International Telecommunication Union

ITU-T

TELECOMMUNICATION
STANDARDIZATION SECTOR
OF ITU

F.749.11

(11/2019)

SERIES F: NON-TELEPHONE TELECOMMUNICATION SERVICES

Multimedia services

Requirements for civilian unmanned aerial vehicles enabled mobile edge computing

Recommendation ITU-T F.749.11

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Recommendation ITU-T F.749.11

Requirements for civilian unmanned aerial vehicles enabled mobile edge computing

Summary

Civilian unmanned aerial vehicle (CUAV) enabled mobile edge computing (MEC) utilizes CUAV as an MEC platform to realize a flexible, efficient and on-demand computing service that can be rapidly deployed and move according to the practical service needs of devices. Recommendation ITU-T F.749.11 describes the framework and specifies requirements for a CUAV-MEC system, including functional, service and security requirements.

History

Edition	Recommendation	Approval	Study Group	Unique ID*
1.0	ITU-T F.749.11	2019-11-29	16	11.1002/1000/14104

Keywords

Civilian unmanned aerial vehicle, mobile edge computing.

* To access the Recommendation, type the URL http://handle.itu.int/ in the address field of your web browser, followed by the Recommendation's unique ID. For example, http://handle.itu.int/11.1002/1000/11830-en.

FOREWORD

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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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Requirements for civilian unmanned aerial vehicles enabled mobile edge computing

1 Scope

This Recommendation specifies the system framework and requirements for civilian unmanned aerial vehicle-enabled mobile edge computing (CUAV-MEC).

The scope of this Recommendation includes:

– system framework of CUAV-MEC;

– functional requirements for CUAV-MEC;

– service requirements for CUAV-MEC;

– security requirements for CUAV-MEC.

2 References

None.

3 Definitions

3.1 Terms defined elsewhere

This Recommendation uses the following terms defined elsewhere:

3.1.1 application [b-ITU-T Y.101]: A structured set of capabilities, which provide value-added functionality supported by one or more services.

3.1.2 civilian unmanned aerial vehicle [b-ITU-T F.749.10]: An unmanned flying device controlled by a ground control station or telecontroller via various wireless communication means. It usually consists of an aeroplane body, a power device, aviation electrical and electronic equipment and mission payload equipment, etc. and is used in non-military application areas such as industrial and consumer areas to complete the specific operation and transportation of data including audio, video and image.

3.1.3 device [b-ITU-T Y.4000]: With regard to the Internet of things, this is a piece of equipment with the mandatory capabilities of communication and the optional capabilities of sensing, actuation, data capture, data storage and data processing.

3.1.4 service [b-ITU-T Y.101]: A structure set of capabilities intended to support applications.

3.2 Terms defined in this Recommendation

This Recommendation defines the following terms:

3.2.1 civilian unmanned aerial vehicle collaboration: Utilization of the ability of multiple unmanned aerial vehicles to accomplish specific tasks through network communication.

3.2.2 civilian unmanned aerial vehicle-enabled mobile edge computing: Utilization of civilian unmanned aerial vehicles as a mobile edge computing platform to accomplish computation-intensive and latency-critical applications through task offloading.

3.2.3 communication service: Service that controls information transmission, including uplink transmission of input data for the application (offloading from the devices to civilian unmanned aerial vehicles (CUAVs)) and downlink transmission of the results (from the CUAVs to the devices).

3.2.4 mobile edge computing: System which provides an information technology (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].

3.2.5 resource allocation: Allocation that controls resource usage, including communication, computing and cache resources within civilian unmanned aerial vehicles according to the task offloading decisions.

3.2.6 task offloading: Offloading determining where to execute tasks and how to allocate tasks according to various factors, such as the computation demands of devices and existing resources of civilian unmanned aerial vehicles.

3.2.7 task requirements: The required communication and computing resources and the executed latency constraints for applications generated by devices.

4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

4G	Fourth Generation
5G	Fifth Generation
CUAV	Civilian Unmanned Aerial Vehicle
CUAV-MEC	Civilian Unmanned Aerial Vehicle-enabled Mobile Edge Computing
MEC	Mobile Edge Computing
WiFi	Wireless Fidelity

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.

6 Overview

Mobile edge computing (MEC) brings computation and storage to the edge of a mobile network and promises dramatic reduction in latency and mobile energy consumption. However, in many realistic-scenarios, such as emergency and public safety situations, temporary hotspot areas, and military scenarios, the static ground base stations are damaged or it is difficult to meet the requirements of the devices. The civilian unmanned aerial vehicle (CUAV) is a promising solution to extend edge service scope and provide offloading opportunities for devices in such scenarios owing to its mobility, autonomy and flexibility. Because some typical scenarios for CUAV-MEC are appearing and growing rapidly, requirements for CUAV-MEC need to be addressed.

7 System framework of the CUAV-MEC

Figure 1 shows a reference framework for the CUAV-MEC system, which has three layers: a device interface, CUAV on-board servers and a central management platform.

The device interface layer is used by various kinds of devices, such as cars, mobile phones and sensors. A device application locates directly in the device that exploits the CUAV-MEC service.

Data generated by devices can be uploaded to CUAV on-board servers supported by the communication service.

The CUAV on-board server layer offers four main function modules for location placement, communication service, task offloading and resource allocation. Location placement determines the locations of CUAVs according to service demands and devices. As a communication module in the middle layer, the communication service module allows CUAV on-board servers to communicate with lower devices and the upper central platform to transmit related data. The task-offloading module aims to make suitable offloading decisions for devices. The resource allocation module controls the usage of communication, computing and cache resources within CUAVs.

The central management platform layer provides multiple management services and controls the overall MEC function. The device management module manages devices and CUAVs hosted on lower layers. The service management module profiles the CUAV server services available. The status monitoring module monitors CUAV computation resource status and communication channel status.

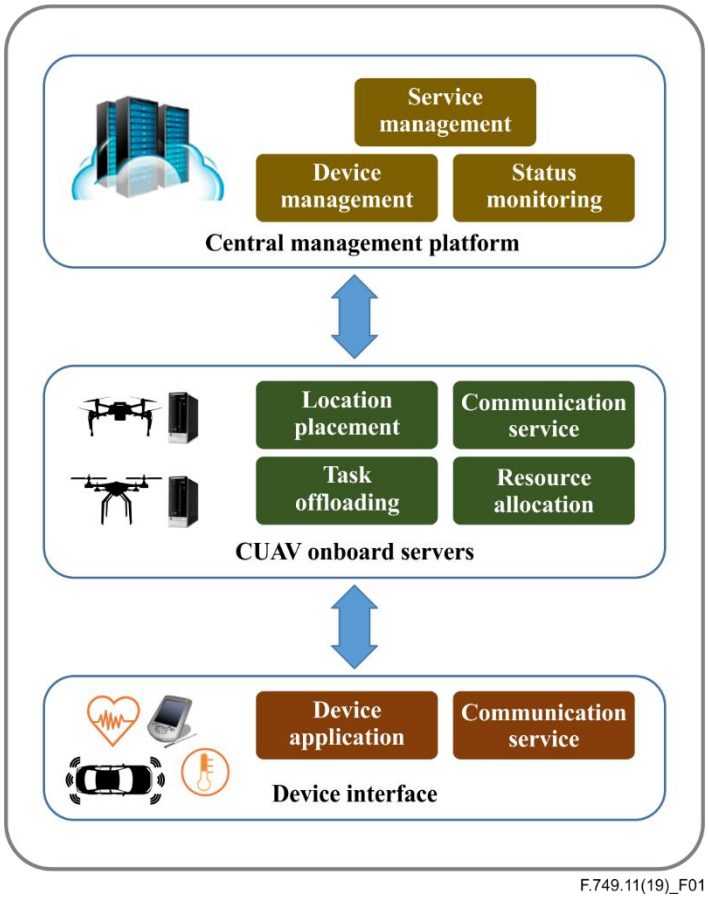

Figure 1 – The system framework of CUAV-MEC

8 Function requirements for CUAV-MEC

8.1 Requirements for location placement for CUAV-MEC

FUN-001: The location information of devices includes the location of all devices currently associated with the CUAV.

FUN-002: The CUAV-MEC system is required to feasibly move the CUAV toward devices and provide MEC service for connected devices. It is of critical importance to determine the CUAV

parameters affecting service performance, such as altitude, location and trajectory according to changes in device location information.

8.2 Requirements for communication services for CUAV-MEC

FUN-003: The CUAV-MEC system is required to establish a stable and reliable communication link between a CUAV and devices so as to transmit input data for task execution and output results.

FUN-004: The CUAV-MEC system is required to establish a stable and reliable communication link between a CUAV and the central management platform so as to interactively share control and management data.

FUN-005: The CUAV-MEC system is recommended to establish a stable and reliable communication link between CUAVs so as to collaboratively serve the devices.

FUN-006: The CUAV-MEC system is recommended to establish the communication link by utilizing fourth generation (4G), fifth generation (5G) or wireless fidelity (WiFi) access methods. The CUAV-MEC system is recommended to adjust the data transmission and network mode in response to changes in bandwidth status.

8.3 Requirements for task offloading for CUAV-MEC

FUN-007: The CUAV-MEC system is required to make suitable decisions on task offloading aiming to determine whether the offloading is profitable for devices and can reduce energy consumption and execution delay.

FUN-008: The CUAV-MEC system is required to make suitable decisions to satisfy the task requirements of devices.

FUN-009: The CUAV-MEC system is recommended to design different task-offloading strategies according to the various applications requirements and consider various parameters that play critical roles for the performance of task offloading, including latency, bandwidth utilization, context awareness and scalability.

FUN-010: The CUAV-MEC system is recommended to make adaptive task-offloading decisions based on changes in communication, storage and computation resources.

8.4 Requirements for resource allocation for CUAV-MEC

FUN-011: The CUAV-MEC system is required to allocate communication resources for devices.

FUN-012: The CUAV-MEC system is required to allocate computing resources for devices.

FUN-013: The CUAV-MEC system is recommended to provide a resource allocation strategy during the whole edge computing stage in order to significantly improve system performance and network resource utilization. The resource allocation strategy includes joint communication and computation resource allocation, service scheduling and CUAV selections.

8.5 Requirements for CUAV collaboration for CUAV-MEC

FUN-014: The CUAV-MEC system is recommended to serve devices in a cooperative way according to the mobility of devices and changes in service demand.

FUN-015: The CUAV-MEC system is recommended to utilize the CUAV collaboration to decrease handover, optimize resource allocation and improve performance.

9 Service requirements for CUAV-MEC

SRV-001: The CUAV-MEC system is required to support data transmission and data processing in multiple formats, such as image, audio and video.

SRV-002: The CUAV-MEC system is required to support real-time data transmission from devices to CUAVs.

SRV-003: The CUAV-MEC system is required to support real-time data processing on CUAVs for multiple devices.

SRV-004: The CUAV-MEC system is required to support collection of the communication and computation resource status of CUAVs.

SRV-005: The CUAV-MEC system is required to support collection of the task requirements and environmental status of devices.

SRV-006: The CUAV-MEC system is required to provide task execution information for ground devices.

SRV-007: The CUAV-MEC system is recommended to support task management. The task requirement and task execution mechanisms are required to be efficient and flexible.

SRV-008: The CUAV-MEC system is recommended to utilize CUAV collaboration to jointly serve all associated devices.

SRV-009: The CUAV-MEC system is recommended to provide different services according to task priority.

SRV-010: The CUAV-MEC system is recommended to have the ability to store corresponding contents so as to rapidly provide services.

10 Security requirements for CUAV-MEC

SEC-001: The CUAV-MEC system is required to permit authorized devices to access the system and obtain edge computing services. The CUAV-MEC system is required to forbid an unauthorized device to utilize any resource of the system and perform incorrect operations in CUAV-MEC.

SEC-002: The CUAV-MEC system is required to ensure the security of data transmission. It is required to protect privacy of data communication and provide network transmission with high availability and high reliability.

SEC-003: The CUAV-MEC system is required to ensure security of data processing. It is required to provide appropriate mechanisms to control and manage security of data collection, storage and computation. The required security mechanisms include device privacy protection, network attack avoidance, data security isolation and service authorization.

Appendix I

Typical scenarios of CUAV-enabled mobile edge computing

(This appendix does not form an integral part of this Recommendation.)

This appendix describes four typical scenarios for CUAV-MEC. See Figure I.1.

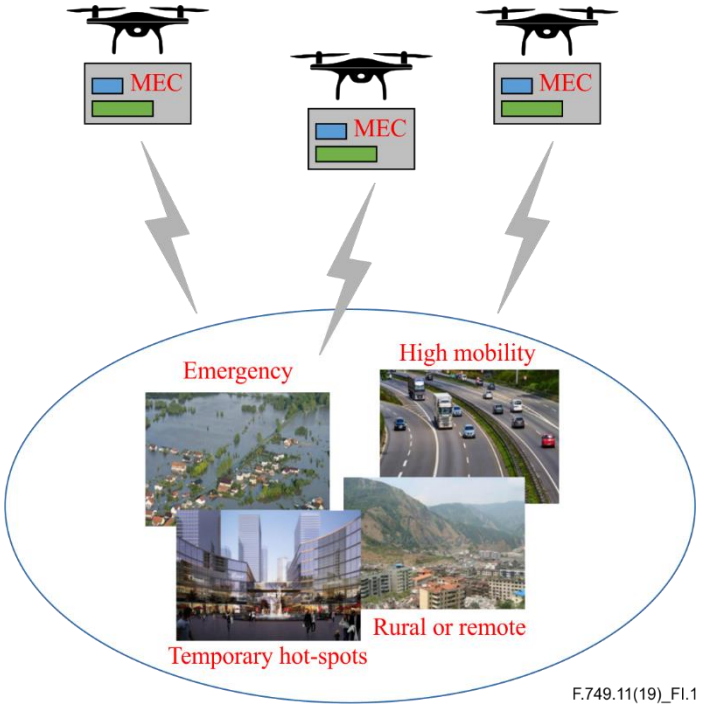

Figure I.1 – Typical scenarios of CUAV-MEC

I.1 Emergency scenarios deployment

CUAV can play an important role in disaster or emergency relief scenarios, as ground devices with limited processing capabilities can benefit from CUAV-aided execution of data analytics application, such as assessing victim location, hazardous terrain and structures. In addition, if the ground communication infrastructure is damaged or inadequate, the CUAV can simultaneously provide connectivity and computation service for ground devices.

I.2 Temporary hot-spot scenarios deployment

The temporary hot-spot scenarios usually create hard-to-predict inhomogeneous service demands. Meeting the requirements of this scenario is challenging, especially for delay-sensitive and compute-intensive applications. The existing facilities cannot meet the needs of devices, while establishing the temporary infrastructures can easily lead to cost increase and waste of resources. CUAV is appropriate to apply in this scenario, because of its high flexibility, scalability and mobility, enabling dynamic adaptation to device movement and changes in service demands.

I.3 High mobility scenarios deployment

The mobility of CUAVs enables devices with high mobility and data execution demand, e.g., autonomous driving and road navigation, to be served. CUAV-MEC can provide vehicle monitoring and address various analytics, which can reduce traffic congestion, increase road safety and enhance the overall driving experience.

I.4 Rural or remote areas scenarios deployment

A rural or remote edge network often does not offer a large computation service due to its sparsely spread populations. Moreover, the service is not always reliable, which leads to an inadequate device experience in rural or remote areas. CUAV-MEC is considered to be a flexible, efficient, low-cost and low-power infrastructure to provide various functionalities, including communication, computing, caching and transportation, for rural or remote areas.

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Printed in Switzerland
Geneva, 2020