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**ĐÁP ÁN ÔN TẬP ĐỀ PE
NWC203c FALL 2021 SV
PHẢI LÀM TỪNG
BƯỚC ĐẾN KẾT QUẢ**

(<https://kaymid.notion.site/Gi-i-th-c-h-nh-b419cf5442fa43af9be4bfa492c7d1f7>)

1. Suppose two hosts, A and B, are separated by 30,000 kilometers and are connected by a direct link of $R = 3$ Mbps. Suppose the propagation speed over the link is 2.5×10^8 meters/sec.

a. Calculate the bandwidth-delay product, $R \cdot d_{\text{prop}}$.

b. Consider sending a file of 900,000 bits from Host A to Host B. Suppose the file is sent continuously as one large message. What is the maximum number of bits that will be in the link at any given time?



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Transmission rate(R) of the direct link between A and B = 3Mbps

Change to bps: $3 * 10^6$ bps (1 Mbps = 10^6 bps)

Propagation Speed(S) of the link between A and B : $2.5 * 10^8$ meters/sec

Calculate the propagation delay:

$$d_{\text{prog}} = \frac{\text{Distance}}{\text{Speed}} = \frac{3 * 10^7}{2.5 * 10^8} = 0.12 \text{sec}$$

Calculate the band-width delay product:

$$R * d_{\text{prog}} = 3 * 10^6 * 0.12 = 36 * 10^4 \text{bits}$$

Therefore, band-width delay product is 360000 bits

- b. Size of the file = 900000 bits ($9 * 10^5$)

Transmission rate(R) of the direct link between A and B = 3Mbps

Change to bps: $3 * 10^6$ bps (1 Mbps = 10^6 bps)

The band-width delay product:

$$R * d_{\text{prog}} = 3 * 10^6 * 0.12 = 36 * 10^4 \text{bits}$$

Therefore, the maximum number of bits at a given time will be 360000bits.

2. Let $g(x) = x^3 + x + 1$. Consider the information sequence 1001. Find the codeword corresponding to the preceding information sequence. Using polynomial arithmetic we obtain

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Step 1: add 000 to data string we have 1001000 because the highest degree of x in $g(x)$ is 3

Step 2: $1001000 \bmod 1011$

\\ chuyển về dạng đa thức để chia cho đa

$x^6 + x^3$ chia cho $x^3 + x + 1$

Lay du

Kết quả = $x^6 + x^3$ + phần dư (chuyển qua 1001...)

3. A packet switch receives a packet and determines the outbound link to which the packet should be forwarded. When the packet arrives, one other packet is halfway done being transmitted on this outbound link and four other packets are waiting to be transmitted. Packets are transmitted in order of arrival.

Suppose all packets are 2,500 bytes and the link rate is 3 Mbps. What is the queuing delay for the packet? More generally, what is the queuing delay when all packets have length L , the transmission rate is R , x bits of the currently-being transmitted packet have been transmitted, and n packets are already in the queue?

Note:

$L = 2500 \text{ bytes} = 20000 \text{ bits}$

$R = 3 \text{ Mbps} = 3 \cdot 10^6 \text{ bps}$

$x = L/2 = 10000 \text{ bits}$

$N = 4$

Formula

$(n \cdot L + (L - x)) / R = 0.03$





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for this code

Solution:

(4)

Given,

=>16-bit words

=>Four 16-bit words = (11111111 11111110, 11111111 00000000, 11110000 11110000, 11000000 11000001)

Explanation:

Calculating internet checksum:

Step 1:

=>Summing all the four 16-bit words

=>Summation = 1111111111111110 + 1111111100000000 + 1111000011110000 + 1100000011000001

=>Summation = 111011000010101111

Step 2:

=>Summation contains 18 bits so wrapping around extra 2 bits

=>Wrapped summation = 1011000010101111 + 11

=>Wrapped summation = 1011000010110010

Step 3:

=>Taking the 1's complement of wrapped summation

=>Internet checksum = 1's complement of wrapped summation

=>Internet checksum = 1's complement of 1011000010110010

=>Internet checksum = 0100111101001101

=>Internet checksum = 01001111 01001101

I have explained each and every part with the help of statements attached to the answer above.

5. Consider a packet of length 2,000 bytes that propagates over a link of distance 3,500 km with propagation speed of $2.5 \cdot 10^8$ m/s, and transmission rate 2 Mbps?

a. How long does the packet propagation take?

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Ở phút 1:32:00 : Câu này có chút nhầm lẫn trong bài chữa và video chữa của thầy, cụ thể là ở câu a. Trong bài chữa, thầy để rằng thời gian để truyền gói tin đã được tính là $3500 \times 10^3 \text{m} / 2.5 \times 10^8$. Tức là ý nói thời gian truyền thì bằng độ dài quãng đường chia cho vận tốc truyền. Tuy nhiên, đây là cách hiểu thiếu. Công thức trên thì chỉ dùng để tính propagation delay. Thời gian để truyền gói tin cần phải cộng thêm với transmission delay nữa. Mà transmission delay thì = Length / Transmission rate. Tức là = $2000 \times 8 / (2 \times 10^6) = 0.008 \text{s} = 8 \text{ms}$ (Cần phải đổi ra bit nhé. Lưu ý rằng 2Mbps tức là 2 Megabit per second mà 1 Mb = 1.000.000 bits) Vậy thì ta có bài giải như sau:
 Transmission delay = 8ms
 Propagation delay = $(3500 \times 10^3 / (2.5 \times 10^8)) = 0.014 = 14 \text{ms}$
 Vậy total time = 14ms + 8ms = 22ms.

Solution:- Here, given that

$$\text{Length of packet (L)} = 2000 \text{ byte}$$

$$= 2000 \times 8 \text{ bit}$$

$$= 16,000 \text{ bit}$$

$$\text{distance (d)} = 3500 \text{ km} = 3500 \times 10^3 \text{ m}$$

$$\text{propagation speed (v)} = 2.5 \times 10^8 \text{ m/s}$$

$$\text{Transmission rate (BW)} = 2 \text{ mbps} = 2 \times 10^6 \text{ bps.}$$

Now,

$$(a) \text{ propagation delay (T}_p\text{)} = \frac{\text{distance (d)}}{\text{propagation speed}}$$

$$= \frac{3500 \times 10^3 \text{ m}}{2.5 \times 10^8 \text{ m/s}}$$

$$= \frac{35 \times 10^{-3} \text{ s}}{2.5}$$

$$= 14 \times 10^{-3} \text{ s}$$

$$= 14 \text{ msec}$$

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(b) NO, this propagation delay does not depends on packet length, because here we have used propagation delay formula $T_p = \frac{d}{v}$ where T_p depends on length of link and speed.

(c) NO, This is because propagation delay depends on distance between two routers and its velocity/speed but it does not depend on length of packet or the transmission link.

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$= 16,000 \text{ bit}$

distance (d) = $3500 \text{ km} = 3500 \times 10^3 \text{ m}$

propagation speed (v) = $2.5 \times 10^8 \text{ m/s}$

Transmission rate (BW) = $2 \text{ mbps} = 2 \times 10^6 \text{ bps}$.

Now,

(a) propagation delay (T_p) = $\frac{\text{distance } (d)}{\text{propagation speed}}$

$$= \frac{3500 \times 10^3 \text{ m}}{2.5 \times 10^8 \text{ m/s}}$$

$$= \frac{35}{2.5} \times 10^{-3} \text{ s}$$

$$= 14 \times 10^{-3} \text{ s}$$

$$= 14 \text{ msec}$$

Hence, the packets takes 14 msec for their propagation.

(b) No, this propagation delay does not depends on packet length, because here we have used propagation delay formula $T_p = \frac{d}{v}$ where T_p depends on length of link and speed.

(c) No, This is because propagation delay depends on distance between two routers and its velocity/speed but it does not depend on length of packet or the transmission link.

6. A router has the following

CIDR entries in its routing

table: Address/mask Next hop

135.46.56.0/22 Interface 0

135.46.60.0/22 Interface 1

192.53.40.0 /23 Router 1

default Router 2

(a) What does the router do if a packet with an IP address 135.46.63.10



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135.46.56.0/22

135.46.60.0/22

192.53.40.0/23

Format is Address/Mask

So /Mask determines number of bits of 1's in subnet mask.

Let us find the subnet mask in octet representation :

For /22, the first 22 bits will be 1 followed by 0

So

11111111.11111111.11111100.00000000

which is 255.255.252.0

For /23, the first 23 bits will be 1 followed by 0

So

11111111.11111111.11111110.00000000

which is 255.255.254.0

So our routing table now looks like :

Address	Mask	Next Hop
135.46.56.0	255.255.252.0	Interface 0
135.46.60.0	255.255.252.0	Interface 1
192.53.40.0	255.255.254.0	Router 1
Default	0.0.0.0 (default subnet mask)	Router 2

part a.

IP address arrives at the router 135.46.63.10.

We have to determine as per the routing table where the router forwards this packet to.

So we perform ANDing of this IP address with the subnet masks in the table.

If there is a match with the address in the table, the packet is forwarded to the next hop in the table.

In case of multiple match, the packet is forwarded to the next hop having the longest subnet mask.

In case of no match, follow the default route.

So performing

135.46.63.10 AND 255.255.252.0

we have :

10000111.00101110.00111111.00001010

11111111.11111111.11111100.00000000



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It does not match the first row of the routing table but matches with the second row of the routing table.

But we have to check by ANDing with the third row subnet mask as well.

So performing

135.46.63.10 AND 255.255.254.0
we have :

10000111.00101110.00111111.00001010

11111111.11111111.11111110.00000000

10000111.00101110.00111110.00000000

which is : **135.46.62.0**

But this does not match with the third row in the routing table.

Only match found is : Row 2 which is 135.46.60.0

Hence the packet is forwarded to Interface 1 part b.

IP address arrives at the router 135.46.57.14

So firstly,

135.46.57.14 AND 255.255.252.0, we have :

10000111.00101110.00111001.00001110

11111111.11111111.11111100.00000000

10000111.00101110.00111000.00000000

which is : 135.46.56.0 (Matches with first row)

Now check with subnet mask 255.255.254.0

135.46.57.14 AND 255.255.254.0, we have :

10000111.00101110.00111001.00001110

11111111.11111111.11111110.00000000

10000111.00101110.00111000.00000000

which is : 135.46.56.0 (It is not matching with third row)

So the only match is first row.

Hence packet is forwarded to Interface 0



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A to Host B has three links, of rates $R_1 = 250$ kbps, $R_2 = 3$ Mbps, and $R_3 = 2$ Mbps.

- a. Assuming no other traffic in the network, what is the throughput for the file transfer?
- b. Suppose the file is 4 million bytes. Dividing the file size by the throughput, roughly how long will it take to transfer the file to Host B?

Ans : (a) Throughput is limited by the minimum of capacity of the links .Here , minimum is R_1 .So throughput is 250 kbps.

(b) Dividing the size of the file by the throughput to get approximate time to transfer to host B :-

$$t = (4 \times 1000000 \times 8) / (250 \times 1000) \text{ . } \{ 1 \text{ mb} = 8 \text{ million bit } \}$$

$$= 128 \text{ sec.}$$

8. Suppose an application layer entity wants to send an L -byte message to its peer process, using an existing TCP connection. The TCP segment consists of the message plus 20 bytes of header. The segment is encapsulated into an IP packet that has an additional 20 bytes of header. The IP packet in turn goes inside an Ethernet frame that has 18 bytes of header and trailer. What percentage of the transmitted bits in the physical layer correspond to message information, if $L = 200$ bytes, 1000 bytes, 2000 bytes

The IP packet in turn goes inside an Ethernet frame that has 18 bytes of header and trailer.

The packet in turn goes inside an Ethernet frame that has 18 bytes of header and trailer.

TCP/IP over Ethernet allows data frames with a payload size up to 1460 bytes.

Therefore, $L = 200, 1000$ are within this limit.

The message overhead includes:

TCP: 20 bytes of header

IP: 20 bytes of header

Ethernet: total 18 bytes of header and trailer.

Therefore

$$L = 200 \text{ bytes, } 200/258 = 77.5\% \text{ efficiency.}$$

$$L = 1000 \text{ bytes, } 1000/1058 = 94.5\% \text{ efficiency.}$$

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is 1 megabyte

- a. How long does it take to download the file over a 35 kilobit/second modem?
- b. How long does it take to take to download the file over a 1 megabit/second modem?
- c. Suppose data compression is applied to the text file. How much do the transmission times in parts (a) and (b) change?

If we assume a maximum compression ratio of 1:6, then we have the following times for the 35 kilobit and 1 megabit lines respectively:

Cách 1 :

Handwritten calculations for download times:

a) $T_{35k} = \frac{8(1024)(1024)}{35000} = 239.67 \text{ sec.}$

b) $T_{1M} = \frac{8 \times 1024 \times 1024 \text{ bits}}{1 \times 10^6 \text{ bits/sec.}} = 8.39 \text{ sec.}$

c) If we assume maximum ratio of 1:6, then we have the following times for the 35 kilobit and 1 megabit lines respectively.

$T_{35k} = \frac{8 \times 1024 \times 1024}{35000 \times 6} = 39.946 \text{ sec.}$

$T_{1M} = \frac{8 \times 1024 \times 1024}{1 \times 10^6 \times 6} = 1.398 \text{ sec.}$

Cách 2 :

$$T = L/R$$

$$a) (1024 \times 1024 \times 8) / (35 \times 10^3) = 239.6745s$$

$$b) 8.389s \text{ (tuong tu cau a)}$$

$$c) T_{35kb} = 8 \times 1024 \times 1024 / (35 \times 10^3 \times 6) =$$

$$T_{1mb} = 8 \times 1024 \times 1024 / (10^6 \times 6)$$

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station A arrives at station B, requesting a TCP connection. Explain how the three-way handshake procedure ensures that the connection is rejected.

(b) Now suppose that an old SYN segment from station A arrives at station B, followed a bit later by an old ACK segment from A to a SYN segment from B. Is this connection request also rejected?

In three-way handshake, there are three messages transmitted by TCP to establish connection between computer.

1. SYN: Client sets the segment sequence number to a random value (say X) and send SYN message to server.
2. SYN-ACK: Server sends SYN-ACK in response to client. Set acknowledgment number to one more than the received sequence number (X+1) and sequence number of the packet to another random value (say Y)
3. ACK- Finally, Client sends an ACK back to the server and set sequence number to the received acknowledgment number (X+1) and acknowledgment number to one more than received sequence number (Y+1).

In this process, one must ensure that first sequence number(i.e. X) is always unique.

Now, if station B receives an old SYN segment from station A, station B will acknowledge request based on old sequence number and send acknowledgment to station A by adding one more to the received old sequence number. A will find out that B had received wrong sequence number. Hence, A will discard the acknowledgment and reject the connection.

Yes, the connection will get rejected if an old SYN segment from station A arrives at station B followed a bit later by an old ACK segment from A to a SYN segment from B. Initially when B receives an old SYN segment from A, B will send a SYN segment with its own unique sequence number. Now, if B receives an old ACK from A, B will identify that the old ACK sequence number does not match with the sequence number sent by B previously and notify A that the connection is invalid. That is why the connection will be rejected.

11. Sender A wants to send 100111010011110 to receiver B. This transmission uses CRC algorithm for error detection with generator polynomial bits string is 10110. What is bits string will be transmitted on the medium. Show your all steps to have result.



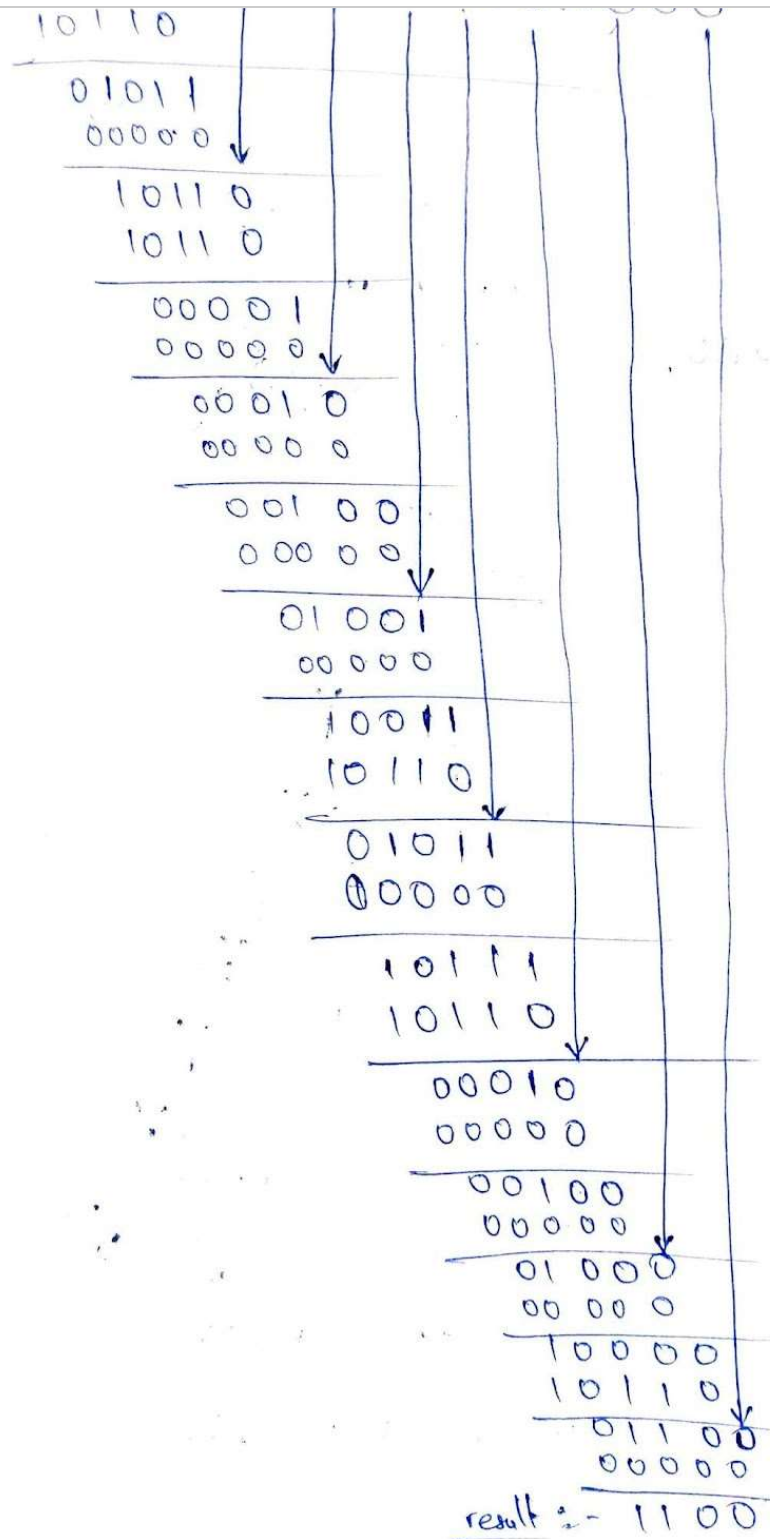
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The data to be transmitted from sender A
to receiver B is 10011101001110
Generator Polynomial bits string is '10110'.

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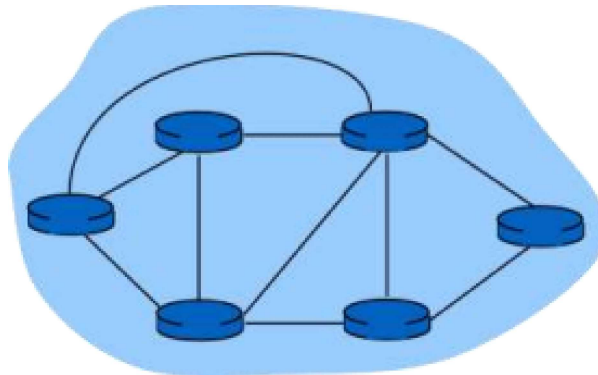
hence forms the code-word to be sent to the receiver.

$$\begin{array}{r} \text{ie. } 100111010011100000 \\ + \quad \quad \quad 1100 \\ \hline 100111010011101100 \end{array}$$

The bit string that will be transmitted on the medium is 100111010011101100.

12. Consider the following network Figure 1. With the indicated link costs, use Dijkstra's shortest-path algorithm to compute the shortest path from u to all network nodes. Show how the algorithm works by computing a table.

5



2 v 3 w 5
u 2 4 z
14



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Figure 1

13. Let $g_1(x) = x + 1$ and let $g_2(x) = x^3 + x^2 + 1$. Consider the information bits $(1, 1, 0, 1, 1, 1)$.

- a. Find the codeword corresponding to these information bits if $g_1(x)$ is used as the generating polynomial.
- b. Find the codeword corresponding to these information bits if $g_2(x)$ is used as the generating polynomial.

In polynomial form:

$$x^6 + x^5 + x^3 + x^2 + 1$$

(a) Generating Polynomial:
 $g_1(x) = x + 1$

Binary rep = (1, 1)

Code word = $x^{n-k} i(x) + r(x)$

$\left. \begin{array}{l} \text{Highest power} \\ \text{variable of generating} \\ \text{function} \end{array} \right\}$ information variable.

Here,

$$x^{n-k} = x$$

$$i(x) = x^6 + x^5 + x^3 + x^2 + 1$$

NOW,

Divide $\frac{i(x) \times x^{n-k}}{g_1(x)}$

remainder

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$$\begin{array}{r}
 x^4 + x^3 \\
 \underline{x^4 + x^3} \\
 x^4 + x^3 - x^4 - x^3 \\
 \hline
 x + 1
 \end{array}$$

remainder

Now :

$$\begin{aligned}
 \text{codeword} &= x \cdot i(x) + \text{remainder} \\
 &= x^7 + x^6 + x^4 + x^3 + x + 1 \\
 &= (1, 1, 0, 1, 1, 0, 1, 1)
 \end{aligned}$$

Ans

Thus:

$$\text{Code word} = x^3 * i(x) + \text{remainder}$$

information bits

$$\therefore x^3 * i(x) = x^3 * (x^6 + x^5 + x^3 + x^2 + 1)$$

$$= x^9 + x^8 + x^6 + x^5 + x^3$$

Now,

$$\begin{array}{r}
x^6 + x^2 + x \\
x^3 + x^2 + 1 \overline{) x^9 + x^8 + x^6 + x^5 + x^3} \\
\underline{x^9 + x^8 + x^6} \\
x^5 + x^3 \\
\underline{x^5 + x^4} \\
x^4 + x^3 + x^2 \\
\underline{x^4 + x^3} \\
x^2 + x \\
\underline{x^2 + x} \\
0
\end{array}$$

remainder

$$\text{Code word} = x^3 * i(x) + \text{remainder}$$

$$= x^9 + x^8 + x^6 + x^5 + x^3 + x^2 + x$$

$$= (1, 1, 0, 1, 1, 0, 1, 1, 0)$$

Ans

14. Consider the 7-bit generator, $G=10111$, and suppose that D has the value 1010100001. What is the value of R ? Show your all steps to have result.

Given,

$G=10111$

$D=1010100001$



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After dividing D with G we get remainder 1111

so, $r = 1111$