1-D and 2-D Parity FEC

`draft-ietf-fecframe-1d2d-parity-scheme-00`

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Introduction

- 1-D and 2-D parity codes are systematic FEC codes of decent complexity that provide protection against
  - Bursty losses
  - Random losses

- This document
  - Describes the 1-D and 2-D parity codes
  - Specifies the RTP payload format for these codes

- Full RTP compliance with NO backward compatibility with existing specs

1-D and 2-D Parity FEC
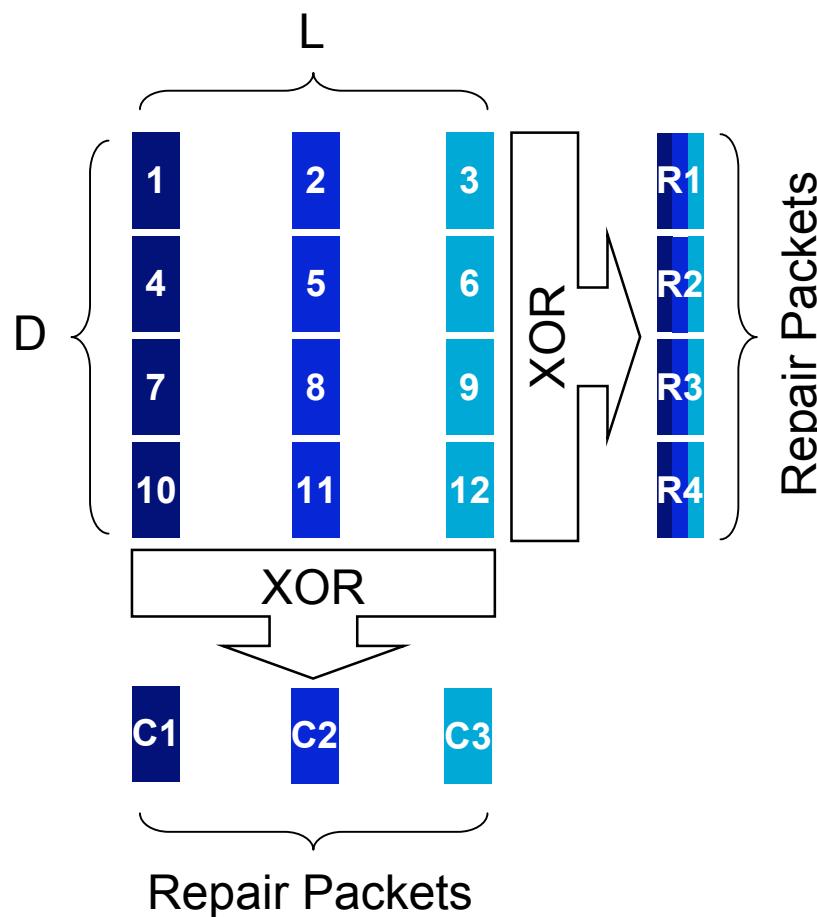
- Source block size: D x L

- 1-D Column FEC (for Bursty Losses)
  - Each column produces a single packet
  - Overhead = 1 / D
  - L-packet duration should be larger than the (target) burst duration

- 1-D Row FEC (for Random Losses)
  - Each row produces a single packet
  - Overhead = 1 / L

- 2-D (Column + Row) FEC
  - Overhead = (D+L) / (DxL)

1-D and 2-D Parity FEC Limitations
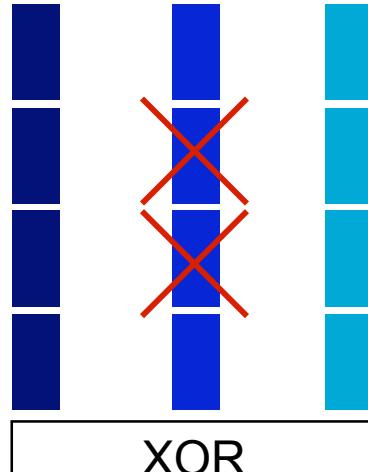
1-D Column FEC fails!
1-D Row FEC would work
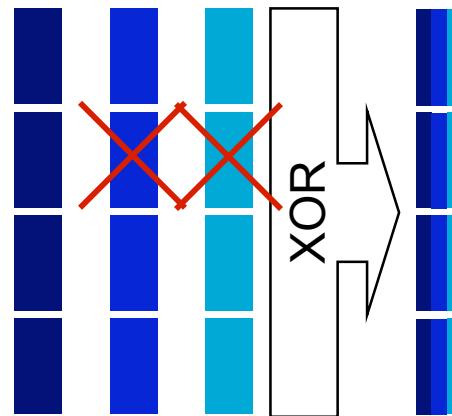
1-D Row FEC fails!
1-D Column FEC would work
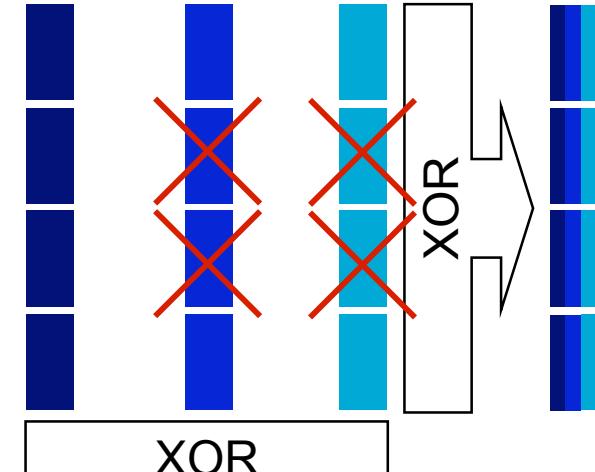
Both 1-D and 2-D
FEC fails!

✕ Packet Loss

RTP Header

```
 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
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|V=2|P|X|  CC   |M|     PT      |       Sequence number         |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                           Timestamp                           |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|           Synchronization source (SSRC) identifier            |
+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+
|            Contributing source (CSRC) identifiers             |
|                             ....                              |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```
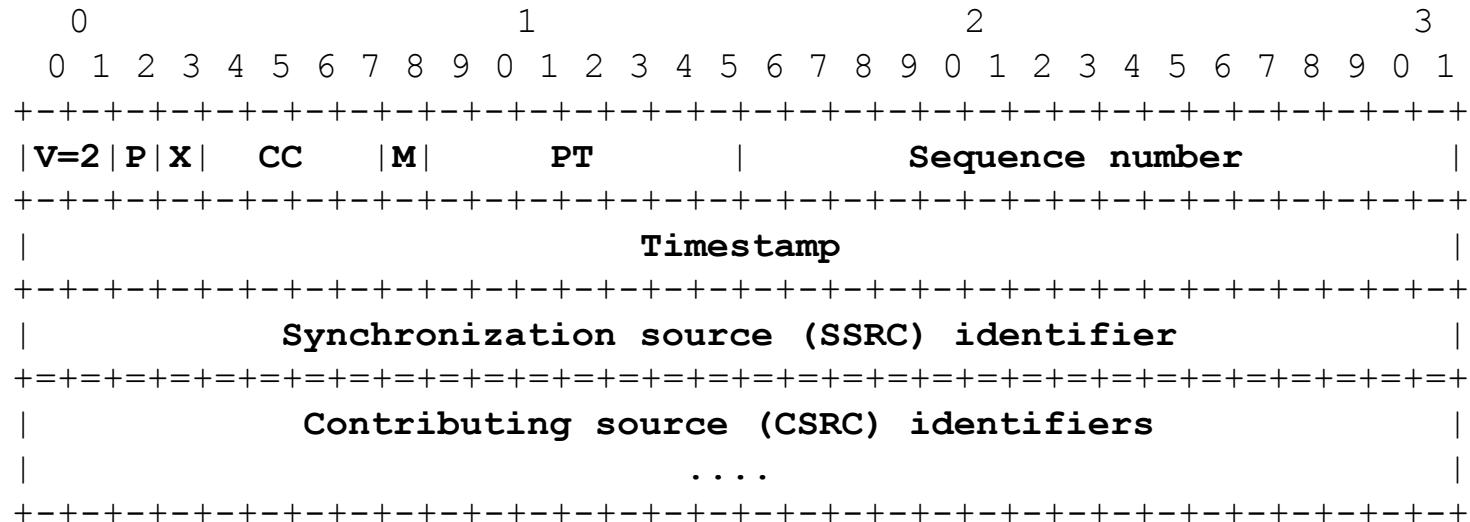
- M bit: Not used, set to 0
- PT: Two types are introduced in this document
  - Interleaved (column) and non-interleaved (row)
  - Requires IANA registration
- Sequence number: One higher for each subsequent packet
- Timestamp: Set to the time corresponding to the transmission time
- SSRC: Randomly assigned per RFC 3550
  - Sender can multiplex the source and repair flows on the same port, or multiple repair flows on a single port
  - RTCP CNAME field is used to associate the repair flows with the source flow

FEC Header

```
 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
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|E|I|P|X|  CC   |M| PT recovery |              SN base          |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                          TS recovery                          |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|        Length recovery        |             Padding           |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                       Padding (optional)                      |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```
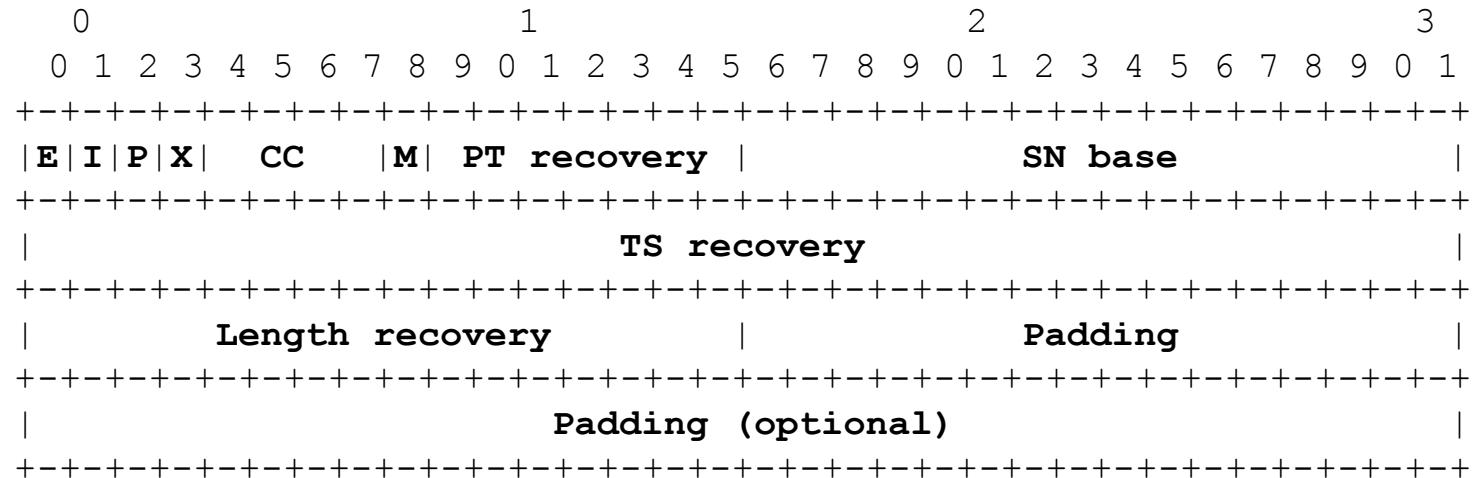
- E bit: Extension flag, set to 0. Reserved for future use

- I bit: Set to 0 for 2-byte padding, and 1 for 6-byte padding

- P, X, CC, M and PT: Protect the respective fields in the source packets

- SN base: Set to the lowest sequence number of those source packets protected by this repair packet

- TS recovery: Protects the timestamp of the source packets

- Length recovery: Allows FEC to be applied even when the lengths of the protected source packets are not identical

IANA Registrations

- We register the following for audio/video/text/application
  - non-interleaved-parityfec
  - interleaved-parityfec

- Required Parameters
  - rate: RTP timestamp (clock) rate
  - L: Number of columns of the source block
  - D: Number of rows of the source block
  - ToP: Type of the protection applied by the sender
    - 0 for 1-D interleaved FEC protection
    - 1 for 1-D non-interleaved FEC protection
    - 2 for 2-D parity FEC protection
    - 3 is reserved
  - repair-window (us): Time span of the source and repair packets

SDP Example

```
v=0
o=ali 1122334455 1122334466 IN IP4 fec.example.com
s=2-D Parity FEC Example
t=0 0
a=group:FEC S1 R1 R2
m=video 30000 RTP/AVP 100
c=IN IP4 224.1.1.1/127
a=rtpmap:100 MP2T/90000
a=mid:S1
m=application 30000 RTP/AVP 110
c=IN IP4 224.1.2.1/127
a=rtpmap:110 interleaved-parityfec/90000
a=fmtp:110 L:5; D:10; ToP:2; repair-window: 200000
a=mid:R1
m=application 30000 RTP/AVP 111
c=IN IP4 224.1.2.2/127
a=rtpmap:111 non-interleaved-parityfec/90000
a=fmtp:111 L:5; D:10; ToP:2; repair-window: 200000
a=mid:R2
```

Next Steps

- Work with SMPTE and complete this work