RTP Payload Format for Multi-Flow FEC
draft-peck-fecframe-rtp-mf-00

Abstract

This document defines a new RTP payload format for the Forward Error Correction (FEC) that is used to protect multiple source flows. The format defined by this document enables the protection of multiple
media sources encapsulated in RTP with one or more repair flows and is based on the FEC framework (described in [I-D.ietf-fecframe-framework]) and the SDP Elements for FEC Framework (described in [I-D.ietf-fecframe-sdp-elements]).

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1. Introduction

This document defines a new RTP payload format for the Forward Error Correction (FEC) protecting multiple source flows.

[I-D.ietf-fecframe-framework] allows multiple source flows to be protected by the same FEC repair flow.

Multiple source flows are transmitted either as Multi-Session or as Multi-source (see definition below).

The format defined by this document enables the protection of multiple media source flows (Multi-Session or Multi-Source transmission) with one or more repair flows without adding additional information to the source packets.

The method described in this document is generic to all FEC schemes.

2. Requirements Notation

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 [RFC2119].

3. Definitions, Notations and Abbreviations

This document uses the following definitions and notations. For further definitions that apply to FEC Framework in general, see [I-D.ietf-fecframe-framework].

3.1. Definitions

FEC: Forward Error Correction.

Source Flow: The packet flow to which FEC protection is to be applied.

Repair Flow: The packet flow carrying FEC data.

Source Block: The group of source data packets which are to be FEC protected as a single block.

Source Packets: Packets that are transmitted over a source flow

Repair/FEC Packets: Packets that are transmitted over a repair flow
FEC header: A FEC-scheme specific header as defined by different I-Ds, usually follows the RTP header.

FEC-MF header: The FEC Multi-flow header. Contains information about the different source-flows and their order in the FEC block.

multi-session transmission: In multi-session transmission, media data from a single media source is split over multiple RTP sessions. The term "layered multicast" is equivalent to multi-session transmission for sessions using multicast addresses.

multi-source transmission: In multi-source transmission, data from a single media source is sent as several RTP streams in the same RTP session. The sources contained in an RTP session are identified by their synchronization source identifiers (SSRCs) or, if combined by a RTP mixer, by their contributing source identifiers (CSRCs), as defined in RTP [RFC3550].

Source Correlation: The logical association of RTP streams transferred as multiple separate sessions or as multiple sources in the same session to one layered media.

3.2. Notations

4. Source Correlation

When a FEC packet protects multiple source-flows (multi-session or multi-source transmission), the receiver must correlate between a received FEC packet and the RTP source-packets protected by it.

For correlating between FEC packets and source flow packets sent as multi-sessions, this draft uses the ‘fec-source-flow’ (see section 6.2) parameter sent in SDP as defined in SDP Elements for FEC Framework. The list of different ‘fec-source-flow’ identifiers are used in a newly defined FEC-MF-Header.

For correlating FEC packets and source flows sent as multi-source, the ‘fec-source-flow’ parameter is used as well. However, as stated in RFC 3550 (section 5.2) ‘multiplexing multiple related sources of the same medium in one RTP session using different SSRC values is the norm for multicast sessions’. When different SSRCs are used on the same RTP session, the encoder is receiving RTP packets that use multiple sequence-number spaces. Since a FEC encoder is not always aware of other source-flows transmitted on the same RTP session in multicast transmission, the SSRC should be used for source correlation in order to uniquely identify the protected source-flow.
The coupling of the fec-source-flow and the source flow SSRC identifier creates a unique identifier for a source-flow, and therefore enables the FEC decoding procedure for multiple source flows.

5. Packet Formats

This section defines the formats of the source and repair packets

5.1. Source Packets

The FEC Framework requires that source packets will contain information identifying the source block and the position within the source block occupied by the packet. However, in order to maintain backwards compatibility, this document enables the receiver to get this information without appending additional information to the source packet. Specifically this information is obtained using the combination of sequence number and SSRC identifier found in the RTP header, and information provided in the FEC header and FEC-MF header of each repair packet. Such behavior enables both non-FEC-capable and FEC-capable receivers to receive and interpret the same source packets sent in a multicast session.

5.2. Repair Packets

The FEC repair packets contain information that enables the receiver to reconstruct the source block in the remote end. This is done by using the RTP header of the repair packets as well as other headers placed within the RTP payload. The additional headers, referred to as the FEC headers as shown in Figure 1 from the [FECFRAME-FRAMEWORK] (section 6.4.1), are the FEC-MF header and the additional FEC headers for each source-flow, as shown in Figure 2.

The FEC repair packets MUST be sent in a separate RTP session from the protected source-flows.
The RTP header is formatted according to [RFC3550] with some further clarifications listed below:

- Marker (M) Bit: For this payload type, the Marker Bit is used for indicating if SSRC identifiers are appended in the FEC-MF header. If set to 0, no SSRC identifiers are sent in the FEC-MF header.

- Payload Type: The (dynamic) payload type for the repair packets is determined through out-of-band means. Note that this document registers new payload formats for the repair packets (Refer to Section 6 for details). According to [RFC3550], an RTP receiver that cannot recognize a payload type must discard it. This provides for backward compatibility. The FEC mechanisms can then be used in a multicast group with mixed FEC-capable and non-FEC-capable receivers. If a non-FEC-capable receiver receives a
repair packet, it will not recognize the payload type, and hence, will discard the repair packet.

- Sequence Number (SN): The sequence number maintains the standard definition. It is one higher than the sequence number in the previously transmitted repair packet. The initial value of the sequence number is random (unpredictable) [RFC3550].

- Timestamp (TS): The timestamp is set to a time corresponding to the repair packet’s transmission time. Note that the timestamp value has no use in the actual FEC protection process and is usually useful for jitter calculations.

- Synchronization Source (SSRC): The SSRC value is randomly assigned as suggested by [RFC3550].

5.2.2. FEC-MF header format

The FEC-MF header includes information that enables the receiver to correlate a received FEC packet with the protected source-flows.

The FEC-MF header includes a list of source-flow identifiers (FID list), and a list of SSRC identifiers (SSRC list) for uniquely identifying the protected source flows. The SSRC list is appended to the FEC-MF header if the Marker Bit in the RTP header is set to 1.

Specific FEC-scheme information for every source-flow is provided by the FEC headers appended to the MF-FEC header. The FEC headers are ordered by the FID in the FID list.

The order of the FIDs (and the matching FEC headers) should be the same as the order of the source flows as they were arranged in the FEC source block before encoding. This is required to ensure the correct construction of the FEC block in the decoding process.

The format of the FEC-MF header is shown in figure 3.

```
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
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|  Num Flows    |      FID      |     FID       |       FID     |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|     FID       |       FID     |     padding   |   padding     |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                       SSRC identifiers                        |
|                            ...                                |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```
The FEC-MF header consists of the following general fields:

- **Num Flows** - The number of source flows protected by this FEC packet.

- **FID** - Source flow Identifier. The FEC-MF includes a list of FID identifying each source flow. The FID value is as specified in the id parameter in the "fec-source-flow" field in SDP. See example in section 6.3.3. The number of FID fields is ‘Num Flows’. The FEC-MF header will be padded with zeros to 4-bytes alignment, if needed, after the last FID field (calculation for number of padded bytes is: 4-((2+Num Flows)%4)). Each FID is correlated with a FEC header appended to the FEC-MF header by the order of the FID in the FID list. The number of appended FEC headers MUST equal the value of ‘Num Flows’.

- **SSRC identifiers** - list of SSRC identifiers (optional). If Marker Bit in RTP header is 0, the list length is 0. If set to 1, the list is at the length of Num Flows. Each SSRC is taken from the protected source-flow SSRC field in the RTP header, and is represented by 4 bytes.

Editor’s Note: in order to avoid sending unnecessary SSRC identifiers, it should be defined when the SSRC is redundant information. SSRC is redundant when Multi-Source is not used, or when there is only one sender for the RTP session. In this case the ‘fec-source-flow’ is a unique identifier for a source flow.

### 5.2.3. FEC Headers Format

The FEC-MF header is followed by a list of FEC headers, according to the FEC scheme signalled by SDP (See Section 6). Each FEC header in the list represents the matching source-flow in the FID list by order.

### 5.2.4. Repair Data Format

The repair data is added after the last FEC header in the RTP repair packet. It includes the result of FEC scheme code over the source block constructed from the different source-flows. The repair data format is defined by the FEC scheme used for this repair packet as signalled by SDP.
6. Payload Format Parameters

According to the FEC framework, when RTP is used as a transport for repair packet flows, the scheme must define an RTP Payload Format for the repair data. This section provides the media subtype registration for the Multi-Flow FEC. The parameters that are required to configure the FEC encoding and decoding operations are also defined in this section.

6.1. Registration of application/mf-fec

Type name: application

Subtype name: mf-fec

Required parameters:

- FEC-scheme - the FEC scheme used for encoding. The value used here should be the FEC payload type as it was registered in the relevant RFC/draft.

Optional parameters: None.

Encoding considerations: This media type is framed and binary, see section 4.8 in [RFC4288]

Security considerations: Please see security consideration in [I-D.ietf-fecframe-framework]

Interoperability considerations: None.

Published specification: TBD

Applications that use this media type: Multimedia applications that want to improve resiliency against packet loss by sending redundant data for multiple source media flows.

Additional information: None.

Magic number(s): none defined

File extension(s): none defined

Macintosh file type code(s): none defined

Person & email address to contact for further information: Orly Peck, orlyp@radvision.com
7. Mapping of SDP Parameters

For a proper operation details of the FEC operation have to be communicated between the sender and the receiver. The receiver must be notified that the FEC operation was used for multiple source flows. Specifically, the receiver has to know the FEC scheme that was used by the sender to encode the source flows. In addition, different FEC scheme-specific parameters should be communicated. One way to provide this information is to use the Session Description Protocol (SDP) [RFC4566].

The mapping of the media type specification for "mf-fec" and their parameters in SDP is as follows:

- The media type (e.g., "application") goes into the "m=" line as the media name.
- The media subtype ("mf-fec") goes into the "a=rtpmap" line as the encoding name.
- The 'FEC-scheme' goes into the "a=rtpmap" line as the encoding parameters.
- Additional scheme-specific parameters go into the "a=fmtp" line as a semicolon-separated list of parameter=value pairs.
- The "group" and "fec-source-flow" attributes should be used according to [I-D.ietf-fecframe-sdp-elements].

See section 9 for SDP examples.

8. FEC Packet Example

This section demonstrates the structure and data in a FEC packet protecting multiple source flows.

In this example, the following FEC packet is the result of Reed-Solomon encoding for 3 different source flows. Two of the source flows (1 and 2) share the same RTP session and same payload type, and are differentiated by different SSRC identifiers (Multi-Source
The other source flow (3) is transmitted through a different RTP session but share the same SSRC identifier as the one used by source-flow 2 (Multiple-Session Transmission).

The FEC payload represents the Reed-Solomon scheme over RTP as defined in draft-galanos-fecframe-rtp-reedsolomon-00. This draft is general for all FEC schemes transmitted through RTP, and the use of Reed-Solomon is only for illustration purposes.

The source-flows protected by this FEC packet are defined as follows:

- source-flow-1: identified as fec-source-flow: id=0 in SDP, with SSRC=10.
- source-flow-2: identified as fec-source-flow: id=0 in SDP, with SSRC=11.
- source-flow-3: identified as fec-source-flow: id=1 in SDP, with SSRC=11.

### 8.1. MF-FEC Header Example

```
0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
| num FID=3 | FID=0 | FID=0 | FID=1 |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
| SSRC = 10 |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
| SSRC = 11 |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
| SSRC = 11 |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
| SSRC = 11 |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

Figure 4: FEC-MF Header Example
8.2. FEC Headers Example

| N-K | i | SN Base=1000 |
| N-K | i | SN Base=0 |
| N-K | i | SN Base=500 |

Figure 5: FEC Headers Example

8.3. SDP Example

The following example demonstrates the SDP for the above FEC packet example.

```plaintext
v=0
o=orly 1122334455 1122334466 IN IP4 fec.example.com
s= MF FEC Example
t=0 0
a=group:FEC S1 S2 R1
m=video 30000 RTP/AVP 100
a=rtpmap:100 MP2T/90000
a=fec-source-flow: id=0
a=mid:S1
m=video 30000 RTP/AVP 100
a=rtpmap:100 MP2T/90000
a=fec-source-flow: id=1
a=mid:S2
m=application 30000 RTP/AVP 110
a=rtpmap:110 fec-mf/90000/reed-solomon-fec
a=fmtp:110 max_N:5; repair-window:200000; symbol-size:8
a=mid:R1
```

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9. Offer/Answer considerations

TBD

10. Security Considerations

TBD

11. IANA Considerations

New media subtypes are subject to IANA registration. For the registration of the payload formats and their parameters introduced in this document, refer to Section 7.

12. Acknowledgments

Some parts of this document are borrowed from the following documents: [RFC5109], [draft-ietf-fecframe-ld2d-parity-scheme-01], [draft-galanos-fecframe-rtp-reedsolomon-mf-00]. The author would like to thank the editors of these documents.

13. References

13.1. Normative References


13.2. Informative References


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