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Inter-destination Media Synchronization using the RTP Control Protocol (RTCP)
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Abstract

This document gives information on an RTP Control Protocol (RTCP) Packet Type and RTCP Extended Report (XR) Block Type including associated Session Description Protocol (SDP) parameters for Inter-Destination Media Synchronization (IDMS). This document mandates the use of the RTCP XR Block Type 12, which is used to collect media playout information from participants in a group playing out (watching, listening, etc.) a specific RTP media stream. This RTCP XR Block Type is specified and registered with IANA by ETSI. The RTCP packet type specified by this document is used to distribute a common target playout point to which all the distributed receivers, sharing a media experience, can synchronize.

Typical use cases in which IDMS is usefull are social TV, shared service control (i.e. applications where two or more geographically separated users are watching a media stream together), distance learning, networked video walls, networked loudspeakers, etc.

time. It is inappropriate to use Internet-Drafts as reference material or to cite them other than as "work in progress."

This Internet-Draft will expire on January 17, 2013.

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1. Introduction

Inter-Destination Media Synchronization (IDMS) refers to the playout of media streams at two or more geographically distributed locations in a time synchronized manner. It can be applied to both unicast and multicast media streams and can be applied to any type and/or combination of streaming media, such as audio, video and text (subtitles).[Ishibashi2006] and [Boronat2009] provide an overview of technologies and algorithms for IDMS.

IDMS requires the exchange of information on media receipt and playout times among participants in an IDMS session. It may also require signaling for the initiation and maintenance of IDMS sessions and groups of receivers.

The presented RTCP specification for IDMS is independent of the used synchronization algorithm, which is out-of-scope of this document.

2. Rationale

2.1. Applicability of RTCP to IDMS

Currently, a large share of real-time applications make use of RTP and RTCP [RFC3550]. RTP provides end-to-end network transport functions suitable for applications requiring real-time data transport, such as audio, video or data, over multicast or unicast network services. The timestamps, sequence numbers, and payload (content) type identification mechanisms provided by RTP packets are very useful for reconstructing the original media timing, and for reordering and detecting packet loss at the client side.

The data transport is augmented by a control protocol (RTCP) to allow monitoring of the data delivery in a manner that is scalable to large groups, and to provide minimal control and identification functionality. RTP receivers and senders provide reception quality feedback by sending out RTCP Receiver Report (RR) and Sender Report (SR) packets [RFC3550], respectively, which may be augmented by eXtended Reports (XR) [RFC3611]. Both RTP and RTCP are intended to be tailored through modifications in order to include profile-specific information required by particular applications, and the guidelines on doing so are specified in [RFC5868].

IDMS involves the collection, summarizing and distribution of RTP packet arrival and playout times. As information on RTP packet arrival times and playout times can be considered reception quality feedback information, RTCP is well suited for carrying out IDMS, which may facilitate the implementation and deployment in typical

multimedia applications.

2.2. Applicability of SDP to IDMS

RTCP XR [RFC3611] defines the Extended Report (XR) packet type for the RTP Control Protocol (RTCP), and defines how the use of XR packets can be signaled by an application using the Session Description Protocol (SDP) [RFC4566].

SDP signaling is used to set up and maintain a synchronization group between Synchronization Clients (SCs). This document describes two SDP parameters for doing this, one for the RTCP XR block type and one for the new RTCP packet type.

2.3. This document and ETSI TISPAN

ETSI TISPAN [TS183063] has specified architecture and protocol for IDMS using RTCP XR exchange and SDP signaling. For more information on how this document relates to [TS183063], see Section 12.

This document mandates the use of an ETSI specified RTCP XR block for the purpose of collecting RTP packet arrival and playout times. For completeness, that XR block is contained in this document in section 7.

3. Terminology

The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD", "SHOULD NOT", "RECOMMENDED", "MAY", and "OPTIONAL" in this document are to be interpreted as described in RFC 2119 [RFC2119] and indicate requirement levels for compliant implementations.

4. Overview of IDMS operation

This section provides a brief example of how the RTCP functionality is used for achieving IDMS. The section is tutorial in nature and does not contain any normative statements.

```
          Alice's  . . . . . . . .tv:abc.com . . . . . . . . . . Bob's
          TV (Sync Client)    (Sync Server)          Laptop (Sync Client)
            |                       |                          |
            |      Media Session    |                          |
            |<=====================>|                          |
            |            Invite(URL,Sync-group ID)             |
            |------------------------------------------------->|
            |                       |   Media Session Set-up   |
            |                       |<========================>|
            |                       |                          |
            |                 Call set-up                      |
            |<================================================>|
            |                       |                          |
            |       RTP Packet      |        RTP Packet        |
            |<----------------------|------------------------->|
            |      RR + IDMS XR     |                          |
            |---------------------->|       RR + IDMS XR       |
            |                       |<-------------------------|
            |    RTCP IDMS packet   |     RTCP IDMS packet     |
            |<----------------------|------------------------->|
            |                       |                          |
```

Figure 1: Example of a typical IDMS session

Alice is watching TV in her living room. At some point she sees that a football game of Bob's favorite team is on. She sends him an invite to watch the program together. Embedded in the invitation is the link to the media server and a unique sync-group identifier.

Bob, who is also at home, receives the invite on his laptop. He accepts Alice's invitation and the RTP client on his laptop sets up a session to the media server. A VoIP connection to Alice's TV is also set up, so that Alice and Bob can talk while watching the game together.

As is common with RTP, both the RTP client in Alice's TV as well as the one in Bob's laptop send periodic RTCP Receiver Reports (RR) to the media server. However, in order to make sure Alice and Bob see the events in the football game at (approximately) the same time, their clients also periodically send an IDMS XR block to the sync server function of the media server. Included in the XR blocks are timestamps on when both Alice and Bob received (and, optionally, when they played out) a particular RTP packet.

The sync server function in the media server calculates a reference client from the received IDMS XR blocks (e.g. by selecting whichever client received the packet the latest as the reference client). It then sends an RTCP IDMS packet containing the playout information of

this reference client to the sync clients of both Alice and Bob.

In this case Bob's connection has the longest delay and the reference client therefore includes a delay similar to the one experienced by Bob. Upon reception of this information, Alice's RTP client can choose what to do with this information. In this case it decreases its playout rate temporarily until the playout time matches with the reference client playout (and thus matches Bob's playout). Another option for Alice's TV would be to simply pause playback until it catches up. The exact implementation of the synchronization algorithm is up to the client.

Upon reception of the reference client RTCP IDMS packet, Bob's client does not have to do anything since it is already synchronized to the reference client (since it is based on Bob's delay). Note that other synchronization algorithms may introduce even more delay than the one experienced by the most delayed client, e.g. to account for delay variations, for new clients joining an existing synchronization group, etc.

For this functionality to work correctly, it is nessecary that the wall clocks of the receivers are synchronized with each other. Alice and Bob both report when they receive, and optionally when they play out, certain RTP packets. In order to correlate their reports to each other, it is necessary that their wallclocks are synchronized.

5. Inter-Destination Media Synchronization use cases

There are a large number of use cases in which IDMS might be useful. This section will highlight some of them. It should be noted that this section is in no way meant to be exhaustive.

A first usage scenario for IDMS is Social TV. Social TV is the combination of media content consumption by two or more users at different devices and locations combined with the real-time communication between those users. An example of Social TV is when two or more users are watching the same television broadcast at different devices and locations, while communicating with each other using text, audio and/or video. A skew in their media playout processes can have adverse effects on their experience. A well-known use case here is one friend experiencing a goal in a football match well before or after other friend(s).

Another potential use case for IDMS is a networked video wall. A video wall consists of multiple computer monitors, video projectors, or television sets tiled together contiguously or overlapped in order to form one large screen. Each of the screens reproduces a portion

of the larger picture. In some implementations, each screen may be individually connected to the network and receive its portion of the overall image from a network-connected video server or video scaler. Screens are refreshed at 60 hertz (every 16-2/3 milliseconds) or potentially faster. If the refresh is not synchronized, the effect of multiple screens acting as one is broken.

A third usage scenario is that of the networked loudspeakers, in which two or more speakers are connected to the network individually. Such situations can for example be found in large conference rooms, legislative chambers, classrooms (especially those supporting distance learning) and other large-scale environments such as stadiums. Since humans are more susceptible to differences in audio delay, this use case needs even more accuracy than the video wall use case. Depending on the exact application, the need for accuracy can then be in the range of microseconds.

6. Architecture for Inter-Destination Media Synchronization

The architecture for IDMS, which is based on a sync-maestro architecture [Boronat2009], is sketched below. The Synchronization Client (SC) and Media Synchronization Application Server (MSAS) entities are shown as additional functionality for the RTP receiver and sender respectively.

It should be noted that a master/slave type of architecture is also supported by having one of the SC devices also act as an MSAS. In this case the MSAS functionality is thus embedded in an RTP receiver instead of an RTP sender.

```
+-----------------------+        +-----------------------+
|                       |  SR +  |                       |
|      RTP Receiver     |  RTCP  |      RTP Sender       |
|                       |  IDMS  |                       |
|  +-----------------+  | <----- |  +-----------------+  |
|  |                 |  |        |  |                 |  |
|  | Synchronization |  |        |  |      Media      |  |
|  |     Client      |  |        |  | Synchronization |  |
|  |      (SC)       |  |        |  |   Application   |  |
|  |                 |  |        |  |      Server     |  |
|  |                 |  | RR+XR  |  |      (MSAS)     |  |
|  |                 |  | -----> |  |                 |  |
|  +-----------------+  |        |  +-----------------+  |
|                       |        |                       |
+-----------------------+        +-----------------------+
```

6.1. Media Synchronization Application Server (MSAS)

An MSAS collects RTP packet arrival times and playout times from one or more SC(s) in a synchronization group. The MSAS summarizes and distributes this information to the SCs in the synchronization group as synchronization settings, e.g. by determining the SC with the most lagged playout and using its reported RTP packet arrival time and playout time as a summary.

6.2. Synchronization Client (SC)

An SC reports on RTP packet arrival times and playout times of a media stream. It can receive summaries of such information, and use that to adjust its playout buffer.

6.3. Communication between MSAS and SCs

Two different message types are used for the communication between MSAS and SCs. For the SC->MSAS message containing the playout information of a particular client, an RTCP XR Block Type is used (see Section 6). For the MSAS->SC message containing the synchronization settings instructions, a new RTCP Packet Type is defined (see Section 8).

7. RTCP XR Block Type for IDMS

For reporting IDMS information, SCs SHALL use the ETSI specified RTCP XR Block Type 12. For completeness, that RTCP XR Block Type is repeated here fully.

The definition of the XR block type is based on [RFC3611]. The RTCP XR is used to provide feedback information on receipt times and presentation times of RTP packets to e.g. a Sender [RFC3611], a Feedback Target [RFC5760] or a Third Party Monitor [RFC3611].

In most cases, a single RTP receiver will only be part of single IDMS session, i.e. it will report on receipt and presentation times of RTP packets from a single RTP stream in a certain synchronization group. In some cases however, an RTP receiver may be a member of multiple synchronization groups for the same RTP stream, e.g. watching a single television program simultaneously with different groups. In even further cases, a receiver may wish to synchronize different RTP streams at the same time, either as part of the same synchronization group or as part of multiple synchronization groups. These are all valid scenario's for IDMS, and will require multiple reports by an SC.

SCs SHOULD report on a recently received RTP packets. This document does not define new rules on when to sent RTCP reports, but uses the existing rules specified in [RFC3550] for sending RTCP reports. When the RTCP reporting timer allows an SC to send an IDMS report, the SC SHOULD report on the latest RTP packet received or played out (depending on whether the SC reports on presentation timestamps or receipt timestamps). For more details on which packet to report on, see below under 'Packet Received RTP timestamp'.

```
 0                   1                   2                   3
 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|V=2|P| Resrv   |   PT=XR=207   |             length            |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                      SSRC of packet sender                    |
+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+
|     BT=12     | SPST  |Resrv|P|         block length=7        |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|     PT      |               Resrv                             |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|              Media Stream Correlation Identifier              |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                      SSRC of media source                     |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|      Packet Received NTP timestamp, most significant word     |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|      Packet Received NTP timestamp, least significant word    |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|              Packet Received RTP timestamp                    |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|              Packet Presented NTP timestamp                   |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

The first 64 bits form the header of the RTCP XR, as defined in [RFC3611]. The SSRC of packet sender identifies the sender of the specific RTCP packet.

The IDMS report block consists of 8 32-bit words, with the following fields:

Block Type (BT): 8 bits. It identifies the block format. Its value SHALL be set to 12.

Synchronization Packet Sender Type (SPST): 4 bits. This field identifies the role of the packet sender for this specific eXtended Report. It can have the following values:

SPST=0 Reserved For future use.

SPST=1 The packet sender is an SC. It uses this XR to report synchronization status information. Timestamps relate to the SC input.

SPST=2 This setting is reserved in order to preserve compatibility with ETSI TISPAN [TS183063]. See Section 12 for more information.

SPST=3-15 Reserved For future use.

Reserved bits (Resrv): 3 bits. These bits are reserved for future definition. In the absence of such a definition, the bits in this field MUST be set to zero and MUST be ignored by the receiver.

Packet Presented NTP timestamp flag (P): 1 bit. Bit set to 1 if the Packet Presented NTP timestamp field contains a value, 0 if it is empty. If this flag is set to zero, then the Packet Presented NTP timestamp SHALL be ignored.

Block Length: 16 bits. This field indicates the length of the block in 32 bit words minus one and SHALL be set to 7, as this RTCP Block Type has a fixed length.

Payload Type (PT): 7 bits. This field identifies the format of the media payload, according to [RFC3551]. This is the payload type of the RTP packet reported upon. The media payload is associated with an RTP timestamp clock rate. This clock rate provides the time base for the RTP timestamp counter.This clock rate is nessecary for the MSAS to relate reports from different SCs on different RTP timestamp values.

Reserved bits (Resrv): 25 bits. These bits are reserved for future use and SHALL be set to 0.

Media Stream Correlation Identifier: 32 bits. This identifier is used to correlate synchronized media streams. The value 0 (all bits are set "0") indicates that this field is empty. The value 2^32-1 (all bits are set "1") is reserved for future use. If the RTCP Packet Sender is an SC (SPST=1) or an MSAS (SPST=2), then the Media Stream Correlation Identifier field contains the Synchronization Group Identifier (SyncGroupId) to which the report applies.

SSRC: 32 bits. The SSRC of the media source SHALL be set to the value of the SSRC identifier carried in the RTP header [RFC3550] of the RTP packet to which the XR relates.

Packet Received NTP timestamp: 64 bits. This timestamp reflects the

wall clock time at the moment of arrival of the first octet of the RTP packet to which the XR relates. It is formatted based on the NTP timestamp format as specified in [RFC5905]. See Section 9 for more information on how this field is used.

Packet Received RTP timestamp: 32 bits. This timestamp has the value of the RTP timestamp carried in the RTP header [RFC3550] of the RTP packet to which the XR relates. Several consecutive RTP packets will have equal timestamps if they are (logically) generated at once, e.g., belong to the same video frame. It may well be the case that one receiver reports on the first RTP packet having a certain RTP timestamp and a second receiver reports on the last RTP packet having that same RTP timestamp. This would lead to an error in the synchronization algorithm due to the faulty interpretation of considering both reports to be on the same RTP packet. When reporting on an RTP packet which is one of several consecutive RTP packets having equal timestamps, an SC SHOULD report on the RTP packet it received with the lowest sequence number. Note that with 'lowest sequence number' here is meant the first in the sequence of RTP packets just received, not from an earlier time before the last wrap-around of RTP timestamps (unless this wrap-around occurs during the sequence with equal RTP timestamps).

Packet Presented NTP timestamp: 32 bits. This timestamp reflects the wall clock time at the moment the rendered frame contained in the first byte of the associated RTP packet is presented to the user. It is based on the time format used by NTP and consists of the least significant 16 bits of the NTP seconds part and the most significant 16 bits of the NTP fractional second part. If this field is empty, then it SHALL be set to 0 and the Packet Presented NTP timestamp flag (P) SHALL be set to 0. Presented here means the moment the data is played out to the user of the system, i.e. sound played out through speakers, video images being displayed on some display, etc. The accuracy resulting from the synchronization algorithm will only be as good as the accuracy with which the receivers can determine the delay between receiving packets and presenting them to the end-user.

8. RTCP Packet Type for IDMS (IDMS Settings)

This section specifies the RTCP Packet Type for indicating synchronization settings instructions to the receivers of the RTP media stream. Its definition is based on [RFC3550].

```
  0                   1                   2                   3
  0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
 +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
 |V=2|P| Resrv   |     PT=TBD    |             length            |
 +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
 |                     SSRC of packet sender                     |
 +=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+
 |                     SSRC of media source                      |
 +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
 |              Media Stream Correlation Identifier              |
 +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
 |      Packet Received NTP timestamp, most significant word     |
 +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
 |      Packet Received NTP timestamp, least significant word    |
 +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
 |              Packet Received RTP timestamp                    |
 +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
 |     Packet Presented NTP timestamp, most significant word     |
 +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
 |     Packet Presented NTP timestamp, least significant word    |
 +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

The first 64 bits form the header of the RTCP Packet Type, as defined in [RFC3550]. The SSRC of packet sender identifies the sender of the specific RTCP packet.

The RTCP IDMS packet consists of 7 32-bit words, with the following fields:

SSRC: 32 bits. The SSRC of the media source SHALL be set to the value of the SSRC identifier of the media source carried in the RTP header [RFC3550] of the RTP packet to which the RTCP IDMS packet relates.

Media Stream Correlation Identifier: 32 bits. This identifier is used to correlate synchronized media streams. The value 0 (all bits are set "0") indicates that this field is empty. The value 2^32-1 (all bits are set "1") is reserved for future use. The Media Stream Correlation Identifier contains the SyncGroupId of the group to which this packet is sent.

Packet Received NTP timestamp: 64 bits. This timestamp reflects the wall clock time at the reference client at the moment it received the first octet of the RTP packet to which this packet relates. It can be used by the synchronization algorithm on the receiving SC to adjust its playout timing in order to achieve synchronization, e.g. to set the required playout delay. The timestamp is formatted based on the NTP timestamp format as specified in [RFC5905]. See Section 9

for more information on how this field is used. Because RTP timestamps do wrap around, the sender of this packet SHOULD use recent values, i.e. choose NTP timestamps that reflect current time and not too far in the future or in the past.

Packet Received RTP timestamp: 32 bits. This timestamp has the value of the RTP timestamp carried in the RTP header [RFC3550] of the RTP packet to which the XR relates. This SHOULD relate to the first arriving RTP packet containing this particular RTP timestamp, in case multiple RTP packets contain the same RTP timestamp.

Packet Presented NTP timestamp: 64 bits. This timestamp reflects the wall clock time at the reference client at the moment it presented the rendered frame contained in the first octet of the associated RTP packet to the user. The timestamp is formatted based on the NTP timestamp format as specified in [RFC5905]. If this field is empty, then it SHALL be set to 0. This field MAY be left empty if none or only one of the receivers reported on presentation timestamps. Presented here means the moment the data is played out to the user of the system.

In some use cases (e.g. phased array transducers), the level of control an MSAS might need to have over the exact moment of playout is so precise that a 32bit Presented Timestamp will not suffice. For this reason, this RTCP Packet Type for IDMS includes a 64bit Presented Timestamp field. Since an MSAS will in practice always add some extra delay to the delay reported by the most lagged receiver (to account for packet jitter), it suffices for the IDMS XR Block Type with which the SCs report on their playout to have a 32bit Presented Timestamp field.

9. Timing and NTP Considerations

To achieve IDMS, the different receivers involved need synchronized (wall) clocks as a common timeline for synchronization. This synchronized clock is used for reporting the Packet Received NTP Timestamps and the Packet Presented NTP Timestamp, and for interpretation of these fields in received IDMS reports. Depending on the synchronization accuracy required, different clock synchronization methods can be used. For social TV, synchronization accuracy should be achieved on the order of hundreds of milliseconds. In that case, correct use of NTP on receivers will in most situations achieve the required accuracy. As a guideline, to deal with clock drift of receivers, receivers should synchronize their clocks at the beginning of a synchronized session. In case of high required accuracy, the synchronized clocks of different receivers should not drift beyond the accuracy required for the synchronization mechanism.

In practice, this can mean that receivers need to synchronize their clocks repeatedly during a synchronization session.

Because of the stringent synchronization requirements for achieving good audio in some use cases, a high accuracy will be needed. In this case, use of the global NTP system may not be sufficient. For improved accuracy, a local NTP server could be set up, or some other more accurate clock synchronization mechanism can be used, such as GPS time or the Precision Time Protocol [IEEE-1588].

[I-D.draft-williams-avtcore-clksrc] defines a set of SDP parameters for signaling the clock synchronization source or sources available to and used by the individual receivers. SCs MAY use this draft to indicate their clock synchronization source or sourced in use and available. Using these paramenters, an SC can indicate which synchronization source is being used at the moment, the last time the SC synchronized with this source and the synchronization frequency. An SC can also indicate any other synchronization sources available to it. This allows multiple SCs in an IDMS session to use the same or a similar clock source for their session.

Applications performing IDMS may or may not be able to choose a synchronization method for the system clock, because this may be a system-wide setting which the application cannot change. How applications deal with this is up to the implementation. The application might control the system clock, or it might use a separate application clock or even a separate IDMS session clock. It might also report on the system clock and the synchronization method used, without being able to change it.

[I-D.draft-gross-leap-second] presents some guidelines on how RTP senders and receivers should deal with leap seconds. When relying on NTP for clock synchronization, IDMS is particularly sensitive to leap second induced timing discrepancies. It is RECOMMENDED to take the guideline specified in [I-D.draft-gross-leap-second] into account when implementing IDMS.

10. SDP Parameter for RTCP XR IDMS Block Type

The SDP parameter sync-group is used to signal the use of the RTCP XR block for IDMS, as specified by ETSI, included here for completeness. It is also used to carry an identifier of the synchronization group to which clients belong or will belong. This SDP parameter extends rtcp-xr-attrib as follows, using Augmented Backus-Naur Form [RFC5234].

```
rtcp-xr-attrib = "a=" "rtcp-xr" ":" [xr-format *(SP xr-format)] CRLF
```

```
; Original definition from [RFC3611], section 5.1

xr-format =/ grp-sync ; Extending xr-format for Inter-Destination
Media Synchronization

grp-sync = "grp-sync" [",sync-group=" SyncGroupId]

SyncGroupId = 1*10DIGIT ; Numerical value from 0 through 4294967294

DIGIT = %x30-39
```

SyncGroupId is a 32-bit unsigned integer represented in decimal. SyncGroupId identifies a group of SCs for IDMS. It maps on the Media Stream Correlation Identifier as described in Section 7 and Section 8. The value SyncGroupId=0 represents an empty SyncGroupId. The value 4294967294 (2^32-1) is reserved for future use.

The following is an example of the SDP attribute for IDMS

```
a=rtcp-xr:grp-sync,sync-group=42
```

11. SDP Parameter for RTCP IDMS Packet Type

The SDP parameter rtcp-idms is used to signal the use of the RTCP IDMS Packet Type for IDMS. It is also used to carry an identifier of the synchronization group to which clients belong or will belong. The SDP parameter is used as a media-level attribute during session setup. This means that in case of multiple related streams, IDMS is performed on one of them. The other streams will be synchronized to this first stream using existing inter-stream synchronization (i.e. lip-sync) solutions, i.e. using Sender Reports based on a common clock source. Basic guidelines for choosing the media stream for IDMS is to choose audio above video, as humans are more sensitive to degradation in audio quality then in video quality. When using mutli-description or multi-view codecs, the IDMS control should be performed on the base layer.

This SDP parameter is defined as follows, using Augmented Backus-Naur Form [RFC5234].

```
rtcp-idms = "a=" "rtcp-idms" ":" [sync-grp] CRLF

sync-grp = "sync-group=" SyncGroupId

SyncGroupId = 1*10DIGIT ; Numerical value from 0 through 4294967294

DIGIT = %x30-39
```

SyncGroupId is a 32-bit unsigned integer and represented in decimal. SyncGroupId identifies a group of SCs for IDMS. The value SyncGroupId=0 represents an empty SyncGroupId. The value 4294967294 (2^32-1) is reserved for future use.

The following is an example of the SDP attribute for IDMS.

a=rtcp-idms:sync-group=42

12. Compatibility with ETSI TISPAN

As described in Section 2.3, ETSI TISPAN has described its mechanism for IDMS in [TS183063]. One of the main differences between the TISPAN document and this document is the fact that the TISPAN solution uses an RTCP XR block for both the SC->MSAS message and the MSAS->SC message (by selecting SPST-type 2), while this document specifies a new RTCP Packet Type for the MSAS->SC message. The message from MSAS to SC is not in any way a report on how a receiver sees a session, and therefore a separate RTCP packet type is more appropriate than the XR block solution chosen in ETSI TISPAN. To achieve compatibility, MSAS implementations SHOULD implement both the TISPAN RTCP block and the new RTCP IDMS Settings packet for MSAS->SC messages. SCs MAY implement support for both types of messages. For the MSAS->SC signaling, it is recommended to use the RTCP IDMS Settings packet defined in this document. The TISPAN RTCP XR block with SPST=2 MAY be used for purposes of compatibility with the TISPAN solution, but MUST NOT be used if all nodes involved support the new RTCP IDMS Settings packet.

13. SDP rules

13.1. Offer/Answer rules

The SDP usage for IDMS follows the rules defined in RFC3611 in section 5 on SDP signalling, with the exception of what is stated here. The IDMS usage of RTCP is a (loosely coupled) collaborative parameter, in the sense that receivers sent their status information and in response (asynchronously) the MSAS sents synchronization instructions. Both the sync-group parameter (defined by ETSI TISPAN) and the rtcp-idms parameter (defined in this document) thus indicate the ability to sent and the ability to receive indicated RTCP messages. This section defines how these SDP parameters should be used.

Most of the times, the IDMS SDP parameters will be used in the offer/answer context. Receivers will indicate in their SDP which RTCP

messages they support.

For a unicast situation, three situations are possible in offer/answer context:

- If a receiver indicates at least the rtcp-idms SDP parameter, the MSAS SHOULD reply with only the rtcp-idms parameter and use only the RTCP IDMS Settings packet for MSAS->SC communication

- If a receiver indicates only the sync-group SDP parameter, and the MSAS also supports this, it SHOULD reply with only the sync-group parameter and use only the RTCP XR block with SPST=2 for MSAS->SC communication

- If a receiver indicates only the sync-group SDP parameter, and the MSAS does not support this, the media sender MUST ignore the parameter. This receiver will not become part of the synchronization session

Note that it is possible that for a certain synchronization group, that the MSAS sends RTCP IDMS packets to one receiver and RTCP XR IDMS blocks with SPST=2 to another receiver.

In a multicast situation using the offer/answer context, it will work a bit differently. The negotiation is the same as in the unicast situation. But, the MSAS will multicast all RTCP messages to all receivers. So:

- If all receivers support the RTCP IDMS Settings packet, the MSAS SHOULD only sent the RTCP IDMS Settings packet for MSAS->SC messages

- If not all receivers support the RTCP IDMS Settings packet, but all receivers support the TISPAN solution, the MSAS SHOULD only sent the RTCP XR block with SPST=2 for MSAS->SC messages.

- If some receivers support only the RTCP IDMS Settings packet and other receivers support only the TISPAN solution, the MSAS SHOULD sent both the RTCP IDMS Settings packet and the RTCP XR block with SPST=2 for MSAS->SC messages. This is less efficient, since the information sent is duplicated, but this is the only way to include all receivers in a synchronization session in this scenario.

In certain multicast situations, there is no offer/answer context, but only a declarative modus. In that case, the MSAS SHOULD use only the RTCP IDMS packet type and thus use only the SDP parameter rtcp-idms. Receivers that do not support the RTCP IDMS packet will just

ignore both the SDP parameter and the RTCP IDMS packets, and will thus not join the synchronization session. For compatability with the TISPAN solution, the MSAS MAY choose to use the RTCP XR IDMS block type instead, using the SDP parameter sync-group. The media sender SHOULD NOT use both parameters at the same time in this case of no offer/answer context.

13.2. Declarative cases

In certain multicast situations, there is no offer/answer context, but only a declarative modus. In that case, the MSAS SHOULD use only the RTCP IDMS packet type and thus use only the SDP parameter rtcp-idms. Receivers that do not support the RTCP IDMS packet will just ignore both the SDP parameter and the RTCP IDMS packets, and will thus not join the synchronization session. For compatability with the TISPAN solution, the MSAS MAY choose to use the RTCP XR IDMS block type instead, using the SDP parameter sync-group. The media sender SHOULD NOT use both parameters at the same time in this case of no offer/answer context.

14. On the use of presentation timestamps

A receiver can report on different timing events, i.e. on packet arrival times and on playout times. A receiver SHALL report on arrival times and a receiver MAY report on playout times. RTP packet arrival times are relatively easy to report on. Normally, the processing and playout of the same media stream by different receivers will take roughly the same amount of time. Synchronizing on packet arrival times, may lead to some accuracy loss, but it will be adequate for many applications, such as social TV.

Also, if the receivers are in some way controlled, e.g. having the same buffer settings and decoding times, high accuracy can be achieved. However, if all receivers in a synchronization session have the ability to report on, and thus synchronize on, actual playout times, or packet presentation times, this may be more accurate. It is up to applications and implementations of this RTCP extension whether to implement and use this.

15. Security Considerations

The security considerations described in [RFC3611] apply to this document as well.

The specified RTCP XR Block Type in this document is used to collect, summarize and distribute information on packet reception- and

playout-times of streaming media. The information may be used to orchestrate the media playout at multiple devices.

Errors in the information, either accidental or malicious, may lead to undesired behavior. For example, if one device erroneously reports a two-hour delayed playout, then another device in the same synchronization group could decide to delay its playout by two hours as well, in order to keep its playout synchronized. A user would likely interpret this two hour delay as a malfunctioning service.

Therefore, the application logic of both Synchronization Clients and Media Synchronization Application Servers should check for inconsistent information. Differences in playout time exceeding configured limits (e.g. more than ten seconds) could be an indication of such inconsistent information.

No new mechanisms are introduced in this document to ensure confidentiality. Encryption procedures, such as those being suggested for a Secure RTP (SRTP) at the time that this document was written, can be used when confidentiality is a concern to end hosts.

16. IANA Considerations

This document defines a new RTCP packet type called IDMS Settings packet in the IANA registry of RTP parameters, part of RTCP Control Packet types (PT), based on the specification in Section 11.

Further, this document defines a new SDP parameter "rtcp-idms" within the existing IANA registry of SDP Parameters, part of the "att-field (media level only)".

The SDP attribute "rtcp-idms" defined by this document is registered with the IANA registry of SDP Parameters as follows:

SDP Attribute ("att-field"):

Attribute name: rtcp-idms

Long form: RTCP report block for IDMS

Type of name: att-field

Type of attribute: media level

Subject to charset: no

Purpose: see sections 7 and 10 of this document

Reference: this document

Values: see this document

17. Contributors

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