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SERIES H: AUDIOVISUAL AND MULTIMEDIA SYSTEMS  
IPTV multimedia services and applications for IPTV –  
Digital Signage

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## Digital signage: Functional architecture

Recommendation ITU-T H.781

ITU-T



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# Recommendation ITU-T H.781

## Digital signage: Functional architecture

### Summary

Recommendation ITU-T H.781 defines a detailed functional architecture to provide digital signage (DS) services. The functional architecture consists of DS server, DS client, content delivery server and content delivery client. This Recommendation describes how functions in the architecture interact with each other to provide the services according to general information flows and defines reference points that can be considered in specifying detailed protocols.

### History

Edition	Recommendation	Approval	Study Group	Unique ID*
1.0	ITU-T H.781	2015-04-29	16	<a href="http://handle.itu.int/11.1002/1000/12466">11.1002/1000/12466</a>

### Keywords

Digital signage, functional architecture, information flows, reference points.

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\* 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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# Recommendation ITU-T H.781

## Digital signage: Functional architecture

### 1 Scope

This Recommendation describes functional architecture for digital signage (DS) services as follows:

- architectural overview;
- functions and functional entities (FEs);
- reference points;
- information flows to support the services.

This Recommendation extends the high-level architecture defined in [ITU-T H.780] to accommodate various kinds of underlying transport infrastructures. This expansion covers interactive services amongst audience and terminal devices by using external devices such as touch panels. This Recommendation can be used as a reference for specifying protocols for DS services.

### 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 H.780] Recommendation ITU-T H.780 (2012), *Digital signage: Service requirements and IPTV-based architecture*.

### 3 Definitions

#### 3.1 Terms defined elsewhere

This Recommendation uses the following terms defined elsewhere:

**3.1.1 content** [ITU-T H.780]: A combination of audio, still image, graphic, video, or data.

NOTE – Variety of formats is classified as the "data" (e.g., text, encoded values, multimedia description language introduced by [b-ITU-T H.760]).

**3.1.2 delivery** [ITU-T H.780]: Sending of contents to terminal devices.

**3.1.3 digital signage (DS)** [ITU-T H.780]: A system that sends information, advertising and other messages to electronic devices (e.g., displays, speakers) in accordance with the time of day and the location of the display, or the actions of audience. Content and its relevant information such as display schedules is delivered over networks.

**3.1.4 network provider** [ITU-T H.780]: The organization that maintains and operates the network components required to support a service or set of services.

**3.1.5 overlay network** [b-ITU-T X.1162]: An overlay network is a virtual network that runs on top of another network. Like any other network, the overlay network comprises a set of nodes and links between them. Because the links are logical ones, they may correspond to many physical links of the underlying network.

**3.1.6 peer** [b-ITU-T X.1161]: Communication node on P2P network that functions simultaneously as both "client" and "server" to the other nodes on the network.

**3.1.7 peer-to-peer (P2P)** [b-ITU-T Y.2206]: A system is considered to be P2P if the nodes of the system share their resources in order to provide the service the system supports. The nodes in the system both provide services to other nodes and request services from other nodes.

**3.1.8 playlist** [ITU-T H.780]: Composed of a list of contents.

NOTE 1 – This data is created and provided by digital service providers.

NOTE 2 – This data can be selected by an end-user when interactivity is supported in a digital signage terminal device.

NOTE 3 – This data may indicate an order of playing content.

**3.1.9 playlist schedule** [ITU-T H.780]: Composed of a list of playlists indicated by a specific play date and/or time.

## **3.2 Terms defined in this Recommendation**

This Recommendation defines the following terms:

**3.2.1 buffer map**: Messages in peer-to-peer (P2P) networks that peers exchange to indicate which chunks of data a peer currently has buffered and can share with other peers.

**3.2.2 content delivery schedule**: A schedule that describes time constraints of specific content to be delivered to terminal devices.

NOTE – Since content needs to be distributed to terminals prior to being displayed, the content delivery schedule may provide alternative ways for content delivery with specific time constraints.

**3.2.3 proof-of-play (PoP)**: Any technique that can identify and prove that the content has been displayed on the screen.

## **4 Abbreviations and acronyms**

This Recommendation uses the following abbreviations and acronyms:

AM	Audience Measurement
CliCnf	Client Configuration
CliCnfMgm	Client Configuration Management
CliCntMgm	Client Content Management
CliInfMgm	Client Information Management
CliLogGen	Client Log Generator
CliLogMgm	Client Log Management
CliPlySch	Client Play Scheduler
CntDlvCliCtrl	Content Delivery Client Control
CntDlvLogMgm	Content Delivery Log Management
CntDlvSchMgm	Content Delivery Schedule Management
CntDlvSvrCtrl	Content Delivery Server Control
CntIngReg	Content Ingestion and Registration
CntMtdMgm	Content Metadata Management
CntP2pPeer	Content P2P Peer

CntPly	Content Player
CntPrp	Content Pre-process
CntPullCli	Content Pull Client
CntPullSvr	Content Pull Server
CntPushCli	Content Push Client
CntPushSvr	Content Push Server
DS	Digital Signage
DvcCtr	Device Control
DvcEvtRcv	Device Event Receiver
DvcStsMnr	Device Status Monitor
EvtDatCnv	Event Data Converter
FE	Functional Entity
IPTV	Internet Protocol Television
LogRptSch	Log and Report Scheduler
LytArr	Layout Arrangement
LytMgm	Layout Management
LytRnd	Layout Rendering
NIC	Network Interface Card
P2P	Peer-to-Peer
PlyLogGen	Play Log Generator
PlyLogMgm	Play Log Management
PlySchMgm	Play Schedule Management
PoP	Proof-of-Play
RegEvtDsp	Registered Event Dispatcher
SMS	Short message service
SngSvcCtr	Signage Service Control
SngSvcMnr	Signage Service Monitor
StrMgm	Storage Management
SysAltCtr	System Alert Control
TTS	Text-to-Speech

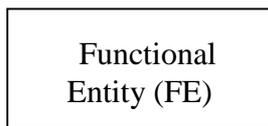
## 5 Conventions

In this Recommendation:

- The keyword "functions" is defined as a collection of functionalities. It is represented by the following symbol in this Recommendation:

Functions

- The keyword "functional entity" (FE) is defined as a group of functionalities that has not been further subdivided at the level of detail described in this Recommendation. It is represented by the following symbol in this Recommendation:



NOTE – In the future, other groups or other Recommendations may possibly further subdivide these FEs.

Frame borders of "functions" and "FE", and relational lines among "functions" and "FE" are drawn with solid lines or dashed lines. The solid lines mean required functionalities or relations. On the other hand, the dashed lines mean optional functionalities or relations.

## **6 Functional architecture of DS services**

This clause describes the detailed functional architecture for DS services by extending the high-level architecture defined in [ITU-T H.780] for accommodating various kinds of underlying transport infrastructures and support of various new features described as follows. It is aligned with the requirements that are defined in [ITU-T H.780]:

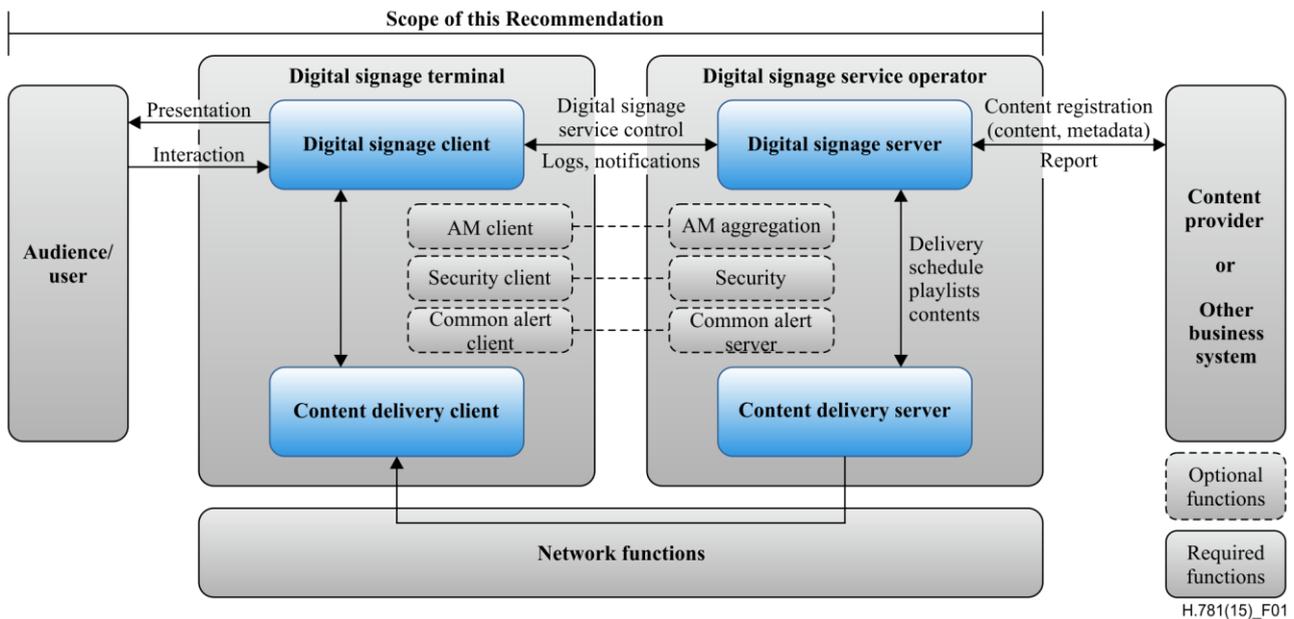
- Support of a wide variety of content delivery methods:  
While both push and pull modes of content delivery are supported, this Recommendation defines an alternative FE for P2P-based content delivery;
- Support of interaction with user through various peripheral devices:  
This Recommendation defines several FEs to support interactions with audiences by making use of external devices that are attached to the terminal devices;
- Definition of reference points:  
This Recommendation defines reference points that are for further study for specifying mechanisms and protocols to be used for interoperability.

### **6.1 Overview of functional architecture of DS service**

Figure 1 shows an overview of functional architecture for DS services. This Recommendation covers interaction among an audience/user, a DS terminal device and a DS service operator.

NOTE 1 – In this Recommendation, "user" means a person who uses the DS service for the purpose of their business. For example, a retailer can utilise a DS service for sales promotion.

The interaction between a DS service operator and a content provider is out of scope of this Recommendation.



**Figure 1 – Architectural overview for DS services**

There are several entities in DS services, including but not limited to the following:

- **Audience/user:** The audience or user, or his/her own device that interacts with a DS terminal device for exchange of information;
- **DS terminal:** The device that displays content received from a DS service provider. Its behaviour is controlled and managed by the DS service provider;
- **DS service operator:** The business operator that provides DS services. It manages DS terminal devices for displaying content received from a content provider;
- **Content provider or business system:** This entity provides content to the DS provider for a particular purpose, e.g., advertisements, information, alerts.

NOTE 2 – Use cases linking with other business systems are listed in [b-ITU-T HSTP.DS-UCIS].

Main groups of functions within the DS terminal and the DS service operator are as follows:

- **DS client:** Is responsible for content presentation and interactions with audiences;
- **Content delivery client:** Is responsible for acquiring content through a network;
- **DS server:** Has capabilities for administration of DS system, control of content delivery and management of DS terminal devices;
- **Content delivery server:** Delivers content to the content delivery client.

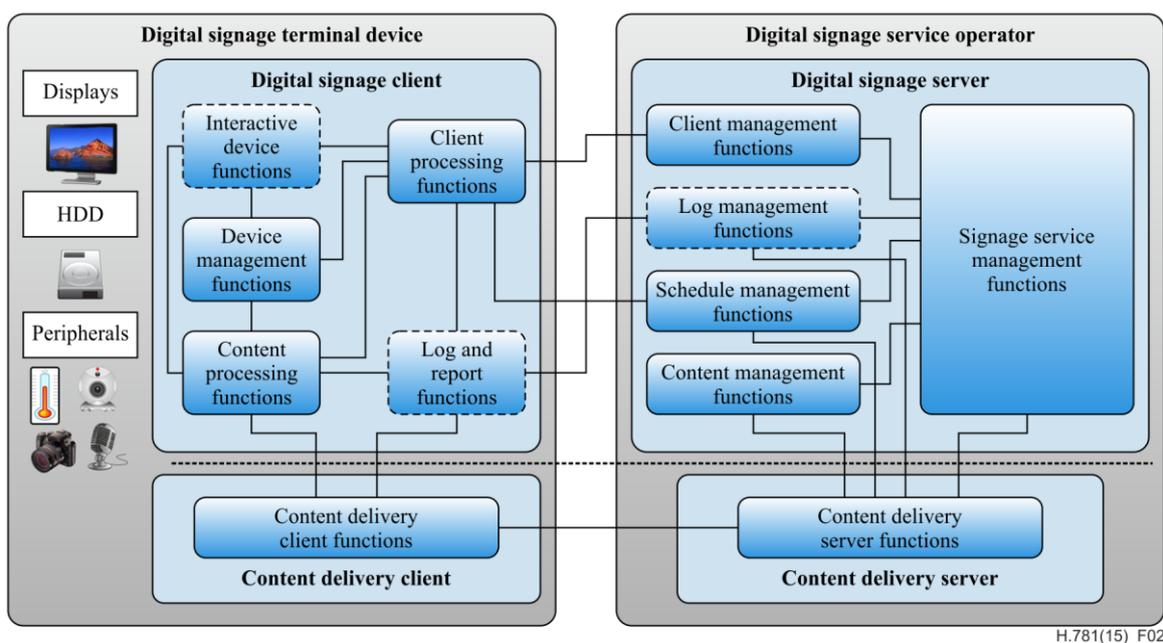
The following are optional functionalities:

- **Security:** Controls the protection of the services and content. Content protection includes control of access to content and the protection of content using methods such as encryption. Service protection includes authentication and authorization of access to services. (See [ITU-T H.780], clause 6.2.2.);
- **Security client:** Interacts with the security functions to provide service protection and content protection. The security client functions verify the usage rights and decrypt content. It is also necessary to consider physical security of the terminal devices under unmanned conditions. (See [ITU-T H.780], clause 6.2.2.);
- **Audience measurement (AM) aggregator:** Aggregates AM information, such as viewership, audience interaction information and audience-related information. It also may

summarize and report the information to organizational entities in a content provider domain. (See [ITU-T H.780], clause 6.2.2.);

- **AM client:** Analyses audience information and report to the AM functions (e.g., the number of people in the audience) (See [ITU-T H.780], clause 6.2.2.);
- **Common alert client:** Supports display of alerting messages received from common alerting servers and can send device events from the DS terminal to the common alert server. This client can convert alerting information to other media formats for accessibility;
- **Common alert server:** Supports a common alerting service in DS by managing data relevant to the common alerting service, such as alerting area, list of terminal, exit routing information, etc. This server receives alert information from the alert agency, and delivers it to the common alert client.

Figure 2 shows functional architecture for DS services between the DS terminal and the DS service operator in a functions level.



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**Figure 2 – Functional architecture of DS services**

A DS terminal consists of two types of clients: A DS client and a content delivery client, as shown in Figure 2. The following is an outline of functionalities:

- **Client processing functions:** Manage the overall behaviour of the DS terminal. They control the scheduling of the content played, configuration regarding services and interactions with the DS server;
- **Interactive device functions:** Handle interactions between an audience and manipulation devices/sensors of a terminal device;
- **Content processing functions:** Prepare content prior to display to the terminal;
- **Device management functions:** Manage devices that are attached to the terminal such as storage, peripherals and displays;
- **Log and report functions:** Aggregate log messages generated during system operation, and sends them to the signage server according to its policy, such as reporting frequency and time to report. It is possible to store the logs into a local storage for a while. It is also possible to report whenever a log message is generated;
- **Content delivery client functions:** Receive and download content from the content server. They can also distribute content to other terminals.

NOTE 3 – These functions include *content delivery* functions of Internet protocol television (IPTV)-based terminal device functions (refer to [ITU-T H.780], clause 8.2.2).

A DS service operator consists of a DS server and a content delivery server.

- **Client management functions:** Control and monitor the DS terminals;
- **Signage service management functions:** Control and monitor DS services;
- **Log management functions:** Aggregate logs from terminals and store them for further usages such as generating records or remote diagnosis;
- **Content management functions:** Manage content and metadata;
- **Schedule management functions:** Manage scheduling of the DS service which includes play schedule and content delivery schedule;
- **Content delivery server functions:** Deliver content to the DS terminal based on the delivery schedule.

NOTE 4 – These functions include *content delivery* functions of IPTV-based DS systems (refer to [ITU-T H.780], clauses 6.2.2 and 8.3).

NOTE 5 – Table 1 shows a relationship of ITU-T H.780 functional blocks with functions/FEs in this Recommendation.

**Table 1 – Relations of functional blocks of [ITU-T H.780]**

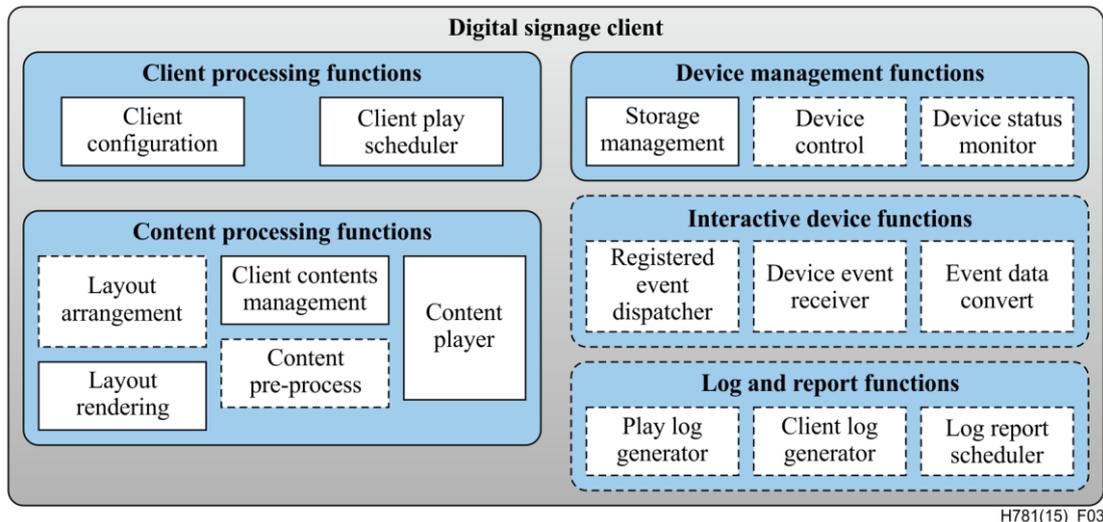
<b>DS client functional blocks in [ITU-T H.780]</b>	<b>Functions/FEs in this Recommendation</b>
Play control (clause 8.2.1.1)	Client processing functions: – Client play scheduler (CliPlySch) FE Log and report functions: – Play log generator (PlyLogGen) FE; – Log report scheduler FE
Media processing (clause 8.2.1.2)	Content processing functions: – Content pre-process (CntPrp) FE; – Layout arrangement FE; – Layout rendering (LytRnd) FE
Storage (clause 8.2.1.5)	Device management functions: – Storage management (StrMgm) FE
Service discovery (for content delivery services)	For further study

**Table 1 – Relations of functional blocks of [ITU-T H.780]**

<b>DS application functional blocks in [ITU-T H.780]</b>	<b>Functions/FEs in this Recommendations</b>
Configuration (clause 8.1.1)	Client management functions: – Client configuration management (CliCnfMgm) FE; – Client information management (CliInfMgm) FE
System management (clause 8.1.2)	Signage service management functions: – Signage service control (SngSvcCtr) FE; – Signage service monitor (SngSvcMnr) FE
Play log aggregation and reporting (clause 8.1.3)	Log management functions: – Play log management (PlyLogMgm) FE
Schedule and delivery management (clause 8.1.5)	Schedule management functions: – Content delivery schedule management (CntDlvSchMgm) FE; – Play schedule management (PlySchMgm) FE Log management functions; – Content delivery log management (CntDlvLogMgm) FE
Content management (clause 8.1.4)	Content management functions: – Content ingestion and registration (CntIngReg) FE; – CntPrp FE; – Content metadata management (CntMtdMgm) FE

## 6.2 Functional architecture of a DS client

This clause describes functions for a DS client. The DS client consists of five functions: Client processing functions, content processing functions, device management functions, interactive management functions and log and report functions.



**Figure 3 – Functional architecture of a DS client**

## **6.2.1 Client processing functions**

Client processing functions control the behaviour of DS terminals. There are two FEs: CliPlySch FE and client configuration (CliCnf) FE.

### **6.2.1.1 CliPlySch FE**

The CliPlySch FE manages schedules regarding play of content/change of layout, and interacts with the PlySchMgm FE of a DS server for retrieving the schedules.

This FE is also capable of reordering or manipulating the schedule on specific local events, if permitted. For example, when the audience manipulates the terminal by interacting with a touch panel, the schedule of the content or layout may be changed for providing information that the audience has requested.

### **6.2.1.2 CliCnf FE**

The CliCnf FE interacts with the client management functions of the DS server for setting the configuration parameters of a DS terminal device. This FE may handle metadata describing capabilities or characteristics of the terminal.

NOTE – Details of metadata of terminal device information is for further study. The metadata is defined in [ITU-T H.780], clause 9.2 "Terminal device information", however, it is necessary to extend the specifications to better accommodate detailed characteristics of peripherals.

## **6.2.2 Content processing functions**

Content processing functions prepare content prior to sending the stream to output devices (such as display and speaker). They perform transcoding, multimedia decoding, LytRnd, etc. These functions consist of five FEs: content player (CntPly) FE, client content management (CliCntMgm) FE, CntPrp FE, LytRnd FE and layout arrangement (LytArr) FE.

### **6.2.2.1 LytRnd FE**

The LytRnd FE renders layout consisting of multiple kinds of content by interacting with the LytArr FE, CliCntMgm FE and CntPrp FE, and outputs the rendered content to the display. Since the characteristics of display are often different (such as ratio, size and colour), this FE may change layout parameters such as position and size, according to the characteristics.

### **6.2.2.2 CliCntMgm FE**

The CliCntMgm FE manages content which is obtained from a content delivery client. It also maintains content metadata, such as aspect ratio, resolution and sound. Content has its own identifier which will be used within the playlist and playlist schedule.

### **6.2.2.3 CntPrp FE**

The CntPrp FE processes the content received from the server, in order to convert it to the appropriate format for presentation. It performs transcoding, resizing, etc. in order to fit with capabilities of terminal devices. Pre-processing of content by the DS server for all terminals is optional.

### **6.2.2.4 LytArr FE**

The LytArr FE provides layout information to the LytRnd FE. It is possible to display multiple kinds of content on a single screen by arranging positions of the content as a layout. This FE may acquire layout information from the layout management (LytMgm) FE of DS server, and it can keep multiple layouts for rapid switching of layout. For example, this FE can change a pre-specified layout that can be used in a special situation such as an emergency in a unified manner. This FE is optional if the client does not manage layouts locally.

### **6.2.2.5 CntPly FE**

The CntPly FE plays content according to playlists. It can interact with the PlyLogGen FE to report the event related to play of content.

## **6.2.3 Device management functions**

Device management functions manage the internal/external data storage and the attached devices including peripherals and display. There are three FEs: storage management (StrMgm) FE, device control (DvcCtr) FE and device status monitor (DvcStsMnr) FE.

### **6.2.3.1 StrMgm FE**

The StrMgm FE stores and manages logs, content and content metadata into a local storage.

### **6.2.3.2 DvcCtr FE**

The DvcCtr FE controls external peripherals that are attached into a DS terminal. Since a DS terminal can use various devices, the DvcCtr FE interacts with each device to get input and probing for the status of peripherals. This FE is optional.

### **6.2.3.3 DvcStsMnr FE**

The DvcStsMnr FE monitors the status of device activities. It is important to keep track of the current status of each device, in particular by periodically probing the status of devices or receiving events to check whether they are operating properly. For example, if there is a network failure due to disconnection of a LAN cable that is attached to the network interface card (NIC) of a terminal device, the failure is detected and recorded as an event by this FE. When the network is recovered, the record may be sent to the client log management (CliLogMgm) FE for reporting to the server as per a pre-defined schedule. This FE is optional if the terminal does not support status monitoring of terminal devices.

## **6.2.4 Interactive device functions**

Interactive device functions translate actions of user/audience or sensor data, which are sensed through external/internal devices, into system events processed by client functionalities. There are three FEs: registered event dispatcher (RegEvtDsp) FE, device event receiver (DvcEvtRcv) FE and event data converter (EvtDatCnv) FE.

### **6.2.4.1 RegEvtDsp FE**

The RegEvtDsp FE registers and manages events requested by other functions or FEs. Other functions or FEs can request this FE to inform them of the occurrence of particular events from an indicated device. The indicated device includes touch panel, keyboard, sensor, camera, or any other device in which an event can occur that has significance to the requester. A request from the requester may be in the form of a device identifier and description of the event. This FE registers the request and notifies the requester when the specified event occurs. If an event occurs in which no functions or FE has interest, the event is ignored. This FE is optional if the terminal does not support receiving event data from devices.

### **6.2.4.2 DvcEvtRcv FE**

The DvcEvtRcv FE receives event data in raw data format from the interactive devices. It sends the received data to the EvtDatCnv FE. This FE is optional if the client does not support receiving event data from devices.

### **6.2.4.3 EvtDatCnv FE**

The EvtDatCnv FE converts the event data to an event message that has a consistent format. The format of the raw data is varied depending on the types of interactive devices. This FE is optional if the client does not support receiving event data from devices.

## **6.2.5 Log and report functions**

Log and report functions keep records of play logs and system logs, and send them to the DS server based on policies regarding the report schedule. It consists of: PlyLogGen FE, client log generator (CliLogGen) FE and log and report scheduler (LogRptSch) FE.

### **6.2.5.1 PlyLogGen FE**

The PlyLogGen FE creates a play record for content played in the client, and sends the play log to log and report functions in the DS server. The LogRptSch FE may initiate this reporting procedure. This FE may include information regarding system operation, play of content and audience measurement. The kind of information that should be logged is defined by service providers or system vendors.

Since the network between the DS server and terminal devices can be a best effort network (i.e., the network does not guarantee reliability), the report message should be stored in a local storage for retransmission.

When it is requested to confirm the integrity of the report message, such as proof-of-play (PoP), this FE includes PoP in the log data to provide proof of whether particular content has been played or not in the terminal device and provides a method for assuring the integrity of play log record. The PoP data can be acquired from specialized devices, such as a small camera attached in front of the display. Another possible method is to generate data for PoP by adding digital signatures or encrypting the play log data. The content owner may specify the format of data for PoP. This FE is optional if it does not support the functionality of generating records of content played.

### **6.2.5.2 CliLogGen FE**

The CliLogGen FE aggregates logs for system maintenance. This FE receives reports from DvcStsMnr FE on various kinds of events that are related to the operation of the client. This FE stacks up log messages until it receives a request from the LogRptSch FE to send a report to the DS server. This FE is optional if it does not support the functionality of handling status log of the terminal device.

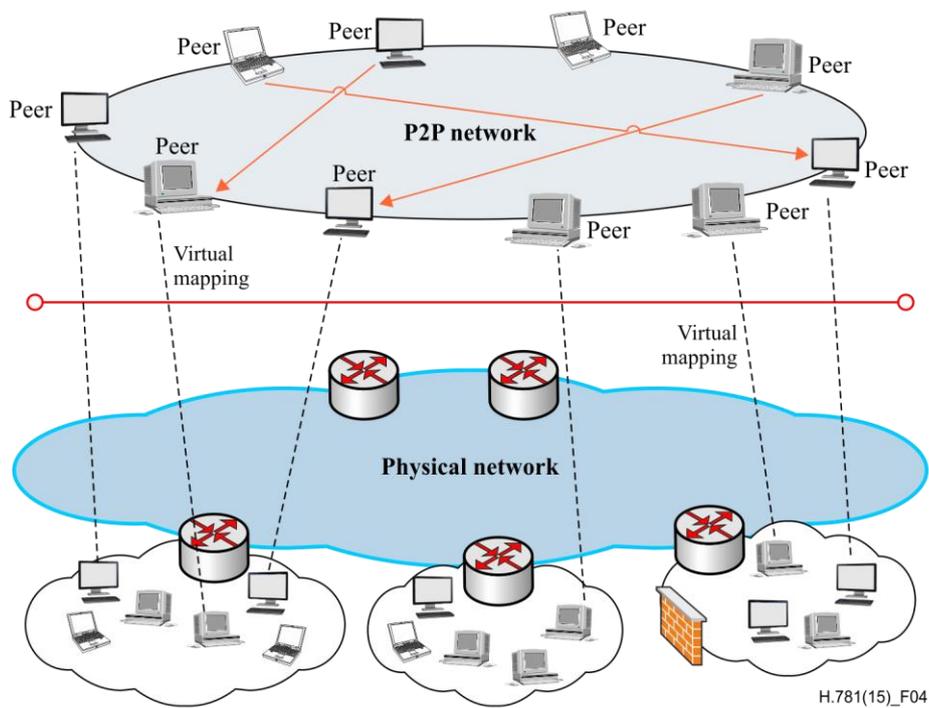
### **6.2.5.3 LogRptSch FE**

The LogRptSch FE manages reporting. It receives a reporting policy, such as time to report and reporting frequency, from the server CliCnfMgm FE through the client CliCnf FE. When it is time to send a report message, it interacts with the PlyLogGen FE or the CliLogGen FE to request the sending of accumulated log data to a pre-specified address. This FE is optional if it does not support the functionality of scheduled reporting.

## **6.3 Functional architecture of a content delivery client**

This clause describes the FEs of a content delivery client that acquires content from a content delivery server of a service provider. The content can be delivered in various ways, such as push, pull and P2P. Before the client receives content, it may first receive the content delivery schedule from the content delivery server. If it is specified to receive content with push mode, content is pushed to the content delivery client by the content delivery server. In the case of pull mode, each client requests particular content from the server. Since all DS terminals are connected into a network, it is possible to exchange content with each other. This lowers the load of the content delivery server and enhances distribution performance. Even though P2P-based content distribution can provide efficient and enhanced performance, an alternative delivery method needs to be provided since, while P2P-based delivery is delay-tolerant, the content should be delivered to the terminal device prior to actual display.

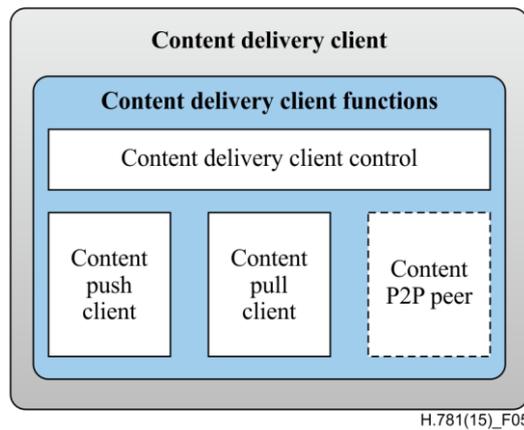
NOTE – A P2P network is an overlay network composed of peers that share their resources with other peers, and it is constructed virtually amongst peers that are built on top of another network. See Figure 4.



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**Figure 4 – P2P network (b-ISO/IEC TR 20002)**

When content distribution is done with P2P-based methods, an overlay network is constructed that contains the address of terminals that are currently downloading or have a full or partial copy of the content, and logically slices the content into multiple chunks with pre-specified size. Each terminal acting as a peer exchanges the chunks with multiple peers simultaneously. In general, one overlay network is constructed for one content, but it is possible to create one overlay network for multiple content as well.



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**Figure 5 – Functional architecture of a content delivery client**

Figure 5 shows the functional architecture of a content delivery client that is composed of content delivery client functions.

### 6.3.1 Content delivery client functions

Content delivery client functions receive content from a remote content delivery server according to the delivery schedule. These functions consist of four FEs: Content delivery client control (CntDivCliCtrl) FE, content push client (CntPushCli) FE, content pull client (CntPullCli) FE and content P2P peer (CntP2pPeer) FE.

### **6.3.1.1 CntDlvCliCtrl FE**

The CntDlvCliCtrl FE interacts with the content delivery server control (CntDlvSvrCtrl) FE to get a content delivery schedule that describes the time, delivery method and network address that has content to be distributed, etc. This FE controls the other FEs for acquiring content according to the schedule. In order to deliver content prior to actual display, the content delivery schedule would have time constraints. If the content delivery client fails to acquire content with specific time constraints, it retries to acquire content. In this case, terminal devices may acquire content from an alternative content server with an alternative method.

### **6.3.1.2 CntPushCli FE**

The CntPushCli FE receives content from the content delivery server with a push-type delivery. When the CntDlvCliCtrl FE requests the CntPushCli FE to prepare for receiving specific content, this FE begins to listen to a specific network interface. It is also possible for it to be ready all the time to receive content from the server. When this FE completes reception of content, the FE checks the integrity of the received content and notifies the result of content delivery to the CntDlvCliCtrl FE.

### **6.3.1.3 CntPullCli FE**

The CntPullCli FE gets content by requesting content as specified in a content delivery schedule. Since the schedule contains the delivery schedule per each terminal, this FE begins to request delivery according to a pre-specified time. When it completes the delivery of a particular content, this FE notifies the CntDlvCliCtrl FE after an integrity check.

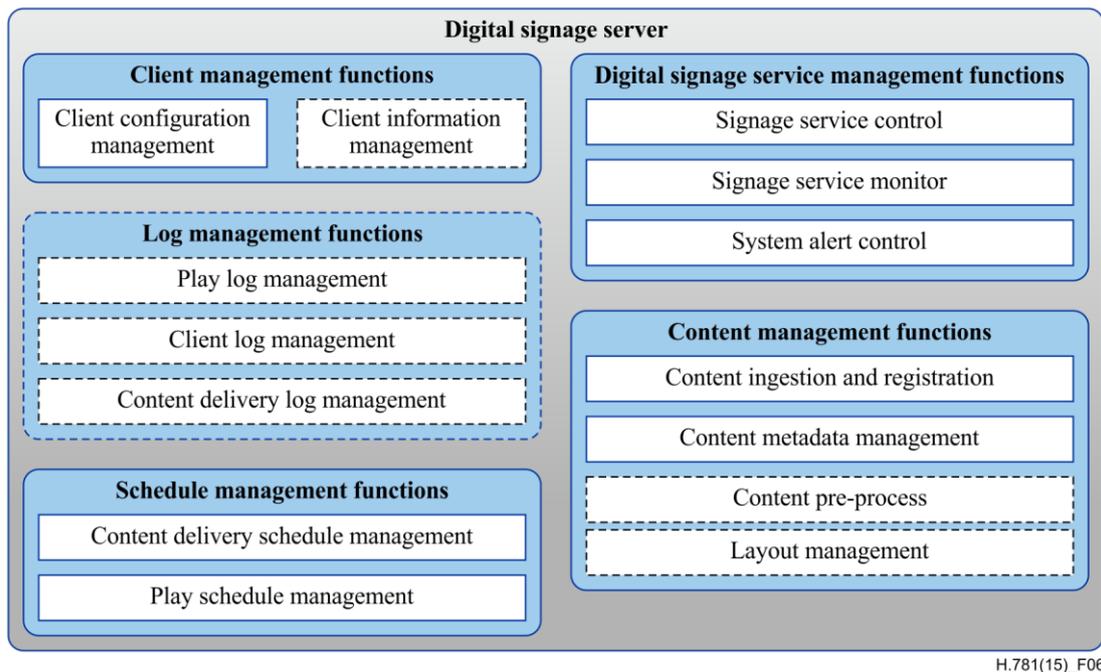
### **6.3.1.4 CntP2pPeer FE**

The CntP2pPeer FE receives content with P2P-type delivery. Since a DS service provider manages terminal device information such as its IP address, an overlay network for specific content delivery is pre-constructed. This FE receives the addresses of other CntP2pPeer FEs from the CntDlvCliCtrl FE of the content delivery server, and exchanges the content in parallel with other clients. This FE is optional if the terminal does not support P2P-based content delivery.

NOTE – In generic P2P-based content delivery, a client is required to explicitly join or leave processes of an overlay network. Since an overlay network for content delivery is pre-constructed in DS services, terminal devices do not need to explicitly join or leave the overlay network.

## **6.4 Functional architecture of DS server**

This clause describes the functions of a DS server, which consists of five functions: client management functions, log management functions, schedule management functions, DS service management functions and content management functions. See Figure 6.



**Figure 6 – Functional architecture of DS server**

#### 6.4.1 Client management functions

Client management functions remotely control and monitor DS terminal devices. Two FEs are defined: CliCnfMgm FE and CliInfMgm FE.

##### 6.4.1.1 CliCnfMgm FE

The CliCnfMgm FE controls each DS terminal device's behaviours by managing configurations of the terminal devices through interacting with the clients' CnfMgm FE. It can order the clients to retrieve the latest playlist.

NOTE – Some types of operations that are dependent on the DS application (such as remote system administration) are out of scope of this Recommendation.

##### 6.4.1.2 CliInfMgm FE

The CliInfMgm FE manages information related to terminal devices. When an operator wants to register a new terminal device, the operator provides related information such as location, contact information (e.g., person in charge), terminal identifier, etc. When the terminal device boots up, it registers its information into this FE. This FE is optional.

##### 6.4.1.3 Signage service management functions

DS service management functions control DS services on behalf of the system operator and trigger alarms in case of system malfunction. These functions also manage the service profile for controlling the service.

##### 6.4.1.4 SngSvcCtr FE

The SngSvcCtr FE controls specific DS services based on the signage service profile. It interacts with other management functions within DS servers: content management, client management, log management and schedule management.

##### 6.4.1.5 SngSvcMnr FE

The SngSvcMnr FE monitors the log management functions for specific events. A periodic status report or play report will be delivered to log management functions. If a particular event that should

be handled immediately occurs, this FE delivers the event message to the system alert control (SysAltCtr) FE.

#### **6.4.1.6 SysAltCtr FE**

The SysAltCtr FE alerts DS service administrators in case of a serious problem. In order to make this possible, the DS server should have a method (such as e-mail or short message service (SMS)) to notify to an administrator.

### **6.4.2 Log management functions**

Log management functions aggregate logs from DS terminal devices, and keep the records for further usage. These logs and reports can be used for PoP on specific content.

#### **6.4.2.1 PlyLogMGM FE**

The PlyLogMgm FE aggregates play logs from DS terminals. According to the policy regarding reporting frequency for the terminal, report from the client may contain multiple log data within it. Hence, this FE can be ready for receiving multiple logs within a record as well as one log within a record. This FE is optional if the system does not support the functionality of keeping records of content play.

#### **6.4.2.2 CliLogMgm FE**

The CliLogMgm FE aggregates logs of system status of DS client-side FEs, without play logs and content delivery logs. This FE is optional if it does not support logging of the status of client.

#### **6.4.2.3 CntDlvLogMgm FE**

The CntDlvLogMgm FE aggregates logs from content delivery clients and servers. The log message contains detailed information regarding content delivery such as content delivery method, start/end time of delivery, the address of terminal and content identifier. Content sharing activities may also be treated if P2P has been used. This FE is optional if the system does not support the functionality of aggregation of content delivery logs.

### **6.4.3 Schedule management functions**

Schedule management functions create and/or manage two types of schedules: a playlist schedule and a content delivery schedule. The content delivery schedule prevents a server or network from collapsing in case multiple clients try simultaneously to acquire content from a server. Therefore, the content delivery schedule may assign different content delivery time slots to each DS terminal device for traffic scattering, and embed additional information such as content information, time constraints, preferred delivery schedule and terminal device lists that are to acquire content.

#### **6.4.3.1 PlySchMgm FE**

The PlySchMgm FE creates and stores playlists and sends them to proper functions or FEs.

#### **6.4.3.2 CntDlvSchMgm FE**

The CntDlvSchMgm FE manages schedules for content delivery. This FE requests the content delivery client to distribute particular content to multiple DS terminals.

### **6.4.4 Content management functions**

Content management functions manage content and metadata. They receive and register content from the content provider or other business systems with detailed descriptions of the content.

#### **6.4.4.1 LytMgm FE**

The LytMgm FE creates layout for displaying one or more pieces of content within a single screen, and the layout will be sent to the LytMgm FE of each terminal. Generally, a layout is created and

managed by a service operator, not terminal. A service operator can create various types of layout and allocate them to appropriate terminal devices. This FE is optional if LytMgm is not supported.

#### 6.4.4.2 CntPrp FE

The CntPrp FE pre-processes the content that is received from content providers or other business systems, prior to delivering it to DS terminal devices. This FE has functionalities similar to that of the CntPrp FE of a client that performs transcoding, resizing, etc. Optionality of the client and server CntPrp FEs are described in clause 6.2.2.3.

#### 6.4.4.3 CntIngReg FE

The CntIngReg FE receives content and its related metadata from a content provider or other business systems. When registration procedures are completed, this FE sends the content to content delivery server functions and registers metadata into the CntMtdMgm FE. Even though the content is sent to the content delivery server functions, the content is not delivered before the server functions receive the delivery request from CntDlvSchMgm FE.

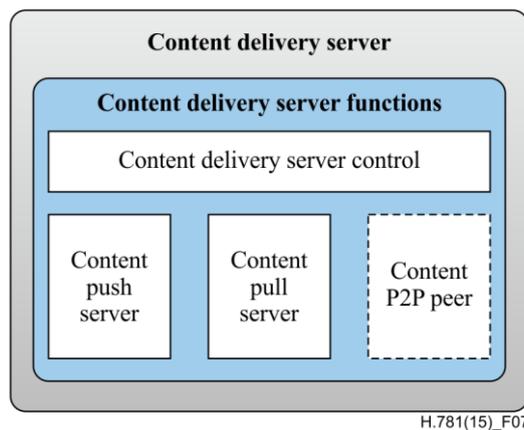
#### 6.4.4.4 CntMtdMgm FE

The CntMtdMgm FE manages the metadata of content. It receives metadata from the content owner or other business systems and processes the metadata.

### 6.5 Functional architecture of content delivery server

The content delivery server takes the role of content delivery to remote DS terminal devices in various ways according to delivery schedules. If a massive number of signage terminal devices request content from a particular content server, the server may suffer from bottleneck problems, such as network congestion. Hence, the content delivery servers need to use delivery schedules.

Figure 7 shows the functional architecture of a content delivery server that is composed of content delivery server functions.



**Figure 7 – Functional architecture of content delivery server**

#### 6.5.1 Content delivery server functions

Content delivery server functions deliver content to DS terminal devices according to a content delivery schedule managed by schedule management functions. It consists of four FEs: CntDlvSvrCtrl FE, content push server (CntPushSvr) FE, content pull server (CntPullSvr) FE and CntP2pPeer FE.

### 6.5.1.1 CntDlvSvrCtrl FE

The CntDlvSvrCtrl FE controls other content delivery-related server FEs and interacts with content delivery client functions. When the content delivery server delivers content by means of P2P, this FE manages the overlay network.

### 6.5.1.2 CntPullSvr FE

The CntPullSvr FE sends content with pull-type delivery, based on requests from terminal devices. This FE waits for the request from a client for specific content. Prior to sending the requested content, it checks whether the requester is authorized to access the content. When it finishes sending the requested content, this FE may notify the CntDlvSvrCtrl FE that interacts with the CntDlvLogMgm FE of the DS server.

### 6.5.1.3 CntPushSvr FE

The CntPushSvr FE pushes content to remote DS terminal devices. This FE pushes content based on a delivery schedule.

### 6.5.1.4 CntP2pPeer FE

The CntP2pPeer FE performs the same functionalities as the CntP2pPeer FE of the content delivery client except that it already has content. This FE is optional if P2P-based content delivery is not supported.

## 7 Reference points

This clause describes reference points between related entities, as illustrated in Figure 8.

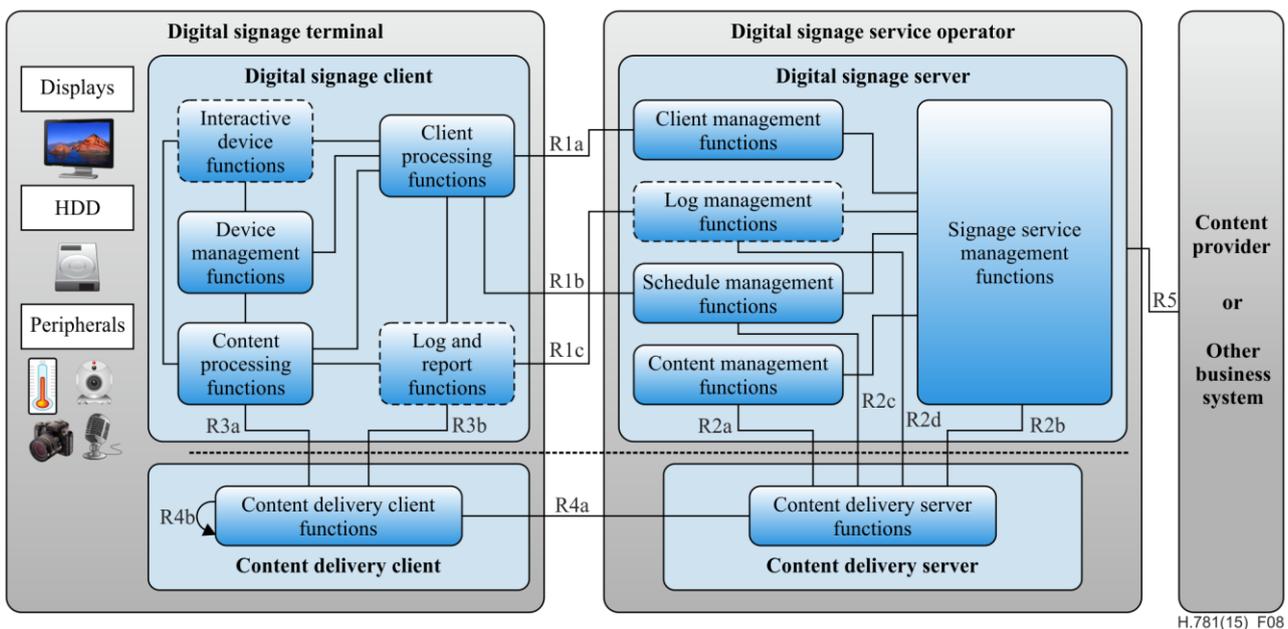


Figure 8 – Reference points between related entities

### 7.1 R1: Digital signage client and digital signage server

Table 2 lists, for reference point R1, some of the interactions between a DS client and a DS server.

**Table 2 – Details of reference point R1**

Reference point	Category	Operations
R1a	Terminal registration	When a DS terminal is booted, it performs terminal registration procedures for accessing a DS server. The terminal registers its current status information after terminal authentication, if needed.
	Remote control of terminal	The DS server needs to control the operation of terminals such as turning off the display or speaker remotely.
R1b	Delivery of playlist schedules	The DS server sends playlist schedule information to each terminal.
R1c	Reporting of system/service maintenance information	If the terminal detects particular events, it reports the event information to the remote signage server. The report can be sent immediately or periodically, depending on the urgency of the events. In addition to system maintenance events, the terminal also reports service events such as play of content, completion of content download, etc.

## 7.2 R2: Digital signage server and content delivery server

Table 3 lists, for reference point R2, some of the interactions between a DS server and a content delivery server.

**Table 3 – Details of reference point R2**

Reference point	Category	Operations
R2a	Content distribution	Content is distributed from the content management functions to the content delivery server functions before sending content.
R2b	Request of delivery	When the DS server decides to deliver content to terminals, it requests the content delivery server to send it through the R2b reference point.
R2c	Scheduled delivery	When a content delivery server decides to deliver content to the terminal devices according to a content delivery schedule, the schedule is given through the R2c reference point.
R2d	Report of delivery	The content delivery server reports to the DS server regarding the results of content delivery. This information is managed by the DS server.

## 7.3 R3: Digital signage client and content delivery client

Table 4 lists, for reference point R3, some of the interactions between a DS client and a content delivery client.

**Table 4 – Details of reference point R3**

Reference point	Category	Operations
R3a	Acquiring of content	The DS client acquires content from the content delivery client.
	Request of content delivery	The DS client requests the content delivery client to get the content in pull mode or in P2P mode.
R3b	Report of content delivery	The content delivery client notifies when it finishes the reception of specified content. When all terminals try to receive specific content at the same time, it will suffer from a bottleneck problem. Hence, the DS client may specify content download schedules, based on its play schedule. Since content should be ready prior to display of content according to the schedules, time constraints for content delivery may be included.

#### 7.4 R4: Content delivery client and content delivery server

Table 5 lists, for reference point R4, some of the interactions between a content delivery client and the content delivery server.

**Table 5 – Details of reference point R4**

Reference point	Category	Operations
R4a	Delivery of content delivery schedule	The content delivery server sends a content delivery schedule to the client. This operation can be requested by the server and the client.
	Delivery of content	Content is delivered from the content delivery server to the client according to the content delivery schedule. The content is delivered to the client through push/pull/P2P methods.
	Report of content delivery	When the client finishes receiving content, it reports the results of content delivery to the server. This information can be reported immediately or can be reported periodically.
R4b	Sharing of content	In P2P mode, the content is delivered from a P2P peer to other P2P peers according to the content delivery schedule.

#### 7.5 R5: Digital signage server and content provider

In reference R5, the DS server and a content provider interact with each other to selecting time slots for content display and/or target terminals for content delivery, registering content, etc. The details of reference point R5 are out of the scope of this Recommendation.

### 8 Information flows

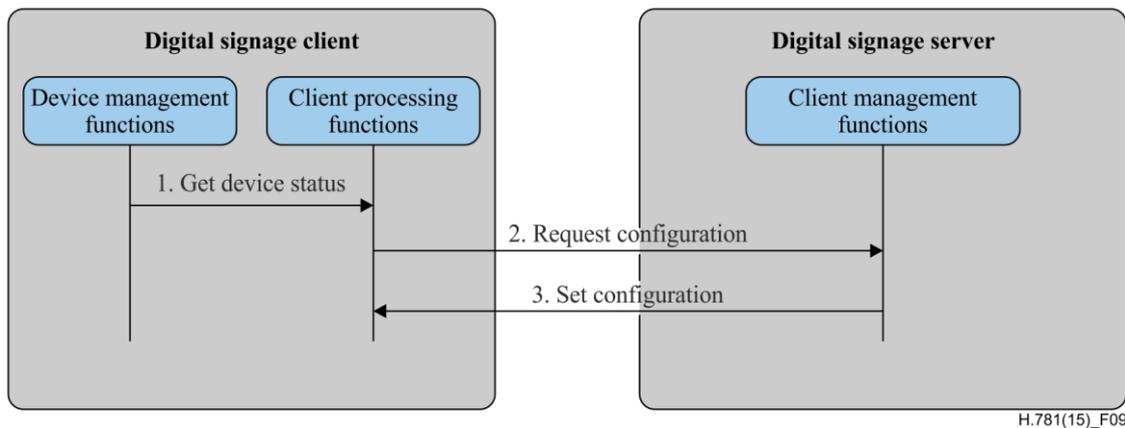
This clause describes generic information flows for providing DS services.

#### 8.1 Configuration of terminal devices

This method is effective when a DS server gives configuration of DS terminal devices. For example, if a terminal with a speaker is installed in a restricted area where it should not make noise, the signage server can give appropriate terminal behaviour configuration. This flow assumes that the terminal has been already enrolled by a DS operator.

When the DS terminal boots up, its configuration parameters should be set from the DS server. See Figure 9.

NOTE – There may be other configuration procedures. Procedures regarding authentication and authorization in DS services are for further study.



**Figure 9 – Terminal configuration procedures**

1. When a DS client application has been launched, client processing functions may initially probe device status from the device management functions of the DS client.
2. Client processing functions of the DS client interact with the client management functions of the DS server in order to register the terminal device. When client processing functions request configuration, the following information may be sent to the server:
  - terminal device information (e.g., terminal ID, IP address);
  - terminal device status information (e.g., hardware/software errors);
  - auxiliary device information (e.g., types of attached external devices);
  - venue information (e.g., the address of an installation place);
  - client pre-configuration information.
3. Client management functions of the DS server check validation and authentication whether or not the terminal is authorized to access this server. If it is not authorized yet, it returns a failure message. When the authentication procedure finishes, client management functions send configuration to the terminal. The configuration may include, *inter alia*, the following information:
  - content delivery server information;
  - location of playlist schedule;
  - reporting frequency, types of events to be reported, address of a log server when using distributed log servers, etc.

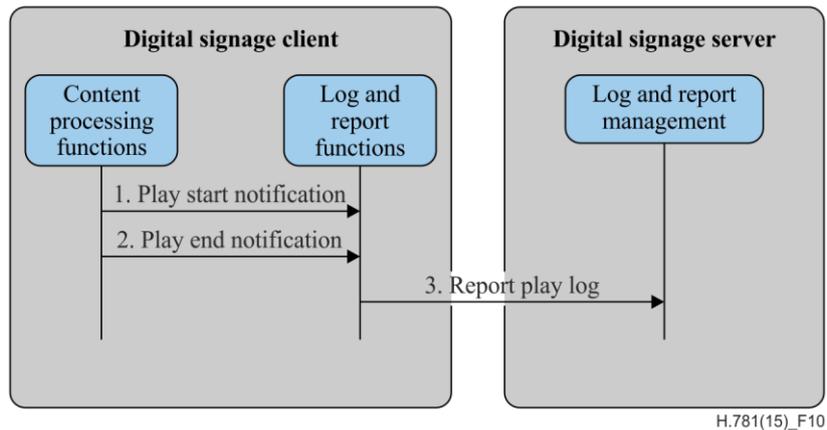
## 8.2 Play of content and its report

This clause applies to the case where DS systems are capable of handling logs. When a DS terminal device plays content according to a play schedule, the terminal device may report the play results to the DS server. These records can be used to confirm whether content has been played successfully.

### 8.2.1 Reporting play log

When the DS terminal plays content according to the play schedule, it reports the play result to the DS server in the form of a play log. This play log will be used to confirm whether the content has been played successfully. It is possible to display multiple contents simultaneously within a single display. In other words, a single layout can contain multiple contents. In this case, multiple play logs

will be generated (since a play log records events for one content). This flow shows a procedure for logging a single content being played, and multiple logs will be generated if multiple contents are displayed simultaneously. See Figure 10.

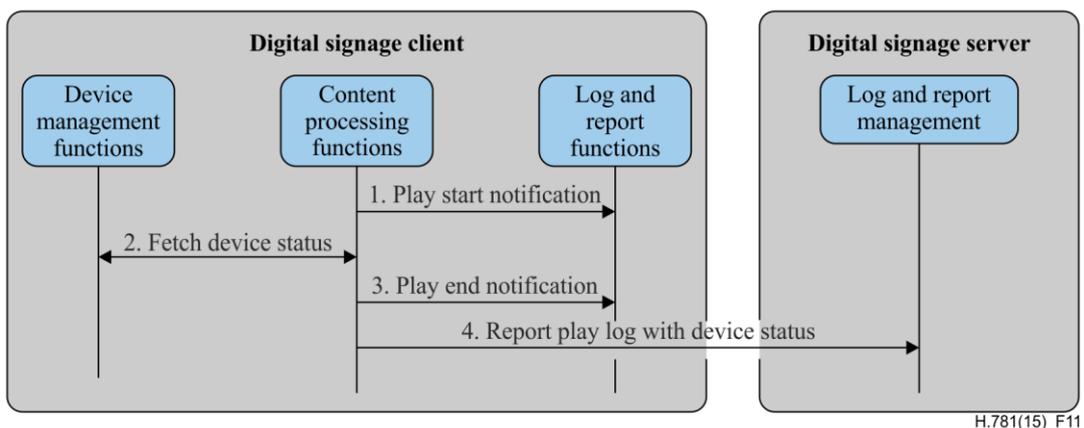


**Figure 10 – Procedures for reporting play logs**

1. Content processing functions (e.g., CntPly FE) notify log and report functions when a specific content starts to play. If content processing functions fail to play the specific content, it also logs the event.
2. When the play of the content has finished, content processing functions notify log and report functions.
3. Log and report functions generate play log information and send it to log and report management functions of the DS server.
  - In general, if the play log event is not an urgent event, the DS terminal may not report the logged event immediately, instead, the terminal temporarily accumulates the log messages and sends the aggregated reports to the server on a pre-defined schedule.

### 8.2.2 Reporting play log with device status

It is possible to use external devices, such as a small camera, in front of a display for assuring PoP and status of the display. For example, a monitor blackout problem during content play can be detected by using such devices. Even though there is no external device that detects the status of the monitor, content providers may want to know the history of specific device status while their content is being played if it uses specific features such as user interaction using auxiliary devices like a touch panel. See Figure 11 on procedures for reporting a play log with device status.



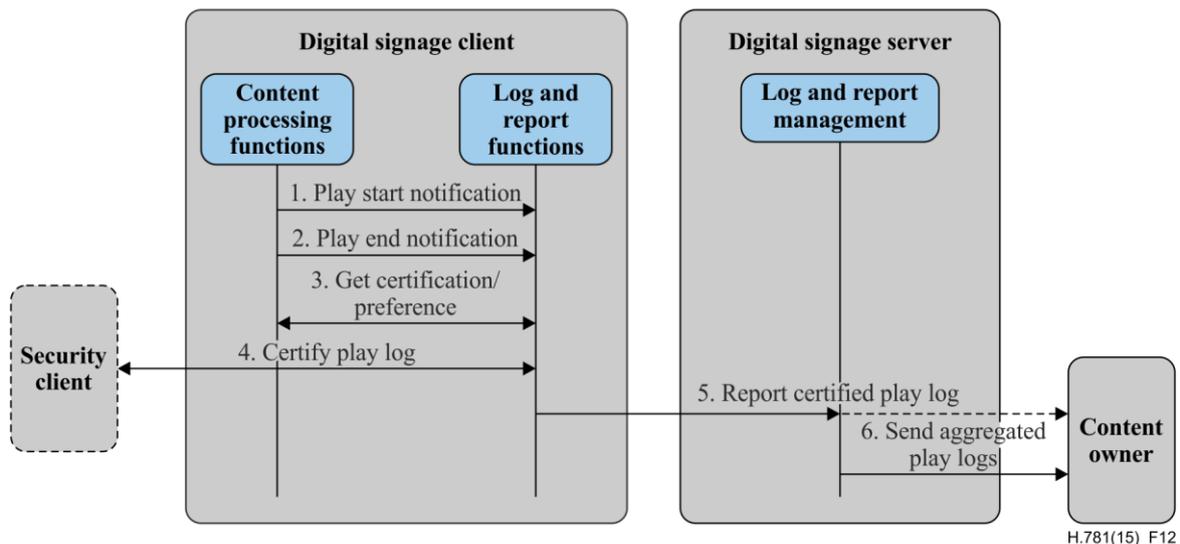
**Figure 11 – Procedures for reporting play log with device status**

1. Content processing functions notify the log and report functions when specific content starts to play. If it fails to play specific content, it also logs the event.
2. Content processing functions fetch the current status of a specific device, such as a specialized camera for observing the pattern of electronic display.
3. When the content finishes playing, the content processing functions notify the event to the log and report functions.
4. Log and report functions generate play-log information that includes device status information and sends it to the log and report management functions of the DS server.

### 8.2.3 Reporting confidential play log for PoP

There is a case where a content owner requests confidential records as PoP (see clause 6.2.5.1). In this case, the content owner may request more reliable proof than a simple play log to confirm that the content has actually been played. DS services can use digital signatures in the play log to provide PoP.

As an assumption, the content owner has already registered its digital signature and preferences that contain formats of log messages for the play of content. This registration process is made during the content registration procedure as requested by the content owner. See Figure 12.



**Figure 12 – Procedures for reporting play log with confidentiality**

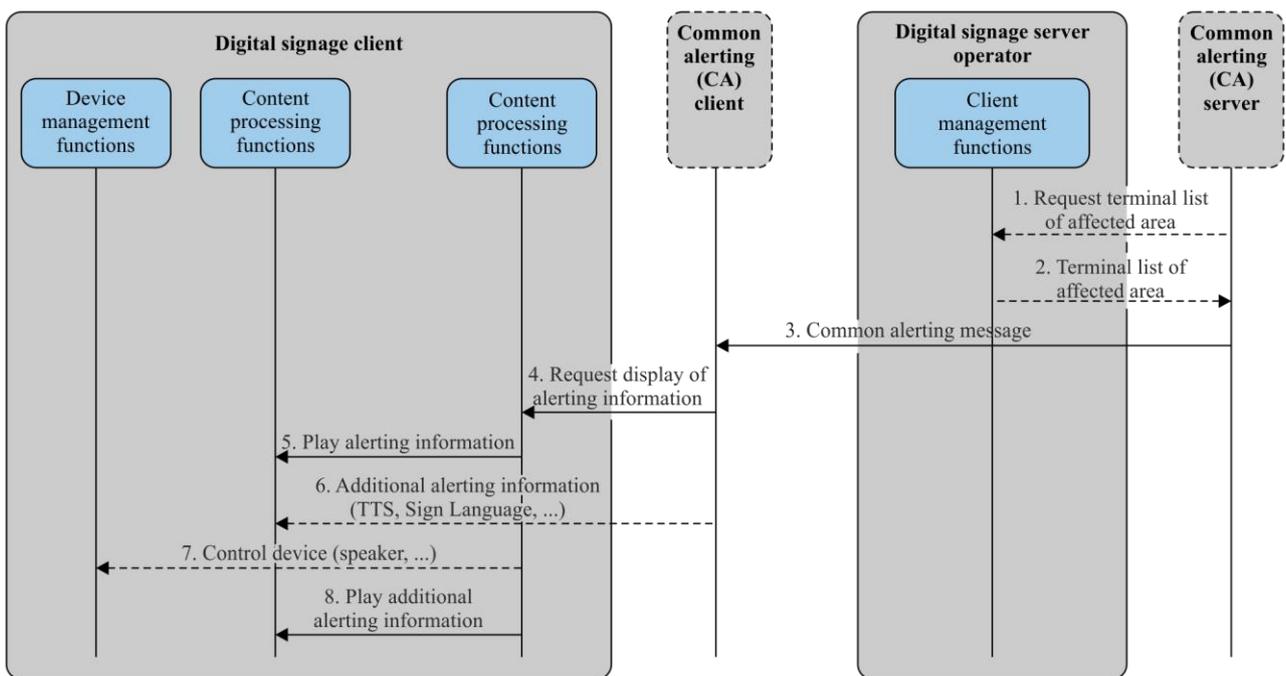
1. Content processing functions notify the log and report functions when specific content starts to play. If it fails to play the specific content, it logs the event.
2. Content processing functions fetch the current status of a specific device such as a specialized camera for observing the pattern of electronic display.
3. Log and report functions retrieve certifications such as a digital signature and preferences that include format of log messages for the content being played.
  - If there is no preference for the content, log and report functions generate log messages based on a default format that is pre-defined by the service provider. If the digital signature for the content is not assigned, it will skip the remaining procedures, and sends a log message to the DS server.
4. Log and report functions request a security client to certify the play log record with the digital signature of the content. This certification is used for PoP.
  - It is also possible to encrypt the play log record for security reasons by using the digital signature.

5. Log and report functions send the play log with the PoP to the DS server and/or directly to the content owner.
  - When sending play logs directly to the content owner, the content owner has the capability to receive them, even if at a high frequency.
6. Log and report management functions of the DS server send the aggregated play logs to the content owner.

### 8.3 Display of alerting information

This clause applies when common alerting features are implemented.

Since a DS service offers rich information in an open area by which many people pass, DS can play a crucial role in providing alerting services. In general, it is useful to provide multimedia-based alerting information through DS terminal devices. It is assumed that a common alerting server has already received an alert from an alert agency, and the alert contains the affected area information. Figure 13 shows the procedures of a common alerting service.



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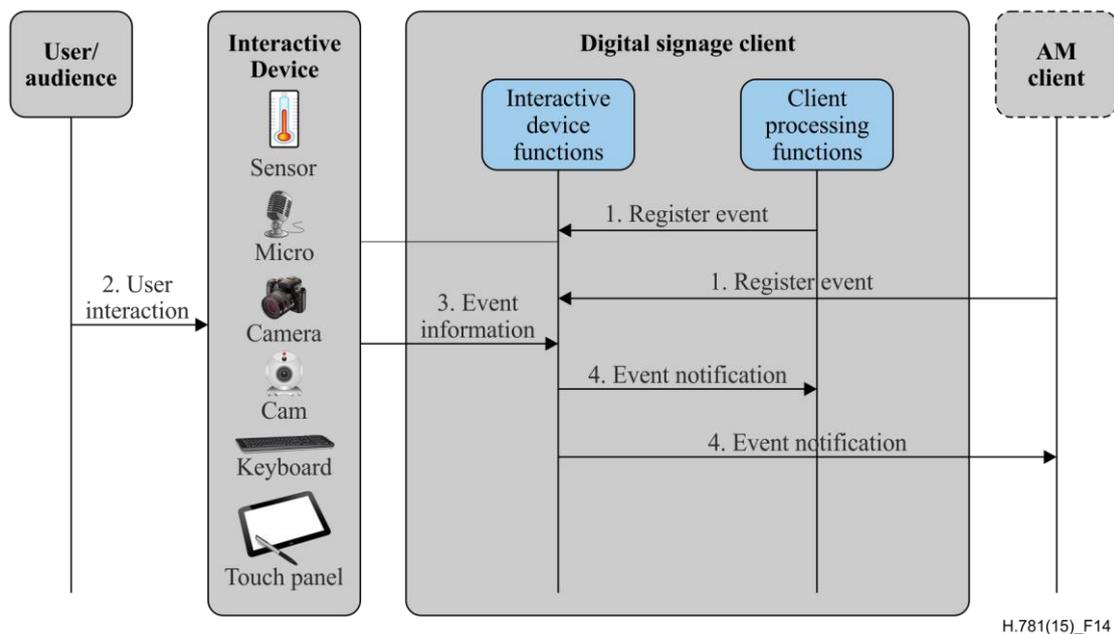
**Figure 13 – Procedures for display of alerting information**

1. The common alerting server may request a terminal list of the affected area to client management functions of the DS server which manage locations of DS terminals.
2. Client management functions may send the terminal list of the affected area based on step 1.
3. The common alerting server creates a common alerting message and sends it to the common alerting (CA) clients pertaining to DS terminals.
  - The common alerting client can select the display mode, such as sole screen, screen division and screen overlay, according to the type and class of alert.
4. The common alerting client requests display of alerting information to the client processing functions of the DS client.
  - The common alerting client can provide the pre-arranged emergency exit route information on how to evacuate according to the type and class of alert. If emergency exit route information is provided, the common alerting client uses emergency exit route information with the alerting message.

- The common alerting client can change play schedules according to the type and class of alert by interacting with the DS client. It requests the change of play schedules to the client processing functions of the DS client.
5. Client processing functions request to display the alert information to the content processing functions.
  6. The common alerting client can convert alerting information into audio or sign language format for universal design presentations by interacting with the DS client.
    - If the content processing functions of the DS client have a universal design presentation functionality, the common alerting client can request the conversion of alerting information to the content processing functions.
  7. The common alerting client can control the devices according to the type and class of common alert information by interacting with the DS client.
    - The common alerting client can request control of a connected device to the device management functions of the DS client. For example, it can increase the volume of a speaker with a siren.
  8. Client processing functions request to display the additional alerting information such as text-to-speech (TTS) and sign language to content processing functions.

#### 8.4 Interactive services

A DS system can control interactive devices connected to the DS client. Figure 14 shows the basic flow for interactive services.



**Figure 14 – Interactive services**

The content displayed by the DS client may request specific events from interactive devices. For example, content may request an audience to select a service item from a certain menu by using a DS touch screen. Based on the user selection, the content or the playlist that is being displayed can be changed.

1. Client processing functions request interactive device functions to be notified of particular events with the registered event messages. The events can be registered for each auxiliary device.

- Other functions such as AM client functions can request to be notified for a particular event with the event registration message. The event can be registered with an auxiliary device.

NOTE – If different services register the same event, the type of notification can be identical or different, depending upon implementation.

2. An audience performs some actions to the interactive device to cause events.
3. Upon occurrence of events, interactive device functions receive event notifications from interactive devices.

Interactive device functions convert raw data to the specified event message.

- The functions check the list of event requesters which are interested in the received events. If there is no requester that is interested in that particular event, the event message is ignored.

4. Interactive device functions notify the requester of the events with interactive devices. A single event can be notified to more than one requester.

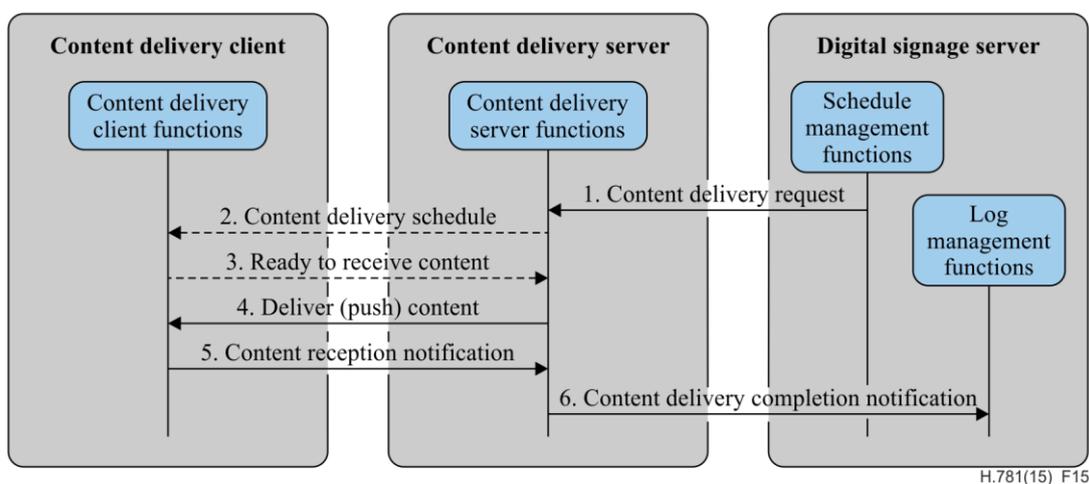
- Optionally, new content or a new playlist schedule can be displayed afterwards.

## 8.5 Content delivery

This clause provides information flows for delivering content from the DS service provider to DS terminal devices. When the DS server constructs a content delivery schedule, the schedule may include varied information that would be used for content delivery, such as content information, content identifier, content delivery method and schedule, alternative content server and additional requirements regarding the delivery procedures. Content will be delivered according to the content delivery schedule.

### 8.5.1 Push-based content delivery

Figure 15 shows flows for delivering specific content to DS terminals by use of a push-type delivery method. If the content delivery client is always ready to receive content from a pre-specified content delivery server, step 3 may be omitted.



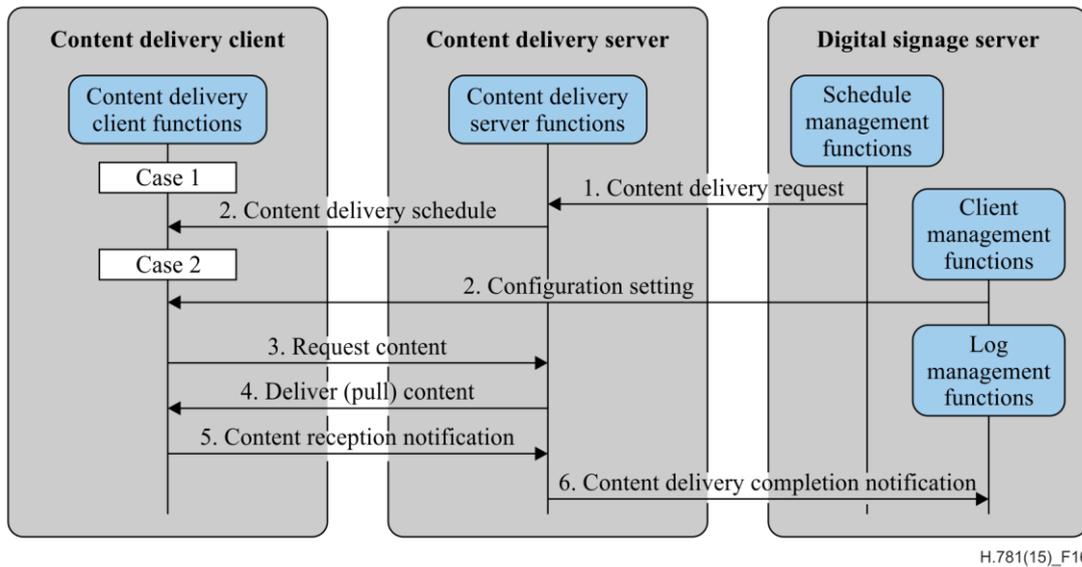
**Figure 15 – Content delivery through push-type delivery method**

1. Schedule management functions of the DS server request the content delivery server to send specific content to DS terminals.
2. Content delivery server functions of the content delivery server may send content delivery schedules that may describe a delivery method for specific content.

3. When it is ready, content delivery client functions may notify the content delivery server based on step 2.
4. Content delivery server functions send the content to the content delivery client functions.
5. Content delivery client functions send a content reception notification.
6. Content delivery server functions send the notification to log management functions of the DS server.

### 8.5.2 Pull-based content delivery

Figure 16 shows flows for delivering specific content to the DS terminals by use of pull-type delivery method.



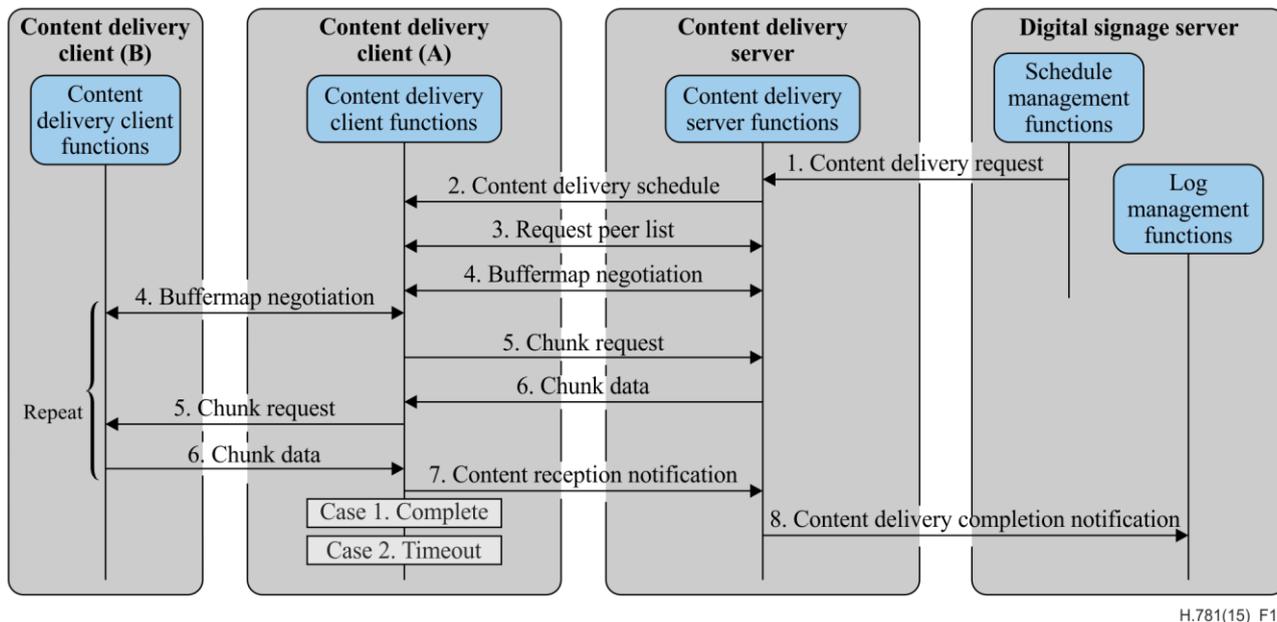
**Figure 16 – Content delivery through pull-type delivery method**

1. Schedule management functions of the DS server request the content delivery server to send specific content to DS terminals.  
NOTE – When a massive number of clients tries to receive content at the same time, the server is likely to suffer from a bottleneck problem. This will lead to performance degradation. Hence, a specific delivery schedule is needed for each client in the content delivery schedule.
2. *Case 1:* Content delivery server functions send the content delivery schedule to content delivery client functions of content delivery clients.
3. *Case 2:* When using periodic polling for acquiring content (i.e., the continuous checking with the content delivery server for the content that it has), polling schedules for the client devices are set as configuration data in the manner described in clause 8.1.
4. Content delivery client functions send a request for specific content according to the content delivery schedule.
5. Content delivery server functions send the requested content.
6. When they complete content delivery, content delivery client functions send a content delivery completion notification.
7. Content delivery server functions send the notification to the log management functions of the DS server.

### 8.5.3 P2P-based content delivery

This Recommendation assumes that the P2P delivery method is implemented with either a push or pull delivery method. Figure 16 shows flows for delivering specific content to a DS terminal by use

of a P2P-type delivery method. Since it is difficult to strictly guarantee timed delivery when using a P2P network, the content delivery schedule for a P2P-based delivery method embeds alternative server addresses that are ready to transfer the content with pull-based or push-based delivery as a backup plan. The flow for content delivery using the P2P-based delivery method is illustrated in Figure 17.



**Figure 17 – Content delivery through P2P-based delivery method**

1. Schedule management functions of the DS server request the content delivery server to deliver specific content to DS terminals with a P2P-based delivery method. Content delivery schedule information, such as overlay network identifier, size of chunk, deadline of content delivery, alternative content server information, etc., is used for P2P delivery.
2. Content delivery server functions send the content delivery schedule to the content delivery client functions.
3. Content delivery client functions request the addresses of other clients.
4. Content delivery client functions connect simultaneously to other content delivery client functions, and exchange buffer maps that show the availability of specific chunks of data across the peers in the P2P network.
5. If another client including a server-side peer has a chunk that this client does not have, this client requests another client to deliver the chunk.
6. Content delivery client functions receive the requested chunk from another client and repeat steps 4 to 7 until all whole chunks are received.
7. *Case 1:* When it completes the delivery, the client notifies the content delivery server functions of the content reception.  
*Case 2:* When it does not complete the delivery within the defined time limit, it initiates the alternative delivery procedures that are depicted in Figure 14 or Figure 15.
8. Content delivery server functions send a content delivery completion notification to the log management functions of the DS server.

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