

# 5G 모바일 엣지 컴퓨팅 (MEC) 기술 표준

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# 목차

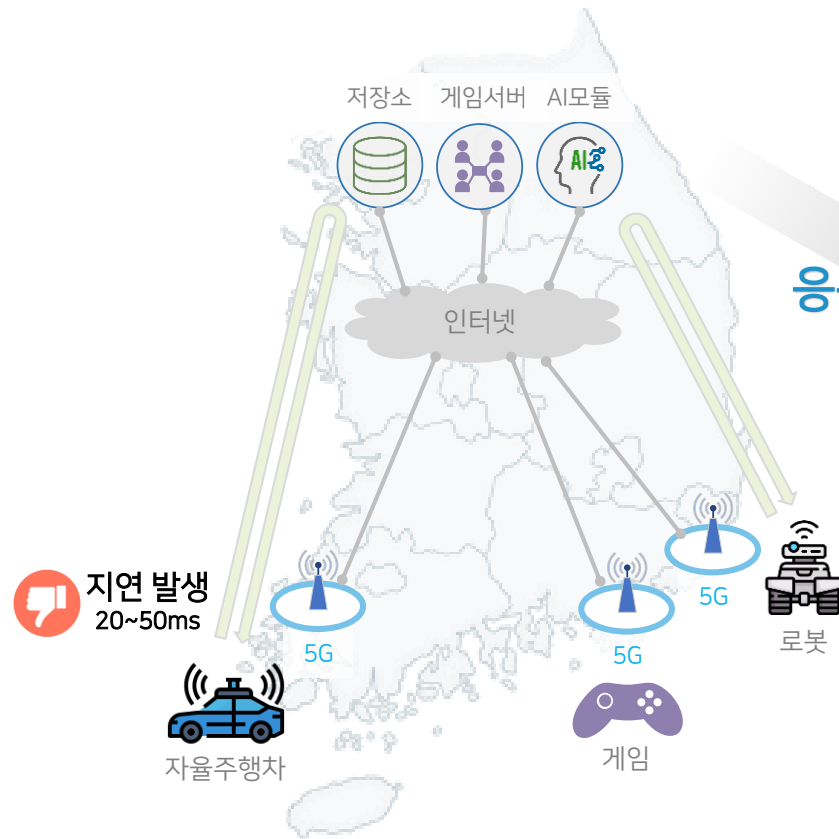
- 5G MEC 표준화 현황
- 3GPP 5G MEC 표준: 응용 지원
- 3GPP 5G MEC 표준: 네트워크 지원
- 향후 전망

# 5G MEC 표준화 현황

기술 개요, 표준 현황 요약

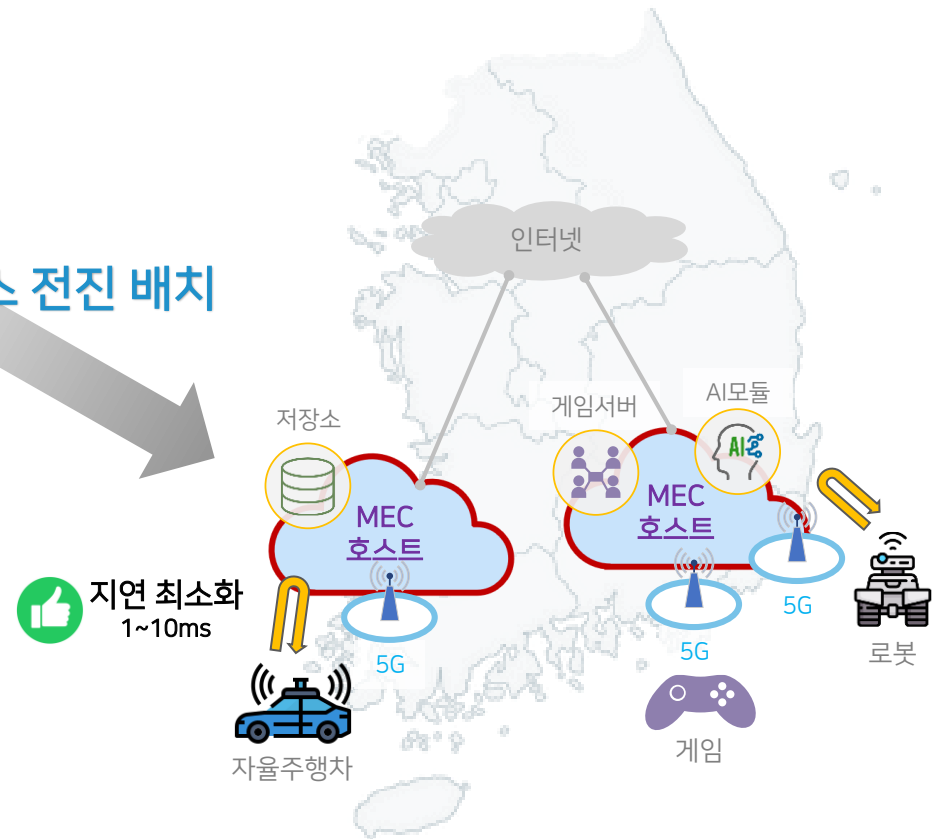
# 5G MEC 기술 개요

일반 5G

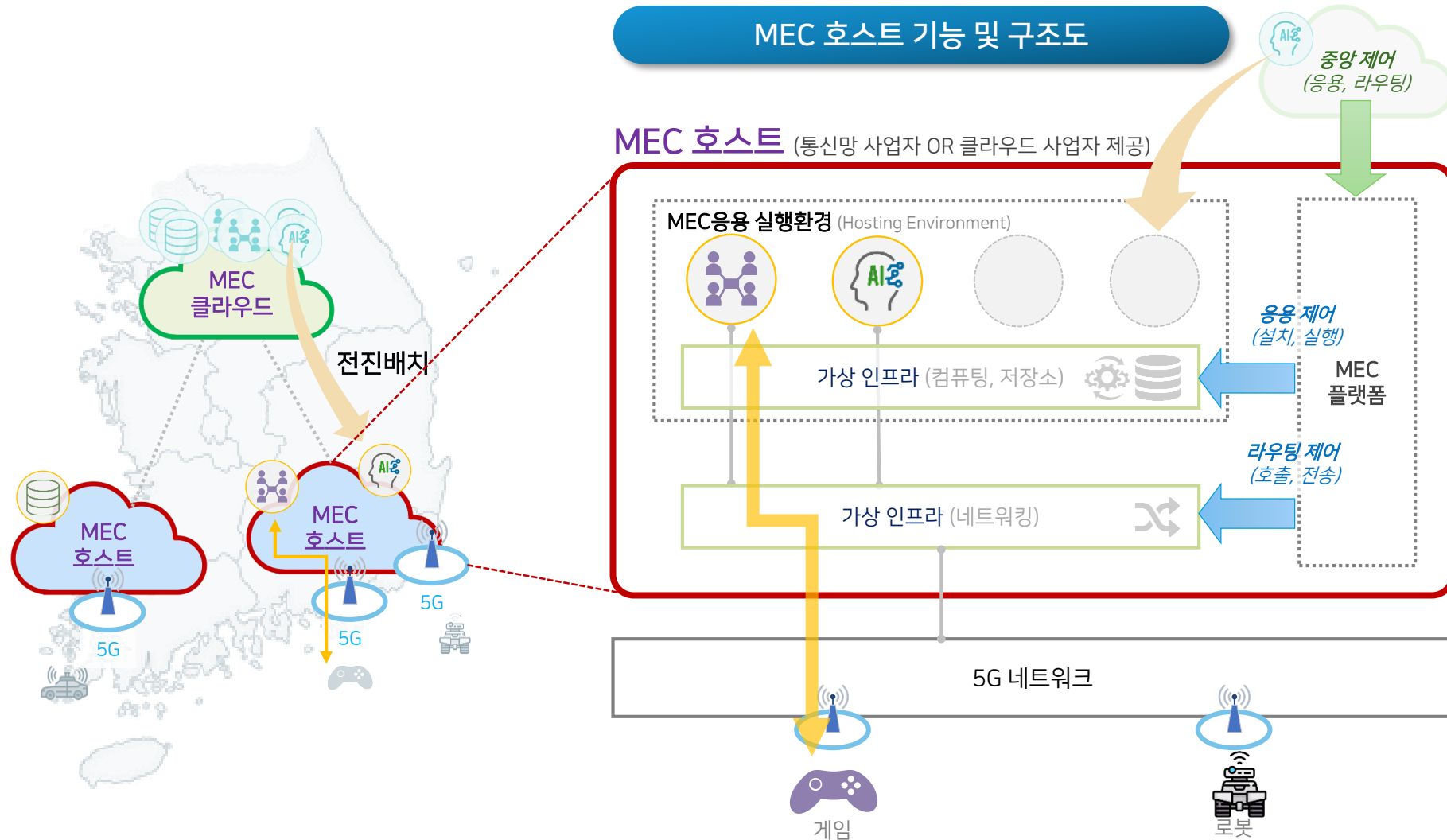


응용·서비스 전진 배치

5G + MEC

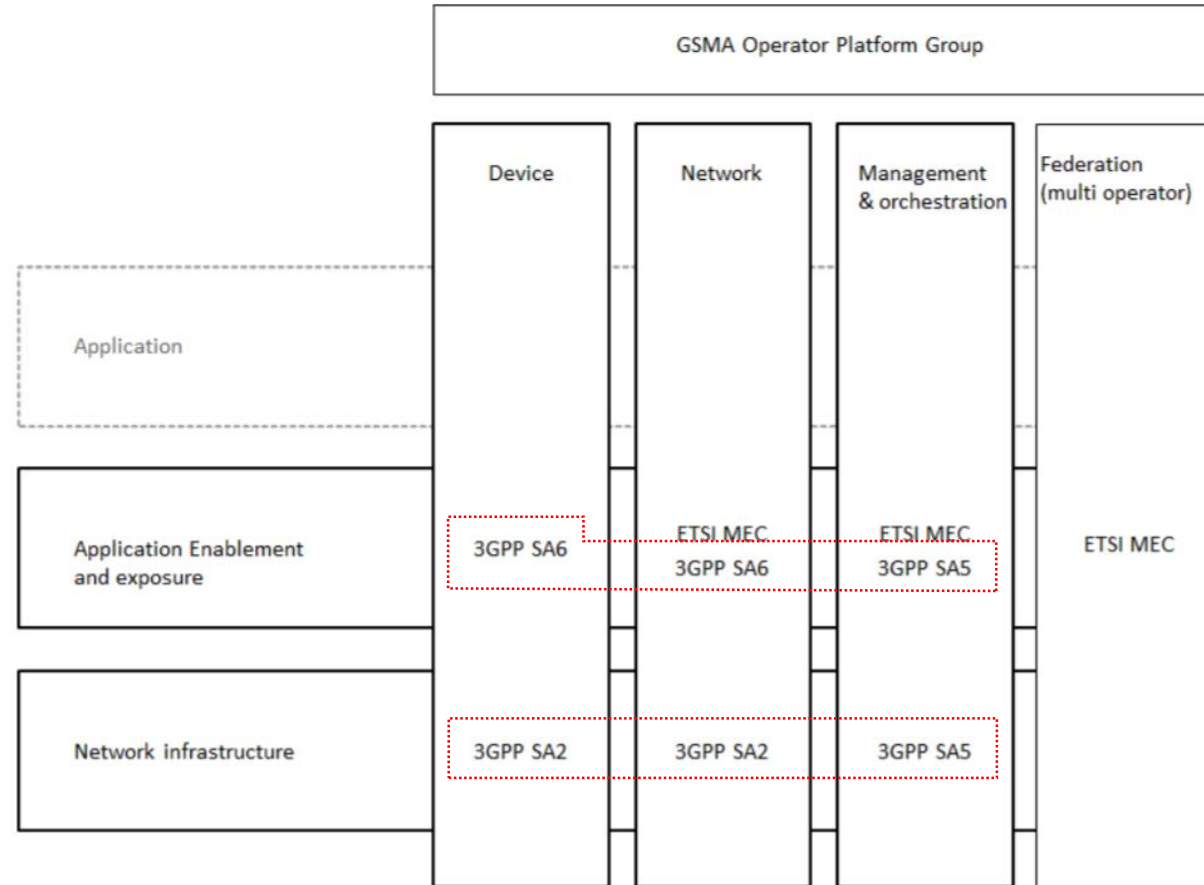


# 5G MEC 기술 개요



# 5G MEC 표준화 현황

- Standardization Issues
  - MEC deployment scenarios
  - Traffic steering
  - MEC Platform
  - Management & orchestration
  - Charging
  - UE and application mobility
  - Capability exposure
  - UE application interface
- Relevant SDOs
  - ETSI ISG MEC
  - 3GPP SA6, SA2, SA5
  - ITU-T SG11, SG13
  - (others) GSMA, 5GAA



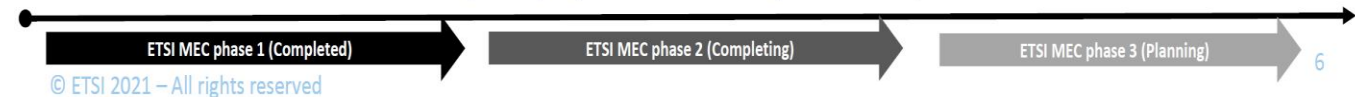
ETSI White Paper #36, "Harmonizing standards for edge computing," July 2020

# 5G MEC 표준화 현황: ETSI ISG MEC

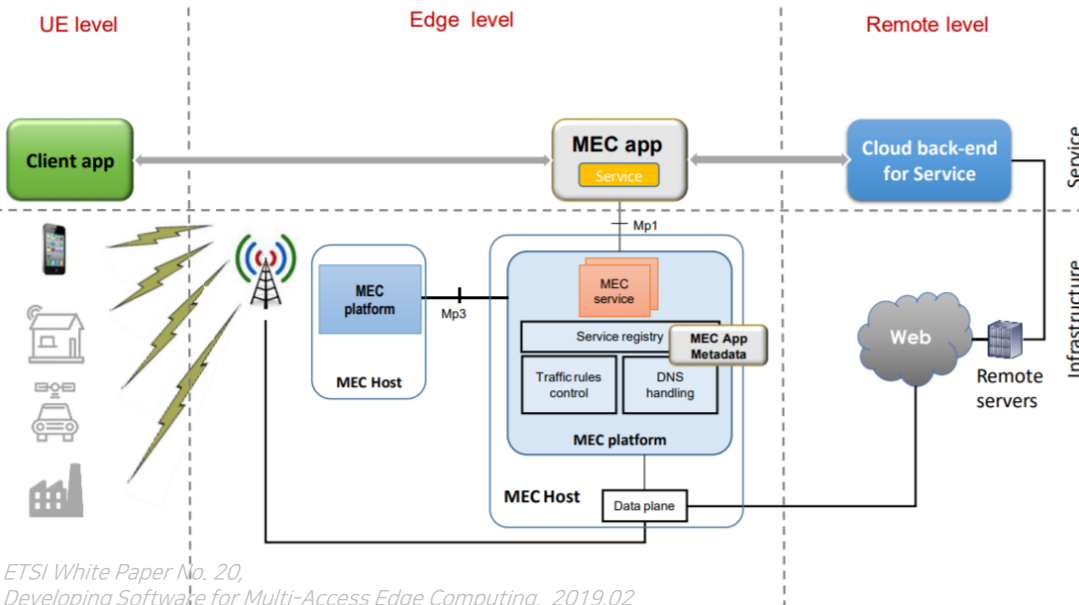
ETSI ISG MEC, ETSI MEC: An Introduction, 2021.04

- Basic principles
  - offers to application developers and content providers cloud-computing capabilities and an IT service environment at the edge of the network
  - Telco edge, access-agnostic, open standard, NFV,

- 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 – published)
  - Lawful Intercept (MEC 026 – published)
- Addressing key Industry Segments
  - V2X (MEC 022 – published; MEC 030 – published)
  - IoT (MEC 033), Industrial Automation, VR/AR
- Key use-cases and new requirement
  - Network Slicing (MEC 024 – published)
  - Container Support (MEC 027 – published)
- Normative work for integration with NFV
  - Incorporate in v2 of existing specs as needed
- From “Mobile” to “Multi-Access”
  - Wi-Fi (MEC 028 – published)
  - Fixed Access (MEC 029 – published)
- MEC integration in 5G networks (MEC 031)
- Developer community engagement
  - API publication through ETSI Forge (more overleaf)
  - Hackathons, MEC Deployment Trials
- Testing and Compliance (MEC-DEC 025 – published; multipart specification MEC-DEC 032-x)
- Preliminary activities starting now.
  - Full Phase 3 work started already, while completing outstanding Phase 2 work.
- MEC as heterogeneous clouds
  - Expanding traditional cloud and NFV LCM approaches
  - Inter-MEC systems and MEC-Cloud systems coordination (MEC 035): “MEC Federation”
  - Mobile or intermittently connected components, and resource constrained devices (MEC 036)
  - Consumer-owned cloud resources
- MEC deployments
  - MEC in Park enterprises (MEC 038)
- Continuing emphasis on enabling developers
  - Application Package Format and Descriptor Specification (MEC 037)
  - API Serialization
  - Sandbox development
  - Testing and compliance
- Continue to defined services that meet industry demand
- Maintain completed APIs



< Standardization phases of ETSI ISG MEC >



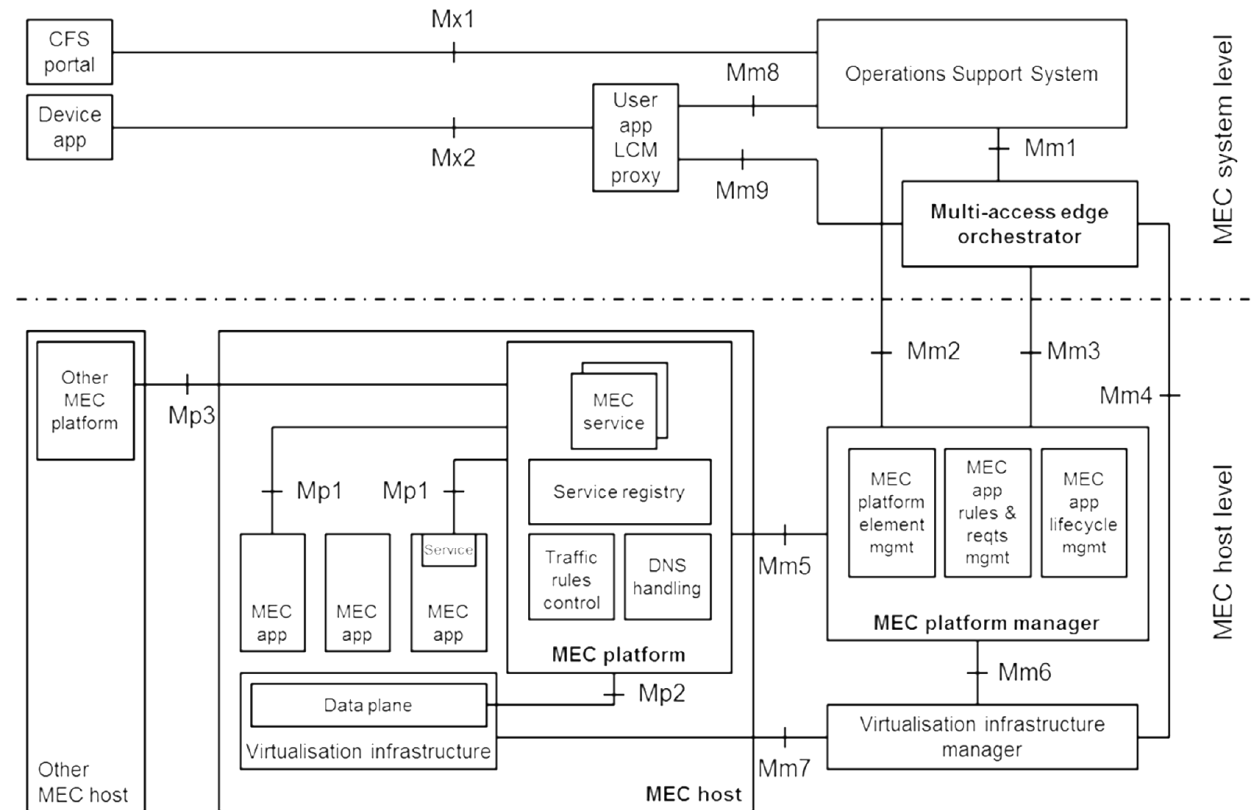
ETSI White Paper No. 20,  
Developing Software for Multi-Access Edge Computing, 2019.02

< MEC-based application development paradigm >

# 5G MEC 표준화 현황: ETSI ISG MEC

- ETSI ISC MEC standardization scope
  - Application Enablement and Framework
    - Use Cases and Requirements
    - Framework and Reference Architecture
    - Application Enablement API
  - API Principles
  - Specific service-related APIs
    - Radio Network Information API
    - Location API
    - UE Identity API
    - Bandwidth Management API
  - Management and Orchestration related APIs
    - Inter-MEC & MEC-Cloud
    - Lifecycle management of MEC Apps
    - MEP management w/ NFV

ETSI GS MEC 003 (v2.2.1), Multi-access Edge Computing (MEC); Framework and Reference Architecture, 2020.12



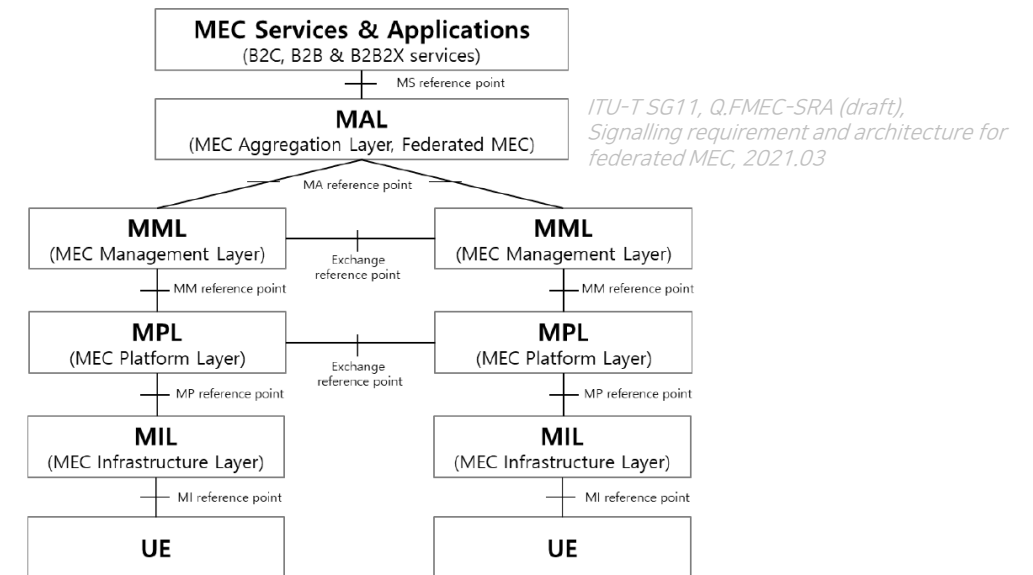
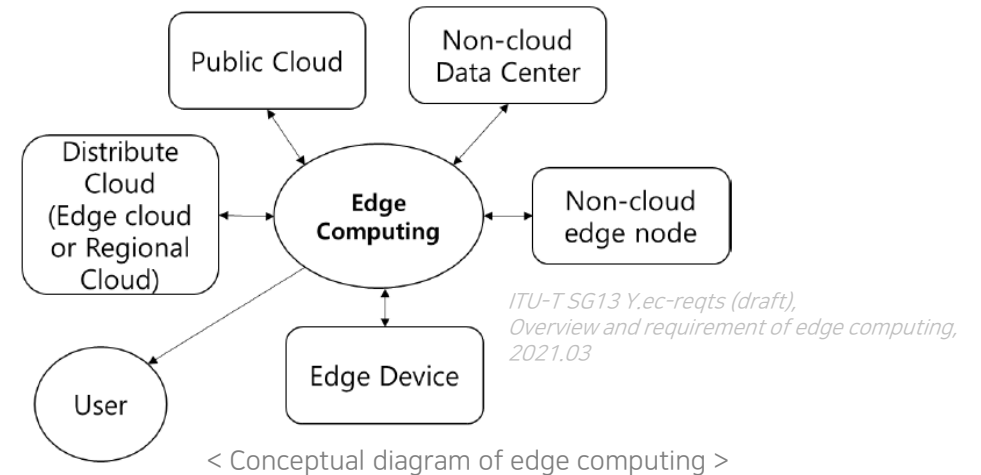
< ETSI ISG MEC system reference architecture >



# 5G MEC 표준화 현황: ITU-T

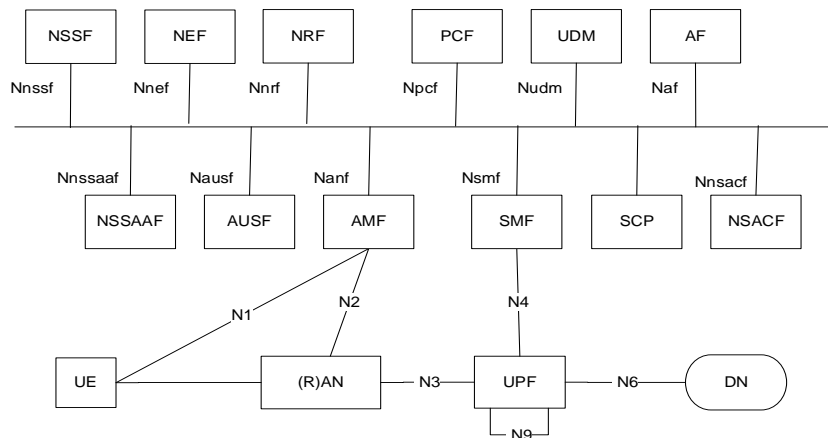
- ITU-T standardization scope
  - framework, use cases, requirements of edge computing
  - complement to cloud computing, MEC for IMT-2020, capability exposure, local traffic routing, MEC federation

Work Item	Questions	Subject/Title	Timing
Y.IMT2020-CAN-reqts	Q17/13 (WP2)	Functional requirements of computing-aware networking	'22-Q2
Y.ec-reqts	Q17/13 (WP2)	Overview and requirement of edge computing	'22-12
Y.IMT2020-CEFEC	Q20/13 (WP1)	Framework of capability exposure function in edge computing for IMT-2020 networks and beyond	'22-Q3
Y.LSMEC	Q21/13 (WP1)	Local shunting for multi-access edge computing in IMT-2020 networks	'21-12
Y.FMSC-MEC	Q23/13 (WP1)	Multi-access Edge Computing for fixed, mobile and satellite convergence in IMT-2020 networks and beyond	'22-Q3
Y.FMC-AAEC-req	Q23/13 (WP1)	Use cases and Technical requirements for supporting application addressing in edge computing for future networks including IMT-2020 network	'21-Q4
Y.FMC-EC	Q23/13 (WP1)	Unified edge computing for supporting fixed mobile convergence in IMT-2020 networks	'21-Q3
Q.FMEC-SRA	Q7/11 (WP2)	Signalling requirement and architecture for federated MEC	'21-12



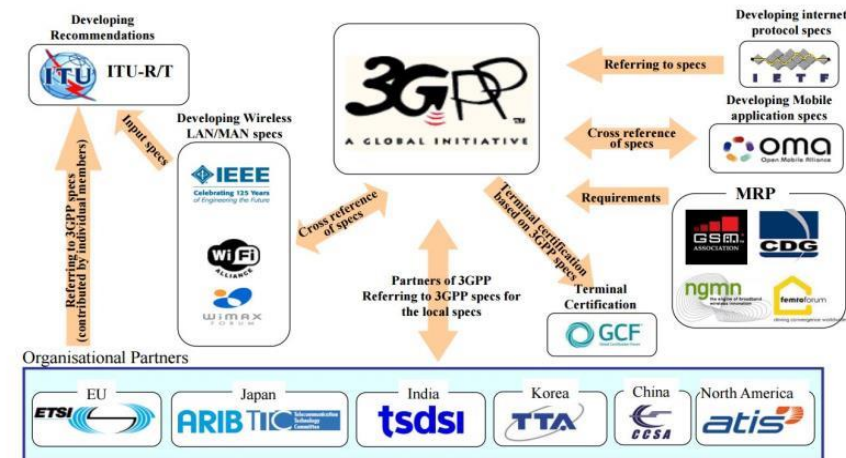
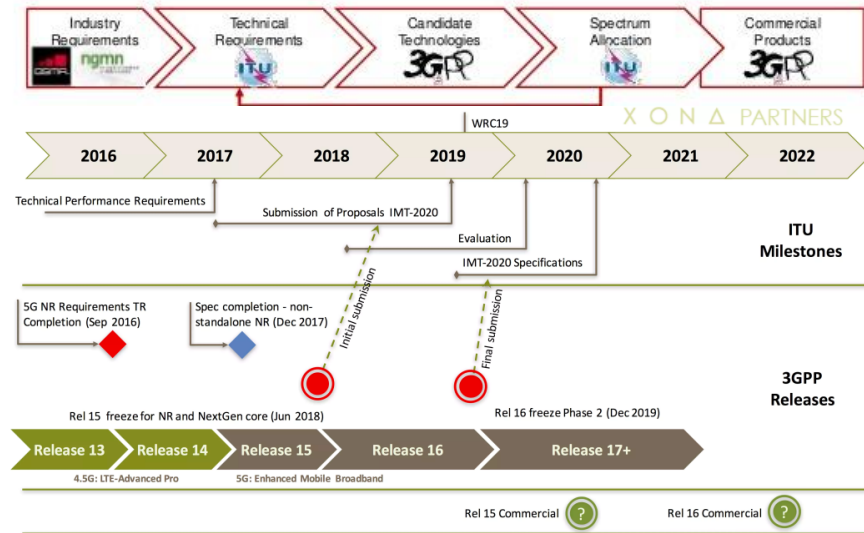
# 5G MEC 표준화 현황: 3GPP

- Design principle of new 5G system (Rel-15~)
  - Separation of UP and CP functions
  - Modularize the function design
  - Procedures as services to be re-used
  - Stateless NFs, "compute" decoupled from "storage"
  - Network slicing for multi-service
  - Deployments using SDN and NFV
  - Capability exposure



3GPP TS 23.501 (Rel-17), System architecture for the 5G System (5GS), 2021.03

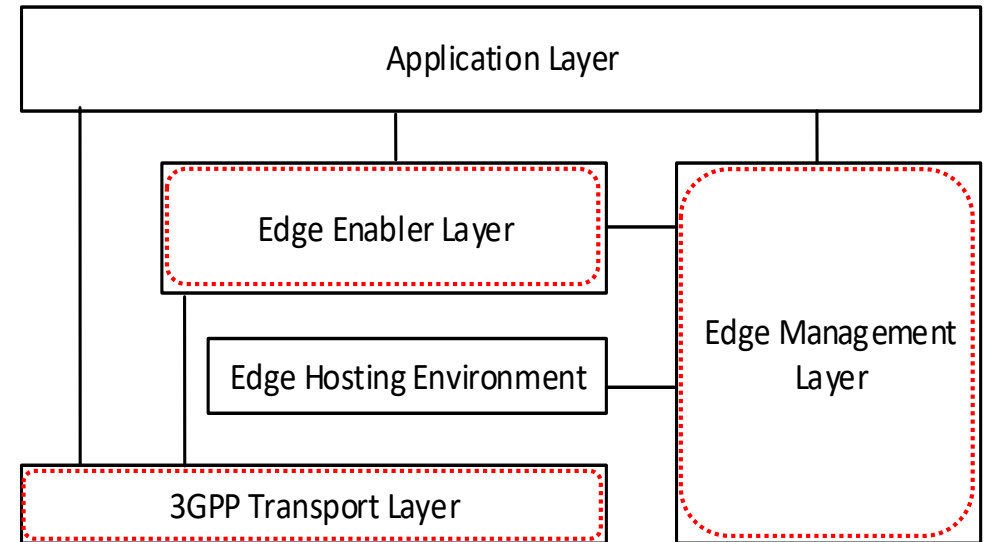
## 5G Standardisation – timeline, key dates and players



Source: 3GPP

# 5G MEC 표준화 현황: 3GPP

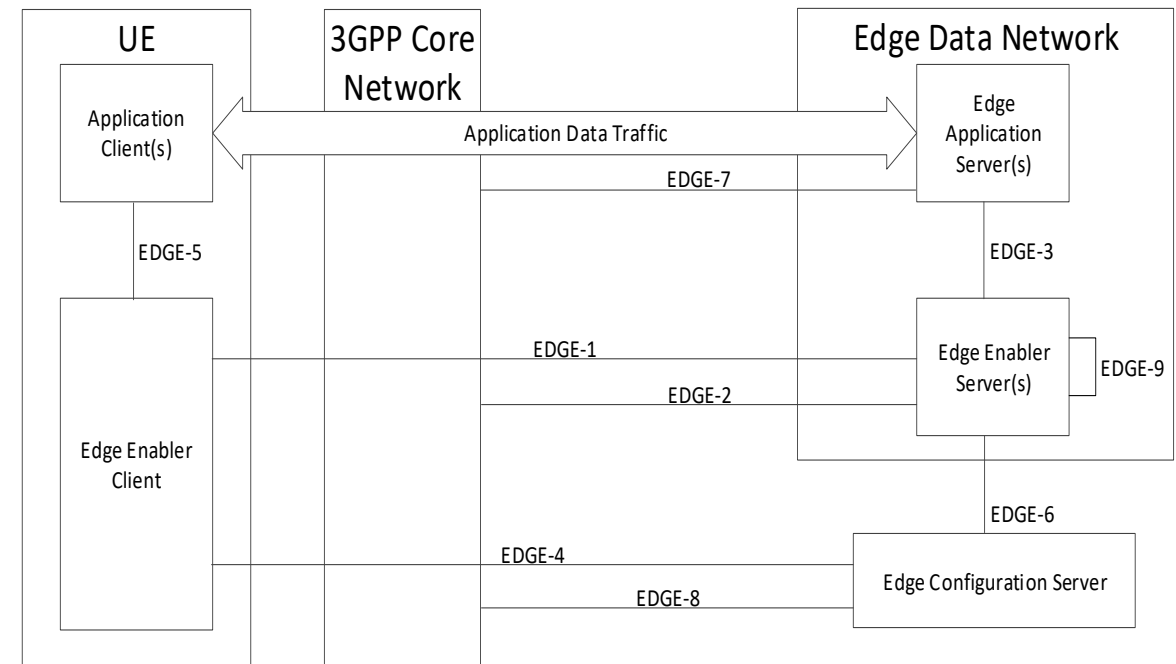
- 3GPP 5G MEC standardization scope
  - **Edge enabler layer**
    - service provisioning, EAS discovery, application context transfer, capability exposure
    - [SA6] EDGEAPP, TS 23.548, Rel-17 (98% completed as of 2021.06)
  - **3GPP transport layer** (edge-unaware)
    - local routing, traffic steering, service continuity, AF-influenced routing
    - [SA2] eEDGE\_5GC, TS 23.558, Rel-17 (75% completed as of 2021.06)
  - **Edge management layer**
    - lifecycle management, NRM of edge components (EAS, EES, ECS, EASDF), performance assurance, fault supervision
    - [SA5] eEDGEM, TS 28.538, Rel-17 (*in-progress*)



< Overview of 3GPP 5G edge computing support >

# 3GPP 5G MEC: Edge Enabler Layer (3GPP SA6)

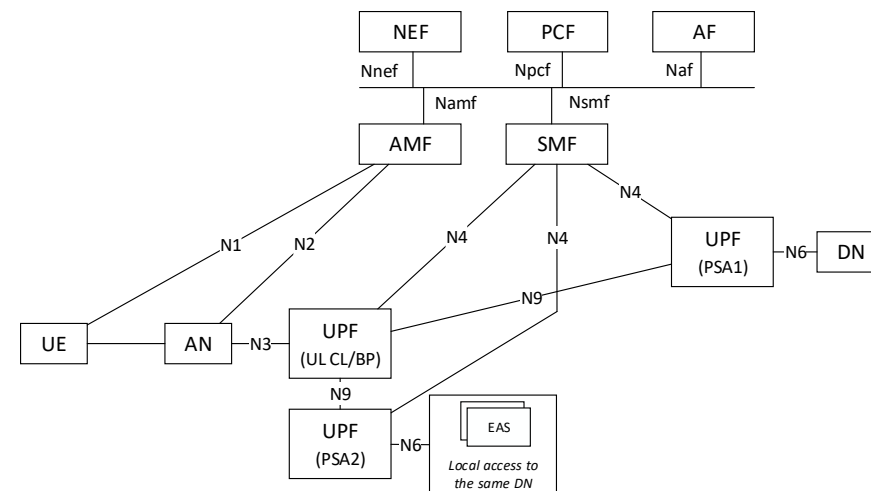
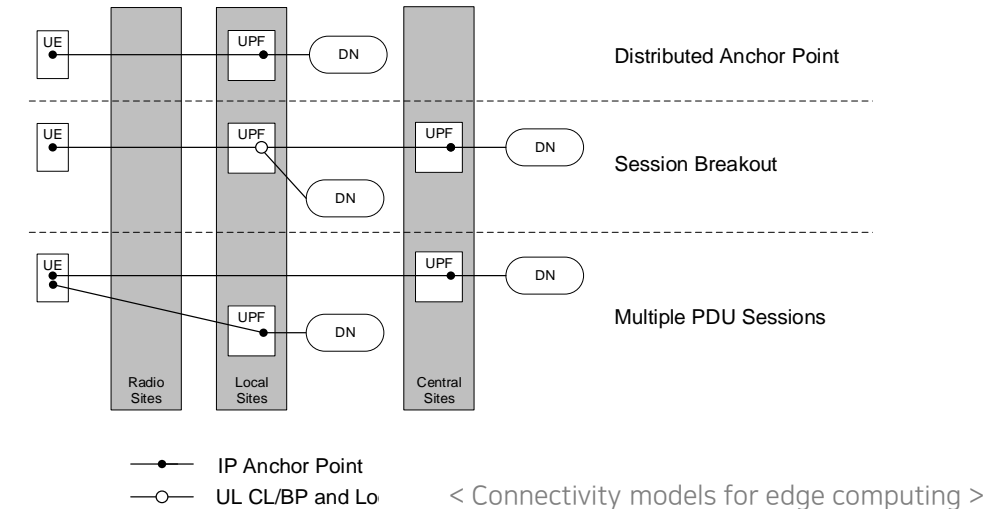
- (EDGEAPP) Architecture for enabling Edge Applications [TS 23.558, Rel-17]
  - Service provisioning for edge service access
  - Registration of UE and Application server
  - EAS discovery for access to suitable edge service
  - Capability exposure to EAS (application)
  - Support for service continuity due to UE mobility
  - Security for communications among enabler entities
  - Dynamic EAS instantiation as per application needs



< Architecture for enabling edge applications >

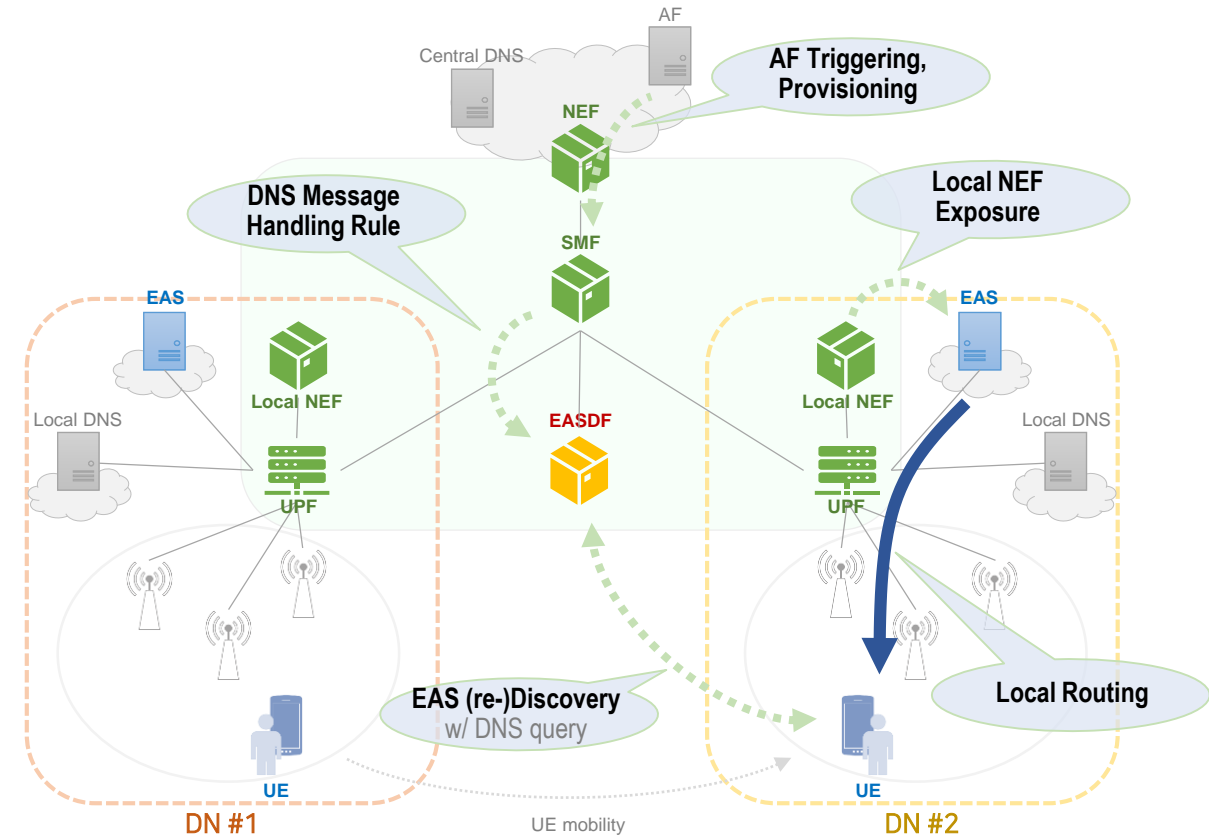
# 3GPP 5G MEC: Transport Layer (3GPP SA2)

- **(5GC)** Edge computing support of 5G core network [TS 23.501,502, Rel-16]
  - User plane (re)selection
  - Local Routing and Traffic Steering
  - Session and service continuity
  - AF influenced UPF (re)selection and traffic routing
  - Network capability exposure
  - QoS and Charging
  - Support of Local Area Data Network



# 3GPP 5G MEC: Transport Layer (3GPP SA2)

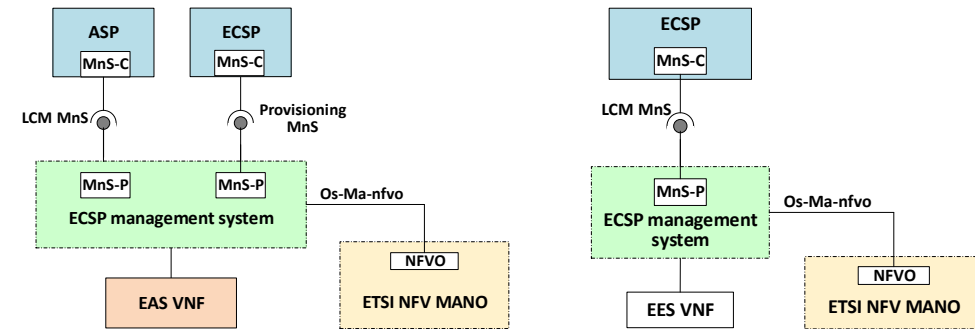
- (eEDGE\_5GC) Enhancement of support for Edge Computing in 5GC [TS 23.548, Rel-17]
  - EAS (re-)discovery with **DNS queries**
  - **EASDF** for centralized DNS handling in 5GC
  - Edge relocation support by routing and buffering
  - Timely network exposure by local NEF
  - Support of 3GPP application layer (SA6)



< Overview of edge computing support in 5GC (Rel-17) >

# 3GPP 5G MEC: Management Layer (3GPP SA5)

- **(FS\_eEDGE\_Mgt)** Management aspects of edge computing [TR 28.814, Rel-17]
  - Lifecycle management of EDN and edge components including EAS, EES and ECS.
  - Performance Assurance of edge components
  - Fault Supervision of edge components
  - Virtual resource management for edge components
  - EDN capability management including the type and capabilities of EAS(s) available in the EDN.
- **(eEDGEM)** Edge Computing Management [TS 28.538, Rel-17] (WID approved as of 2021.06)
  - Enhancement to 3GPP NRMs: Lifecycle management of EAS, EES, ECS and EASDF; EAS profile configurations; EAS, EES and ECS access to 5GC functionality
  - Performance Assurance: performance measurements and KPIs for EAS, EES, ECS and EASDF
  - Fault Supervision: 5GC NF alarms collection to support EAS fault supervision
  - Specifying workflows for EAS, EES, ECS and EASDF for edge computing management
  - Specifying enhancements of provisioning MnS needed to support the asynchronous mode of operations for LCM



< EAS and EES lifecycle management >



< Deployment model for edge computing support >

# 3GPP 5G MEC: Edge Enabler Layer

[3GPP SA6] EDGEAPP, 3GPP TS 23.558 (Rel-17),  
Architecture for enabling Edge Applications

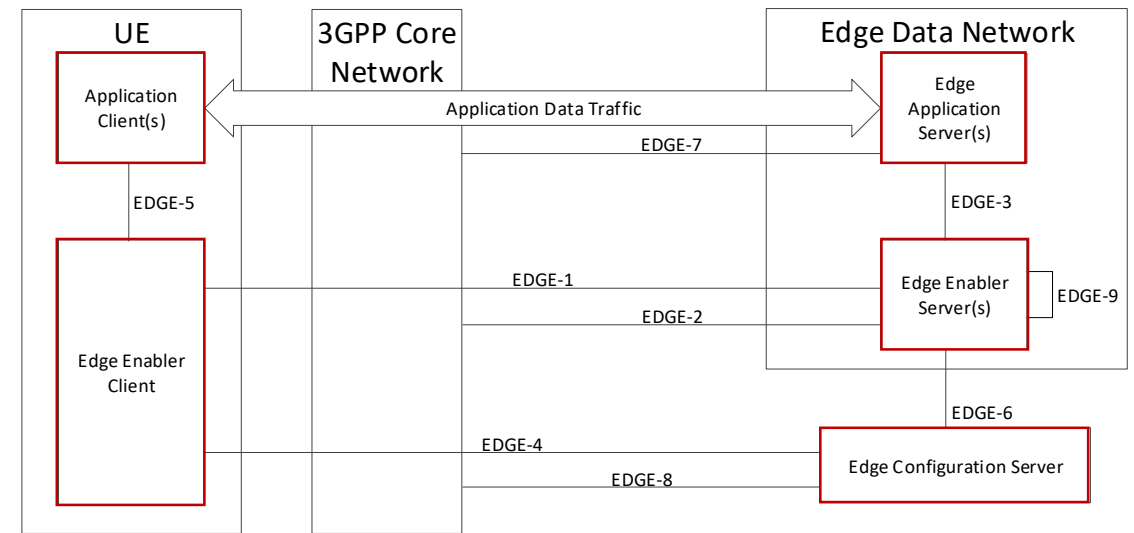


# Feature of edge enabler layer

- Service provisioning
  - supply the information required by the UE to access the edge services.
  - configuration depends on UE's location, service requirements, service preferences, connectivity information
- Registration
  - allow entities (e.g. UE and Application Server) in the edge enabler layer to provide information about itself
- **EAS discovery**
  - enable the UE to obtain information about suitable EASs (Edge Application Servers) of interest in the EDN (Edge Data Network)
- Capability exposure to EAS
  - exposes services towards the EASs
    - services of the Edge Enabler Layer with SEAL, CAPIF
    - re-exposed and enhanced services of the 3GPP core network via NEF
- Support for **service continuity**
  - per UE mobility, provides several features for minimizing the application layer service interruption by replacing the S-EAS connected to the AC in the UE, with a T-EAS
- Security
  - supports secure communication amongst the enabler layer entities (i.e., EEC authentication and authorization)
- Dynamic EAS instantiation
  - interact with the EAS management system to trigger instantiation of a suitable EAS as per application needs

# Architecture

- Functional entities
  - (ECS) Edge Configuration Server
    - provisioning of EDN/EES to EEC, EES registration, CN exposure
  - (EES) Edge Enabler Server
    - provisioning of EAS to EEC, EEC/EAS registration, CN exposure, ACT, EAS instantiation triggering
  - (EAS) Edge Application Server
    - server function where AC connects to
  - (EEC) Edge Enabler Client
    - configuration retrieval/provisioning of EAS, EAS discovery
  - (AC) Application Client
    - client function in UE (out of scope)



< Architecture for enabling edge applications >

# Service provisioning

- ECS discovery (configuration)
  - ECS: Edge Configuration Server
    - bootstrapping server for EEC
    - operated by MNO or ECSP
  - ECS configured in UE by
    - AC/EEC pre-configuration
    - user configuration
    - 5GC NAS signaling (EEC-SMF-UDM on PDU session) [TS 23.548]
    - derived from PLMN identifiers
- Service provisioning
  - EDN(s) configuration to EEC by ECS
    - based on UE location, service requirements, preferences
    - triggered by EEC request or ECS notification (for update)
  - EDN configuration information
    - DNN/APN, service area, serving EES(s), lifetime

< EDN configuration information >

Information element	Status	Description
<b>EDN connection information</b> (NOTE 1)	M	Information required by the UE to establish connection with the EDN.
> DNN/APN	M	Data Network Name/Access Point Name
> S-NSSAI	O	Network Slice information
> EDN Topological Service Area	O	The EDN serves UEs that are connected to the Core Network from one of the cells included in this service area. See possible formats in Table 8.2.7-1.
<b>List of EESs</b>	M	List of EESs of the EDN.
> EESID	M	The identifier of the EES
> EES Endpoint	M	The endpoint address (e.g. URI, IP address) of the EES
> EASIDs (NOTE 2)	O	List of EASIDs registered with the EES.
> EES Provider identifier	O	The identifier of the EES Provider (such as ECSP)
> EES Topological Service Area	O	The EES serves UEs that are connected to the Core Network from one of the cells included in this service area. EECs in UEs that are located outside this area shall not be served. See possible formats in Table 8.2.7-1.
> EES Geographical Service Area	O	The area being served by the EES in Geographical values (as specified in clause 7.3.3.3)
> List of EES DNAI(s)	O	DNAI(s) associated with the EES/EAS. This IE is used as Potential Locations of Applications in clause 5.6.7 of 3GPP TS 23.501 [2].
> EES Service continuity support	O	Indicates if the EES supports service continuity or not. This IE also indicates which ACR scenarios are supported by the EES.
> EEC registration configuration	M	Indicates whether the EEC is required to register on the EES to use edge services or not.
Lifetime	O	Time duration for which the EDN configuration information is valid and supposed to be cached in the EEC.
NOTE 1: If the UE is provisioned or pre-configured with URSP rules by the HPLMN, the UE handles the precedence between EDN connection info and URSP rules as defined in 3GPP TS 23.503 [12] clause 6.1.2.2.1. EDN connection info is considered to be part of UE Local Configurations.		
NOTE 2: EAS information is limited to the EEC requested applications. If no AC profiles were present in the service provisioning request, the EAS information is subject to the ECSP policy (e.g. no EAS information or a subset of EAS information related to the EES).		

# Registration

- EEC registration with EES
  - registration, update/de-registration
  - EEC information for registration
    - EEC ID, UE ID(GPSI), security credential, AC profile, EEC service continuity support, EEC context ID, source EES
  - **AC profile**
    - AC ID, type (e.g., V2X), preferred ECSP, expected service area, service continuity support, EAS list

< AC Profile >

Information element	Status	Description
ACID	M	Identity of the AC.
<b>AC Type</b>	O	The category or type of AC (e.g. V2X). This is an implementation specific value.
<b>Preferred ECSP list</b>	O	When used in a service provisioning request, this IE indicates to the ECS which ECSPs are preferred for the AC. The ECS may use this information in the selection of EESs.
AC Schedule	O	The expected operation schedule of the AC (e.g. time windows)
Expected AC Geographical Service Area	O	The expected location(s) (e.g. route) of the hosting UE during the AC's operation schedule. This geographic information can express a geographic point, polygon, route, signalling map, or waypoint set.
AC Service Continuity Support	O	Indicates if service continuity support is required or not for the application. The IE also indicates which ACR scenarios are supported by the AC and which of these are preferred by the AC.
<b>List of EASs</b>	O	List of EAS that serve the AC along with the service KPIs required by the AC
> EASID	M	Identifier of the EAS
> Expected AC Service KPIs	O	KPIs expected in order for ACs to receive currently required services from the EAS, as described in Table 8.2.3-1
> Minimum required AC Service KPIs	O	Minimum KPIs required in order for ACs to receive meaningful services from the EAS, as described in Table 8.2.3-1

# Registration

- EAS registration with EES
  - registration, update/de-registration
  - EAS information for registration
    - EAS profile, security credential, expiration time
  - **EAS profile**
    - EAS ID, endpoint addr, serving AC ID(s), provider ID, type (e.g., V2X), service area, service KPI, service feature, service continuity support, DNAI(s), status

< EAS Profile >

Information element	Status	Description
EASID	M	The identifier of the EAS
<b>EAS Endpoint</b>	M	Endpoint information (e.g. URI, FQDN, IP address) used to communicate with the EAS. This information maybe discovered by EEC and exposed to ACs so that ACs can establish contact with the EAS.
<b>ACID(s)</b>	O	Identifies the AC(s) that can be served by the EAS
<b>EAS Provider Identifier</b>	O	The identifier of the ASP that provides the EAS.
<b>EAS Type</b>	O	The category or type of EAS (e.g. V2X)
EAS description	O	Human-readable description of the EAS
EAS Schedule	O	The availability schedule of the EAS (e.g. time windows)
<b>EAS Geographical Service Area</b>	O	The geographical service area that the EAS serves. ACs in UEs that are located outside that area shall not be served.
<b>EAS Topological Service Area</b>	O	The EAS serves UEs that are connected to the Core Network from one of the cells included in this service area. ACs in UEs that are located outside this area shall not be served. See possible formats in Table 8.2.7-1.
<b>EAS Service KPIs</b>	O	Service characteristics provided by EAS, detailed in Table 8.2.5-1
EAS service permission level	O	Level of service permissions e.g. trial, gold-class supported by the EAS
<b>EAS Feature(s)</b>	O	Service features e.g. single vs. multi-player gaming service supported by the EAS
EAS Service continuity support	O	Indicates if the EAS supports service continuity or not. This IE also indicates which ACR scenarios are supported by the EAS.
<b>List of EAS DNAI(s)</b>	O	DNAI(s) associated with the EAS. This IE is used as Potential Locations of Applications in clause 5.6.7 of 3GPP TS 23.501 [2]. It is a subset of the DNAI(s) associated with the EDN where the EAS resides.
List of N6 Traffic Routing requirements	O	The N6 traffic routing information and/or routing profile ID corresponding to each EAS DNAI.
EAS Availability Reporting Period	O	The availability reporting period (i.e. heartbeat period) that indicates to the EES how often it needs to check the EAS's availability after a successful registration.
EAS Required Service APIs	O	A list of the Service APIs that are required by the EAS
<b>EAS Status</b>	O	The status of the EAS (e.g. enabled, disabled, etc.)

# Registration

- EES registration with ECS
  - registration, update/de-registration
  - EES information for registration
    - EES profile, security credential, expiration time
- EES profile
  - EES ID, endpoint addr, EAS IDs, EEC registration required, providing ECSP, service area, DNAI(s), service continuity support

< EES Profile >

Information element	Status	Description
EESID	M	The identifier of the EES
EES Endpoint	M	Endpoint information (e.g. URI, FQDN, IP address) used to communicate with the EES. This information is provided to the EEC to connect to the EES.
EASIDs	M	List of EASIDs registered with the EES.
EEC registration configuration	M	Indicates whether the EEC is required to register on the EES to use edge services or not.
EES Provider Identifier	O	The identifier of the ECSP that provides the EES Provider.
EES Topological Service Area	O	The EES serves UEs that are connected to the Core Network from one of the cells included in this service area. EECs in UEs that are located outside this area shall not be served. See possible formats in Table 8.2.7-1.
EES Geographical Service Area	O	The area being served by the EES in Geographical values (as specified in clause 7.3.3.3)
List of EES/EAS DNAI(s)	O	DNAI(s) associated with the EES/EAS. This IE is used as Potential Locations of Applications in clause 5.6.7 of 3GPP TS 23.501 [2].
EES Service continuity support	O	Indicates if the EES supports service continuity or not. This IE also indicates which ACR scenarios are supported by the EES.

# EAS Discovery

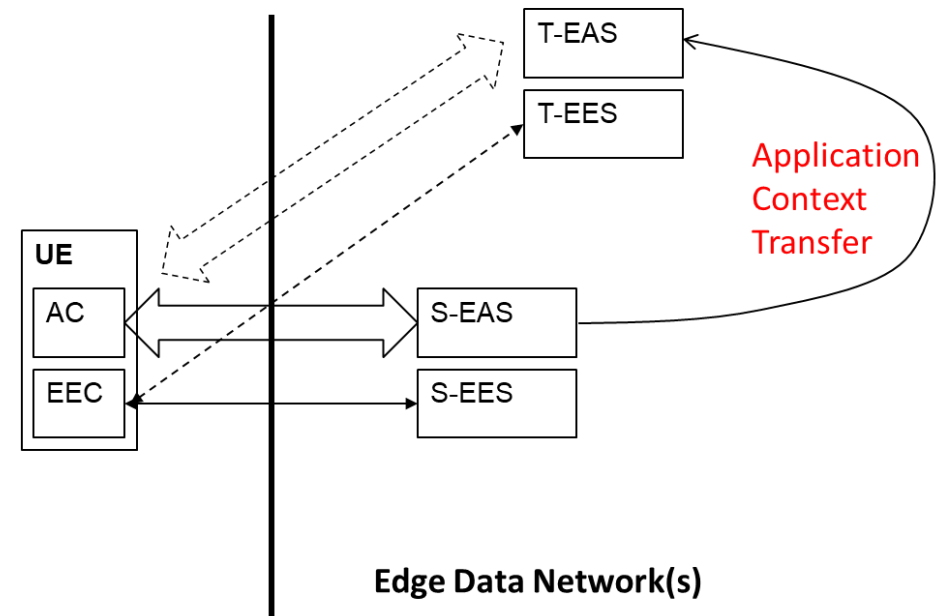
- EAS(s) information to EEC by EES
  - based on interest, filter
  - triggered by EEC request or EES notification (for update)
    - example conditions: AC installation, re-installation, activation, application server access, ACR
  - Discovery request parameters
    - UE ID, filters (AC/EAS characteristics), UE location, target DNAI, service continuity support

< EAS discovery filters >

Information element	Status	Description
<b>List of AC characteristics</b> (NOTE 1)	O	Describes the ACs for which a matching EAS is needed.
> AC profile (NOTE 2)	M	AC profile containing parameters used to determine matching EAS. AC profiles are further described in Table 8.2.2-1.
<b>List of EAS characteristics</b> (NOTE 1, NOTE 3)	O	Describes the characteristic of required EASs.
> EASID	O	Identifier of the required EAS.
> EAS provider identifier	O	Identifier of the required EAS provider
> EAS type	O	The category or type of required EAS (e.g. V2X)
> EAS schedule	O	Required availability schedule of the EAS (e.g. time windows)
> EAS Geographical Service Area	O	Location(s) (e.g. geographical area, route) where the EAS service should be available.
> EAS Topological Service Area	O	Topological area (e.g. cell ID, TAI) for which the EAS service should be available. See possible formats in Table 8.2.7-1.
> Service continuity support	O	Indicates if the service continuity support is required or not.
> EAS status	O	Required status of the EAS (e.g. enabled, disabled, etc.)
> Service permission level	O	Required level of service permissions e.g. trial, gold-class
> Service feature(s)	O	Required service features e.g. single vs. multi-player gaming service
NOTE 1: <b>Either "List of AC characteristics" or "List of EAS characteristics" shall be present.</b>		
NOTE 2: "Preferred ECSP list" IE shall not be present.		
NOTE 3: The "List of EAS characteristics" IE must include at least one optional IE, if used as an EAS discovery filter.		

# Service Continuity

- Basic concept
  - Due to **UE mobility** (or performance),
  - → suitable **EAS change**:  
S-EAS (source) → T-EAS (target)
  - → minimize service interruption
  - → application context transfer (ACT/ACR):  
S-EAS → T-EAS
- Triggering scenarios
  - (for intra-EDN, inter-EDN, LADN)
  - UE mobility (predictive, expected)
  - overload in S-EAS or EDN
  - EAS Maintenance (e.g., graceful shutdown)



< Basic Concept of Application Context Transfer >



# EEC Context and EEC Context relocation

- EEC context
  - UE/AC information, S-EES, EDGE-1 subscriptions for capability exposure
  - created by EES at the initial registration
- EEC context relocation
  - EES performs EEC Context Pull/Push Relocation based on context ID
  - when EEC registration, ACR

< EEC Context >

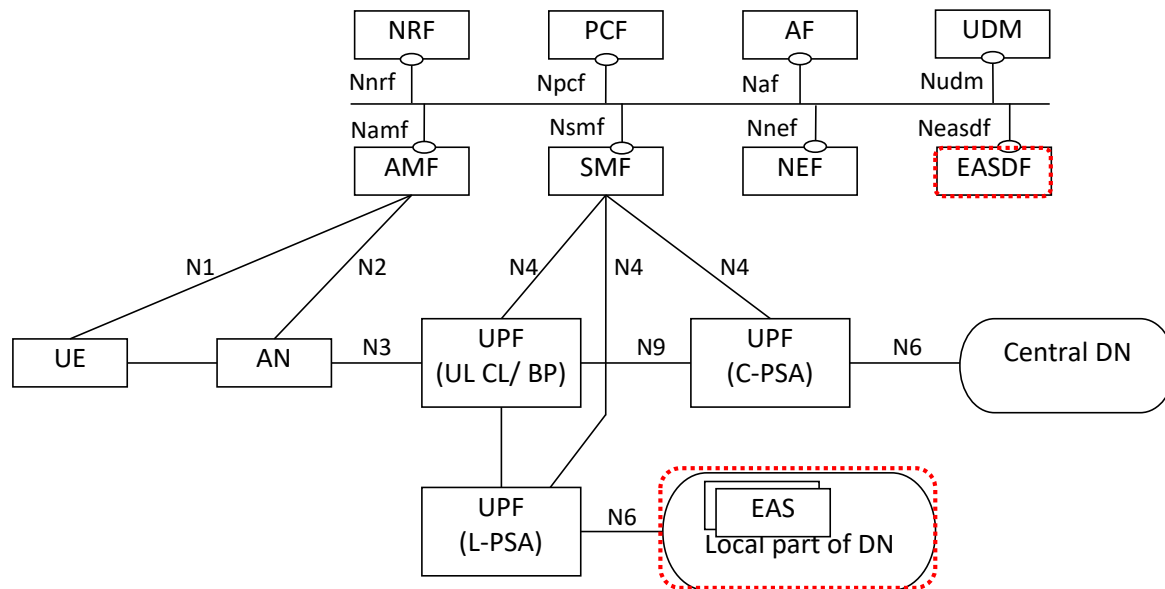
Information element	Status	Description
EEC ID	M	Unique identifier of the EEC.
EEC Context ID	M	Identifier assigned to the EEC Context
Source EES Endpoint	M	The endpoint address (e.g., URI, IP address) of the EES that provided EEC context ID.
UE Identifier	O	The identifier of the hosting UE (i.e., GPSI or identity token)
List of EDGE-1 subscriptions	O	List of subscriptions IDs for capability exposure to the EEC ID
UE location	O	Latest UE location of the UE hosting the EEC which was available at the EES.
List of AC Profiles	O	Information about the ACs as described in Table 8.2.2-1.
List of Service Session Contexts	O	List of associated Service Session Context IEs. Each Service Session Context includes information maintained by the EES for the services (involving UE related resources) received from an EAS registered to the EES.
> Service Session Context	M	Service Session Context is described in Table 8.2.8-2

# 3GPP 5G MEC: Transport Layer

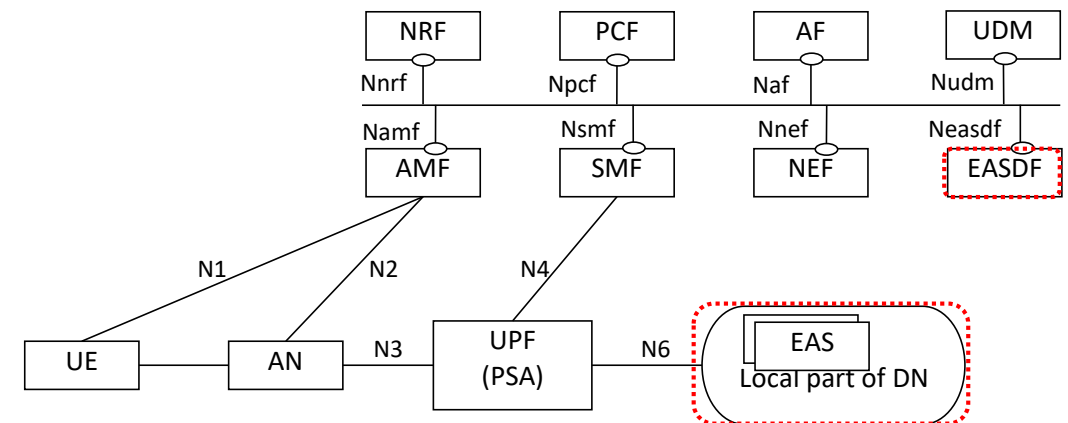
[3GPP SA2] eEDGE\_5GC, 3GPP TS 23.548 (Rel-17),  
5G System Enhancements for Edge Computing

*(75% Completed)*

# Reference Architecture for Supporting EC



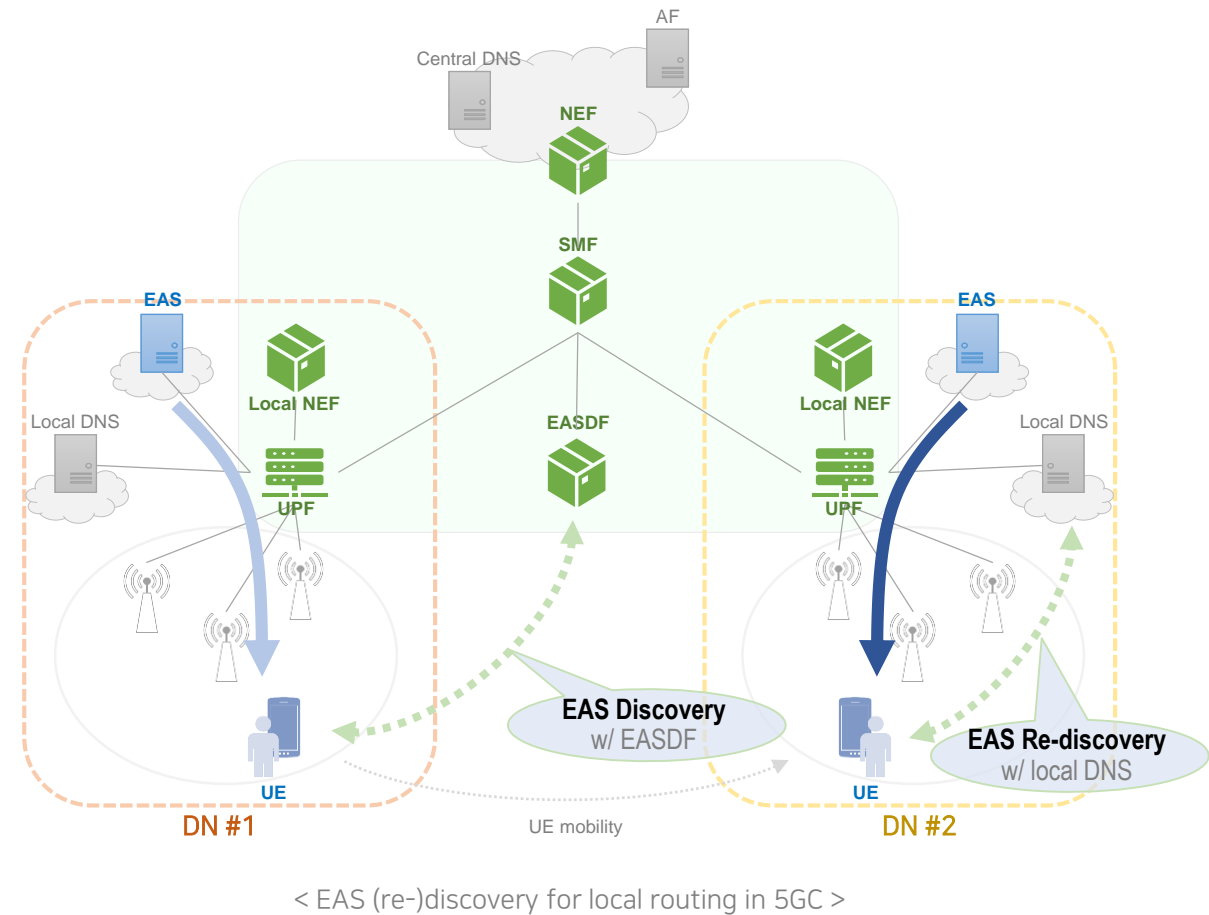
< 5GS providing access to EAS with UL CL/BP >



< 5GS providing access to EAS without UL CL/BP >

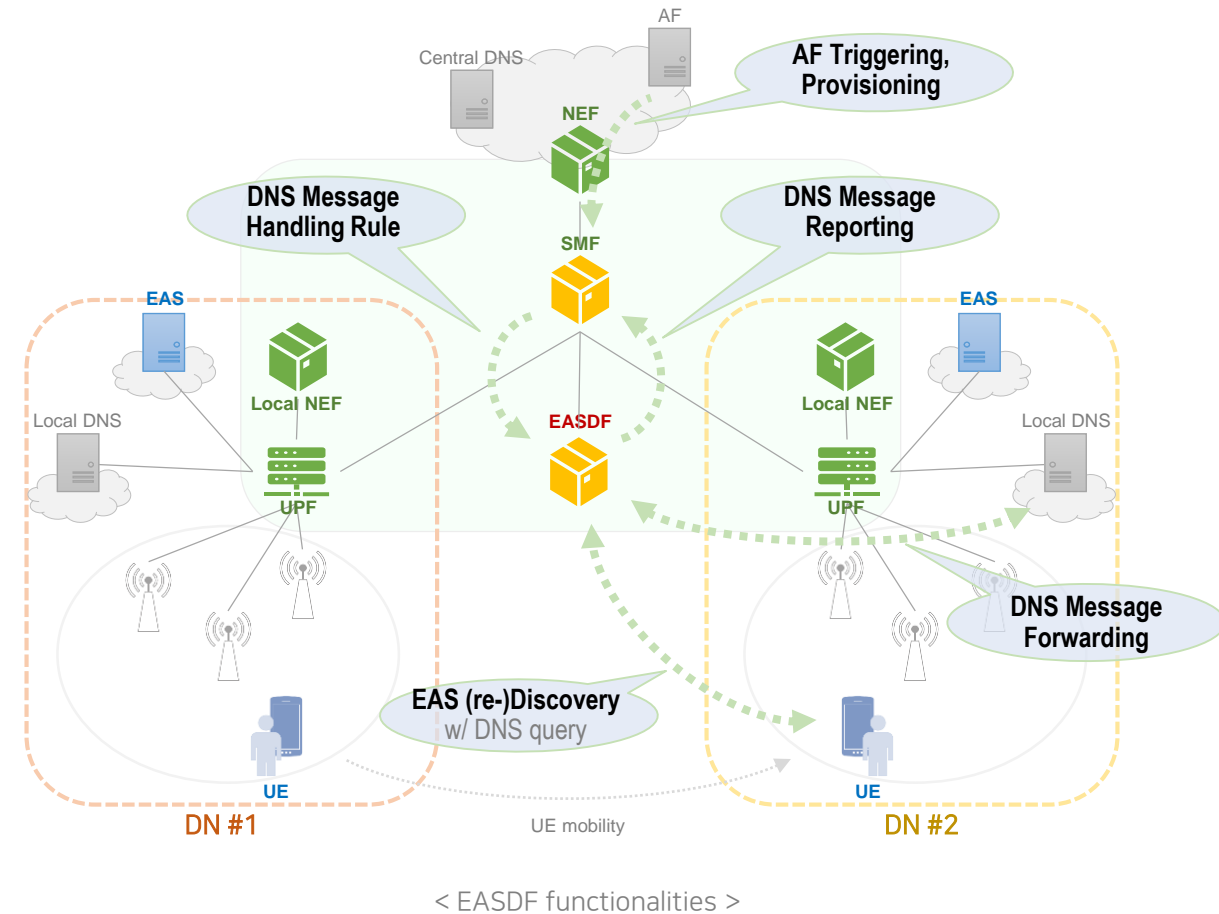
# EAS Discovery and Re-discovery

- EAS discovery
  - discovers the IP address of a suitable EAS using DNS
  - → traffic routing path can be optimized to the discovered EAS
- EAS re-discovery
  - EAS replaced when previously discovered EAS cannot be used or may have become non-optimal
  - → edge relocation
- DNS translation from FQDN of EAS to IP address
  - by Central-DNS, Local-DNS servers
  - which is topologically close to the UE, based on
    - source IP address of DNS query
    - EDNS Client Subnet (ECS) option [RFC 7871]
- 5GC-defined EAS discovery
  - DNS queries to EASDF as DNS resolver indicated by SMF



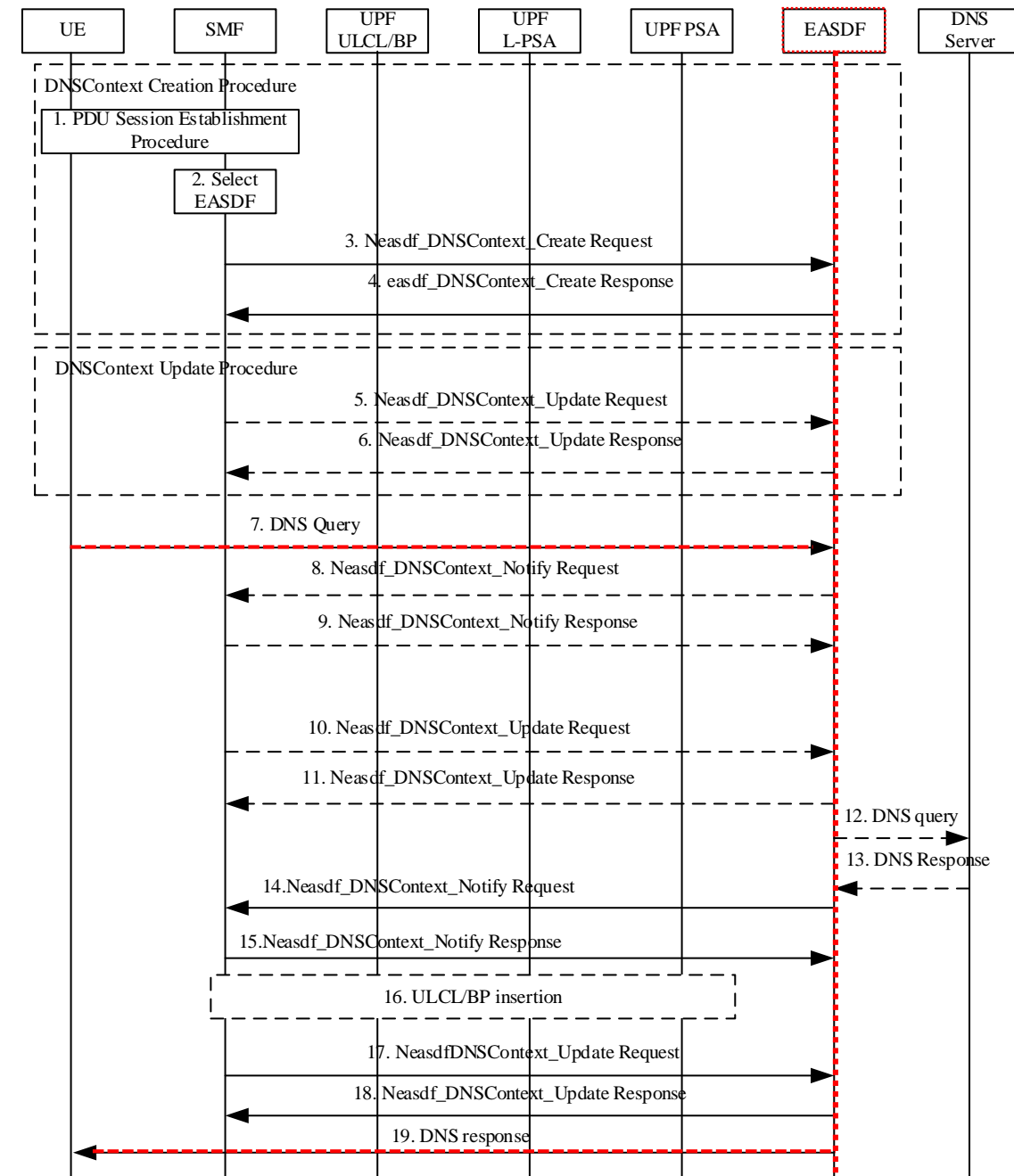
# EAS Discovery and Re-discovery

- Edge Application Server Discovery Function (**EASDF**)
  - Registering to NRF for EASDF discovery and selection.
  - Handling the DNS messages according to the instruction from the SMF, including:
    - Receiving DNS message handling rules from SMF
    - Exchanging DNS messages from the UE
    - Forwarding DNS messages to C-DNS or L-DNS for DNS query
    - Adding EDNS Client Subnet (ECS) option into DNS query for an FQDN
    - Notifying EASDF related information to SMF
  - Terminates the DNS security, if used.



# EAS Discovery Procedure with EASDF

- Procedure summary
  - SMF selects an EASDF and provides its address to the UE as the DNS Server to be used for the PDU Session
  - SMF configures the EASDF with DNS message handling rules to forward DNS messages of the UE; and/or report when detecting DNS messages
  - EASDF handles DNS query from UE; forwards DNS query to DNS server
    - Option A: The EASDF adds the EDNS Client Subnet (ECS) option into the DNS Query message; sends the DNS Query message to the C-DNS server
    - Option B: The EASDF forwards the DNS Query message to a suitable L-DNS server
  - EASDF sends **DNS message reporting** to SMF based on DNS message reporting rule
    - The SMF may trigger UL CL/BP and L-PSA insertion based on the reporting
  - EASDF sends **DSN response** to UE



# EAS Discovery Procedure with L-DNS/R

- Procedure summary

- Option C:

- SMF chooses a Local DNS server based on the DNAI and configures it to the UE as new DNS server
    - SMF also configures traffic routing rule on the UL CL (including e.g. Local DNS server address) or the BP (e.g. the new IP prefix @ Local PSA) to route traffic destined to the L-DN including the DNS Query messages to the L-PSA

- Option D:

- If the SMF has been configured that DNS Queries for an FQDN (range) query can be locally routed on the UL CL, then the subsequent DNS queries for the FQDN (range) will be locally routed to a Local DNS server.

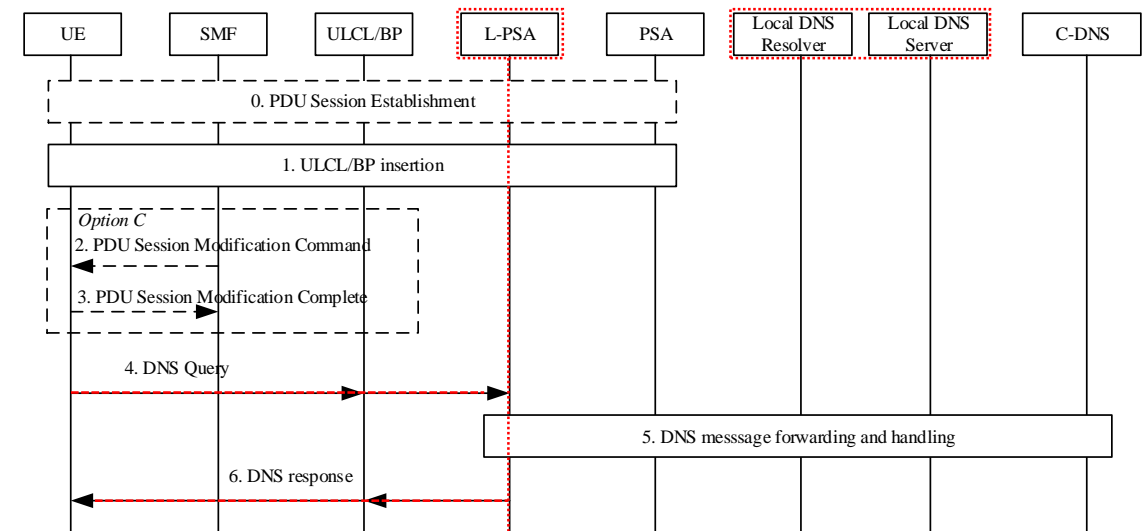
- step 5

- Option C,

- the target address of the DNS Query is the IP address of the Local DNS Server. The DNS Query is forwarded to the Local DNS Server by UL CL/BP and Local PSA.

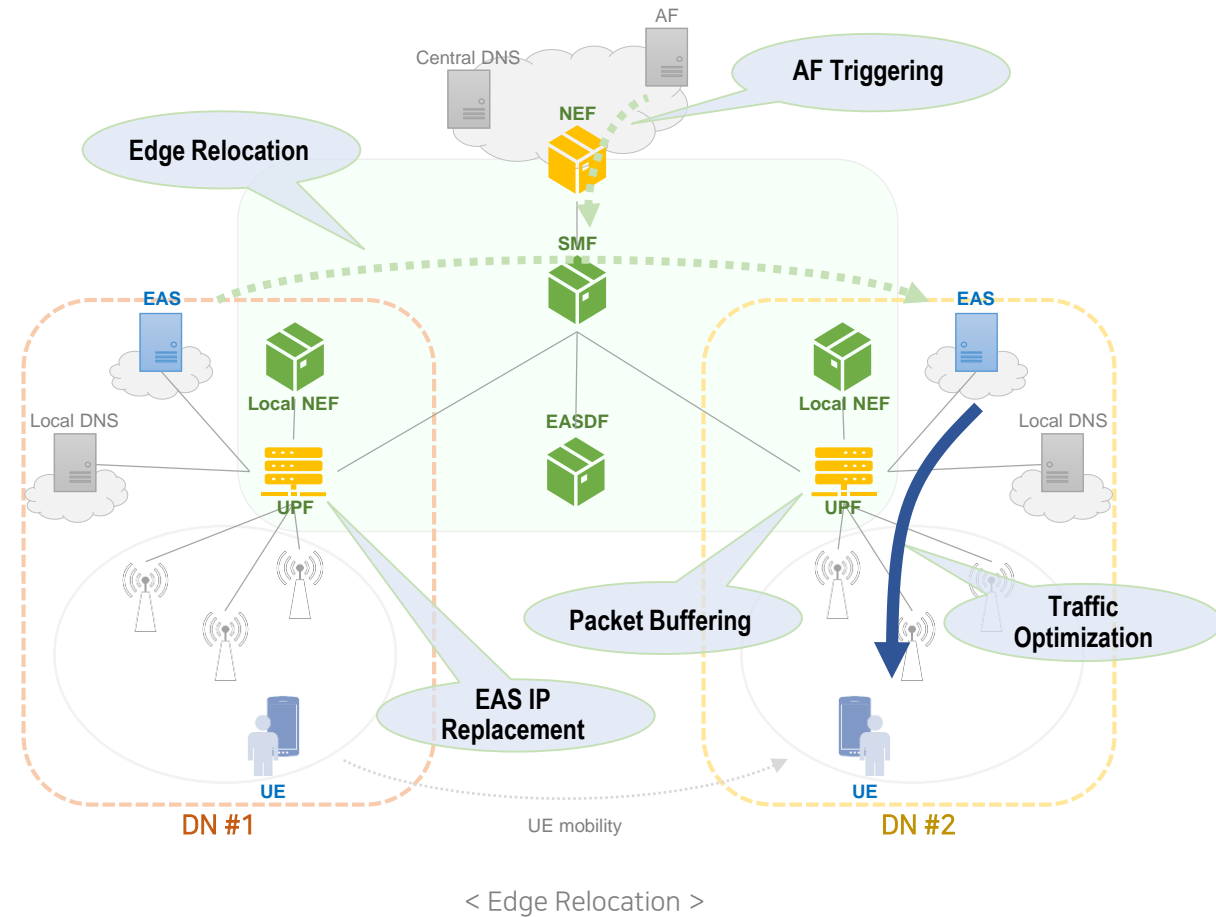
- Option D:

- The Local PSA sends the DNS traffic to the Local DNS Server that resolves the FQDN target of the DNS query by itself or that communicates with a C-DNS server to recursively resolve the EAS IP address.



# Edge Relocation

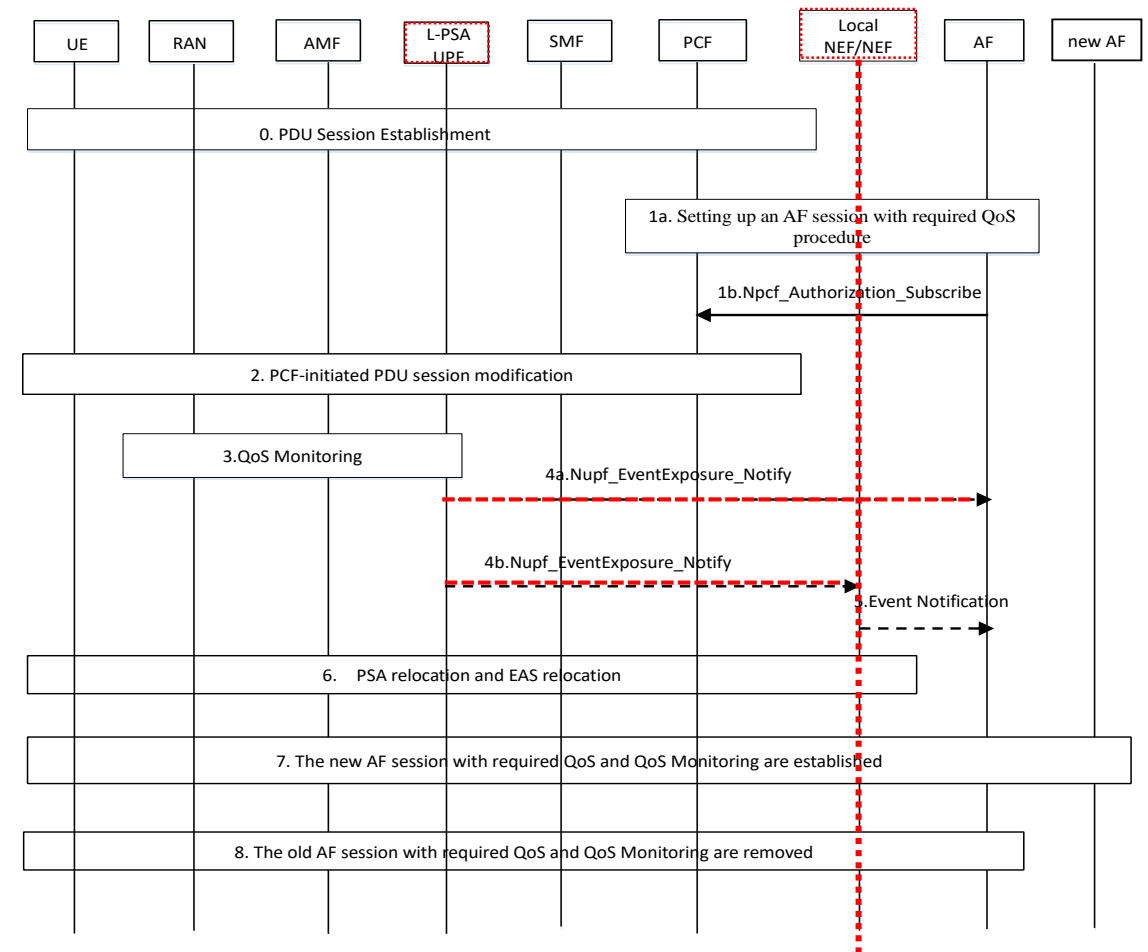
- EAS changes and/or PSA UPF relocation
  - triggered by **network** due to UE mobility; **AF request** due to load balance between EAS instances
- Involving AF change
  - AF triggering via *Nnef\_TrafficInfluence\_Create*, *Npcf\_PolicyAuthorization\_Create*, *Nnef\_TrafficInfluence\_Update*
- EAS IP Replacement
  - Local PSA UPF replaces the source/old Target EAS IP address/port with the target/new target EAS IP address/port for uplink (or vice versa for downlink)
- Packet Buffering for Low Packet Loss
  - buffering uplink packets in the target PSA in order to prevent packet loss if the application client sends UL packets to a new EAS before the new EAS is prepared to handle them
- User Plane Latency Requirement
  - SMF decides to relocate the PSA-UPF based on AF requested user plane latency requirements (maximum allowed user plane latency)





# Network Exposure to EAS

- Low latency network exposure to EAS
  - L-PSA UPF exposes QoS monitoring results (e.g., user path latency) to local AF
  - UPF reports PDU session information directly to AF via local NEF (not via SMF or PCF)
- UPF exposure interface
  - *Nupf\_EventExposure\_Notify* to AF or local NEF
- Local NEF discovery
  - via NRF or NEF redirect the AF request to L-NEF



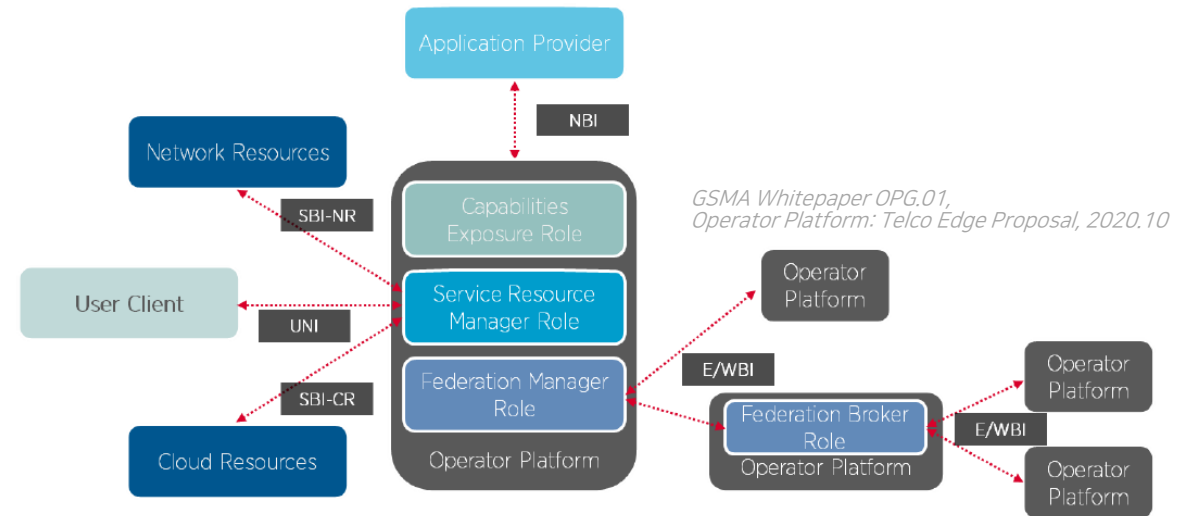
< Procedure for Network Exposure to EAS >

# 향후 전망

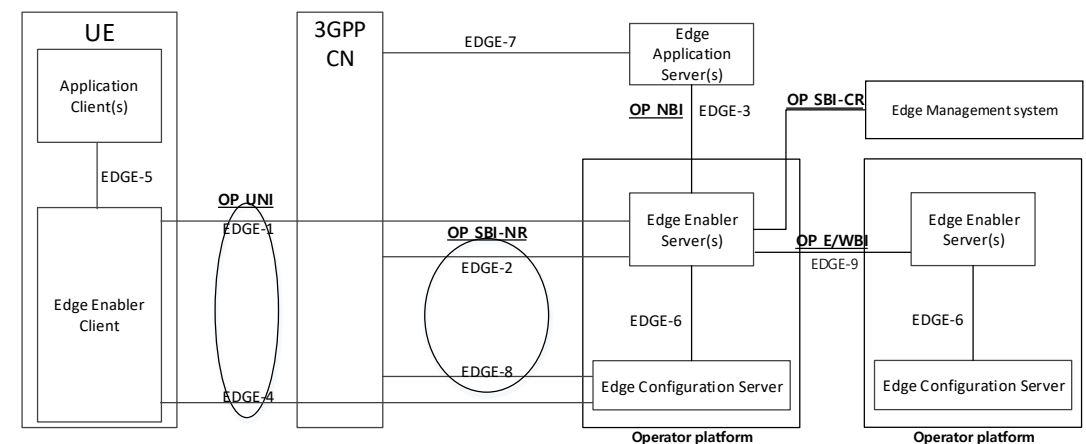
GSMA OP, 3GPP Rel-18 (5G Advanced)

# GSMA Operator Platform: Telco Edge

- **Operator Platform** [GSMA OPG]
  - common exposure & capability framework
    - security, settlement and charging, identity management, monitoring and logging
  - network resource and service capabilities
    - exposure to application providers, end-users
  - **Federation** and service availability in visited network
    - publish and discovery of capabilities of operators
- OP phase-1: **Telco Edge**
  - focus on edge computing with supporting exposure and platforms
  - reference architecture for edge computing
  - 3GPP TSG-SA under discussion about integration/alignment of SA2, SA5, SA6 works



< GSMA OP – Telco Edge Reference Architecture >

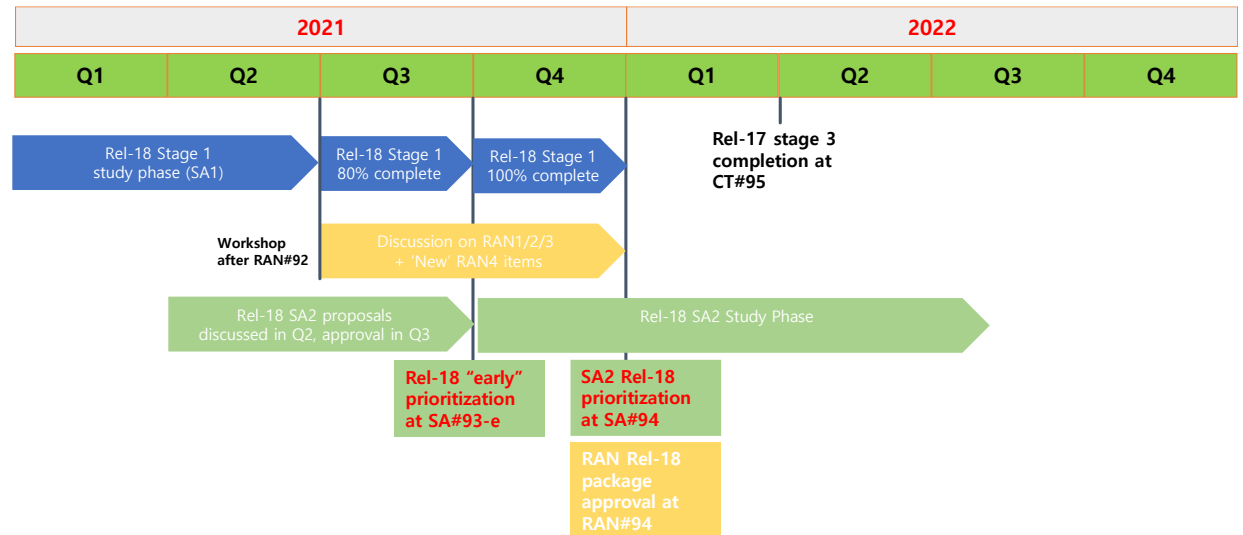


< Relationship between EDGEAPP and GSMA OP architecture >

# 3GPP 5G MEC: New Work Items (Rel-18)

- [SA6] FS\_eEDGEAPP (Rel-18 Study, TR 23.700-98)
  - Roaming support
  - Service **federation** among different EC domains
  - **Service continuity** support at roaming and federation
  - New **EEL** capabilities
  - **Application context relocation** b/w EAS and cloud application servers
  - EEL **service differentiation**
  - Co-operations with **network layer**
  - Feature **optimizations**
  - Enhancement based on CAPIF
  - *(alignment with ETSI MEC, GSMA OP)*

- [SA2] FS\_eEDGE\_5GC\_ph2 (Rel-18 SID, under discussion)
  - Exposure of traffic-related information from UPF
  - Support of ATSSS
  - Traffic steering and offloading
  - Additional network information for exposure
  - ...
  - *(to be discussed until SA#93, 2021.09)*



# 감사합니다.

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# References

- ETSI White Paper #36, "Harmonizing standards for edge computing," 2020.07
- 3GPP TS 23.501 (Rel-17), System architecture for the 5G System (5GS), 2021.03
- 3GPP TS 23.502 (Rel-17), Procedures for the 5G System (5GS), 2021.03
- 3GPP TR 23.748 (Rel-17), Study on enhancement of support for Edge Computing in 5GC, 2020.12
- 3GPP TS 23.548 (Rel-17), 5G System Enhancements for Edge Computing, 2021.06 (draft)
- 3GPP TS 23.558 (Rel-17), Architecture for enabling Edge Applications, 2021.06 (draft)
- 3GPP TR 28.814 (Rel-17), Study on management aspects of edge computing, 2021.06 (draft)
- 3GPP TS 28.538 (Rel-17), Management aspects of edge computing, 2021.06 (draft)
- 3GPP TR 28.815 (Rel-17), Study on charging aspects of Edge Computing, 2021.03 (draft)
- ETSI GS MEC 003 (v2.2.1), Multi-access Edge Computing (MEC); Framework and Reference Architecture, 2020.12
- ETSI ISG MEC, ETSI MEC: An Introduction, 2021.04
- ETSI ISG MEC, White Paper No. 20, Developing Software for Multi-Access Edge Computing 2nd edition, 2019.02
- ITU-T SG13 Y.ec-reqts, Overview and requirement of edge computing, 2021.03 (draft)
- ITU-T SG11, Q.FMEC-SRA, Signalling requirement and architecture for federated MEC, 2021.03 (draft)
- 3GPP TS 23.222 (Rel-17), Common API Framework for 3GPP Northbound APIs, 2021.04
- GSMA Whitepaper OPG.01, Operator Platform: Telco Edge Proposal, 2020.10