教育部「5G行動寬頻人才培育跨校教學聯盟計畫」
5G行動網路協定與核網技術聯盟中心

行動邊緣計算
可推廣教材模組

單元-02：邊緣計算架構與標準: ETSI MEC

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Outline

- An Introduction to ETSI MEC
- Foundation for Edge Computing
- Telco World: ETSI MEC and 5G
- MEC and NFV: A Common Approach to Management

An Introduction to ETSI MEC

ETSI ISG MEC

- ETSI ISG MEC is the leading voice in standardization & industry alignment around MEC
  - Key building block in the evolution of mobile-broadband networks, complementing NFV & SDN
  - Key enabler for IoT and mission-critical, vertical solutions
  - Widely recognized as one of the key architectural concepts and technologies for 5G
  - Can be used to enable many 5G use cases without a full 5G roll-out (i.e. with 4G networks)
  - Enable a myriad of new use cases across multiple sectors as well as innovative business opportunities

ETSI MEC: Enabling Edge through Standardization

ETSI ISG MEC

ETSI: The Standards People
We produce globally applicable standards for ICT-enabled systems, applications and services deployed across all sectors of industry and society

MEC: Multi-access Edge Computing
Cloud Computing at the Edge of the network.

ISG: Industry Specification Group
open to all of industry, regardless of ETSI membership and focused on all industry needs

Standards + **Industry Enablement +** **Telco Edge Focus**

5

Completing our 2nd 3-year Phase of work

- Key overall specification
  - Technical Requirements (MEC 002)
  - Framework and Ref. Arch. (MEC 003)
  - MEC PoC Process (MEC-IEG 005)
  - API Framework (MEC 009)
- IaaS Management APIs
  - Platform mgmt. (MEC 010-1)
  - Application mgmt. (MEC 010-2)
  - Device-triggered LCM operations (MEC 016)
- PaaS Service Exposure
  - Required Platform Svcs / App. Enablement (MEC 011)
  - Service APIs (MEC 012, 013, 014, 015)
- Key Studies for Future Work
  - Study on MEC in NFV (MEC 017)
  - Study on Mobility Support (MEC 018)

- Evolution of Phase 1 and closing open items
  - Application Mobility (MEC 021)
  - Lawful Intercept (MEC 026 - published)
- Addressing key Industry Segments
  - V2X (MEC 022 - published, MEC 030)
  - IoT (MEC 033), Industrial Automation, VR/AR
- Key use-cases and new requirement
  - Network Slicing (MEC 024)
  - Container Support (MEC 027)
- Normative work for integration with NFV
  - Incorporate in v2 of existing specs as needed
- From "Mobile" to "Multi-Access"
  - Wi-Fi (MEC 028)
  - Fixed Access (MEC 029)
- MEC integration in 5G networks (MEC 031)
- Developer community engagement
  - API publication through ETSI Forge (more overleaf)
  - Hackathons
- Testing and Compliance (MEC 025 - published, MEC 032)

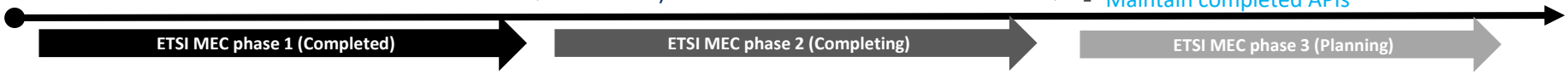
- Preliminary activities starting now.
- Full work planned to start late 2020

- MEC as heterogeneous clouds
  - Expanding traditional cloud and NFV LCM approaches
  - Inter-MEC systems and MEC-Cloud systems coordination (MEC 035)
  - Mobile or intermittently connected components
  - Consumer-owned cloud resources

- Continuing emphasis on enabling developers
  - API Serialization
  - Sandbox development
  - Testing and compliance

- Continue to defined services that meet industry demand

- Maintain completed APIs



2014 ~ 2017

2017 ~ 2020

2020 ~

ETSI MEC Phase 1 (2014 ~ 2017)

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ETSI MEC Phase 3 (2020 ~)

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- Full work planned to start late 2020

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ETSI MEC Phase 3 (2020 ~)

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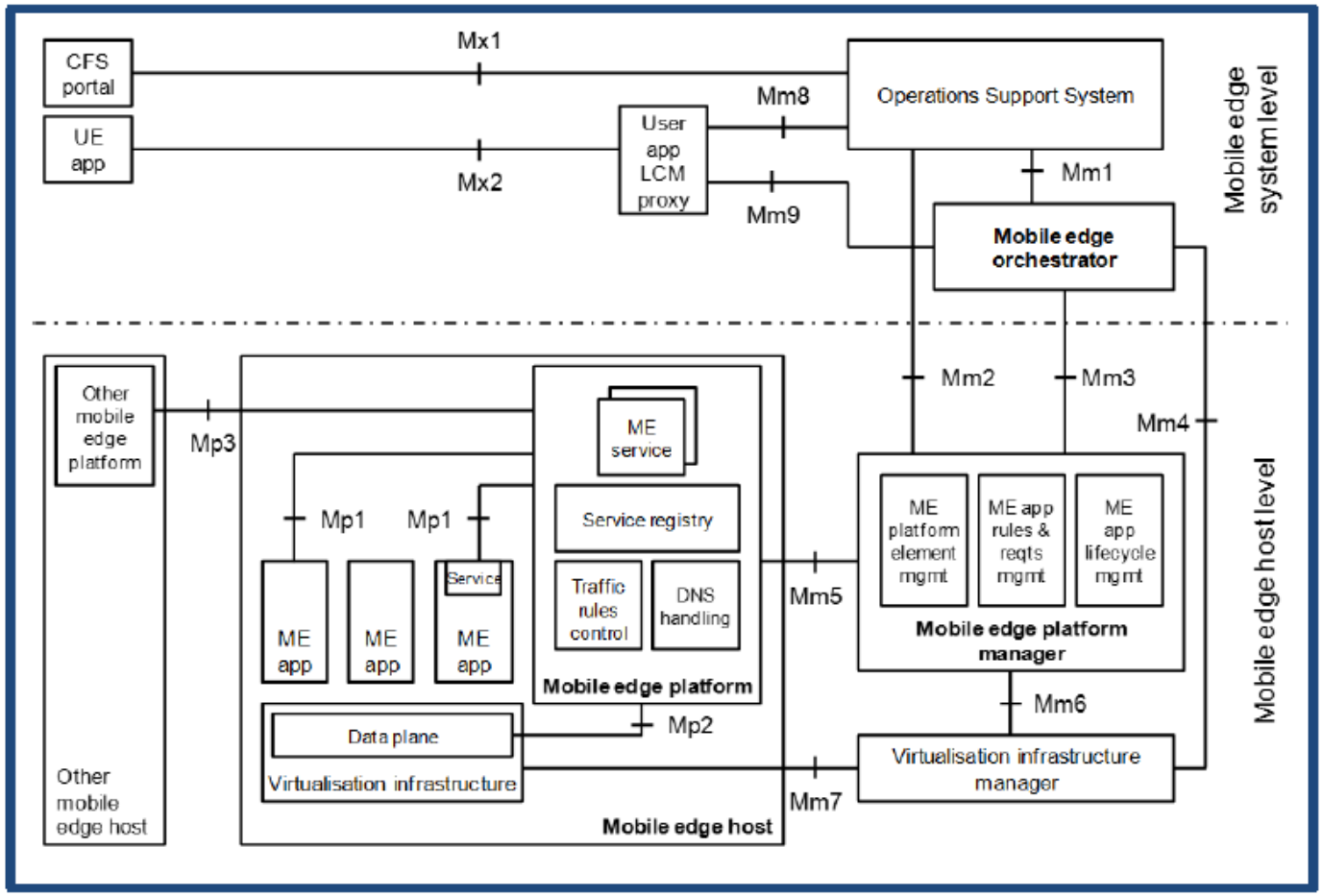
- Continue to defined services that meet industry demand
- Maintain completed APIs

Foundation for Edge Computing

MEC Reference Architecture



Application Enablement and Framework

Service definition framework and baseline platform services authorized applications.

- Registration, discovery and notification;
- Methodology for authentication and authorization of apps providing/consuming services;
- Communication support for services (query/response and notifications).

API Principles

Principles and guidance for developing and documenting APIs

- Developer-friendly approach to foster development
- ***Ensures that a consistent set of APIs*** are used by developers.
- Defines approach for authentication and authorization of apps providing/consuming services
- Based on TMF and OMA best practices

Specific Service-Related APIs

Standardized service-exposure APIs for key services that

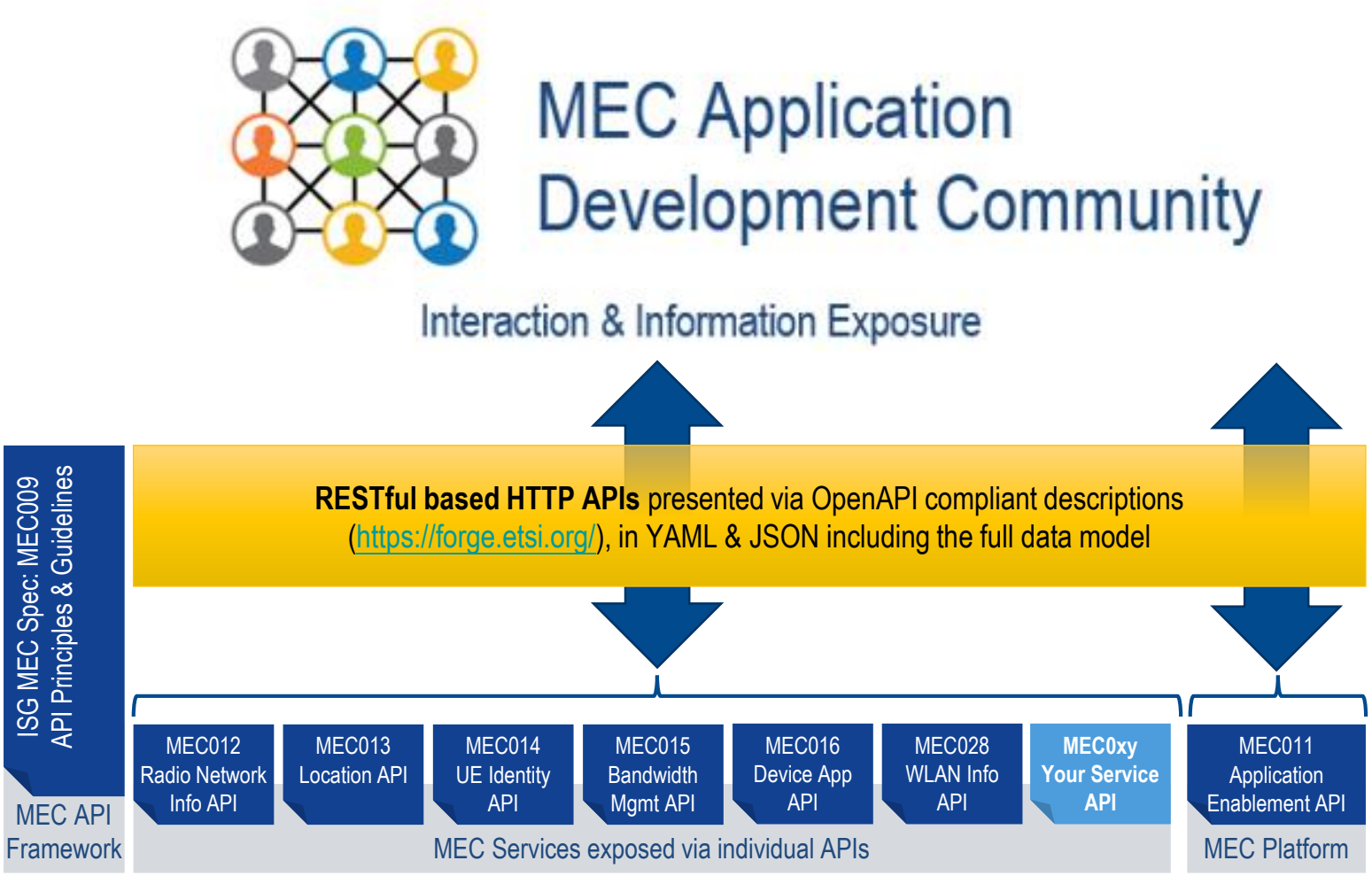
- Expose network and context information
- Allow definition of localized, contextual services
- Support key use cases (e.g. enterprise, vehicular)
- Allow fine-grained edge traffic management

Management and Orchestration Related APIs

Management of MEC hosts either as ***stand-alone*** entities or part of a larger ***NFV-managed*** framework

- Facilitate running of 3rd party application
- Enable deployment ***at the correct location at the right time***, based on technical and business parameters
- Integrate into telco operations systems, e.g. OSS

Global Application Portability



Global Application Portability

- ✓ Simple to use, well documented APIs, published with OpenAPI Framework
- ✓ Create innovative applications quickly and easily, reducing time-to-revenue
- ✓ New APIs (compliant with the MEC API principles) can be added
- ✓ Increase the Total Addressable Market (TAM)

MEC and Management: The Killer Use Case for Automation

MEC deployments present challenging environment

- (large scale: geography) x (small scale: cloud footprint)
- Unmanned/lights out location
- Outside traditional service areas

While supporting “critical infrastructure”

- Telco, public safety, etc.
- “9’s” of availability requirements

MEC and Management

Unique requirements and processes

- Minimize need for human presence
- Maximize service time intervals
- Minimize skills required from those on site

In other words

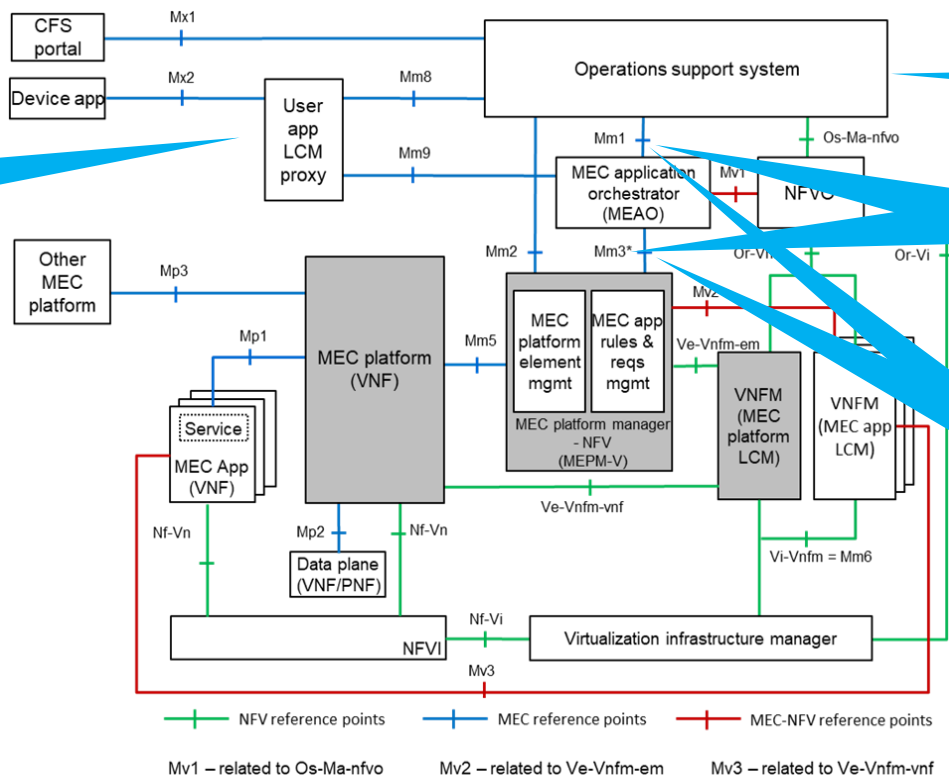
- Get as close as possible to the web-scale maintenance model
- In a very non-web-scale environment

MEC Deployment

- ETSI White Papers address the MEC deployment aspects:
  - WP#23: Cloud RAN and MEC: A Perfect Pairing
  - WP#24: MEC Deployments in 4G and Evolution Towards 5G
  - WP#28: MEC in 5G networks
  - WP#30: MEC in an Enterprise Setting: A Solution Outline
- Standards are necessarily tools, not solutions
  - Enable interoperability
  - Support a broad range of use cases and system architecture
  - Address only a specific part of the whole picture

All white papers are available in https://portal.etsi.org/TBSiteMap/MEC/MECWhitePapers.aspx

A key part of ETSI Network Automation Standards



Inter-MEC & MEC-Cloud (MEC 035 Study)

Device-triggered LCM Enablement (MEC 16)

Management of MEP as a VNF (MEC 10-1)

LCM Mgmt of 3rd party Apps (MEC 10-2)

ZSM: overall approach | NFV, OSM: managing telco clouds | MEC: managing edge telco clouds

MEC Proof of Concepts (PoCs)

- Recent examples:

MEC Deployment Trial (MDT): MEC in action in Live Networks

- Next step from MEC PoC to keep engaging the ecosystem in MEC standards based deployments
  - From Proof of Concept to proof of viability in a Live Network environment
  - Follows the proven MEC PoC framework with a new set of acceptance criteria

1. Trial deployed in Live Network
2. Demonstrated to the industry, e.g. in an industry event or in ISG MEC
3. Feedback to MEC standardization; improvement proposals, lessons learnt, next steps

Active MEC Deployment Trials

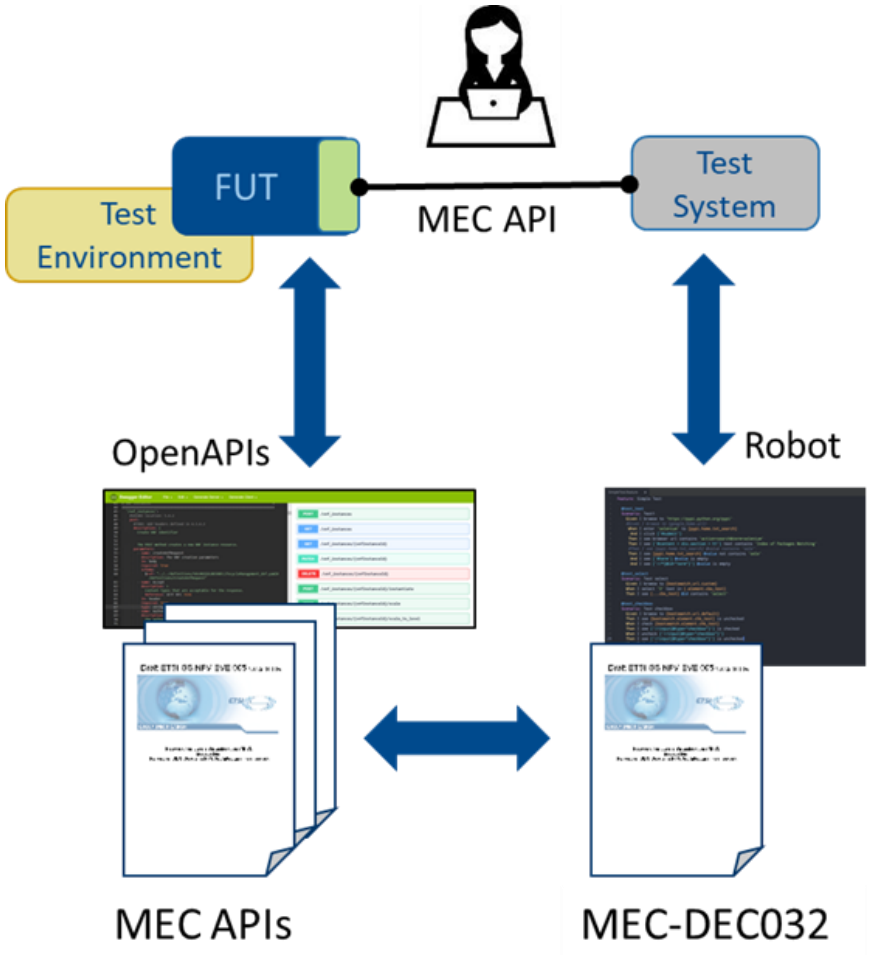
http://mecwiki.etsi.org

MEC Testing and Conformance

- API conformance test specifications critical to validate the standard
- Executable test suites serve developer communities and industry in enabling API implementation conformance testing
- Specifications key input to the ongoing ETSI NFV/MEC Plugtest™

"Test once, use anywhere"

MEC Testing and Conformance



MEC-0032:
MEC API Conformance Test Specifications

MEC Testing and Conformance

MEC-0025: Testing Framework

Compliancy
Test Cases

The foundation, providing the testing methodology guidelines & framework

MEC-0032:
MEC API Conformance Test Specifications

Part 1: Test requirements and Implementation Conformance Statement (ICS)

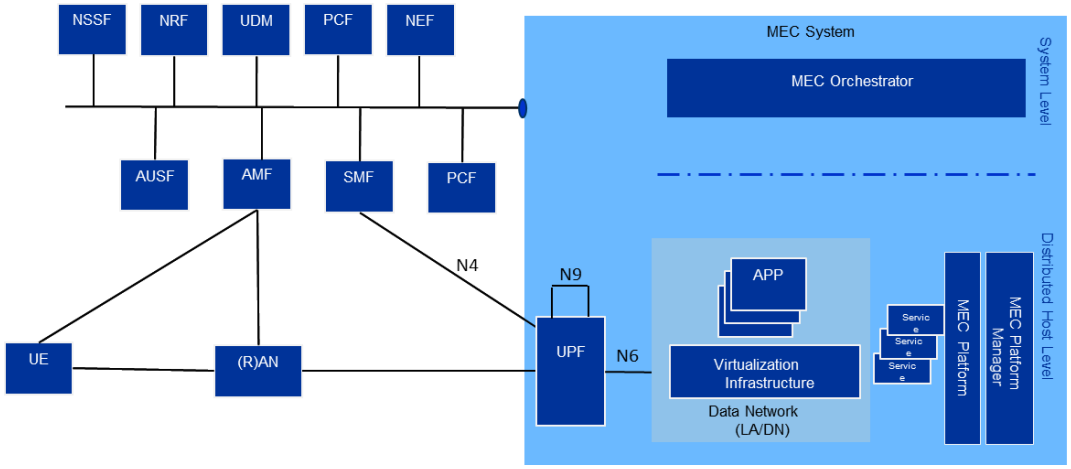
Part 2: Test Suite Structure (TSS) and Test Purposes (TPs) using the standardized notation

Part 3: Abstract Test Suite (ATS) written in a machine-readable specification languages TTCN-3 & Robot (ETSI Forge hosted)

Telco World:
ETSI MEC and 5G

MEC Phase 2 – Study Item MEC in 5G (MEC 031)

- The scope includes the following
  1. C-plane interactions with 5GC,
  2. Functional split between MEC and 5GC wrt. API framework,
  3. Organization of MEC as an AF,
  4. Pertinent interactions of MEC with (R)AN



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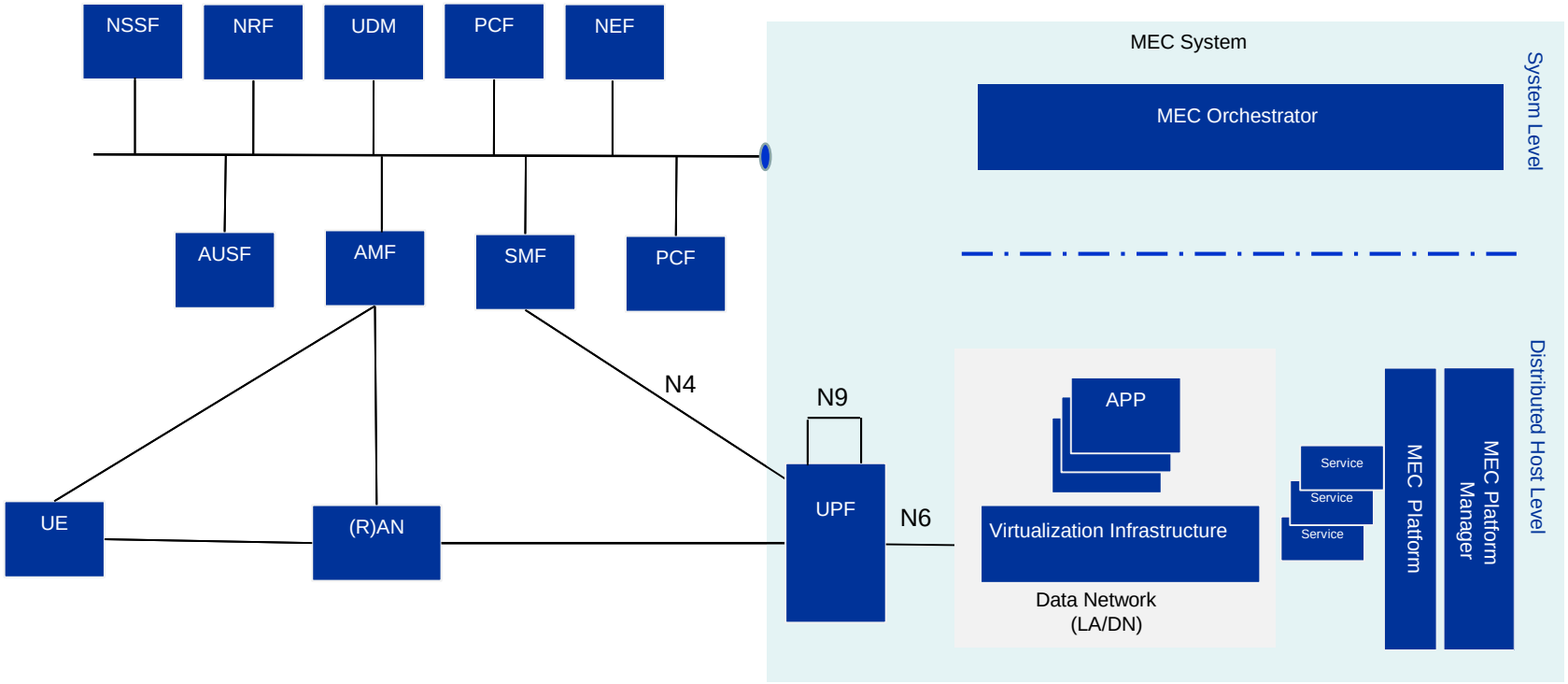
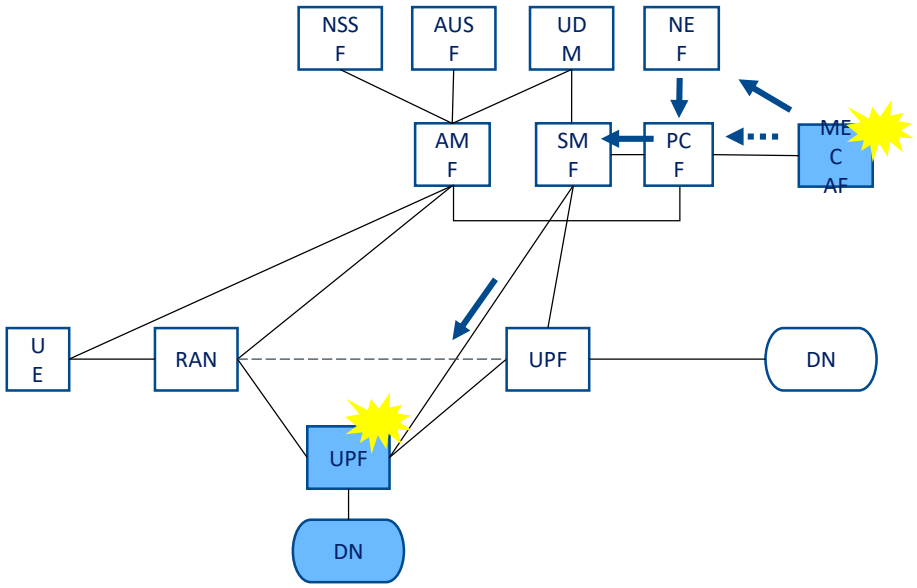


3GPP enablers for MEC – Selection & re-location of UPF



Selection & re-location of UPF

AF influence on traffic routing

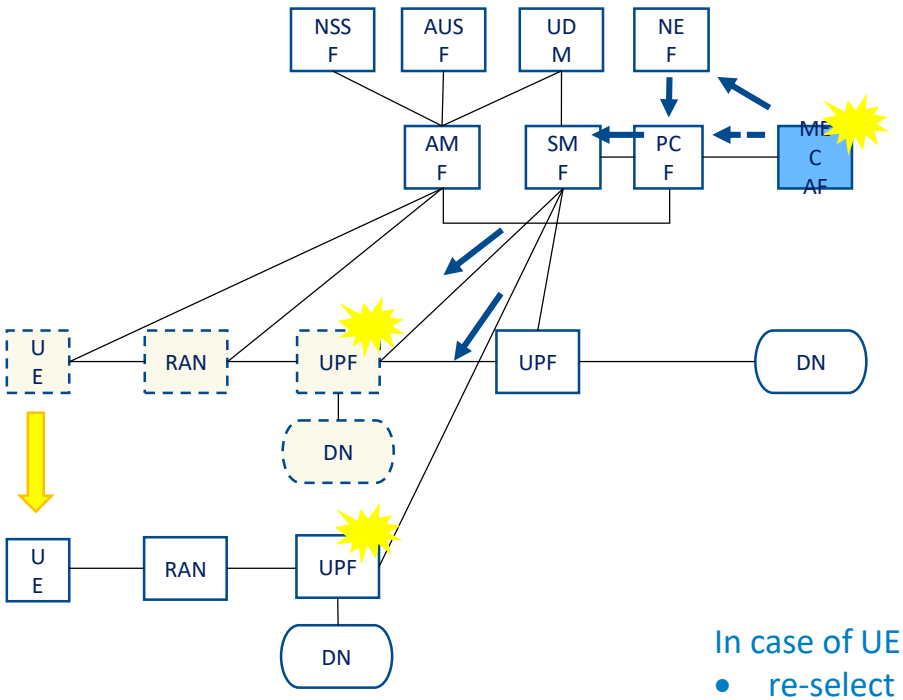
Mobility event notifications from SMF

Concurrent access to local and central DN

MEC as an AF (Application Function) can request the 5GC to

- Select a local UPF near the target (R)AN node
- use the local UPF for PDU sessions of the target UE(s)
- control the traffic forwarding from the local UPF so that the UL traffic matching with the traffic filters received from MEC (AF) is diverted towards MEC hosts while other traffic is sent to the Central Cloud

3GPP enablers for MEC – Selection & re-location of UPF

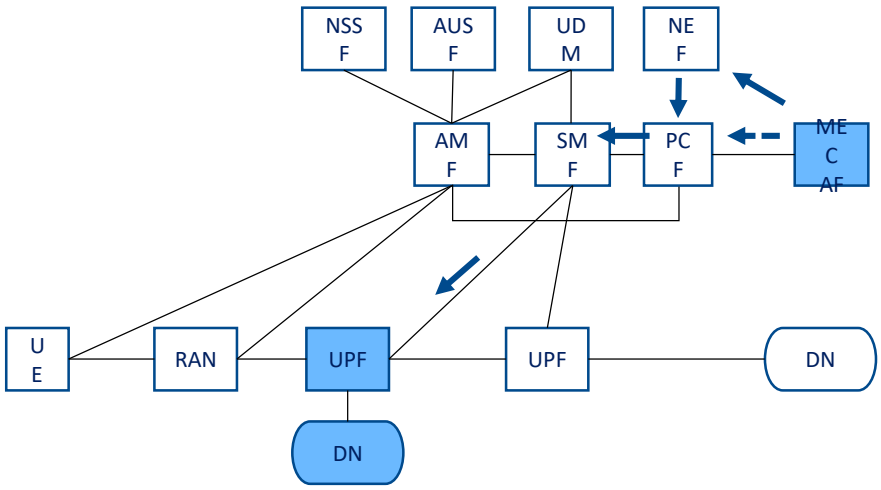


- **Selection & re-location of UPF**
- AF influence on traffic routing
- Mobility event notifications from SMF
- Concurrent access to local and central DN

In case of UE mobility, the 5GC can

- re-select a new local UPF more suitable to handle application traffic identified by MEC (AF)
- notify the AF about the new serving UPF

3GPP enablers for MEC – AF influence on traffic routing



Selection & re-location of UPF

AF influence on traffic routing

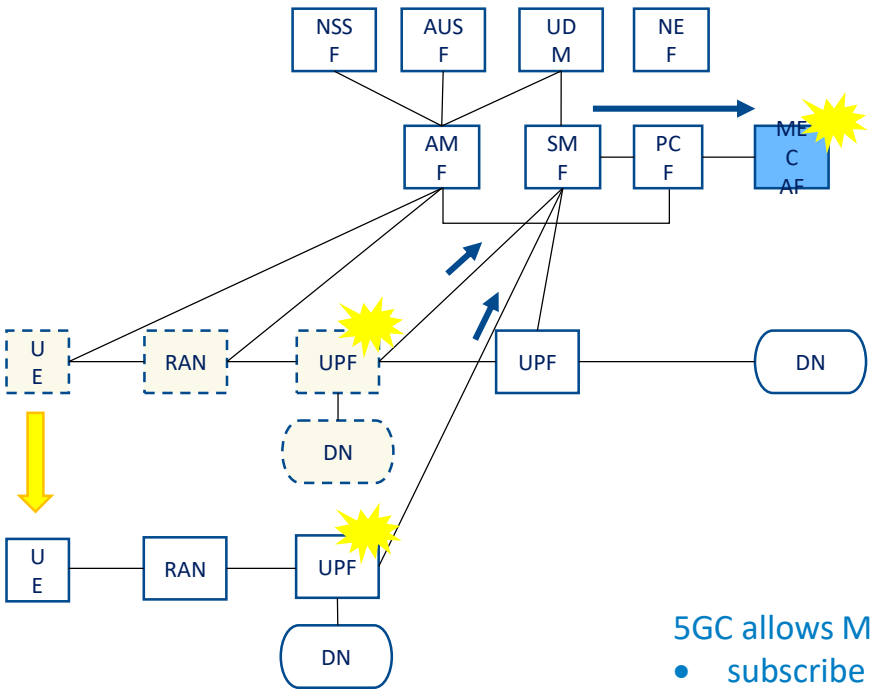
Mobility event notifications from SMF

Concurrent access to local and central DN

MEC as an AF can provide the following to 5GC

- traffic filters identifying MEC applications deployed locally on MEC hosts in Edge Cloud
- the target UEs (one UE identified by its IP/MAC address, a group of UE, any UE)
- information about forwarding the identified traffic further e.g. references to tunnels towards MEC hosts

3GPP enablers for MEC – Mobility event notifications



Selection & re-location of UPF

AF influence on traffic routing

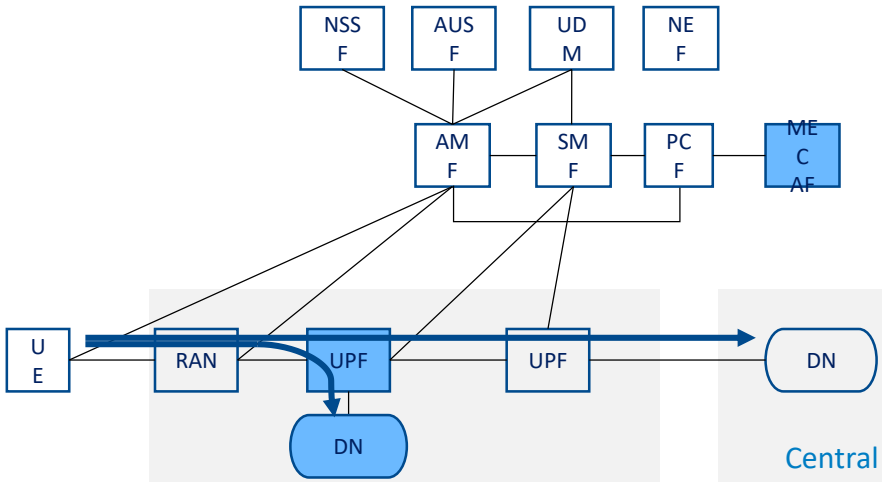
Mobility event notifications from SMF

Concurrent access to local and central DN

5GC allows MEC as an AF

- subscribe to UE mobility events that may affect traffic forwarding to MEC applications
- Receive notifications of UE mobility events affecting MEC application instances

3GPP enablers for MEC - Concurrent access to local and central DN



Edge Cloud for Ultra-low latency, high reliability services

Central Cloud
a.k.a. Conventional “internet”

- Selection & re-location of UPF
- AF influence on traffic routing
- Mobility event notifications from SMF
- **Concurrent access to local and central DN**

Same UP session allows the UE to obtain content both from local server and central server

Service continuity enabled by IP address anchoring at the centralized UPF.
No impact on UE in case of Uplink Classifier (ULCL) option is used.

MEC and NFV:
A Common Approach to Management

Relationship to NFV

Complementary concepts which can exist independently

- Focused on porting network functions to virtual environments
- Enables the migration from a proprietary appliance-based setup to a standard, hardware and cloud-based infrastructure
- Virtual functions can be connected or chained together to create communication services.

RAN Virtualization

- Focused on creating an open environment in the RAN, allowing 3rd-party application/service integration (application-level enablers and APIs)
- Creates a new value chain and an energized ecosystem, based on innovation and business value
- Enables a myriad of new use cases across multiple sectors

MEC

- MEC reuses the NFV virtualization infrastructure and the NFV infrastructure management to the largest extent possible.
- The scope of MEC is focused and its business objective differs from that of NFV.

Notes

Mobile Edge Computing: Framework

- MEC utilizes the NFV infrastructure.

  The NFV infrastructure may be dedicated to MEC or shared with other network functions or applications.

- MEC uses (as far as possible) the NFV infrastructure management entity.

NFV

MEC is fully compliant with the 3GPP architecture

- MEC uses existing 3GPP functional elements and reference points.

3GPP

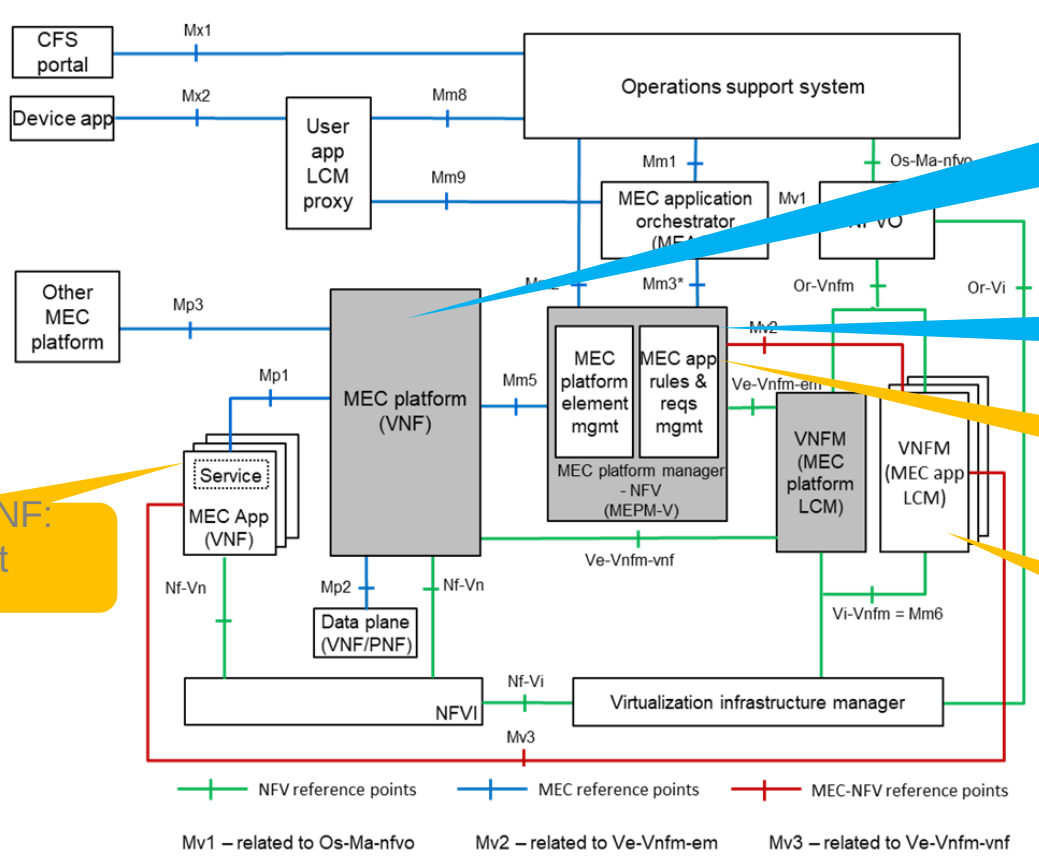
Third-party applications can be intelligently and flexibly deployed in a seamless manner on different MEC platforms (based on technical and business parameters).

Orchestration

MEC supports multiple deployment scenarios, including at a multi-Radio Access Technology (RAT) cell aggregation site, at an aggregation point, at the cloud RAN and at the edge of the core network.

Deployment scenarios

MEC and NFV: MANO for the Telco Edge



MEP as a VNF: must be running for any other VNF/app to run

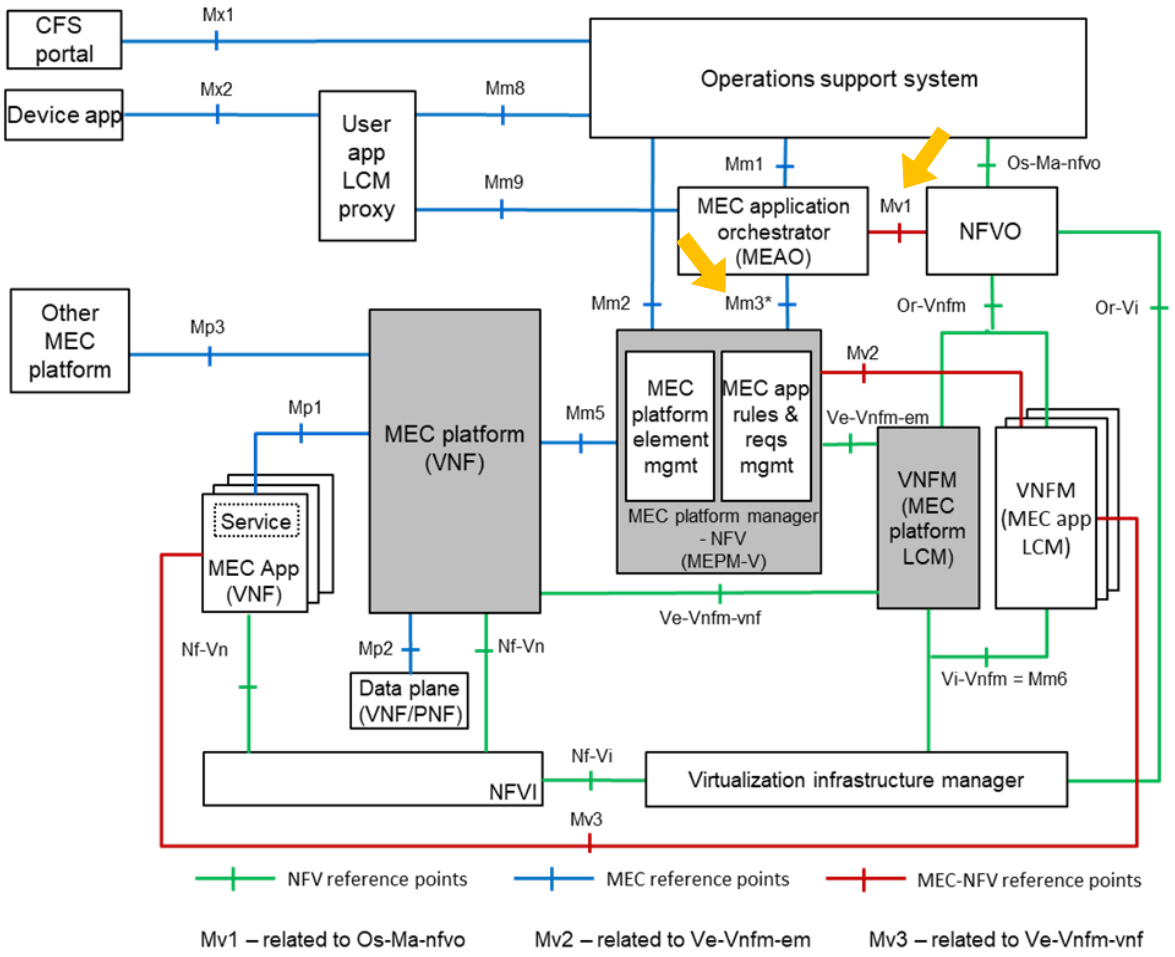
MEPM: EMS for MEP

MEPM is (part of) App's EMS

MEPM can be App's VNFM

App can be a VNF: even if it doesn't know it

MEC management: MEC-specific Operations (1/2)



MEC management: MEC-specific Operations (2/2)

Mm1 required APIs:

- Application Package Management
- Application Lifecycle Management

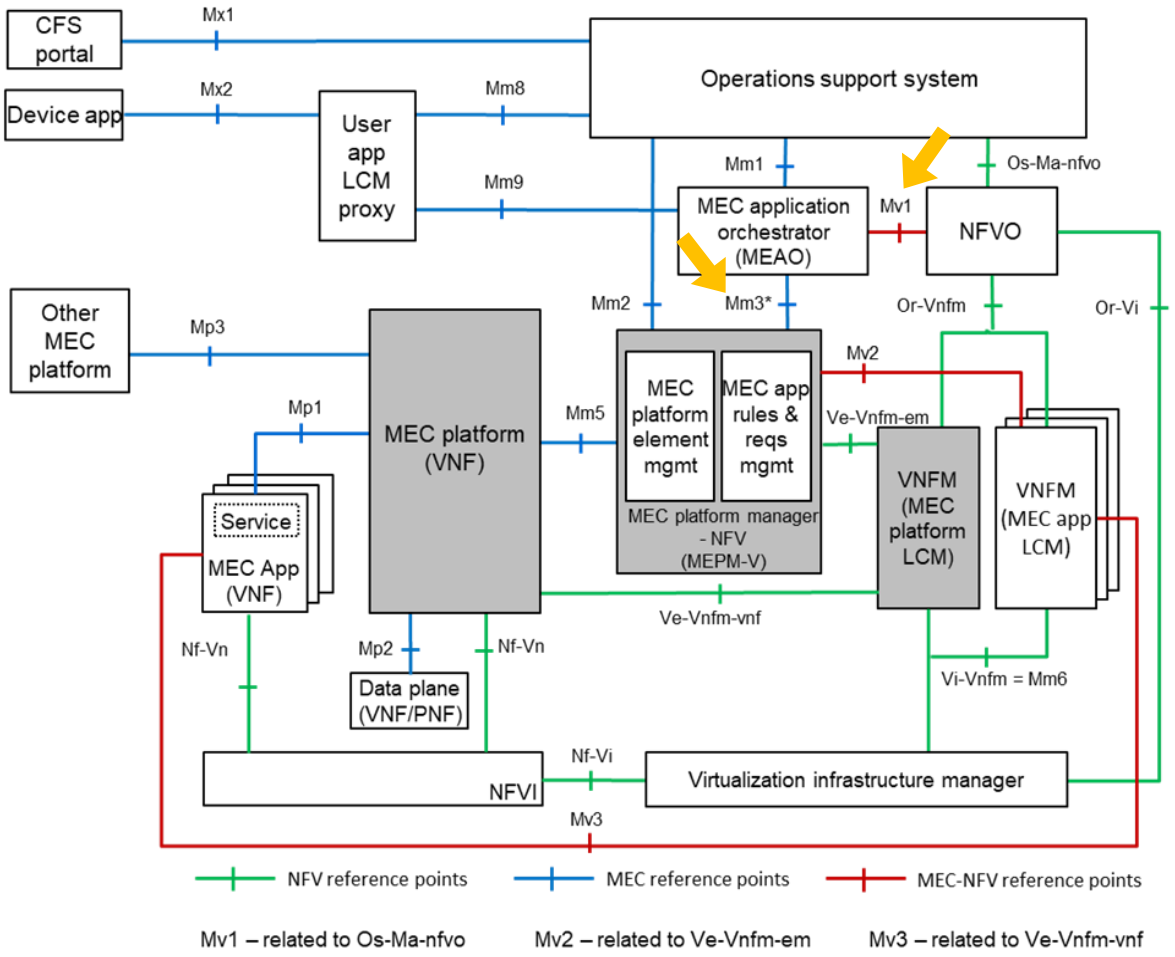
Mm3 required APIs:

- Application Package Management
- Application Lifecycle Management
- Application Lifecycle Change Notification

These NFV semi-agnostic

- Information models designed to be feasible without NFV
- Data models are NFV-consistent and compatible

MEC management: MEC-NFV Interaction (1/2)



MEC management: MEC-NFV Interaction (2/2)

Three “Hybrid” Reference points identified as shown

- Mv3: at this point no specific changes to Ve-Vnfm-vnf are expected (i.e. it can be used as is)
- Mv2: Necessary changes are being addressed by NFV IFA as part of FEAT12 work (MECinNFV)
- Mv1: work identified, coordination plan is on-going

MEC descriptor (AppD) must be linked to NFV descriptor (VNFD).

- This has been addressed as part of Rel 3 work using Non-MANO artifact capability as defined in Annex B of ETSI GS NFV-SOL 004 v. 2.5.1 and higher.

Conclusion

- Mobile Edge Computing complements SDN and NFV and advances the transformation of the mobile-broadband network into a programmable world, ensuring
  - highly efficient network operation and service delivery,
  - ultimate personal experience, and
  - new business opportunities.
- Mobile Edge Computing is
  - a key enabler for IoT and mission-critical, vertical solutions
  - one of the key architectural concepts and technologies for 5G
    - helping to satisfy the demanding requirements for the 5G era in terms of expected throughput, latency, scalability and automation.
  - offers additional privacy and security and ensures significant cost savings
- Many of the use cases can be enabled with Mobile Edge Computing prior to 5G.

Discussions