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RTCP Extension for Feedback Suppression Indication
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Abstract

In a large RTP session using the RTCP feedback mechanism defined in RFC 4585, a media source or middlebox may experience transient overload if some event causes a large number of receivers to send feedback at once. This feedback implosion can be mitigated if the device suffering from overload can send a third party loss report message to the receivers to inhibit further feedback. This memo defines RTCP extensions for third party loss report, to suppress NACK and FIR feedback requests. It also defines associated SDP signalling.

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1. Introduction

RTCP feedback messages [RFC4585] allow the receivers in an RTP session to report events and ask for action from the media source (or a delegated feedback target defined in SSM [RFC5760]). There are cases where multiple receivers may initiate the same, or an equivalent message towards the same media source. When the receiver count is large, this behavior may cause transient overload of the media source, the network or both. This is known as a "feedback storm" or a "NACK storm". One common cause of such a feedback storm is receivers utilizing RTP retransmission [RFC4588] as a packet loss recovery technique based, sending feedback using RTCP NACK messages [RFC4585] without proper dithering of the retransmission requests.

Another use case involves video Fast Update requests. A storm of these feedback messages can occur in conversational multimedia scenarios like Topo-Video-switch-MCU [RFC5117]. In this scenario, packet loss may happen on an upstream link of an intermediate network element such as a Multipoint Control Unit(MCU). Poorly designed receivers that blindly issue fast update requests (i.e., Full Intra Request (FIR) described in [RFC5104]), can cause an implosion of FIR requests from receivers to the same media source.

RTCP feedback storms may cause short term overload and, and in extreme cases to pose a possible risk of increasing network congestion on the control channel (e.g. RTCP feedback), the data channel, or both. It is therefore desirable to provide a way of suppressing unneeded feedback.

One approach to this, suggested in [DVB-IPTV], involves sending a NACK message to the other clients (or receiver) in the same group as the sender of NACK. However sending multicast NACK to the group can not prevent large amount of unicast NACK addressed to the same media source or middlebox, for example when the NACK is used as a retransmission request [RFC4588]. Also NACK is defined as a receiver report sent from a receiver observing a packet loss, therefore it only inform others that sender of NACK detected loss while the case the sender of the feedback has received reports that the indicated packets were lost is not covered. This document specifies a new message for this function. It further is more precise in the intended uses and less likely to be confusing to receivers. It tells receivers explicitly that feedback for a particular packet or frame loss is not needed for a period of time and can provide an early indication before the receiver reacts to the loss and invokes its packet loss repair machinery.

2. Terminology

The keywords "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD", "SHOULD NOT", "RECOMMENDED", "MAY", and "OPTIONAL" in this document are to be interpreted as described in [RFC2119].

3. Protocol Overview

This document extends the RTCP feedback messages defined in the Audio-Visual Profile with Feedback (AVPF) and define the Third Party Loss Report message. The Third Party Loss Report message informs the receiver in the downstream path of the middlebox that the sender of the Third Party Loss Report has received reports that the indicated packets were lost and asks a receiver to not send feedback messages for particular packets (indicated by their RTP sequence numbers) independent of whether the receiver detected the packet loss or detected a need for a decoder refresh point.

In order to observe packet loss before the receivers perceive it, one or more intermediate nodes may be placed between the media source and the receivers. These intermediates are variously referred to as Distribution servers, MCUs, RTP translator, or RTP mixers, depending on the precise use case. These intermediaries monitor for packet loss upstream of themselves by checking RTP sequence numbers, just as receivers do. Upon observing (or suspecting) an upstream loss, the intermediary may send Loss Party Loss Report message towards the receivers as defined in this specification.

These intermediate nodes need to take into account such factors as the tolerable application delay, the network dynamics, and the media type. When the packet loss is detected upstream of the intermediary and additional latency is tolerable, the intermediate node may itself send a feedback message asking for the suspected lost packet or ask for the correct decoder refresh point. Because it has already provided the necessary feedback toward the source, the intermediate node can be reasonably certain that it will help the situation by sending a Third Party Loss Report message to all the relevant receivers, thereby indicating to the receivers that they should not transmit feedback messages for a period of time.

Alternatively, the media source may directly monitor the amount of feedback requests it receives, and send Third Party Loss Report messages to the receivers.

When a receiver gets such a Third Party Loss Report message, it should refrain from sending a feedback request (e.g., NACK or FIR) for the missing packets reported in the message for a period of time.

A receiver may still have sent a Feedback message according to the AVPF scheduling algorithm of [RFC4585]before receiving a Third Party Loss Report message, but further feedback messages for those sequence numbers will be suppressed by this technique for a period of time. Nodes that do not understand the Third Party Loss Report message will ignore it, and might therefore still send feedback according to the AVPF scheduling algorithm of [RFC4585]. The media source or intermediate nodes cannot assume that the use of a Third Party Loss Report message actually reduces the amount of feedback it receives.

RTCP Third Party Loss Report follows the similar format of message type as RTCP NACK. But unlike RTCP NACK, the third party loss report is defined as an indication that the sender of the feedback has received reports that the indicated packets were lost and conveys the packet receipt/loss events at the sequence number level from the middlebox to the receivers in the downstream path of middlebox while NACK [RFC4585]just indicates that the sender of the NACK observed that these packets were lost. The Third Party Loss Report message can also be generated by RTP middleboxs that has not seen the actual packet loss and sent to the corresponding receivers. Intermediaries downstream of an intermediary detecting loss obviously SHOULD NOT initiate their own additional Third Party Loss Report messages for the same packet sequence numbers. They may either simply forward the Third Party Loss Report message received from upstream, or replace it with a Third Party Loss Report message that reflects the loss pattern they have themselves seen. The Third Party Loss Report does not have the retransmission request [rfc4588] semantics.

Since Third Party Loss Report interacts strongly with repair timing, it has to work together with feedback to not adversely impact the repair of lost source packets. One example is the middle box gets the retransmitted packet by sending a NACK upstream and sent it downstream. This retransmitted packet was lost on the downstream link. In order to deal with this, the downstream receiver can start a timeout in which it expected to get a retransmission packet. When this timeout expires and there is no retransmitted packet or a new third party loss report message, it can take its normal behavior as if there is no current retransmission suppression. In some cases where the loss was detected and repair initiated much closer to the source, the delay for the receiver to recover from packet loss can be reduced through the combination of intermediary feedback to the source and Third Party Loss Report downstream. In all (properly operating) cases, the risk of increasing network congestion is decreased.

4. RTCP Feedback Report Extension

This document registers two new RTCP Feedback messages for Third Party Loss Report. Applications that are employing one or more loss-repair methods MAY use Third Party Loss Report together with their existing loss-repair methods either for every packet they expect to receive, or for an application-specific subset of the RTP packets in a session. In other words, receivers MAY ignore Third Party Loss Report messages, but SHOULD react to them unless they have good reason to still send feedback messages despite having been requested to suppress them.

4.1. Transport Layer Feedback: Third-party Loss Report

This Third Party Loss Report message is an extension to the RTCP Transport Layer Feedback Report and identified by RTCP packet type value PT=RTPFB and FMT=TBD.

The FCI field MUST contain one or more entries of transport layer third party loss Early Indication (TLLEI). Each entry applies to a different media source, identified by its SSRC.

The Feedback Control Information (FCI) for TLLEI uses the similar format of message Types defined in the section 4.3.1.1 of [RFC5104]. The format is shown in Figure 1.

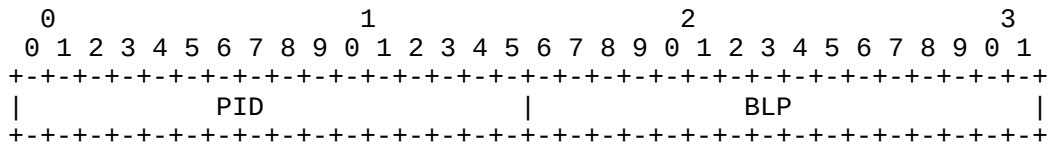

Figure 1: Message Format for the Third Party Loss Report

Packet ID (PID): 16 bits

The PID field is used to specify a lost packet. The PID field refers to the RTP sequence number of the lost packet.

bitmask of proceeding lost packets (BLP): 16 bits

The BLP allows for reporting losses of any of the 16 RTP packets immediately following the RTP packet indicated by the PID. The BLP's definition is identical to that given in [RFC4585].

4.2. Payload Specific Feedback: Third-party Loss Report

This message is an extension to the RTCP Payload Specific Feedback report and identified by RTCP packet type value PT=PSFB and FMT=TBD.

The FCI field MUST contain a Payload Specific Third Party Loss Early Indication (PSLEI) entry. Each entry applies to a different media source, identified by its SSRC.

The Feedback Control Information (FCI) for PSLEI uses the similar format of message Types defined in the section 4.3.1.1 of [RFC5104]. The format is shown in Figure 2.

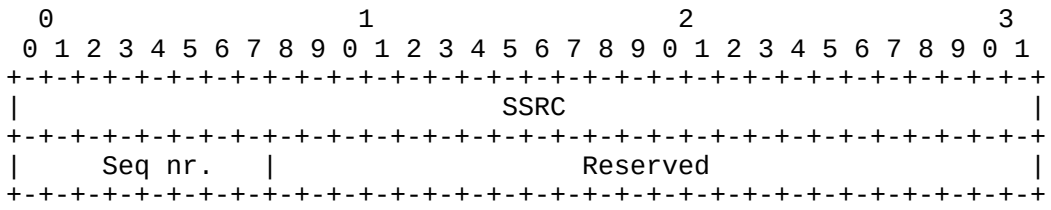

Figure 2: Message Format for the Third Party Loss Report

SSRC (32 bits):

The SSRC value of the media source that is requested to send a decoder refresh point.

Seq nr:8bits Command sequence number. The sequence number space is unique for each pairing of the SSRC of command source and the SSRC of the command target. The sequence number SHALL be increased by 1 modulo 256 for each new request.

Reserved: 24 bits

All bits SHALL be set to 0 by the media source and SHALL be ignored on reception.

5. SDP Signaling

A new feedback value "tplr" needs to be defined for the Third Party Loss Report message to be used with Session Description Protocol (SDP) [RFC4566] using the Augmented Backus-Naur Form (ABNF) [RFC4585].

The "tplr" feedback value SHOULD be used with parameters that

indicate the third party loss supported. In this document, we define two such parameter, namely:

- "tllei" denotes support of transport layer third party loss early indication (fsei).
- "pslei" denotes support of payload specific third party loss early indication.

In the ABNF for rtcp-fb-val defined in [RFC4585], there is a placeholder called rtcp-fb-id to define new feedback types. "tplr" is defined as a new feedback type in this document, and the ABNF for the parameters for tplr is defined here (please refer to section 4.2 of [RFC4585] for complete ABNF syntax).

```
      rtcp-fb-val        =/ "tplr" rtcp-fb-tplr-param
      rtcp-fb-tplr-param  = SP "tllei";transport layer third party loss early
 indication
                          / SP "pslei";payload specific third party loss earl
y indication
                          / SP token [SP byte-string]
                                    ; for future commands/indications
   byte-string = <as defined in section 4.2 of [RFC4585] >
```

Refer to Section 4.2 of [RFC4585] for a detailed description and the full syntax of the "rtcp-fb" attribute.

6. Example Use Cases

The operation of feedback suppression is similar for all types of RTP sessions and topologies [RFC5117], however the exact messages used and the scenarios in which suppression is employed differ for various use cases. The following sections outline the intended use cases of using Third Party Loss Report for feedback suppression and give an overview of the particular mechanisms.

6.1. Source Specific Multicast (SSM) use case

In SSM RTP sessions as described in [RFC5760], one or more Media Sources send RTP packets to a Distribution Source. The Distribution Source relays the RTP packets to the receivers using a source-specific multicast group.

In order to avoid the forms of Feedback implosion described in section 1,the distribution source should be told that the indicated packets were lost. How the distribution source know the indicated packets were lost is beyond of scope of this document. When upstream link or downstream aggregate link packet loss occurs, the distribution source creates a Third Party Loss Report and sent it to

all the RTP receivers, over the multicast channel. Another possibility is when there may be multiple distribution sources placed between the media source and the receivers, the upstream distribution source may inform downstream distribution sources of the detected packet loss using Third Party Loss Report messages. In response, the downstream distribution sources forward Third Party Loss Report received from upstream to all the RTP receivers, over the multicast channel. This Third Party Loss Report message tells the receivers that the sender of the third party loss report has received reports that the indicated packets were lost. The distribution source then can (optionally) ask for the lost packets from the media source on behalf of all the RTP receivers. The lost packets will either be forthcoming from distribution source, or it irretrievably lost such that there is nothing to be gained by the receiver sending a NACK to the media source.

The distribution source must be able to communicate with all group members in order for either mechanism to be effective at suppressing feedback.

As outlined in the [RFC5760], there are two Unicast Feedback models that may be used for reporting, - the Simple Feedback model and the Distribution Source Feedback Summary Model. The RTCP Feedback extension for Third Party Loss Report specified in the Section 4 of this document will work in both Feedback models. Details of operation in each are specified below.

6.1.1. Simple Feedback Model

In the simple Feedback Model, NACKs from the receiver observing the loss will be reflected to the other receivers, and there’s no need for distribution source to create the third-party loss report. The distribution source that has not seen the actual packet loss should pass through any Third Party Loss Report message it receives from the upstream direction.

This RTCP Third Party Loss Report message lets the receivers know that the sender of the Third party Loss Report has received reports that the indicated packets were lost and feedback for this packet loss is not needed and should not be sent to the media source(s). If the media source(s) are part of the SSM group for RTCP packet reflection, the Distribution Source must filter this packet out. If the media source(s) are not part of the SSM group for RTCP packets, the Distribution Source must not forward this RTCP Third Party Loss Report message to the media source(s).

6.1.2. Distribution Source Feedback Summary Model

In the distribution source feedback summary model, there may be multiple distribution sources and the Loss Detection instances are distributed into different distribution sources. In some cases, these Loss Detection instances for the same session can exist at the same time, e.g., one Loss Detection instance is implemented in the upstream distribution source A, a second Loss Detection instance for the same session is part of feedback target A and feedback target B respectively within the distribution source B. The distribution source B is placed in the path between distribution A and downstream receivers. In this section, we focus on this generic case to discuss the distribution Source Feedback Summary Model.

The distribution source A must listen on the RTP channel for data. When the distribution source A observes RTP packets from a media source are not consecutive by checking the sequence number of packets, the distribution source A generates the new RTCP Third Party Loss Report message described in the Section 4, and then send it to receivers in the downstream path via the multicast channel. Note that the distribution source A must use its own SSRC value as packet sender SSRC for transmitting the new RTCP Third Party Loss Report message.

a second detection instance within the Distribution Source B must also listen for RTCP data sent to the RTCP port. Upon receiving the RTCP Third Party Loss Report from the Distribution Source A, the distribution source B needs to check whether it sees upstream third party loss report from distribution source A reporting the same event. If the upstream Third Party Loss Report reports the different event, the distribution source B passes through any Third Party Loss Report message it receives from the upstream direction. If the same event is reported from distribution source A, the distribution source B replaces it with the summary Third Party Loss Report with the information summarization received from two loss detection instances within the Distribution Source B. In order to reduce the processing load at the distribution source, each loss detection instance may provide preliminary summarization report.

During the summary third party loss report creating, the Distribution Source B must use its own SSRC value as packet sender SSRC for transmitting summarization information and MUST perform proper SSRC collision detection and resolution.

The distribution source B may send this new RTCP summary third party loss report described in the Section 4to the group on the multicast RTCP channel and meanwhile send a packet loss request to the media source.

In some case, the distribution source B may receive RTCP NACK messages from the receivers behind the Distribution Source before the distribution source detects the packet loss which may cause potential Feedback implosion. In such case, the distribution source B may filter them out if it already detected the same loss or sent a packet loss request for the missing packet to the media source.

When the host receives the RTCP Third Party Loss Report message, if the host understands this message it will not send packet loss request (e.g., NACK) for the missing packets reported in the message. If it did not understand this new message, the host MAY send packet loss request(e.g., NACK messages) to the specified media source.

6.2. Unicast based Rapid Acquisition of Multicast Stream (RAMS) use case

The typical RAMS architecture [I-D.ietf-avt-rapid-acquisition-for-rtp]may have several Burst/ Retransmission Sources(BRS) behind the multicast source (MS) These BRSes will receive the multicast SSM stream from the media source. If one of the BRSes detects packet loss (i.e., First loss in Figure 3) on its upstream link between the MS and BRS, but the others BRSes have not, as the packet loss took place on SSM tree branch that does not impact the other BRSes. In such case, the BRSes with loss detection functionality support cannot detect packet loss at their upstream link, therefore these BRSes will not create new Third Party Loss Report message and send it to receivers in their downstream path. If the BRS impacted by packet loss has loss detection support, the BRS MAY choose to create new Third Party Loss Report message and send it to the receivers in the downstream link. Note that BRS must use its own SSRC as packet sender SSRC for transmitting the feedback suppress message.

The BRS may also send a NACK upstream to request the retransmitted packet. Upon receiving the retransmitted packet, the BRS sent it downstream. Note that this retransmitted packet may get lost (i.e., second loss in the Figure 3) on the downstream link. In order to deal with this issue, the downstream receiver can start a timeout clock in which it expected to get a retransmission packet. When this timeout expires and there is no retransmitted packet or a new Third Party Loss Report message, it can take its normal behavior as if there is no current retransmission suppression in place.

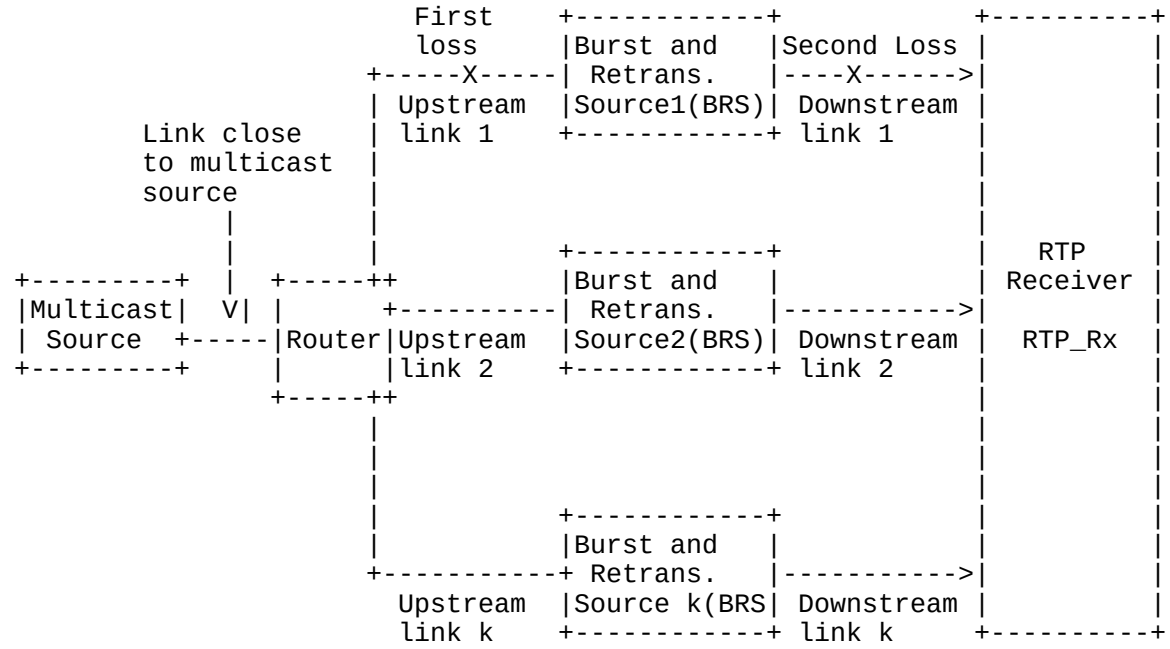

Figure 3: RAMS Use Case

6.3. RTP transport translator use case

A Transport Translator (Topo-Trn-Translator), as defined in [RFC5117] is typically forwarding the RTP and RTCP traffic between RTP clients, for example converting between multicast and unicast for domains that do not support multicast. The translator can identify packet loss from the upstream and send the Third Party Loss Report message to the unicast receivers. Note that the translator must be a participant in the session and can then use it’s own SSRC as packet sender SSRC for transmitting the Third Party Loss Report message

6.4. Multipoint Control Unit (MCU) use case

In point to multipoint topologies using video switching MCU (Topo-Video-switch-MCU) [RFC5117], the MCU typically forwards a single media stream to each participant, selected from the available input streams. The selection of the input stream is often based on voice activity in the audio-visual conference, but other conference management mechanisms (like presentation mode or explicit floor control) exist as well.

In this case the MCU may detect packet loss from the sender or may decide to switch to a new source. In both cases the receiver may

lose synchronization with the video stream and may send a FIR request. If the MCU itself can detect the mis-synchronization of the video, the MCU can send the FIR suppression message to the receivers and send a FIR request to the video source. As suggested in RFC 5117, this topology is better implemented as an Topo-mixer, in which case the mixer's SSRC is used as packet sender SSRC for transmitting Third Party Loss Report message.

7. Security Considerations

The defined messages have certain properties that have security implications. These must be addressed and taken into account by users of this protocol.

Spoofed or maliciously created feedback messages of the type defined in this specification can have the following implications:

Sending Third Party Loss Report with wrong sequence number of lost packet that makes missing RTP packets can not be compensated.

To prevent these attacks, there is a need to apply authentication and integrity protection of the feedback messages. This can be accomplished against threats external to the current RTP session using the RTP profile that combines Secure RTP [RFC3711] and AVPF into SAVPF [RFC5124].

Note that middleboxes that are not visible at the RTP layer that wish to send Third Party Loss Reports on behalf of the media source can only do so if they spoof the SSRC of the media source. This is difficult in case SRTP is in use. If the middlebox is visible at the RTP layer, this is not an issue, provided the middlebox is part of the security context for the session.

Also note that endpoints that receive a Third Party Loss Report would be well-advised to ignore it, unless it is authenticated via SRTCP or similar. Accepting un-authenticated Third Party Loss Report can lead to a denial of service attack, where the endpoint accepts poor quality media that could be repaired.

8. IANA Consideration

New feedback type and New parameters for RTCP Third Party Loss Report are subject to IANA registration. For general guidelines on IANA considerations for RTCP feedback, refer to [RFC4585].

This document assigns one new feedback type value x in the RTCP

feedback report registry to "Third Party Loss Report" with the following registrations format:

Name:	TPLR
Long Name:	Third Party Loss Report
Value:	TBD
Reference:	This document.

This document also assigns the parameter value y in the RTCP TPLR feedback report Registry to " Transport Layer Third Party Loss Early Indication ", with the following registrations format:

Name:	TLLEI
Long name:	Transport Layer Third Party Loss Early Indication
Value:	TBD
Reference:	this document.

This document also assigns the parameter value z in the RTCP TPLR feedback report Registry to "Payload Specific Third Party Loss Early Indication ", with the following registrations format:

Name:	PSLEI
Long name:	Payload Specific Third Party Loss Early Indication
Value:	TBD
Reference:	this document.

The contact information for the registrations is:

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