International Telecommunication Union

ITU-T Y.4412/F.747.8

(11/2015)

TELECOMMUNICATION
STANDARDIZATION SECTOR
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SERIES Y: GLOBAL INFORMATION INFRASTRUCTURE, INTERNET PROTOCOL ASPECTS AND NEXT-GENERATION NETWORKS, INTERNET OF THINGS AND SMART CITIES

Internet of things and smart cities and communities – Frameworks, architectures and protocols

SERIES F: NON-TELEPHONE TELECOMMUNICATION SERVICES

Requirements and reference architecture for audience-selectable media service framework in the IoT environment

Recommendation ITU-T Y.4412/F.747.8

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Recommendation ITU-T Y.4412/F.747.8

Requirements and reference architecture for audience-selectable media service framework in the IoT environment

Summary

Recommendation ITU-T Y.4412/F.747.8 describes requirements and reference architecture for the audience-selectable media (ASM) service framework. The ASM service provides audiences with media selection options according to their interests and preferences. Examples of media selection options include the selection of an object of interest, and the selection of an interested camera object among multi-camera objects providing different views.

History

Edition	Recommendation	Approval	Study Group	Unique ID*
1.0	ITU-T Y.4412/F.747.8	2015-11-29	16	11.1002/1000/12620

Keywords

ASM, audience-selectable, Internet of things, media.

* 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.

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Introduction

Recently, demands for personalized media and interactivity in the media service are increasing and media service platforms are needed to support the fast development and deployment of new multimedia services/applications by reconfiguration of the existing service components. Due to the expansion of the Internet of things (IoT), objects related to media services can be identified and recognized by people or other objects. Also, the IoT enables person-to-object and object-to-object communications as well as person-to-person communication.

Audience-selectable media (ASM) service enables viewers to be interactive and select preferred media in the running time by providing media selection options.

Recommendation ITU-T Y.4412/F.747.8

Requirements and reference architecture for audience-selectable media service framework in the IoT environment

1 Scope

This Recommendation defines requirements and reference architecture for audience-selectable media (ASM) service in the Internet of things (IoT). The scope of this Recommendation includes:

– concept of ASM service framework;

– requirements of ASM service framework;

– reference architecture of ASM service framework; and

– functional entities of ASM service framework.

2 References

None.

3 Definitions

3.1 Terms defined elsewhere

This Recommendation uses the following terms defined elsewhere:

3.1.1 device [b-ITU-T Y.4400]: An apparatus through which a user can perceive and interact with the web.

3.1.2 Internet of things [b-ITU-T Y.4000]: A global infrastructure for the information society, enabling advanced services by interconnecting (physical and virtual) things based on existing and evolving interoperable information and communication technologies.

NOTE 1 – Through the exploitation of identification, data capture, processing and communication capabilities, the IoT makes full use of things to offer services to all kinds of applications, whilst ensuring that security and privacy requirements are fulfilled.

NOTE 2 – From a broader perspective, the IoT can be perceived as a vision with technological and societal implications.

3.1.3 object [b-ITU-T Y.2002]: An intrinsic representation of an entity that is described at an appropriate level of abstraction in terms of its attributes and functions.

3.1.4 resources [b-ITU-T Y.4400]: The term "resource" is whatever might be identified by a URI.

NOTE – Familiar examples include an electronic document, an image, a source of information with a consistent purpose (e.g., "today's weather report for Los Angeles"), a service (e.g., an HTTP-to-SMS gateway), and a collection of other resources. A resource is not necessarily accessible via the Internet; e.g., human beings, corporations, and bound books in a library can also be resources. Likewise, abstract concepts can be resources, such as the operators and operands of a mathematical equation, the types of a relationship (e.g., "parent" or "employee"), or numeric values (e.g., zero, one, and infinity).

3.1.5 thing [b-ITU-T Y.4000]: With regard to the Internet of things, this is an object of the physical world (physical things) or the information world (virtual things), which is capable of being identified and integrated into communication networks.

3.2 Terms defined in this Recommendation

This Recommendation defines the following terms:

3.2.1 camera control server: A server that selects and updates camera objects, camera object groups, and the main camera object. It also controls camera objects.

3.2.2 camera object: A device that captures and tracks objects of interest. It can also transmit and receive the tracked position of each object of interest to both other camera devices and a camera control server through the Internet. Its pan-tilt-zoom may be controlled by the camera control server for tracking objects of interest.

3.2.3 camera object group: A group of camera objects that capture the same object of interest whose occupied region size in the frame is greater than the pre-defined value.

3.2.4 main camera object: A camera object that captures a main broadcasting video. The initial main camera object is selected by audiences or the broadcaster. The main camera object can be changed to the sub-camera object during the service.

3.2.5 object of interest: A moving person or a moving thing in the video of which the service audience may have interest.

3.2.6 sub-camera object: A camera object that is not selected as a main camera object. An initial sub-camera object is usually selected by the broadcaster. The sub-camera object can be changed to the main camera object by audiences during the service.

4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

ASM	Audience-Selectable Media
FE	Functional Entity
ID	Identifier
IoT	Internet of Things
URI	Uniform Resource Identifier
Wi-Fi	Wireless Fidelity

5 Conventions

None.

6 Overview of audience-selectable media (ASM) service

Internet of things (IoT) and web of things (WoT) enable physical devices to be accessed as resources and services/applications of the web.

As new multimedia services/applications are emerging, media service platforms need to support fast development and deployment of new multimedia services/applications by reconfiguration of the existing service components. Also, media service devices, such as cameras, are beginning to provide wireless fidelity (Wi-Fi) technology.

IoT-applied media service enables objects in media service to be identified and recognized by people or other objects; IoT also enables person-to-object and object-to-object communications as well as person-to-person. This realizes the smart media service where objects can be automatically reconfigured to create and deliver media content according to the audience's demands and preferences.

In the current broadcasting service, a suitable camera object is selected among available camera objects, video from the selected camera object is encoded, and the encoded video is broadcasted to viewers. Attributes of the content and service region are considered for broadcasting.

This traditional broadcasting service does not provide any options to audiences to select various views from different camera objects in the same scene. The lack of this option causes audiences to remain passive.

The ASM service enables audiences to be interactive and select preferred media in the running time by providing media selection options. Examples of media selection options include the selection of an object of interest and a selection of an interested camera object among multi-camera objects providing different views. Figure 1 illustrates the concept of the ASM service.

As described in Figure 1, there are three components in the ASM service: Broadcaster, audience, and camera management server. These components generate and update object of interest, camera group for each object of interest, and a camera view-video that the audience is interested in, including the following:

(1) **broadcaster**: The broadcaster shows object of interest candidates to the audience.

(2) **audience**: The audience selects one object from the object of interest candidates, selects one of the camera objects in the camera group for the selected object of interest, and watches the selected camera view-video.

(3) **camera management server**: The camera management server updates the cameras in each camera group for each object of interest, gets the selection option inputs from the audience, and broadcasts the selected camera-view video to the audience.

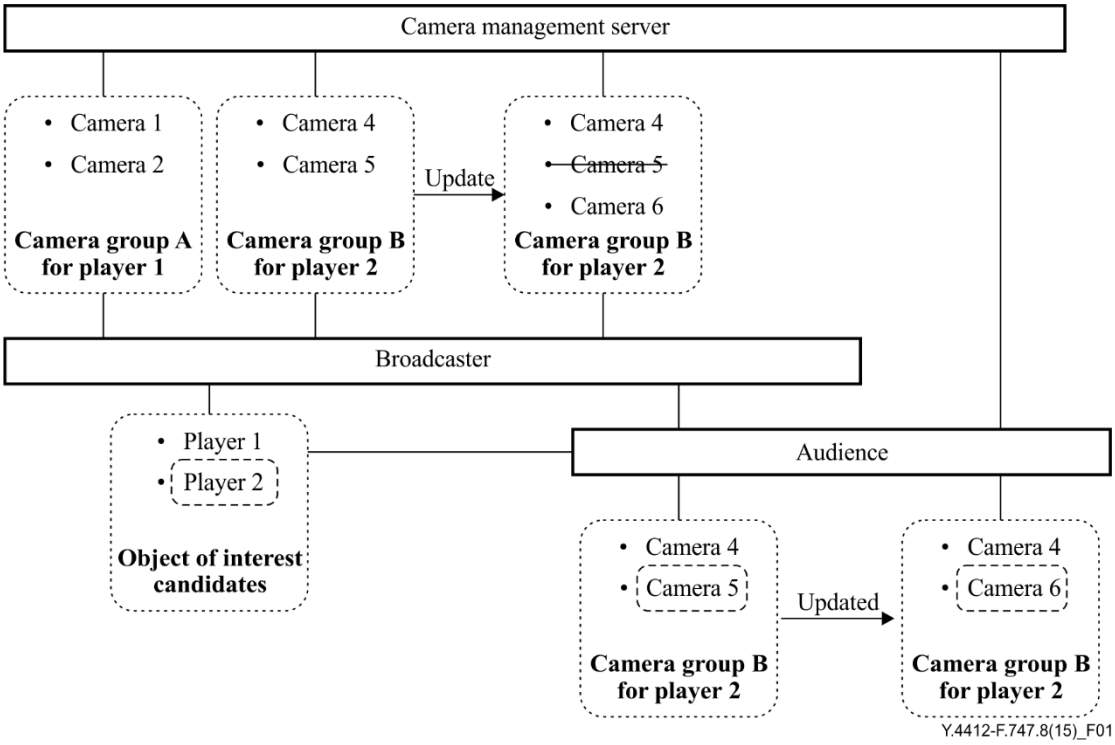

Figure 1 – Concept of ASM service

The concept of the ASM service described in Figure 1 can be explained as follows:

– broadcasters first specify the object of interest candidates in the scene (e.g., player 1 and player 2) and then show them to the audience for selection;

– the camera management server constitutes an initial corresponding camera group for each object of interest candidate using all available cameras based on the positions of each object of interest, and each camera;
– an audience first selects one object from the object of interest candidates (e.g., player 2), and also selects one of the cameras in the selected camera group (e.g., camera 5 in camera group B);
– the camera management server receives the audience's selections for the camera and object of interest, and broadcasts a selected camera-view video (e.g., camera 5 in camera group B);
– as an object of interest (e.g., player 2) moves in the scene during the running time, the camera management server updates each member of each camera group based on the updated position of each object of interest (e.g., In Figure 1, camera 5 in the initial camera group B is deleted from the updated camera group B);
– with updated camera members of each group, the camera management server shows each updated selectable camera list for each object of interest;
– then, an audience may change which camera view to watch (e.g., from camera 5 in initial camera group B to camera 6 in updated camera group B).

7 Requirements of ASM service framework

7.1 Service requirements

7.1.1 Media selection option

The ASM service is required to provide audiences with:

– media selection option to select media according to their interests and preferences;
– video selection option to select one camera object among multi-camera objects;
– switching option to change the current camera object to another camera object among multi-camera objects.

7.1.2 Object of interest selection option

The ASM service is required to:

– provide audiences with a selection option of object of interest to select an object they wish to watch;
– support audiences with changing option of object of interest to in the running time;
– support identification of each object of interest with an appropriate identifier (ID).

7.1.3 Main camera object selection option

– the ASM service is required to provide audiences with a main camera object selection option among multi-camera objects.

7.1.4 Camera object group selection option

– the ASM service is required to provide audiences with the choice of a camera object group selection that captures each object of interest among multi-camera object groups according to their preferences.

7.2 Functional requirements

7.2.1 Functional requirements of a camera object

Each camera object is required to:

– be able to obtain the position or the tracking result of an audience-selected object of interest in each captured frame;
– receive the positions or the tracking results of an audience-selected object of interest in each frame of the main camera object as a sub-camera object;
– convert the tracked position of an audience-selected object of interest in the main camera object to the position of each camera object;
– receive audience's video selection information from the video playback terminal through the camera control server;
– share an ID of each tracked object of interest with other camera objects within the same camera object group.

Each camera object selected as a main camera object is required to:

– transmit the positions or the tracking result of an audience-selected object of interest in each frame to the other sub-camera objects and the camera control server.

7.2.2 Functional requirements of camera control server

A camera control server is required to:

– select camera objects that should be shown to the audience for selection;
– update members of each camera object group based on the tracking results of the audience-selected object of interest within the appropriate time interval;
– update the main camera object candidates in each camera object group based on the tracking results of the audience-selected object of interest within the appropriate time interval;
– recommend the main camera object candidates in each camera object group to the audiences based on the tracking results of the object of interest;
– notify audiences of updates of members in each camera object group;
– receive audience's selection information such as an object of interest selection, camera object group selection, and main camera object selection;
– notify audience's selection information to each audience-selected camera object for video transmission to the audience's video playback terminal;
– receive the positions or the tracking results of the audience-selected object of interest in each frame of all camera objects within the appropriate time interval;
– manage each camera object member within each camera object group according to the movement of each object of interest.

A camera control server is recommended to:

– control the pan-tilt-zoom of each sub-camera object according to the tracked position and the size of the object of interest in the frame of the main camera object.

8 Reference architecture of ASM service framework

8.1 Reference architecture

Figure 2 shows a reference architecture of the ASM service framework which consists of ASM service framework functions, functional entities (FEs) of each ASM service framework function, reference points between each ASM service framework function.

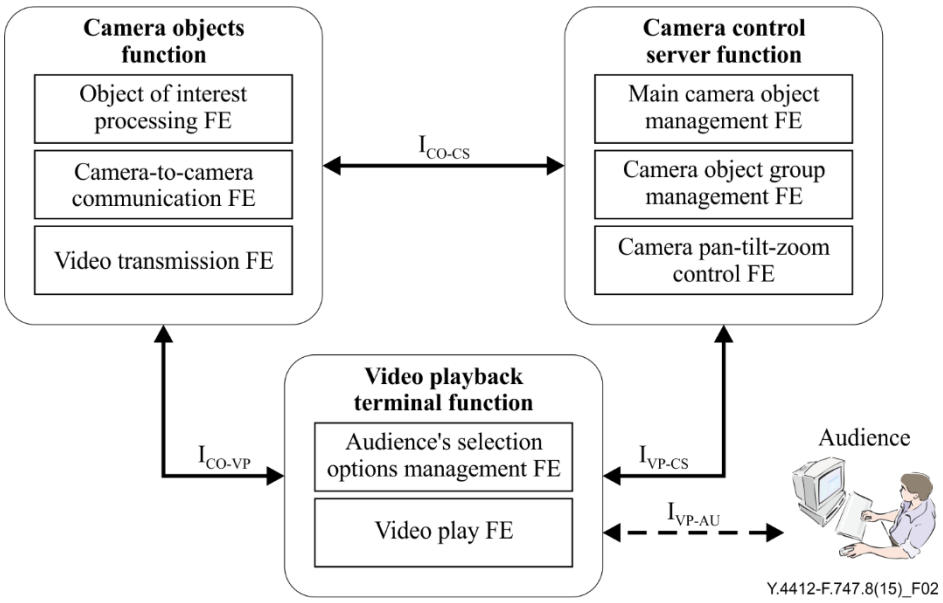

Figure 2 – Reference architecture of ASM service framework

As shown in Figure 2, there are three ASM service framework functions: camera objects function, camera control server function and video playback terminal function. Each function is described as follows in terms of supported functions, supported information, and supported FEs:

– **camera objects function**: A camera objects function tracks an object of interest, communicates the updated status of the object of interest to the camera control server function, and transmits the audience-selected video to the video playback terminal function. Based on these functional descriptions, the camera objects function includes three FEs of object of interest processing, communication, and video transmission;

– **camera control server function**: The camera control server function manages the main camera object based on the audience's selection, updates the camera object group based on the tracking result of the object of interest, and controls each camera object using the calculated pan, tilt, and, zoom values. Camera control server function contains three FEs of main camera object management, camera object group management, and camera pan-tilt-zoom control;

– **video playback terminal function**: Video playback terminal function receives the audience's selection options, transmits the audience's selection information to the camera objects function and camera control sever function, and plays the audience-selected video. The video playback terminal function consists of two FEs of the audience's selection options management and video play.

As illustrated in Figure 2, there are four reference points: I_{CO-CS}, I_{CO-VP}, I_{VP-CS}, and I_{VP-AU} as follows:

– **I$_{CO-CS}$**: I_{CO-CS} is a reference point between the camera objects function and the camera control server function. The position of the object of interest is transferred from the camera objects function to the camera control server function. On the other hand, updated information, including object of interest selection, main camera object selection, camera object group selection, and camera control (e.g., pan, tilt, and zoom values of each camera object) information is transferred from the camera control server function to camera objects function;

– **I$_{CO-VP}$**: I_{CO-VP} is a reference point between the camera object function and video playback terminal function. The camera objects function sends the audience-selected video to the video playback terminal function. Also, the playback terminal function sends the audience's selection information and playing options to the camera objects function;

– **I_{VP-CS}**: I_{VP-CS} is a reference point between the video playback terminal function and camera control server function. Through this reference point, video playback terminal transfers the audience's selection information and playing options to the camera control server function. Also, the video playback terminal function transmits the updated information, including the main camera object selection information (for each camera object group), camera object group selection information (for each object of interest), and camera control information for each camera object to the camera control server function;

– **I_{VP-AU}**: I_{VP-AU} is a reference point between the video playback terminal function and the audience. The video playback terminal function shows a list of the audience's selection options available to the audience. The video playback terminal function then receives the audience's selection information and playing options from the audience. Through this reference point, the video playback terminal function shows the current status of each camera object group, current camera control status of each camera object, currently-selected main camera object, position of each object of interest, multi-camera video thumbnails, and audience-selected video with selected playing options during the service.

8.2 Camera objects function

The camera objects function:

– consists of object of interest processing, communication, and video transmission FEs.

8.2.1 Object of interest processing FE

The object of interest processing FE:

– obtains the ID and the position or the tracking result of the audience-selected object of interest in each captured frame through object of interest extraction and tracking;

– identifies an object of interest in order to provide positional information of each object of interest that is used for generating and updating its corresponding camera object group in camera control server function;

– converts the tracked position of the audience-selected object of interest in the main camera object to the position in each frame captured by its sub-camera object using the camera position and pose information.

8.2.2 Communication FE

The communications FE:

– transmits the ID and the positions or the tracking results of an audience-selected object of interest in each captured frame to the other sub-camera objects and the camera control server function when one of the camera object functions is selected as a main camera object;

– receives the positions or the tracking result of the audience-selected object of interest in each frame of the main camera object when one of the camera objects is selected as a sub-camera object;

– receives the audience's selection information such as an object of interest selection, a main camera object selection in a camera object group, a selection of an interested camera object among multi-camera objects, video playback terminal selection, and camera object group selection from the video playback terminal function;

– receives the camera control information such as pan-tilt-zoom values from camera pan-tilt-zoom control FE of the camera control server function.

8.2.3 Video transmission FE

The video transmission FE:

– transmits a video stream of the main camera object selected by audience to the video playback terminal function.

8.3 Camera control server function

The camera control server function:

– consists of main camera object management, camera object group management, and optional camera pan-tilt-zoom control FEs.

8.3.1 Main camera object management FE

The main camera object management FE:

– receives the audience's main camera object selection information from the video playback terminal function;

– updates the main camera object candidates in each camera object group for updating based on the tracking results of the audience-selected object of interest transmitted from the object of interest processing FE within appropriate intervals;

– recommends the main camera object candidates in each camera object group to the audiences based on the tracking results of the object of interest when the main camera object needs to be updated;

– notifies the audience's selection to the newly audience-selected main camera object in order to track the selected object of interest and transmit an audience-selected video when the audience's main camera object selection information is updated from the video playback terminal function.

8.3.2 Camera object group management FE

The camera object group management FE:

– initially generates camera object groups according to each identified object of interest;

– classifies each camera object into its corresponding camera object group according to the existence of identified objects of interest in camera objects;

– receives the position or the tracking result of the audience-selected object of interest in each frame from all the camera objects in the group within appropriate time interval;

– updates the members of each camera object group based on the tracking result of each audience-selected object of interest;

– notifies member updates in each camera object group to the audiences.

8.3.3 Camera pan-tilt-zoom control FE

The camera pan-tile-zoom control FE:

– calculates pan, tilt, and zoom values of each sub-camera object according to the position and the size of the object of interest in the frame of the main camera object in order to make camera objects within the same camera object group look at the same object of interest;

– transmits the calculated pan, tilt, and zoom values of sub-camera objects to each corresponding sub-camera object within the same camera object group in order to control the sub-camera objects, respectively.

8.4 Video playback terminal function

The video playback terminal function:

– consists of the audience's selection options management and video play FEs.

8.4.1 Audience's selection options management FE

The audience's selection options management FE:

– shows a list of available audience selection options to the audience;

– receives audience's selection information from the audience;

– transmits audience's selection information to the camera control server function;

– transmits audience's selection information to each camera object function;

– includes options of an object of interest selection, a main camera object selection, and a selection of interested camera objects among multi-camera objects providing different views;

– includes the audience's choices among available audience selection options.

8.4.2 Video play FE

The video play FE:

– receives an audience-selected video from the camera object function;

– shows a current status of each camera object group, a current camera control status of each camera object, a currently-selected main camera object, the position of each object of interest, multi-camera video thumbnails, and an audience-selected video with audience-selected playing options;

– plays an audience-selected video;

– controls a playing status of the current audience-selected video with audience-selected playing options.

Appendix I

Use cases for ASM service

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

I.1 Use case for an ASM broadcasting service using multi-camera objects

Figure I.1 shows a use case for an ASM broadcasting service using multi-camera objects. This use case provides audiences with a selection option of choosing a video media from one camera object amongst multi-camera objects that capture a person (an object of interest) whom an audience is interested in. It also provides a selection option of switching a video media from one camera object to another camera object.

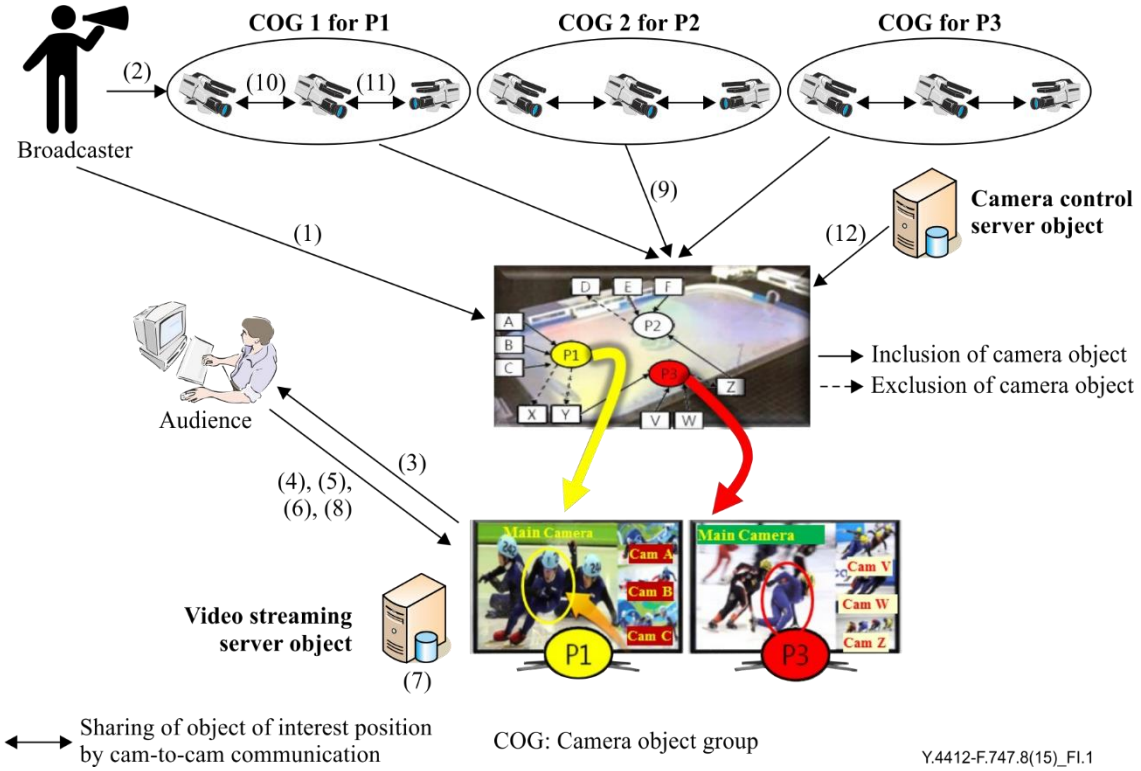

Figure I.1 – Use case for ASM broadcasting service using multi-camera objects

In this use case, there is the assumption that each audience has its own object of interest (e.g., a person such as a sports player or famous actress or actor) in the broadcasted video and each object of interest appears and disappears in some camera objects and frames.

(1) broadcasters predefine object of interest candidates (e.g., sports players) that will appear in the scene that they are going to broadcast;

(2) broadcasters generate camera object groups by combining suitable multi-camera objects that capture candidate objects of interest among available camera objects located at the site where broadcasters want to broadcast;

(3) broadcasters show videos or thumbnail images captured by each camera object group to the audiences;

(4) an audience selects one camera object group that captures an object of interest that he or she is interested in among multi-camera object groups;

(5) the audience also selects a main camera object among multi-camera objects in the selected camera object group;

(6) the audience also selects a region of interest that includes an object of interest in the main camera object image;

(7) video streaming server object streams and shows a video of the main camera object with sub-images (e.g., thumbnails) of other camera objects to the audience;

(8) during the streaming, the audiences may switch the main camera object to another camera object if he or she wants to watch the video with a different camera angle;

(9) after the object of interest selection, a video processing server object that is linked with the main camera object starts the video processing, such as automatic tracking of a selected object of interest in the main camera object frame by frame;

(10) during the tracking process, the main camera object transmits a tracked position of the selected object of interest to the other camera objects by camera-to-camera transmission;

(11) the other camera objects receive and calculate the position of the selected object of interest from the received tracked position in the image of the main camera object;

(12) based on each calculated position of an object of interest in each camera object, the camera object control server object updates the component camera objects in each camera object group;

(13) the process repeats step 4) to step 13) until the audiences or the broadcasters quit the current media service.

Finally, each audience can enjoy personalized video media content that includes an object of interest and has a camera view that each audience wants to watch.

I.2 Use case for an open screen service using multi-camera objects

Open screen service can be a use case of the ASM service. Open screen service is a service based on open platform to control various types of screens and to show content by sensing states (e.g., age and gender) and movement of a human being. Representative use cases of open screen service include digital signage and emergency service. For example, if a person is near a screen using open platform of open screen service, the screen can show an image or video media advertisement or an evacuation route to the person.

In order to sense states and movement of human beings, multi-camera objects and camera control servers are mandatory for the open screen service. In the perspective of open screen service, the audience can be an advertiser or emergency service provider, and the object of interest can be a human being who is a customer of an advertiser.

Figure I.2 explains use case for an open screen service using multi-camera objects:

(1) an object of interest (e.g., customer) moves to the vicinity of a screen (e.g., screen 1) equipped with a camera object (e.g., camera object 1).

(2) The camera object (e.g., camera object 1) captures video data of the object of interest and then sends the captured video data to camera control server.

(3) The camera control server sends information for tracking the object of interest to the camera object (e.g., camera object 1).

(4) The camera control server sends the position information and captured video data to media server being owned by the audience (e.g., advertiser) and providing image or video media (e.g., advertisement) that the audience (e.g., advertiser) wants to provide for the object of interest (e.g., customer).

(5) The media server determines images or video media (e.g., advertisements) that the audience wants to provide for the object of interest (e.g., customer), and then provides the media to the screen (e.g., screen 1). Interaction between camera objects can include information for supporting the camera's tracking the object of interest. The information for tracking the object of interest can include position information for where the object of interest is located.

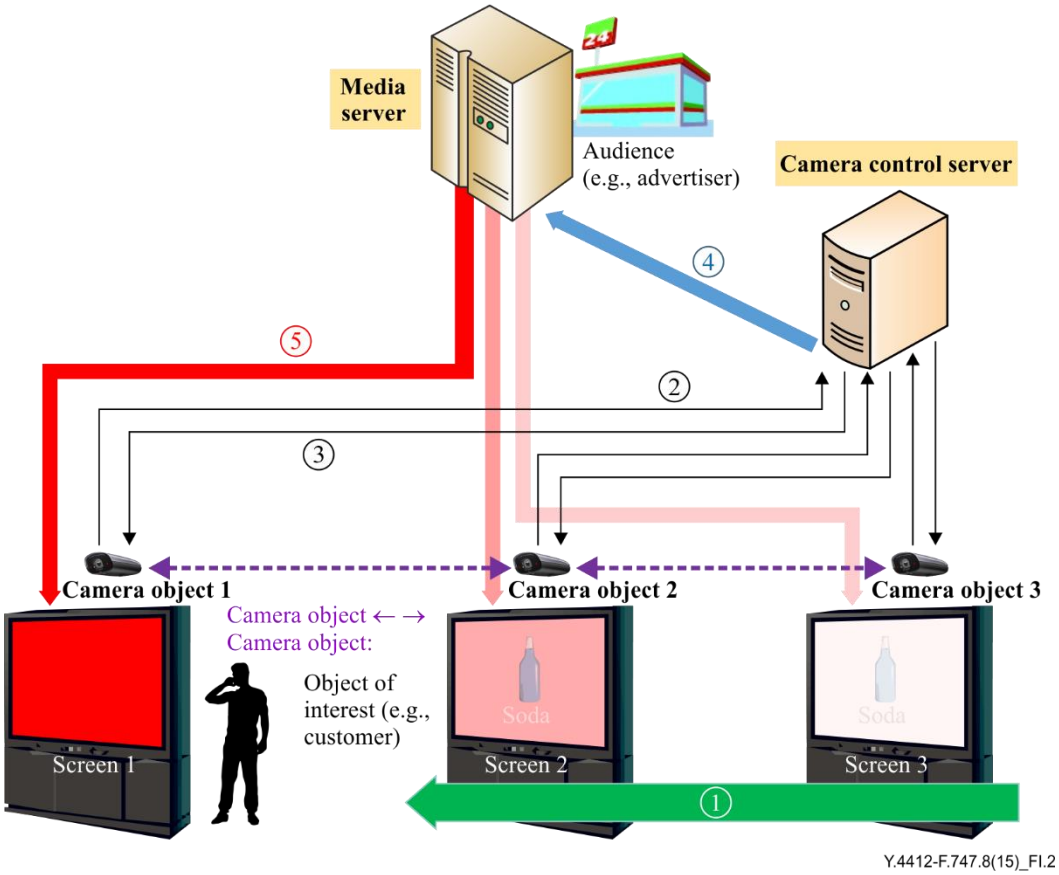

Figure I.2 – Use case for an open screen service using multi-camera objects, camera control server and media server

Bibliography

[b-ITU-T Y.2002] Recommendation ITU-T Y.2002 (2009), *Overview of ubiquitous networking and of its support in NGN*.

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Printed in Switzerland
Geneva, 2016