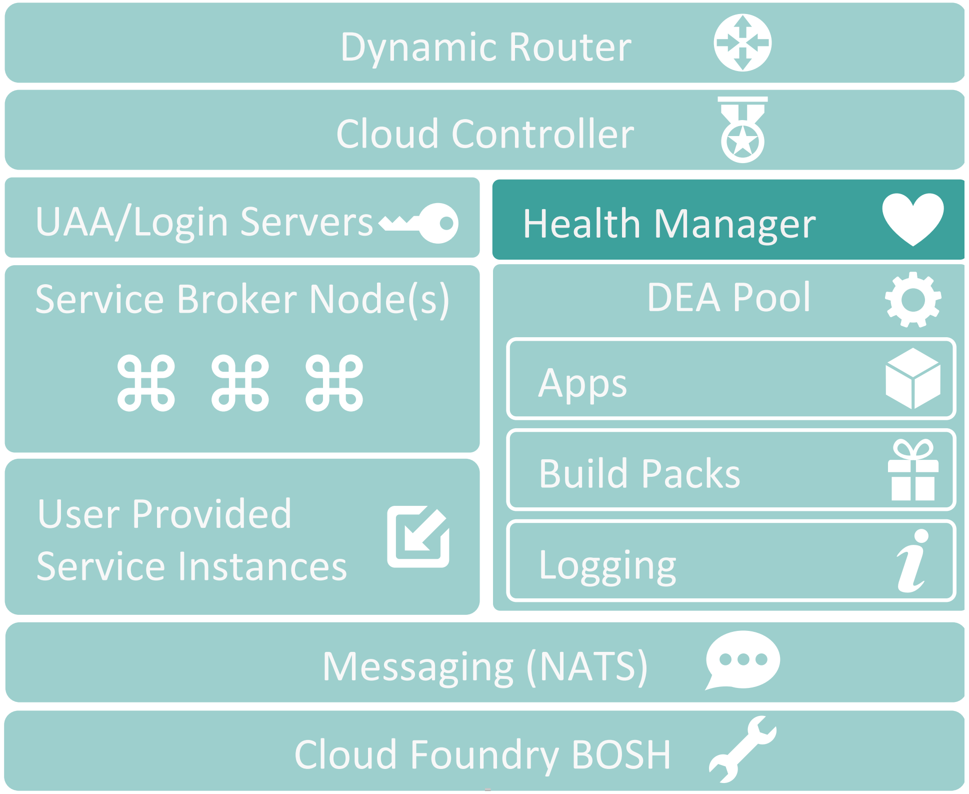
- The Cloud Controller maintains command and control systems, including interface with clients (CLI, Web UI, Spring STS), account and provisioning control. It also provides RESTful interface to domain objects (apps, services, organizations, spaces, service instances, user roles, and more).
- Responsible for:
  - Expected App state, state transitions, and desired convergence
  - Permissions/Auth
  - Orgs/Spaces/Users
  - Services management
  - App placement
  - Auditing/Journaling and billing events
  - Blob storage



Cloud Foundry Components

Health Manager

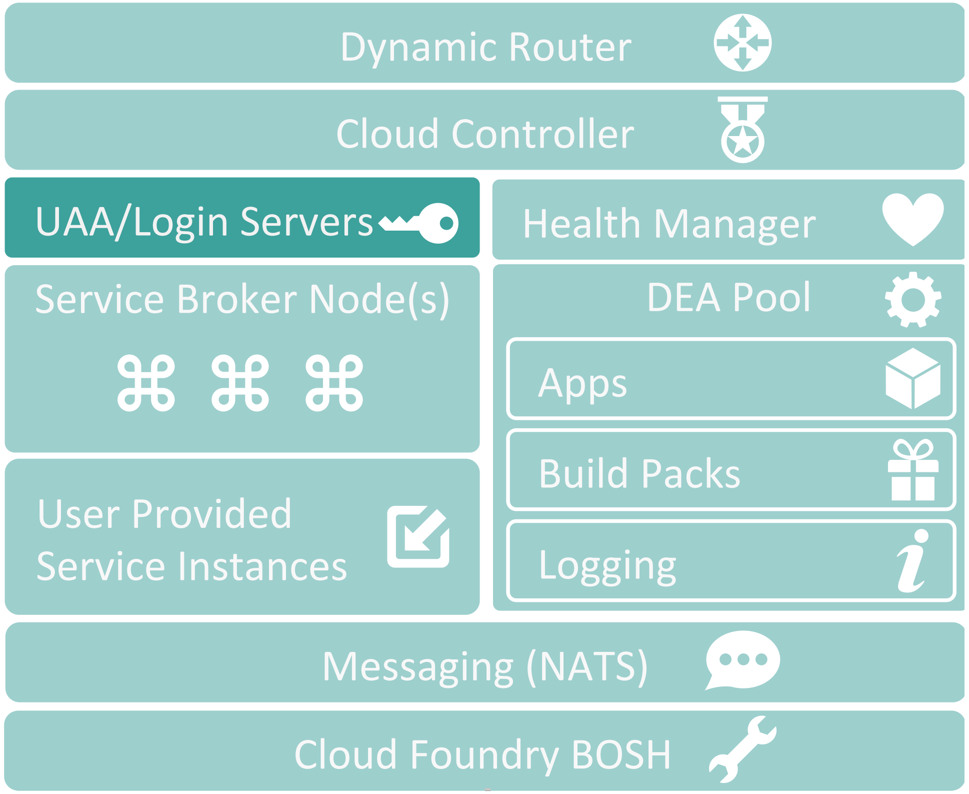
- Health Manager monitors application uptime by listening to the NATS message bus for mismatched application states (expected vs. actual). The Cloud Controller publishes expected state and the DEAs publish actual state. State mismatches are reported to the Cloud Controller.
- Responsible for:
  - Maintains the **actual state** of apps
  - Compares to **expected state**
  - Sends suggestions to make actual match expected (cannot make state changes itself – only CC can do that!)



Cloud Foundry Components

User Authorization and Authentication (UAA) and Login Servers

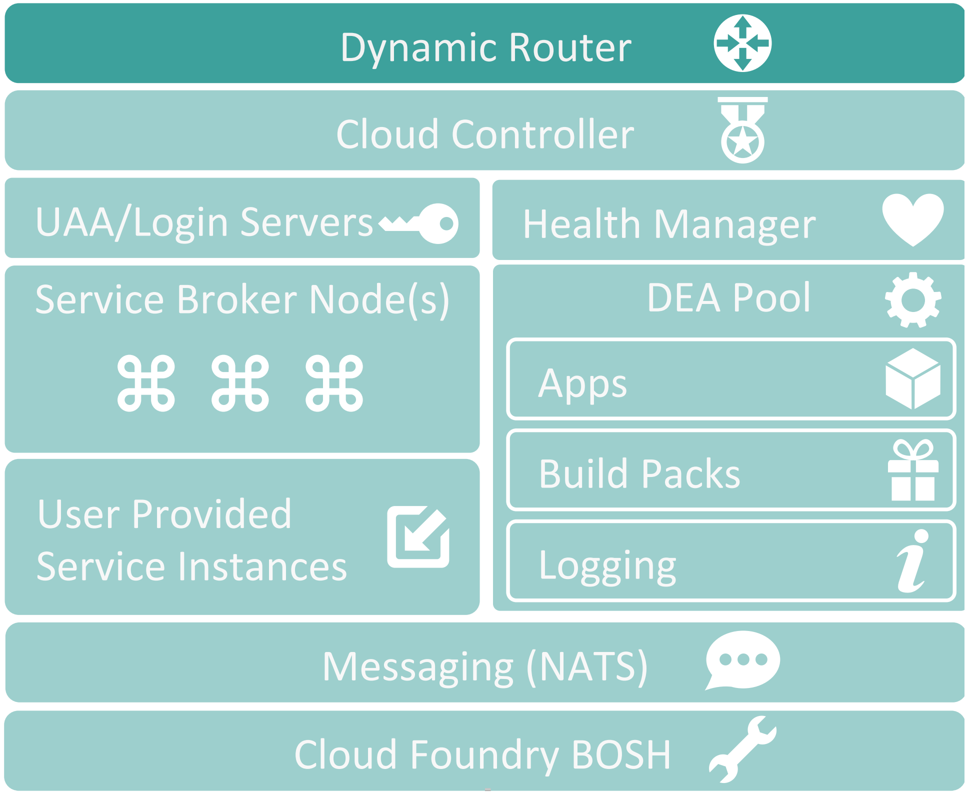
- User Authorization and Authentication (UAA) provides identity, security and authorization services. It manages third party Oauth 2.0 access credentials and can provide application access and identity-as-a-service for apps running on Cloud Foundry. Composed of: UAA Server, Command Line Interface, Library.
- Responsible for:
  - Token Server
  - ID Server (User management)
  - OAuth Scopes (Groups) and SCIM
  - Login Server
    - UAA Database
    - SAML support (for SSO integration) and Active Directory support with the VMWare SSO Appliance
  - Access auditing



Cloud Foundry Components

Router

- The router shapes and routes all external system traffic (HTTP/API) and application traffic from the internet/intranet. It maintains a dynamic routing table for each load-balanced app instance with IP addresses and ports.
- Responsible for:
  - Load balancing
  - Maintaining an active routing table
  - Access logs
  - Supports web sockets



Cloud Foundry Components

Use of other Open Source software

- Cloud Foundry makes use of a number of components developed in other projects
  - Consul — Provides service discovery and configuration management for clusters. Implemented as distributed datastore that survives node failures. Developed by HashiCorp.
  - etcd — Similar to Consul, . Developed by CoreOS.
  - NFS — Networked File System
  - HA Proxy — Load balancer
  - PostGres — Relational database

References

- Pivotal, Cloud Foundry Technical Overview, http://www.slideshare.net/cdavisafc/cloud-foundry-technical-overview