EN (2022/2023)

① A) The transport layer receives a service from the IP network layer that does not garantee the delievery of all packets nor their sequence.

② 16 QAM → $M=16$ → $C = \underbrace{2 \cdot B}_{10\ \text{Ksymbol/s}} \cdot \log_2(M) = 10 \cdot \log_2(16) = 40\ \text{Kbit/s}$

R: B)

③
- Length = L
- $P(\text{bit in error}) = B$

→ $P(\text{frame\_error}) = ?$

1) $P(\text{bit\_success}) = (1-B)$

$$P(\text{frame\_error}) = 1 - \overbrace{P(\text{frame\_success})}^{(P(\text{bit\_success}))^{\text{Length}}}$$
$$= \boxed{1 - (1-B)^L}$$

R: D)

④
- ARQ Go-Back-N
- $W=3$ → $w = 2^k - 1$ ⇒ $K = \log_2(4) = 2$ (number of bits to code sequence number)

We can have 4 frames!

Receiver was waiting to receive I_2, but instead received I_3. Happening this, the receiver rejects the frame received, I_3, and asks for the frame he wants to receive REJ2.

R: A)

5. A)

6. C)

7. D) - Formulário !

8. C)

9.
- 23.45.67.89 → 23.45.01000011.01011001
- 23.45.67.128/25 → 23.45.01000011.10000000 → $n_{hosts} = 2^7 = 128$ hosts
- 23.45.64.0/24 → 23.45.01000000.00000000 → $n_{hosts} = 2^8 = 256$ hosts
- 23.45.67.130 → Default

R: A)

10.
- They assume that web server is using HTTP 1.1 with Keep-Alive enabled. Keep-Alive allows multiple requests to be sent over a single connection, reducing the number of round-trip times.
- With Keep-Alive enabled, the browser sends an initial request for the HTML page. The server then sends back the HTML page along with headers that indicate that the connection will be kept open. This consumes one round-trip time.
- The browser then sends the 5 images, wich are sent over the same open connection. This means that the browser does not need to establish a new connection for each image request, wich reduces the number of round-trip times (RTT). This consumes two more round-trip times, for a total of 3 round-trip times.

R: C)

11.
- Selective Repeat ARQ
- $C = 1\ Mbit/s = (10^6)\ bit/s$
- $T_p = 18\ ms$
- $L = 750\ Bytes = 6000\ bits$
- $K = 3$
- $BER = 0$

→ $R_{MAX} = ?$

$$\boxed{R_{MAX} = S \cdot C}$$

$$W = 2^{K-1} = 2^2 = 4$$

$$1+2\cdot a = 1+2\cdot\frac{T_p}{T_f} = 1+2\cdot\frac{T_p}{L/C} = 1+2\cdot\frac{0{,}018\times(10^6)}{6000} = 7$$

Como $W < 1+2\cdot a$, então

$$S = \frac{W}{1+2\cdot a} = \frac{4}{7} \rightarrow R_{MAX} = S\cdot C = \frac{4}{7}\times 10^6 = (571\times 10^3)\ bit/s = \boxed{571\ Kbit/s}$$

(12) ∘ $L_{bloco} = 75$ KBytes $= (6{,}0 \times 10^5)$ bits
∘ $T = ?$

$$num\_frames = \frac{6{,}0 \times 10^5}{6000} = 100 \text{ frames}$$

$$T_{frame} = \frac{L}{R} = \frac{6000}{10^6} = (6{,}0 \times 10^{-3})\,s = 6{,}0\ ms$$

∘ Como $W = 4$ (isto é, pode mandar 4 frames antes de receber uma mensagem de confirmação por parte do receiver), então:

$$num\_ACK = \frac{100}{4} = 25 \text{ ACK}$$

∘ $T_{bloco} = (num\_frames \times T_f) + (num\_ACK \times T_p)$
$= (100 \times 6{,}0) + (25 \times 18)$
$= \boxed{1050\ ms}$

(13) ∘ $L = 100$ Bytes $= 800$ bits
∘ $BER = 10^{-4}$

∘ Como afirma que podemos ter qualquer valor de bits para a numeração das frames, então: $\uparrow K \Rightarrow \uparrow W \Rightarrow W \geq 1 + 2a$.

∘ Assim:

$$S = 1 - P_e = 1 - FER$$

$1 - \underbrace{(1-BER)^L}$ case where all the bits are correct. or where the frame is received correctly

$= 1 - [1 - (1-BER)^L]$
$= 1 - [1 - (1 - 10^{-4})^{800}] = 0{,}9231$
$\to \boxed{92\%}$

(14) ∘ M/M/1
∘ $\lambda = 120$ pac/s
∘ $\rho = 80\% = 0{,}80$
∘ $E[L] = 1500$ Bytes $= 12000$ bits
$\to T = ?$

$\mu = \frac{C}{L} \Rightarrow C = \mu \cdot L = 150 \times (12\,000)$
$= (1{,}8 \times 10^6)$ bit/s
$= 1{,}8$ Mbit/s

$$\rho = \frac{\lambda}{\mu} \Rightarrow \mu = \frac{120}{0{,}80} = 150 \text{ pac/s}$$

$$T = \frac{1}{\mu - \lambda} = \frac{1}{150 - 120} = 0{,}033\,s = \boxed{33\ ms}$$

(15) ○ $E[L] = 500$ Bytes $= 4000$ bits

$\rightarrow T_s = ?$

Calculado no exercício anterior

$$\mu = \frac{C}{L} = \frac{(1{,}8 \times 10^6)\ \text{bit/s}}{4000\ \text{bits}} = 450\ \text{pac/s}$$

$$T_s = \frac{1}{\mu} = \frac{1}{450} = 0{,}002\ s = \boxed{2\ ms}$$

C/L

(16) ○ $E[L] = 1500$ Bytes $= 12000$ bits

$\rightarrow T_w = ?$

○ As it is refered, the length of the packets is constant, so we are referring to a M/D/1.

$$T_w = \frac{\rho}{2 \cdot \mu \cdot (1-\rho)} = \frac{0{,}80}{2 \cdot 150 \cdot 0{,}20} = 0{,}013\ s = \boxed{13\ ms}$$

(17) ○ SW1) 20.0.0.001 00000/27 $\rightarrow K = 32-27 = 5 \rightarrow$ num_hosts $= 2^K - 2 = 2^5 - 2 = 32 - 2 = 30$ hosts

[20.0.0.32 , 20.0.0.64]

○ SW2) 20.0.0.0000 0000/28 $\rightarrow K = 32-28 = 4 \rightarrow$ num_hosts $= 2^K - 2 = 2^4 - 2 = 14$ hosts

[20.0.0.0 , 20.0.0.16]

○ SW3) $2^K - 2 = 11$ hosts $\Rightarrow K = \log_2(13) \approx 4 \rightarrow$ mask $= 32 - 4 = 28$

$\rightarrow$ num_hosts $= 2^4 - 2 = 16 - 2 = 14$ hosts

20 . 0 . 0 . 16 /28

[20.0.0.16 , 20.0.0.32] $\rightarrow (32-16)-2 = 16-2 = 14$ hosts

Como o SW3 só precisa de 11 hosts, estes podem ser colocados no intervalo em cima.

R: $\boxed{20.0.0.16/28}$

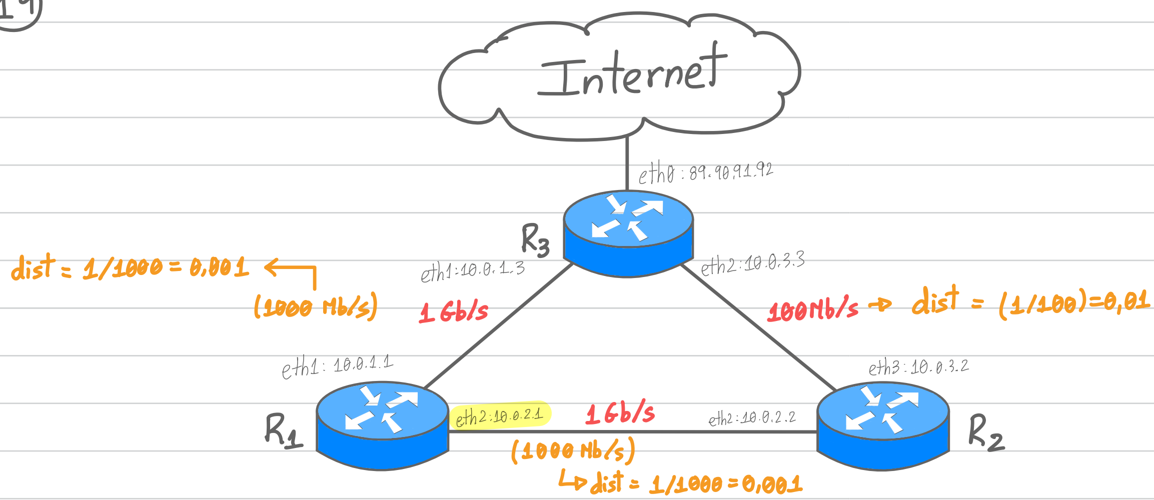
(18) ∘ Firstly, you need to put all bits of the mask to 1.

R2 - eth0 : 20.0.0.00000000 → 20.0.0.00001111
(20.0.0.15)

∘ As the last ethernet address (all 1's) is reserved to the broadcast, we need to make the highest address the one before that (broadcast -1):

$\boxed{20.0.0.14}$

(19)



∘ The default gateway for router R2 would be $\boxed{10.0.2.1}$, pois a aresta que liga os routers R1 e R2 é a que tem menor distância (0,001), quando comparado com a aresta que liga os routers R2 e R3 (0,01).

(20) B)