International Telecommunication Union

ITU-T

TELECOMMUNICATION
STANDARDIZATION SECTOR
OF ITU

F.743.12

(06/2021)

SERIES F: NON-TELEPHONE TELECOMMUNICATION SERVICES

Multimedia services

Requirements for edge computing in video surveillance

Recommendation ITU-T F.743.12

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Recommendation ITU-T F.743.12

Requirements for edge computing in video surveillance

Summary

Recommendation ITU-T F.743.12 defines the requirements for edge computing in video surveillance. Edge computing is a distributed computing paradigm aimed at providing various computing services at the edge of the network, and it brings computation and data storage closer to the data source or the location where it is needed, to improve response time and save bandwidth. By using the edge computing technology, the video surveillance system can perform intelligent video analysis and store data near the network premises units. And the edge computing platform provides the management capabilities of the edge resources and functional components to the video surveillance system. It can improve the video processing efficiency and quality of services and reduce the infrastructure cost of the video surveillance system. This Recommendation describes the application scenarios and requirements for edge computing in the video surveillance system.

History

Edition	Recommendation	Approval	Study Group	Unique ID*
1.0	ITU-T F.743.12	2021-06-13	16	11.1002/1000/14680

Keywords

Edge computing, requirements, scenarios, video surveillance.

* 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.

In some areas of information technology which fall within ITU-T's purview, the necessary standards are prepared on a collaborative basis with ISO and IEC.

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In this Recommendation, the expression "Administration" is used for conciseness to indicate both a telecommunication administration and a recognized operating agency.

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1 Scope

Edge computing technology can support efficient video processing and storage at the network edge of the video surveillance system, to improve the quality of services and reduce the infrastructure cost. This Recommendation describes the application scenarios and requirements for edge computing in the video surveillance system.

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.

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 customer unit [b-ITU-T H.626V2]: A device located at the customer part of a video surveillance system and used to present multimedia information (such as audio, video, image, alarm signal, etc.) to the end user.

3.1.3 premises unit [b-ITU-T H.626V2]: A device located at the remote part of a video surveillance system and used to capture multimedia information (such as audio, video, image, alarm signal, etc.) from a surveilled object.

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

3.1.5 video surveillance system [b-ITU-T H.626V2]: A telecommunication service focusing on video (including audio and image) application technology, which is used to remotely capture multimedia (such as audio, video, image, alarm signal, etc.) and present them to the end user in a user-friendly manner, based on a managed broadband network with ensured quality, security and reliability.

3.2 Terms defined in this Recommendation

This Recommendation defines the following term:

3.2.1 edge computing platform supporting video surveillance: A geographically distributed computing paradigm, in which various servers at the edge of the network are ubiquitously networked to collaboratively provide the elastic computation, communication, and storage services to video surveillance applications. By constructing the edge computing layer between the premises units and the remote video surveillance centre, the multimedia data can be processed and stored in the

networked edge servers, which is close to the data sources. It can also effectively meet the demands of real-time or latency-sensitive video surveillance applications, and notably ease the network bandwidth bottleneck, in comparison with the centralized computing paradigm.

4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

CU Customer Unit

ECPVS Edge Computing Platform supporting Video Surveillance

IPU Intelligent Premises Unit

IVS Intelligent Video Surveillance

PTZ Pan/Tilt/Zoom

PU Premises Unit

VS Video Surveillance

5 Conventions

In this Recommendation:

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

6 Scenarios

This clause describes the various scenarios for edge computing in video surveillance (VS).

6.1 Video analysis based on edge computing servers

Case 1: Traffic flow analysis

The intelligent video surveillance (IVS) system can be used by the traffic department for monitoring the traffic flow situation. The traffic flow analysis function component is deployed in the edge computing servers for the IVS system. When a traffic administrator needs to obtain the traffic flow situation of some key road sections, they can configure the traffic flow analysis function of the related regional edge servers to process the related surveillance video streams.

Step 1: The user logs into the IVS system through the customer unit (CU), chooses some premises units (PUs) which are deployed at the interested key road sections and configures the traffic flow analysis function. They then submit the traffic flow analysis request to the IVS system.

Step 2: After receiving the request, the IVS system authenticates the user information, and configures the traffic flow analysis function of the corresponding edge computing servers. The IVS system then responds to the CU with the information of the traffic flow analysis function.

Step 3: The edge servers pull the video streams from the corresponding PUs, perform the traffic flow analysis function online, and then sends the analysis results to the IVS system which are finally shown to the user.

Case 2: Abnormal event analysis

The traffic administration department can use the IVS system to find an abnormal event in the work area. For example, the vehicle violation detection function component is deployed in the edge

computing servers for the IVS system, which then automatically detects the illegal parking event and notifies the traffic administrator.

Step 1: The user logs into the IVS system through the CU, chooses some PUs which are deployed at the interested regions and configures the illegal parking detection function. They then submit the request to the IVS system.

Step 2: After receiving the request, the IVS system authenticates the user information, and configures the illegal parking detection function of the corresponding edge computing servers. The IVS system then responds to the CU with the information of the illegal parking detection function.

Step 3: The edge servers pull the video streams from the corresponding PUs, perform the illegal parking detection function online, and then sends the analysis results to the IVS system which are finally shown to the user.

Case 3: Surveillance video preprocessing

The edge computing servers in the IVS system can support online video preprocessing such as pixel brightness transformation, geometric transformation, image smoothing, and edge detection. The output of the video preprocessing can be used for the accurate understanding of video content. However, the video preprocessing algorithms are quite different for the different video analysis functions. Thus, the administrator of the system can configure the video preprocessing functions in the edge computing servers according to further demand of video analysis.

6.2 Collaborative computing based on intelligent premises units (IPUs) and edge computing servers

Currently, many intelligent premises units (IPUs) deployed on the roadside have vehicle structuring functions, e.g., vehicle detection, vehicle colour recognition, and vehicle type recognition. Meanwhile, the intelligent vehicle retrieval function component deployed in the edge computing servers can be configured according to the user's request.

Step 1: The user logs into the IVS system through the CU. Sets several functional parameters such as the channel numbers of the related IPUs with the vehicle structuring function, and the picture of the target vehicle, and then sends the online vehicle retrieval request to the IVS system.

Step 2: After receiving the request, the IVS system authenticates the user information, and analyses the key features of the target vehicle in the picture.

Step 3: The IVS system configures the related IPUs and the online vehicle retrieval function in the related edge computing servers, and then sends the detected features of the target vehicle to the edge computing servers.

Step 4: After loading the vehicle retrieval function, the edge IPUs detect the features of the vehicle in the surveillance video streams, and then the detected results are transmitted to the edge computing servers for real-time vehicle retrieval. If the features of the received data from the IPUs match the attributes of the target vehicle successfully, the retrieval results are sent back to the IVS system which notifies the user instantly.

6.3 Collaborative edge-cloud computing

Case 1: Collaborative edge-cloud retrieval

Owing to the limited resources and data of the edge devices, the video processing results of the edge computing servers can be transmitted to the remote cloud computing platform for further analysis. For example, Tom is an administrator of an IVS system. In the case of vehicle retrieval, when Tom logs into the IVS system through the CU, he can set the channel numbers of the PUs for vehicle retrieval. The edge computing servers can detect the vehicles in the monitoring video streams after loading the vehicle detection function, and then the detected vehicle pictures are transmitted to the

remote cloud platform for real-time vehicle retrieval. The remote cloud platform can compare the vehicle pictures from the edge computing platform with samples in the vehicle database and send back the retrieval results to the IVS system.

Case 2: Collaborative edge-cloud alarm linkage

The VS system allows users to configure the collaborative edge-cloud alarm linkage. When the edge computing server reports an alarm event, the remote cloud computing platform performs the associated actions, such as recording, sending messages, and sending emails.

Case 3: Collaborative edge-cloud data subscription

The remote cloud computing platform can subscribe to the intelligent video metadata and the service alarm data generated by the edge computing platform. If the subscribed data is generated on the edge computing platform, it will be sent to the cloud computing platform directly.

6.4 Regional PU/IPU management based on edge computing servers

The edge computing servers are usually deployed at the video surveillance (VS) network edge close to the PU/IPU. Once the VS system has been deployed, the edge computing servers can automatically discover the regional PUs/IPUs within the local network, and then connect with the central management platform of the VS system. For example, Tom is an administrator of a VS system. When Tom logs into the VS system through the CU, he can set the region name of each edge computing server and the channel name of each PU/IPU within the management region of the edge server. The edge computing server can provide the related interfaces for the management of the regional PUs/IPUs, such as addition, deletion, modification, searching browsing, pan/tilt/zoom (PTZ) control, local data storage and management, media distribution for the regional PUs/IPUs.

6.5 Video storage

The edge computing server can access its regional PUs/IPUs, and the video data captured by the PUs/IPUs can be stored in the local edge computing server instead of being stored in the remote central management platform or the cloud storage system. When Tom logs into the VS system through the CU, he can replay the history video files stored in the edge computing server according to the channel name of the PU/IPU and the video start time. The edge computing server can provide the related interfaces for the playback of the history video files, such as fast-forward, fast-backward, pause, stop, and volume adjustment.

6.6 Resource, task, and algorithm management

The edge computing platform can manage the video processing algorithms stored in it. A video processing task is a running instance of a video processing algorithm. The resources of the edge computing server, including computing and storage resources, etc., can be allocated to the video tasks deployed on it flexibly, and the video tasks can be deployed on the edge computing server dynamically. The edge computing platform can manage the resources of distributed edge servers remotely and configure the video processing tasks on demand, which can reduce operation and maintenance costs.

7 Requirements for edge computing in video surveillance

7.1 User requirements

– USR-001: An edge computing platform supporting video surveillance (ECPVS) is required to support the registration and de-registration of the end user, and the end user can view and modify the personal information.

– USR-002: An ECPVS is required to support the end user login and logout from the platform conveniently. The username and password are required when an end user logs into the platform.

– USR-003: An ECPVS is recommended to support the end user view of the user access logs or other platform logs.

– USR-004: An ECPVS is required to support the end user view of the information of the edge computing server, including name, status, capabilities, location, and other information of the edge computing server.

– USR-005: An ECPVS is required to support the end user use the different platform services, including video storage and playback, video distribution, video processing, resource management, task management, and algorithm management through the graphical user interface or application programming interfaces.

7.2 Service requirements

7.2.1 Video analysis service requirements

– SER-001: An ECPVS is recommended to support the video analysis. The video analysis components deployed in the edge computing server can receive the video streams from PUs/IPUs and perform the analysis functions online and process the video files stored in the local edge computing server offline.

– SER-002: An ECPVS is recommended to support the management of the video processing algorithm repository, including algorithm addition, algorithm modification, and algorithm deletion. The video processing algorithm repository is a subsystem in the ECPVS, which is used for the algorithm storage and can be accessed by the corresponding management interfaces.

– SER-003: An ECPVS is recommended to support the management of the video processing tasks in the edge computing servers, such as creation, pause, restart, and deletion. And an ECPVS is recommended to support the concurrent running of multiple video processing tasks.

– SER-004: An ECPVS is recommended to support the view of the progress of the video analysis tasks.

– SER-005: An ECPVS is recommended to support the view of the status of the resource utilized by the video analysis tasks.

– SER-006: An ECPVS is recommended to support the view of the log files which record the operations of the video analysis tasks.

7.2.2 Collaborative computing service requirements

– SER-007: An ECPVS is recommended to support the collaborative end-edge computing based on the IPUs and edge computing servers. The intelligent video collaborative computing components deployed in the edge computing server can further analyse the results processed by the IPUs collaboratively.

– SER-008: An ECPVS is recommended to support the collaborative edge-cloud computing mode. The video processing results output by the intelligent analysis components deployed in edge servers can be further analysed by the intelligent cloud computing platform collaboratively.

– SER-009: An ECPVS is recommended to support the alarm linkage between the edge computing platform and the remote cloud computing platform. Consequently, the remote cloud computing platform can perform the associated actions, such as recording, sending messages, or emails when an alarm event is generated by the edge computing platform.

– SER-010: An ECPVS is recommended to support the subscription of the intelligent video metadata and the service alarm data from the other computing platform.
– SER-011: An ECPVS is recommended to support the management of the intelligent video collaborative computing tasks, such as creation, pause, restart, and deletion.
– SER-012: An ECPVS is recommended to support the view of the progress of the intelligent video collaborative computing tasks.
– SER-013: An ECPVS is recommended to support the view of the status of the resource utilized by the collaborative computing tasks.
– SER-014: An ECPVS is recommended to support the view of the log files which record the operations of the collaborative computing tasks.

7.2.3 Regional PU/IPU management service requirements

– SER-015: An ECPVS is recommended to support the management of the regional PUs/IPUs, such as addition, deletion, modification, searching, browsing, PTZ control of regional PUs/IPUs, and media distribution for regional PUs/IPUs.
– SER-016: An ECPVS is recommended to support the view of the log files which record the operations of the regional PU/IPU management service.

7.2.4 Video storage service requirements

– SER-017: An ECPVS is recommended to support the storage of the surveillance video captured by the regional PUs/IPUs.
– SER-018: An ECPVS is recommended to support the video data management capabilities, including browsing, searching, playback, download, and deletion of the locally stored video files.
– SER-019: An ECPVS is recommended to support the configuration for the local video storage, including setting the time for recording video, setting the time for video retention, etc.

7.3 Security requirements

7.3.1 Authentication security requirements

– SEC-001: An ECPVS is required to provide the mechanisms for authentication and authorization, and it is required to only permit the authorized users to access the platform and use the platform services. An ECPVS is required to forbid an unauthorized user to handle any resources of the platform.
– SEC-002: An ECPVS is required to support the multi-level user rights management and implement the fine-grained user group authority control.

7.3.2 Access security requirements

– SEC-003: An ECPVS is required to operate in the environment where network address translation (NAT) and/or firewall devices are present. It is recommended to utilize the specified firewalls, gatekeepers, and other network devices to ensure the security for access to some special edge computing services.

7.3.3 Content security requirements

– SEC-004: An ECPVS is required to ensure the security of the stored video files, the results of the video processing, etc.
– SEC-005: An ECPVS is required to protect user privacy.
– SEC-006: An ECPVS is recommended to support the addition of the digital watermark in the video of the specified cameras.

– SEC-007: An ECPVS is recommended to support the media transmission encryption including video streaming encryption and image encryption during media transmission.

7.3.4 System security requirements

– SEC-008: An ECPVS is required to have the capability of resisting various attacks.

– SEC-009: An ECPVS is required to provide the mechanisms for troubleshooting. It is required that a structural single-node problem be avoided (i.e., a problem at a single node should not cause the failure of the entire platform).

7.4 Management requirements

7.4.1 Resource management requirements

– MAN-001: An ECPVS is required to provide the unified management of the edge computing servers.

– MAN-002: An ECPVS is recommended to support the resource management of the edge computing servers, such as computing resources, and storage resources. The resources can be allocated and withdrawn flexibly according to the service requests.

– MAN-003: An ECPVS is recommended to monitor, record, search, and display the operational status of the resources.

7.4.2 Tasks management requirements

– MAN-004: An ECPVS is recommended to support the dynamic task deployment in the edge computing servers, and the edge computing tasks can be installed and uninstalled flexibly according to the service requests.

– MAN-005: An ECPVS is recommended to support the computing task management, including configuration, addition, deletion, migration, search, and browsing of the edge computing tasks.

– MAN-006: An ECPVS is recommended to monitor, record, search, and display the status of the edge computing tasks.

7.4.3 Algorithm management requirements

– MAN-007: An ECPVS is recommended to support the algorithm management, including addition, deletion, update, search, and browsing of the edge computing algorithms in the video algorithm repository. The video processing algorithms are usually stored in the video algorithm repository subsystem which can be accessed by the corresponding interfaces.

7.4.4 Service management requirements

– MAN-008: An ECPVS is recommended to provide the capabilities of selecting the specific invoking location of various services among the edge computing servers.

– MAN-009: An ECPVS is recommended to provide the various computing service subscription means for users and the capabilities of querying, viewing, and modifying their subscription information of the edge computing services.

– MAN-010: An ECPVS is recommended to provide the capability of accounting, billing, and charging for the edge computing service operation.

– MAN-011: An ECPVS is recommended to provide the various alternative accounting modes, and to support flexible combination of payment modes, billing modes, billing cycles, preferential pricing, etc.

7.4.5 System management requirements

– MAN-012: An ECPVS is required to provide the unified system management interface which can be called conveniently.

– MAN-013: An ECPVS is recommended to provide the graphical user interface.

7.5 Scalability requirements

– SCA-001: An ECPVS is required to provide resource scalability. When the edge computing servers are increased or decreased, the edge computing capability of the ECPVS is increased or decreased accordingly, and the platform services are uninterrupted.

– SCA-002: An ECPVS is recommended to provide the resource scalability for each specific edge computing task. The computing and storage resources of individual edge computing tasks can be increased or decreased according to the user's demand.

7.6 Reliability requirements

– REL-001: An ECPVS is required to ensure the reliability of the edge computing services. When some edge computing servers have failed, the other edge computing servers should be guaranteed to operate normally, and the corresponding edge computing services can be used normally.

– REL-002: An ECPVS is recommended to support the continuous video data transmission after network interruption to ensure that the video is not be lost.

– REL-003: An ECPVS is required to support the autonomy ability of the edge computing server to continue its service when the edge computing server is disconnected from the central management platform due to unreliable network condition. While the network condition improves, the connection between the central management platform and the edge computing server will be established and the data of both sides will be synchronized again.

7.7 Performance requirements

– PER-001: An ECPVS is required to support the concurrent user operations. The system can serve many users simultaneously while ensuring the quality of service.

– PER-002: An ECPVS is required to support the concurrent execution of the different tasks while ensuring task execution efficiency.

Bibliography

[b-ITU-T H.626V2] Recommendation ITU-T H.626 (2019), *Architectural requirements for a video surveillance system*.

[b-ITU-T Y.101] Recommendation ITU-T Y.101 (2000), *Global Information Infrastructure terminology: Terms and definitions*.

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Printed in Switzerland
Geneva, 2021