Computer Network Homework 1

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1.

For a), **transport layer** provides reliable, connection-oriented path through flow control, segmentation/desegmentation, and error control.

For b), **data link layer** is responsible for medium access control. It handles wireless channel access control, determining which user has access to the shared media.

For c), **data link layer** has the function of framing, i.e. encapsulating packets into frames, adding header and trailer information.

For d), **network layer** handles logical addressing and routing, determining the routing path and the appropriate outgoing interface for IP datagrams.

2.

a)

ASK: Amplitude Shifted Keying,

FSK: Frequency Shifted Keying,

PSK: Phase Shifted Keying,

QAM: Quadrature Amplitude Modulation

b)

Low Earth Orbit (LEO) satellites

Medium Earth Orbit (MEO) satellites

Geosynchronous Earth Orbit (GEO) satellites

c)

Twisted Pair

Coaxial Cable

Fiber Optic

d)

FDM: Frequency Division Multiplexing,

TDM: Time Division Multiplexing,

WDM: Wavelength Division Multiplexing,

CDM: Code Division Multiplexing,

3.

Not always. There are several reasons.

- When the network is congested, queuing delays will be higher in packet switching, it may not perfor better than circuit switching in the same system.
- In packet switching, each packet needs to be processed at each node, which increases end-to-end delay compared to circuit switching.
- In packet switching, each packet may encounter queuing delay as they wait for being transmitted at each node, which increases end-to-end delay compared to circuit switching.

4. 12, 8.45%, 0.149

a)

$6Mbps/500Kbps = 12$

Thus at most 12 users can be hosted.

b)

$$\begin{aligned} P(overload) &= P(N > 12) \\ &= 1 - P(N \leq 12) \\ &= 1 - BinomialCDF(12, 30, 0.3) \\ &= 8.45\% \end{aligned} \tag{1}$$

c)

According to *Shannon's Theory*,

$30MHZ \times \log_2(1 + SNR) \geq 6Mbps$

$SNR \geq 0.149$

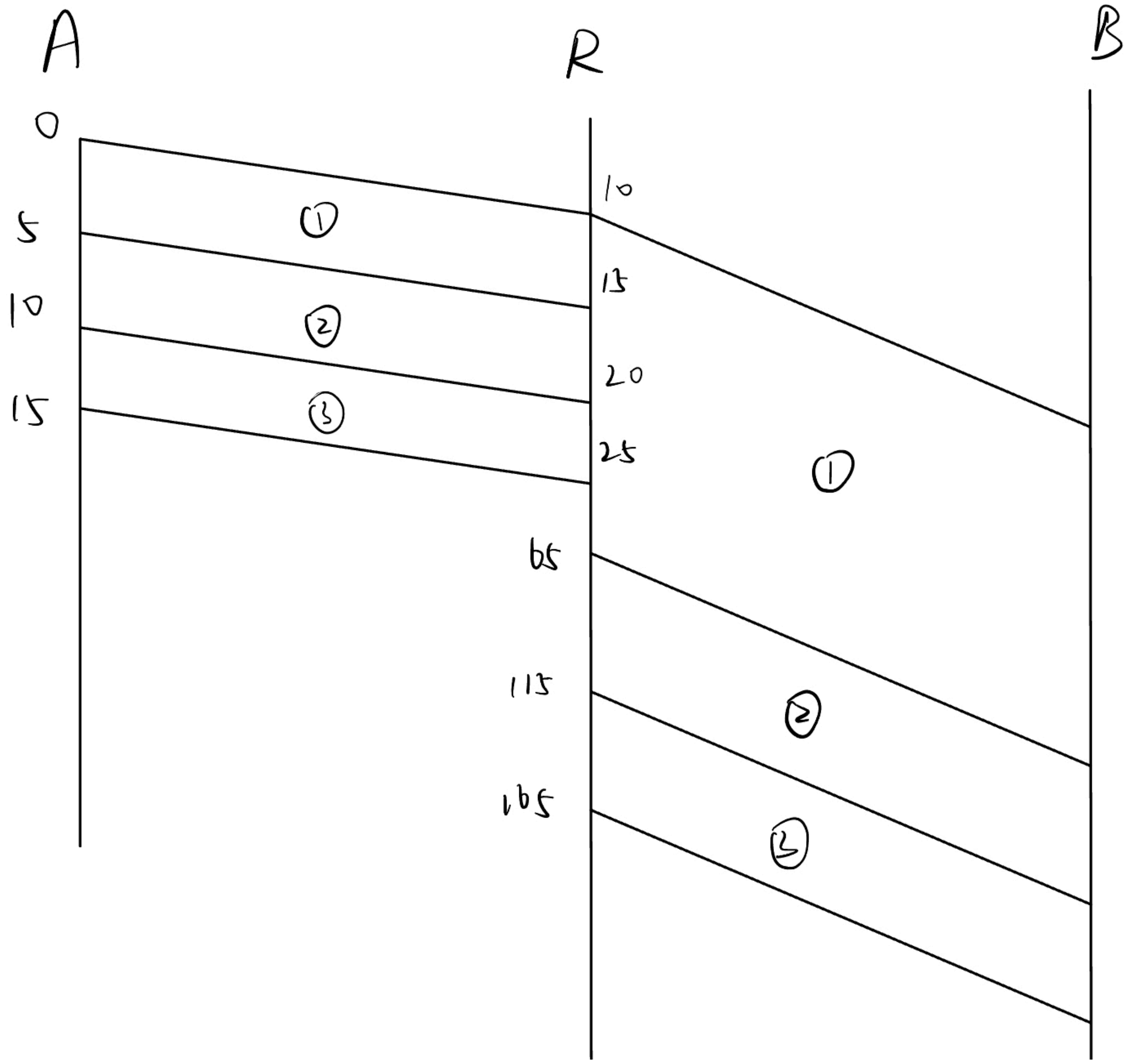
5. 90msec

Transmission Delay(A->R)=$50kbits/10Mbps = 5msed$

Transmission Delay(R->B)=$50kbits/1Mbps = 50msed$

As is shown in the graph below, if the time packet 1 starts to be transmitted from A to R is 0, packet 3 arrives R at $25msed$ and starts to be transmitted from R to B at $115msed$.

Thus, the queuing delay of packet 3 at R is $115 - 25 = 90msed$.



6. 1, 0, not transmitted, 1

$A \cdot S = \frac{1}{8} \sum_{i=1}^{m} A_i S_i = 1$

$B \cdot S = \frac{1}{8} \sum_{i=1}^{m} B_i S_i = -1$

$C \cdot S = \frac{1}{8} \sum_{i=1}^{m} C_i S_i = 0$

$D \cdot S = \frac{1}{8} \sum_{i=1}^{m} D_i S_i = 1$

Thus $S = A - B + 0C + D$.

Station A transmitted 1,

station B transmitted 0,

station C did not transmit,

station D transmitted 1.

7. 4

As is discussed in class, the horizontal-vertical parity check code can detect at most 3 erroneous bits and correct at most 1 bit.

Considering detection capability, the code distance must be ≥ 3 + 1 = 4.

Considering correction capability, the code distance must be ≥ 2*1 + 1 = 3.

Thus the Hamming distance is 4.

8. 9, 1001001011110

a)

$n + k \leq 2^k - 1, n = 9$

The minimum value of k is 4, thus 4 check bits are needed.

b)

- Determine the position of data bits and check bits.

13	12	11	10	9	8	7	6	5	4	3	2	1
1	0	0	1	0	P_4	1	0	1	P_3	1	P_2	P_1

- Group data bits and check bits.

	$D_1 : P_1$	$D_2 : P_2$	$D_4 : P_3$	$D_8 : P_4$
$D_3 : 1$	$\surd$	$\surd$		
$D_5 : 1$	$\surd$		$\surd$	
$D_6 : 0$		$\surd$	$\surd$	
$D_7 : 1$	$\surd$	$\surd$	$\surd$	
$D_9 : 0$	$\surd$			$\surd$
$D_{10} : 1$		$\surd$		$\surd$
$D_{11} : 0$	$\surd$	$\surd$		$\surd$
$D_{12} : 0$			$\surd$	$\surd$
$D_{13} : 1$	$\surd$		$\surd$	$\surd$

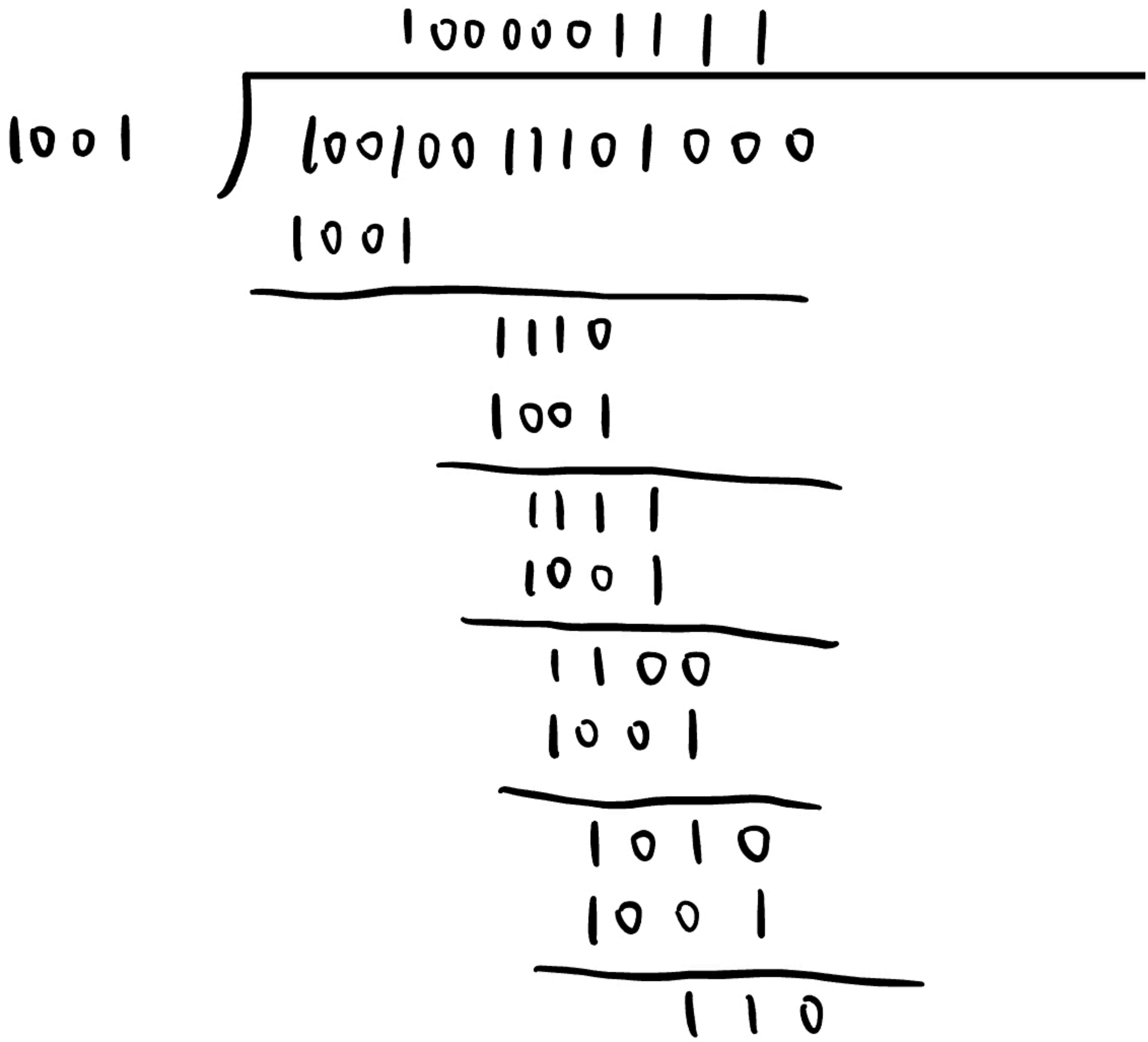
- Calculate check bits
  - $P_1 = D_3 \oplus D_5 \oplus D_7 \oplus D_9 \oplus D_{11} \oplus D_{13} = 0$
  - $P_2 = D_3 \oplus D_6 \oplus D_7 \oplus D_{10} \oplus D_{11} = 1$
  - $P_3 = D_5 \oplus D_6 \oplus D_7 \oplus D_{12} \oplus D_{13} = 1$
  - $P_4 = D_9 \oplus D_{10} \oplus D_{11} \oplus D_{12} \oplus D_{13} = 0$
- The encoded Hamming codeword : 1001001011110

9. 10010011101110, can be detected

a)

As is shown in the graph below, the remainder is 110.

Thus $T(x) = 10010011101110$



b)

As is shown in the graph below, the calculated remainder is not 0, thus the errors are detected.

```
           1111100001
1001 ) 01110011101110
        1001
        ----
         1110
         1001
         ----
          1111
          1001
          ----
           1101
           1001
           ----
            1001
            1001
            ----
                1110
                1001
                ----
                 111
```