1.) 10 MB file

1.5 sec $\Rightarrow$ 5 MB

3 sec $\Rightarrow$ 3 MB

$$1.5\text{ sec} + \frac{5 \times 8 \text{ Mbits}}{BW_1} = 3\text{ sec} + \frac{3 \times 8 \text{ Mbits}}{BW_2},$$

$$1.5 + \frac{40}{BW_1} = 3 + \frac{24}{BW_2} \Rightarrow \boxed{\frac{40}{BW_1} - \frac{24}{BW_2} = 1.5}$$

To simplify, we assume that $BW_1 = BW_2 = BW$

$$1.5\,BW = 16 \Rightarrow BW = \frac{16}{1.5} = \underline{10.67 \text{ Mbps}}$$

2.) 10 Gbps shared link
150 Mbps per user
a user Xmits 10% of the time.

1. $Pr[\text{user Xmits}] = \frac{10}{100} = 0.1$

2. $Pr[n\text{Xmit}] = \binom{120}{n}(0.1)^n(.9)^{120-n}$

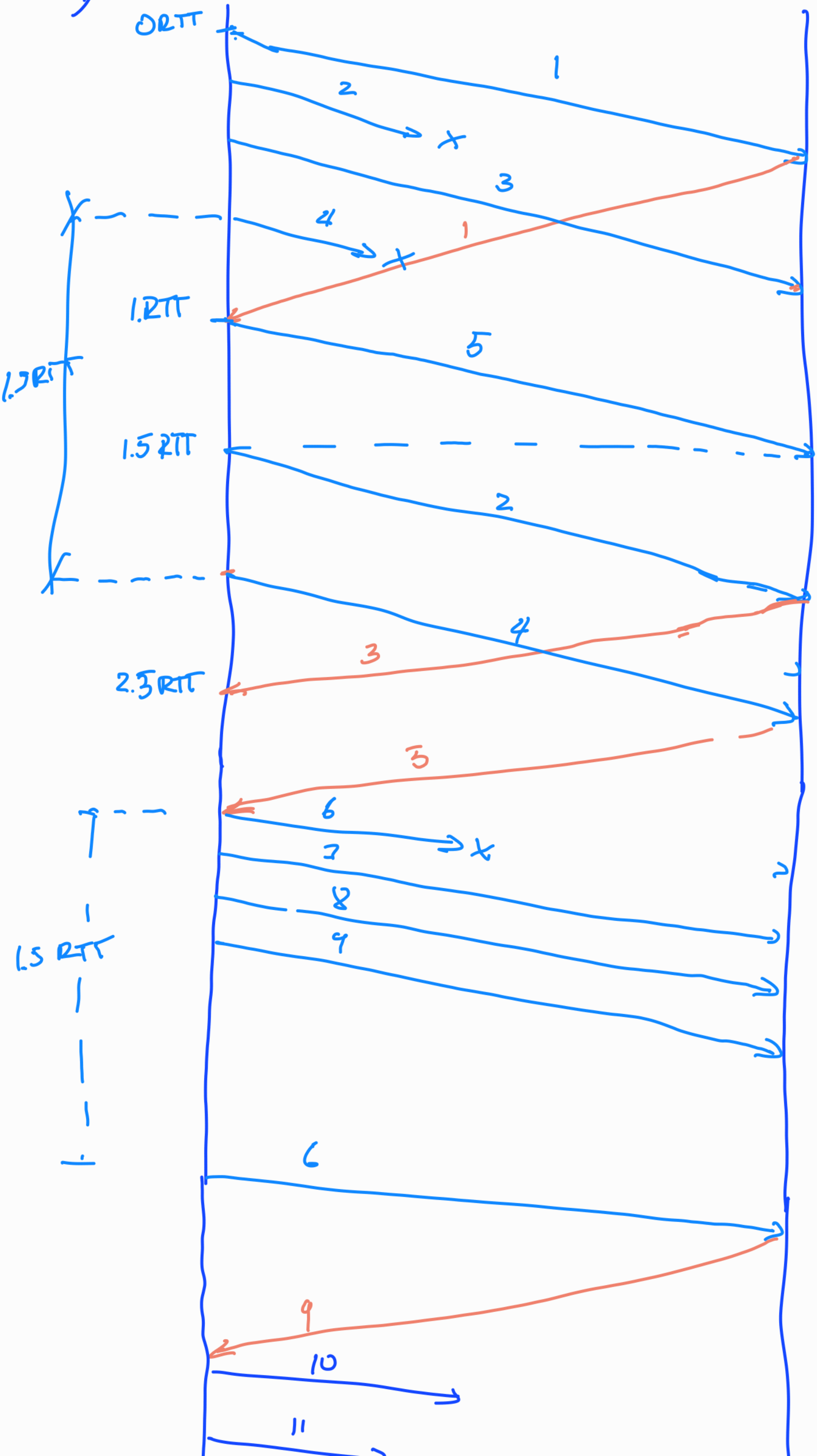
3. $Pr[\text{21 or more Xmit}] = 1 - \sum_{i=0}^{20} Pr[n].$

$$= 1 - \sum_{i=0}^{20}\binom{120}{i}(0.1)^i(.9)^{120-i}$$

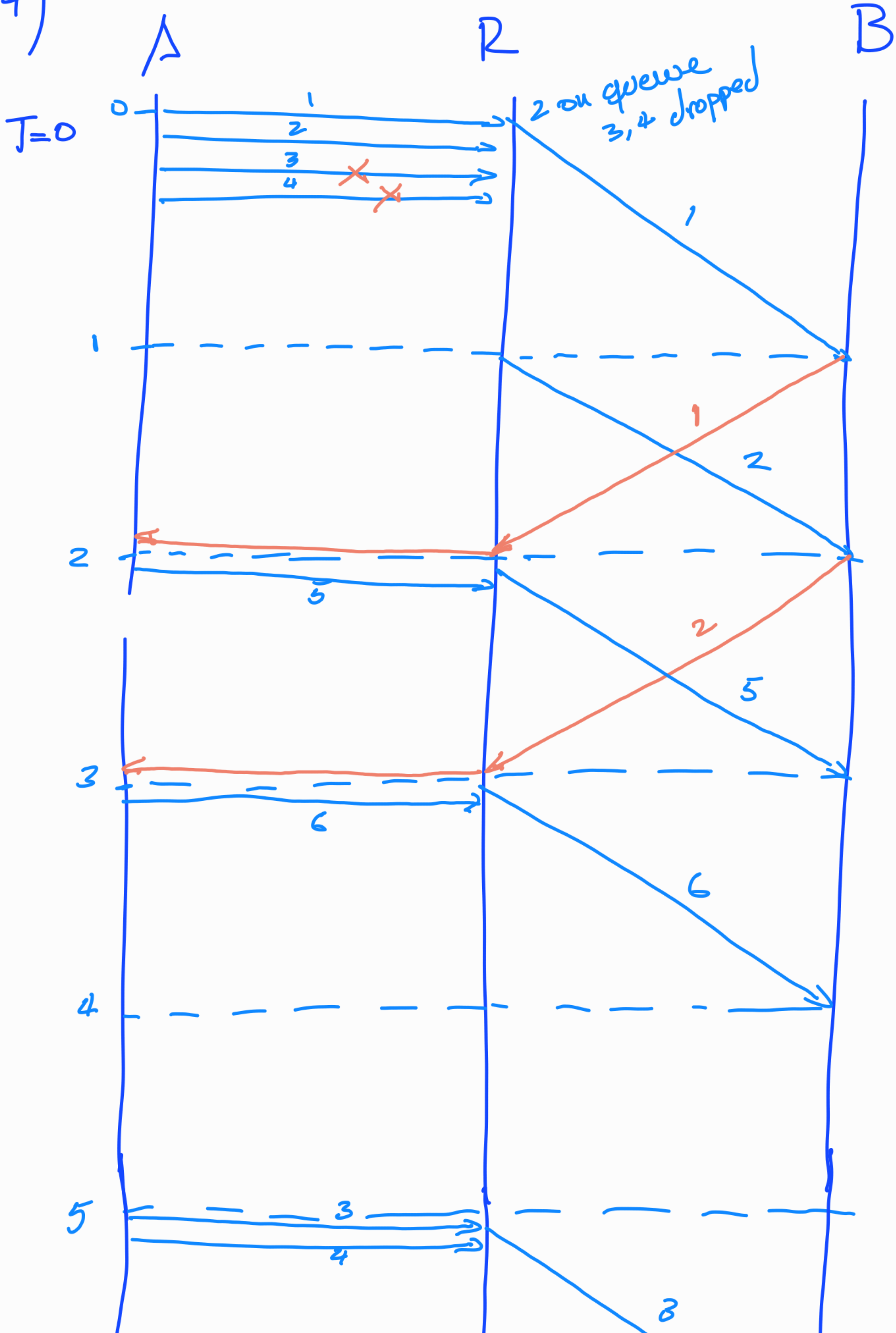
$$= 1 - 0.99206$$

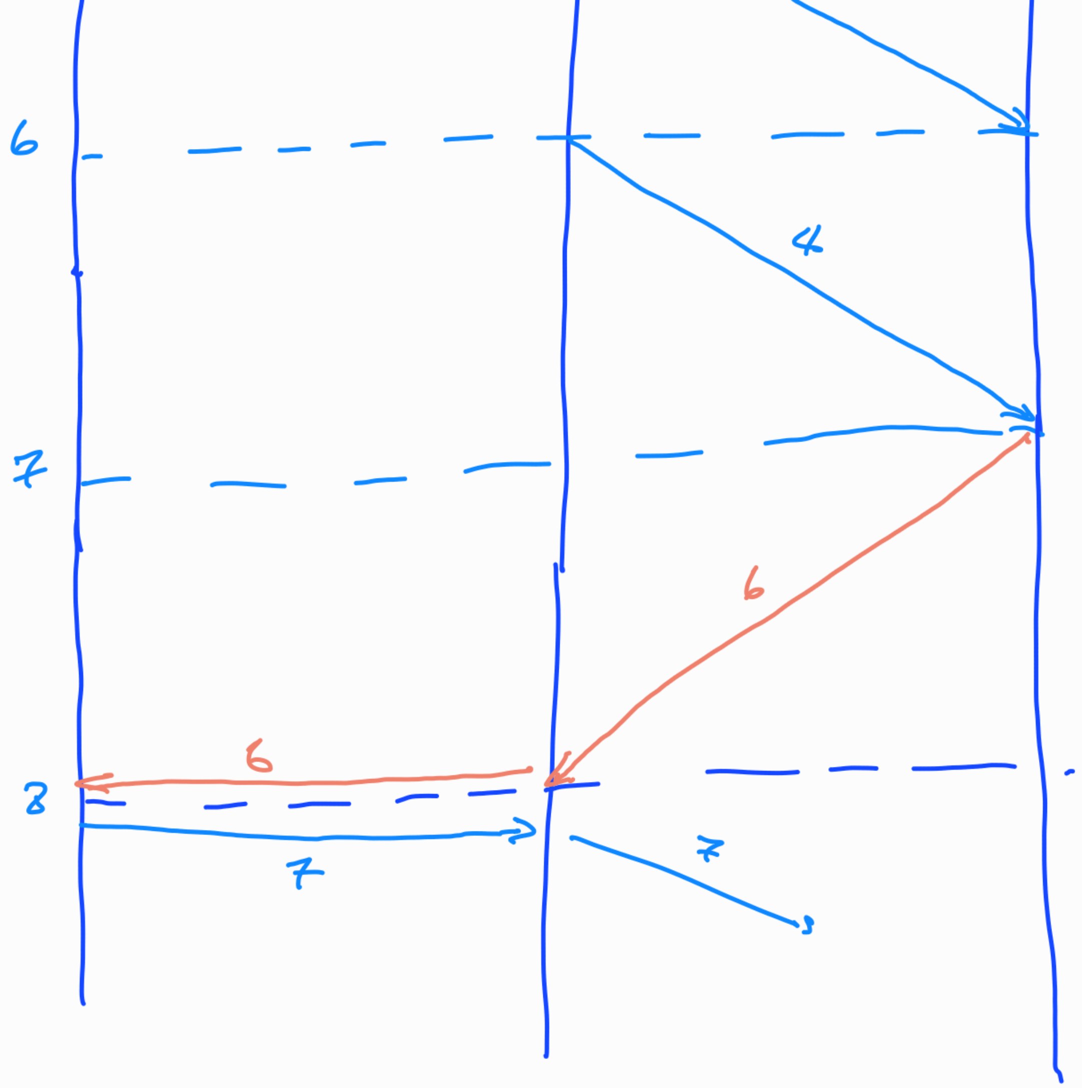
$$= .00794$$

3)



4)

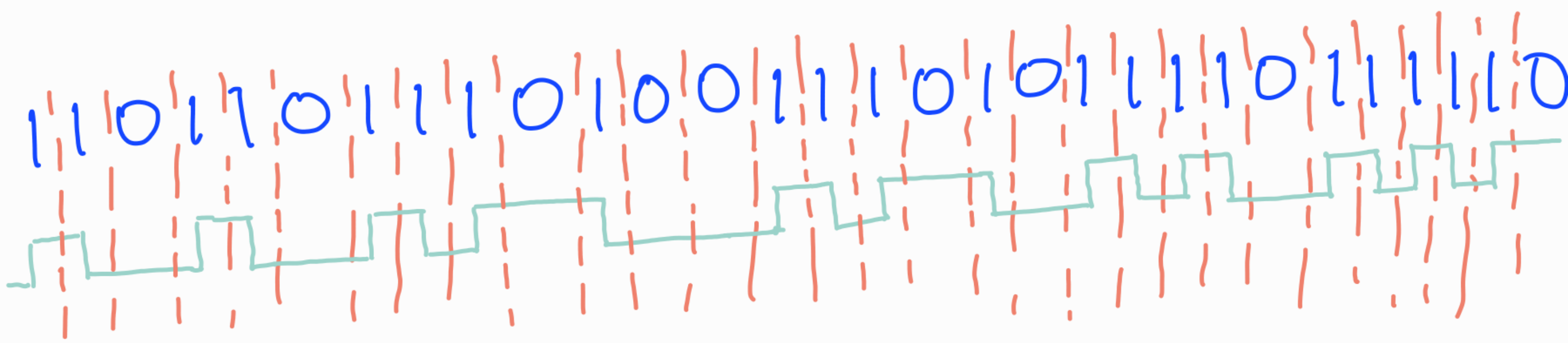




5) 1101 0110 1001 0011 1111 0000

4B/5B

11011 01110 10011 10101 11101 11110



6) • Streaming:

High BW. Live streaming usually runs <10secs behind the actual event so the BW must be enough to fill the buffers at the player. Higher quality ⇒ higher BW.

• Video conference: This one requires both. Since these events are usually interactive, application buffers are small, which requires low latency. The quality of the voice and video depends on the BW.

• File server: Latency isn't important. We need BW.

• Electronic wallet: Given that security is important here, wallets usually

need to do a few transmissions to vali-
date the transaction. This requires low latency so that the transaction is completed in real time.

7)

- Eng: 150 machines.
- Hr: 20 machines
- Sales:

10 sales people. (26 periods - 2 weeks each).

to simplify each period we add 1 salesperson until we have 20, when we start adding 2, then 3, and so forth.

It takes ~ 10 periods to get to 20 salespeople
~ 5 periods to get to 30
~ 3 to get to 40
~ 2 to get to 50
~ 2 to get to 60

~2 to get to 70
~1 to get to 80
~1 to get to 90

~26 periods ⟹ 90 salespeople.

- Big data

$$1.25\left(\frac{100 \times 8 \times 10^{12} \text{ bits}}{10 \times 10^{9} \frac{\text{bits}}{\text{sec}}}\right) = \frac{10^{15}}{10^{10}} \text{ sec}$$

$= 100{,}000$ sec

≈ 28 hours

It takes ~28 hours to transmit 125 TB over a 10 Gbps link.

Given that we need to transmit this data each hour, we need at least 28 computers just to Xmit that data.

Or we could use 12 with 25 Gbps NICs, or 3 with 100 Gbps NICs.

⟹ Accounting for the compute time,

We could use 16 machines with 25G NICs, or 4 with 100G NICs.

In total we need:

Sales and engineering 260 laptops with 1G NICs, 90 desktops w/ 1G.

Big data 16 servers w/ 25G NICs.

Sales desktops: 192.168.1.1 – 192.168.1.90

Sales laptops: 192.168.1.91 – 192.168.1.180

HR: 192.168.1.181 – 192.168.1.200

Eng: 192.168.1.201 – 192.168.2.95

Big data: 192.168.2.96 – 192.168.2.111.

We use the 192.168.1.0/23 network.