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SERIES F: NON-TELEPHONE TELECOMMUNICATION SERVICES

Multimedia services

Requirements for mobile edge computing-enabled content delivery networks

Recommendation ITU-T F.743.10

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Recommendation ITU-T F.743.10

Requirements for mobile edge computing-enabled content delivery networks

Summary

Recommendation ITU-T F.743.10 specifies the general framework, scenarios and requirements for mobile edge computing- (MEC-)enabled content delivery networks (CDNs). Recommendation ITU-T F.743.10 also specifies the requirements for MEC functions on which a CDN edge node relies. The deployment of a CDN edge node with an MEC system is described in the general framework. Several use cases are introduced in Recommendation ITU-T F.743.10 to illustrate the usage of MEC-enabled CDN.

History

Edition	Recommendation	Approval	Study Group	Unique ID*
1.0	ITU-T F.743.10	2019-11-29	16	11.1002/1000/14103

Keywords

MEC-enabled CDN, mobile edge CDN, mobile edge computing.

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The World Telecommunication Standardization Assembly (WTSA), which meets every four years, establishes the topics for study by the ITU-T study groups which, in turn, produce Recommendations on these topics.

The approval of ITU-T Recommendations is covered by the procedure laid down in WTSA Resolution 1.

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As of the date of approval of this Recommendation, had not received notice of intellectual property, protected by patents, which may be required to implement this Recommendation. However, implementers are cautioned that this may not represent the latest information and are therefore strongly urged to consult the TSB patent database at http://www.itu.int/ITU-T/ipr/.

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Requirements for mobile edge computing-enabled content delivery networks

1 Scope

This Recommendation specifies requirements and offers a general framework for mobile edge computing- (MEC-) enabled content delivery networks (CDNs), as well as several application scenarios to illustrate their effectiveness. Requirements include those for CDN service, MEC function, security and charging.

2 References

None.

3 Definitions

3.1 Terms defined elsewhere

None.

3.2 Terms defined in this Recommendation

This Recommendation defines the following terms:

3.2.1 mobile edge computing: System which provides an IT service environment and cloud-computing capabilities at the edge of an access network which contains one or more type of access technology, and in close proximity to devices.

NOTE – Based on the definition of multi-access edge computing in [b-ETSI GS MEC 001].

3.2.2 mobile edge computing-enabled content delivery network: A content delivery network (CDN) enhanced by mobile edge computing (MEC), which is able to provide distribution and delivery service at the edge of the network. An MEC-enabled CDN can be composed of a conventional CDN node and a mobile edge CDN node.

3.2.3 mobile edge content delivery network: A group of content delivery network nodes, which is deployed locally on a mobile edge computing host, which can provide content delivery service to users on the edge of a mobile network.

3.2.4 mobile edge content delivery network instance: A mobile edge content delivery network node, which is instantiated in mobile edge computing system as an application.

4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

3D Three Dimensional

AR Augmented Reality

API Application Program Interface

App Application

CDN Content Delivery Network

DNS Domain Name System

FQDN Fully Qualified Domain Name

GSLB	Global Server Load Balance
IP	Internet Protocol
IT	Information Technology
MEC	Mobile Edge Computing
QoE	Quality of Experience
RNIS	Radio Network Information Service
RTT	Round-Trip Time
UE	User Equipment
VCR	Video Cassette Recorder
VR	Virtual Reality

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 document is to be claimed.

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

The keywords "can optionally" and "may" indicate an optional requirement which is permissible, without implying any sense of being recommended. These terms are not intended to imply that the vendor's implementation must provide the option and the feature can be optionally enabled by the network operator/service provider. Rather, it means the vendor may optionally provide the feature and still claim conformance with the specification.

6 Introduction

CDN is built for serving content to users in a transparent and efficient way, by which, the quality of experience (QoE) of mobile users is guaranteed with optimized availability and performance. Nowadays, rapid growing high-resolution video-related services and interactive content, such as 4K/8K video formats and (virtual reality/augmented reality (VR/AR), require lower latency and higher throughput from the network. However, considerable latency and a bandwidth availability bottleneck exist in a mobile backhaul network when CDN is highly deployed on a backbone or metro network.

MEC-enabled CDN refers to a CDN including conventional CDN and mobile edge CDN. The general framework of a MEC-enabled CDN is shown in Figure 6-1.

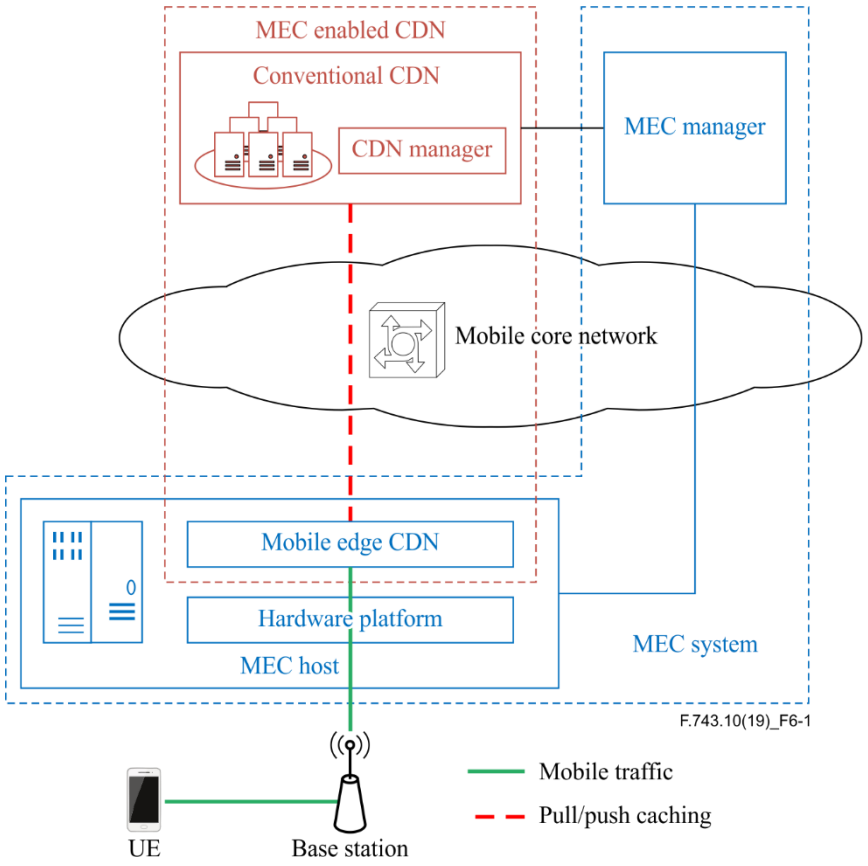

Figure 6-1 – The general framework of MEC-enabled CDN

MEC is proposed for migrating computation, storage and service capability to the network edge. It is considered to be a promising technology for establishing mobile edge CDN due to its traffic routing ability and cloud computing or information technology (IT) service environment. An MEC system consists of a MEC host and MEC manager, in which a mobile edge CDN node is deployed and instantiated as a MEC application (app) [b-ETSI GS MEC 003].

Through the MEC manager, related mobile edge CDN network service files and software can be downloaded to and validated by an MEC host for further instantiation and deployment, as well as other management functionalities, such as life cycle management.

By utilizing MEC, mobile edge CDN nodes can be deployed locally in a distributed way (e.g., collocated with base station) and should be able to interact with conventional CDN nodes for pull caching and push caching.

This Recommendation describes scenarios and requirements of MEC-enabled CDN.

7 MEC-enabled CDN scenarios

This clause describes various scenarios for MEC-enabled CDN.

7.1 Hot content caching locally

Because of the wide adoption of social media, a large number of users within a geographical area, such as a campus, enterprise or residential area, may request the same hot content in a given period of time, including news, music and videos. This puts tremendous pressure on the backhaul bandwidth of a mobile network and leads to a poor QoE for users.

This problem can be alleviated by MEC-enabled CDN with cloud-computing capabilities and an IT service environment provided by MEC; see Figure 7-1. In mobile edge CDN, the most popular content can be stored at the edge of a mobile network (e.g., collocated with a base station) and consumed in the local area. Once requested, the hot content can be sent to users from the edge of a mobile network with high quality and low latency. In that case, there is no need to transfer content over a mobile core network from the conventional CDN. The mechanism of hot content selection shall be predefined or dynamically updated to fulfil the request of the user.

Therefore, by deploying MEC-enabled CDN, the backhaul occupation of a mobile network can be saved and the QoE of users improved as content is transferred without additional delays from the mobile core network and backbone network. In addition, CDN operators can achieve better system performance and cost savings on the transport bandwidth.

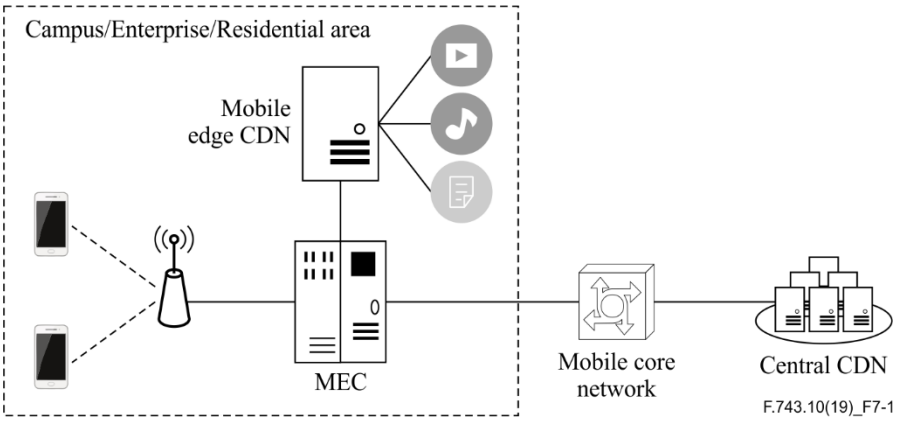

Figure 7-1 – Hot content caching in mobile edge CDN

7.2 VR/AR

VR/AR involves a computer-generated three-dimensional (3D) simulation environment that presents virtual experience to the user. VR applications mainly include VR videos and VR games.

In the next few years, smartphones and other smart devices will become the entry point for most VR/AR consumers. To achieve an immersive panoramic video experience, VR applications need at least 100 MB of bandwidth, which will pose great challenges for mobile network bandwidth. For example, a 60-frame 4K video consumes 1 GB to 10 GB of traffic per minute, and a 20 min 4K video requires almost 100 GB of traffic. CDN can cope with transferring and delivering large files to users while ensuring QoE. An MEC-enabled CDN allows users to download VR/AR data they request from the nearest CDN node, thus guaranteeing the immersive experience of a VR application.

As shown in Table 7-1, the development of VR services can be divided into four grades, corresponding to different experience requirements. Deep immersion requires an RTT less than 20 ms and full immersion requires an RTT less than 10 ms, which imposes demanding requirements on network latency. Network latency needs the help of mobile edge CDN to meet the delay requirements of VR services, such as illustrated in Figure 7-2.

Table 7-1 – Experimental parameters for VR immersion experience

Grade	Video resolution	Bandwidth	Round-trip time (RTT)
Entry-level immersion	4K 2D 360 videos	20-50 Mbit/s	< 40 ms
Partial immersion	8K 2D 360 videos	50-200 Mbit/s	< 30 ms
Deep immersion	12K 2D 360 videos	200 Mbit/s-1 Gbit/s	< 20 ms
Fully immersion	24K 3D 360 videos	2-5 Gbit/s	< 10 ms

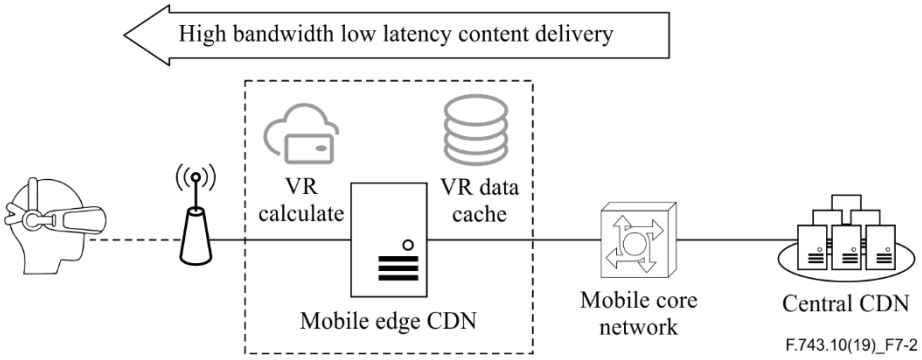

Figure 7-2 – VR service provided by the MEC-enabled CDN

7.3 Live video

Live video brings a much higher demand for concurrency, continuity and low latency. A complex mobile network environment may cause adverse effects, such as high latency, packet loss and video jam for live video service, which could affect live interaction with audiences and reduce QoE. Future live video will rely on high stability and interactivity, with a video delay ratio under 1%, latency less than 2 s and fluency higher than 99%, when there are high numbers of simultaneous online users. A traditional centralized CDN cannot meet the requirements for live video service.

In an MEC-enabled CDN, video data is preferentially sent to the nearest mobile edge CDN based on global server load balance (GSLB) and the streaming media transmission protocol. Simple video processing and content management is supported by computing capability provided by MEC. In addition, with the radio network information service (RNIS) provided by the MEC system, video rate can be adaptively adjusted to achieve smooth live video transmission in a weak network situation. At the same time, live video can be saved in real time by a mobile edge CDN. If other users request playback of the live video, it can be directly distributed by the mobile edge CDN without returning to the conventional CDN. In MEC-enabled CDN, video data can be transferred to the live centre that is deployed on the backbone network through the intelligent scheduling system for video processing and fast content delivery.

In addition, for the mobile live video shown in Figure 7-3, a bullet screen in live video and a real-time commentary subtitle, can be directly delivered to CDN nodes by MEC-based bullet screen delivery technology, thus ensuring real-time bullet screen interaction for users.

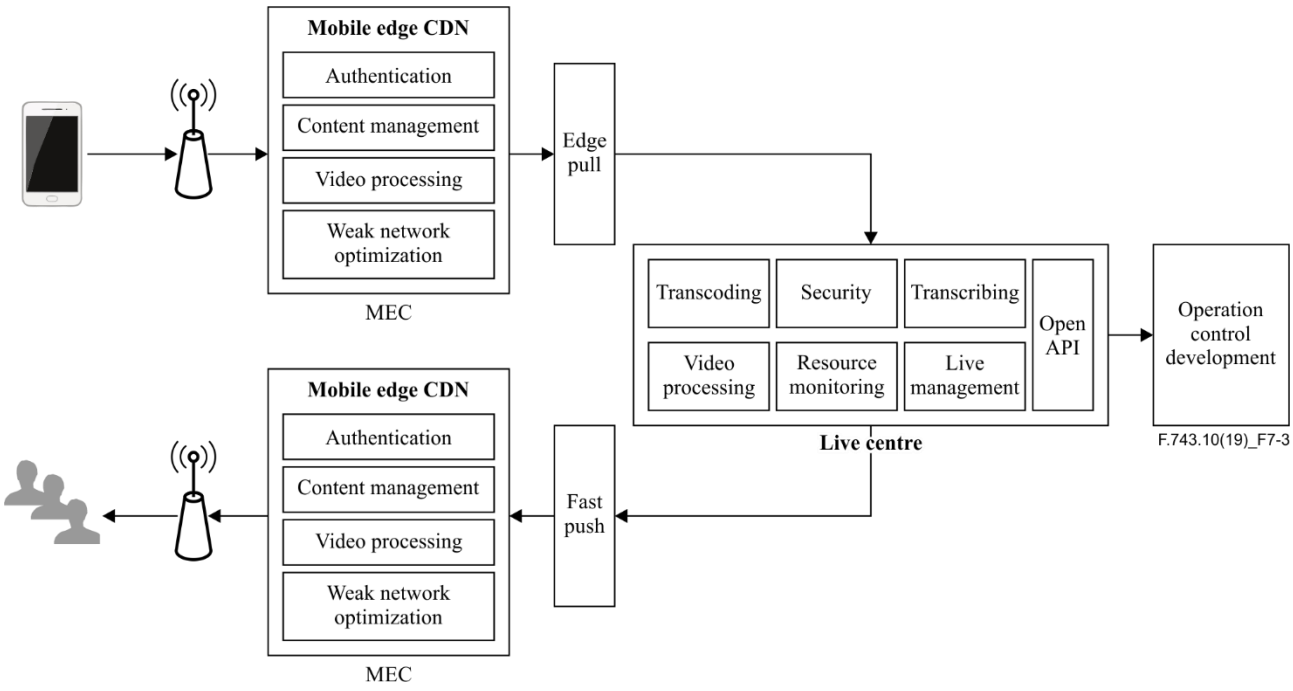

Figure 7-3 – A mobile live video provided by a MEC-enabled CDN

In a stadium environment, as shown in Figure 7-4, the MEC system can be configured with strong computing or storage capability and bandwidth to meet the processing and delivery requirements of the video uploaded by multiple video capture devices (e.g., video cassette recorders (VCRs), cameras, and civilian unmanned aerial vehicles). Also, there is a considerable amount of video traffic that needs to be transmitted back to local users through the MEC system.

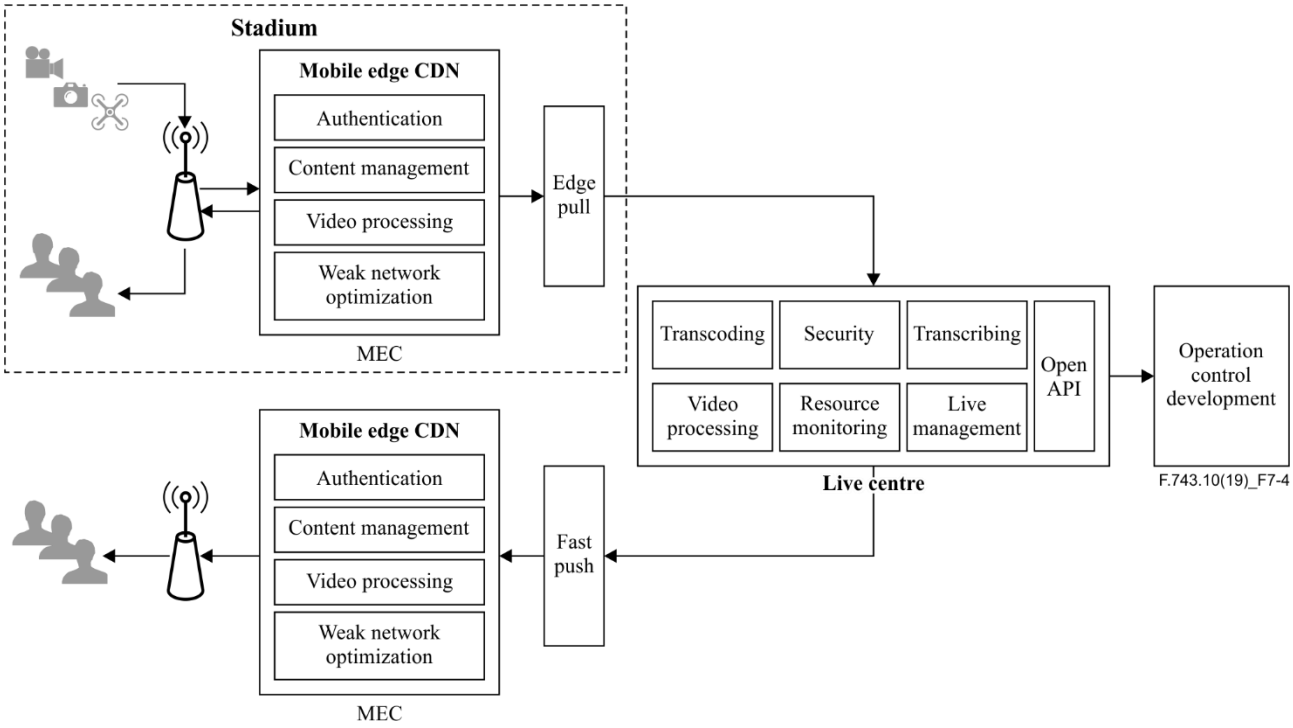

Figure 7-4 – Live video in a stadium environment

Therefore, with the local access, computing, storage and bandwidth capabilities provided by the MEC system, a one-stop solution is available for capture, processing, delivery and transcoding of live video,

as well as reducing video jams and long delays on a mobile network. With an MEC-enabled CDN, an expediently accessible, high-definition, low-latency, high-concurrency environment is brought to live video. Consequently, end users can enjoy a fast, fluent and stable live video experience. Furthermore, the traffic cost of a live video platform can be reduced by an MEC-enabled CDN, increasing user adherence and enhancing the brand value.

8 Requirements for MEC-enabled CDN

To deploy a MEC-enabled CDN, the following requirements should be fulfilled.

8.1 CDN service requirements

The requirements for a CDN specified in this clause are specific to the support of MEC-enabled CDNs.

8.1.1 Content ingestion

CSR01: The MEC-enabled CDN is required to ingest content from the content source into MEC-enabled CDN nodes.

CSR02: The MEC-enabled CDN is recommended to ingest content from other CDN nodes into MEC-enabled CDN nodes.

8.1.2 Content acceleration

CSR03: A mobile edge CDN node is recommended to support content acceleration, e.g., that for video/audio on demand, large file download and distribution and live video acceleration.

8.1.3 Content process

CSR04: An MEC-enabled CDN is recommended to process original content locally in mobile edge nodes before distribution or delivery, including reformatting and transcoding.

8.1.4 Content cache

CSR05: An MEC-enabled CDN is required to cache or store content locally.

8.1.5 Content distribution

CSR06: An MEC-enabled CDN is recommended to distribute content within other nodes under the coverage of the MEC service, according to the distribution policy.

8.1.6 Content delivery

CSR07: An MEC-enabled CDN is required to deliver content corresponding to user requests to end-users.

CSR08: An MEC-enabled CDN is recommended to deliver content from one node to other nodes.

8.1.7 Content request routing

CSR09: An MEC-enabled CDN is recommended to redirect content requests to other MEC-enabled CDN nodes or CDN nodes when local content is not available.

8.1.8 Connectivity

CSR10: Mobile edge CDN nodes are required to communicate with other mobile edge CDN nodes running on different MEC hosts through the MEC system.

CSR11: Mobile edge CDN nodes are required to communicate with conventional CDN nodes deployed in external networks through the MEC system.

8.1.9 Traffic routing

CSR12: A mobile edge CDN node is recommended to retrieve selected user plane traffic.

8.1.10 Domain name system (DNS) support

CSR13: A CDN manager is recommended to configure a local DNS proxy on an MEC host by association with a specific fully qualified domain name (FQDN) according to the Internet protocol (IP) addresses allocated to a mobile edge CDN node.

8.1.11 Service customization

CSR14: Multiple types of service customization and priority rank are optionally being predetermined and supported for various uses of mobile edge CDNs.

8.2 MEC functional requirements

The requirements for an MEC system specified in this clause are specific to the support of MEC-enabled CDNs.

8.2.1 Service request

MFR01: An MEC system is recommended to receive service requests from a CDN operation system.

8.2.2 App deployment

MFR02: The functional components of MEC-enabled CDNs are recommended to be virtualized and run as one or more MEC apps.

8.2.3 Traffic routing

MFR03: Application data traffic routing is required to be supported by an MEC system among mobile edge CDN nodes, user equipment (UE) and conventional CDN nodes.

MFR04: An MEC system is recommended to influence traffic routing according to CDN requirements, such as location.

8.2.4 DNS support

MFR05: An MEC system is recommended to take charge of the DNS functionality of mobile edge CDN nodes to route all DNS traffic received from any UE to a local DNS server or proxy.

MFR06: An MEC system can optionally support eDNS [b-IETF RFC 6891] functions, which can intercept DNS requests and insert location information.

8.2.5 Mobility support

MFR07: An MEC system is required to support service continuity of mobile subscribers when they are moving, resulting in a switch of serving MEC hosts on one MEC system.

MFR08: An MEC system can optionally support service continuity of mobile subscribers when they are moving, resulting in a switch of serving MEC hosts among different MEC systems.

MFR09: An MEC system is required to support two mobile edge CDN instances running on different MEC hosts in transmission of application-specific user-related information between instances through a specific interface for UE mobility support.

8.2.6 System monitoring and information open

MFR10: An MEC system is required to provide an application program interface (API) service function that provides information and services from the network to an MEC-enabled CDN.

MFR11: An MEC system is recommended to collect virtualization resources usage information about the MEC host and expose it to the CDN manager.

MFR12: An MEC system is recommended to provide up-to-date information of available MEC hosts to the CDN manager.

MFR13: An MEC system is optionally able to store and provide the up-to-date topology status (e.g., location information) of a mobile edge CDN network to avoid circuitous traffic.

MFR14: An MEC system is optionally able to provide necessary information about the radio access network, traffic load and network status to the CDN manager.

MFR15: An MEC system is optionally able to provide radio access network information to an MEC-enabled CDN for its service optimization.

MFR16: An MEC system is optionally able to monitor mobile edge CDN instances for performance measurement.

MFR17: An MEC system can optionally receive: any configuration changes to the CDN from the CDN manager; any usage changes to the MEC system; or UE location changes, and notify CDN UE.

MFR18: An MEC system should provide location information to assist UE to select the optimal MEC system or MEC-enabled CDN.

8.2.7 Dynamic virtualization resource allocation

MFR19: An MEC manager is recommended to dynamically configure the virtualization resources of mobile edge CDN instances according to requests from the CDN manager.

8.3 Security

SC01: Any request for MEC system monitoring information (e.g., mobile edge CDN node performance, traffic load, network status, virtualization resource usage or available MEC hosts) is recommended to be authorized by the MEC system.

8.4 Charging

CH01: An MEC system is recommended to provide charging-related information (e.g., traffic usage, application instantiation, access, usage duration and resource usage) to the CDN manager.

CH02: An MEC-enabled CDN is recommended to support different charging rules.

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