International Telecommunication Union

ITU-T X.609.10

(09/2020)

TELECOMMUNICATION
STANDARDIZATION SECTOR
OF ITU

SERIES X: DATA NETWORKS, OPEN SYSTEM COMMUNICATIONS AND SECURITY

OSI networking and system aspects – Networking

Managed P2P communications: Signalling requirements for data streaming

Recommendation ITU-T X.609.10

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Recommendation ITU-T X.609.10

Managed P2P communications: Signalling requirements for data streaming

Summary

Recommendation ITU-T X.609.10 defines the signalling requirements for data streaming that runs on the reference points among related entities of the managed peer-to-peer (P2P) network communications.

This Recommendation also addresses service procedures for providing data streaming services based on managed P2P networks.

History

Edition	Recommendation	Approval	Study Group	Unique ID*
1.0	ITU-T X.609.10	2020-09-29	11	11.1002/1000/14422

Keywords

Data streaming, managed P2P, requirements.

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

FOREWORD

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Managed P2P communications: Signalling requirements for data streaming

1 Scope

This Recommendation defines the signalling requirements for data streaming that runs on the interface among entities of managed peer-to-peer communications. The requirements can be used to design a signalling protocol among peers. This Recommendation describes the service architecture for data streaming services over managed peer-to-peer communications and signalling requirements.

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 X.609.1] Recommendation ITU-T X.609.1 (2016), *Managed P2P communications: Peer activity management protocol (PAMP).*

[ITU-T X.609.2] Recommendation ITU-T X.609.2 (2016), *Managed P2P communications: Overlay resource control protocol (ORCP).*

3 Definitions

3.1 Terms defined elsewhere

This Recommendation uses the following terms defined elsewhere:

3.1.1 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.

3.1.2 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.

3.1.3 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.

NOTE – Peer is the node in a P2P system.

3.1.4 managed P2P [b-ISO/IEC TR 20002]: P2P with manageability features to manage the P2P-based service and P2P network by the P2P participants such as P2P service provider, ISP, and peer.

3.1.5 buffermap [b-ITU-T X.609]: A map showing downloading status of fragments comprising a shared content.

3.16 fragment [b-ITU-T X.609]: A piece of the shared content.

3.1.7 fragmentation [b-ITU-T X.609]: A process that divides the shared content into multiple fragments in order to share the content in a distributed manner.

3.1.8 index file [b-ITU-T X.609.6]: A file that describes the contents to be distributed over a peer-to-peer overlay network.

3.1.9 overlay resource [ITU-T X.609.2]: A dedicated resource to an overlay network for enhancing performance and stability of the overlay network. This includes virtual peers of a cache server and relay instances of relay server.

3.1.10 virtual peer [ITU-T X.609.2]: An instance acting as a peer running on a cache server. A virtual peer, acting as a peer, joins one or more overlay networks and exchanges fragments with other peers. Virtual peers running on a cache server are uniquely identified.

3.2 Terms defined in this Recommendation

This Recommendation defines the following terms:

3.2.1 data source: An entity generating data to be streamed. A data source can initiate a data streaming session by interacting with a source peer.

3.2.2 source peer: A peer that is responsible for establishing an overlay network corresponding to the streaming session initiated by a data source. For streaming data, a source peer may conduct fragmentation or merge multiple data into a fragment.

4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

CS Cache Server

IoT Internet of Things

ISP Internet Service Provider

IXS Index Server

MP2P Managed Peer-to-Peer

OMS Overlay Management Server

PAMS Peer Activity Management Server

UMS User profile Management Server

UNIS Underlying Network Information Server

5 Conventions

In this Recommendation:

– The keywords "is required to" indicate a requirement which must be strictly followed and from which no deviation is permitted if conformance to this 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. This term is not intended to imply that the vendor's implementation must provide the option, and the feature can be optionally enabled by the network operator/service provider. Rather, it means the vendor may optionally provide the feature and still claim conformance with this Recommendation.

6 Overview

Data streaming service is a service for delivering the data which a data source generates continuously or on a specific event. Different from audio or video frames in multimedia streaming service, each data generated by the data source in the data streaming service can be processed independently. For example, a data source can continuously generate data which is composed of a text in a predefined format such as the humidity or temperature of a certain place.

In data streaming services, one or more data sources can initiate a streaming session by requesting a source peer through R11 to prepare the streaming session. To prepare the session and establish the corresponding overlay network, the source peer interacts with the index server (IXS), through R6, and the overlay management server (OMS), through R5. On receiving streams from the data source, the source peer may conduct fragmentation which slices the streamed data into multiple fragments. Note that the source peer may also merge multiple data into one fragment, if the size of the streamed data is smaller than that of a fragment. The source peer can then distribute the generated fragments to the non-source peers in the overlay network and the peers can subsequently exchange the fragments with each other, through R10. It is also possible that a data source pushes data stream to the cache server (CS) directly, through R12. In such case, CS takes the role of a source peer. Such case happens when a data streaming service provider does not offer any source peer.

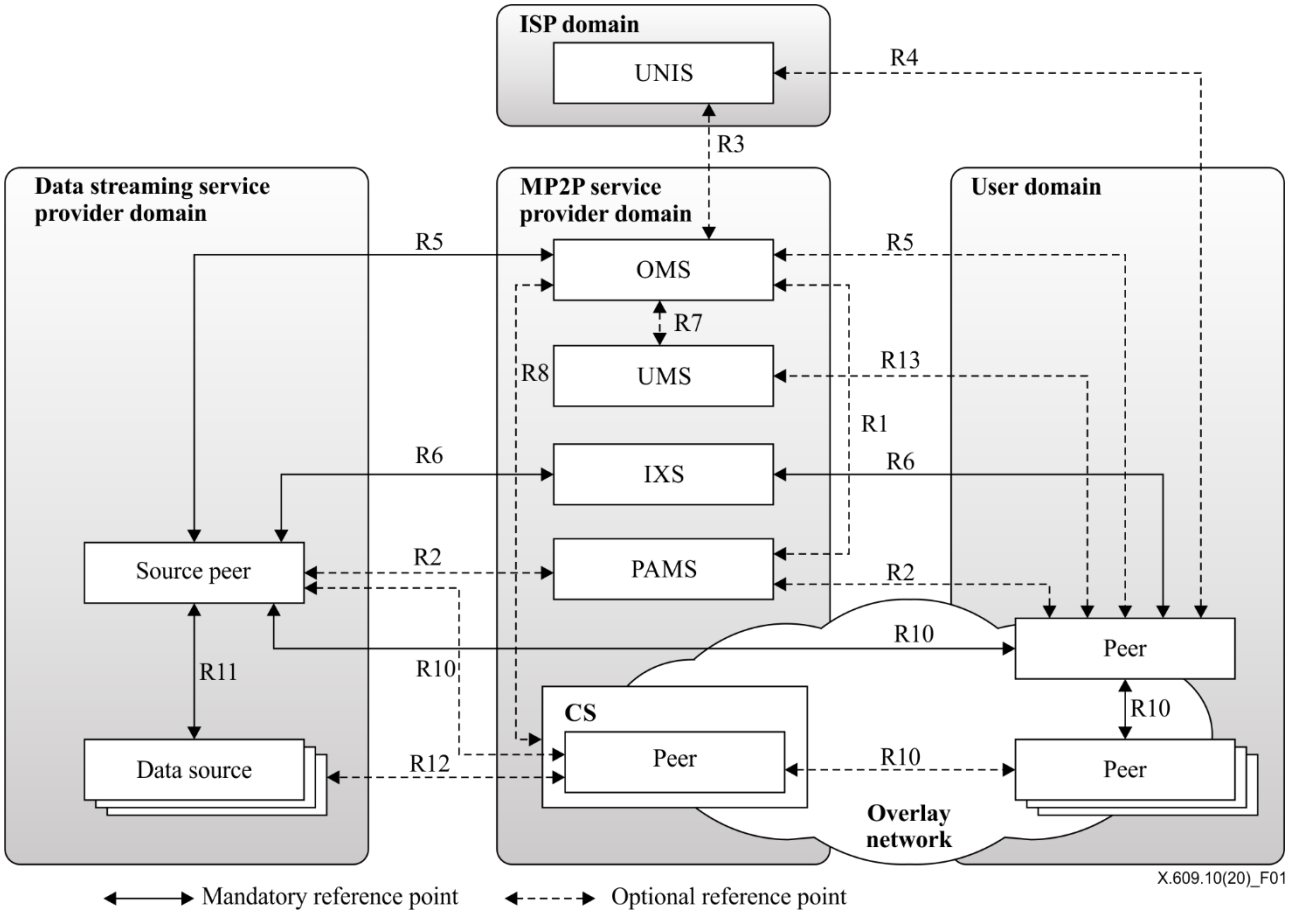

Figure 1 – Data streaming service over the MP2P communications network

Figure 1 shows entities and reference points among them for data streaming service over managed peer-to-peer (MP2P) communications network. The reference points represented as dotted lines in Figure 1 are not essentially required for a data streaming service.

7 Procedures and components

7.1 Procedures for data streaming services over MP2P communications network

Figure 2 shows an overall procedure for data streaming service over MP2P communications network. As shown in Figure 2, data streaming service is composed of three phases: initiation, distribution and termination.

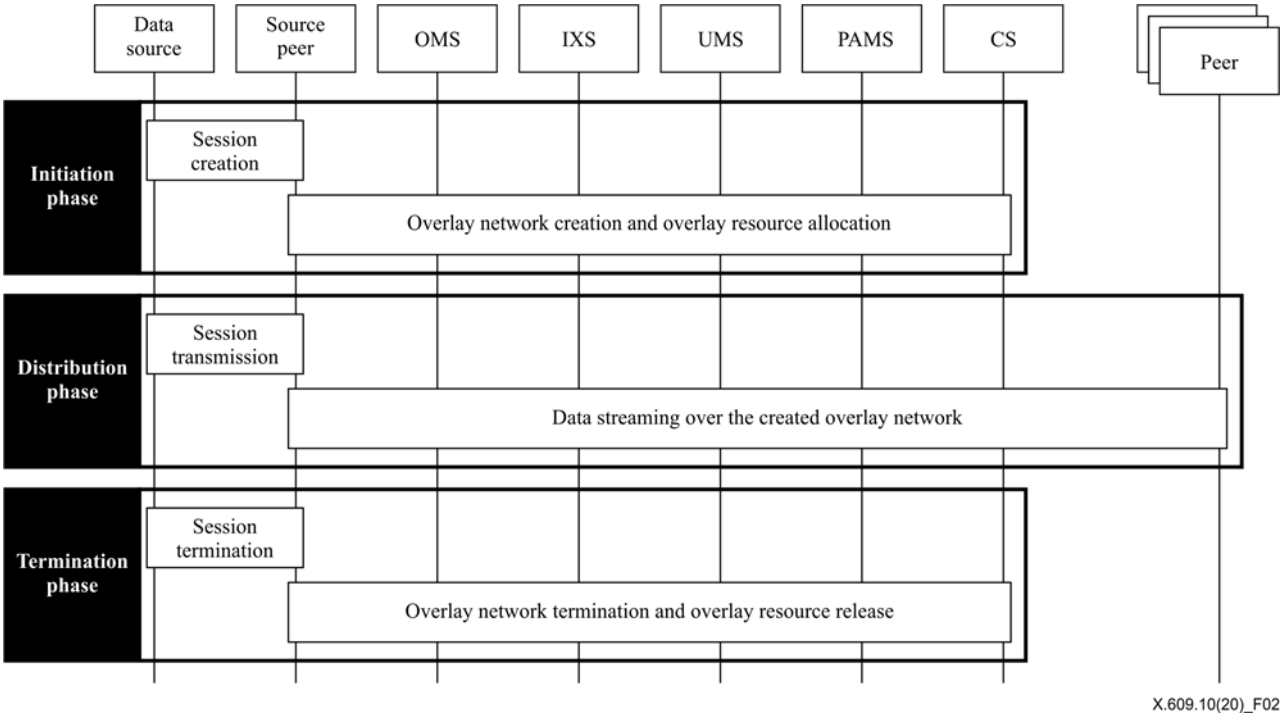

Figure 2 – Overall procedure for data streaming service over the MP2P network

7.1.1 Initiation phase

In the initiation phase, as shown in Figure 3, the MP2P service provider prepares a streaming session by establishing a P2P network corresponding to the streaming session. A data source commands a source peer to create a streaming session. The source peer then creates an overlay network by interacting with the OMS and also registers session information on IXS. Meanwhile, the MP2P service provider may register overlay resources that can be used to enhance the performance and to balance the load among peers. The OMS can then assign overlay resources to the created overlay network if requested by the source peer. The OMS may also register the overlay network on the peer activity management server (PAMS) in order to maintain the status of the overlay network during the session.

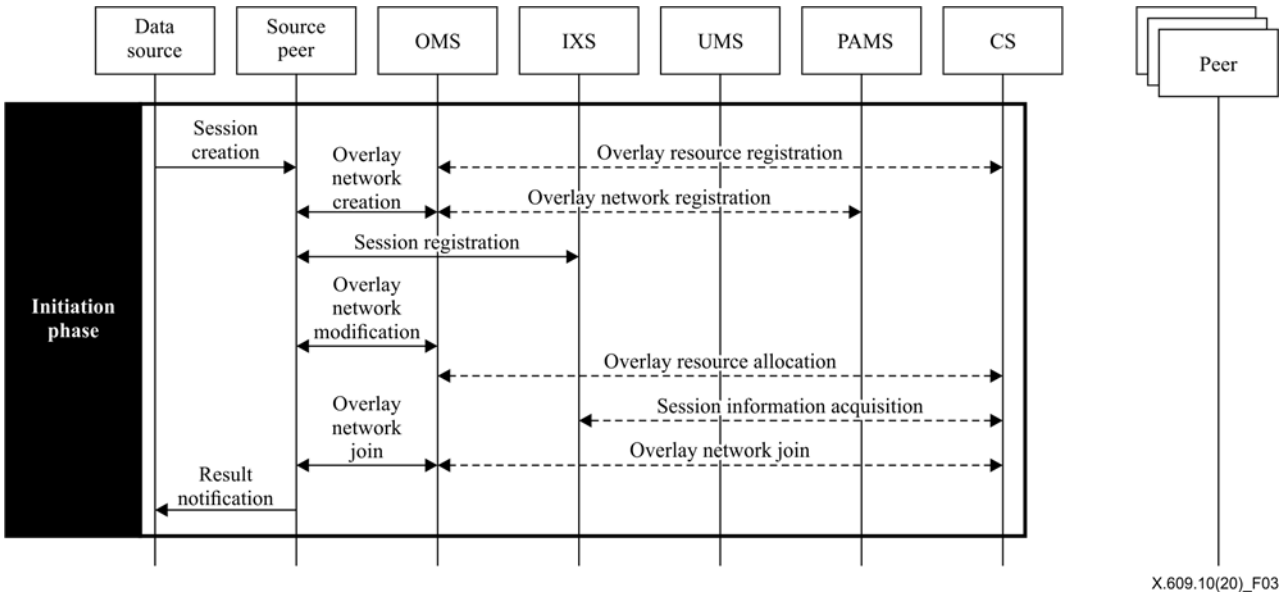

Figure 3 – Procedure for data streaming service initiation phase

7.1.2 Distribution phase

In the distribution phase, a data source sends data stream to its source peer as shown in Figure 4. The source peer then slices the incoming stream into multiple fragments, where each fragment can be identified by an index number, and the fragments will be distributed to other peers including CSs. Each peer reports their activity to the peer activity management server (PAMS) if an activity report is requested.

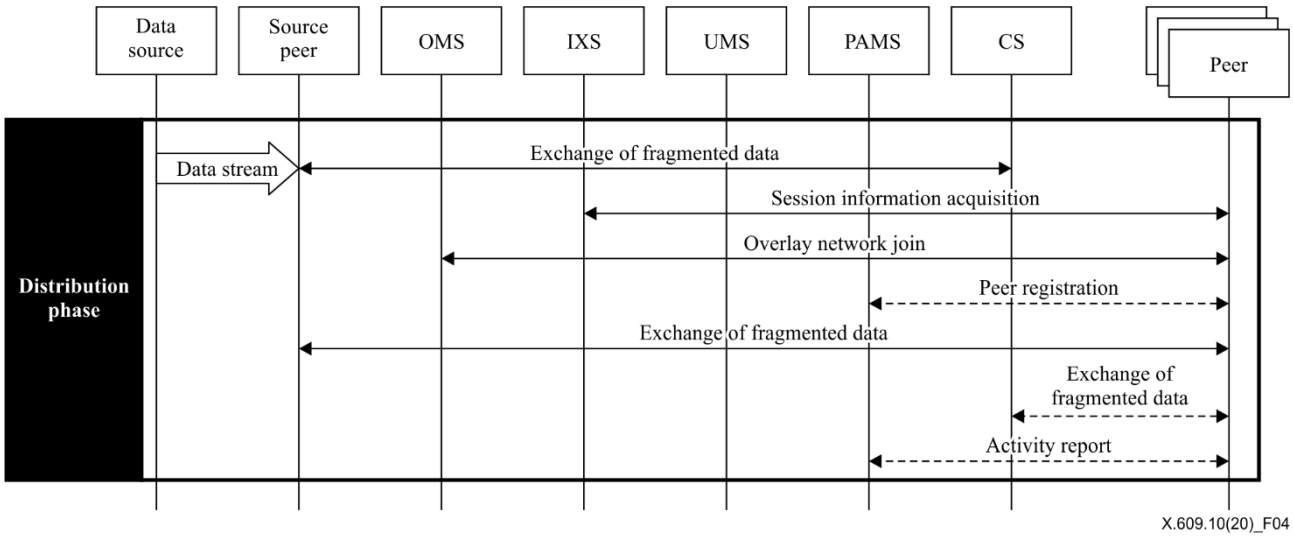

Figure 4 – Procedure for data streaming service distribution phase

7.1.3 Termination phase

In the termination phase, a data source commands its source peer to terminate the session as shown in Figure 5. The source peer then deregisters session information by interacting with the IXS and also requests the OMS to remove the overlay network corresponding to the session being terminated. The OMS also requests PAMS to deregister the overlay network. Different from the source peer, peers in an overlay network may leave at any time.

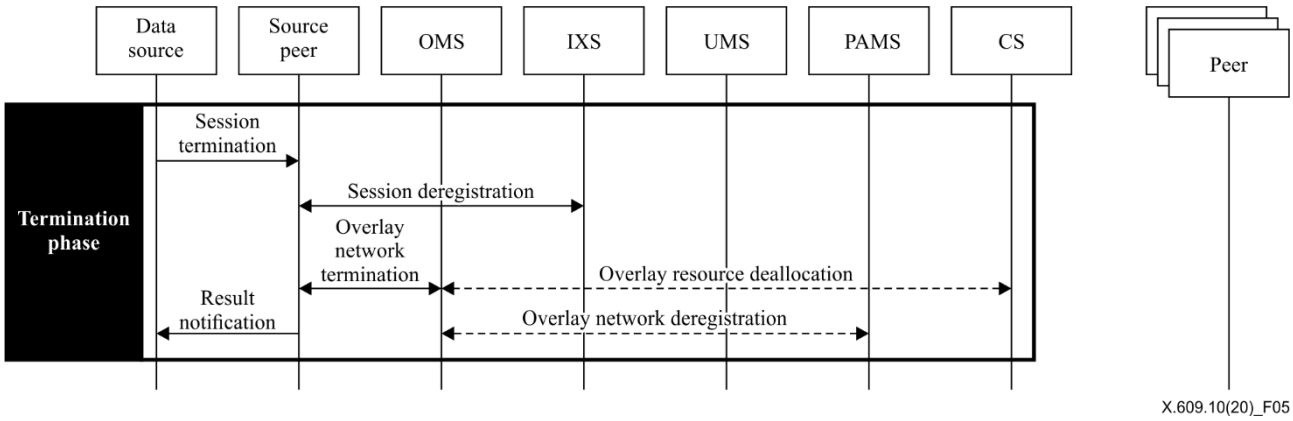

Figure 5 – Procedure for data streaming service termination phase

7.2 Roles of MP2P components for data streaming

7.2.1 Peer

Peers exchange the received fragments with each other. A source peer is responsible for slicing data stream from data source into multiple fragments. Thus, the source peer does not receive any fragment from other peers.

7.2.2 Cache server (CS)

The CS can contribute its resources for enhancing the performance of data stream service and balancing the load among peers. The resources are controlled by the OMS, and the allocated resources are utilized as a virtual peer, which is a logical instance of the CS.

7.2.3 Index server (IXS)

The IXS manages metadata for data streaming session. The metadata includes the information about session and the corresponding overlay network.

NOTE – The information about a session includes the title of the session.

7.2.4 Overlay management server (OMS)

The OMS manages the information concerning the overlay network. The information of each overlay network includes network information of the peers participating in each overlay network. A peer can establish connections with other peers in the same overlay network. If necessary, OMS can interact with other servers such as the underlying network information server (UNIS) or PAMS. In addition, OMS also manages the overlay resources, that is, the CS. OMS can command the CS to join or leave a specific overlay network.

7.2.5 Peer activity management server (PAMS)

PAMS manages the information regarding the activity of a peer. In other words, PAMS keeps track of the actual status of the overlay network which is composed of peers reporting its activity. The status includes distribution status of fragments, peer's contribution ratio, etc.

7.2.6 User profile management server (UNIS)

The UNIS provides information concerning the underlying network and can also provide network distance between peers, if the Internet service provider (ISP) does not provide its network information for some reason such as security.

8 Signalling requirements of each reference point

This clause describes the requirements to be considered in developing relevant protocols for providing data streaming service. This Recommendation assumes that any other existing protocols and its combinations can be used if they can meet the requirements that are listed in this clause.

8.1 Signalling requirements of reference point R1 (PAMS-OMS)

Through reference point R1, PAMS interacts with OMS to deliver a peer list or the status of a specific peer of an overlay network. When OMS requests a peer list, it can specify conditions for a fine-grained peer list.

The following are some requirements for reference point R1:

a) R1 is required to support registration of an overlay network on the basis of the OMS's request including the following information:
   i) the identifier of the overlay network to be registered.

b) R1 is required to enable PAMS to provide a report interval when PAMS responds to the registration request from OMS.

c) R1 is required to enable OMS to send PAMS a registration request at every report interval provided by PAMS.

d) R1 is required to enable PAMS to provide a peer list to OMS on the basis of the OMS's request including the following information:
   i) the status of the overlay network activity;
   ii) the maximum number of peers in the response;
   iii) the criteria for ordering peers;
   iv) conditions for specifying peers.

e) R1 is required to support the removal of the registered overlay network on the basis of the OMS's request including the following information:
   i) the identifier of the overlay network to be removed.

f) R1 is required to enable the OMS to send PAMS a query about the status of a specific peer.

8.2 Signalling requirements of reference point R2 (PAMS-Peer)

Through reference point R2, PAMS interacts with peer to gather the status information of peers. Every peer reports its status periodically or on a specific event, and the reports will be used to analyse the status of the overlay network. It is also possible that PAMS requests peers to send the status information.

The following are some requirements for reference point R2:

a) R2 is required to support the registration of a peer on the basis of the peer's request including the following information:
   i) the identifier of the peer to be registered.

b) R2 is required to enable PAMS to provide a report interval when PAMS responds to the registration request from peer.

c) R2 is required to enable a peer to report its status information to PAMS at every report interval provided by PAMS.

d) R2 is required to support the removal of the registered peer on the basis of the registered peer's request including the following information:
   i) the identifier of the peer to be removed.

8.3 Signalling requirements of reference point R3 (OMS-UNIS)

Through reference point R3, OMS interacts with the UNIS to obtain the physical network status. OMS gives the peer list of an overlay network, and the UNIS then classifies and orders the received peer list according to the policy of the ISP or the status of physical network.

The following are some requirements for reference point R3:

a) R3 is recommended to support the interaction between the OMS and the UNIS to ascertain the preferences of the ISP for selecting a peer list for a specific peer.

b) R3 is recommended to enable the OMS to build a local cache of the information related to the network distance among peers. The local cache is used to prevent frequent queries toward the UNIS.

c) R3 is recommended to enable the OMS to send a query to the UNIS for updating the information about network distance only at every update request interval.

d) R3 is recommended to enable UNIS to provide an update request interval to OMS.

8.4 Signalling requirements of reference point R4 (UNIS-Peer)

Through reference point R4, peers interact with the UNIS to retrieve the physical network status.

The following are some requirements for reference point R4:

a) R4 is recommended to enable each peer to keep the local cache of the information about network distance from other peers. The local cache is used to prevent frequent queries toward UNIS.

b) R4 is recommended to enable each peer to send the UNIS a query for updating the information about network distance only at every update request interval.

c) R4 is recommended to enable each peer to optionally set its preferences for UNIS's calculation of network distance between peers.

d) R4 is recommended to enable UNIS to optionally provide an update request interval to the interacting peer.

8.5 Signalling requirements of reference point R5 (Peer-OMS)

Through reference point R5, a peer interacts with the OMS to join a particular overlay network and get a list of peers in the overlay network.

The following are some requirements for reference point R5:

When a source peer creates a data streaming session, it is required to create a corresponding overlay network by interacting with the OMS. The OMS responds with an identifier of the new overlay network, if the request from the source peer is accepted.

a) R5 is required to enable the OMS to allow a source peer to create a new overlay network corresponding to a new data streaming session.

b) R5 is required to enable the OMS to provide a unique identifier for the new overlay network if the request from the source peer is accepted.

c) R5 is required to enable the OMS to provide the refresh expiration time for each overlay network and removes the overlay network if no refresh message from the corresponding source peer received prior to the expiration time.

d) R5 is recommended to enable a source peer to send a refresh message prior to the expiration time for preventing removal of its overlay network.

To create a closed session, a source peer can specify a list of peers which are eligible to join the session or a password to be used for joining the session.

e) R5 is required to enable a source peer to provide a peer list when the source peer creates a closed session where only particular peers can join. The peer list includes a set of peer identifiers.

f) R5 is required to enable a source peer to provide a security information such as a password when the source peer creates a closed session where only the peers with the predefined password can join.

To support differentiated services, the OMS can provide a list of peers selected based on the level/class of the user corresponding to a peer when the peer requests the OMS to send a list of peers in a specific overlay network. Refer to clause 8.2.5 of [ITU-T X.609.1].

g) R5 is recommended to enable the OMS to provide a list of peers selected based on the information of the user corresponding to the peer which will receive the list.

8.6 Signalling requirements of reference point R6 (Peer-IXS)

Through reference point R6, a peer interacts with the IXS to register and retrieve an index file that contains information regarding a data streaming session. A newly joining peer gets the latest index file from the IXS through R6 and then gets a peer list of the overlay network that is specified in the index file through reference point R5.

The following are some requirements for reference point R6:

a) R6 is required to support registration of an index file including the following information, conducted by a source peer:
   i) a title of data streaming session;
   ii) an address of the OMS and overlay network identifier;
   iii) an identifier of data source;
   iv) an identifier of data;
   v) a size of a fragment;
   vi) descriptions for containing human readable information to explain the data.

b) R6 is required to support the update of data streaming session for an existing overlay network by sending the updated index file, and an index file includes the following information:
   i) a version of the index file;
   ii) a title of data streaming session;
   iii) an identifier of data source.

c) R6 is required to enable the IXS to provide the up-to-date index file to peers. It means that the IXS does not provide an older version of the index file in any case.

d) R6 is required to support removal of a registered session, and the operation requires the following information:
   i) a version of the index file;
   ii) an identifier of data source;
   iii) an identifier of data.

e) R6 is required to support query of a registered session, and the operation requires the following information:
   i) a version of the index file;
   ii) a title of data streaming session;
   iii) an identifier of data source;
   iv) an identifier of data.

8.7 Signalling requirements of reference point R7 (OMS-UMS)

Through reference point R7, OMS interacts with the UMS to retrieve user-specific information. On the basis of the request from the OMS, the UMS checks the access rights of each user for a requested streaming session, and then the OMS may use the check results.

The following are some requirements for reference point R7:

a) R7 is required to enable the UMS to verify the access rights of each user for a request streaming session and provide the verification results to the OMS, if requested by the OMS.

b) R7 is recommended to enable the UMS to provide the verification results including validity periods.

8.8 Signalling requirements of reference point R8 (OMS-CS)

Through reference point R8, OMS interacts with the CS. The CS can provide overlay resources to one or more overlay networks for improving the stability of the overlay networks or for service delegation [ITU-T X.609.2].

The following are some requirements for reference point R8:

a) R8 is recommended to enable OMS to allocate and release the resource of CS dynamically on the basis of the status of an overlay network or the operation policy.

b) R8 is recommended to enable OMS to provide the information of PAMS to CS, if OMS requests resource allocation for an overlay network which includes PAMS.

c) R8 is recommended to enable OMS to provide priority information about the overlay resource of CS when it requests resource allocation.

8.9 Signalling requirements of reference point R10 (Peer-Peer)

Through reference point R10, peers interact with each other to share fragmented data.

The following are some requirements for reference point R10:

a) R10 is required to enable a peer to request other peers to send fragments when they have the fragment which the peer needs.

b) R10 is required to enable a peer that has the possibility to do so to send fragments to a requesting peer.

Various transport protocols can be used when peers interact with each other peer.

c) R10 is required to enable a peer to support transmission control protocol

as a transport protocol.

d) R10 can optionally enable a peer to use web real-time communications to interact with each other running as a web application.

8.10 Signalling requirements of reference point R11 (Source-Peer)

Through reference point R11, a data source gathers data from various devices such as Internet of things (IoT) devices and sends the data to a certain source peer. It is also possible for data sources to send a data directly to the source peer if the data sources can generate data. The source peer then shares the received data with other peers instantly through reference point R10. Unlike the multimedia streaming and content distribution services, multiple data sources can exist at the same time within an overlay network.

The following are some requirements for reference point R11:

a) R11 is required to enable a source peer to receive data from various sources, and convert them into a specified format to be distributed over an overlay network in a unified manner;

b) R11 is recommended to enable a source peer to accommodate multiple data sources at the same time;

c) R11 is required to enable a data source to provide its identifier to the source peer;

d) R11 is required to enable a source peer to be able to identify multiple data sources using their identifiers;

e) R11 is required to enable a data source to register itself on a source peer as its initiation operation;

f) R11 is required to enable a source peer to support registration of data sources;

g) R11 is required to enable a data source to send its data to a source peer which the data source has previously registered.

8.11 Signalling requirements of reference point R12 (Data source-CS)

Through reference point R12, a data source interacts with the CS. The CS operates as a source peer, if the data source provides data stream to the CS instead of a source peer in the data streaming service provider domain.

a) R12 is recommended to enable CS to provide multiple methods to a data source to receive data streams such as file transfer protocol, hypertext transfer protocol and real-time transport protocol.

8.12 Signalling requirements of reference point R13 (UMS-Peer)

Through reference point R13, a peer interacts with the UMS. A service provider may specify a list of users which can access the data stream provided by a source peer in a subscription-based data streaming service. In such case, the peers corresponding to the users on the list need channel information for joining an overlay network of the data streaming channel.

a) R13 is required to enable each peer to interact with the UMS to obtain a list of channels which they need to join.

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Printed in Switzerland
Geneva, 2020