Microsoft

ARCHITECH

Kubernetes Hackfest

Building Cloudy Applications

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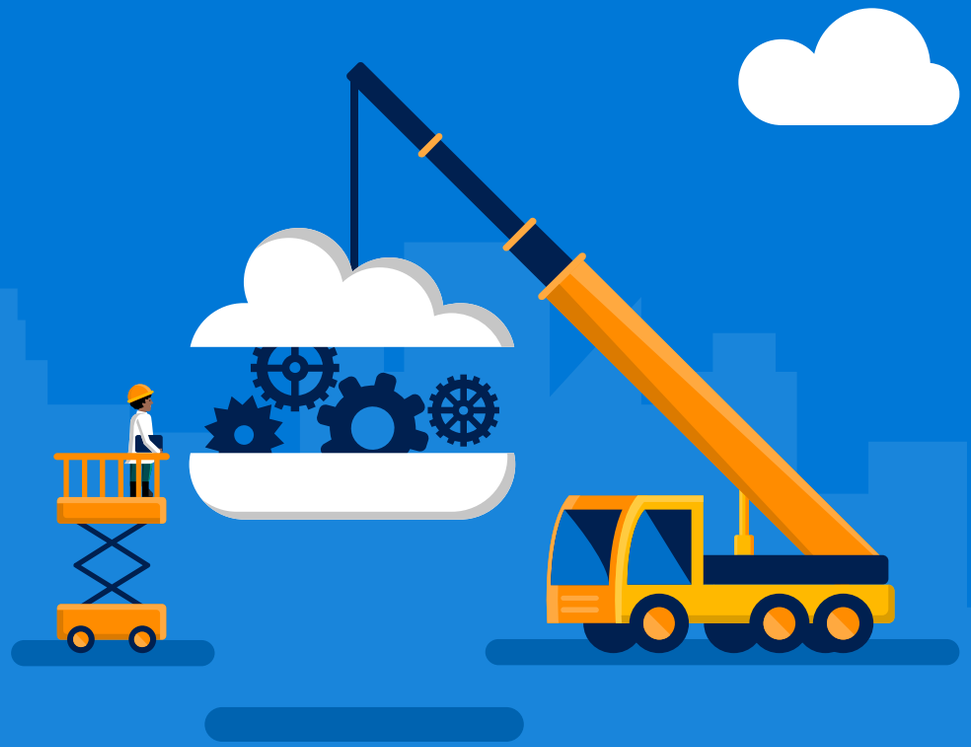


Setting up you environment

- Wifi Access: TBD
- Link to Github Repo with all code/examples:
  - https://github.com/jungho/k8s-bootcamp

Agenda

Time	Activity
8:00AM - 8:30AM	REGISTRATION
8:30AM – 9:00AM	BREAKFAST
9:00AM – 10:30AM	Kubernetes Architecture and Core Concepts
10:30AM – 10:45AM	BREAK
10:45AM – 12:00	Hackfest Challenges
12:30 – 1:15PM	LUNCH
12:45PM – 2:00PM	Deploying/Reverse-Engineering the Todo Application
2:00PM – 2:45PM	Advanced K8S topics (RBAC, Ingress, Helm)
2:45PM – 3:00PM	BREAK
3:00PM – 4:15PM	Hackfest Challenges
4:15PM – 4:30PM	End of Day Summary & Prizes!!

Hackfest Approach

- Goal is to maximize hands-on time
- Introduce a series of topics then break for “Challenges”
- Not step-by-step guided labs.
- Code samples available
- Advanced scenarios possible

How to get help...

- Kubernetes API Reference: https://v1-8.docs.kubernetes.io/docs/api-reference/v1.8/
- kubectl explain e.g. kubectl explain pods.spec, kubectl explain pods.spec.containers...
- Ask us :-)

Objective By End of Day

- You have hands-on exposure deploying a micro-service based application to K8S
- You have a base understanding of K8S architecture
- You have a base understanding of core K8S concepts and resources
- You have a base understanding of K8S tooling
- You are excited about K8S and how it can change how you build enterprise solutions using open-source technologies on Azure!!

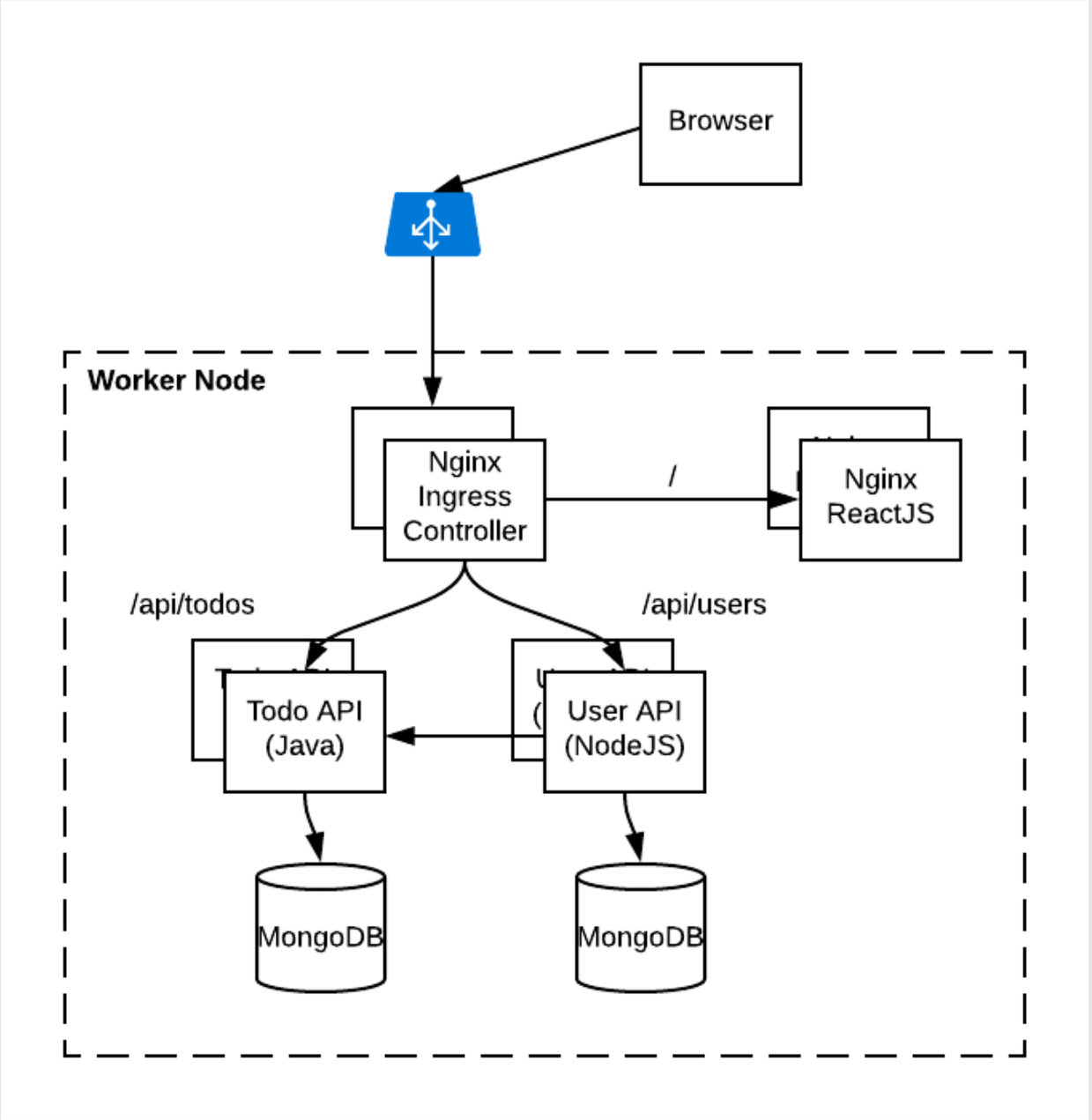
What we won’t cover

- K8S is a large topic, we can’t cover everything in one day
- We won’t cover:
  - How to secure your cluster (e.g PodSecurityPolicy, NetworkPolicy, etc)
  - Best-practices for building lean, secure Docker images
  - Best-practices when building native K8S apps
  - Different cluster provisioning options e.g. acs-engine, kubeadm, kubespray
  - CNI (Container Network Interface) and different options to meet K8S network requirements
  - Advanced scheduling scenarios (e.g taints/tolerations, affinity/anti-affinity)
  - Service-mesh such as Linkerd, Istio
  - Auto-scaling cluster nodes on Azure
  - Extending K8S e.g. Custom Resource Definitions, custom controllers

We do have a 2-Day Kubernetes Bootcamp for that!!

Todo Application

- Simple Micro-service based application
- ReactJS UI
- Java Springboot TodoItem API
- NodeJS User API
- MongoDB for the database
- Supports OpenID Connect/OAuth2 with Azure AD

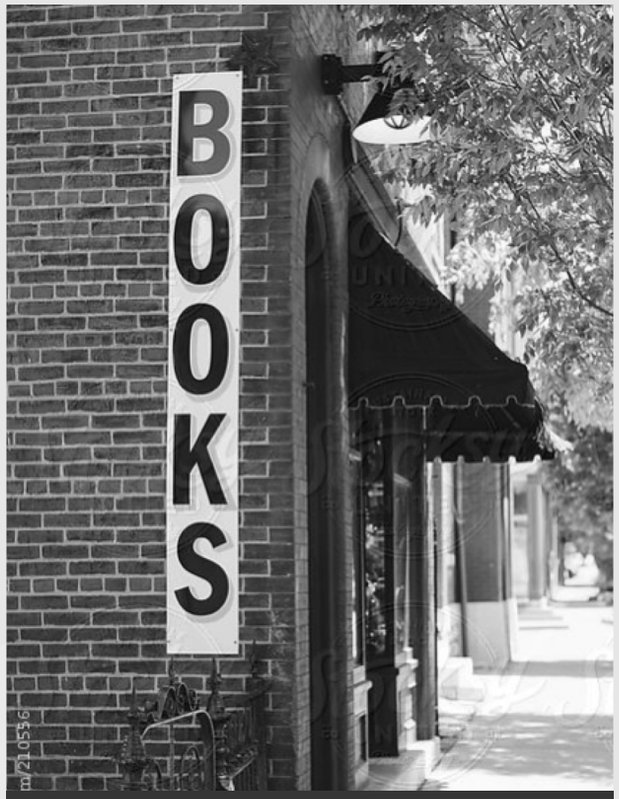


Why Modernize Apps?

NETFLIX

UBER

skype™



amazon.com

Our world is changing

Past

Long application cycles

Monolithic apps

Servers and VMs

Less data

Distinct infrastructure and operations teams

Today

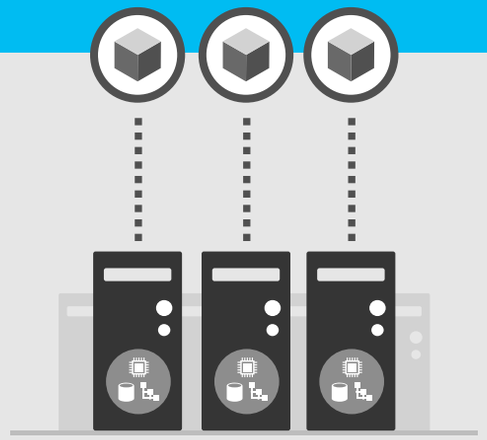
Rapid innovation

Loosely-coupled apps and microservices

Serverless

Big Data

Service-focused DevOps teams

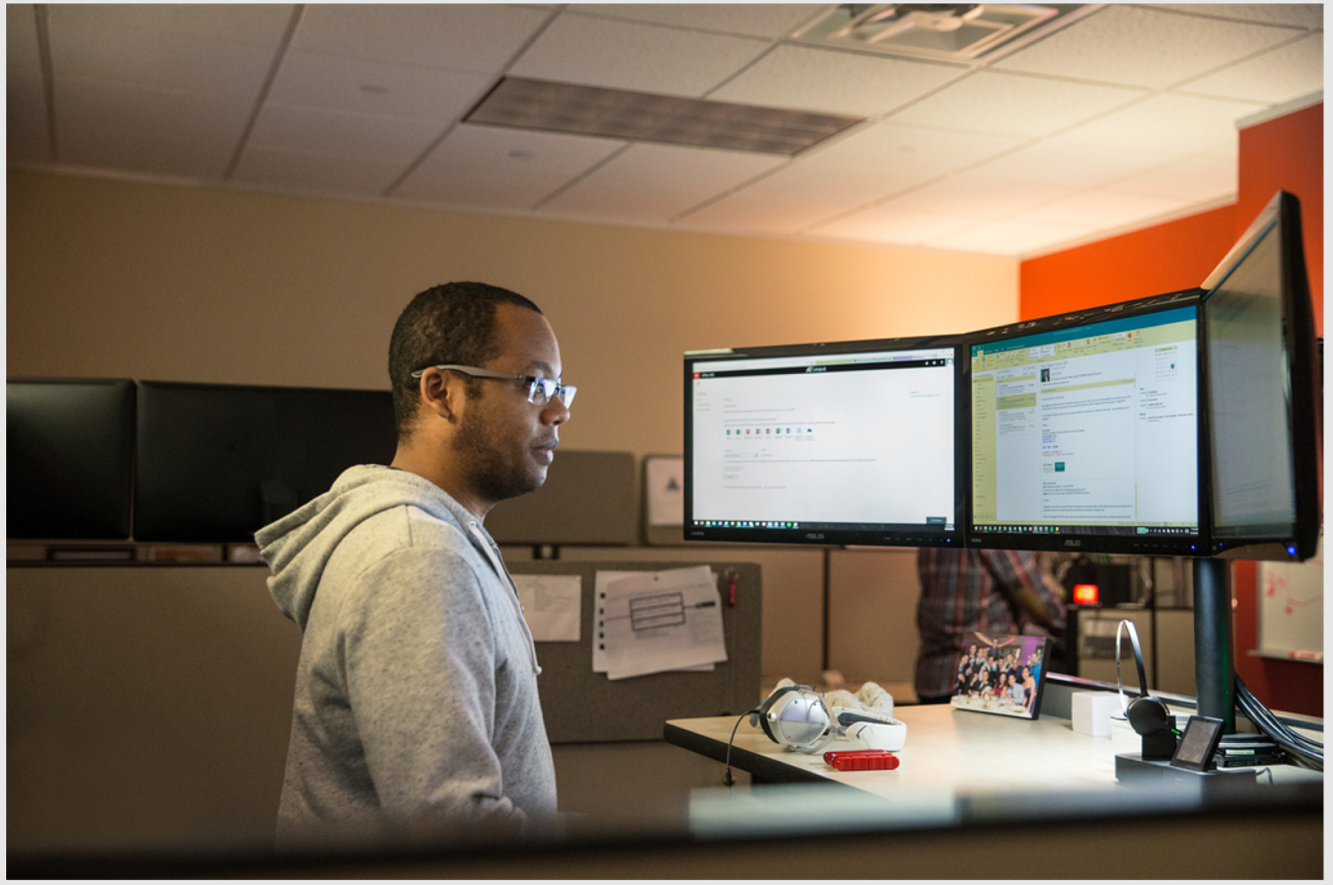


Servers

Services

Where do developers spend time…

- Maintaining ***existing*** applications
- "Fixing" ***existing*** applications
- Adding features to ***existing*** applications
- Fixing the feature someone else added to the ***existing*** applications
- Building a ***new*** application *(maybe … if there's time)*

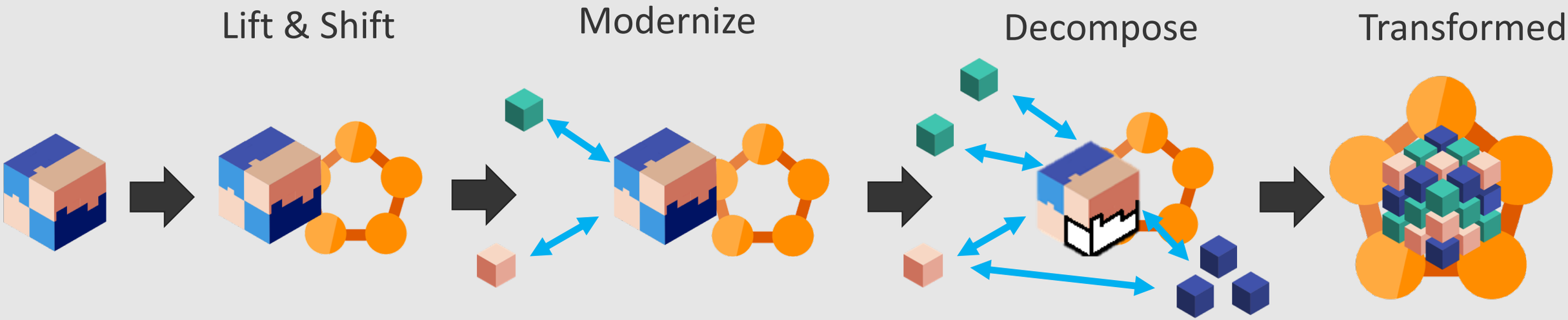


Where do application admins spend time…

- Maintaining ***existing*** applications
- Re-deploying new versions of ***existing*** applications
- Diagnosing issues with ***existing*** applications
- Troubleshooting issues from feature additions to the ***existing*** applications
- Deploying a ***new*** application

Help customers free resources and work more efficiently by modernizing traditional applications

Ways to Modernize Applications



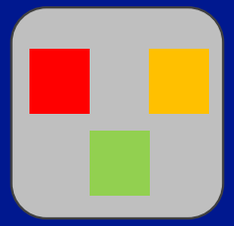
1) Traditional application

…You can stop at any stage

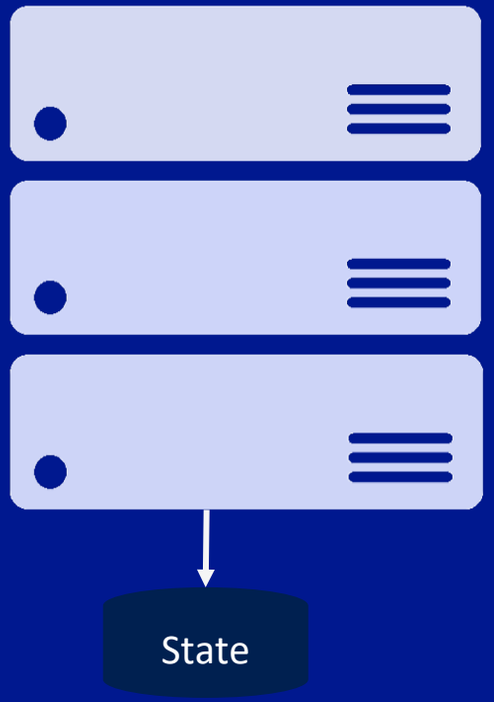
Monolithic application approach

- A monolithic application has most of its functionality within a single process that is commonly componentized with libraries.

Monolith



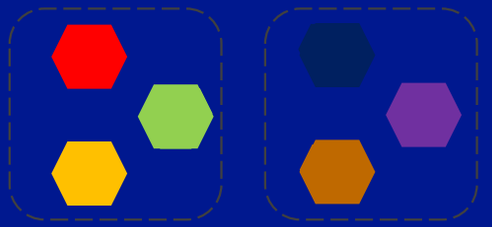
- Scales by cloning the app on multiple servers/VMs/Containers



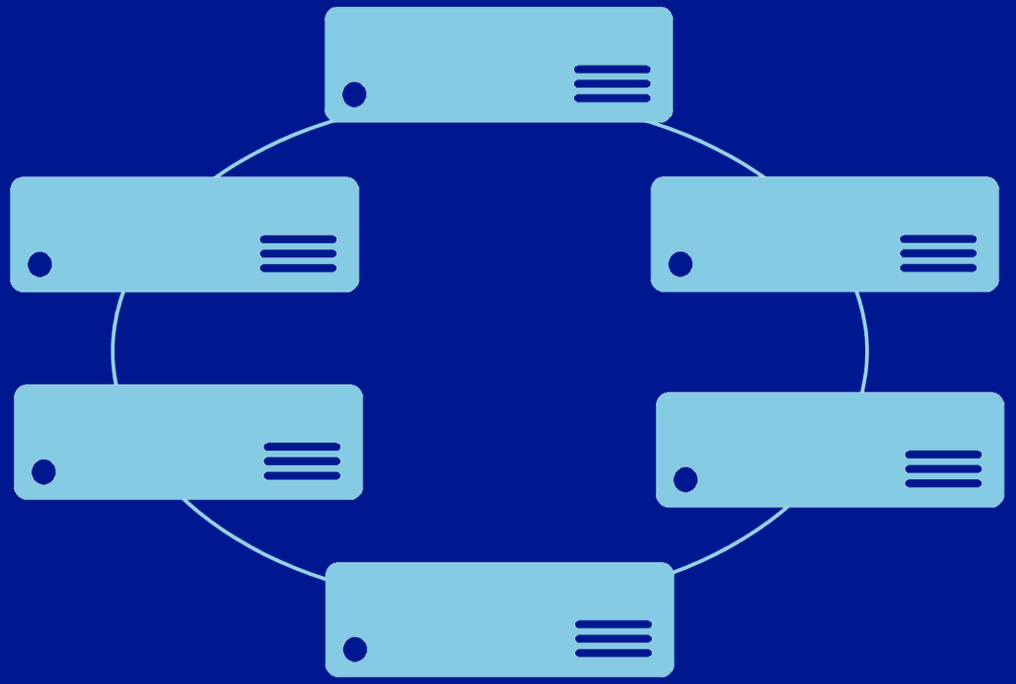
Microservices application approach

- A microservice application separates functionality into separate smaller services.

Microservices

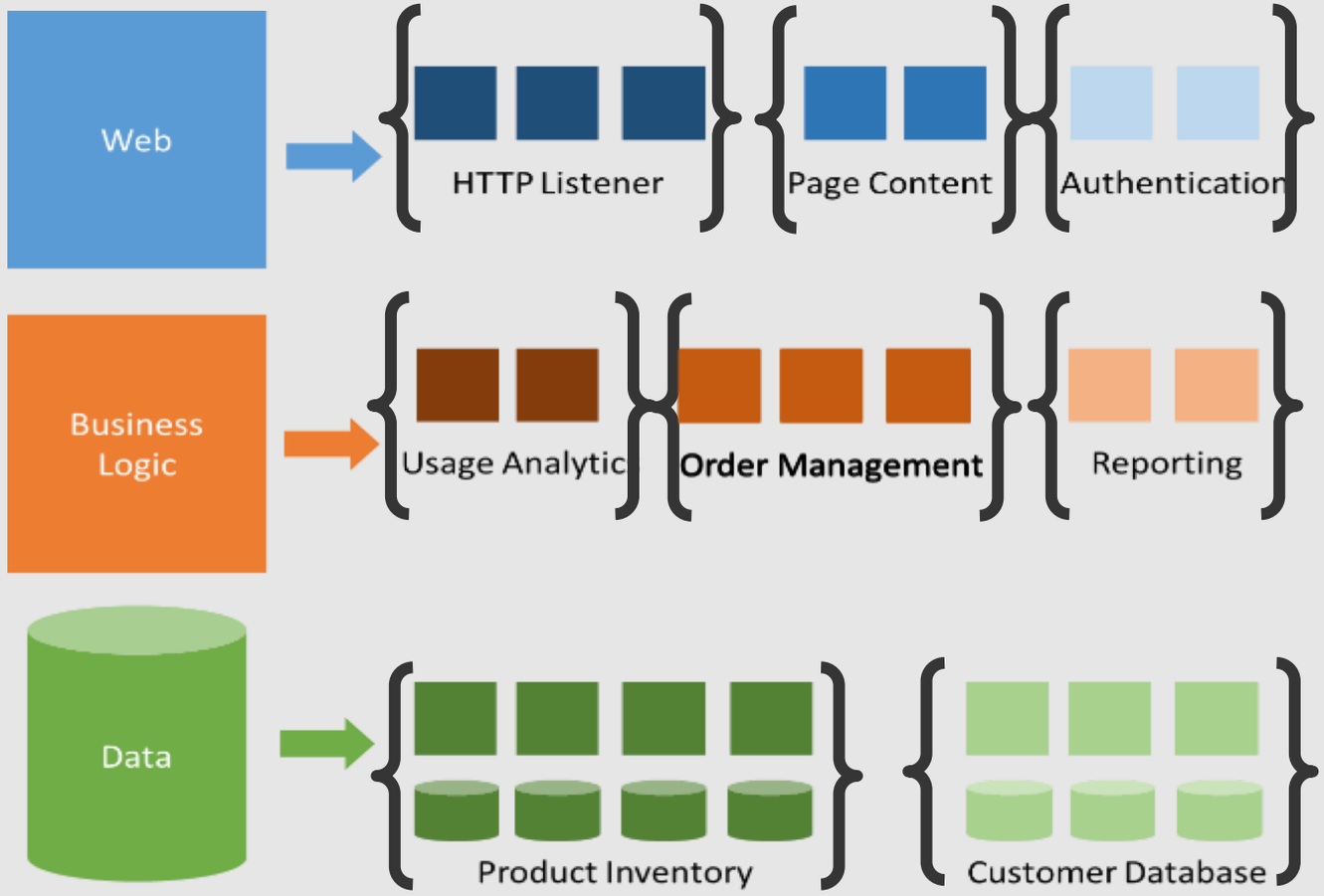


- Scales out by deploying each service independently creating instances of these services across servers/VMs/containers



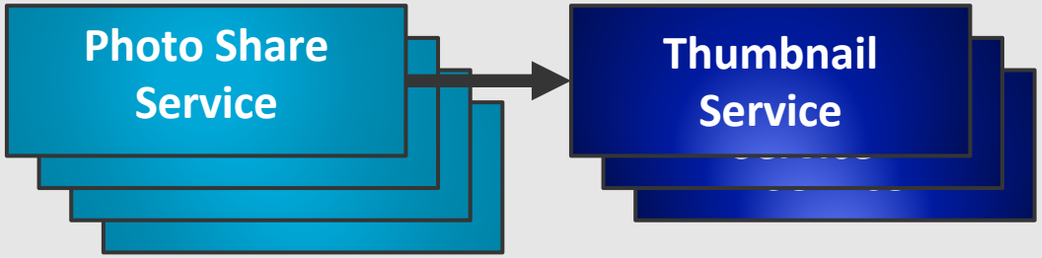
Modernization with microservices

- Individually built and deployed
- Small, independent services
- Integrate using published API
- Fine-grained, loosely coupled

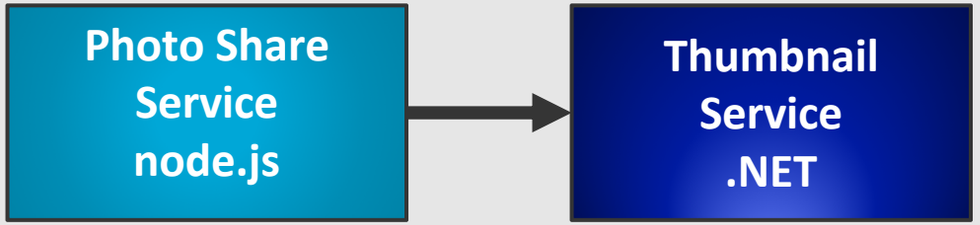


Microservice architecture benefits

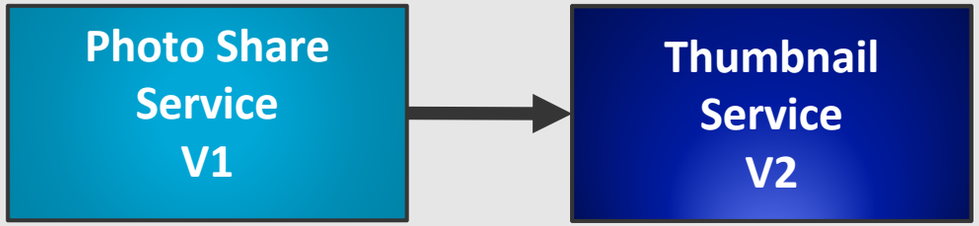
Scale Independently



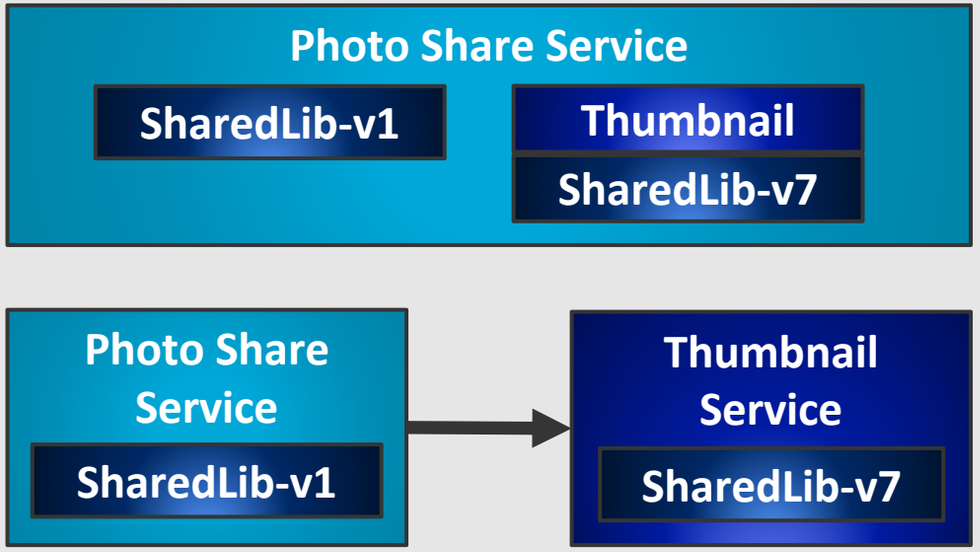
Different Technology Stacks



Independent Deployments



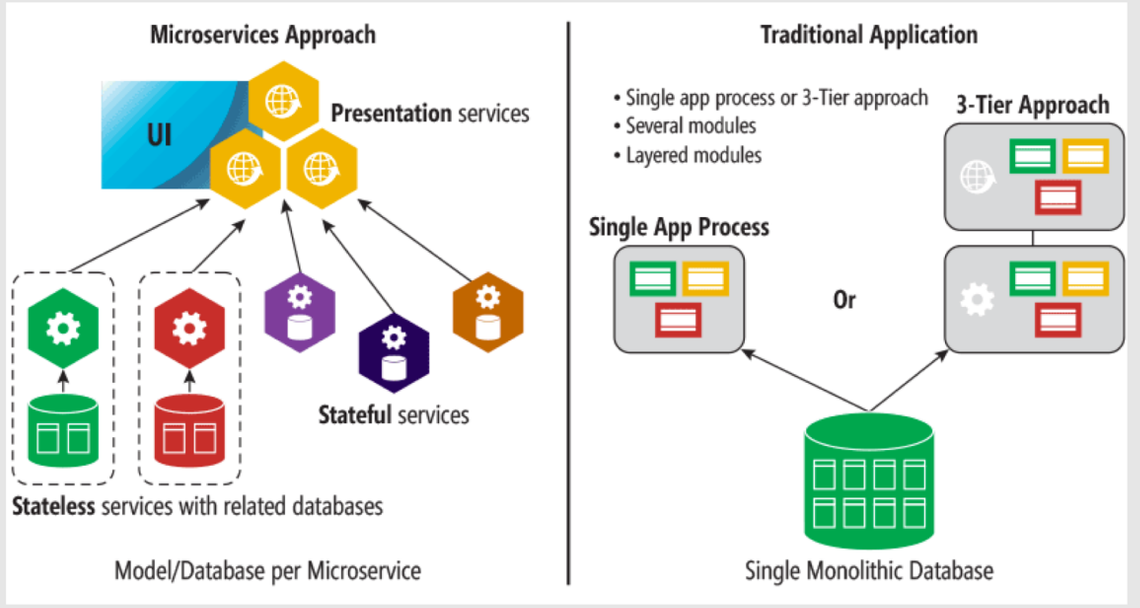
Conflicting Dependencies



Microservices Benefits

- ✓ Independent deployments
- ✓ Enables continuous delivery
- ✓ No downtime upgrades
- ✓ Improved scale and resource utilization per service
- ✓ Fault isolation
- ✓ Security isolation
- ✓ Services can be distributed across multiple servers or environments

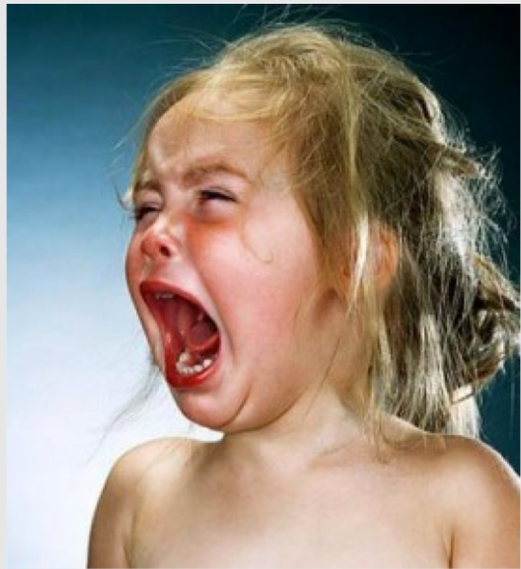
- ✓ Multiple languages / diversity
- ✓ Smaller, focused teams
- ✓ Code can be organized around business capabilities
- ✓ Autonomous developer teams



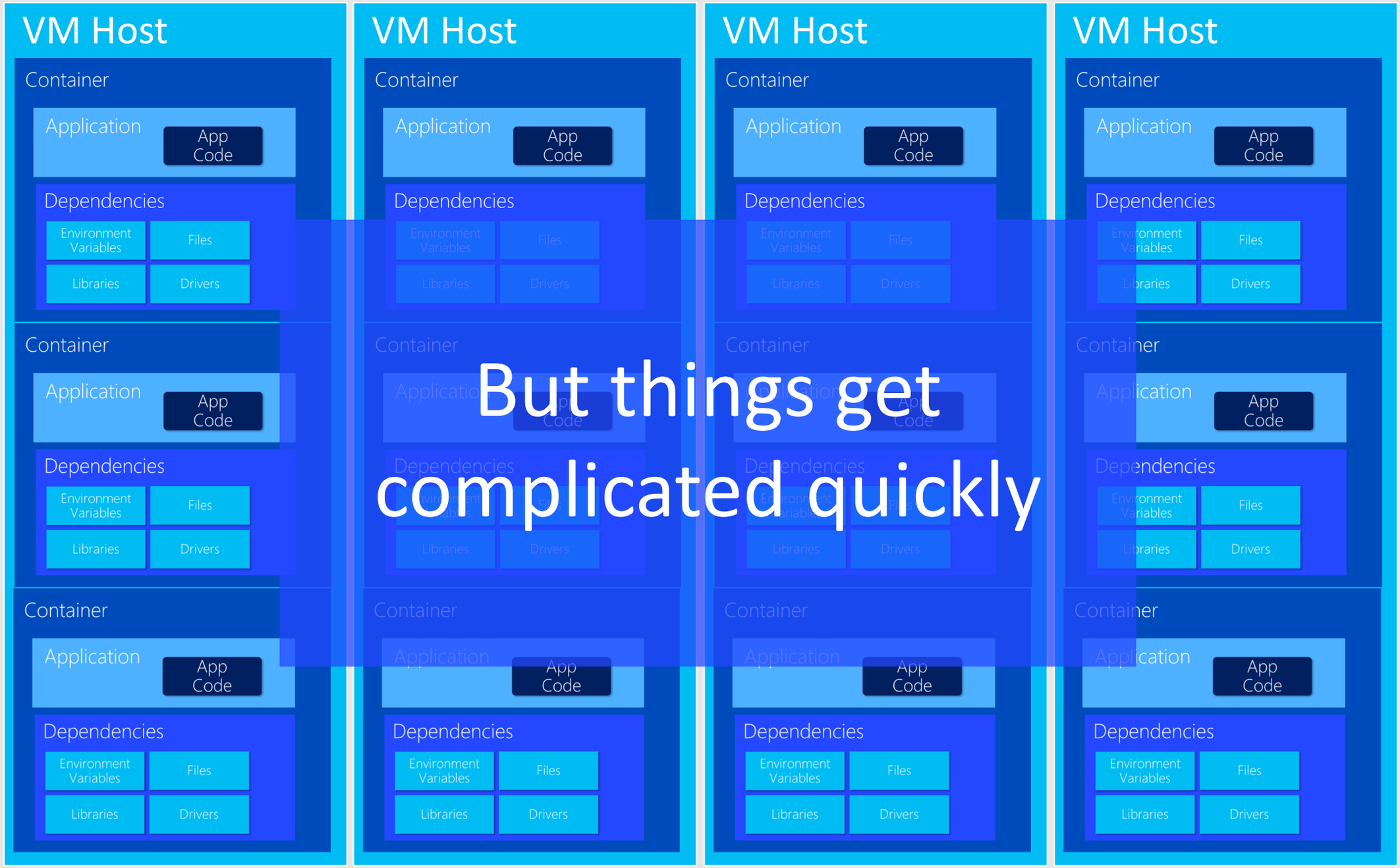
Microservices – The Hard Part

- ✓ Deployment is complex
- ✓ Testing is difficult
- ✓ Debugging is difficult
- ✓ Monitoring/Logging is difficult
- ✓ New service versions must support old/new API contracts
- ✓ Distributed databases make transactions hard
- ✓ Cluster and orchestration tools overhead

- ✓ Distributed services adds more network communication
  - ✓ Increased network hops
  - ✓ Requires failure/recovery code
  - ✓ Need service discovery solution
- ✓ Advanced DevOps capability: short-term pain for long-term gain



“Distributed apps are sufficiently complicated that they need to be flown by the instruments”


VM Host
Container
Application
App Code
Dependencies
Environment Variables
Files
Libraries
Drivers
But things get complicated quickly


VM Host
Container
Application
App Code
Dependencies
Environment Variables
Files
Libraries
Drivers
Very Quickly

What do cluster orchestrators do?

Provision	Security
Deploy (app / container)	Storage
Health Monitoring	Networking
Scaling	Service Discovery
Monitoring / Logging	Registry

Container Management at Scale

Cluster Management: deploy and manage cluster resources	**Scheduling**: where containers run	**Lifecycle & Health:** keep containers running despite failure	**Naming & Discovery**: where are my containers	**Load Balancing**: evenly distribute traffic
Scaling: make sets of containers elastic in number	**Image repository**: centralized, secure Docker container images	**Continuous Delivery**: CI/CD pipeline and workflow	**Logging & Monitoring**: track what's happening in containers and cluster	**Storage volumes**: persistent data for containers

Orchestrator Ecosystem (Constantly Changing)

Cloud services

- Azure Container Services (AKS, ACS)
- Azure Service Fabric (ASF)
- Amazon EC2 Container Services (ECS)
- Google Kubernetes Engine (GKE)
- Heroku
- Tutum

Low-level

- Docker Swarm
- CoreOS Fleet

Complete platforms

- Kubernetes
- Red Hat OpenShift (OCP)
- Cloud Foundry
- Mesosphere (Marathon)
- Enterprise DC/OS
- Docker Enterprise
- Rancher

Why Kubernetes (K8s)?

- Industry Momentum
  - It’s Microsoft’s Direction
  - It’s Docker’s Direction
  - It’s OCP’s Direction
  - It’s Cloud Foundry’s Direction
- Brendan Burns
  - One of the Founders of K8s
  - Now works at MS heading up Container Strategies

What is Kubernetes?

- History
  - Google open sourced borg. Google still actively involved, but less so every day
  - Schedules and runs application containers across a cluster of machines
  - Kubernetes v1.0 released on July 21, 2015. Joe Beda, Brendan Burns, & Craig McLuckie
  - Over 1,700 authors
- Key features
  - Declarative infrastructure
  - Self-healing
  - Horizontal scaling
  - Automated rollouts and rollbacks
  - Service discovery and load balancing
  - Automatic binpacking
  - Storage orchestration
  - Secret and configuration management
  - Not a PaaS platform

Azure Container Service (AKS)

Simplify the deployment, management, and operations of Kubernetes

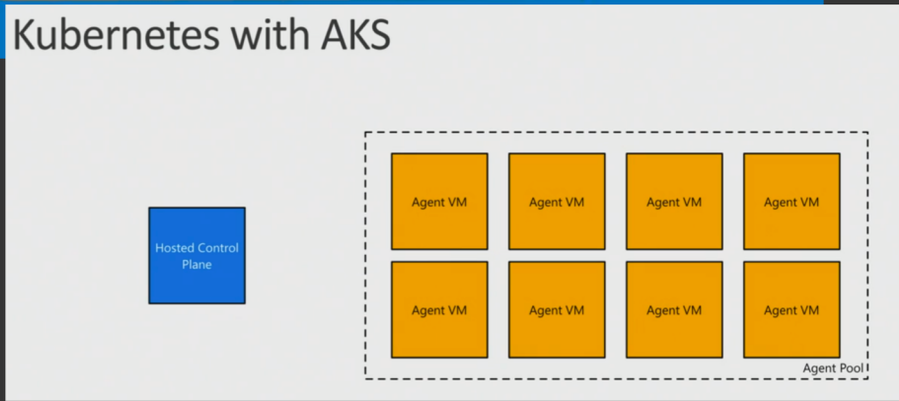
Container hosting solution optimized for Azure

Azure-hosted control plane

Only pay for resource consumption

Automated upgrades, self-healing, easy scaling

Ease Kubernetes management with open source upstream portability



AKS Roadmap for GA

- Automated Kubernetes upgrades
- Self-healing Control Plane
- etcd SSD backed, automated, H/A, backup/restore
- Customized networking (Azure VNETs, CNI)
- Cluster scaling
- TLS everywhere. Backed by Azure KeyVault
- RBAC and Azure AD integrated
- Hybrid Clusters (futures)

AKS Futures

- Custom VNET support
- Kubernetes RBAC with AAD Integration
  - kubectl OIDC Auth
- Virtual Node Pools
  - Standard Compute
  - FPGA, GPU
- Agent Pool Management
  - Self-healing
  - Auto-scaling
  - Hybrid Cluster: Linux and Windows Pools

Azure Container Instance (ACI)

Containers as a core Azure resource

- Fastest and easiest way to run a container in the cloud
- No VM management
- Per-second billing based on resource requirements (CPU + Memory)
- Deploy images from Docker Hub, Azure Container Registry, or any other Docker registry

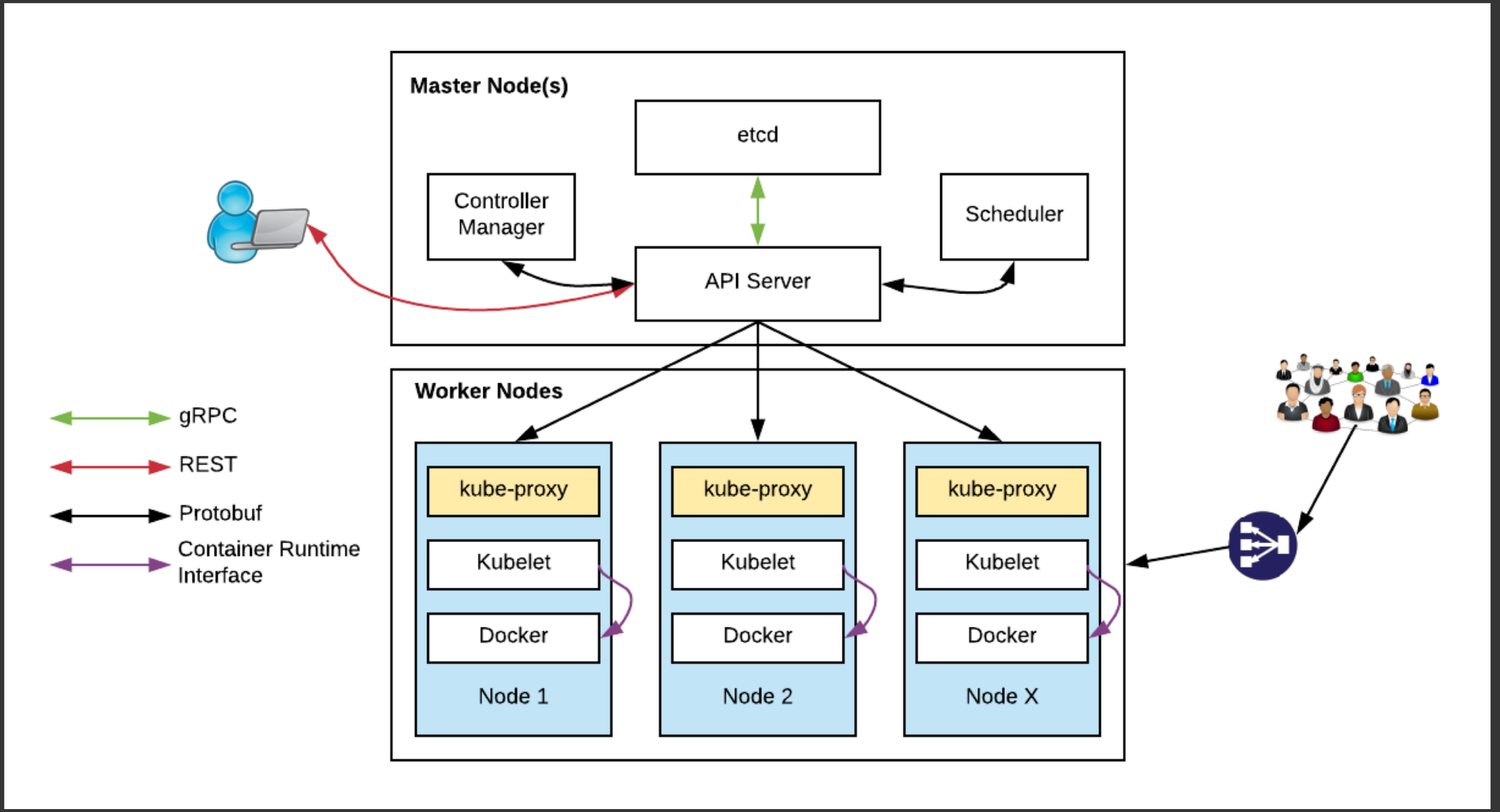
The ACI model: billing

- One-time charge for container creation: $0.0025
- Per-second charge for CPU/memory requested:
  - 1 vCPU core: $0.000013
  - 1 GB memory: $0.000013
- Examples:
  - Single container with 1 CPU/1 GB running for one month: $62.21
  - 100 containers with 2 CPU/3 GB running for one hour each: $22.75

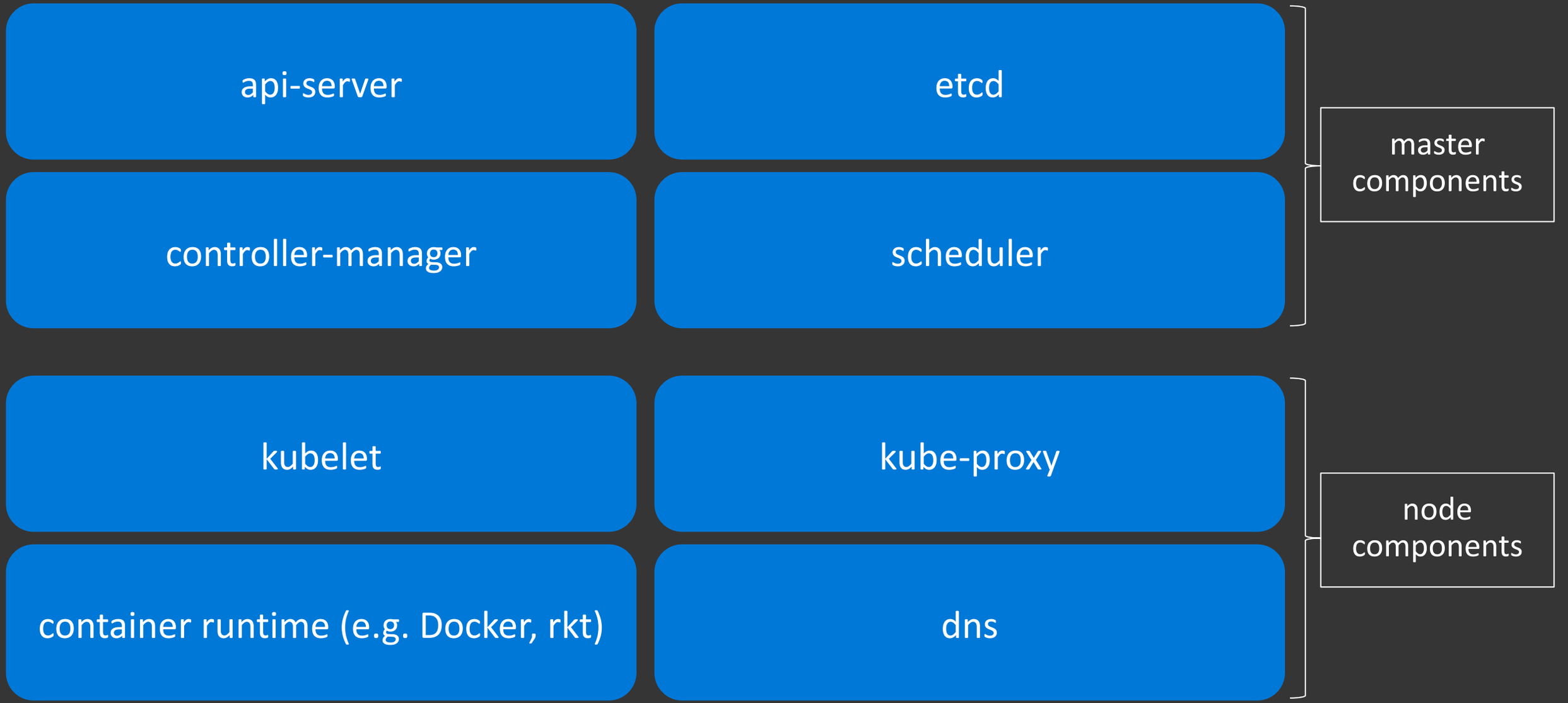
ACS Engine – Fully customized deployments

- Generates ARM templates for Azure Container Service clusters
- Golang tool - can be run in Docker or natively on Windows, OS X, Linux
- Cluster defined by a JSON cluster definition file
- Generates ARM template or directly deploys to Azure
- Some of the customization options:
  - Choice of DC/OS, Kubernetes, or Swarm orchestrators
  - Multiple agent pools where each agent pool can specify:
    - standard or premium VM Sizes
    - node count
    - Virtual Machine ScaleSets or Availability Sets
    - Storage Account Disks or Managed Disks (under private preview)
  - Docker cluster sizes of 1200
  - Custom VNET

Kubernetes Architecture



Kubernetes Architecture Components



Master Components

- api-server: Front-end control plane. Exposes API
- etcd: Cluster database. Distributed, highly available
- controller-manager. Runs controllers, eg. replication controller, deployment controller, and more
- scheduler: assigns pods to nodes
- Add-ons
  - DNS
  - Heapster. enables monitoring and performance analysis
  - Dashboard
  - Logging

Worker Node Components

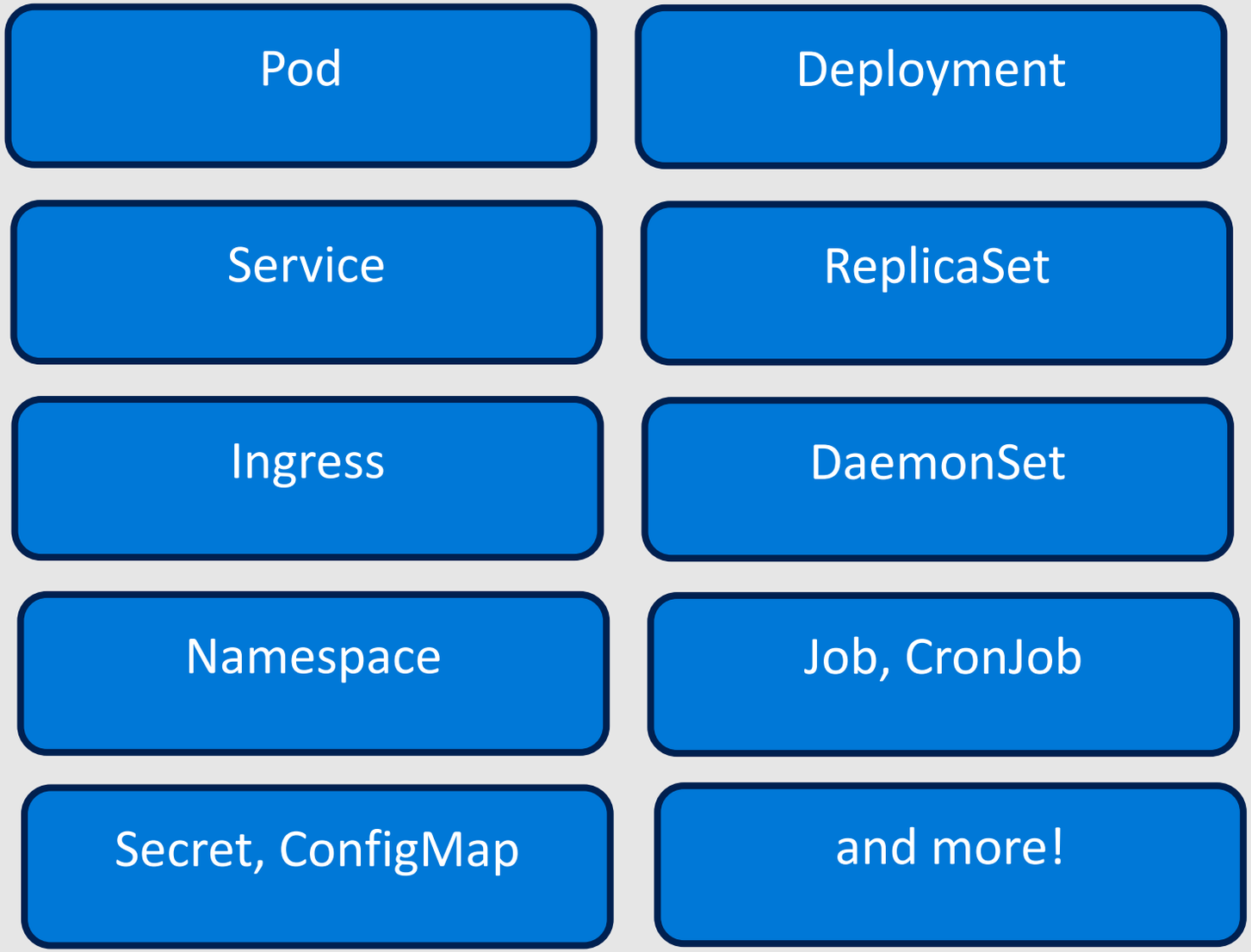
- kubelet:
  - Primary node agent
  - Watches and runs assigned pods
  - Executes health probes and reports status
  - Also key to “self-hosted” deployment of K8S where K8S is used to host K8S!!
- kube-proxy: enables network services
- docker: container engine (rkt supported experimentally)

kubectl: CLI to run commands against a Kubernetes cluster

- Swiss Army Knife: run deployments, exec into containers, view logs, etc.
- Syntax largely the same as `docker`
- Pronounced “koob sea tee el”…
  - Or “koob cuddle”

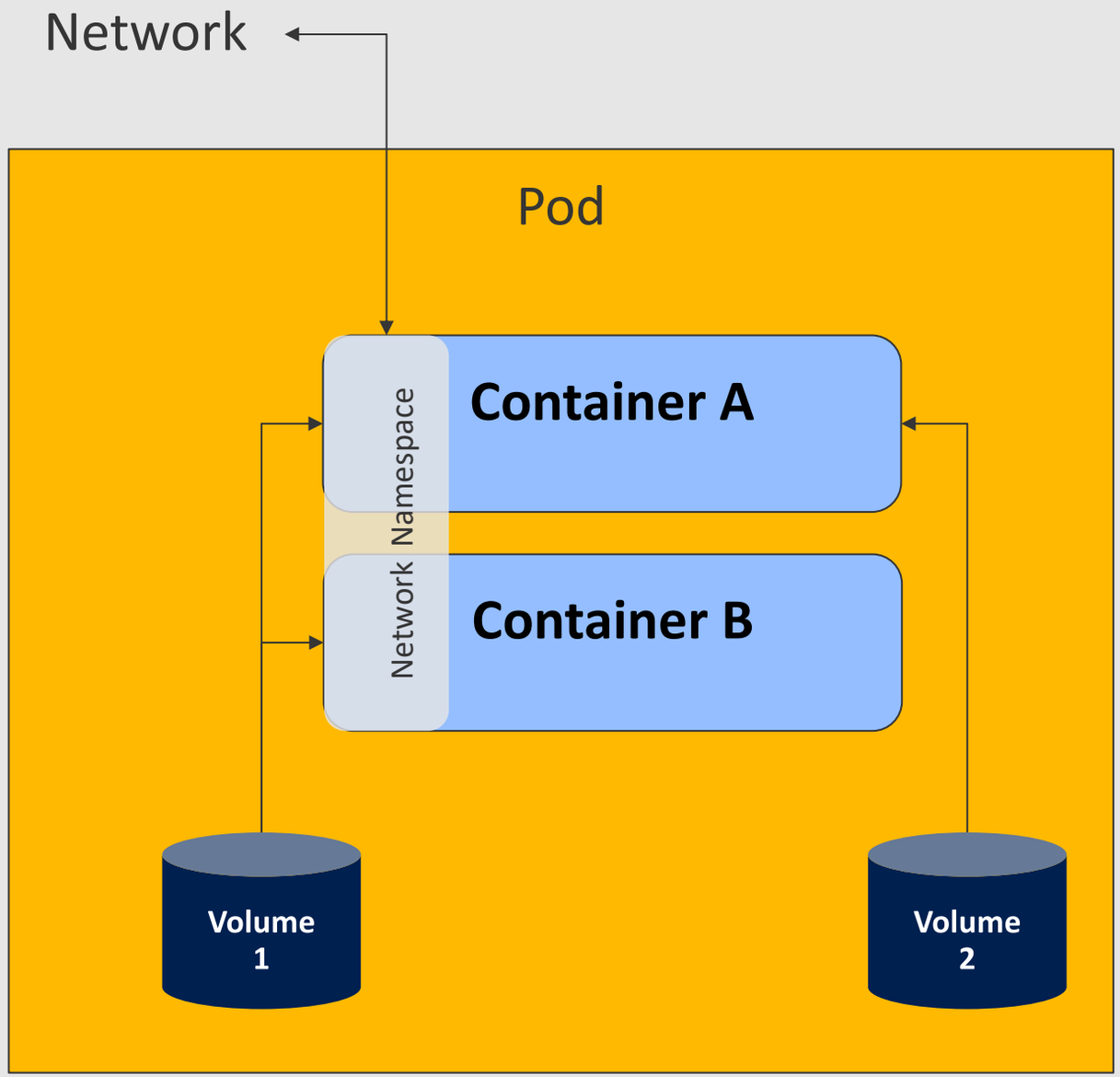
Kubernetes Resources

- Describes the ***"desired state"*** of your system
- Components such as Controllers, the Scheduler, API Server, kubelet work together to put the system into the "desired state"
- etcd stores this state



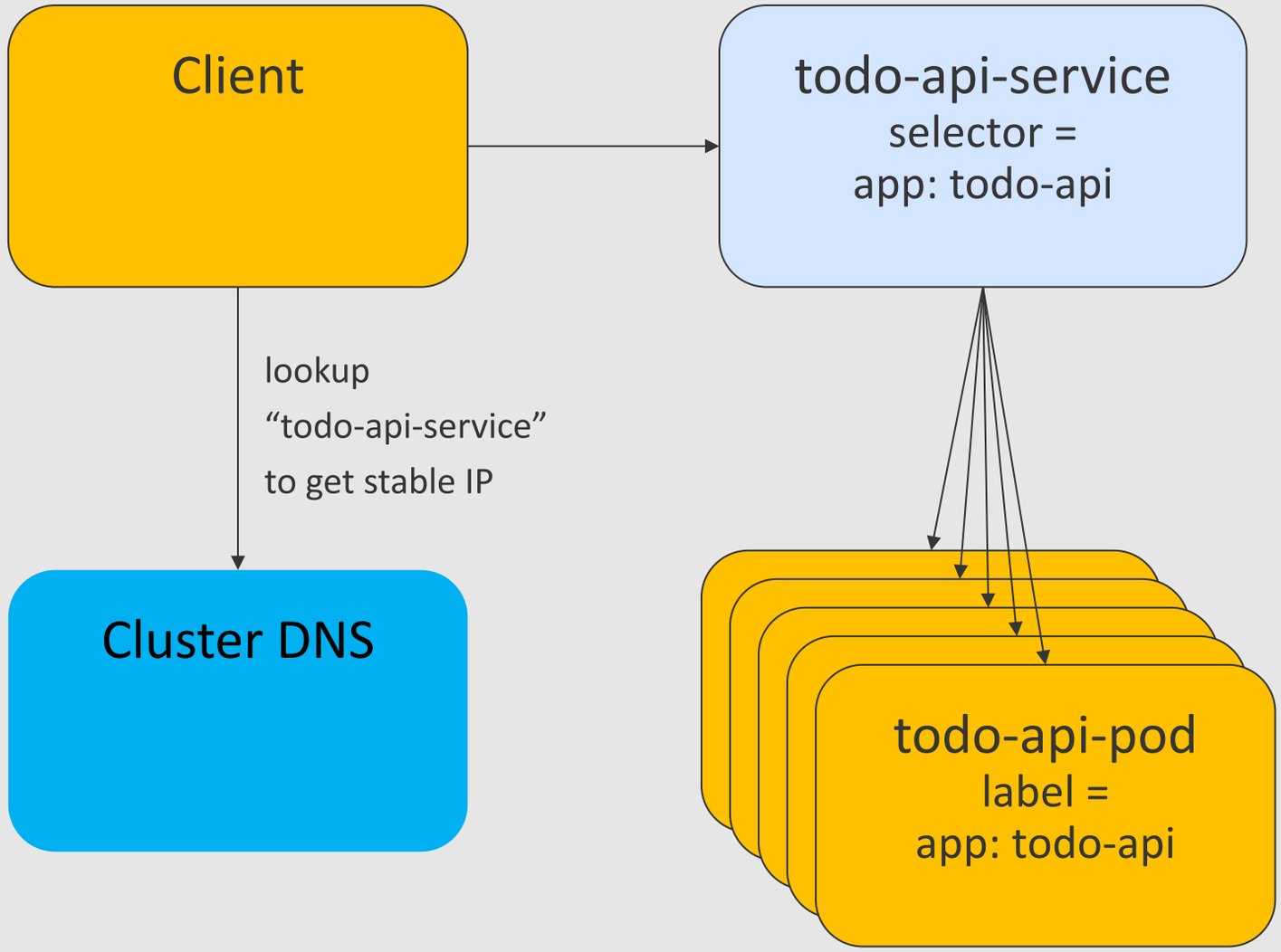
Pods

- Pods are the smallest unit of deployment in K8S
- Each pod gets an IP within the cluster address space
- They can container 1 or more containers
- The containers share a network namespace and can share volumes but have separate process namespace



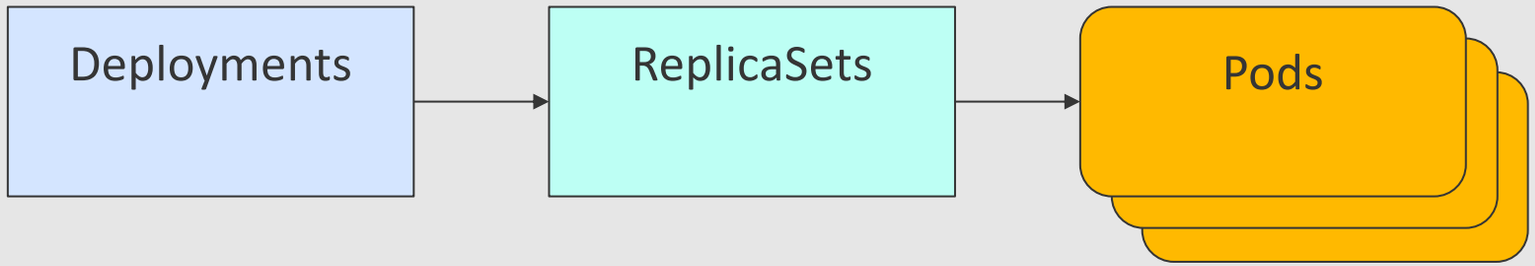
Services

- Pods can come and go, so you need a stable IP to access your pods
- Services and cluster DNS enables Service Discover in K8S
- A service provides stable IP for clients
- A service manages the dynamic endpoints that represent the Pods IP



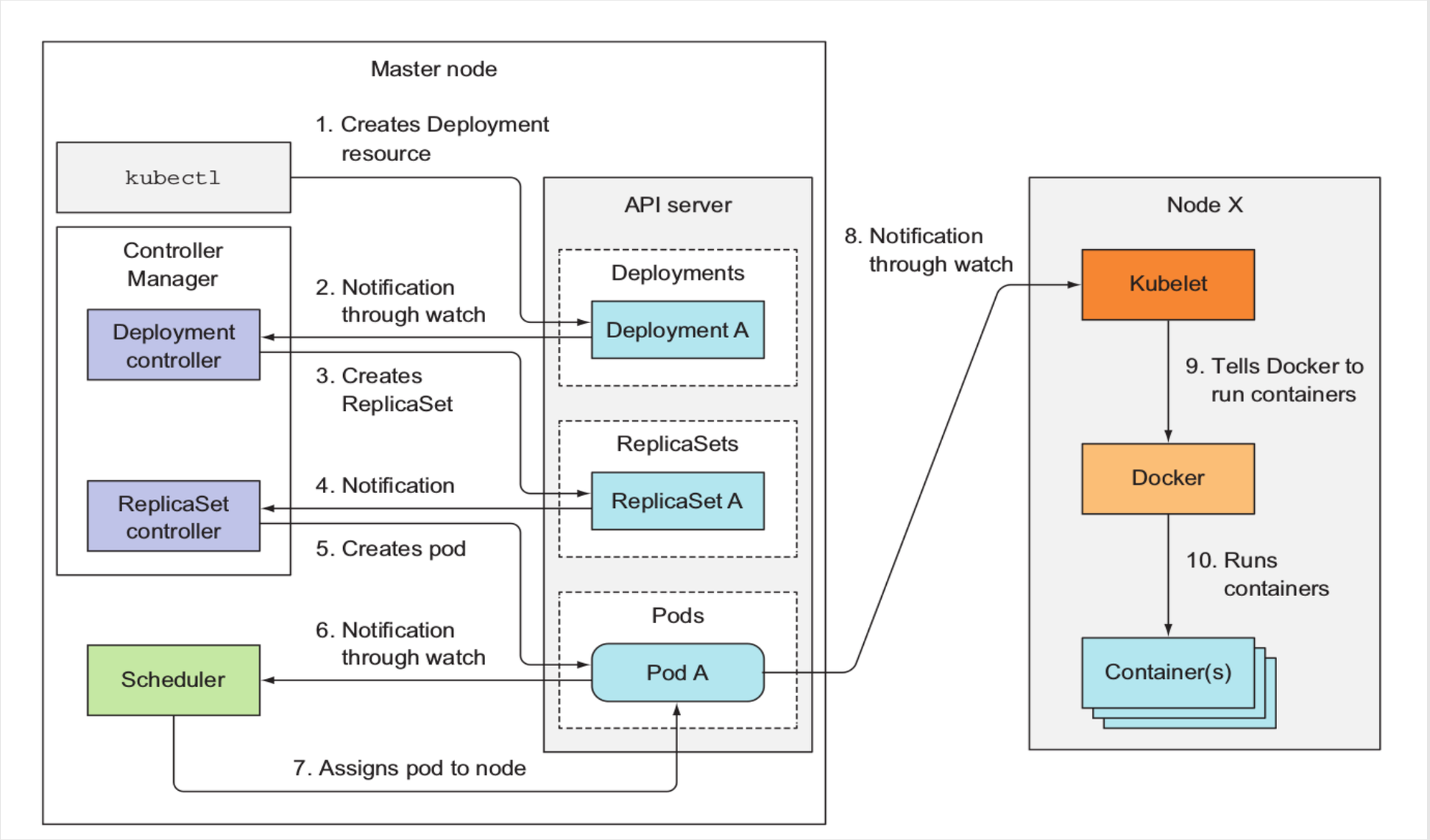
Deployments and Replicasets

- Deployments enable you to do controlled rollouts of your pods
- When you create a deployment, a replicaset is automatically created, the replicaset supervises many instances of your pods should be deployed




```
kubectl scale --replicas=3 deployment/todo-api
kubectl rollout status deployment/todo-api
kubectl rollout undo deployment/todo-api
```

Deployment Events



From "Kubernetes in Action" by Manning

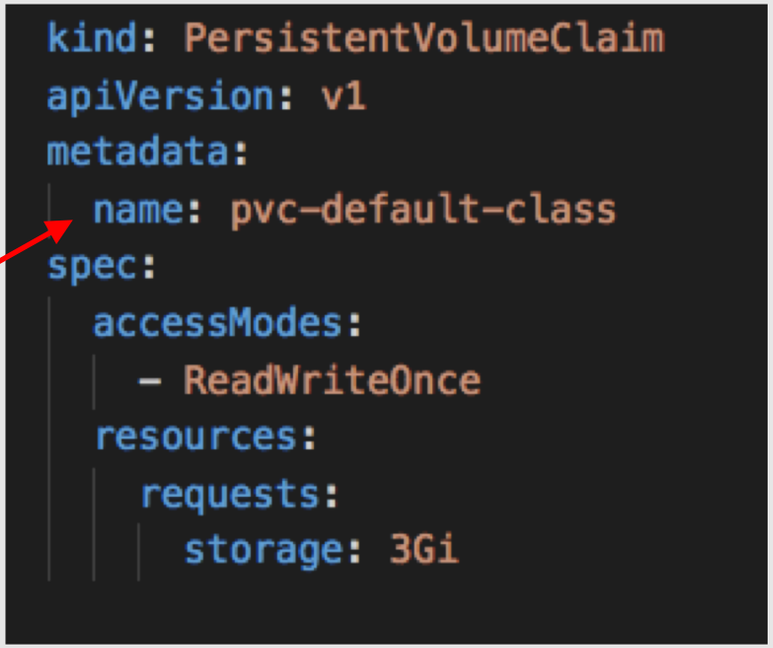
Persistent Volumes

- Persistent Volumes are resources to specify how storage volumes are made available to pods
- The containers in your pods mount these volumes to a path in their filesystem
- K8S supports many volume types
  - https://kubernetes.io/docs/concepts/storage/volumes/

```yaml
kind: PersistentVolume
apiVersion: v1
metadata:
  name: task-pv-volume
  labels:
    type: local
spec:
  capacity:
    storage: 10Gi
  #only once process can read/write
  accessModes:
    - ReadWriteOnce
  #when the PVC is released, retain the data.
  #valid values are Retain (default), Recycle and Delete.
  #Not all volume plugins support Recycle. See the volume plugin for details.
  persistentVolumeReclaimPolicy: Retain
  # hostPath volume type so the volume is mapped to a path on the node
  hostPath:
    path: "/tmp/data"
```

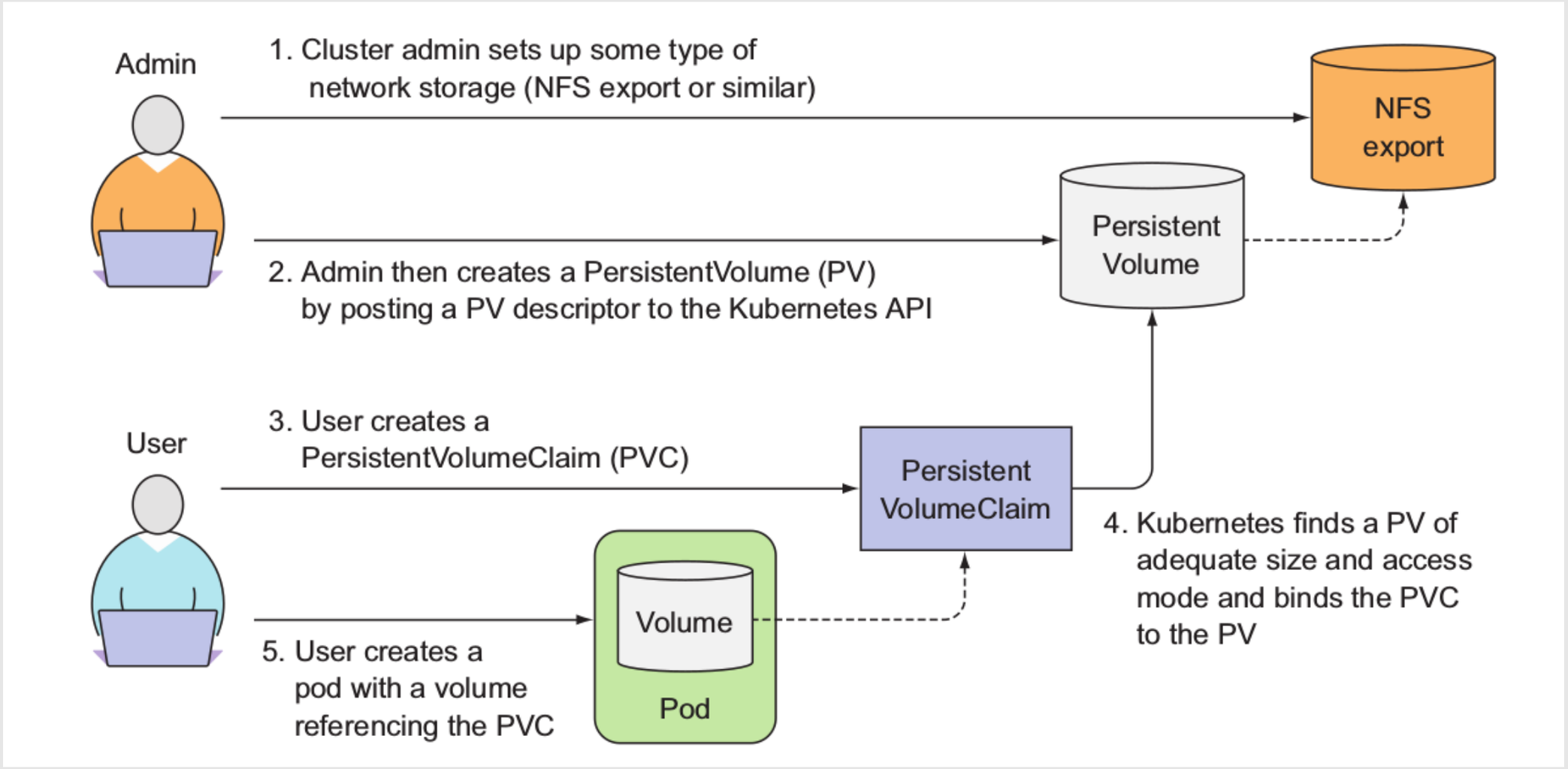
Persistent Volume Claims

```yaml
kind: Pod
apiVersion: v1
metadata:
  name: task-pv-pod
spec:
  volumes:
  - name: default-class-pod
    persistentVolumeClaim:
      claimName: pvc-default-class
  containers:
  - name: nginx
    image: nginx
    ports:
    - containerPort: 80
      name: "http-server"
    volumeMounts:
    - mountPath: "/usr/share/nginx/html"
      name: default-class-pod
```



```yaml
kind: PersistentVolumeClaim
apiVersion: v1
metadata:
  name: pvc-default-class
spec:
  accessModes:
    - ReadWriteOnce
  resources:
    requests:
      storage: 3Gi
```

Persistent Volume Claims



From "Kubernetes in Action" by Manning

Storage Class

- Storage classes are means for cluster admins to define different classes of storage for developers to use e.g. disk speed, capacity, etc
- Developers can then request storage of a specific class in their PVC
- If a storage class is not specified, and there is a default, then it will be used.

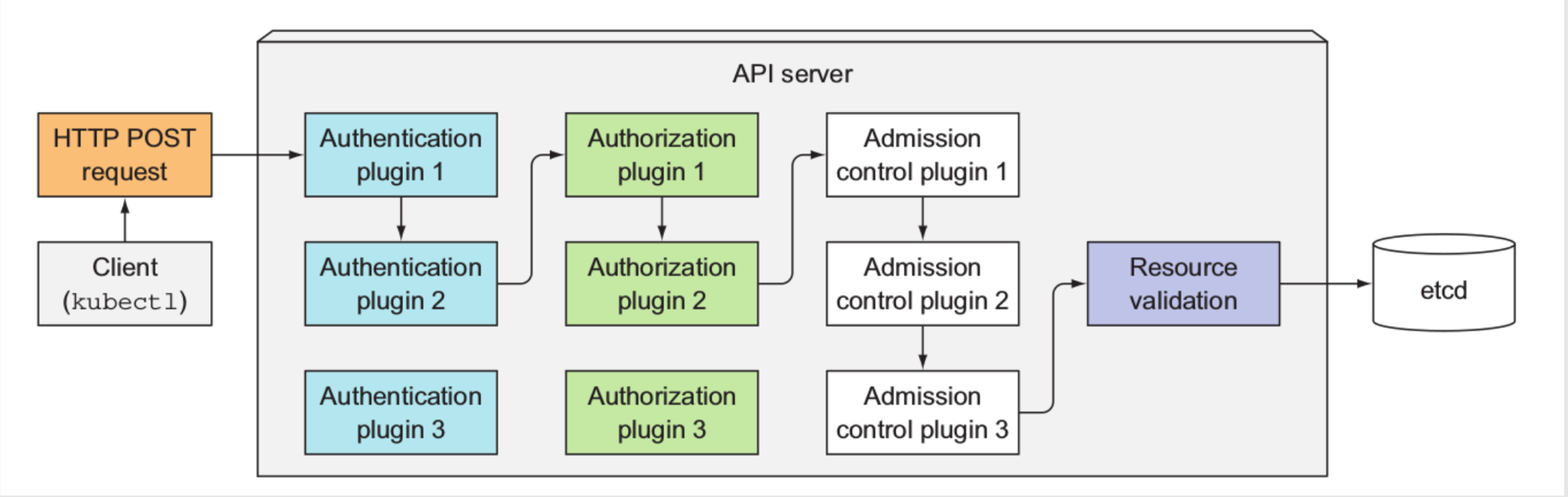
```
kubectl get storageclasses

NAME                 PROVISIONER
default (default)    kubernetes.io/azure-disk
managed-premium      kubernetes.io/azure-disk
```

Default Storage Class for AKS

```
apiVersion: storage.k8s.io/v1
kind: StorageClass
metadata:
  annotations:
    storageclass.beta.kubernetes.io/is-default-class: "true" ...
  labels:
    ...
  name: default
parameters:
  kind: Managed
  storageaccounttype: Standard_LRS
provisioner: kubernetes.io/azure-disk
reclaimPolicy: Delete
```

Authentication/Authorization

- Authr decision based on a set of attributes:
  - apigroup, resource, verb, subject
- Modules executed in order, short-circuit upon successful authentication/authorization



From "Kubernetes in Action" by Manning

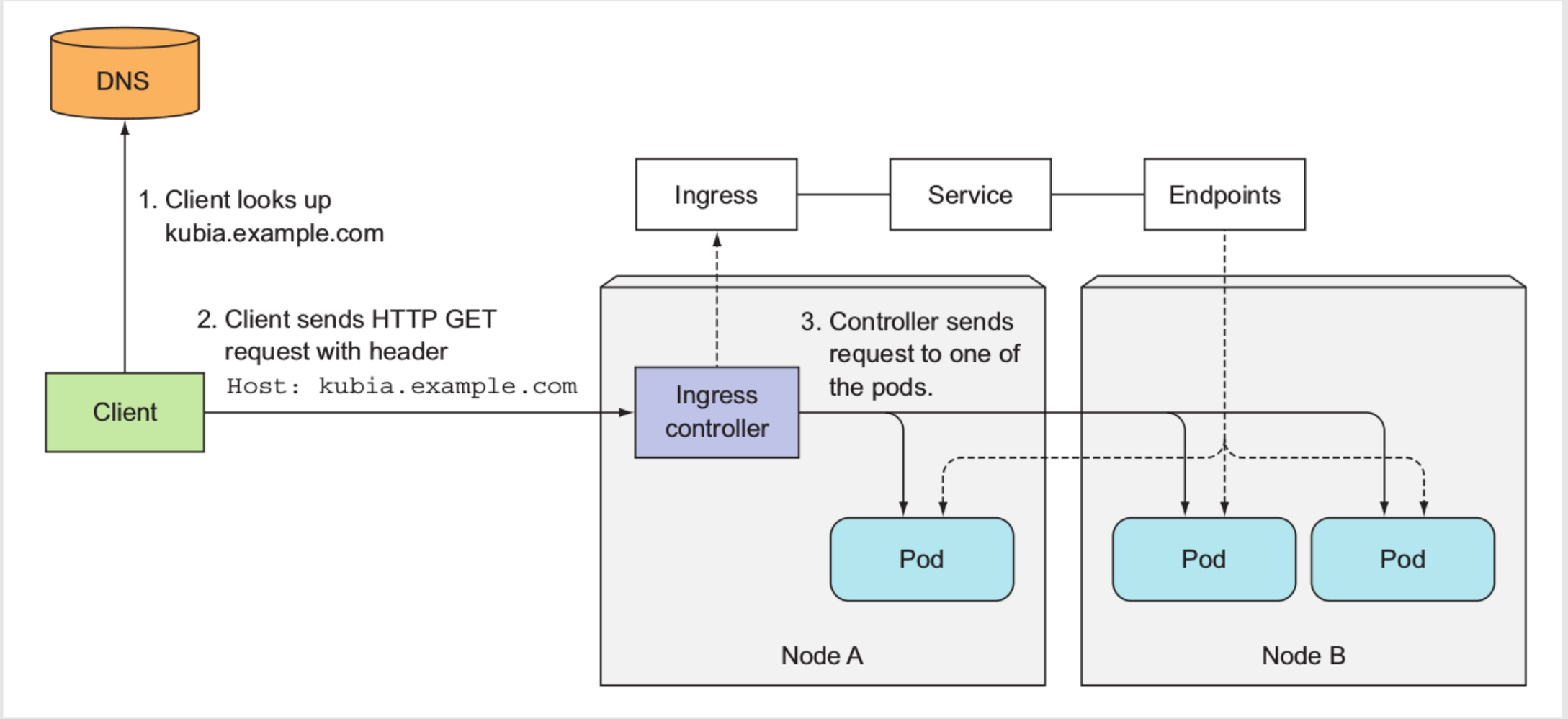
RBAC

- Roles define permissions
- RoleBindings grant permissions to subject at a namespace level

```yaml
kind: Role
apiVersion: rbac.authorization.k8s.io/v1 #for v1.8.0++
#apiVersion: rbac.authorization.k8s.io/v1beta1 #for v1.7.x
metadata:
  name: production-role
  namespace: production
rules:
- verbs:
  - "create"
  - "delete"
  - "update"
  - "patch"
  - "get"
  - "list"
  - "watch"
  apiGroups: ["*"]
  resources: ["*"]
```

```yaml
kind: RoleBinding
apiVersion: rbac.authorization.k8s.io/v1 #for v1.8.0++
#apiVersion: rbac.authorization.k8s.io/v1beta1 #for v1.7.x
metadata:
  name: production-deployer
  namespace: production
roleRef:
  kind: Role
  apiGroup: rbac.authorization.k8s.io
  name: production-role
subjects:
- kind: User
  name: jenkins
  namespace: production
  apiGroup: rbac.authorization.k8s.io
```

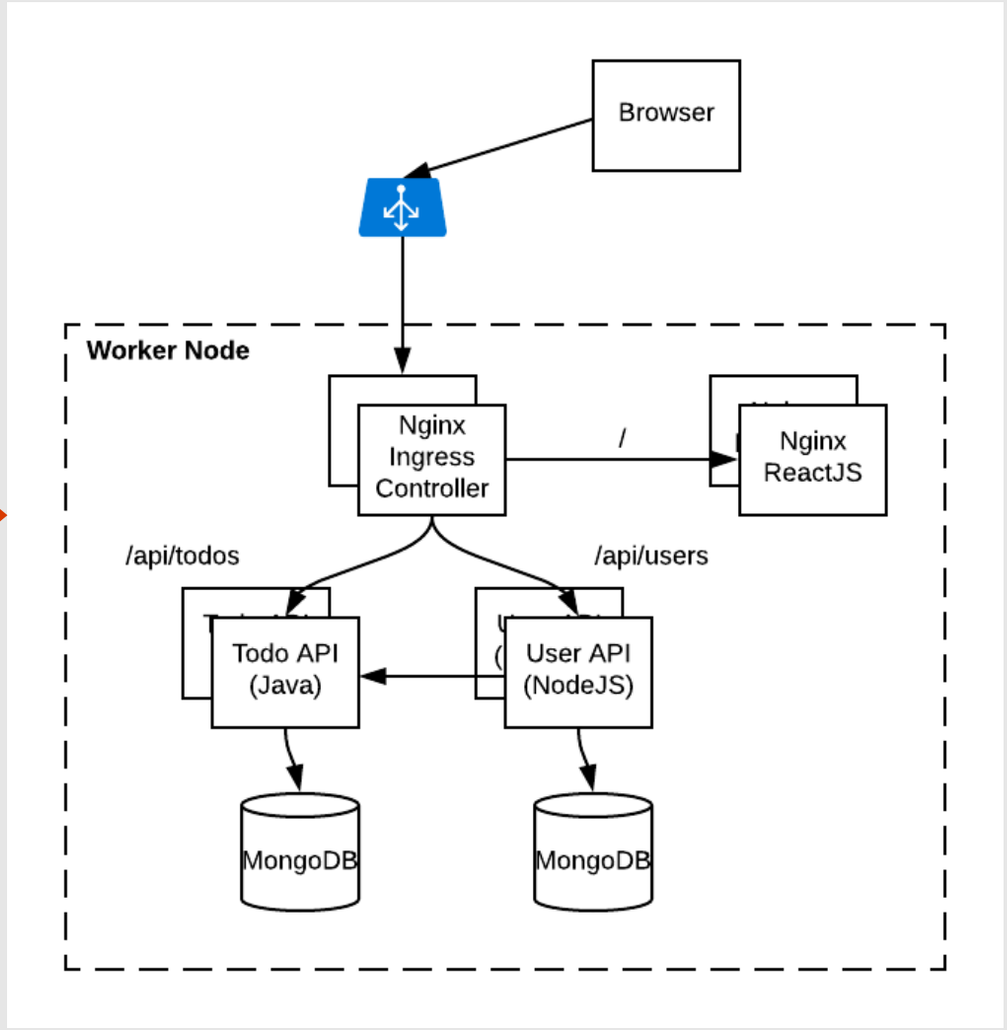
Ingress



From “Kubernetes in Action” by Manning

Ingress Rule

```
apiVersion: extensions/v1beta1
kind: Ingress
metadata:
  name: todo-app-ingress
  annotations:
    ingress.kubernetes.io/ssl-redirect: "false"
spec:
  rules:
  - host: 192.168.99.100.nip.io
    http:
      paths:
      - path: /
        backend:
          serviceName: todo-webui-service
          servicePort: 80
      - path: /api/todos
        backend:
          serviceName: todo-api
          servicePort: 8080
      - path: /api/user
        backend:
          serviceName: user-api
          servicePort: 8082
  #The service that will handle all other
  #paths. e.g. return a 404 not found page.
  backend:
    serviceName: default-http-backend
    servicePort: 80
```

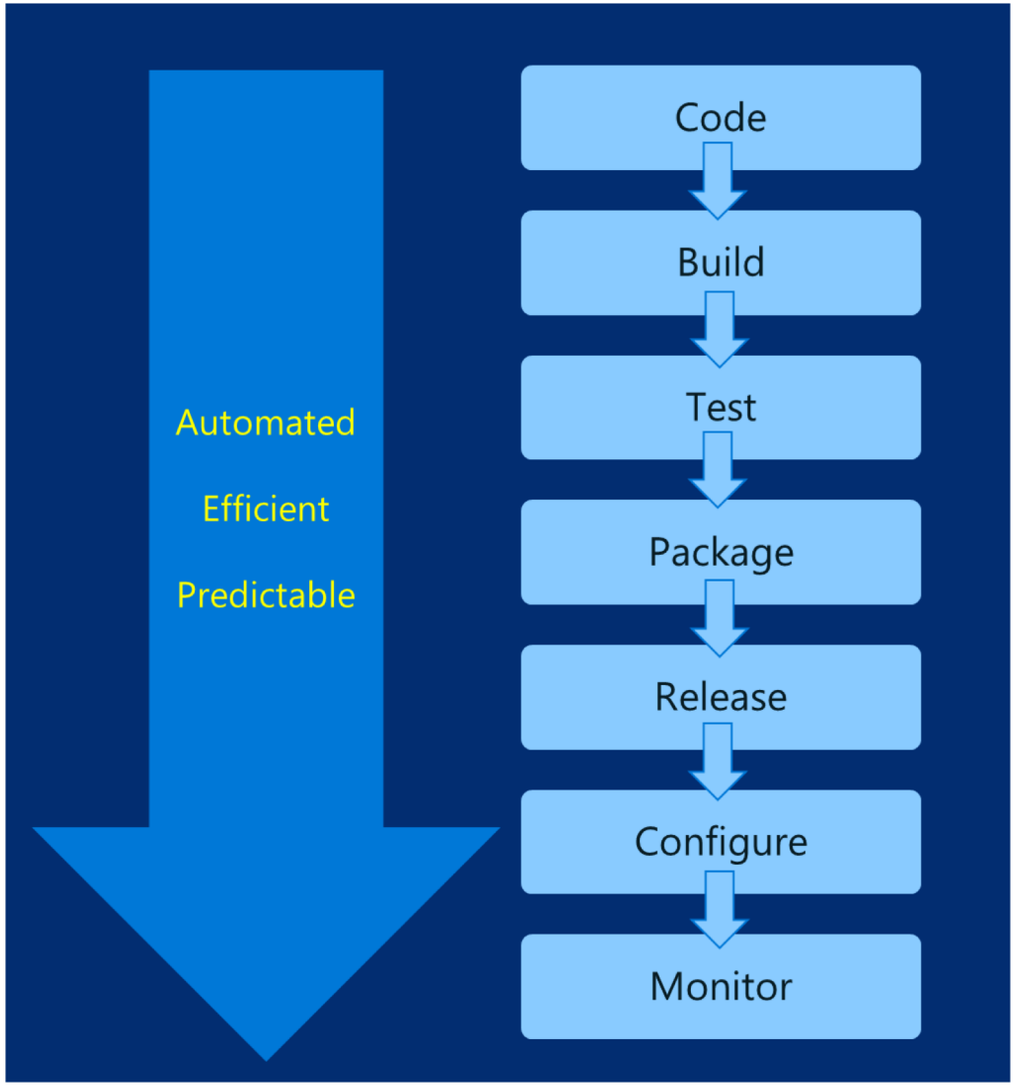


DevOps &
CI / CD

DevOps Practices Arrive

- Developers: Test, Build, Code, Plan
- Operations: Monitor, Release, Deploy, Operate
- DevOps Features
  - Speed of application delivery/updates
  - Faster time to value
  - Repeatable/consistent
  - Automated testing
  - Traceability of process
  - Applying developer patterns to infrastructure
    - Infrastructure as code
    - Ops teams embracing source control
  - Centralized monitoring, logging, debugging
- CI / CD – key aspect of quality DevOps

DevOps – Why you care



Deploy 200 times more frequently

Go from code check-in to production 2,555 times faster

Recover from failure 24 times faster

Spent 50% less time remediating security challenges

Spent 22% less time on unplanned work

2.2 times more likely to believe their places a great place to work

Source: https://puppet.com/resources/white-paper/2016-state-of-devops-report

Common Toolsets

- Jenkins
- Visual Studio Team Services
- Spinnaker and Netflix OSS
- Travis
- TeamCity
- CircleCI
- Additional utilities: code quality scanning, security, collaboration, etc.

Helm:
Kubernetes Package Manager

Birth of Helm

On October 15th, 2015

Hackathon project at company offsite

> Could we take the ideas behind npm and Homebrew and build something for deploying apps into Kubernetes?

Installation tool for Deis Workflow

Announced at the first KubeCon in San Francisco 2015

Helm Charts

Application definition

Consists of:

- Metadata
- Kubernetes resource definitions
- Configuration
- Documentation

Stored in chart repository

- Any HTTP server that can house YAML/tar files (Azure, GitHub pages, etc.)
- Public repo with community supported charts (eg – Jenkins, Mongo, etc.)

Helm (CLI) + Tiller (server side)

Release: Instance of chart + values -> Kubernetes

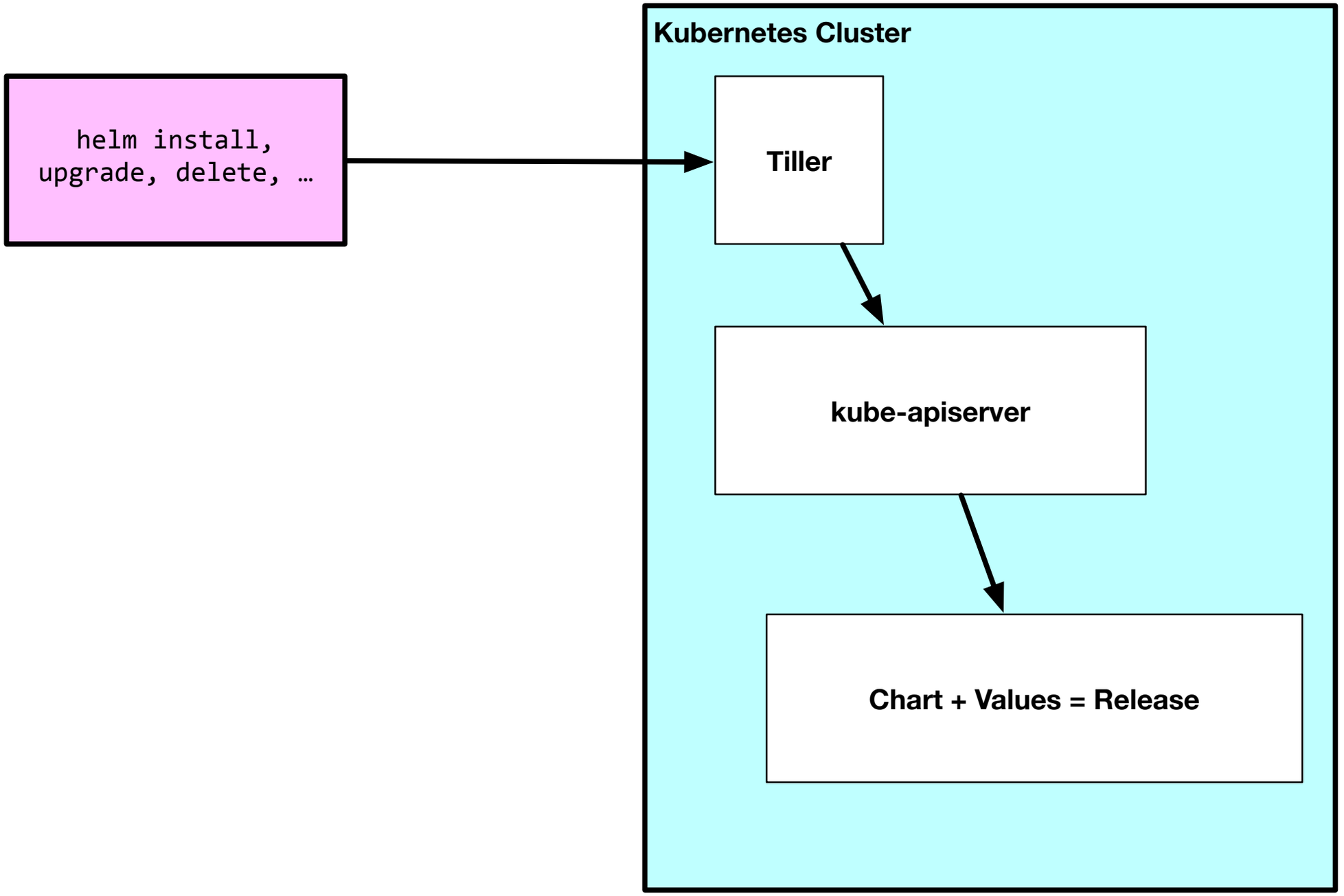

helm install,
upgrade, delete, …
Kubernetes Cluster
Tiller
kube-apiserver
Chart + Values = Release

Chart structure

- Charts have structure
  - Set of conventions, including file and directory names
  - Charts can be packaged into tarballs for distribution

Chart structure

- Layout
  - Helm expects a strict chart structure

```
wordpress/
  Chart.yaml          # A YAML file containing information about the chart
  LICENSE             # OPTIONAL: A plain text file containing the license for the chart
  README.md           # OPTIONAL: A human-readable README file
  values.yaml         # The default configuration values for this chart
  charts/             # OPTIONAL: A directory containing any charts upon which this chart depends.
  templates/          # OPTIONAL: A directory of templates that, when combined with values,
                      # will generate valid Kubernetes manifest files.
  templates/NOTES.txt # OPTIONAL: A plain text file containing short usage notes
```

Chart.yaml

```
name: The name of the chart (required)
version: A SemVer 2 version (required)
description: A single-sentence description of this project (optional)
keywords:
  - A list of keywords about this project (optional)
home: The URL of this project's home page (optional)
sources:
  - A list of URLs to source code for this project (optional)
maintainers: # (optional)
  - name: The maintainer's name (required for each maintainer)
    email: The maintainer's email (optional for each maintainer)
engine: gotpl # The name of the template engine (optional, defaults to gotpl)
icon: A URL to an SVG or PNG image to be used as an icon (optional).
```

Helm values.yaml

- The knobs and dials:
  - A `values.yaml` file provided with the chart that contains **default** values
  - Use -f to provide your own values overrides
  - Use --set to override individual values

Helm Templates

- Built on Go's template language w/addition of 50 or so add-on template functions
- Almost anything goes! ;-)
- Also useful in generating random values (e.g. passwords)
  - Provides flow control (if/else, with, range, etc)
  - Named templates (partials)

Open Service Broker for Azure

- Connect Kubernetes apps to Azure simply and securely
  - Azure Database for MySQL
  - Azure Database for PostgreSQL
  - Azure SQL
  - Azure CosmosDB
  - Azure Redis
  - Azure Container Instances
  - Azure Service Bus
  - Azure Storage
  - More to come…
- Built on an open standard
- Integrated with Helm

Draft: Streamlined Kubernetes Development

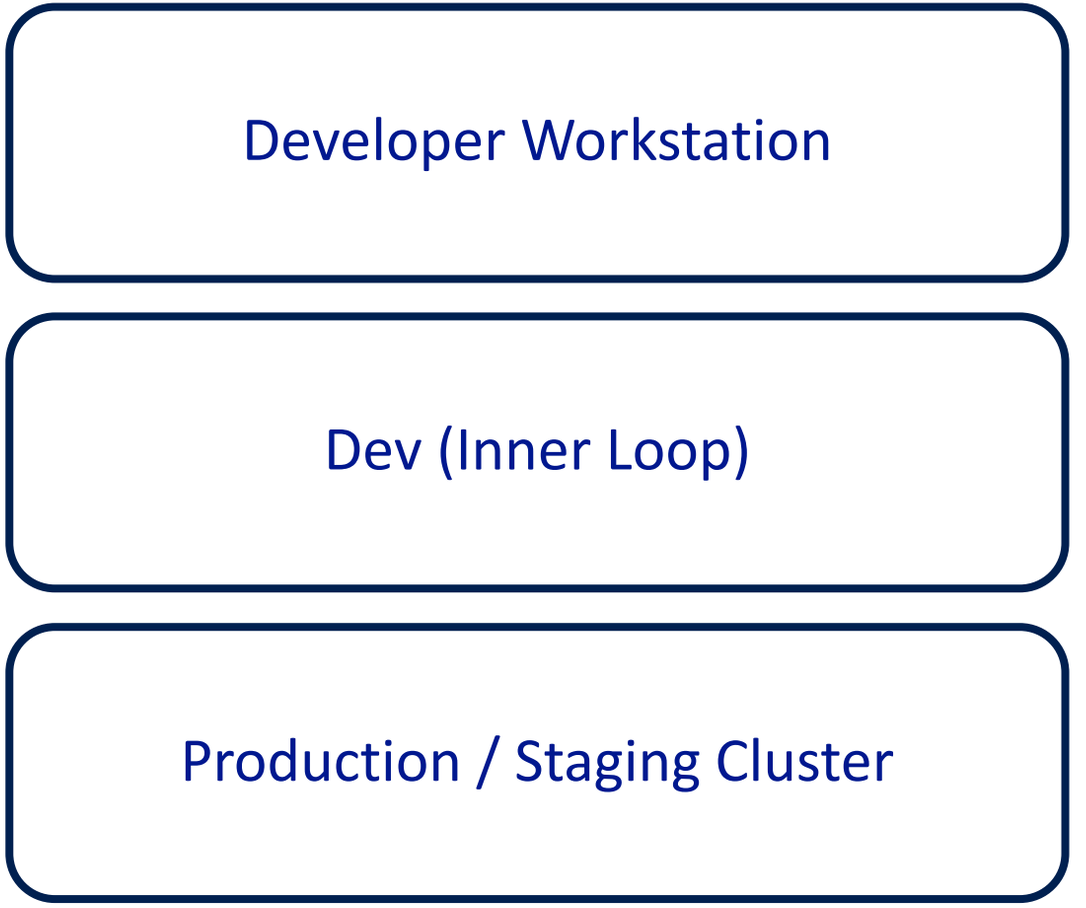
What is draft?

Developer workstations cannot mimic production

As devs hack on code prior to committing to version control

Draft targets the "inner loop" of a developer's workflow

Works with other Deis tools such as Helm and Workflow



DRAFT

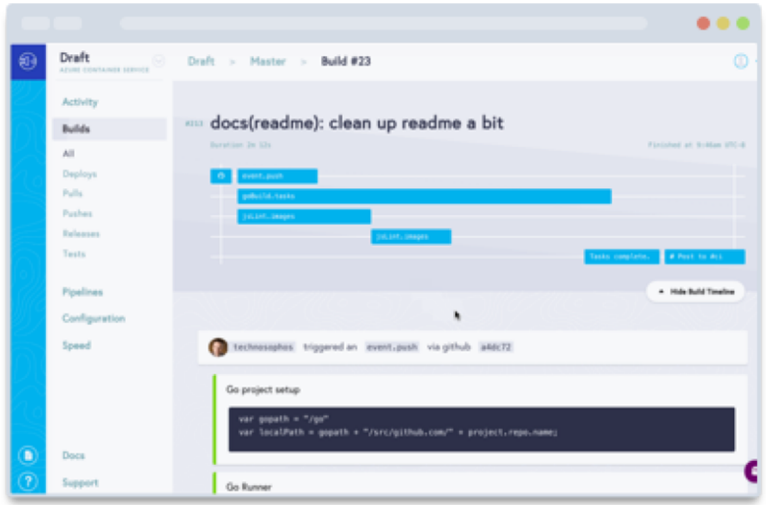
brigade: event-driven scripting for kubernetes

- encapsulate functions in containers
- run in parallel or serial
- trigger workflow from Github, Docker registry, etc.
- javascript (pipeline as code)
- project config stored as secrets
- well suited for CI/CD pipelines

kashti: a dashboard for brigade projects

Kashti

- easy viewing and constructing brigade pipelines
- waterfall diagram of brigade builds
- view log output of build steps
- quick peek at configuration for builds



Questions?

WHO WE ARE

Design. Build. Transform.

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As a digital product studio, we enable digital transformation up to 87% faster.

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100+ people

300+ projects

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Migrate and rewrite applications to modern cloud architectures

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Accelerate the delivery timelines of open source development projects

PRODUCT INNOVATION

Lean product innovation from concept to MVP

DIGITAL PRODUCT STUDIO

Teams	Mastery Excellence	Integrated Collaborative	Skilled Certified	Agile Lean
Capabilities	Strategy + Design + Engineering + Cognitive Analytics			
Methodology	Lean Startup + Design Thinking + Agile Engineering			
Technology	Industry Proven | Lightweight | Open Source | Cloud-First			
Partners	Microsoft	redhat.	dotCMS	scalar

The right, quality solution, fast.

TECHNOLOGIES & PARTNERS

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