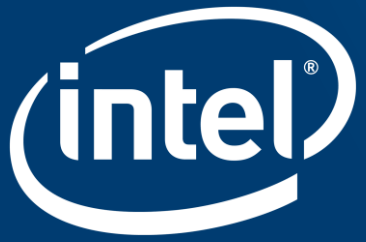


OPEN NETWORK EDGE SERVICES SOFTWARE (OPENNESS): APIS

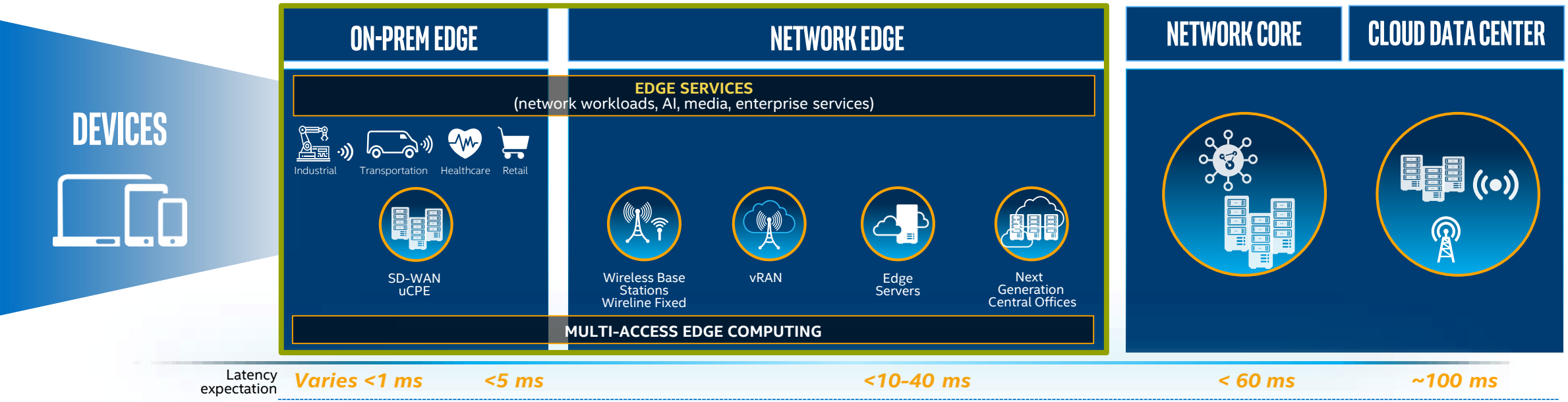
Edge Computing and Ecosystem Enabling

Network Platforms Group (NPG)

Topics

- Quick Overview of OpenNESS
  - High performance, secure, modular edge platform
  - Microservices-based
  - Customizable platform by selective use of services
- Classes of interfaces
  - RESTful interfaces
  - Protobuf interfaces
  - “Kubernetes” interfaces

Edge Definitions



- Comply with data locality
- Reduce application latency
- Meet reliability requirements
- Deliver rich user experiences
- Optimize TCO
- Improve service capabilities

Edge Computing: Placement Of Data Center-Grade Network, Compute and Storage Closer to the Endpoint Devices

OPENNESS:
WHAT DO YOU GET

An Optimized and
Cohesive Framework for Managing
Apps and Services

OPENNESS EXPERIENCE KIT:

Available at openness.org

Microservices

Sample applications (with relevant SDKs integrated – eg. Smart city)

SDKs (OpenVINO, IPP, MKL, DPDK…)

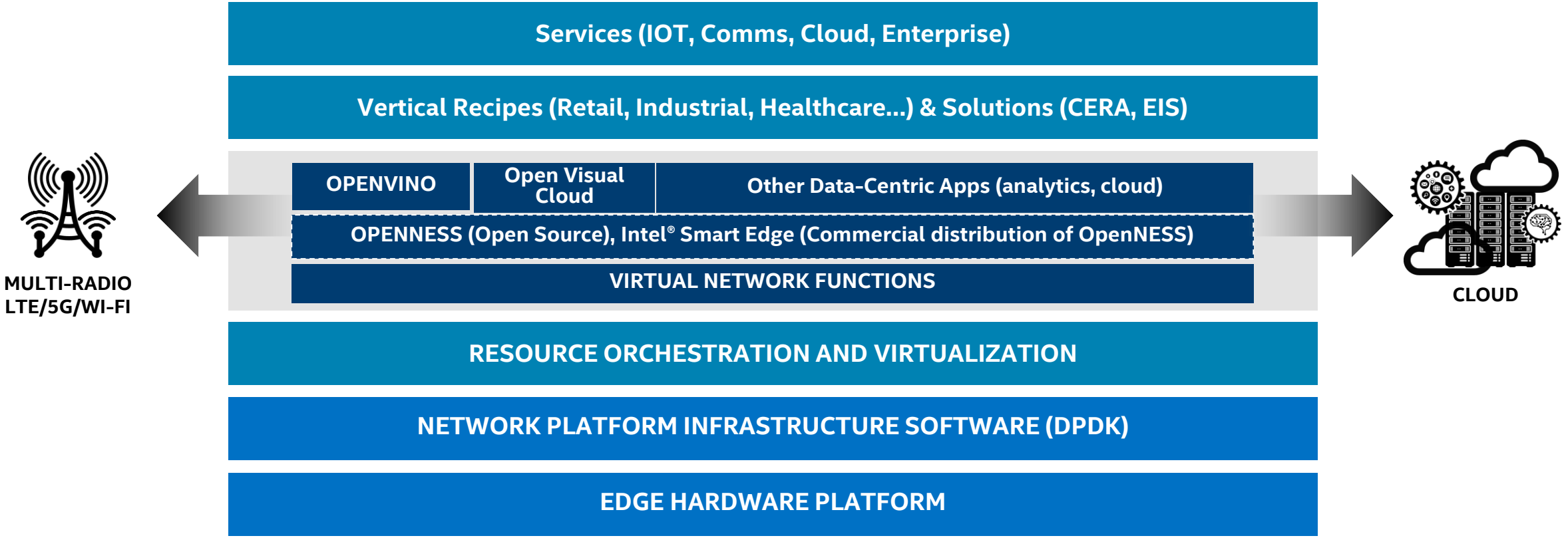
OS Kernel and bios configurations

Reference hardware specs

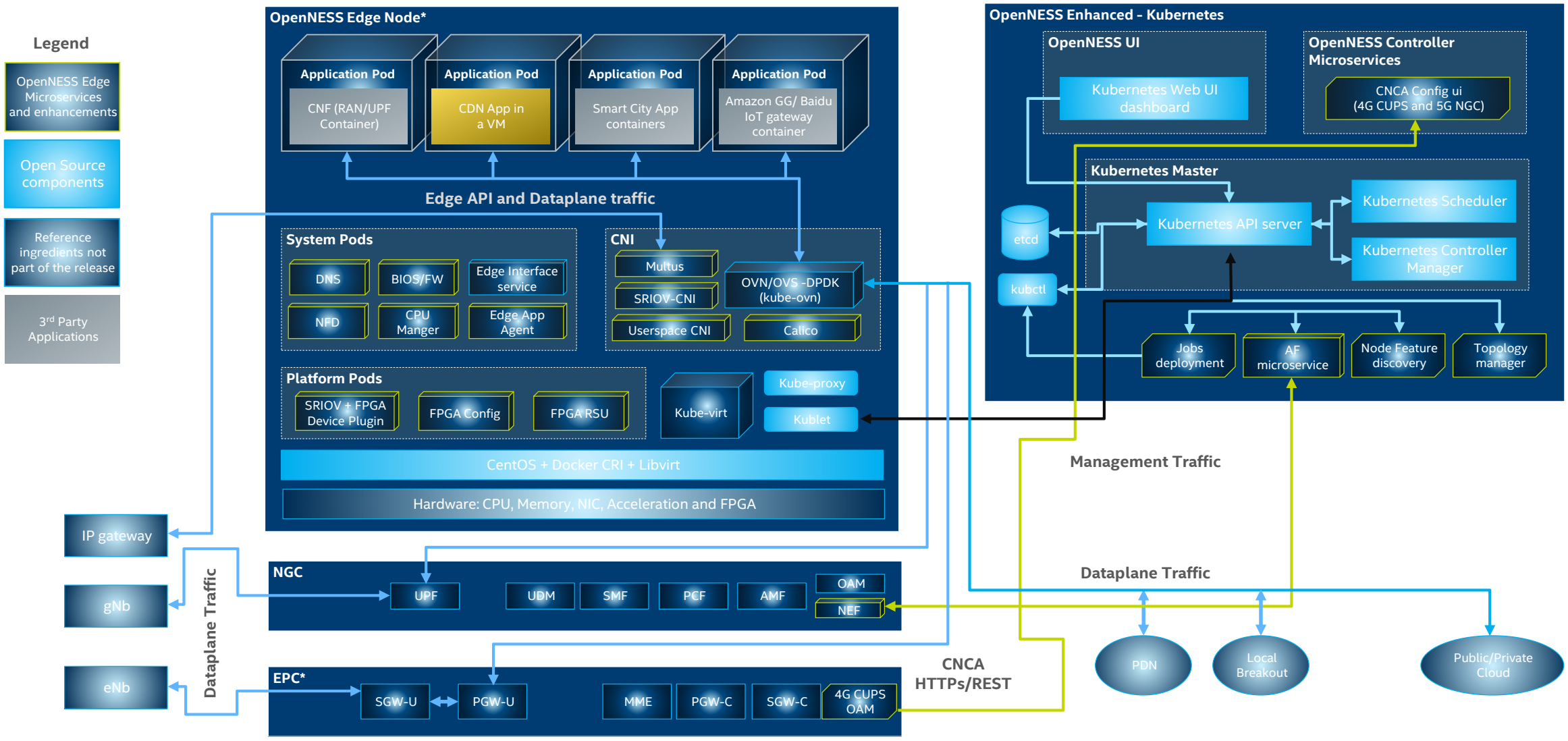
Performance benchmarks (in the future)

Ansible Playbooks

Intel's Edge Platform Offering



Architecture (Network Edge Deployment)



*OpenNESS Edge Node can be deployed on Network Edge or On-Premise Edge

OpenNESS Functionality: A Closer Look (1/2)

Data Plane

OVN/OVS-DPDK

High-performance Data Plane microservices supporting a Container Network Interface (CNI) and can be managed by a standard SDN controller via Open Flow

SR/IOV

Enable allocation of PCIe SRIOV virtual function to applications and network functions

Multi-Access Networking

5G – AF, NEF

3GPP Network function microservices enabling deployment of edge cloud in a 5G network

4G-LTE OAM

Microservice extending the capability of 3GPP 4G core network enabling deployment of edge cloud

CNCA (Core Network Configuration API)

REST Based interface for configuring 4G and 5G Network Functions in edge cloud deployments

Multus

Container network interface (CNI) plugin for Kubernetes that enables the attachment of multiple network interfaces to pods.

Enhanced Platform Awareness (EPA)

NFD (Node Feature Discovery)

Kubernetes add-on that detects and advertises hardware and software capabilities of a platform that can, in turn, be used to facilitate intelligent scheduling of a workload.

TAS (Telemetry Aware Scheduler)

Making available hardware and software Telemetry data for scheduling and de-scheduling decisions Kubernetes

CMK (CPU Manager for Kubernetes)

Kubernetes plugin that provides core affinity for applications deployed as Kubernetes pods

Topology Manager - NUMA

Solution permitting CPU Manager and Device Manager, to coordinate the resources allocated to a workload.

RMD, SST-BF (QoS)*

Provide a central uniform interface portal for hardware resource management tasks on x86 platforms

*Coming soon as part of future enhancements

OpenNESS Functionality: A Closer Look (2/2)

Accelerator

FPGA Orchestration
Enable Programming, Configuration and resource allocation of FPGAs

HDDL Orchestration
Enable allocation of Intel® Movidius™ Myriad™ X High Density Deep Learning (HDDL) cards to cloud native applications

VCA Orchestration
Enable allocation of Intel® Visual Compute Acceleration cards to Cloud native applications

Application

Multi Cloud
Enable deployment of Public Cloud IOT gateways on Edge platform

Service Mesh
Provide a common message bus for applications and services on the platform to publish and subscribe.

DNS
DNS microservices with forwarding capability for edge applications and network functions

Security*

Securely Store Data*
Enable Applications to securely store and retrieve data

Isolate Secure Data*
Enable Isolation of data from application instances on the edge node

SGX (Software Guard Extensions)
Enable allocation of Key storage and secure enclave resource to applications

RBAC (Role-Based Access Control, PKI (Public Key Infrastructure)
Configure fine-grained and specific sets of permissions that define how a user, or group of users, can interact with the system objects

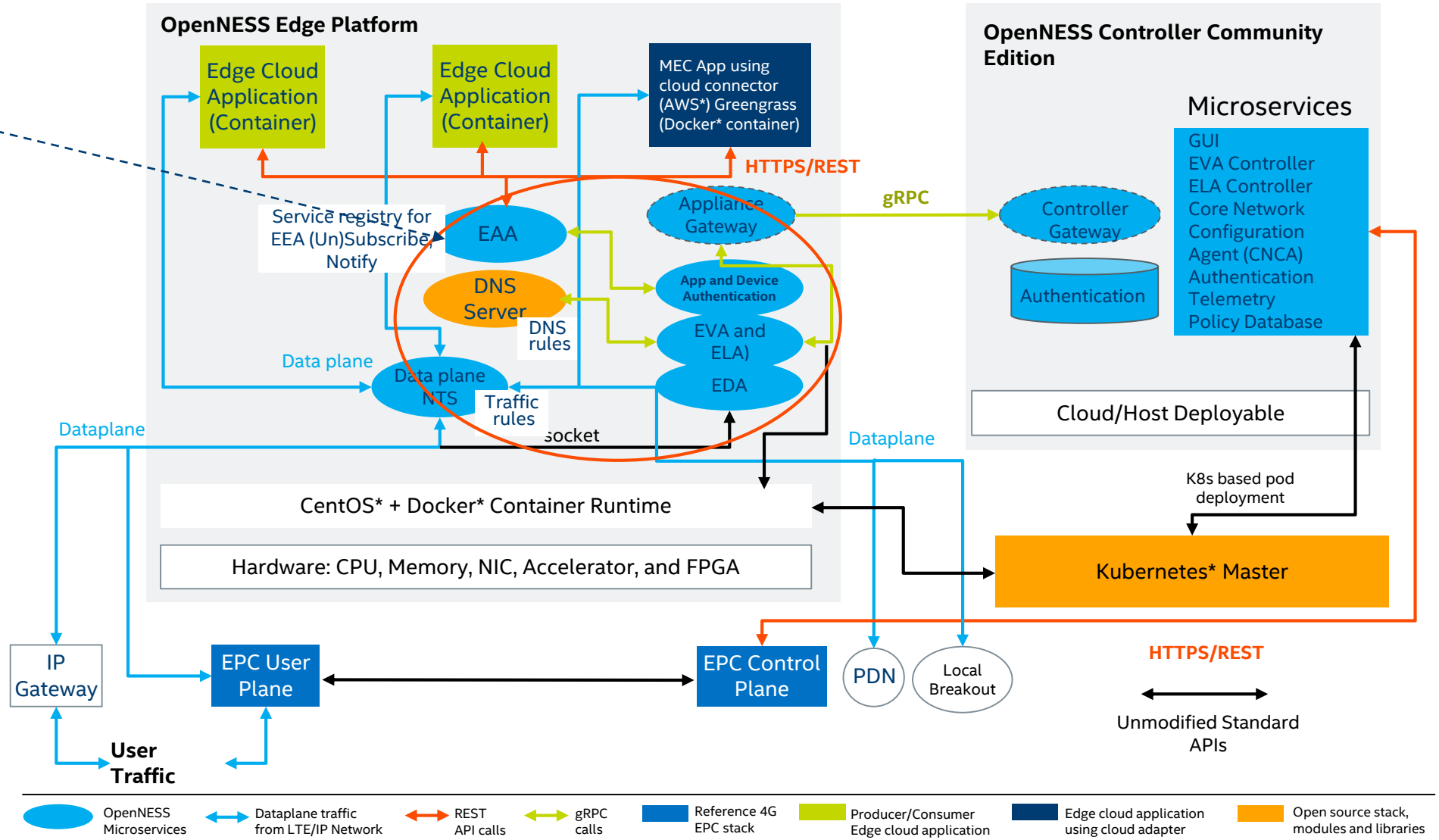
ISEC-L
Intel® Security Libraries extend the concept of the “chain of trust” using a remote Verification Service to verify the measured server components against previously-stored known-good measurements

*Coming soon as part of future enhancements

OpenNESS Microservices Architecture

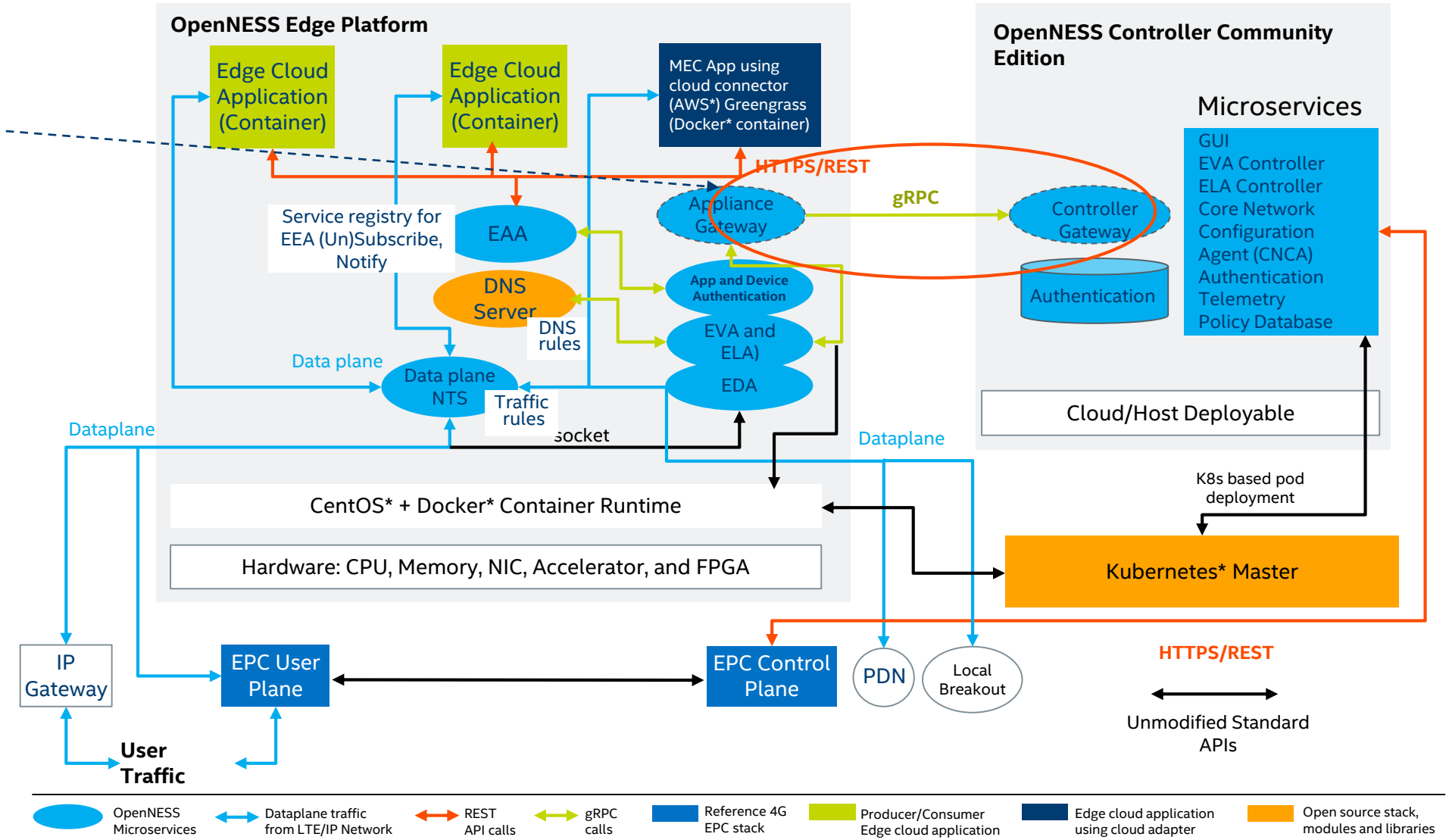
OpenNESS follows a microservice architectural style

- gRPC used as underlying API framework
- RESTful APIs provided for integration with external subsystems and apps
- Microservices implemented in a split Service/Agent (in Controller/Platform) style for resilience
- External interfaces are also supported
  - Open source APIs (e.g., OpenStack, Kubernetes)
  - Network Interfaces (e.g., sockets, DPDK)
  - LTE Control and User Plane interfaces



Platform/Controller Gateway

- API gateway for Edge Platform and controller communication.
- Controller and agent microservices communicate through these gateways.

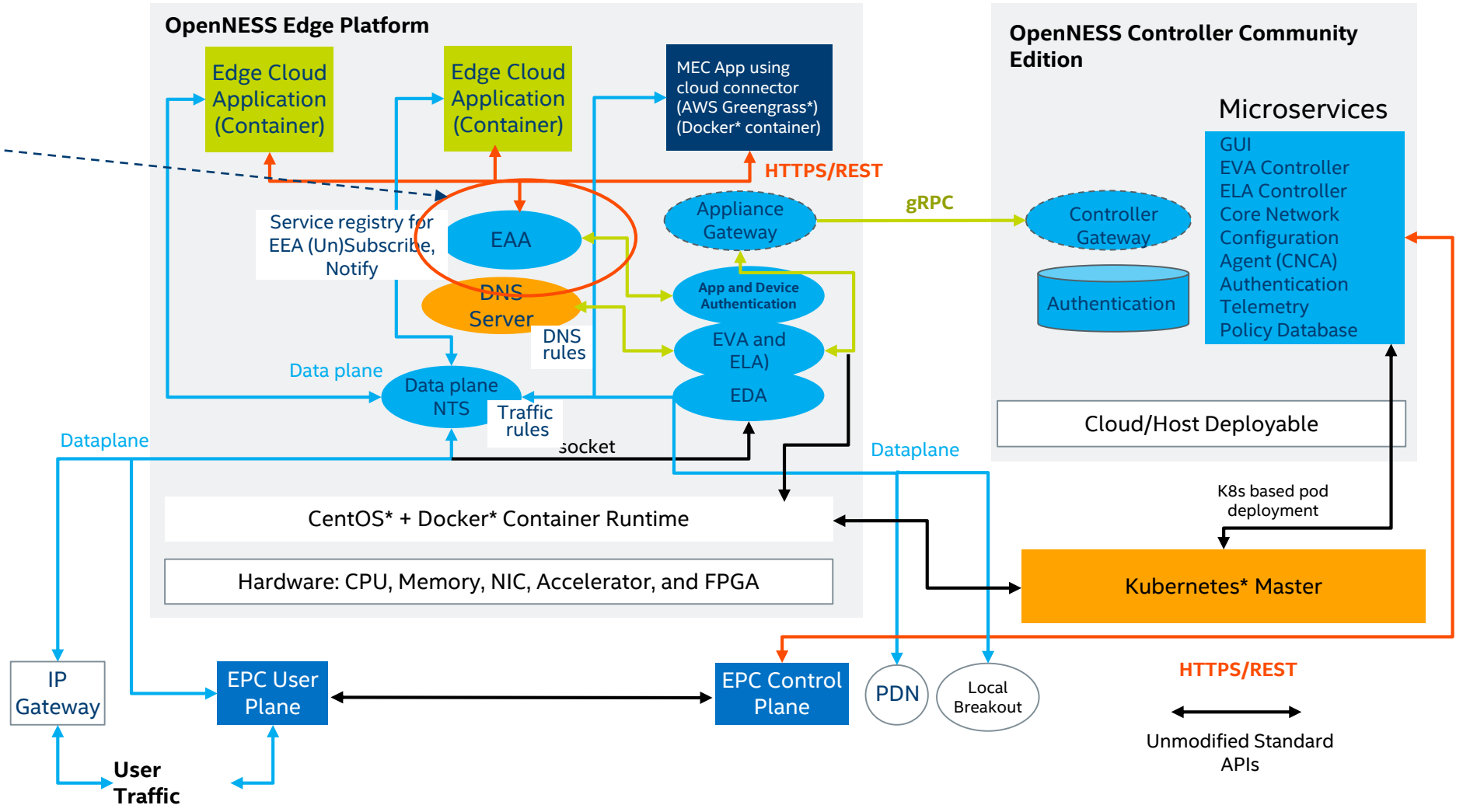


Edge Application Service/Agent

Allows applications to act as Edge Services

Acts as a message bus for inter-application communication

- Service registration
- Service discovery
- Communication support for services
- Application availability



•Edge Application API: EAA

Edge Lifecycle Service/Agent

Manage configuration of the Edge Platform deployment

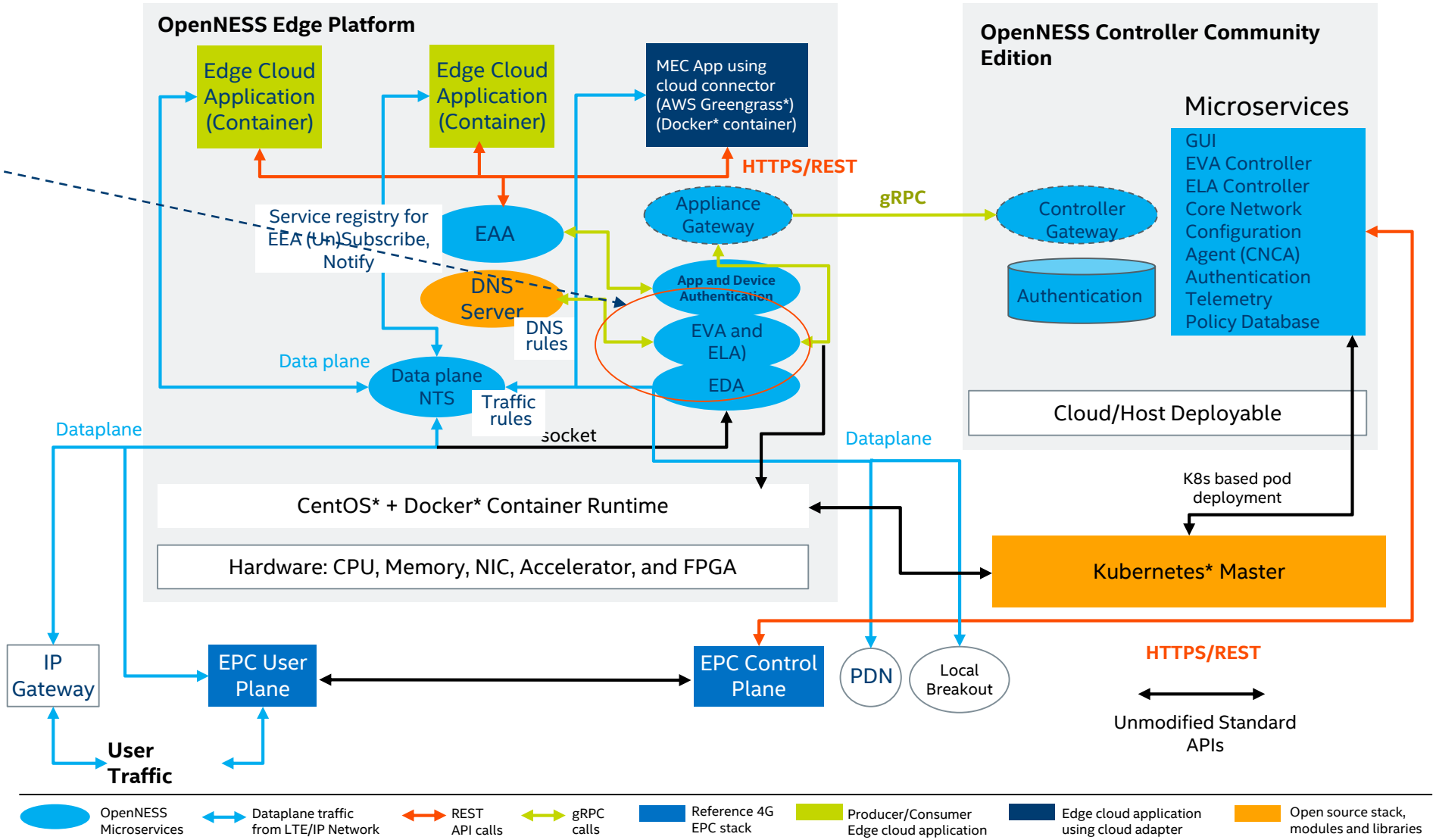
- Enroll Edge Platform with controller and create certificate
- Configure edge platform network ports for use in traffic steering

Configure Application rules

Support application authentication for application services

Carry out application lifecycle support procedures

•Edge Lifecycle Management API: ELA

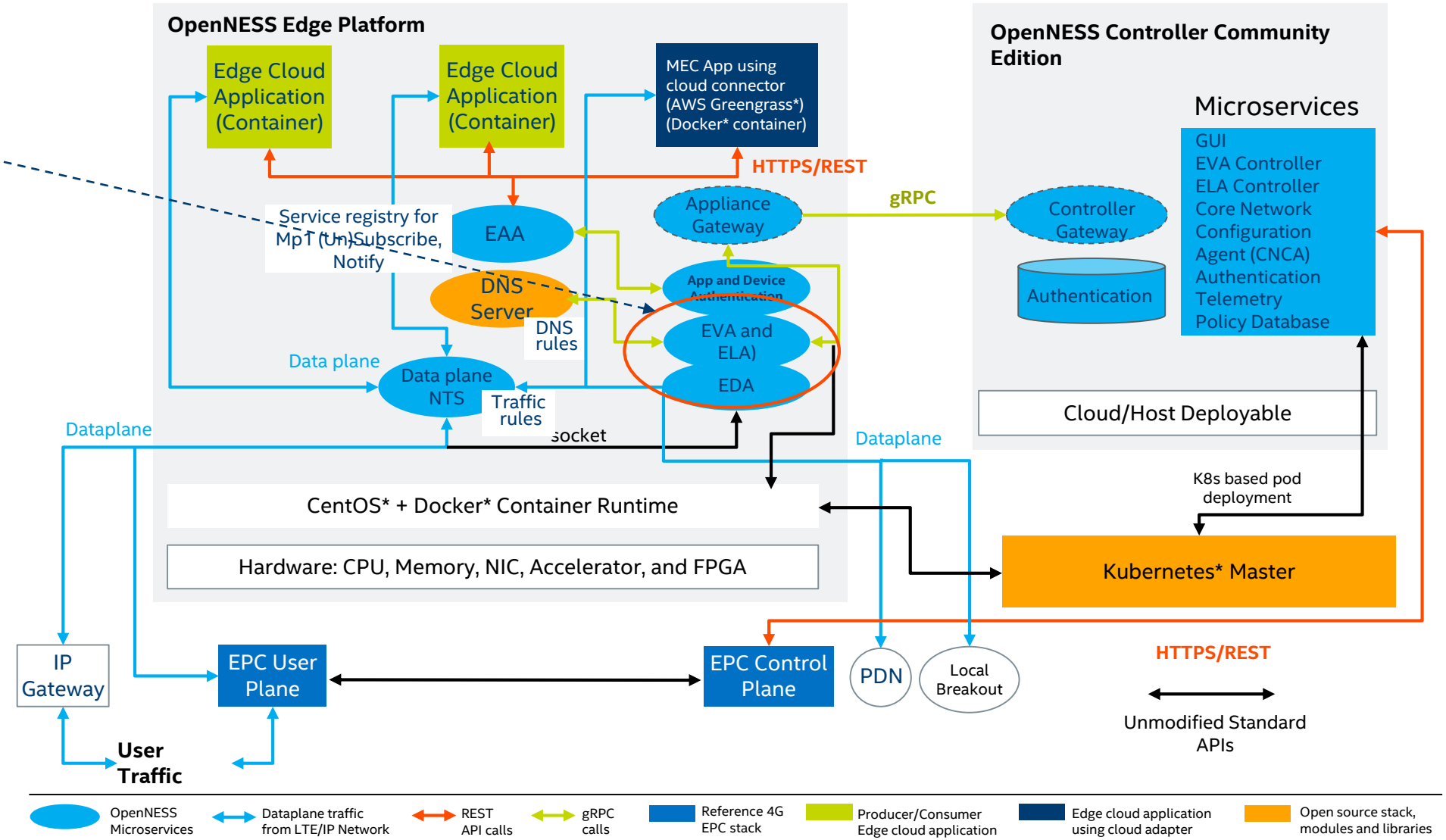


Edge Virtualization Service/Agent

Manage virtualized resources on edge platform

Ensure proper operation both in presence and absence of Virtualization Manager (i.e., OpenStack, Kubernetes)

- Instantiate, start, stop containers/VMs via platform virtualization manager if present in the deployment environment
- Instantiate, start, stop containers/VMs directly via libraries if virtualization manager is not present



Edge Virtualization Infrastructure API: EVA

Controller APIs

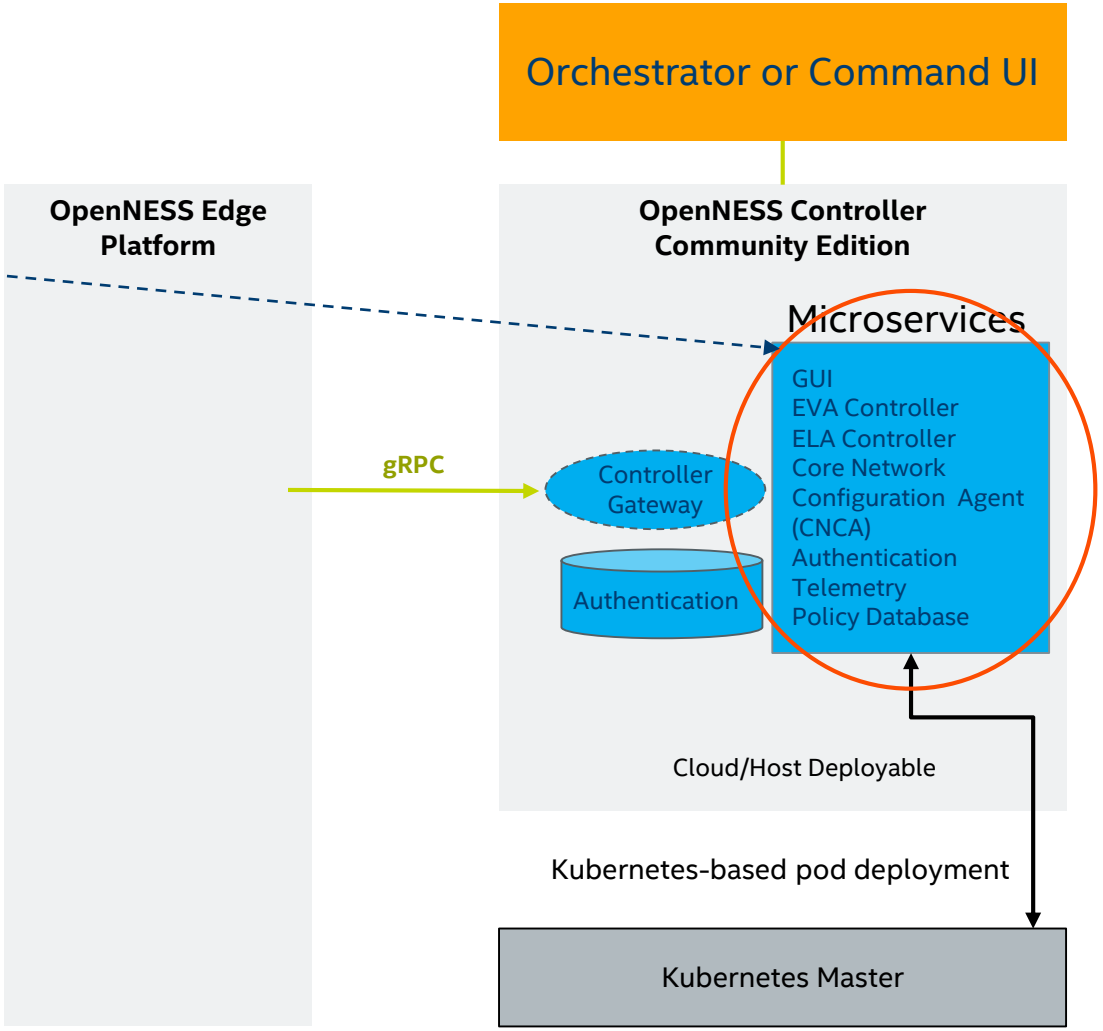
APIs implemented by the Controller

Used by Orchestrator or (web-based) UI application to carry out activities on the system

Objects controlled by APIs are:

- Node: refers to an edge platform; API performs an operation on a platform
- Application: refers to an application image managed by controller.
- Policy: refers to a traffic policy (to be applied to an application or to a node)
- Interface: refers to a network interface on a node, to be configured
- DNS: refers to a DNS configuration (combination of “A” records and forwarding rules) to be applied to a node

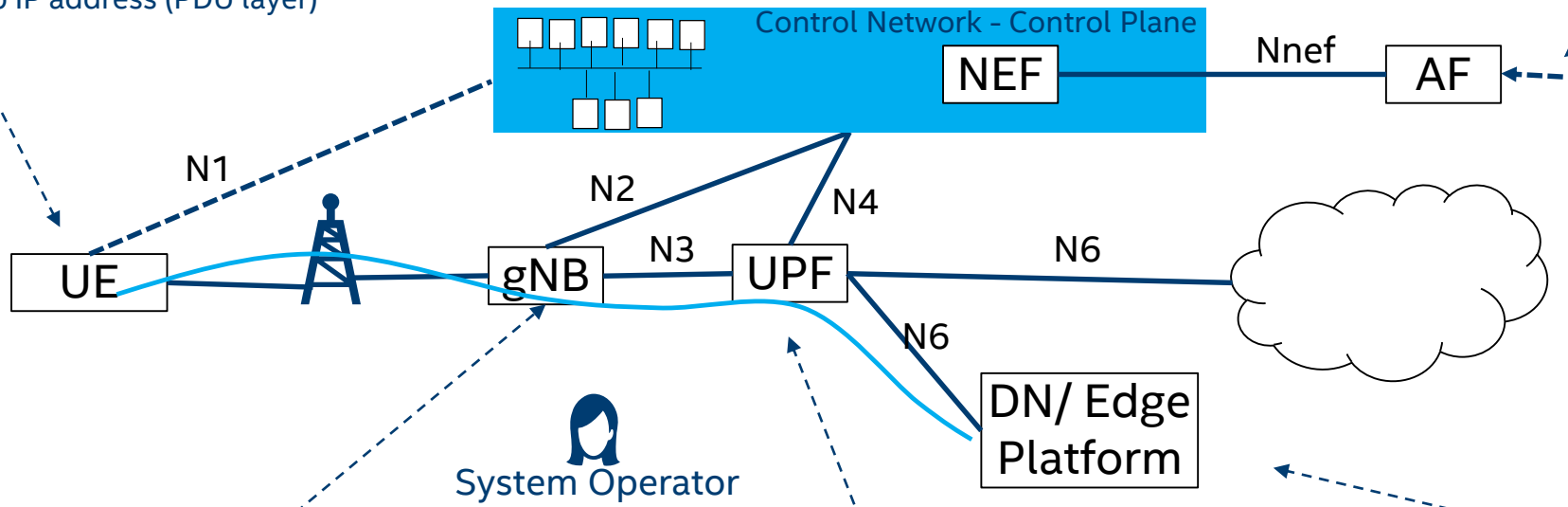
•OnPremises Controller API: EAA



Configuring the Edge App in the 5G Network

UE identifiers (provisioned at installation or registration)
- UE IP Address (PDU layer)
- DNN (Data Network Name)
- Edge App IP address (PDU layer)
- …

Edge App Information
- Location of app in DN
- Application/Service ID



Tenant and System Operator must agree on
- DN Information
- App ID information
- Population of UEs authorized to use app

gNB identifiers and data elements
User Location Information
UPF IP Address
GTP-U Tunnel ID for UPF

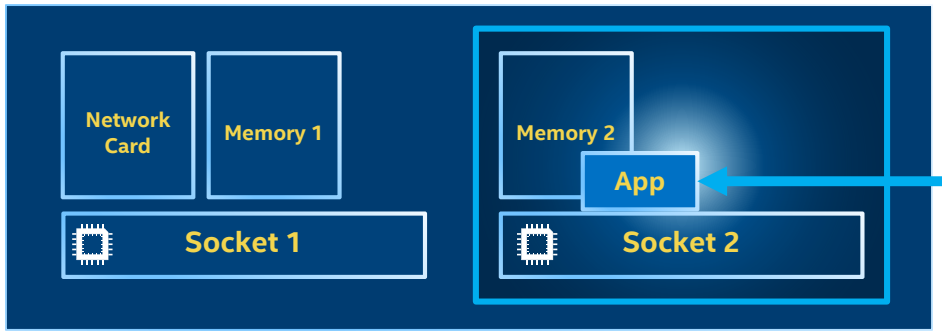
UPF identifiers and data elements
- App info:
  - App ID
  - Traffic Filters
- **UE info**:
  - IP Address (PDU layer)
  - MAC address
  - GPSI (Generic Public Subscriber Identifier
  - Any UE or group of UEs (selected)

DN identifiers and data elements
- DNN (Data Network Name)
- Route (IP address)
- GTP-U Tunnel ID

[Core Network Configuration API]

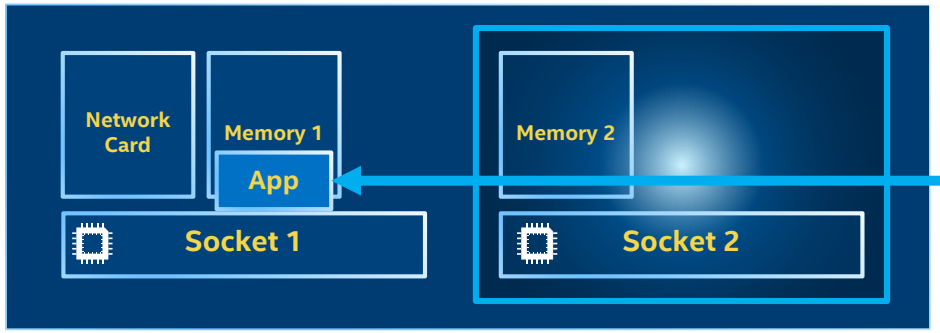
Topology Manager Microservice

Node without Topology Manager



Not NUMA Aware
Application may be deployed to the wrong socket leading to performance degradation

Node with Topology Manager



NUMA Aware
Application always deployed on the socket with the desired resources for deterministic & reliable performance

TM Microservice: Part of EPA family

What does it do?

For un-balanced NUMA nodes with network card attached to only one socket:

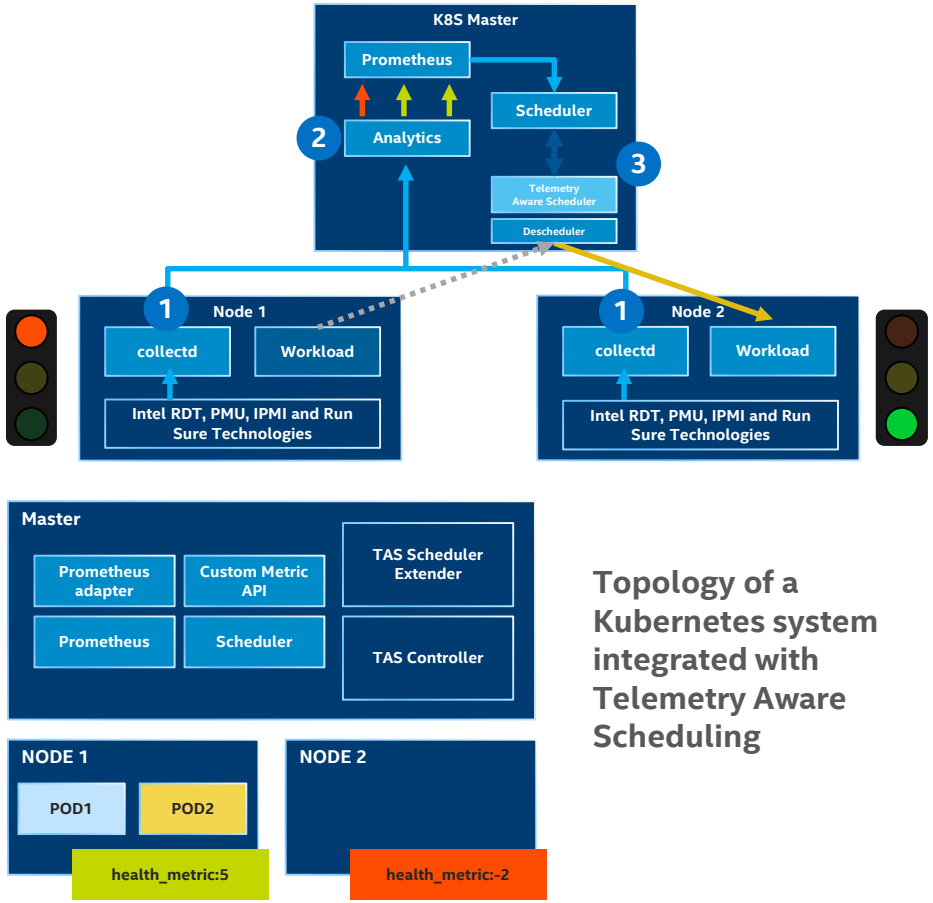
- TM microservice exposes which socket is attached to the network card
- Enables the orchestrator to properly deploy performance sensitive edge applications (throughput, latency)

Alternative Solutions:

Suboptimal allocation of resources resulting in degraded performance

Makes the orchestrator NUMA Aware, enabling optimum deployment of performance sensitive edge applications

Telemetry Aware Scheduler (TAS) Microservice



Topology of a Kubernetes system integrated with Telemetry Aware Scheduling

TAS MICROSERVICE: PART OF EPA FAMILY

What does it do?

TAS collects and exposes platform telemetry from collected and other sources to the Master

Master able to monitor performance of respective nodes and dynamically place/migrate workloads for optimum performance

Example:
Content Delivery Network in Loc A has a service provider with a high revenue generating streaming app along with voice app.

Loc A experiences voice app overloads due to local emergency.

Using telemetry data from TAS the K8s Master observes bottleneck at Loc A and identifies Loc B that is capable of added workload.

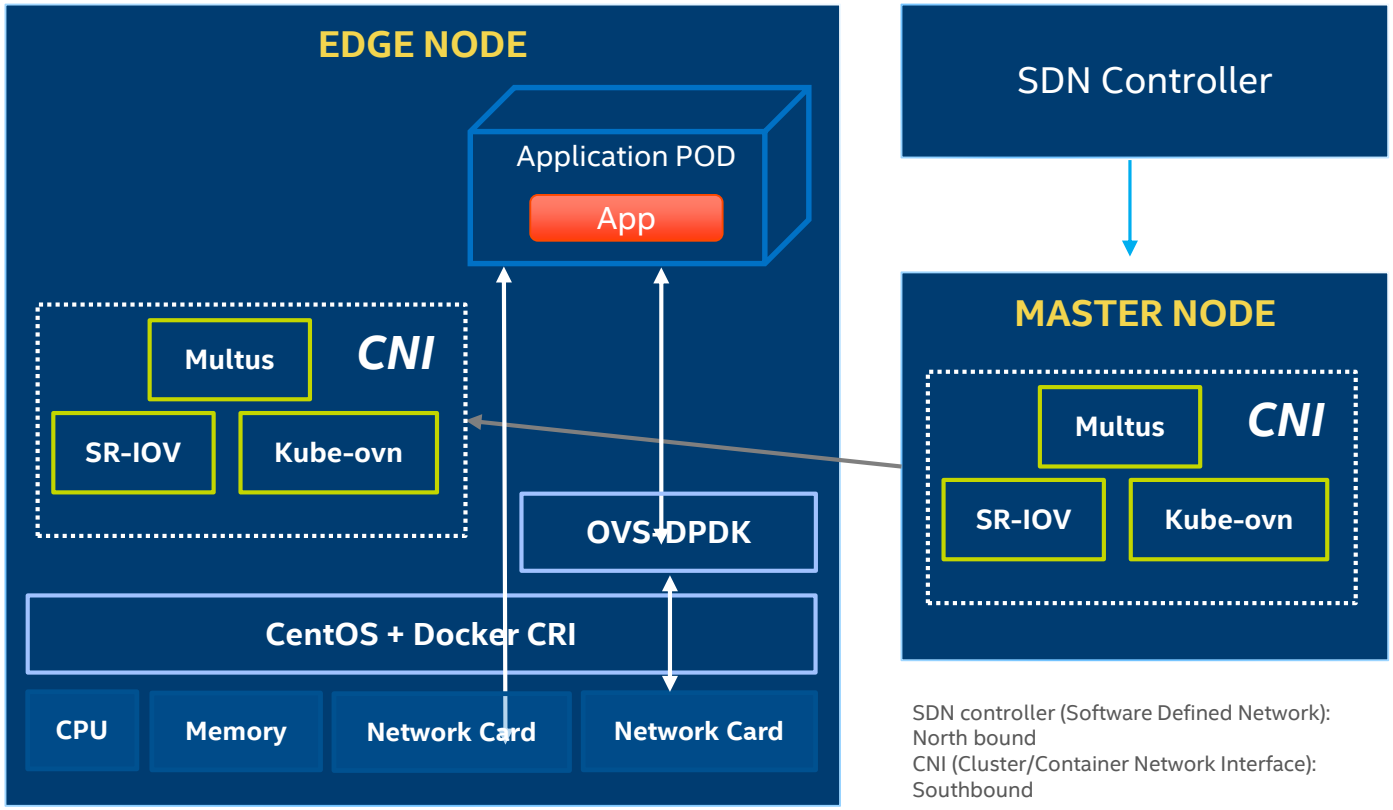
Service provider quickly and seamlessly moves the streaming app to Loc B with minimal impact to customer experience

Alternative Solutions:

Absent this level of telemetry integration there is no way to get real time data needed to identify bottleneck and suitable node for dynamic offload

Exposes edge node telemetry metrics enabling service providers to implement rules based workload placement for optimum performance and resilience

OVN/OVS-DPDK Microservice



SDN controller (Software Defined Network): North bound
CNI (Cluster/Container Network Interface): Southbound

OVN/OVS-DPDK Microservice: Part of Dataplane family

What does it do?

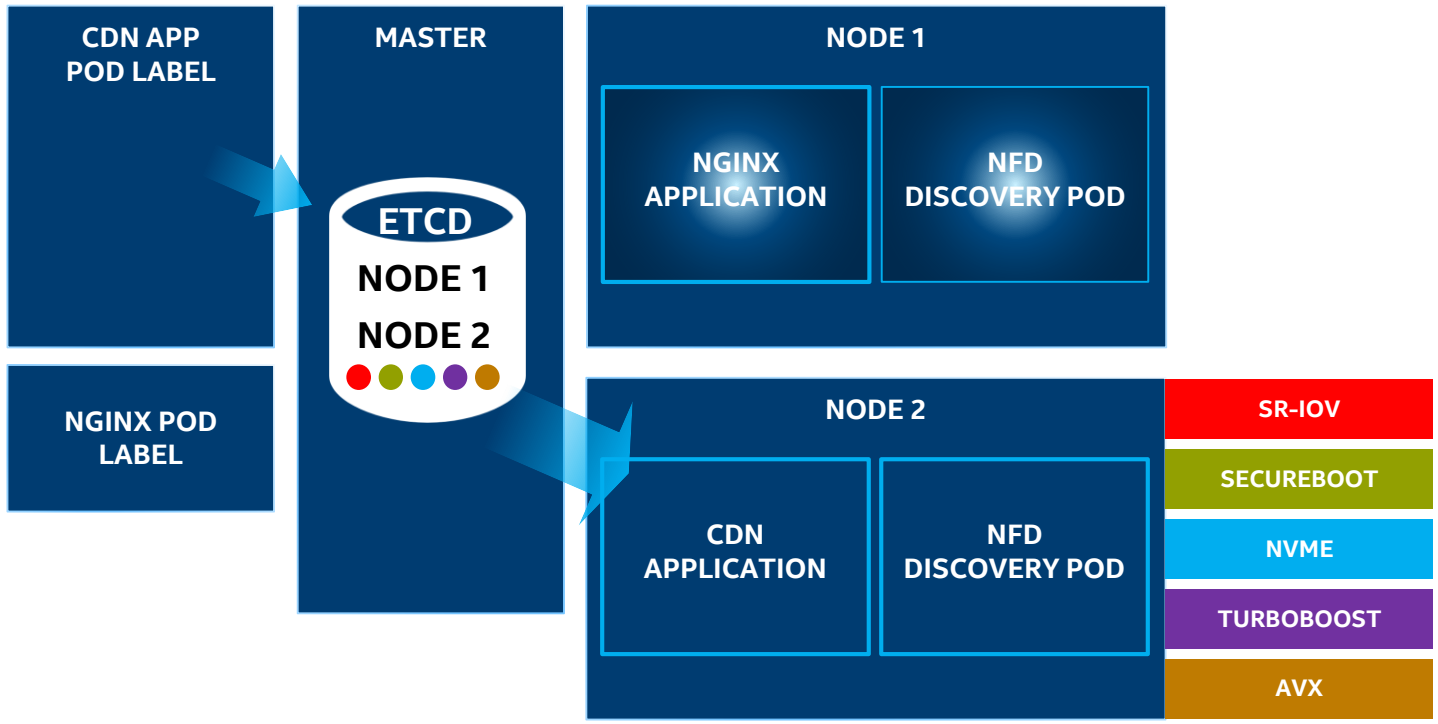
- Supports network overlay and dataplane using OVN/OVS-DPDK to accelerate data throughput
- OVN CNI (container network interface) helps
  - Configure network interfaces on OVS-DPDK
  - Configure data plane routing defined by SDN Controller (Openflow)
- Multus provides support for multiple network interfaces in the PODs deployed by Kubernetes

Alternative Solutions:

Absent this microservice, a more traditional approach around kernel stack packet routing would be needed which has significant performance implications

Enables implementation of high performance data plane (OVS-DPDK) on a cloud native edge environment with standard SDN controller

Node Feature Discovery (NFD) Microservice



Unique HW capability examples: FPGA, Security, Performance, …

NFD Microservice: Part of EPA Family

What does it do?

Advertises edge node capabilities to the orchestrator

Enables the orchestrator to deploy the applications to the edge node with optimum capabilities that best meet edge KPIs

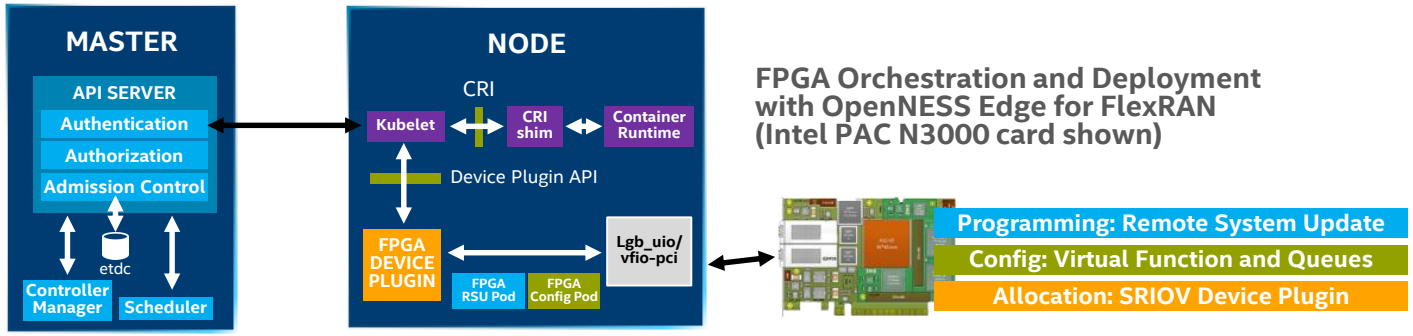
Alternative Solutions:

Without NFD, application is deployed with degraded performance

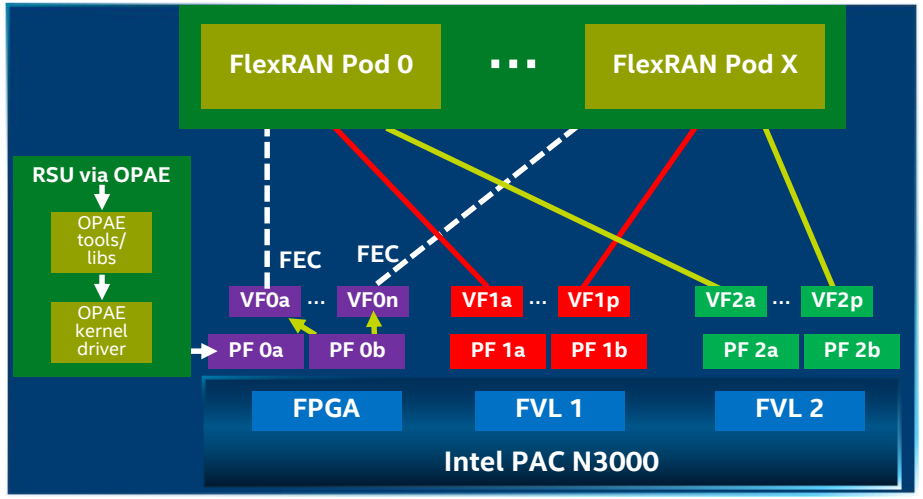
Implement a custom solution for the deployment

Exposes node specific HW capabilities to the orchestrator to enable intelligent placement of workloads for optimized application performance and manageability

FPGA Microservice



FPGA Orchestration and Deployment with OpenNESS Edge for FlexRAN (Intel PAC N3000 card shown)



OpenNESS Network Edge Intel PAC N3000 RSU and resource allocation

FPGA Microservice: Part of Accelerator Family

What does it do?

Once NFD microservice checks for FPGA presence, version, status etc

FPGA RSU microservice programs and reboots the FPGA (as needed)

FPGA Config microservice configures it for deployment

FPGA Plugin allocates resources (eg. RAN-CNF) to the FPGA

In-field configuration/programming capabilities are currently not available in off the shelf k8s

Alternative Solutions:

Physically program/config the FPGA (truck roll)

Implement custom/proprietary solutions

Enables automated remote programing/configuration of the FPGA and resource allocation to it

How to get started:

Get access to Open Network Edge Services Software at OpenNESS.org

DOCUMENTATIONS:

Architecture Overview

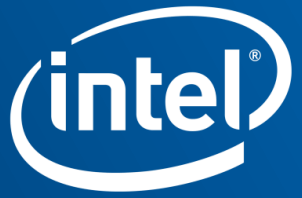
User Guides

OpenNESS White Paper

OpenNESS Overview Webinar/Video

Other Developer Resources here

Intel® Network Builder University Training



OPENNESS

ACCELERATING SERVICE INNOVATION AT THE EDGE