Edge Automation – Potential Strategies for Deploying ONAP at Edge

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Our Proposal

• Edge group to consider additional scope in ONAP for Edge Application Management – as per MEC guidelines

• ONAP deployment to suit edge automation scenarios

• MVP closely following the standards to enable interoperability.
Reference Implementation of MEC Architecture

• Step 1. MVP “Orchestration Level”:
  - MEAO
  - Ref Points: Mm1, Mv1

• Step 2. “Management Level”:
  - MEMPM-V
  - ME Platform LCM
  - ME App LCM
  - Ref Points: Mm2, Mm3*, Mv2, Mm6

• Step 3. “Platform and Applications”:
  - ME Platform
  - ME Application
  - Ref Points: Mm5, Mp1, Mp2, Mv3, Nf-Vn

• Step 4. “External Interfaces”
  - CFS Portal
  - UE Application
  - User App LCM Proxy
  - Ref Points: Mx1, Mx2, Mm8, Mm9

• Step 5. “Network Edge”:
  - Ref Point: Mp3
Potential ONAP Edge Deployment Scenarios

- **Central ONAP**
- **Edge Infra**
- **Edge ONAP SL**
- **Edge ONAP HL**
- **Edge Akraino SL**
- **Edge Akraino HL**
- **Partner Edge HL**
- **PMO**
- **FMO1**

**Backbone**
- Central ONAP
- Mv1
- FMO1
- Mm3

**Backhaul**
- Central ONAP
- Mv1
- Partner Edge SL
- Mm3

**Fronthaul**
- Edge Infra
- Edge Infra
- Edge Infra
- Edge Infra

PMO - (Present Mode of Operation)
FMO1 – (Future Mode of Operation)

Central and Edge ONAP – not mean physical location of ONAP instance, but responsibility.
Focus of this presentation

Scope for PMO

Edge System Level Management as per MEC
Scope for FMO

PMO – Present Mode of Operation
FMO – Future Mode of Operation
MVP – Minimum Value Product
About MEC Use Cases in General

• 3 kinds of Use Cases:
  - Consumer-oriented services (AR, VR, Cognitive Assistance...)
  - Operator and third party services (device location tracking, big data, security, safety)
  - Network performance and QoE improvements (performance, video optimization...)

• MEC does not care about in what MEC Application do in Use Case.
  - MEC just fulfill requirements of MEC Application (Mobility, Compute resources...).
  - Like MANO does not care what VFN do (vCPE, vEPC, vFW...), but care about LCM
  - MEC Application requirements - still evolving.
Use Case: Application computation off-loading (Example 1)

- MEC host executes compute-intensive functionalities with high performance instead of mobile devices.
- Business value of such applications is:
  - graphical rendering (high-speed browser, artificial reality, 3D game, etc.),
  - intermediate data-processing (sensor data cleansing, video analysing, etc.)
  - value-added services (translation, log analytics, etc.).
- This is most simple Use Case is good for ONAP Dublin deployment showcase.
  - Need to demonstrate LCM on dummy MEC Application.
  - Include all basic MEC Management components (SL/HL) and reference points.
  - No need to support Mobility and integration with 5G RAN for Radio Interface.
  - No need to demonstrate Slicing and integration with 5G Core.
MEC and 5G Interworking

MEC integration with 5G

MEC Host’s DP is mapped to UPF in 5G
MEC Host’s CP is mapped to AF in 5G

ETSI MEC - 5GCoreConnect Feature: [link]
ETSI MEC – Use case for MEC deployment in 5G: [link]
Typical Management Functionalities at Edge for various NFV based Use Cases (General) – Reference ETSI MEC

**FMO Edge Orchestration (MEC System Level Management)**

- **Edge Or orchestrator**
  - Inventory Management
  - Catalog Management
  - Application Placement and LCM Triggering
- NFVO
- User Application LCM Proxy
- Interaction with OSS/BSS
- License Management
- Assurance (System Level)

**FMO Host Level (MEC Host Level Management)**

- **Platform Manager (MEPM-V)**
  - Platform Element Mgmt
  - Assurance (Host Level)
- **App LCM**
- **Platform LCM**
- **VIM**

**Available Functions in ONAP, but need adaptation for MEC.**

- Optionally placed at System Level as well.

Scope of ONAP MVP. Can be aggregate for multiple Edges

Scope of VNF vendor and Cloud Provider
FMO: Functional Responsibility of Central and Edge Management System

**Central (E2E Orchestration)**
- SP OSS/BSS
- Partner OSS/BSS

**Edge Domain Orchestration**
- Akraino NFV & Application Orchestration
- Akraino Edge Platform
- Akraino - Edge IaaS

**Edge NF Management and Network Control**
- Akraino Stack

**Edge Infrastructure**
- DP Connectivity

**SP Central Management and Orchestration**
- SP Edge System Level Management (Edge Domain Orchestration)
- Edge Host Level Management

**Partner Edge Domain Or orchestrator (non-ONAP)**
- Partner Edge Domain Orchestration (non-ONAP)

**MEF Legato or Interlude (TMF 641, 640, 638,633), Proxy for MEC Mm2,Mm9 , MEC MM1**

**ETSI Or-Vnfm, Ve-Vnfm-em, Ve-Vnfm-vnfProxy for MEC Mm2, Mm3**

**ETSI Vi-Vnfm, Proxy for Or-Vi**

**Potential ONAP Scope**
- 3GPP 5G Naf (Optional)
- ETSI 5G Naf (Optional)

**Partner OSS/BSS**
- End to End Service Management
- Service Design and Distribution
- OSS/BSS Integration
- User Application LCM Proxy Function (assumption)
- CSMF, NSMF Functionality for Slicing

**MEF Sonata**
- Domain Level Orchestration
- MEAO and NFVO functionality as per MEC
- Maintains domain level catalog and inventory
- Domain level Control loop
- NSSMF Functionality for Slicing

**MEF Interlude**
- Edge Application Platform Management
- Element and NF Management
- Network Control (SDN)

**Infrastructure Management (VIM,PIM)**

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**Infrastructure Management (VIM,PIM)**

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Applications can be classified at a high level as follows:

- **Near Real Time Data Plane Applications**: Deployed in the DP and resides in the Edge Cloud infra near to other NFs – e.g. Video Cache, IoT etc.
- **Near Real Time Control Plane Applications**: Deployed in the close proximity of the host level management functions, managed by the Edge Platform – e.g. Traffic steering rules update.
- **Non-Real Time Data Plane Applications**: Deployed in public cloud and traffic is steered to them by local cloud proxy applications.
- **Non-Real Time Management Applications**: Deployed in the close proximity of the system level management functions – e.g. Fault and Performance Aggregation per host, Closed control loop.
- **Non-Real Time Operational Applications**: Deployed in the close proximity of the End to End/ Central Orchestration, typically used for end to end monitoring at NOC, SOC – e.g. Fault and Performance Aggregation across systems, SLA Monitoring.

MEC mainly focus on the applications deployed on the Data plane serving UEs directly. This slide try to emphasize the need for other type of applications which have management and operational scope and potential deployment model.
FMO : MEC Functional Mapping to ONAP
FMO: ONAP Functional Mapping to MEC Functions: Typically for Data Plane Applications

- OSS/BSS
- ONAP CLI
- U-UI
- ONAP Portal

- User LCM Proxy
- DESIGN-TIME (SDC)
  - VNF Onboarding
  - Service/VF/PNF Design
  - DCAE Design Studio
- CLAMP
  - Workflow Designer
  - Controller Design Studio
- Catalog

- Dashboard OA&M (VID)
- Policy Framework
- DCAE
- Correlation
- Service Orchestration
- Project
- A&AI/ESR

- RUN-TIME
  - MEAO + NFVO
  - NFVO + VNFM (Optional)
- Common Services
  - AA/F
  - Logg
  - Others

- MEC Platform Manager + VNFM
- MSB/DMAAP
- Multi-VIM/Cloud Infrastructure Adaptation Layer
- SDN-C
- Application Controller (APPC)
- Multi-VNF/Cloud Infrastructure Adaptation Layer

- External Systems
  - 3rd Party Controller
  - vVNF
  - EMS

- Network Function Layer
  - VNFs
  - Hypervisor/OS Layer
  - VNFM
  - Managed Environment

- Private Edge Cloud
- MPLS
- Private DC Cloud
- IP
- Public Cloud

- Recipe/Eng Rules & Policy Distribution
  Note 1: VF-C is ETSI-aligned.
FMO: ONAP Functional Mapping to MEC Functions: Typically for Monitoring Applications

ONAP External APIs

ONAP External APIs

Dashboard OA&M (VID)

Policy Framework

DCAE MEAO + NFVO + MEPM Engine (Holmes)

Service Orchestration Project

A&AI/ESR

Common Services

AAF

OOF

Logging

MUSIC

Others

External Systems

3rd Party Controller

sVNF

EMS

Managed Environment

Network Function Layer

VNFs

PNFs

Hypervisor / OS Layer

OpenStack

Commercial VIM

K8S

Public Cloud

Private Edge Cloud

MPLS

Private DC Cloud

IP

Public Cloud

Recipe/Eng Rules & Policy Distribution

Note 1 - VF-C is ETSI-aligned.
FMO: An MVP View for ONAP at Edge and Central

SDC
(Application Package, VNF Package, NS Package)

Orchestration (MEAO, NFVO for MVP1)
RT Catalog
WF Engine
Adaptors

A&AI
Full Deployment

Policy FW
PAP
PIP
PDP

DCAE
Full Deployment

External API
Generic Controller (MEPM for MVP1)

Long term storage at central site based on pull model from Central
PAP, PIP at Central
PDP at Edge

Extended processing, analytics at Central, Metrics aggregation at Central, Controller for deploying DCAE MS from Central

Common Services (DMaaS, MSB, OOF)

Distribution of NSD, VNFD, AppD

Edge service Orchestration (Especially Central to Domain or Partner)

FMO: NS and Application LCM

ONAP Project Impact

PMO: E2E & NS, Infra, App LCM
FMO: Only E2E Service LCM

Inventory Graph

Common Services (DMaaS, MSB)

OSS/BSS

Optional Proxy connection with OSS/BSS (Mm1)

External API

Extended processing, analytics at Central, Metrics aggregation at Central, Controller for deploying DCAE MS from Central

Common Controller SDK with essential MS or Light weight CM. Can function as MEPM

ONAP Edge (System Level Management, Domain Orchestration)
FMO : Central and Edge ONAP API Scope (MVP2)

SP OSS/BSS
- Service Order Management (TMF 641)
- Service Catalog Management (TMF 633)
- Service Inventory Management (TMF 638)
- Network Slice Management (ETSI)

Central ONAP (Hosts MEC User Application LCM Proxy)
- Platform Configuration, Fault, PM (MEC Mm1)
- UE Application Request (ETSI MEC Mm9)
- Application LCM (ETSI MEC Mm1)

Edge System Level ONAP (Domain Orchestration)
- ETSI MANO (Or-Vnfm)
- Platform Configuration, Fault, PM (MEC Mm1)
- ETSI MANO (Or-Vi)
- Application lifecycle, Rules Mgmt, MEC Services Monitoring (MEC Mm3)

Edge Host Level Management
- Inter-Platform Communication for App mobility (Optional)

Partner OSS/BSS
- Product Order Management (MEF SONATA)

Partner Central Orchestrator
- Service Order Management (TMF), MEF Interlude
- UE Application Request (ETSI MEC Mm9)

Partner Edge System Level Management
- Service Order Management (ETSI, MEF Interlude)

Partner Edge Host Level Management
- Network Slice Subnet Management (ETSI)
- MEF Interlude (Optional, Not defined by ETSI yet)
- Inter-Platform Communication for App mobility (Optional)
## ONAP Central vs Edge System Level Functionality Split (FMO)

### ONAP Central

<table>
<thead>
<tr>
<th>Component</th>
<th>Capability</th>
</tr>
</thead>
<tbody>
<tr>
<td>SDC</td>
<td>End to end service design, Service distribution to Central and Edge ONAP System Level</td>
</tr>
<tr>
<td>External API</td>
<td>Proxy the connection to OSS/BSS to enable MM2, Coordinate communication with</td>
</tr>
<tr>
<td>SO</td>
<td>Optional – Infrastructure Service for ONAP Edge, Onboarding and LCM for System level monitoring applications (Mainly DCAE Apps)</td>
</tr>
<tr>
<td>DCAE</td>
<td>Host applications that aggregate monitoring data and carry out analytics from multiple Edge System level management functions.</td>
</tr>
<tr>
<td>A&amp;AI</td>
<td>Edge System level Inventory reconciliation</td>
</tr>
<tr>
<td>VID</td>
<td>Infrastructure Service Instantiation</td>
</tr>
<tr>
<td>CLAMP</td>
<td>Closed loop configuration, deployment for Edge System level infrastructure services</td>
</tr>
<tr>
<td>Policy</td>
<td>For managing CL Policy</td>
</tr>
<tr>
<td>Generic Controller</td>
<td>Can Function like MEPM in MVP 1 scenario</td>
</tr>
</tbody>
</table>

### ONAP Edge System Level

<table>
<thead>
<tr>
<th>Component</th>
<th>Capability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Runtime Catalog</td>
<td>Maintains application and VNF packages those are distributed by SDC from Central</td>
</tr>
<tr>
<td>SO/VFC</td>
<td>Application and NS Lifecycle, Edge Platform LCM, Role of MEAO + NFVO</td>
</tr>
<tr>
<td>DCAE</td>
<td>Host applications that aggregate monitoring data from multiple host level management systems and carry out analytics for CL</td>
</tr>
<tr>
<td>A&amp;AI</td>
<td>Edge Host level inventory reconciliation</td>
</tr>
<tr>
<td>Generic Controller</td>
<td>For VNF and Application LCM, Application Traffic Steering. Can take the role of Platform Manager</td>
</tr>
<tr>
<td>Policy</td>
<td>For managing the CL Policy</td>
</tr>
<tr>
<td>Ext-API</td>
<td>For enabling the MEC System level NBI</td>
</tr>
<tr>
<td>CLAMP</td>
<td>Optional – For onboarding/instantiation the Control loop applications</td>
</tr>
</tbody>
</table>

### ONAP Edge Host Level

<table>
<thead>
<tr>
<th>Component</th>
<th>Capability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Generic Controller</td>
<td>Persona for Edge Platform Management, especially for provisioning the application and connectivity rules</td>
</tr>
</tbody>
</table>

Note: Further study required to come up with specific changes
Operational Scenario: Sequence Diagram for Application Onboarding

Designer User  Operation User  ONAP Central  SDC  Central ONAP RT  UUI (Optional)

Onboard Application Package, VNF Package, Design
End to End Service Package
Distribute Package

End to End Control Loop Service Package (optional) for Central DCAE
Application Package Distribution

End to End Service Package Distribution

Control Loop Service Package (optional)
Onboard Application Package (ETSI MEC 10 Part 2)
Distribute NS Package (Existing SO API)

Get SDC Catalog Items
Optional: Onboard Application Package
Optional: Distribute NS Package

PMO Scenario

FMO Scenario

Additional Feature Requirement in ONAP (Ext-API or SO)

Refer also to this ETSI GR Issue 6
Operational Scenario: Edge Platform Instantiation – PMO

Assumptions:
- VNFM for Edge applications and Edge Platform is supported by Central ONAP or external to ONAP
- Application LCM is responsibility of Central ONAP
- Platform Manager consolidates the metrics, events from platform and passes on the aggregated metrics to ONAP Central
- Edge Platform is instantiated as Infra service component
- Central ONAP Generic Controller acts like a Platform Manager for multiple Edge hosts

Common flows
Operational Scenario: Edge Platform Instantiation – FMO
Case 1: Platform Instantiation controlled by Central ONAP

- VID/Ext-API
- SO
- OOF
- A&AI

Central ONAP

- Create Edge Infra Service instance in inventory
- Decompose
- Create Edge Infra Service in ONAP of SPPartner (Ref: CCVPN use case)
- Response with Service Instance Id
- Create SPPartner Resource Instance

Edge ONAP Ext-API

- Create Edge Infra Service
- Response with Service Instance Id
- Decompose
- Refer to previous slide

Edge ONAP SO

Edge ONAP A&AI

Edge infrastructure Service Instantiation
Operational Scenario: Edge Platform Instantiation – FMO
Case 2: Platform Instantiation controlled by Edge ONAP

Edge infrastructure Service Instantiation

Create Edge Infra Service instance in inventory

Decompose

Homing/Optimization

Create Edge Platform VNF Inventory Instance

Assign Edge Platform VNF network resources

Create VF Module Inventory Instance (Platform & Platform Manager)

Assign network resources for VF Module

Instantiate workload (for Platform Manager and Platform)
Operational Scenario: Sequence Diagram for Application Instantiation

PMO
OSS/BSS
Ext-API
SO
A&AI
Platform Manager (Generic Controller)
Multi-Cloud

Components in ONAP Central

Instantiate Application Request
Not Supported Currently

Instantiate Application Request
Not Supported Currently

Create Application Instance in Inventory
Allocate network resources for Application
Instantiate workload
Activate
Update Inventory

Via VIM
Configuration Request
Application

Reference: ETSI GS MEC 010-2 V1.1.1 (2017-07)
Operational Scenario: Sequence Diagram for Application Instantiation: FMO

1. End User Device
2. MEC User Application LCM Proxy
3. Ext-API
4. SO
5. A&AI
6. Platform Manager (Generic Controller)
7. Multi-Cloud
8. ONAP Edge Level

Reference ETSI GS MEC 016 V1.1.1 (2017-09)

- Query Application
- Create Application Context
- Instantiate Application Request (via OSS)
- Instantiate Application Request
- Create Application Instance in Inventory
- Allocate network resources for Application
- Instantiate workload
- Activate
- Update Inventory
- Via VIM
- Application
- Configuration Request
Summary – What we are suggesting?

• MEC recommends separation of System Level and Host Level Management
• Enable MEC functional capabilities in ONAP components – Especially System Level Management and Host Level Management as FMO
• System Level Management mapped to Edge Orchestration Component
• Enhance ONAP scope to handle Application LCM Orchestration
  - Different Categories of Applications
  - Modelling constructs to support Application Descriptors, NSD – AppD Association
  - License Management of Applications
  - Application onboarding and instantiation workflows
  - End user dynamic application instantiation capability
  - Enable Capabilities as per 3GPP 5G AF for application traffic steering
Next Steps

• Wiki pages detailing (target: Dublin)
  - Study on the impact of Application Orchestration on ONAP
  - Study on aligning ONAP with MEC Architecture

• A use case proposal for edge application orchestration through ONAP (target: Dublin)

• Study on the Control loop scenarios for Edge Deployment of Non Real-time management applications at Edge
Thanks
Deployment Models

Appliance based standalone deployment

- MEC Orchestrator + NFVO + Platform Manager + Application Lifecycle Manager
- MEC Platform
- MEC Apps
- Network Functions

Edge Cloud deployment

- MEC Host
  - Application 1
  - Application 2
  - Application 3
  - Application n
  - MEC Platform (VNF)
  - Network Functions
  - NFVI + VIM

Option 1: ONAP deployed as a standalone single node VM as part of the appliance

Option 2: ONAP deployed as a separate cluster for managing a set of MEC hosts

Scope of ONAP

Reference: ETSI MEC Presentation – link
MEC and Slice Management
### VNFD attribute vs. AppD attribute

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Reference **ETSI GR MEC 017 V1.1.1 (2018-02)**

**VNFD as per** ETSI GS NFV-IFA 011, **AppD as per** ETSI GS MEC 010-2

Additional attributes to support AppD