Variation of GCF Block Error Rate With Block Length

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Increasing the Ground Communications Facility (GCF) block length to 4800 bits from the present 1200 bits will no more than triple the error rate.

In the Error Control Study (Ref. 1) of the GCF, all numerical calculations were based on the current NASA-standard block length of 1200 bits for the GCF. Now that it is being contemplated to standardize all of NASA Communications system (NASCOM) for a block length of 4800 bits, it is important to know how much this change would affect the GCF error rate. This question will be answered here for both the 4800-bit/s high-speed and 50-kbit/s wideband data lines.

If the GCF errors were random instead of occurring in bursts, a percentage increase in block length would be accompanied by approximately the same percentage increase in the block error rate. So, for example, going from a block length of $n = 1200$ bits to a longer block of length $N = 4800$ bits would make the error rate approximately four times as great. It is not so with burst noise channels; while it is true that the block error rate still increases with block size, the error is no longer a linear function of the block length (see Ref. 1, pp. 166 and 173). For the same bit error rate (BER), the random error channel has a higher block rate, although the error blocks on a bursty channel contain a higher density of bit errors. This is why forward error correction coding alone (capable of correcting only a few bit errors or short bursts) is not effective in the GCF, thus making error correction by feedback retransmission method a must.

Table 1 shows the predicted block error rates for block sizes up to 6000 bits. For the 4800-bit/s data line, the expected block rate for 4800-bit blocks varies from twice (at the highest RED error mode) to (just) less than four times (at the GREEN mode) the present GCF error rate for the 1200-bit blocks. This means that changing to 4800-bit blocks would increase the block error rate to about 4×10^{-2} from the current 2 percent. The average rate would increase from 2.2×10^{-3} to about 7×10^{-3}. The increases are not as sharp in the 50-kbit/s data line, where the highest error rate is not expected to rise above 8×10^{-3}.

For comparison, these variations in rates are graphed for both the high-speed and wideband data lines. Table 2 contains the average performances in the RED, AMBER, and GREEN error modes.

Reference

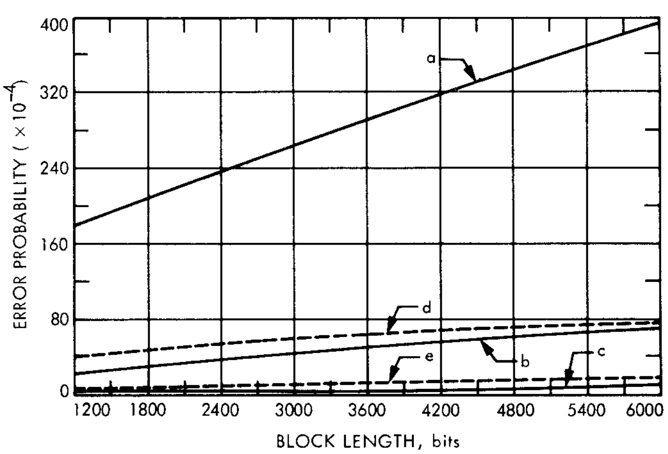
1. Adeyemi, O., *Error Control in the GCF: An Information-Theoretic Model for Error Analysis and Coding*, Technical Memorandum 33-699, Jet Propulsion Laboratory, Pasadena, Calif., October 1974.

Table 1. Error probability ($\times 10^{-4}$)

Block length, bits	Highest error (RED mode) BER = 5.06×10^{-4}	Overall average performance BER = 4.38×10^{-5}	GREEN mode BER = 1.89×10^{-6}
4800-bit/s data line			
1200	179.0	21.9	2.1
1800	208.0	29.3	3.0
2400	255.1	36.0	3.9
3000	262.1	42.5	4.8
3600	289.0	48.8	5.6
4200	315.7	55.0	6.5
4800	342.4	61.1	7.4
5400	369.1	67.3	8.2
6000	395.7	73.4	9.1
	BER = 2.42×10^{-4}	BER = 3.54×10^{-5}	
50-kbit/s data line			
1200	41.6	6.8	
1800	48.4	8.1	
2400	54.2	9.5	
3000	59.2	10.8	
3600	63.5	12.1	
4200	67.3	13.4	
4800	70.6	14.7	
5400	73.5	16.1	
6000	76.1	17.4	

Table 2. Error probability ($\times 10^{-4}$)

Block length, bits	Averaged RED group BER = 2.45×10^{-4}	Averaged AMBER group BER = 2.93×10^{-5}	Averaged GREEN group BER = 3.32×10^{-6}
48-bit/s data line			
1200	65.0	21.2	3.7
1800	76.8	30.7	5.6
2400	87.3	39.9	7.4
3000	97.6	48.8	9.2
3600	107.7	57.5	11.0
4200	117.8	65.9	12.9
4800	128.0	74.1	14.7
5400	138.1	82.0	16.5
6000	148.2	89.8	18.3



4800-bit/s DATA LINE (SOLID LINES)	a HIGHEST ERROR MODE	(BER = 5.06×10^{-4})
	b OVERALL AVERAGE PERFORMANCE	(BER = 4.38×10^{-5})
	c GREEN MODE	(BER = 1.9×10^{-6})
50-kbit/s DATA LINE (BROKEN LINES)	d HIGHEST ERROR MODE	(BER = 2.42×10^{-4})
	e OVERALL AVERAGE PERFORMANCE	(BER = 3.54×10^{-5})

Fig. 1. Variation of block error rate with block size