Abstract

This document defines extensions to the "RTCP-Based Feedback" [RFC4585] to reduce synchronization time when an RTP receiver joins a multicast stream at a random point in time.
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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 "Key words for use in RFCs to Indicate Requirement Levels" [RFC2119].

2. Introduction

Sections 4 and 5 of "Unicast-Based Rapid Synchronization with RTP Multicast Sessions" [I-D.versteeg-avt-rapid-synchronization-for-rtp] describe possible reasons for a synchronization delay while joining a multimedia stream in a random point in time. Over the years, different techniques have been developed in the industry in order to cope with these problems. Today, organizations such as DVB and ATIS are standardizing applications and topologies in the IPTV arena that require a smooth user experience while joining a multimedia multicast stream at a random point in time.

We believe that the IETF needs to define a set of standard tools to be used by these and other applications, while deferring the application framework to other standardization bodies. We believe that the required tools can be built as extensions to existing RTP and RTCP mechanisms.

Specifically, this document proposes extensions to "RTCP-Based Feedback" [RFC4585] to reduce synchronization time when an RTP receiver joins a multicast stream at a random point in time. The defined mechanism relies on the definitions and the mechanisms introduced in "RTP Retransmission Payload Format" [RFC4588] and "RTCP Extensions for Single-Source Multicast Sessions with Unicast Feedback" [I-D.ietf-avt-rtcpssm].

3. Definitions

The following terms are used in this document:

Media Session: Media session as defined in "RTP: A Transport Protocol for Real-Time Applications" [RFC3550].

Original Stream: The one-to-many RTP stream of single source multicast (SSM) RTP packets to which an RTP receiver joins at a random point in time.
Feedback Target: (Unicast RTCP) feedback target as defined in "RTCP Extensions for Single-Source Multicast Sessions with Unicast Feedback" [I-D.ietf-avt-rtcpssm].

Retransmission Packet: A "retransmission packet" as defined in "RTP Retransmission Payload Format" [RFC4588].

Burst Packet: An RTP packet constructed according to definitions of "RTP Retransmission Payload Format" [RFC4588] and generated upon a request from the receiver as defined in this document.

Retransmission Stream: The stream of retransmission and burst packets associated with the original multicast stream and transmitted in a separate unicast RTP session in accordance with standard RTP rules.

Burst Stream: The stream of burst packets associated with the original multicast stream and typically transmitted at an accelerated rate. A burst stream is a logical subset of a retransmission stream (i.e., transmitted in the same RTP session).

Retransmission Source: The RTP/RTCP endpoint generating retransmission stream that can be triggered and controlled by mechanisms defined in "RTP Retransmission Payload Format" [RFC4588] and in this document.

Media and Reference Information: Media and reference information is a media stream containing the media content and the metadata about it sufficient to reconstruct and use the content in the context of a specific application. The meaning, format, and the size of this information are specific to the application and are out of scope of this document.

Nominal Original Bandwidth: The actual bitrate of the original multicast stream. The burst mechanism defined in this document assumes that the nominal bandwidth of the original multicast stream is lower than the maximum bandwidth that the receiver can accommodate for incoming traffic.

Maximal Burst Bandwidth: The maximal bitrate for the unicast burst stream, which is also the maximum bitrate that the receiver can accommodate for incoming traffic.

4. Architectural Assumptions

The burst mechanism defined in this document assumes that a receiver
can accommodate an incoming media and reference information stream at a bandwidth higher than the nominal bandwidth of the original multicast stream.

The burst mechanism defined in this document is performed on the transport layer, i.e., it is independent of the particular codec or application in use.

The burst mechanisms defined in this document MUST support an architecture where the original multicast source, its feedback target, and the retransmission source are logical entities that are either collocated, or implemented by different physical entities in the network. The communications between these logical entities are out of scope for this document.

The mechanism defined in this document builds on the existing IETF mechanisms as described in this section below:

The retransmission source and the receiver both support "RTP Retransmission Payload Format" [RFC4588]. Specifically, they support the session multiplexing mode as required for the multicast case. The receiver learns about the addresses of the multicast source and the RTP session used for sending the retransmission stream by out-of-band means (e.g., SDP).

A unicast RTCP session is signaled out-of-band and used for sending feedback messages to the original multicast stream in accordance with the concepts defined in "RTCP Extensions for Single-Source Multicast Sessions with Unicast Feedback" [I-D.ietf-avt-rtcpssm]. Specifically, this unicast session is used for sending NACK messages to trigger retransmission of the original packets over a separate unicast RTP session as defined in "RTP Retransmission Payload Format" [RFC4588].

The same unicast RTCP session between the receiver and the feedback target is used for sending the new RTCP feedback primitives as defined in this document to trigger and control the burst stream of packets.

The same unicast retransmission RTP session is used to carry the burst stream of packets that are formatted according to "RTP Retransmission Payload Format" [RFC4588] from the retransmission source to the receiver.

The retransmission stream carrying both burst and retransmission packets MUST comply with "RTP Retransmission Payload Format" [RFC4588]. Specifically, the sequence number has the standard RTP definition, i.e., it MUST be one higher than the sequence number of
the preceding packet sent in the retransmission stream; the retransmission packet timestamp MUST be set to the original timestamp, i.e., to the timestamp of the original multicast packet.

5. Burst Mechanism Description

The set of tools defined in this document is designed to facilitate a simple "burst mechanism" as described below:

Before joining the original multicast media session, a new receiver learns about the addresses of the multicast source, its feedback target, and the RTP session used for sending retransmission packets by out-of-band means (e.g., SDP).

The receiver indicates that it needs to receive media and reference information "as soon as possible" within the bandwidth limits (i.e., maximal burst bandwidth) known to the receiver by sending a new RTCP Feedback "Lack of Synchronization Indication" (LSI) to the feedback target.

Upon receiving the indication, the feedback target calculates the actual burst rate based on the received value and its own local policy and sends a new RTCP Feedback "Burst Bandwidth Indication" (BBI) containing the expected bandwidth to the receiver.

Then the retransmission source proceeds to stream the media and reference information of the indicated original stream using the retransmission packet format at an accelerated rate (i.e. at the rate indicated in the BBI, which is some rate higher than the nominal original bandwidth).

Note that as a general rule, if the streaming rate needs to be adjusted according to the retransmission local policy, the feedback target first sends a new RTCP Feedback BBI containing the updated bandwidth and then the retransmission source proceeds to stream at the newly indicated bitrate.

Once the information in the burst stream matches the information being streamed in the original stream (i.e. the burst stream "catches up" with the original multicast media session), the feedback target sends a new RTCP Feedback BBI and the retransmission source drops to the nominal original bandwidth or a lower rate, subject to local application policy.

At any stage, the receiver can join the original multicast stream and ask to terminate the burst stream by sending a new RTCP Feedback "Synchronization Completed Indication" (SCI) to the feedback target.
6. Burst Mechanism Example Flow

Figures 1 and 2 below show an example of how a simple burst mechanism can be implemented using the extensions defined in this document. The flow can be tailored to various applications’ needs and constraints, which are out of scope for this document. Figure 2 also illustrates how the burst stream can be followed by retransmission packets, and then the client can close both the retransmission and the original sessions by sending RTCP BYE packets to each.

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**Key:**
- - -> Multicast RTP
***** Unicast RTCP
......> Unicast RTCP
======> IGMP

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Figure 1: Example of the Burst Mechanism Topology
Figure 2: Example of the Use of the Burst Mechanism

7.1. Lack of Synch Indication (LSI)

The LSI FB message is identified by PT=RTPFB and FMT=2.

There MUST be exactly one LSI contained in the FCI field.

7.1.1. Semantics

With the Lack of Sync Indication, a receiver can inform a feedback target that it will be joining the original multicast media session and therefore it needs to receive media and reference information over the retransmission RTP session at an accelerated rate.

The LSI includes a Bitrate value which identifies the maximum bitrate that the receiver will accommodate for the incoming unicast burst stream.

7.1.2. Format

The Lack of Synch Indication uses additional FCI fields, the contents of which are depicted in Figure 3. The length of the FB message MUST be set to 3+n, with n being the number of 32-bit words comprising the "Extensions" contained in the LSI field. If the "Extensions" does not fall on a 32-bit boundary, then the last word MUST be padded to the boundary using further bits set to 0.

```
+-----------------------------+-----------------------------+-----------------------------+
|                          Bitrate                          |                |
+-----------------------------+-----------------------------+-----------------------------+
|                          Extensions                          |                |
+-----------------------------+-----------------------------+-----------------------------+
```

Figure 3: Syntax of the Lack of Synch Indication (LSI)

Bitrate: 32 bits - Bitrate indicated by the receiver in bits per second - this is the maximum bitrate of RTP stream it can accommodate.
Extensions: Optional extended parameters encoded using Type/Length/Value (TLV) elements as described below:

Type: A single-octet identifier that defines the type of the parameter represented in this TLV element.

Length: A two-octet field that indicates the length of the Value field.

Value: Variable sized set of octets that contains the specific value for the parameter.

7.2. Burst Bandwidth Indication (BBI)

The BBI FB message is identified by PT=RTPFB and FMT=3.

There MUST be exactly one BBI contained in the FCI field.

7.2.1. Semantics

When the streaming rate needs to be changed due to a target feedback local policy, the target feedback first sends BBI message containing an updated bandwidth and then the retransmission source proceeds with the streaming accordingly.

7.2.2. Format

The Burst Bandwidth Indication uses additional FCI fields, the content of which are depicted in Figure 4. The length of the FB message MUST be set to 3+n, with n being the number of 32-bit words comprising the "Extensions" contained in the BBI field. If the "Extensions" does not fall on a 32-bit boundary, then the last word MUST be padded to the boundary using further bits set to 0.
Bitrate: 32 bits - Bitrate indicated by the sender in bits per second - this is the actual bitrate of the RTP stream that follows.

Extensions: Optional extended parameters encoded using Type/Length/Value (TLV) elements as described below:

Type: A single-octet identifier that defines the type of the parameter represented in this TLV element.

Length: A two-octet field that indicates the length of the Value field.

Value: Variable sized set of octets that contains the specific value for the parameter.

7.3. Synch Completed Indication (SCI)

The SCI FB message is identified by PT=RTPFB and FMT=4.

There MUST be exactly one SCI contained in the FCI field.

7.3.1. Semantics

The receiver sends this indication to the feedback target to indicate that the burst stream can be terminated.

7.3.2. Format

The Synch Completed Indication uses additional FCI fields, the content of which are depicted in Figure 5. The length of the FB message MUST be set to 2+n, with n being the number of 32-bit words comprising the "Extensions" contained in the SCI field. If the "Extensions" does not fall on a 32-bit boundary, then the last word MUST be padded to the boundary using further bits set to 0.
Extensions: Optional extended parameters encoded using Type/Length/Value (TLV) elements as described below:

Type: A single-octet identifier that defines the type of the parameter represented in this TLV element.

Length: A two-octet field that indicates the length of the Value field.

Value: Variable sized set of octets that contains the specific value for the parameter.

8. Establishing the Retransmission RTP Session with Burst using SDP

This section will specify one of the possible ways to use an "out-of-band" signaling to establish the retransmission RTP Session with burst as defined in this document.

One method is to use the SDP definitions introduced in "RTP Retransmission Payload Format" [RFC4588] and "RTCP Extensions for Single-Source Multicast Sessions with Unicast Feedback" [I-D.ietf-avt-rtcpsm], and new SDP attributes (if needed) for the burst mechanism defined in this document.

9. IANA Considerations

9.1. New Transport Layer Feedback Messages

Three new RTCP Transport Layer Feedback Messages will be registered through this document: "Lack of Synch Indication" (LSI), "Burst Bandwidth Indication" (BBI), and "Synch Completed Indication" (SCI).

9.2. New SDP attributes

New SDP attributes will be registered through this document (if needed) for the "out-of-band" signaling specific to the mechanism defined in this document.

10. Security Considerations


The normal RTP security mechanism (defined in Section 9 of "RTP: A Transport Protocol for Real-Time Applications" [RFC3550]) and "Extended Secure RTP Profile for RTCP-Based Feedback" [RFC5124] apply to the extensions defined in this document.

11. Acknowledgements

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12. References

12.1. Normative References


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