



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

Hidetsugu SUGIYAMA / Chief Architect, Red Hat K.K.  
Seisho YASUKAWA / Group Leader, NTT Network Technology



## 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/>

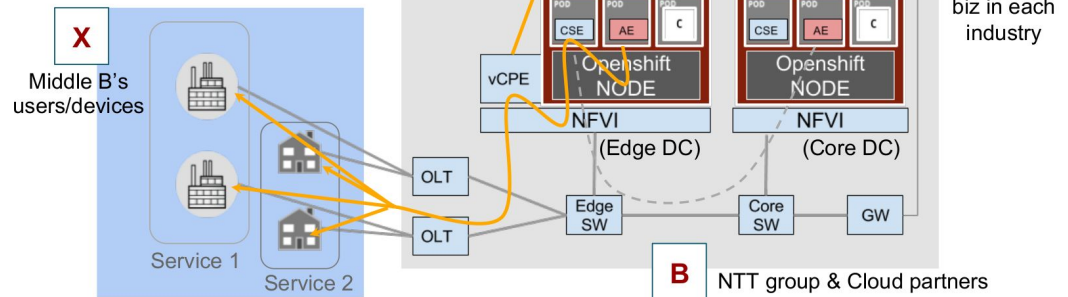
vCPE suite: Broadband Gateway, Firewall, Elastic Load Balancer, etc  
CSE in Infrastructure : IoT GW, AAA, etc

User's AE: IoT Robotics controller

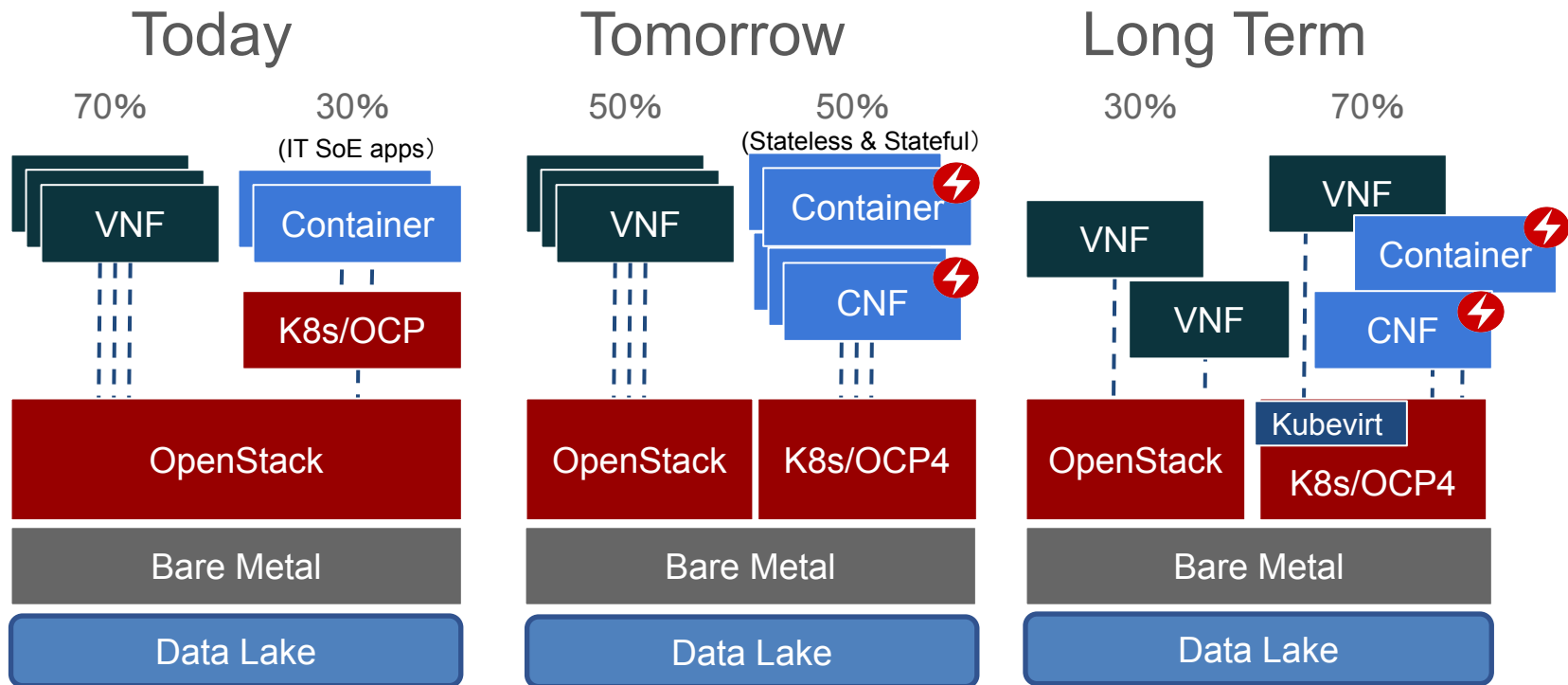
vCPE(virtual Customer Premise Equipment)

CSE(Common Service Entity)

AE(Application Entity)



# NFV Evolution to Kubernetes



SoR: System of Record  
SoE: System of Engagement



OCP4: OpenShift Container Platform 4



# Agenda

- Kubernetes on bare metal deployment
- 5GC workloads
- O-RAN alliance
- Edge computing workloads
- Summary

# Innovation - 2019

## 4G

All IP packet

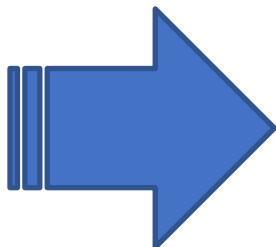
Carrier  
Grade  
Linux

Network  
Function  
Virtualization

Distribute  
Compute  
Node

## VNF

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

Edge AI platform(Intelligent Edge)

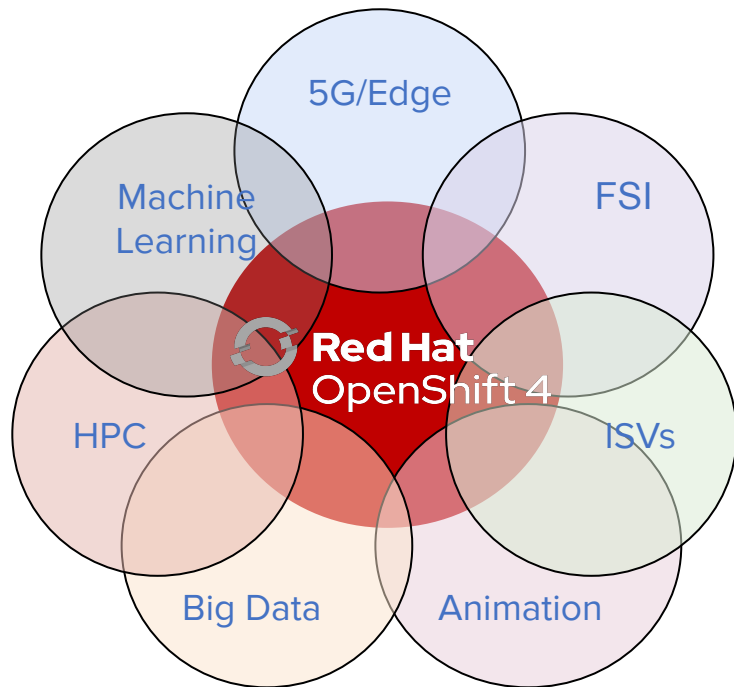
Data Lake /Data Hub

# OpenShift/k8s on BM deployment

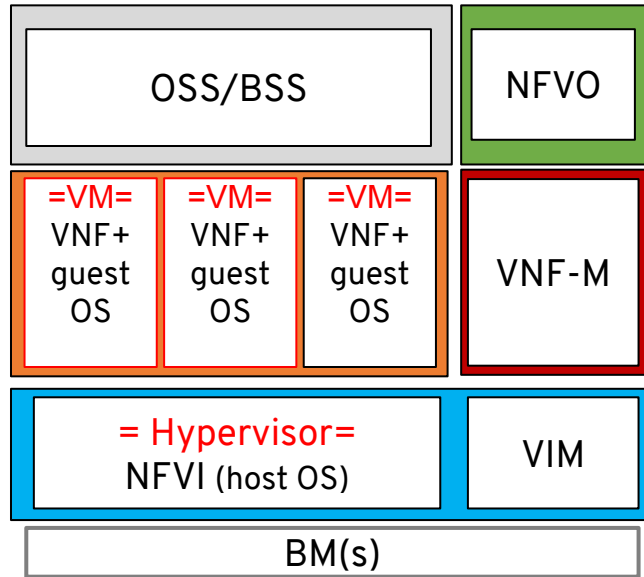
# Performance Sensitive Application Platform

Kubernetes can enhance (with adapting from more significant open sources) like an OpenShift 4 that becomes the **single platform** to run any application.

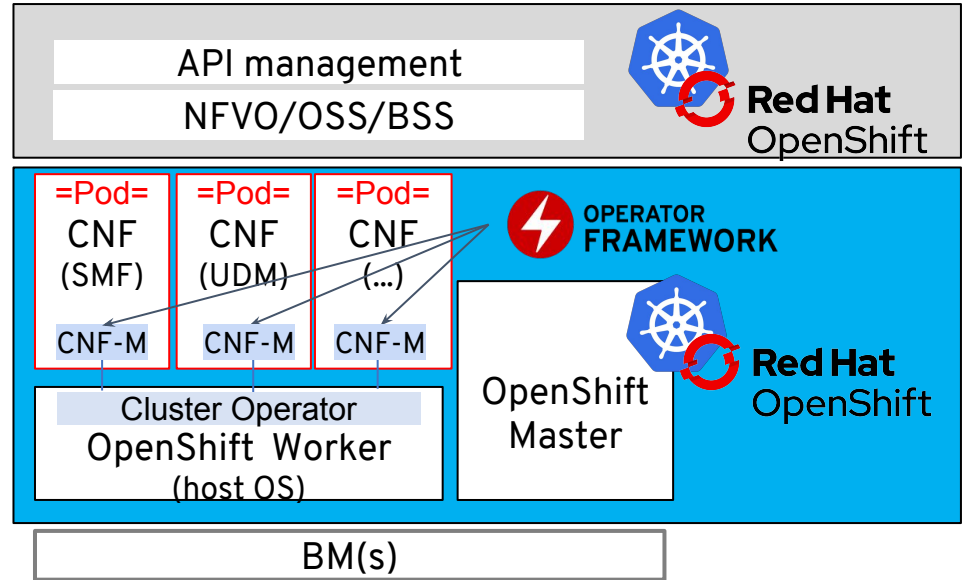
- Old or new
- Monolithic/Microservice



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



## VNF



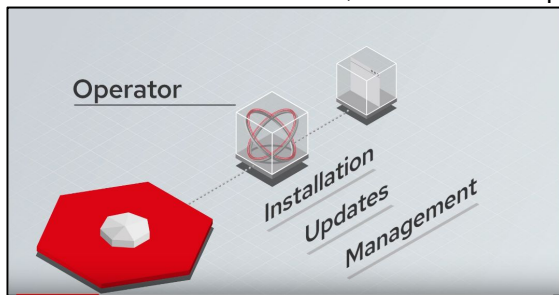
## CNF



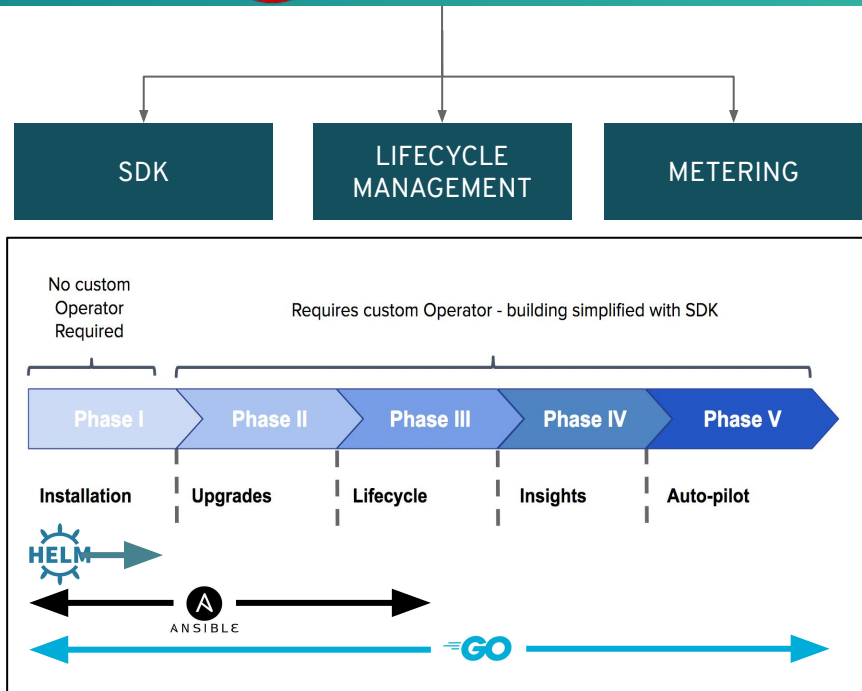
# Kubernetes Operator



- Automate day 2 lifecycle management of containerized 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)
- Helm Operator allows you to convert Helm Charts into Operators
  - Deploy Charts without requiring Tiller
  - Leverage Kube RBAC to deploy Charts
  - Automated, over the air updates for Chart



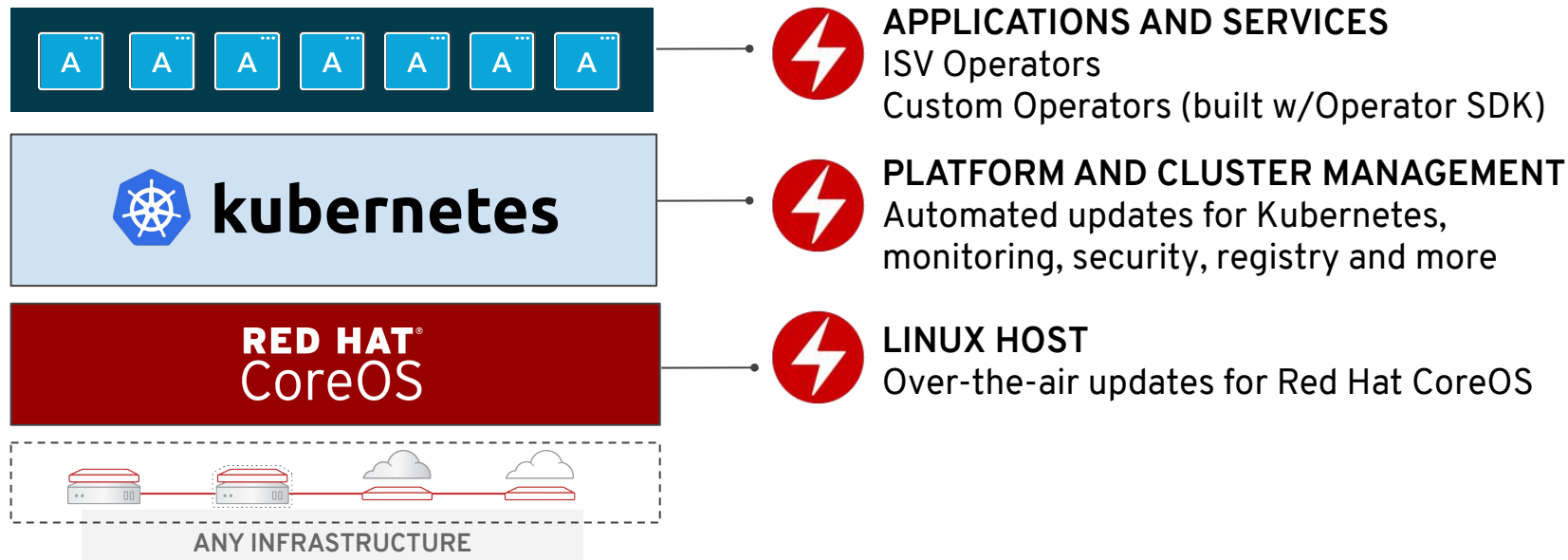
<https://www.youtube.com/watch?v=LymzLHRbQdk>



Implementation pattern of "SRE (Site Reliability Engineering)" that incorporates operations by software



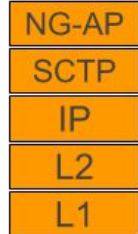
# Full-Stack Automated Operations in OpenShift



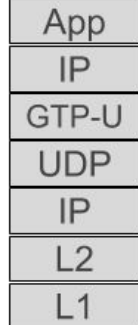
# 5GC Service Based Architecture on Kubernetes

# 5GC system architecture

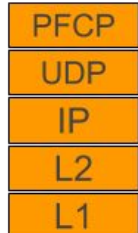
N2 stack



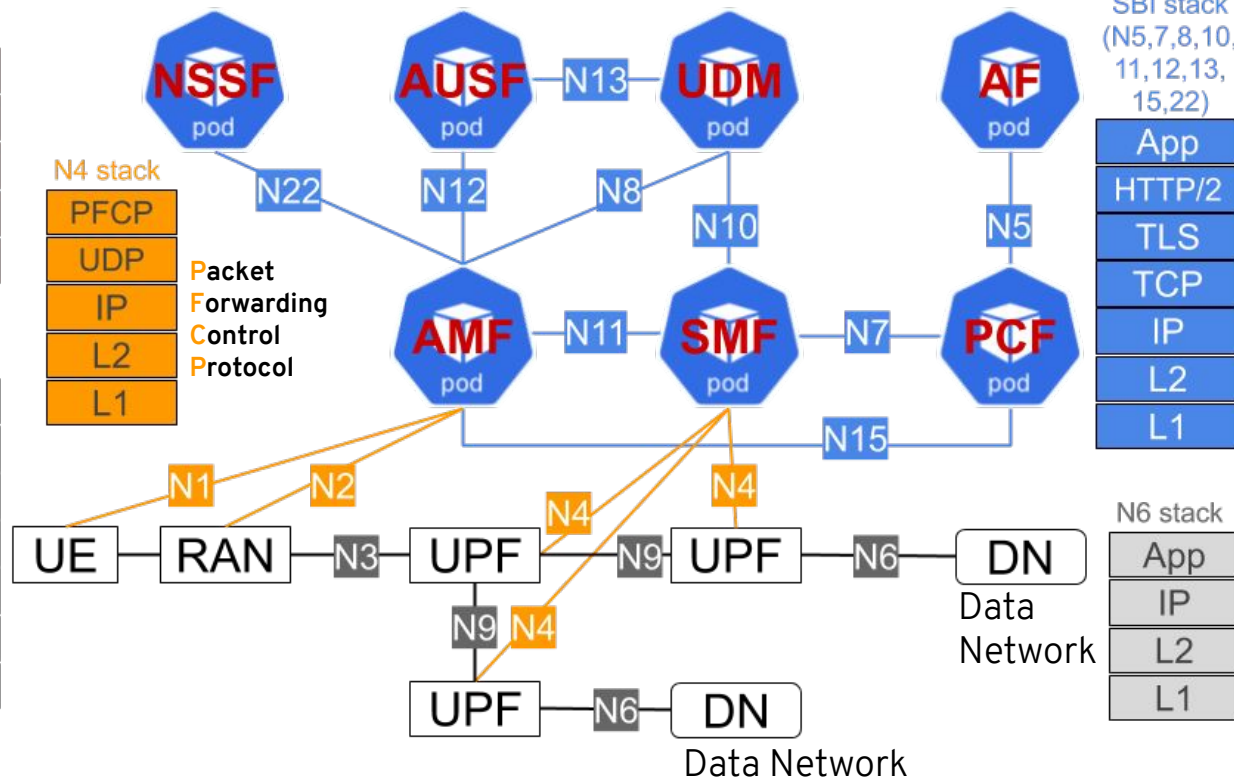
N3 stack



N4 stack



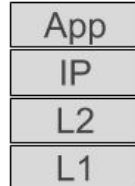
Packet Forwarding Control Protocol



SBI stack  
(N5,7,8,10,11,12,13,15,22)



N6 stack



- Network Exposure Function
- Network Slice Selection Function
- Access & Mobility management Function
- User Plane Function
- Authentication Server Function
- Policy Control Function
- Unified Data Management Session Management Function



# 5G SBI and Service Mesh

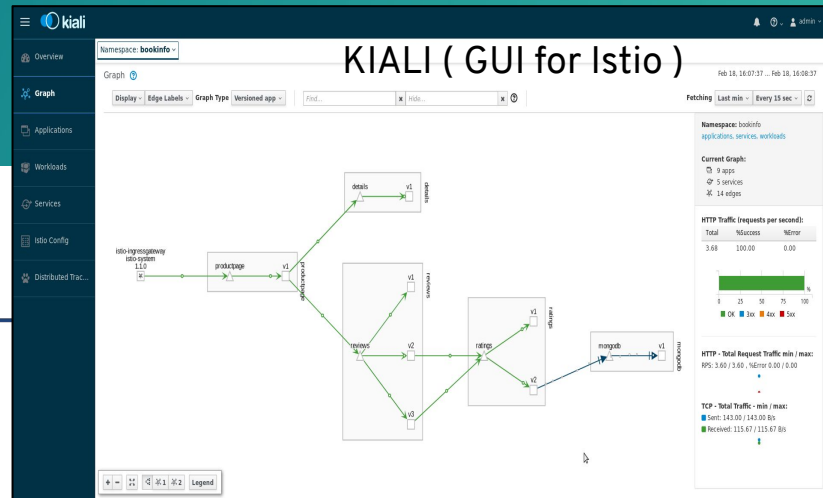
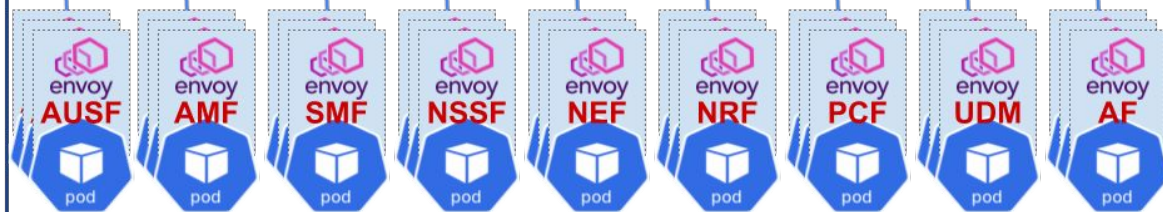


## OPENSIFT SERVICE MESH

Jaeger Pilot Mixer Auth

5G Service Base Interface (RESTful API)

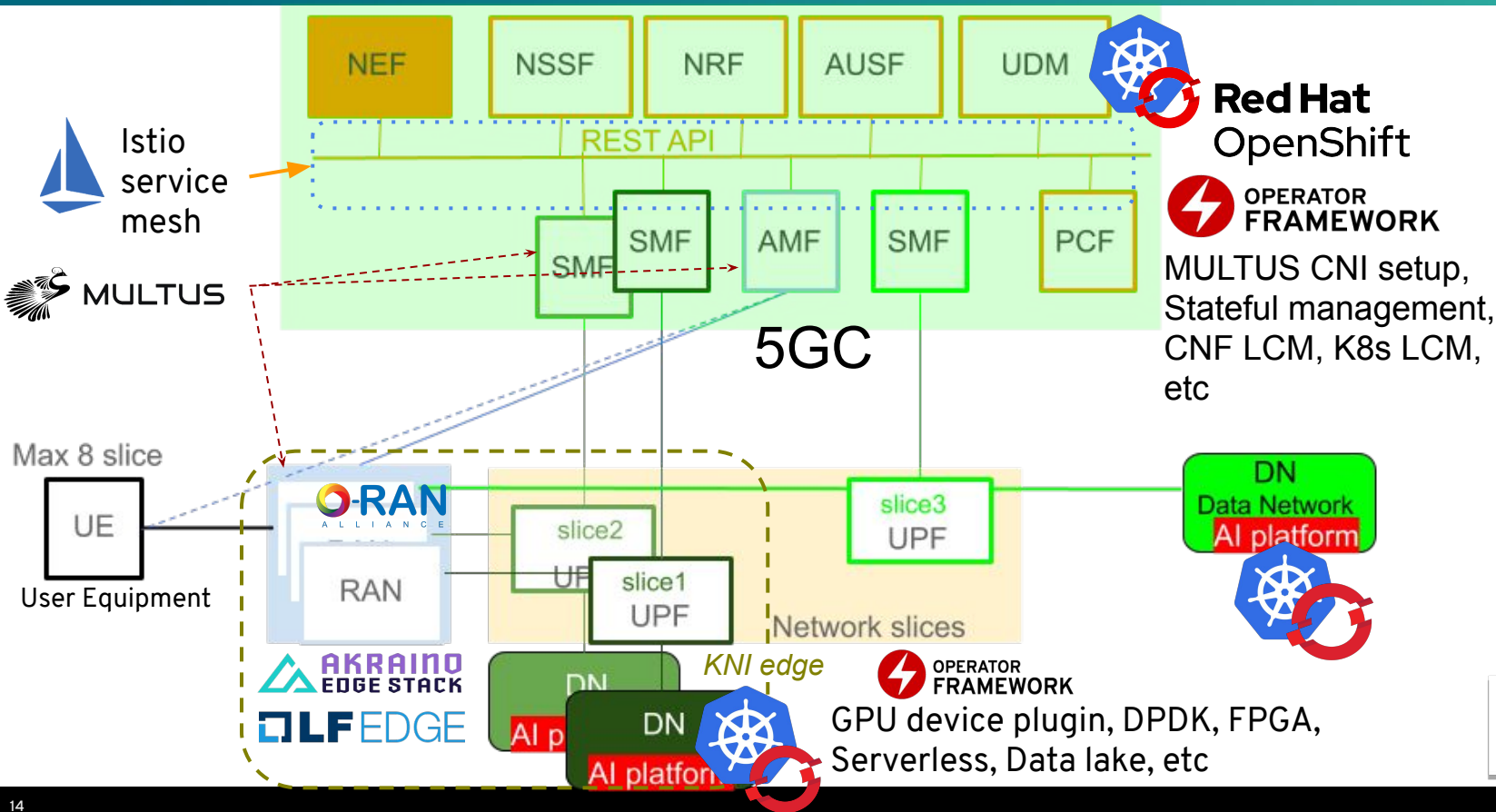
Istio Service Mesh



- 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

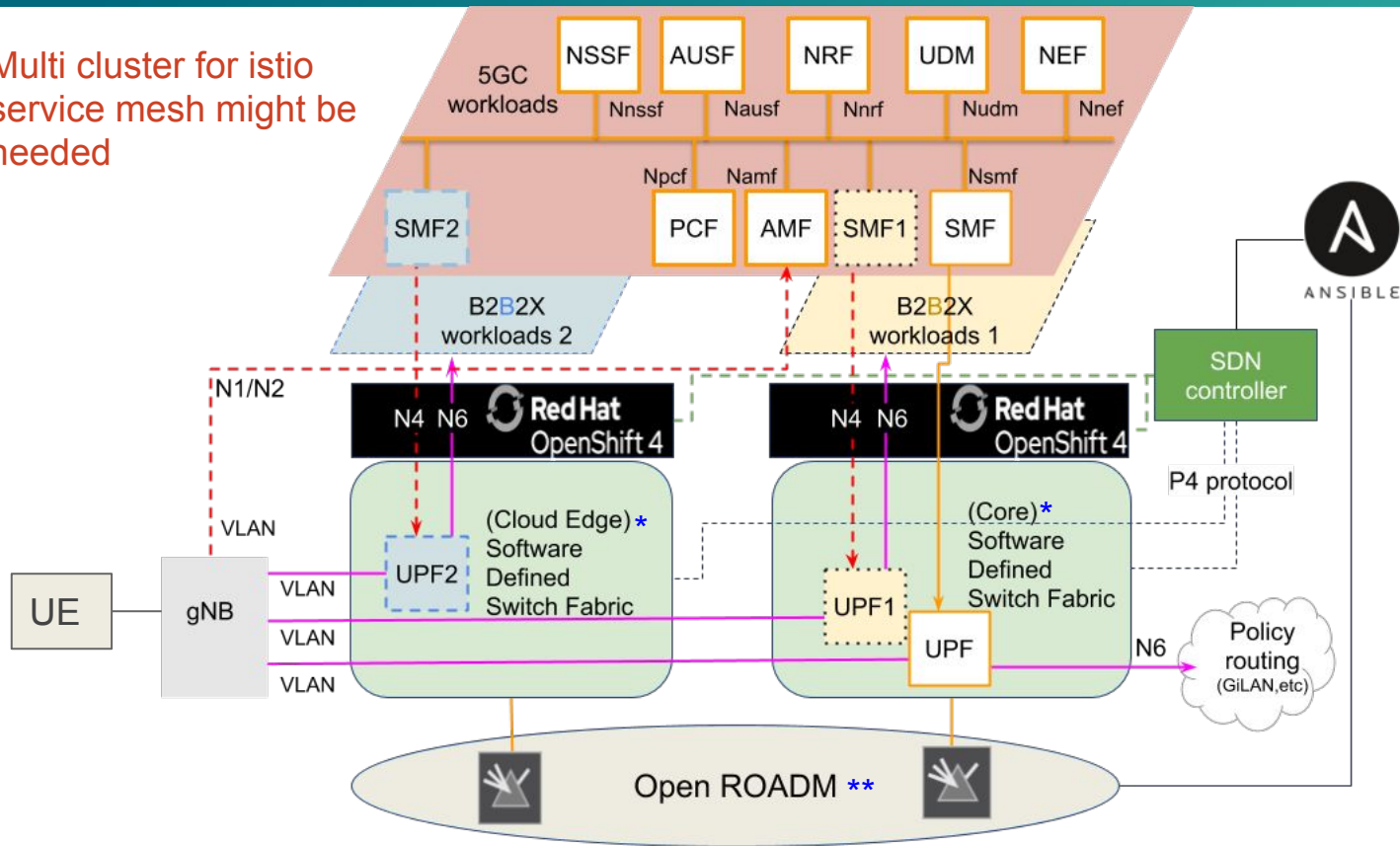
# 5GC SBA with Service Mesh KNI(Kubernetes Native Infrastructure) for Edge

- Network Exposure Function
- Network Slice Selection Function
- Access & Mobility mngmt Function
- Network Repository Function
- Authentication Server Function
- Policy Control Function
- Unified Data Management Session Management Function



# 5GC, UPF and Network Slicing (Cloud edge fabric case)

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>

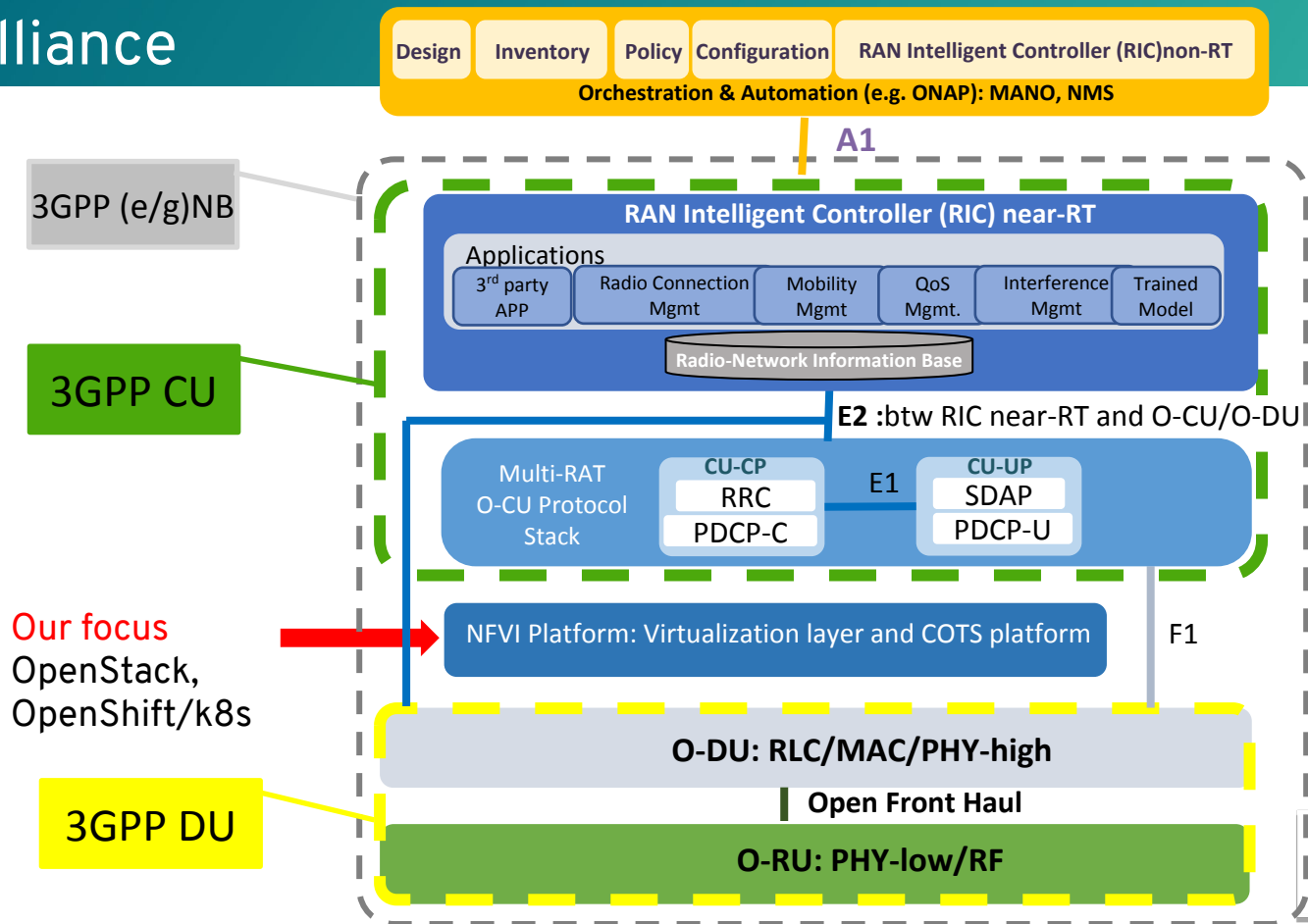
\*\* [https://www.pilab.jp/ipop2019/exhibition/WhitePaper\\_iPOP2019.pdf](https://www.pilab.jp/ipop2019/exhibition/WhitePaper_iPOP2019.pdf)



# O-RAN alliance & RAN Cloudification w/ Kubernetes

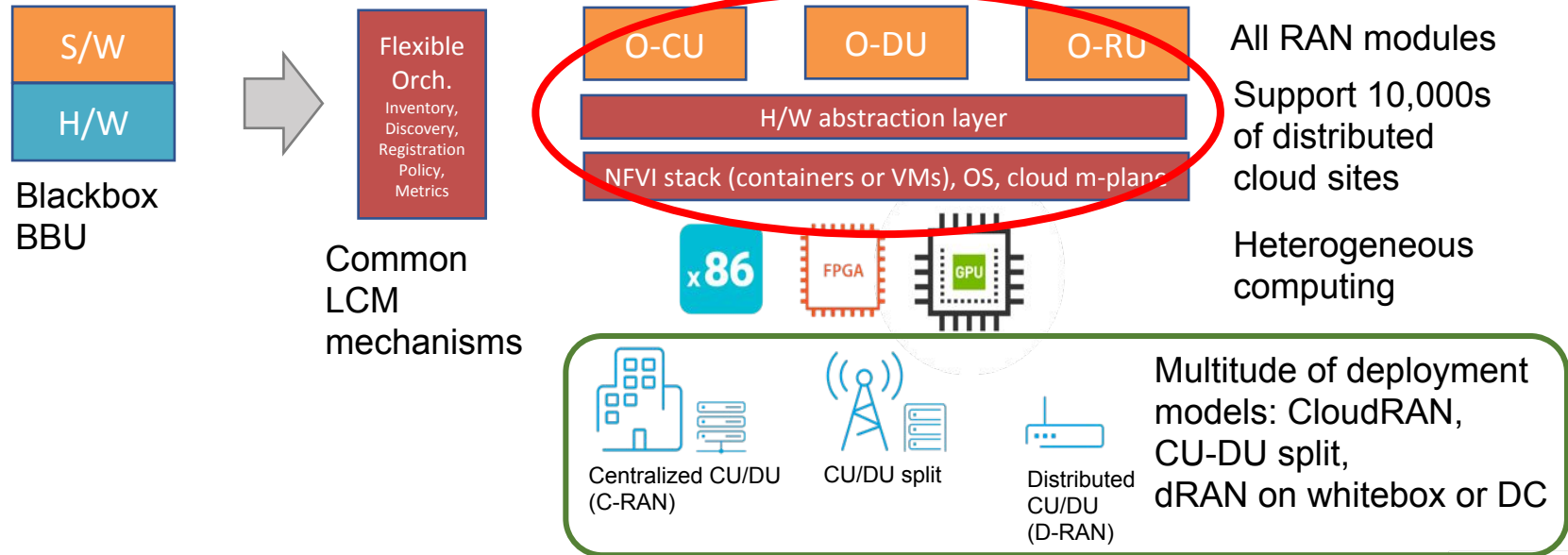


# 3GPP & O-RAN alliance



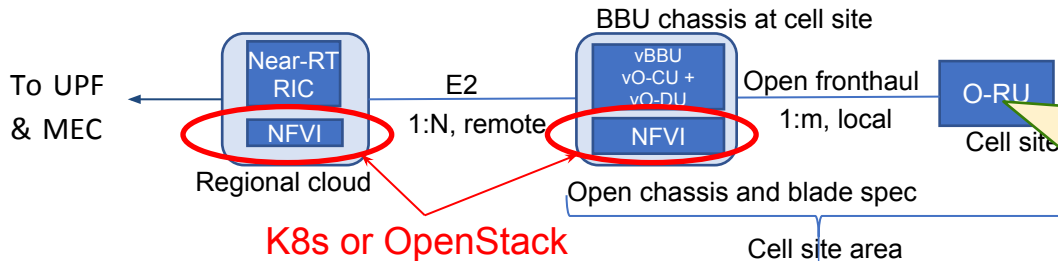
# O-RAN alliance WG6

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



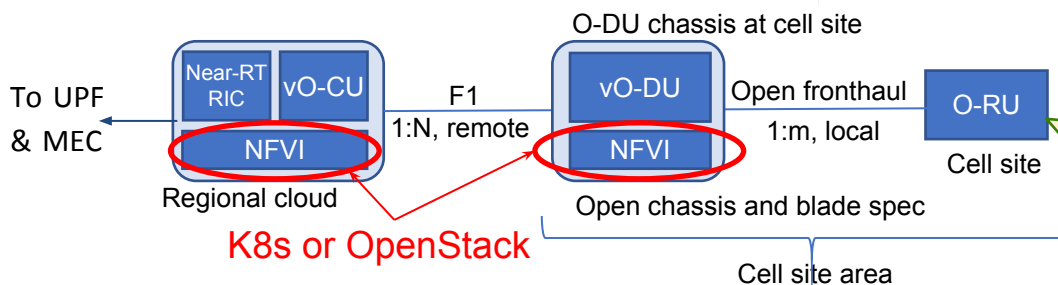
# Candidate WG6 Scenarios B,C

## 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.

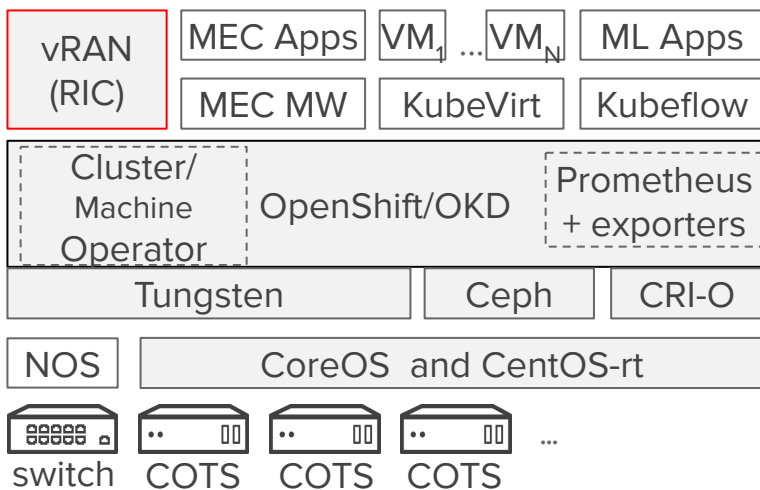
# KNI Edge Kubernetes Native Infrastructure

# Akraino Edge Stack project

## KNI-Edge Blueprints (in Progress)

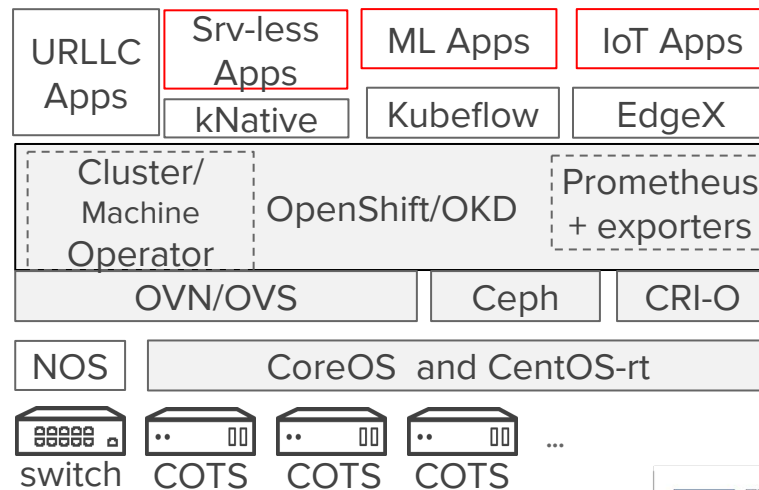
### Provider Access Edge (PAE)

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



### Industrial Edge (IE)

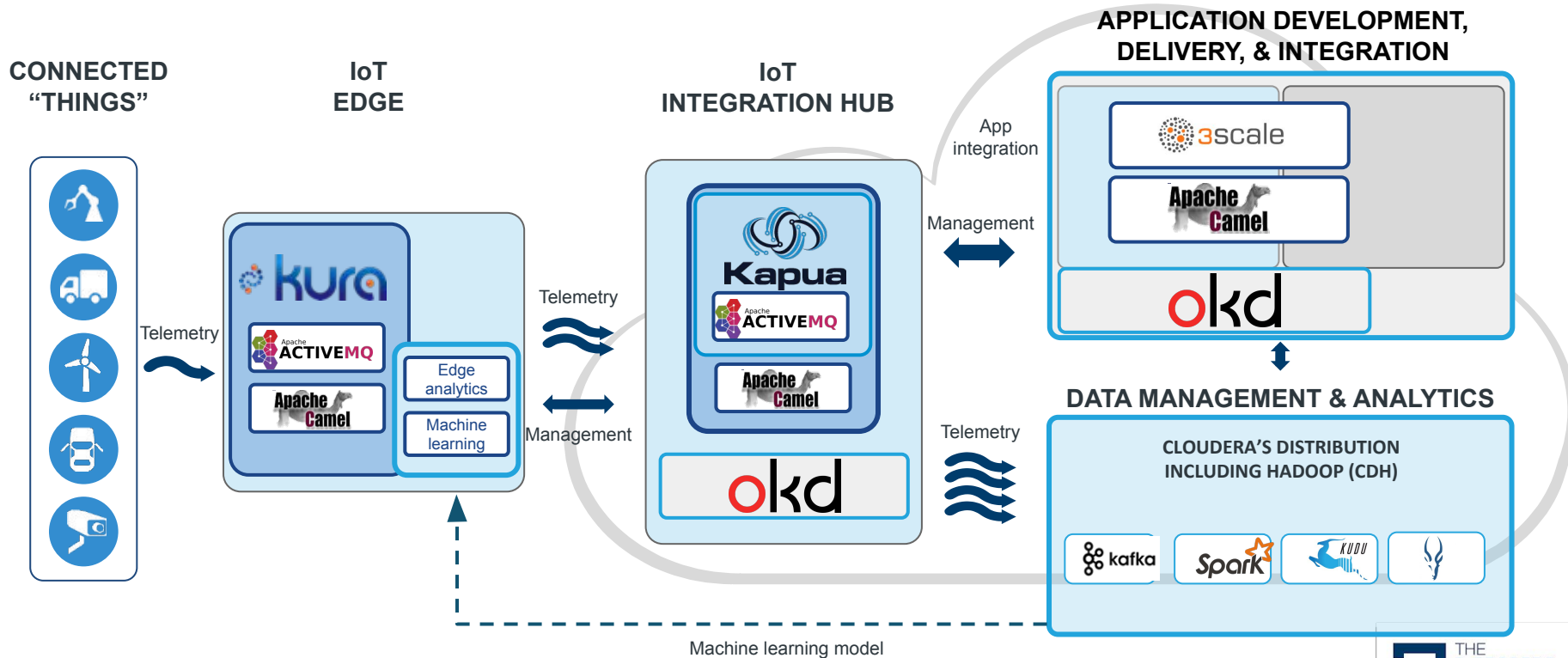
Optimized for small footprint and low-latency for IoT, serverless, and machine learning workloads.



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

UBI: <https://www.redhat.com/en/blog/introducing-red-hat-universal-base-image>

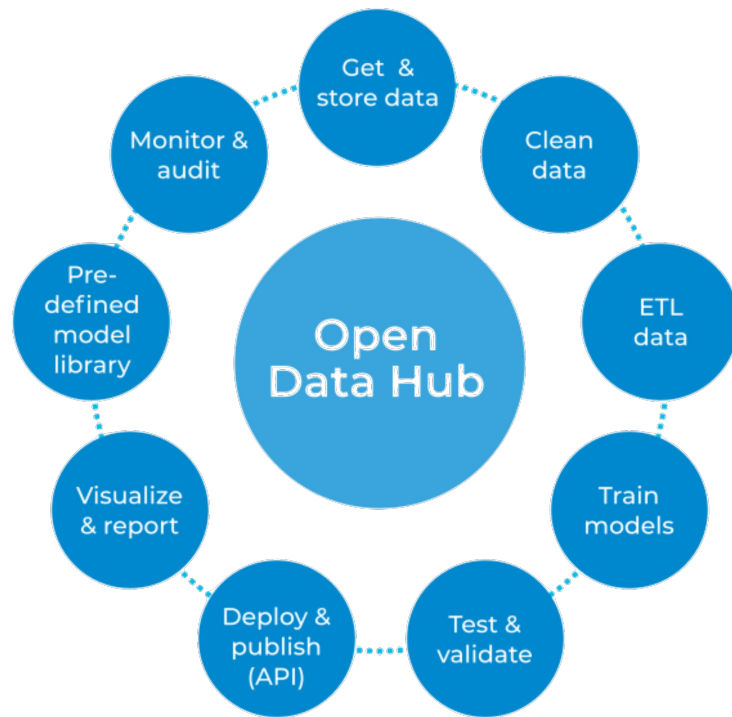
# IoT Apps - Eclipse IoT project



# ML Apps - OPEN DATA HUB

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

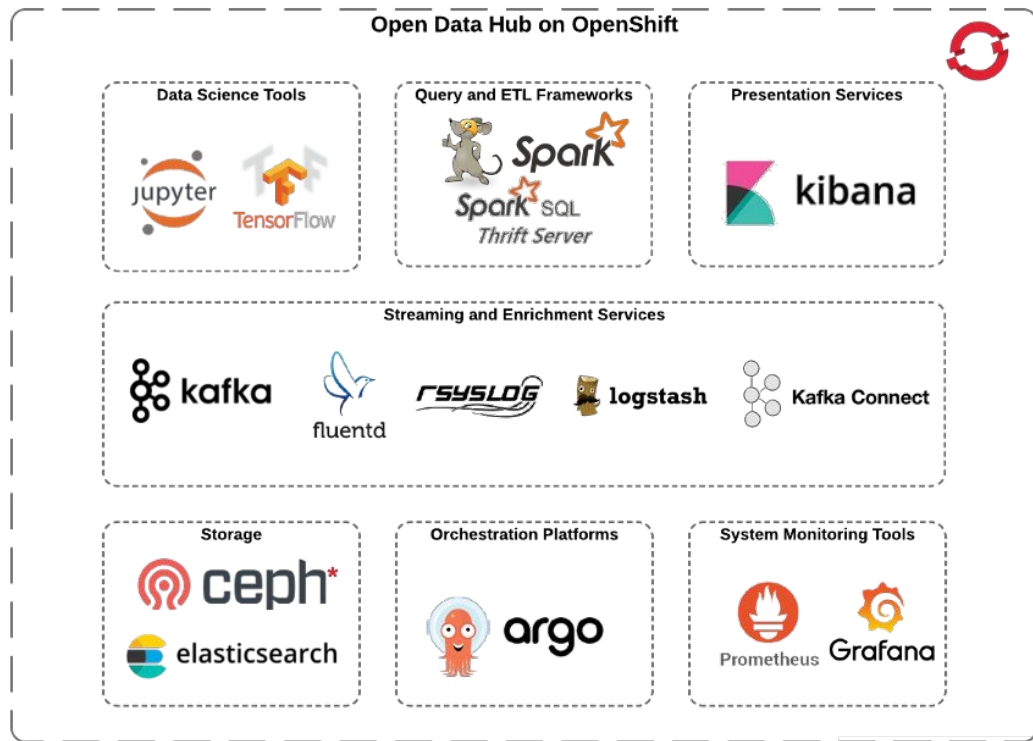
A collection of open source and cloud components packaged in a “machine learning-as-a-service” platform to solve business problems.



End-to-end Security & Compliance

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

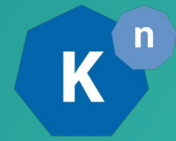
- AI Library
- Data Science and ETL Tools
- Streaming and Enriching Data
- Storing Data
- Managing Data
- Monitoring Infrastructure



\* Ceph nano can be used when deploying to Minishift



# Serverless Apps - Knative



- Familiar to Kubernetes users. Native.
- Scale to 0 and autoscale to N based on demand
- Applications and functions. Any container workload.
- Powerful eventing model with multiple event sources.
- Operator available via OperatorHub
- Knative v0.6 (v1beta1 APIs)
- No vendor lock in

Learn more

<https://www.openshift.com/learn/topics/knative>

The image displays two screenshots from the OpenShift ecosystem. The top screenshot shows the OpenShift console interface for a Knative build named 'knative-build'. It includes a sidebar with navigation options like 'Home', 'Catalog', and 'Workloads'. The main content area shows the build's configuration, including 'Provided APIs' (Build, Build Template, Cluster Build Template) and a 'Description' section. Below this, there is a 'ClusterServiceVersion Overview' section showing the build's status as 'Succeeded'.

The bottom screenshot shows the Kiali dashboard, which is used for service mesh monitoring. It displays a service graph for the 'myproject' namespace. The graph shows several services and their dependencies: 'knative-ingressgateway' (Istio-system), 'helloworld-go-00001', 'autoscaler' (Knative-serving), 'activator' (Knative-serving), and 'dumppy-00001'. The 'helloworld-go-00001' service is highlighted with a red circle. To the right of the graph, there is a detailed view for the 'helloworld' application, showing its 'Request Traffic (requests per second)' and a bar chart of traffic over time. The traffic data shows a peak in traffic around 25 seconds.

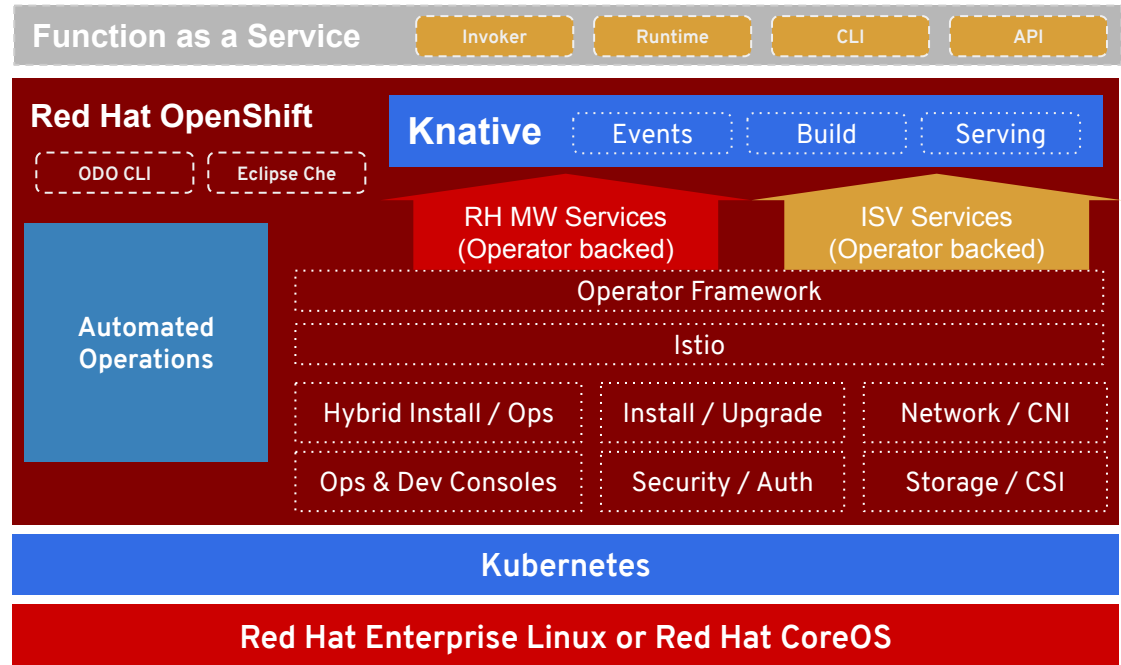


# Red Hat OpenShift Hybrid Serverless

*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)*



# Knative Event Sources

## Upstream Event Sources:

GitHub

Kubernetes Events

Pub/Sub (AWS SQS, Kafka, NATS, Google PubSub)

Websockets

Expose an ingress



APACHE®

Camel

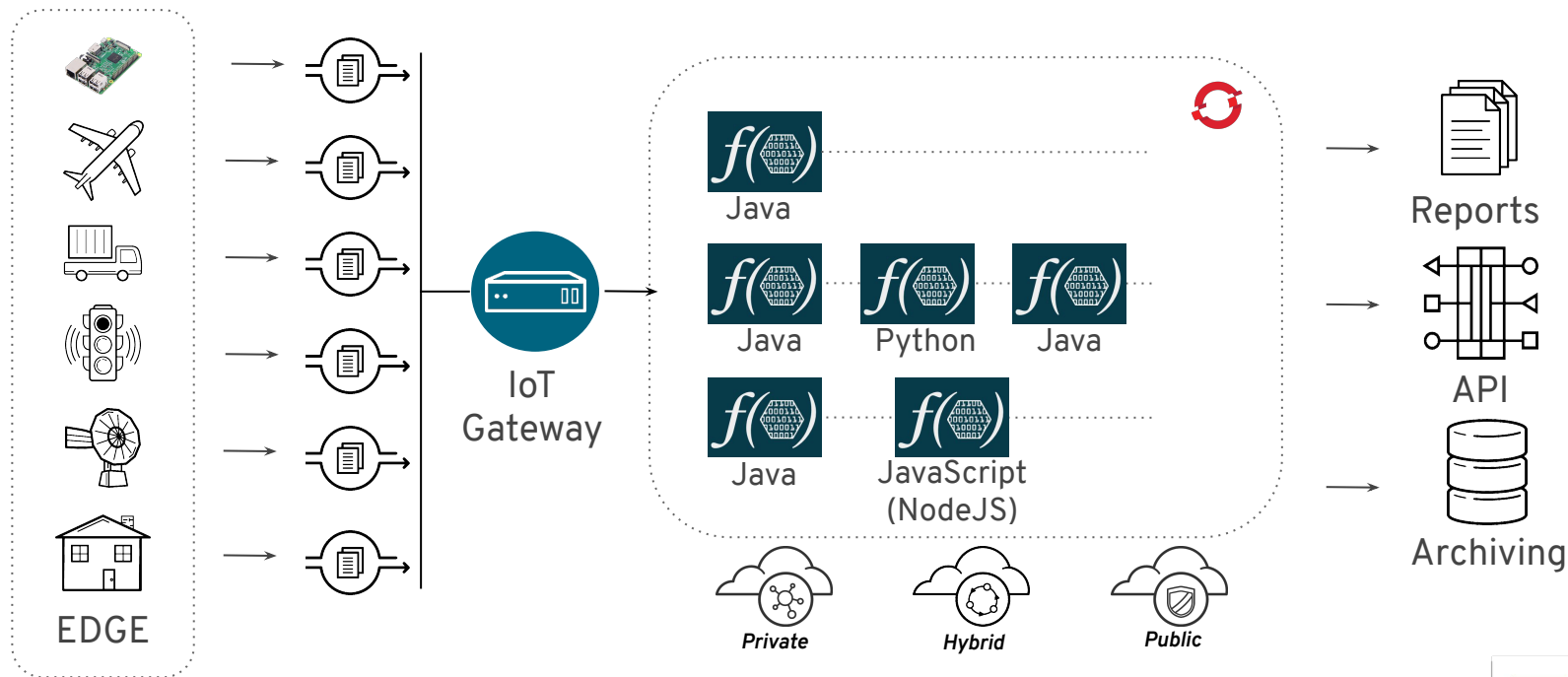


**200+ event sources through Camel-K**

[Camel-K + Knative Demo](#)

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

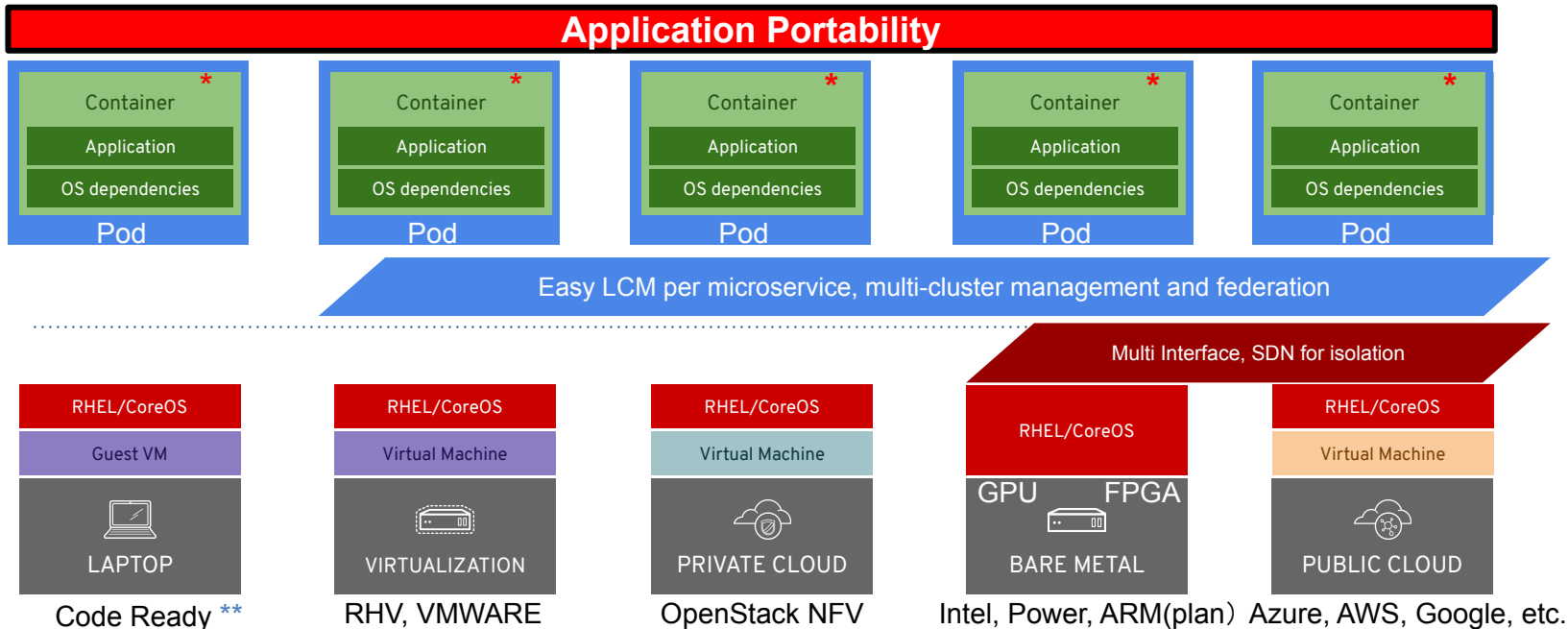
# Serverless : IoT & Sensor



# Summary

# Next Generation DX platform

Application portability in any environment and consistency in operation.



\* By using UBI (Universal Base Image), developers can concentrate on container application development at any platform.

It is also possible to duplicate and store the same container image in geographically distant places (utilization of Ceph data lake and QUEY)

\*\* <https://github.com/code-ready/crc>

# Summary

1. Heterogeneous Computing Platform
2. K8s as AI platform at Telco Edge
  - a. Data Lake/Hub at Telco node
3. 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 micro service
  - c. Serverless at Telco edge node

A large, stylized number '9' graphic is positioned on the left side of the slide. The number is filled with a teal color and has a semi-transparent nature-themed background of leaves and branches visible through its curves. The rest of the slide has a solid teal background.

# Thank you!