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SERIES H: AUDIOVISUAL AND MULTIMEDIA SYSTEMS

Broadband, triple-play and advanced multimedia services – Advanced multimedia services and applications

## Architecture for intelligent video surveillance systems

Recommendation ITU-T H.626.5

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# Recommendation ITU-T H.626.5

## Architecture for intelligent video surveillance systems


### Summary

Recommendation ITU-T H.626.5 defines an architecture for intelligent video surveillance systems, including the functional requirements, functional architecture and reference points. The intelligent video surveillance system provides intelligent analysis capabilities and services for users based on the images, video slices or video streams from surveillance cameras. Meanwhile, the system also aggregates and stores the video and image information from the intelligent analysis, the surveillance devices, or manual annotation. Based on this aggregation and storage, the system provides application services and sharing services for users through the network, such as query and retrieval about the video and image information, subscription and notification, etc. This Recommendation is based on Recommendation ITU-T F.743.1, *"Requirements for intelligent visual surveillance"*.

This edition updates the title and functional architecture, deletes the service-control flow and signalling, and revises the references points.



### History

| Edition | Recommendation | Approval | Study Group | Unique ID* |
|---|---|---|---|---|
| 1.0 | ITU-T H.626.5 | 2019-05-14 | 16 | 11.1002/1000/13905 |
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### Keywords

Architecture, intelligent, video surveillance systems.


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## Architecture for intelligent video surveillance systems

### 1 Scope

This Recommendation specifies architecture for intelligent video surveillance systems.

The scope of this Recommendation includes:

– Functional architecture

– Reference points

### 2 References

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

[ITU-T F.743.1] Recommendation ITU-T F.743.1 (2015), *Requirements for intelligent visual surveillance.*

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

[ITU-T H.627] Recommendation ITU-T H.627 (V2) (2020), *Signalling and protocols for a video surveillance system.*

[IETF RFC 3261] IETF RFC 3261 (2002), *SIP: Session Initiation Protocol.*

[IETF RFC 3550] IETF RFC 3550 (2003), *RTP: A Transport Protocol for Real-Time Applications.*

[IETF RFC 7230] IETF RFC 7230 (2014), *Hypertext Transfer Protocol (HTTP/1.1): Message Syntax and Routing.*

### 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 central control server** [b-ITU-T H.626.3]: A device located at the central part of the visual surveillance system. It is used for centralized system management, service operation management and access control.

NOTE – The centre control server consists of centre management unit and service-control unit.

**3.1.3 customer unit** [ITU-T H.626]: 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.

**3.1.4 functional architecture** [b-ITU-T Y.2012]: A set of functional entities and the reference points between them used to describe the structure of an NGN. These functional entities are separated by reference points, and thus, they define the distribution of functions.

**3.1.5 functional entity** [b-ITU-T Y.2012]: An entity that comprises an indivisible set of specific functions. Functional entities are logical concepts, while groupings of functional entities are used to describe practical, physical implementations.

**3.1.6 media server** [ITU-T H.626]: A device located at the centre part of a video surveillance system. It is used to forward real-time media stream as well as store, retrieve and replay historical media stream. The media server receives the media stream from premises unit or other media server and forwards the media stream to other customer unit or media server. It consists of media distribution unit and media storage unit.

**3.1.7 premises unit** [ITU-T H.626]: 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.

**3.1.8 reference point** [b-ITU-T Y.2012]: A conceptual point at the conjunction of two non-overlapping functional entities that can be used to identify the type of information passing between these functional entities.

**3.1.9 service** [b-ITU-T Y.101]: A structured set of capabilities intended to support applications.

**3.1.10 service platform** [ITU-T H.626]: A series of devices and subsystems located at the centre part of a video surveillance system. It is used to integrate all of the capabilities and provide video surveillance services to customers. The main functions include service-control function, media switching, distribution, storage, and control and management.

**3.1.11 surveilled object** [ITU-T H.626]: The target (such as site, human, and related environment) on which surveillance is performed.

**3.1.12 video surveillance system** [ITU-T H.626]: A telecommunication service focusing on video (but 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 managed broadband network with ensured quality, security and reliability.

## 3.2 Terms defined in this Recommendation

This Recommendation defines the following terms:

**3.2.1 centre management unit (CMU)**: The centre management unit (CMU) is located at the centre of the video surveillance (VS) system. Its main functions include centralized system management, service operation management, etc.

**3.2.2 client intelligent video (CIV)**: An intelligent identification module in the customer unit (CU). It identifies required information from input video and outputs the result and retrieves the recorded video data with specified information.

**3.2.3 data storage and service (DSS)**: The storage and sharing centre for video and image information within the intelligent video surveillance system. The DSS accepts registration, keepalive reports from the intelligent premises unit (IPU), intelligent video management (IVM) or intelligent application service (IAS) and obtains video and image information from them. It can also provide information network sharing services such as information querying, subscription, guard and alarm, etc.

**3.2.4 intelligent application service (IAS)**: The intelligent application service (IAS) is located at the application service core of the intelligent video surveillance system. Its main functions include providing application services about the video and image information, such as information query

and retrieval, subscription and notification, manual annotation, etc.; providing external operations such as the creation and start-up of intelligent analysis tasks based on intelligent video management (IVM); obtaining the list of devices from the central control server (CCS) or data storage and service (DSS) and sharing them with the IVM so that it can schedule intelligent video units (IVUs) for video stream analysis, etc.

**3.2.5 intelligent customer unit (ICU)**: The client subsystem within the intelligent video surveillance system. The client intelligent video (CIV) is added to the customer unit (CU) in order to achieve comprehensive intelligent video analysis.

**3.2.6 intelligent premises unit (IPU)**: The premises subsystem within the intelligent video surveillance system. The premises intelligent video (PIV) module is added to the premises unit (PU) for intelligent video analysis.

**3.2.7 intelligent video management (IVM)**: The intelligent video management (IVM) unit supports strategies configuration of intelligent applications by users and video sources schedules dynamically. The IVM accepts registration, deletion, capability reports from intelligent video units (IVUs) and schedules the IVUs dynamically. It can also store, manage, and schedule those capabilities dynamically.

**3.2.8 intelligent video unit (IVU)**: The intelligent video unit (IVU) identifies specific objects automatically, and outputs recognition results to an intelligent video management (IVM) system. The recognition information includes triggered events and acquired data. One or more intelligent analysis algorithms can be loaded or unloaded on an intelligent video unit (IVU) according to different requirements.

**3.2.9 media distribution unit (MDU)**: The media distribution unit (MDU) is used to transport media from the premises unit (PU) to the customer unit (CU). Its main functions include media receiving, media processing, media routing, media transmission, media forwarding and media replication.

**3.2.10 media storage unit (MSU)**: The media storage unit (MSU) is used to retrieve and store media and provide media serving capability. Its main functions include media storage, media serving, media indexing and media downloading.

**3.2.11 premises intelligent video (PIV)**: An intelligent identification module in the premises unit (PU). It identifies required information from input video and outputs the result.

**3.2.12 service-control unit (SCU)**: The service-control unit (SCU) is located at the centre of the video surveillance (VS) system. It is a distributed network equipment, fulfilling the access functions of the premises unit (PU) and the customer unit (CU). Its main functions include access registration, access authentication, identification, authorization, call control, location, presence and target media serving function selection.

**3.2.13 video and image information**: Video clips, images, related files and content description information.

## 4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

API Application Programming Interface

C/S Client/Server

CCS Central Control Server

CIV Client Intelligent Video

CMU Centre Management Unit

| | |
|---|---|
| CPU | Central Processing Unit |
| CRUD | Create/Read/Update/Delete |
| CU | Customer Unit |
| DSS | Data Storage and Service |
| DVR | Digital Video Recorder |
| HTTP | Hyper Text Transfer Protocol |
| IAS | Intelligent Application Service |
| ICU | Intelligent Customer Unit |
| IPU | Intelligent Premises Unit |
| IVM | Intelligent Video Management |
| IVS | Intelligent Video Surveillance |
| IVU | Intelligent Video Unit |
| MDU | Media Distribution Unit |
| MS | Media Server |
| MSU | Media Storage Unit |
| NTP | Network Time Protocol |
| NVR | Network Video Recorder |
| OCX | OLE Control Extension |
| OLE | Object Linking and Embedding |
| PIV | Premises Intelligent Video |
| PTZ | Pan/Tilt/Zoom |
| PU | Premises Unit |
| RTCP | Real-time Transport Control Protocol |
| RTP | Real-time Transport Protocol |
| SCU | Service-Control Unit |
| SIP | Session Initiation Protocol |
| TCP | Transmission Control Protocol |
| UDP | User Datagram Protocol |
| USB | Universal Serial Bus |
| VS | Video Surveillance |

## 5 Conventions

In this Recommendation, the following conventions apply:

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

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

The keywords "can optionally" indicate an optional requirement which is permissible, without implying any sense of being recommended.

## 6 Functional architecture

Figure 6-1 shows the composition of an intelligent video surveillance system.

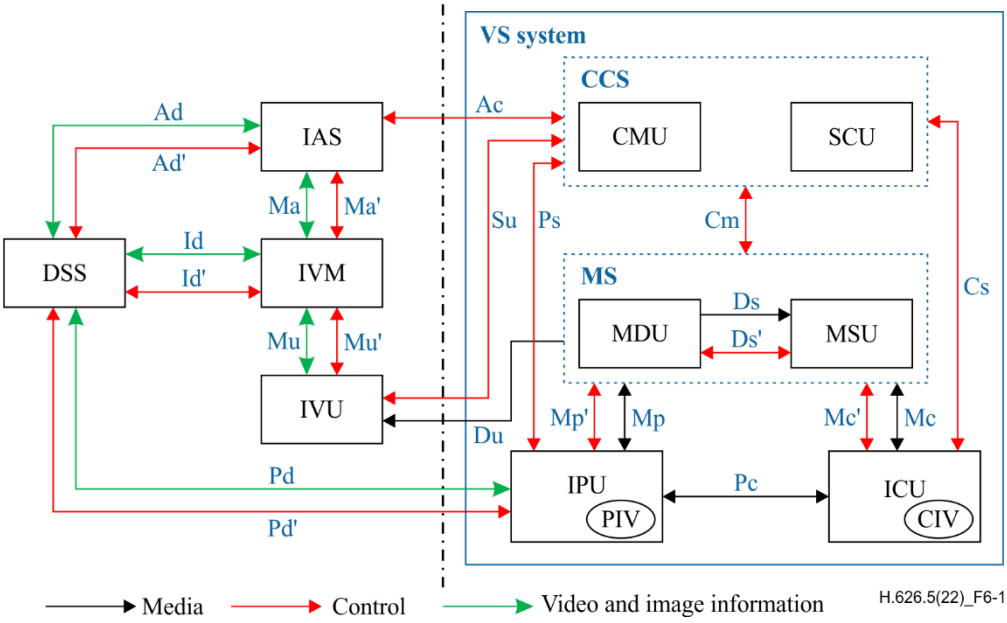


**Figure 6-1 – Composition of an intelligent video surveillance system**

The functional architecture for the intelligent video surveillance system could be decomposed into ten units:

– Centre management unit (CMU)
– Service-control unit (SCU)
– Media distribution unit (MDU)
– Media storage unit (MSU)
– Intelligent video unit (IVU)
– Intelligent video management (IVM)
– Intelligent customer unit (ICU)
– Intelligent premises unit (IPU)
– Data storage and service (DSS)
– Intelligent application service (IAS)

The centre management unit (CMU), service-control unit (SCU), media distribution unit (MDU) and media storage unit (MSU) are defined in [ITU-T H.626]. The rest of units shown in Figure 6-1 are described in clauses 6.1 to 6.6 and the reference point in clause 7.

### 6.1 Intelligent premises unit

Intelligent premises unit (IPU) is the premises subsystem within the intelligent video surveillance system, such as video edge gateway, digital video recorder (DVR), network video recorder (NVR), or intelligent camera. The premises intelligent video (PIV) module is added to the premises unit (PU) for intelligent video analysis. The PIV is an intelligent identification module in the PU. It identifies required information from input video and outputs the analysis result. The PIV can search

designated records from video files. The identifiable information includes triggered events and acquired data.

The IPU implements the following functions like a normal PU as defined in [ITU-T H.626], it:

– Captures multimedia information (such as audio, video, image, alarm signals, etc.) from the surveilled object.

– Encodes multimedia (audio, video and image) streams.

– Outputs alarm signals to an external linkage device.

– Parses pan/tilt/zoom (PTZ) commands and transmits them to the devices in order to control the camera.

– Provides network transportation and transmits bidirectional media streams and alarm signals to other entities.

The IPU also implements some additional functions for intelligent applications, it:

– Identifies required information from input videos and outputs analysis results.

– Reports the identified results such as triggered events and acquired data to the DSS.

Figure 6-2 shows the function modules of the IPU based on a PU as defined in [ITU-T H.626]. The premises intelligent video (PIV) module is the only new module to implement intelligent identification functions or corresponding operations.

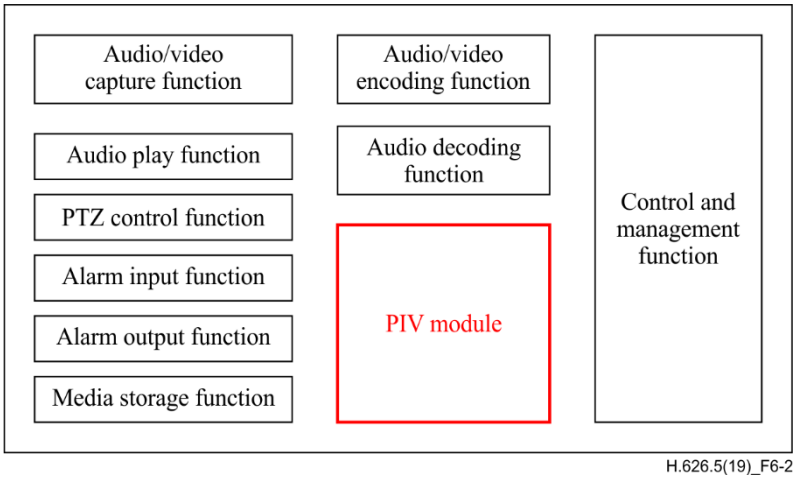


**Figure 6-2 – Function modules of IPU**

## 6.2 Intelligent customer unit

Intelligent customer unit (ICU) is the client subsystem within the intelligent video surveillance system. It is used to present multimedia information (such as audio, video, image, alarm signal, etc.) to the end user and trigger the related actions. The client intelligent video (CIV) is added to the CU in order to achieve comprehensive intelligent video analysis. The CIV is an intelligent identification module in the customer unit (CU). It identifies required information from the input video and outputs the analysis result. The CIV can search designated records from video files. The identifiable information includes triggered events and acquired data.

It implements the following functions like a normal CU as defined in [ITU-T H.626]:

– Multimedia decoding function.

– Audio play and video/image display function.

– Console interface for end user to operate the video surveillance (VS) system.

It also implements some additional functions for intelligent applications, it:

– Identifies required information from input video and outputs the analysis result.

– Retrieves the recorded video data with specified information.

– Reports and presents the analysis result to end users.

Figure 6-3 shows the function modules of the ICU based on the CU as defined in [ITU-T H.626]. The client intelligent video (CIV) module is the only new module to implement intelligent identification related functions.

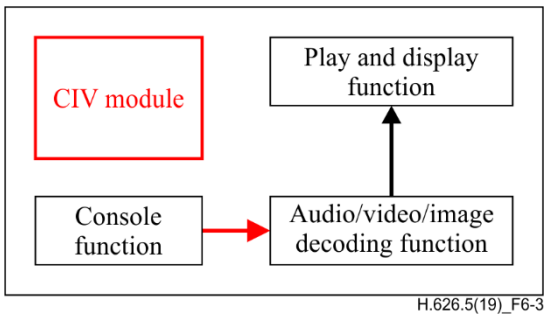


**Figure 6-3 – Function modules of ICU**

## 6.3 Intelligent video management

Intelligent video management (IVM) is the premises subsystem within the intelligent video surveillance system.

The intelligent video unit (IVU) implements some normal functions for intelligent applications, it:

– Supports configuration of intelligent applications by users and video sources schedules dynamically.

– Accepts registration, deletion, capability report from IVU and schedules IVUs dynamically.

– Stores, manages and schedules the category, supplier and capability of IVU dynamically.

– Manages intelligent analysis tasks such as query, start, pause and stop.

– Manages the licenses of special intelligent analysis tasks.

– Accepts intelligent capabilities queries from the intelligent application service (IAS) and sends the response.

– Accepts intelligent strategies queries from IAS and sends the response.

It also implements some additional functions for intelligent applications, such as managing the IVU licenses using method such as universal serial bus (USB) keys and software keys.

## 6.4 Intelligent video unit

Intelligent video unit (IVU) is the premises subsystem within the intelligent video surveillance system.

It implements some normal functions for intelligent applications, it:

– Identifies specific objects automatically and outputs recognition results to the IVM.

– Recognizes information including triggered events and acquired data.

– Loads or unloads one or more intelligent analysis algorithms on IVU according to different requirements.

– Sends capability lists and statuses to the IVM.

– Supports the standard video stream transmission protocols (refer to [ITU-T H.627]).

– Supports acquiring video streams from the video surveillance platform using application programming interfaces (APIs).

– Support images analysis using hypertext transfer protocol (HTTP), (refer to [IETF RFC 7230] protocol).

It also implements some additional functions for intelligent application, such as IVU capability extension and IVU virtualization.

## 6.5 Data storage and service

Data storage and service (DSS) is the subsystem within the intelligent video surveillance system, it:

– Obtains the video and image information from the intelligent premises unit (IPU), IVM and manual annotation from the IAS.

– Receives registration and keepalive report from the IVM, IAS, IPU, and synchronizes the status maintained in the system.

– Supports the configuration of different storage strategies to meet the access requirements.

– Manages the video and image information and stores it.

– Provides services to the IAS and IVM such as query, analysis, and sharing of the information.

– Supports information management and access control of the accessed IVM, IAS and IPU.

Figure 6-4 shows the DSS functional composition.

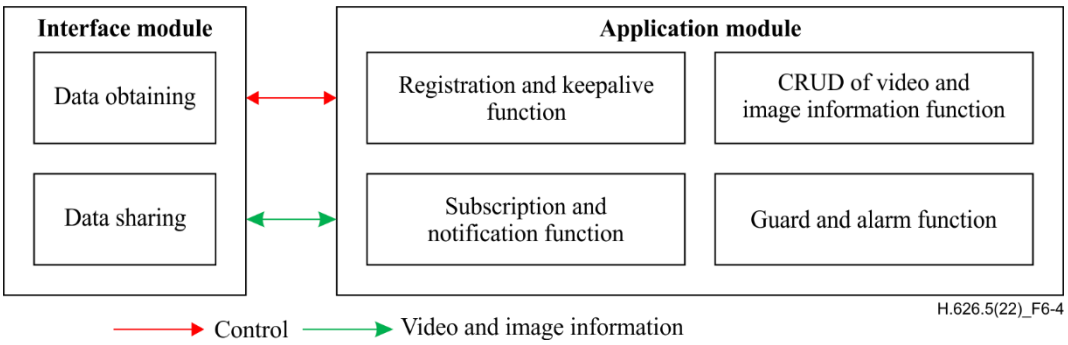


**Figure 6-4 – DSS functional composition**

The DSS's main process is as follows:

Firstly, the data obtaining of interface module obtains the information transported from the IPU, IVM or IAS. Then the information is transferred and used by the application module. The data sharing of interface module provides services to the IAS and IVM such as query, analysis, and sharing of the information.

In the intelligent video surveillance system, when the IPU, IVM, or IAS access the DSS, they need to register with the DSS actively, and de-register from the DSS when it stops running. The keepalive heartbeat interval and timeout times can be configured in the IPU, IVM, IAS and DSS. The IPU, IVM, and IAS are required to send heartbeat messages to the DSS according to the "heartbeat interval" periodically to keep the heartbeat alive. When the continuous timeout of heartbeat messages reaches the "keep-alive timeout times", the unit is considered offline and disconnected. The registration and keepalive function of the DSS processes the registration and keepalive information received by the interface module, performs information authentication on the accessed IPU, IVM, and IAS, and synchronizes their status maintained in the system.

The DSS is required to support video and image information operations such as adding, modifying, deleting and querying from the IPU, IVM or IAS. After the interface module receives the identification information or manual annotation information, it forwards the request to the create/read/update/delete (CRUD) of the video and image information function. After data verification, cleaning and conversion, the function submits the information to storage.

The DSS is required to support the IVM or IAS to subscribe or unsubscribe video and image information, such as vehicles, personnel, IPU device lists, etc. When the subscribed resource generates new information data, the DSS is recommended to notify immediately the IVM or IAS for data synchronization. The subscription and notification function implements them.

The DSS or IVM is required to receive the guard commands of the IAS and should send notification messages to the IAS when the target object is found. After the announcement is sent, if no response is received within 5 seconds, the notification is deemed to have failed and should be retransmitted. If 3 consecutive retransmissions are still unsuccessful, it is deemed that there is a problem with the link, the information is cached, and the registration is performed again. After successful registration, all unannounced data will be retransmitted. The guard and alarm function implements them.

### 6.6 Intelligent application service

Intelligent application service (IAS) is the subsystem within the intelligent video surveillance system.

It implements some normal functions for intelligent applications, it:

– Supports application services about video and image information such as query, analysis, disposition and subscription.

– Receives IPU device lists from the CCS or the DSS. The updated device lists can be transferred to the DSS or IVM in order to obtain the media stream of these devices from the MS to the IVU.

– Supports application services about the manual annotation of the video and image information and stores the manual annotation to the DSS.

– Obtains video or image information from the DSS and distributes them according to different requirements.

– Creates and invokes intelligent analysis tasks for the IVM.

– Invokes the strategies and capabilities configuration for the IVM.

## 7 Reference points

The reference points Cm and Ds and Ds' are defined in [ITU-T H.626].

### 7.1 Reference point Ps: IPU – CCS

The reference point Ps is located between the IPU and the central control server (CCS). It is used as defined in [ITU-T H.626].

### 7.2 Reference point Mp/Mp': IPU – MS

The reference points Mp and Mp' are between the IPU and the media server (MS). They are used by the MS as defined in [ITU-T H.626].

### 7.3 Reference point Pc: IPU – ICU

The reference point Pc is between the IPU and the ICU. It is used as defined in [ITU-T H.626].

### 7.4 Reference point Cs: ICU – CCS

The reference point Cs is between the ICU and CCS. It is used as defined in [ITU-T H.626].

### 7.5 Reference point Mc/Mc': ICU – MS

The reference points Mc and Mc' are between the ICU and the MS. They are used as defined in [ITU-T H.626].

### 7.6 Reference point Su: IVU – CCS

The reference point Su is between the IVU and the CCS. It is used to:

– Send real-time audio and video requests to the IPU through the CCS.

– Send video storage and video requests to the IPU through the CCS.

It uses the session initiation protocol (SIP).

### 7.7 Reference point Du: IVU – MS

The reference point Du is between the IVU and the MS. It is used to:

– Acquire video and audio streams from the MS through real-time transport protocol (RTP) (refer to [IETF RFC 3550])/RTCP protocol.

– Send UDP private network packets to the MS.

– Acquire RTP/RTCP packet from the MS in the TCP mode.

### 7.8 Reference point Mu/Mu': IVU – IVM

The reference points Mu and Mu' are between the IVU and the IVM. Mu is used to:

– Report the results of the intelligent analysis from the IVU to the IVM.

Mu' is used to:

– Register/de-register and keep alive from the IVU to the IVM.

– Send the request of an intelligence analysis task from the IVM to the IVU.

– Report the status of the intelligence analysis task from the IVU to the IVM.

– Report the intelligence analysis capabilities and resource usage status from the IVU to the IVM.

– Manage the license of special intelligent analysis task from the IVM to IVU, IVM loads or releases the IVU according to the license information.

They use the HTTP+JSON protocol.

### 7.9 Reference point Ma/Ma': IVM – IAS

The reference points Ma and Ma' are between the IVM and the IAS. Ma is used to:

– Report the results of the intelligent analysis task from the IVM to the IAS.

Ma' is used to:

– Register/de-register and keep alive from the IVM to the IAS.

– Send the user request of an intelligence analysis task (such as search target by image, search target by attribute, etc.) from the IAS to the IVM.

– Report the status of the intelligence analysis task from the IVM to the IAS.

– Control the intelligence analysis task from the IVM to the IAS.

They use the HTTP+JSON protocol.

### 7.10 Reference point Ad/Ad': DSS – IAS

The reference points Ad and Ad' are between the DSS and the IAS. Ad is used to:

– Transmit video and image information from the IAS to the DSS when the manual annotation information captured by the IAS is required to be collected to the DSS.

– Transmit the authorized video and image information, IPU list from the DSS to the IAS when the data stored in the DSS is required to be accessed by the IAS's users.

Ad' is used to:

– Register/de-register and keep alive from the DSS to the IAS.

– Send video and image information and IPU list access request from the IAS to the DSS such as information query or subscription, etc.

They use the HTTP + JSON protocol.

### 7.11 Reference point Id/Id': DSS – IVM

The reference points Id and Id' are between the DSS and the IVM. Id is used to:

– Transmit video and image information from the IVM to the DSS when the recognition information parsed by the IVUs of the IVM is required to be collected to the DSS.

– Transmit the authorized video and image data from the DSS to the IVM when the data stored in the DSS is required to be accessed by the IVM's users.

Id' is used to:

– Register/de-register and keep alive from the IVM to the DSS.

– Send data access request from the IVM to the DSS.

– Support information query based on the feature attributes of the video image information from the IVM to the DSS.

– Support the disposition and notification of video image information between the DSS and the IVM.

– Support subscription and notification of video image information, collection device/system lists, etc., between the IVM and the DSS.

They use the HTTP + JSON protocol.

### 7.12 Reference point Pd/Pd': DSS – IPU

The reference points Pd and Pd' are between the DSS and the IPU. Pd is used to:

– Transmit video and image data from the IPU to the DSS when the recognition information captured by the IPU is required to be collected to the DSS.

Pd' is used to:

– Register/de-register and keep alive from the IPU to the DSS.

They use the HTTP + JSON protocol.

### 7.13 Reference point Ac: IAS – CCS

The reference point Ac is between the IAS and the CCS. It is used to:

– Send the user authentication request from the IAS to the CMU and return the authentication result.

– Acquire the IPU list that the user has been authorized to access, the configuration information of the specified IPU, the alarm information, the status information and the platform video storage information.

It uses the HTTP+JSON protocol.

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