Error Correction

On Trunk Links

Why bother with error correction?

Forward Error Correction (FEC) allows the receiver to detect and correct errors.

It can dramatically reduce the retry rate.

For example;

In a transmission with Maxframe 7 and paclen 255, there are 255 x 7 x 8 = 14280 bits.

Just 1 single bit error in this will cause up to 7 frames to be retried!
If the link is giving 1 error in every 10,000 bits, it won't work at all well with these parameters.

Better than 1 error in every 100,000 bits is required if you want to rattle data through like that.

How does FEC work?

Each FEC ‘block’ has, say, 7 bits

B1 B2 B3 B4 B5 B6 B7

There are 3 ‘parity’ bits and 4 data bits

P1 P2 D3 P4 D5 D6 D7

Number them, in binary of course!

1 0 1 0 1 0 1 - P1

0 1 1 0 0 1 1 - P2

0 0 0 1 1 1 1 - P4

Giving real values to the data bits…….

```
P1  P2  D3  P4  D5  D6  D7

x   x   1   x   0   0   1
```

Set even parity for P1, P2 and P4 counting only those data bits where there is a ‘1’ in the lines below…..

```
1   0   1   0   1   0   1 - P1  = 0
0   1   1   0   0   1   1 - P2  = 0
0   0   0   1   1   1   1 - P4  = 1
```

So the transmitted data stream is……

```
0   0   1   1   0   0   1
```

At the receiver...

An error occurred!

P1	P2	D3	P4	D5	D6	D7
0	0	1	1	1	0	1

Counting parity in the same way, but including the parity bits...

```
1  0  1  0  1  0  1 - P1 = 1

0  1  1  0  0  1  1 - P2 = 0

0  0  0  1  1  1  1 - P4 = 1
```

The result is the number of the bit with the error, i.e. bit 5.

You never get owt for nowt

When using FEC you need to send the parity bits, so the 'live' data rate is reduced.

In general terms, each FEC block can be 2^N-1 bits long.

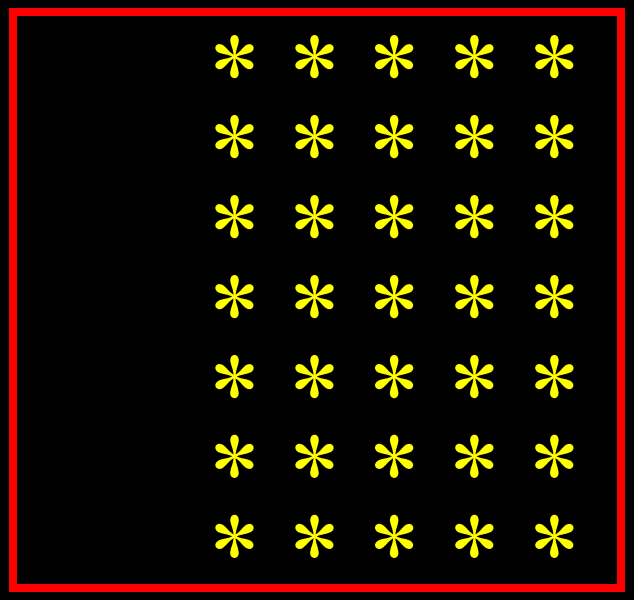
In each block there are 'N' parity bits and (2^N-1)-N data bits.

N	Block length	Parity bits	Data bits	Data rate
3	7	3	4	5486
4	15	4	11	7040
5	31	5	26	8052
6	63	6	57	8686
7	127	7	120	9071
8	255	8	247	9299

Interleaving

That's OK for single errors, but what about bursts of errors caused by ignition noise for instance? That can be allowed for by interleaving the data.

Load the data bits into a matrix row by row. Each row is a complete FEC block.

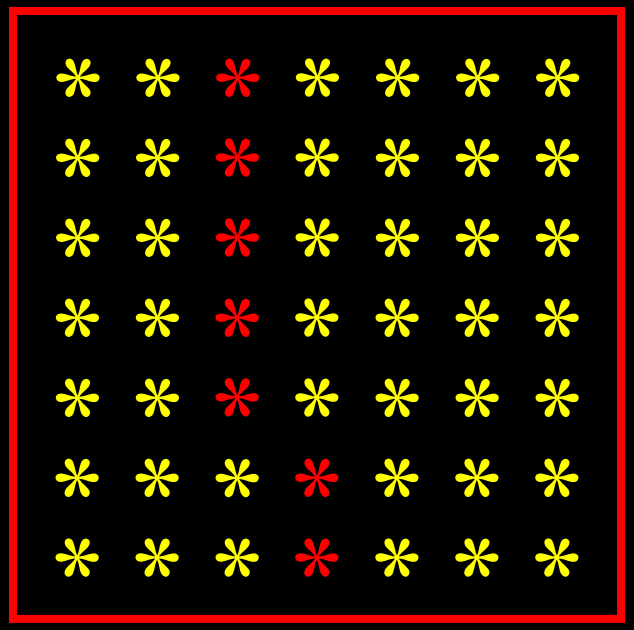


…etc!

Then transmit them column by column.

At the receiver...

Store the received bits in a matrix column by column.



Up to 7 bits can be missed and there will still be only one error in each FEC block when the bits are read out row by row.

Summing up

FEC can improve the performance of a moderate link so that larger packets can be used thus improving the efficiency of AX25.

However;

The actual data rate will be reduced.
There is a processing delay.

But;

Delays and reduced effective data rates caused by retries in AX25 will be significantly reduced.

FEC is not a cure for poorly engineered links or co-channel interference etc.