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FEC FRAME Raptor Extensions for Multiple RTP Synchronization Sources
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Abstract

The FEC FRAME Raptor code options do not currently address the case of bundled protection of multiple media types over multiple real-time transport protocol (RTP) synchronization sources (SSRC's). This document provides the FEC source and repair payload definitions that enable a single repair flow to be defined for multiple RTP flows

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1. Introduction

[RFC6681] provides the specification of the fully formed Forward Error Correction (FEC) scheme for Raptor/RaptorQ codes in the context of the FEC Framework (FEC Frame - see [RFC6363]). This document provides extensions that allow for protection of multiple RTP flows where each flow has its own unique sequence number space. There are two approaches described: one using explicit source FEC payload ID's, and one that does not.

2. Multi-sequenced Flows with Explicit Source FEC Payload ID

As per Section 6 of [RFC6681], arbitrary flows (including RTP flows) can be protected if the source is identified explicitly using a Source FEC Payload ID. However, the Source FEC Payload ID must be sent along with the source payload to the receiver.

2.1. RTP Header Extension for Source FEC Payload ID

It is recommended that the Source FEC Payload ID as defined in Section 6.2.2 of [RFC6681] be used in an RTP header extension for each RTP source stream packet. Since the Source FEC Payload ID is 32 bits long (4 bytes), the 1-byte header extension solution in Section 4.2 of [RFC5285] is sufficient for identifying the Source FEC Payload ID. Note however that there may be reasons to use the 2-byte header extension solution provided in Section 4.3 of [RFC5285] (e.g. due to the need for 8-bit extension ID encoding).

2.2. Repair FEC Payload ID

The Repair FEC Payload ID is used as defined in Section 6.2.3 of [RFC6681]. This will be sent along with the associated repair payload in a repair FEC stream (i.e. RTP flow). This can also be sent as a RTP header extension (although it can be included in the RTP payload of the repair FEC stream). As with the Source FEC Payload ID, the 1-byte header extension method is preferred.

2.3. New RTP Header Extension URI's

[RFC EDITOR NOTE: Please replace RFCXXXX with the RFC number of this document.]

This document defines two new extension URI's in the RTP Compact Header Extensions subregistry of the Real-Time Transport Protocol (RTP) Parameters registry, according to the following data:

Extension URI: urn:ietf:params:rtp-hdrex:FEC-FR:SourceID
Description: Source FEC Payload ID
Contact: mandyam@quicinc.com
Reference: RFCXXXX

Extension URI: urn:ietf:params:rtp-hdrex:FEC-FR:RepairID
Description: Repair FEC Payload ID
Contact: mandyam@quicinc.com
Reference: RFCXXXX

3. Multi-sequenced Flows without Source FEC Payload ID

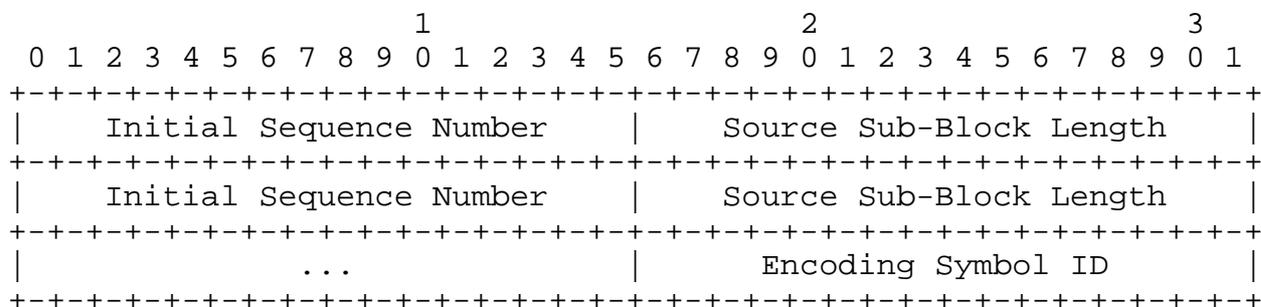
Section 8 of [RFC6681] describes the necessary procedures for single-sequenced flows. This section extends this method for multi-sequenced flows, in particular multiple RTP flows corresponding to different SSRC's. The FEC Scheme ID's used are 5 and 6.

3.1. Source FEC Payload ID

As with the approach provided in [RFC6681] for single-sequenced flows, a source FEC Payload ID is not used as the source packets are not modified.

3.2. Repair FEC Payload ID

In contrast to Section 8.1.3 of [RFC6681], only one format for the Repair FEC Payload is provided (based on Format A), but with necessary extensions for multi-sequenced flows. The number of flows in a repair packet and the order in which the flows appear in the repair packet are determined using out-of-band signalling (for an SDP example, see Section 5.2).



Repair FEC Payload ID (multisequence)

Figure 1

Initial Sequence Number (Flow i ISN), (16 bits): This field specifies the lowest 16 bits of the sequence number of the first packet to be included in this sub-block. If the sequence numbers are shorter than 16 bits, then the received Sequence Number SHALL be logically padded with zero bits to become 16 bits in length, respectively. The field type is unsigned integer.

Source Sub-Block Length (SSBL), (16 bits): This field specifies the length of the source sub-block in symbols. The field type is unsigned integer.

Encoding Symbol ID (ESI), (16 bits): This field indicates which repair symbols are contained within this repair packet. The ESI provided is the ESI of the first repair symbol in the packet. The field type is unsigned integer.

3.3. Procedures

There are slight changes necessary to the procedures outlined in Section 8.2 of [RFC6681] in order to accomodate multiple sequenced flows.

3.3.1. Source Symbol Construction

FEC Scheme 5 and FEC Scheme 6 use the procedures defined in Section 5 of [RFC6681] to construct a set of source symbols to which the FEC code can be applied.

During the construction of the source block:

- o the flow identifier, $f[i]$, for each flow included in the source packet information.
- o the length indication, $l[i]$, included in the Source Packet Information for each packet shall be dependent on the protocol carried within the transport payload. Rules for RTP are specified below.
- o the value of $s[i]$ in the construction of the Source Packet Information for each packet shall be the smallest integer such that $s[i]*T \geq (l[i]+3)$.

3.3.2. Derivations of Source FEC Packet Identification Information

The Source FEC Packet Identification Information for a source packet is derived from the flows in each packet, sequence number of each individual flow of the packet, and information received in any repair FEC packet belonging to this source block. The application data units (ADU's) that constitute the source block are identified by the associated flow identifier and sequence number of the first source packet in the block. This information is signaled in all repair FEC packets associated with the source block in the Initial Sequence Number field.

The length of the Source Packet Information (in octets) for source packets within a source block is equal to the length of the payload containing encoding symbols of the repair packets (i.e., not including the Repair FEC Payload ID) for that block, which MUST be the same for all repair packets. The Application Data Unit Information Length (ADUIL) in symbols is equal to this length divided by the encoding symbol size (which is signaled in the FEC Framework Configuration Information). The set of source packets included in the source block is determined by the Initial Sequence Number (ISN) and Source Sub-Block Length (SSBL) as follows:

Let,

- o f be the index of the flow, i.e. if f refers to the first flow in the source block then $f=1$.
- o $I(f)$ be the Initial Sequence Number of the source sub-block from flow f
- o $LP(f)$ be the Source Sub-Block Information Length in symbols for flow f
- o $LB(f)$ be the Source Sub-Block Length in symbols for flow f

Then, source packets with sequence numbers from $I(f)$ to $I(f) + (LB(f)/LP(f)) - 1$ for flow f inclusive are included in the source block. The Source Sub-Block Length, $LB(f)$, MUST be chosen such that it is at least as large as the largest Source Packet Information Length $LP(f)$.

Note that if no FEC repair packets are received, then no FEC decoding is possible, and it is unnecessary for the receiver to identify the Source FEC Packet Identification Information for the source packets.

For FEC Scheme 1, the ESI value placed into a repair packet is calculated as specified in Section 5.3.2 of [RFC5053].

For FEC Scheme 2, the ESI value placed into a repair packet is calculated as specified in Section 4.4.2 of [RFC6330].

In both cases, K is identical to the sum of all the SSBL's indicated in the repair packet.

3.3.3. Procedures for RTP Source Flows

In the specific case of RTP source packet flows, the RTP Sequence Number field SHALL be used as the sequence number in the procedures described above. The length indication included in the Application Data Unit Information SHALL be the sum over all flows of the RTP payload length plus the length of the contributing sources (CSRCs), if any, the RTP Header Extension, if present, and the RTP padding octets, if any. Note that this length is always equal to the UDP payload length of the packet minus 12.

4. Registration of the 'bundled/raptorfec' Media Type

This RTP payload format is identified using the 'bundled/raptorfec' media type that is registered in accordance with [RFC4855] and uses

the template of [RFC4288]. The Media Type Definition is identical to 'video/raptorfec' and can be found in Section 6.2.1 of [RFC6682].

5. SDP Example

5.1. With RTP Extensions

An SDP example employing bundled protection of a video and audio stream (derived from Section 10 of [RFC6681]) is shown below. In this example, the SDP guidance provided in Section 5 of [RFC5285] is also used.

```
v=0
o=ali 1122334455 1122334466 IN IP4 fec.example.com
s=Raptor FEC Example
t=0 0
a=group:FEC-FR S1 S2 R1
m=video 30000 RTP/AVP 100
c=IN IP4 233.252.0.1/127
a=rtpmap:100 MP2T/90000
a=fec-source-flow: id=0
a=mid:S1
a=extmap:1 urn:ietf:params:rtp-hdrex:FEC-FR:SourceID
m=audio 10000 RTP/AVP 0 8 97
c=IN IP4 233.252.0.2/127
b=AS:200
a=rtpmap:0 PCMU/8000
a=mid:S2
a=extmap:1 urn:ietf:params:rtp-hdrex:FEC-FR:SourceID
a=fec-source-flow: id=1
m=application 30000 UDP/FEC
c=IN IP4 233.252.0.3/127
a=fec-repair-flow: encoding-id=6; fssi=Kmax:8192,T:128,P:A
a=repair-window:200ms
a=mid:R1
a=extmap:1 urn:ietf:params:rtp-hdrex:FEC-FR:RepairID
```

5.2. Without RTP Extensions

An SDP example employing bundled protection of a video and audio stream (derived from Section 10 of [RFC6681]) is shown below. In this example, source flows (S1 and S2) identified in the 'a=group' attribute appear in this order in the Repair FEC Payload ID (see Figure 1).

```
v=0
o=ali 1122334455 1122334466 IN IP4 fec.example.com
s=Raptor FEC Example
t=0 0
a=group:FEC-FR S1 S2 R1
m=video 30000 RTP/AVP 100
c=IN IP4 233.252.0.1/127
a=rtpmap:100 MP2T/90000
a=fec-source-flow: id=0
a=mid:S1
m=audio 10000 RTP/AVP 0 8 97
c=IN IP4 233.252.0.2/127
b=AS:200
a=rtpmap:0 PCMU/8000
a=mid:S2
a=fec-source-flow: id=1
m=application 30000 UDP/FEC
c=IN IP4 233.252.0.3/127
a=fec-repair-flow: encoding-id=6; fssi=Kmax:8192,T:128,P:A
a=repair-window:200ms
a=mid:R1
```

6. IANA Considerations

This memo includes no request to IANA.

7. Normative References

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