K8s (Kubernetes) and SDN for Multi-access Edge Computing deployment

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AGENDA

- Multi-access Edge Computing (MEC) use cases
- K8s/Openshift as candidate for Edge PaaS in MEC
- Adapting to MEC - K8s/Openshift on OpenStack
- Conclusion
WHAT IS EDGE FOR YOU?

● Regional Data Center?
● Network access node, core node (Telco Central Office)?
● eNodeB, Mobile Packet Core node (Telco Central Office)?
● CPE at customer site?
MULTI-ACCESS NETWORKS

Telco Central Office

- Fixed Cu (xDSL, HFC)
- Fixed Optical (xPON, WDM)
- Fixed Wireless (WiFi,...)
- Mobile (4G, 5G...)

Location Sensitive “Mobile” Subscribers

Location Sensitive “Fixed” Subscribers

Fronthaul/Access Aggregation Network(s)

Site / Location Specific Network AAA

Device / Location Specific Network AAA

Metro/Core Network IP/MPLS/Optical
EDGE COMPUTING USE CASE-1

- Residential vCPE service at CO/DC
- Enterprise vCPE/Universal CPE service at customer site (replacement of SD-WAN) and CO/DC
EDGE COMPUTING USE CASE-2

- Mobile Edge Computing (MEC) at eNodeB node
- Mobile Edge Computing at Mobile Packet Core node (vGiLAN, MVNO, etc)
MEC APPLICATION USE CASE

Network-performance Service Scenarios
Intelligent Video Acceleration

Consumer-oriented Service Scenarios
Augmented Reality

IoT Service Scenarios
Video Analytics

Third-party Service Scenarios
Connected Vehicles

Vehicle-to-infrastructure

Existing cloud services are extended into the highly distributed mobile base station environment, leveraging the existing LTE connectivity.

The MEC application operates as a roadside unit for vehicle-to-infrastructure (V2I).

Road hazards can be recognized and warnings can be sent to nearby cars with extremely low latency.

Enables a nearby car to receive data in a matter of milliseconds, and the driver to react instantly.
KUBERNETES/OPENSSHIFT

Candidate PaaS for Container Applications in Edge Computing
WHY KUBERNETES?

Universal Edge service platform
Application can be run Anytime Anywhere selected by user!

Container Applications

MEC  NFV Cloud  Cloud IaaS  GCE  Amazon  Azure

RED HAT® OPENSTACK PLATFORM

DevOps

PaaS

DevOps

OPENSHIFT by Red Hat
KUBERNETES
CONTAINER ORCHESTRATION AT SCALE

Open Source platform

Portable:
  Public, Private, Hybrid, Multi-cloud, Bare metal

Extensible:
  Modular, Pluggable, Hookable, Composable

Self-healing:
  Auto-placement, Auto-restart, Auto-replication, Auto-scaling

Strong ecosystem
**CORE CONCEPTS**

- **Pod** (image -> Container -> Pod)
- **Labels & Selectors**
- **Replication Controller**
- **Persistent Volumes**
- **Router**
  - Layer 7 LB /Reverse Proxy
  - SSL/TLS Termination
  - Name based Virtual Hosting
  - Context Path based Routing
  - Customizable (image)
    - HA-Proxy, F5 Big-IP
- **Service**
  - Load-Balanced Virtual-IP (layer 4)
  - Abstraction layer for your App
  - Enables Service Discovery
    - DNS, ENV
KUBERNETES NETWORKING

- **External to Internal**
  External load balancers (e.g. GCE's ForwardingRules or AWS's ELB) which target all nodes in a cluster

- **Pod to Service**
  The service abstraction to group pods under a common access policy (e.g. load-balanced)

- **Pod to Pod**
  Openshift SDN, Flannel, 3rd party solutions

- **Container-to-Container**
  Sharing local IP address and reaching each other's ports on localhost
K8s/OPENSHIFT NETWORKING

SDN for Application DevOps-Awareness networks

Pod to Pod network
Application software
project based
isolation

Network plugins (OpenShift SDN, etc)

Master Toolsets

Operations

Developer

API server

controller manager

scheduler

kube Proxy

kubelet

C1

C2

C3

Pod 1

Pod 2

FW/LB

External access

Docker image

Container

Pod

SDN controller

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POD TO POD NETWORKING

Application DevOps awareness network

- Flannel, L2 networks and linux bridging, OVS(Open VSwitch), OVN(Open Virtual Networking)
- Big Switch Networks
- Contiv (native L3 using BGP, overlay vxlan, classic L2 or Cisco-SDN/ACI)
- Contrail (Juniper Contrail/OpenContrail)
- Nuage VCS (Virtualized Cloud Services)
- Openshift SDN(OVS, VXLAN)
- Google Compute Engine
- etc
MEC ADAPTATION

K8s/Openshift on Openstack
MULTI-ACCESS EDGE COMPUTING (MEC)

- Can become a major use case for Containerized VNFs (IoT, etc.)
- Opens for new services and development models in different market verticals (e.g., Edge PaaS for some of the IoT gateway functionalities)
MEC REFERENCE ARCHITECTURE

For Edge Platform as a Service

Kubernetes
RED HAT OPENSHIFT Container Platform
RED HAT OPENSTACK PLATFORM
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NEW PROBLEMS AT NETWORKING SETUP

- Double-tunneling will have negative impact on data-plane performance (e.g. Kubernetes ‘flannel’ tunnel encapsulated in OpenStack ‘vxlan’ tunnel when running Kubernetes on top of OpenStack).
- OpenStack VM-to-K8s Pod data-plane performance

Solution:
Kuryr-Kubernetes, by enabling native Neutron-based networking in Kubernetes.
KURYR CNI & KURYR CONTROLLER
Kuryr-Kubernetes
COMMON NETWORKING FOR MIXED WORKLOADS

Neutron
- Port
- Network
- Subnet
- Router
- VIP

OpenShift API server
- K8s API
  - Pod
  - Service
  - Endpoints
  - Namespace

OpenShift node
- Kuryr
  - Controller
- Neutron
  - Agent
  - CNI
  - OVS
  - Pod

Kubelet
- Agent
- Kuryr
- CNI
- OVS
- Pod

Os-vif plug
- Add Config
  - veth

Registry
- Router
Kuryr - pods in VMs - Neutron Trunk Ports

OVS tbr-a9381a34-4
- tag: 42
  - spt-09fe7521-1d

OVS br-int
- spi-09fe7521-1d
  - subnet tag: 19

Pod 1
- eth0.42
  - 15.0.0.17/24

Pod 2
- eth0.40
  - 15.0.0.18/24

VM (OpenShift AppNode)
- eth0
  - 15.0.0.11/24

tap-6ce88405-01
- tpt-6ce88405-01
- subnet tag: 3
K8s/OPENSHIFT ON OPENSTACK = MEC
MULTI-ACCESS EDGE COMPUTING
PaaS for container applications

OSS/BSS

NFVO

K8s/Openshift node MEP (Mobile Edge Platform)

VIM

NFVi

ODL

Ceph

KVM

OVS

RED HAT OPENSTACK PLATFORM

DPDK

RED HAT OPENSTACK PLATFORM

Network

Storage

Compute
KUBERNETES FEDERATION - FUTURE

High Availability, Multi-Cloud, Multi-region, **GEO locality to end users** .......

Network Traffic management

Customer

Cross-cluster traffic distributor

Resource placement

Admin

MEC cluster in NFV

Global DC cluster, GCE, AWS

Reginal DC cluster

Cluster Federation

GCE, AWS

Global DC cluster
CONCLUSION

● K8s/Openshift on OpenStack is adaptable to Edge PaaS in Multi-access Edge Computing.

● Many upstream projects in Kubernetes
  ○ No need to create new feature spec from scratch for Multi-access Edge platform.
  ○ Evaluate existing upstream projects and find feature gap first.