BITS Pilani
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Kubernetes

Aditya Goel

Agenda

- **Kubernetes**
  - ✓Introduction
  - ✓Architecture
  - ✓Components
  - ✓Hands-On Demo

Kubernetes

Official definition of Kubernetes:

- Open source container orchestration tool
- Developed by Google
- Helps manage containerized applications

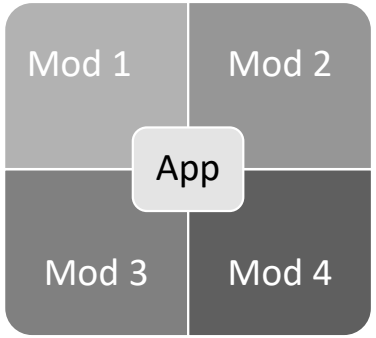
Why Kubernetes?

- What Problems does Kubernetes solve?
- What are the tasks of an orchestration tool?

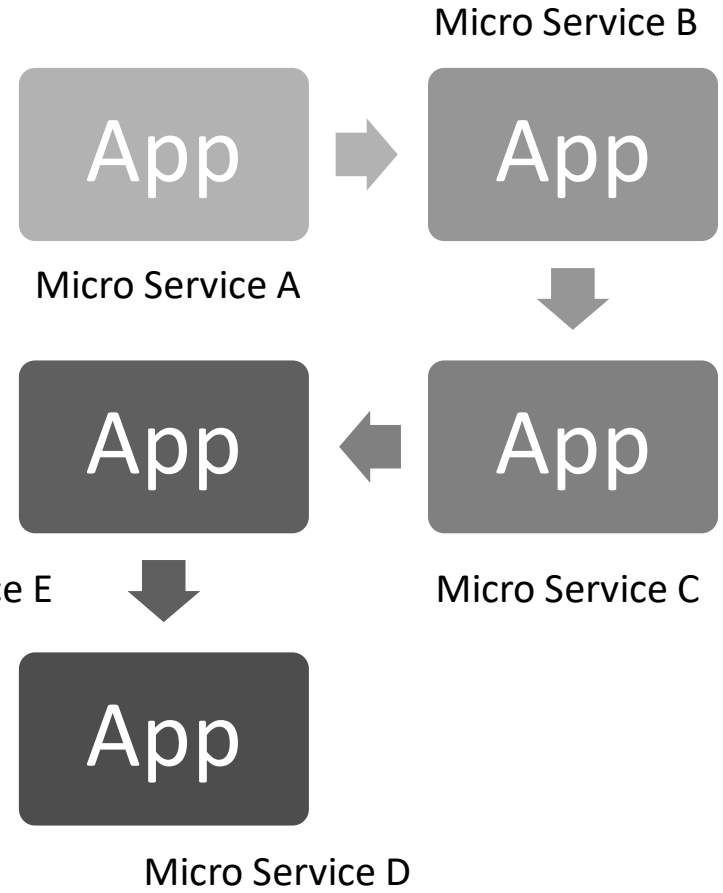
Why Kubernetes?

Need for container orchestration tool

- Trend from Monolithic arch to Micro-Services arch



Monolithic



Micro Service B

Micro Service A

Micro Service C

Micro Service E

Micro Service D

Kubernetes - Features

What features do orchestration tools offer?

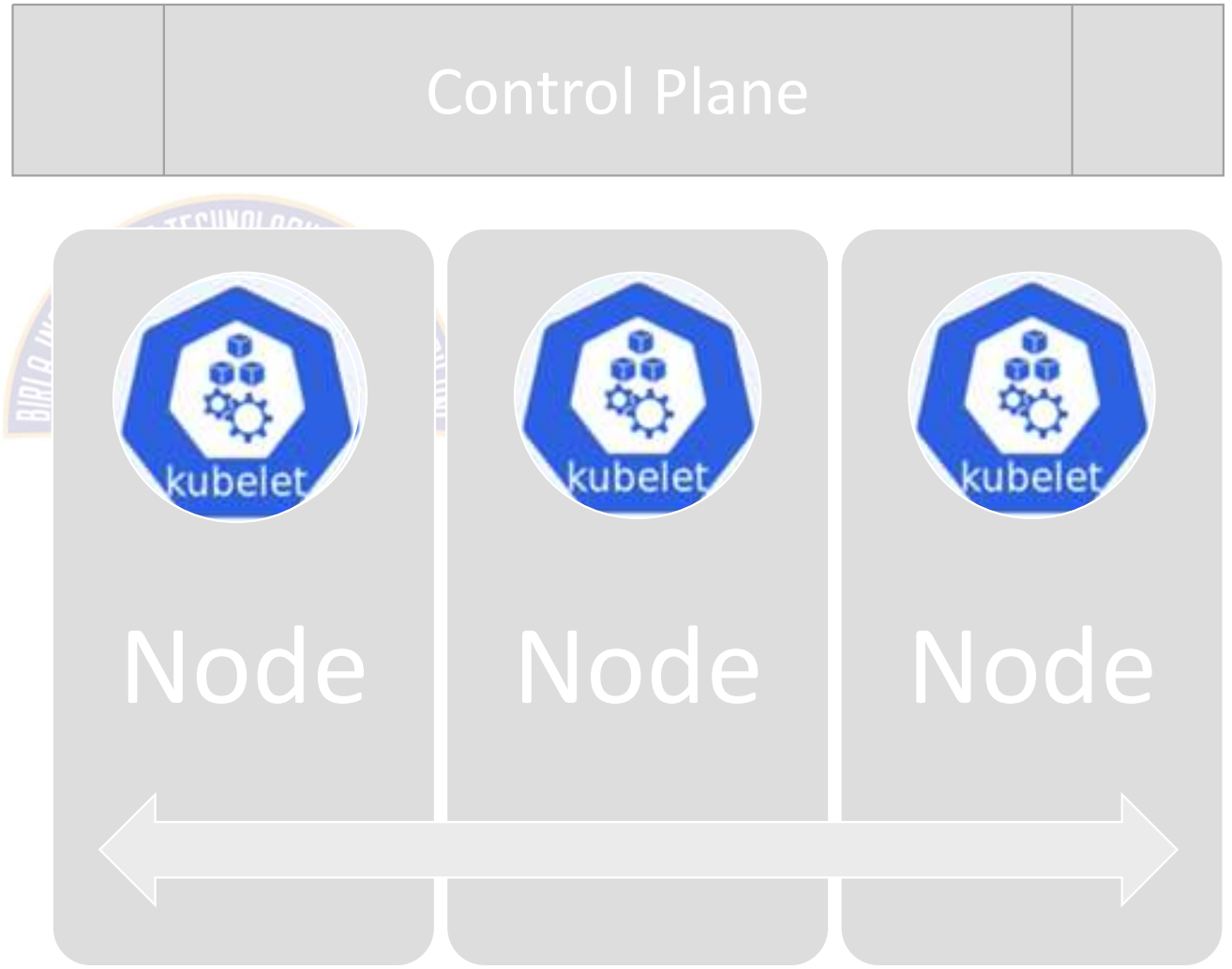
- High Availability or no downtime

- Scalability or high performance

- Disaster recovery – backup and restore

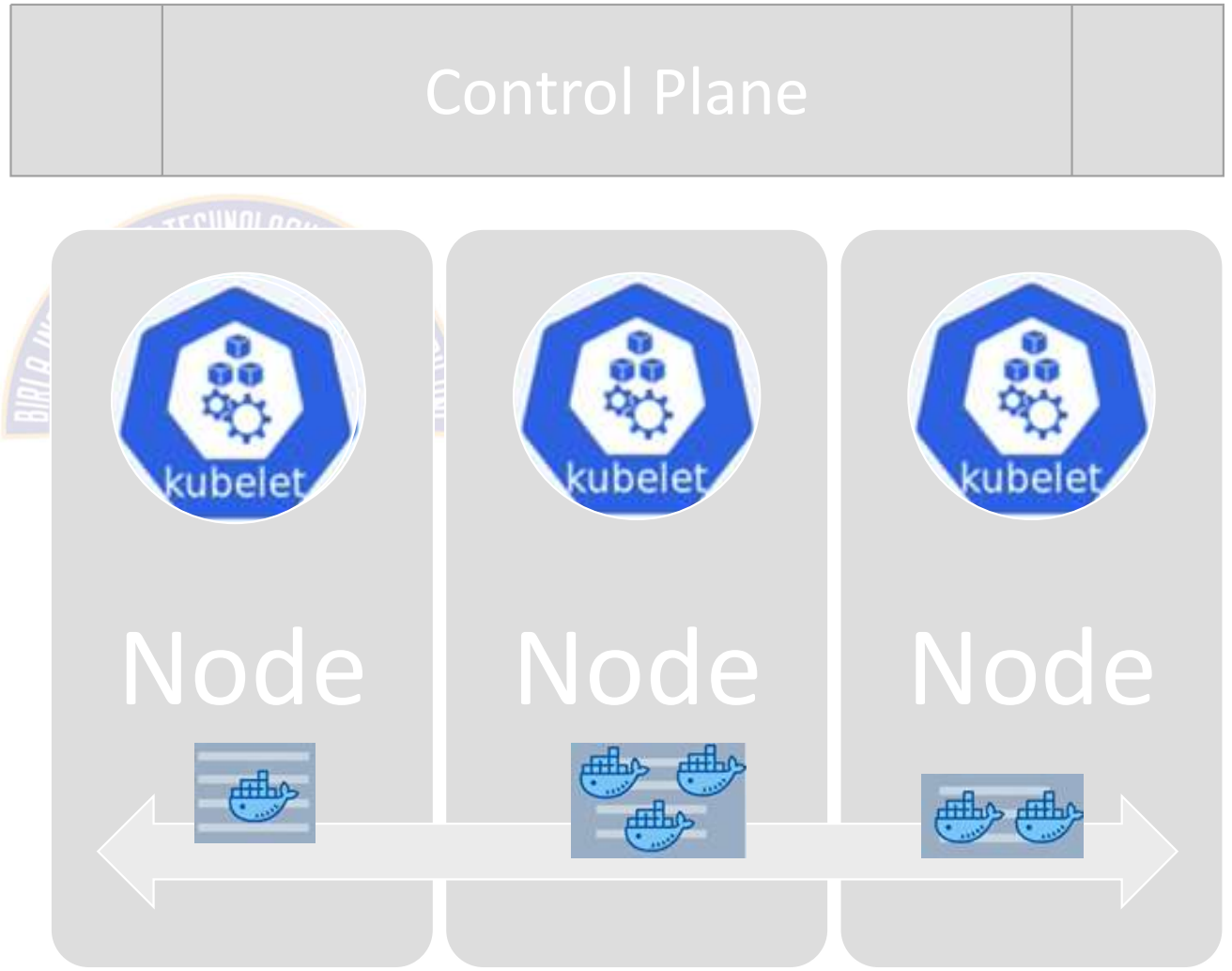
Kubernetes - Architecture

Primary “node” agent



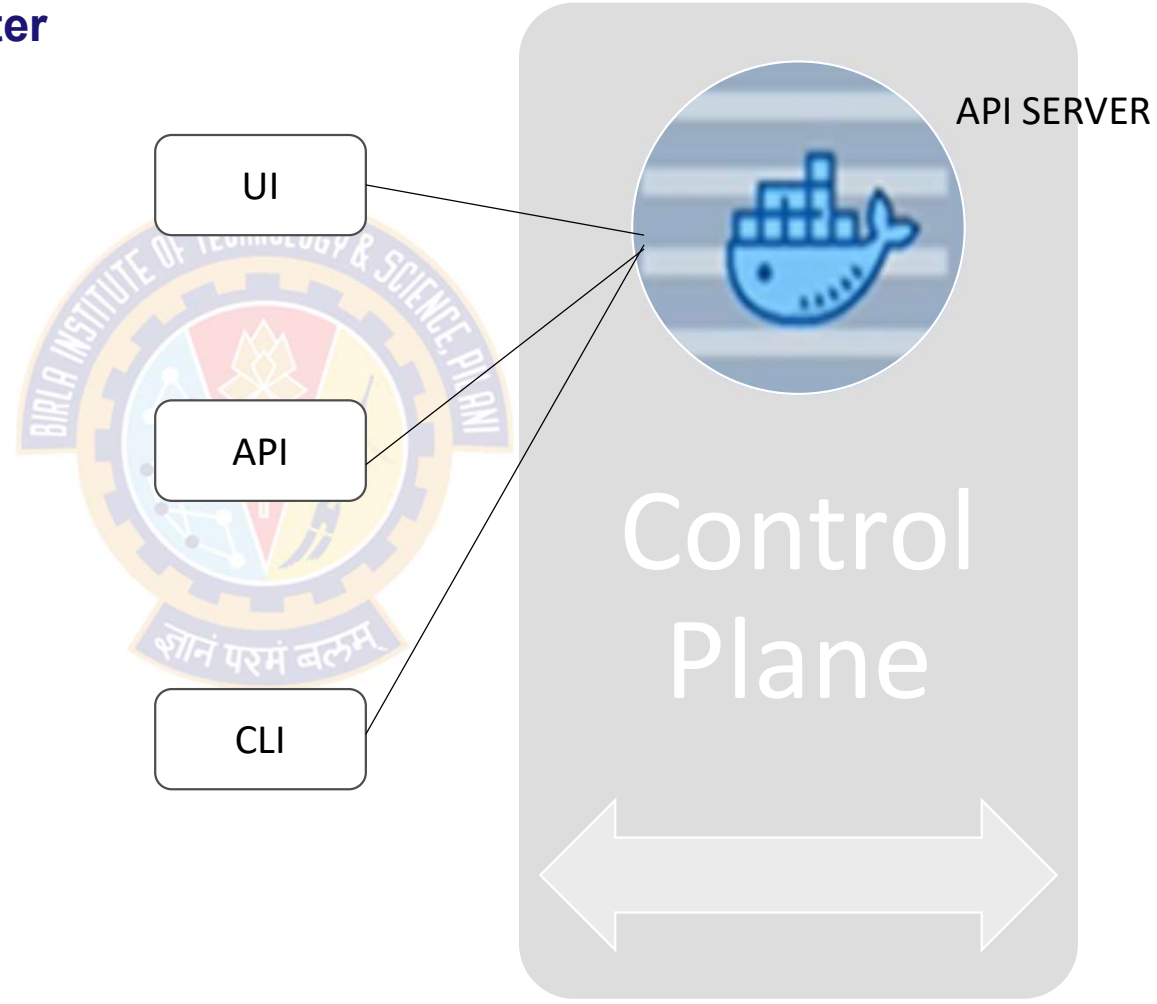
Kubernetes - Architecture

Primary “node” agent



Kubernetes - Processes

API Server: Entry-point to K8s cluster

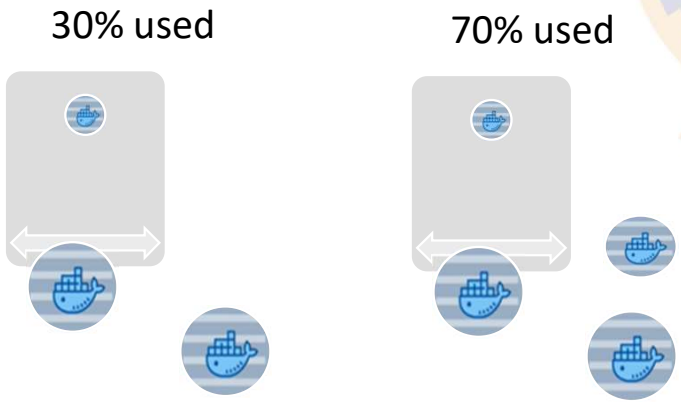


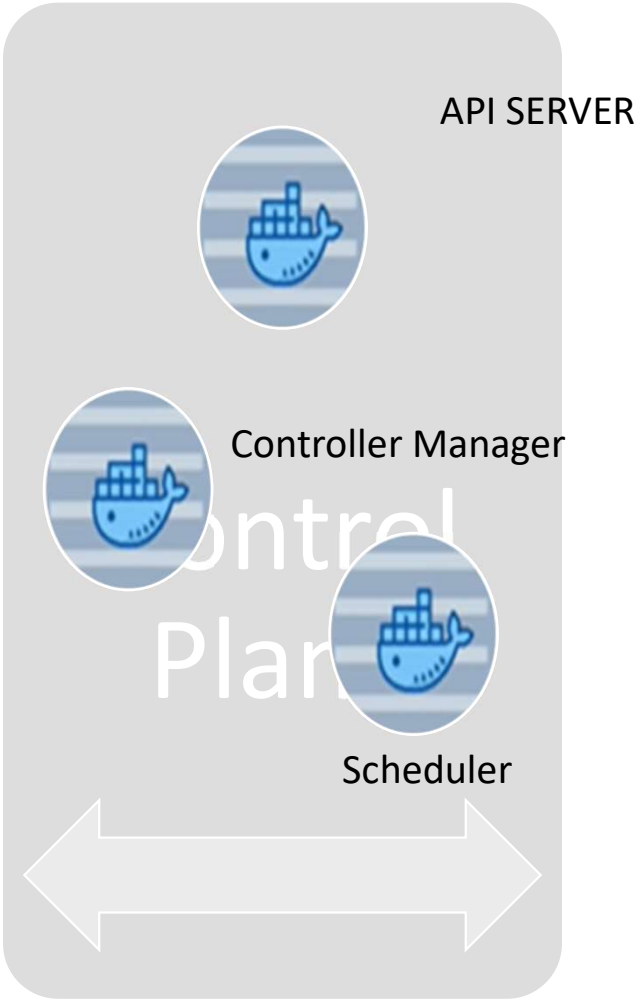
Kubernetes - Processes

API Server: Entry-point to K8s cluster

Controller manager: keeps track of whats happening in the cluster

Scheduler: ensure pods placement





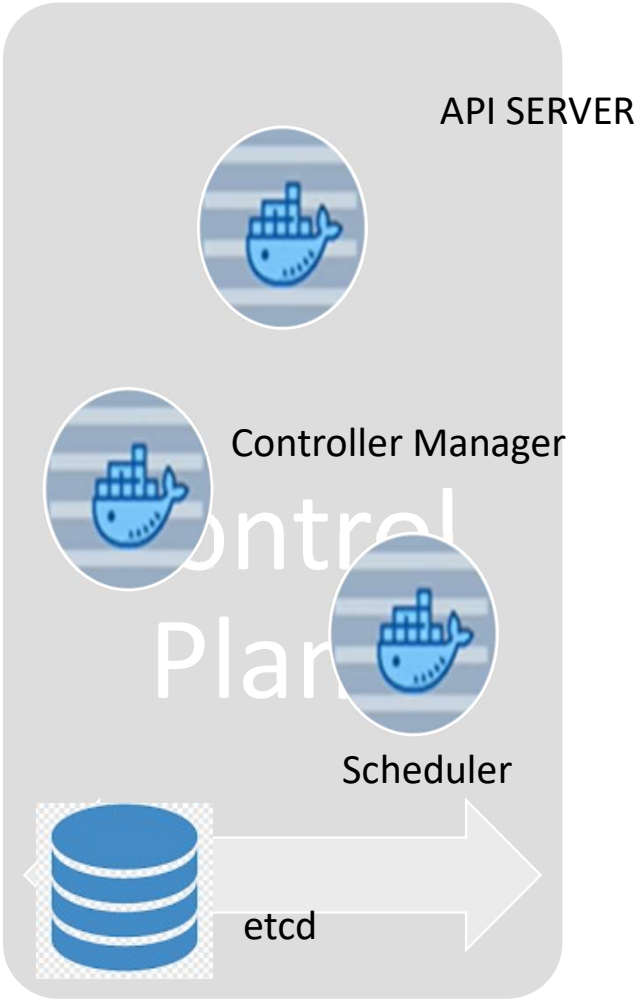
Kubernetes - Processes

API Server: Entry-point to K8s cluster

Controller manager: keeps track of whats happening in the cluster

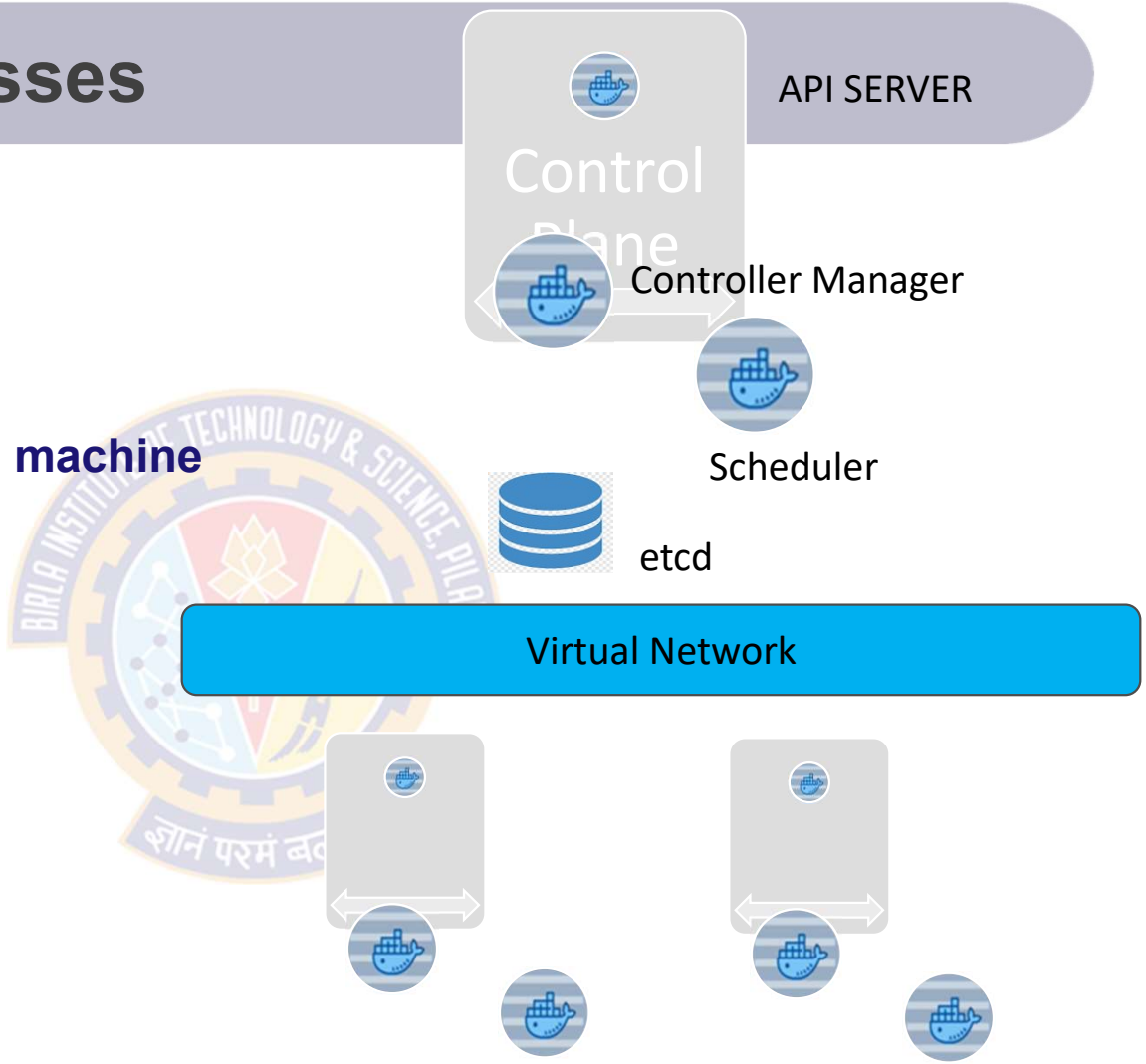
Scheduler: ensure pods placement

etcd: Kubernetes backing store

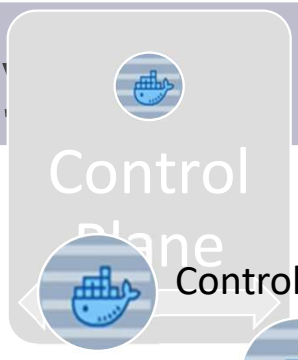


Kubernetes - Processes

Virtual Network: creates one unified machine



Kubernetes – Master Redundancy



API SERVER

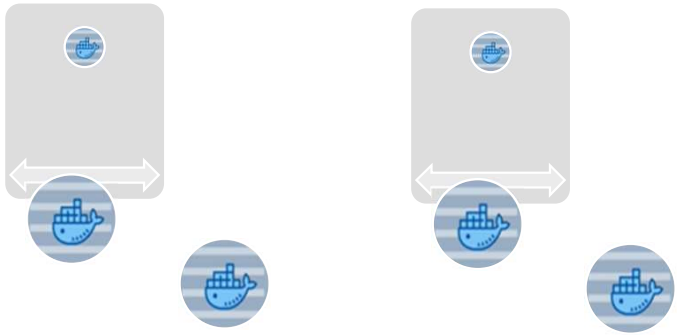
Control Plane Nodes

Handful of master processes

Controller Manager

Scheduler

etcd



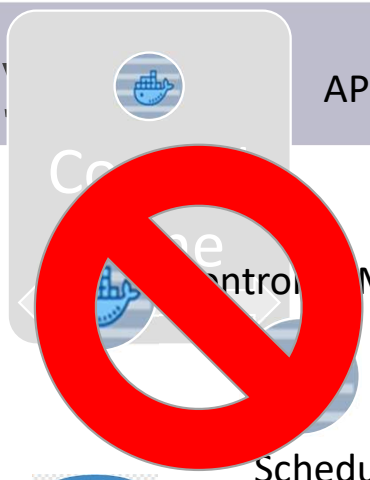
Worker Nodes

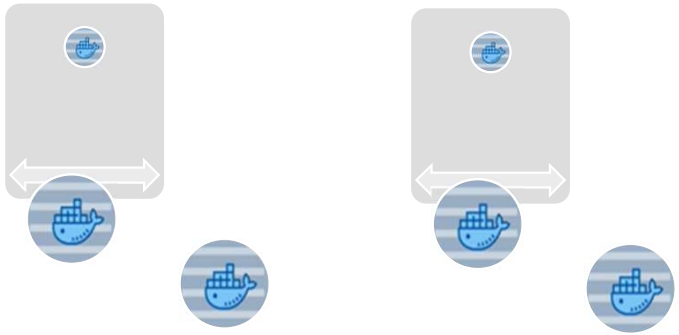
Higher workload

Much bigger and more resources

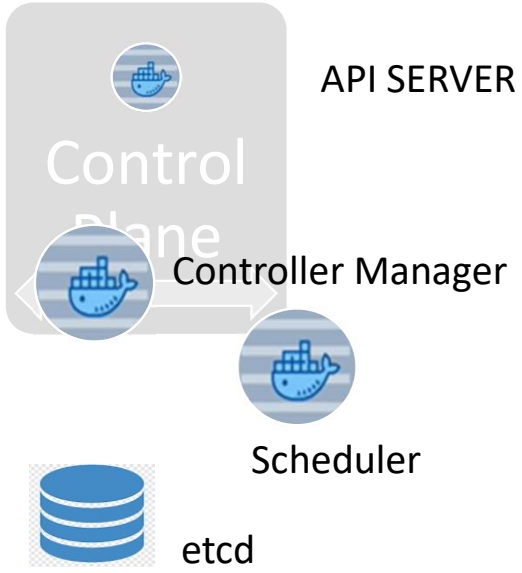
Kubernetes – Master Redundancy

Control Plane Nodes
Handful of master processes
Much more important





Worker Nodes
Higher workload
Much bigger and more resources

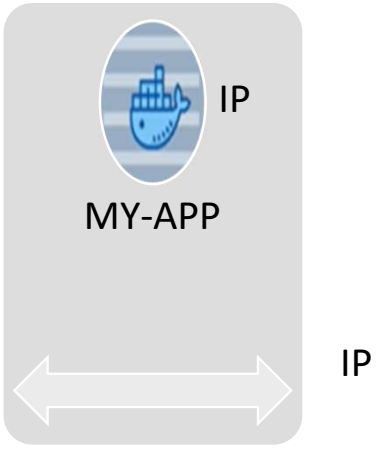


Kubernetes Components

- Pod
- Service
- Ingress
- ConfirgMap
- Secret
- Deployment
- StatefulSet

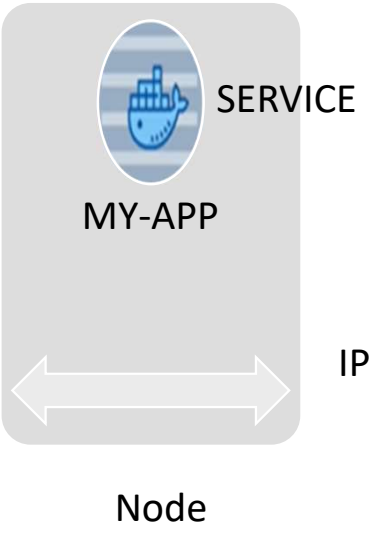
Pod

- Smallest unit of Kubernetes
- Abstraction over container
- Usually 1 application per pod
- Each pod gets its own IP address
- New IP address on re-creation



Service

- Permanent IP address
- Lifecycle of Pod and Service not connected

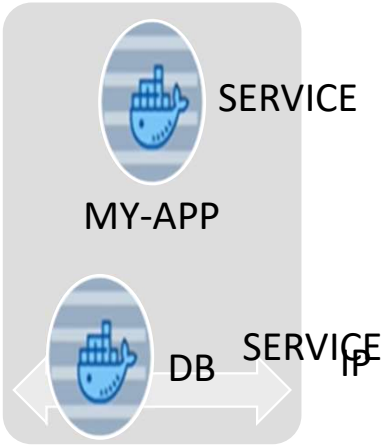


Service

App should be accessible through browser

http://node-ip:port

EXTERNAL SERVICE

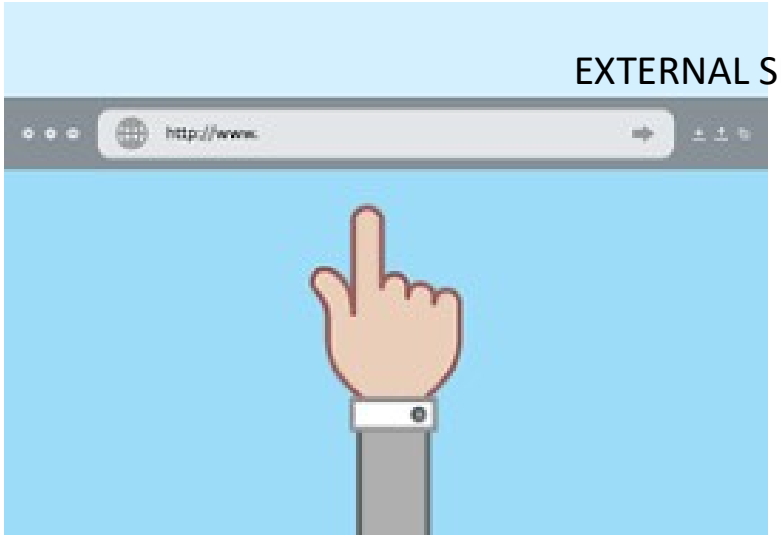


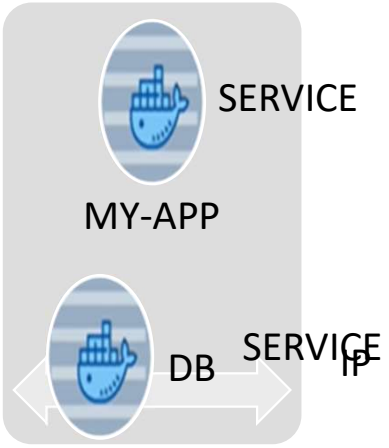
Node

Service

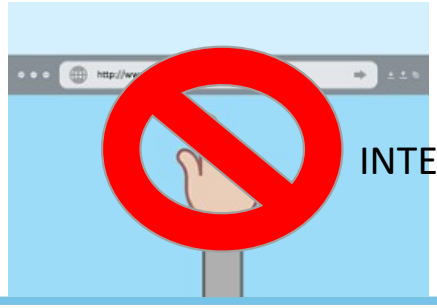
App should be accessible through browser

http://node-ip:port





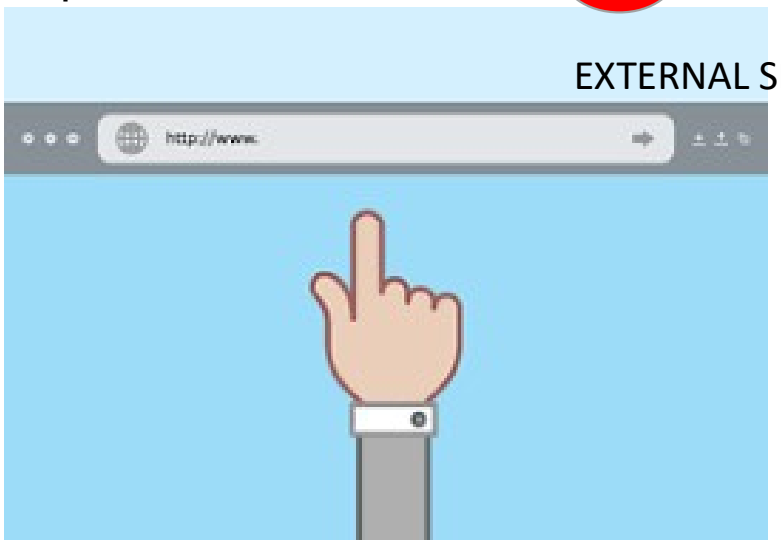
http://db-service-ip:port



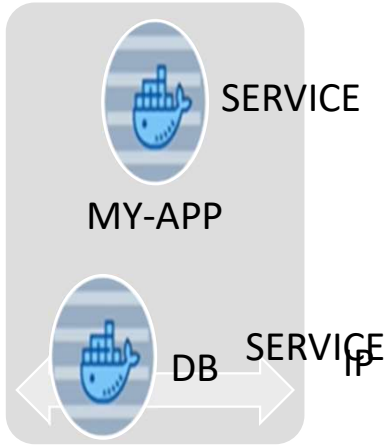
Service

App should be accessible through browser

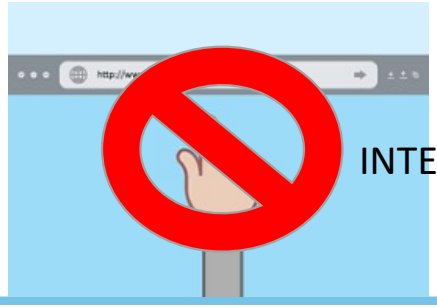
http://124.89.101.2:8080



EXTERNAL SERVICE



http://db-service-ip:port

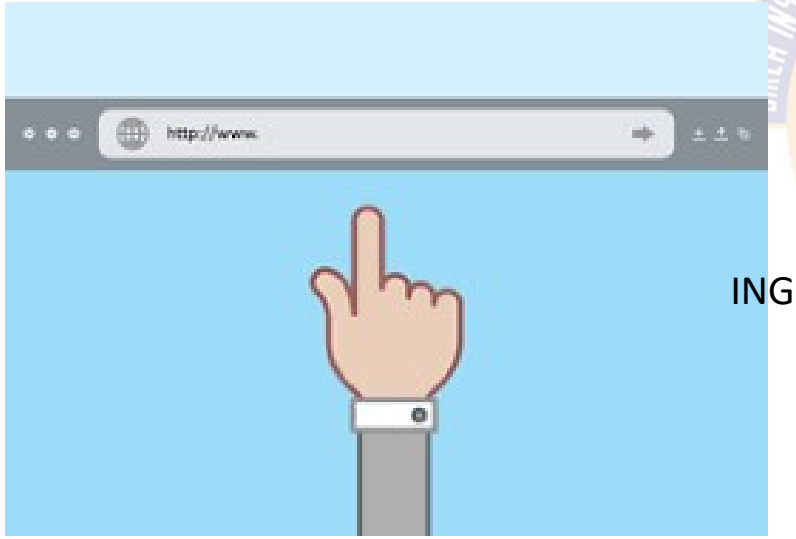


INTERNAL SERVICE

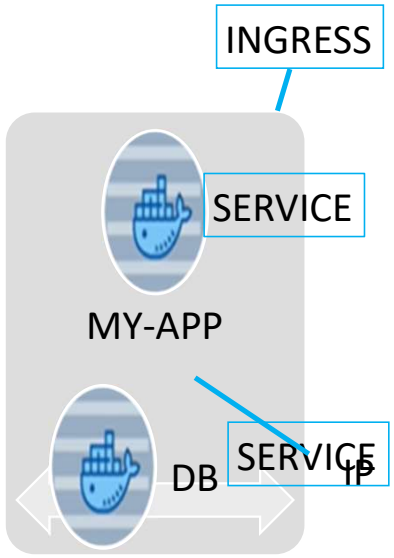
Ingress

App should be accessible through browser

http://my-app.com



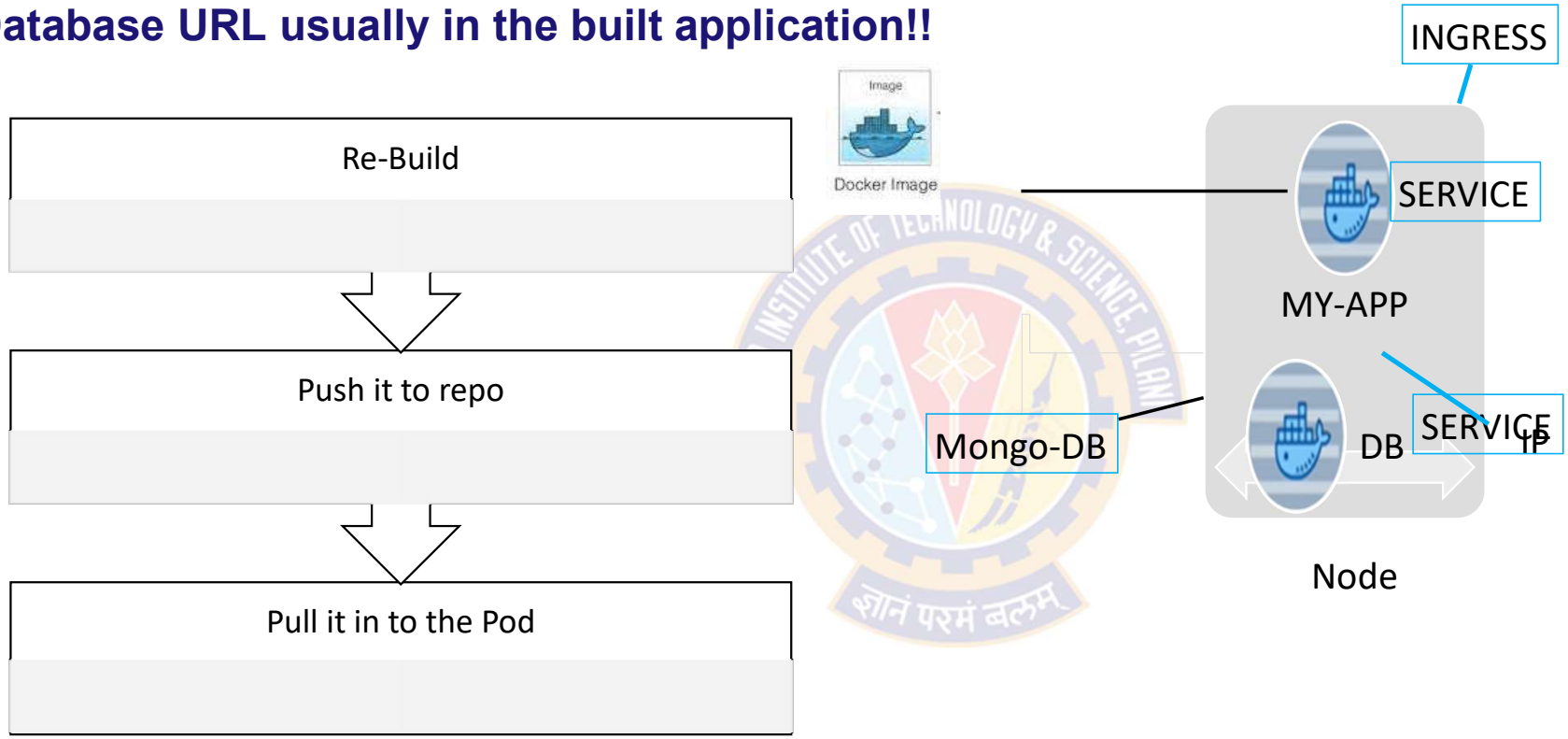
INGRESS



Node

Component?

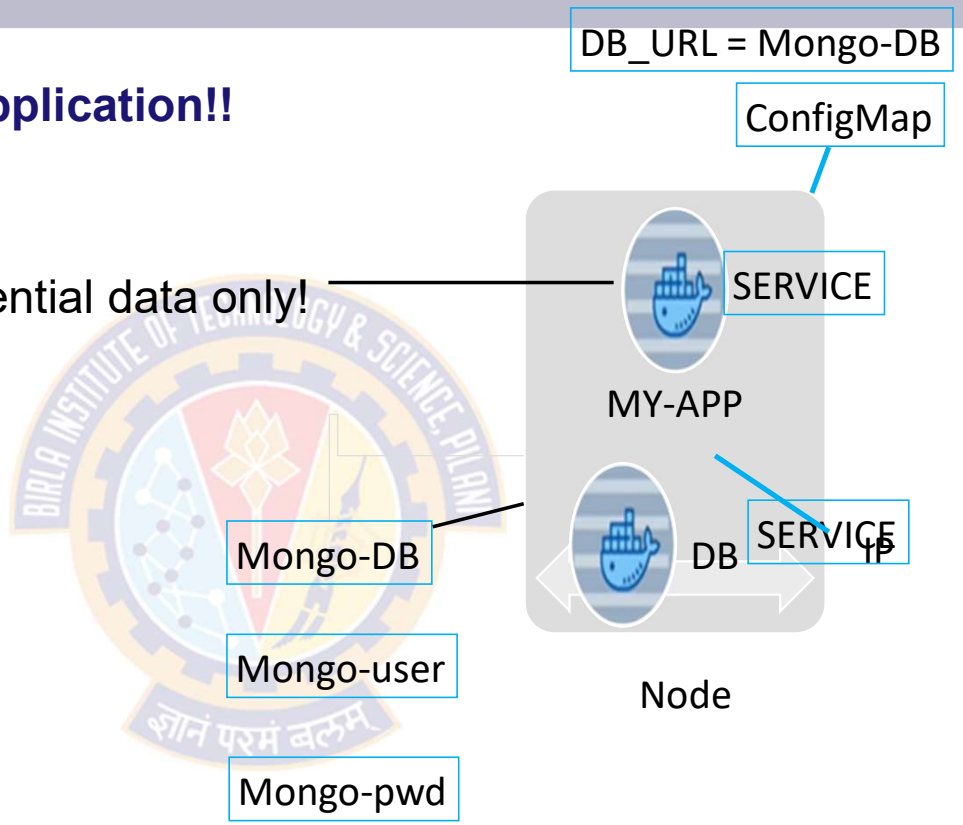
Database URL usually in the built application!!



ConfigMap

Database URL usually in the built application!!

ConfigMap is for non-confidential data only!



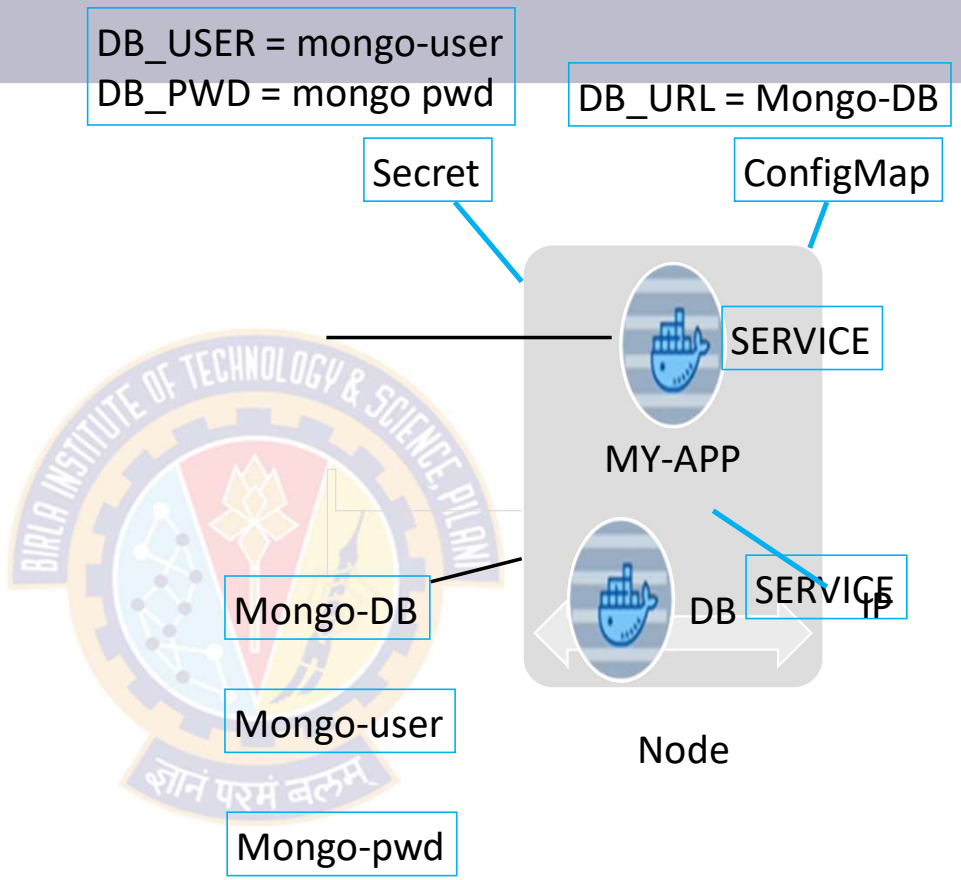

```
Map map = new HashMap<>();

map.put("DB_URL", "http://mongoDB.jswsteel.vasind.bits.edu");
map.put("WS_EndPoint", "http://weatherforecastingdata.gov.in");
map.put("NumberOfThreadsAllowed", 10);
```

Secret

Used to store secret data

Reference Secret in Deployment



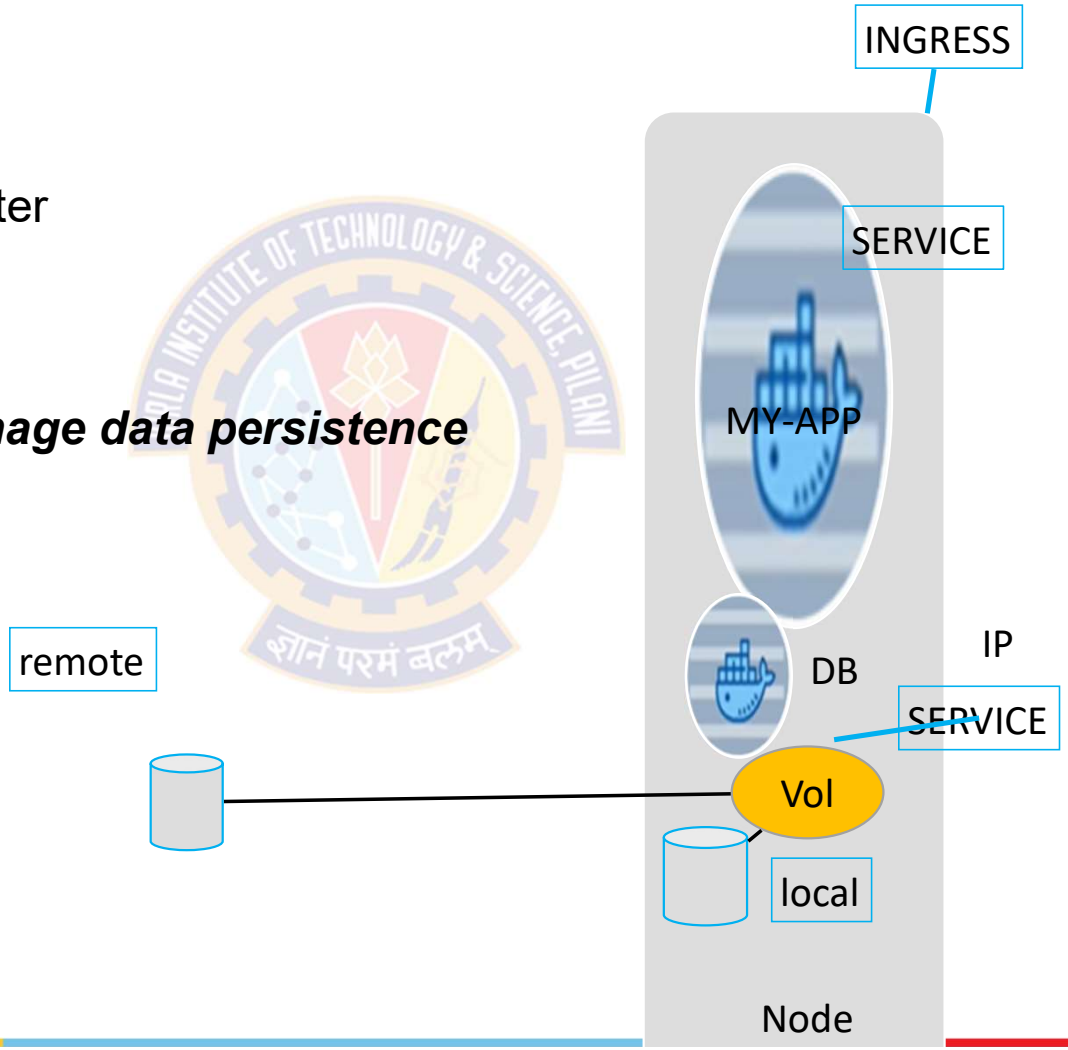
Vol

Storage

Storage on local machine

Or remote, outside the K8s cluster

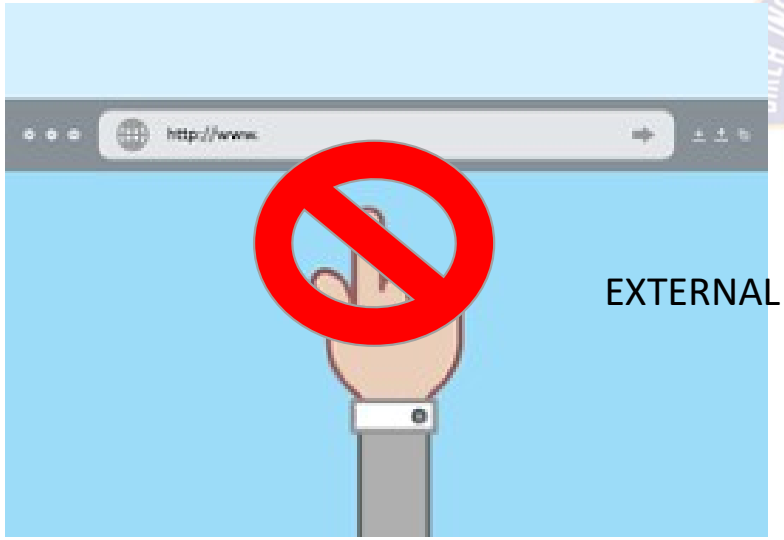
PS: Kubernetes does not manage data persistence



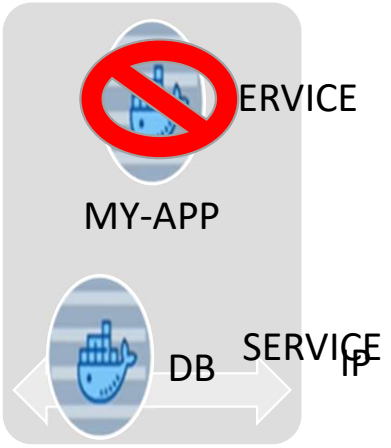
Deployment??

App should be accessible through browser

http://node-ip:port



EXTERNAL SERVICE

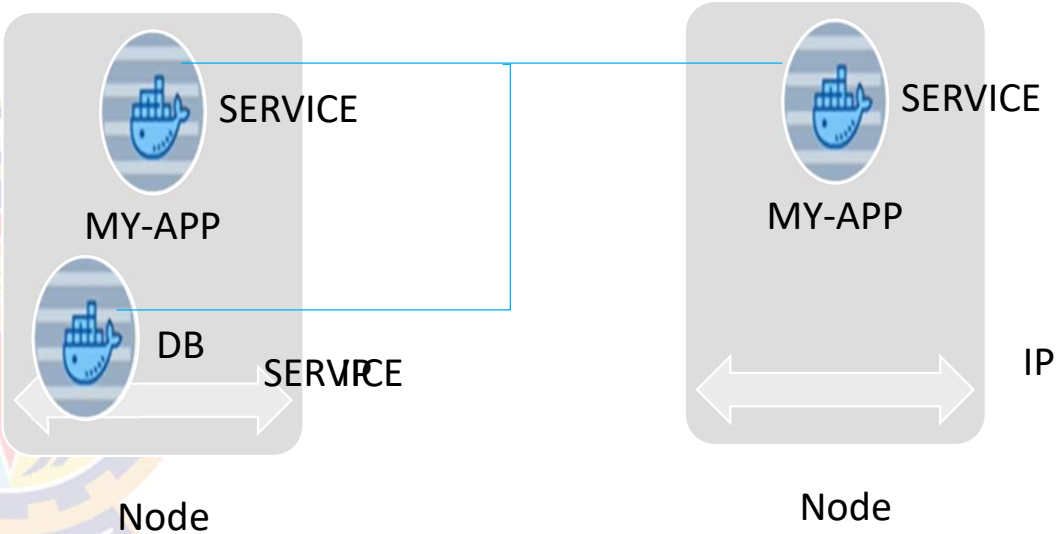


Node

Deployment??

Permanent IP

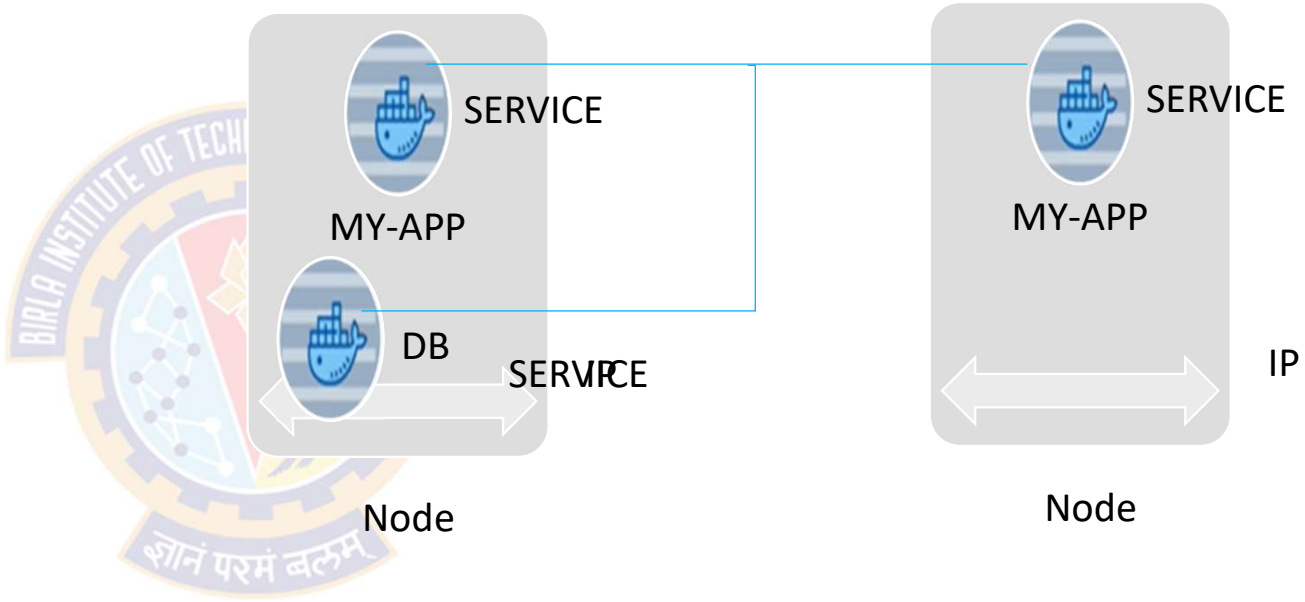
Load balancer



Deployment

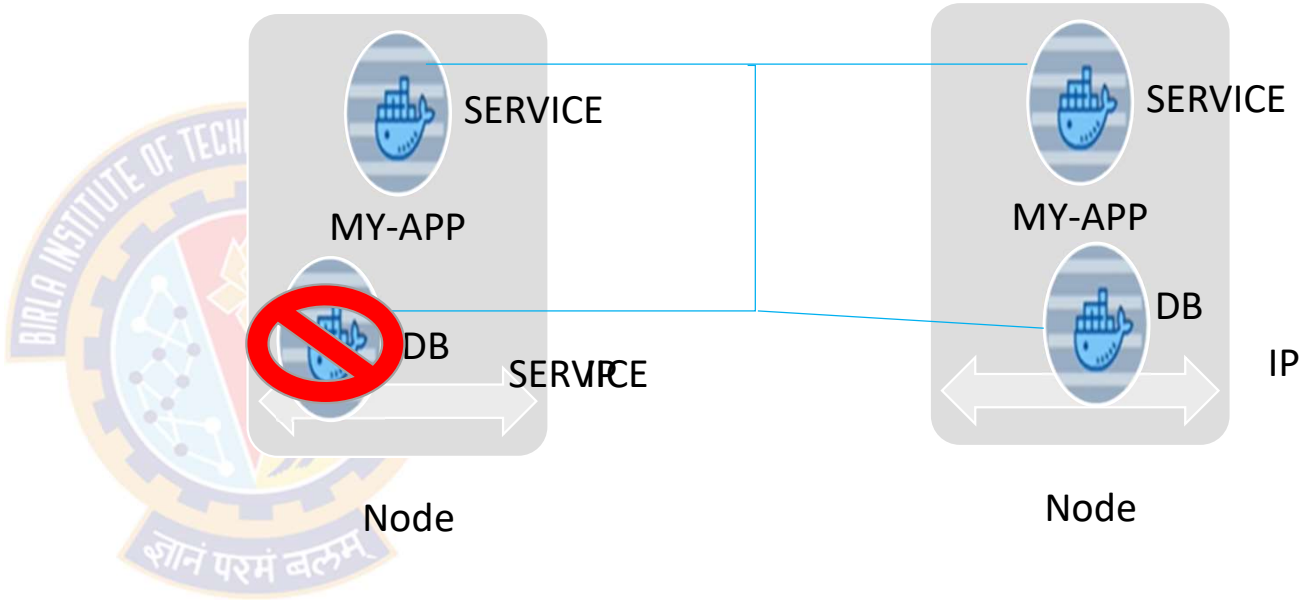
Blueprint for “MY-APP” Pods

Create “Deployments”



Deployment

DB can not be replicated via Deployment



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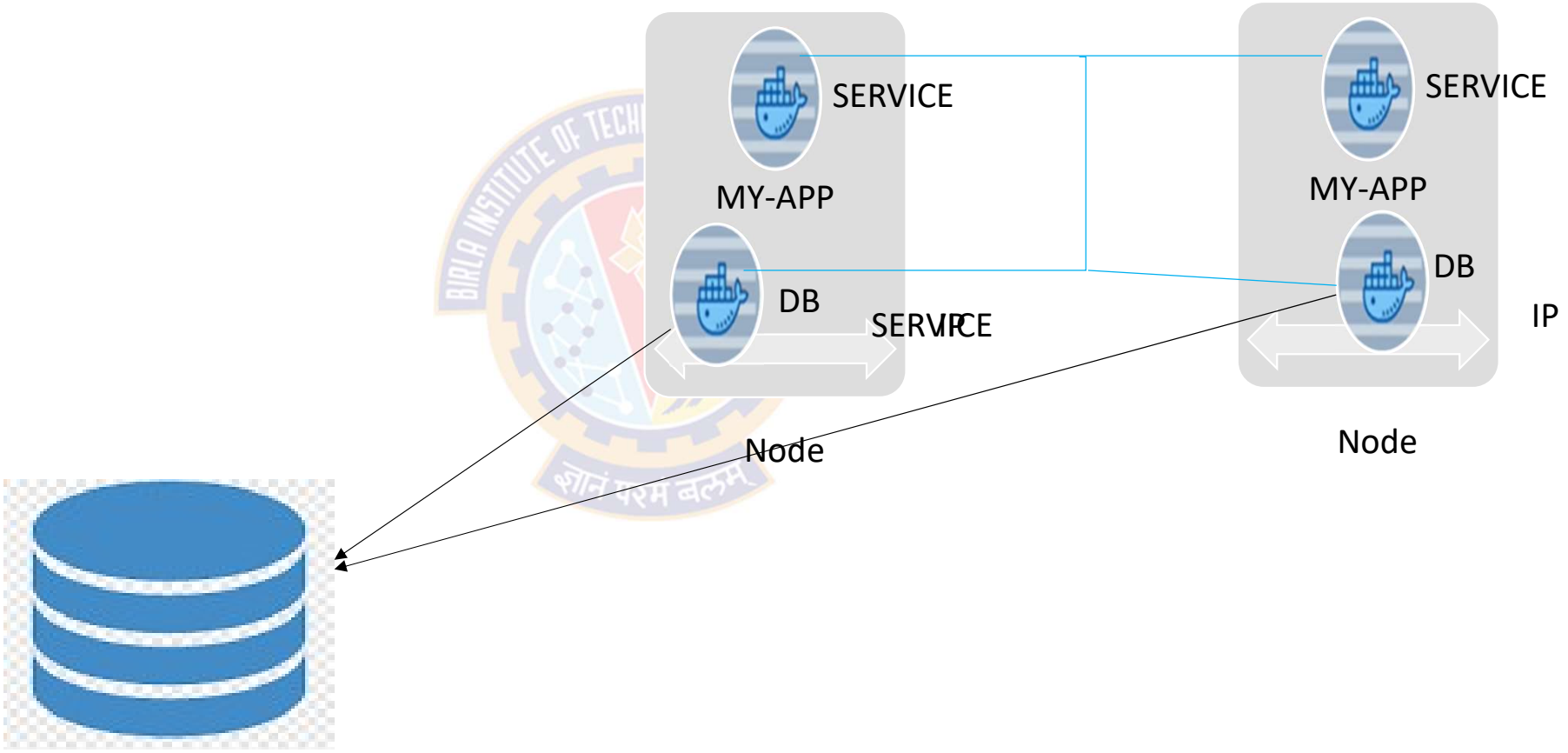
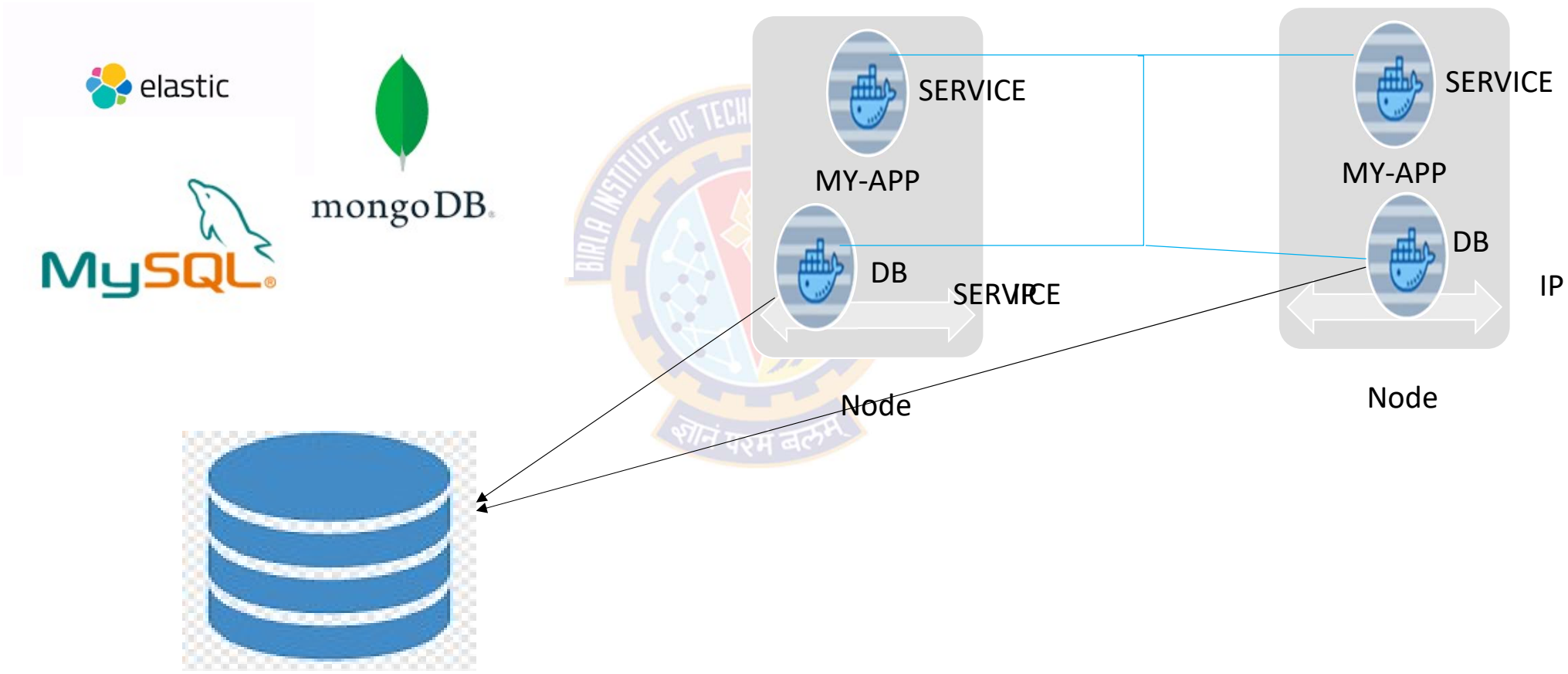


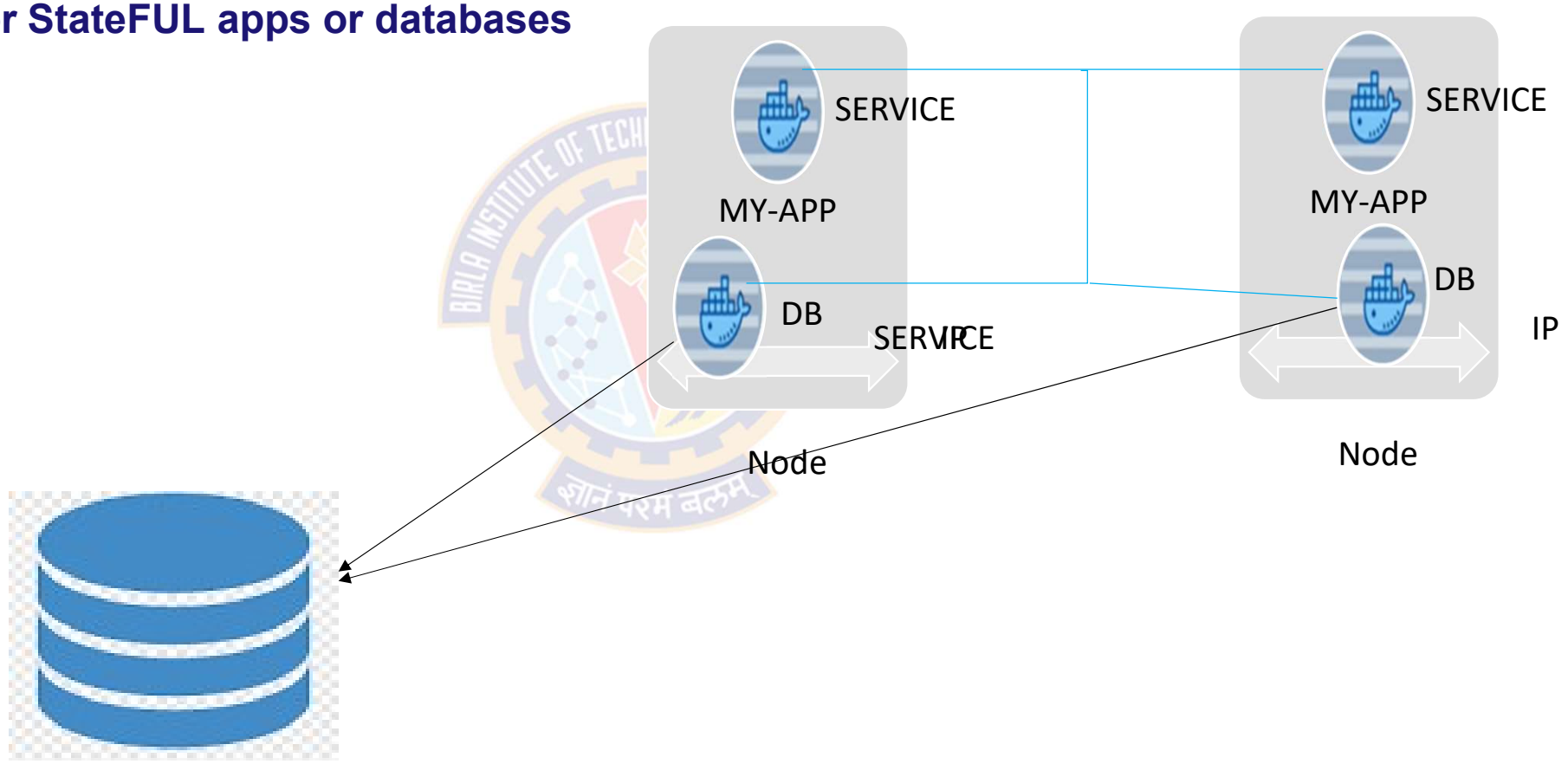
StatefulSet

For Stateful apps



Deployment for Stateless apps

StatefulSet for StateFUL apps or databases

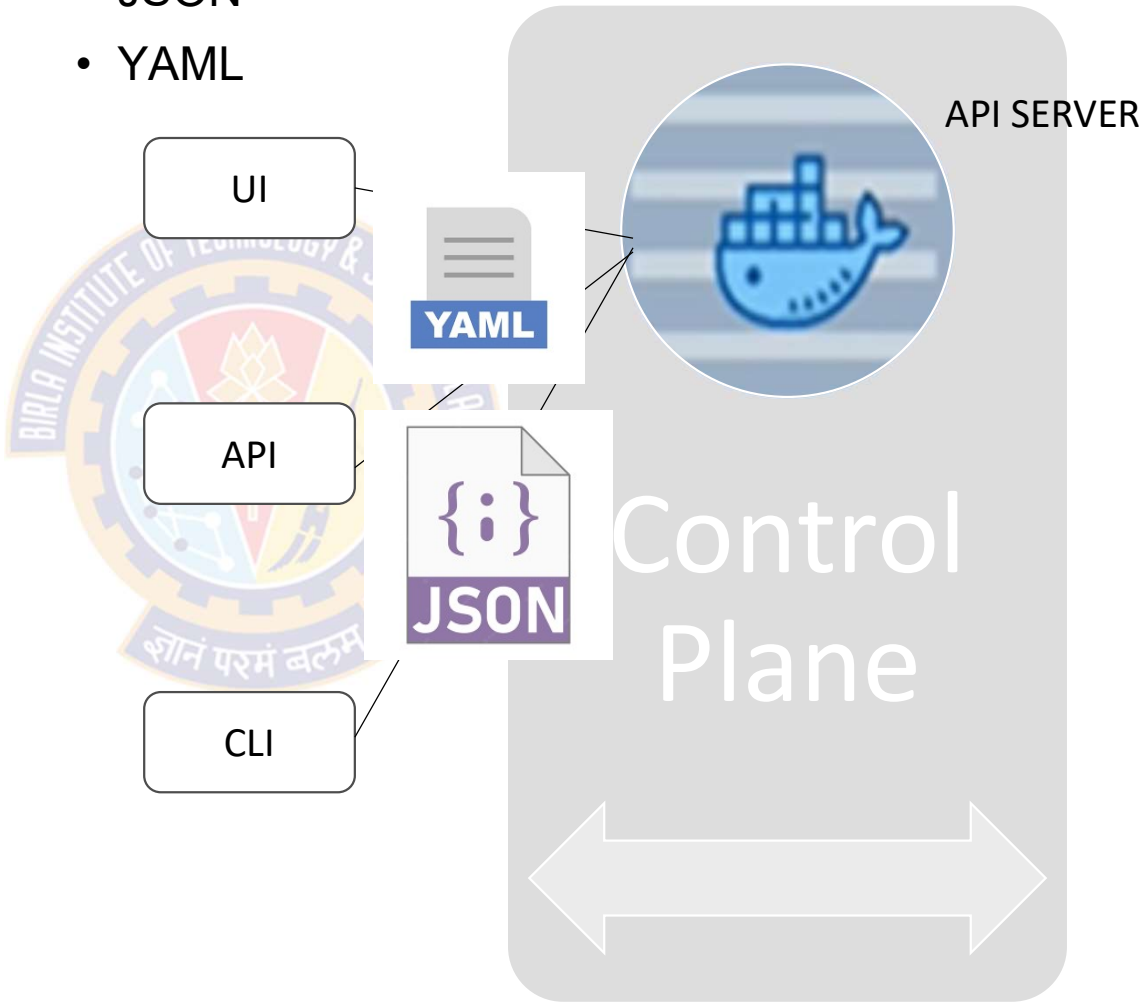


Kubernetes - Configuration

API Server: Entry-point to K8s cluster

```yaml
apiVersion: apps/v1
kind: Deployment
metadata:
  name: my-app
  labels:
    app: my-app
spec:
  replicas: 2
  selector:
    matchLabels:
      app: my-app
  template:
    metadata:
      labels:
        app: my-app
    spec:
      containers:
        - name: my-app
          image: my-image
          env:
            - name: SOME_ENV
              value: $SOME_ENV
          ports:
            - containerPort: 8080
```

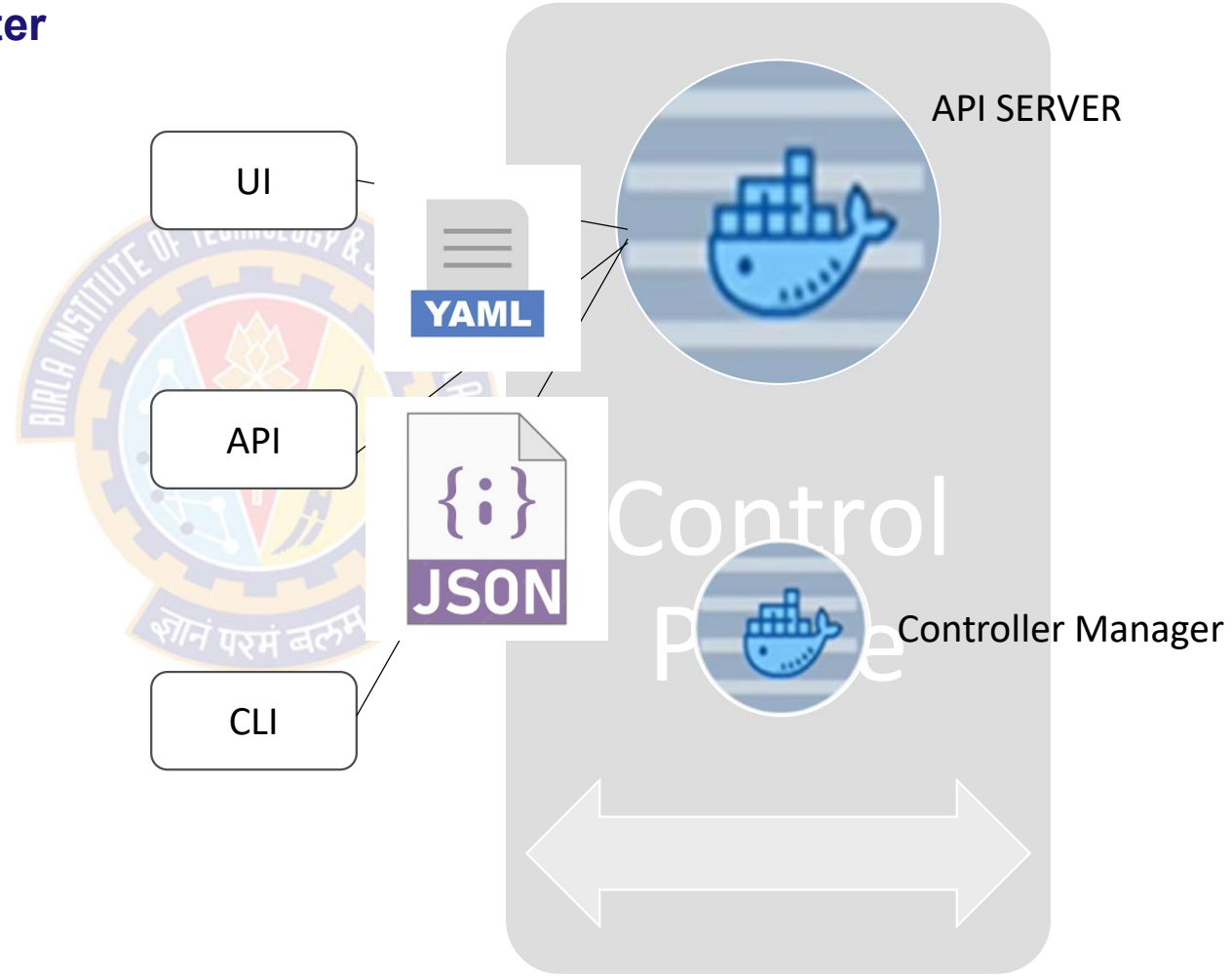
- JSON
- YAML



Kubernetes - Configuration

API Server: Entry-point to K8s cluster

- Declarative
- Is == Should



Kubernetes Configuration

- Each Configuration file has 3 parts:
  - **Metadata**
  - Specification
  - Status

Deployment

nginx-deployment.yaml

```
1   apiVersion: apps/v1
2   kind: Deployment
3   metadata:
4     name: nginx-deployment
5     labels:…
7   spec:
8     replicas: 2
9     selector:…
12    template:…
22
```

Service

nginx-service.yaml

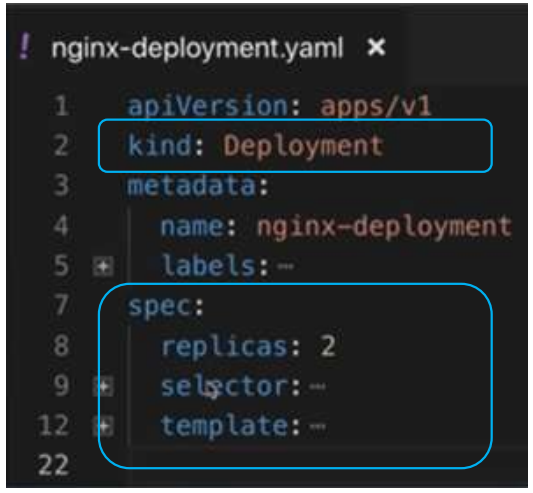
```
1   apiVersion: v1
2   kind: Service
3   metadata:
4     name: nginx-service
5   spec:
6     selector:…
8     ports:…
12
```

Kubernetes Configuration

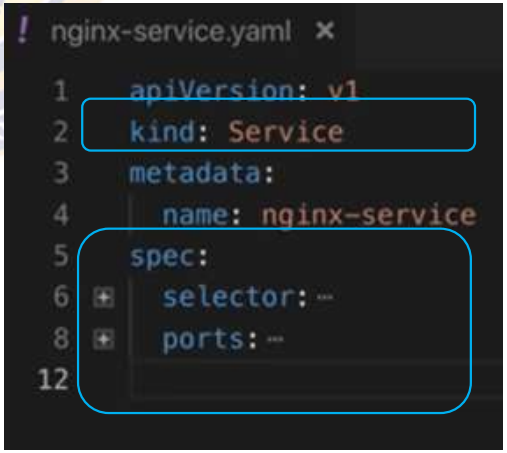
- Each Configuration file has 3 parts:
  - Metadata
  - **Specification**
  - Status

Attributes of "**Spec**" are specific to the "**kind**"

Deployment



Service



Kubernetes Configuration

- Each Configuration file has 3 parts:
  - Metadata
  - Specification
  - **Status : K8s updates the state continously**

Deployment Desired? Vs Actual?

nginx-deployment.yaml

```
1   apiVersion: apps/v1
2   kind: Deployment
3   metadata:
4     name: nginx-deployment
5     labels:
7   spec:
8     replicas: 2
9     selector:
12    template:
22
```

Where does K8s get this status data?

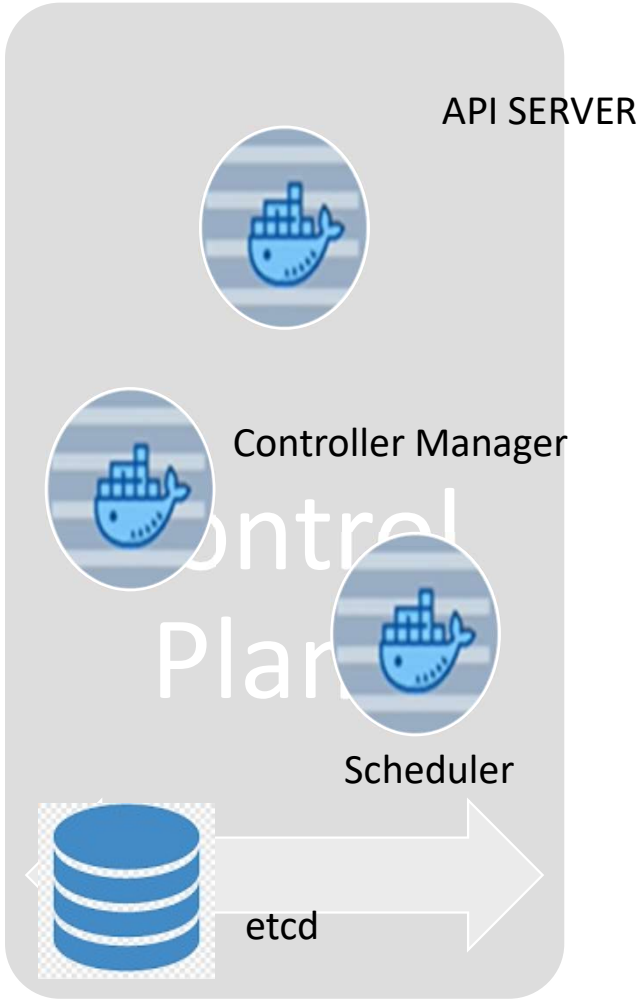
API Server: Entry-point to K8s cluster

Controller manager: keeps track of whats happening in the cluster

Scheduler: ensure pods placement

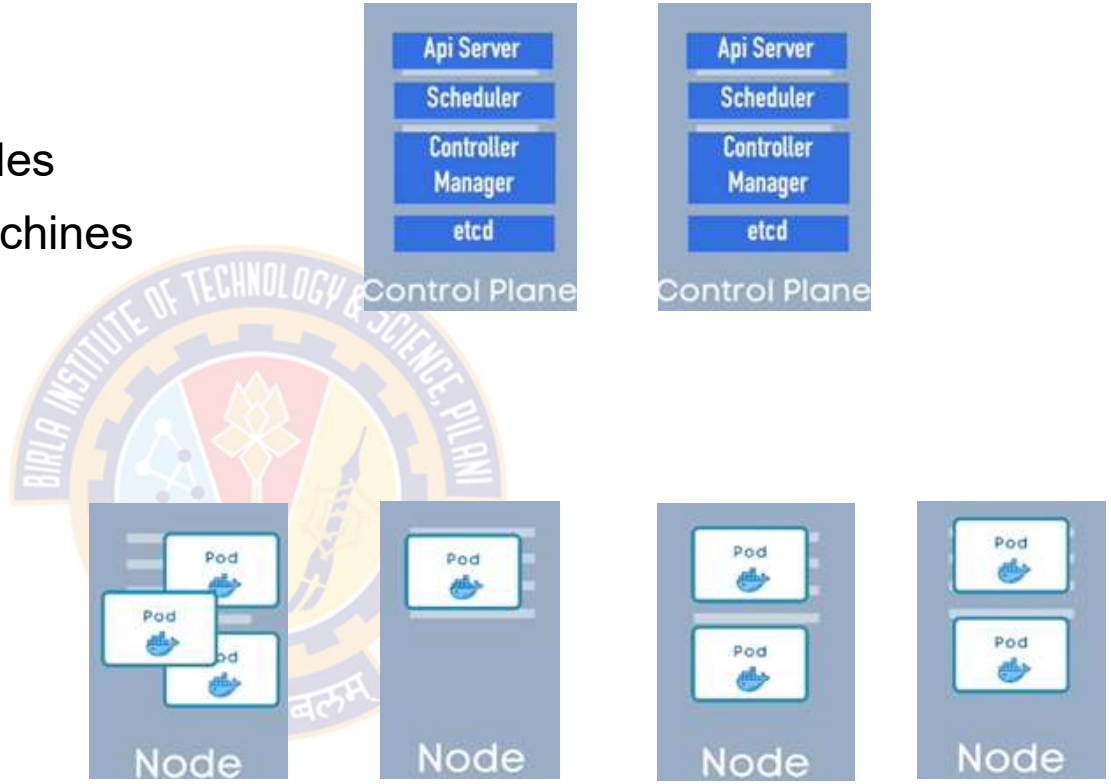
etcd: Kubernetes backing store

Provides the Status information



Production Cluster

- Multiple Master and Worker nodes
- Separate Virtual or Physical machines



Test/Local Cluster Setup

- Master and Node processes run on One machine
  - Minikube
  - Micro K8s

mongo-configmap.yaml and mongo-secret.yaml

```
apiVersion: v1
kind: ConfigMap
metadata:
  name: mongo-config
data:
  mongo-url: mongo-service
```

```
apiVersion: v1
kind: Secret
metadata:
  name: mongo-secret
type: Opaque
data:
  mongo-user: bW9uZ291c2Vy
  mongo-password: bW9uZ29wYXNzd29yZA==
```

Mongo.yaml

```yaml
apiVersion: apps/v1
kind: Deployment
metadata:
  name: mongo-deployment
  labels:
    app: mongo
spec:
  replicas: 1
  selector:
    matchLabels:
      app: mongo
  template:
    metadata:
      labels:
        app: mongo
    spec:
      containers:
      - name: mongodb
        image: mongo:5.0
        ports:
        - containerPort: 27017
```

```yaml
env:
      - name: MONGO_INITDB_ROOT_USERNAME
        valueFrom:
          secretKeyRef:
            name: mongo-secret
            key: mongo-user
      - name: MONGO_INITDB_ROOT_PASSWORD
        valueFrom:
          secretKeyRef:
            name: mongo-secret
            key: mongo-password
---
apiVersion: v1
kind: Service
metadata:
  name: mongo-service
spec:
  selector:
    app: mongo
  ports:
    - protocol: TCP
      port: 27017
      targetPort: 27017
```

Webapp.yaml

```
apiVersion: apps/v1
kind: Deployment
metadata:
  name: webapp-deployment
  labels:
    app: webapp
spec:
  replicas: 1
  selector:
    matchLabels:
      app: webapp
  template:
    metadata:
      labels:
        app: webapp
    spec:
      containers:
      - name: webapp
        image: nanajanashia/k8s-demo-app:v1.0
        ports:
        - containerPort: 3000
```

```
env:
        - name: USER_NAME
          valueFrom:
            secretKeyRef:
              name: mongo-secret
              key: mongo-user
        - name: USER_PWD
          valueFrom:
            secretKeyRef:
              name: mongo-secret
              key: mongo-password
        - name: DB_URL
          valueFrom:
            configMapKeyRef:
              name: mongo-config
              key: mongo-url
---
apiVersion: v1
kind: Service
metadata:
  name: webapp-service
spec:
  type: NodePort
  selector:
    app: webapp
  ports:
    - protocol: TCP
      port: 3000
      targetPort: 3000
      nodePort: 30100
```

Use private IP of any of the nodes to access the app!!

- Kubectl get node
- Kubectl apply –f mongo-configmap.yaml
- Like wise apply – mongo-secret.yaml, mongo.yaml, webapp.yaml
- Kubectl get deployments
- Kubectl get pods
- Kubectl get services
- Kubectl get all
- Kubectl describe service webapp-service

- Kubectl delete service <service-name>
- Kubectl delete deployment <deployment-name>
- Kubectl delete configmap <configmap name>
- Kubectl delete secret <secret-name>