FEC Framework
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SDP Elements for FEC Framework
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Abstract

This document specifies the use of Session Description Protocol (SDP) to describe the parameters required to signal the Forward Error Correction (FEC) Framework Configuration Information between the sender(s) and receiver(s). This document also provides the semantics for grouping multiple source and repair flows together for the applications that simultaneously use multiple instances of the FEC Framework.

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1. Introduction

The Forward Error Correction (FEC) Framework, described in [I-D.ietf-fecframe-framework], outlines a general framework for using FEC-based error recovery in packet flows carrying media content. While a continuous signaling between the sender(s) and receiver(s) is not required for a Content Delivery Protocol (CDP) that uses the FEC Framework, a set of parameters pertaining to the FEC Framework MUST be initially communicated between the sender(s) and receiver(s).

One way to communicate this information is to use the Session Description Protocol (SDP)[RFC4566]. SDP provides a simple text-based format for announcements and invitations to describe multimedia sessions. These SDP announcements and invitations include sufficient information for the sender(s) and receiver(s) to participate in the multimedia sessions. SDP also provides a framework for capability negotiation, which MAY be used to negotiate all or a subset of the parameters pertaining to the individual sessions.

The purpose of this document is to introduce the SDP elements that MUST be used by the CDPs using the FEC Framework that choose SDP [RFC4566] as their session description protocol.

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. Forward Error Correction (FEC) and FEC Framework

This section gives a brief overview of FEC and the FEC Framework.

3.1. Forward Error Correction (FEC)

Any application that needs a reliable transmission over an unreliable packet network has to cope with the packet losses. FEC is an effective approach that provides reliable transmission particularly in multicast and broadcast applications where the feedback from the receiver(s) may be potentially limited. In a nutshell, FEC groups source packets into blocks and applies protection to generate a desired number of repair packets.

Repair packets MAY be sent on demand or independently of any receiver feedback. The choice depends on the FEC code used by the application, the error characteristics of the underlying network, the

transport scheme (e.g., unicast, multicast, and broadcast), and the application. At the receiver side, lost packets can be recovered by erasure decoding provided that a sufficient number of source and repair packets are received. See [I-D.ietf-fecframe-framework] for further details.

3.2. FEC Framework

The FEC Framework [I-D.ietf-fecframe-framework] outlines a general framework for using FEC codes in multimedia applications that stream audio, video or other types of multimedia content. It defines the common components and aspects of Content Delivery Protocols (CDP). The FEC Framework also defines the requirements for the FEC schemes that need to be used within a CDP. However, the details of the FEC schemes are not specified within the FEC Framework. For example, the FEC Framework defines what configuration information has to be known at the sender and receiver(s) at minimum, but the FEC Framework neither specifies how the FEC repair packets are generated and used to recover missing source packets, nor dictates how the configuration information is negotiated or signaled between the sender and receiver(s). These are rather specified by the individual FEC schemes or CDPs.

For a proper operation, the information required by the FEC Framework and the details of an FEC scheme have to be communicated between the sender and receiver(s). One way to provide this information is to use the Session Description Protocol (SDP)[RFC4566]. SDP provides a commonly used text-based format for announcements and invitations that describe multimedia sessions. These SDP announcements and invitations include sufficient information for clients to participate in multimedia sessions. By using the SDP capability negotiation framework, all or a subset of the parameters pertaining to the FEC Framework MAY also be negotiated between the sender and receiver(s).

The purpose of this document is to introduce the SDP elements that MUST be used by the CDPs using the FEC Framework that choose SDP as their session description protocol.

3.3. FEC Framework Configuration Information

The FEC Framework defines a minimum set of information that MUST be communicated between the sender and receiver(s) for a proper operation of an FEC scheme. This information is called the FEC Framework Configuration Information. This information specifies how the sender applies protection to the source flow(s) and how the repair flow(s) can be used to recover lost data. In other words, this information specifies the relationship(s) between the source and repair flows.

The FEC Framework Configuration Information includes identifiers for unique identification of the source and repair flows that carry the source and repair packets, respectively. For example, a packet flow that is transmitted over UDP is uniquely identified by a tuple {Source IP Address, Destination IP Address, Source UDP port, Destination UDP port}. However, an integer identifier MAY be used internally within the FEC scheme as a shorthand to identify this flow.

Multiple instances of the FEC Framework MAY simultaneously exist at the sender and the receiver(s) for different source flows, for the same source flow, or for various combinations of source flows. Each instance of the FEC Framework MUST provide the following FEC Framework Configuration Information:

1. Identification of the repair flows.

2. For each source packet flow protected by the FEC repair flow(s):

   a. Definition of the source flow.

   b. An integer identifier for this flow definition (i.e., tuple). This identifier MUST be unique amongst all source flows that are protected by the same FEC repair flow. The identifiers SHOULD be allocated starting from zero and increasing by one for each flow.

   A source flow identifier need not be carried in source packets since source packets are directly associated with a flow by virtue of their packet headers. Note that an application MAY wildcard some of the fields if only a subset of the fields of the tuple (e.g., {Destination IP Address, Destination UDP port}) is sufficient.

3. The FEC Scheme ID that identifies the FEC scheme.

4. The length of the Source FEC Payload ID (in bytes).

   This value MAY be zero indicating that no Explicit Source FEC Payload ID is used by the FEC scheme. However, in the case that the Explicit Source FEC Payload ID is used, then only one FEC scheme MUST be used for this source flow, unless the generic tag is used by all of the FEC schemes protecting this source flow.

5. An opaque container for the FEC-Scheme-Specific Information (FSSI).

FSSI includes the information that is specific to the FEC scheme used by the CDP. FSSI is used to communicate the information that cannot

be adequately represented otherwise and is essential for the proper FEC decoding operation. FSSI is transmitted in a variable-length opaque container that carries an octet string. The FEC schemes define the structure of this octet string, which MAY contain multiple distinct elements. If the FEC scheme does not require any specific information, the FSSI MAY be null.

For the fully-specified FEC schemes, a full description of the encoded information MUST be provided. See [I-D.ietf-fecframe-framework] for details.

4. FEC Framework Descriptors

This section defines the SDP elements that MUST be used to describe the FEC Framework Configuration Information in multimedia sessions by the CDPs that choose SDP [RFC4566] as their session description protocol. Example SDP configurations can be found in Section 5.

4.1. Transport Protocol Identifiers

This specification defines a class of new transport protocol identifiers for SDP media descriptions. For all existing identifiers <proto>, this specification defines the identifier 'fec/<proto>'. This identifier MAY be used as the transport protocol identifier in the media descriptions for the source data to indicate that the FEC Source Packet format defined in Section 6.3 of [I-D.ietf-fecframe-framework] is used, where the original transport payload field is formatted according to <proto>. However, if the FEC scheme does not use the Explicit Source FEC Payload ID described in Section 6.3 of [I-D.ietf-fecframe-framework], then the original transport protocol identifier MUST be used to support backward compatibility with the receivers that do not support FEC at all.

This specification also defines another transport protocol identifier, 'udp/fec', to indicate the FEC Repair Packet format defined in Section 6.4 of [I-D.ietf-fecframe-framework].

4.2. Media Stream Grouping

The FEC Framework [I-D.ietf-fecframe-framework] states that multiple instances of the FEC Framework MAY exist at the sender and the receiver(s), and a source flow MAY be protected by multiple FEC Framework instances. Furthermore, within a single FEC Framework instance, multiple source flows MAY be protected by multiple repair flows. However, each repair flow MUST provide protection for a single FEC Framework instance. An example relationship between the source and repair flows is shown in Figure 1. Here, source flows 1

and 2 are grouped together and protected by the repair flows 4 and 5; source flow 1 is protected by the repair flow 6; source flows 2 and 3 are grouped together and protected by the repair flows 7, 8 and 9.

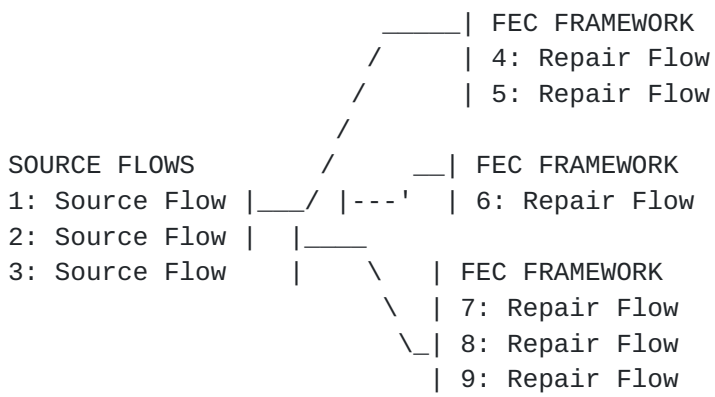

Figure 1: Relationship between the source and repair flows

The 'group' attribute and the FEC grouping semantics defined in [RFC4756] are used to associate source and repair flows together with the following additional requirement:

In the case that the Explicit Source FEC Payload ID is used, then only one FEC Scheme MUST be used for this source flow, unless the generic tag is used by all of the FEC Schemes for the Source FEC Payload ID field, as defined in [I-D.ietf-fecframe-framework].

The 'group' attribute MAY be used to associate multiple repair flows with one or more source flows. This means that the repair flows MAY be used together in an additive manner.

To let the receivers know the order which they MUST use the repair flows MAY be communicated by using the parameter 'priority' of the attribute 'fec-repair-flow'. See Section 4.5 for details.

4.3. Source IP Addresses

The 'source-filter' attribute of SDP ("a=source-filter") as defined in [RFC4570] is used to express the source addresses or fully qualified domain names in the FEC Framework.

Editor's note: Additional requirements or exceptions regarding source filters are TBD.

4.4. Source Flows

The FEC Framework allows that multiple source flows MAY be grouped and protected together by a single or multiple FEC Framework instances. For this reason, as described in Section 3.3, individual source flows MUST be identified with unique identifiers. For this purpose, we introduce the attribute 'fec-source-flow'.

The syntax for the new attribute in ABNF [RFC4234] is as follows:

```
fec-source-flow-line = "a=fec-source-flow:" source-id
     [";" SP tag-length] CRLF

source-id = "id=" src-id
src-id = 1*DIGIT

tag-length = "tag-len=" tlen
tlen = *DIGIT
```

The MANDATORY parameter 'id' is used to identify the source flow.

The OPTIONAL 'tag-len' parameter is used to specify the length of the Source FEC Payload ID (in bytes) and MUST be used according to the requirements listed in Section 4.2. If no value is specified for the 'tag-len' parameter, it indicates a value of zero.

4.5. Repair Flows

A repair flow MUST contain only repair packets formatted as described in [I-D.ietf-fecframe-framework] for a single FEC Framework instance. In other words, packets belonging to source flows or other repair flows from a different FEC Framework instance MUST NOT be sent within this flow. We introduce the attribute 'fec-repair-flow' to describe the repair flows.

The syntax for the new attribute in ABNF is as follows:

```
fec-repair-flow-line = "a=fec-repair-flow:" fec-scheme-id
     [";" SP flow-priority] [";" SP fec-scheme-specific] CRLF

fec-scheme-id = "scheme-id=" sch-id
sch-id = 1*DIGIT ; FEC scheme ID

flow-priority = "priority=" priority-of-the-flow
priority-of-the-flow = *DIGIT

fec-scheme-specific = "scheme-specific=" scheme-specific-info
scheme-specific-info = *CHAR
```

The MANDATORY parameter 'scheme-id' is used to identify the FEC scheme used to generate this repair flow. These identifiers MUST be registered with IANA by the FEC schemes that use the FEC Framework.

The OPTIONAL parameter 'priority' is used to indicate the priorities of the repair flows when multiple repair flows are grouped together to be used in an additive manner within a single FEC Framework instance. The exact usage of the parameter 'priority' and the pertaining rules SHOULD be defined by the FEC scheme or the CDP. If no value is specified for the parameter 'priority', it means that the receiver(s) MAY use the repair flows in any order.

The OPTIONAL parameter 'scheme-specific' is an opaque container to convey the FEC-Scheme-Specific Information (FSSI) that includes the information that is specific to the FEC scheme used by the CDP. FSSI is transmitted in a variable-length opaque container that carries an octet string. The FEC schemes define the structure of this octet string, which MAY contain multiple distinct elements. If the FEC scheme does not require any specific information, the FSSI MAY be null.

4.6. Minimum Buffer Size

An FEC receiver usually needs to buffer source packets before it receives the repair packets and can perform FEC decoding. The amount of this buffer can be determined by the CDP or can be implementation specific. This document specifies a new attribute to describe the amount of buffer size in milliseconds.

The syntax for the attribute in ABNF is as follows:

```
min-buffer-size-line = "a=min-buffer-size:" buf-size-in-ms CRLF
buf-size-in-ms = 1*DIGIT ; in milliseconds
```

The "a=min-buffer-size" attribute is a media-level attribute since each repair flow MAY have a different buffer requirement.

4.7. Bandwidth Specification

The bandwidth specification as defined in [RFC4566] denotes the proposed bandwidth to be used by the session or media. The specification of bandwidth is OPTIONAL.

In the context of the FEC Framework, the bandwidth specification can be used to express the bandwidth of the repair flows or the bandwidth of the session. If included in the SDP, it SHALL adhere to the following rules:

The session-level bandwidth for an FEC Framework instance MAY be specified. In this case, it is RECOMMENDED to use the Transport Independent Application Specific (TIAS) bandwidth modifier [RFC3890] and the 'a=maxprate' attribute for the session.

The media-level bandwidth for the individual repair flows MAY also be specified. In this case, it is RECOMMENDED to use the TIAS bandwidth modifier [RFC3890].

The Application Specific (AS) bandwidth modifier [RFC4566] MAY be used instead of TIAS, however, this is NOT RECOMMENDED since TIAS allows the calculation of the bitrate according to the IP version and transport protocol, whereas AS does not. Thus, in TIAS-based bitrate calculations, the packet size SHALL include all headers and payload, excluding the IP and UDP headers. In AS-based bitrate calculations, the packet size SHALL include all headers and payload, plus the IP and UDP headers.

For the ABNF syntax information of the TIAS and AS, refer to [RFC3890] and [RFC4566], respectively.

5. SDP Examples

This section provides SDP examples that can be used by the FEC Framework.

Editor's note: We need to fill in SDP examples showing single and multiple FEC Framework instances each using single or multiple repair flows.

5.1. Session Announcement Considerations

In multicast-based applications, the FEC Framework Configuration Information pertaining to all FEC protection options available at the sender MAY be advertised to the receivers as a part of a session announcement. This way, the sender can let the receivers know all available options for FEC protection. Based on their needs, the receivers MAY choose one or more protections and subscribe to the respective multicast group(s) to receive the repair flow(s). Unless explicitly required by the CDP, the receivers SHOULD NOT send an answer back to the sender specifying their choices.

5.2. Offer/Answer Considerations

In unicast-based applications, a sender and receiver MAY adopt the Offer/Answer Model [RFC3264] to set the FEC Framework Configuration Information. In this case, the sender offers all available options to the receiver and the receiver answers back to the sender with its choice(s). Note that some FEC protection options MAY be offered to only a particular set of (i.e., premium) receivers.

Eligible receivers MAY also use the SDP capability negotiation framework [I-D.ietf-mmusic-sdp-capability-negotiation] to negotiate all or a subset of the FEC Framework parameters.

6. Security Considerations

For the general security considerations related to SDP, refer to [RFC4566]. For the security considerations related to source/FEC media stream grouping in SDP and use of source address filters in SDP, refer to [RFC4756] and [RFC4570], respectively.

7. IANA Considerations

7.1. Transport Protocols

The 'proto' sub-field of the media description field ("m=") describes the transport protocol used. This document registers the following two values:

UDP/FEC
DCCP/FEC

7.2. Attribute Names

As recommended by [RFC4566], the following attribute names should be registered with IANA.

The contact information for the registrations is:

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SDP Attribute ("att-field"):

Attribute name:	fec-source-flow
Long form:	Pointer to FEC Source Flow
Type of name:	att-field
Type of attribute:	Media level
Subject to charset:	No
Purpose:	See this document
Reference:	This document
Values:	See this document

SDP Attribute ("att-field"):

Attribute name:	fec-repair-flow
Long form:	Pointer to FEC Repair Flow
Type of name:	att-field
Type of attribute:	Media level
Subject to charset:	No
Purpose:	See this document
Reference:	This document
Values:	See this document

SDP Attribute ("att-field"):

Attribute name:	min-buffer-size
Long form:	Minimum Buffer Size in Milliseconds
Type of name:	att-field
Type of attribute:	Media level
Subject to charset:	No
Purpose:	See this document
Reference:	This document
Values:	See this document

8. Acknowledgments

The author would like to thank the FEC Framework Design Team for their inputs, suggestions and contributions.

9. References

9.1. Normative References

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9.2. Informative References

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