CS 204 : Computer Networks
Assignment – 04
Roll no. 180010011

1. With pure ALOHA, the usable bandwidth is .184 x 56 = 10.3 kbps.
Each station requires 10 bps, so N = 10300/10 = 1030 stations.

2. With pure ALOHA transmissions can start instantly. With slotted ALOHA, it hast to wait for the next slot. This introduces half a slot time delay on average.

3. $E(p) = Np\ (1 - p)^{N-1}$
$E'(p) = N(1-p)^{\ N-1} - Np(N-1)(1-p)^{N-2}$
$= N(1-p)\ N-2((1-p)-p(N-1))$
$= 0$
Therefore, $p^* = 1/N$
$E(p^*) = N(1/N)\ (1 - 1/N)^{N-1}$
$= (1-1/N)^{N-1}$
$= (1-1/N)N/(1-1/N)$
Since $(1 - 1/N)N = 1/e$ as N approaches infinity,
$E(p^*) = 1/e$

4. $E(p) = Np(1 - p)^{2(N-1)}$
$E'(p) = N(1-p)^{2(N-2)} - N\ p2(N - 1)(1-p)^{2(N-3)}$
$= N(1-p)^{2(N-3)}((1-p)-p2(N-1))$
$= 0$
Therefore, $p^* = 1/(2N - 1)$
$E(p^*) = (N/(2N - 1))\ (1 - 1/(2N - 1))2(N-1)$
$\text{Lim}_{\ N\text{-> infinity}} E(p*) = 1/2 \cdot 1/e = 1/2e$

5. Formula for slotted ALOHA is $E(p) = Np\ (1 - p)^{N-1}$
Formula for pure ALOHA is $E(p) = Np\ (1 - p)^{2(N-1)}$

Question 5

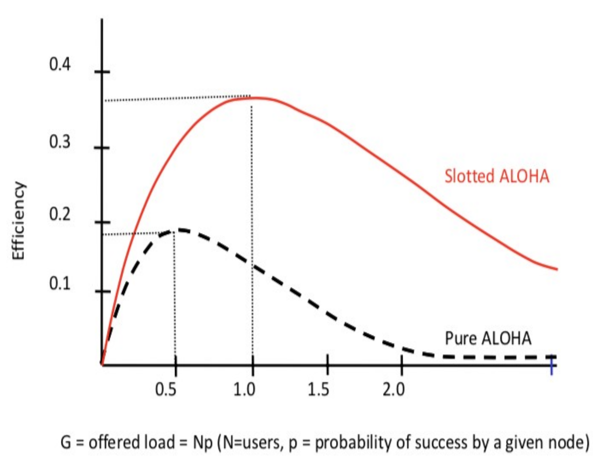

Figure 2: Performance of ALOHA and Slotted ALOHA

For Pure ALOHA at N = 15:
1) Max efficiency occurs at P = 1/29
2) Efficiency increases from 0 to 1/29 and decreases from 1/29 to 1
3) Graph is concave from 0 to 2/29 and convex from 2/29 to 1
4) Max efficiency is 0.19363

For Slotted ALOHA at N = 15:
1) Max efficiency occurs at P = 1/15
2) Efficiency increases from 0 to 1/15 and decreases from 1/15 to 1
3) Graph is concave from 0 to 2/15 and convex from 2/15 to 1
4) Max efficiency is 0.38

For Pure ALOHA at N = 25:
1) Max efficiency occurs at P = 1/49
2) Efficiency increases from 0 to 1/49 and decreases from 1/49 to 1
3) Graph is concave from 0 to 2/49 and convex from 2/29 to 1
4) Max efficiency is 0.18963

For Slotted ALOHA at N = 25:
1) Max efficiency occurs at P = 1/25
2) Efficiency increases from 0 to 1/25 and decreases from 1/25 to 1
3) Graph is concave from 0 to 2/25 and convex from 2/15 to 1
4) Max efficiency is 0.37541

For Pure ALOHA at N = 35:
1) Max efficiency occurs at P = 1/69
2) Efficiency increases from 0 to 1/69 and decreases from 1/69 to 1
3) Graph is concave from 0 to 2/69 and convex from 2/69 to 1
4) Max efficiency is 0.18797

For Slotted ALOHA at N = 35:
1) Max efficiency occurs at P = 1/35
2) Efficiency increases from 0 to 1/35 and decreases from 1/35 to 1
3) Graph is concave from 0 to 2/35 and convex from 2/35 to 1
4) Max efficiency is 0.3732241

6. Given K = 4
In CSMA/CD, after the fifth collision, that means $\{0,1,2,. . . ,2^5 - 1\}$ i.e from 0 to 31.
p(k = 4) = 1/32
∴ The probability that a node chooses k value as 4 is 1/32=0.03125.
Network speed = 10 Mbps;
Bit time = 0.1 ms;
Delay = k*512*bit time
= 4 * 512 * 0.1ms
= 204.8ms

7. Given Data (D) = 10110
Generator (G) = 1001
Since r = 3, append 3 0 bits to D
Resulting Bit stream (B) = 10110000 Remainder we get after binary binary division(B/G, XOR operation) = 100
∴ CRC bits (R) = 0100
Final message sent (B) = 10110100

8. Given Data (D) = 1010101010
Generator (G) = 10011
No. of bits in G = 5
Since r = 4, append 4 0 bits to D
Resulting Bit stream (B) = 10101010100000 Remainder we get after binary binary division(B/G, XOR operation) = 0100
CRC bits (R) = 0100

9. Generator (G) = 10011
No. of bits in G = 5
r = 4

a) Given Data (D) = 1001010101
As r = 4, add 4 zero bits to end of D
Resulting bit stream (B) = 10010101010000
Remainder we get after binary division of B with G (XOR operation) = 0000
CRC bits (R) = 0000

b) Given Data (D) = 0101101010
As r = 4, add 4 zero bits to end of D
Resulting bit stream (B) = 01011010100000
Remainder we get after binary division of B with G (XOR operation) = 1111
CRC bits (R) = 1111

c) Given Data (D) = 1010100000
As r = 4, add 4 zero bits to end of D
Resulting bit stream (B) = 10101000000000
Remainder we get after binary division of B with G (XOR operation) = 1001
CRC bits (R) = 1001

10. The minimum length checksum field should be 4*4 matrix. For our data, two dimensional (even) parity:

					parity bit
	1	1	1	0	1
	0	1	1	0	0
	1	0	0	1	0
	1	1	0	1	1
parity bit	1	1	0	0	0

Note: Two-dim Parity = Generalization of the simple (one-dim) parity scheme:
1. Form an MxN matrix of bits, then
2. Add a (even or odd) parity bit to each row and to each column

11. Suppose we begin with the initial two-dimensional parity matrix:

0	0	0	0
1	1	1	1
0	1	0	1
1	0	1	0

With a bit error in row 2, column 3, the parity of row 2 and column 3 is now wrong in the matrix below:

0	0	0	0
1	1	0	1
0	1	0	1
1	0	1	0

Now suppose there is a bit error in row 2, column 2 and column 3. The parity of row 2 is now correct! The parity of columns 2 and 3 is wrong, but we can't detect in which rows the error occurred!

0	0	0	0
1	0	0	1
0	1	0	1
1	0	1	0

The above example shows that a double bit error can be detected (if not corrected).