

## MAYAH Application Note 31

# Using Forward Error Correction

## 1. General description

Not all IP based connections are within trusted and well-managed networks. Many times – especially when using public networks - like the Internet - IP packets may be lost due to different causes, such as:

- routers discarding damaged packages (e.g. invalid checksum)
- an overload situation that causes a router to discard packages
- different packages of the same stream are routed differently – which may cause high latency and subsequently package loss.

Forward Error Correction (FEC) provides the possibility of error detection and/or correction by adding redundant data streams. Thereby retransmission or corruption of data can often be avoided at the cost of higher bandwidth needs and increased delay.

The FEC algorithm used by MAYAH is described in the “Pro-MPEG Code of Practice #3 release ([www.pro-mpeg.org](http://www.pro-mpeg.org)) based on RFC 2733 ([www.ietf.org/rfc/rfc2733.txt](http://www.ietf.org/rfc/rfc2733.txt)).

Opposed to other FEC schemes used for e.g. satellite transmissions this algorithm does not correct single bits inside an IP packet, but attempts to recreate the entire lost IP packet. This is essential for the use in IP based networks, since due to the nature of these networks a transport problem always leads to a complete loss of one or several successive packets (burst loss).

## 2. Technical description

FEC generates additional packets using matrixes. Every FEC matrix has got L columns and D rows to create additional packets, but with the following restrictions:

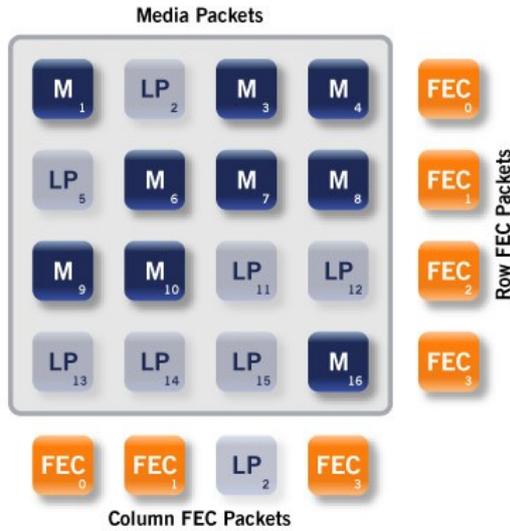
$$L \times D \leq 100$$

$$1 \leq L \leq 20$$

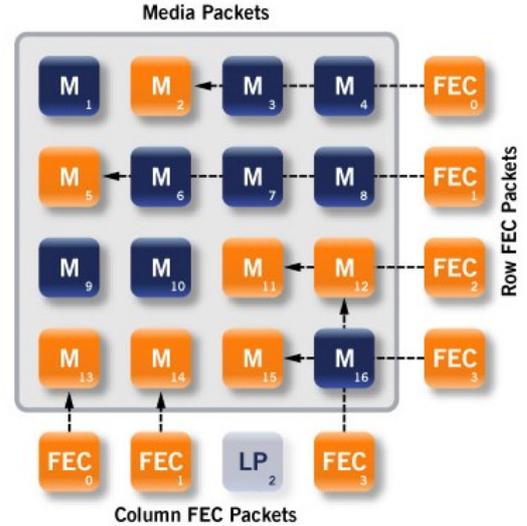
$$4 \leq D \leq 20$$

FEC packets are generated from RTP packets by a XOR (exclusive or) operation. Each FEC packet corresponds to one row or column.

The FEC packets are transmitted on dedicated ports in separate streams. There is always a stream for column FEC packets (2 ports above media port; usually port 5006), optional also row FEC packets can be sent (4 ports above media port; usually port 5008).



[Lost Packets at an RTP transmission using FEC (4,4) matrix]



[Recreation of lost packets in a FEC (4,4) Matrix:]

As you can see in the example above all lost RTP media packets could be rebuilt.

Generally all matrix sizes are possible. However, MAYAH has chosen to offer presets for FEC parameters for all typical scenarios. These are described in the diagram below.

Preset name	L	D	Mode	Overhead	Buffer size [bytes]	Latency[ms]			Recovery
						3Mbps	10Mbps	100Mbps	
lowestdelay	4	2	C	50%	10656	28,42	8,52	0,85	4
lowdelay	5	5	C	20%	33300	88,8	26,64	2,66	5
middledelay	10	4	C	25%	53280	142,08	42,62	4,26	10
lowbitrate	5	20	C	5%	133200	355,2	106,56	10,66	5
highsecurity	20	5	CR	25%	133200	355,2*	106,56*	10,66*	20+ **

[FEC Parameters presets]

\* Due to the nature of the decoding scheme for CR mode the actual latency will be significantly higher than the theoretical.

\*\* Due to the nature of the decoding scheme for CR mode the potential number of packets that can be recovered is much higher and depending on the pattern of which packets are lost.

**L,D**

Number of columns (L) and rows (D)

**Mode**

C: column FEC only

CR: column and row FEC

### Overhead

Overhead introduced by FEC

Example:

$L=4, D=2 \rightarrow$  matrix size = 8 packets  $\rightarrow$  4 column FEC packets generated and transmitted per matrix equals 50%

### Buffer size

In order to perform the FEC operation  $L \times D$  packets have to be retained in a buffer. The above table presumes that one media packet has a size of 1316 bytes. A FEC packet has the size of a media packet plus a special FEC header of 16 bytes:  $1316\text{bytes} + 16\text{ bytes} = 1332\text{ bytes}$ . A matrix size of  $4 \times 2 = 8$  corresponds thus to a buffer of  $8 \times 1332 = 10656\text{ bytes}$ .

### Latency

This shows what a given buffer size corresponds to at a certain line speed (3Mbps, 10Mbps, 100Mbps). ( $10656\text{bytes} \times 8 = 85248\text{ bits} / 3\text{ Mbps} = 0,02842\text{s} = 28,42\text{ms}$ )

**N.B.:** This is just the theoretical minimum latency. Encoding time, decoding time and decoding buffer are not evaluated. Especially in CR mode with certain patterns of packet loss the latency will be significantly higher.

### Recovery

The maximum number of IP-Packets that can be recovered. In CR mode this value is determined by the pattern of which packets are lost.

## 3. How to use FEC on MAYAH devices

FEC can currently be used with any RTP connection and is enabled via direct command.

### 3.1 with Direct Commands

The standard way of using FEC is via the `com_fecmode` command.

```
com_fecmode <param1>
```

Parameter:

Param1: [no, lowestdelay, lowdelay, middledelay, lowbitrate, highsecurity, ?]

This sets the default FEC mode for following connect commands. If used with the question mark parameter it queries the current status of FEC operation.

Also, the `com_connect` command can be extended by "`FEC:columnsXrows CR`", where columns and rows correspond to the desired numbers of columns and rows. Please note, that the restrictions described in Chapter 2 apply.

The parameter CR indicates a FEC with two FEC streams (one for column and one for row FEC packets). Alternatively C can be used to operate in column only FEC mode with one FEC stream.

Please note that sending FEC has to be enabled separately on each device - while receiving and decoding is done automatically. So if you want to use FEC on a bidirectional link for both directions each device has to be enabled individually.