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-SITE FOR TELCO

- **Customer site**
  - ~10..100k’s locations
- **Distributed CO**
  - ~1k..10k’s locations
- **Regional Data Center**
  - 1000 servers ~
- **Consolidated CO**
  - ~10’s..100’s locations
  - ~2..20 locations
- **Core Network**
  - 100 servers ~

- **Access Network**
- **Metro Network**
- **Core Network**

- **eNodeB (C-RAN)**
  - ~40 km (CPRI Fronthaul)
- **RRH**
- **BBU pool**

- **Distance**
  - < 4km
  - < 20 km (consolidated optical), < 100km two tier
MULTI-ACCESS NETWORKS

Telco Central Office

Fixed Cu (xDSL, HFC)

Fixed Optical (xPON, WDM)

Fixed Wireless (WiFi,..... )

Mobile (4G, 5G,...)

Fronthaul/Access Aggregation Network(s)

Location Sensitive “Fixed” Subscribers

Location Sensitive “Mobile” Subscribers

CORD: Central Office Re-architected as a Datacenter

M-CORD Mobile CORD

R-CORD Residential CORD

E-CORD Enterprise CORD

Site / Location Specific Network AAA

Device / Location Specific Network AAA

Metro/Core Network IP/MPLS/Optical

PON (Passive Optical Network) WDM (Wavelength Division Multiplexer) Cu (Central unit) DSL (Digital Subscriber Line) HFC (Hybrid Fiber Coax)
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

* Universal CPE is out of scope in this session.
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

- Distributed live video service
- Ensures unique experience
- Ensures low latency and

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/OPENSHEFT

Candidate PaaS for Container Applications in Edge Computing
WHY KUBERNETES?

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

- Master (openshift master)
- Worker Node (openshift node)
- Pod (image -> Container -> Pod)
- Service
  - Load-Balanced Virtual-IP (layer 4)
  - Abstraction layer for your App
  - Enables Service Discovery
    - DNS, ENV
- Labels
- Replication Controller
- Router
  - Layer 7 LB /Reverse Proxy
  - SSL/TLS Termination
  - Name based Virtual Hosting
  - Context Path based Routing
  - Customizable (image)
    - HA-Proxy, F5 Big-IP
K8s/OPENSHIFT NETWORKING

SDN controller

Pod to Pod network
Application software project based isolation

SDN for Application DevOps-Awareness networks

Pod

VIP

kube Proxy
kubelet

WORKER / NODE

FW/LB

External access

Docker image

Container

Pod

Developer

API server
controller manager
scheduler

Management Toolsets

Operations

External access

Network plugins(OpenShift SDN, etc)

SCM
CI/CD

CI/CD

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POD TO POD NETWORKING

Application DevOps awareness network

- Service Providers; Google Compute Engine, etc
  1. Flannel
  2. OVS (Open VSwitch)
  3. Nuage VCS (Virtualized Cloud Services)
  4. Big Switch Networks  Big Cloud Fabric
  5. Openshift SDN (OVS, VXLAN)
  6. OVN (Open Virtual Networking)
  7. Calico
  8. Contiv (native L3 using BGP, overlay vxlan, classic L2 or Cisco-SDN/ACI)
  9. Contrail (Juniper Contrail/OpenContrail)
- etc
MEC ADAPTATION

K8s/Openshift on Openstack

OpenStack and Kubernetes better together:
http://superuser.openstack.org/articles/openstack_kubernetes_better_together/
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
# K8s/OPENSHIFT ON OPENSTACK

## Docker image Containerized Applications

<table>
<thead>
<tr>
<th>K8s/OPENSHIFT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Master</td>
</tr>
<tr>
<td>Nodes</td>
</tr>
<tr>
<td>Registry</td>
</tr>
</tbody>
</table>

## OPENSTACK SHARED SERVICES

<table>
<thead>
<tr>
<th>Component</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compute (Nova)</td>
</tr>
<tr>
<td>Networking (Neutron)</td>
</tr>
<tr>
<td>Block Storage (Cinder)</td>
</tr>
<tr>
<td>Orchestration (Heat)</td>
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<tr>
<td>DNSaaS (Designate)</td>
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<tr>
<td>LBaaSv2 (Octavia)</td>
</tr>
<tr>
<td>File Storage (Manilla)</td>
</tr>
</tbody>
</table>

## HARDWARE
NEW PROBLEMS AT NETWORKING SETUP

- OpenStack VM-to-K8s Pod data-plane performance
- 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).

Solution:
Kuryr-Kubernetes, by enabling native Neutron-based networking in Kubernetes.
KURYR CNI & KURYR CONTROLLER
Kuryr-Kubernetes

http://superuser.openstack.org/articles/networking-kubernetes-kuryr/
Containers in Pod

K8s/OPENSHIFT ON OPENSTACK = MEC
MULTI-ACCESS EDGE COMPUTING

PaaS for container applications

OSS/BSS

NFVO

K8s/OpenShift node MEP (Mobile Edge Platform)

VIM

RED HAT OPENSTACK PLATFORM

Containers in Pod

Network

Storage

Compute

ODL

Ceph

KVM

CVS

DPDK

NFVi

K8s/OpenShift NODE

K8s/OpenShift NODE
MEC ACROSS MULTI-CENTRAL OFFICES

Containers in Pod

Frontend Pods
- K8s/OpenShift Node
- SDN for AppDevOps awareness network
  K8s CNI (Container Network Interface)

OpenStack multi-sites

RBD mirroring

CEPH

SDN DCI solutions

Transport SDN

Metro fiber optical networks

RRH

Customer site

Distributed CO

Consolidated CO

Data Center

ANSIBLE TOWER by Red Hat

RED HAT CLOUDFORMS

ManageIQ
High Availability, Multi-Cloud, Multi-region, GEO locality to end users
BIMODAL ICT IN TELECOM INDUSTRY

Mode 1: NFV Carrier Grade solution

- OSS/BSS
- NFVO
- EMS
- VNF
- VNF-M
- ODL
- OVS
- DPDK
- Ceph
- KVM
- VIM
- NFVi
- Network
- Storage
- Compute

Mode 2: MEC Edge PaaS DevOps for Open Innovation

Solution 1
Modern Container APPs
Micro services ...co-creation

Solution N

AWS
GCE
Azure
CONCLUSION

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

- SDNs have to control traffic to:
  - Container in Pod, Container in Pod in VM (K8s on Openstack NFV)
  - ... Leaf/spine switch across multi DCs/COs

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