



THE LINUX FOUNDATION  
**OPEN SOURCE SUMMIT**  
JAPAN

# **Kubernetes Native Infrastructure and Operator Framework for 5G Edge Cloud Computing**

Hyde Sugiyama - Chief Architect, Red Hat K.K.

# OpenShift/K8s on OpenStack NFV session@OSS2018



Open Source possibility for 5G deployment with  
OpenStack NFV edge computing, K8s Edge Container Platform  
Ceph storage Data Lake

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## OpenShift on OpenStack NFV B2B2X for SoE apps in OpenShift (in VM) on top of DCN(NFVI)

### Carrier Edge DC use case - NTT NT Lab(B2B2X)

<https://blog.openshift.com/openshift-commons-gathering-at-austin-2017-recap/>

vCPE suite: Broadband Gateway, Firewall, Elastic Load Balancer, etc

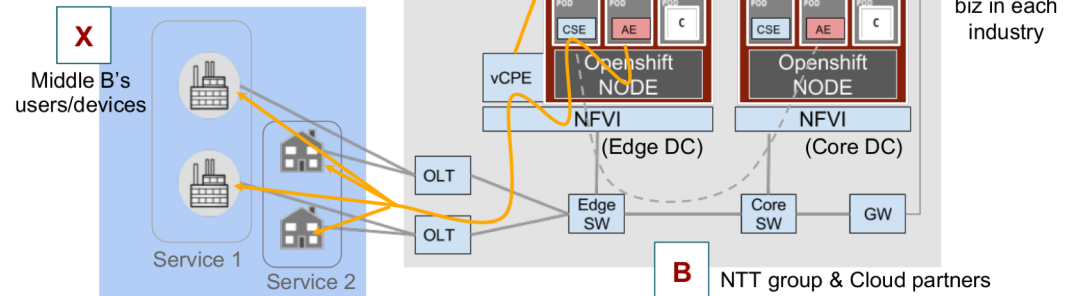
CSE in Infrastructure : IoT GW, AAA, etc

User's AE: IoT Robotics controller

vCPE(virtual Customer Premise Equipment)

CSE(Common Service Entity)

AE(Application Entity)



# Innovation

## 4G

All IP packet

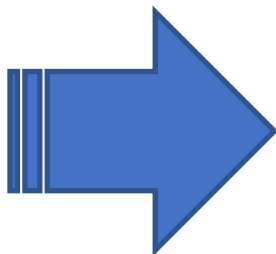
Carrier  
Grade  
Linux

Network  
Function  
Virtualization

## VNF

Distribute  
Compute  
Node

Multiaccess  
Edge  
Computing



## 5G

### 5GC

Cloud native/Service Based Architecture  
CP and UPF separation

Network slicing

UPF offload (FPGA, Edge Switch Fabric)

vRAN CU-DU split

Heterogeneous Computing

## CNF

DPDK(vCPU)

GPU

FPGA

Autonomous micro edge cloud .... Local 5G

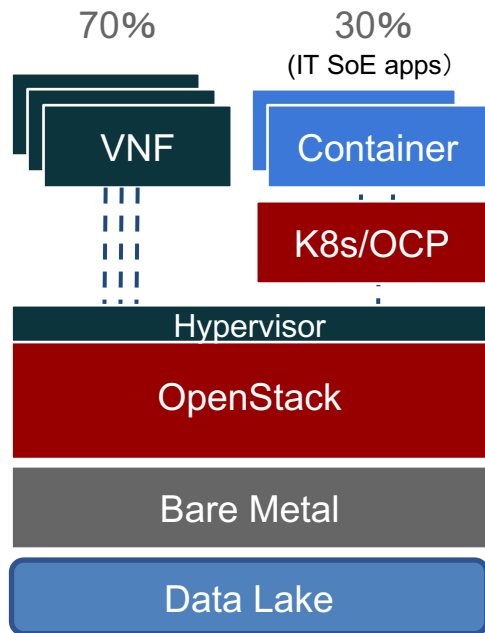
Edge AI platform(Intelligent Edge)

Data Lake /Data Hub

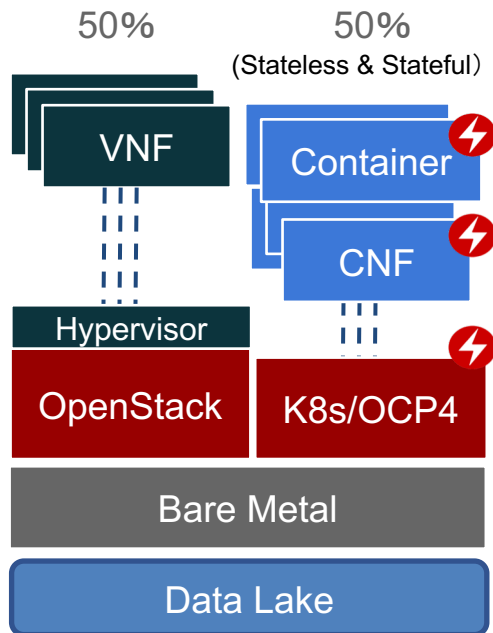


# NFV Evolution to Kubernetes

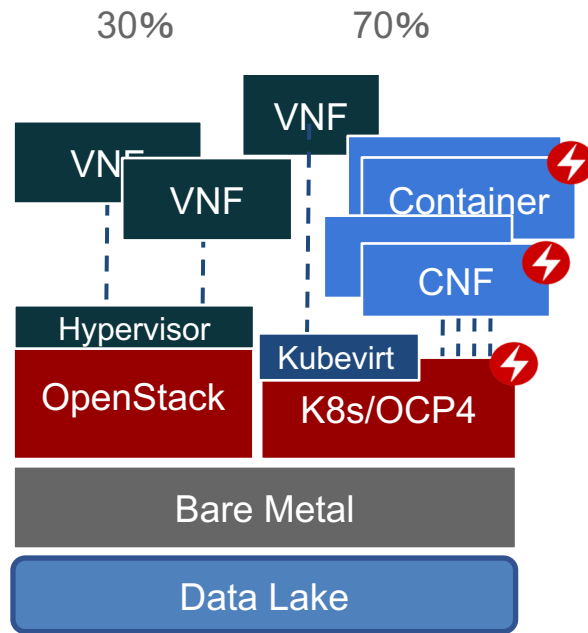
Y2018-2019



Y2019-2020



Y2020-2021



SoE: System of Engagement



OCP4: OpenShift Container Platform 4



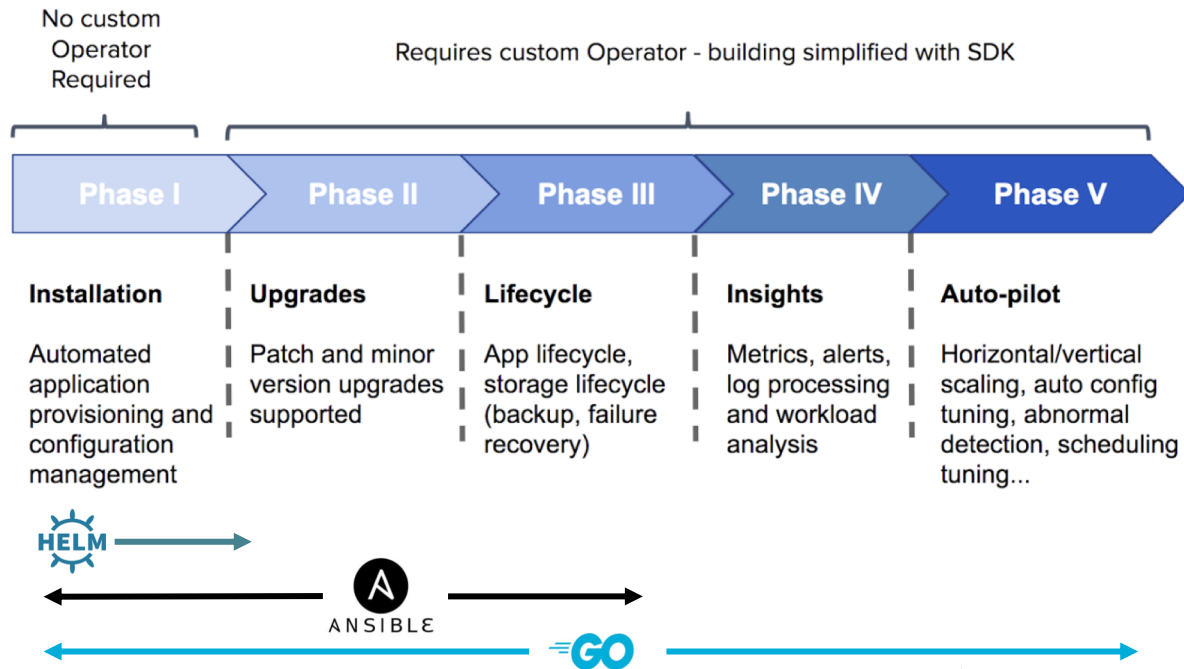
# Agenda

- OpenShift/K8s on BM and Operator Framework for CNF
- KNI for 5G core service based architecture
- KNI for 5G radio access network
- KNI (Kubernetes Native Infrastructure) for 5G edge
- Summary

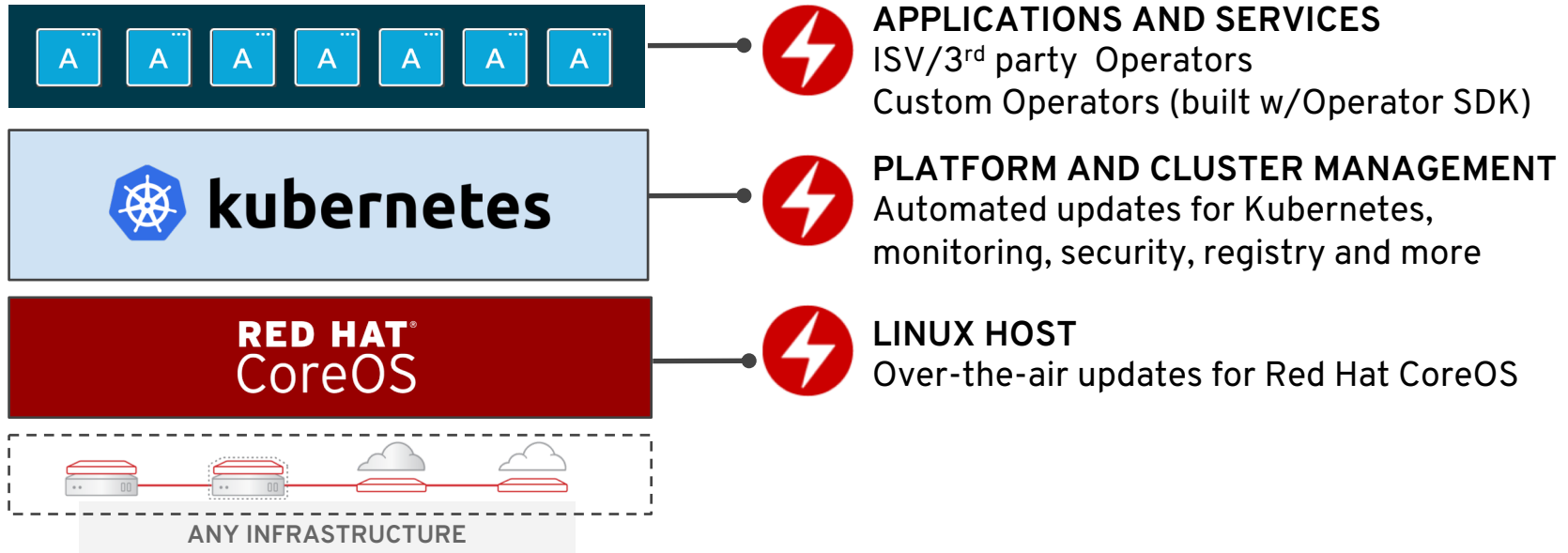
# OpenShift/k8s on BM deployment and Operator Framework for CNF

- Automate Day 2 lifecycle management of container applications in Kubernetes
- Leverage CRDs to deploy Kubernetes native services that can access Kube API events
- Operator SDK simplifies creation of Operators in Go (or leverage Helm or Ansible automation)

## Operator Maturity Model

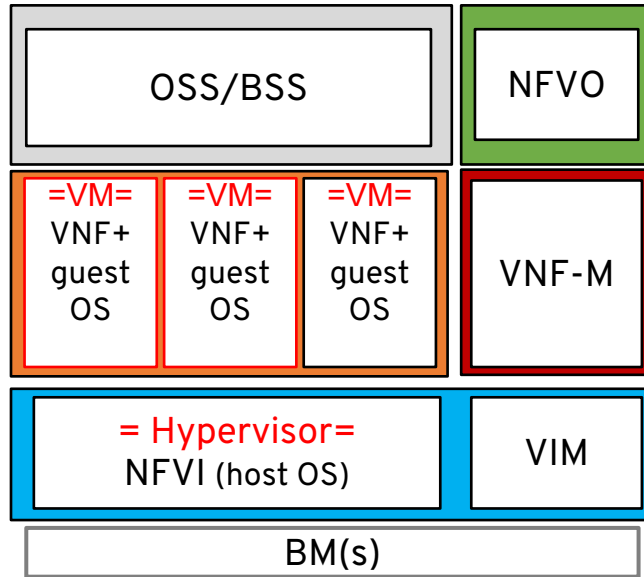


# Full-Stack Automated Operations in OpenShift

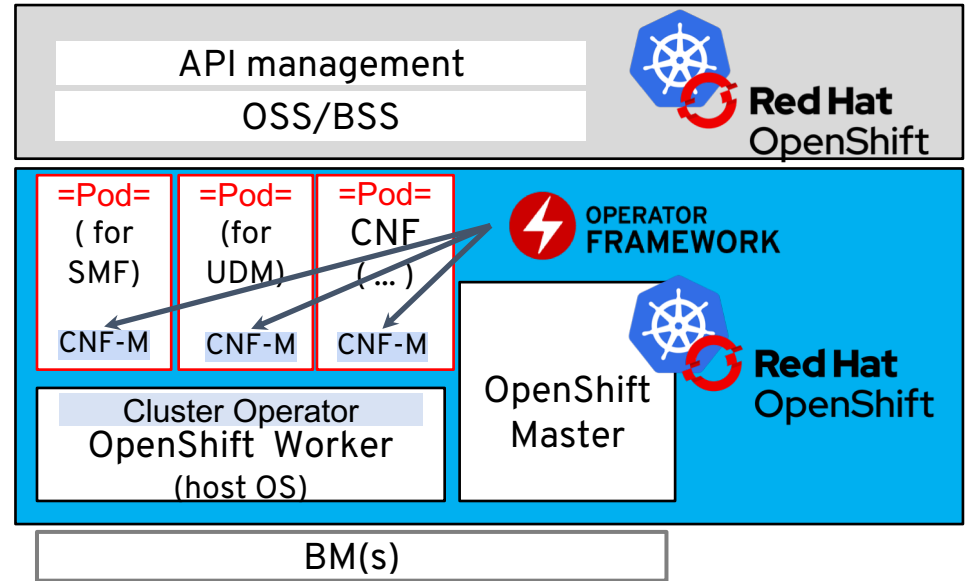




# Possibility for NFV architecture change by adapting Kubernetes Operator (OpenShift Operator framework)



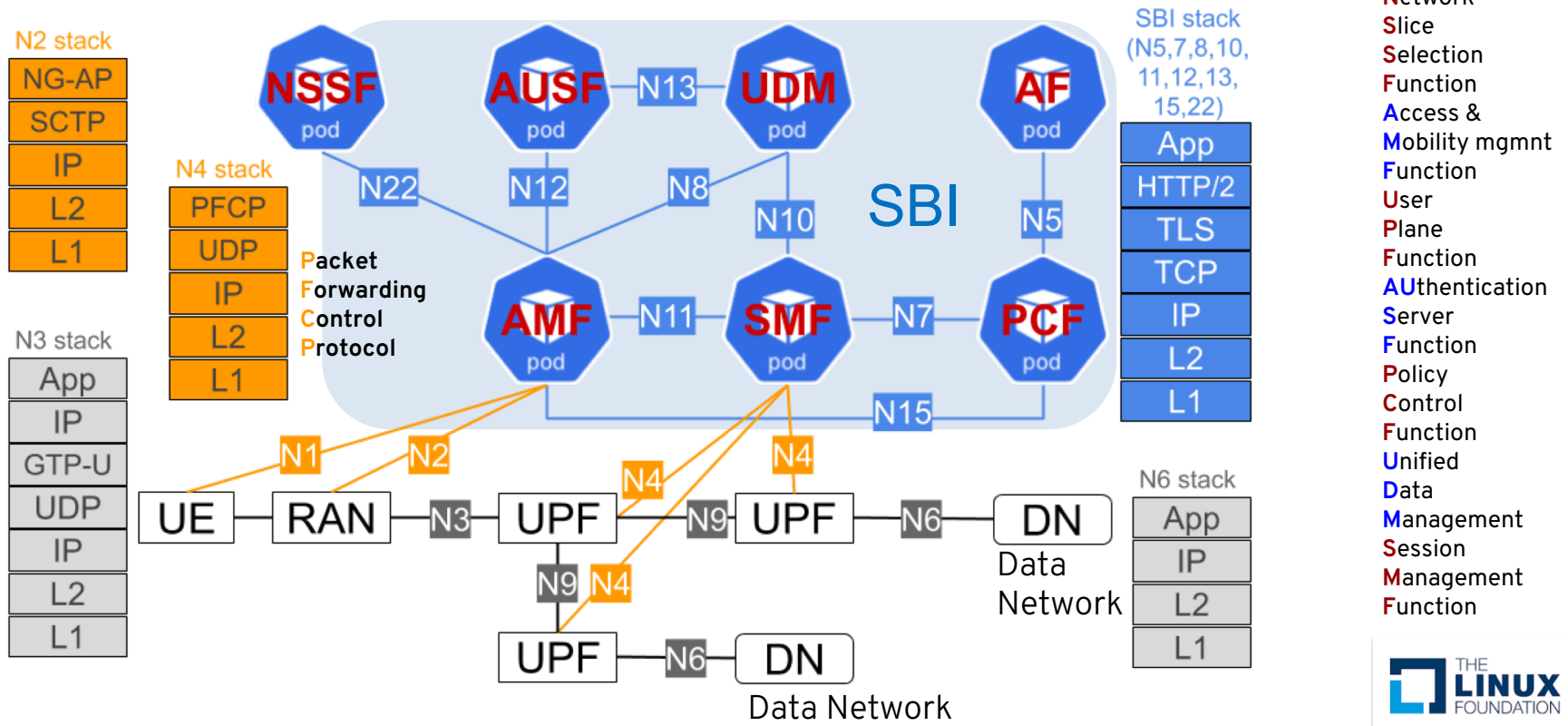
## VNF



## CNF

# 5GC Service Based Architecture on Kubernetes

# 5GC system architecture



# 5G SBI and Service Mesh

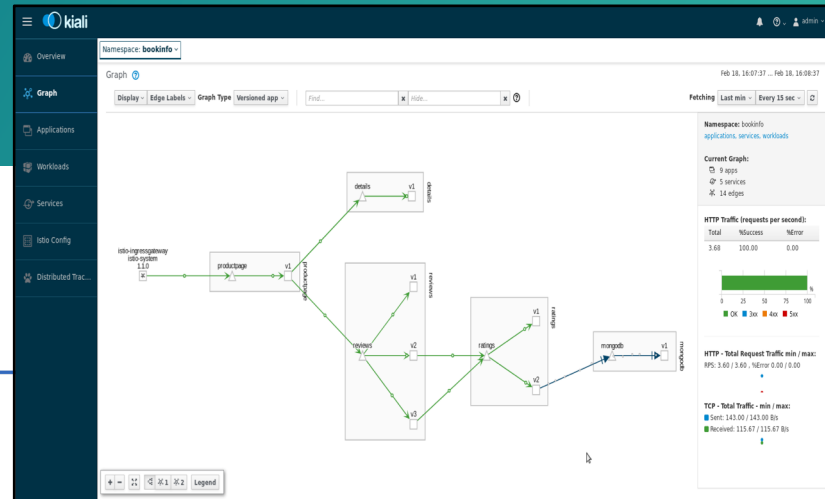
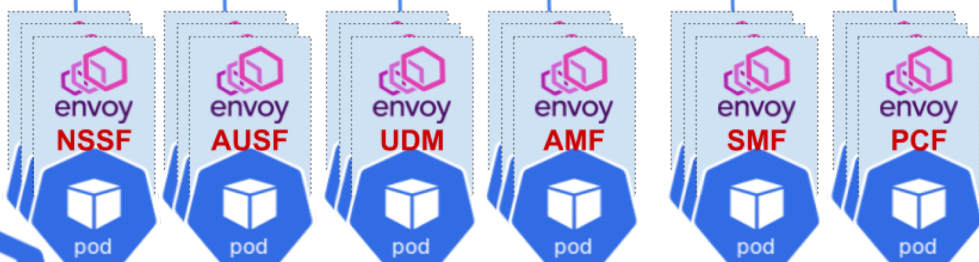


## OPENSIFT SERVICE MESH

Jaeger Pilot Mixer Auth

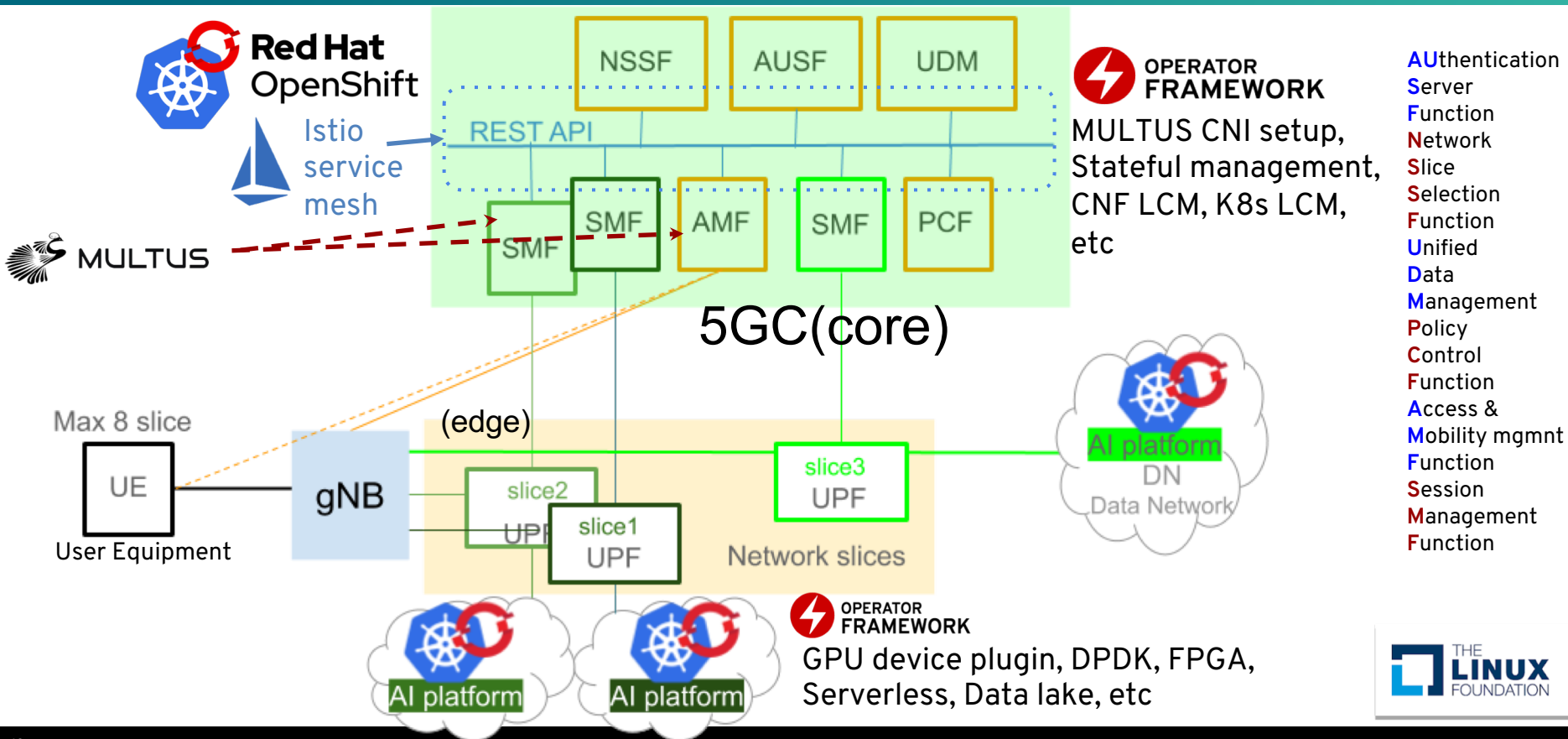
5G Service Base Interface  
(RESTful API)

Istio Service Mesh



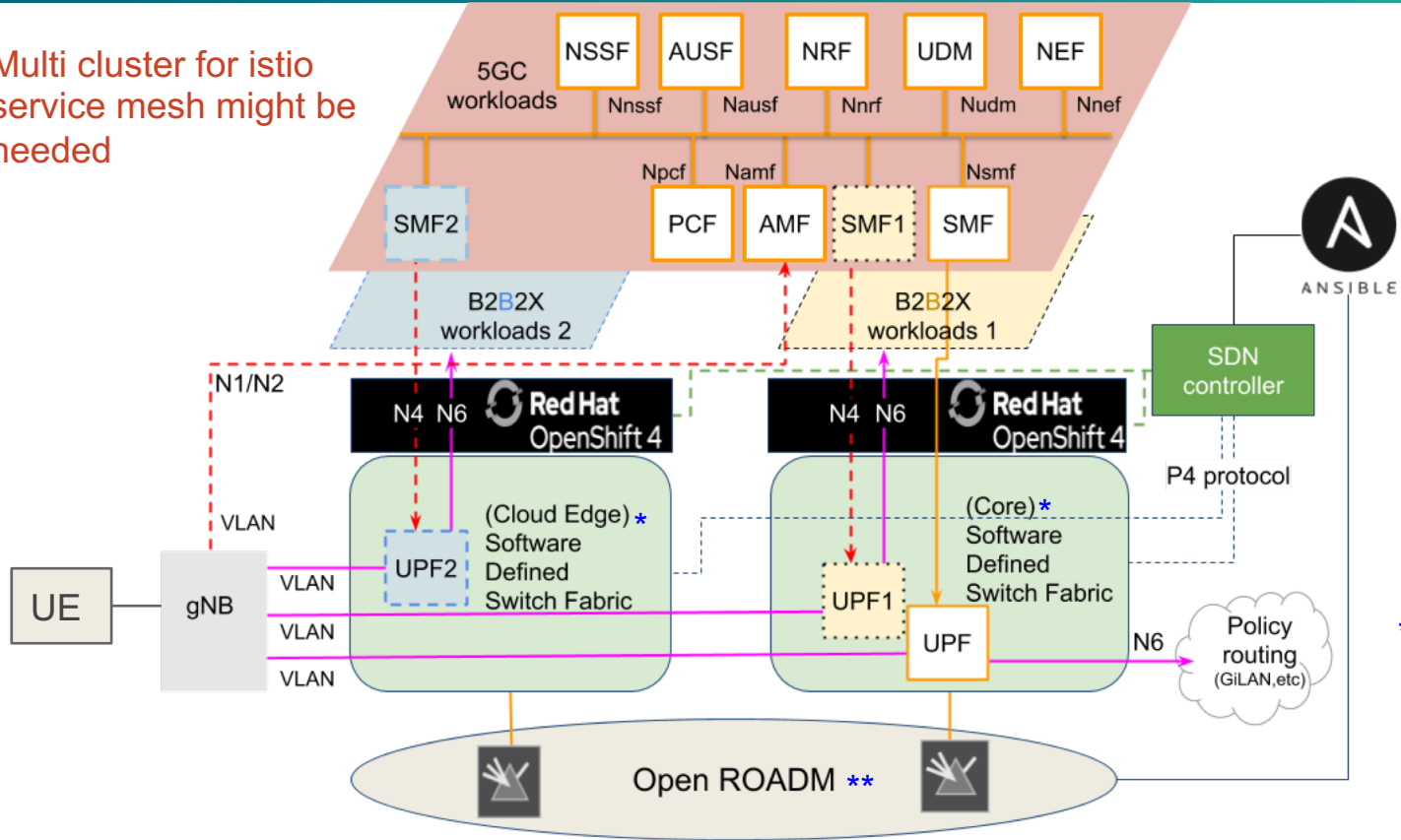
- A dedicated network for service to service communications
- Observability and distributed tracing
- Policy-driven security
- Routing rules & chaos engineering
- Powerful visualization & monitoring
- Will be available via OperatorHub

# Service Mesh & 5GC SBA(Service-Based Architecture)



# 5G UPF and Network Slicing in Cloud edge fabric for B2B2X workloads and etc

Multi cluster for istio service mesh might be needed



Slice 1 for B2B2X workloads 1 : SMF1 & UPF1

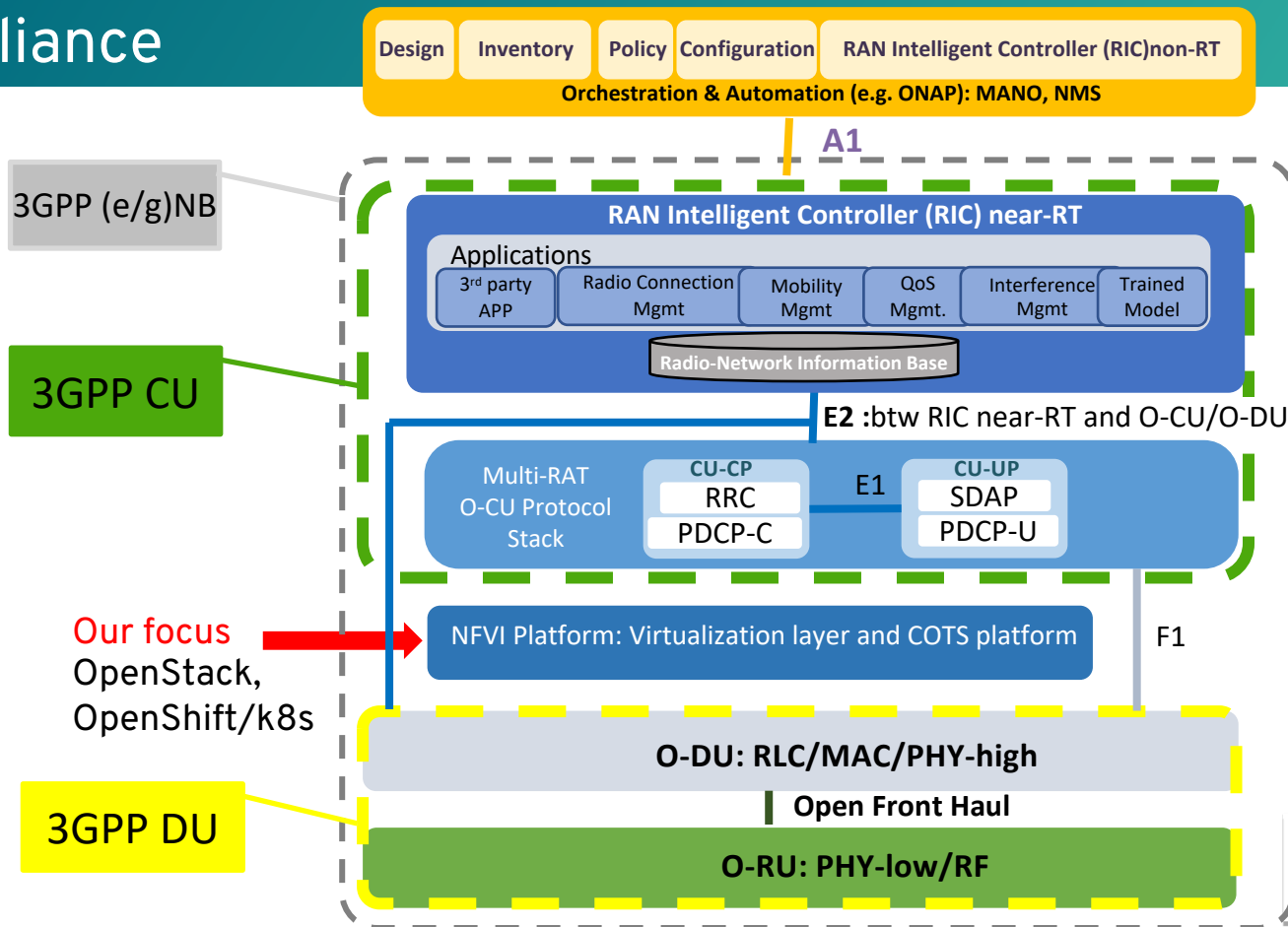
Slice 2 for B2B2X workloads 2 : SMF2 & UPF2

- \* <https://www.youtube.com/watch?v=1X5U4Jo0Jlw>
- \*\* [https://www.pilab.jp/ipop2019/exhibition/WhitePaper\\_iPOP2019.pdf](https://www.pilab.jp/ipop2019/exhibition/WhitePaper_iPOP2019.pdf)



# O-RAN alliance & RAN Cloudification w/ Kubernetes

# 3GPP & O-RAN alliance



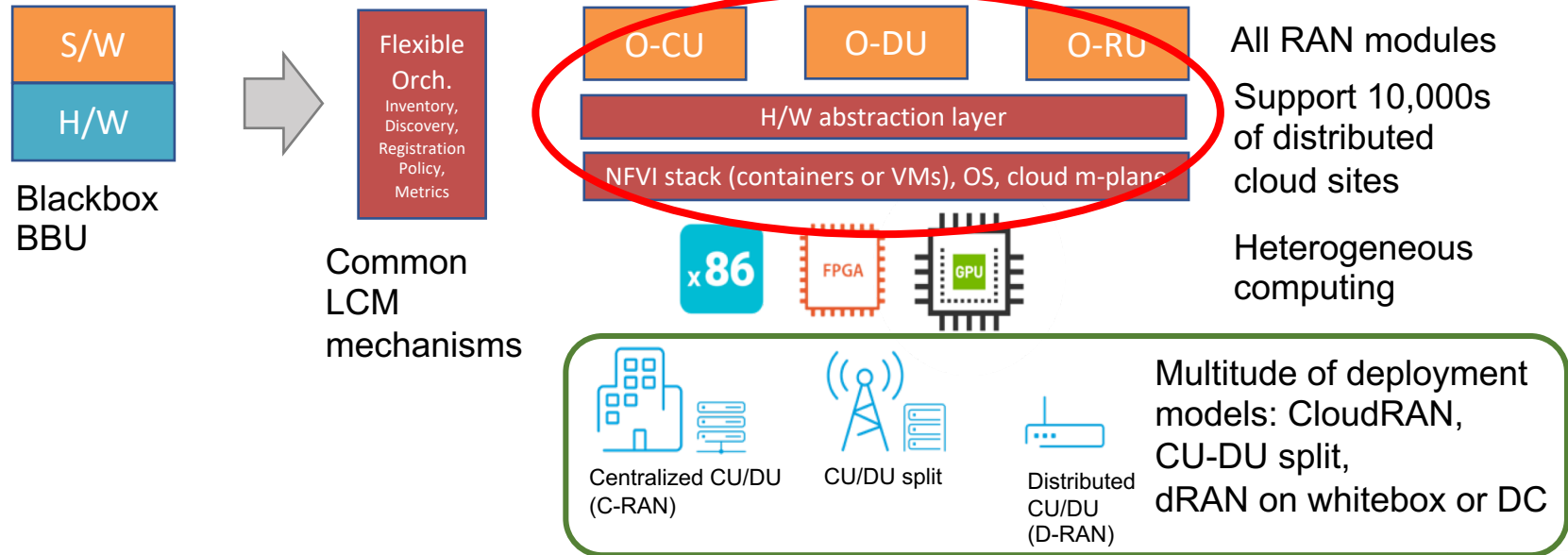
**Our focus**  
OpenStack,  
OpenShift/k8s





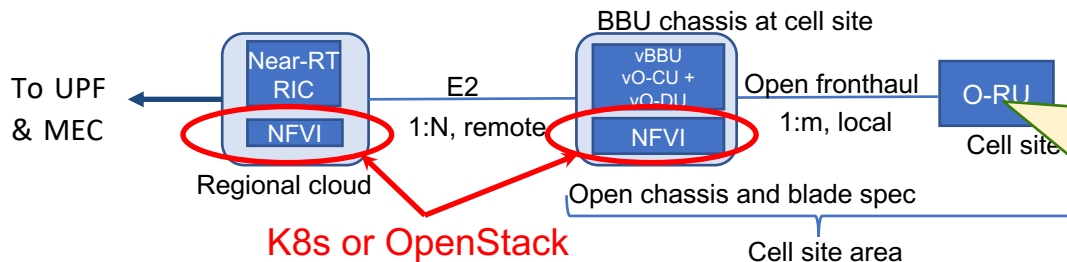
# O-RAN alliance WG6

Decoupling of software from hardware for all RAN modules in all splits



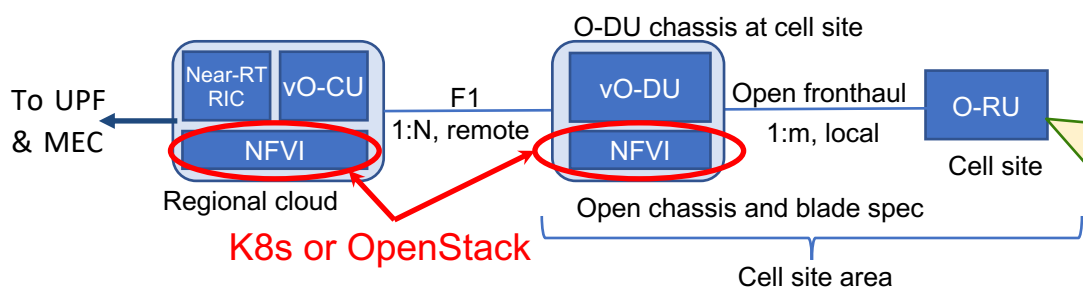
# Candidate WG6 Scenarios B,C

## Scenario B: Distributed vO-CU and vO-DU



The O-CU/O-DU functionality can be pooled from multiple O-RUs, and meet O-DU latency requirements. Near-RT RIC can serve a very large number of O-RUs

## Scenario C: Centralized vO-CU with distributed vO-DU



The O-DU functionality can be pooled from multiple O-RUs, and meet O-DU latency requirements. Near-RT RIC can serve a very large number of O-RUs, and O-CU is very centralized.

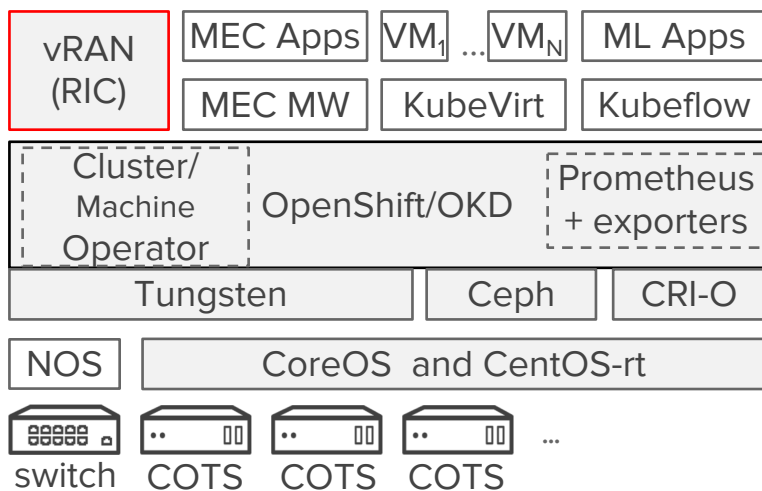
# KNI Edge Kubernetes Native Infrastructure for Edge

# Akraino Edge Stack project

## KNI-Edge Blueprints (in Progress)

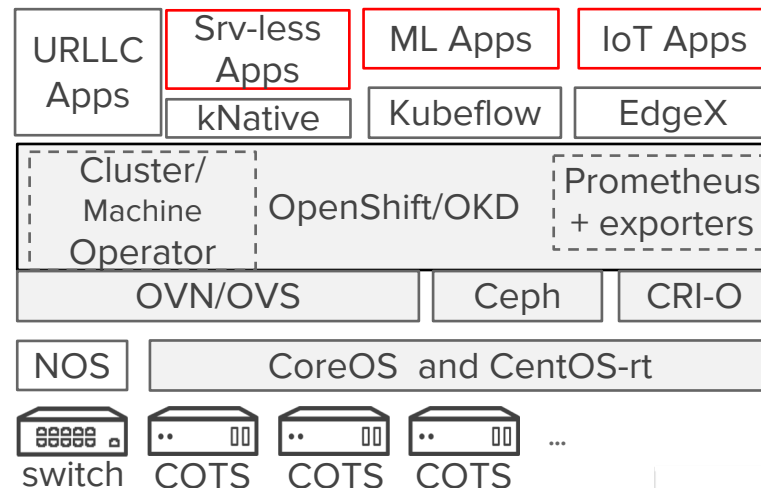
### Provider Access Edge (PAE)

Optimized for real-time and networking performance for Containerized vRAN and MEC workloads.



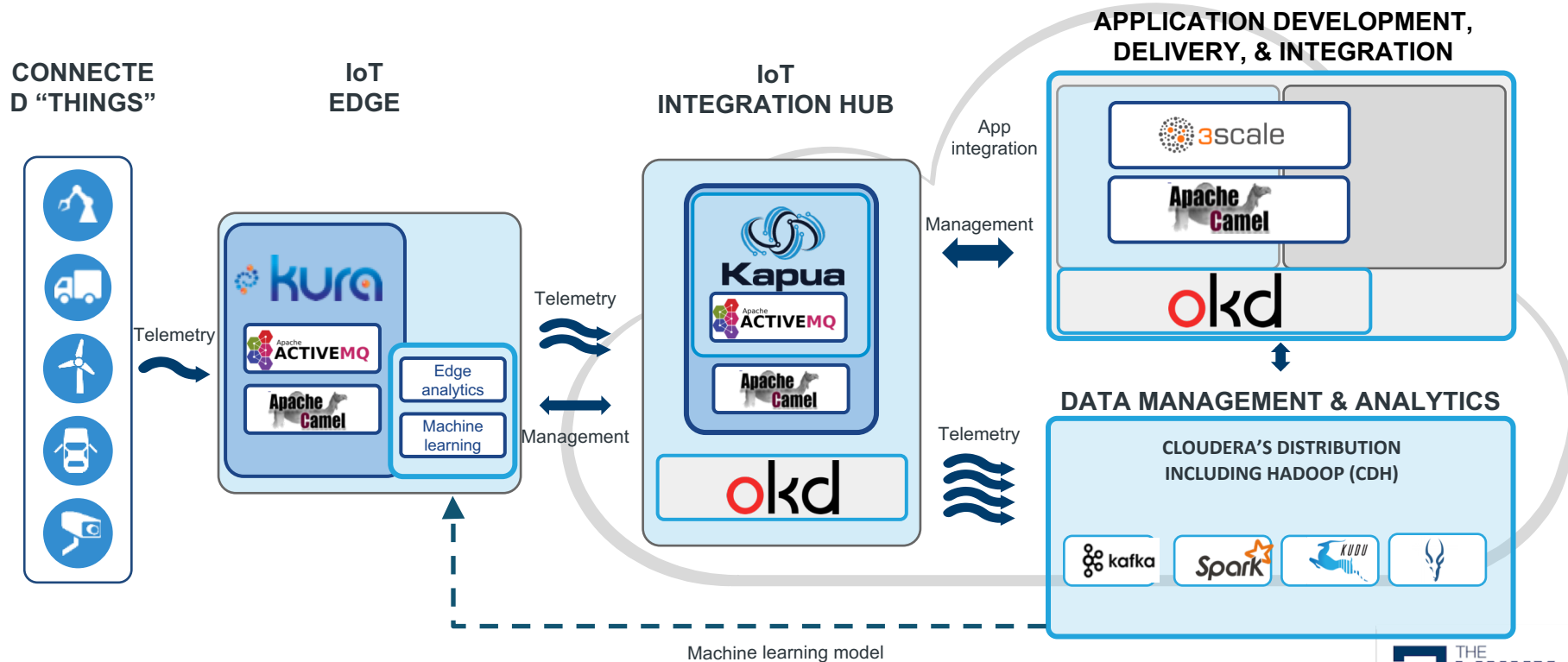
### Industrial Edge (IE)

Optimized for small footprint and low-latency for IoT, serverless, and machine learning workloads.



<https://wiki.akraino.org/display/AK/Kubernetes-Native+Infrastructure+%28KNI%29+Blueprint+Family>

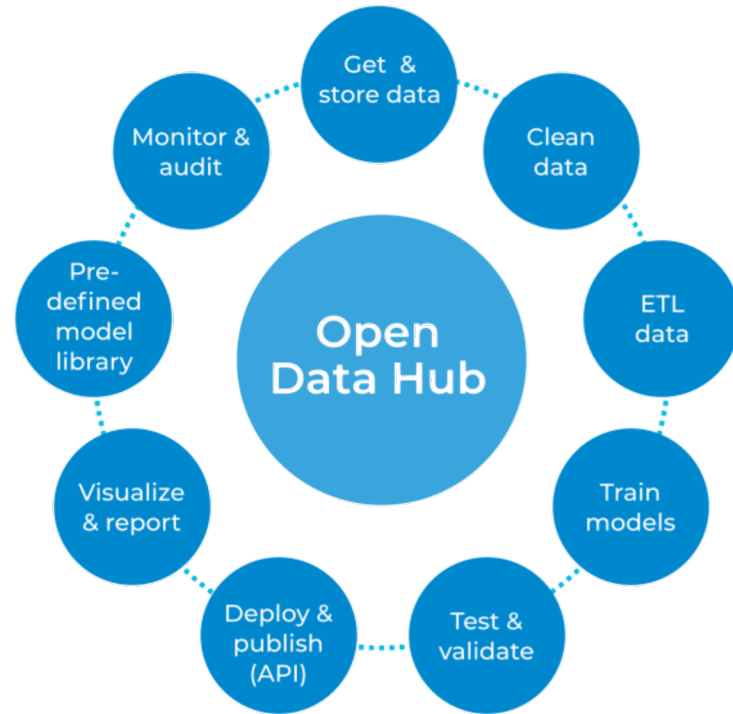
# IoT Apps - Eclipse IoT project



# ML Apps - OPEN DATA HUB

Collaborate on a Data & AI platform for the Edge Cloud & Core

A collection of open source and cloud components packaged in a “machine learning-as-a-service” platform to solve business problems.



End-to-end Security & Compliance



# OPEN DATA HUB

AI as a Service  
OpenShift reference  
architecture

<https://opendatahub.io/news/2019-04-29/project-road-map-for-2019.html>

## Artificial Intelligence & Machine Learning



**Model Lifecycle**  
*Seldon MLFlow*

**ML Applications**  
*Open Data Hub AI Library*

**Interactive Notebooks**  
*JupyterHub Hue*

**Business Intelligence**  
*Superset*

## Data Analysis

**Big Data Processing**  
*Spark Spark SQL Thrift*

**Streaming**  
*Kafka Streams Elasticsearch*

**Data Exploration**  
*Hue Kibana*

## Metadata Management

*Hive Metastore*

## Storage

**Data Lake**  
*Red Hat® Ceph Storage*

**In-Memory**  
*Red Hat® Data Grid (Infinispan)*

**Relational Databases**  
*PostgreSQL MySQL*

## Data in Motion

*Red Hat® AMQ Streams (Kafka Strimzi)* *Red Hat® Ceph S3 API* *Kafka Connect* *Logstash* *Fluentd* *rsyslog*



## Security & Governance

## Monitoring & Orchestration

*Red Hat® OpenShift OAuth*

*Red Hat® Single Sign-On (Keycloak)*

*Red Hat® Ceph Object Gateway*

*Red Hat® 3scale*

Data Steward

*Prometheus*

*Grafana*

*Argo Workflows*

*Jenkins CI/CD*

DevOps Engineer



Open Data Hub Operator



Red Hat  
OpenShift



# Red Hat OpenShift Hybrid Serverless

*Developer experience*

*APIs, CLI, service binding*

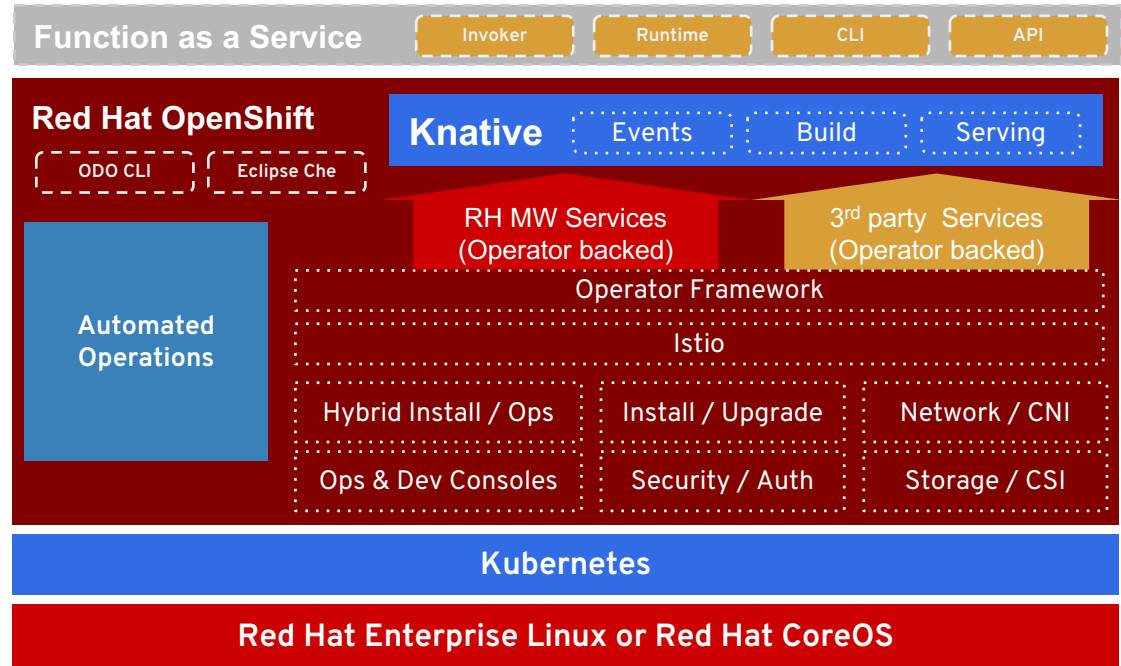
*Building blocks for serverless*

*Source-centric and container-based*

*The leading enterprise Kubernetes platform*

*Automated Operations*

*Build an run anywhere (Hybrid Cloud)*

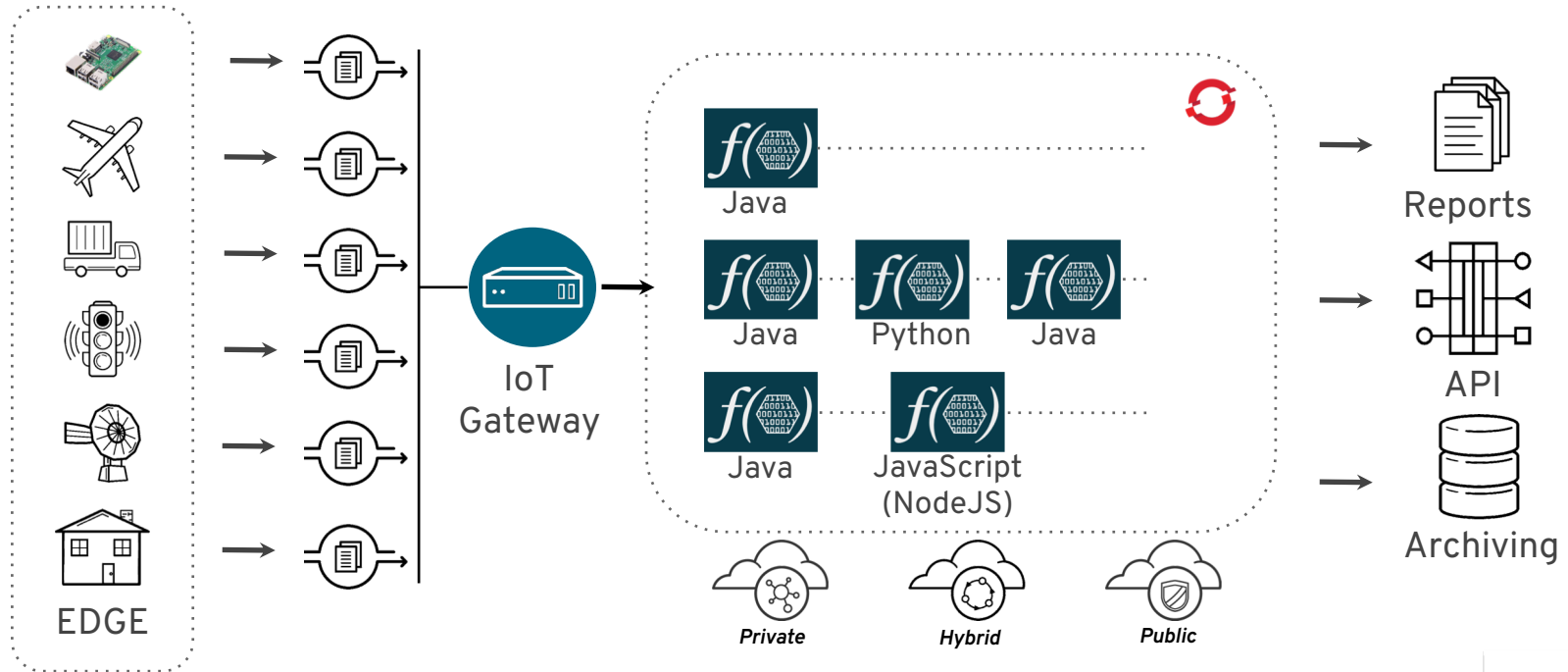


<https://github.com/knative/eventing-sources>





# Serverless : IoT & Sensor



# Summary

# Summary

## Kubernetes Native Infrastructure on Bare metal across Telco Core and Telco Edge

- a. Operator Framework for Site Reliability Engineering and Provider extension
  - i. Autonomous micro-cloud at Telco edge
  - ii. Digital Service Provider driven CNF apps management
- b. Service mesh for 5GC SBA
- c. UPF and Network slicing
- d. O-RAN CU/DU cloudification
- e. KNI for edge
  - i. ML as a Service and Open Data Hub at Telco node
  - ii. Challenge for Serverless at Telco edge node

# Reference

- <https://github.com/operator-framework/getting-started>
- <https://github.com/operator-framework/community-operators>
- <https://commons.openshift.org/sig/operators.html>
- [#kubernetes-operators](#) on the kubernetes slack
- <https://groups.google.com/forum/#!forum/operator-framework>

A large, stylized number '9' is positioned on the left side of the slide. It is filled with a teal color and contains a circular cutout showing a nature scene with green leaves and branches. The background of the entire slide is a solid teal color with a thin white border.

# Thank you!

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