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Future networks

Unified multiaccess edge computing for supporting fixed mobile convergence in IMT-2020 networks

Recommendation ITU-T Y.3138

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Recommendation ITU-T Y.3138

Unified multiaccess edge computing for supporting fixed mobile convergence in IMT-2020 networks

Summary

A unified and cloud-based edge computing platform allows operators to flexibly deploy network functions and support infrastructure for fixed mobile convergence (FMC) to provide unified multiaccess edge computing capabilities for all access network technologies in IMT-2020 networks.

Recommendation ITU-T Y.3138 specifies the requirements, architecture and functions of unified multiaccess edge computing for supporting FMC in networks.

History

Edition	Recommendation	Approval	Study Group	Unique ID*
1.0	ITU-T Y.3138	2022-09-29	13	11.1002/1000/15055

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Fixed mobile convergence, IMT-2020 networks, unified edge computing.

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Unified multiaccess edge computing for supporting fixed mobile convergence in IMT-2020 networks

1 Scope

This Recommendation specifies the requirements, architecture and functions of unified multiaccess edge computing for supporting fixed mobile convergence (FMC), including security considerations; it discusses unified multiaccess edge computing capabilities for all access network technologies in IMT-2020 networks.

2 References

The following ITU-T Recommendations and other references contain provisions which, through reference in this text, constitute provisions of this Recommendation. At the time of publication, the editions indicated were valid. All Recommendations and other references are subject to revision; users of this Recommendation are therefore encouraged to investigate the possibility of applying the most recent edition of the Recommendations and other references listed below. A list of the currently valid ITU-T Recommendations is regularly published. The reference to a document within this Recommendation does not give it, as a stand-alone document, the status of a Recommendation.

[ITU-T Y.3101] Recommendation ITU-T Y.3101 (2018), *Requirements of the IMT-2020 network.*

3 Definitions

3.1 Terms defined elsewhere

This Recommendation uses the following term defined elsewhere:

3.1.1 fixed mobile convergence [b-ITU-T Y.3100]: In the context of IMT-2020, the capabilities that provide services and applications to end users regardless of the fixed or mobile access technologies being used and independently of the users' location.

3.2 Terms defined in this Recommendation

This Recommendation defines the following term:

3.2.1 unified multiaccess edge computing: System which provides a unified and cloud-based edge computing platform, which allows operators to flexibly deploy network functions and support infrastructure for fixed mobile network convergence (FMC) and thereby to provide unified multiaccess edge computing capabilities for all access network technologies in IMT-2020 networks.

NOTE – It conforms to the design considerations of the IMT-2020 FMC network, converged with regard to fixed access and mobile access, and interacts with the FMC network to provide collaborative capabilities and services. The management and orchestration functions of the unified multiaccess edge computing platform interact with the management and orchestration of the FMC network to achieve unified operation and maintenance.

4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

AI	Artificial Intelligence
API	Application Program Interface
APP	Application
AR/VR	Augmented Reality / Virtual Reality
CDN	Content Delivery Network
CPU	Central Processing Unit
DevOps	Development and Operations
DNS	Domain Name System
FMC	Fixed Mobile Convergence
GPU	Graphic Processing Unit
ICT	Information and Communication Technology
ID	Identifier
MEAO	Multiaccess Edge Computing Application Orchestration system
MEC	Multiaccess Edge Computing
MEP	Multiaccess Edge computing Platform
ME-PAAS	Multiaccess Edge Platform As A Service
MEPM	Multiaccess Edge computing Platform Management system
ML	Machine Learning
NFV	Network Function Virtualization
NFVI	Network Function Virtualization Infrastructure
NFVO	Network Function Virtualization Orchestrator
NUMA	Non-Uniform Memory Access
O&M	Operation and Maintenance
OLT	Optical Line Terminal
OTT	Over The Top
PAAS	Platform As A Service
PGW	Public data network Gateway
PLMN	Public Land Mobile Network
RNIS	Radio Network Information Service
SDN	Software Defined Network
SGW	Serving Gateway
SLA	Service Level Agreement
SR-IOV	Single Root Input/Output Virtualization
TCP	Transmission Control Protocol

UE	User Equipment
UHD	Ultra-High Definition
UPF	User Plane Function
vCPU	virtualized Central Processing Unit
vBRAS	virtualized Broadband Access Server
vCPE	virtualized Customer Premise Equipment
VM	Virtualize Machine
VNFM	Virtualized Network Function Manager
vOLT	virtualized Optical Line Terminal
vPGW-U	virtualized Packet Data Network Gateway User plane
vSGW-U	virtualized Serving Gateway User plane
WLAN	Wireless Local Area Network

5 Conventions

In this Recommendation:

The keywords "is required to" indicate a requirement which must be strictly followed and from which no deviation is permitted, if conformance to this Recommendation is to be claimed.

The keywords "is recommended" indicate a specification which is recommended but which is not absolutely required. Thus, this specification need not be present to claim conformance.

6 Overview of unified multiaccess edge computing in IMT-2020 FMC networks

Multiaccess edge computing enables services to be hosted close to the UE's access point so as to achieve efficient service delivery through reduced end-to-end latency and load on the transport network, while providing edge services in a variety of ways.

As a product of information and communication technology (ICT) convergence, a multiaccess edge computing platform can support network function virtualization deployment with cloud-based FMC architecture, such as a central unit, user plane function (UPF), virtualized serving gateway user plane (vSGW-U), virtualized packet data network (PDN) gateway user plane (vPGW-U), virtualized customer premise equipment (vCPE), virtualized broadband access server (vBRAS) and virtualized optical line terminal (vOLT). On the basis of cloud-based architecture, operators can open the storage, computing, network, and security capabilities of the edge computing platform to third-party application developers and content providers with application program interfaces (APIs) and provide over the top (OTT) applications with unified edge deployment and management. Furthermore, the multiaccess edge computing platform can abstract and encapsulate ICT network capabilities into a variety of services (for example, radio network information service (RNIS), location services, user equipment (UE) identifier, bandwidth management and transmission control protocol (TCP) optimization), and open them to third-party applications and vertical applications to improve the communications capabilities and performance of their services.

A unified and cloud-based multiaccess edge computing platform allows operators to flexibly deploy network functions, and support the cloud-based infrastructure of FMC specified in [b-ITU-T Y.3131]. The infrastructure and service capabilities of the platform itself can help third-party applications to improve user experience, and maximize the value of both applications and networks.

The unified multiaccess edge computing platform conforms to the design considerations of the IMT-2020 FMC network. The unified multiaccess edge computing platform is converged with regard to fixed access and mobile access, and interacts with the FMC network to provide collaborative capabilities and services. The management and orchestration functions of the unified multiaccess edge computing platform interact with the management and orchestration of the FMC network to achieve unified operation and maintenance.

7 Unified multiaccess edge computing requirements of FMC

7.1 Edge cloud-based network infrastructure

The cloud-based network infrastructure is a set of interconnected multilayer data centres (e.g., edge data centres) with general purpose standardized hardware, centralized management and orchestration enabled by network function virtualization (NFV) and software defined network (SDN) technologies.

1) It is required to support flexible and automatic network deployment, extension, scalability and life cycle management, which is expected to be deployed on cloud-based infrastructure as one of the IMT-2020 FMC network capabilities.
2) It is required to support network functions to be designed and deployed in a cloud native way, such as the edge data centre.
3) It is recommended to support a resource-saving mode, which can be achieved by temporarily disabling some management functions, as resources of the edge cloud are insufficient in some cases.
4) It is recommended to support automatic disaster recovery with cloud-based technologies.

7.2 Customizing the FMC network

As an important means of customizing the FMC network, the unified MEC can apply the following scenario-based implementation functions:

1) It is required to provide users with customized access networks with multiple access options based on localized networks, such as 4G / 5G / wireless local area network (WLAN) / fixed broadband network.
2) It is required to select the most appropriate access link for different services based on link capability, link status, user attributes and service requirements, and to perform handover between the access networks to guarantee service continuity and to improve user experience.
3) It is required to provide access capability through fixed mobile converged UPF to achieve unified service bearer and unified user management in the IMT-2020 network.
4) It is recommended to provide a customized policy control function and customized charging function for users.
5) It is recommended to provide a network isolation capability for vertical industry users; in this way, a logically dedicated network can be deployed for different vertical industry users.
6) It is recommended to apply artificial intelligence (AI) / machine learning (ML) technologies in customizing the FMC network; in this way, the automation and timeliness of service provision to users can be guaranteed.

7.3 Multiaccess edge computing platform

As a computing platform on the edge of the FMC network, a multiaccess computing platform provides edge cache, content delivery network (CDN) and other edge network capabilities for the

fixed and mobile converged network, implements MEC-based unified services and provides opportunities for cooperation with content providers.

1) It is required to route the mobile user's service requests directly to the nearest fixed network exit. This is responsible for video cache content regeneration for services that have deployed CDN resources on the fixed network using the distributed features of the fixed network gateway.
2) It is required to implement local services for fixed and mobile users, used as an edge node of a specific edge cache or service CDN.
3) It is recommended to expose the edge cache and CDN capabilities to third-party applications through APIs.
4) It is recommended to expose other edge network capabilities to third-party applications through APIs, such as network status information, user identifier, user location and bandwidth management.

7.4 Support of mobility

Due to user or application mobility, service continuity and session continuity may be required based on the requirements of the service or the IMT-2020 FMC network.

1) It is required to maintain connectivity between UE and an application (APP) instance when UE performs a handover to another network connection associated with the same MEC host.
2) It is required to maintain connectivity between UE and an APP instance when UE performs a handover to another network connection not associated with the same MEC host.
3) It is required to use available fixed and mobile network information to optimize the mobility procedures required to support service continuity and session continuity.
4) It is required to use available user information to optimize the mobility procedures required to support service continuity and session continuity.
5) It is required to perform location update if UE performs a handover, whether the new network connection is associated with the same MEC host or not.
6) It is required to perform connection management for UE and APP on the basis of their mobility.

7.5 Support of access network capability exposure

The IMT-2020 FMC network is required to provide access network information APIs to the MEC system; the need for MEC service that exposes up-to-date information regarding specific access network technology exists and the access network information is required to include:

1) Access type, including 4G, 5G, WLAN, fixed broadband accesses, etc.
2) Bidirectional bandwidth information delivered to/from the specific user.
3) Granular bidirectional bandwidth information delivered to/from the specific user on the level of specific application, class of service, etc.
4) Latency information, such as delays due to packet assembly in the network sublayer and queuing delays in the link sublayer.
5) Access technology specific information, such as network identifiers, fixed link conditions and radio link conditions.
6) Network conditions, such as congestion, overload and link failure.
7) User subscription information, including current user subscription information and history user subscription information.

8) Public land mobile network (PLMN) information, including the broadcast PLMN identifier (ID) and its access requirements.

7.6 Flexible routeing

In the IMT-2020 FMC network, the mobile access network and the fixed access network have their own advantages, and the advantages of different access networks can be exerted through the flexible routeing feature of the MEC.

1) It is recommended that the mobile access backhaul link be used to carry the fixed broadband access service, or the fixed broadband access network be used to share the pressure of 5G high throughput on the backhaul bandwidth of the mobile access network.

7.7 Multiaccess network collaboration

In order to make full use of the service resources in each network, MEC can realize multiaccess network collaboration, decouple the access network and the backhaul network, and improve the user's service experience and network resource utilization.

1) It is recommended that the user's service access request select an appropriate backhaul link according to the location, service bandwidth and speed of the service deployment.

2) It is recommended that business applications based on multiaccess edge computing platforms serve users under different access networks at the same time, and ensure the same user's consistent experience under different access networks.

8 Unified multiaccess edge computing architecture of FMC

The architecture design of unified multiaccess edge computing is based on the IMT-2020 FMC architecture. The unified multiaccess edge computing platform may reuse the NFV infrastructure and its management functionality of the FMC network, and make some enhancements to network functions and cloud-based architecture. The unified multiaccess edge computing platform is deployed at the edge of the IMT-2020 FMC core network, such as at the aggregation points, gateways, etc. The services and applications of edge computing are deployed at FMC unified multiaccess edge computing platform or at data centre.

As shown in Figure 8-1, the architecture of unified MEC is based on the architecture of FMC in IMT-2020 networks, and consists of network function virtualization infrastructure (NFVI), multiaccess edge computing platform (MEP) and edge management and orchestration function. MEP includes multiaccess edge (ME) platform as a service (ME-PAAS), MEC network services, capability exposure function and MEC applications. On the basis of FMC networks, the unified MEC platform provides flexible capabilities (in the form of APIs) and services for developers to enable third-party applications and vertical industry service.

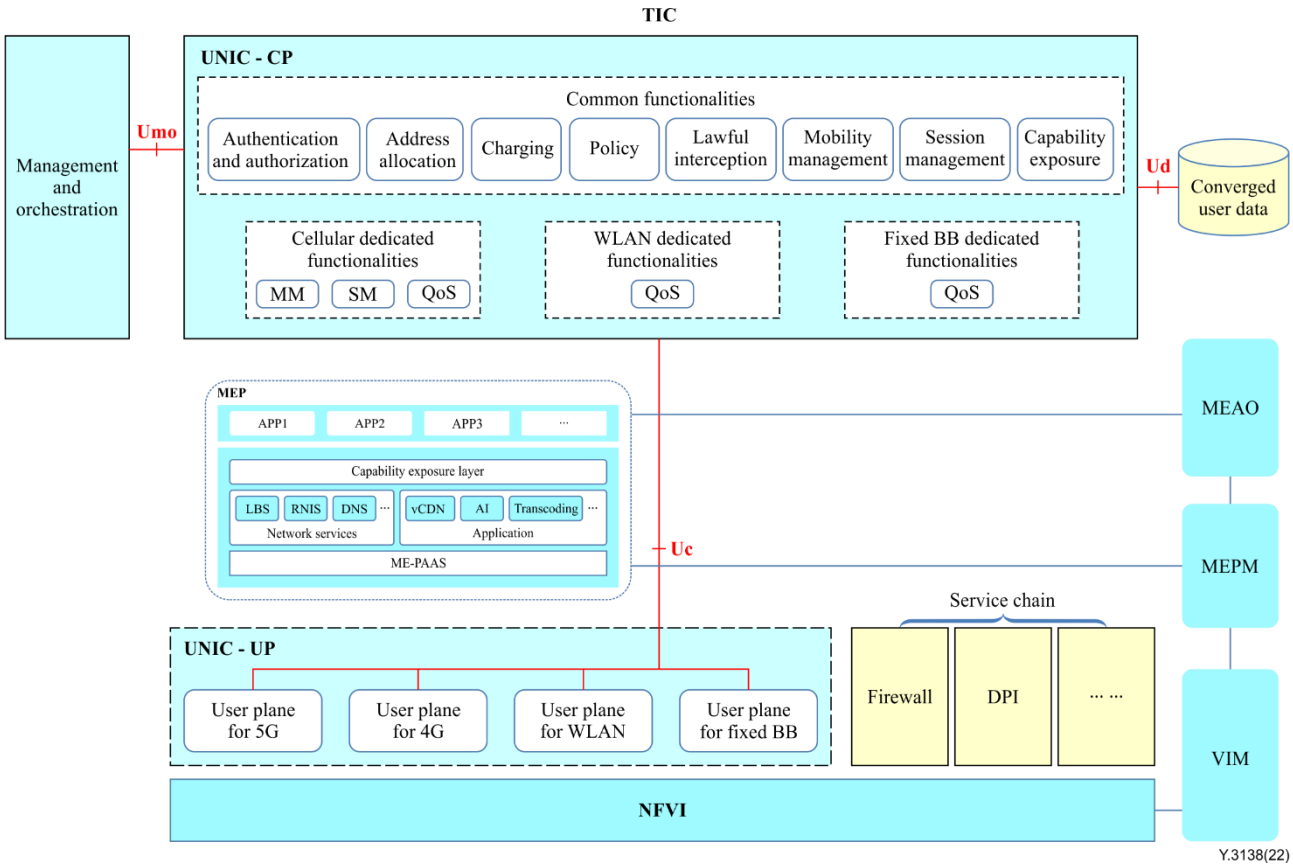

Figure 8-1 – Architecture of unified MEC in IMT-2020 FMC networks

8.1 MEP

8.1.1 ME-PAAS

Unified MEC in IMT-2020 FMC networks is required to provide platform as a service (PAAS) functions to ensure the quick integration of storage, computing, network and security capabilities, and to build up an ecosystem for operator's and third-party's services and applications. The ME-PAAS is required to support the following functions:

1) Virtualization compatibility: ME-PAAS supports the unified orchestration and deployment of containers, supports bare metal containers and virtualize machine (VM) containers, and shields the difference of NFVI layers for services and applications.

2) Container management: Secure containers are supported to provide security isolation for services and applications. Container images and templates are also supported to ensure software compatibility for services and applications.

3) Software management: The ME-PAAS provides software repositories, supports security verification, version management, secure storage for container images and software packages, and supports deployment suites.

NOTE – One example of a deployment suite is Helm.

4) DevOps capability: ME-PAAS supports development and operations (DevOps) toolchains to provide an end-to-end development and verification environment for services and applications.

5) Optimization and acceleration

a) The PAAS platform provides different heterogeneous hardware acceleration capabilities for different MEC service scenarios. The capabilities include graphic processing units (GPU) acceleration, hardware encryption and decryption, hardware forwarding, high-speed storage and AI computing.

b) The PAAS platform supports container huge page tables, non-uniform memory access (NUMA) node binding, virtualized central processing unit (vCPU) and central processing unit (CPU) set binding, and single root input/output virtualization (SR-IOV) networking.

6) Micro services

a) The PAAS platform provides basic service governance functions for services and applications, including service registration, service discovery, service release, service proxy and doman name system (DNS) functions.

b) For multi-instance and service offloading from services and applications, the PAAS platform supports load balancing, such as the load balancing and service chain.

c) The PAAS platform provides support for service and application reliability, meets fault tolerance and self-recovery service level agreement (SLA), and ensures automatic scaling of services and applications.

d) The PAAS platform provides basic platform capabilities for the quick integration of services and applications. It also provides various platform middleware, such as distributed messages, distributed transactions, distributed databases, distributed caches and API gateways, for different application scenarios.

e) For better service management, the PAAS platform is required to monitor and manage the performance status of services and applications, and accurately and effectively display service status.

7) O&M management

a) In the unified MEC edge computing scenario, the PAAS platform is required to support centralized operation and maintenance (O&M) management, and collaborates with the multiaccess edge computing platform management system (MEPM) and multiaccess edge computing application orchestration system (MEAO) for unified O&M management.

b) To ensure the automated and centralized deployment of services and applications, the PAAS platform is required to support SDN network automation.

c) The multitenant management function is required. This supports sharing of the same system or program components in a multiuser environment while still ensuring data isolation between users.

d) The PAAS platform provides centralized software repository and unified software management to support O&M operations, such as centralized rollout, synchronization and upgrade of service and application software.

e) Layered O&M is required. The PAAS platform is required to monitor the basic load and status of services and applications, collect data and display the data in a unified manner.

8.1.2 MEC network service

An MEC network service is a service provided and deployed either by the MEC platform or an MEC application. When provided by an MEC application, it can be registered in the list of services to the MEC platform. The services of MEC platform include RNIS, location services, UE identifier, bandwidth management and TCP optimization, which can be categorized as MEC network services; while the services of MEC application include CDN, AI/ML, and transcoding, which can be categorized as MEC application services.

8.1.3 MEC application

An MEC application runs on top of the virtualization infrastructure, and can interact with the MEC platform to provide and deploy MEC services. In certain cases, MEC applications can interact with the MEC platform to perform the procedures related to the lifecycle management of the application, such as indicating availability, preparing relocation of user state, etc. MEC applications can have a

certain number of rules and requirements associated to them, such as required resources, minimum bandwidth, maximum latency, required services, etc.

The applications use the exposed network capabilities, infrastructure capabilities and service capabilities of the capability exposure layer of MEP and the capability exposure function in UNIC-CP, to provide various services and applications to end users of public network and dedicated network, such as ultra-high-definition (UHD) video service, augmented reality / virtual reality (AR/VR) service, cloud gaming service, broadcasting service, multicasting service, vertical industry service and vehicular service.

8.1.4 Capability exposure

The capability exposure layer of MEP provides an integrated development environment for services and applications, offers secure and efficient network capabilities and application enabling functions for services and applications, and orchestrates and manages services and applications to meet diverse service requirements.

The capability exposure layer of MEP exposes the network capabilities and infrastructure capabilities of ME-PAAS, and the service capabilities of network services and application services, to the APP layer of MEP and third-party applications outside MEP.

The exposed capabilities include those specified in clause 7 of this Recommendation.

The capability exposure layer of MEP is recommended to interact with the capability exposure function in UNIC-CP of the FMC network, to provide non-edge capabilities of the FMC network to APP layer of MEP.

8.2 Edge management and orchestration

The edge management and orchestration, which includes MEAO and MEPM, is the brain of the entire FMC edge computing platform. It receives scheduling instructions from O&M personnel, terminals and management interfaces, and schedules edge resources for services and applications deployed at the edge. In this way, edge services and applications can be deployed, and the lifecycles of services and applications can be managed automatically or manually.

MEAO is the service orchestration management centre of the FMC edge computing platform. It is responsible for the overall ME-APP orchestration and lifecycle management. The network functions virtualization orchestrator (NFVO) is the overall orchestration and lifecycle management centre of network components. The MEAO and NFVO cooperate with each other to manage a massive number of FMC edge cloud sites. Based on service requirements and policies, the MEAO manages and orchestrates the required ME-APP in specific regions, while the NFVO manages and orchestrates the UPF or vPGW-U.

The MEPM manages the lifecycles of ME-APPs and MEPs, while the virtualized network function manager (VNFM) manages the lifecycles of the UPFs. The MEPM and VNFM carry out deployment tasks delivered by the MEAO and NFVO, respectively, allocate resources to FMC edge cloud sites and deploy the required ME-APPs and user plane NFs.

9 Security considerations

The unified FMC edge computing platform is required to take into account the issues of security and privacy. Each component of the unified FMC edge computing platform is required to adopt the measures of network information protection and user information protection, to avoid unauthorized access and information leaking.

Security and privacy concerns should be aligned with the requirements specified in [ITU-T Y.3101] and [b-ITU-T Y.2701]. The aspects of physical security, deployment security, communications security, data security and service/application security are required for a unified FMC edge computing platform.

Bibliography

[b-ITU-T Y.2701] Recommendation ITU-T Y.2701 (2007), *Security requirements for NGN release 1*.

[b-ITU-T Y.3100] Recommendation ITU-T Y.3100 (2017), *Terms and definitions for IMT-2020 network.*

[b-ITU-T Y.3131] Recommendation ITU-T Y.3131 (2019), *Functional architecture for supporting fixed mobile convergence in IMT-2020 networks*.

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