姚熙源 3190300677 计算机网络作业 3

1.The following character encoding is used in a data link protocol:

A: 01000111 B: 11100011 FLAG: 01111110 ESC: 11100000

Show the bit sequence transmitted(in binary) for the four-character frame A B ESC FLAG when each of the following framing methods is used:

(a) Byte count.

(b) Flag bytes with byte stuffing.

(c) Starting and ending flag bytes with bit stuffing.

Answer：

(a) (5byte)00000101 01000111 11100011 01111110 11100000
(b) 01111110 01000111 11100011 11100000 11100000 11100000 01111110 01111110
(c) 01111110 01000111 110100011 11100000 011111010 01111110

2. Hamming code is an effective way for error correcting. Show that the # of check bits(i.e. r) in the Hamming codes described in the textbook(e.g., Fig.3-6) (almost) achieves the low bound of Eq (3-1).

Answer：（m=7）

对于任意的 $0 < r < 4$，$(m + r + 1) \leqslant 2^r$ 不等式不成立，而对于任意 $r \geqslant 4$，不等式成立。由枚举得，当 r=1, r=2, r=3 时，分别得到 $9 \leqslant 2$，$10 \leqslant 4$，$11 \leqslant 8$，三个不等式均不成立，而当 $r \geqslant 4$ 时，需要证明$(8 + r) \leqslant 2^r$，设$\mathrm{f(r)} = 2^{\mathrm{r}} - r \geq 8$，求导得$\frac{\mathrm{df(r)}}{dr} = 2^r ln2 - 1 \geq 16ln2 - 1 > 0$。因此，f(r)在 $r \geqslant 4$ 时为单调递增函数，故 $f(r) \geqslant 16 - 4 = 12 \geqslant 8$ 成立，因此 r=4 是该不等式得下界（low bound），至少需要 4 位校验码（4 check bits）。

3. Suppose you have the following 12-bit message: 010100111111

(a) Numbering bits from right to left (ie least-significant bit on the right), insert check bits according to to Hamming's 1-bit error correction system. Indicate which bits are check bits and which are message bits.

(b) Hamming's scheme only corrects 1-bit errors. Since it' s a distance 3 code, it could also be used to detect 2-bit errors. Describe a 3-bit error (3 *1-bit errors) in the above codeword affecting only message bits (not check bits) that would be undetected (and of course uncorrected). Be sure to describe how and why the algorithm fails.

Answer：

(a) m = 12，由于$(m + r + 1) \leqslant 2^r$，∴得 $r \geqslant 5$，需要 5 位校验码。

位数	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
Value	0	P5	1	0	1	0	0	1	1	P4	1	1	1	P3	1	P2	P1

Checkbit									校验 结果
1	0	1	1	0	1	1	1	1	0
2	1	0	0	1	1	1	1		1
4	1	0	1	0	1	1	1		1
8	1	0	1	0	0	1	1		0
16	0								0

Final result:

位数	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
Value	0	0	1	0	1	0	0	1	1	0	1	1	1	1	1	1	0

Checkbit : 00110 , Message bit : 0101 0011 1111

(b) 将第 7、10、13 位发转，变为 0，因为 D7 xor D10 xor D13 = 0，所以不影响结果，因此该错误不会被检测到

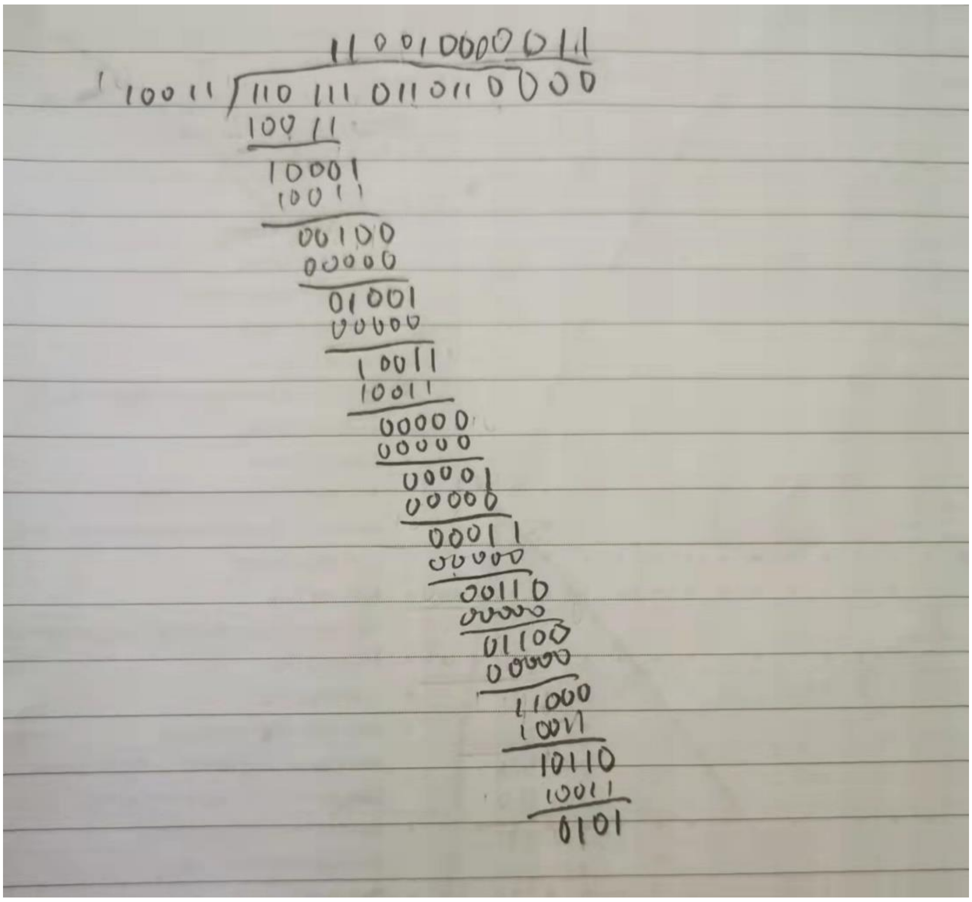
位数\Checkbits	16	8	4	2	1
7	0	0	1	1	1
10	0	1	0	1	0
13	0	1	1	0	1
xor	0	0	0	0	0

4.Consider an original frame 110111011011. The generator polynomial x4+x+1, show the converted frame after appending the CRC.

Answer :

110111011011 mod 10011 = 0101

$\therefore$ after appending the CRC, result is $1101110110110000 + 0101 = 1101110110110101$



5.A 3000-km-long T1 trunk (with data rate 1.536Mbps) is used to transmit 64-byte frames. How many bits should the sequence numbers be for protocol 5 and protocol 6 respectively? The propagation speed is 6usec/km.

Answer：

线路传输时间 $t_{prop} = 3000 * 6 = 18000\mu sec = 18ms$

传输或接收 64byte 帧得时间$\frac{64*8}{1.536M} = 0.33\text{ms}$

从发第一帧到接收第一帧得总时间位$18\text{ms} * 2 + 0.33\text{ms} = 36.33\text{ms}$. 所以缓存区应该能够容纳 36.33ms 所发送的帧的数量，即$\frac{36.33}{0.33} = 110 frames$

对于 protocol 5 而言，需要$\log_2 110 = 7bits$

对于 protocol 6 而言，需要$\frac{\text{MAX}_{\text{SEQ}}+1}{2} = 110$，*需要*$\log_2 220 = 8bits$

6.Frames of 1000 bits are sent over a 1-Mbps channel using a geostationary satellite whose propagation time from the earth is 270msec. Acknowledgements are always piggybacked onto data frames. The headers are very short. Three-bit sequence numbers are used.

What is the maximum achievable channel utilization for

(a) Stop-and-wait?

(b) Protocol 5?

(c) Protocol 6?

Answer :

Let t = 0 as the start of transmission, at t = 1msec, the first frame has been transmitted. At t=271msec, the first frame arrived, at t = 272msec, the frame acknowledged and has been sent. At t = 542msec, the acknowledged frame has arrived. Thus, the cycle is 542msec. A total of k frames are sent in 542msec, for utilization of k/542.

(a) k = 1, utilization = 1/542 = 0.18%
(b) k = 7 frames (3 bit sequence number) utilization $\mathrm{u} = \frac{7}{542} = 1.29\%$
(c) k = 4 frames(max sequence + 1 / 2, 3+1/2 = 2) utilization $\mathrm{u} = \frac{4}{545} = 0.74\%$