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Inter-Destination Media Synchronization (IDMS) Using the RTP Control Protocol (RTCP)

Abstract

This document defines a new RTP Control Protocol (RTCP) Packet Type and an RTCP Extended Report (XR) Block Type to be used for achieving Inter-Destination Media Synchronization (IDMS). IDMS is the process of synchronizing playout across multiple media receivers. Using the RTCP XR IDMS Report Block defined in this document, media playout information from participants in a synchronization group can be collected. Based on the collected information, an RTCP IDMS Settings Packet can then be sent 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 useful 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.

Status of This Memo

This is an Internet Standards Track document.

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Information about the current status of this document, any errata, and how to provide feedback on it may be obtained at <http://www.rfc-editor.org/info/rfc7272>.

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1. Introduction

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.

Inter-Destination Media Synchronization (IDMS) requires the exchange of information on media arrival and presentation 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 synchronization algorithm employed, which is out of scope of this document.

1.1. 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].

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 the original order of packets and for detecting packet loss at the receiver.

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 report (XR) blocks [RFC3611].

IDMS involves the collection, summarization, and distribution of RTP packet arrival and presentation times. As information on RTP packet arrival times and presentation times can be considered reception quality feedback information, RTCP is well suited for carrying out IDMS.

2.2. IDMS and ETSI

A first version of IDMS for use with RTP/RTCP was standardized by ETSI Telecommunications and Internet converged Services and Protocols for Advanced Networking (TISPAN) in [TS183063], resulting in an IANA registration for an RTCP XR Block Type. This work was then brought as input to the IETF AVTCORE WG for further standardization, leveraging the RTP/RTCP expertise present in the AVTCORE WG. This document is the result of that effort.

Although the IDMS protocol described in this document has evolved significantly from the version that was originally specified by ETSI TISPAN, it is still backwards compatible with the ETSI version. As such, it had been decided in ETSI to update the TS 183 063 document to reference this document as the normative specification of IDMS. This update can be found in newer versions of TS 183 063 (i.e., versions higher than 3.5.2). In accordance, this document proposes to update the IANA registration for the RTCP XR IDMS Report Block to point to this document. Finally, this document proposes an IANA registry for Synchronization Packet Sender Type (SPST) values, allowing the registration of extensions to this document.

3. Inter-Destination Media Synchronization (IDMS) Use Cases

There is 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 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 another 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, with users noticing tearing effects and no longer perceiving a single image.

A third usage scenario is that of 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 sensitive to differences in audio delay compared to video 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.

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.

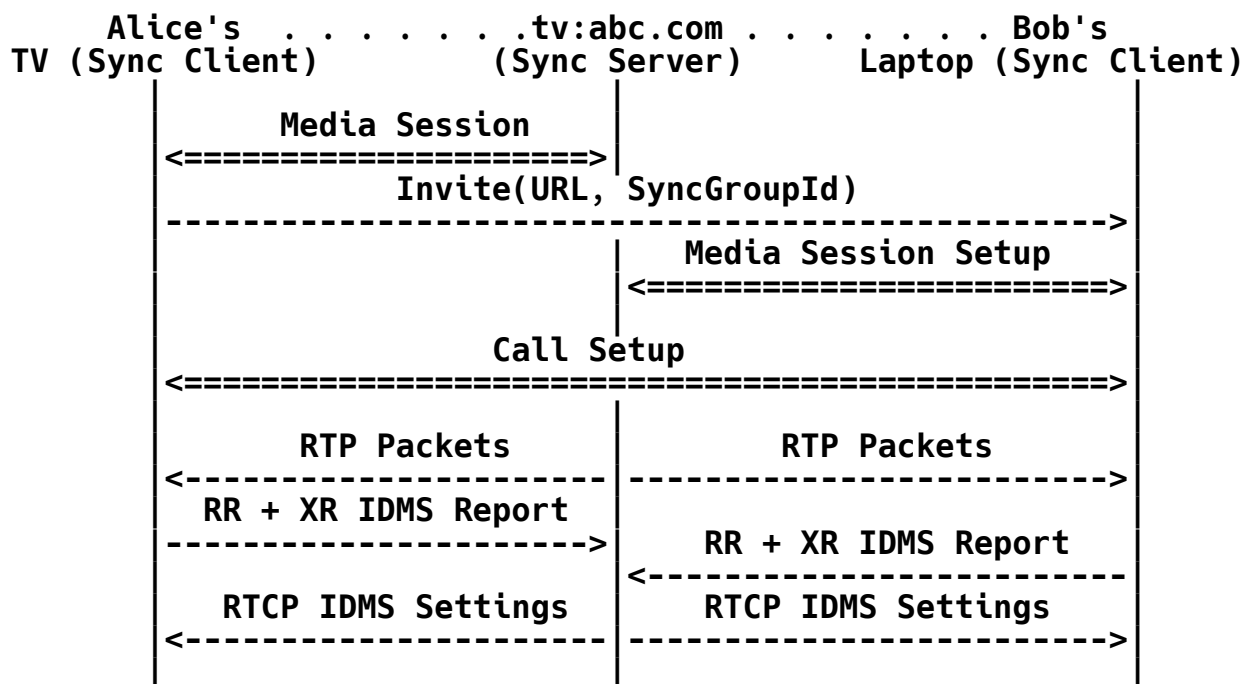


Figure 1: Example of a Typical IDMS Session

Alice is watching TV in her living room. At some point, she sees that Bob's favorite team is playing football. 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 with the media server. A Voice over IP (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 RRs to the media server. However, in order to make sure Alice and Bob see the events in the football game at the same time, their clients also periodically send an RTCP XR IDMS Report Block to the Sync Server function of the media server. Included in the RTCP XR IDMS Report 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 RTCP XR IDMS Report Blocks (e.g., by selecting the most lagged client as the reference for IDMS). It then sends an RTCP IDMS Settings 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 RTCP IDMS Settings 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 necessary that the wallclocks of the receivers are synchronized with each other. While Alice and Bob both report when they receive, and optionally when they

playout, certain RTP packets, in order to correlate their reports to each other, it is necessary that their wallclocks are synchronized.

5. Architecture for Inter-Destination Media Synchronization

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

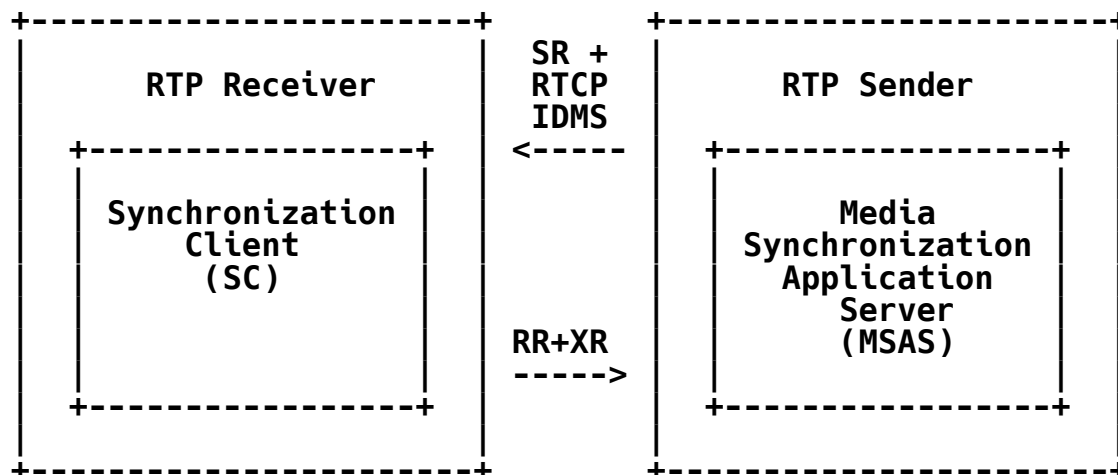


Figure 2: IDMS Architecture Diagram

5.1. Media Synchronization Application Server (MSAS)

An MSAS collects RTP packet arrival times and presentation times from one or more SCs in a synchronization group by receiving RTCP XR IDMS reports. The MSAS summarizes and distributes this information to the SCs in the synchronization group as synchronization settings via the RTCP IDMS Settings Packet messages, e.g., by determining the SC with the most lagged playout and using its reported RTP packet arrival time and presentation time as a summary.

It should be noted that while the diagram above shows the MSAS as part of the RTP sender, this is not necessary. For example, an MSAS might also be implemented as an independent function in the network or in a master/slave type of architecture where one of the SC devices also acts as an MSAS. Wherever the MSAS is implemented, it is important that the MSAS has access to the RTP stream to which the XR reports apply, so that it is able to correlate the RTCP XR IDMS reports coming from different SCs.

5.2. Synchronization Client (SC)

An SC reports on RTP packet arrival times and presentation times of a media stream. It can receive IDMS Settings Packets containing summaries of such information and use that to adjust its playout buffer. The SC sends RTCP XR IDMS reports to the MSAS.

5.3. Communication between MSAS and SCs

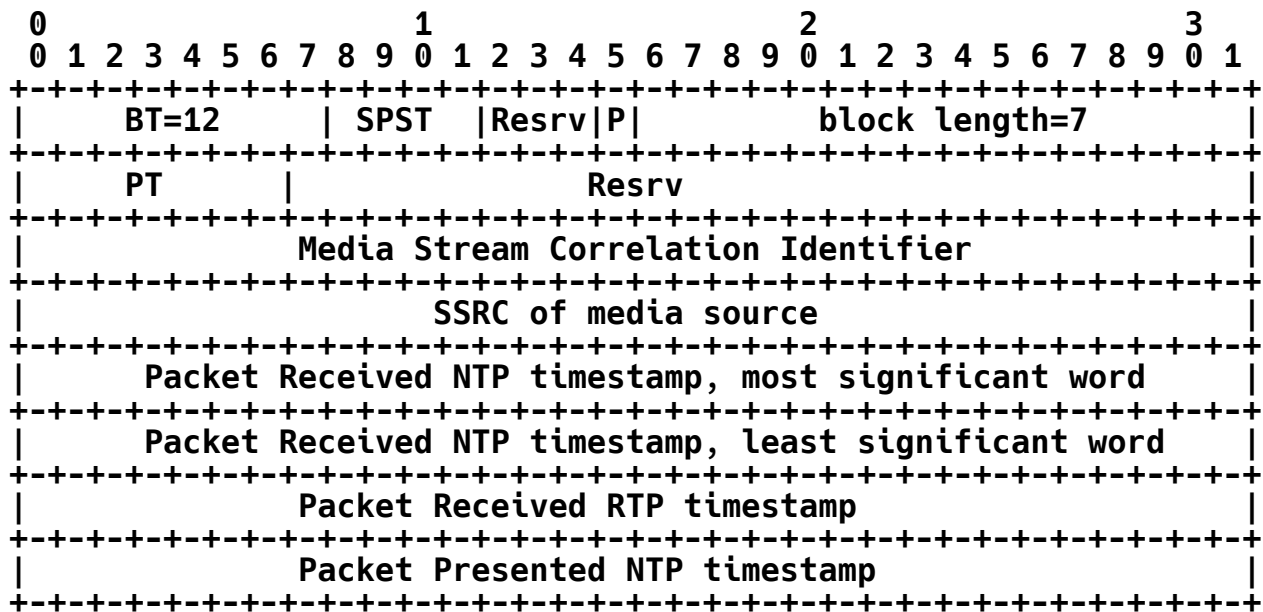
Two different message types are used for the communication between MSAS and SCs. For the SC->MSAS message containing the arrival and playout information of a particular client, an RTCP XR IDMS Report Block is used (see Section 6). For the MSAS->SC message containing the synchronization settings instructions, a new RTCP IDMS Settings Packet is defined (see Section 7).

6. RTCP XR IDMS Report Block

This section specifies a new RTCP XR Block Type, the RTCP XR IDMS Report Block, for reporting IDMS information to an MSAS. In particular, it is used to provide feedback information on arrival times and presentation times of RTP packets. Its definition is based on [RFC3550] and [RFC3611].

In most cases, a single RTP receiver will only be part of a single IDMS session, i.e., it will report on arrival 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 scenarios for IDMS and will require multiple reports by an SC.

This document does not define new rules for when to send 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 an RTP packet received during the period since the last RTCP XR IDMS Report Block was sent. Because of RTP timestamp rollover, there is ambiguity in mapping RTP timestamps to NTP timestamps. The recommendation to report on recent RTP packets serves to manage this ambiguity. For more details on which packet to report on, see below under "Packet Received RTP timestamp".



The RTCP XR 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 is 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, as enumerated in a registry maintained by IANA (see Section 13.4):

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=2-4 Values defined by ETSI TISPAN (see [TS183063]).

SPST=5-15 Unassigned.

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 at transmission 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 0, then the Packet Presented NTP timestamp SHALL be ignored by the receiver.

Block Length: 16 bits. This field indicates the length of the block in 32-bit words minus one and is set to 7, as this RTCP XR IDMS Block Report 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 PT field is needed in the case where the MSAS is neither the media server nor a receiver of the media stream, i.e., it is implemented as a third-party entity. In such cases, the MSAS needs the PT to determine the rate of advancement of the timestamps of the RTP media stream to be able 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 at transmission and MUST be ignored by the receiver.

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), then the Media Stream Correlation Identifier field contains the Synchronization Group Identifier (SyncGroupId) to which the report applies.

Synchronization Source (SSRC): 32 bits. The SSRC of the media source is set to the value of the SSRC identifier carried in the RTP header [RFC3550] of the RTP packet to which the XR IDMS relates.

Packet Received NTP timestamp: 64 bits. This timestamp reflects the wallclock time at the moment of arrival of the first octet of the RTP packet to which the XR IDMS relates. It is formatted based on the NTP timestamp format as specified in [RFC5905]. See Section 8 for more information on how this field is used.

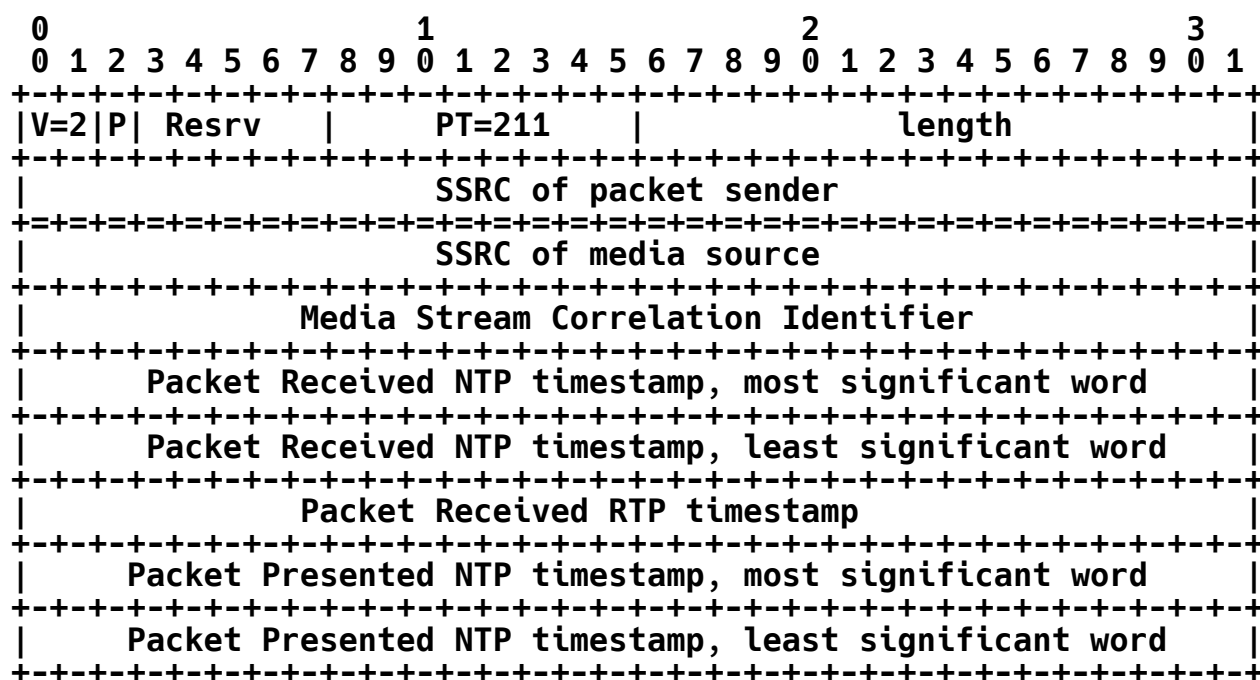
Packet Received RTP timestamp: 32 bits. This timestamp has the value of the RTP timestamp carried in the RTP header [RFC3550] of the RTP packet to which the XR IDMS relates. Several consecutive RTP packets will have equal timestamps if they are (logically) generated at once, e.g., belong to the same video frame. It may well be the case that one receiver reports on the first RTP packet that has a certain RTP timestamp, and a second receiver reports on the last RTP packet that has 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 'lowest sequence number' here is meant to be 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 wallclock time at the moment the rendered media unit (e.g., video frame or audio sample) 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 no Packet Presented NTP timestamp is available, this field SHALL be set to 0 and be considered empty, and the Packet Presented NTP timestamp flag (P) SHALL be set to 0. With regards to NTP epoch and rollover, the value of the Packet Presented NTP timestamp is considered to always be greater than the Packet Received NTP timestamp and to be within 2^{16} seconds of it. Presented in this context 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 SCs can determine the delay between receiving packets and presenting them to the end user. If no presentation timestamps are reported by SCs, the ability to accurately synchronize playout may be limited.

7. RTCP Packet Type for IDMS (IDMS Settings Packet)

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]. Synchronization settings take the form of a report referencing a real or hypothetical RTP packet selected or contrived by the MSAS.



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

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

PT: 211, as registered by IANA.

SSRC: 32 bits. The SSRC of the media source is 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 Settings 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 wallclock 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 8 for more information on how this field is used. Because RTP timestamps do wrap around, the sender of this packet **MUST** use recent values, i.e., choose NTP timestamps that reflect current time and not too far in the future or in the past so as to create ambiguity with regards to RTP timestamp wrap around.

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 IDMS relates. This **SHOULD** relate to the first arriving RTP packet containing this particular RTP timestamp, in case multiple consecutive RTP packets contain the same RTP timestamp.

Packet Presented NTP timestamp: 64 bits. This timestamp reflects the wallclock time at the reference client at the moment it presented the rendered media unit (e.g., video frame or audio sample) 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 no Packet Presented NTP timestamp is available, this field **SHALL** be set to 0 and be considered empty. 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 32-bit Presented timestamp will not suffice. For this reason, this RTCP packet type for IDMS includes a 64-bit 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 RTCP XR IDMS Report Block with which the SCs report on their playout to have a 32-bit Presented Timestamp field.

8. Timing and NTP Considerations

To achieve IDMS, the different receivers involved need synchronized wallclocks as a common timeline for synchronization. This synchronized clock is used for reporting the Packet Received NTP timestamp and the Packet Presented NTP timestamp, and for interpretation of these fields in received IDMS Settings Packets. 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 quality 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 [IEEE1588-2008].

[RFC7273] defines a set of Session Description Protocol (SDP) parameters for signaling the clock synchronization source or sources available to and used by the individual receivers. SCs MAY use [RFC7273] to indicate their clock synchronization source or sources in use and available. Using these parameters, an SC can indicate which synchronization source is being used at the moment. 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 that 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.

[RFC7164] 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 guidelines specified in [RFC7164] into account when implementing IDMS.

9. On the Use of Presentation Timestamps

A receiver can report on different timing events, i.e., on packet arrival times and on playout or presentation 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 and rendering 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 presentation times, this will be more accurate. It is up to the applications and implementations of this RTCP extension whether to implement and use presentation timestamps.

10. SDP Signaling for RTCP IDMS Settings Packet

The SDP attribute `rtcp-idms` is used to signal the use of the RTCP IDMS Settings Packet and the associated RTCP XR IDMS Report Block. It is also used to carry an identifier of the synchronization group to which clients belong or will belong. The SDP attribute 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 reference or master stream using existing inter-stream synchronization (such as 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 most sensitive to degradation in audio synchronization. When using multi-description or multi-view codecs, the IDMS control should be performed on the base layer.

This SDP attribute 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 ; Decimal 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 4294967295 ($2^{32}-1$) is reserved for future use. For a description on the value of SyncGroupId to include, see Section 11.

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

```
a=rtcp-idms:sync-group=42
```

11. SDP Rules

11.1. Offer/Answer Rules

The SDP usage for IDMS follows the rules defined in [RFC4566] and Section 5 of [RFC3611] on SDP signaling with the exception of what is stated here. The IDMS usage of RTCP is a loosely coupled collaborative attribute, in the sense that receivers send their status information and, in response, the MSAS asynchronously sends synchronization setting instructions. The `rtcp-idms` attribute, thus, indicates the ability to send and receive indicated RTCP messages. This section defines how this SDP attribute should be used with regard to an offer/answer context.

It is expected that, in most cases, the `rtcp-idms` attribute will be used in an offer/answer context where receivers will have predetermined, through some means outside the scope of this document, a `SyncGroupId` before the media session is set up. However, A sender that assigns a `SyncGroupId` is also supported for cases, for example, where the MSAS contains group management functionality and is co-located with or otherwise communicates with the sender. Thus, both senders and receivers can insert the attribute and the `SyncGroupId`. Furthermore, the attribute is allowed to be inserted for more than one media stream, allowing an SC to become part of multiple synchronization groups simultaneously. This effectively couples two (or more) synchronization groups to each other. If the `rtcp-idms` attribute is inserted more than once for a particular media session, each `SyncGroupId` SHALL only be inserted once.

In order to join an IDMS session, the receiver (the SC) inserts the `rtcp-idms` attribute as a media-level attribute in the SDP offer. This SDP offer can be an initial offer if the media session is starting as a synchronized session. The SDP offer can also be an update to an existing media session, converting the session to an IDMS session. If the receiver has a predetermined `SyncGroupId` value, it SHOULD use this value for setting the `SyncGroupId` parameter in the `rtcp-idms` attribute. If the receiver does not know the `SyncGroupId` to be used, it MAY leave the `SyncGroupId` parameter empty by setting its value to 0.

The sender SHALL include the `rtcp-idms` attribute in its answer. If the value of the `SyncGroupId` parameter in the offer is not empty (not equal to 0), the sender SHOULD NOT change the `SyncGroupId` in its answer. If the `SyncGroupId` is empty, the sender SHALL include the proper `SyncGroupId` in its answer. If the sender receives an offer with the value of the `SyncGroupId` parameter set to 0, and cannot determine the proper `SyncGroupId`, it SHALL remove the attribute from its answer.

A sender receiving an SDP offer without the `rtcp-idms` attribute can also decide that IDMS is applicable to that media session. In such a case, the sender MAY insert the `rtcp-idms` attribute, including a non-empty `SyncGroupId`, as part of its answer.

A receiver receiving an `rtcp-idms` attribute as part of the SDP answer from a sender SHALL start sending RTCP XR IDMS reports (following all the normal RTCP rules for sending RTCP XR IDMS Report Blocks) and SHALL be ready to start receiving IDMS Settings. As usual, if a receiver does not support the attribute (e.g., in case of an MSAS-inserted IDMS attribute), it SHALL ignore the attribute.

Different updates are applicable to such an IDMS session. Updates can be sent omitting the `rtcp-idms` attribute, thereby ending involvement in the synchronization session. Updates can also be sent including the `rtcp-idms` attribute, but with a different `SyncGroupId`. This indicates a switch in the synchronization group.

11.2. Declarative Cases

In certain situations, there is no offer/answer context, but only a declarative modus. In this case, the MSAS just inserts the `rtcp-idms` attribute and a valid `SyncGroupId`. Any receiver receiving the `rtcp-idms` attribute in such a declarative case SHALL start sending RTCP XR IDMS Report Blocks and SHALL be ready to start receiving RTCP IDMS Settings Packets.

12. Security Considerations

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

The RTCP XR IDMS Report Block defined 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 or maliciously 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 SCs and MSASs should check for out-of-bound information. Differences in playout time exceeding configured limits (e.g., more than ten seconds) could be an indication of such out-of-bound information.

Apart from checking for out-of-bound information in the endpoints, an IDMS implementation can reduce its vulnerability to attacks by including source authentication and message integrity measures, reducing the potential for man-in-the-middle attacks. [RFC7201] provides an overview of the security options in RTP environments and includes a set of recommendations for message integrity and source authentication that are applicable to IDMS. In addition to preventing man-in-the-middle attacks from inserting erroneous IDMS reports, the message confidentiality mechanisms outlined in [RFC7201] also prevent third parties from determining that two or more end hosts are receiving the same stream by looking at the Media Stream Correlation Identifier.

Apart from attacking an IDMS session directly by sending incorrect IDMS reports, and with it introducing delays for all devices in a synchronization group, another potential vulnerability comes from the clock synchronization method used. Should an attacker succeed in adjusting an SC's wallclock, that SC will report incorrect IDMS reports. In order to prevent such clock synchronization attacks, it is recommended to use a secure time synchronization service.

13. IANA Considerations

This document defines a new RTCP packet type, the RTCP IDMS Packet (IDMS Settings), within the existing Internet Assigned Numbers Authority (IANA) registry of RTCP Control Packet Types. This document also defines a new RTCP XR Block Type, the RTCP XR IDMS Report Block, within the existing IANA registry of RTCP Extended Reports (RTCP XR) Block Types.

Further, this document defines a new SDP attribute "rtcp-idms" within the existing IANA registry of SDP Parameters, which is part of the "att-field (media level only)". Finally, this document defines a new IANA registry subordinate to the IANA RTCP Extended Reports (RTCP XR) Block Type Registry: the IDMS XR Block SPST Registry.

13.1. RTCP IDMS Packet Type

This document assigns the packet type value 211 in the IANA 'RTCP Control Packet types (PT)' registry to the RTCP IDMS Packet (IDMS Settings).

13.2. RTCP XR IDMS Report Block

This document updates the assignment of value 12 from the RTCP XR Block Type for reporting IDMS information as per [TS183063] to the RTCP XR IDMS Report Block defined in this document.

The RTCP XR IDMS Report Block contains an extensible SPST value field; therefore, a new registry for this field is required. This new registry is defined in Section 13.4.

13.3. RTCP-IDMS SDP Attribute

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 IDMS Parameters

Type of name: att-field

Type of attribute: media level

Subject to charset: no

Purpose: see Section 10 of this document

Reference: this document

Values: see this document

13.4. IDMS XR Block SPST Registry

This document defines a new IANA registry subordinate to the IANA RTCP Extended Reports (RTCP XR) Block Type Registry: the IDMS XR Block SPST Registry.

Initial values for the IDMS XR Block SPST Registry are given below; future assignments are to be made through the Specification Required policy [RFC5226]. The registry is limited to 16 entries (numbered 0-15), with 0 being Reserved. Values 5-15 are available for assignment.

In accordance with [RFC5226], a Designated Expert will review any applications made to IANA for the registry. Primary criteria for the Designated Expert to use when reviewing new applications are clarity

of the specification and, due to the relatively small value range of SPST values available, potential overlap in functionality with existing SPST registrations.

Value	Name	Reference
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1	Synchronization Client	This document, Section 7
2	MSAS	[TS183063]
3	SC Prime Input	[TS183063]
4	SC Prime Output	[TS183063]

13.5. Contact Information for Registrations

The contact information for the registrations is:

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14. Contributors

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