Contents:

• Brief introduction to China Unicom’s Cube-Net 2.0 & Cube-Edge
• Open Edge Project Comparison
• China Unicom’s Architecture
• StarlingX Deep Dive
• Conclusion
• Q&A
China Unicom’s CUBE-NET V2.0 Strategy

New Network
Shared NFV & Cloud Infrastructure

New Management Model
Resource Orchestration Automation and AI Operation

New Business Model
Business Agility and Capability Open

5G network of China Unicom will be an elastic network based on regional, local and edge data centers, which will quickly respond to and shorten the deployment time of new services.
Committed to Establish an Open MEC Edge Platform to Provide Rich Capabilities and Unified APIs for Application Developers

**Open**
- Open Cloud API
- Open Management API
- Open Network Capability

**Agility**
- Pay-as-you-Go
- IaaS/PaaS Agile resource orchestration
- ICT Unified MANO

**Security**
- Carrier-level Cloud OS
- Resource redundancy
In 2018 MWC, China Unicom announced Edge-Cloud pilot in 15 China provinces.
Focus on 4 Areas, Work with Industry to Construct 5G Edge Ecosystem, More than 100 Partners

Establish Edge-Cloud Innovation Laboratory, Investigate on StarlingX Project (Cooperation with INTEL & 99 Cloud)
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## Open Source Project Overview for Edge

### vCO

<table>
<thead>
<tr>
<th>Mission</th>
<th>The Akraino Edge Stack is designed to improve the state of edge cloud infrastructure for enterprise edge, OTT edge, and carrier edge networks.</th>
<th>The goal of the Virtual Central Office project is to produce an OpenDaylight-based reference architecture that, when combined with other functional elements (such as NFV and Orchestration software stacks) can support the delivery of Residential, Business and Mobile Services.</th>
<th>To build an open reference implementation of CORD, bringing datacenter economies and cloud agility to service provider networks.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Foundation</td>
<td>Akraino : Linux Foundation Airship : OpenStack Foundation StarlingX : OpenStack Foundation</td>
<td>Linux Foundation ➔ OPNFV</td>
<td>Linux Foundation ➔ ONF ➔ CORD (?)</td>
</tr>
<tr>
<td>Edge Mano</td>
<td>ONAP/Tacker</td>
<td>ONAP(Started from v2.0)/Tacker</td>
<td>XOS</td>
</tr>
<tr>
<td>SDN</td>
<td>ODL/Commercial/</td>
<td>ODL</td>
<td>ONOS</td>
</tr>
<tr>
<td>Open VNF</td>
<td>n/a</td>
<td>n/a</td>
<td>Provide Open vEPC/vOLT and etc (*)</td>
</tr>
<tr>
<td>Since from</td>
<td>2018</td>
<td>2018</td>
<td>2016</td>
</tr>
<tr>
<td>Latest Version</td>
<td>1.0</td>
<td>2.0</td>
<td>6.0</td>
</tr>
<tr>
<td>HW Preference</td>
<td>n/a</td>
<td>White Box+Open Rack</td>
<td>White Box+Open Rack</td>
</tr>
<tr>
<td>Sub Projects</td>
<td>Airship, StarlingX</td>
<td>n/a</td>
<td>R-CORD/M-CORD/E-CORD</td>
</tr>
<tr>
<td>Edge Infra</td>
<td>OpenStack on Kubernetes (OOK),</td>
<td>OpenStack</td>
<td>OpenStack/K8S</td>
</tr>
</tbody>
</table>

* There is some GPL issue in using Open VNF [https://wiki.opencord.org/display/CORD/GPL+Issue+August+2018](https://wiki.opencord.org/display/CORD/GPL+Issue+August+2018)
vCO Architecture

Service Assurance
(Grafana, OPNFV Barometer, Doctor, proprietary software)

Residential VCO VNFs
- vBNG
- vFW, AntiDOS, DPI
- vRouter

Enterprise VCO VNFs
- VPN
- vFW
- vRouter

OpenStack Tacker (VNFM)

OpenStack (VIM)

OpenStack (SDN controller)

NFVI
- Switch software (networking)
- KVM with DPDK (computer), Ceph (storage)

Bare Metal Switches
- OCP Servers - Controllers
- Standard IA Servers - Compute
- OCP Servers - Storage

OPNFV
- OPNFV-integrated components

Figure 3: VCO Demo Reference Architecture
Figure 2. Open source software components in CORD. XOS assembles multi-tenant services, ONOS hosts control applications, and OpenStack/Docker manage compute instances. Specific services and control apps are described in later sections.
ETSIs MEC RA
ETSI's MEC RA v.s. CORD

CORD Modules mapping to ETSI

CORD Modules Out of ETSI

Admin GUI (XOS)

User app LCM Proxy

Operations Support System

Cord Analytics

Mobile edge system level

Mobile edge host level

Other mobile edge platform

Other mobile edge host

Mobile edge platform

Infra Orchestrator (OpenStack + K8S)

Virtualization Infrastructure

OpenStack/K8S

Data plane

ODL

Open VNF

ME service

Service Delivery

Traffic Control

DNS

Mobile edge platform

Mobile edge host

Mobile edge host level

Infra Orchestrator (OpenStack + K8S)
ETSI's MEC RA v.s. Akraino

Network Data Plane
Network Control Plane
Storage
OS

ME service
Service Delivery
Traffic rules control
DNS Handling

Lightweight Edge App Orchestration
NFV & Domain Specific Orchestration (ONAP)

Mobile edge platform
Mobile edge host

Infra Orchestrator (OpenStack + K8S)

Mobile edge system level
Mobile edge host level

Admin GUI
User GUI
UE APP

Other mobile edge platform
Other mobile edge host

Network Edge Cruiser Tricycle Unicycle
Customer Edge Satellite Rover

Akraino Modules mapping to ETSI
Akraino Modules out of ETSI

Testing Tooling Frame (ETE) PINC Security Tool (ETE)

Platform Workflow (Camunda)
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China Unicom’s Decision Making Factors on Open Edge Platform Options

- The urgency level to support China Unicom’s Edge roadmap
- The readiness level of open infra techs
- The ROI level of adoption for Open Techs

<table>
<thead>
<tr>
<th>Category</th>
<th>Open Tech Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Open Edge Infra - VM</td>
<td>OpenStack, StarlingX</td>
</tr>
<tr>
<td>Open Edge Infra - Container</td>
<td>K8S</td>
</tr>
<tr>
<td>Open Edge MANO</td>
<td>Tacker, ONAP</td>
</tr>
<tr>
<td>Open Edge VIM</td>
<td>Airship</td>
</tr>
<tr>
<td>White box HW</td>
<td>OCP/RSD</td>
</tr>
<tr>
<td>Open VNF</td>
<td>Open vEPC, ngic, c3po</td>
</tr>
</tbody>
</table>

Size stand for the estimation RoI to implement this tech
CORD v.s. Akraino

Comparison

- VNF Capability
- OSS Data Feeding
- HW Re-Define
- Multi-Edge Deployment
- MEAO
- Edge-VNFI

CORD
Akraino
ETSI's MEC RA v.s
China Unicom Design (Based on Akraino)
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Re-Configure Proven Cloud Technologies for Edge Compute

- Orchestrate system-wide for telco and other vertical markets
  - Deploy and manage Edge clouds, share configurations
- Simplify deployment to geographically dispersed, remote Edge regions

*Other names and brands may be claimed as the property of others*
As ETSI GS MEC 010-1 V1.1.1 (2017-10) (Mobile Edge Computing (MEC); Mobile Edge Management; Part 1: System, host and platform management) defined:

7.3.1 Fault Management interface

For Alarm Management, the following 3GPP defined IRPs are used:

- ETSI TS 132 111-2 [4]: "Digital cellular telecommunications system (Phase 2+); Universal Mobile Telecommunications System (UMTS); LTE; Telecommunication management; Fault Management; Part 2: Alarm Integration Reference Point (IRP): Information Service (IS) (3GPP TS 32.111-2)."
- ETSI TS 132 332 [5]: "Digital cellular telecommunications system (Phase 2+); Universal Mobile Telecommunications System (UMTS); LTE; Telecommunication management; Notification Log (NL) Integration Reference Point (IRP); Information Service (IS) (3GPP TS 32.332)."

*Other names and brands may be claimed as the property of others*
As ETSI GS MEC 010-1 V1.1.1 (2017-10) (Mobile Edge Computing (MEC); Mobile Edge Management; Part 1: System, host and platform management) defined:

5.1.1 Requirements for reference point Mm2.
5.1.1.1 Requirements related to the mobile edge host.

5.1.1.1.1 Configuration Management requirements.

- **RFQ-MM2-MEH-CM-1**: The Mm2 reference point shall support a capability allowing the OSS to retrieve the information model of the mobile edge host, or parts thereof, from the mobile edge platform manager.

- **RFQ-MM2-MEH-CM-2**: The Mm2 reference point shall support a capability allowing the mobile edge platform manager to notify changes related to the information model of the mobile edge host to the OSS.

- **RFQ-MM2-MEH-CM-3**: The Mm2 reference point shall support a capability allowing the OSS to configure the mobile edge host.

- **RFQ-MM2-MEH-CM-4**: The Mm2 reference point shall support a capability allowing the OSS to retrieve the rules.

- **RFQ-MM2-MEH-CM-5**: The Mm2 reference point shall support a capability allowing the OSS to configure the rules.

*Other names and brands may be claimed as the property of others*
StarlingX Deep Dive （Not ETSI Required but critical to Edge）
- VM HA Acceleration

<table>
<thead>
<tr>
<th>OS</th>
<th>Size</th>
<th>Restore Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>CentOS</td>
<td>800M</td>
<td>~30s</td>
</tr>
<tr>
<td>Cirros</td>
<td>12M</td>
<td>~20s</td>
</tr>
</tbody>
</table>

VM Restored in 34s (CentOS, 800M)

C/C++ codes in HA source code
StarlingX Deep Dive （Not ETSI Required but critical to Edge）
- Controller HA Optimization

<table>
<thead>
<tr>
<th>Test case</th>
<th>Platform Status</th>
<th>Restore Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stop 1 controller nova-compute</td>
<td>Running but w/ warning</td>
<td>1s</td>
</tr>
<tr>
<td>Disable 1 controller nova-compute</td>
<td>Running but w/ warning</td>
<td>15s</td>
</tr>
<tr>
<td>Shutdown 1 controller Host</td>
<td>Running but w/ warning</td>
<td>Need manually start Neutron service</td>
</tr>
</tbody>
</table>

- Single Server
  - Runs all functions

- Dual Server
  - Redundant design

- Multiple Server
  - Fully resilient and geographically distributable
Nodal Configuration
- Network Interfaces (DPDK)
- Inventory Discovery
- Physical NICs (# and bandwidth)
- H/W acceleration devices for edge networking (SR-IOV, SmartNIC etc.)
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Conclusion

• Among those three open projects, CORD & Akraino are more mature than vCO. CORD & Akraino are with real codes but vCO is only in PoC stage.

• Between CORD and Akraino, CORD is with more scope in VNF opensource and white box hardware integration for central office re-architecture. Akraino is more focus on software level and with more ready-to-use edge infra and deployment approach.

• According to China Unicom’s roadmap, we will keep eyes on those three projects and start some pilot based on Akraino.

• Mapping to ETSI standard, even it is not a mandatory standard, based on the future China Unicom edge framework, we need put efforts to optimize in MEAO/MEPM modules and integration with VNF/PNF to get it ready for edge business.

• StarlingX, the complete Edge stack, is available now to try out as a scalable solution with configuration, fault, service, software and host management to ensure high availability of user applications.
Q&A
Thank you!